**Swarm accelerometer data: temperature dependence and GPS-based calibration**

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**Swarm A/C: deep orbit resonance**

Passage through 46:3 resonance in Feb 2016

- Upper figures: typical ground tracks in a month
- Lower figures: sparse coverage due to deep orbital resonance (Feb 2016)
- Next deep orbital resonances:
  - 77:5 at 422.7 km in 2020
  - 31:2 at 393.2 km well beyond 2020

**Linear temperature correction (LTC)**

SIM-validation of accelerometer (ACC) data

Validation by means of simulated NG signal

\[ \text{UNCAL} = B + S \times \text{SIM} + Q \times T(t+F) + G \times (t-t_0) + \varepsilon \]

\[ \text{CAL} = \left[ \text{UNCAL} - B - Q \times T(t+F) - G \times (t-t_0) \right] / S \]

- UNCAL...uncalibrated ACC data; B..bias; S..scale factor; SIM..modelled NG signal;
- Q..temperature factor; T(t+F) ..temperature with phase shift F; t..time; G..trend; ε..noise
- CAL..calibrated ACC signal
- Linear temperature correction: \( \text{LTC}=Q \times T(t+F) \)
- Local reference frame: along-track (A-T); cross-track (C-T); radial (RAD) directions

**Anomalous periods in ACC data**

- ESA: problematic 3-week period in Oct–Nov 2014: large number of steps, impossible to correct reliably; the net effect close zero.
- Originally, this issue concerned A-T data of Swarm C covering period Jun-Dec 2014
- Application of LTC to ACC data of Swarm A → both Swarm A and Swarm C experienced similar problems in the same periods!
- Taking 1.5 yr of ACC data for Swarm A/C → correlation between the anomalous periods and the minima in AC component of the signal measured by ACC instrument.

**Effect of LTC on A-T component**

- ACC data with no temperature correction do not correspond well to physical NG signal.
- Correlation of temperature corrected ACC data with NG is improved substantially.
- Increase in #SIM-validated blocks by LTC

**GPS-based calibration of ACC data**

**Acceleration approach: ASU version**

Assume the geopotential is known and define GPS-based NG accelerations

\[ a_{\text{GPS}}(\text{GPS}) = a_{\text{GPS}} - (a_{\text{geo}} + a_{\text{LS}} + a_{\text{TID}} + a_{\text{REL}}) \]

where \( a_{\text{LS}} , a_{\text{TID}} , a_{\text{REL}} \) ... lunisolar, tides, relativity

\[ a_{\text{GPS}}(\text{GPS}) = B + S \times a_{\text{ACC(UNCAL)}} + \varepsilon \]

Calibration parameters B/S for ACC are obtained by solving linear system (+)

Problem: Numerical derivative amplifies noise in GPS positions. Solution: Generalized least squares (GLS) → linear transformation of (+)

**Simulated data**

- GPS noise 0.01 mm (unrealistic): zooming to see the ACC/NG signal
- GPS noise 3 cm (≈realistic): zooming to see the ACC/NG signal

**Real Swarm data**

- GPS-based NG acceleration:

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