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Supercooled liquid water representation with the LIMA 2-moment microphysical scheme during the ICICLE field campaign

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Supercooled cloud water is the source of a meteorological phenomenon with significant societal challenges: icing. Icing occurs when supercooled water droplets freeze upon contact with a solid surface and is even more intense with larger drops, resulting in stronger accretion. Anticipating the icing risk is crucial to ensure aviation safety, as ice on the fuselage can lead to a loss of lift. Icing as well occurs on wind turbines and train catenaries, making it a concern for both energy and transport sectors.

Supercooled water is often underestimated in numerical models. Our objectives are first to assess the two-moment microphysical scheme LIMA (Vié et al., 2016), second to identify the physical processes which are responsible for the lesser supercooled water before improving them.

To this end, numerical simulations of the research model Meso-NH (Lac et al., 2018) are compared to the observations of the ICICLE measurements campaign (https://www.eol.ucar.edu/field_projects/icicle). This airborne campaign was launched in February 2019 from Rockford (USA) by the USA's Federal Aviation Administration. During 29 flights, microphysical parameters as the mixing ratio and the size of liquid and icy hydrometeors have been measured. These observations form an exceptional data set for studying the microphysical behaviour of models.

19 days, including all the 23 research flights of the campaign, were simulated. An extensive evaluation of the simulations was carried out, both on a flight-by-flight basis using Meso-NH's flight simulator, and statistically combining observations from all flights. During the campaign, several cases of classical freezing rain, and lake effect situations, were sampled, allowing for a robust evaluation of model performance in these situations.

For lake effect cases, supercooled liquid water is forecast down to −30 °C, and mixed phase clouds are present between 0 °C and −10 °C, but cloud are almost completely icy around −20 °C. In freezing rain events, the precipitation tends to freeze again below the warm part of the cloud. To identify the sources of supercooled liquid water underestimation, a detailed analysis of microphysical processes budgets is performed. The impact of aerosols on forecasts is also investigated, using in-situ aerosol observations and CAMS reanalyses.