This presentation participates in OSPP

EGU

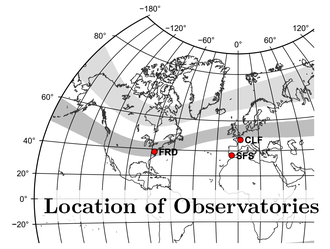
Outstanding Student & PhD candidate Presentation contest

To Abstract:

Extraction of Solar Forcing Signatures in Ground Magnetometer Data from Sub-Auroral Regions

Veronika Haberle[1,2], Aurélie Marchaudon[1], Aude Chambodut[2], and Pierre-Louis Blelly[1]

[1]Institut de Recherche en Astrophysique et Planétologie, Université de Toulouse, CNRS, CNES, Toulouse, France
[2]Institut Terre et Environnement de Strasbourg, ITES UMR7063, (Université de Strasbourg / CNRS) Strasbourg, France)



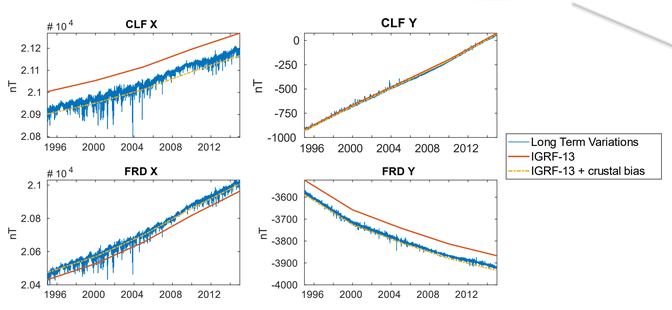
Introduction

Strong solar events that reach Earth can significantly disturb the geomagnetic field. As the recorded magnetic signal is a superposition of sources that act on a broad amplitude-frequency spectrum, **the isolation of storm signatures within geomagnetic field measurements** becomes an important and nontrivial task. In order to determine the strength in real-time, **the identification of storms needs to be automated**.

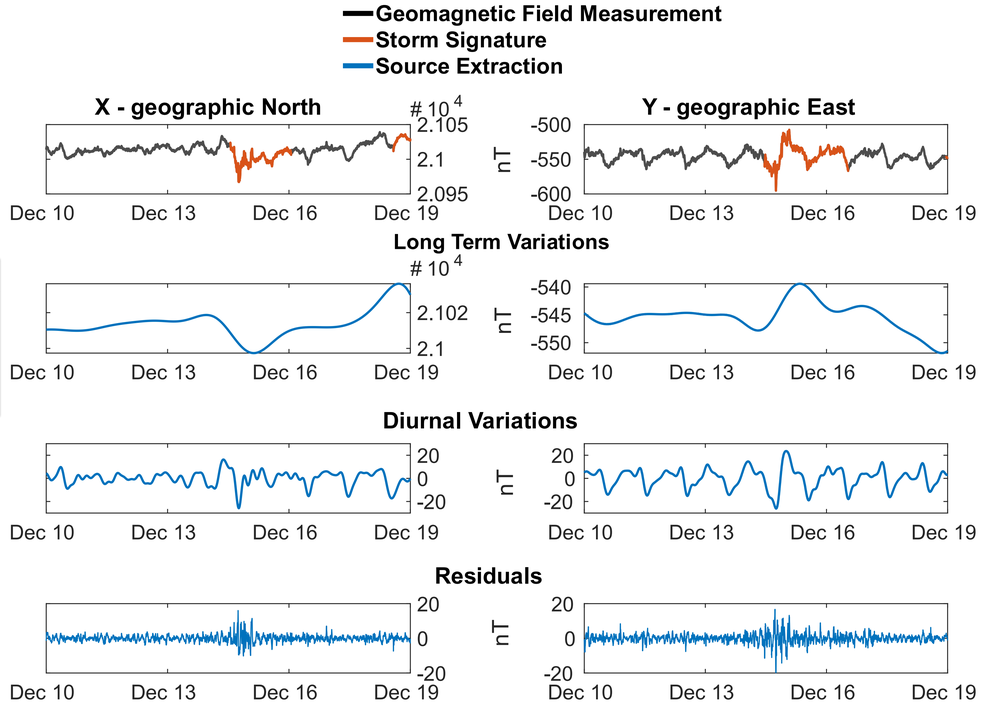
Data

Geomagnetic field measurements are taken from observatories at mid-latitudes that are part of INTERMAGNET and which provide high quality data in minute resolution in the local NED coordinate system:
X geographic North, Y geographic East, Z vertically down
The extraction of sources is realised via **temporal filters** with periods of above 36h for the long-term and at periods of 24h, 12h, 8h, and 6h for the diurnal variations, see Haberle et al. 2022.

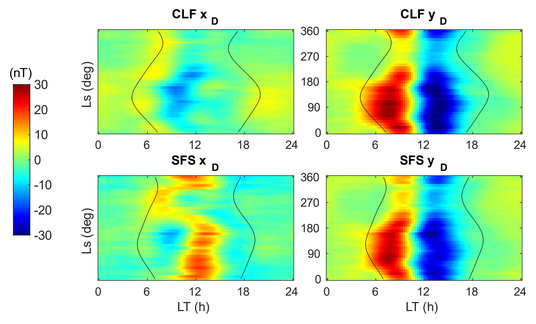
Long Term Variations



The overall trend of the extracted long term variations is in **good agreement with the IGRF model** (Alken et al. 2021), indicating that the filter catches **the secular variation**. Contributions of other internal and external sources are also present.



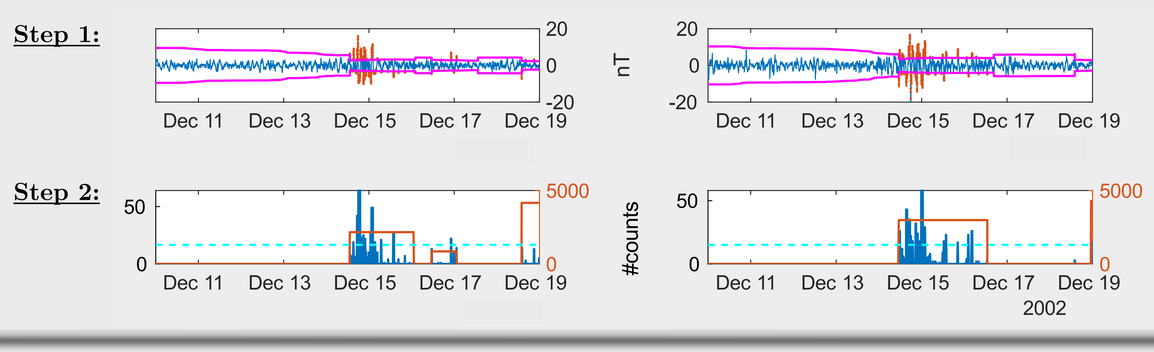
Diurnal Variations



The superposed epoch analysis of diurnal variations in dependence of solar longitude and local time is generated over geomagnetically quiet periods. The characteristics are in good agreement with the **solar quiet current system** (Haberle et al. 2022).

Extraction of Storm Signatures

Removing long-term and diurnal variations from geomagnetic field measurements results in **the residuals containing predominantly solar forcing contributions**. These can then be used to characterise disturbances within the geomagnetic field. The automatic identification of storm signatures is done in two steps. First, typical quiet levels are determined, followed by the counting of non-quiet residuals per time interval.



Step 1: Determining quiet levels
A quiet-time expectation boundary is defined by taking into account the previous three months. Residuals outside this boundary are considered storm candidates.

Step 2: Defining storm intervals
Zero-crossings for storm candidates between upper and lower boundaries are taken care of. A minimum storm time duration threshold defines storm signatures.

Conclusion and Perspective

With these traditional methods stronger storms are identified correctly including recovery phases. Sometimes shorter, quiet periods are mistakenly marked as a storm but tuning of parameters is time-consuming. Can artificial intelligence help in finding optimal parameters and improve storm identification?

Magnetic Observatory Data Access

CLF	FRD	SFS
Chambon-la-Foret	Fredericksburg	San Fernando
BCMT data repository	INTERMAGNET data repository	
doi.org/10.18715/BCMT.MAG.DEF	doi.org/10.5880/INTERMAGNET.1991.2018	

References
Alken, P. et al. Earth Planets Space 73, 49 (2021). https://doi.org/10.1186/s40623-020-01288-x
Haberle, V. et al. (2022) Journal of Geophysical Research: Space Physics, 127. https://doi.org/10.1029/2022JA030407

École et observatoire des sciences de la Terre, Université de Strasbourg

Scan for Haberle et al. 2022

More questions? Reach out!
veronika.haberle@irap.omp.eu

Scan for LinkedIn