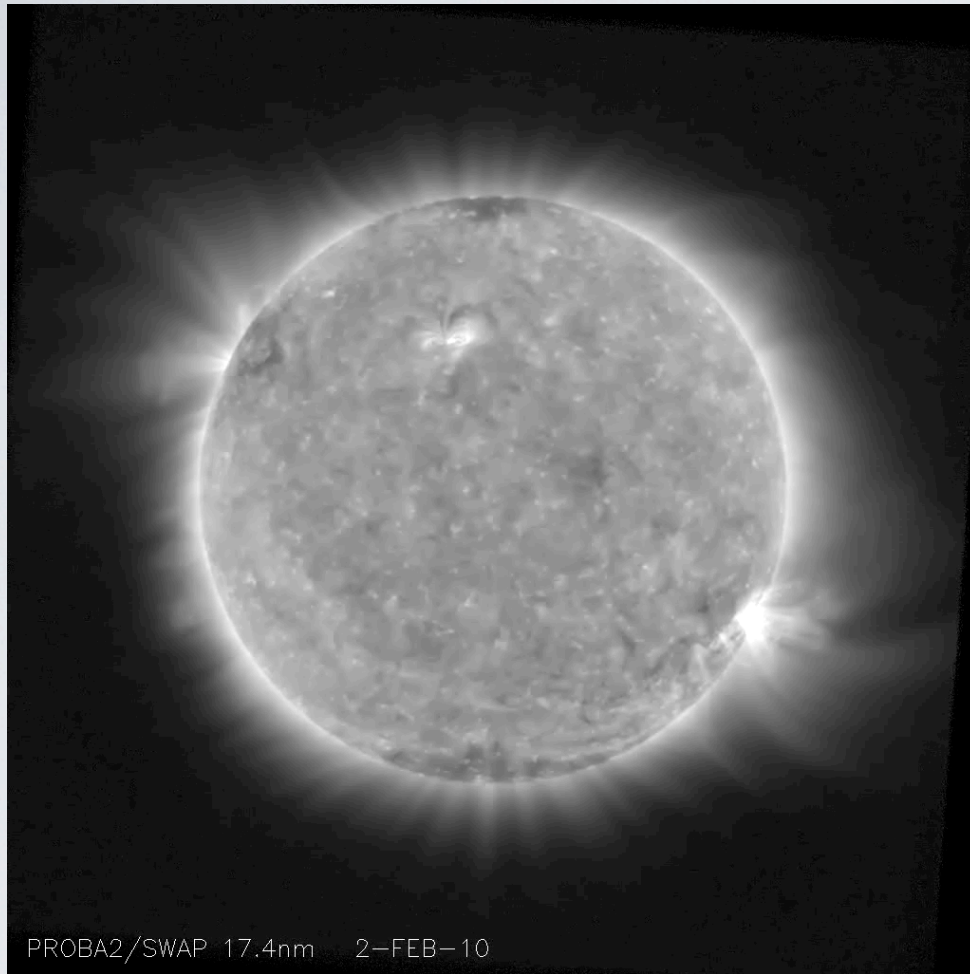
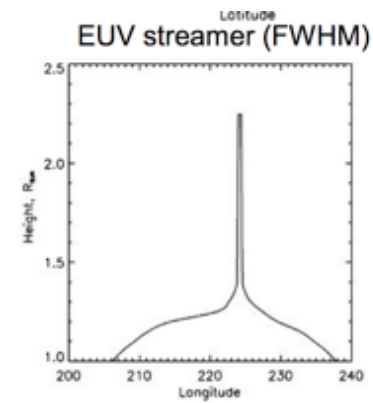


SWAP & LYRA SPLINTERS

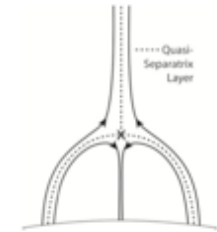


PROBA2 Science Meeting 6, November 6 2012
Académie Royale de Belgique, Brussels

Vladimir Slemzin (LPI, Moscow)



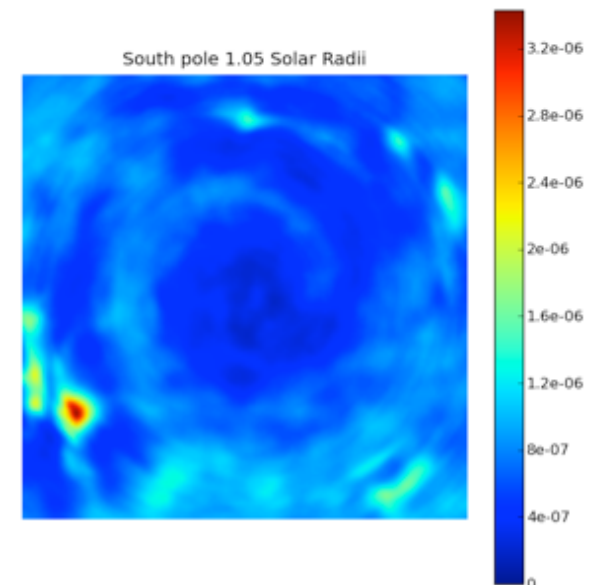
Pseudostreamer



Wang et al. 2007, 2012,
Crooker et al. 2012

Even number of arcs with
opposite direction of field

Chloé Guennou (IAS, Orsay)

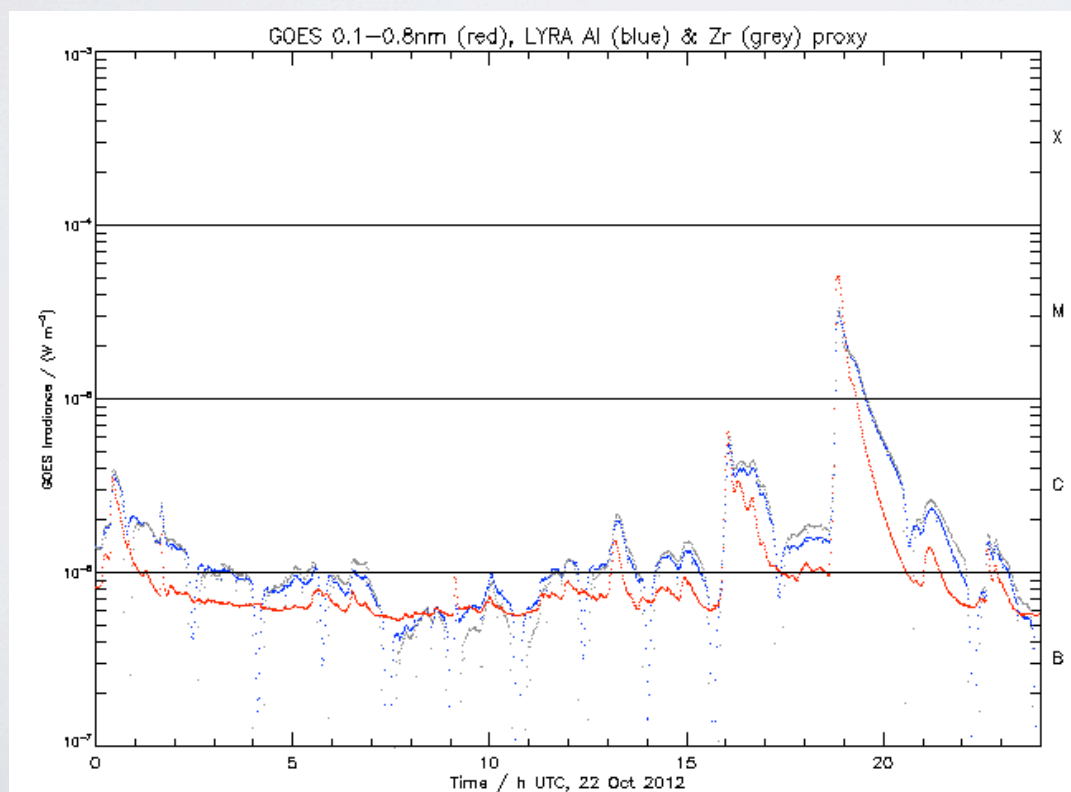
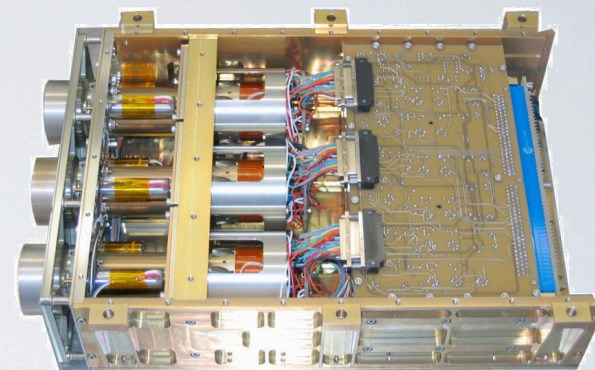




LYRA

Marie Dominique (ROB, Brussels)
Ali Ben Moussa & Boris Giordanengo

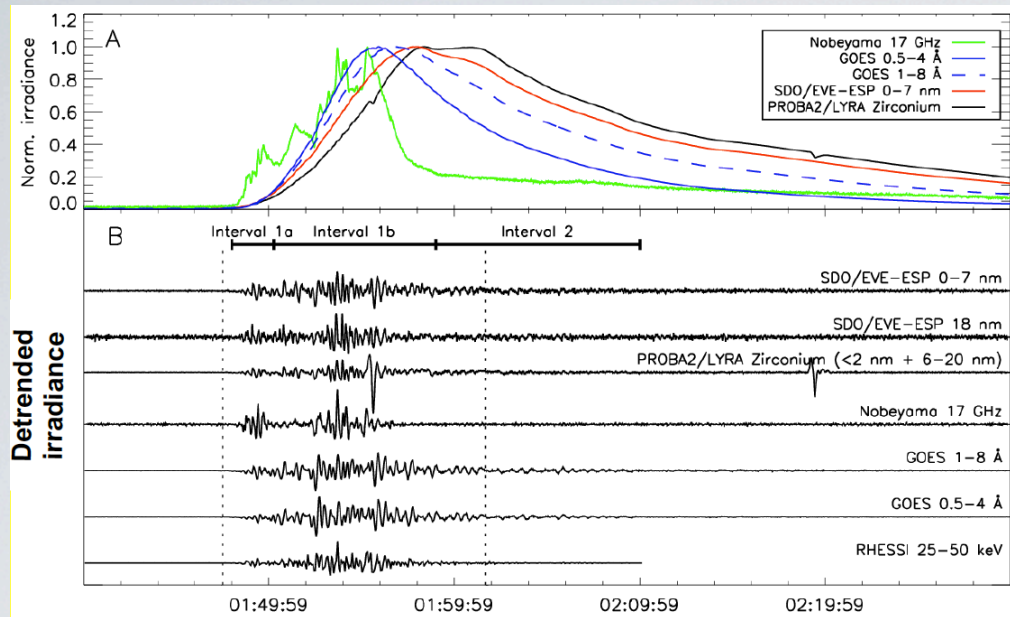
	LYMAN ALPHA	HERZBERG	ALUMINIUM	ZIRCONIUM
UNIT1				
UNIT2				
UNIT3				



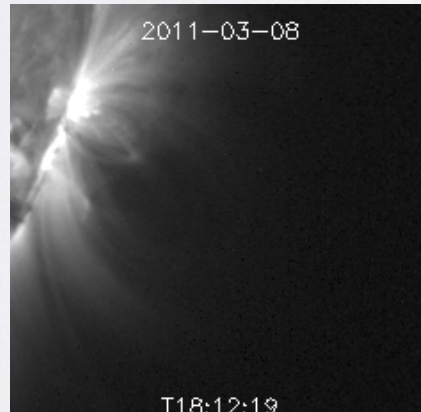
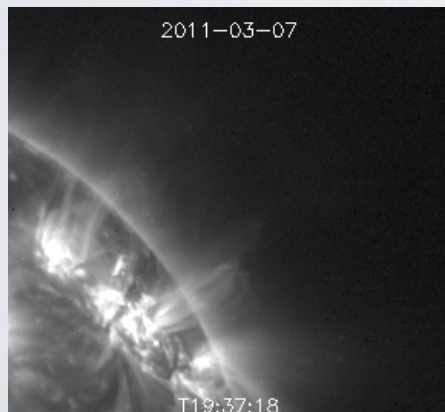
LYRA channels

Lyman alpha	120-123 nm
Herzberg	190-222 nm
Aluminium	17-80 nm + <5nm
Zirconium	6-20 nm + <2nm

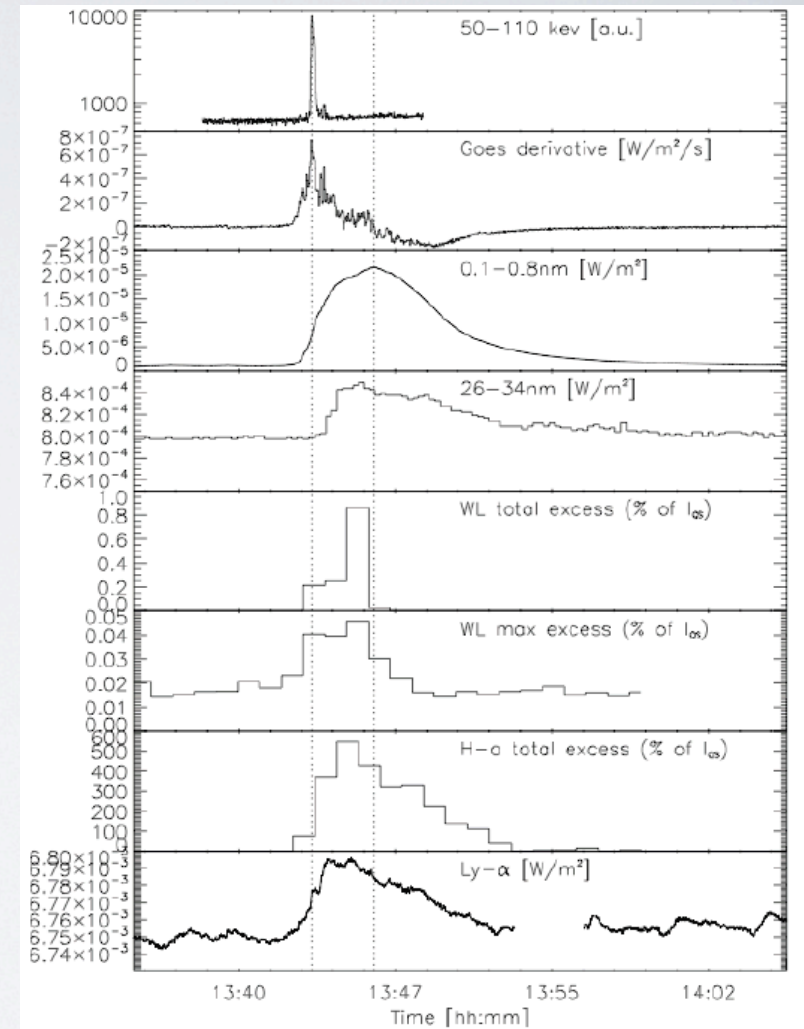
SCIENCE



Van Doorsselaere et al 2011 (KULeuven)
Dolla 2012 (ROB)



Antonio Guerrero & Consuelo Cid
(Univ. Alcala)



Matthieu Kretzchmar
(Univ. Orleans)

OBSERVATIONS:

On Earth:

D-region

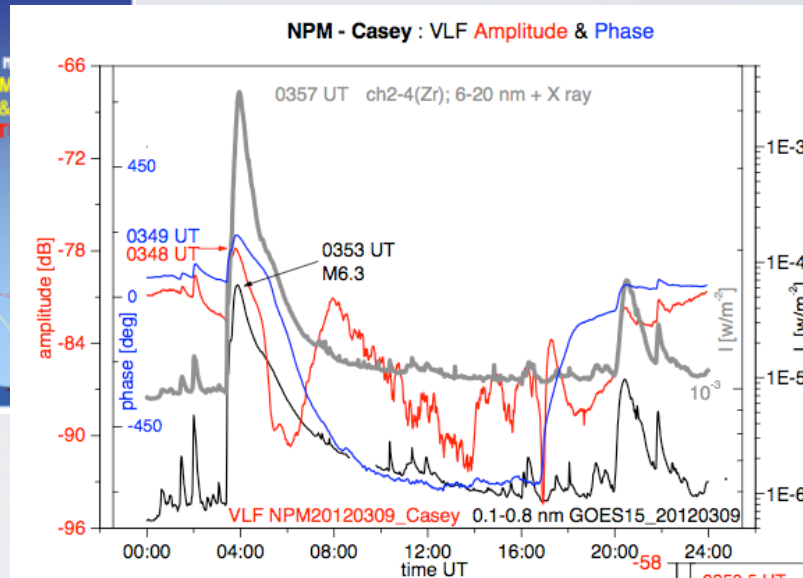
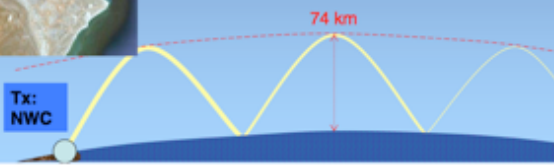
Radiowave propagation

(Supported by NOSC LWPC)
Solar Lyman Alpha (121.6 nm)
during flares: **Solar X-rays**

VLF
 $f < 30$ kHz

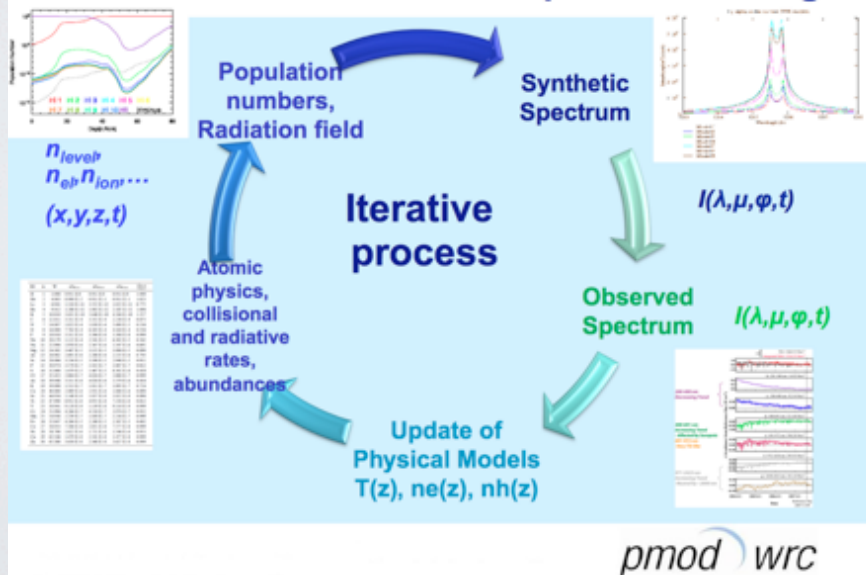


Tx:
NWC



Vida Zigman
(UNG, Slovenia)

EUV reconstruction - Semi-empirical modeling



Magrit Haberreiter
(PMOD/WRC, Davos),
POSTER 3A.1

Space Situational Awareness Services offered by PROBA2

K. Bonte¹*, M. Dominique², I. Dammasch³, F. Verströte¹,
D. Berghmans³, A. De Groof³, S. Poedts¹

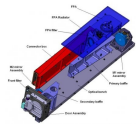
[1] Centre for mathematical Plasma-Astrophysics, KU Leuven (B); [2] SIDC, Royal Observatory of Belgium, Brussels (B); [3] ESA, c/o Royal Observatory of Belgium, Brussels (B)

Abstract

PROBA2 is the second Project for On-board Autonomy (PROBA) spacecraft, an ESA micro-satellite in orbit since end 2009. Besides two in-situ plasma instruments, the science payload consists of the solar monitoring instruments SWAP and LYRA that are controlled from the PROBA2 Science Operations Centre (PSOC) at the Royal Observatory of Belgium. The Sun Watcher using Active Pixel System (SWAP) is an EUV imager imaging the million degree solar corona at a minute cadence while the Large Yield Radiometer (LYRA) is an EUV radiometer operating non-stop, nominally operating at a 20Hz cadence. In this paper we concentrate on recent developments for SWAP and LYRA to deliver a full flare monitoring service. We will present the new LYRA data product that shows flare timelines in the same format as the familiar ABCM scaling from the NOAA GOES SXR instrument (so-called "LYRA proxies"). In addition we will show the SoFAST automated processing pipeline to detect the occurrence and location of flares in the SWAP EUV image series. These results will be fused into a dedicated webpage for flare monitoring (<http://proba2.oma.be/ssa>). We believe that such a flare monitoring service based on an ESA microsatellite can be a prototype in the future space segment of ESA's Space Situational Awareness Program. We'll additionally discuss the further possibilities concerning event catalogues and flare alert messages.

SWAP Sun Watcher using Active Pixel System detector and Image Processing

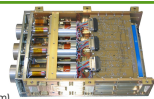
- EUV imager
- 17.4 nm bandpass
- 130s cadence
- CMOS APS detector 1024 x 1024
- FOV of 54 arcminutes



LYRA Large Yield Radiometer

- 3 instrument units (redundancy)
- 4 spectral channels per head (wavelengths in nm)

Ly-alpha	Herzberg	Aluminium	Zirconium
120-123	190-222	17-80 <5	6-20 <2
- 3 types of detectors (silicon + 2 types of diamond (PIN, MSM))
- High cadence up to 100 Hz



SWAP IMAGE PRE-PROCESSING

- SWAP calibrated "level-1" images:
 - Dark subtracted
 - Corrected for bad pixels
 - Corrected for instrumental and spacecraft effects
 - Normalized to exposure time
 - In DN per second per pixel (FITS file format)

SoFAST: Solar Flare Automated Search Tool

- Flare detection in EUV images
- Accepting only regular "level-1" images
 - No off-pointing
 - No blurred images
- Typically covering 80% of high energy flares, in addition detecting more EUV activity
- The so-called EUV-significance parameter routinely quantifies the EUV relative variability. It gives an idea of how active/dynamic an Active Region really is in the EUV.
- Robust algorithm: towards onboard intelligence

PROBA2

Project for On-Board Autonomy



LYRA DATA PRE-PROCESSING

- LYRA calibrated data:
 - Dark subtracted
 - Corrected for the degradation trend
 - Converted in physical units
 - In Watts per m² (FITS file format)

LYRA as a flare monitor

- Flare detection in irradiance of spectral intervals:
 - 2 channels are dedicated to flare detection, namely Aluminium (CH3) and Zirconium (CH4)
 - Using "level-3" data
 - Calibrated data, averaged over 1 minute
- LYRA flarelist – currently listing GOES flare detections that are seen by LYRA – covers flares down to B1.0 (NOAA class)
- Ongoing work on automated LYRA flare detection
- Aiming towards automated LYRA flare classification: "LYRA proxy curves" approach GOES curves pretty well. From there, similar flare classification can be achieved.

Space Situational Awareness

An example: 9 September 2011, flaring region around 06:00 UT, during GOES data gap



The Solar Flare Automated Search Tool

[SoFAST: Bonte et al., 2012]

EUV flares detected by SoFAST

SoFAST EUV flarelist

SWAP image of the day with highlighted flare location

SoFAST event details and graphs

Current LYRA flarelist

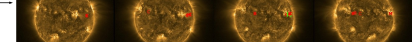
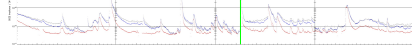
LYRA and GOES data, 1 hour before and 2 hours after this flare peak

SoFAST detections together with GOES X-ray curve

www.sidc.be/sofast

proba2.oma.be/ssa

LYRA "proxy curves" with indication (green line) of time occurrence of the flare that is highlighted in red below



www.sidc.be/sofast

proba2.oma.be/ssa

Space Weather and Particle Effects on the Orbital Environment of PROBA2

Daniel B. Seaton ■ Marie Dominique ■ David Berghmans ■ Bogdan Nicula
Erik Pylyser ■ Koen Stegen ■ Royal Observatory of Belgium
Johan De Keyser ■ Belgian Institute for Space Aeronomy



Abstract.

Data from the EUV imager SWAP and UVIEUV radiometer LYRA on board the PROBA2 spacecraft are regularly affected by space weather conditions along the spacecraft's orbital path. While these effects are generally removed from calibrated data intended for scientific analysis, they provide an interesting opportunity to characterize the evolution near-Earth space environment as the result of changing space weather conditions. Here we present an analysis of these space weather effects on PROBA2 observations and some conclusions about both the long-term evolution of the inner magnetosphere and short-term events driven by the active sun.

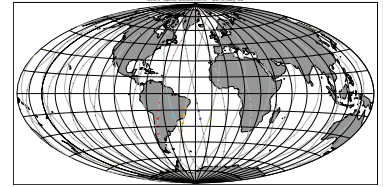
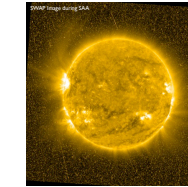
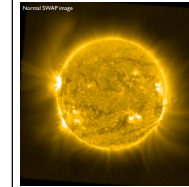
About PROBA2.

PROBA2 is a space-weather oriented microsatellite launched on 2009 November 2. Among its four scientific instruments are SWAP, an EUV solar imager, and LYRA, a four-channel UVIEUV radiometer. PROBA2 also hosts 17 technology demonstrations and two in-situ plasma instruments, DSEP and TMAP. Though SWAP and LYRA nominally observe the sun, a study of noise in the data they produce allows us to indirectly characterize radiation in low Earth orbit.



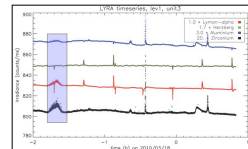
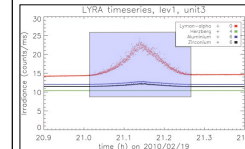
Space Weather Effects on SWAP.

Typical SWAP images reveal the structure of the high-temperature inner Solar Corona around 17.4 nm, the result of Fe IX/X emission lines that form at temperatures of about $8 \times 10^6 - 1 \times 10^7$ K (below left). However, several times a day PROBA2's orbit carries the spacecraft through radiation belts at a height of about 725 km, resulting in noisy images (below center). Counting the number of radiation-related spikes in each image yields an estimate of the variation of radiation intensity SWAP experiences as it orbits. By plotting the resulting spike counts as a function of location, we can map the intensity of radiation in the low Earth orbit environment (below right). The color of each point indicates the time of day of the observation (purple is early in the day, red late) while their size is proportional to the number of spikes. In such a map, the location of the South Atlantic Anomaly (SAA) over eastern South America becomes immediately apparent.



Space Weather Effects on LYRA.

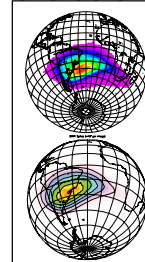
LYRA is composed of three, four-channel irradiance detectors, only some of which are sensitive to the effects of space weather. This is easy to see in dark data—that is, data obtained with instrument covers closed (below left). LYRA's silicon-based detectors are sensitive to radiation effects, and register the SAA (blue shaded areas), while its diamond-based detectors, like the Herzberg detector (green curve) on Unit 3, do not. With the covers open (below right), the effects of radiation are not as obvious, but can still be seen in the data; again, against the diamond-based detector's curve is flat.



LYRA and the Auroral Ovals.

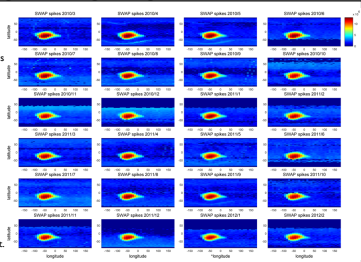
In addition to the SAA, LYRA observes increased signal when passing through the Auroral Ovals in the days following geomagnetic events with $K_p \geq 4$. Interestingly, these effects are not present when the instrument covers are closed, and are seen only in EUV/X-ray channels. Possible explanations range from direct detection of aurora-related EUV photons to Bremsstrahlung caused by the interaction of energetic electrons and the instrument filters. Both SWAP and LYRA clearly observe energetic protons in the SAA, and SWAP does occasionally observe some signal in the auroral zones as well as LYRA, but not as frequently. Work on this topic is ongoing.

Characterizing the near-Earth Space Environment.



By combining multiple observations from throughout PROBA2's mission, we can construct a map of the particle environment through with the spacecraft's orbit travels. A comparison between maps from ESA's Space Environment Information System (SPENVIS; top left) and measured SWAP radiation intensity (bottom left) reveals that while the structure of the SAA is relatively unchanged, it has drifted west since the best-known recent measurements were made, now many years ago. The SAA is now largely centered over the southwestern quadrant of South America and has considerably weaker influence in the South Atlantic region.

Plotting these results on a monthly basis (right), we see the additional influence of radiation from the auroral ovals during periods of geomagnetic activity. The strongest example occurred during April 2010, during the same CME-related event that caused the Galaxy-15 spacecraft to fail.

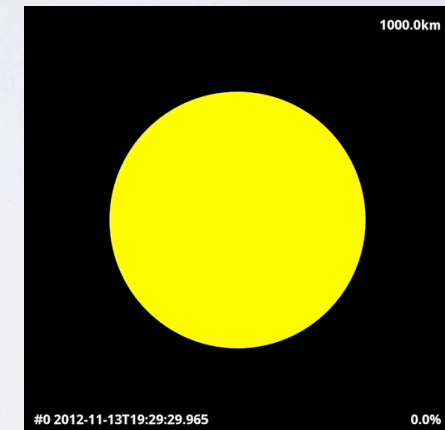
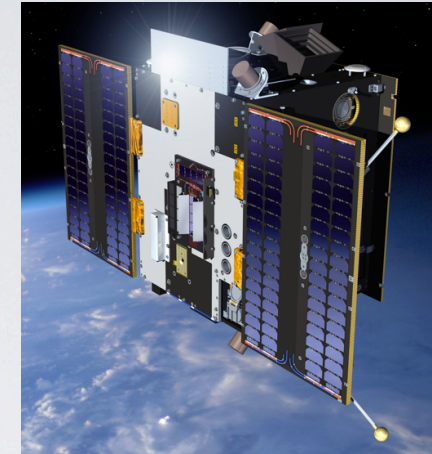


Katrien Bonte (KU Leuven)

Dan Seaton (ROB, Brussels)

UPCOMING

- this afternoon, science fair: PROBA2 stand & posters
- November 13: eclipse
- End November: mission extension till 2016
- 2 Job openings!
- Next years: Adoption by SSA



<http://proba2.oma.be>

<http://proba2.oma.be/community/meetings/SWT6>