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VARIATIONS IN MARINE BOUNDARY LAYER CLOUD PROPERTIES FROM MODIS OBSERVATIONS

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ABSTRACT

To aid in understanding the role marine boundary layer (MBL) clouds play in climate and assist in improving their representations in general circulation models, we quantify their long-term microphysical and macroscale characteristics using observations from the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument aboard NASA's Terra and Aqua satellites. Five years of MODIS data are used from five geographically diverse oceanic study regions where these cloud types are common. We characterize how MBL cloud systems across the globe are organized (macroscale structure), their associated microphysical properties (e.g., liquid-water path and particle size), and the seasonal dependence of their variations. The interrelationships of these characteristics are explored while considering the influences of the MBL state that include the MBL depth and the occurrence of drizzle.

Several common features emerge from the analyses for the five different study regions. Although MBL clouds contain the best natural examples of plane-parallel clouds, overcast clouds are found to occur only about 10% of the time, which emphasizes the importance of accurately representing the broken MBL cloud scenes in climate models. Mesoscale organization is related to the seasonal cycle of MBL depth. The months of peak cloud occurrence correlate with the deepest boundary layers, when the fraction of overcast and clumped cloud scenes increase at the expense of scattered cloud scenes. Cloud liquid-water path (LWP) and optical depth (τvis) trend strongly with mesoscale organization, with the greatest values occurring for the scenes that are drizzling; however, there are considerable inter-region differences in the trends, which indicate that different relationships must be used for each region. However, the mean Reff does not tend to be in phase with the seasonal cycle of MBL cloud occurrence, suggesting that other different from the seasonal cycle of meteorological properties exert a great influence (e.g., aerosols).

Overall, Canary and Australia regions generally have similar features that are distinctively different from the other regions. They have a more pronounced seasonal cycle in cloud structure, and a larger frequency of scattered cloud scenes, which have low τvis and low LWP. These features are in stark contrast with those from Angola and Peru, which have a greater fraction of clumped and overcast clouds that have a larger mean τvis and LWP. The California region includes characteristics of each of the other regions.