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Dome Degradation Characterization of Wide-Field-of-View Nonscanner aboard ERBE and its Reprocessing

Alok K. Shrestha^{1,2}, Seiji Kato², Takmeng Wong², Wenying Su², Paul W Stackhouse², Fred Rose^{1,2}, Walter F. Miller^{1,2}, Kathryn Bush^{1,2}, David A. Rutan^{1,2}, Patrick Minnis², David Doelling², and George L. Smith^{1,2}

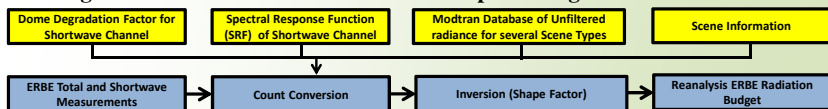
NASA Langley Research Center
Hampton, VA



Introduction

Earth Radiation Budget Experiment (ERBE) wide-field-of-view (WFOV) nonscanners aboard ERBS and NOAA-9/NOAA-10 provided broadband shortwave and longwave irradiances from 1985 to 1999. The previous analysis showed dome degradation in the shortwave nonscanner instruments. The correction was performed with a constant spectral (gray assumption) degradation. We suspect that the gray assumption affected daytime longwave irradiance and led to a day-minus-night longwave flux differences (little change in night time longwave) increase over time. Based on knowledge from the CERES process, we will reprocess entire ERBE nonscanner radiation dataset by characterizing shortwave dome transmissivity with spectral dependent degradation using the solar data observed by these instruments. Once spectral dependent degradation is derived, imager derived cloud fraction and the cloud phase as well as surface type over the FOV of nonscanner instruments will be used to model unfiltering coefficients. This poster primarily explains the reprocessing techniques and includes initial comparison of several months of data processed with existing and our recent methods.

Flow diagram of ERBE WFOV Nonscanner data processing



Previous Results (Analysis) (Wong et. al., 2005, Journal of Climate, Vol 19, PN 4028-4040)

- Figure 3 shows the time series of 36-day averaged (reduce diurnal aliasing) tropical mean (20° NS) ERBS nonscanner WFOV irradiances derived from Edition3 datasets. The nighttime LW is nearly constant while the daytime LW has increased significantly over the same period resulting in increased day-minus-night LW difference over time. This suggests that the WFOV total channel is stable over time, but the WFOV SW channel has drifted slightly over the same period.
- Degradation of SW dome over time reduces WFOV SW irradiance. Because daytime LW is derived by daytime total minus SW, the daytime LW irradiance increases. The total channel does not degrade because it has no dome.

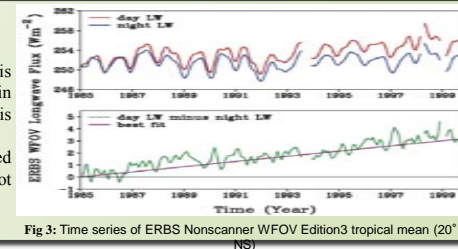


Fig 3: Time series of ERBS Nonscanner WFOV Edition3 tropical mean (20° NS)

Recent Analysis/Results

- We reprocessed four months (Jan, Mar, Jul, Oct) of ERBS nonscanner data for each year from 1985 through 1993 on X86 machine (earlier was processed by a SUN) using the new approach to generate S7 dataset. The S7 dataset provides irradiance for every footprints.
- The shortwave and longwave monthly mean irradiance over tropics (20° NS) is estimated from both new and old S7 data products. The time series of differences of these monthly means are evaluated.
- The spectral correction is expected to increase the SW, thus decreases daytime LW irradiances. As expected, differences are small for the nighttime longwave, which is caused by processing on different machines (not shown).

- To remove the effect of the ERBE WFOV nonscanner shortwave dome response, we use MODTRAN to characterize reflected spectral radiances for many earth scenes. These radiances are then used to estimate theoretical unfiltering coefficients.
- Irradiance at the satellite altitude are converted to those at 30 km altitude using so-called the shape factor. The shape factor is constant for longwave for all scenes, while it depends on scene type and solar zenith angle for shortwave.

ERBS WFOV Nonscanner Shortwave Dome Characterization

- Figure 1: Original spectral response function (SRF) for ERBS and examples of modeled degraded SRF for various degradation factor α . The degraded SRF is modeled by following equation, where β is set to 1. As indicated by the figure, lower value of α corresponds to higher degradation.

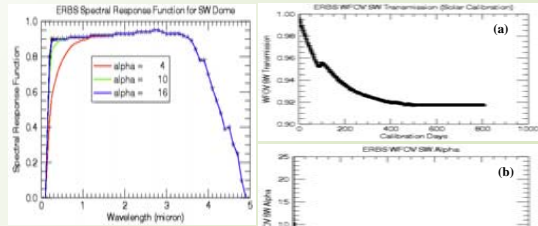


Fig 1: Spectral Response Function (SRF)

Fig 2: (a) Transmission (Solar Calibration), (b) SRF degradation factor

- Figure 2(a): Time series of the transmission derived from solar measurements for ERBS SW. The dome degraded approximately 8% over the operation period.
- Figure 2(b): α , which characterizes the spectral dependent dome degradation, derived from the transmission shown in Figure 2(a).

Recent Analysis/Results (Daytime Shortwave)

- Fig. 4 shows time series of daytime SW monthly tropical mean irradiances and their annual differences estimated from new and old S7 products. The differences corresponds to left y-axis and year to top x-axis, while mean irradiances corresponds to right y-axis and year/month to bottom x-axis.
- As expected, the daytime SW differences increases over time.

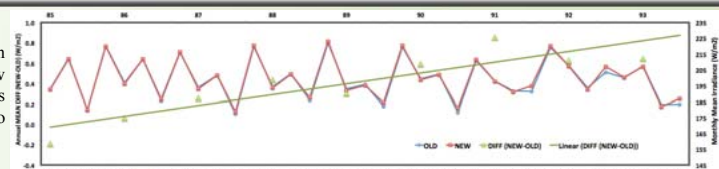


Fig 4: Time series of ERBS Nonscanner WFOV tropical mean (20° NS) for daytime shortwave

Recent Analysis/Results (Daytime Longwave)

- Similar to Figure 4, Figure 5 is for daytime LW.
- Even though the new approach corrects SW degradation, it changes LW because the daytime LW is estimated by subtracting the SW measurements from daytime total. Any change in SW affects the daytime longwave. Since the reprocessed SW increased relative to the old SW, the daytime longwave is decreased over time relative to the old LW.

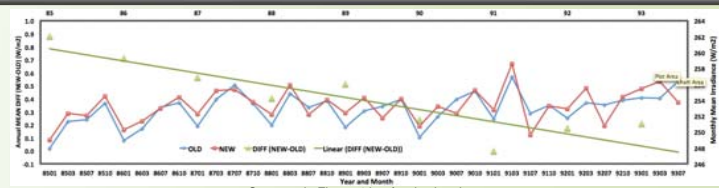


Fig 5: Same as in Figure 4 but for daytime longwave

Summary

- The characterization of spectral dome degradation might eliminate the irradiance correction using the time series of tropical day and nighttime means. To reduce the effect of orbit drifts, the results with S10, which takes into account of time and sample averaging, needs to be evaluated.
- The goal is to reprocess the entire record of ERBE WFOV nonscanner data ranging from 1985 to 1999 using this new approach. The overlap of ERBE observations with CERES periods provides a way to transfer calibration and assisting the production of consistent Earth-Radiation datasets.

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Contact: alok.k.shrestha@nasa.gov