ITRF origin: Diagnosis of current realization

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Motivation

• Understand the current status of the realized ITRF origin definition and accuracy

• Explore potential causes for the apparent bias and drift of the ITRF2005 origin relative to ITRF2000 frame

• Discuss the potential approaches to stabilize the reference frame origin in the future
Realization of ITRF origin

• The origin of ITRF is at the center of mass (CM) of the entire Earth including the oceans and atmosphere.

• The ITRF origin is represented through a set of globally distributed station coordinates and velocities.

• The ITRF2005 origin is realized by zero translation and translation rate between ITRF2005 and ILRS (SLR) time series.

• The accuracy of realized ITRF2005 origin is evaluated through its consistency with respect to ITRF2000.
SLR Origin and Scale Variations \textit{WRT} ITRF2000

By courtesy of Zuheir Altamimi, AGU 2006 talk
Potential causes for the SLR origin drift wrt ITRF2000 frame

• Geophysical processes (real drift)

• Limited SLR stations with poor geographic network distribution

• Shrinking SLR network, ageing instruments, and unsolved systematic errors

• Non-linear behavior in individual SLR station coordinate solution time series
SLR network

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Large mass redistribution on the Earth causes geocenter motion

From Univ. of Colorado web site

From Cheng of CSR (2007)

From NASA/JPL, Kwok (2007)
Derive SLR origin and scale time series wrt ITRF2000 frame -- our tests

- ILRS CGS weekly solutions (1992.9-2005.9)
  ILRS DGFI weekly solutions (1992.9-2005.9)

- Adopt Kalman filter approach to stack the data and impose the minimum constraints
  Assign weekly network parameters as global parameters instead of stochastic parameters

- Following the procedures of Altamimi (2006)

- Treat coordinates and velocities for Stations Simens (1873 and 1893), San Fernando (7824) and Arequipa (7403) empirically
ILRS CGS origin and scale wrt ITRF2000 frame
ILRS dgfi origin and scale wrt ITRF2000 frame

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<table>
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<tr>
<th>solution</th>
<th>Tx mm</th>
<th>Ty mm</th>
<th>Tz mm</th>
<th>$\dot{\gamma}_x$ mm/y</th>
<th>$\dot{\gamma}_y$ mm/y</th>
<th>$\dot{\gamma}_z$ mm/y</th>
<th>S ppb</th>
<th>$j^Y$ ppb/y</th>
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<td>3.3</td>
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Considerations of stabilizing reference origin

• Research on the non-linear behavior of the station coordinate solutions
  real: geophysical process, in particular large scale mass redistribution
  not real: systematic errors

• Enlarge SLR network to improve the distribution and to avoid overly rely on few stations
  lobby congress?

• Consider adding other technique solutions
  GPS?
Reduce systematic errors in GPS data analysis

- Improve various models currently used in GPS data analysis
- Antenna phase center variation model
- Second-order ionosphere correction
- ‘GPS year’ errors
- Deal with the spatially non-uniform station distribution: weighted by Voronoi cells
- Common-mode-errors (CME)
East CME from global GPS network

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Summary

• The current assessment about the ITRF2005 origin consistency may be relatively conservative.

• The main causes for the SLR determined origin inconsistency are: limited number of stations, poor network geometry distribution, and non-linear behavior in the station coordinate time series.

• Avoid overly relying on a few stations to determine the frame origin: before it becomes too late.