

Mitigation of ionospheric scintillation effects in kinematic LEO precise orbit determination

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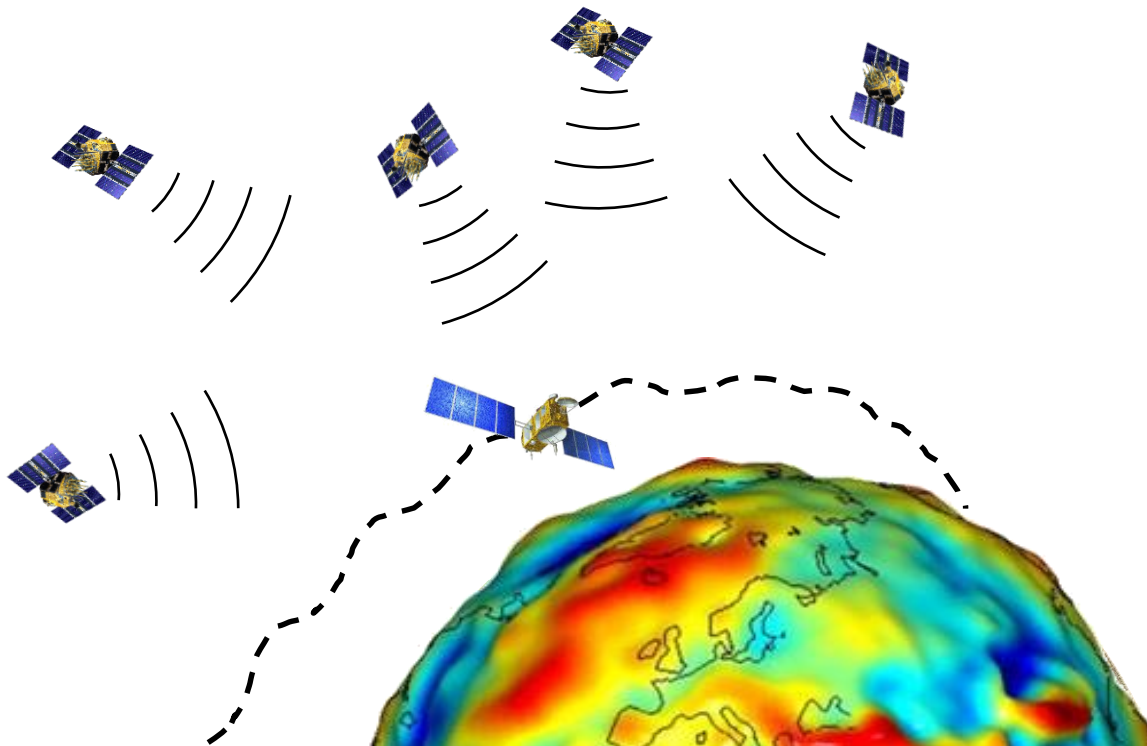
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Introduction

- Kinematic orbit determination for gravity field estimation

High-low satellite-to-satellite tracking



Introduction

- Kinematic orbit determination for gravity field estimation
- Orbit accuracy directly affects gravity field results

Orbit errors are mapped to the gravity field

- Random errors
- Systematic errors

Precise orbit determination

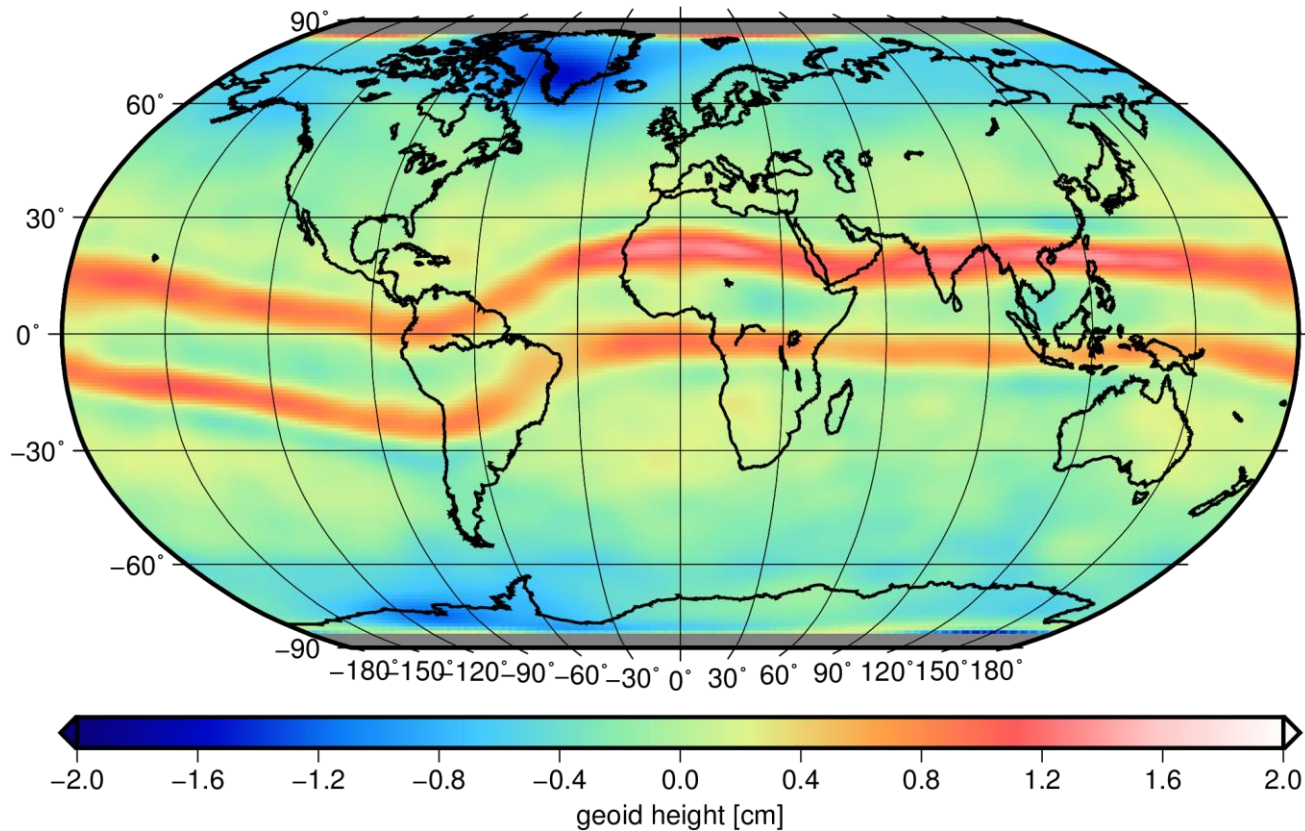
- Precise point positioning approach
- Precise orbits and clocks (IGS, ...)
- Raw observations
 - no linear combination
 - no differencing
- Code and phase used in one adjustment

Precise orbit determination

- Azimuth and elevation dependent ACVs for receiver and transmitter
 - Code and phase observation
- Azimuth and elevation dependent weighting scheme
 - Code and phase observation
- Ionosphere: STEC estimated, 2nd and 3rd order terms considered, bending correction
- ...

Systematic effect

- Gravity field and steady state Ocean Circulation Explorer



GOCE SST-hl vs. GOCO05, Gaussian filter 500 km applied

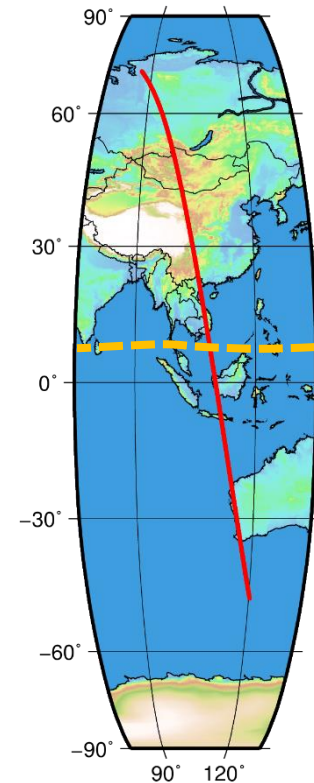
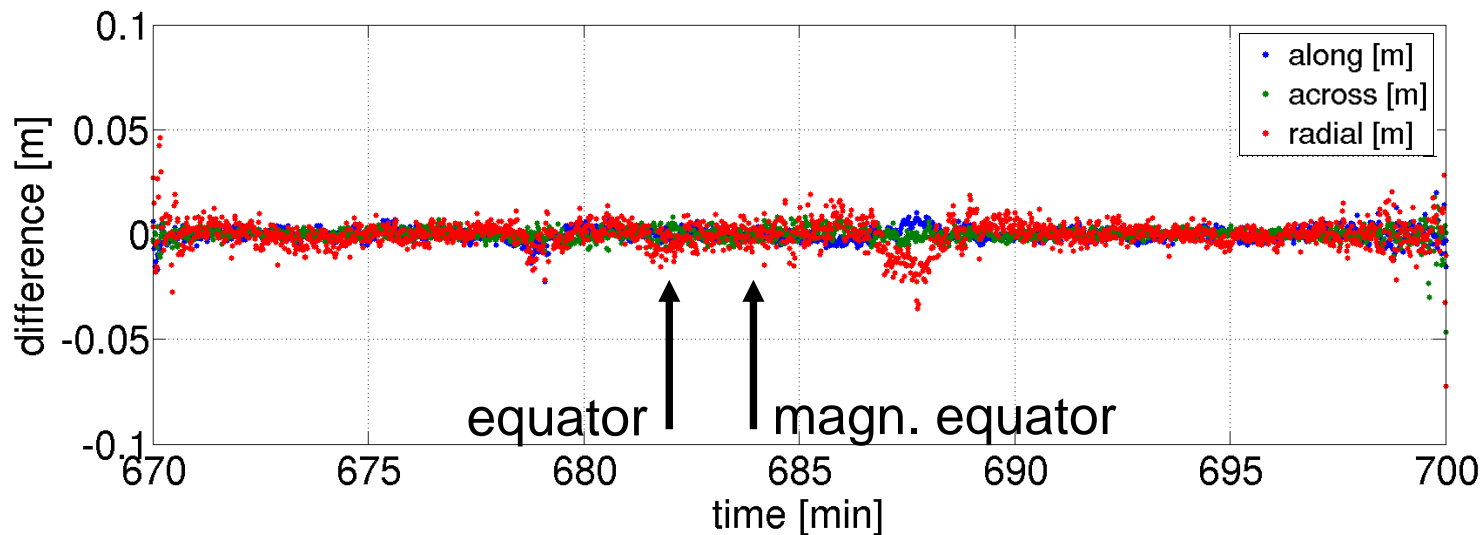
Geomagnetic effect?

- Obviously related to geomagnetic field
- Magnetic field influences ionosphere
 - Especially in equatorial and polar regions
- Higher order ionospheric terms already included
- Ionospheric bending corrected

Reason?

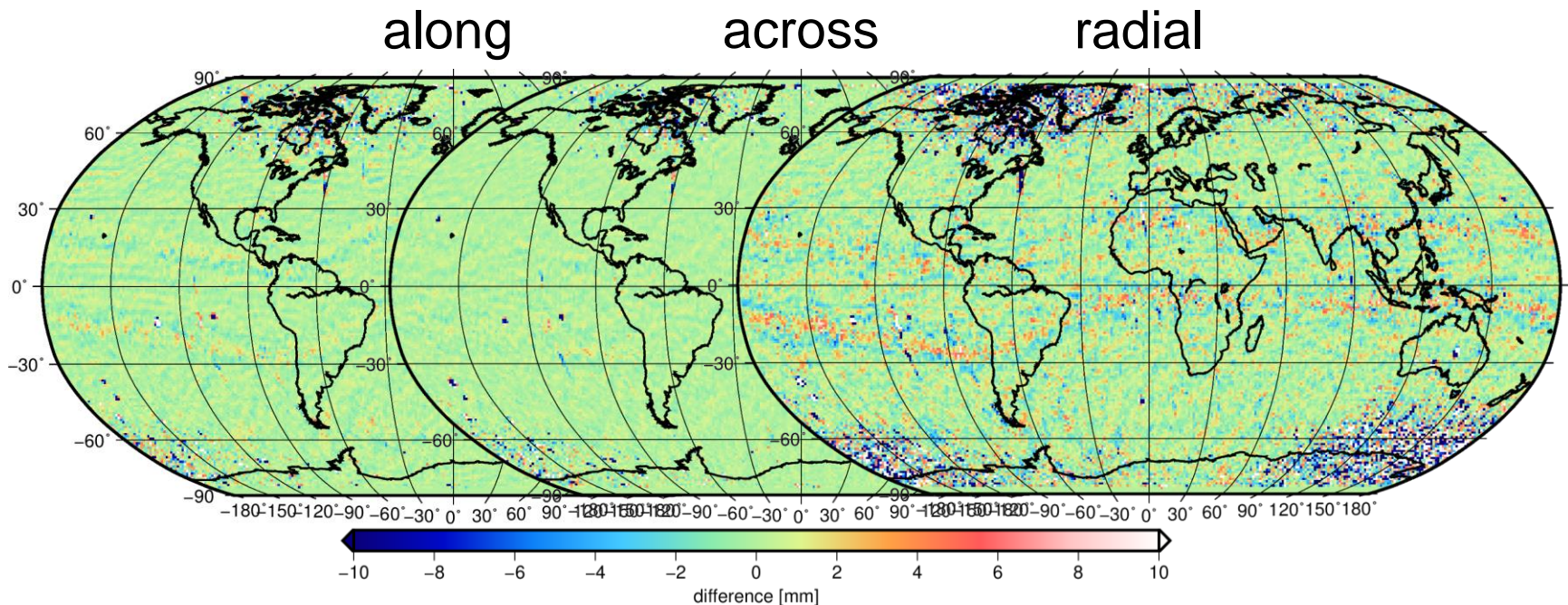
Ionospheric effect

- Only occurs in ascending arcs of GOCE (dusk-dawn orbit)
 - Ascending at ~18:00 local time
- Very small in terms of positioning error



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Ionospheric scintillations

- Hard to characterize → hard to model or correct
- Find out which observations are affected and remove or reduce the weight

Rate Of TEC Index

- ROTI is defined as:

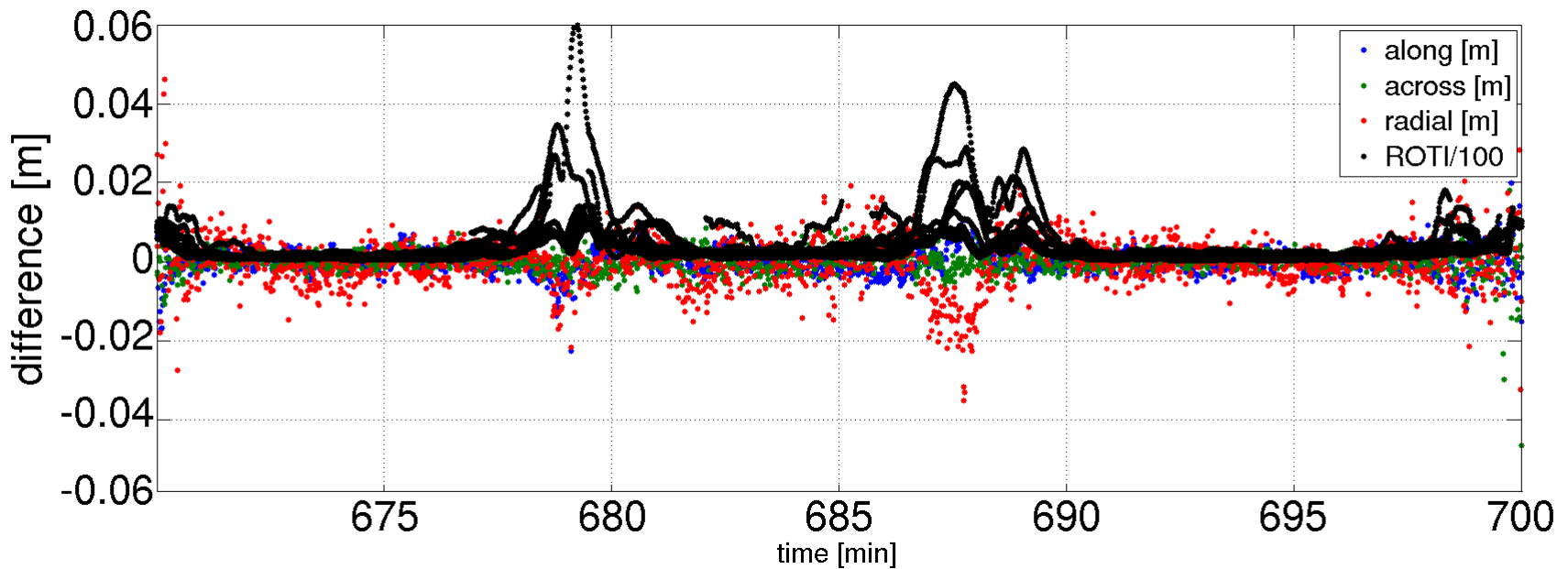
$$ROTI^2 = \frac{\langle \Delta TEC^2 \rangle - \langle \Delta TEC \rangle^2}{\Delta t^2}$$

- Index indicates ionospheric irregularities
- Applied to ΔTEC in a moving window manner
- GOCE data: 1 Hz, window size: 31 epochs

Rate Of TEC Index

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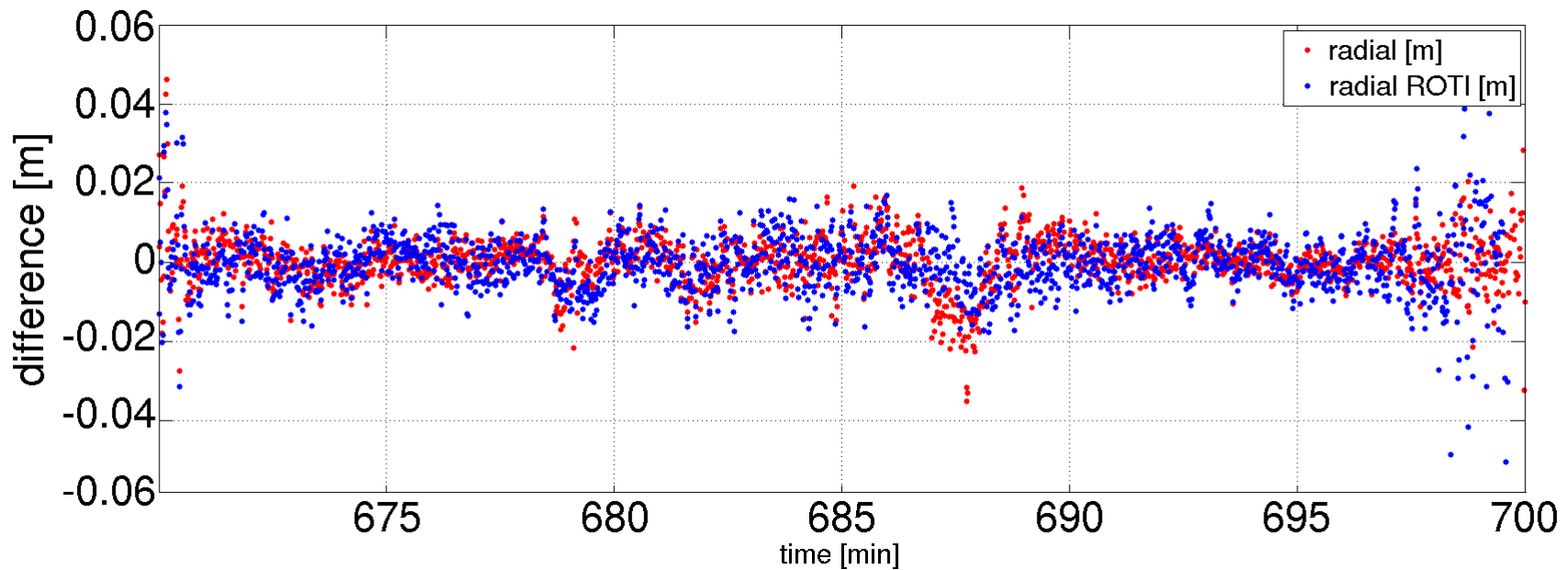


Rate Of TEC Index

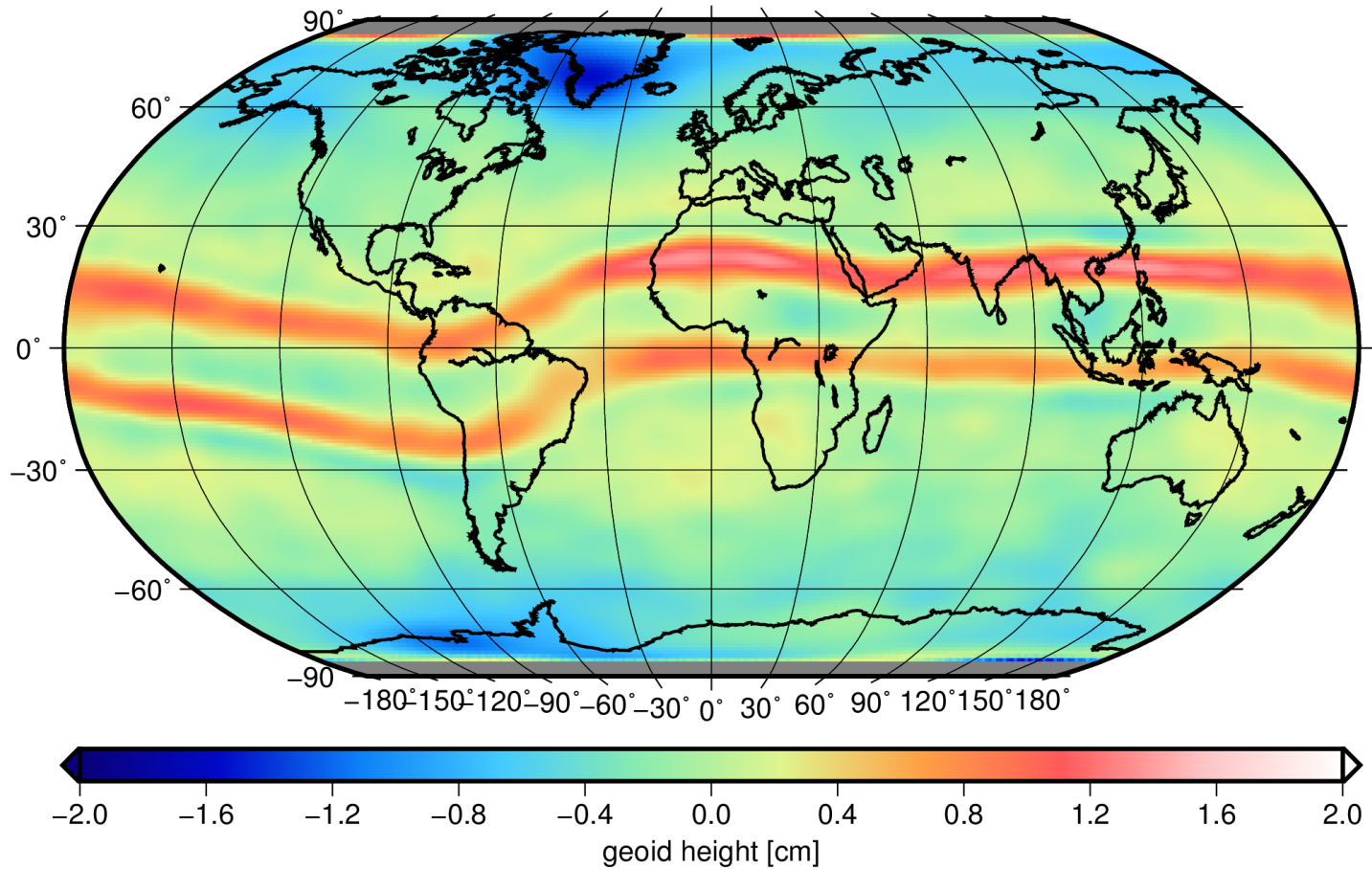
- Change observation weight depending on ROTI:
- $\sigma = 10 \cdot ROTI \cdot \sigma_0$ if $ROTI > 0.1$
- Observations are not removed completely
- Critical epochs are still solvable
- ~97% of weights unchanged

Rate Of TEC Index

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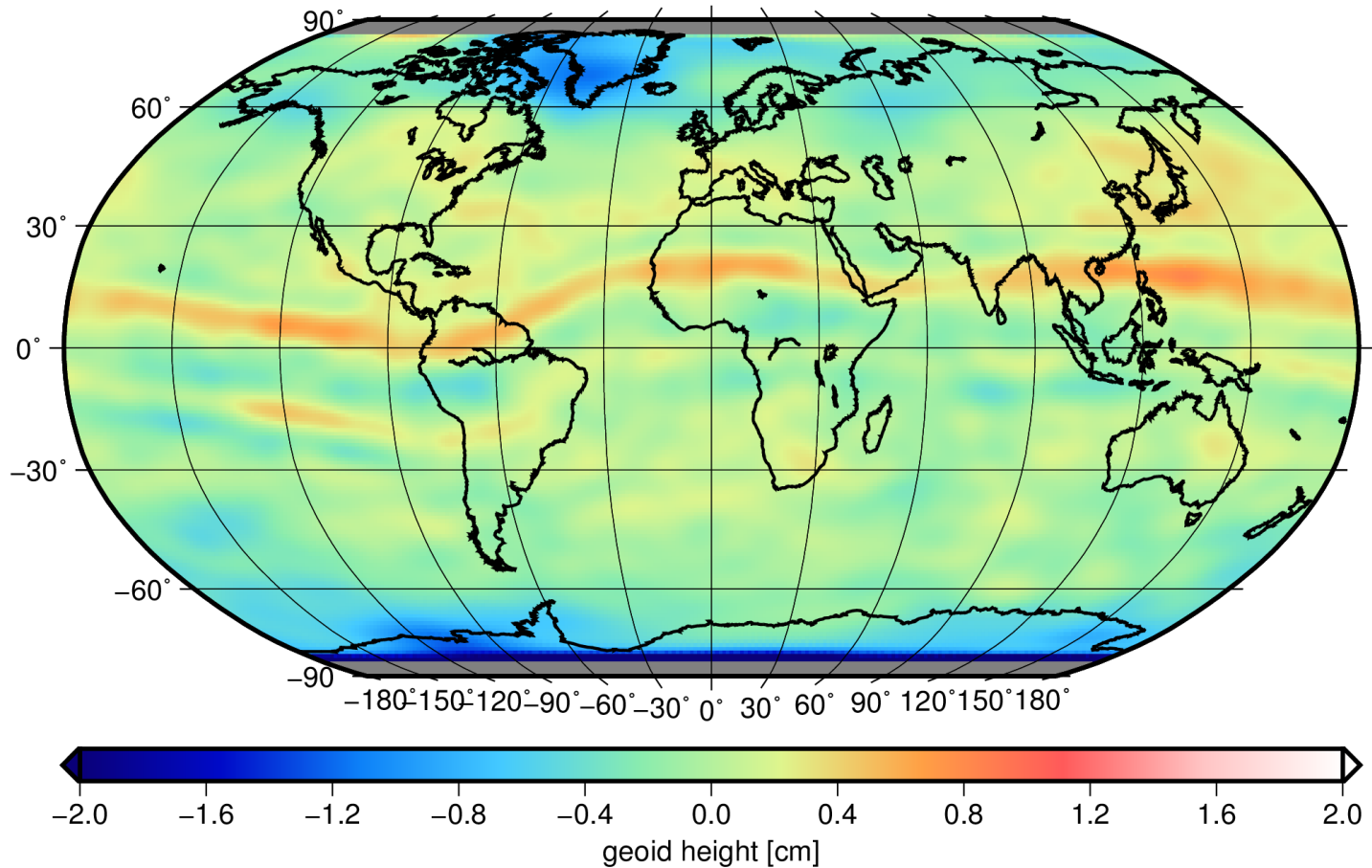


Gravity field



GOCE SST-h1 vs. GOCO05, Gaussian filter 500 km applied

Gravity field



GOCE SST-hl vs. GOCO05, Gaussian filter 500 km applied

Conclusions

- Ionospheric scintillations limit achievable accuracy in POD
 - Along the geomagnetic equator
 - Around the geomagnetic poles
- ROTI well suited to find affected observations
- Effect is almost removed by weight function

Orbits are available at:
www.itsg.tugraz.at

Thank you

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