

Summary

The authors develop a new algorithm to retrieve sea ice concentration from the L-Band SMOS measurements at 1.4 GHz. At 1.4 GHz, the influence of the atmospheric properties on brightness temperatures is very low and, additionally, SMOS provides full-polarized measurements at different incident angles. Due to a higher penetration depth, information about the sea-ice thickness can be retrieved in addition to sea-ice concentration. Ideally, the method here is a first step to combining sea-ice concentration (SIC) and sea-ice thickness measurements from the same place at the same time.

For their new SIC retrieval method, the authors take advantage of the special features provided by SMOS and introduce two indices, the polarization difference and the angular difference, to avoid the dependence of the brightness temperature on the sea-ice thickness. They use a Maximum Likelihood Estimator in combination with these two indices in opposite to the more usual method of linear estimation used in algorithms designed for higher frequencies. They find that the retrieved SIC compare well with observations, except in fall, where there are differences in regions of thin ice due to the high penetration depth of the low-frequency radiation.

The topic is timely and the approach of the Maximum Likelihood Estimator is interesting. The authors took well into account previous comments and therefore improved the manuscript notably. However, I think there is still room for improvement in the structure and writing style. The clarity of your message would profit from a careful structure- and writing-oriented (instead of topic-oriented) proof-reading.

I suggest minor revisions. I have some comments and questions and I hope the authors can answer them. Also, I have some suggestions that could improve the clarity of the manuscript.

Thematic comments

#1 It is not totally clear to me what is the advantage of this new method, with which I mean a SIC retrieval at 1.4 GHz. I can understand that there has not been any SIC retrieval at this frequency before but is it then not only one new method amongst others to retrieve SIC? If I understood right, this retrieval yields smaller errors in summer. You could underline a bit more that this is a key advantage compared to other algorithms, which have problems in summer due to melt ponds and wet snow for example.

#2 On the same note, you state as an advantage that, as we now could in principal retrieve both sea-ice thickness and SIC from 1.4 GHz-measurements, these could be combined to retrieve both at the same time. But can thickness and concentration be retrieved at the same time if the retrieval method for SIC has problems in the thin ice areas (under 60 cm) and the retrieval method for sea-ice thickness is only for thin ice areas, up to 50 cm (Kaleschke et al., 2012; Huntemann et al., 2014)? I would like the authors to comment on that.

Writing comments

#3 The words “below”, “above”, “former”, “latter” are used a lot. Often this is too vague and it is not clear what exactly is meant by them. The reader is pointed in a lot of directions and gets off the track of the actual message. I suggest that you rethink the structure of the manuscript to avoid as much as possible having to point to another place in a manuscript.

#4 It is sometimes unclear what was done in the study and what has been done before. As you use several tenses (past, perfect, present, future) and active and passive mode in an inconsistent way (sometimes changing in the middle of a paragraph), I suggest to carefully proof-read the manuscript and to correct the inconsistencies. This would remove some of the confusion.

#5 Also, very often a paragraph or sentence starts with “the figure shows”, “the table shows” or “the authors show”. I think if the emphasis was on the message of the figure/reference and the figure/reference was only given in parenthesis at the end of the sentence, your message would gain in clarity.

Consider as an example the difference between:

P13 L1-4 : “Figure 11 shows the spatial distribution of SIC in the Arctic Ocean estimated from (a) SMOS for the 3-day period 2–5 March 2015, (b) OSI-SAF SIC on 4 March 2014, and (c) the difference between (b) and (a). ”

P14 L22-23 : “However, the sensitivity of the brightness temperature to sea surface temperature, atmosphere, and wind speed is clearly reduced when observing the sea surface with radiometers working at lower frequencies (Figure 1) ...”

#6 I find it confusing when parentheses are used for a whole sentence. Either it is important for the study, then the sentence can be written as such, or it is not important and it can be left out.

#7 Some sentences are very long with several dependencies and often too many or too less commas. I lost track several times. Shorter sentences would improve clarity.

#8 There are still several typos and grammatical mistakes. I tried to highlight some of them but I suggest that you let a native speaker or just another person read through your manuscript.

Specific comments

P1 L11: I don't see the logical connection from the previous sentence to the “therefore”

P1 L18: Replace “ice cover” by “sea-ice cover”

P2 L5-7: The sentence is unclear as you use both “therefore” and “because”. Try to divide it into two sentences.

P2 L7 : Replace “since” by “for”

P2 L16 : Comma after “that” and it is not clear to what “former” refers. Add “the ice penetration of the former”.

P2 L22: I think you can leave out “what is left for a future work”

P2 L29: Not clear why the spatial resolution of 35 to 50 km is a key feature. Maybe remove “key” in L28.

P3 L10: Remove the sentence in parentheses.

P3 L30-31: Move the product version to the OSI SAF parenthesis.

P4 L3 and L7 : I think you can remove “see below”.

P4 L5 : You always only mention data from 2014. Would it be right to only write “from the year 2014”? And then you could leave out in the rest of the manuscript all the time you mention “over the year 2014”. If you use more years (that did not become clear to me), write “from 2014 to XXXX”. Otherwise it is not clear when your data period ends.

P4 L13 : Remove “As discussed in Section 1”

P4 L13 : Replace “different incidence angle at” by “different incidence angles to”

P4 L14: I think you can start a new sentence: “TB can be expressed as”.

P4 L18: Replace “into” by “on”

P4 L21: Write sentence without parentheses. Do you mean “We use TB to refer to surface brightness temperature”? The surface emissivity would be ϵ_s , right? This is not clear.

P5 L4-5: There is no logical sequence between “varies **linearly** with emissivity” and “The **nonlinearity**”.

P5 L7: Replace “with” with “on the”

P5 L8-10: Write the sentence without parentheses

P5 L20: I think you can remove the sentence in parentheses.

P5 L30: I think it would be clearer to introduce the equation directly when you cite it for the first time (near L8). Maybe it would work if you change the sequence of the paragraphs on P5 and P6.

P6 L25-29: I think this sentence is too long.

P7 L2: I think “microwave remote sensing model” is not the right term here. Maybe you mean “microwave emission model”?

P7 L10: Remove “deletedwhen”

P7 L9-11: I don’t understand this sentence.

P7 L20: It is not clear what “the former” refers to.

P7 L24-29: “In this study”, “in this context”, “in this applications”. The logical sequence of these sentences is not clear.

P8 L1: you could cite (Tab. 1) after ice

P8 L6: “indicated above” is not specific enough, it could be 25°, 60°, 30°, 50°.

P8 L28: I don’t know if “reasonable” is the right word here. Maybe “average”?

P9 L5: “done by other authors”. It is not clear to what “done” refers. Did they focus on TB or on inversion algorithms using PD and AD? I am quite sure that it is the former but this is not clear from the sentence structure.

P9 L14: If the level of uncertainty is unquantified, does it still mean that it is negligible?

P9 L27: add “defined” before “above”

P9 L32-P10 L2: The paragraph starts with “Table 1 lists”. It reads as if you were introducing something new. But, actually, you have referenced Table 1 several times before. This relates again to the structural issue (see #3).

P11 L5: If possible, try to use another letter for the distributions. rho was already used for the density before.

Section 5.1.: This is more a listing of different figures than a coherent story (see #5). I suggest that you rethink about the message you want to convey in this section.

P12 L1: Remove “replacedmoents” and replace “epochs” by “periods”.

P12 L29: I think you can remove “As we have shown”

P13 L5: I think you can remove “here” and “some days in”

P13 L9: It is not clear to what “that response” relates to.

P13 L31-33: Reformulate this sentence. Not clear.

P14 L6: I think you can replace “that is, the square of correlation coefficients” by “ R^2 ” or “ r^2 ”

P14 L11: You don’t need to put parentheses here.

P14 L19: It is not clear if this has been identified by Ivanova et al. (2015) or by someone else.

P14 L30: You introduce the full names of AD and PD only later in the conclusions (P15 L6).

P15 L24: Do you mean “determination” or “correlation” coefficients?

Figures

The caption often contains more explanations than are needed. And I think you do not need to reference in which part of the text the figure is discussed. So I think you can remove all “see XXX”.

Figure 1: A similar sentence can be found in the text, I think you can remove it.

Figure 4: Replace “gray” by “black”.

Figure 10, 11 and 12: I suggest that you use different colorbars. This would improve the clarity of the figures. You could use blue-white-red for difference plots and blues or reds for absolute values.

Figure 11 and 12: Replace “3th” by “3rd”

Figure 14: In the colorbar, replace “SAF<0.9” by “Both<0.9”.

References

Several references are missing dois. In other cases, the format of the dois is not consistent, e.g. for Huntemann et al, 2014, Shokr et al., 2015 and many others.

Also sometimes, journal abbreviations are used, sometimes not.

Tonboe et al., 2016 is not a discussion paper anymore.

Ulaby et al., 2014: Replace “adn” by “and”

Vant et al, 1978: A “T” is missing in the beginning of the title.