

## Advances in Mesoscale to Microscale Coupling for Wind Energy Applications

Dr. Sue Ellen Haupt, Senior Scientist  
Deputy Director, Research Applications Laboratory  
National Center for Atmospheric Research

The purpose of the US DOE's Mesoscale-Microscale Coupling (MMC) Project is to develop, verify, and validate physical models and modeling techniques that bridge the most important atmospheric scales that determine wind plant performance and reliability. The project seeks to create a new predictive numerical simulation capability that represents a range of dynamic atmospheric flow conditions impacting wind plant performance.

The project approach is to choose case days for which there are observational data for validation. Best-practices studies use data from the flat terrain Scaled Wind Farm Technology site in Texas. For complex terrain cases, the team leverages observational data from the WFIP2 field project in the Pacific Northwest. Science questions include: 1) What is the impact of modeling across the so-called *terra incognita*, that grid resolution between about 100 m and the boundary layer depth at which numerical artifacts are often difficult to distinguish from physical boundary layer rolls? 2) How to best initialize turbulence at the microscale that was not resolved in the mesoscale model? 3) What is the best way to handle the surface layer parameterizations consistently at the mesoscale and the microscale?

The team has systematically devised strategies to address each of these issues and made substantial progress in understanding the physics behind each issue as well as toward recommending best practices for coupled modeling in both flat and complex terrain. Some difficult issues remain, but the team continues to study ways to improve such coupled modeling.