Overview of Swarm accelerometer data quality

Christian Siemes, Jiri Kraus, Eelco Doornbos, Ludwig Grunwaldt, Radek Peresty, Joao Encarnacao, Jose van den IJssel, Jakob Flury, Guy Apelbaum, Sergiy Svitlov, Poul Erik Holmdahl Olsen

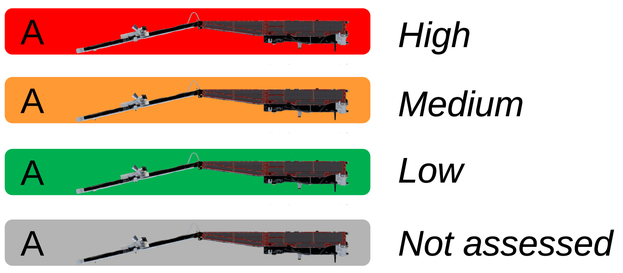
Contact: Christian Siemes • RHEA for ESA – European Space Agency • christian.siemes@esa.int

Introduction

The Swarm satellites carry accelerometers as part of their scientific payload. These instruments measure the non-gravitational acceleration due to forces like drag or radiation pressure acting on the spacecraft, from which thermosphere neutral densities and potentially winds can be derived.

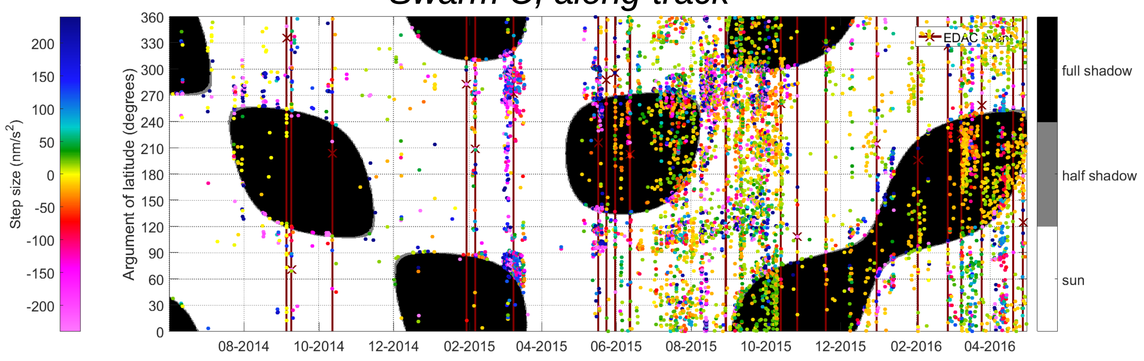
Unfortunately, the acceleration measurements suffer from a variety of perturbations that we present on this poster. Though all perturbation are visible in the measurements of all Swarm accelerometers, their severity is much different for the three Swarm satellites. We use the colour code on the right side to indicate the severity of the perturbation. The first letter indicates the Swarm satellite.

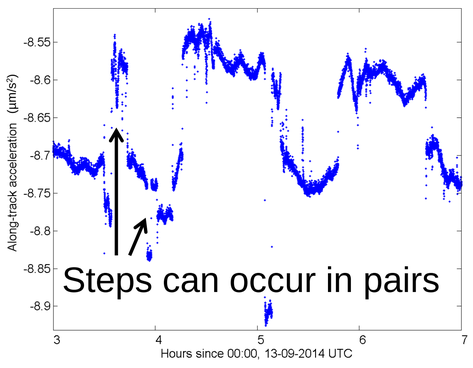
Severity colour code



Steps

Swarm C, along-track



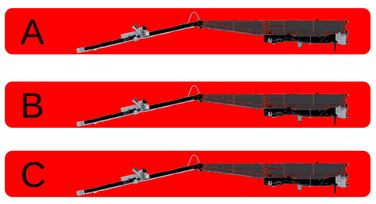


About 9000 steps in 2 years

Some periods are better, some worse

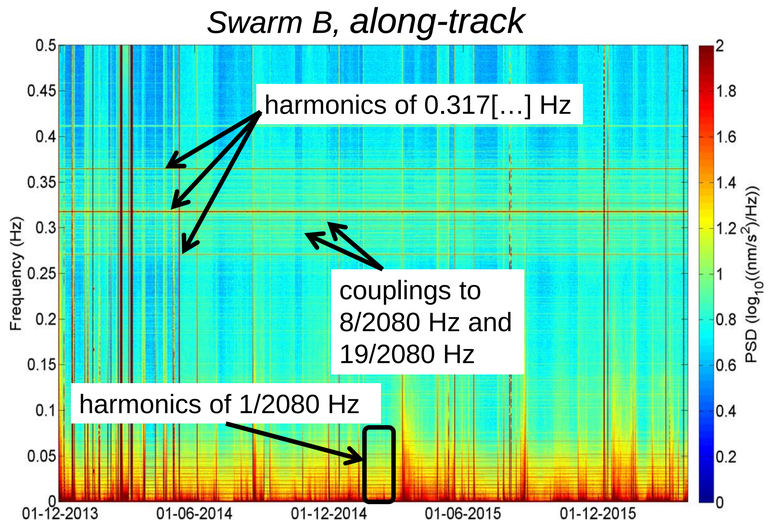
Step size ranges from 10 nm/s² to 10 µm/s²

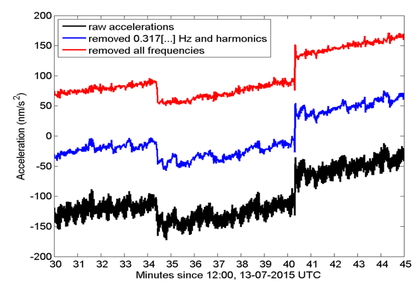
Severity



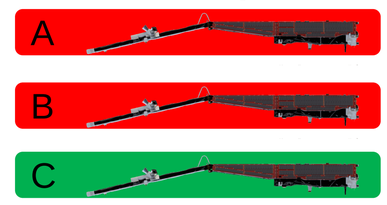
Artificial periodic signals

Swarm B, along-track



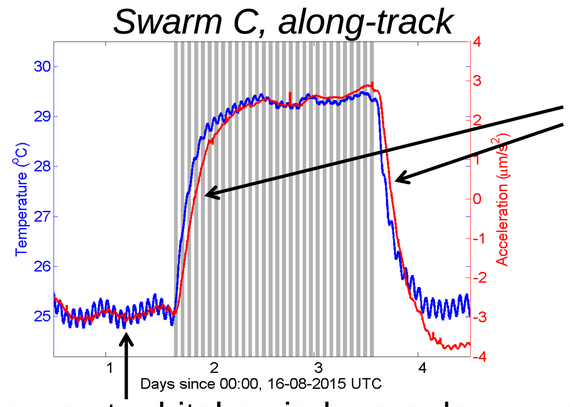


Severity



Temperature effects

Swarm C, along-track

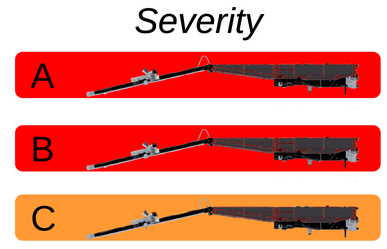


Thermistor measures temperature change

Accelerometer responds with a small time lag

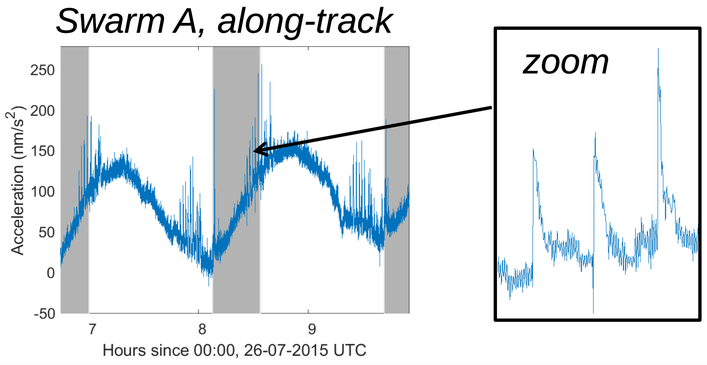
Response at orbital period more dampened than response at daily period

Severity



Spikes

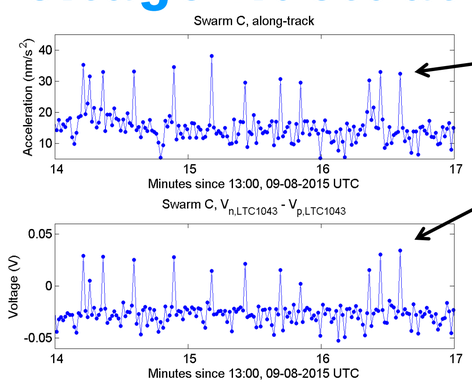
Swarm A, along-track



Spikes occur often twice per orbit

Severity

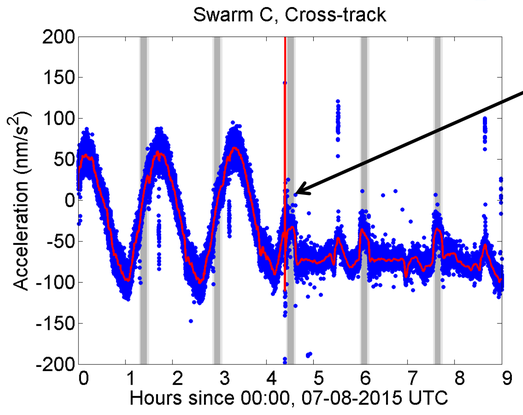
Voltage fluctuations



Single epochs appear as acceleration outliers and seem to be linked to outliers in the voltages

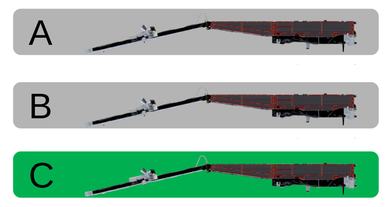
Severity

Character changes

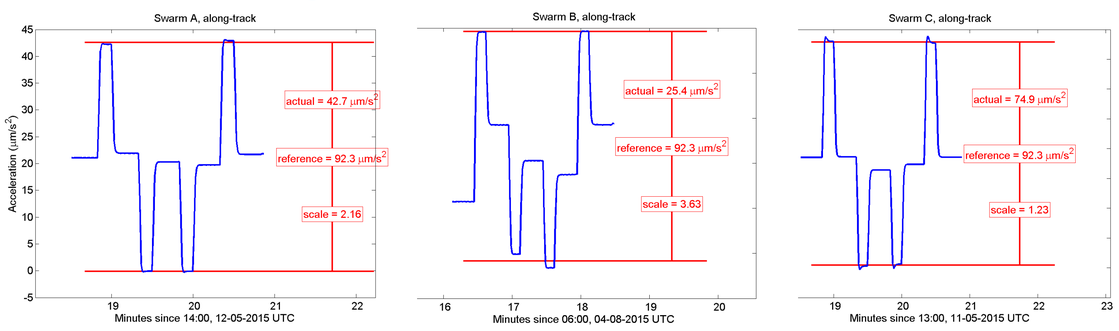


Scale factor and temperature effects sometimes change significantly at large steps and EDAC failure events

Severity



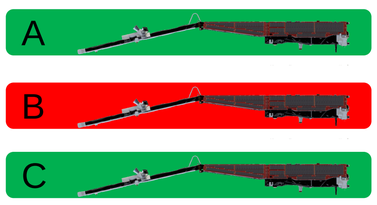
Sensitivity



Scale factors related to the conversion from control voltages to acceleration show large differences between satellites

Large scale factor = Low sensitivity

Severity



Conclusions

- Swarm C accelerometer data is less affected by perturbations compared to Swarm A and B accelerometer data. In particular, the temperature effects are about ten times smaller compared to Swarm B
- Swarm B accelerometer data is heavily affected by steps, temperature effects and artificial periodic signals
- For Swarm B, the combination of the low acceleration signal due to the higher altitude, the low sensitivity of the accelerometer, and the larger perturbations makes scientific use difficult
- The performance of Swarm A accelerometer data is in between that of the Swarm B and C accelerometer data
- The combination of the expected similarity of the acceleration signals of Swarm A and C due the to orbits and the large number of spikes in Swarm A accelerometer data limits the added value of the latter on top of the first

Reference

C Siemes, J Encarnacao, E Doornbos, J van den IJssel, J Kraus, R Peresty, L Grunwaldt, G Apelbaum, J Flury, P E Holmdahl Olsen (2016) *Swarm accelerometer data processing from raw accelerations to thermospheric neutral densities.* Earth, Planets and Space, 68:92. DOI 10.1186/s40623-016-0474-5