A Comparison of HIRS Cloud Top Pressure and AVHRR-Derived Cloud Overlap

Michael J. Pavolonis[1] and Andrew K. Heidinger[2]

[1]Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin, Madison, WI

[2]Office of Research and Applications, NOAA/NESDIS, Madison, WI

1. Objectives

-Demonstrate the ability to detect multiple cloud layers using Advanced Very High Resolution Radiometer (AVHRR) data.

-Relate regions of AVHRR-derived cloud overlap to cloud top pressures retrieved using High Resolution Infrared Radiation Sounder (HIRS) measurements.

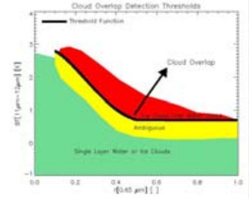
-Demonstrate the potential usefulness of the AVHRR cloud overlap algorithm when applied to HIRS data.

2. AVHRR Cloud Overlap Theory

-Algorithm utilizes channel 1 (0.63 µm) reflectance, channel 4 (10.8 µm) brightness temperature, and channel 5 (12 µm) brightness temperature data.

-For a semi-transparent ice cloud overlying a lower water cloud, the difference in transmission through the ice cloud at 10.8 µm and 12 µm will generally result in an 10.8 – 12 µm brightness temperature difference that is larger than that for a single layer water cloud with a similar reflectance as the lower cloud.

3. Radiative Transfer Simulations



-A radiative transfer model was used to perform single layer cloud (water and ice) simulations and simulations with an ice cloud overlapping a water cloud.

-Thresholds of 10.8 – 12 µm brightness temperature difference were determined as a function of 0.63 um reflectance for various viewing and solar zenith angles.

-The figure above shows the theoretical relationship exploited in the algorithm.

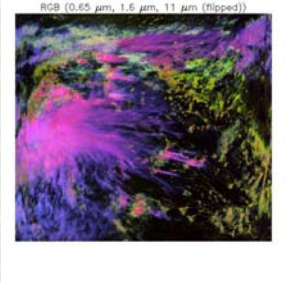
4. Additional Algorithm Constraints

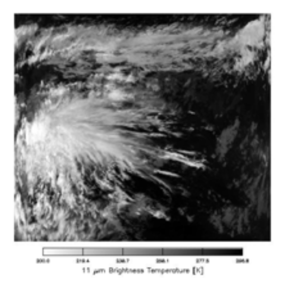
-the 10.8 µm brightness temperature < 270.0 K

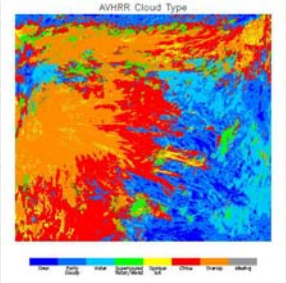
-the 0.63 µm reflectance > 0.30

-not used over known snow/ice surfaces or deserts

5. Algorithm Performance

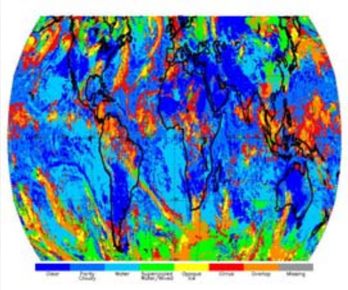


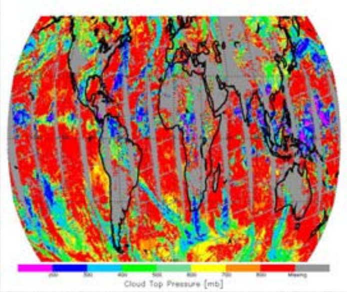


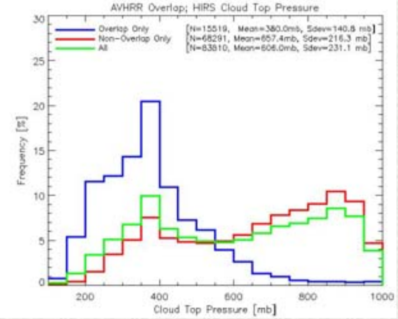


The above images show that the AVHRR algorithm is effective at detecting cloud overlap, which can visually be inferred from the multi-spectral image on the left and the infrared image in the center. This AVHRR scene is from July 2, 2001 and located over the Eastern Pacific Ocean. The complete AVHRR cloud typing algorithm, which is implemented in the extended Clouds from AVHRR (CLAVR-x) processing system, was applied to this scene.

7. AVHRR Cloud Overlap vs HIRS Cloud Top Pressure

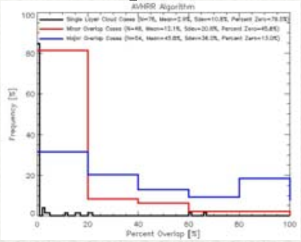






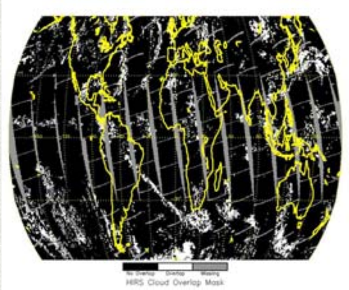
The complete AVHRR cloud typing algorithm was applied to AVHRR data for the ascending node of NOAA-16 on October 13, 2003 (left). HIRS-derived cloud top pressures for the same orbits are shown in the center image. The HIRS data is from a rotating 1T file. Both the AVHRR and HIRS data were mapped to a 0.5 degree equal area grid. The figure on the right shows a histogram of the HIRS cloud top pressure for grid cells in which overlapping clouds were the dominant cloud type, for cloudy grid cells in which cloud overlap was not dominant, and for all cloudy grid cells. The results indicate that the presence of multiple cloud layers can potentially cause the average retrieved HIRS cloud top pressure to be about 50 mb lower compared to when the cloud overlap regions are filtered out.

6. Validation



Single layer, minor cloud overlap (overlap is present less than 50% of a 30 minute interval), and major cloud overlap (overlap is present at least 50% of a 30 minute interval) cases were identified by cloud radar over the ARM SGP and TWP sites. The AVHRR cloud overlap algorithm was applied to MODIS (Moderate Resolution Imaging Spectroradiometer) pixels that were within 15 km of the cloud radar at overpass time. The chosen 30 minute radar time series was centered on the MODIS overpass time. The fraction of cloudy pixels that passed the cloud overlap test are shown for each case.

8. Cloud Overlap Detection with HIRS



The AVHRR cloud overlap algorithm was applied to HIRS channel 20 (0.69 µm), channel 8 (11.11 µm), and channel 10 (12.47 µm) data with no adjustments. The day shown is the same used in Section 7. These initial results indicate that the AVHRR algorithm could be effective at detecting cloud overlap with HIRS. Cloud overlap information may be useful for improving cloud top height retrievals.

9. References

Pavolonis, M,J. and A.K. Heidinger, 2003: Daytime cloud overlap detection from AVHRR and VIIRS. Rev. Submitted to *J. Appl. Meteor.* (October, 2003).

The AVHRR cloud typing algorithm is part of the extended Clouds from AVHRR (CLAVR-x) processing system run by NOAA. The CLAVR-x cloud typing results, including the cloud overlap detection, is available globally in real-time at the pixel level and mapped to a 50 km grid.

For more information on, and to access, the CLAVR-x products go to,

http://cimss.ssec.wisc.edu/clavr/

Corresponding authors:

Michael Pavolonis: mpav@ssec.wisc.edu and Andrew Heidinger: andrew.heidinger@noaa.gov

International TOVS Study Conference, 13th, TOVS-13, Sainte Adele, Quebec, Canada, 29 October-4 November 2003. Madison, WI, University of Wisconsin-Madison, Space Science and Engineering Center, Cooperative Institute for Meteorological Satellite Studies, 2003.