Towards Cross-Calibration of SWAP, LYRA, TIMED/SEE, EVE

IED 28 Jun 2011

The ultimate motivation for this report is to get more insight into LYRA's performance, especially, to find out which portions of the short-wavelength channel 3 (Al) and channel 4 (Zr) are contributed by EUV, and which portions are contributed by SXR.

The month of July 2010 was chosen to be used in the former ESWW7 poster and the planned Solar Physics publication, "LYRA and SWAP integrated flux comparison", because it contains several passes of a solar eclipse on 11 Jul 2010. Comparing the irradiance values for this day, different instruments with different spectral intervals give the following values (all in W/m²):

	ESP (SDO/EVE)	TIMED/SEE in comparison
0.1-7nm	0.00025	0.00017
17.5-21.1nm	0.00060	0.00061
	0.00085	0.00078

	LYRA Zr-channel	TIMED/SEE in comparison
0-2nm	?	0.00005
6-20nm	?	0.00070
	0.00080	0.00075

	LYRA Al-channel	TIMED/SEE in comparison
0-5nm	?	0.00011
17-80nm	?	0.00210
	0.00230	0.00221

So LYRA, ESP, and TIMED/SEE appear to be in good agreement. It seems plausible to accept the value that TIMED/SEE gives for the SWAP interval, 17-18nm, as a start: 0.00022 W/m². But this is only a "modeled" value, since it is below 27nm, and TIMED/SEE has no spectral resolution there. (EVE gives 0.00017 W/m² for the SWAP spectral interval.)

It may be interesting to compare this 17-18nm value with the theoretical (i.e. pre-flight) prediction according to SWAP's performance characteristics. In order to do so, the SWAVINT value of 11 Jul 2010 has to be transformed to comparable physical units. SWAVINT is given as approx 12 DN/s on this day. Since this is a value for the average pixel, it has to be multiplied by the number of pixels on the detector, and divided by the area of solar radiation effecting the detector.

irrad(SWAP) = 12 DN/s/px * 1024*1024px / area
= 1.25829e+07 DN/s / area

This value has to be transformed by the knowledge about SWAP's spectral response in DN/photon. It is taken from Figure 1 of the above-mentioned paper, showing the measured bandpass of SWAP within its nominal spectral interval.

Simplification: The integral of this curve between 17nm and 18nm is used. (In a more sophisticated attempt, the response curve in the more complete interval 16.5-19nm could be weighted with the solar spectrum.) The integral is 0.000667 DN/photon.

irrad(SWAP) = 1.25829e+07 DN/s / (0.000667 DN/photon) / area
= 1.88649e+10 photon/s / area

The value in photon/s has to be transformed into W to make it comparable to the other instruments. Here, the following relation is used:
photon = h*c/lambda, where:
h = 6.626d-34 Ws² is Planck's constant,
c = 2.998d+08 m/s is the speed of light, and
lambda = 17.4e-09 m is the wavelength corresponding to the peak of SWAP's bandpass.
Thus, photon = (6.626d-34 Ws²* 2.998d+08 m/s) / 17.4e-09 m = 1.1416522e-17 Ws

irrad(SWAP) = 1.88649e+10 * 1.1416522e-17 Ws/s / area
= 2.15372e-07 W / area

The area effective for the SWAP detector is given as “the 33mm-diameter entrance pupil”.
Thus, area = π*0.0165*0.0165 m² = 0.000855299 m²

irrad(SWAP) = 2.15372e-07 W / 0.000855299 m²
= 0.000251809 W/m²

One could argue that this is “in good agreement with other instruments”, since it is only 14% more than TIMED/SEE gives for solar irradiance in a comparable spectral interval on 11 Jul 2010.

Remark:
Some data values were simply taken from the following figures.