NOTE

Current Data on the Chemical Composition of Air and Precipitation

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Last spring an informal conference on atmospheric chemistry, initiated by Prof. C. G. Rossby, was held at the Meteorological Institute of the University of Stockholm and a note on this conference was published in Tellus (ERIKSSON, 1954). Among other things a new network of collecting stations for precipitation and air samples was discussed; this network was to extend over the whole of Scandinavia and Britain. A preliminary plan was adopted, and after the conference, detailed plans were drawn up jointly by the two institutions mentioned above, in cooperation with Professor K. BUCH (Finland), Professor J. LÅG (Norway), and Dr R. M. GOODY (Gr. Britain). The Danish net was planned according to advices kindly given by Director FRODE HANSEN, Studsgaard, and interested support was given by the directors and assistants of three agricultural experiment farms proposed as station sites in Britain.

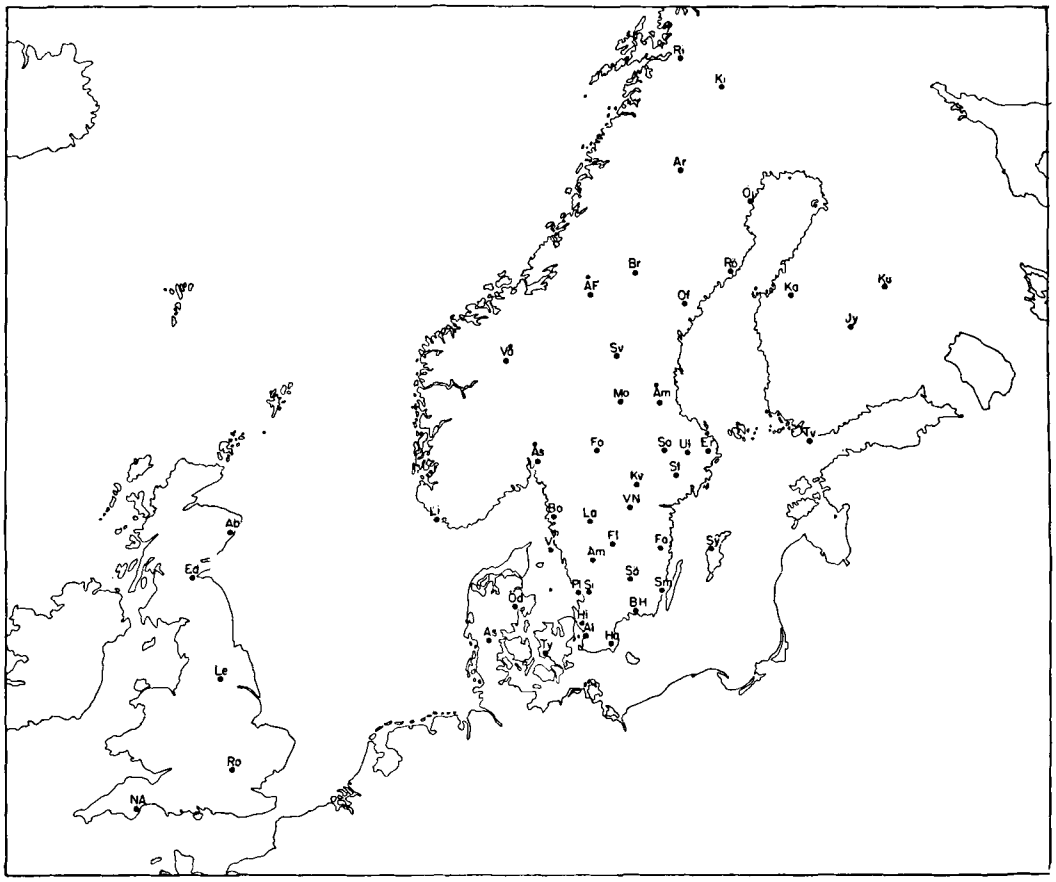
The Swedish network was constructed by slight rearrangements and extension (particularly in the northern parts of Sweden) of the network built up by one of us (EGNÉR) in the last few years with financial aid from the Swedish research councils of agriculture and natural sciences. The experience of sampling technique and analytical procedures acquired at the Agricultural College thus could be utilized.

The new equipment was built and assembled in the fall of 1954 in Uppsala and sent out and installed with the cooperation of Mr G. BRODIN, and Mr O. JOHANSSON of the Agricultural College, and Mr S. FONSELIUS of the Meteorological Institute. Unfortunately, the installation of the British stations has been delayed due to the stevedore strike during the last months of 1954. This installation will be completed as soon as possible. The sampling at the rest of the stations started on November 1, 1954.

The operation of the project has been made possible by a substantial economical support from the Wallenberg Foundation in Sweden, covering costs of new equipment, installations, and analytical work. Economical support has been given by the other participating countries, as well, to cover the cost of electric connections to the stations, maintenance of the same and postage in these countries.

During the conference last spring it was recommended that the analytical data for three months periods should be sent out to all participants in mimeographed form. After some reconsideration it has been decided that they should be published in TELLUS for each three months period as a special bulletin. In this way the data will be available to all people interested in atmospheric chemistry.

In this first report on the subject a map showing the location of the stations is given in which the stations are indicated by code designations as printed below the map. In addition the chemical data on precipitation and air for Nov. and Dec. 1954 are listed. Each month is given a code number, where the first figure is the last figure of the year and the



Map showing the position of sampling stations. The name of the station corresponding to the code letters are as follows:

Code	Station	Code	Station	Code	Station	Code	Station
Ri	Riksgränsen	Ul	Ultuna	Pl	Plönninge	Jy	Jyväskylä
Ki	Kiruna	Er	Erken	Sö	Söraby	Tv	Tvärminne
Ar	Arjeplog	St	Strängnäs	Sm	Smedby	Öd	Ödum
Öj	Öjebyn	Fo	Forshult	Sy	Sylfaste	As	Askov
Rö	Röbäcksdalen	Kv	Kvarntorp[2]	BH	Bräkne-Hoby	Ty	Tystofte
Of	Offer	VN	Västra Ny	Ha	Hammenhög	Ab	Aberdeen
Br	Bredkälen	La	Lanna	Al	Alnarp	Ed	Edinburgh
ÅF	Åre	Bo	Bornö	Hi	Hilleshög	Le	Leeds
ÅH	Åre, Hummeln[1]	Vi	Vinga	Ås	Ås	Ro	Rothamsted
Sv	Sveg	Fa	Falsterbobruk	Vå	Vågåmo	NA	Newton Abbot
Mo	Mora	Fl	Flahult	Li	Lista		
Åm	Åmot	Am	Ambjörnarp	Ka	Kauhava		
Sa	Sala	Si	Simlångsdalen	Ku	Kuopio		

[1] ÅH located a few km from ÅF

[2] Kv 1 and Kv 7 are at one and seven km distance resp. from a large slate burning plant.

two following figures give the number of the month. The letter D in front of the code number refers to precipitation whereas L refers to air samples. In each country, the stations are registered from north to south. A very brief description of the technique of sampling, and of analytical procedures follows.

The instrument cabinet is a double walled box

D 411

Station	Code	mm	mg/m²								pH	$\frac{\mu val}{l}$ HCO_3^-	ohm^{-1} · cm^{-1} $\varkappa \cdot 10^6$
			S	Cl	NO_3-N	NH_3-N	Na	K	Mg	Ca			
Riksgränsen	Ri	8	—	13	0	0	12	—	—	—	6.6	—	17
Kiruna	Ki	10	2	3	0	0	6	1	1	9	6.4	41	14
Arjeplog	Ar	4	0	0	1	2	7	0	0	16	6.7	—	37
Öjebyn	Öj	25	25	22	5	9	13	10	4	24	6.2	50	20
Röbäcksdalen	Rö	48	47	39	8	14	31	5	4	15	4.8	0	23
Offer	Of	22	32	23	5	16	29	5	4	28	6.5	41	29
Bredkälen	Br	8	13	11	3	6	16	1	3	10	6.9	—	34
Åre	ÅF	20	3	18	2	2	11	2	3	7	5.4	0	11
Åre, Hummeln	ÅH	—	—	—	—	—	—	—	—	—	—	—	—
Sveg	Sv	14	2	12	3	4	22	7	4	24	6.3	51	31
Mora	Mo	14	6	12	4	5	9	5	4	41	6.8	81	31
Åmot	Åm	57	60	48	11	27	32	11	6	29	5.0	0	20
Sala	Sa	69	92	62	12	33	55	42	13	78	6.3	18	22
Ultuna	Ul	69	79	86	14	33	65	13	11	32	4.9	0	25
Erken	Er	61	65	90	11	12	61	27	13	44	5.0	0	23
Strängnäs	St	63	60	54	11	20	45	8	7	29	5.0	0	18
Forshult	Fo	75	64	75	14	19	60	10	9	26	4.7	0	24
Kvarntorp	Kv1	76	394	217	19	74	152	32	29	229	3.9	0	132
Kvarntorp	Kv7	—	—	—	—	—	—	—	—	—	—	—	—
Västra Ny	VN	86	74	127	15	25	98	18	16	35	5.1	0	20
Lanna	La	72	102	279	19	40	179	40	27	60	6.1	22	32
Bornö	Bo	131	53	783	21	22	453	34	66	56	4.9	0	38
Vinga	Vi	77	343	7,840	22	20	4,870	180	570	251	5.0	0	474
Falsterbobruk	Fa	49	49	46	9	14	33	35	7	23	5.6	13	18
Flahult	Fl	56	54	136	10	20	81	20	10	26	5.1	0	24
Ambjörnarp	Am	68	69	302	18	23	196	18	22	41	5.1	0	33
Simlångsdalen	Si	84	65	554	20	26	424	26	63	37	4.7	0	45
Plönninge	Pl	59	109	498	22	56	323	25	42	44	4.7	0	63
Söraby	Sö	28	82	126	12	15	115	13	15	57	5.4	0	53
Smedby	Sm	32	38	138	10	17	66	19	9	137	6.6	68	49
Sylfaste	Sy	48	50	85	12	16	68	13	8	34	5.5	0	21
Bräkne-Hoby	BH	53	86	155	20	46	99	12	13	35	4.8	0	38
Hammenhög	Ha	56	83	220	17	41	136	38	17	46	5.2	0	36
Alnarp	Al	60	108	183	16	34	134	18	16	86	4.9	0	39
Hilleshög	Hi	39	107	200	16	30	133	19	33	111	6.4	5	55
Ås	Ås	134	82	159	19	22	119	19	15	33	5.0	0	16
Vågåmo	Vå	2	1	0	—	1	0	1	0	4	6.7	—	—
Lista	Li	100	274	2,850	36	49	1,600	82	215	116	4.8	0	142
Kauhava	Ka	9	9	15	5	4	5	0	3	7	6.4	22	17
Kuopio	Ku	31	13	8	4	2	12	1	2	9	5.9	5	7
Jyväskylä	Jy	38	16	12	5	3	22	2	3	10	6.0	7	7
Tvärminne	Tv	57	36	142	10	11	89	9	10	18	4.9	0	22
Ödum	Öd	63	136	696	18	57	425	29	48	68	5.0	0	67
Askov	As	56	122	648	18	52	425	30	51	57	4.8	0	76
Tystofte	Ty	46	142	217	16	102	140	15	18	45	5.4	0	55

of hard masonite, some 50 × 50 × 50 cm³, built on a frame-work of wooden rods and well insulated with rock wool. The four legs are dug into the ground to make a rigid stand. The temperature is kept above freezing by help of electric heating (incandescent bulb, blackened to prevent growth of algae) governed by a thermostat relay set at +6° C. Precipitation is collected by help of a glass funnel with an area of about 180 cm², tightly inserted in the roof, and connected to a sampling bottle inside the cabinet. A device to prevent contaminations from bird droppings (EGNÉR, ERIKSSON, and EMANUELSSON, 1949) is used. Sampling bottles of pyrex glass or polyethylene are exchanged for new ones every month and immediately sent to Uppsala for analysis. Like everything else in the equipment,

D 412

Station	Code	mm	mg/m²								pH	$\frac{\mu val}{l}$ HCO_3^-	ohm^{-1} · cm^{-1} $\varkappa \cdot 10^6$
			S	Cl	NO_3-N	NH_3-N	Na	K	Mg	Ca			
Riksgränsen	Ri	8	1	11	1	1	8	0	1	3	5.8	10	9
Kiruna	Ki	15	9	1	1	0	1	1	2	4	5.3	0	8
Arjeplog	Ar	19	15	9	5	4	16	2	3	13	6.0	11	11
Öjebyn	Öj	40	37	24	7	12	43	10	6	25	6.2	40	16
Röbäcksdalen	Rö	65	60	5	14	17	52	8	6	13	4.7	0	21
Offer	Of	36	34	22	8	12	32	6	5	22	6.2	16	14
Bredkälen	Br	13	11	14	4	7	13	2	2	0	5.9	6	16
Åre	ÅF	31	16	66	4	4	47	8	7	7	5.8	8	15
Åre, Hummeln	ÅH	—	—	—	—	—	—	—	—	—	—	—	—
Sveg	Sv	30	8	9	5	0	35	2	7	27	6.8	64	13
Mora	Mo	47	31	13	7	8	15	7	4	32	6.1	15	10
Åmot	Åm	70	39	26	11	12	34	10	4	16	5.6	4	9
Sala	Sa	53	49	32	11	8	28	6	5	25	4.9	0	16
Ultuna	Ul	42	46	38	13	19	31	9	4	9	4.7	0	23
Erken	Er	31	44	39	9	8	30	5	7	27	5.0	0	24
Strängnäs	St	43	47	32	14	15	29	7	5	25	5.4	0	16
Forshult	Fo	78	46	58	15	11	54	7	11	24	5.4	0	11
Kvarntorp	Kv1	61	392	56	14	42	52	22	20	345	4.5	0	72
Kvarntorp	Kv7	62	63	107	14	14	83	9	12	42	5.0	0	23
Västra Ny	VN	73	48	35	14	12	37	5	6	20	5.1	0	12
Lanna	La	39	39	83	8	14	66	7	14	30	6.3	19	20
Bornö	Bo	69	66	473	19	17	310	19	36	36	5.4	0	36
Vinga	Vi	64	234	3 550	18	13	2,300	90	242	112	5.4	0	223
Falsterbobruk	Fa	43	32	36	10	5	27	6	4	15	4.9	0	16
Flahult	Fl	75	47	95	13	11	66	11	9	22	4.8	0	19
Ambjörnarp	Am	89	65	153	16	18	117	13	13	38	5.3	0	17
Simlångsdalen	Si	144	97	253	29	36	172	15	28	18	4.6	0	25
Plönninge	Pl	89	89	330	18	36	208	14	25	30	4.7	0	20
Söraby	Sö	57	63	104	14	14	88	10	11	26	5.6	38	30
Smedby	Sm	41	40	46	12	10	66	7	8	50	6.6	40	20
Sylfaste	Sy	37	39	43	12	13	37	5	6	24	5.3	0	19
Bräkne-Hoby	BH	58	84	115	23	95	92	34	55	21	6.6	66	31
Hammenhög	Ha	88	104	177	22	48	118	19	14	35	4.7	0	27
Alnarp	Al	86	155	283	18	41	175	23	26	93	4.8	0	34
Hilleshög	Hi	81	108	360	16	35	222	19	28	41	4.5	0	29
Ås	Ås	74	60	178	19	17	138	12	17	26	4.9	0	22
Vågåmo	Vå	22	10	9	4	7	15	4	3	5	6.3	30	10
Lista	Li	171	425	5,860	33	23	3,880	176	430	144	4.8	0	151
Kauhava	Ka	34	16	17	6	7	16	2	10	12	6.0	10	9
Kuopio	Ku	23	13	5	4	2	7	0	14	3	5.0	0	10
Jyväskylä	Jy	Sample spoiled by accident											
Tvärminne	Tv	60	51	154	17	13	116	13	13	32	4.7	0	26
Ödum	Öd	60	96	490	8	39	327	16	34	28	5.8	12	43
Askov	As	104	160	1,406	17	52	917	47	90	59	4.8	0	66
Tystofte	Ty	55	104	401	11	62	295	20	61	58	6.3	21	48

these must be kept scrupulously clean and protected from contaminations, and are steamed out between sampling periods.

The air sample is sucked in through a glass tube in the roof of the cabinet, and washed in modified *Cauer*-tubes (CAUER, 1935) with fritted glass plates, using very dilute nitric acid with hydrogen peroxide as wash solution. The volume is measured in a dry gas meter. A low capacity (3 watts) electric pump, "aerator", pumps about 30 m³ of air per month, which gives an amount of solutes sufficient for analysis. Here, too, the samples are sent to Uppsala monthly.

The analytical determinations are all carried out in the Inst. of General Chemistry of the Royal Agricultural College of Sweden in Uppsala, under

Station	Code	L 411 $\mu g/m^3$ (=kg/km³)							L 412 $\mu g/m^3$ (kg/=km³)						
		S	Cl	NH_3-N	Na	K	Mg	Ca	S	Cl	NH_3-N	Na	K	Mg	Ca
Riksgrønsen	Ri	0.0	0.0	1.2	4.1	4.1	0.5	8.1	—	—	—	—	—	—	—
Kiruna	Ki	0.0	0.0	0.1	2.6	1.1	0.0	6.2	Sample spoiled (dry)						
Arjeplog	Ar	0.7	22.4	0.9	1.3	0.4	0.3	18.6	0.2	4.5	1.1	0.4	0.0	0.8	3.2
Öjebyn	Öj	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Röbäcksdalen	Rö	20.2	0.2	3.8	9.7	5.0	1.6	132.	5.7	3.8	1.4	2.9	1.4	0.9	2.5
Offer	Of	0.0	0.5	1.2	0.6	0.2	0.0	4.3	1.7	0.3	1.7	0.6	0.0	0.7	1.9
Bredkälen	Br	0.0	1.8	1.3	2.4	2.9	0.0	6.2	2.4	3.3	0.9	2.1	0.0	0.8	0.5
Åre	ÅF	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Åre, Hummeln	ÅH	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sveg	Sv	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mora	Mo	6.3	0.0	1.8	0.8	0.4	0.3	4.2	7.5	0.8	2.2	1.0	0.1	0.1	0.8
Åmot	Åm	1.5	0.2	1.0	1.3	1.6	0.1	2.2	2.6	0.0	1.4	1.2	0.3	0.4	0.6
Sala	Sa	6.6	0.9	1.5	0.8	0.8	0.2	10.5	9.4	0.0	1.7	0.9	0.6	0.0	1.8
Ultuna	Ul	6.8	0.8	0.8	0.4	0.1	0.1	0.0	9.7	0.1	1.4	1.1	0.6	0.0	0.6
Erken	Er	0.5	0.9	0.5	0.4	0.9	0.4	0.9	6.7	0.4	1.9	1.3	1.3	0.6	1.8
Strängnäs	St	6.8	1.1	1.5	1.4	0.6	0.5	0.4	3.9	0.6	1.9	0.7	0.4	0.1	0.8
Forshult	Fo	—	—	—	—	—	—	—	0.7	0.7	1.2	0.3	0,0	0.0	0.7
Kvarntorp	Kv1	77.0	0.2	8.4	2.6	2.6	1.1	19.8	79.2	2.4	7.1	0.8	0.2	0.8	6.3
Kvarntorp	Kv7	4.4	0.8	0.5	0.3	0.3	0.1	1.1	4.2	1.3	0.9	0.3	0.0	0.1	0.8
Västra Ny	NV	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lanna	La	15.7	8.4	5.3	6.9	4.7	0.8	6.4	3.4	0.6	2.1	1.3	0.0	0.8	2.7
Bornö	Bo	4.6	8.7	1.0	6.9	2.4	1.1	11.8	4.6	3.1	1.9	3.7	0.0	1.3	3.8
Vinga	Vi	32.1	185.0	2.0	109.0	5.8	14.5	7.8	11.5	97.4	1.0	43.5	1.6	5.1	2.0
Falsterbobruk	Fa	18.9	3.7	2.0	0.9	0.8	0.2	0.6	0.0	2.4	0.8	0.5	0.0	0.1	0.6
Flahult	Fl	5.4	20.6	1.9	1.6	0.6	0.1	13.9	4.0	3.6	1.0	0.6	0.0	0.0	1.3
Ambjörnarp	Am	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Simlångsdalen	Si	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Plönninge	Pl	16.5	4.7	3.2	2.4	0.3	0.4	1.0	9.2	1.5	4.3	1.2	0.0	0.2	0.5
Söraby	Sö	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Smedby	Sm	6.1	1.9	1.3	0.8	0.7	0.2	0.7	4.5	1.6	1.3	0.6	4.9	0.0	0.8
Sylfaste	Sy	0.0	2.3	3.0	5.4	4.5	1.3	5.4	7.2	0.0	1.8	1.8	0.6	0.7	1.1
Bräkne-Hoby	BH	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hammenhög	Ha	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Alnarp	Al	16.0	7.1	3.2	3.6	1.5	0.7	2.7	13.7	2.8	2.0	3.2	0.1	0.0	1.3
Hilleshög	Hi	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ås	Ås	5.4	0.9	0.5	1.8	0.8	0.1	0.5	—	—	—	—	—	—	—
Vågåmo	Vå	0.0	3.0	5.1	2.6	0.5	0.8	0.0	1.6	0.0	2.7	0.2	0.0	0.9	1.1
Lista	Li	6.3	19.1	1.0	10.7	0.4	1.2	0.0	4.6	31.4	0.5	13.4	1.0	1.3	1.1
Kauhava	Ka	0.0	150.0	1.3	1.3	0.0	0.2	0.0	4.6	1.4	1.8	2.4	0.5	1.1	2.7
Kuopio	Ku	0.0	25.9	0.4	2.4	0.1	0.1	0.0	—	—	—	—	—	—	—
Jyväskylä	Jy	0.5	7.2	1.0	0.9	0.7	0.1	0.0	2.9	0.6	0.6	3.5	0.2	0.2	1.5
Tvärminne	Tv	0.0	5.4	0.6	1.9	0.1	0.7	0.0	2.7	4.4	0.6	3.5	0.0	0.4	0.8
Ödum	Öd	7.6	0.0	2.8	1.7	0.6	0.3	0.0	6.9	2.6	3.1	1.3	0.0	0.2	0.6
Askov	As	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Tystofte	Ty	10.2	7.3	5.2	2.0	0.0	0.3	0.0	7.8	4.2	5.4	1.8	0.5	2.7	4.1

the supervision of one of us (EGNÉR) and under the immediate direction of Mr G. BRODIN.

The precipitation collected is weighed, and recalculated to millimeters to make it possible to express the constituents found in concentration units, if so desired. They are given in the tables, however, in milligrams per m^2, with the self-evident exception of pH, conductivity, and bicarbonate ion.

Ammonia and nitrate are determined in one aliquot of the sample by successive destillations in all-glass stills with excess of sodium hydroxide, and Devarda's alloy. The final estimate of ammonia is made with a special Nessler technique, using a photoelectric colorimeter.

In another aliquot, electric conductivity (small pipette electrode vessel with unplatinized electrodes), and pH (glass electrodes) are first measured. To ascertain the content of "free" acid, or bicarbonate, microtitration to a pH of 5.5 is then

carried out (methyl red indicator, titrated to hue of buffer).

The determinations just described have to be made in the fresh sample after minimal contact with laboratory atmosphere (which, in turn, has to be kept as clean as possible). For the rest of the determinations, the samples as a rule are evaporated on a steam bath to a volume of about 100 ml. In aliquots of this volume, sulfur compounds (oxidized to sulfate) are determined by conductometric microtitration with barium trichloracetate (special method) and chloride in another aliquot by the same technique, using silver nitrate.

Sodium, potassium, and calcium are determined with a flame photometer (Beckman UD, acetylene-oxygen flame, multiplier attachment). Magnesium is measured colorimetrically with thiazol yellow (HUNTER, 1950), using a Beckman B spectrophotometer.

The air samples arrive at the laboratory in 100 ml Jena bottles, and are analyzed for the same main constituents as the precipitation samples, with the exception—forced upon us by the technique of sampling—of nitrate, pH, conductivity, and bicarbonate. The analytical technique is the same as for precipitation, but some modifications must be made on account of the still smaller amounts in the air samples.

Details of the sampling, and analytical procedures will be given elsewhere. Quite a lot of precautions as to the purity of reagents etc. have to be taken, and some of the methods used have been worked out particularly for this purpose.

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