Inter-comparison of X-band radar and lidar low-level wind measurement for air traffic control (ATC)

Thomas Ernsdorf
German Weather Service, Aeronautical Meteorology Department, Germany
Stiller, Bernd (German Weather Service, Research and Development Department for Remote Sensing)
Beckmann, Björn-Rüdiger (German Weather Service, Aeronautical Meteorology Department)
Weipert, André (Selex ES GmbH)
Kauczok, Sebastian (Selex ES GmbH)
Hannesen, Ronald (Selex ES GmbH)

E-mail: Thomas.Ernsdorf@dwd.de

Abrupt changes of wind velocity can cause serious aircraft hazards. Wind shear poses a great danger during climb-out and approach operations since aircraft air speed and height are near critical values, thus rendering the aircraft susceptible to the adverse effects of wind shear. In order to detect, quantify and alert on the presence of low-level wind shear a novel combined system based on X-band Doppler polarimetric radar and 1.6 µm Doppler lidar measurements has been developed and installed at the international airports of Frankfurt and Munich. As a fact of the combination of both sensors the wind field can be observed in rain as well as in clear air conditions. Depending on weather conditions and application of filtering techniques there exist overlapping between radar and lidar wind measurements which is the baseline for our studies as described in the following.

Aimed at wind shear detection wind profiles are retrieved from the Doppler volume scans using the established volume velocity processing (VVP) method. Until today, no inter-comparison studies on radar and lidar retrieved VVP wind speed and direction have been performed. Focus of our investigations will be on high-resolution wind data (30 m vertical resolution) of the lower atmosphere (up to 800 m vertical). Depending on seasonal availability studies we will present an extensive verification of the radial velocity data and the wind vectors obtained from Doppler radar and lidar by inter-comparison.

Inter-comparison studies will be performed using modified wind standard deviation and signal-to-noise (lidar) thresholds, and echo classification techniques (radar). Statistical analysis of radar/lidar wind differences (RMS, bias) will be applied for different data volumes by varying scan elevation angles and ranges considering homogeneity and stationary effects. A key aspect of the study will be on radial velocity data of the 3° elevation scan slice covering the aircraft glide paths. The influence of instrument pointing accuracy on the wind profile differences will be discussed. As result retrieval methods are to be found that combines high quality low-level wind with high availability to obtain wind shear information for ATC applications.

The quality controlled and verified low-level wind data retrieved from X-band radar and lidar is foreseen to assimilate in high-resolution NWP (numerical weather prediction) models to improve weather forecasts.