Over the GCPEx study domain (Fig. 1) on 18 February 2012 a warm frontal precipitation band rapidly evolved from genesis, maturity, and decay from 0730 UTC to 1334 UTC 18 February (Fig. 2).

Narrow and intense bands have been well documented for cold fronts, but not for warm fronts. The conceptual model of a warm frontal band is fairly broad (50 km wide), with a strong connection to generating cells aloft.

Questions:

What processes led to the rapid intensification and subsequent weakening of the warm frontal precipitation band?

What is the role of latent heating and cooling on the band evolution?

How did the ice and water amounts change within the band as it evolved?

How well can a mesoscale model predict this warm frontal band evolution?

Model Setup and Configuration

The Advanced Research WRF (Weather Research and Forecasting; Skamarock et al. 2008) model version 3.5.1 was used for a 30-h run with a triple-nested grid configuration at 9-, 3-, and 1-km horizontal grid spacing (Fig. 3).

Forecasts were initialized at 1800 UTC 17 February 2012. The initial and lateral boundary conditions from 6-hourly 13-km isotropic RUC analyses.

All ice-phases particles in the P3 scheme are represented by four mixing ratio variables (total mass, rime mass, rime volume, and number) that freely evolve in time and space.

The band developed with low-level deformation and frontogenesis along the sloping warm frontal zone, and the vertical motions became large enough to produce graupel on the south side of the band. Embedded convective cells developed earlier in our GCPEx event, but the frontogenesis was weak then and banding was limited. As the deformation increased the stability also increased near the band location (MPX6), which favored the development of single band. Through sensitivity studies (not shown) we found that latent heating helps increase the frontal circulations and resulting band development. Latent cooling also helps increase the frontogenesis given the evaporative and sublimation cooling within the frontal precipitation.

At 1142 UTC, the ZDRs are near zero or slightly positive within the band, and the correlation coefficients are relatively high (r > 0.89, not shown), suggesting horizontally falling snow crystals and aggregates. The ZDRs are more negative to the south of the band and at 1235 UTC, indicative of graupel (Fig. 7).

The conceptual model of a warm frontal precipitation band (c) located out of the study area of southwest Ontario (not shown), with a relatively weak surface warm front stretching to the east of the cyclone (Fig. 4).

At 1223-1242 UTC, the ZDRs (shaded in red) and dBZ (shaded, contours every 4 dBZ) starting at 8 dBZ from (a) PPI and (b) RHI scans valid at 1124 and 1123 UTC 18 February, respectively. (d) Same as in (a), (b) except observed at 1236 and 1211 UTC, respectively. Aircraft spiral flight pattern (red) is denoted in (d) and location where the flight intersected the RHI scan (vertical dashed red line) is denoted in (d) and (e). The red star in (b) and (d) denotes location of aircraft 2DC probe samples in Fig. 8a and 17a.

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