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VERTICAL MOTIONS IN ARCTIC MIXED-PHASE STRATUS

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ABSTRACT

Vertical motions leading to condensation play a critical role in the formation of condensate and the partitioning of phase in mixed-phase clouds. Using measurements from the Mixed-Phase Arctic Cloud Experiment (M-PACE), which was conducted at the ARM North Slope of Alaska (NSA) site in the fall of 2004, the role of vertical motions in Arctic mixed-phase stratus is examined. Estimates of vertical velocity and other cloud macro-and microphysical properties are made using cloud radar Doppler spectra and supporting measurements from lidar, microwave radiometer, and soundings. In general, the retrievals of vertical motion compare well with nearly coincident measurements by research aircraft, lending credence to the use of radar for deriving these cloud-scale motions in this type of cloud. The average vertical motion observed in the liquid portions of these fall mixed-phase stratus is an updraft of 0.56 m/s with a range of 1.75 m/s upward to 0.46 m/s downward. It is found that the liquid and ice water mass simultaneously increase in an updraft due to growth by vapor deposition. These mixed-phase clouds are typically liquid-dominant, although the liquid-to-ice ratio actually decreases during an updraft. This behavior is largely due to the relatively slower decrease of liquid during a downdraft, which allows for the persistence of liquid water, and the pulse-like behavior of relatively quick ice formation and fallout associated with the cloud-scale circulations. Spectral analysis of the derived vertical motion timeseries indicates dominant scales-of-motion in the range of 0.7-10 km. Typical circulation strengths, which are indicated by variations in vertical velocity, are on the order of +/-0.7 m/s from the mean state. There is a slight tendency towards narrower and stronger updrafts coupled with weaker and broader downdrafts.