The solar irradiance registered at a flat- hemispherical field of view- Bolometric Oscillation Sensor on board PICARD satellite

Ping Zhu[1], Özgur Karatekin[1], Michel van Ruymbeke[1], Steven Dewitte[2], Gérard Thuillier[3]

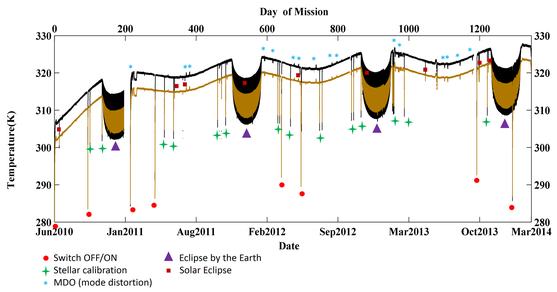
(1)Royal Observatory of Belgium, 3, Avenue Circulaire, 1180-Brussels, Belgium (2)Royal Meteorological Institute of Belgium, 3, Avenue Circulaire, 1180-Brussels, Belgium (3)LATMOS, 4 place Jussieu 75252 Paris Cedex 05, France

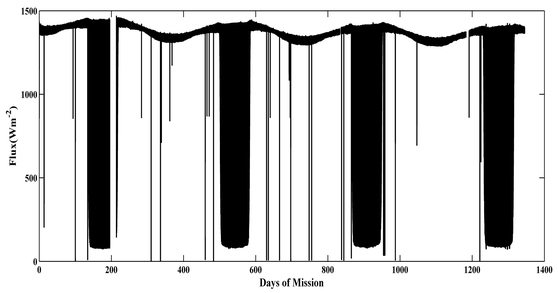
Royal Observatory of Belgium

belspo

INTRODUCTION

A Bolometric Oscillation Sensor was designed for the **SO**lar **VA**riability experiment for **P**ICARD mission (SOVAP). The experiment was composed with a DIARAD absolute radiometer and the BOS. The BOS is measuring the relative variability of the total solar irradiance with a 10 seconds cadence. One of the objective is to extend the solar irradiance measurements towards the higher frequency band comparing to the classical absolute radiometer.

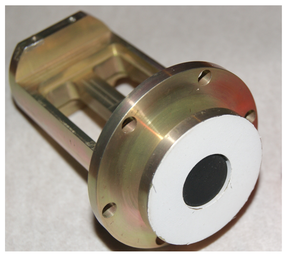


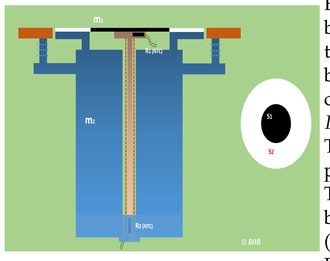


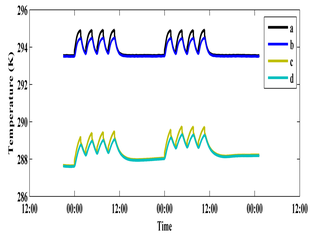
The missionary duty of BOS was started at June 28, 2010 and ended at March 04, 2014. It is just one month ago the satellite was completely shut down by the PICARD missionary center at CNES, Toulouse. The instrument is well functioning during the entire PICARD life time. Left figure, N_1 product, Right figure,N_2 product. The higher level data is produced based on N_2, to remove a priori known instrumental, environmental, and orbital effects. They are the following and derived data.

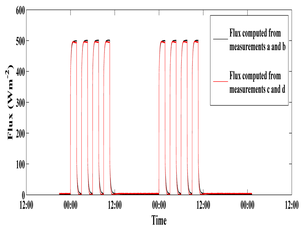
| Nominal Solar Radiation | Nominal Terrestrial Radiation at the top-of-atmosphere | PICARD satellite manoeuvre (Modes star, Modes distortion) | Occultation by the Earth | Solar eclipse

BOLOMETRIC OSCILLATION SENSOR







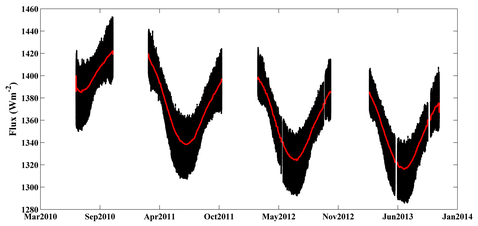


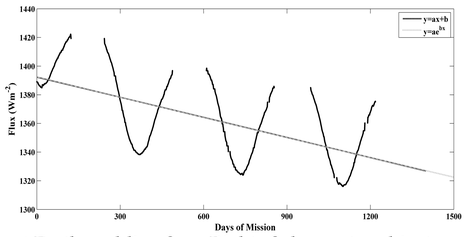
Either photons or infrared radiation is absorbed by the black surface s_1. But the surface s_2 is more sensitive to the infrared radiation. It is reflecting the most visible light. The temperature measured with R_1 is rapidly change($m_1 = 0.8gram$) compare to the temperature of R_2, which is damped by a heavier mass($m_2 = 160gram$). The m_2 is also playing a role of heat sink, thus the complete unit is passive thermal stabilized.
Two experiments were conducted: a and b is calibrated reading from R_1 and R_2 at a thermal chamber ($\Delta T < 0.1°$), c and d is at underground Lab.($\Delta T < 10°$). Both experiments has a the same light source, a tungshten lamp. The Flux is determined from two experiment were plotted together, the value is $F_{ab} = 496.2 \pm 1.4 Wm^{-2}$ and $F_{cd} = 496.4 \pm 0.7 Wm^{-2}$.

Table 1: 1,Diameter of the support plate, 2, Diameter of white surface, 3, Diameter of black surface. Power consumption of the unit is about $300mW$.

Parameter	Data	Parameter	Data
Mass	$168gram$	Volume	$366.7cm^3$
Height	$91.3mm$	Diameter[1]	$63.4mm$
Diameter[2]	$46.5mm$	Diameter[3]	$18.1mm$

Observation and data treatment

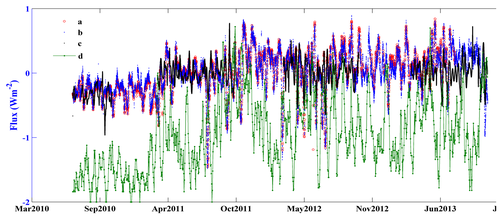


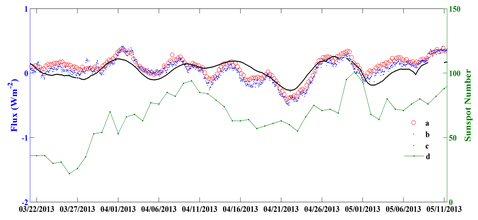


Left: The observation during normal mode operation, black line Sun+Earth, red line Sun, Right: Solar part and instrument degradation mode,

- BOS bares a hemispherical field of view. The variation of flux observed during nominal mode is not only related to the solar irradiance but also containing the reflected solar and reemitted infrared from the top−of−atmosphere.Between 94% and 97% of global recorded energy is solar origin (Upper figure).
- At the altitude of PICARD,the BOS is looking around 1.2% Earth's global surface area. The Earth's contribution is from $40Wm^{-2}$ to $80Wm^{-2}$, the exact number is depending on Earth−Sun position at the orbit.
- The terrestrial contribution is removed by 7 days time running mean. The decrease slope was fitted separately by a linear and an exponential function. At the PICARD life time scale, both fittings gave the same results. A $-17.08Wm^{-2}/yr$ linear degradation during the three and half year's observations is obtained.

DISCUSSIONS





a− TIM−Sorce(v15 → $1361.12 \pm 0.33 Wm^{-2}$), b− Virgo−SOHO(v6−004 → $1366.02 \pm 0.31 Wm^{-2}$), c− BOS−PICARD (N2−a−v01 → $1363.54 \pm 0.45 Wm^{-2}$), d− Daily mean sunspot number.

- BOS was initially designed to make observe short term variations of the solar irradiance without an absolute onboard calibration. But by applying the data analysis procedure presented above, BOS is shown to provide valuable information also for long term TSI variations.
- Data from different instruments covering approximately 3.5 years are compared with BOS in the figure above.
- BOS results follow very well those given by absolute radiometers TIM-Sorce and Virgo-Soho with much finer time resolution (better high frequency resolution) . The difference in absolute TSI between the three instruments is less than $5Wm^{-2}$. with typical RMS varying between $0.3 - 0.5Wm^{-2}$
- The differences among the results of absolute radiometers are still in debate, since the design and calibration procedure of each unit is different, whereas BOS results providing relative TSI variations do not need onboard absolute calibration.
- The number of sun spots is fairly correlated to the TSI variations.

ACKNOWLEDGEMENTS

The BOS experiment is financed by Belgian-PRODEX program, ESA project with the management support of BELSPO. The virgo-soho data is from `ftp.pmodwrc.ch/`, Tim-Sorce is from `lasp.colorado.edu/home/sorce/`, BOS `//picard-bos.oma.be`.

Conference: EGU2014, 27 April-02 May,2014, Vienna-Austria

Corresponding author: zhuping@oma.be