Master of Science Project

Geoscience and Remote Sensing

Themes: Atmospheric measurement techniques / Atmospheric simulations

Flying drones in large-eddy simulations & optimizing measurement strategies

Context

Large-eddy simulations (LES) have proven to be invaluable tools for simulating various atmospheric processes, particularly those occurring within the boundary layer. With their ability to capture turbulent eddies and small-scale phenomena, LES provide a detailed and realistic depiction of the complex interactions that shape our atmosphere.

On the measurement side of things, in recent years, drones have emerged as powerful instruments for collecting precise measurements of atmospheric properties in the boundary layer. They offer the advantage of being able to perform innovative sampling techniques and providing finer-scale data compared to traditional methods. Drone measurements can thus help understand atmospheric processes and dynamics at scales not accessible previously.

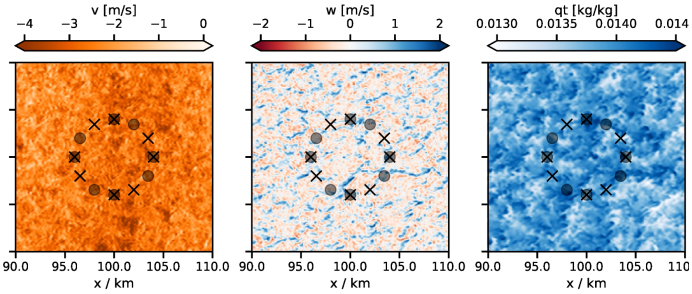

Figure-1: *A snapshot of drones sampling measurements in different fields of an LES dataset. This dataset is stored after the simulation is run, and sampling is not during the simulation itself. To leverage the most out of drones, sampling from the LES should be at very fine time-steps (seconds) and spatial intervals (metres). Storing such high-resolution data from LES is very compute- and storage-intensive. To circumvent this problem, this masters project aims to get the sampling done online, i.e. when the simulation is running.*

Project Description

An obvious synergy evolves here between LES & drones, by implementing a "drone-flight" module within the DALES (Dutch Atmospheric Large-Eddy Simulation) model. Such a module will "make measurements" along pre-defined virtual flights while an LES simulation is running. This integration will enhance LES as a virtual laboratory for testing & optimizing drone-flight strategies before their implementation in real-word field measurements.

With this new module in place, different strategies for drone measurements will also be tested for different scientific research objectives. Optimizing flight paths, altitudes, and sensor configurations will help gather the most relevant data, contributing to a deeper understanding of atmospheric processes.

By implementing a new module in LES and by using it to recommend optimal drone-flight strategies, this masters project aims to further the capabilities of both LES and atmospheric measurement techniques.

Student's profile

We are looking for students enthusiastic about atmospheric/climate modeling or measurements. The work involves developing a module for the DALES model, which is written in Fortran.

You should ideally have some programming experience, or should be ready to learn some basic Fortran and Python. There will be guidance along the way. By the end of the project, you will have a good idea of how the inner workings of an LES model are implemented, i.e. learning about how different numerical solvers and components communicate with each other.

Any background in fluid dynamics / atmospheric dynamics / atmospheric measurements / atmospheric simulations is a plus.

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For students of Applied Earth Sciences, Aerospace Engineering, Mathematics or Computer Science