

## Responses to the Community comment

We would like to thank to Dr. Alexander Ukhov, for giving constructive criticisms, which are very helpful in improving the quality of the manuscript. We have made revision based on your critical comments and suggestions. The community comments are reproduced (*black*) along with our replies (*blue*) and changes made to the text (*red*) in the revised manuscript. All the authors have read the revised manuscript and agreed with submission in its revised form.

**Comment NO.1:** *I would advice authors to switch to simple dust\_opt=1 as it is known that the AFWA scheme strongly underestimates dust emissions.*

**Response:** Thank you very much for your advice. As recommended by RC2, to reduce the underestimation of dust emission in AFWA scheme and start from a relatively unbiased simulation, the adjustable dust emission factor is calibrated and selected as 21 based on the AERONET-observed AOT and AE.

In order to investigate the influence of different dust emission schemes on the dust emission during 14-23 March 2021, another experiment named FR-dustopt1 (dust\_opt=1) has been conducted to compare with FR experiment (dust\_opt=3). The accumulated dust emissions in Gobi desert during 14-23 March 2021 are 36.99Tg and 43.00Tg for FR and FR-dustopt1 experiments. In general, the dust emission simulated by GOCART and AFWA dust emission schemes have no significant differences in Gobi desert. Therefore, we still use AFWA dust emission scheme in the revised manuscript.

**Changes in Manuscript:** Please refer the description in the revised manuscript, from Page 5 Line 144 to Page 6 Line 146.

**Comment NO.2:** *Also I could not find which WRF-Chem version has been used. I recommend v 4.1.3 and above.*

**Response:** Done. We have modified the WRF-Chem version from 3.5 in the original manuscript to 4.4 in the revised manuscript.

**Changes in Manuscript:** Please refer the description in the revised manuscript, Page 5 Line 136.

**Comment NO.3:** *Also there is a bug in the calculation of optical properties when GOCART scheme is used, i.e. 5th dust bin is not accounted. Authors are welcome to contact me if it is needed.*

**Response:** Done. We have already fixed the bug in the calculation of optical properties.

The calculation of the dust optical properties is improved with three corrections: (1) remap the fractions of AFWA bin 1 dust in 0.2-2  $\mu\text{m}$  into Mie calculation bins as Ukhov et al. (2021); (2) redistribute fractions of the dust mass based on the assumption that bin concentration is a function of natural logarithm radius as Ukhov et al. (2021); (3) increase the 8 dust size bins in Mie subroutine to 9 as 0.039-0.078, 0.078-0.156, 0.156-0.312, 0.312-0.625, 0.625-1.25, 1.25-2.5, 2.5-5.0, 5.0-10.0  $\mu\text{m}$ , and 10-20  $\mu\text{m}$  to distribute the AFWA bin 5 dust in 12-20  $\mu\text{m}$  into bins for Mie calculation.

Reference:

Ukhov, A., Ahmadov, R., Grell, G., & Stenchikov, G. Improving dust simulations in WRF-Chem v4.1.3 coupled with the GOCART aerosol module. *Geosci. Model Dev.*, 2021.

**Changes in Manuscript:** Please refer the description in the revised manuscript, from Page 5 L147 to Page 6 L155.