# Science Overview

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# Three Components of Space Geodesy

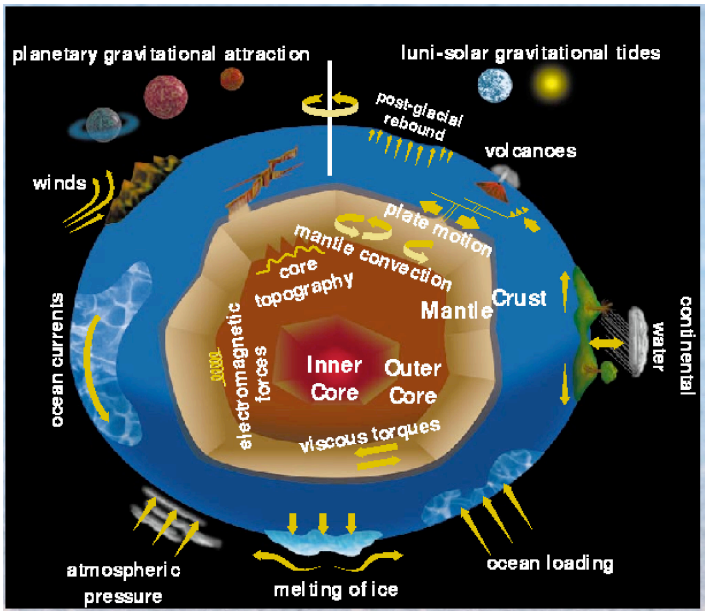
- Terrestrial Reference Frame (TRF)
- Celestial Reference Frame (CRF)
- Earth Orientation Parameters (EOP)

# Terrestrial Reference Frame

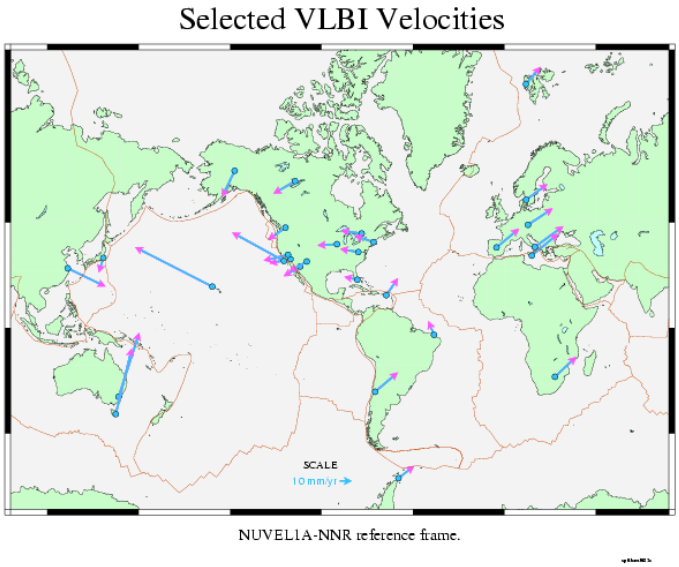
- Define the positions and velocities of a dense set of reference sites over the entire Earth
- Contributions from VLBI, GPS, SLR, and DORIS
  - VLBI – scale of TRF, nutation, UT1-UTC
  - GPS – polar motion, densification
  - SLR – center of mass
  - DORIS – densification



# Causes for Plate Motion and Variations in Earth Orientation

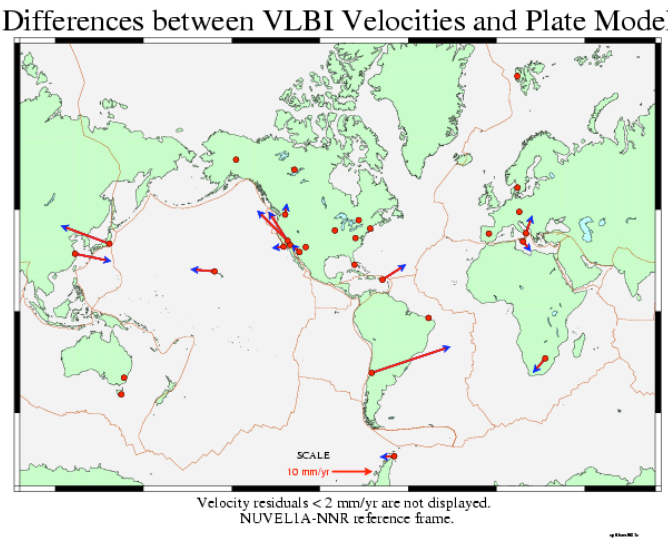


# Plate Velocities from VLBI

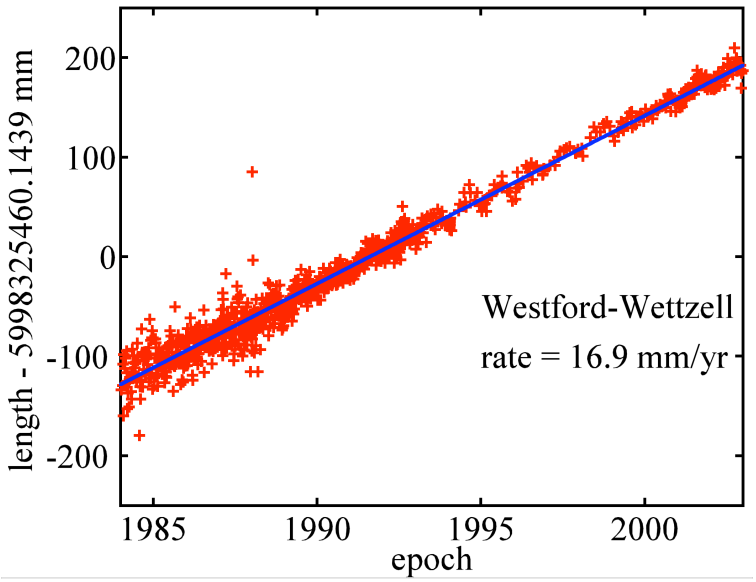





# Differences between VLBI Velocities and Plate Model

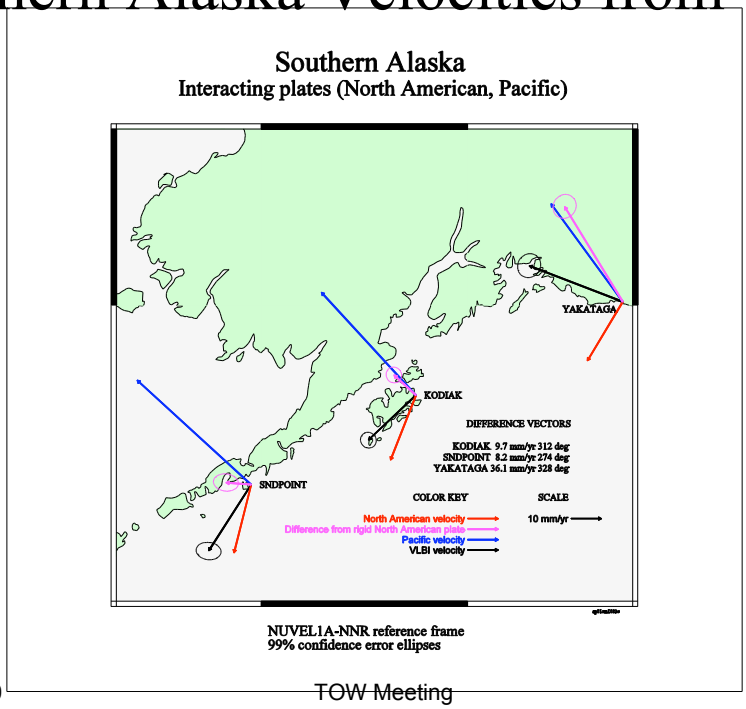


# Westford- Wettzell Baseline

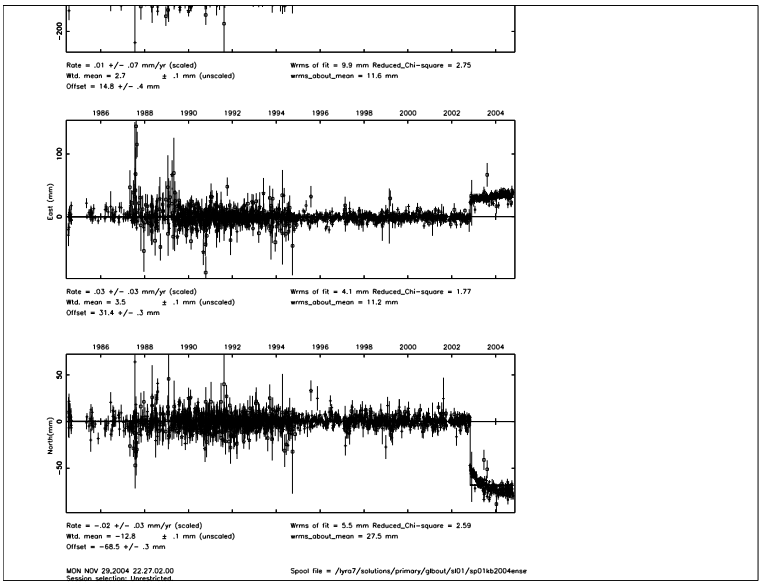





# Southern Alaska Velocities from VLBI

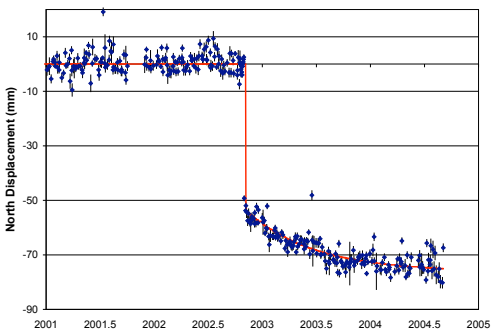


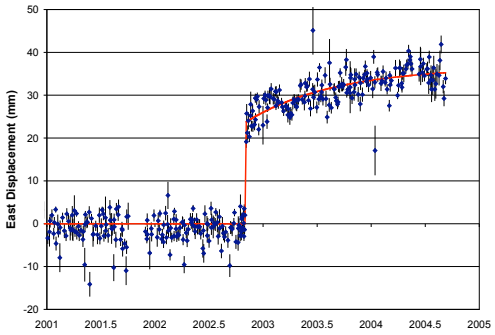
# Gilcreek Position



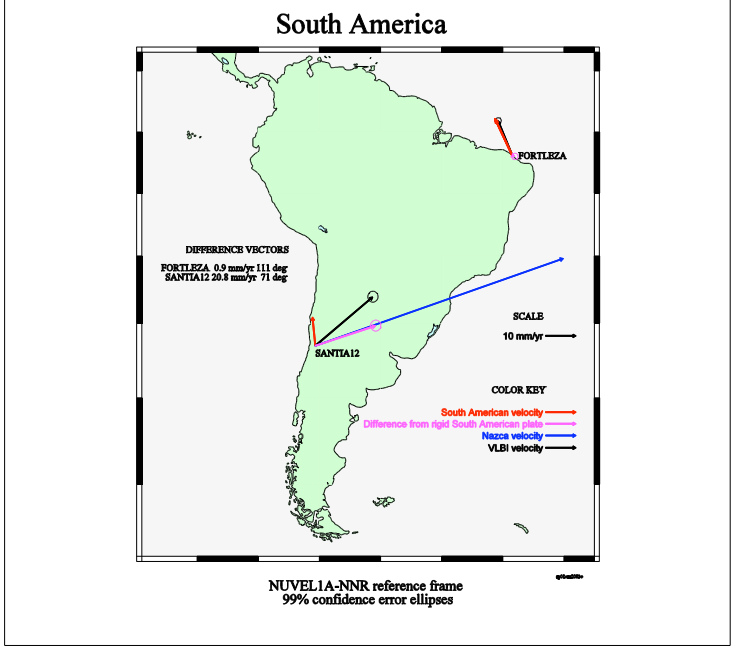



# Gilcreek North and East
## (data and model from Dan MacMillan)



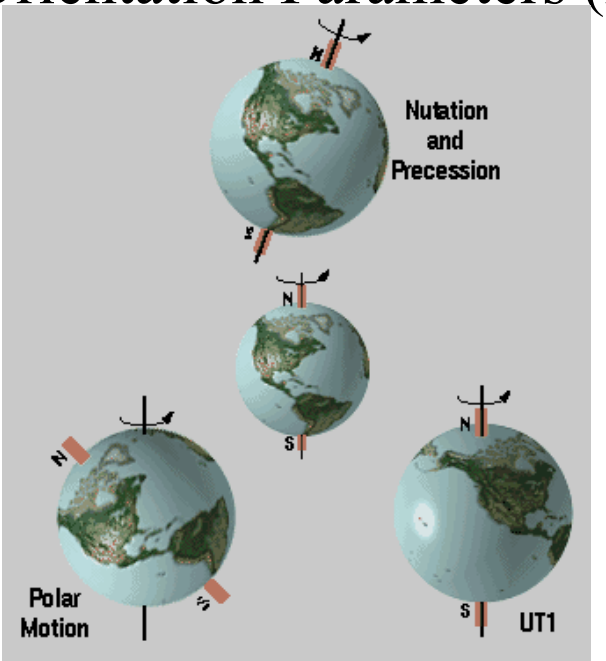



# South America Velocities from VLBI

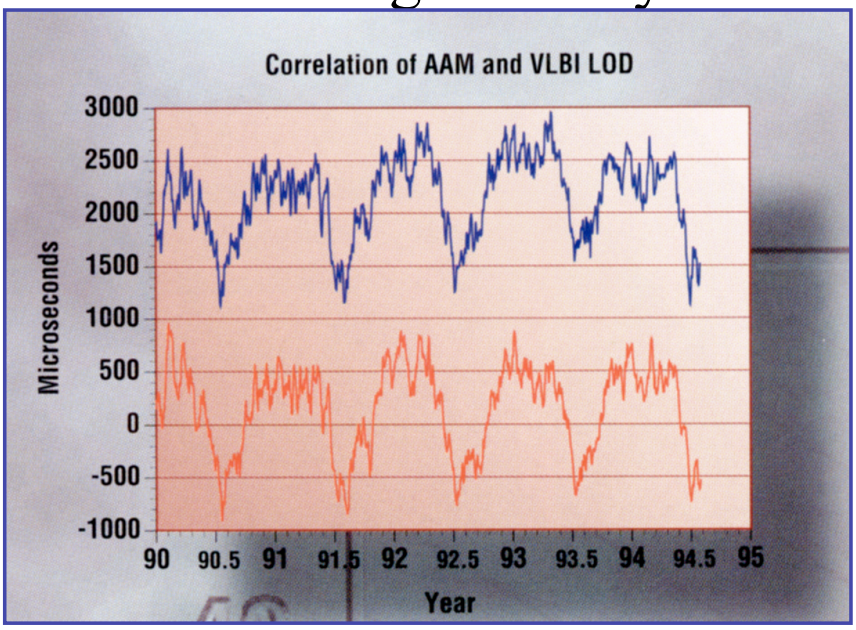





# Earth Orientation Parameters (EOP)



# Atmospheric Angular Momentum and Length of Day





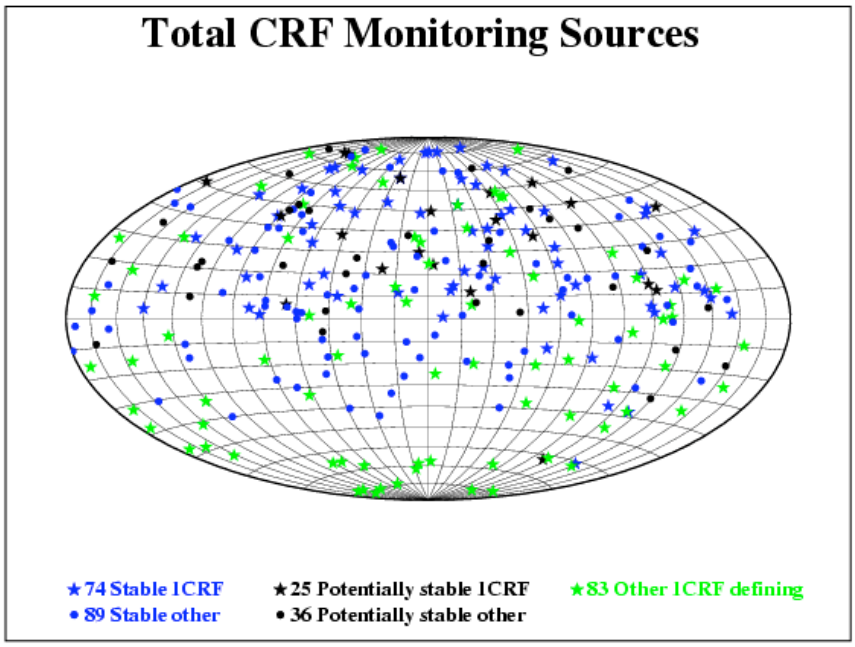

# Celestial Reference Frame - 1

- Extragalactic radio sources serve as the definition of all positions on the sky.
  - measured by VLBI
  - revolution when changed from stars
  - fewer objects but much more accurate
- Most sessions use about 100 sources, but CRF needs about 600 (or more) sources
  - need to monitor positions and strengths
  - CRF sources being added to R1s and R4s

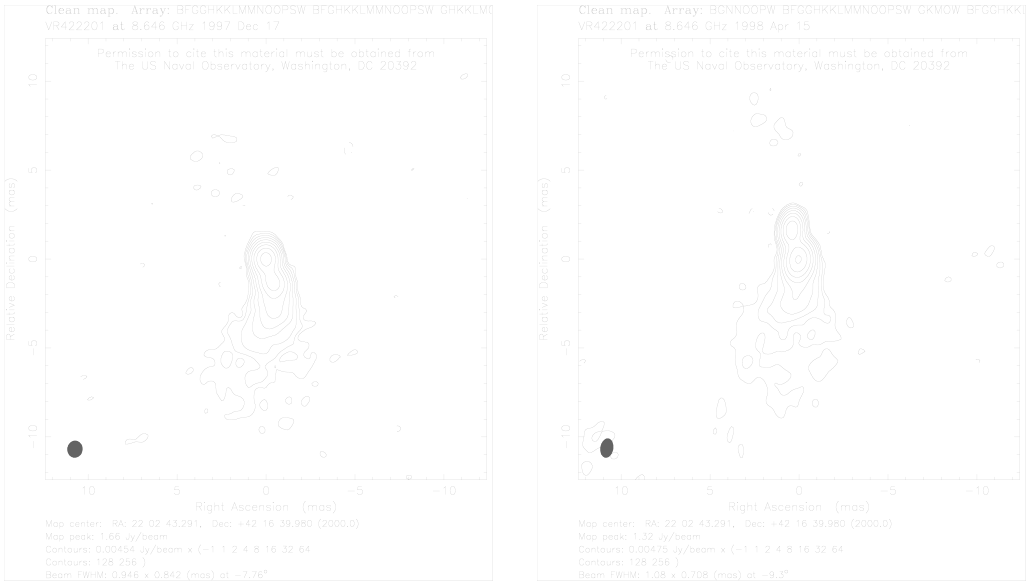
# Celestial Reference Frame - 2

- CRF provides inertial frame for absolute orientation of Earth in the Universe
  - allows measurement of properties of mantle and core
  - necessary for maintaining satellite orbits
- GAIA satellite (2010 or beyond) is planned to find optical positions of extragalactic sources more accurate than VLBI by factor of 100, but:
  - only accessible from space, so
  - VLBI will continue to be used for TRF and EOP



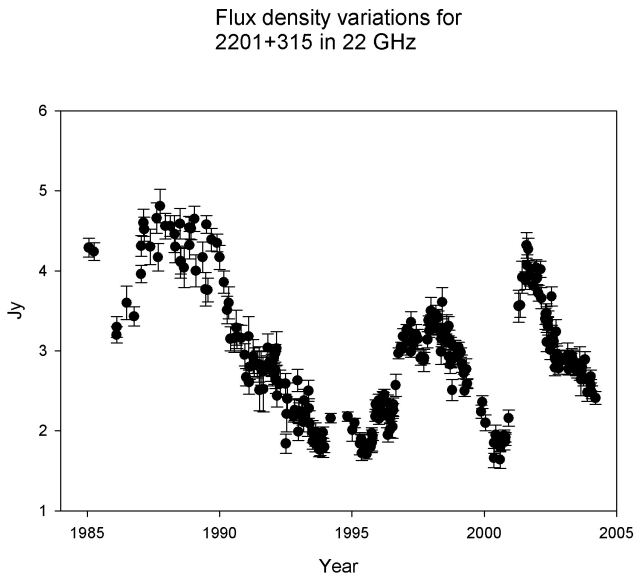


# Source Structure Changes



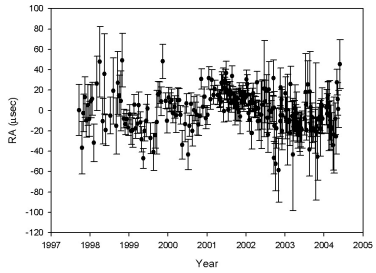



# Flux Density Variations

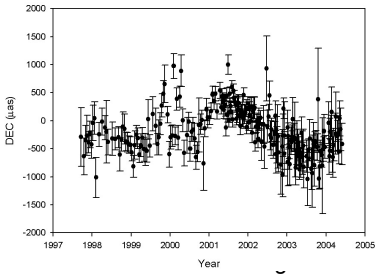


# Source Position Variations

The daily variations in RA of the source 2201+315
from VLBI data in 1997-2004




The daily variations in DEC for the source 2201+315
from VLBI data in 1997-2004






# Summary

- VLBI is unique among the space geodetic services for:
  - absolute orientation in space (nutation, UT1-UTC)
  - Celestial Reference Frame
- VLBI is primary for the scale of the Terrestrial Reference Frame.
- But best results for TRF and EOP will come from combination of all techniques.