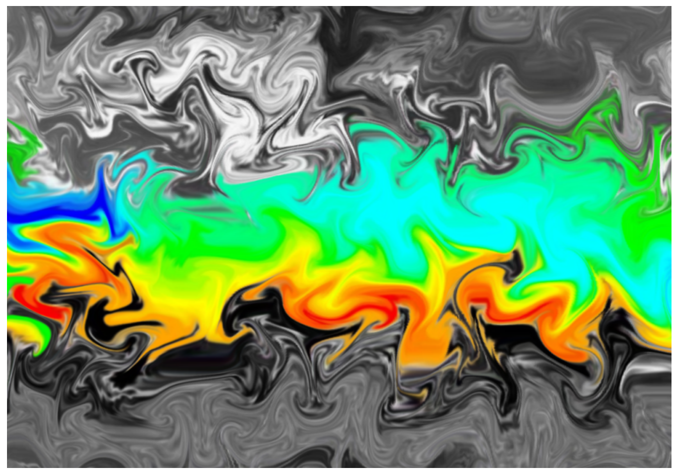
New Turbulence Model Shakes Things Up

Most people who have been on an airplane have most likely heard the pilot come on the intercom and announce turbulence. But the term extends much farther beyond the atmosphere. Turbulence is a naturally occurring phenomena in the movement of liquids or gases, such as in fire, clouds, or smoke. It occurs not only in the air, but in the ocean, the human body, and in machines. It is possible to solve the known equations for fluid flow in order to predict turbulence, but the process is computationally intense. Simple turbulent flows require months of supercomputer time to solve in this way, and this is not useful for engineers. The alternative approach is turbulence modeling.



Cross-section through a turbulent fluid showing the complex and chaotic motions that enhance mixing.

For the past 100 years, scientists have been trying to model turbulence. To do this, scientists traditionally tried to simplify the known equations for fluid flow. Recently, however, Dr. Blair Perot, a professor of Mechanical and Industrial Engineering at UMass Amherst, has developed a radically different approach to modeling turbulent flow. Not only is his model a much cheaper method than classic approaches, but is also faster and more accurate. In the past, Dr. Perot explains, calculations have not been exact enough to be anything more than "helpful." His model is poised to change all that, and will revolutionize the way that computer simulations are used in modeling turbulence.

Based on earlier research, there was a general understanding of what a turbulent flow would do in certain situations. From there, Dr. Perot decided to work backward, to see if modeling turbulence as a collection of colliding objects behaved like a turbulent flow. Together with several graduate students in his lab, Dr. Perot began looking at turbulence as a group of spinning chunks of fluid called eddies. These eddies crash into each other, based on some simple statistical rules. Compared to current approaches, Dr. Perot's eddy-collision model has much more accurate predictive capabilities.

Turbulence models do have limitations. They predict statistics, not individual events. Think again about riding in an airplane. Turbulence models can be used to determine the likelihood of a bumpy flight, but can't predict if your particular flight next week will be a smooth ride.

The potential applications for Dr. Perot's research are widespread. These models can be used to compute the turbulent flow in a car piston, leading to reduced emissions and improved efficiency. They can help to predict the sun and the galaxy (both of which are turbulent flows). Turbulent models are important for understanding the rate of atmospheric heat and CO_2 transfer into the oceans. This is significant for both predicting long-term global warming, as well as short-term plankton growth.