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Cloud albedo's hemispheric asymmetry: why is the Southern Ocean cloudier?

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Recent work has shown that the hemispheric asymmetry in cloud albedo is maximized over extratropical oceans: the Southern Ocean exhibits greater climatological cloud albedo than its northern counterpart. We investigate the dynamical causes of such asymmetry by evaluating how albedo responds to a series of cloud controlling factors, namely: sea surface temperature (SST), pressure velocity at 500mb (ω_{500}), Estimated Inversion Strength (EIS), Marine Cold Air Outbreak (MCAO) index, SST-T_{2m} (ΔT_{sfc}), and surface wind (V_{sfc}). A cloud albedo parameterization applied to MODIS optical thickness and fractional cloud cover is used in conjunction with ERA-Interim reanalysis products over oceanic points in the 50°–65° bands and for a 15-year period. Cloud properties are bin-averaged according to the range of variability of each predictor, using a 1-day timescale. We find that although ω_{500} strongly controls cloud albedo, it cannot explain the observed hemispheric asymmetry. Instead, we find that surface wind most skillfully explains the hemispheric albedo difference, due to the much greater winds in the Southern Ocean. We further show that V_{sfc} is not only a predictor of cloud albedo but it also controls physical processes in the boundary layer such that stronger winds ultimately lead to thicker and more horizontally extended cloud decks. The interhemispheric albedo asymmetry is significantly reduced in winter, responding to a strengthening of winds in the North Atlantic and Pacific Oceans during this season. Our findings have significant implications regarding GCM cloud biases over the Southern Ocean for the current climate, as well as for cloud feedback in a warming planet.