

EduServ 10
Distance elearning courses
Spring 2012

Course: Terrestrial Reference Frames: application to the realisation of the European Reference System (ETRS89)

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Education level of students: Master degree, PhD students, PhD

Minimum number of students: 10

Prerequisites: Good level in Geodesy, least squares, GPS processing with scientific software

Context of the course: The practical application of this course is to be placed in the context of the optimal implementation of the ETRS89 by the European National Mapping and Cartographic Agencies (NMCAs). Using data collected at GNSS permanent stations and analysed by scientific software packages allows precise determination of their coordinates, yet to be optimally expressed in the ETRS89. This goal could be achieved by following EUREF guidelines and geodetic procedures that will be described during the course.

Outline of the main contents of the course:

The course will comprise the following theoretical aspects:

- Theoretical concepts of terrestrial reference systems and their realisation by terrestrial reference frames
- 7 and 14 similarity transformation
- Description of the International Terrestrial Reference System (ITRS) and its realisation by the International Terrestrial Reference Frame (ITRF)
- Description and realisation of the European Terrestrial Reference System (ETRS89) and its mathematical relationship with the ITRS/ITRF
- Mathematical equations for combination of terrestrial reference frames, based on 7 and 14 similarity transformation:
 - Observation equations
 - Linearised unknowns
 - Construction of the normal equation
 - Constraint handling, including types of constraints used for reference frame definition
- Analysis of time series of station positions and their stacking for the determination of long term solutions of station positions at a reference epoch and station velocities

The numerical applications will cover the following aspects, using CATREF software developed for the ITRF combination activities:

- Brief history of ITRF combination activities and the ETRS89 realisations at the European level as well as at the level of the National Mapping Agencies
- Comparisons and estimation of transformation parameters between quasi-instantaneous as well as long-term reference frame solutions
- Time series analysis and stacking of the European Permanent Network (EPN) weekly solutions provided in SINEX format
- Numerical application for the realisation of the ETRS89 by a weekly solution as well as using long-term solutions of the EPN

In particular, the following aspects will be addressed:

- Understanding of the CATREF software philosophy
- Removal of constraints for the purpose of combination.
- Rank deficiency of the Normal Equation.
- Possible types of reference frame definition for the combined solution.
- Usage of Minimum and Internal Constraints approach for reference frame definition
- Variance component estimation
- Weighting of individual input solutions
- Quality evaluation: analysis of the results: residuals, outliers, discontinuities in the time series, RMS, WRMS,
- Visualisation of time series of station position residuals