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(Almost) Ten Years of Cloud Optical and Microphysical Retrievals from MODIS Terra: Trending Analysis

Steven Platnick[1], Michael D. King[2], Paul Hubanks[1,3], Galina Wind[1,4], G. Thomas Arnold[1,4], Nandana Amarasinghe[1,4], Steven A. Ackerman[5]

[1] *NASA Goddard Space Flight Center, Greenbelt, MD USA,* [2] *University of Colorado, Boulder, CO USA,* [3] *Wyle, Lanham, MD USA,* [4] *SSAI, Lanham, MD USA,* [5] *CIMSS/U. Wisconsin, Madison, WI USA*

Introduction

The MODIS cloud optical properties algorithm (**MOD06/ MYD06** for Terra and Aqua MODIS, respectively) has undergone a number of improvements and enhancements since the launch of Terra. The latest version is incorporated into the Collection 5 processing stream. Here, we calculate trends in the nearly 10 year MODIS Terra cloud record from archived Collection 5 Monthly Level-3 data (1° grid) as described in King et al. (TGRS, 2003) and the Level-3 Atmosphere Team Algorithm Theoretical Basis Document: *http://modis-atmos.gsfc.nasa.gov/reference_atbd.php*.

MOD06 provides thermodynamic phase, optical properties (optical thickness and effective radius), and derived water path. Compared to previous versions, the **Collection 5** processing stream included changes to the phase algorithm, ice cloud radiative models, spectral surface albedo maps (including the spectral albedo of snow by ecosystem), and inclusion of baseline pixel-level uncertainty estimates for optical thickness, effective radius, and water path. To improve overall retrieval quality, Collection 5 implemented a **Clear-Sky Restoral** algorithm to exclude pixels identified by the **MODIS Cloud Mask (MOD35)** that are expected to be unsuitable for cloud retrievals, including: flagging heavy aerosol and sunglint, cloud edge removal, and partly cloudy detection using the MOD35 cloud mask 250m tests.

MODIS Terra Trending Analysis

For the time period **July 2000–June 2009**, we calculate linear decadal trends in either annual or seasonal global means of cloud optical properties, retrieved cloud fraction, and cloud fraction from the MODIS Cloud Mask (daytime). Annual and NH winter/summer trends for selected cloud properties are shown. In the figures, trends associated with goodness-of-fit $r^2 \geq 0.5$ are highlighted by contours.

Discussion

Differences in the MODIS Cloud Mask (MOD35) and the Cloud Retrieval Fraction (all phases) are consistent with the clear-sky restoral used in MOD06 (explained above).

Of particular note is the large decrease in liquid cloud optical thickness (COT) over many land masses, generally associated with a decrease in cloud amount. This is similar to Aqua 7-year trends (not shown).

Meaningful trending from a 9-year data record is problematic due to significant interannual variability (approximate time to detect trend Δ_x in quantity x to 95% confidence ~ $(\sigma_x/\Delta_x)^{2/3}$, with σ_x the climate/retrieval noise in x; Weatherhead et al., JGR, 1998). For example, if in a particular region Δ_{COT}=10%/decade, and σ_{COT}=20% (interannual), then trend detection would take ≈16 years (assuming zero autocorrelation).