# Mapping of Topographic Effects on Maximum Sustained Surface Wind Speeds in Landfalling Hurricanes

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**Principal Investigator** Craig Miller
Boundary Layer Wind Tunnel Laboratory
Department of Civil and Environmental Engineering
University of Western Ontario

## Project Synopsis

While the effect of large-scale topography, such as that found on Hispaniola, on the overall structure of a hurricane passing over such topography is reasonably well understood, forecasters at the Tropical Prediction Centre/National Hurricane Centre (TPC/NHC) currently have no means available to them to assess the impact of small-scale topography on surface wind speeds in hurricanes making landfall over such terrain. This project uses the MS-Micro linear model for boundary layer flow over small-scale topography, described by Walmsley *et al.* (1982), Taylor *et al.* (1983), and Walmsley *et al.* (1986), in combination with the US Geological Survey's National Elevation Dataset (NED) to map the effects of topography on surface wind speeds at a height of 10 m for Puerto Rico and the US Virgin Islands. The intended primary outcome of the project is a set of maps showing contours of speed-up factors that can then be used by a forecaster to assess the effects of topography on maximum sustained surface wind speeds in hurricanes making landfall in Puerto Rico or the US Virgin Islands. It is anticipated that a successful conclusion to the project would lead to an improved ability to forecast maximum sustained surface wind speeds in areas with significant topography as identified in TPC/NHC hurricane forecaster priority TPC-6.

## Progress Report

The Year 1 progress report identified several questions about the impact of changes of surface roughness on the calculated topographic speed-up factors that arose in the course of discussions during a visit to the TPC/NHC in June 2006. These changes of surface roughness include not just those changes that occur in transitioning from open-water to over-land conditions, but also the natural variations in surface roughness that occur over land. It was noted in this report that the version of MS-Micro being used included a model for the effects of surface roughness changes on the mean wind speed, although the original project proposal did not call for this capability to be used. As a result it was proposed that the already completed calculations be repeated by first considering the case in which there are two surface roughness values, one for over-water conditions, the other for over-land conditions, before carrying out a third set of calculations to explore the impact of the actual over-land surface roughness variations on the calculated topographic speed-up factors.

Initial tests of the module included with the MS-Micro code for the generation of an input roughness grid from a set of scattered seed points showed that the code did not correctly reproduce the input surface roughness variations. As a result a completely new module was developed to take a set of input seed points describing the underlying land cover variations before interpolating them onto a master roughness grid. The latter was then used to generate a set of input roughness grids, one for each wind direction considered, for use by the main MS-Micro program. Modification of the Graphical User Interface (GUI) used to control the execution of MS-Micro was also required to give the user the option of calculating the effects of topography variations alone with a constant surface roughness length throughout the solution domain, or the combined effects of topography and surface roughness variations.

Figure 1 shows a plot of the percentage difference between the calculated speed-up values assuming that the over-land roughness length is equal to 0.03 m and the over-water roughness length is equal to 0.003 m relative to the base case which assumes open-water throughout the solution domain. In general the effect of the increased over-land surface roughness is to increase speed-up values near the crests of topographic features, while increasing the sheltering effect on lee slopes. The percentage differences are relatively small, the majority of the re-calculated speed-up values being within +/- 10% of the base open-water case values. Work is currently proceeding on incorporating the effects of the actual over-land surface roughness variations into the calculated speed-up maps.

In terms of implementing the display of the speed-up maps a Windows based package using MapWindowGIS has been developed that allows the user to select the maximum sustained wind speed and track heading before calculating and plotting the resulting topographically enhanced wind speeds. These can be plotted in terms of either the wind speed in kts, or by Saffir-Simpson category, and overlaid with layers showing features such as population centres, major roads, etc.

**References**

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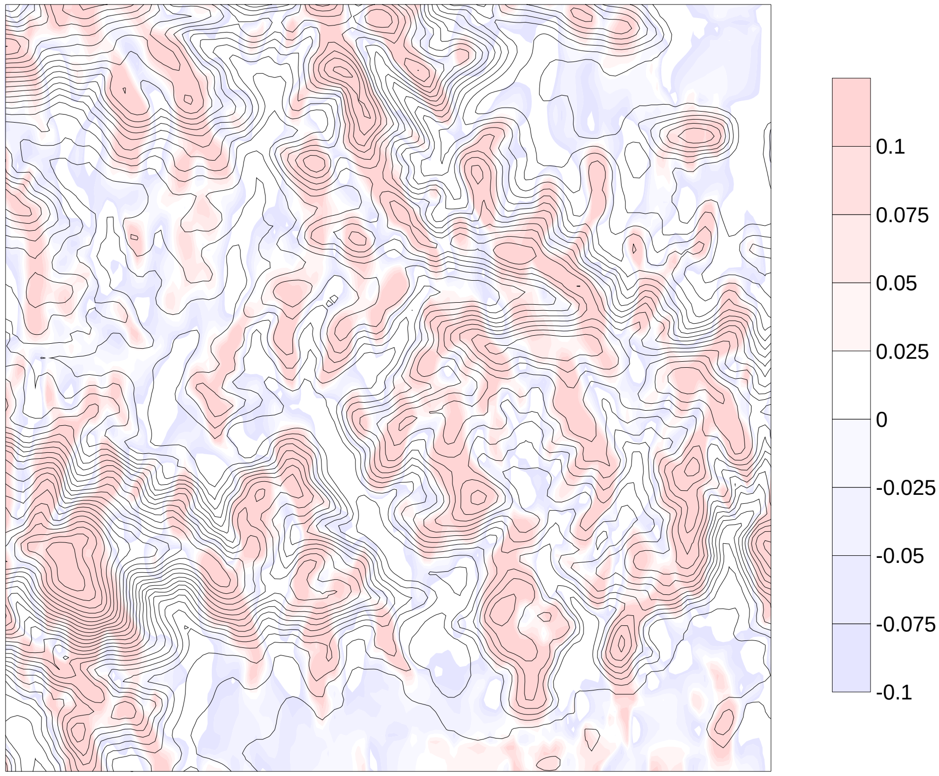


**Figure 1:** Percentage difference between speed-up values calculated assuming that the over-land roughness length is equal to 0.03 m and the over-water roughness length is equal to 0.003 m relative to the base case which assumes open-water conditions throughout the solution domain