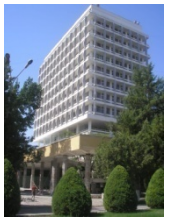

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Determination of transformed parameters between CS42 and WGS84 for Uzbekistan territory

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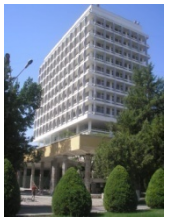
United Nations/Croatia Workshop on the Applications of Global Navigation Satellite Systems, 21-25 April 2013, Baska, Krk Island



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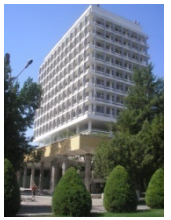
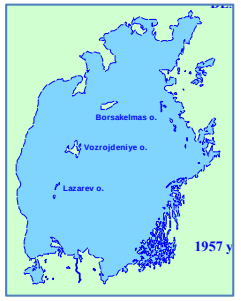


CAPITAL: Tashkent

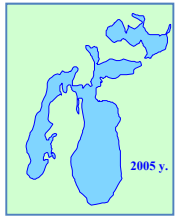
The population of Uzbekistan is 30,000,000

total area of 447,400 sq km

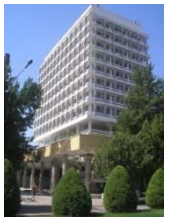
1957



2005

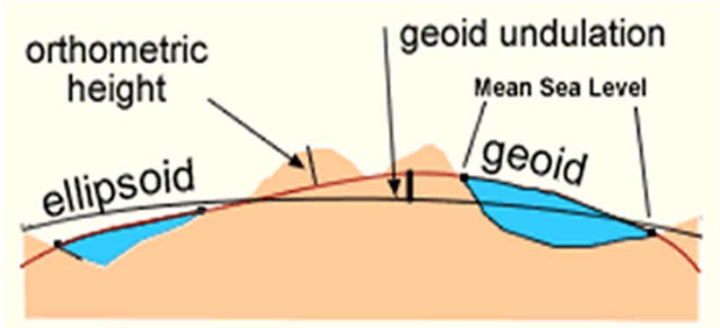


Aral sea level



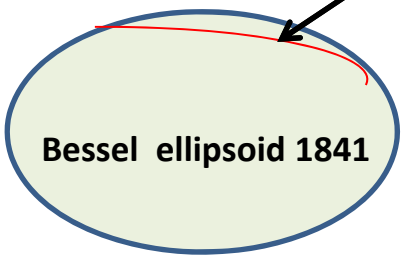
The geoid of Ferghana valley (1897)

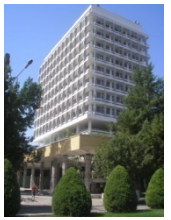
Prof.Pomeranzev



Zero-point
(Tashkent observatory)
φ= 40° 10' 05.55 "
λ= 68° 19' 42.09 "

The Geoid of Ferghana valley



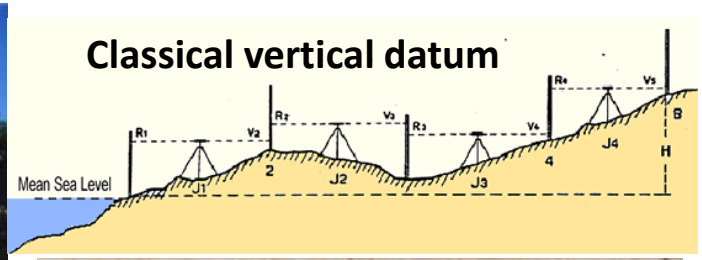


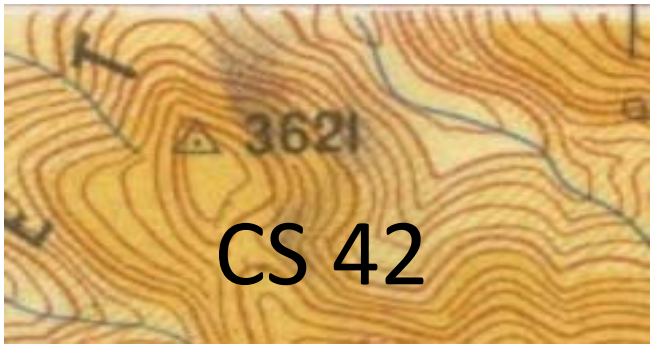
Coordinate system CS42

Zero-point
Pulkovo

Krasovsky
1878-1948

Kronstadt sea -gauge

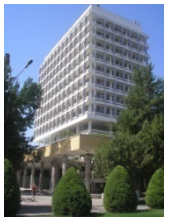


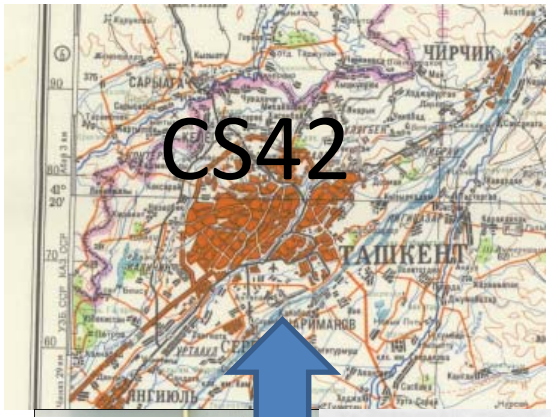


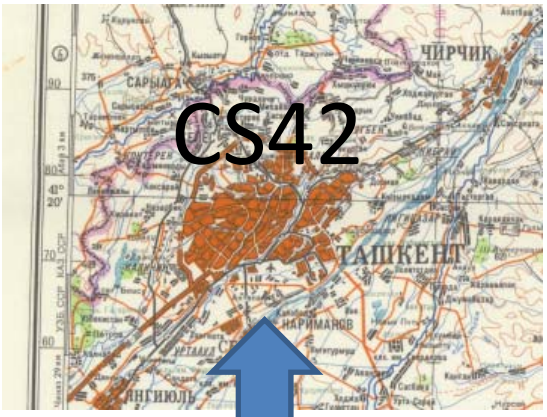
$B_0=\phi_0 -\xi_0 = 59^0\ 46/\ 18//.71 - 0//.16 = 59^0\ 46/\ 18//.55$

$L_0= \lambda_0 -\eta_0 \sec B_0 = 30^0\ 19/\ 38//.55+3//.54 = 30^0\ 19/\ 42//.09$

$A_0=\alpha_0 - \eta_0 \mathrm{tg} B_0 = 121^0\ 40/\ 36//.13+2//.66=121^0\ 40/\ 38//.79$

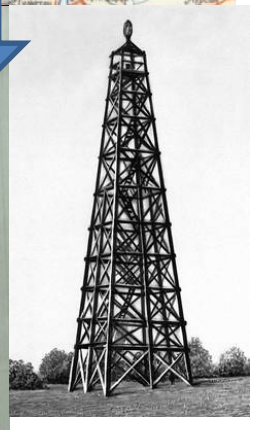



CS42
ЧИРЧИК
ТАШКЕНТ


CS42
ЧИРЧИК
ТАШКЕНТ

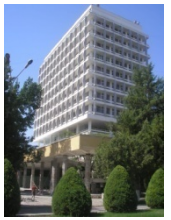

САГЛАМ
WGS84

CS42& WGS84




Trimble R8
GNSS


Trimble R8
GNSS



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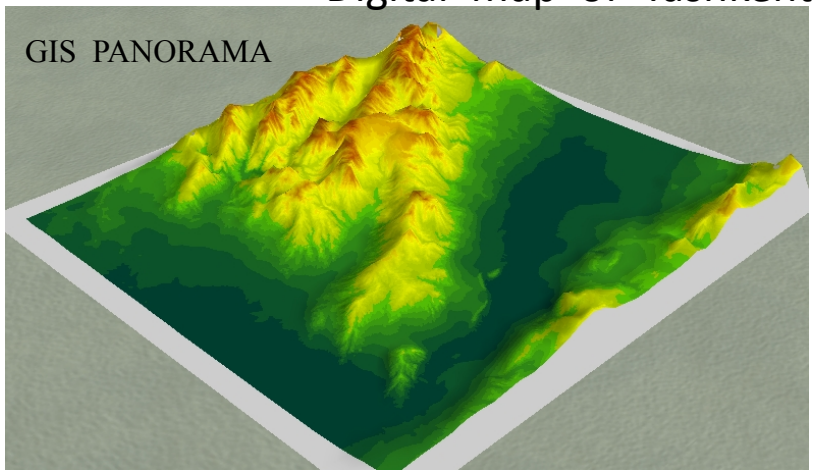
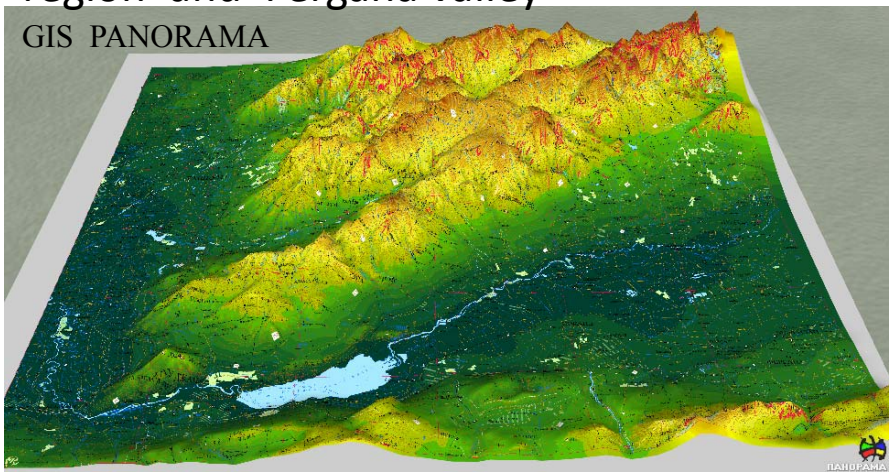
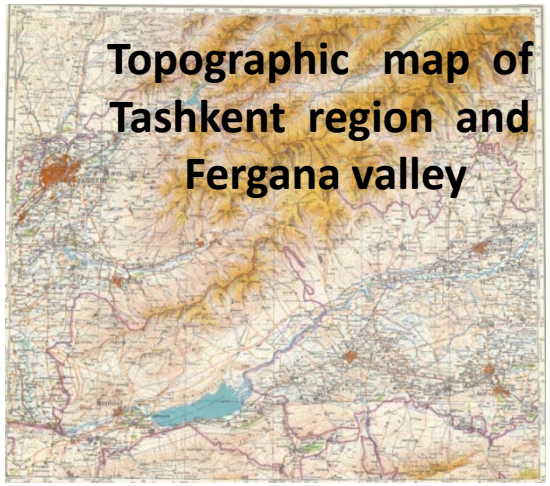
Digital map of Tashkent region and Fergana valley







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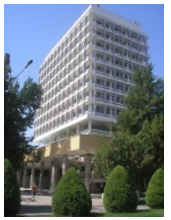
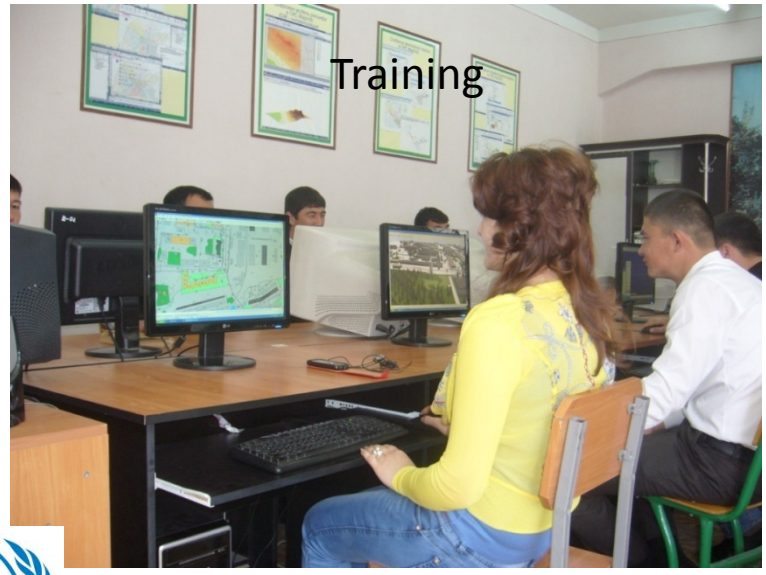


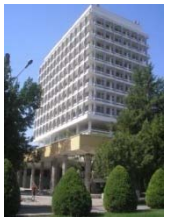
3D NUU

3D Model

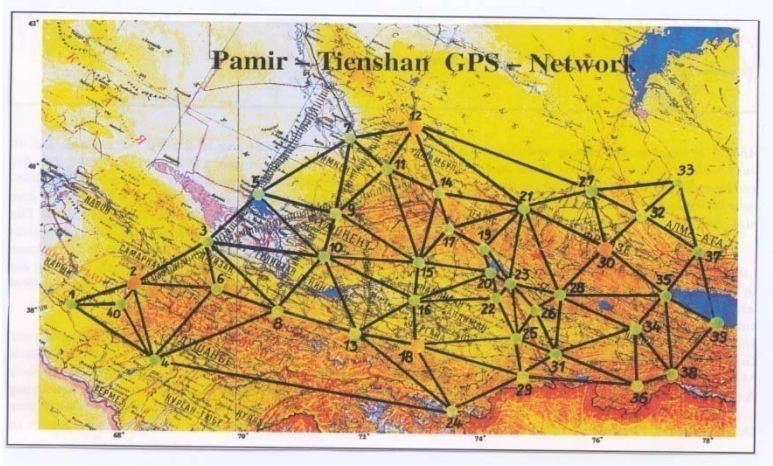


Training

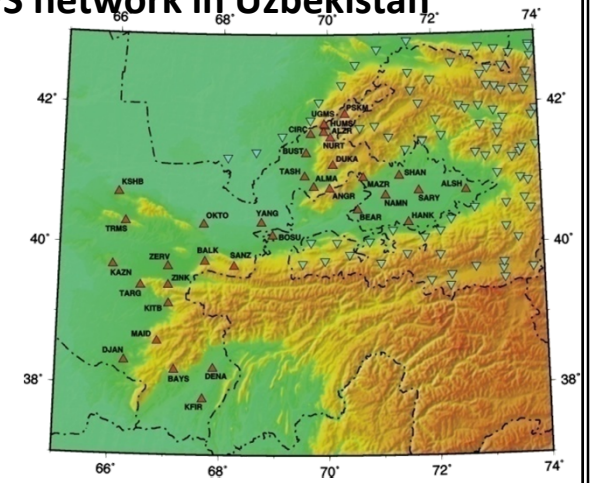
Training

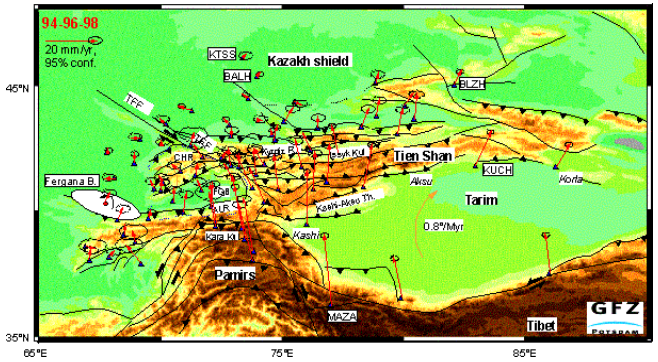


Central Asian Tectonic Sciences (CATs),GFZ,GERMANY



GPS network in Uzbekistan





CATS

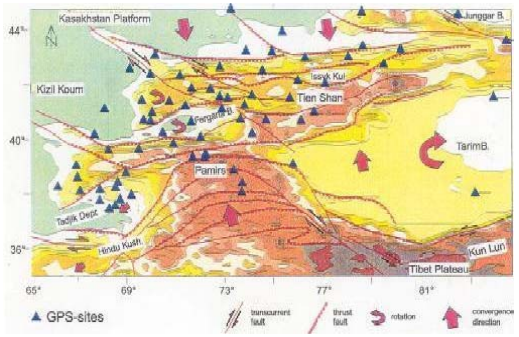
Russia

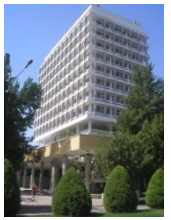
Kazakhstan

Kyrgistan

Uzbekistan

China





CATS network in Uzbekistan (WGS 84)

№	name	B	L	h,м
1	DJAN	38°20′16″.1	66°6′21″.7	790.5
2	KITB	39°8′5″.2	66°53′7″.6	622.6
3	OKTO	40°17′25″.7	67°40′11″.3	334.5
4	DENA	38°14′6″.7	67°52′48″.8	477.5
6	SANZ	39°41′37″.7	68°14′46″.1	1942.5
9	CICR	41°34′20″.8	69°39′39″.0	771.2
10	ALMA	40°49′42″.9	69°43′49″.0	737.9
16	SARY	40°46′25″.2	71°42′2″.3	351.0
40	MADA	38°41′4″.1	66°56′29″.3	2690.7
54	ANGR	41°6′7″.7	70°4′53″.7	1307.3
55	ADRA	40°48′1″.3	70°1′21″.6	1556.0
56	BESH	40°21′24″.0	70°31′25″.2	421.7
58	BAYS	38°10′31″.0	67°2′45″.6	1061.3
59	KFIR	37°50′17″.3	67°52′5″.5	590.9
79	BOZB	41°28′44″.6	71°47′7″.9	1758.7

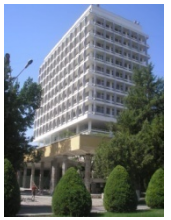
$$\left.\begin{aligned} B_{WGS\ 84} &= B_{CS\ 42} + \Delta B \\ L_{WGS\ 84} &= Lcs_{\ 42} + \Delta L \\ Hwgs_{\ 84} &= Hcs_{\ 42} + \Delta H \end{aligned}\right\}$$

1992-1996 **The international program CATs(GFZ,Germany)**

RMS = ±1-3mm. for x, y

RMS = ± 5mm. for H.

RMS = ±1-2cm. for Global network



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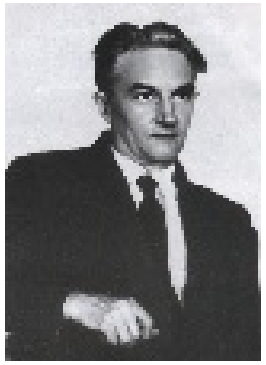


Molodensky 1909-1991

Molodensky method

station	dB(arcsec)	dL(arcsec)	dh, m
KITB	-0.117	-0.508	132
CIRC	-0.124	-0.503	134
MADA	-0.117	-0.510	132

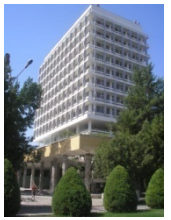
$$\Delta B = \frac{\rho''}{M+H}[-T_X \sin B \cos L - T_Y \sin B \sin L + T_Z \cos B + \Delta a_E (Ne^2 \sin B \cos B)/a_E +$$

$$+ \frac{N \Delta e_E^2}{2}\left(\frac{N^2}{a_E^2}+1\right)\sin B \cos B] + (1+e_E^2 \cos 2B)(\omega_X \sin L - \omega_Y \cos L) - \rho'' e_E^2 \mu \sin B \cos B;$$

$$\Delta L = \frac{\rho''}{(N+H)\cos B}(-T_X \sin L + T_Y \cos L) - tgB\,(1-e_E^2)(\omega_X \cos L + \omega_Y \sin L) + \omega_Z;$$

$$\Delta H = T_X \cos B \cos L + T_Y \cos B \sin L + T_Z \sin B - \frac{a_E \Delta \alpha_E}{N} + \frac{\Delta e_E^2 N \sin^2 B}{2} +$$

$$+ e_E^2 N \sin B \cos B \left(\frac{\omega_X}{\rho''}\sin L - \frac{\omega_Y}{\rho''}\cos L\right) + \mu (N + H - e_E^2 \sin^2 B).$$



Helmert F. 1843-1917

Helmert method

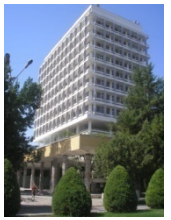
$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{CK-42} = \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{WGS-84} + \begin{bmatrix} T_X \\ T_Y \\ T_Z \end{bmatrix} + \begin{bmatrix} m & \omega_Z & -\omega_Y \\ -\omega_Z & m & \omega_X \\ \omega_Y & -\omega_X & m \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{WGS-84}$$

$$L = arctg\frac{Y}{X}$$

$$N = \frac{a}{\sqrt{1 - e^2 \sin^2 B}}$$

$$B^{(i)} = arctan\frac{Z + N^{(i-1)} e^2 \sin B^{(i-1)}}{r_p}$$

DATUM	ΔX	ΔY	ΔZ	Method	Comments
CS42-WGS84	+15	-130	-84	Molodensky	NIMA
CS42-WGS84	+43	-108	-119	Helmert	NIMA
CS42-WGS84	+28	-130	-95	Molodensky	NIMA
CS42-WGS84	+25	-141	-80	Helmert	GOST(RU)
CS42-WGS84	+22	-123	-83	Molodensky	Bazlov(RU)
CS42-WGS84	+23	-125	-87	Molodensky	Fazilova(UZ)



the world of GPS we have to remember one critical thing, and that is that the datum used by the GPS satellites is wgs84. So all datum changes will be from wgs84 to your selected or defined datum.

WGS84 – CS42

To= -22.56 m

Ty=+125.03 m

Tz=83.81 m

Errors up to 0.04 m

NEW SPHEROID

WGS84 Centre

WGS84-OSGB36

Tx=-446.448 m

Ty=+125.157 m

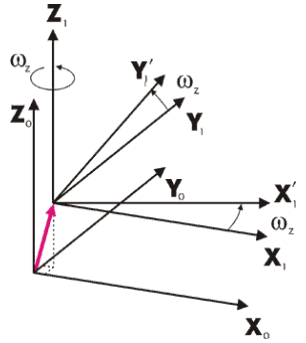
Tz=-542.060 m

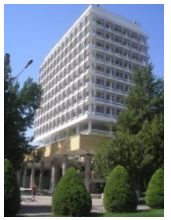
Errors up to 4 m

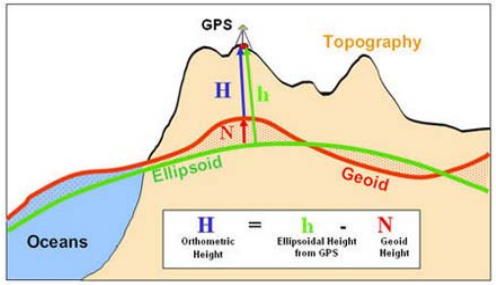
ΔX

ΔZ

ΔY







The geoid-ellipsoid separation

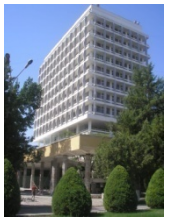
Regional reference ellipsoid

(σ_1 = local area, a country)

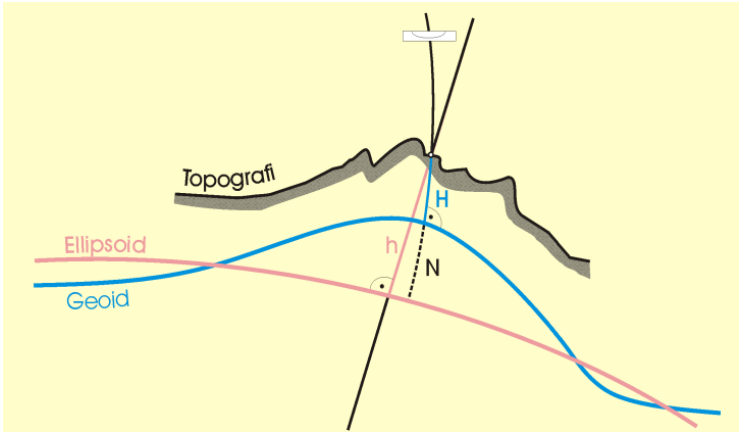
$$\iint_{\sigma_1} N^2 d\sigma = \text{minimum}$$

Mean Earth Ellipsoid (σ=whole earth)

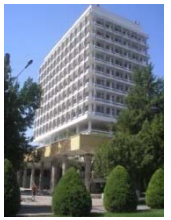
$$\iint_{\sigma} N^2 d\sigma = \text{minimum}$$

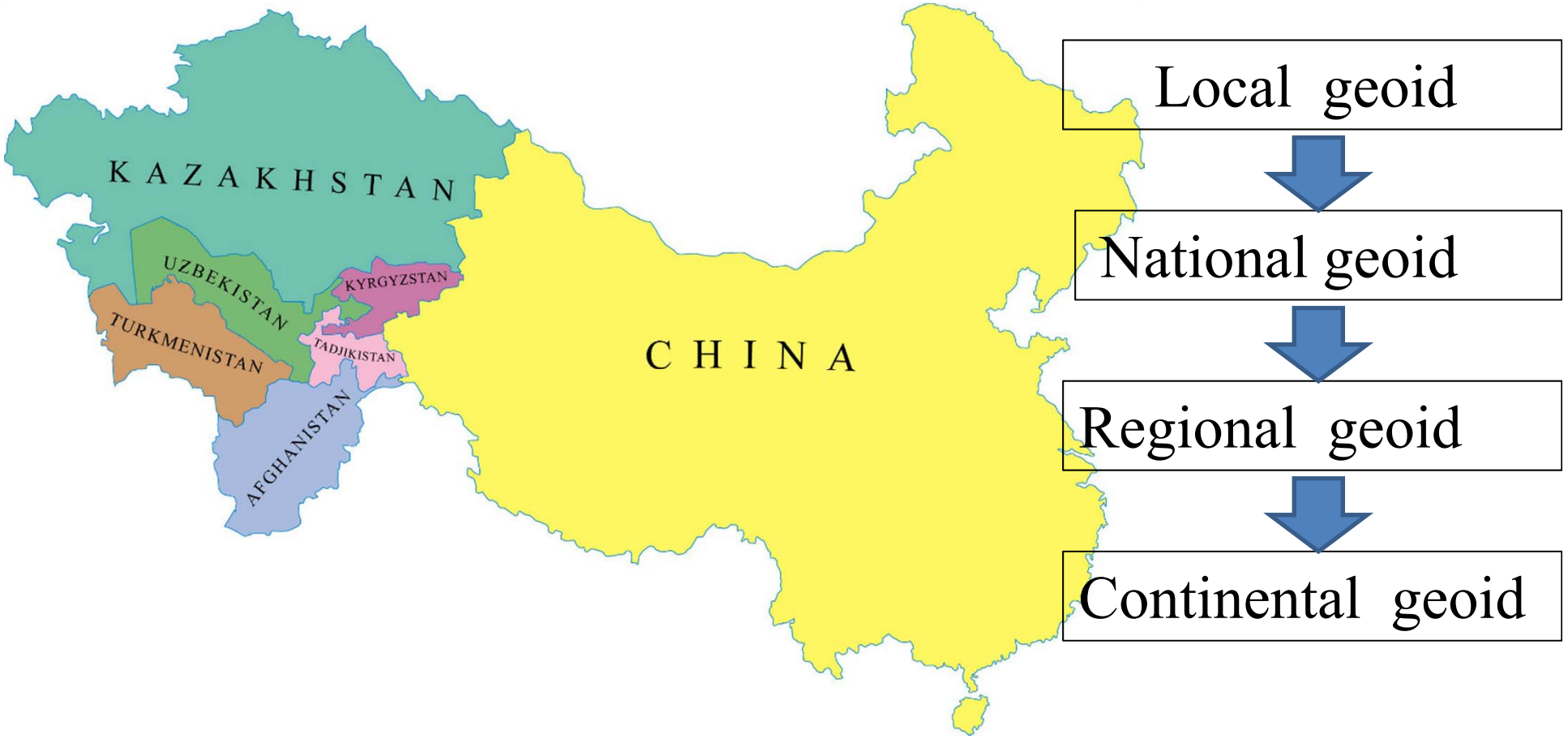


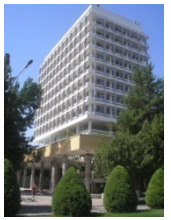
№ст		B_{wgs84}	L_{wgs84}	φ_{cs42}	λ_{cs42}	H,м	N,м
1	DJAN	38°20′16″.1	66°06′21″.7	16.268	24.922	790.5	-37.73
2	KITB	39°08′05″.2	66°53′07″.6	05.282	10.797	622.6	-36.71
3	OKTO	40°17′25″.7	67°40′11″.3	25.665	14.488	334.5	-40.14
4	DENA	38°14′06″.7	67°52′48″.8	06.829	51.879	477.5	-41.37
6	SANZ	39°41′37″.7	68°14′46″.1	37.699	49.214	1942.5	-36.96
9	CICR	41°34′20″.8	69°39′39″.0	20.604	42.084	771.2	-41.60
10	ALMA	40°49′42″.9	69°43′49″.0	42.765	52.043	737.9	-42.90
16	SARY	40°46′25″.2	71°42′02″.3	25.019	05.174	351.0	-50.97
40	MADA	38°41′04″.1	66°56′29″.3	04.217	32.473	2690.7	-35.64
54	ANGR	41°06′07″.7	70°04′53″.7	07.532	56.726	1307.3	-40.41
55	ADRA	40°48′01″.3	70°01′21″.6	01.159	24.617	1556.0	-42.86
56	BESH	40°21′24″.0	70°31′25″.2	23.883	28.156	421.7	-46.79
58	BAYS	38°10′31″.0	67°02′45″.6	31.156	48.743	1061.3	-37.90
59	KFIR	37°50′17″.3	67°52′05″.5	17.462	08.564	590.9	-43.85
79	BOZB	41°28′44″.6	71°47′07″.9	44.357	10.798	1758.7	-43.16

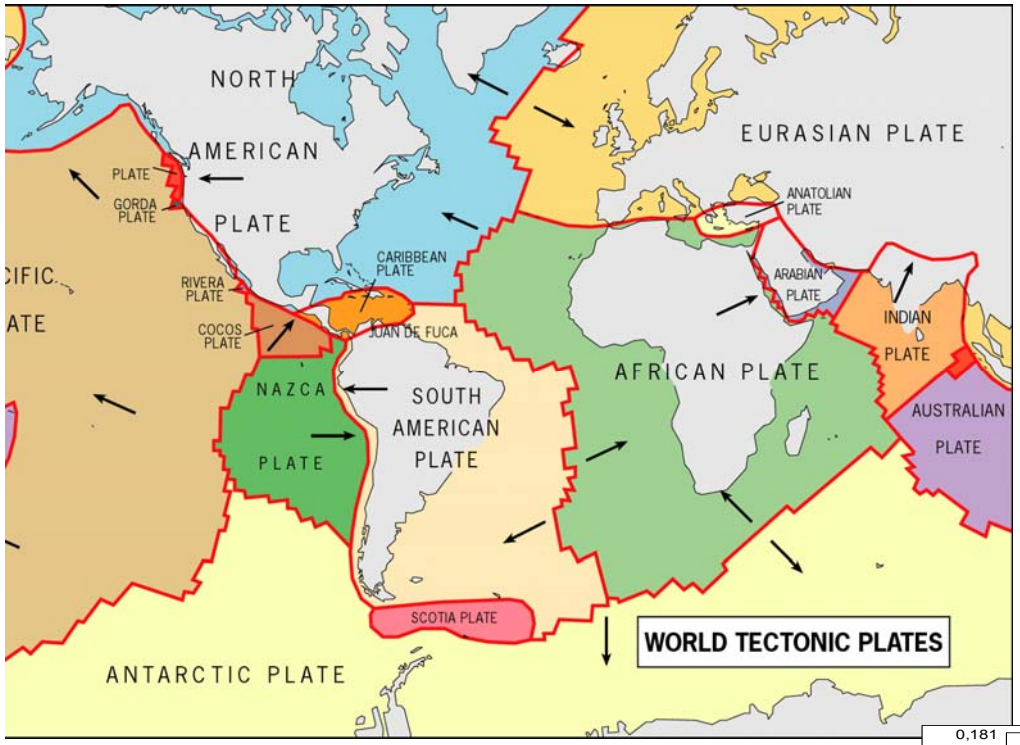


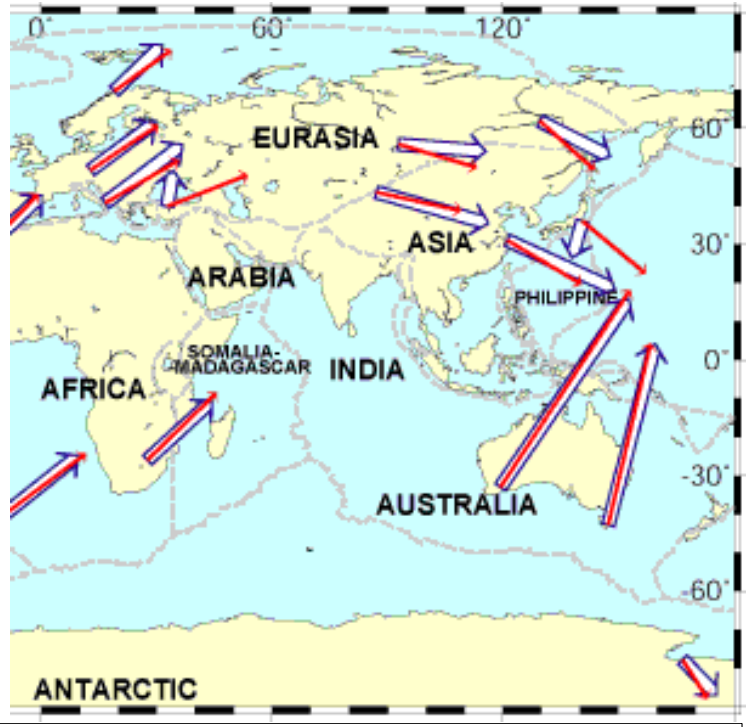
$$N = \frac{GM}{\rho\gamma_0}\left[1 + \sum_{n=2}^{\infty}\sum_{m=0}^{n}\left(\frac{a}{\rho}\right)^n P_{nm}(\sin\varphi_r) \times (C_{nm}\cos m\lambda_r + S_{nm}\sin m\lambda_r)\right].$$

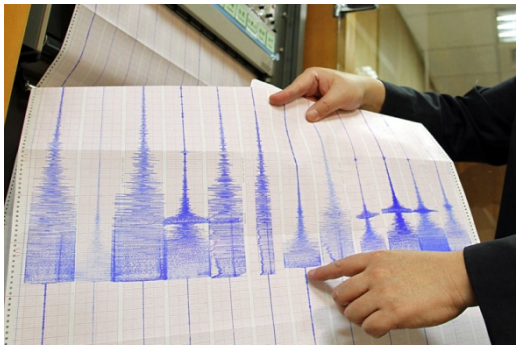


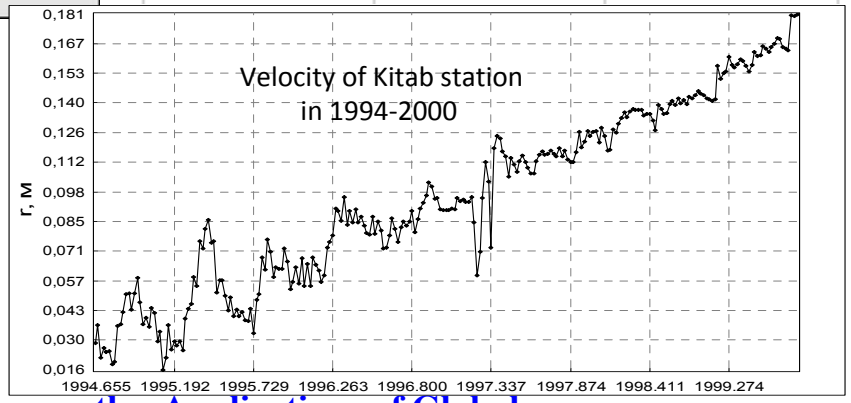

KAZAKHSTAN
UZBEKISTAN
KYRGYZSTAN
TURKMENISTAN
TADJIKISTAN
AFGHANISTAN
CHINA
Local geoid
National geoid
Regional geoid
Continental geoid

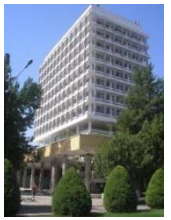



NORTH
AMERICAN
PLATE
EURASIAN PLATE
ANATOLIAN PLATE
CARIBBEAN PLATE
ARABIAN PLATE
INDIAN PLATE
AFRICAN PLATE
NAZCA PLATE
SOUTH AMERICAN PLATE
AUSTRALIAN PLATE
SCOTIA PLATE
ANTARCTIC PLATE
WORLD TECTONIC PLATES


EURASIA
ASIA
ARABIA
AFRICA
SOMALIA-MADAGASCAR
INDIA
PHILIPPINE
AUSTRALIA
ANTARCTIC




Velocity of Kitab station
in 1994-2000
r, м
0,181
0,167
0,153
0,140
0,126
0,112
0,098
0,085
0,071
0,057
0,043
0,030
0,016
1994.655 1995.192 1995.729 1996.263 1996.800 1997.337 1997.874 1998.411 1999.274



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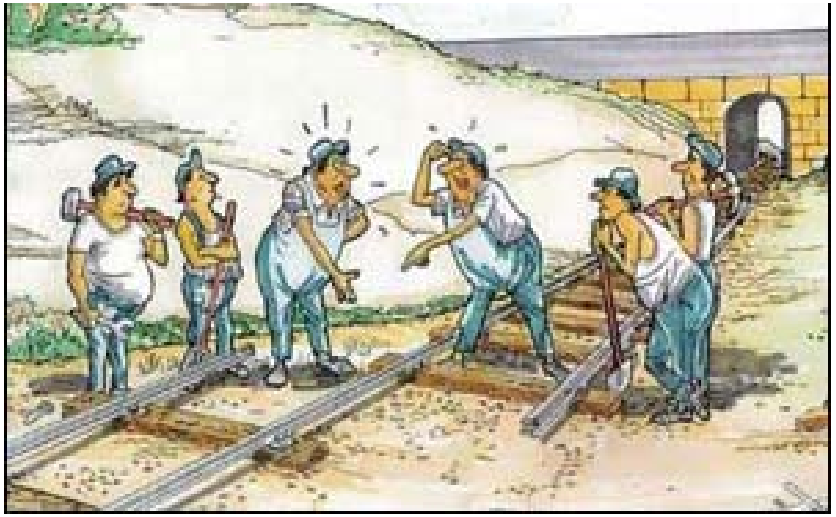
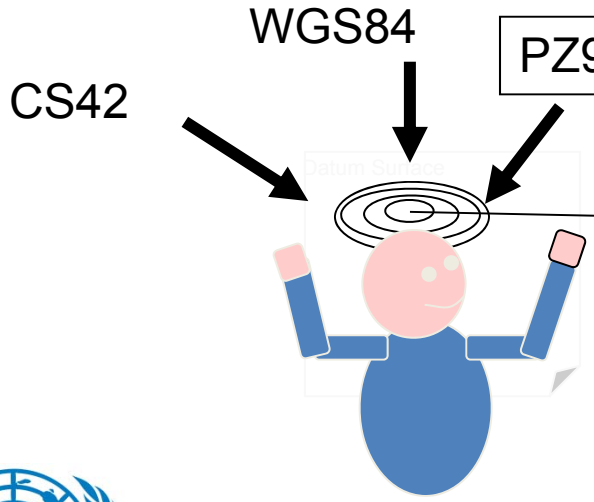
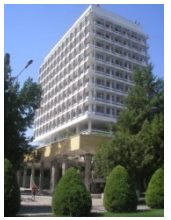
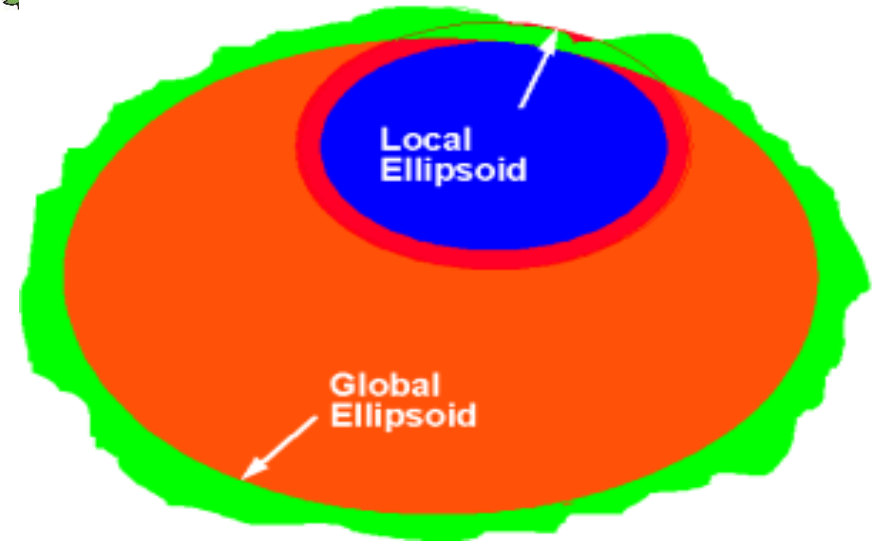
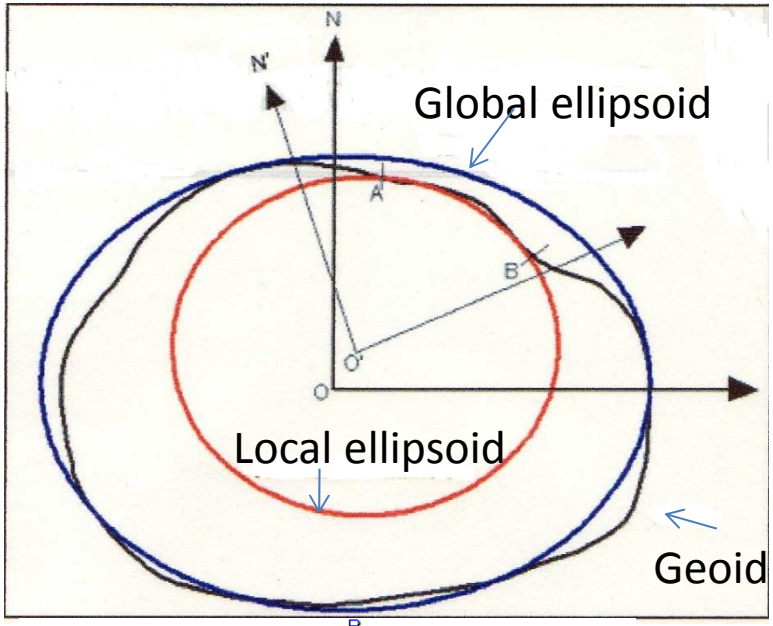
What is reference system for our region

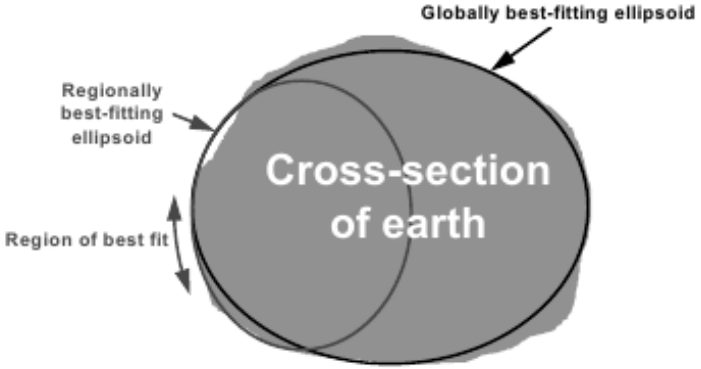


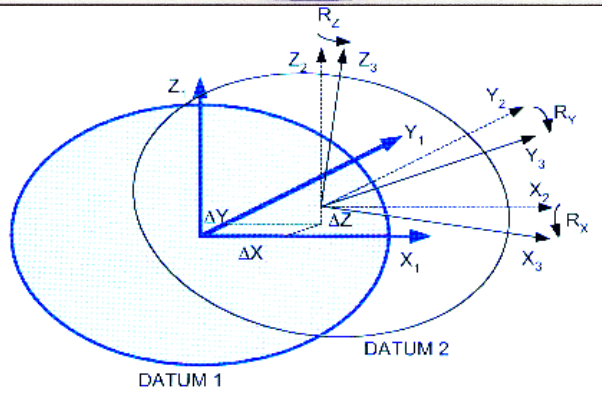





Local
Ellipsoid
Global
Ellipsoid


N
N'
Global ellipsoid
A
B
O'
O
Local ellipsoid
Geoid


Globally best-fitting ellipsoid
Regionally
best-fitting
ellipsoid
Cross-section
of earth
Region of best fit


R_Z
Z_2
Z_3
Z_1
Y_2
R_Y
Y_1
Y_3
X_2
R_X
ΔY
ΔZ
ΔX
X_1
X_3
DATUM 2
DATUM 1

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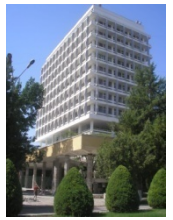
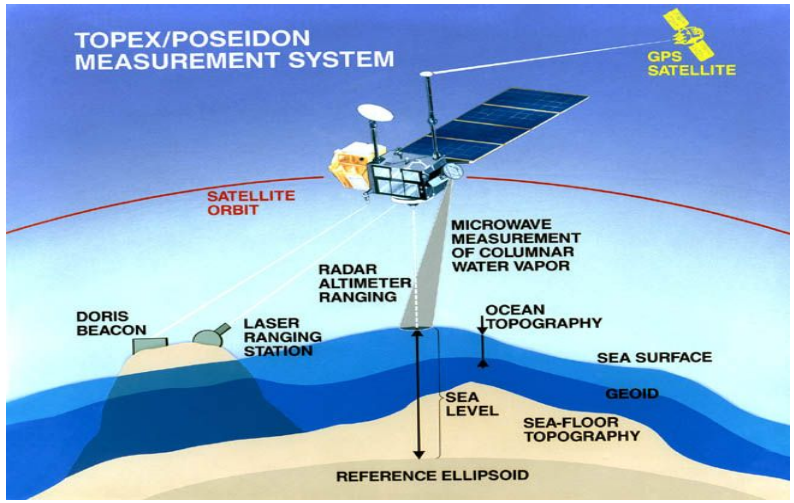
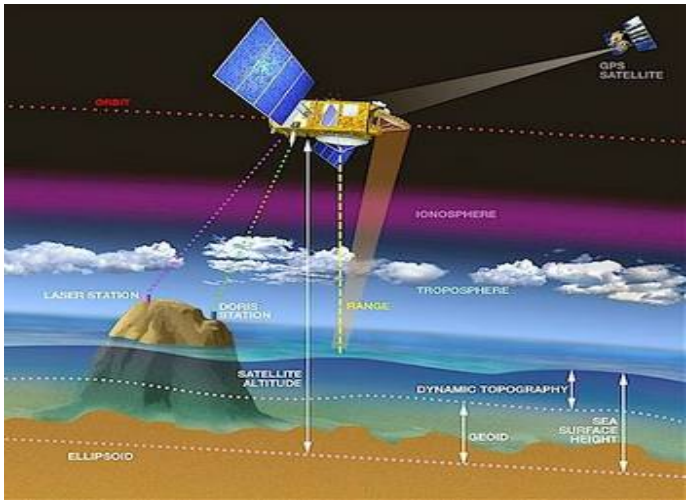
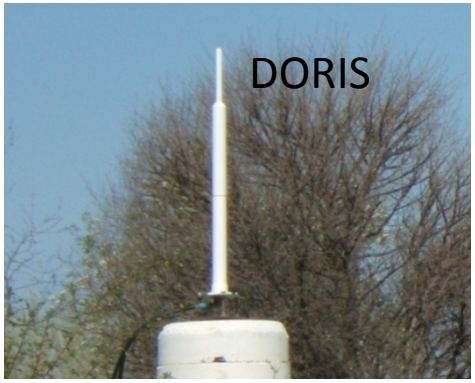






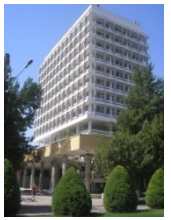


Kitab

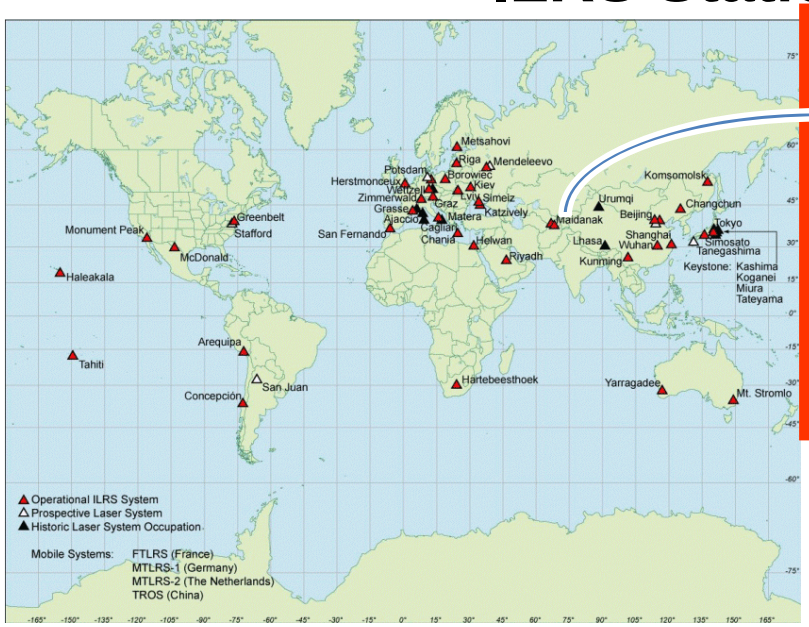
Kitab

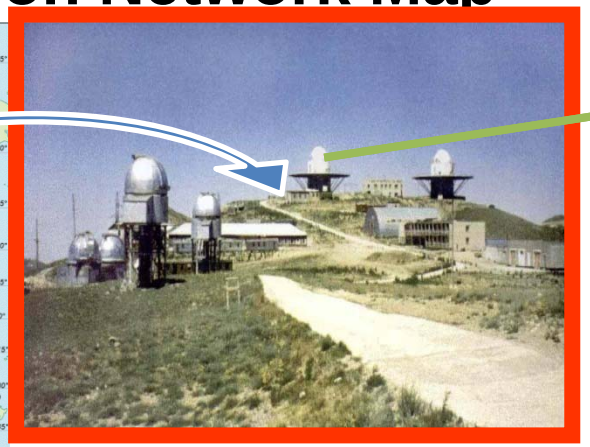
Tashkent

United Nations/Croatia Workshop on the Applications of Global Navigation Satellite Systems, 21-25 April 2013, Baska, Krk Island

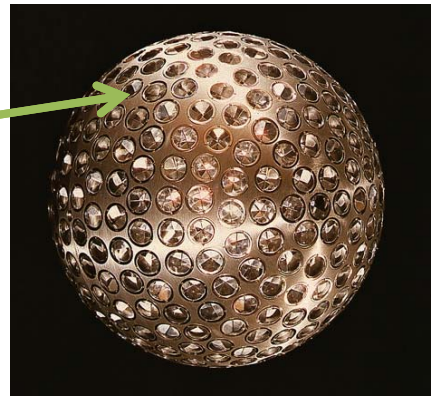


ILRS Station Network Map





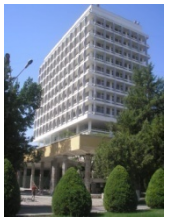
Maydanak (Uzbekistan)



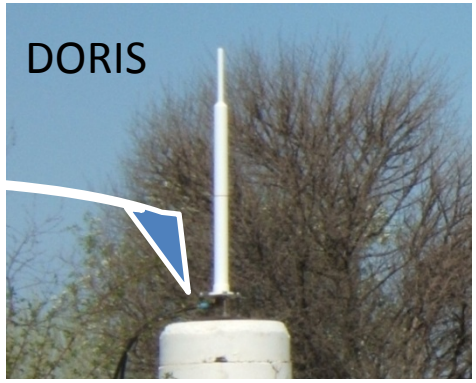
Lageos -1

H=2700m (BSL)
B= 38°41′ N
L= 66°56′ E
RMS= ± 5cm(Lageos)

GPS

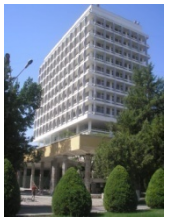


DORIS NETWORK

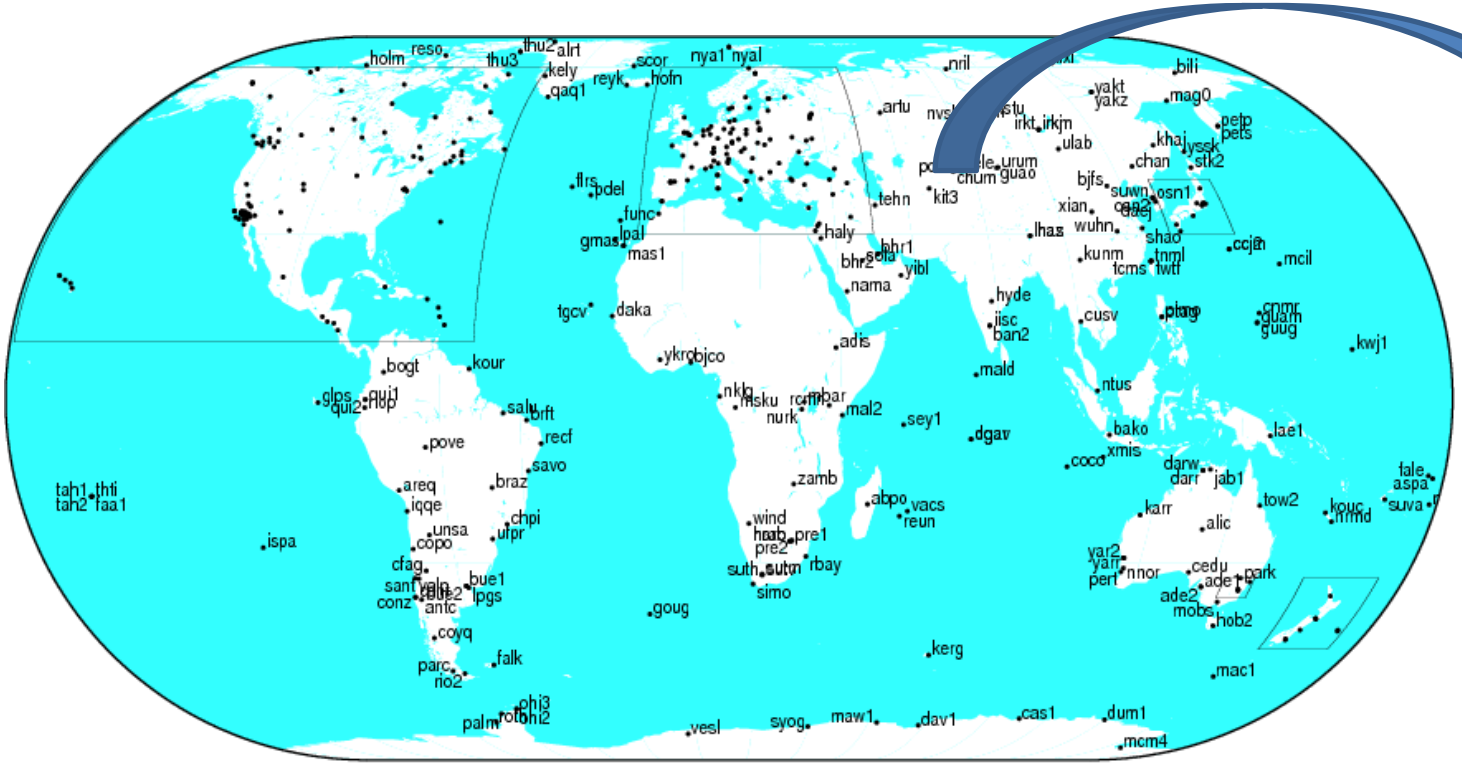


Kitab(Uzbekistan)

φ=39° 07′ 59″, λ=66⁰ 52/ 57.0//, H=657м.

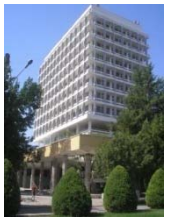


IGS Network



Kit3

Kitab, Uzbekistan



Global ellipsoid

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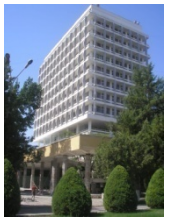
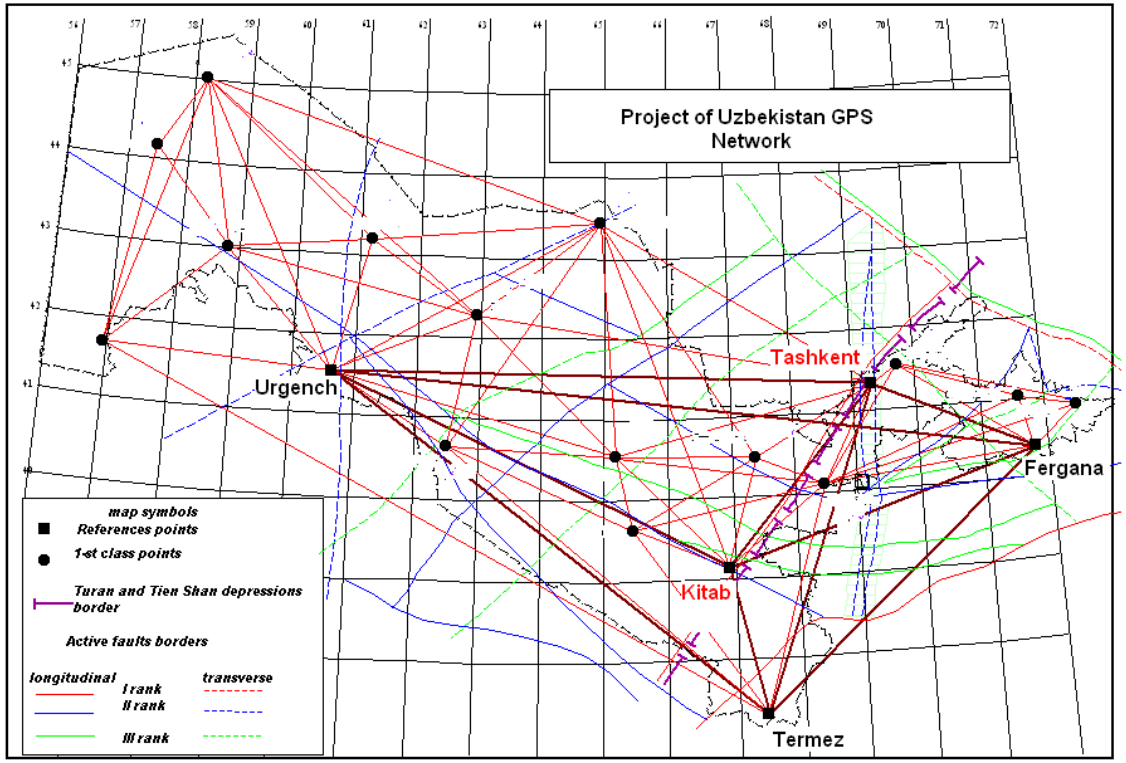
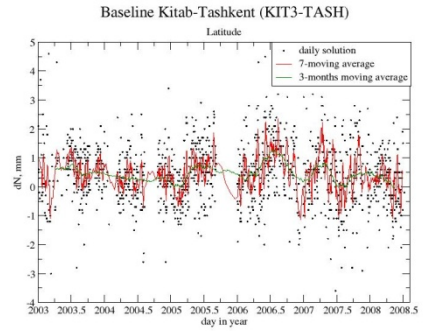
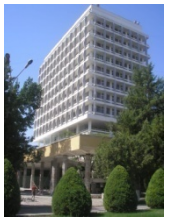


Project of Uzbekistan GPS network



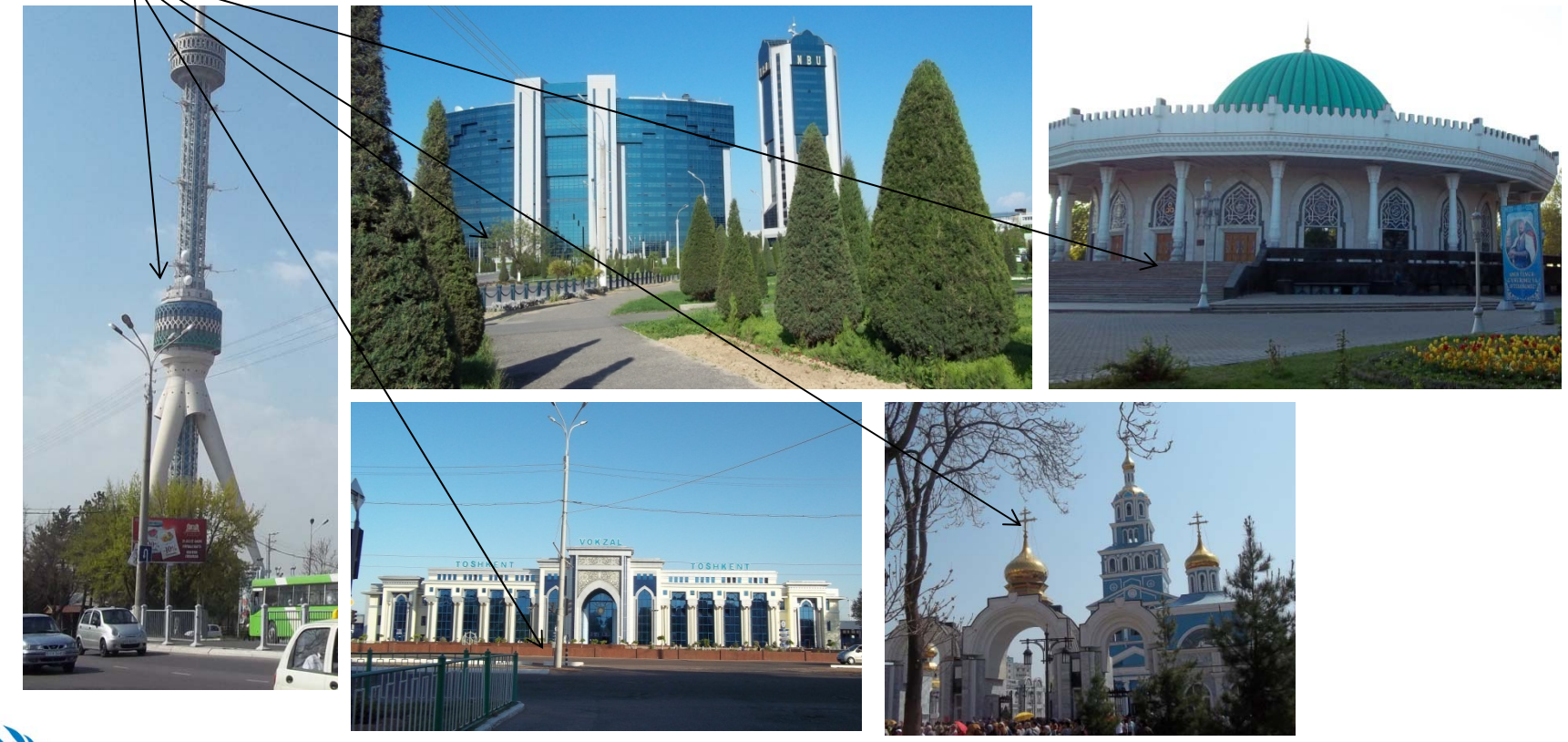


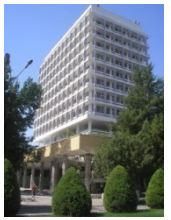
The new network consists of a hierarchy of stations, consisting of 5 reference stations, 15 1st Order stations.



In the future

Accurately measuring and modeling the geoid of Uzbekistan and its gravity field to precisely determine the position and velocity of points or objects at the surface.





Thank you
for your attention!

The author is very thankful
for financial support of the UN
(Office for Outer Space Affairs)