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Seasonal cycle of idealized polar clouds: large eddy simulations driven by a GCM XIYUE ZHANG, UCAR/NCAR, TAPIO SCHNEIDER, ZHAOYI SHEN, California Institute of Technology, KYLE PRESSEL, Pacific Northwest National Laboratory, IAN EISENMAN, Scripps Institution of Oceanography, University of California, San Diego — The uncertainty in polar cloud feedbacks calls for process understanding of the cloud response to climate warming. As an initial step, we investigate the seasonal cycle of polar clouds in the current climate by adopting a novel modeling framework using large eddy simulations (LES), which explicitly resolve cloud dynamics. Resolved horizontal and vertical advection of heat and moisture from an idealized GCM are prescribed as forcing in the LES. The LES are also forced with prescribed sea ice thickness, but surface temperature, atmospheric temperature, and moisture evolve freely without nudging. A semigray radiative transfer scheme, without water vapor or cloud feedbacks, allows the GCM and LES to achieve closed energy budgets more easily than would be possible with more complex schemes; this allows the mean states in the two models to be consistently compared. We show that the LES closely follow the GCM seasonal cycle, and the seasonal cycle of low clouds in the LES resembles observations in the Arctic: maximum cloud liquid occurs in late summer and early autumn, and winter clouds are dominated by ice in the upper troposphere. Large-scale advection of moisture provides the main source of water vapor for the liquid clouds in summer, while a temperature advection peak in winter makes the atmosphere relatively dry and reduces cloud condensate. The framework we develop and employ can be used broadly for studying cloud processes and the response of polar clouds to climate warming.

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