

WHO WE ARE

The ERC project **GERACLE** investigates the effects of past and possible future **reversals and excursions (GER)** of the geomagnetic field on our habitat.

Earth's magnetic field is our planet's protective shield against solar wind and cosmic radiation. But throughout Earth's history, this shield has dramatically weakened and changed during magnetic reversals.

These events may influence the magnetosphere, atmosphere, climate, and space weather in ways we still do not fully understand.

For the first time, **GERACLE** project is comprehensively studying the entire Sun-Earth system under realistic changing geomagnetic field conditions, combining expertise in:

Geo/Paleomagnetism

at GFZ, Potsdam, Germany

Solar-Terrestrial Relations

at University of Helsinki, Finland

Radiation and Atmosphere

at University of Oulu, Finland

Earth System Modelling

at BOKU University, Vienna, Austria

WHERE TO FIND US

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Geomagnetic Excursions and Reversals

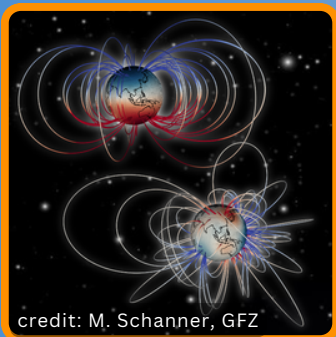
Establishing their Atmospheric and Climatic Effects



Funded by
the European Union



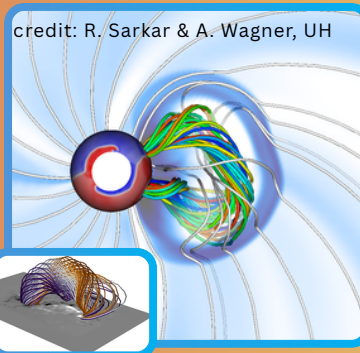
European Research Council
Established by the European Commission



credit: M. Schanner, GFZ

Paleomagnetism: Tracing the Earth's Shifting Magnetic Field

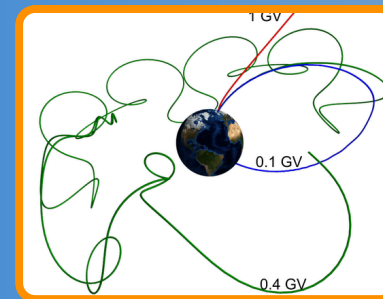
Paleomagnetism studies Earth's magnetic field history using signals preserved in sediments, rocks, and archaeological structures. **Magnetic minerals** in sediment align with the field and when they settle, they lock-in a buried polarity record. The geomagnetic field experiences **polarity reversals** and shorter **excursions**, both weakening its protective strength against radiation and becoming magnetically complex. GFZ's team, led by Dr. Monika Korte, is addressing this matter by measuring new **sediment cores**, combining this data with existing records, and building improved global models of three GER events to better understand their similarities, differences, and implications for future reversals.



credit: R. Sarkar & A. Wagner, UH

Unravelling how the Sun Shapes the Earth's Space Environment

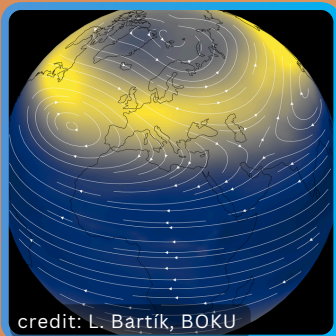
The **Sun** is an active star that constantly affects the space environment of our planet through electromagnetic radiation, energetic particles, the **solar wind**, and solar eruptions. The solar wind is a constant flow of ionized gas, known as **plasma**. It fills the interplanetary space carrying with it the magnetic field from the Sun. The energetic particles and magnetized plasma accelerated and released during solar eruptions travel through the solar wind. At Earth, these drive **geomagnetic storms** that range in magnitude and effect. The Helsinki team, led by Prof. Emilia Kilpua, is investigating, through observational analysis and numerical modelling, how the solar activity will impact Earth during the long periods of geomagnetic field reversals.



credit: N. Larsen, OTSOp

Earth's Magnetic Shield and Radiation Environment

Earth's magnetic field shields our planet from **energetic particles** from the Sun and **galactic cosmic rays**. The University of Oulu team, led by Prof. Ilya Usoskin, will investigate how this protection changes during geomagnetic excursions and reversals. The researchers will examine how the weakened, strongly non-dipolar field configurations affect the access of solar energetic particles, their atmospheric cascades, and the resulting **radiation** environment. They will also explore how radiation patterns may shift across the globe and whether unusual magnetic conditions could support long-lived trapped particle populations and radiation belt systems.



credit: L. Bartik, BOKU

How a Changing Magnetic Field Affects the Earth's Atmosphere and Climate

During geomagnetic excursions and reversals, the intensity of Earth's magnetic field decreases, reducing its shielding against energetic particles. These particles trigger chemical reactions that alter **atmospheric composition**, including **ozone** concentrations in the middle and upper atmosphere, with potential effects on the radiation field, atmospheric circulation, and climate. Within GERACLE, the BOKU team, led by Prof. Harald Rieder, uses Earth-system models to investigate these complex interactions. By studying several GERs under a range of solar, volcanic, and climate conditions, the team aims to quantify their **atmospheric** and **climatic impacts** and better understand the consequences of past and potential future GERs.