A new Melting Layer Detection Algorithm that Combines Polarimetric Radar-based Detection with Thermodynamic Output from Numerical Models

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The accurate detection of the presence/absence of an elevated warm layer is a fundamental requirement of the development of a surface-based Hydrometeor Classification Algorithm for transitional winter events. Polarimetric radar, through careful examination of radar reflectivity (Z), differential reflectivity (ZDR), and correlation coefficient (rhoHV) at high elevation scans (4-10º elevation) has been shown to provide accurate estimation of melting layer (ML) top and bottom at locations close to the radar, but the azimuthal projection of those heights to more distant locations have proven to be unrealistic for most meteorological situations. Similarly, while polarimetric variables at lower elevation angles (<4º elevation) can provide ML designations at more distant ranges, their interpretation is often complicated by the effects of beam broadening. These complicating factors point out a need for a ML detection method that can 1) be applied over the entire radar domain, and 2) also capitalize on additional information provided by thermodynamic output from numerical models, which are increasingly being used as part of the classification process.

In this paper, we describe a new ML detection algorithm that combines radar observations with thermodynamic output from the High Resolution Rapid Refresh (HRRR) model to provide a hybrid ML designation over the entire radar domain. Radar-based, range-dependent Gaussian weighting functions for both high- and low-elevation ML designations, which take into account inherent errors known to each technique, are combined with a model-based Gaussian weighting function that depends on horizontal gradients in wet-bulb temperatures to create a "blended" map of ML detections. A separate, time-dependent weighting function is used to account for time lag in the model analyses by de-emphasizing the contribution from the numerical model as the delta_t from the radar volume and the most recent model analysis becomes large. Aggregate values from the combined weighting functions are then compared to surface observations of known precipitation types to come up with a final ML product.