Computing Vorticity from Airborne Doppler Radar VAD Profiles

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The velocity-azimuth display (VAD) analysis technique has been used since the 1960s to compute vertical profiles of horizontal winds from ground-based conically-scanning radars. The technique works by fitting the Doppler velocities from a single scan, taken as a function of scan azimuth angle, to a sinusoidal function from which the horizontal wind at each range gate can be derived. Since each range gate will be located at a different altitude, the horizontal winds at multiple range gates can be interpreted as the horizontal winds at multiple altitudes. In addition to profiles of the horizontal wind, the VAD technique can also be used to compute profiles of shearing and stretching deformation and, depending on the radar elevation angle and the assumptions made regarding the underlying wind field, divergence and vertical hydrometeor velocity. Recently, Tian et al. (2015) demonstrated that the VAD technique could be successfully applied to downward-pointing conically-scanning airborne radar data, despite errors introduced by the continuous motion of the aircraft during the scans.

Building on the work of Tian et al. (2015), the present study describes a method to compute vorticity and divergence profiles from airborne radar VAD profiles of horizontal winds and deformations. This technique relies on the unique ability of airborne radar to produce curtains of VAD profiles, allowing for the computation of along-track wind gradients. Furthermore, by combining the divergence profiles computed using this technique with information from the basic VAD technique, profiles of vertical hydrometeor velocity can also be computed. This presentation will focus on describing the technique and evaluating the accuracy of the technique using Doppler velocities generated from both analytic wind fields and idealized simulations. Additionally, the technique will be demonstrated using data from two high-altitude airborne radars, HIWRAP and EXRAD.

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