

Surface Radiative Budget (SRB) Project

Reporting Period: October 2005 – August 2006

Starting Date: Circa 1985

URL: <http://gewex-srb.larc.nasa.gov>

Chair: Paul W. Stackhouse, Jr., NASA Langley Research Center

Overview

The GEWEX Surface Radiation Budget was instituted to process satellite data sets and produce estimates of the Earth's surface radiation budget on a long-term basis. The goal is to produce surface radiative flux time series accurate enough to determine surface radiation budgets and assess variability from global to regional horizontal scales and from decadal to diurnal time scales. To that end, the SRB project has aided in the calibration of ISCCP and produced several data sets, the latest being released this year. SRB plays an interactive role with other GEWEX projects using cloud and radiance data products from ISCCP, comparing surface flux data sets to BSRN measurements and providing data sets to ISLSCP and GPCP. SRB also computes Top-of-atmosphere fluxes and compares to ERBE and will continue to compare with new CERES surface and top-of-atmosphere flux products. With the latest data set and with a group of researchers involved in the measurement and estimation of surface radiation fluxes, the SRB project will play a prominent role in the newly initiated GEWEX Radiation Panel Radiative Flux Assessment activity. This activity will serve to assess currently available surface radiation data sets and will lead to the identification of uncertainties required to address long-term changes in the Earth's radiation budget. The current status, recent accomplishments, planned work are summarized below.

Status

GEWEX SRB has completed the following since October 2005:

- Produced and archived a 21.5+ year (258 months) SRB Release 2.5 data set spanning July 1983 – December 2004 for the GEWEX LW, SW Quality Check (QC), and LW QC flux algorithms. 3-hourly, monthly averaged 3-hourly, daily averaged and monthly averaged data sets are now available at the NASA Langley Atmospheric Sciences Center (ASDC).
- Reprocessed the 21.5 year GEWEX SW v2.5 version twice owing to discovery of faulty assumptions and code errors. The latest version is v2.7 and this version is to be archived within the next month.
- Processed ISCCP DX for all codes for Jan. - June 2005 and these data will be added to the archive within a month.
- Prepared and delivered data products for the GEWEX Radiative Flux Assessment project.
- Delivered data sets to several users and contributed to several scientific papers.
- Compared latest gridded flux products to CERES and ISCCP-FD TOA and surface radiative fluxes.
- Continued to make improvements in the flux algorithms and this work is ongoing.

New Directions

The following tasks are expected for 2006-2007:

- **Archival:** Complete archival of v2.5/ SW v2.7 for flux and cloud/ancillary 3-hourly data set containing inputs to SRB processing codes.
- **Processing:** Update archive as ISCCP continues processing
- **Validation/Intercomparison activities:** Continue and extend validation and intercomparison of surface and TOA flux estimates against satellite and surface measurements. Extend intercomparisons between other surface and TOA flux datasets such as: CERES SARB/SOFA, ISCCP-FD, etc. Also, extend surface analysis to direct, diffuse, and PAR fluxes with an emphasis of validating under various sky conditions. Continue time series analysis relative to surface measurement time series of GEBA and BSRN. A new emphasis on polar fluxes validation will be made.

- **Algorithm Upgrade Activities:** Under a newly submitted research proposal several activities have been proposed including with the goal of a general reprocessing towards 2008-2009. For the next year these include:
 - Develop improved parameterizations for conversion of narrow-band radiance to flux in GEWEX SW model using new CERES information in collaboration with Dr. Rachel Pinker of U. of Md.
 - Improve surface spectral albedo and emissivity properties in collaboration with U. of Md. and NASA GISS.
 - Improve aerosol treatment in SW and LW codes in collaboration with NASA GSFC and GISS
 - Improve various cloud and boundary layer assumptions in the GEWEX LW code.
- **Radiation Flux Assessment:** Data products and expertise from the SRB project will contribute significantly to the GRP Radiation Flux Assessment working group activity towards a systematic report in 2007.
- **Web-based Products and Analysis:** Upgrade SRB web site. Provide datasets to “My NASA Data” live access server and look into contributing data sets for NASA GSFC “GIOVANNI” package.

Key Results

- Bias and RMS difference compared to BSRN, World Radiation Data Centre (WRDC) and Global Energy Balance Archive (GEBA) have been reduced in the latest versions. In particular, SW differences for monthly averaged 3-hourly RMS differences were reduced by nearly 20 W m^{-2} between V2.0 and V2.7. LW monthly mean differences with BSRN measurements (1992-1995) were reduced from -4 W m^{-2} to within $+0.5 \text{ W m}^{-2}$ using GEOS-4 meteorological input.
- Time series analysis using both GEBA and SRB fluxes over 19 years gave slope changes within uncertainties but it was demonstrated that the rate of change of the fluxes required a longer time series to satisfy 95% probability that the slope was statistically significant. TOA anomalies agree well with ERBE/CERES and ISCCP-FD.
- SRB TOA and surface fluxes were found to be within the range of variation between CERES, ISCCP-FD, NCEP, and ERA-40. Global annual average surface SW and LW fluxes showing good agreement with ISCCP-FD within a $2\text{-}3 \text{ W m}^{-2}$. Differences observed in monthly averages quantities showed large differences and will merit continued study and assessment.

Issues and Recommendations

1. The World Radiation Data Centre surface radiometer collection database of the WMO and GAW still have not been able to make data readily available in large quantities and long-time series after 1993. However, additional funding for this purpose has evidently been obtained by the World Radiation Data Centre in St. Petersburg to rectify this situation.
2. A renewal proposal was submitted for review in FY2006. Survival of the project as it exists today through NASA support depends upon the outcome of the subsequent review and decision process.

Summary

This past year GEWEX SRB has continued to improve, assess and validate TOA and surface radiation parameters. SRB has and is contributing to the GEWEX Radiation Flux Assessment project. The work and the resulting data sets completed by the SRB team has been included in nine known submitted journal articles two of which (Raschke et al., 2006 and Zhang et al., 2006) are already published and four others “in press” (see complete references below). Nine SRB team presentations and posters have been made at major conferences and 5 SRB presentations have been made at meetings and GEWEX related conferences since Oct. 2005. SRB presentations are scheduled for this year’s GRP and GRP WGDMA meetings.

Reference List:

Fotiadi, A., N. Hatzianastassiou, P.W. Stackhouse, Jr., C. Matsoukas, E. Drakis, K.G. Pavlakis, D. Hatzidimitriou, I. Vardavas, 2006: Spatial and temporal distribution of long-term solar

surface radiation budget over Greece. (accepted to *Quarterly Journal of Royal Meteorological Society*)

- Hatzianastassiou, N., C. Matsoukas, A. Fotiadi, E. Drakakis, P. W. Stackhouse Jr, P. Koepke, K. G. Pavlakis, D. Hatzidimitriou, I. Vardavas, 2006: Modelling the Direct Effect of Aerosols in the Near Infrared on Planetary Scale. (submitted to *Atmospheric Chemistry and Physics (ACP)*).
- Koster, R., B.M. Fekete, G.J. Huffman and P.W. Stackhouse, 2006: Revisiting a Hydrological Analysis Framework with ISLSCP-2 Rainfall, Net Radiation, and Runoff Fields (in press to *JGR*)
- Matsoukas, C., A. C. Banks, N. Hatzianastassiou, K.G. Pavlakis, D. Hatzidimitriou, E. Drakakis, P.W. Stackhouse, and I. Vardavas, 2005: The seasonal head budget of the Mediterranean Sea. (in press, *J. Geo. Res.*)
- Matsoukas, C., A. C. Banks, K. G. Pavlakis, N. Hatzianastassiou, D. Hatzidimitriou, E. Drakakis, P. W. Stackhouse, and I. Vardavas, 2006: The seasonal heat budget of the Red and Black Seas (submitted to *JGR Oceans*).
- Raschke, E., S. Bakan, and S. Kinne, 2006: An assessment of radiation budget data by ISCCP and GEWEX-SRB. *Geophys. Res. Lett.*, **33**, LO7812, doi:10.1029/2005GL025503
- Yang, Kun, Toshio Koike, Paul Stackhouse, Colleen Mikovitz, 2006: Assessment of satellite surface radiation budget radiation products in highland regions with Tibet instrumental data (submitted to *GRL*)
- Zhang, B., R. T. Pinker, and P.W. Stackhouse, Jr., 2005. An EOF Iteration approach for obtaining homogeneous radiative fluxes from satellite observations. (in press to the *J. of Applied Meteorology*)
- Zhang, Y., W. B. Rossow, and P. W. Stackhouse, Jr. (2006), Comparison of different global information sources used in surface radiative flux calculation: Radiative properties of the near-surface atmosphere, *J. Geophys. Res.*, **111**, D13106, doi:10.1029/2005JD006873.

SRB project related conference papers/presentations:

- Cox, S. J., P.W. Stackhouse, Jr., S.K. Gupta, J. C. Mikovitz, T. Zhang, L. Hinkelman, M. Wild, and A. Ohmura, 2006: The NASA/GEWEX Surface Radiation Budget Project: Overview and Analysis. 12th Conference on Atmospheric Radiation, American Meteorological Society, Madison WI, July 10-14.
- Gupta, S.K., P.W. Stackhouse, Jr., S. J. Cox, J. C. Mikovitz, T. Zhang and L. Hinkelman, 2006: The NASA/GEWEX Surface Radiation Budget Dataset. American Geophysical Union, 22-26 May, Baltimore, Md.
- Gupta, S. K., P. W. Stackhouse, Jr., J. C. Mikovitz, S. J. Cox, and T. Zhang, 2006: Surface radiation budget over Pacific and Atlantic: Interannual Variability. In Proceedings of the 12th conference on atmospheric radiation. Madison, WI, July 10-14.
- Hinkelman, L. M., T. Zhang, B. Weatherhead, B. A. Wielicki, P. W. Stackhouse Jr., J. C. Mikovitz, M. Wild, and A. Ohmura, 2006: Detection of global energy budget trends using satellite and surface sites: is the current surface site distribution sufficient? In Proceedings of the 12th conference on atmospheric radiation. Madison, WI, July 10-14.
- Mikovitz, J. C., P. W. Stackhouse, Jr., S. K. Gupta, T. Zhang, S. J. Cox, D. R. Doelling, D. F. Keyes, and L. M. Hinkelman, 2006: A Comparison of Surface Flux Products From GEWEX Surface Radiation Budget With ECMWF ERA-40, NCEP/NCAR Reanalysis and CERES SRBAVG. In Proceedings of the 12th conference on atmospheric radiation. Madison, WI, July 10-14.
- Mlynczak, P. E., G.L. Smith, P.W. Stackhouse, Jr., S.K. Gupta, 2006: Diurnal Cycles of the surface radiation budget data set. 18th Conference on Climate Variations. American Meteorological Society, Atlanta, GA, 29 January – 2 February.
- Wilbur, A.C., G.L. Smith, P.W. Stackhouse and S.K. Gupta, 2006: Annual cycle of cloud forcing of the surface radiation budget. In Proceedings of the 12th conference on atmospheric radiation. Madison, WI, July 10-14.
- Zhang, T., P. W. Stackhouse, Jr., S. K. Gupta, S. J. Cox, J. C. Mikovitz, and L. M. Hinkelman, 2006: Long-term validation and variability of the shortwave and longwave radiation data of

the GEWEX Surface Radiation Budget (SRB) project. In Proceedings of the 12th conference on atmospheric radiation. Madison, WI, July 10-14.

SRB project related presentations at workshops/meetings

GRP Working Group for Data Management and Analysis (WGDMA), Nov. 2005

GEWEX-RFA Workshop, Feb. 2006 (2 presentations)

CERES Science Team Meeting, May 2006

BSRN Scientific Working Group, May 2006