

Interactive comment on “Change of the Asian dust source region deduced from the relationship between anthropogenic radionuclides in surface soil and precipitation in Mongolia” by Y. Igarashi et al.

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Reply to the referee comments

To referee No. 1

Scientifically, the revised version of the paper is largely improved in the manner of logical flow. However, I still have several doubts:

1. I am still not convinced that the higher ^{137}Cs , ^{90}Sr activities and $^{137}\text{Cs}/^{90}\text{Sr}$ activity ratio of the Taklimakan dust compared to the Taklimakan soil is simply caused by
C5762

analytical error as listed in Table 1. The analytical error seems very small compared to the difference. Maybe grain size is the answer. The dust has finer grain size composition thus higher ^{137}Cs , ^{90}Sr activities and $^{137}\text{Cs}/^{90}\text{Sr}$ activity ratio. This is probably also the case for the Japanese dust. The higher ^{137}Cs , ^{90}Sr activities and $^{137}\text{Cs}/^{90}\text{Sr}$ activity ratio of the Japanese dust is probably simply caused by the preferential transportation of fine particles from Asian arid continent rather than a mixing between local and Asian dust endmembers.

Ans: As we discuss in the text, we cannot totally reject the grain-size effect on the $^{137}\text{Cs}/^{90}\text{Sr}$ activity ratio in the soil dust. We have begun to analyze the finer sized grains for ^{90}Sr and ^{137}Cs . Although we cannot completely explain the problem at present, we have obtained some data for the fine-grain samples (see Fig. app1). Appendix B was added to the text to address this topic. The fine-grain-sized fraction, which corresponds to the clay–silt-size range ($1\ \mu\text{m}$; modal diameter: several microns), is being obtained by using pneumatic separation with cyclone separators. The silt fraction ($10\ \mu\text{m}$; modal diameter: a few tens of microns) is also being obtained at the same time. Although the number of samples is currently limited to 6, the results of our analyses of the clay–silt-sized samples are similar to those obtained for the $53\text{-}\mu\text{m}$ fraction.

2. I cannot see clear shift in compositions of anthropogenic nuclides between the 1990s dust and 2000s dust based monthly deposit as the author claimed that the 2000s' dust have Asian dust source endmember with higher ^{137}Cs activity. There is just 3 events have significant higher ^{137}Cs activity out of the dozen samples. Could this be captured by chance?

Ans.: We have added a figure (Fig. 5) showing the frequency distribution of the $^{137}\text{Cs}/^{90}\text{Sr}$ activity ratio in the spring atmospheric depositions in the 1990s and the depositions in the 2000s. The difference between the averages of the two groups is statistically significant.

3. It is hard to believe that the wet dust events have significant contribution from local sources similar to the dry deposition based on the two endmember interpretation since the Asian dust source is expected to dominant during the dust event and local emission should be suppressed in wet condition.

Ans: In response to the reviewer's concern we added the following passage to the text (End of page 9 to first of page 10): Local dust can be raised into the air by small-scale swirls or gusts, which occur when cold fronts are passing. Frontal systems are composed of several sub-scale fronts and precipitation is not homogeneous but patchy. Because agricultural activities occur during the spring in Japan, the conditions in the fields in the Kanto area, where Tsukuba is located, favor soil particle suspension (the fields are bare plowed surfaces). Especially during the early stage of a rain event, local dust could be sampled along with the rain. The interpretation of the deposition is thereby more complicated. Hayasaki et al. (2011) showed a typical example of this type of situation.

4. As the ^{137}Cs and ^{90}Sr have half-lives of about 30 years, should the samples analysed in different time be calibrated when making comparison between each other? The error induced by the decay would not be very large during a course of decade or so but still may be significant. I cannot judge from the manuscript if all the samples are analysed in the same year and how would this effect the interpretation.

Ans: Thank you for this very helpful comment. We have decay-corrected the data to the time of sampling (fall 2007) and revised the relevant figures and tables. A duration of 10 years after the analysis brings the data disparity to about 20%, and this increases to 30% with an interval of 15 years. The maximum difference of 25–30% in some of the present data was comparable with the maximum analytical error in monthly ^{137}Cs deposition data. The decay-correction broke the perfect accordance of the slope of the ^{137}Cs – $^{137}\text{Cs}/^{90}\text{Sr}$ correlation between Taklimakan and Mongolian soils, but these changes do not alter our discussion or conclusions (see the revised Fig. 4).

C5764

The writing of the revised version of the paper is largely improved in a more concise manner, especially for the part before the section 3.2 where intensive comments were made in my first review. However the section 3.2 and 3.3 may still need polishing as pointed out below as well as other minor points.

Ans: The 2nd revised version of the manuscript has also been reviewed, and edited where necessary, by two native speakers of English.

Page 2844 Line 15. Reaching conclusion before analysing? Suggest change 'should be' ! 'maybe'.

Ans: The expression was revised as "are supposed to be."

Page 2846 Line 6. Leading to misunderstanding, climate change in a fixed source region or changing source region with different climate condition.

Ans: This passage was deleted.

Page 2851 Line 1-13, change the past tense of the verb to the present tense when necessary to describe the characteristics of the nature.

Ans: The corresponding part was revised as suggested.

Line 1. Delete 'significant'.

Ans: The sentence was revised to "statistically significant" to be more precise.

Line 23-26. Delete 'This linear curve : : : : :in the region'. It is quite obvious that ^{137}Cs and $^{137}\text{Cs}/^{90}\text{Sr}$ activity ratio should correlate to each other since they are both controlled by precipitation as pointed out in line 20-23.

Ans: We did not make the suggested change, because we think this is not duplication but introduces the possible involvement of factors other than precipitation.

Line 26. Delete 'in Fig. 4'.

Ans: We made the suggested deletion.

C5765

Line 26-27 and line 1-5 of page 2852. ! 'The Taklimakan soil samples also exhibit a linear correlation between ^{137}Cs activity and $^{137}\text{Cs}/^{90}\text{Sr}$ activity ratio with similar slope to that of the Mongolian soil but higher intercept. Although the higher intercept of the Taklimakan soil is not fully understood, the similar slope of the ^{137}Cs - $^{137}\text{Cs}/^{90}\text{Sr}$ correlation between Taklimakan and Mongolia soil imply that the soil in the wide arid and semiarid areas of North China, Inner Mongolia and Mongolia may exert the same ^{137}Cs - $^{137}\text{Cs}/^{90}\text{Sr}$ correlation as to that of the Taklimakan and Mongolia soil.

Ans: We revised this passage mainly along the lines suggested by the reviewer, but we used "will show" instead of "may exert" because we did not feel the use of "may exert" is appropriate (middle of page 9).

Page 2852. Line 6. 'The Taklimakan dust showed a higher $^{137}\text{Cs}/^{90}\text{Sr}$ ratio (4.0_1.0), possibly because of the relatively large error' ! 'The Taklimakan dust showed a higher $^{137}\text{Cs}/^{90}\text{Sr}$ activity ratio (4.0_1.0) than the local soil, possibly because of the relatively large analytical(?) error.

Ans: We revised the passage as suggested.

Line 6-7. 'The Tsukuba soil samples compose another group in the upper left corner of Fig. 4.' ;The Tsukuba soil samples are characterized by low ^{137}Cs activity and high $^{137}\text{Cs}/^{90}\text{Sr}$ activity ratio, which is distinctive to that of the Asian continental soil.'

Ans: We revised the passage as suggested.

Line 17-19. Delete 'The atmospheric depositions in the 2000s' spring are created by mixing the Tsukuba and continental soils (likely to be two components from relatively dry and relatively humid zones).'

Ans: We do not agree with this comment, because the referee's concern about the grain-size effect on the $^{137}\text{Cs}/^{90}\text{Sr}$ ratio may not be valid (see Fig. A1). We think our preliminary data on effect of grain size strengthen our argument.

Line 19. Should be four out of the five single precipitation events during spring 2007
C5766

exhibited relatively high ^{137}Cs specific activity? See the Fig. 4.

Ans: "Three out of the four single precipitation events during spring 2007" is correct. One monthly deposition was mistaken as a single precipitation event; a clearer legend has been added to the figure.

Line 21. 'could be interpreted to mean' ! 'could reflect'

Ans: The suggested change was made.

Line 24. What's the 'nature'?

We replaced "nature" with "characteristics."

Page 2853 Line 2. 'in which' ! 'when'

Ans: The suggested change was made.

Page 2854 Line 1. I doubt there are particles up to several hundred micrometres in the dust deposition.

Ans: In fact, there are particles that large strong winds uplift even gravel into the air. Our total deposition includes both dry and wet depositions, and local dust events can bring particles of this size into the samples.

Line 26. 'to the additional sources' ;the adjacent source regions'?

Ans: The suggested change was made.

Page 2857 Line 2-3. Delete 'for which conventional isotope tracers would be of no use.' Conventional isotope tracers still could stand if different climatic zone is coincidentally matches the eologic zone.

Ans: We revised the sentence to "for which conventional isotope traces were of almost no use."

Line 15. The appendix has not been mentioned in any place of the main text. It is

not relevant to the major argument of this paper. So, I would suggest to delete the appendix.

Ans: Considering the public response also to the radioactivity emitted by the crisis at the Fukushima facility, we cannot avoid mentioning the negligible effect of radioactivity contained in Asian dust. We added a couple of sentences to the Introduction to connect the main text and Appendix A. Appendix B is also cited in the main text.

Reference Hayasaki, M. et al., Asian dust transport to Kanto by flow around Japan's central mountains, SOLA, 7A, 032–035, doi:10.2151/sola.7A-009 (2011)

Please also note the supplement to this comment:

<http://www.atmos-chem-phys-discuss.net/11/C5762/2011/acpd-11-C5762-2011-supplement.pdf>

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 2843, 2011.