

Dear editor Gabriele Messori

Many thanks for your clear recommendation to do a major revision of our manuscript entitled: 'Developing the Svalbard Integrated Arctic Earth Observing System - SIOS'.

We have now done this revision focussing on handling all points raised by the two reviewers and yourself.

Please find here the list outlining how we have addressed the points raised by the reviewers

- Concerns from reviewer 1:
  - In the revised version we have addressed the major point raised on the links between disciplines are not well developed. We have included a new section entitled 2.2 The State of interdisciplinary Earth System Science in Svalbard. In this section we describe the state of interdisciplinarity in ESS in Svalbard. We also in this new section link this interdisciplinarity to the extreme events as requested by this reviewer linking Svalbard to the changes going on in the Arctic.
  - Regarding the comment by this reviewer about the inclusion of the M/LTI studies being a stretch in this context: Svalbard itself is a major research hub for the M/LTI community with a multitude of instrumentation dedicated to the field located on and around the archipelago, as discussed in the SIOS SESS reports. If we are to understand the entire Earth system then we cannot treat the M/LTI region as inconsequential. As discussed in line 302 (resubmitted 'clean' manuscript) - 'we must quantify and understand in detail all physical processes that ultimately warm the atmosphere'. These processes must also include those effects which couple the upper and lower atmosphere, as discussed briefly in lines 311 - 314.
  - Regarding the comment on checking the references: The two last references (Wilkinson et al., 2016) and (Zhang et al., 2016) have fallen out of the uploaded technically revised manuscript, and are now added into the revised manuscript. The Moreno-Ibáñez M., et al. 2021 reference is in the reference list, but an open line has fallen out of the reference list, so that this reference has become part of the previous reference (Meredith et al., 2019). The line between the two references are added in the revised text. The Cnossen (2020) reference is in the text in line 316.
  - Figure 2 has been revised and is now making use of color to discriminate between the different measurements in the different environments. And it has gotten geographical location names on the inset three maps as requested by reviewer two.
  
- Concerns from reviewer 2:

- Regarding comment no. 1: We think that the introduction is presenting the changes going on in the climate system largely controlling the Earth system, but are also reviewing the linkages between the spheres and the effects on the environment. In addition we have added a new section 2.2 The State of interdisciplinary Earth System Science in Svalbard, that addresses the interdisciplinarity even more as part of the new section on SIOS.
- Regarding comment no. 2: The introduction is presenting in detail the most recent research documenting that the warming in the Svalbard area/region of the Arctic is the largest going on now.
- Regarding comment no. 3 and the overarching recommendation to increase the amount of historical background information: We have added a full new section (section 2) describing briefly the history of Svalbard science coordination leading up to SIOS. This section addresses all the points raised in this comment including focussing on the relationship between SIOS and NySMAC. This part also includes a new Figure 3 presenting the importance of the SESS reporting in developing SIOS.
- Regarding comment no. 4: As requested, we have added a table with information of SIOS consortium members as supplementary material (S1)
- Regarding comment no. 5: We have added a paragraph to section 2 to address this concern. The paragraph includes links to both the SIOS data catalogue that hosts metadata about SIOS datasets and provides access to them, and the SIOS Observation Facility Catalogue. The latter catalogue provides an overview to planned, current, and historic research infrastructure collecting SIOS data in the archipelago. We have added a brief overview of the volume of the data available through the data catalogue and highlighted the longest continuous timeseries of synop measurements from the Hopen weather station spanning back to 1945.
- Regarding comment no. 6: We have included links to various relevant parts of the SIOS webpage in the revised text.

#### Comments to minor points raised by reviewer 2:

- We have also addressed the wish to have the names included for each inset map in Figure 2.
- We have addressed in detail the connections between the atmosphere-cryosphere-marine and terrestrial environments in the new sub section 2.3 The State of interdisciplinary Earth System Science in Svalbard. And the surface energy balance is also addressed indirectly in several places as there is a focus on snow, precipitation and black carbon.
- The push to increase the number of parameters being observed by AWS is mentioned especially for eastern and northern Svalbard, where only basic AWS infrastructure existed at the time of the SESS reporting. This implies that new technological developments are required with respect to sensors as well as green power supply systems. And so, we agree that it would be best if all AWS were

measuring the exact same parameters, but given the present logistics of the observation infrastructure (access to power supply and power types and thus consistency of power access) it is not possible to measure as many and especially power demanding parameters in remote location in particularly eastern and northern Svalbard. It would of course be very nice if the number of AWS and thus the density of this type of basic infrastructure could be increased. This can however be challenging due to both logistics and the required permissions to establish infrastructure in the many protected areas in Svalbard.

With this revision we have focussed also on the main point raised by you, about the benefit for a broader contextualisation of SIOS, its goals and how these fit within overarching scientific questions. Presently, the identification of the water cycle as the main overarching research need clearly identified and discussed with an ESS perspective.

We hope that you will consider our revised manuscript for publication, based on the major revision performed.

Kind regards,

Hanne Christiansen and Ilkka Matero