Assessment of a Technique for Estimation of Outgoing Longwave Radiation from the Atmospheric Infrared Sounder Radiance Observations

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A new technique for estimating outgoing longwave radiation (OLR) at the top of atmosphere (TOA) has been derived from the Atmospheric Infrared Sounder (AIRS) radiance measurements in the NOAA/NESDIS [1]. The technique is to estimate AIRS regression OLR by least square regression of the Earth's Radiant Energy System (CERES) TOA outgoing longwave fluxes with the principal component scores (PCSs) of the AIRS radiance observations. The accuracy and precision is 0.02 Wm^{-2} and 2.1 Wm^{-2} for uniform scenes in spatial scale of 100 km. In order to study temporal stability of AIRS regression OLR, AIRS OLR is compared with CERES OLR in monthly and daily temporal scales using about two years of data.

AIRS monthly OLR is estimated from AIRS global daily gridded radiances got from AIRS near-real-time system. CERES monthly OLR is adopted from the CERES Aqua FM3/FM4 Edition 2B/2C Monthly TOA/Surface Averages (SRBAVG) product. The global monthly OLR of AIRS is ranged from 235 Wm^{-2} to 244 Wm^{-2} (Figure 1a). It has an annual cycle similar to that of CERES OLR with identical phases and similar amplitude. Figure 1b shows that the OLR differences between AIRS and CERES FM3 ranges from 0.2 to 1.2 Wm^{-2}. The absolute values of the differences between AIRS and CERES FM4 are under 0.5 Wm^{-2} in most of months. The AIRS OLR is closer to the CERES FM4 OLR than the CERES FM3 OLR. The spatial standard deviations (STDDEV) of the monthly OLR differences are larger than 6 Wm^{-2} for both the CERES FM4 and the CERES FM3 (Figure 1c), except for the months with less AIRS radiance observations (Figure 1d). The accuracy and precision are comparable to those of monthly HIRS OLR relative to CERES OLR (2 Wm^{-2} and 4 Wm^{-2}) for similar global monthly comparisons [2]. The large spatial variation of the OLR differences between AIRS and CERES appears to be related to the differences in spatial resolution and temporal samplings of the AIRS gridded radiances and the CERES SRBAVG datasets.

For both AIRS and CERES daily OLR, the area-weighted mean are calculated from 60°S to 60°N because the CERES gridded OLR data have no values at the wintertime polar region. Figures 2a–d present the daily regional average of the AIRS and CERES OLR from 60°S to 60°N and their differences for both daytime and nighttime. Both the AIRS and CERES OLR show similar annual cycle and seasonal variation (Figures 2a and 2b). The mean differences between AIRS and CERES OLR are approximately 1 Wm^{-2} for both daytime and nighttime (Figures 2c and 2d). At night, the biases are rather stable with the mean and 1-σ variation of the differences about 0.6 Wm^{-2} and 0.3 Wm^{-2}, respectively. However, the daytime differences show a jump around the beginning of April 2005, which is caused by changed version of the AIRS processing code and the changes in the AIRS level 2 channel property file in the AIRS near-real time system.

The AIRS OLR time series for global monthly average and daily regional average are stable relative to CERES outgoing fluxes. The small differences between AIRS and CERES indicate that AIRS can be used as a backup in case of CERES failure. Similarly, the technique can be extended to the Cross-track Infrared Sounder (CrIS) that will be onboard the National Polar-Orbiting Operational Environmental Satellite System (NPOESS), and therefore the CrIS can be used to monitor the performance of CERES and potential surrogate since both will be on the future NPOESS satellites. The same technique of empirical principle component regression OLR can be applied to the Infrared Atmospheric Sounding Interferometer (IASI) onboard the European meteorological polar-orbiting satellite (EUMETSAT) through the Meteorological Operational satellite programme (MetOp) to provide better temporal coverage.

References

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Bibliography

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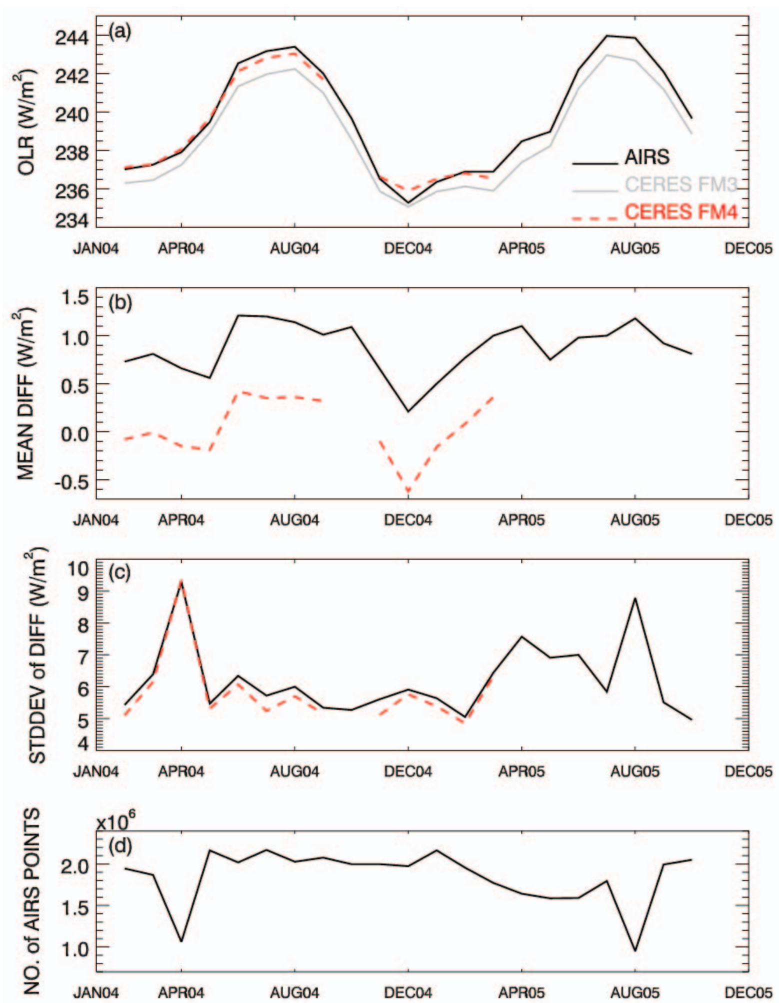

Figure 1 Time series of (a) global mean OLR from AIRS (black solid line), CERES FM3 (grey solid line) and CERES FM4 (red dashed line); (b) global mean OLR differences between AIRS and CERES FM3 (black solid line), and between AIRS and CERES FM4 (red dashed line); (c) spatial standard deviations of the OLR differences (black solid line for AIRS minus FM3 and red dashed line for AIRS minus FM4); and (d) the number of AIRS instantaneous observations.

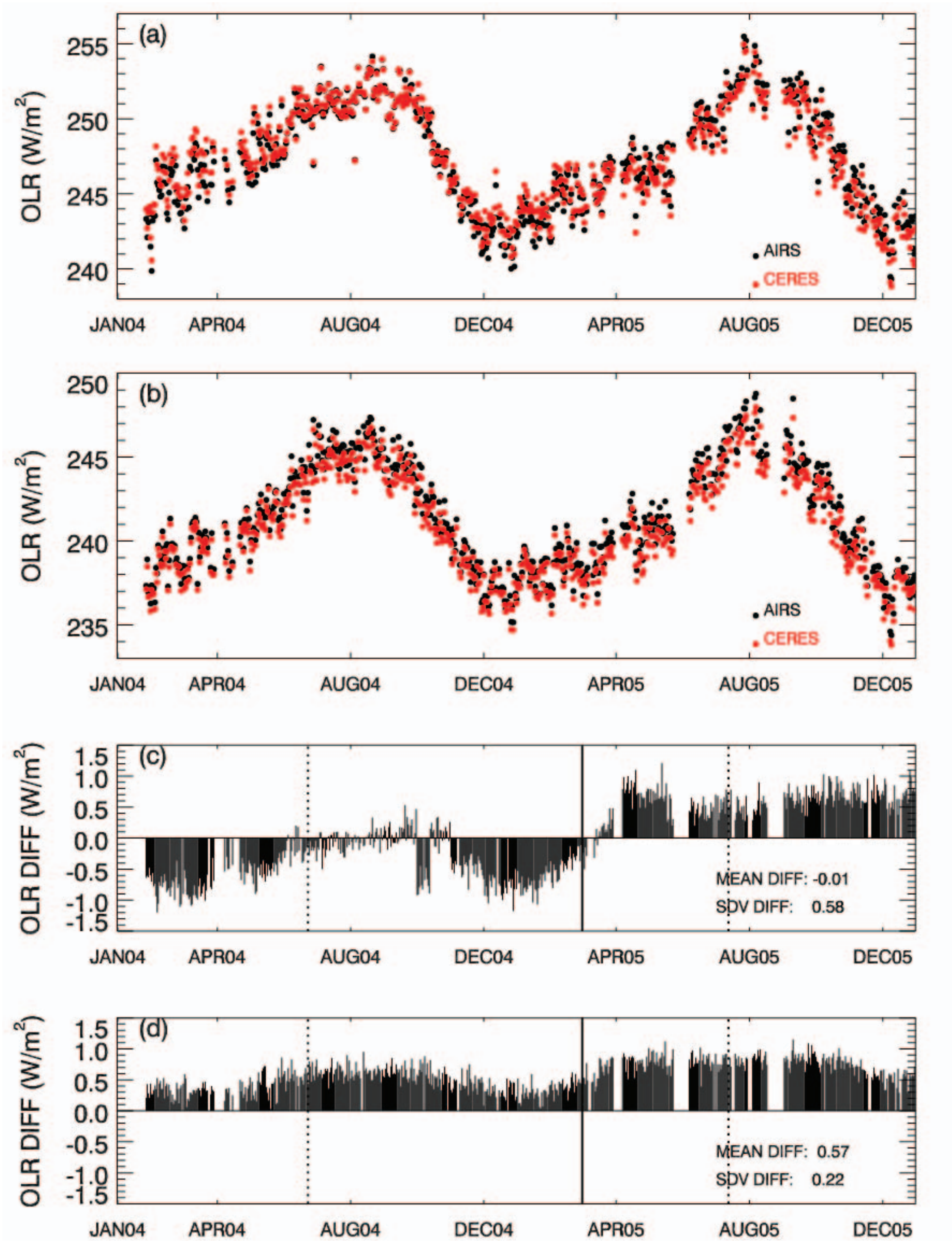

Figure 2 AIRS and CERES daily mean OLR and their differences from 60°S to 60°N. (a) Mean OLR for ascending orbits (day), (b) mean OLR for descending orbits (night), (c) and (d) the differences between AIRS and CERES for daytime and nighttime, respectively. In Figure 1c and 1d, the solid vertical line shows the beginning of version 9.5.1 AIRS level 2 channel property file. The first dot vertical line shows the start of version 3.6 AIRS processing code, and the second shows the start of version 4.0.9 AIRS processing code.