Improvements in Broadband Shortwave and Longwave Fluxes over ARM Domains

M.M. Khaiyer, D.R.Doelling, M.L. Nordeen, R. Palikonda, Y. Yi
Science Systems and Applications, Inc.

P. Minnis

National Aeronautics and Space Administration Langley Research Center

Climate Science Branch

Introduction

- NASA Langley Cloud Group provides broadband (BB) shortwave (SW) and longwave (LW) fluxes derived from GOES narrowband (NB) radiances (Available from May 1998 to August 2005)
- Narrow-to-broadband (NB-BB) conversion technique based on regressing coincident co-located 1° averaged CERES BB and GOES NB fluxes. Regression coefficients unique for each domain (SGP, MASRAD, etc). Currently for GOES8 (Apr00-Mar03), there is only a single NB-BB fit based on Terra CERES data.
- SW: Comparisons with BBHRP fluxes revealed that SW fluxes derived using GOES8 fit compared well at Terra overpass time (1030 LT), but systematic differences occurred at other times
- LW: Comparisons with BBHRP fluxes revealed a diurnal dependency of the bias with good agreement at 1030 LT
- New fits needed to address these issues:
  - LW: seasonally, day and night
  - SW: seasonally, function of solar zenith angle (SZA)
    - SZA dependence from MSG9 GERB

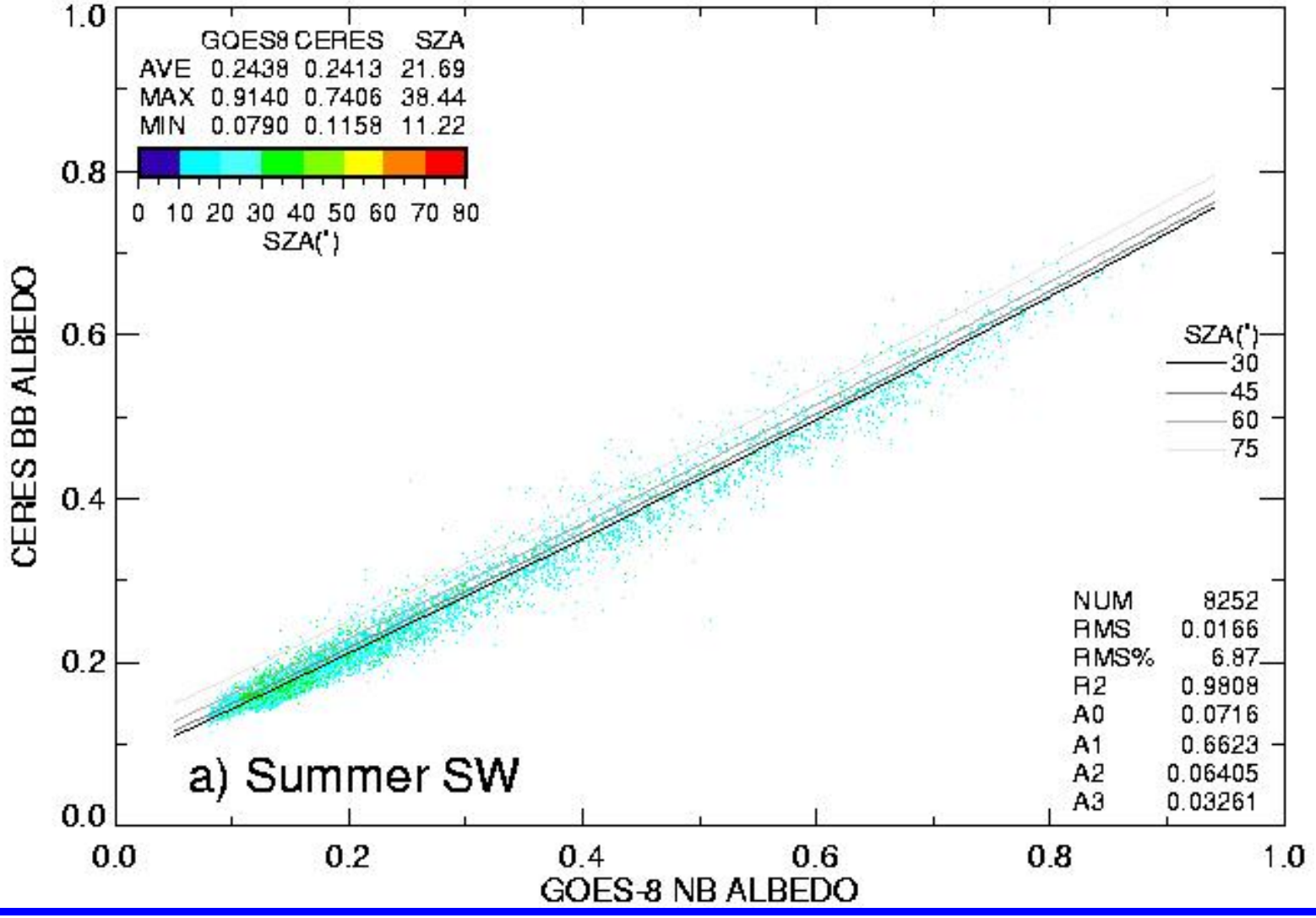
Deriving a Narrowband-to-broadband Conversion Fit

- BB fluxes from Terra Ed2C Revision 1 CERES FM-1 or FM-2 scanner are matched with the GOES NB fluxes
  - CERES 20-km Single Scanner Footprint TOA/Surface Fluxes and Clouds (SSF; Geier et al, 1999)
  - SSF footprint data averaged into 1° grid: Monthly Gridded Surface Fluxes and Clouds (SFC)
  - CERES FM-1 or 2 SFC fluxes (cross-track mode only) matched to 1° GOES NB fluxes within ±15 minutes of overpass time, at CERES VZA < 65°, GOES VZA < 70°
  - Convert NB flux to BB using empirical equations:
    - $SW_{bb} = a_0 + a_1*S_{nb} + a_2*S_{nb}^2 + a_3*\ln(1/csza))$ (1)
      where SW_{bb}= SW BB flux, S_{nb} = SW NB flux, csza=cos(SZA)
    - $OLR_{bb} = A_0 + A_1*L_{nb} + A_2*L_{nb}^2 + A_3*L_{nb}*\ln(colRH)$ (2)
      where OLB_{bb} = LW BB flux, L_{nb}=LW NB flux, and colRH=column-weighted RH
  - Third order correction applied to OLR

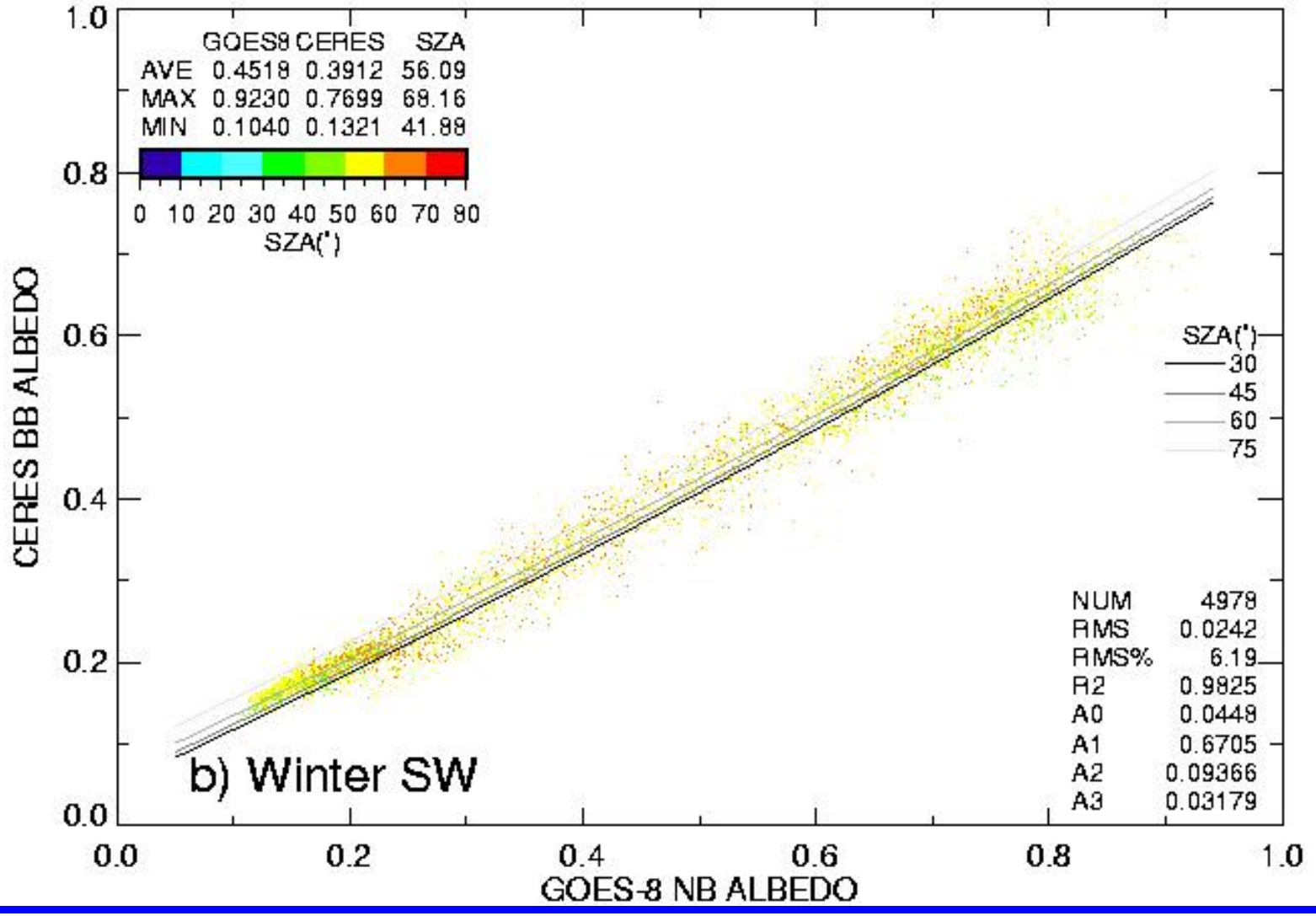
SW Improvements

- New seasonal GOES8-Terra SGP SW NB-BB fits for summer (Jun-Aug00), winter (Dec00-Feb01)
- spring and fall derived also, not shown
- Accounts for SGP vegetation cycle

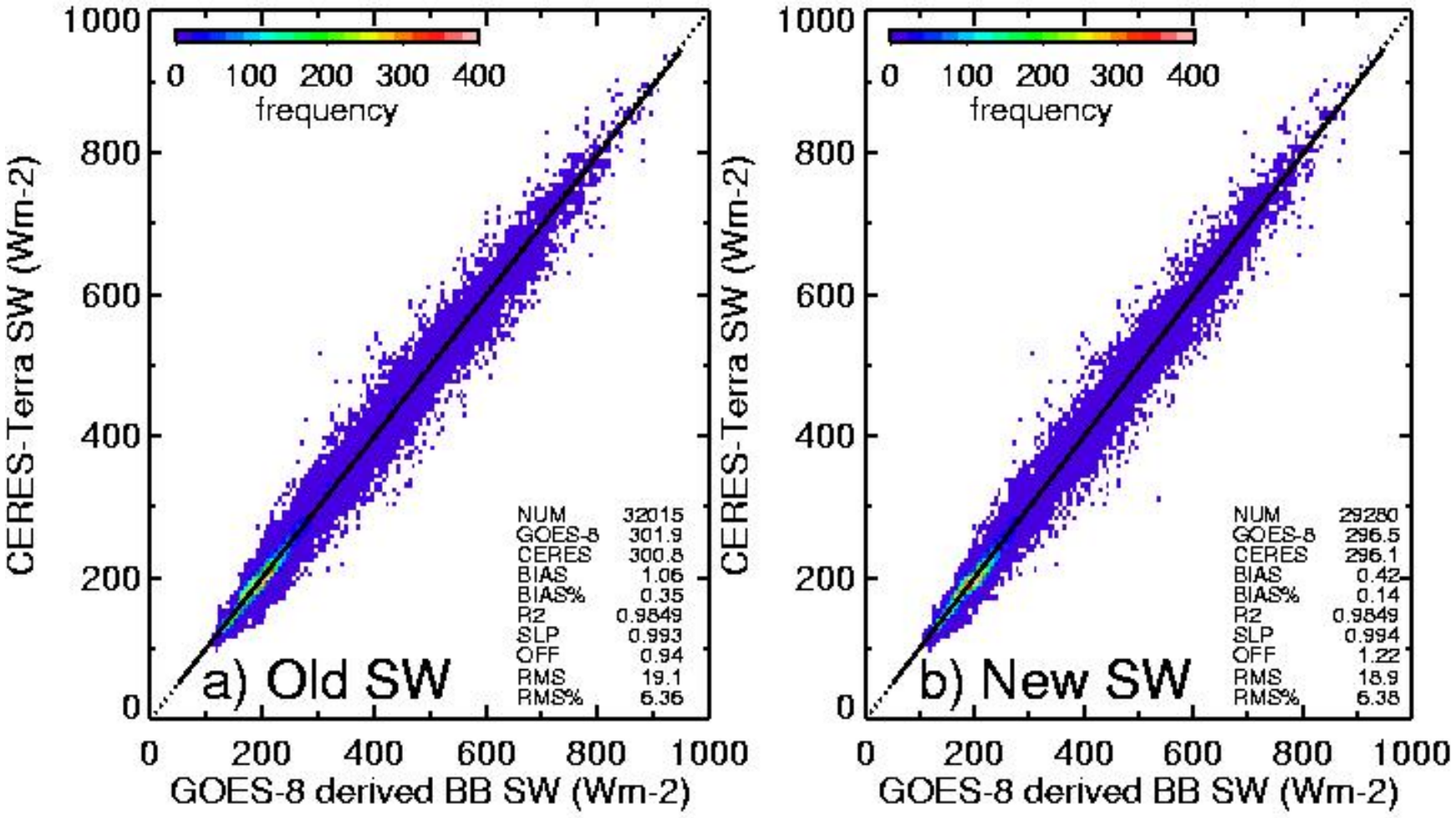
SGP GOES8-Terra SW Seasonal NB-BB Fit: Summer



SGP GOES8-Terra SW Seasonal NB-BB Fit: Winter



Comparison of Old (Operational) SW Fit and New Seasonal SW Fit



SW Improvements

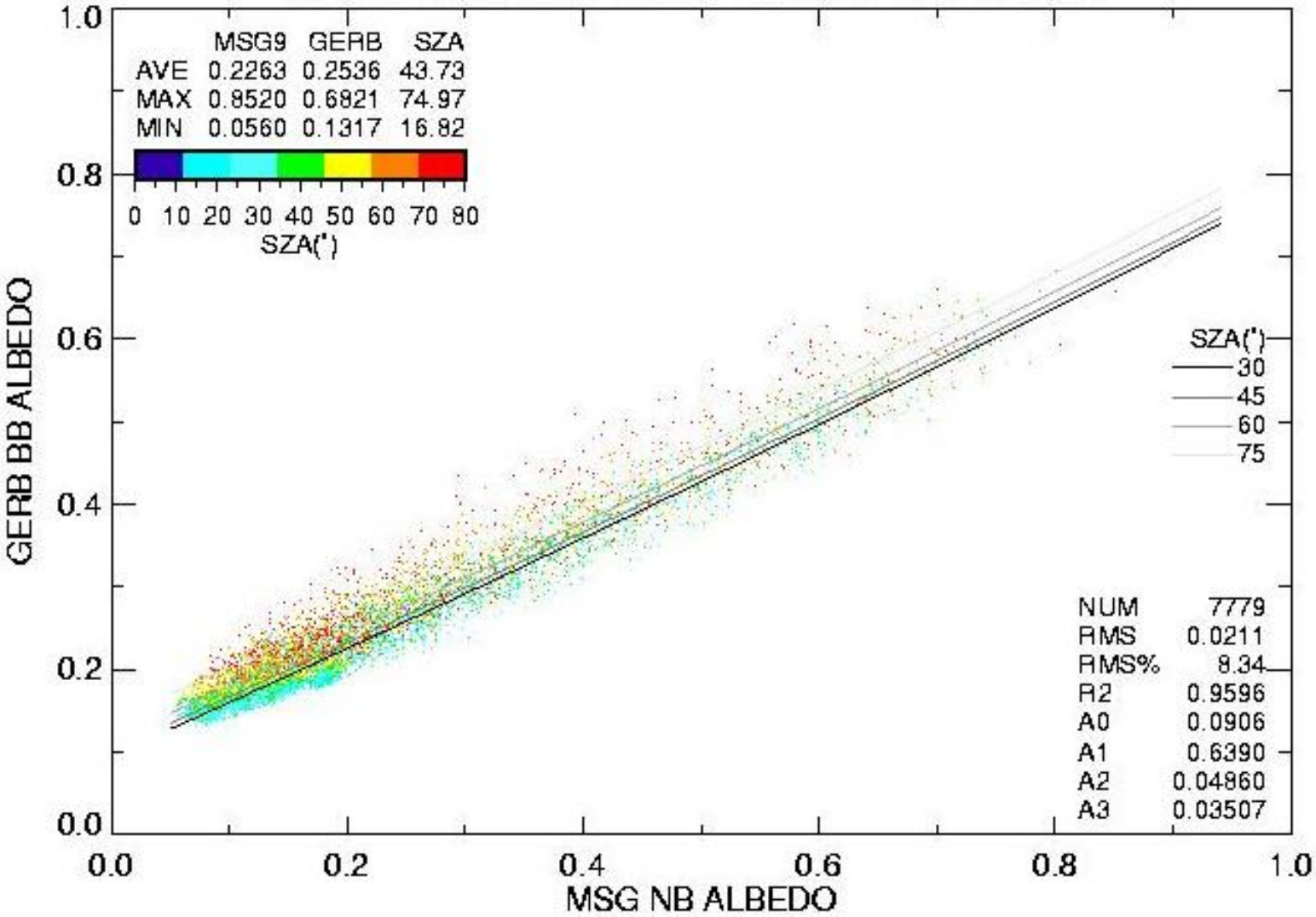
- Terra CERES/GOES matches are limited in SZA range and may not resolve the functionality with SZA

- Use GERB/MSG9 NB-BB matches to derive the SZA coefficient.
  - 1^{o}GERB BARG (Binned Averaged Rectified Geolocated) near-real time data used - may be of reduced accuracy compared to Edition GERB

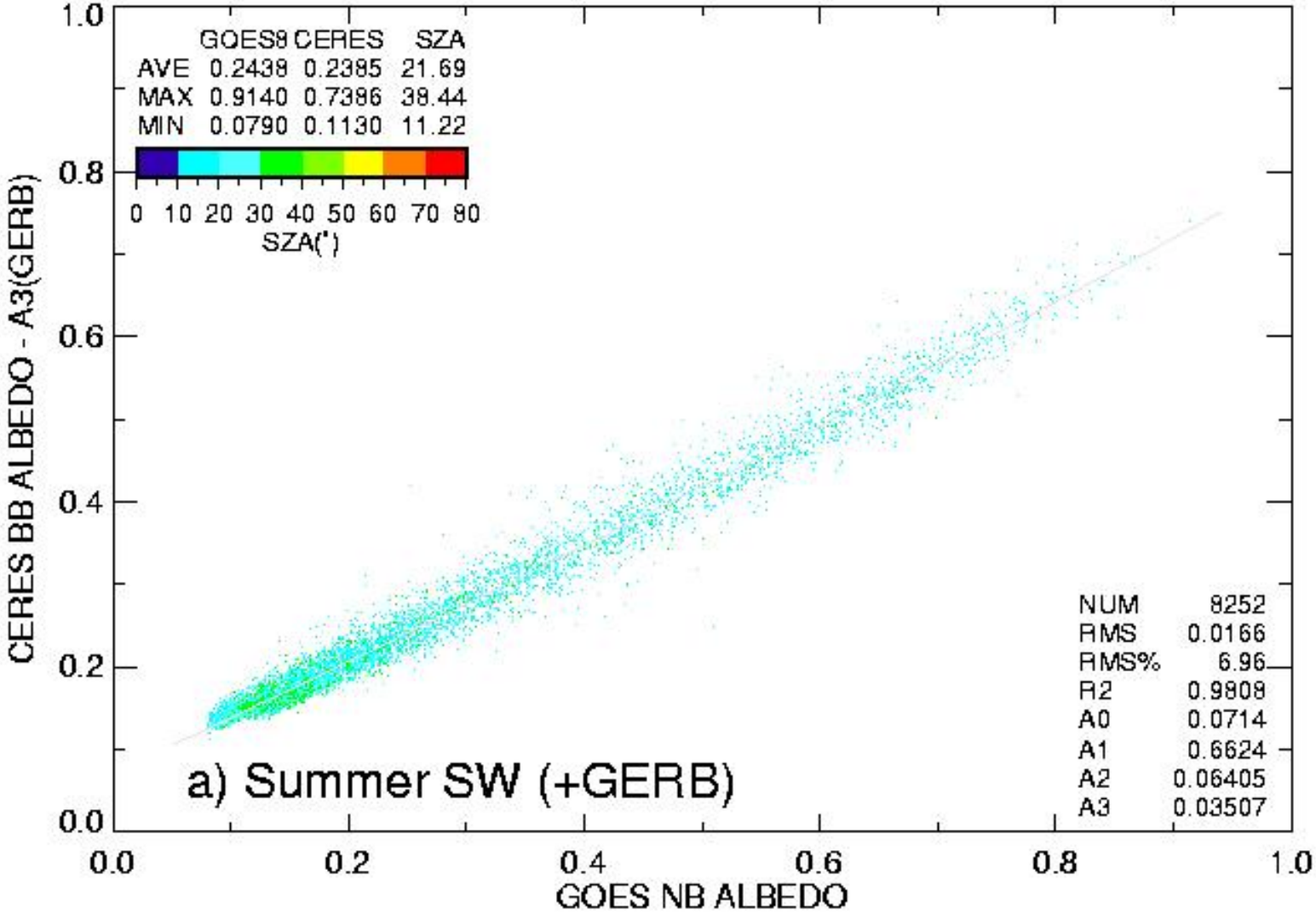
SW Results

- Match METEOSAT-9 (MSG) NB / GERB BB data and fits using July 2007 hourly images

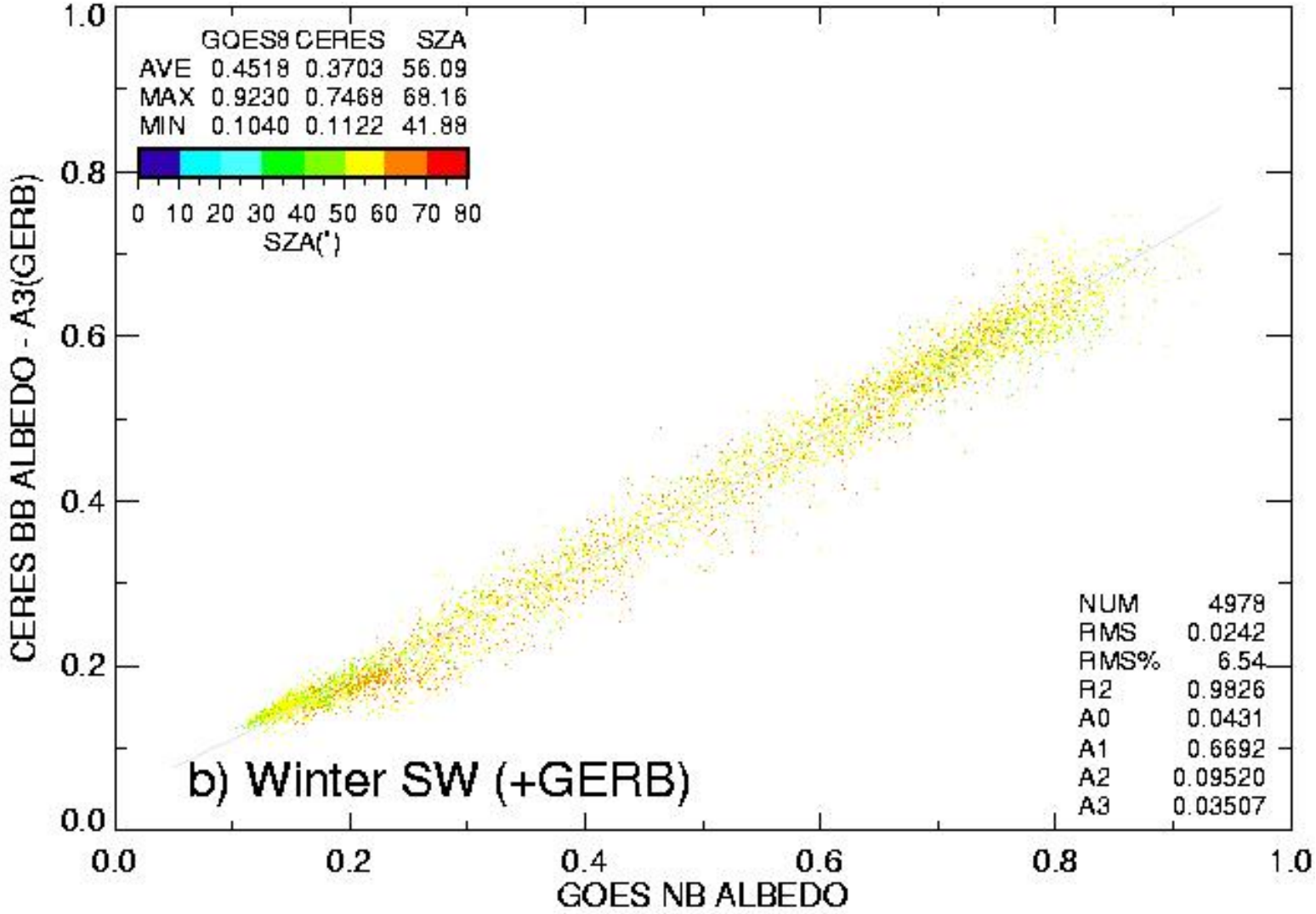
Europe GERB-MSG9 SW Jul07 NB-BB Fit



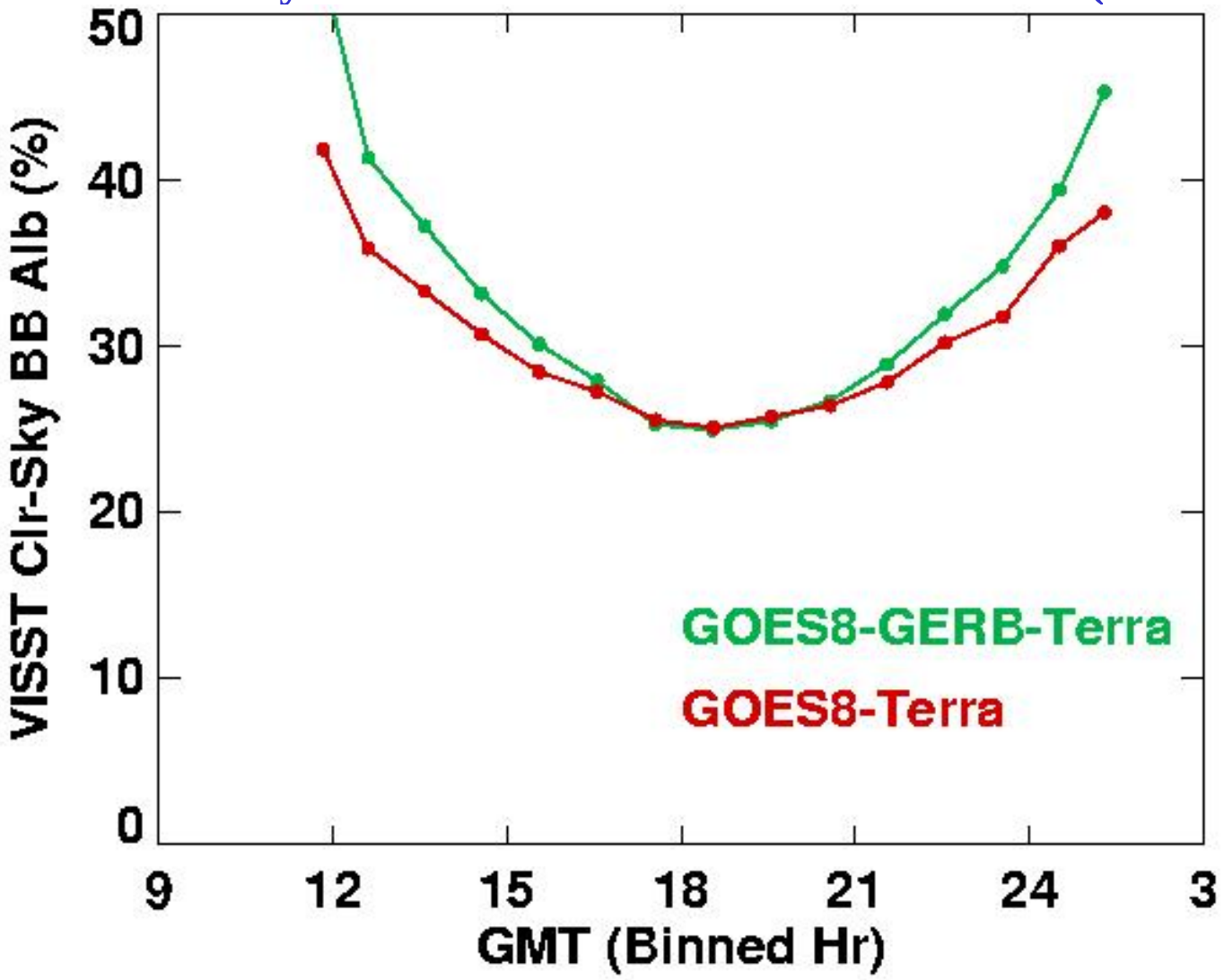
SGP GOES-8-Terra (GERB-Enhanced) SW Seasonal NB-BB Fit: Summer



SGP GOES-8-Terra (GERB-Enhanced) SW Seasonal NB-BB Fit: Winter



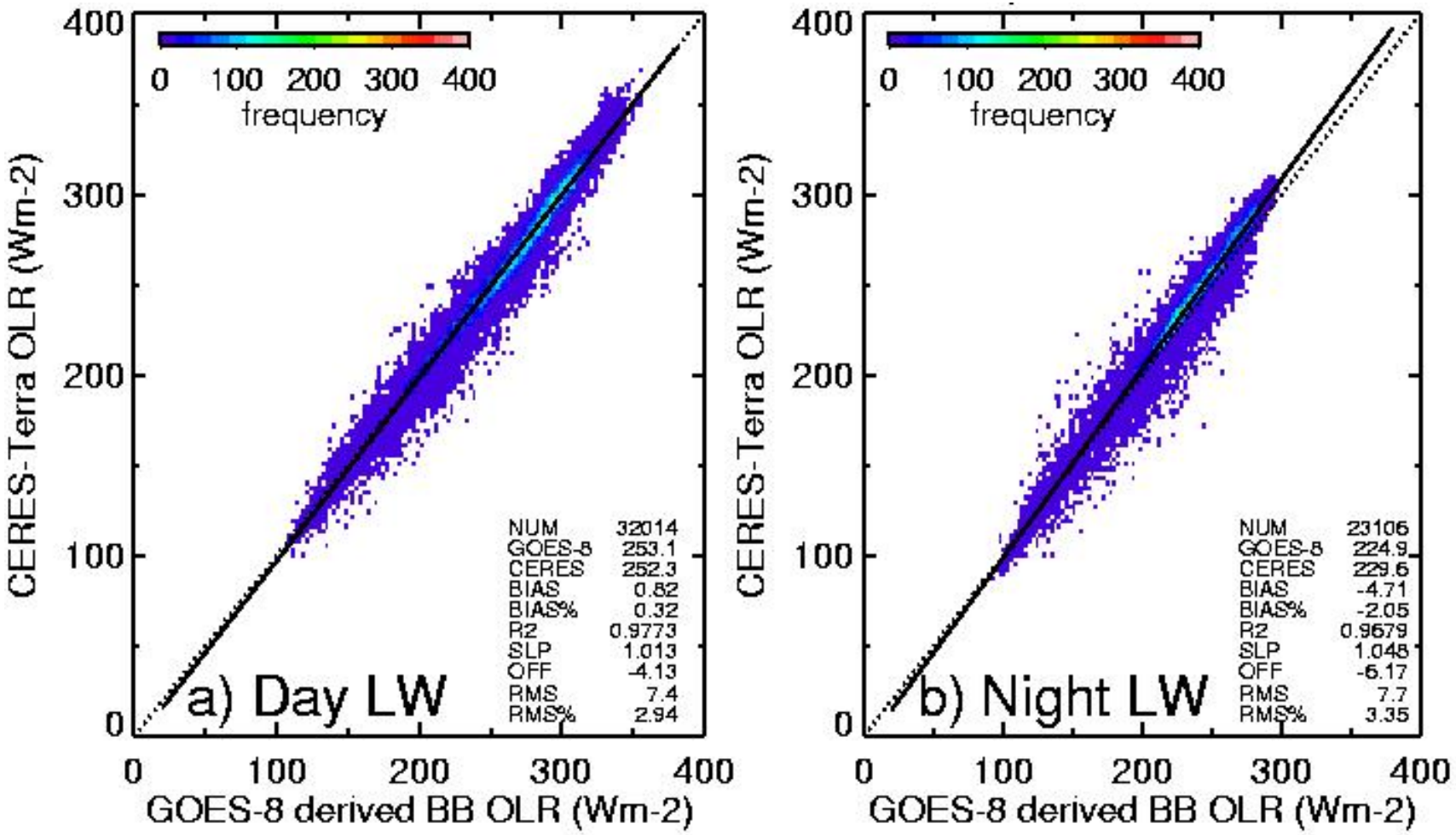
Comparison of Clr-Sky BBAL: Old and New SW NB-BB Fits (Mar00-Feb01)



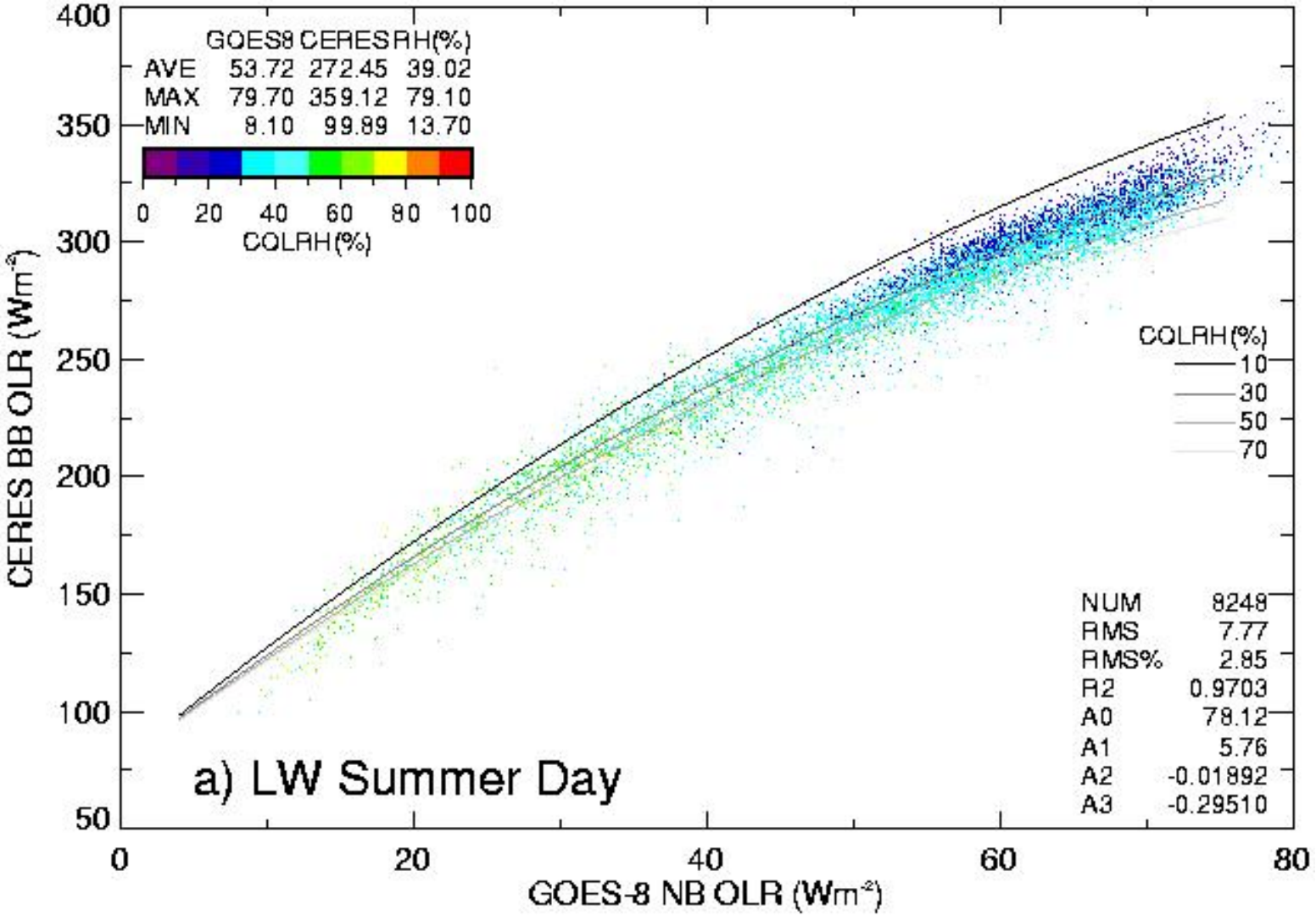
LW Improvements

•Examine GOES BB flux differences derived from day, night, and seasonal NB-BB regressions

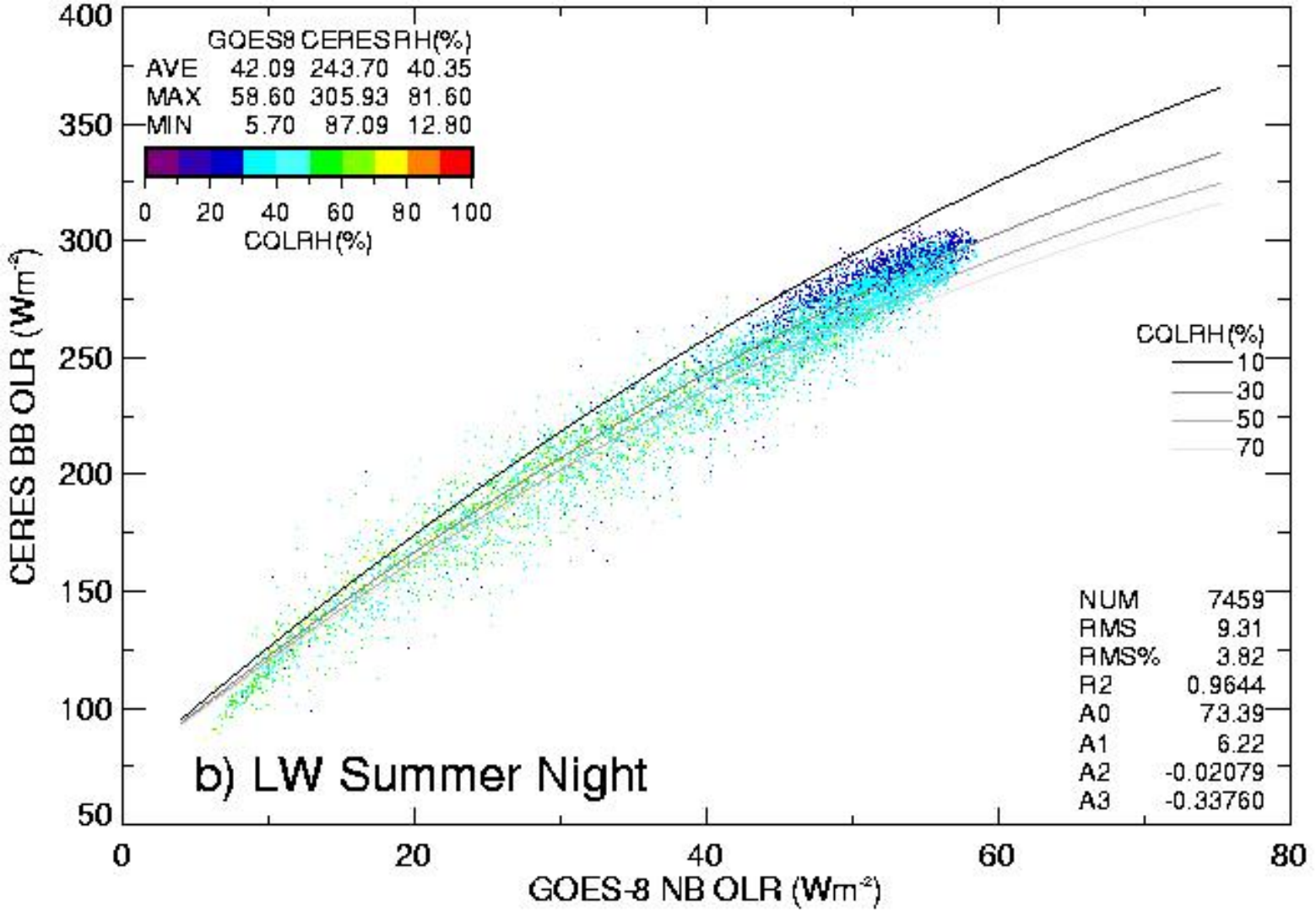
Day and Night Bias in Operational LW NB-BB



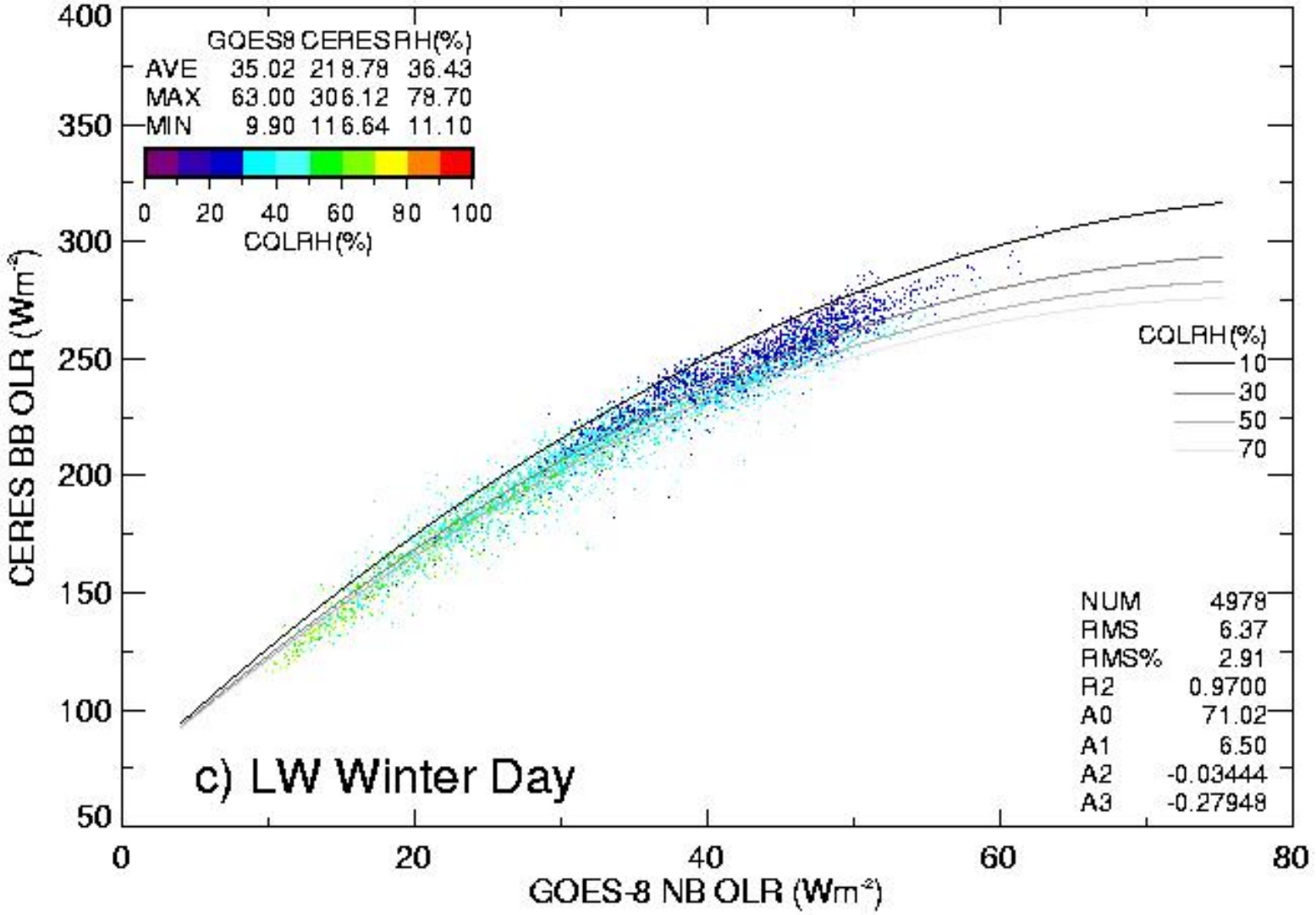
SGP G8-Terra LW Seasonal, Day-Night NB-BB Fits: Summer Day



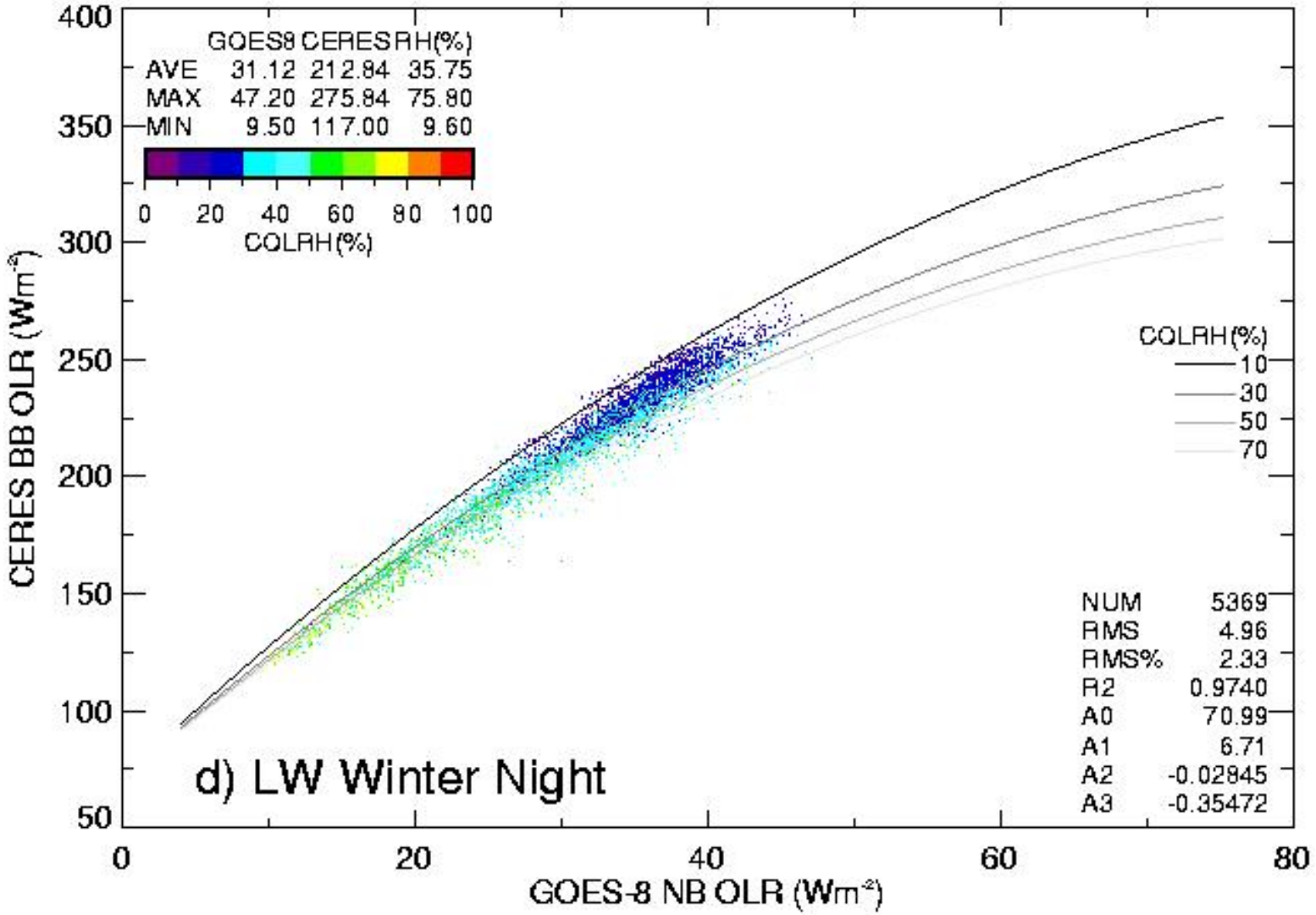
SGP G8-Terra LW Seasonal, Day-Night NB-BB Fits: Summer Night



SGP G8-Terra LW Seasonal, Day-Night NB-BB Fits: Winter Day



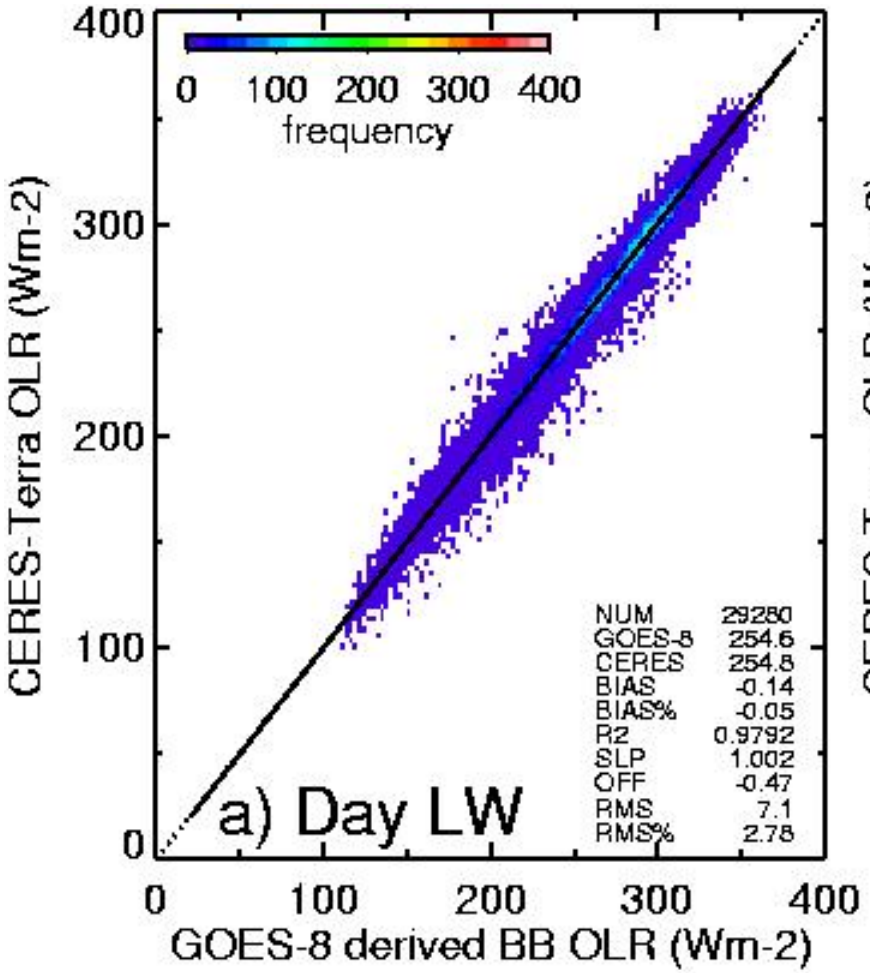
SGP G8-Terra LW Seasonal, Day-Night NB-BB Fits: Winter Night

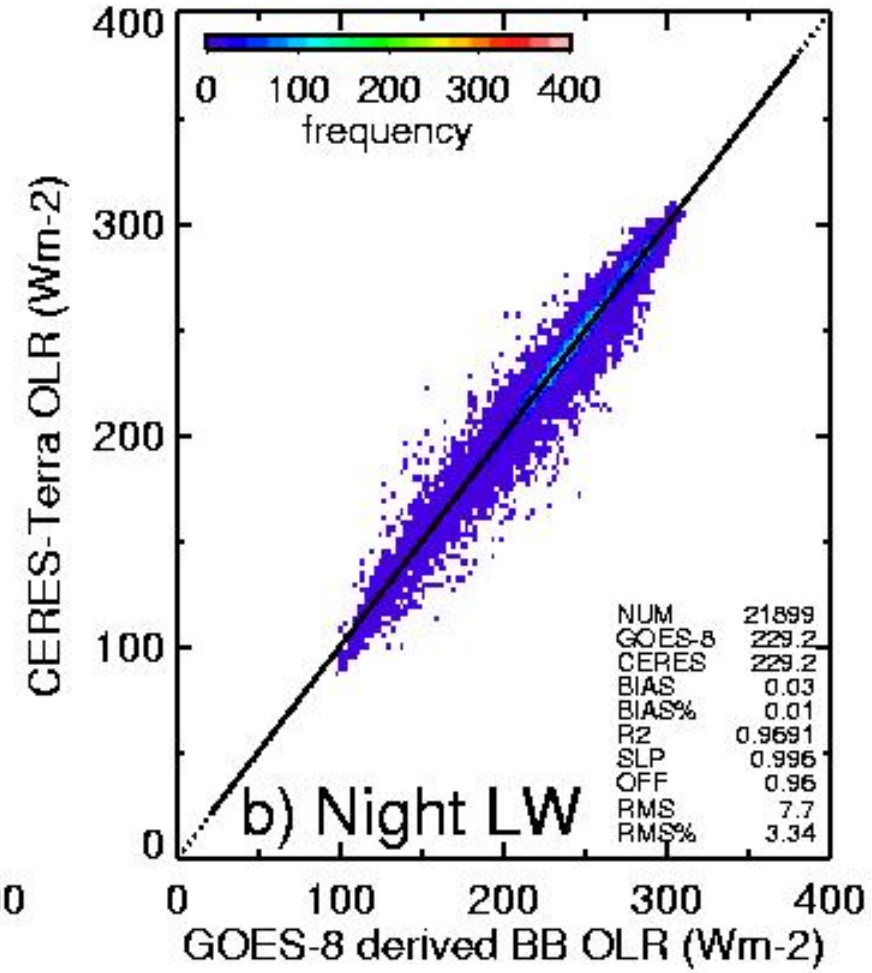


LW Results

- Improvement seen due to separate day-night LW fits, when comparing old and new Mar00-Feb01 CERES/GOES-8 OLR

Improved Day-Night Results using new LW NB-BB Fit





Summary

•New CERES-GOES NB-BB LW conversion method developed using separate sets of seasonal and day/night coefficients for SGP.

•Old SGP LW nighttime bias of –4.7 W/m^2 is eliminated

•Day-night-seasonal fits for SGP also showed improvement from the old one-fit approach. For Mar00-Feb01:

- –Old LW bias = 0.8 W/m^2; RMS = 7.4 W/m^2
- –New LW bias = -0.1 W/m^2; RMS = 7.1 W/m^2
- –Old SW bias = 1.1 W/m^2; RMS = 19.1 W/m^2
- –New SW bias = 0.4 W/m^2; RMS = 18.9 W/m^2

•GOES8-Terra SW NB-BB fit further enhanced at non-Terra overpass times, using SZA term from Europe Jul07 GERB-MSG9

.

•Better account for SZA dependence of GOES8-Terra fits, qualitatively improving derived BB albedo.

Future Work

- Use a full year of GERB-MSG NB-BB, to account for both the green-up and brown-down phases of SGP SW NB-BB fits.
- SW fits will be compared with BBHRP and CERES TRMM flux dependencies.
- SGP LW NB-BB fit will also be evaluated with GERB-MSG9 LW NB-BB data.
- NB-BB fits will also be re-derived for other domains (e.g., MASRAD) using these updates.

http://www-pm.larc.nasa.gov