ITRF2005 and consequences for ETRF2005

- Introduction
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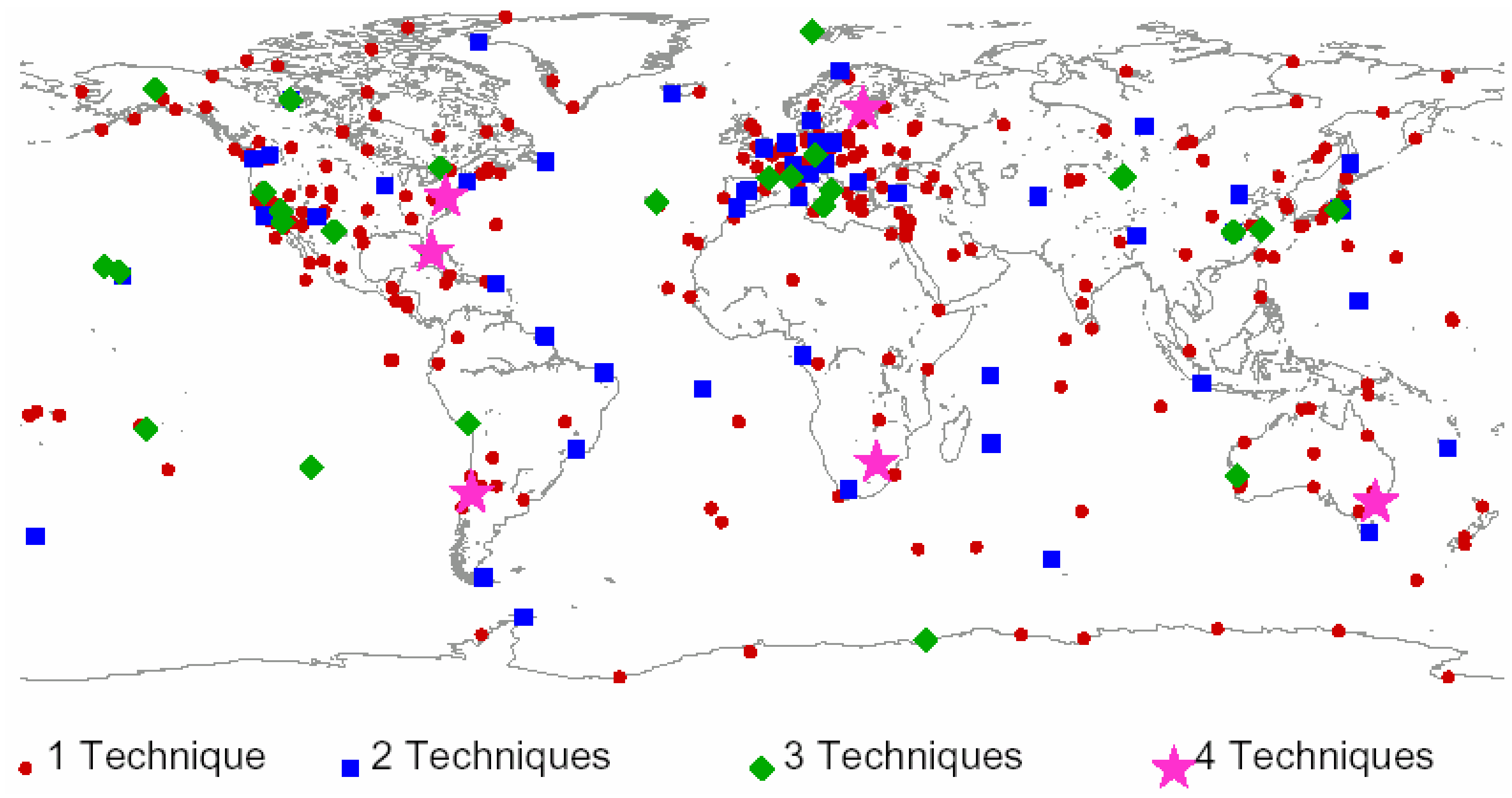
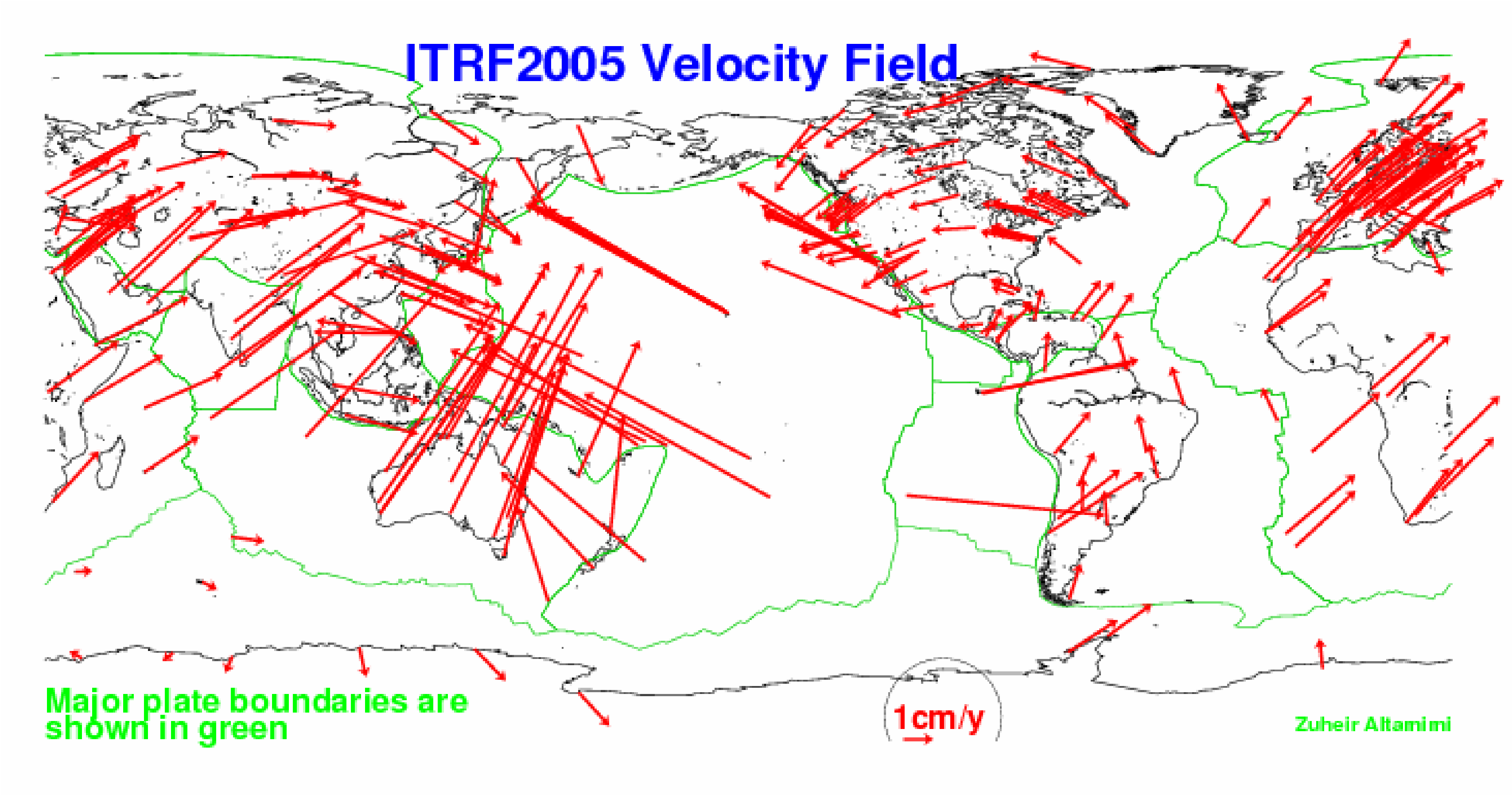
ITRF2005 Co-locations



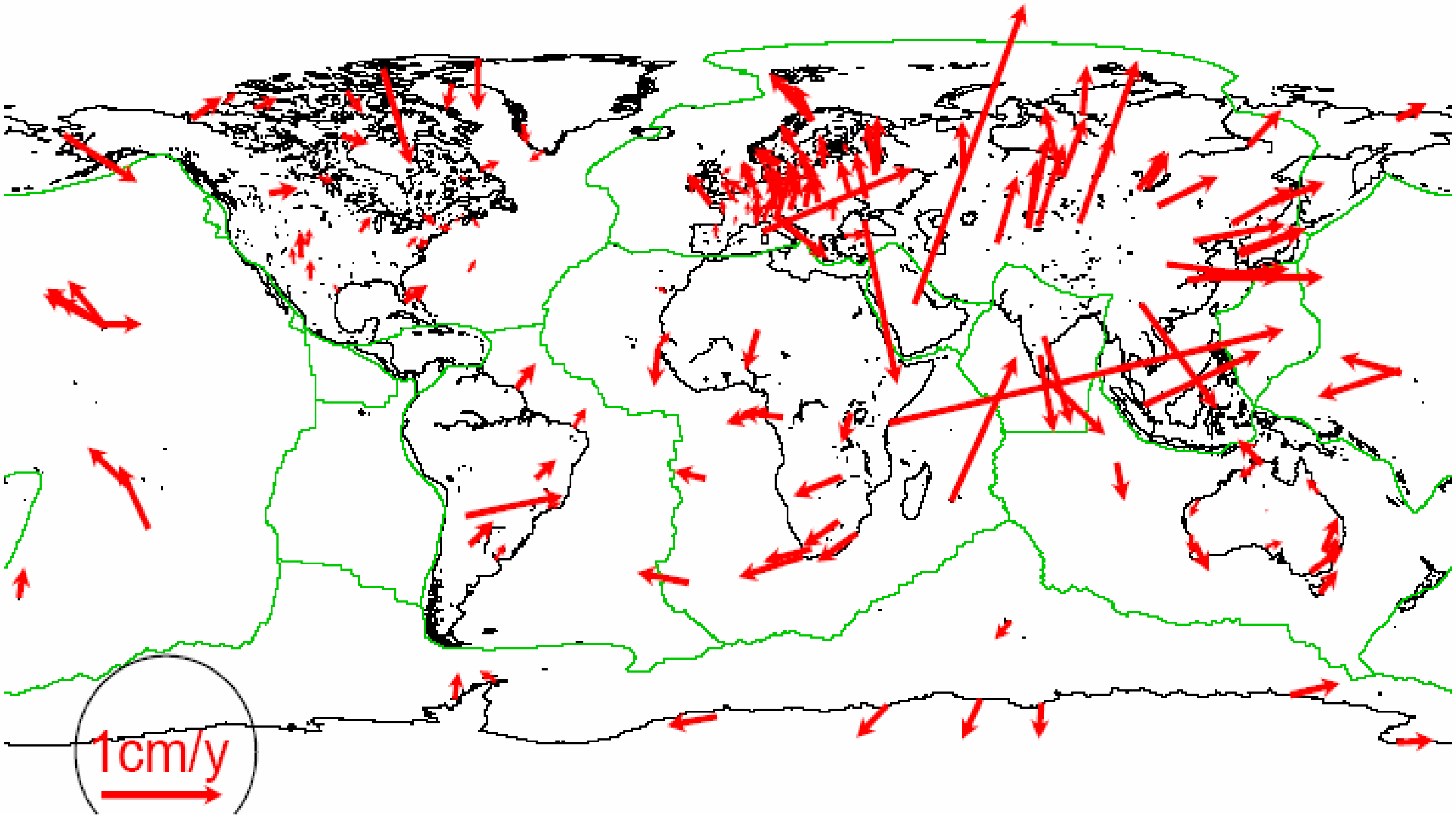
Transformation Parameters From ITRF2005 to ITRF2000

	TX mm mm/y	TY mm mm/y	TZ mm mm/y	Scale ppb ppb/y
Offset At 2000.0	0.1	-0.8	-5.8	0.40
Drift	-0.2	0.1	-1.8	0.08

ITRF2005 and Plate motion:
Horizontal Site velocities with σ < 3mm/y



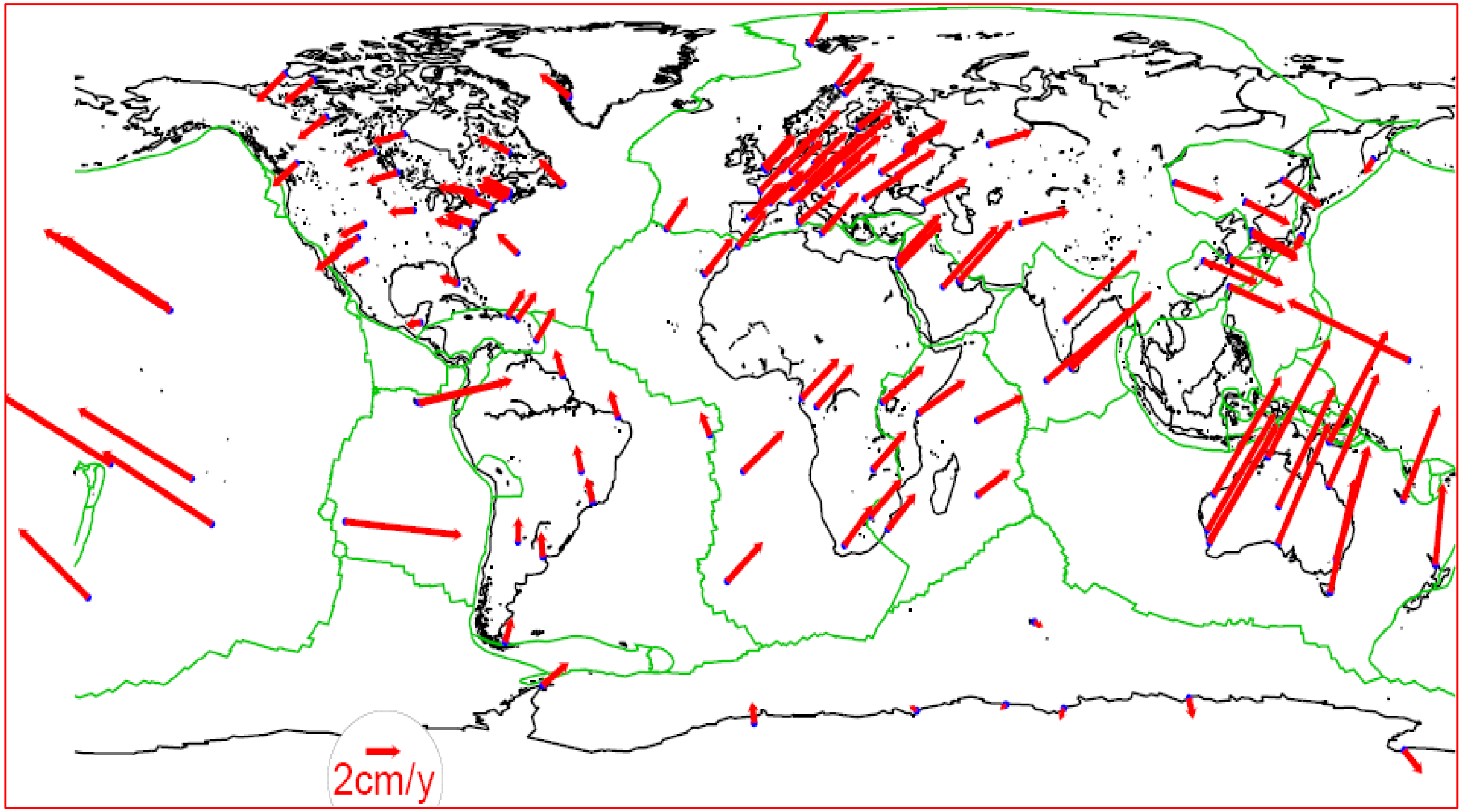
Differences ITRF2005 – NNR-NUVEL-1A



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)



ITRF2005 Plate Motion Model

Table 7. ITRF2005 Absolute Rotation Poles

Plate	NS[a]	ϕ, *deg*	λ, deg	ω(deg/m.y.)
Amurian	5	56.263	-102.789	0.269
±		6.532	8.569	0.011
Antarctica	8	59.813	-125.315	0.223
±		0.864	1.676	0.007
Arabia	5	49.642	5.061	0.579
±		0.581	2.278	0.019
Australia	14	32.407	37.367	0.628
±		0.267	0.356	0.003
Caribbean	3	39.318	-104.279	0.241
±		10.553	35.968	0.145
Eurasia	41	56.330	-95.979	0.261
±		0.549	0.969	0.003
India	3	49.823	21.841	0.614
±		6.628	24.578	0.108
Nazca	3	45.101	-101.441	0.642
±		1.856	0.753	0.015
N. America	30	-4.291	-87.385	0.192
±		0.861	0.571	0.002
Nubia	13	49.955	-82.501	0.269
±		0.483	1.255	0.003
Okhostk	3	-32.041	-132.910	0.083
±		7.519	12.034	0.006
Pacific	10	-62.569	112.873	0.682
±		0.222	0.743	0.004
S. America	9	-16.800	-129.631	0.121
±		1.593	2.051	0.003
Somalia	3	53.661	-89.542	0.309
±		3.650	8.988	0.019
Yangtze	3	59.425	-109.737	0.310
±		6.651	18.298	0.021

[a] Number of used sites

ITRFyy Eurasia Rotation Poles

Table 4: Estimation of $\dot{R}_{YY}$

YY	$\dot{R}1$ mas/y	$\dot{R}2$ mas/y	$\dot{R}3$ mas/y
89	0.11	0.57	-0.71
90	0.11	0.57	-0.71
91	0.21	0.52	-0.68
92	0.21	0.52	-0.68
93	0.32	0.78	-0.67
94	0.20	0.50	-0.65
96	0.20	0.50	-0.65
97	0.20	0.50	-0.65
00	0.081	0.490	-0.792
	±0.021	±0.008	±0.026
05	0.054	0.518	-0.781
	±0.009	±0.006	±0.011

Velocity diff. at the Equator 0.8 mm/yr & 0.5 in Europe

ETRS89 Definition

- **Coincides with ITRS at epoch 1989.0:**
  - **Definition at a reference epoch (1989.0)**
  - **The 7 parameters between ITRS and ETRS89 are zero at 1989.0**
- **Fixed to the stable part of the Eurasian plate**
  - **Co-moving with the plate: law of time evolution**
  - **Time derivatives of the transformation parameters are zero except the 3 rotation rates**

ETRS89 Realization

- Expression in ITRF$_{YY}$ at central epoch (t_c) of the implied observations
- Expression in ETRS89 using 14 transformation parameters some of them are zeros

Positions

$$X^E(t_c) = X^I_{YY}(t_c) + T_{YY} + \begin{pmatrix} 0 & -\dot{R}3_{YY} & \dot{R}2_{YY} \\ \dot{R}3_{YY} & 0 & -\dot{R}1_{YY} \\ -\dot{R}2_{YY} & \dot{R}1_{YY} & 0 \end{pmatrix} \times X^I_{YY}(t_c).(t_c - 1989.0)$$

Velocities

$$\begin{pmatrix} \dot{X}^E_{YY} \\ \dot{Y}^E_{YY} \\ \dot{Z}^E_{YY} \end{pmatrix} = \begin{pmatrix} \dot{X}^I_{YY} \\ \dot{Y}^I_{YY} \\ \dot{Z}^I_{YY} \end{pmatrix} + \begin{pmatrix} 0 & -\dot{R}3_{YY} & \dot{R}2_{YY} \\ \dot{R}3_{YY} & 0 & -\dot{R}1_{YY} \\ -\dot{R}2_{YY} & \dot{R}1_{YY} & 0 \end{pmatrix} \times \begin{pmatrix} X^I_{YY} \\ Y^I_{YY} \\ Z^I_{YY} \end{pmatrix}$$

EUROPEAN TERRESTRIAL REFERENCE SYSTEM 89 (ETRS89)

Definition

The IAG Subcommision for the European Reference Frame (EUREF) , following its Resolution 1 adopted in Firenze meeting in 1990, recommends that the terrestrial reference system to be adopted by EUREF will be coincident with ITRS at the epoch 1989.0 and fixed to the stable part of the Eurasian Plate. It will be named European Terrestrial Reference System 89 (ETRS89).

Realization

Following its definition, ETRS89 could be realized through several ways, and specifically:

- **using ITRS realizations: for each frame labelled ITRF$_{yy}$ a corresponding frame in ETRS89 can be computed and labelled ETRF$_{yy}$.The following ETRF solutions are presently available:**
  - **ETRF89**
  - **ETRF90**
  - **ETRF91**
  - **ETRF92**
  - **ETRF93**
  - **ETRF94**
  - **ETRF96**
  - **ETRF97**
  - **ETRF2000**
  - **ETRF2005**
  - **ETRF2005 (SINEX file)**
- **positioning with GPS measurements of a campaign or permanent stations: using recent ITRF$_{yy}$ station coordinates and IGS precise ephemerides following the procedure described in (Boucher and Altamimi, 2007): Postscript version, PDF version.**

Consequences for ETRF2005

- T_{YY} : known at the 1 cm level

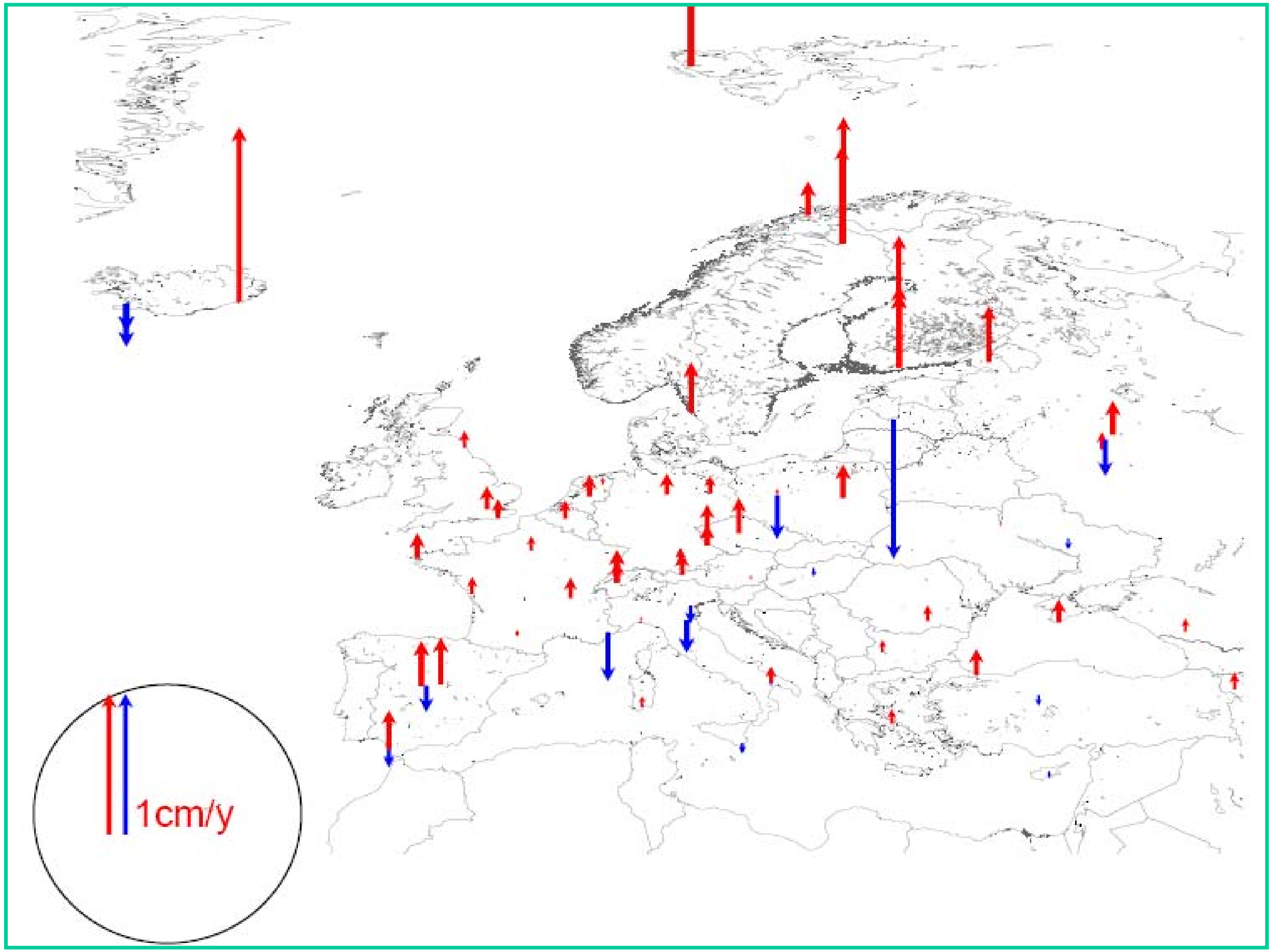
- $(t_c - 1989.0)$ together with $\dot{R}_{YY}$

  - **Velocity change of 0.5 mm/yr produce position change by ~1 cm at epoch 2007**

- **Vertical velocities change by** ***1.8 sin(φ) mm/yr***

ETRF2005 Horizontal Velocities

ETRF2005 Vertical Velocities



Conclusions

- **ITRF2005 ==> ETRF2005:**
  - **Transformation uncertainty : ~ 1cm**
  - **Jumps in station positions to be expected when going from ETRF2000 to ETRF2005**
- **ETRF2005 internal consistency is not altered**
- **Revision/amendment of ETRS89 definition might be necessary**