Changing of the Guard for the Total Solar Irradiance Record

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EGU 2020 (remote)

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The Total Solar Irradiance Record



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The Current Total Solar Irradiance Record

- The uninterrupted, 42year-long spaceborne TSI record includes contributions from more than 15 NASA, ESA, and NOAA instruments
 - The record continues to rely on continuity and stability
 - Improvements have been made to absolute accuracy
- We present updates on the four most recently operating instruments





Recent Instruments Contributing to the TSI Record

- VIRGO continues to operate but has not released new data since May 2018
- TCTE was decommissioned in July 2019
 - Data Dec. 2013 May 2019
- SORCE was decommissioned in Feb. 2020
 - Data Feb. 2003 Feb. 2020
- TSIS-1 is currently the only instrument acquiring and releasing TSI data

- Data Jan. 2018 - present





The SoHO/VIRGO Continues the Longest-Duration TSI Dataset

- Beginning in early 1996, the VIRGO now has the longest-duration measurement record
- The SoHO's L-1 observation location enables continual solar observations
 - This enables straightforward, unaliased power spectra of solar activity
- Data have not been updated since May 2018

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- Friend and long-time VIRGO PI, Claus Fröhlich, passed away in early 2019
- Data continue to be acquired and will hopefully be updated and released at some point



- The SORCE/TIM has better intrinsic stability than any other TSI instrument flown
 - This is due to a robust black metal NiP radiometer coating
- The SORCE/TIM provides one of the longest-duration TSI records
- Data available at <u>http://lasp.colorado.edu/home/sorce/data/tsi-data/</u>



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- Launched in 2003, the SORCE Total Irradiance Monitor (TIM) established the nowaccepted lower TSI value of 1361 W m⁻² (Kopp & Lean, GRL, 2011)
 - This was the result of a new and improved instrument design
 - Older instruments were retroactively adjusted downward

plots available at

http://spot.colorado.edu/~koppg/TSI



- The SORCE/TIM recorded the first measurement of a solar flare in TSI
 - This quantified the net radiative energy released by the flare



plot available at http://spot.colorado.edu/~koppg/TSI

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- The SORCE/TIM observed two Venus transits and four Mercury transits
 - These show transit signatures in addition to normal solar variability, indicating feasibility of Earth-like exoplanet detection in front of a Sun-like star via the transit method
 plots available at



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The TCTE/TIM Provided Data Redundancy and Continuity



- The TSI Calibration Transfer Experiment (TCTE) TIM provided measurement redundancy to connect the SORCE and the TSIS-1 in the event of a SORCE failure or TSIS-1 delay
 - The TCTE was commissioned, built, calibrated, and launched quickly after the launch failure of the NASA Glory mission in 2011 to maintain data continuity in the event of loss of the aging SORCE mission

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This instrument was nearly identical to the SORCE/TIM design

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Data available at <u>http://lasp.colorado.edu/home/tcte/data/</u>

LASP

- Helped confirm the lower TSI value established by the SORCE/TIM
 - The TCTE/TIM and the Picard/PREMOS were validated using the new ground-based TSI Radiometer Facility at LASP prior to launch
- The TCTE/TIM observed the 2016 Mercury transit



plot available at http://spot.colorado.edu/~koppg/TSI

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TSIS-1/TIM Is the Only TSI Instrument Currently Providing Data

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- Manifested on the ISS, TSIS–1/TIM data begin in Jan. 2018
- This instrument is the most accurate of any TSI instrument to date
 - Absolute accuracies <150 ppm (0.015%)
- Data available at

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<u>http://lasp.colorado.edu/home/tsis/data/tsi-data/</u>





Future TSI Measurement Plans

- Data updates from the VIRGO are anticipated
- Data from the NorSat–1/CLARA may become available in the future
- The PROBA–3/DARA is planned for launch in 2021
- The Compact TIM (CTIM), a CubeSat TSI instrument, will be ready for launch in 2021
- TSIS-2/TIM, a rebuild of the TSIS-1/TIM, is being prepared for a 2023 launch on a free-flyer



Total Solar Irradiance Missions

plot updated regularly at http://spot.colorado.edu/~koppg/TSI

