

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

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

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



ITRFyy Eurasia Rotation Poles

	YY	$\dot{R}1$	$\dot{R}2$	$\dot{R}3$			
		mas/y	mas/y	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			
Velocity diff. at	97	0.20	0.50	-0.65			
the Equator	+ 00	0.081	0.490	-0.792			
0.8 mm/yr &		± 0.021	± 0.008	± 0.026			
0.5 mm/yr in	+ 05	(0.054)	0.518	-0.781			
Europe		± 0.009	± 0.006	± 0.011			

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



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)

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

• Vertical velocity change by $1.8 \sin(\varphi) mm/yr$

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



WTZR Time Series (ETRS89)



EPN CB

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Proposal

- Adopte ETRF2000 as a <u>conventional frame</u> 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	т2	т3	D	R1	R2	R3	Epoch
	mm	mm	mm	10-9	mas	mas	mas	У
	 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	т2	т3	D	R1	R2	R3 Epc	ch
	mm	mm		10-9	mas	mas	mas	У
	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

	Тх	Ту	Tz	D	Rx	Ry	Rz
Тх						-0.88	
Ту					0.94		-0.79
Tz				-0.72		0.65	
D							
Rx							
Ry							
Rz							



Residuals at 2010.0





- 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

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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:

$$X_{ETRF}(1989.0) \equiv X_{ITRF}(1989.0)$$
 (1)
 $\sum \dot{X} = 0$ (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)