Atmospheric Prediction

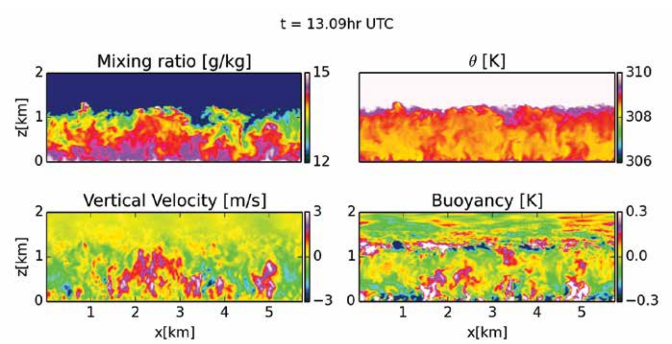
Heus studies boundary layer to improve weather, climate modeling

The clouds above our heads provide some of the biggest uncertainties in weather prediction, but a better understanding of their layers could unlock answers.

Thijs Heus, Ph.D., Cleveland State University, is using the Oakley Cluster at the Ohio Supercomputer Center to perform large eddy simulations—high-resolution computer simulations—to study the atmospheric boundary layer (ABL), which could result in better weather and climate modeling along with improved air quality.

"It starts with improved weather and climate models," Heus said, "not just for weather models but for climate prediction. What's going on in the boundary level is one of the bigger uncertainties. If we can get that right, then the overall weather and climate predictions would improve.

"The atmospheric boundary layer is the layer we are living in, so a good understanding of it impacts what goes on directly around us."



► Graphs show the humidity, temperature, buoyancy and vertical velocity in the atmospheric boundary layer throughout the day according to simulations done through OSC resources.

Above & below: Rendering of a generated cloud field.

For example: Why is an urban environment warmer than outside the city? To accurately assess that you need a good understanding of the ABL.

The ABL is the lowest few kilometers of the atmosphere, and during the day the sun heats the ground and the lowest layers of air, making the ABL unstable and convective. This means warm surface air rises from just above the surface to right below the top of the ABL. This is key to meteorology because of its relevancy to air quality and pollution, and because the clouds directly above it hold that aforementioned source of uncertainty in weather and climate modeling.

Part of the uncertainty lies in the mixing between the top of the boundary layer and the atmosphere above, in a small-scale interfacial layer tens of meters high or less. Clouds are often rooted in this layer, and varying degrees of cloud cover control the amount of solar heating that fuels the CBL generation. Weather and climate models normally involve a larger scale, meaning sub-models need to be created. And in order to do that, it's important to have a strong understanding of the underlying processes.

The study is in collaboration with the National Oceanic and Atmospheric Administration (NOAA), and funded by the Department of Energy's Atmospheric Radiation Measurement facility at the Southern Great Plains site in Oklahoma. The NOAA team performs the meteorological observations. Heus' team takes those observations and performs the large-eddy simulations, and high performance computing is crucial to that process. •

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Research Title: Characterizing the turbulent structure of the atmospheric boundary layer using large eddy simulations
Funding Source: Department of Energy
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