Comment on egusphere-2022-819
Anonymous Referee #1

Referee comment on "The impact of assimilating Aeolus wind data on regional Aeolian dust model simulations using WRF-Chem" by Pantelis Kiriakidis et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-819-RC1, 2022

Review on paper titled “The impact of assimilating Aeolus wind data on regional Aeolian dust model simulations using WRF-Chem" by Pantelis Kiriakidis et al.

Paper compares output from two WRF-Chem model runs: with and without assimilated wind fields. In particular, authors use extensive set of ground and satellite observations to estimate model skill to simulate dust events. The article is well written and easy to follow. Authors conclude that they got significant improvements in dust simulation over the EMME region using assimilated wind data, while comparisons with the whole simulated domain diffused the improvements.

My main concern is the ability of WRF-Chem to correctly simulate the dust cycle in this study. Fig. 2 demonstrates it, i.e there is a better agreement in PM10 between runs rather than between runs and observations. See also Fig. A2, where good agreement between models is shown. Model also overpredicts PM10 and not capable to capture high pollution events in most of the cases. Thus, I think, authors pay attention to the 2nd order effect, while 1st order effect (dust simulation itself) is not satisfactory resolved. Therefore, I recommend revision before accepting for publication.

General comments:

the title is a misleading. It is not clear, whether WRF model itself assimilates wind data or not.

Introduction is lengthy, 2nd paragraph on page 1 and 1st on page 3 could be shortened.
References [2] and [3] devoted to rigorous dust simulation on the Middle East are missing in the manuscript.

Not clear why authors used complex (MADE/SORGAM) aerosol scheme to simulate dust? Is there any justification for it? However, here [1] you may find some useful details on how to simulate dust in WRF-Chem using modal aerosol scheme.

**Specific comments and technical corrections:**


Line 90: HSRL, HLOS unknown abbreviations.

Line 107: .. seasons of the region. Please specify which region.

Line 130: Natural emissions. Please explain, what do you mean?

Line 170-172: what type of FDDA you used? Not clear, who lateral boundary conditions can be improved by FDDA? If FDDA is enabled in WRF, then model fields (not observations) are nudged to reanalysis fields.

Line 188: remove ; ?

Line 200: height of \((t,V,\text{lat},\text{lon})\) model level, and \(\Delta H\) - width of the \((t,V,\text{lat},\text{lon})\) model level.

Lines 200-201: Please remove in in units.

Formula 1: add \((t,V,\text{lat},\text{lon})\) to PH and PHB
Formula 2: Replace by \( AOD(t, \text{lat}, \text{lon}) = \sum EC55(t, V, \text{lat}, \text{lon}) \times \Delta H(t, V, \text{lat}, \text{lon}) \), where \( \sum \) - sum over \( V \).

Figure 1: Land contours are hardly seen (Fig. A3 same).

Line 301: missing formula for IOA.

Line 317: 14-19th. Please add October.

Figure 5: what os hel1, 4 on plot legend? Please cut top altitude to 5km.

Figure 6: Please replace AERONET-alpha by “Ångström Coefficient”, replace y-axis label by “Ångström Coefficient”

Figure 8: Please replace ‘black boxes’ by ‘black rectangles’.

Figure A1: Please move it to the main text and illustrate all (if possible) geographical locations mentioned in the study. Also plot locations of AERONET stations (remove Fig. 4a, which is empty anyway).

References:

- Osipov et al, Severe atmospheric pollution in the Middle East is attributable to anthropogenic sources
- Parajuli et al, Dust Emission Modeling Using a New High-Resolution Dust Source Function in WRF-Chem With Implications for Air Quality
- Ukhov, A. et al. Assessment of natural and anthropogenic aerosol air pollution in the Middle East using MERRA-2, CAMS data assimilation products, and high-resolution WRF-Chem model simulations