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Intermediate reference frame for Uzbekistan topographic maps

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United Nations/Russian Federation Workshop on the Applications of Global Navigation Satellite Systems, Krasnoyarsk, 18-22.05.2015

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GNSS

EDUCATION

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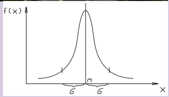
APPLICATION

NUU,TABI,TIMI



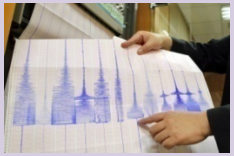


AI, SI

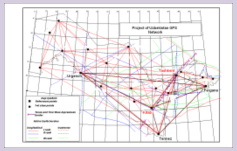



$D = \sigma^2$

$\sigma^2 = \frac{\sum (X_i - \bar{X})^2}{n}$



NCGC,UZGASHLITI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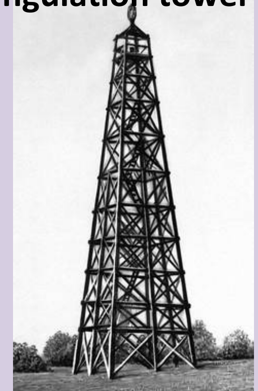
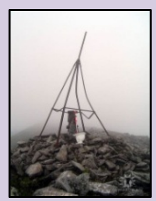
Before 1995-2000

Triangulation tower

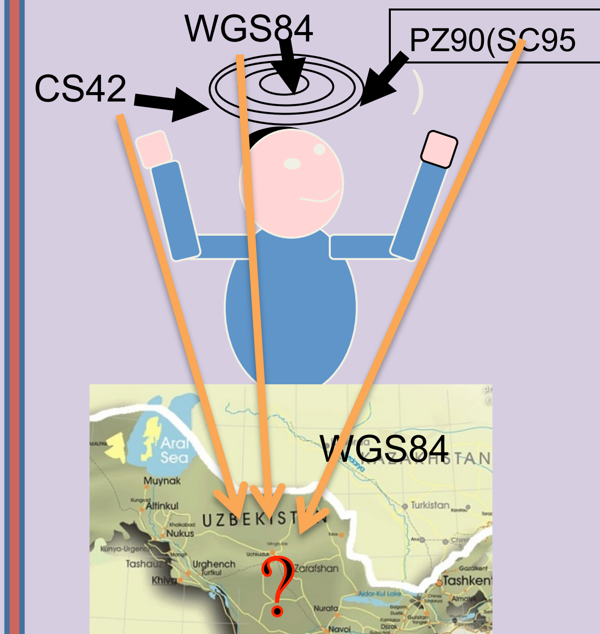


BENCH MARK

Now



In the future



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Tashkent coordinate system

Central Asian triangulation measurement were produced in Tashkent coordinate system (1875). This works are based on the Bessel –ellipsoid (1841), a=6 377 397m., α= 1/299.14

The were measurement and calculated the longitude for 900 points (rms= ± $0^{s}.25$).

Gedeonov D.D 1854-1908

In 1950 about 50% of the European triangulation networks and about 20% of other continents networks (also Russia and Uzbekistan) were based on the Bessel ellipsoid.

$\lambda = -4^{h}37^{m}10.80^{s}$ **1891**

$\varphi = 41^{0}\, 19^{/}\, 31^{//}.48$ **1895-1896**

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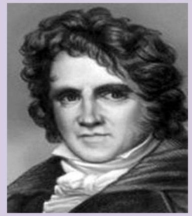
COORDINATE SYSTEM CS-32



Bessel F.V.
(1784-1846)

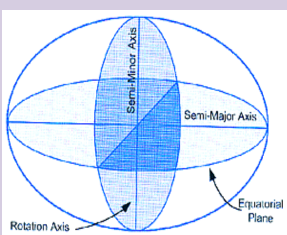
Origin: Sablino, Russia.1930.

Bessel reference ellipsoid

a=6377397.155m
b=6356078.963

f=1:298,3.

ΔX=382m.
Δ Y=151m.
Δ Z=574m.
Δ a=739.845
Δ f= 0.10037483



Pulkovo

COORDINATE SYSTEM CS-42

Origin: Bugry, Russia.1942.

Krasovsky reference ellipsoid

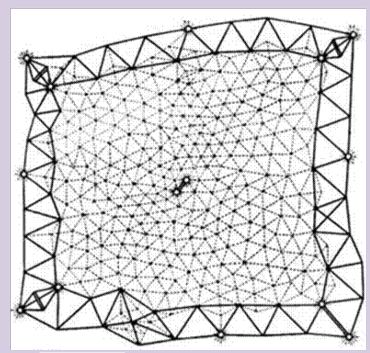
a=6378245m ***b=6356863*** *f=1/298.3*

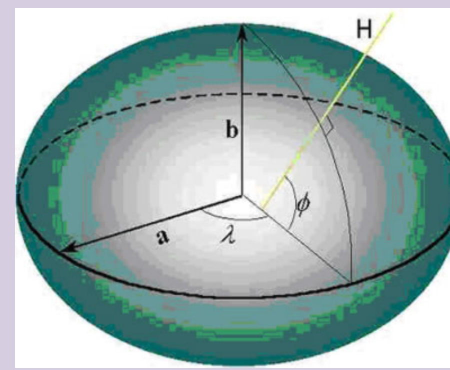
Krasovsky
1878-1948

Resolution of the SU government, №760, 1946.04.07.
Astronomy- geodetic network (87 polygons) of 1 order

$$B_0=\varphi_0-\xi_0=59^0\,46'\,18''.71-0''.16=59^0\,46'\,18''.55$$
$$L_0=\lambda_0-\eta_0\sec B_0=30^0\,19'\,38''.55+3''.54=30^0\,19'\,42''.09$$
$$A_0=\alpha_0-\eta_0 tg B_0=121^0\,40'\,36''.13+2''.66=121^0\,40'\,38''.79 \text{ (Bugry)}$$

$$\xi_{0=}=-dB_o=0{,}16'',\quad \eta_o \sec B=-dL_{o=}=-3{,}54'',\quad \eta_o=1{,}78''.$$





Triangulation line 1ord
Triangulation line 2ord
Base-line
Astronomical points

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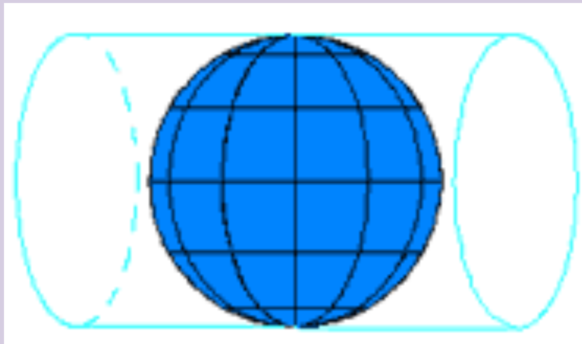
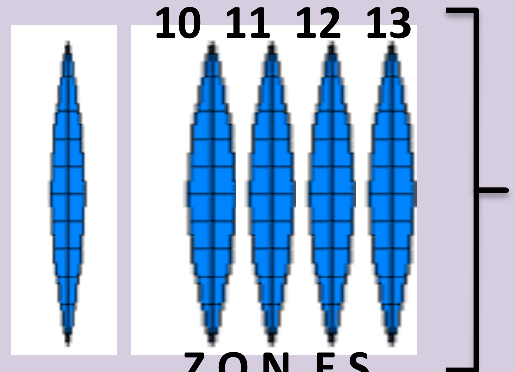
THE GAUSS-KRUGER PROJECTION

Gauss K F
(1777 – 1855)





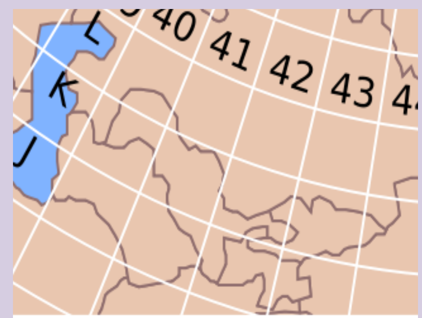
Z O N E S
UZBEKISTAN

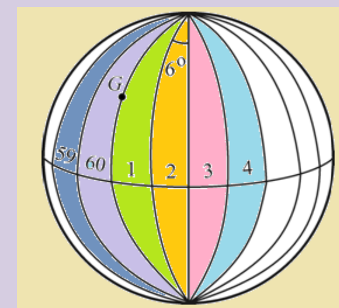
J. Krüger
1853-1923

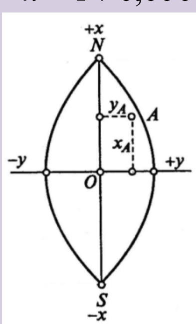
$$x = S + \frac{l^2}{2} r\,SinB + \frac{l^4}{24} r\,Cos^2 B\;SinB(5 - t^2 + 9\eta^2 + 4\eta^4);$$

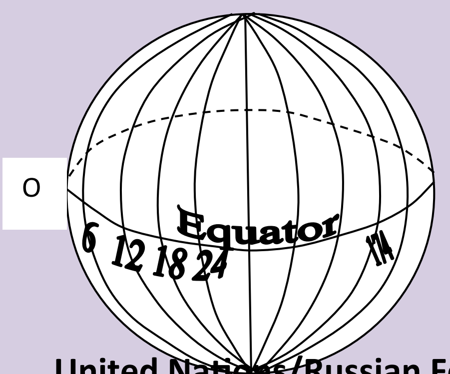
$$y = lr + \frac{l^3}{6} r\,Cos^2 B(1 - t^2 + \eta^2) + \frac{l^5}{120} r\,Cos^4 B(5 - 18t^2 + t^4 - 14\eta^2 - 58\eta^2 t^2);$$

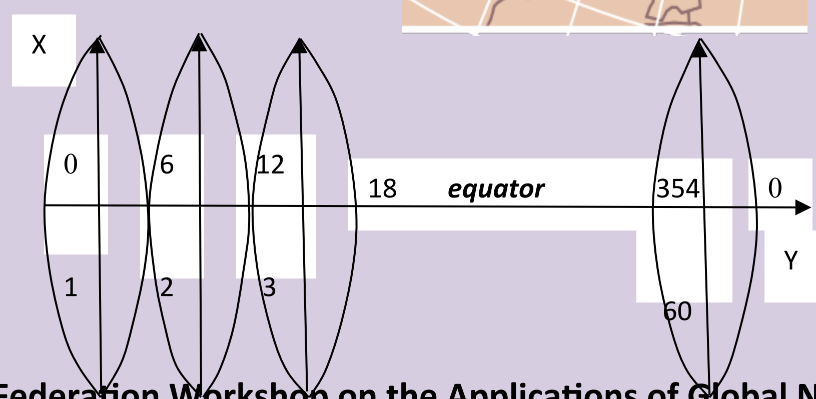
$$m = n = 1 + 0{,}000152 l^2 Cos^2 B; \quad p = m^2; \quad w = 0; \quad t = tgB; \quad \eta^2 = e'^2 Cos^2 B,$$











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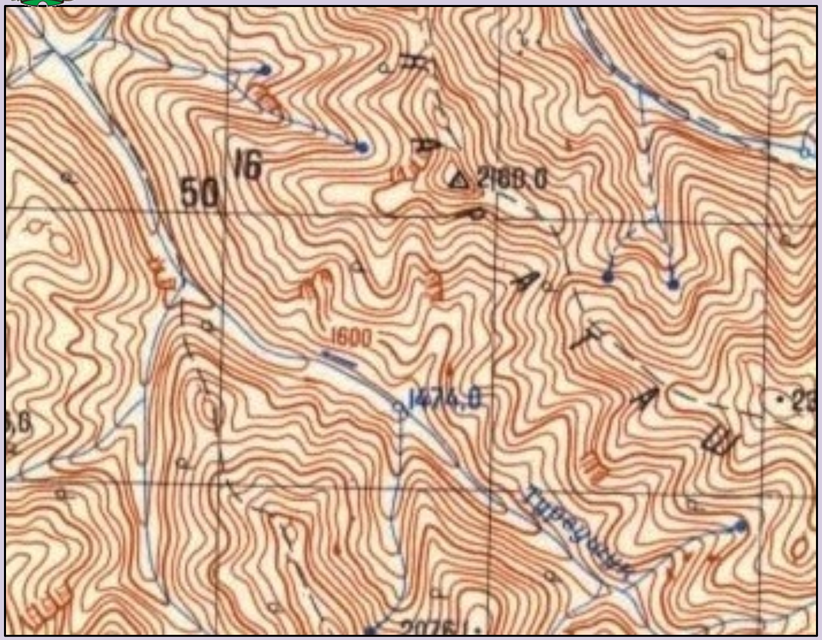

SK42, WGS84

SK42(Pulkovo)

$y_{wgs84} - y_{sk42}$=64m. , $L_{wgs84} - L_{sk42}$ = 2.90 arcsec
$x_{wgs84} - x_{sk42}$=9m. , $B_{wgs84} - B_{sk42}$ = 0.23 arcsec

$h_{wgs84} - h_{sk42}$=109m

$B_0 = \varphi_0 - \xi_0$
$L_0 = \lambda_0 - \eta_0 \sec B_0$
$A_0 = \alpha_0 - \eta_0 \mathrm{tg} B_0$

Scale	$\Delta X_{wgs84-sk42}$	$\Delta Y_{wgs84-sk42}$	
1:100 000	0.09mm	0.64mm	
1:50 000	0.18mm	1.28mm	
1:25 000	0.30mm	2.56mm	
1:10 000	0.9mm	6.40mm	
1:5 000	1.8mm	12.8mm	

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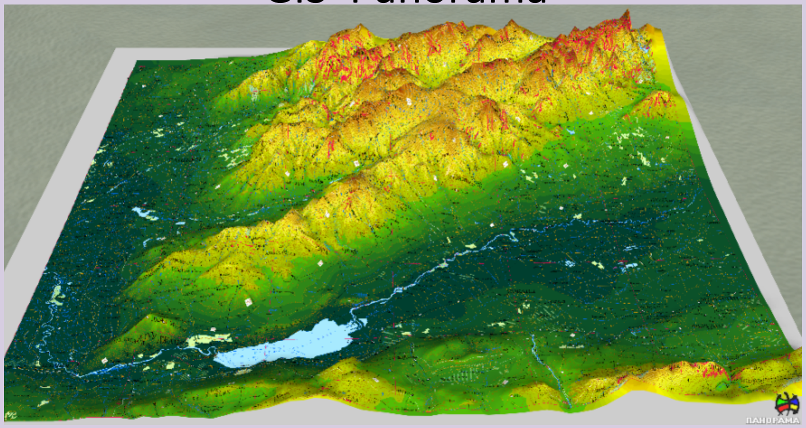
The first geoid

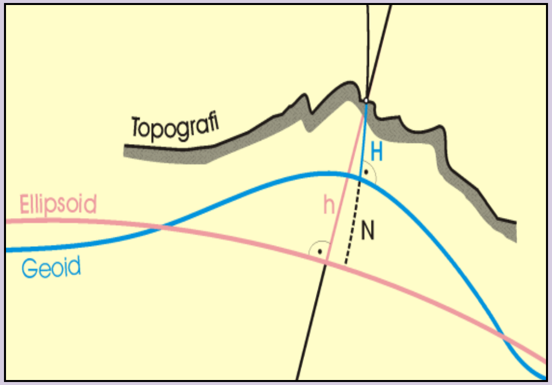
Ferghana valley

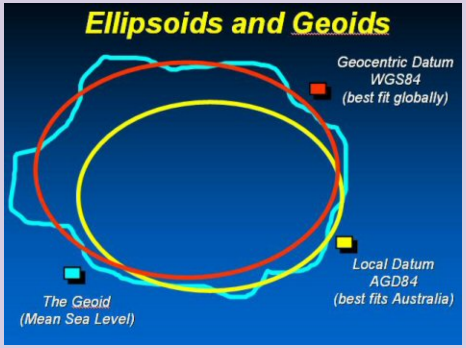
GIS Panorama



Prof.Pomeranzev
1847-1921

The geoid of Ferghana valley (1897).
B-φ=12.73'' , L-λ=16.31 '', Rms= ±0.30 ''
33 points.





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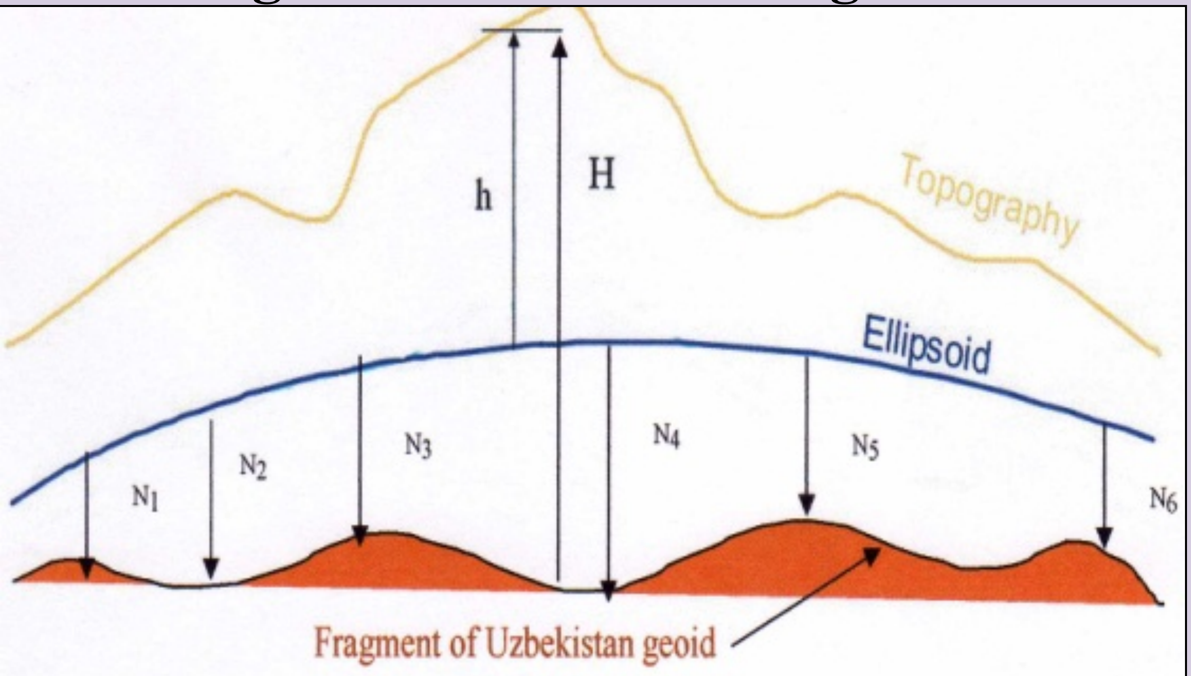
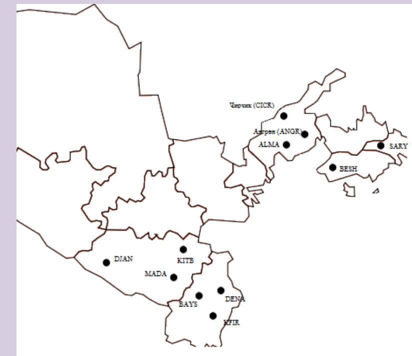
Fragment of Uzbekistan geoid

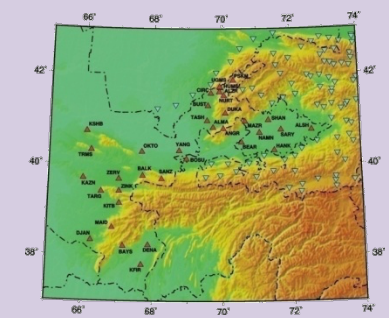


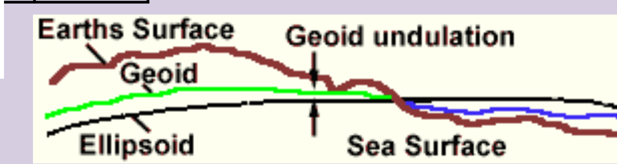
$$N = \frac{GM}{\rho\gamma_0}\left[1+\sum_{n=2}^{\infty}\sum_{m=0}^{n}\left(\frac{a}{\rho}\right)^n P_{nm}(\sin\varphi_r)\times(C_{nm}\cos m\lambda_r + S_{nm}\sin m\lambda_r)\right].$$

CATS network (Uzbekistan)(1992-1996)

№ст	N,м
1	-37.73
2	-36.71
3	-40.14
4	-41.37
6	-36.96
9	-41.60
10	-42.90
16	-50.97
40	-35.64
54	-40.41
55	-42.86
56	-46.79
58	-37.90
[illegible]	-43.85
[illegible]	-43.16







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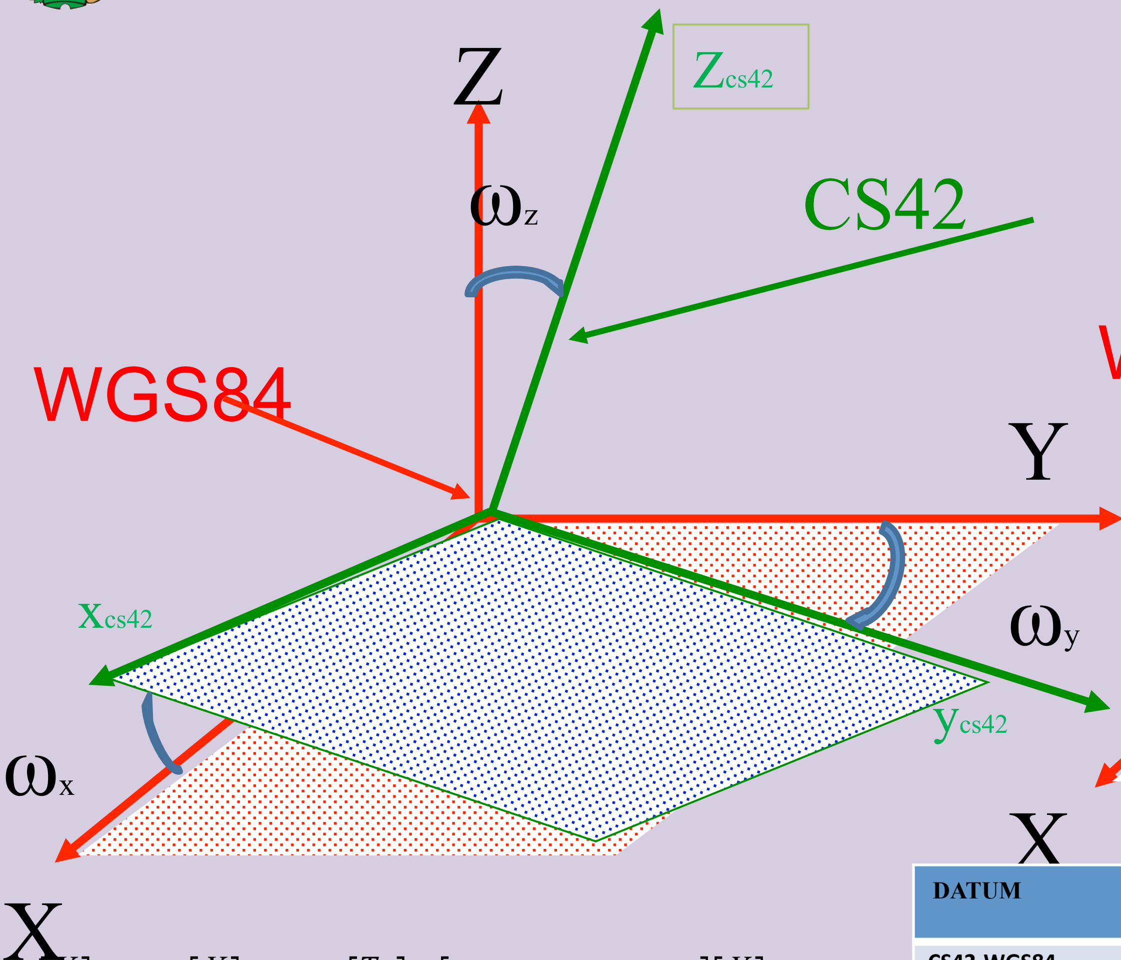

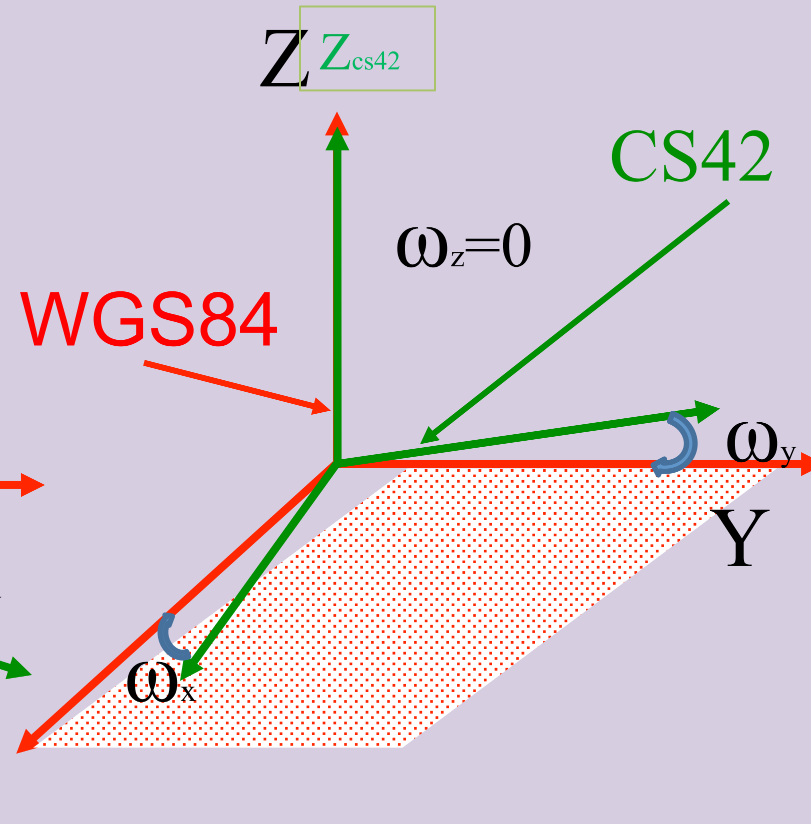

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{SK-42} = \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{WGS-84} + \begin{bmatrix} T_X \\ T_Y \\ T_Z \end{bmatrix} + \begin{bmatrix} m & \omega_Z & -\omega_Y \\ -\omega_Z & m & \omega_X \\ \omega_Y & -\omega_X & m \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{WGS-84}$$

DATUM	ΔX	ΔY	ΔZ	Method	Comments
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)

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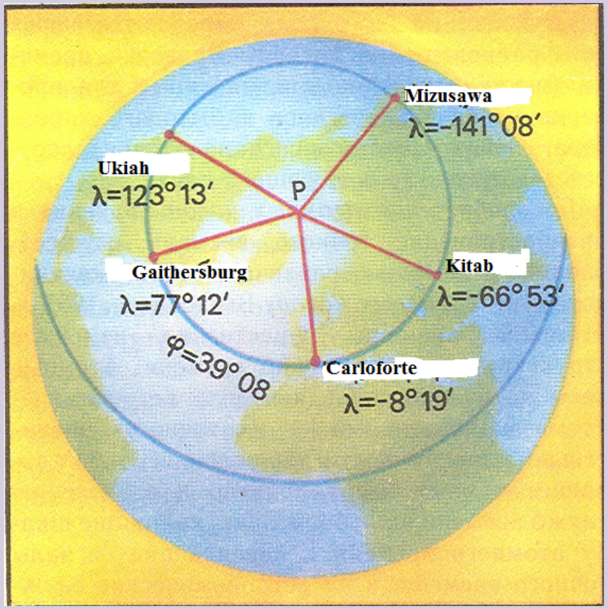
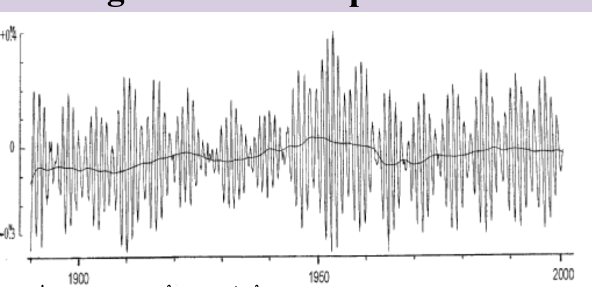
International Latitude station (1899)



Change of the north pole coordinate



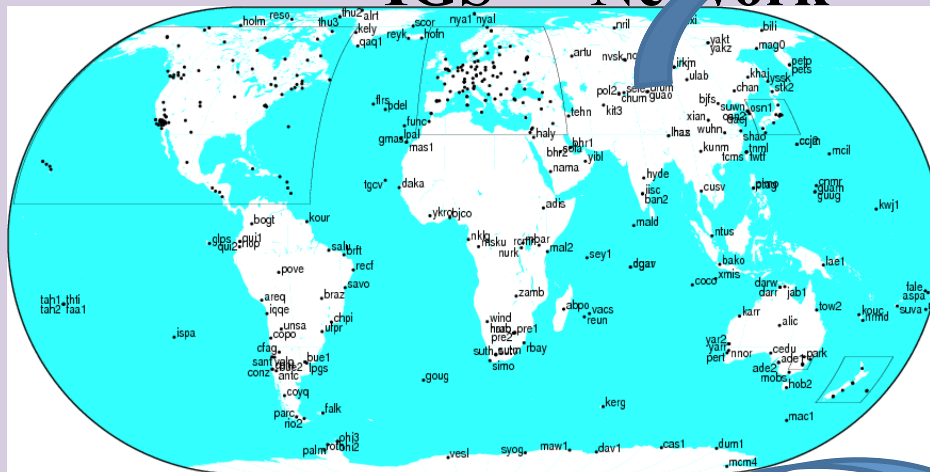
$\varphi^* - \varphi = x \cos\lambda - y \sin\lambda;$

$\lambda^* - \lambda = (x \sin\lambda - y \cos\lambda)\,tg\varphi;$

$\eta^* - \eta = (\lambda^* - \lambda)\cos B;$

$A^* - A = (x \sin\lambda - y \cos\lambda)\cos\varphi.$

IGS Network



Kit3

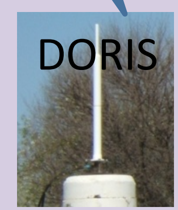
Kitab, Uzbekistan

CHAMP

Tashkent

DORIS NETWORK

DORIS



Kitab

MAID

Maidanak

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Transformation of coordinate system

$x = (N+H)\cos B\cos L$
$y = (N+H)\cos B\sin L$
$z = (N(1-e^{2})+H)\sin B$

B, L, H, WGS84

X,Y,Z (WGS84)

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

X,Y,Z (CS42)

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

$$H = \sqrt{X^2+Y^2} \times \sec B - N$$

B, L,H, CS-42

$$x = S + \frac{l^2}{2} r\, SinB + \frac{l^4}{24} r\, Cos^2 B\ SinB(5 - t^2 + 9\eta^2 + 4\eta^4);$$

$$y = lr + \frac{l^3}{6} r\, Cos^2 B(1 - t^2 + \eta^2) + \frac{l^5}{120} r\, Cos^4 B(5 - 18t^2 + t^4 - 14\eta^2 - 58\eta^2 t^2);$$

$$m = n = 1 + 0{,}000152 l^2 Cos^2 B; \quad p = m^2; \quad w = 0; \quad t = tgB; \quad \eta^2 = e'^2 Cos^2 B,$$

x,y(CS42)
G-К projection

$y_{wgs84} = y_{sk42} + \Delta y$
$x_{wgs84} = x_{sk42} + \Delta x$

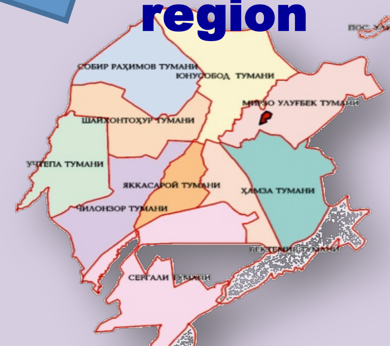
Intermediate
G-К projection

REFERENCE FRAME

NATIONAL

LOCAL(1+2 regions)

region



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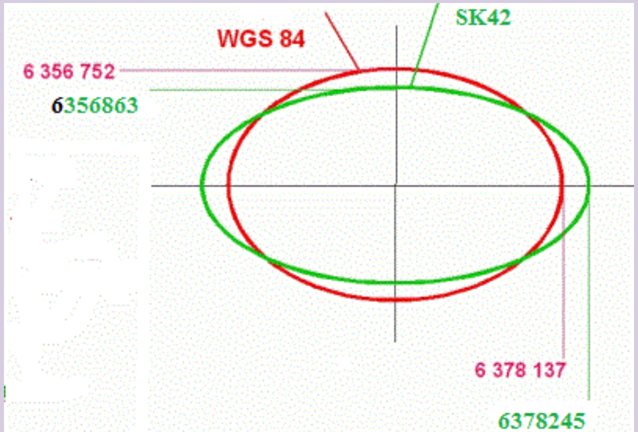

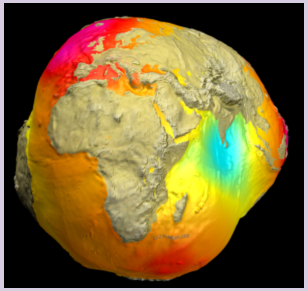

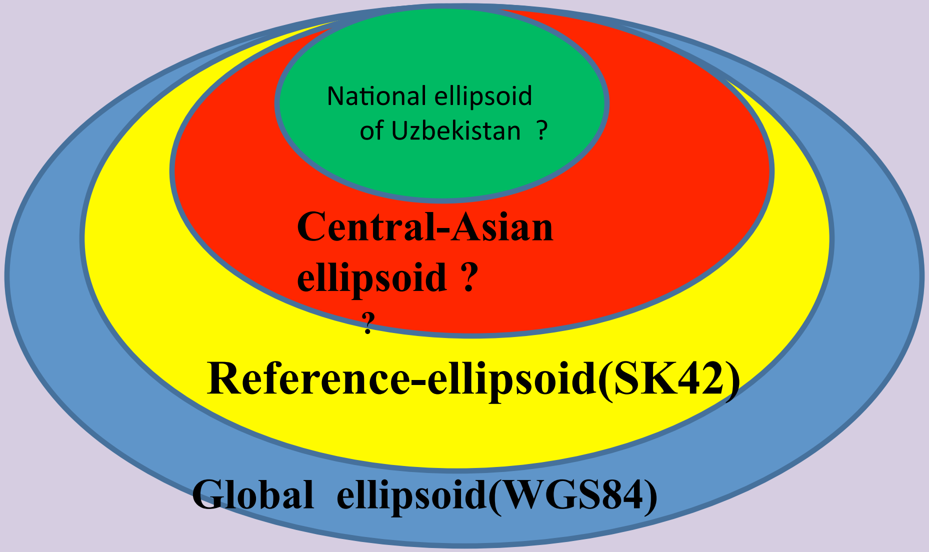

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Thank you
for your attention!

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