State Geodetic Administration
Gruška 20 / 10 000 Zagreb
www.dgu.hr, www.cropos.hr

CROPOS – on-line transformation services

M. Marjanović, T. Bašić

EUREF Symposium 2011
Chisinau, 25-28 May 2011.

Coordinates

- 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 (HVRS71)

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

Transformation problem

- Transformation between geodetic datums: HTRS96 (Ellipsoid GRS80) < > HDKS (Ellipsoid Bessel)
- Local transformation (smaller areas): Satisfying accuracy – but coordinate differences in border areas (up to 20 cm) – inhomogeneity of trignometric network
- Global transformation (state level)

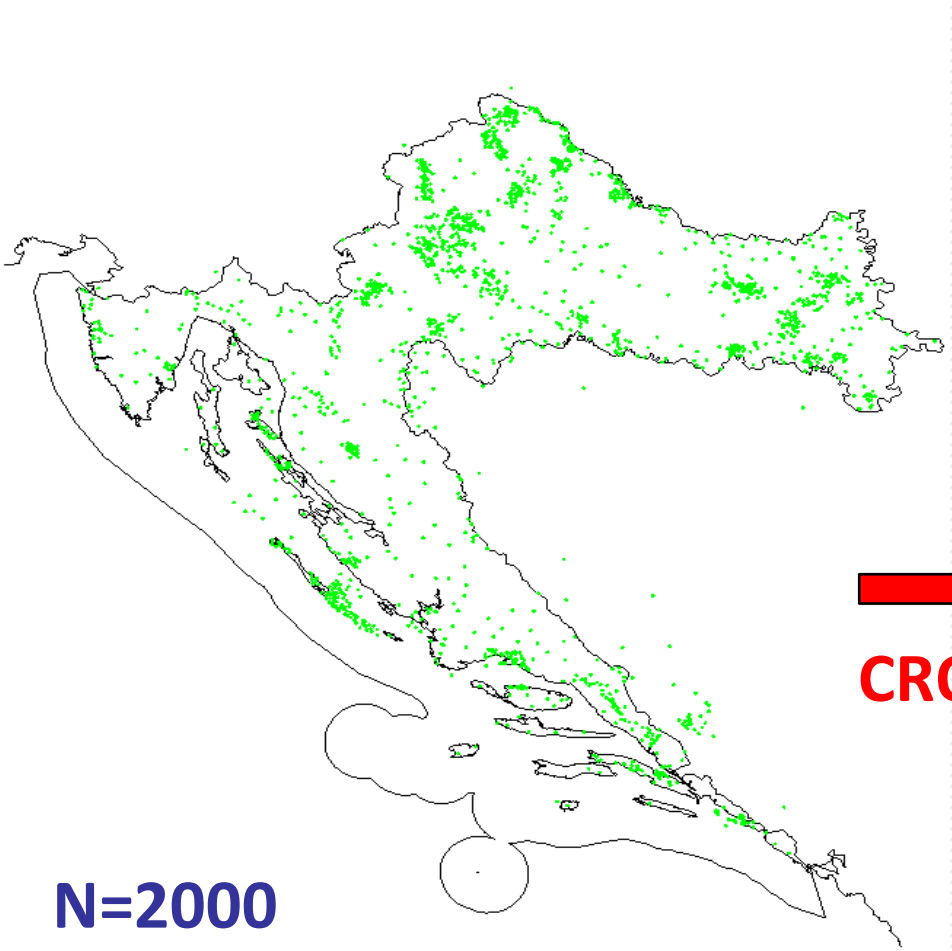
Transformation method	Accuracy
Molodensky	5 m
3D – 7 parameters	1 m
GRID	0.1 – 0.3 m

T7D – new transformation model

- Unique transformation model HTRS96 <> HDKS - uniform, reliable and simple transformation system, primarily available to all users

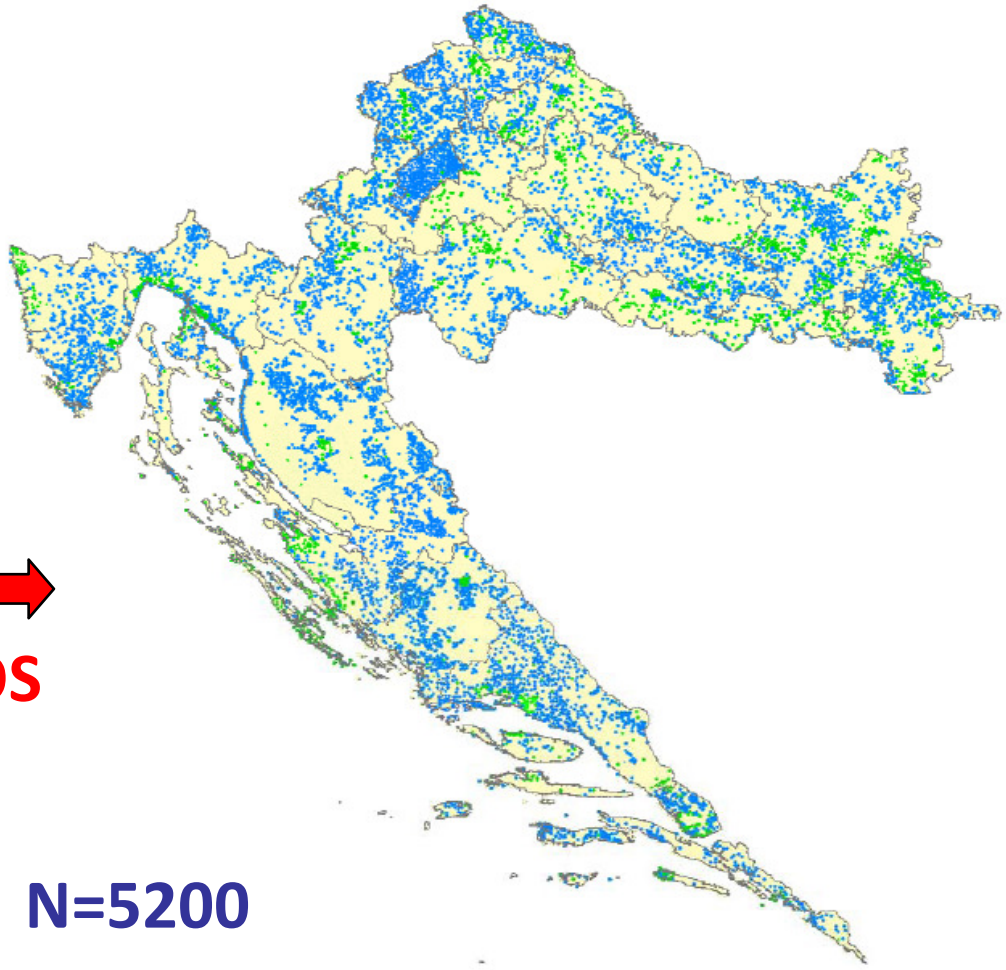
- GRID transformation for the whole Croatian territory, consisting of 7-parameter transformation and a proper raster predicted values of distortion, both in plane coordinates and height

Identical points



N=2000

CROPOS

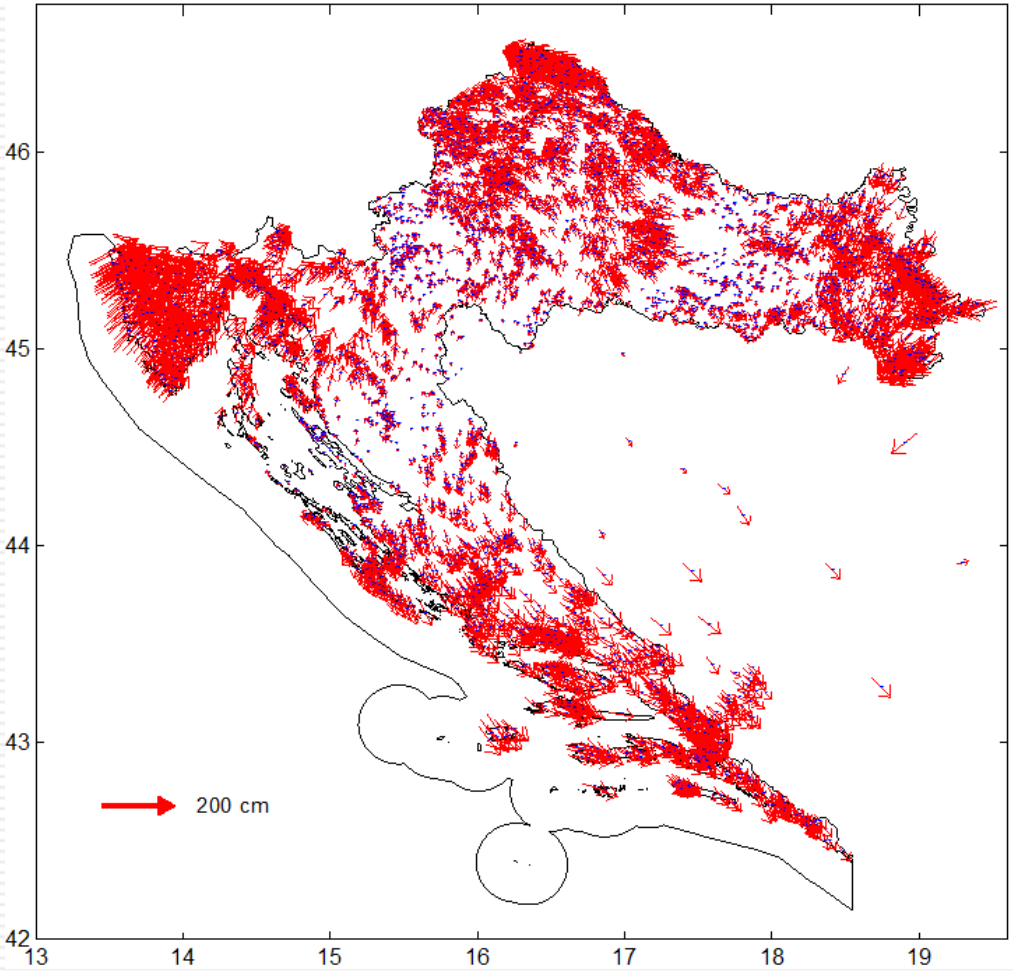


N=5200

T7

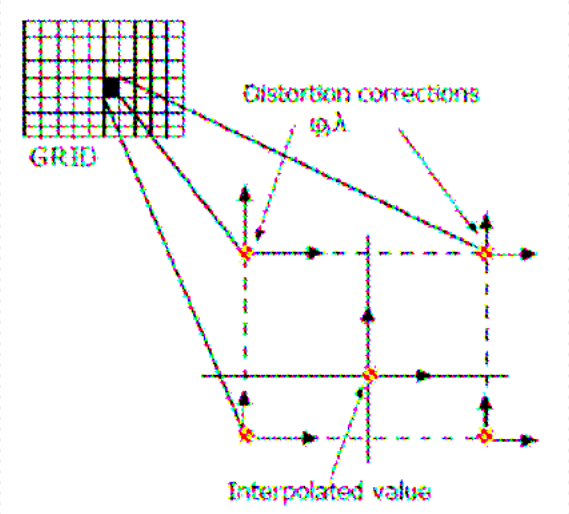
N = 5200	Transformation parameters	Accuray estimation (m_0=0. 804 m)
Tx	-546.616 m	±0. 593 m
Ty	-162.375 m	±0. 657 m
Tz	-469.482 m	±0. 586 m
Rx	5.90498 ''	±0. 0189 ''
Ry	2.07397 ''	±0. 0218 ''
Rz	-11.50994 ''	±0. 0187 ''
μ	4.43885 ppm	±0. 075 ppm

σ φ	±0. 533 m
σ λ	±0. 587 m
σ h	±0. 129 m
σ 2D	±0. 793 m
σ 3D	±0. 804 m

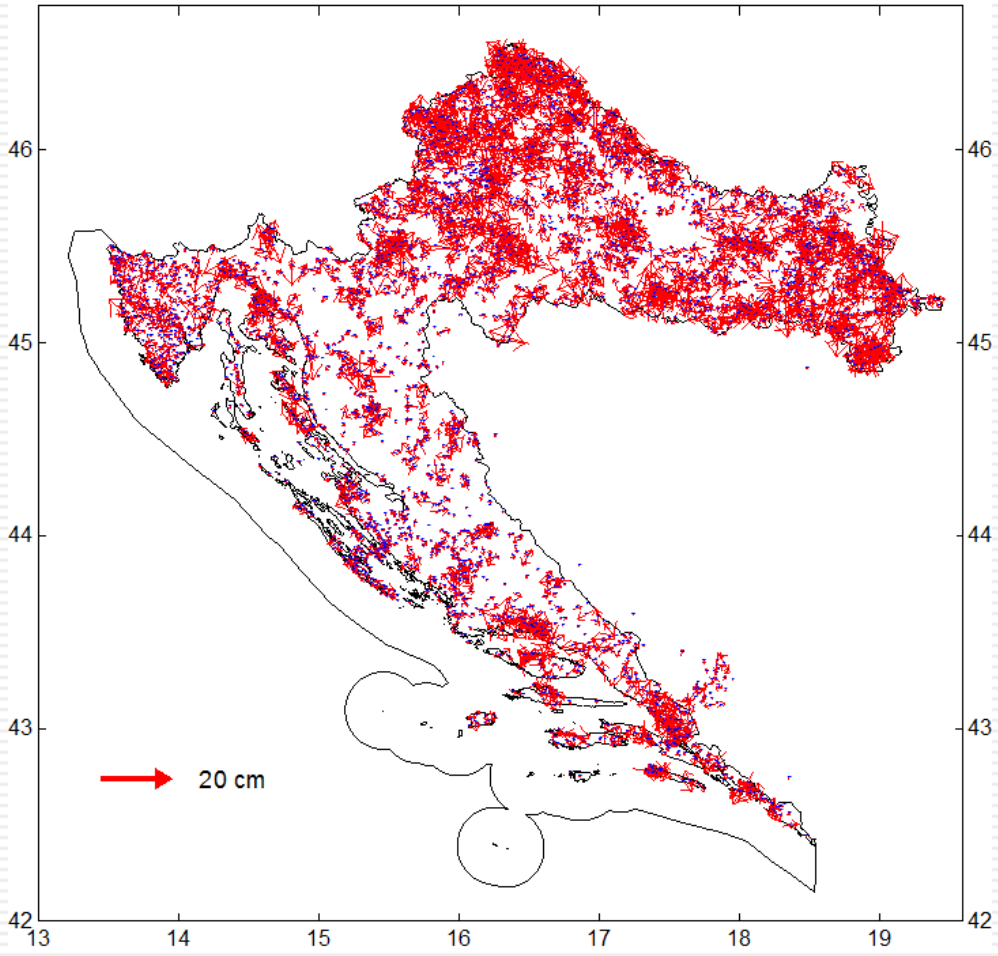


T7D (7P + D)

δφ, δλ (bi-linear interpolation)



σ φ	±0. 041 m
σ λ	±0. 041 m
σ h	±0. 001m
σ 2D	±0. 058 m
σ 3D	±0. 058 m



HRG2009 – new geoid solution

- First geoid solution – HRG2000
- Earth's gravity field - free air anomalies (over 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
- Internal accuray $\sigma = \pm 0.03$ m; Absolute accuracy based of comparison of GNSS/Leveling results (59 points – not included in model) $\sigma = \pm 0.04$ m

Implementation of models in CROPOS

- Trimble Transformation Generator
- New services > update CROPOS source table
  1) CROPOS_VRS_HTRS96
     HTRS96/TM – on-line geoid model
  2) CROPOS_VRS_HDKS
     HDKS – datum transformation &
     on-line geoid model
- RTCM 3.1

RTCM 3.1 format

No.	Description
1001	GPS L1
1002	
1003	GPS L1/l2
1004	
1005	Reference station coordinates
1006	
1007	Antenna information
1009	
1009	GLONASS L1
1010	
1011	GLONASS L1/L2
1012	
1013	System parameters
1014	RTK – message (GNSS network)

No.	Description
1015	RTK – ionosphere correction
1016	RTK – geometrical correction
1017	RTK – combination (iono. + geom.)
1018	-
1019	Satellite orbits data
1020	
1021	Transformation parameters
1022	Transformation parameters
1023	Transformation corrections
1024	Transformation corrections
1025	Projection (definition)
1026	Projection (definition)
1027	Projection (definition)

- Message 1021 - Transformation parameters (Tx, Ty, Tz, dM, Rx, Ry, Rz)
- Message 1023 - Transformation corrections (δφ, δλ or N)

TTG input data

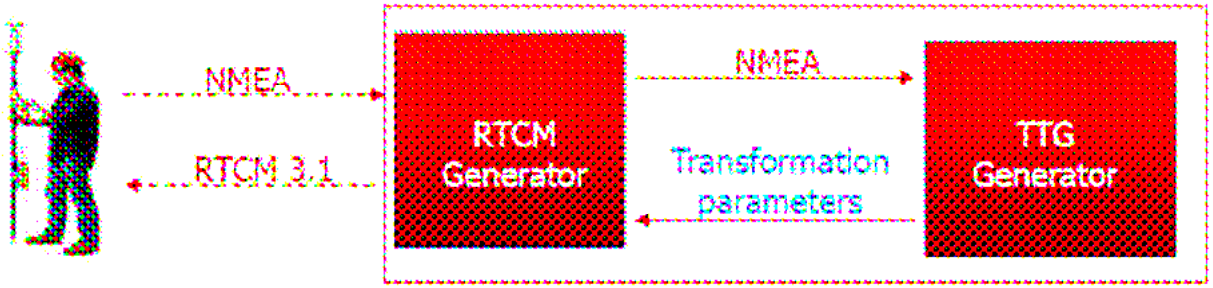
1) CROPOS_VRS_HTRS96

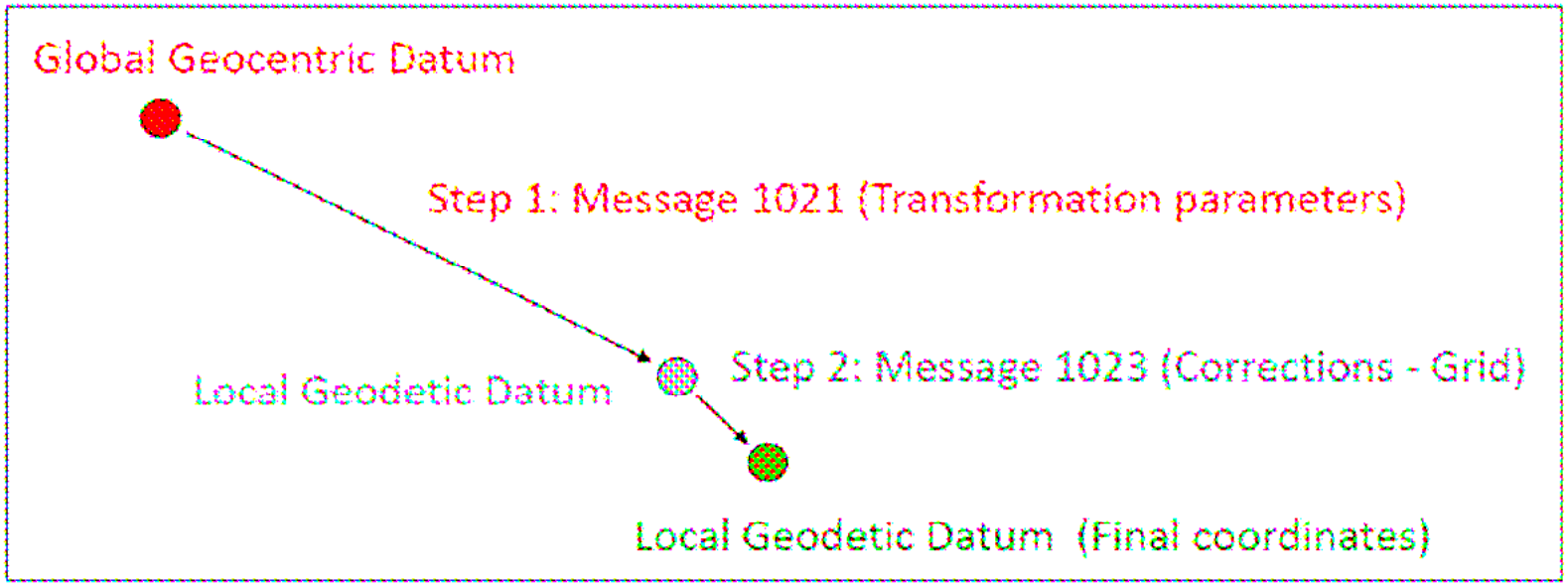
- Start ellipsoid GRS80 > Goal ellipsoid GRS80 (a,b)
- Transformation parameters (7P = 0.0)
- Grid files: Geoid – HVRS71 (undulations N)
  Distortion (corrections = 0.0)

2) CROPOS_VRS_HDKS

- Start ellipsoid GRS80 > Goal ellipsoid Bessel (a, b)
- Transformation parameters (7P – TX,TY,TZ,M,RX,RY,RZ)
- Grid files: Geoid – Trst (undulations N)
  Distortion (corrections)

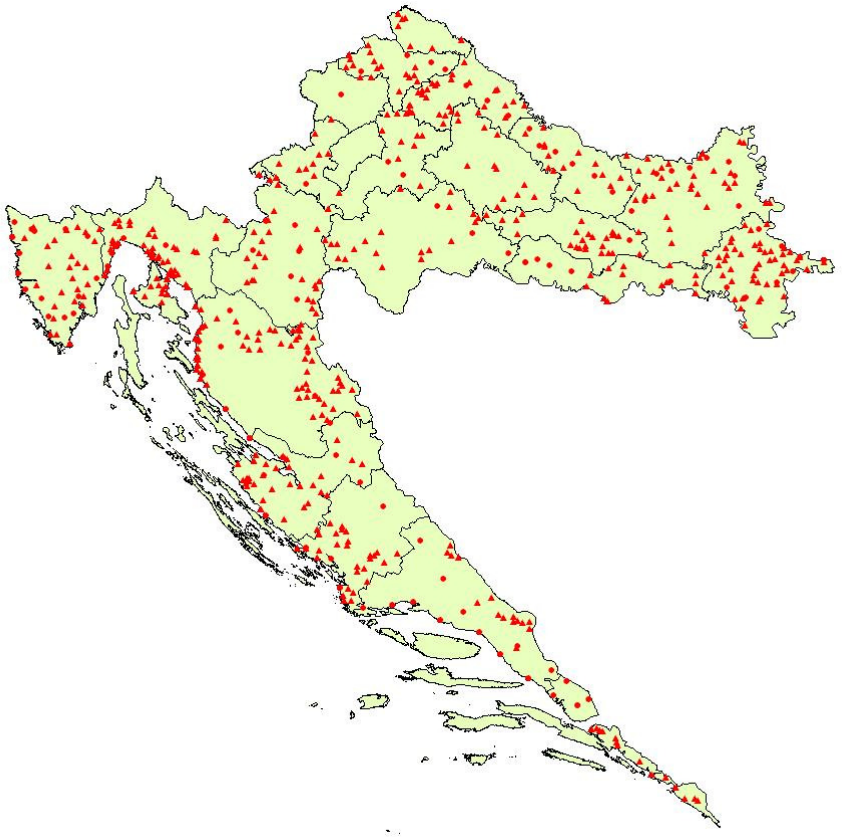
Transformation Data Flow





CROPOS_VRS_HTRS96

- Field test measurements on 604 points (September-November 2010)
- Comparison: post-processing vs on-line results
- Differences 0, +1 mm, -1 mm



- January 3rd, 2011

CROPOS_VRS_HDKS

- Service implemented in CROPOS

- 1000 points (March-May 2011)
- First testing results OK
- Comparison of results: on-line transformation vs post-processing transformation results

- Official use June/July 2011

Conclusion

- Measurements and results in unique official global and local reference frame
- It is not necessary to measure identical geodetic points and compute transformation parameters
- Faster and more efficient performing of geodetic works