Geophysical Research Abstracts
Vol. 14, EGU2012-5793, 2012
EGU General Assembly 2012

Assimilation of water vapor lidar observations: impact study on the COPS precipitation forecasts and hindcasts

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The Convective and Orographically-driven Precipitation Study carried out in summer 2007 over northeastern France and southwestern Germany provided a fairly comprehensive description of the low-troposphere water vapour field thanks, in particular, to the deployment of two airborne differential absorption lidar systems. These lidar observations were assimilated using the 3D VAR assimilation system of the Application of Research to Operations at MEsoscale (AROME) numerical weather prediction mesoscale model. The assimilation was carried out for the period of 4 July-3 August by running a 3-hour forward intermittent assimilation cycle.

First, the impact of the lidar observations was assessed by comparing the analyses with a set of more than 200 independent soundings. The lidar observations were found to have a positive impact on the analyses by reducing the dry bias in the first 500 m above ground level and by diminishing the root mean square error by roughly 15% in the first km.

Then, the impact of the lidar observations was assessed by comparing the AROME precipitation forecasts (obtained with and without the lidar observations for the period of 15 July-2 August) with the gridded precipitation observations provided by the Vienna Enhanced Resolution Analysis. In general, the impact was found to be positive but not significant for the 24h precipitation, and positive and significant for the 6h precipitation with an improvement lasting up to 24h.

Additional experiments performed with the Meso-NH research model showed that the results were improved when the model was run in hindcast mode and indicated that the model 24h-precipitation was more sensitive to boundary conditions errors than to initial condition errors in the moisture field.