Comment on essd-2021-358
Anonymous Referee #1

Referee comment on "The MONARCH high-resolution reanalysis of desert dust aerosol over Northern Africa, the Middle East and Europe (2007–2016)" by Enza Di Tomaso et al., Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2021-358-RC1, 2021

The MONARCH high-resolution reanalysis of desert dust aerosol over Northern Africa, the Middle East and Europe (2007-2016)
Enza Di Tomaso et al.

SUMMARY

The manuscript describes a data set of assimilated dust aerosol concentrations and optical properties. The data covers an area including Europe, North Africa, and Middle East, at a resolution of 0.1x0.1 degrees. The time period is 2007-2016, and data is available every 3 hour. Simulations were done using the MONARCH atmospheric model. AOD observations of MODIS were assimilated using an ensemble approach (LETKF), the product consists of ensemble mean, std.dev., maximum, and median.

The production of the data set is extensively described. Some extra clarification could be made (see SPECIFIC COMMENTS below), but in general the assimilation procedure is described sufficiently detailed to understand what has been done, including the generation of the ensemble, calibration, data selection, error statistics used, and assimilation sequence. Where necessary references are present where details could be found. With this the paper could serve as a reference for studies that actually use the data set, as indicated in section 7.

With some minor clarifications the manuscript could be published in this journal.

GENERAL COMMENTS

The manuscript describes a validation of the data set in terms of AOD (or specific, DOD, Dust Optical Depth). This is also the quantity that is assimilated, and it therefore makes sense to use this as first validation. For a data set related to dust, it would however be useful to have also an idea on the dust concentrations themselves, and how accurate these are. The only dust-related results are shown in Figure 4, but no comparison with observations has been made. Will there be a validation of the dust concentrations included in the follow-up papers mentioned in Section 7? It would be useful to have that clearly
mentioned. Also, some remarks could be made already on the dust concentrations themselves and how they are changed by the analysis.

For example, what is the impact of the calibration described in Section 6.1 on the dust load in the ensemble members? If my interpretation is correct, the calibration factors for the dust emissions range from 0.004 for the K14 emission scheme, to 2.65 for the MB95 scheme. This is a huge difference; does it mean that the K14 scheme by default has a huge over-estimation? After calibration, do the ensemble members have dust concentrations that are more or less in the same range?

The adjustment of the dust concentrations depends strongly on how DOD is calculated, thus on the optical properties and the radiance computations. Is there any idea on how accurate these computations are? With incorrect optical properties computed, the dust concentrations might require unrealistic perturbations to obtain the correct DOD’s. The meteorological data is also relevant for this computation I guess; since this comes in the ensemble from two different models (MERRA2 and ERA-Interim), is there a clear difference seen between the DOD’s computed for different meteo?

Some clarification on the ensemble generation would be useful. Section 3 describes that a 12-member ensemble is used, with each member choosing one-of-two meteo sets, one-of-three emission schemes, and a random value for (among others) the friction threshold; is that indeed what is done? I guess that each member then keeps it’s choice for meteo and emission scheme, but are the emission parameters changing in time or per grid cell?

**SPECIFIC COMMENTS**

Lines 145-146: What does a Frequency-of-Occurrence of 0.20 mean? That in 20% of the days dust is observed over a location?

Line 230: What is meant with a time slot centered around 12 UTC? Aren’t more MODIS orbits assimilated then, with different time slots?

The analysis weights in Eq. (2) might provide some information on a preference of the analysis for certain ensemble members, for example the members with a specific emission scheme. Is that indeed possible, and has some information been deduced from them?

Section 6 describes that an observation screening is applied. Is it kept which fraction of the observations has been rejected, and whether that is especially in certain regions?

Table 6: What is exactly done for “DOD-mixed2”? How could AE be <0.75 and >1.2?

Line 492: The “DOD-mixed2” leads to more zero values; should that be visible in Figure 10 then as a a higher density?

Line 502. Is the change in statistics associated with changed conditions? Or could it be related to a degradation of the data?

Line 510: Which complexity of the topography is relevant here?

**SPELL AND GRAMMAR**

Line 78: chemical formula should not in math mode
Line 79: “additionally”

Lines 197, 199: shouldn’t it be: ‘friction velocity “for” wind velocity’?

Subsection 6.1: shouldn’t this be a section?