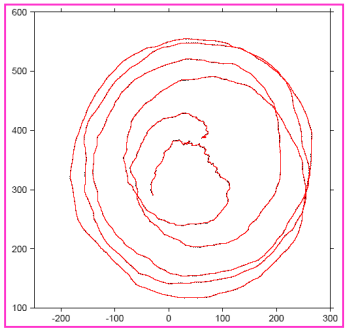
Rigorous Combination to ensure ITRF and EOP Consistency

- ITRF2005 summary
- EOPs estimated in ITRF2005 combination
- ITRF2005 and 05 C04 consistency over time
  - Using CATREF
  - Using Paris Obs. Method
  - Comparison
- Recent Results



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Journées Système de Référence 2007, Meudon, 17-19 September 2007

Keyword: ITRF&EOP Consistency

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ITRF2005

- For 1st time, use Time Series of Station Positions
  - Daily (VLBI)
  - Weekly (GPS, SLR & DORIS)

and Earth Orientation Parameters:

Polar Motion (x_p, y_p)

Universal Time (UT1) (Only from VLBI)

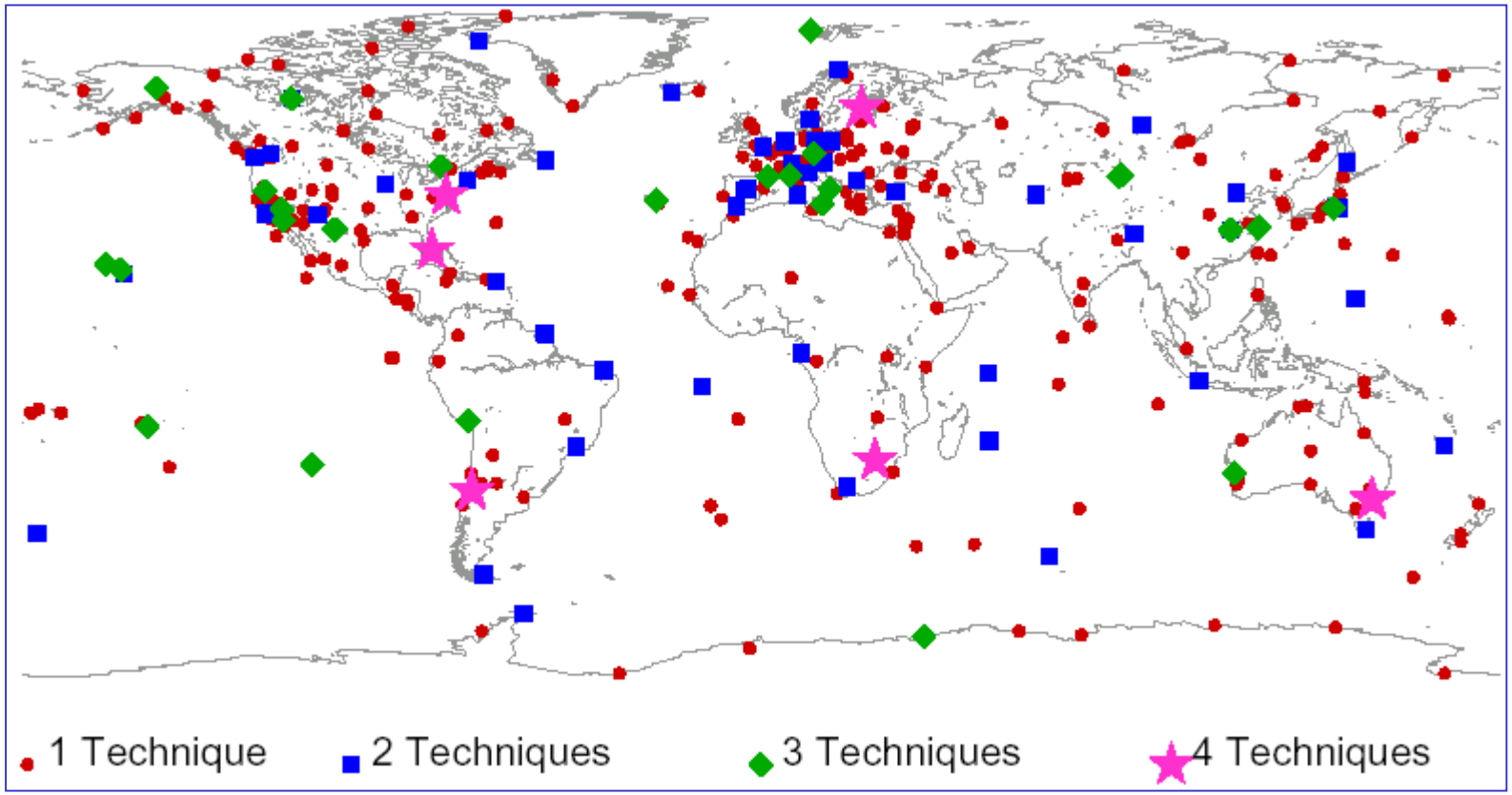
Length of Day (LOD) (Only from VLBI)

- 3 ITRF CC: NRCan, DGFI, IGN

Submitted data

TC - AC	Time-span	Type of constraints/solution	
IVS VLBI	1980.0-2006.0	Normal Equation	Daily
ILRS SLR	1992.9-2005.9	Loose; Var-Covar	Weekly
IGS GPS	1996.0-2006.0	Minimal; Var-Covar	
IDS - IGN DORIS	1993.0-2006.0	Loose; Var-Covar	
IDS -LCA DORIS	1993.0-2005.8	Loose; Var-Covar	

ITRF2005 Co-locations



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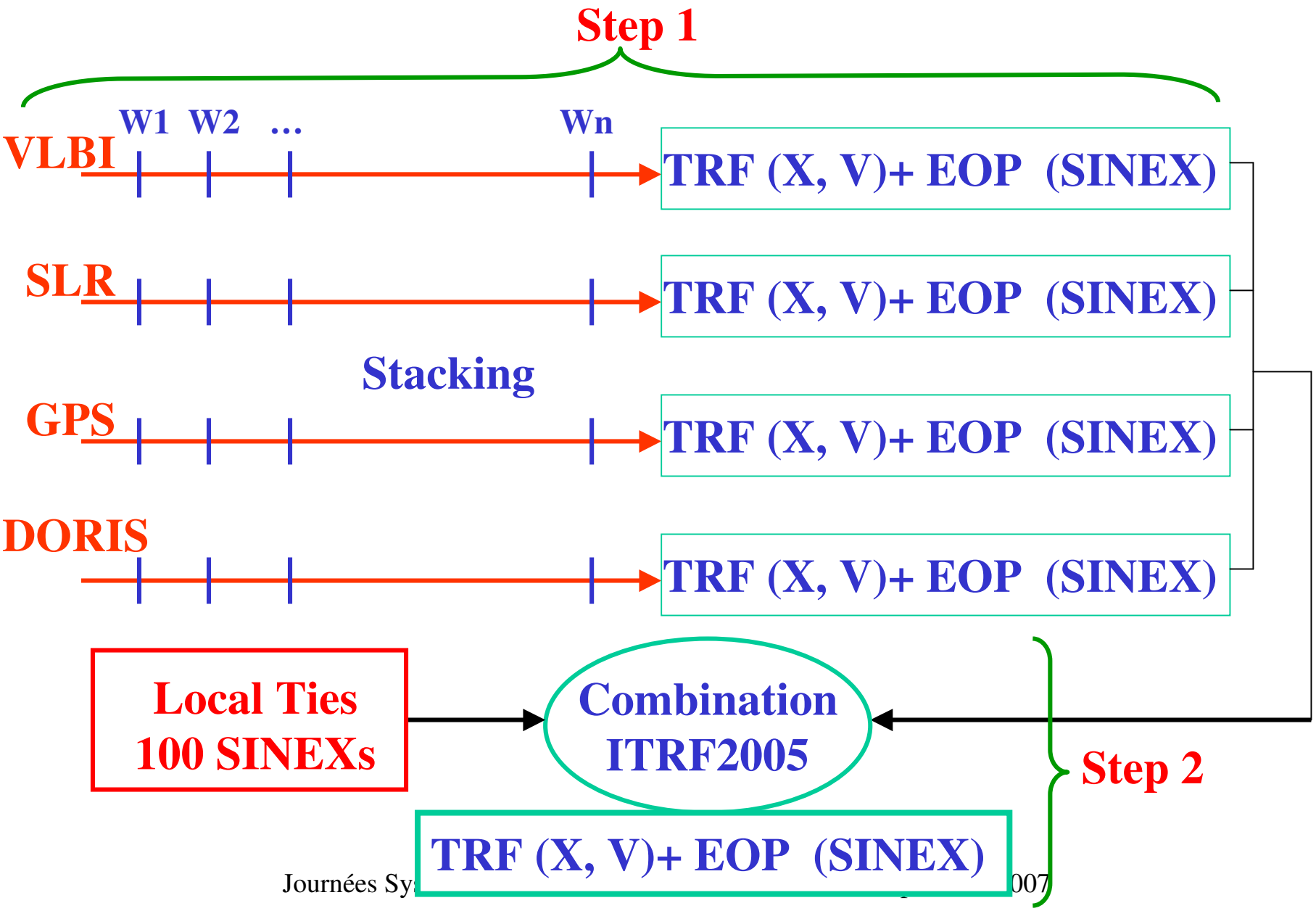
ITRF2005 Derivation



CATREF Software

Station Positions & Velocities

$$\begin{cases} X_s^i &= X_c^i + (t_s^i - t_0)\dot{X}_c^i \\ &+ T_k + D_k X_c^i + R_k X_c^i \\ &+ (t_s^i - t_k)\left[\dot{T}_k + \dot{D}_k X_c^i + \dot{R}_k X_c^i\right] \\ \dot{X}_s^i &= \dot{X}_c^i + \dot{T}_k + \dot{D}_k X_c^i + \dot{R}_k X_c^i \end{cases}$$

EOPs

$$\begin{cases} x_s^p &= x_c^p + R2_k \\ y_s^p &= y_c^p + R1_k \\ UT_s &= UT_c - \frac{1}{f} R3_k \\ \dot{x}_s^p &= \dot{x}_c^p + \dot{R}2_k \\ \dot{y}_s^p &= \dot{y}_c^p + \dot{R}1_k \\ LOD_s &= LOD_c + \frac{\Lambda_0}{f}\dot{R}3_k \end{cases}$$

Derived from relationship btw Celestial & Terrestrial Systems :

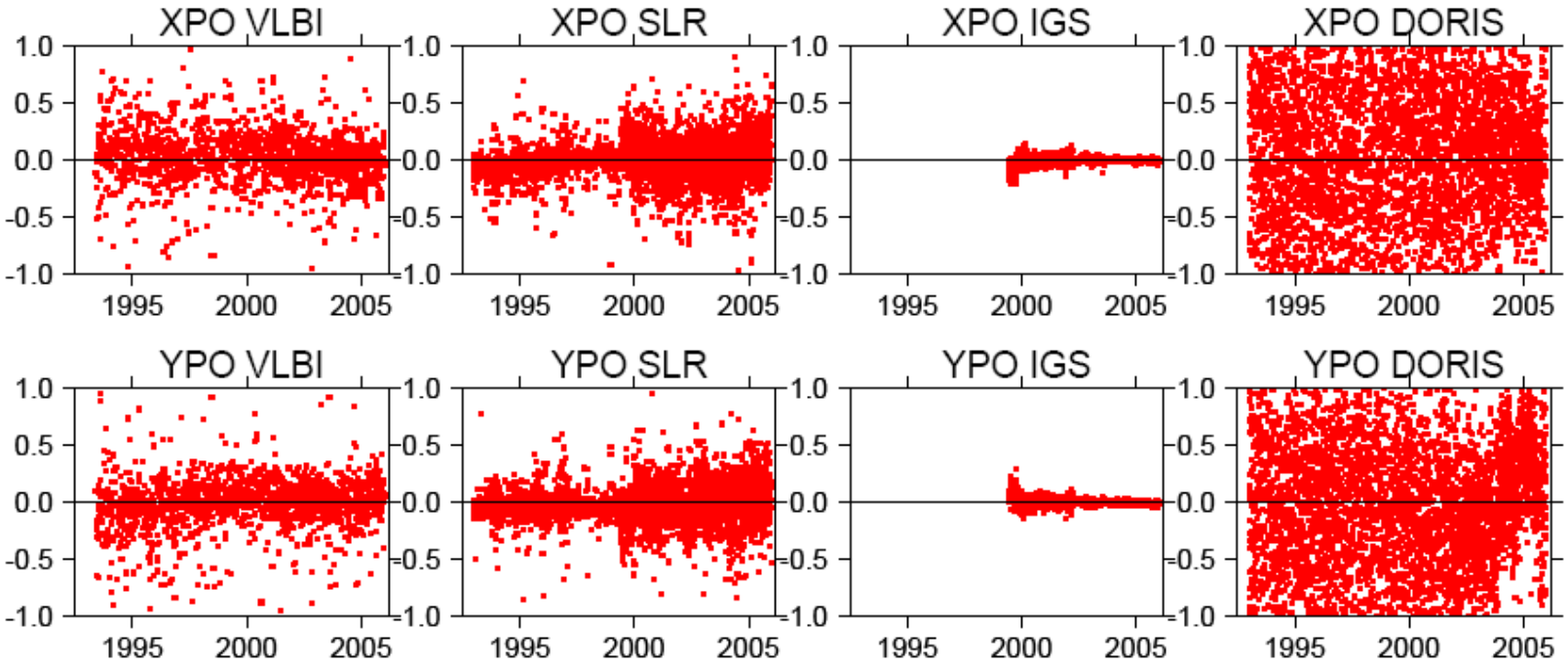
$$X_{CRS} = S.N.P.X_{TRS}$$

$$LOD = \int_t^{t+\Lambda_0} dUT$$

Advantages of using Time Series

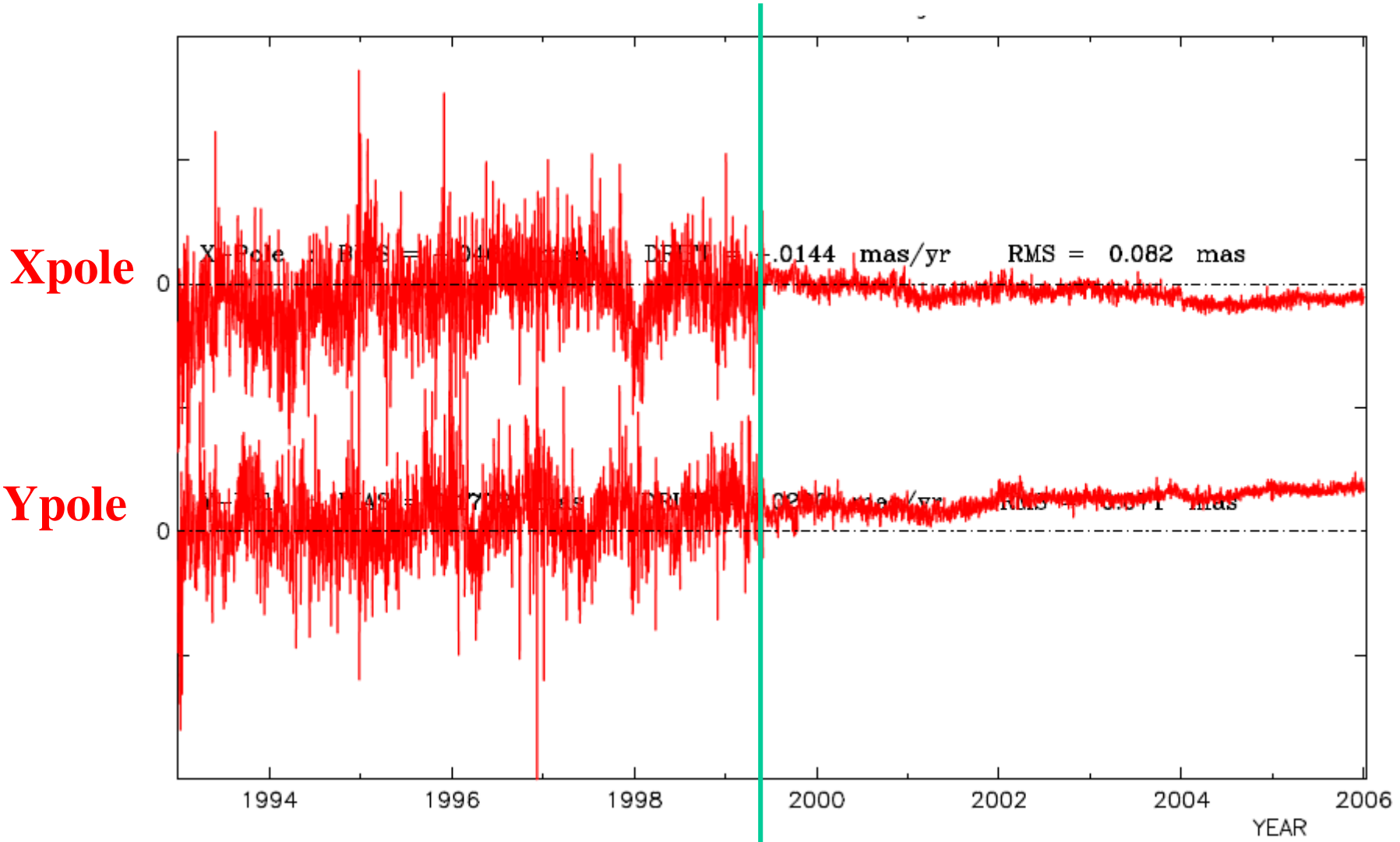
- monitor station non-linear motion and discontinuities
- ==>- ensure optimal velocity field determination
  - ensure optimal orientation time evolution
- examine the temporal behavior of the frame physical parameters: origin & scale
- ==> ensure optimal temporal stability of a secular frame as the ITRF
- ensure EOP and ITRF consistency

ITRF2005: Polar Motion Residuals (mas)



Solution	WRMS (μas)
VLBI	160-170
SLR	135-145
GPS	50
DORIS	650-700

Polar Motion
differences ITRF2005 – Old-IERS C04



VLBI + SLR + DORIS **… + GPS**

Recomputation of the EOP 05C04

- For the first time ITRF2005 available with an associated EOP system
- Upgrade of the C04 code
- Good opportunity to recompute the 05C04 series since 1962 in a frame consistent with ITRF2005

Upgrade of the C04 code

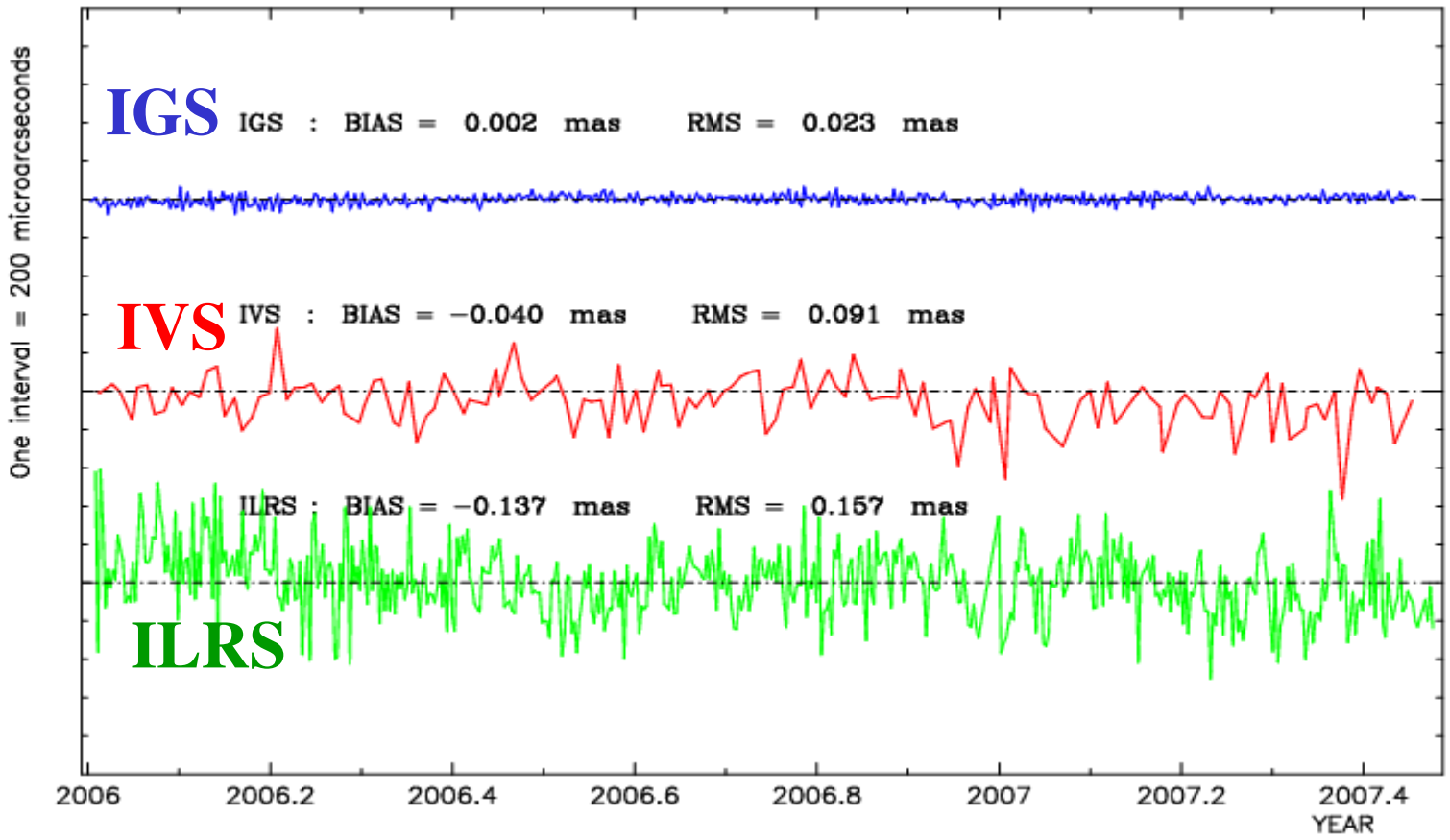
- **What is new ? :**
  - **New philosophy, system is maintained wrt the ITRF reference**
  - **Implementation of the nutation model IAU 2000**
  - **Solution can be performed over 20 years in one run**
  - **New approach for combination of LOD (GPS), compatible with UT1-UTC.**
  - **Estimation of formal errors**

Performance of the new combination code

Comparison of RMS of the differences

- GPS Polar motion : a few mas improvement
- GPS LOD : 6 ms improvement
- UT1 : a few ms improvement
- Celestial pole offsets (for 8 series) : 10 mas to 20 mas improvement

X-Pole: Differences IGS, IVS and ILRS with 05C04

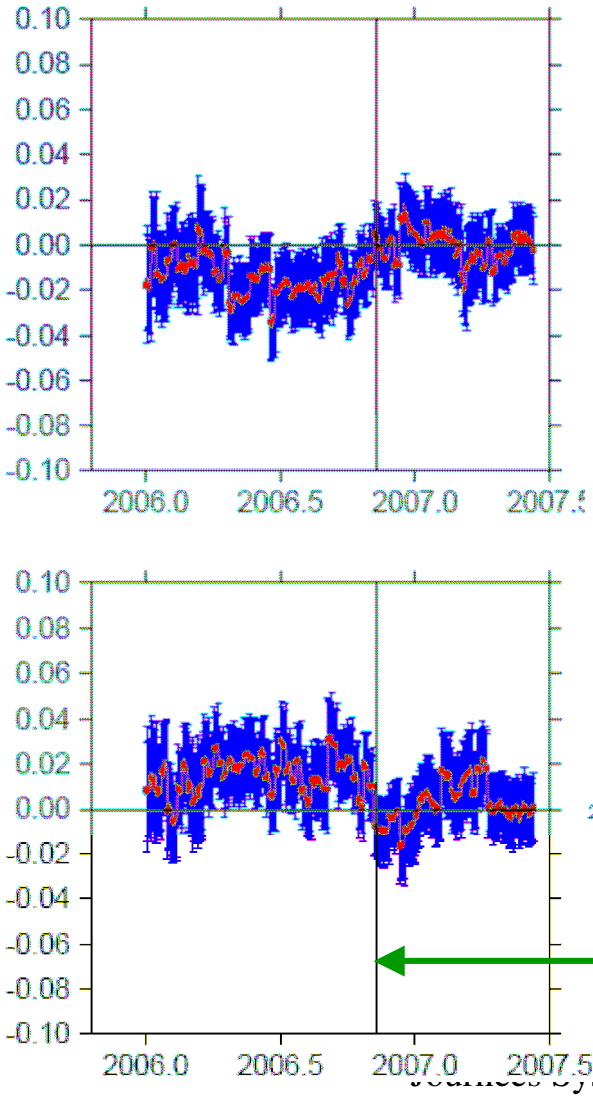


ITRF2005 IERS 05 C04 consistency over time

- Main Objective: ensure the ITRF2005 and EOPs consistency over time
- Extension of the EOPs (ITRF2005)
  - By OP using their updated procedure
  - Stacking weekly time series (SINEX files) using CATREF ==> Long-Term solution per technique over 2006.0 - Onward
  - Combine LT solutions: (different options)
    - Adding local ties
    - Adding ITRF2005 core sites of the 4 techniques
  - Repeat every 6 months
  - A complete ITRF2005-Extended combination is also forseen

ITRF2005 IERS 05 C04 consistency over time

CATREF GPS stacking
***minus* IGS00P03 (mas)**



ITRF2005-extended *minus* 05 C04

(week 1400)

Concluding Remarks

- **Continuous improvement of the ITRF solutions, since the BIH era...**
- **Time series analysis is critical for ITRF implementation**
- **ITRF2005: Starting point of rigorous unification of ITRF and EOPs**
- **Consistency btw ITRF2005 & 05 C04 could be ensured at the level of ±20-30 mas**