

# ***Interactive comment on “Present-day and future Greenland Ice Sheet precipitation frequency from satellite observations and an Earth System Model” by Jan T. M. Lenaerts et al.***

## **Anonymous Referee #1**

Received and published: 2 March 2020

Lenaerts et al. use precipitation frequency observations from CloudSat to evaluate the accuracy of the Community Earth System Model (CESM) across the Greenland Ice Sheet. They find that CESM is able to reproduce present-day spatial patterns and seasonality of precipitation frequency fairly well. This lends confidence to their assessment of future precipitation frequency changes by 2080-2095. Overall, the paper is well-organized and easy to follow. The methods are clearly articulated and the results are thoroughly described. The discussion recognizes the limitations of CloudSat and the biases in CESM and presents a very insightful explanation about how we can use Earth System Models to make precipitation forecasts for the Greenland Ice Sheet. I have a few suggestions that would improve the manuscript which I detail below. The

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main ones are to tidy up the first three paragraphs of the introduction and describe a bit more about how this study will actually aid future satellite planning campaigns. If the authors can address my relatively minor comments, I would be happy to endorse publication in The Cryosphere.

Title: I would urge the authors to consider replacing “satellite observations” with “Cloud-Sat” and “Earth System Model” with the “Community Earth System Model” in the title. Being more specific would probably make the paper more searchable.

P1 L16: “Clearly” is vague, how do we know that mass loss has accelerated? Models? GRACE?

P1 L19-20: Consider adding a reference that supports this statement.

P2 L3-4L: According to observations, precipitation decreased in western Greenland between 1996 and 2016 (Lewis et al. 2019; <https://doi.org/10.5194/tc-13-2797-2019>). Consider clarifying that this statement refers only to models.

P2 L7-9: There are two nice papers that were recently published in Science Advances that investigated this feedback. Consider referencing Noël et al. (2019; <https://advances.sciencemag.org/content/5/9/eaaw0123>) and Ryan et al. (2019; <https://advances.sciencemag.org/content/5/3/eaav3738>).

P3 L5-6: I was interested to learn about the “implications for future radar missions” but was disappointed that this was absent from the discussion and conclusions. Either remove this statement or discuss the implications for future radar missions in the manuscript. I would urge the latter to round off a very nice paper.

P3 L24: “heavy precipitation” do the authors mean “heavy rainfall”?

P8 L3-13: Might some of these uncertainties be explained by surface air temperatures in CESM being too warm/cold? If so, please discuss.

P9 L2-4: The authors miss an opportunity here to describe the future climate of Green-

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land according to an Earth System Model and how it differs from the present-day climate. What is the difference in mean average air temps? Is the seasonality of air temps weaker?

Figure 7b: Why would there be differences in the grid cell area between CloudSat and CESM? Please clarify.

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Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2020-31>, 2020.

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