Review of ACP manuscript acp-2022-655 "Comparison of dust optical depth from multi-sensor products and the MONARCH dust reanalysis over Northern Africa, the Middle East and Europe" by Michail Mytilinaios, Sara Basart, Sergio Ciamprone, Juan Cuesta, Claudio Dema, Enza Di Tomaso, Paola Formenti, Antonis Gkikas, Oriol Jorba, Ralph Kahn, Carlos Pérez García-Pando, Serena Trippetta, and Lucia Mona

General comments

This paper presents a thorough assessment of a novel atmospheric dust reanalysis dataset with unique characteristics (high resolution, dust properties). The assessment uses a combination of different satellite datasets (with different strengths and weaknesses, and with different information content) and ground-based observations (with limited spatial sampling). The combination of different reference datasets allows a meaningful assessment despite of the given limitations of each dataset. The analysis and the conclusions are thoroughly made and presented and altogether they support the high quality of the evaluated reanalysis dataset.

The paper discusses a relevant topic (assessing the quality of a novel atmospheric dust reanalysis), since atmospheric dust has several strong impacts on the Earth system, human health and economic sectors. The comparison methodology applied is clearly outlined and follows the state of the art. Related work of the authors and the community are properly credited (while I note that the list of references is quite long). Title and abstract as well as the language (as far as I can judge as non-native English speaker) are well suited. The quantities used to assess the dataset quality are clearly defined in the Appendix. The authors have made a meaningful selection of the multiple elements in the study for the main paper and added the additional material in a supplement (the parts of which are also referenced in the main paper).

The only significant improvement which I suggest, is an enhancement of guidance for a reader through the vast collection of evaluation steps done (see my first specific comment). This means a major revision (but likely not too high efforts) in terms of the paper presentation / structure, but only minor revisions in terms of its content.

Specific comments

My main point is on the presentation / structure of the paper: The paper presents a rich set of analysis to assess the quality of the MONARCH reanalysis dataset. The authors have already made an effort to avoid overwhelming the reader by splitting of parts of the material into a supplement. However, even in the main paper as it is now a reader may easily loose the overview with so many different aspects. I therefore recommend for better guidance of the reader:

- to provide an overview table in the beginning of section 2 or in section 2.6 which lists the different analysis made (e.g. satellite validation, reanalysis assessment of DOD, coarse DOD, annual, seasonal, …) versus the various reference datasets used; this should include the analysis shown in the supplement and at the same time identify the placing in the paper (main paper or supplement) for each analysis element
- to add sub or sub-sub headings (e.g. for the section on DOD and coarse DOD) in the analysis and discussion sections
- to add short titles to the figures to help a quick reader

Further specific comments:

Some paragraphs do not seem to fit in the section they are presented in – they should be moved:

- lines 274 – 287: should better become an overview at the start of section 2 or in section 2.6 (and there the overview table which I suggested could be added, too)
- lines 347 – 357: should better be moved to the discussion section

In the abstract the tense is mixed up (mostly present, but at some places simple past is used, e.g. line 11) – this should be harmonized.

In the abstract (line 24/25) relative bias are provided as fractions of 1, which can easily be mixed up with absolute AOD values. I therefore recommend to use %-values.

In the introduction impact of atmospheric dust is summarized; I miss a statement on fertilizing the Amazonas here.

In summarizing the MONARCH reanalysis in the introduction, data assimilation of specific satellite datasets is mentioned. Can you add here which datasets are used, so that a reader can understand immediately in how far these are different from the datasets which are used for the evaluation in this paper.

Section 2.4: can you add a statement, why you chose this particular IASI dataset and what unique characteristics it has as compared to the IASI datasets provided by the operational Copernicus Climate Change Service / Climate Data Store (https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-aerosol-properties?tab=overview).

Figures 2 – 5: The top row images (2 per column) are too small to be able to see much in them (on paper) – please enlarge them both to the size of the other maps and place them one below the other on top of each column (this should still fit on one page)

In many places you alternate "MONARCH" with "reanalysis" – for reader guidance I would find it easier to follow, if you keep "MONARCH" in all places

Fig. 4 and 5: There is a strong land-sea contrast I the MB map for MIDAS, which I missed in the text – can you please add this

Technical corrections
Line 52: delete "the" before "airborne aerosols"
Line 76: better replace "data availability" by "measurement possibility"
Line 79: better replace "e.g.," by "and" (as there are two separate aspects in this sentence)
Line 19/20: I do not understand the statement iii) – can you please extend or reword to explain what this means?
Line 131: better replace "-30° E" by "30° W"
Line 151: you could add "profile" before "variables"
Fig. 1: should the area "Northern Europe" not better be renamed to "Northern and Central Europe"?
Line 175: can you add some quantitative information here (an average 5 value for example)
Lines 178 – 187: I find this discussion of technical matching in UTC confusing, as the difference in local time is smaller – maybe you should point this out in addition
Lines 244 and 260: the radius limits of 2 µm and 0.6 µm differ – can you please explain?
Line 282: nighttime measurements: are they used at all in this paper? Please state explicitly.
Lines 284/285: "usually" and "in most cases" duplicate their meaning

Lines 300/301: this means that these cases are not used at all, correct? Please state this explicitly

Line 303: fine mode radius of 0.6 µm – you should mention / discuss the impact of the different definition elsewhere (0.5 µm; e.g., line 57)

Line 304: can you mention that wildfires may lead to significantly high AOD values (versus sea salt with only low values)?

Lines 317/318: I do not understand this sentence, can you please reword?

Line 320: can you please add the number of stations which meet this criterion?

Lines 505 – 507: can you add a reference for this statement?

Line 709: please add "total column"