Poster Number: 322

Mitigating a Gap in Total Solar Irradiance Measurements Between the SORCE and TSIS Missions

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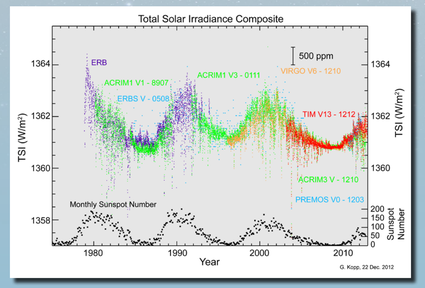
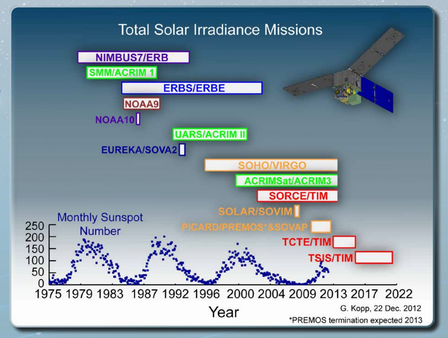
TCTE Will Sustain the Solar Climate Record

The Total Solar Irradiance (TSI) Climate Data Record (CDR) is critical for understanding Earth's climate variability. The TSI record extends forward from 1978 and is currently sustained with data from NASA's SOlar Radiation and Climate Experiment (SORCE). However, SORCE will likely fail prior to the launch of its successor, NOAA's Total Solar Irradiance Sensor (TSIS). This would create an observation gap that precludes the sensor-to-sensor inter-calibration required to sustain the climate record's long-term precision (stability, repeatability). To "bridge" the gap, the Joint Polar Satellite System (JPSS) will launch the TSI Calibration Transfer Experiment (TCTE) in 2013. The innovative TCTE mission leverages spare sensor components and a research flight of opportunity, and will help ensure the TSI CDR continues to grow in length and scientific value.



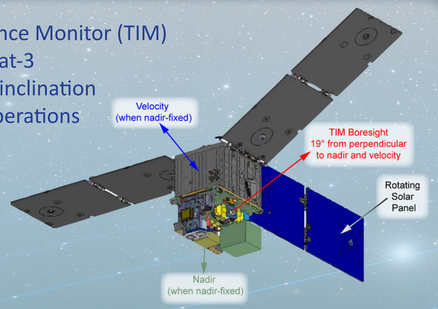
What Made a Measurement Gap So Likely?

NASA's Glory satellite was slated to sustain the TSI record after SORCE and before TSIS. When Glory failed on launch in 2011, the aging SORCE (launched 2003) remained the only viable system for continuing the TSI climate record. The likelihood of an observation gap between SORCE and TSIS grew when the TSIS launch was postponed to 2016 and as SORCE's batteries became increasingly unreliable.



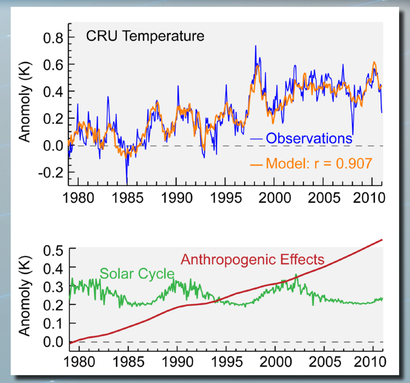
TCTE Mission Specifications

- Sensor: Total Irradiance Monitor (TIM)
- Satellite: USAF/STPSat-3
- Orbit: 500km, 45.5° inclination
- Extended mission operations (>1 yr): under study
- Planned Launch: August 2, 2013 from Wallops Island, Virginia via a Minotaur 1 rocket



Why Is the Solar Climate Record So Important?

TSI varies by about 0.1% over a solar cycle and plays a key role in climate variability. About 85% of surface temperature variability since 1980 can be explained by TSI and three other variables: anthropogenic greenhouse gases, natural and anthropogenic aerosols, and natural variability such as El Niño/La Niña[1]. Note the lack of warming over the past decade coincides with the declining solar irradiance phase of the current cycle.



Top: Monthly anomalies in global surface air temperature since 1980 estimated from observations (blue line) and an empirical model[3] (orange line following). Observations compiled by Climatic Research Unit of University of East Anglia.
Bottom: Model contributions from the solar cycle and anthropogenic effects.

Mitigating a TSI Measurement Gap

Kopp and Lean[2] assessed options for mitigating a measurement gap, such as using existing research satellites or solar models driven by ground or space observations. Although the impact of a measurement gap varies with its length, none of the mitigation methods studied could achieve the required stability (0.001%/yr). The TCTE mission, conceived in 2012, meets the requirements despite its unconventional sampling cadence.

	Instrument and Model Performance Estimates			
	Instrument	**Accuracy (ppm)**	**Stability (ppm per year)**	**Noise (ppm)**
Space-based Sensors	SORCE	350	10	4
	ACRIMSat/ACRIM3	1000	57	68
	SoHo/VIRGO	2500	23	28
	PICARD/PREMOS	350(7)	71	<42
	JPSS/TIM	100	10	10
Solar Models	NRL Model	NA	37	39
	SFO Model	NA	?	18

Errors from One and a Half Year TIM Data Gap with One Year Overlap Duration				
Instrument	**ACRIM**	**VIRGO**	**PREMOS**	**NRL Model**
Error (ppm)	123	53	152	81

TCTE Flight Phases

Phase a)

1) **SORCE and TCTE overlap period**
   - Should span >2 solar rotations (~50 days)
   - Minimum solar observation: once every other day
2) **Normal TCTE operations**
   - Minimum solar observation: once per week
3) **TCTE and TSIS overlap period**
   - Should span >2 solar rotations (~50 days)
   - Minimum solar observation: once every other day

References

1. Kopp, G., and J. L. Lean (2011), A new, lower value of total solar irradiance: Evidence and climate significance, *Geophys. Res. Lett.*, **38**, L01706, doi:10.1029/2010GL045777.
2. Kopp, G. and J. Lean (2011), *Uncertainties Spanning Potential SORCE/TIM to JPSS/TIM Gap*. Available upon request from NOAA's National Climatic Data Center (NCDC), Asheville, North Carolina.
3. Lean, J. L., and D. H. Rind (2009), How will Earth's surface temperature change in future decades?, *Geophys. Res. Lett.*, **36** , L15708, doi:10.1029/2009GL038932.

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Protecting the past... Revealing the future

January 2013