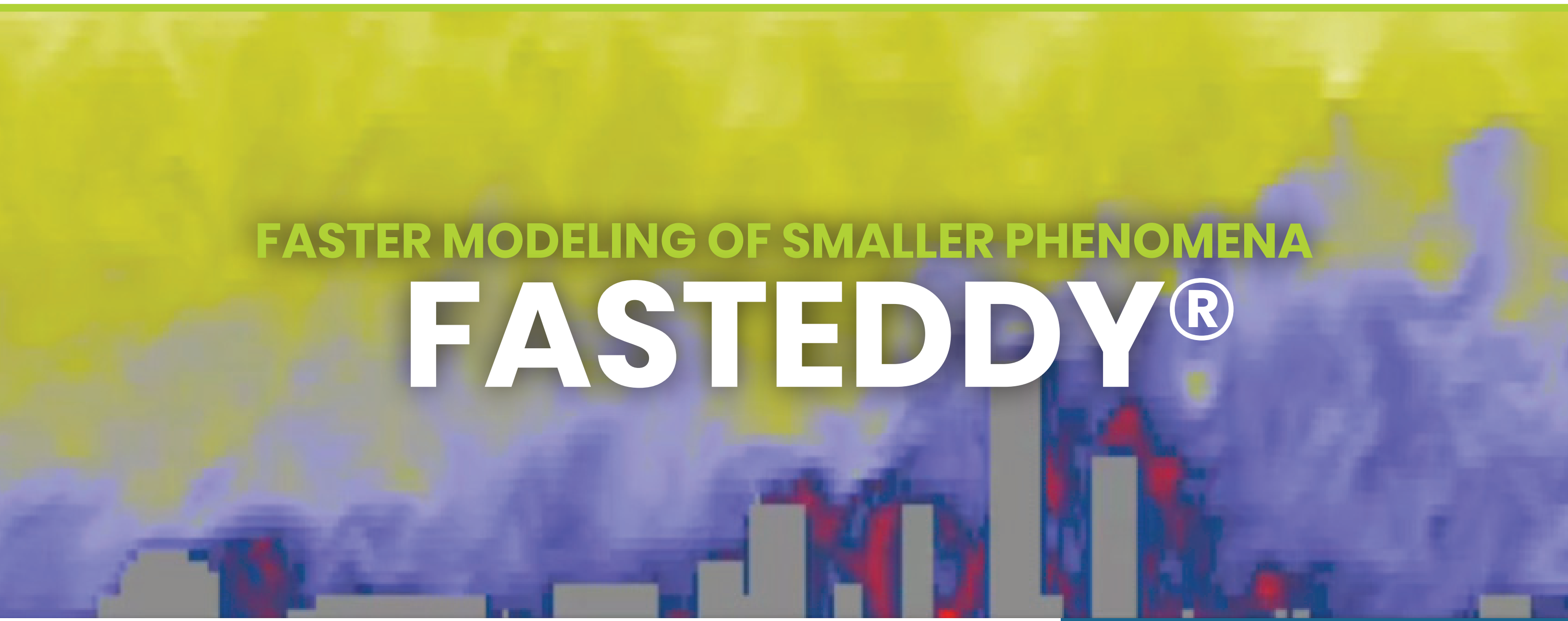
NCAR | RESEARCH APPLICATIONS LABORATORY



FASTER MODELING OF SMALLER PHENOMENA

FASTEDDY®

Scale & Speed

Society depends on weather forecasting in myriad ways. Forecasts grow more sophisticated and accurate every year. Unfortunately, for even the most advanced prediction models, an entire category of weather has historically gone unseen: the microscale. Microscale weather is wind that swirls around tall buildings, enhances and inhibits wind energy resource harvesting; drives pollutants through the air, and turbulence that buffets aircraft. Some computer models can simulate the microscale, just not fast enough to support real-time decision making.

The frontier of actionable atmospheric science and the benefits it promises to society demand that we model weather over minutes and meters. So, can we not just simulate, but actually forecast microscale weather skillfully enough and fast enough to make a difference? The answer is FastEddy®.

BUILT FOR SPEED

From its inception, FastEddy® was designed to set a new standard in GPU-accelerated (fast) large-eddy simulations (eddy). The original intent of the project was to include accelerated microscale modeling with first-responder training, specifically transport and dispersion of atmospheric plumes. FastEddy® had to match the speed of the best models in the world without requiring a supercomputer to do it.

Benefits & Impacts

- Harnessing the speed of graphics processors (GPUs)
- Simulating airborne threats faster than they travel
- Transforming research, forecasting, and education in microscale meteorology

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The performance of FastEddy® on GPUs versus similar models run on CPUs, is determined by scaling tests using 1 GPU to 256 CPU cores. At this ratio, FastEddy simulates the weather six times faster than similar CPU models using the same electricity. Alternatively, FastEddy® uses one eighth the electricity to achieve equivalent prediction rates. FastEddy®'s speed and efficiency allow broader application of large-eddy simulations to emerging atmospheric boundary-layer research topics, while using less energy to deliver faster results.

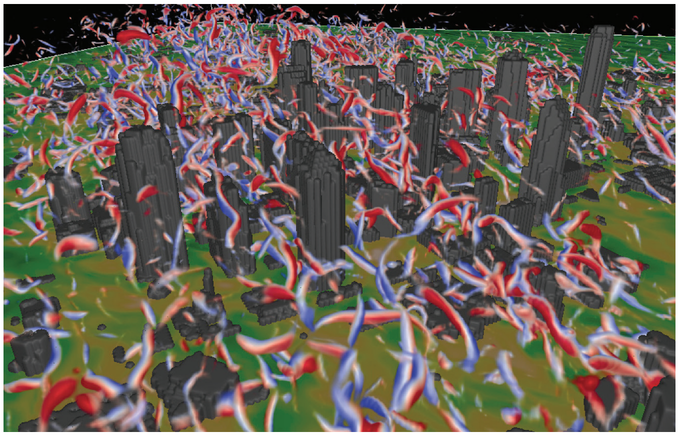
FASTER IS FINE BUT ACCURACY IS EVERYTHING ~WYATT EARP

In forecasting, success is not just about speed. For this reason, FastEddy® has been extensively verified and validated against industry-standard models and observations from laboratories and field studies.

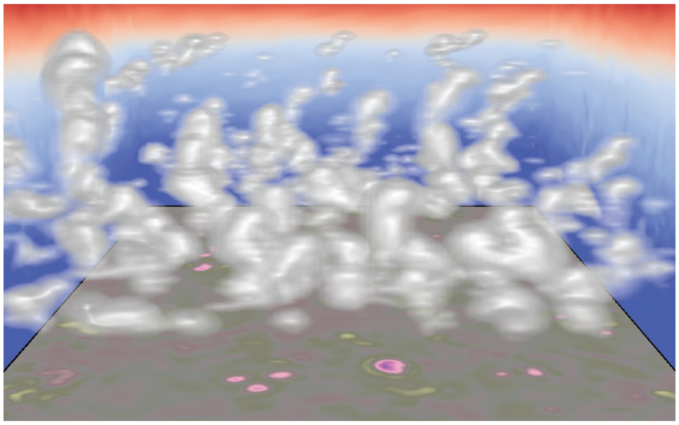
A significant majority of social and economic activities are concentrated within densely populated urban areas. Coupling FastEddy® to mesoscale numerical weather prediction models enables accurate simulation and prediction of urban-scale weather that was not included in standard forecasting in the past.

RESEARCH, OPERATIONS, AND EDUCATION

Fast LES modeling is ideally suited for basic and applied research, operational forecasting, and education in microscale meteorology. Examples include:



Visualizing turbulence structures within the urban canop



Shallow cumulus clouds from the BOMEX model intercomparison

- Enhancing our understanding of the boundary layer's response to exchange processes between the planet's surface and the atmosphere in complex terrain
- Optimally siting wind turbines, forecasting wind-farm production, and assessing wind resources
- Calculating the building-aware transport and dispersion of chemical, biological, or radiological material in the atmosphere, in response to an accidental or intentional release
- Calculating infiltration and exfiltration between indoor and outdoor spaces
- Characterizing turbulence for unmanned aerial systems
- Studying and predicting the behavior of wildfires
- Teaching students how the atmospheric boundary layer responds in real time to changes in temperature, humidity, wind, and other conditions

NOW AND TOMORROW

FastEddy® is in its third year of custom development, refinement, and application in RAL as a consortium-like, multi-project, multi-stakeholder initiative. The model is being applied to emerging needs in national security, aviation, renewable energy, wildfire behavior, urban weather, and basic atmospheric research. By incorporating multiple and ever broadening stakeholder interests into FastEddy's evolution, RAL offers a unique and promising opportunity to invest in, influence, and capitalize on the technological innovation of accelerated GPU computing in microscale meteorology.

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