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Benefit of microwave radiometer and cloud radar observations for data assimilation and fog process studies during the SOFOG3D experiment

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Fog forecasts still remain quite inaccurate due to the complexity, non linearities and fine scale of the main physical processes driving the fog lifecycle. Additionally to the complex modelling of fog processes, current numerical weather prediction models are known to suffer from a lack of operational observations in the atmospheric boundary layer and more generally during cloudy-sky conditions. Continuous observations of both thermodynamics and microphysics during the fog lifecycle are thus essential to develop future operational networks with the aim of validating current physical parameterizations and improving the model initial state through data assimilation techniques. In this context, an international network of 8 ground-based microwave radiometers (MWRs) has been deployed at a regional-scale on a 300 x 300 km domain during the SOFOG3D (SOuth FOGs 3D experiment for fog processes study) that has been conducted from October 2019 to April 2020. The MWR network has been extended with ceilometers at all MWR sites and additional microphysical observations from the 95 GHz cloud radar BASTA at two major sites as well as wind measurements from a Doppler lidar deployed at the super-site. After an overview of the SOFOG3D objectives and experimental set-up, preliminary results exploiting mainly the MWR network and cloud radar observations will be presented. Firstly, the capability of MWRs to provide temperature and humidity retrievals within fog and stratus clouds will be evaluated and discussed against radiosoundings launched during intensive observation periods (IOPs). Secondly, first retrievals of liquid water content profiles within fog and stratus clouds derived from the synergy between MWRs and the BASTA cloud radar will be presented. To that end, a one dimensional variational approach (1D-Var) directly assimilating MWR brightness temperatures and cloud-radar reflectivities has been developed. 1D-Var retrievals will be validated through a dataset of simulated observations and real fog cases of the SOFOG3D experiment. The capability of MWR and cloud radar observations to improve the initial state of the AROME model during fog conditions will be discussed with a focus on selected case studies. Finally, the usefulness of ground-based remote sensing networks to improve

our understanding of fog processes and to validate physical parameterizations will be illustrated using the operational AROME model and the AROME Ensemble Prediction System