

Interactive comment on “Source backtracking for dust storm emission inversion using adjoint method: case study of northeast China” by Jianbing Jin et al.

Anonymous Referee #3

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Research article review: acp-2020-435 “Source backtracking for dust storm inversion using adjoint method: case study of northeast China”

The manuscript proves very important issue related to missing sources in numerical atmospheric-dust models, which directly, due to the very high sensitivity of models to input dust source information, impact dust forecast quality. Horqin desert is in some literature recognized as a potential source area, but this information (as many other sources) is not included in many numerical atmospheric-dust forecast models. In Ginoux et al. (2012) and the report “Global Assessment of Sand and Dust Storms” (2016) this area is mentioned, but in terms of anthropogenic-dust sources. Horqin desert is

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named as “Horqin sandy land”. Sandy soils are not efficient dust emissive areas because of the relatively coarse soil texture, but in the reference is stated that this area contains anthropogenic dust sources. In the same reference the mean number of days with dust ($M\text{-}DB2\ DOD > 0.2$, for 2002-2009) for this region is relatively low (compared with emission frequency from major global sources) and appears in March-May and September-November seasons. Also, anthropogenic impact on increasing source activity could be increasing in recent years. Since this manuscript proves significant emission originate from Horqin area, it proves the need for update of dust source information in models, or specific model used in the manuscript (LOTOS-EUROS).

This referee suggests that manuscript should be published after minor revision, as suggested below. It includes contribution for better understanding of east Asia dust source regions, usually underestimated in dust forecast models. The authors present alternative way to explore new dust source areas from airborne dust observation.

As the authors adopted suggested corrections by this referee in first cycle of review (before public discussion), only few more following suggestions are required from the authors to consider:

• General comment:

The authors need to explore published papers on dust sources and dust modeling that cover domain of northeast China, and include related findings – to emphasize the significance of the work presented in this manuscript and the necessity of upgrading dust source information in numerical models in order to reduce dust forecast uncertainties in this area. Few suggestions for such references are listed below.

Some of the references that recognized dust emission activity in this region are:

UNEP, WMO, UNCCD: Global Assessment of Sand and Dust Storms, United Nations Environment Programme, 2016., which includes already discussed: Ginoux, P., Prospero, M.J. Gill, T.E., Hsu, C. and Zhao, M.: Global scale attribution of anthropogenic

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and natural dust sources and their emission rates based on MODIS Deep Blue aerosol products. *Reviews of Geophysics*, 50, RG3005, doi: 10.1029/2012RG000388, 2012., and DTF: Integrated Desert Terrain Forecasting for Military Operations, Earth and Ecosystem Sciences, 2013.

Reference about need for updating dust source masks in numerical dust forecast model: Kim, D., M. Chin, H. Bian, Q. Tan, M. E. Brown, T. Zheng, R. You, T. Diehl, P. Ginoux, and T. Kucsera, The effect of the dynamic surface bareness on dust source function, emission, and distribution, *J. Geophys. Res.*, 118, doi: 10.1029/2012JD017907, 2013.

Reference that describe dust model simulation for this region, but with special intervention to include Horquin source: Zhang, DF, et al., Effects of climate changes on dust aerosol over East Asia from RegCM3, *Advances in Climate Change Research*, Volume 7, Issue 3, pp. 145-153, <https://doi.org/10.1016/j.accre.2016.07.001>

etc.

â€” Technical comments:

Page 7, line 21:

Rephrase the sentence: “Note that the dust emission model computes hourly emissions per grid cell, which may vary strongly from hour to hour.” to “Note that the dust emission model output data are on every hour per grid cell, and results may vary strongly from hour to hour. Also, dust concentration extremes that last less than one hour, can be missed in model output data. ”

explanation (if I have understood well meaning of these data in the manuscript): numerical dust atmospheric model can calculate in time steps much lesser than one hour (depending on spatial resolution and setup of model for physics time steps), but model output data are what matters in presenting forecast and perform model verification. As is understood from the text, this sentence refers to the frequency of model output data.

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Page 17, line 22-23:

At the end of paragraph, add the comment with reference (it considers the detection of high latitude sources): These emissions may originate from high-latitude sources, as one discussed in Bullard et al. (2016). (or rephrase it as you wish)

Bullard, J. E. et al. High-latitude dust in the Earth system. *Rev. Geophys.* 54, 447–485, 2016.

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