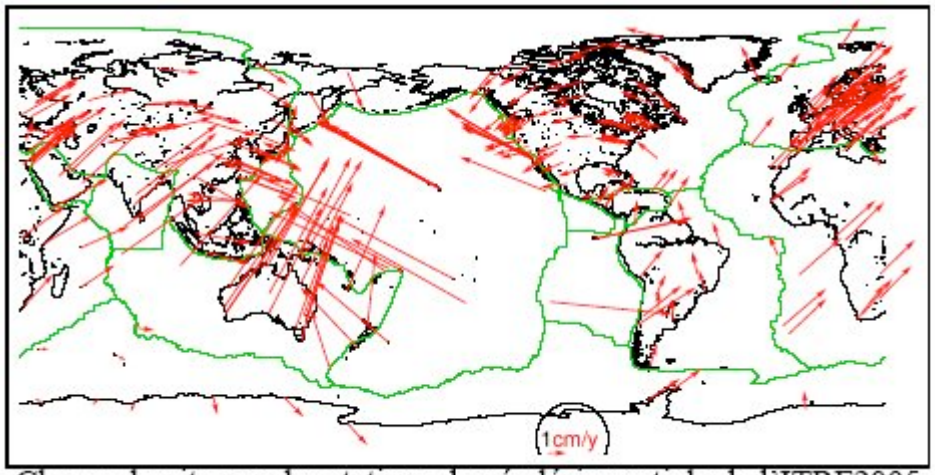
ITRF2005



Champ de vitesses des stations de géodésie spatiale de l'ITRF2005

itrf.ensg.ign.fr/ITRF_solutions/2005/

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Colloque G2, 23/11/2006 La Rochelle

ITRF2005

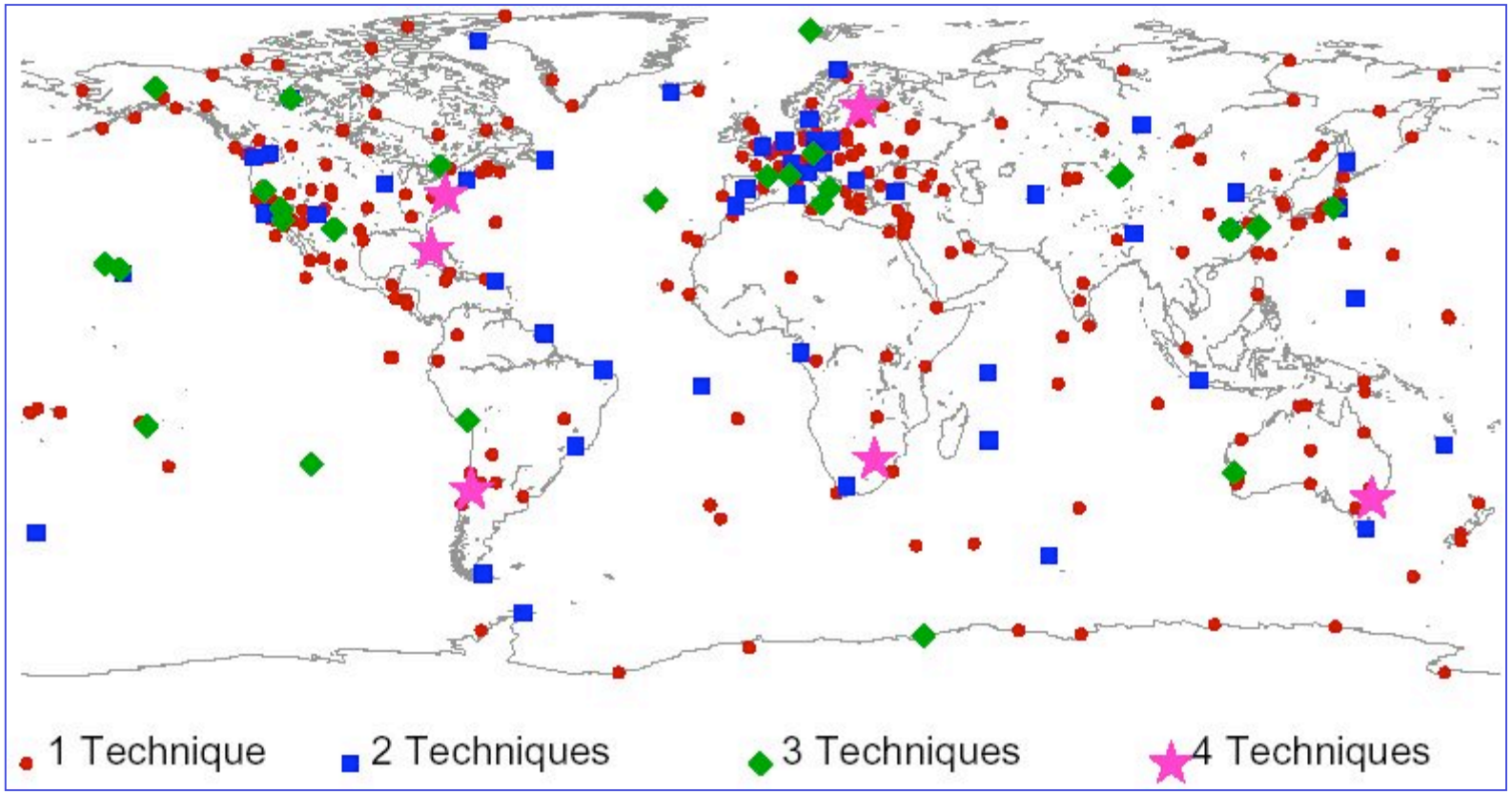
- **Pour la 1ère fois, on dispose de séries temporelles de positions de stations :**
  - **Journalières (VLBI)**
  - **Hebdomadaires (GPS, SLR & DORIS)**
- **Et des paramètres d'orientation de la Terre :**
  - **Mouvement du pôle (x_p, y_p)**
  - **Temps Universel (UT1) (VLBI)**
  - **Durée du jour (LOD) (VLBI)**

- **3 centres de combinaison ITRF : NRCan, DGFI, IGN**

Données soumises à l'ITRF2005

TC - AC	Time-span	Type of constraints/solution	
IVS VLBI	1980.0-2006.0	Normal Equation	Journ.
ILRS SLR	1992.9-2005.9	Loose; Var-Covar	Hebdo.
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	

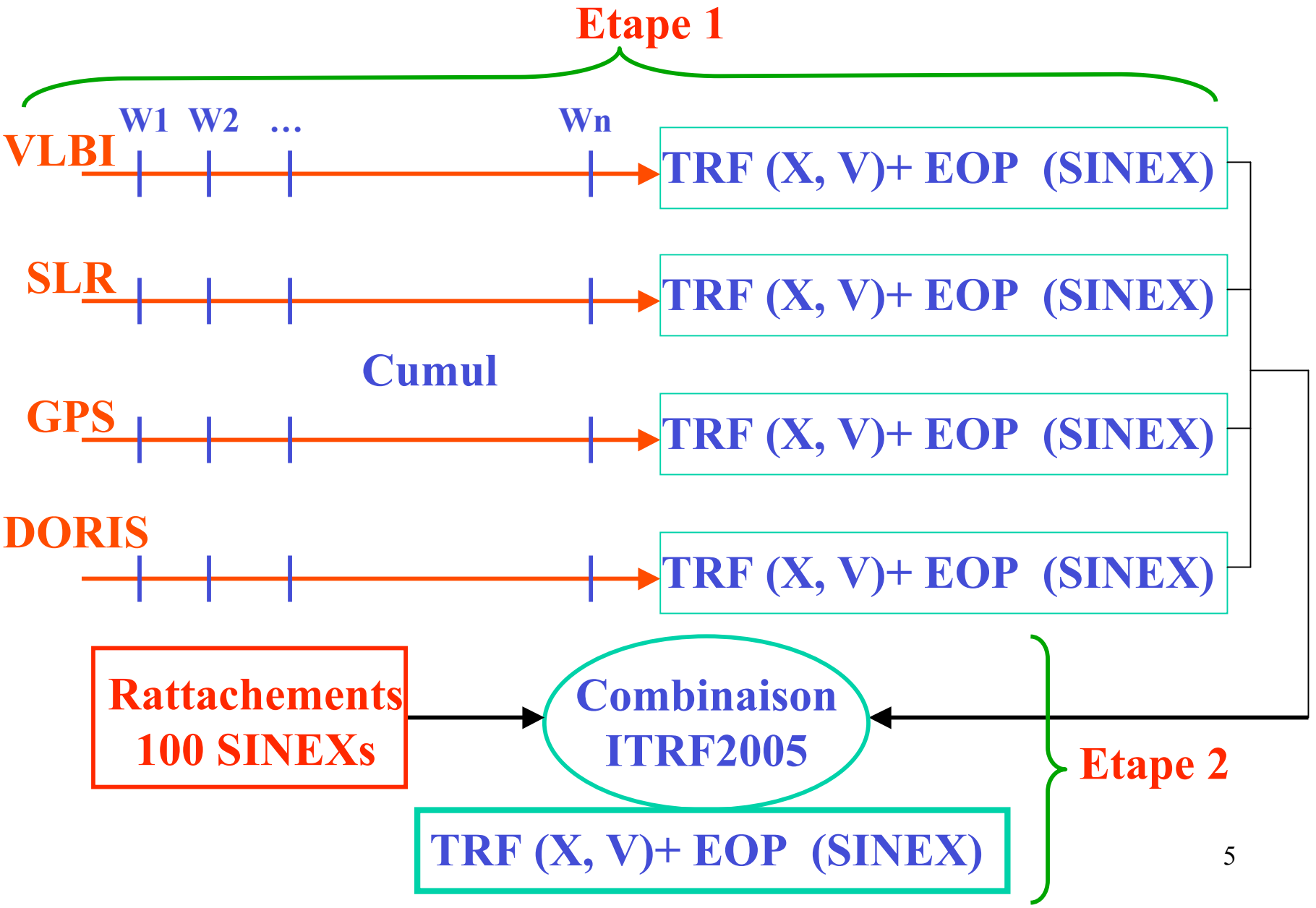
ITRF2005 Co-locations



(48) (25) (6)

175 vecteurs rattachement (100 fichiers SINEX)

Calcul de l'ITRF2005



Stacking
TRF & EOP time series Combination

CATREF Software

INPUT: $X(t)$, **EOP(t) in daily/weekly/monthly SINEX files**

time series

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

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

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

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

Définition du RRT combiné lors du cumul de séries temporelles

- **(1) Definition/fixation de l'origine, échelle et orientation à une époque de référence t_0**

==> 7 degrés de liberté

- **(2) Definition/fixation de l'évolution temporelle (séculaire) sur les 7 paramètres**

==> 7 degrés de liberté

Suppose mouvement linéaire des stations:

- **Tenir compte des discontinuités (estimation par morceaux)**
- **Analyse des mouvements non linéaires via les séries temporelles des résidus.**

Méthodes d'implémentation

- **(1) Choisir une référence externe (X_R) et application des contraintes minimales:**

$$X_R = X_c + A\theta \xrightarrow{\theta = 0} (A^T A)^{-1} A^T (X_R - X_c) = 0$$

Ou

- **(2) Considérant chaque paramètre de transfo. *P* :**

$$P(t) = P(t_0) + \dot{P}.(t - t_0)$$

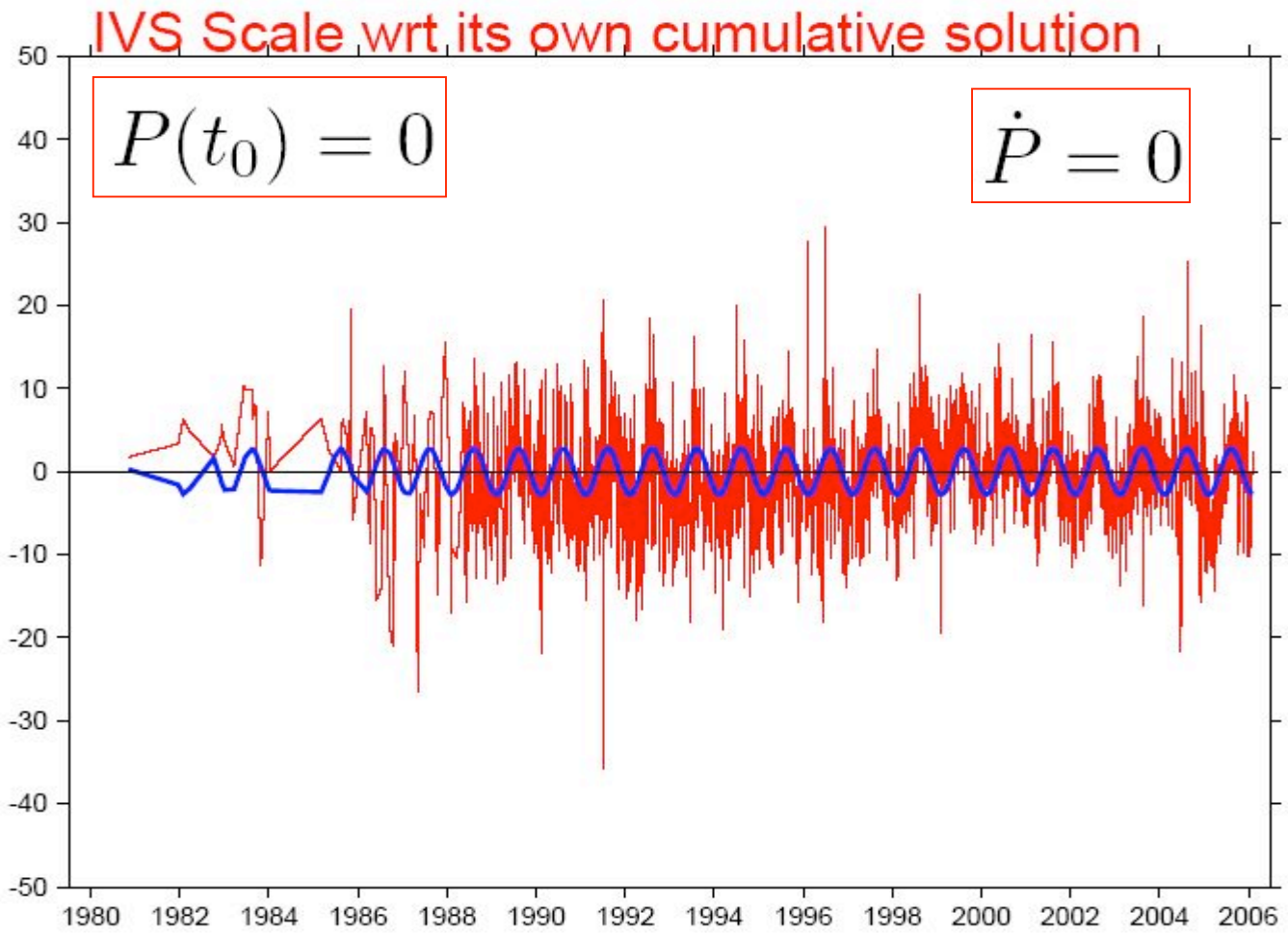
Conditions internes/intrinsèques:

$$P(t_0) = 0 \quad \textbf{et} \quad \dot{P} = 0$$

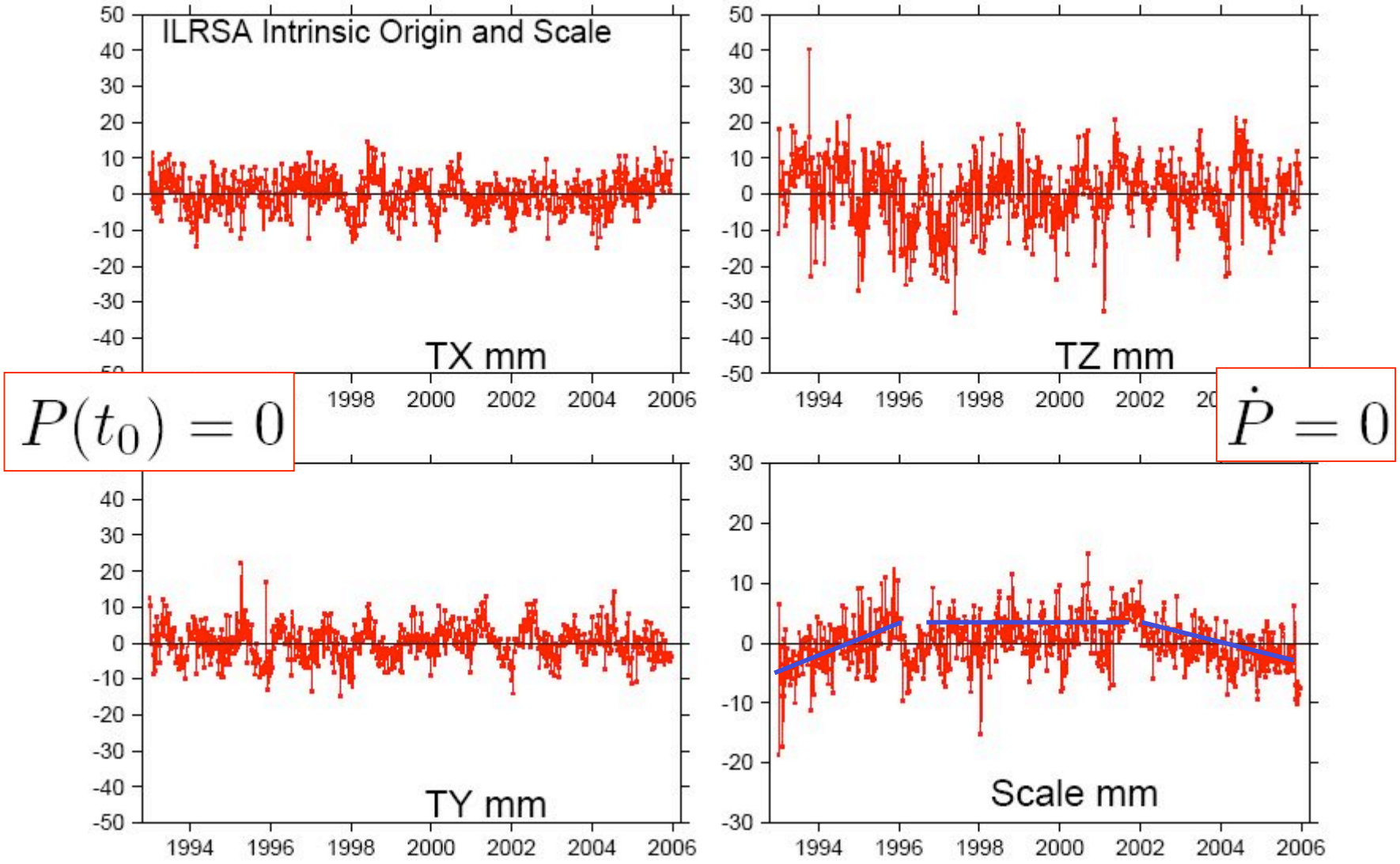
ou

$$\begin{cases} \sum_{k \in K} P(t_k) & = & 0 \\ \sum_{k \in K} \frac{P(t_k)}{t_k - t_0} & = & 0 \end{cases}$$

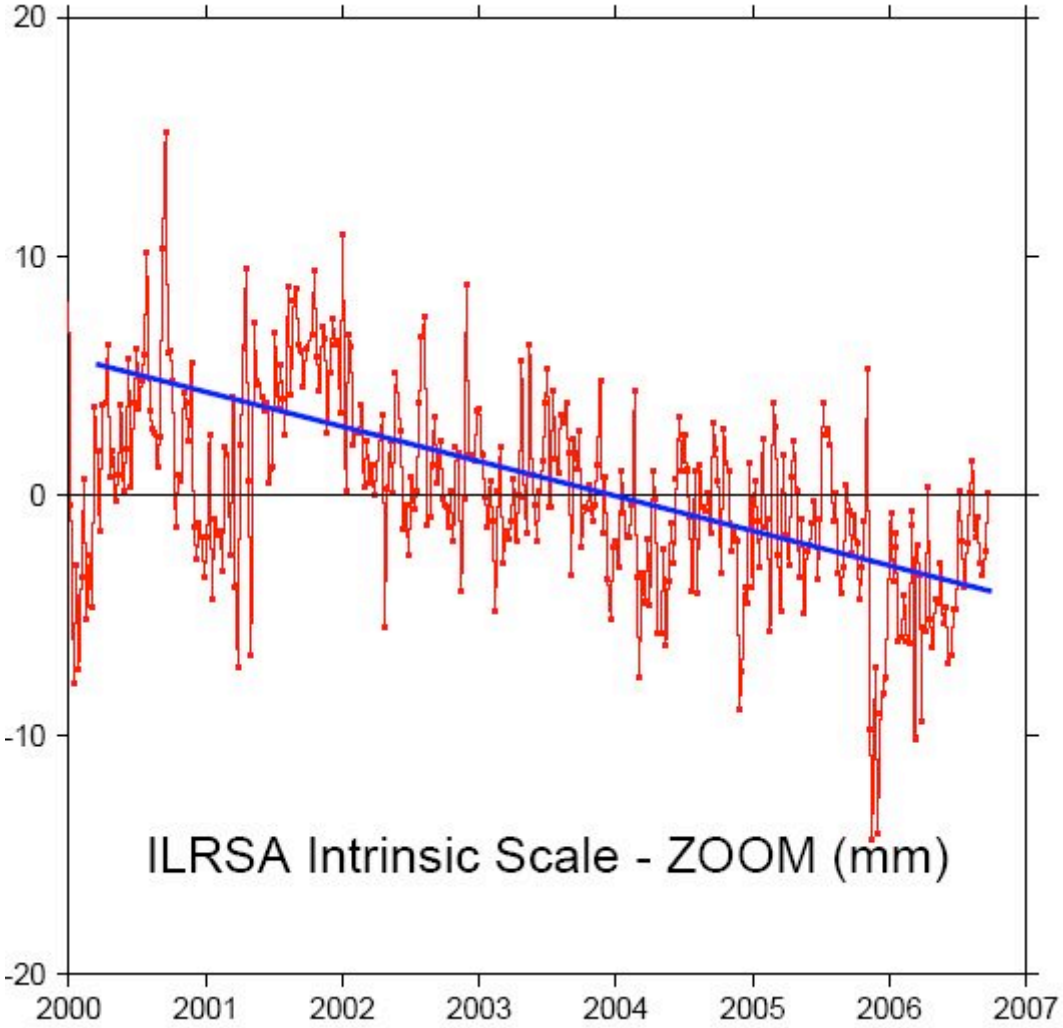
Echelle Intrinsèque VLBI



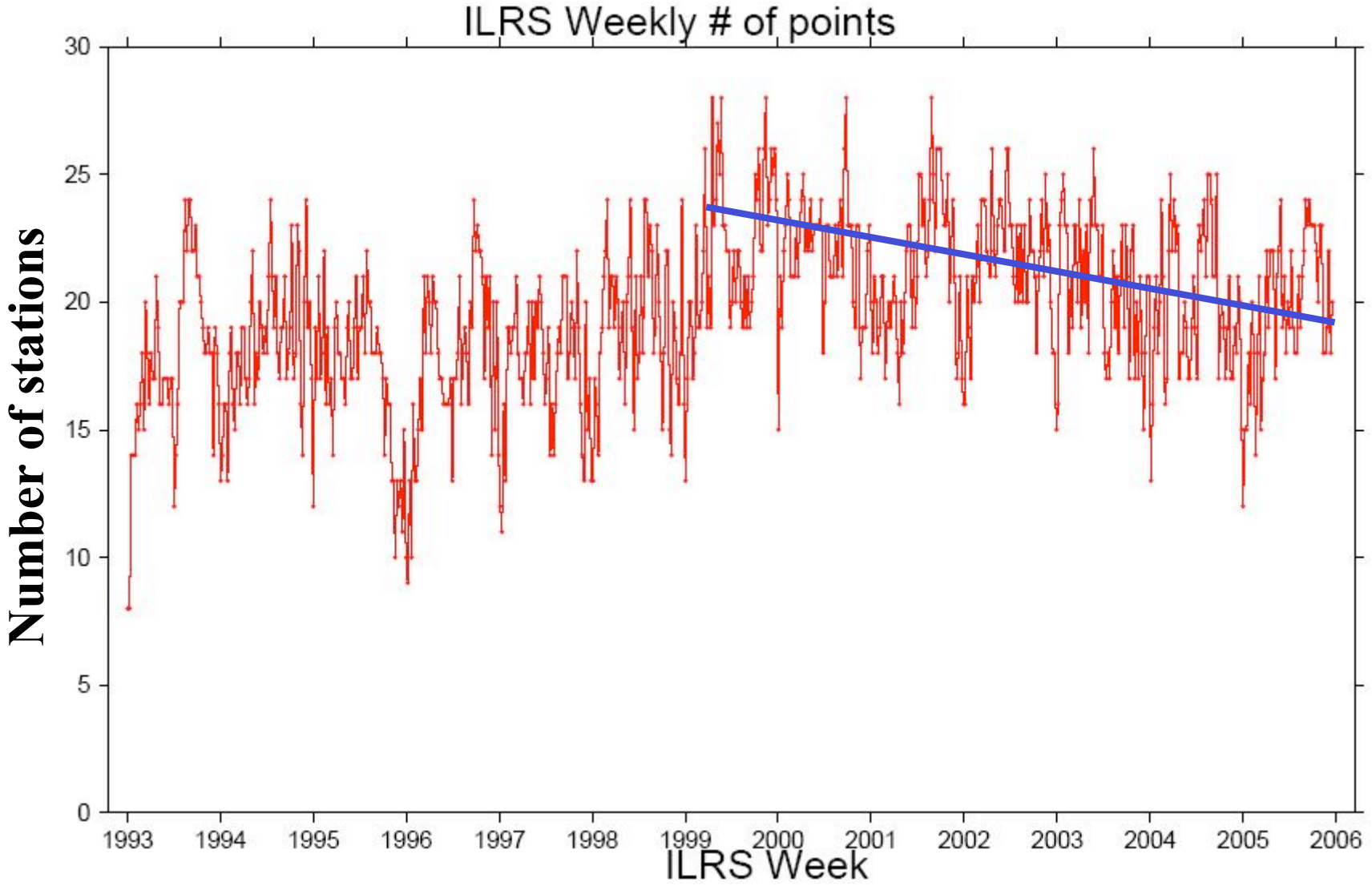
Origine et échelle intrinsèques SLR



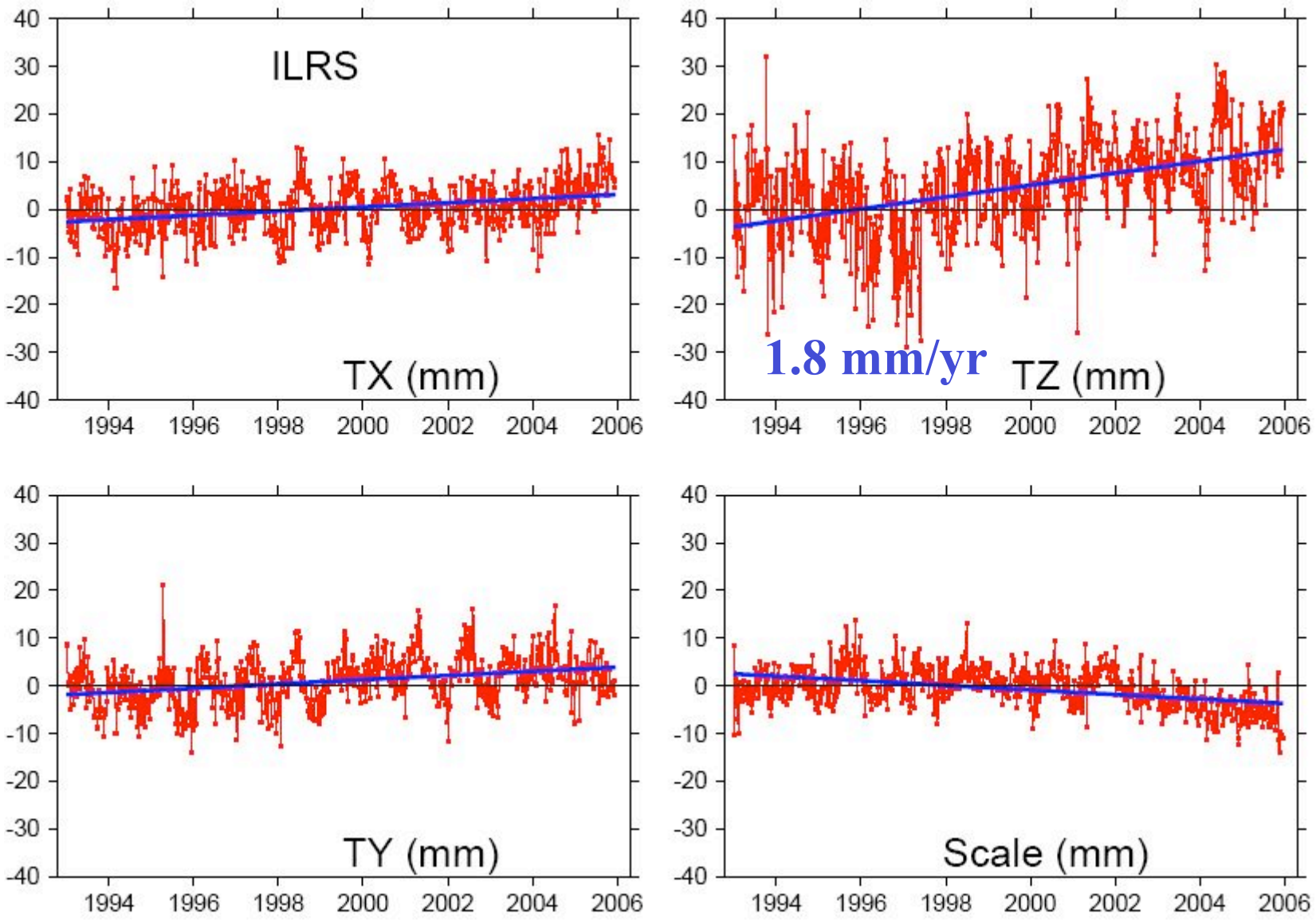
Zoom sur l'échelle SLR



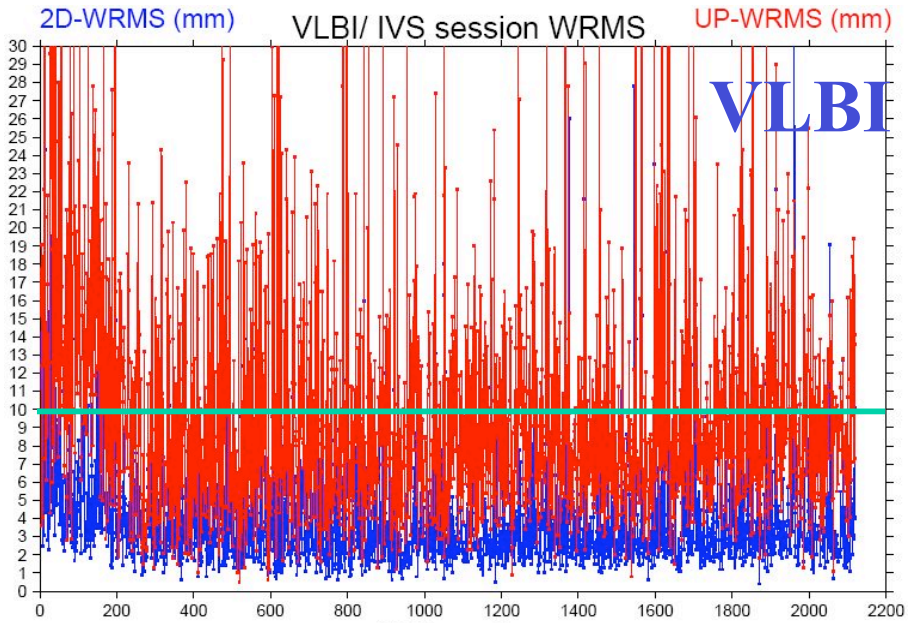
Réseau SLR ILRS

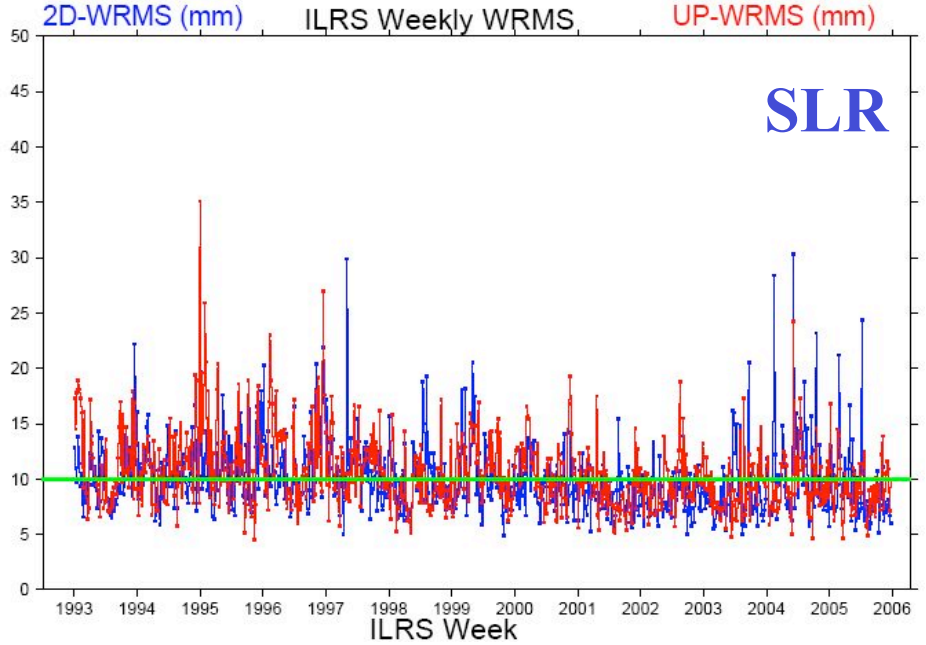


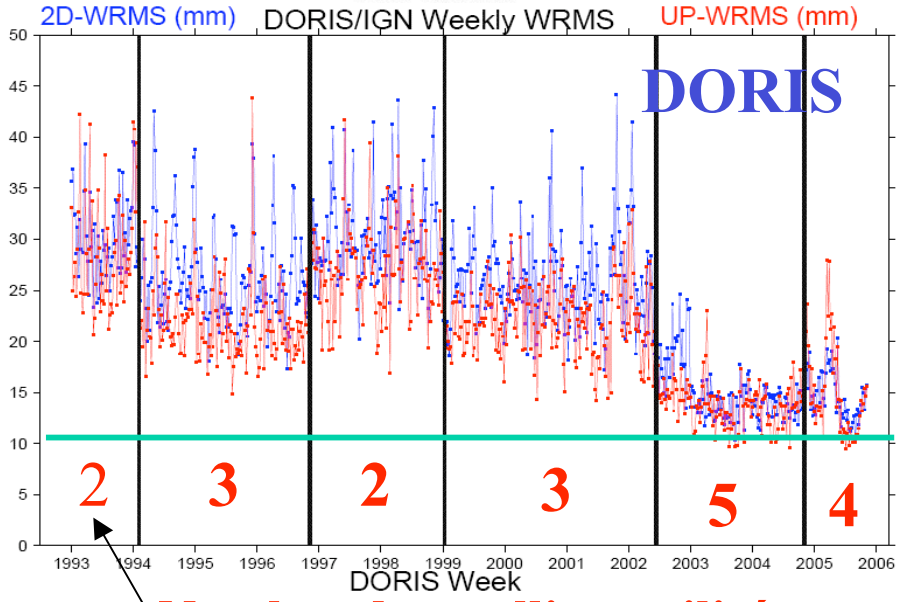
Origine et échelle SLR par rapport à l'ITRF2000

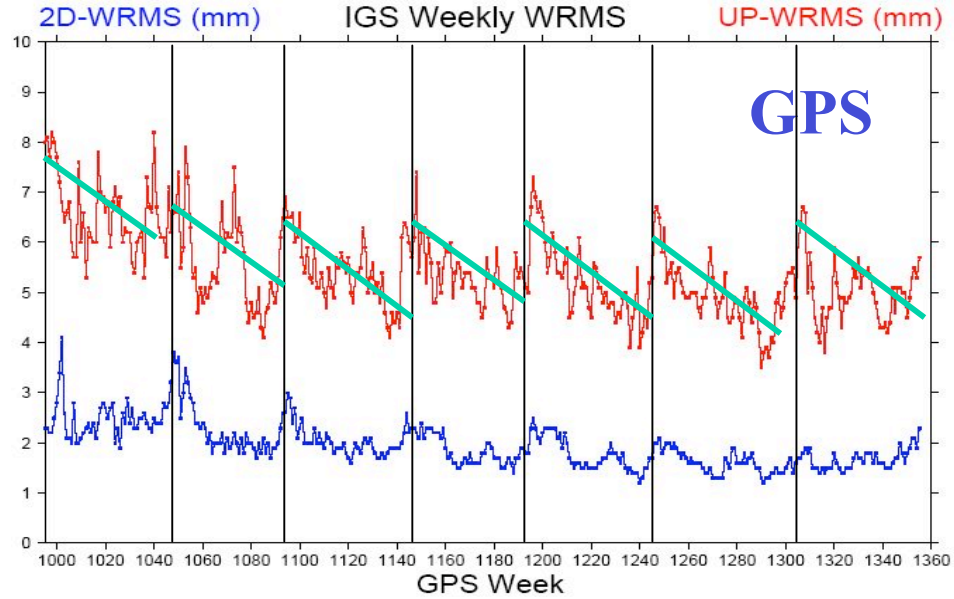


ITRF2005: Performance en positionnement



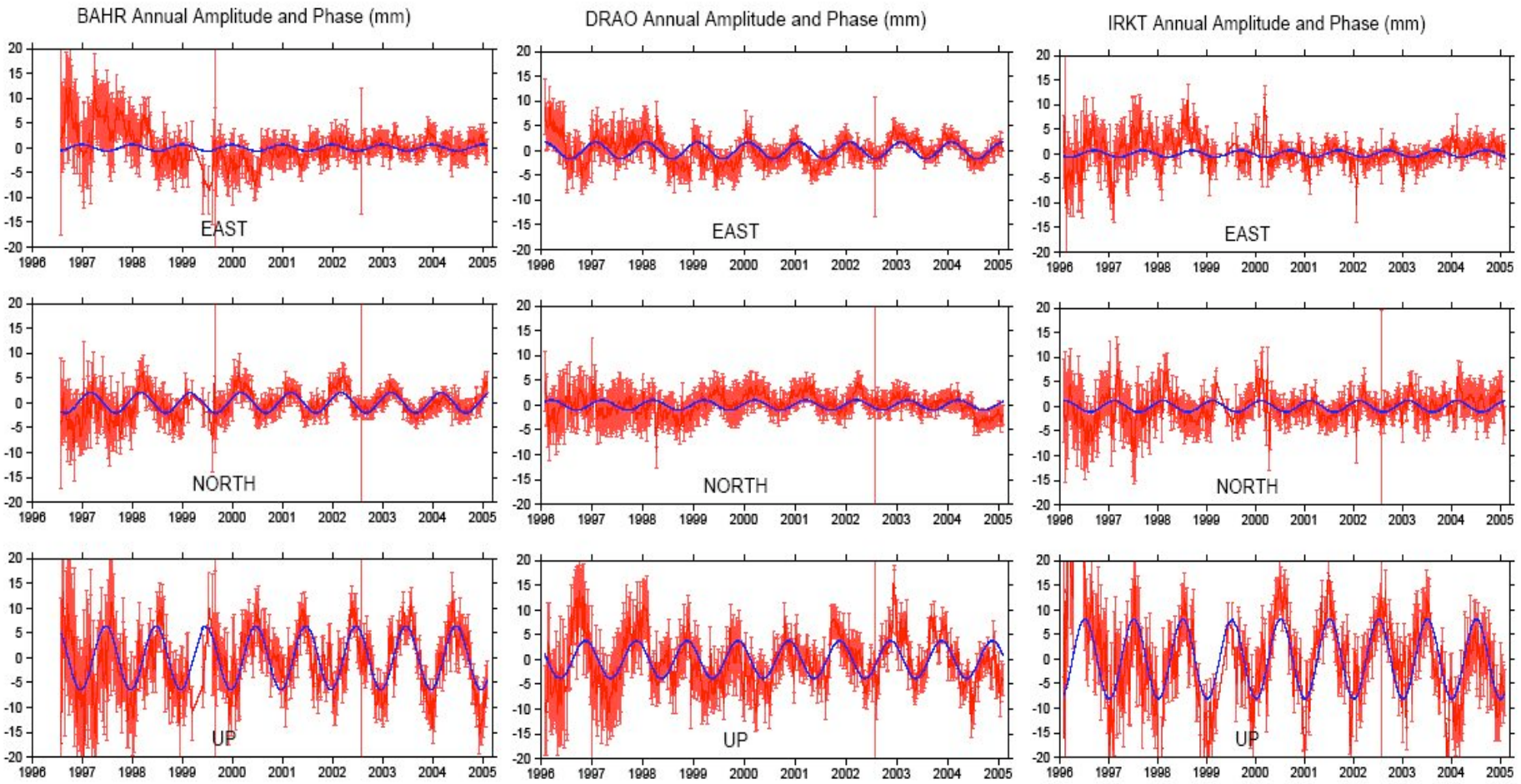






Nombre de satellites utilisés

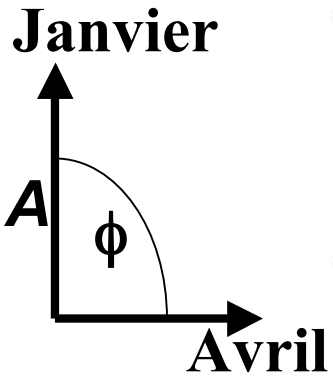
Variations saisonnières: Sites GPS/IGS

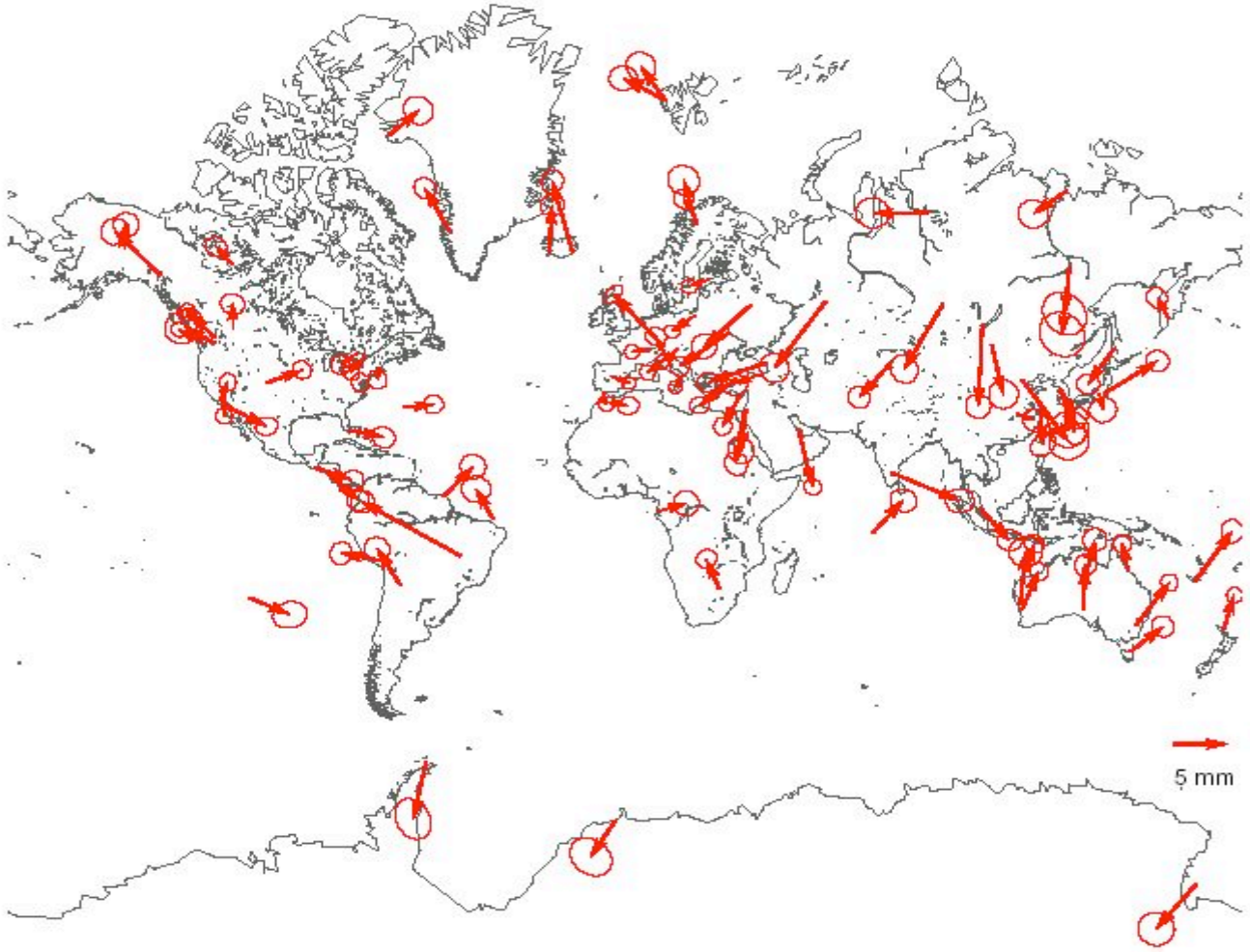


BAHR **DRAO** **IRKT**

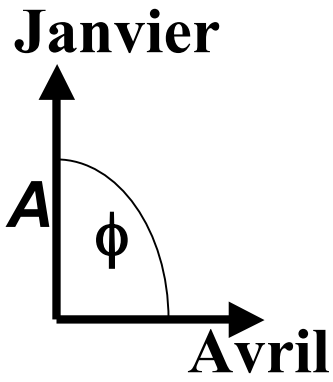
Amplitudes et phases annuelles des composantes verticales des stations GPS/IGS

$$Dh = A.\cos(2\pi f (t - t_0) - \phi)$$





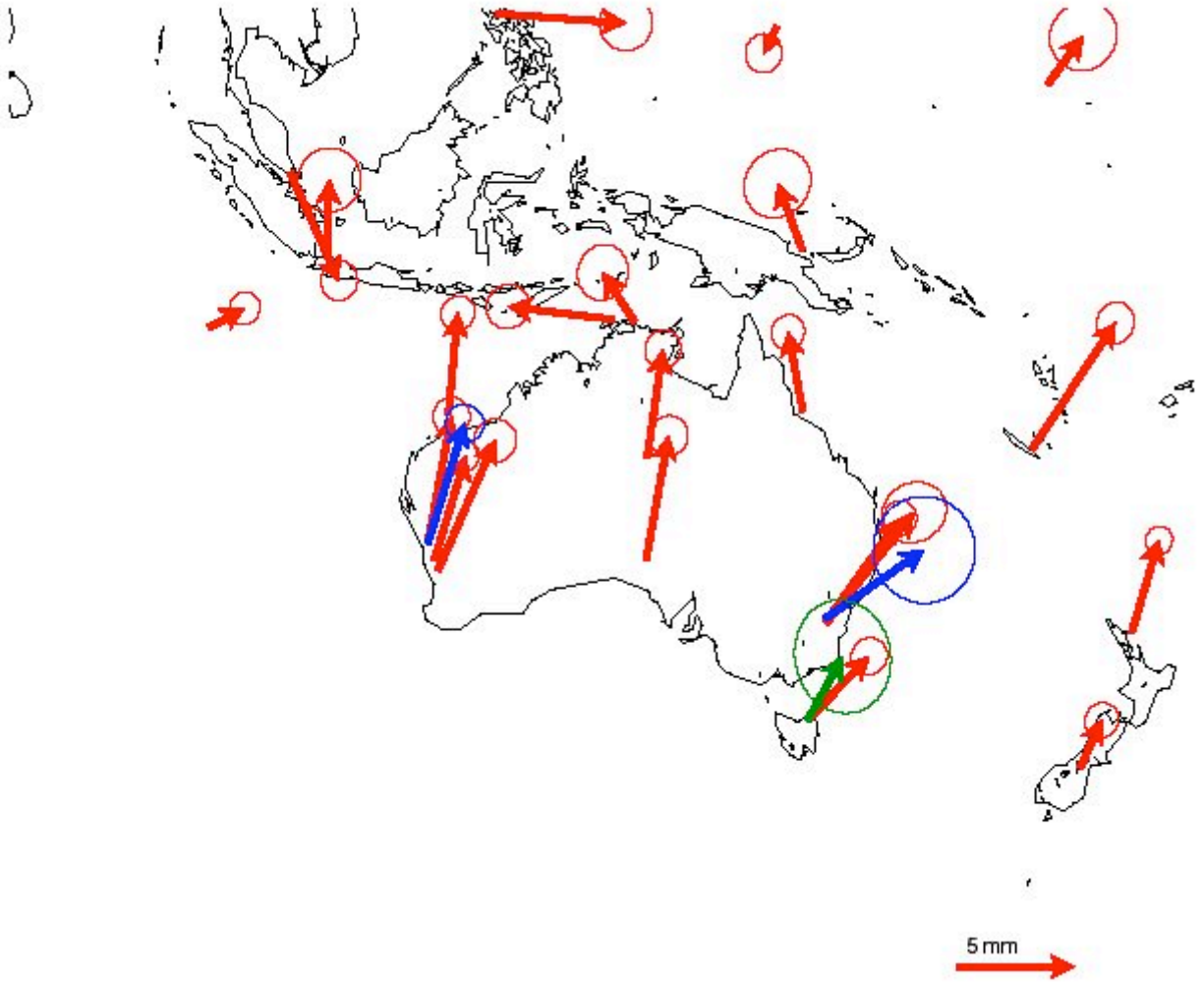
Le cas de l'Australie



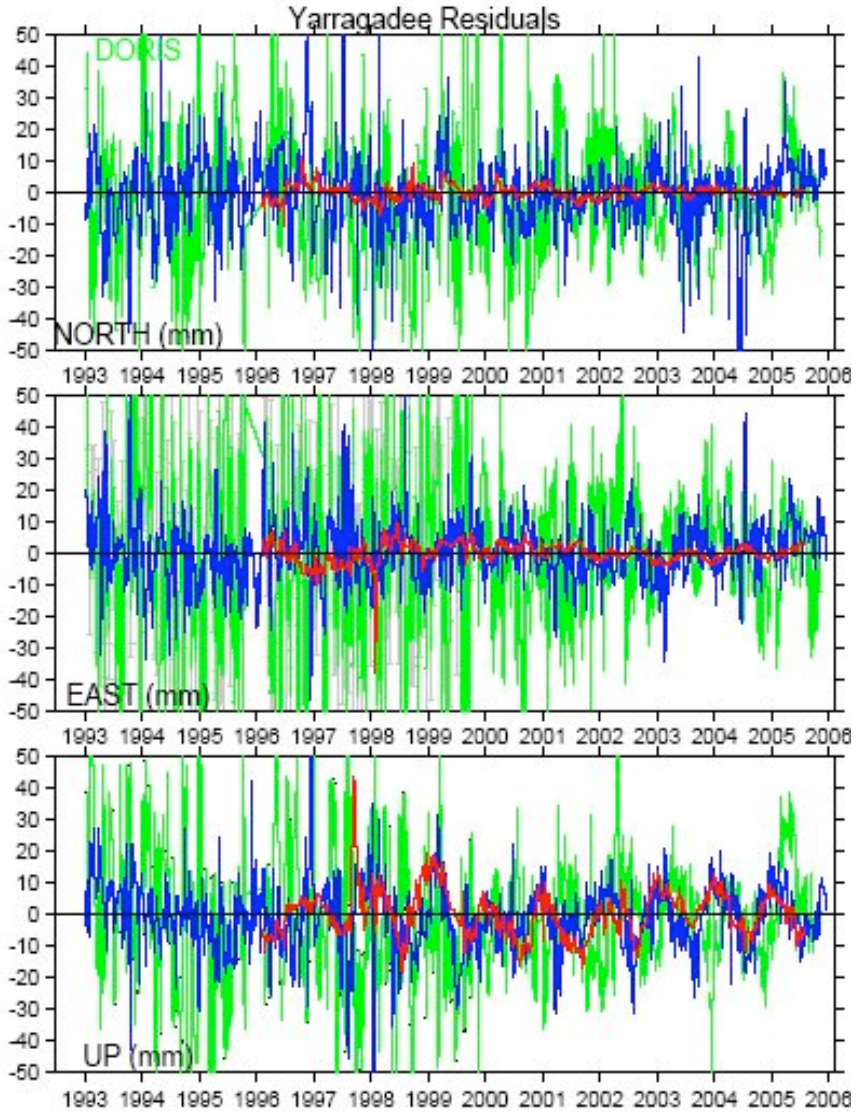
GPS

VLBI

SLR



Signal Géodésique ?
Site de Yaragadee: SLR, GPS et DORIS



SLR

GPS

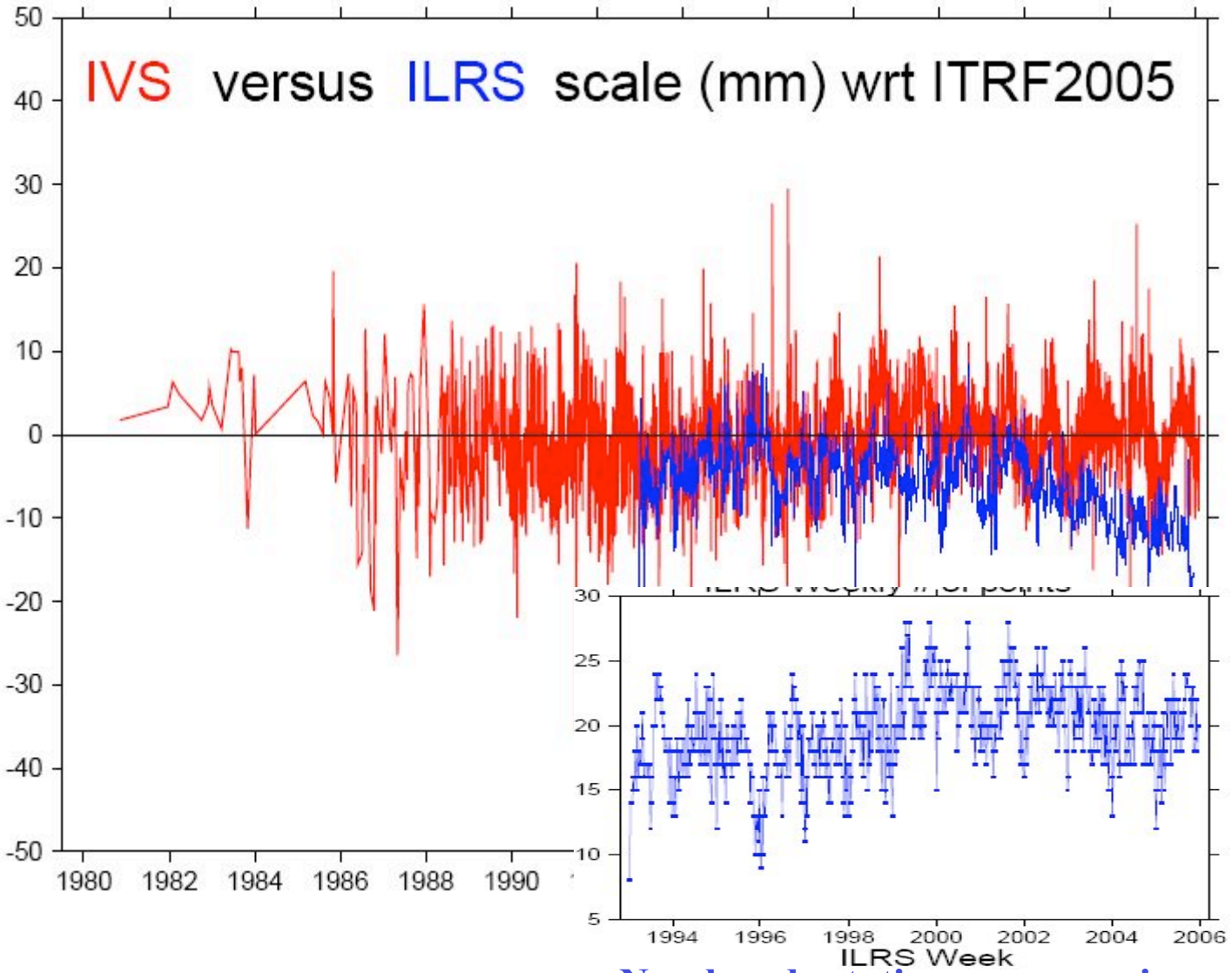
DORIS

Combinaison ITRF2005

- **Solutions à long-termes des 4 techniques: positions, vitesses et EOPs**
- **100 SINEX de rattachement dont 50 % avec variance complète**
- **Origine: définie en fixant à zéro les translations de la solution SLR**
- **Echelle: définie en fixant à zéro l'échelle de la solution VLBI**
- **Orientation & NNR: définie par alignement à l'ITRF2000**

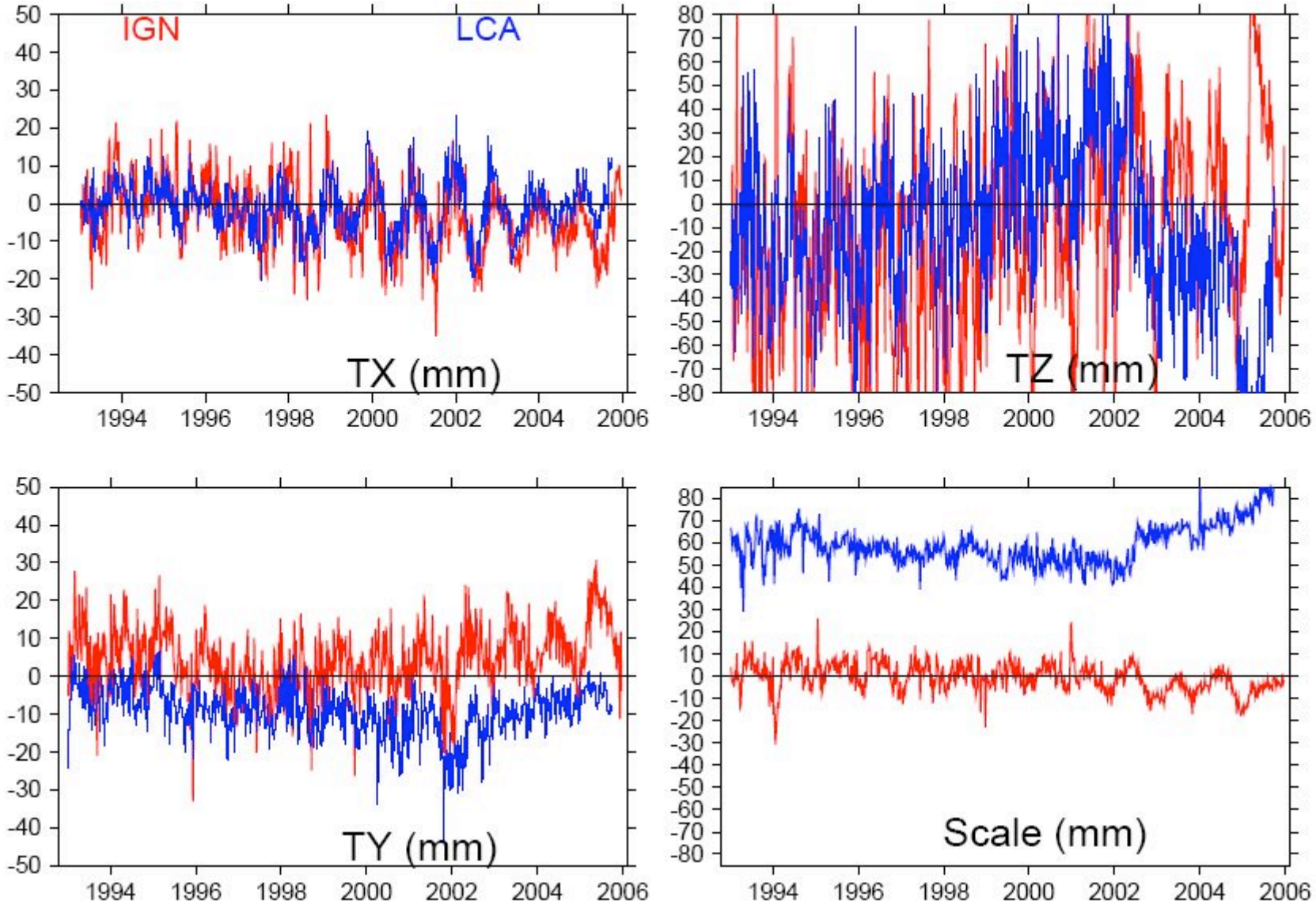
==> Mise en évidence d'un biais d'échelle de 1 ppb (6.3 mm) entre VLBI et SLR

Echelle VLBI et SLR par rapport à l'ITRF2005



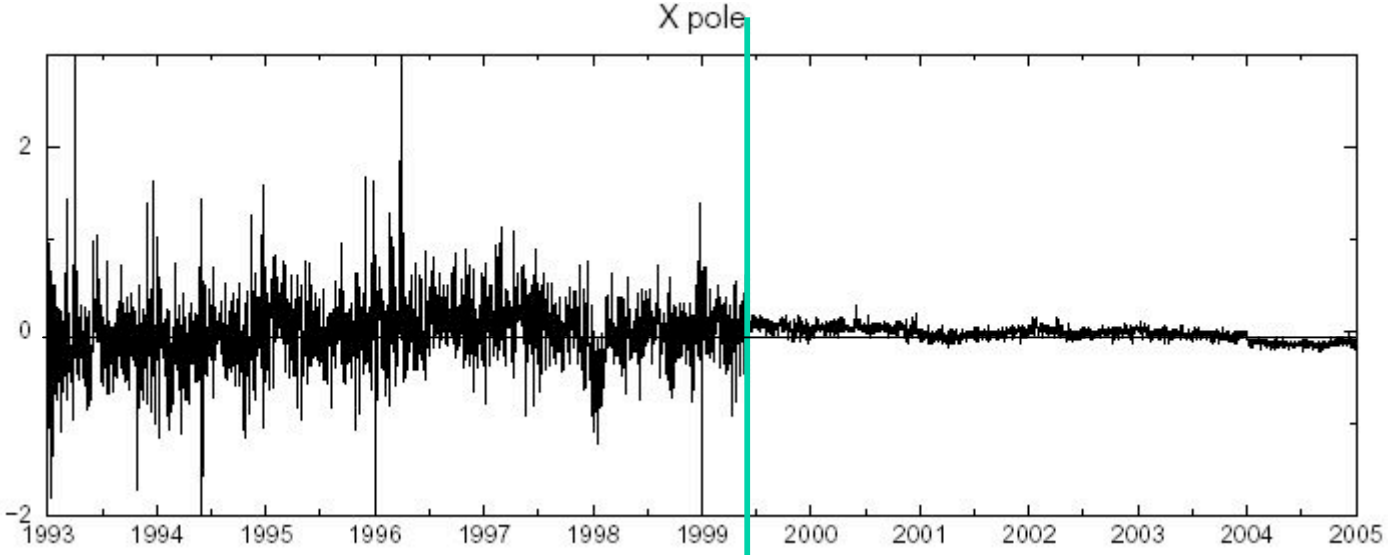
Nombre de stations par semaine

Origine et échelle DORIS par rapport à l'ITRF2005

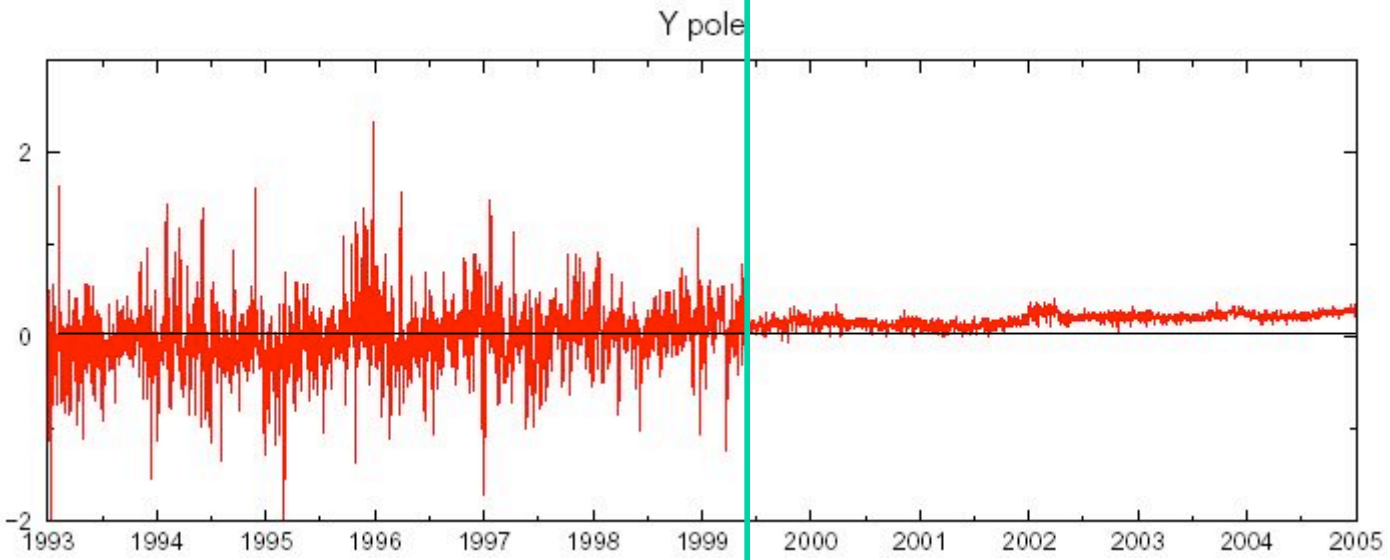


Mouvement du pôle
différences ITRF2000 - IERS C04

Xpole



Ypole



VLBI + SLR + DORIS **… + GPS**

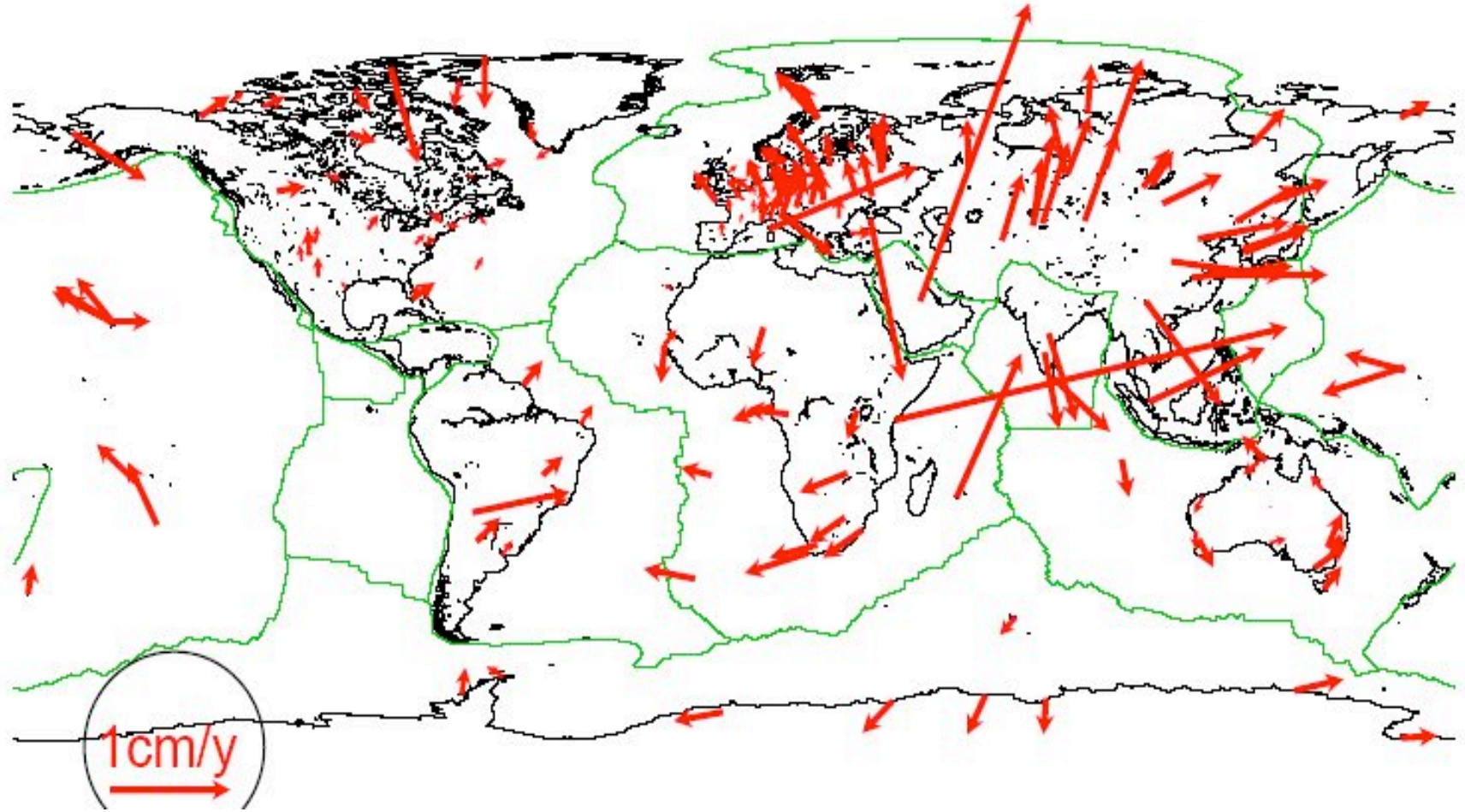
ITRF2005 et la condition NNR

Rotation rate diffs wrt ITRF2005 Using Ref set of 70 stations

- ITRF2000 (NNR-NUVEL-1A)
- APKIM 2005 (Drewes, 2006)
- GRSM-2 model by (Kreemer et al. 2006)

ω_1 mas/y	ω_2 mas/y	ω_3 mas/y	
-0.035	0.002	-0.024	APKIM2000
-0.026	0.010	-0.015	APKIM 2005
-0.050	0.049	-0.058	GRSM 2001
-0.037	0.041	-0.063	GRSM-2
-0.02	0.04	-0.04	Diff ~ 2mm/yr

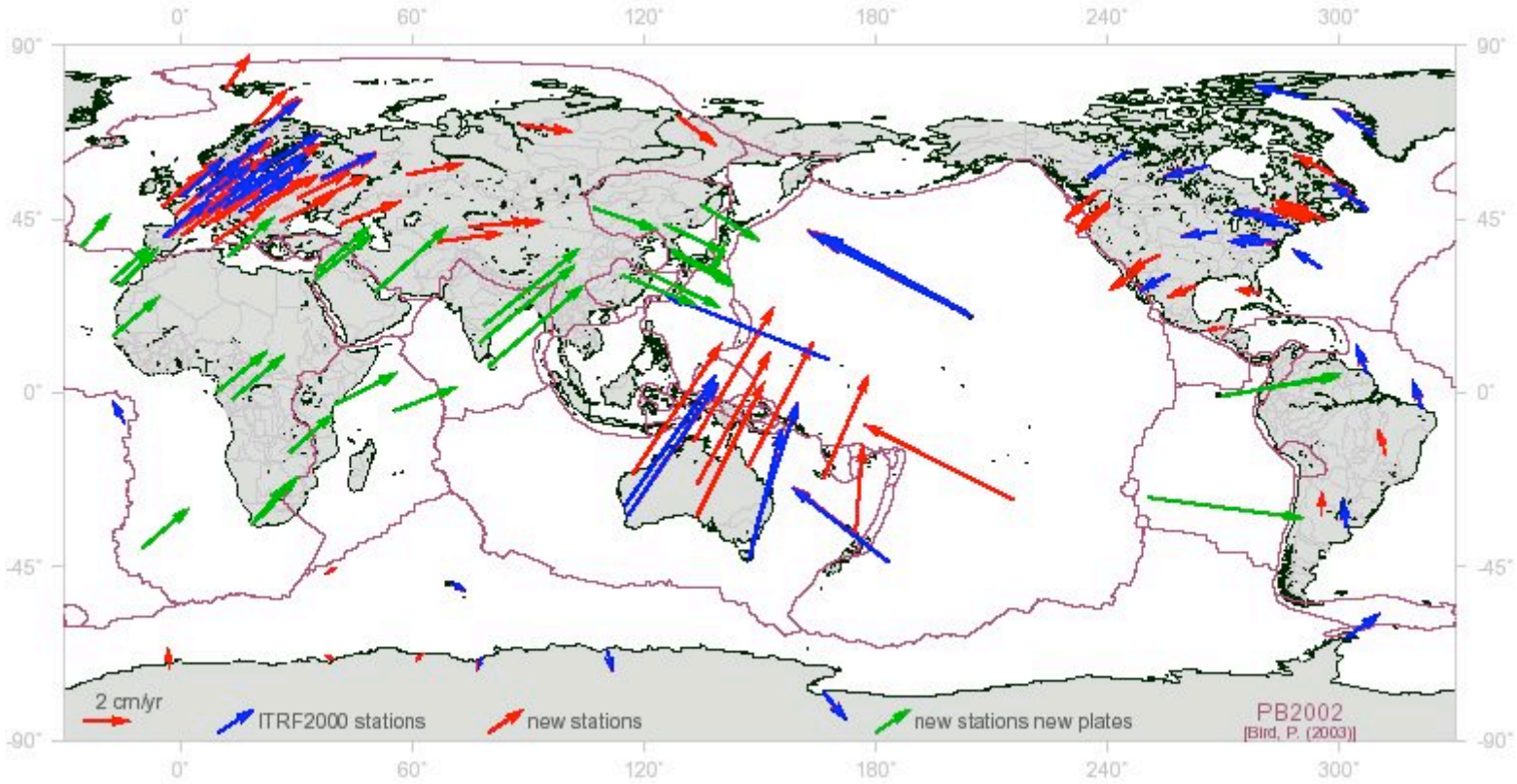
Différences ITRF2005 – NNR-NUVEL-1A



Example of selected sites for plate angular velocities estimation

Pacific
Africa
Amur
Antarctica
Arabia
Australia
Caribbean
Eurasia
India
North America
Nazca
Okhotsk
South America
Somalia
Yangtze

Using PB 2002 Plate boundaries (Bird, 2003)



Evaluation de l'exactitude de l'ITRF2005

	Biais à l'époque 2000.0 (mm)	Dérivée mm/an
Origine	5	2
Echelle	6.3	0.6
NNR		2

Conclusions

- **Origin:**
  - **Significant drift / ITRF2000 in TZ : 1.8 mm/y**
  - **Consider Impact on ITRF2005 velocity field**

    (ITRF2005 velocities are 1.8 mm/yr larger than ITRF2000)
- **Scale:**
  - **~ 1 ppb bias btw solutions from VLBI and SLR**
- **NNR Condition: Still at the level of 2 mm/yr**
- **Still too many issues to improve …**