

The Cryosphere Discuss., referee comment RC2
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Comment on tc-2021-104

Anonymous Referee #2

Referee comment on "Development of a diffuse reflectance probe for in situ measurement of inherent optical properties in sea ice" by Christophe Perron et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2021-104-RC2>, 2021

Review of manuscript entitled "Development of a diffuse reflectance probe for in situ measurement of inherent optical properties in sea ice" by Christophe Perron, Christian Katlein, Simon Lambert-Girard, Edouard Leymarie, Louis-Philippe Guinard, Pierre Marquet, and Marcel Babin

This manuscript describes the development and testing of a novel instrument for direct measurement of the scattering coefficient in the interior of sea ice. Sea ice is a strongly multiply forward-scattering domain so direct measurements of the inherent optical properties have been challenging. This instrument uses an active optical test to acquire reflectance data used to interpret the spatial distribution of scattered light in a relatively small volume. A forward radiative transfer model is run for a wide range of scattering coefficients to generate a look-up table to which the observed reflectance pattern is compared. Results indicate that inferred scattering coefficients fall into the range of expected values.

The probe itself appears to have significant promise for investigation of the optical properties of sea ice. The manuscript describing the probe is comprehensive and does a good job of outlining the theoretical basis for the probe, its design, validation, and an example data set. The figures are clear and appropriate (one minor comment on Fig. 1, below). I have no substantial concerns about this manuscript and recommend it for publication. I was a bit surprised that the field tests did not include more information about the IOPs of the ice near its upper surface. Seems this is where this instrument could really shine, but it sounds as though there may be some technical issues to work through before the instrument can be used to interpret scattering through the entire column.

The remainder of my comments are minor and address the clarity of the language. There are numerous instances where the language is a bit imprecise, so obscures the intended meaning. I've attempted to point these out below. Otherwise, the presentation does a good job of motivating and explaining the hardware, results, and issues associated with data interpretation.

19 – 22: sentence beginning "Comparison to a Monte Carlo.." This sentence implies that all three IOPs can be inferred, whereas in practice it appears that satisfactory inversions are accomplished by assuming α and γ ? Also, this sentence should be broken into two sentences.

22-23: Sentence beginning "Monte Carlo simulations..." needs to be rewritten for clarity

29: strongly dependent *on* gamma?

30: "novel probe" delete "developed"; also "scattering in sea ice" not "into".

32: govern (not "are governing")

45: "the vertical distribution of IOPs"

48: "approximations"

51: instead of enlightenment, solar insolation or incident illumination

85: Does G also depend on the viewing direction of the receiving fibers (enclosed angle between direction of centers of source and detector fibers)?

97-98: fewer moments required as number of scattering events in the optical path augments. Do you mean "optical path increases"? Rewrite for clarity.

122-125: I think it likely that Grenfell & Hedrick (1983) had difficulty isolating single scattering and were probably measuring a domain somewhere between single scattering and diffusion regime.

128: Please check this reference.

134 (paragraph beginning): Is "N" defined? Is it the same as "n"? It is not clear exactly what is being evaluated here. What is meant by "set free"?

149: Please provide a reference for precipitated salt crystals that are smaller than the wavelength and thus serving as Rayleigh scatterers.

158: "impenetrable"? optically dense?

169: Light et al Monte Carlo model uses reciprocity to solve the RT equation, but is not truly an inverse model.

Figure 1: would it be helpful to show an arrow going from "Filter & photodiode" to "Computer" to show that the measured light is compared with MC simulations?

221: bandpass filtering at 633 nm designed to reject sunlight, but there is plenty of sunlight in the ice at this wavelength? Maybe just say "reject sunlight at extraneous wavelengths"?

307, 311, 390: horizontally? Not clear what this means?

329 - 331: this last sentence could be omitted

416: lowest (not coldest) temperature

544 inclusions "fusion"? Maybe merging inclusions?