

## ***Interactive comment on “Forcing and Responses of the Surface Energy Budget at Summit, Greenland” by Nathaniel B. Miller et al.***

**P. Kuipers Munneke (Referee)**

p.kuipersmunneke@uu.nl

Received and published: 3 November 2016

Review of "Forcing and responses of the surface energy budget at Summit, Greenland" by Nathaniel Miller et al., submitted for publication in The Cryosphere.

### GENERAL

This manuscript presents a multi-year data set of surface energy budget observations, including one year with sufficient observations for a full closure of the budget, from July 2013 to June 2014. While similar estimates and observations have been presented in earlier literature, this paper extends the analysis towards forcings, responses, and the role of clouds and cloud types on the SEB terms and surface temperature.

This paper is clearly written, well illustrated, and a relevant contribution to the recent

C1

surge in literature on the effect of clouds on Greenland climate. The efforts that went into the collection of these rich data definitely warrant publication. However, I feel that the manuscript could benefit from some restructuring, more condensed writing, and some additional analysis. Regarding the latter, I feel a bit of a disconnect between the presentation of the monthly-mean and annual SEB components on one hand (sections 3.3 and further), and the case studies of section 3.2 on the other. It would be worthwhile to improve the connection here, for example by looking at the SEB for different cloud types throughout the season. This illuminates the role of clouds year-round.

Below, I detail my major and minor issues.

### MAJOR ISSUES

- Section 3.2 presents a number of observational data sets that are not introduced in the Measurements and Methods section before. This should be added for a proper understanding of the data sets. Specifically, no information is given for the MMCR data, the balloon soundings, cloud radar, and perhaps additional methods that were used in the analysis of cloud cover and type.

- I am somehow struggling with the organization of the results in section 3. The whole section would benefit from some reorganization. In 3.1, surface temperature (being a response to terms in the SEB) is analyzed and discussed. Then, section 3.2 focuses on particular case studies. 3.3 presents annual cycles of SEB fluxes, and 3.4 is about forcings and responses. Personally, I would prefer a structure in which the entire SEB data set is presented first (more or less the current 3.3). After that, the discussion about forcing and responses. And finally, the elucidation of the role of clouds.

- With such a rich data set on cloud properties, it is somewhat disappointing that the analysis in the present manuscript is limited to two - admittedly well chosen - case studies. It would be great if the year-round SEB data set could be split into cloud and non-cloud occurrences and do the analysis on the entire data set. Or bin the results by LWP, by cloud type, etc. This would give even more quantitative insight in the role

C2

of clouds on the SEB throughout the year. It would provide insight in the changes over central Greenland that we may expect in a warming climate.

#### MINOR ISSUES

P1 L6: what do you mean by "primarily"?

P1 L23: icecap -> ice sheet

P2 L5: there exists newer literature on runoff increase under scenario forcings.

P3 L17: the literature cited here is focused a bit on the work at Utrecht University. There are more observations around the GrIS, like those done at Edinburgh and GEUS in Copenhagen (Denmark).

P3 L23: a more recent example of sublimation analysis from Summit is found in Cullen et al., 2014 (<http://onlinelibrary.wiley.com/doi/10.1002/2014JD021557/abstract>)

P3 L33: compliment -> complement

P4 L5: remove "in central Greenland"

P4 L11: visa versa -> vice versa

P4 L17: it's -> its

P5 L26: longer term -> longer-term

P6 L13: add Delta to LWP and PWV

P6 L15: hydrometers -> hydrometeors (meteor refers to the Greek word for falling, rather than meter which refers to the Greek word for observing)

P6 L31: I had never heard of the word "thusly" before

P7 L15: Is the linear relation between albedo and Z also used under cloudy conditions? If so, the should be reconsidered as the dependence of albedo on Z vanishes if clouds are sufficiently thick.

C3

P10 L2: Ric -> Ri

P10 L5: very-stable -> very stable

P11 L18: LW derived -> LW-derived

P11 L27: simliar -> similar

P13 L8: boundary-layer -> boundary layer

P13 L32: visa versa -> vice versa

P14 sec 3.3.1: it would be useful here to contrast observations in other studies (from other years and summers) with the numbers you find.

P16 L25: decrease -> decreases

P17 L2: replace the two >'s by <'s.

P20 L25: please provide numbers from the other studies, so that the reader doesn't have to go and look for the differences himself. A table could be useful here.

---

Interactive comment on The Cryosphere Discuss., doi:10.5194/tc-2016-206, 2016.

C4