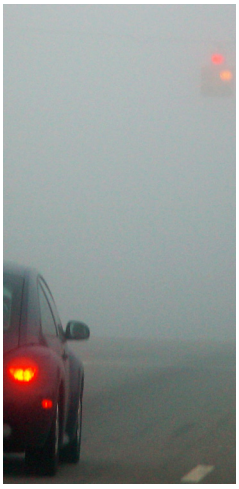
April 2011

GOES-R Aviation Products
Fog/Low Cloud Detection

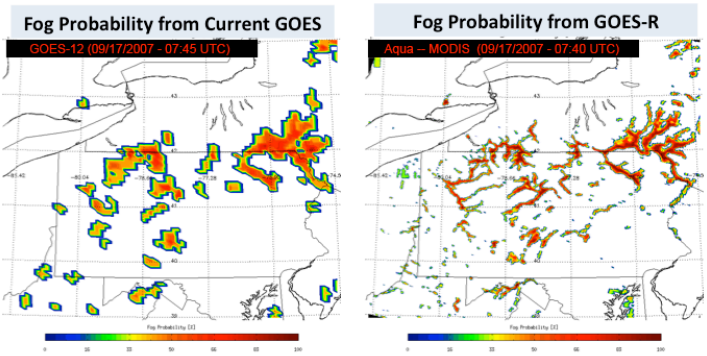


What Is GOES-R?
The Geostationary Operational Environmental Satellite - R Series (GOES-R) is the next generation of National Oceanic and Atmospheric Administration (NOAA) geostationary Earth-observing systems. Superior spacecraft and instrument technology will support expanded detection of environmental 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.

What Is Fog and Low Stratus?
Fog is defined as a stratus cloud that has a cloud base at or close to the surface that reduces the surface visibility to less than 1 km. Even if the base of a stratus cloud is not in contact with the surface, it can be a hazard to aviation. For instance, Instrument Flight Rules (IFR) are required to fly through stratus clouds that have a ceiling of 1000 ft (305 m) or lower. As such, the GOES-R **Fog/Low Cloud Detection** product is designed to quantitatively identify clouds that produce IFR or Low Instrument Flight Rules (LIFR) conditions.

Why Is Fog/Low Stratus an Important Safety Issue?
Fog and low stratus clouds are a hazard to public and personal transportation. Visibility under foggy conditions can be drastically reduced, creating dangerous situations for vehicles on roadways as well as airplanes, trains, boats, and other means of transport. From 1995 to 2005 the National Highway Traffic Safety Administration (NHTSA) determined an average of 38,700 vehicular accidents, resulting in about 16,300 injuries and 600 deaths, were directly related to fog each year in the United States. In the same time period, the National Transportation Safety Board (NTSB) reported an annual average of 81 airplane crashes, 61 of which resulted in at least one fatality, caused by reduced visibility due to clouds, fog, or low ceiling. In addition, millions of dollars are lost each year by commercial airlines from cancellations, delays, and rerouting forced by low visibilities at airports due to fog and low stratus clouds.

Fog advecting inland from the Pacific Ocean over the Golden Gate Bridge in San Francisco, CA.



A valley fog event in Pennsylvania and surrounding states, on September 17, 2007, is used to illustrate the advantages of GOES-R over the current GOES series for fog detection. The probability of fog derived from the current series of GOES is shown on the left and the fog probability derived from GOES-R ABI, using the Moderate Resolution Spectroradiometer (MODIS) as a proxy for the ABI, is shown on the right. As this example shows, small-scale fog features will be depicted by the GOES-R ABI with much greater detail than the current GOES system can provide. In both cases shown above, the GOES-R fog algorithm is used to generate the fog probability.

GOES-R (Geostationary Operational Environmental Satellite-R Series)

A multi-vehicle traffic accident caused by low visibilities due to fog.

Fog disrupts flights at Salt Lake City International Airport on 1/6/11.

How Will GOES-R Detect Fog and Low Stratus?

The GOES-R **Fog/Low Cloud Detection** results are available as a statistical probability (a binary fog mask is also available). At night, the algorithm utilizes the 3.9 and 11 µm channels to assign a fog probability. Fog probability during the day is determined using the 0.65, 3.9, and 11 µm channels. The fog probability is based on textual and spectral information, as well as the difference between the cloud radiative temperature and surface temperature. A sophisticated cloud object based filtering technique is also applied to increase algorithm skill.

When not obstructed by higher cloud layers, the GOES-R **Fog/Low Cloud** algorithm will detect and monitor areas of potentially hazardous fog/low stratus clouds. In addition, the improved spatial and temporal resolution of the ABI will greatly aid in fog/low cloud monitoring. The current GOES fog products are limited to a qualitative brightness temperature difference approach (3.9µm - 11µm), available at 15 or 30-minute intervals, that can only be used at night. The GOES-R algorithm will produce a quantitative analysis of the probability that fog or low stratus is present, both day and night. An example of how this product could have been used occurred on December 13, 2009 in Alva, Oklahoma. A man was killed when his plane crashed due to heavy fog at the Alva Municipal Airport. The airport was located right on the western edge of a large area of fog or low stratus around the time of the crash. Surface observations were not available at the airport, but the public reported a visibility of only around 200 feet. The GOES-R **Fog/Low Cloud** algorithm indicated there was a greater than 80% chance that a low cloud ceiling may be present. If this information was available, the pilot may have changed his mind about landing in Alva at that time.

What Are the Benefits?

Unlike surface observations that are very localized and can be quite sparse in parts of the country, the GOES-R **Fog/Low Cloud Detection** algorithm will provide a more spatially and temporally continuous quantitative estimation of the probability that fog or low stratus clouds are present. The higher spatial and temporal resolution of the GOES-R ABI will allow forecasters to better identify potential hazards caused by reduced visibility and/or low ceilings, and relay the information accordingly. Animations of the GOES-R **Fog/Low Cloud** product will also show how these areas are moving or dissipating, aiding in clearing time estimation, which is very important to the aviation industry.

Research and Development Partners for Fog/Low Cloud Detection Product

- NOAA National Environmental Satellite, Data and Information Service, Center for Satellite Applications and Research (NESDIS/STAR)
- Cooperative Institute for Meteorological Studies (CIMSS)
- National Weather Service (NWS)

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

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