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Relationship between Arctic low cloud variability and static stability in the lower troposphere

Zhujun Li (1) and Kuan-Man Xu (2)

(1) NASA Postdoctoral Program, Universities Space Research Association, Hampton, VA, USA, (2) NASA Langley Research Center, Mail Stop 420, Hampton, VA 23681, USA

The Arctic sea ice cover is crucial to regional and global climate variability through the ice-albedo feedback, and the Arctic clouds play an important role in the regional radiation budget. Cloud physical processes, especially those of low-level mixed-phase clouds, are considered crucial to the accelerated ice decline, due to their impact on the Arctic surface energy budget. Low-level mixed-phase clouds appear in both the single-layer and multiple-layer forms in the Arctic lower troposphere, including thin cloud layers near the surface (fog) that associated with the near surface stable layer. This study examines the relationships between Arctic low cloud variability and the static stability between the surface and 700 hPa and between the surface and 925 hPa, respectively, using two state-of-the-art re-analysis data products, namely, the Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) and European Centre for Medium-range Weather Forecasts (ECMWF) interim re-analysis (ERA-Interim). The daily-averaged and monthly-averaged data are analyzed in order to reveal the mechanisms of cloud variability that operate at different time scales. Despite statistically greater cloud fractions produced by cloud parameterizations in the ECMWF model, both data sets show a weak but significant positive correlation between the monthly-averaged static stability and maximum cloud fraction below 925 hPa. This result corresponds to the seasonal variation of large-scale atmospheric circulation and sea ice fraction. At the daily timescale, MERRA2 and ERA-Interim are consistent in showing a weak but significant negative correlation between the static stability below 700 hPa and the maximum cloud fraction between 925 hPa and 700 hPa. This result is associated with the horizontal advection of temperature and moisture within this layer of the lower troposphere. We also perform the Lagrangian trajectory analysis to examine the temporal evolution of Arctic boundary layer in order to understand the response of Arctic low clouds to different influential factors.