Improvements to melting snow behavior in an NWP bulk microphysics scheme

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Snow falling into a melting layer will eventually consist of a fraction of meltwater and hence change its characteristics in terms of size, shape, density, fall speed and stickiness. Given that these characteristics contribute to determine the phase and amount of precipitation reaching the ground, precisely predicting such are important in order to obtain accurate weather forecasts for which society depends on. For example, in hydrological modelling precipitation phase at the surface is a first-order driver of hydrological processes in a watershed. Also, melting snow exerts a possible threat to critical infrastructure because the wet, sticky snow may adhere to the structures and form heavy ice sleeves.

Most widely used bulk microphysical parameterization schemes part of numerical weather prediction models represent only purely solid or liquid hydrometeors, and so melting particle characteristics are either ignored or represented by parent species with simple conditions for behavior in the melting layer. The Thompson microphysics scheme is explicitly developed for forecasting winter conditions in real-time as part of the WRF model, and to maintain computational performance, the introduction of additional prognostic variables is undesirable. This research aims at improving the Thompson scheme with respect to melting snow characteristics using a physically based approximation for the snowflake melted fraction, as well as a new definition of melting level and melting particle fall velocity. A real 3D WRF case is set up to compare with in-situ measurements of hydrometeor size and fall velocity from a disdrometer and a vertically pointing Doppler radar deployed during the Olympic Mountain Experiment (OLYMPEX). The modified microphysics scheme is able to replicate the bimodal distribution of fall speed – diameter relations typical of mixed precipitation seen in disdrometer data, as well as the non-linear increase in snow fall speed with melted fraction through the melting layer.