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From large-eddy simulation to multi-UAVs sampling of shallow cumulus clouds

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In-situ sampling of clouds that can provide simultaneous measurements at satisfying spatio-temporal resolutions to capture 3D small scale physical processes continues to present challenges. This project (SKYSCANNER) aims at bringing together cloud sampling strategies using a swarm of unmanned aerial vehicles (UAVs) based on Large-eddy simulation (LES). The multi-UAV-based field campaigns with a personalized sampling strategy for individual clouds and cloud fields will significantly improve the understanding of the unresolved cloud physical processes. An extensive set of LES experiments for case studies from ARM-SGP site have been performed using MesoNH model at high resolutions down to 10 m. The carried out simulations led to establishing a macroscopic model that quantifies the interrelationship between micro- and macrophysical properties of shallow convective clouds. Both the geometry and evolution of individual clouds are critical to multi-UAV cloud sampling and path planning. The preliminary findings of the current project reveal several linear relationships that associate many cloud geometric parameters to cloud related meteorological variables. In addition, the horizontal wind speed indicates a proportional impact on cloud number concentration as well as triggering and prolonging the occurrence of cumulus clouds. In the framework of the joint collaboration that involves a Multidisciplinary Team (including institutes specializing in aviation, robotics and atmospheric science), this model will be a reference point for multi-UAVs sampling strategies and path planning.