The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC1
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Comment on tc-2022-106

Anonymous Referee #1

Referee comment on "Validation of a fully-coupled radiative transfer model for sea ice with albedo and transmittance measurements" by Zhonghai Jin et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2022-106-RC1, 2022

General comments:

The authors have extended a coupled ocean-atmosphere radiative transfer (COART) model to the radiative transfer model (RTM) in the atmosphere-sea ice-ocean system (hereafter, the extended COART model). They compared the simulation results with measurement data of spectral albedo and transmittance collected at SHEBA and ICESCAPE stations to validate the extended COART model, and showed the agreement with previous studies that the model representations were improved by considering the vertical structure of sea ice such as SSL, DL and IL. They also showed the effect of contamination (LAPs and ice algae) of spectral albedo and transmittance of sea ice. The effectiveness of the extended COART model was emphasized through the series of analysis.

The result of albedo and transmittance comparisons between measurement and model looks good, but there are some questions on the results. In particular, following major comment (1) is critical issue. This paper's main purpose is to validate the extended COART model. However, because there are few in-situ measurement data required for the validation of RTM, most of the simulated results are based on guesswork. Therefore, this paper is a qualitative discussion and is insufficient to validate the accuracy of the extended COART model. The authors should reconsider how to validate the RTM, so that a major revision would be needed.

Major comments:

1. Most of snow and sea ice physical parameters (sea ice density, ice temperature, salinity, ice thickness Chl. a concentration, snow grain size, LAPs, snow density, snow depth), which are input parameters used for the radiative transfer calculations, are not based on in-situ measurement data, but on the guess due to the lack of the information about snow and sea ice. Although the result of albedo and transmittance comparisons

between measurement and model looks good, it is no exaggeration to say that the input variables are adjusted to match the calculation results with the observation ones. In general, since we simulate spectral albedo and transmittance based on the measurement data, we can validate a proposed model and can also find the physical processes that cannot be considered yet. In order to achieve the purpose of this paper, sufficient data must be prepared. The authors need to review the data used for the validation work again. If it is difficult to prepare the data, an alternative method is to confirm the reproducibility of your model by comparing it with a well-validated model.

2. Regarding the extended COART model, (a) why is it necessary to add the surface roughness scheme in the sea ice surface? Please add the reason by referring to Lamare et al. [2022; TCD]. In addition, the surface roughness is related to the specular reflection, and the magnitude of the surface roughness differs depending on the value of σ in the Gaussian normal distribution. The authors need to explain how the value of σ was determined. Furthermore, did authors apply this scheme to the boundary between the atmosphere and the melt pond where there is a large difference in refractive index between two medias? Please describe the explanation in detail. (b) There are various sizes of melt pond in the horizontal scale. The authors should describe the applicability of the extended COART model which is a plane-parallel RTM.

Technical comments:

L31-33: "The interaction between … surface temperature" this sentence is not clear. Explain the details about climate models mentioned in the text and cite references.

L48-: The last two paragraphs were well documented, but they do not mention the specific focus and the motivation for this manuscript. The authors need to describe it more clearly.

L78-: There is no mention about the ice algae in the section 2 which is a crucial for the transmittance of the sea ice though authors mentioned it in Fig. 6. Provide more details about the treatment of absorption/scattering properties of the ice algae.

L143: What does "AOPs" stand for?

The comments in the section 3 and below are omitted because they overlap with the major comment 1.