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RADIATIVE ENERGY BUDGET OF AFRICAN MONSOONS: NASA CERES OBSERVATIONS VERSUS NOAA NCEP REANALYSIS 2 DATA

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1. INTRODUCTION

Understanding the nature of tropical monsoon systems is essential for improving model forecasts in the tropics and the quality of life for billions of people living within the monsoon regions. Monsoon systems are forced by the distribution of solar heating and affect the tropical circulation by directly modulating the regional radiative energy balance. Understanding the spatial and temporal variability of the radiative energy budget in these monsoon regions is therefore essential for understanding these monsoon systems.

This study will examine the observed radiative energy budget of African monsoons using National Aeronautic and Space Administration's (NASA's) Clouds and the Earth's Radiant Energy System (CERES) measurements (Wielicki, et al., 1996) and compare them directly to the results from the NOAA/NCEP Reanalysis 2 data. Analysis will include examination of the outgoing longwave radiation (OLR) and reflected solar radiation (RSR) on daily, seasonal, and annual time scale over the African monsoon regions. Section 2 will provide a general description of the data and analysis method used in this study. Preliminary results will be discussed in section 3. Section 4 will give a summary of this work.

2. DATA DESCRIPTION

The global radiation measurements used in this study are extracted from the first full year of CERES/Terra ERBE-like Edition-1 ES-9 FM-1 and FM-2 combined dataset and cover the period between March 1, 2000 and February 28, 2001. Specifically, these data include regional daily mean estimate of top of atmosphere (TOA) OLR and RSR on a 2.5^{o} equal-angle grid and cover all regions on the Earth between North and South Pole. The modeled NCEP/Reanalysis 2 daily mean OLR and RSR data for the same period are obtained by regridding the original 6-hourly NCEP data into the CERES ERBE-like grid and averaging these data into a daily mean estimate. These daily mean data are then used to compute seasonal mean OLR and RSR. Finally, comparisons are performed between observations and modeled radiation fields.

3. PRELIMINARY RESULTS

The four-panel figure in both Figs. 1 and 2 shows the regional map of seasonal mean OLR for the four seasons (Spring, Summer, Fall, and Winter) over the Africa deduced from the first year of NASA/CERES observations and the NOAA/NCEP Reanalysis 2 system, respectively. Figure 1 clearly shows the annual migration of convection over the Africa on the seasonal time scale. The onset of west African monsoon is shown as a northward movement of convections (low OLR areas in the figure) from Spring to Summer, followed by the southward retreat of convections in the Fall. While the Reanalysis 2 system did a fairly good job simulating the seasonal position and movement of these monsoonal convections as shown in Fig. 2, it underestimated the actual strength of the convections. The OLR values over the convective regions in the NCEP Reanalysis 2 data were too high when compared to the actual CERES observations. This points to some deficiencies in the current Reanalysis 2 system. Since the magnitude of the OLR is inversely related to the strength of the surface precipitation, this overestimation in OLR can further lead to underestimation in modeled seasonal mean surface precipitation. For the seasonal RSR fields (not shown), the performance of the NCEP Reanalysis 2 system for convections was similar to those of the OLR fields. However, the NCEP Reanalysis 2 system also had problems reproducing the seasonal RSR signals resulting from the present of stratus clouds off the coast of Africa. The lack of these stratus signals is most disturbing.

Figures 3 shows the CERES observed and the NCEP Reanalysis 2 simulated daily mean OLR from March 1, 2000 to February 28, 2001 at a longitude zone along 16W between 30N and 20S. The CERES observed OLR shows the annual migration

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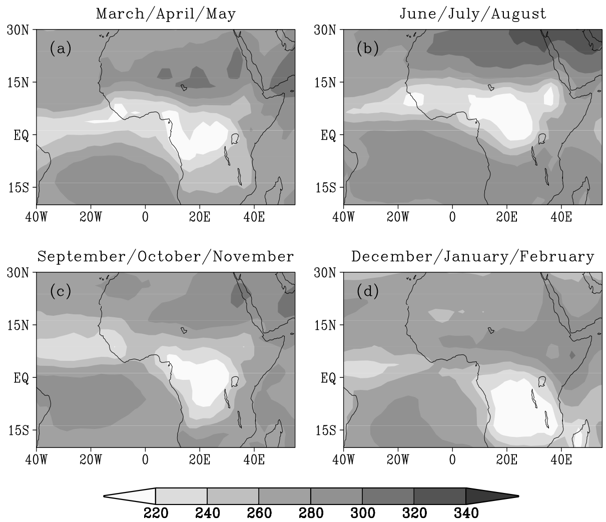

FIG. 1. Regional map of CERES/Terra observed seasonal mean OLR (Wm^{-2}) for (a) Spring, (b) Summer, (c) Fall, and (d) Winter season over Africa.

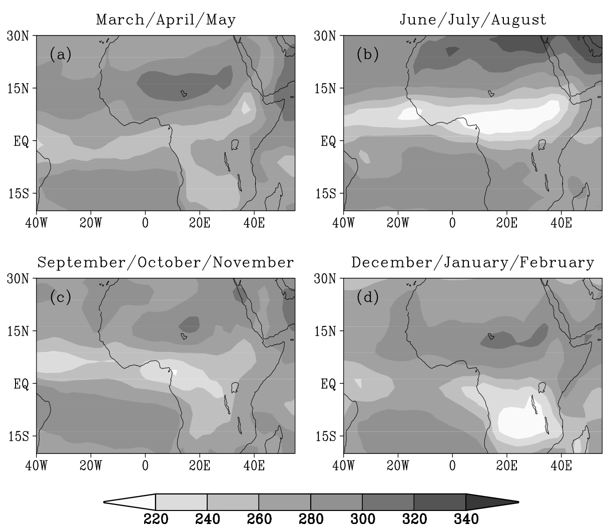

FIG. 2. Same as Fig. 1 but for NOAA/NCEP Reanalysis 2 simulated OLR (Wm^{-2}).

of convections from Equator during the Spring to 10N between May and September. The shift of convections begins during the month of May and marks the onset of the west African monsoon. Comparing with the CERES measurements, the NCEP Reanalysis 2 simulated OLR appeared less organized and formed further south than the actual observations. The less coherent nature of the simulated daily OLR fields suggests that there may be problems associated with the convective parameterization scheme used in the NCEP system.

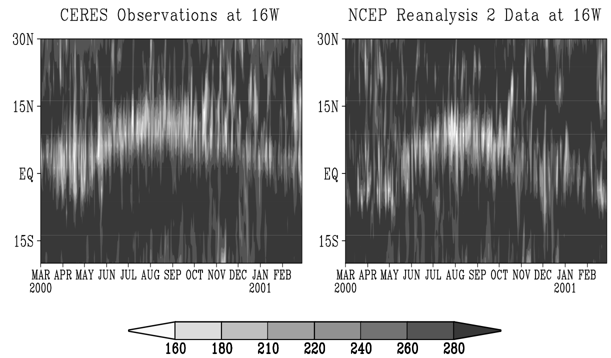

FIG. 3. CERES observed (left) and NCEP Reanalysis 2 simulated (right) daily mean OLR (Wm^{-2}) at a longitude zone along 16W, between 30N and 20S, from March 1, 2000 to February 28, 2001.

4. SUMMARY

Understanding the distribution of radiation budget of African monsoon is essential for unlocking the secret of these monsoon systems. This paper examined the observed radiative energy budget of African monsoons using NASA/CERES measurements from the Terra spacecraft and compared them directly to the results from the NOAA/NCEP Reanalysis 2 data. CERES OLR and RSR observations show convective features associated with the annual migration of west African monsoon. While the NCEP Reanalysis 2 simulated OLR and RSR captured some aspects of these features, there is plenty of room for improvements.

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