# vgosDB Manual

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## Revision History

| | |
|---|---|
| 2021-09-20 | This is based on an earlier version published in 2018. Much of the original content has been kept but the order has been rearranged to make it easier to use this as a reference manual |
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Note to the reader: If you find errors in this manual please let me know. If you have suggestions for how to improve it, please let me know. I will periodically update it as time permits.

This version still has the DRAFT watermark. I intend to remove this ~2021-01-01 after I have incorporated comments.

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# Summary

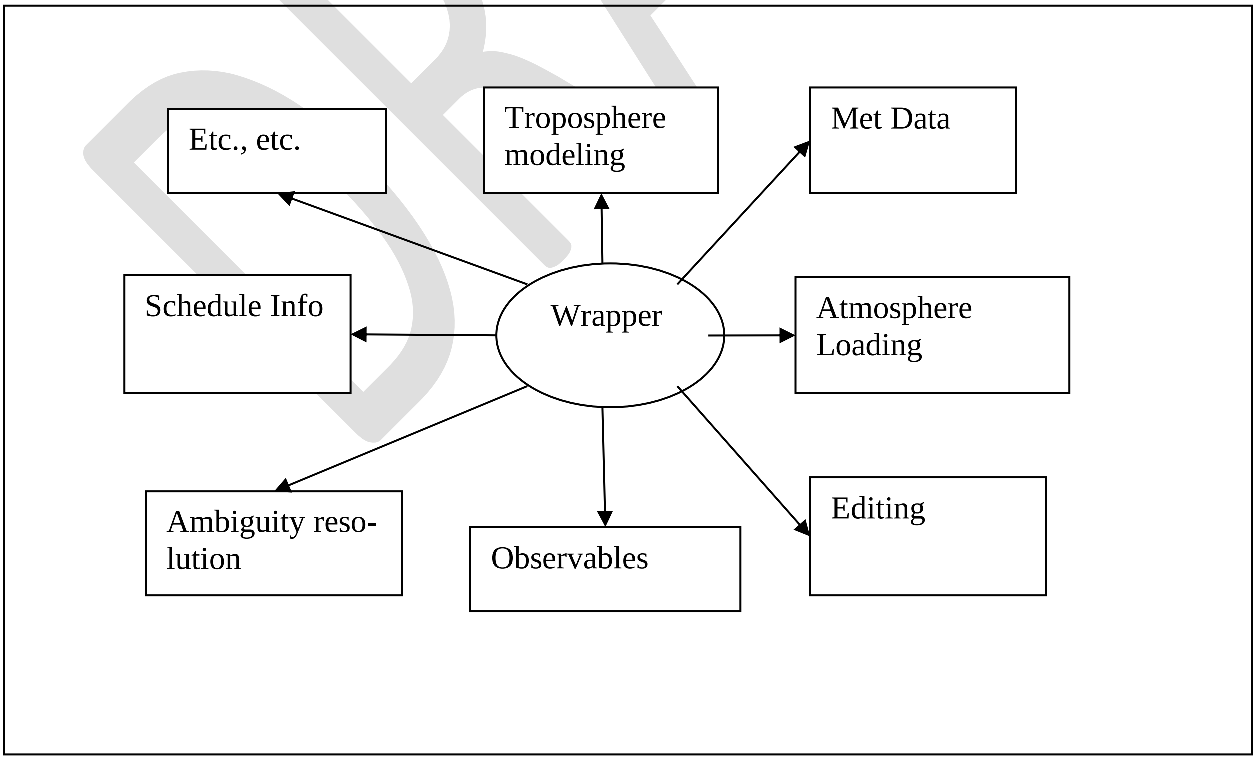
This document presents the vgosDB format to organize and archive VLBI data. VLBI data is organized by session and stored in open and widely used formats. This scheme has several advantages over storing data in Mark3 databases: (SCOPE-F)

1. **Open**. With a few exceptions, all data is stored in a format that can be handled using software in the public domain. This software has interfaces to many computer languages.
2. **Platform independent**. The data is platform independent and can be accessed from a variety of operating systems.
3. **Separable.** Users can get only the data that they need for analysis. It is possible to replace only a subset of the data, for example, the meteorological data.
4. **Extensible and Flexible**. New data types can be easily incorporated as the need arises.
5. **Compact**. The data is organized by scan to reduce redundancy.
6. **Fast**. Data access is fast.

The general idea is that VLBI data is organized by sessions. Within sessions the data is broken down into files based on the kind of data, the scope of the data, how frequently the data is used, and whether the data may change. The data is stored in either ASCII or NetCDF files.

A special ASCII file called a **wrapper** which organizes the data within a session. The wrapper contains pointers to the files which contain the actual data. Wrappers allow us to easily expand the kind of data we use. They also allow us to replace data that is obsolete or incorrect.

**Figure 1. Wrappers Organize the Data**



# Definitions

This section gathers in one place definitions of some terms used in this manual. Many of these terms have fuller definitions later in this manual.

## *Geodetic VLBI*

**Scan**
A set of antennas observing a given source at a common time.

**Observation**
Two VLBI stations observing the same source at the same time. There are usually many observations in a scan. In an N-station scan there (N-1)×N/2 observations.

**Baseline**
The two stations which participate in a scan.

**Site**
A location with a collection of geodetic measurement equipment. A site can have none, one, or more VLBI antennas.

**Station**
A VLBI antenna and associated receiving and recording equipment.

**Station-Scan**
A scan that a particular station participates in.

## *vgosDB*

**vgosDB**
vgosDB is the IVS standard format for storing, transmitting, and archiving VLBI data.

A vgosDB is a collection of NetCDF and ASCII files which contain almost all the information required to process a single VLBI session. Most of the binary files are stored in NetCDF format.

**Wrapper**
A wrapper is an ASCII file that contains pointers to the files in a vgosDB. A wrapper has a name like 12JAN04XA_xxxx.wrp, with ‘wrp’ indicating it is a wrapper, and ‘xxxx’ indicating extra characters used to distinguish different wrappers. There can be many wrappers associated with a given vgosDB. Roughly speaking, each wrapper corresponds to a different Mark3-DB version.

**History**
History files contains information about one or more processing steps for a vgosDB. The history is usually split into multiply files, with each file corresponding to a single step in the processing.

**vgosDB Session**

A vgosDB session is a VLBI session in which a group of stations with compatible frequency sequencies observe together. This is consistent with the current usage of VLBI session. Most vgosDB sessions are either (roughly) 1-hour or 24-hours.

A vgosDB session is stored in a directory and subdirectories.

**vgosDB Variable**

A vgosDB variable is some distinct VLBI related data which is reasonable to group together. Examples include station names, source positions, observed delay, etc. Currently vgosDB variables are stored as NetCDF arrays. For convenience we will often not distinguish between the name of the vgosDB variable and the value. There are roughly 400 vgosDB variables.

- Most Mark3-database Lcodes have a corresponding vgosDB variable.
- Some Mark3 obsolete Mark3 Lcodes do not have a corresponding vgosDB variable.
- Some vgosDB variables have no corresponding LCODE.

**vgosDB File**

A vgosDB file is a file (usually a NetCDF file) that contains one or more vgosDB variables. Most vgosDB files contain a few closely related vgosDB variables. For example, Met.nc contains Temperature, Pressure, Temperature and Humidity at a Station. GroupDelay_bX.nc contains the X-band Group Delay and Sigma.

**Scope**

Scope is a measure of how broadly applicable some vgosDB variable is. The scope can be Session-, Scan-, Observation- or Station-dependent. Data that does not fit any of these variables is 'Mixed'.

## *Mark3 Database*

Prior to the advent of vgosDB, the default format for storing and archiving data was the Mark3 database, or MK3-DB.  Occasionally in the discussion of vgosDB there are references to MK3-DB related terms.

**Mark3 Database**

A Mark3 database is a collection of data related to a single VLBI session that contains data required to analyze a VLBI session. Data in a MK3-DB is stored in Lcodes. A Mark3 database is not a ‘database’ in the modern sense of the word.

**Mark3 Database version.**

Whenever data is added or deleted from an MK3-DB the original version is kept, and a new version is created. Early sessions have more than 40 versions. The more recent sessions typically had 5, and here is how they were created.

1. Version 1 databases are made from the correlator fringe files by the program *dbedit*.
2. Version 2 databases have theoretical and partial values added by the program *calc*.
3. Version 3 databases have cable-cal and met data added by the program *dbcal.*

4. Version 4 database are the results of merging some of the S-band data into the X-band database and doing editing and ambiguity resolution.

**Mark3 Database handler.**
Software designed to read and write data in MK3-DB.
**Mark3 TOC (Table of Contents)**
All Mark3 databases contain a Table of Contents indicating what data (Lcodes) they contain.

**Mark3 History**
All Mark3 databases contain a History summarizing what was done to the database. Ideally this includes what programs were run on the database, the correlator report, what data was added or removed, and anything discovered during the initial analysis of the database.

**Mark3-Lcode**
An Lcode is a collection of related data for a single VLBI session. Examples include Station names, Station positions, group delays, SNRs, etc. Each Lcode has associated with it an 8-character name. An Lcode can be ASCII, Integer*2, Integer*4, Real*4, Real*8. Lcodes can have up to 3 dimensions.

**Lcode-type**
There are three types of Lcodes. Type 1 Lcodes contain data that is valid for the entire session. This includes Station Names, Source Names, Station Positions, etc.

Type 2 Lcodes contain that is valid for a single observation. This includes Group Delay, SNR, Quality Code, etc. There is no essential difference between Type 2 and Type 3 Lcodes. Type 3 Lcodes were introduced because of space limitations on the hardware designed to run the MK3-database handler.

Type 3 Lcodes are functionally equivalent to Type2 Lcodes. They were introduced because of operating system limitations. Depending on the session, the same data is sometimes stored as a Type 2 or Type 3 Lcode.

**Superfiles**
Accessing the MK3-database using the database handler is slow. Because of this a binary file which contains a subset of the MK3-data was invented for use in routine processing. This binary file is called a superfile.

# 1 Introduction

This document serves many purposes.

- First and foremost, it describes the vgosDB format. By reading this document you should understand the organization of the vgosDB format. You should be able to access data written in this format. And you should be able to define and write your own types of data.
- This document also contains information of a historical nature.
  - It gives a brief history of the working group.
  - It describes the philosophical underpinnings behind vgosDB
  - It documents a bug in the time-tags of some sessions

## *1.1 vgosDB Overview*

As much as anything, the vgosDB format is a philosophy for organizing and storing data. Here are some of the guiding principles.

1. VLBI data should be written in an open format.
2. You should know where the data came from.
3. Data should be self-describing.
4. Data should be organized by its characteristics.
5. Reducing redundancy is good.
6. Data should be broken up into small enough pieces so that users only need to access that part of the data they want.
7. In most cases, data should never be overwritten.
   a. If you have a better version of the data, for example, a newer geophysical model, you should keep the original data with the original name and create a new version of the data in a separate file. This allows you to reproduce in the future what you have done in the past.
   *b.* An exception to this is if there is an obvious blunder in the very initial stages of the processing. In this case it makes sense to wipe the stage clean and start over. This should *only* be done if there is no danger of someone using the original 'messed-up' data.
8. The number of different files that the data is stored in should be kept reasonably small.
9. The number of data items in a file should be small.
10. Consistency is an important, but not overriding principle.

Sometimes these principles come into conflict and trade-offs had to be made.

To accomplish these goals, VLBI data is organized by Sessions which correspond to the current IVS sessions. All the data for a given VLBI session is stored in a session directory and its subdirectories. Most data are stored in NetCDF files. Some data is stored in ASCII files or other proprietary files such as correlator output files. Most of the data files contain only a few closely related data items. This allows users to access only those parts of the data they are interested in. It also means that, in the case of updates, you only need to update a small subset of the data.

As with all general statements, there are exceptions to the above rule. These will also be covered in this document.

## 1.2 vgosDB Directory structure

In the vgosDB format, each VLBI session is stored in a separate directory named for the session, for example 10JAN04XA. The session directory has a set of subdirectories where data which share some characteristics are stored. A typical directory structure looks like the following:

| | | | |
|---|---|---|---|
| /vgosDB | | | |
| | 1979/ | | |
| | …./ | | |
| | 2010/ | | |
| | | …/ | |
| | | 10JAN04XU/ | |
| | | | KOKEE |
| | | | WETTZELL |
| | | | Apriori |
| | | | Observables |
| | | | ObsEdit |
| | | | … |
| | | | Scan |
| | | …. | |
| | 2011/ | | |

The Observables directory contains all Observables produced by the correlator. KOKEE contains all data related to KOKEE. ObsEdit contains data editing criteria. Scan contains scan related data, and so on.

This directory and all the subdirectories *are* the vgosDB for this session. There is a section which describe the directory structure in full. To archive and share this information the entire directory structure is tarred-and-gzipped to produce a file like 10JAN04XU.tgz. These tgz files are available on the IVS data centers.

The vgosDB directory structure is described more fully in its own section of this manual.

## 1.3 vgosDB Files

In the final stages of routine geodetic VLBI analysis you only deal with a relatively small of data types, such as station position, source position, group-delay and sigma.

There are several hundred different kinds of data associated with a session. Some of these are used at an early stage of data analysis but not used thereafter. For example, the frequencies of the different channels are used to calculate the reference frequency. Other kinds of data are used for debugging purposes or may be used in special cases. The vgosDB format groups similar kinds of data together and stores them in NetCDF files. Currently there are less than 100 different kinds of NetCDF vgosDB files. Most of these NetCDF files contain only a few related data items: GroupDelay_bX.nc contains the observed group delay and sigma; Met.nc for a station contains all the met data a station. For each VLBI session the kinds of data in each file remain the same.

An exception to the general rule that each NetCDF file contain only a few items is the CorrInfo_xxxx.nc file. This contains on the order of 100 different data types related to the session and the correlation of it. The kinds of data in this file depends on the kind of correlator that produced the data.

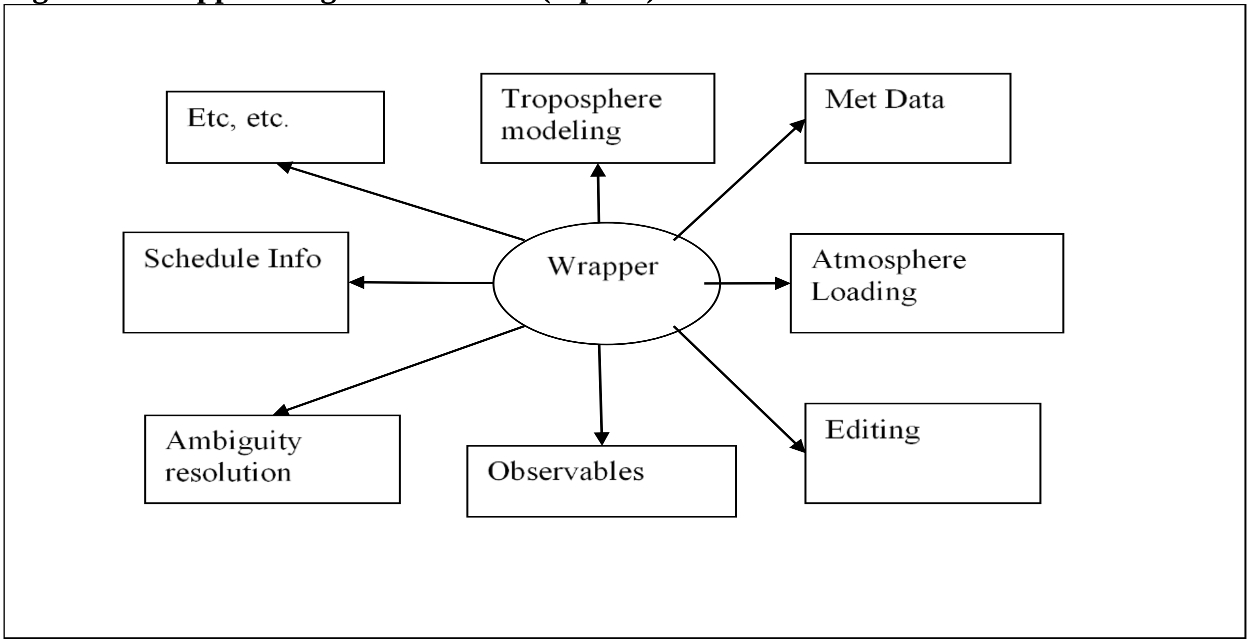
VgosDB files have mnemonic names which indicate (to an English language speaker) what the files contain. The name consists of a sequence of fields separated by the underscore character, with the first character after the underscore indicating the kind of field. All characters before the first underscore are the filename stub and indicate what type of data is stored in the file. A simple example is Cal-Cable_kPCMA.nc. The stub is Cal-Cable, indicating it is a cable-cal file. The "_kPCMA" indicates what kind of cable-cal it contains. All files with the same stub are plug-compatible—that is, the contain the same kind of data, and can be used interchangeable in data analysis.

The vgosDB naming convention as well as the vgosDB files and their contents are described more fully in their own section.

## *1.4 vgosDB Wrappers*

Since the VLBI data is split into many small pieces the data needs to be organized. This is done by a special ASCII file called a wrapper which as an extension 'wrp'.  Repeating the figure from the summary, this can be symbolically expressed below.

**Figure 2. Wrappers Organize the Data (reprise)**



The wrapper contains pointers to the files in a vgosDB session. Since you may have several kinds of functionally equivalent files (e.g., a few cable-cal files for a station), the wrapper tells you which file to use.

For each vgosDB there are many wrappers. These correspond to different stages in the processing of a vgosDB, or processing of the same vgosDB by different individuals. Roughly speaking, wrappers correspond to different versions of the MK3-DB but allow more flexibility.  Anytime one or more NetCDF files is added to the vgosDB a new wrapper is created. Wrapper structure and vocabulary has its own section.

## 1.5 Organization of this Manual

This section describes the organization of the rest of this manual. The approach has been to start with general considerations and then to get into the details. Some things are better understood by example, and we try to give examples of all of the concepts.

Two sections are devoted to how to organize and store VLBI data and provide the philosophical basis of vgosDB. These elaborate on some of the things discussed in this section

We then get into concrete details related to vgosDB. This includes the organization of sessions in directories, and the directory structure within sections.

This is followed by a section on linking different vgosDB data items together. Since vgosDB separates Observation, Scan and Station-dependent data you must have some way of linking these different kinds of data items. This can be done if you know the time-tags and sources. For purposes of speed, it is useful to have a cross-reference tables that rapidly links these items.

There is a section on vgosDB files and vgosDB variables. This does not go into details about all the vgosDB variables or the files they are stored in. Instead, it gives general information these concepts. It also describes the header information common to all vgosDB files.

There are several sections devoted to wrappers. These describe the organization of wrappers, describe wat is in the different sections of a wrapper, and includes a dictionary of wrapper keywords. We also include two example wrappers for an R1 session and an Intensive session.

This is followed by a section on the processing of VLBI data where we describe the processing steps, and which files are produced at each step.

I include two sections of historical interest. One is a history of IVS Working IV on data structures. The other discusses some pre-vgosDB ways of organizing data.

The last three sections of this manual are strictly reference material.

- Dictionary of all the current vgosDB files and which vgosDB variables they contain.
- Dictionary of all vgosDB variables.
- Mapping from Lcodes into vgosDB variables.

## 1.6 Conclusions

I welcome feedback on this manual. If you find errors, please let me know. If you have ideas for improvement, please let me know. My email is John.M.gipson@nasa.gov or John.Gipson@nviinc.com.

# 2 Organizing VLBI Data

The smallest piece of VLBI data that is routinely analyzed is a VLBI session. In a VLBI session a group of stations observe a set of stations for some period of typically on the order of a day or less. In the past most VLBI sessions have been one of the following:

1. A standard VLBI session is 24 hours. There are a few standard sessions which are shorter than this, and a few of the early VLBI sessions are longer than this.
2. There are special Intensive sessions designed to measure UT1. These involve a few stations with long East-West baselines. The typical observing time is 1-hr, although some sessions are longer.
3. Tie sessions. These are special purpose sessions designed to tie to VLBI antennas together. The length varies from a few hours to 24-hours.

With very few exceptions, for example, the CONT campaigns, there are usually gaps between sessions to allow station personnel to change equipment etc. Hence a VLBI session is a natural piece of VLBI data to work with.

In the most optimistic VGOS scenario, there are never gaps in the observing. Some stations may stop observing for a time (for example, for scheduled maintenance), but there will always be a few stations observing. This is analogous to the situation in GPS and SLR, where some instruments are always on. However, both techniques find it useful to divide data into smaller pieces for analysis.

A crucial difference between VLBI and the other space-geodetic techniques is that VLBI is a co-operative venture—stations must observe in a coordinated manner, i.e., two or more stations must observe the same source at the same time, and the observing modes must be the same or similar. If the observing mode is substantially different, then you cannot correlate the data between two stations, and hence there are no observables.

The generalization of a VLBI session to continuous recording is described below.

## *2.1 Observing Session*

VLBI data is organized by Sessions.

1. An IVS-Session consists of a group of observations from a set of stations observing in a coordinated manner using the same or closely related set of frequencies, bandwidths and sampling characteristics called an "observing mode".
    a. Within a given session, the default is that all stations use the same set of frequencies, bandwidths, and sampling.
        i. Some stations may observe only a subset of the common frequencies or use a different bandwidth. The most common cause for this is equipment failure or lack of equipment.
2. For the VLBI data already taken, each IVS-Session is a separate session.
3. Historically, most sessions are either 24 hours (standard sessions), or 1-2 hours (intensives).

    a. A few of the early VLBI sessions are longer than 24 hours. For example, 79AUG03 ran 2 days 14 hours and 56 minutes.
4. As we move to continuous (in time) recording which has no “natural” boundaries, it is useful to artificially partition the data into smaller pieces, such as 1-day or 1-week.
    a. For each session, the considerations of item 1 apply. There is no advantage to mixing data with different observing modes.
5. Sessions are distinguished by the date of the first observation within a session.
    a. For consistency with GPS, we may want to start all sessions at 0-hours UT.
6. Session identification.
    a. By default, sessions are identified by the date of the first observation, followed by optional characters, e.g., 10JAN04XA.
    b. Mark3 databases were identified by the date of the first observation followed by optional characters, e.g., $79AUG03XX, $10JAN04XU. “$” is a special character identifying the file as a database. The penultimate character identifies the band, while the last character identifies the session-type. In data processing, initially there was one database for each band. These are merged into a single database in a later stage of the processing. In the new scheme all the bands are contained in a single vgosDB from the start.

## 2.2 Characterizing VLBI Session Data

VLBI Session data consists of all data related to an observing session. One goal of WG-4 is to make all this data available, and if possible, available online. This would allow re-processing of this data as our knowledge and models improve.

In deciding how to organize the data we need to understand its characteristics.

### 2.2.1 Useful Ways of Characterizing VLBI Session Data

The following list gives several different ways of characterizing VLBI data.

1. Primitiveness: Is it derivable from other quantities or not?
2. Time dependence:
    a. Is the data time independent? (Station name, DOMES number, etc.)
    b. Is the data effectively constant for the session? (e.g., station position)
    c. Is the data time dependent? (Met data, cable cal)
3. Scope: Is it applicable to:
    a. The entire session?
    b. A scan?
    c. A station?
    d. An observation?
4. At what stage in the data processing is the data available? It makes sense to keep together data that is produced at the same time. See the discussion of MK3-DB processing below in Organizing Session Data.
5. When is the data available?
    a. Available before the session starts? (a priori station positions)

    b. Measured during the session? (Met-data)
    c. Determined after the session is over? (Source maps)
6. Observables vs calculable.
    a. An observable: depends on or closely related to a measurement. Examples include measurement time-tag, source involved, baselines, observed group delay, etc.
    b. A calculated value independent of the observables. This includes model values like nutation, as well as some partials. (All partials are independent of the VLBI observable, but some depend on other measured quantities, such as the met data.)
7. Use in analysis:
    a. Required—always used.
    b. Convenient—nice to have
    c. Seldom used
    d. Rarely used
    e. Not used in analysis, but useful for troubleshooting.
8. Static or Dynamic. This is distinct from time dependence.
    a. Static: Once determined these values do not change, ever. Examples include: the epoch of the observation, stations and sources involved in the observation, some calculated model values.
    b. Dynamic: Values may change over time, or you may use alternatives. Examples include:
        i. Loading corrections
        ii. Ionosphere
        iii. Troposphere calibration.
        iv. Editing.
9. Band. The VLBI observable may be characterized by the band.
10. Origin of data:
    a. Internal: Measured by the VLBI equipment or estimated in the analysis. Examples include cable cal, the delays, etc.
    b. External: Available from another source.
    c. Either:  Examples include met data, or ionosphere corrections.
11. Is the data related to other data, either in origin or logically? Some examples:
    a. Usually temperature, pressure and relative humidity come from a single metrological sensor. Because of this it makes sense to group this data together.
    b. Observations and their sigmas are closely related.
    c. There is a wealth of information contained in correlator output files.
12. Required storage format for data: Character, integer, real, etc.

The above suggest that any organizing scheme should have the following characteristics:

1. Separate required data from optional data.
2. Separate commonly used data from less commonly used.
3. Separate static data from dynamic data.
4. Separate theoretical and model values from observables.
5. Organize data by time-dependence and scope.
6. Group data together that is produced at similar stages in processing.
7. Group data together that comes from similar data sources.

## 2.3 Organizing Session Data

Here we describe how the above considerations effect how the Session Data is organized.

### 2.3.1 Separating Data by Type

A key feature of data is whether it is an *observable*, *a priori* or *theoretical* value. *Observables* never change. *A priori* values may change with better information, and *theoretical* values may change if the *a priori value* changes or if we have better models. Because of this it makes sense to separate these different data types.

Theoretical data can be further separated depending on whether it is:

1. Partial derivatives of the delay or rate with respect to some parameter, e.g., EOP or station position.
2. Calibrations. That is models applied to the delay and rate to account for various geophysical and model effects such as EOP, tropospheric delay, etc.
3. Something else--e.g., nutation predictions.

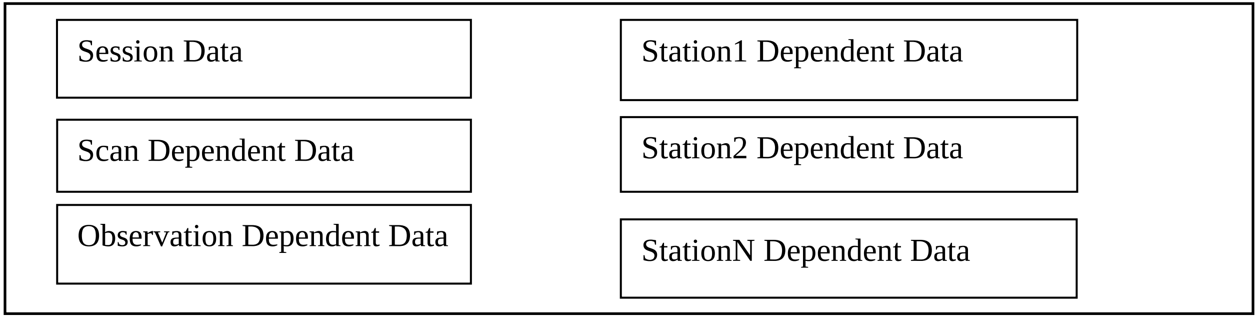
### 2.3.2 Separating Data by Processing Stage

Another criterion for organizing data is when it becomes available. Data produced at different stages in the processing should be stored in different files. This way we will not need to create different versions of th files at different stages in the processing.

### 2.3.3 Organizing Data by Scope

In general, data is organized by scope, that is how broadly applicable the data is. Figure 3, below presents a schematic view of this situation. Data with different Scopes is kept separate. The simplest way of doing so is to store the data with different scopes in different files and directories: Session-dependent data is stored in one directory, Scan-dependent data in another directory, Observation-dependent data is stored in several directories, and there is one directory for each station in a session.

**Figure 3. Data is organized by scope.**



### 2.3.4 Session Dependent Data

Session dependent data is stored in small NetCDF files that contain information applicable to the entire session. The most important session dependent files is Head.nc, which contains the station and sources which participate in the session.

# 3 Storing VLBI Data

In the previous sections, we discussed how to organize the VLBI data. In this section, we discuss how to store the data. They are not entirely independent, because the storage formats may limit what kind of data can be stored, and the internal organization. For example, NetCDF version 3 and below, does not recognize c-style structures.

In the discussion that follows, we assume that all data that is *routinely* used in VLBI analysis will be stored in either ASCII format or as a NetCDF file. Rarely used data, or data used by only a small subset of analysis centers, may be stored in other formats. Examples include:

1. Correlator output files.
2. FITS files
3. Schedule files, log files, etc.

Because these files are used infrequently in the standard analysis, it is not worth the effort to convert them, together with the software used to access them, into another format.

## 3.1 General Principles

We list some general principles for handling and creating files that contain VLBI session data.

1. VLBI data files are never (or very, very seldom) overwritten. Instead, a new version of the file is made.
2. VLBI data is grouped depending on use, scope, and type of data and whether it is static.
3. Static data is kept separately from non-static data.
    a. Static data never needs to be updated.
    b. Non-static data may need to be.
4. Any program that creates a new VLBI data file indicates:
    a. What the input is.
    b. When the file was created.
    c. Who created it.
5. Data files contain meta-data that:
    a. Gives a brief description of the data.
    b. Indicate the units, where appropriate.

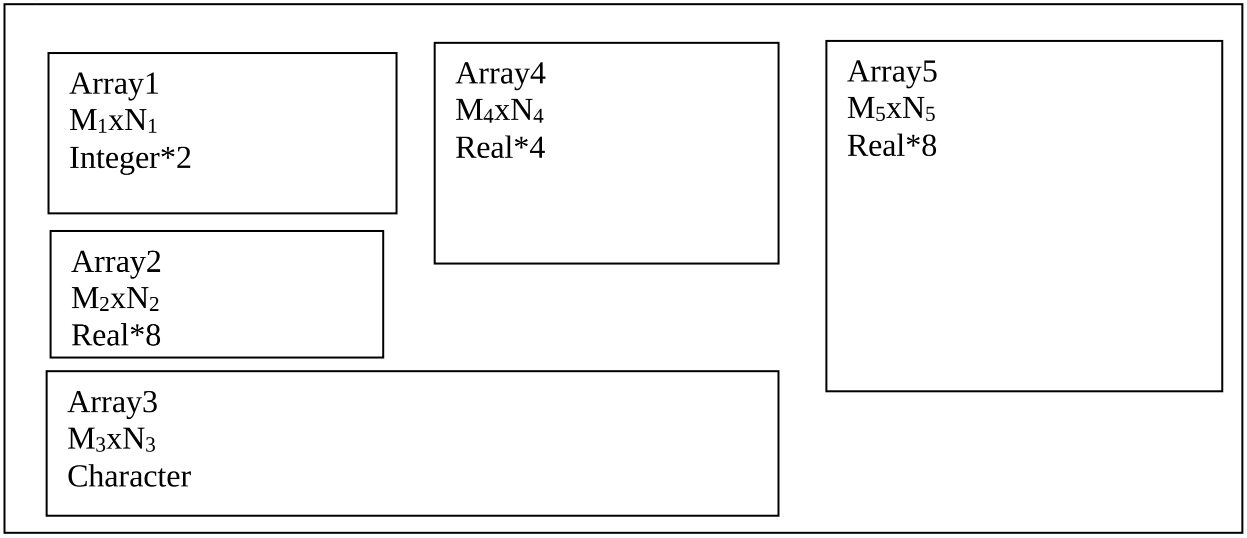
## 3.2 Key Features of NetCDF

NetCDF is a data format widely used in the meteorological community. It is open source and has a large user base, interfaces to many languages, and many utilities. Here are some key features:

1. NetCDF is a platform independent storage format with interfaces to most programming languages.
2. NetCDF is designed to store arrays.
3. The valid NetCDF data types are summarized in **Error! Reference source not found.**.
    a. These include most of the variable types used in C and Fortran.
    b. All the VLBI data can convenient be stored using these data types.
4. Within a given array, all the data must be of the same type.
5. The NetCDF file extension is “.nc”.

6. The utility *ncdump* converts a NetCDF file into a special kind of ASCII file with an extension ".CDL". (CDL= Common data form Description Language.)
7. The utility *ncgen* works in the other direction: it converts an ASCII file written in CDL to a NetCDF file with an ".nc" extension.
8. You can store meta-data about the arrays together with the arrays. The kind of meta-data is arbitrary and is user defined. Some examples include:
    a. Long-name.
    b. Description
    c. Units
    d. History
9. NetCDF allows users to define arbitrary attributes for data. For example, you can specify the coordinate system as XYZ or UEN, or the time-tag as Implicit. This gives you great freedom in storing meta-data about your data.
10. You can store several different arrays in a single NetCDF file.
    a. The arrays do not need to be of the same type.
    b. The number of dimensions can vary from array to array.
    c. The size of each dimension can vary from array to array.

**Figure 4. A NetCDF file is a container to hold arrays.**



NetCDF recognizes only a limited number of data types. All elements in an array must be of the same type. Hence NetCDF does not recognize C-structures or Fortran 90 structures. The types of NetCDF data types available in 2010 when this project began are listed below.

**Table 1 NetCDF data types**

| Type | Fortran Type | NetCDF Fortran Mnemonic | # Bits |
|---|---|---|---|
| Byte | | NF_BYTE | 8 |
| Char | Char | NF_CHAR | 8 |
| Short | Integer*2 | NF_SHORT | 16 |
| Int | Integer*4 | NF_INT | 32 |
| Float | Real*4 | NF_FLOAT | 32 |
| Double | Real*8 | NF_DOUBLE | 64 |

# 4 vgosDB Directories

In this section we discuss the organization of vgosDB format data by directories.

## 4.1 Organization of Session Directories

**Table 2. Global Directory Structure**

| | | |
|---|---|---|
| vgosDB/ | | |
| | 1979/ | |
| | ..../ | |
| | 2010/ | |
| | | 10JAN02XK/ |
| | | 10JAN03XK/ |
| | | 10JAN04XK/ |
| | | 10JAN04XA/ |
| | | 10JAN04XU/ |
| | | .... |
| | 2011/ | |

The vgosDB format organizes VLBI data by year and then by session, with each session having its own directory. The session directory name is of the form *YYMMMDDXX* which is similar to the Mark3 database naming convention. Here YY is the two-digit year, MMM is the three-letter month abbreviation, DD is the two digit day of month and XX is a character designation indicating the particular session. So, for example, the session directory for R1412 which ran on 2010-January-04 is 10JAN04XA. The session directory for the intensive that ran on the same date is 10JAN04XU. A schematic version of this structure is displayed on the right. For reasons of compatibility, the vgosDB directory usually contains the name of the corresponding X-band Mark3 database. However, in contrast to the Mark3 databases that have separate databases for each band, the vgosDB format stores all the session data for all bands together in the same directory.

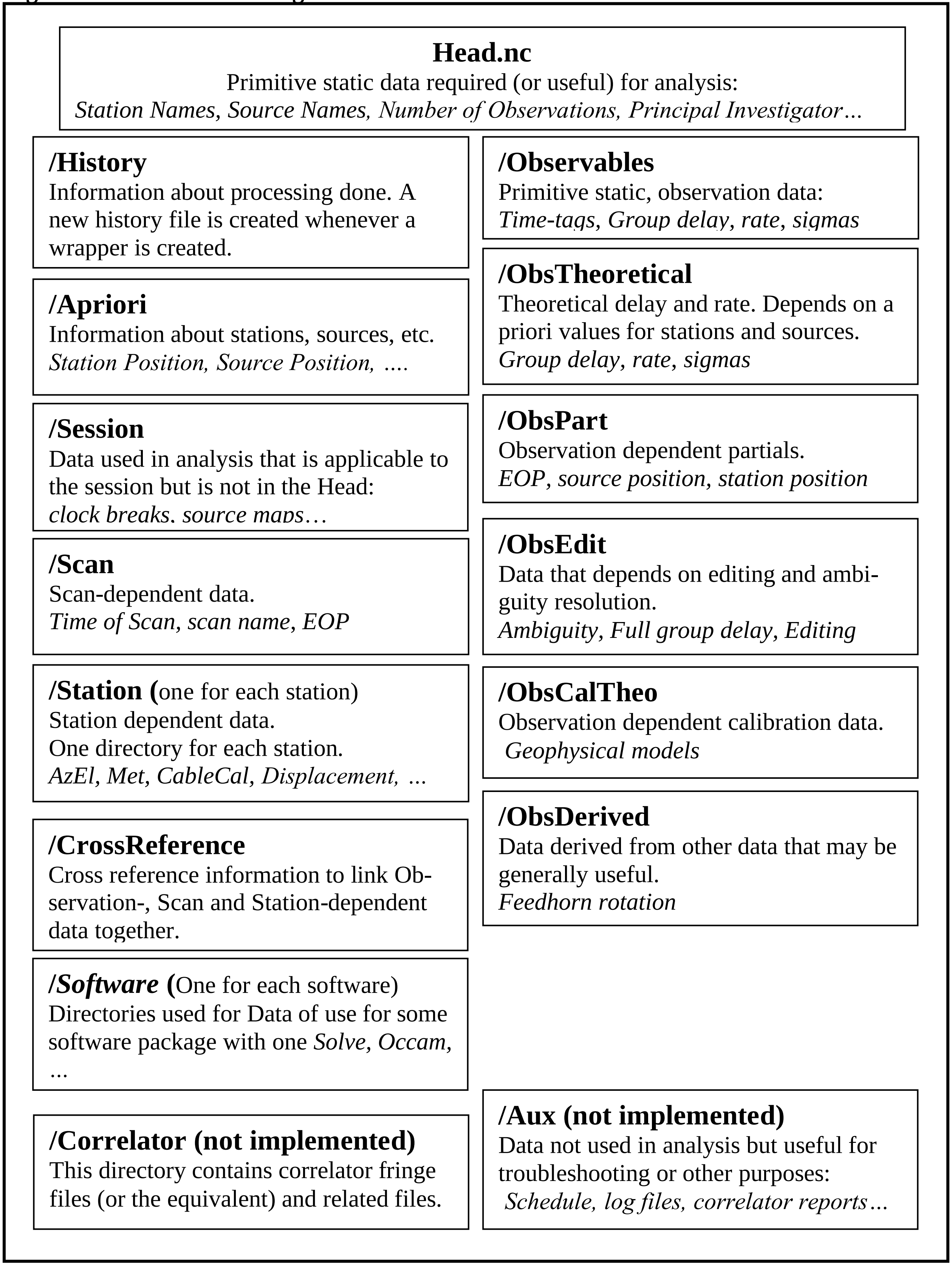
## 4.2 Session Directory Structure

Within each session directory are several sub-directories which contain a mixture of ASCII and NetCDF files. Most of the data proper is stored in NetCDF files with an extension ".nc". A few ASCII files are used to give information about or organize the data.

1. Wrapper files organize the data and end with the extension '.wrp'. There may be may many wrapper files for each session, with each wrapper describing a consistent set of the VLBI data. Different software packages may have their wrapper.
2. History files, which end with the extension '.hist', are usually closely paired with wrapper files. These files give information about the processing of the VLBI data. Additional information is also contained within the files themselves.

Figure 1 on the following page gives an overview of a recommended way to organize the data within a session. All the boxes except for Head consist of directories. There are directories called Session, Aux, Observables, etc. There are two exceptions to this.  Two exceptions to this rule are the boxes labeled Station and Software. There is one Station directory for each Station, for example, KOKEE, TSUKUBA, WESTFORD, etc. These directories contain station specific data. There is also one Software directory for each VLBI analysis software package, for example, Solve, VieVS, etc.

**Figure 5. Recommended Organization of Session Data**



**Head.nc**
Primitive static data required (or useful) for analysis:
*Station Names, Source Names, Number of Observations, Principal Investigator…*

**/History**
Information about processing done. A new history file is created whenever a wrapper is created.

**/Apriori**
Information about stations, sources, etc.
*Station Position, Source Position, ….*

**/Session**
Data used in analysis that is applicable to the session but is not in the Head:
*clock breaks, source maps…*

**/Scan**
Scan-dependent data.
*Time of Scan, scan name, EOP*

**/Station (**one for each station)
Station dependent data.
One directory for each station.
*AzEl, Met, CableCal, Displacement, …*

**/CrossReference**
Cross reference information to link Observation-, Scan and Station-dependent data together.

**/*Software* (**One for each software)
Directories used for Data of use for some software package with one *Solve, Occam,* …

**/Correlator (not implemented)**
This directory contains correlator fringe files (or the equivalent) and related files.

**/Observables**
Primitive static, observation data:
*Time-tags, Group delay, rate, sigmas*

**/ObsTheoretical**
Theoretical delay and rate. Depends on a priori values for stations and sources.
*Group delay, rate, sigmas*

**/ObsPart**
Observation dependent partials.
*EOP, source position, station position*

**/ObsEdit**
Data that depends on editing and ambiguity resolution.
*Ambiguity, Full group delay, Editing*

**/ObsCalTheo**
Observation dependent calibration data.
*Geophysical models*

**/ObsDerived**
Data derived from other data that may be generally useful.
*Feedhorn rotation*

**/Aux (not implemented)**
Data not used in analysis but useful for troubleshooting or other purposes:
*Schedule, log files, correlator reports…*

### 4.2.1 Head.nc

The file Head.nc contains static information that is applicable to the session. All the items are known after processing by the correlator and will not change in subsequent analysis. Most of the data in the Head is available prior to making any observations and is available in the schedule file. Although in principle it might be possible to generate the Head.nc prior to observing, there are some arguments for not doing so. For example, if a station doesn't observe because of equipment problems, there is no need to include it.

We specifically exclude data that is either:

1. Easily calculable.
2. Not static, for example, EOP.
3. That needs to be measured.
4. That can change with better information, such as Station a priori position.

The rationale for the first exclusion is that if it is easily calculable, there is no reason to store it, or at least not to give it priority. The rationale for items 2-4 is that we want the Head to be static-that is, not change in further stages of the analysis.

Most of the data in Head.nc comes from Mark3-DB type-1 Lcodes. It also includes additional data not in the type 1-Lcodes.

***Since this data is required for analysis and is not expected to change, it makes sense to gather all of this into one file.***

### 4.2.2 History

This directory contains ASCII files that contain the results of processing the data. Usually there is one history entry every time a new wrapper is created.

### 4.2.3 Session

This directory contains information that is applicable to a given session. Examples include:

1. Clock-break information.
2. Source-maps.

### 4.2.4 Scan

This directory contains scan-dependent data. This data is applicable to all observations within a given scan.

The scan directory contains a file TimeUTC.nc that contains the epochs for all scan dependent data. Other scan dependent data items include:

1. Scan sources.
2. UT1 and polar motion.
3. Ephemeris information.

***It is useful to split Scan Data into different files depending on the data they contain. Files can be updated independently, and users can choose which kinds of data they want.***

### 4.2.5 Station

There is one station directory for each station, and the name of the directory is identical the IVS name of the station with the exception that spaces are replaced by underscores. Hence “NRAO 85” becomes NRAO_85. All station names are capitalized, e.g., KOKEE, not Kokee.

Each station directory contains a file TimeUTC.nc which contains the epochs for all station dependent data. These are the epochs that the stations participate in.

There are roughly 50 station dependent vgosDB variables. These are grouped in files each of which contains a few data items. Here are some examples:

1. Met.nc contains local meteorological data. This can be either from a sensor or an external source.
2. Cable-cal data.
3. Displacement data. This is measured or modeled displacement of the station given in either XYZ or UEN format.
4. Calibration data that modifies the delay. There are several different kinds:
    a. Internal calibration data, such as cable cal, is measured during a session.
    b. Model results, such as ocean loading, which depend only on the epoch.
    c. External calibration data, such as pressure loading. This is currently not stored in the database, but as an external file.
5. Partials. This is something estimated in the analysis process which is station dependent. Common examples associated with the atmosphere are the mapping function and gradients.

The Mark3 databases include examples of all these Station Dependent Data.

All current analysis packages require the cable cal data taken from the Mark3 databases. Some analysis packages do not use the partials or the models in the database, and instead compute them as needed.

Station dependent data could be stored as observation dependent data, which is what is done in the Mark3 databases. However, by treating it separately you have the potential to greatly reduce redundancy with the cost of an increase in the amount of book-keeping involved.

***In contrast to the data in the Head, it is useful to split Station Data into different files depending on the data they contain. Files can be updated independently, and users can choose which kinds of data they want.***

### 4.2.6 A priori

This directory contains a priori information needed to process the data. This includes station and source position. It also includes a priori clock offset and rate if known.

vgosDB separates this from the information in Head.nc because a priori information occasionally changes, particularly with new stations or sources. In contrast Head.nc is never expected to change.

This information is also used in calculating the theoretical delay and rate.

### 4.2.7 CrossReference

This directory contains cross-reference tables used to quickly link observations with the appropriate Scan-dependent and Observation-dependent data. A description of the data stored in this directory can be found in the section Linking Observation, Scan & Station Dependent Data

### 4.2.8 Observables

This directory contains items that are directly associated with a given observation and are not expected to change.

This directory contains a file TimeUTC.nc that contains the epochs for all observation dependent data including data stored in other directories.

Examples of observation dependent data include:

1. Source
2. Baseline
3. Group Delay and sigma.
4. Observing bands and frequencies
5. Accumulation period for the correlator.

The Mark3 database contains around 200 Lcodes that are "Observables".

- Some ‘observables’ are required by all analysis packages. Examples include the epoch of the observation, the source and the stations involved, and the group delay and sigma.
- Other ‘observables’ are only used by some analysis packages, such as Single Band Delay, or only rarely, such as Phase Delay.
- Some ‘observables’ are used only once and then not needed again. Channel frequencies are used to calculate the effective ionosphere frequency but are not required thereafter.
- Most data items are never or very rarely used, but maybe useful for debugging purposes. This includes, for examples, details about the fringing process.

In the case of Mark3 or Mark4 correlators, all the Observables are originally found in the correlator output files or VEX files.

- We separate out the most commonly used data into many smaller files, with each file containing only a few data items. For example, the file GroupDelay contains the measure Group Delay and associated sigma.
- The remaining data items that are not commonly used (but may be useful for debugging purposes) are stored in a single CorrInfo-xxxx file, where Xxxxx labels the kind of correlator. Since different correlators produce different output, the contents of the CorrInfo-Xxxx depends on the correlator. (Different correlators produce different data items.)

### 4.2.9 ObsTheoretical

This directory contains the theoretical delay and rate. It may contain other observation dependent or theoretical or model data as well.

### 4.2.10 ObsPart

This directory contains observation dependent partials. Examples include, but are not limited to: EOP partials, station-position partials, or source position partials. Many analyses packages compute this ‘on the fly’. However, by pre-computing this information it may be possible to speed up analysis. Furthermore, by having the ability to store this information in an external file it is possible to compare the intermediate results of different software packages.

### 4.2.11 ObsCalTheo

This directory holds observation dependent data that is used to calibrate the observations. Examples include loading effects, solid earth tide, etc. Many analyses packages compute this ‘on the fly’. However, by pre-computing this information it may be possible to speed up analysis. Furthermore, by having the ability to store this information in an external file it is possible to compare the intermediate results of different software packages.

### 4.2.12 ObsEdit

This directory holds data that is the result of initial data editing and ambiguity resolution or that directly depends on this.

1. Number of ambiguities and editing criteria are a result of initial processing.
2. The total Group Delay depends on the number of ambiguities.

Since different groups may use different editing criteria, it is useful to keep this information in separate files.

### 4.2.13 ObsDerived

This directory consists of data items that are of general interest, and that are derived from other data items by simple manipulation of other data items. Examples include the effect of the feed horn rotation on the phase delay.

### 4.2.14 Software

These directories consist of data items that are specific to some software package. Examples include information about how to setup the solutions, what calibrations to apply, and what kind of constraints. There is one directory for each analysis package.

## 4.3 TimeTags

Although this was mentioned previously, I want to call this out separately. The directories Observables, Scans, and each station directory contains a file called TimeUTC.nc

1. Observables/TimeUTC.nc contains the time tags for all observation dependent data, regardless of which directory the data is actually in.

2. Scan/TimeUTC.nc contains the time tags for all scan-dependent data, regardless of which directory the scan data is actually in.
3. Similarly, STATIONX/TimeUTC.nc contains the time tags for that station.

The file TimeUTC.nc contains the time tag in two parts: An integer part which contains YMDHM, and a float which contains the seconds part of the time tag.

## *4.4 Other Useful Files which are not part of the vgosDB format.*

There are various files which may be required in early stages of the processing but are currently not part of the vgosDB format. In this section we discuss a few notable examples.

### *4.4.1 Session related files*

There are several files associated with the session. These include:

1. The schedule
2. Schedule notes
3. Station log files
4. Correlator report
5. Analysis reports.

These are currently available via the web, and on the IVS data centers.

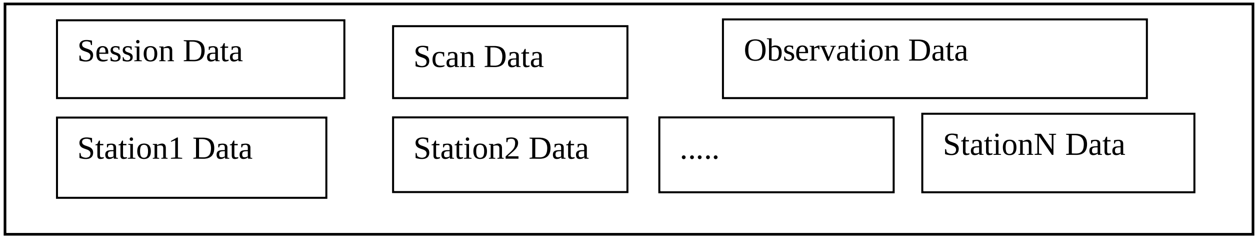
### *4.4.2 Correlator Files*

Beginning in 2021 correlator output files were being archived on CDDIS and some of the other IVS data centers. These files are large, typically a few 100 Gbyte. These are used for making source maps and may be useful for debugging and troubleshooting purposes. Because of their size they are not part of the vgosDB format.

# 5 Scan, Observation & Station Dependent Data

In contrast to the Mark3-database where all data is session-dependent (type-1 Lcodes) or observation dependent data (type-2 or type-3 Lcodes), the data in the vgosDB format can be Session, Scan, Station or Observation dependent. Because of this, you need some way of connecting the data items together. We discuss how to do so in this section.

**Figure 6. Data Organized by Scope**



Session Data

Scan Data

Observation Data

Station1 Data

Station2 Data

.....

StationN Data

We will repeatedly use R1296 as an example. The sked listing of the first few scans is below.

**Table 3. Sked Listing of Beginning of R1296.**

```
Source      Start      DURATIONS
name     yyddd-hhmmss   Ft  Hh  Ho  Ny  Tc  Ts  Wf  Wz
0727-115 07274-170000|          40      40  40        |
1611+343 07274-170000| 108  99      92         108  86|
0059+581 07274-170240|                      40  40  40|
1057-797 07274-170319|         105     105            |
0955+476 07274-170416|              40      40  40  40|
1637+574 07274-170556|                      40  40  40|
1334-127 07274-170614| 200             200            |
2106-413 07274-170723|      99  99                    |
```

## 5.1 Scans

Each line of this corresponds to a single scan. The scans are identified by the epoch and the source. After the source-name and epoch each column corresponds to a different station. The numbers are the duration of the observation.

You can have two scans at the same time if they involve different stations.

1. There are two scans at 17:00:00.
   a. The stations Ho-Tc-Ts observe 0727-115.
   b. The stations Ft-Hh-Ny-Wf-Wz observe 1611+343.

It is impossible to have a station participate in two scans at the same time. (Like all absolute statements there are exceptions to this. If you are expert, you can think of some examples. For the rest of you ignore this detail.)

Scans are specified by the epoch and the observation. Following is a partial listing of the scans in this schedule.

Note that scans 1 and 2 start at the same time but involve different sources.

**Table 4. First Few Scans of R1296**

| Scan # | name | yyddd-hhmmss |
|---|---|---|
| 1 | 0727-115 | 07274-170000 |
| 2 | 1611+343 | 07274-170000 |
| 3 | 0059+581 | 07274-170240 |
| 4 | 1057-797 | 07274-170319 |
| 5 | 0955+476 | 07274-170416 |
| | | |

The Scan directory contains two arrays that uniquely identify the scans: ScanName.nc, and TimeUTC.nc.

## *5.2 Observations*

In VLBI we deal with observations. Our observable is the difference in arrival time of a signal at two VLBI antennas. Each scan may contain many observations. Each observation corresponds to a baseline in a scan. The first two scans have the following baselines:

1. Scan 0727-115 has three baselines: Ho-Tc, Ho-Ts, Tc-Ts.
2. Scan 1611-115 has ten baselines: Ft-Hh, Ft-Ny, Ft-Wf, Ft-Wz, Hh-Ny, Hh-Wf, Hh-Wz, Ny-Wf, Ny-Wz, Wf-Wz.

In general, an N-station scan will contain N×(N-1)/2 observations.

Since we can have several observations at the same time we need to know:

1. The epoch.
2. The source.
3. The baseline, e.g., the two stations in the observation.

It is conventional to order observations in this order.

**Table 5. First Observations of R1296**

| Obs # | Source | yyddd-hhmmss | Base-line | |
|---|---|---|---|---|
| 1 | 0727-115 | 07274-170000 | Ho | Tc |
| 2 | 0727-115 | 07274-170000 | Ho | Ts |
| 3 | 0727-115 | 07274-170000 | Tc | Ts |
| 4 | 1611+343 | 07274-170000 | Ft | Hh |
| 5 | 1611+343 | 07274-170000 | Ft | Ny |
| 6 | 1611+343 | 07274-170000 | Ft | Wf |
| 7 | 1611+343 | 07274-170000 | Ft | Wz |
| 8 | 1611+343 | 07274-170000 | Hh | Ny |
| 9 | 1611+343 | 07274-170000 | Hh | Wf |
| 10 | 1611+343 | 07274-170000 | Hh | Wz |

| | | | | |
|---|---|---|---|---|
| **11** | 1611+343 | 07274-170000 | Ny | Wf |
| **12** | 1611+343 | 07274-170000 | Ny | Wz |
| **13** | 1611+343 | 07274-170000 | Wf | Wz |
| **14** | 0059+581 | 07274-170240 | Ts | Wf |
| **15** | 0059+581 | 07274-170240 | Ts | Wz |
| **16** | 0059+581 | 07274-170240 | Wf | Wz |
| **17** | 1057-797 | 07274-170319 | No | Tc |

The directory Observables contains three files that identify the observation. These are:

1. TimeUTC.nc
2. Source.nc.  This lists the source names in the observation.
3. Baseline.nc. This lists the station names in the observation.

## 5.3 Station Dependent Data

Not all stations participate in all Scans in a session. We call the scans that a particular station participates in Station Scans. Table 6 and Table 7 below display the Station-Scans for Hobart and Wettzell. These are the scans that each station participates in and are labeled in consecutive order. The last column indicates what Session-Scan in the session the Station-Scan corresponds to.

**Table 6. Station Scans for Hobart in R1296**

| Station Scan # | name | yyddd-hhmmss | Session Scan # |
|---|---|---|---|
| **1** | 0727-115 | 07274-170000 | 1 |
| **2** | 1057-797 | 07274-170319 | 4 |
| **3** | 2106-413 | 07274-170723 | 8 |

**Table 7. Station Scans for Wettzell in R1296**

| Station Scan # | name | yyddd-hhmmss | Session Scan # |
|---|---|---|---|
| **1** | 1611+343 | 07274-170000 | 2 |
| **2** | 0059+581 | 07274-170240 | 3 |
| **3** | 0955+476 | 07274-170416 | 5 |
| **4** | 1637+574 | 07274-170556 | 6 |

All Station directories contain the file TimeUTC.nc which contains the time-tags of station dependent data. In the above example, the files:

1. HOBART/TimeUTC.nc
2. WETTZELL/TimeUTC.nc

will contain different values since they participate in different scans.

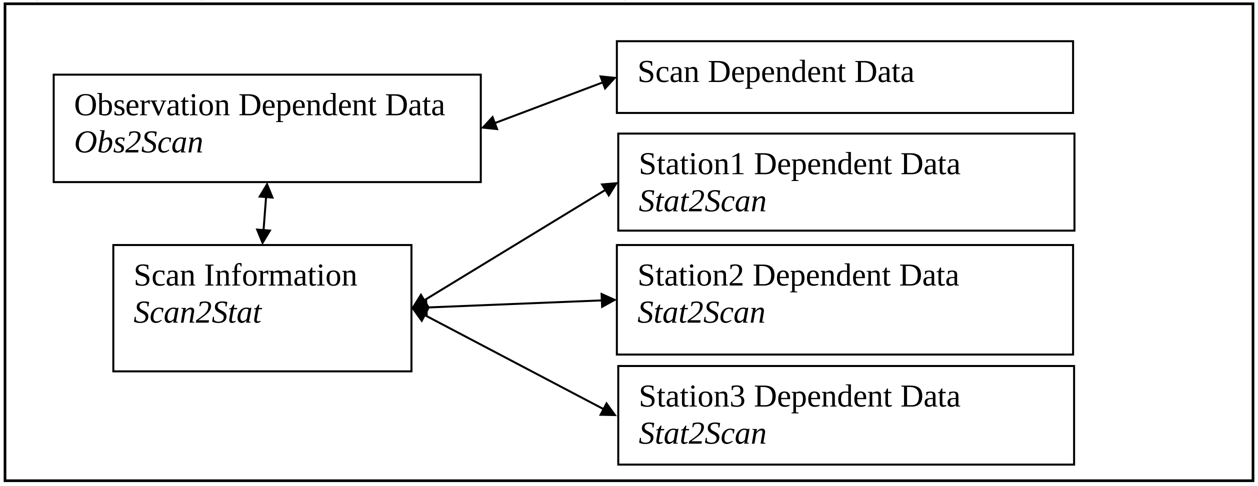
In principle since a station can participate in only one scan at a time, all that is necessary for station dependent data is to give the time of the observation.

Unfortunately, things are not quite that simple. However, because of ‘bug’ in the time-tags of about 100 sessions it appears that a station is participating in two scans at the same time. Details of this bug are discussed in the section Coincident TimeTags Bug. When this situation occurs, the station’s TimeUTC file will have consecutive identical entries corresponding to the two distinct scans. To determine which scan a data item refers to you need to know the source.

## 5.4 Tying the Data Together by Cross Reference Tables

As an alternative to matching up observations with scan-dependent and station-dependent data 'on-the-fly' it is also possible to pre-compute cross-reference tables which embody this information. This allows the process of associating some scan or station dependent data with some set of observations to be done much faster. The cross-reference tables *Obs2Scan*, *Scan2Stat* and *Stat2Scan* serve this purpose. There is use is illustrated schematically in Figure 1 below. We want to emphasize that the use of these table is not a requirement to use the vgosDB format.

**Figure 7. Using auxiliary arrays to tie data together.**



We continue to use R1296 as a concrete example. For convenience we repeat the sked listing.

**Table 8. Sked Listing of Start of R1296 (reprise)**

```
Source      Start      DURATIONS
name     yyddd-hhmmss   Ft  Hh  Ho  Ny  Tc  Ts  Wf  Wz
0727-115 07274-170000|          40      40  40        |
1611+343 07274-170000| 108  99      92         108  86|
0059+581 07274-170240|                      40  40  40|
1057-797 07274-170319|         105     105            |
0955+476 07274-170416|              40      40  40  40|
1637+574 07274-170556|                      40  40  40|
1334-127 07274-170614| 200             200            |
2106-413 07274-170723|      99  99                    |
```

### 5.4.1 Obs2Scan Array

The Obs2Scan array links observations to the scan they belong in. The number of elements in this array is equal to the number of observations. The value of each element in the array is the scan corresponding to the given observation. Looking at Table Table 8 we note that the first scan involves 3 stations and hence has 3 observations. The second scan has 5 stations and therefore has 10 observations. The third scan has 3 stations and 3 observations, etc. The corresponding Obs2Scan array is simply:

**Table 9. Obs2Scan for R1296**

| **Obs** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **..** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Scan** | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 4 | 5 | .. |

### 5.4.2 Obs2Baseline Array

The Obs2Baseline array links observations to the corresponding stations. This is a 2xNumObs dimensional array. Assuming that the observations are sorted by baseline, then the Obs2Baseline array for R1296 looks like the following.

**Table 10. Obs2Baseline for R1296**

| **Obs** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **..** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Stat1** | 3 | 3 | 5 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 4 | 4 | 7 | 6 | 6 | 6 | 3 | 4 | .. |
| **Stat2** | 5 | 6 | 6 | 2 | 4 | 7 | 8 | 4 | 7 | 8 | 7 | 8 | 8 | 7 | 8 | 9 | 5 | 6 | |

### 5.4.3 Scan2Stat Array

Scan-dependent data is arranged in order of the time-tags of the scans, and there is one value for each scan. In contrast, for station dependent data we have data values only for the scans that the stations participate in. The array Scan2Stat helps determine which station-dependent data is appropriate for a particular scan. Table 8 shows the Scan2Stat array. The first three columns are not part of the array itself but provide descriptive information. A non-zero value for a station in a particular row indicates that the station participated in that scan. The non-zero entries for each station increase consecutively.

**Table 11. Scan2Stat for R1296**

| | | | **Scan2Stat** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Scan #** | Source | TimeTag | Ft | Hh | Ho | Ny | Tc | Ts | Wf | Wz |
| **1** | 0727-115 | 07274-170000 | | | 1 | | 1 | 1 | | |
| **2** | 1611+343 | 07274-170000 | 1 | 1 | | 1 | | | 1 | 1 |
| **3** | 0059+581 | 07274-170240 | | | | | | 2 | 2 | 2 |
| **4** | 1057-797 | 07274-170319 | | | 2 | | 2 | | | |
| **5** | 0955+476 | 07274-170416 | | | | 2 | | 3 | 3 | 3 |
| **6** | 1637+574 | 07274-170556 | | | | | | 4 | 4 | 4 |
| **7** | 1334-127 | 07274-170614 | 2 | | | | 3 | | | |
| **8** | 2106-413 | 07274-170723 | | 2 | 3 | | | | | |
| **9** | 0636+680 | 07274-170725 | | | | | | 5 | 5 | |
| **10** | 0537-441 | 07274-171138 | | | 4 | | 4 | | | |
| **11** | 1705+018 | 07274-171237 | | 3 | | 3 | | | 6 | 5 |
| **12** | 0149+218 | 07274-171552 | | | 5 | | | 6 | | 6 |
| **13** | 1144-379 | 07274-171555 | 3 | | | | | | 7 | |

For clarity, we have left out the zero values that indicates that a station is not observing. In this example, *Ho*, *Tc*, and *Ts* participate in the first scan. *Ft*, *Hh*, *Ny*, *Wf* and *Wz* participate in the second scan, etc. The first two scans occur simultaneously, illustrating the need to distinguish scans by more than just their time tag.

### 5.4.4 Stat2Scan Array

The Stat2Scan array helps link station data to the appropriate scan. This array has N-columns corresponding to the N-stations. The number of rows is the maximum number of scans that any station participates in. For a given station, the entries in the columns correspond to the scans that the station participates in. Using R1296 as an example and just listing the first three rows we have:

**Table 12. Stat2Scan for R1296**

| Station-Scan | Ft | Hh | Ho | Ny | Tc | Ts | Wf | Wz |
|---|---|---|---|---|---|---|---|---|
| **1** | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 2 |
| **2** | 7 | 8 | 4 | 5 | 4 | 3 | 3 | 3 |
| **3** | 13 | 11 | 8 | 11 | 7 | 5 | 5 | 5 |
| **4** | … | … | … | … | … | … | … | … |

# 6 vgosDB Variables and Files

In this section we give more detail about the vgosDB specification for files and data.

We refer to a particular data item as a vgosDB *variable*. Many, although not all vgosDB variables correspond to MK3-DB Lcodes.

- These variables can be any data item associated with a VLBI session such as Correlator, Source Positions, Stations, Observables, etc.
- vgosDB variables can be ASCII strings, integers, single precession numbers, double precession numbers, or arrays of such items.

There are approximately 500 vgosDB variables.

- There are some vgosDB variables which are present in *all* vgosDBs. Examples include station names and positions, source names and positions, time-tag data, etc.
- Some vgosDB variables are only present in some sessions. This may because the data is missing—for example, there is no met data at a station, or the processing chain is different, for example, different correlators produce different data.

vgosDB variables are stored in NetCDF files. At its most abstract, a NetCDF can be viewed as container that stores arrays. Since most VLBI data can be naturally viewed as an array, this is suitable way of storing the data.

A complete list of vgosDB variables is given elsewhere.

Most of the vgosDB files contain a few related variables. All the met data for a station is stored together. The delay and its sigma are stored together. This approach contrasts with the Mark3 database or NGS card format where all the data for a single session is stored in a single file. It has the advantage that:

1. Users can access only that part of the data they are interested in.
2. You can update part of the data without disturbing the rest.

The main disadvantages are that:

1. You need to impose an external structure on the data. This is done by wrapper files which are discussed separately.
2. It may not be clear what data is available. This disadvantage is overcome by the TOC file which lists all the data available for a particular session.

There are roughly 100 different vgosDB files in a typical session. A complete list of vgosDB files and what they contain is given elsewhere.

## *6.1 vgosDB Files*

A vgosDB file stores a set of vgosDB variables. Most vgosDB files store only a few closely related vgosDB variables. This allows users to access only those data items that they are interested in.

### 6.1.1 vgosDB File Naming Conventions.

A vgosDB filename consists of a string of ASCII characters (a-z, A-Z, 0-9, -) separated by underscores. ASCII underscore is a reserved character used to separate fields in the filename. The type of field is determined by the first character after the underscore. The length of each field is arbitrary. The first set of characters before the initial underscore indicates what kind of vgosDB file it is and is called the 'Stub'. Files with the same Stub are 'plug compatible'—that is they contain the same vgosDB variables (perhaps with different values.) Although we anticipate that most of the files will be accessed using software, one of our goals in the file naming convention was to be able to make the file-names human readable and understandable. The table below general form of a vgosDB filename:

**Table 13. vgosDB File Naming Convention**

| Field | Designator (Not case sensitive but encourage lower case) | Description |
|---|---|---|
| **Stub** | None | What kind of vgosDB file is this? |
| **Kind** | k, K | Kind of data the file contains. |
| **Institution** | i, I | Institution or individual |
| **Version** | v, V | Version indicator. |
| **Band** | b, B | Band of the observation. Required for band-dependent data. |

Table 14 below presents some example vgosDB filenames. A complete listing of all the Stubs is given in Appendix B.

**Table 14. Example vgosDB filenames**

| Filename | Description |
|---|---|
| **10JAN04XA_v004_kSolve.wrp** | Wrapper file for session 10JAN04XA for use by Solve analysis package. This is version 4 of the wrapper. |
| **Met.nc** | File containing meteorological data. |
| **Cal-Cable.nc** | Cable cal data for some site. |
| **Cal-Cable_v2013Jan03.nc** | Cable cal data for a site. The version is 2013Jan03. |
| **Cal-Bend.nc** | Contribution of general-relativistic bending to the observation. |
| **Dis-OcnLoad.nc** | Displacement caused by ocean loading. |
| **Edit_iGSFC.nc** | Data editing criteria from GSFC. |
| **Edit_iGSFC_V005.nc** | Data editing criteria from GSFC. Version 5. |
| **Edit_iBKG.nc** | Data editing criteria from BKG. |
| **Part-Bend.nc** | File containing partial with respect to 'bending'. |
| **Part-EOP.nc** | Partials with respect to EOP. |
| **Part-HorizonGrad_kNMF.nc** | Horizontal gradient at a site using NMF. |
| **SBDelay_bS.nc** | Single band delay for S-band. |
| **GroupDelay_bX.nc** | Single band delay for X-band. |
| **Freq_bX.nc** | File containing frequency information about the X-band data. |

### 6.1.2 vgosDB Header Information

All NetCDF vgosDB files contain header information that gives details about when the file was made, who made it, where the data came from, etc. Table 15 lists the optional and required header information. All header information is composed of ASCII strings. The header information serves several purposes. It contains information that serves as a redundancy check to make sure that we are applying the correct data. (For example, the Session-id and the Station serves this purpose.) It provides information about where the data came from. Header information can also identify stray or misplaced files. Table 16 shows the header information from the Head.nc file.

**Table 15. vgosDB Header Information**

| Name | Description | Required | Examples |
|---|---|---|---|
| **Stub** | Indicates what kind of file this is and the data it contains. | Yes | Head<br>Part<br>Met |
| **CreateTime** | When was the file created | Yes | 2015/05/27 17:55:59 |
| **CreatedBy** | Who created it? | Yes | NASA/GSFC |
| **Program** | Which program created the information. | Yes | db2vgosDB |
| **DataOrigin** | Where did the data come?<br>If present, then all data has a common origin.<br>If absent different data items come from different places. | No | R1542wz.log<br>Correlator fringe files |
| **TimeTag** | Most time-dependent data uses data contained in the external file TimeUTC.<br>However some data may use time-tags contained within the file. | Yes, if data time dependent | Internal<br>StationScan<br>Scan<br>Observation |
| **TimeTagFile** | Which file contains time-tag data for this data?<br>Only required if the time-tag file differs from the default. | Optional | TimeUTC |
| **Session** | IVS Session name | Optional | XUS79C |
| **Band** | Which band is this information for?<br>Only required for band dependent data. | Depends | X<br>S |
| **Station** | Which station is this data for?<br>Only required for station dependent data. | Depends | KOKEE<br>WETTZELL |
| **Subroutine** | Which subroutine/program created the data. | Optional | |
| **History** | An arbitrary ASCII string containing information about how the data was processed. | Optional | |

**Table 16. Example Header Information**

```
Stub = "Head" ;
CreateTime = "2015/05/27 17:55:59" ;
CreatedBy = "John Gipson NVI, Inc./GSFC" ;
Program = "db2vgosDB        2015May27       John M. Gipson" ;
Subroutine = "Write_Session_File 2015May27 V0.05 JMGipson" ;
DataOrigin = "GSFC database 79AUG03XX version  29" ;
Session = "XUS79C" ;
```

## 6.2 vgosDB Variables

There are roughly 500 Mark3 database Lcodes. Each Lcode consists of some VLBI related data item. Some of the Lcodes, such as DEL OBSV (the group delay) contain data that is used by all analysis packages. Many of the Lcodes contain data that is only used by Solve. Many of the Lcodes are obsolete or no longer needed. And some of the Lcodes are only occasionally needed. Removing the obsolete Lcodes still leaves a few hundred data items that must be contained in the vgosDB format. In this section we discuss the general principles for achieving this.

### 6.2.1 Naming Conventions

A vgosDB variable name can be up to 32 characters long. It must consist of only ASCII upper and lower characters and the numbers 0-9. It cannot include spaces, slashes, periods, dashes, underscores, or other special characters. Character case is not significant, although it is encouraged that the start of a new word begin with a capital letter for readability: GroupDelay, not groupdelay. (This convention is sometimes called 'CamelFont' because of the bumps in the words.)

Names are chosen so that they are mnemonic, at least to English language speakers. For example, the vgosDB variable that contains the measured group delay is called GroupDelay. The uncertainty associated with this variable is GroupDelaySig.

vgosDB variables are unique within the following limits:

1. Station dependent variables use the same name at different stations. The temperature data at both Kokee and Wettzell is called TempC.
2. Band-dependent variables use the same names in each band. For example, the observed group delay at both X- and S-band is called GroupDelay. These are distinguished because they are contained in different files.

In another section we give a list of the most common vgosDB variable names. A complete list is given in Appendix C.

### 6.2.2 Attributes

vgosDB variables have attributes that give additional information about the variables. Some of the attributes are required while others are optional.

**Table 17. vgosDB Variable Attributes**

| Attribute | Description | Type | Required | Examples |
|---|---|---|---|---|
| **Definition** | Brief description of the data item. | CHAR*(*) | Yes | Temp in C at local station<br>Measured group delay |
| **LCODE** | Corresponding Mark3 Lcode name<br>Although not required, strongly recommended if there is a corresponding LCODE | CHAR*8 | Optional | TEMPC<br>DEL OBSV |
| **Band** | What band? | | Only relevant for Band-dependent data. | |
| **Units** | Appropriate units.<br>Units should be SI | CHAR*(*) | Required for observables | Celsius<br>Second<br>Meter |
| **History** | Information about the origin of the data | CHAR*(*) | Optional | |
| **CreateTime** | Date the variable was created | CHAR*22 | No, but encouraged. | 2013/01/26 23:27:28 |
| **CalcVer** | Version of Calc OR other program used to calculate theoretical values. | CHAR*10 | Required for variables calculated by Calc | Calc10.1 |

| | | | | |
|---|---|---|---|---|
| **REPEAT** | Number of times the data repeats. Used to indicate data that is constant over all observations or scans | INTEGER | Optional | 4223 |

As an example, here is a listing of the vgosDB variables contained in the Met.nc.

**Table 18. Attributes of Variables in Met.nc**

```
 double RelHum(NumScans) ;
    RelHum:LCODE = "REL.HUM." ;
    RelHum:definition = "Rel.Hum. at local WX st (50%=.5)" ;
    RelHum:units = "%" ;
   double TempC(NumScans) ;
    TempC:LCODE = "TEMP C " ;
    TempC:definition = "Temp in C at local WX station" ;
    TempC:units = "Celsius" ;
   double AtmPres(NumScans) ;
    AtmPres:LCODE = "ATM PRES" ;
    AtmPres:definition = "Pressure in mb at site" ;
    AtmPres:units = "millibar" ;
```

The REPEAT attribute deserves a little explanation. Some variables may have the same value for all scans or observations. Rather than repeat the same value for all the observations, you can specify that the value repeats, and indicate how many times it does so as illustrated in Table 19

**Table 19. Use of REPEAT attribute.**

```
 double RefFeq(Dim000001) ;
    FreqPhaseReference:LCODE = "REF FREQ" ;
    FreqPhaseReference:REPEAT = 4223 ;
    FreqPhaseReference:definition = "Frequency to which phase is referenced"
;
    FreqPhaseReference:units = "MHz" ;
```

### 6.2.3 *Time Tags*

The default time-tags for vgosDB variables are in UTC. This has the advantage that this is the time-tag used to schedule and correlate the data and is easily understood by humans. The UTC time is stored as an integer array YMDHM with 5 elements per row corresponding to Year, Month, Day, Hour, and a double precision array Seconds.

The time-tags for vgosDB variables can be either implicit or explicit, and internal or external. If the time-tag is explicit then the NetCDF file that contains the data also contains the appropriate time-tag. If the time-tag is implicit (which is the case for most vgosDB variables) the time tag is contained in an external file called TimeUTC. There are three distinct types of TimeUTC files depending on the Scope of the variable.

1. The file Scan/TimeUTC.nc contains the time-tag information for all scan-dependent data.
2. The file Observables/TimeUTC.nc contains the time-tag for all observation-dependent data. This time-tag is applicable for ALL observation dependent variables regardless of which directory they are in.

3. Each station directory also contains a TimeUTC.nc file which contains the time-tags for all scans that the station participates in.

### 6.2.4 Special Treatment of Data with Derivatives

For some vgosDB variables it is useful or required not only to have the variable but also its time derivative (or even its second time derivative). The most common reason for requiring this information is you are using observed Group Rates in your analysis. One possibility would be to define two independent vgosDB variables: one for the variable itself, and a second for the derivative. Instead of doing this, the variable and its time derivative are stored together. For example, the vgosDB variable ElTheo contains both the Elevation and the time derivative of the Elevation. In Fortran this is stored as (NumScan, 2) array, where the second index indicates whether we are dealing with the elevation or its derivatives.

- The name of the index that differentiates whether it is the function, or its derivative is called TimeDim2 or TimeDim3.

Most Calibration or Partial files include the time derivative.

A few vgosDB variables include the 2$^{nd}$ time derivative. An example is the vgosDB variable ROT-CF2JK which contains a 3x3x3 matrix for each scan. This is best viewed as 3 different 3x3 matrices. The first contains the rotation matrix going from a crust-fixed coordinate system to J2000. The second matrix is the derivative of this, and the third matrix is the second derivative. The dimensions of this variable as reported by the NetCDF utility ncdump are: (NumScans, TimeDim3, 3, 3), where TimeDim3=3. Note that the order of dimensions is reversed from the Fortran standard.

# 7 Using Wrappers to Organize VLBI Session Data

In contrast to the current Mark3 databases where all (actually most) of the data required to analyze a data is one file, the new scheme proposes dividing the data up into smaller pieces. This allows updating the individual pieces separately and gives great flexibility in what is used. Because we split the data into smaller pieces, there must be another means of organizing the data. Wrappers solve this problem.

## 7.1 Features of Wrappers

1. A wrapper is a special file which contains
   a. Information about the session
   b. Pointers to files which contain the actual data
   c. It may also contain information about models used in the analysis.
2. A wrapper file is distinguished by the extension ".wrp".
3. The files pointed to by wrappers may reside locally or remotely.
4. A wrapper may contain a pointer to another wrapper file.
5. Wrappers are never over written. Instead, as the results of analysis, or as needs change, a new wrapper is created.
6. For each session the IVS will maintain a wrapper file that contains
   a. Pointers to the data required to analyze the data.
   b. Recommended models used in this analysis.

The IVS is responsible for maintaining the definition of the wrapper file and associated files.

### 7.1.1 Advantages of the wrappers

1. Flexibility.
   a. Different institutions can use different wrappers.
   b. The format is flexible enough that it could be used by all analysis packages.
2. Extensibility.
   c. New data types can easily be incorporated.
3. Research. By modifying the pointers in the wrapper, you can study the effect of using different models.
4. Private wrappers. Individuals can use custom wrappers to study the effect of different models, editing, etc.
5. Easy exchange of information. Breaking the data into smaller pieces and using wrappers to organize the data facilitates the exchange of data. If you are interested in seeing the effect of different editing criteria, all you need to do is get a copy of the editing criteria and modify the wrapper.
6. No obsolete data. The wrapper only needs to point to data that is used. As data becomes obsolete, you no longer need to reference it.
7. Ability to reproduce prior analysis. Since nothing is ever overwritten, it should be possible to reproduce the analysis from 5 or 10 years ago.

## 7.2 Wrapper Format

A session wrapper is an ASCII file that contains pointers to files which contain the actual data. There are three kinds of lines in a wrapper.

1. A comment line is preceded by any of the characters: “!”
2. Keyword Value(s). Examples are: “Default_dir Observables”, or “Begin Observables”. The case of the keyword is unimportant. The case of the arguments may or may not be depending on the context. For example, filenames are case sensitive.
3. Filenames such as Met.nc, GroupDelay_bX.nc.
4. Blank lines are ignored.

Sections of a wrapper are demarcated by

```
BEGIN section_name
…
END section_name
```

## 7.3 Sections of a Wrapper

A wrapper may contain one or more of the following sections:

1. Version
2. History. Who created the wrapper and when.
3. Description. This describes the wrapper.
4. Session. This contains information about the session, and pointers to data about the session.
5. Scans. This contains pointers to scan-dependent data.
6. Stations. This contains pointers to station-dependent data.
7. Obs. This contains pointers to the observation dependent data.

The organization of a wrapper mimics the overall organization of VLBI session data, and there is a natural correspondence between kinds of VLBI data and sections of the wrapper.

The first NetCDF file reference by a wrapper should be Head.nc since this contains information about the session as a whole.

## 7.4 Version

The first line in the wrapper specifies the vgosDB version. This looks like:

```
VERSION 1.002   2017Oct02
```

Here VERSION refers to the vgosDB format version. (In the above example  1.002.)

## 7.5 History

This contains information about who created the wrapper and when, as well as information about the processing of the data. The History section consists of blocks which describe each stage in the processing. There are two equivalent forms for these blocks:

```
Begin Program XXXXX
…
End Program XXXXX
```

Or

```
Begin Process XXXXX
…
End Process XXXXX
```

Each block contains information describing the program/process, who ran it, when it was run, and where you can find a detailed history of what was done. It can also contain information about files used by the process.

vgosDBs from older sessions (prior to ~2017-Jan-01) were converted from MK3-DB and do not have information about all the processing steps. Below is a History block created by the program db2vgosDB that converts MK3-DB to vgosDB.

```
Begin History
!
Begin Program Calc/Solve Processing
Version  Mixed
CreatedBy John M. Gipson
Default_dir History
RunTimeTag 2015/05/07 17:33:51
History  10JAN04XA_kMK3DB_V005.hist
End Program Calc/Solve Processing
!
Begin Program db2vgosDB
Version  2015May03
CreatedBy John M. Gipson
Default_dir History
RunTimeTag 2015/05/07 17:33:51
History  10JAN04XA_kdb2vgosDB_V20150507173351.hist
End Program db2vgosDB
End History
```

Below is the History block for an intensive session. This gives more information about each step in the processing.

```
Begin History
Begin Process Correlator
Version 1
CreatedBy correlator operator
Default_dir History
RunTimeTag 2021/01/04 21:00:39 UTC
History 21JAN04XU_V000_kMk4.hist
End Process Correlator
!
Begin Process SgLib/vgosDbMake
Version 0.6.4/0.4.4
CreatedBy WACO (USNO Correlator), United States Naval Observatory
```

```
Default_dir History
RunTimeTag 2021/01/04 21:04:41 UTC
History 21JAN04XU_V001_kvgosDbMake.hist
End Process SgLib/vgosDbMake
!
Begin Process SgLib/vgosDbCalc
Version 0.7.3/0.4.3
CreatedBy Oper, NVI, Inc. / NASA Goddard Space Flight Center
Default_dir History
RunTimeTag 2021/01/04 22:09:07 UTC
History 21JAN04XU_V002_kvgosDbCalc.hist
InputWrapper 21JAN04XU_V001_iWACO_kall.wrp
End Process SgLib/vgosDbCalc
!
Begin Process SgLib/vgosDbProcLogs
Version 0.7.3/0.5.3
CreatedBy Oper, NVI, Inc. / NASA Goddard Space Flight Center
Default_dir History
RunTimeTag 2021/01/04 22:09:42 UTC
History 21JAN04XU_V003_kvgosDbProcLogs.hist
InputWrapper 21JAN04XU_V002_iGSFC_kall.wrp
End Process SgLib/vgosDbProcLogs
!
Begin Process SgLib/nuSolve
Version 0.7.2/0.7.2
CreatedBy Karen Baver, Goddard Space Flight Center VLBI Analysis
Center
Default_dir History
RunTimeTag 2021/01/04 22:16:05 UTC
History 21JAN04XU_V004_knuSolve.hist
InputWrapper 21JAN04XU_V003_iGSFC_kall.wrp
End Process SgLib/nuSolve
```

## *7.6 Description*

The description section gives an overview of the content of the wrapper. This section is optional but recommended, Within the description the format is free form.

```
Begin Description
Information about this wrapper.
More information.
….
End Description
```

## *7.7 Session*

The Session Section contains pointers to files that have information about the session.

Each line in the Session Section consists of a keyword followed by optional arguments. The first keyword must be `Session` (R1412 below). The first vgosDB file must be Head.nc. This is required because it contains information about the session used elsewhere.

The format of the Session Section is:

```
Begin Session
Session R1412
AltSessionId 0JAN04XA
!
Head.nc
!
Default_dir Apriori
Eccentricity.nc
Antenna.nc
Station.nc
Source.nc
!
Default_dir CrossReference
StationCrossRef.nc
SourceCrossRef.nc
!
Default_dir Session
GroupBLWeights.nc
!
Default_dir Solve
CalibrationSetup.nc
Misc.nc
CalcInfo.nc
ClockSetup.nc
AtmSetup.nc
ERPSetup.nc
IonoSetup.nc
CalcERP.nc
SelectionStatus.nc
BaselineClockSetup.nc
End Session
```

The order of sections after the SESSION section is more or less arbitrary.

## *7.8 Scan Section*

The Scan Section contains information and pointers to files that have information which are scan-dependent. A typical scan section might look like:

```
Begin Scan
!
Default_dir Scan
TimeUTC.nc
```

```
ERPApriori.nc
ScanName.nc
NutationEQX_kIAU2006.nc
NutationEQX_kWahr.nc
NutationNRO_kIAU2006.nc
Ephemeris_kDE405JPL.nc
Rot-CF2J2K.nc
!
Default_dir Solve
ScanTimeMJD.nc
End Scan
```

The first line changes the default directory to $SESSION_DIR/SCAN. The next line points to the TimeUTC file which contains the time of each scan. The next lines point to other information associated with the scan.

## 7.9 Station Section

The Station Section contains pointers to files that have station dependent information. There is one Station Section for each station in the session.

A typical Station Section looks like:

```
Begin Station KOKEE
Default_dir KOKEE
TimeUTC.nc
Cal-Cable.nc
FeedRotation.nc
Met.nc
Part-AxisOffset.nc
AzEl.nc
Cal-StationOceanLoad.nc
Cal-AxisOffset.nc
Cal-SlantPathTropDry_kNMF.nc
Part-ZenithPathTropWet_kNMF.nc
Part-ZenithPathTropDry_kNMF.nc
Cal-SlantPathTropWet_kNMF.nc
Part-HorizonGrad_kNMF.nc
Dis-OceanLoad.nc
End Station KOKEE
```

### 7.9.1 Station Partial Files

Many analysis packages compute partials “on-the-fly”, that is, as needed. Some analysis packages such as Solve compute these values once in the early stages of processing and read them in later when needed.

The Station Partials stub is `PART-XXXX`, where `XXXX` describes the partial(s). Most files contain values for a single partial.
A few contain more than one partial. For example, the file `Part-HorizonGrad` contains both the EW and NS gradient partials.

If the station is:

1. The first station of the baseline, the partial is multiplied by +1.
2. The second station of a baseline, the partial is multiplied by -1.

### *7.9.2 Station Calibration Files*

Station calibration files contain station dependent data calibration data used to correct the observable. The Station Calibrations stub is `CAL-XXXX`, where `XXXX` describes the calibration.

This may be the result of:

1. Theoretical calculations, e.g., ocean loading or general relativity.
2. Measurements, for example, cable cal.
3. Externally derived data, for example, pressure loading, or troposphere corrections.

The default unit for all station calibration files is seconds.

If the station is the:

1. First station of the baseline, the calibration is subtracted from the measured delay.
2. Second station of the baseline, the calibration is added to the measured delay.

### *7.9.3 Station Displacement Files*

The Station Displacement stub is `DIS-XXXX.` Station Displacement files contain information about station displacement during a session. Examples include ocean loading and pressure loading. It is the responsibility of the analysis package to handle displacements correctly.

The default unit is meters. The default coordinate system is geocentric, unless the array has the attribute `Coordinate` set to `UEN`, in which case the displacement is given in local UEN.

## *7.10 Observation Section*

The Observation Section contains pointers to files that contain information that is observation dependent. This includes data that describe the observation, the observables, the results of analysis, pointers to raw data, etc.

Observation dependent files are organized according to several criteria:

1. Observables are grouped by band.
2. More commonly used data is separated from less commonly used data.
3. The results of analysis are separated from the data.

Some of the wrapper keywords such as GroupDelay and Ambig are modified by adding a band identifier. The observation section of a wrapper looks like:

```
Begin Observation
Default_Dir Observables
```

```
TimeUTC.nc
Baseline.nc
Source.nc
ChannelInfo_bS.nc
PhaseCalInfo_bS.nc
CorrInfo-difx_bS.nc
RefFreq_bS.nc
AmbigSize_bS.nc
QualityCode_bS.nc
SBDelay_bS.nc
GroupDelay_bS.nc
GroupRate_bS.nc
Phase_bS.nc
DataFlag_bS.nc
SNR_bS.nc
Correlation_bS.nc

….
End Observation
```

Although the number of “columns” in an observation dependent array may vary, the number of rows is always the same, and is the number of observations.

### *7.10.1 Observation Partial*

Observation partial files contain observation dependent partials. The stub is `PART-XXXX`, where `XXXX` describes the partial. These files contain one or a few closely related partials.

### *7.10.2 Observation Calibration*

Observation calibration files contain observation dependent data that is used to “correct” the observable. The stub is `CAL-XXXX`, where `XXXX` describes the calibration. These calibrations may be the result of:

1. Theoretical calculations, for example, ocean loading or general relativity.
2. Measurements, for example, cable cal.
3. Externally derived data, for example, pressure loading, or troposphere corrections.

The unit for all station calibration files is seconds.

## *7.11 Program Sections*

There are optional program sections which contain analysis program specific data. A typical section for the solve program is:

```
Begin Program Solve
Default_dir Solve
!
Begin Session
CalcInfo.nc
CalibrationSetup.nc
ClockSetup.nc
```

```
AtmSetup.nc
ERPSetup.nc
IonoSetup.nc
CalcERP.nc
SelectionStatus.nc
End Session
!
Begin Scan
ScanTimeMJD.nc
End Scan
!
Begin Observation
IonoBits.nc
FractC.nc
UserSup.nc
End Observation
End Program Solve
```

Note that within the program section are Session, Scan, and Observation sections which contain solve-specific information.

# 8 Wrapper Dictionary

This section gives a detailed specification of the wrapper grammar. This is organized roughly by section with some common

## 8.1 General Keywords and Syntax

### 8.1.1 Comments and blank lines

If the first character of a line is "!" it is interpreted as a comment. Comments can be freely intermixed. Blank lines are ignored.

### 8.1.2 Section Blocks

The vgosDB wrapper is broken into sections or blocks:

```
BEGIN SECTION_NAME
…
END SECTION_NAME
```

Section_Name denotes the section.

### 8.1.3 Default directory and Default_Dir keyword

The default directory is the directory that we read and write files to. Initially the default directory refers to the same directory the wrapper is. The default directory can be changed by the Default_dir command.

| | |
|---|---|
| Example: | `Default_dir Directory_Name` |
| Description: | Change the default directory. |
| Comments: | Valid in all wrapper sections. |

The new default directory depends on the first character of `directory_name`

1. The scope of Default_Dir is only within a given section of the wrapper file.
2. Default_dir is over-ridden by subsequent instances.
3. Directory_name is assumed relative unless it begins with a "/".
4. Specifying the complete path name for a file always overwrites the default directory.

### 8.1.4 File references

File references are with respect to the default directory unless the first character is a "/" in which the filename is an absolute path.

## 8.2 History Keywords

This section describes keywords in the history section.

### *8.2.1 Begin Program/End Program Block*

The History Section is broken into blocks which describe the different stages of the processing.

```
BEGIN PROGRAM PROGRAM_NAME
…
END PROGRAM PROGRAM_NAME
```

Program_name describes the program, and the beginning and ending names must match.

### *8.2.2 Begin Process/End Process Block*

This is an alternative form of the Program Block.

```
BEGIN PROCESS PROCESS_NAME
…
END PROGRAM PROCESS_NAME
```

Process_name describes the process, and the beginning and ending names must match.

### *8.2.3 RunTimeTag*

| | |
|---|---|
| Example: | RunTimeTag 2021/02/05 15:25:06 UTC |
| Description: | Time-tag when the process was run. |
| Comments: | This is used for informational purposes. ***This is required.*** |

### *8.2.4 CreatedBy*

| | |
|---|---|
| Example: | CreatedBy John Gipson |
| Description: | Who ran the process. |
| Comments: | This is used for informational purposes. ***This is required.*** |

### *8.2.5 History*

| | |
|---|---|
| Example: | History 21JAN04XA_V001_kvgosDbMake.hist |
| Description: | Location of the history file which describes what was done. |
| Comments: | This is used for informational purposes. ***This is required.*** |

### *8.2.6 InputWrapper*

| | |
|---|---|
| Example: | InputWrapper 21JAN04XA_V001_iMPI_kall.wrp |
| Description: | Input wrapper used in the process. |
| Comments: | This is used for informational purposes. ***This is required.*** |

### *8.2.7 InputFile/InputFiles*

| | |
|---|---|
| Example: | InputFile solve_apriori/last.erp<br>InputFiles solve_apriori/last.erp calc.cfg |
| Description: | Input (files) used in the process. |
| Comments: | This is not required but is encouraged for debugging purposes. |

## 8.3 Session Keywords

### 8.3.1 SessionName

| | |
|---|---|
| Example: | `Session 2009Jan04` |
| Description: | Set the name of the session. |
| Comments: | If the Session section is present, this keyword is required. The session name is used as a check in all NetCDF files generated specifically for this session.<br>***The SessionName keyword must be the first keyword in this section.*** |

### 8.3.2 Head

| | |
|---|---|
| Example: | `Head head.nc` |
| Description: | Point to file that contains the head information. |
| Comments: | If the Session section is present, this keyword is required. |

# 9 Example Wrapper Files

In this Section we present examples of some recent files.

## 9.1 Wrapper for Intensive

The following is a wrapper for intensive session I21004 produced during the standard processing of this session at GSFC.   Some comment lines have been removed for brevity.

The name of the wrapper is 21JAN04XU_V004_iGSFC_kall.wrp

```
VERSION 1.002   2017Oct02
Begin History
!
Begin Process Correlator
Version 1
CreatedBy correlator operator
Default_dir History
RunTimeTag 2021/01/04 21:00:39 UTC
History 21JAN04XU_V000_kMk4.hist
End Process Correlator
!
Begin Process SgLib/vgosDbMake
Version 0.6.4/0.4.4
CreatedBy WACO (USNO Correlator), United States Naval Observatory
Default_dir History
RunTimeTag 2021/01/04 21:04:41 UTC
History 21JAN04XU_V001_kvgosDbMake.hist
End Process SgLib/vgosDbMake
!
Begin Process SgLib/vgosDbCalc
Version 0.7.3/0.4.3
CreatedBy Oper, NVI, Inc. / NASA Goddard Space Flight Center
Default_dir History
RunTimeTag 2021/01/04 22:09:07 UTC
History 21JAN04XU_V002_kvgosDbCalc.hist
InputWrapper 21JAN04XU_V001_iWACO_kall.wrp
End Process SgLib/vgosDbCalc
!
Begin Process SgLib/vgosDbProcLogs
Version 0.7.3/0.5.3
CreatedBy Oper, NVI, Inc. / NASA Goddard Space Flight Center
Default_dir History
RunTimeTag 2021/01/04 22:09:42 UTC
History 21JAN04XU_V003_kvgosDbProcLogs.hist
InputWrapper 21JAN04XU_V002_iGSFC_kall.wrp
End Process SgLib/vgosDbProcLogs
!
Begin Process SgLib/nuSolve
Version 0.7.2/0.7.2
CreatedBy Karen Baver, Goddard Space Flight Center VLBI Analysis Center
Default_dir History
RunTimeTag 2021/01/04 22:16:05 UTC
```

```
History 21JAN04XU_V004_knuSolve.hist
InputWrapper 21JAN04XU_V003_iGSFC_kall.wrp
End Process SgLib/nuSolve
End History
Begin Session
Session I21004
AltSessionId 21JAN04XU
!
Head.nc
Default_Dir Apriori
Antenna.nc
Station.nc
Source.nc
Eccentricity.nc
!
Default_Dir CrossReference
StationCrossRef.nc
SourceCrossRef.nc
!
Default_Dir Session
GroupBLWeights.nc
LeapSecond.nc
MiscCable.nc
MiscFourFit.nc
!
End Session
!
Begin Station KOKEE
!
Default_Dir KOKEE
TimeUTC.nc
Tsys.nc
Met.nc
AzEl.nc
FeedRotation.nc
Cal-AxisOffset.nc
Cal-Cable.nc
Cal-SlantPathTropDry_kNMF.nc
Cal-SlantPathTropWet_kNMF.nc
Cal-StationOceanLoad.nc
Part-AxisOffset.nc
Part-ZenithPathTropDry_kNMF.nc
Part-ZenithPathTropWet_kNMF.nc
Part-HorizonGrad_kNMF.nc
Dis-OceanLoad.nc
End Station KOKEE
!
Begin Station WETTZELL
!
Default_Dir WETTZELL
TimeUTC.nc
Tsys.nc
Met.nc
AzEl.nc
```

```
FeedRotation.nc
Cal-AxisOffset.nc
Cal-Cable.nc
Cal-SlantPathTropDry_kNMF.nc
Cal-SlantPathTropWet_kNMF.nc
Cal-StationOceanLoad.nc
Part-AxisOffset.nc
Part-ZenithPathTropDry_kNMF.nc
Part-ZenithPathTropWet_kNMF.nc
Part-HorizonGrad_kNMF.nc
Dis-OceanLoad.nc
End Station WETTZELL
!
Begin Scan
!
Default_Dir Scan
TimeUTC.nc
CorrRootFile.nc
ERPApriori.nc
ScanName.nc
NutationEQX_kWahr.nc
NutationEQX_kIAU2006.nc
NutationNRO_kIAU2006.nc
Ephemeris_kDE421JPL.nc
Rot-CF2J2K.nc
!
End Scan
!
Begin Observation
!
Default_Dir Observables
TimeUTC.nc
Baseline.nc
Source.nc
ChannelInfo_bS.nc
PhaseCalInfo_bS.nc
CorrInfo-difx_bS.nc
RefFreq_bS.nc
AmbigSize_bS.nc
QualityCode_bS.nc
SBDelay_bS.nc
GroupDelay_bS.nc
GroupRate_bS.nc
Phase_bS.nc
DataFlag_bS.nc
SNR_bS.nc
Correlation_bS.nc
!
Default_Dir ObsDerived
Cal-SlantPathIonoGroup_bS.nc
EffFreq_bS.nc
EffFreq_kEqWt_bS.nc
!
Default_Dir Observables
```

```
ChannelInfo_bX.nc
PhaseCalInfo_bX.nc
CorrInfo-difx_bX.nc
RefFreq_bX.nc
AmbigSize_bX.nc
QualityCode_bX.nc
SBDelay_bX.nc
GroupDelay_bX.nc
GroupRate_bX.nc
Phase_bX.nc
DataFlag_bX.nc
SNR_bX.nc
Correlation_bX.nc
!
Default_Dir ObsDerived
Cal-SlantPathIonoGroup_bX.nc
EffFreq_bX.nc
EffFreq_kEqWt_bX.nc
!
Default_Dir ObsEdit
Edit.nc
NumGroupAmbig_bS.nc
GroupDelayFull_bS.nc
NumGroupAmbig_bX.nc
GroupDelayFull_bX.nc
!
Default_Dir CrossReference
ObsCrossRef.nc
!
Default_Dir ObsTheoretical
DelayTheoretical.nc
RateTheoretical.nc
Default_Dir ObsCalTheo
Cal-BendSunHigher.nc
Cal-BendSun.nc
Cal-Bend.nc
Cal-EarthTide_kIERS2003.nc
Cal-HiFreqERP_kIERS2003.nc
Cal-OceanLoad.nc
Cal-Parallax.nc
Cal-PoleTideOldRestore.nc
Cal-PoleTide_kIERS2003.nc
Cal-TiltRemover.nc
Cal-Unphase_bS.nc
Cal-FeedCorrection_bS.nc
!
Default_Dir ObsDerived
UVFperAsec_bS.nc
!
Default_Dir ObsCalTheo
Cal-Unphase_bX.nc
Cal-FeedCorrection_bX.nc
!
Default_Dir ObsDerived
```

```
UVFperAsec_bX.nc
!
Default_Dir ObsCalTheo
Cal-Wobble.nc
Cal-OceanLoadOld.nc
Cal-OceanPoleTideLoad.nc
Cal-HiFreqLibration_kIERS2010.nc
Default_Dir ObsPart
Part-Bend.nc
Part-Gamma.nc
Part-ERP.nc
Part-NutationNRO_kIAU2006.nc
Part-Parallax.nc
Part-Poletide_kIERS2006.nc
Part-RaDec.nc
Part-XYZ.nc
End Observation
!
Begin Program Solve
Default_dir Solve
!
Begin Session
CalcInfo.nc
CalibrationSetup.nc
ClockSetup.nc
AtmSetup.nc
ERPSetup.nc
IonoSetup.nc
CalcERP.nc
SelectionStatus.nc
End Session
!
Begin Scan
ScanTimeMJD.nc
End Scan
!
Begin Observation
IonoBits.nc
FractC.nc
UserSup.nc
End Observation
!
End Program Solve
```

## 9.2 l Wrapper for R1980 Session

The following is the wrapper for R1980 produced during the standard processing of this session at GSFC. Some comment lines have been removed for brevity.

The name of the wrapper is 21JAN04XA_V004_iGSFC_kall.wrp

```
VERSION 1.002   2017Oct02
Begin History
```

```
!
Begin Process SgLib/vgosDbMake
Version 0.7.2/0.5.2
CreatedBy oper, MPIFR correlator
Default_dir History
RunTimeTag 2021/02/05 15:25:06 UTC
History 21JAN04XA_V001_kvgosDbMake.hist
End Process SgLib/vgosDbMake
!
Begin Process SgLib/vgosDbCalc
Version 0.7.3/0.4.3
CreatedBy Oper, NVI, Inc. / NASA Goddard Space Flight Center
Default_dir History
RunTimeTag 2021/02/05 15:30:36 UTC
History 21JAN04XA_V002_kvgosDbCalc.hist
InputWrapper 21JAN04XA_V001_iMPI_kall.wrp
End Process SgLib/vgosDbCalc
!
Begin Process SgLib/vgosDbProcLogs
Version 0.7.3/0.5.3
CreatedBy Oper, NVI, Inc. / NASA Goddard Space Flight Center
Default_dir History
RunTimeTag 2021/02/05 15:30:41 UTC
History 21JAN04XA_V003_kvgosDbProcLogs.hist
InputWrapper 21JAN04XA_V002_iGSFC_kall.wrp
End Process SgLib/vgosDbProcLogs
!
Begin Process SgLib/nuSolve
Version 0.7.3/0.7.3
CreatedBy Sergei Bolotin, NVI, Inc. / NASA Goddard Space Flight Center
Default_dir History
RunTimeTag 2021/02/05 16:08:38 UTC
History 21JAN04XA_V004_knuSolve.hist
InputWrapper 21JAN04XA_V003_iGSFC_kall.wrp
End Process SgLib/nuSolve
!
End History
!
Begin Session
Session R1980
AltSessionId 21JAN04XA
!
Head.nc
!
Default_Dir Apriori
Antenna.nc
Station.nc
Source.nc
Eccentricity.nc
!
Default_Dir CrossReference
StationCrossRef.nc
SourceCrossRef.nc
!
```

```
Default_Dir Session
GroupBLWeights.nc
ClockBreak.nc
LeapSecond.nc
MiscCable.nc
MiscFourFit.nc
!
End Session
!
Begin Station HART15M
!
Default_Dir HART15M
TimeUTC.nc
Tsys.nc
Met.nc
AzEl.nc
FeedRotation.nc
Cal-AxisOffset.nc
Cal-SlantPathTropDry_kNMF.nc
Cal-SlantPathTropWet_kNMF.nc
Cal-StationOceanLoad.nc
Part-AxisOffset.nc
Part-ZenithPathTropDry_kNMF.nc
Part-ZenithPathTropWet_kNMF.nc
Part-HorizonGrad_kNMF.nc
Dis-OceanLoad.nc
End Station HART15M
!
Begin Station KOKEE
!
Default_Dir KOKEE
TimeUTC.nc
Tsys.nc
Met.nc
AzEl.nc
FeedRotation.nc
Cal-AxisOffset.nc
Cal-Cable.nc
Cal-SlantPathTropDry_kNMF.nc
Cal-SlantPathTropWet_kNMF.nc
Cal-StationOceanLoad.nc
Part-AxisOffset.nc
Part-ZenithPathTropDry_kNMF.nc
Part-ZenithPathTropWet_kNMF.nc
Part-HorizonGrad_kNMF.nc
Dis-OceanLoad.nc
End Station KOKEE
!
Begin Station MATERA
!
Default_Dir MATERA
TimeUTC.nc
Tsys.nc
Met.nc
```

```
AzEl.nc
FeedRotation.nc
Cal-AxisOffset.nc
Cal-Cable.nc
Cal-SlantPathTropDry_kNMF.nc
Cal-SlantPathTropWet_kNMF.nc
Cal-StationOceanLoad.nc
Part-AxisOffset.nc
Part-ZenithPathTropDry_kNMF.nc
Part-ZenithPathTropWet_kNMF.nc
Part-HorizonGrad_kNMF.nc
Dis-OceanLoad.nc
End Station MATERA
!
Begin Station NOTO
!
Default_Dir NOTO
TimeUTC.nc
Tsys.nc
AzEl.nc
FeedRotation.nc
Cal-AxisOffset.nc
Cal-SlantPathTropDry_kNMF.nc
Cal-SlantPathTropWet_kNMF.nc
Cal-StationOceanLoad.nc
Part-AxisOffset.nc
Part-ZenithPathTropDry_kNMF.nc
Part-ZenithPathTropWet_kNMF.nc
Part-HorizonGrad_kNMF.nc
Dis-OceanLoad.nc
End Station NOTO
!
Begin Station NYALE13S
!
Default_Dir NYALE13S
TimeUTC.nc
Tsys.nc
Met.nc
AzEl.nc
FeedRotation.nc
Cal-AxisOffset.nc
Cal-SlantPathTropDry_kNMF.nc
Cal-SlantPathTropWet_kNMF.nc
Cal-StationOceanLoad.nc
Part-AxisOffset.nc
Part-ZenithPathTropDry_kNMF.nc
Part-ZenithPathTropWet_kNMF.nc
Part-HorizonGrad_kNMF.nc
Dis-OceanLoad.nc
End Station NYALE13S
!
Begin Station SEJONG
!
Default_Dir SEJONG
```

```
TimeUTC.nc
Met.nc
AzEl.nc
FeedRotation.nc
Cal-AxisOffset.nc
Cal-SlantPathTropDry_kNMF.nc
Cal-SlantPathTropWet_kNMF.nc
Cal-StationOceanLoad.nc
Part-AxisOffset.nc
Part-ZenithPathTropDry_kNMF.nc
Part-ZenithPathTropWet_kNMF.nc
Part-HorizonGrad_kNMF.nc
Dis-OceanLoad.nc
End Station SEJONG
!
Begin Station WETTZ13N
!
Default_Dir WETTZ13N
TimeUTC.nc
Tsys.nc
Met.nc
AzEl.nc
FeedRotation.nc
Cal-AxisOffset.nc
Cal-SlantPathTropDry_kNMF.nc
Cal-SlantPathTropWet_kNMF.nc
Cal-StationOceanLoad.nc
Part-AxisOffset.nc
Part-ZenithPathTropDry_kNMF.nc
Part-ZenithPathTropWet_kNMF.nc
Part-HorizonGrad_kNMF.nc
Dis-OceanLoad.nc
End Station WETTZ13N
!
Begin Station WETTZELL
!
Default_Dir WETTZELL
TimeUTC.nc
Tsys.nc
Met.nc
AzEl.nc
FeedRotation.nc
Cal-AxisOffset.nc
Cal-Cable.nc
Cal-SlantPathTropDry_kNMF.nc
Cal-SlantPathTropWet_kNMF.nc
Cal-StationOceanLoad.nc
Part-AxisOffset.nc
Part-ZenithPathTropDry_kNMF.nc
Part-ZenithPathTropWet_kNMF.nc
Part-HorizonGrad_kNMF.nc
Dis-OceanLoad.nc
End Station WETTZELL
!
```

```
Begin Station YARRA12M
!
Default_Dir YARRA12M
TimeUTC.nc
Tsys.nc
Met.nc
AzEl.nc
FeedRotation.nc
Cal-AxisOffset.nc
Cal-SlantPathTropDry_kNMF.nc
Cal-SlantPathTropWet_kNMF.nc
Cal-StationOceanLoad.nc
Part-AxisOffset.nc
Part-ZenithPathTropDry_kNMF.nc
Part-ZenithPathTropWet_kNMF.nc
Part-HorizonGrad_kNMF.nc
Dis-OceanLoad.nc
End Station YARRA12M
!
Begin Scan
!
Default_Dir Scan
TimeUTC.nc
CorrRootFile.nc
ERPApriori.nc
ScanName.nc
NutationEQX_kWahr.nc
NutationEQX_kIAU2006.nc
NutationNRO_kIAU2006.nc
Ephemeris_kDE421JPL.nc
Rot-CF2J2K.nc
!
End Scan
!
Begin Observation
!
Default_Dir Observables
TimeUTC.nc
Baseline.nc
Source.nc
ChannelInfo_bS.nc
PhaseCalInfo_bS.nc
CorrInfo-difx_bS.nc
RefFreq_bS.nc
AmbigSize_bS.nc
QualityCode_bS.nc
SBDelay_bS.nc
GroupDelay_bS.nc
GroupRate_bS.nc
Phase_bS.nc
DataFlag_bS.nc
SNR_bS.nc
Correlation_bS.nc
!
```

```
Default_Dir ObsDerived
Cal-SlantPathIonoGroup_bS.nc
EffFreq_bS.nc
EffFreq_kEqWt_bS.nc
!
Default_Dir Observables
ChannelInfo_bX.nc
PhaseCalInfo_bX.nc
CorrInfo-difx_bX.nc
RefFreq_bX.nc
AmbigSize_bX.nc
QualityCode_bX.nc
SBDelay_bX.nc
GroupDelay_bX.nc
GroupRate_bX.nc
Phase_bX.nc
DataFlag_bX.nc
SNR_bX.nc
Correlation_bX.nc
!
Default_Dir ObsDerived
Cal-SlantPathIonoGroup_bX.nc
EffFreq_bX.nc
EffFreq_kEqWt_bX.nc
!
Default_Dir ObsEdit
Edit.nc
NumGroupAmbig_bS.nc
GroupDelayFull_bS.nc
NumGroupAmbig_bX.nc
GroupDelayFull_bX.nc
!
Default_Dir CrossReference
ObsCrossRef.nc
Default_Dir ObsTheoretical
DelayTheoretical.nc
RateTheoretical.nc
!
Default_Dir ObsCalTheo
Cal-BendSunHigher.nc
Cal-BendSun.nc
Cal-Bend.nc
Cal-EarthTide_kIERS2003.nc
Cal-HiFreqERP_kIERS2003.nc
Cal-OceanLoad.nc
Cal-Parallax.nc
Cal-PoleTideOldRestore.nc
Cal-PoleTide_kIERS2003.nc
Cal-TiltRemover.nc
Cal-Unphase_bS.nc
Cal-FeedCorrection_bS.nc
!
Default_Dir ObsDerived
UVFperAsec_bS.nc
```

```
!
Default_Dir ObsCalTheo
Cal-Unphase_bX.nc
Cal-FeedCorrection_bX.nc
!
Default_Dir ObsDerived
UVFperAsec_bX.nc
!
Default_Dir ObsCalTheo
Cal-Wobble.nc
Cal-OceanLoadOld.nc
Cal-OceanPoleTideLoad.nc
Cal-HiFreqLibration_kIERS2010.nc
!
Default_Dir ObsPart
Part-Bend.nc
Part-Gamma.nc
Part-ERP.nc
Part-NutationNRO_kIAU2006.nc
Part-Parallax.nc
Part-Poletide_kIERS2006.nc
Part-RaDec.nc
Part-XYZ.nc
!
End Observation
!
Begin Program Solve
Default_dir Solve
!
Begin Session
CalcInfo.nc
CalibrationSetup.nc
ClockSetup.nc
AtmSetup.nc
ERPSetup.nc
IonoSetup.nc
CalcERP.nc
BaselineClockSetup.nc
SelectionStatus.nc
End Session
!
Begin Scan
ScanTimeMJD.nc
End Scan
!
Begin Observation
IonoBits.nc
FractC.nc
UserSup.nc
End Observation
!
End Program Solve
!
```

# 10 Processing Steps and Common vgosDB Files

In this section we describe some of the commonly used vgosDB files and variables and when they are introduced in the VLBI analysis and processing. We go through the steps required to produce a vgosDB session which is ready for use in analysis. At each step in the processing new files are added. After the initial creation of the vgosDB most processing steps introduce only a few files. At no stage are existing files deleted or modified. The vgosDB philosophy is that you should never delete a file. Instead, you should create a new version.

**Table 20. Processing Steps**

| Step | What Happens |
|---|---|
| **Required Processing Steps** | |
| **Making Initial vgosDB Session** | Correlator fringe files are read.<br>Head.nc is produced.<br>Observable files are produced.<br>TimeUTC.nc files produced.<br>CorrInfo-XXX file is produced. |
| **Calculation of theoretical delays and rates.** | A priori files produced.<br>Theoretical delay and rates calculated and produced.<br>CalcInfo file produced. |
| **Adding external information from log file** | Cable cal and met data is extracted from log file and put into files Cal-Cable.nc and Met.nc<br>Other information, e.g., Tsys can also be added at this stage. |
| **Calculation of Effective Ionosphere Frequency** | This uses channel and frequency information contained in CorrInfo. |
| **Ambiguity resolution and editing.** | NumAmbig file produced.<br>Group delay calculated and GroupDelayFull file produced.<br>X-band Ionosphere calibration calculated and<br>Cal-SlantPathIonoGroup_bX.nc |
| **Optional Processing Steps** | |
| **Calculation of partials and calibrations** | This can be done at the same time as the calculation of the theoretical delays and rates. |
| **Making cross reference files** | This is not required but is useful for some software packages. The presence of these files is required for *solve.* |

## 10.1 Required Processing Steps and Files

We start with the required processing and proceed to optional processing steps.

### 10.1.1 Making the Initial vgosDB Session

This is the stage of processing in which correlator output files are knit together to form the initial set of vgosDB session files. This is equivalent to the current "Version 1" database which contains observational info and little else. All the other processing steps occur after this.

**Table 21. Files Made During Initial Processing**

| File | Description/Comments |
|---|---|
| **Head.nc** | Information about the session that is not expected to change. |
| ***The following files are in the Scan Directory.*** | |
| **TimeUTC.nc** | Time-tags for scan dependent information. |
| **ScanName.nc** | Names of scan. |
| **The following files are in the Station directories** | |
| **TimeUTC.nc** | Time-tags for station dependent data. |
| **Source.nc** | Sources that the station is observing.<br>This is only required if it is necessary to distinguish between scans. |
| ***The following are in the Observables Directory*** | |
| **TimeUTC.nc** | Time-tags for observation dependent variables |
| **Source.nc** | Source for the observation. |
| **Baseline.nc** | Baseline for the observation. |
| ***The following are band-dependent observables in the Observables Directory.<br>We list just the X-band data. Files for other bands should be present if data is available.*** | |
| **GroupDelay_bX.nc** | Measured group delay and sigma |
| **GroupRate_bX.nc** | Measured group rate and sigma |
| **DataFlag_bX.nc** | If 0, then data is OK. Non-zero values indicate some problem, for example missing data. |
| **Phase_bX.nc** | Measured phase and sigma. |
| **SBDelay_bX.nc** | Measured single band delay and sigma |
| **AmbigSize_bX.nc** | Ambiguity size |
| **Correlation_bX.nc** | Correlation coefficient. Varies between 0 and 1. |
| **QualityCode_bX.nc** | Correlator quality code. |
| **SNR_bX.nc** | Signal to Noise Ratio |
| **DelayDataFlag_bX.nc** | Optional information about the observable. Indicates if the observable is missing or bad. |
| **RefFreq_bX.nc** | Reference frequency for phase delay observable. |
| **CorrInfo_kAAA_bX.nc** | Miscellaneous information about the observing and fringing process. Most of this information is used only rarely.<br>AAA indicates the kind of correlator: Mark3, Mark4, VLBA, DiFX, etc. |
| **ChannelInfo_bX.nc** | Information about which bands were observed, their frequencies, etc. |

Following the initial stage of processing there are several steps that can occur independently.

### *10.1.2 Calculation of Theoretical Delays and Rates*

In this stage we calculate theoretical delay and rate values for the observations. Since these values depend on the a priori station and source position we also generate vgosDB files containing this information. The theoretical delay and rate also depend on the various models used in the calculation. This information is kept track of in CalcInfo.nc. It is useful to keep this information for archival purposes. This step is only required for vgosDB which will be used by solve.

**Table 22. Adding Required Theoretical Values**

| File | Description/Comments |
|---|---|
| ***The following files are in the Apriori directory*** | |

| | |
|---|---|
| **StationApriori.nc** | List of stations and information about the stations. |
| **SourceApriori.nc** | List of sources and information about the sources |
| **ClockAprirori.nc** | Information about a priori clock offset and rate used in correlation.<br>Only required if this information is available. |
| ***The following files are in the Station directory.*** | |
| **AzEl.nc** | Pointing information |
| **FeedRotation.nc** | Rotation of the feed horn. Used in phase delay solutions. |
| ***The following files are in ObsTheoretical*** | |
| **DelayTheoretical.nc** | Theoretical delay based on the assumed sources, baseline, and epoch. |
| **RateTheoretical.nc** | Theoretical delay based on the assumed sources, baseline, and epoch. |
| **CalcInfo.nc** | Information about how 'calc' was setup: what flags were turned on and what models applied. |

### 10.1.3 Adding External Data by Parsing the Log File

In this stage of processing log files are read in and miscellaneous station-dependent calibrations and assorted information is put into the appropriate vgosDB files. This stage occurs after making the initial session. Currently only two files are created during this step. Other station dependent files such as system temperature may be produced at a later stage.

**Table 23. Data Added from Log File**

| **File** | **Description/Comment** |
|---|---|
| **Met.nc** | Meteorological information. Required if available. |
| **Cal-Cable.nc** | Cable calibration information. Required if available |

### 10.1.4 Calculation of Effective Ionosphere Frequency

This stage calculates the effective ionosphere frequencies.

**Table 24. Adding Effective Ionosphere Frequencies**

| **File** | **Description/Comments** |
|---|---|
| **The following files are in ObsDerived** | |
| **EffFreq_bX.nc** | Effective ionosphere frequencies for group delay, group rate and phase delay. |

### 10.1.5 Editing and Ambiguity Resolution

This stage occurs after all the previous steps and comprises a series of solutions usually done under manual control. The following things happen during this step.

1. Group Delay Ambiguity resolution. The delay resolution function is periodic, which means that the measured Group Delay is indeterminate. The period of the delay resolution function is called the ambiguity and is 50-100 ns. The exact value depends on the channel frequencies. As part of this stage of processing we determine how many ambiguities to add to the Group Delay.
2. Editing. We determine which data to keep and throw away.
3. Clock-breaks. We detect the epoch (and perhaps size) of the clock breaks if any.
4. Ionosphere. After a solution is performed for each band, we determine the ionosphere correction to be applied at X-band.
5. Phase Delay Ambiguity resolution. This is optional and is rarely done. If the SNR is high enough it may be possible to do a phase delay solution and determine the Phase Delay

ambiguities. The size of the Phase Delay ambiguity is the wavelength of the observing band. The measurements must be very precise in order to do a Phase Delay solution.

**Table 25. Data Added After Ambiguity Resolution and Editing**

| File | Description/Comments |
|---|---|
| ***The following files are in the ObsEdit directory.<br>Although we only list X-band, S-band is also required.*** | |
| **Edit_bX.nc** | Editing flags for X-band group delay. |
| **NumAmbigGroup_bX.nc** | Number of Group delay ambiguities. |
| **NumAmbigPhase_bX.nc** | Number of Phase delay ambiguities.<br>Only required for a phase delay solution. |
| **GroupDelayFull_bX.nc** | Full group delay with ambiguities included |
| **Cal-IonGroup_bX.nc** | X-band ionosphere correction for Group Delay. |
| **Cal-IonPhase_bX.nc** | X-band ionosphere correction for Phase Delay.<br>Only required if a phase delay solution was done. |
| ***The following file(s) are in Session.*** | |
| **ClockBreak.nc** | Information about the epoch (and perhaps size) of real clock breaks. |
| **ClockBreak_bX.nc** | Pseudo-clock break for some session. |

## 10.2 Optional Processing Steps

There are some processing steps that are optional. These produce files that are required by *solve* and may be useful for other users but are not required.

### 10.2.1 Generation of Cross Reference Tables

One of the advantages of the current Mark3 database structure is that all the data for a particular observation is grouped together. This has the disadvantage that there is redundancy in the data. In contrast the vgosDB format separates data by Scope. The vgosDB format reduces redundancy, but it also means that you must match up data items. This can be done during processing, but this can also be pre-computed. The cross-reference tables contain the results of this pre-computation. They allow you to easily find the appropriate scan-dependent or station-dependent data for a given observation. The definition of the cross-reference tables is discussed in the Section Scan, Observation & Station Dependent Data.

**Table 26. Generation of Cross Reference Table**

| File | Description/Comments |
|---|---|
| ***The following files are in the CrossReference Directory.*** | |
| **ObsCrossRef.nc** | Cross reference from observation to scan and to stations.<br>Contains: Obs2Scan and Obs2baseline |
| **SourceCrossRef.nc** | Cross reference from scan to source.<br>Contains: CrossRefSourceList, Scan2Source |
| **StationCrossRef.nc** | Cross reference from scan to station and from station to scan.<br>Contains: CrossRefStationList, Staiton2scan, and Scan2Stat. |

### 10.2.2 Calculation of Theoretical Models

This stage of processing produces files which are used by the Goddard *solve* analysis packages or contain additional information about the theoretical delays. These files can be grouped into a few specific categories and a catchall category.

1. Partial files start with Part-AAA, where AAA indicates what kind of partial derivative it is. These files contain variables that are the partial derivatives of the delay (and rate) with respect to some parameter of interest. For example, Part-AxisOffset is the Axis-Offset partial derivative. Part-EOP contains the partial derivatives with respect to EOP. Part files can be either station dependent or observation dependent. There can be several different variables in a partial file. The arrays in partial files *always* have two dimensions. The first index labels the observation (for observation dependent calibrations) or the scan (for station dependent calibrations). The second index labels whether it is a partial derivative with respect to delay or rate.
2. Calibration files start with Cal-AAA, where the AAA indicates what kind of calibration it is. These files contain variables that are calibrations that can be added to or removed from the data. They can be station dependent or observation dependent. As an example, Cal-Cable.nc is the partial file that contains cable cal specific information. A calibration file can contain several different calibrations. The variables in calibration files can have either one or two indices. If they have only one index than the calibration applies only to the delay. If there are two indices, then there are calibration values for both the delay and rate.
3. Displacement files start with Dis-AAA, where AAA indicates what kind of displacement.
4. In addition to the above, there are many other special kinds of files.

Since there are so many different files produced, we break the table into smaller pieces.

**Table 27. Scan-dependent 'Calc' Files.**

| File | Description/Comments |
|---|---|
| ***The following files are in the Scan directory.*** | |
| **EOPApriori.nc** | A priori EOP for each scan. This is the EOP used in 'calcing' the data. |
| **Ephemeris_kAAA.nc** | Contains information about the position of the Sun, Moon, Earth.<br>May contain other planets as well. AAA gives information about the ephemeris. |
| **Nut_kWahr.nc** | Calculated Wahr's nutation model. |
| **Nut_k2000PsiEps.nc** | IERS 2000 nutation model for Psi and Eps. |
| **Nut_2000XYS.nc** | IERS 2000 nutation model for X and Y |
| **Rot_kCF2J2K.nc** | Rotation matrix. |

**Table 28. Station Dependent 'Calc Files'**

| File | Description/Comments |
|---|---|
| ***The following files are in the Station directories*** | |
| **Cal-AxisOffset.nc** | Axis offset calibration. |
| **Cal-NMFDry.nc** | NMF mapping function calibration. |
| **Cal-Ocean** | Ocean loading calibration. |
| **Dis-Ocean** | Displacement caused by ocean loading. |
| **Part-AxisOffset.nc** | Axis offset partial derivatives. |
| **Part-NMFDry.nc** | Partial derivative with respect to the NMF Dry mapping function |

**Table 29. Observation Dependent Calibration 'Calc' files.**

| File | Description/Comments |
|---|---|
| ***The following files are in ObsCalTheo and are observation dependent calibrations.*** | |
| **Cal-Bend.nc** | Total calibration due to general relativistic bending. |
| **Cal-BendSun.nc** | First order contribution of the sun to bending. |
| **Cal-BendSunHigher.nc** | Higher order bending contribution. |
| **Cal-EarthTide.nc** | Calibrations due to the earth tide. |
| **Cal-FeedCorrection.nc** | Feed rotation. Only effects the rate. |
| **Cal-HFEO_IERS2003.nc** | Calibrations due to 2003 IERS HF EOP model. |
| **Cal-OceanLoad.nc** | Ocean loading calibrations. This information can be derived from the station-dependent ocean loading calibration. |
| **Cak_kParrallax.nc** | Calibration due to parallax |
| **Cal-Poletide.nc** | Calibration due to Pole Tide. |
| **Cal-PoleTideOldRestore.nc** | If added to PoleTide will restore to an older version of the poletide. |
| **Cal-TiltRemover.nc** | Removes contribution of Axis tilt. |
| **Cal-Unphasecal.nc** | Calibration to remove the effect of phase-cal. |
| **Cal-Whar.nc** | Contribution of Wahr nutation model to the delay and rate. |
| **Cal-WobNut.nc** | Corrections due to "High frequency nutation". |
| **Cal-Wobble.nc** | Corrections to the delay/rate due to the polar motion. |

**Table 30. Observation Dependent Partial 'Calc' files.**

| File | Description/Comments |
|---|---|
| ***The following files are in ObsPart and are observation dependent partials.*** | |
| **Part-Bend.nc** | Partial with respect to General Relativistic Bending. |
| **Part-EOP.nc** | Partial derivatives for UT1 and Polar Motion. |
| **Part-Gamma.nc** | Derivative with respect to gamma. |
| **Part-Nut2KPsiEps.nc** | Partial derivatives with respect to nutation Psi and Eps. |
| **Part-Nut2XY.nc** | Partial derivatives with respect to X and Y |
| **Part-Parallax.nc** | Partial derivative with respect to parallax. |
| **Part-PoleTide.nc** | Partial derivative with respect to Poletide. |
| **Part-Precession.nc** | Partial derivative with respect to Precession. |
| **Part-RaDec.nc** | Partial derivatives for source position. |
| **Part-XYZ.nc** | Partial derivative of station positions. |

## 10.3 Current Processing Steps

The above discussion was somewhat abstract. In this section we discuss the current processing chain using Solve.

### 10.3.1 vgosDbMake

This program takes the initial correlator output and produces the initial vgosDB. It also makes the cross-reference tables and calculates the effective ionosphere frequencies.

### 10.3.2 vgosDbCalc

This stage calculates the theoretical values and partials.

### 10.3.3 vgosDbProcLogs

This stage reads the log files and produces the cable-cal and met files. For some stations the met data is extracted from other sources.

### 10.3.4 nuSolve

This stage does editing and ambiguity resolution. It also sets up the clock breaks. It also does additional tasks associated with setting up the solve runs.

### 10.3.5 Example of Building up a vgosDB

The table below illustrates how the vgosDB session is built up over time. The vertical axis labels the different directories. The Horizontal axis labels the different versions.

**Table 31. Building up the vgosDB**

| Directoy | V1 | V2 | V3 | V4 |
|---|---|---|---|---|
| Top | 21JAN04XU_V001_iWACO_kall.wrp | | | |
| Top | Head.nc | | | |
| Top | | 21JAN04XU_V002_iGSFC_kall.wrp | | |
| Top | | | 21JAN04XU_V003_iGSFC_kall.wrp | |
| Top | | | | 21JAN04XU_V004_iGSFC_kall.wrp |
| Top | | | | 21JAN04XU_V004_iIVS_kall.wrp |
| History | 21JAN04XU_V000_kMk4.hist | | | |
| History | 21JAN04XU_V001_kvgosDbMake.hist | | | |
| History | | 21JAN04XU_V002_kvgosDbCalc.hist | | |
| History | | | 21JAN04XU_V003_kvgosDbProcLogs.hist | |
| History | | | | 21JAN04XU_V004_knuSolve.hist |
| Session | MiscFourFit.nc | | | |
| Session | | LeapSecond.nc | | |
| Session | | | MiscCable.nc | |
| Session | | | | GroupBLWeights.nc |
| Apriori | | Antenna.nc | | |
| Apriori | | Source.nc | | |
| Apriori | | Station.nc | | |
| Apriori | | | | Eccentricity.nc |
| CrossReference | ObsCrossRef.nc | | | |
| CrossReference | SourceCrossRef.nc | | | |
| CrossReference | StationCrossRef.nc | | | |
| Scan | CorrRootFile.nc | | | |
| Scan | ScanName.nc | | | |
| Scan | TimeUTC.nc | | | |
| Scan | | Ephemeris_kDE421JPL.nc | | |
| Scan | | ERPApriori.nc | | |
| Scan | | NutationEQX_kIAU2006.nc | | |

| | | | |
|---|---|---|---|
| Scan | | NutationEQX_kWahr.nc | |
| Scan | | NutationNRO_kIAU2006.nc | |
| Scan | | Rot-CF2J2K.nc | |
| KOKEE | TimeUTC.nc | | |
| KOKEE | | AzEl.nc | |
| KOKEE | | Cal-AxisOffset.nc | |
| KOKEE | | Cal-SlantPathTropDry_kNMF.nc | |
| KOKEE | | Cal-SlantPathTropWet_kNMF.nc | |
| KOKEE | | Cal-StationOceanLoad.nc | |
| KOKEE | | Dis-OceanLoad.nc | |
| KOKEE | | FeedRotation.nc | |
| KOKEE | | Part-AxisOffset.nc | |
| KOKEE | | Part-HorizonGrad_kNMF.nc | |
| KOKEE | | Part-ZenithPathTropDry_kNMF.nc | |
| KOKEE | | Part-ZenithPathTropWet_kNMF.nc | |
| KOKEE | | | Cal-Cable.nc |
| KOKEE | | | Met.nc |
| KOKEE | | | Tsys.nc |
| WETTZELL | TimeUTC.nc | | |
| WETTZELL | | AzEl.nc | |
| WETTZELL | | Cal-AxisOffset.nc | |
| WETTZELL | | Cal-SlantPathTropDry_kNMF.nc | |
| WETTZELL | | Cal-SlantPathTropWet_kNMF.nc | |
| WETTZELL | | Cal-StationOceanLoad.nc | |
| WETTZELL | | Dis-OceanLoad.nc | |
| WETTZELL | | FeedRotation.nc | |
| WETTZELL | | Part-AxisOffset.nc | |
| WETTZELL | | Part-HorizonGrad_kNMF.nc | |
| WETTZELL | | Part-ZenithPathTropDry_kNMF.nc | |
| WETTZELL | | Part-ZenithPathTropWet_kNMF.nc | |
| WETTZELL | | | Cal-Cable.nc |
| WETTZELL | | | Met.nc |
| WETTZELL | | | Tsys.nc |
| ObsCalTheo | | Cal-Unphase_bS.nc | |
| ObsCalTheo | | Cal-Unphase_bX.nc | |
| ObsCalTheo | | Cal-Bend.nc | |
| ObsCalTheo | | Cal-BendSun.nc | |
| ObsCalTheo | | Cal-BendSunHigher.nc | |
| ObsCalTheo | | Cal-EarthTide_kIERS2003.nc | |
| ObsCalTheo | | Cal-FeedCorrection_bS.nc | |
| ObsCalTheo | | Cal-FeedCorrection_bX.nc | |
| ObsCalTheo | | Cal-HiFreqERP_kIERS2003.nc | |
| ObsCalTheo | | Cal-HiFreqLibration_kIERS2010.nc | |

| | | | |
|---|---|---|---|
| ObsCalTheo | | Cal-OceanLoad.nc | |
| ObsCalTheo | | Cal-OceanLoadOld.nc | |
| ObsCalTheo | | Cal-OceanPoleTideLoad.nc | |
| ObsCalTheo | | Cal-Parallax.nc | |
| ObsCalTheo | | Cal-PoleTide_kIERS2003.nc | |
| ObsCalTheo | | Cal-PoleTideOldRestore.nc | |
| ObsCalTheo | | Cal-TiltRemover.nc | |
| ObsCalTheo | | Cal-Wobble.nc | |
| ObsDerived | | UVFperAsec_bS.nc | |
| ObsDerived | | UVFperAsec_bX.nc | |
| ObsDerived | | | Cal-SlantPathIonoGroup_bX.nc |
| ObsDerived | | | EffFreq_bX.nc |
| ObsDerived | | | EffFreq_kEqWt_bX.nc |
| ObsDerived | | | Cal-SlantPathIonoGroup_bS.nc |
| ObsDerived | | | EffFreq_bS.nc |
| ObsDerived | | | EffFreq_kEqWt_bS.nc |
| ObsEdit | | | Edit.nc |
| ObsEdit | | | NumGroupAmbig_bX.nc |
| ObsEdit | | | GroupDelayFull_bX.nc |
| ObsEdit | | | NumGroupAmbig_bS.nc |
| ObsEdit | | | GroupDelayFull_bS.nc |
| Observables | AmbigSize_bS.nc | | |
| Observables | AmbigSize_bX.nc | | |
| Observables | Baseline.nc | | |
| Observables | ChannelInfo_bS.nc | | |
| Observables | ChannelInfo_bX.nc | | |
| Observables | Correlation_bS.nc | | |
| Observables | Correlation_bX.nc | | |
| Observables | CorrInfo-difx_bS.nc | | |
| Observables | CorrInfo-difx_bX.nc | | |
| Observables | DataFlag_bS.nc | | |
| Observables | DataFlag_bX.nc | | |
| Observables | GroupDelay_bS.nc | | |
| Observables | GroupDelay_bX.nc | | |
| Observables | GroupRate_bS.nc | | |
| Observables | GroupRate_bX.nc | | |
| Observables | Phase_bS.nc | | |
| Observables | Phase_bX.nc | | |
| Observables | PhaseCalInfo_bS.nc | | |
| Observables | PhaseCalInfo_bX.nc | | |
| Observables | QualityCode_bS.nc | | |
| Observables | QualityCode_bX.nc | | |
| Observables | RefFreq_bS.nc | | |

|  |  |  |  |
|---|---|---|---|
| Observables | RefFreq_bX.nc |  |  |
| Observables | SBDelay_bS.nc |  |  |
| Observables | SBDelay_bX.nc |  |  |
| Observables | SNR_bS.nc |  |  |
| Observables | SNR_bX.nc |  |  |
| Observables | Source.nc |  |  |
| Observables | TimeUTC.nc |  |  |
| ObsPart |  | Part-Bend.nc |  |
| ObsPart |  | Part-ERP.nc |  |
| ObsPart |  | Part-Gamma.nc |  |
| ObsPart |  | Part-NutationNRO_kIAU2006.nc |  |
| ObsPart |  | Part-Parallax.nc |  |
| ObsPart |  | Part-Poletide_kIERS2006.nc |  |
| ObsPart |  | Part-RaDec.nc |  |
| ObsPart |  | Part-XYZ.nc |  |
| ObsTheoretical |  | DelayTheoretical.nc |  |
| ObsTheoretical |  | RateTheoretical.nc |  |
| Solve | ScanTimeMJD.nc |  |  |
| Solve |  | CalcERP.nc |  |
| Solve |  | CalcInfo.nc |  |
| Solve |  | FractC.nc |  |
| Solve |  |  | IonoBits.nc |
| Solve |  |  | UserSup.nc |
| Solve |  |  | AtmSetup.nc |
| Solve |  |  | ClockSetup.nc |
| Solve |  |  | ERPSetup.nc |
| Solve |  |  | IonoSetup.nc |
| Solve |  |  | SelectionStatus.nc |
| Solve |  |  | CalibrationSetup.nc |

# 11 History of IVS Working Group IV on Data Structures

At the 15 September 2007 IVS Directing Board meeting I proposed establishing a "Working Group on VLBI Data Structures". The thrust of the presentation was that, although the VLBI database system has served us very well these last 30 years, it is time for a new data structure that is more modern, flexible, and extensible. This proposal was unanimously accepted, and the board established IVS Working Group 4. Quoting from the IVS Web site [1]:

*"The Working Group will examine the data structure currently used in VLBI data processing and investigate what data structure is likely to be needed in the future. It will design a data structure that meets current and anticipated requirements for individual VLBI sessions including a cataloging, archiving, and distribution system. Further, it will prepare the transition capability through*

*conversion of the current data structure as well as cataloging and archiving software to the new system.”*

## 11.1 Organization of the Working Group

**Table 32. Members of IVS Working Group**

| Chair | John Gipson |
|---|---|
| **Analysis Coordinator** | Axel Nothnagel |
| **GSFC/Calc/Solve** | David Gordon |
| **JPL/Modest** | Chris Jacobs<br>Ojars Sovers |
| **Occam** | Oleg Titov<br>Volkmar Tesmer |
| **TU Vienna** | Johannes Böhm |
| **IAA** | Sergey Kordobov |
| **Observatorie de Paris/ PIVEX** | Anne-Marie Gontier |
| **NICT** | Thomas Hobiger<br>Hiroshi Takiguchi |

Any change to the VLBI data format affects everyone in the VLBI community. Therefore, it is important that the working group have representatives from a broad cross-section of the IVS community. Table 1 lists the members of WG4 together with their affiliation or function. The initial membership was arrived at in consultation with the IVS Directing Board. While we wanted to ensure that all points of view were represented, we also wanted to make sure that the size did not make WG4 unwieldy. The composition and size of WG4 is a reasonable compromise between these two goals. My initial request for participation in WG4 was enthusiastic: everyone I contacted agreed to participate except for an individual who declined because of retirement.

## 11.2 History and Goals

WG4 held its first meeting at the 2008 IVS General Meeting in St. Petersburg, Russia. This meeting was open to the general IVS community. Roughly 25 scientists attended: ten WG4 members and fifteen others. This meeting was held after a long day of proceedings. The number of participants and the lively discussion that ensued is strong evidence of the interest in this subject.

A set of design goals, displayed in Table 33, emerged from this discussion. In some sense the design goals imply a combination and extension of the current VLBI databases, the information contained on the IVS session Webpages, and much more information [2].

During the next year the working group communicated via email and telecon and discussed how to meet the goals that emerged from the St. Petersburg meeting. A consensus began to emerge about how to achieve most of these goals.

**Table 33. Design Goals of Working Group IV**

| Goal | Description |
|---|---|
| **Provenance** | Users should be able to determine the origin of the data and what was done to it. |
| **Compactness** | The data structure should minimize redundancy and the storage format should emphasize compactness. |
| **Speed** | Data retrieval should be fast. |
| **Platform/OS/ Language Support** | Data should be accessible by programs written in different languages, running on a variety of computers and operating systems. |

| | |
|---|---|
| **Extensible** | It should be easy to add new data types. |
| **Open** | Data should be accessible without the need of proprietary software. |
| **Decoupled** | Different types of data should be separate from each other. |
| **Multiple data levels** | Data should be available at different levels of abstraction. For example, levels most users are only interested in the delay and rate observables. Specialists may be interested in correlator output. |
| **Completeness** | All VLBI data required to process (and understand) a VLBI session from start to finish should be available: schedule files, email, log-files, correlator output, and final 'database'. |
| **Web Accessible** | All data should be available via the Web. |

The next face-to-face meeting of WG4 was held at the 2009 European VLBI Meeting in Bordeaux, France. This meeting was also open to the IVS community. At this meeting a proposal was put forward to split the data contained in the current Mark3 databases into smaller files which are organized by a special ASCII file called a wrapper. I summarized some of the characteristics and advantages of this approach. Overall, the reaction was positive. In the summer of 2009, we worked on elaborating these ideas, and in July a draft proposal was circulated to Working Group 4 members. The ideas continued to be refined over the next several years.

Because of the desire for the new format to be open, and as a nod to Mark3 database structure, the new format is called vgosDB.

## *11.3 Overview of New Organization*

In this section we present a brief overview of the new format.

### *11.3.1 Modularization*

A solution to many of the design goals of Table 3 is to modularize the data, that is to break up the data associated with a session into smaller pieces. These smaller pieces are organized by 'type'; e.g., group delay observable, met-data, editing criteria, station names, and station positions. In many, though not all, cases, each 'type' corresponds to a Mark3 database Lcode.

Different data types are stored in different files, with generally only one or a few closely related data types in each file. For example, it is convenient to store all the met-data for a station together in a file since the different kinds of met-data (temperature, pressure, and humidity) frequently come from a single instrument. However, there is no compelling reason to store the met-data together with pointing information. Splitting the data in this way has numerous advantages, some of which are outlined below. The first three directly address the design goals. The last was not originally specified but is a consequence of this design decision.

1. Separable. Users can retrieve only that part of the data in which they are interested.
2. Extensible. As new data types become used, for example, source maps, they can be easily added without having to rewrite the whole scheme. All you need to do is specify a new data type and the file format.
3. Decoupled. Different kinds of data are separated from each other. Observables are separated from models. Data that won't change is separated from data that might change.

4. Partial Data Update. Instead of updating the entire database, as is done for the MK3-DB, you only need to update that part of the data that has changed.

Data is also organized by ‘scope’, that is how broadly applicable it is:

1. Does it hold for the entire session?
2. For a particular scan?
3. For a particular scan and station?
4. For a particular observation?

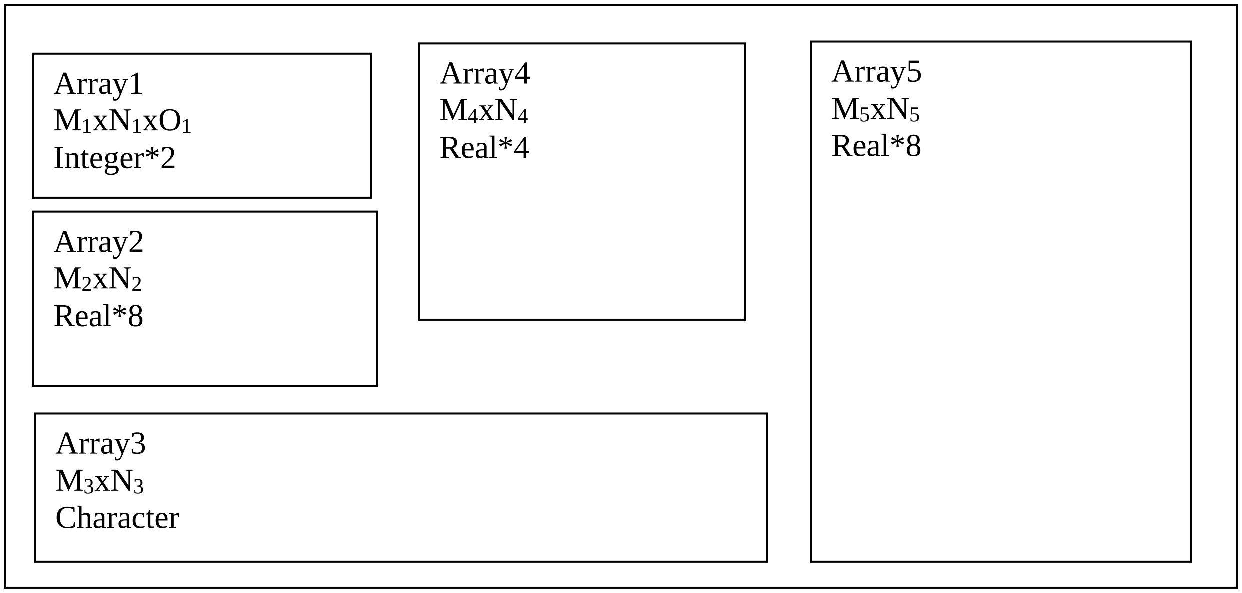
In some sense this is a generalization of the MK3-DB Lcodes, where there two types of Lcodes—Type-1 session dependent Lcodes, and Type-2 (and Type-3) observation dependent Lcodes. By introducing the additional scopes of scan-dependent, and station-scan dependent, we can reduce the redundancy. For example, in an N-station scan in a MK3-DB, the a priori EOP is stored once for each N*(N-1)/2 observations, instead of once for the whole scan. The met data for each station is stored once for each of the (N-1) times observations the station participates in. Organizing data by scope allows you to reduce the redundancy.

### *11.3.2 NetCDF as Default Storage Format*

Working Group 4 reviewed a variety of data storage formats including NetCDF, HCDF, CDF, and FITS. In some sense, all these formats are equivalent—there exist utilities to convert from one format to another. Ultimately, we decided to use NetCDF, because it has a large user community and because several members of the Working Group have experience with using NetCDF. At its most abstract, NetCDF is a means of storing arrays in files. The arrays can be of different sizes and shapes, and contain different kinds of data—strings, integer, real, double, etc. All VLBI data used in analysis can be stored as an array. From this point of view using NetCDF is a natural choice. These files can contain history entries which aid in provenance. Storing data in NetCDF format has the following advantages:

1. Platform/OS/Language Support. NetCDF has interface libraries to all commonly used computer languages running on a variety of platforms and operating systems.
2. Speed. NetCDF is designed to access data fast.
3. Compactness. The data is stored in binary format, and the overhead is low. A NetCDF file is much smaller than an ASCII file storing the same information.
4. Open. NetCDF is an open standard, and software to read/write NetCDF files is freely available.
5. Transportability. NetCDF files use the same internal format regardless of the machine architecture. Access to the files is transparent. For example, the interface libraries take care of automatically converting from big-endian to little-endian.
6. Large User Community. Because of the large user community, there are many tools developed to work with NetCDF files.

**Figure 8. A NetCDF file is a container to hold arrays.**



### *11.3.3 Feasibility Demonstration*

In August of 2009 John Gipson began a partial implementation of these ideas and wrote software to convert a subset of the data in a Mark3 database into the new format. This subset of data included all the data available in NGS card format. The subset was chosen because many VLBI analysis packages including Occam, Steelbreeze, and VieVS use NGS cards as input. The GSFC VLBI group made available via anonymous FTP an Intensive, an R1 and a RDV session.

In the fall of 2010, Andrea Pany of the Technical University of Vienna developed an interface to VieVS working with the draft proposal. During this process the definition of a few of the data items needed to be clarified, which emphasizes the importance of working with the data hands on. At NASA's Goddard Space Flight Center, Sergei Bolotin interfaced a variant of this format to Steelbreeze. Steelbreeze uses its own proprietary format, and one motivation for interfacing to the new format was to see if there was a performance penalty associated with using the new format. Bolotin found a small performance penalty of 40 μs/observation.

Meanwhile Gipson continued working on a utility to convert all the data in all Mark3 databases into the new format. As there approximately 500 different Lcodes this process took longer than he anticipated. At the same time, he began to modify Solve so that it could use the vgosDB format as a replacement for supertiles. The goal was to make the use of vgosDB files as transparent as possible. The software modification process began in the fall of 2011 and by spring of 2012 Gipson had a version of Solve that would work with the vgosDB format with a few restrictions--for example, the "user-partial" feature did not work. Gipson continued to work on solve to remove the restrictions and completed this by the fall of 2012.

At the time of this work there were over 8000 24-hour Sessions and 4000 intensive sessions. In the process of converting all these databases to vgosDB format Gipson uncovered several anomalies and each of these had to be handled in turn. For example, many databases have duplicate Lcodes—the same data is stored in a Type 2 and Type 3 Lcode. In that case the duplicate Lcodes are removed. As another example, all databases contain a Type 1 Lcode NUM OBS which tells how many observations there are in the Type 2 and Type 3 Lcodes. However, several of the older databases had fewer observations than was contained in the header, and a few had more.

The process of modifying Solve to use the vgosDB format resulted in a further refinement of the vgosDB specifications.

Timing tests done with Solve and the vgosDB format indicate that there is a performance penalty for smaller databases such as the Intensives and the older databases[1]. However, for larger Sessions, such as the RDVs or CONT08 or CONT11, using the vgosDB format is up to 30% faster. In processing large global solutions which include a mix of the overall time required to run a solution using vgosDB is faster than using the Mark3 superfile format.

[1] This is because the vgosDB format splits the VLBI data into several small files, and there is a certain amount of overhead involved in opening each file. For large sessions this overhead is compensated by the speed of access of the data items.

# 12 Pre-vgosDB Organization of VLBI Data

This section describes some previous ways of organizing and storing data.

## *12.1 Mark3 Databases*

Prior to the advent of vgosDB, the official IVS version of the data was archived and stored in Mark3 database. These databases contain information used in the analysis of a VLBI session.

The Mark3 database organizes data by “Lcodes” with each Lcode corresponding to a different data item. The data associated with a given Lcode can be stored as ASCII strings, Integer*2, Integer*4 or Real*8. The Mark3 database was designed to contain all[2] the data necessary to analyze a VLBI session within a single file. The database file contains the observables, but it also contains theoretical values, partials, and calibrations.

There are two types of Lcodes:

1. Type-1 Lcodes contain data that is applicable for the entire session.
    a. Examples: Station Names, Station Positions, Source Names, Source Position, Session Name, PI, etc.
    b. This information occurs only once in the database.
    c. There are roughly 100 different Type-1 Lcodes.
2. Type-2 and -3 Lcodes are conceptually identical. Type-3 Lcodes were introduced because of limitations of the HP operating system in the 1980s. These Lcodes contain observation dependent data:
    a. Examples: EOP data, a priori nutation, various partials, delay, rate, sigmas.
    b. The database contains data for each Lcode and each observation, e.g., each observation has an associated EOP value, met values, etc.
    c. There are around 400 different Type-2 and Type-3 Lcodes. A typical Mark3 database will contain around 200 Type-2 and Type-3 Lcodes.

The Mark3 databases are fundamentally organized by observation, as illustrated below.

**Table 34. Mark3 databases are organized by session- and observation-dependent data.**

| **Table of Contents** | | | | | |
|---|---|---|---|---|---|
| List of all lcodes in the MK3-DB, their definition, the kind of data (ASCII, Integer*2, Integer*4, Real*4) and the dimension. | | | | | |
| **History** | | | | | |
| A history of changes made to the data. | | | | | |
| **Type 1 Lcodes: Session Data** | | | | | |
| Source List | Station List | Correlator | Principle Investigator | Flags | Etc... |
| **Type 2 and 3 Lcodes: Observation Data** | | | | | |

[2] Over time this proved impractical, and some of data is now stored in external files. Examples include EOP files, pressure loading, episodic motion, etc.

|  | Lcode1<br>Source-Name | Lcode2<br>1st Station | Lcode3<br>2nd Station | Lcode3<br>EOP | … | LcodeM<br>Observable |
|---|---|---|---|---|---|---|
| **Obs1** |  |  |  |  |  |  |
| **Obs2** |  |  |  |  |  |  |
| **…** |  |  |  |  |  |  |
| **ObsN** |  |  |  |  |  |  |

It is important to note that the Mark3 database format is both a method of organizing data and a means of storing data. Data is organized by Lcodes, where the Lcodes are Session-dependent or Observation dependent. The data is stored in a proprietary format.

The Mark3-DB format has some nice features which we do not want to lose. Among these are:

1. Table of Contents. You can easily see what data is available in the database.
2. Self-descriptive data. Each data item has a brief description of what it is.
3. History. Each database contains a history of its processing.

The number of Lcodes has increased over time because of model changes, the desire to use new kinds of data, etc. The specific Lcodes within a database vary depending on the age of the database and how the data was processed.

1. Older databases contain obsolete Lcodes which are relics of how the data was analyzed at the time.
2. In addition, databases contain information about the fringing process, and this information is different for each kind of correlator.

A consequence of this is that a Mark3 database contains data that is obsolete and never used.

Some problems associated with Mark3 databases are:

1. Requires proprietary software.
2. Only used by the *calc/solve* user community.
3. Redundancy.
    a. Much VLBI data is scan-dependent, not observation dependent.
    b. There is one database for each band.
4. Mixing of observations and theoretical models.
5. Changing a model or adding new kinds of data means updating the entire database.
6. Difficult or impossible to exchange partial information, i.e., ambiguity resolution or editing criteria.
7. Contains obsolete data and models.
8. Contains data that is very seldom used.
9. Contains data that is *calc/solve* specific.
10. Slow data access which makes it prohibitively time-consuming to use the Mark3 database in large VLBI solutions.

Despite the above problems, the Mark3 database was in use for over 35 years which is a testament to the many virtues it has.

## 12.2 NGS Card Format

Because of the proprietary nature of the Mark3 database an alternative format called "NGS card" format was developed to exchange VLBI information. This consists of a single ASCII file with a series of lines. The top of the file contains header information which describes the session, such as stations, sources, and their positions. This is analogous to the Type-1 Lcodes in the Mark3 database. This is followed by information about the observations. This is analogous to the information contained in the Type-2 Lcodes.

The advantage of the NGS format is that it is easy to write software to parse the file. Some of the disadvantages are:

1. Inflexible. Hard to add new data types.
2. Does not contain all the VLBI data needed to analyze a solution from the beginning. Hence errors in the initial data editing and ambiguity resolution are 'baked-in' to the data.
3. Machine access is slower than for binary files.

## 12.3 Other Formats

Because of the speed advantages that storing data in binary files has, most VLBI analysis software uses a custom format specific to the software.

For doing large global solutions which combine data from many sessions, *solve* stored data in 'superfiles'. These superfiles are essentially binary dumps of Fortran common blocks which contain subsets of the data in a Mark3 database. The organization is also roughly similar to that of Mark3 databases. One common block contains information common to the session. Another common block contains information applicable to a given observation. Solve uses this information by reading in the common-block for a particular observation *en masse*.

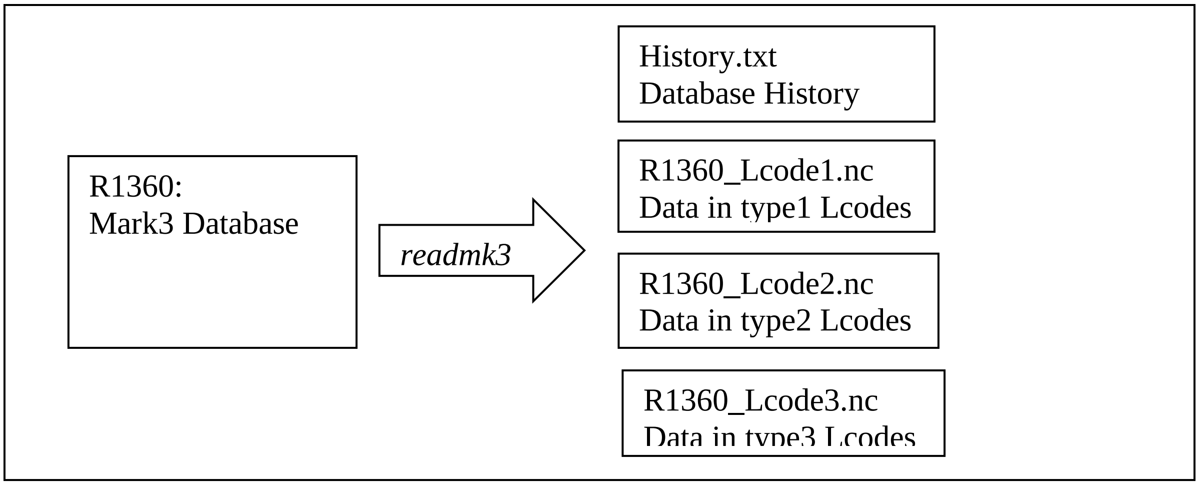
Other software packages such as Steelbreeze, Occam and VieVs use their own proprietary format. This makes it difficult to exchange data.

As mentioned above, one of the primary reasons for using a proprietary format is that Mark3 database access is slow. Proprietary binary formats were developed in part as a reaction to this. On the other hand, the NetCDF format is designed for fast access. One of the goals of the vgosDB is to encourage the use of a common format for data processing and exchange.

## 12.4 Storage Format is Independent of Organization

Thomas Hobiger wrote a routine *readmk3* that converts a Mark3 database into a text file and 3 NetCDF files. The text file contains the history information, and the 3 NetCDF files contain the information contained in the Type1, Type2 and Type3 Lcodes. There is a 1-to-1 correspondence between Mark3 Lcodes and NetCDF arrays. This conversion is illustrated schematically below:

**Figure 9. Hobiger's conversion of Mk3 databases to NetCDF.**



This mapping preserves the organization of the Mark3 databases. It has the advantage that the data can easily be accessed using freely available, platform independent software.

It also illustrates that data-organization is distinct issue from data-storage, although they are related.

# 13 Coincident TimeTags Bug

In this section, we describe a ‘bug’ in calculating time tags which results in distinct observations involving the same station being assigned the same time-tags. This bug affects about 100 databases. Table 35 lists part of the schedule R1562 where this bug occurs.

**Table 35. Sked Dump of Middle of R1562**

```
Source      Start      DURATIONS
name     yyddd-hhmmss   Ft  Hb  Ho  Ke  Kk  Ny  Tc  Ts  Wf  Wz
1759-396 12339-093649|          74  74                        |
3C446    12339-093920|      82      82              43        |
OJ287    12339-094118|  87             421 113 405      43 421|
2008-159 12339-094125|         117 117              57        |
0133+476 12339-094427|                      43      43  43    |
2255-282 12339-094516|     242 242  69                        |
```

Prior to early 2013, sessions processed through the Mark4 hardware correlator and the DiFX correlator used different time-tags. The Mark4 correlator used the time-tag of the middle of the period when *all* the stations were observing. In the above example this is equivalent to taking the start of the scan, and then adding ½ of the shortest observing time. In contrast the DiFX correlator started with the start of the observing time, and then added ½ of the longest scans. The corresponding time-tags for these two cases are displayed below. Depending on the scan, sometimes the length of the ½ scan is rounded up or down. For this example, I inferred the rounding by taking the time-tags from the database.

**Table 36. Mark4 vs buggy DiFX TimeTag.**

| Source | Scan Start | ½ Min Scan | ½ Max Scan | Mark4 time-tag | DiFX time-tag |
|---|---:|---:|---:|---:|---:|
| **1759-396** | 9:36:49 | 37 | 37 | 9:37:26 | 9:37:26 |
| **3C446** | 9:39:20 | 21 | 41 | 9:39:41 | 9:40:01 |
| **OJ287** | 9:41:18 | 21 | 211 | 9:41:39 | 9:44:49 |
| **2008-159** | 9:41:25 | 28 | 58 | 9:41:53 | 9:42:23 |
| **0113+476** | 9:44:27 | 22 | 22 | 9:44:49 | 9:44:49 |
| **2255-282** | 9:45:16 | 121 | 35 | 9:47:17 | 9:45:51 |

Note that for the DiFX time-tags, the scans involving OJ287 and 0113+476 have the same time-tag! Since both NyAlesund and Westford participate in both these scans, it looks like both sources are observing two different sources at the same time.

For some station dependent variables such as met-data (which varies slowly) this is not that important. For other station dependent variables such as pointing information, mapping functions, or cable-cal, it is important that you know which scan we is the relevant one.

The time-tag bug is a bug in the problem DiFX2Mark4. The time-tag bug was discovered by Sergei Bolotin and John Gipson, and the cause of it tracked down by Roger Cappalo who subsequently fixed it.

# 14 vgosDB File Dictionary

In this section we give a description of all the vgosDB files. In the next section we give a complete list of all the current vgosDB file types. This is followed by a list of all the vgosDB files.

## 14.1 Complete List of vgosDB File Types

The following is a complete list of the vgosDB file types arranged alphabetically. Each file-type includes a brief description of the data contained into it as well as the Scope. A designation of 'Solve' for the scope indicates that the file is used by Solve, usually in setting up a solution.

The scope of most vgosDB file types is fixed. For example, all AzEl files are Station dependent. The notable examples to this are:

1. 'Cal' files. These files contain calibrations to the data. These can either be observation dependent or station dependent.
2. 'Part' files. These contain partial derivative information. These can either be observation dependent or station dependent.
3. TimeUTC files. These are of three types: Observation-, Scan- and Station-dependent.

**Table 37. Dimensions used in vgosDB files.**

| Dimension Name | Description |
|---|---|
| **NumBaselines** | Number of baselines in a session. This is equal to NumStat×(NumStat-1)/2 |
| **NumChannels** | Number of channels used when observing.<br>Dimension used for some variables in *CorrInfo.nc.* |
| **NumObs** | Number of observations made in a session. Dimension used in scopes *Session* and *Obs.* |
| **NumScans** | Number of scans made in a session. Dimension used in scope *Session*. |
| **NumSource** | Number of sources observed in a session. Dimension used in scope *Session.* |
| **NumStatScan** | Station dependent dimension, number of scans. Dimension used in scope *Station*. |
| **NumStation** | Number of stations participating in a session. Dimension used in scope *Session* |
| **TimeDim2** | Indicates that the vgosDB variable includes a variable and its first time derivative.<br>For example, AzTheo(1,j) is the azimuth of the j-th observation at a station; AzTheo(2,j) is the time derivative of the azimuth. |
| **TimeDim3** | Indicates that the vgosDB variable includes a variable and its first and second time derivative. |

**Table 38. Complete List of vgosDB File Types**

| File | Description | **Required?** | **Dir** | **Scope** |
|---|---|---|---|---|
| **AmbigSize_b?** | Size of group delay ambiguities | | Observables | Obs |
| **AntennaApriori** | Antenna information. | | Apriori | Session |
| **AtmSetup** | Atmosphere constraints for solution. | | Solve | Session |
| **AzEl** | Station Pointing | Y | Station | Station |
| **Baseline** | Baseline array | Y | Observables | Obs |
| **BaselineClockSetup** | Solution setup. | Y | Solve | Session |

| | | | | |
|---|---|---|---|---|
| **Cal-Xxxx** | Station dependent Calibration. Xxxx indicates the type. | | Station | Station |
| **Cal-Xxxx** | Observation dependent calibration. Xxxx indicates the type. | | ObsCalTheo | Obs |
| **CalcEop** | A prioiri EOP used by Calc | | Solve | Session |
| **CalcInfo** | Information about calc run | Y | ObsTheoretical | Session |
| **CalibrationSetup** | Solution setup. | Y (If data available) | Solve | Session |
| **ChannelInfo_b?** | Information about the channel setup including frequencies | Y | Observables | Obs |
| **ClockApriori** | A priori Clock | | Apriori | Session |
| **ClockBreak** | Clock Break setup | | Session | Session |
| **ClockSetup** | Solution setup | | Solve | Session |
| **Correlation_b?** | Correlation coefficient | Y | Observables | Obs |
| **CorrInfo_b?** | Information about correlation | Y | Observables | Obs |
| **DelayDataFlag_b?** | Is the data good | | Observables | Obs |
| **DelayTheoretical** | Theoretical Delay | Y | ObsTheoretical | Obs |
| **Dis-Xxxx** | Station dependent displacement. Xxxx indicates the type | | Station | Station |
| **EccentricityApriori** | Eccentricity Information. | | Apriori | Session |
| **Edit** | Editing criteria | Y | ObsEdit | Obs |
| **EffFreq_b?** | Effective phase frequency | Y | ObsDerived | Obs |
| **EOPApriori** | A priori EOP used by Calc | | Scan | Scan |
| **EopSetup** | Solution setup. | | Solve | Session |
| **Ephemeris_kDE405JPL** | Ephemeris | | Scan | Scan |
| **FeedRotation** | Rotation of feed horn | | *Station* | Station |
| **FeedRotNet** | Net Feed roation. Station1-Staiton2 | | ObsDerived | Obs |
| **FractC** | Fractiional part of a day incluing leapseconds. | | Solve | Obs |
| **GroupBLWeights** | Additive noise for group delay. | | Session | Session |
| **GroupDelay_b?** | Measured group delay | | Observables | Obs |
| **GroupDelayFull_b?** | Fully resolved group delay | | ObsEdit | Obs |
| **GroupRate_b?** | Measured group rate | | Observables | Obs |
| **Head** | Information about the session. | Y | Top Level | Session |
| **IonBits** | Ion information used by solve | | Solve | Obs |
| **IonSetup** | Ionosphere setup in Solve solution | | Solve | Session |
| **Met** | Meteorological data | Y (if available) | *Station* | Station |
| **Misc** | Miscellaneous info used by solve. | | Solve | Session |
| **NumGroupAmbig_b?** | Number group delay ambiguities | Y After doing solution | ObsEdit | Obs |

| | | | | |
|---|---|---|---|---|
| **NumPhaseAmbig_b?** | Number group delay ambiguities | | ObsEdit | Obs |
| **Nut_k2000PsiEps** | Nutation information. | | Scan | Scan |
| **ObsCrossRef** | Links observations to scans | | CrossReference | Obs |
| **Part-Xxxx** | Station dependent Partial. Xxxx indicates the type | | *Station* | Station |
| **Part-Xxxx** | Observation dependent Partial. Xxxx indicates the type | | ObsPart | Obs |
| **Phase_b?** | Measured Phase | | Observables | Obs |
| **PhaseBLWeights** | Noise to add to solution | | Solve | Session |
| **PhaseDelayFull_b?** | Fully resolved phase delay | | ObsEdit | Obs |
| **QualityCode_b?** | Correlator quality code | Y | Observables | Obs |
| **RateTheoretical** | Theoretical Rate | Y | ObsTheoretical | Obs |
| **RefFreq_b?** | Effective frequency for Phase | Y | Observables | Obs |
| **Rot_kCF2J2K** | Rotation matrix. | | Scan | Scan |
| **SBDelay_b?** | Observed SB-delay | Y | Observables | Obs |
| **ScanName** | Scan name | Y | Scan | Scan |
| **SelectionStatus** | Solution setup. | | Solve | Session |
| **SNR_b?** | Observed SNR | Y | Observables | Obs |
| **Source** | Source observed during scan | Y | Observables | Obs |
| **SourceApriori** | A priori source information | Y | Apriori | Session |
| **SourceCrossRef** | Links Scans to Sources | | CrossReference | Session |
| **StationApriori** | A priori station information | Y | Apriori | Session |
| **StationCrossRef** | Links stations to scans | | CrossReference | Session |
| **TimeUTC** | Time-tag for scans. | Y | Scan | Scan |
| **TimeUTC** | Time-tag for stations | *Y* | *Station* | Station |
| **TimeUTC** | Time-tag for observations | Y | Observables | Obs |
| **Tsys** | System temperature | | Observables | Obs |
| **UVFperAsec** | U V in FR per arcsec from CALC | | Solve | Obs |
| **WVR** | WVR data | | *Station* | Station |

## 14.2 Detailed Listing of vgosDB files.

Unless otherwise noted, all variables in each file are required.

### vgosDB File 1. AmbigSize_b?. Band dependent.

| **Variable Name** | **Description** | **Type** | **Dimension** |
|---|---|---|---|
| **AmbigSize** | Size of ambiguities (seconds) | Real*8 | (NumObs) |

### vgosDB File 2. AntennaApriori.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **AntennaName** | Site names array. | Character*8 | (NumStation) |
| **AxisOffset** | Axis offsets (m). | Real*8 | (NumStation) |
| **AxisTilt** | Fixed axis tilt | Real*8 | (2, NumStation) |
| **AxisType** | Axis type (1-eq 2-xy 3-azel 4 5) | Integer*4 | (NumStation) |

### vgosDB File 3. AtmSetup.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **AtmRateSite** | Site list for atm rate constraints | Character*8 | (NumStation) |
| **AtmRateConstraint** | Atmosphere constraint. ps/hr | Real*8 | (NumStation) |
| **AtmInterval** | Batchmode atmos interval - hours | Real*8 | (NumStation) |
| **GradOffsetConstraint** | Gradient Offset Constraint | Real*8 | (NumStation) |
| **GradRateConstraint** | Gradient Rate Constraint | Real*8 | (NumStation) |

### vgosDB File 4. AzEl.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **AzTheo** | Azimuth array definition | Real*8 | (TimeDim2, NumStatScan) |
| **ElTheo** | Elevation array definition | Real*8 | (TimeDim2, NumStatScan) |

### vgosDB File 5. Baseline.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **Baseline** | Ref and rem site names. | Character*8 | (2, NumObs) |

### vgosDB File 6. BaselineClockSetup.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **BaselineClockSite** | List of baseline dependent clocks | Integer*4 | See Note |
| **BaselineClock** | Bl-dependent clock list | Character*16 | See Note |

Used by solve. The dimension is equal to the number of baseline dependent clocks.

### vgosDB File 7. Cal-AxisOffset.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **AxisOffsetCal** | New Axis Offset Contributions | Real*8 | (TimeDim2, NumStatScan) |

### vgosDB File 8. Cal-Bend.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **BendCal** | Consensus bending contrib. (sec) | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 9. Cal-BendSun.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **BendSunCal** | Consensus bending contrib. (sec) | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 10. Cal-BendSunHigher.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **BendSunHigherCal** | High order bending contrib.(sec) | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 11. Cal-Cable.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **CableCal** | Cable calibration data | Real*8 | (NumStatScan) |
| **History** | Description of cable-cal processing | Character*60 | - |
| **CableCalDataFlag** | 0=OK, -1=Missing, -2=bad, 1=Used Near point | Integer*4 | (NumStatScan) |

### vgosDB File 12. Cal-ClockApriori.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **ClockAprioriCal** | Apriori clock contribution to delay, rate. | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 13. Cal-EarthTide.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **EarthTideCal** | Earth tide contributions def. | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 14. Cal-EccentricityMap.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **EccentricityMapCal** | Adding this maps the observables to the monument. | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 15. Cal-FeedCorrection.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **FeedCorrectionCal** | Feedhorn corr. in CORFIL scheme | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 16. Cal-HFEOP-IERS2003.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **UT1OrthoCal** | ORTHO_EOP Tidal UT1 contribution | Real*8 | (TimeDim2, NumObs) |
| **WobOrthoCal** | ORTHO_EOP tidal wobble contribution | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 17. Cal-IonGroup_b?.nc Band dependent.

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **IonGroupCal** | Ion correction. Add to delay | Real*8 | (TimeDim2, NumObs) |
| **IonGroupCalDataFlag** | 0=OK, -1=Missing, -2=bad | Integer*4 | (NumObs) |
| **IonGroupCalSigma** | Ion correction to sigma. Sec | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 18. Cal-IonPhase_b?.nc Band dependent.

| Variable Name | Description | Type | Dimension |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **IonPhaseCal** | Phase Correction Iono | Real*8 | (NumObs) |
| **IonPhaseCalSigma** | Phase Correction RMS | Real*8 | (NumObs) |

### vgosDB File 19. Cal-NMFDry.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **NMFDryCal** | Nhmf (dry) atm. Contribution | Real*8 | (TimeDim2, NumStatScan) |

### vgosDB File 20. Cal-NMFWet.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **NMFWetCal** | Whmf (wet) atm. Contribution | Real*8 | (TimeDim2, NumStatScan) |

### vgosDB File 21. Cal-NutWahr.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **NutWahrCal** | 2000A Nut to Wahr Nut Contribution | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 22. Cal-OceanLoad.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **OceanLoadHorizCal** | Site-dep ocean cont - horizontal | Real*8 | (TimeDim2, NumStatScan) |
| **OceanLoadVertCal** | Site-dep ocean cont - vertical | Real*8 | (TimeDim2, NumStatScan) |
| **OceanLoadCal** | Obs dependent ocean loading | Real*8 | (TimeDim2, NumStatScan) |

### vgosDB File 23. Cal-Parallax.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **ParallaxCal** | Parallax partial/contribution 1 parsec | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 24. Cal-PoleTide.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **PoleTideCal** | Pole tide contributions def. | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 25. Cal-PoleTideOldRestore.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **PoleTideOldRestoreCal** | Old Pole Tide Restorer Contrib. | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 26. Cal-TiltRemover.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **TiltRemoverCal** | Axis Tilt Contribution Remover | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 27. Cal-UnphaseCal.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **UnPhaseCal** | UnPhaseCal effect – group & rate | Real*8 | (2, TimeDim2, NumObs) |

### vgosDB File 28. Cal-Wobble.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **XwobbleCal** | X Wobble contribution definition | Real*8 | (TimeDim2, NumObs) |
| **YwobbleCal** | Y Wobble contribution definition | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 29. Cal-WobNut.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **WobNutCal** | Short period nutation wobble con | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 30. CalcEop.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **CalcUt1Module** | UT1 Module message definition | Character*80 | - |
| **CalcWobModule** | Wobble message definition. | Character*80 | - |
| **UT1ArrayInfo** | Array: (FJD of start, spacing in days, number points, Scaling (should be 1)) | Real*8 | (4) |
| **UT1IntrpMode** | Message for UT1 interp. scheme | Character*60 | - |
| **UT1Origin** | Final Value TAI-UT1 origin text. | Character*80 | - |
| **UT1Values** | Final Value TAI-UT1 data points. | Real*8 | (15) |
| **WobArrayInfo** | Array: (FJD of start, spacing in days, number points) | Real*8 | (3) |
| **WobbleOrigin** | Final Value wobble origin text. | Character*80 | - |
| **WobValues** | Final wobble X Y component value | Real*8 | (2,15) |
| **WobIntrpMode** | Interp. scheme for polar motion. | Character*60 | - |

This file contains information about the EOP values Calc used in its processing.

### vgosDB File 31. CalcInfo.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **ATIFlag** | ATIME Flow Control Message Def. | Character*80 | - |
| **ATIMessage** | ATIME Message Definition | Character*80 | - |
| **ATMFlag** | Atmosphere control flag mess def | Character*80 | - |
| **ATMMessage** | Atmosphere message definition | Character*80 | - |
| **AxisOffsetFlag** | Axis Offset Control flag mes def | Character*80 | - |
| **AxisOffsetMessage** | Axis Offset Message Definition | Character*80 | - |
| **CalcFlagNames** | CALC flow control flags name def | Character*4 | (31) |
| **CalcFlagValues** | CALC flow control flags value def | Integer*4 | (31) |
| **CalcVersion** | CALC version number | Real*8 | - |
| **CoronaData** | Corona model parameters. | Real*8 | (2) |
| **CTIFlag** | CTIMG Flow Control Message Der | Character*80 | - |
| **CTIMessage** | CTIMG Message Definition | Character*80 | - |
| **EarthTideData** | Earth tide module data (la. h l) | Real*8 | (3) |

|  |  |  |  |
|---|---|---|---|
| **EarthTideFlag** | Earth Tide flow control mess def | Character*80 | - |
| **EarthTideMessage** | Earth Tide message definition | Character*80 | - |
| **FeedhornMessage** | Feedhorn rot. angle mod. ident. | Character*80 | - |
| **NutationFlag** | Nutation flow control mess def. | Character*80 | - |
| **NutationMessage** | Nutation message definition | Character*80 | - |
| **OceanAmpEW** | Ocean amp. E-W component(meters) | Real*8 | (NumStation, 2) |
| **OceanAmpNS** | Ocean amp. N-S component(meters) | Real*8 | (NumStation, 2) |
| **OceanAmpUp** | Ocean amp. radial comp.-meters. | Real*8 | (NumStation, 2) |
| **OceanFlag** | Ocean load flow control mess def | Character*80 | - |
| **OceanHorizontalAmp** | Horz ocean loading ampltudes (m) | Real*8 | (11,2, NumStation) |
| **OceanHorizontalPhase** | Horz ocean loading phases (rad). | Real*8 | (11,2, NumStation) |
| **OceanMessage** | Ocean loading message definition | Character*80 | - |
| **OceanPhaseEW** | Ocean phase E-W component (rad) | Real*8 | (NumStation, 2) |
| **OceanPhaseNS** | Ocean phase N-S component (rad) | Real*8 | (NumStation, 2) |
| **OceanPhaseUp** | Ocean phase radial comp.-radians | Real*8 | (NumStation, 2) |
| **OceanStations** | Ocean loading station status. | Character*4 | (NumStation) |
| **OceanUpAmp** | Vert ocean loading ampltudes (m) | Real*8 | (NumStation, 11) |
| **OceanUpPhase** | Vert ocean loading phases (rad). | Real*8 | (NumStation, 11) |
| **ParallaxFlag** | Parallax flow control mess def | Character*80 | - |
| **ParallaxMessage** | Parallax message definition | Character*80 | - |
| **PepMessage** | PEP Utility Message Definition | Character*80 | - |
| **PoleTideFlag** | Pole tide flow control mess def | Character*80 | - |
| **PoleTideMessage** | Pole tide message definition | Character*80 | - |
| **PrecessionData** | Precession constant (asec/cent). | Real*8 | - |
| **PrecessionFlag** | Precession flow contril mess def | Character*80 | - |
| **PrecessionMessage** | Precession message definition | Character*80 | - |
| **RelativityFlag** | Relativistic bending use status | Character*60 | - |
| **RelativityMessage** | Relativity mod data (gamma). | Real*8 | - |
| **SiteMessage** | Site Module Message Definition | Character*80 | - |
| **SiteZenithDelay** | Site zenith path delays (nsec). | Real*8 | (NumStation) |
| **StarMessage** | Star module message definition | Character*80 | - |
| **StarParallaxFlag** | Parallax flow control mess def | Character*80 | - |
| **TheoryMessage** | Theory module identification | Character*80 | - |
| **TidalUT1Flag** | Flag for tidal terms in UT1 secs | Integer*4 | - |
| **UT1EPOCH** | TAI - UT1 epoch value definition | Real*8 | (2,2) |
| **UT1Flag** | UT1 control flag message def. | Character*80 | - |
| **WobbleFlag** | Wobble flow control mess def. | Character*80 | - |
| **WOBEPOCH** | Interpolated wobble array def | Real*8 | (2,2) |

## vgosDB File 32. CalibrationSetup.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|

|  |  |  |  |
|---|---|---|---|
| **CalStationName** | List of sites for standard cal | Character*8 | (NumStation) |
| **FlybyFlag** | Standard flybycal configuration | Integer*4 | (7,NumStation) |
| **FlybyName** | Key to the standard flybycal config | Character*8 | (8) |
| **ObsCalFlag** | Bit set indicate that calibration is recommended. | Integer*4 | - |
| **ObsCalName** | Available obs dependent calibrations (poletide, earthtide, …) | Character*8 | (14) |
| **StatCalFlag** | Bit set indicate that calibration is recommended. | Integer*4 | (NumStation) |
| **StatCalName** | Station dependent calibrations (Cable, Phase, etc.…) | Character*8 | (6) |

There are currently 14 observation dependent calibrations in solve. This number may change.

### vgosDB File 33. ClockApriori.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **ClockAprioriRate** | A priori clock drift (sec/sec) | Real*8 | See note |
| **ClockAprioriOffset** | A priori clock offset (sec) | Real*8 | See note |
| **ClockAprioriSite** | Stations with a priori clock mod | Character*8 | See note |

The ClockApriori.nc file is required only if there is a priori clock information.  The dimension of the variables depends on the number of clocks with a priori information. Table 39 is a dump of the variable information for T2034 where there is information for two sites.

**Table 39. Apriori clock information for T2034.**

```
ClockAprioriSite =
 "GGAO7108",
 "MEDICINA" ;
 ClockAprioriOffset = 1, -0.00010329265 ;
 ClockAprioriRate = 0, 4.0358e-12 ;
```

### vgosDB File 34. ClockBreak.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **BRK_NUMB** | Number of batchmode clock breaks | Integer*4 | - |
| **CLKBREAK** | Status of clock break existence (YE or NO) | Character*2 | - |
| **ClockBreakEpoch** | Batchmode clock break epochs | Real*8 | BRK_NUMB |
| **ClockBreakFlag** | Batchmode clock break flags | Integer*4 | BRK_NUMB |
| **ClockBreakSite** | Sites with real clock breaks | Character*8 | BRK_NUMB |

### vgosDB File 35. ClockSetup.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **CLK_CFLG** | Clock constraint use flag. YE or NO | Character*2 | - |
| **ClockInterval** | Batchmode clock interval – hours | Real*8 | - |
| **ClockRateConstraint** | Clock constraint-Parts in 1.e14 | Real*8 | - |
| **ClockRateName** | Site list for clocks constraints | Character*8 | (NumStation) |
| **NumClockRefSite** | # of clock reference stations | Integer*4 | - |

| | | | |
|---|---|---|---|
| **ReferenceClock** | List of clock reference stations | Character*8 | - |

### vgosDB File 36. Correlation_b?.nc Band dependent.

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **Correlation** | Corr coeff (0 --> 1). | Real*8 | (NumObs) |

### vgosDB File 37. CorrInfo_b?.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **ABASACCE** | Corel bas/apr accel (1/sec**2). | Real*8 | (NumObs) |
| **ABASDEL** | Corel bas/apr delay (sec). | Real*8 | (NumObs) |
| **ABASRATE** | Corel bas/apr delay rate (s/s). | Real*8 | (NumObs) |
| **APCLOFST** | Apriori clock offset microsec. | Real*8 | (NumObs) |
| **AUTOEDIT** | 1=Run resulted from AUTOEDIT. | Integer*4 | (NumObs) |
| **BBCIndex** | Physical BBC number by channel. | Integer*4 | (2, NumChannels, NumObs) |
| **BITSAMPL** | Number of bits per sample. | Integer*4 | (NumObs) |
| **ChanAmpPhase** | Amp(0-1) phs by chan(-180to180) | Integer*4 | (2, NumChannels, NumObs) |
| **ChannelFreq** | RF freq by channel (MHz). | Real*8 | (NumChannels, NumObs) |
| **ChannelID** | One-letter Fourfit channel ID. | Character*32 | (NumObs) |
| **CORBASCD** | Correlator baseline code (2 ch). | Character*2 | (NumObs) |
| **CORBASNO** | Correlator baseline number. | Integer*4 | (NumObs) |
| **CORCLOCK** | Clock offset(sec)/rate(sec/sec). | Real*8 | (2,2, NumObs) |
| **CorCofErr** | Corr. Coeff. formal error | Real*8 | (NumObs) |
| **CORELVER** | Correlator software version numb | Integer*4 | (NumObs) |
| **CROOTFIL** | Correlator root file name. | Character*16 | (NumObs) |
| **DBEDITVE** | Dbedit revision date YYYY MM DD | Integer*4 | (3,NumObs) |
| **DELOBSVM** | Obs delay at central epoch us. | Real*8 | (2, NumObs) |
| **DELRESID** | Delay residual (sec). | Real*8 | (NumObs) |
| **DELTAEPO** | Offset from center of scan (sec) | Real*8 | (NumObs) |
| **DISCARD** | Percent data discarded by FRNGE. | Real*8 | (NumObs) |
| **DLYEPO+1** | Phase delay at epoch+1 sec. | Real*8 | (2, NumObs) |
| **DLYEPO-1** | Phase delay at epoch-1 sec. | Real*8 | (2, NumObs) |
| **DURATION** | Scan duration (sec). | Real*8 | (NumObs) |
| **EffectiveDuration** | Effective run duration sec. | Real*8 | (NumObs) |
| **ERRORATE** | Log err rate by sta sb channel | Integer*4 | (2,2, NumChannels, NumObs) |
| **FOURFFIL** | Fourfit output filename. | Character*16 | (NumObs) |
| **FOURFFXS** | Fourfit output filename S-band | Character*16 | (NumObs) |
| **FOURFUTC** | Fourfit processing time YMDHMS. | Integer*4 | (6, NumObs) |
| **FOURFVER** | Fourfit version number. | Integer*4 | (2, NumObs) |
| **FRNGERR** | Fourfit error flag blank=OK. | Character*2 | (NumObs) |
| **FRQGROUP** | Frequency group code. | Character*2 | (NumObs) |

| | | | |
|---|---|---|---|
| **GeocMBD** | Tot geocenter group delay (sec). | Real*8 | (NumObs) |
| **GeocPhase** | Tot phase ref to cen of Earth. | Real*8 | (NumObs) |
| **GeocRate** | Tot geocenter delay rate (s/s). | Real*8 | (NumObs) |
| **GeocResidPhase** | Resid phs corrected to cen of E. | Real*8 | (NumObs) |
| **GeocSBD** | Tot geocenter sbd delay (sec). | Real*8 | (NumObs) |
| **IDELAY** | Corel instrumental delay (sec). | Real*8 | (2, NumObs) |
| **INCOH2** | Incoh amp from FRNGE plot segs. | Real*8 | (NumObs) |
| **INCOHAMP** | Fr. amp from incoh int of chan. | Real*8 | (NumObs) |
| **INDEXNUM** | Corel index numbers by sb freq. | Integer*4 | (2,16,NumObs) |
| **LOFreq** | LO frequencies per cha/sta MHz. | Real*8 | (2, NumChannels, NumObs) |
| **NumAccum** | No. of accum. periods in Channel | Integer*4 | (32, NumObs) |
| **NumAp** | # of AP by sideband and channel. | Integer*4 | (2, NumChannels, NumObs) |
| **NumBBCFreqs** | No. of BBC frequencies in Band | Integer*4 | (NumObs) |
| **NumChannels** | No. of U-L pairs in integration. | Integer*4 | (NumObs) |
| **NumSamples** | # of samples by sideband and cha | Real*8 | (2, NumChannels, NumObs) |
| **OCCUPNUM** | Site Occupation Number. | Character*8 | (2, NumObs) |
| **ORIGFILE** | Original COREL file name. | Character*6 | (NumObs) |
| **PHASECAL** | PC rate by sta ( us per s). | Real*8 | (2, NumObs) |
| **PhaseCalAmpPhase** | PC amp phs frq by sta channel. | Integer*2 | (3,2, NumChannels, NumObs) |
| **PhaseCalOffset** | Phase cal offset (-18000/18000). | Integer*4 | (2, NumChannels, NumObs) |
| **Polarization** | Polarization per sta/chan R/L. | Character*4 | (NumChannels, NumObs) |
| **ProbFalseDetection** | Prob of false det from FRNGE. | Real*8 | (NumObs) |
| **QBFACTOR** | Measure of uniformity of data. | Real*8 | (NumObs) |
| **RATOBSVM** | Obs rate at central epoch . | Real*8 | (NumObs) |
| **RATRESID** | Rate resid (sec per sec). | Real*8 | (NumObs) |
| **RECSETUP** | Samp rate(kHz) Frames/PP PP/AP. | Integer*4 | (3,NumObs) |
| **RECTRACK** | Trk table by sta sideb channel. | Integer*4 | (2,2,14,NumObs) |
| **REFCLKER** | Ref sta clock epoch microsec. | Real*8 | (NumObs) |
| **RunCode** | Run code e.g. "329-1300". | Character*8 | (NumObs) |
| **S2EFFREQ** | Effective group freq for ion. | Real*8 | (NumObs) |
| **S2PHEFRQ** | Effective phase frequency | Real*8 | (NumObs) |
| **S2REFREQ** | Effective frequency for rate | Real*8 | (NumObs) |
| **SampleRate** | Sample rate (Hz). | Real*8 | (NumObs) |
| **SBRESID** | Single band delay residual. | Real*8 | (NumObs) |
| **SRCHPAR** | FRNGE/Fourfit search parameters. | Real*8 | (6,NumObs) |
| **STARELEV** | Elev angles calc by COREL. | Real*8 | (2, NumObs) |
| **StartOffset** | Offset nominal start time (sec). | Integer*4 | (NumObs) |
| **STARTSEC** | Start time in sec past hour. | Real*8 | (NumObs) |
| **StopOffset** | Offset nominal stop time (sec). | Integer*4 | (NumObs) |
| **StopSec** | Stop time in sec past hour. | Real*8 | (NumObs) |

| | | | |
|---|---|---|---|
| **TapeCode** | Tape quality code. | Character*6 | (NumObs) |
| **TAPEID** | Raw data tape ID for ref and rem | Character*8 | (2, NumObs) |
| **TimeSinceStart** | Interval since start time (sec). | Real*8 | (NumObs) |
| **TotalFringeErr** | Total fringe phase error (deg) | Real*8 | (NumObs) |
| **TOTPCENT** | Tot phase at central epoch. | Real*8 | (NumObs) |
| **UTCCorr** | UTC time tag of correlation. | Integer*4 | (6,NumObs) |
| **UTCErr** | A priori UTC error site 1 (sec) | Real*8 | (NumObs) |
| **UTCMidObs** | UTC at central epoch YMDHMS. | Integer*4 | (6,NumObs) |
| **UTCProc** | YDDD of COREL by sta channel. | Integer*4 | (2,14,NumObs) |
| **UTCScan** | Nominal scan time YMDHMS. | Integer*4 | (6,NumObs) |
| **UTCVLB2** | UTC of FRNGE proc YMDHMS. | Integer*4 | (6,NumObs) |
| **VFDWELL** | Dwell time in each channel (sec) | Real*8 | (NumObs) |
| **VFRQAM** | Normalized channel amplitude | Real*8 | (32, NumObs) |
| **VFRQPCAM** | Phase cal tone Amplitudes | Real*8 | (2,32, NumObs) |
| **VFRQPCFR** | Phase cal tone Frequencies | Real*8 | (2,32, NumObs) |
| **VFRQPCPH** | PHASE cal tone Phases | Real*8 | (2,32, NumObs) |
| **VFRQPH** | Channel Phase (degrees) | Real*8 | (32, NumObs) |
| **VIRTFREQ** | Sky Frequencies | Real*8 | (32, NumObs) |
| **VLB1FILE** | Correlator file name. | Character*6 | (NumObs) |
| **VLB1XTNT** | corr. ext by sideb channel. | Integer*4 | (NumObs) |
| **VLB2PRG** | FRNGE(YYMMDD) Fourfit(x.x) ver. | Character*6 | (NumObs) |
| **VLB2XTNT** | FRNGE extent number. | Integer*4 | (NumObs) |
| **URVR** | Rate derivatives mHz per asec. | Real*8 | (2, NumObs) |
| **ZDELAY** | Corel zenith atmos. delay (sec). | Real*8 | (2, NumObs) |

The vgosDB file CorrInfo.nc contains information about the correlation and fringing process and other information about the session. This information is seldom used but is kept for archival purposes. The exact data in this file depends on the correlator used and the version of the correlator software. Software developers are encouraged to dump as much information as they think may someday be used. They are also encouraged to use as many of the above vgosDB variables which make sense, adding new ones as appropriate.

### vgosDB File 38. DelayDataFlag_b?.nc Band dependent.

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **DelayDataFlag** | 0=OK, -1=Missing, -2=bad,-3=sigma small, -4=sigma big | Integer*4 | (NumObs) |

### vgosDB File 39. DelayTheoretical.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **DelayTheoretical** | Consensus theoretical delay | Real*8 | (NumObs) |

### vgosDB File 40. Dis_kOceanLoad.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **OceanLoadDis** | Ocean load site dependent displace | Real*8 | (3,TimeDim2, NumStatScan) |

### vgosDB File 41. EccentricityApriori.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **EccentricityName** | Site names array. | Character*8 | (NumStation) |
| **EccentricityMonument** | Eccentricity monument name | Character*18 | (Numstation) |
| **EccentricityType** | Eccentricity type: XY or NE | Character*2 | (NumStation) |
| **EccentricityVector** | Eccentricity taken from eccentricity file. | Real*8 | (3,NumStation) |

### vgosDB File 42. Edit.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **DelayFlag** | Delay unweight flag | Integer*4 | (NumObs) |
| **PhaseFlag** | Phase unweight flag | Integer*4 | (NumObs) |
| **RateFlag** | Delay rate unweight flag. | Integer*4 | (NumObs) |
| **UserSup** | User action for suppression | Integer*4 | (NumObs) |

### vgosDB File 43. EffFreq_b?.nc Band dependent

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **FreqGroupIon** | Effective Group Delay Ionospheric Frequency | Real*8 | (NumObs) |
| **FreqPhaseIon** | Effective Phase Delay Ionospheric Frequency | Real*8 | (NumObs) |
| **FreqRateIon** | Effective Group Rate Ionospheric Frequency | Real*8 | (NumObs) |

### vgosDB File 44. EffFreq_kNoAmpWt_b?.nc Band dependent

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **FreqGroupIon** | Effective Group Delay Ionospheric Frequency. All channels equal wt. | Real*8 | (NumObs) |
| **FreqPhaseIon** | Effective Phase Delay Ionospheric Frequency. All channels equal wt. | Real*8 | (NumObs) |
| **FreqRateIon** | Effective Group Rate Ionospheric Frequency. All channels equal wt. | Real*8 | (NumObs) |

### vgosDB File 45. EopApriori.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **PolarMotion** | Polar motion X & Y for obs (rad) | Real*8 | (2, NumScan) |
| **UT1** | UT1 time of day for this obs. | Real*8 | (NumScan) |

### vgosDB File 46. EopSetup.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **UT1OffsetConstraint** | UT1 Offset Constraint | Real*8 | - |

| | | | |
|---|---|---|---|
| **WobOffsetConstraint** | Polar Motion Offset Constraint | Real*8 | - |

### vgosDB File 47. Ephemeris_kDE405JPL.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **EarthXYZ** | Earth barycentric coordinates. | Real*8 | (3, TimeDim3,NumScan) |
| **MoonXYZ** | Lunar geocentric coordinates. | Real*8 | (3, TimeDim2, NumScan) |
| **SunXYZ** | Solar geocentric coordinates. | Real*8 | (3, TimeDim2, NumScan) |

### vgosDB File 48. Head.nc

| Variable Name | Description | Type | Dimension | Required? |
|---|---|---|---|---|
| **Correlator** | Correlator name. | Character*32 | - | N |
| **CorrelatorType** | Correlator type: MK3/MK4/K4 etc. | Character* 8 | - | N |
| **ExpDescription** | Experiment description. | Character*80 | - | N |
| **ExpName** | Experiment name. | Character*16 | - | Y |
| **ExpSerialNumber** | Experiment Serial Number. | Integer*4 | - | N |
| **iUTCInterval** | First and last UTC time tag in input file. | Integer*2 | (5,2) | Y |
| **NumObs** | Number of observations (I*4) | Integer*4 | - | Y |
| **NumScan** | Number of Scans (Integer*4) | Integer*4 | - | Y |
| **NumSource** | Number of radio sources. | Integer*2 | - | Y |
| **NumStation** | Number of sites. | Integer*2 | - | Y |
| **PrincipalInvestigator** | Agency/contact_person/PI name. | Character*80 | - | N |
| **RecordingMode** | Recoding mode. | Character*80 | - | N |
| **SourceList** | Source names array. | Character*8 | (NumSource) | Y |
| **StationList** | Site names array. | Character*8 | (NumStation) | Y |

### vgosDB File 49. FeedRotation.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **FeedRotation** | Feedhorn rotation angle. | Real*8 | (NumStatScan) |

### vgosDB File 50. FeedRotNet.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **FeedRotNet** | Feedhorn correction for phase delay= FeedRotSite1-FeedRotSite2 | Real*8 | (NumObs) |

### vgosDB File 51. FractC.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **FractC** | Coordinate time at site 1 | Real*8 | (NumObs) |

### vgosDB File 52. GroupBLWeights.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **GroupBLWeightName** | B.L.names for formal errors | Character*8 | (2, XXX) |
| **GroupBLWeights** | Group delay and rate re-weighting constants. | Real*8 | (XXX, 2) |

The XXX dimension depends on the number of baseline weights. Usually this is the number of baselines.

### vgosDB File 53. GroupDelay_b?.nc Band dependent

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| GroupDelay | Delay observable produced by fringing. | Real*8 | (NumObs) |
| GroupDelaySig | Delay Measurement Sigma | Real*8 | (NumObs) |

### vgosDB File 54. GroupDelayFull_b?.nc Band dependent

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| GroupDelayFull | Delay Observable with ambiguities resolved and added. | Real*8 | (NumObs) |

### vgosDB File 55. GroupRate_b?.nc Band dependent

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| GroupRate | Rate Observable | Real*8 | (NumObs) |
| DataFlag | 0=OK, -1=Missing, -2=bad,-3=sigma small, -4=sigma big | Integer*4 | (NumObs) |
| GroupRateSig | Rate Measurement Sigma | Real*8 | (NumObs) |

### vgosDB File 56. IonBits.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| IonBits | ICORR for full ion tracking. | Integer*4 | (NumObs) |

### vgosDB File 57. IonSetup.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| IonSolveFlag | Bit flag indicating station has iono correction | Integer*4 | (NumStation) |
| IonStations | Stations with ionocorrection | Character*8 | (NumStation) |

### vgosDB File 58. Met.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| AtmPres | Pressure in hPa at site | Real*8 | (NumStatScan) |
| RelHum | Rel.Hum. at local WX st (50%=.5) | Real*8 | (NumStatScan) |
| TempC | Temp in C at local WX station | Real*8 | (NumStatScan) |

### vgosDB File 59. Misc.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| Aplength | Length of accumul. period in sec | Real*8 | |
| CableSign | Signs of cable cal application | Character*9 | - |
| StationNameCable | Stations for cable sign | Character*8 | (NumStation) |
| FourfitControlFile | Control file name for fourfit. | Character* | |
| FourFitCmdCString | Command string used for fourfit. | Character* | |
| NumLagsUsed | Num of lags used for correlation | Integer*4 | |
| LeapSecond | Leap second | Real*8 | - |

### vgosDB File 60. NGRADPAR.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **NMFGradPart** | Niell dry atm. gradient partials | Real*8 | (2,2, NumObs) |

### vgosDB File 61. NGSQualityFlag.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **NGSQualityFlag** | Zero means good. A Combination of Delay-Flag and IonCode | Integer*4 | (NumObs) |

### vgosDB File 62. NumGroupAmbig_b?.nc Band dependent

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **NumGroupAmbig** | Number of group delay ambiguities. | Integer*4 | (NumObs) |

### vgosDB File 63. NumPhaseAmbig_b?.nc Band dependent

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **NumPhaseAmbig** | Number of phase ambiguities. | Integer*4 | (NumObs) |

### vgosDB File 64. Nut_k2000PsiEps.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **Nut2000PsiEps** | IAU200A Nut. - Dpsi Deps Rates | Real*8 | (2,TimeDim2, NumScans) |

### vgosDB File 65. Nut_k2000XYS.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **Nut2000XYS** | CIP Coordinates X Y S and Rates | Real*8 | (3,TimeDim2, NumScans) |

### vgosDB File 66. Nut_kWahr.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **NutWahrPsiEps** | Wahr nut vals - Dpsi Deps&rates | Real*8 | (2, TimeDim2, NumScans) |

### vgosDB File 67. ObsCrossRef.nc

| Variable Name | Description | Type | Dimension | Required? |
|---|---|---|---|---|
| **Obs2Baseline** | Cross reference from observation to baseline. Stations assumed alphabetical. | Integer*4 | (2, NumObs) | Y |
| **Obs2Scan** | Cross reference from observation to scan | Integer*4 | (NumObs) | Y |

### vgosDB File 68. Part_ kAxisOffset.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **AxisOffsetPart** | Axis Offset partial deriv. def. | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 69. Part-Bend.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **BendPart** | Grav. bend. partial w.r.t. Gamma | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 70. Part-EOP.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **UT1Part** | UT1 partial derivatives def. | Real*8 | (2,TimeDim2, NumObs) |
| **WobblePart** | Wobble partial derivatives def. | Real*8 | (2,TimeDim2, NumObs) |

### vgosDB File 71. Part-Gamma.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **GammaPart** | Consensus partial w.r.t. Gamma | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 72. Part-NMFDry.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **NMFDryPart** | Nhmf2 dry partial deriv. def. | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 73. Part-NMFGrad.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **NMFGradEWPart** | NMF dry atm. EW Gradient Partials | Real*8 | (TimeDim2, NumObs) |
| **NMFGradNSPart** | NMF dry atm. NS Gradient Partials | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 74. Part-NMFWet.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **NMFWetPart** | NMF Wet Partial | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 75. Part-Nut2KPsiEps.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **Nut2000PsiEpsPart** | IAU2000A Nutation Psi Eps Partls | Real*8 | (2,TimeDim2, NumObs) |

### vgosDB File 76. Part-Nut2KXY.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **Nut2KXYPart** | IAU2000A Nutation X Y Partials | Real*8 | (2,TimeDim2, NumObs) |

### vgosDB File 77. Part-NutPsiEps.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **NutPsiEpsPart** | Pre Calc10 Nutation Partial | Real*8 | (2,TimeDim2, NumObs) |

### vgosDB File 78. Part-Parallax.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **ParallaxPart** | Parallax partial deriv. def. | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 79. Part-Poletide.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **WobPart** | Pole Tide Partials w.r.t. X & Y | Real*8 | (2,TimeDim2, NumObs) |

### vgosDB File 80. Part-Precession.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **PrecessionPart** | Precession partial deriv. def. | Real*8 | (TimeDim2, NumObs) |

### vgosDB File 81. Part-RaDec.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **RaDecPart** | Star partial derivatives def. | Real*8 | (2,TimeDim2, NumObs) |

### vgosDB File 82. Part-XYZ.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **XYZPart** | Site partials: dtau/dr_1=-dtau/dr_2 | Real*8 | (3,TimeDim2, NumObs) |

### vgosDB File 83. Phase_b?.nc Band dependent

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **Phase** | Total phase. | Real*8 | (NumObs) |
| **PhaseDataFlag** | 0=OK, -1=Missing, -2=bad,-3=sigma small, -4=sigma big | Integer*4 | (NumObs) |
| **PhaseSig** | Phase delay sigma. | Real*8 | (NumObs) |

### vgosDB File 84. PhaseBLWeights.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **PhaseBLWeights** | Phase formal error constants. | Real*8 | (2, NumBaselines) |

### vgosDB File 85. PhaseDelayFull_b?.nc Band dependent

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **PhaseDelayFull** | Phase delay resolved with ambiguities added. | Real*8 | (NumObs) |

### vgosDB File 86. QualityCode_b?.nc Band dependent

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **QualityCode** | FRNGE quality index 0 --> 9 | Character*1 | (NumObs) |

### vgosDB File 87. RateTheoretical.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **RateTheoretical** | Consensus theoretical rate. | Real*8 | (NumObs) |

### vgosDB File 88. RefFreq_b?.nc Band dependent

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **RefFreq** | Frequency to which phase is referenced. | Real*8 | - |

### vgosDB File 89. Rot_kCF2J2K.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **CF2J2K** | Crust-fixed to J2000 Rot. Matrix and derivatives. | Real*8 | (3,3,TimeDim3, NumScans) |

### vgosDB File 90. SBDelay_b?.nc Band dependent

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **SBDelay** | Single band delay | Real*8 | (NumObs) |
| **SBDelaySig** | Single band delay error | Real*8 | (NumObs) |

### vgosDB File 91. ScanCrossRef.nc

| Variable Name | Description | Type | Dimension | Required? |
|---|---|---|---|---|
| **Scan2Source** | Cross reference scan to source | Integer*4 | (NumScans) | Y |
| **SourceNameCrossRef** | Source names. (Character*8) | Character*8 | (NumSource) | Y |

### vgosDB File 92. ScanName.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **ScanName** | ScanName in database | Character*10 | (NumScans) |
| **ScanNameFull** | ScanName=UTC TimeTag + SourceName | Character*30 | (NumScans) |

Below is a partial dump of this file to illustrate the format.

**Table 40. Partial Dump of ScanName.nc**

```
ScanName =
 "004-1700 ",
 "004-1701 ",
 "004-1702 ",
 "004-1705 ",
 "004-1708a ",
 ….
ScanNameFull =
 "2010/01/04-17:00:20.0 0014+813",
 "2010/01/04-17:02:18.0 1636+473",
 "2010/01/04-17:03:03.0 1334-127",
 "2010/01/04-17:06:25.0 3C418  ",
```

### vgosDB File 93. ScanTimeMJD.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **DayFrac** | Fractional day time tag of scan | Real*8 | (NumScans) |
| **MJD** | MJD time tag of scan | Integer*4 | (NumScans) |

### vgosDB File 94. SelectionStatus.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **BaselineSelectionFlag** | Baseline selection bit mapped array. 1=some obs, etc. | Integer*4 | (NumStation, NumStation) |
| **SourceSelectionFlag** | Source selection status bit-mapped array. | Integer*4 | (NumSource) |

### vgosDB File 95. SNR_b?.nc Band dependent

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **SNR** | Signal to noise ratio. | Real*8 | (NumObs) |

## vgosDB File 96. Source.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **Source** | Radio source name. | Character*8 | (NumObs) |

## vgosDB File 97. SourceApriori.nc

| Variable Name | Description | Type | Dimension | Required? |
|---|---|---|---|---|
| **Source2000RaDec** | J2000 Source RA and Dec (Radians) | Real*8 | (2, NumSource) | Y |
| **SourceNameApriori** | Source names in RA order. | Character*8 | (NumSource) | Y |
| **SourceReference** | Source of coordinate values. | Character*20 | (NumSource) | N But recommneded |

## vgosDB File 98. SourceCrossRef.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **Scan2Source** | Cross reference scan to source | Integer*4 | (NumScans) |
| **SourceNameCrossRef** | Source names. | Character*8 | (NumSource) |

## vgosDB File 99. StationApriori.nc

| Variable Name | Description | Type | Dimension | Required? |
|---|---|---|---|---|
| **StationNameApriori** | Site names in alphabetical order | Character*8 | (NumStation) | Y |
| **StationXYZ** | Site cartesian coords (m). | Real*8 | (3, NumStation) | Y |

## vgosDB File 100. Station CrossRef.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **NumScansPerStation** | Number of scans per station. | Integer*4 | (NumStation) |
| **Scan2Station** | Cross reference scans to station | Integer*4 | (NumStation, NumScans) |
| **Station2Scan** | Cross reference station-scan to schedule-scan | Integer*4 | (NumStation, NumScans) |
| **StationNameCrossRef** | Site names in alphabetical order. Char*8 | Character*8 | (NumStation) |

## vgosDB File 101. TimeUTC.nc (for scans)

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **Second** | Seconds part of time tag for scan | Real*8 | (NumScans) |
| **YMDHM** | YMDHM time tag of scan | Integer*4 | (5, NumScans) |

## vgosDB File 102. TimeUTC.nc (for stations)

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **Second** | Seconds part of time-tag | Real*8 | (NumStatScan) |
| **YMDHM** | YMDHM time tag of station-scan | Integer*4 | (5, NumStatScan) |

## vgosDB File 103. TimeUTC.nc (for observations)

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **Second** | Seconds part of UTC TAG. | Real*8 | (NumObs) |
| **YMDHM** | YMDHM timetag of observation. | Integer*4 | (5, NumObs) |

### vgosDB File 104. Tsys.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **Tsys** | TSYS TMP (K) 14CH AND IF1 IF2 | Real*8 | (NumChannels, NumScans |

Only a few files have Tsys.nc.

### vgosDB File 105. UnPhaseCalFlag.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **UNPHAFLG** | UnPhaseCal flag | Integer*4 | (2, NumObs) |
| | | | (2, NumObs) |

### vgosDB File 106. UVFperAsec.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **UVFperAsec** | UV in FR per arcsec from CALC | Real*8 | (2, NumObs) |

### vgosDB File 107. WVR.nc

| Variable Name | Description | Type | Dimension |
|---|---|---|---|
| **F12VOLT** | F1, F2 VOLT . | Real*8 | (2, NumStatScan |
| **WVRDelay** | WVR LINE OF SIGHT & ZENITH(NSEC) | Real*8 | (2, NumStatScan) |
| **WVRQcode** | WVR DELAY DATA QUALITY CODE | Integer*4 | (2, NumStatScan) |
| **WVRTemp** | BRT TEMP (K) OF WVR ,F1,F2. | Real*8 | (2, NumStatScan) |
| **WVRTempRef** | REFERENCE1,2 WVR TEMP (K). | Real*8 | (3,NumStatScan) |

The variables included in WVR.nc depend on the kind of WVR instrument. The only required variable is WVRDelay.

# 15 Dictionary of vgosDB Variables

This section gives a complete list of all the vgosDB variables and their scope. Many vgosDB variable names take their names from the correspond Lcode names. vgosDB variable names are unique once you specify the station or band.

The table below gives the dimensions when they are fixed or can be determined in advance. A few dimensions can vary from database to database. For example, the dimensions of variables associated with the a priori clock depend on the number of stations we have a priori clock information for. In these cases you should refer to the documentation for the particular file.

For the most commonly used variables I tried to make the names mnemonic. Less commonly used variables that were in the MK3-DB kept their names even if they were obscure, e.g., the first variable ABASACCE. Many of the descriptions are copied directly over from the MK3-DB descriptions and may include spelling mistakes.

**Table 41. Complete list of vgosDB Variables**

| Name | Description | Scope | Directory | File | Type | Dim |
|---|---|---|---|---|---|---|
| **ABASACCE** | Corel bas/apr accel (1/sec**2). | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **ABASDEL** | Corel bas/apr delay (sec). | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **ABASRATE** | Corel bas/apr delay rate (s/s). | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **AmbigSize** | Group delay ambiguity spacing | Obs | Observables | AmbigSize_b? | Real*8 | (NumObs) |
| **AntennaName** | Site names array. | Session | Apriori | AntennaApriori | Char*8 | (NumStation) |
| **APCLOFST** | Apriori clock offset microsec. | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **Aplength** | Length of accumul. period in sec | Session | Solve | Misc | Real*8 | - |
| **ATIFlag** | ATIME Flow Control Message Def. | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **ATIMessage** | ATIME Message Definition | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **ATMFlag** | Atmosphere control flag mess def | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **AtmInterval** | Batchmode atmos interval - hours | Session | Solve | AtmSetup | Real*8 | (NumStat) |
| **ATMMessage** | Atmosphere message definition | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **AtmPres** | Pressure in hPa at site | Station | - | Met | Real*8 | (NumStatScan) |

| | | | | | | |
|---|---|---|---|---|---|---|
| **AtmRateConstraint** | Atmosphere constraint. ps/hr | Session | Solve | AtmSetup | Real*8 | (NumStat) |
| **AtmRateSite** | Site list for clocks constraints | Session | Solve | AtmSetup | Char*8 | (NumStat) |
| **AUTOEDIT** | 1=Run resulted from AUTOEDIT. | Obs | Observables | CorrInfo_b? | Integer*4 | (NumObs) |
| **AxisOffset** | Axis offsets (m). | Session | Apriori | AntennaApriori | Real*8 | (NumStation) |
| **AxisOffsetCal** | New Axis Offset Contributions | Station | - | Cal-AxisOffset | Real*8 | (TimeDim2, NumStatScan) |
| **AxisOffsetFlag** | Axis Offset Control flag mes def | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **AxisOffsetMessage** | Axis Offset Message Definition | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **AxisOffsetPart** | Axis Offset partial deriv. def. | Station | - | Part-AxisOffset | Real*8 | (TimeDim2, NumObs) |
| **AxisTilt** | Fixed axis tilt | Session | Apriori | AntennaApriori | Real*8 | (2, NumStation) |
| **AxisType** | Axis type (1-eq 2-xy 3-azel 4 5) | Session | Apriori | AntennaApriori | Integer*4 | (NumStation) |
| **AzTheo** | Azimuth array definition | Station | - | AzEl | Real*8 | (TimeDim2, NumStatScan) |
| **Baseline** | Ref and rem site names. | OBs | Observables | Baseline | Char*8 | (2, NumObs) |
| **BaselineClock** | List of baseline dependent clocks | Session | Solve | BaselineClockSetup | Integer*4 | (NumBslnClock) |
| **BaselineSelectionFlag** | Baseline selection bit mapped array. 1=some obs, etc. | Session | Solve | SelectionStatus | Integer*4 | (NumStation ,NumStation) |
| **BBCIndex** | Physical BBC number by channel. | Obs | Observables | CorrInfo_b? | Integer*4 | (2, NumChannels, NumObs) |
| **BendCal** | Consensus bending contrib. (sec) | Obs | ObsCalTheo | Cal-Bend | Real*8 | (TimeDim2, NumObs) |
| **BendPart** | Grav. bend. partial w.r.t. Gamma | Obs | ObsPart | Part-Bend | Real*8 | (TimeDim2, NumObs) |
| **BendSunCal** | Consensus bending contrib. (sec) | Obs | ObsCalTheo | Cal-BendSun | Real*8 | (TimeDim2, NumObs) |
| **BendSunHigherCal** | High order bending contrib.(sec) | Obs | ObsCalTheo | Cal-BendSunHigher | Real*8 | (TimeDim2, NumObs) |
| **BITSAMPL** | Number of bits per sample. | Obs | Observables | CorrInfo_b? | Integer*4 | (NumObs) |
| **BRK_NUMB** | Number of batchmode clock breaks | Session | Session | ClockBreak | Integer*4 | - |
| **CableCal** | Cable calibration data | Station | - | Cal-Cable | Real*8 | (NumStatScan) |

| | | | | | | |
|---|---|---|---|---|---|---|
| **CableCalDataFlag** | 0=OK, -1=Missing, -2=bad, 1=Used Near point | Station | - | Cal-Cable | Integer*4 | (NumStatScan) |
| **CableSign** | Signs of cable cal application | Session | Solve | Misc | Char*9 | - |
| **CalcFlagNames** | CALC flow control flags name def | Session | ObsTheoretical | CalcInfo | Char*4 | -31 |
| **CalcFlagValues** | CALC flow control flags valu def | Session | ObsTheoretical | CalcInfo | Integer*4 | -31 |
| **CalcUt1Module** | UT1 Module message definition | Session | Solve | CalcEop | Char*80 | - |
| **CalcVersion** | CALC version number | Session | ObsTheoretical | CalcInfo | Real*8 | - |
| **CalcWobModule** | Wobble message definition. | Session | Solve | CalcEop | Char*80 | - |
| **CalStationName** | List of sites for standard cal | Session | Solve | CalibrationSetup | Char*8 | (NumStation) |
| **CF2J2K** | Crust-fixed to J2000 Rot. Matrix and derivatives | Scan | Scan | Rot_kCF2J2K | Real*8 | (3,3,TimeDim3, NumScan) |
| **ChanAmpPhase** | Amp(0-1) phs by chan(-180to180) | Obs | Observables | CorrInfo_b? | Real*8 | (2, NumChannels, NumObs) |
| **ChannelFreq** | RF freq by channel (MHz). | Obs | Observables | CorrInfo_b? | Real*8 | (NumChannels, NumObs) |
| **ChannelID** | One-letter Fourfit channel ID. | Obs | Observables | CorrInfo_b? | Char*32 | (NumObs) |
| **CLK_CFLG** | Clock constraint use flag. | Session | Solve | ClockSetup | Char*2 | - |
| **CLKBREAK** | Status of clock break existence | Session | Session | ClockBreak | Char*2 | - |
| **ClockAprioriCal** | Apriori clock contribution to delay, rate. | Obs | ObsCalTheo | Cal-ClockApriori | Real*8 | (TimeDim2, NumObs) |
| **ClockAprioriOffset** | A priori clock offset (sec) | Session | Apriori | ClockApriori | Real*8 | See file |
| **ClockAprioriRate** | A priori clock drift (sec/sec) | Session | Apriori | ClockApriori | Real*8 | See file |
| **ClockAprioriSite** | Stations with a priori clock mod | Session | Apriori | ClockApriori | Char*8 | See file |
| **ClockBreakEpoch** | Batchmode clock break epochs | Session | Session | ClockBreak | Real*8 | BRK_NUMB |
| **ClockBreakFlag** | Batchmode clock break flags | Session | Session | ClockBreak | Integer*4 | BRK_NUMB |
| **ClockBreakSite** | Sites with real clock breaks | Session | Session | ClockBreak | Char*8 | BRK_NUMB |
| **ClockInterval** | Batchmode clock interval - hours | Session | Solve | ClockSetup | Real*8 | - |
| **ClockRateConstraint** | Clock constraint-Parts in 1.e14 | Session | Solve | ClockSetup | Real*8 | - |
| **ClockRateName** | Site list for clocks constraints | Session | Solve | ClockSetup | Char*8 | (NumStation) |
| **CORBASCD** | Correlator baseline code (2 ch). | Obs | Observables | CorrInfo_b? | Char*2 | (NumObs) |

| | | | | | | |
|---|---|---|---|---|---|---|
| **CORBASNO** | Correlator baseline number. | Obs | Observables | CorrInfo_b? | Integer*4 | (NumObs) |
| **CORCLOCK** | Clock offset(sec)/rate(sec/sec). | Obs | Observables | CorrInfo_b? | Real*8 | (2,2, NumObs) |
| **CorCofErr** | Corr. Coeff. formal error | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **CORELVER** | Correlator software version numb | Obs | Observables | CorrInfo_b? | Integer*4 | (NumObs) |
| **CoronaData** | Corona model parameters. | Session | ObsTheoretical | CalcInfo | Real*8 | (2) |
| **Correlation** | Corr coeff (0 --> 1) for S-band | Obs | Observables | Correlation_b? | Real*8 | (NumObs) |
| **Correlator** | Correlator name. | Session | - | Head | Char*32 | - |
| **CorrelatorType** | Correlator type: MK3/MK4/K4 etc. | Session | - | Head | Char*8 | - |
| **CROOTFIL** | Correlator root file name. | Obs | Observables | CorrInfo_b? | Char*60 | (NumObs) |
| **CTIFlag** | CTIMG Flow Control Message Der | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **CTIMessage** | CTIMG Message Definition | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **DataFlag** | 0=OK, -1=Missing, -2=bad,-3=sigma small, -4=sigma big | Obs | Observables | GroupRate_b? | Integer*4 | (NumObs) |
| **DayFrac** | Fractional day time tag of scan | Scan | Solve | ScanTimeMJD | Real*8 | (NumScan) |
| **DBEDITVE** | Dbedit revision date YYYY MM DD | Obs | Observables | CorrInfo_b? | Integer*4 | (3,NumObs) |
| **DelayDataFlag** | 0=OK, -1=Missing, -2=bad,-3=sigma small, -4=sigma big | Obs | Observables | DelayDataFlag_b? | Integer*4 | (NumObs) |
| **DelayFlag** | Delay unweight flag | Obs | ObsEdit | Edit | Integer*4 | (NumObs) |
| **DelayTheoretical** | Consensus theoretical delay | Obs | ObsTheoretical | DelayTheoretical | Real*8 | (NumObs) |
| **DELOBSVM** | Obs delay at central epoch us. | Obs | Observables | CorrInfo_b? | Real*8 | (2, NumObs) |
| **DELRESID** | Delay residual (sec). | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **DELTAEPO** | Offset from center of scan (sec) | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **DISCARD** | Percent data discarded by FRNGE. | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **DLYEPO+1** | Phase delay at epoch+1 sec. | Obs | Observables | CorrInfo_b? | Real*8 | (2, NumObs) |
| **DLYEPO-1** | Phase delay at epoch-1 sec. | Obs | Observables | CorrInfo_b? | Real*8 | (2, NumObs) |

| | | | | | | |
|---|---|---|---|---|---|---|
| **DomesNumber** | Domes number array | Session | Apriori | StationApriori | Char*8 | (NumStation) |
| **DURATION** | Scan duration (sec). | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **EarthTideCal** | Earth tide contributions def. | Obs | ObsCalTheo | Cal-EarthTide | Real*8 | (2, NumObs) |
| **EarthTideData** | Earth tide module data (la. h l) | Session | ObsTheoretical | CalcInfo | Real*8 | (3) |
| **EarthTideFlag** | Earth Tide flow control mess def | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **EarthTideMessage** | Earth Tide message definition | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **EarthXYZ** | Earth barycentric coordinates. | Scan | Scan | Ephemeris_kDE405JPL | Real*8 | (3, TimeDim3, NumScan) |
| **EccentricityMapCal** | Adding this maps the observables to the monument. | Obs | ObsCalTheo | Cal-EccentricityMap | Real*8 | (TimeDim2, NumObs) |
| **EccentricityMonument** | Eccentricity monument name | Session | Apriori | EccentricityApriori | Char*18 | (NumStation) |
| **EccentricityName** | Site names array. | Session | Apriori | EccentricityApriori | Char*8 | (NumStation) |
| **EccentricityType** | Eccentricity type: XY or NE | Session | Apriori | EccentricityApriori | Char*2 | (NumStation) |
| **EccentricityVector** | Eccentricity taken from eccentricity file. | Session | Apriori | EccentricityApriori | Real*8 | (3,NumStation) |
| **EffectiveDuration** | Effective run duration sec. | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **ElTheo** | Elevation array definition | Station | - | AzEl | Real*8 | (TimeDim2, NumStatScan) |
| **ERRORATE** | Log err rate by sta sb channel | Obs | Observables | CorrInfo_b? | Integer*4 | (2,2, NumChannels, NumObs) |
| **ExpDescription** | Experiment description. | Session | - | Head | Char*82 | - |
| **ExpName** | Observing program (exp.) name | Session | - | Head | Char*32 | - |
| **ExpSerialNumber** | Experiment Serial Number. | Session | - | Head | Integer*4 | - |
| **F12VOLT** | F1, F2 VOLT . | Station | - | WVR | Real*8 | (2,2) |
| **FeedCorrectionCal** | Feedhorn corr. in CORFIL scheme | Obs | ObsCalTheo | Cal-FeedCorrection | Real*8 | (TimeDim2, NumObs) |
| **FeedhornMessage** | Feedhorn rot. angle mod. ident. | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **FeedRotation** | Feedhorn rotation angle. | Station | - | FeedRotation | Real*8 | (NumStatScan) |
| **FeedRotNet** | Feedhorn correction for phase delay= FeedRotSite1-FeedRotSite2 | Obs | ObsDerived | FeedRotNet | Real*8 | (NumObs) |

| | | | | | | |
|---|---|---|---|---|---|---|
| **FlybyFlag** | Standard flcal configuration | Session | Solve | CalibrationSetup | Integer*4 | (7,NumStation) |
| **FlybyName** | Key to the standard flcal config | Session | Solve | CalibrationSetup | Char*8 | (8) |
| **FOURFFIL** | Fourfit output filename. | Obs | Observables | CorrInfo_b? | Char*16 | (NumObs) |
| **FOURFFXS** | Fourfit output filename S-band | Obs | Observables | CorrInfo_b? | Char*16 | (6, NumObs) |
| **FourFitCmdCString** | Command string used for fourfit. | Session | Solve | Misc | Char*128 | - |
| **FourfitControlFile** | Control file name for fourfit. | Session | Solve | Misc | Char*96 | - |
| **FOURFUTC** | Fourfit processing time YMDHMS. | Obs | Observables | CorrInfo_b? | Integer*4 | (2, NumObs) |
| **FOURFVER** | Fourfit version number. | Obs | Observables | CorrInfo_b? | Integer*4 | (NumObs) |
| **FractC** | Coordinate time at site 1 | Obs | Solve | FractC | Real*8 | (NumObs) |
| **FreqGroupIon** | Effective Group Delay Ionospheric Frequency | Obs | ObsDerived | EffFreq_b? | Real*8 | (NumObs) |
| **FreqPhaseIon** | Effective Phase Delay Ionospheric Frequency | Obs | ObsDerived | EffFreq_b? | Real*8 | (NumObs) |
| **FreqRateIon** | Effective Group Rate Ionospheric Frequency | Obs | ObsDerived | EffFreq_b? | Real*8 | (NumObs) |
| **FRNGERR** | Fourfit error flag blank=OK. | Obs | Observables | CorrInfo_b? | Char*2 | (NumObs) |
| **FRQGROUP** | Frequency group code. | Obs | Observables | CorrInfo_b? | Char*2 | (NumObs) |
| **GammaPart** | Consensus partial w.r.t. Gamma | Obs | ObsPart | Part-Gamma | Real*8 | (TimeDim2, NumObs) |
| **GeocMBD** | Tot geocenter group delay (sec). | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **GeocPhase** | Tot phase ref to cen of Earth. | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **GeocRate** | Tot geocenter delay rate (s/s). | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **GeocResidPhase** | Resid phs corrected to cen of E. | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **GeocSBD** | Tot geocenter sbd delay (sec). | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **GradOffsetConstraint** | Gradient Offset Constraint | Session | Solve | AtmSetup | Real*8 | (NumStat) |
| **GradRateConstraint** | Gradient Rate Constraint | Session | Solve | AtmSetup | Real*8 | (NumStat) |
| **GroupBLWeightName** | B.L.names for formal errors | Session | Session | GroupBLWeights | Char*8 | (2, XXX) |
| **GroupBLWeights** | Group delay and rate re-weighting constants. | Session | Session | GroupBLWeights | Real*8 | (XXX, 2) |
| **GroupDelay** | Observed group delay in sec. | Obs | OBSOLETE | - | Real*8 | (NumObs) |

| | | | | | | |
|---|---|---|---|---|---|---|
| **GroupDelayFull** | Delay Observable with ambiguities resolved and added. | Obs | ObsEdit | GroupDelayFull_b? | Real*8 | (NumObs) |
| **GroupDelaySig** | Delay Measurement Sigma | Obs | Observables | GroupDelay_b? | Real*8 | (NumObs) |
| **GroupRate** | Rate Observable | Obs | Observables | GroupRate_b? | Real*8 | (NumObs) |
| **GroupRateSig** | Rate Measurement Sigma | Obs | Observables | GroupRate_b? | Real*8 | (NumObs) |
| **History** | Description of cable-cal processing | Station | - | Cal-Cable | Char*60 | - |
| **IDELAY** | Corel instrumental delay (sec). | Obs | Observables | CorrInfo_b? | Real*8 | (2, NumObs) |
| **IERSDES** | IERZS Designation array | Session | Apriori | StationApriori | Char*8 | - |
| **INCOH2** | Incoh amp from FRNGE plot segs. | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **INCOHAMP** | Fr. amp from incoh int of chan. | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **INDEXNUM** | Corel index numbers by sb freq. | Obs | Observables | CorrInfo_b? | Integer*4 | (2,16,NumObs) |
| **IonBits** | ICORR for full ion tracking. | Obs | Solve | IonBits | Integer*4 | (NumObs) |
| **IonGroupCal** | Ion correction. Add to theo. sec | Obs | ObsDerived | Cal-IonGroup_b? | Real*8 | (TimeDim2, NumObs) |
| **IonGroupCalDataFlag** | 0=OK, -1=Missing, -2=bad | Obs | ObsDerived | Cal-IonGroup_b? | Integer*4 | (NumObs) |
| **IonGroupCalSigma** | Ion correction to sigma. sec | Obs | ObsDerived | Cal-IonGroup_b? | Real*8 | (TimeDim2, NumObs) |
| **IonPhaseCal** | Phase Corr Iono | Obs | ObsDerived | Cal-IonPhase_b? | Real*8 | (NumObs) |
| **IonPhaseCalSigma** | Phase Corr RMS | Obs | ObsDerived | Cal-IonPhase_b? | Real*8 | (NumObs) |
| **IonSolveFlag** | Bit flag indicating station has iono correction | Session | Solve | IonSetup | Integer*4 | (NumStation) |
| **IonStations** | Stations with ionocorrection | Session | Solve | IonSetup | Char*8 | (NumStation) |
| **iUTCInterval** | First and last UTC time tag in input file. | Session | - | Head | Integer*4 | (5,2) |
| **LeapSecond** | Leap second | Session | Solve | Misc | Real*8 | - |
| **LOFreq** | LO frequencies per cha/sta MHz. | Obs | Observables | CorrInfo_b? | Real*8 | (2, NumChannels, NumObs) |
| **MJD** | MJD time tag of scan | Scan | Solve | ScanTimeMJD | Integer*4 | (NumScan) |
| **MoonXYZ** | Lunar geocentric coordinates. | Scan | Scan | Ephemeris_kDE405JPL | Real*8 | (3,TimeDim2, NumScan) |

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|---|---|---|---|---|---|---|
| **NGSQualityFlag** | Zero means good. A Combination of DelayFlag and IonCode | Obs | ObsEdit | NGSQualityFlag | Integer*4 | (NumObs) |
| **NMFDryCal** | Nhmf (dry) atm. contribution | Station | - | Cal-NMFDry | Real*8 | (TimeDim2, NumStatScan) |
| **NMFDryPart** | Nhmf2 dry partial deriv. def. | Station | - | Part-NMFDry | Real*8 | (TimeDim2, NumObs) |
| **NMFGradEWPart** | NMF dry atm. EW Gradient Partials | Obs | ObsPart | Part-NMFGrad | Real*8 | (TimeDim2, NumObs) |
| **NMFGradNSPart** | NMF dry atm. NS Gradient Partials | Obs | ObsPart | Part-NMFGrad | Real*8 | (TimeDim2, NumObs) |
| **NMFGradPart** | Niell dry atm. gradient partials | Obs | - | NGRADPAR | Real*8 | (2,2,2) |
| **NMFWetCal** | Whmf (wet) atm. contribution | Station | - | Cal-NMFWet | Real*8 | (TimeDim2, NumStatScan) |
| **NMFWetPart** | NMF Wet Partial | Station | - | Part-NMFWet | Real*8 | (TimeDim2, NumObs) |
| **NumAccum** | No. of accum. periods in Channel | Obs | Observables | CorrInfo_b? | Integer*4 | (32, NumObs) |
| **NumAp** | # of AP by sideband and channel. | Obs | Observables | CorrInfo_b? | Integer*4 | (2, NumChannels, NumObs) |
| **NumBBCFreqs** | No. of BBC frequencies in Band | Obs | Observables | CorrInfo_b? | Integer*4 | (NumObs) |
| **NumChannels** | No. of U-L pairs in integration. | Obs | Observables | CorrInfo_b? | Integer*4 | (NumObs) |
| **NumClockRefSite** | # of clock reference stations | Session | Solve | ClockSetup | Integer*4 | - |
| **NumGroupAmbig** | Number of group delay ambiguities | Obs | ObsEdit | NumGroupAmbig_b? | Integer*4 | (NumObs) |
| **NumLagsUsed** | Num of lags used for correlation | Session | Solve | Misc | Integer*4 | - |
| **NumObs** | Number of observations (I*4) | Session | - | Head | Integer*4 | - |
| **NumPhaseAmbig** | Number of phase ambiguities | Obs | ObsEdit | NumPhaseAmbig_b? | Integer*4 | (NumObs) |
| **NumSamples** | # of samples by sideband and cha | Obs | Observables | CorrInfo_b? | Real*8 | (2, NumChannels, NumObs) |
| **NumScan** | Number of Scans (Integer*4) | Session | - | Head | Integer*4 | - |
| **NumScansPerStation** | Number of scans per station. | Session | CrossReference | StationCrossRef | Integer*4 | (NumStation) |

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|---|---|---|---|---|---|---|
| **NumSource** | Number of radio sources. | Session | - | Head | Integer*4 | - |
| **NumStation** | Number of sites. | Session | - | Head | Integer*4 | - |
| **Nut2000PsiEps** | IAU200A Nut. - Dpsi Deps Rates | Scan | Scan | Nut_k2000PsiEps | Real*8 | (2,TimeDim2, NumScan) |
| **Nut2000PsiEpsPart** | IAU2000A Nutation Psi Eps Partls | Obs | ObsPart | Part-Nut2KPsiEps | Real*8 | (2,TimeDim2, NumObs) |
| **Nut2000XYS** | CIP Coordinates X Y S and Rates | Scan | Scan | Nut_k2000XYS | Real*8 | (3, TimeDim2, NumScan) |
| **Nut2KXYPart** | IAU2000A Nutation X Y Partials | Obs | ObsPart | Part-Nut2KXY | Real*8 | (2,TimeDim2, NumObs) |
| **NutationFlag** | Nutation flow control mess def. | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **NutationMessage** | Nutation message definition | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **NutPsiEpsPart** | Pre Calc10 Nutation Partial | Obs | ObsPart | Part-NutPsiEps | Real*8 | (2,TimeDim2, NumObs) |
| **NutWahrCal** | 2000A Nut to Wahr Nut Contribution | Obs | ObsCalTheo | Cal-NutWahr | Real*8 | (TimeDim2, NumObs) |
| **NutWahrPsiEps** | Wahr nut vals - Dpsi Deps&rates | Scan | Scan | Nut_kWahr | Real*8 | (2,TimeDim2, NumScan) |
| **Obs2Baseline** | Cross reference from observation to baseline | Obs | CrossReference | ObsCrossRef | Integer*4 | (2, NumObs) |
| **Obs2Scan** | Cross reference from observation to scan | Obs | CrossReference | ObsCrossRef | Integer*4 | (NumObs) |
| **ObsCalFlag** | Bit set indicate that calibration is recommended. | Session | Solve | CalibrationSetup | Integer*4 | - |
| **ObsCalName** | Available obs dependent calibrations (poletide, earthtide, …) | Session | Solve | CalibrationSetup | Char* | (14) |
| **OCCUPNUM** | Site Occupation Number. | Obs | Observables | CorrInfo_b? | Char*8 | (2, NumObs) |
| **OceanAmpEW** | Ocean amp. E-W component(meters) | Session | ObsTheoretical | CalcInfo | Real*8 | (NumStation, 2) |
| **OceanAmpNS** | Ocean amp. N-S component(meters) | Session | ObsTheoretical | CalcInfo | Real*8 | (NumStation, 2) |
| **OceanAmpUp** | Ocean amp. radial comp.-meters. | Session | ObsTheoretical | CalcInfo | Real*8 | (NumStation, 2) |
| **OceanFlag** | Ocean load flow control mess def | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **OceanHorizontalAmp** | Horz ocean loading ampltudes (m) | Session | ObsTheoretical | CalcInfo | Real*8 | (11,2, NumStation) |

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|---|---|---|---|---|---|---|
| **OceanHorizontalPhase** | Horz ocean loading phases (rad). | Session | ObsTheoretical | CalcInfo | Real*8 | (11,2, NumStation) |
| **OceanLoadCal** | Obs dependent ocean loading | Obs | ObsCalTheo | Cal-OceanLoad | Real*8 | (TimeDim2, NumStatScan) |
| **OceanLoadDis** | Ocean load site dependent displace | Station | - | Dis-OceanLoad | Real*8 | (3, TimeDim2, NumStatScan) |
| **OceanLoadHorizCal** | Site-dep ocean cont - horizontal | Station | - | Cal-OceanLoad | Real*8 | (TimeDim2, NumStatScan) |
| **OceanLoadVertCal** | Site-dep ocean cont - vertical | Station | - | Cal-OceanLoad | Real*8 | (TimeDim2, NumStatScan) |
| **OceanMessage** | Ocean loading message definition | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **OceanPhaseEW** | Ocean phase E-W component (rad) | Session | ObsTheoretical | CalcInfo | Real*8 | (NumStation, 2) |
| **OceanPhaseNS** | Ocean phase N-S component (rad) | Session | ObsTheoretical | CalcInfo | Real*8 | (NumStation, 2) |
| **OceanPhaseUp** | Ocean phase radial comp.-radians | Session | ObsTheoretical | CalcInfo | Real*8 | (NumStation, 2) |
| **OceanStations** | Ocean loading station status. | Session | ObsTheoretical | CalcInfo | Char*4 | (NumStation) |
| **OceanUpAmp** | Vert ocean loading ampltudes (m) | Session | ObsTheoretical | CalcInfo | Real*8 | (NumStation, 11) |
| **OceanUpPhase** | Vert ocean loading phases (rad). | Session | ObsTheoretical | CalcInfo | Real*8 | (NumStation, 11) |
| **ORIGFILE** | Original COREL file name. | Obs | Observables | CorrInfo_b? | Char*6 | (NumObs) |
| **ParallaxCal** | Parallax partial/contr 1 parsec | Obs | ObsCalTheo | Cal-Parallax | Real*8 | (TimeDim2, NumObs) |
| **ParallaxFlag** | Parallax flow control mess def | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **ParallaxMessage** | Parallax message definition | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **ParallaxPart** | Parallax partial deriv. def. | Obs | ObsPart | Part-Parallax | Real*8 | (TimeDim2, NumObs) |
| **PepMessage** | PEP Utility Message Definition | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **Phase** | Total phase | Obs | Observables | Phase_b? | Real*8 | (NumObs) |
| **PhaseBLWeights** | Phase formal error constants | Session | Solve | PhaseBLWeights | Real*8 | (2, NumBaselines) |

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|---|---|---|---|---|---|---|
| **PHASECAL** | PC rate by sta ( us per s). | Obs | Observables | CorrInfo_b? | Real*8 | (2, NumObs) |
| **PhaseCalAmpPhase** | PC amp phs frq by sta channel. | Obs | Observables | CorrInfo_b? | Integer*4 | (3,2, NumChannels, NumObs) |
| **PhaseCalOffset** | Phase cal offset (-18000/18000). | Obs | Observables | CorrInfo_b? | Integer*4 | (2, NumChannels, NumObs) |
| **PhaseDataFlag** | 0=OK, -1=Missing, -2=bad,-3=sigma small, -4=sigma big | Obs | Observables | Phase_b? | Integer*4 | (NumObs) |
| **PhaseDelay** | Phase delay resolved with ambiguities added. | Obs | ObsEdit | PhaseDelayFull_b? | Real*8 | (NumObs) |
| **PhaseDelayFull** | Phase delay resolved with ambiguities added. | Obs | ObsEdit | PhaseDelayFull_b? | Real*8 | (NumObs) |
| **PhaseDelayRaw** | Unresolved phase delay | Obs | Observables | Phase_b? | Real*8 | (NumObs) |
| **PhaseFlag** | Phase unweight flag | Obs | ObsEdit | Edit | Integer*4 | (NumObs) |
| **PhaseSig** | Phase delay sigma. | Obs | Observables | Phase_b? | Real*8 | (NumObs) |
| **Polarization** | Polarization per sta/chan R/L. | Obs | Observables | CorrInfo_b? | Char* | (NumChannels, NumObs) |
| **PolarMotion** | Polar motion X & Y for obs (rad) | Scan | Scan | EOPApriori | Real*8 | (2, NumScan) |
| **PoleTideCal** | Pole tide contributions def. | Obs | ObsCalTheo | Cal-PoleTide | Real*8 | (TimeDim2, NumObs) |
| **PoleTideFlag** | Pole tide flow control mess def | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **PoleTideMessage** | Pole tide message definition | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **PoleTideOldRestoreCal** | Old Pole Tide Restorer Contrib. | Obs | ObsCalTheo | Cal-PoleTideOldRestore | Real*8 | (TimeDim2, NumObs) |
| **PrecessionData** | Precession constant (asec/cent). | Session | ObsTheoretical | CalcInfo | Real*8 | - |
| **PrecessionFlag** | Precession flow contril mess def | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **PrecessionMessage** | Precession message definition | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **PrecessionPart** | Precession partial deriv. def. | Obs | ObsPart | Part-Precession | Real*8 | (TimeDim2, NumObs) |
| **PrincipalInvestigator** | Agency/contact_person/PI name. | Session | - | Head | Char*80 | - |
| **ProbFalseDetection** | Prob of false det from FRNGE. | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |

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|---|---|---|---|---|---|---|
| **QBFACTOR** | Measure of uniformity of data. | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **QualityCode** | FRNGE quality index 0 --> 9 | Obs | Observables | QualityCode_b? | Char*1 | (NumObs) |
| **RaDecPart** | Star partial derivatives def. | Obs | ObsPart | Part-RaDec | Real*8 | (2,TimeDim2, NumObs) |
| **RateFlag** | Delay rate unweight flag. | Obs | ObsEdit | Edit | Integer*4 | (NumObs) |
| **RateTheoretical** | Consensus theoretical rate | Obs | ObsTheoretical | RateTheoretical | Real*8 | (NumObs) |
| **RATOBSVM** | Obs rate at central epoch . | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **RATRESID** | Rate resid (sec per sec). | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **RecordingMode** | Recoding mode. | Session | - | Head | Char*80 | - |
| **RECSETUP** | Samp rate(kHz) Frames/PP PP/AP. | Obs | Observables | CorrInfo_b? | Integer*4 | (3,NumObs) |
| **RECTRACK** | Trk table by sta sideb channel. | Obs | Observables | CorrInfo_b? | Integer*4 | (2,2,14,NumObs) |
| **REFCLKER** | Ref sta clock epoch microsec. | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **ReferenceClock** | Batchmode clock reference site | Session | Solve | ClockSetup | Char*8 | - |
| **RefFreq** | Frequency to which phase is referenced | Obs | Observables | RefFreq_b? | Real*8 | - |
| **RelativityFlag** | Relativistic bending use status | Session | ObsTheoretical | CalcInfo | Char*60 | - |
| **RelativityMessage** | Relativity mod data (gamma). | Session | ObsTheoretical | CalcInfo | Real*8 | - |
| **RelHum** | Rel.Hum. at local WX st (50%=.5) | Station | - | Met | Real*8 | (NumStatScan) |
| **RunCode** | Run code e.g. "329-1300". | Obs | Observables | CorrInfo_b? | Char*8 | (NumObs) |
| **S2EFFREQ** | Effective group freq for ion. | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **S2PHEFRQ** | Effective phase frequency | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **S2REFREQ** | Effective frequency for rate | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **SampleRate** | Sample rate (Hz). | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **SBDelay** | Single band delay | Obs | Observables | SBDelay_b? | Real*8 | (NumObs) |
| **SBDelaySig** | Single band delay error | Obs | Observables | SBDelay_b? | Real*8 | (NumObs) |
| **SBRESID** | Single band delay residual. | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **Scan2Source** | Cross reference scan to source | Session | CrossReference | SourceCrossRef | Integer*4 | (NumScan) |

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|---|---|---|---|---|---|---|
| **Scan2Station** | Cross reference scans to station | Session | CrossReference | StationCrossRef | Integer*4 | (NumStation, NumScan) |
| **ScanName** | Scan name in database | Scan | Scan | ScanName | Char*10 | (NumScan) |
| **ScanNameFull** | ScanName=UTC TimeTag + SourceName | Scan | Scan | ScanName | Char*30 | (NumScan) |
| **Second** | Seconds part of time tag for scan | Scan | Scan | TimeUTC | Real*8 | (NumScan) |
| **SiteMessage** | Site Module Message Definition | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **SiteZenithDelay** | Site zenith path delays (nsec). | Session | ObsTheoretical | CalcInfo | Real*8 | (NumStation) |
| **SNR** | Signal to noise ratio for S-band | Obs | Observables | SNR_b? | Real*8 | (NumObs) |
| **Source** | Radio source name. | Obs | Observables | Source | Char*8 | (NumObs) |
| **Source2000RaDec** | J2000 Source RA and Dec | Session | Apriori | SourceApriori | Real*8 | (2, NumSource) |
| **SourceList** | Source names array. | Session | - | Head | Char*8 | (NumSource) |
| **SourceNameApriori** | Source names in RA order. | Session | Apriori | SourceApriori | Char*8 | (NumSource) |
| **SourceNameCrossRef** | Source names. | Session | CrossReference | SourceCrossRef | Char*8 | (NumSource) |
| **SourceReference** | Source of coordinate values. | Session | Apriori | SourceApriori | Char*20 | (NumSource) |
| **SourceSelectionFlag** | Source selection status bit-mapped array. | Session | Solve | SelectionStatus | Integer*4 | (70) |
| **SRCHPAR** | FRNGE/Fourfit search parameters. | Obs | Observables | CorrInfo_b? | Real*8 | (6,NumObs) |
| **STARELEV** | Elev angles calc by COREL. | Obs | Observables | CorrInfo_b? | Real*8 | (2, NumObs) |
| **StarMessage** | Star module message definition | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **StarParallaxFlag** | Parallax flow control mess def | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **StartOffset** | Offset nominal start time (sec). | Obs | Observables | CorrInfo_b? | Integer*4 | (NumObs) |
| **STARTSEC** | Start time in sec past hour. | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **StatCalFlag** | Bit set indicate that calibration is recommended. | Session | Solve | CalibrationSetup | Integer*4 | (NumStation) |
| **StatCalName** | Station dependent calibrations (Cable, Phase, etc....) | Session | Solve | CalibrationSetup | Char*8 | (6) |
| **Station2Scan** | Cross reference station-scan to schedule-scan | Session | CrossReference | StationCrossRef | Integer*4 | (NumStation, NumScan) |

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|---|---|---|---|---|---|---|
| **StationList** | Site names array. | Session | - | Head | Char*8 | (NumStat) |
| **StationNameApriori** | Site names in alphabetical order | Session | Apriori | StationApriori | Char*8 | (NumStation) |
| **StationNameCable** | Stations for cable sign | Session | Solve | Misc | Char*8 | (NumStation) |
| **StationNameCrossRef** | Site names in alphabetical order | Session | CrossReference | StationCrossRef | Char* | (NumStation) |
| **StationXYZ** | Site cartesian coords (m). | Session | Apriori | StationApriori | Real*8 | (3, NumStation) |
| **StopOffset** | Offset nominal stop time (sec). | Obs | Observables | CorrInfo_b? | Integer*4 | (NumObs) |
| **StopSec** | Stop time in sec past hour. | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **SunXYZ** | Solar geocentric coordinates. | Scan | Scan | Ephemeris_kDE405JPL | Real*8 | (3, TimeDim2, NumScan) |
| **TapeCode** | Tape quality code. | Obs | Observables | CorrInfo_b? | Char*6 | (NumObs) |
| **TAPEID** | Raw data tape ID for ref and rem | Obs | Observables | CorrInfo_b? | Char*8 | (2, NumObs) |
| **TempC** | Temp in C at local WX station | Station | - | Met | Real*8 | (NumStatScan) |
| **TheoryMessage** | Theory module identification | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **TidalUT1Flag** | Flag for tidal terms in UT1 series | Session | ObsTheoretical | CalcInfo | Integer*4 | - |
| **TiltRemoverCal** | Axis Tilt Contribution Remover | Obs | ObsCalTheo | Cal-TiltRemover | Real*8 | (TimeDim2, NumObs) |
| **TimeSinceStart** | Interval since start time (sec). | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **TotalFringeErr** | Total fringe phase error (deg) | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **TOTPCENT** | Tot phase at central epoch. | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **Tsys** | TSYS TMP (K) 14CH AND IF1 IF2 | Obs | Observables | Tsys | Real*8 | (16,2) |
| **UNPHAFLG** | UnPhaseCal flag | Obs | Solve | UnPhaseCal | Integer*4 | (2,2) |
| **UnPhaseCal** | UnPhaseCal effect - group&rate | Obs | ObsCalTheo | Cal-UnphaseCal | Real*8 | (2, TimeDim2, NumObs) |
| **URVR** | Rate derivatives mHz per asec. | Obs | Observables | CorrInfo_b? | Real*8 | (2, NumObs) |
| **UserSup** | User action for suppression | Obs | ObsEdit | Edit | Integer*4 | (NumObs) |
| **UT1** | UT1 time of day for this obs. | Scan | Scan | EOPApriori | Real*8 | (NumScan) |
| **UT1ArrayInfo** | Array: (FJD of start, spacing in days, number points, Scaling (should be 1)) | Session | Solve | CalcEop | Real*8 | (4) |

| | | | | | | |
|---|---|---|---|---|---|---|
| **UT1EPOCH** | TAI - UT1 epoch value definition | Session | ObsTheoretical | CalcInfo | Real*8 | (2,2) |
| **UT1FLag** | UT1 control flag message def. | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **UT1IntrpMode** | Message for UT1 interp. scheme | Session | Solve | CalcEop | Char*60 | - |
| **UT1OffsetConstraint** | UT1 Offset Constraint | Session | Solve | EopSetup | Real*8 | - |
| **UT1Origin** | Final Value TAI-UT1 origin text. | Session | Solve | CalcEop | Char*80 | - |
| **UT1OrthoCal** | ORTHO_EOP Tidal UT1 contribution | Obs | ObsCalTheo | Cal-HFEOP-IERS2003 | Real*8 | (TimeDim2, NumObs) |
| **UT1Part** | UT1 partial derivatives def. | Obs | ObsPart | Part-EOP | Real*8 | (2,TimeDim2, NumObs) |
| **UT1Values** | Final Value TAI-UT1 data points. | Session | Solve | CalcEop | Real*8 | (15) |
| **UTCCorr** | UTC time tag of correlation. | Obs | Observables | CorrInfo_b? | Integer*4 | (6,NumObs) |
| **UTCErr** | A priori UTC error site 1 (sec) | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **UTCMidObs** | UTC at central epoch YMDHMS. | Obs | Observables | CorrInfo_b? | Integer*4 | (6,NumObs) |
| **UTCProc** | YDDD of COREL by sta channel. | Obs | Observables | CorrInfo_b? | Integer*4 | (2,14,NumObs) |
| **UTCScan** | Nominal scan time YMDHMS. | Obs | Observables | CorrInfo_b? | Integer*4 | (6,NumObs) |
| **UTCVLB2** | UTC of FRNGE proc YMDHMS. | Obs | Observables | CorrInfo_b? | Integer*4 | (6,NumObs) |
| **UVFperAsec** | U V in FR per arcsec from CALC | Obs | Solve | UVFperAsec | Real*8 | (2, NumObs) |
| **VFDWELL** | Dwell time in each channel (sec) | Obs | Observables | CorrInfo_b? | Real*8 | (NumObs) |
| **VFRQAM** | Normalized channel amplitude | Obs | Observables | CorrInfo_b? | Real*8 | (32, NumObs) |
| **VFRQPCAM** | Phase cal tone Amplitudes | Obs | Observables | CorrInfo_b? | Real*8 | (2,32, NumObs) |
| **VFRQPCFR** | Phase cal tone Frequencies | Obs | Observables | CorrInfo_b? | Real*8 | (2,32, NumObs) |
| **VFRQPCPH** | PHASE cal tone Phases | Obs | Observables | CorrInfo_b? | Real*8 | (2,32, NumObs) |
| **VFRQPH** | Channel Phase (degrees) | Obs | Observables | CorrInfo_b? | Real*8 | (32, NumObs) |
| **VIRTFREQ** | Sky Frequencies | Obs | Observables | CorrInfo_b? | Real*8 | (32, NumObs) |
| **VLB1FILE** | Correlator file name. | Obs | Observables | CorrInfo_b? | Char*6 | (NumObs) |
| **VLB1XTNT** | corr. ext by sideb channel. | Obs | Observables | CorrInfo_b? | Integer*4 | (NumObs) |
| **VLB2PRG** | FRNGE(YYMMDD) Fourfit(x.x) ver. | Obs | Observables | CorrInfo_b? | Char*6 | (NumObs) |

| | | | | | | |
|---|---|---|---|---|---|---|
| **VLB2XTNT** | FRNGE extent number. | Obs | Observables | CorrInfo_b? | Integer*4 | (NumObs) |
| **WobArrayInfo** | Array: (FJD of start, spacing in days, number points) | Session | Solve | CalcEop | Real*8 | (3) |
| **WobbleFlag** | Wobble flow control mess def. | Session | ObsTheoretical | CalcInfo | Char*80 | - |
| **WobbleOrigin** | Final Value wobble origin text. | Session | Solve | CalcEop | Char*80 | - |
| **WobblePart** | Wobble partial derivatives def. | Obs | ObsPart | Part-EOP | Real*8 | (2,TimeDim2, NumObs) |
| **WOBEPOCH** | Interpolated wobble array def | Session | ObsTheoretical | CalcInfo | Real*8 | (2,2) |
| **WobIntrpMode** | Interp. scheme for polar motion. | Session | Solve | CalcEop | Char*60 | - |
| **WobNutCal** | Short period nutation wobble con | Obs | ObsCalTheo | Cal-WobNut | Real*8 | (TimeDim2, NumObs) |
| **WobOffsetConstraint** | Polar Motion Offset Constraint | Session | Solve | EopSetup | Real*8 | - |
| **WobOrthoCal** | ORTHO_EOP tidal wobble contribution | Obs | ObsCalTheo | Cal-HFEOP-IERS2003 | Real*8 | (TimeDim2, NumObs) |
| **WobPart** | Pole Tide Partials w.r.t. X & Y | Obs | ObsPart | Part-Poletide | Real*8 | (2,TimeDim2, NumObs) |
| **WobValues** | Final wobble X Y component value | Session | Solve | CalcEop | Real*8 | (2,15) |
| **WVRDelay** | WVR LINE OF SIGHT & ZENITH(NSEC) | Station | - | WVR | Real*8 | (2,2,2) |
| **WVRQcode** | WVR DELAY DATA QUALITY CODE | Station | - | WVR | Integer*4 | (2) |
| **WVRTemp** | BRT TEMP (K) OF WVR ,F1,F2. | Station | - | WVR | Real*8 | (2,2) |
| **WVRTempRef** | REFERENCE1,2 WVR TEMP (K). | Station | - | WVR | Real*8 | (3,2) |
| **XwobbleCal** | X Wobble contribution definition | Obs | ObsCalTheo | Cal-Wobble | Real*8 | (TimeDim2, NumObs) |
| **XYZPart** | Site partials: dtau/dr_1=-dtau/dr_2 | OBs | ObsPart | Part-XYZ | Real*8 | (3,TimeDim2, NumObs) |
| **YMDHM** | YMDHM time tag of scan | Scan | Scan | TimeUTC | Integer*4 | (5, NumScan) |
| **YwobbleCal** | Y Wobble contribution definition | Obs | ObsCalTheo | Cal-Wobble | Real*8 | (TimeDim2, NumObs) |
| **ZDELAY** | Corel zenith atmos. delay (sec). | Obs | Observables | CorrInfo_b? | Real*8 | (2, NumObs) |

# 16 Mapping of Lcodes onto vgosDB variables

This appendix indicates how Lcodes are mapped to vgosDB variables. If the directory is given as OBSOLETE the Lcode is not mapped into a vgosDB variable.

| LCODE | vgosDB_variable | Description | Directory | File |
|---|---|---|---|---|
| **# AMBIG** | NumGroupAmbig | Number of group delay ambiguities | ObsEdit | NumGroupAmbig_bX |
| **# CLK_RF** | NumClockRefSite | # of clock reference stations | Solve | ClockSetup |
| **# DELAYS** | # DELAYS | NO. of delays in this obs . | OBSOLETE | - |
| **# RATES** | # RATES | NO. of rates in this obs . | OBSOLETE | - |
| **# SITES** | NumStation | Number of sites. | - | Head |
| **# STARS** | NumSource | Number of radio sources. | - | Head |
| **#CHANELS** | NumChannels | No. of U-L pairs in integration. | Observables | CorrInfo_bX |
| **#GAMBG_S** | NumGroupAmbig | Number of group delay ambiguities | ObsEdit | NumGroupAmbig_bS |
| **#PAMBG_S** | NumPhaseAmbig | Number of phase ambiguities | ObsEdit | NumPhaseAmbig_bS |
| **#PAMBIG** | NumPhaseAmbig | Number of phase ambiguities | ObsEdit | NumPhaseAmbig_bX |
| **#SAMPLES** | NumSamples | # of samples by sideband and cha | Observables | CorrInfo_bX |
| **#VFREQS** | NumBBCFreqs | No. of BBC frequencies in Band | Observables | CorrInfo_bX |
| **A1 - TAI** | A1minusTAI | TAI USNO- TAI BIH = 0.03439 sec. | OBSOLETE | - |
| **A1 - UTC** | A1minusUTC | FJD A1-UTC (sec) rate off.(sec) | OBSOLETE | - |
| **ABASACCE** | ABASACCE | Corel bas/apr accel (1/sec**2). | Observables | CorrInfo_bX |
| **ABASDEL** | ABASDEL | Corel bas/apr delay (sec). | Observables | CorrInfo_bX |
| **ABASRATE** | ABASRATE | Corel bas/apr delay rate (s/s). | Observables | CorrInfo_bX |
| **AC_SITES** | AtmRateSite | Site list for clocks constraints | Solve | AtmSetup |
| **ACCELGRV** | ACCELGRV | Accel grav at earth surface m/s^2 | OBSOLETE | - |
| **AMPBYFRQ** | ChanAmpPhase | Amp(0-1) phs by chan(-180to180) | Observables | CorrInfo_bX |
| **APCLOFST** | APCLOFST | Apriori clock offset microsec. | Observables | CorrInfo_bX |
| **APLENGTH** | Aplength | Length of accumul. period in sec | Solve | Misc |
| **ARCHIVE** | ARCHIVE | Microfiche, B tape number. | OBSOLETE | - |
| **ATI CFLG** | ATIFlag | ATIME Flow Control Message Def. | ObsTheoretical | CalcInfo |

| | | | | |
|---|---|---|---|---|
| **ATI MESS** | ATIMessage | ATIME Message Definition | ObsTheoretical | CalcInfo |
| **ATM CFLG** | ATMFlag | Atmosphere control flag mess def | ObsTheoretical | CalcInfo |
| **ATM FL 1** | ATM FL 1 | List of atmosphere flags | OBSOLETE | - |
| **ATM FL 2** | ATM FL 2 | List of atmosphere flags | OBSOLETE | - |
| **ATM FL 3** | ATM FL 3 | List of atmosphere flags | OBSOLETE | - |
| **ATM FL 4** | ATM FL 4 | List of atmosphere flags | OBSOLETE | - |
| **ATM FL 5** | ATM FL 5 | List of atmosphere flags | OBSOLETE | - |
| **ATM FL 6** | ATM FL 6 | List of atmosphere flags | OBSOLETE | - |
| **ATM FL 7** | ATM FL 7 | List of atmosphere flags | OBSOLETE | - |
| **ATM FL 8** | ATM FL 8 | List of atmosphere flags | OBSOLETE | - |
| **ATM MESS** | ATMMessage | Atmosphere message definition | ObsTheoretical | CalcInfo |
| **ATM PRES** | AtmPres | Pressure in hPa at site | - | Met |
| **ATM_CFLG** | #N/A | #N/A | #N/A | #N/A |
| **ATM_CNST** | AtmRateConstraint | Atmosphere constraint. ps/hr | Solve | AtmSetup |
| **ATM_INTV** | AtmInterval | Batchmode atmos interval - hours | Solve | AtmSetup |
| **ATMEPO 1** | ATMEPO 1 | Atmosphere epochs - J.D.s | OBSOLETE | - |
| **ATMEPO 2** | ATMEPO 2 | Atmosphere epochs - J.D.s | OBSOLETE | - |
| **ATMEPO 3** | ATMEPO 3 | Atmosphere epochs - J.D.s | OBSOLETE | - |
| **ATMEPO 4** | ATMEPO 4 | Atmosphere epochs - J.D.s | OBSOLETE | - |
| **ATMEPO 5** | ATMEPO 5 | Atmosphere epochs - J.D.s | OBSOLETE | - |
| **ATMEPO 6** | ATMEPO 6 | Atmosphere epochs - J.D.s | OBSOLETE | - |
| **ATMEPO 7** | ATMEPO 7 | Atmosphere epochs - J.D.s | OBSOLETE | - |
| **ATMEPO 8** | ATMEPO 8 | Atmosphere epochs - J.D.s | OBSOLETE | - |
| **AUTO_SUP** | AUTO_SUP | Automatic suppression status | OBSOLETE | - |
| **AUTOEDIT** | AUTOEDIT | 1=Run resulted from AUTOEDIT. | Observables | CorrInfo_bX |
| **AXISOFFS** | AxisOffset | Axis offsets (m). | Apriori | AntennaApriori |
| **AXISTILT** | AxisTilt | Fixed axis tilt | Apriori | AntennaApriori |
| **AXISTYPS** | AxisType | Axis type (1-eq 2-xy 3-azel 4 5) | Apriori | AntennaApriori |
| **AXO CFLG** | AxisOffsetFlag | Axis Offset Control flag mes def | ObsTheoretical | CalcInfo |
| **AXO CONT** | AxisOffsetCal | New Axis Offset Contributions | - | Cal-AxisOffset |

| | | | | |
|---|---|---|---|---|
| **AXO MESS** | AxisOffsetMessage | Axis Offset Message Definition | ObsTheoretical | CalcInfo |
| **AXO PART** | AxisOffsetPart | Axis Offset partial deriv. def. | - | Part-AxisOffset |
| **AZ-THEO** | AzTheo | Azimuth array definition | - | AzEl |
| **BAROCALS** | BAROCALS | Baro offset (mbar) and Ht. (m) | OBSOLETE | - |
| **BARONAME** | BARONAME | Names for barometer calibrations | OBSOLETE | - |
| **BASCLCKS** | BaselineClock | List of baseline dependent clocks | Solve | BaselineClockSetup |
| **BASELINE** | Baseline | Ref and rem site names. | Observables | Baseline |
| **BASLSTAT** | BaselineSelectionFlag | Baseline selection bit mapped array. 1=some obs, etc. | Solve | SelectionStatus |
| **BATCHCNT** | BATCHCNT | List of baseline dependent clocks | OBSOLETE | - |
| **BBC IND** | BBCIndex | Physical BBC number by channel. | Observables | CorrInfo_bX |
| **BENDPART** | BendPart | Grav. bend. partial w.r.t. Gamma | ObsPart | Part-Bend |
| **BITSAMPL** | BITSAMPL | Number of bits per sample. | Observables | CorrInfo_bX |
| **BLDEPCKS** | BaselineClock | Bl-dependent clock list | Solve | BaselineClockSetup |
| **BRK_EPOC** | ClockBreakEpoch | Batchmode clock break epochs | Session | ClockBreak |
| **BRK_FLAG** | ClockBreakFlag | Batchmode clock break flags | Session | ClockBreak |
| **BRK_NUMB** | BRK_NUMB | Number of batchmode clock breaks | Session | ClockBreak |
| **BRK_SITE** | ClockBreakSite | Sites with real clock breaks | Session | ClockBreak |
| **BRK_SNAM** | ClockBreakSite | Batchmode clock break stations | Session | ClockBreak |
| **BRK_STAT** | ClockBreakSite | Batchmode clock break stations | Session | ClockBreak |
| **BRT TEMP** | WVRTemp | BRT TEMP (K) OF WVR ,F1,F2. | - | WVR |
| **CABL DEL** | CableCal | Cable calibration data | - | Cal-Cable |
| **CAL FLGS** | StatCalFlag | Bit set indicate that calibration is recommended. | Solve | CalibrationSetup |
| **CAL LIST** | StatCalName | Station dependent calibrations (Cable, Phase, etc.…) | Solve | CalibrationSetup |
| **CALBYFRQ** | PhaseCalAmpPhase | PC amp phs frq by sta channel. | Observables | CorrInfo_bX |
| **CALC VER** | CalcVersion | CALC version number | ObsTheoretical | CalcInfo |
| **CALCFLGN** | CalcFlagNames | CALC flow control flags name def | ObsTheoretical | CalcInfo |
| **CALCFLGV** | CalcFlagValues | CALC flow control flags value def | ObsTheoretical | CalcInfo |

| | | | | |
|---|---|---|---|---|
| **CALSITES** | CalStationName | List of sites for standard cal | Solve | CalibrationSetup |
| **CBL SIGN** | CableSign | Signs of cable cal application | Solve | Misc |
| **CBL STAT** | StationNameCable | Stations for cable sign | Solve | Misc |
| **CC_SITES** | ClockRateName | Site list for clocks constraints | Solve | ClockSetup |
| **CCOR ERR** | CorCofErr | Corr. Coeff. formal error | Observables | CorrInfo_bX |
| **CF2J2K** | CF2J2K | Crust-fixed to J2000 Rot. Matrix and derivatives | Scan | Rot_kCF2J2K |
| **CHAN ID** | ChannelID | One-letter Fourfit channel ID. | Observables | CorrInfo_bX |
| **CLCKEP 3** | CLCKEP 3 | Clock epochs (JD,fraction) | OBSOLETE | - |
| **CLCKEP 4** | CLCKEP 4 | Clock epochs (JD,fraction) | OBSOLETE | - |
| **CLCKEP 5** | CLCKEP 5 | Clock epochs (JD,fraction) | OBSOLETE | - |
| **CLCKEP 6** | CLCKEP 6 | Clock epochs (JD,fraction) | OBSOLETE | - |
| **CLCKEP 7** | CLCKEP 7 | Clock epochs (JD,fraction) | OBSOLETE | - |
| **CLCKEP 8** | CLCKEP 8 | Clock epochs (JD,fraction) | OBSOLETE | - |
| **CLCKFL 3** | CLCKFL 3 | List of clock flags | OBSOLETE | - |
| **CLCKFL 4** | CLCKFL 4 | List of clock flags | OBSOLETE | - |
| **CLCKFL 5** | CLCKFL 5 | List of clock flags | OBSOLETE | - |
| **CLCKFL 6** | CLCKFL 6 | List of clock flags | OBSOLETE | - |
| **CLCKFL 7** | CLCKFL 7 | List of clock flags | OBSOLETE | - |
| **CLCKFL 8** | CLCKFL 8 | List of clock flags | OBSOLETE | - |
| **CLK_CFLG** | CLK_CFLG | Clock constraint use flag. | Solve | ClockSetup |
| **CLK_CNST** | ClockRateConstraint | Clock constraint-Parts in 1.e14 | Solve | ClockSetup |
| **CLK_INTV** | ClockInterval | Batchmode clock interval - hours | Solve | ClockSetup |
| **CLK_SITE** | ReferenceClock | Batchmode clock reference site | Solve | ClockSetup |
| **CLK_SITS** | ReferenceClock | List of clock reference stations | Solve | ClockSetup |
| **CLKBREAK** | CLKBREAK | Status of clock break existence | Session | ClockBreak |
| **CLODRACM** | ClockAprioriRate | A priori clock drift (sec/sec) | Apriori | ClockApriori |
| **CLOOFACM** | ClockAprioriOffset | A priori clock offset (sec) | Apriori | ClockApriori |
| **COHCOR_S** | Correlation | Corr coeff (0 --> 1) for S-band | Observables | Correlation_bS |
| **COHERCOR** | Correlation | Corr coeff (0 --> 1). | Observables | Correlation_bX |

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|---|---|---|---|---|
| **COMMENT2** | COMMENT2 | FRNGE runtime comments. | OBSOLETE | - |
| **CON CONT** | BendCal | Consensus bending contrib. (sec) | ObsCalTheo | Cal-Bend |
| **CONSNDEL** | DelayTheoretical | Consensus theoretical delay | ObsTheoretical | DelayTheoretical |
| **CONSNRAT** | RateTheoretical | Consensus theoretical rate | ObsTheoretical | RateTheoretical |
| **CONSPART** | GammaPart | Consensus partial w.r.t. Gamma | ObsPart | Part-Gamma |
| **COR DATA** | CoronaData | Corona model parameters. | ObsTheoretical | CalcInfo |
| **CORBASCD** | CORBASCD | Correlator baseline code (2 ch). | Observables | CorrInfo_bX |
| **CORBASNO** | CORBASNO | Correlator baseline number. | Observables | CorrInfo_bX |
| **CORCLOCK** | CORCLOCK | Clock offset(sec)/rate(sec/sec). | Observables | CorrInfo_bX |
| **CORELVER** | CORELVER | Correlator software version numb | Observables | CorrInfo_bX |
| **CORPLACE** | Correlator | Correlator name. | - | Head |
| **CORR UTC** | UTCCorr | UTC time tag of correlation. | Observables | CorrInfo_bX |
| **CORRTYPE** | CorrelatorType | Correlator type: MK3/MK4/K4 etc. | - | Head |
| **CROOTFIL** | CROOTFIL | Correlator root file name. | Observables | CorrInfo_bX |
| **CT SITE1** | FractC | Coordinate time at site 1 | Solve | FractC |
| **CTI CFLG** | CTIFlag | CTIMG Flow Control Message Der | ObsTheoretical | CalcInfo |
| **CTI MESS** | CTIMessage | CTIMG Message Definition | ObsTheoretical | CalcInfo |
| **DBEDITVE** | DBEDITVE | Dbedit revision date YYYY MM DD | Observables | CorrInfo_bX |
| **DEL FRQS** | DEL FRQS | ALIAS OF REF FREQ. | OBSOLETE | - |
| **DEL OBSV** | GroupDelay | Delay observable produced by fringing. | Observables | GroupDelay_bX |
| **DELOBSVM** | DELOBSVM | Obs delay at central epoch us. | Observables | CorrInfo_bX |
| **DELRESID** | DELRESID | Delay residual (sec). | Observables | CorrInfo_bX |
| **DELSIGMA** | GroupDelaySig | Delay Measurement Sigma | Observables | GroupDelay_bX |
| **DELTAEPO** | DELTAEPO | Offset from center of scan (sec) | Observables | CorrInfo_bX |
| **DELTFLAG** | DELTFLAG | Delay type 1=grp 2=phs. | OBSOLETE | - |
| **DELUFLAG** | DelayFlag | Delay unweight flag | ObsEdit | Edit |
| **DISCARD** | DISCARD | Percent data discarded by FRNGE. | Observables | CorrInfo_bX |
| **DLERR XS** | GroupDelaySig | Delay Measurement Sigma | Observables | GroupDelay_bS |
| **DLOBS XS** | GroupDelayFull | Delay Observable with ambiguities resolved and added. | ObsEdit | GroupDelayFull_bS |

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|---|---|---|---|---|
| **DLYEPO+1** | DLYEPO+1 | Phase delay at epoch+1 sec. | Observables | CorrInfo_bX |
| **DLYEPO-1** | DLYEPO-1 | Phase delay at epoch-1 sec. | Observables | CorrInfo_bX |
| **DLYEPOCH** | DLYEPOCH | Phase delay at epoch  usec . | OBSOLETE | - |
| **DNP DATA** | DNP DATA | Diurnal polar motion scale fact. | OBSOLETE | - |
| **DOMESNR** | DomesNumber | Domes number array | Apriori | StationApriori |
| **DPHAS XS** | PhaseDelay | Phase delay resolved with ambiguities added. | ObsEdit | PhaseDelayFull_bS |
| **DPHER XS** | PhaseSig | Phase delay sigma. | Observables | Phase_bS |
| **DURATION** | DURATION | Scan duration (sec). | Observables | CorrInfo_bX |
| **EARTH CE** | EarthXYZ | Earth barycentric coordinates. | Scan | Ephemeris_kDE405JPL |
| **EARTHRAD** | EARTHRAD | constant | OBSOLETE | - |
| **ECCCOORD** | EccentricityVector | Eccentricity taken from eccentricity file. | Apriori | EccentricityApriori |
| **ECCNAMES** | EccentricityMonument | Eccentricity monument name | Apriori | EccentricityApriori |
| **ECCTYPES** | EccentricityType | Eccentricity type: XY or NE | Apriori | EccentricityApriori |
| **EFF FREQ** | DummyName | NOTE: Split into 3 variables. | - | - |
| **EFF.DURA** | EffectiveDuration | Effective run duration sec. | Observables | CorrInfo_bX |
| **E-FLAT** | E-FLAT | Earth flattening con (unitless). | OBSOLETE | - |
| **EL-CUT** | EL-CUT | Solution elevation cutoff data. | OBSOLETE | - |
| **EL-THEO** | ElTheo | Elevation array definition | - | AzEl |
| **EMS/MMS** | EMS/MMS | The Earth-Moon mass ratio. | OBSOLETE | - |
| **EOPSCALE** | EOPSCALE | Time scale of EOP table epochs. | OBSOLETE | - |
| **EPHEPOCH** | EPHEPOCH | JPL EPOCH 1950 or 2000. | OBSOLETE | - |
| **EPNAMES** | EPNAMES | Site names for clock-atm epochs | OBSOLETE | - |
| **ERPHS K** | PhaseBLWeights | Phase formal error constants | Solve | PhaseBLWeights |
| **ERROR BL** | GroupBLWeightName | B.L. names for formal errors | Session | GroupBLWeights |
| **ERROR K** | GroupBLWeights | Group delay and rate re-weighting constants. | Session | GroupBLWeights |
| **ERRORATE** | ERRORATE | Logs err rate by sta sb channel | Observables | CorrInfo_bX |
| **ETD CFLG** | EarthTideFlag | Earth Tide flow control mess def | ObsTheoretical | CalcInfo |
| **ETD CONT** | EarthTideCal | Earth tide contributions def. | ObsCalTheo | Cal-EarthTide |
| **ETD DATA** | EarthTideData | Earth tide module data (la. h l) | ObsTheoretical | CalcInfo |

| | | | | |
|---|---|---|---|---|
| **ETD MESS** | EarthTideMessage | Earth Tide message definition | ObsTheoretical | CalcInfo |
| **EXPCODE** | ExpName | Experiment name. | - | Head |
| **EXPDESC** | ExpDescription | Experiment description. | - | Head |
| **EXPNAME** | ExpName | Observing program (exp.) name | - | Head |
| **EXPSERNO** | ExpSerialNumber | Experiment Serial Number. | - | Head |
| **F12 VOLT** | F12VOLT | F1, F2 VOLT . | - | WVR |
| **FALSEDET** | ProbFalseDetection | Prob of false det from FRNGE. | Observables | CorrInfo_bX |
| **FCL FLGS** | FlybyFlag | Standard flcal configuration | Solve | CalibrationSetup |
| **FCL LIST** | FlybyName | Key to the standard flcal config | Solve | CalibrationSetup |
| **FEED.COR** | FeedCorrectionCal | Feedhorn corr. in CORFIL scheme | ObsCalTheo | Cal-FeedCorrection |
| **FOURF CF** | FourfitControlFile | Control file name for fourfit. | Solve | Misc |
| **FOURF CS** | FourFitCmdCString | Command string used for fourfit. | Solve | Misc |
| **FOURFFIL** | FOURFFIL | Fourfit output filename. | Observables | CorrInfo_bX |
| **FOURFFXS** | FOURFFXS | Fourfit output filename S-band | Observables | CorrInfo_bX |
| **FOURFUTC** | FOURFUTC | Fourfit processing time YMDHMS. | Observables | CorrInfo_bX |
| **FOURFVER** | FOURFVER | Fourfit version number. | Observables | CorrInfo_bX |
| **FRNGERR** | FRNGERR | Fourfit error flag blank=OK. | Observables | CorrInfo_bX |
| **FROTDLAY** | FROTDLAY | Delay due to rel. feed rotation. | OBSOLETE | - |
| **FRQGROUP** | FRQGROUP | Frequency group code. | Observables | CorrInfo_bX |
| **FUT1 INF** | UT1ArrayInfo | Array: (FJD of start, spacing in days, number points, Scaling (should be 1)) | Solve | CalcEop |
| **FUT1 PTS** | UT1Values | Final Value TAI-UT1 data points. | Solve | CalcEop |
| **FUT1TEXT** | UT1Origin | Final Value TAI-UT1 origin text. | Solve | CalcEop |
| **FWOB INF** | WobArrayInfo | Array: (FJD of start, spacing in days, number points) | Solve | CalcEop |
| **FWOBTEXT** | WobbleOrigin | Final Value wobble origin text. | Solve | CalcEop |
| **FWOBX&YT** | WobValues | Final wobble X Y component value | Solve | CalcEop |
| **GAUSS** | GAUSS | Gauss's constant (rad). | OBSOLETE | - |
| **GC MBD** | GeocMBD | Tot geocenter group delay (sec). | Observables | CorrInfo_bX |
| **GC PHASE** | GeocPhase | Tot phase ref to cen of Earth. | Observables | CorrInfo_bX |

| | | | | |
|---|---|---|---|---|
| **GC RATE** | GeocRate | Tot geocenter delay rate (s/s). | Observables | CorrInfo_bX |
| **GC SBD** | GeocSBD | Tot geocenter sbd delay (sec). | Observables | CorrInfo_bX |
| **GCRESPHS** | GeocResidPhase | Resid phs corrected to cen of E. | Observables | CorrInfo_bX |
| **GMEARTH** | GMEARTH | GM of the Earth (m^3/sec^2). | OBSOLETE | - |
| **GMMOON** | GMMOON | GM of the Moon (m^3/sec^2). | OBSOLETE | - |
| **GMSUN** | GMSUN | GM of the Sun (m^3/sec^2). | OBSOLETE | - |
| **GPDLAMBG** | AmbigSize | Group delay ambiguity spacing | Observables | AmbigSize_bX |
| **GRIONFRQ** | FreqGroupIon | Effective Group Delay Ionospheric Frequency | ObsDerived | EffFreq_bX |
| **GROBSDEL** | GroupDelay | Observed group delay in sec. | OBSOLETE | - |
| **GRPAMB_S** | AmbigSize | Group delay ambiguity spacing | Observables | AmbigSize_bS |
| **HALF PI** | HALF PI | Half pi - to 17 digits accuracy. | OBSOLETE | - |
| **IDELAY** | IDELAY | Corel instrumental delay (sec). | Observables | CorrInfo_bX |
| **INCOH2** | INCOH2 | Incoh amp from FRNGE plot segs. | Observables | CorrInfo_bX |
| **INCOHAMP** | INCOHAMP | Fr. amp from incoh int of chan. | Observables | CorrInfo_bX |
| **INDEXNUM** | INDEXNUM | Corel index numbers by sb freq. | Observables | CorrInfo_bX |
| **INTERVAL** | iUTCInterval | First and last UTC time tag in input file. | - | Head |
| **INTRVAL4** | iUTCInterval | First and last UTC time tag in input file. | - | Head |
| **ION CODE** | IonCode | Ion corr code. -1=no good 0=OK | OBSOLETE | - |
| **ION CORR** | IonGroupCal | Ion correction. Add to theo. sec | ObsDerived | Cal-IonGroup_bX |
| **ION_BITS** | IonBits | ICORR for full ion tracking. | Solve | IonBits |
| **IONFACTR** | IONFACTR | S/X DIFFERENCE ION SCALING FACTO | OBSOLETE | - |
| **IONPCORR** | IonPhaseCal | Phase Corr Iono | ObsDerived | Cal-IonPhase_bX |
| **IONRMS** | IonGroupCalSigma | Ion correction to sigma. sec | ObsDerived | Cal-IonGroup_bX |
| **IONRMSPH** | IonPhaseCalSigma | Phase Corr RMS | ObsDerived | Cal-IonPhase_bX |
| **JUL DATE** | JUL DATE | Julian date at midnight. | OBSOLETE | - |
| **LIMSTOPS** | LIMSTOPS | Antenna limit stops (deg). | OBSOLETE | - |
| **LO FREQ** | LOFreq | LO frequencies per cha/sta MHz. | Observables | CorrInfo_bX |
| **MARI.ATM** | MARI.ATM | Marini ATM Model | OBSOLETE | - |
| **MARI.DRY** | MARI.DRY | Dry Marini atmosphere | OBSOLETE | - |
| **MARI.WET** | MARI.WET | WET COMP OF MARI | OBSOLETE | - |

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|---|---|---|---|---|
| **MARISTAT** | MARISTAT | Stations with Marini calib | OBSOLETE | - |
| **MCALNAMS** | MCALNAMS | Mode calibrations names | OBSOLETE | - |
| **MCALSTAT** | MCALSTAT | Mode calibrations status | OBSOLETE | - |
| **MEANCABL** | MEANCABL | Mean cable calibration (seconds) | OBSOLETE | - |
| **MOONDATA** | MoonXYZ | Lunar geocentric coordinates. | Scan | Ephemeris_kDE405JPL |
| **NB DELAY** | NB DELAY | Single band delay (microsec). | OBSOLETE | - |
| **NDRYCONT** | NMFDryCal | Nhmf (dry) atm. contribution | - | Cal-NMFDry |
| **NDRYPART** | NMFDryPart | Nhmf2 dry partial deriv. def. | - | Part-NMFDry |
| **NGRADPAR** | NMFGradPart | Niell dry atm. gradient partials | - | NGRADPAR |
| **NLAGS** | NumLagsUsed | Num of lags used for correlation | Solve | Misc |
| **NO.OF AP** | NumAp | # of AP by sideband and channel. | Observables | CorrInfo_bX |
| **NUM4 OBS** | NumObs | Number of observations (I*4) | - | Head |
| **NUMB OBS** | NumObs | Number of observations in file. | - | Head |
| **NUT CFLG** | NutationFlag | Nutation flow control mess def. | ObsTheoretical | CalcInfo |
| **NUT MESS** | NutationMessage | Nutation message definition | ObsTheoretical | CalcInfo |
| **NUT PART** | NutPsiEpsPart | Pre Calc10 Nutation Partial | ObsPart | Part-NutPsiEps |
| **NUT WAHR** | NutWahrPsiEps | Wahr nut vals - Dpsi Deps&rates | Scan | Nut_kWahr |
| **NUT2000A** | Nut2000PsiEps | IAU200A Nut. - Dpsi Deps Rates | Scan | Nut_k2000PsiEps |
| **NUT2000P** | Nut2000PsiEpsPart | IAU2000A Nutation Psi Eps Partls | ObsPart | Part-Nut2KPsiEps |
| **NUT2KXYP** | Nut2KXYPart | IAU2000A Nutation X Y Partials | ObsPart | Part-Nut2KXY |
| **NUT2KXYS** | Nut2000XYS | CIP Coordinates X Y S and Rates | Scan | Nut_k2000XYS |
| **NWETCONT** | NMFWetCal | Whmf (wet) atm. contribution | - | Cal-NMFWet |
| **NWETPART** | NMFWetPart | NMF Wet Partial | - | Part-NMFWet |
| **OBCLFLGS** | ObsCalFlag | Bit set indicate that calibration is recommended. | Solve | CalibrationSetup |
| **OBCLLIST** | ObsCalName | Available obs dependent calibrations (poletide, earthtide, …) | Solve | CalibrationSetup |
| **O-C RES** | O-C RES | DELAY RATE RESIDUALS(s, s per s) | OBSOLETE | - |
| **OCAMP EW** | OceanAmpEW | Ocean amp. E-W component(meters) | ObsTheoretical | CalcInfo |

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|---|---|---|---|---|
| **OCAMP NS** | OceanAmpNS | Ocean amp. N-S component(meters) | ObsTheoretical | CalcInfo |
| **OCAMP RD** | OceanAmpUp | Ocean amp. radial comp.-meters. | ObsTheoretical | CalcInfo |
| **OCCUPNUM** | OCCUPNUM | Site Occupation Number. | Observables | CorrInfo_bX |
| **OCE CFLG** | OceanFlag | Ocean load flow control mess def | ObsTheoretical | CalcInfo |
| **OCE CFLG** | OceanFlag | Ocean load flow control mess def | ObsTheoretical | CalcInfo |
| **OCE CFLG** | OceanFlag | Ocean load flow control mess def | ObsTheoretical | CalcInfo |
| **OCE CONT** | OceanLoadCal | Obs dependent ocean loading | ObsCalTheo | Cal-OceanLoad |
| **OCE DELD** | OceanLoadDis | Ocean load site dependent displace | - | Dis-OceanLoad |
| **OCE HORZ** | OceanLoadHorizCal | Site-dep ocean cont - horizontal | - | Cal-OceanLoad |
| **OCE MESS** | OceanMessage | Ocean loading message definition | ObsTheoretical | CalcInfo |
| **OCE STAT** | OceanStations | Ocean loading station status. | ObsTheoretical | CalcInfo |
| **OCE STAT** | OceanStations | Ocean loading station status. | ObsTheoretical | CalcInfo |
| **OCE STAT** | OceanStations | Ocean loading station status. | ObsTheoretical | CalcInfo |
| **OCE VERT** | OceanLoadVertCal | Site-dep ocean cont - vertical | - | Cal-OceanLoad |
| **OCPHS EW** | OceanPhaseEW | Ocean phase E-W component (rad) | ObsTheoretical | CalcInfo |
| **OCPHS NS** | OceanPhaseNS | Ocean phase N-S component (rad) | ObsTheoretical | CalcInfo |
| **OCPHS RD** | OceanPhaseUp | Ocean phase radial comp.-radians | ObsTheoretical | CalcInfo |
| **ORIGFILE** | ORIGFILE | Original COREL file name. | Observables | CorrInfo_bX |
| **PAN MESS** | FeedhornMessage | Feedhorn rot. angle mod. ident. | ObsTheoretical | CalcInfo |
| **PARANGLE** | FeedRotation | Feedhorn rotation angle. | - | FeedRotation |
| **PEP MESS** | PepMessage | PEP Utility Message Definition | ObsTheoretical | CalcInfo |
| **PHASECAL** | PHASECAL | PC rate by sta ( us per s). | Observables | CorrInfo_bX |
| **PHCALOFF** | PhaseCalOffset | Phase cal offset (-18000/18000). | Observables | CorrInfo_bX |
| **PHCALSTS** | PHCALSTS | Phase cal status: 0/1/2 . | OBSOLETE | - |
| **PHIONFRQ** | FreqPhaseIon | Effective Phase Delay Ionospheric Frequency | ObsDerived | EffFreq_bX |
| **PHSUFLAG** | PhaseFlag | Phase unweight flag | ObsEdit | Edit |
| **PI** | PI | Pi - to 17 digits accuracy. | OBSOLETE | - |
| **PI NAME** | PrincipalInvestigator | Agency/contact_person/PI name. | - | Head |
| **PLX CFLG** | ParallaxFlag | Parallax flow control mess def | ObsTheoretical | CalcInfo |
| **PLX MESS** | ParallaxMessage | Parallax message definition | ObsTheoretical | CalcInfo |

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|---|---|---|---|---|
| **PLX PART** | ParallaxPart | Parallax partial deriv. def. | ObsPart | Part-Parallax |
| **PLX1PSEC** | ParallaxCal | Parallax partial/contr 1 parsec | ObsCalTheo | Cal-Parallax |
| **POLAR XY** | PolarMotion | Polar motion X & Y for obs (rad) | Scan | EOPApriori |
| **POLARIZ** | Polarization | Polarization per sta/chan R/L. | Observables | CorrInfo_bX |
| **PRE CFLG** | PrecessionFlag | Precession flow contril mess def | ObsTheoretical | CalcInfo |
| **PRE DATA** | PrecessionData | Precession constant (asec/cent). | ObsTheoretical | CalcInfo |
| **PRE MESS** | PrecessionMessage | Precession message definition | ObsTheoretical | CalcInfo |
| **PRE PART** | PrecessionPart | Precession partial deriv. def. | ObsPart | Part-Precession |
| **PROC UTC** | UTCProc | YDDD of COREL by sta channel. | Observables | CorrInfo_bX |
| **PRT FLAG** | PRT FLAG | Atmosphere partial to be applied | OBSOLETE | - |
| **PTD CFLG** | PoleTideFlag | Pole tide flow control mess def | ObsTheoretical | CalcInfo |
| **PTD CONT** | PoleTideCal | Pole tide contributions def. | ObsCalTheo | Cal-PoleTide |
| **PTD MESS** | PoleTideMessage | Pole tide message definition | ObsTheoretical | CalcInfo |
| **PTDXYPAR** | WobPart | Pole Tide Partials w.r.t. X & Y | ObsPart | Part-Poletide |
| **PTOLDCON** | PoleTideOldRestoreCal | Old Pole Tide Restorer Contrib. | ObsCalTheo | Cal-PoleTideOldRestore |
| **QBFACTOR** | QBFACTOR | Measure of uniformity of data. | Observables | CorrInfo_bX |
| **QCODE XS** | QualityCode | FRNGE quality index 0 --> 9 | Observables | QualityCode_bS |
| **QUALCODE** | QualityCode | FRNGE quality index 0 --> 9 | Observables | QualityCode_bX |
| **RAD ASEC** | RAD ASEC | Radians per arc second . | OBSOLETE | - |
| **RAD DEG** | RAD DEG | Radians per degree . | OBSOLETE | - |
| **RAD TSEC** | RAD TSEC | Radians per time second . | OBSOLETE | - |
| **RAD/ASEC** | RAD/ASEC | Radians per arc second . | OBSOLETE | - |
| **RAD/DEG** | RAD/DEG | Number of radians per degree. | OBSOLETE | - |
| **RAD/TSEC** | RAD/TSEC | Radians per time second . | OBSOLETE | - |
| **RAT FRQS** | RAT FRQS | ALIAS OF REF FREQ. | OBSOLETE | - |
| **RAT OBSV** | GroupRate | Rate Observable | Observables | GroupRate_bX |
| **RATOBSVM** | RATOBSVM | Obs rate at central epoch . | Observables | CorrInfo_bX |
| **RATRESID** | RATRESID | Rate resid (sec per sec). | Observables | CorrInfo_bX |
| **RATSIGMA** | GroupRateSig | Rate Measurement Sigma | Observables | GroupRate_bX |

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|---|---|---|---|---|
| **RATUFLAG** | RateFlag | Delay rate unweight flag. | ObsEdit | Edit |
| **RECMODE** | RecordingMode | Recoding mode. | - | Head |
| **RECSETUP** | RECSETUP | Samp rate(kHz) Frames/PP PP/AP. | Observables | CorrInfo_bX |
| **RECTRACK** | RECTRACK | Trk table by sta sideb channel. | Observables | CorrInfo_bX |
| **REF FR_S** | RefFreq | Frequency to which phase is referenced | Observables | RefFreq_bS |
| **REF FREQ** | RefFreq | Frequency to which phase is referenced | Observables | RefFreq_bX |
| **REFCLKER** | REFCLKER | Ref sta clock epoch microsec. | Observables | CorrInfo_bX |
| **REL CFLG** | RelativityFlag | Relativistic bending use status | ObsTheoretical | CalcInfo |
| **REL DATA** | RelativityMessage | Relativity mod data (gamma). | ObsTheoretical | CalcInfo |
| **REL.HUM.** | RelHum | Rel.Hum. at local WX st (50%=.5) | - | Met |
| **RFREQ** | ChannelFreq | RF freq by channel (MHz). | Observables | CorrInfo_bX |
| **ROTEPOCH** | ROTEPOCH | UT1 pole interp.reference epochs | OBSOLETE | - |
| **RTERR XS** | GroupRateSig | Rate Measurement Sigma | Observables | GroupRate_bS |
| **RTOBS XS** | GroupRate | Rate Observable | Observables | GroupRate_bS |
| **RUN CODE** | RunCode | Run code e.g. "329-1300". | Observables | CorrInfo_bX |
| **S2EFFREQ** | S2EFFREQ | Effective group freq for ion. | Observables | CorrInfo_bX |
| **S2FLAG** | S2FLAG | S2 or MKIII Flag | OBSOLETE | - |
| **S2PHEFRQ** | S2PHEFRQ | Effective phase frequency | Observables | CorrInfo_bX |
| **S2REFREQ** | S2REFREQ | Effective frequency for rate | Observables | CorrInfo_bX |
| **SAMPLRAT** | SampleRate | Sample rate (Hz). | Observables | CorrInfo_bX |
| **SB DEL_S** | SBDelay | Single band delay | Observables | SBDelay_bS |
| **SB DELAY** | SBDelay | Single band delay | Observables | SBDelay_bX |
| **SB SIG_S** | SBDelaySig | Single band delay error | Observables | SBDelay_bS |
| **SB SIGMA** | SBDelaySig | Single band delay error | Observables | SBDelay_bX |
| **SBRESID** | SBRESID | Single band delay residual. | Observables | CorrInfo_bX |
| **SCAN UTC** | UTCScan | Nominal scan time YMDHMS. | Observables | CorrInfo_bX |
| **SCANNAME** | ScanName | Scan name in database | Scan | ScanName |
| **SEC TAG** | Second | Seconds part of UTC TAG. | Observables | TimeUTC |
| **SIT ELEV** | SIT ELEV | Height above ellipsoid (meters) | OBSOLETE | - |
| **SIT MESS** | SiteMessage | Site Module Message Definition | ObsTheoretical | CalcInfo |

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|---|---|---|---|---|
| **SIT PART** | XYZPart | Site partials: dtau/dr_1=-dtau/dr_2 | ObsPart | Part-XYZ |
| **SIT_KILL** | SIT_KILL | site_killer version date | OBSOLETE | - |
| **SITCODES** | SITCODES | Two-letters site codes . | OBSOLETE | - |
| **SITERECS** | StationXYZ | Site cartesian coords (m). | Apriori | StationApriori |
| **SITEZENS** | SiteZenithDelay | Site zenith path delays (nsec). | ObsTheoretical | CalcInfo |
| **SITHOCAM** | OceanHorizontalAmp | Horz ocean loading ampltudes (m) | ObsTheoretical | CalcInfo |
| **SITHOCPH** | OceanHorizontalPhase | Horz ocean loading phases (rad). | ObsTheoretical | CalcInfo |
| **SITNAMES** | StationNameApriori | Site names in alphabetical order | Apriori | StationApriori |
| **SITOCAMP** | OceanUpAmp | Vert ocean loading ampltudes (m) | ObsTheoretical | CalcInfo |
| **SITOCPHS** | OceanUpPhase | Vert ocean loading phases (rad). | ObsTheoretical | CalcInfo |
| **SLEWRATS** | SLEWRATS | Antenna slew rates (rad/sec). | OBSOLETE | - |
| **SNR_S** | SNR | Signal to noise ratio for S-band | Observables | SNR_bS |
| **SNRATIO** | SNR | Signal to noise ratio. | Observables | SNR_bX |
| **SOL_DATA** | SOL_DATA | Stnd sol data. IDATYP from SOCOM | OBSOLETE | - |
| **SOLVE_VR** | SOLVE_VR | SOLVE system version number | OBSOLETE | - |
| **SOURSTAT** | SourceSelectionFlag | Source selection status bit-mapped array. | Solve | SelectionStatus |
| **SRCHPAR** | SRCHPAR | FRNGE/Fourfit search parameters. | Observables | CorrInfo_bX |
| **STAR ID** | Source | Radio source name. | Observables | Source |
| **STAR REF** | SourceReference | Source of coordinate values. | Apriori | SourceApriori |
| **STAR2000** | Source2000RaDec | J2000 Source RA and Dec | Apriori | SourceApriori |
| **STARELEV** | STARELEV | Elev angles calc by COREL. | Observables | CorrInfo_bX |
| **STARTOFF** | StartOffset | Offset nominal start time (sec). | Observables | CorrInfo_bX |
| **STARTSEC** | STARTSEC | Start time in sec past hour. | Observables | CorrInfo_bX |
| **STAT_ACM** | ClockAprioriSite | Stations with a priori clock mod | Apriori | ClockApriori |
| **StationNameCrossRef** | StationNameCrossRef | Site names in alphabetical order | CrossReference | StationCrossRef |
| **STOP OFF** | StopOffset | Offset nominal stop time (sec). | Observables | CorrInfo_bX |
| **STOP SEC** | StopSec | Stop time in sec past hour. | Observables | CorrInfo_bX |
| **STR CFLG** | StarParallaxFlag | Parallax flow control mess def | ObsTheoretical | CalcInfo |
| **STR MESS** | StarMessage | Star module message definition | ObsTheoretical | CalcInfo |
| **STR PART** | RaDecPart | Star partial derivatives def. | ObsPart | Part-RaDec |

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|---|---|---|---|---|
| **STR TIME** | TimeSinceStart | Interval since start time (sec). | Observables | CorrInfo_bX |
| **STRNAMES** | SourceNameApriori | Source names in RA order. | Apriori | SourceApriori |
| **SUN CONT** | BendSunCal | Consensus bending contrib. (sec) | ObsCalTheo | Cal-BendSun |
| **SUN DATA** | SunXYZ | Solar geocentric coordinates. | Scan | Ephemeris_kDE405JPL |
| **SUN2CONT** | BendSunHigherCal | High order bending contrib.(sec) | ObsCalTheo | Cal-BendSunHigher |
| **SUPMET** | SUPMET | Suppression method | OBSOLETE | - |
| **TAI- UTC** | LeapSecond | Leap second | Solve | Misc |
| **TAPEID** | TAPEID | Raw data tape ID for ref and rem | Observables | CorrInfo_bX |
| **TAPQCODE** | TapeCode | Tape quality code. | Observables | CorrInfo_bX |
| **TECTMODL** | TECTMODL | Default tectonic plate model name | OBSOLETE | - |
| **TECTPLNM** | TECTPLNM | 4-char tectonic plate names. | OBSOLETE | - |
| **TEMP C** | TempC | Temp in C at local WX station | - | Met |
| **THE MESS** | TheoryMessage | Theory module identification | ObsTheoretical | CalcInfo |
| **TIDALUT1** | TidalUT1Flag | Flag for tidal terms in UT1 series | ObsTheoretical | CalcInfo |
| **TILTRMVR** | TiltRemoverCal | Axis Tilt Contribution Remover | ObsCalTheo | Cal-TiltRemover |
| **TOTPCENT** | TOTPCENT | Tot phase at central epoch. | Observables | CorrInfo_bX |
| **TOTPHA_S** | Phase | Total phase | Observables | Phase_bS |
| **TOTPHASE** | Phase | Total phase | Observables | Phase_bX |
| **TPHA ERR** | TotalFringeErr | Total fringe phase error (deg) | Observables | CorrInfo_bX |
| **TSEC/AU** | TSEC/AU | Number of seconds per A.U. | OBSOLETE | - |
| **TSEC/DAY** | TSEC/DAY | Second per day . | OBSOLETE | - |
| **TSYS TMP** | Tsys | TSYS TMP (K) 14CH AND IF1 IF2 | Observables | Tsys |
| **TWOPI** | TWOPI | TWO PI . | OBSOLETE | - |
| **UACSUP** | UserSup | User action for suppression | ObsEdit | Edit |
| **U-GRV-CN** | U-GRV-CN | Universal grav con m^3/kg*s^3. | OBSOLETE | - |
| **UNCALDLY** | UNCALDLY | Bad Phase Cal Delay. Removed from Obs. | - | - |
| **UNCALFLG** | UNCALFLG | Delay+rate uncal if flag=1. | OBSOLETE | - |
| **UNPHAFLG** | UNPHAFLG | UnPhaseCal flag | Solve | UnPhaseCal |
| **UNPHASCL** | UnPhaseCal | UnPhaseCal effect - group&rate | ObsCalTheo | Cal-UnphaseCal |

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|---|---|---|---|---|
| **URVR** | URVR | Rate derivatives mHz per asec. | Observables | CorrInfo_bX |
| **USER_REC** | USER_REC | User observation recovery status | OBSOLETE | - |
| **USER_SUP** | USER_SUP | User observation suppression sts | OBSOLETE | - |
| **UT1 CFLG** | UT1FLag | UT1 control flag message def. | ObsTheoretical | CalcInfo |
| **UT1 MESS** | CalcUt1Module | UT1 Module message definition | Solve | CalcEop |
| **UT1 PART** | UT1Part | UT1 partial derivatives def. | ObsPart | Part-EOP |
| **UT1 -TAI** | UT1 | UT1 time of day for this obsvr. | Scan | EOPApriori |
| **UT1EPOCH** | UT1EPOCH | TAI - UT1 epoch value definition | ObsTheoretical | CalcInfo |
| **UT1INTRP** | UT1IntrpMode | Message for UT1 interp. scheme | Solve | CalcEop |
| **UT1ORTHO** | UT1OrthoCal | ORTHO_EOP Tidal UT1 contribution | ObsCalTheo | Cal-HFEOP-IERS2003 |
| **UTC ERR** | UTCErr | A priori UTC error site 1 (sec) | Observables | CorrInfo_bX |
| **UTC TAG** | YMDHM | Epoch UTC YMDHM. | Observables | TimeUTC |
| **UTC TAG4** | UTC TAG4 | Epoch UTC YMDHMS (4 digit year). | OBSOLETE | - |
| **UTCM TAG** | UTCMidObs | UTC at central epoch YMDHMS. | Observables | CorrInfo_bX |
| **UVF/ASEC** | UVFperAsec | U V in FR per arcsec from CALC | Solve | UVFperAsec |
| **VFDWELL** | VFDWELL | Dwell time in each channel (sec) | Observables | CorrInfo_bX |
| **VFRQ#APS** | NumAccum | No. of accum. periods in Channel | Observables | CorrInfo_bX |
| **VFRQAM** | VFRQAM | Normalized channel amplitude | Observables | CorrInfo_bX |
| **VFRQPCAM** | VFRQPCAM | Phase cal tone Amplitudes | Observables | CorrInfo_bX |
| **VFRQPCFR** | VFRQPCFR | Phase cal tone Frequencies | Observables | CorrInfo_bX |
| **VFRQPCPH** | VFRQPCPH | PHASE cal tone Phases | Observables | CorrInfo_bX |
| **VFRQPH** | VFRQPH | Channel Phase (degrees) | Observables | CorrInfo_bX |
| **VIRTFREQ** | VIRTFREQ | Sky Frequencies | Observables | CorrInfo_bX |
| **VLB1FILE** | VLB1FILE | Correlator file name. | Observables | CorrInfo_bX |
| **VLB1XTNT** | VLB1XTNT | corr. ext by sideb channel. | Observables | CorrInfo_bX |
| **VLB2 UTC** | UTCVLB2 | UTC of FRNGE proc YMDHMS. | Observables | CorrInfo_bX |
| **VLB2PRG** | VLB2PRG | FRNGE(YYMMDD) Fourfit(x.x) ver. | Observables | CorrInfo_bX |
| **VLB2XTNT** | VLB2XTNT | FRNGE extent number. | Observables | CorrInfo_bX |
| **VLIGHT** | VLIGHT | The speed of light (m/sec). | OBSOLETE | - |
| **WAHRCONT** | NutWahrCal | 2000A Nut to Wahr Nut Contribution | ObsCalTheo | Cal-NutWahr |

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|---|---|---|---|---|
| **WBEPOCH** | WBEPOCH | LIST OF SITE NMES FOR EPOCHS | OBSOLETE | - |
| **WOB CFLG** | WobbleFlag | Wobble flow control mess def. | ObsTheoretical | CalcInfo |
| **WOB MESS** | CalcWobModule | Wobble message definition. | Solve | CalcEop |
| **WOB PART** | WobblePart | Wobble partial derivatives def. | ObsPart | Part-EOP |
| **WOBEPOCH** | WOBEPOCH | Interpolated wobble array def | ObsTheoretical | CalcInfo |
| **WOBINTRP** | WobIntrpMode | Interp. scheme for polar motion. | Solve | CalcEop |
| **WOBNUTAT** | WobNutCal | Short period nutation wobble con | ObsCalTheo | Cal-WobNut |
| **WOBORTHO** | WobOrthoCal | ORTHO_EOP tidal wobble contribution | ObsCalTheo | Cal-HFEOP-IERS2003 |
| **WOBXCONT** | XwobbleCal | X Wobble contribution definition | ObsCalTheo | Cal-Wobble |
| **WOBYCONT** | YwobbleCal | Y Wobble contribution definition | ObsCalTheo | Cal-Wobble |
| **WVR CODE** | WVRQcode | WVR DELAY DATA QUALITY CODE | - | WVR |
| **WVR DELY** | WVRDelay | WVR LINE OF SIGHT & ZENITH(NSEC) | - | WVR |
| **WVR STAT** | WVR STAT | Stations with WVR calib . | OBSOLETE | - |
| **WVR TEMP** | WVRTempRef | REFERENCE1,2 WVR TEMP (K). | - | WVR |
| **WVR.DELY** | WVRDelay | WVR PATH DELAYWVR PATH DELAY AND | - | WVR |
| **WVRDELAY** | WVRDelay | WVR line of sight & ZENITH(sec) | - | WVR |
| **ZDELAY** | ZDELAY | Corel zenith atmos. delay (sec). | Observables | CorrInfo_bX |