The Cryosphere Discuss., 4, C383–C385, 2010
www.the-cryosphere-discuss.net/4/C383/2010/

The Cryosphere Discussions

Interactive comment on "Increasing runoff from the Greenland Ice Sheet at Kangerlussuaq (Søndre Strømfjord) in a 30-year perspective, 1979–2008" *by* S. H. Mernild et al.

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Received and published: 14 June 2010

The paper is improved by adding additional conclusions to the manuscript related to the 'proxies' the reviewer is asking for, between GrIS satellite-derived melt extent and Kangerlussuaq runoff, and Kangerlussuaq runoff and overall GrIS runoff.

An example from the Introdcuction chapter (the goal of the paper): 'In this study we applied a surface modeling system called SnowModel (Liston and Elder 2006; Liston et al., 2007; Mernild et al., 2010b; Mernild and Liston, 2010) to the Kangerlussuaq region for the 30-year period from 1978/79 through 2007/08 to illustrate the observed climate-driven fluctuations in the water balance components. Our objectives were related to

the changes in climate: 1) to simulate the variations and trends in the surface-water-balance components: precipitation, changes in storage, and freshwater runoff for the Kangerlussuaq catchment, and address whether Kangerlussuaq runoff can be used as a proxy for the whole GrIS runoff; 2) to estimate the percentage of catchment runoff explained by GrIS runoff; and 3) to compare satellite-derived GrIS melt-extent changes with the local Kangerlussuaq simulated runoff patterns to illustrate the link between surface melt and freshwater runoff, and whether satellite data are useful proxies of runoff from the Kangerlussuaq drainage area.'

An example from the discussion: 'The variations in Kangerlussuaq runoff from 1978/79 through 2007/08 closely follow the overall variations in satellite-derived GrIS surface melt area (Fig. 5a) (however, the simulated runoff does not take into account year-to-year runoff variations due to all possible changes in GrIS freshwater storage), where 64% of the simulated runoff variation could be explained by satellite-derived melt area (Fig. 5b). The satellite-derived GrIS melt-extent can therefore be used as a proxy of runoff from the Kangerlussuaq drainage area, as stated for the entire GrIS by Fettweis et al. (2006), indicating that runoff was directly proportional to satellite-derived melt extent. Here, it should be kept in mind that the 30-year Kangerlussuaq runoff variations not only are driven by melting conditions, but also by winter snow accumulation. Studies by Hanna et al. (2008) and Mernild et al. (2009) stated, for the GrIS in general: retention and refreezing in the snow pack indicated that high runoff years were synchronous with low precipitation/accumulation years, since more melt water was retained in the thicker snowpack, reducing runoff; This effect is most pronounced above the GrIS ELA, where melt water does not infiltrate far into the snowpack because of the cold state of the snowpack.'

An example from the discussion: 'Surface-modeled water-balance components for the Kangerlussuaq drainage area were compared with an overall GrIS area surface study from 1995/96 through 2006/07 (Mernild et al., 2009). For Kangerlussuaq, the average simulated runoff of 1.02 ($\pm$0.25) km3 y$-$1, equals 2.5‰ of the average GrIS surface

runoff of 397 ($\pm$62) km3 y$-$1. The Kangerlussuaq runoff trend, illustrated in Fig. 3a, is in accordance with the runoff trend for the GrIS; both indicating increasing runoff. The simulated variations in Kangerlussuaq runoff and the overall GrIS runoff (simulated based on 5-km grid-cell increment) were significant equal (r2=0.53; p<0.01), even though only 53% of the variations in Kangerlussuaq runoff were explained by variations in the GrIS runoff. Here, it should be kept in mind that the comparison only was based on an overlap of runoff for 12 years, therefore using Kangerlussuaq runoff as representative of the overall GrIS runoff should be done with caution.'

The 'summary and conclusion' chapter has been rewritten.

We have decided to keep 'Results and discussion' in the same chapter, since this is common.

The author mentioned that the 'Results and discussion' starts with a discussion about sublimation. This is correct, and we did that to put our results in perspective according to previous sublimation studies. Sublimation is typically an overseen parameter in the surface water balance discussion; therefore we decided to bring up the discussion in the beginning of this chapter. The sublimation part was however rewritten to make it clearer.

Interactive comment on The Cryosphere Discuss., 4, 321, 2010.