Validity of Today’s Solar Irradiance Measurements to Future (100 Years) Climate Studies

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Sunspot Data Record

400 Years of Sunspot Observations

- Longest Observational Climate Record
- Instrumental Temperature Record

See:
- Hoyt and Schatten
- Frédéric Clette
- Leif Svalgaard

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2015 Sun-Climate Symposium
November 10, 2015
Committees and Reports of the 1980’s

Global Change: Impacts on Habitability
Richard Goody (Chairman), July 1982, Woods Hole (JPL, 1982)

Toward an International Geosphere-Biosphere Program
Herbert Friedman, NRC 1983

Earth System Science: A Program for Global Change
Francis Bretherton, ESSC, 1986 and 1988
Earth System Science: A Program for Global Change
Bretherton + 15 Others, 1988
Environmental Data Records (EDR’s)

EOS Instruments were designed to measure the following environmental variables:

- Cloud Properties
- Surface Temperature
- Elevation and mass of land ice and sea ice
- Accumulation and ablation of snow
- Circulation of the oceans
- Structure and motion of sea ice; growth, melting, and flow of glaciers
- Mineral composition of exposed soils and rocks
- Structure, composition, and dynamics of the atmosphere — winds, lightning, and precipitation
- Changes in stress and surface elevation around geological faults
- Exchange of energy, momentum and gases between the Earth’s surface and atmosphere
- Biological activity on land and in near-surface waters
- Input of solar radiation and energetic particles to the Earth

EDR — a time series of measurements of sufficient length, consistency, and continuity to determine climate variability and change. [NRC, 2004]
The Earth's Radiation and Energy Balance

Radiation Balance of the Earth (Jeffrey T. Kiehl)

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TSI Observations 1978 to 2003

W/m² $\Rightarrow$ Kg/m²s²/m²

1360 W/m² is 1.95 cal/cm²min
Full Solar Spectrum

![Graph showing the full solar spectrum with UV and SOLSTICE spectra highlighted.](image)
Achieving an Accurate TSI/SSI Observation

• GOAL # 1 — place the instrument on orbit with the best possible calibration (SI units) and characterization

• GOAL # 2 — Determine on-orbit changes in instrument responsivity, correct solar data

• GOAL # 3 — Establish a solar irradiance EDR that can be reliably compared to future observations
GOAL # 2 — Determine on-orbit and correct changes in instrument responsivity
Radiation Balance of the Earth (Jeffrey T. Kiehl)
Solar–Stellar Irradiance Comparison

Solar Irradiance

Eta UMa Irradiance (×10^9)

17,000 K
SOLSTICE Design

Solar Observation: Modified Monk-Gillieson Spectrometer

Diagram showing the setup of a modified Monk-Gillieson spectrometer with labeled components such as Camera Mirror, Entrance Slit, Solar Exit Slit, Photomultiplier Detector, and Diffraction Grating.
Stars at 170 nm

SOLSTICE G-Channel at 170 nm

Normalized Sensitivity

Exposure Time (days)

Version 14 Stellar Data
SORCE SOLSTICE Instrument
Achieving an Accurate TSI/SSI Observation

• GOAL # 1 — place the instrument on orbit with the best possible calibration (SI units) and characterization

• GOAL # 2 — Determine on-orbit changes in instrument responsivity, correct solar data

• GOAL # 3 — Establish a solar irradiance EDR that can be reliably compared to future observations
GOAL # 3 — solar irradiance EDR, is directly compared to other observations

UARS (1991-2005)

Trend?

1980
SC-21
1990
SC-22
2000
SC-23
2410
SC-60
2420