Comparison Between Assimilation of Radial Velocity and Radar Atmospheric Motion Vectors in a 3DVAR System to Forecast Precipitation

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Radar data assimilation (RDA) has become a key tool when doing very shortrange forecast and many studies had shown improvements on precipitation forecast in the first 0-12 hours. Despite the known positive impact of RDA, it has its counterpart that is the imbalance added to the analysis after the data assimilation processes, mainly in a 3DVAR system compared to other more sophisticated formulations. From our experiments we have noticed that the radial velocity (RV) data is the primary source, by far, of the analysis imbalance. On the other hand, the RV data is important since they provide the dynamic structure to sustain the reflectivity (RF) information. We have found that when only RF data is assimilated, many convective systems do not have dynamical support and they rapidly vanish. This work attempts to avoid the assimilation of RV data, and the Atmospheric Motion Vectors (AMV) obtained from radar CAPPIs (Constant Altitude Plan Position Indicator) is assimilated instead. The CPTEC/INPE operational AMV algorithm was slightly modified and used to estimate the horizontal displacements in the radar CAPPI measurements. This algorithm was designed to track brightness temperature of cloud tops and water vapor gradients in IR or WV channels from geostationary satellite, and it was adapted to track the horizontal features of the cloud water reflectivity from radar. Maximum cross correlation tracking method is used in the wind estimation algorithm. Segments of 16x16 points were used with no height assignment applied as each CAPPI represents a known level. Each image segment overlaps its neighbors in 25% to increase the wind vectors spatial coverage. For quality control, the same quality indicator (QI) test used in the operational wind product was applied to the radar AMVs. This QI test associates a value from 0 to 1 with 1 indicating the maximum quality. A different wind field was estimated for each CAPPI at heights 2, 3, 4, 5, 6, 7, 8, 9 and 10 km and only AMVs with QI greater than 0.5 where assimilated in the 3DVar scheme. The first result is that the wind increments are much smoother when compared to the ones assimilating RV data. As a result of this characteristic, the analysis from the AMV assimilation is much less noisy than the one with the assimilation of RV data. This result is obtained by examining the domain averaged surface pressure tendency during the model integration. Regarding the precipitation forecast, the one made from the analysis assimilation of AMV is slightly worse in the first 1.5 hours and better after that, compared to the forecast using RV. This result may be explained by the fact that the RV data produce higher increments, including where convection actually exist in the radar observation. Therefore, production of convection is much more efficient at the beginning, however, due to the rapidly error growth, the forecast using AMV prevails and it provides better results in later time. Finally, it was evaluated the behavior of the both run if the reflectivity was included. It turned out that the effect of assimilating AMV was even more pronounced and the convection started faster, improving even more the forecast skill in the first 1-2 hours.

Keywords: Radar Data Assimilation, Atmospheric Motion Vectors, Precipitation