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Illuminating the blind spot of sub-mesoscale phenomena with a dense station network

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Between June and August 2020 an observational network of 103 autonomous ground-based stations covered the greater area (50 km × 35 km) of Hamburg (Germany) within the framework of the FESST@HH field experiment. The purpose of the experiment was to conduct meteorological measurements at sub-mesoscale resolution (500 m to 5 km) to observe phenomena that typically remain unresolved in operational networks. The experimental design focuses on studying cold pools that form through evaporation underneath precipitating clouds and spread on the Earth's surface.

During the experiment 82 low-cost APOLLO (Autonomous cold POoL LOgger) stations sampled air temperature and pressure at 1 s resolution to adequately capture the rapid signals of horizontally propagating cold-pool fronts. A secondary network of 21 autonomous weather stations with commercial sensors provided additional information on relative humidity, wind speed and precipitation at 10 s resolution. This work introduces the novel type of instruments, describes the generated data set, and presents first results of the experiment.

Over the three-month period the FESST@HH network experienced more than 30 cold-pool events of different strength and size. Case studies demonstrate that the observations allow to capture the internal structure and growth of a cold pool and to infer its vertical depth based on the hydrostatic assumption. The data set does not only provide novel insights into the life cycle of cold pools, but also opens new perspectives on phenomena like the urban heat island. Moreover, the experiment may serve as a prototype for the design of future observational networks, including citizen science approaches.