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ONE YEAR OF DAILY AVERAGED LONGWAVE RADIATION MEASUREMENTS FOR ENVIRONMENTAL AND CLIMATE CHANGE STUDIES

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ABSTRACT

One year of daily averaged scanner outgoing longwave radiation (OLR) 2.5 degree region measurements from the Clouds and the Earth's Radiant Energy System (CERES) instrument is made available on the Internet/Web for use by the scientific and educational community. This year of daily averaged data is from scanner measurements taken by the CERES instrument on the Terra satellite which is in a sun-synchronous orbit with an equator crossing time of about 10:40 AM. The data set spans the period from March 2000 through February 2001 and can be viewed and accessed using a web browser located on a server at NASA, Langley Research Center. The browser uses a live access server (LAS) developed by the Thermal Modeling and Analysis Prtoject at NOAA's Pacific Marine Environmental Laboratory. LAS allows researchers to interact directly with the data to view, select, and subset the data in terms of month, year, latitude, and longitude. In addition to daily OLR measurements, monthly average and variation over the month will be included on LAS.

1. INTRODUCTION

For many years there has been considerable interest in the earth's radiation budget (ERB) or energy balance, which includes measurements of absorbed solar radiation, reflected shortwave radiation (RSW), thermal outgoing longwave radiation (OLR), and net radiation. ERB data are fundamental to the development of realistic climate models and for studying natural and anthropogenic perturbations of the climate. Beginning in the mid 1960's earth-orbiting satellites began to play an important role in making measurements of the earth's radiation flux although much effort had gone into measuring ERB parameters prior to 1960 (House *et al.*, 1986).

Beginning in 1974 and extending until the present time, satellite experiments have been making radiation budget measurements almost continually in time (Smith *et al.*, 1977; Jacobowitz *et al.*, 1984; Barkstrom, 1984; Barkstrom and Smith, 1986).

In 1984 major advances were made with the Earth Radiation Budget Experiment (ERBE) (Barkstrom, 1984; Barkstrom and Smith, 1986). This experiment consists of three satellites, two sun-synchronous National Oceanic and Atmospheric Administration (NOAA) polar orbiters, and one precessing orbiter, the earth radiation budget satellite (ERBS), that observes at varying local times. Measurements from these three satellites, independently and combined, provide accurate and well calibrated results for observing the radiation budget of the earth. The ERBE instrument package on the satellites included earth-viewing narrow-field-of-view (NFOV) scanners as well as non-scanner WFOV active-cavity radiometers with different detectors and filters. The scanner instrument package contained three detectors to measure SW (0.2 - 5 µm), longwave (5 - 200 µm), and total waveband radiation (0.2 - 200 µm) (Kopia, 1986). Each detector scans the earth perpendicular to the satellite ground track from horizon-to-horizon. The nonscanner instrument package contained four earth-viewing channels and a solar channel. For each channel there is a total spectral channel which is sensitive to all wavelengths and a shortwave channel which transmits only shortwave radiation from 0.2 - 5 mm. The polar orbiters from the ERBE, *NOAA-9* and *NOAA-10* , had equator-crossing times of 0230 and 0730 LST, respectively at an orbit altitude of 872 km and 833 km respectively. ERBS is in 57 degreea precessing orbit at an orbit altitude of 610 km.

An extension of ERBE was begun in 1997 with the Clouds and the Earth's Radiant Energy System (CERES) experiment. CERES is part of NASA's Earth Observing System (EOS). CERES products include

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both solar reflected and Earth-emitted radiation from top of the atmosphere to the Earth's surface.

CERES instruments were first launched aboard the Tropical Rainfall Measuring Mission (TRMM) in November 1997 and on the EOS Terra satellite in December 1999. Two additional instruments will fly on the EOS Aqua spacecraft in 2002. CERES instruments are based on the ERBE scanning radiometer but has twice the spatial resolution and improved instrument calibration. One of the two instruments operates in a cross-track mode as did ERBE. The other instrument operates in a biaxial mode for better angular information. There are three spectral channels: a shortwave channel (0.3 – 5.0 µm), a total channel (0.3 > 100 µm), and a "window" channel (8 – 12 µm).

The purpose of this paper is to describe a subset of the CERES data set which will be made available over a web site located at NASA, Langley Research Center. The data set covers one year of scanner measurements and is from the dedicated EOS Terra satellite referred to as Terra data and should be useful to anyone interested in research in atmospheric sciences, especially climate studies.

2. DATA DESCRIPTION

All data are daily average gridded outgoing longwave radiation (OLR) from March 2000 through February 2001 for the Terra scanning instrument. The 1-year data set for Terra scanner is taken from the ES4G combined (FM1 + FM2), Edition 1 product. The Terra data set contains the regional time and space averages of radiant exitance at TOA. The ERBS data set on the web site are 2.5° x 2.5° daily equal-angle regional averages. The first region of the grid encompasses the area from 0° to 2.5° longitude and from 88.75° to 86.25° latitude

Thus, the regional data values that go into producing the maps form a 144 by 72 matrix of 2.5° regions. This matrix represents 72 latitude zones, each zone containing 144 regions represented by longitude. There are thus 10368 of these 2.5° grids that produce a map. The first grid is centered at 87.5 N, 1.25 longitude. The last grid is centered at 87.5 S, 358.75 longitude.

3. DATA AVAILABILITY

The 1-year Terra scanner daily data set will be available over a world-wide-web browser located at NASA, Langley Research Center, Hampton, VA. The data sets are made available over the browser by using a live access server (LAS) developed by the Thermal Modeling and Analysis Project (TMAP) at NOAA's Pacific Marine Environmental Laboratory (PMEL) (Hankin et al., 1997). The LAS is dynamic in that gridded data variables such as OLR, RSW, albedo and associated images can be viewed in their entirety, or the data files may be regionally subsetted, say as a function of space (latitude, longitude) and time (year, month). The LAS is very versatile in that it can display many variables, and they can be saved as tab or comma delimited or generic ASCII files or as NetCDF files.

4. DISCUSSION OF DATA

From the data base on the server, daily averaged OLR and their associated maps can be viewed using the live access server, LAS. On a daily basis some grids of OLR may not have values. When this occurs, linear interpolation fill in the grids. Anomalies and standard deviations of OLR of the days of each month of the year are also available.

To give samples of the 1-year Terra daily data set the next four maps are included. Maps for only 2 days of the year are shown. Results for 365 days are included on LAS. The first map in Figure 1 shows OLR for day 11, January 2001. The gray scale image (although not as revealing as its color counterpart) shows that OLR patterns are zonal in nature, and mainly influenced by surface temperature, cloud cover, cloud height, temperature lapse rate, and moisture content of the atmosphere. The familiar regions of convection over South America, Africa, and Indonesia are evident, and the daily map is similar to what a monthly averaged map looks like. The anomaly map for January OLR is shown in Figure 2. Regions of low OLR variation from the monthly mean are almost random in location which may be a reflection of clouds in the region. Figure 3 is a map of OLR for July 2000, day 11. The map of OLR for July is also similar to what a monthly averaged map looks like with high OLR over the deserts and significant lows over Indonesia and India. Figure 4 is an anomaly for July 2000, day 11. Similar to the anomaly map for January, the low regions of OLR seem to be random in nature, and are probably a reflection of clouds in the region. Significant lows are present over Indonesia and in the ocean region near Australia. The absence of clouds is indicative of high OLR anomalies which for the January map is shown in the Indian Ocean. The July OLR anomaly map shows a region in the ocean off the coast of China where the OLR for day 11 is significantly higher than the monthly mean.

Besides global latitude-longitude maps, LAS will allow smaller regions at any location to be displayed as latitude-longitude maps of OLR. Also, profile plots of OLR as a function of either latitude or longitude can be displayed for a set location. Latitude-time and longitude-time maps are also available using LAS.

5. SUMMARY

A 1-year data set of daily averaged satellite radiation measurements from the CERES, Terra satellite scanner instrument and means of displaying and accessing via the world wide web (WWW) have been described. A live access server (LAS) enables one to interact directly with the data sets to select and subset data sets in

terms of space and time. The data sets can be used to study environmental and climate change and time series analysis

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Figure 1

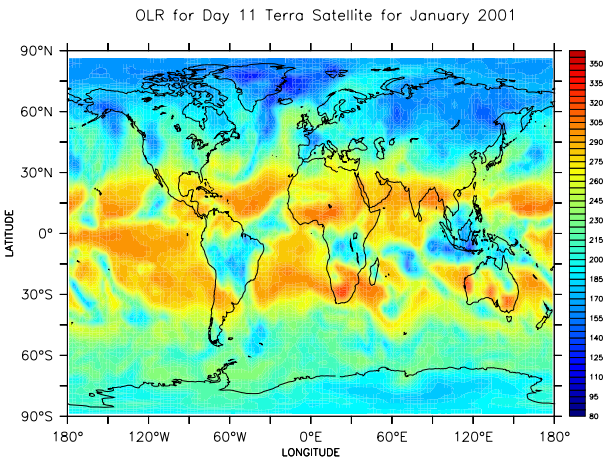

Figure 2

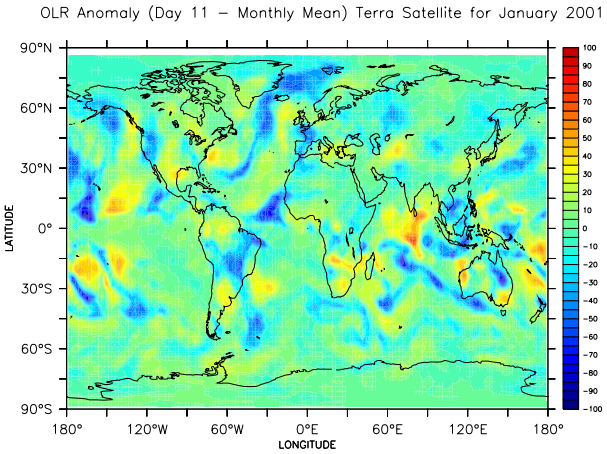

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Figure 3

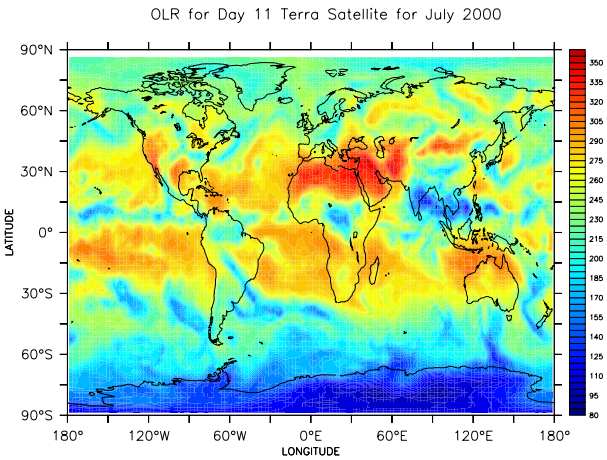
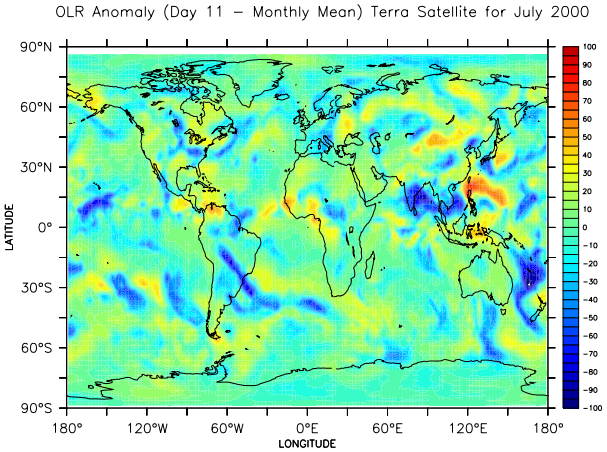


Figure 4



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