Universidad de Alcalá

SWE SPACE WEATHER GROUP

Comparing different types of solar flares with radio bursts detected by SMOS

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EGU 2020 – 4 to 8 of May

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The SMOS mission

"ESA's Soil Moisture and Ocean Salinity (SMOS) mission is dedicated to making global observations of soil moisture over land and salinity over oceans."

Web of the mission: https://www.esa.int/Applications/Observing_the_Earth/SMOS/Introducing_SMOS

MIRAS (Microwave Imaging Radiometer using Aperture Synthesis)

- 2D microwave interferometer
- 69 equally distributed antenna elements
- 1.413 GHz (21 cm)
- Full polarization

Sun synchronous orbit

- Dusk-dawn 6am/6pm
- Altitude 758 km
- Inclination 98.44°

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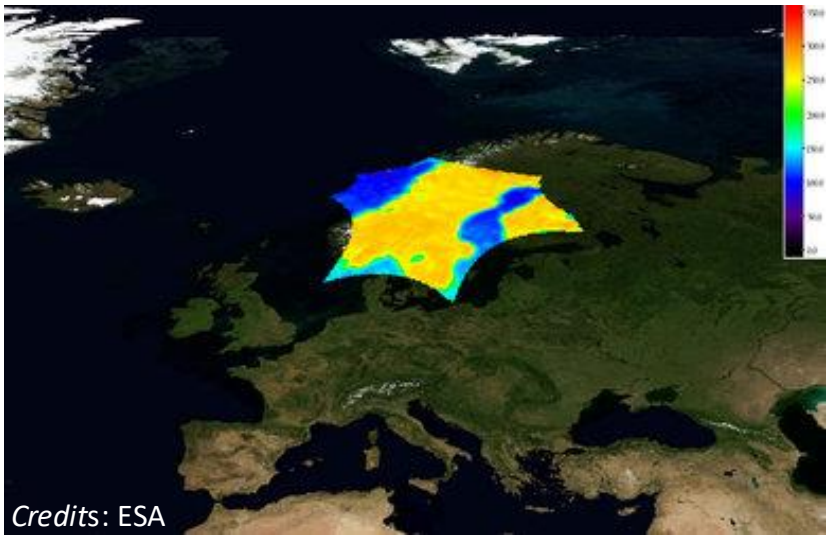
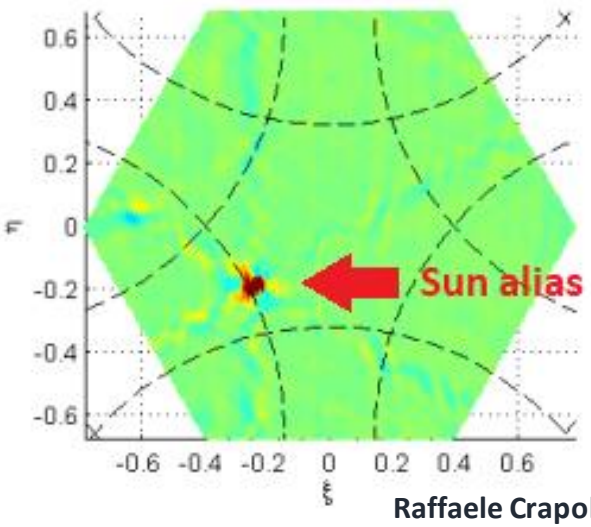
Solar “contamination” in the SMOS data

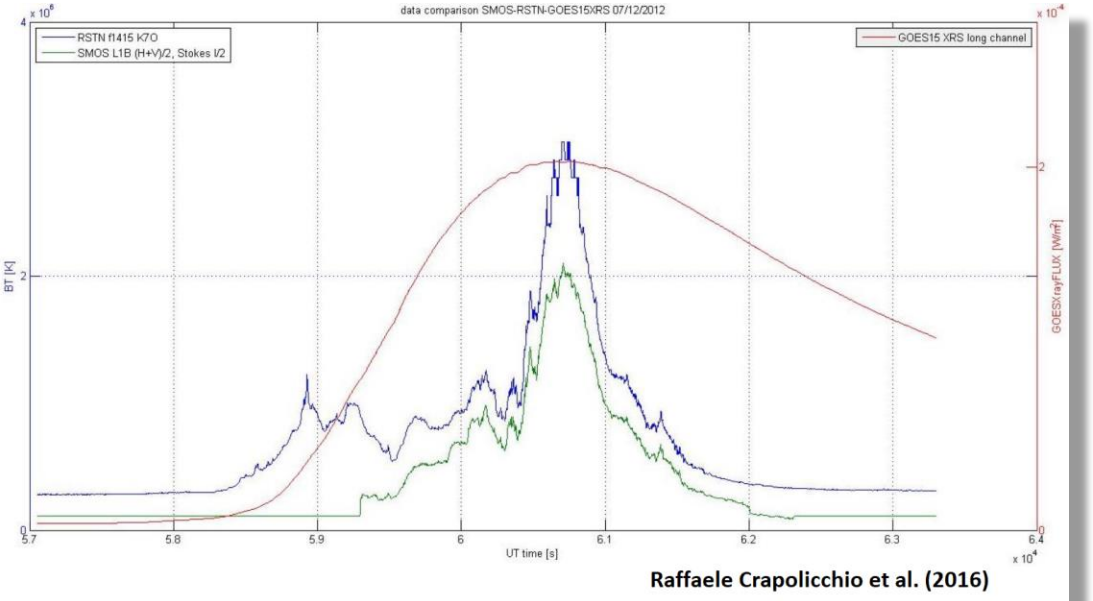




Raffaele Crapolicchio et al. (2016)

Earth images taken by SMOS are contaminated by a Sun alias.

The temporal variation of the alias during solar flares agrees well with the 1.4 GHz radio bursts detected by the RSTN (Raffaele Crapolicchio et al. 2016).



Raffaele Crapolicchio et al. (2016)

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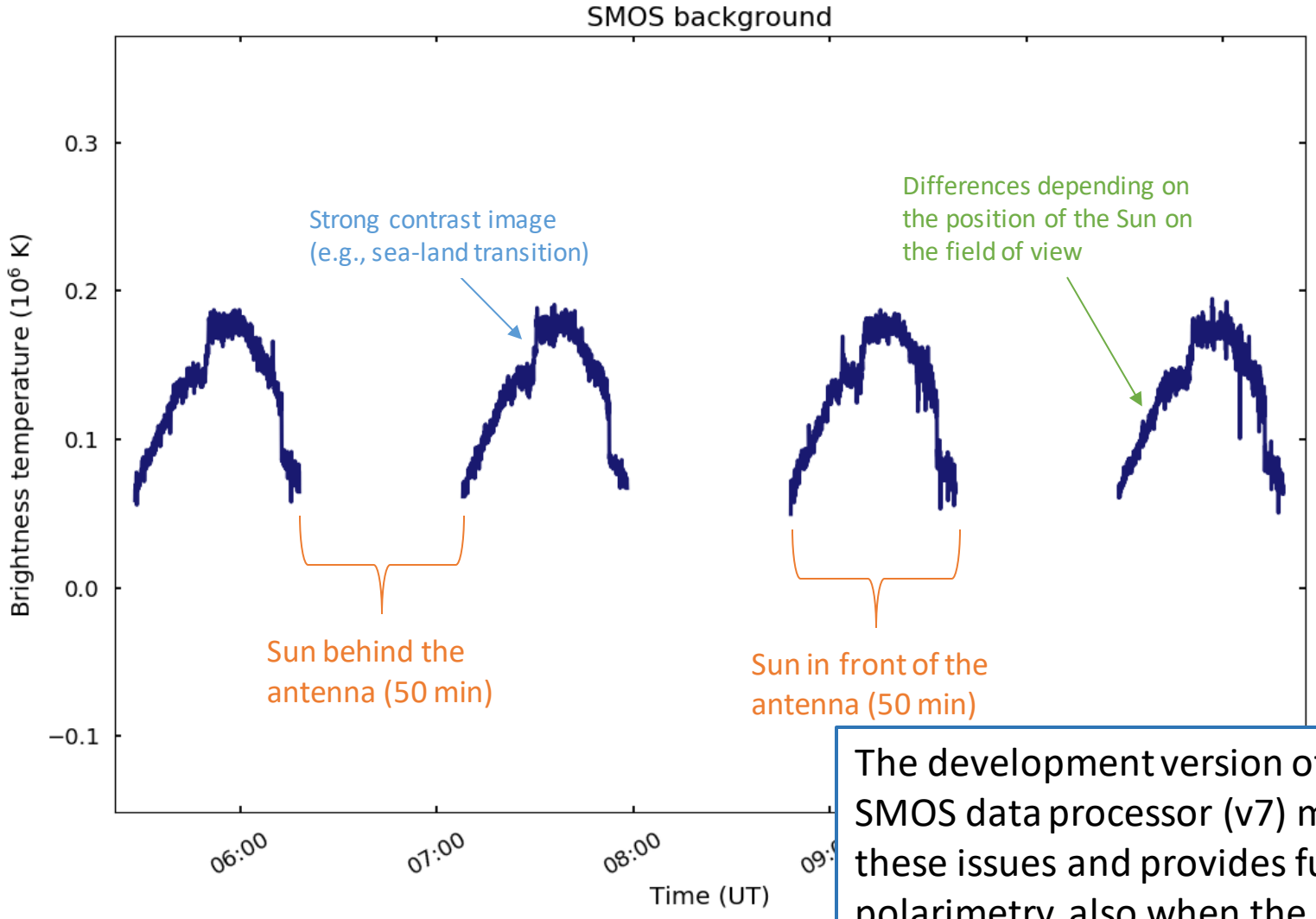
The problems of noise recycling

as of the current SMOS v6 data



The development version of the SMOS data processor (v7) minimizes these issues and provides full polarimetry, also when the Sun is in the back of the antenna.

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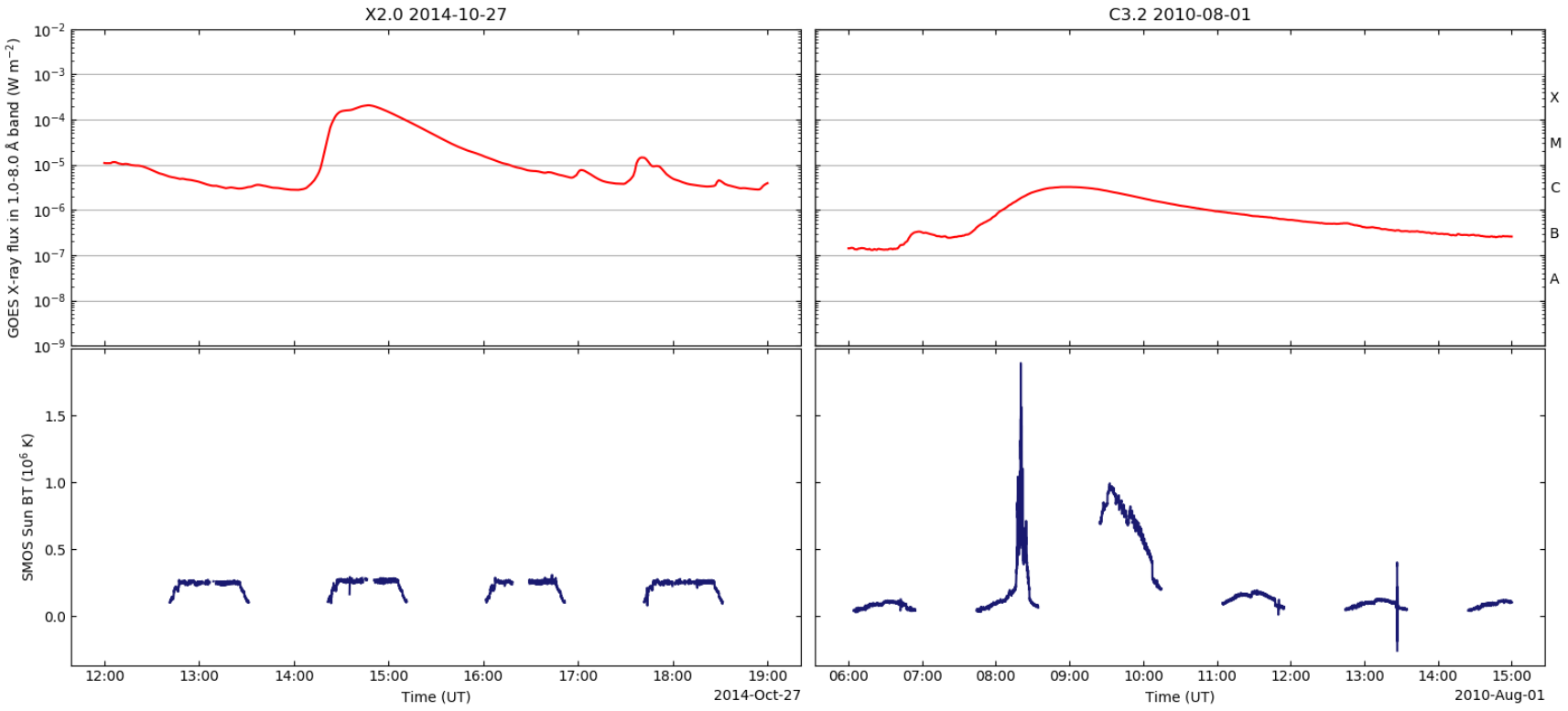
Correlation with X-rays

Radio 1.4 GHz signal shows little correlation with X-rays but has (at least in some cases) better correlation with Space Weather effects.



Strong X-ray flare. Triggered a R3 alert but ended having no geomagnetic effect. SMOS detected nothing.

Weak X-ray flare. It did not trigger any alert, but its effects were noted on Earths environment. SMOS detected moderately strong radio bursts.

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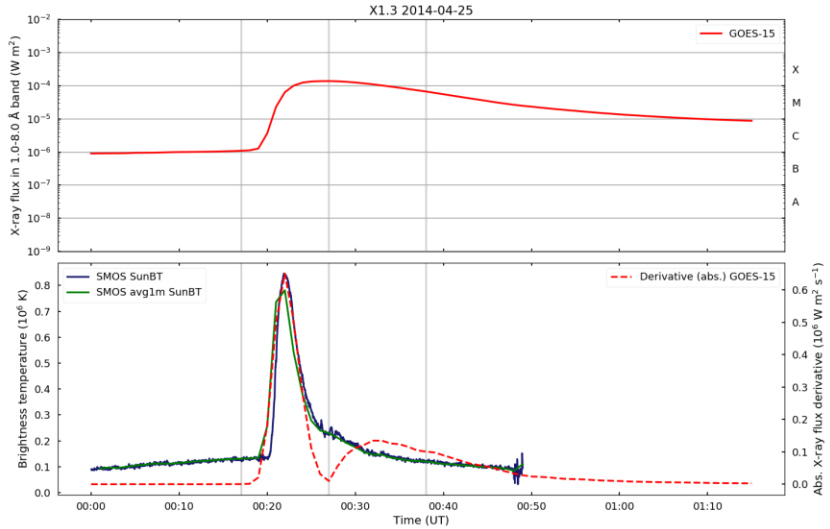
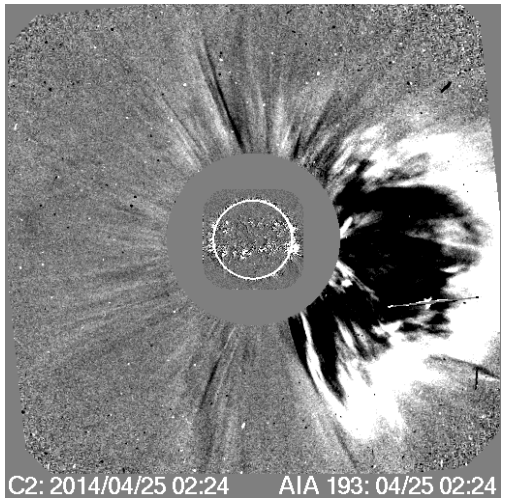
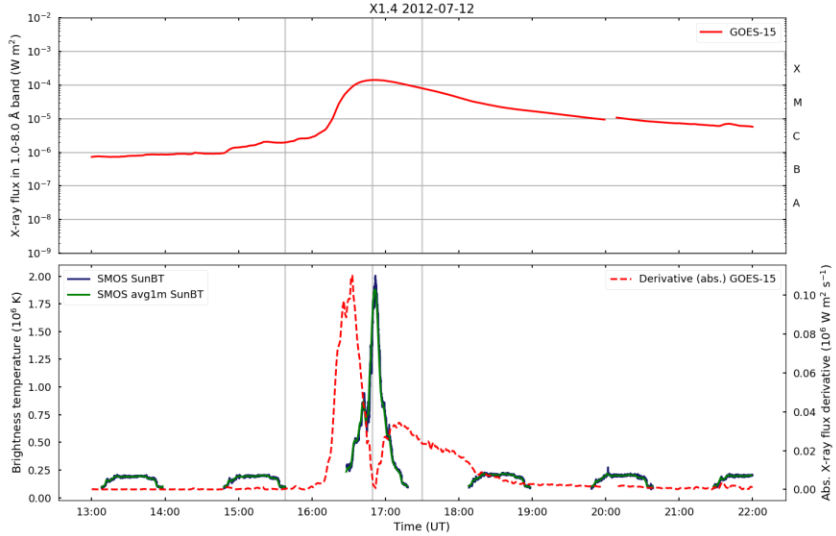
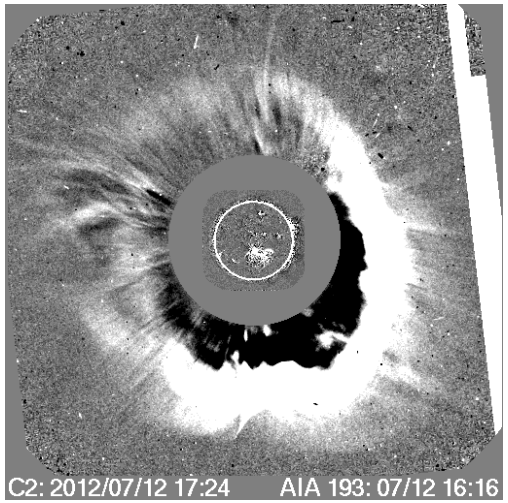
Early detection of Earth-directed CMEs

Radio bursts with strong signal during the decay phase of the flare tend to be more common in flares that have produced an Earth-directed CME.









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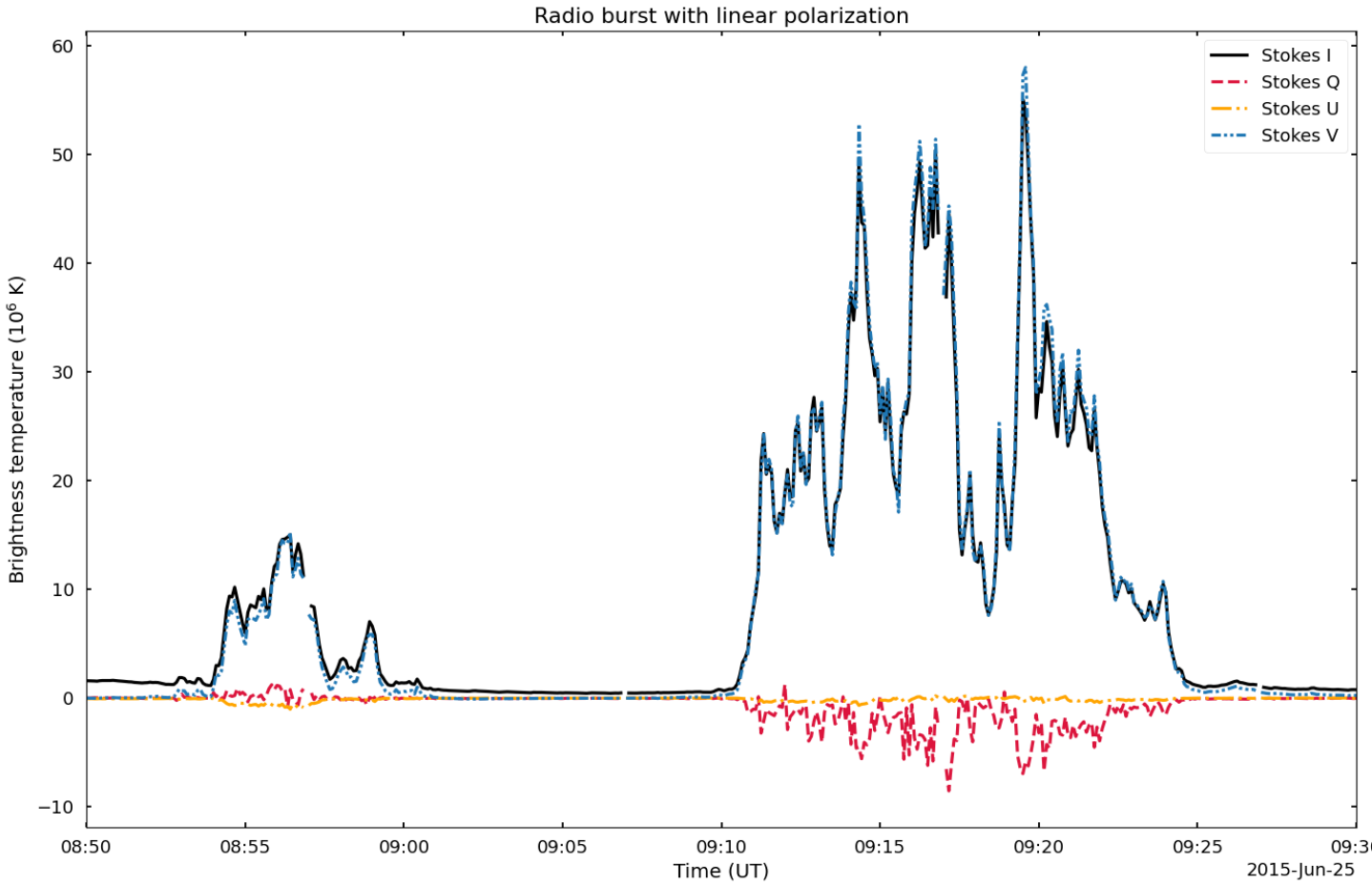
Linear polarization from Earth-directed CMEs

Linear polarization detected in strength so far only in radio bursts associated to Earth-directed CMEs. But the data sample with full Stokes polarimetry is still small.



Stokes parameters are still not calibrated.

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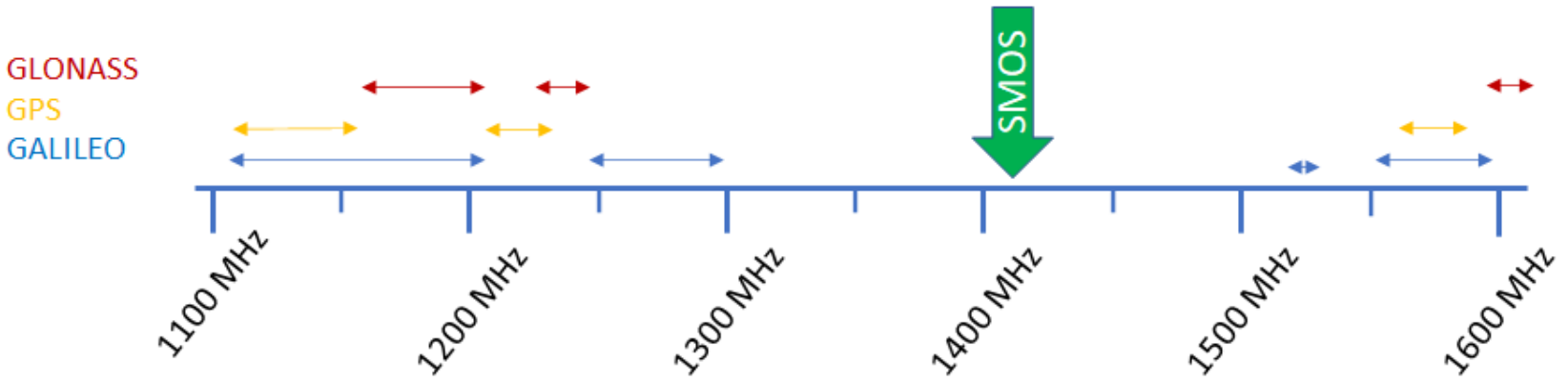
GNSS signal fades during SMOS radio bursts



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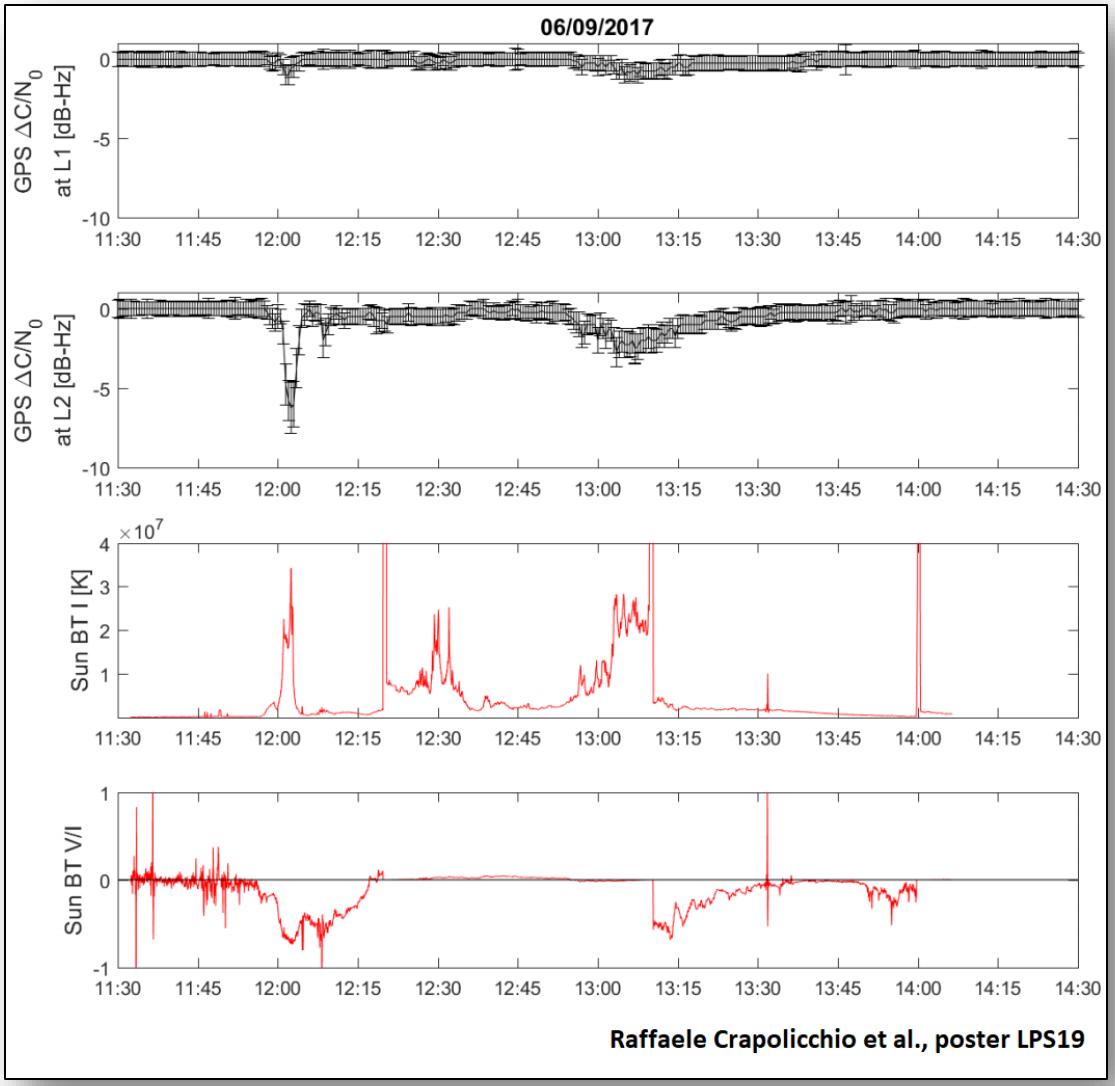
GNSS signal fades during SMOS radio bursts



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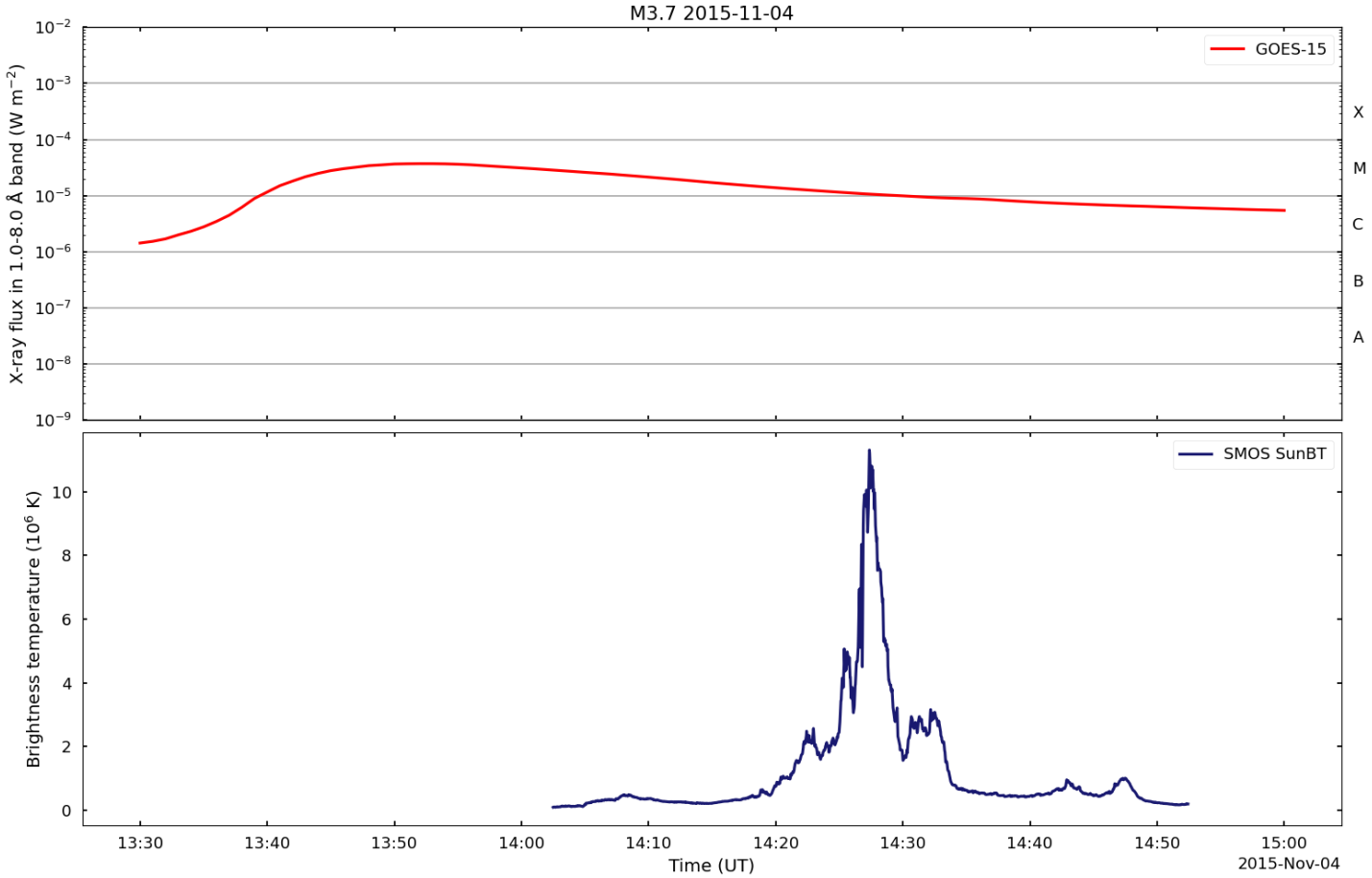
Disturbances of air traffic control radars

On November 4th, 2015, radars for air traffic control were strongly disturbed in several European countries. The responsible was a solar radio burst with peak intensity close to 1.4 GHz. The associated X-ray flare was a mild M3.7 (R1 alert level).



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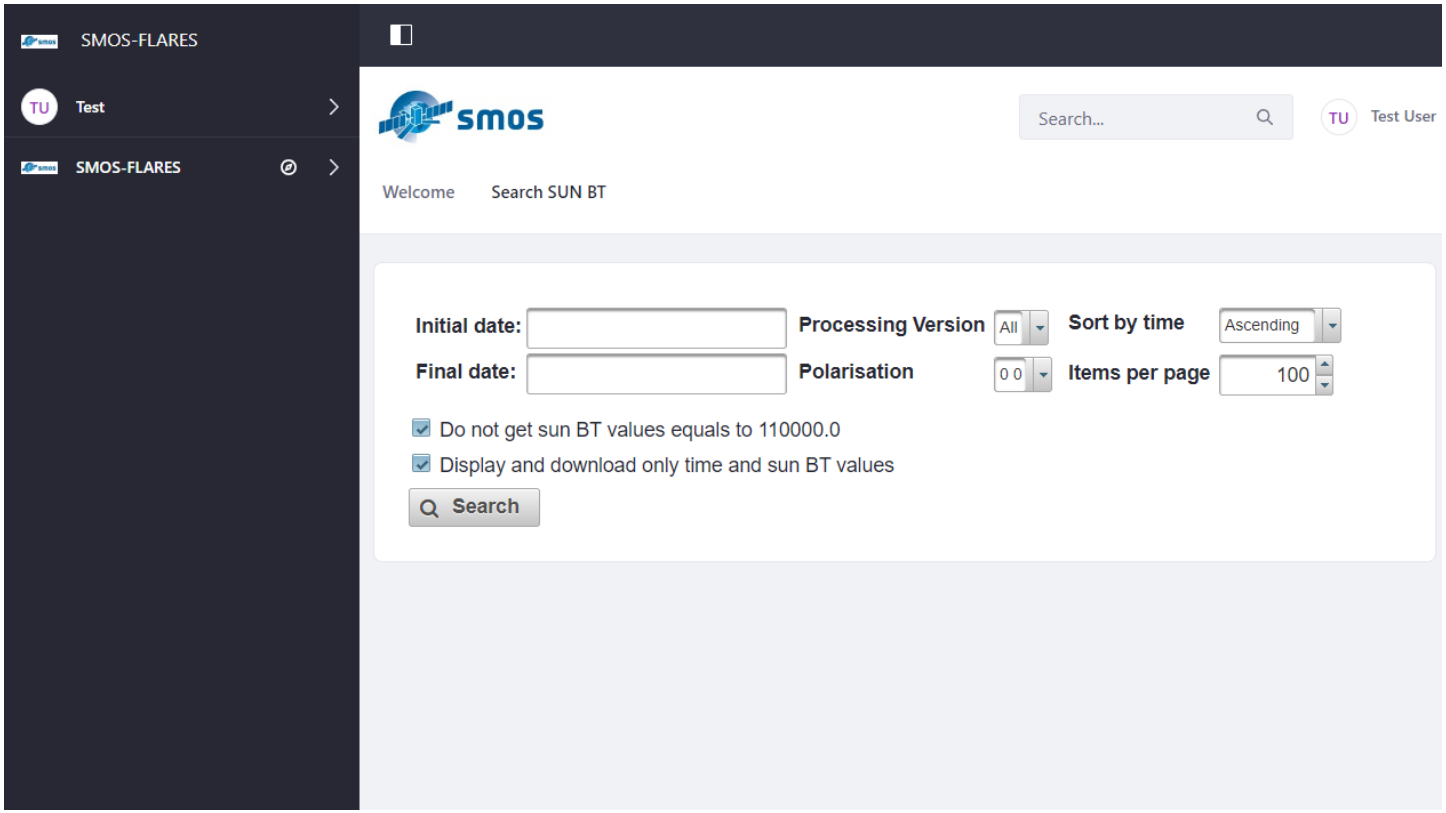
SMOS data access

Implemented by Deimos Space Romania

- http://smos-flares.elecnor-deimos.com
- Also via curl command
- Data release in mid-2020
- Any comments or suggestions are very welcome!



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Thanks for your attention!!

Acknowledgements: We are very thankful to Deimos Space for their help with the data. This work is being supported by ESA contract "Synergic use of SMOS L1 Data in Sun Flare Detection and Analysis" and MINECO project AYA2016-80881-P. We acknowledge the use of data from GOES, the SOHO LASCO CME Catalog and the RSTN.

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