EGUsphere, author comment AC1
https://doi.org/10.5194/egusphere-2022-755-AC1, 2022

Reply on RC1

Marc Prange et al.

Author comment on "How adequately are elevated moist layers represented in reanalysis and satellite observations?" by Marc Prange et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-755-AC1, 2022

On behalf of the authors, I want to thank the reviewer for their detailed and insightful comments on our manuscript. In general, we are happy to hear that the reviewer thought the manuscript has scientific value, makes for an engaging read and views our manuscript as being almost ready to publish. In this first response, we would like to address some of the more urgent comments of the reviewer and provide some outline of a more detailed response, including a revision of the manuscript after the open discussion. In the following, we address some of the reviewer's comments point by point.

Comment:

Line 55: "We address this gap in this study." While I loosely agree with the authors that the study of EMLs are underrepresented in hyperspectral IR product evaluations, I think it prudent to add a qualifier to this statement to suggest that the study of EMLs go beyond what the authors present in this paper. I suggest one of following edits: "We take steps to start addressing this gap" or "We partially address this gap". EMLs are three dimensional features spanning hundreds of kilometers, can last a day (many hours!) and are associated with deep convection globally and especially in the extra-tropics. In short, these are large features on a global scale. In this paper, the authors do not do a 3-D analysis, nor do a global evaluation. Instead, they use a point source dataset (GRUAN radiosondes) at one single location as the reference set, against which all other datasets are evaluated. At best the authors can conclude that at a specific site and for a specific location within an EML feature (3-D blob), their results hold true. Would this not be more accurate? Or do the authors feel confident that their results can be extrapolated globally? If so, kindly motivate.

Response:

We agree with the reviewer that choosing a more nuanced phrasing to describe our contribution to the scientific gaps around EMLs and their representation in satellite retrievals is beneficial here. The points raised by the reviewer make up a nice framework to describe our specific contribution to the field, which is a 1D analysis of EMLs, while questions remain about their 3D structure and representation in the investigated data products.

Comment:

Section 2.4, Lines 129-143: The authors opted to use the relative humidity field that is reported in the CLIMCAPS L2 file on 66 pressure levels. This field is derived from the water vapor column density field [molec/cm2] retrieved directly from the IR radiances and reported on 100 pressure layers. It is possible that the vertical bias reported here is due to a shift from pressure layers (air_pres_lay) to levels (air_pres_h2o) when converting to relative humidity. Another issue, and one that is entirely the fault of the product team, is that the relative humidity field already has the boundary layer adjustment applied but this is not communicated in the technical documents (I discover to my dismay). The authors, therefore, didn't need to do this adjustment. I commend them, however, for following the science guides to a fault. In future I will be curious to learn if the authors report a similar bias when starting their analysis with the column density field instead (mol_lay/h2o_vap_mol_lay).

Response:

We thank the reviewer for their insightful comment and specific suggestion of an explanation for the biases we identify. We look forward to following up on how our results may be affected by purely processing induced errors that do not reflect the data product's actual performance. We will give a more detailed response to this in the point-by-point response after the public discussion phase.

Comment:

Lines 154-156: "…the IASI product attempts retrieval through the clouds, CLIMCAPS…represent the atmospheric state around the clouds…". Does the IASI L2 product really retrieve through clouds? Can the authors explain this algorithm component in a sentence or two? Thinking out loud, I wonder if IASI L2 uses the collocated AVHRR cloud fractions to determine which regression coefficients to apply. But even then, the cloudy regression retrieval would not represent the atmosphere through the cloud. Infrared radiance is highly sensitive to clouds and does not transmit through opaque clouds. The IR radiances, therefore, do not contain information within and under such clouds. Can the authors elaborate on this distinction they're drawing here? This will help the reader better understand the results. As it is written and laid out currently, it appears that the authors say that there is no difference in EML detection between an algorithm scheme performing cloud clearing (aggregate footprints) and one retrieving through clouds (usually single footprint). But the IASI fields are also on aggregate footprints… I'm confused.

Response:

We can see that it is worth writing some more words about the differences in cloud handling of the IASI L2 CDR and CLIMCAPS. We agree with the reviewer's statements about inherently limited IR information content in the presence of clouds. However, a fundamental difference between the IASI L2 CDR and CLIMCAPS lies in the fact that for IASI there is humidity information available from a microwave instrument (MHS), which in fact contains humidity information in the presence of clouds. Hence, the IASI L2 CDR can actually be thought of as representing the atmospheric states through the clouds, as we write in the manuscript. We agree with the reviewer, though, that we should describe this distinction in some more detail, especially because information content in the presence of clouds is still limited to the MW data that does not contain the same amount of information as IASI in clear-sky conditions. We are not sure about the reviewer's suggestion of whether or not the retrieval's regression coefficients are adjusted depending on the scene's cloudiness. The user guide speaks of distinguishing different "observation classes (e.g. surface type and elevation)" that the linear regression depends on, with no specific mention of cloudiness. We will attempt to shed more light on this by communicating with EUMETSAT and come back in more detail in the point-by-point

response after the open discussion.

Comment:

Lines 317-319: "Nonetheless, the number of moisture anomalies in the AIRS CLIMCAPS retrieval speaks [of] a good capability…to capture vertical moisture capability." This is a positive result as far as CLIMCAPS goes and surprised me. From the abstract and introduction, I expected only negative results for CLIMCAPS. I wonder if the authors can update their abstract to reflect the value in different retrieval approaches, as far as EMLs go.

Response:

We thank the reviewer for pointing out some apparent inconsistencies in our descriptions of our findings in different parts of the manuscript. In particular, we agree that we could point out more the capabilities of CLIMCAPS instead of constraining our conclusions to the limitations and biases we find. We will address this in the revised manuscript.

Comment:

Do the authors think that their results apply to reanalysis models in general, or to ERA5 specifically? CLIMCAPS uses MERRA-2 as a-priori for its water vapor column density retrievals and it will be interesting to know how much CLIMCAPS follows or deviates from the MERRA-2 fields, especially since it uses an optimal estimation scheme that gives it the ability to adjust a-priori fields based on scene-specific information content from the measurements. In future the authors could include an evaluation of the averaging kernels to help make sense of this.

Response:

We agree that an evaluation of other reanalysis models would be interesting and beneficial for our study, especially MERRA-2, which fills a similar role as ERA5 does for the IASI L2 CDR. We agree that it would be particularly interesting to see how an optimal estimation scheme deviates from the prior information compared to a regression-based scheme and whether one of the retrieval's priors (ERA5 and MERRA-2) performs significantly better than the other, possibly explaining some differences we find in the retrieval performances. However, we do not see that this can still be achieved within the frame of this study due to time constraints. We shall, however, emphasize this point more in the concluding remarks of our manuscript to motivate future research on this.