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Towards micro- and macrophysical parameterization of shallow convective clouds:
From Large-Eddy Simulation to multi-UAV-based cloud sampling

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The lack of adequate measurements of cloud dynamics and microphysics key parameters that regulate cloud formation has caused a divergence in the formulation of cloud models. Most cloud related studies, justify their lack of understanding of small-scale cloud-related physical processes because of insufficient simultaneous in-situ measurements. It is not only the precision of the instrument that matters, rather it is the way in which the sampling strategy is applied. As of yet, bringing together a sampling strategy for a field campaign using a swarm of unmanned aerial vehicles (UAVs) based on large-eddy simulation (LES) has not thoroughly been explored. This project (Skyscanner) which is a joint collaboration that involves a Multidisciplinary Team (including institutes specializing in aviation, robotics and atmospheric science), aims on bringing together novel shallow cumulus cloud sampling strategies using a swarm of UAVs based on Large-eddy simulation (LES). For this purpose, an extensive set of LES has been performed with the use of MesoNH-LES model. The numerical experiments were driven by initial conditions from case studies over ARM-SGP site. The simulations have been performed at three horizontal resolutions: 10 m, 25 m and 100 m. For each of these resolutions, four microphysics schemes have been tested with three horizontal wind speeds. The results reveal relationships between geometric properties, dynamics and microphysics of shallow convective clouds. The numerical experiments enabled bringing about a macroscopic model that quantifies the interrelationship between micro- and macrophysical properties of shallow convective clouds. These results are used for optimal UAV conception and control, and optimal control of a fleet of UAVs.