Long term monitoring of Total Solar Irradiance: Results and Challenges

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Introduction:
The role of solar forcing is not yet understood

Results:
- 30 years of TSI space observations
- Measurement of the absolute value of TSI

Challenge #1:
- Construct a TSI composite over 30 years

Challenge #2:
- Maintain TSI monitoring in the future!
Comparison irradiance forcing with ice ages

Illustration from Wikipedia
Climate anomalies
Temperature reconstruction

Uncertainty is large!
IPCC radiative forcing

LOSU
Level of Scientific Understanding
Since 1979 Total Solar Irradiance is measured from space
TSI from space experiments

Days (Epoch Jan 0, 1980)

TIM/SORCE

0  2000  4000  6000  8000

0.2%

78  80  82  84  86  88  90  92  94  96  98  00  02

ACRIM I

ACRIM II vers: 101001

ACRIM III vers: 062002

ERBS

VIRGO v5.004

HF

Total Solar Irradiance (Wm^{-2})

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TSI from space experiments

a) Original Data

4.5 W/m² difference in the absolute level of TIM/SORCE versus all other experiments
PICARD – a French Micro-satellite

PREMOS – Swiss radiometer on PICARD

Filter Radiometers

Total Solar Irradiance
PREMOS A is the first and so far only radiometer in space with a SI-traceable irradiance calibration in vacuum

Traceable to the irradiance calibration facility at LASP in Boulder (TRF)

- PICARD was launched June 15, 2010
- PREMOS first light was July 27th, 2010
The absolute value of the solar constant
... and the new PREMOS data
The Solar Constant

PREMOS/PICARD → The Solar Constant is 1361 W/m²

in agreement to the value from TIM/SORCE and (re-characterized) ACRIM3, which both were not SI-traceable calibrated

PICARD: French Micro-Satellite
There are three TSI composites.
TSI-composites normalized

Monthly mean: ACRIM, DIARAD, PMOD, PREMOS composites

PMOD, ACRIM

± 0.2 W/m² / 10-years

DIARAD

normalized 2004-2005


Date

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Is there a long-term trend?

Average of minima: 1365.442 ± 0.014 Wm⁻²
Difference of minima to average: +0.123; +0.070; −0.193 Wm⁻²
Cycle amplitudes: 0.928 ± 0.019; 0.919 ± 0.020; 1.039 ± 0.017 Wm⁻²

Could we detect a trend with a composite?

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Requirements for a TSI monitoring

„Any plan to rely on an unbroken chain of measurements is broken“

- Not only because of a potential gap;
- But mainly because of the continuously increasing uncertainty.

⇒ Accurate **absolute** measurements are required!
Presently, 4 operational space experiments observing TSI:
- VIRGO (launched 1995)
- ACRIM III (launched 2000)
- TIM (launched 2003)
- PREMOS (launched 2010)
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Several new missions with TSI instruments are in the planning …

... but no new mission is really approved so far!!
Thank you for your attention