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Fog due to stratus lowering: experimental and modelling case study

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Fog strongly perturbs aviation, marine and land transportation and accurate forecasts are thus required to reduce its impact on human activities. However there are still many unknowns in the physical mechanisms driving fog variability and how they interact, especially for fog formed by stratus lowering. The Numerical Weather Prediction (NWP) model AROME has some difficulties to correctly forecast this type of fog (Philip et al, 2016). Thus, the purpose of our study is to better understand the key processes involved in the fog formed by stratus lowering over continent.

We analyze here data collected during a field campaign that took place during autumns 2015 and 2016 in the north-east of France at the OPE station (Observatoire Perenne de l'environnement), Extensive measurements were performed with in-situ and remote sensing instruments. During the intensive observation periods (IOP), in situ vertical profiles have been carried out with a tethered balloon and Unmanned Aerial Vehicles (UAV) in addition to classical soundings. Sampled fog events during this experiment are mainly radiation (RAD) fog and stratus-lowering (STL) fog.
This work first documents, from analysis of detailed observations, the differences between STL, RAD and quasi-fog formation by stratus lowering (cloud base varies between 120m and 50m) in terms of the thermodynamical conditions and microphysical properties.
Then, we present results from a 3D numerical simulation performed with Meso-NH model (Lac et al, 2018) applied at 100 m resolution with a downscaling approach from AROME analysis. We focus on IOP2 (1-2 Dec 2016) in order to investigate the physical mechanisms involved in the fog formed by stratus lowering. We use a 2-moment microphysical scheme (LIMA) (Vié et al, 2016) to lead an accurate analysis of the microphysical properties of the stratus and fog, and to compare with in-situ droplet size distribution measurements.

The budget analysis shows that advection processes seem crucial to feed the stratus, in order to favor the stratus top rising and the stratus base lowering. Both experimental and modelling studies underline the complexity of this type of fog and the necessity to better understand the key processes driving the cloud life cycle.