JP1.1 NASA CLOUD OBJECT DATA WEBSITE: AN INTERATIVE CLOUD OBJECT DATA RETRIEVAL SYSTEM FOR CLIMATE QUALITY SATELLITE CLOUD AND RADIATION DATA

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1. INTRODUCTION

The greatest uncertainty in future projections of climate arises from cloud and their interactions with radiation. Traditional approaches for evaluating and improving cloud-radiative feedbacks in climate models have yielded only small advances over the past decade. A new method based on statistical information obtained from large ensemble of cloud objects observed by National Aeronautics and Space Administration (NASA) Earth Observing System (EOS) satellite combined with matched 4-dimensional atmospheric state data have recently been developed to overcome many of the problems associated with the traditional approaches (Xu et. al., 2004). Statistical comparisons between cloud model results with Clouds and the Earth's Radiant Energy System (CERES) instrument observed cloud objects from this new approach have yielded significant insight into the deficiencies of current cloud models. In addition, statistical comparisons based on large ensemble of CERES observed tropical deep convective cloud objects during the peak of 1998 El Nino in March 1998 and those from the climatological near normal conditions in March 2000 have yielded important scientific information relating to the observed sensitivity of these cloud systems as climate state changed from El Nino to near normal conditions.

As part of our on-going effort to distribute these Earth Science Information to the broader community, a web-based cloud object data retrieval system has been developed at NASA Langley Research Center to allow Earth science users to pick and choose the individual cloud object data and download them directly from the internet. This short paper will give an overview of this NASA cloud object data website. Section 2 will provide a general introduction to the cloud object data. Section 3 will give a short description on each component of this web-based cloud object data retrieval system and an overview of how to access the data using this system. Final summary and future plan for the cloud object data retrieval system will be given in section 4.

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2. CLOUD OBJECT DATA DESCRIPTION

A cloud object is defined as a continuous region composed by individual satellite footprints that satisfy a set of physically-based cloud system selection criteria. Due to the limited width of satellite swath and the section criteria, a cloud object can just include part of a cloud system. The limited width of satellite swath can truncate a cloud system. The selection criteria can break a large cloud system into several smaller cloud objects. A "region-growing" strategy based on cloud imager derived cloud properties is used to identify the cloud objects within a single satellite swath (Wielicki and Welch 1986). A key part of this task is to label the boundaries of an individual cloud object along the scan lines of satellite. Two scan lines are examined simultaneously to identity the boundary footprints of a larger continuous cloud region. A cloud footprint is flagged as a cloud edge footprint if one or more of its sides is adjacent to a clear footprint. A cloud object is uniquely determined if no cloud edge footprints are adjacent to another cloud object.

There are three types of data in the cloud object data product: 1) cloud object footprint data, 2) cloud object statistical data, and 3) cloud object histogram data. All of these data are available on the NASA cloud object website. Detail of this website is given in the next section. The cloud object footprint data contain raw cloud footprint information, deduced from the CERES SSF data product, that satisfy an unique set of selection criteria. A list of available data parameters in the cloud object data product is given in Table 1. The cloud object statistical data contain normal statistics for each of the individual cloud object. The cloud object histogram data contain information about the characteristics of the spatial variabilities for each cloud object. The individual cloud object histogram file can be used to produce the overall statistics for a large ensemble of cloud objects associated with a given geographic regions, cloud object size or

cloud system type, which can then be used for further climate analyses using statistical techniques.

TABLE 1. A list of parameters in the cloud object data set.

Parameter type	Parameter name
Cloud macrophysics	Cloud fraction Effective cloud height Effective cloud pressure Cloud radiative temperature
Cloud microphysics	Cloud liquid water path Cloud ice water path Cloud water droplet radius Cloud ice particle diameter
Cloud optics	Visible cloud optical depth Cloud infrared emissivity
TOA broadband radiation	Albedo Reflected shortwave flux Outgoing longwave flux

At the time of writing of this paper, four distinct types of single-layer, oceanic cloud systems have been extracted from the CERES/SSF data products during the CERES/TRMM data period (January to August 1998 and March 2000). They include (1) tropical deep convection, (2) boundary-layer solid stratus, (3) transition stratocumulus, and (4) trade/shallow cumulus. The selection criteria for each of these cloud object types are given in Table 2. The tropical deep convection covers the area between 25N and 25 S while the other three cloud types have a covered area between 40N and 40S.

TABLE 2. Selection criteria used for determining the four types of cloud-systems.

Cloud type	Cloud top height	Cloud optical depth	Cloud fraction
Tropical deep Convection	> 10 km	> 10	1.0
Trade/shallow cumulus	< 3 km	---	0.1 - 0.4
Transition stratocumulus	< 3 km	---	0.4 - 0.99
Solid stratus	< 3 km	---	0.99 - 1.0

3. CLOUD OBJECT DATA RETRIEVAL SYSTEM

The NASA cloud object data retrieval system is composed of three main components as shown in Fig. 1. The front-end component of this data system is the NASA Cloud Object Data Website, which is the interactive human interface to this data retrieval system and consists of a set of user-definable parameters that can be used to search for specific cloud object data. The web server is powered by Apache system. This component is linked to the back-end of the data system through a set of Java Script and Perl Script procedures. These procedures transfer the user's requests into basic instructions that can be understand by the back-end of the data system. The back-end of this system consists of database system powered by MySQL, which retrieves the user-defined cloud object data and then upload them to the user's computer system through the Internet using standard File Transfer Protocol (FTP).

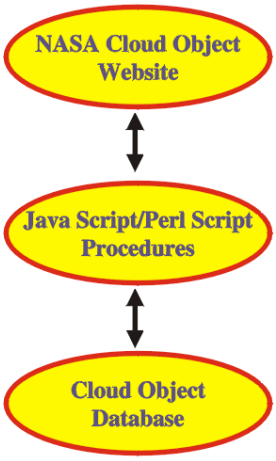

FIG. 1. Schematic of the NASA Cloud Object Retrieval System.

3.1 *NASA Cloud Object Website*

The NASA Cloud Object Website is located at http://cloud-object.larc.nasa.gov on the world wide web. Figure 2 shows a screen capture of the homepage of this website. This website has been constructed using user friendly principles. Data User can easily access all information on this website by clicking the various buttons on top of the web page. This includes information on (1) the cloud objects themselves, (2) cloud object references in the literatures which are hyper-linked to downloadable Adobe PDF files for easy access, (3) cloud object data access, (4) frequently asked questions, and (5) related web sites. Additional information on news, updates, and release schedule about the cloud object project will be included in the near-future.

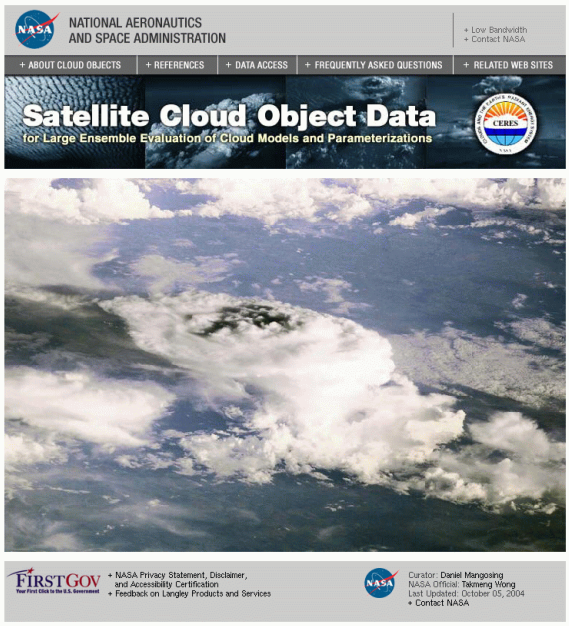

FIG. 2. Screen capture of the home-page of the NASA Cloud Object Website.

3.2 *Cloud Object Data Access*

Cloud object data is accessible by clicking the data access button on the top of the cloud object website. This will take user to the cloud object data access web page (shown in Fig. 3). On this page, user can specify the type of cloud objects, the month of the cloud objects, the location of the cloud objects, and the equivalent diameter size of the cloud objects in the database. These user requests are sent to the cloud object database for direct data query. A list of cloud objects matching the user request will be displayed on the NASA cloud object website for additional data sub-setting. At the data sub-setting web page (shown in Fig. 4), user can also rearrange the order of the cloud object listing or sort the data by time, locations, size, and satellite viewing geometry. In addition, user will be given the opportunity to fine tune their request by picking a specific subset of cloud objects or the entire set. Once the user made the final decision in the data sub-setting web page, a data download web page (shown in Fig. 5) will appear on the screen showing a list of cloud data product types that is available for the selected cloud objects. User can choose all data types or selected data type from the list. The data are then directly uploaded to the user's computer using FTP.

Another interactive feature of the cloud object data sub-setting web page is in its ability to display

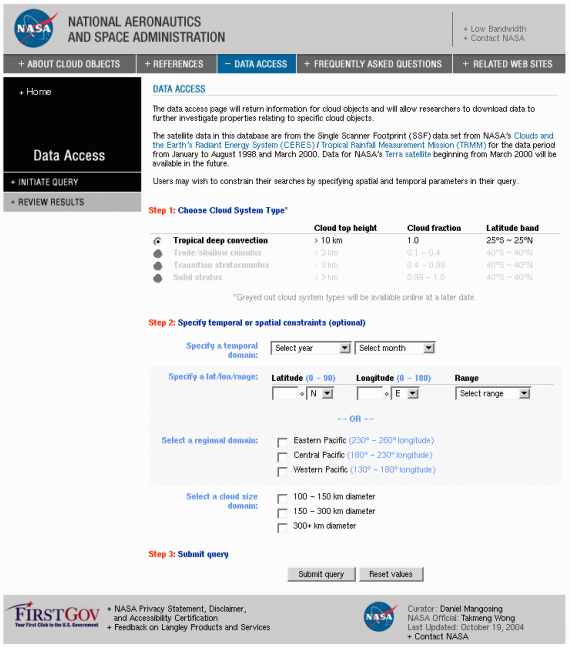

FIG. 3. Screen capture of the cloud object data access web page.

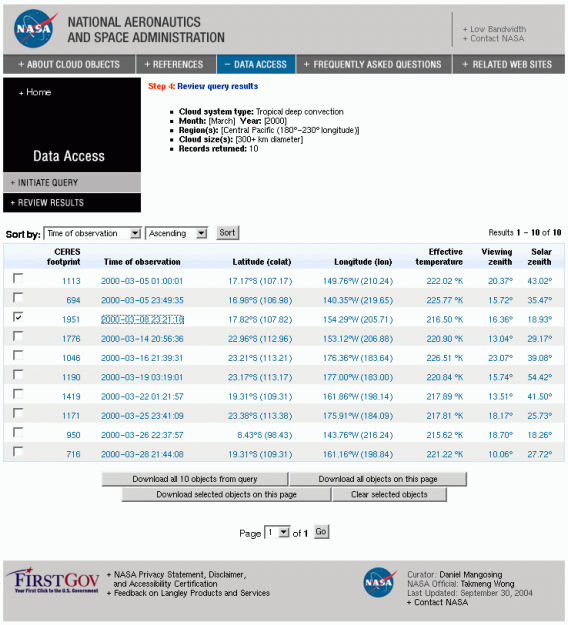

FIG. 4. Screen capture of the cloud object data sub-setting web page.

graphical information about each of the cloud object. This features is activated by clicking the individual cloud object on the listing. A separated cloud object properties web page (shown in Fig. 6) will appear on screen displaying general and statistical information about the requested cloud object.

User can view various graphical information about the cloud object by clicking the hyper-linked text on this web page. For example, one can view the actual shape of the cloud object (shown in Fig. 7) as well as histograms of various cloud and radiation parameters associated with the cloud object (shown in Fig. 8).

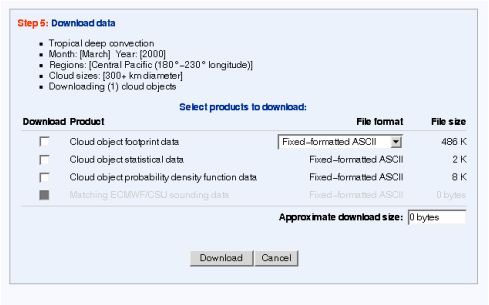

FIG. 5. Screen capture of the cloud object data download web page.

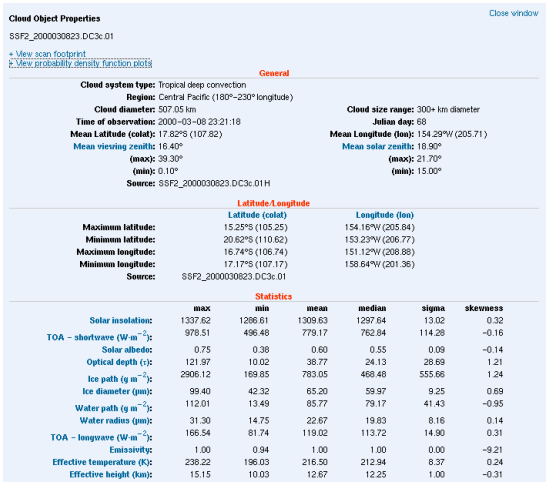

FIG. 6. Screen capture of the cloud object properties web page.

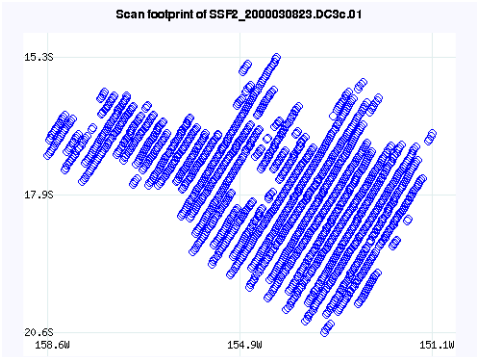

FIG. 7. Graphical illustration of the shape of a cloud object.

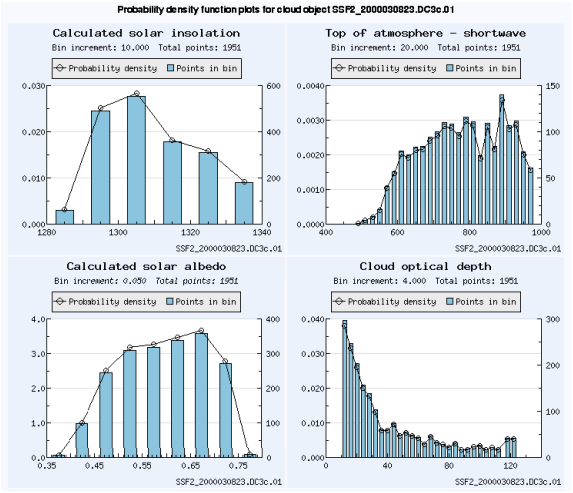

FIG. 8. Graphical illustration of the histograms of various cloud and radiation parameters associated with a cloud object.

4. SUMMARY

The NASA cloud object data web-page provide a unique data set for studying the sensitivity of cloud and radiation fields to changes in climate. The cloud object data is also an excellent data source for validating and improving parameterization of clouds and radiation in current climate models. The current cloud object data retrieval system contains only database for the CERES/TRMM period from January to August 1998 and March 2000. Future plan includes (1) extending the cloud object database to the CERES/Terra period, beginning from March 2000 and (2) adding new cloud system types into the cloud object database.

Acknowledgments. This work has been supported by NASA EOS interdisciplinary study program and by NSF grant ATM-0336762. The CERES data were provided by NASA Langley Atmospheric Sciences Data Center at Hampton, Virginia.

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