

Note that reviewers' questions are in **black**, our response is in **blue**, and the changes made is in **red**.

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Ref: No.: acp-2022-282

Title: Detection of Stratospheric Air Intrusion Events From Ground-based High-resolution  $^{10}\text{Be}/^7\text{Be}$  by Accelerator Mass Spectrometry

Journal: Atmospheric Chemistry and Physics

**We thank Professor Guan for his comments on our paper, and it is an honor to receive your attention to our work. We reply to your questions one by one as follows:**

Q1: The description of how accelerator mass spectrometry measures  $^7\text{Be}$  is not detailed enough.  $^7\text{Be}$  does not have a standard sample, how to measure it, and how to calculate it, it is not clear.

A1: The measurement of  $^7\text{Be}$ -AMS mainly adopts the method we used in 2017 (detailed explanation in the Zhang and Fu 2017, doi: 10.1088/1674-1137/41/1/018201). Among them, the correction for  $^7\text{Be}$  is based on  $^{10}\text{Be}$  standard as an internal correction, and then the correction is combined with the gamma spectrum.  $^{10}\text{Be}/^7\text{Be}$  ratio is directly obtained by AMS measurement. In addition, for the measurement process of  $^{10}\text{Be}$ - $^7\text{Be}$ -AMS, combined with the comments of reviewer #1, relevant instructions have been added to the supplementary materials:

#### **Analysis of $^7\text{Be}$ and $^{10}\text{Be}$ by AMS**

First, both were extracted as  $\text{BeO}^-$  particles from the ion source. Next, with the accelerator terminal voltage set at 2.5 MV, beryllium ions are accelerated and the +2 charge state is selected using a high-energy analysis magnet. Stripping efficiency of  $\text{BeO}^- \rightarrow \text{Be}^{2+}$  is approximately 47%. After the stable and rare nuclides were separated by the analysis magnet, the rare nuclides passed through a secondary stripping film (500 nm,  $\text{Si}_3\text{N}_4$ ) are stripped to +4 charge state. The beryllium atoms are completely stripped, that is,  $\text{BeO}^- \rightarrow \text{Be}^{2+} \rightarrow \text{Be}^{4+}$ . Based on the  $\text{Be}^{2+}$  to  $\text{Be}^{4+}$  method we initially established in 2017 (Zhang and Fu, 2017), the stripping efficiency has been improved. The increase in efficiency is based on the carefully adjustments to the quadrupole lens behind the  $65^\circ$  ESA. Based on this, in the  $^{10}\text{Be}$  analysis, the terminal voltage works at

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2.5 MV, the efficiency of  $^{10}\text{Be}^{2+}$  to  $^{10}\text{Be}^{3+}$  is  $\sim 31\%$ , and the efficiency of  $^{10}\text{Be}^{2+}$  to  $^{10}\text{Be}^{4+}$  is  $\sim 24\%$ . Secondary stripping technology effectively eliminates ( $^7\text{Li}$ ) or reduces ( $^{10}\text{B}$ ) interference from the isobar. The  $^{10}\text{Be}/^9\text{Be}$  of the sample is calibrated according to the standard ( $^{10}\text{Be}/^9\text{Be} = 2.709 \cdot 10^{-11}$ ) in Nishiizumi et al. (2007) . The measured energy spectrum is shown in Fig. S3.

Q2: The work in the article involves two regions, two samples, one year of collection and isotopic beryllium analysis. This is not the case in actual work, not every day, and part of the time data is not available and needs to be clearly described.

A2: We thank the reviewer for the comment. The daily resolution here means that the sample sampling period is one day, some of which are continuous every day, and another part of the time is not continuous due to the sampling process such as impact of COVID-19. The continuous distribution of the data can also be seen from the data graph in Figure 1.

Q3: Are suspended particles in rainwater removed prior to analysis? Why the rain sample does not contain the re-suspending dust 0.5h hours after the initiated? Both STE exchange derived and tropospheric generated  $^{10}\text{Be}$  are associated to air particles, not as gas, where the resuspension dust is also particles, which might be also diffused to a few thousands meters height, is there any evident showing that re-suspension particles (dust) can be removed in the first half hour rain precipitation, but not the particles that TSE originated do? Although these issues are mentioned in the manuscript, a clear description will help improve the quality of the manuscript.

A3: Thanks to the reviewer for their attention to the issue of resuspension dust interference. For the rainwater sample collection, the initial rainwater samples is removed (described in 2.1 Sample collection), which can effectively avoid the interference of the resuspended dust on the rainwater sample(Graham et al., 2003). Here, a rainwater sample was used as a control for resuspended dust interference

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correction. Due to the limitation of the random occurrence of the rainfall process, the research of the tracer STE is more based on aerosol samples. stratospheric  $^{10}\text{Be}/^{7}\text{Be}$  ratios much larger than  $^{10}\text{Be}/^{7}\text{Be}$  ratios observed near the surface air. When stratospheric air intrudes, the  $^{10}\text{Be}/^{7}\text{Be}$  ratio in the atmosphere at the earth's surface increases. In addition, the "V" event shown in Figure 3, The "V" event mentioned here refers to the change in the observed aerosol  $^{10}\text{Be}/^{7}\text{Be}$  ratio in the days before, during and after the rain. That is, the  $^{10}\text{Be}/^{7}\text{Be}$  ratio was high in the days before the rain, it decreased significantly during the rain, and the value began to rise again in the days after the rain stopped. This also shows that the interference of resuspended dust is relatively large in the loess area of China, and correction is necessary. In addition to the comments of other reviewers, the description of the second paragraph of Section 3.3 of the manuscript has been revised as follows:

The corrected aerosol  $^{10}\text{Be}/^{7}\text{Be}$  ratios (red line in Fig. 3a) remove abrupt transient changes associated with dust-borne  $^{10}\text{Be}$  (not STE events). This fluctuation is especially apparent at the XA site and is seen as "V"-shaped changes in the uncorrected record (enlarged view of Fig. 3a, which refers to the uncorrected aerosol  $^{10}\text{Be}/^{7}\text{Be}$  ratios change in the days before, during, and after the rain).