Dear reviewer, dear editor,

Thanks for your comments and your suggestions. In the revised manuscript all the suggested reformulations are accounted for, and your question has been addressed. We have listed your questions and comments below (in red), then explained how we have addressed each point in the revised manuscript and provided new sentences (in green).

Reviewer #2's feedback #2 - accepted subject to minor revisions

I am satisfied with most of the replies to my comments and commend the authors for the revisions made to the manuscript to address them. However, my comment on the impact of the assumption that cloud particles above 4km altitude are ice was not sufficiently addressed in my view. The additional text added to the manuscript is:

“The cloud model phase used during the retrieval process can also be improved, particularly the assumption of 4 km made for the top of the liquid phase, for tests on mixed-phase clouds, given that supercooled liquid clouds can be present well above 4 km altitude. A better definition of the different cloud phases would allow for a better representation of the cloud's optical properties.”

I think this assumption can have a significant impact. At this stage I am not asking for thorough simulations to quantify this impact, but I suggest the authors give a rough estimate of the impact or at least estimate whether this will lead to over- or underestimations for super-cooled liquid tops (for example for liquid cloud tops at -20 degrees Celcius).

➔ We agree that the assumption that all cloud particles above 4 km are ice can have a non-negligible impact, particularly when supercooled liquid layers are present at higher altitudes. Without simulations, the quantitative evaluation of this impact cannot be obtained. Nevertheless, in the shortwave infrared (SWIR) range, the cloud optical thickness (COT) and effective radius retrievals are highly sensitive to the assumed thermodynamic phase. As shown by King et al. (2013), the SWIR bands at 1.6 µm, 2.1 µm, and 3.7 µm used in MODIS retrievals exhibit different sensitivities to droplet size and phase, with the 2.1-µm band being more influenced by deeper cloud layers and 3.7-µm band by smaller droplets near the cloud top. When an ice phase is assumed, the simulated reflectances in these bands would likely be lower, leading to an underestimation of COT and biases in retrieved microphysical parameters.

Moreover, King et al. (2013) emphasize that *"ice cloud retrievals are particularly sensitive to particle shape (habit) assumptions"* and that a robust phase classification is a crucial step before the derivation of optical properties. In earlier versions of their algorithm, clouds with undetermined phase were *"subsequently processed as if they were liquid water"*, which resulted in systematic biases in retrieved COT and effective radius. This demonstrates that phase assumptions directly affect the accuracy of SWIR-based retrievals. In our case, applying a fixed 4-km threshold between liquid and ice phases could introduce similar biases. For supercooled liquid tops (e.g., around −20°C), we can expect the retrievals to underestimate the cloud optical thickness and potentially misattribute part of the SWIR absorption to water vapor above the cloud. We have added the following paragraphs to the conclusion/perspectives section:

- *"Indeed, assuming that all cloud particles above 4 km are considered as ice may introduce non-negligible uncertainties. In the SWIR spectral range, this assumption is likely to lead to lower simulated reflectances, resulting in an underestimate of cloud optical thickness and biases in the retrieved microphysical parameters (e.g., King et al., 2013). Consequently, a similar effect can be expected in our case. We have shown that COT retrieval affects the IWV_AC retrieval, and since the representation of the cloud thermodynamic phase directly impacts COT retrieval, it consequently also indirectly influences the IWV_AC retrieval."* (new file, page.21 lines.432-437)
- *"To determine the cloud top phase, we plan to use the 670 nm channel from the CLOUD imager since the ratio between the visible and the SWIR non-absorbing channel (1.04 µm) provides information on the cloud top phase (Riedi et al., 2010). In case of liquid cloud, the liquid cloud algorithm would be applied and in case of cloud top ice phase, we will use climatological profiles to better constraint the transition altitudes."* (new file, pages.21-22 lines.438-441)

Furthermore, in the added text, I would remove "for tests on mixed-phase clouds" as I think that is a confusing addition.

➔ Regarding the terms "liquid clouds" and "mixed-phase clouds", in the new version, we have opted for the terms "low- /mid-level clouds" instead of "liquid clouds" and "high-level clouds" instead of "mixed-phase clouds." (new file, pages.[8, 18, 19, 21] lines.[183-184, 365-366, "caption figure 11", 431] – we have replaced "for tests on mixed-phase clouds" by "for tests on high-level clouds")

Editor’s feedback

Thank you for your revised submission. I have received one further review of it from one of the original referees, and from that and my own reading would appreciate some further revisions related to ice clouds. The reviewer's comments are:

"I am satisfied with most of the replies to my comments and commend the authors for the revisions made to the manuscript to address them. However, my comment on the impact of the assumption that cloud particles above 4km altitude are ice was not sufficiently addressed in my view. The additional text added to the manuscript is:

“The cloud model phase used during the retrieval process can also be improved, particularly the assumption of 4 km made for the top of the liquid phase, for tests on mixed-phase clouds, given that supercooled liquid clouds can be present well above 4 km altitude. A better definition of the different cloud phases would allow for a better representation of the cloud's optical properties.”

I think this assumption can have a significant impact. At this stage I am not asking for thorough simulations to quantify this impact, but I suggest the authors give a rough estimate of the impact or at least estimate whether this will lead to over- or underestimations for super-cooled liquid tops (for example for liquid cloud tops at -20 degrees Celcius). Furthermore, in the added text, I would remove “for tests on mixed-phase clouds” as I think that is a confusing addition."

I agree with this reviewer and would appreciate it if you could further revise the manuscript to better account for these comments. Furthermore, please note these comments from the file review team:

"1. You used scientific abbreviations in the "Short summary" text (LES) and are kindly asked to provide at least one written out version. This does not apply to chemical elements.”

➔ In the new version of the manuscript, the acronyms in the abstract have been removed.

“2. The ROR database lists the institution of the corresponding author but with a different city than given in the manuscript. Please clarify whether the ROR "Laboratoire d'Optique Atmosphérique (Villeneuve-d'Ascq, France)" is still correct."

➔ The correct affiliation since 2018 is indeed the one indicated in the paper: *Univ. Lille, CNRS, UMR 8518 - LOA - Laboratoire d'Optique Atmosphérique, F-59000 Lille, France*

Added references:

- King, M. D., Platnick, S., Menzel, W. P., Ackerman, S. A., and Hubanks, P. A.: Spatial and Temporal Distribution of Clouds Observed by MODIS Onboard the Terra and Aqua Satellites, IEEE Transactions on Geoscience and Remote Sensing, pp. 3826–3852, https://doi.org/10.1109/TGRS.2012.2227333, 2013. (new file, page.25 lines.544-546)
- Riedi, J., Marchant, B., Platnick, S., Baum, B. A., Thieuleux, F., Oudard, C., Parol, F., Nicolas, J.-M., and Dubuisson, P.: Cloud thermodynamic phase inferred from merged POLDER and MODIS data, Atmospheric Chemistry and Physics, pp. 11 851–11 865, https://doi.org/10.5194/acp-10-11851-2010, 2010. (new file, page.26 lines.576-578)