JP1.13 Extratropical Transitions: Forecasted vs. Observed Evolution

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1. Introduction

Current precipitation forecasts associated with landfalling tropical cyclones are based on a simple algorithm where the maximum 24-h precipitation (in inches) is forecast by 100/v, where v (in m.p.h.) is the translational speed of the cyclone. This algorithm, however, provides little insight as to the precipitation distribution and intensity that can be expected in a landfalling tropical cyclone. Furthermore, several recent cases (Danny 1997, Dennis, Floyd, and Irene 1999) show that precipitation distribution and intensity can be drastically altered by interactions with mid-latitude troughs and jet streaks which often result in extratropical transitions. Occasionally, these interactions produce catastrophic rainfalls as illustrated by hurricane Floyd in September 1999. While several papers have been written concerning extratropical transitions (i.e. Palmen 1958, DiMego and Bosart 1982b, and Bosart and Lackman 1995) the focus of this paper will be to try and evaluate the performance of current operational forecast guidance in quantifying the evolution of these transitions

2. Data and Methodology

Synoptic scale data used for analysis and diagnostics in this paper are the twice daily initialized and forecast fields taken from the National Centers for Environmental Prediction's (NCEP) operational forecast models (AVN/Eta). Subsynoptic scale data are taken from the initialized fields of the Rapid Update Cycle of the ETA model with a grid resolution of 32 km as provided by NCEP.

3. Results and Discussion

Hurricane Floyd made landfall on the coast of North Carolina in the early morning hours of 16 September 1999. While most of the forecast warnings associated with Floyd concerned the potential for wind damage along a relatively large stretch of the North Carolina/Virginia coast line, as Floyd was a strong category 2 hurricane, the greater disaster concerning the loss of life and property by far was the widespread flooding that occurred as a result of the interaction of Floyd with an approaching midlatitude trough.

Figures 1a-c show the AVN forecast (48h, 36h, and 24h respectively) of the 300-200 hPa potential vorticity along with the 1000-500 hPa thickness and mean sea level pressure all valid at 00 UTC 17 Sep. Fig. 1d shows the verification fields taken from the initialized AVN grids for 00 UTC 17 Sep. It is clear from this figure that the AVN failed to capture the extent of the interaction between Floyd and the midlatitude system. Specifically, the model forecast failed to capture the southern extent and orientation of the midlatitude trough, particularly in the 36 and 48 h forecasts (Figs. 1a & b). The midlatitude trough in the forecast fields has a considerably more positive tilt as compared to verification. This error may in part be attributed to the models failure to capture the strength and extent of the thermal ridge associated with Floyd. Note for instance that the 576 dm thickness contour is located off the New England coastline in the 48 h (Fig. 1a) forecast while the verification panel shows the 576 dm thickness contour lying north of Long Island. This thickness ridge in combination with the relatively cool air associated with the mid latitude trough results in a much stronger baroclinic zone along the Eastern seaboard than forecast. The implication being that there is significantly greater forcing for ascent associated with warm air advection along the east coast than forecast.

Figure 2 displays the 250 hPa height and isotachs and 850 hPa absolute vorticity. The date convention is the same as fig. 1. The strength of the outflow jet to the north of the circulation of Floyd is generally underestimated in the forecast fields (Figs. 2a-c). Only 24 h before the event does the Venal begin to suggest that there will be a dual entrance region structure immediately poleward of Floyd. Once again, it is clear that the strength of the ridging along the east coast has been under forecast by the model. Also note that compact nature of the vorticity field associated with Floyd is not correctly represented in the model forecast Figs. 2a-c). It appears that the AVN elongates the vorticity associated with Floyd, leaving the maximum vorticity center further south along the Middle Atlantic coast, while creating a warm frontal type signature poleward underneath the equatorward jet entrance region as opposed to coupling the circulation center of Floyd with the jet entrance region.

Finially, Figure 3 displays the 300-200 hPa layer average PV/wind and the 850-700 hPa layer average PV/wind. Once again, the forecast field (Figs. 3a-c) failed to capture the compactness and strength of the low-level flow field as shown in Fig. 3d. The magnitude of the low-level PV anomaly is approximately three times as strong in the verification panel (Fig. 3d) as compared to the 48 h forecast (Fig. 3a). Another key aspect is the pronounced anticyclonic curvature of the upper-level PV anomaly west of the Maritime Provinces (Fig. 3d) relative to the 36 and 48 h forecasts (Figs. 3a-b). This anticyclonic curvature is consistent with the thermal ridge found in Fig. 1d. These results suggest that the inability of the models to replicate the intensity of the outflow anticyclone associated with Floyd, led to an inability to capture the impending negatively tilted nature of the transitioning storm. As such, the precipitation forecasts associated with this event were quantitatively lacking.

4. Acknowledgments:

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5. References

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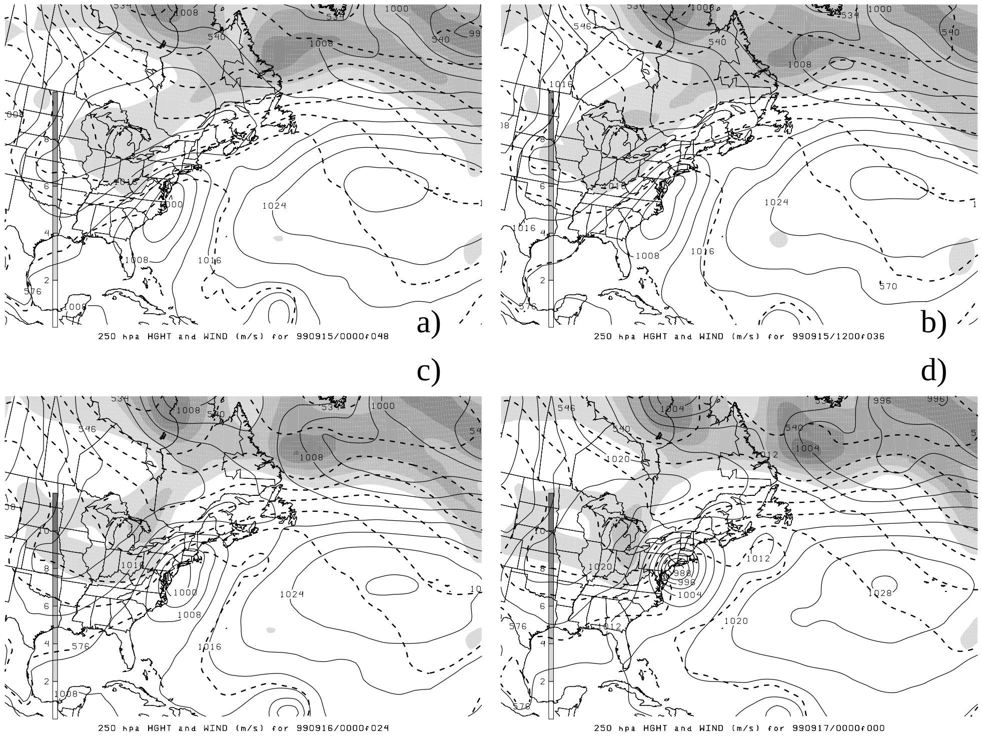

Figure1. 1000-500 hPa thickness (dashed lines, contoured every 6 dm), 300-200 hPa PV (shaded above 2 PVU, every 2 PVU) and mean sea level pressure (solid lines, contoured every 4 hPa) for a) 48 h forecast, b) 36 h forecast, c) 24 h forecast, and d) 00 h forecast.

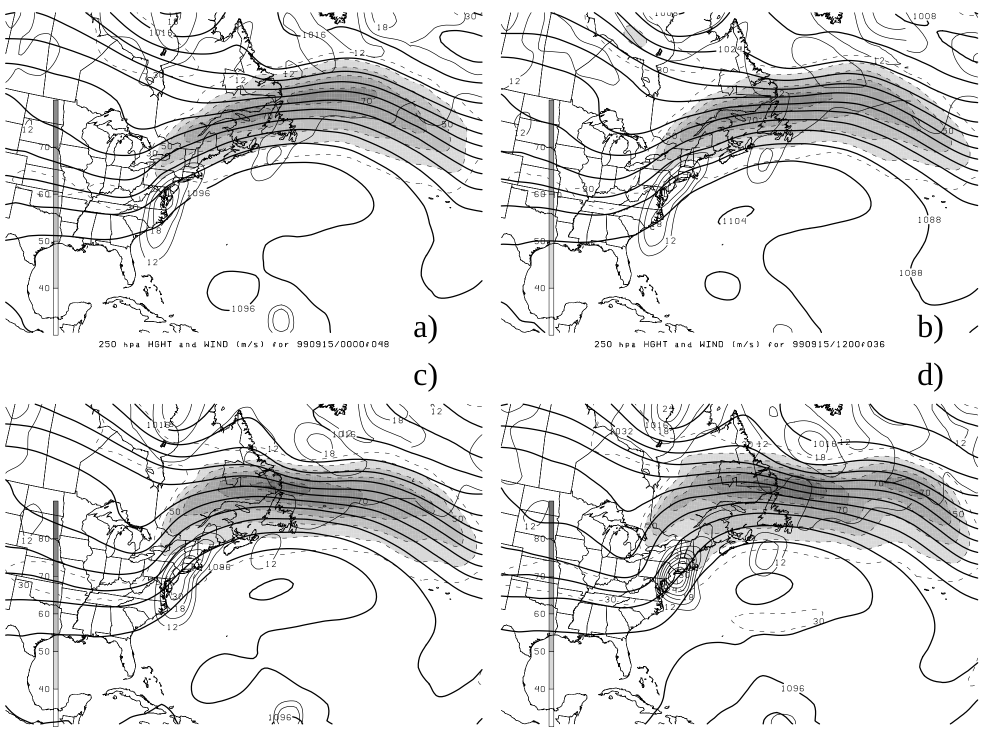

Figure 2. 250 hPa geopotential (thick solid lines, contoured every 8dm), isotachs (shaded above 40 m s^{-1}, every 10 m s^{-1}), and 850 hPa absolute vorticity (thin solid lines, contoured above 12 x 10^{-5} s^{-1}, every 2 x 10^{-5} s^{-1}. Date convention same as Fig. 1.

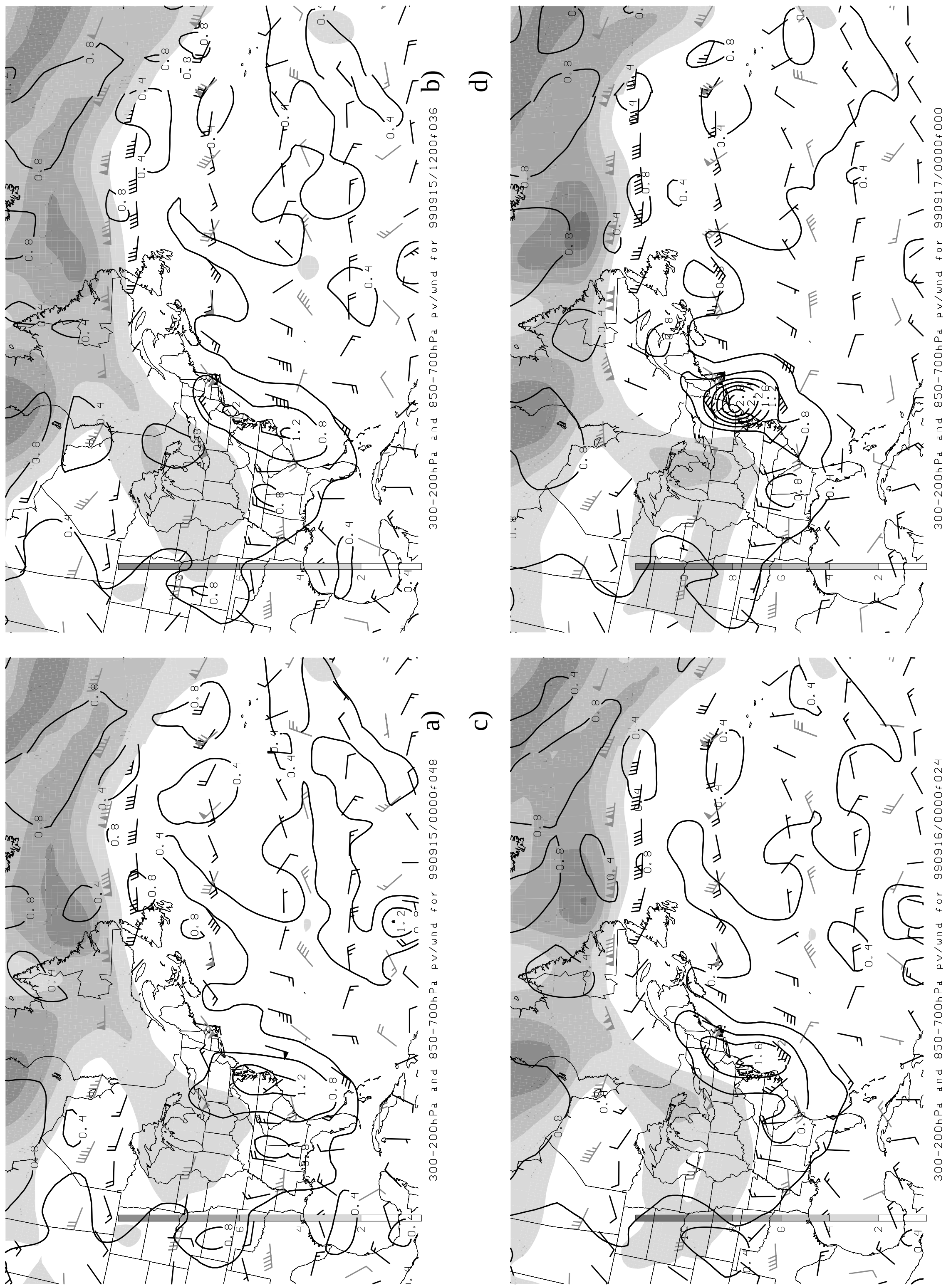

Figure 3. 300-200 hPa layer average PV/wind (shaded as in Fig.1/light wind barbs, knots convention) and 850-700 hPa layer average PV/wind (contoured every.2 PVU starting at.8 PVU/ dark wind barbs). Date convention same as Fig. 1.