SMOS for Space Weather: the first steps of a succesful project

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Space Weather Research Group

University of Alcalá

HOME PICTURES PROGRAM FUN ABOUT WHO IN PRACTICE PRESS PAST LOCAL CONTACT

SESSION - OPEN SESSION ON SPACE WEATHER APPLICATIONS AND ENGINEERING CONCERNS

A. Glover and the ESWW12 PC

This session targets the wide range of application de
of application types including algorithms and applicat
ground, analysis toolkits and supporting data(base) i

The session is open to well established applications
applications and proof of concept demonstrations. Su
include a discussion of how the author has worked w
concerns. In all cases, authors are strongly encourag
application performance and to outline their vision an
application.

Talks
Friday November 27, 11:00 - 13:00, Permeke

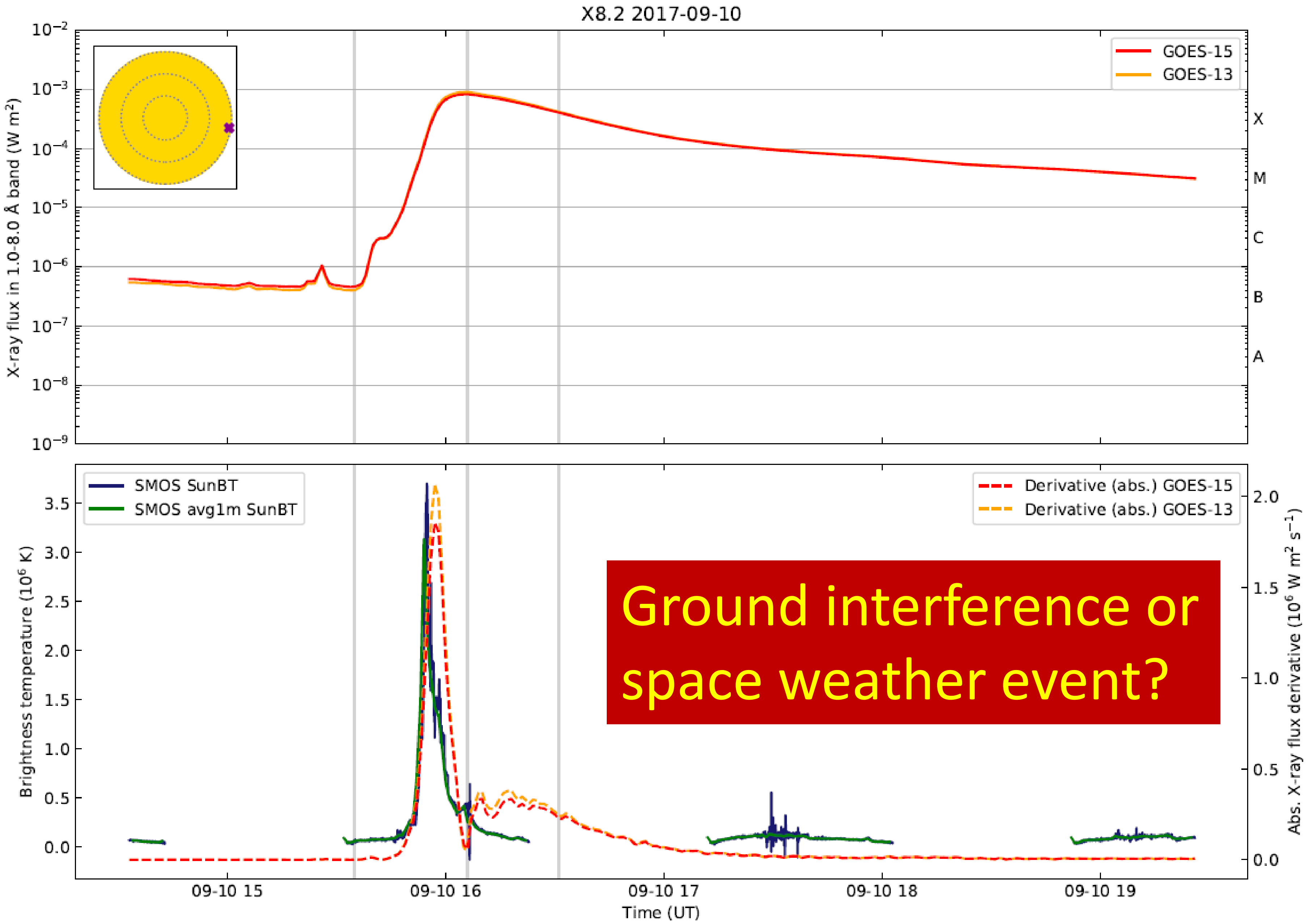
Poster Viewing
Friday November 27, 10:00 - 11:00, Poster area

Click here to toggle abstract display in the schedule

TALKS : TIME SCHEDULE

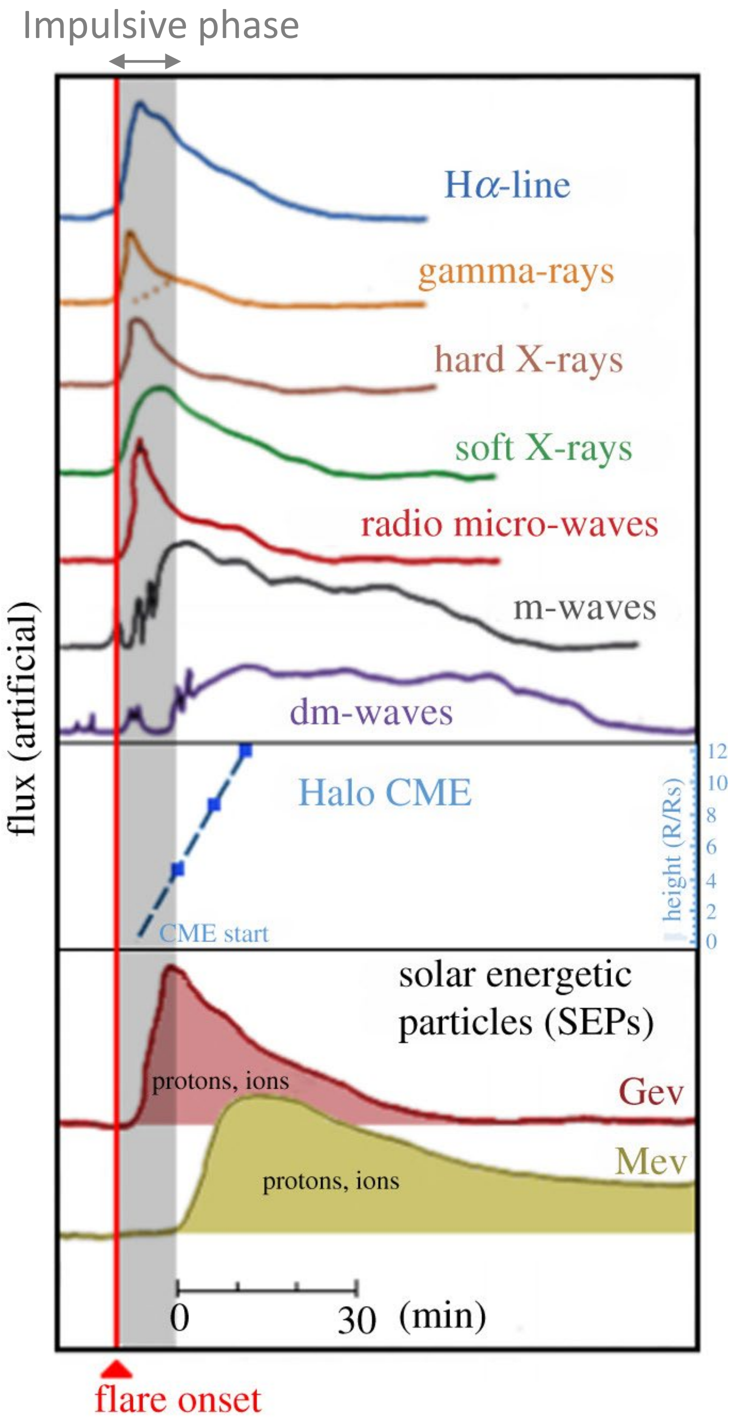
Friday November 27, 11:00 - 13:00, Permeke

11:00	Modeling the Radiation Belt Electron Environment: Fusion of Physics and System Science Approaches	*Walker, S et al.*	Oral
11:20	Introducing SPENVIS Next Generation	*Messios, N et al.*	Oral
11:40	Space Weather Helioviewer	*Nicula, B et al.*	Oral
12:00	The Spanish Space Weather Service (SeNMEs)	*Cid, C et al.*	Oral
12:20	Space Monitoring Data Centre of MSU and Operational Control of Radiation Conditions at Low Earth's Orbits	*Kalegaev, V et al.*	Oral
12:40	Sun L-band brightness temperature measurements from Soil Moisture and Ocean Salinity (SMOS) mission. Preliminary results for a potential usage of SMOS data for space weather applications.	*Crapolicchio, R et al.*	Oral


X8.2 2017-09-10
X-ray flux in 1.0-8.0 Å band (W m²)
GOES-15
GOES-13
X
M
C
B
A
SMOS SunBT
SMOS avg1m SunBT
Derivative (abs.) GOES-15
Derivative (abs.) GOES-13
Brightness temperature (10⁶ K)
Abs. X-ray flux derivative (10⁶ W m² s⁻¹)
09-10 15
09-10 16
09-10 17
09-10 18
09-10 19
Time (UT)
Ground interference or space weather event?

NOAA Scale for Radio Blackouts

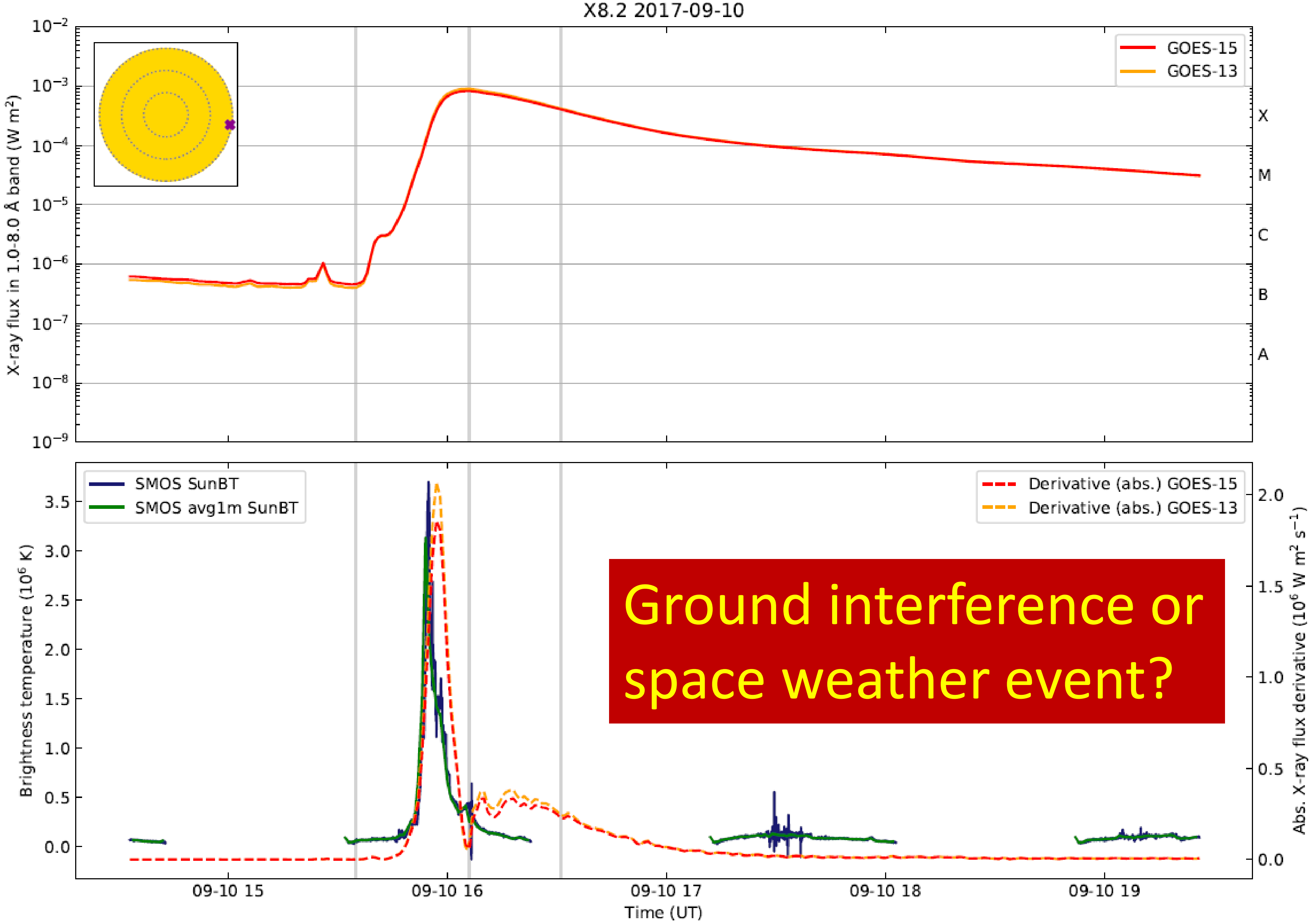
Scale	Description	Effect	Physical measure	Average Frequency (1 cycle = 11 years)
R 5	Extreme	**HF Radio:** Complete HF (high frequency) radio blackout on the entire sunlit side of the Earth lasting for a number of hours. This results in no HF radio contact with mariners and en route aviators in this sector. **Navigation:** Low-frequency navigation signals used by maritime and general aviation systems experience outages on the sunlit side of the Earth for many hours, causing loss in positioning. Increased satellite navigation errors in positioning for several hours on the sunlit side of Earth, which may spread into the night side.	X20 (2×10^{-3})	Less than 1 per cycle
R 4	Severe	**HF Radio:** HF radio communication blackout on most of the sunlit side of Earth for one to two hours. HF radio contact lost during this time. **Navigation:** Outages of low-frequency navigation signals cause increased error in positioning for one to two hours. Minor disruptions of satellite navigation possible on the sunlit side of Earth.	X10 (10^{-3})	8 per cycle (8 days per cycle)
R 3	Strong	**HF Radio:** Wide area blackout of HF radio communication, loss of radio contact for about an hour on sunlit side of Earth. **Navigation:** Low-frequency navigation signals degraded for about an hour.	X1 (10^{-4})	175 per cycle (140 days per cycle)
R 2	Moderate	**HF Radio:** Limited blackout of HF radio communication on sunlit side, loss of radio contact for tens of minutes. **Navigation:** Degradation of low-frequency navigation signals for tens of minutes.	M5 (5×10^{-5})	350 per cycle (300 days per cycle)
R 1	Minor	**HF Radio:** Weak or minor degradation of HF radio communication on sunlit side, occasional loss of radio contact. **Navigation:** Low-frequency navigation signals degraded for brief intervals.	M1 (10^{-5})	2000 per cycle (950 days per cycle)



An 'academic' SWE event

The geomagnetic disturbance is out of the time range of the Figure. It will take place between 1 to 3 days after the flare onset

(Anastasiadis+ 2019)



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Ground interference or space weather event?

eo science for society

Synergetic use of SMOS L1 Data in Sun Flare detection and analysis (SMOS-FLARES)

DEIMOS SPACE s.r.l. (RO)

Information

Domain
Science

Prime contractor
DEIMOS SPACE s.r.l. (RO)

Subcontractors
UNIVERSIDAD DE ALCALA (ES)

PERMANENTLY OPEN CALL SCIENCE

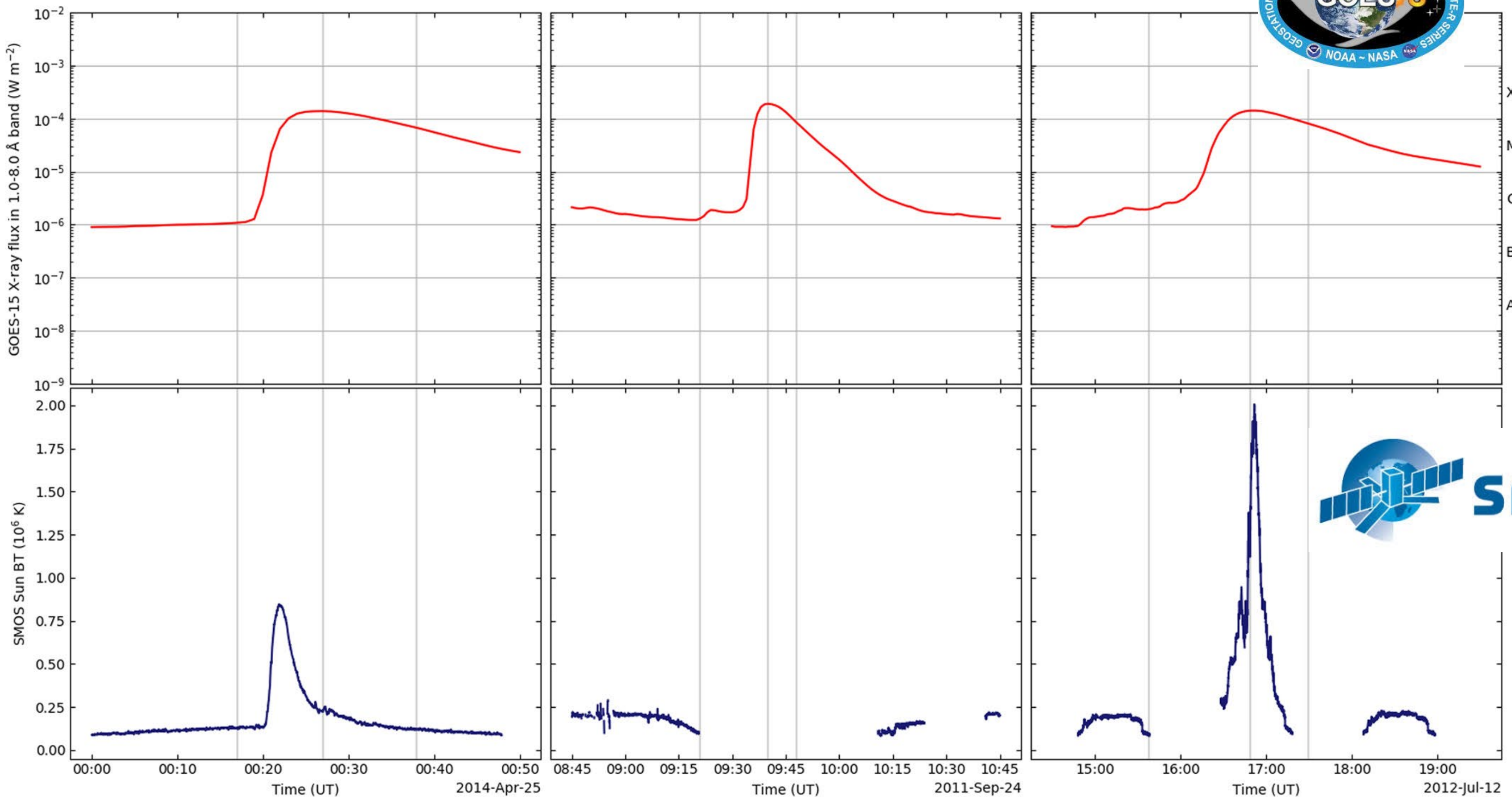
Summary

The aim of the project is to develop a systematic retrieval of Sun Brightness Temperature in L-Band as measured by the SMOS Mission and analyse its correlation with measurements of solar flares currently used in Space Weather, as GOES X-ray flux. The analysis will also focus on dedicated re-processing activities on selected dates with new Sun retrieval algorithms recently developed for the SMOS Mission, to assess the suitability of these new techniques and explore further evolutions.

The full set of available SMOS Mission Data will be used to perform a systematic timing

https://eo4society.esa.int/projects/synergetic-use-of-smos-l1-data-in-sun-flare-detection-and-analysis/

SMOS versus GOES or Solar X-ray flux versus radio flux



Data gaps in SMOS have an impact in flare monitoring

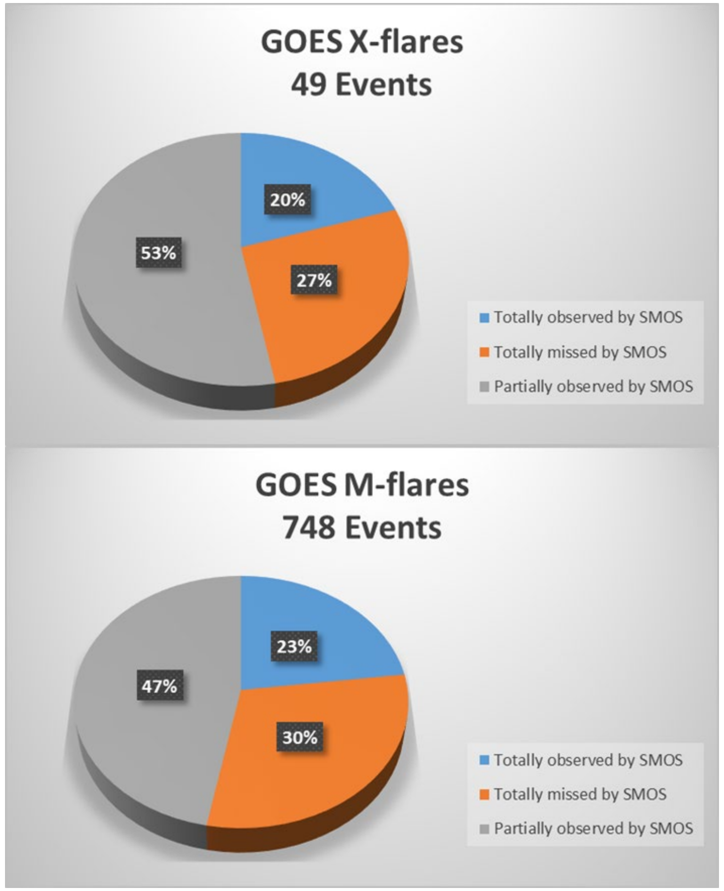
(adapted from [Flores-Soriano+ 2020](#))

Comparing with GOES M-X flares from 01-2010 to 06-2019. The impact of data gaps in SMOS v6

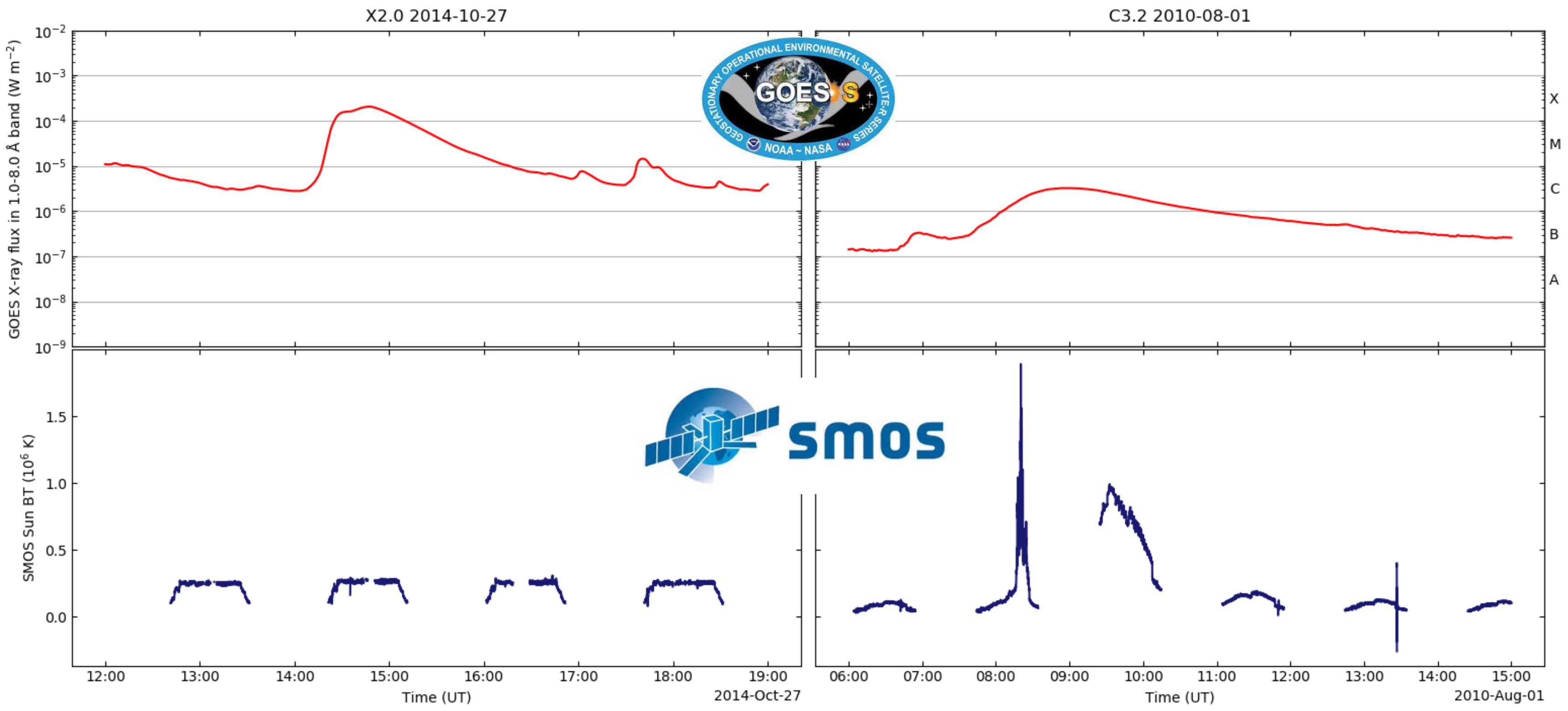
- 20% of GOES events observed from start to end
- 30% of GOES events totally missed
- 50% of GOES events partially observed

SMOS has the potential of seeing more events than a ground-based radio observatory (70% vs 50%)

But fewer of them are complete events (20% vs 50%), at least until new extraction algorithm is implemented



Comparing with GOES M-X flares from 01-2010 to 06-2019. The impact of the physical phenomena



- SMOS and GOES are not seeing the same physical phenomena
- Intensities do not correlate

CMEs are even more relevant for space weather than solar flares

AGU PUBLICATIONS

Space Weather

NEWS ARTICLE
10.1002/2015SW001213

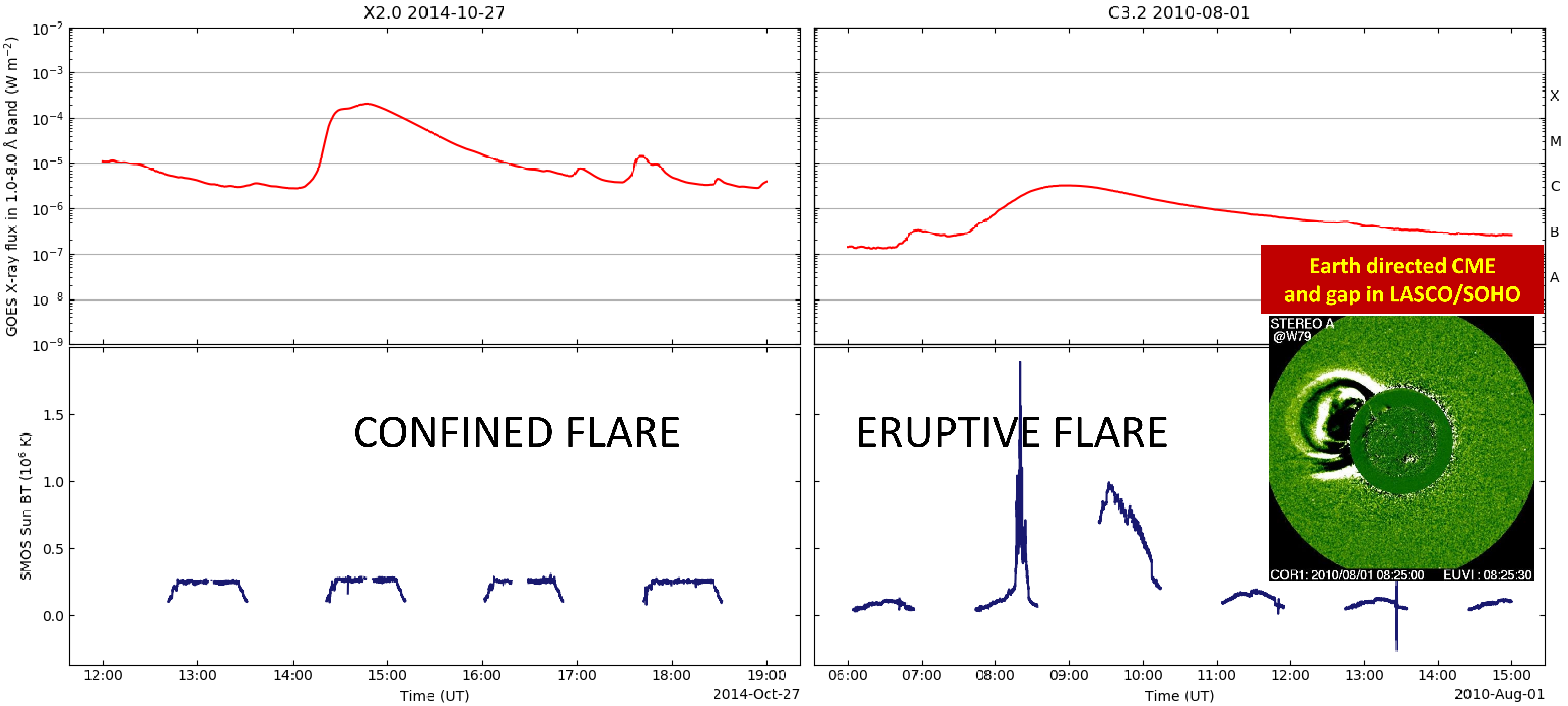
No Major Solar Flares but the Largest Geomagnetic Storm in the Present Solar Cycle

Y. Kamide and K. Kusano

Citation:
Kamide, Y., and K. Kusano (2015), No Major Solar Flares but the Largest Geomagnetic Storm in the Present Solar Cycle, *Space Weather*, *13*, doi:10.1002/2015SW001213.

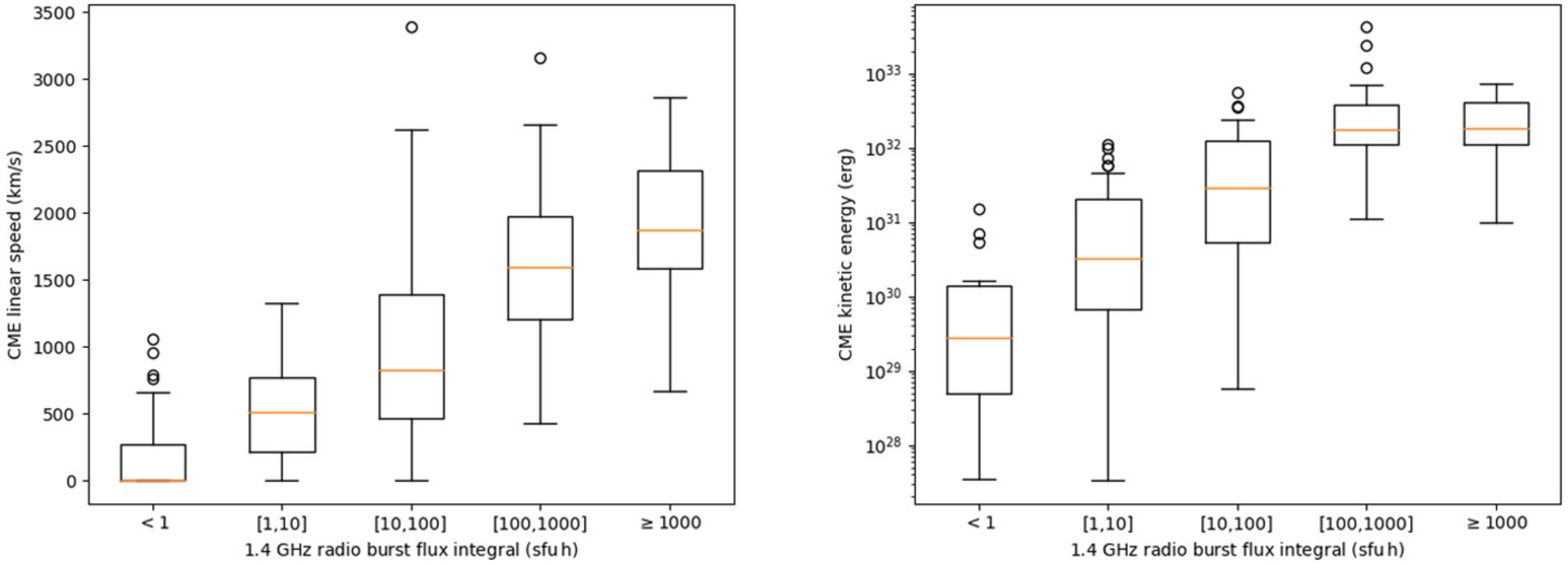
A severe geomagnetic storm, and the largest in solar cycle 24, occurred on 17–18 March 2015 without significant precursor X- or M-type solar flares. Figure 1 shows (first to fourth panels) solar wind variables, auroral electrojets indices, and the Disturbance Storm Time (*Dst*) index associated with the event, which was classified as a G4 (severe) level storm (http://www.swpc.noaa.gov/noaa-scales-explanation). Red auroras were seen even from the northern part of Japan for first time during the present cycle, attracting considerable interest by the media and general public. Some of the headlines in Japan are as follows: Auroras came to northern Japan after 11 years (Asahi newspaper) and space weather prediction came off and low-latitude auroras appeared (Yomiuri newspaper). Unfortunately, space weather agencies worldwide, including the ones in the United States, Japan, and Europe failed to predict that a severe geomagnetic storm would arrive at the near-Earth environment.

Eruptive versus confined flares



(adapted from Flores-Soriano+ 2020)

CME properties and solar radio fluence at 1.4 GHz from RSTN

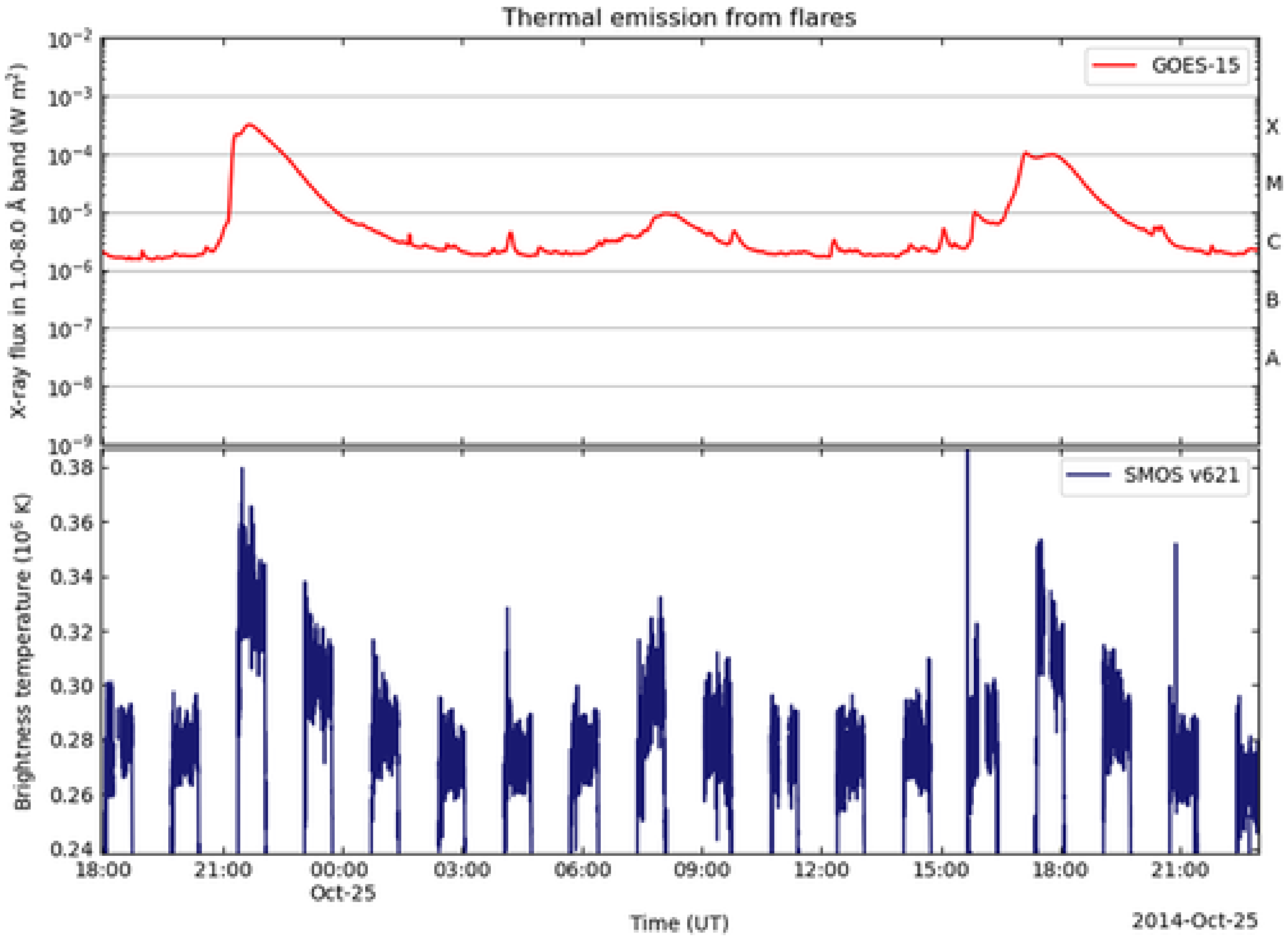


(adapted from Flores-Soriano+ 2020)

SMOS Solar Flux (if available in real time) can be used to forecast the speed and the kinetic energy of the CMEs arriving to the Earth

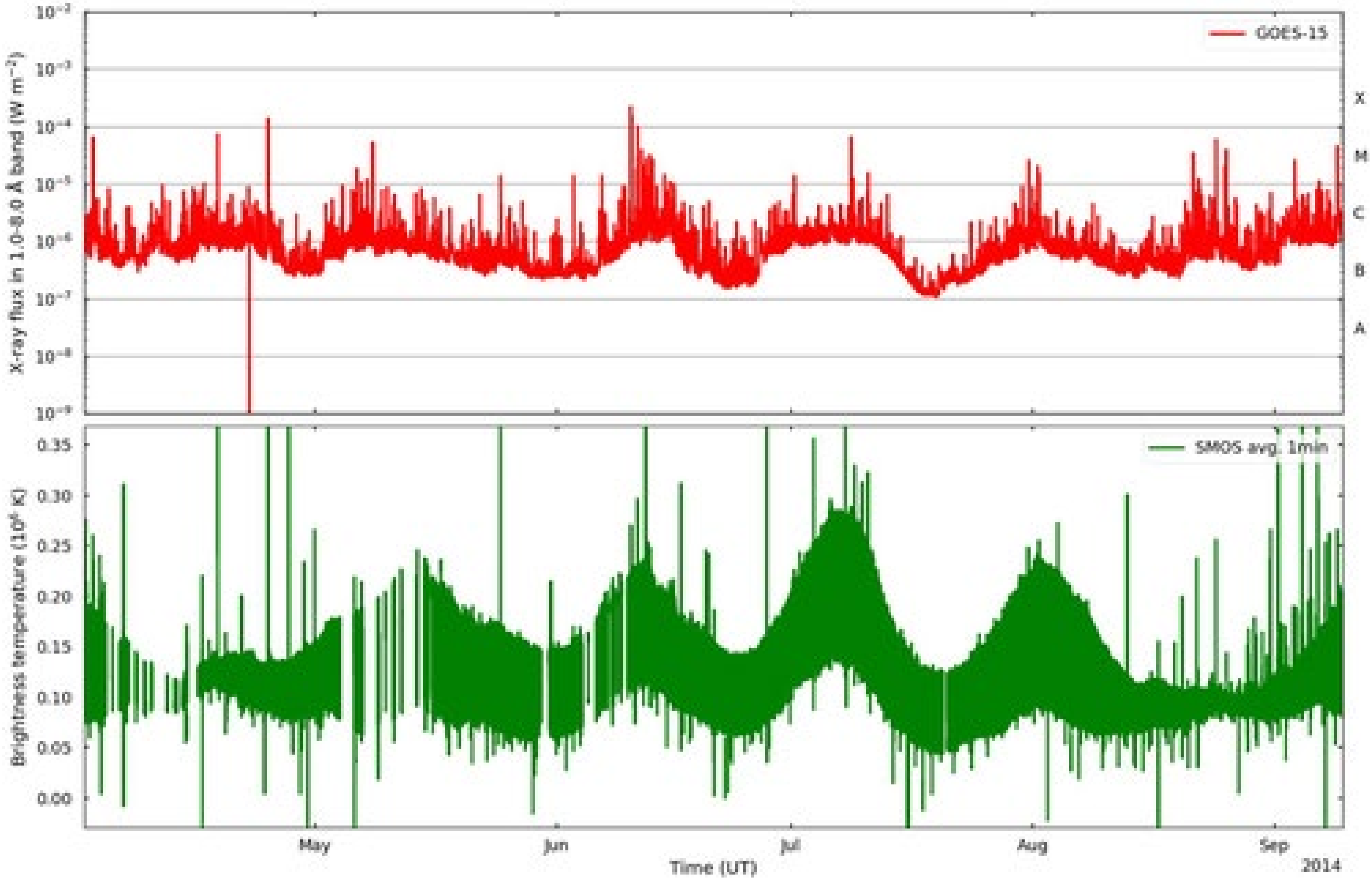
Besides space weather applications, yet adittional value of SMOS for solar physics community

SMOS is sensitive enough to detect the thermal emission from confined flares



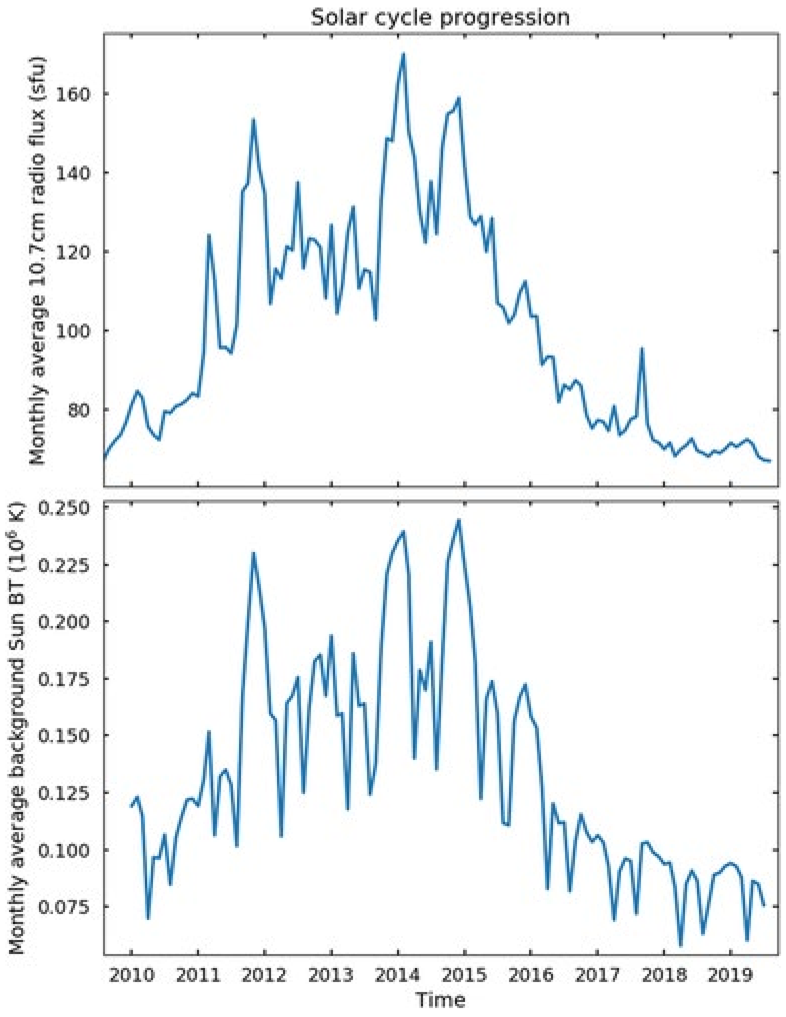
(from Flores-Soriano+ 2020)

SMOS is sensitive enough to detect the thermal emission as the solar rotation carries active regions in and out of the visible hemisphere



(from Flores-Soriano+ 2020)

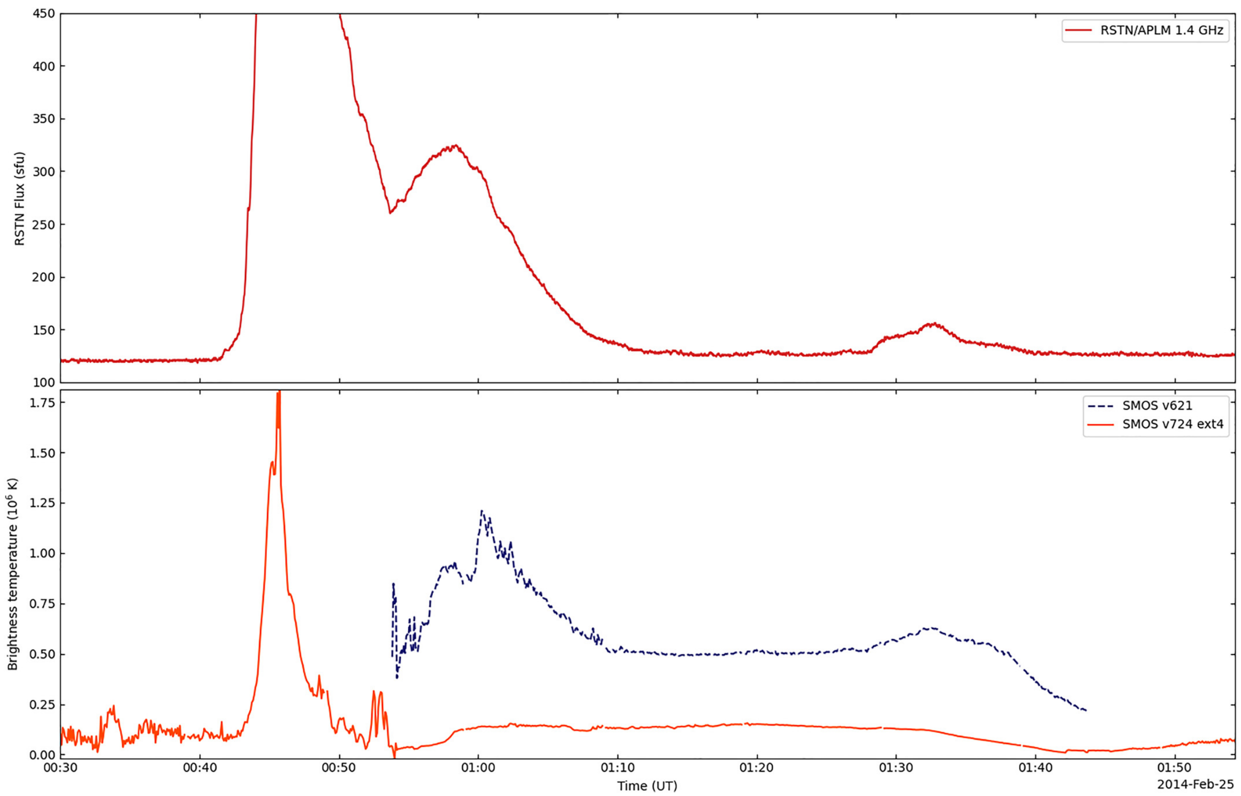
SMOS is also able to monitor the Solar Cycle progression…
but a specific product should to be developed



(from Flores-Soriano+ 2020)

Comparing different versions of SMOS Solar flux

SMOS v7 detects the radio burst when the Sun was behind the antenna but misses the bursts from 01:00 to 1:35 that SMOS v6 was able to detect.



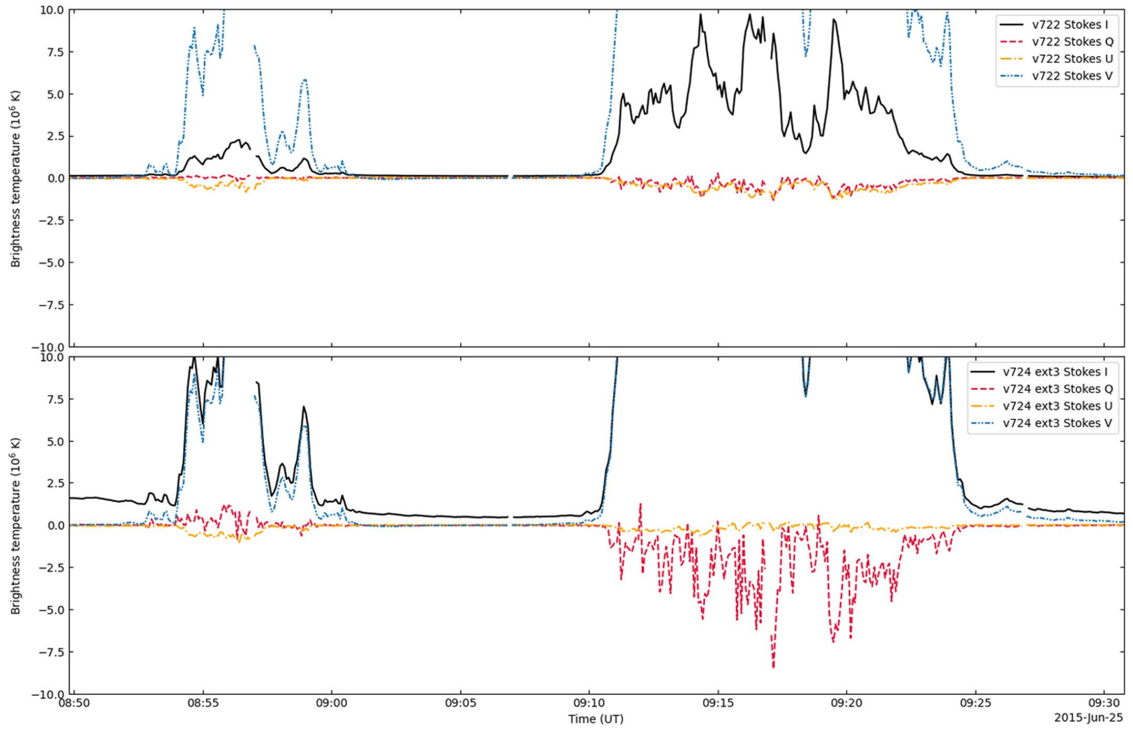
(from Flores-Soriano+ 2020)

Universidad de Alcalá SWE SPACE WEATHER GROUP

Comparing different versions of SMOS Solar flux

- Inconsistencies between polarization of radio burst as detected by SMOS v722 and v724 appear
- Different intensity for different versions

Just a matter of calibration?



(from Flores-Soriano+ 2020)

Conclussion

We have demostrated that SMOS data are useful for solar and space weather communities, but a specific product should be developed

This was our taks for the last one year and a half and we succeeded!

(Do not miss the presentations after the coffee break)

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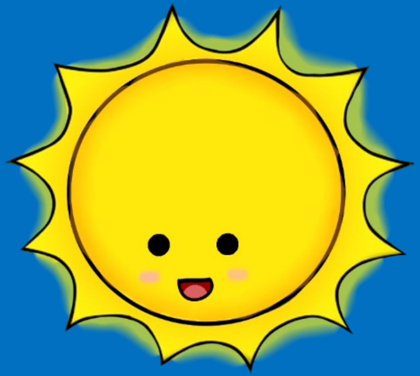

THANK YOU

FOR

YOUR ATTENTION!