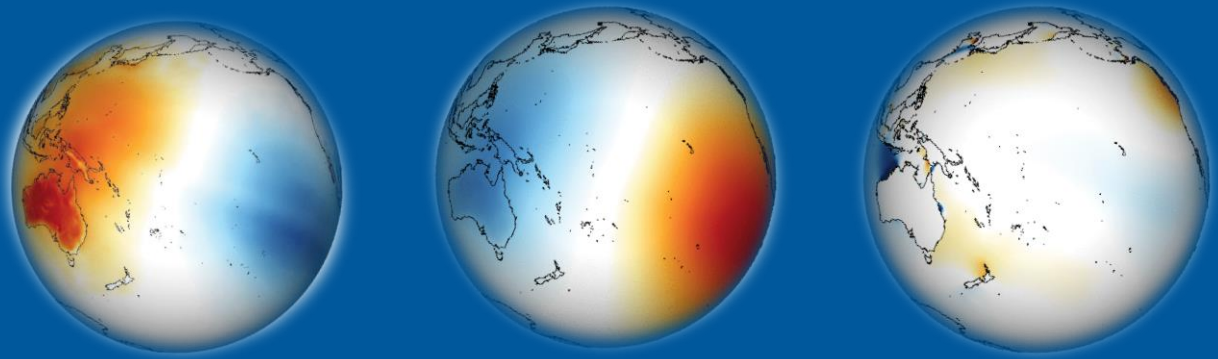
How Do Atmospheric Tidal Loading Displacements Differ Temporally as Well as between Models?



Kyriakos Balidakis, Roman Sulzbach, Robert Dill, and Henryk Dobslaw

GFZ German Research Centre for Geosciences, Earth System Modelling, Potsdam, Germany

Reference Frames for Applications in Geosciences, Space Geodetic Measurement Techniques

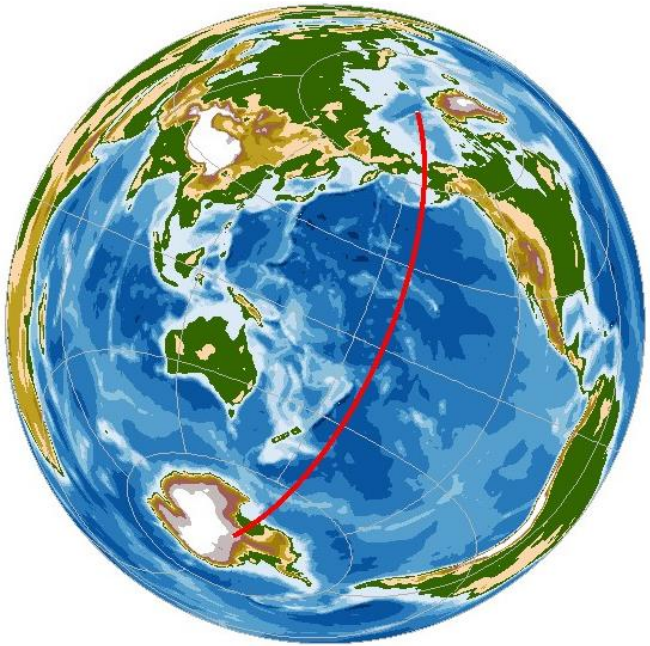
Thessaloniki, October 20th, 2022

GFZ Helmholtz Centre Potsdam

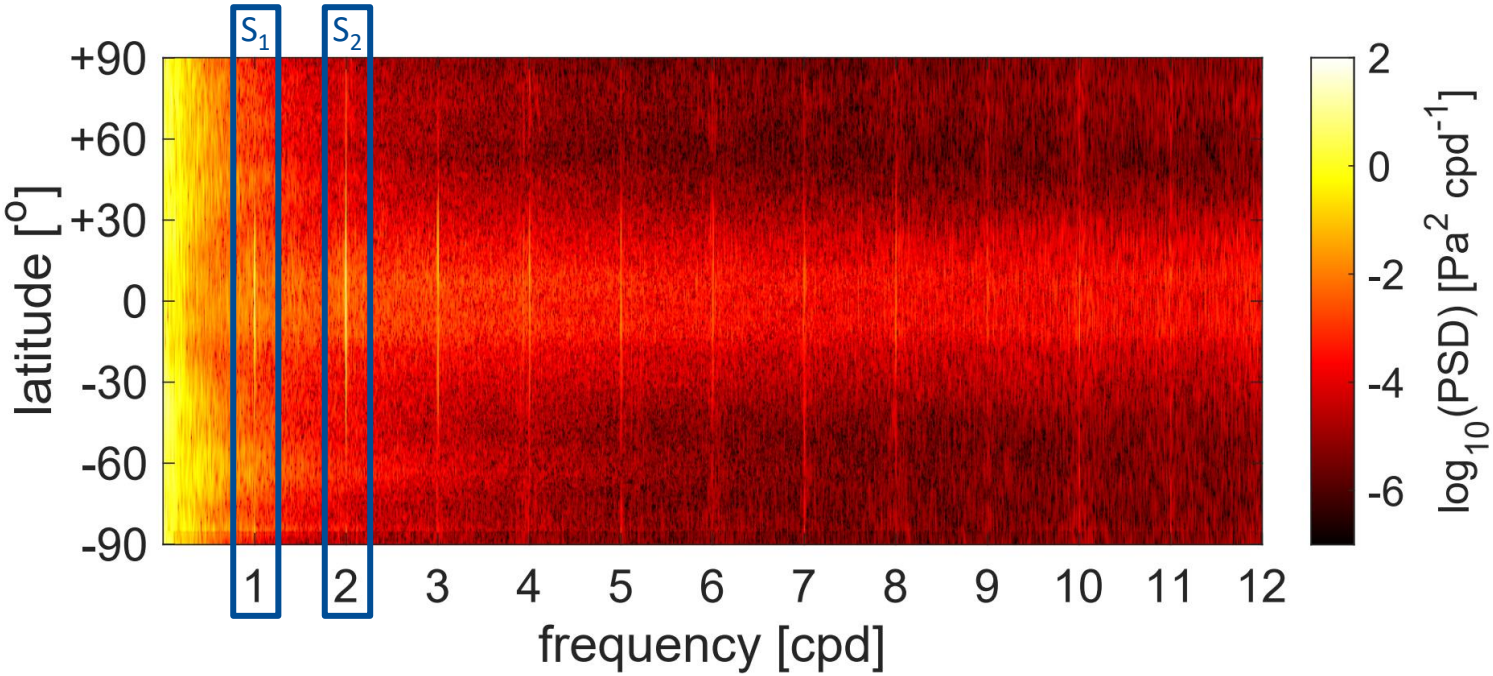
Terra2

HELMHOLTZ

. . . along the 169°W Meridian



Atmospheric Pressure Power Spectral Density



Atmospheric Tides

- Excited by
  - **Water vapor** (IR radiation);
  - **Ozone** (UV radiation)
  - Gravity, Rossby waves, convection, etc.
- Manifest in
  - High-freq atmospheric **density** & **wind** variations
- Affect
  - **Gravity** anomalies
  - Surface **loading** deformation
  - Atmospheric **refraction**
  - **Earth rotation**

In this presentation . . .

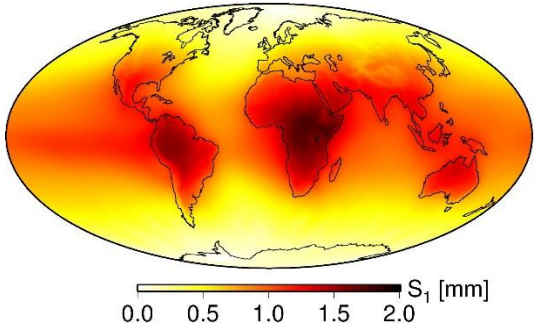
- How does atmospheric tidal loading vary
  - *temporally?*
  - *between atmospheric models?*

Tools and Materials

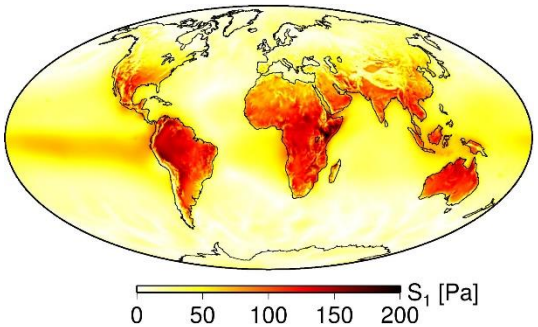
- Operational
  - IFS (ECMWF), ICON-Global (DWD)
- Reanalysis
  - ERA5 (ECMWF), JRA55 (JMA), MERRA2 (NASA)

Atmospheric Tide Manifestations
Loading – Mass – Refraction

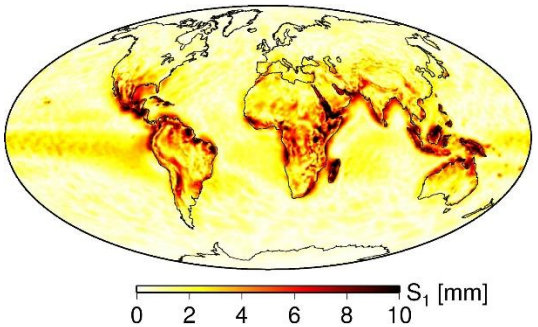
Radial loading displacement amplitude

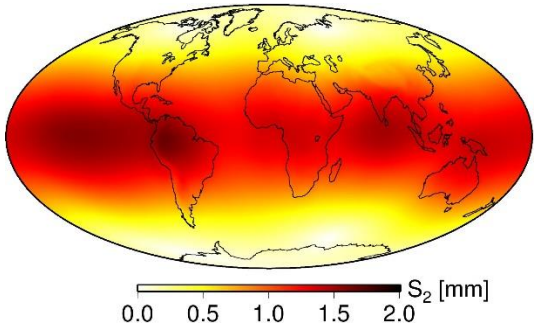


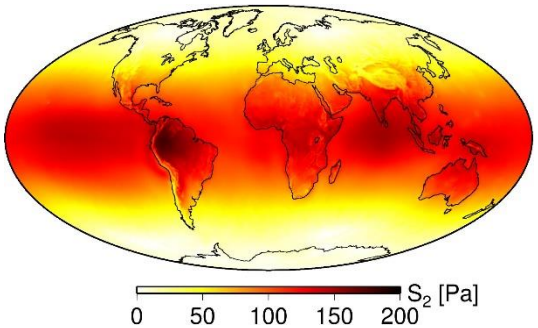
Mass anomaly amplitude

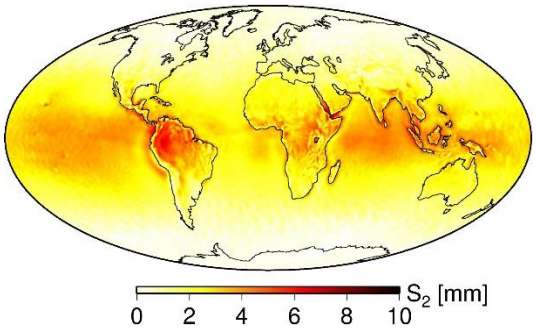


Zenith delay amplitude



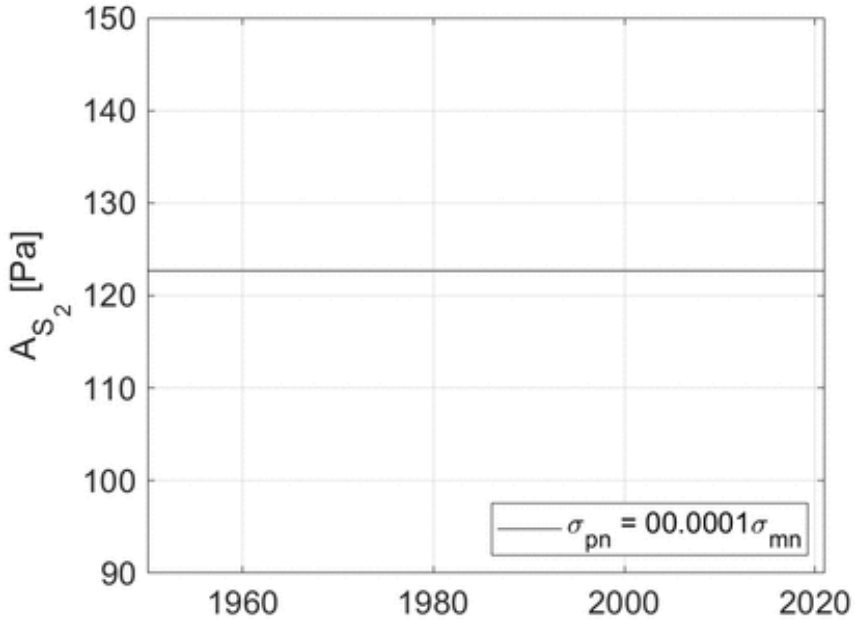


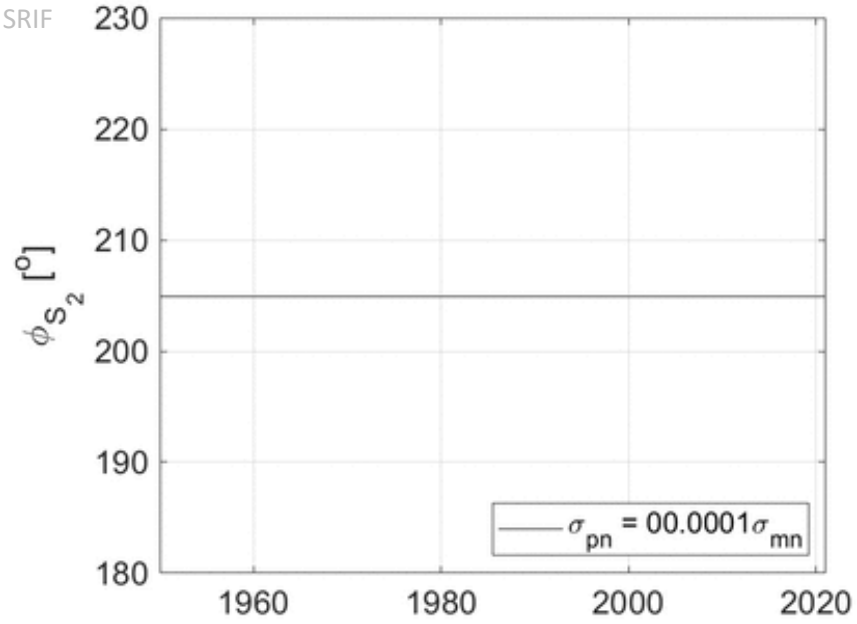




Do High-Frequency Harmonics *Vary in Time*?

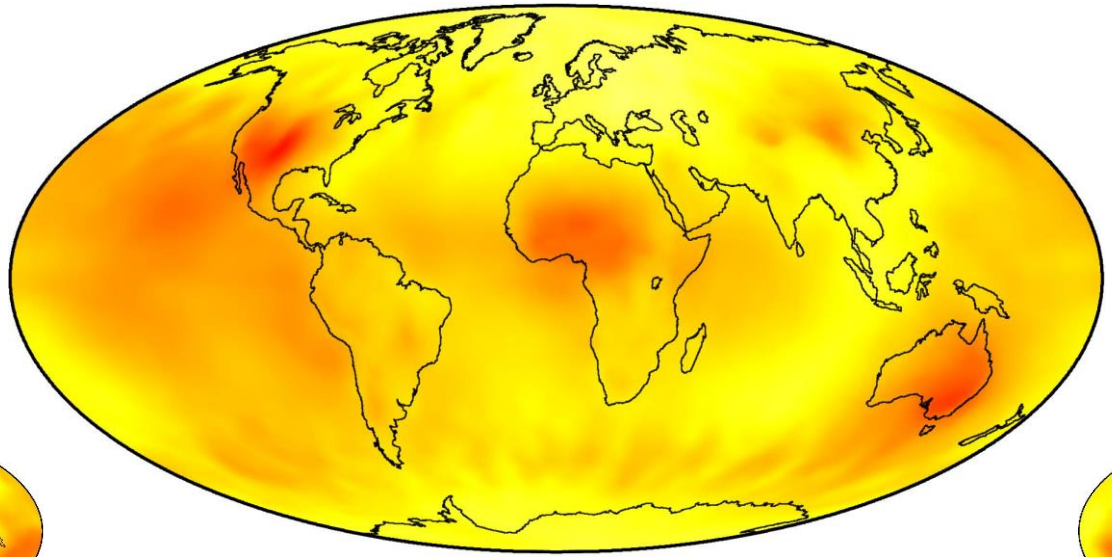
We vary
the process noise
in a SRIF

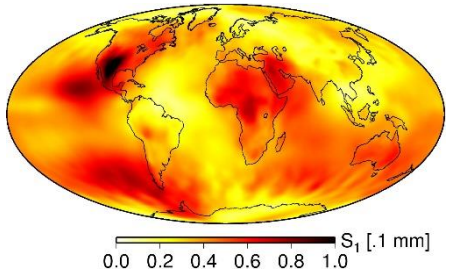


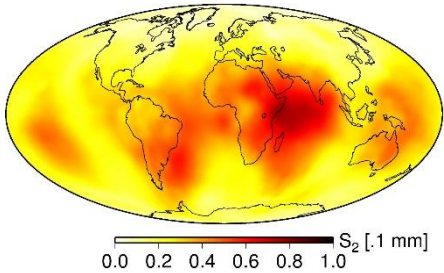


Do High-Frequency Harmonics *Vary in Time*?

Average variability wrt reference

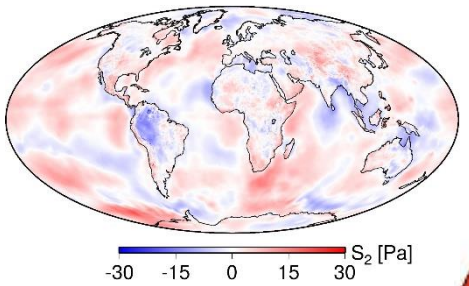




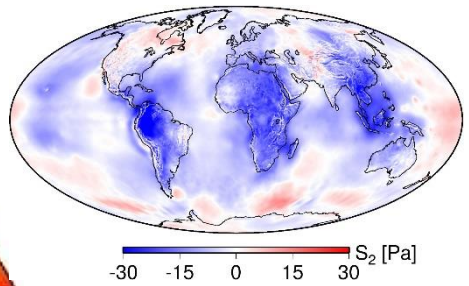


Do High-Frequency Mass Harmonics *Vary Between Atmospheric Models*?

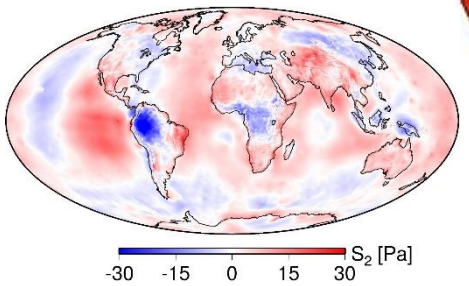
ICON – ERA5

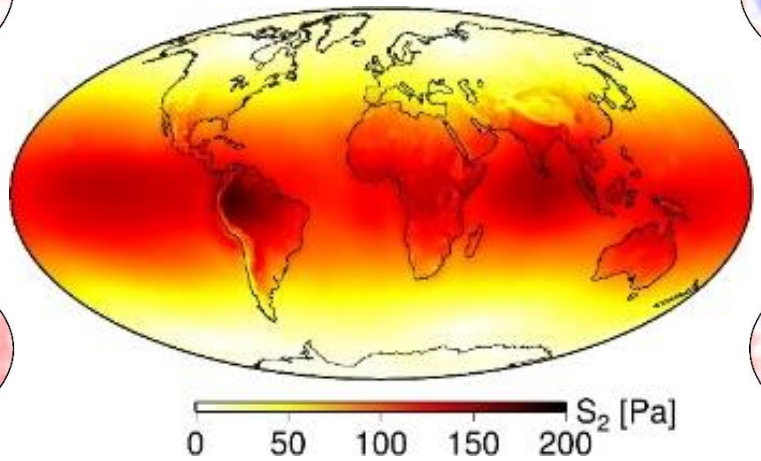


JRA55 – ERA5

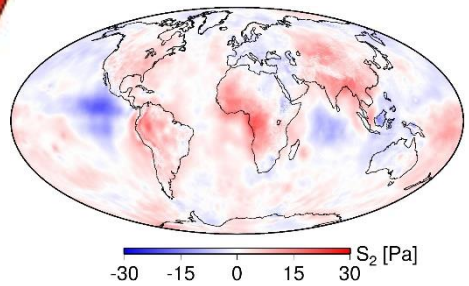


MERRA2 – ERA5





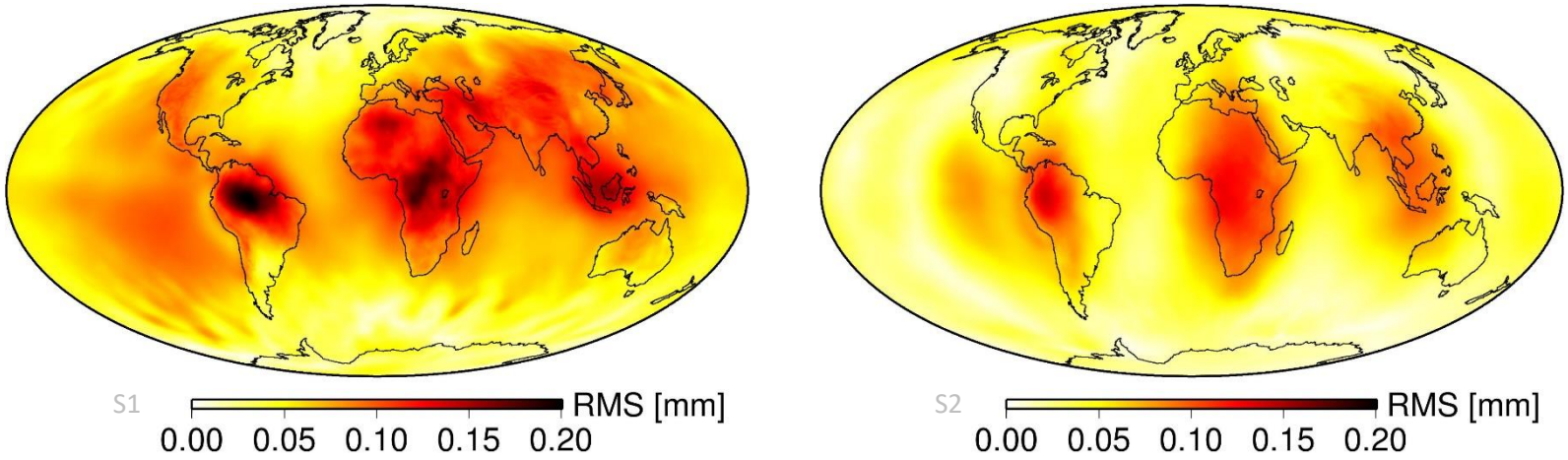
IFS – ERA5



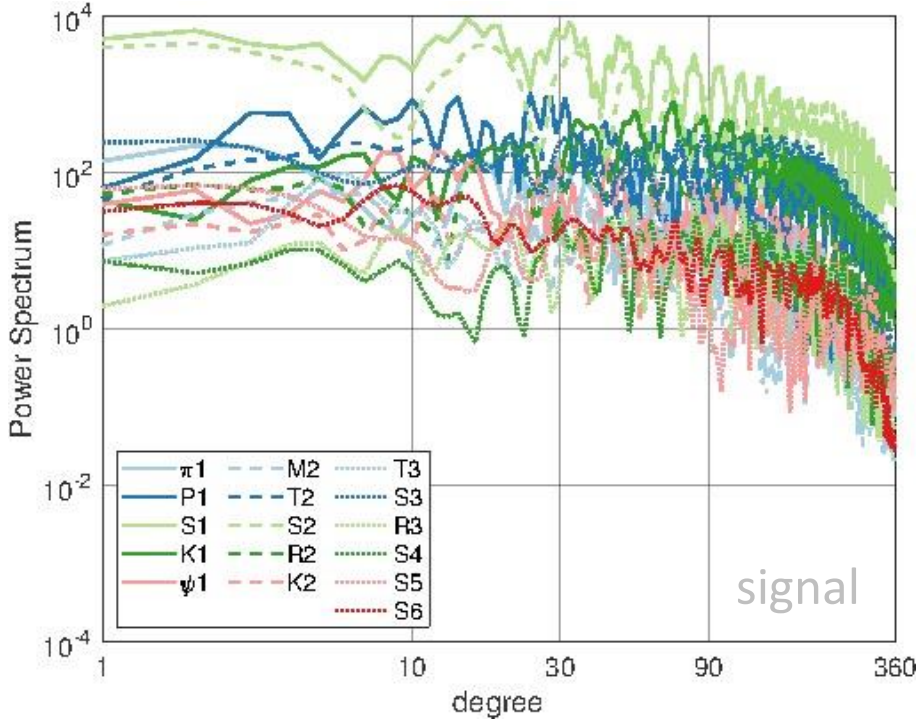
Do High-Frequency Mass Harmonics *Vary Between Atmospheric Models*?

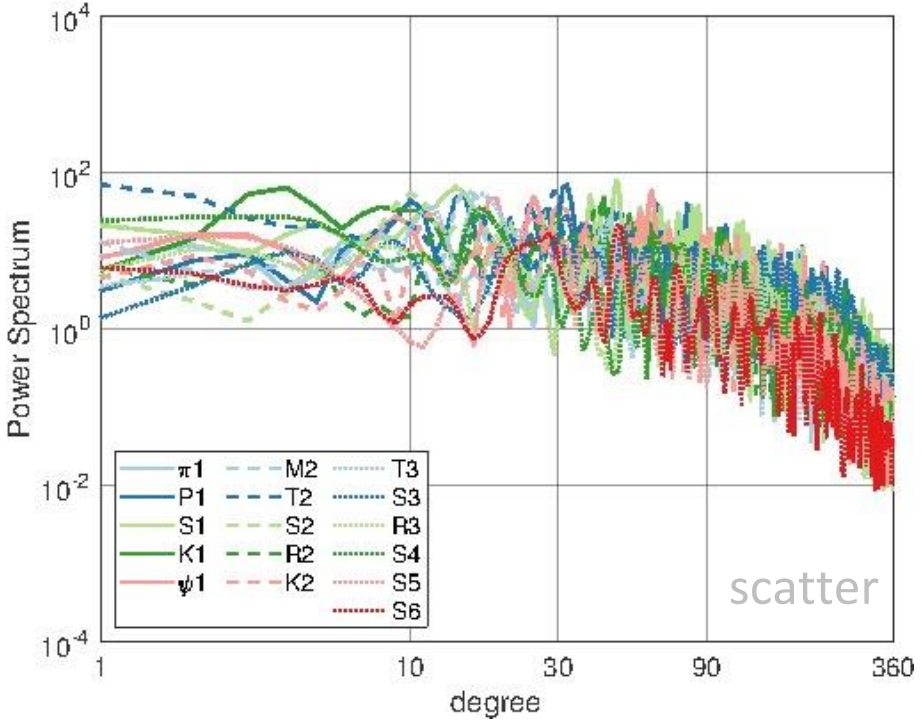
Inter-Model scatter

ERA5, MERRA2, JRA55, ICON-Global, IFS

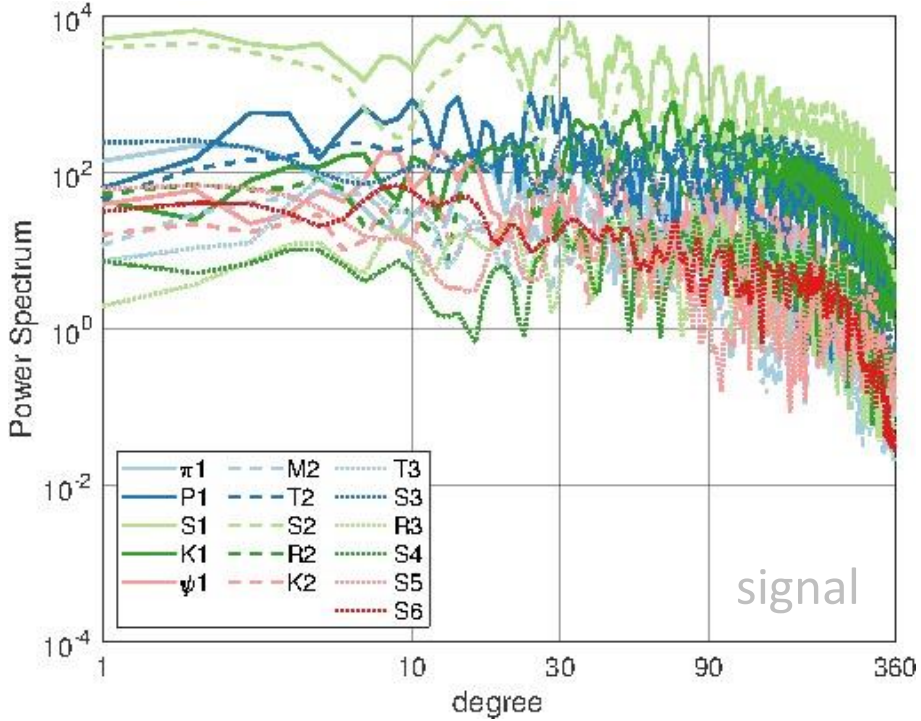


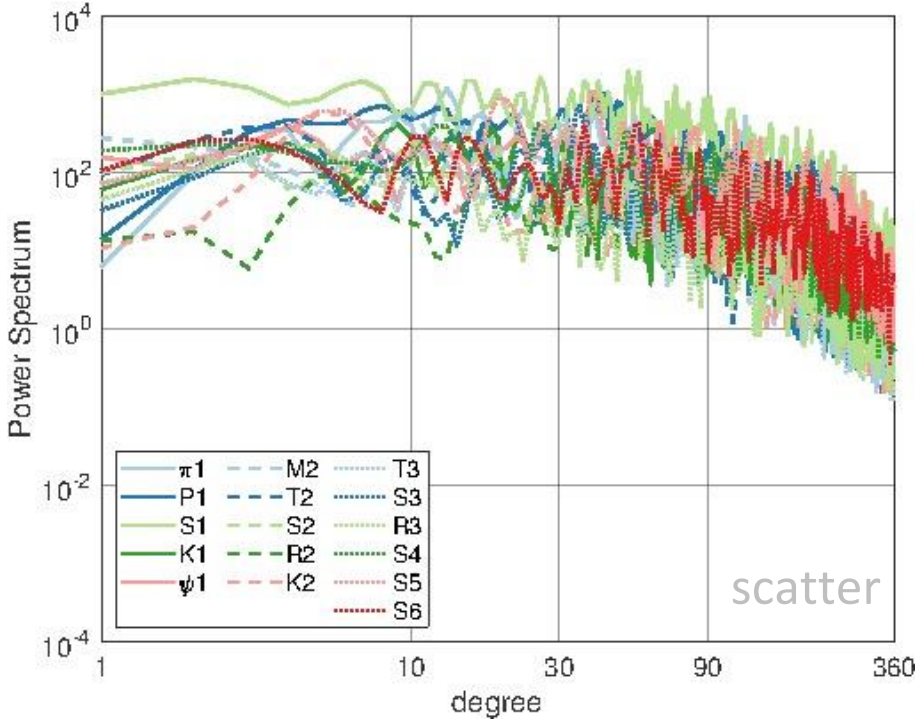
Absolute Spectral Assessment (*Time* Variance)





Absolute Spectral Assessment (*Model* Variance)





Recapitulation

- Developed square-root information filter

to estimate high-frequency harmonic modulations

in mass anomalies, atmospheric delays, loading displacements

employing ECMWF IFS, ICON, ERA5, JRA55, and MERRA2

- Do signals vary in time?

Yes (inter-annual and S_a/S_{sa} modulations)

- Do models agree?

Yes (model > time)

- Future work: model validation

Acknowledgements

Data: DWD (ICON-Global), ECMWF (IFS, ERA5), NASA GMAO (MERRA2), JMA (JRA55)

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Computations: DKRZ (Mistral, Levante)

Data availability

https://doi.org/10.5880/GFZ.1.3.2022.006

http://rz-vm115.gfz-potsdam.de:8080/

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