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# **Copernicus Sentinel-1 satellites: Sensitivity of antenna** offset estimation to orbit and observation modelling

## Introduction

The SAR (Synthetic Aperture Radar) Copernicus Sentinel-1 satellites require a high orbit accuracy of 5 cm in 3D. The official orbit products delivered by the Copernicus POD (Precise Orbit Determination) Service (Fernández et al. 2015) fulfil this requirement. Nevertheless, analyses show discrepancies in the orbit results for the two satellites

## Sentinel-1A and Sentinel-1B.

Differences in **GPS antenna offset coordinates** might explain the discrepancies in the estimated orbit parameters. Such offset estimations are, however, very sensitive to orbit and observation modelling.

The Copernicus Sentinel-1 satellites have a very complex shape with the long SAR antenna and the two large solar arrays. A simple box-wing model might not be sufficient for this. Simple assumptions on shadowing effects or a raytracing model of the satellite can improve the orbit modelling. Recently also a big improvement step on observation modelling side has been done by making single receiver ambiguity resolution possible.

The impact of both orbit and observation modelling improvements on GPS antenna offset estimation is analysed and presented for the two Copernicus Sentinel-1 satellites.



Figure 1: Artificial view of the Sentinel-1 satellite with the GPS antennas on top and axes in satellite bodyfixed reference system.



S1A S1B Year 2018

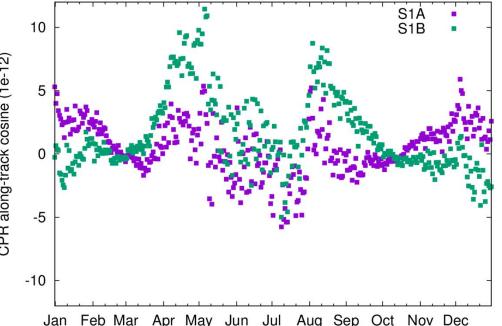


Figure 2: Examples for differences in estimated orbit parameters (radiation pressure coefficient (top) and CPR along-track sine (**bottom**) for Sentinel-1A and -1B in the year 2018. Possible cause are erroneous displacement

vectors between GPS antenna phase centers and center of mass of the satellite.

 $\Rightarrow$  Estimation of the Y- and Z-component of this displacement vector (satellite antenna offset) for **both satellites.** X-component closely corresponds to flight direction and is correlated to the timing and, therefore, to the GPS receiver clock estimates.





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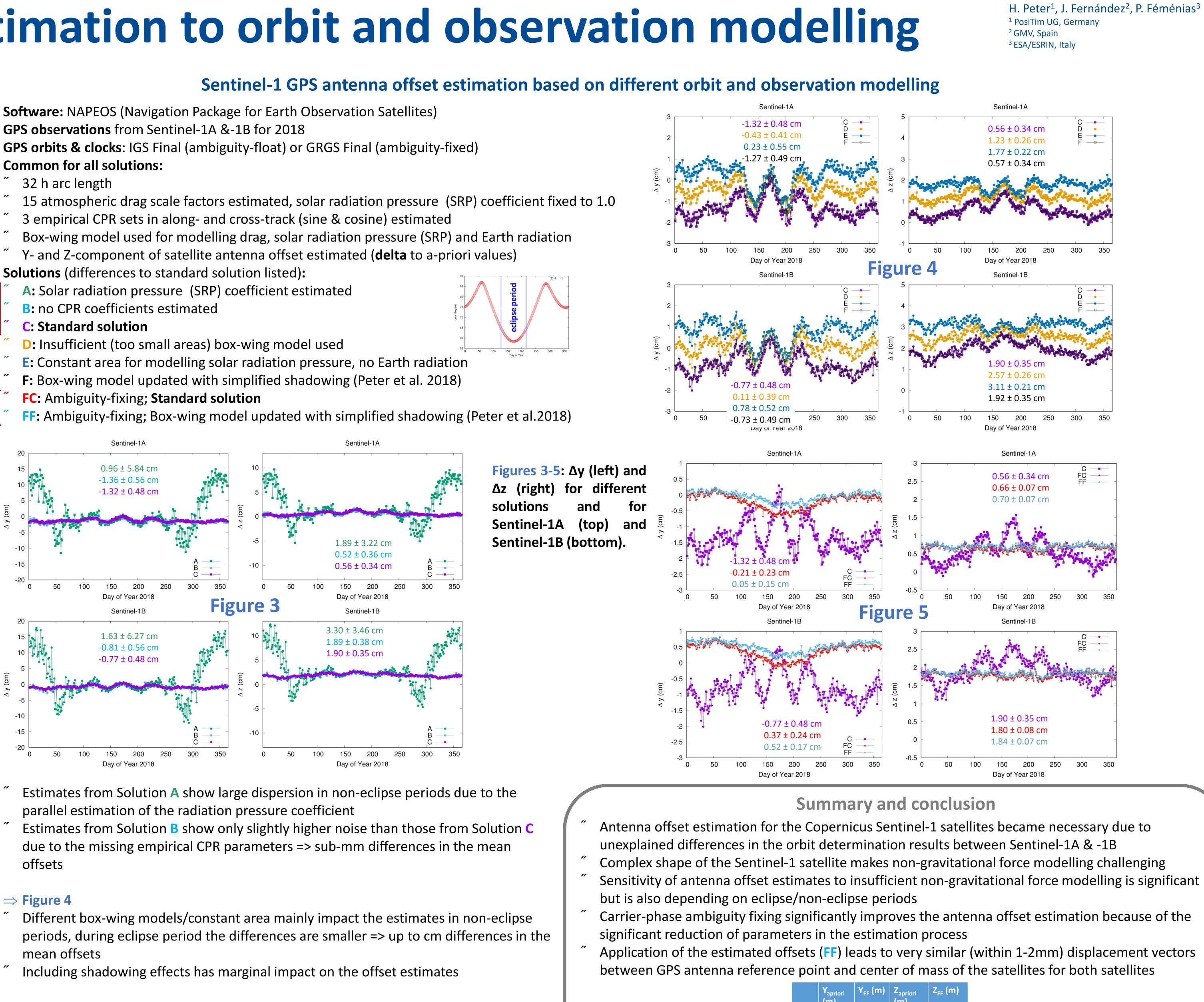
Fig. 3

Fig. 4 —

Fig. 5

## **Common for all solutions:**

- A: Solar radiation pressure (SRP) coefficient estimated
- **B:** no CPR coefficients estimated



Reference

### $\Rightarrow$ Figure 5

- **Carrier-phase ambiguity fixing significantly stabilises the offset estimates**
- Including shadowing effects (FF) slightly changes the offset estimates

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Fernández J., Escobar D., Ayuga F. (2015) Copernicus POD Service operations, In: Proceedings of the Sentinel-3 for science workshop, 2-5 June 2015, Venice, Italy Peter H., Fernández J., Otten M., Féménias P. (2018) Improved box-wing modelling for the low Earth orbiting Sentinel satellites, presented at 42nd COSPAR Scientific Assembly, 14-22 July 2018, Pasadena CA, USA

**S-1A** 0.3411 **0.3406** -1.88

**S-1B** 0.3341 **0.3393** -1.892





i	Z <sub>FF</sub> (m)
10	-1.8740
20	-1.8736



