Co-seismic magnetic field perturbations detected by Swarm three-satellite constellation

Supplementary Material

In this Supplementary Material we provide the output tracks where some possible co-seismic effects on magnetic field have been detected and one example where we do not found any evidence of possible earthquake-source disturbance.

Each Track presents the residual of the analysis of X, Y, Z and the total intensity of the magnetic field (see the manuscript text for data processing description), together with the FFT of the central part of the signal to check the frequency content of the signal (between minimum and maximum Dobrovoslky*'s latitude showed as a yellow circle in the map); a map with the projection of the satellite tracks on the ground with colour according to the Flags of satellite Swarm: brown nominal conditions, red abnormal conditions; a green star represents the epicentre and the title reports the main parameters of the track as the time (UTC and local time); the first letter of the satellite; type of orbit: U ascending, D Descending; geomagnetic indices Dst and ap during the acquisition and how many and which Flags present abnormal conditions.

For all tracks, the residual calculated with the spline (method 1; see [1]) and the one calculated with respect to the geomagnetic global model IGRF-12 (method 2) are presented one after the other.

* The Dobrovolsky radius is defined in km as $10^{0.43M}$, where M is the magnitude of the seismic event [2]. In Figures from S1 to S10, the circle of Dobrovolsky is represented as a yellow circle on the maps. Here, the only scope of this representation is to provide a visual idea of the Energy released by the seismic events, although it could represent a possible area to search for possible effects induced by the preparation of the earthquake.

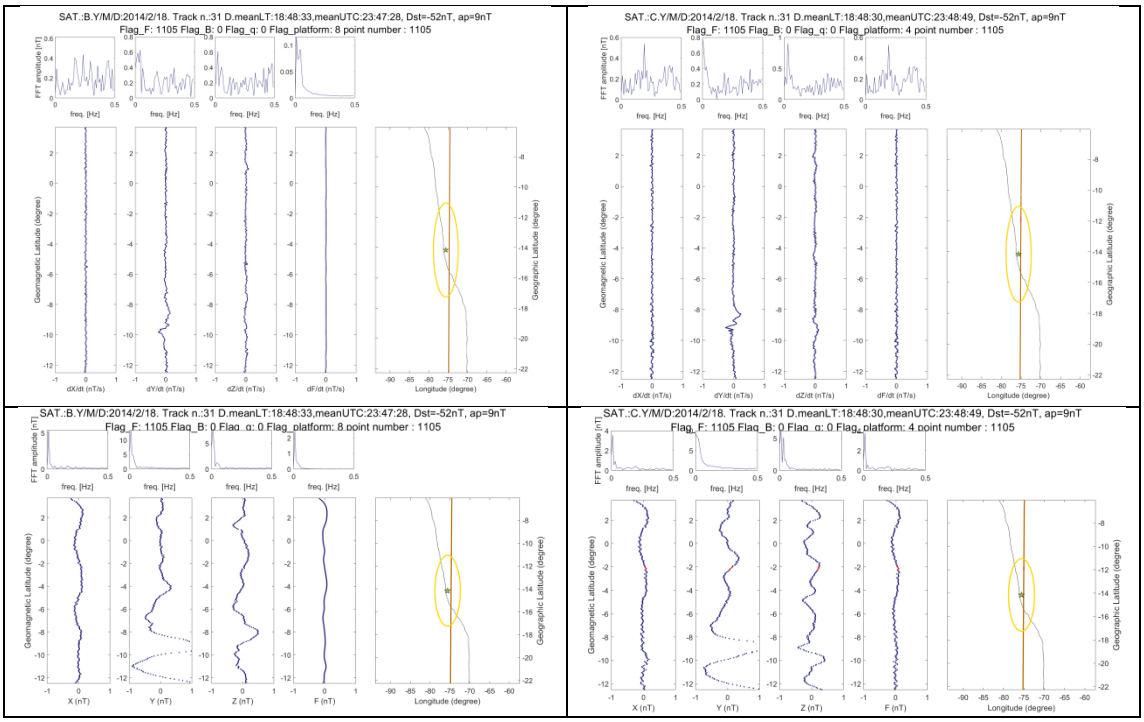

Figure S1. Residual of magnetic signal of Swarm Bravo and Charlie during the occurrence of M5.9 2014-02-18 earthquake.

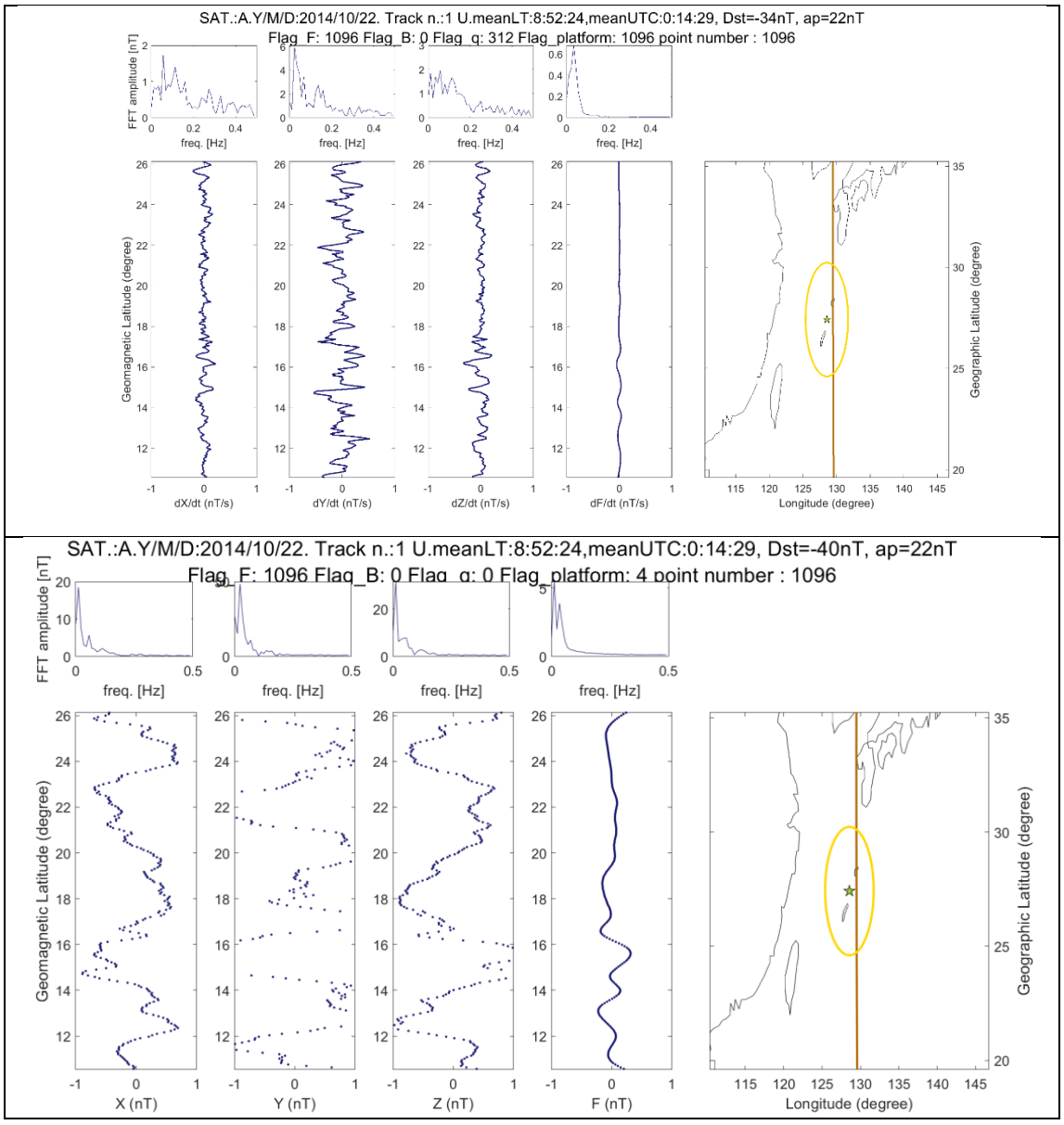

Figure S2. Residual of magnetic signal of Swarm Alpha during the occurrence of M5.8 2014-10-22 earthquake.

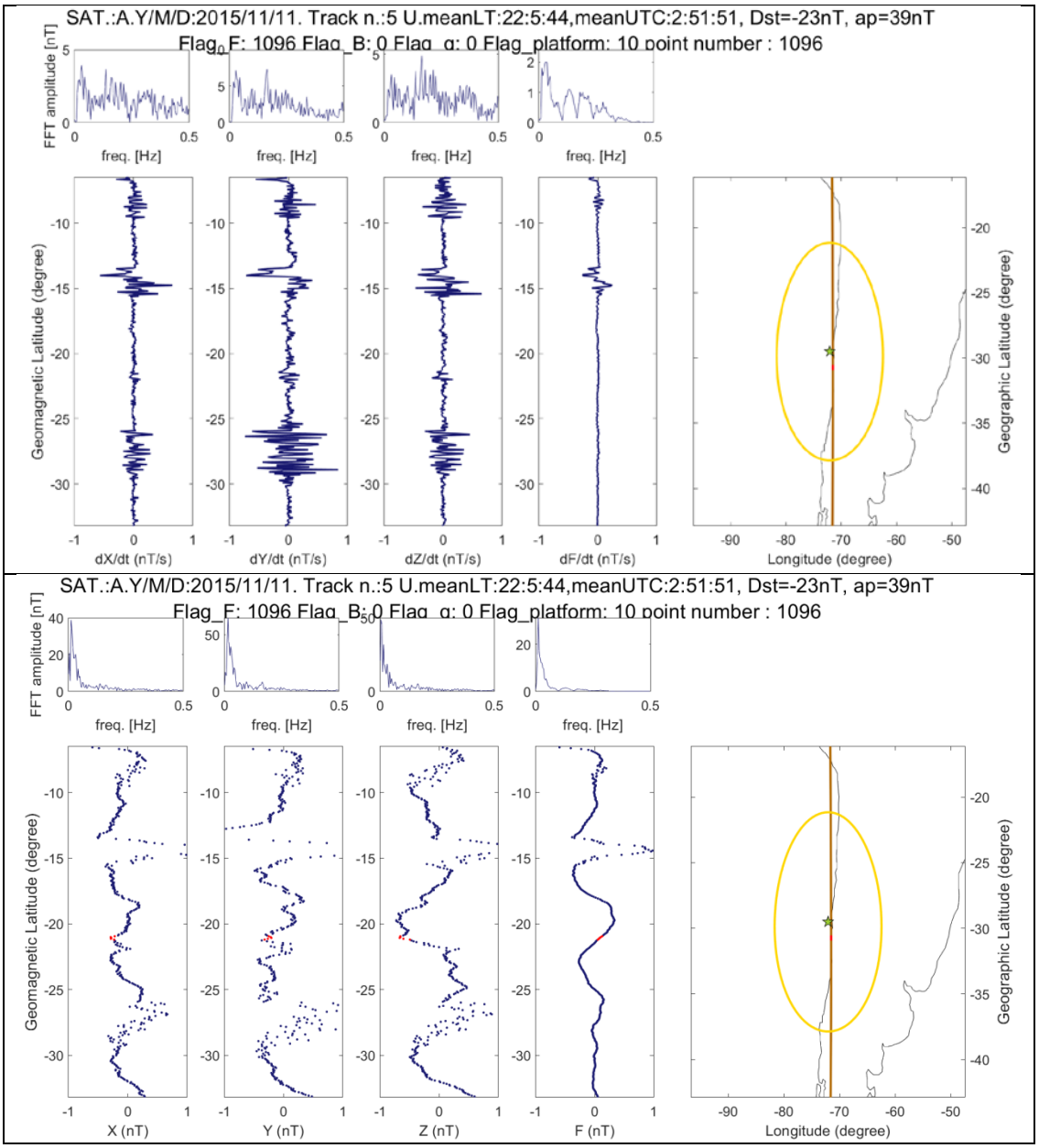

Figure S3. Residual of magnetic signal of Swarm Alpha during the occurrence of M6.9 2015-11-11 earthquake.

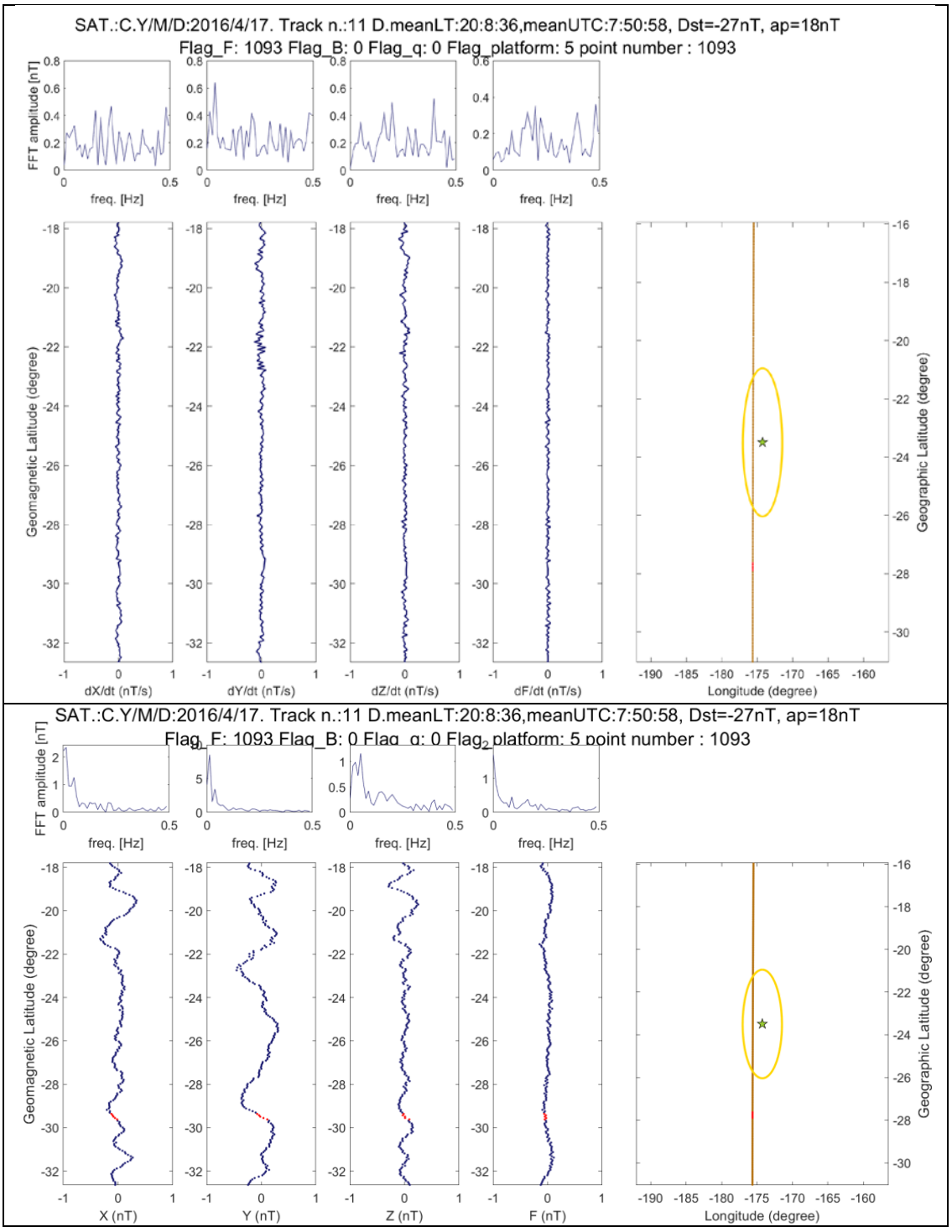

Figure S4. Residual of magnetic signal of Swarm Charlie during the occurrence of M5.7 2016-04-17 earthquake.

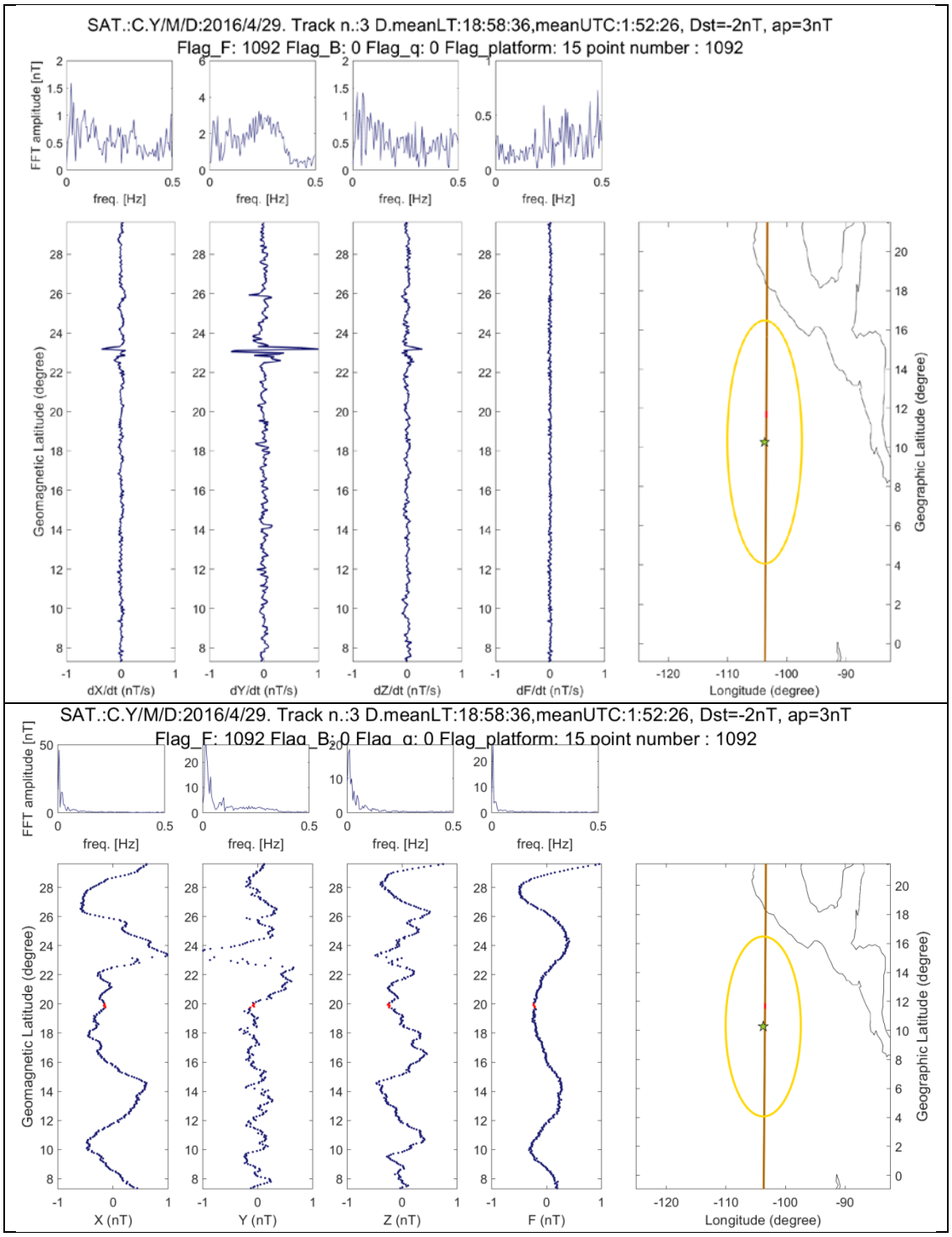

Figure S5. Residual of magnetic signal of Swarm Charlie during the occurrence of M6.6 2016-04-29 earthquake.

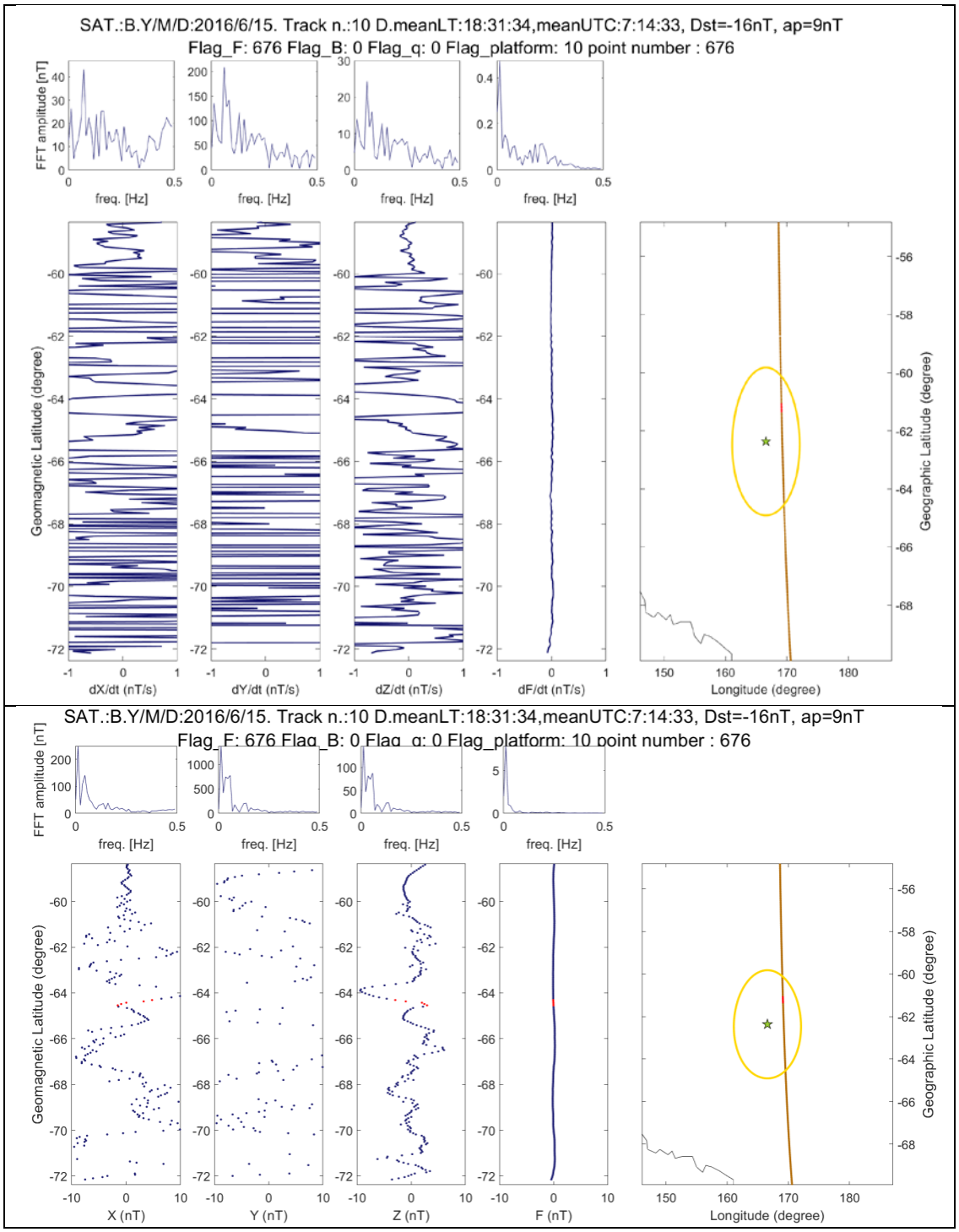

Figure S6. Residual of magnetic signal of Swarm Bravo during the occurrence of M5.7 2016-06-15 earthquake. The track shows an high disturbance due to the Southern polar region. For this track the scale has been set to -10nT / 10 nT due to large residuals.

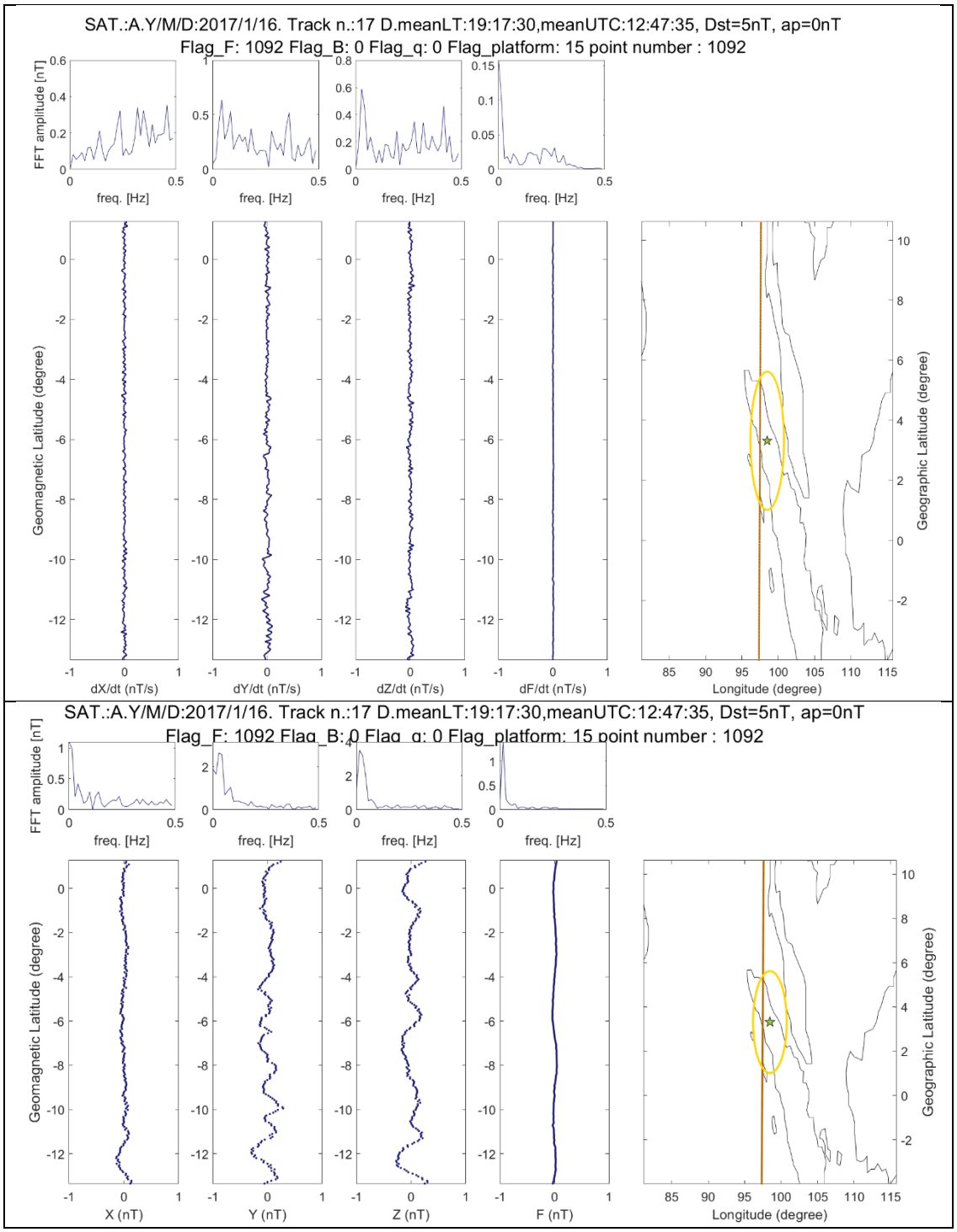

Figure S7. Residual of magnetic signal of Swarm Alpha during the occurrence of M5.6 2017-01-16 earthquake.

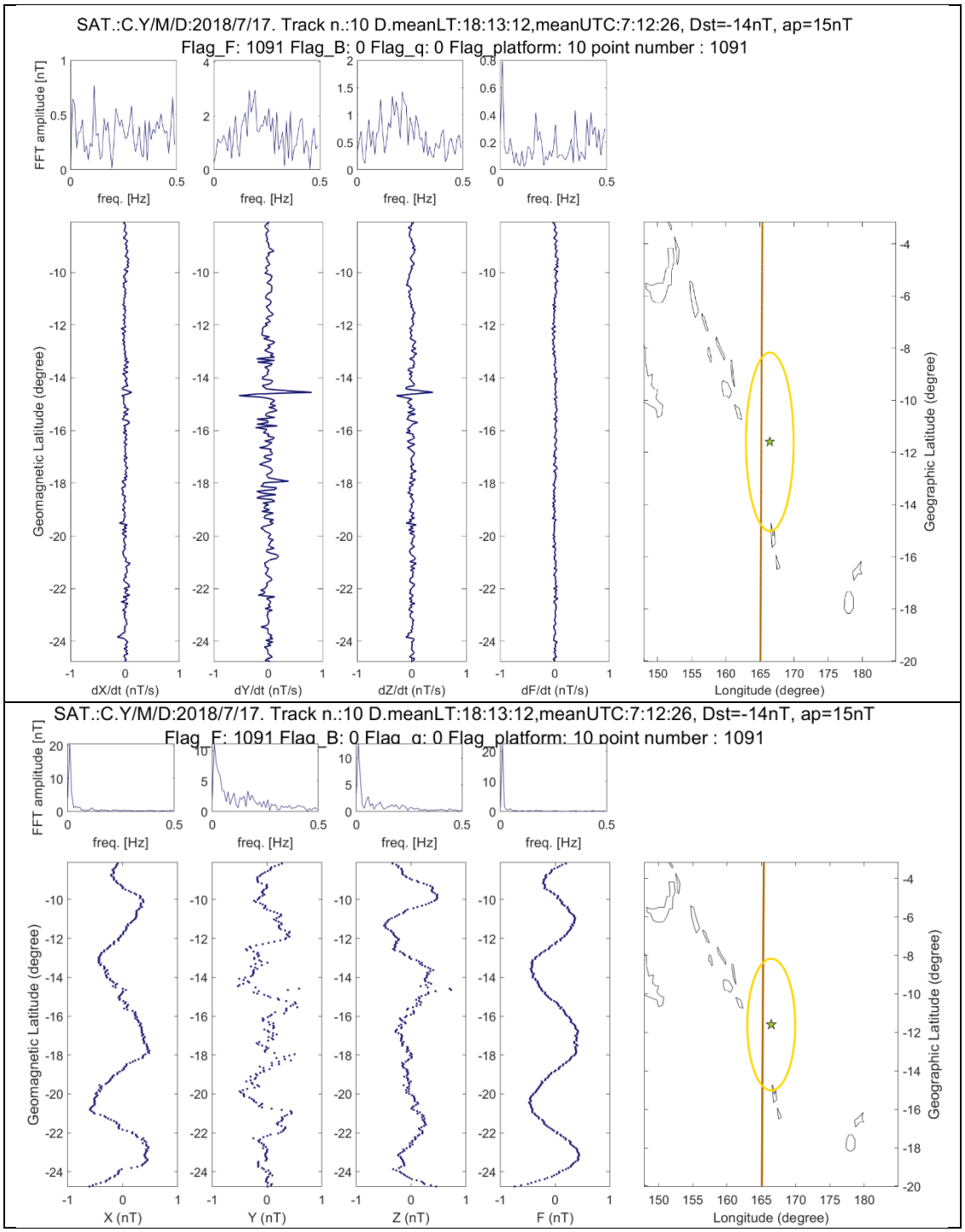

Figure S8. Residual of magnetic signal of Swarm Charlie during the occurrence of M6.0 2018-07-17 earthquake.

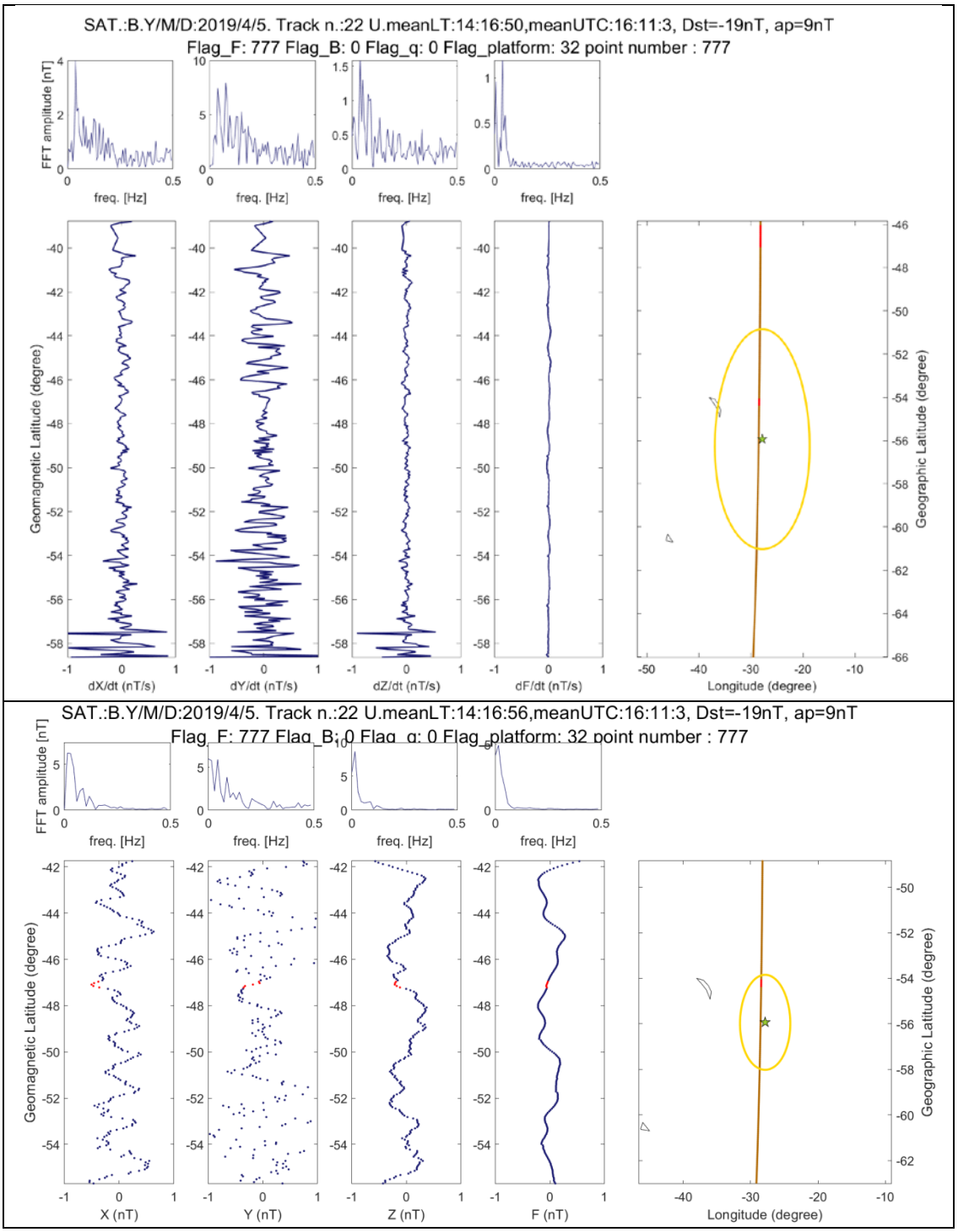

Figure S9. Residual of magnetic signal of Swarm Bravo during the occurrence of M6.4 2019-04-05 earthquake.

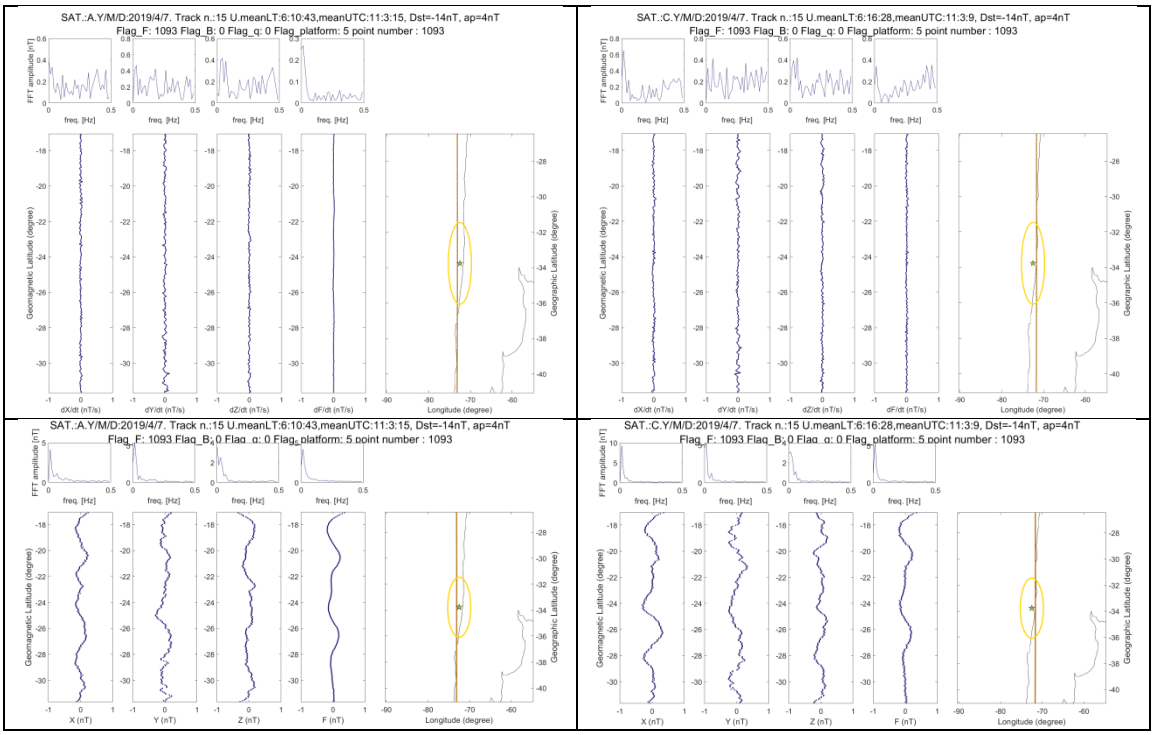

Figure S10. Residual of magnetic signal of Swarm Alpha and Charlie during the occurrence of M5.6 2019-04-07 earthquake.

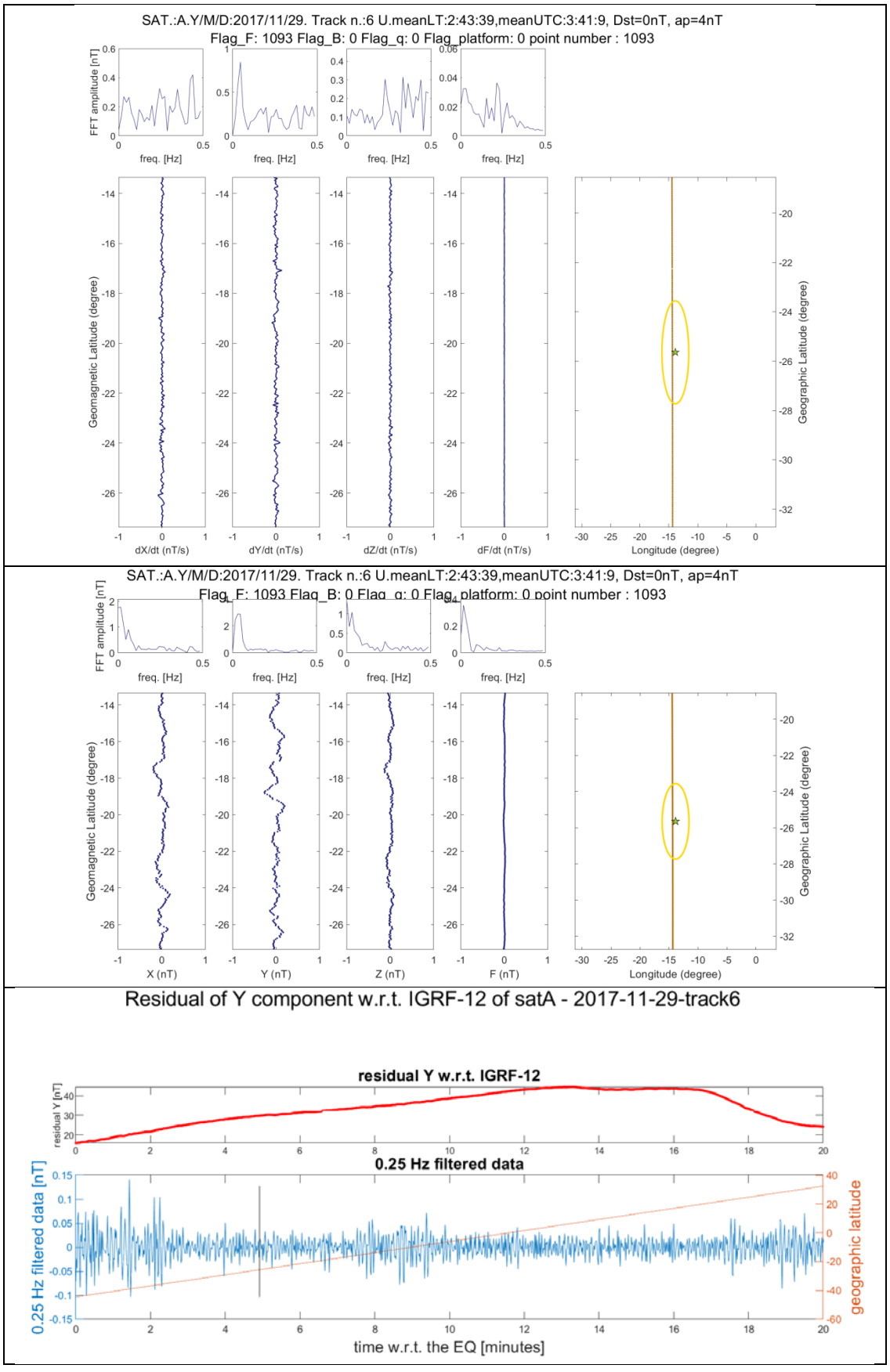

Figure S11. Example of an excluded track. Residual of magnetic signal of Swarm Alpha during the occurrence of M5.5 2017-11-29 earthquake in Atlantic sea.

References:

1. De Santis, A.; Balasis, G.; Pavón-Carrasco, F.J.; Cianchini, G.; Mandea, M. Potential earthquake precursory pattern from space: the 2015 Nepal event as seen by magnetic Swarm satellites. Earth and Planetary Science Letters. **2017**, *461*, 119–126.
2. Dobrovolsky, I.P.; Zubkov, S.I.; Miachkin, V.I. Estimation of the Size of Earthquake Preparation Zones. *PAGeoph.* **1979**, *117*, 1025.