Comments on the manuscript entitled "Convection-Aerosol Interactions in the United Arab Emirates: A Sensitivity Study" by Ricardo Fonseca, et al.

Recommendation: Major Revisions

General comments:

This manuscript 'Convection-Aerosol Interactions in the United Arab Emirates: A Sensitivity Study' mainly investigate the impacts of aerosol loading and properties on the atmospheric circulation, convective activity, surface/air temperature, and local precipitation by Weather Research and Forecasting (model) in UAE on 14 August 2013. The authors carried out ten different scenarios for WRF simulations and compared the different results of circulation, radiative effect, convective, and rainfall. In general, the paper presents in a logical way, but the English writing need to be greatly improved. Some interesting results of this manuscript will be helpful to understanding the interactions between the convection and aerosol. I therefore recommend publication of this paper in A**tmospheric Chemistry and Physics** after major revisions. My comments are listed as follows.

Major Comments:

1. Compared with the previous published papers, what are the main innovations of this manuscript? Please elucidate clearly in the context.

   Many conclusions of this manuscript are consistent with the previous publications. For instance,

   (**Page 1, Abstract, lines 13-15**) 'The convection on 14 August 2013 was triggered by the low-level convergence of the circulation associated with the Arabian Heat Low (AHL) and the daytime sea-breeze circulation.' **This conclusion is the same as the previous publications in** (**Page 3, 1. Introduction, Lines 113-116.**) 'As discussed in Schwitalla et al. (2020) and Branch et al. (2020), it is normally triggered by the convergence of the low-level circulation associated with the Arabian Heat Low (AHL; Fonseca et al., 2021), the sea-breeze circulation from the Arabian Gulf and Sea of Oman, and the upslope flows on the mountains.' (**Page 6, 1. Introduction, Lines 123-124.**) 'Here, they are commonly triggered by the low-level convergence of the AHL and sea-breeze circulations (Steinhoff et al., 2018)'.

(**Page 2, Abstract, lines 31-32 and the Conclusions**) 'The surface downward and upward shortwave and upward longwave radiation fluxes are found to scale linearly with the aerosol loading, ….' **This conclusion is consistent with** (**Page 4, 1. Introduction, Lines 80-84.**) 'Liu et al. (2020) used the WRF model with Chemistry (WRF-Chem; Grell et al., 2005) to investigate the effects of biomass burning aerosol on radiation, clouds and precipitation in the Amazon basin. The authors found that ACI effects prevail at lower emission rates and low values of aerosol optical depth (AOD), while the ARI plays the largest role at high emission rates and high AODs.'

2. (**Page 11, 2.2 WRF Experiments and the whole context**): The authors implemented 10 different scenarios for WRF simulations based on two aerosol distributions (an idealized aerosol distribution profile and a climatological profile) and compared the different impacts of aerosol loading and optical properties on the atmospheric circulation, radiative effect, convective, and rainfall. The authors carried out a lot of simulations for sensitivity experiments and acquired many conclusions, **but it is not clear for the readers, which conclusion is important and which one is close to the observed results for this manuscript**.

For instance, (1) **Page 56, 5. Discussion and Conclusions, Lines 855-856**, 'The best agreement with that observed is obtained when the climatological values multiplied by a factor of 5, in line with the dustier atmosphere during this event'. (2) **Pages 57-58, Lines 879-882**, 'The downward and upward shortwave and the upward longwave radiation fluxes are found to decrease linearly as the as aerosol loading is increased, with a 10-fold increase in the amount of aerosols leading to a daily-averaged drop of the surface net shortwave flux of about 91 Wm^{-2}, and …….'.

(3) **Page 58, Lines 887-889**, 'When 20% of the aerosols are replaced with more absorbing (carbonaceous) particles, the roughly 87 Wm^{-2} decrease in the surface net shortwave radiation flux…when the aerosol loading is augmented by a factor of 10'.

(4) **Page 58, Lines 897-899**, 'The sensitivity to the maritime aerosol model, for which 20% of the rural aerosols are replaced by sea-salt and the larger particles removed, on the other hand, is much reduced.'

Whether the changes of aerosol loading and optical properties in the WRF sensitivity simulations could reflect the true observations or not?

In this manuscript, the authors indicated that 'The 14 August 201 was also a rather dusty day in the UAE, with Aerosol Optical Depths (AODs) in excess of two', and **I suggest the authors should implement the sensitivity of the potential effects of dust aerosols' loadings and optical properties on the circulation, convection, radiative forcing, and precipitation**.

3. In WRF simulations of this manuscript, how to consider the potential influences of environmental field (e.g. wind speed field, air humidity field), and vertical convection on the ARI, ACI, circulation, convection activity, and precipitation, etc?

4. The English written of this whole manuscript need to be greatly improved.

Minor comments:

1. Page 3, lines 58-60: 'Dust has been shown to have an important impact on the climate system, in particular on the atmosphere (e.g. Min et al., 2014; Liu et al., 2019; Francis et al., 2020), ocean (e.g. Evan et al., 2012) and cryosphere (e.g. Francis et al., 2018) dynamics.'

⇒ Please delete all the 'e.g.' in the cited literatures, and modify the other places in the context.

2. When talking about the direct and semi-direct radiative effects of aerosols, the authors could cite other references,

[1] Li Z., Y. Wang, J. Guo, et al. 2019: East Asian study of tropospheric aerosols and their impact on regional clouds, precipitation, and climate (EAST-AIR(CPC)). *Journal of Geophysical Research: Atmospheres*. 124 (23), 13026-13054. DOI: 10.1029/2019JD030758.

[2] Wang W., J. Huang, P. Minnis, et al. 2010: Dusty cloud properties and radiative forcing over dust source and downwind regions derived from A-Train data during the Pacific Dust Experiment. *Journal of Geophysical Research: Atmospheres*. 115 . DOI:10.1029/2010JD014109.