Matera CGS VLBI Analysis Center

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Abstract

This paper reports the VLBI data analysis activities at the Space Geodesy Center (CGS) at Matera from March 1999 through December 2000 and the contributions that the CGS intends to provide for the future as an IVS Data Analysis Center.

1. Introduction

The VLBI data analysis activities at the CGS in the year 2000 are mainly dominated by the unavailability of the workstation used to process the VLBI solutions due to a power supply failure. In spite of that some activities related to the VLBI analysis have been carried out.

2. Combination of Velocity Fields from SLR, GPS and VLBI for the Italian Region

We combined four space geodetic solutions produced at the CGS analysis center in Matera:

1. a daily GPS network solution of the European area
2. a daily GPS precise point positioning solution that recovers single station coordinates for some stations in the European area
3. a VLBI solution for the European area
4. a global SLR solution

Since each single-technique solution realizes its own reference frame, it is necessary to define a common reference frame in which to perform the combined solution. We chose to transform and combine the velocity fields within the ITRF97 reference frame by determining the time derivatives of rotation, translation and scale parameters that transform each solution in the common frame. For small rotations and velocities, typically on the order of a few mas and mm/yr respectively, the approximated equations defining the roto-translations of the velocities fields are:

$$\dot{\mathbf{X}}_{solution} - \dot{\mathbf{X}}_{ITRF} = (\dot{\mathbf{d}} + \dot{\varepsilon})\mathbf{X}_{ITRF} + \dot{\mathbf{T}} \tag{1}$$

where $\mathbf{X}$ are the site cartesian coordinates (x,y,z) and $\dot{\mathbf{X}}$ their corresponding velocities. The unknowns are respectively the scale factor $\dot{d}$, the three rotations and three translation time derivatives $\dot{\varepsilon}_x$, $\dot{\varepsilon}_y$, $\dot{\varepsilon}_z$, $\dot{T}_x$, $\dot{T}_y$, $\dot{T}_z$.

The covariance matrix $\mathbf{C}_{solution}$ of each velocity solution has been propagated accordingly:

$$\mathbf{C}_{ITRF} = \mathbf{C}_{solution} + \mathbf{\Gamma}^T\mathbf{C}_H\mathbf{\Gamma} \tag{2}$$

where $\mathbf{C}_{ITRF}$ is the covariance matrix transformed in the ITRF97 reference frame, $\mathbf{C}_H$ is the covariance matrix of the roto-translation parameters and $\mathbf{\Gamma}$ is the matrix of the partials w.r.t. the roto-translation parameters.

Once each velocity field was expressed in the common reference system, the combined 3-D velocity field has been estimated in a least squares sense, minimizing the velocity residuals:

$$\dot{\mathbf{X}}_C = (\mathbf{A}^T\mathbf{W}\mathbf{A})^{-1}\mathbf{A}^T\mathbf{W}\mathbf{Y} \tag{3}$$

Where $\dot{\mathbf{X}}_C$ is the combined velocity solution, $\mathbf{A}$ is the matrix of the partials w.r.t. the estimated parameters and has the form:

$\mathbf{A} = \begin{pmatrix} \mathbf{I} \\ \vdots \\ \mathbf{I} \end{pmatrix}$ with $\mathbf{I}$ identity matrix,

$\mathbf{W}$ is the total weight matrix:

$\mathbf{W} = \begin{pmatrix} \mathbf{\Sigma}_1^{-1} & & \mathbf{0} \\ & \ddots & \\ \mathbf{0} & & \mathbf{\Sigma}_n^{-1} \end{pmatrix}$ with $\mathbf{\Sigma}_i^{-1}$ covariance matrix of each single velocity solution

and

$\mathbf{Y} = \begin{pmatrix} \mathbf{X}_1 \\ \vdots \\ \mathbf{X}_n \end{pmatrix}$ with $\mathbf{X}_i$ single velocity solution.

More details and the results of this work can be found in Devoti et al. 2000 [1].

3. Spectral Analysis of Time Series

The estimated geodetic time series could be affected by non-tectonic signals such as: mismodeling in the data analysis models, local phenomena induced by human activities and local geophysical or geological phenomena. It is expected that some of these phenomena have a periodical behavior and a spectral analysis should highlight their presence. We developed some tools for the spectral analysis of the time series. Our initial target is to recover the stationary part of a signal; this is obtained using a wavelets approach that is able to distinguish the stationary part of the signal from the non-stationary one. After that a least-squares procedure is used to characterize frequency, amplitude and phase of the stationary part in the form: $\sum_i A_i \cos(\omega_i t + \phi_i)$. These tools are based on the Lomb-Scargle periodogram that is suitable for time series with unevenly sampled data. At the present the tools have been developed and we shall use them in the near future.

4. Contribution to IVS for 2001

The following items represent the contribution that the CGS intends to provide to the IVS for the year 2001:

- Global analysis using all geodetic sessions to estimate TRF and EOP
- Dedicated analysis for the VLBI experiments from the EUROPE campaign
- Combination of TRF and EOP solutions available from IVS and IERS
- Comparisons of tropospheric parameters derived by VLBI and GPS

References

[1] R. Devoti, C. Ferraro, R. Lanotte, V. Luceri, A. Nardi, R. Pacione, P. Rutigliano, C. Sciarretta, E. Gueguen, G. Bianco, F. Vespe: "Geophysical interpretation of geodetic deformations in the central Mediterranean area", AGU book 2000.