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AIRBORNE MEASUREMENTS
OVER SKAGERRAK 29 JANUARY 1981

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AIRBORNE MEASUREMENTS
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1 BACKGROUND

To study the chemistry of power station plumes over the North Sea, a programme of aircraft measurements is conducted by the Central Electricity Research Laboratories (CERL). In order to locate the position of the plume, tracer material is released at a rate of $50 \text{ kg SF}_6 \text{ h}^{-1}$ for 20 h from the power station Eggborough (53 42N, 0107E).

The Norwegian Institute for Air Research (NILU) has agreed to undertake airborne measurements near Norwegian waters, if suitable conditions exist. One such measurement flight took place over Skagerrak on 29 January 1981, when CERL experiments were conducted, and trajectory forecasts were favourable.

Some emission of SF_6 to the atmosphere near the southern Norwegian coast is known to take place from a factory of Norsk Hydro A.S. near Porsgrunn. To estimate the release to the atmosphere, low level sampling in the Hydro plume was conducted the following day.

2 SAMPLING EQUIPMENT

Aerosol sulphate and sulphur dioxide were collected on plain and impregnated filters arranged in series. The sampling time was between 15 and 20 minutes, and the samples were analyzed by ion chromatography. Concentrations of sulphur dioxide below $3 \mu\text{g m}^{-3}$ and of sulphate aerosols below $1.5 \mu\text{g m}^{-3}$ could not be estimated with any accuracy, due to slightly contaminated filters.

Air samples taken with syringes and in plastic bags were later analyzed in the laboratory on NILUS tracer gas chromatograph to determine SF₆ concentrations.

The detection limit for laboratory analyses is about 1 ppt SF₆. Detection limit on the gas chromatograph used in the aircraft is around 10 ppt.

3 SAMPLING PROCEDURE AND RESULTS - 29 JANUARY 1981

Table 1 and Figure 1 give location of sampling tracks (midpoints). It had been planned to continue the flight along the west coast of Denmark after refuelling at Kjevik. Unfortunately, the flight had to be abandoned due to low clouds and fog covering southern Scandinavia.

Only the traverse over the inner part of Skagerrak, midpoint E, gave a positive indication of SF₆ in the air. Positions of the syringe samplings are not shown, because no SF₆ was detected. Locations of bag sampling are also shown.

Figure 2 shows the vertical temperature distribution and extent of the haze layer observed during an ascent/descent close to position E. Surface and 850 mb weather charts are shown in Figure 3. A cold front was encountered at position F.

4 ESTIMATE OF SF₆ RELEASE FROM PORSGRUNN FACTORIES

It is known that SF₆ is used as a flame quenching gas at Herøya. An amount of 30 kg per 8-work shift has been quoted.

On the return flight to Oslo, 30th January, a low level inversion, marked by a smoke layer over the Porsgrunn area, prevented the vertical rise of the SF₆ containing plume. The sampling in the plume was performed at a distance of between 4 and 5 km from the plant, where plume width was about 1500 m and the vertical extent about 150 m. Two bag samples showed SF₆ concentrations of 175 ppt. Five syringe samples gave values from 8 ppt to 539 ppt SF₆.

As 1 ppm equals $5.9 \text{ mg SF}_6 \text{ m}^{-3}$, and the observed wind speed at the flight level (from a weather station near by) was 3.5 m s^{-1} , the rate of release was estimated at about $2.5 \text{ kg SF}_6 \text{ h}^{-1}$. Considering all uncertainties involved, all that can be said is that the release rate most probably is somewhere between 1 and 5 kg h^{-1} . The quoted use of 30 kg SF_6 per 8-shift (i.e., 3.8 kg h^{-1}) is of the same order. It thus seems that virtually all the SF_6 used at Herøya escapes into the atmosphere.

5 CONCLUSION

On 29 January, a positive observation of SF_6 over Skagerrak was made at one location only. It is not clear whether this concentration was due to the experimental release in England or was the result of a continuous release of SF_6 from a factory at Herøya near the Norwegian coast.

Low level winds in the area indicate a NE-ly plume drift from Herøya, that is to the north of the actual sampling track. It is therefore a possibility that the observed concentration was indeed due to long range transport.

Preliminary results from aircraft sampling made by CERL, over the North Sea along the Danish coast, indicate that SF_6 was concentrated in and below the low level clouds. Concentrations were about 5 ppt. That may explain why our sampling over western parts of Skagerrak, made at higher levels, did not show any concentrations.

Concentrations of sulphur dioxide and of sulphate particles were fairly low. The highest SO_2 value, $13 \text{ } \mu\text{g m}^{-3}$ over Oslofjord, most probably was due to local sources.

Table 1: Aircraft sampling 29 January 1981.
 Sulphur on filters. SF₆: bag (a), syringe (b).

Time GMT	Posn.	Height FT	Temp. °C	Flight Cond.	SO ₂ μg m ⁻³	SO ₄ μg m ⁻³	SF ₆ ppt
1157	A 5930N 1040E	1200	12.0	On top 8/8-2/8 St	13	<1.5	-
1233	B 5850N 1020E	1000		2/8 Sc			2 (b)
1241	C 5830N 1020E	1000	12.0	On top 1/8-8/8	< 3	<1.5	-
1303	D 5800N 0945E	1300	10.6	On top 8/8 Sc	≈ 3	<1.5	-
1328	E 5750N 0830E	10500		Top of haze			-
1340	F 5745N 0750E	10000	-2.1	Between layers - near front	≈ 5	<1.5	-
1345	G 5745N 0730E	9750					0 (a)
1405	H 5745N 0800E	6500					0 (a)
1407	I 5750N 0820E	6500	3.2	Between layers - thick haze	≈ 5	≈2.0	-
1426	J 5745N 0820E	3500	10.1	On top 8/8 Sc	6	<1.5	0
1445	K 5900N 0800E	1500			≈ 2	<1.5	0 (a)

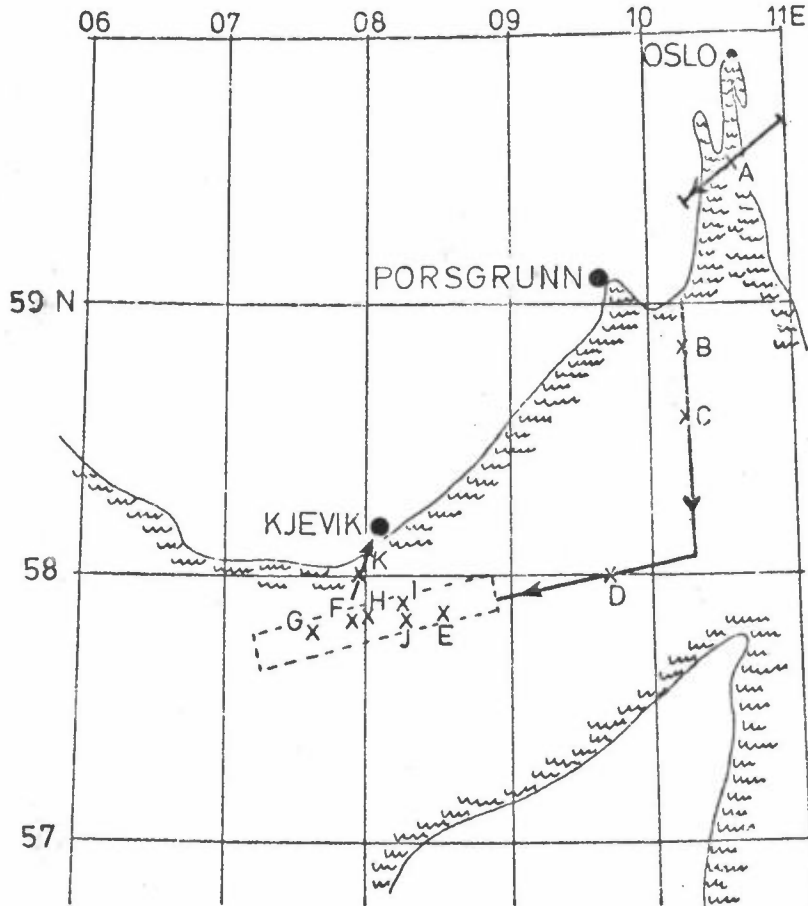


Figure 1: Aircraft flight 29 January 1981.
Letters refer to positions given in Table 1.

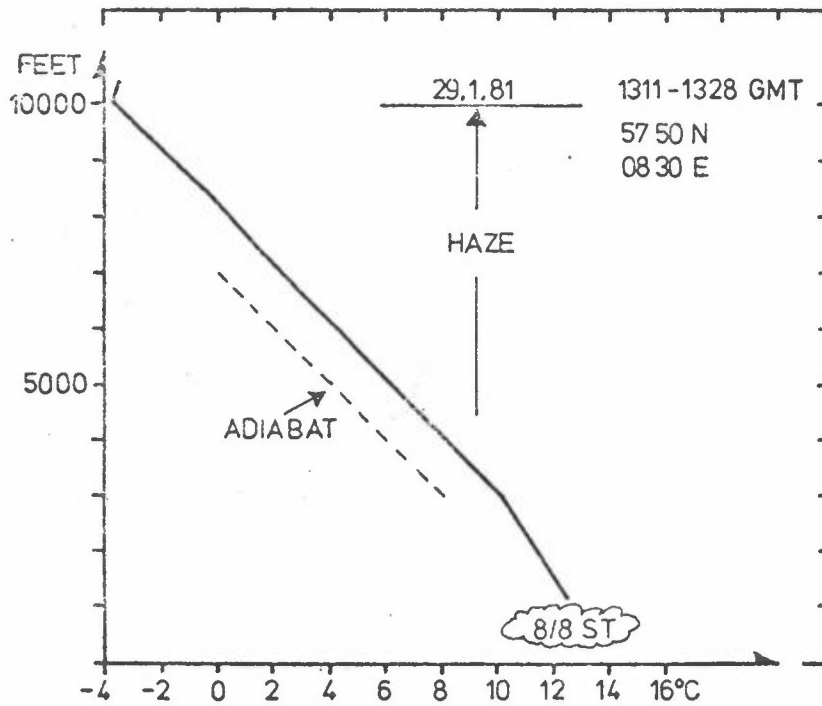
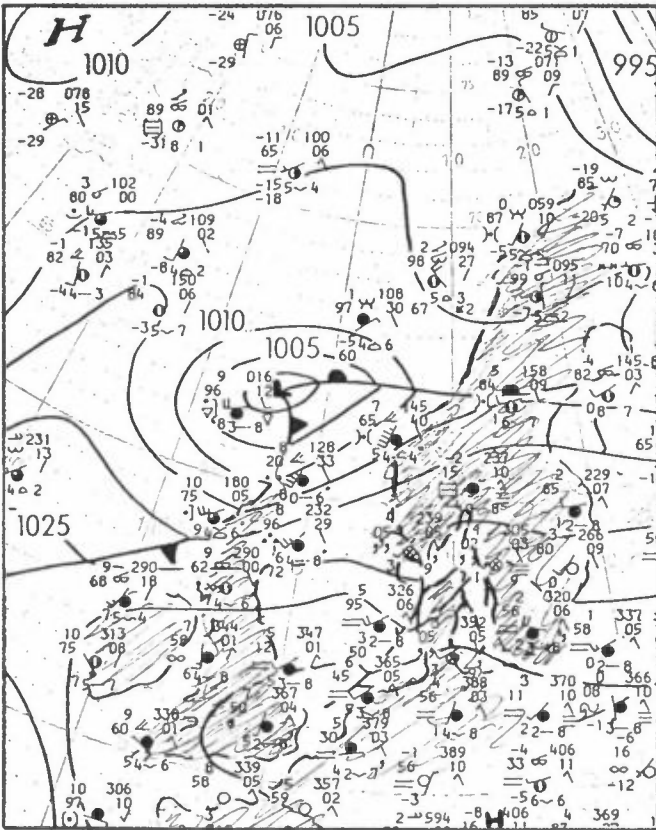
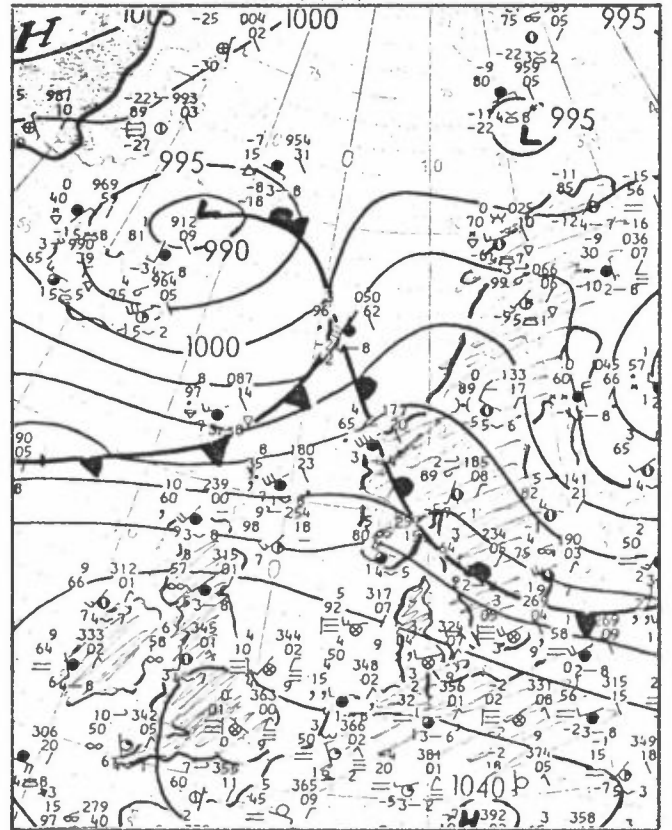


Figure 2: Vertical temperature distribution.

12 GMT

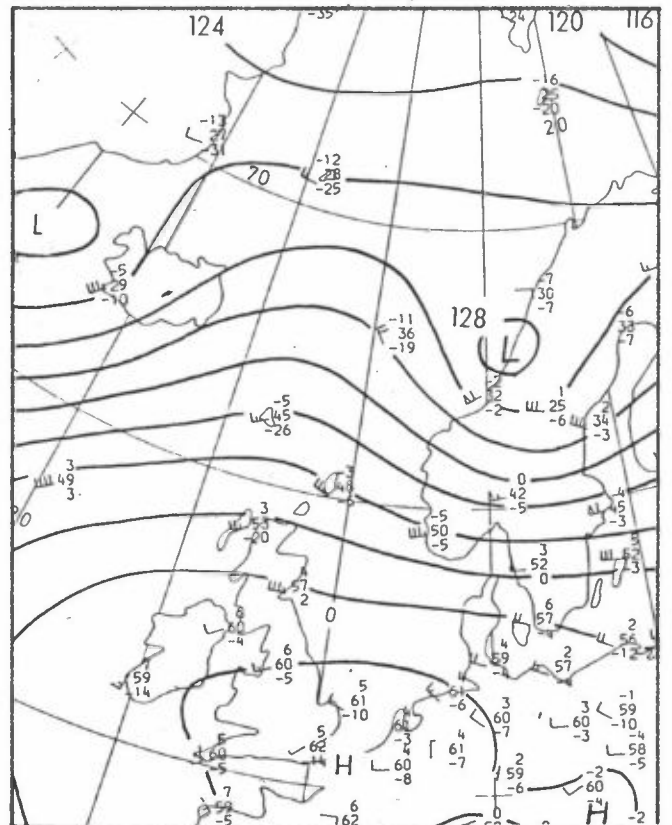
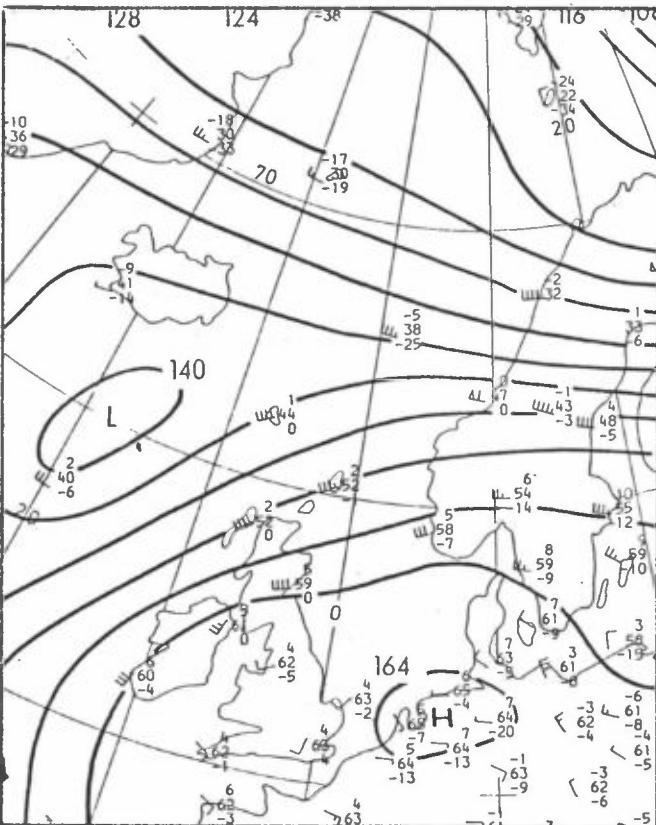


12 GMT



29 Jan 1981

30 Jan 1981



850 mb. 00 GMT

850 mb. 00 GMT

Figure 3.

