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(Relatively) Simple Models of Flow in Complex Terrain

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The term, "complex terrain" includes both topography and variations in surface roughness and thermal properties. The scales that are affected can differ and there are some advantages to modeling them separately.

In studies of flow in complex terrain we have developed 2 D and 3 D models of atmospheric PBL boundary layer flow over roughness changes, appropriate for longer fetches than most existing models. These "internal boundary layers" are especially important for understanding and predicting wind speed variations with distance from shorelines, an important factor for wind farms around, and potentially in, the Great Lakes. The models can also form a base for studying the wakes behind woodlots and wind turbines. Some sample calculations of wind speed evolution over water and the reduced wind speeds behind an isolated woodlot, represented simply in terms of an increase in surface roughness, will be presented. Note that these models can also include thermal effects and non-neutral stratification.
We can use the model to deal with 3-D roughness variations and will describe applications to both on-shore and off-shore situations around the Great Lakes. In particular we will show typical results for hub height winds and indicate the length of over-water fetch needed to get the full benefit of siting turbines over water.

The linear Mixed Spectral Finite-Difference (MSFD) and non-linear (NLMSFD) models for surface boundary-layer flow over complex terrain have been extended to planetary boundary-layer flow over topography This allows for their use for larger scale regions and increased heights. The models have been applied to successfully simulate the Askervein hill experimental case and we will show examples of applications to more complex terrain, typical of some Canadian wind farms. Output from the model can be used as an alternative to MS-Micro, WAsP or other CFD calculations of topographic impacts for input to wind farm design software.