

The Cryosphere Discuss., referee comment RC2  
<https://doi.org/10.5194/tc-2022-63-RC2>, 2022  
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## Comment on tc-2022-63

Anonymous Referee #2

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Referee comment on "Brief communication: A continuous formulation of microwave scattering from fresh snow to bubbly ice from first principles" by Ghislain Picard et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2022-63-RC2>, 2022

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This is a welcome short communication that addresses an important issue. The authors proposed to apply a new method for non-local strong contrast expansion, developed by Torquato and Kim (2021) to compute wave propagation in a two-phase media, to the full range of snow density and microstructure found throughout cryspheric regions. The intention is to help to address problems of grain size, shape, and snow density in electromagnetic theory, particularly related to the computation of the microwave scattering coefficient. The paper is well-written and concise. There are several corrections recommended for clarity, and a suggestion for expansion of the discussion. Several other minor corrections are recommended, listed sequentially.

### General comments

- Can the authors comment on the general applicability for active microwave modelling? Or is this applicable only to passive microwave solutions?
- We have often observed enhanced scattering where substantial depth hoar (DH) is present. Does the work of TK12/SCE support/explain this behaviour wrt DH given the distinct microstructure? Given the strong scattering from DH, it would be nice to see some comments on suitability for DH. The authors state in the abstract that this method should be applicable for coarse-grained snow and again in the conclusion but specific reference to DH would be welcome.

### Specific comments

- on Line 22, the authors state that existing theories "prevent consistent modelling of snow". Can the authors clarify what they mean by consistent?
- Line 21-24. Related to the above point, perhaps the authors can cite specific studies that
- In the study by TK21, they do not refer to Strong Contrast Expansion (SCE). While the authors' descriptor is useful, SCE in our community generally refers to snow cover extent which might be confusing for some readers. By way of a suggestion, perhaps the authors could use an alternative descriptor?
- Line 35. In the paper (TK21), they did not specify a snow medium but a 2-phase medium more generally. The authors make it seem as though TK21 had derived it explicitly for snow. Perhaps re-phrase "...which can be used to express the dielectric polarizability..."
- Equation 1, and Line 47 – As is not defined. It is sort of defined on Lines 51-52 but still not very clear. Please can the authors define this term as it is in equation 1.
- Line 41 - Is this the same as the scaled SCE in Figure 1? If so, be sure to use consistent nomenclature. If not, then can the authors explain the difference more clearly?
- Line 46 – it is not clear what the italicized symbol is in the in-text definition of  $K_e$ . This should be defined.
- Line 57 - what, specifically, would be needed in terms of 'increasingly more detailed information of microstructure?' What does this mean? The authors should provide the reader with more clarity since field experimentalists will be interested.
- Lines 56 – 59 – What is the benefit of  $n > 2$  should it be a feasible computation? Or, in other words, what are we missing out on by using  $n = 2$ ? What are the practical implications?
- Figure 1 and lines 70 – 71, Line 80 (and discussion throughout paper) – RT08 does not appear in Figure 1. Do the authors mean SCE R08? Similarly, TK21 in Figure 1. Do you mean Scaled SymSCE T21? The authors should check that the text matches the figure descriptors, here, and throughout the paper. Otherwise, it is confusing.
- Line 78 – what is the FDTD method ? Please expand this acronym.
- Line 80 – The authors imply that there is some spread between Scaled SymSCE T21 and Mie DMRT and IBA for  $koa > \sim 1$ . What are the implications, or is this unimportant?
- Line 122 – the authors write "Let choose a linear combination..." This should be "Let us choose..."
- Line 125 – you introduce SymSCE. Is this the same as Scaled SymSCE T21 shown in Figure 1? This gets a little confusing.
- Line 149 – 151 - Is there work going forward on this? There must be some existing suite of in situ measurements that could satisfy the requirements, no?
- Line 155 – the authors call for more precise in-situ microwave and snow measurements than what is available at present. What do you mean by more precise? Please be more specific here – what measurements, exactly, are needed? How does 'SCE' relate to physical field measurements? What field measurements are needed?