X-band Radar Observations of the Angular Dependence of Specific Differential Phase Above the Bright Band

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Previous studies suggest that differential measurements, including specific differential phase, can be affected by the viewing angle of the radar on the hydrometeor. This study examines how specific differential phase above the melting layer changes with radar elevation angle. Observations of stratiform weather during winter 2018 in Southern England from the NCAS mobile dual-polarization X-band radar show that specific differential phase does change with radar elevation angle. Generally, higher positive values are associated with low elevation angles whilst values of approximately 0 degrees/km are observed at high elevation angles. However, the relation between elevation angle and specific differential phase appears to be dependent on temperature and reflectivity, with a greater change in values of specific differential phase over the same range of viewing angles for observations associated with colder temperatures or larger reflectivity. For temperatures closer to the melting layer and for lower reflectivity, specific differential phase has a value of ~0 degrees/km even for low elevation angle. Using additional radar variables and ancillary observations from the Facility for Airborne Atmospheric Measurements as evidence, we propose that the reason for this dependence on temperature and reflectivity is the presence of aggregates - aggregates are more common in temperatures closer to the melting layer, and appear more spherical at all viewing angles, reducing specific differential phase, while other ice hydrometeors are wider than thick, so when viewed side on they will produce a higher specific differential phase to be observed in the returned radar signals. These results could lead to improved corrections to specific differential phase at elevations above 70 degrees, where current methods struggle. In turn, this may lead to improvements in radar derived data products such as hydrometeor classification and ice water content.

Keywords: Specific Differential Phase, X-Band, Elevation Angle, Aggregates