B. Fluche[1], C. Stolle[1,2], J. Baerenzung[2], J.L. Chau[3], E. Kronberg[4], J. Kusche[5], J. Vogt[6]:
1: GFZ Potsdam 2: Universität Potsdam 3: Leibniz Institut für Atmosphärenphysik Kühlungsborn 4: LMU München. 5: Universität Bonn 6: Jacobs University Bremen

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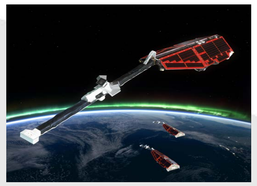
DFG priority programme 1788 „Dynamic Earth“: A joint interpretation of geomagnetic, geodetic and ionosphere/thermosphere data from low-orbit satellite missions

About SPP 1788

The system "Earth" changes continuously. Variations of the Earth's interior, the atmosphere, the oceans, and near-Earth space give rise to changes in global potential fields, particularly in Earth's magnetic and gravity fields. The underlying processes can be identified and studied through monitoring and analysis of fundamental geomagnetic and gravity parameters.

Swarm mission and satellites



Satellite A + C:
- Current altitude ca. **450km**

Satellite B:
- Current altitude ca. **500km**

⇒ Multi-instrument mission
(magnetic and electric field, plasma density and temperature, GPS (topside-TEC), accelerometer)

Participating universities and research institutes

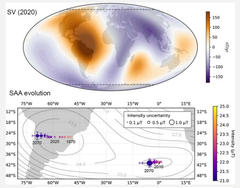
Geomagnetism

The focus of this topic is to study the dynamics and evolution of Earth's magnetic field. The projects within this subject area focus on analyzing the magnetic field contributions from Earth's core, lithosphere, magnetosphere, ionosphere, from oceanic currents and mantle induction. For this, they rely on data analyses, empirical modelling and geodynamo simulations.

Geodynamo and secular variation

Predictions of the geomagnetic secular variation based on data assimilation of geomagnetic field models by dynamo simulations

Improved modelling techniques – better and more realistic results for the dynamo equations

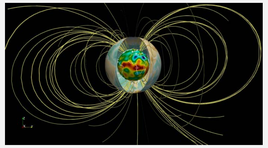


Sanchez & Wicht (2020)

Kalmag model – candidate for IGRF-13

New approach to derive a geomagnetic field model from direct measurements of the Earth's magnetic field with CHAMP and Swarm data.

Using Kalman filter method to predict further spatio-temporal development



Link to model of Potsdam university:
https://ionocovar.agnld.uni-potsdam.de/Kalmag/

Baerenzung, Holschneider (2021)

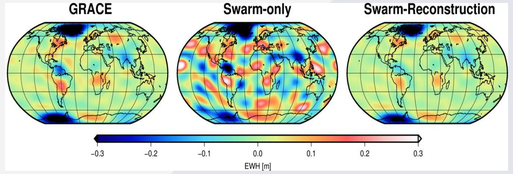
More information about the Swarm mission:

earth.esa.int/eogateway/missions/swarm

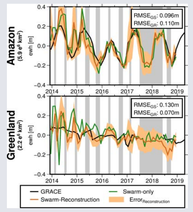
Gravity

In this subject area the global variations of mass and mass balances are investigated, as well as interaction and exchange mechanisms (hydrological cycle, ice melting in the polar regions, sea-level fluctuations, groundwater, relationship with anthropogenic influences, tides of oceans and atmosphere), length-of day variation, and high-resolution models of the gravity field.

Closing the 11-months-gap between GRACE/GRACE-FO



We use the method of a Principal Component Analysis and combine the existing Swarm gravity data with the dominant patterns of mass changes, determined from GRACE. Therefore, we investigate the global spatial resolution (upper panel) as well as mass changes in selected areas (right panel). Our new solution we call “Swarm-Reconstruction” as we use the GRACE patterns to reconstruct it. This solution has a significantly lower noise and a higher spatial resolution.



Lück, Kusche et al. (2021)

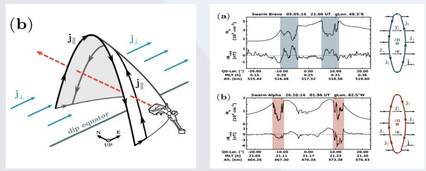
More information about all projects in SPP1788:

www.spp-dynamicearth.de/en

Ionospheric Currents

This topical area addresses E-region ionospheric current systems and field-aligned currents (FACs) at higher latitudes, coupling of the ionosphere and magnetosphere, contributions of ionospheric and field-aligned currents to the energy budget of the atmosphere, near-Earth verification of magnetospheric currents

Equatorial Plasma Depletions in the Ionosphere

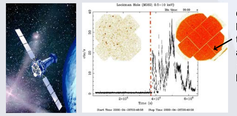


Field aligned curremts (FAC) flow along the edges of the EPD zones in interhemispherical direction

Rodriguez-Zuluaga et al. (2020)

Magnetospheric protons contaminate XMM-Newton X-Ray telescope

Using a machine learning approach we derive a model to predict the contamination and learn physics behind.



Observations by the X-ray telescope are affected by ~100 keV protons

Future missions should minimize observations associated with high solar wind speed and avoid closed magnetic field lines.

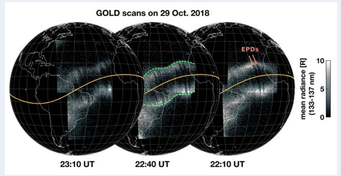
Kronberg et al. (2020)

Ionosphere/Thermosphere Coupling

This subject area is devoted to the quantification of solar contributions (EUV, solar wind) and the influence of the lower and middle atmosphere (waves and tides) on the variability of the upper atmosphere, the interaction between ionospheric plasma and neutral gas, E- and F-region ionospheric currents from high to low latitudes, understanding and predicting ionospheric and atmospheric irregularities from equatorial to polar latitudes including signal disturbances for communication and navigation systems.

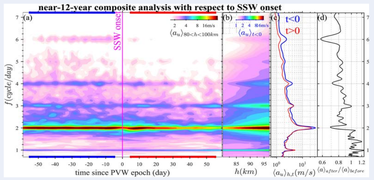
A synoptic-scale wavelike feature of the nighttime equatorial ionization anomaly

Structure:
- is symmetric about the dip equator
- appears stationary with time over the night



Rodriguez-Zuluaga et al. (2021)

The impact of a SSW onset on the higher solar tide harmonics



(a) Composite analysis of altitude-averaged (over 80–100 km) wavelet spectrum of the zonal wind over Juliusruh with respect to SSW onsets referring to the PVWs. (b) Wavelet spectrum averaged in the time window indicated by the blue lines before the onset in (a). (c) Temporal average of (a) within the time window indicated by the blue and red lines in (a). (d) Ratio between the red and the blue lines in (d).

He, Chau et al. (2020)

HELMHOLTZ