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Measuring the variability on meso and submeso scales for improving numerical weather prediction

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Numerical weather prediction (NWP) models applied on regional scales use a typical grid spacing of O(2 km). While such a grid spacing allows to start explicitly resolving convection - at least deep convection - several features of the flow remain of subgrid-scale nature, e.g. turbulence, shallow convection, or may be distorted by the coarse grid spacing. Large-eddy simulations (LES) with grid spacing of at least O(100 m) can be used to get more information on smaller-scale, generally under-resolved, phenomena. But such simulations also rely on parameterizations, most notably turbulence and microphysics. Getting information on the atmospheric flow on scales O(500 m) from observations remains challenging as the measurement network lacks the spatial resolution. For instance automatic measurement stations of the German Weather Service (DWD) have a typical horizontal distance of O(25 km). This makes the validation of NWP models and LES difficult.

We present the plan of a field campaign, which deploys a high-density measurement network that will allow us to observe features of the atmospheric flow occurring on scales between 500 m and 5 km. This formally corresponds to part of the micro-scale and of the meso-gamma scale. The measurements will be used to (i) improve our process understanding, (ii) validate aspects of convection-permitting NWP simulations and (iii) investigate the usefulness of such a high-density measurement network in view of the design of future measurement networks in a world where simulations tend to use higher and higher resolution. In addition to the measurements, various simulations will be performed in support of the field campaign and for validation purposes. This includes data assimilation experiments using the collected measurements.

The measurement campaign focuses on four different topics, which are either an expression or a source of submesoscale variability: boundary layer patterns, cold pool, wind gust and roughness length. The four topics are inter-connected via cold pools, which both generate boundary layer patterns and wind gusts and whose properties depend upon roughness length. The measurement campaign will take place in Lindenberg (east Germany) for an extended summer season in 2020. Lindenberg is chosen given the already various existing instruments, the support by DWD available on site as well as the relatively flat topography. Moreover Lindenberg experiences more frequent convective activity than many other flat regions in Germany. One particular feature of the planned field experiment is the use of about 100 ground base stations, spread over a 10 km x 10 km domain.