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Observation of fog by a sodar at Roissy-CDG airport

A. Dabas and the CNRM Team
Météo-France, CNRM, Toulouse, France (alain.dabas@meteo.fr, 0033 56107 9627)

Fog severely limits the capacity of airports, causing delays or cancellations of flights. It is why a system able to reliably predict the formation and dissipation of fogs hours in advance is sought by all major airports. Weather prediction centers have developed tools that combine local observation and models, but because the physical processes involved are highly non linear, and for some of them, poorly represented and/or poorly documented by meteorological sensors, fog prediction is a difficult problem that has not yet received a fully satisfactory answer.
Regarding the observation, the height of the fog layer and the vertical profile of liquid water content have been identified as the two parameters that may have the greatest impact on fog prediction but are not presently documented by existing, operational sensors.
In 2006, a review of the potential offered by remote sensors was conducted at the Centre Nationale de Recherches Météorologiques of Météo-France. Sodar was identified as the single technique available « off the shelf » that can detect in real-time the inversion at the top of the fog layer. The acquisition of a sodar followed by a test experiment at Roissy-CDG (first european airport) was decided. The purposes were: 1./ check the sodar can operate properly on an airport, and 2./ assess the capacity of a sodar to actually detect the top of fog layers.
In 2008, a sodar DSPDA.90-64 from the Metek company was purchased. It was delivered at Roissy-CDG in July and installed at the doorstep of runaway 09L where ambiant noise is occasionnally very high, but otherwise very low (below 50dBA). The sodar was set such that vertical profiles of wind and accoustic refectivity are obtained once every 10 minutes up to a maximum height of 350 meters, and a vertical resolution of 10 meters.
After a few months of continous operations, the fog experiment started in early November and last 4 months. During this period, a tethered ballon was deployed at the closest distance (7km) allowed the air traffic control. The experiment also relied on the operational sensors based at the airport. The experimental set-up was activated every time weather conditions favorable to fog formation were forecasted, the purpose being to document the low-level vertical structure of the atmosphere before, during and after a fog event. During observation periods (typically one night), the sonde attached to the tethered balloon was lifted up and down a regular intervals, providing vertical profiles of temperature and humidity every hour or so.
The analysis of temperature profiles and sodar reflectivities clearly confirm that the inversion at the top of the fog is well-marked by a distinct peak of accoustic reflectivity. Inside the fog layer, the reflectivity is on the contrary very low, much lower than reflectivity levels usually observed outside fog events.