NWM based rigorous Mapping Functions & Horizontal Gradients for selected stations and the globe with no latency

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Intro

In GPS processing the tropospheric delay T is approximated

$$T(e,a) = m_h(a_h, b_h, c_h, e) \cdot z_h + m_w(a_w, b_w, c_w, e) \cdot z_w + \mathrm{mg}(e) \cdot (N \cos(a) + E \sin(a))$$

e ... elevation angle
a ... azimuth angle
zh ... zenith hydrostatic delay
zw ... zenith non-hydrostatic delay
mh ... hydrostatic MF (Marini 1972, Radio Science, Herring 1992)
mw ... non-hydrostatic MF (Marini 1972, Radio Science, Herring 1992)
ah ... ah-coefficient
bh ... bh-coefficient
ch ... ch-coefficient
aw ... aw-coefficient
bw ... bw-coefficient
cw ... cw-coefficient
mg ... gradient MF (Chen & Herring, 1997, JGR)
N ... NS gradient
E ... EW gradient

Utilizing NWM data and the Direct Numerical Simulation (DNS) tool (*) we determine

$$x=[ah,bh,ch,aw,bw,cw,zh,zw,N,E]$$

for specific locations

(1) the E-GVAP stations (1664 stations)
(2) a global grid with 1° resolution.

(*) details can be found here:
Zus et al. 2014, Radio Science
Zus et al. 2014, GPS Solut.

Method

We use Potsdam Mapping & Slant Factors (PMFs & PSFs). For any location

zenith delays & abc's:

10 hydrostatic (non-hydrostatic) PMFs are computed for various elevation angles (down to 3°) and then the hydrostatic (non-hydrostatic) abc's of the MF are determined by least-square fitting.

N & E gradient:

(1) 120 PSFs and corresponding PMFs are computed for various elevation and azimuth angles.

(2) zenith delays are applied to obtain azimuth-dependent and azimuth-independent slant delays.

(3) the difference between azimuth-dependent and azimuth-independent slant delays is computed.

(4) the N and E gradient are determined by least-square fitting.

Features

NWM : NCEP's GFS 6 & 9 h forecast (1° resolution, 26 pressure levels).

Frequency: 3h (0, 3, 6, 9, 12, 18, 21UTC)

Grid : 1° resolution (world.ell)

Stations : E-GVAP (egvap.ell)

Latency : no latency

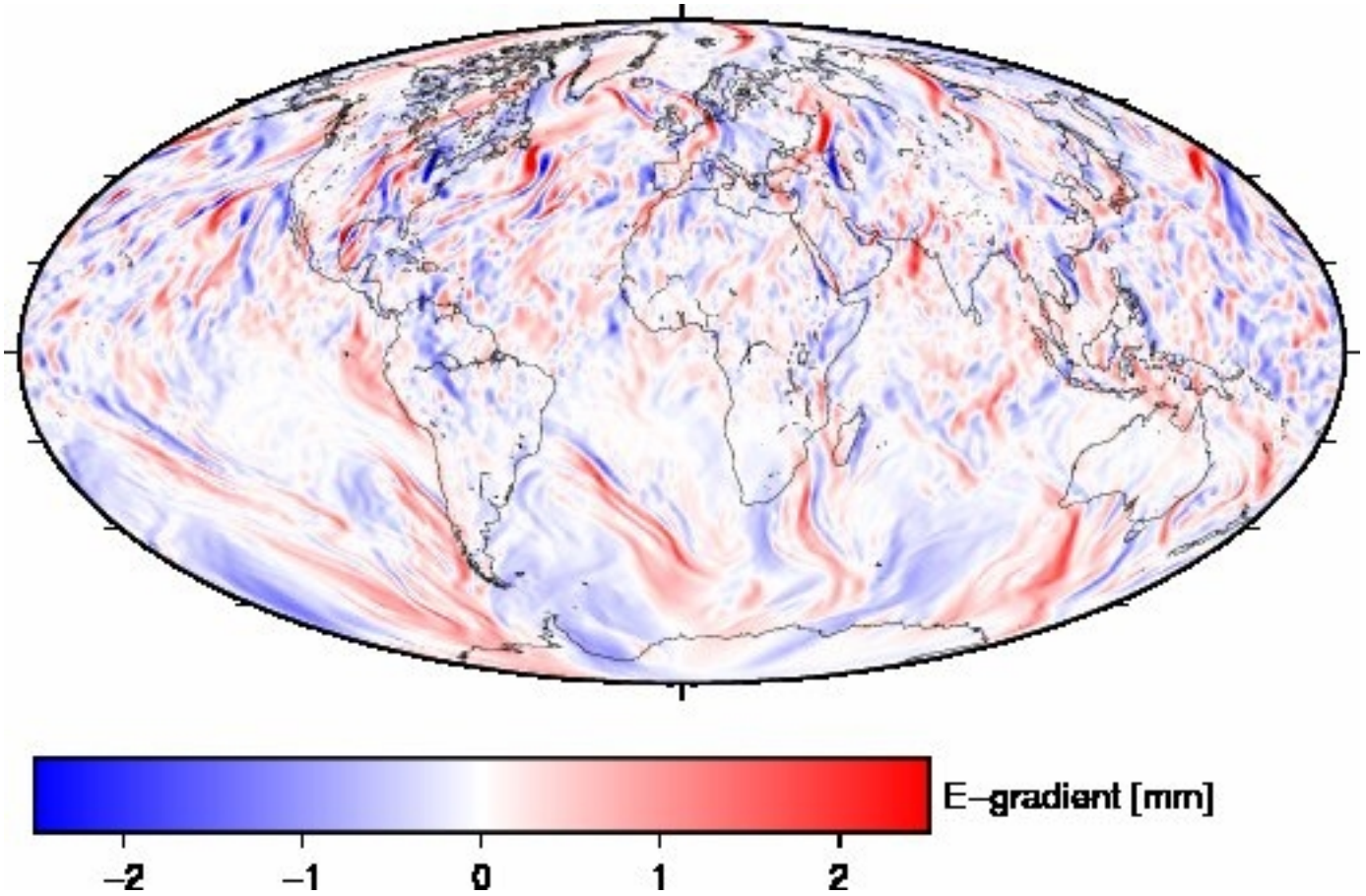
Data files : ascii

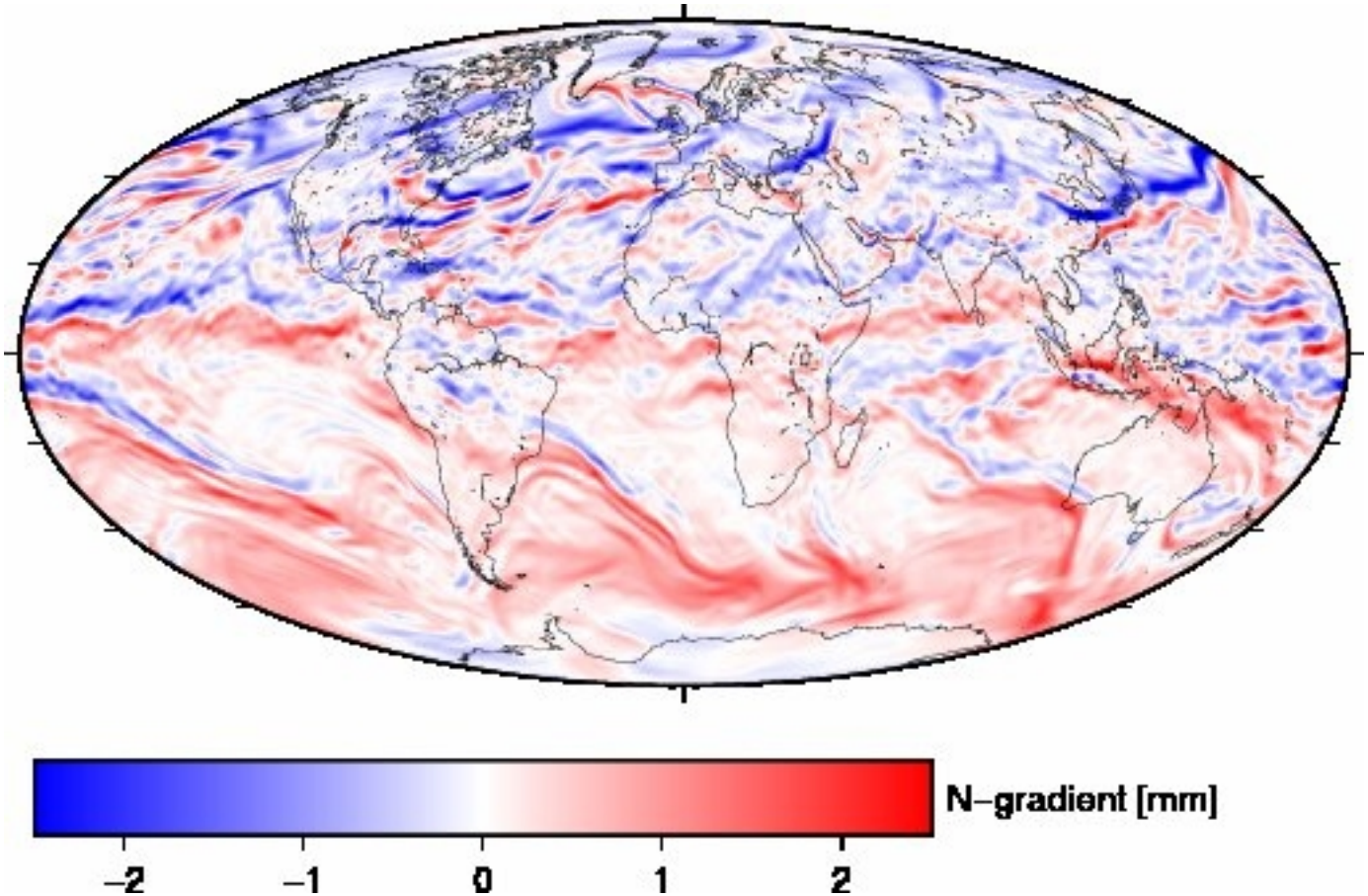
Plots : jpeg

Processing time: 10 min for one epoch (NCEP grip ftp download to jpeg)

Status : experimental

Example




N–gradient [mm]
–2
–1
0
1
2

Purpose

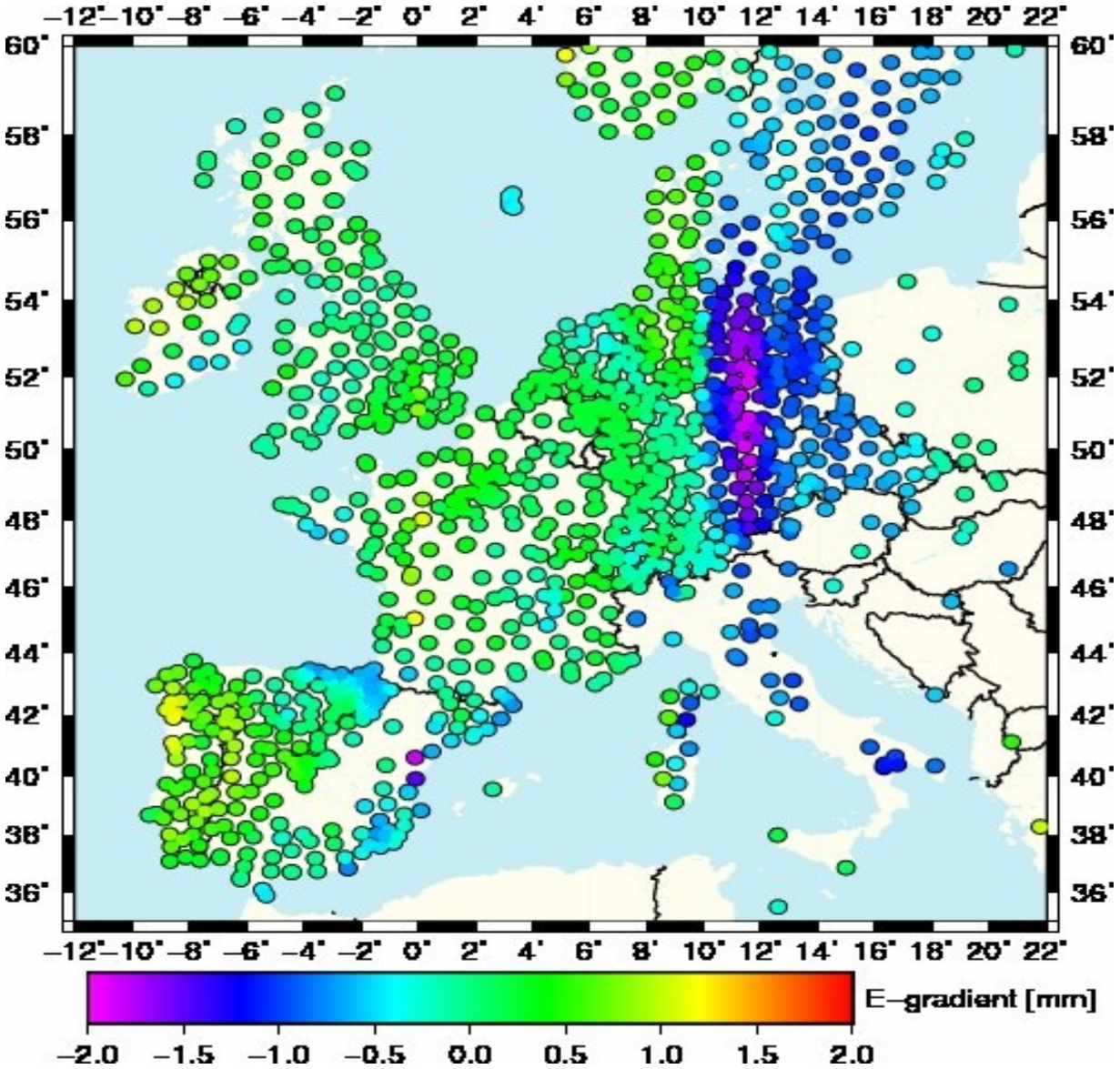
(1) compare the NWM solution with the GPS solution,
i.e., zenith delays, gradients (& abc's).

(2) use the NWM solution as a background information in GPS processing.

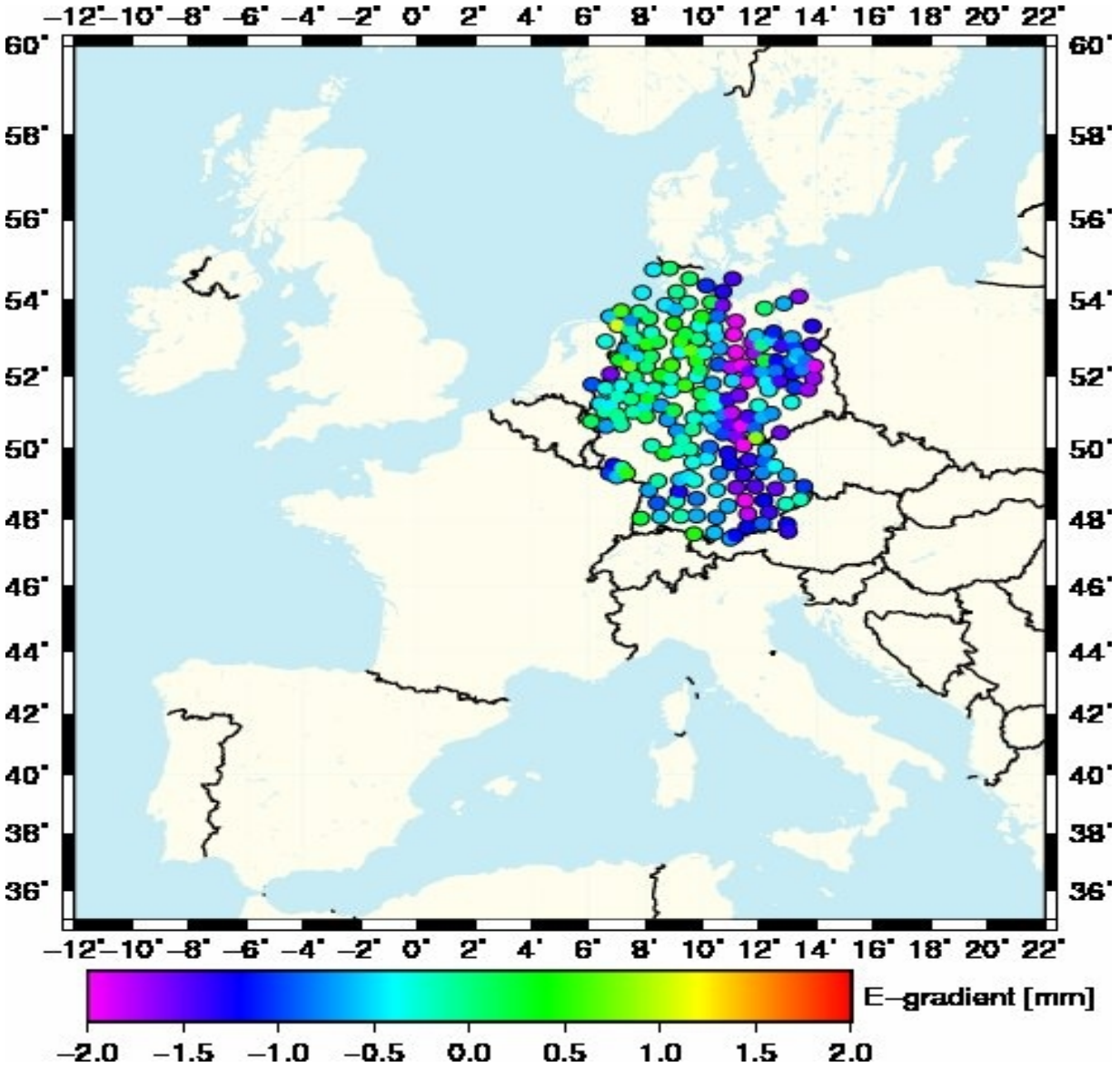
(3) check if (2) improves the GPS solution (positioning & atm domain).

At the moment we are at stage 1 ...

NWM


−12° −10° −8° −6° −4° −2° 0° 2° 4° 6° 8° 10° 12° 14° 16° 18° 20° 22°
60° 58° 56° 54° 52° 50° 48° 46° 44° 42° 40° 38° 36°
E−gradient [mm]
−2.0 −1.5 −1.0 −0.5 0.0 0.5 1.0 1.5 2.0

GPS


−12° −10° −8° −6° −4° −2° 0° 2° 4° 6° 8° 10° 12° 14° 16° 18° 20° 22°
60° 58° 56° 54° 52° 50° 48° 46° 44° 42° 40° 38° 36°
E−gradient [mm]
−2.0 −1.5 −1.0 −0.5 0.0 0.5 1.0 1.5 2.0

Conclusion & outlook

(1) we generate NWM based zenith delays, MF and gradients.

(2) plots (& in near future data) are available with no latency @

ftp://ftp.gfz-potsdam.de/home/kg/zusflo/EGVAP
ftp://ftp.gfz-potsdam.de/home/kg/zusflo/WORLD

(3) some comparison studies are ongoing with TU Vienna and GOP.

Question

What about clouds? see e.g. Solheim et al. 1999, JGR,
Brenot et al. 2006, JGR,
Yang and Zou 2012, JGR,
Zou et al 2012, JAS.