

Abstract

Severe dust storms e.g., the one in March 2020 over East Asia, present great threats to the environment, property and human health over the areas in the downwind of arid regions. Several dynamical dust models have been developed to predict the dust concentrations in the atmosphere. Currently, the accuracy of these models is limited mainly due to the imperfect modeling of dust emissions. Along with the progress in the dust and aerosol modeling, the advances in remote sensing have made large-scale aerosol measurements feasible. The rich measurements provide opportunities to estimate uncertain emission fields, and subsequently, to improve the forecast/simulation skills.

Data and method

Data assimilation algorithm:

The dust emission inversion was carried out using the 4DVar data assimilation method, which is based on minimization the cost function:

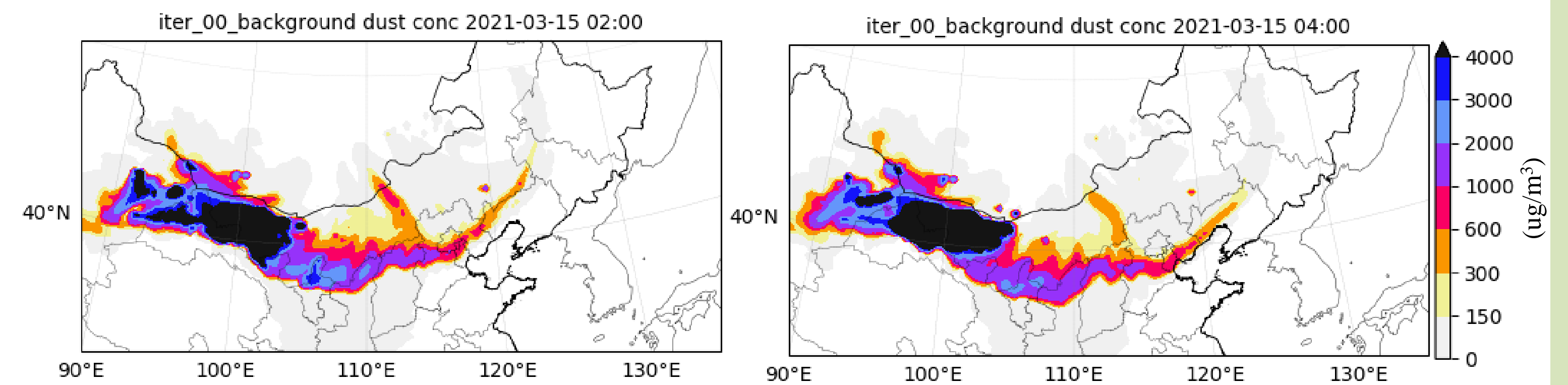
$$\mathcal{J}(x_0) = \frac{1}{2}(x_0 - x_0^b)^T \mathbf{B}^{-1} (x_0 - x_0^b) + \frac{1}{2} \sum_{i=1}^k (y_i - \mathcal{H}_i(x_i))^T \mathbf{R}_i^{-1} (y_i - \mathcal{H}_i(x_i))$$

Observations and Model

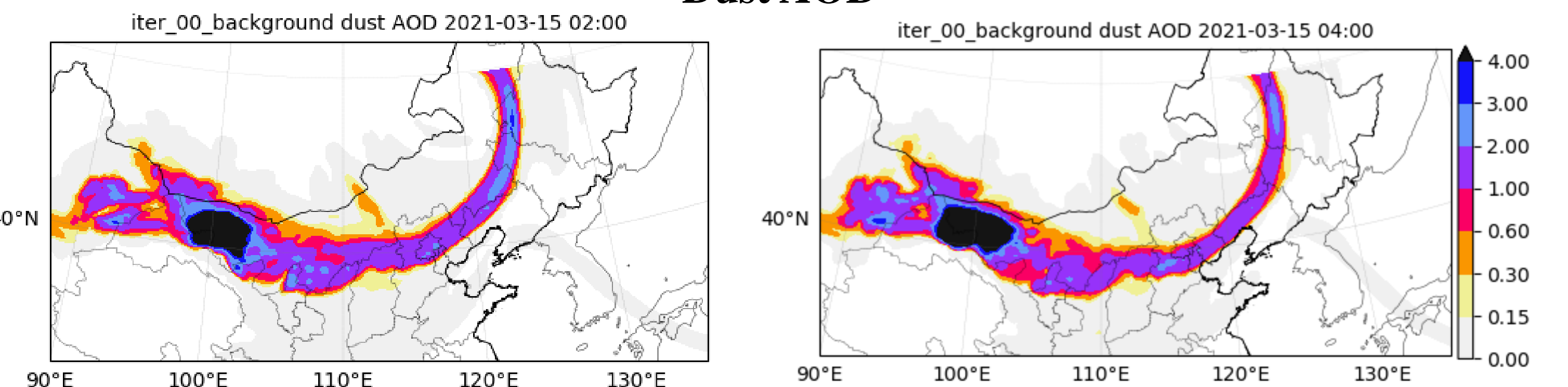
Both remote sensing and ground-based observation are assimilated for estimating the dust emission for the dust event in March 2020.

Lotos-Euros simulation

Surface dust concentration

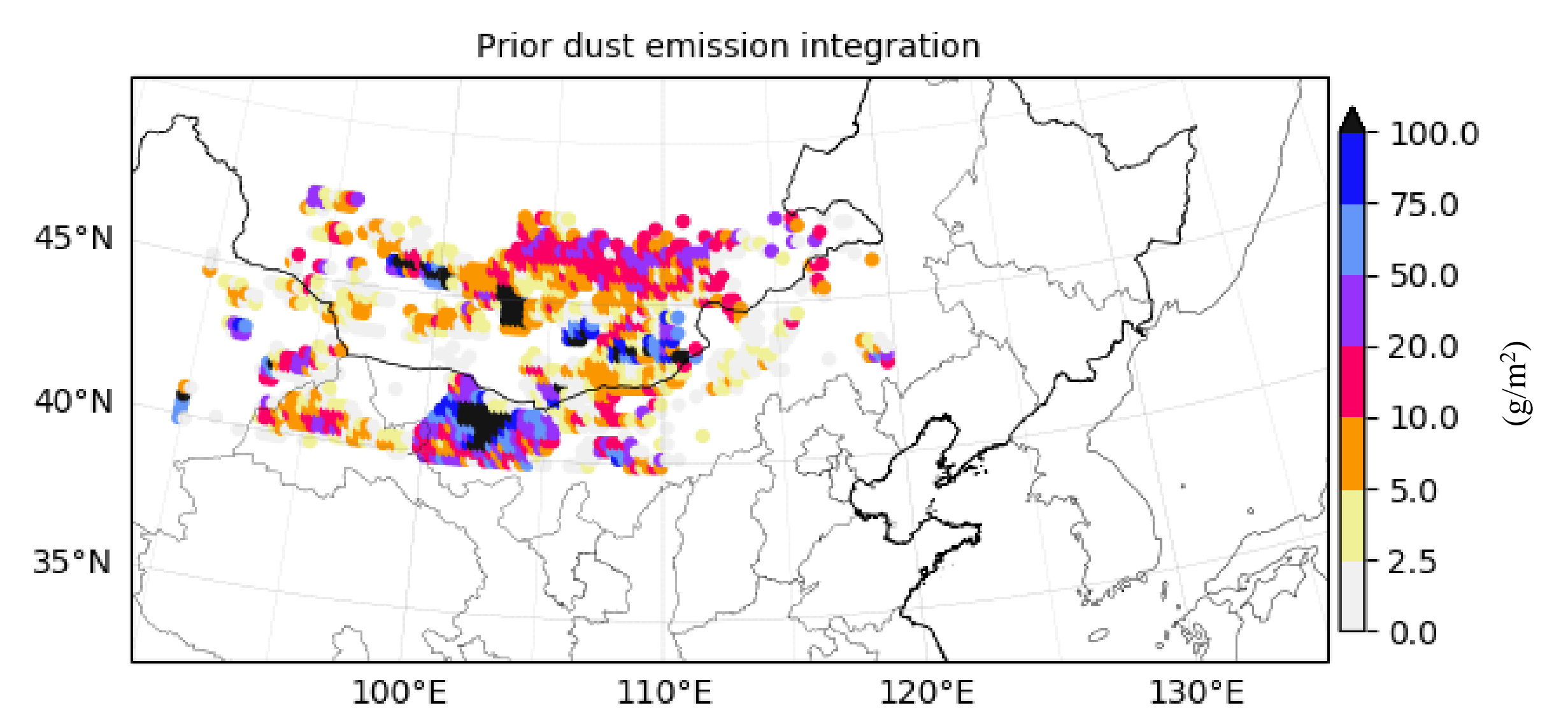


Dust AOD

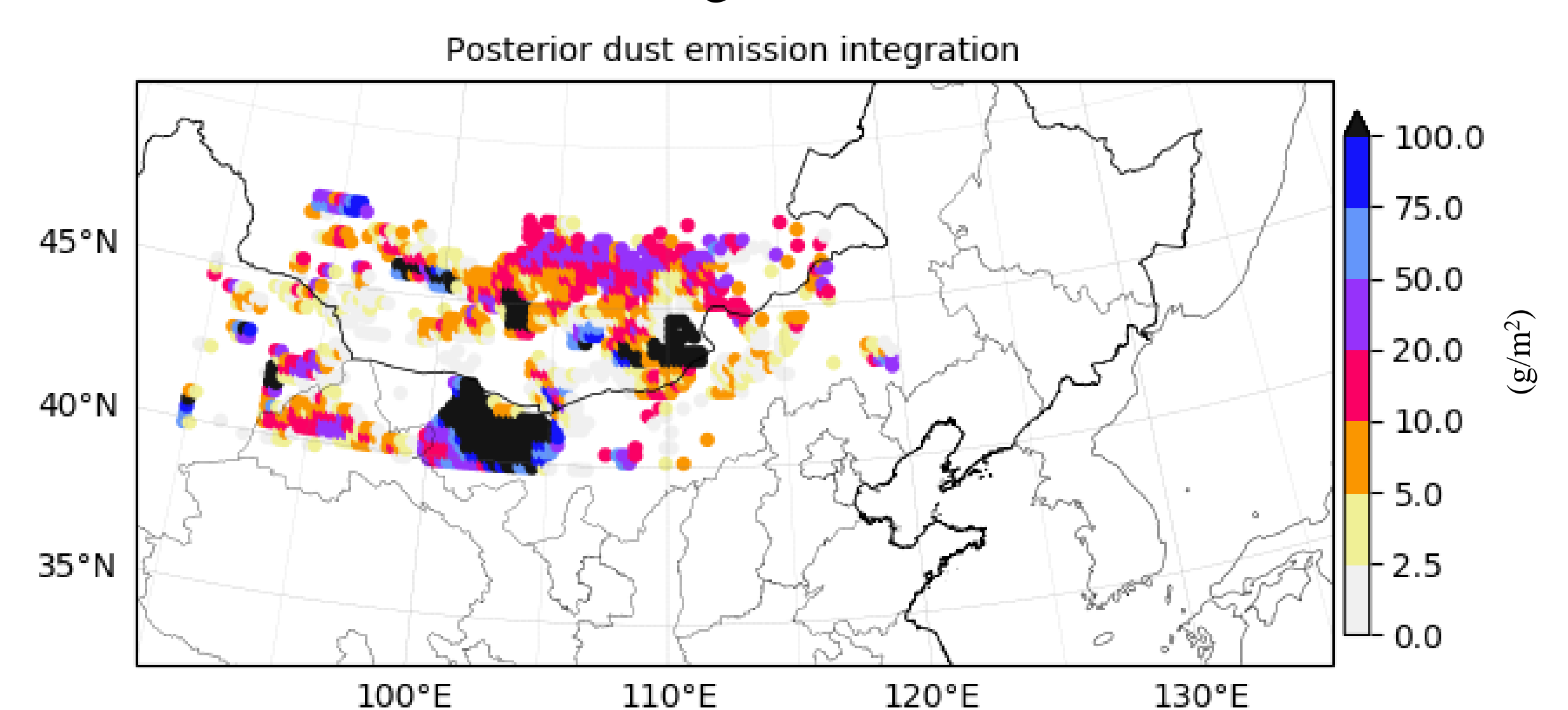


Result

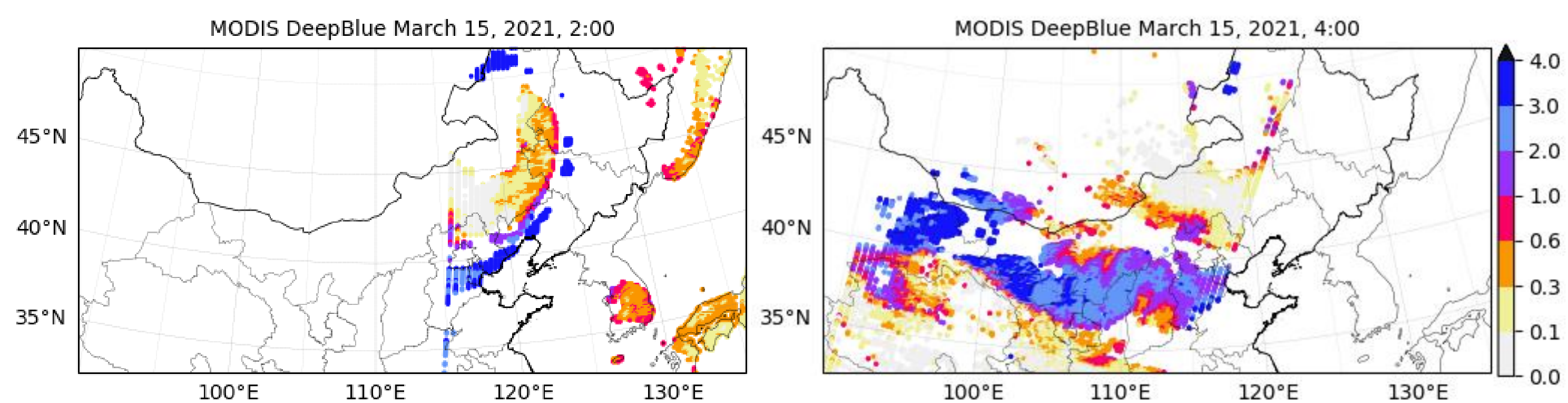
The prior dust emission integration



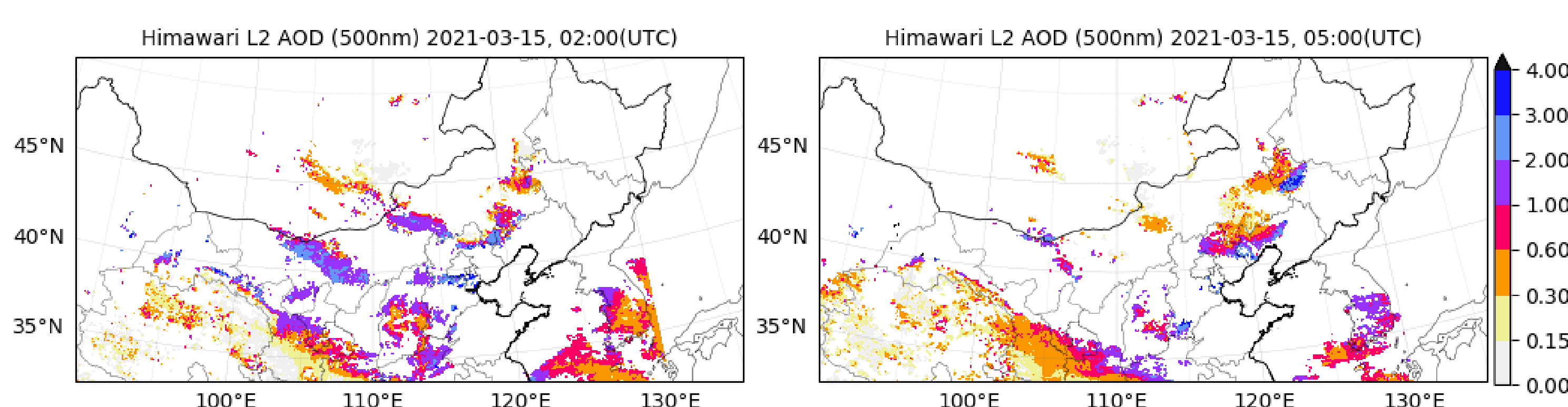
The posterior dust emission integration by assimilation MODIS, Himawari-8 AOD and ground PM10 concentration



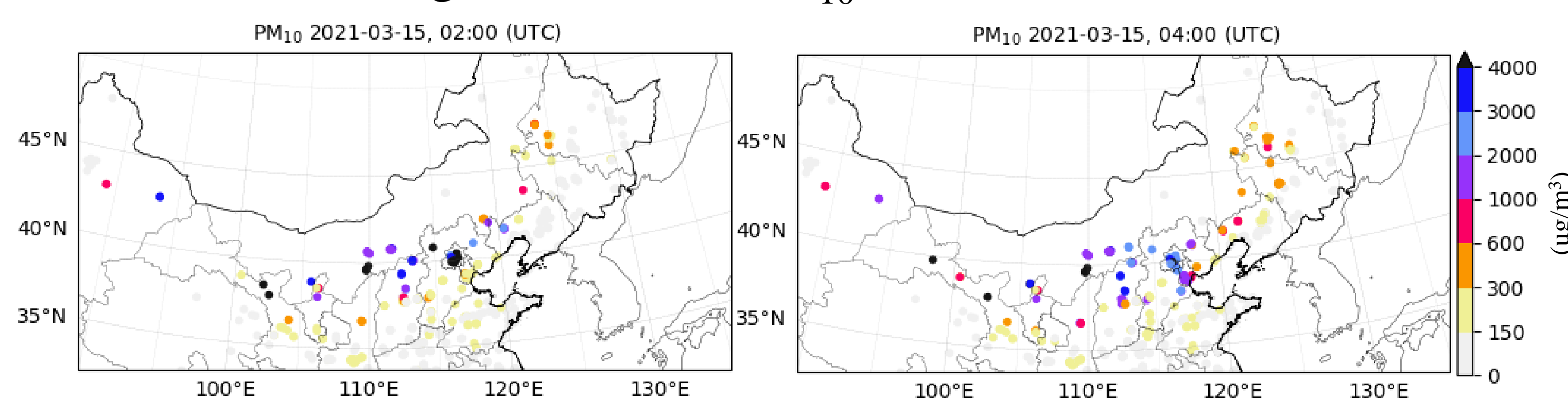
MODIS DeepBlue AOD



Himawari-8 L3 AOD



ground based PM₁₀ concentration



Conclusions

- Multiple data including the MODIS, Himawari-8 AODs as well as the ground PM₁₀ observation are used in the dust emission inversion.
- Desert over Mongolia contributed most of the dust during this event.



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References

- Jianbing Jin*, Arjo Segers, Hong Liao*, Arnold Heemink, Richard Kranenburg, and Hai Xiang Lin. Source backtracking for dust storm emission inversion using an adjoint method: case study of Northeast China. *Atmospheric Chemistry and Physics*, 2020, 20, 15207-15225.
- Jianbing Jin*, Hai Xiang Lin, Arjo Segers, Yu Xie, Arnold Heemink. Machine learning for observation bias correction with application to dust storm data assimilation. *Atmospheric Chemistry and Physics*, 2019, 19(15): 10009-10026.
- Jianbing Jin*, Arjo Segers, Hong Liao*. Position correction in dust storm forecast using LOTOS-EUROS v2.1: grid distorted data assimilation v1.0. *Geoscientific Model Development Discussion*, 2021, 1-25.