A synthesis of MODIS cloud regimes

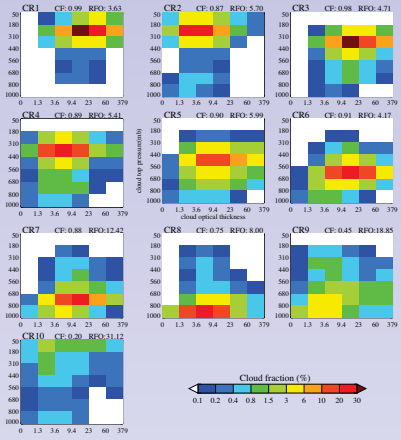
1. NASA's Goddard Space Flight Center 2. USRA's Goddard Earth Sciences Technology and Research 3. Morgan State University 4. NASA's Langley Research Center

Objectives of the study

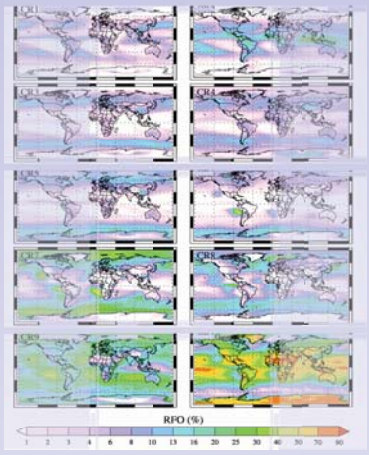
- To classify cloud mixtures observed by MODIS into "cloud regimes" (CRs) by performing clustering analysis on daily p_c-τ joint histograms.
- To explore the nature of the regimes using other coincident observations.
- To understand regime radiative and hydrological importance.

The MODIS cloud regimes

- 10 years of MODIS Terra-Aqua C5.1 daily p_c-τ joint histograms were used.
- Global CRs were derived using clustering analysis, similarly to prior work based on ISCCP histograms.



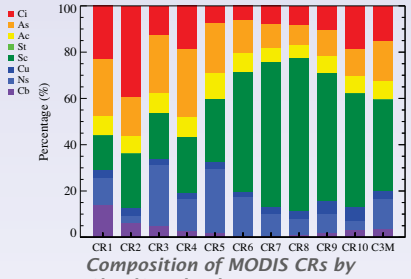
The MODIS CRs (cluster centroids) derived from clustering analysis. Each regime's global cloud fraction and RFO (relative frequency of occurrence) is provided.



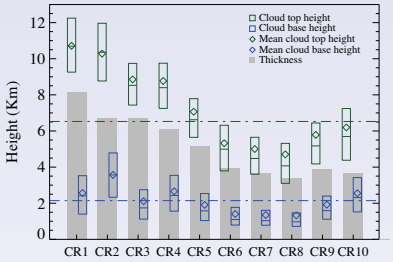
Geographical distribution of each regime's multi-annual RFO.

What active observations tell us about the regimes

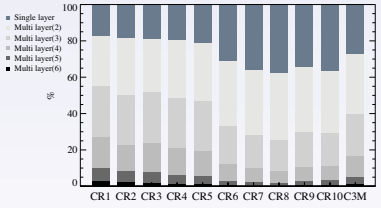
We use CloudSat/CALIPSO data as aggregated in the C3M product to examine how the MODIS regimes are viewed by active sensors. We use only Aqua CR occurrences to perform this compositing in order to achieve better spatiotemporal matching.



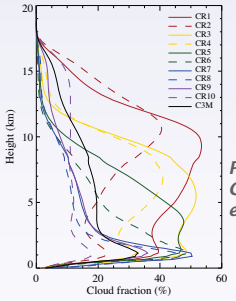
Composition of MODIS CRs by CloudSat cloud type



C3M information on max cloud top height and min cloud base height for each MODIS CR.



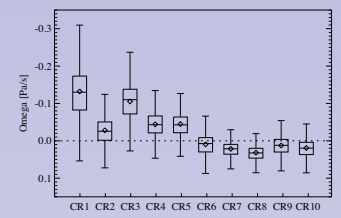
Number of coincident overlapping cloud layers for each MODIS CR as detected by CloudSat/CALIPSO



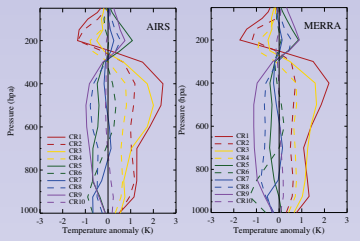
Profiles of volumetric C3M cloud fraction for each MODIS CR.

Meteorology associated with MODIS CRs

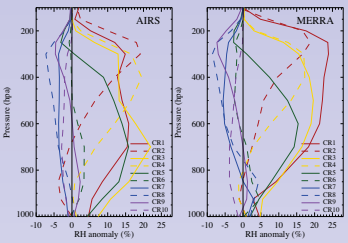
We composite 500 hPa vertical velocity from MERRA and AIRS/MERRA temperature and RH anomaly profiles in order to glean relationships between MODIS CRs and meteorology.



Boxplot composites by MODIS CR of MERRA 500 hPa pressure vertical velocities. Negative values indicate ascending motion.



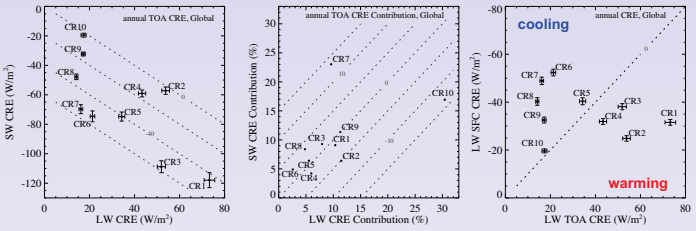
Composites by MODIS CR of temperature anomaly profiles from AIRS and MERRA.



Composites by MODIS CR of RH anomaly profiles from AIRS and MERRA.

Regime cloud radiative effect breakdown

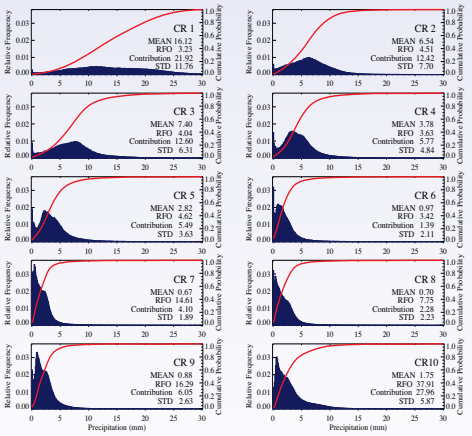
We are interested in the SW, LW and net CRE of the MODIS regimes, in order to delineate their radiative distinctiveness, radiative importance, and influence on atmospheric heating. We use CERES SYN 1deg combined Terra-Aqua diurnal averages for the compositing of gridcells with the same Terra and Aqua CR.



Mean global CRE (left), % contribution to total global CRE (middle), and relationship between LW SFC and TOA CRE (right) broken down by MODIS CR. The error bars (0.1 of actual value) indicate spatial variability.

Regime rainfall

Similarly to CRE we also composite GPCP 1deg daily precipitation to get insight into the hydrological importance of MODIS CRs.



Histograms (incl. cumulative) of GPCP daily precipitation for each MODIS CR. We also show mean, contribution and variability (STD) for each CR.

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