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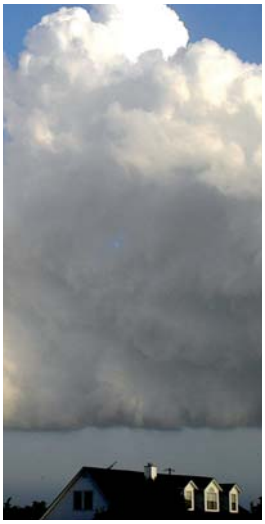
GOES-R Cloud Products



What Is GOES-R?
The Geostationary Operational Environmental Satellite - R Series (GOES-R) is the next generation of National Oceanic and Atmospheric Administration (NOAA) geostationary Earth-observing systems. Superior spacecraft and instrument technology will support expanded detection of environmental phenomena, resulting in more timely and accurate forecasts and warnings. The Advanced Baseline Imager (ABI), a sixteen channel imager with two visible channels, four near-infrared channels, and ten infrared channels, will provide three times more spectral information, four times the spatial resolution, and more than five times faster temporal coverage than the current system. Other advancements over current GOES capabilities include total lightning detection (in-cloud and cloud-to-ground flashes) and mapping from the Geostationary Lightning Mapper (GLM), and increased dynamic range, resolution, and sensitivity in monitoring solar X-ray flux with the Solar UV Imager (SUVI). GOES-R is scheduled for launch in 2015.

How Will GOES-R Provide Cloud Properties?
A suite of products is being developed that will provide advanced cloud detection and retrieval of cloud properties. The GOES-R Cloud Applications Team has developed five algorithms to generate ten unique cloud products for the GOES-R ABI. The enhanced resolution and additional channels provided by the ABI will offer new opportunities for remote sensing, providing more accurate measurements of cloud location, cloud type and phase, and cloud top properties. This information is useful for weather forecasting and improving aviation safety. Observations regarding cloud vertical structure obtained during the NASA Cloud-Aerosol Lidar and Infrared Pathfinder Satellite (CALIPSO) and CloudSat missions have greatly benefited efforts to validate and characterize algorithm performance for the cloud products.

How Do These Products Work?
The **Clear Sky Mask** quickly distinguishes between clear and cloudy pixels. The algorithm was designed to exploit the temporal and spatial advances offered by the ABI. These advances allow for improved day/night performance and increase the overall sensitivity to cloud in all situations. The **Clear Sky Mask** is used in many of the other ABI products and therefore has a large impact on the overall performance of the entire ABI product suite. The **Clear Sky Mask** is also used in the National Weather Service (NWS) Numerical Weather Prediction (NWP) forecast models.

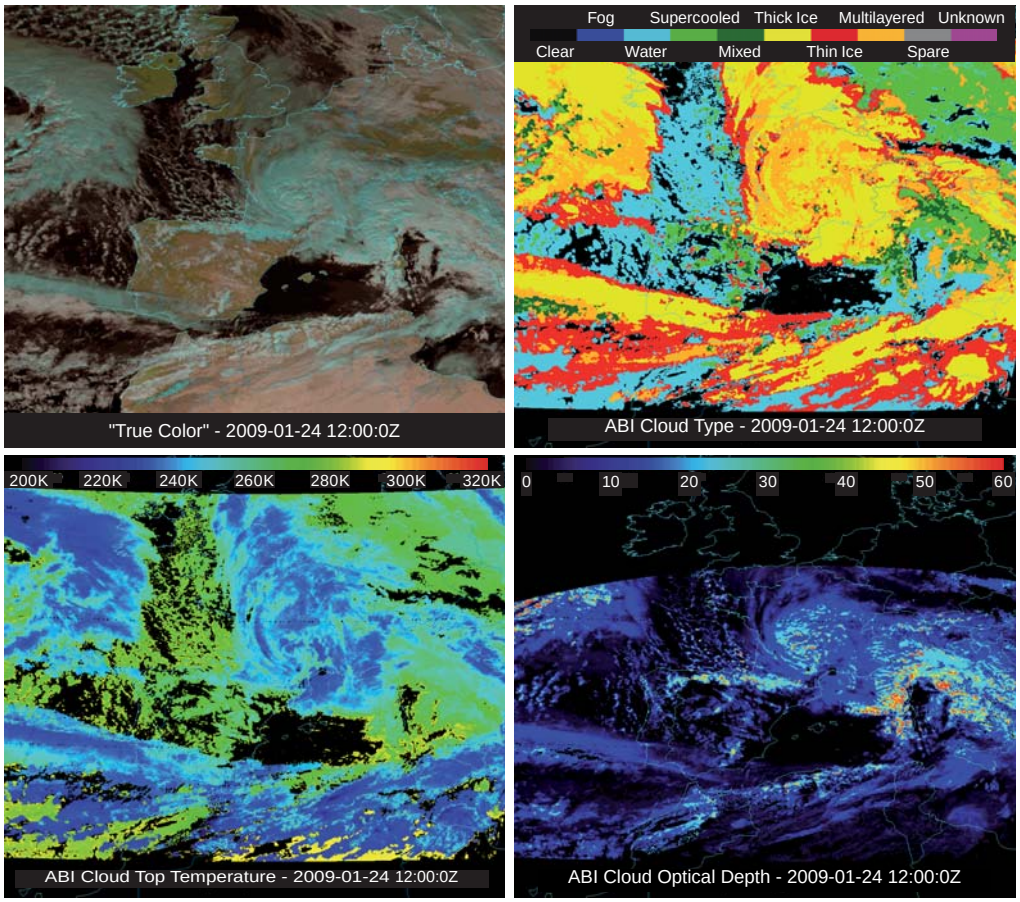
Cloud Type and **Cloud Top Phase** classify the type of clouds present in a given scene. Cloud classification categories include: clear (no cloud), fog, supercooled, mixed, thick ice, cirrus, and overlapping, while cloud phases include: ice, water, and mixed phase. **Cloud Type** and **Cloud Top Phase** are determined through the use of a forward radiative transfer model that is applied to several ABI channels. These products are particularly effective in establishing the maturity, convective intensity, and life cycle evolution of systems of clouds. It is important to determine what types of clouds may be in the path of aircraft in order to avoid potentially dangerous locations that may be prone to icing.

The **Cloud Top Height, Cloud Top Temperature,** and **Cloud Top Pressure** products indicate where the top of a cloud resides for a particular cloud-containing pixel. Cloud height information is used in NWP models and to forecast convective development. **Cloud Top Height** also contributes to aviation safety by detecting the height of cloud tops, enabling aircraft to be routed around towering thunderstorms and convective storm hazards. In addition,

Above the stratocumulus looking at multi-layers of clouds.

the height, temperature, and pressure information is crucial for the generation of satellite-derived winds, which are used by forecasters and in weather forecast models.

Cloud optical and microphysical products include daytime and nighttime **Cloud Optical Depth, Cloud Particle Size Distribution, Cloud Liquid Water,** and **Cloud Ice Water Path**. These cloud properties provide forecasters with information for climate research, such as feedback of clouds into the Earth's radiation budget, and more accurate characterization of cloud properties, amount, and distribution. In addition to climatology studies, the **Cloud Liquid Water** and **Cloud Ice Water Path** can more accurately describe the initial state of clouds in the forecast model domain. While polar orbiters can provide a global view at high spatial resolution, the ABI provides much greater temporal resolution. The high temporal resolution of the GOES-R ABI over a full diurnal (daily) observation cycle more accurately characterizes the variability of clouds than is possible from low earth orbiting satellites alone. This is particularly valuable for detecting rapidly changing signatures in cloud properties that can be indicative of developing severe weather events.



GOES-R simulated cloud product images generated by McIDAS-V (Man computer Interactive Data Access System) using data from SEVIRI (Spinning Enhanced Visible and Infrared Imager), on-board Meteosat 9 (data courtesy of EUMETSAT) are shown for a severe storm over France on January, 24, 2009, the worst in a decade for Western Europe.

Research and Development Partners for Cloud Products

- Cooperative Institute for Meteorological Satellite Studies (CIMSS) at the University of Wisconsin
- NOAA National Environmental Satellite, Data, and Information Service, Center for Satellite Applications and Research (NESDIS/STAR)
- National Aeronautics and Space Administration (NASA), Langley Research Center
- NASA Goddard Space Flight Center

On the Web http://cimss.ssec.wisc.edu/geocat/

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What Are the Benefits?

The improved spectral, spatial, and temporal resolution provided by the ABI will lead to prompt and accurate estimates of cloud and thunderstorm properties, which are necessary to detect potential threats to aircraft and the public. In addition, these advanced cloud monitoring and interpretation products will both improve the forecast models and serve as a more accurate source of validation. Improved cloud properties will also serve as a more accurate basis for other derived products, such as atmospheric motion vectors and surface visibility.

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