WILEY

Continued Researches on the Height Variation of the Atmospheric Electric Potential
Gradient

Author(s): Harald Norinder

Source: *Geografiska Annaler*, Vol. 4 (1922), pp. 116-121

Published by: Wiley on behalf of Swedish Society for Anthropology and Geography

Stable URL: <http://www.jstor.org/stable/519739>

Accessed: 25-06-2016 01:44 UTC

Your use of the JSTOR archive indicates your acceptance of the Terms & Conditions of Use, available at
<http://about.jstor.org/terms>

JSTOR is a not-for-profit service that helps scholars, researchers, and students discover, use, and build upon a wide range of content in a trusted digital archive. We use information technology and tools to increase productivity and facilitate new forms of scholarship. For more information about JSTOR, please contact support@jstor.org.

Swedish Society for Anthropology and Geography, *Wiley* are collaborating with JSTOR to digitize, preserve and extend access to *Geografiska Annaler*

CONTINUED RESEARCHES ON THE HEIGHT VARIATION OF THE ATMOSPHERIC ELECTRIC POTENTIAL GRADIENT

By *HARALD NORINDER.*

In a previous work¹ the author proved that in the lowest layers of the air the potential gradient was subject to a very marked increase with the height. The general opinion hitherto was that the potential gradient should decrease. The absolute mean value of the potential gradient at Upsala was also found to be lower than the mean value of Europe, a fact already established by the author in an earlier publication.²

The researches in question were carried out on a field situated near the Meteorological Institution at Upsala. The field was situated on the border of the town, naturally a not very convenient locality for observations of atmospheric electricity. Therefore the author grasped the first opportunity of repeating his researches in a more convenient locality. The Royal Swedish Board of Waterfalls has established some research stations for thunderstorms, and as the author is in charge of the investigations in question it was quite natural to continue the observations of the height variation of potential gradient at one of the thunderstorm stations.

The electric station, situated 10 kilometres west of Upsala on the landed estate of Brunna was preferred for the purpose. The proprietor Mr. C. V. Rosenlund had with great courtesy allotted land for the station on one of his larger flat fields.

The location of the station in respect to surroundings is given in the map of fig. 1, where the level lines per each half metre elevation are drawn. The map extends over an area around the point of observation of about twenty times the height of observations.

The little wood (at *D* fig. 1) consists of trees at about 10 metres height and is not deep but continued by a greater field. The general location of the sta-

¹ Height Variation of Electric Potential Gradient. *Geografiska Annaler*. Häft. 1 1921. Stockholm 1921.

² K. Sv. Vetenskapsakademiens Handl. Bd 58 n:o 4. Stockholm 1917.

tion is a very open one. At C , C_1 (fig. 1) there are some remote trees at a height of 6—8 metres.

At the points A , B fig. 1 are erected two posts 15 metres in height and 100 metres apart; at right angles to them are erected at A_1 , B_1 fig. 1 two posts 9 metres in height. Near the post at B is placed the instrument hut about 4 metres in height. Between the posts horizontal insulated steel wires were fixed, carrying convenient collectors at the middle.¹ A general idea of the observation locality may be obtained from fig. 2.

Fig. 1. Map of the location of the Station.

used, on each wire with a polonium covered surface of 6 square centimetres on each wire, for later observations collectors with a polonium covered surface of 12 square centimetres on each wire.

By a simple manipulation the lower collector with wire and insulators could be changed for the upper one and vice versa. When the systems in question were perfect it was not possible to observe any difference in potential gradient

Fig. 2. The Station and its surroundings.

As to the special arrangements the reader is referred to the previous works of the author.

Table 1.

Individual Values of Potential Gradient at 0.5—13.25

Date	12.9	13.9	13.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	18.9	18.9	27.9	27.9
Time	6.50 p 7.30 p	7.20 p 7.50 p	8.0 p 8.30 p	10.50 a 11.20 a	0.0 p 0.30 p	1.35 p 2.0 p	6.10 p 6.50 p	7.10 p 8.0 p	10.5 p 10.30 p	10.50 p 11.30 p	9.40 a 10.20 a	10.45 a 11.30 a	5.10 p 5.40 p	6.30 p 7.0 p
Height m.														
0.5	41	8	8	39	39	56	31	22	55	31	55	59	76	61
1.25	46	18	22	40	50	31	28	33	48	24	48	64	31	33
3.25	72	22	33	31	42	33	31	37	37	20	72	98	40	24
5.25	44	52	59	33	44	37	42	46	55	31	55	72	39	31
7.25	61	55	35	39	46	35	55	42	37	37	35	85	29	37
9.25	77	39	40	52	42	33	42	40	37	55	64	114	39	42
11.25	—	37	57	48	—	37	50	46	—	35	—	—	42	—
13.25	—	—	66	18	—	—	55	44	—	—	—	—	—	—

Date	7.10	7.10	7.10	7.10	8.10	8.10	8.10	8.10	8.10	6.10	28.11	28.11	28.11	28.11
Time	11.50 a 0.30 p	0.40 p 1.10 p	3.0 p 3.20 p	5.30 p 6.10 p	10.50 a 11.20 a	11.30 a 0.5 p	4.25 p 5.0 p	5.20 p 5.40 p	5.50 p 6.20 p	6.25 p 6.55 p	1.10 p 1.30 p	1.50 p 2.10 p	2.30 p 2.50 p	2.50 p 3.20 p
Height m.														
0.5	90	89	84	109	86	97	33	28	28	41	42	46	44	25
1.25	94	96	72	63	99	57	0	0	24	6	49	42	49	44
3.25	114	120	116	83	74	116	37	40	63	— 6	76	66	66	59
5.25	85	129	114	96	112	98	42	37	116	35	66	63	73	52
7.25	94	123	109	140	51	35	94	103	109	68	71	73	56	56
9.25	110	123	143	70	96	57	127	68	103	39	68	73	54	54
11.25	—	121	153	88	—	57	136	86	114	24	73	61	61	66
13.25	—	—	162	123	—	24	162	105	109	112	—	39	56	51

before and after changing, provided that the observations in question were corrected for the variation of the potential gradient that occurred in the mean-while. The voltage differences of the collectors to earth were recorded by two Benndorf electrometers, which were kindly placed at my disposal by Professor Svante Arrhenius, Stockholm. The sensitiveness of the electrometers was tested by a Wulf electroscope with a system of suitable air condensers provided with a guard ring.¹

The distance between the collectors was 12.IX—8.X 51 centrimetres and later on 44 centimetres. The observed potential gradient was always reduced to volts per metre.

In observing the height variation of potential gradient practical experience showed that it was most convenient to observe as quickly as possible through

¹ The electroscope with air condensers was delivered by Günther et Tegetmeyer, Braunschweig.

metres above Ground in Volts per meter. Brunna 1921.

5.10	5.10	5.10	5.10	5.10	5.10	5.10	6.10	6.10	6.10	6.10	6.10	6.10	6.10	7.10	7.10
3.20 p	4.40 p	5.20 p	5.50 p	6.25 p	7.15 p	8.0 p	3.15 p	4.0 p	4.50 p	5.40 p	7.15 p	8.0 p	8.30 p	10.20 a	11.5 a
3.40 p	5.20 p	5.50 p	6.20 p	6.50 p	7.45 p	8.30 p	3.45 p	4.50 p	5.30 p	6.10 p	7.50 p	8.30 p	9.0 p	11.0 a	11.30 a
33	20	16	9	6	105	86	105	101	70	59	104	86	64	114	90
63	9	7	26	26	77	33	15	22	31	59	77	33	59	66	59
64	31	17	42	42	131	52	11	92	57	112	131	52	96	83	123
64	39	53	39	33	134	126	57	94	116	116	134	127	105	70	129
64	31	50	53	52	90	68	107	94	103	112	90	68	158	125	158
59	37	57	46	53	175	63	55	101	50	145	175	63	92	96	162
57	42	50	57	39	142	105	72	145	99	178	142	105	126	50	96
—	37	50	77	24	132	92	81	156	121	156	132	92	119	86	—
28.11	28.11	28.11	28.11	28.11	28.11	28.11	29.11	29.11	29.11	29.11	29.11	30.11	30.11	30.11	30.11
3.50 p	4.20 p	5.15 p	5.50 p	6.20 p	8.0 p	8.40 p	1.10 p	2.10 p	2.25 p	3.0 p	5.30 p	10.55 a	11.30 a	0.10 p	2.30 p
4.20 p	5.0 p	5.45 p	6.15 p	7.0 p	8.30 p	9.15 p	1.45 p	2.25 p	2.55 p	3.25 p	6.0 p	11.20 a	0.10 p	0.40 p	3.15 p
27	50	56	7	23	46	23	46	46	46	38	67	59	86	88	56
61	58	54	51	121	34	121	68	73	73	61	104	81	87	112	81
68	76	59	46	20	46	20	83	71	68	73	118	68	73	68	88
63	103	59	41	34	29	32	73	81	54	68	71	95	73	68	76
46	88	56	46	44	49	54	66	61	54	63	68	68	61	66	88
71	93	68	39	46	46	63	54	66	59	63	63	73	54	83	88
81	89	88	34	46	56	51	61	71	59	66	41	82	49	66	85
—	—	86	—	34	54	51	59	59	41	54	51	—	49	—	76

the whole height interval. This was made possible by a little improvement in the arrangements. The hoisting ropes for the collector carriages were so arranged that the collector wires could be controlled by one winch near the instrument hut. By this time was saved. When the collectors had to be moved up or down useless disturbance around the collectors was avoided. The time necessary for observing the gradient 0.5 to 13.25 metres above the ground was also shortened by observing only two minutes at each height interval 0.5, 1.25, 3.25—13.25 metres. When possible consecutive observation series were taken on the same day of observation. In table 1 the individual values of the potential gradient observed at Brunna are given.

The values are in general found during normal conditions on days without special disturbance in form of precipitation, fog, low clouds, etc. The variability of the potential during the time of observation was controlled by the percentage voltage difference of two consecutive minute recording points at the same height

above the ground. A tendency to relatively greater variability was sometimes found at the higher intervals and therefore the corresponding observations had to be omitted.

The observations include two periods:

1) 12.IX—8.X 1921. On account of the retarded autumn, the values of this period may be regarded as typical for advanced summer conditions.

2) 28.XI—30.XI 1921. During this period the ground was frozen and partly covered with snow around the observation locality. The values obtained are characteristic for autumn conditions.

By comparing consecutive observation series in tab. 1 we can find values of the potential gradient that seem to be very markedly influenced by the effect of ion absorption. During observations in the daytime the absorption of ions is not so pronounced as during observations in the evening. Therefore the height variation of potential in comparable observation series is not so striking during observations 10 a—5 p as for the later ones.

The mean values for the two periods of observation and for different height intervals (0—9.25 metres, 0—11.25 metres and 0—13.25 metres respectively) are given graphically in fig. 3. For the sake of comparison, the corresponding gradient values of Upsala, for summer and for autumn—spring, are also reproduced in fig. 3. The first period of observation 12.IX—8.X is to be found to the left in figure 3 (a).

We can establish:

a) By fig. 3 (a) a very marked increase with height of the potential gradient at Brunna. This prevails also for Upsala. The difference in gradient variation of the two places is to be found nearest to the ground. The potential gradient in Upsala was proved to decrease nearest to the ground. My explanation of this fact was an outflow of positive ions in excess through the capillaries from the earth. At Brunna, contrary to Upsala, the locality of observation was surrounded by large freshly ploughed fields, which naturally involved a greater outflow of positive ions. Therefore the gradient decrease at Brunna is more marked than at Upsala. At Brunna the effect of the outflow of ions is supposed to reach 3—4 metres, and if we presume a curve with this effect eliminated it must be somewhat like the dotted one in fig. 3. The difference of absolute mean potential gradient values as illustrated by the Upsala curve of fig. 3 (a) and the dotted one of Brunna can be fully explained by the yearly variation of the potential gradient. The curve of Upsala also contains observations during the middle of summer.

b) By fig. 3 (b) a very marked increase of the potential gradient nearest to the ground at Brunna that is not to be found in the corresponding values at Upsala. This difference may be explained by the conditions of observation.

At Brunna the values are found with the ground frozen and partially snow-covered, contrary to many observations at Upsala, which were influenced by an unfrozen ground and a more intense outflow of positive ions in excess. The height variation at Brunna and at Upsala agrees higher up and the variation of the two localities is to be considered as a transition stage to winter conditions.

Thus I have established that the height variation of the potential gradient,

Fig. 3. Relation between Height and Potential Gradient.

that was the result of my investigation at Upsala also holds good for another locality of observation, where, owing to the absence of smoke and dust disturbances the observation conditions were more favourable. In the lowest layers of the air apart from the stratum nearest to the ground there prevails as a rule a negative volume charge in excess. According to the investigations the mean potential gradient at Brunna is, as was the case also at Upsala, considerably lower than the potential gradient that has been found as a mean value for Europe.