

Magnetic Datasets from Non-dedicated Satellites

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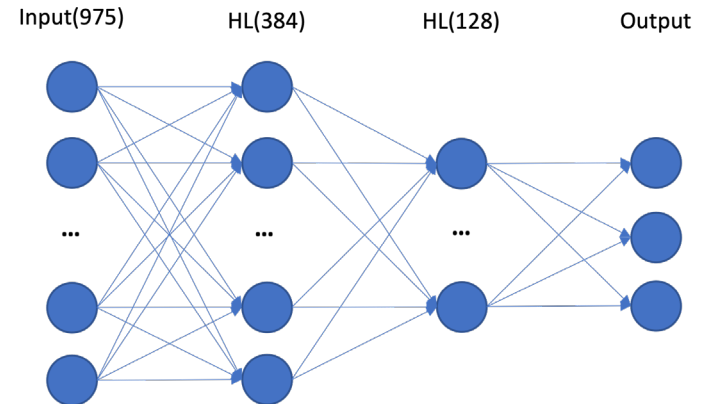
³ IAP Kühlungsborn

- Enlarging datasets of magnetic space-based measurements interesting to space physics and geomagnetism
- Interested in satellites carrying platform magnetometers
 - Low-Earth orbit
 - Polar orbit
 - Increase MLT coverage
 - GOCE, GRACE-FO, in future others

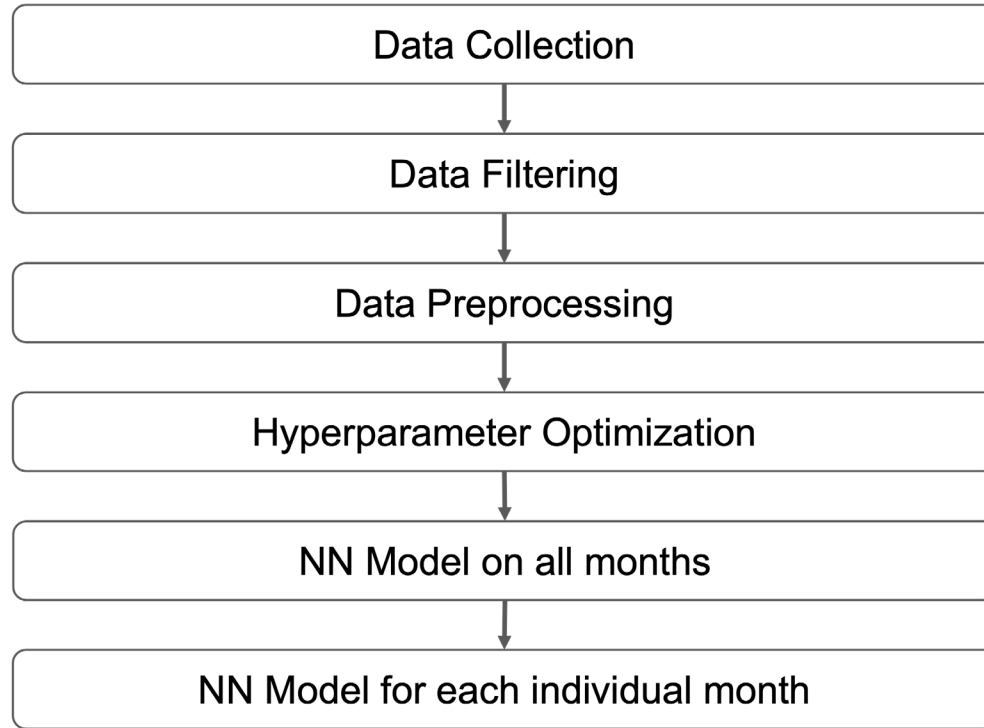
- Platform magnetometers are only roughly calibrated
 - Part of attitude and orbit control system (AOCS)
 - Engineered to an error below 500nT
- Our goal: post-launch calibration
 - Adjusting artificial disturbances
 - As much information as possible
 - Enable scientific application of the measurements

- Machine Learning-based calibration
- Neural networks
 - Automatic feature selection
 - Non-linearities between features
 - More available information can be incorporated
 - No manual feature preselection

- Input to model
 - Magnetometer measurements, currents, temperatures, magnetorquer activations, thrusters
 - telemetry data like status variables, flags, and others
- Model is Feed-Forward Neural Network
- Reference model is CHAOS7
 - Includes core, crustal, and large-scale magnetospheric parts
 - Heavily supported by Swarm
- Details in publications



Approach

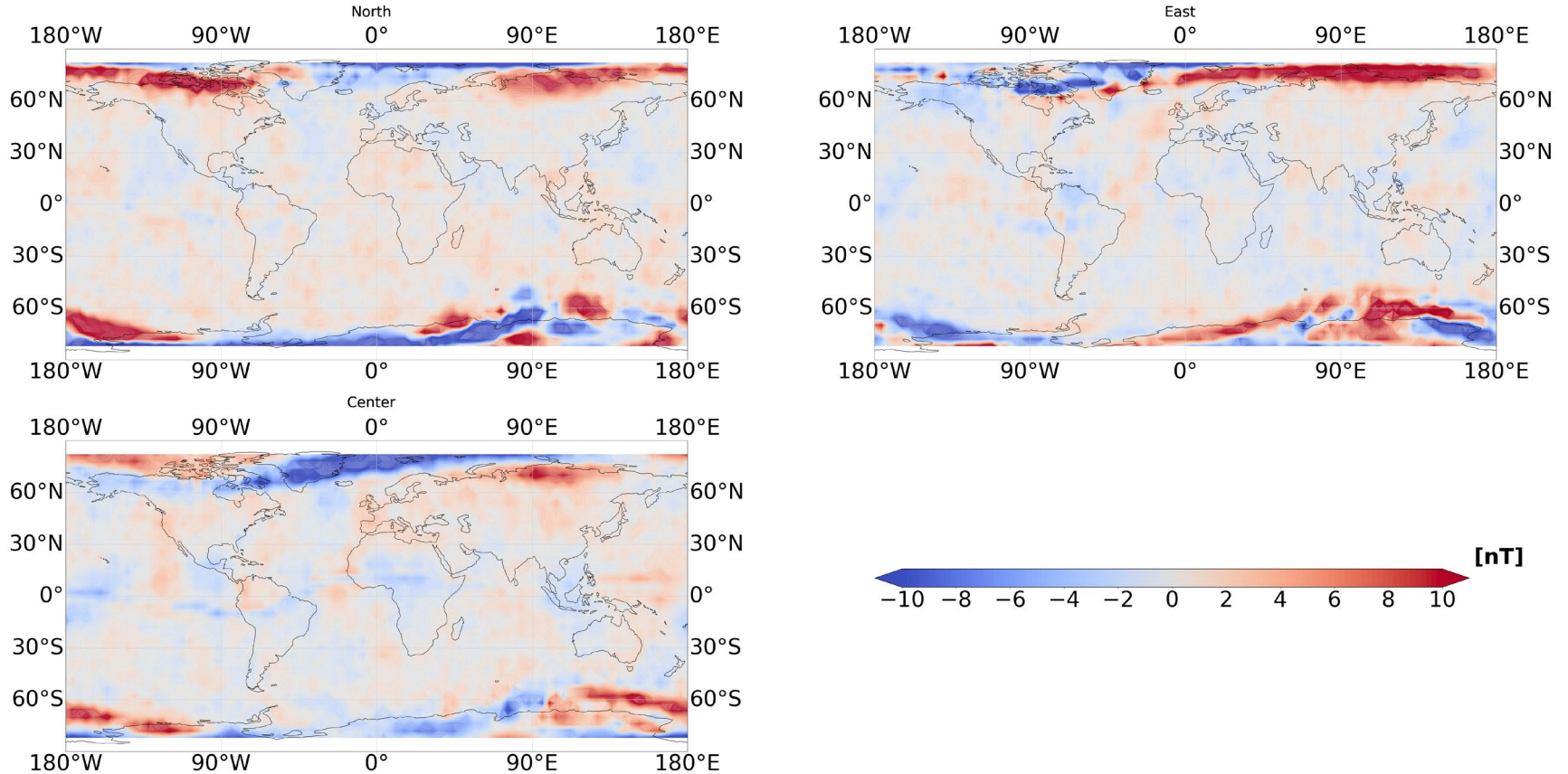


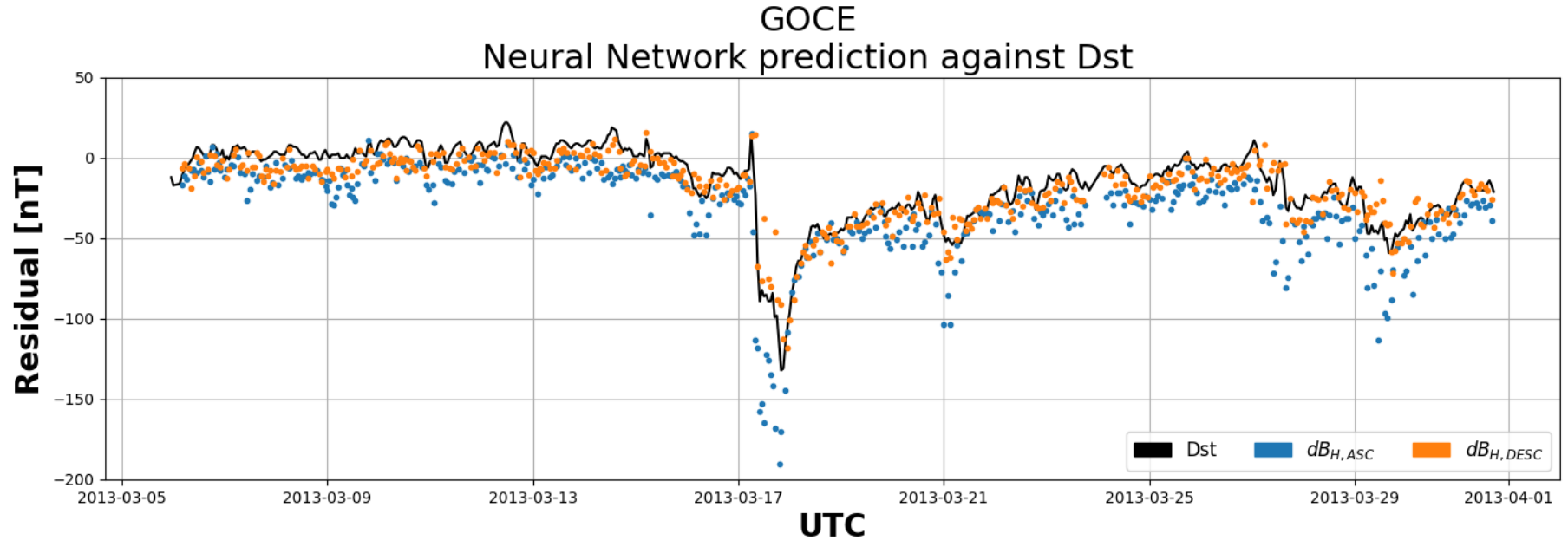
- Today we mainly focus on GOCE satellite
 - Similar approach applied to GRACE-FO satellite
- Gravity field and steady-state Ocean Circulation Explorer (GOCE)
 - Launched March 2009
 - Ended November 2013
 - 268km altitude
 - Very interesting due to high-precision satellite data gap
- After preprocessing
 - ~4.8mil. data points whole mission
 - ~975 features



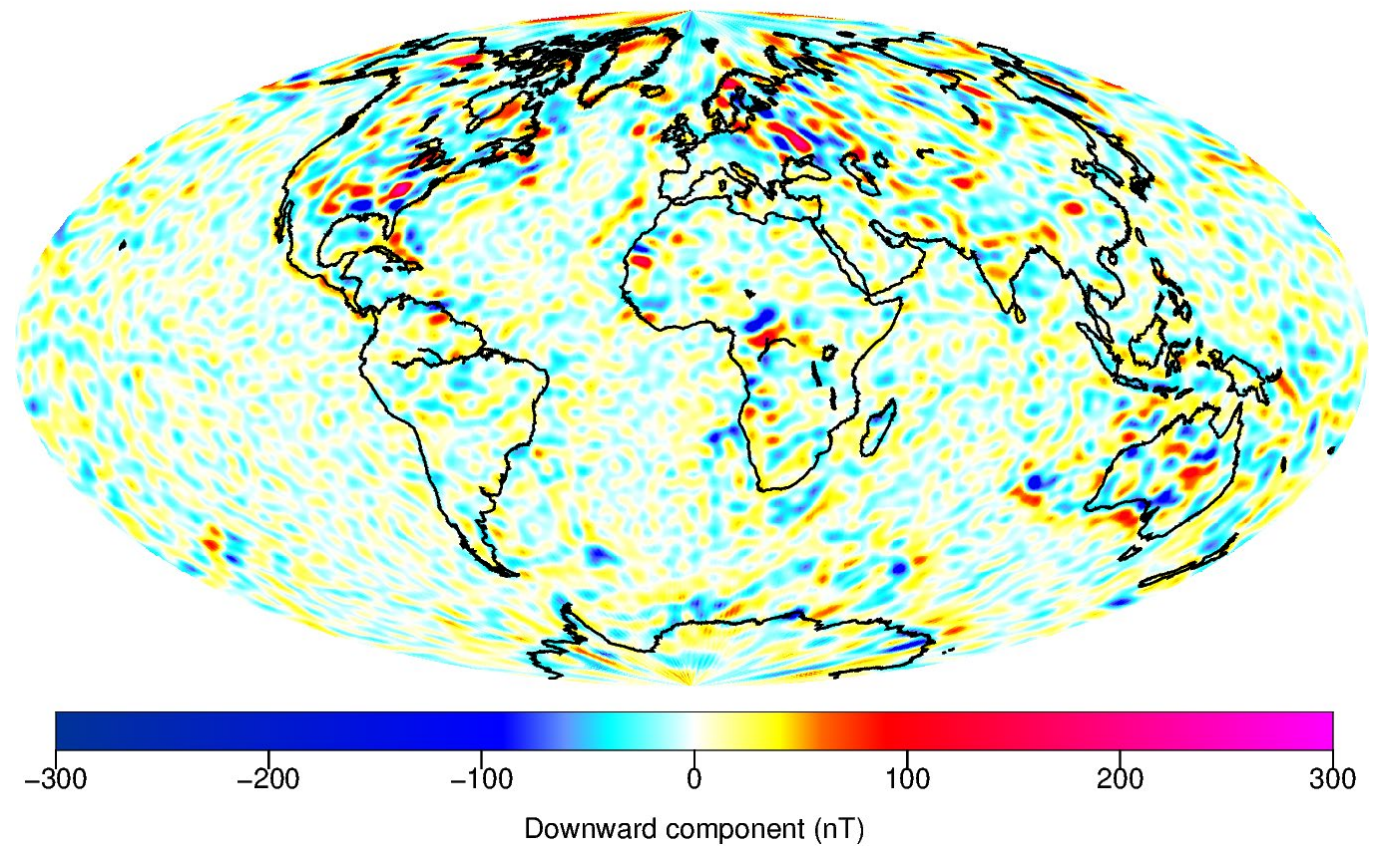
- Comparison to reference model CHAOS7
 - Low mean absolute residual of about 6.5nT for low- and mid-latitudes
- Validation of results for geophysical correctness
- Possible geophysical applications will be shown

Difference: Calibration and CHAOS7

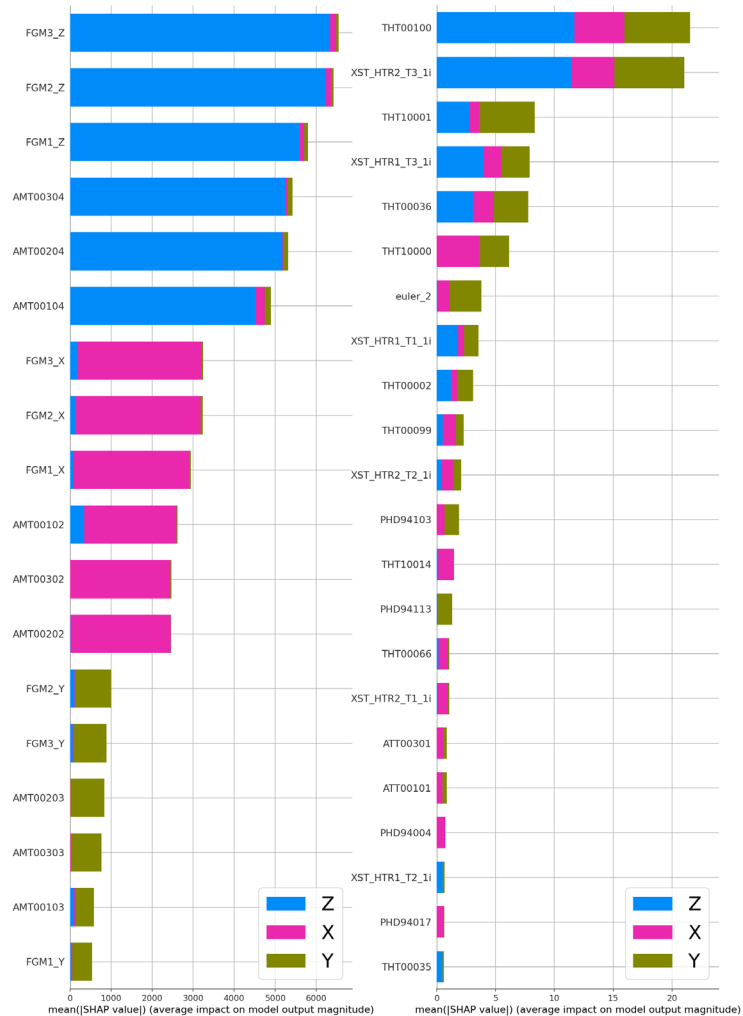




Lithospheric field at the Earth's surface derived from calibrated GOCE data

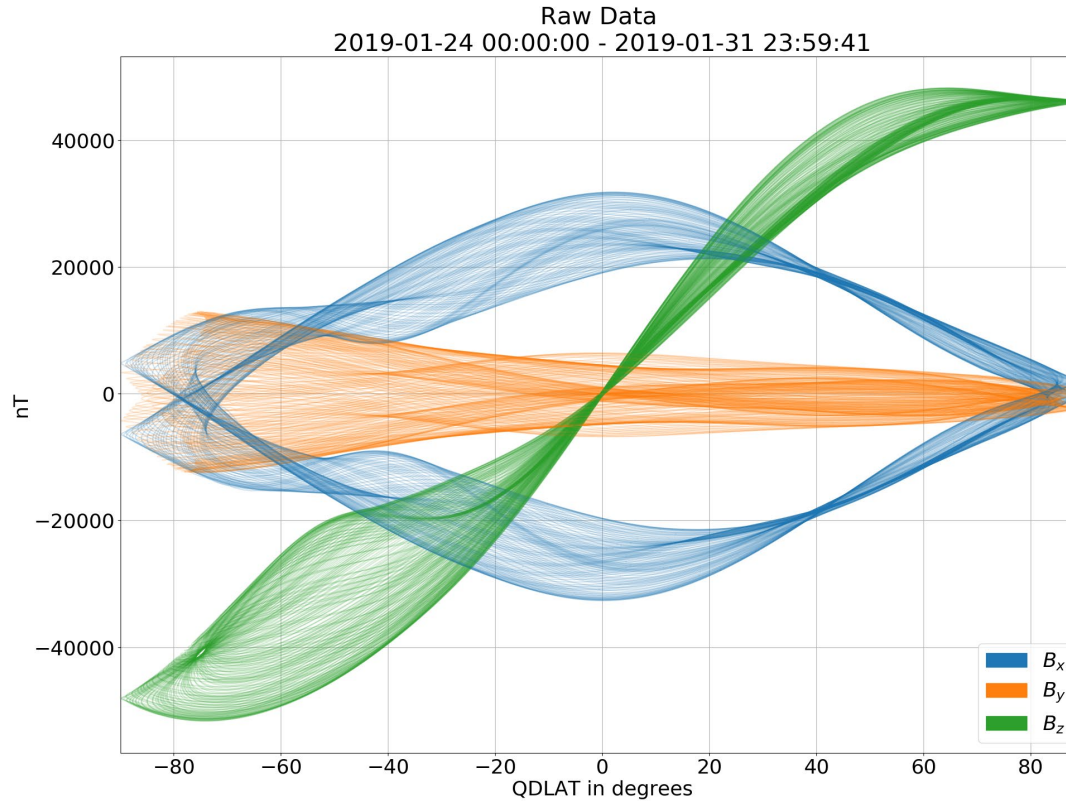


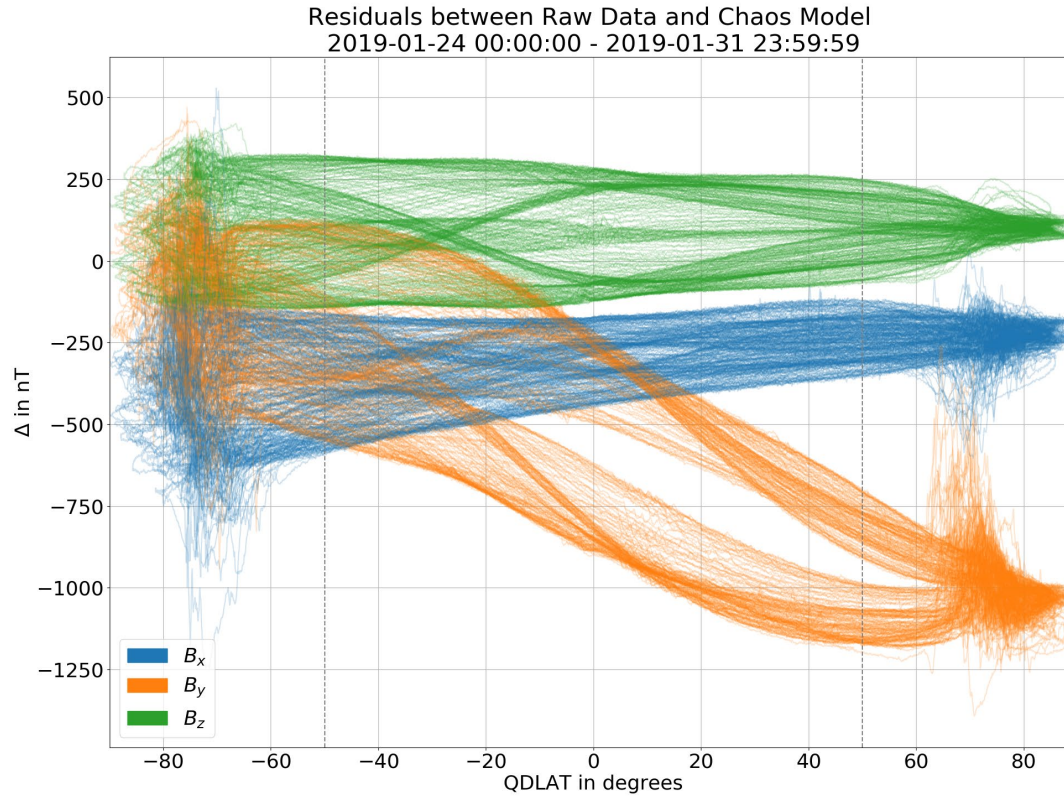
- Impact analysis using the SHAP method
 - Larger values imply larger contribution
- Most important are the magnetometers (left)
- Also valuable are temperatures, xenon tank heaters, some currents, and the magnetorquers (right)



- We achieved a low residual for the calibration
- Large-scale geophysical applications are possible
- The Swarm satellite enables a true swarm of satellite
 - The proposed approach is well applicable to other satellites
- Magnetic datasets from non-dedicated satellites are available
 - <https://isdc.gfz-potsdam.de/platform-magnetometer/>

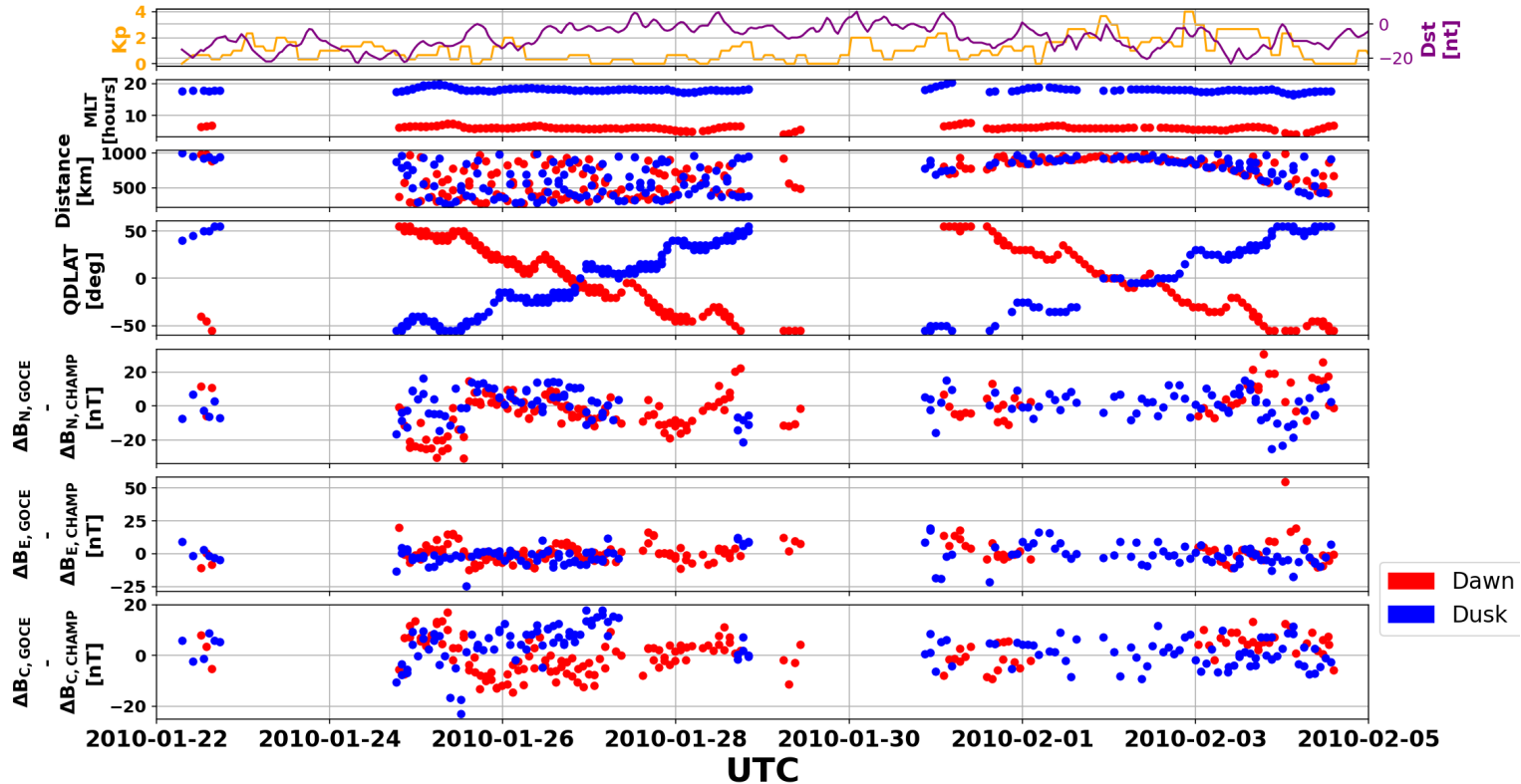
Backup





CHAMP Conjunctions

Satellite Conjunctions GOCE and CHAMP



Comparison to Analytical Method

