Status of the ITRF2004

• Current Status:
  • TC latest submissions
  • Internal Consistency of TC solutions

• Preliminary Analysis : Some Results
  • Origin (Geocenter)
  • Scale
  • Earth Orientation Parameters
  • Seasonal variations

• Conclusions

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IGN, France

Claude Boucher, CGPC, France

IERS Workshop, Potsdam, October 10-11, 2005
ITRF2004 Derivation

VLBI \[ W_1 \quad W_2 \quad \ldots \quad W_n \] \[ \rightarrow \] TRF (X, V) + EOP (SINEX)

SLR \[ \rightarrow \] TRF (X, V) + EOP (SINEX)

GPS \[ \rightarrow \] TRF (X, V) + EOP (SINEX)

DORIS \[ \rightarrow \] TRF (X, V) + EOP (SINEX)

Local Ties \[ \rightarrow \] Combination ITRF2004

ITRF2004 \[ \rightarrow \] TRF (X, V) + EOP (SINEX)
ITRF2004: Input Data  
(Status September 2005)

- **Combined set of Time Series per Technique:**
  - VLBI 1984 – 2005 (under analysis)
  - SLR 1993 – 2005 (under analysis)
  - GPS 1996 – 2005 (ready)

- **Individual Solutions**
  - DORIS 1993 – 2005 (IGN-JPL, INASAN, LCA)

- **No multi-technique solutions at obs. level submitted**

- **Co-location tie vectors**
TRF & EOP time series Combination

**C\text{AT}REF Software**

**INPUT:** \( X(t), \text{EOP}(t) \) in daily/weekly/monthly SINEX files

**OUTPUT:** \( X(t_0), \dot{X}, \text{EOP}(t), (T_x, T_y, T_z, D, R_x, R_y, R_z) \)

Datum Definition with Minimum Constraints Over a Reference Set of stations

\[
\begin{align*}
X^i_s &= X^i_{itr} + (t^i_s - t_0)\dot{X}^i_{itr} + T_k + D_kX^i_{itr} + R_kX^i_{itr} \\
&\quad + (t^i_s - t_k)\left[\ddot{T}_k + \dot{D}_kX^i_{itr} + \dot{R}_kX^i_{itr}\right] \\
\dot{X}^i_s &= \dot{X}^i_{itr} + \ddot{T}_k + D_kX^i_{itr} + R_kX^i_{itr}
\end{align*}
\]

\[
\begin{align*}
x^p_s &= x^p + R2_k \\
y^p_s &= y^p + R1_k \\
U_T s &= U_T - \frac{1}{f}R3_k \\
\dot{x}^p_s &= \dot{x}^p + R2_k \\
\dot{y}^p_s &= \dot{y}^p + R1_k \\
LOD_s &= LOD + \frac{\Lambda_0}{f}\dot{R3}_k
\end{align*}
\]

- Matching common EOP parameters at UT noon
- Propagate at UT noon if rates are available

\[
(A^TA)^{-1}A^T(X_{RS} - X_c) = 0
\]
Status of IVS submission

• 3rd version submitted in August:
  – Data span 1984.1 – 2005.3
  – 2024 Sessions/SINEX files
  – 85 are not usable:
    • Mostly files with unsolved parameters
    • Some files with unidentified parameters
  – Preliminary analysis seems OK
IVS WRMS: Internal Precision
IGS – IVS PM Differences

IGS - IVS EOP Diff. (Preliminary Analysis)

XPO diff (mas)

YPO diff (mas)
Status of ILRS submission

- 3rd version submitted in July:
  - Data span 1993.0 – 2005.4
  - 641 Weeks/SINEX files
  - Preliminary analysis unsatisfactory
  - ILRS AWG recommendation is to re-analyse the data (Eastbourne mtg, Oct. 1st) by all ACs and new combination: deadline Oct. 31
ILRS Combined WRMS

Before

After

Outlier rejection
## Range & Tropo. Bias

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<th>Tropospheric Bias</th>
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Status of IGS submission

• 3rd version submitted in August:
  – Data span 1996.1 – 2005.6
  – EOPs start 1999.2
  – 497 weeks/SINEX files
  – Preliminary analysis satisfactory
    • Intercomparison NRCan – DGFI – IGN
      (global consistency at the 1 mm level)
Status of IDS submission

• 3 solutions
  – LCA: 1993.0 – 2005.0 (early submission)
  – INASAN: 1993.0 – 2004.4 (early submission)

• Preliminary analysis of IGN and LCA solutions
DORIS WRMS: IGN & LCA

Comparaison to IGS:
Indicative WRMS

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IGS – DORIS PM Differences

Xpole

Ypole

IGN

LCA

Xpole

Ypole
Internal Quality Evaluation: Weekly WRMS

- DORIS/IGN Weekly WRMS
- VLBI/IVS session WRMS
- ILRS Weekly WRMS
- GPS Week
SLR Origin and Scale Variations

[Graphs showing variations over time for different locations and scale (mm)]
DORIS Origin and Scale Variations

IGN

LCA

TX (mm)

TZ (mm)

TY (mm)

Scale (mm)
Seasonal Variations GPS/IGS Sites

BAHR Annual Amplitude and Phase (mm)

DRAO Annual Amplitude and Phase (mm)

IRKT Annual Amplitude and Phase (mm)

BAHR

DRAO

IRKT
GPS Annual Vertical Amplitude & Phase
Polar motion differences with IERS C04

VLBI + SLR + DORIS  ... + GPS
Mult-technique Combination over 12 years
Polar Motion Residuals (Zoom ± 1 mas)
Site velocities with $\sigma < 3 \text{ mm/Yr.}$
Site velocities used in kinematic model estimation
Site velocities used in kinematic model estimation - Residuals
Missing Ties

SLR/GPS (2)

VLBI/GPS (4)

DORIS/GPS (1)

VLBI/SLR (1)

Brewster
Haleakala
Ottawa
Kunm
URUM
KUNM
MIZU
SAKAL
Krimea

27x61 to 38x71
83x325
138x446
516x254
513x589
138x578
93x199
230x188
Co-locations
A new difficulty

• Most of IGS/GPS stations experience jumps (discontinuities) in the time series of station positions
• Most of Co-location sites are concerned
• A few station discontinuities are detectable for other techniques
• Having only one tie: to which segment should the tie be applied ???
• Careful combination analysis is needed
A Co-location site with Discontinuities

X

Tie

Time

GPS
SLR
VLBI
DORIS
Preliminary ITRF2004 combination
Tie Residuals

Tie Residuals (mm)

# of Tie vectors
Summary & Conclusions

• TCs submissions
  – IGS and IVS: OK
  – ILRS: re-submission (October 31) & discontinuity list to be confirmed
  – IDS: Two solutions to be combined (IGN & LCA)
    • Exclude EOPs from LCA solution
    • Discontinuity list to be confirmed

• ITRF2004 Datum definition:
  – Origin: consistency between ILRS and ITRF2000
  – Scale: ILRS and IVS average consistent with ITRF2000
  – Orientation: Alignment to ITRF2000 at \( t_0 \) (e.g. 00:001)
  – NNRC: tests to be done using:
    • ITRF2000
    • APKIM2004
    • Kreemer et al.
    • Others (?)
ITRF2004 Final

Target: End of November