



CROPOS – Current Status and Implementation of T7D Transformation Model

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Introductory remarks

This lecture builds on:

- *"Introduction and implementation of ESRS in Croatia"* (T. Bašić). Zveza geodetov Slovenije, 37. Geodetski dan, "S koordinatami v Evropi", 16.11.2007, Hotel Perla, Nova Gorica, Slovenia; *Geodetski vestnik*, ISSN: 0351-0271, Volume 51, Issue 4, 751-762, UDK: 528.236(497.5).
- *"Unique transformation model and a new Croatian geoid model"* (T. Bašić). CGS&SGA "1st CROPOS Conference", Zagreb, 8-9, June 2009. SGA: Reports on the scientific and professional projects 2006-2008, Ed. M. Bosiljevac, 5-21, Zagreb 2009.
- *"CROPOS – positioning easier than ever"* (M. Marjanović & T. Bašić), INF-0002, Trimble Dimensions 2010 conference "Converge, Connect and Collaborate" (5th), 8-10, November 2010, Las Vegas, USA.

CROPOS – launched on 9th of Dec. 2008

- CROPOS is a reference GNSS network of permanent stations of the Republic of Croatia enabling its users to determine a location with the GNSS technology in the real time with an accuracy of 2 cm for position and 4 cm in height on the entire Croatian territory

Importance:

- Introduction and application of new geodetic reference systems (datums) of the Republic of Croatia
- Homogenization of coordinate system
- Same accuracy of measurement and coordinate determination at the entire territory
- Utilization of the unique measurement methods - standardization in performing of geodetic works
- Faster and more efficient performing of geodetic works

CROPOS – Basics

- Collecting the data from the reference stations that are placed at 30 locations at the territory of the Republic of Croatia
- Reference station real-time GNSS data exchange with the neighbouring countries
- Networking and computing the real-time correction parameters
- Distribution of measuring data and real-time correction parameters to the users
- Monitoring of the system operation and users support
- 24/7/365 service availability

CROPOS – Current Status

- Hardware upgrade: data storage (+ 2 TB), tape backup (1 GB)
- Software update: Trimble GPSNet Ver. 2.730, GNSS receiver firmware Ver. 4.03
- Implementation of system for remote administration and system control of servers
- New application for user administration and charging, additional system usage statistics
- Processing of RINEX data in order to monitor and analyse stability of CROPOS reference frame – GPS week solutions

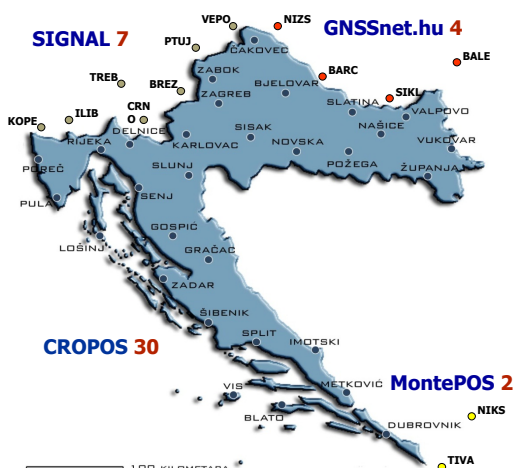
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CROPOS – Current Status (43 stations)

www.cropos.hr

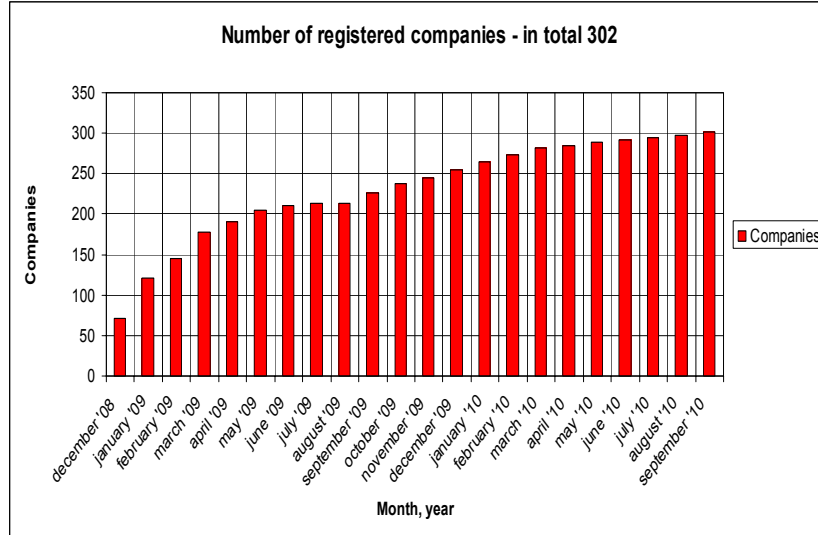


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CROPOS Statistics

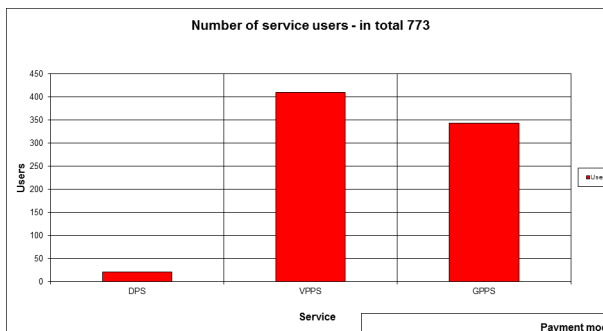


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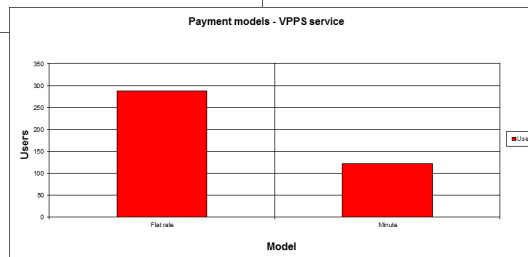
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CROPOS Statistics ...



Average of 40 users connected at the same time during working hours (max. 79)

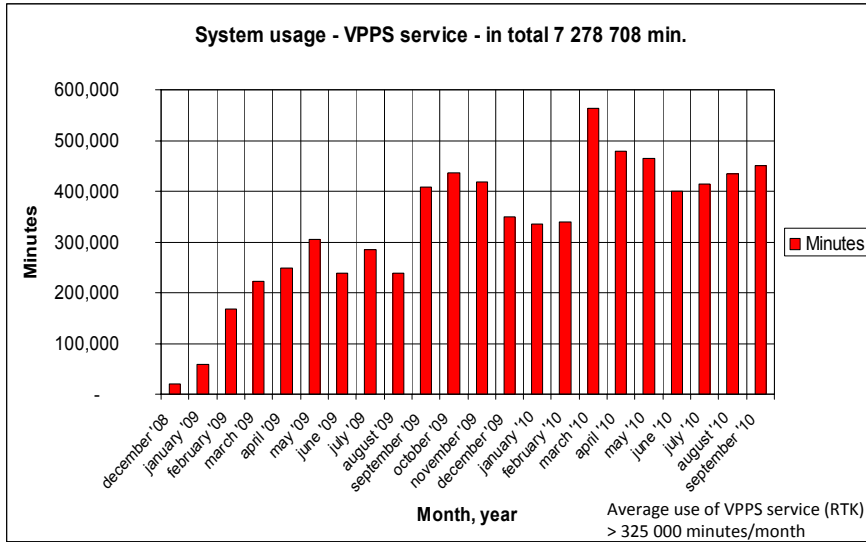


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CROPOS Statistics ...

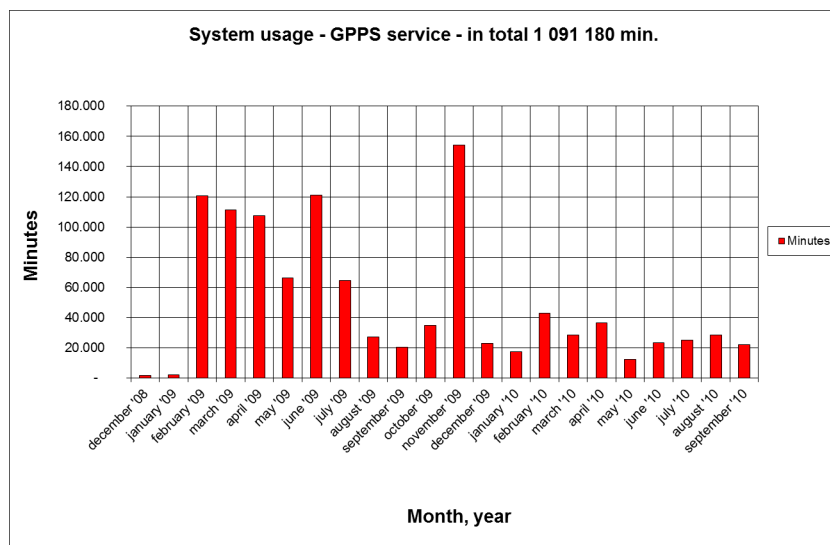


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CROPOS Statistics ...



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HRG2009 – New Geoid Solution

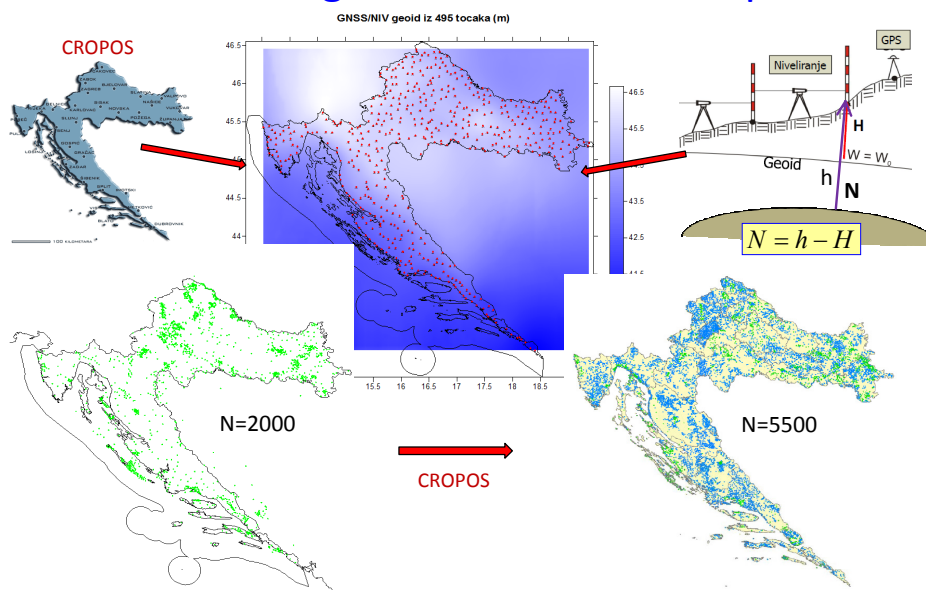
- Data:
 - Earth's gravity field - free air gravity anomalies (~ 30000)
 - Satellite altimetry in the Adriatic Sea (400)
 - Global geopotential model EGM2008
 - High frequencies field structures modeled with the help of 3" x 3" Shuttle Radar DEM's
 - Discrete geoid undulations obtained by GNSS/leveling on the mainland (495)
- Least squares collocation calculation technique
- Geoid surface point raster 30" x 45"
- Internal accuracy $\sigma = 2 - 3$ cm
- Absolute accuracy based on comparison with GNSS/Leveling values (59 points – not included in model); $\sigma = \pm 3.5$ cm

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GNSS/Leveling and transformation points

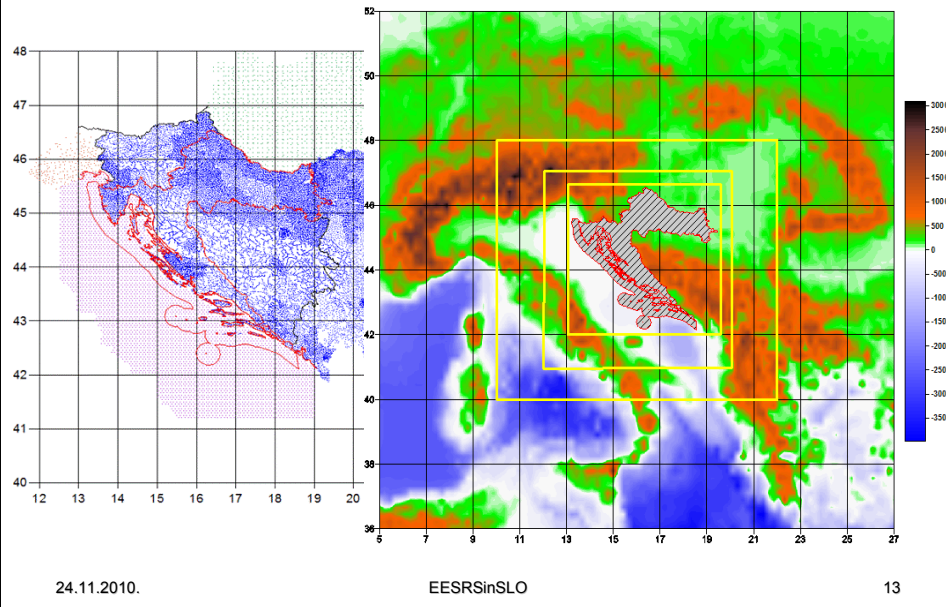


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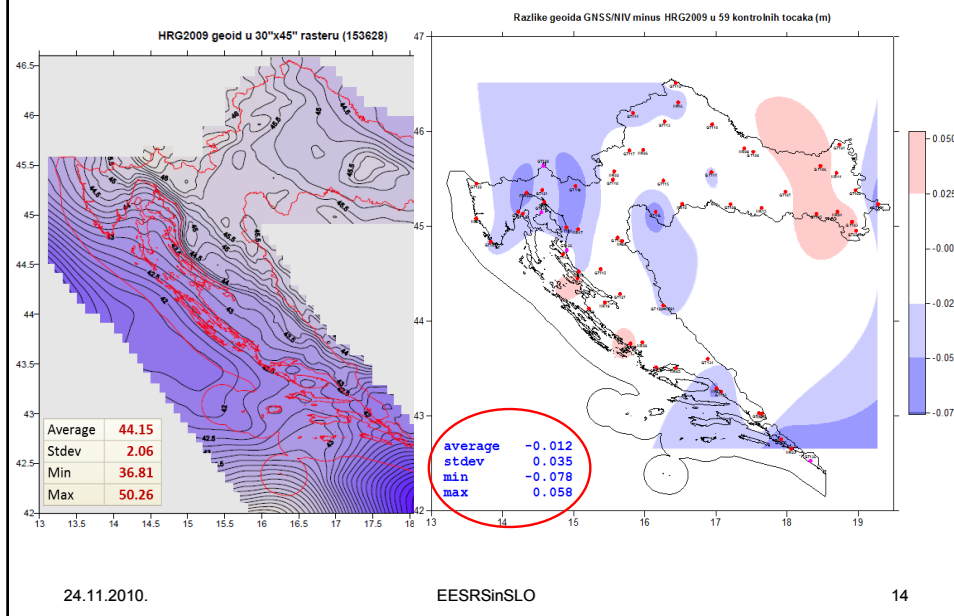
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Gravity data and DTM (3"x3" i 1'x1' SRTM)



HRG2009



T7D – new transformation model

- ❖ Unique transformation model HTRS96<>HKDS - uniform, reliable and simple transformation system, available to all users
- ❖ GRID transformation for the whole Croatian territory, consisting of 7-parameter transformation and a proper raster predicted values of distortion, both in plane coordinates and height

Transformation Problems:

➤ ETRF00 (R05), 1989.0 (ETRS89)

- GRS80
- φ, λ, h (X, Y, Z)
- Ellipsoidal height: h

➤ HTRS96/TM

- GRS80
- N, E, H (Transverse-Mercator projection)
- Orthometric height: $H = h - N$ (HTRS71)

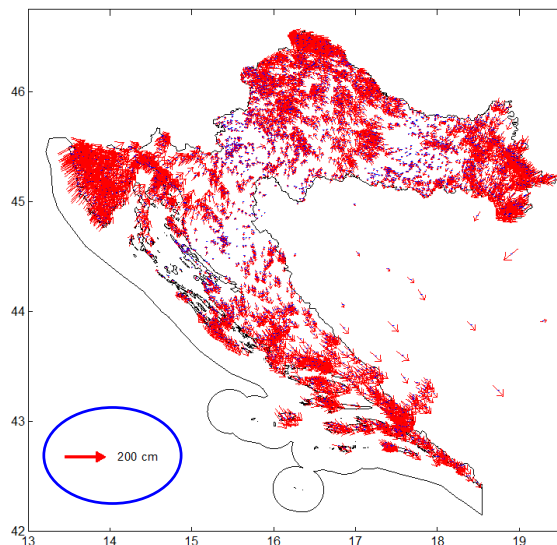
➤ HDKS

- Bessel
- y, x, H (Gauss-Krüger projection)
- Orthometric height : $H = h - N$ (Trieste)

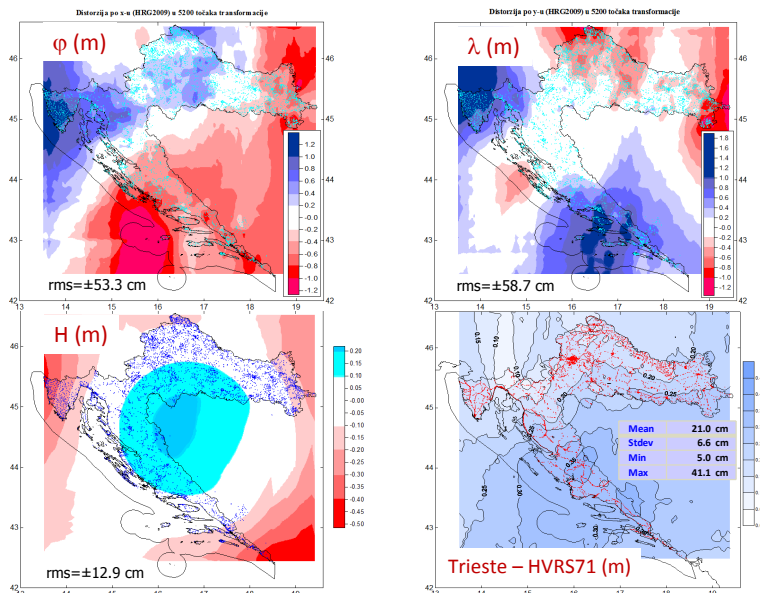
T7

N = 5200	Transformation parameters	Accuracy estimation ($m_0=0.804$ m)
Tx	-546.62 m	± 0.59 m
Ty	-162.38 m	± 0.66 m
Tz	-469.48 m	± 0.59 m
Rx	5.905 "	± 0.019 "
Ry	2.074 "	± 0.022 "
Rz	-11.510 "	± 0.019 "
μ	4.439 ppm	± 0.075 ppm

σ_φ	± 0.53 m
σ_λ	± 0.59 m
σ_h	± 0.13 m
2D	± 0.79 m
3D	± 0.80 m



Positional and height distortion



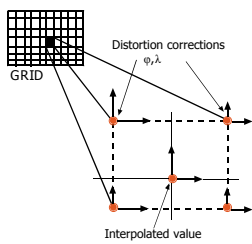
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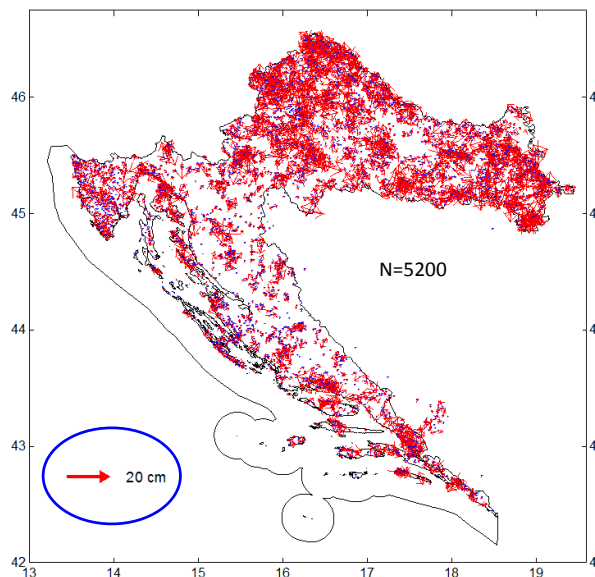
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T7D

7P + ($\delta\varphi$, $\delta\lambda$)
(bi-linear interp.)



σ_{φ}	±0.041 m
σ_{λ}	±0.041 m
σ_h	±0.001 m
2D	±0.058 m
3D	±0.058 m

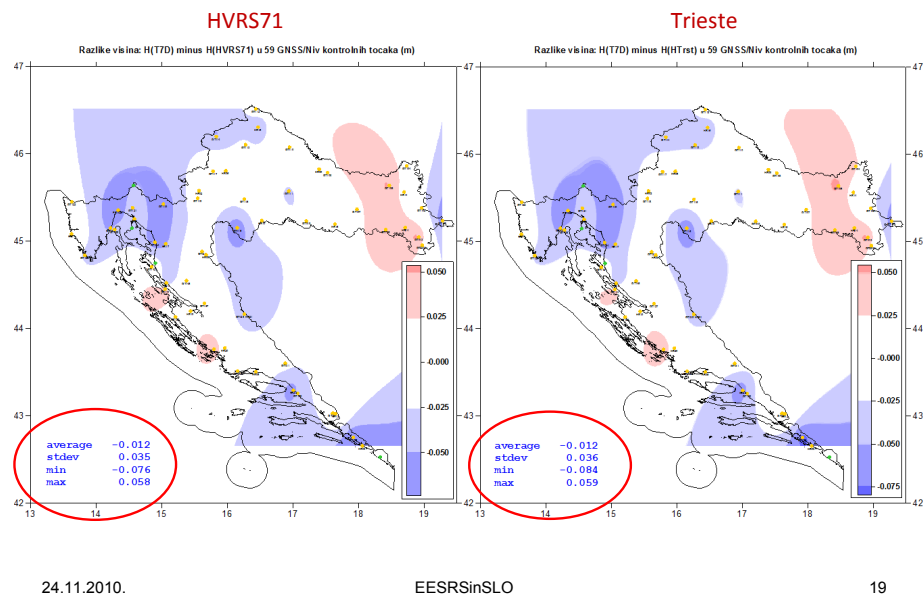


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Control of height transformation using T7D model



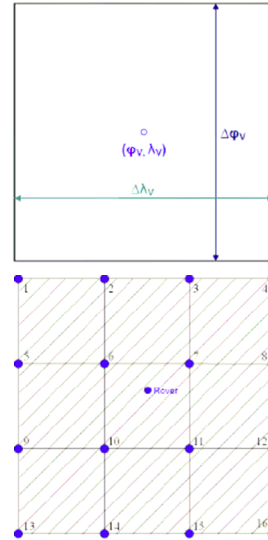
Upgrading CROPOS

- **Implementation of T7D model in CROPOS** in order to facilitate on-line transformation of coordinates in real time (on site)
- **Trimble Transformation Generator (TTG)**: standalone application, installed on a separate server, which allows the preparation RTCM 3.1 transformation messages 1021 and 1023 for users (it is possible to select multiple types of transformation depending on user choice – *source table*)

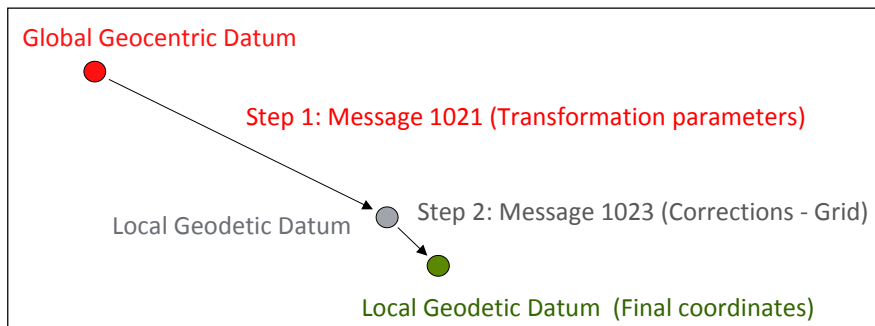
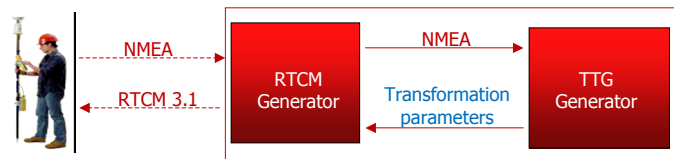
Implementation of T7D in CROPOS

TTG new services > update CROPOS source table

- CROPOS_VRS_HTRS96
HTRS96/TM – on-line geoid model
- CROPOS_VRS_HDKS
HDKS – datum transformation & on-line geoid model
- ❖ RTCM 3.1
- Message 1021
 - 7 parameter transformation
(Tx, Ty, Tz, dM, Rx, Ry, Rz)
- Message 1023
 - Transformation corrections
($\delta\lambda$, $\delta\lambda$ or δN)

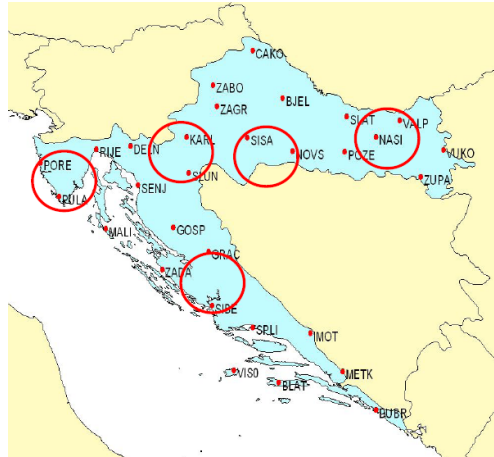


Transformation Data Flow



Testing of on-line geoid model

- 1000 points (September/November 2010)
- Comparison of heights: on-line geoid model vs post-processing geoid model



First results

ID	H (m) CROPOS	H (m) T7D	ΔH (mm)
1011719	400.124	400.125	-1
1010883	387.532	387.532	0
1011777	211.111	211.111	0
1018843	90.913	90.912	+1
1018868	151.783	151.784	-1
1005817	94.426	94.425	+1
1021685	35.003	35.003	0
1021683	57.500	57.499	+1
1021830	221.837	221.838	-1

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Future Activities

- Official use of on-line geoid model – January 1st, 2011
- Preparing of grid files for positional datum transformation and their testing in on-line mode (Spring 2011)
- Processing of RINEX data in order to monitor and analysis stability of CROPOS reference frame – GPS week solutions
- Use of CROPOS data and processing results in geodynamic research
- Organization of “2nd CROPOS User Conference”

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Conclusion

- CROPOS project – successful story
- User trust – reliable and accepted system
- “With CROPOS positioning easier than ever”

HVALA – THANKS !