FLOWSTAR-Energy Complex Terrain Flow Field Validation: *Blashaval*

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FLOWSTAR-Energy 5.1

1 Introduction

The aim of this study was to compare wind speed and direction measured at various distances from an isolated hill with FLOWSTAR-Energy predictions.

The site selected, the hill called Blashaval, is located on the eastern side of the island of North Uist in the Outer Hebrides of Scotland at 57°37'N 7°12'W. The measurements were obtained during the five-week period 6th September to 8th October 1982 under neutral stability conditions. The weather was unusually windy with a great deal of heavy rain, so there was extensive cloud cover. The predominant wind directions were from the south and west but almost all wind directions occurred during the period. Hourly average values of wind speed and direction were measured at a number of points on and around the hill. It was observed that when the 8 m-wind speed was greater than 5 m/s, the ratios of the wind speeds at various heights were independent of wind speed, suggesting the effects of atmospheric stability were small. For the present study, data from the five measurement sites shown in Figure 1 are analysed.

Firstly, wind speed profiles at the reference site R are compared with model results as a function of wind direction. Then, the wind speed and direction at 8 m at the summit site S, and sites A, B and C as a function of wind direction are compared with model results.

2 Input data

2.1 Terrain data

Blashaval rises approximately 100 m above the surrounding terrain and has a base diameter of about 800 m. Figures 1 and 2 illustrate the topography used as input to the model.

The flow field has been observed at different locations. Site R in Figure 1 is used as a reference site and was located on a peat bog extending to the west of the hill. Site S is at the summit of the hill and sites A, B and C lie to the south west of the summit. The positions of the sites at which mean velocities were measured are marked on Figure 1.

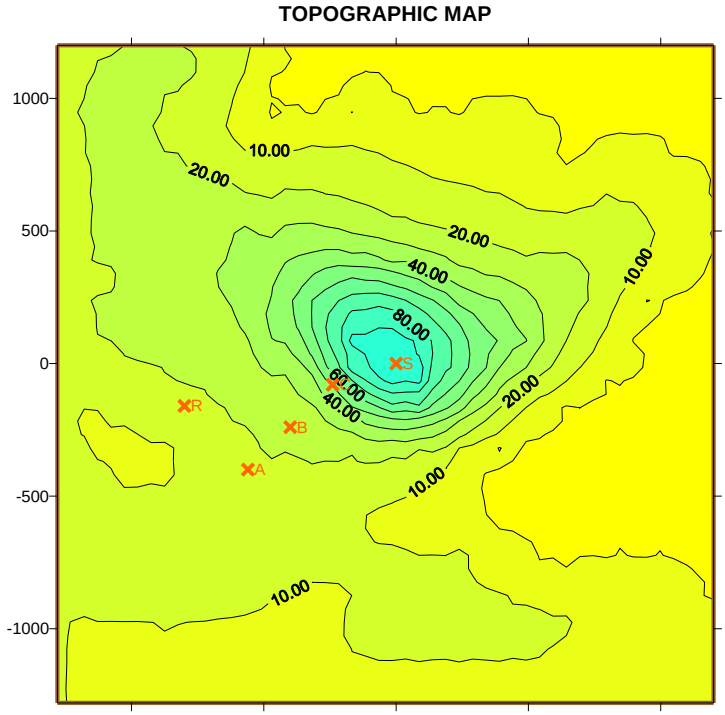

Figure 1 - Blashaval topography

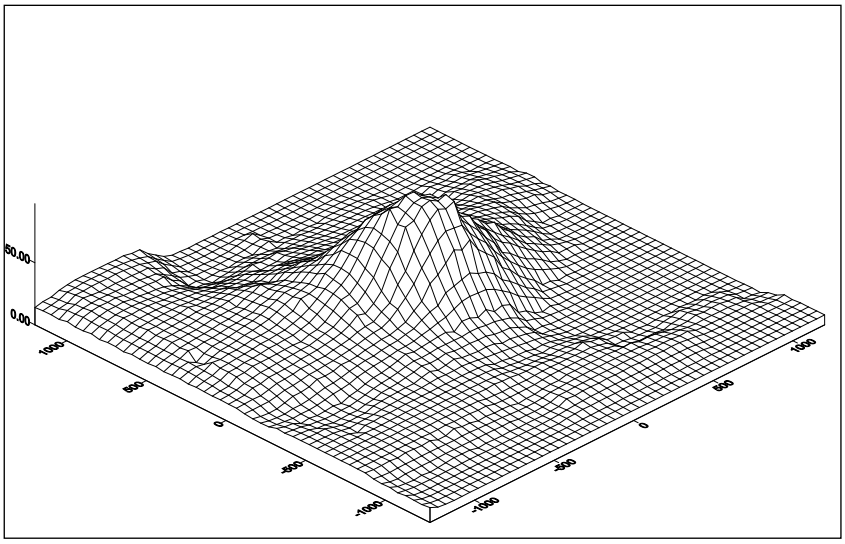

Figure 2 - Surface representation

2.2 Surface roughness

The terrain in the immediate vicinity of Blashaval is almost homogeneous. The main inhomogeneities in the surface are the many lakes. The vegetation is a uniform cover of heather and grass growing in peat, and the only small-scale irregularities are peat cuttings and bluffs about 2 m high adjacent to the lakes. Despite these irregularities, the terrain is quite smooth and a roughness length of 0.01 m obtained from measurements has been assumed for the model runs.

2.3 Meteorological data

This study takes place under neutral stability conditions. The model used as input: a wind speed of 10 m/s measured at 8 m; zero heat flux; and a boundary layer height of 800 m. The model was run with wind directions ranging from 5° to 355° at 10° intervals. The latitude was set to 57.5°.

3 Results

3.1 Velocity Profile

The velocity profile at the reference site R predicted by FLOWSTAR-Energy has been compared to the results from Mason and King[1] [1]. A summary of the averages obtained at each height is shown in Table 1. As can been seen from the table, the average change in wind speed with height obtained by the model is in very good agreement with the observed values.

Height (m)	Observed average U/U(16m)	Model average U/U(16m)	Model / Observed
2	0.71	0.72	1.02
4	0.82	0.82	1.00
8	0.91	0.91	1.00

Table 1 – Averages of wind speed profiles

3.2 Mean flow at 8m at points S, A, B and C

The wind speed ratios between the sites S, A, B and C to the reference point R are compared in Figures 3 to 6.

The speed up at the summit (approximately a factor of 1.6) is well predicted by the model. The change to the flow at the other sites is generally much smaller and is again well predicted by the model except when the point is in the lee of the hill.

[1] Figure 7, page 630

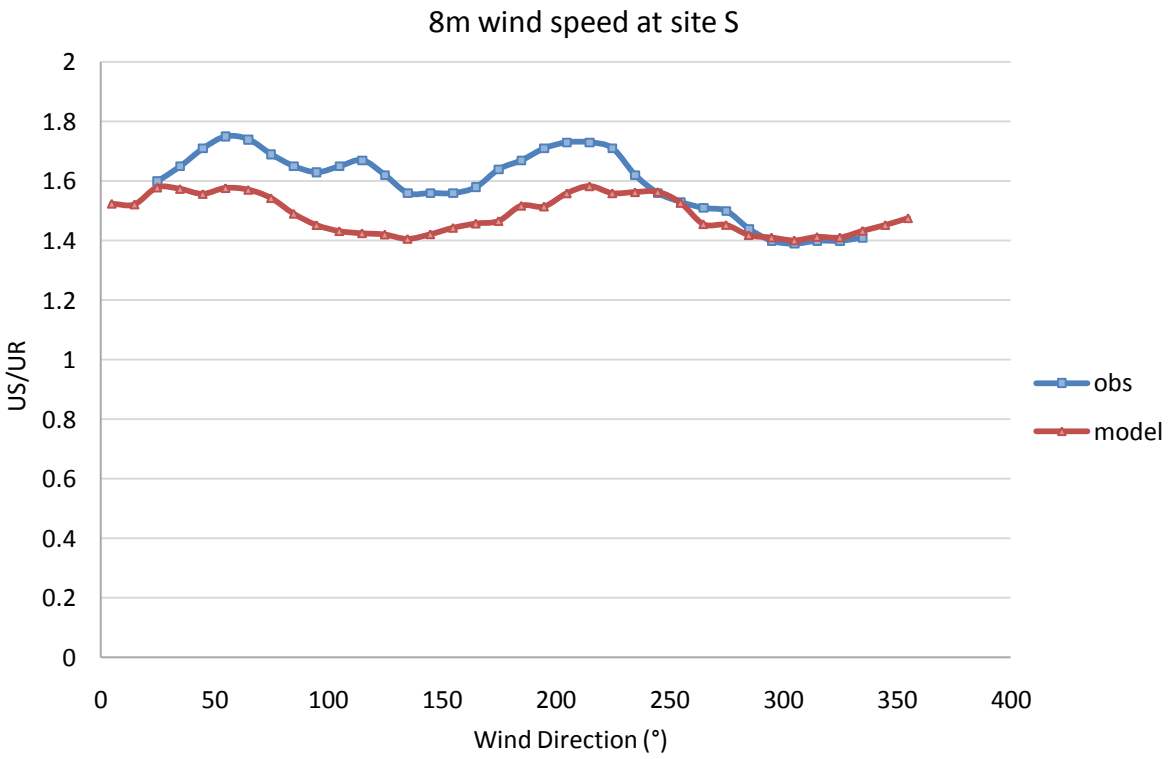

Figure 3 - Comparison of 8 m wind speed at the summit site S

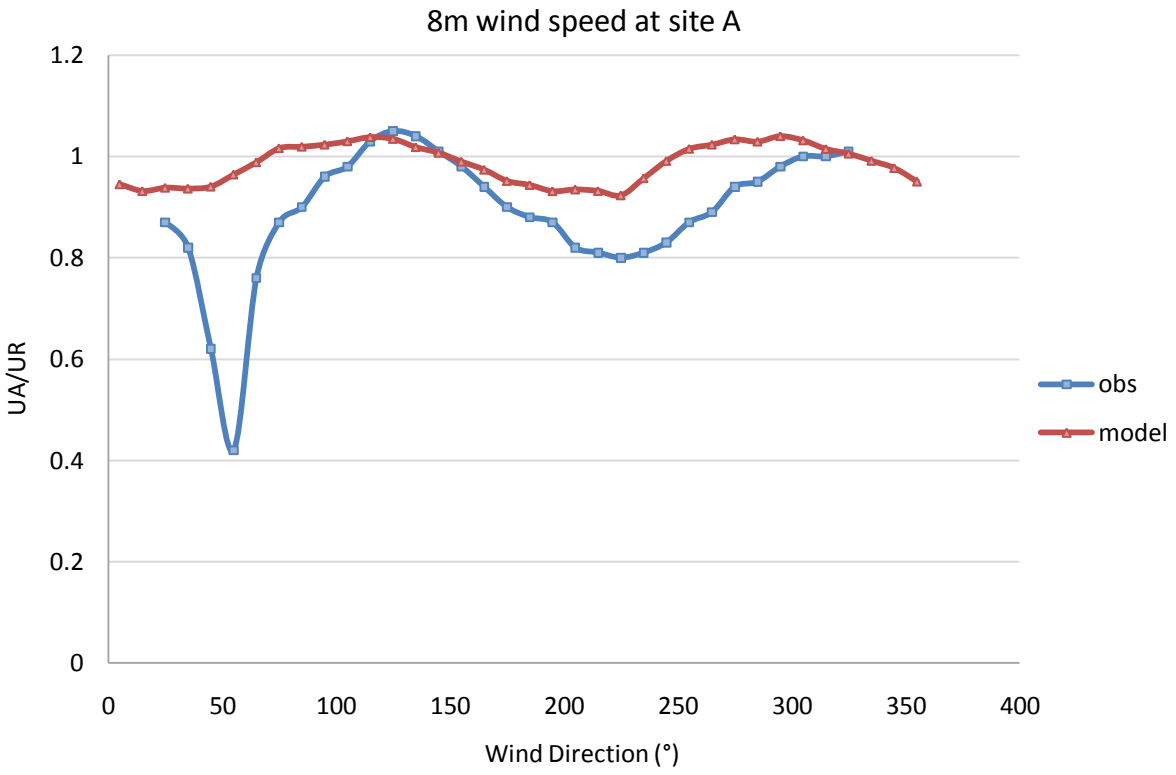

Figure 4 – Comparison of 8 m wind speed at site A

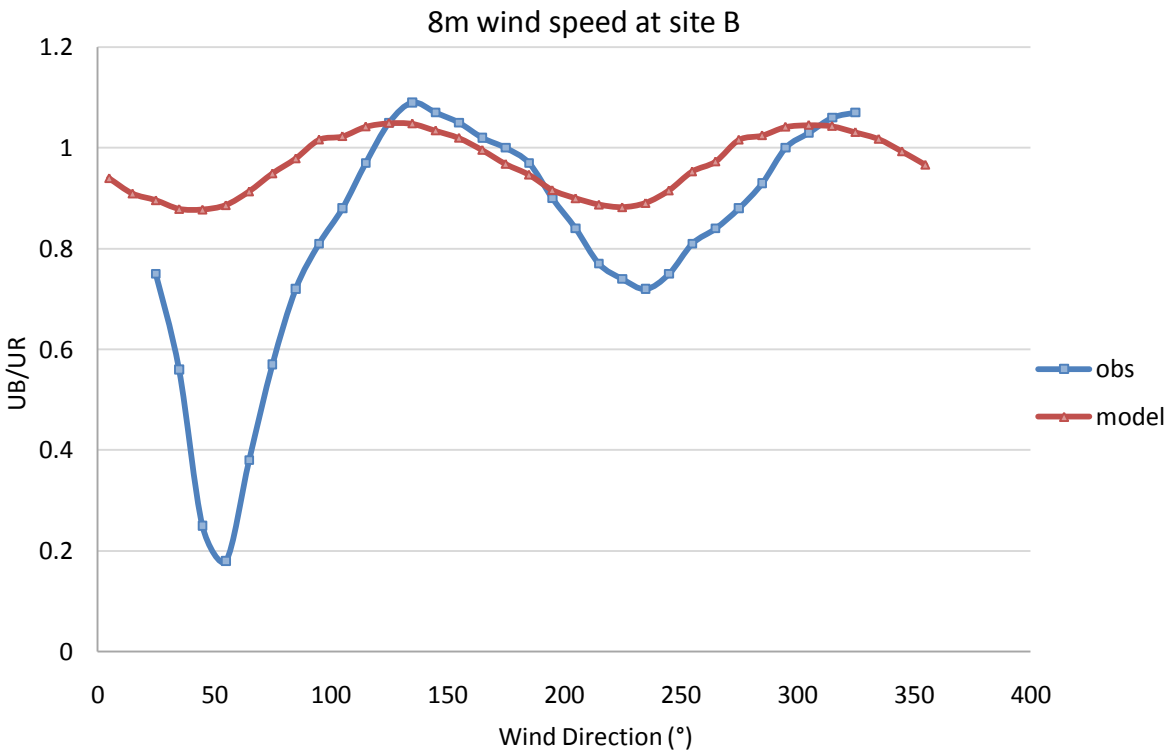

Figure 5 - Comparison of 8 m wind speed at site B

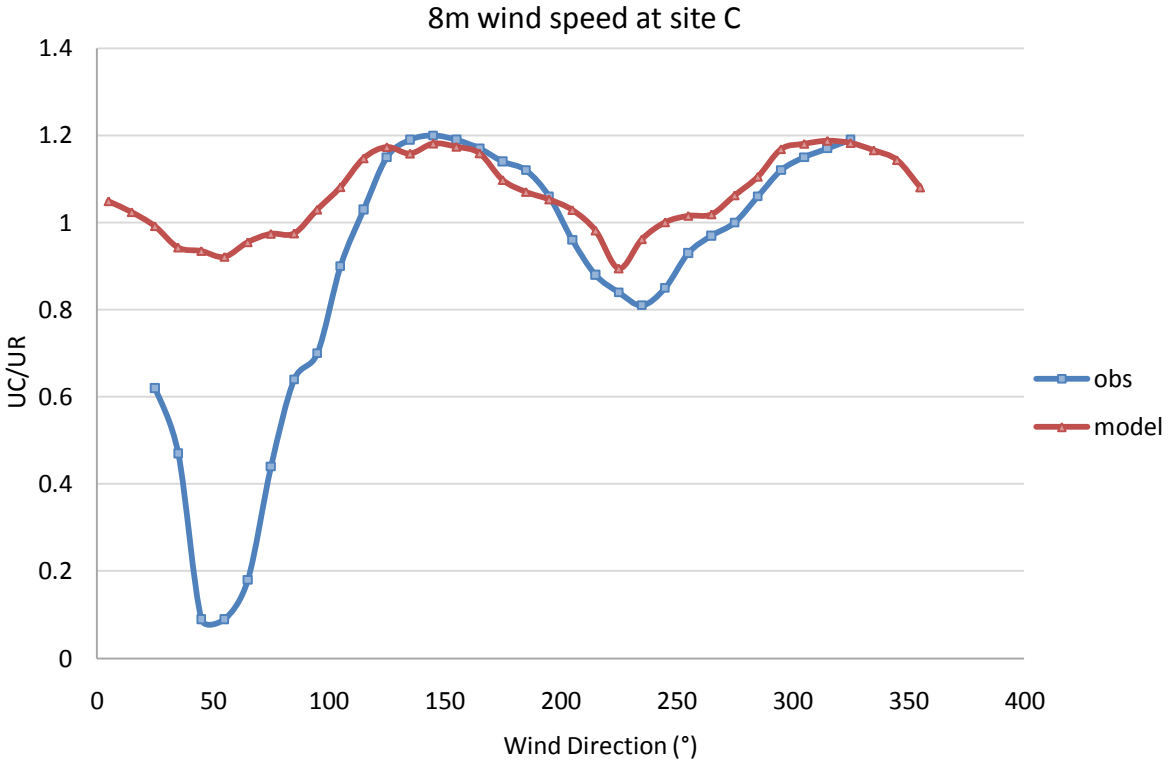

Figure 6 - Comparison of 8 m wind speed at site C

4 References

[1] P.J. Mason and J.C. King, 1985: *Measurements and predictions of flow and turbulence over an isolated hill of moderate slope*, Quart. J.R. Met. Soc., 111, pp. 617-640