

# **ETRS89 Realizations: Current status, ETRF2005 and future developments**

- **Recall ETRS89 definition**
- **Consequence of ETRF2005**
- **TWG proposal & recommendation**
- **Future developments**

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# 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<sub>YY</sub> at central epoch ( $t_c$ ) of the implied observations
- Expression in ETRS89 using 14 transformation parameters some of them are zeros

## Positions

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

## Velocities

$$\begin{pmatrix} \dot{X}_{YY}^E \\ \dot{Y}_{YY}^E \\ \dot{Z}_{YY}^E \end{pmatrix} = \begin{pmatrix} \dot{X}_{YY}^I \\ \dot{Y}_{YY}^I \\ \dot{Z}_{YY}^I \end{pmatrix} + \begin{pmatrix} 0 & -\dot{R}_{3YY} & \dot{R}_{2YY} \\ \dot{R}_{3YY} & 0 & -\dot{R}_{1YY} \\ -\dot{R}_{2YY} & \dot{R}_{1YY} & 0 \end{pmatrix} \times \begin{pmatrix} X_{YY}^I \\ Y_{YY}^I \\ Z_{YY}^I \end{pmatrix}$$

# 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 $\pm 0.021$	0.490 $\pm 0.008$	-0.792 $\pm 0.026$
05	0.054 $\pm 0.009$	0.518 $\pm 0.006$	-0.781 $\pm 0.011$

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

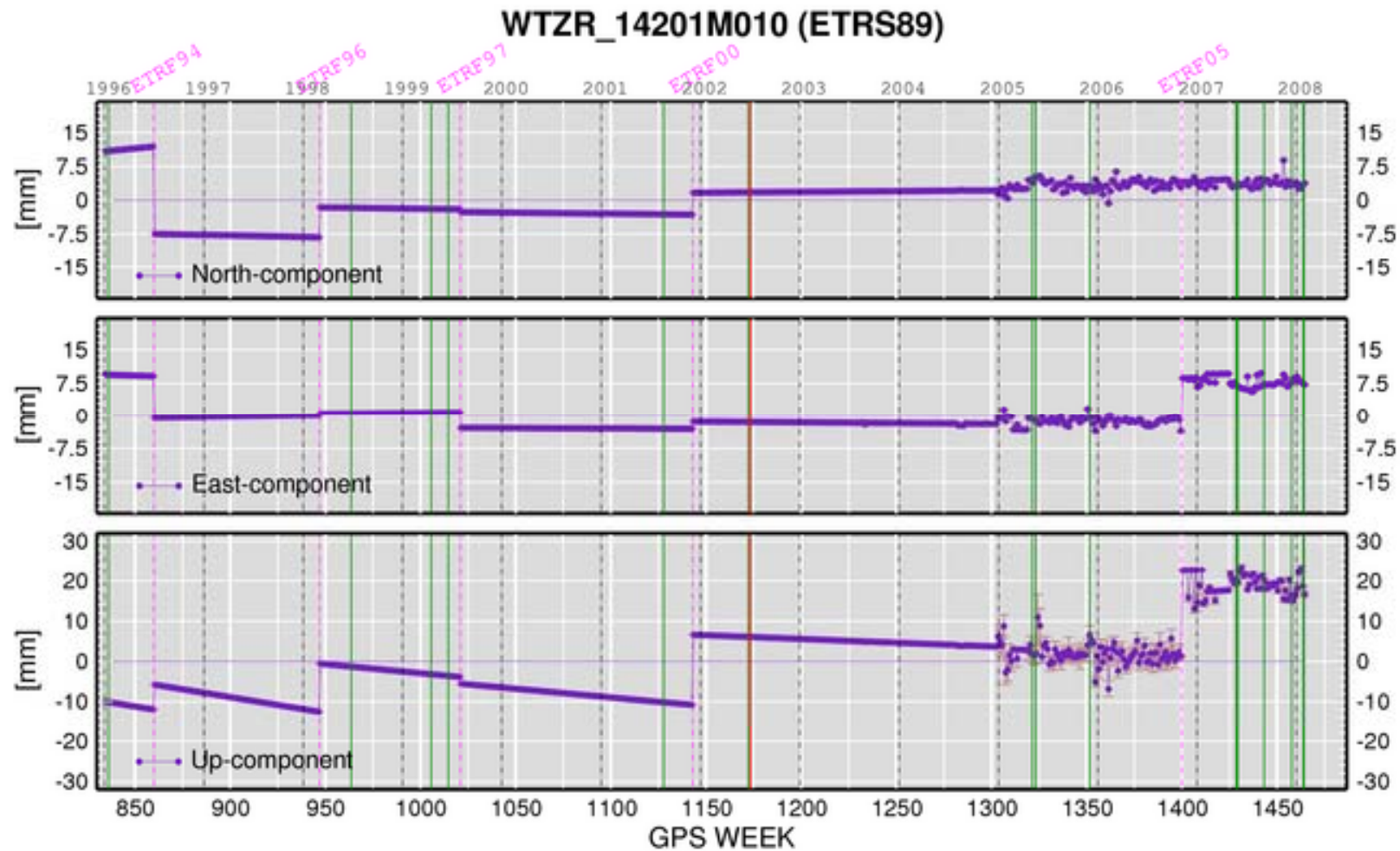
## Consequences for ETRF2005

- $T_{YY}$  : 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
- Tz drift between ITRF2000 and ITRF2005  
(see next)

# Impact of the Z-translation drift btw ITRF2005 & ITRF2000: 1.8 mm/yr

- Vertical velocity change by  $1.8 \sin(\varphi) \text{ mm/yr}$ 
  - Zero at the equator and  $+1.8, -1.8 \text{ mm/yr}$  at north and south poles, respectively
- North velocity change by  $1.8 \cos(\varphi) \text{ mm/yr}$ 
  - $1.8 \text{ mm/yr}$  at the equator and zero at north and south poles, respectively

# WTZR Time Series (ETRS89)



EPN CB

Thu Apr 24 08:19:05 2008

# Proposal

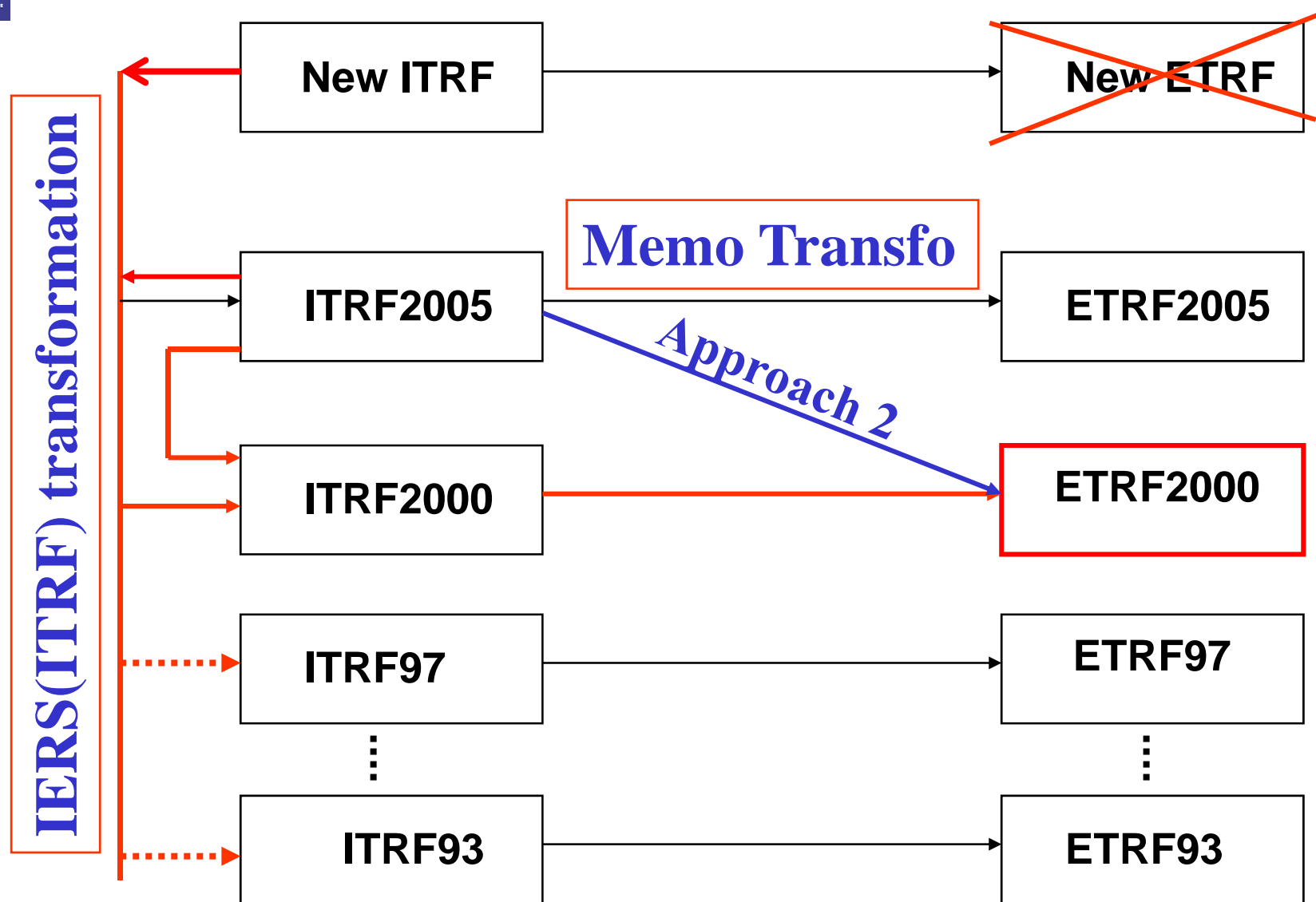
- Adopte ETRF2000 as a conventional frame of the ETRS89 system
- Provide transformation parameters (14) from **ITRF2005 to ETRF2000**
- Target: harmonize the ETRS89 realization overall Europe



# Procedures

- There are two possible procedures
- **Approach 1 (A):**
  - Transform from ITRF2005(8, 10) to ITRF2000 (97, ...,93)
  - Use the ITRS-to-ETRS89 Transformation Formulae
  - ==> 14 transformation parameters
- **Approach 2:** Estimate 14 transformation parameters derived from (a subset of) the EPN stations available in both ITRF2005 and ETRF2000 published lists

# Approach A



## Approach A: Advantages

- Straightforward and clear approach
- Guarantees full compatibility of the transformation parameters between the global ITRFs and the regional ETRFs
- Valid for the **past** and the **future**
- Satisfies all users
- Already used by a certain number of NMAs
- **Minimizes the jumps**

# Computed Parameters

## Summation of the transformation parameters

- ITRF2005-To-ITRF2000 (From IERS)
  - and
  - ITRF2000-To-ETRF2000 (EUREF Memo)
- ==> 14 transformation parameters

### From ITRF2005 To ETRF2000

	T1 mm	T2 mm	T3 mm	D 10 <sup>-9</sup>	R1 mas	R2 mas	R3 mas	Epoch y
	54.1	50.2	-53.8	0.40	0.891	5.390	-8.712	00:001
Rates	-0.2	0.1	-1.8	0.08	0.081	0.490	-0.792	

# Estimated Parameters

Using ITRF2005 & ETRF2000 published solutions: 35 stations

	T1	T2	T3	D	R1	R2	R3	Epoch
	mm	mm	mm	10 <sup>-9</sup>	mas	mas	mas	y
	49.3	54.0	-49.1	0.58	0.983	5.616	-8.838	00:001
+/-	1.9	3.0	1.6	0.23	0.089	0.065	0.063	
Rates	-1.6	3.4	-0.6	-0.14	0.161	0.553	-0.848	
+/-	1.9	3.0	1.6	0.23	0.089	0.065	0.063	

**Note: There are other possibilities of selected stations**

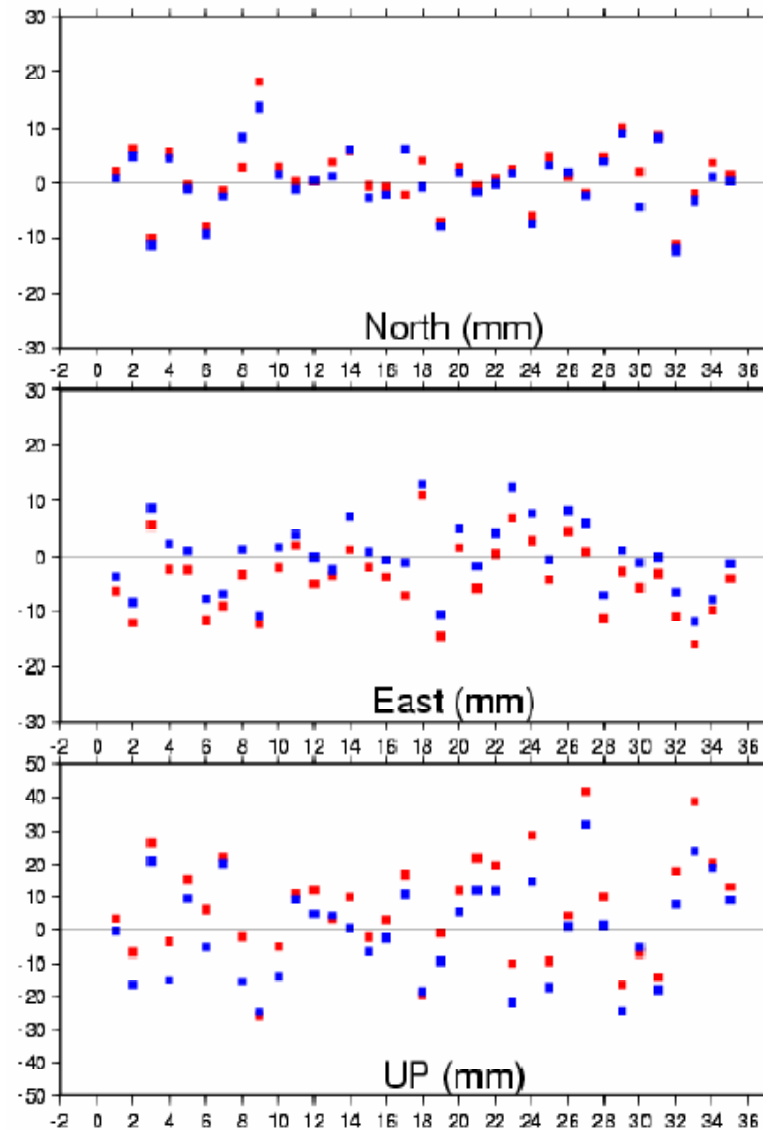
## Correlation between parameters and their rates

	<b>T<sub>x</sub></b>	<b>T<sub>y</sub></b>	<b>T<sub>z</sub></b>	<b>D</b>	<b>R<sub>x</sub></b>	<b>R<sub>y</sub></b>	<b>R<sub>z</sub></b>
<b>T<sub>x</sub></b>						<b>-0.88</b>	
<b>T<sub>y</sub></b>					<b>0.94</b>		<b>-0.79</b>
<b>T<sub>z</sub></b>				<b>-0.72</b>		<b>0.65</b>	
<b>D</b>							
<b>R<sub>x</sub></b>							
<b>R<sub>y</sub></b>							
<b>R<sub>z</sub></b>							

# Residuals at 2010.0

■ Using computed parameters

■ Using estimated parameters



# Users of ETRS89 Realizations

- **Type\_1 : all national datum users:**
  - Different ETRFyy frames were already adopted by different countries, with legal status  
**--> Use Approach A**
- **Type\_2: EPN users: weekly solutions**
  - (1): users who wants to have access ETRS89 via the whole EPN network  
**==> Use ITRF2005-to-ETRF2000 transformation**
  - (2): users of country-EPN stations, but need weekly solutions expressed in their national ETRFyy  
**==> Use Approach A**



# Conclusion

- **Primary ETRS89 realization:**
  - EPN weekly time series
  - EPN cumulative solution

==> both properly expressed in ETRF2000: e.g.

  - Use ITRF2005-to-ETRF2000 transformation
  - Use minimum constraints approach
- **Secondary access: national and campaign-type access: ==> Use Approach A**

# Future Developments

- TWG to set up a WG to discuss future ETRS89 realizations:
  - Alternatives
  - Terminology
  - Involve/adopt recommendation of the IAG WG on terminology
- Alternatives
  - Continue with ETRF2000 as a conventional frame and use approach A
  - Apply the two ETRS89 conditions in mathematically appropriate constraints and perform a least squares adjustment:

$$X_{ETRF}(1989.0) \equiv X_{ITRF}(1989.0) \quad (1)$$

$$\sum \dot{X} = 0 \quad (2)$$

## TWG Recommendations

- Accept the existence of ETRF2005 (Memo);
- Use ETRF2000 frame as the basis of the ETRS89 realization
- Recommend the usage of Approach A, with its **ITRF2005-to-ETRF2000** transformation parameters (14)
- The Memo will be updated accordingly
- Make available **ETRF2000(R05)** list of European station positions/velocities (GPS, VLBI, SLR, DORIS)