

## ***Interactive comment on “The seasonal cycle and interannual variability of surface energy balance and melt in the ablation zone of the west Greenland ice sheet” by M. van den Broeke et al.***

### **Anonymous Referee #1**

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#### General Comments

This paper uses an excellent data set to explore the seasonal cycle and interannual variability in the surface energy balance at 3 sites in the ablation zone of the west Greenland ice sheet (2003 – 2010). The surface energy balance model (developed in previous work) shows an impressive level of agreement with measured surface melt rates and temperatures under melting and non-melting conditions, respectively. This gives a high level of confidence to the interpretations made. An important finding is that inter-annual melt variability at the lowest site is driven by the turbulent flux of sensible heat, which has implications for the melt response of the ice sheet as it retreats on land

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under a warming climate. Overall this is a very good paper, which is easy to follow and which presents significant new results. Together with some technical corrections, there are a few minor 'specific points' for the authors to consider below, which are aimed to improve clarity and help in the assessment of spatial representativeness of the results. Overall, though there is very little wrong with the paper and the authors did a very good job.

### Specific Comments

- Section 2.1, paragraph 3. It isn't entirely clear how you determine the snow depth and ice surface horizon. Measured albedo is a poor at differentiating old snow from ice for the reasons you explain, so presumably you use the previous end of summer ice surface as a base horizon to determine the snow depth at the start of the melt season (May). Please clarify.

- Page 783, lines 15-25. If this is so, then the measured albedo input to the SEB model will be high (mixed snow/ice) relative to the albedo at the sonic height ranger (ice) for most of the ablation period. In which case, one would expect the lowering measured by the sonic height ranger to be faster than that calculated by the model, but if anything Fig. 4a shows the opposite. Please provide an explanation.

- Section 2.2 SEB Model. It is understandable for the sake of conciseness that the previously published SEB model equations are not repeated here. However, locating the published sources is not straightforward since model components have been published in more than one earlier paper, some of which are not referenced in this section. Hence, please provide a list of papers for the full set of model equations and parameterisations in the first paragraph of this section.

- Spatial representativeness of results. On the one hand it is stated on page 792, lines 17-18 '...the AWS observations used in this study are only locally representative...', and the question of their spatial representativeness is left open in the Summary. On the other hand, the discussion of Table 2 on Page 787 (point flux values at AWSs) and

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Figure 11 (point values joined by straight lines across space) imply continuous variation or trends and that point values can be extrapolated to large areas. Probably it is safe to make some cautious extrapolation of the point values, but better consideration of what else might affect flux values in unmeasured areas should be made, for example albedo,  $z_0$ , air temperature and wind speed, possibly cloud. Related to this point, it would be useful to see a plot of temporal variability of  $z_0$  for the lowest site (similar to Fig. 2).

#### Technical Corrections

Page 781, line 24, replace 'operates' with 'has operated'. Page 784, line 11, is '[Wm-2]' supposed to appear after the equation? Page 786, line 12, replace 'hat' with 'that'. Page 787, line 15 and Figure 5. Is melt frequency based on hourly or daily data? Please clarify. Page 788, line 11 contradicts Page 787, line 22. Does melt commence in May or June at S9? References. Give volume and page numbers for Van den Broeke et al., 2009b.

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Interactive comment on The Cryosphere Discuss., 5, 779, 2011.

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