FLOWSTAR-Energy Complex Terrain Flow Field Validation: *Askervein Hill*

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February 2016

FLOWSTAR-Energy 5.1

1 Introduction

Askervein Hill is a 116 m high hill on the west coast of the island of South Uist in the Outer Hebrides of Scotland. During September and October of 1983 an experiment was conducted on and around the hill, with measurements made of the speed-up over the hill under neutral atmospheric stability conditions.

2 Input Data

2.1 Study Area

Askervein is a relatively isolated hill. The summit of the hill is at a height of 116 m above sea level. The terrain is covered mostly with heather, grass, low scrub and flat rocks, plus some small lochs (lakes). Surface roughness values of 0.03 m [2] and 0.1 m have been investigated.

Terrain data on a 32 x 32 grid point resolution was used to represent a 3 km x 3 km area, giving a grid spacing of approximately 97 m.

Figure 1 shows the modelled terrain area.

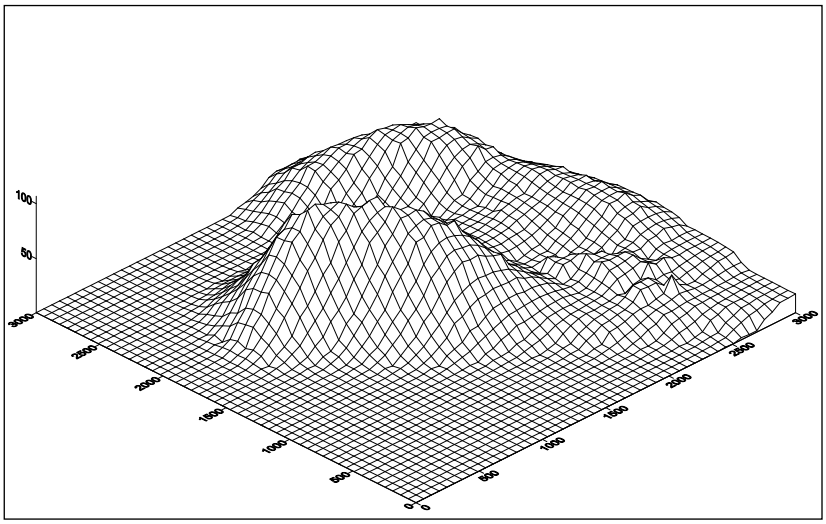

Figure 1– Modelled terrain around Askervein Hill

2.2 Receptors

Figure 2 shows a contour plot of the surface elevation along with receptor locations for the study.

Measurements were made at locations situated approximately along the line A-A in Figure 2 and compared with results at the reference site, RS. Line A-A runs through the point HT at an angle of 43°.

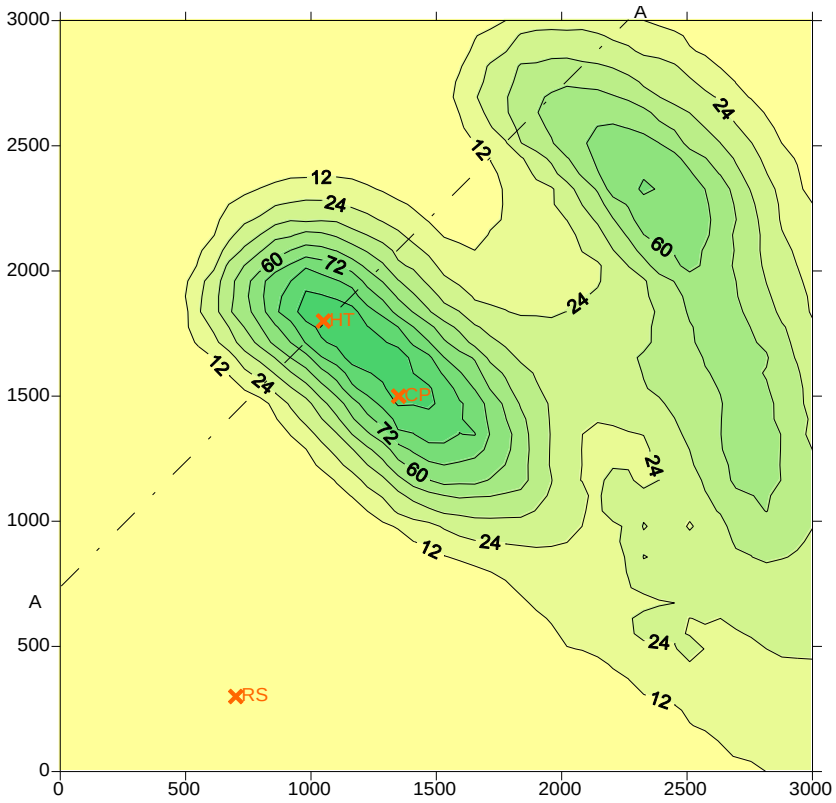

Figure 2 – Contour plot of surface elevation and receptor locations.

2.3 Meteorological Data

Measurements were reported for winds approaching the hill from 210° and 180° under neutral atmospheric conditions. Similar conclusions can be drawn from the results for both wind directions, so the results for 210° only are presented here.

The meteorological data used are presented in table 1.

Wind speed (m/s)	5
Height of recorded wind (m)	10
Wind direction (°)	210
Surface sensible heat flux (W/m^2)	0
Boundary layer depth (m)	800

Table 1 – Meteorological Data

3 Results

Modelled and observed fractional speed-up ratios are compared in plots in Section 3.1.

The fractional speed up ΔS, is defined as follows:

$$\Delta S = \frac{V(Z')}{V_{RS}(Z')} - 1$$

Where $V_{RS}(Z')$ is the flow speed as the reference site at $Z' = 10$ m, and $V = \sqrt{U^2 + V^2 + W^2}$ at various points along the line A-A.

3.1 Fractional speedup plots

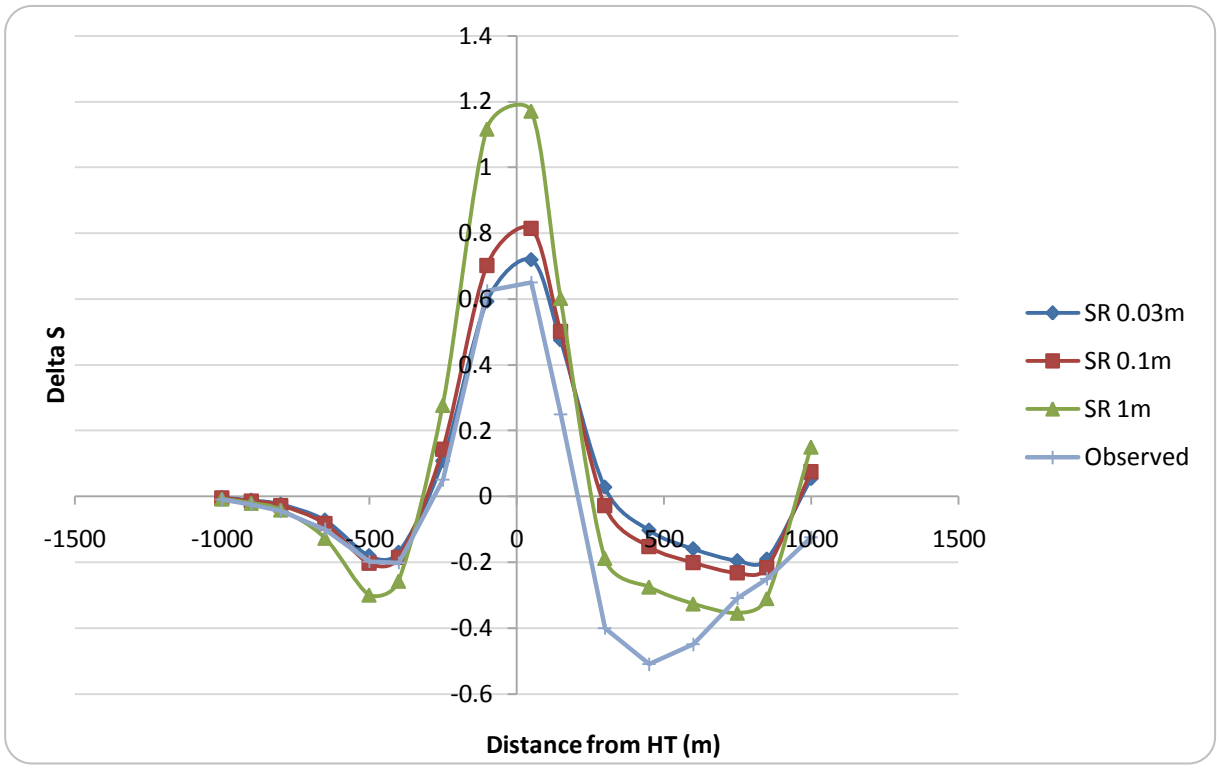

Figure 3 – Fractional speed up ratio plots for FLOWSTAR-Energy results with surface roughnesses of 0.03m (blue diamonds), 0.1m (red squares) and 1m (olive green triangles), and observed data (lilac crosses)

4 Discussion

The FLOWSTAR-Energy results show the same trends as the observed data. The predicted values of ΔS agree well with the measured values on the windward side of Askervein, for both 0.03 m and 0.1 m surface roughness values in the model, but the model does not capture the magnitude of flow deceleration on the lee side of the hill.

5 References

[1] Raithby G. D., Stubley G.D. and Taylor P. A., 1987: *The Askervein Hill project: A finite control volume prediction of three-demensional flows over the hill*, Boundary Layer Meteorology 39, pp. 247-267

[2] Taylor P. A. and Teunissen H. W., 1986: *The Askervein project: Overview and background data*, Boundary Layer Meteorology 39, pp. 15-39