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Detecting thin cirrus in MISR aerosol retrievals

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Thin-cirrus clouds (optical depth < 0.3) are often undetected by standard cloud masking in satellite aerosol retrieval algorithms. However, the Multi-angle Imaging SpectroRadiometer (MISR) aerosol retrieval has the potential to discriminate between the scattering phase functions of cirrus and aerosols, thus separating these components. Theoretical tests show that MISR is sensitive to cirrus optical depth (OD) within Max{0.05, 20%}, similar to MISR's sensitivity to aerosol OD, and MISR can distinguish between small droxtal-like cirrus crystals and larger hexagonal-like crystals, even at low latitudes, where the range of scattering angles observed by MISR is smallest. Including just two cirrus components in the aerosol retrieval algorithm would capture typical MISR sensitivity to the natural range of cirrus properties; in situations where cirrus is present but the retrieval comparison space lacks these components, the retrieval tends to underestimate OD. Generally, MISR can also distinguish between cirrus and common aerosol types when the proper cirrus and aerosol optical models are included in the retrieval comparison space and total column OD $>\sim 0.2$. However in some cases, especially at low latitudes, cirrus can be mistaken for some combinations of dust and large non-absorbing spherical aerosols, raising a caution about retrievals in dusty marine regions when cirrus is present. Comparisons of MISR with lidar and AERONET show good agreement in a majority of the cases, but situations where cirrus have optical depths above 0.15 and are horizontally inhomogeneous on spatial scales shorter than $\sim$50 km pose difficulties for cirrus retrieval using the MISR aerosol algorithm.