Wind shear detection using radar and lidar at Frankfurt and Munich airports

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At the German international airports of Frankfurt and Munich, low-level wind shear detection systems consisting of an X-band polarimetric scanning radar and an IR scanning lidar have recently been installed. The systems perform 3D volume scans at a repetition time of 5 minutes and 2D PPI scans using the glide slope angle of 3 degrees every minute. Non-meteorological echoes are removed from radar data using various signal processor filters and a polarimetric fuzzy-logic radar echo and hydrometeor classification. Filtered velocity data are used to derive low-level wind shear alerts using (a) gust front (GF), microburst (MB) and runway-oriented shear (ROSHEAR) algorithms for horizontal wind shear alerts; and (b) volume velocity processing (VVP) algorithm for vertical wind shear alerts.

In the first part, availability of the 2D PPI data as a function of range is investigated for the cases (a) radar only, (b) lidar only, (c) radar and lidar, and (d) no sensor. The dependency on the season is also given. For small ranges below a few kilometers, data are mostly available from lidar only. At larger distances, the contribution of the radar becomes more important, in particular in winter time.

In the second part, the availability of VVP wind profile results is analyzed. Therefore, horizontal wind vector and vertical wind shear are calculated in vertical steps of 100 feet (approx. 30 meters) using radial wind data from 3 nautical miles (approx. 5.5 kilometers) around the sensor. Results depending on the season are also given. Data are mostly available from lidar only, in particular in the lower levels. For higher levels, the contribution of the radar becomes more important, in particular in winter time.

In the third part, the availability of ROSHEAR wind data from the 3 degree PPI scans is investigated. The influence of the season is also shown. Similar to results of the first part, data are mostly available from lidar only, in particular for the runway sections. For the outer approach and departure sections, radar becomes more important, in particular in winter time.

Finally, frequencies of wind shear alerts from the ROSHEAR and VVP products are shown. As before, the cases (a) radar only, (b) lidar only, and (c) radar and lidar are considered. Analyses are performed using the ICAO thresholds for moderate wind shear (15 knots loss or gain from ROSHEAR, and 5 knots per 100 feet vertical shear from VVP) and for severe wind shear (30 knots loss or gain, and 8 knots per 100 feet, respectively).

All results show that one sensor only (radar or lidar) is not sufficient for a continuous, year-round monitoring of the low-level wind shear. Each instrument helps to overcome the weaknesses of the other, which are reduced range of the lidar during precipitation and void radar data in dry conditions.