Dataset Nanoion2010_11

Air ions and nanoparticles

Charged molecular clusters and nanometer particles carry electric current in the air. Therefore, they are called *atmospheric ions* or *air ions*. A classic survey of atmospheric ions is available in a monograph by Israël (1970). A synopsis of new viewpoints can be found in journal papers e.g. by Hirsikko et al. (2011). Traditionally, air ions are categorized according to their electric mobility into three classes: small, intermediate, and large ions. Hõrrak et al. (2000) specifed the intermediate air ion mobility range of 0.034–0.5 $cm^2V^{-1}s^{-1}$ and showed that they are, on average, responsible for only about 2% of total air conductivity. Physically, small ions are charged molecules or clusters whose internal energy levels are not excited during impacts with molecules of a carrier gas. Intermediate ions are charged nanometer particles whose internal energy changes during impacts. The transition from the first type of impacts to the second type happens at a particle diameter of about 1.6 nm (Tammet, 1995). Intermediate ions are created in the initial stage of aerosol nucleation. They cannot immediately act as condensation nuclei due to their small size, but can be considered to be the germs of condensation nuclei in the atmosphere. The genesis and following evolution of nanoparticles is a key to understanding the formation of atmospheric aerosols, which is an essential factor of the Earth's climate. Contemporary interest in the study of intermediate ions is driven by discussions about the role of air ions in the formation of new aerosol particles in atmospheric air (Enghoff and Svensmark, 2008; Hirsikko et al., 2011).

In aerosol research, the particles are characterized with the mobility equivalent diameter defined as the diameter of a singly charged ideal sphere with the same mobility and diffusion coefficient as the real particle. In the present dataset, the diameter of a particle is related to its electric mobility according to Tammet (1995, 2012) and the diameter range of intermediate ions is estimated to be 1.6–7.4 nm. Distribution of air ions according to mobility Z and nanoparticles according to size d is described with fraction concentrations n (Z_a, Z_b) and n (d_a, d_b) or distribution functions:

$$\frac{dn}{d(\lg Z)} \approx \frac{n(Z_a, Z_b)}{\lg \frac{Z_b}{Z_a}}, \qquad \frac{dn}{d(\lg d)} \approx \frac{n(d_a, d_b)}{\lg \frac{d_b}{d_a}}$$

The values of distribution functions are presented in cm^{-3}. The concentrations of intermediate ion fractions are often about 1 cm^{-3} and remain below the sensitivity level of old instruments. New instruments, e.g. the SIGMA (Tammet, 2011), have enhanced sensitivity and allow measuring the low concentrations of intermediate ions. Systematic measurements with the SIGMA enabled to obtain essential new information and reconsider the knowledge about intermediate ions in atmospheric air.

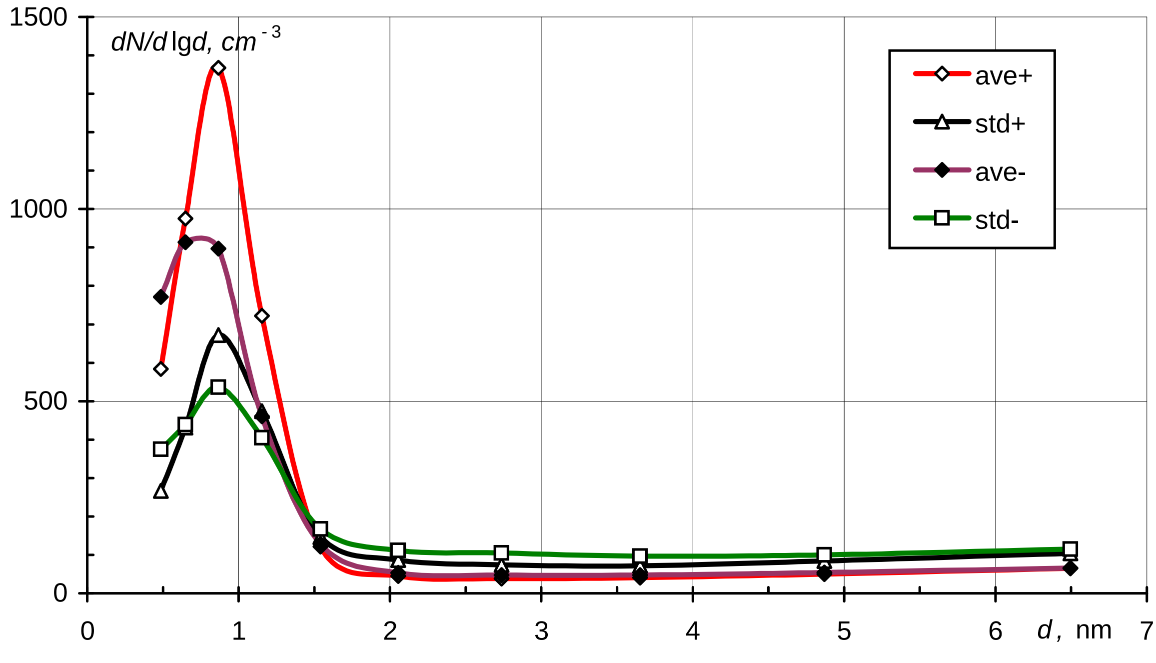
Origin of data

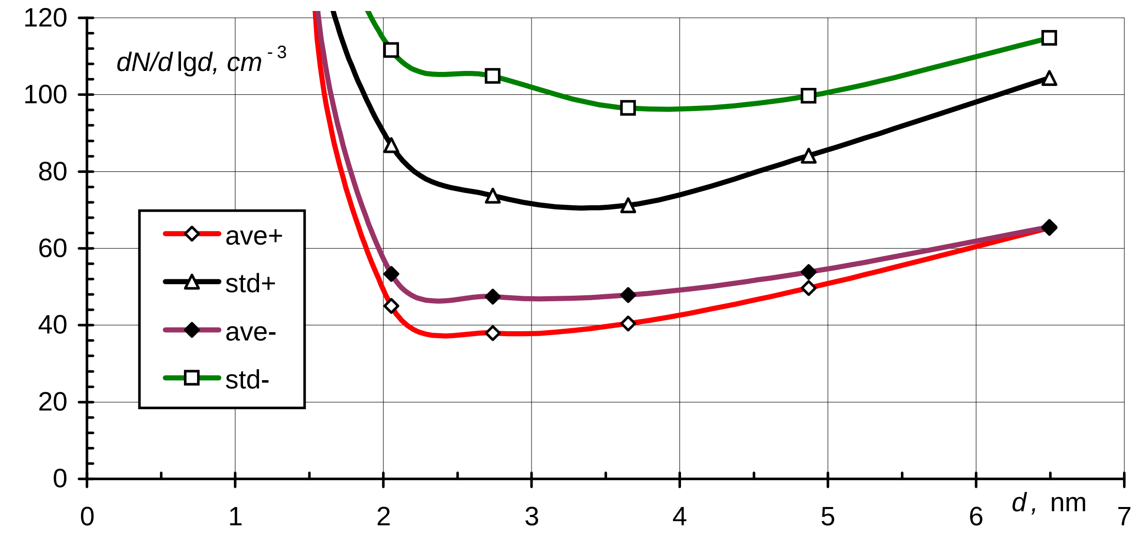
The dataset *Nanoion2010_11* includes results of small and intermediate air ion measurements. It was prepared in the process of writing papers by Tammet, Komsaare and Hõrrak (2013, 2014) and proposed as the most detailed and reliable data about mobility and size distribution of intermediate air ions. Air ion fraction concentrations were meassured by means of the air ion mobility spectrometer SIGMA (Tammet, 2011) at Tartu, Estonia (4 Tähe Street, 58.373 N, 26.727 E, 70 m a.s.l.). The air quality in Tartu represents typical small town without heavy industry in hemiboreal zone of Eastern Europe. Information about the instrument and software is available in the abbreviated manual appended to the dataset. The instrument was installed inside an attic room on the top of a four-story building close to the town center. The air sample was taken through the window at a height of about 1 m above the flat bitumen-covered roof. Accompanied meteorological data are copied from the archive of an automatic weather station (http://meteo.physic.ut.ee/), which was located on the roof of the same building. The mobility range is logarithmically uniformly divided into 16 fractions of positive ions and a further 16 fractions of negative ions. 16 fractions cover two decades of mobility while lg $(Z_a / Z_b) = 1 / 8$ and dn/dlg$Z = 8\ n\ (Z_a, Z_b)$. Air ion fraction concentrations were recorded every 5 minutes. The 10 first mobility fractions cover the subrange of intermediate ions of a mobility of 0.032–0.56 $cm^2V^{-1}s^{-1}$ and the 6 last fractions the subrange of small ions of a mobility of 0.56–3.16 $cm^2V^{-1}s^{-1}$. The fraction structure of measurements forced to specify the mobility range of intermediate ions 0.032–0.56 $cm^2V^{-1}s^{-1}$, which is a little different from the traditional range of 0.034–0.50 $cm^2V^{-1}s^{-1}$. The directly measured mobility distributions were converted into the size distributions according to Tammet (1995, 2012) considering the simultaneously measured air temperature and pressure.

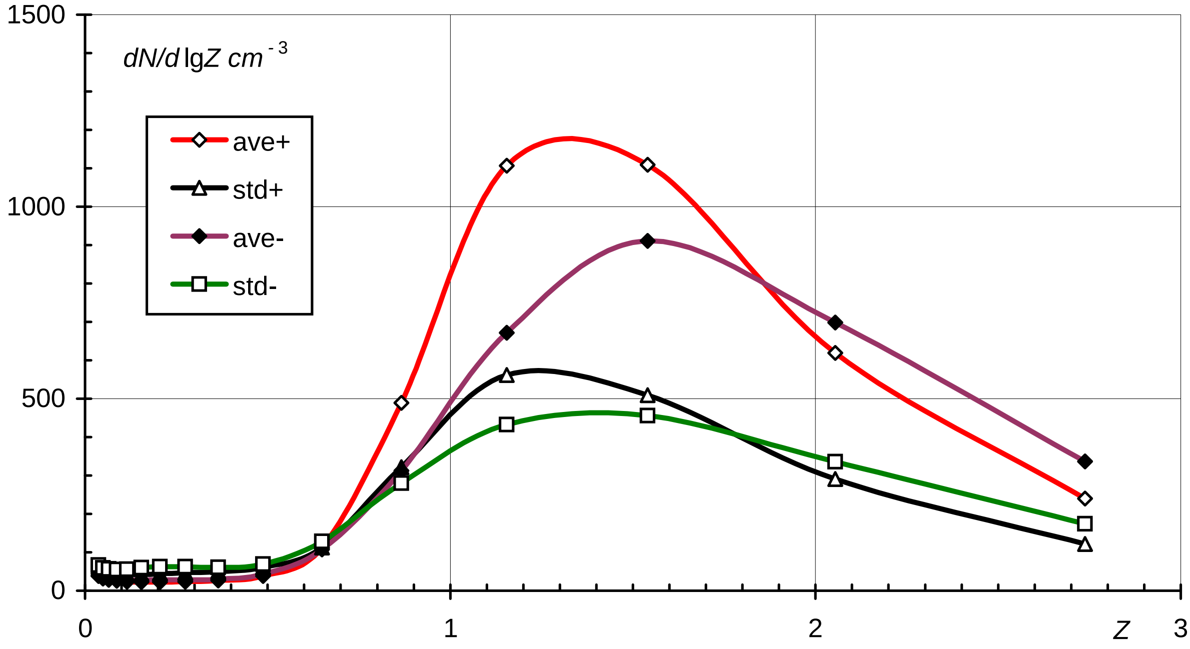
The dataset includes results of a measurement campaign started at 1 April 2010 and finished at 8 November 2011. The author acknowledges Kaupo Komsaare for taking care of the instrument, Sander Mirme for presenting the meteorological data, and Urmas Hõrrak for general arrangements and discussions. The measurements were temporarily stopped during vacation of maintaining personnel, servicing of the instrument and using it in laboratory studies. Some measurements were excluded from the dataset because of enhanced instrumental noise, which happened when the aspiration condenser was polluted. The high-quality measurements of atmospheric ions cover 7647 hours, which is about 54% of the full 587 day measurement period. The data and explanations can be immediately accessed in web clicking the links in the index of the dataset. A recommended alternative is to download the compressed package *nanoion2010_11.zip*, unzip all files into a dedicated folder and use the dataset offline on a personal computer.

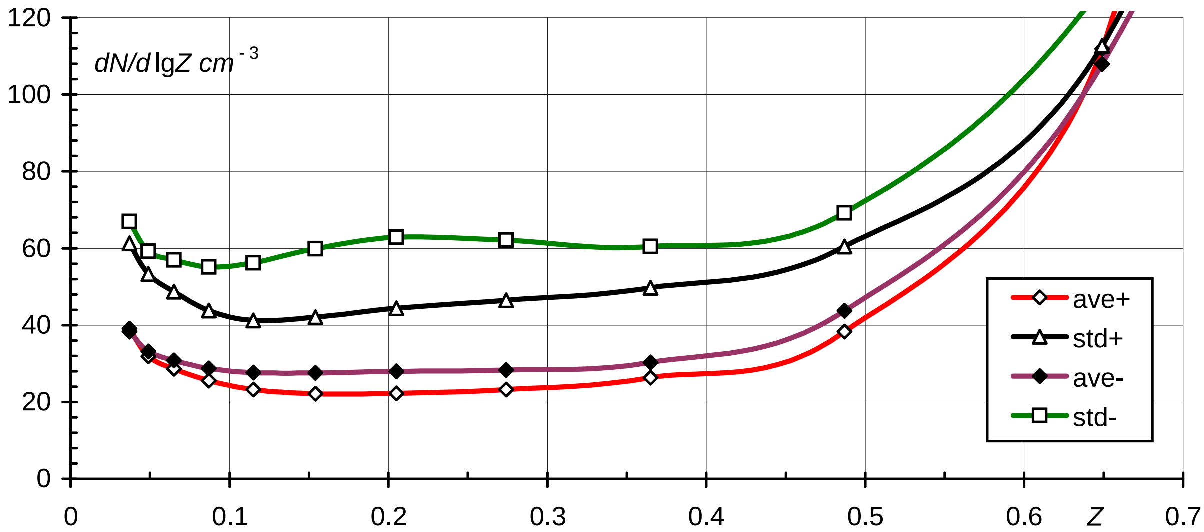
Average mobility and size distribution

The diagrams show the mean and standard deviation of distribution functions for full period of measurement campaign. The standard deviations are calculated for hourly averages.




dN/d lgd, cm - 3
ave+
std+
ave-
std-
d , nm
0
1
2
3
4
5
6
7
0
20
40
60
80
100
120


dN/d lgZ cm - 3
ave+
std+
ave-
std-
Z
0
1
2
3
0
500
1000
1500


dN/d lgZ cm - 3
ave+
std+
ave-
std-
Z
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0
20
40
60
80
100
120

Mean and standard deviations of integral parameters:

	mean	std
T:C(S)	7.27	8.86
T:C(m)	5.58	8.99
RH:%(S)	69.9	18.5
RH:%(m)	80.2	19.4
p:mb(S)	1007	10.9
p:mb(m)	1006	10.5
dp:mb/h	0.003	0.349
Prec:mm	0.03	0.16
E:lx	6385	7573
H:uSv/h	0.094	0.002

	mean	std
N+	35.1	54.6
N–	39.6	67.9
n+	473	235
n–	400	220
Z+	1.50	0.07
Z–	1.67	0.12
noise+	6.46	2.86
noise-	6.27	2.71
defect	42.91	11.45

Two tables and one set of diagrams

The data is available simultaneously in a presentation file *nanoion2010_11diagrams.ppt* and in two different numerical files *nanoion2010_11hours.xls* and *nanoion2010_11records.xls*. Both numerical files contain simple tab-delimited text and can be opened in MS Notepad or as tables in MS Excel (recommended). The two numerical files present generally the same measurements. However, in case of few exeptions some measurements are included into only one file due to different methods of disqualification the data according to the instrumental noise. The papers by Tammet, Komsaare, and Hõrrak (2013, 2014) are based on analysis of the file of hourly averages *nanoion2010_11hours.xls*.

The distinctive properties of the two numerical files are:

- *nanoion2010_11hours.xls* is composed from hourly averages. It contains one header line and 7647 data lines. A data line includes one-hour averages of measurements made by the air ion mobility spectrometer SIGMA as well as simultaneous measurements of meteorological quantities made by the automatic weather station (http://meteo.physic.ut.ee/) located on the roof of the same building and maintained by Sander Mirme. One hour contains 12 five-minute measurements and the instrumental noise is suppressed about three times when compared with the data in file *nanoion2010_11records.xls*. The quality of data was estimated individually for every hour and the number of included hours in one day varies between 0 and 24. The numbers of included hours for every day are shown in Table 1.
- *nanoion2010_11records.xls* is composed from 147 full day series. It contains one header line and 42336 data lines while every line presents measurements made by the air ion mobility spectrometer SIGMA with a period of five minutes. The quality of data was estimated for whole days. High quality measurements were included and low-quality measurements were excluded by full days. Every full day is presented with 288 data lines and the total number of data lines is 147×288. The meteorological information is presented here only with air temperature, pressure and humidity recorded with the SIGMA own internal meteosensors.

The file *nanoion2010_11diagrams.ppt* includes contour plots illustrating the evolution of nanoparticle size distribution during the same 147 days, which are presented in the table *nanoion2010_11records.xls*.

Table 1

Numbers of hours (UTC+02) included in the table *nanoion2010_11hours.xls* for every day from 1 April 2010 until 8 November 2011. Year is shown with two digits 10 or 11.

Year →	10	10	10	10	10	10	10	10	10	11	11	11	11	11	11	11	11	11	11	11
Month→ / Day of month ↓	04	05	06	07	08	09	10	11	12	01	02	03	04	05	06	07	08	09	10	11
1	8	23	11	22	0	0	21	**24**	10	0	**24**	22	23	**24**	0	0	14	0	**24**	16
2	14	**24**	0	15	0	0	3	19	0	0	23	15	20	**24**	0	0	15	0	**24**	**24**
3	17	**24**	0	**24**	0	0	14	8	14	0	**24**	14	19	**24**	0	0	15	0	9	22
4	21	1	0	23	0	0	**24**	23	14	0	21	20	23	**24**	0	0	13	0	21	21
5	23	13	0	19	0	0	**24**	**24**	18	0	**24**	21	21	23	0	0	17	8	**24**	14
6	18	**24**	0	23	0	0	**24**	20	13	0	**24**	23	16	**24**	0	0	15	14	**24**	**24**
7	21	**24**	0	4	0	0	**24**	22	19	0	**24**	**24**	19	**24**	0	0	11	20	**24**	22
8	20	22	0	0	0	0	**24**	23	21	0	17	23	22	**24**	0	0	6	22	**24**	12
9	**24**	22	0	0	0	0	21	18	8	0	17	**24**	**24**	**24**	0	0	5	**24**	20	
10	21	23	0	0	0	0	12	18	0	0	**24**	**24**	**24**	23	0	0	0	**24**	23	
11	22	**24**	9	0	0	0	**24**	**24**	6	0	10	22	**24**	23	0	0	7	20	**24**	
12	23	23	22	0	0	0	**24**	**24**	11	10	20	**24**	**24**	**24**	0	0	0	**24**	**24**	
13	**24**	20	21	0	0	0	**24**	15	19	14	**24**	21	**24**	**24**	0	0	0	19	**24**	
14	**24**	23	23	0	0	0	12	22	22	14	**24**	17	**24**	**24**	0	0	0	**24**	**24**	
15	**24**	**24**	**24**	0	0	0	16	16	**24**	23	23	**24**	**24**	**24**	0	0	0	**24**	**24**	
16	**24**	15	**24**	0	0	0	**24**	**24**	**24**	20	21	**24**	18	**24**	0	0	1	23	**24**	
17	**24**	20	**24**	0	0	0	**24**	22	20	16	**24**	**24**	17	19	0	0	6	22	**24**	
18	**24**	20	**24**	0	0	0	**24**	16	8	0	16	**24**	**24**	**24**	0	0	3	17	**24**	
19	23	21	**24**	0	0	0	22	11	8	0	**24**	21	**24**	23	0	0	6	23	23	
20	**24**	22	21	0	0	0	15	8	**24**	0	14	19	**24**	16	0	0	0	**24**	**24**	
21	23	0	7	0	0	0	10	3	18	0	**24**	22	**24**	23	0	0	0	23	**24**	
22	**24**	4	0	0	0	0	17	10	18	9	17	**24**	**24**	**24**	0	0	0	23	23	
23	**24**	14	18	0	0	0	23	12	21	15	22	**24**	18	22	0	0	0	23	13	
24	23	13	**24**	0	0	10	23	14	8	15	**24**	**24**	**24**	**24**	0	0	0	**24**	21	
25	23	15	20	0	0	**24**	21	10	0	1	**24**	21	**24**	**24**	0	0	0	**24**	**24**	
26	**24**	11	23	0	0	20	20	21	0	7	22	23	**24**	**24**	0	0	0	**24**	21	
27	20	6	**24**	0	0	21	21	20	0	10	**24**	20	**24**	19	0	0	0	**24**	20	
28	11	11	23	0	0	22	**24**	15	0	0	**24**	17	**24**	0	0	0	0	21	16	
29	8	23	21	0	0	**24**	22	20	0	0		17	**24**	0	0	0	0	20	**24**	
30	23	**24**	23	0	0	**24**	**24**	16	0	15		18	**24**	0	0	0	0	21	**24**	
31		**24**		0	0		**24**		0	17		**24**		0		0	0		18	

Structure of the file nanoion2010_11hours.xls

First line of the table is the header and includes identifiers of the variables. The beginning of this line is:

```
Day2010  Year  Month  Day  Hour  Week  DOW  Season. . . . .
```

Following 7647 lines contain 81 tab-delimited numbers in every line, which make of 81 columns of the table. Measurements are recorded according to local zone time UTC+02 independent of the season. The variable columns are explained in Table 2

Table 2

Columns of table nanoion2010_11hours.xls

No	Excel	Header	Value	Sign	Range, nm or $cm^2V^{-1}s^{-1}$
1	A	Day2010	Day from Jan 1, 2010 (4 decimals)		
2	B	Year	Year 2010 or 2011		
3	C	Month	1..12		

No	Excel	Header	Value	Sign	Range, nm or $cm^2V^{-1}s^{-1}$
4	D	Day	1..31		
5	E	Hour	1..24		
6	F	Week	Week of year 1..52 (integer)		
7	G	DOW	Day of week (1 = Mon, 7 = Sun)		
8	H	Season	1) 12+1+2, 2) 3+4+5, 3) 6+7+8, 4) 9+10+11		
9	I	DayQrt	1) 22..4, 2) 4..10, 3) 10..16, 4) 16..22		
10	J	T:C(S)	Temperature (SIGMA sensor), C		
11	K	T:C(m)	Temperature (meteostation), C		
12	L	RH:%(S)	RH (SIGMA sensor), %		
13	M	RH:%(m)	RH (meteostation), %		
14	N	p:mb(S)	Pressure (SIGMA sensor), mb		
15	O	p:mb(m)	Pressure (meteostation), mb		
16	P	dp:mb/h	Pressure trend, mb/h		
17	Q	Prec:mm	Precipitation, mm/h		
18	R	E:lx	Illuminance, lx		
19	S	H:uSv/h	Dose rate, μSv/h		
20	T	Position	($N_+ + N_-$) rank position 0..100%		see comment
21	U	N+	Concentration of aerosol ions +, cm^{-3}	+	0.032–0.56
22	V	N–	Concentration of aerosol ions −, cm^{-3}	–	0.032–0.56
23	W	n+	Concentration of cluster ions +, cm^{-3}	+	0.56−3.16
24	X	n–	Concentration of cluster ions −, cm^{-3}	–	0.56−3.16
25	Y	Z+	$Z_{average}$ of cluster ions +, $cm^2V^{-1}s^{-1}$	+	0.56−3.16
26	Z	Z–	$Z_{average}$ of cluster ions −, $cm^2V^{-1}s^{-1}$	–	0.56−3.16
27	AA	D+0.487	$f_{\log d} = dn / d \log d$, cm^{-3}	+	0.42−0.56
28	AB	D+0.649	$f_{\log d} = dn / d \log d$, cm^{-3}	+	0.56−0.75
29	AC	D+0.866	$f_{\log d} = dn / d \log d$, cm^{-3}	+	0.75−1.00
30	AD	D+1.155	$f_{\log d} = dn / d \log d$, cm^{-3}	+	1.00−1.33
31	AE	D+1.540	$f_{\log d} = dn / d \log d$, cm^{-3}	+	1.33−1.78
32	AF	D+2.054	$f_{\log d} = dn / d \log d$, cm^{-3}	+	1.78−2.37
33	AG	D+2.738	$f_{\log d} = dn / d \log d$, cm^{-3}	+	2.37−3.16
34	AH	D+3.652	$f_{\log d} = dn / d \log d$, cm^{-3}	+	3.16−4.22
35	AI	D+4.870	$f_{\log d} = dn / d \log d$, cm^{-3}	+	4.22−5.62
36	AJ	D+6.494	$f_{\log d} = dn / d \log d$, cm^{-3}	+	5.62−7.50
37	AK	D–0.487	$f_{\log d} = dn / d \log d$, cm^{-3}	−	0.42−0.56
38	AL	D–0.649	$f_{\log d} = dn / d \log d$, cm^{-3}	−	0.56−0.75
39	AM	D–0.866	$f_{\log d} = dn / d \log d$, cm^{-3}	−	0.75−1.00
40	AN	D–1.155	$f_{\log d} = dn / d \log d$, cm^{-3}	−	1.00−1.33
41	AO	D–1.540	$f_{\log d} = dn / d \log d$, cm^{-3}	−	1.33−1.78
42	AP	D–2.054	$f_{\log d} = dn / d \log d$, cm^{-3}	−	1.78−2.37
43	AQ	D–2.738	$f_{\log d} = dn / d \log d$, cm^{-3}	−	2.37−3.16
44	AR	D–3.652	$f_{\log d} = dn / d \log d$, cm^{-3}	−	3.16−4.22
45	AS	D–4.870	$f_{\log d} = dn / d \log d$, cm^{-3}	−	4.22−5.62
46	AT	D–6.494	$f_{\log d} = dn / d \log d$, cm^{-3}	−	5.62−7.50
47	AU	Z+0.037	$f_{\log Z} = dn / d \log Z$, cm^{-3}	+	0.032–0.042
48	AV	Z+0.049	$f_{\log Z} = dn / d \log Z$, cm^{-3}	+	0.042–0.056
49	AW	Z+0.065	$f_{\log Z} = dn / d \log Z$, cm^{-3}	+	0.056–0.075

No	Excel	Header	Value	Sign	Range, nm or $cm^2V^{-1}s^{-1}$
50	AX	Z+0.087	$f_{\log Z}$ = dn / d log Z, cm^{-3}	+	0.075–0.100
51	AY	Z+0.115	$f_{\log Z}$ = dn / d log Z, cm^{-3}	+	0.100–0.133
52	AZ	Z+0.154	$f_{\log Z}$ = dn / d log Z, cm^{-3}	+	0.133–0.178
53	BA	Z+0.205	$f_{\log Z}$ = dn / d log Z, cm^{-3}	+	0.178–0.237
54	BB	Z+0.274	$f_{\log Z}$ = dn / d log Z, cm^{-3}	+	0.237–0.316
55	BC	Z+0.365	$f_{\log Z}$ = dn / d log Z, cm^{-3}	+	0.316–0.422
56	BD	Z+0.487	$f_{\log Z}$ = dn / d log Z, cm^{-3}	+	0.422–0.562
57	BE	Z+0.649	$f_{\log Z}$ = dn / d log Z, cm^{-3}	+	0.562–0.750
58	BF	Z+0.866	$f_{\log Z}$ = dn / d log Z, cm^{-3}	+	0.75–1.00
59	BG	Z+1.155	$f_{\log Z}$ = dn / d log Z, cm^{-3}	+	1.00–1.33
60	BH	Z+1.540	$f_{\log Z}$ = dn / d log Z, cm^{-3}	+	1.33–1.78
61	BI	Z+2.054	$f_{\log Z}$ = dn / d log Z, cm^{-3}	+	1.78–2.37
62	BJ	Z+2.738	$f_{\log Z}$ = dn / d log Z, cm^{-3}	+	2.37–3.16
63	BK	Z–0.037	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.032–0.042
64	BL	Z–0.049	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.042–0.056
65	BM	Z–0.065	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.056–0.075
66	BN	Z–0.087	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.075–0.100
67	BO	Z–0.115	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.100–0.133
68	BP	Z–0.154	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.133–0.178
69	BQ	Z–0.205	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.178–0.237
70	BR	Z–0.274	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.237–0.316
71	BS	Z–0.365	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.316–0.422
72	BT	Z–0.487	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.422–0.562
73	BU	Z–0.649	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.562–0.750
74	BV	Z–0.866	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.75–1.00
75	BW	Z–1.155	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	1.00–1.33
76	BX	Z–1.540	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	1.33–1.78
77	BY	Z–2.054	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	1.78–2.37
78	BZ	Z–2.738	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	2.37–3.16
79	CA	noise+	SIGMA zero noise index	+	
80	CB	noise–	SIGMA zero noise index	–	
81	CC	defect	Disturbance index		see comment

Comments on special parameters:

Position: all 7647 hours were sorted according to ascending the total number of intermediate ions $N_{\pm} = N_+ + N_-$ and the parameter *position* was determined as 100 × (rank of $N_{\pm}$) / 7647. The value of position is positively correlated with the concentration of intermediate ions and high positions are characteristic of the new particle formation events.
Lowest value of $N_{\pm}$ is 8 cm^{-3}, *position* = 50% value (median) $N_{\pm}$ = 42 cm^{-3} and highest value $N_{\pm}$ = 1590 cm^{-3}.

Disturbance index is a measure of random disturbances in the mobility distribution. The parameter considers the fluctuations of instrumental zero level, the roughness of the time series for fraction concentrations and the roughness of the mobility distribution curve for both positive and negative ions. The disturbance index varies between 11 and 70 with median value of 43. Low value of the index is characteristic for high quality measurements and high value of low quality neasurements.

Structure of the file nanoion2010_11records.xls

First line of the table is the header and includes identifiers of the variables. The beginning of this line is:

```
YYMMDD  HHMM  DAY2010  T:C  RH:%  p:mb  noise+  noise  D+0.487 . . .
```

Following 42336 lines contain 78 tab-delimited numbers in every line, which make of 78 columns of the table. Measurements are recorded according to local zone time UTC+02 independent of the season. The variable columns are explained in Table 3

Table 3

Columns of table nanoion2010_11records.xls

No	Excel	Header	Value	Sign	Range, nm or $cm^2V^{-1}s^{-1}$
1	A	YYMMDD	Date YYMMDD		
2	B	HHMM	Time HHMM (center of the interval)		
3	C	DAY2010	Day from Jan 1, 2010 (4 decimal places)		
4	D	T:C	Temperature, ºC (1 decimal place)		
5	E	RH:%	Rel. humidity, % (1 decimal place)		
6	F	p:mb	Air pressure, mb (2 decimal places)		
7	G	noise+	Index of zero level noise, cm^{-3}		
8	H	noise-	Index of zero level noise, cm^{-3}		
9	I	D+0.487	$f_{\log d}$ = d*n* / d log *d*, cm^{-3}	+	0.42−0.56
10	J	D+0.649	$f_{\log d}$ = d*n* / d log *d*, cm^{-3}	+	0.56−0.75
11	K	D+0.866	$f_{\log d}$ = d*n* / d log *d*, cm^{-3}	+	0.75−1.00
12	L	D+1.155	$f_{\log d}$ = d*n* / d log *d*, cm^{-3}	+	1.00−1.33
13	M	D+1.540	$f_{\log d}$ = d*n* / d log *d*, cm^{-3}	+	1.33−1.78
14	N	D+2.054	$f_{\log d}$ = d*n* / d log *d*, cm^{-3}	+	1.78−2.37
15	O	D+2.738	$f_{\log d}$ = d*n* / d log *d*, cm^{-3}	+	2.37−3.16
16	P	D+3.652	$f_{\log d}$ = d*n* / d log *d*, cm^{-3}	+	3.16−4.22
17	Q	D+4.870	$f_{\log d}$ = d*n* / d log *d*, cm^{-3}	+	4.22−5.62
18	R	D+6.494	$f_{\log d}$ = d*n* / d log *d*, cm^{-3}	+	5.62−7.50
19	S	D–0.487	$f_{\log d}$ = d*n* / d log *d*, cm^{-3}	−	0.42−0.56
20	T	D–0.649	$f_{\log d}$ = d*n* / d log *d*, cm^{-3}	−	0.56−0.75
21	U	D–0.866	$f_{\log d}$ = d*n* / d log *d*, cm^{-3}	−	0.75−1.00
22	V	D–1.155	$f_{\log d}$ = d*n* / d log *d*, cm^{-3}	−	1.00−1.33
23	W	D–1.540	$f_{\log d}$ = d*n* / d log *d*, cm^{-3}	−	1.33−1.78
24	X	D–2.054	$f_{\log d}$ = d*n* / d log *d*, cm^{-3}	−	1.78−2.37
25	Y	D–2.738	$f_{\log d}$ = d*n* / d log *d*, cm^{-3}	−	2.37−3.16
26	Z	D–3.652	$f_{\log d}$ = d*n* / d log *d*, cm^{-3}	−	3.16−4.22
27	AA	D–4.870	$f_{\log d}$ = d*n* / d log *d*, cm^{-3}	−	4.22−5.62
28	AB	D–6.494	$f_{\log d}$ = d*n* / d log *d*, cm^{-3}	−	5.62−7.50
29	AC	Z+0.037	$f_{\log Z}$ = d*n* / d log *Z*, cm^{-3}	+	0.032–0.042
30	AD	Z+0.049	$f_{\log Z}$ = d*n* / d log *Z*, cm^{-3}	+	0.042–0.056
31	AE	Z+0.065	$f_{\log Z}$ = d*n* / d log *Z*, cm^{-3}	+	0.056–0.075
32	AF	Z+0.087	$f_{\log Z}$ = d*n* / d log *Z*, cm^{-3}	+	0.075–0.100
33	AG	Z+0.115	$f_{\log Z}$ = d*n* / d log *Z*, cm^{-3}	+	0.100–0.133
34	AH	Z+0.154	$f_{\log Z}$ = d*n* / d log *Z*, cm^{-3}	+	0.133–0.178
35	AI	Z+0.205	$f_{\log Z}$ = d*n* / d log *Z*, cm^{-3}	+	0.178–0.237
36	AJ	Z+0.274	$f_{\log Z}$ = d*n* / d log *Z*, cm^{-3}	+	0.237–0.316
37	AK	Z+0.365	$f_{\log Z}$ = d*n* / d log *Z*, cm^{-3}	+	0.316–0.422
38	AL	Z+0.487	$f_{\log Z}$ = d*n* / d log *Z*, cm^{-3}	+	0.422–0.562
39	AM	Z+0.649	$f_{\log Z}$ = d*n* / d log *Z*, cm^{-3}	+	0.562–0.750
40	AN	Z+0.866	$f_{\log Z}$ = d*n* / d log *Z*, cm^{-3}	+	0.75–1.00
41	AO	Z+1.155	$f_{\log Z}$ = d*n* / d log *Z*, cm^{-3}	+	1.00–1.33

No	Excel	Header	Value	Sign	Range, nm or $cm^2V^{-1}s^{-1}$
42	AP	Z+1.540	$f_{\log Z}$ = dn / d log Z, cm^{-3}	+	1.33–1.78
43	AQ	Z+2.054	$f_{\log Z}$ = dn / d log Z, cm^{-3}	+	1.78–2.37
44	AR	Z+2.738	$f_{\log Z}$ = dn / d log Z, cm^{-3}	+	2.37–3.16
45	AS	Z–0.037	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.032–0.042
46	AT	Z–0.049	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.042–0.056
47	AU	Z–0.065	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.056–0.075
48	AV	Z–0.087	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.075–0.100
49	AW	Z–0.115	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.100–0.133
50	AX	Z–0.154	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.133–0.178
51	AY	Z–0.205	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.178–0.237
52	AZ	Z–0.274	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.237–0.316
53	BA	Z–0.365	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.316–0.422
54	BB	Z–0.487	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.422–0.562
55	BC	Z–0.649	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.562–0.750
56	BD	Z–0.866	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	0.75–1.00
57	BE	Z–1.155	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	1.00–1.33
58	BF	Z–1.540	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	1.33–1.78
59	BG	Z–2.054	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	1.78–2.37
60	BH	Z–2.738	$f_{\log Z}$ = dn / d log Z, cm^{-3}	–	2.37–3.16
61	BI	sparsity	Number of unknown neighbors		0–2
62	BJ	rough_T+	Roughness along time, +	+	
63	BK	rough_T–	Roughness along time, –	–	
64	BL	rough_Z+	Roughness along mobility, +	+	
65	BM	rough_Z–	Roughness along mobility, –	–	
66	BN	bias+	Electrometer bias +, mV	+	
67	BO	bias–	Electrometer bias −, mV	–	
68	BP	maxneg+	Largest (–dZ/dlogN) in columns 29–38	+	
69	BQ	maxneg–	Largest (–dZ/dlogN) in columns 45–54	–	
70	BR	asym	Asymmetry of driving high voltage, promille		
71	BS	N+	Concentration of aerosol ions +, cm^{-3}	+	0.032–0.49
72	BT	N–	Concentration of aerosol ions −, cm^{-3}	–	0.032–0.49
73	BU	n+	Concentration of cluster ions +, cm^{-3}	+	0.49−3.16
74	BV	n–	Concentration of cluster ions −, cm^{-3}	–	0.49−3.16
75	BW	Z+	$Z_{average}$ of cluster ions +, $cm^2V^{-1}s^{-1}$	+	0.49−3.16
76	BX	Z–	$Z_{average}$ of cluster ions −, $cm^2V^{-1}s^{-1}$	–	0.49−3.16
77	BY	defect+	Complex index of disturbances		
78	BZ	defect–	Complex index of disturbances		

Additional explanations of complex variables:

- *DAY2010* – during 2010 equals Day of Year, during 2011 equals Day of Year + 365,
- *sparsity* – number of neighboring unknown values in the theoretical full table,
- *rough_T* – roughness of measurements in time,
- *rough_Z* – roughness of measurements in mobility,

Roughness is measured with mean square deviation of a value from cubic interpolation of four neighbors in time or in mobility. Let $x_{i,j}$ is the number in row *i* and column *j*.

$$rough\_T_i = 100 \frac{\sqrt{\sum_{j=a...b} \left(x_{i,j} - \left(-x_{i-2,j} + 4x_{i-1,j} + 4x_{i+1,j} - x_{i+2,j}\right)/6\right)^2}}{100 + \sqrt{\sum_{j=a...b} \left(x_{i,j}\right)^2}}$$

$$rough\_Z_i = 100 \frac{\sqrt{\sum_{j=a+2...b-2} \left(x_{i,j} - \left(-x_{i,j-2} + 4x_{i,j-1} + 4x_{i,j+1} - x_{i,j+2}\right)/6\right)^2}}{100 + \sqrt{\sum_{j=a+2...b-2} \left(x_{i,j}\right)^2}}$$

The boundaries are: a = 29, b = 38 for positive and a = 45, b = 54 for negative ions.

Parameter *defect* is a complex characteristic of disturbances calculated as follows:

$$defect = noise + maxneg/2 + rough\_T/3 + rough\_Z/2 + 10 \times sparsity^2,$$

where *noise* is the value in column 7 or 8 depending on the polarity.

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