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Sensitivity of cloud retrieval statistics to algorithm choices: Lessons learned from MODIS product development

Steven Platnick (1), Steven Ackerman (2), Michael King (3), Zhibo Zhang (4), and Galina Wind (5)

(1) NASA Goddard Space Flight Center, Greenbelt MD, USA (steven.platnick@nasa.gov), (2) University of Wisconsin/CIMSS, Madison WI, USA , (3) University of Colorado/LASP, Boulder CO, USA , (4) University of Maryland - Baltimore County, Baltimore MD, USA , (5) SSAI, Lanham MD, USA

Cloud detection algorithms search for measurement signatures that differentiate a cloud-contaminated or "not-clear" pixel from the clear-sky background. These signatures can be spectral, textural or temporal in nature. The magnitude of the difference between the cloud and the background must exceed a threshold value for the pixel to be classified having a not-clear FOV. All detection algorithms employ multiple tests ranging across some portion of the solar reflectance and/or infrared spectrum. However, a cloud is not a single, uniform object, but rather has a distribution of optical thickness and morphology. As a result, problems can arise when the distributions of cloud and clear-sky background characteristics overlap, making some test results indeterminate and/or leading to some amount of detection misclassification. Further, imager cloud retrieval statistics are highly sensitive to how a pixel identified as not-clear by a cloud mask is determined to be useful for cloud-top and optical retrievals based on 1-D radiative models.

This presentation provides an overview of the different 'choices' algorithm developers make in cloud detection algorithms and the impact on regional and global cloud amounts and fractional coverage, cloud type and property distributions. Lessons learned over the course of the MODIS cloud product development history are discussed.

As an example, we will focus on the 1km MODIS Collection 5 cloud optical retrieval algorithm (product MOD06/MYD06 for Terra and Aqua, respectively) which removed pixels associated with cloud edges as defined by immediate adjacency to clear FOV MODIS cloud mask (MOD35/MYD35) pixels as well as ocean pixels with partly cloudy elements in the 250m MODIS cloud mask – part of the so-called Clear Sky Restoral algorithm. The Collection 6 algorithm attempts retrievals for these two types of partly cloudy pixel populations, but allows a user to isolate or filter out the populations. Retrieval sensitivities for these populations will be shown with an emphasis on the optical and microphysical structure of warm boundary layer marine clouds that are of fundamental importance for understanding a variety of cloud radiation and precipitation processes. Global and regional statistical results of marine warm cloud retrieval sensitivities to the cloud edge and 250m partly cloudy pixel populations are shown for the preliminary Collection 6 MOD06 product. As expected, retrievals for these pixels are generally consistent with a breakdown of the 1D cloud model. While optical thickness for these suspect pixel populations may have some utility for radiative studies, the retrievals should be used with extreme caution for process and microphysical studies.