

**Peer-review:** “Impacts of air fraction increase on Arctic sea-ice thickness retrieval during melt season” by Evgenii Salganik, Odile Crabeck, Niels Fuchs, Nils Hutter, Philipp Anhaus, and Jack Christopher Landy

**General comments:**

This paper analyses the importance of accurately estimating the air volume in density measurements of sea ice. The importance of the air fraction on sea ice density is not recognized in the current literature. The paper compares different methods to estimate the sea ice density, i.e., hydrostatic weighing and indirect calculation from ice freeboard and ice thickness measurements. The paper uses data from different publicly available data sets, which cover both first-year ice and second-year ice. The paper discusses the influence of melt ponds, ridges, and snow thickness variability on density measurements and freeboard measurements. This research is relevant because sea-ice density estimates affect ice thickness based on freeboard measurements using remote sensing.

The findings of the paper are relevant and appropriate for the journal.

My recommendation for this paper is “major revision.” This is not a reflection of the quality of the research, but only of the presentation of the findings. The paper is long and difficult to read. It is not immediately clear what the main aim of the paper is. The paper introduces topics that are adjacent to the research, and it is not always clear how they relate to the main research aim. The actual research becomes lost as a result. Considering that this paper aims to target the remote sensing community (to my understanding), the paper would benefit from narrowing down its scope and from focusing its arguments to make the paper more accessible.

That being said, the overall language is clear. The figures are clear and add to the understanding of the paper. The paper could benefit from tables that summarize data that is currently only presented in the text. Furthermore, the authors should pay attention that each paragraph of text addresses only one topic at a time. Many paragraphs in the results and discussion sections are exceedingly long and jump between multiple different topics, which makes the paper very difficult to read.

**Major comments:**

1. The introduction is quite long, which dilutes the main message of the paper. The need of the research is introduced in the first two paragraphs of the paper. The topics “sea ice density” and “air in ice” are only introduced in the fifth paragraph (Lines 71-97). It is not directly clear how the remaining paragraphs support the aim of the paper. The information in these paragraphs could possibly be cited in the Discussion section when the information is needed or unexpected to the relevant research community.
2. The results section is difficult to read. Readability could be improved by summarizing relevant data in tables that the authors could refer to. Section 3.4 is especially difficult to read because each paragraph presents multiple ideas at the same time. Readability could be improved by rewriting this section to include smaller paragraphs that each focus on one idea at a time.
3. The discussion is the most difficult to read of all the sections and requires extensive restructuring and refocusing. The current discussion section is exceedingly long (8 out of 23 pages). Moreover, the discussion section presents an extensive overview of literature as well as additional analysis of the results. The discussion introduces topics that do not necessarily support the aim of the research paper. Many of the paragraphs are very long and present multiple different ideas at the same time. Please consider restructuring the text into shorter paragraphs that are focused on one topic each. Please also refer to a Section/Figure/Table instead of repeating the data in the discussion.

4. The conclusion clearly states the aim of the paper and summarizes individual results nicely. However, a conclusion should not merely summarize the results; it should also interpret the findings of the paper at a higher level of abstraction.

**Minor comments:**

1. The title is appropriate, but it could be improved. The paper mainly focuses on the importance of accurate density measurements, and air fraction increase is presented as one variable affecting density. Density estimates affect sea-ice thickness retrieval; however, this message becomes lost in the paper. Sea-ice thickness retrieval is presented as the reason why this paper is important, but not as the main aim of the paper. The title may not need to be changed depending on how the authors decide to re-structure the remaining paper.
2. The abstract captures the essence of the hypothesis, findings, and significance. Lines 1-7 are clear and support the title of the abstract. Lines 8-11 present a discussion of the results and Lines 11-13 highlight the relevance, without mentioning the air fraction nor density. The coherence between these different sections is not clear and the scope of the abstract could be narrowed down.
3. Lines 167-172: This paragraph explains the role of meltwater and how to account for meltwater using methods that are not related to ice coring or mass balance buoys. You then refer to Section 2.3. Could you highlight how this paragraph connects with the remaining Section 2.1?