GPT2/GMF2: An improved empirical model for troposphere delays

J. Böhm, K. Lagler, M. Schindelegger, H. Krásná, T. Nilsson

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Troposphere delay modeling

$$\Delta L(e) = \Delta L_h^z \cdot mf_h(e) + \Delta L_w^z \cdot mf_w(e)$$

- if available
  - pressure values at the site (or numerical weather models)
  - ray-traced delays or Vienna Mapping Functions 1 coefficients a_h and a_w
- otherwise empirical models
  - e.g., Global Pressure and Temperature model (GPT)
  - e.g., Global Mapping Functions (GMF)

Motivation

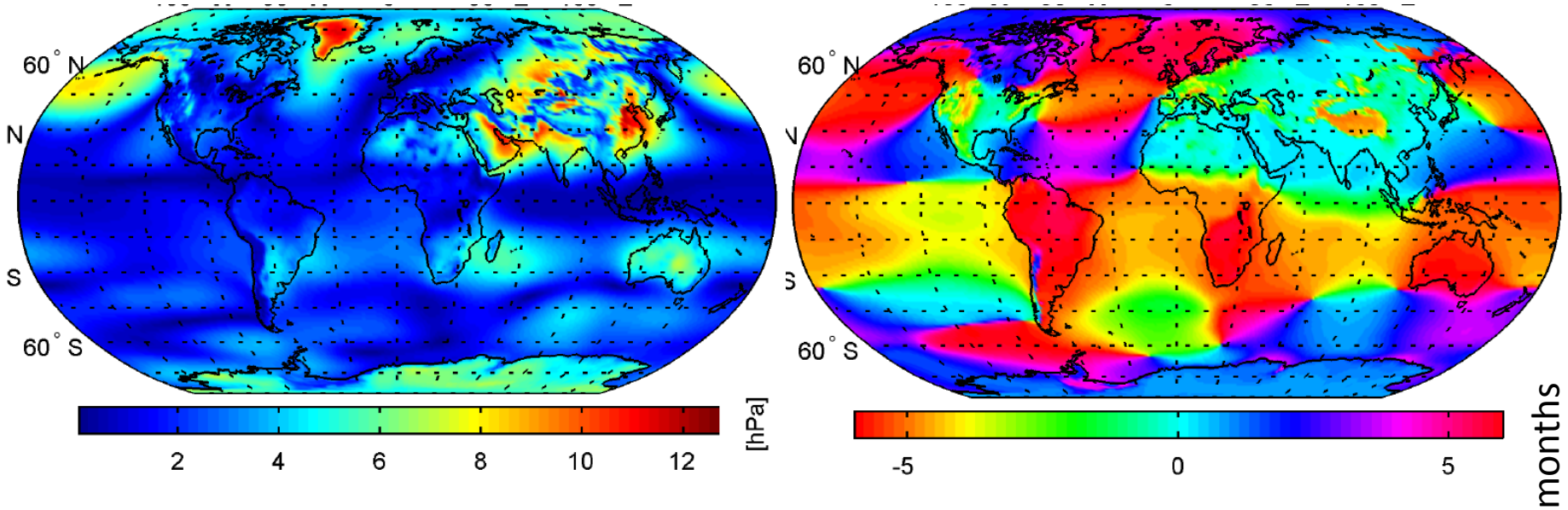
GPT/GMF	
3 years (1999-2002) monthly mean profiles from ERA40 (23 pressure levels)	
Spherical harmonics to degree and order 9 at mean sea level	
Mean and annual terms	
Phase fixed to January 28	
Pressure (p), temperature (T), a_h, a_w	

Motivation

GPT/GMF	GPT2
3 years (1999-2002) monthly mean profiles from ERA40 (23 pressure levels)	10 years (2001-2010) monthly mean profiles from ERA-Interim (37 levels)
Spherical harmonics to degree and order 9 at mean sea level	5 degree grid at mean ETOPO5 heights
Mean and annual terms	Mean, annual, and semiannual terms
Phase fixed to January 28	Phase estimated
Pressure (p), temperature (T), a_h, a_w	p, T, lapse rate (dT), water vapour pressure (e), a_h, a_w

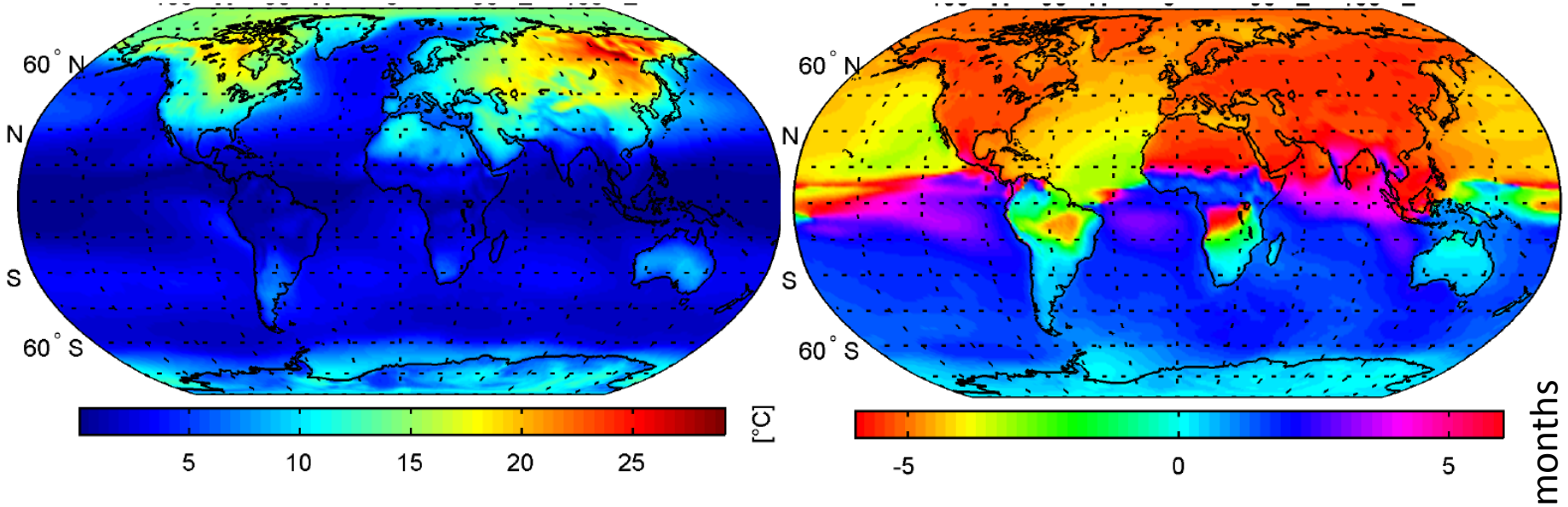
GPT2 - Pressure

- Annual amplitude and phase of the pressure



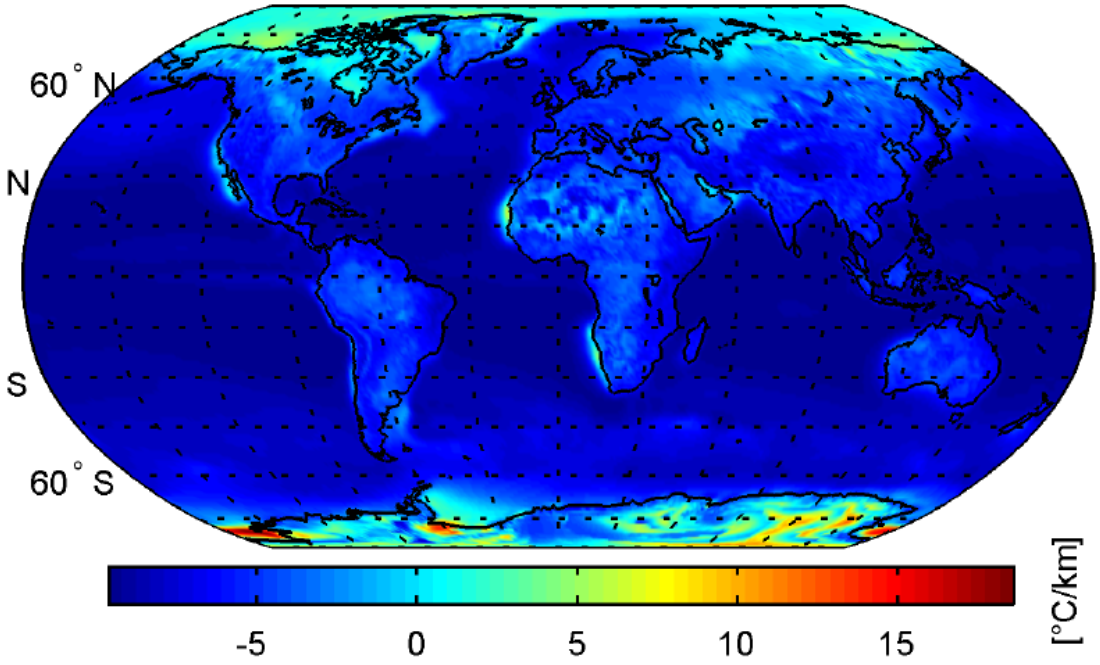
GPT2 - Temperature

- Annual amplitude and phase of the temperature



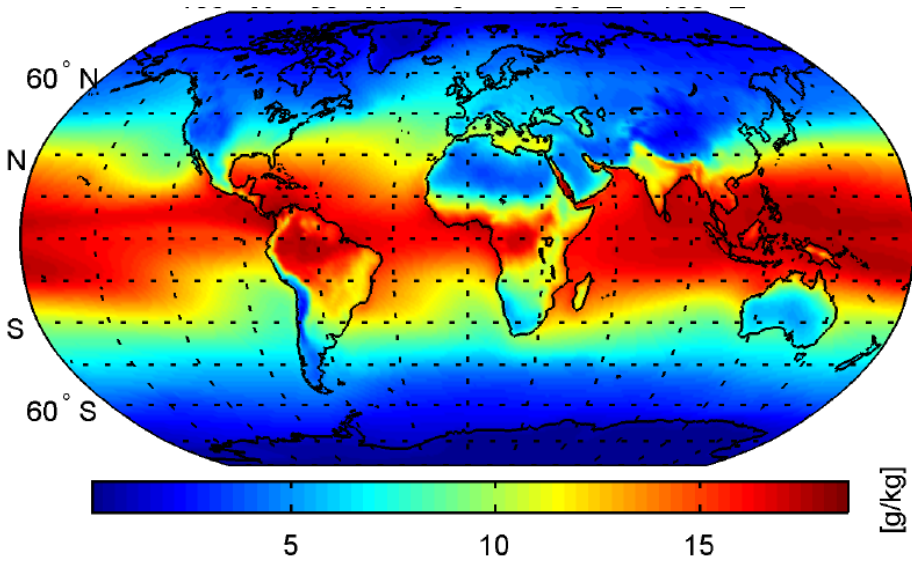
GPT2 – Temperature lapse rate

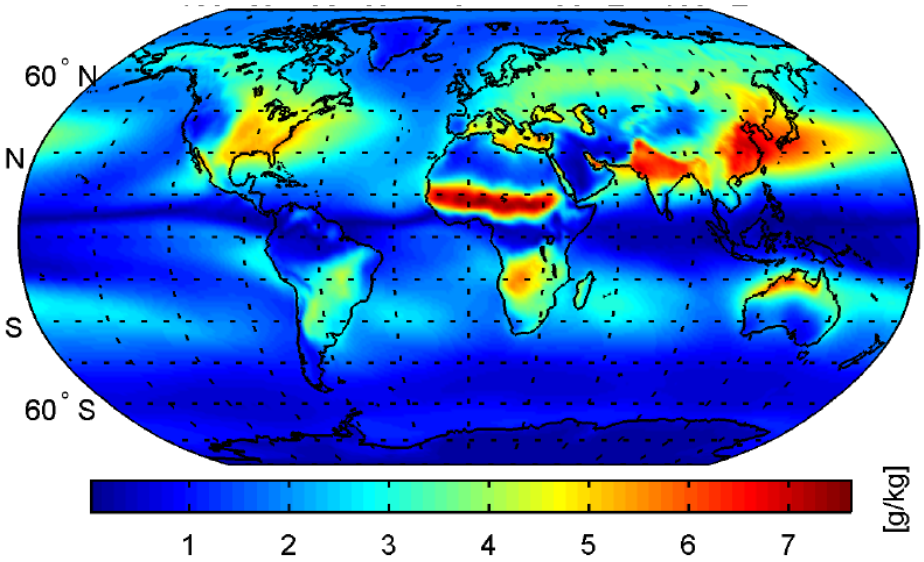
- GPT: - 6.5 °C/km
- GPT2: Mean, annual and semi-annual



GPT2 – Specific humidity

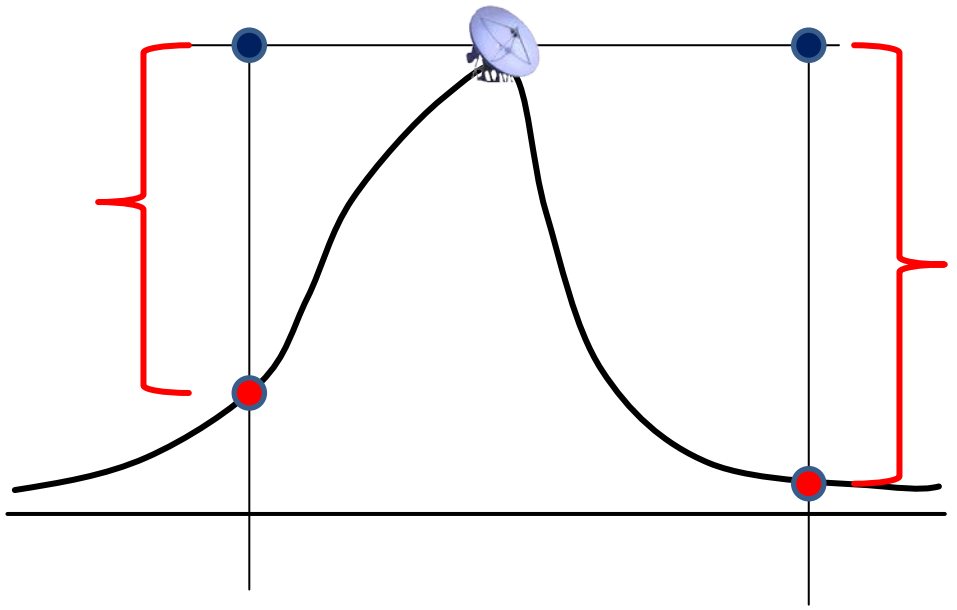
- Mean and semi-annual amplitude of specific humidity





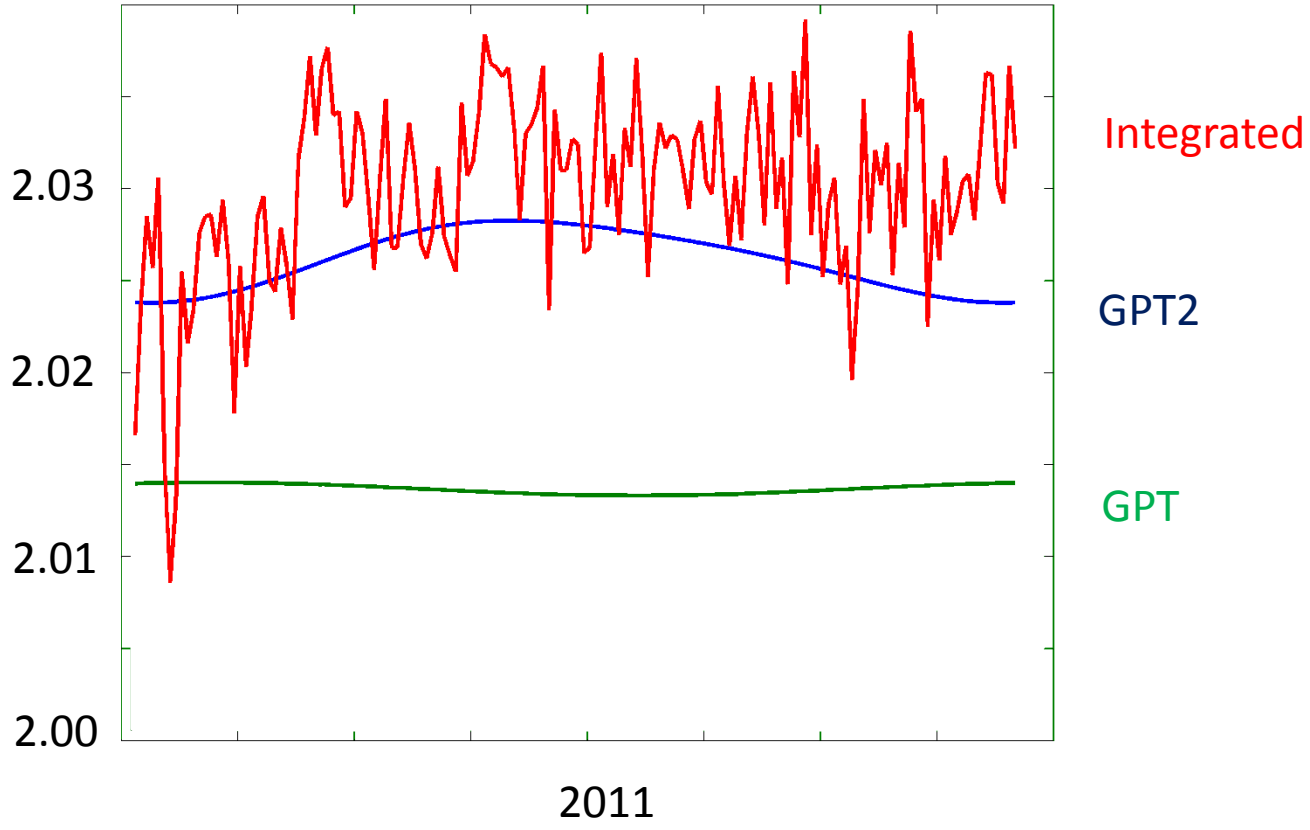
Algorithm for GPT2

- Selection of four grid points around the site
- Determine parameters at those grid points
- Reduction to the site height (dT, Tv)
- Bilinear interpolation



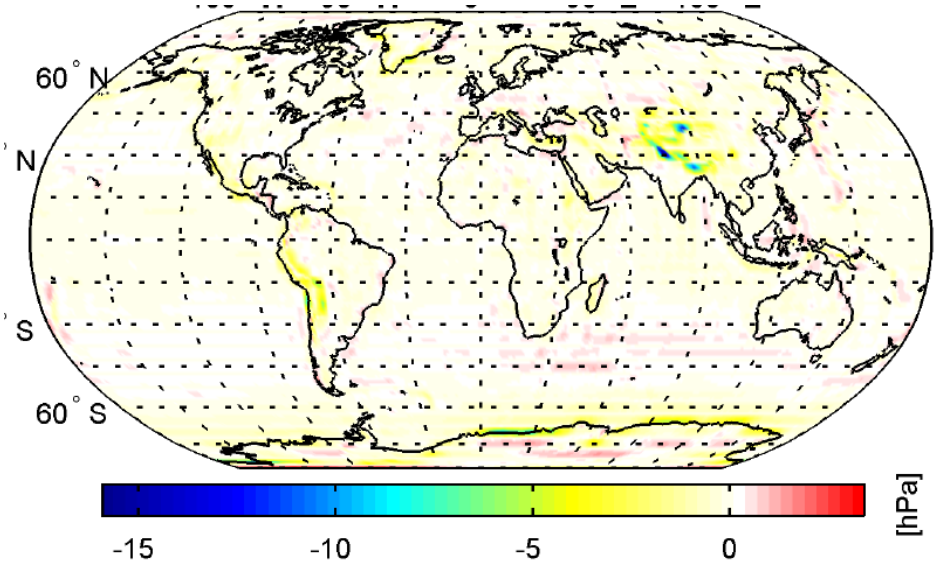
Algorithm for GPT2

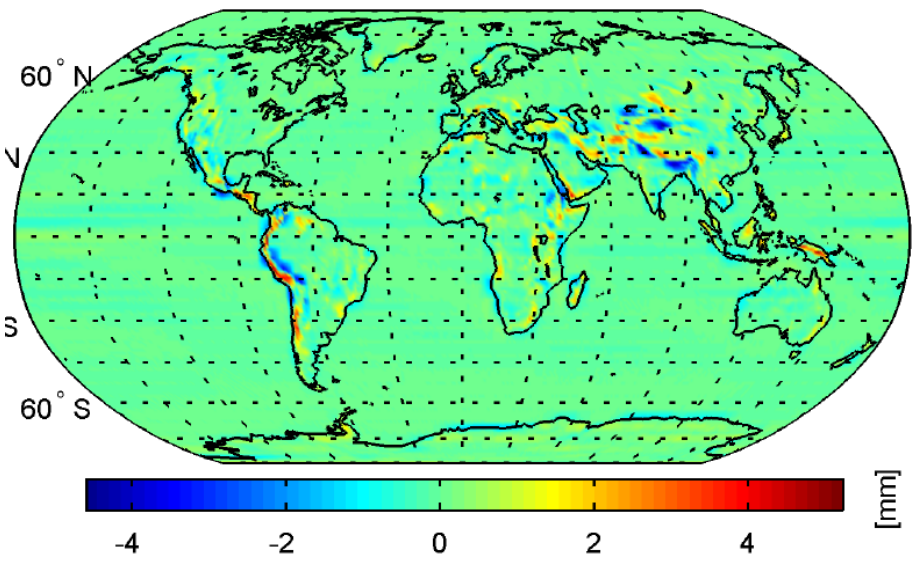
- Hydrostatic zenith delay at Kokee at 1177 m height
- grid points at sea level



Resolution of grid – 1° vs 5°

- Mean pressure and hydrostatic mapping function
- rule of thumb to express difference in height

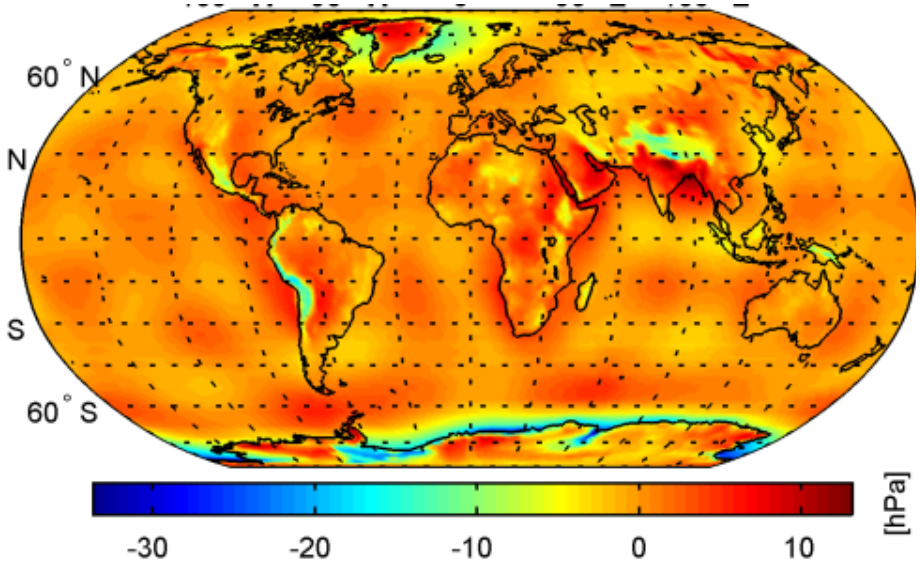


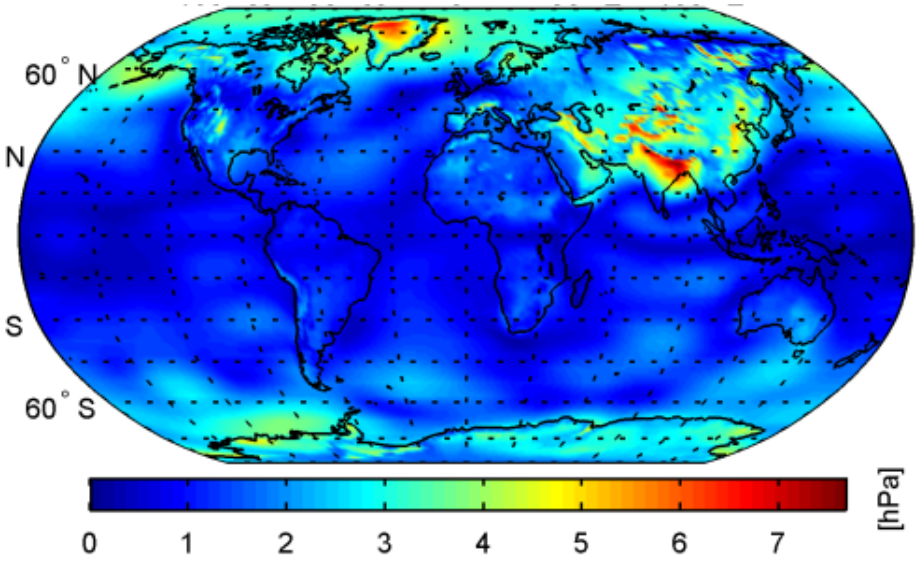


99% of grid points < 1 mm

GPT2 (5°) vs GPT

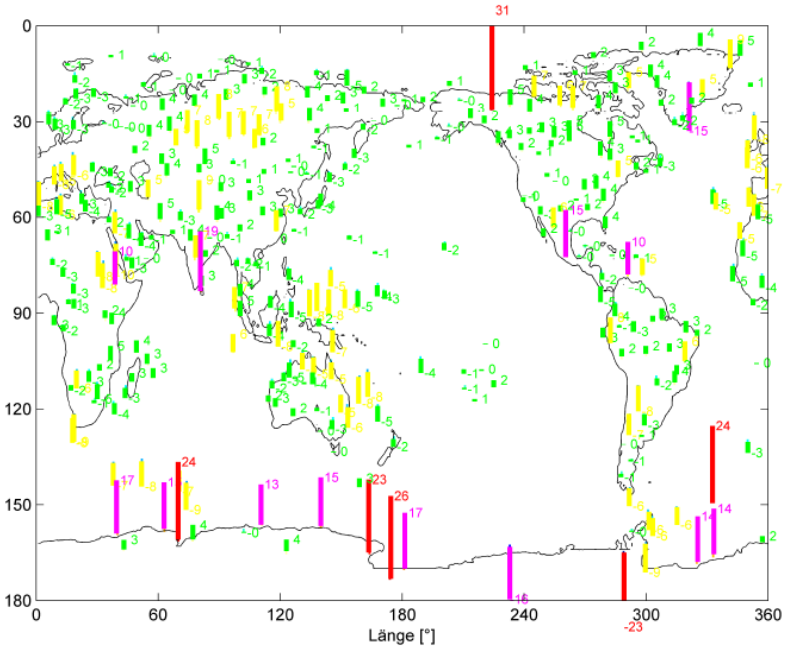
- Pressure: bias and std. dev. (hPa)



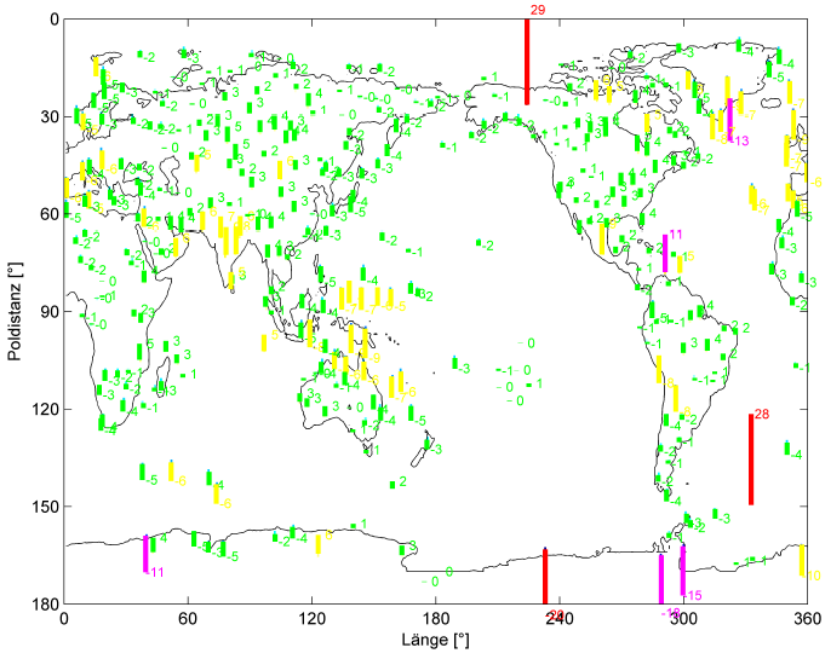


Comparison with in-situ data

GPT

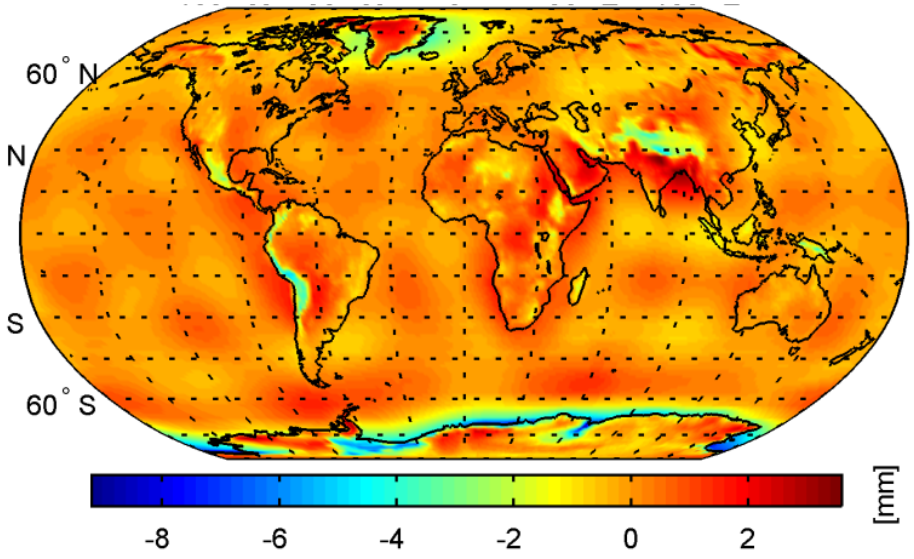


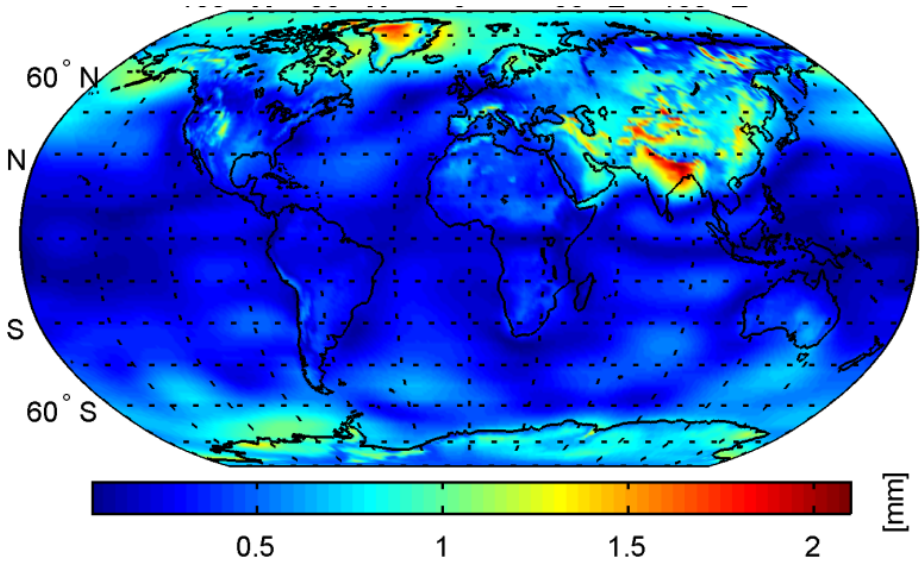
GPT2



GPT2 (5°) vs GPT

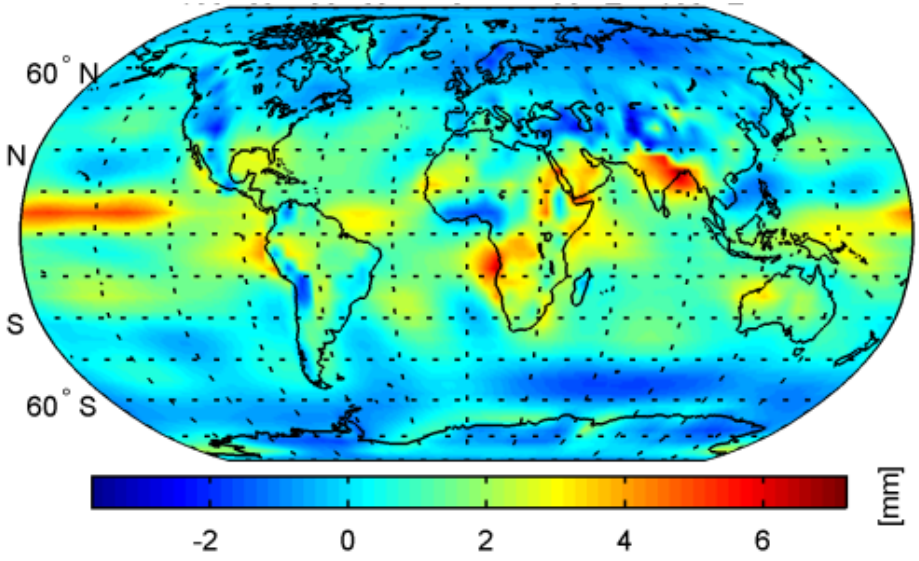
- Pressure: bias and std. dev. (mm)

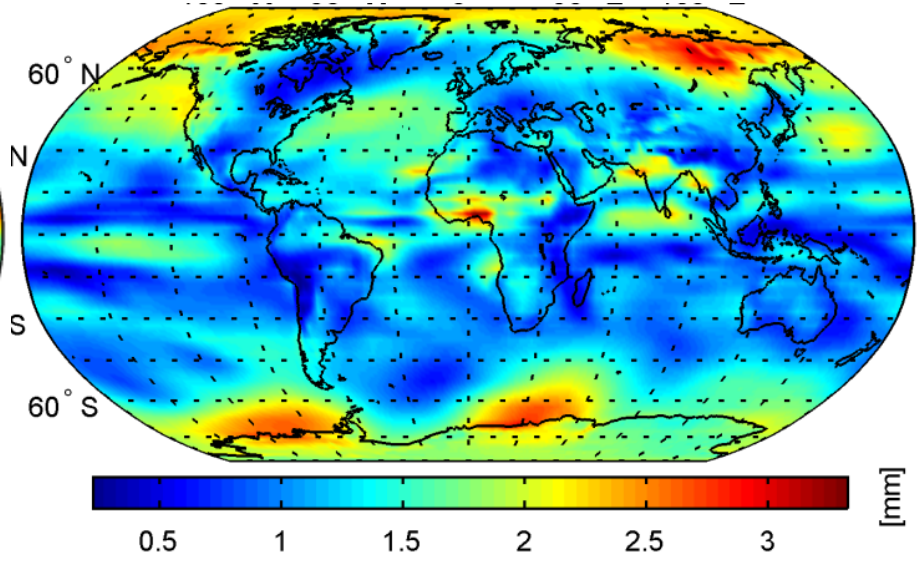




GPT2 (5°) vs GMF

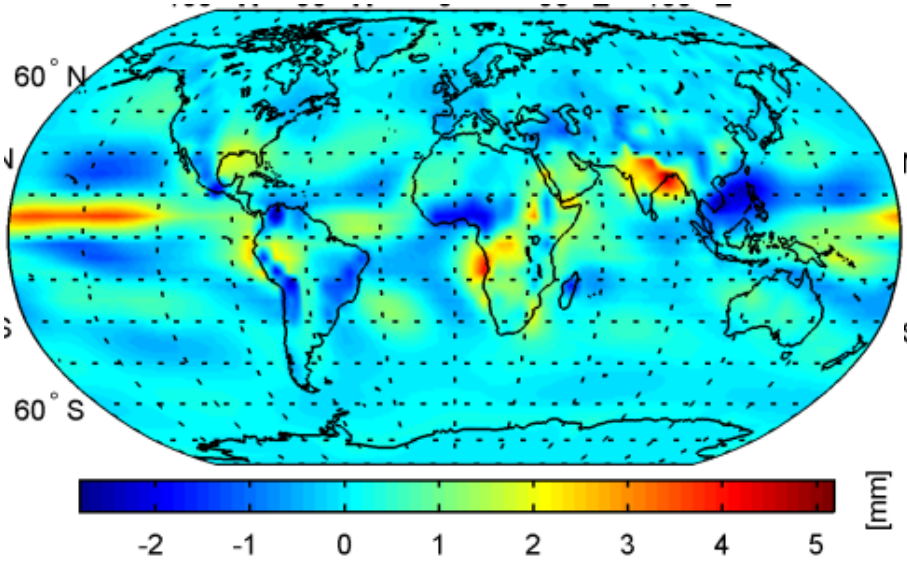
- Hydrostatic mf: bias and std. dev. (mm)

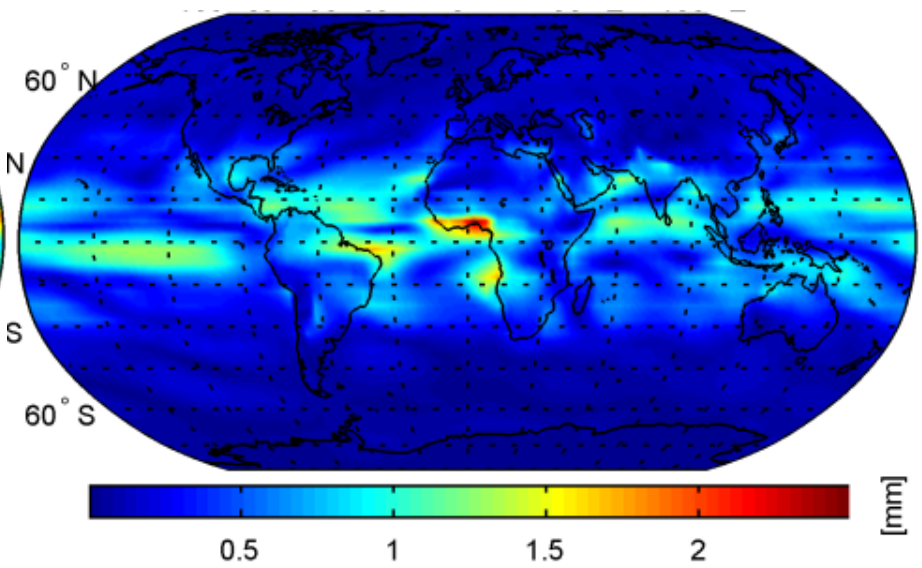




GPT2 (5°) vs GMF

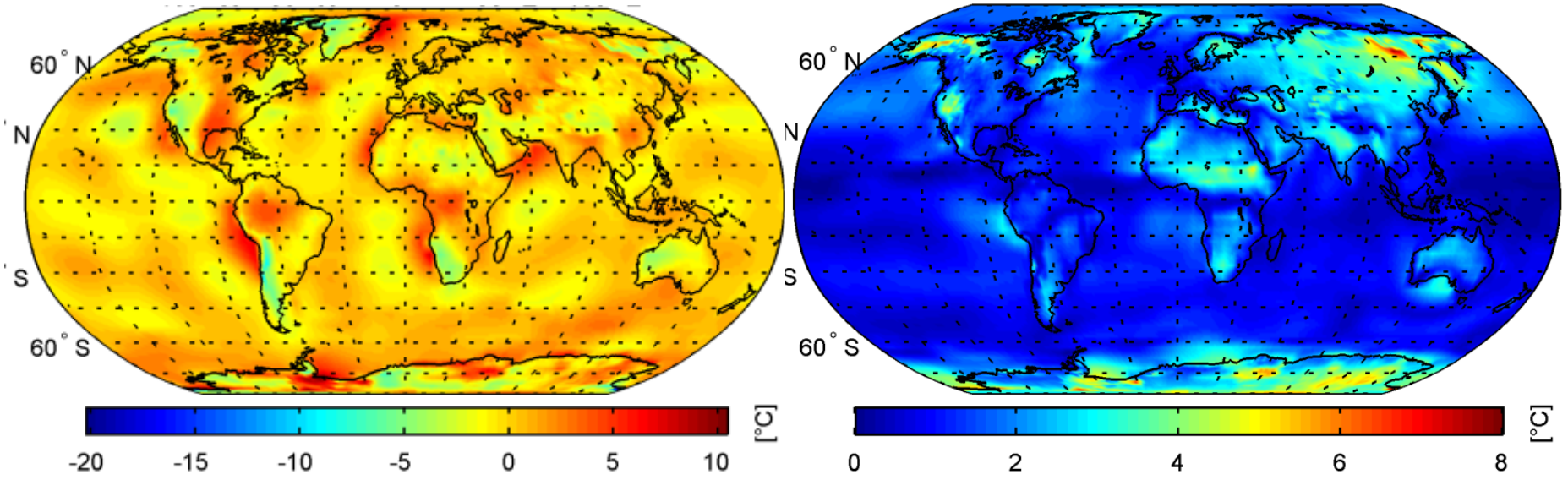
- Wet mf: bias and std. dev. (mm)





GPT2 (5°) vs GPT

- Temperature: bias and std. dev.

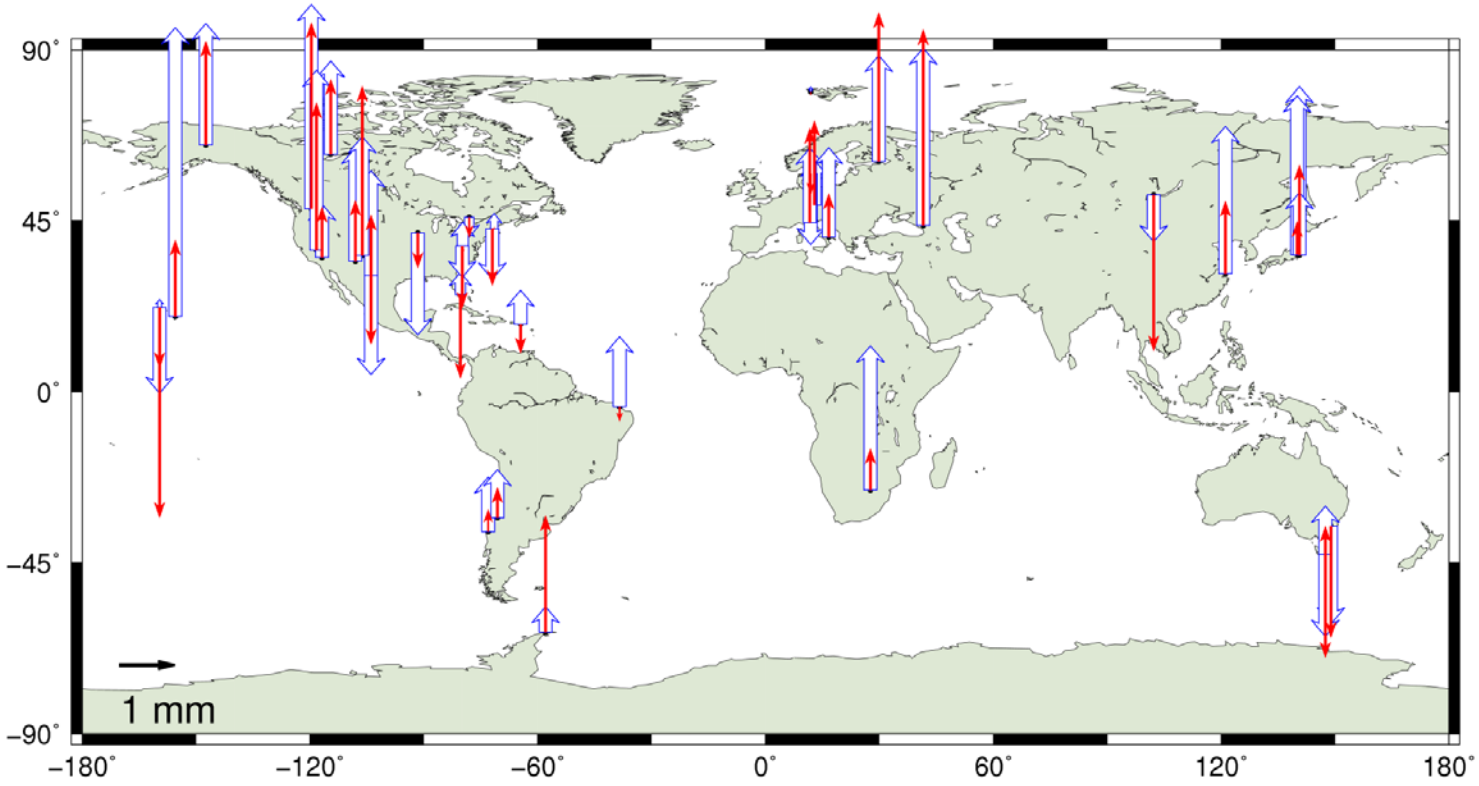


VLBI analysis

- Global solution with VieVS (1984 – 2012.5)
- Correction of atmosphere pressure loading
- Comparison of station heights from three solutions
  - VMF1 with pressure values at the site
  - GPT/GMF
  - GPT2

VLBI analysis

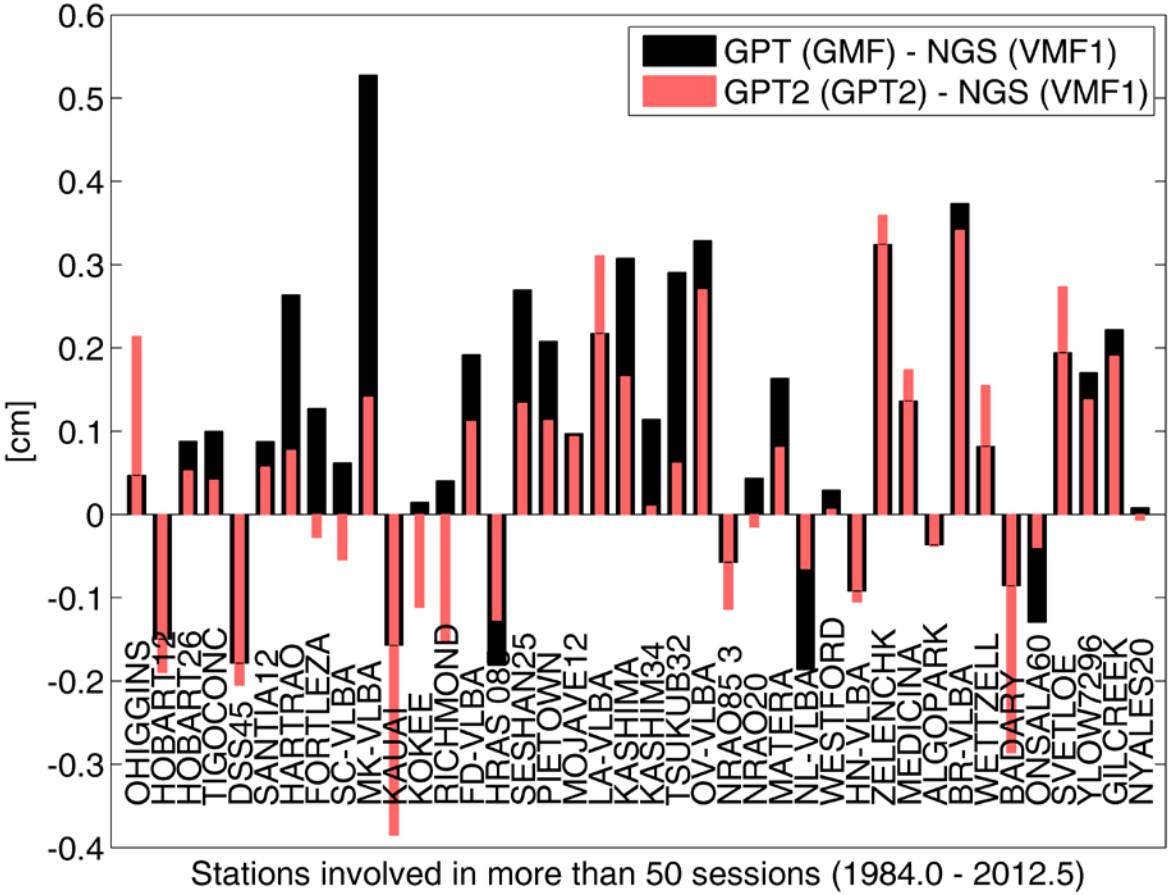
- Mean station height differences w.r.t. VMF1



GPT/GMF
GPT2

VLBI analysis

- Mean height differences w.r.t. VMF1



Conclusions

- New empirical (blind) model for troposphere delay modeling: GPT2
- GPT2 replaces GPT/GMF
- Higher resolution in space and time
- Additonal parameters: dT, e, a_h, a_w
- Allow modeling of zenith wet delays
- Coefficients a_h and a_w to be used with vmf1_ht.f
- Available at: http://ggosatm.hg.tuwien.ac.at/DELAY/SOURCE

THANKS FOR YOUR ATTENTION