We would like to thank the referee for their time and effort in reviewing this manuscript.

Review comments are in blue and the responses by the authors are in black text.

Referee #1:

Line 23, remove it within “partition the total optical depth it into”

The change has been made. Sentence now reads:
Additionally, we use spectral analysis in an attempt to partition the total optical depth into its τ_{aer} *and cirrus cloud optical depth* (τ_{cld}) *components in the absence of coarse-mode aerosols.*

Line 49-50, a recent study by Yang et al. (2020, doi: 10.1029/2019EA000574) also indicated this point and could be cited as a support.

The reference to Yang et al., 2019, which further supports the notion that clouds interfere with aerosol optical depth retrievals, was added to line 50.

Line 52, “when cirrus is present” is suggested.

The sentence has been updated with “is” replacing “are”
...though these techniques are limited when cirrus is present (Smirnov et al., 2018).

Line 61-62, is there any reference to support so high cirrus fraction here? If there is, it is worthy to mention.

The reference to Sassen et al.,. 2008 was cited again, and a reference to Zou et al., (2020; https://doi.org/10.5194/acp-20-9939-2020) was added to support the claim that cirrus have relatively high frequency of occurrence in the tropics.

Line 54-55, it is worthy to mention other types of thin clouds. For example, there are a large fraction of thin clouds in the Arctic with longwave emissivity less than 0.95 as indicated by Garrett et al. (2013, doi: 10.5194/amt-6-1227-2013), who developed a spectral radiation based retrieval algorithm for those thin clouds.

We added text to the end of the paragraph that acknowledges how other thin cloud types cause difficulties when remote sensing aerosols. We also take the opportunity to highlight the approach taken by Garrett and Zhao to study these thin clouds. The Garrett and Zhao paper is also now cited later in the Introduction section in response to a separate comment by the referee.

Other thin cloud types, such as low-level clouds in the Arctic, can have relatively high rates of occurrence and therefore pose challenges when using remote sensing techniques to study cloud or aerosol optical properties. For the case of thin Arctic clouds, Garrett and Zhao (2013) demonstrated the utility of thermal spectral remote sensing to derive the optical properties when the clouds have an emissivity less than unity.

Line 77-79, To me, this method is similar to those thin cloud retrieval algorithm that are based on two different band radiation measurements like Garrett et al. (2013) mentioned above.

We now highlight how Garrett and Zhao similarly used the concept a ratio of two spectral measurements to develop a retrieval for thin cloud optical properties. The two methods rely on different physics – in this manuscript the retrievals are based on the study of shortwave radiation, while Garrett and Zhao use transmission and thermal emission, however the point made by the referee is important and we have adjusted the manuscript as follows:

The concept of using a ratio of two spectral measurements to study thin clouds has been previously developed by Garrett and Zhao (2013) who used a ratio of measured thermal emission to study thermodynamic phase and optical properties of thin Arctic clouds.

Line 122, how thin the clouds should be to make this equation reliable?

The point we are making by referencing the thin cloud limit (Equation 4) is that the dependence of the diffuse ratio on the asymmetry parameter (g) becomes minimal as clouds become thinner. We feel this point is clear in the manuscript as it is currently written. However, to the referee's point: the measured diffuse ration will have some dependence on g given the presence of any cloud. The question is then at what point does the uncertainty induced from having an unconstrained value of g become insignificant? For the purposes of the Diffuse Method (RD) described in this study, the measurement uncertainty is greater up to optical depts of ~0.5, above this value uncertainty in g becomes a significant source of error. This relationship between the two sources of uncertainties can be seen in Figure 2.

Line 134, I am not sure if dust aerosol has similar absorption characteristics as clouds, please help explain. Thanks.

The use of the term absorption was a mistake. We meant to say that large aerosols and small cloud particles can have similar scattering characteristics -- both can have spectrally flat optical depths at visible wavelengths. It is for this reason that we apply the diffuse method (RD) in the absence of aerosols (because the diffuse signature from large aerosols may look similar to that of clouds). The sentence in line 134 was adjusted as follows:

Fine-mode aerosols are commonly absorbing, while coarse-mode aerosols, such as sea-salt and dust, have similar scattering characteristics to clouds, both of which limits the application of RD to samples without aerosols (the implications aerosols have on RD are discussed in more detail in Section 5).

Line 169, have low AE values or have a low AE value?

Thank you for catching this mistake: the word "value" has been changed to the plural form, "values".

Line 255, "One other" should be "Another"? "outputs" or "falls"

This sentence has been corrected in the manuscript.

Another limitation that is worth mentioning: the output of RD falls below the identity line because of difference in the scattering phase functions used in the simulated data and the DR calculations in the retrieval.

Line 308, 317 and others, personally, I would like to use "from ... to ..."

We have change how we specify data ranges throughout the manuscript based on the referee's suggestion.

Line 332-335, Why do not the authors correct the diffuse radiation instead of cloud optical depth outputs based on the FOV information?

We correct the optical depths themselves because the bias induced by the FOV is proportional to the optical depth of the cloud. Therefore, given a measurement of the diffuse radiation, finding the magnitude of the bias correction requires that you have information about the cloud optical depth. In our case we use radiative transfer simulations to relate the retrieved optical depth (that's biased by the FOV error) to the un-biased (true) optical depth. Since deriving cloud optical depth is a necessary part of doing the correction, it is simpler to correct the output optical depth rather than correct the diffuse irradiance and then run the retrieval again using this corrected irradiance. This is a similar technique that has been commonly used in past attempts at FOV corrections, for example how FOV bias was handled in Min et al. (2004; doi:10.1029/2003JD003964) or described by Segal-Rosenheimer et al. (2013).

Line 380, "wavelength"

This typo has been corrected.

Figure 4, consistent with other figures, the titles in x- and y- coordinates might start with a capital letter.

The Figure has been updated.

Line 560, "which is shown"?

The word "which" has been added to the sentence. It now reads:

Like with the ORACLES results, we compare $\tau_{RS,tot}$ to τ_{RD} for two cases: (1) above the aerosol layer, which is shown in the left panel of Figure 10, and (2) the optical depths for complete spiral profiles (i.e., data from above and within the aerosol layer), which is shown in the right panel of Figure 10.

Line 613, "related to"

This sentence has been reworked. See the following comment.

Line 613-615, Please rephrase this sentence since it seems with grammar error.

This sentence has been reworked as follows:
Another source of uncertainty in optical depth retrievals relying on direct/diffuse measurements made from SPN-S is the wide FOV associated with shadow band radiometer systems, which results in an overestimation of the direct transmittance. Biased measurements of transmittances due to the sensor FOV being wider than the solar disk are an issue associated with sun-photometers as well, however the FOV of the SPN-S system is greater than commonly used sun-photometers ($\sim 5-10° \; vs \sim 1°$), making FOV correction necessary for accurate optical depth retrievals (di Sarra et al, 2015; Wood et al, 2017).
