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THE SATELLITE-DERIVED CLOUD COVER PRODUCT

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Editor's Note: The following is a summary of National Weather Service Technical Procedures Bulletin 410 from which more detailed information about the Satellite-derived Cloud Cover Product may be obtained.

Introduction

Utilization of the Automated Surface Observation System (ASOS) continues to increase as does the number of commissioned ASOS sites. Although ASOS will enhance modernization plans in the National Weather Service, it poses some limitations. The inability of the ground-based ceilometer of ASOS to measure cloud bases above 12,000 feet above ground level (AGL) leaves sky conditions above 12,000 feet unknown leading to incomplete cloud observations.

This limitation of ASOS has led to the development of the Satellite-derived Cloud Cover Product (SCP). The SCP was developed by the National Environmental Satellite, Data, and Information Service (NESDIS) and the Cooperative Institute for Meteorological Satellite Studies (CIMSS), and complements ASOS by providing cloud cover information above 12,000 feet mean sea level (MSL) through techniques using satellite data. The SCP will provide the necessary cloud data above 12,000 feet (AGL), which may be needed in certain applications such as the NWS hourly roundup, NMC surface analysis and weather depiction charts, pilot briefings, and any other use dependent upon total sky conditions.

The Product

The SCP provides cloud cover information above 12,000 feet (MSL) for each commissioned ASOS station across the United States. Additional observations are provided for research sites and soon-to-be commissioned ASOS sites. Of course, the number of sites covered in the SCP will increase as additional ASOS sites are commissioned. The SCP is updated hourly, approximately 55 minutes past the hour. Delays will occur at 1200 UTC for all stations and at 0500, 1100, 1700 and 2300 UTC for stations south of 35°N due to satellite scheduling conflicts. Currently, the areal coverage of the SCP includes only the contiguous United States, but future coverage may become available for Alaska, Hawaii, and Puerto Rico. The SCP is under the AFOS headers: NMCSCPxxx (xxx=WR1 for Western Region, CR1 for Central, ER1 for Eastern, SR1 for Southern).

The following data are provided by the SCP:

1) Identifier for ASOS observing station

2) Date and time (UTC)

3) Cloud coverage at midlevels
   - Cloud tops between 631-400 mb or 12,000-23,600 feet (MSL) in the standard atmosphere
4) Cloud coverage at high levels
   - Cloud tops above 400 mb or 23,600 feet (MSL)

5) Range of cloud top heights (MSL)
   - Range of cloud top heights from a lower limit of 631 mb or 12,000 feet (MSL) to an upper limit set to the first guess of the tropopause height from the NGM. Cloud heights are determined from each of 25 field of views (FOV) centered over an observed site. Each FOV is a horizontal field measured by the satellite having a resolution of approximately 10 km. Measurements of cloud heights of all 25 FOVs are then compared indicating a range of cloud heights for the observed site.

6) Average effective cloud amount (ECA)
   - Measure of total cloud cover and cloud opacity in percent. The average ECA is helpful in determining if a layer is thin (CLR=0, OVC=100, <33 for BKN and <66 for OVC indicates likelihood of thin clouds).

For Example:

Layer	ECA	Indicates
OVC	50	-OVC
OVC	80	OVC
BKN	20	-BKN
BKN	40	BKN

Standard categorical breakdowns are used in describing sky conditions (CLR, SCT, BKN, OVC). Mostly clear (MCLR) is also reported when very thin transparent clouds may be present above 631 mb (12,000 feet MSL), but there is insufficient data to accurately measure total cloud cover and cloud top heights. Although MCLR is located in the MID (middle level) column, thin clouds may be present at any level above 631 mb (12,000 feet MSL).

Technique

The SCP is derived from satellite techniques using the Geostationary Operational Environmental Satellite/Visible Infrared Spin-Scan Radiometer Atmospheric Sounder (GOES/VAS). The satellite begins measuring radiances from north to south across the scan area at approximately 20 minutes past each hour, completing the process at approximately 30 minutes past the hour. Processing and distribution take an additional 20 to 25 minutes, accounting for the availability at about 55 minutes past the hour.

The estimation of cloud coverage and height begins with the measurement of radiances for up to 25 FOVs (5x5 grid) centered over each observed site listed in the SCP. Each FOV has

an approximate horizontal resolution of 10 km at midlatitudes. The combined 25 FOVs encompass a 50x50 km box centered over the observed site.

The estimation of cloud information then continues with a three-step process for each site. This process begins with the estimation of the ECA and cloud top pressure for each FOV surrounding a site. Second, a decision tree is used to estimate the composite cloud coverage for each site. To complete the process, the average ECA is computed for each site by averaging the individual ECAs from the 25 FOVs around the observation site which is expressed in percent.

To enhance the satellite detection performance, the CO2 absorption technique is used, which measures from three infrared spectral channels that are all sensitive to CO2 absorption at various atmospheric levels. The CO2 technique helps to avert errors caused by infrared brightness temperatures of cirrus that are warmer than the temperatures associated with the true altitude of the cloud. If uncorrected, this error can miss cirrus clouds or mistake them for lower clouds.

Although the CO2 technique enhances satellite detection, this technique also experiences difficulties. In most cases, this technique only detects the highest cloud top within a given FOV leaving individual cloud tops of multilayered clouds undetected. When a FOV contains a thin cloud layer overlaying another, a cloud top between the two layers will be estimated. Also, if only one high thin layer exists, a cloud layer will be estimated to be between the thin layer and the earth's surface. This can result in high thin clouds being misidentified as low-level clouds. The CO2 technique also faces problems during episodes of strong temperature inversions, when the satellite estimates a cloud layer at midlevels based on the actual measured radiances of very cold surface temperatures. In general, resolution is near 10 km in the midlatitudes leaving smaller cloud elements or small cloud breaks unresolved.

Performance

A test compared the results between observations made by human observers and ASOS/satellite observations. In general, ASOS/satellite observations tended to favor extremes (clear or overcast with less instances in the SCT and BKN categories). With the subjectivity involved in human observations, a single categorical difference may not always indicate a substantial discrepancy, but two categorical differences should be regarded as significant.

An evaluation of the ASOS/satellite observations ability to differentiate between thin and opaque clouds was made. It was shown that ASOS/satellite observations estimated total sky cover better than opaque sky cover. At night, the ASOS/satellite observations had a bias toward overestimation of the total sky cover.

References

NWS, 1994: The satellite-derived cloud cover product. *NWS Tech. Proc. Bull.* 410. (Attachment 1)