Non-gravitational accelerations and magnetic disturbances

What can be observed from the residual series of accelerometers on GRACE C?

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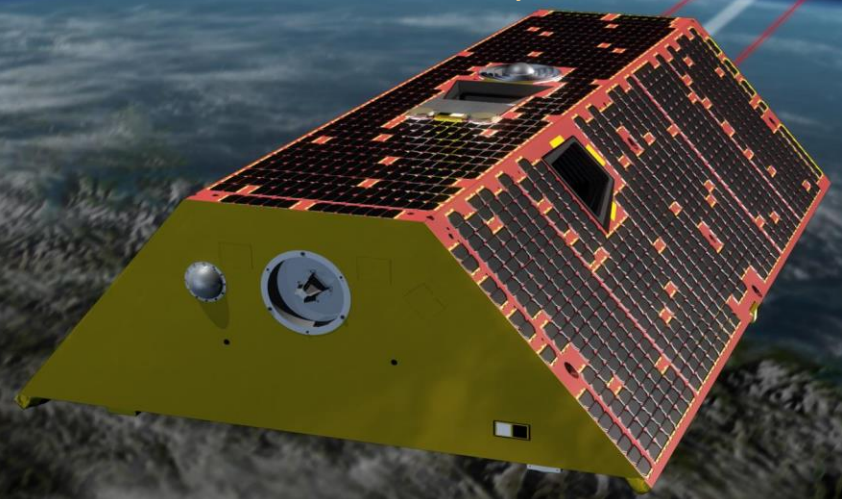


EGU General Assembly 2022

A data driven model of drag and SRP – Analysis of Residuals

- **Filter** method of ACW1B: Create a weighted 1Hz dataset

Weighted datasets are important:

Analysis in the frequency domain

Accuracy of the models

- Model the Drag and the Solar Radiation Pressure (SRP) from measurements of GRACE C

Physical Drag models are not well determined

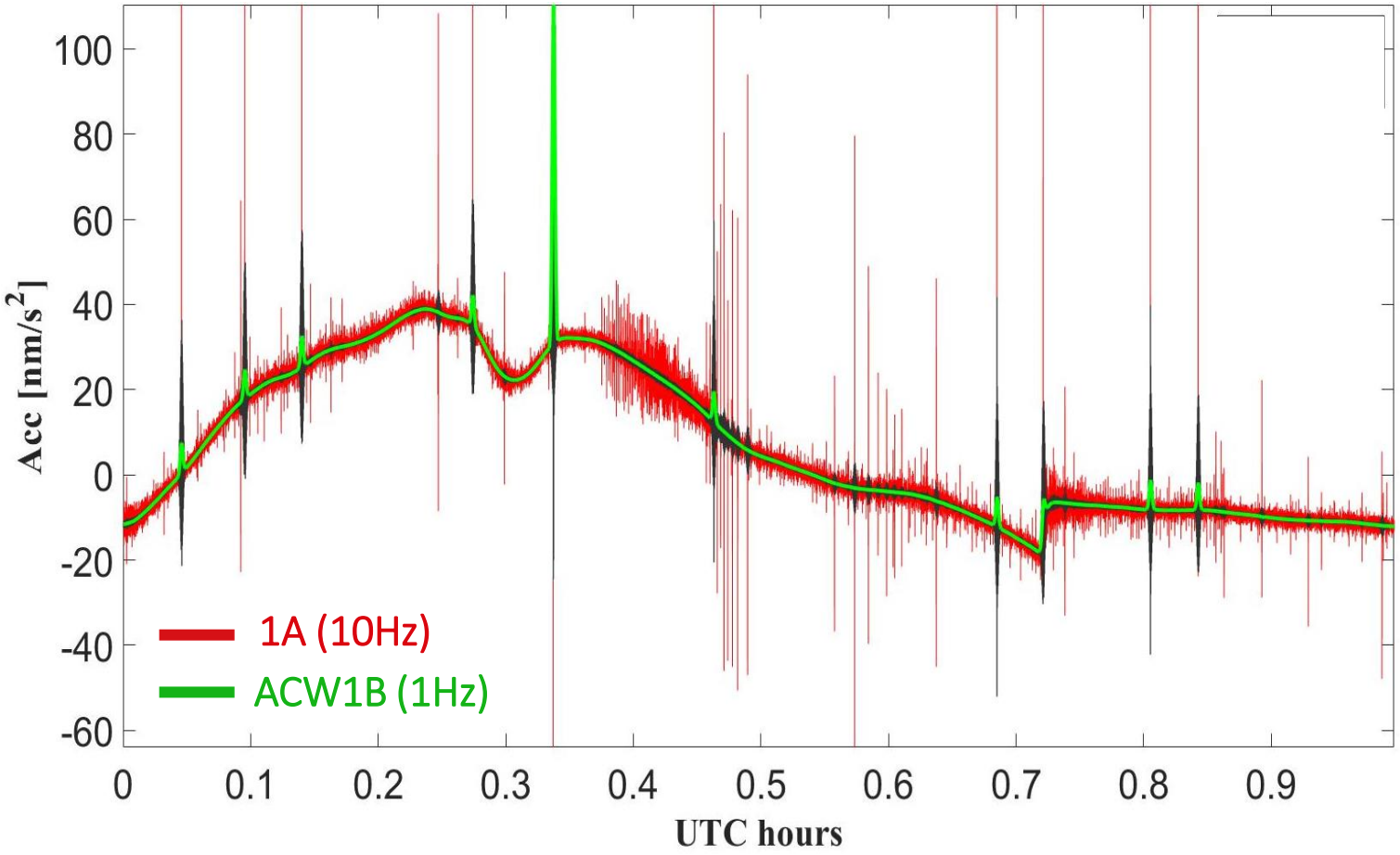
Large residuals in the x-axis

- Investigation of residual series using signal decomposition

Analysis into different frequency bands

ACW1B: Weighted dataset

Radial direction: z-axis



- Create a weighted 1A (10 Hz) dataset: variances of 11-points window
- ACW1B: 1Hz using a Gaussian filter of 35mHz
- Variances of filtered values: ACF using the variances of 1A

Importance of Weighted datasets

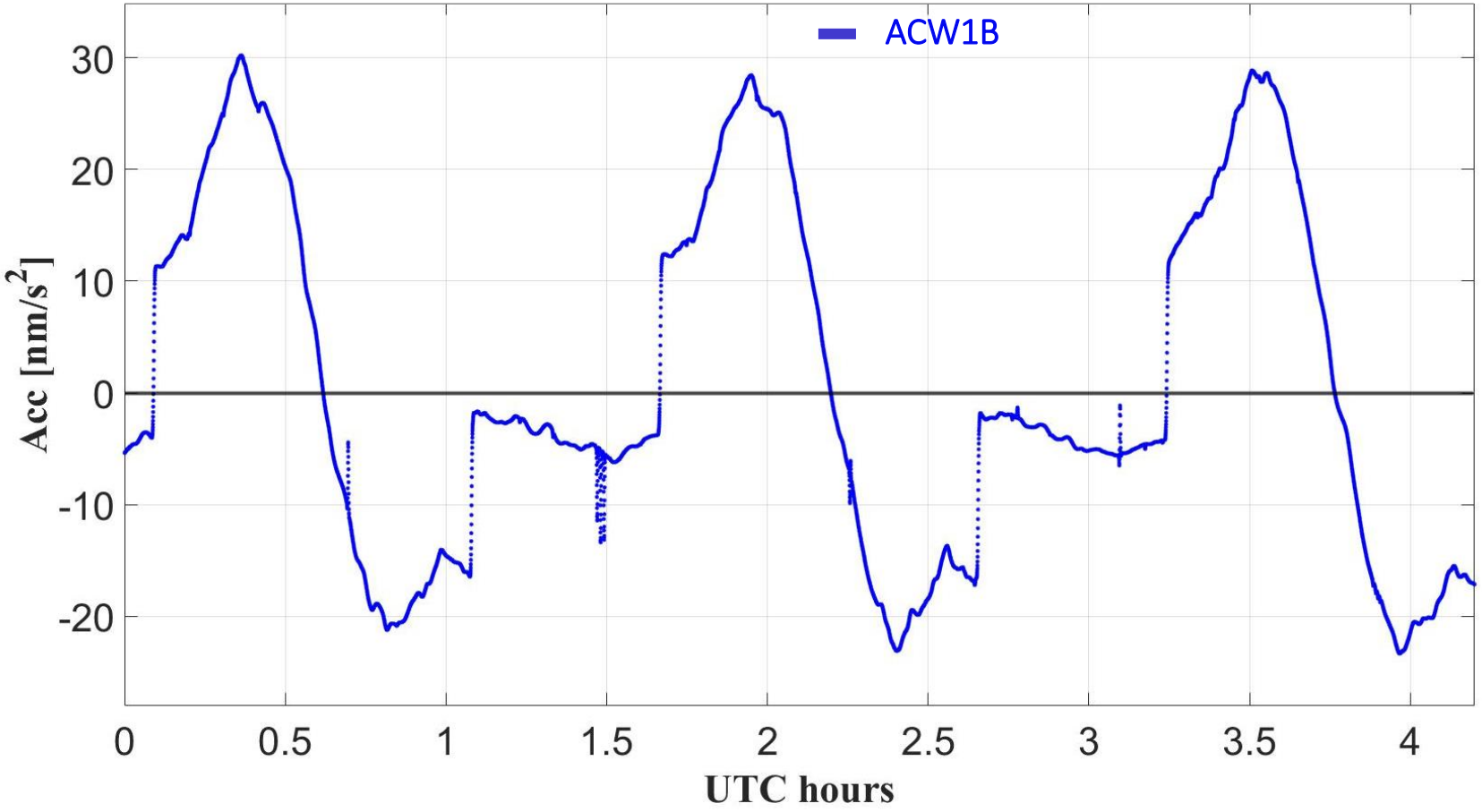
Analysis in the frequency domain

Models and Residuals are weighted

Noisy measurements on the y-axis and the z-axis

Drag and Radiation Pressure Models on GRACE-FO

Innovation: DRAG and SRP weighted models based on satellite measurements

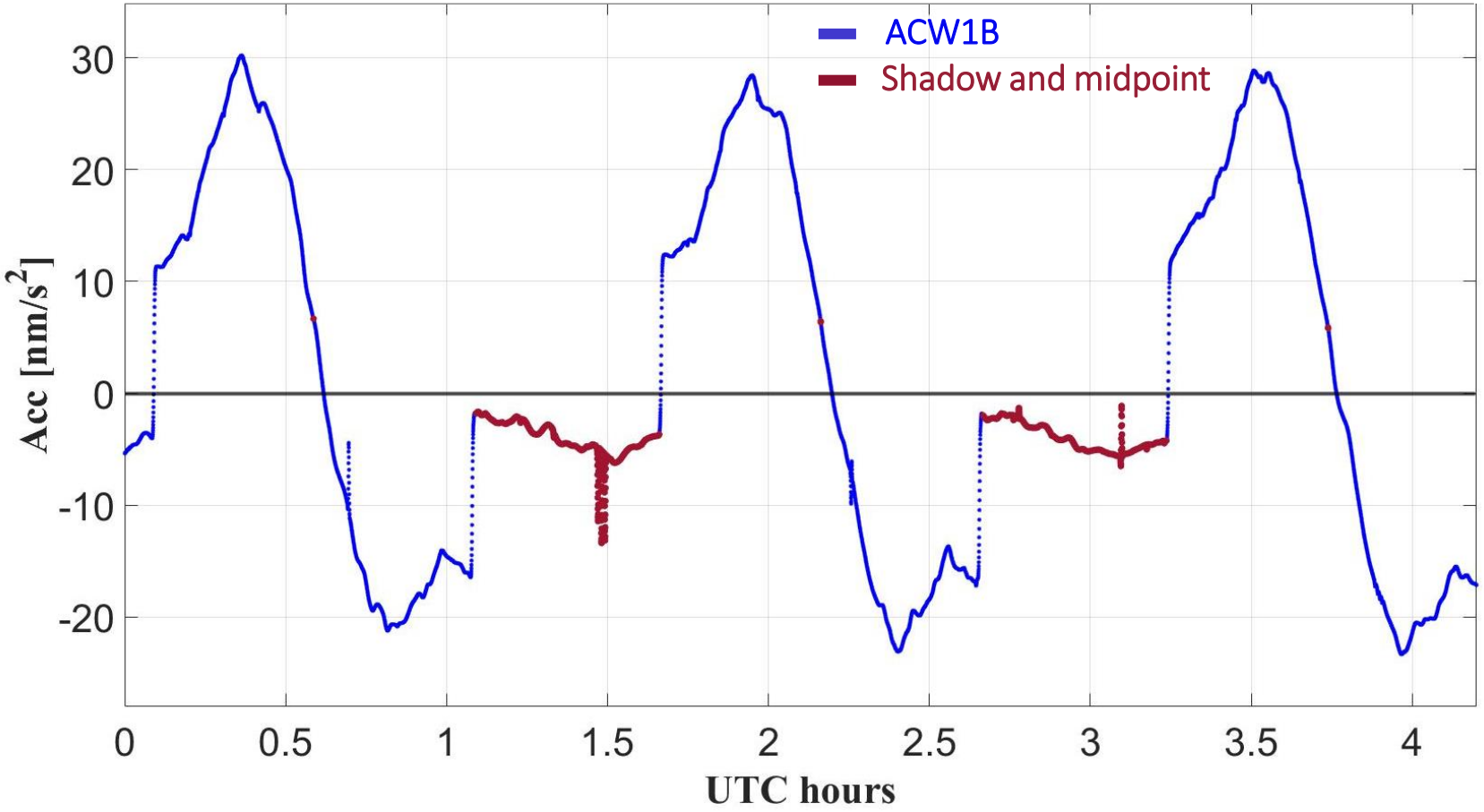


x-axis (along track)

- The most affected axis by the drag
- Model of drag very challenging
- The largest residuals

Drag and Radiation Pressure Models on GRACE-FO

Innovation: DRAG and SRP weighted models based on satellite measurements

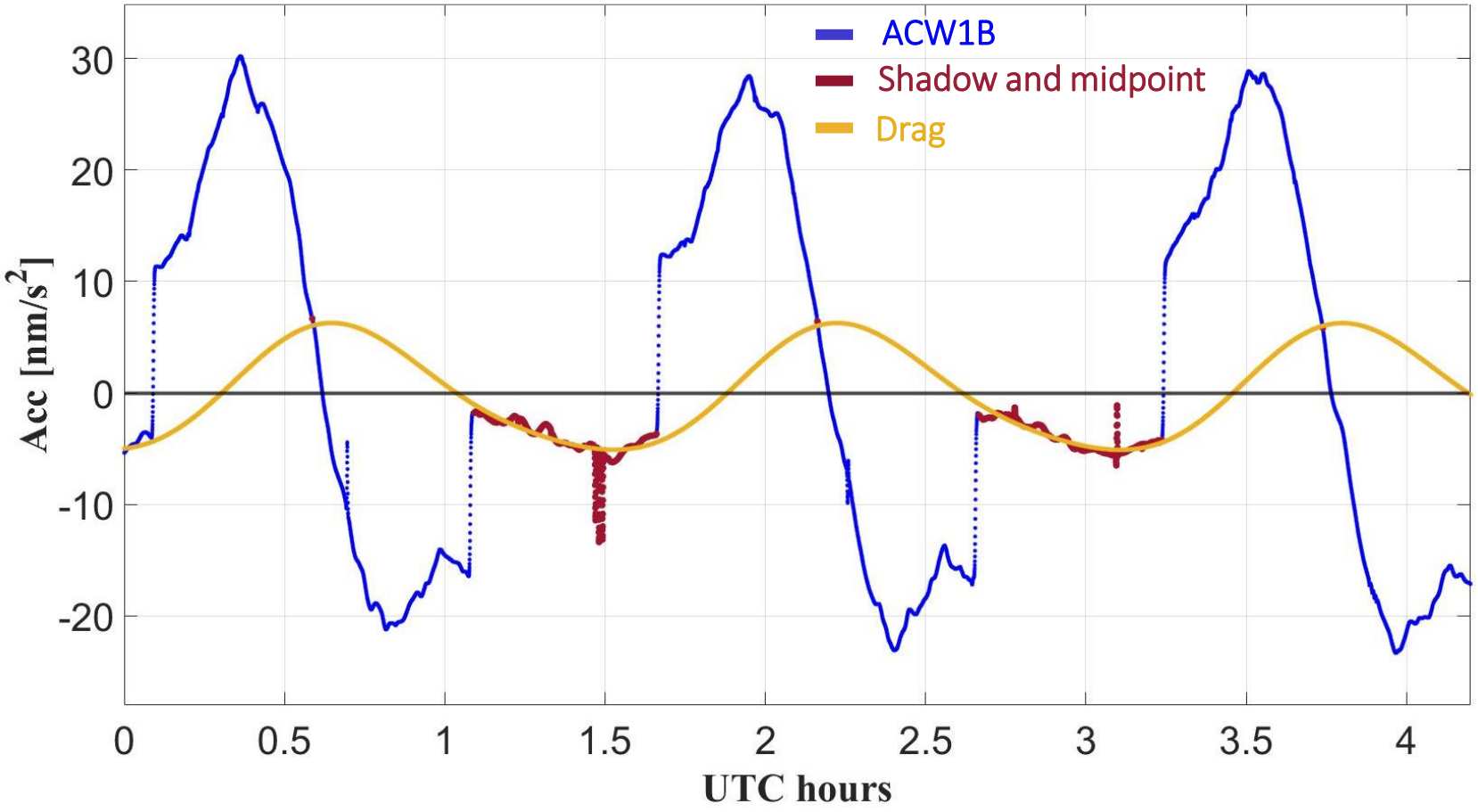


x-axis (along track)

- Select the shadow parts and the midpoint of the sun part.
- These points ⟶ SRP=0

Drag and Radiation Pressure Models on GRACE-FO

Innovation: DRAG and SRP weighted models based on satellite measurements

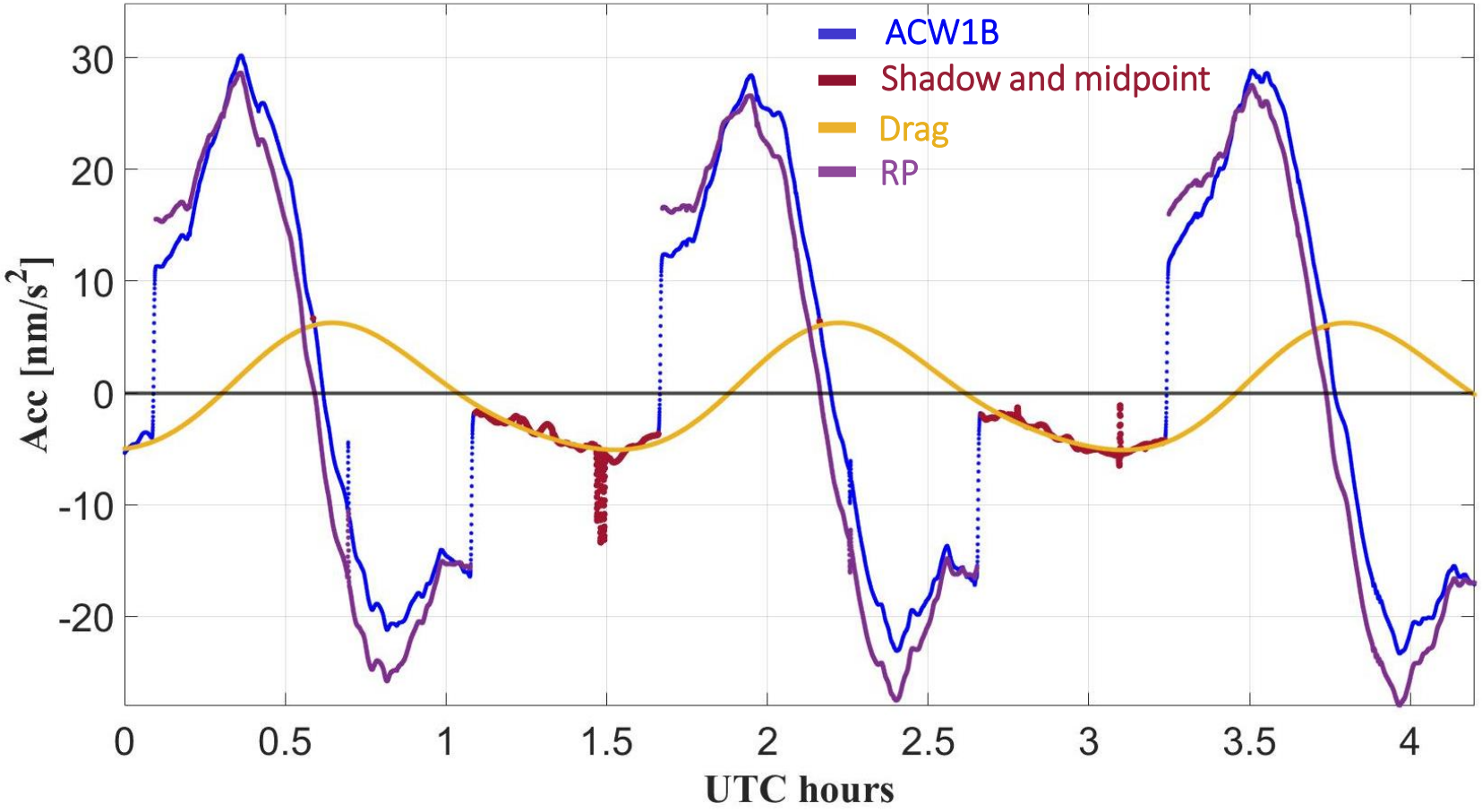


x-axis (along track)

- Modelling the drag using the LSSA.
- Resonant frequencies: 0.17mHz 0.35mHz (Period and 2nd harmonic)

Drag and Radiation Pressure Models on GRACE-FO

Innovation: DRAG and SRP weighted models based on satellite measurements

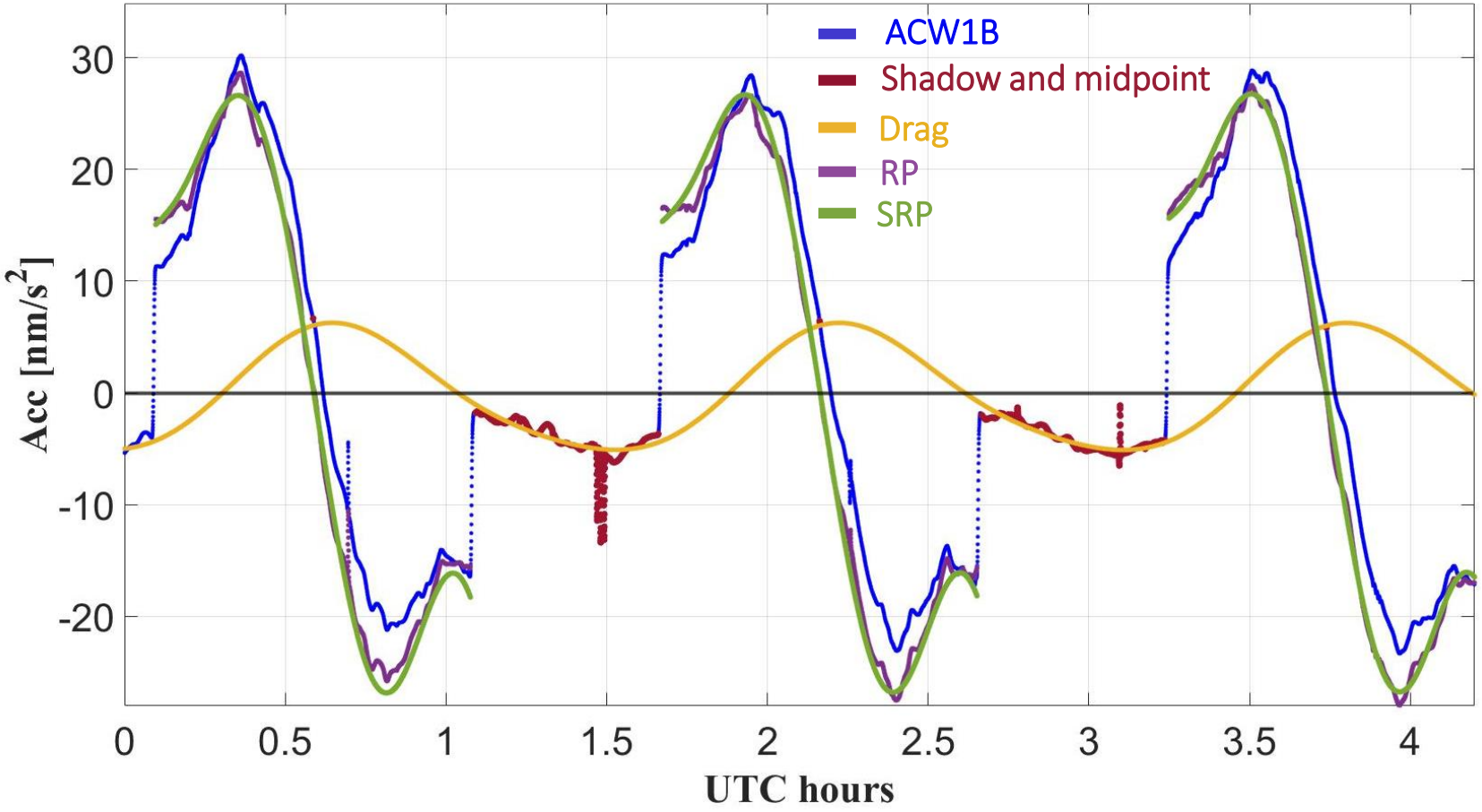


x-axis (along track)

- Radiation Pressure = ACW1B- drag
- RP: SRP, Thermal Radiation, shorter drag variations

Drag and Radiation Pressure Models on GRACE-FO

Innovation: DRAG and SRP weighted models based on satellite measurements

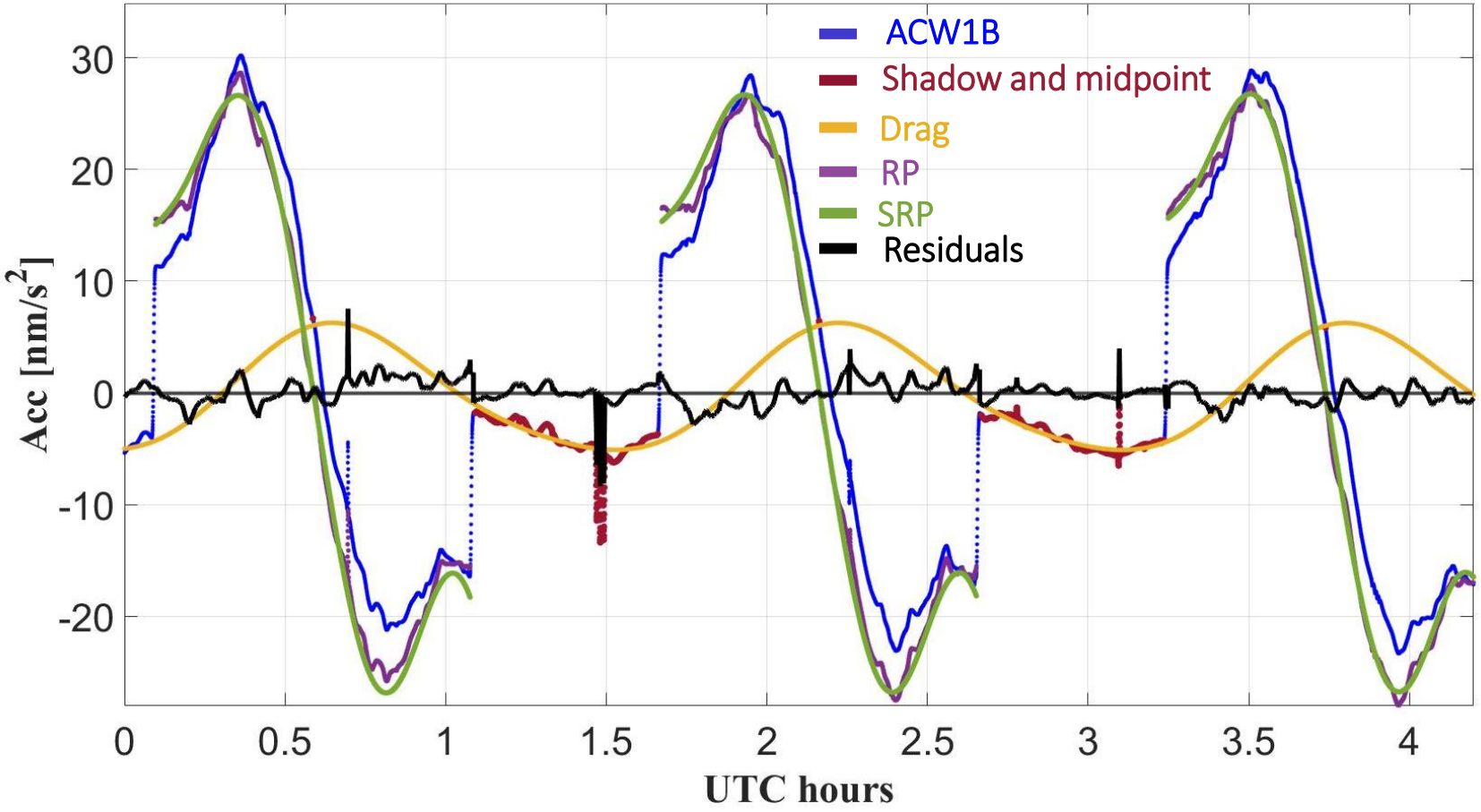


x-axis (along track)

- Modeling the RP ⟶ SRP
- Resonant frequencies: Period and the 3 harmonics

Drag and Radiation Pressure Models on GRACE-FO

Innovation: DRAG and SRP weighted models based on satellite measurements



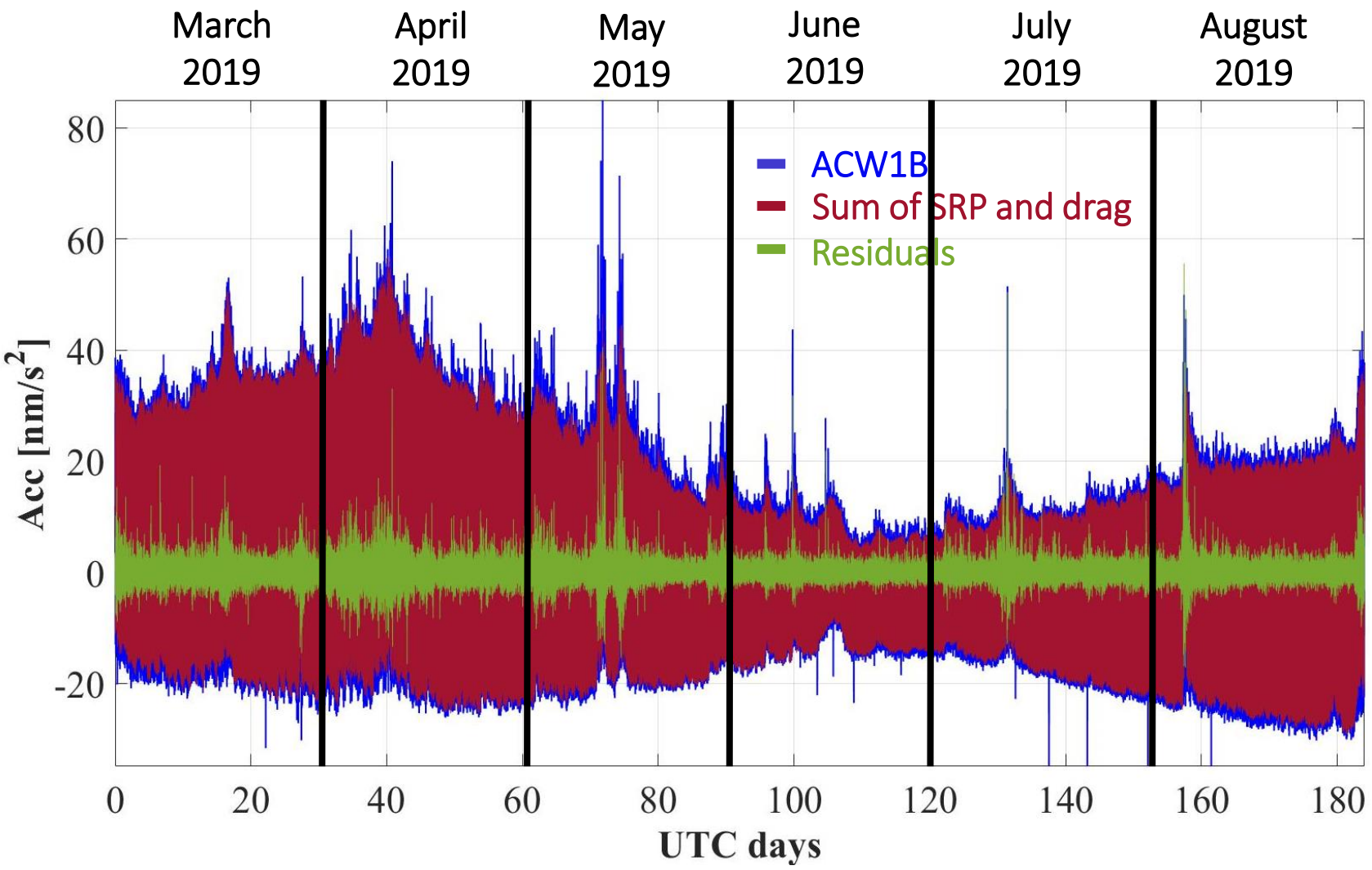
x-axis (along track)

- Drag variations, Radiation Pressure
- Weighted residuals

	Standard deviation
ACW1B	$\sim 0.5\ nm/s^2$
DRAG	$\sim 1.5\ nm/s^2$
SRP	$\sim 1.8\ nm/s^2$

Drag and Radiation Pressure Models on GRACE-FO

Weighted data driven model of Drag and SRP: March 2019-May 2019



x-axis (along track)

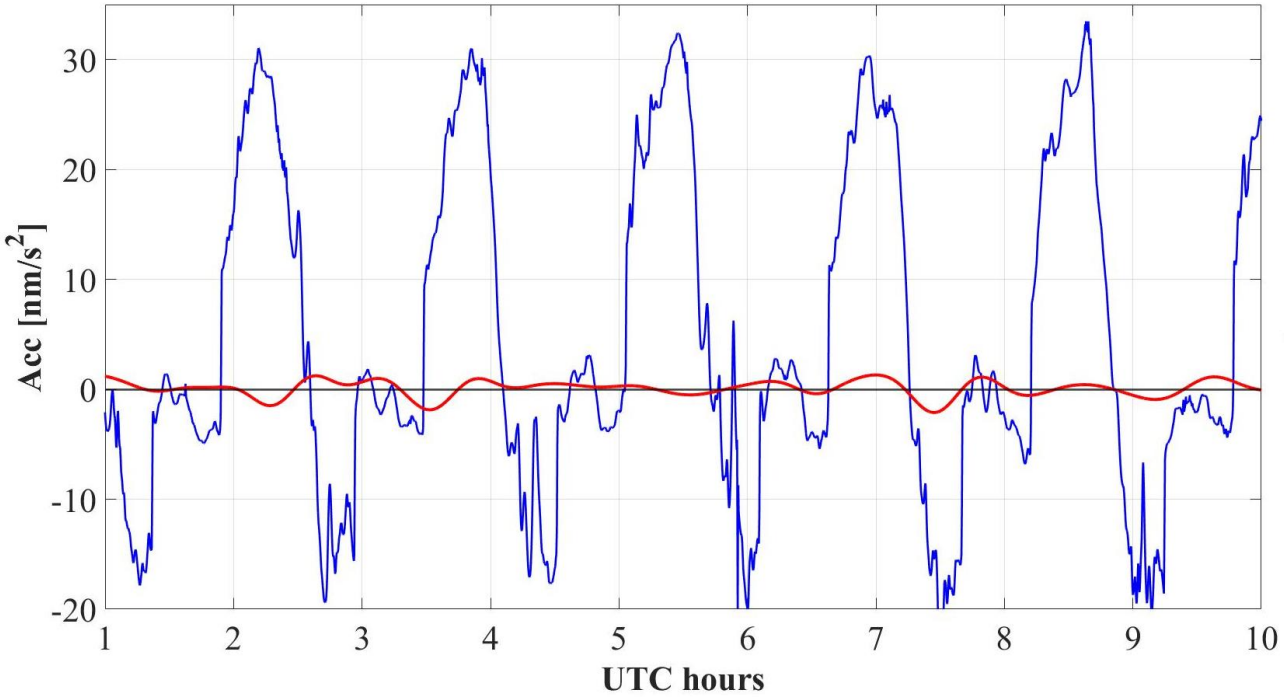
- Drag variations, ERP, Thermal variations
- $Kp > 4$ ⟶ Larger Residuals

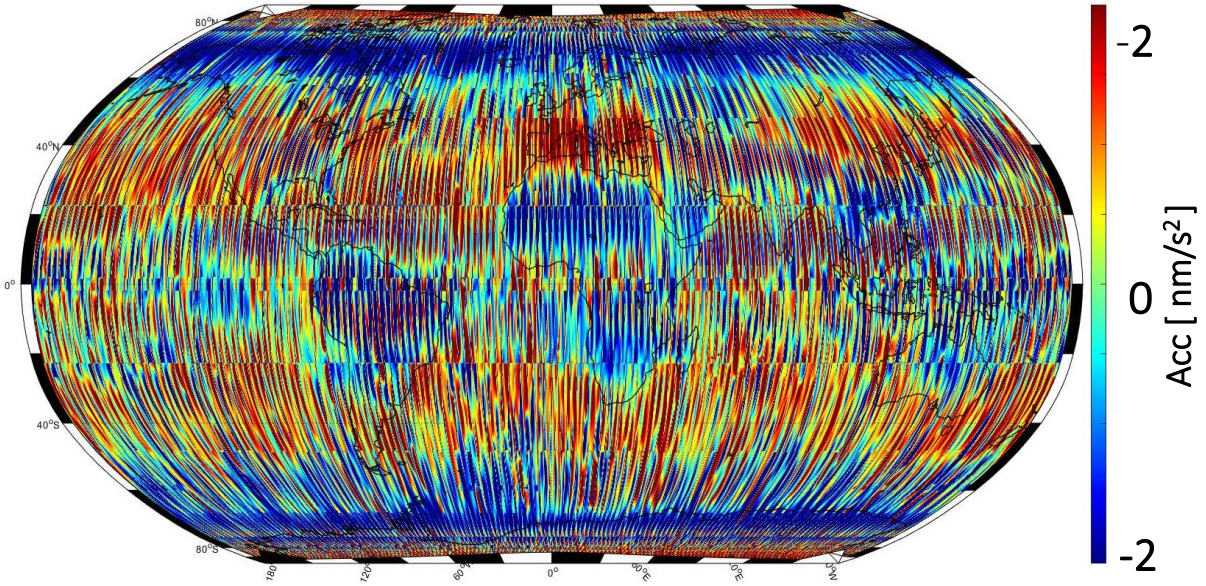
Signal Decomposition of Residuals

Signal Multiresolution: Signal Decomposition using wavelets into different levels **x-axis**

- Residual series: lowpass filter of 9mHz
- Decomposition using wavelets db4 of 13 Levels

$\mathbf{0.1\ mHz - 0.51\ mHz}$ → Radiation?

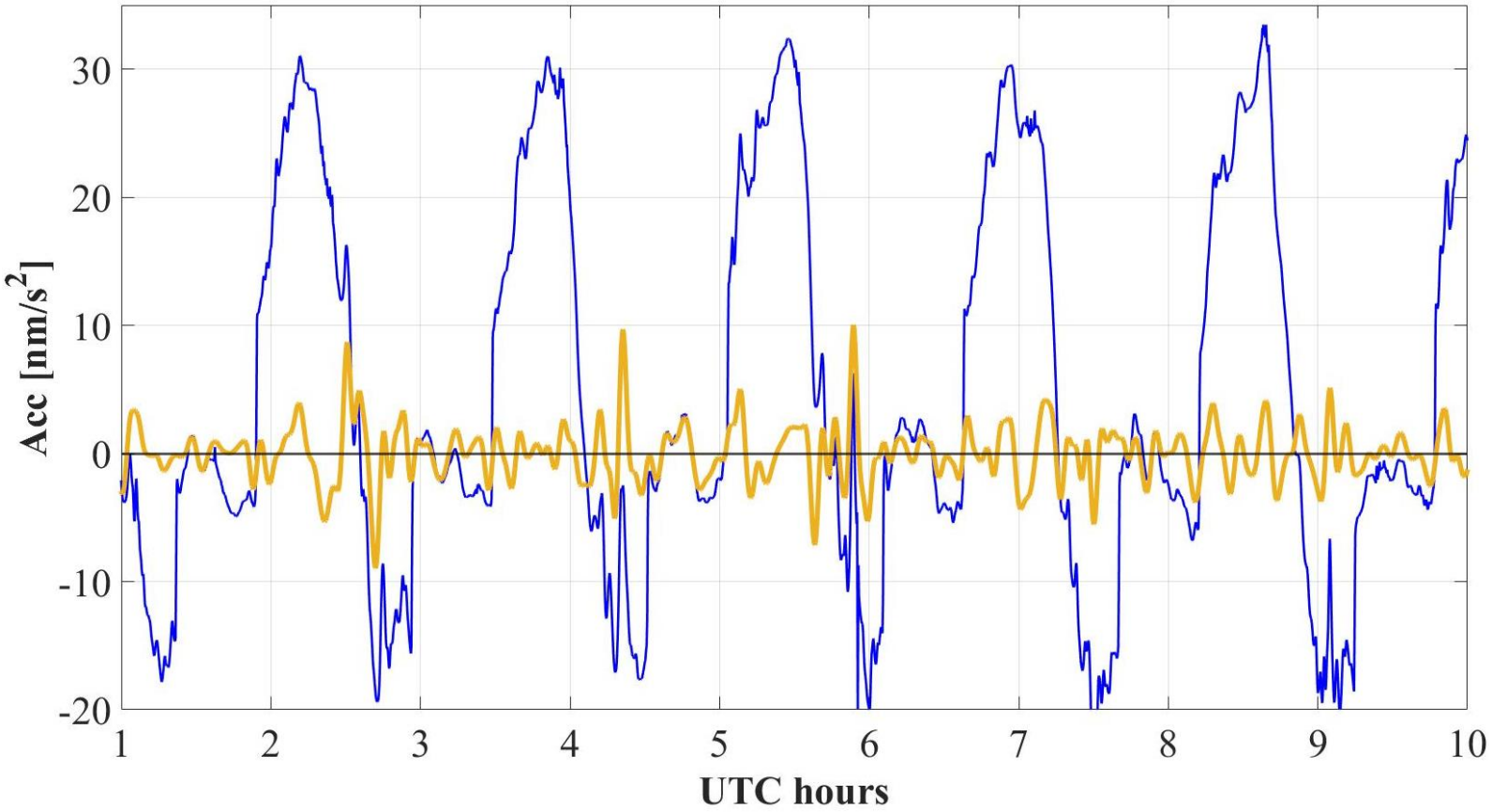




Signal Decomposition of Residuals

Signal Multiresolution: Signal Decomposition using wavelets into different levels **x-axis**

$\mathbf{0.5\ mHz - 4\ mHz}$ → Drag variations due to atmospheric changes



Shorter wavelengths

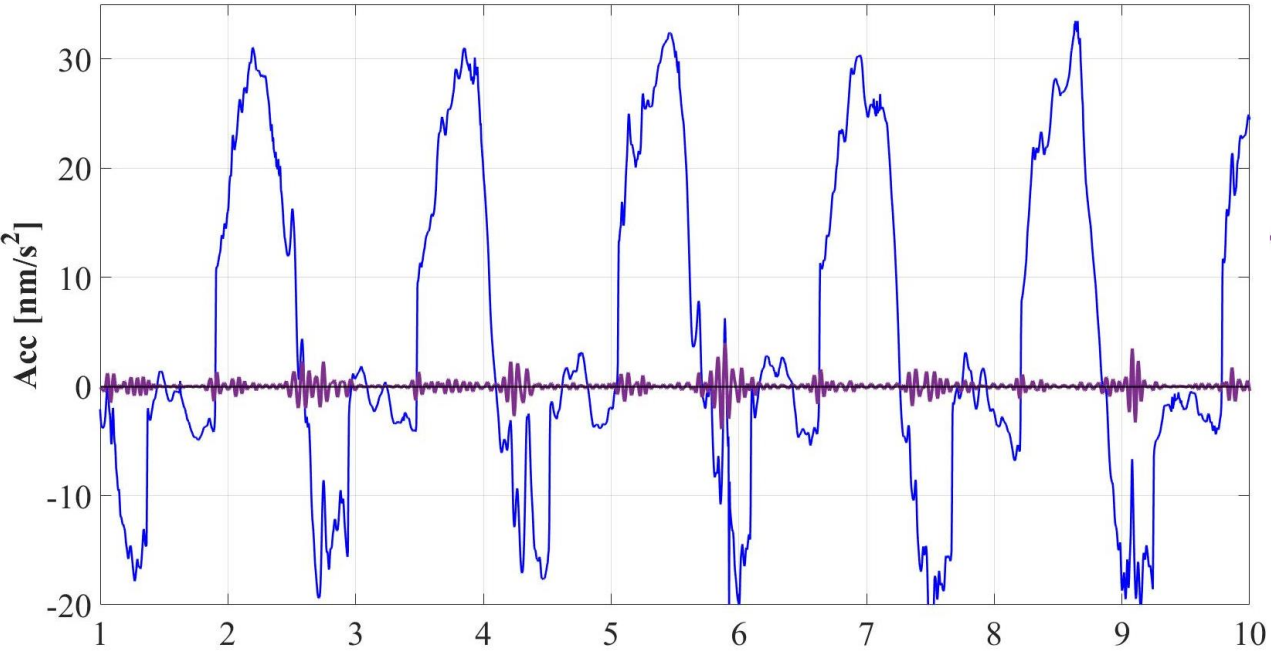
Disturbances in agreement with the shadow parts

Signal Decomposition of Residuals

$4mHz - 8\ mHz$ ⟶ Disturbances only in the poles

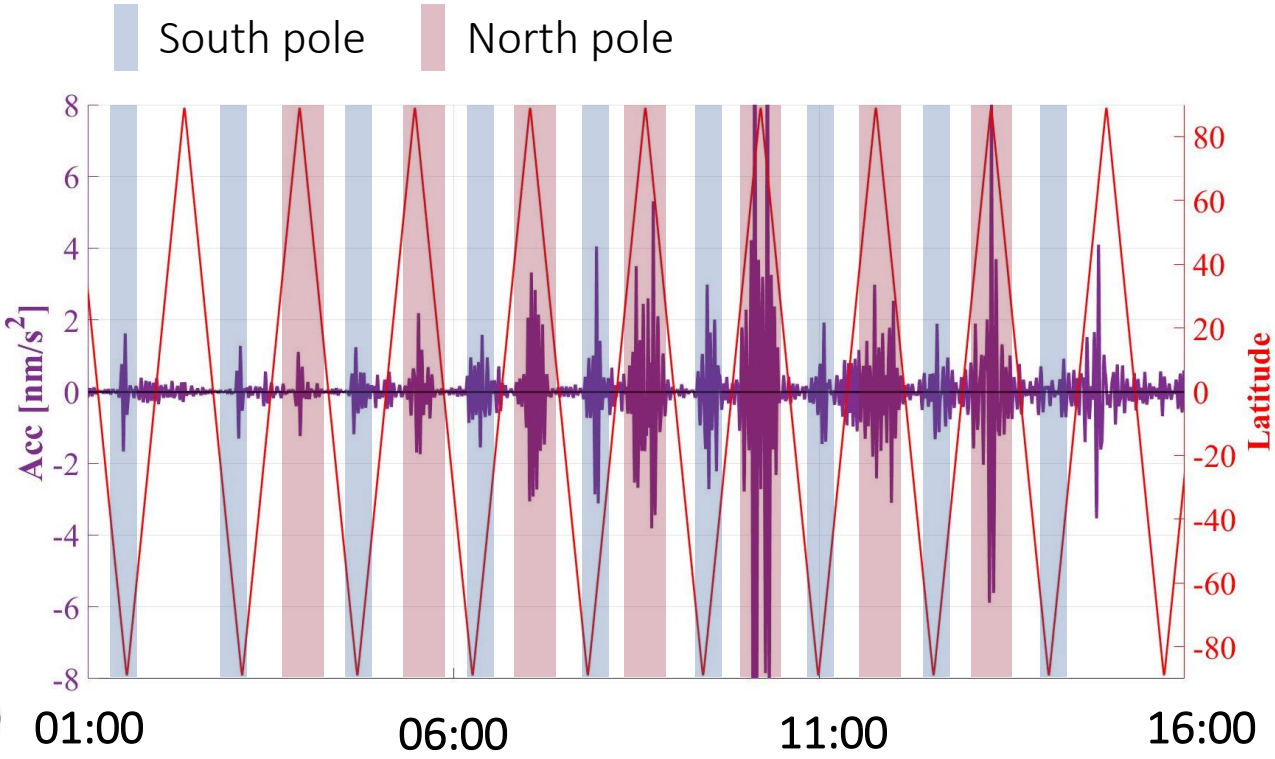
Ignore Signals $< 0.5\ nm/s^2$

Quiet day : Disturbances at descending orbits $65^{\circ}\ S$



UTC hours – 4 March 2019

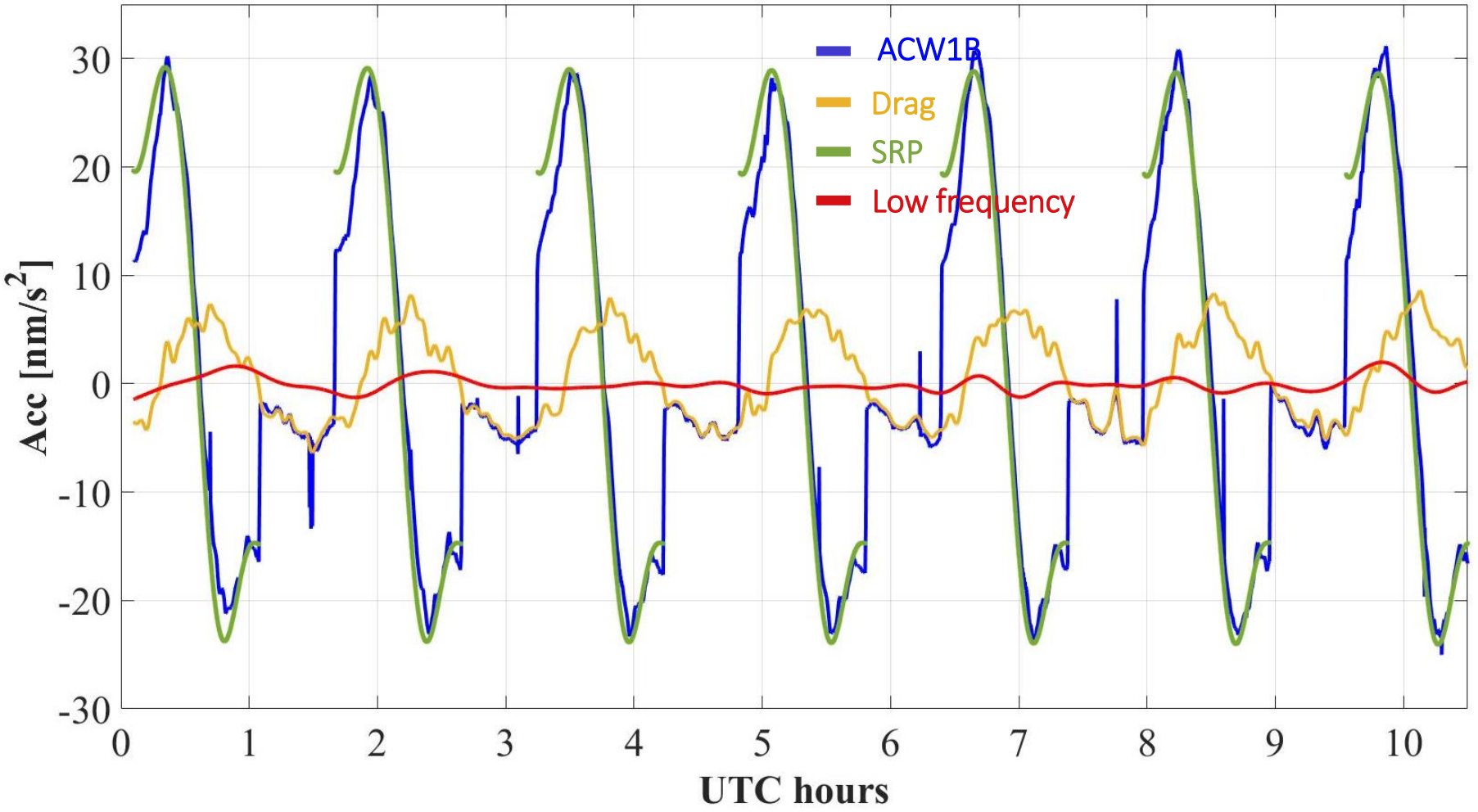
Correlation with the LT of the geomagnetic storm



UTC hours – 5 August 2019

Final SRP and Drag models

x-axis: November 18, 2018



Attribute the shorter drag variations to the drag model from LSSA

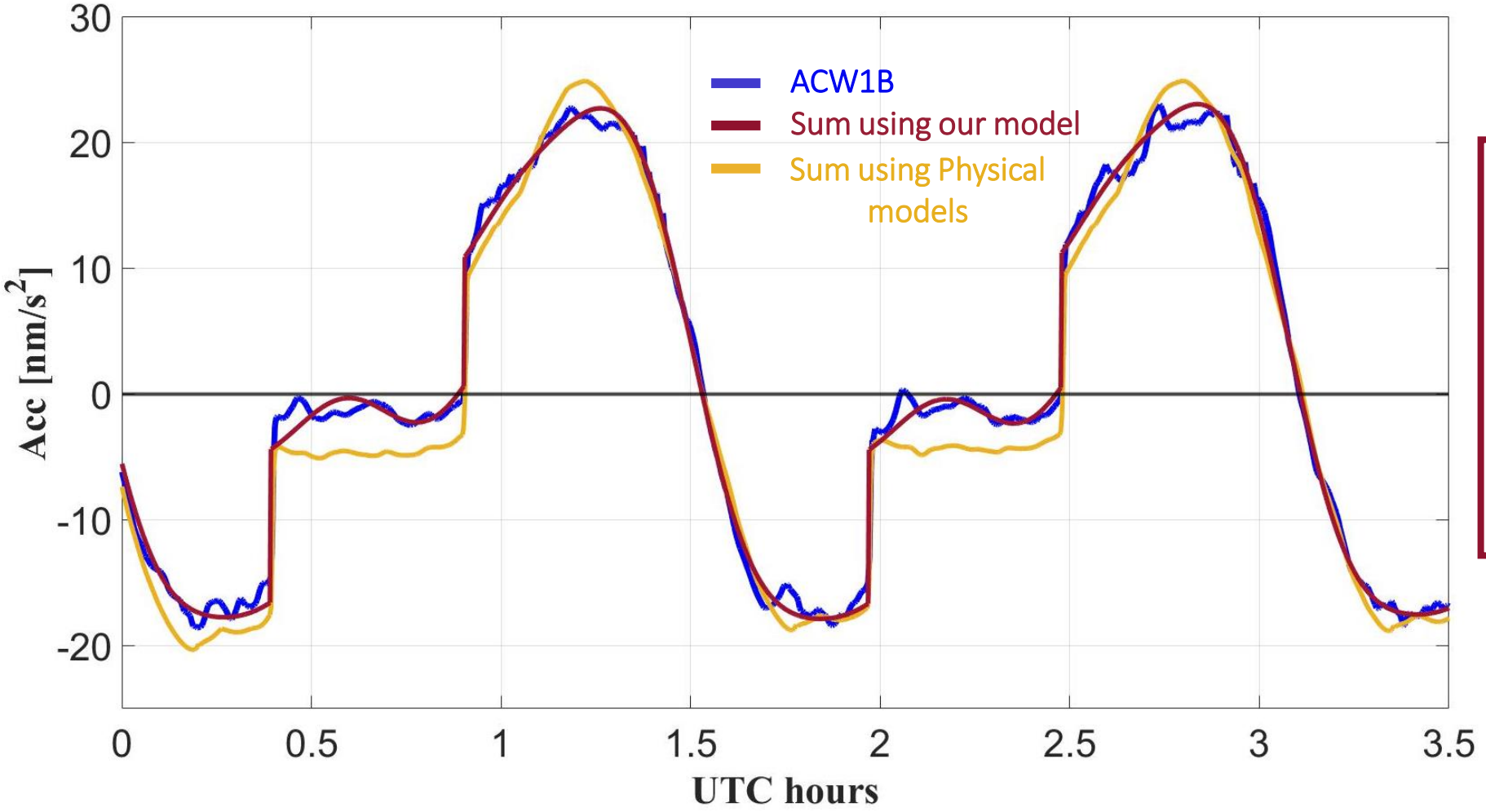
Summary – Future Work

- ✓ Weighted dataset of 1A and 1B is provided
- ✓ The first drag and SRP data-driven model has been derived for GRACE-C
- ✓ Weighted models and residual series
- ✓ Signal decomposition of residuals using wavelets into 13 Levels
- ✓ $4mHz - 8\,mHz$ disturbances only connected to Field Aligned Currents or geomagnetic storms

- ➢ Improve the variances of ACW1B by choosing different windows for the ACF
- ➢ Derive the drag and SRP models for a year for GRACE-FO and Swarm for comparison purposes
- ➢ Attribute the low-frequency signals to ERP and Thermal Radiation
- ➢ Investigation of residuals of the y-axis and z-axis using 1-D and 2-D signal decomposition

THANK YOU FOR YOUR TIME!

Back up Material
Comparison with Physical models



23 February 2019

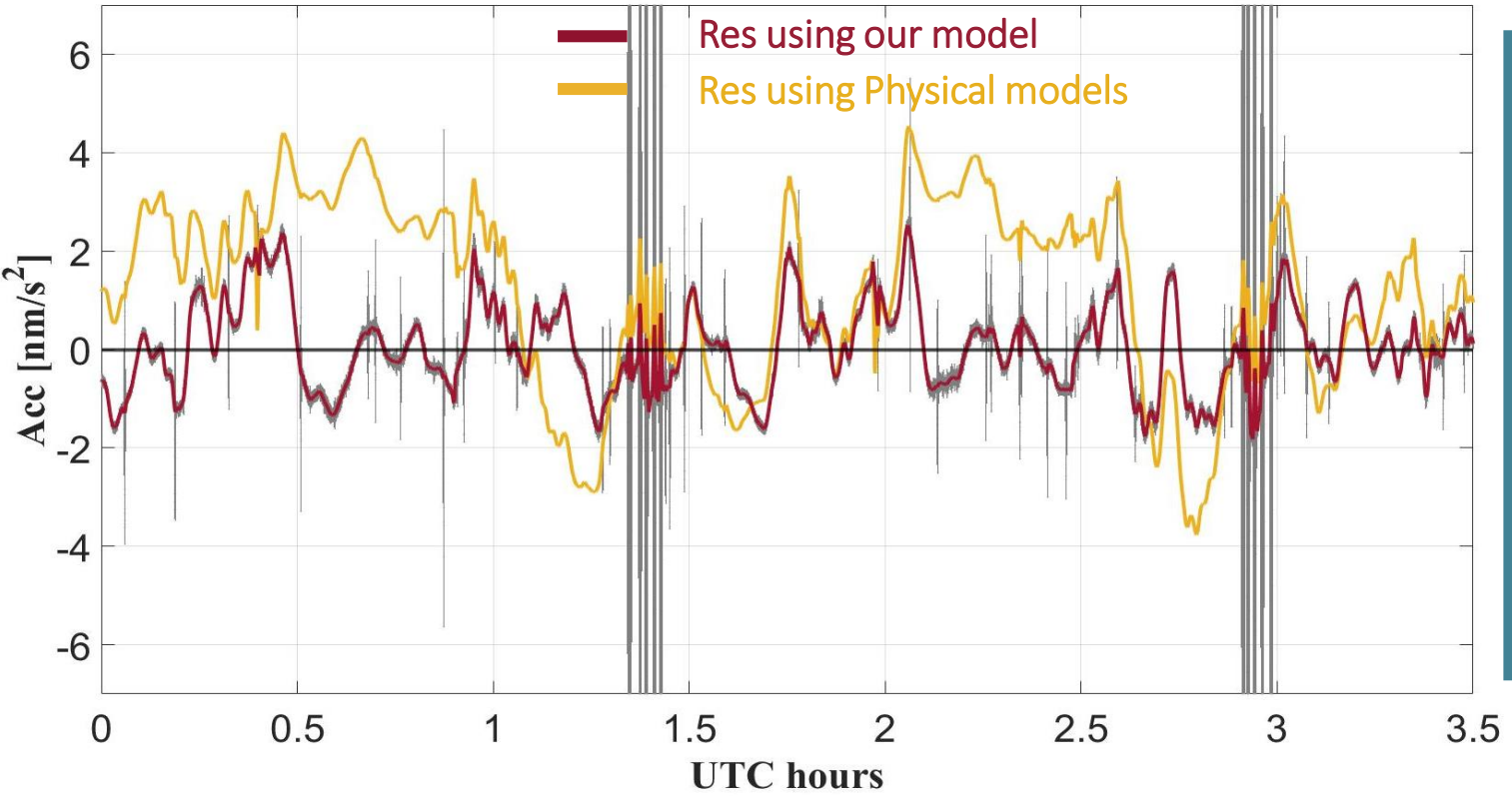
LSSA MODEL

Better fit in **penumbra transitions**

Better fit in **shadow parts**

Better fit in **sun parts**

Back up material
Comparison with Physical models



23 February 2019

Weighted Residuals

The spikes do not affect the solution / large standard deviations

Our residuals are 2.5x smaller

Back up material
ACW1B: Weighted dataset

Filter method of ACW1B

- Create a weighted 1A (10 Hz) dataset: variances of 11-points window
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- Variances of filtered values: ACF using the variances of 1A

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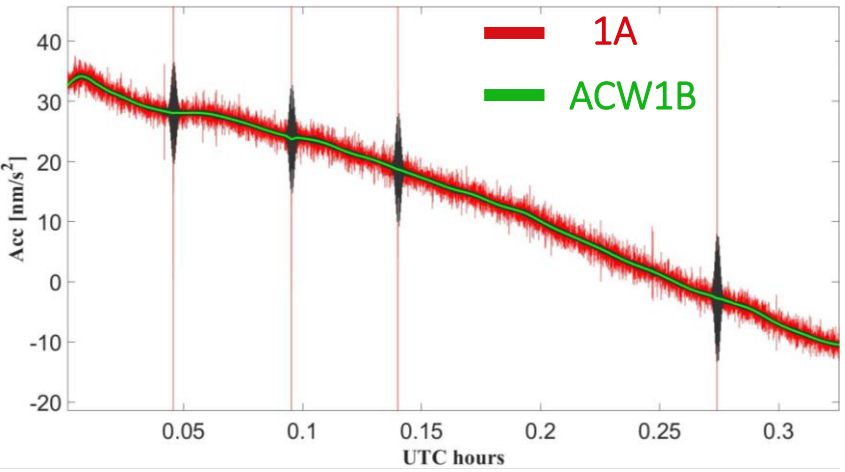
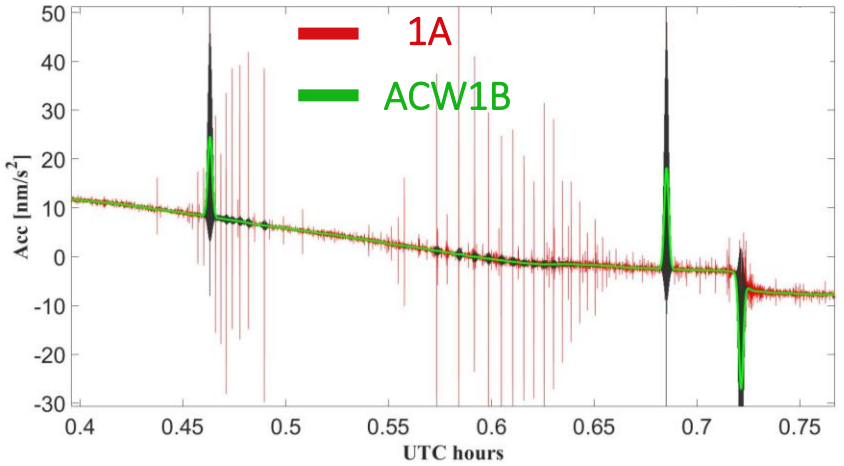
x-axis



y-axis



z-axis