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The Cryosphere
Discussions

Interactive comment on "Comment on "Exceptionally high heat flux needed to sustain the Northeast Greenland Ice Stream" by S. Smith-Johnson et al., The Cryosphere, 14, 841–854, 2020" *by* Paul D. Bons et al.

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Review of: Comment on "Exceptionally high heat flux needed to sustain the Northeast Greenland Ice Stream" by S. Smith-Johnson et al., TheCryosphere, 14, 841–854, 2020 Bons et al. comment on the exceptionally high heat flux used in a modelling study by Smith-Johnsen et al. in order to explain the Northeast Greenland Ice Stream. This comment is a valuable contribution as it puts the modelling values used in the first study in perspective and explains that such a high value must be unrealistic, at least on a regional scale without any geological evidence pointing otherwise. The only change,

I would suggest to the manuscript is to revise the statement that "state-of-the-art simulation codes, such as the sophisticated Ice Sheet System Model (ISSM; Larour et al., 2012; Beyer et al., 2018), apparently miss some critical component(s), as they are not able to replicate a major ice stream such as NEGIS without unrealistic boundary conditions." The reason for suggesting to rephrase this sentence is the second study by Smith-Johnsen et al. (2020) that explores different heat flux models and not necessarily demands an exceptional high heat-flux. Indeed, the uncertainty of the input/model parameters is a critical element as the comment confirms. Surface heat flux is critical, but the geophysical models can only provide a rough proxy. Local geological conditions (e.g. bedrock permeability) and topographic gradients affect groundwater flow and can disturb the effective heat flux from geophysical data sensitive to the deeper Earth structure. While this will not lead to an equivalent of 970 mW/m**2, this can alter temperatures under the ice, even in a geological old region (see Maystrenko et al. 2015). Such studies, as the comment and the studies by Smith-Johnsen et al. show that further efforts have to be made to combine geophysical and glaciological models in a more consistent and realistic manner in order to avoid biases by the applied parameters.

Maystrenko, Y., Olesen, O. & K. Elvebakk, H. 2015: Indication of deep groundwater flow through the crystalline rocks of southern Norway. Geology 43, 327–330.

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