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Data assimilation experiments of a ground-based microwave radiometer network for fog forecast improvement.

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While fog can severely affect human activities (air, land and marine transportation), its forecast with current numerical weather prediction (NWP) models stays challenging, especially due to the lack of observations in the atmospheric boundary layer and the misrepresentation of non linear small scale processes. To improve knowledge on fog formation, evolution and dissipation, several instruments have been deployed during the SOFOG3D (SOuth west FOGs 3D experiment for processes study) experimental campaign to provide an unprecedent database of detailed 3D observations. In that context, a network of 8 ground-based microwave radiometers (MWR) provided continuous temperature profiling as well as integrated water vapor and liquid water path measurements during a 6 month period. Additionally, Martinet *et al* (2020) highlighted large temperature errors in the AROME-France (Application of Research to Operations at Mesoscale) NWP model background profiles during fog forecasts, leading to temperature differences up to 6 K when compared to tower measurements. Nevertheless, this study also demonstrate that the assimilation of MWR observations with a one dimensional variational data assimilation scheme could leads to improved initial conditions. To go further in that direction, MWR temperature profile observations from the SOFOG3D experiment have been added in the AROME-France operational data assimilation system, which uses a three dimensional variational algorithm (3D-Var) and climatological and homogeneous background error covariances (**B** matrix), to quantify the benefit on operational analyses and forecasts of several fog events. Then, the recently developped ensemble variational (EnVar) data assimilation system has been used to conduct new assimilation experiments. The main advantage of such method is to prescribe a fully flow dependent **B** matrix which is spatially and temporally coherent with the forecasted meteorological conditions. In consequences, it leads to more realistic increments. The results obtained with the different assimilation experiments will be presented. Firstly, a statistical analysis of the impact on the AROME-France analyses and short-range forecasts against conventional observations will be discussed. Secondly, specific SOFOG3D observations will be used to investigate the benefit on dedicated fog case studies.