The International Satellite Cloud Climatology Project (ISCCP) Web Site

An Online Resource for Research

BY W. B. ROSSOW AND E. N. DUEÑAS

The International Satellite Cloud Climatology Project (ISCCP) was established in 1982 as the first project of the World Climate Research Program to: 1) produce a global, uniformly calibrated, satellite radiance dataset from which cloud parameters can be derived; 2) coordinate world research on techniques for inferring the physical properties of clouds from satellite measurements; 3) produce and validate a global cloud climatology; 4) promote research using ISCCP datasets to improve parameterizations of clouds in climate models; and 5) improve understanding of Earth's radiation budget and hydrological cycle using ISCCP datasets.

These tasks have been conducted over the past 20 years by an international collaboration involving 10 institutions in five countries that collect and analyze the measurements from the international constellation of weather satellites to characterize the variations of clouds from diurnal to decadal and mesoscale to planetary scales. More than 1000 research papers using ISCCP datasets and results have been published to date.

An ISCCP Web site (http://isccp.giss.nasa.gov) was created by a research group at NASA Goddard Institute for Space Studies (GISS) to support ISCCP project functions, but it has continued to evolve to provide much more and a wider variety of information, data access, and illustrations of data analysis results. The wide range of studies conducted with the ISCCP datasets and the changing environment for accessing datasets over the Internet suggested the need for the Web site to provide: 1) a larger variety of information about the project and its data products for a much wider variety of users [e.g., people who may not use a particular ISCCP data product but could use some ancillary information (such as the map grid definition, topography, snow and ice cover)]; 2) more information about the main data products in several different forms (e.g., illustrations of the cloud analysis method) and more flexible access to the full documentation; 3) access to more data summaries and diagnostic statistics to illustrate research possibilities for students, for classroom use by educators, or for users with "simple" climatology questions (e.g., annual and seasonal means); and 4) direct access to the complete data products (e.g., the whole monthly mean cloud dataset is now available online).

The diagnostic material also includes a collection of research results obtained using the ISCCP data products, especially the complete reconstruction of global radiative fluxes and cloud effects on them, reported at five levels from the surface to the top of the atmosphere (the monthly mean radiative fluxes are also available online).

OVERVIEW OF CONTENTS. With the recent addition of many datasets and analysis results, the ISCCP Web site (see home page in Fig. 1) now offers: 1) the complete ISCCP data documentation in a variety of forms; 2) the ability to browse summaries of many cloud, atmosphere, surface, and radiative flux datasets; 3) uniform radiance calibrations and operations histories for the whole weather satellite system; 4) illustrative analysis results, especially related to different cloud types and the radiation budget; 5) a research bibliography, and; 6) links to many other cloud-data-related Web sites and data centers. Some whole datasets are also available on an associated anonymous ftp site.

AFFILIATIONS: ROSSOW—NASA Goddard Institute for Space Studies, New York, New York; DUEÑAS— SGT, Inc., at NASA Goddard Institute for Space Studies, New York, New York
CORRESPONDING AUTHOR: William B. Rossow, NASA Goddard Institute for Space Studies, 2880 Broadway, New York, NY 10025
E-mail: wrossow@giss.nasa.gov
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ISCCP data documentation can be viewed and downloaded from the ISCCP Web site (see Table 1). These contain very detailed descriptions of the data-processing procedures and data formats, which have traditionally been published as "gray" literature and tend to become difficult to obtain with time, especially after the project ends. Now, however, these materials are commonly placed online at a project Web site. The ISCCP documents (separate chapters are in individual files) are augmented by online copies of the key peer-reviewed papers about the project and its data products, a guide to the relevant peer-reviewed literature that provides evaluations of the analysis method and data accuracy, and an extensive general bibliography of papers using the ISCCP datasets. With the advent of electronic access to the major scientific journals, the growing literature on the ISCCP analysis method, its data products, and research results obtained with them is becoming totally accessible online.

The cloud and other browse products (Table 2) can either be viewed graphically or downloaded. This collection of data serves several distinct purposes. First, one subset is a guide to the ISCCP cloud data products and the comprehensive radiative flux product, including correlative atmospheric and surface information. These products are illustrated by the monthly, seasonal, and annual mean geographic distributions. These products are useful for educators,

Table 1. List of documentation materials (viewable and downloadable).

- Project overview
- Project data centers and participants
- Description of data products
- Ordering and downloading information (including archives links)
- Project status reports
- Known and fixed errors
- Changes to data products
- Dataset naming convention
- Radiance calibrations
- Spectral response functions
- Satellite operation histories
- Cloud analysis method description
- Map grid definitions and ancillary information
- READ software
- Complete documentation
- Relevant papers (37) about analysis method
- Research bibliography

Fig. 1. The ISCCP Web site's home page.

students, and other nonresearch users, who are interested in Earth's atmosphere, surface, clouds, and radiation budget. Also, simple, high-level summaries of the ISCCP results, together with the data analysis section, suggest various possible lines of research for scientists. Most of the quantities in the ISCCP cloud product are available as global maps (viewable and downloadable as a table of numbers) for each month/year and for climatological seasonal and annual means. For example, the first two panels in Fig. 2 compare the climatological annual mean total cloud cover amount from the ISCCP dataset and a similar summary produced from surface weather observations that is also available on the ISCCP Web site (with a link to this project's Web site and access to the full dataset). The third and fourth panels show the climatological annual mean geographic distribution of two particular cloud types, cirrus and deep convection, identified in the ISCCP products by their cloud top pressures and optical thicknesses.

Figure 3 illustrates the results of one major use of the ISCCP cloud products, the diagnosis of cloud effects on Earth's radiation budget. The differences of the two LW flux patterns illustrate the decoupling of the top-of-atmosphere and surface radiation budget. The cloud effect on radiative heating of the atmosphere occurs mostly in the LW, altering one of the two heat sources driving the atmospheric general circulation.

Although we expect that many researchers will use the ISCCP cloud and radiative flux data products directly, ISCCP makes available all of the information about the weather satellite radiances, especially their calibration. Any user of radiance measurements from

Table 2. List of cloud and related browse products (viewable and downloadable).

ISCCP D2 cloud product (mean annual, seasonal, monthly, and mean for month/year) Total, low, middle, high cloud amounts, liquid and ice cloud amounts, amounts for 15 cloud types, cloud-top temperature and pressure, cloud optical thickness and water path, surface temperature
Samples of ISCCP DX and D1 cloud products (esp. for the GEWEX Cloud System Study–Data Integration for Model Evaluation)
Mesoscale cloud inhomogeneity climatology Optical thickness and albedo, emissivity and temperature
Cloud particle size climatology (liquid and ice)
Cloud amounts from surface observations
ISCCP-FD radiative flux product (mean annual, seasonal, monthly and mean for month/year) Shortwave, longwave, total upwelling and downwelling fluxes, net fluxes for all sky, clear sky, cloudy sky at top-of-atmosphere, in-atmosphere and surface, cloud effect on fluxes and net fluxes
Atmosphere climatology (mean annual, seasonal, monthly and mean for month/year) Total precipitable water, total ozone, 500-mb temperature, tropopause temperature, and pressure
Surface climatology (mean annual, seasonal, monthly and mean for month/year) Ice/snow cover fraction, surface skin temperature and albedo, infrared and microwave emissivities

these same satellites now has an easier time using them because they can access the operations and calibration history compiled by ISCCP to support their own analysis.

Table 3, listing the materials provided in the data-analysis section, illustrates various topics that can be investigated using the ISCCP data products. This list is still growing. Example maps and plots from this section (Fig. 4) show that monthly average cloud properties vary more strongly with geographic region than with season, that mesoscale variations are significant, and that there is an intriguing slow variation of global mean cloud cover. The geographic distribution of cloud types is also available, together with a climatology of mean cloud particle sizes and cloud vertical structure. Many additions are being prepared now, including illustrations of the mean life cycle and composite spatial distribution of the cloud properties of midlatitude cyclones and tropical convection, along with the associated radiative and precipitation heating of the atmosphere. Eventually these materials will provide a complete description of the spatial and temporal variations of clouds and radiation, together with links to datasets describing the same for water vapor, precipitation and surface evaporation.

International Internet links on the Web site guide researchers to other useful and extensive collections of cloud, radiative flux, and precipitation data, as well as the links to the major Earth-science data centers. In addition to the browse datasets, several whole datasets are available from the anonymous ftp site. Currently, these include the ISCCP-D2 cloud (monthly means) and the radiative flux (monthly mean ISCCP-FD) products.

DISCUSSION. Since the ISCCP Web site was created and is maintained by a research group at NASA GISS, its evolution has not been systematic; but its characteristics now suggest a new possibility for the dissemination of scientific results. When a research topic matures, the tradition has been to summarize the knowledge in review articles and textbooks, each of which has different review procedures. The advent of all-electronic publishing of research articles and the widespread use of the Internet for finding and disseminating information and datasets suggest that a Web site, like the one developed for ISCCP, could be used to "publish" and distribute a comprehensive collection of scientific data and analysis results in lieu of a traditional print journal review paper or textbook.

This alternative has several advantages over the traditional summaries, the main one being the capability to provide not only the digital data that under-

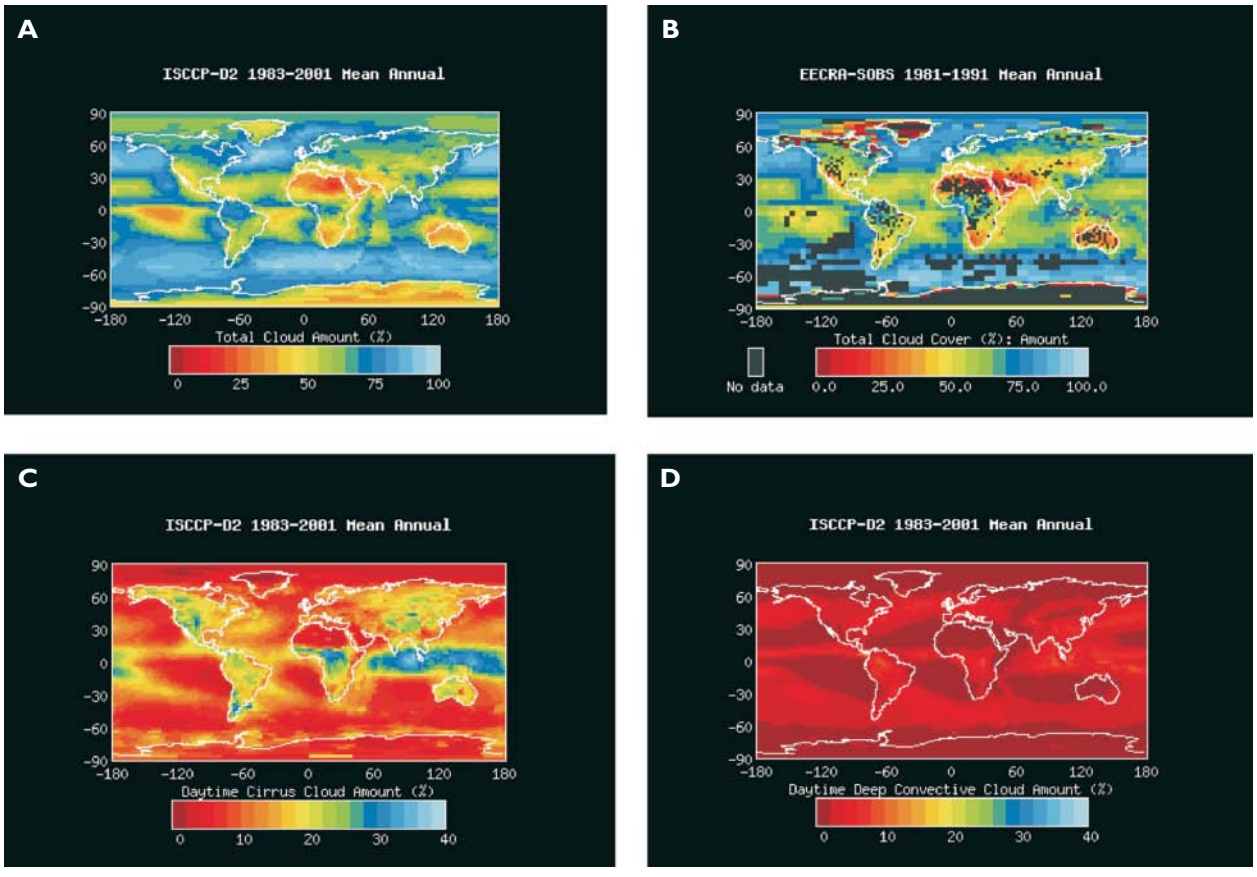

Fig. 2. A sample of the quantities that can be displayed or downloaded from the ISCCP D2 browse page: (a) annual mean total cloud amount from ISCCP; (b) the annual mean total cloud amount from the surface weather observations (accessed from a separate page); (c) annual mean cirrus cloud amount; and (d) annual mean deep convective cloud amount.

Table 3. List of climate data analysis sections.

Cloud analysis
• Climatology of global mean cloud properties
• Regional variations of cloud properties
• Seasonal variations of cloud properties
• Diurnal variations of cloud properties
• Synoptic variations of cloud properties
• Mesoscale inhomogeneity of clouds
• Cloud layer structure
• Cloud microphysics
• Cloud changes of radiative heating/cooling
• Clouds and precipitation
• Cloud variation relations with other atmosphere and surface properties
Global radiation budget
• (Shortwave/longwave/total, upwelling/downwelling/net, full/cloudy/clear sky fluxes) at top-of-atmosphere, at surface, and in-atmosphere (three levels)

lie any graphics but also access to the whole dataset discussed. Thus, a "Web-site review article" could not only summarize the analysis results of others, but could also illustrate additional analyses that might be performed using the datasets that are also supplied through the Web site. For example, instead of presenting zonal monthly mean cloud cover plots for all 219 months of ISCCP now available to show variations, a few summary plots could be shown to illustrate the principle of the analysis, together with the whole dataset and the software needed to produce similar plots. That way

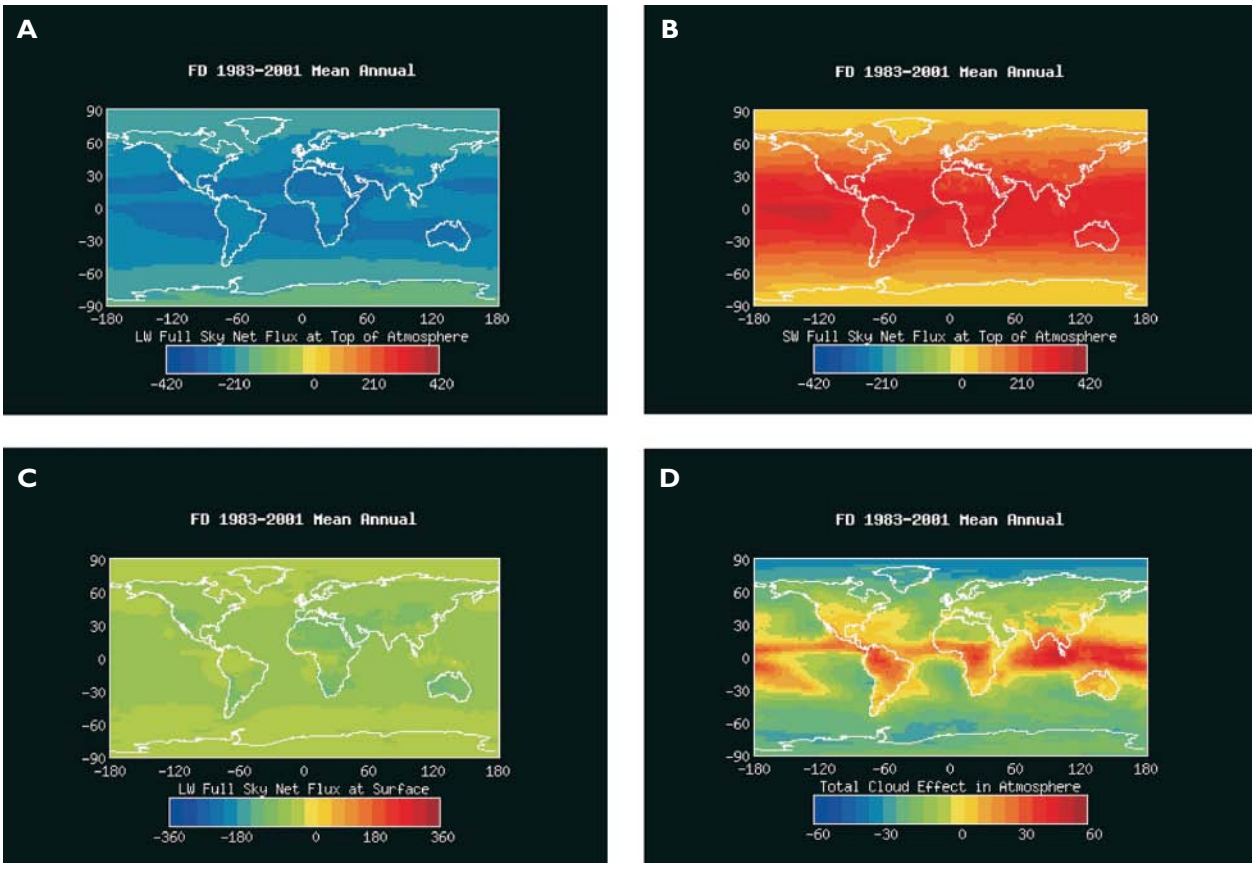

FIG. 3. A sample of the quantities that can be displayed or downloaded from the radiative flux browse page: (a) annual mean top-of-atmosphere (TOA) net longwave (LW) flux; (b) annual mean TOA net-shortwave (SW) flux; (c) annual mean surface net-LW flux; and (d) annual mean cloud effect on the total net flux in the atmosphere.

someone could look at all of these plots or simply make a plot for some particular time period by acquiring the data and software from the Web site. Another advantage is that the Web-site review article could extend the traditional reference list to providing copies of the articles cited by connection to online journals and could expand the reference list by providing links to other related Web sites, online datasets, and data centers. The third advantage is that the materials (text, graphics, data) could be accessed by the user/researcher in the much more flexible manner that hyperlink texts provide. This concept of a Web-site review article or "Web-site textbook" would extend and enhance the information beyond text and graphics to include the analysis procedures (software) and the data to be analyzed.

For this publishing option to be possible, there would need to be some procedure for certifying or peer reviewing the Web site contents and preserving (archiving) it for the future as if it were a part of the dataset and/or the regular scientific literature. The review process could follow the procedures currently used for publishing textbooks, where sometimes the reviews occur after publication, or they could follow the (sometimes stricter) procedures for journal articles after the Web site is submitted to a publishing institution. Although the ISCCP Web site contains a lot of material, the reviewer would need only read the text and examine the graphics with the same thoroughness as currently applied to a regular review article (i.e., the reviewer does not verify the accuracy of every fact, graphic, or citation). Once reviewed, that version of the Web site could be archived; this procedure can also be adapted to allow for updates to the Web site after a similar review process. This alternative but complementary publication process could be provided by the professional societies, like the AMS, that review and publish many of the scientific journals or by the government-maintained data archives that hold the larger datasets.

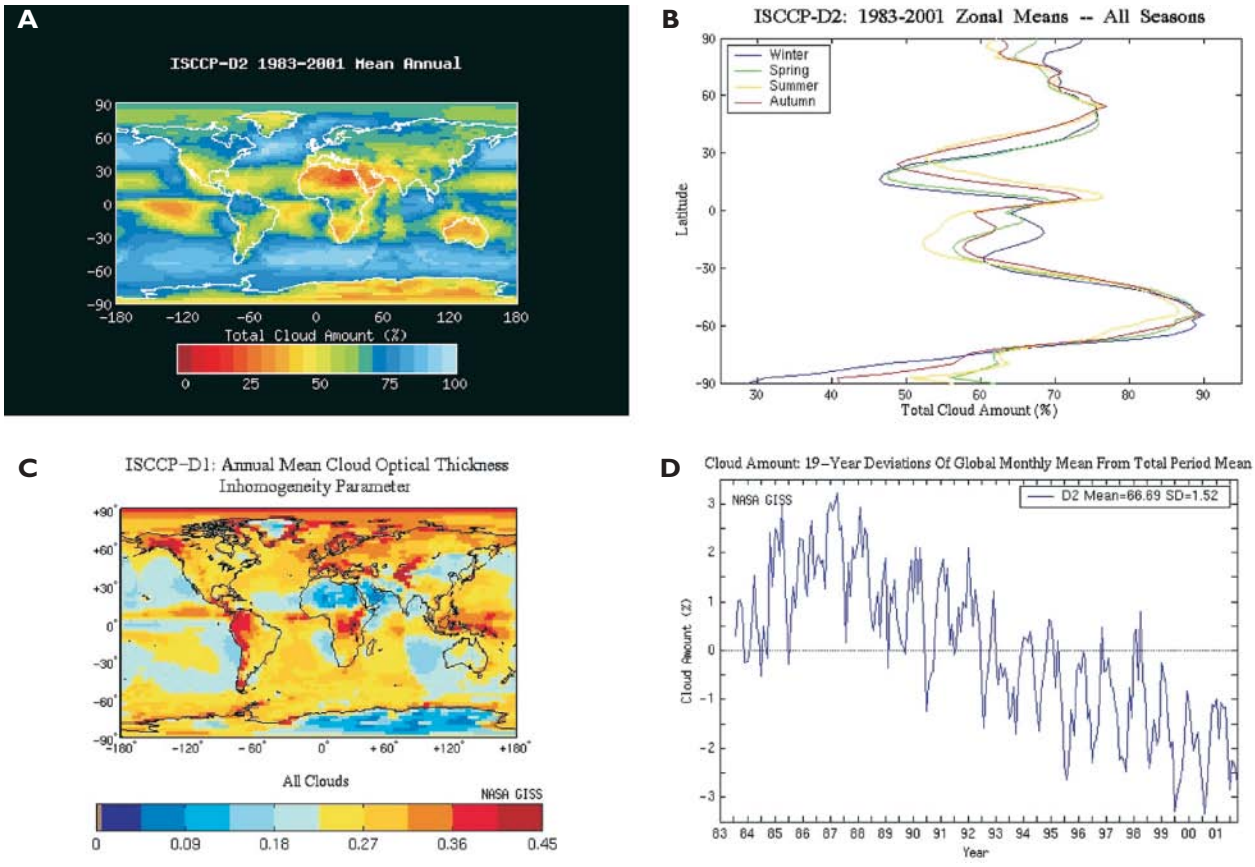

FIG. 4. A sample of the analysis results available in the data-analysis section: (a) annual mean total cloud cover amount map; (b) zonal/seasonal mean total cloud-cover amount plot; (c) map of annual mean mesoscale variability of cloud optical thickness; and (d) plot of the time variation of deviations of global, monthly mean cloud-cover amount from the long-term average value.

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FOR FURTHER READING

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