

Support information

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

Xu-Ke Liu^{1,2,3,5,#}, Yun-Chong Fu^{1,2,4,#,*}, Li Zhang^{1,2}, George S. Burr¹, Yan-Ting Bi⁵, Guo-Qing Zhao^{1,2}

1. State Key Laboratory of Loess and Quaternary Geology, Institute of Earth Environment, Chinese Academy of Sciences (IEECAS), Xi'an 710061, China

2. Shaanxi Key Laboratory of Accelerator Mass Spectrometry Technology and Application, Xi'an AMS Center of IEECAS, Xi'an 710061, China

3. University of Chinese Academy of Sciences, Beijing 100049, China

4. Institute of Global Environmental Change, Xi'an Jiaotong University, Xi'an 710049, China

5. Xi'an Institute for Innovative Earth Environment Research, Xi'an, 710061, China

#The authors contribution equally to this work and should be considered co-first authors

*Corresponding author: Yun-Chong Fu, E-mail: fuyc@ieecas.cn

1. Supplementary experimental details

Standard solutions and reagents

The standard solutions and reagents used in sample preparation were as follows: 1) ^9Be standard solution (1000 mg/L) from NCS Testing Technology Co. Ltd. 2) Guaranteed reagent (GR): HNO_3 , HCl , $\text{NH}_3\cdot\text{H}_2\text{O}$ and H_2O_2 . The cation exchange resin and anion exchange resin used are Dowex50W \times 8 (H^+) and Dowex1 W \times 8 (Cl^-) produced by Merck Co. Bio-rad 1.0 cm \times 20 cm ion exchange column. 3) Purified water (18.2 $\text{M}\Omega\cdot\text{cm}$, 25 $^\circ\text{C}$) was prepared by a Milli-Q ultrapure water system.

Analysis of ^7Be and ^{10}Be by AMS

First, both were extracted as 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, Si_3N_4) are stripped to +4 charge state. The beryllium atoms are completely

stripped, that is, $\text{BeO}^- \rightarrow \text{Be}^{2+} \rightarrow \text{Be}^{4+}$. Secondary stripping technology effectively eliminates (^7Li) or reduces (^{10}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.

Analysis of ^7Be in aerosols by a high purity germanium detector

Some polypropylene membranes with high aerosol concentrations were selected, and 1/4 of them were analyzed by ^7Be -AMS. The ^7Be in the remaining 3/4 filter membrane (approximately 1500 m^3 sampling volume) were analyzed with a high purity germanium (HpGe) detector (ORTEC: GEM-C5970, software: Gamma Vision 6.08), and analyzed at 477.6 keV by gamma spectrometry at Guangxi University. To obtain sufficient ^7Be counts and ensure that the measurement error was less than 6%, the measurement duration of each sample was 24 hours. The radioactive activity obtained by gamma spectrometry was converted into ^7Be atoms $\cdot \text{m}^{-3}$. Details of the instrument have been reported elsewhere (Guan et al. 2021).

The average ^7Be and ^{10}Be measurement error for small aerosol samples by AMS is less than 1.5% (Tables S2, S3). The measurement cycle of this method for a single sample is approximately 35 minutes, and the accuracy is greatly improved. However, for gamma spectrometry, it is difficult to reach the same precision for ^7Be due to the small sample size (the measurement time of a single sample is more than two weeks).

2. Supporting figures

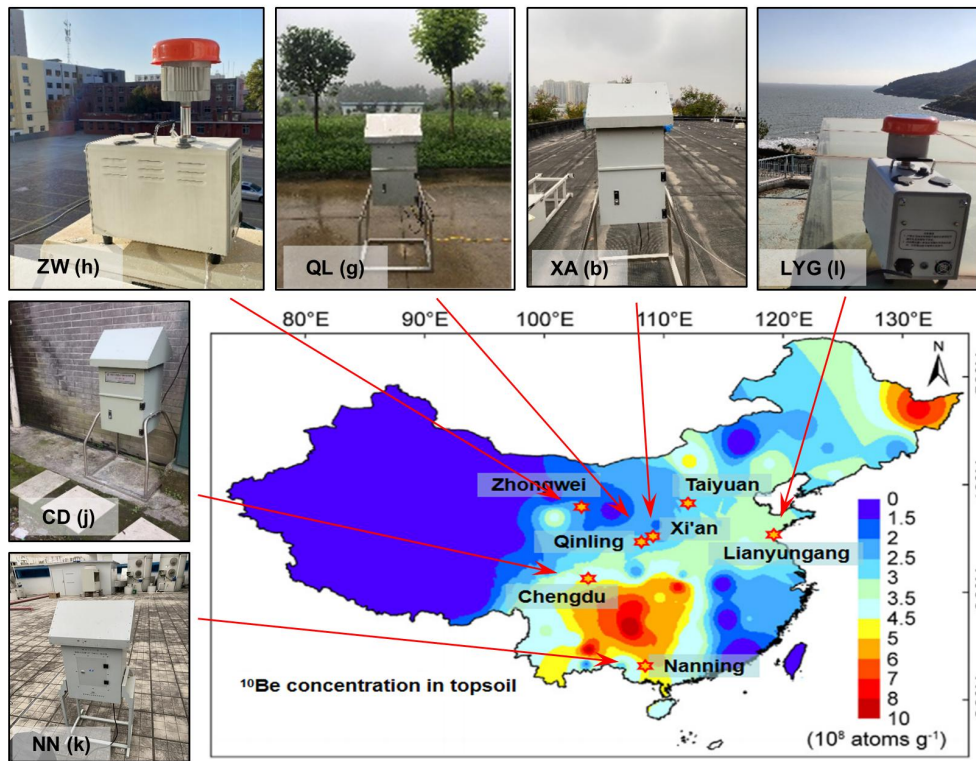


Fig. S1 The surrounding environment of each sampling point and the ^{10}Be concentration in topsoil (topsoil ^{10}Be concentration is from Yi et al. (2019))

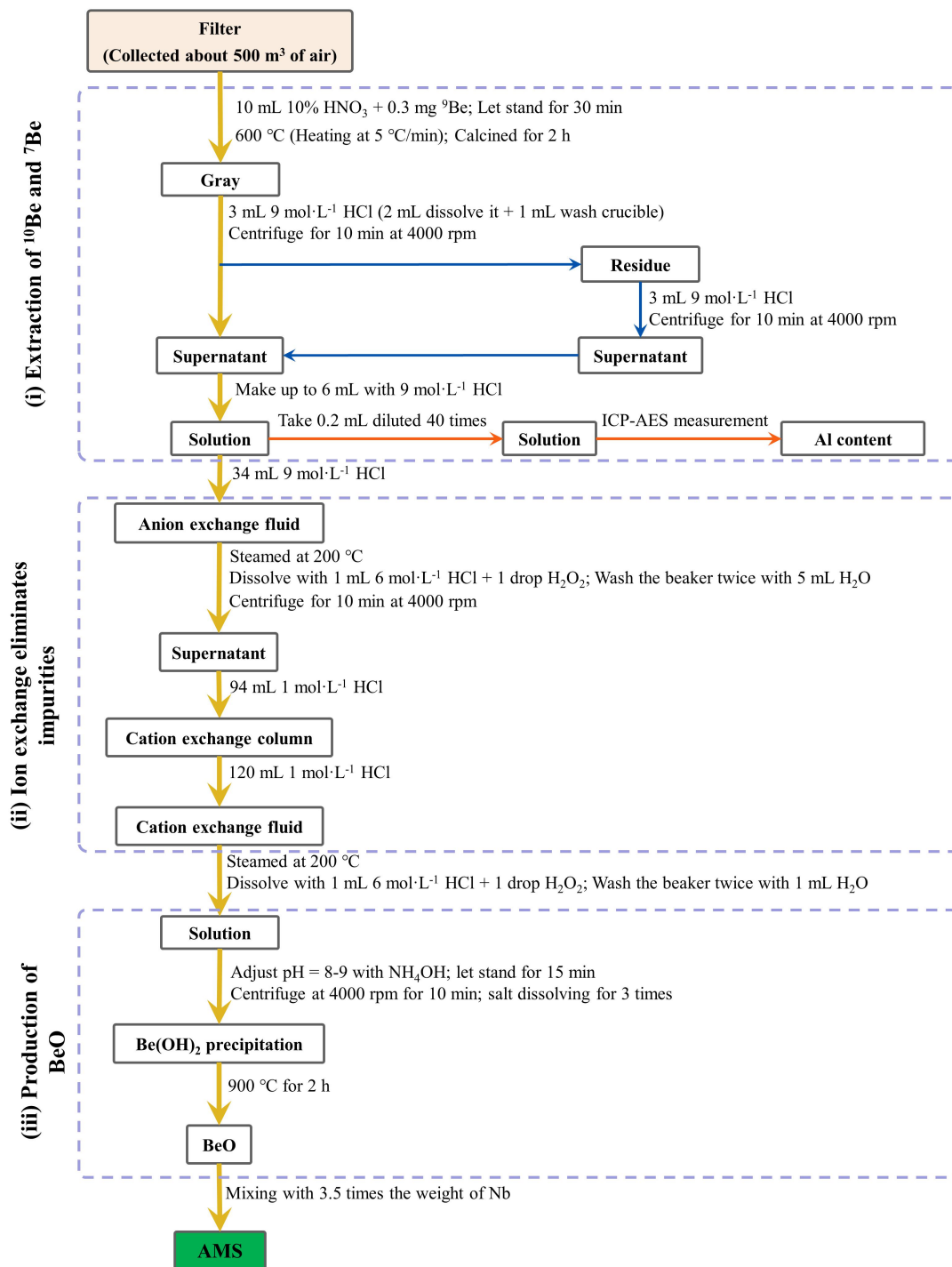


Fig. S2 Chemical extraction scheme for aerosol ^7Be and ^{10}Be .

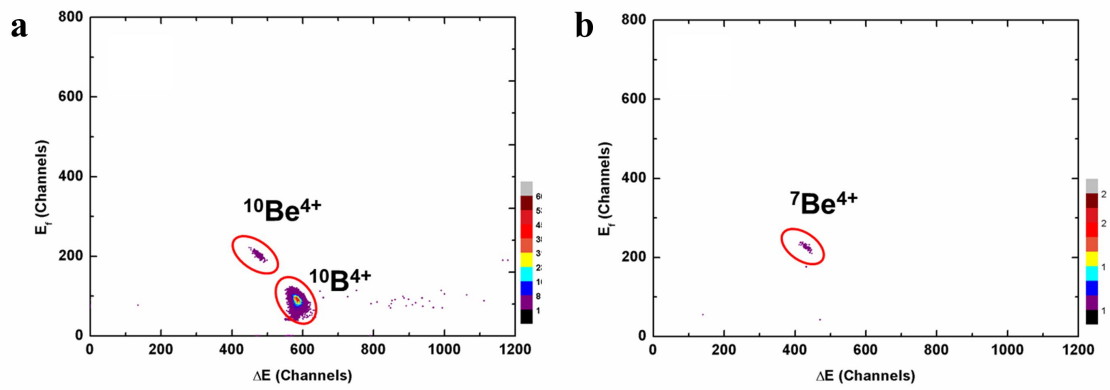


Fig. S3 Spectra of $^{10}\text{Be}^{4+}$ (a) and $^7\text{Be}^{4+}$ (b) in AMS

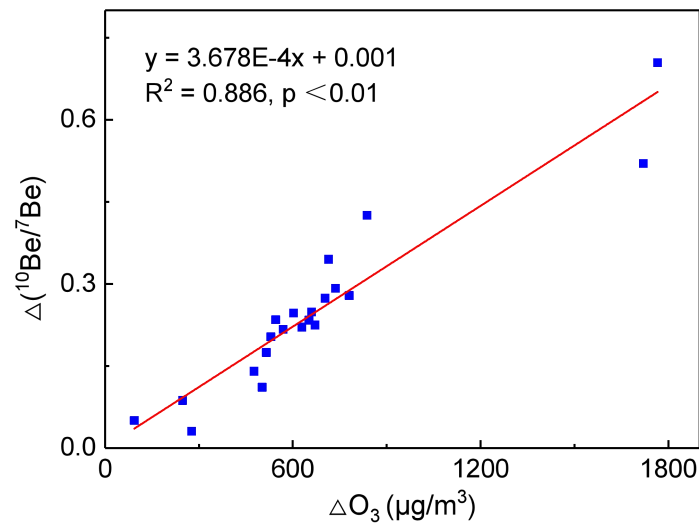


Fig. S4 The ΔO_3 and corrected $\Delta(^{10}\text{Be}/^7\text{Be})$ at the XA site in winter (November-January) show a significant linear positive correlation. The contribution of stratospheric air intrusion to surface O_3 increase (ΔO_3) is estimated by substituting the $\Delta(^{10}\text{Be}/^7\text{Be})$ for the $\Delta^7\text{Be}$. That is to replace surface O_3 during stratospheric air intrusion with recent surface O_3 without stratospheric air intrusion, which obtains the cumulative increase in surface O_3 concentration and $^{10}\text{Be}/^7\text{Be}$ ratio during each stratospheric air intrusion (shaded area in Fig. 5) as ΔO_3 and $\Delta(^{10}\text{Be}/^7\text{Be})$, respectively.

3. Supporting tables

Table S1 Parallel sample measurement results

No.	Sample No.	AMS measurement 1		AMS measurement 2	
		⁷ Be (10000 atoms·m ⁻³)	¹⁰ Be (10000 atoms·m ⁻³)	⁷ Be (10000 atoms·m ⁻³)	¹⁰ Be (10000 atoms·m ⁻³)
1	XA20200507	1.567 ± 0.068	3.127 ± 0.136	1.528 ± 0.063	3.227 ± 0.132
2	XA20200616	1.088 ± 0.053	1.346 ± 0.066	1.038 ± 0.051	1.348 ± 0.067
3	XA20200723	1.322 ± 0.023	4.842 ± 0.086	1.378 ± 0.040	4.818 ± 0.140
4	XA20201109	4.286 ± 0.066	8.920 ± 0.138	4.201 ± 0.192	8.403 ± 0.385
5	XA20201215	5.893 ± 0.074	9.990 ± 0.126	6.023 ± 0.158	10.302 ± 0.270

Table S2 ⁷Be measurement results of the same sample by AMS and gamma spectrometry

No.	Sample No.	gamma spectrometry		AMS	
		Sample volume (m ³)	⁷ Be (10000 atoms·m ⁻³)	Sample volume (m ³)	⁷ Be (10000 atoms·m ⁻³)
1	XA20201202	1565.910	5.024 ± 0.255	521.970	5.083 ± 0.114
2	XA20201203	1597.523	5.952 ± 0.299	532.508	5.945 ± 0.092
3	XA20201206	1604.363	5.222 ± 0.261	534.788	5.418 ± 0.101
4	XA20201208	1610.310	6.809 ± 0.340	536.770	7.062 ± 0.131
5	XA20201209	1611.173	4.791 ± 0.241	537.058	4.802980.104
6	XA20210301	1614.750	7.892 ± 0.299	538.250	7.711 ± 0.108
7	XA20210303	1618.988	4.487 ± 0.166	539.663	4.411 ± 0.074
8	XA20210305	1618.898	4.466 ± 0.166	539.633	4.491 ± 0.075
9	XA20210306	1617.060	4.971 ± 0.186	539.020	4.952 ± 0.075
10	XA20210308	1611.525	6.117 ± 0.232	537.175	6.220 ± 0.087

Table S3. Measurement results of ^7Be and ^{10}Be concentration and $^{10}\text{Be}/^7\text{Be}$ ratio and the quantitative results of dust-borne ^{10}Be in the XA atmosphere

Time	Dry settlement							Wet settlement				
	TSP ($\mu\text{g}\cdot\text{m}^{-3}$)	Al content ($\text{ng}\cdot\text{m}^{-3}$)	^{10}Be ($10^4 \text{ atoms}\cdot\text{m}^{-3}$)	^7Be ($10^4 \text{ atoms}\cdot\text{m}^{-3}$)	$^{10}\text{Be}/^7\text{Be}$	Corr. ^{10}Be ($10^4 \text{ atoms}\cdot\text{m}^{-3}$)	Corr. $^{10}\text{Be}/^7\text{Be}$	Cont. rate (%)	^{10}Be ($10^4 \text{ atoms}\cdot\text{g}^{-1}$)	^7Be ($10^4 \text{ atoms}\cdot\text{g}^{-1}$)	$^{10}\text{Be}/^7\text{Be}$	
May 28,2020	96.712	2611.191	6.666 ± 0.172	1.633 ± 0.042	4.083 ± 0.297	5.257	3.22	21.136				
Jun. 3,2020	141.191	3993.407	9.241 ± 0.09	1.873 ± 0.018	4.933 ± 0.119	6.99	3.731	24.367				
Jun. 5,2020	161.416	3941.733	9.079 ± 0.095	1.899 ± 0.02	4.782 ± 0.123	6.858	3.612	24.467				
Jun. 6,2020	136.656	3173.645	8.484 ± 0.082	1.989 ± 0.019	4.265 ± 0.099	6.695	3.366	21.079				
Jun. 8,2020	49.396	1161.969	3.109 ± 0.037	0.81 ± 0.01	3.837 ± 0.099	2.455	3.029	21.058	7.137 ± 0.291	3.218 ± 0.131	2.218 ± 0.152	
Jun. 10,2020	146.624	1647.341	2.441 ± 0.042	0.597 ± 0.01	4.088 ± 0.156	1.513	2.533	38.038				
Jun. 12,2020	126.490	2318.953	2.833 ± 0.05	0.594 ± 0.01	4.768 ± 0.196	1.526	2.568	46.141	2.616 ± 0.146	1.671 ± 0.094	1.813 ± 0.132	
Jun. 15,2020									1.311 ± 0.148	0.446 ± 0.05	2.941 ± 0.624	
Jun. 16,2020	57.233	72.368	1.199 ± 0.017	0.382 ± 0.006	3.134 ± 0.089	1.158	3.028	3.382				
Jun. 18,2020	119.658	2009.242	8.371 ± 0.101	2.014 ± 0.024	4.156 ± 0.169	7.238	3.594	13.523				
Jun. 24,2020	146.281	3660.676	6.828 ± 0.093	1.611 ± 0.022	4.238 ± 0.294	4.765	2.958	30.203				
Jun. 27,2020	67.328	363.745	2.949 ± 0.049	0.976 ± 0.016	3.023 ± 0.126	2.744	2.813	6.947	3.739 ± 0.128	1.558 ± 0.053	2.399 ± 0.188	
Jun. 28,2020	67.328	363.745	2.949 ± 0.049	0.976 ± 0.016	3.023 ± 0.126	2.744	2.813	6.947				
Jul. 6,2020	98.926	2009.787	7.497 ± 0.09	1.991 ± 0.024	3.766 ± 0.216	6.363	3.196	15.135				
Jul. 10,2020	68.045	989.632	5.688 ± 0.065	1.935 ± 0.022	2.94 ± 0.08	5.131	2.651	9.830				
Jul. 11,2020	28.488	249.839	4.095 ± 0.06	1.32 ± 0.019	3.101 ± 0.105	3.954	2.995	3.418				
Jul. 13,2020									4.081 ± 0.124	1.45 ± 0.044	2.815 ± 0.238	
Jul. 15,2020	78.787	360.164	4.15 ± 0.07	1.434 ± 0.024	2.894 ± 0.177	3.947	2.752	4.907	2.656 ± 0.116	1.008 ± 0.044	2.634 ± 0.249	
Jul. 16,2020	31.156	153.249	2.001 ± 0.031	0.845 ± 0.013	2.367 ± 0.112	1.914	2.265	4.309	2.736 ± 0.127	1.166 ± 0.054	2.347 ± 0.229	
Jul. 18,2020									9.156 ± 0.200	2.826 ± 0.062	3.24 ± 0.196	

Jul. 23,2020	130.507	274.313	4.818 ± 0.14	1.378 ± 0.04	3.497 ± 0.37	4.661	3.383	3.260				
Jul. 24,2020	104.711	325.473	3.997 ± 0.062	1.314 ± 0.02	3.042 ± 0.169	3.814	2.903	4.569	2.845 ± 0.107	1.002 ± 0.038	2.839 ± 0.276	
Jul. 28,2020	268.789	3617.222	4.962 ± 0.078	1.518 ± 0.024	3.269 ± 0.181	2.924	1.926	41.083				
Jul. 30,2020	76.868	1089.573	2.763 ± 0.05	1.204 ± 0.022	2.295 ± 0.147	2.149	1.785	22.222	3.89 ± 0.166	1.857 ± 0.079	2.095 ± 0.239	
Aug. 1,2020									2.146 ± 0.116	1.201 ± 0.064	1.791 ± 0.189	
Aug. 5,2020	135.239	1199.453	1.391 ± 0.043	0.44 ± 0.014	3.158 ± 0.528	0.715	1.623	48.607				
Aug. 7,2020	49.583	67.661	0.322 ± 0.017	0.177 ± 0.01	1.814 ± 0.398	0.283	1.599	11.852	1.864 ± 0.101	1.116 ± 0.061	1.67 ± 0.201	
Aug. 12,2020									1.69 ± 0.085	1.217 ± 0.061	1.389 ± 0.123	
Aug. 13,2020	76.439	1618.996	2.512 ± 0.047	1.001 ± 0.019	2.509 ± 0.124	1.599	1.597	36.349				
Aug. 14,2020									2.366 ± 0.094	1.803 ± 0.072	1.312 ± 0.217	
Aug. 17,2020	30.262	519.703	1.201 ± 0.032	0.594 ± 0.016	2.021 ± 0.145	0.908	1.528	24.394	3.737 ± 0.112	2.33 ± 0.070	1.604 ± 0.177	
Aug. 18,2020	41.291	762.339	3.09 ± 0.061	1.396 ± 0.027	2.213 ± 0.075	2.66	1.906	13.873				
Aug. 19,2020									2.459 ± 0.095	1.739 ± 0.067	1.414 ± 0.084	
Aug. 25,2020	148.336	3490.771	8.021 ± 0.124	4.831 ± 0.075	1.66 ± 0.066	6.053	1.253	24.518				
Aug. 27,2020	178.104	3492.987	7.111 ± 0.104	4.46 ± 0.065	1.594 ± 0.057	5.142	1.153	27.666				
Sep. 4,2020	144.583	4413.142	6.739 ± 0.106	4.36 ± 0.069	1.546 ± 0.056	4.252	0.975	36.934				
Sep. 8,2020	227.078	5039.284	8.339 ± 0.12	6.07 ± 0.087	1.374 ± 0.043	5.499	0.906	34.061				
Sep. 9,2020	72.379	365.432	5.827 ± 0.087	5.91 ± 0.089	0.986 ± 0.027	5.621	0.951	3.550	5.413 ± 0.327	5.343 ± 0.323	1.01 ± 0.04	
Sep. 11,2020	149.916	2717.054	5.967 ± 0.097	4.474 ± 0.073	1.334 ± 0.046	4.436	0.991	25.712				
Sep. 17,2020	95.450	4003.324	7.49 ± 0.107	4.772 ± 0.068	1.57 ± 0.049	5.234	1.097	30.127				
Sep. 20,2020	75.000	528.444	6.005 ± 0.094	5.035 ± 0.079	1.193 ± 0.036	5.707	1.133	5.029	5.242 ± 0.172	4.692 ± 0.154	1.117 ± 0.082	
Sep. 21,2020	52.292	291.249	3.376 ± 0.067	3.517 ± 0.07	0.96 ± 0.033	3.211	0.913	4.896	3.537 ± 0.146	3.753 ± 0.155	0.943 ± 0.156	
Sep. 27,2020	141.640	1002.778	4.379 ± 0.108	3.638 ± 0.09	1.204 ± 0.059	3.814	1.048	12.957				
Oct. 1,2020	54.279	570.276	7.436 ± 0.11	5.096 ± 0.075	1.459 ± 0.044	7.114	1.396	4.318	6.43 ± 0.368	4.708 ± 0.27	1.366 ± 0.232	
Oct. 5,2020	106.165	1253.171	5.551 ± 0.094	3.997 ± 0.068	1.389 ± 0.046	4.845	1.212	12.743	6.748 ± 0.227	4.823 ± 0.163	1.399 ± 0.102	
Oct. 8,2020	153.144	1395.702	3.597 ± 0.071	2.609 ± 0.052	1.379 ± 0.051	2.810	1.077	21.900				

Oct. 10,2020	489.187	2682.434	3.001 ± 0.066	1.437 ± 0.032	2.089 ± 0.094	1.489	1.036	50.407			
Oct. 12,2020	114.283	538.191	4.662 ± 0.084	3.705 ± 0.066	1.258 ± 0.043	4.358	1.176	6.518	6.617 ± 0.197	5.307 ± 0.158	1.247 ± 0.097
Oct. 13,2020	51.889	133.010	3.759 ± 0.077	3.439 ± 0.07	1.093 ± 0.037	3.684	1.071	2.013			
Oct. 14,2020	75.787	871.586	4.766 ± 0.114	3.357 ± 0.08	1.42 ± 0.091	4.274	1.273	10.352			
Oct. 15,2020	65.430	353.831	4.594 ± 0.121	3.818 ± 0.101	1.203 ± 0.193	4.394	1.151	4.323	9.246 ± 0.238	7.742 ± 0.199	1.194 ± 0.065
Oct. 20,2020	160.977	3720.322	7.114 ± 0.204	4.671 ± 0.134	1.523 ± 0.123	5.017	1.074	29.481			
Oct. 21,2020	314.854	7714.622	10.289 ± 0.192	5.522 ± 0.103	1.863 ± 0.142	5.941	1.076	42.244			
Oct. 22,2020	287.279	7474.739	9.783 ± 0.219	4.933 ± 0.11	1.983 ± 0.208	5.57	1.129	43.066			
Oct. 23,2020	289.958	6670.286	9.899 ± 0.15	5.554 ± 0.084	1.782 ± 0.133	6.139	1.105	37.991			
Oct. 24,2020	336.313	6538.307	10.253 ± 0.157	4.878 ± 0.075	2.102 ± 0.068	6.568	1.346	35.966			
Oct. 25,2020	347.374	5907.274	8.981 ± 0.165	4.413 ± 0.081	2.035 ± 0.097	5.651	1.281	37.052			
Oct. 27,2020	138.724	2459.519	7.585 ± 0.093	5.519 ± 0.068	1.374 ± 0.038	6.198	1.123	18.268	14.681 ± 0.419	10.637 ± 0.304	1.38 ± 0.104
Oct. 30,2020	153.533	667.867	3.237 ± 0.071	2.959 ± 0.064	1.094 ± 0.053	2.86	0.967	11.609			
Nov. 2,2020	190.975	3818.426	7.471 ± 0.082	4.064 ± 0.045	1.838 ± 0.037	5.319	1.309	28.781			
Nov. 3,2020	263.841	4240.073	7.421 ± 0.104	4.196 ± 0.059	1.769 ± 0.054	5.031	1.199	32.222			
Nov. 4,2020	322.500	3246.562	6.727 ± 0.081	5.007 ± 0.06	1.344 ± 0.038	4.897	0.978	27.232			
Nov. 6,2020	183.851	3836.520	11 ± 0.123	8.22 ± 0.092	1.338 ± 0.043	8.838	1.075	19.656			
Nov. 9,2020	344.585	5876.225	8.92 ± 0.138	4.286 ± 0.066	2.081 ± 0.064	5.608	1.309	37.098			
Nov. 11,2020	393.133	4423.324	8.228 ± 0.148	4.43 ± 0.08	1.857 ± 0.127	5.735	1.294	30.318			
Nov. 12,2020	384.275	4668.576	8.499 ± 0.161	3.695 ± 0.07	2.3 ± 0.117	5.868	1.588	30.957			
Nov. 13,2020	422.923	6983.735	9.371 ± 0.369	4.333 ± 0.171	2.163 ± 0.229	5.435	1.254	42.025			
Nov. 15,2020	460.394	2378.717	5.931 ± 0.139	3.058 ± 0.072	1.94 ± 0.086	4.591	1.501	22.629			
Nov. 16,2020	478.115	2675.219	6.528 ± 0.265	3.246 ± 0.132	2.011 ± 0.192	5.02	1.546	23.123			
Nov. 17,2020	126.860	1471.106	5.967 ± 0.146	3.538 ± 0.086	1.687 ± 0.1	5.138	1.452	13.571	4.768 ± 0.352	3.13 ± 0.231	1.524 ± 0.269
Nov. 18,2020	187.098	3728.608	6.771 ± 0.127	3.056 ± 0.057	2.216 ± 0.082	4.67	1.528	31.047			
Nov. 20,2020	122.566	616.585	3.516 ± 0.072	3.098 ± 0.064	1.135 ± 0.042	3.169	1.023	9.868	10.309 ± 0.325	8.54 ± 0.269	1.207 ± 0.076

Nov. 21,2020	94.047	587.890	4.277 ± 0.094	3.076 ± 0.068	1.39 ± 0.071	3.946	1.282	7.770			
Nov. 22,2020									13.436 ± 0.507	7.917 ± 0.299	1.401 ± 0.079
Nov. 23,2020	91.562	358.963	4.935 ± 0.08	4.386 ± 0.071	1.125 ± 0.032	4.733	1.079	4.089			
Nov. 24,2020	312.927	865.238	6.254 ± 0.099	4.676 ± 0.074	1.338 ± 0.039	5.767	1.233	7.848			
Nov. 25,2020	108.635	945.959	2.717 ± 0.059	1.962 ± 0.042	1.385 ± 0.071	2.184	1.113	19.639			
Nov. 27,2020	352.481	5345.922	9.572 ± 0.115	6.738 ± 0.081	1.421 ± 0.031	6.558	0.973	31.527			
Nov. 30,2020	456.893	2358.735	10.319 ± 0.195	6.818 ± 0.129	1.513 ± 0.072	8.989	1.318	12.888			
Dec. 1,2020	373.945	233.770	4.357 ± 0.082	4.03 ± 0.076	1.081 ± 0.035	4.226	1.049	2.960	12.16 ± 0.538	9.007 ± 0.399	1.35 ± 0.099
Dec. 2,2020	134.682	408.846	7.966 ± 0.179	5.083 ± 0.114	1.567 ± 0.077	7.736	1.522	2.872	12.877 ± 0.514	8.439 ± 0.337	1.526 ± 0.107
Dec. 3,2020	177.966	2456.007	10.262 ± 0.158	5.571 ± 0.086	1.842 ± 0.067	8.877	1.593	13.518			
Dec. 6,2020	293.217	2101.925	8.387 ± 0.157	6.33 ± 0.118	1.325 ± 0.044	7.202	1.138	14.113			
Dec. 8,2020	313.589	3475.288	11.216 ± 0.207	7.062 ± 0.131	1.588 ± 0.062	9.258	1.311	17.443			
Dec. 9,2020	250.485	2687.416	7.392 ± 0.16	4.802 ± 0.104	1.539 ± 0.052	5.877	1.224	20.468			
Dec. 10,2020	292.836	4202.012	8.925 ± 0.12	5.183 ± 0.07	1.722 ± 0.04	6.557	1.265	26.539			
Dec. 15,2020	355.168	5141.221	9.99 ± 0.126	5.893 ± 0.074	1.695 ± 0.032	7.093	1.204	28.968			
Dec. 16,2020	358.173	5046.369	9.965 ± 0.158	6.05 ± 0.096	1.647 ± 0.037	7.121	1.177	28.537			
Dec. 17,2020	277.882	3.253	10.069 ± 0.122	7.45 ± 0.091	1.352 ± 0.022	10.068	1.351	0.074			
Dec. 18,2020	263.854	5004.076	10.941 ± 0.139	7.66 ± 0.097	1.428 ± 0.031	8.121	1.06	25.770			
Dec. 20,2020	405.655	7767.470	10.418 ± 0.153	5.847 ± 0.086	1.782 ± 0.045	6.04	1.033	42.031			
Dec. 21,2020	237.583	3006.577	8.837 ± 0.119	5.445 ± 0.073	1.623 ± 0.053	7.143	1.312	19.162			
Dec. 22,2020	381.897	4878.246	9.77 ± 0.264	6.499 ± 0.176	1.503 ± 0.11	7.021	1.080	28.144			
Dec. 25,2020	327.830	6183.355	11.112 ± 0.138	4.513 ± 0.056	2.462 ± 0.09	7.627	1.690	31.357			
Dec. 27,2020	450.787	7598.422	12.253 ± 0.138	4.142 ± 0.047	2.958 ± 0.107	7.97	1.924	34.956			
Dec. 28,2020	413.442	6313.059	11.559 ± 0.157	4.225 ± 0.057	2.736 ± 0.076	8.001	1.894	30.775			
Dec. 29,2020	350.272	6653.102	11.668 ± 0.139	3.687 ± 0.044	3.165 ± 0.129	7.918	2.147	32.164			
Jan. 1,2021	291.795	6638.630	12.341 ± 0.16	4.282 ± 0.055	2.882 ± 0.095	8.599	2.008	30.326			

Jan. 2,2021									11.753 ± 0.677	8.488 ± 0.489	1.385 ± 0.191
Jan. 3,2021	305.029	7935.022	12.465 ± 0.164	5.464 ± 0.072	2.281 ± 0.071	7.993	1.463	35.861			
Jan. 5,2021	154.908	4480.878	9.575 ± 0.135	5.602 ± 0.079	1.709 ± 0.042	7.049	1.258	26.390			
Jan. 7,2021	283.313	6685.660	10.841 ± 0.136	4.6 ± 0.058	2.357 ± 0.084	7.073	1.537	34.790			
Jan. 8,2021	28.792	4265.822	9.322 ± 0.131	4.622 ± 0.065	2.017 ± 0.072	6.918	1.497	25.781			
Jan. 9,2021	289.618	4840.091	9.684 ± 0.136	4.326 ± 0.061	2.238 ± 0.082	6.956	1.608	28.150			
Jan. 10,2021	622.478	12026.953	15.803 ± 0.167	6.465 ± 0.068	2.444 ± 0.076	9.024	1.396	42.881			
Jan. 11,2021	312.938	5991.435	13.958 ± 0.175	7.592 ± 0.095	1.839 ± 0.06	10.581	1.394	24.198			
Jan. 12,2021	239.582	4156.551	10.202 ± 0.155	4.731 ± 0.072	2.156 ± 0.117	7.86	1.661	22.959			
Jan. 13,2021	204.372	4166.052	7.932 ± 0.117	3.672 ± 0.054	2.16 ± 0.112	5.584	1.521	29.583			
Jan. 14,2021	493.317	9824.180	12.84 ± 0.156	4.183 ± 0.051	3.069 ± 0.156	7.303	1.746	43.109			
Jan. 15,2021	595.747	12227.324	14.639 ± 0.147	6.074 ± 0.061	2.41 ± 0.118	7.747	1.276	47.054			
Jan. 16,2021	367.150	6203.429	12.253 ± 0.163	5.341 ± 0.071	2.294 ± 0.081	8.757	1.64	28.509			
Jan. 18,2021	317.331	4888.792	10.712 ± 0.134	5.842 ± 0.073	1.834 ± 0.057	7.957	1.362	25.736			
Jan. 20,2021	405.655	7767.470	10.418 ± 0.153	5.847 ± 0.086	1.782 ± 0.045	6.04	1.033	42.031			
Jan. 21,2021	237.583	3006.577	8.837 ± 0.119	5.445 ± 0.073	1.623 ± 0.053	7.143	1.312	19.162			
Jan. 22,2021	381.897	4878.246	9.77 ± 0.264	6.499 ± 0.176	1.503 ± 0.11	7.021	1.08	28.144			
Jan. 25,2021	327.830	6183.355	11.112 ± 0.138	4.513 ± 0.056	2.462 ± 0.09	7.627	1.69	31.357			
Jan. 27,2021	450.787	7598.422	12.253 ± 0.138	4.142 ± 0.047	2.958 ± 0.107	7.97	1.924	34.956			
Jan. 28,2021	413.442	6313.059	11.559 ± 0.157	4.225 ± 0.057	2.736 ± 0.076	8.001	1.894	30.775			
Jan. 29,2021	350.272	6653.102	11.668 ± 0.139	3.687 ± 0.044	3.165 ± 0.129	7.918	2.147	32.164			
Feb. 1,2021	291.795	6638.630	12.341 ± 0.16	4.282 ± 0.055	2.882 ± 0.095	8.599	2.008	30.326			
Feb. 3,2021	305.029	7935.022	12.465 ± 0.164	5.464 ± 0.072	2.281 ± 0.071	7.993	1.463	35.861			
Feb. 5,2021	154.908	4480.878	9.575 ± 0.135	5.602 ± 0.079	1.709 ± 0.042	7.049	1.258	26.390			
Feb. 13,2021									16.934 ± 0.493	7.966 ± 0.232	2.126 ± 0.118
Feb. 22,2021	319.931	8781.190	11.002 ± 0.152	4.168 ± 0.058	2.64 ± 0.083	6.053	1.452	45.000			

Feb. 23,2021	528.476	10234.394	12.613 ± 0.166	4.572 ± 0.06	2.758 ± 0.062	6.844	1.497	45.722			
Feb. 24,2021	562.210	396.274	2.77 ± 0.076	1.86 ± 0.051	1.489 ± 0.07	2.547	1.369	8.059	10.718 ± 0.220	7.445 ± 0.153	1.44 ± 0.078
Feb. 25,2021									3.745 ± 0.132	2.254 ± 0.079	1.661 ± 0.156
Feb. 26,2021	328.872	1738.037	7.174 ± 0.13	3.856 ± 0.07	1.861 ± 0.065	6.194	1.607	13.649			
Feb. 28,2021	302.440	3384.527	14.427 ± 0.195	5.481 ± 0.074	2.632 ± 0.077	12.519	2.284	13.222			
Mar. 1,2021	270.601	3440.059	14.173 ± 0.198	7.711 ± 0.108	1.838 ± 0.048	12.666	1.643	10.609			
Mar. 3,2021	359.124	4259.739	8.778 ± 0.147	4.411 ± 0.074	1.99 ± 0.049	6.98	1.582	20.503			
Mar. 5,2021	391.675	4221.819	9.035 ± 0.151	4.491 ± 0.075	2.012 ± 0.077	7.096	1.58	21.471			
Mar. 6,2021	249.656	1120.589	8.964 ± 0.136	4.952 ± 0.075	1.81 ± 0.061	6.563	1.325	26.796			
Mar. 8,2021	391.675	4221.819	11.498 ± 0.161	6.22 ± 0.087	1.849 ± 0.057	9.119	1.466	20.714			
Mar. 10,2021	249.656	1120.589	8.964 ± 0.136	4.414 ± 0.067	2.031 ± 0.045	6.563	1.487	26.785	4.006 ± 0.149	2.527 ± 0.094	1.585 ± 0.144
Mar. 11,2021	216.700	2074.146	3.09 ± 0.093	1.831 ± 0.055	1.688 ± 0.097	1.921	1.049	37.855			
Mar. 12,2021	271.853	3156.539	3.737 ± 0.112	1.233 ± 0.037	3.032 ± 0.201	1.958	1.588	47.625			
Mar. 13,2021	228.697	2134.556	3.177 ± 0.095	1.759 ± 0.052	1.806 ± 0.106	1.974	1.122	37.874			
Mar. 22,2021	524.889	12411.457	18.066 ± 0.226	3.832 ± 0.048	4.715 ± 0.204	11.07	2.889	38.727			
Mar. 24,2021	546.938	12199.769	17.115 ± 0.232	5.817 ± 0.079	2.942 ± 0.084	10.239	1.76	40.177			
Mar. 25,2021	444.653	6065.966	11.152 ± 0.174	3.653 ± 0.057	3.053 ± 0.1	7.733	2.117	30.590			
Mar. 26,2021	175.336	3938.444	11.842 ± 0.18	5.88 ± 0.09	2.014 ± 0.077	9.622	1.636	18.769			
Mar. 31,2021	297.709	4336.187	12.26 ± 0.183	3.342 ± 0.05	3.668 ± 0.157	9.816	2.937	19.929			
Apr. 1,2021	71.688	234.798	1.8 ± 0.07	1.28 ± 0.049	1.406 ± 0.108	1.667	1.303	7.326	4.876 ± 0.146	3.161 ± 0.095	1.542 ± 0.135
Apr. 2,2021	53.426	323.479	0.682 ± 0.042	0.448 ± 0.028	1.522 ± 0.191	0.5	1.115	26.741			
Apr. 3,2021									2.628 ± 0.122	1.421 ± 0.066	1.849 ± 0.200
Apr. 5,2021	201.794	3241.908	7.229 ± 0.154	3.405 ± 0.073	2.123 ± 0.1	5.402	1.586	25.189			
Apr. 6,2021	268.546	3302.944	6.827 ± 0.133	3.575 ± 0.07	1.91 ± 0.088	4.965	1.389	27.277			
Apr. 8,2021	273.210	4094.424	8.818 ± 0.160	3.373 ± 0.061	2.614 ± 0.088	6.51	1.93	26.167			
Apr. 9,2021	283.406	3775.775	9.012 ± 0.151	4.558 ± 0.076	1.977 ± 0.056	6.884	1.51	23.622			

Apr. 10,2021	267.777	3047.882	8.101 ± 0.164	3.319 ± 0.067	2.441 ± 0.111	6.383	1.923	21.221			
Apr. 11,2021	233.684	2836.690	7.766 ± 0.156	3.695 ± 0.074	2.102 ± 0.079	6.168	1.669	20.599			
Apr. 12,2021	184.743	2855.160	7.641 ± 0.134	2.222 ± 0.039	3.439 ± 0.123	6.032	2.715	21.053			
Apr. 13,2021	296.927	4783.395	11.675 ± 0.187	3.417 ± 0.055	3.417 ± 0.142	8.979	2.628	23.090			
Apr. 14,2021	281.550	4083.615	8.859 ± 0.158	2.509 ± 0.045	3.53 ± 0.179	6.557	2.613	25.977			
Apr. 16,2021	504.841	11228.584	20.039 ± 0.257	5.004 ± 0.064	4.005 ± 0.11	13.71	2.74	31.586			
Apr. 18,2021	360.464	5568.052	11.064 ± 0.209	3.211 ± 0.061	3.445 ± 0.184	7.925	2.468	28.360			
Apr. 19,2021									6.325 ± 0.284	2.523 ± 0.113	2.507 ± 0.291
Apr. 20,2021	103.645	346.003	3.413 ± 0.123	1.887 ± 0.068	1.809 ± 0.104	3.218	1.706	5.694			
Apr. 21,2021	148.565	1094.058	1.262 ± 0.055	0.396 ± 0.017	3.188 ± 0.353	0.646	1.631	48.839			
Apr. 22,2021									7.115 ± 0.329	4.178 ± 0.193	1.703 ± 0.177
Apr. 23,2021	82.170	234.168	1.927 ± 0.104	1.576 ± 0.085	1.223 ± 0.125	1.795	1.139	6.868	2.987 ± 0.122	2.15 ± 0.088	1.334 ± 0.134
Apr. 24,2021	110.874	473.613	2.777 ± 0.064	1.31 ± 0.03	2.121 ± 0.104	2.51	1.917	9.618			
Apr. 25,2021	87.374	246.289	1.765 ± 0.092	1.423 ± 0.074	1.24 ± 0.12	1.626	1.143	7.823			
Apr. 26,2021	120.574	1624.452	1.646 ± 0.07	0.526 ± 0.022	3.127 ± 0.255	0.731	1.388	55.612			
Apr. 27,2021	163.105	2004.893	8.65 ± 0.195	2.808 ± 0.063	3.081 ± 0.167	7.52	2.679	13.048	11.366 ± 0.357	4.896 ± 0.154	2.321 ± 0.246
Apr. 28,2021	210.683	3397.257	11 ± 0.197	4.845 ± 0.087	2.27 ± 0.07	9.086	1.875	17.401			
Apr. 30,2021	425.887	6359.839	12.741 ± 0.22	2.91 ± 0.05	4.379 ± 0.154	9.156	3.147	28.134			
May 2,2021									9.384 ± 0.212	5.045 ± 0.114	1.86 ± 0.112
May 3,2021	199.445	2090.696	6.049 ± 0.191	2.366 ± 0.075	2.557 ± 0.139	4.871	2.059	19.476			
May 6,2021	526.313	9498.563	18.794 ± 0.26	3.685 ± 0.051	5.1 ± 0.188	13.44	3.647	28.490			
May 7,2021	591.150	11142.949	29.575 ± 0.347	7.292 ± 0.086	4.056 ± 0.141	23.295	3.195	21.228			
May 8,2021	368.146	6832.396	13.748 ± 0.197	2.99 ± 0.043	4.598 ± 0.188	9.897	3.31	28.012			
May 10,2021	299.342	5119.374	11.197 ± 0.144	4.196 ± 0.054	2.668 ± 0.097	8.312	1.981	25.750			
May 12,2021	181.150	3017.842	6.572 ± 0.123	2.369 ± 0.044	2.774 ± 0.113	4.871	2.056	25.883			
May 13,2021	162.418	2202.734	2.779 ± 0.081	0.778 ± 0.023	3.572 ± 0.244	1.537	1.976	44.681	5.684 ± 0.273	2.972 ± 0.143	1.913 ± 0.172

May 14,2021	87.251	1873.774	2.903 ± 0.071	0.736 ± 0.018	3.945 ± 0.227	1.847	2.51	36.375			
May 15,2021									4.885 ± 0.305	2.315 ± 0.145	2.11 ± 0.235
May 16,2021	86.786	1051.219	8.59 ± 0.131	4.573 ± 0.07	1.879 ± 0.055	7.998	1.749	6.919			
May 17,2021	84.101	1077.243	12.225 ± 0.157	5.482 ± 0.071	2.23 ± 0.052	11.618	2.119	4.978			
May 19,2021	134.951	1872.771	9.797 ± 0.138	3.817 ± 0.054	2.567 ± 0.091	8.742	2.29	10.791			
May 20,2021	124.256	2083.853	9.159 ± 0.134	3.781 ± 0.055	2.422 ± 0.07	7.984	2.112	12.799			
May 22,2021									8.829 ± 0.403	5.248 ± 0.24	1.682 ± 0.122
May 23,2021	128.955	3807.389	10.379 ± 0.186	5.235 ± 0.094	1.982 ± 0.055	8.233	1.573	20.636			
May 25,2021	162.434	3246.261	8.076 ± 0.18	4.55 ± 0.101	1.775 ± 0.061	6.246	1.373	22.648			
May 26,2021	252.413	5860.419	15.979 ± 0.241	7.172 ± 0.108	2.228 ± 0.054	12.675	1.767	20.691			
May 28,2021	207.188	5738.178	13.788 ± 0.231	4.763 ± 0.080	2.895 ± 0.084	10.554	2.216	23.454			
May 30,2021	228.227	4315.448	10.901 ± 0.199	5.688 ± 0.104	1.916 ± 0.052	8.468	1.489	22.286			
Jun. 1,2021	151.093	3224.380	9.964 ± 0.161	4.863 ± 0.079	2.049 ± 0.051	8.146	1.675	18.253			
Jun. 2,2021	106.875	1771.416	8.594 ± 0.186	5.484 ± 0.119	1.567 ± 0.048	7.596	1.385	11.615	8.677 ± 0.91	6.087 ± 0.638	1.426 ± 0.199

Table S4. Measurement results of ⁷Be and ¹⁰Be concentration and ¹⁰Be/⁷Be ratio and the quantitative results of dust-borne ¹⁰Be in the QL atmosphere

Time	Dry settlement							Wet settlement			
	TSP (µg·m ⁻³)	Al content (ng·m ⁻³)	¹⁰ Be (10 ⁴ atoms·m ⁻³)	⁷ Be (10 ⁴ atoms·m ⁻³)	¹⁰ Be/ ⁷ Be	Corr. ¹⁰ Be (10 ⁴ atoms·m ⁻³)	Corr. ¹⁰ Be/ ⁷ Be	Cont. rate (%)	¹⁰ Be (10 ⁴ atoms·g ⁻¹)	⁷ Be (10 ⁴ atoms·g ⁻¹)	¹⁰ Be/ ⁷ Be
Jul. 24,2020									1.835 ± 0.079	0.776 ± 0.034	2.364 ± 0.293
Jul. 26,2020	52.008	3083.194	5.582 ± 0.114	3.165 ± 0.065	1.764 ± 0.172	5.17	1.633	7.426			
Jul. 29,2020	52.514	322.463	3.661 ± 0.137	1.809 ± 0.068	2.024 ± 0.483	3.427	1.894	6.423			
Aug. 6,2020									0.473 ± 0.048	0.342 ± 0.035	1.385 ± 0.256
Aug. 8,2020	30.194	236.728	1.999 ± 0.048	1.494 ± 0.036	1.338 ± 0.111	1.826	1.223	8.595			

Aug. 10,2020	57.376	469.442	3.715 ± 0.075	2.577 ± 0.052	1.442 ± 0.076	3.373	1.309	9.223			
Aug. 12,2020									2.659 ± 0.091	2.116 ± 0.072	1.257 ± 0.069
Aug. 18,2020									7.848 ± 0.182	4.862 ± 0.113	1.614 ± 0.084
Aug. 26,2020	40.707	429.338	5.566 ± 0.108	4.754 ± 0.092	1.171 ± 0.05	5.254	1.105	5.636			
Sep. 3,2020	38.901	661.043	4.207 ± 0.08	4.027 ± 0.077	1.045 ± 0.04	3.726	0.925	11.483			
Sep. 9,2020									12.284 ± 0.586	10.318 ± 0.492	1.191 ± 0.185
Sep. 10,2020	26.442	176.850	4.697 ± 0.092	4.223 ± 0.082	1.112 ± 0.043	4.569	1.082	2.698			
Sep. 16,2020	33.064	501.091	6.005 ± 0.096	3.951 ± 0.063	1.52 ± 0.05	5.64	1.428	6.053			
Sep. 21,2020									5.53 ± 0.38	5.878 ± 0.404	0.941 ± 0.279
Sep. 24,2020	58.995	680.890	2.438 ± 0.065	1.484 ± 0.039	1.643 ± 0.095	1.943	1.309	20.329			
Sep. 26,2020	63.121	316.545	3.657 ± 0.068	2.882 ± 0.054	1.269 ± 0.064	3.479	1.207	4.886			
Sep. 30,2020	67.473	316.854	2.24 ± 0.056	2.169 ± 0.054	1.033 ± 0.056	2.062	0.951	7.938			
Oct. 10,2020	82.755	240.752	1.239 ± 0.047	0.751 ± 0.029	1.65 ± 0.163	1.103	1.47	10.909			
Oct. 12,2020	41.726	222.506	4.13 ± 0.069	4.096 ± 0.068	1.008 ± 0.041	4.004	0.978	2.976	9.868 ± 0.234	7.446 ± 0.177	1.325 ± 0.077
Oct. 14,2020	15.236	88.703	3.762 ± 0.069	2.768 ± 0.051	1.359 ± 0.062	3.712	1.341	1.325			
Oct. 19,2020	50.434	684.554	5.652 ± 0.078	4.141 ± 0.057	1.365 ± 0.046	5.267	1.272	6.813			
Oct. 21,2020	119.525	3476.220	6.992 ± 0.087	4.582 ± 0.057	1.526 ± 0.042	5.033	1.098	28.047			
Oct. 23,2020	123.310	2807.278	7.351 ± 0.104	3.625 ± 0.051	2.028 ± 0.071	5.769	1.591	21.548			
Oct. 27,2020	29.175	381.611	2.763 ± 0.114	2.067 ± 0.085	1.337 ± 0.096	2.548	1.233	7.779	12.014 ± 0.313	7.372 ± 0.192	1.63 ± 0.1
Oct. 29,2020	84.840	612.377	2.497 ± 0.096	1.956 ± 0.075	1.277 ± 0.082	2.152	1.1	13.861			
Oct. 31,2020	70.669	1982.223	5.106 ± 0.127	3.129 ± 0.078	1.632 ± 0.076	3.989	1.275	21.875			
Nov. 2,2020	57.196	1046.757	4.841 ± 0.106	3.232 ± 0.071	1.498 ± 0.061	4.251	1.315	12.216			
Nov. 4,2020	70.989	763.963	4.588 ± 0.12	3.291 ± 0.086	1.394 ± 0.063	4.157	1.263	9.397			
Nov. 6,2020	70.347	1672.086	7.101 ± 0.152	4.829 ± 0.104	1.47 ± 0.053	6.158	1.275	13.265			
Nov. 12,2020	151.115	1075.546	5.512 ± 0.113	3.869 ± 0.079	1.425 ± 0.049	4.906	1.268	11.018			
Nov. 14,2020	188.163	906.441	4.655 ± 0.112	3.191 ± 0.077	1.459 ± 0.056	4.144	1.299	10.966			

Nov. 16,2020	320.223	923.557	4.811 ± 0.103	4.152 ± 0.089	1.159 ± 0.044	4.29	1.033	10.871			
Nov. 17,2020									6.087 ± 0.222	5.777 ± 0.211	1.054 ± 0.067
Nov. 18,2020	88.718	1500.123	6.594 ± 0.103	6.025 ± 0.094	1.094 ± 0.028	5.748	0.954	12.797			
Nov. 20,2020	82.201	403.686	3.686 ± 0.089	3.565 ± 0.086	1.034 ± 0.081	3.459	0.97	6.190			
Nov. 24,2020	107.922	254.869	3.863 ± 0.079	3.578 ± 0.073	1.08 ± 0.062	3.719	1.039	3.796			
Nov. 27,2020	284.250	1089.749	5.881 ± 0.151	4.679 ± 0.12	1.257 ± 0.053	5.267	1.126	10.422			
Dec. 1,2020	311.293	152.101	4.105 ± 0.075	4.095 ± 0.075	1.002 ± 0.027	4.019	0.981	2.096			
Dec. 8,2020	170.286	622.297	7.965 ± 0.139	7.881 ± 0.138	1.011 ± 0.026	7.614	0.966	4.451			
Dec. 10,2020	90.064	619.221	7.503 ± 0.115	7.171 ± 0.11	1.046 ± 0.021	7.154	0.998	4.589			
Dec. 12,2020	232.718	4277.013	9.806 ± 0.132	6.735 ± 0.091	1.456 ± 0.027	7.396	1.098	24.588			
Dec. 14,2020	170.098	2066.670	8.364 ± 0.1	6.048 ± 0.072	1.383 ± 0.023	7.199	1.19	13.955			
Dec. 18,2020	103.971	1177.237	8.473 ± 0.116	4.035 ± 0.055	2.1 ± 0.046	7.809	1.935	7.857			
Dec. 21,2020	147.293	1028.644	7.964 ± 0.123	3.832 ± 0.059	2.078 ± 0.049	7.384	1.927	7.267			
Dec. 23,2020	135.133	2501.101	9.729 ± 0.151	8.281 ± 0.129	1.175 ± 0.024	8.32	1.005	14.468			
Dec. 25,2020	189.791	1898.067	9.072 ± 0.164	4.201 ± 0.076	2.16 ± 0.057	8.002	1.905	11.806			
Dec. 27,2020	156.364	933.826	6.758 ± 0.114	2.97 ± 0.05	2.275 ± 0.058	6.232	2.098	7.780			
Dec. 29,2020	89.199	1589.953	8.158 ± 0.115	5.014 ± 0.07	1.627 ± 0.057	7.262	1.448	11.002			
Dec. 31,2020	139.184	1650.992	7.16 ± 0.087	4.212 ± 0.051	1.7 ± 0.051	6.23	1.479	13.000			
Jan. 5,2021	228.693	3345.376	8.805 ± 0.104	5.8 ± 0.069	1.518 ± 0.041	6.92	1.193	21.410			
Jan. 9,2021	140.950	2551.301	8.779 ± 0.097	5.562 ± 0.061	1.578 ± 0.04	7.341	1.32	16.350			
Jan. 11,2021	180.866	4260.927	11.938 ± 0.112	6.634 ± 0.062	1.8 ± 0.04	9.536	1.438	20.111			
Jan. 13,2021	131.847	3310.993	7.515 ± 0.095	4.397 ± 0.056	1.709 ± 0.037	5.648	1.285	24.810			
Jan. 15,2021	117.962	4999.014	13.302 ± 0.125	5.941 ± 0.056	2.239 ± 0.04	7.103	1.196	46.583			
Jan. 21,2021	129.853	2042.001	9.307 ± 0.102	7.275 ± 0.08	1.279 ± 0.021	8.156	1.121	12.353			
Jan. 23,2021	404.988	2503.021	9.237 ± 0.238	6.581 ± 0.17	1.404 ± 0.233	7.826	1.189	15.313			
Jan. 25,2021	199.421	4445.388	9.788 ± 0.105	5.216 ± 0.056	1.876 ± 0.044	7.283	1.396	25.586			

Feb. 23,2021	450.879	6101.586	13.279 ± 0.148	5.921 ± 0.066	2.243 ± 0.055	9.84	1.662	25.903			
Feb. 24,2021									7.116 ± 0.189	4.909 ± 0.13	1.45 ± 0.142
Feb. 25,2021	54.562	38.698	0.529 ± 0.028	0.531 ± 0.028	0.997 ± 0.118	0.507	0.956	4.112			
Mar. 2,2021	102.456	1622.940	12.064 ± 0.122	6.541 ± 0.066	1.844 ± 0.036	11.149	1.704	7.592			
Mar. 4,2021	102.637	1238.447	7.535 ± 0.102	3.495 ± 0.047	2.156 ± 0.062	6.837	1.956	9.276			
Mar. 8,2021	216.905	1719.306	9.315 ± 0.12	4.983 ± 0.064	1.87 ± 0.061	8.346	1.675	10.428			
Mar. 10,2021	134.238	99.600	2.635 ± 0.062	1.68 ± 0.039	1.569 ± 0.088	2.579	1.535	2.167			
Mar. 14,2021	141.908	1095.871	3.413 ± 0.071	2.041 ± 0.043	1.672 ± 0.066	2.795	1.37	18.062			
Mar. 21,2021	244.998	5506.565	19.062 ± 0.156	6.237 ± 0.051	3.057 ± 0.058	15.959	2.559	16.290			
Mar. 25,2021	190.652	3118.828	10.805 ± 0.127	3.956 ± 0.046	2.731 ± 0.068	9.047	2.287	16.258			
Apr. 1,2021									4.4 ± 0.222	2.977 ± 0.15	1.478 ± 0.228
Apr. 7,2021	104.297	544.110	4.718 ± 0.097	2.245 ± 0.046	2.101 ± 0.078	4.411	1.964	6.521			
Apr. 9,2021	77.465	351.806	7.401 ± 0.119	3.321 ± 0.053	2.229 ± 0.067	7.203	2.169	2.692			
Apr. 11,2021	102.210	756.595	5.785 ± 0.091	3.092 ± 0.049	1.871 ± 0.064	5.358	1.733	7.376			
Apr. 15,2021	289.308	4668.339	18.673 ± 0.138	6.384 ± 0.047	2.925 ± 0.055	16.042	2.513	14.085			
Apr. 19,2021	63.784	662.247	6.785 ± 0.084	3.655 ± 0.045	1.856 ± 0.061	6.412	1.754	5.496			
Apr. 23,2021	39.662	64.756	1.955 ± 0.058	1.601 ± 0.048	1.221 ± 0.063	1.919	1.198	1.884	7.128 ± 0.308	5.537 ± 0.239	1.287 ± 0.09
Apr. 26,2021	59.444	970.752	2.784 ± 0.058	1.254 ± 0.026	2.219 ± 0.094	2.237	1.783	19.648			
Apr. 30,2021	155.855	2921.164	9.617 ± 0.097	3.72 ± 0.037	2.585 ± 0.055	7.97	2.142	17.137			
May 2,2021	106.070	1171.825	5.748 ± 0.08	2.986 ± 0.042	1.925 ± 0.053	5.088	1.704	11.481			
May 9,2021	62.779	1099.916	8.009 ± 0.087	4.404 ± 0.048	1.819 ± 0.048	7.389	1.678	7.752			
May 11,2021	119.911	1018.652	7.361 ± 0.103	3.024 ± 0.042	2.434 ± 0.07	6.787	2.244	7.806			
May 13,2021	65.002	847.211	1.926 ± 0.064	1.111 ± 0.037	1.734 ± 0.092	1.448	1.304	24.798			
May 18,2021	35.689	467.238	11.436 ± 0.138	7.41 ± 0.09	1.543 ± 0.028	11.173	1.508	2.268			
May 20,2021	49.214	1068.578	8.505 ± 0.118	4.827 ± 0.067	1.762 ± 0.038	7.903	1.637	7.094			
May 25,2021	27.730	747.904	6.662 ± 0.1	4.248 ± 0.064	1.568 ± 0.034	6.241	1.469	6.314			

May 27,2021	102.414	2275.211	10.205 ± 0.157	5.081 ± 0.078	2.008 ± 0.049	8.922	1.756	12.550
May 29,2021	59.494	1175.187	9.042 ± 0.12	5.355 ± 0.071	1.688 ± 0.032	8.38	1.565	7.287
Jun. 3,2021	46.530	1077.672	7.002 ± 0.143	3.339 ± 0.068	2.097 ± 0.065	6.395	1.915	8.679

Table S5. Measurement results of ^7Be and ^{10}Be concentration and $^{10}\text{Be}/^7\text{Be}$ ratio and the quantitative results of dust-borne ^{10}Be in other typical regions

Season	Site	Time	Aerosol Al ($\text{ng}\cdot\text{m}^{-3}$)	^{10}Be ($10^4\text{atoms}\cdot\text{m}^{-3}$)	1σ	^7Be ($10^4\text{atoms}\cdot\text{m}^{-3}$)	1σ	$^{10}\text{Be}/^7\text{Be}$	1σ	Corr. $^{10}\text{Be}/^7\text{Be}$	Cont. rate (%)
Autumn	ZW (h)	October 20,2020	14873.548	12.808	0.400	5.266	0.165	2.432	0.242	1.162	52.220
		October 21,2020	4798.280	7.341	0.293	5.117	0.204	1.435	0.141	1.013	29.408
		October 22,2020	2643.868	7.638	0.288	4.729	0.178	1.615	0.103	1.364	15.542
		October 23,2020	5267.033	7.178	0.315	4.282	0.188	1.677	0.193	1.123	33.035
		October 24,2020	2825.372	6.123	0.294	4.917	0.236	1.245	0.141	0.987	20.723
		October 25,2020	2704.611	5.545	0.355	4.896	0.313	1.133	0.168	0.884	21.977
	LYG (l)	October 20,2020	699.031	4.405	0.258	3.174	0.186	1.388	0.157	1.174	15.418
		October 21,2020	2480.487	6.158	0.422	4.220	0.289	1.459	0.145	0.888	39.136
		October 22,2020	2805.689	8.729	0.302	3.623	0.125	2.409	0.271	1.657	31.216
		October 23,2020	826.220	5.746	0.339	3.928	0.231	1.463	0.227	1.258	14.012
		October 24,2020	858.698	4.242	0.252	3.554	0.211	1.194	0.166	0.959	19.682
		October 25,2020	985.703	5.998	0.228	5.180	0.197	1.158	0.178	0.973	15.976
	CD (j)	October 20,2020	566.693	2.899	0.083	2.338	0.067	1.240	0.074	0.986	20.484
		October 21,2020	840.867	5.539	0.083	3.931	0.059	1.409	0.047	1.185	15.898
		October 22,2020	742.469	4.684	0.080	3.517	0.060	1.332	0.055	1.110	16.667
		October 23,2020	577.994	4.278	0.080	4.002	0.075	1.069	0.045	0.917	14.219
		October 24,2020	923.984	6.247	0.097	3.096	0.048	2.018	0.104	1.705	15.510

		October 25,2020	1643.878	6.046	0.094	3.930	0.061	1.539	0.058	1.100	28.525
		January 8,2021	201.219	4.208	0.083	3.076	0.061	1.368	0.060	1.331	2.705
	TY	January 11,2021	1465.357	5.115	0.091	2.775	0.049	1.843	0.056	1.546	16.115
	(i)	January 15,2021	881.319	3.222	0.045	2.018	0.028	1.597	0.037	1.351	15.404
		January 16,2021	672.923	4.731	0.099	3.294	0.069	1.436	0.047	1.321	8.008
		January 8,2021	946.762	4.629	0.068	2.782	0.041	1.664	0.075	1.307	21.454
		January 9,2021	857.418	4.391	0.070	2.999	0.048	1.464	0.058	1.164	20.492
		January 10,2021	958.176	4.919	0.096	2.859	0.056	1.721	0.082	1.369	20.453
	CD	January 11,2021	1334.089	5.782	0.144	3.251	0.081	1.778	0.147	1.348	24.184
	(j)	January 12,2021	1306.465	5.182	0.106	3.250	0.067	1.595	0.077	1.173	26.458
		January 13,2021	1436.451	3.324	0.056	1.801	0.030	1.845	0.082	1.009	45.312
	Winter	January 14,2021	1183.568	4.864	0.083	2.792	0.048	1.742	0.072	1.298	25.488
		January 15,2021	2420.348	6.213	0.090	3.673	0.053	1.691	0.063	1.000	40.863
		January 16,2021	2215.565	7.857	0.121	4.548	0.070	1.728	0.061	1.217	29.572
		January 8,2021	553.689	3.815	0.076	2.449	0.049	1.558	0.087	1.452	6.804
		January 9,2021	952.664	4.434	0.086	3.146	0.061	1.409	0.060	1.268	10.007
	NN	January 11,2021	1213.032	5.274	0.084	3.207	0.051	1.645	0.045	1.468	10.760
	(k)	January 12,2021	1299.104	5.526	0.081	3.949	0.058	1.400	0.043	1.246	11.000
		January 13,2021	2651.982	5.570	0.086	3.449	0.053	1.615	0.042	1.256	22.229
		January 14,2021	2366.024	6.737	0.107	4.736	0.075	1.423	0.048	1.189	16.444
		January 15,2021	1365.486	6.033	0.097	4.304	0.069	1.402	0.045	1.254	10.556
		April 9,2021	691.285	4.169	0.158	2.252	0.085	1.852	0.167	1.713	7.505
	ZW	April 10,2021	605.486	6.371	0.215	2.984	0.101	2.135	0.127	2.044	4.262
	(h)	April 12,2021	2500.139	7.138	0.182	2.183	0.056	3.270	0.225	2.754	15.780
		April 13,2021	1320.903	8.737	0.205	3.066	0.072	2.850	0.187	2.656	6.807
	LYG	April 9,2021	1128.285	6.063	0.265	2.697	0.118	2.248	0.200	1.842	18.060

(l)	April 10,2021	878.260	6.887	0.197	2.944	0.084	2.340	0.121	2.050	12.393
	April 11,2021	229.922	4.064	0.148	2.176	0.079	1.868	0.158	1.765	5.514
	April 12,2021	460.666	3.201	0.404	1.548	0.196	2.068	0.478	1.779	13.975
	April 13,2021	826.640	7.477	0.252	2.262	0.076	3.306	0.230	2.951	10.738
	April 14,2021	563.947	8.564	0.264	3.471	0.107	2.467	0.145	2.309	6.405
CD (j)	April 9,2021	24.981	0.831	0.041	0.525	0.026	1.582	0.130	1.532	3.161
	April 10,2021	95.292	3.273	0.099	1.722	0.052	1.901	0.102	1.843	3.051
	April 11,2021	435.788	3.334	0.078	1.891	0.044	1.764	0.071	1.522	13.719
	April 12,2021	317.827	2.321	0.066	0.998	0.028	2.326	0.124	1.992	14.359
	April 14,2021	436.782	2.217	0.063	0.629	0.018	3.523	0.277	2.795	20.664

References

Nishiizumi, K., Imamura, M., Caffee, M. W., Southon, J. R., Finkel, R. C., & McAninch, J. (2007). Absolute calibration of ^{10}Be AMS standards. *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms*, 258(2), 403–413. doi:10.1016/j.nimb.2007.01.297

Guan, Y., Zhang, P., Huang, C., Wang, D., Wang, X., Li, L., ... Liu, Z. (2021). Vertical distribution of Pu in forest soil in Qinghai-Tibet Plateau. *Journal of Environmental Radioactivity*, 229-230, 106548. doi:10.1016/j.jenvrad.2021.106548

Yi, P., Yu, Z., Chen, P., Aldahan, A., Hou, X., Fan, Y., ... Murad, A. (2019). Late Holocene pathway of Asian Summer Monsoons imprinted in soils and societal implications. *Quaternary Science Reviews*, 215, 35–44. doi:10.1016/j.quascirev.2019.05.002