BLUE WATERS
SUSTAINED PETASCALE COMPUTING

Allocation: BW Professor/250 Knh

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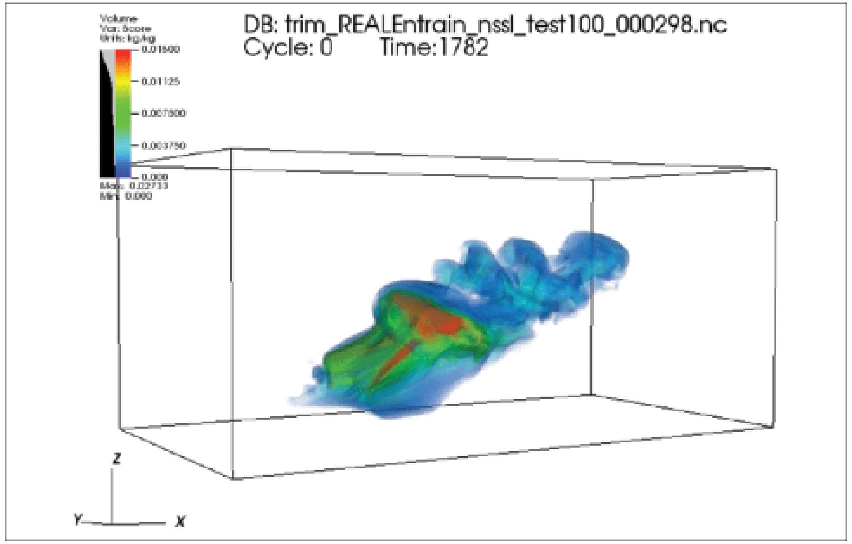
Geoscience



Visualization of the 3D core of a developing thunderstorm. Warm colors (yellow, red) denote areas of greater amounts of precipitation mass; cool colors (green, blue) denote areas with little water mass remaining.

UNTANGLING ENTRAINMENT AND PRECIPITATION IN CONVECTIVE CLOUDS

Research Challenge

A problem with meteorological models is that they often predict rain formation too early and in excessive amounts. This research focuses upon quantifying how much dry air is entrained by cumulus clouds and storms, that may limit their strength and the precipitation they produce. It requires high spatial resolution to represent small scale turbulence in the clouds and storms, but the resolution required for accuracy is itself an open question that the research team is investigating.

Methods & Codes

The research team is using the NCAR CM1 model to simulate convective cumulus clouds and storms at high resolution using the Blue Waters system. They then apply their own codes to quantify the amount of dry air brought into the clouds/storms, and assess the effects upon the amount of precipitation produced. Comparison to observations and theoretical predictions provide confidence in the modeling results.

Results & Impacts

Atmospheric scientists are working to produce approximations of entrainment, as weather and climate models cannot represent all of the cloud motions. This research provides new quantitative knowledge for that effort.

The latest results show that closer spacing between storms, expected to decrease the effects of entrainment and encourage precipitation, can instead initially *delay and decrease* precipitation, as they compete for the warm moist air beneath their bases that fuel them. Identifying competing effects is critical for making progress upon this research problem.

Why Blue Waters

Blue Waters, with its large number of nodes, its high speed, and its large storage capability for high-resolution model output and analysis, allows us to push the spatial scale limit to include more turbulent motions much farther than in the past. Blue Waters staff have helped the research to learn new and practical ways to visualize the output for easier analysis.