P6.6 **The NASA/GEWEX Surface Radiation Budget Dataset**

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1. INTRODUCTION

Radiative fluxes at the Earth's surface are major components of the surface energy budget, and are as important for the studies of weather and climate phenomena as radiative fluxes at the top-of-atmosphere (TOA). These fluxes play an important role in atmospheric and oceanic general circulation (Suttles and Ohring 1986). Developing long time series of surface radiation budget (SRB) parameters is essential to accomplishing the objectives of a number of World Climate Research Program (WCRP) projects, such as the Global Energy and Water-cycle Experiment (GEWEX). Under the sponsorship of the WCRP/GEWEX Radiation Panel, a 12-year-plus (July 1983 to October 1995) global dataset of shortwave (SW) and longwave (LW) SRB parameters on a 1°x1° grid has been developed as a part of the NASA/GEWEX Surface Radiation Budget Project (Stackhouse et al. 2002) at the NASA Langley Research Center (LaRC). Together with radiation budget measurements at the TOA and inferred flux divergences at several levels within the atmosphere produced under NASA's Clouds and the Earth's Radiant Energy System (CERES; Wielicki et al. 1996) project, SRB datasets help provide a complete picture of radiative processes in the atmosphere. In addition, SRB datasets are finding increasing use in renewable energy, architecture, and agriculture industries.

2. RADIATION MODELS AND INPUT DATA

Since SRB cannot be directly measured by satellite-borne sensors, surface fluxes are generally derived with radiation algorithms using meteorological inputs from satellite measurements and/or other operational sources. The NASA/GEWEX SRB (hereafter GEWEX/SRB) project makes use of two sets of algorithms. One set of SW and LW algorithms is designated as primary, and the other set designated quality-check as follows: the primary SW algorithm is Pinker and Laszlo (1992); the primary LW algorithm is an adaptation of Fu et al. (1997) by P. Stackhouse; the quality-check SW algorithm is known as the Langley Parameterized Shortwave Algorithm (LPSA; Gupta et al. 2001); and the quality-check LW algorithm is Gupta et al. (1992). For detailed descriptions of these algorithms, the reader is referred to the references cited above. All except the quality-check SW algorithm provide 3-hourly fluxes which are then averaged to daily, monthly/3-hourly, and monthly products. The quality-check SW algorithm provides daily fluxes only which are also averaged into monthly values.

Meteorological inputs for this project were obtained from many satellite data archives and data assimilation products. Cloud properties were derived on a 1°x1° resolution using International Satellite Cloud Climatology Project (ISCCP; Rossow and Schiffer 1991) pixel-level (DX) datasets. Other meteorological input, namely, the temperature and humidity profiles were taken from GEOS-1 reanalysis product of the Global Modeling and Assimilation Office at NASA Goddard Space Flight Center (GSFC). Ozone data were obtained from the Total Ozone Mapping Spectrometer (TOMS) archive.

3. RESULTS AND DISCUSSION

A brief description of the temporal and spatial distributions and averages of a few SRB parameters is presented below. Because of the size limitation of this abstract, results from the primary SW and LW algorithms only will be presented here.

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3.1 *Distributions and Averages*

The time series of hemispheric and global averages of downward SW and LW fluxes (hereafter DSF and DLF respectively) are presented in Figs. 1a and 1b respectively. These figures show seasonal cycles and interhemispheric differences of the fluxes. In Fig. 1a, the amplitude of the seasonal cycle for the Southern Hemisphere (SH) is slightly greater than for the Northern Hemisphere (NH). This is related to the annual variations of the Sun-Earth distance (smallest in January) and water vapor abundance in the two hemispheres (much higher in the NH during NH summer). The LW time series (Fig. 1b) show that seasonal cycle amplitude for the NH is much greater than for the SH. This is related to the facts that both surface temperature and water vapor abundance show much larger annual variation in the NH than in the SH.

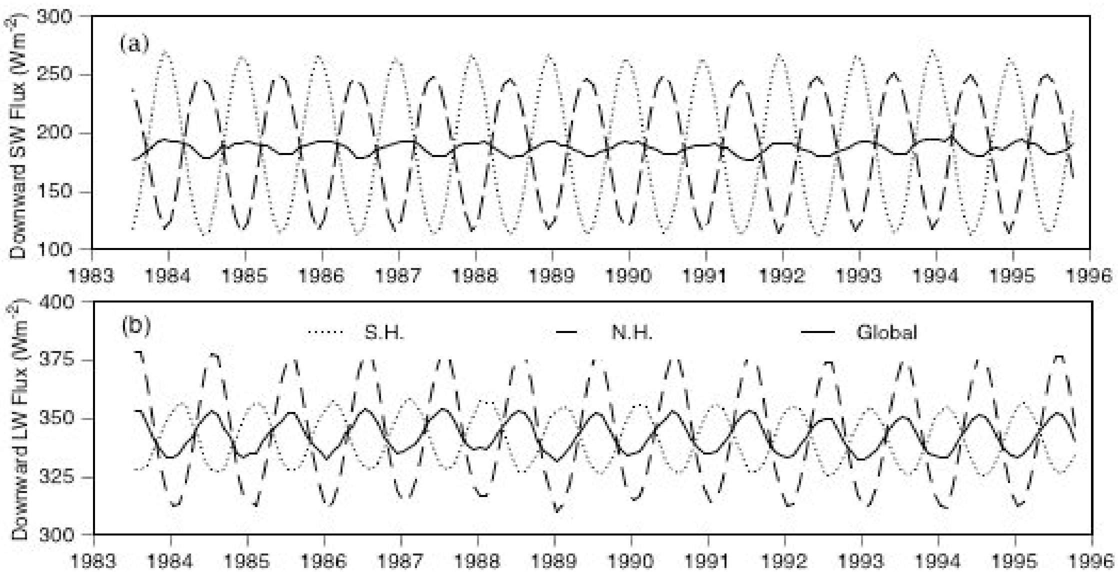

Fig. 1. Time series of monthly average downward fluxes (a) shortwave and (b) longwave for the period Jul1983-Oct1995 produced under the GEWEX/SRB project.

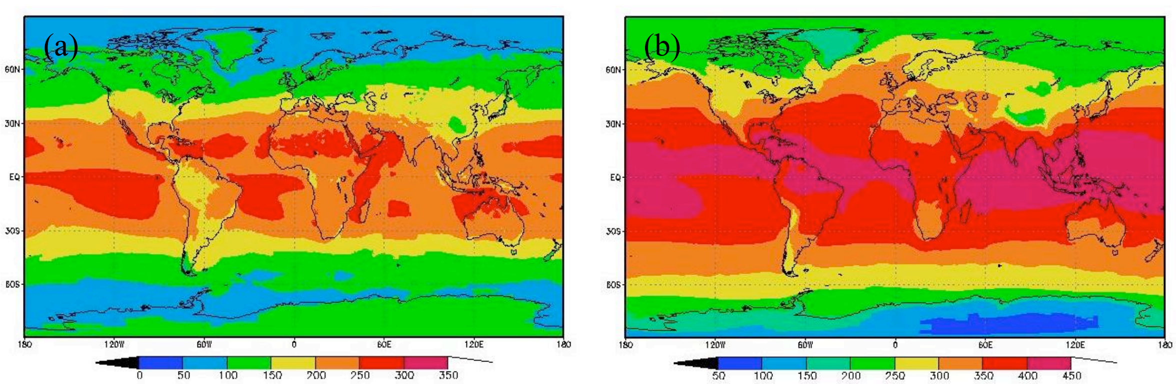

Fig. 2. Twelve-year averages of (a) DSF and (b) DLF .

The panels (a) and (b) of Fig. 2 show geographical distribution of the 12-year (Jul1983-Jun1995) averages of DSF and DLF respectively. These figures show flux distributions which can be reasonably understood in terms of the underlying temperature, water vapor, and cloudiness. Zonal averages of downward and net fluxes for the same 12-year period are shown in Figs. 3a and 3b.

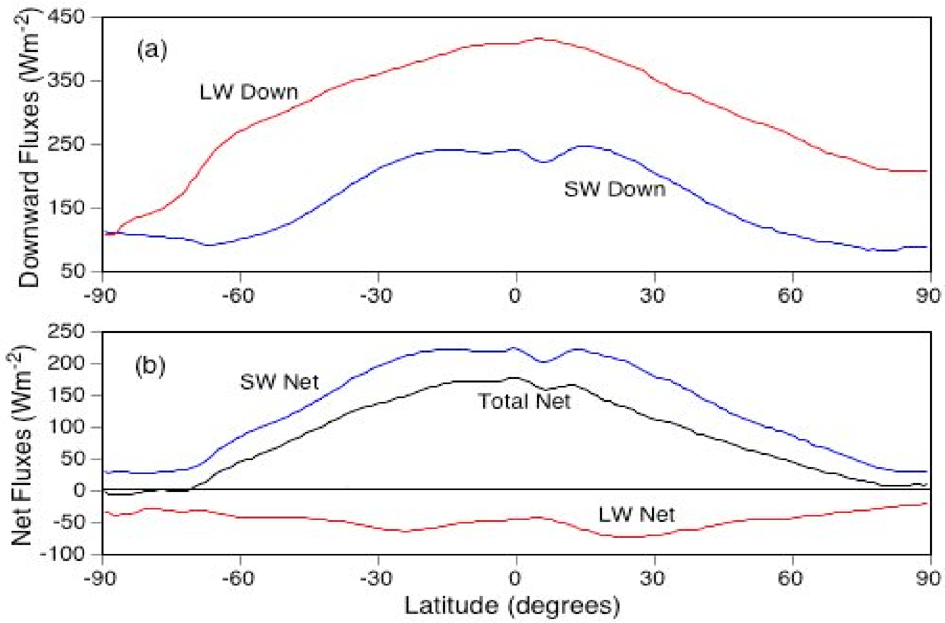

Fig. 3. Twelve-year zonal average fluxes (a) downward and (b) net.

3.2 *Validation*

Surface fluxes derived in this project were validated primarily with ground-based measurements obtained from the Baseline Surface Radiation Network (BSRN). This high-quality network of ground stations began operation in 1992 with 8-10 stations in diverse climate regimes around the globe. The number of stations has steadily increased over the years. Comparisons of monthly average DSF and DLF with BSRN data for the 1992-1995 period are presented in Figs. 4a-c, where ground-measured fluxes are shown on the x-axis and the model-derived fluxes on the y-axis. Fig. 4a shows DSF comparison for all BSRN stations. Even though the bias in this comparison is not high, a large part of it is coming from polar stations of the network. These include stations at the South Pole, on the Antarctic coast, and Ny Alesund in the Arctic region. When points from these stations are excluded from the comparison, the DSF bias goes down considerably as shown in Fig. 4b. Corresponding DLF comparison for all stations is presented in Fig. 4c. Excluding points from the polar sites in this comparison had a very small effect on the bias. Similar comparisons at other temporal resolutions, namely, 3-hourly, daily, and monthly/3-hourly were also made, but those results are not presented because of space limitation.

3.3 *Interannual Variability*

An analysis was undertaken to examine the signature of interannual phenomena like El Nino and La Nina episodes in this dataset. Two El Nino episodes which peaked respectively in May 1987 and March 1992, and a La Nina episode which peaked in July 1988 occurred during the period of this dataset. Anomalies of DSF, DLF, and total cloud amount over tropical Pacific ocean (20N-20S; 120E-120W) for the March 1992 El Nino episode are shown in Fig. 5. These are shown as fields of the difference for each variable between March 1992 and 12-year average for March. These anomalies are found to be nearly opposite over the western (120E-Dateline) and the eastern (Dateline-120W) Pacific regions. The flux anomalies appear to be driven primarily by cloud amount anomalies. Positive cloud amount anomaly in the eastern Pacific gives rise to a positive anomaly in DLF and a negative anomaly in DSF. The effects in the western Pacific are nearly opposite. Corresponding anomalies were derived for the May 1987 El Nino and the July 1988 La Nina also, but the results are shown here.

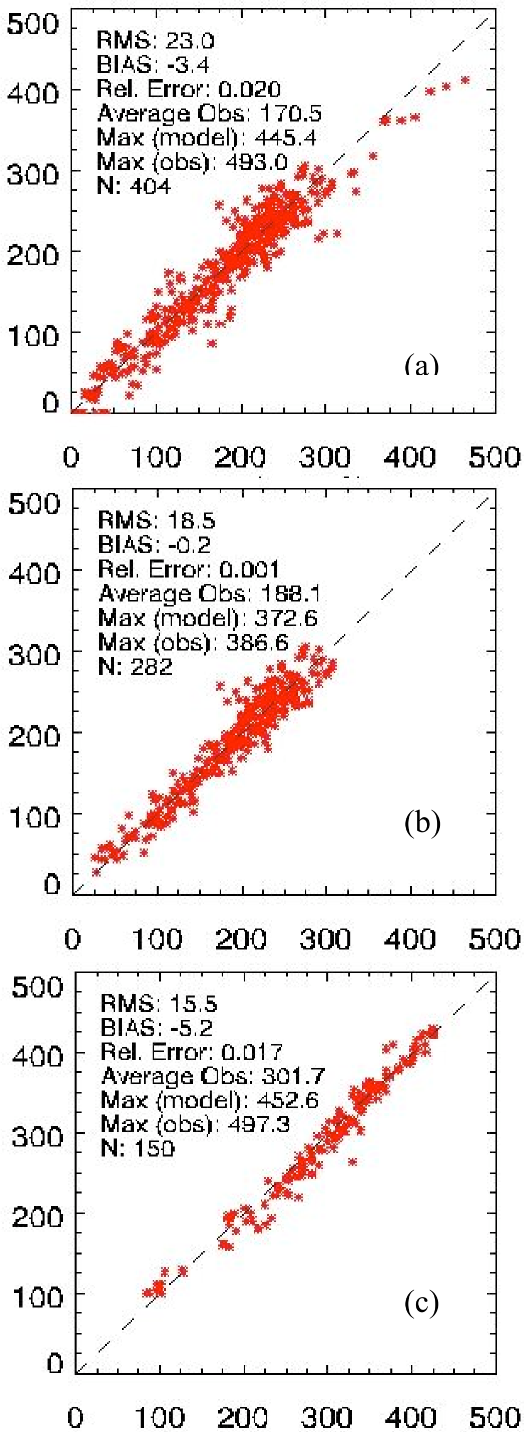

Fig. 4. Comparisons of monthly average DSF and DLF with BSRN data for the 1992-1995 period. Panel (a) shows DSF comparison including polar stations; panel (b) is for DSF excluding polar station; and panel (c) is for DLF for all stations.

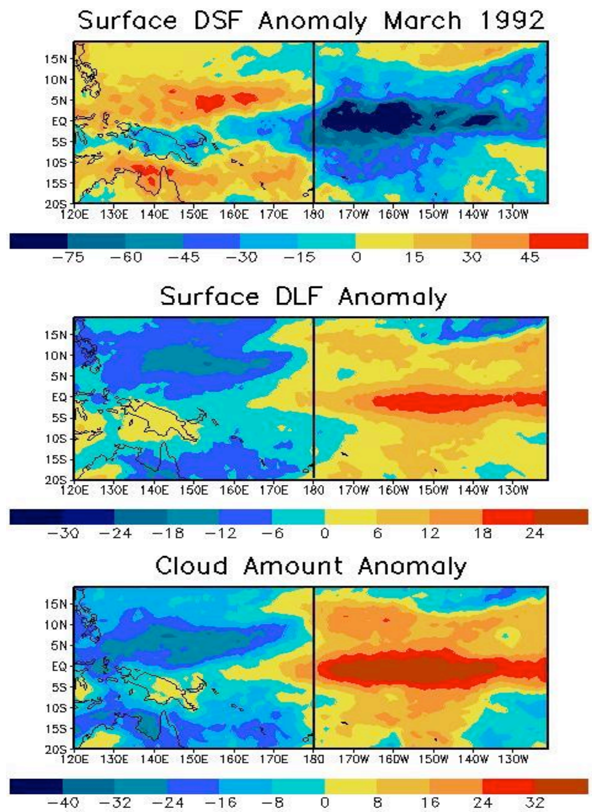

Fig. 5. Anomalies of total cloud amount, DSF, and DLF over tropical Pacific Ocean for the El Nino episode which peaked in March 1992.

4. CONCLUDING REMARKS

A 12-year-plus (Jul1983-Oct1995) global data set of SRB parameters on a 1°x1° grid has been developed using two sets of SW and LW algorithms. One set is designated as primary, and the other as quality-check. All except the quality-check SW algorithm provide initial results on a 3-hourly temporal resolution which are then processed into daily, monthly/3-hourly, and monthly averages. The quality-check SW results are initially produced on a daily resolution and processed into monthly averages. For the 1992-1995 period, downward SW and LW fluxes were compared with ground-based measurements from BSRN stations on all time scales even though only monthly average comparisons are presented here. Mean bias was found to be between 0 to –5 Wm^{-2} and random error between 15-20 Wm^{-2}. The dataset exhibited interannual variability related to ENSO episodes which occurred within its period.

5. FUTURE PLANS AND DATA AVAILABILITY

Efforts are underway to extend this dataset to the present and beyond in step with the availability of the ISCCP data. Also, newer reanalysis products (e.g., GEOS-4 in place of GEOS-1) are already being used where new products are available. All algorithms are being improved based on experience gained with them so far.

This dataset is identified as SRB Release 2 and is available to the worldwide science community form the Atmospheric Sciences Data Center (ASDC) at NASA/LaRC from the website:

http://eosweb.larc.nasa.gov/PRODOCS/srb/table_srb.html

All files of this dataset have a prefix 'SRB_REL2' in their names. Also 'README' files containing useful documentation and codes for regridding the fields to a true 1°x1° grid are available from the above website. Note that the original fields are on an equal-area grid.

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