

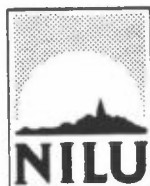
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INTEGRATED FOREST STUDY ON EFFECTS OF  
ATMOSPHERIC DEPOSITION

Study area: Nordmoen

Annual report 1986, NILU

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ROYAL NORWEGIAN COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

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## SUMMARY

The Norwegian Forest Institute has started a field research programme at Nordmoen in Akershus county to evaluate the role of acid deposition in producing changes in forest nutrient cycling. The programme is financed mainly by EPRI, USA, and is coordinated with similar programmes in USA. This is accomplished by undertaking atmospheric deposition and meteorological measurements in cooperation with the Norwegian Institute for Air Research (NILU) and nutrient cycling measurements.

In this report the measurements made by NILU are described. The NILU programme was started up in April 1986, with measurements of the main chemical components in precipitation and air, including ozone. Sampling of dry deposition and fog with a NILU-designed collector was started in November 1986.

Meteorological measurements were also started in January, comprising wind velocity and air temperature 30 m above the ground, temperature difference (air stability) between 30 and 6 m above the ground and radiation and relative humidity at 6 m above the ground.

Some results are presented, including the first test results of the combined dry deposition/fog collector.

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## 1 INTRODUCTION

The Norwegian Forest Institute has started a field research programme at Nordmoen in Akershus county to evaluate the role of acid deposition in producing changes in forest nutrient cycling. This is accomplished by undertaking atmospheric deposition and meteorological measurements in cooperation with the Norwegian Institute for Air Research (NILU), and nutrient cycling measurements. This programme is financed mainly by EPRI, USA, and is coordinated with similar programmes in USA.

In this report the measurements made by NILU in 1986 are described. Main cooperators at NILU have been V. Dahl, R. Dreiem, J.H. Wasseng (instrumentation), J.E. Hanssen and G. Staff Knudsen (chemistry), and A. Semb and S. Larsen (design and production of the fog/dry deposition collector).

## 2 MEASUREMENTS

### 2.1 SITE DESCRIPTION, LOCATION

The site is located at Nordmoen Field Station (11°06' E., 60°16' N) about 60 km north of Oslo at an elevation of 200 m (Fig. 1).

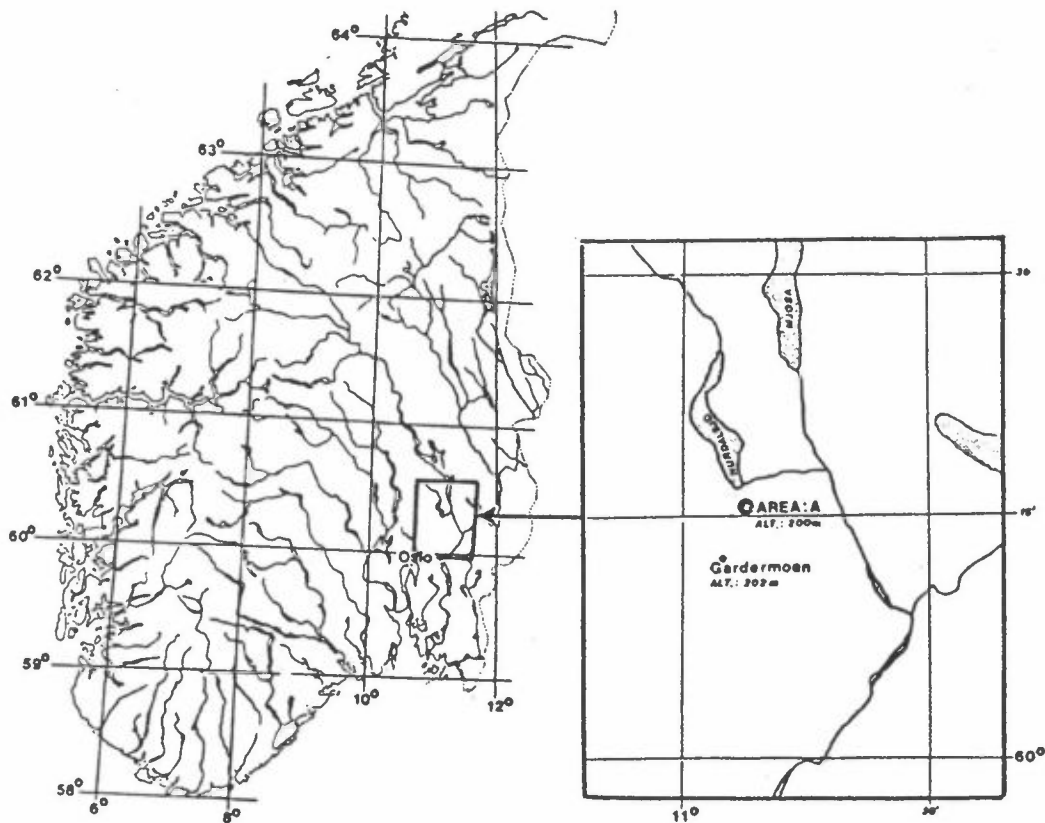


Figure 1: The location of the Norway Spruce site.

## 2.2 TOWER

A telescopic tower was completed in an opening of the spruce stand, and a heated instrument house with AC line power was installed near the base. The tower is situated 100 to 150 m from the soil and throughfall plots. The tower is 30 m high, extending 5 m above the mean height of the established canopy.

## 2.3 METEOROLOGICAL AND OZONE EQUIPMENT

The set up of the station is shown in Figure 2. The installation of the 30 m tower and the field testing of the sensors and the data logger took place in January 1986. The wind speed (Vaisala anemometer WAA), direction (NILU design, digital 8 bit, grey code) and air temperature (platina resistance, Pt 1000) is measured at the height 30 m. The temperature difference (air stability) is measured between the heights 30 m and 6 m. The radiation (Schenk star pyranometer, No. 1293)

and the relative humidity (hair hygrometer and transducer), is measured at 6 m above the ground. The hygrometer is calibrated regularly. All different measuring devices are mounted on separate booms.

The Dasibi ozone unit and its data logger is installed in the instrument house, and the sensor has its sampling inlet at 2.5 m above the ground. From January 1987 the sampling will be made 10 m above the ground by means of a telescopic mast.

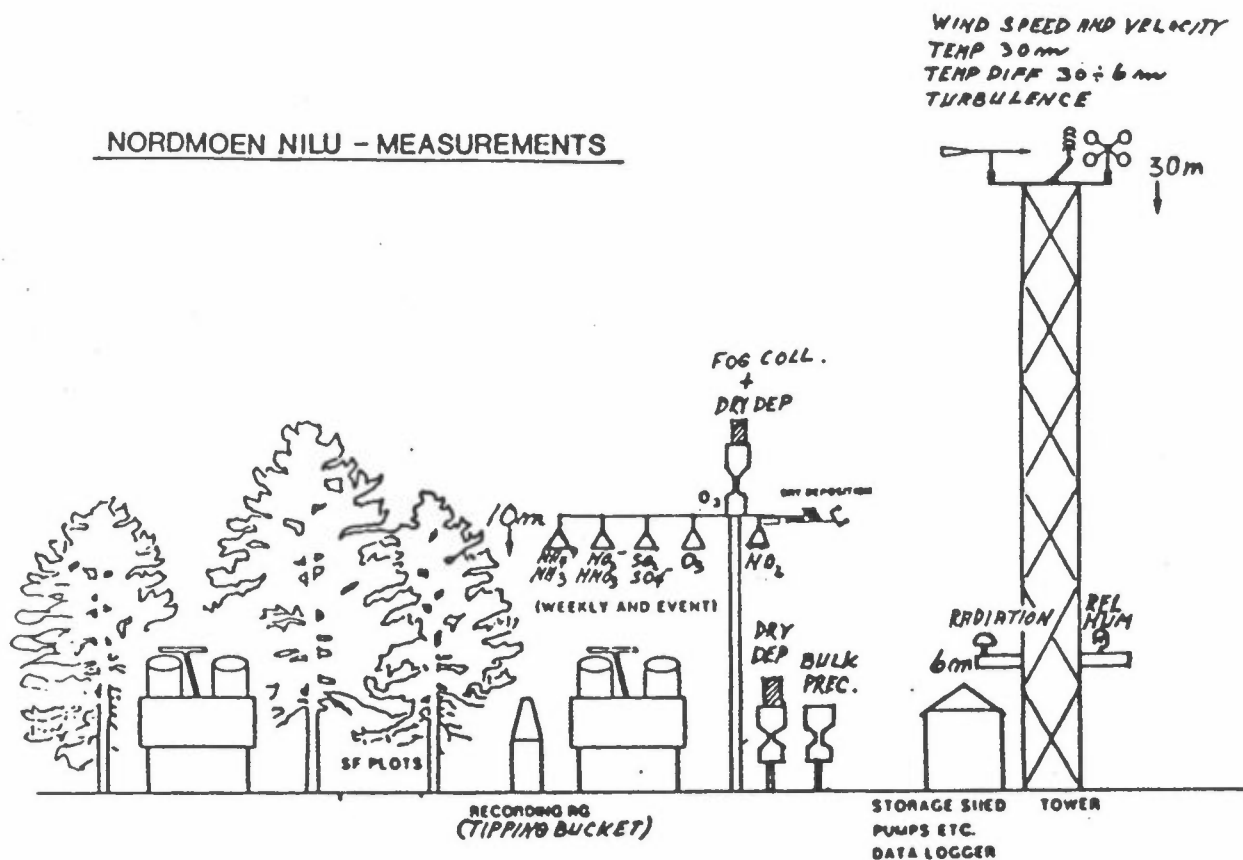


Figure 2: The atmospheric deposition sampling at the Norway Spruce site.

#### 2.4 DRY DEPOSITION, ATMOSPHERIC CHEMISTRY, FOG AND PRECIPITATION COLLECTORS

During January 1986, the filter packs for aerosol- and gas sampling were mounted, with 2.5 m as sampling heights. The sampled components are  $\text{SO}_2$ -gas,  $\text{SO}_4^{2-}$ -aerosols,  $\text{NO}_2$ -gas, total  $\text{NH}_4^+ + \text{NH}_3$  and total  $\text{NO}_3^- + \text{HNO}_3$ . The samplings are made 3 times a week (two, two and three days in sequence). Filterblanks are analyzed weekly. In Table 1 is listed information about the different analyses.

Table 1: Chemical analyses.

	Filter	Impregnation	Analytical method	Detection level
SO <sub>2</sub>	Whatman 40	KOH (1N)	Ion chromatography	0.1 μgS/m <sup>3</sup>
SO <sub>4</sub>	" "		" "	0.01 μgS/m <sup>3</sup>
NO <sub>2</sub>	-	-	TGS-ANSA method Norw. standard 4855	0.3 μgN/m <sup>3</sup>
NO <sub>3</sub> + HNO <sub>3</sub>	Whatman 40	NaOH (1%)	Ion chromatography	0.01 μgN/m <sup>3</sup>
NH <sub>4</sub> + NH <sub>3</sub>	" "	Oxalic acid (3%)	Indophenol method	0.01 μg/m <sup>3</sup>

The dry deposition is calculated by multiplying the measured concentrations with empirically determined deposition velocities, which depend on seasonally varying surface conditions (wetness, physical acitivity of the vegetation) and variation of the air stability.

From January 1987 the sampling will be made at the height 10 m by means of a telescopic mast, and connected to mass flow controlled air pumps mounted in the instrument house at the base.

A dry deposition collector for coarse particles will be installed at the same height (10 m), when received from ORNL.

It is, as yet, not planned to apply active fog sampler in the Norwegian field experiment.

A new combined, passive fog and dry deposition sampler has been designed, as shown in Figure 3. The diameter of the polypropylene netting threads is similar to the spruce needles. This sampler will be applied during the summer season, generally as weekly sampler but also on event basis. It will be used in combination with a bulk sampler of the same design, to obtain a measure of the net deposition to the forest stand. The ratio between the total deposition area of the present netting and the opening of the precipitation gauge corresponds to a "leaf area index" (LAI) of 7.88. A typical average forest in southern Norway consists of 25 spruces, 12 pines and 7 birches per decare, with a total needle/leaf area of 4.4 decares (LAI 4.4). The leaf area for the forest stand at Nordmoen will be estimated later.

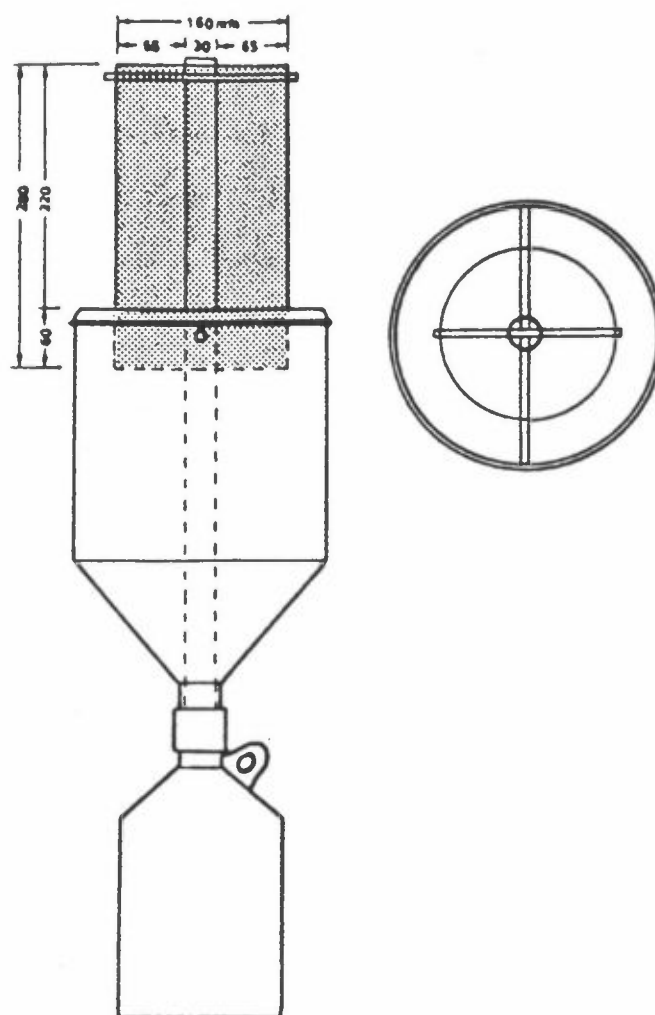


Figure 3: The combined passive fog and dry deposition sampler (NILU).

Two of this sampler type have been installed at Nordmoen in November 1986 at the site for incident precipitation to test the reproducibility of the sampling. One sampler is exposed at the Norwegian Institute for Air Research. Some results are discussed in Chapter 3.

The site for incident precipitation was installed in January 1986 100-150 m from the soil plots in the forest clearing near the 30 m tower. At this site has hitherto been used two bulk samplers for analyses in precipitation of the main ions ( $H^+$  (pH)),  $SO_4^{2-}$ ,  $NO_3^-$ ,  $NH_4^+$ ,  $CA^{2+}$ ,  $K^+$ ,  $Mg^+$ ,  $Na^+$ ,  $Cl^-$ ) and the heavy metals Pb, Cd and Zn. The samples are not analysed for alkalinity, because the pH is mainly below 5.5.



The bulk sampling is made weekly and as event sampling. Some typical results are shown below. As rain recorder is used a tipping bucket, type Lambrecht 1518H3.

Three commercial wet-only rain samplers (Parelco AAPS, Finland) were delivered from the factory in December 1986. This equipment is now being tested in the field and will probably be ready for operation in January 1987. One sampler will be placed in the clearing near the bulk and dry deposition/fog sampler. The other two samplers will be placed in the forest stand. The sampling frequency is weekly, but some event samples will be collected during intensive periods.

### 3 SAMPLE RESULTS

Table 2 gives some bulk precipitation data from the first summer season 1986 at Nordmoen.

Table 2: Precipitation concentrations March to July 1986.

Date	H <sup>+</sup>	Na	K	Mg	Ca	NH	NO <sub>3</sub>	SO <sub>4</sub>	Cl	SO <sub>4</sub>	SO <sub>2</sub>	NO <sub>2</sub>	HNO <sub>3</sub> +	NH <sub>3</sub> +	NH <sub>4</sub>
	µeq/l									µgS/m <sup>3</sup>		µgN/m <sup>3</sup>			
March	54	23	2	3	4	39	43	46	21	1.49	1.3	2.9	-	1.33	
April	47	13	1.2		6	102	45	48	17	1.10	0.5	1.6	0.30	0.55	
May	81	66	4	6	28	56	49	102	10	1.21	0.5	1.6	0.41	0.80	
June	67	7	3	4	8	27	25	84	6	1.38	0.5	1.4	0.39	0.78	
July	86	10	1.2	3	12	29	37	94	11	1.05	0.3	1.2	0.30	0.59	
Period	70	24	2	4	12	45	40	78	13	1.22	0.52	1.16			

Precipitation fluxes March to July 1986.

Date	Precip	H <sup>+</sup>	Na	K	Mg	Ca	NH <sub>4</sub>	NO <sub>3</sub>	SO <sub>4</sub>	Cl
	mm	meq/m <sup>2</sup>								
March	60.9	3.29	1.40	0.12	0.20	0.24	2.38	2.62	2.80	1.28
April	29.8	1.40	0.38	0.04	0.08	0.18	3.04	1.34	1.44	0.51
May	52.8	4.27	3.48	0.21	0.32	1.48	2.96	2.59	5.38	0.53
June	40.2	2.69	0.28	0.12	0.14	0.32	1.09	1.01	3.38	0.24
July	74.0	6.36	0.74	0.09	0.24	0.88	2.15	2.74	6.96	0.81
Period	257.7	18.04	6.18	0.51	0.92	3.10	11.60	10.31	20.10	3.35



deposition of  $\text{SO}_4$ ,  $\text{NO}_3$  and Cl are important contributors to the total deposition. The measured precipitation amounts for bulk with net (bulk net) were less than for bulk precipitation probably because of evaporation from the netting.

Table 3: Precipitation and fog collection at Lillestrøm (NILU roof).

Date	Weather	Type of analysis	Amount of precip. mm	$\text{H}^+$ $\mu\text{eq}/\text{m}^2$	$\text{SO}_4$ -S $\text{mg}/\text{m}^2$	$\text{NO}_3$ -N $\text{mg}/\text{m}^2$	Cl $\text{mg}/\text{m}^2$
14-17 Nov.	Fog	Bulk precip.	6.3	643	13.1	6.9	9.6
		Bulk net	4.5	84	20.7	8.8	12.9
		Net wash	(4.8)	187	20.3	18.5	103.2
		Sum		271	41.0	27.3	116.1
17-24 Nov.	Fog and rain	Bulk precip.	33.4	2839	42.1	31.7	52.1
		Bulk net	30.9	2089	76.6	50.4	99.2
		Net wash	(4.3)	153	7.7	6.6	19.0
		Sum		2242	84.3	57.0	118.2

We expect the differences between the two collectors to be less pronounced in the forest plot at Nordmoen. The results show that the polypropylene net works, however.

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3 STIKKORD (å maks. 20 anslag) Air chemistry                      Deposition                      Meteorol. measurements			
REFERAT (maks. 300 anslag, 7 linjer) En undersøkelse av eventuelle endringer i næringscyklusen i skog pga sur nedbør er startet i 1986 av Norsk institutt for skogforskning, med finansiering av EPRI, USA. NILU deltar med målinger av deposisjon og meteorologiske parametre. Måleprogram og noen resultater er presentert, innbefattet testprøver av et nytt instrument for måling av tørr- og duggavsetning, konstruert ved NILU.			

TITLE
ABSTRACT (max. 300 characters, 7 lines) An investigation of the role of acid deposition in producing changes in forest nutrient cycling is started in 1986 by the Norwegian Forest Institute, financed by EPRI, USA. NILU is engaged with measurements of deposition and meteorological parameters. The measurement programme and some results in 1986 are presented. Included are test results of a new fog and dry deposition collector, constructed at NILU.

\* Kategorier: Åpen - kan bestilles fra NILU                      A  
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                   Kan ikke utleveres                                        C