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Aircraft Moisture Observations: Their importance in Nowcasting and NWP

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Numerous studies have assessed the impact of AMDAR temperature and wind reports in local forecast offices and both regional and global NWP systems. The results have shown very positive impact on time scales from hours to days, as well as documenting that aircraft data are the most cost effective of all major observing systems. However, the full impact of the AMDAR observations as a supplement/enhancement/gap-filler for traditional rawinsonde data in NWP, as well as for local, short-range hazardous weather forecast applications, has in the past been limited by the lack of sufficient moisture measurements in the aircraft ascent/descent profiles.

Specific humidity reports using the WVSS-II laser-diode sensor are now available from over 135 aircraft over the CONUS, providing more than 1000 profiles throughout the day. We show that these data are as accurate and representative as rawinsonde humidity measurements, if not more so. This will be followed by examples of forecaster use of these higher-time-frequency reports in a variety of hazardous/severe weather applications.

Although the use of frequently observed moisture profiles can play a key role in subjective Nowcasting, the impacts on NWP much more readily quantified. Two different approaches are then used to assess impact in two NWP systems – a data denial observing system experiment and an adjoint-based observation sensitivity experiment. In both cases, very few changes were needed to Q/C. Improving moisture analyses and forecasts in larger-scale models is essential to advancing Nowcasting, in that they provide analysis background and boundary conditions for higher resolution local area models.

Results will show that for forecasts over the CONUS, AMDAR WVSS-II profile data have a larger influence than any other in-situ observation, including events of extreme moisture. The greatest positive impact was in the warm-season humidity analyses and forecasts (including precipitation) in the first 12 hours, but extending beyond 72 hours. Impacts are noted throughout the troposphere, with AMDAR data collected during ascent and descent having nearly equal impact per report. The availability of multiple moisture observations at locations more distant from rawinsonde launch sites appears to be key to the analysis and forecast improvements.

Detailed results, including comparisons against independent precipitation analyses and GPS total-column precipitable water measurements, will show that the improvements using WVSS data extend to extreme events as well as less dramatic cases. The potential to manage costly, specially launched, off-time rawinsondes launches will also be discussed.