

GNSS network of Uzbekistan: achievements, prospects and challenges

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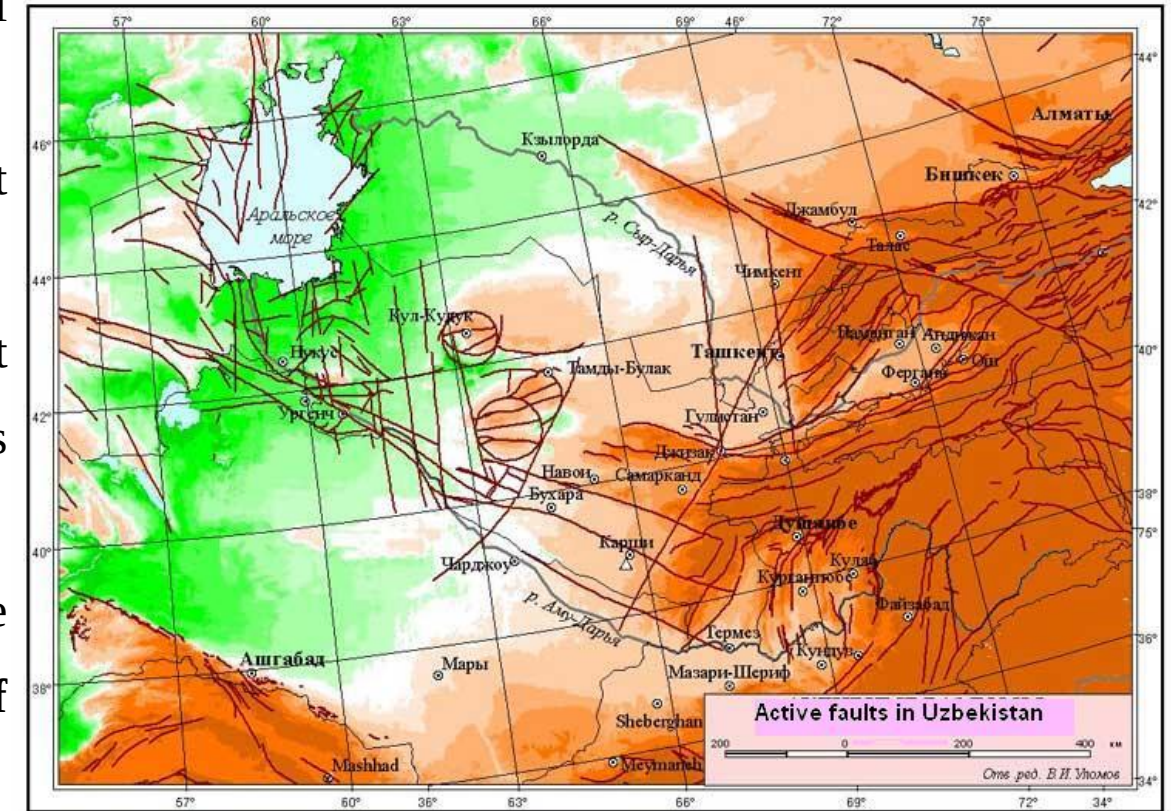
Outline

- 1. Introduction: drivers for datum modernisation**
- 2. GNSS network and first processing results**
- 3. Transformation parameters between local and geocentric datums**
- 4. Height transformation using precise geoid models**

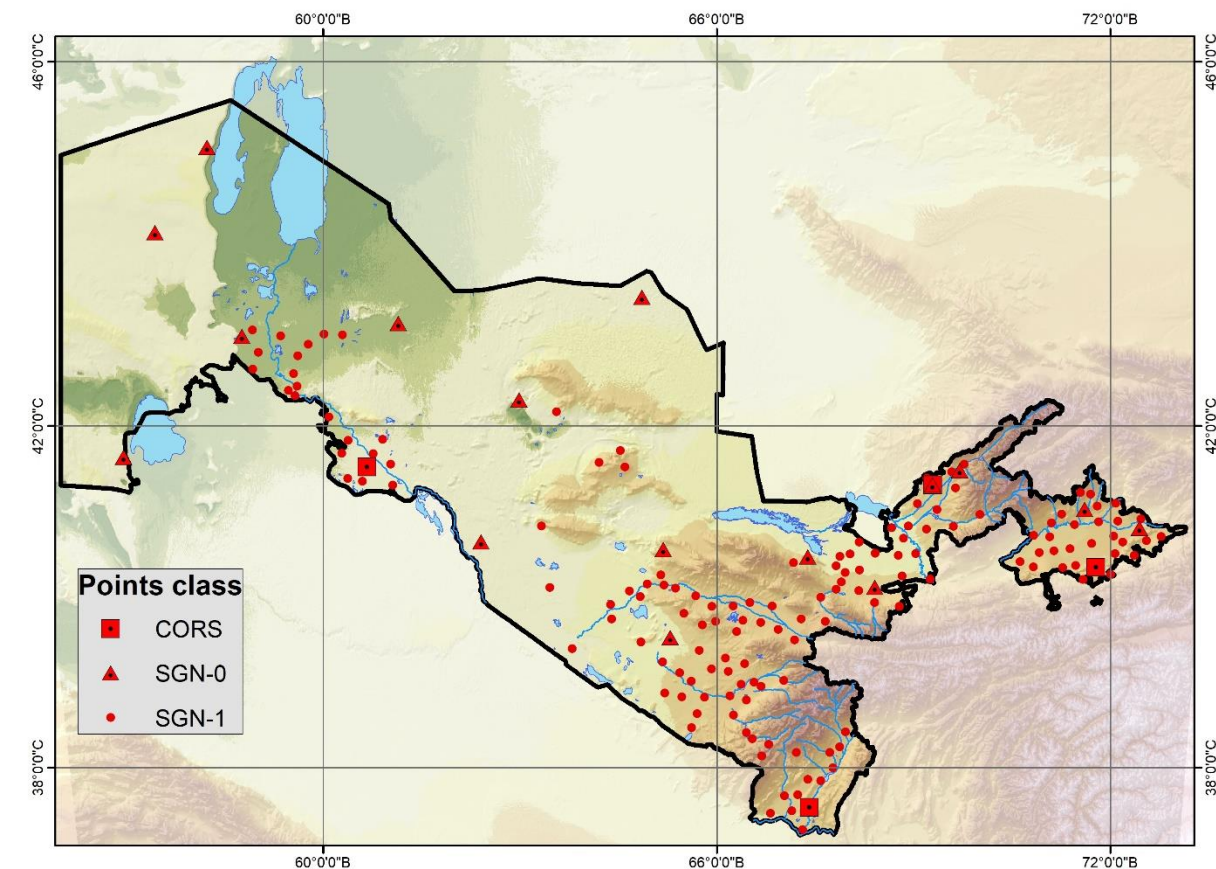


The drivers for new datum development: *remove existing distortions in current old datum*

- ❑ The Coordinate System of 1942 (CS42) has been our national datum since its adoption in 1946, providing fundamental positioning infrastructure for Uzbekistan.
- ❑ Vertical coordinates are referred to the Baltic Normal Height Datum of 1977 (BHD)
- ❑ The general regional deformations in the north and the east countries made 20-30 m, local deformations on border of blocks of up to 10 m and more have been recorded
- ❑ The territory of Uzbekistan, lying across the Eurasia/India plate boundary, is subject to ground movements across the **country of 4-5 cm/year**, disregarding the effects of large earthquakes.



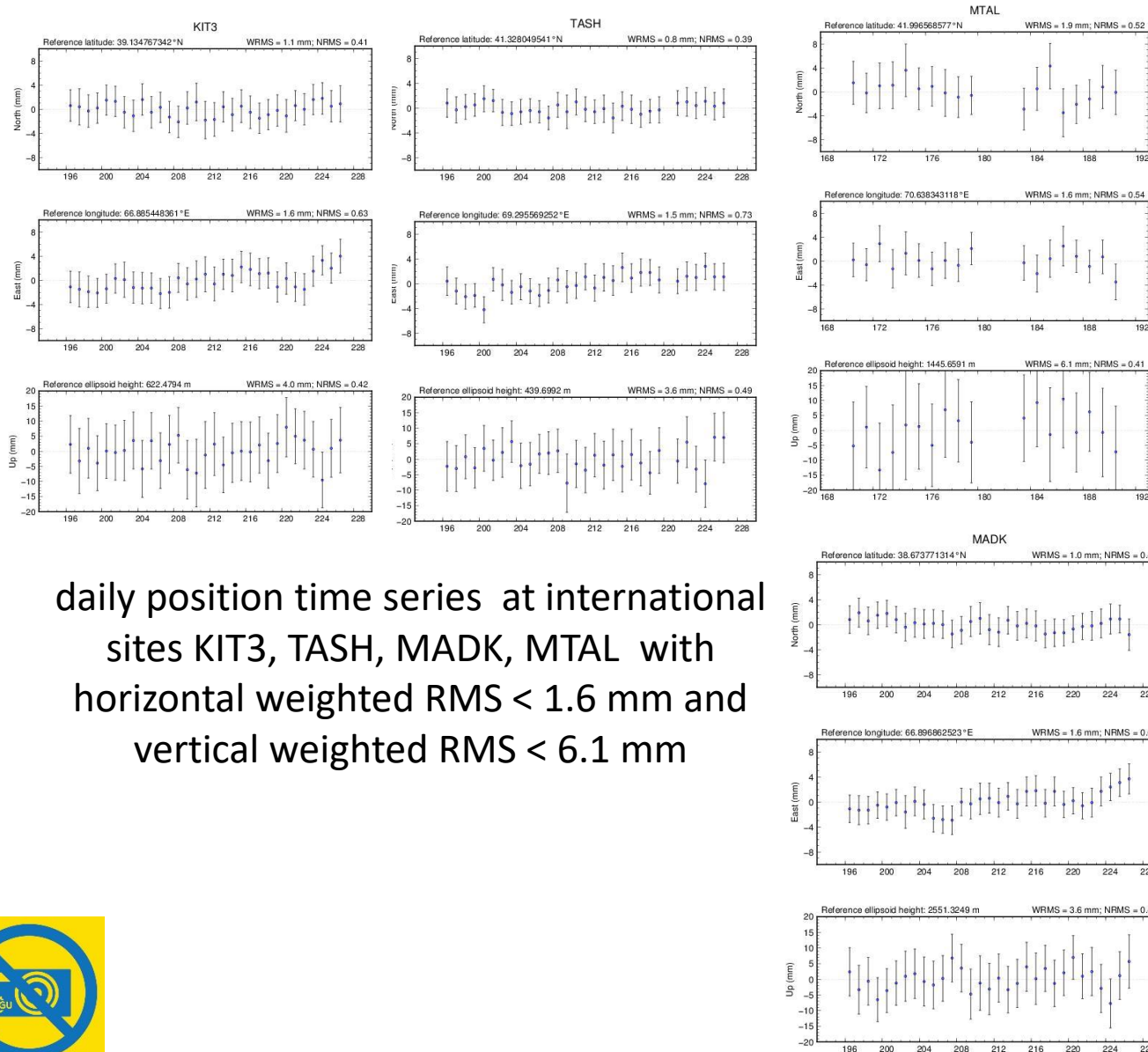
Technological improvements : GNSS network



Subnetwork	Measurements period	Number of stations	Distance between stations
Reference Station Network (RGN)	9.09.05- 9.11.05 15.08.06-28.09.06	4 MAGK (Tashkent) FARG (Fergana) JARQ (Dzharkurgan) URGA (Urgench)	500-800 km
Satellite geodetic network 0-th class points (SGN-0)	13.09.05 по 31.10.05 17.08.06 по 26.09.06	15	100-300 km
Satellite geodetic network 1st class points (SGN-1)	the network developed in stages from 2010 to 2014	145	30-150 km
Continuously Operating Reference Station System (CORS)	Since 2018	50	25-30 km



GNSS processing

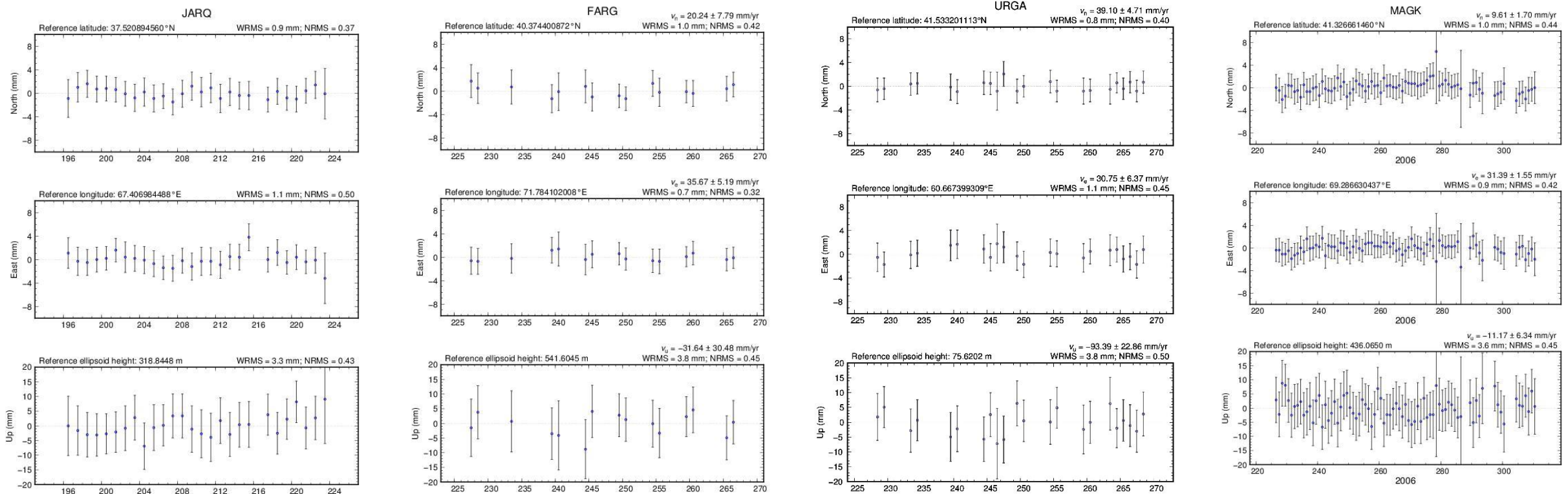


daily position time series at international sites KIT3, TASH, MADK, MTAL with horizontal weighted RMS < 1.6 mm and vertical weighted RMS < 6.1 mm

Software version	GAMIT/GLOBK 10.71
Reference frame	igb14
Fixed stations	artu, badg, chum, guao, hyde, iisc, irkt, kit3, mdvj, pol2, tash
Processing method	2 steps: free and network solution (DD)
Correlation strategy	LC (L3-P3)
Residual strategy	Outlier ejected
Ambiguity resolution method	"Wide Lane" & "Narrow Lane"
Orbit, EOP and satellite clocks	from IGS (final)
Elevation mask	10°
Interval	30 s
Ocean tide	FES2004
Atmospheric tide	NONE
Tropospheric model	VMF1
Ionospheric model	Global ionosphere
Adjustment method	Kalman filter

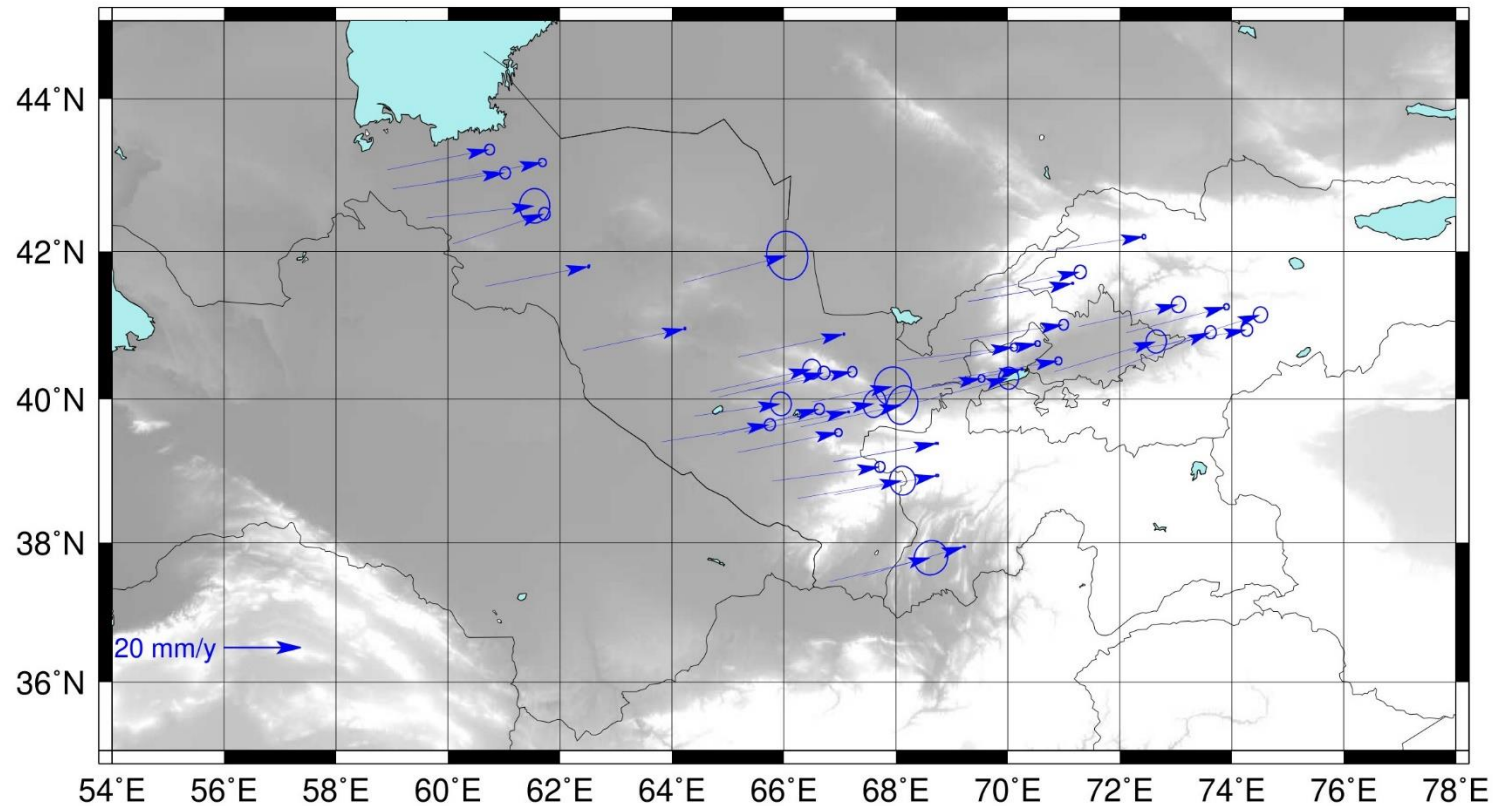


GNSS processing



daily position time series at reference sites (RGP) JARQ, FARG, URG, MAGK with horizontal weighted RMS < 1.0 mm and vertical weighted RMS < 3.8 mm.

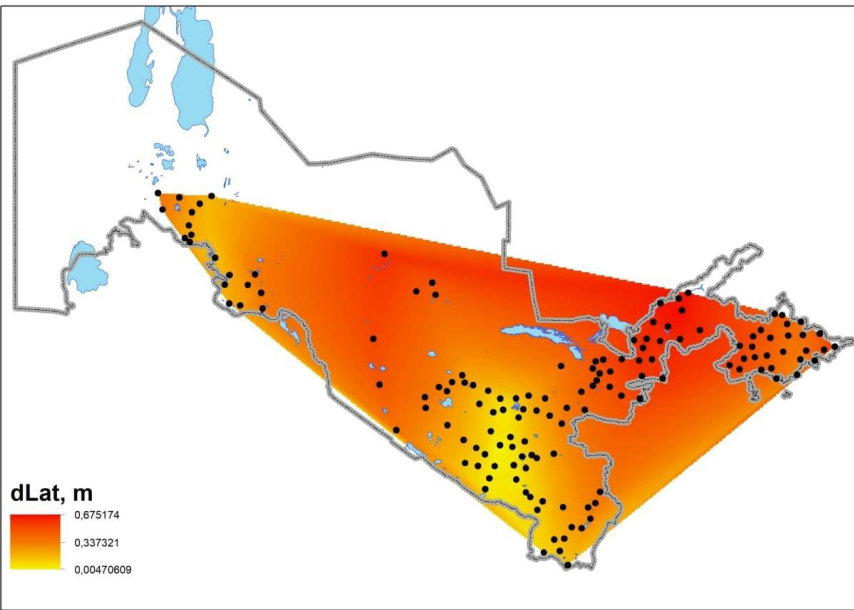
CORS stations velocities from 2018-2020



The resulting velocities at the 50 sites show uncertainties that range between 0.07 and 2.58 mm/yr for the horizontal components and between 0.31 and 8.9 mm/yr

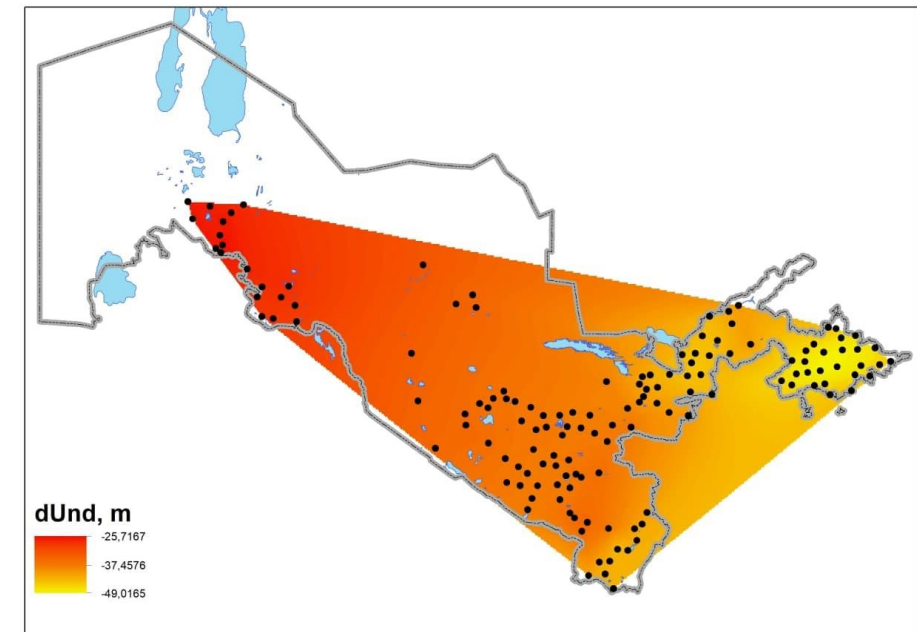
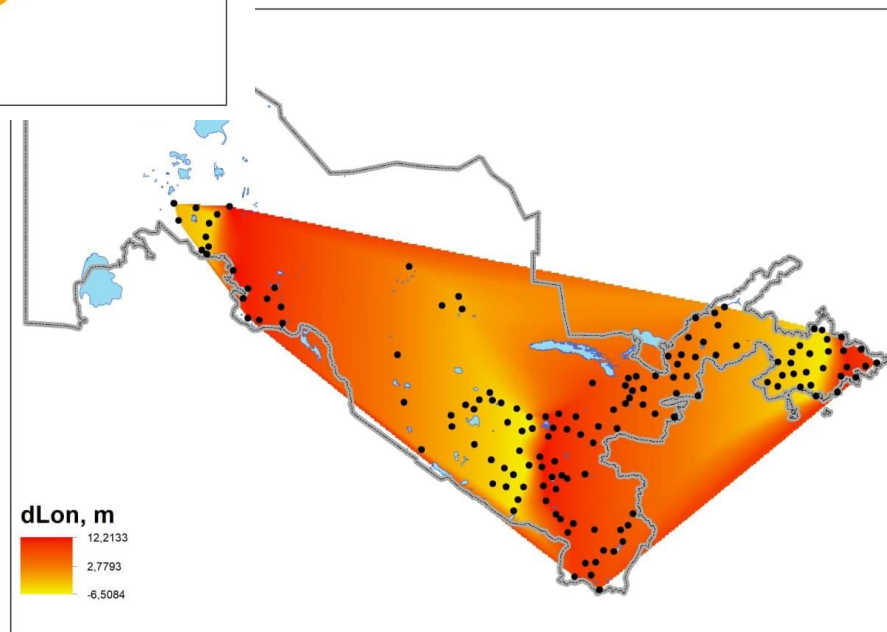
Dilbarkhon Fazilova, EGU 2021, Online/Onsite, 19-30 April, 2021

Deformation matrices between CS42 and WGS84

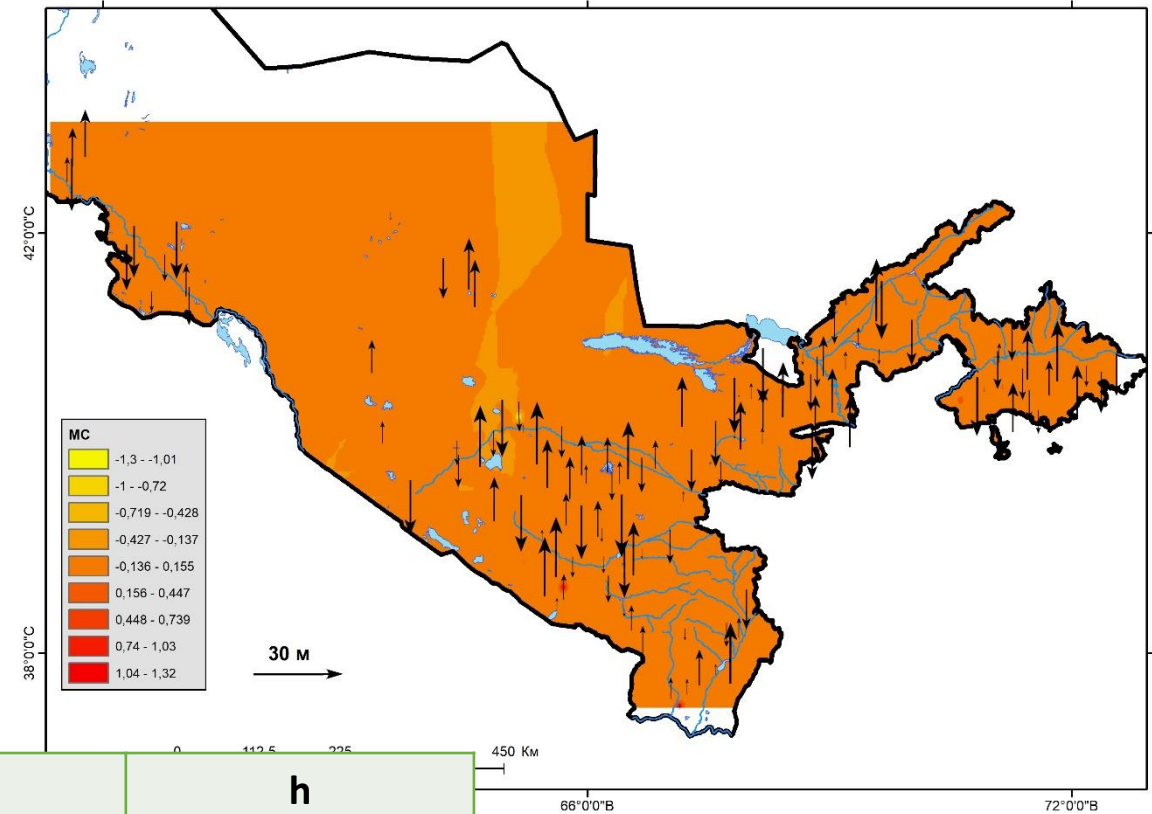
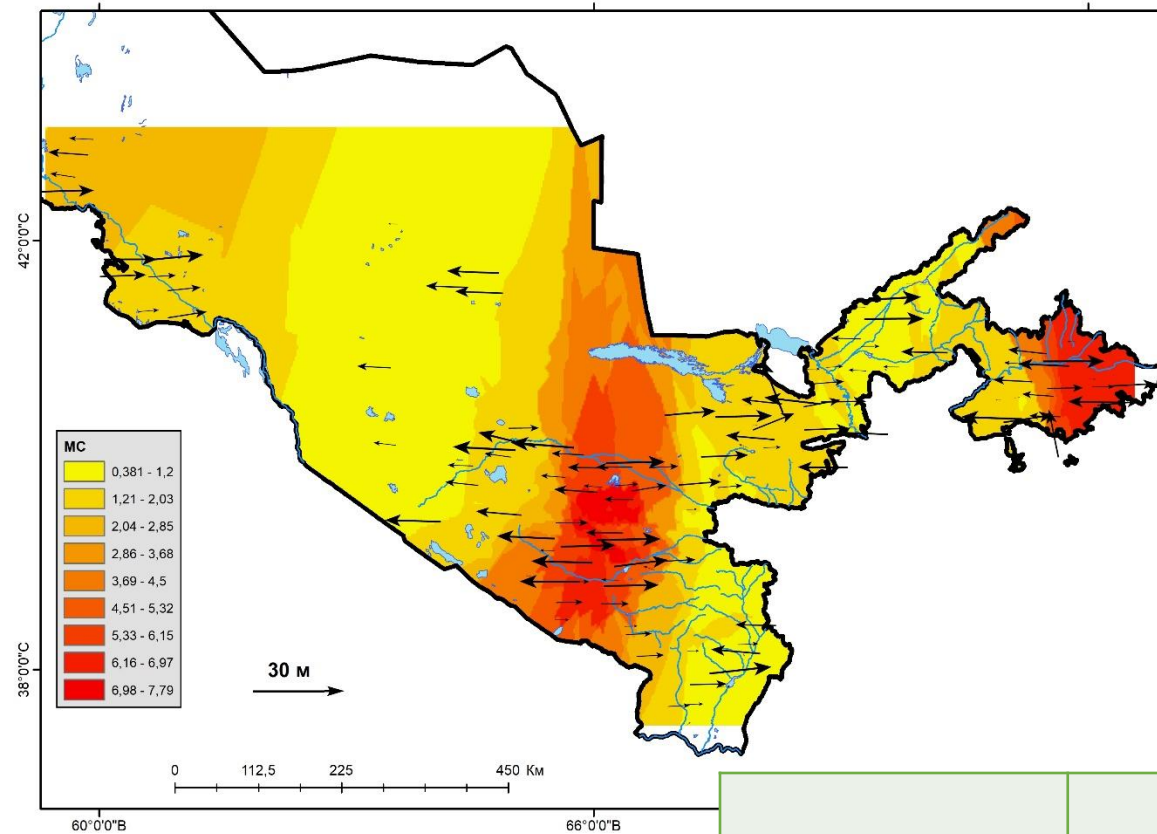


Maximal height anomalies (up to -40 m) is in Fergana valley region

Horizontal deformation (mostly in longitude) is near the main tectonic faults



Comparison “modeled” and “measured” coordinates



	r	h
Min	0.02	-1.57
Max	31.95	1.61
Mean	2.74	0.01
Std. dev.	4.47	0.24

Height system definition :

1. The improvement of GGM with GNSS-leveling data is based on modeling and interpolation of the differences between the GNSS-leveling geoid heights and GGM geoid heights at “common” points.

$$\Delta N_i = N_i^{GNSS-leve\text{lling}} - N_i^{GGM}$$

2. GGM geoid undulations N^{GGM} at control points are received using Calculation Service of the International Center of Global Terrestrial Models (ICGEM).

3. Corrector surface fitting (CSF) approach

$$f(\varphi, \lambda) = \Delta N = N_i^{GNSS-lev} - N_i^{GGM} = a_0 + a_1\varphi_1 + a_2\lambda_i \dots = a_i^T x + v_i$$

$$T_i = a_0 + a_1\varphi_1 + a_2\lambda_i + \dots - \text{trend surface}$$

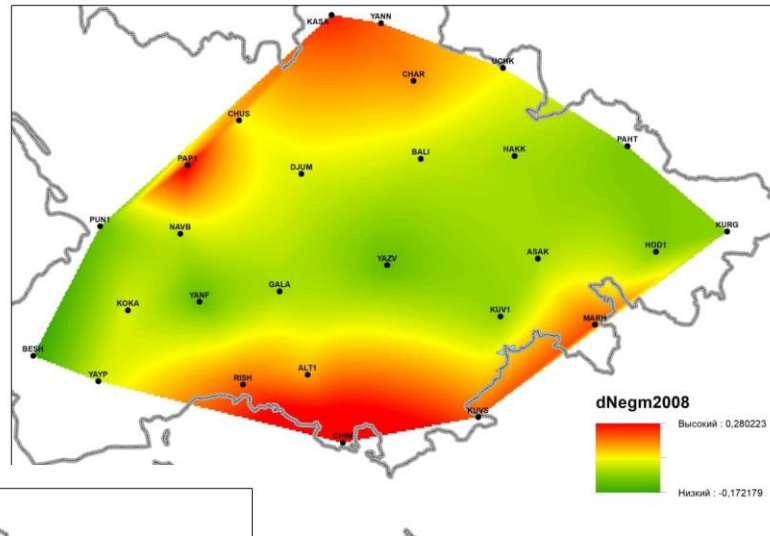
4. The trend values calculated for each point then dN values were calculated by subtracting the geoid height differences

$$dN_i = \Delta N_i - T_i$$

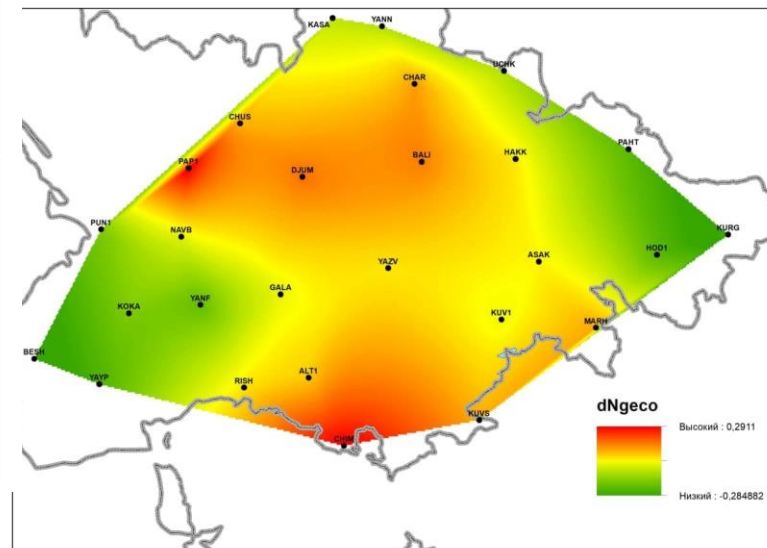
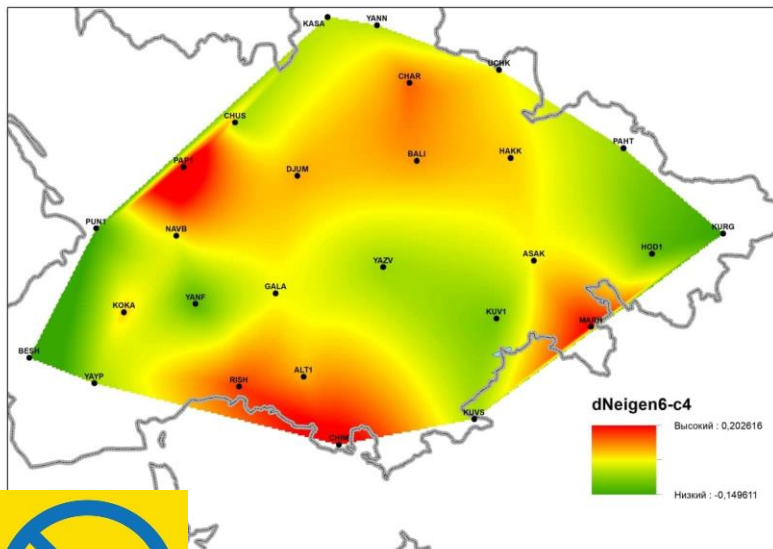
5. The improved geoid height:

$$N_i^{improv} = N_i^{GGM} + dN_i$$

GGM's corrector surface construction: case Fergana valley



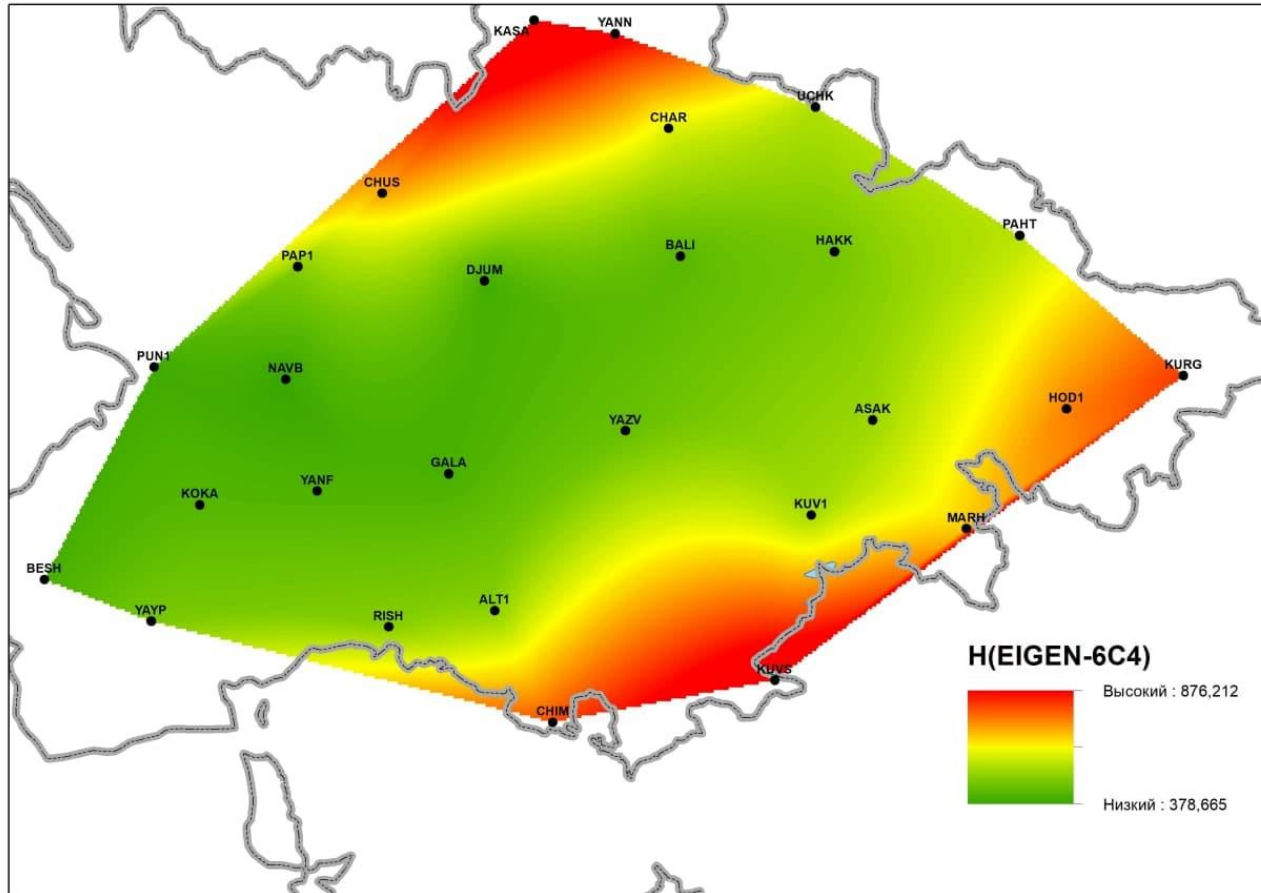
GGM	Time of releasing	Max degree/order	Data used for GGM
EGM2008	2008	2190	S(GRACE), G, A
EIGEN-6C4	2014	2190	S(GOCE, GRACE, LAGEOS), G, A
GECO	2015	2190	EGM2008, S(GOCE)



	EGM2008	EIGEN6C4	GECO
min, m	-0,1738	-0,1513	-0,2854
max, m	0,2856	0,2069	0,2966



Normal height using GGMs: EIGEN-6C4 and GECO vs EGM2008



	EGM2008	EIGEN-6C4	GECO
min, m	377,99	378,20	378,20
max,m	879,97	880,25	880,43

$$ME = \frac{1}{n} \sum_{i=1}^n (Z_{EGM2008} - Z_{GGM})$$

$$RMSE = \sqrt{\frac{1}{n} \sum_{i=1}^n (Z_{EGM2008} - Z_{GGM})^2}$$

	EIGEN-6C4	GECO
ME, m	-0,245	-0,292
RMSE, m	0,249	0,324

Conclusions

Development of upgraded datum for Uzbekistan is currently underway. However, there are many more options to consider in regards to the final implementation of the datum:

- adopting the most accurate and homogeneous data based on the most recent ITRF
- taking into account the tectonic deformation model
- determining the transformation parameters between reference systems taking into account the quasi geoid, and
- further refining the global geopotential models by using gravimetric measurements.

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Thank you for your attention!

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