Fog Nowcasting and Prediction

An MP-3000 Microwave Profiler delivers continuous temperature, humidity and liquid soundings that are essential for accurate fog, visibility, precipitation, and icing hazard Nowcasting and prediction. This proven, portable technology makes these data available in real time during nearly all weather conditions.

Accurate Fog Nowcasting

The MP-3000 directly measures liquid profiles and can therefore provide stand-alone fog Nowcasting. In addition, through its direct measurement of upper-air RH, the radiometer can serve as a fog forecast system. For example, fog conditions in the Denver basin, located just to the east of the Rocky Mountains, typically occur during upslope conditions and are preceded by low RH values in the boundary layer. This is true for the example shown in radiosonde soundings before and after the onset of fog on 16 Feb 01 associated with a winter upslope storm (Figure 1). In this case, boundary layer humidity steadily increased from 50% to saturation during the 12 hour interval between radiosonde soundings. At 1235 UTC the radiometer measured fog with 0.16 g/m^3 density and a 5 C elevated temperature inversion at 1 km height -- typical signatures of Denver Basin winter upslope storms. By monitoring and extrapolating the radiometer humidity trend, fog onset time was predicted with 30 minute accuracy.

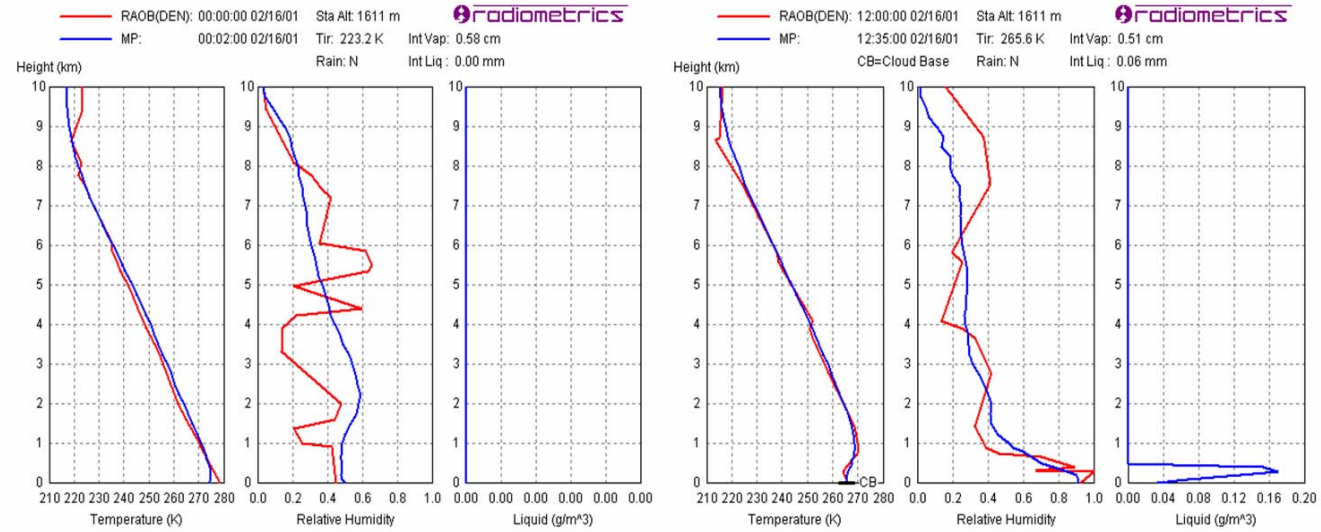

Figure 1. Boulder radiometer (blue) and Denver radiosonde (red) temperature and humidity soundings to 10 km height at 0000 and 1200 UTC on 21 Feb 01 (Denver is 50 km southeast of Boulder). Supercooled liquid is clearly identified in the radiometer retrieval (right).

Improving Short Term Forecast Skill

Typically, clouds are “spun up” in numerical weather models over intervals up to 8 hours. The absence of observational liquid data in the model during spin-up contributes to poor short-term forecast skill. However, the MP-3000 provides timely temperature, humidity and liquid soundings that are essential to improve Nowcasting and short-term forecast skill.

For example, a mass of cold air is seen below 500 m height just before noon UTC on 21 Feb 2001 in the time series contour plots shown in Figure 2. Steady increase of boundary layer humidity is seen starting from 50% at 1100 UTC and reaching saturation with onset of fog at 1235 UTC. Extrapolation of the RH trend during this time interval can be used to estimate the time that RH saturation and onset of fog occurs. In fact, such a crude short-term prediction would have surpassed the skill of the NOAA and NCAR forecasts, both of which failed to predict fog on this day.

As a result, there was an unplanned 18-hour diversion of flights from Denver International Airport. The continuous microwave profiler data shown in Figure 2 were later assimilated by NCAR into a weather forecast re-run that accurately predicted this Denver Basin fog event (Vandenberghe and Ware, 2002).

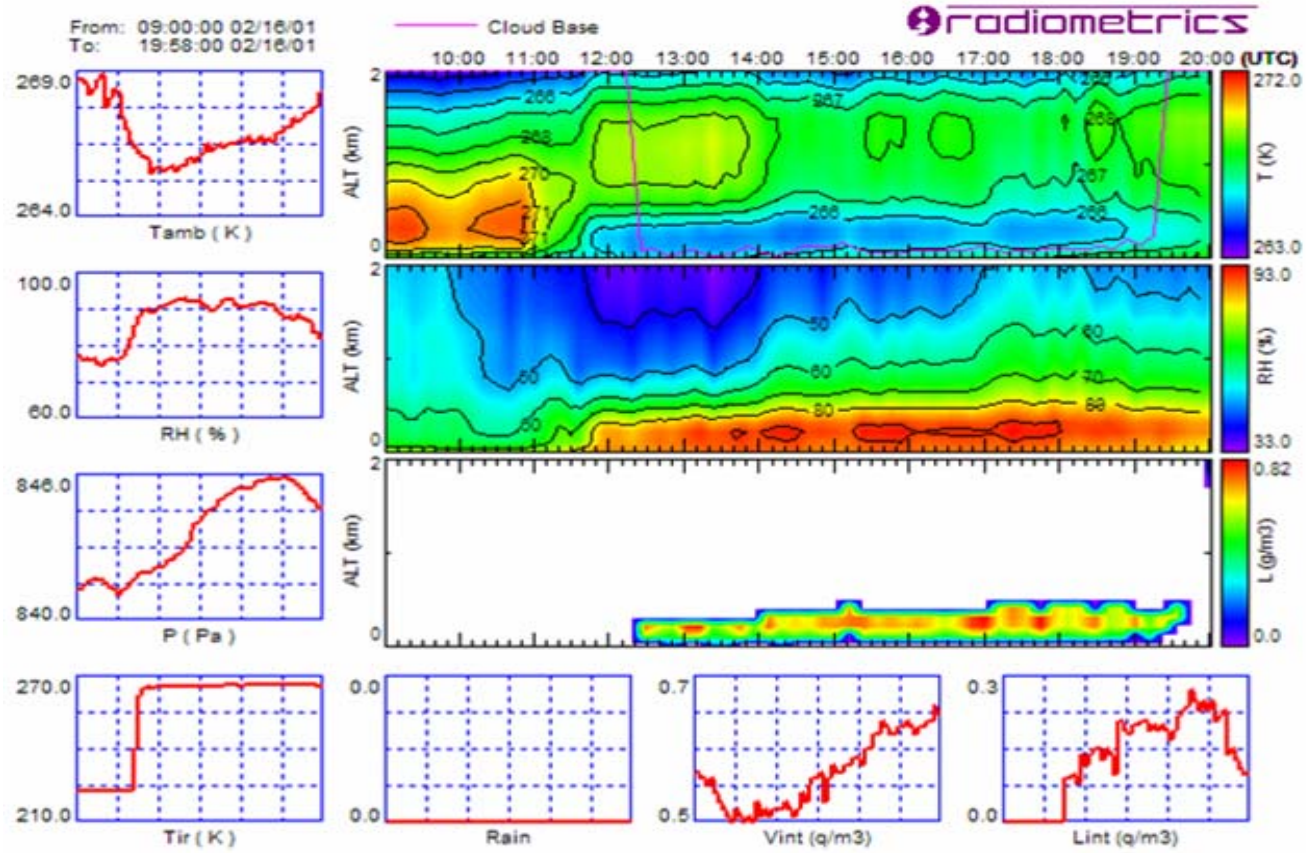

Figure 2. Temperature, humidity and liquid retrievals are shown to 2 km height from TP/WVP-3000 (first generation microwave profiler) observations at Boulder, Colorado, on 21 Feb 2001. Dense fog caused flight diversions at Denver International Airport after 1200 UTC.

A similar upslope weather event occurred on 4 March 2003 including heavy fog and drizzle at temperatures below freezing. This event, which NOAA and NCAR did not predict, caused more than $1 million in damage to jet aircraft engines at Denver International Airport. NCAR scientists clearly identified freezing drizzle in the radiometer data (Herzegh et al., 2004). If jet pilots receive timely warnings of freezing drizzle (supercooled liquid), they can use special takeoff procedures to prevent jet engine damage.

References

Croft, P., R. Pfost, J. Medlin, and G. Johnson, Fog Forecasting for the Southern Region: A Conceptual Model Approach, 1997: ***Weather and Forecasting, 12****, 545-556.*

Herzegh, P., S. Landolt and T. Schneider, The Structure, Evolution and Cloud Processes of a Colorado Upslope Storm as Shown by Profiling Radiometer, Radar and Tower Data, 2003: ***31st Conf. Radar Meteor., AMS****.*

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