P8.2 WEB-BASED SATELLITE PRODUCTS DATABASE FOR METEOROLOGICAL AND CLIMATE APPLICATIONS

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1. INTRODUCTION

The need for ready access to satellite data and associated physical parameters such as cloud properties has been steadily growing. Air traffic management, weather forecasters, energy producers, and weather and climate researchers among others can utilize more satellite information than in the past. Thus, it is essential that such data are made available in near real-time and as archival products in an easy-access and user friendly environment. A host of Internet web sites currently provide a variety of satellite products for various applications. Each site has a unique contribution with appeal to a particular segment of the public and scientific community. This is no less true for the NASA Langley's Clouds and Radiation (NLCR) website (http://www-pm.larc.nasa.gov) that has been evolving over the past 10 years to support a variety of research projects This website was originally developed to display cloud products derived from the Geostationary Operational Environmental Satellite (GOES) over the Southern Great Plains for the Atmospheric Radiation Measurement (ARM) Program. It has evolved into a site providing a comprehensive database of near real-time and historical satellite products used for meteorological, aviation, and climate studies. To encourage the user community to take advantage of the site, this paper summarizes the various products and projects supported by the website and discusses future options for new datasets.

2. DATA

The raw satellite datasets are taken from near-real time streams accessed from the University of Wisconsin Space Science and Engineering Center through the Man-computer Interactive Data Analysis System (McIDAS, Lazzara et al., 1999). The Langley system regularly ingests data from GOES East and West imagers, the National Oceanic and Atmospheric (NOAA) Advanced Very High Resolution Radiometer (AVHRR) on NOAA-12,14, 15, 16, and 17, GOES-9 over the western Pacific, Meteosat-8 Spinning Enhanced Visible and Infrared Imager (SEVIRI), and *Terra* and *Aqua* Moderate Resolution Imaging Spectroradiometer (MODIS). The SEVIRI data are currently delayed by 6 hours. AVHRR data are retrieved for the western United States (US) from the NOAA NESDIS archive in near-real time and for other selected areas *post facto*. AVHRR and older Geostationary Meteorological Satellite (GMS) data taken over the Tropical Western Pacific (TWP) are collected *post facto* from the ARM External Data Center (http://www.xdc. arm.gov/). These data are converted into a variety of multi-spectral GIF images covering a variety of pre-specified regions and, for some domains, are analyzed prior to archiving. The available satellite images are summarized in Table 1. CONUS refers to the continental US, while PACS refers to the Pan American Climate Studies (PACS) southeastern Pacific domain. Typically, the GIF images for each domain include the 0.65, 10.8, and 3.9 channels, the brightness temperature differences between 10.8 and 3.9 and 10.8 and 12.0 μm as well as two different pseudocolor combinations of channels. Images are also created for other selected wavelengths such as 6.7 or 0.87 μm. High-resolution multi-spectral images are also available for more than thirteen different field campaign domains such as the NASA Cirrus Regional Study of Tropical Anvils and Cirrus Layers – Florida Area Cirrus Experiment (CRYSTAL-FACE), the WB-57 Midlatitude Cirrus Experiment (MidCiX), and The Observing-system Research and Predictability Experiment (THORPEX).

Table 1. Real-time and archived satellite imagery available at the NLCR web site.

Domain	Satellite	Date
Midwest (ARM SGP)	GOES-12	Feb 00 - present
Pacific/West US	GOES-10	Feb 00 - present
ATReC/AIRS	GOES-12	Nov 03 - present
Northeast US	GOES-8/-12	May 00 - present
Florida	GOES-12	July 01 - present
Mid-Atlantic US	GOES-8/-12	May 00 - present
TWP	GOES-9	Oct 03 - present
TWP	GMS-5	Jan 00 – Apr 03
Southeast US	GOES-8/-12	May 00 - present
CONUS	GOES-12	Feb 00 - present
CONUS	AVHRR	Mar 00 - present
CONUS	MODIS	Nov 02 - present
PACS/EPIC	GOES-12	Nov 99 – Oct 01
Europe/N Africa	Meteosat-8	Apr 04 - present

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Table 2. Real-time and archive satellite cloud products available on the NLCR web site. VISST used unless indicated otherwise.

Domain	Satellite	Date
SGP	GOES-10	Nov 03 - Present
SGP	GOES-12	Jan 04 - Present
SGP	GOES-8	Jan 00 – Apr 03
SGP (LBTM)	GOES-8	Apr 94 – Aug 03
TWP	GOES-9	Oct 03 - Present
TWP	NOAA-16	Jul 03
TWP (LBTM)	GMS-5	Jan 98 – Apr 03
East CONUS	GOES-12	Nov 03 - Present
West CONUS	GOES-10	Nov 03 - Present
CONUS	GOES-10/12	Mar 04 - Present
Europe/ N Africa	Meteosat-8	May 04 - Present
CRYSTAL-FACE	GOES-8	Jul 02
ATReC/AIRS	NOAA-16	Nov 03 - Dec 03
ATReC/AIRS	GOES-12	Nov 03 - Feb 04
PACS	GOES-8	Oct 99, 01; Jan-Dec 00

Cloud and radiation properties are derived for a variety of domains using the digital satellite data following the procedures described by Minnis et al. (2004) using the Visible Infrared Solar-infrared Split-window Technique (VISST) and the approach described by Minnis et al. (1995) using the Layered Bispectral Threshold Method (LBTM) for older data. The LBTM yields regional (0.3°, 0.5°, or 1°) cloud amounts, heights, temperatures, optical depths, and cloudy and clear-sky visible and shortwave albedos and infrared temperatures and longwave fluxes for daytime data. No optical depths are derived at night, thus no corrections are made for the semi-transparency of optically thin clouds at night, so their heights are underestimated. The VISST and associated methods are used to derive pixel-level cloud properties such as phase, optical depth, cloud-top and base heights, pressures, and temperatures, effective particle size, liquid or ice water path, icing probability, shortwave albedo, and longwave flux. It also produces shortwave albedo, longwave flux, and skin temperature for clear pixels. Table 2 summarizes the domains with cloud products available. Figure 1 shows an example of the visible (VIS) channel image and cloud optical depths for the Europe/North Africa domain.

For the (CONUS) and ARM SGP domains, cloud properties are retrieved from 4 km GOES-East and –West data every 30 minutes and hourly for daytime and nighttime images, respectively. During field experiments or intensive operational periods (IOP), retrievals are performed every 15 minutes.

The ARM TWP domain covers 10°N to 20°S and 120°E to 180°E. Cloud products have been derived from GOES-9 hourly data since October 2003. NOAA-16 AVHRR cloud products were also processed for selected days in July 2003. Information about the other domains can be found at the website. The cloud products and satellite images are archived in an online database and are available in ASCII, binary, netCDF,

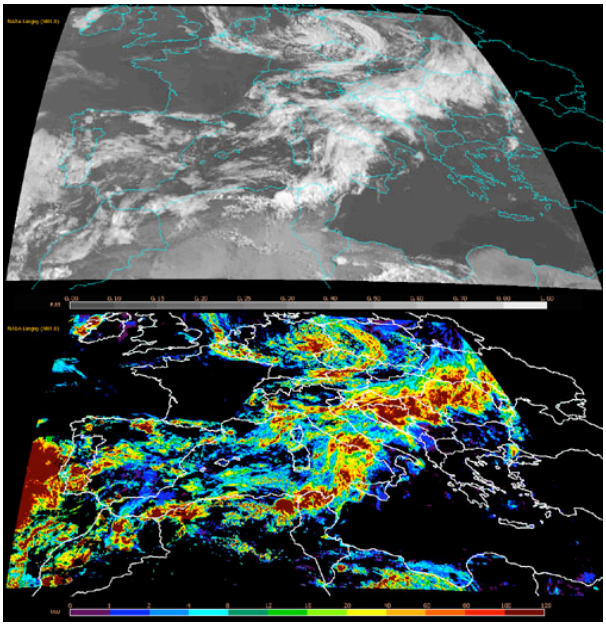


Fig. 1. Meteosat-8 VIS image (top) and retrieved cloud optical depth (bottom), 0700 UTC, 23 May 2004.

and GIF formats. They can be accessed at the web site also.

3. TOOLS

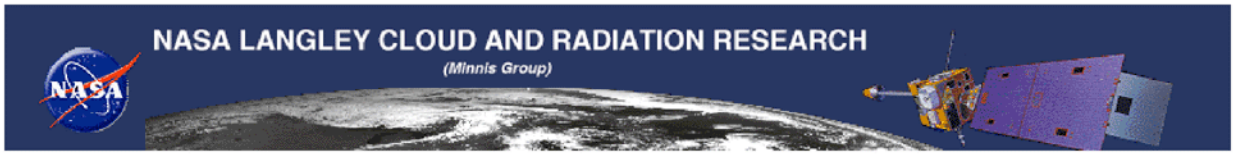
The satellite and cloud products can be acquired in individual images or looped with animated GIF or JAVA applet tools. These tools are available on the satellite products web page (Fig. 2) along with several other aids for data visualization. An example of the looping applet is shown in Fig. 3.

Averages of each parameter are determined for several different surface locations for comparisons with surface observations or along research aircraft flight tracks for comparisons with in situ or remote sensing data. The results for one flight during a field experiment are plotted in Fig. 4. Figure 5 shows an example of ground site data retrievals. Flight track overlays are also available for field experiments. Surface radar data are also available for selected locations.

An interactive orbit predictor is available to determine the times when a given satellite passes over a particular location. “The Predictor” (see Fig. 2) provides viewing and illumination conditions for nearly all meteorological satellites and can be upgraded to include other satellites upon request.

4. SUMMARY

This web site includes many features not detailed here and will continue evolving in the coming years.



Site Map:

Minnis Group Homepage

Viewers/Tools:

NOAA AVHRR Viewer

MODIS Viewer

MID-Atlantic NEXRAD

ARM-SGP NEXRAD

Satellite Overpass Predictor

Field Experiments:

ARM SGP

CRYSTAL

CLAMS

THORPEX

SAFARI 2000

FIRE Arctic (1999)

INCA Spring 2000

ATReC 2003

MIDCIX 2004

Satellite Imagery And Cloud Products Page

Real-time and Historical Cloud Product Loops: The cloud products are derived with VISST/SIST algorithm. Please select a domains below to access the real-time and archived products. JV applet may not work on some Mac browsers (use non-java version).

SGP GOES-10 JV applet	**SGP GOES-12** JV applet	**TWP GOES-9** JV applet	**West CONUS** non-java JV applet	**East CONUS** non-java JV applet
CRYSTAL JV applet	TWP NOAA-16	**ATReC/AIRS GOES-12** JV applet	ATReC/AIRS NOAA-16	**CONUS (merged)** non-java JV applet
Monterey JV applet				

Real-time and Historical Satellite Imagery Loops: The links below provides access to the real-time and historical loops from several GEO satellites.

Mid-West (SGP) JV applet	**North East** JV applet	**Mid-Atlantic** JV applet	**South East** JV applet	**CONUS** JV applet
Pacific/West JV applet	**Florida** JV applet	**TWP GOES-9** JV applet	GMS-5 TWP	PACS EPIC
ATReC GOES-12 JV applet	AVHRR CONUS	MODIS CONUS		

Check the Notes on using java applet for any difficulty of displaying the images on your browser

FTP Access to Binary data and GIF Files

- VISST pixel-level cloud products:

  GOES-8 SGP | GOES-10 SGP | GOES-9 TWP | GOES-10 CONUS | GOES-12 CONUS | GOES-8 PACS | GOES-8 CRYSTAL | ATReC/AIRS |

- VISST cloud product GIF images:

  GOES-8 SGP | GOES-10 SGP | GOES-9 TWP | GOES-10 CONUS | GOES-12 CONUS | MERGED CONUS | GOES-8 PACS | GOES-8 CRYSTAL | ATReC/AIRS |

- LBTM gridded cloud products:

  ARM-SGP | SGP-CART | ARM-TWP | TWP-Manus | TWP-Nauru | TWP-Darwin |

- Satellite imagery GIF files:

  Midwest | Northeast | Mid-alantic | Southeast | CONUS | Pacific/West | Florida | TWP | PACS | ATReC/AIRS |

Cloud Products derived at Ground Site: Interactive tool to plot cloud products.

- VISST - *Computed from pixel retrievals inside a 10 or 20km radius centered on the site.*

  ARM SGP | CRYSTAL-FACE | TWP Nauru | TWP Manus | TWP Darwin | ATReC Bangor | ATReC Montreal | SIRTA France | Chilbolton U.K | Cabauw Netherlands |

- LBTM - *Computed from 3x3 1/3 ° regions centered on the site.*

  SGP CART | TWP Nauru | TWP Manus | TWP Darwin

Fig 2. NASA Langley's Clouds and Radiation satellite imagery and could products webpage.

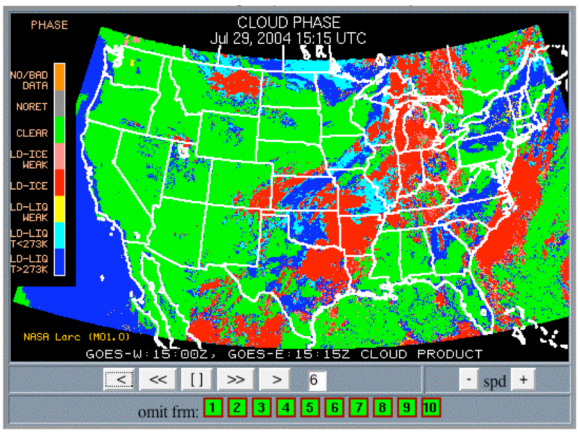


Fig 3. Javascript tool to animation cloud products and satellite imagery.

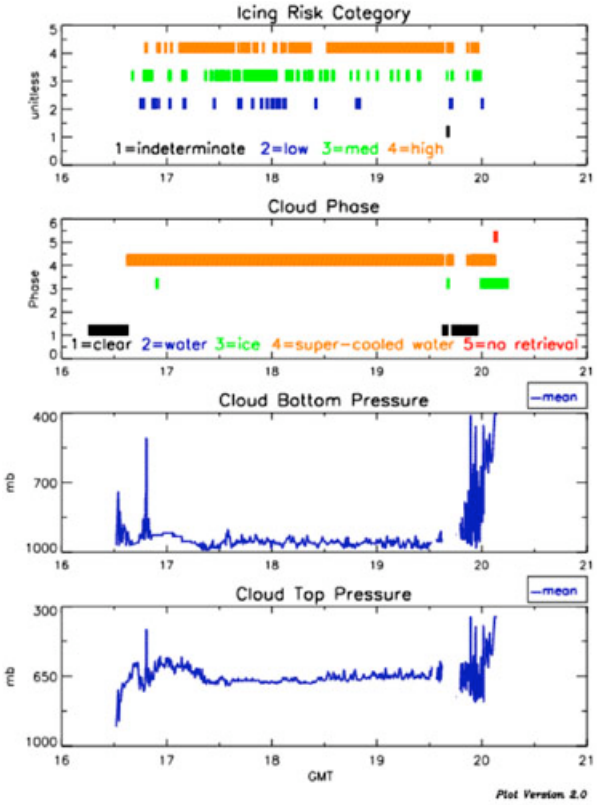


Fig 4. Example of GOES-12 VISST derived cloud products matched along Citation flight track on 30 November 2003 during ATReC/AIRS II field campaign.

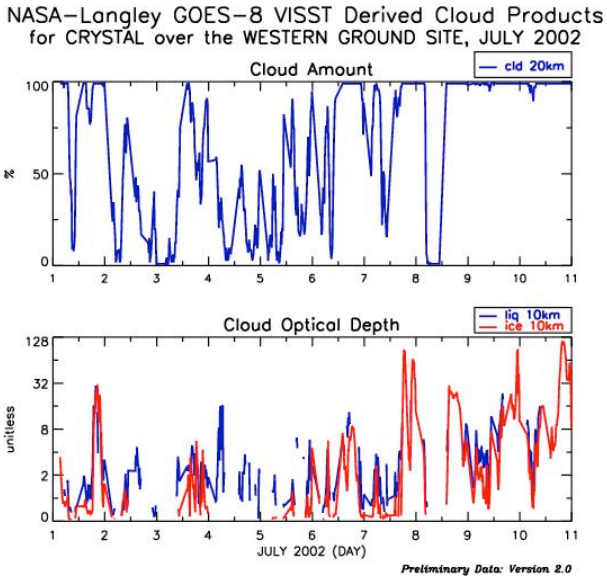


Fig 5. GOES-8 VISST derived cloud products over the Western ground site during CRYSTAL-FACE field campaign in July 2002.

Acknowledgments

The research was support by the NASA Earth Science Enterprise Office, Code YS Radiation Sciences Branch, the Environmental Sciences Division of U.S. Department of Energy Interagency Agreement DE-A102-97ER62341 through the ARM Program, and the NASA Advanced Satellite Aviation-weather Program. Many thanks to Marianne Koenig of EUMETSAT for developing the McIDAS ADDE server code used to read SEVIRI data.

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