Seasonal variation on geochemical characteristics in the snow pit at Styx Glacier plateau, Antarctica

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ABSTRACT

Snow samples were collected from the wall of a 1.6 m snow pit at Styx Glacier plateau (73°51.10′S, 163°41.22′E) in Victoria Land, Antarctica, during 2014/2015 austral summer season. Here we present the data record for various chemical components such as stable water isotopes ($\delta^{18}O$, δD), major ions (Na^+, Mg^{2+}, Ca^{2+}, NH_4^+, Cl^-, SO_4^{2-}, MSA), and trace elements from the snow samples. Trace elements were determined by inductively coupled plasma-sector field mass spectrometer (ICP-SFMS) coupled to a high-efficiency sample introduction system (Apex-HF/ACM). Sample preparations and analytical operations were carried out under ultraclean conditions; class 10 clean benches in class 1000 clean room at Korea Polar Research Institute, due to their extremely low concentrations of trace element in Antarctic snow. Seasonal variations in $\delta^{18}O$, δD, and major ion values were observed. The snow pit contained 4 austral winters and summers, from late austral summer 2011 to austral summer 2014/2015.

Site and Sampling
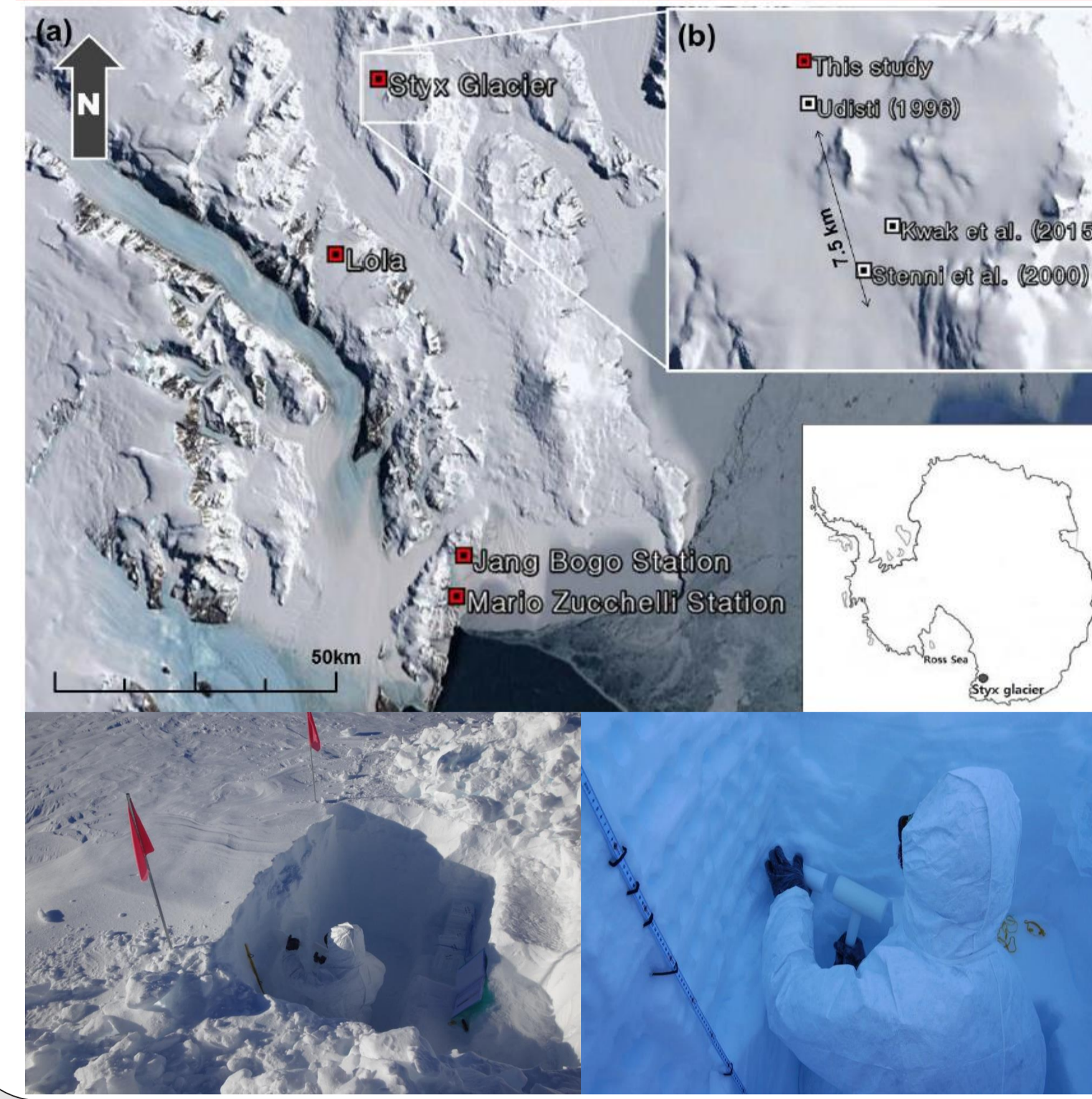
(a) The location of Styx glacier 85 km north of Jang Bogo Station and Mario Zucchelli Station.
(b) The snow pit sampling site for previous studies and this study within the Styx glacier area.
 * The map was modified from a Google Earth image.

Sampling: a 1.6 m snow pit at Styx Glacier plateau (73°51.10′S, 163°41.22′E) in Victoria Land, Antarctica, during 2014/2015 austral summer season.

- We obtained 32 snow samples using an PTFE tube and hammer.
- Ultraclean procedures and great precaution were taken during all the sampling steps to prevent the possibility of snow contamination.
- Snow samples were collected in pre-cleaned 1L LDPE bottles.
- All sample bottles were double sealed and transported back to KOPRI clean laboratory, which were stored at −20 ℃ until analysis.
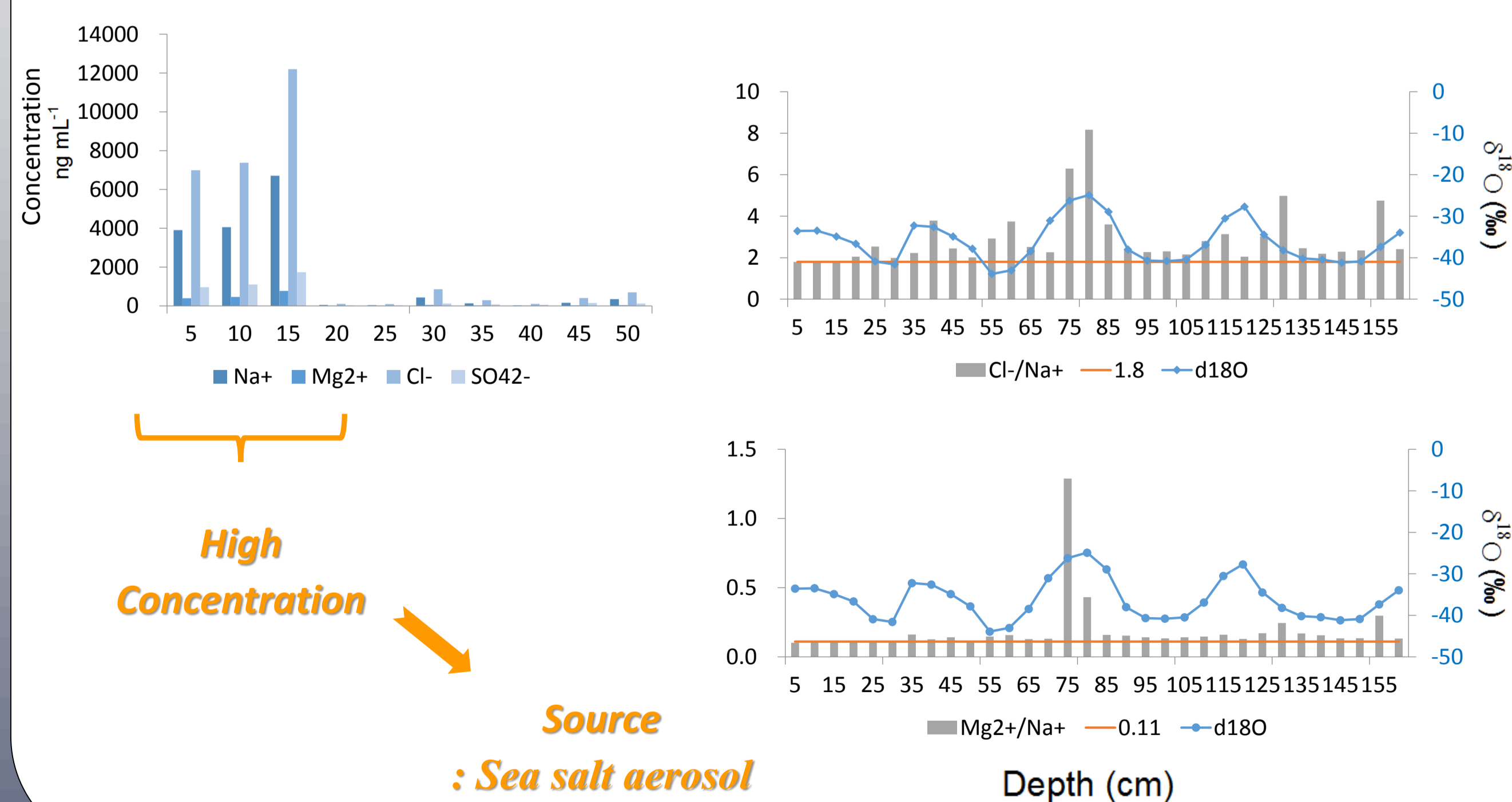
Results and discussion

Age dating

Stable water isotopes

✓ The $\delta^{18}O$ and δD depth profiles fluctuate in phase and represent recognizable seasonal patterns.
✓ We assumed about 4 years of snow deposition from late austral summer 2011 to austral summer 2014/2015.
✓ The stable water isotopes were recorded by post-depositional processes such as wind scouring or ablation caused by snowdrift.

Major ions (Na^+, Mg^{2+}, Cl^-, SO_4^{2-}, NO_3^-, and MSA)

High Concentration
Source : Sea salt aerosol

Trace elements concentration (pg g⁻¹)

Depth (cm)	Rb	Sr	Y	Mo	Cd	Sb	Ba	Tl	Bi	U	Al	Sc	V	Cr	Mn	Fe	Co	Cu	Zn	As
5	66.8	3793	12.586	3.980	0.672	0.413	125.3	0.405	0.213	2.875	24976	4.034	47.6	15.8	620.6	23135	11.1	25.0	119.2	5.5
10	74.5	4181	11.634	4.624	0.700	0.541	115.8	0.414	0.218	3.126	26116	3.660	43.2	19.7	612.9	24849	11.2	24.4	119.6	5.3
15	83.9	5036	19.049	5.003	0.674	0.481	119.3	0.392	0.208	3.087	26667	3.884	41.1	19.3	596.8	26915	10.9	23.4	59.0	5.8
20	57.4	3903	8.448	4.326	0.414	0.364	93.7	0.353	0.157	2.046	17914	2.540	29.2	20.3	390.2	17494	7.6	17.9	45.0	3.7
25	9.0	179	1.541	0.692	0.250	0.226	55.0	0.250	0.105	0.273	3350	0.532	5.8	24.8	64.0	3233	1.4	6.6	42.8	2.1
30	6.3	120	0.882	0.806	0.215	0.303	22.5	0.158	0.095	0.194	2118	0.319	7.5	7.8	40.4	2507	1.8	7.8	31.3	1.6
35	13.3	110	3.196	0.612	0.129	0.141	65.5	0.186	0.112	0.772	7616	1.403	13.5	8.3	167.4	8601	4.1	7.6	32.1	3.3
40	24.0	239	9.744	0.929	0.571	0.204	68.9	0.366	0.314	2.989	13409	2.917	22.8	11.9	330.4	16020	7.4	19.4	44.0	4.2
45	34.1	257	5.444	1.017	0.545	0.248	100.0	0.385	0.358	1.212	14479	2.887	28.5	14.4	322.7	15960	8.3	19.8	61.9	4.8
50	14.0	258	3.901	0.846	0.549	0.267	56.3	0.288	0.322	0.807	9519	1.567	13.7	8.7	220.7	10040	4.9	14.8	31.7	4.8
55	9.2	301	1.042	0.982	0.520	0.460	14.5	0.235	0.204	0.332	2402	0.410	5.4	7.8	50.1	2091	1.2	6.8	22.0	4.7
60	7.9	202	1.217	0.607	0.416	0.281	12.8	0.202	0.225	0.267	2675	0.989	8.2	4.3	65.2	3824	1.7	9.6	17.1	3.6
65	3.9	49	0.721	0.399	0.108	0.162	7.1	0.126	0.076	0.396	1155	0.232	4.2	6.6	37.6	1244	1.1	3.7	6.6	1.0
70	4.4	67	0.577	0.571	0.087	0.083	6.7	0.119	0.080	0.348	1354	0.253	3.9	2.3	37.6	1117	1.2	6.1	8.1	1.1
75	2.3	90	0.136	0.434	0.079	0.087	1.8	0.112	0.075	0.130	246	0.061	0.5	1.0	7.5	239	0.3	2.2	8.6	1.0
80	1.4	5	0.137	0.304	0.030	0.094	1.8	0.159	0.058	0.075	242	0.071	1.1	1.0	5.8	230	0.2	3.4	9.5	0.4
85	4.3	10	1.474	0.357	0.140	0.089	7.3	0.120	0.076	0.293	1090	0.232	2.1	3.2	32.0	1226	1.5	3.9	9.9	1.1
90	10.4	86	1.426	0.515	0.114	0.134	13.7	0.164	0.097	0.278	3682	0.861	6.8	3.9	53.8	3033	1.6	6.5	11.0	1.8
95	19.7	230	6.399	0.913	0.326	0.167	65.5	0.263	0.121	1.212	14849	2.139	19.1	16.0	306.0	15505	7.3	19.0	34.6	2.9
100	23.7	205	5.896	1.159	0.330	0.138	93.4	0.344	0.175	0.882	12709	2.501	24.8	16.3	200.3	14484	6.4	21.9	37.6	2.6
105	17.9	216	4.926	0.747	0.345	0.147	57.6	0.269	0.163	1.069	12113	2.038	18.4	15.8	242.6	12155	5.8	15.9	128.8	2.4
110	14.1	230	4.049	0.853	0.502	0.165	55.5	0.252	0.157	1.021	11961	1.660	16.2	9.7	224.3	11263	5.1	14.3	94.4	2.2
115	10.5	46	2.522	0.436	0.129	0.100	16.6	0.193	0.103	0.679	3855	0.750	6.8	4.0	131.6	3802	2.9	12.0	30.4	3.5
120	18.9	76	3.846	0.645	0.109	0.177	36.4	0.247	0.187	1.438	6891	1.641	13.1	7.2	222.8	7848	4.3	14.3	30.6	2.1
125	4.8	70	2.553	0.541	0.165	0.175	26.3	0.209	0.156	0.464	5899	1.088	9.9	5.1	130.4	6569	4.0	20.6	23.2	2.1
130	11.0	99	2.542	0.620	0.206	0.170	36.7	0.167	0.144	0.390	5867	0.872	10.9	3.7	126.4	5347	2.2	7.6	27.9	2.9
135	11.7	126	2.554	0.642	0.200	0.212	48.5	0.149	0.144	0.578	6027	0.956	10.7	4.9	123.7	6112	2.5	8.7	40.8	2.7
140	8.6	99	2.044	0.610	0.166	0.169	28.6	0.161	0.110	0.334	5028	0.692	8.7	2.9	92.1	4174	1.7	6.3	15.0	2.6
145	7.0	72	1.574	0.440	0.163	0.111	34.6	0.154	0.112	0.259	4388	0.691	7.6	3.5	80.9	4003	1.6	6.0	15.0	2.1
150	4.7	97	0.781	0.449	0.186	0.132	11.1	0.135	0.101	0.132	2287	0.345	3.3	1.7	32.0	1915	0.8	4.2	9.9	2.2
155	6.5	21	0.598	0.327	0.142	0.085	8.0	0.150	0.123	0.252	1226	0.316	2.2	1.6	43.7	1767	0.9	4.6	13.1	1.2
160	9.3	46	0.604	0.324	0.088	0.089	7.7	0.166	0.210	0.371	1864	0.422	3.1	3.5	36.8	2326	1.3	5.7	8.8	1.1