

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**

Zuheir Altamimi, Xavier Collilieux, Juliette Legrand

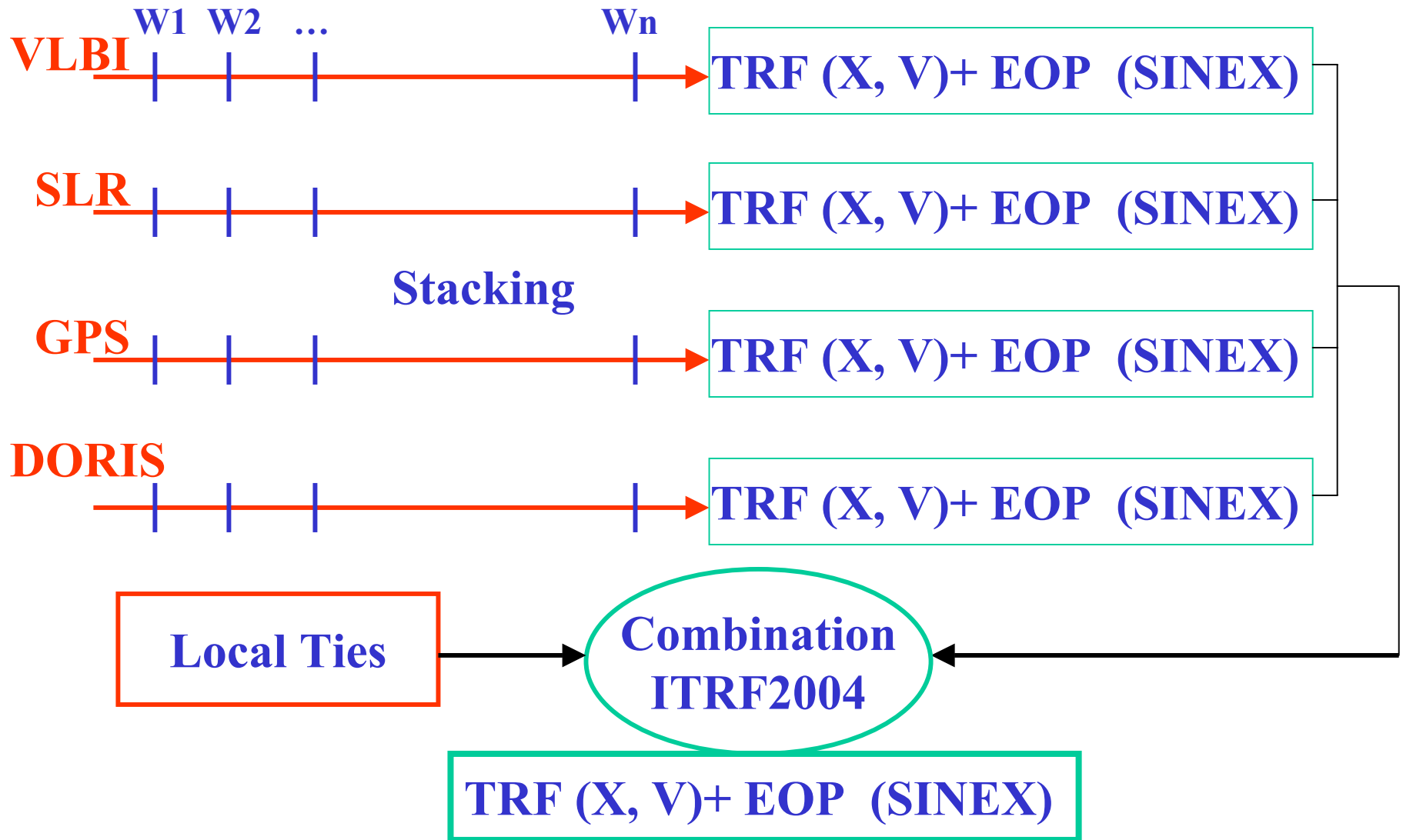


IGN, France

Claude Boucher, CGPC, France



ITRF2004 Derivation



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

CATREF Software

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

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

$$\begin{cases} X_s^i = X_{itr}^i + (t_s^i - t_0) \dot{X}_{itr}^i + T_k + D_k X_{itr}^i + R_k X_{itr}^i \\ \quad + (t_s^i - t_k) [\dot{T}_k + \dot{D}_k X_{itr}^i + \dot{R}_k X_{itr}^i] \\ \dot{X}_s^i = \dot{X}_{itr}^i + \dot{T}_k + \dot{D}_k X_{itr}^i + \dot{R}_k X_{itr}^i \end{cases}$$

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

Datum Definition with Minimum Constraints Over a Reference Set of stations

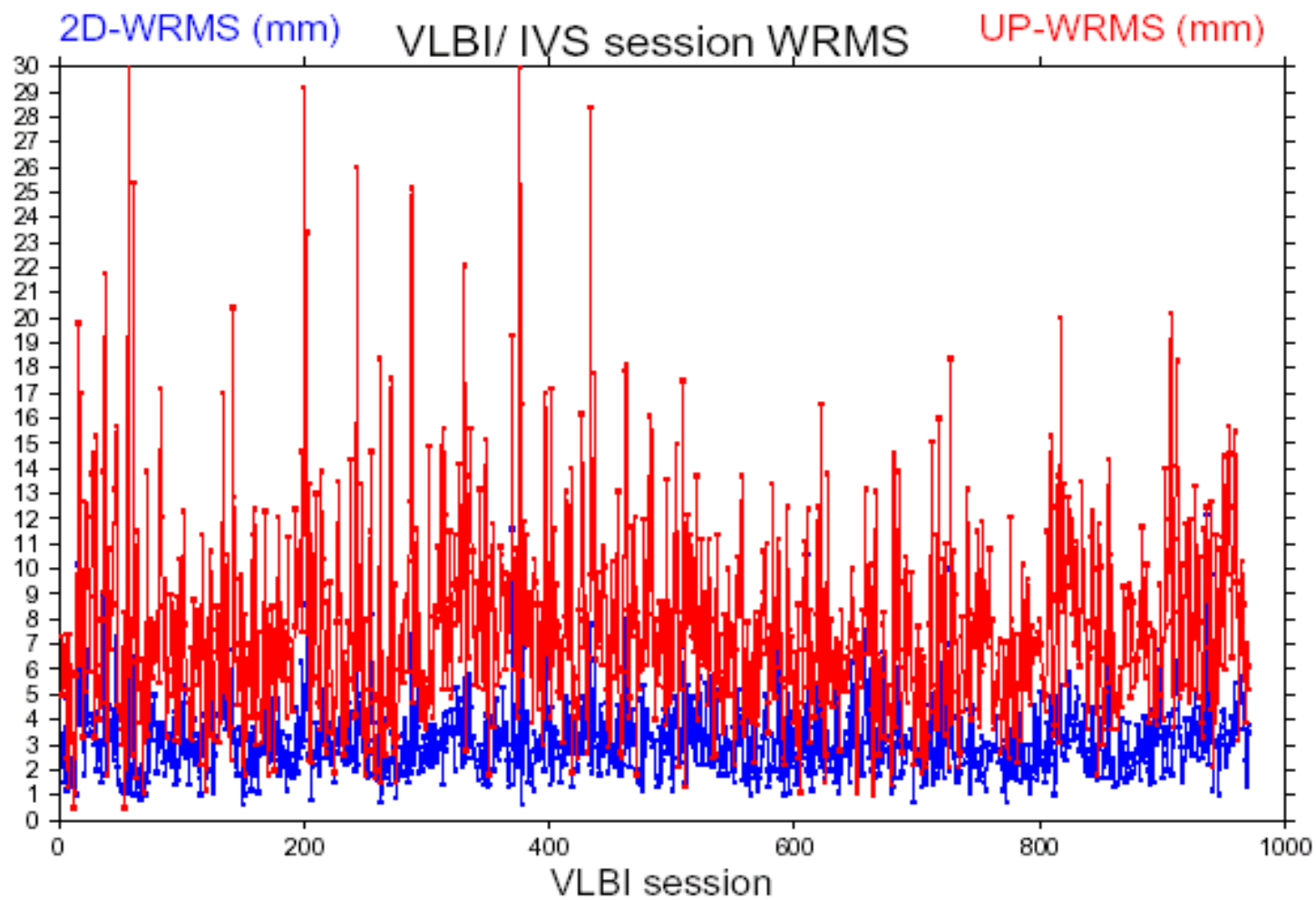
$$(A^T A)^{-1} A^T (X_{RS} - X_c) = 0$$

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

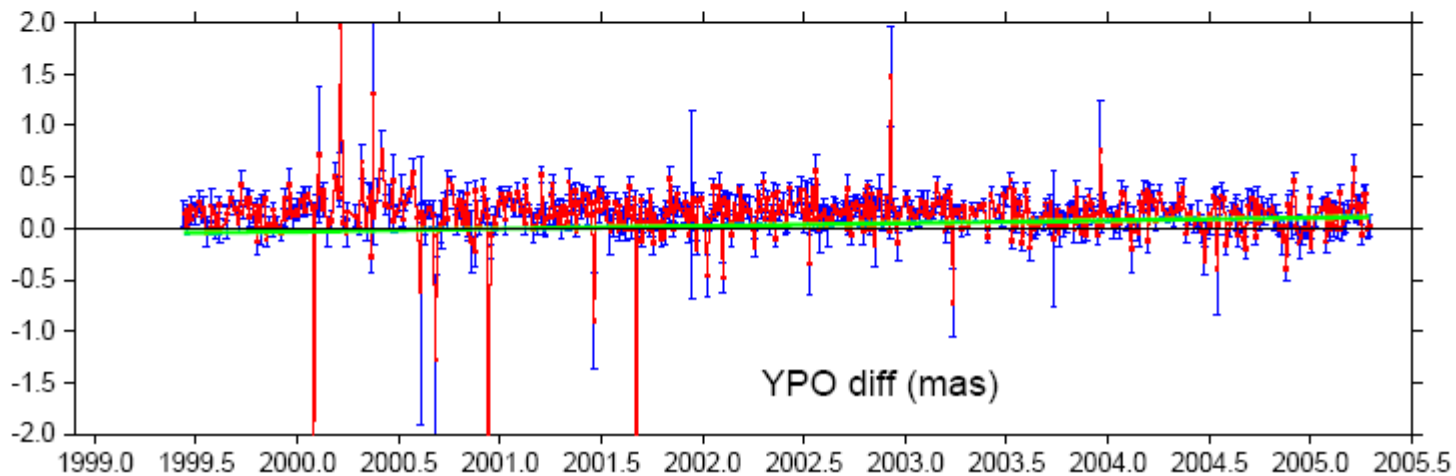
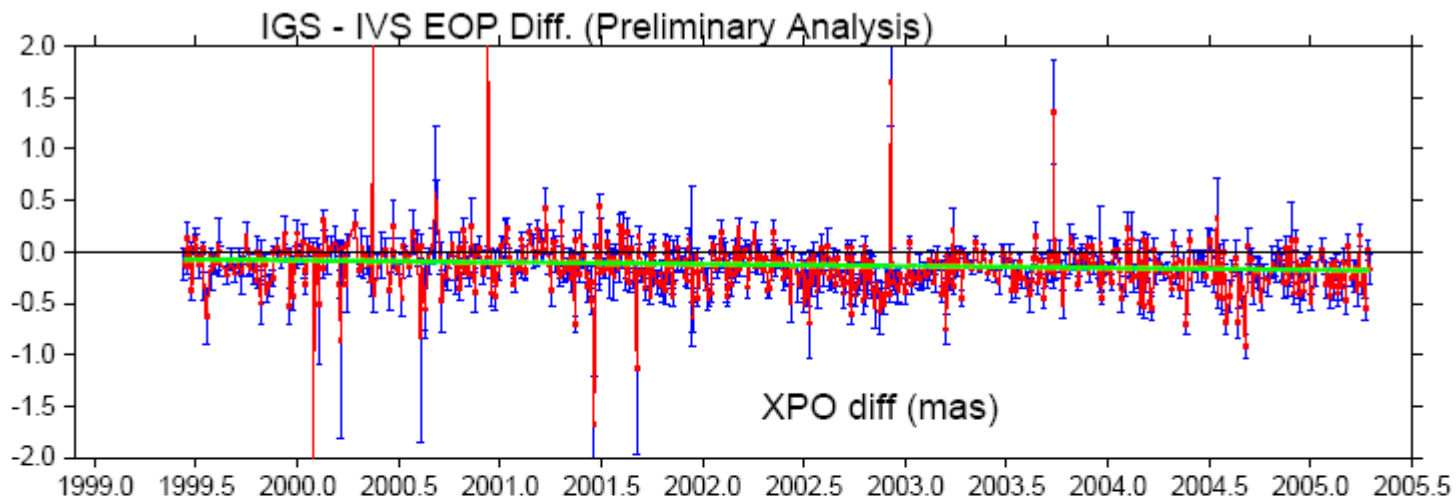
Status of IVS submission

- **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

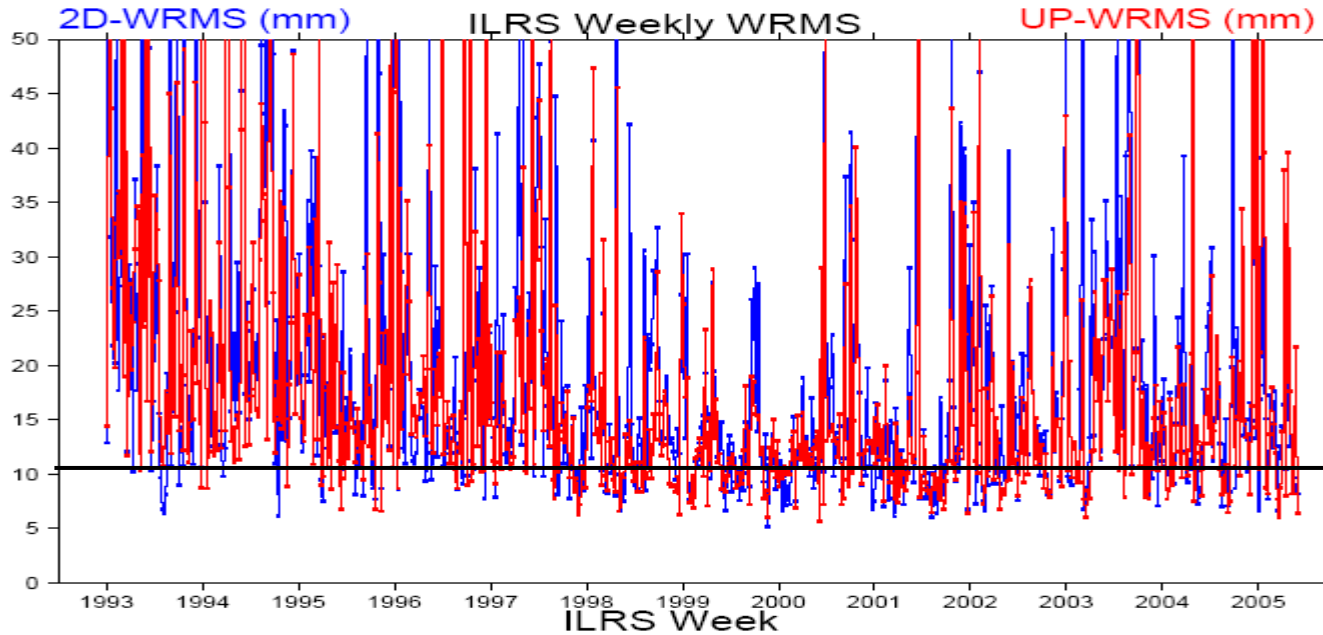


Status of ILRS submission

- **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**

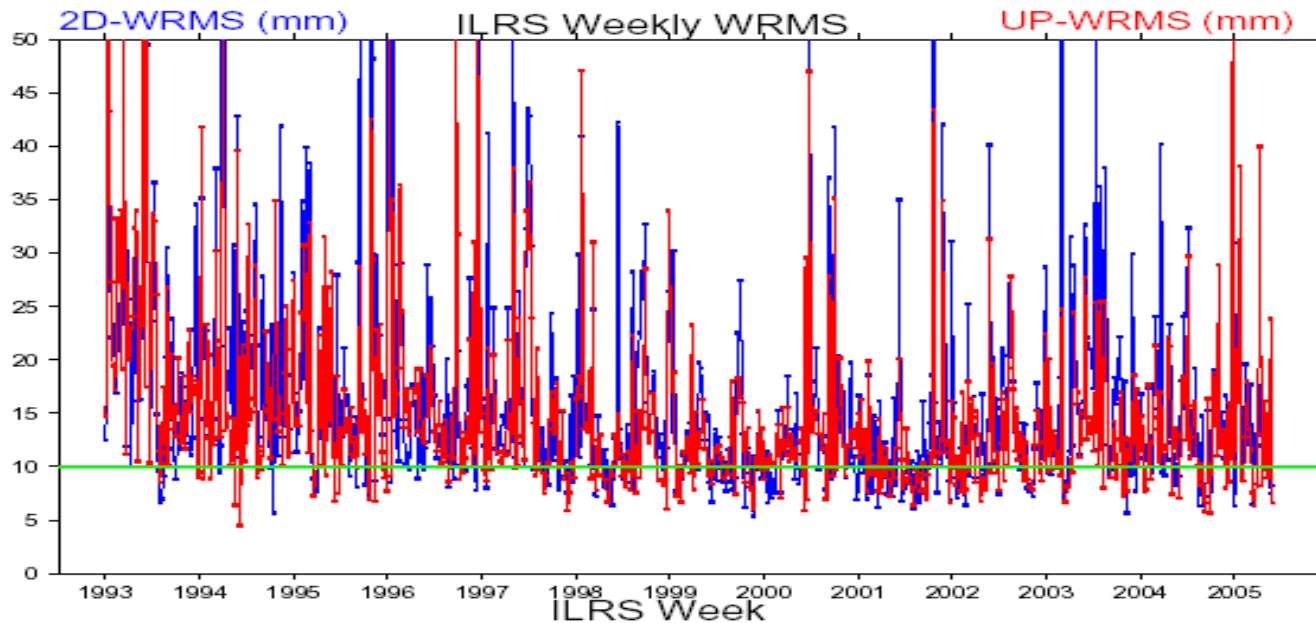
ILRS Combined WRMS

Before

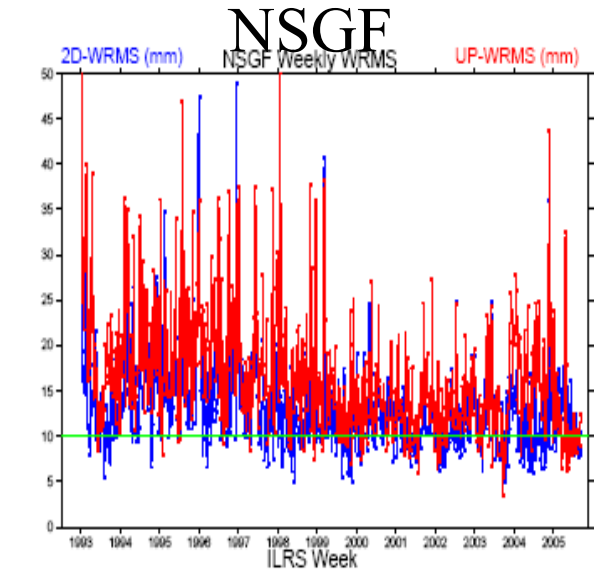
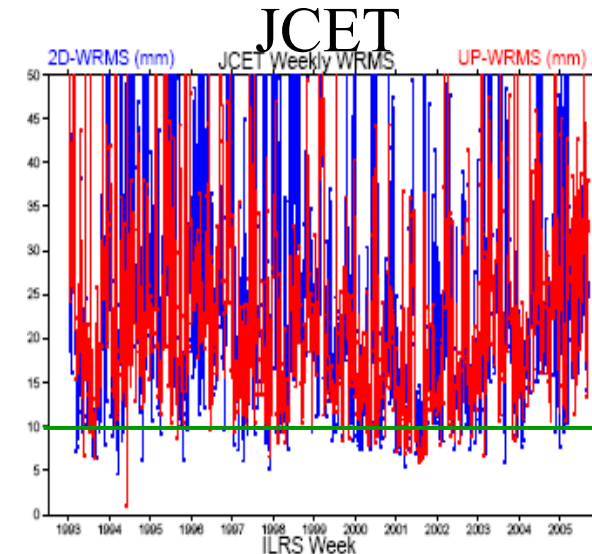
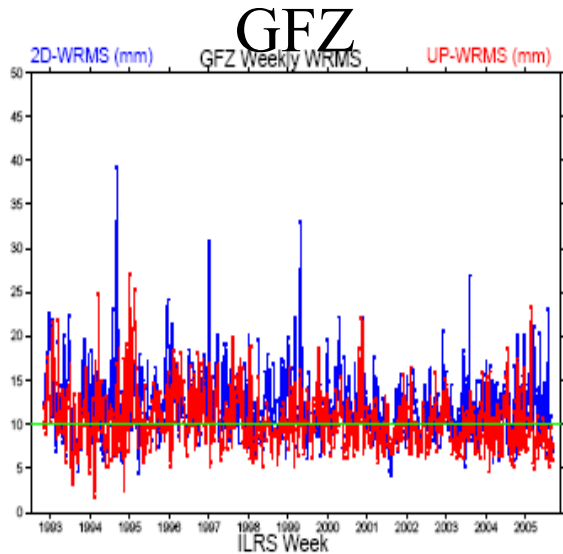
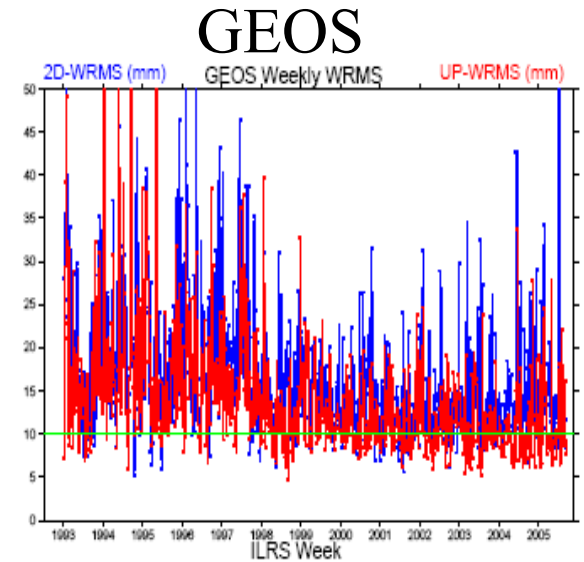
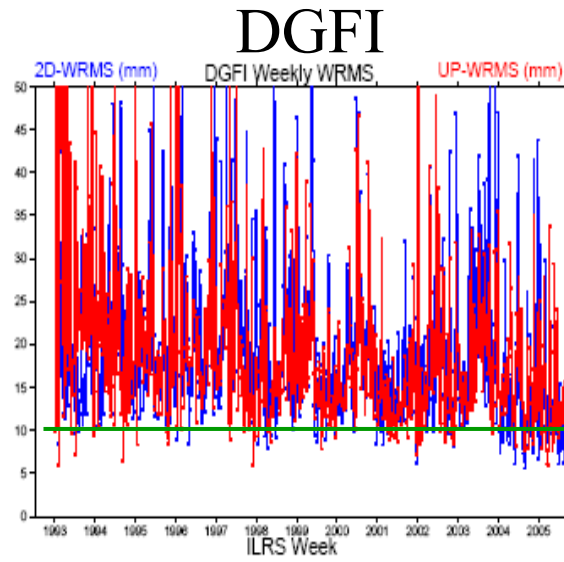
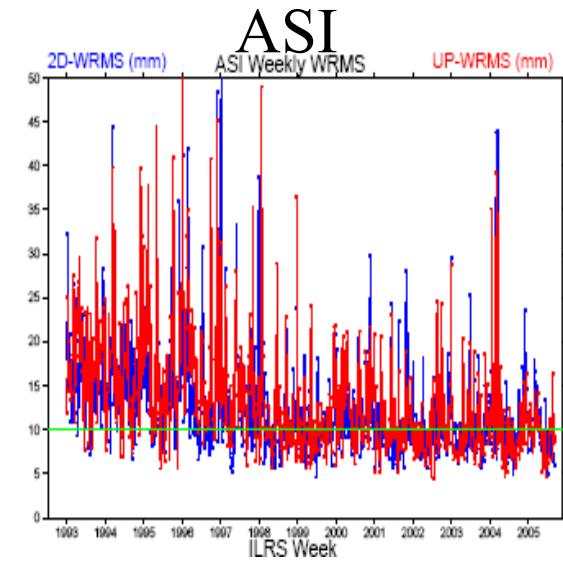


After

Outlier
rejection



WRMS: AC's Internal Precision



Range & Tropo. Bias

AC	Range Bias	Tropospheric Bias	MF
ASI	Applied	None	Marini-Murray
DGFI	pass dependent (sig. only) & (No)	Not estimated	Marini-Murray
GFZ	Not estimated	Not estimated	Marini-Murray
JCET	estimated for some sites	estimated for core sites	New Porto model + P.Ciddor
NSGF	estimated for some sites	Not estimated	Marini-Murray
GEOS	Not estimated	Not estimated	Marini-Murray

Status of IGS submission

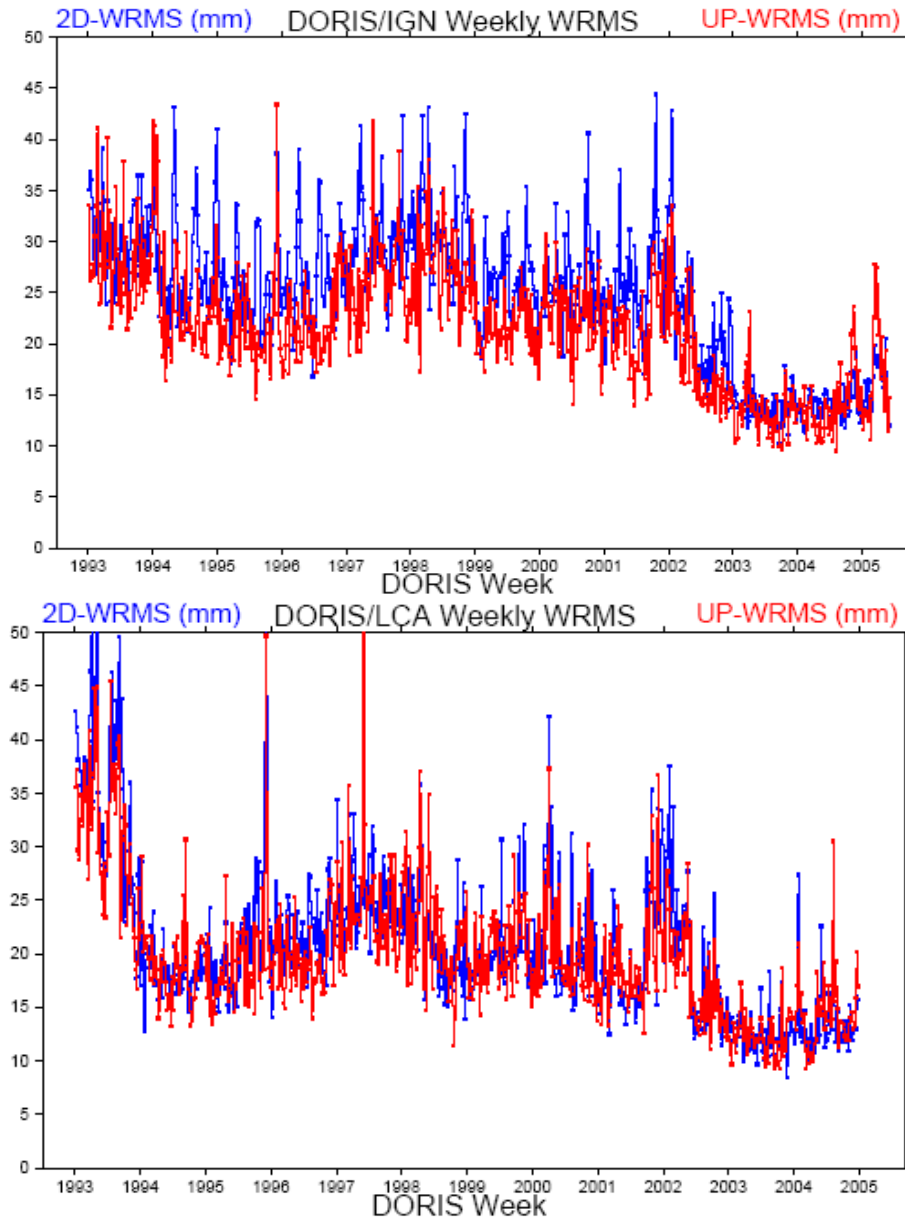
- **3rd version submitted in August:**
 - **Data span 1996.1 – 2005.6**
 - **EOPs start 1999.2**
 - **497 weeks/SINEX files**
 - **Preliminary analysis satisfactory**
 - **Intercomparison NRCan – DGFI – IGN**
(global consistency at the 1 mm level)

Status of IDS submission

- **3 solutions**
 - **IGN :** 1993.0 – 2005.5 (updated regularly)
 - **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

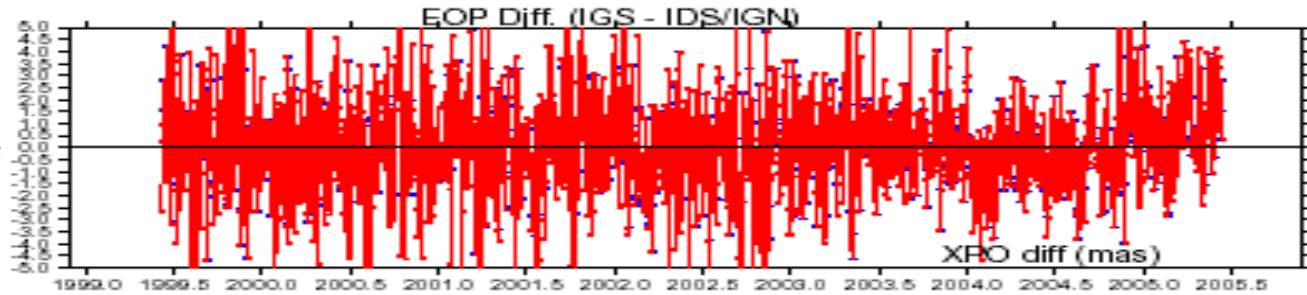
Comparison to IGS: Indicative WRMS



Pos.	2-D mm	UP mm
IGN	5.0	4.8
LCA	6.6	9.0
Vel.	2-D mm/y	UP mm/y
IGN	1.9	1.7
LCA	2.0	2.5

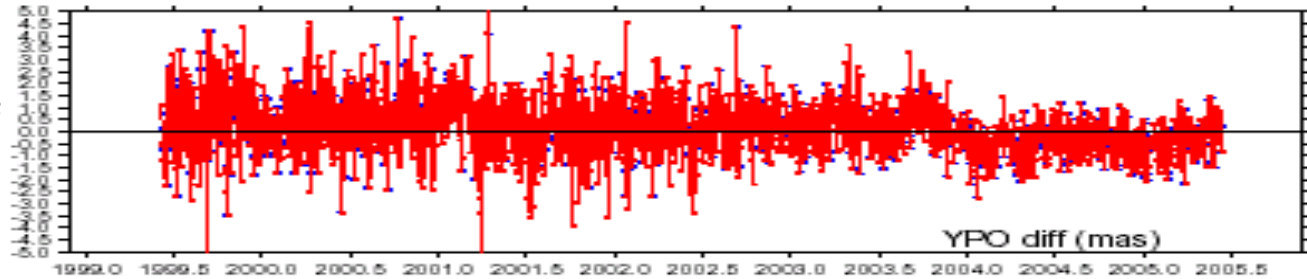
IGS – DORIS PM Differences

Xpole

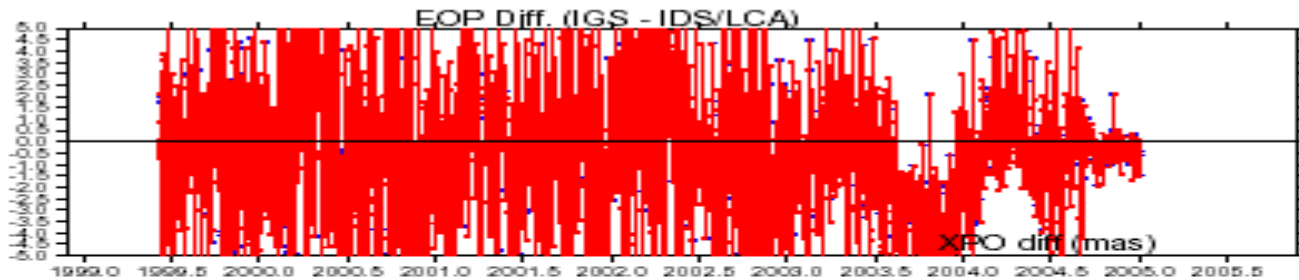


IGN

Ypole

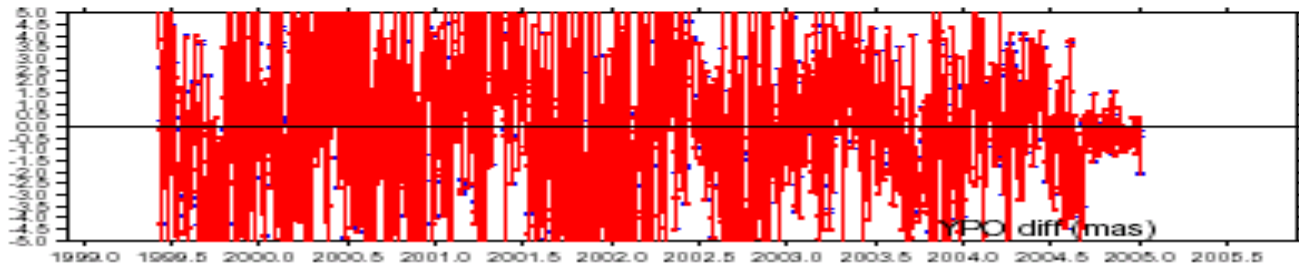


Xpole

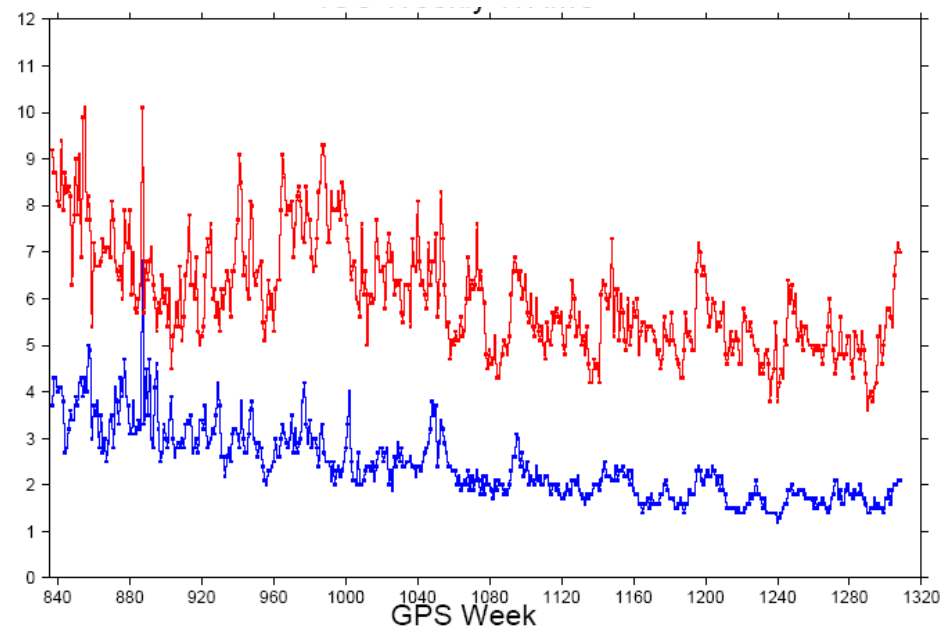
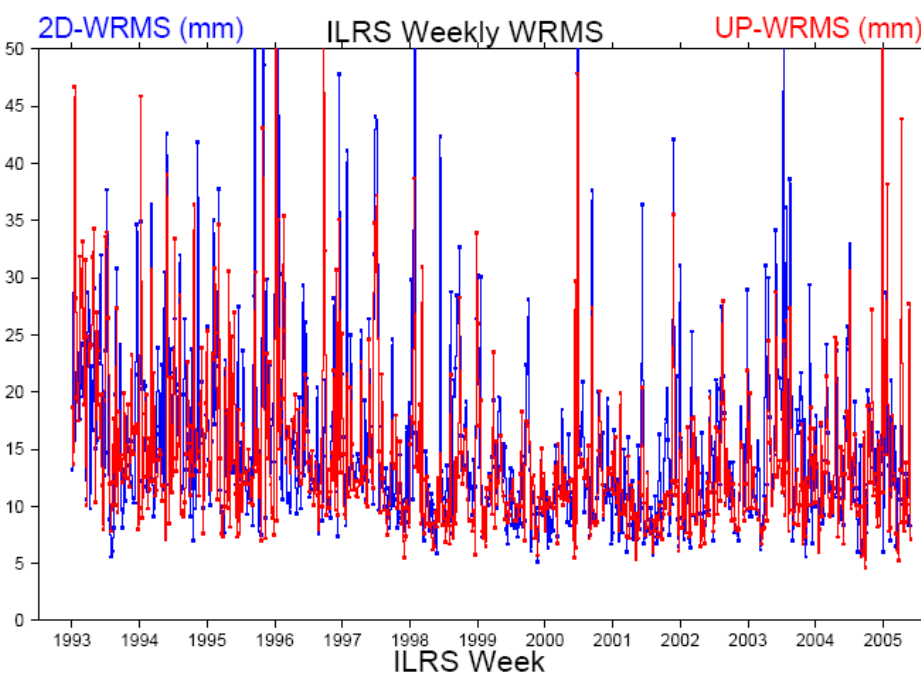
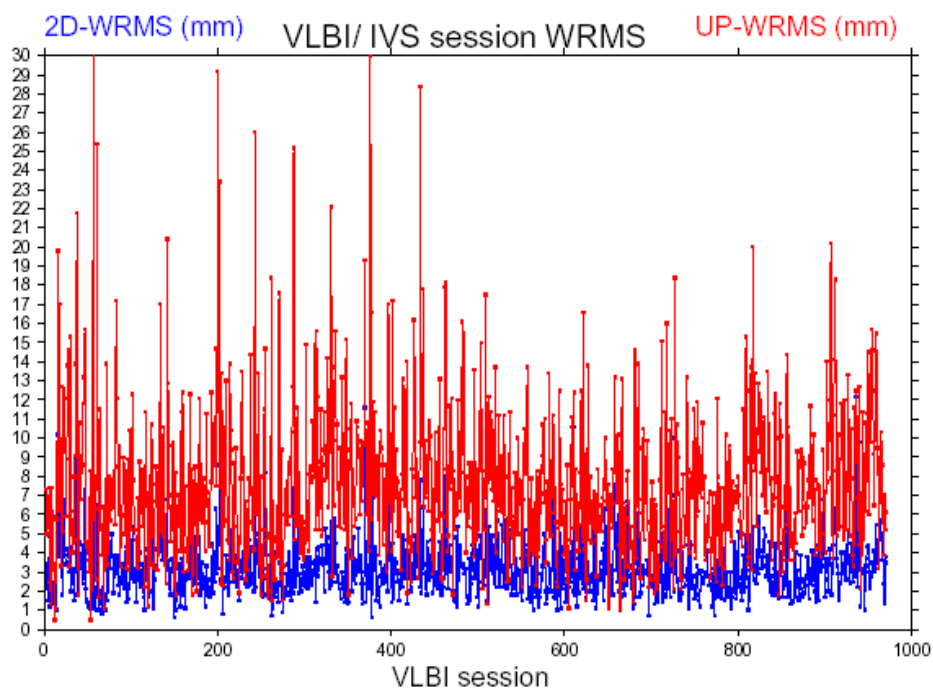
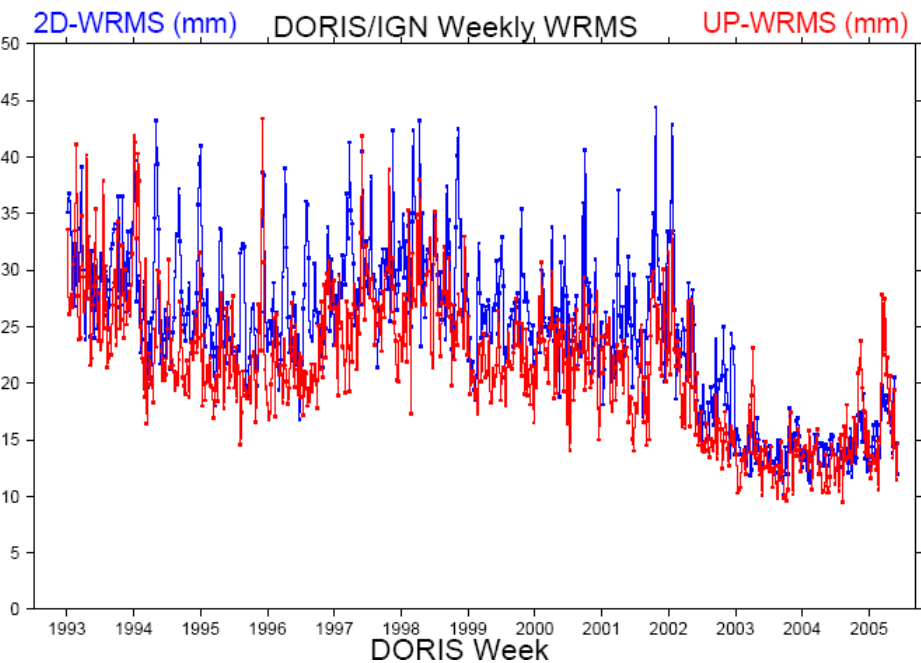


LCA

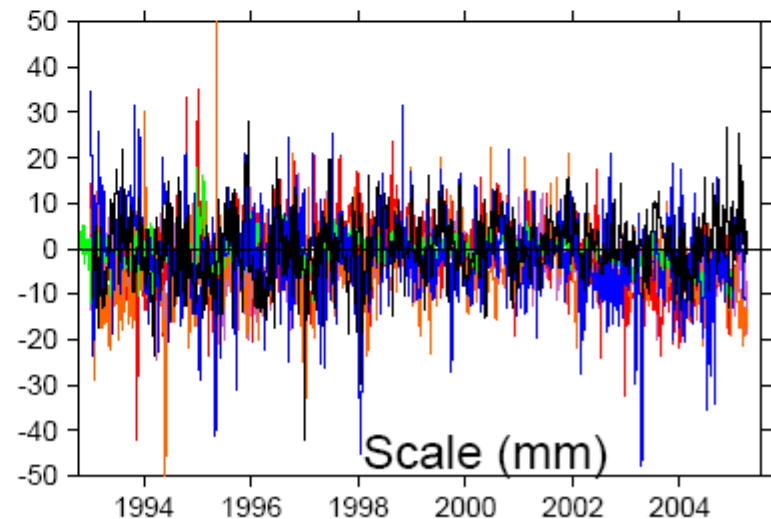
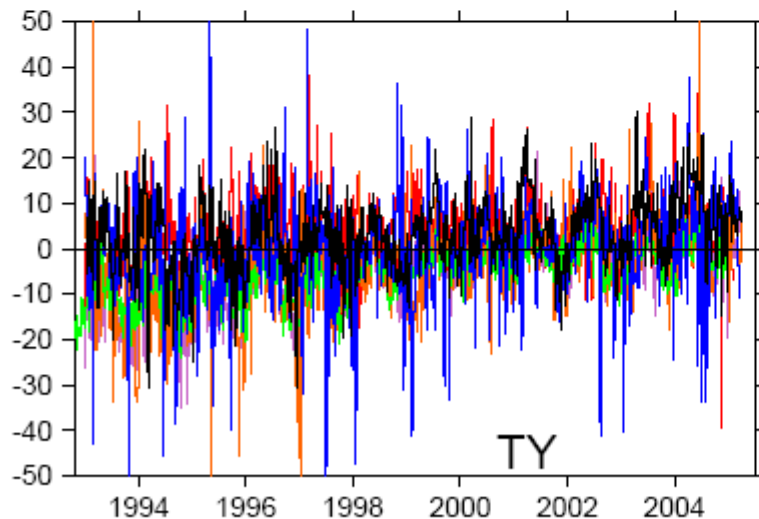
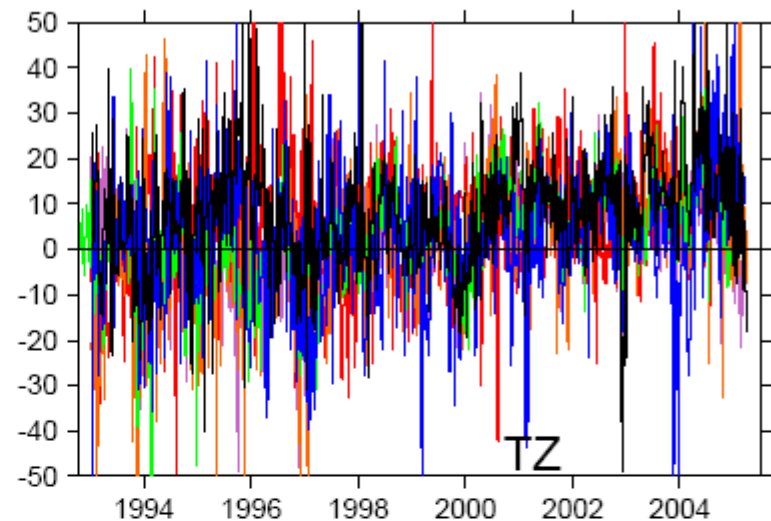
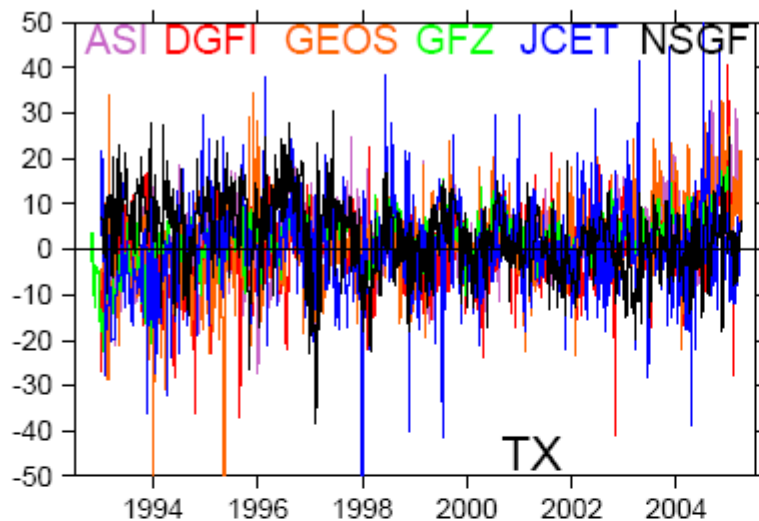
Ypole



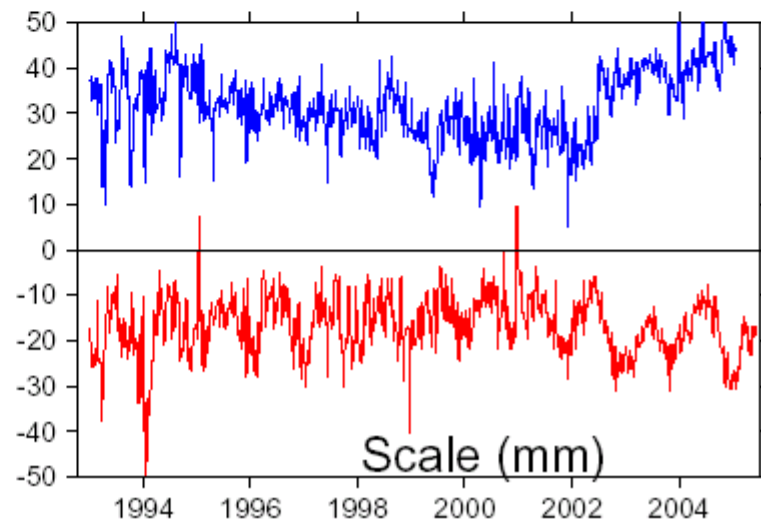
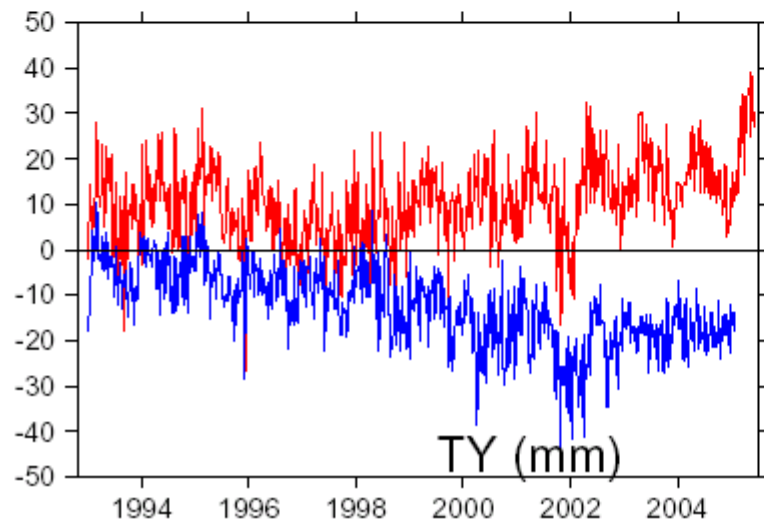
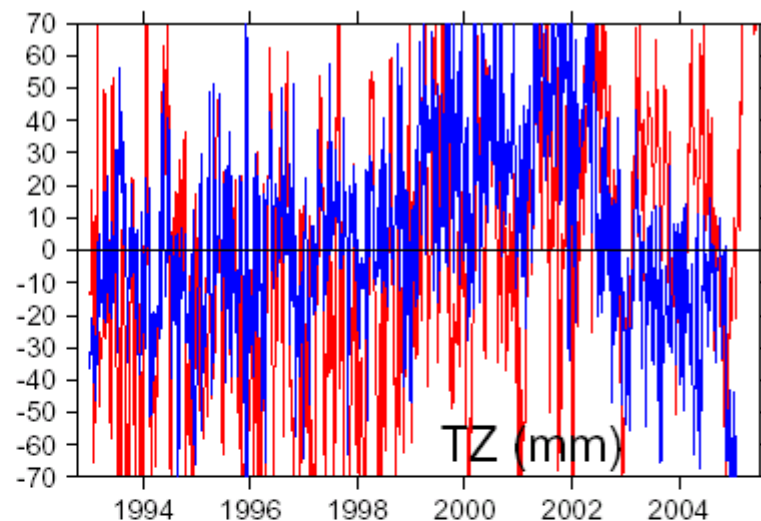
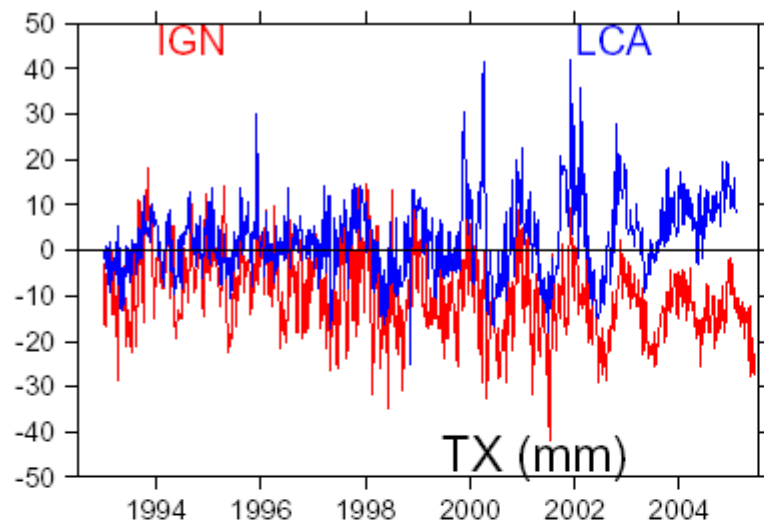
Internal Quality Evaluation: Weekly WRMS



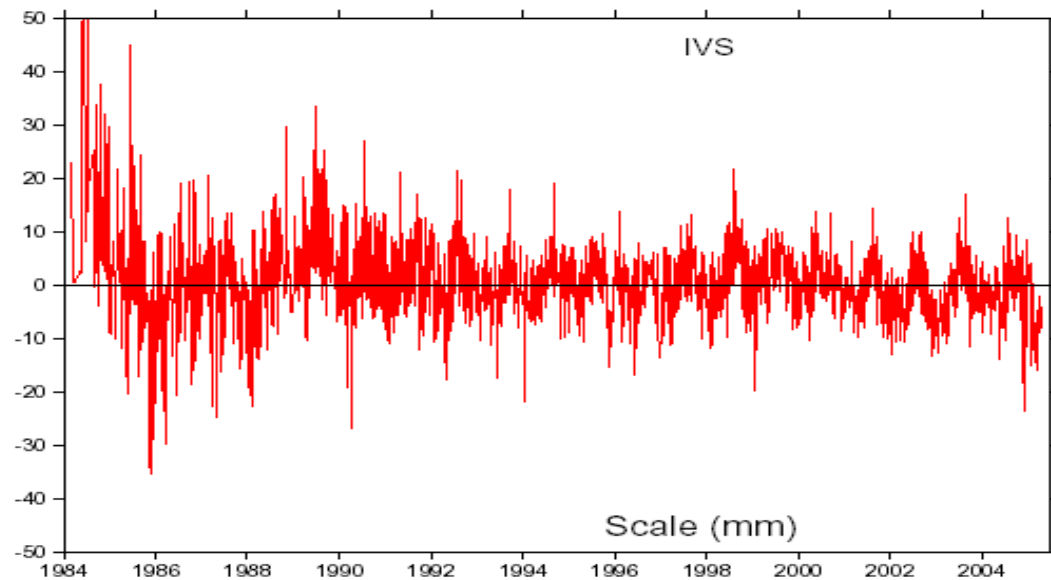
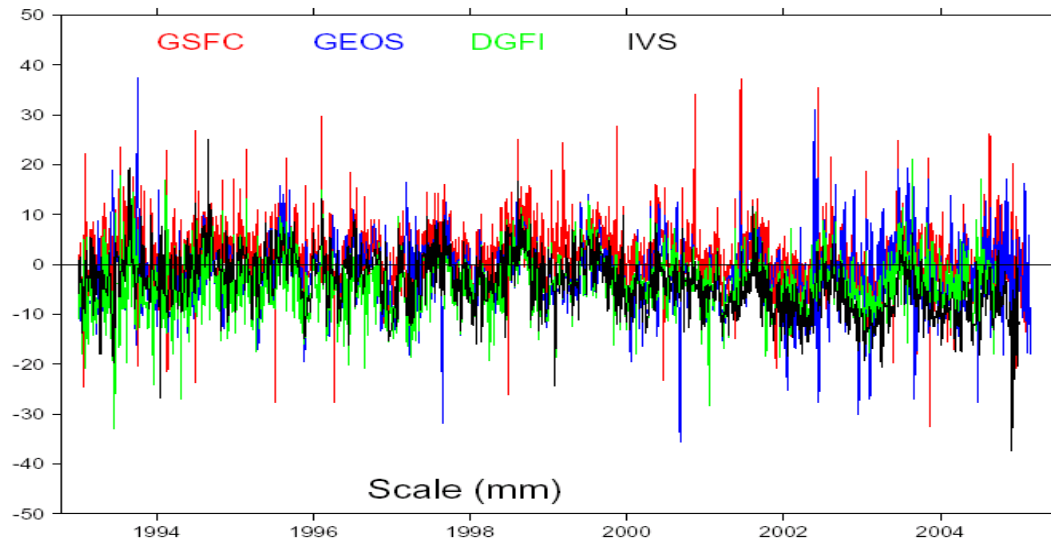
SLR Origin and Scale Variations



DORIS Origin and Scale Variations

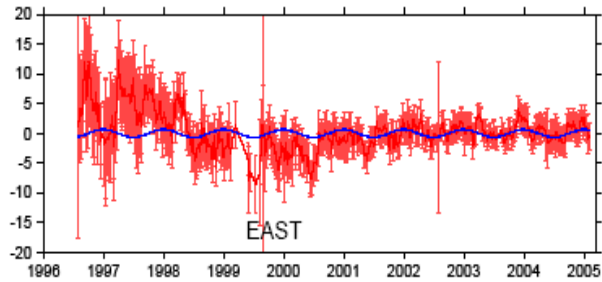


VLBI Scale Variations

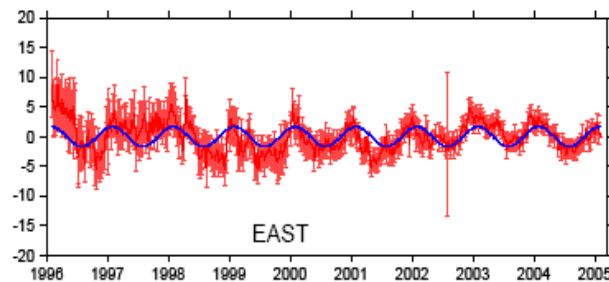


Seasonal Variations GPS/IGS Sites

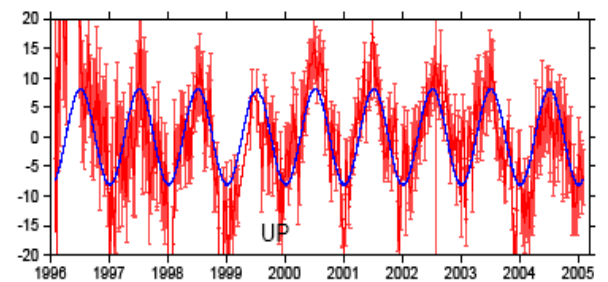
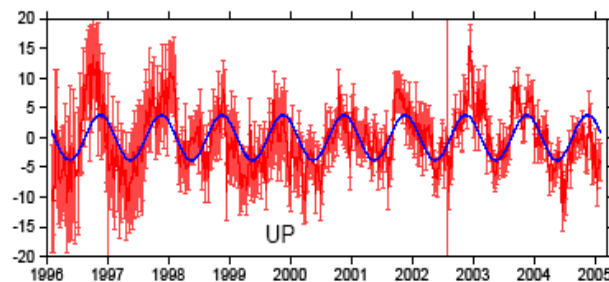
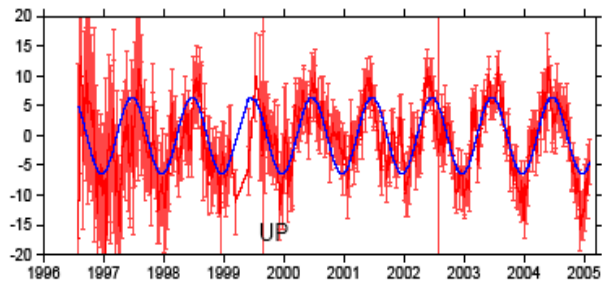
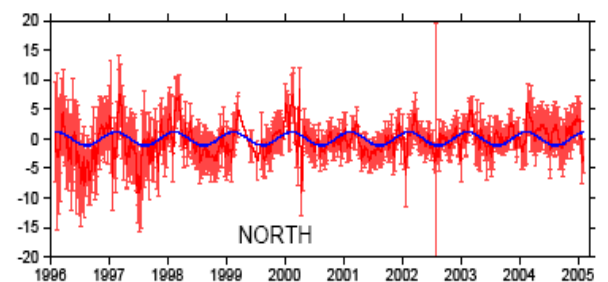
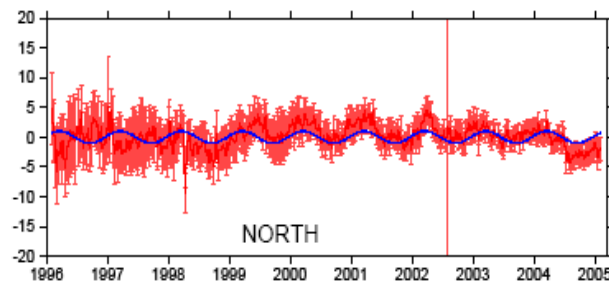
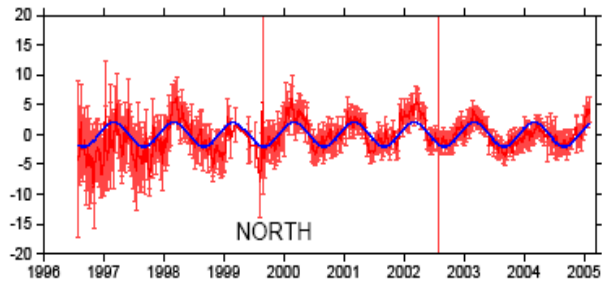
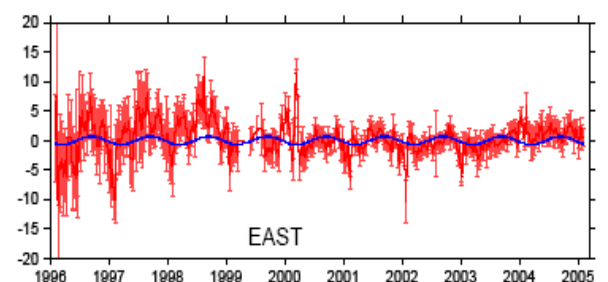
BAHR Annual Amplitude and Phase (mm)



DRAO Annual Amplitude and Phase (mm)



IRKT Annual Amplitude and Phase (mm)

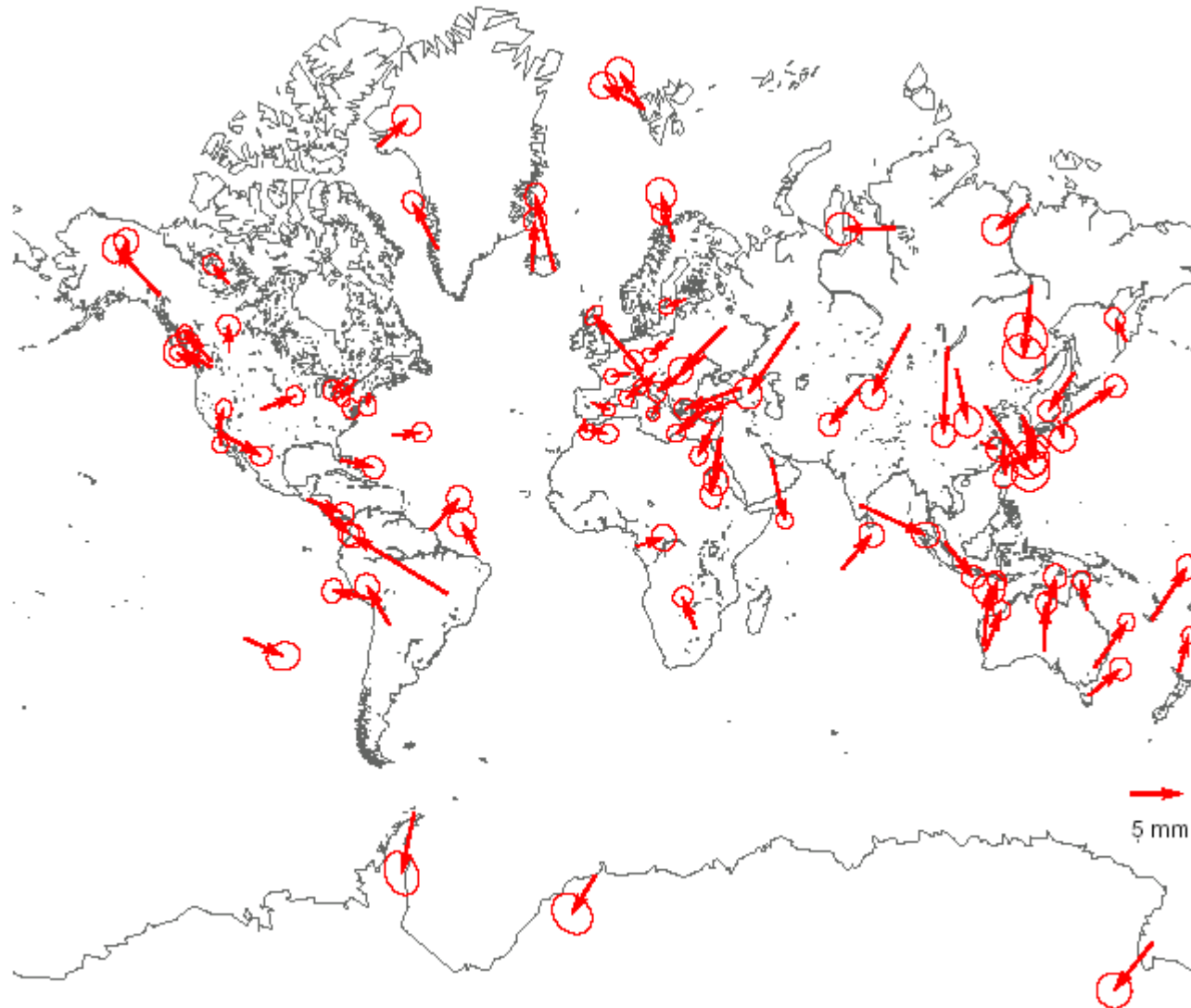


BAHR

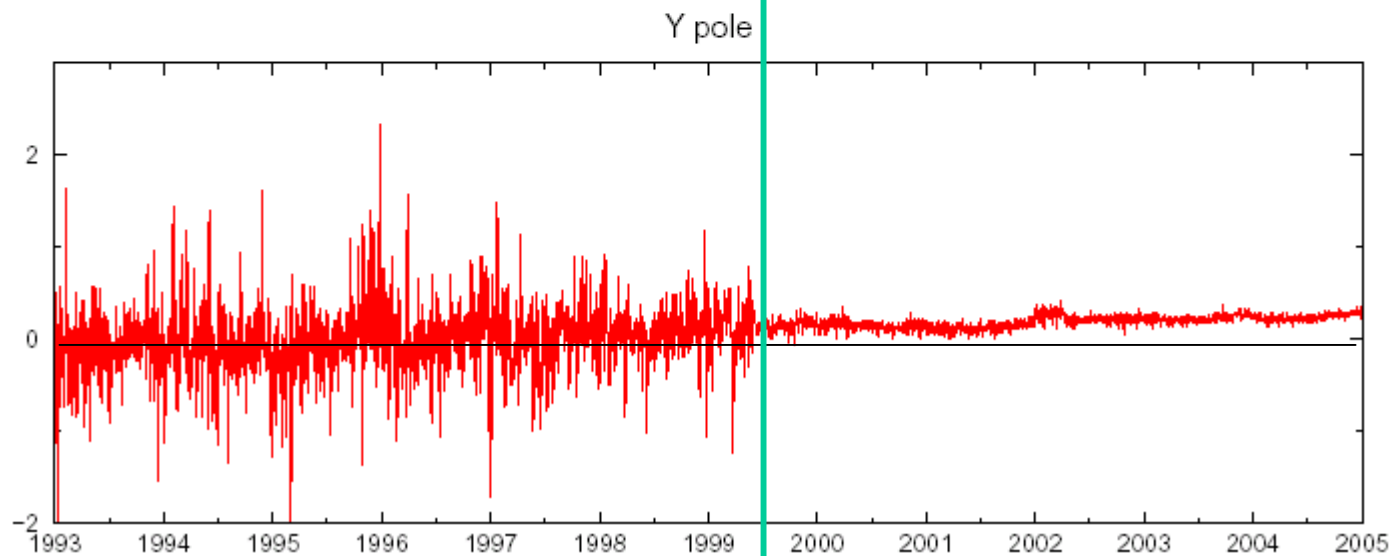
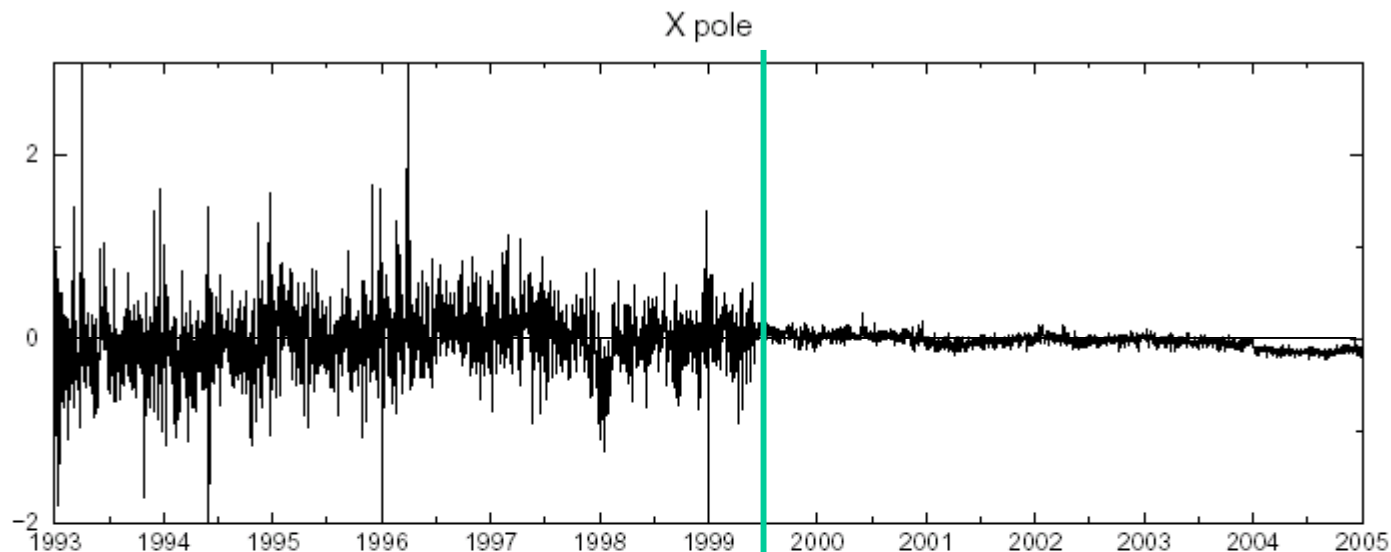
DRAO

IRKT

GPS Annual Vertical Amplitude & Phase



Polar motion differences with IERS C04



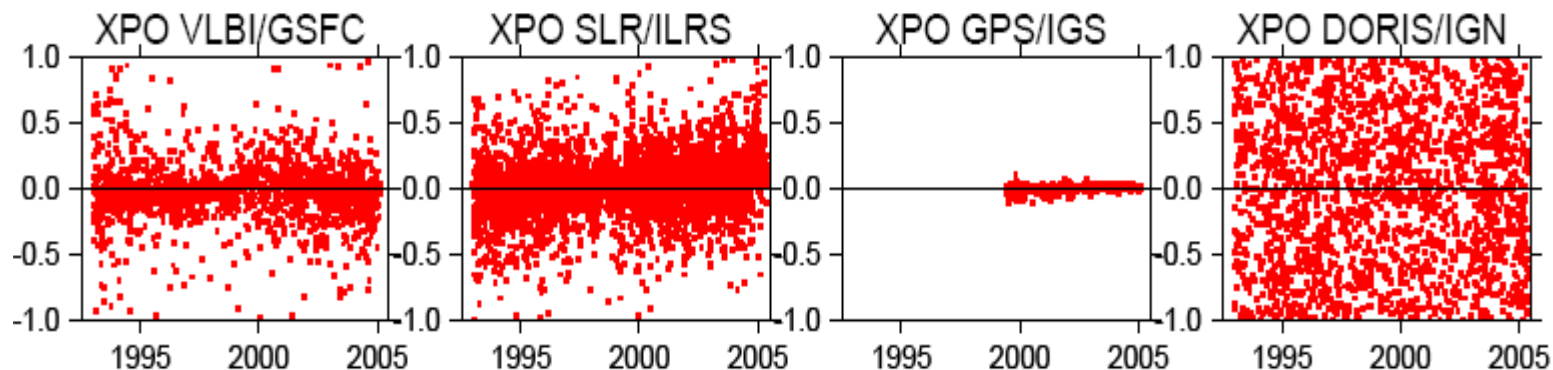
VLBI + SLR + DORIS

... + GPS

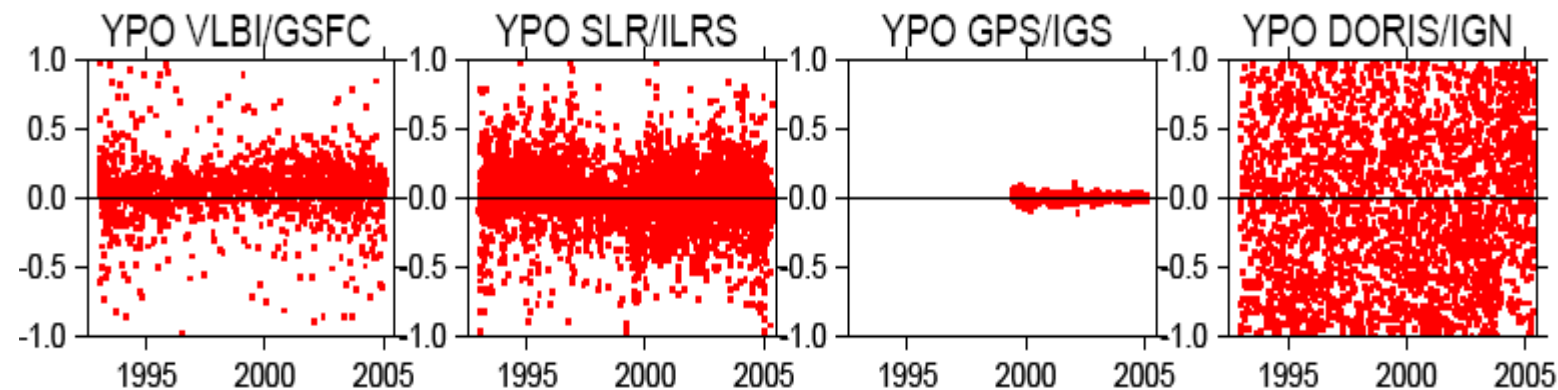
Mult-technique Combination over 12 years

Polar Motion Residuals (Zoom ± 1 mas)

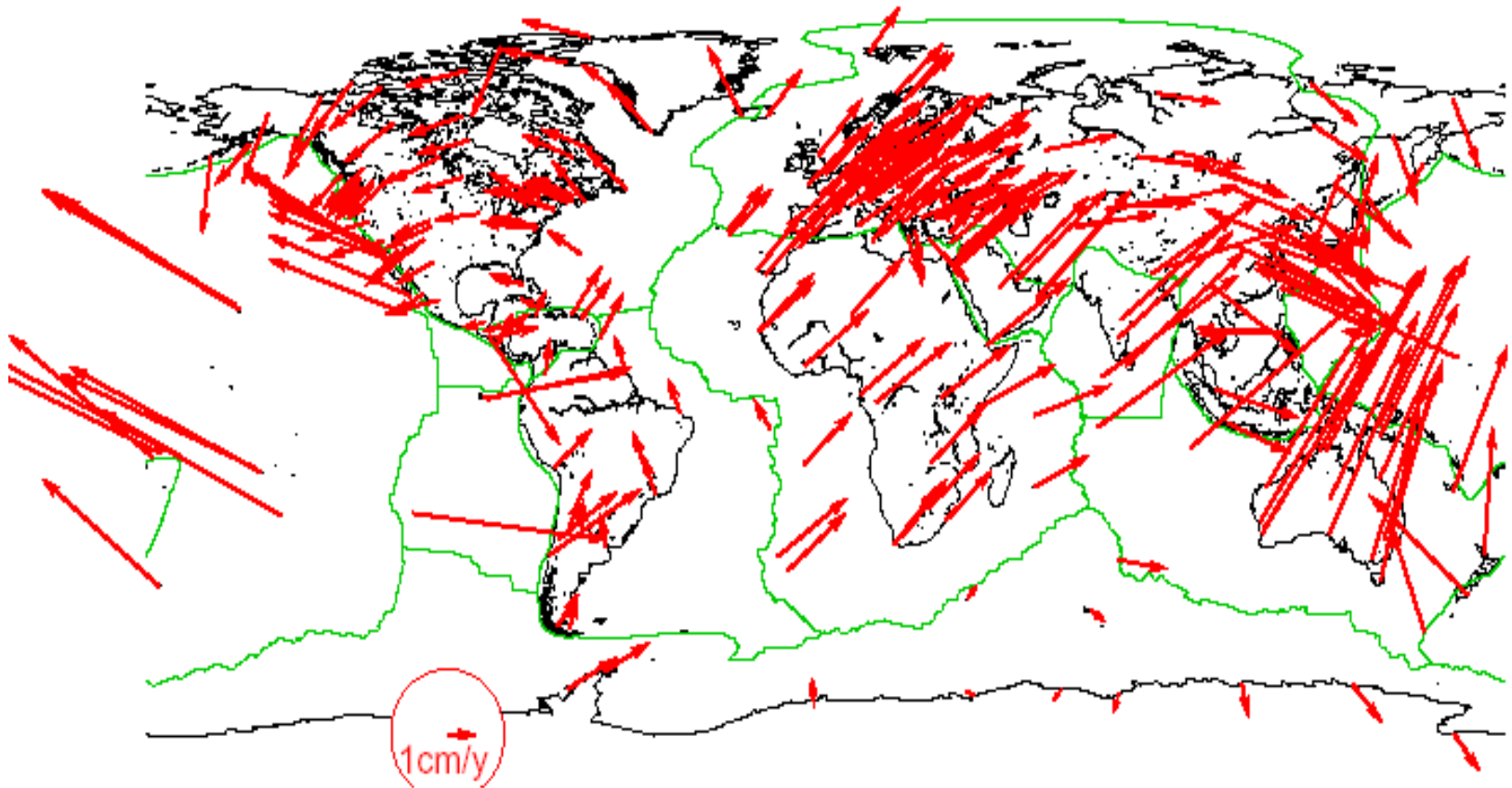
x-pole



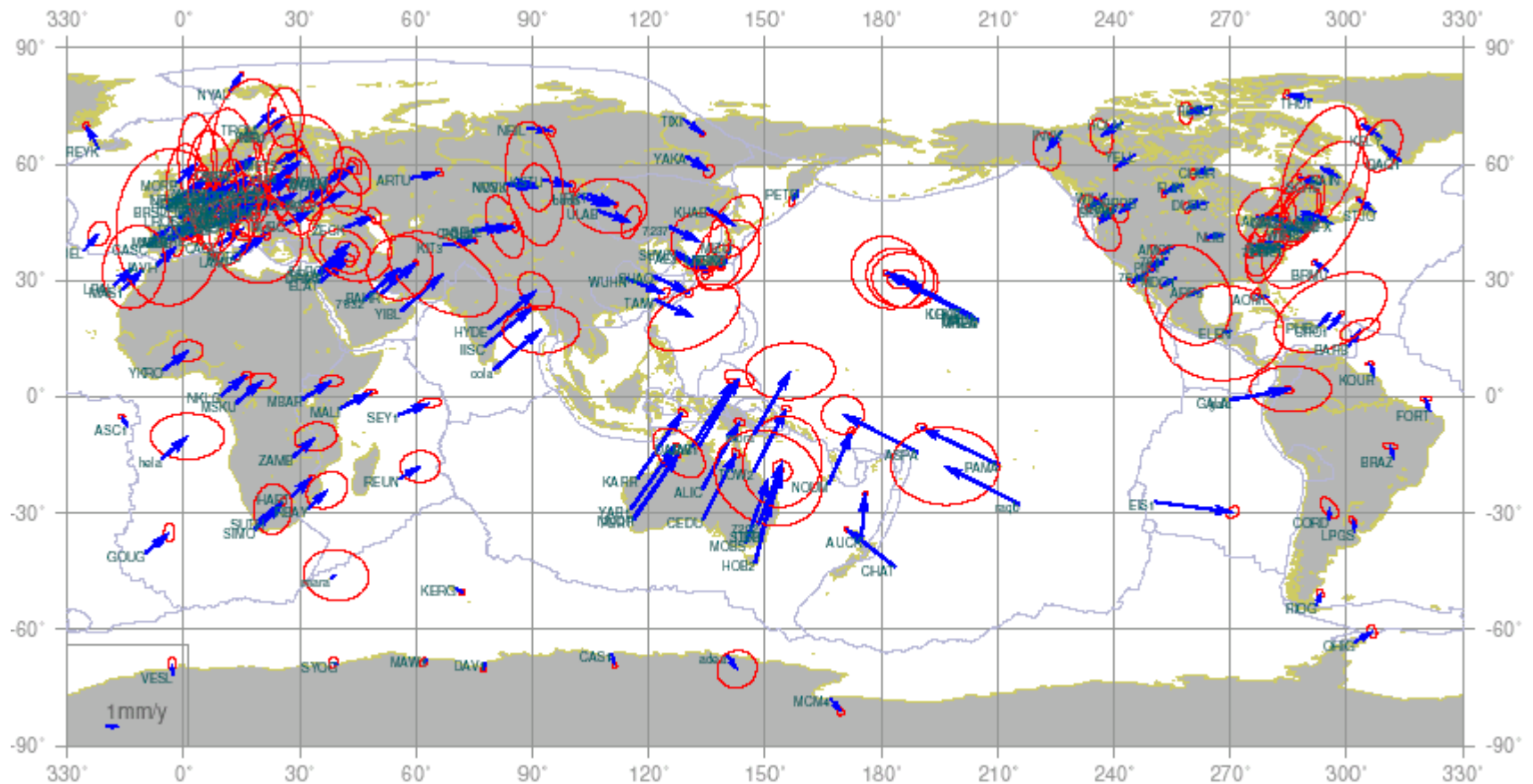
y-pole



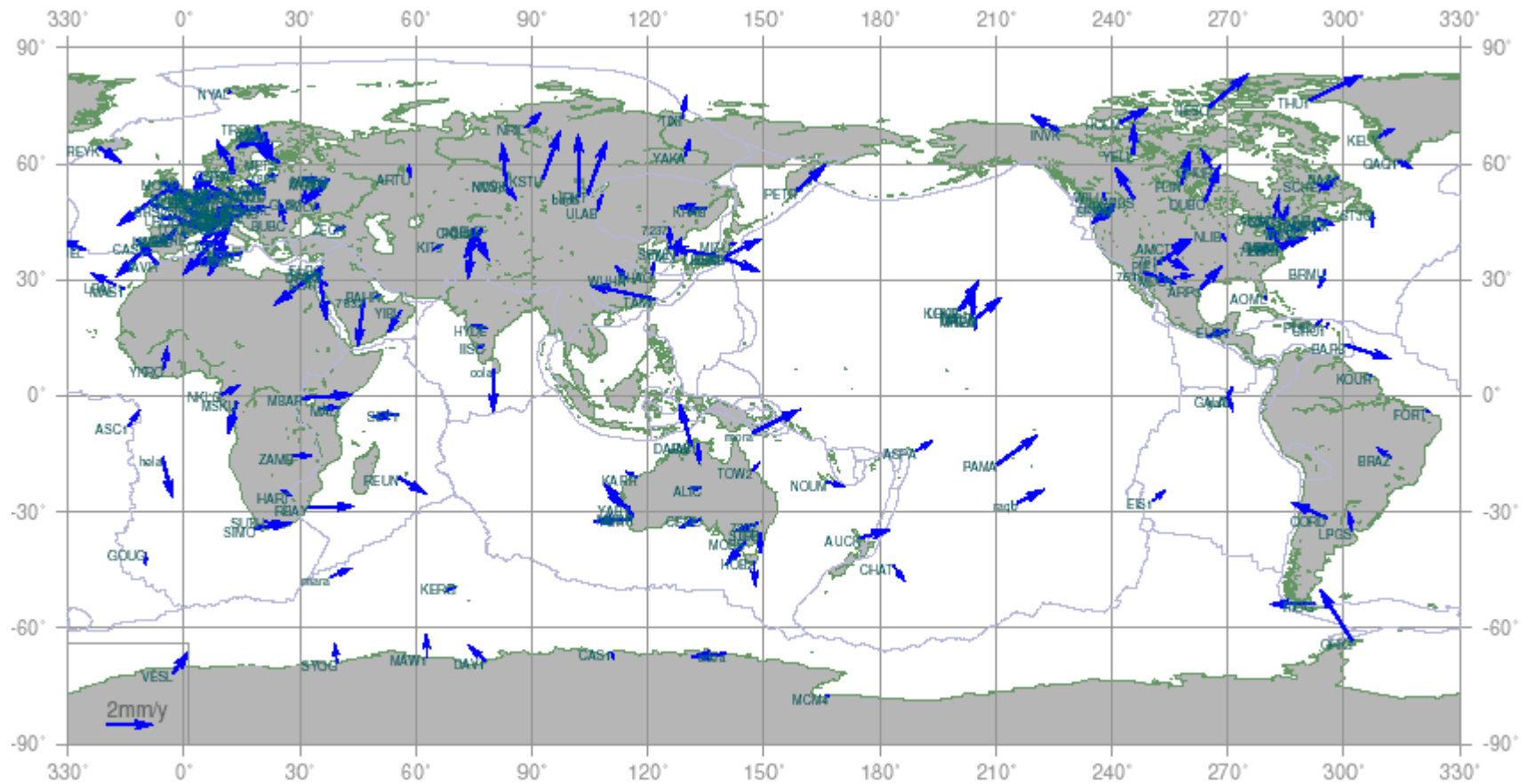
Site velocities with $\sigma < 3$ mm/Yr.



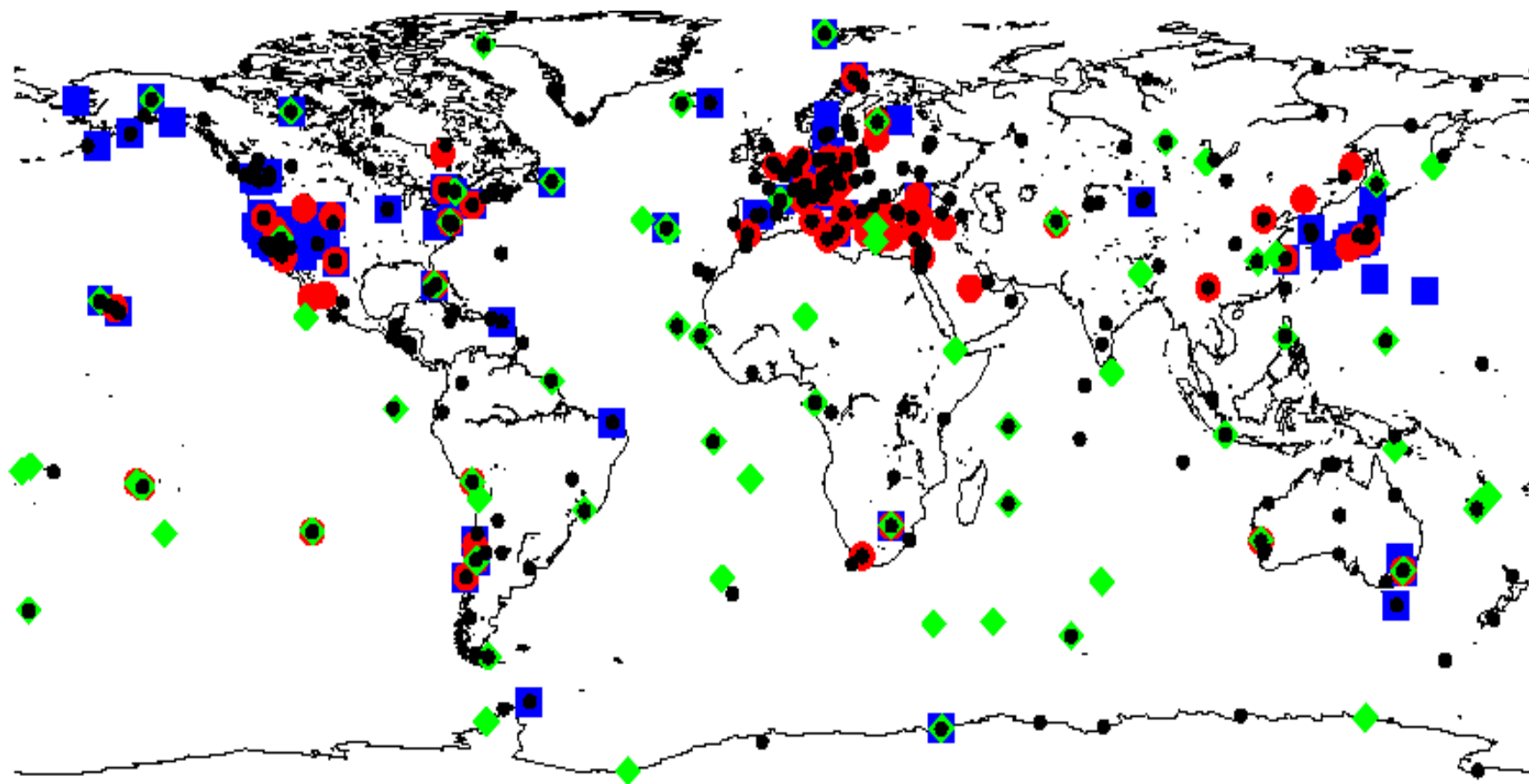
Site velocities used in kinematic model estimation



Site velocities used in kinematic model estimation - Residuals



ITRF2004: Co-locations



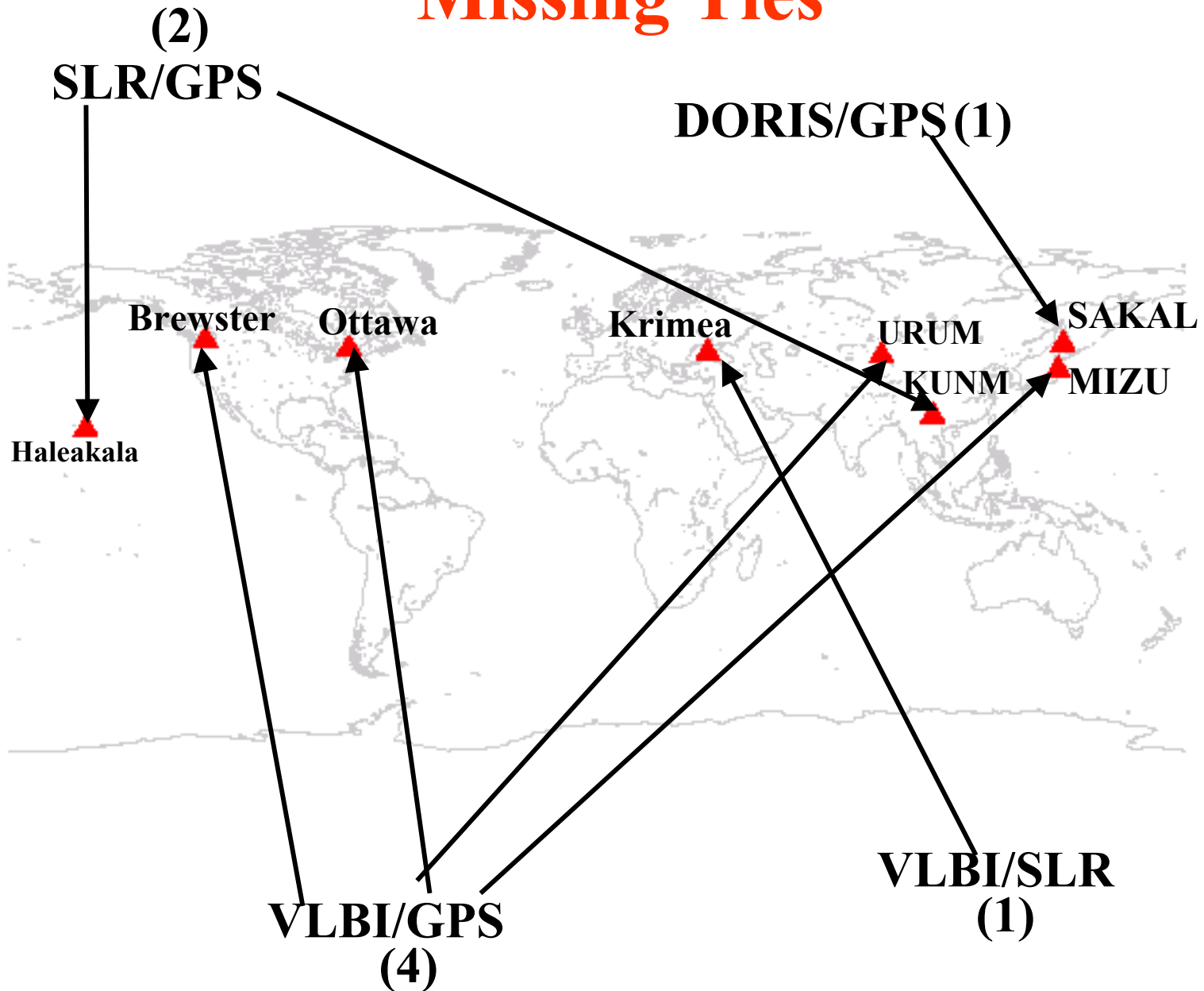
■ VLBI
107

● SLR
93

◆ DORIS
124

● GPS
350

Missing Ties

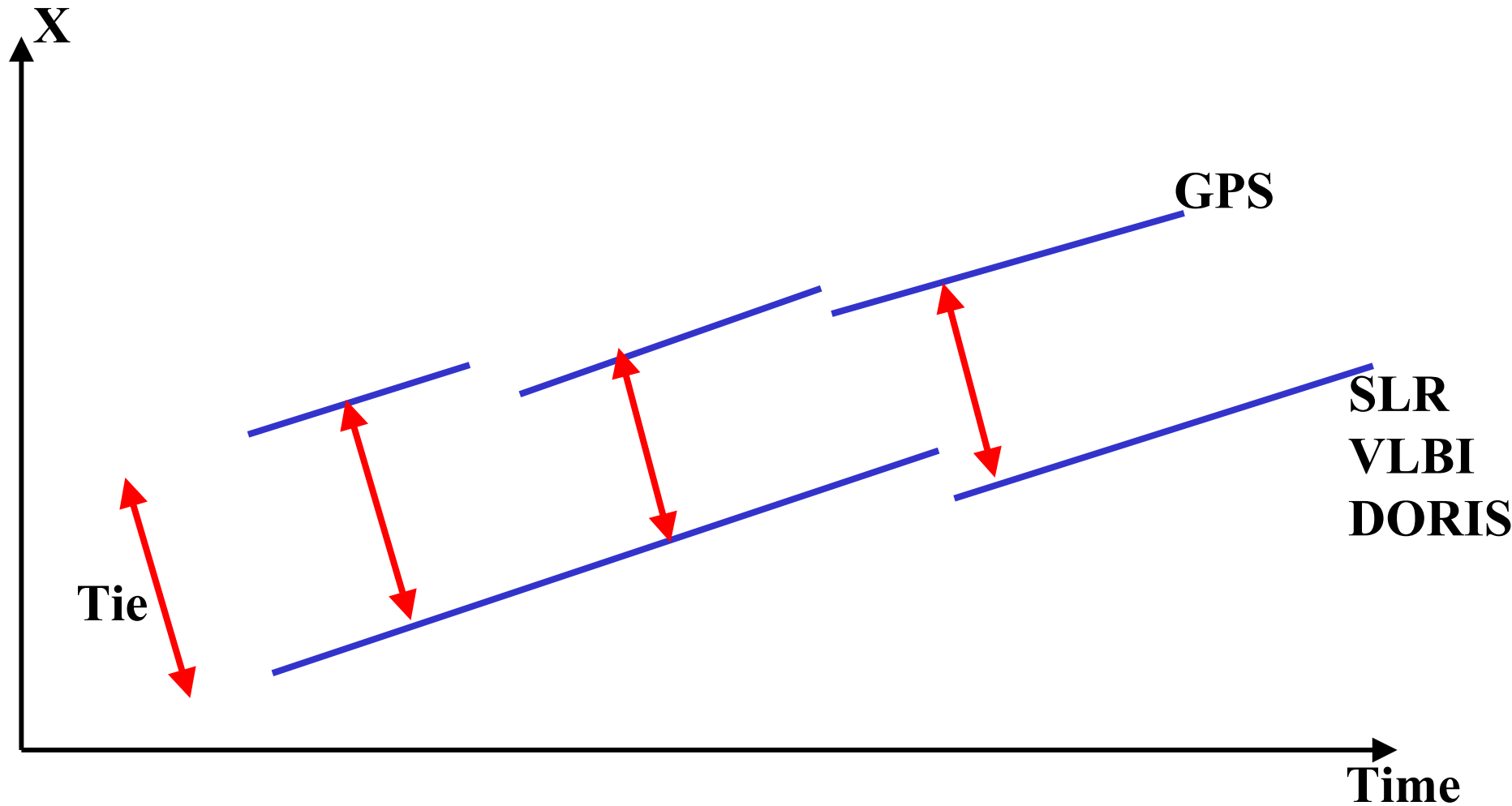


Co-locations

A new difficulty

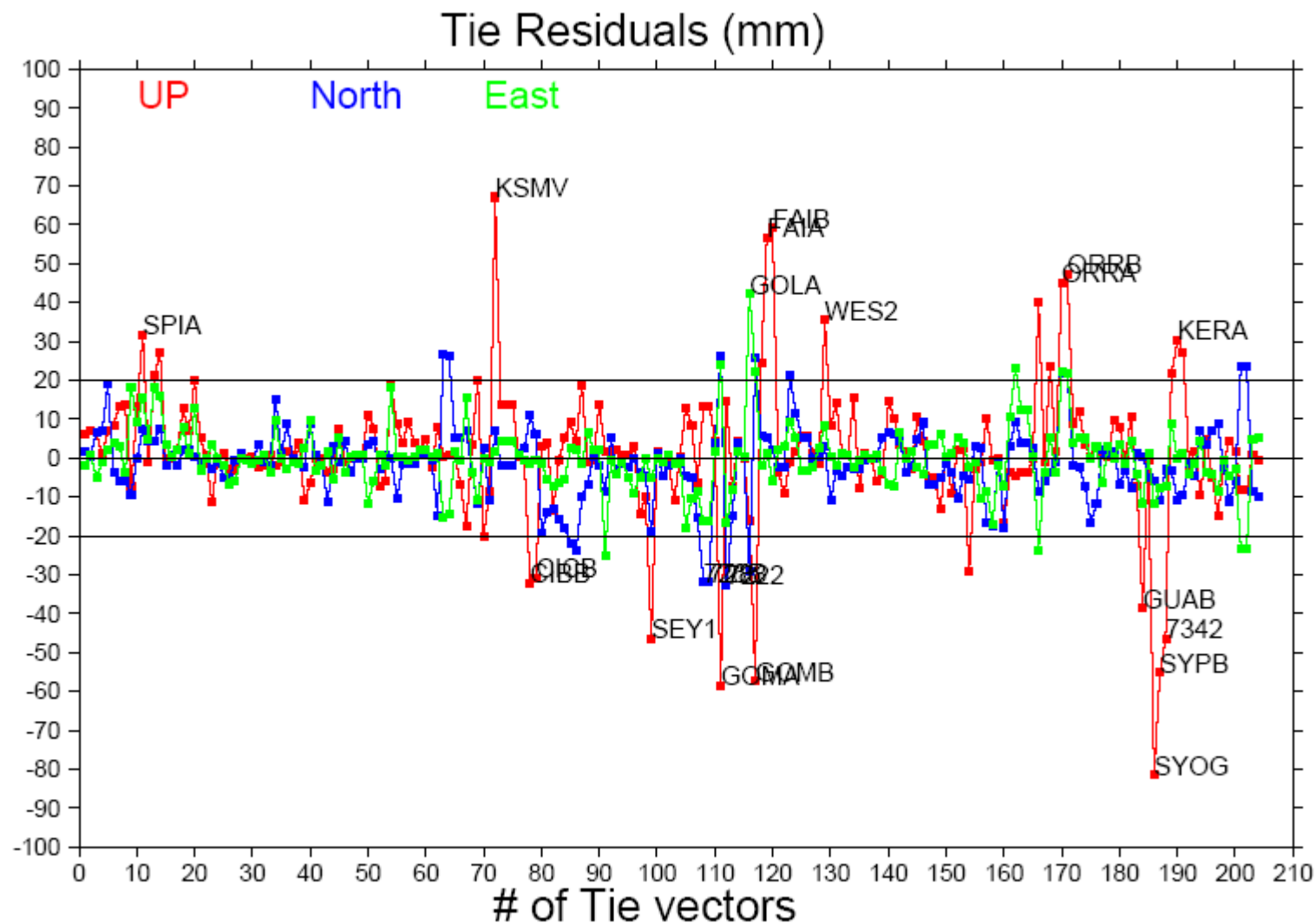
- **Most of IGS/GPS stations experience jumps (discontinuities) in the time series of station positions**
- **Most of Co-location sites are concerned**
- **A few station discontinuities are detectable for other techniques**
- **Having only one tie: to which segment should the tie be applied ???**
- **Careful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

A Co-location site with Discontinuities



Preliminary ITRF2004 combination

Tie Residuals



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