

# In-flight performance of Solar Irradiance Monitor-II on-board FY-3C and its TSI data

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## Introduction

FengYun-3(FY-3) is the Chinese second generation of polar orbiting meteorological series satellite. It is designed to contain 8 satellites: 3 morning orbits, 3 afternoon orbits, 1 early-morning orbit and 1 mid-latitude orbit for rain monitoring

Solar Irradiance Monitor(SIM) is a key payload of Fengyun-3 satellites. It is designed to onboard on FY-3A(AM), FY-3B(PM), FY-3C(AM), FY-3E(EM) and FY-3F(AM) for observing total solar irradiance at the top of atmosphere, capture solar daily changes and build a climate dataset.

The instrument is based on SIAR radiometer designed and produced by *Changchun Institute of Optics, Fine Mechanics and Physics*.

After 3 successful satellites, we are understanding and improving the instruments step by step, now there are two models SIM-I and SIM-II.

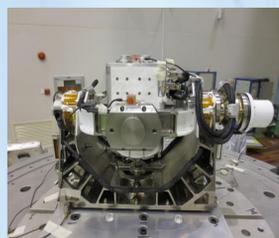
## Solar Irradiance Monitor-II

Improvement in SIM-II comparing with SIM-I:

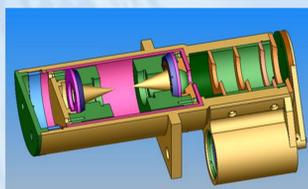
✓Tracking system  
FOV nearly  $\pm 2^\circ$ ; tracking accuracy is  $\pm 0.1^\circ$ ; more stable incident solar energy

✓Temperature control system  
The design temperature control accuracy is 0.3K; one big heat sink contains two same absolute radiometers, the same thermal environment could have a good consistency between the two channels.

SIM-II



Detector-SIAR



| Parameter                    | FY-3A/B SIM-I    | FY-3C SIM-II    |
|------------------------------|------------------|-----------------|
| Spectral range               | 0.2~50um         | 0.2~50um        |
| Absolute accuracy            | 0.5%             | 0.1%            |
| Relative accuracy            | 0.03%/3 years    | 0.02%/4 years   |
| SIARs                        | 3                | 2               |
| FOV                          | $\pm 13.3^\circ$ | $\pm 2^\circ$   |
| Tracing accuracy             | --               | $\pm 0.1^\circ$ |
| Temperature control accuracy | --               | 0.3K            |

The total solar irradiance at 1 AU from FY-3C/SIM-II is calculated by:

$$E_s = (E_{Sun} - E_{Space}) \times f_{fov} \times f_{Doppler} \times f_{AU} \times f_{WRR} \times f_{re}$$

All the equation parameters have an optimization benefitted from the instrument improvement and calculating method.

## In-flight performance

FY-3C was successfully launched on Sep. 23, 2013 and SIM-II began solar observation on Oct. 1, 2013. Based on the three month on-orbit testing results, SIM-II operation pattern has been fixed as: SIAR1 is operational observation on every orbit, SIAR2 works one day a month.

From May 27, 2015 to Sep.16, 2015, SIM-II was closed caused by some problem of satellite platform energy. The property of instrument showed similar as before while it reopened.

An early increase in sensitivity had also been found in SIM-II. We also identified SIAR2 had a longer time constant than SIAR1. This was the main reason of choosing SIAR1 as the routine observation radiometer.

Since SIM-II began to observe just after satellite launching, the first two months data showed bigger noise needing more analysis and correction. The TSI dataset in this work is began with 22 Dec., 2013.

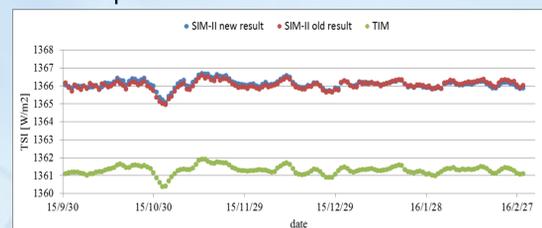
After an assessment on instrument in-flight performance, some improvement has been made for a better quality TSI data. The work contains:

- improve data quality control;
- develop a new method for background correction;
- rebuild an aging model;

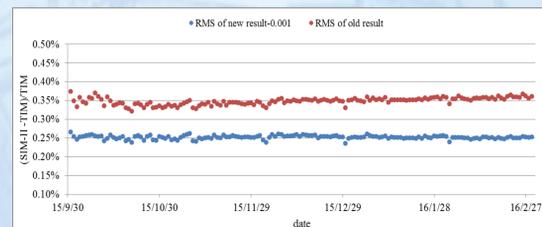
Based on new algorithm, the comparison of FY-3C/SIM-II and SORCE/TIM showed an over-estimated degradation signal had been excluded.

comparison between SIM-II and TIM

TSI



RMS

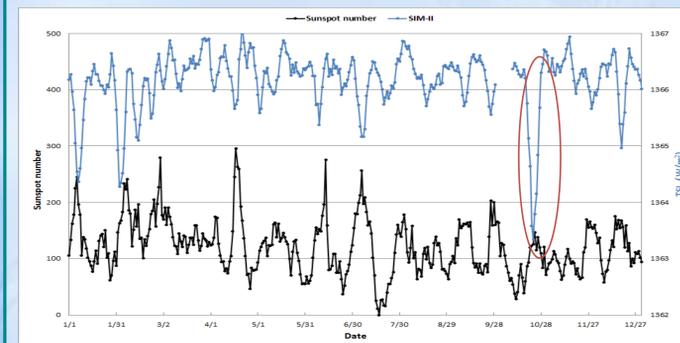


|                         | old     | new     |
|-------------------------|---------|---------|
| TSI (W/m <sup>2</sup> ) | 1366.04 | 1366.09 |
| Relative RMS (ppm)      | 95      | 47.6    |

## Conclusion

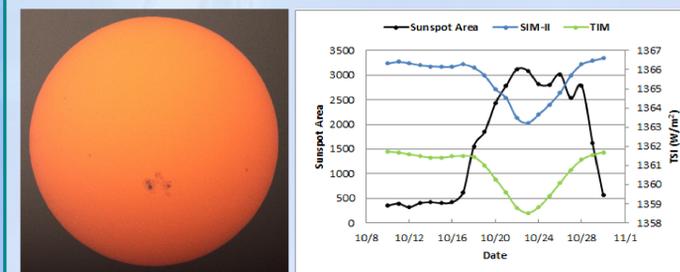
- Based on SIM-II in-flight performance, we optimize data quality and stability by estimating all factors in TSI calculation;
- A new TSI data record is presented from the observation of Chinese second generation polar-orbiting meteorological satellite FY-3C, which is traceable to WRR and showed as the level of 1365.97W/m<sup>2</sup>;
- The TSI record has similar solar change signal with SORCE/TIM and SOHO/VIRGO.

## Solar activity monitoring



Comparing results of FY-3C/SIM-II TSI and sunspots during 2014

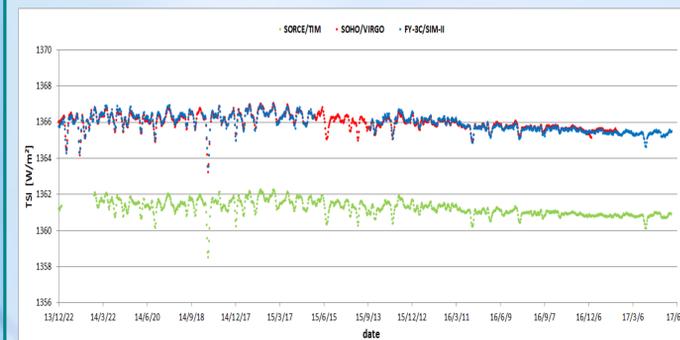
Quantitative Monitoring the very strong solar activity in Oct. 2014



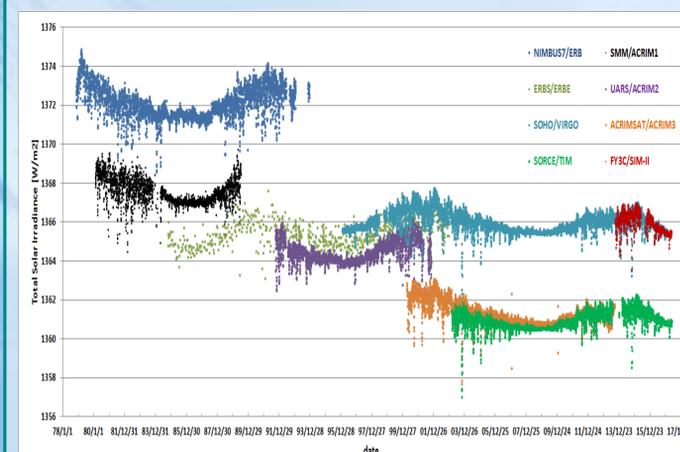
|                           | Oct. 17th | Oct. 23th | Change |
|---------------------------|-----------|-----------|--------|
| Sunspot Area              | 620       | 3090      | 2470   |
| SIM-II(W/m <sup>2</sup> ) | 1366.27   | 1363.33   | -2.94  |
| TIM(W/m <sup>2</sup> )    | 1361.5    | 1358.52   | -2.98  |

## TSI data record

Comparison with SORCE/TIM and SOHO/VIRGO from 22 Dec., 2013 to 24 May, 2017



The gap in SIM-II TSI caused by battery problems of FY-3C platform



Total Solar Irradiance data records