

## ***Interactive comment on “Simulation of radon-222 with the GEOS-Chem global model: Emissions, seasonality, and convective transport” by Bo Zhang et al.***

### **Anonymous Referee #1**

Received and published: 2 September 2020

#### General Comments:

The sensitivity of Rn-222 to emission data sets is examined using GEOS-Chem driven by meteorological fields from two sources.

This manuscript would be stronger and of more scientific significance if it used MERRA-2 meteorological fields, which have been available for several years, and if the simulations were performed at  $1 \times 1.25^\circ$ , which has become the standard resolution for global simulations.

The phrase “excessive Asian emissions” is confusing. It could be misinterpreted as indicating that model emissions are too high over Asia. Please go through manuscript

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and rephrase as necessary.

Perhaps a Table could be added that concisely summarizes differences between the 4 emission scenarios. It's tedious reading through 4 pages describing the different emission scenarios

You correctly point out the deficiencies of using a simplistic emission inventory but you should also mention that there are benefits for using a simplistic emission inventory. For example, Rn-222 concentrations can be used as an indicator for how recently an air mass encountered land or a quick method of interpreting the effects of changes in the model configuration on convective mixing.

The method used to construct the ZKC inventory is a bit confusing. Does it consist of the SW98 inventory over North America and the ZK11 inventory elsewhere, with the latter multiplied by a factor of 1.2 over China? If yes, say this concisely and include the latitude/longitude range for the factor of 1.2 adjustment. Why is this adjustment applied to China and not southern China? If you want people to use this inventory rather than ZK11 you need to document it better – here.

In general, the figures are of excellent quality and enlightening.

Specific Comments P1 L25 (add lower bound to <70%)

P5 L7-8 Please rephrase awkward sentence that begins with “Due to the availability of”

P6 L19: TPCORE is internal nomenclature; please choose a more descriptive term such as monotonic if appropriate

P7: What is the difference between GEOS-FP and MERRA-2?

P9 L25: What is your rationale for not including these updates?

P10 L7 Define GCi

P12 L4: How many sites are located in the SH?

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P12 L6: What do you mean by the Rn-222 observations were made in consecutive years. Is this true of all 51 sites? Do you mean at least 2 years of consecutive data are available at each site?

P12: Any thoughts on why Rn-222 profile data sets are scarce given the proliferation of other profile data sets?

P13: Would make for a more interesting read if “significantly”, “substantially”, and “remarkably” were quantified.

P16 L2: Why would the annual means be less representative? Were they obtained from only a portion of the year?

P19 L1-4: This is a bit confusing. Increasing the scaling factor over China from 1.2 to a higher value would lead to a better agreement between simulated and observed deposition fluxes over Asia (Figure 7c). However, this would also lead to an overestimate of deposition fluxes in the Northern Hemisphere. Please explain more clearly and/or reference the latter result.

P21 L3: Please quantify the model high-bias.

P25 L1: Are profiles of any more widely sampled trace gases useful for evaluating the convective detrainment level? I worry that some of the issue is with the observed profiles.

P30L15: Why would re-mapping have a greater impact on GEOS-FP than MERRA?

Figure 7b – be sure to indicate in caption that these are annual mean values of deposition fluxes. Also, be clear as to what each symbol shows and how many total there are. Is it 9 x 5?

Figure 8: Be clear that you are comparing an observed climatology from various years to a simulation of 2013. Are standard deviations of monthly means available at any of the sites? If yes, consider adding them.

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Figure 12a. How much trust should we put into the observed profile based on multiple sites. How many of the profiles extended into the upper troposphere and were those from a small subset of the total locations?

Figure 13. When examining the effects of convection on trace gas profiles, it seems odd to show annual mean plots. Perhaps you should just show the summer hemisphere.

Figure 14. Please relabel this plot. The percent contribution cannot be zero. Perhaps call it the Percent Change in annual zonal mean 222-Rn due to convection

Technical Comments

P3 L10 shaping 222Rn → shaping its

P3 L21 (remove period at end of line)

P3 L24 degree of discrepancies → discrepancies

P6 L3: apparent changes → changes

P7 L9: considerable → a considerable

P11 L5 further low latitudes → low latitudes

P11 L15: “changes are possible depending on the availability of measurements in these areas “ → changes are possible when measurements become available in these areas

P15L23: Replace excessive with large

P16 L19 Consider replacing “tentative” with “provisional”

P17 L11 three times at → three times higher at

P29 L22 & L24: Replace excessive with very large

Figure 13: Replace GESO with GEOS.

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P45 L8 : range with → range within

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Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2020-804>, 2020.

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