Total Solar Irradiance Data from Fengyun-3 Meteorological Satellites

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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 1mid-latitude orbit for rain monitoring. At 2020, there will be a constellation observation system with 4 different orbits.

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 SIARs designed and produced by CIOMP.

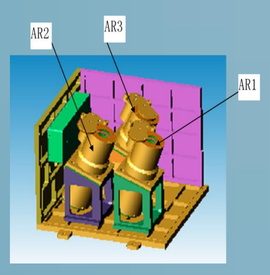
After 3 successful satellites, we are understanding and improving the instruments step by step, now there are two models SIM-I and SIM-II.

Properties of SIM

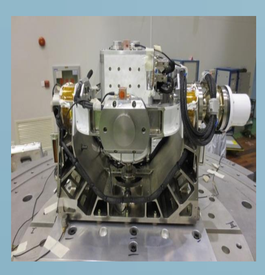
Improvement in SIM-II comparing with SIM-I:

- Adding tracing system, FOV is smaller, incident solar energy is more stable, space background influence is smaller ;
- Adding Temperature control system, reduced thermal environment influence.

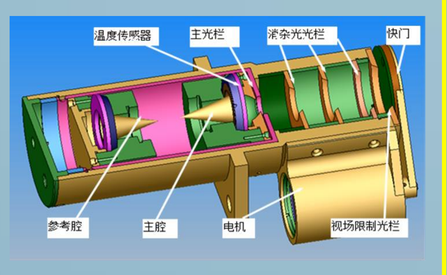
SIM-I



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
Backup channels		
FOV	±13.3°	±2°
Tracing accuracy	--	±0.1°
Temperature control accuracy	--	0.3K

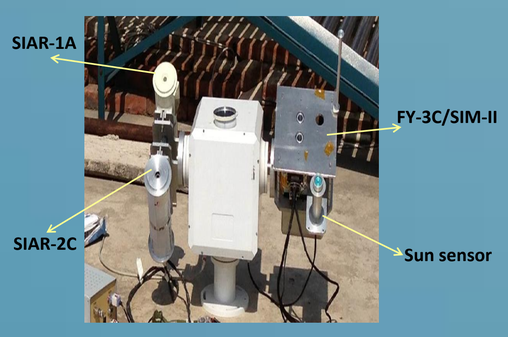
Calibration

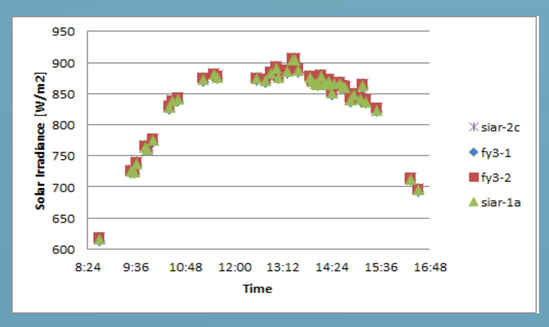
The total solar irradiance at 1 AU from FY-3C/SIM-II is calculated by:

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

Traceable to WRR:

The field comparison experiment was held from March 27 to April 5, 2013 at Yunnan province, China. As the reference, SIAR-1A and SIAR-2C had already completed the 11th International Pyrheliometer Comparison (IPC-XI); With the WRR standard, the observations from SIM-II will be traceable.

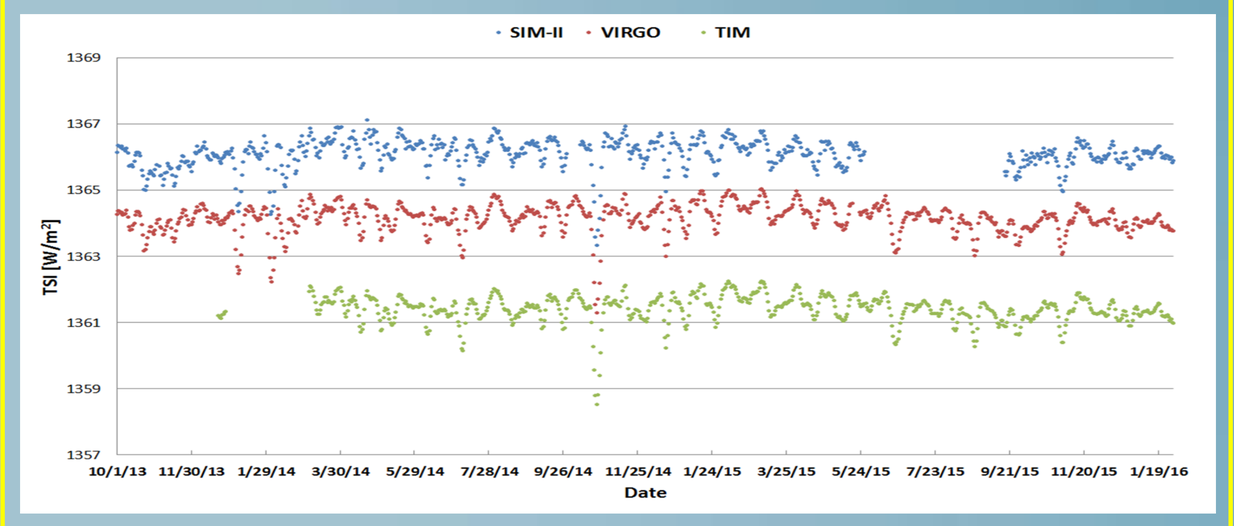




Instrument	SIAR-1A	SIAR-2C	FY3-1	FY3-2
WRR	1.0024	0.999839	1.005927	1.000448
σ	0.000997	0.001125	0.000785	0.000769

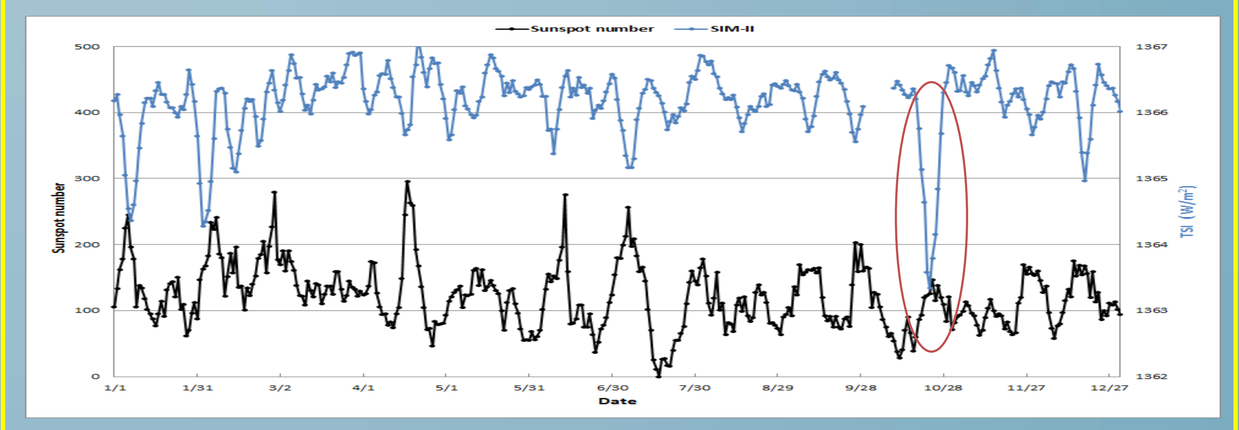
TSI data record

Daily results from FY-3C/SIM-II, SOHO/VIRGO and SORCE/TIM during Oct.1, 2013 to Jan.31, 2016



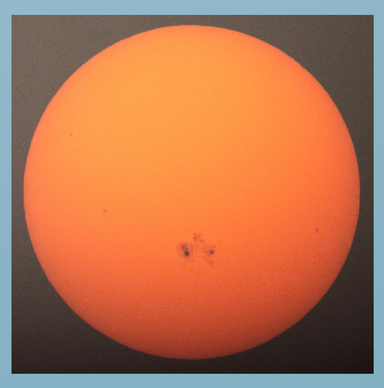
1. The VIRGO value is minus 2W/m² for better display;
2. The gap in SIM-II TSI caused by battery problems of FY-3C platform.

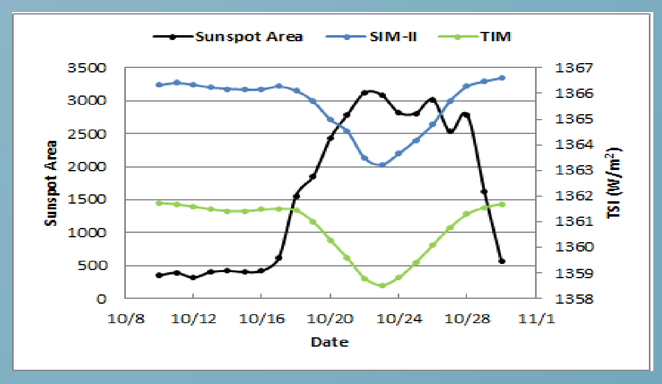
Solar activity monitoring



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/m²)	1366.27	1363.33	-2.94
TIM(W/m²)	1361.5	1358.52	-2.98

Future plan

FY-3E is planed to be an early-morning orbit satellite. It has a good condition for solar observation. We design to build total and spectral solar irradiance simultaneous observation capability.

For TSI:

1) we would like to have cooperation with RMIB and PMOD, to build an instrument package as JTSIM;
2) Improve SIM-II by considering space background and aging monitor.

For SSI: we would like to have a new instrument – Solar Spectral Irradiance Monitor (SSIM) to obtain its daily observations between 165~1650nm.

Properties of SSIM

Channel	Spectral range	Spectral resolution	Wavelength accuracy	Absolute accuracy
UV	165-320 nm	1 nm	0.05nm	3%
VIS	285-700 nm	1 nm	0.05nm	2%
NIR	650-1650 nm	8 nm	0.1nm	2%