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# ***Interactive comment on* “Evaluation of observed and modelled aerosol lifetimes using radioactive tracers of opportunity and an ensemble of 19 global models” by N. I. Kristiansen et al.**

**Anonymous Referee #1**

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Here, the authors have exploited the release of radioactive isotopes ( $^{137}\text{Cs}$ ,  $^{133}\text{Xe}$ ) during the Fukushima Dai-ichi nuclear power plant accident to constrain modelled aerosol lifetimes in 19 global models. The paper suggests that the majority of models underestimate aerosol lifetimes compared to observations. Deviations between modelled and observed lifetimes are greatest in the Arctic. Comparison of the modelled and observed passive tracer ( $^{133}\text{Xe}$ ) indicate errors in simulated transport mechanisms. However, results from the aerosol tracer  $^{137}\text{Cs}$  indicate that the pervasive low bias in Arctic (and global) aerosol (within the majority of models) is driven by too fast removal in the PBL and free troposphere. This study provides a novel method for eval-

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uating global models and I recommend publication after the authors address the minor comments detailed below:

Page 24516, line 11: '...also contribute to the Arctic aerosol underestimates'

Underestimate or underestimates is a verb used here as a noun. Please correct by replacing with 'low bias' or re-structuring the final sentence.

Page 24516, line 20:

Do the authors really need to abbreviate accumulation mode to AM? If it is necessary, AccM might be better as Aitken mode also begins with A (capital). In general I'm unsure why accumulation mode needs to be abbreviated, ACP has no word limit.

Page 24516, line 25:

Please add citation.

Page 24517, line 24-25: 'Compared to aircraft measurements models seem to overestimate aerosol concentrations in the middle and upper troposphere. Thus, a short lifetime appears necessary to reproduce such observations.'

It is unclear what this statement is in reference to (please cite). To my knowledge AE-ROCOM has shown a general overestimation of BC mass in the upper troposphere. BC lifetime is not analogous to accumulation sulphate due to the aging step implemented in most model and the size partitioning of primary emissions. (see below)

Page 24518, line 24:

As discussed above, I'm unsure why it is necessary to introduce another abbreviation (FD-NPP) shortening to Fukushima seems sufficient.

Page 24519, lines 3-4: 'They further explained that elemental carbon or BC were not likely the transport carriers. ...'

Change to: They further explained that elemental carbon (EC) or black carbon (BC)

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Interactive Discussion

Discussion Paper



particles were unlikely to be transport carriers

Page 24519, line 20: 'Cesium from FD-NPP'

Was the Cesium (and Xenon) isotope emitted only from Fukushima? Both were released in large quantities but the text includes no explicit discussion of the uniqueness of the emission. If alternative sources exist how would this effect the results?

Page 24519, line 29:

'fact' not facts

Figure 2:

To aid understanding of the transport pathways it would be useful to add a fourth (and possibly fifth) column showing the distribution in the first week of emission (2-5 days). Please also consider showing the full latitudinal range (90S to 90N) or using a NH satellite projection centered at the pole. Finally, rainbow color bars are inaccessible to the color-blind and provide a distorted perception of data (<http://www.climate-lab-book.ac.uk/2014/end-of-the-rainbow/>) please consider converting to a hue saturated scale.

Page 24525, lines 15-19: 'Before day 15, . . .'

As discussed above additional plots in figure 2 would make this easier to follow.

Page 24526, line 8: 'Both measured and mean modelled lifetimes are shorter below 50N suggesting less efficient aerosol removal at high-latitudes. . . . .'

. . . in spring. Please refer to time period. Previous work in the literature suggests results at high-latitude may be different in late summer. It would be useful here to include some discussion of the seasonality of high-latitude aerosol lifetime.

Page 24536, line 8: 'Underestimate near the surface. . .'

Change to 'Underestimate mass near the surface'

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Discussion Paper



Page 24543, line 15: 'BC removal is also dependent on the aging parametrizations, . . .'

The deviation between sulphate and BC lifetimes could also be driven by primary emission size (Reddington et al., 2013- <http://www.atmos-chem-phys.net/13/4917/2013/acp-13-4917-2013.html>). Your results here are in direct contrast to the recommendations of Bond et al.,(2013). Please discuss further.

Page 24545, line 10: 'The underestimations are largest for the aerosols. . .'

Change to: 'The underestimation is largest for aerosol'

Page 24545, line 11-12: 'deviations to the observations.'

Change to: 'deviation from observations'

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Interactive comment on Atmos. Chem. Phys. Discuss., 15, 24513, 2015.

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