



XXVII FIG CONGRESS

11-15 SEPTEMBER 2022
Warsaw, Poland

Volunteering
for the future –
Geospatial excellence
for a better living

Accurate PROJ parametrization of the Uniform National Projection System of Hungary (EOV)

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ORGANISED BY



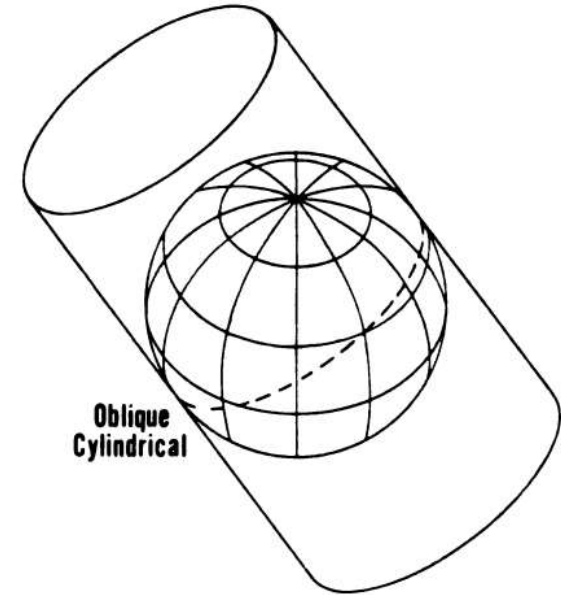
PLATINUM SPONSORS



Uniform National Projection System of Hungary (EOV)

- Introduced in 1972 for cadastral work and mapping in Hungary
- Oblique, Conformal, Cylindrical (~Oblique Mercator)
- Ellipsoidal form: Double projection: **Ellipsoid → Conformal Sphere → Plane**
- Switzerland, Rosenmund, 1903
- Madagascar, Laborde, 1928
- Malaysia, Hotine, (Rectified Skew Orthomorphic), 1947
- Alaskan Panhandle, Hotine, 1947

Good summary in Snyder's 1987 work: „Map Projections – a working manual”



Proj definition with „somerc”

```
+proj=somerc \  
+lat_0=47.1443937222222 \  
+lon_0=19.0485717777778 \  
+k_0=0.99993 \  
+x_0=650000 \  
+y_0=200000 \  
+ellps=GRS67
```

Uniform National Projection System

From ellipsoid to sphere:

Normal latitude: minimal distortion, where the sphere fits to the ellipsoid:

$$\Phi_n = 47^{\circ}10'00.0''$$

From sphere to plane:

Central latitude, where the cylinder fits to the sphere

$$\Phi_0 = 47^{\circ}8'39.817362''$$

These latitudes differ from each other, and no option in PROJ, to define this...

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Solved

- EPSG 23700 code,
- 1.7 mm maximal error...
- ... but does not meet the standard...

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These latitudes differ from each other, and no option in PROJ, to define this...

To meet the standard...

Using the „pipeline” operation, introduced in PROJ 5.0.0.

- From ellipsoid to sphere:

$$tg\left(45^\circ + \frac{\varphi}{2}\right) = \frac{1}{k_1} \cdot tg^{k_2}\left(45^\circ + \frac{\phi}{2}\right) \cdot \left[\frac{1 - e \cdot \sin(\phi)}{1 + e \cdot \sin(\Phi)}\right]^{\frac{k_2 \cdot e}{2}}$$

$$\lambda - \lambda_0 = k_2 \cdot (\Lambda - \Lambda_0)$$

- No proper transformation in PROJ, but:

To meet the standard...

Using the „pipeline” operation, introduced in PROJ 5.0.0.

- From ellipsoid to sphere:

~~$$tg\left(45^\circ + \frac{\phi}{2}\right) = \frac{1}{\tan(\Phi)} \cdot tg^{k_2}\left(\lambda - \lambda_0 + \frac{\lambda}{2}\right) \cdot \left[\frac{1 - e \cdot \sin(\phi)}{1 + e \cdot \sin(\Phi)}\right]^{\frac{k_2 \cdot e}{2}}$$

$$\lambda - \lambda_0 = k_2 \cdot \left(\lambda - \lambda_0\right)$$~~

- No proper transformation in PROJ, but:
- Horner Polynomial Evaluation:

```

kHD72GG>
+proj=horner
+ellps=GRS67
+fwd_origin=19.048571777777781,47.166666666666666
+inv_origin=19.048571777777781,47.122238277777775
+deg=3
+fwd_u=19.048571777777781,1.0007197049,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0
+fwd_u=47.122238277777775,0.998446010000000,0.000087562800000,-0.000000068688000,0.0,0.0,0.0,0.0,0.0,0.0
+inv_u=47.166666666666666,1.001556410000000,-0.000087969600000,0.000000084369600,0.0,0.0,0.0,0.0,0.0,0.0
+inv_u=19.048571777777781,0.999280812702622,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0
    
```

To meet the standard...

Using the „pipeline” operation, introduced in PROJ 5.0.0.

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```

- From sphere to plane:

Spherical form of the somerc projection

```

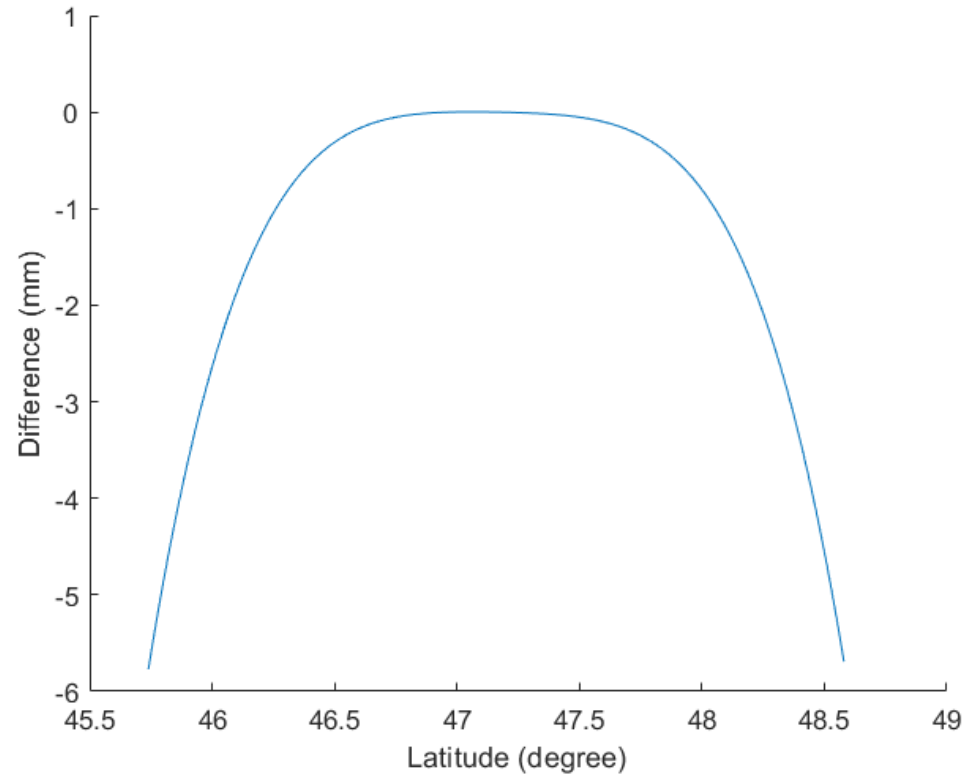
+proj=somerc \
+R=6379743.001 \
+lat_0=47.100000 \
+lon_0=19.04857177777778 \
+k_0=0.99993 \
+x_0=650000 \
+y_0=200000
    
```


Usage example

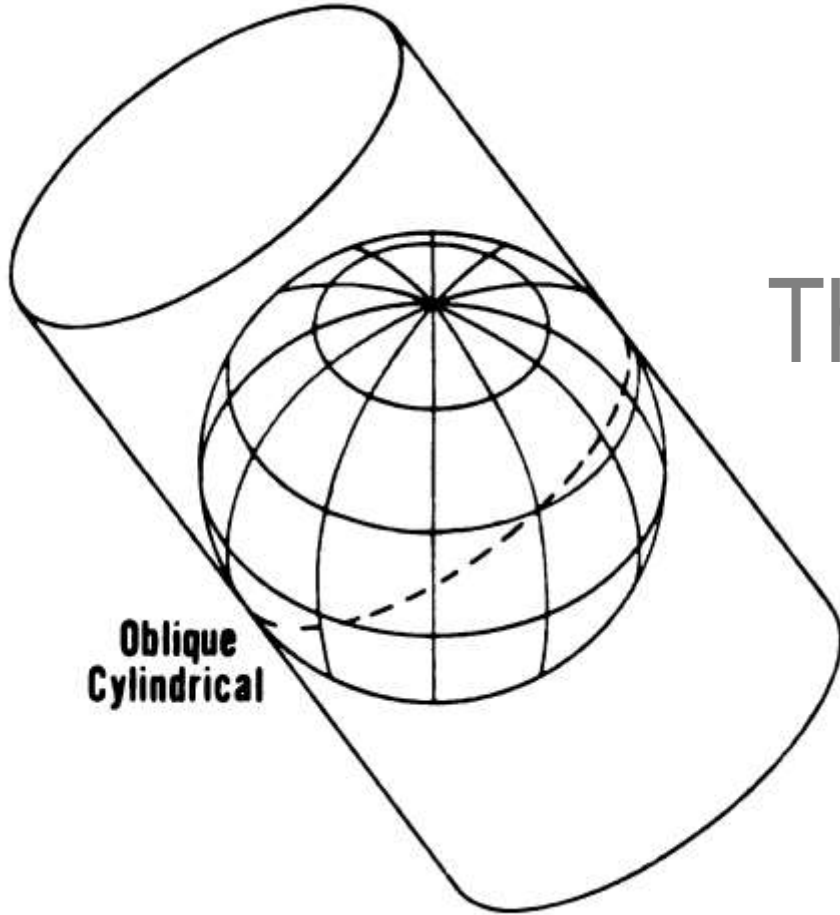
```
cct -vvv -z 0 -t 0 -d 10 ^  
+proj=pipeline ^  
+step +proj=eqc +a=57.295779513082323 ^  
+step +init=proba:HD72GG ^  
+step +proj=eqc +a=57.295779513082323 +inv ^  
+step +proj=somerc +R=6379743.001 +lat_0=47.100000000  
+lon_0=19.048571777777781 +k_0=0.99993 +x_0=650000.0 +y_0=200000.0
```

Horner Polynomial Evaluation does not support ellipsoidal coordinates as input...

... what you gain on the roundabouts ... you lose on the swing...



Difference of coordinates projected by the exact solution and by the PROJ pipeline method proposed here, in mm.



**Oblique
Cylindrical**

Thank you for your kind attention!