Technical Note on CERES EBAF Ed2.7
TOA Incident Shortwave Radiation (rsdt)

1. Intent of This Document and POC

1a) This document is intended for users who wish to compare CMIP5/IPCC historical climate model output with satellite-derived observations. Users are not expected to be experts in satellite-derived Earth system observational data. This document summarizes essential information needed for comparing this dataset to climate model output. References are provided at the end of this document to additional information.

This NASA dataset is provided as part of an experimental activity to increase the usability of NASA satellite observational data for the modeling and model analysis communities. This is not a standard NASA satellite instrument product, but does represent an effort on behalf of data experts to identify a product that is appropriate for routine model evaluation. The data may have been reprocessed, reformatted, or created solely for comparisons with climate model output. Community feedback to improve and validate the dataset for modeling usage is appreciated. Email comments to HQ-CLIMATE-OBS@mail.nasa.gov.

Dataset File Name (as it appears on the ESGF):

rsdt_CERES-EBAF_L3B_Ed2-7_200003-201304.nc

1b) Technical point of contact for this dataset:

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2. Data Field Description

CF variable name, units:	TOA Incident Shortwave Radiation (rsdt), W m^{-2}
Spatial resolution:	1°x1° latitude by longitude
Temporal resolution and extent:	Monthly averaged from 03/2000 to 04/2013
Coverage:	Global

3. Data Origin

The CERES science team provides monthly regional mean TOA incident shortwave radiation derived from the Total Solar Irradiance (TIM) instrument aboard the Solar Radiation and Climate Experiment (SORCE) satellite. The TIM instrument measures the absolute intensity of solar radiation, integrated over the entire solar disk and the entire solar spectrum reported at the mean solar distance of 1 astronomical unit (AU). The SORCE spacecraft was launched on January 25, 2003 and became operational on February 25. It launched into a 645 km, 40° orbit and is operated by the Laboratory for Atmospheric and Space Physics (LASP) at the University of Colorado (CU) in Boulder, Colorado, USA. The CERES product uses the daily fluxes from the SORCE web site at:
`http://lasp.colorado.edu/sorce/tsi_data/daily/sorce_tsi_L3_c24h_latest.txt` that begin on February 25, 2003. The daily fluxes are updated from this site on a regular basis, and there usually is a 2-month data lag from real-time. From March 2000 until February 24, 2003 the composite_d41_62_0906.dat dataset from Fröhlich and Lean (1998) is used with an offset value

of -4.4388599 W m^{-2} to put the daily fluxes on the same radiometric scale as SORCE. These are available from: ftp://ftp.pmodwrc.ch/pub/data/irradiance/composite/. The Fröhlich and Lean fluxes are derived from six independent space-based radiometers since 1978 using overlap time periods to normalize the fluxes to a common reference. The fluxes are observed from the Hickey-Frieden (HF), Active Cavity Radiometer Irradiance Monitor (ACRIM 1, II and III), Earth Radiation Budget Satellite (ERBS), and Variability of solar Irradiance and Gravity Oscillations (VIRGO) missions. The basis for 2000-2003 was mainly from VIRGO. Figure 1 displays the SORCE data in red and the pre-SORCE solar irradiance records adjusted to SORCE composite daily fluxes in blue. On the rare occasion that the daily flux is missing it is linearly interpolated from the nearest daily measurements. The CERES EBAF dataset (the basis of the present data) uses daily varying SORCE-TIM TOA solar incoming irradiances. The mean TOA solar irradiance from SORCE-TIM is ~1361 W m^{-2}. Earlier versions of CERES and Earth Radiation Budget Experiment (ERBE) assumed a constant solar irradiance of 1365 W m^{-2}.

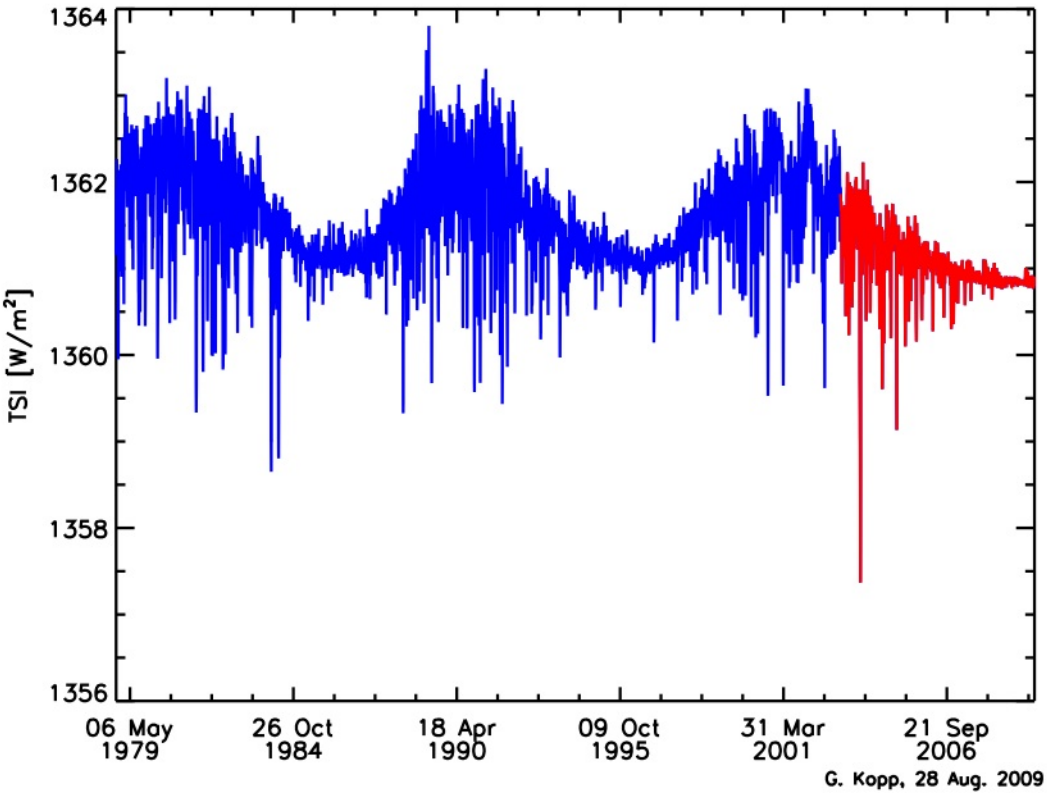

Figure 1. The Fröhlich and Lean (1998) composite TOA solar incoming fluxes in blue and the SORCE TIM daily fluxes in red beginning on February 25, 2003.

To compute the solar incoming irradiance for a given region as a function of time, CERES uses JPL DE200 to compute the daily earth-sun distance and the Consultative Committee for Space Data Systems CCSDS 301.0-B-2 (1994) almanac to compute the daily solar declination angle and sidereal day or right ascension or hour angle. The CCSDS database can be downloaded at http://public.ccsds.org/publications/SilverBooks.aspx and the JPL DE200 at http://heasarc.nasa.gov/listserv/heafits/msg00050.html. The regional solar zenith angle or solar insolation is then computed analytically, as referenced in Liou (1980).

CERES uses geodetic weighting to average the zonal fluxes into a global mean. This assumes the earth is an oblate spheroid with an equator radius of 6378.137 km and polar radius of 6356.752 km. This increases the annual global incoming solar flux by 0.29 W m^{-2} over weighting assuming a spherical earth (Loeb et al. 2009).

4. Validation and Uncertainty Estimate

The TIM Total Solar Irradiance (TSI) measurements monitor the incident sunlight to the Earth's atmosphere using an ambient temperature active cavity radiometer. Using electrical substitution radiometers (ESRs) and taking advantage of new materials and modern electronics, the TIM measures TSI to an estimated absolute accuracy of 350 ppm (0.035%). Relative changes in solar irradiance are measured to less than 10 ppm/yr (0.001%/yr), allowing determination of possible long-term variations in the Sun's output (Kopp et al. 2005).

5. Considerations for Model-Observation Comparisons

The solar incoming TOA flux is derived from daily SORCE TIM measurements, which has an average annual flux of ~1361 W m^{-2}, varies with time, and takes into account the solar sunspot cycle with an amplitude of ~0.1%.

6. Instrument Overview

The first paragraph under section 3 gives an overview of the SORCE TIM instrument.

7. References

The full version of CERES EBAF Ed2.7 is available from the following ordering site:

http://ceres.larc.nasa.gov/order_data.php

Fröhlich, C., and J. Lean, 1998: The Sun's total irradiance: Cycles, trends and related climate change uncertainties since 1976. *Geophys. Res. Lett*., **25**(23), 4377-4380.

Kopp, G. and G. Lawrence, 2005: The Total Irradiance Monitor (TIM): Instrument design. *Sol. Phys.*, **230**, 91-109.

Liou, Kuo-Nan, 1980: *An introduction to atmospheric radiation*. Academic Press, 392 pp.

Loeb, N. G., B. A. Wielicki, D. R. Doelling, G. L. Smith, D. F. Keyes, S. Kato, N. Manalo-Smith, T. Wong, 2009: Toward optimal closure of the Earth's top-of-atmosphere radiation budget. *J. Climate*, **22**, 748-766, doi:10.1175/2008JCLI2637.1.

8. Dataset and Document Revision History

Rev 0 – 09 Aug 2011 – This is a new document/dataset

Rev 1 – 05 Mar 2012 – Updated to Edition2.6r. EBAF Ed2.6r corrects a code error in the calculation of global mean quantities in EBAF Ed2.6. Also updates temporal extent to 06/2011 from 12/2010.

Rev 2 – 06 Jun 2012 – Updated temporal extent to 12/2011 from 06/2011.

Rev 3 – 01 Nov 2012 – Updated temporal extent to 06/2012 from 12/2011.

Rev 4 – 28 Aug 2013 – Updated to Edition2.7. No change from Edition2.6r. Updated temporal extent to 02/2013 from 06/2012.

Rev 5 – 18 Sep 2013 – Updated temporal extent to 04/2013 from 02/2013.