Long-Term Stability of the ITRF Origin and Scale

• Datum definition for time series analysis
• Stability of the
  • IVS VLBI scale
  • ILRS SLR origin & scale
• Comparison to external solutions and models
• Conclusions

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Analyzed data and models

- IVS VLBI sessions 1980 – March 2007
  - Scale temporal behaviour
- ILRS SLR weekly solutions 1993-March 2007
  - Scale and origin temporal behaviour
- IGN/OCA SLR weekly solutions (Coulot et al., 2007)
  - Range bias estimated using temporal decorrelation method
  - Compare with ILRS scale
- Displacements models
  - GPS+OBP (Wu, 2006): Global inversion of GPS residuals & Ocean bottom pressure variations for loading displacements
  - Loading model (van Dam, 2007) : Hydrology + non-tidal Ocean + Atmosphere
  - Compare model Geocenter motion and scale with SLR
- Impact of GPS Abs. Ant. Ph. corrections on an ITRF-like combination
Datum Definition for Time Series stacking
(CATREF Software)

• Consider Transfo. Param. as unknowns in Normal Eq. Sys.
• Estimate time series of Transfo. Param. & long-term solution
• Considering linear transf. parameter $P$

\[ P(t) = P(t_0) + \dot{P}.(t - t_0) \quad (1) \]

• Eq. 1 could be solved by linear regression:

\[
\begin{pmatrix}
K & \sum_{k \in K} (t_k - t_0)

\sum_{k \in K} (t_k - t_0) & \sum_{k \in K} (t_k - t_0)^2
\end{pmatrix}
\begin{pmatrix}
P_k(t_0)

\dot{P}_k
\end{pmatrix}
= 
\begin{pmatrix}
\sum_{k \in K} P_k

\sum_{k \in K} (t_k - t_0)P_k
\end{pmatrix}
\]

Intrinsic conditions:

\[
P(t_0) = 0 \quad \& \quad \dot{P} = 0 \quad \text{or}
\]

\[
\sum_{k \in K} P_k(t_k) = 0
\]

\[
\sum_{k \in K} \frac{P_k(t_k)}{(t_k - t_0)^{-1}} = 0
\]
IVS Intrinsic Scale

IVS VLBI intrinsic scale wrt its own cumulative solution

ITRF2005
ILRS SLR Intrinsic Origin and Scale

Graphs showing time series data for SLR/ILRS, TX (mm), TZ (mm), TY (mm), and Scale (mm) from 1994 to 2006.
ILRS SLR Intrinsic Origin and zero Scale

- TX (mm)
- TZ (mm)
- TY (mm)
- Scale (mm)
ILRS SLR Intrinsic Origin and Scale

SLR/ILRS

ZERO Scale

TX (mm)

TZ (mm)

TY (mm)

Scale (mm)
Geocenter ILRS SLR vs models

SLR/ILRS

TX (mm)

TZ (mm)

TY (mm)

Scale (mm)
Geocenter ILRS SLR vs GPS+OBP model

Graphs showing the comparison between SLR/ILRS and GPS+OBP models for TX, TZ, TY, and Scale (mm) from 1994 to 2006.
ILRS SLR & GPS+OBP Power Spectrum

TX

TZ

TY

Scale

0.64 cy
Geocenter Translations for TX

black = degree 1 terms
red = SLR site displacements 1 terms
Geocenter Translations for TZ

black = degree 1 terms
red = SLR site displacements 1 terms

Geocenter offset (mm)

Geocenter ILRS SLR vs Loading model

SLR/ILRS vs Loading

TX (mm)

TZ (mm)

TY (mm)

Scale (mm)
Geocenter ILRS SLR vs GPS+OBP and Loading models
ILRS SLR Intrinsic origin and scale
(ITRF2005 + 64 weeks)
Zimmerwald SLR Station

Discontinuities not taken into account

Discontinuities taken into account

Range Bias events
ILRS vs OCA scales wrt ITRF2005
GPS ABS vs REL APCV : Up Residuals: Tie - Space Geodesy

WRMS: ABS (7 mm)  REL (5 mm)

Local tie weights as in ITRF2005
Conclusions

• We showed evidences that SLR weekly translations and scales should be estimated for the ITRF

• Despite its poor network, apparent geocenter motion is embedded in SLR weekly solutions
  – Good agreement with GPS+OBP and Loading models

• Range Bias effect on SLR scale (?)
  – Extended ILRS time series still show a scale bias/drift wrt ITRF2005 (VLBI scale)

• VLBI scale:
  – Seasonal variation due to thermal expansion!
  – Troposphere modeling (?)

• GPS scale is "heterogeneous", because of Antenna-based PCV until all data reprocessed

• GPS-APCV and tie agreement is unclear !!