

Referee comment on “How well do the regional atmospheric and oceanic models describe the Antarctic sea ice albedo?” by Verro et al.

The study investigates the model performance of several regional oceanic and regional atmospheric models with respect to the representation of sea ice properties (surface albedo), snow and ice thickness in Antarctica. The authors compare the model results with measurements from ground-based, drone-based, and satellite-based observations. Publications of this kind, which make use of so many models, are rare. I appreciate the work the authors have done to bring together observational data and modelling results.

Overall, the authors have done a good job of providing an overview of the models used and the observational dataset. The intercomparison of modelled surface albedos is presented well. Some suggestions for improving the content are provided below. I can recommend the publication after minor revisions.

General Comments

1. The abstract is a bit long. It goes into a lot of detail that is not necessary at this point. I would like to see more quantitative results in the abstract instead.
2. Section 5 reads like a summary. There is no further discussion of the results, which were very nicely presented in the previous section. I recommend deleting the whole section.

Minor/Specific Comments

1. p112, p2141, p3176: “regional climate model” → regional atmospheric climate model
2. p1117: “RACMO and ERA5 predict significantly darker sea ice over the Weddell Sea during the...”: I would omit “darker” here. A surface can appear darker under cloudy conditions even though its albedo is the same or even higher.
3. p2150: “sea ice albedo parametrisation recommendations, such as those given in Ebert and Curry (1993);” Ebert and Curry give basically climatological-based values. Maybe emphasize that.
4. p2152: “surface temperature”: Is it the skin temperature?
5. p41107: “Broadband albedo was measured from pyranometers installed”: give type of pyranometers similar to section 2.2
6. p41108: “FIMR station”: What means FIMR?
7. p41113: “The accuracy is approximately 3% for the shortwave radiation measurements (Vihma et al., 2009).” Is this the uncertainty of the irradiance or the derived albedo?
8. p5 Figure caption: “The image shows an overlay of Landsat surface temperatures over a Landsat grayscale visible image on October 10, 2022.” – It is not discussed in the main text. Use larger fonts in Fig. 1b and lon/lat grid as in Fig. 1a to get a better orientation.
9. P61139: “... but the broadband albedo products can be calculated at 30 m and 20 m resolutions”: Give retrieval uncertainty here. Currently, the numbers are mentioned in Sec. 4.5.
10. P81169: “The shortwave radiation in the atmosphere and the coupled ice/snow layer is handled by a Delta-Eddington multiple scattering radiative transfer model (Briegleb et al., 2007).” Does the model consider clouds?
11. p10 Figure 2: Please use larger fonts. Think about to show a distribution of the albedo difference in addition.
12. P111274: “The albedo is derived by using separate values for near-infrared and visible light.” How is the broadband albedo derived from the albedo of the two spectral regions?
13. P121283: “ERA5 considers the Marsden CS to be on land, not on sea ice.” What are possible effects?

14. P12I294: "During the ISPOL campaign, the weather was warm for this location, with the air temperature mostly above -5°C and even around zero degrees during the first week of December." Already mentioned before. Can be removed.
15. P12I295: "HCLIM reproduces the surface temperature well" Maybe use "best" instead of "well"?
16. P18I392: "However, NEMO output for the Ross Sea in November 2022 was unavailable, as the model data extends only up to 2018. Therefore, data from November 2004 for the same region is used instead." – Does this mean that the distributions at Marsden in 2022 are being compared with those in 2004? Why was 2004 chosen? What makes this year a representative sample of 2022?
17. P18I407: "The spread of the drone-based albedo probability distributions, which represent the measurement uncertainty during ~10 minute flight, ..." – Why does the distribution represent the measurement uncertainty? Rather, it should reflect the variability of the surface.
18. P18I412: "Hence, we can argue that it also represents the spatial albedo variability, though biased toward the albedo of the most frequent surface type that happened to occur right below the pyranometer." Can we really say here that temporal variability can be taken as a proxy for spatial variability? Albedo variability also depends on atmospheric parameters such as SZA and cloud cover, which are certainly reflected in the temporal variability within the one-month period. However, for a 10-minute flight, I would assume that these parameters have less effect.
19. P18I420: "The discrepancy between the observations and the models over the thinner ice is large: $\Delta_{\text{mean}} = 0.2$, and 0.14 for MetROMS-UHel and NEMO respectively." Is the comparison meaningful, as different years with probably different conditions are taken into account?
20. P19 Section 4.5: It is useful to show the spatial variability of satellite and model data. However, the authors could also use high-resolution satellite data to compare albedo directly with ground-based observations.
21. P19I439: "Landsat 9 albedo observations on the 1st of November in Fig. 7, and Sentinel 2 observations on the 14th of November, 2022 ..." - Is this an example that can be used to represent the whole period?
22. P20I444: "However, the albedo over land is about 0.06 higher in the Sentinel 2 image compared to the Landsat 9 image." – The manuscript is about sea ice. Therefore, I would limit the discussion to that.
23. P21I482: "This peak does not come from sea ice concentrations in the area but from the sea ice albedo parameterisation." – Can you elaborate this statement?
24. P22I489: "The spatial distribution and density distribution of the observed albedo are best reproduced by the MetROMS-UHel model." – This statement suggests that CLARA-A3 is the truth. How large is the retrieval uncertainty of the CLARA-A3 product? Perhaps it is better to say here that the MetROMS-UHel model shows the best agreement with the satellite product.
25. P24 Section Discussion: This section is more of a summary than a discussion. Apart from some text at the end that could be moved to the 'Conclusions' section, I don't see much new information here.
26. P26 Section Conclusion: It would be good to support the conclusions with some numbers to make them more quantitative.

Technical Comments

1. check format of citations for example:

p2l39: "0.06.(Warren," p2l48: "by (Debernard et al., 2017..." p3l54: "as in ERA5 Hersbach et al. (2020)", p4l107: "snow. (Hellmer et al., 2006).", p6l148: "zenith angles Traversa and Fugazza (2021)", p8l167: "scheme Lipscomb and Hunke (2004)"

2. p7 Table 1: first line "absorption/scattering" check hyphen separation, last line "otherwise" typo
3. p8l194: "Melt pond properties as given by the physical level-ice scheme characterised by..." → are characterised
4. P8l182: "The model runs at 0.25° resolution" → 1/4° as used in Table 1
5. p9l203: "The regional atmospheric model HARMONIE Climate (HCLIM, Belušić et al. (2020)) cycle 43 using the non-hydrostatic ..." → model HARMONIE Climate cycle 43 (HCLIM, Belušić et al., 2020)
6. p10 Figure 2: Please use larger fonts. Think about to show a distribution of the albedo difference in addition.
7. P11l269: "at the lateral boundaries (van Dalum et al. submitted to the Cryosphere)." Cite the discussion paper.
8. P12 Figure 3: Think about to move the legend from Fig 3c to the top of the figure.
9. P34l691: "https://doi.org/https://doi.org/10.1029/2023EA003482": remove first "https://doi.org/", there are several more references with similar issues
10. P34l700: please update reference
11. P35l738: please update reference
12. P38l841: please update reference