

Interactive comment on “The Copernicus Polar Ice and Snow Topography Altimeter (CRISTAL): Expected Mission Contributions” by Michael Kern et al.

Anonymous Referee #2

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The paper presents an introduction and major update to the anticipated satellite mission, Copernicus Polar Ice and Snow Topography Altimeter (CRISTAL). The key observables of the mission are sea-ice thickness and elevation measurements of ice sheets and glaciers. The motivation for these observables are described. The content of the paper is useful for the scientific and broader communities, and warrants publication. However, there are major issues in the clarity, organization, and redundancy of the text that require attention. These issues prevent the main points of the paper from being communicated.

My major recommendations are to: consolidate Section 5 with the mission objectives

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listed in Section 3 since much of the content is repetitive; break up numerous run-on sentences and rewrite for clarity; carefully proof the manuscript and correct the many typos and grammatical errors within.

L24. Here and throughout the paper, it is not clear what is meant by "evolution." Please describe.

L28. "properties of snow cover on ice" I recommend changing this to snow depth since its retrieval has been demonstrated with Ku- and Ka-band data, whereas the other suggested property retrievals have not yet been fully demonstrated.

- Polar Regions, Polar Oceans, and Total Column Water Vapour should not be capitalized.

L29. "foreseen" does not seem like the correct word here since it is not a prediction. "Planned" may be a better word.

L43-46. Here and throughout the paper, there are run-on sentences with mixed messages. Please rewrite these for clarity.

L50-51. I'd suggest changing this to stakeholders for inclusivity. Derived products may be useful for indigenous communities.

L51. While I understand this is a European effort, the listed motivations in this paragraph also apply to other countries. I'd suggest broadening this or adding a statement to be more inclusive of the international community, as it would strengthen the motivation and utility of such a mission.

L53. "It also has..." what does "it" refer to here?

L57. These potential impacts are not limited to European weather. They may affect global weather patterns.

L61-63. The following section is more about the history of the Copernicus programme, rather than an overview of the missions under development. I'd suggest editing either

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this sentence or the section to be consistent with one another. Depending on who the target audience is, the mission overviews may be more useful for the broader community than the history of the Copernicus programme.

L70-82. Who is the target audience of this paper? Do they need to know the history of the Copernicus programme?

L84. This is vague. Potential for what?

L85. For future what? This is vague.

L103. What "so-called Long-Term Scenario" is this sentence referring to? It is unclear.

L105. "EC" and "RMC" elsewhere. Use acronyms consistently.

L105-106. What does "integrated end-to-end system approach" mean? Here and throughout, such buzzwords are not informative.

L133. UNFCC. This and other acronyms are defined and used only once. I recommend deleting unnecessary acronyms such as this one for easier reading.

L150. OSTST in-text definition missing.

L155+ I suggest using bold font or italics for the first lines of each bullet point for easier reading.

L202-203. "is added for snow depth measurements to distinguish between snow and ice layers" needs rewriting for clarity.

L216-217. Is a parenthesis missing?

L242. Add "over sea ice" after snow depth.

L254. What does "on a best effort basis" mean?

L272. "its presence limits human access" I suggest considering a different perspective of sea ice. It's a platform enabling subsistence hunting and travel for indigenous coastal

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communities.

L274. ice-infested. Why use a word with such negative connotations?

L280-281. "to safeguard both climate and operational data services" Safeguard does not seem like the right word. "extending" or "advancing" may be better.

L282-289. Confusing, run-on sentences.

L288. Essential Climate Variable sounds important, but what does that really mean?

L308. Please clarify that this information relates to Copernicus sea ice thickness products.

L310. Please state which satellite this uncertainty pertains to.

L319-322. Run-on, confusing sentence.

L320. This uncertainty value is not consistent with the one given in the preceding paragraph. Please provide more detail on why these are different values.

L330-333. References are needed. The uncertainty in snow depth data from the historical period is as good as it can possibly get, on the order of 1 cm and less. The uncertainty is not halved over first year sea ice. Several studies have shown snow to be thinner over first year sea ice in areas where Operation IceBridge surveys were conducted. In other regions of the Arctic, deep snow can exist on first year sea ice.

L333 Giles et al. 2007 seems like a more appropriate reference here since it was the first study to demonstrate the propagating uncertainties associated with snow depth and other geophysical parameters.

L338-341. Please rewrite for grammar.

L354-355. Computing mass balance and identifying mass imbalance seem like the same thing here.

L360. The continuous record provides.... a long-term record. This is circular.

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L365-366. Are commas missing? Please rewrite for grammar.

L375. "agility of tracking" It's not clear what is meant by this. How is the satellite going to be agile?

L378. Grammar.

L382-383. I suggest adding a little more detail here for clarity, e.g. retrieval accuracy of what exactly?

L386. "allow" seems like the wrong word here. "Have" may be better.

L389. It would be relevant to state the anticipated spatial resolutions here since leads come in all sizes.

L399-401. This is unclear. Please rewrite.

L403. Reference needed for main causes...

L404. Reference needed for largest uncertainty in the current prediction...

L414. Please rewrite for clarity.

L427-428. These sentences are vague. Please be more direct. Is snow depth retrieval not possible over land with CRISTAL frequencies?

L432-433. What is meant by status?

L434-435. Is it the spatial resolution that limits the wide use of altimetry data for snow and permafrost research or the frequencies used?

L460+ Wouldn't it be important to mention the relevance for monitoring the Antarctic cryosphere?

L467. Is this true? ICESat-2 reaches 88-deg latitude.

L471. It'd be helpful to restate the along-track resolution here since it is a key element for the mission.

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