

EUREF W.G. on the Development of the ETRS89: Objectives and First Steps

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INTRODUCTION

OBJECTIVES

How to achieve coordinates based on ETRS89

ETRF2000 as the conventional frame for the ETRS89 system



Introduction

- ETRS89 introduced partly as an answer to user needs to harmonize geo-referencing applications throughout Europe.
- Occasionally there have been coordinate shifts in successive realizations of ETRS89, derived from different ITRFyy (discussions at previous symposia!)
- ETRF2000 adopted as a "conventional" frame for ETRS89
- User groups and user requirements



Therefore, the EUREF TWG has formed:

EUREF Working Group on Future Development of ETRS89

Input from you, especially regarding your expectation on ETRS89, are very welcomed!

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Objectives

1. Clarify the definition of ETRS89 and its target groups

- Documentation on ETRS89; how it has been used in the past, and how it should be used in the future
- How to treat intraplate velocities in terms of ETRS89
- Use of ETRS89 in the scientific community
- 2. Propose to the TWG approaches for the long-term maintenance of the ETRS89
 - With special attention to the potential benefit from EPN!



Life without ETRS89!!!!



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ETRS89 definition

The IAG Sub-commission 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).



The formula for transformation from ITRFyy to ETRFyy

(Boucher&Altamimi Memo v7, chapter 3)

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



The physical idea..

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

The rotation rates are used to compute the rotations of the Eurasian plate between two epochs, epoch of observation, tc, and 1989.0, when the system ETRS89 was fixed to the Eurasian plate.

Applying these rotations means that the axes are rotated back to their estimated directions at 1989.0

The knowledge about the rotation of the Eurasian plate has been improved during the years, therefore the used values have also changed



The role of translation

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

The translation vector accounts for the difference betweens the origin of ITRFyy and the origin of ITRF89

This translation vector is a computational effect due to different stations, observations, techniques, models, etc. between the different realizations of ITRS



In practice

- Compute GNSS positions in "latest ITRFyy, epoch of observation, tc"
- Convert these positions to ETRS89

ITRF2005	 ETRF2005
ITRF2000	 ETRF2000
ITRF97	 ETRF97



"Jumps" between successive realizations

Small (typically <1cm) shifts visible from EPN, due to used ITRFyy (ETRS89 raw time series) Example from (VIS0) and (MEDI)





"Jumps" between successive realizations (2)





Use ETRF2000 as the conventional frame for the ETRS89 system





Use ETRF2000 as the conventional frame for the ETRS89 system (2)





How to compute

- Follow Boucher & Altamimi "Memo: Specifications for reference frame fixing in the analysis of a EUREF GPS campaign ", Version 7: 24-10-2008
- 2. Compiled parameters available in table 5;

 Table 5: Transformation parameters from ITRF2005 to ETRF2000 at epoch 2000.0

 and their rates/year

	T1	T2	T3	D	R1	R2	R3
	$\mathbf{m}\mathbf{m}$	$\mathbf{m}\mathbf{m}$	mm	10^{-9}	mas	mas	mas
	54.1	50.2	-53.8	0.40	0.891	5.390	-8.712
Rates	-0.2	0.1	-1.8	0.08	0.081	0.490	-0.792



How to compute (2)

$$T = \begin{bmatrix} T1 \\ T2 \\ T3 \end{bmatrix} \dot{T} = \begin{bmatrix} \dot{T}1 \\ \dot{T}2 \\ \dot{T}3 \end{bmatrix} = \begin{bmatrix} R1 \\ \dot{T}2 \\ \dot{T}3 \end{bmatrix} = \begin{bmatrix} R1 \\ R2 \\ R3 \end{bmatrix} \dot{R} = \begin{bmatrix} \dot{R}1 \\ \dot{R}2 \\ \dot{R}3 \end{bmatrix} = \begin{bmatrix} \dot{R}1$$

$$X_{ETRF\,2000} = X_{ITRF\,2005} + T_{tc} + \begin{bmatrix} D_{tc} & -R3_{tc} & R2_{tc} \\ R3_{tc} & D_{tc} & -R1_{tc} \\ -R2_{tc} & R1_{tc} & D_{tc} \end{bmatrix} \cdot X_{ITRF\,2005}$$



TWG recommendation (Memo v7),

"In order to harmonize future realizations of the ETRS89 overall Europe, the EUREF Technical Working Group (TWG) recommends not to use the ETRF2005 and rather to adopt the ETRF2000 as a conventional frame of the ETRS89 system." ...

..."Consequently, the European countries who will adopt the ETRS89 or want to redefine their national systems are encouraged to adopt the ETRF2000 frame and to express their station coordinates in that frame."