TLE data products

ver. 1.0

February 4, 2021

1 SIG File description

`http://swarm4anom.cbk.waw.pl/gauss/SIG/`

The naming convention is as follows:

SIG_[A/B/C]_YYYY-MM-DDTHH:MM:SS.SS0000__xxxxx_????_256_vv.cdf

xxxxx - stands for the record number in the original MAGx_HR file

???? - denotes maximum amplitude of the detected peak vv - denotes type of data used for lightning information:

_00, _20, _40 - lightning information is taken from the GLM data

_0a - high-resolution lightning data, obtained by individual request for precise verification of events

_0w - low-resolution lightning data, acquired from the WWLLN server

Structure of the file is provided in the Table

Name of Variable	**Description**
Timestamp_light	Timestamp of the lightning event
light_lon	Lightning longitude
light_lat	Lightning latitude
light	Lightning event description [longitude, latitude, longitude_projected_onto_magnetic_field_line, latitude_projected_onto_magnetic_field_line, distance_to_the_satellite(km)]
Tim_resid	Timestamp of magnetic field residuals
T	Time in seconds around the detected spike
Lon_resid	Longitude of residuals along the satellite track
Lat_resid	Latitude of residuals along the satellite track
Trend	Three components and scalar field of the main trend [N,E,C,F] based on polynomial approximation
B_NEC	Three components [N,E,C] of the main trend
SIG	Residuals of three components of magnetic field [δN,δE,δC]
B_SIG	Residuals of the scalar magnetic field [δF]
Radius	Radius from the Earth Center

2 TLE QuickLook data

In addition to the CDF SIG files, so called QuickLook data, representing all detected fluctuations, can be accessed from the following link: `http://swarm4anom.cbk.waw.pl/gauss/`. Three categories of images are provided:

- global representation of fluctuations detected on the selected day, separately for ascending and descending passes (example Figure 1). Naming convention of files helps

to distinguish fluctuations only related to lightning events (files ending with suffix "_g.png") from all registered on the following day (files ending with suffix "_a.png").

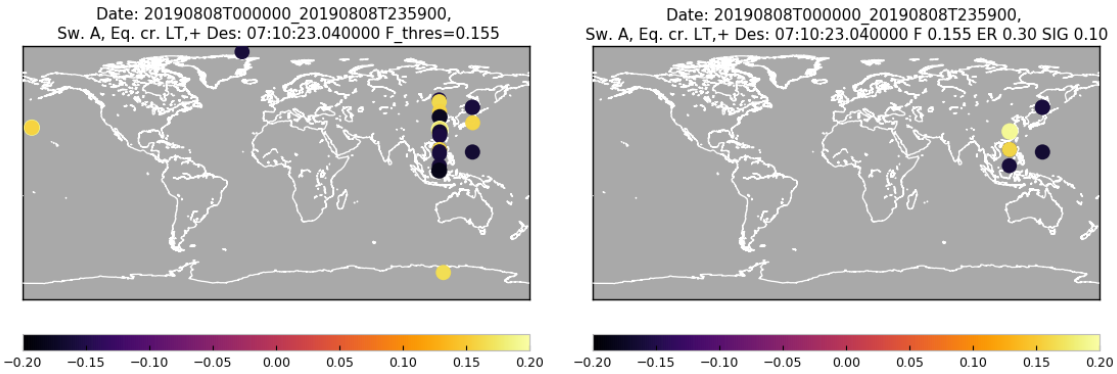

Figure 1: Global distribution of detected fluctuations on 20190808. Left panel: all cases - files ending with suffix "_a.png"; right panel: cases with verified lightning events - files ending with suffix "_a.png". Color scale represents amplitude of fluctuations of the scalar field

- plots showing synthetic function, and 30 samples of data representing detected peak. Each file of this type included coordinates of the peak (where it was detected), and exact UTC time (example Figure 2)

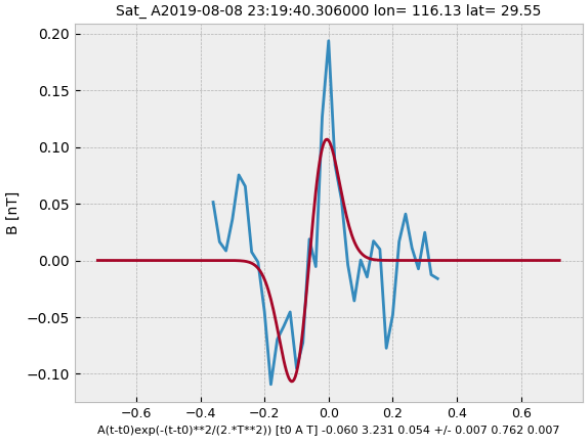

Figure 2: Synthetic function and Swarm fluctuations

  - Original file Swarm HR MAG file, in which fluctuation was detected:

SW_OPER_MAGA_HR_1B_20190808T000000_20190808T235959_0505_

- Repeated date and version of the algorithm:
  20190808_000000_20190808_235959_Mod12.012_
- Timeframe of detected event: HHMMSS **_231940_**
- Longitude and latitude, of detected fluctuation: **_116.1_29.5_**
- Amplitude of fluctuation and quality of fit (under ideal condition second parameter should be equal to 1): **_0.19_0.24_f.png**

- Summary plot showing: spectrum of magnetic field fluctuations, time series derived from spectral fits, waveform of δF and combination of plasma parameters: N_e, T_e. Red stars denote lightning activity, while blue star indicated detected peak (example: Figure 3)

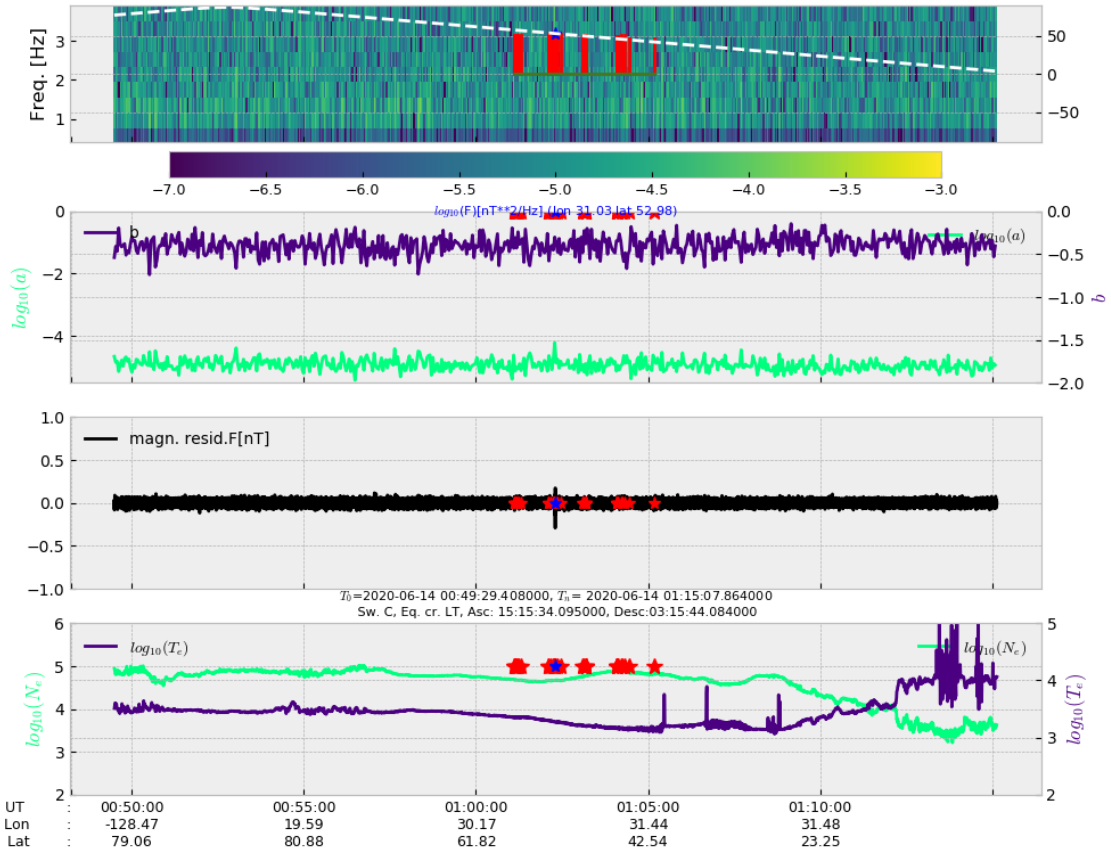

Figure 3: Power spectrum and waveform of magnetic field, combined with registered plasma parameters.