TOPROF: A European COST initiative for improving weather forecasts by emerging ground-based profiling networks

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A new generation of high-resolution (~1km) weather forecast models now becoming operational over Europe promises to revolutionize predictions of severe weather, specifically by explicitly resolving convection. For this to be successful, a dense and highly temporally resolving observing network is beneficial, focusing especially on the lowest few km of the atmosphere. Such developments are being pursued within the current European COST Action ES1303 TOPROF (http://www.toprof.eu) which, in collaboration with the EUMETNET E-PROFILE project (http://www.eumetnet.eu/e-profile), is implementing the provision of real-time data from so-far un-exploited European networks for numerical weather prediction. The objective is to exploit inexpensive, reliable unmanned instrument networks, that can provide calibrated and quality controlled profiles of temperature, humidity, winds, aerosol, dust and clouds in near real-time to national weather forecast centres so the data can be assimilated into the forecast models. Specifically TOPROF focuses on a) automatic lidars and ceilometers (profiles of backscatter from aerosol, clouds, dust and volcanic ash), b) Doppler lidars (boundary layer winds, shear and turbulence), and c) microwave radiometers (profiles of temperature and humidity). At present profiles from 82 ceilometers from 9 European countries are being distributed in near real time to European weather services. The number is expected to rise to 250 by December 2017. Distribution of real-time Doppler Wind Lidar is just starting and should be completed in 2018, with the delivery of microwave radiometer real-time data proposed for 2019.

Within TOPROF forward model operators for ceilometers and microwave radiometers have been developed to be able to derive backscatter profiles and brightness temperatures, respectfully from model output, i.e. a ground-based RTTOV (fast microwave radiative transfer) version has been developed in collaboration with the Met-Office (UK) to make the direct assimilation of brightness temperatures possible. In addition, data analysis chains for the different instruments are currently developed providing rigorous uncertainty and total error estimates. Long-term O-B comparisons show promising results and give rise to the expectation that a positive assimilation could be possible from the instrumental side. In addition, first 1D-VAR and 3D-VAR assimilation trials show positive impacts on temperature, respectively precipitation forecasts. Future network configurations and data assimilation experiments will be discussed.