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USING A WEB BROWSER FOR ENVIRONMENTAL AND CLIMATE CHANGE STUDIES

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ABSTRACT

A new web browser for viewing and manipulating meteorological data sets is located on a web server at NASA, Langley Research Center. The browser uses a live access server (LAS) developed by the Thermal Modeling and Analysis Project 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 location (latitude, longitude) and time such as day, month, or year. In addition, LAS can compare two data sets and can perform averages and variances, LAS is used here to show how it functions as an internet/web browser for use by the scientific and educational community. In particular its versatility in displaying and manipulating data sets of atmospheric measurements 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 is demonstrated. These measurements are from the Clouds and the Earth's Radiant Energy System (CERES) experiment and the surface radiation budget (SRB) experiment.

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), surface radiation budget (SRB) 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 wide field-of-view (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 (Luther, *et al*., 1986). 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

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equator-crossing times of 0230 and 0730 LST, respectively at an orbit altitude of 872 km and 833 km respectively. ERBS is in 57 degree precession 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 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 were flown 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

Another radiation data set, the NASA/GEWEX Surface Radiation Budget (SRB) Project has developed a 12-year (+) /148-month global dataset of surface shortwave (SW) and longwave (LW) fluxes on a 1 deg. x 1 deg. grid. SW and LW fluxes were computed with detailed radiative transfer models. Input datasets were obtained from a number of sources including ISCCP, GEOS-1, and ERBE. Daily and monthly average fluxes for the period from July 1983 to October 1995 are available from the Langley Atmospheric Sciences Data Center (ASDC). The current version of flux measurements are identified as SRB Revision 2.

All of the ERBE, CERES, and SRB datasets will be made available over a web site located at NASA, Langley Research Center as they become available to the public. The focus in this paper is the SRB dataset which covers twelve years of surface radiation measurements and is from the SRB global dataset of SW and LW fluxes which should be useful to anyone interested in research in atmospheric sciences, especially climate studies.

2. DATA DESCRIPTION

All data are monthly average grid SW fluxes, LW fluxes, and albedos from July 1983 through October 1995 for the SRB global dataset archived at ASDC. The SRB dataset contains regional time and space averages of SW and LW on a 1.0° x 1.0° monthly equal-angle grid.

Thus, the regional data values that go into producing the maps form a 180 by 360 matrix of 1.0° regions. This matrix represents 180 latitude zones, each zone containing 360 regions represented by longitude. The first grid is centered at 89.5 S, 179.5 W longitude. The last grid is centered at 89.5 N, 179.5 E longitude.

3. DATA AVAILABILITY

The 12-year SRB global dataset of SW and LW will be available over a world-wide-web browser located at NASA, Langley Research Center, Hampton, VA. The datasets 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 LW, SW, 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, monthly averaged albedos, SW, and LW and their associated maps can be viewed using the live access server, LAS.

To demonstrate the subsetting capability of LAS, a region in Europe from 5° E to 35° E longitude and 50° N to 70° N latitude is investigated. This location identifies a region of intense study by a number of European countries. The project is known as The Baltic Sea Experiment (BALTEX). The region of BALTEX is shown in Figure 1.

BALTEX includes the entire Baltic Sea water catchment and is a long-term multi-national project to study coupled hydrological processes between terrain, sea and ice, and atmospheric circulation to determine the energy and water budgets of the Baltic Sea.

To give samples of the 12-year SRB global dataset the next six maps are included. The first map in Figure 2 shows upward LW flux at top-of-atmosphere (TOA) in W/M^2 for August 1984. The LW ranges from about 257 W/M^2 over Poland to 217 W/M^2 over Norway and Sweden. Figure 3 shows 1.0° x 1.0° grid values of upward LW flux. These numbers can be saved as a tab or comma delimited file. These files can then be loaded into a spreadsheet for further analysis. Figure 4 shows a map of the same region that displays the surface clear sky upward longwave flux in W/M^2. The flux values range in value from about 416 W/M^2 over Poland to 358 W/M^2 over Norway and Sweden. Figure 5 shows a Hovmoller map of the same region centered at 60 N latitude for four years (1983 – 1986). The results are for TOA upward LW flux and ranges from 178 W/M^2 to 256 W/M^2. Figure 6 and Figure 7 show difference maps for (July 1983 – July 1984) and (July 1983 – July 1985) respectively for upward LW flux at TOA. For most of the BALTEX region July 1983 has a larger TOA LW flux than either July 1984 or July 1985.

Figure 2

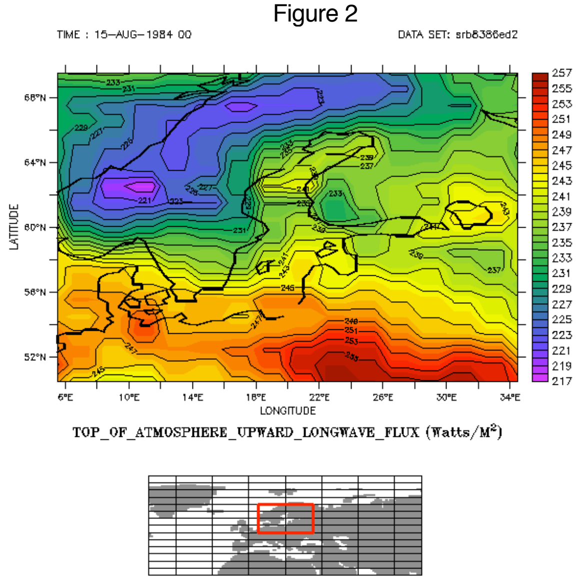


Figure 3

VARIABLE : TOP_OF_ATMOSPHERE_UPWARD_LONGWAVE_FLUX (Watts/M^2)
FILENAME : srb8386ed2.cdf
FILEPATH : /LAS_data/data/SARB/
BAD FLAG : -999.0000
SUBSET : 30 by 20 points (LONGITUDE-LATITUDE)
TIME : 15-AUG-1984 00:00

coordinates		5.5E	6.5E	7.5E	8.5E	9.5E	10.5E	11.5E	12.5E
50.5N	247.5	244.1	244.1	241	241	242.1	242.1	245.4	245.4
51.5N	251.2	247.9	247.9	245.7	245.7	245	245	246.7	246.7
52.5N	249.1	248.1	248.1	245.5	245.5	247.9	247.9	248.1	248.1
53.5N	248.7	247.2	247.2	247.9	247.9	250.5	250.5	246.9	246.9
54.5N	246.4	245.7	245.7	247.8	247.8	249.9	249.9	246.1	246.1
55.5N	246.1	248.2	248.2	247.8	247.8	247.1	247.1	245.8	245.8
56.5N	244.1	246.1	246.1	246.1	246.1	244.9	244.9	244.6	244.6
57.5N	244.1	245.9	245.9	245.2	245.2	243.7	243.7	240.7	240.7
58.5N	244.3	239.7	239.7	237.8	237.8	239	239	235.8	235.8
59.5N	240.1	232.6	232.6	230	230	231.5	231.5	233.7	233.7
60.5N	235.8	226.5	226.5	224.8	224.8	226.8	226.8	228.9	228.9
61.5N	233.5	223.4	223.4	221.8	221.8	221.6	221.6	222.8	222.8
62.5N	230	226	226	219.4	219.4	217.6	217.6	224.9	224.9
63.5N	229.6	226.1	226.1	222.7	222.7	223.3	223.3	223	223
64.5N	230.6	226.9	226.9	224.6	224.6	223.8	223.8	222.3	222.3
65.5N	230	227.1	227.1	225.9	225.9	224.8	224.8	222.7	222.7
66.5N	230.3	230.1	230.1	227.6	227.6	224.3	224.3	222.8	222.8
67.5N	230.5	227.7	227.7	226.3	226.3	224.8	224.8	225.1	225.1
68.5N	230.3	230.1	230.1	231	231	230.7	230.7	230.1	230.1
69.5N	234.6	235.5	235.5	235.7	235.7	234.7	234.7	233.2	233.2

Figure 4

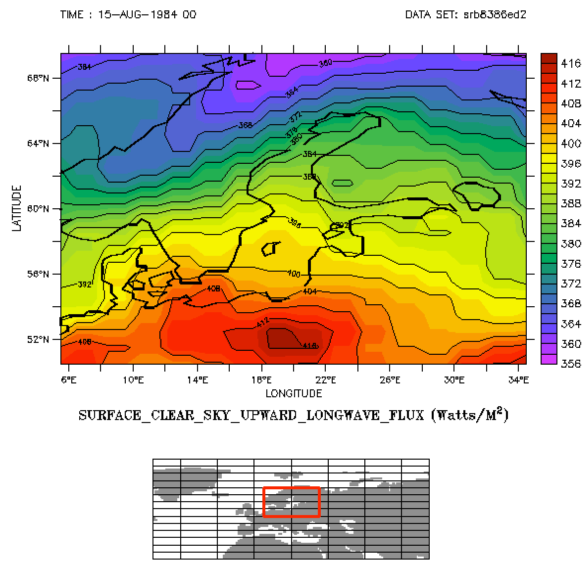


Figure 5

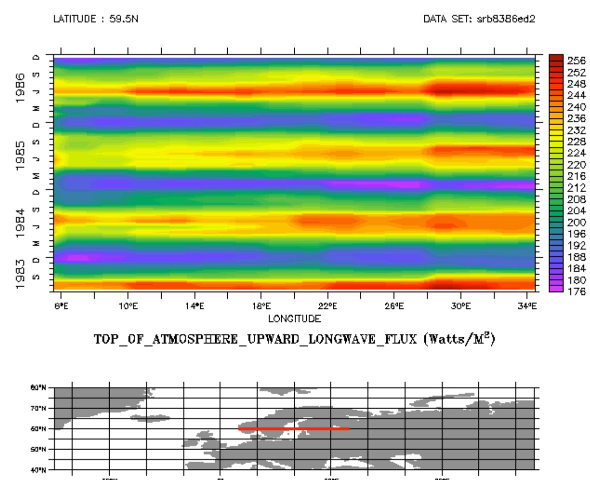


Figure 6

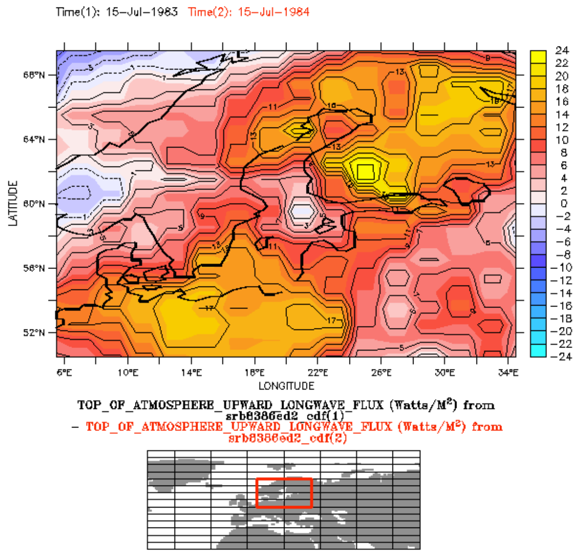
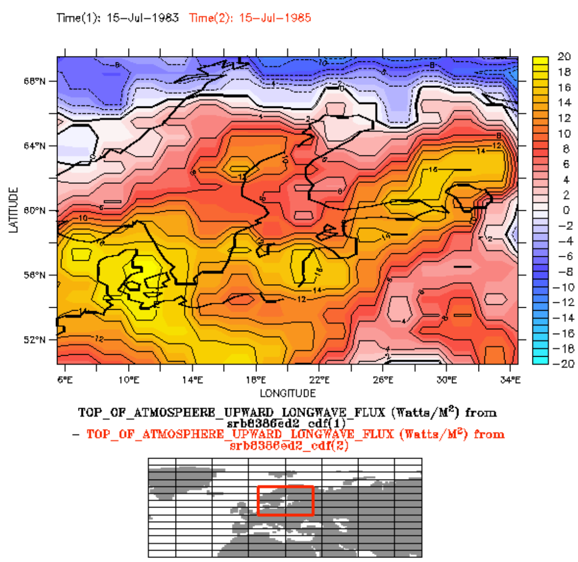


Figure 7



5. SUMMARY

A 12-year dataset of surface radiation measurements from the NASA/GEWEX Surface Radiation Budget (SRB) Project 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 datasets in terms of space and time. The datasets can be used to study environmental and climate change and time series analysis

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