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Investigation of aerosol-cloud interactions in ship tracks using MISR

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Ship tracks serve as a well-known manifestation of marine aerosol-cloud interactions. Whereas ample evidence exists that increased aerosol levels lead to more numerous and smaller cloud droplets and thus higher cloud albedo (the so-called Twomey effect), the response of cloud macrophysics (i.e. cloud thickness, liquid water path) to aerosol perturbations is not as clear-cut. Based on in-situ airborne measurements and A-Train satellite observations of individual ship tracks, Chen et al. (2012) found that under conditions with closed cell structure (i.e. cloud cells ringed by a perimeter of clear air), with sufficiently dry air above cloud tops and/or higher cloud top heights, the cloud albedo can become lower in ship tracks, an effect that had not been previously documented. In light of this study, here we compile an independent Terra MODIS/MISR database of ship tracks, taking advantage of the high spatial resolution multiangle observations uniquely available from MISR to examine the robustness of the previous conclusion on cloud albedo response and to understand the dynamical control on cloud response in detail. MISR provides (a) multiangle stereo imagery that enables retrieval of cloud top height variations with 50 m precision vertically, (b) independent cloud albedo retrievals based on integration of the multiangular radiances, and (c) 1.1-km spatial resolution measurements of the cloud-top wind field. Both the standard MISR data products as well as higher-resolution specialized products generated using the MISR INteractive eXplorer (MINX) tool are used in this study. These attributes make possible a novel, systematic statistical analysis of cloud response in ship tracks.