

Improvements to GOES Twilight Cloud Detection over the ARM SGP



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I. Introduction

a) Definition of Twilight

- Here twilight is defined as when $82.0 < \theta < 87.5$, where θ is the solar zenith angle

b) Challenges of Twilight Cloud Detection

- Very little visible reflectance
- Low water clouds have little thermal contrast with the underlying surface
- A small solar component negates the usefulness of channels near $3.7 \mu\text{m}$

III. Method

- Method is summarized in Figure 1
- The Visible Infrared Solar-infrared Split-window Technique (VISST) uses a version of the Clouds and the Earth's Radiant Energy System (CERES) cloud mask (CM) as the primary method of cloud detection
- Mean clear and cloudy brightness temperatures (BTs) and other statistics are calculated from the satellite observations preceding twilight
- During twilight, the CERES CM is executed as usual
- After the cloud masking is performed, these statistics and the CM results are compared to the observations for each pixel under twilight conditions
- Depending on the CM result and how well the twilight statistics match the statistics from the preceding satellite overpass, the CM is adjusted
- This statistical algorithm is supplemental to the CERES CM and is designed to detect as much cloud as possible while minimizing false cloud detections

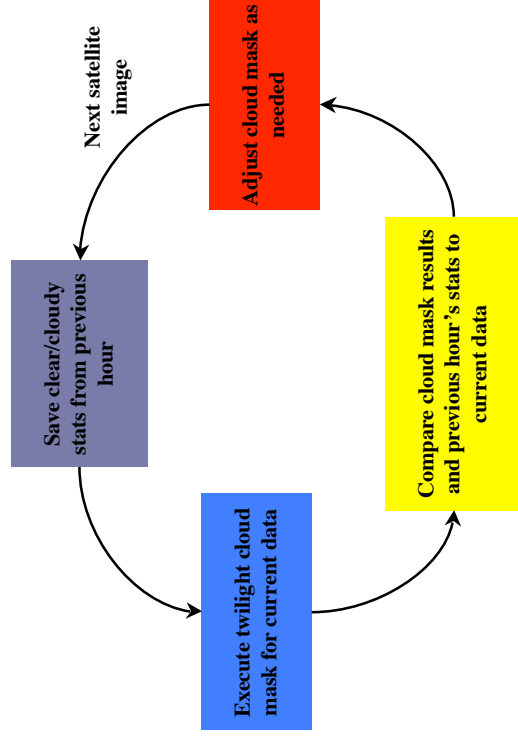


Fig. 1. Flowchart illustrating the new twilight cloud detection process

III. Improved Cloud Detection over the SGP

- GOES-8 data from June to November 1998 were reprocessed over a region within a 10-km radius of the ARM SGP Central Facility using the new stats algorithm to aid cloud detection during twilight
- Table 1 shows how the new VISST cloud amounts compare to 30-minute averaged cloud amounts derived from micropulse lidar (MPL) data. Values in parentheses were obtained without using the stats algorithm

VISST Cloud Amount (%)	ARM Cloud Amount (%)		
	≤ 5	$5 < CA < 95$	≥ 95
≤ 5	60.5 (84.9)	18.2 (29.5)	1.7 (6.8)
$5 < CA < 95$	34.9 (12.8)	52.3 (40.9)	40.7 (42.4)
≥ 95	4.7 (2.3)	29.5 (29.5)	57.6 (50.8)

Table 1. Comparison of VISST and 30-minute averaged cloud amounts from MPL data. Values in parentheses were obtained without use of the stats algorithm.

- An example from June 5, 1998, is illustrated in Figure 2 below
- Most of the warm low clouds over Kansas and northern Oklahoma were detected by the nighttime cloud mask at 1115 Z (not shown) but missed by the twilight cloud mask at 1145 Z (Fig. 2a)
- The stats algorithm restores much of the cloud cover (Fig. 2b) and this is easily verified by looking at an enhanced visible satellite image (Fig. 2c)
- A red circle indicates the location of the ARM site (36.62°N , 97.50°W)

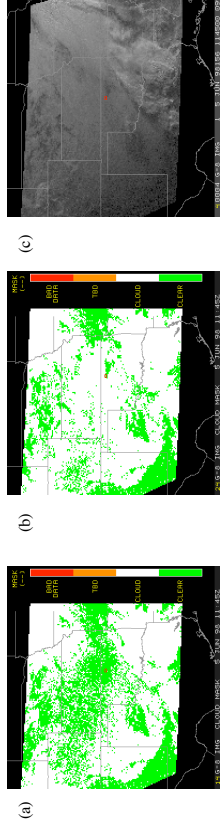


Fig. 2. Images of (a) the CERES cloud mask at 1145 Z, (b) the CERES cloud mask at 1145 Z after re-processing with the new stats algorithm, and (c) an enhanced GOES-8 visible image at 1145 Z.

IV. Summary

- An algorithm has been developed to aid cloud detection during twilight hours
- Satellite observations are compared to clear and cloudy statistics from the previous satellite overpass to provide a smoother transition from the daytime to the nighttime cloud mask algorithm
- The initial results indicate that cloud detection increased by about 10% when compared to the MPL data using the new algorithm
- The statistical approach outlined here is supplemental to the CERES cloud mask and is not intended to replace a rigorous cloud mask algorithm

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