Response to reviewer 2

First, we thank the reviewer for reading our paper and for his/her comments.

This technical note deals with the sensitivity of the future CIMR microwave mission to various ocean and ice parameters. It is an update of the Wilheit figure that has been widely used with a focus on the incidence angle of CIMR (55 ◦) and using a more recent modelling. I have no doubt that this information will be useful to the CIMR community, but I find the novelty of the paper quite modest with respect to other studies. I think with some changes (see below) the paper could represent a more important contribution to the community. It is nicely written and easy to read.

We are aware that this paper does not present fondamental novel results. It is a practical update of the Wilheit figure that has been widely used by the community. This is why we chose to submit this result as a technical note and not as a regular paper.

A first concern is about the atmospheric contribution : to which extent is the Rosenkranz (2017) model valid at L-Band ? The Rosenkranz citation corresponds to a code and I did not find easily the corresponding references in the litterature but I am not sure at all it considers the contribution of the molecular Oxygen which is the dominant contribution at low frequency. Even though this contribution is much less than at higher frequency, given the low sensitivity of the brightness temperature to the salinity at L-Band, it cannot be ignored. This model is not used in salinity retrieval processors today.

The Rosenkranz gas absorption coefficients have been widely used in the microwave community, even for the retrieval of water vapor and temperature in the assimilation of microwave satellite data in operational weather centers. It includes all the physics required for an accurate evaluation of the atmospheric absorption by water vapor and oxygen in the atmosphere. It is valid from 1 GHz up to 1000 GHz. The provided citation includes many more citations to different works from Rosenkranz and colleagues. The reviewer may refer to the MPM model from Liebe that is also widely used. Note that Liebe and Rosenkranz worked a lot together, with Rosenkranz still active, with the model we used including the latest updates.

Another concern is with Figure 2 : the title of the paper makes a focus on the Arctic Ocean but this figure is for the middle latitudes, I suggest you change the title of the paper or do this Figure for Arctic conditions. The conditions described in Table 2 are very restrictive and do not represent the true variation of the parameters. I suggest you consider more representative variations and report the corresponding sensitivity as a shadowing around median conditions on Figure 2. The normalisation of Figure 2 does not allow to get quantitative estimates. I suggest you add several Y axis with scales corresponding to the non normalized sensitivity for each parameter.

Figure 4 provides the information the reviewer suggests, without normalization.

Detailed remarks :
Abstract Line 7-8 ’state of the art’: Levine and Dinnat (2020) recently published a similar study with a discussion of the sensitivity given by various state of the art ocean RTMs. The originality here is not to reproduce the figure of Wilheit with a recent model, but to update it at 55 ◦ which was not specifically studied by Levine and Dinnat. In addition, to my knowledge, the Rosenkranz atmospheric model is not considered as a state of the art model at L-Band.
Le Vine, D.M.; Dinnat, E.P. The Multifrequency Future for Remote Sensing of Sea Surface Salinity from Space. Remote Sens. 2020, 12, 1381.

Thank you for the reference to the LeVine and Dinnat paper, we added it to our paper.

The atmospheric model that is presented in LeVine and Dinnat is the MPM92 model from Liebe et al (1985, 1992) (reference 37 and 38 in there paper) with Rosenkranz improvements (reference 39 of the same paper). It is the same model that we use, but with a more recent reference.

Line 29-30 : what are the main parameters of interest on METOP-SG for CIMR ? Maybe add a reference for METOP-SG. What do the acronyms MWI/ICI and SCA mean ?

There are two instruments of interest on MetOp-SG, for synergy with CIMR. First the scatterometer ASCAT that can provide the ocean wind speed with accuracy, and second the two microwave imagers MicroWave Imager (MWI) and the Ice Cloud Imager (ICI) that extent the frequency range of CIMR up to 654 GHz, for atmospheric retrievals. Products from ASCAT (ocean wind speed) and from MWI/ICI (water vapor and liquid water content) could be used as first guess in the retrievals of CIMR.

The meanings of the acronyms have been added : "MetOp MicroWave Imager (MWI)/Ice Cloud Imager (ICI) and SCAtterometer (SCA) measurements »

Line 40 : I guess it is meant : state of the art of the various components of Radiative Transfer Model. In fact only one model is considered for each contribution whereas several are in use in the community and none of them have been absolutely ruled out given present uncertainties. I suggest to refer to the recent study of Levine and Dinnat who showed the sensitivities obtained with various widely used components of radiative transfer models.

We agree that the paper from Levine and Dinnat presents an interesting comparison of the different radiative transfer models for the ocean. Our model selection is based on Kilic et al., 2019 that also compared different models (including the ones used in Levine and Dinnat), including comparisons with satellite observations. Kilic et al 2019 showed that the model that fits the observations better over the full frequency range and environment ranges is the model from RSS.

Table 2 : how do realistic variations in the surface and atmospheric conditions modify the results ? I would suggest putting a shadow around the curves on Figure 2 to reflect the variations due to surface and atmospheric conditions as well as uncertainties coming from uncertainties on RTM.

The variations due to the surface and atmospheric parameters are shown in Figure 3 for 3 typical cases. The uncertainties of the RTM is a problem that is partly treated in Kilic et al., 2019. We would like to keep Figure 2 easy to understand and close to Figure of Wilheit.

Lines 68-75 : Molecular Oxygen is the main contributor at L-Band and is a significant contributor at low frequency (see Levine and Dinnat, appendix C), it should be considered. How does the Rosenkranz model compare with the MPM92 model more widely used at L-Band ?
Strictly speaking, equation 1 should be vertically integrated ; I guess neglecting the vertical integration might have some impact on the result, especially at high frequency, this should be discussed.

We are fully aware that O2 is the main contributor to the atmospheric absorption at L-band. See our response above. It is actually Rosenkranz who derived the oxygen parameter for the Liebe models. Liebe was mainly working on the water vapor attenuation. Liebe passed away several years ago and a new reference for the model is the one that is given in the paper.

Line 91 and Figure 2: I guess you mean : maximum value of the sensitivity. I don't like much this normalisation because it does not allow a quantitative reading (I also have this problem when reading the Wilheit figure). You might envisage to add several Y axis with scales corresponding to the non normalized sensitivity for each parameter.

We would like to keep Figure 2 close to the Wilheit one. But in Figure 4 the sensitivities are shown unnormalized with a logarithmic scale.

Line 111 : Partly redundant with the introduction

Yes the sentence "CIMR has a 55 ◦ incidence angle and a large swath (>1900 km) to provide full coverage of the poles (i.e., with no gap at the pole itself), for the first time with a conical scanner" has been deleted.
We modified the following sentence by: "The choice of an incidence angle of 55° for CIMR has been constrained by the swath width (to fully cover the poles), and the spatial resolution.»

Legend of Figure 4 : unclear what does 'units' mean

The units are the units of measurements for the sensitivities to the different parameters. It is explained in the text e.g., "The TCWV and TCLW show respectively a sensitivity of 1.0 K per 1 kg/m2 at 18.7 GHz, and 1.05 K per 20 g/m2 at 36.5 GHz".