CLIMATOLOGICAL DEVIATION MAPS

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FREMLAGT I VIDENSKAPS-AKADEMIETS MØTE DEN 9DE FEBRUAR 1962

Abstract. In order to study the broad features of the variations of the weather conditions in Norway, mean values of the meteorological elements were computed for three-monthly intervals (winter, spring, summer and autumn) from the winter 1901 to the autumn 1930. These mean values were used for the construction of smoothed weather charts, in all 120 sets of charts. In order to make the variations more conspicuous the average values themselves were not plotted in the maps, but the differences from the means for the seasons in the whole period 1901—30.

The study of the deviation maps shows how the additional winds from the warmer regions in south and south-west generally bring positive temperature deviations and positive precipitation deviations, while additional winds from the colder and drier surroundings in north and east bring colder air and moderate precipitation. Our maps show further the influence of the great mountain chains in Norway, causing heavy precipitation on the windward sides and deficit of precipitation on the lee sides. The deviation charts show also the influence of the mountain chains on the crossing air flow itself. The theoretical pattern of V. BJERKNES for such streams was completely confirmed.

For a numerical study of the deviations the country was divided into districts. As such were chosen the 18 administrative counties, and for these were computed mean values of the meteorological elements for each of the 3-monthly periods. It was then found that the division could be simplified into 6 principle geographical districts, each with tolerably uniform climatological conditions. For each of these 6 districts statistical studies of different kinds were made.

The statistics confirmed the influence of the geographical conditions, seen by the direct study of the maps. Generally there were considerable differences between the deviations in the different districts, and they varied differently with the direction and curvature of the additional wind. Correlation coefficients were computed in order to find to what extent the precipitation deviations were different in adjacent districts — studies of direct practical interest for the planning of the exchange of electrical power from the waterfalls between the different parts of the country.

CONTENTS

I. THE MAPS

1. Computation of the deviations. As basis for the studies there were computed for each separate season in the period 1901—30:

$\bar{p}$ = the mean atmospheric pressure at the station.

$\bar{T}$ = the mean air temperature,

R = the amount of precipitation.

The seasons used were the winter (December—February), the spring (March—May), the summer (June—August) and the autumn (September—November), all comprising three months. The computations were made for all the meteorological stations in Norway.

Furthermore, the following seasonal means for the whole period 1901—30 were computed for all stations:

$\bar{p}_{1901-30}$ = mean seasonal atmospheric pressure 1901—30.

$\bar{T}_{1901-30}$ = mean seasonal air temperature 1901—30.

$\bar{R}_{1901-30}$ = mean seasonal precipitation 1901—30.

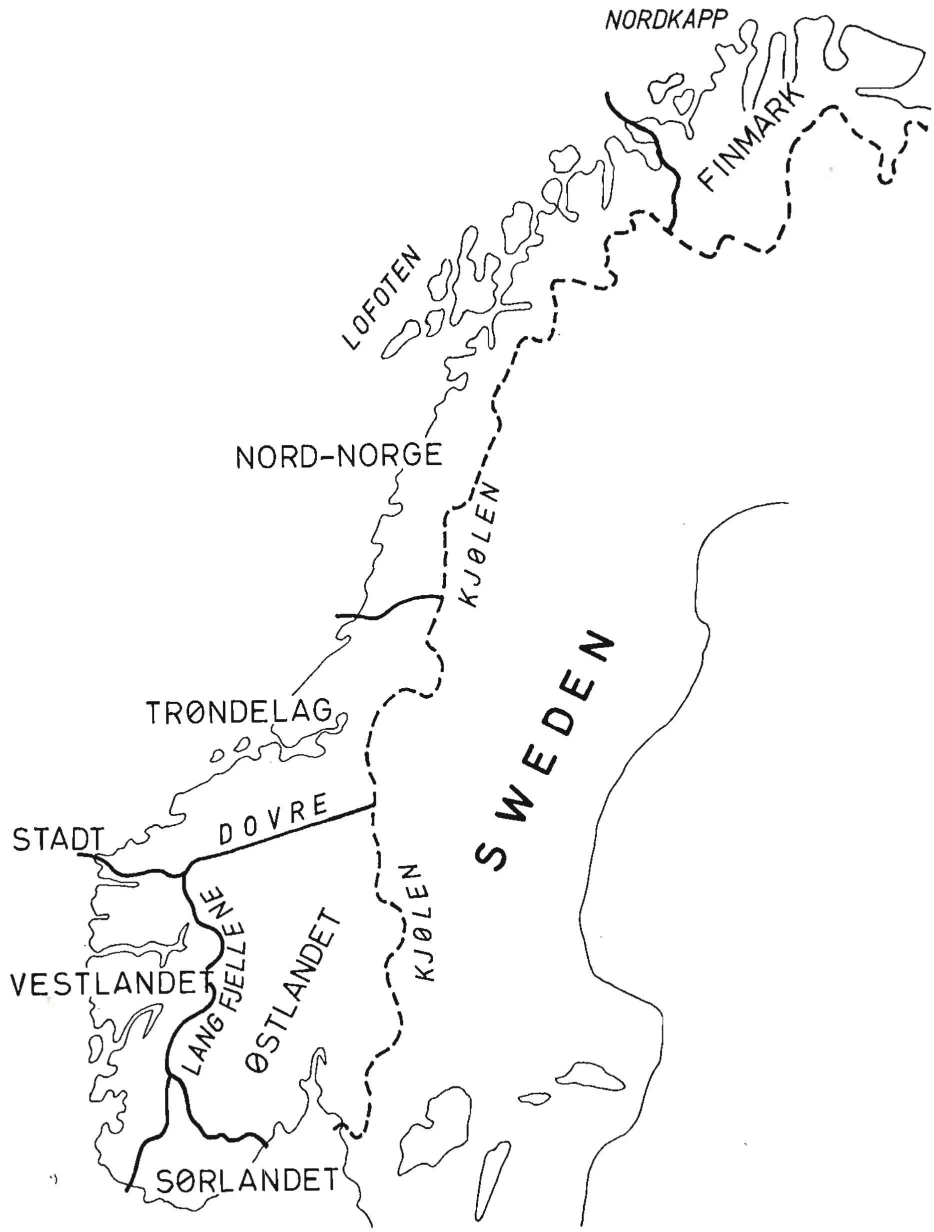


Fig. 1: An orientation map over Norway.

Finally the deviations $\triangle p$, $\triangle T$ and $\triangle R$ were computed by means of the equations:

$$\triangle p = \bar{p} - \bar{p}_{1901-30}$$

$$\triangle T = \bar{T} - \bar{T}_{1901-30}$$

$$\triangle R = \frac{R - \bar{R}_{1901-30}}{\bar{R}_{1901-30}}$$

The deviations were computed in mbar and tenths for the atmospheric pressure, in centigrades and tenths for the temperature and in percent for the precipitation.

2. Analysis of the deviation maps. The deviations were plotted on maps, one set for each season, in all 120 sets of charts from the winter 1901 until the autumn 1930.

The deviations for atmospheric pressure and air temperature were plotted on the same maps in the scale 1:10 000 000 comprising Europe and a part of the Atlantic Ocean, while we for the numerous precipitation deviations had to use maps over Norway in the scale 1:1 300 000.

On these maps were drawn curves for equal values of the deviations. It was found that the deviations $\triangle p$ and $\triangle T$ varied so little on each map that it sometimes was difficult to draw isolines from the Norwegian network of stations alone. We therefore computed $\triangle p$ and $\triangle T$ for 35 additional stations, spread over the adjacent countries.

The map for $\triangle p$ does not give only a picture of the mean additional atmospheric pressure deviations but also of the mean additional gradient winds in the same way as an ordinary chart over the atmospheric pressure gives a representation of the gradient winds.

The direction is seen from the course of the isallobars and the velocity was found by means of a gradient scale with marks for the velocities 0.5, 1.5, 2.5, 3.5 and 4.5 m/sec.

In this way the deviation maps give the additional values of the important meteorological elements, wind, temperature and precipitation.

Before we discuss the maps, it is desirable to look at the map in Fig. 1. In southern Norway we have the mountaineous *Vestlandet* along the west coast. It is separated from the relative low *Østlandet* by the chain of mountains called *Langfjellene*. The southern part of the country is called *Sørlandet.* In north Østlandet is separated by the mountains *Dovre* from *Trøndelag.* In east there is a chain of lower mountains *Kjølen* along the frontier to *Sweden.* North of Trøndelag we have *Nord-Norge* where the coast has a direction from SE to NE up to *Nordkap.* The distance from the sea up to the frontier to Sweden with the mountain-chain Kjølen is here relatively short. There are many islands, among which we will mention *Lofoten.* South-east of Nordkap we have the large plains of *Finmark.*

This short survey of the chief parts of Norway and the most important chains of mountains is necessary because the topography plays an important role for the climatic conditions, and in the following all the names mentioned are used.

3. The deviation maps for the winter 1918. As an example we will discuss the set of deviation maps for the winter 1918 (December 1917—February 1918).

In Fig. 2a we see the map with iso-curves for the additional atmospheric pressure and for the additional air temperature, and in Fig. 2b—Fig. 2c we find the corresponding deviations for the precipitation in southern and in northern Norway.

The fully drawn lines in Fig. 2a are the isallobars. They show a low atmospheric pressure (—2.6 mbar) over Finmark and higher pressure deviations towards west (+ 6.2 mbar over Ireland and + 9.6 mbar over Iceland). The curves are equipped with arrow-heads showing the direction of the additional gradient winds. Over whole Norway the direction is from N to NNW, except in Finmark, where the barometric minimum is situated, and measurements with the gradient scale show velocities from 3 up to 5 m/sec.

These additional northerly winds bring relatively cold air, and the curves for the temperature deviations (the stippled curves) show deviations of 0.5 to 3 degrees below the mean values for the winters 1901—30. South of Norway the additional winds have directions from northwest to west and they bring warmer air from the North Sea (temperature deviations from 0 up to + 1 degree). Over Finmark there is a minimum of temperature deviation (—3.5°), due to the temperature inversions in the relative calm weather.

Over the great mountain-chains in the central part of southern Norway we see that the course of the isallobars is slightly disturbed, the place is marked with a double line. We will come back to this phenomenon in chapter 5.

In Fig. 2b—c the curves give the precipitation deviations (precipitation surplus in per cent of the mean amount for the winters in the years 1901—30), and the arrows give the direction of the additional gradient wind as found from Fig. 2a.

From Vestlandet in south to Nordkap in north there is an excess of precipitation of 20 to 80 per cent from the coast up to the top of the mountains along the coast. This is evidently caused by the rising of the airmasses on the windward side. At the leeward side, over the interior of Østlandet we have 40 to 60 per cent lower precipitation than the means. In the eastern part of Østlandet we find decreasing deficits of precipitation again because of the mountain-chain Kjølen along the border to Sweden. The 0-per cent curve begins at Vestlandet, where the direction of the additional gradient wind is tangential to the coastline and follows the mountains Langfjellene up to Dovre where the mountain-chain and also the 0-per cent line turn to northeast.

Further to the north over Nordland (Fig. 2c) the 0- per cent line follows Kjølen up to Finmark. Here it turns to east and follows the coast — because the direction of the additional gradient winds change to a southerly direction. At Lofoten we find up to 80 per cent excess of precipitation along the windward side of the islands, while the excess is more modest at the leeward side of the high mountains of the islands.

From this survey of the curves of Fig. 2a—c it is evident that there is a connection between the additional gradient winds and the deviations of the air temperature and of the precipitation. The influence of the topographical conditions is also evident.

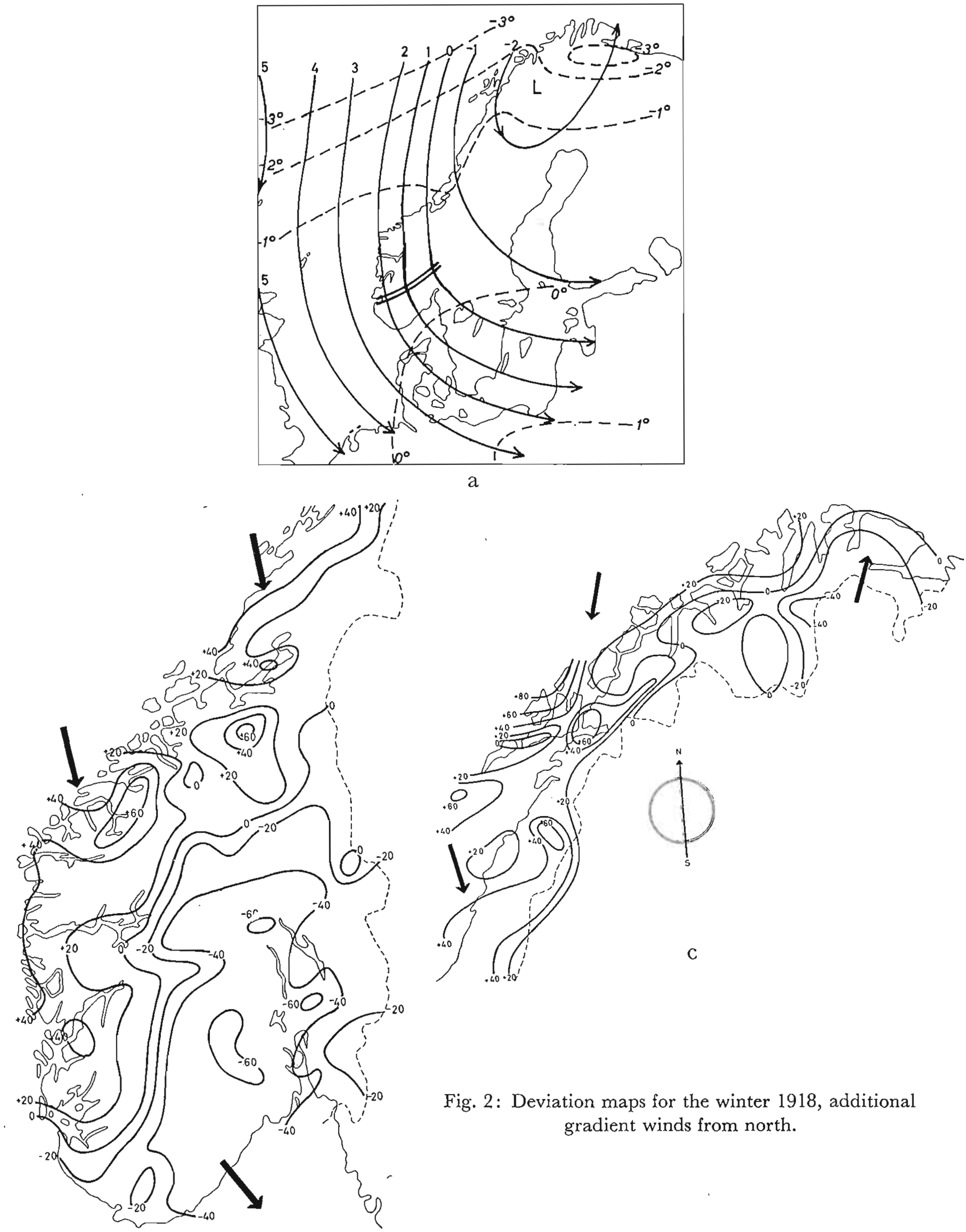
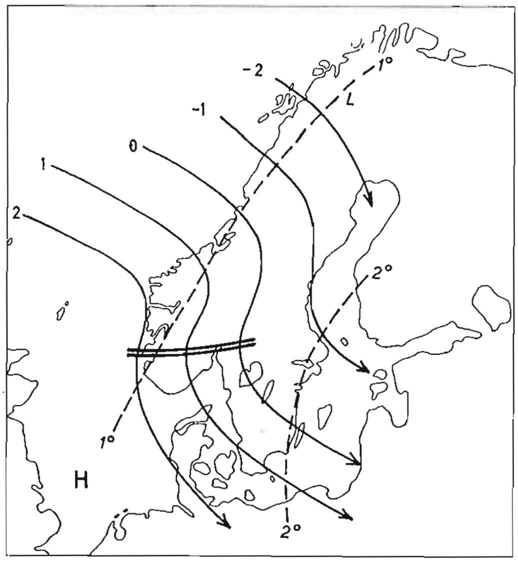


Fig. 2: Deviation maps for the winter 1918, additional gradient winds from north.

It would lead too far to discuss in details the 120 sets of seasonal maps for the 30 years 1901—30. In order to show how the distribution of the deviations of the air temperature and the precipitation depends on the additional gradient winds we will however in the next chapter discuss shortly one set of maps for each of the principle directions of these winds.

4. Deviation maps for each of the principle directions of the additional gradient winds. In chapter 3 we have discussed in detail a case with additional gradient winds from north. We therefore start with a case, where the additional gradient winds come from northwest, and continue with the case with additional winds from west, southwest and after that round the compass to northeast. Figs. 3a—9a give the deviation maps for the atmospheric pressure and the air temperature, and the Figs. 3b—9b give the corresponding deviation maps for the precipitation over southern Norway. In order to simplify the discussion of the maps, the precipitation maps over northern Norway are omitted, and the discussion is limited to the southern parts of the country.



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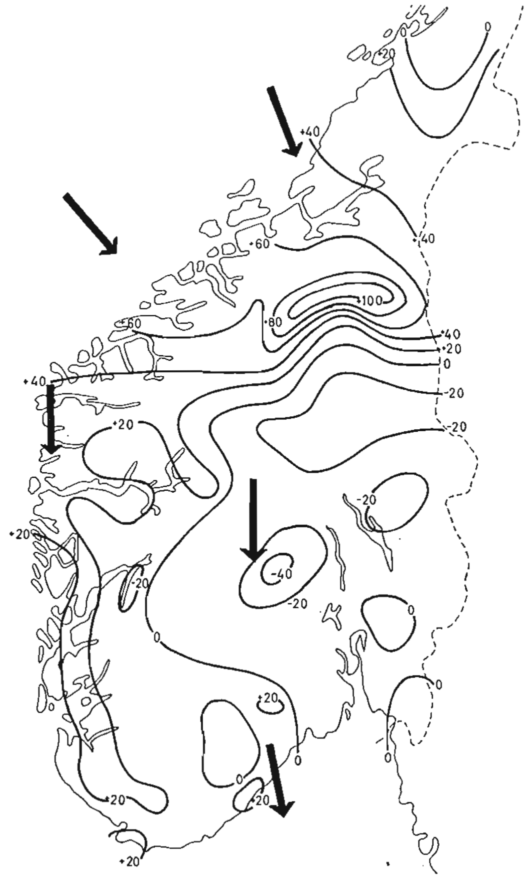
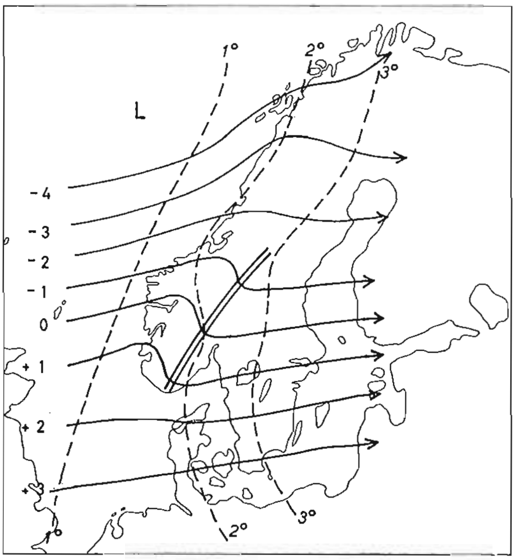


b

Fig. 3: Deviation maps for the winter 1911, additional gradient winds from northwest.

Additional gradient winds from northwest in winter 1911. In Fig. 3a the predominating additional gradient winds are from northwest, but over the central parts of the country they get a more northerly direction. The airmasses come from the temperate North Sea, and we find positive deviations of the air temperature.

Fig. 3b shows an excess of precipitation along the western coast with a maximum of + 20 per cent, where the airmasses have a rise over the mountains. Especially great is the surplus at the northern slopes of Dovre with up to 100 per cent. At the leeward side of Dovre and in the protected interior of Østlandet we have deficits of precipitation.



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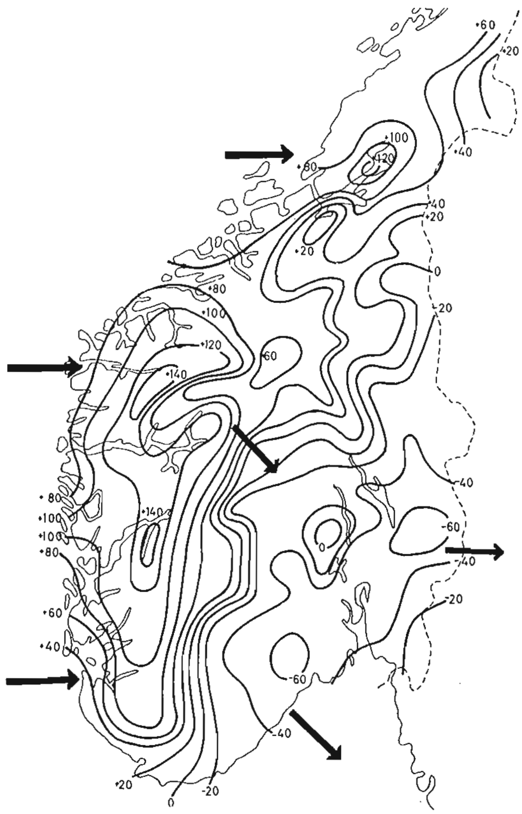
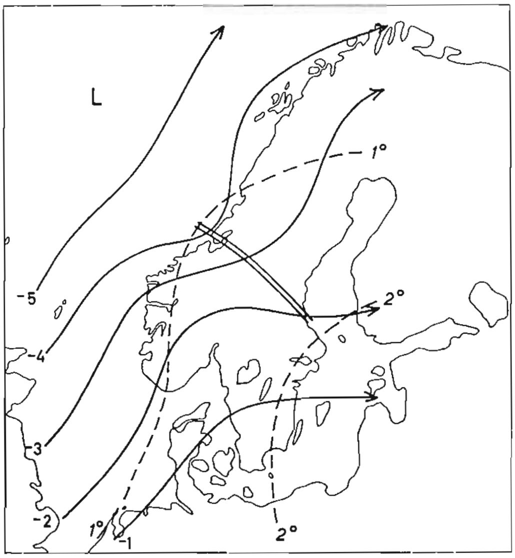


b

Fig. 4: Deviation maps for the spring 1921, additional gradient winds from west.

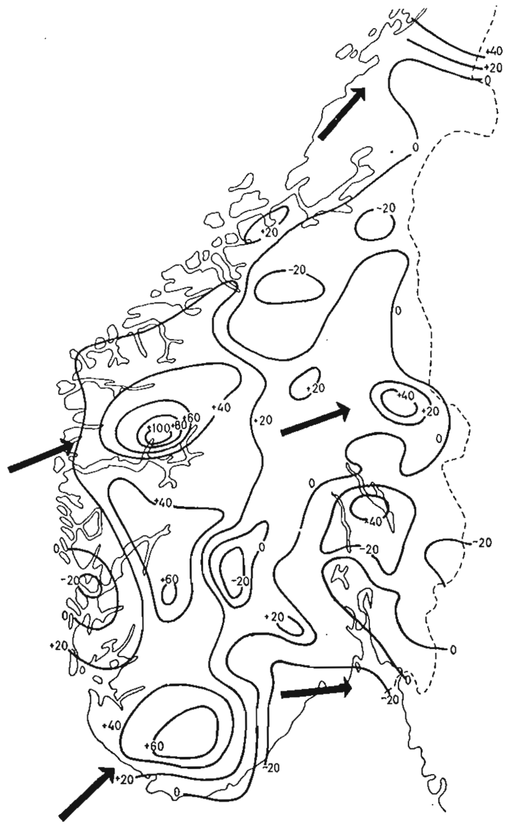
Additional gradient winds from west in spring 1921. In Fig. 4 we see predominating additional gradient winds from west that over the mountains turn to northwest. The airmasses come from the warmer North Sea and the temperature deviations are positive.

The westerly winds cause heavy precipitation along the coast where the precipitation deviation goes up to + 100 per cent with maxima where the airmasses rise up to the summit of Langfjellene (+ 140 per cent). On the leeward side of the mountains there are great areas with deficit of precipitation, down to − 60 per cent.



a

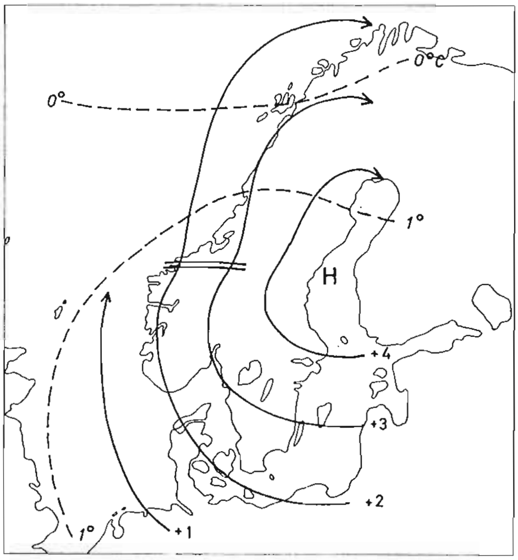
Fig. 5: Deviation maps for the spring 1913, additional gradient winds from southwest.



b

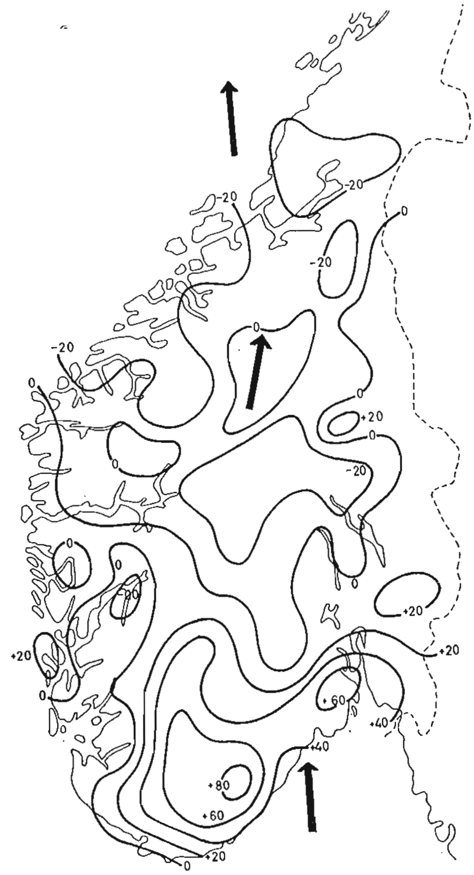
Additional gradient winds from southwest in spring 1913. In Fig. 5a there are predominating additional gradient winds from southwest that have a more westerly direction over Vestlandet and Langfjellene. The temperature deviations are positive.

Fig. 5b shows that these additional winds cause a surplus of precipitation over Vestlandet and Sørlandet. There is an area in Østlandet with negative precipitation deviations, but we find positive deviations on the southern slopes of Dovre that are now the windward side. On the other side of Dovre there is an area with deficit of precipitation.



a

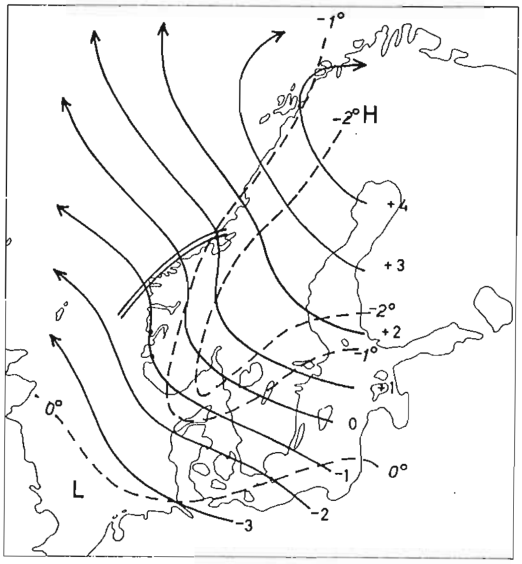
Fig. 6: Deviation maps for the summer 1917, additional gradient winds from south.



b

Additional gradient winds from south in summer 1917. In Fig. 6a we find additional gradient winds from south and positive deviations of the temperature.

Fig. 6b shows that the area with excess of precipitation has been removed to the southeastern coast and the interior of Østlandet, while there is chiefly a deficit of precipitation west of Langfjellene and north of Dovre.



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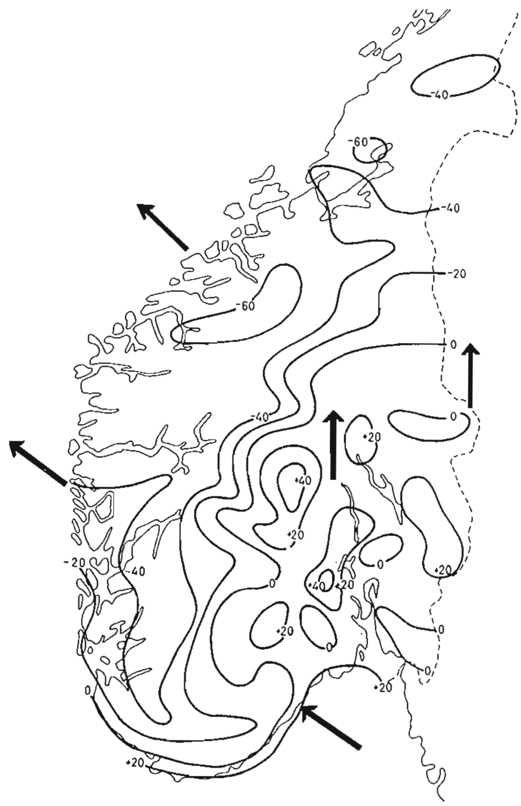

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Fig. 7: Deviation maps for the winter 1926, additional gradient winds from southeast.

Additional gradient winds from southeast in winter 1926. The map in Fig. 7a shows predominating additional gradients from southeast, but over Østlandet the direction is more southerly. The airmasses coming from eastern countries bring colder air in winter.

The airmasses are also relatively dry, so that the excess of precipitation amounts only to 20—40 per cent over Østlandet, while there on the leeward sides of the mountain-chains Langfjellene and Dovre are deficits of precipitations of — 20 to —60 per cent (Fig. 7b).

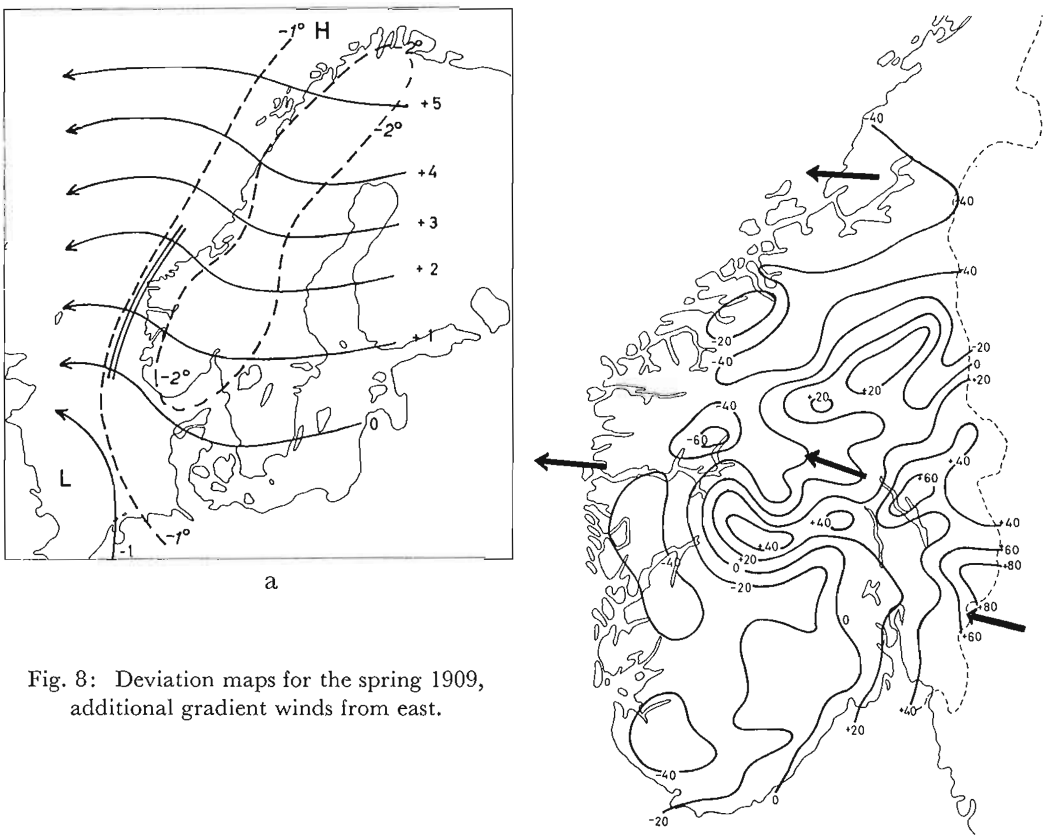
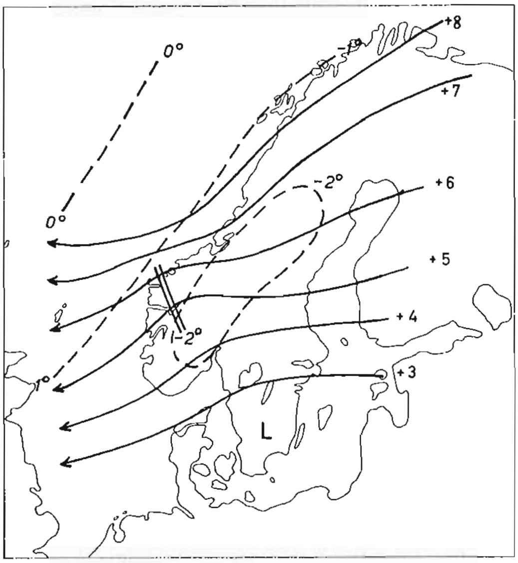


Fig. 8: Deviation maps for the spring 1909, additional gradient winds from east.

Additional gradient winds from east in spring 1909. In Fig. 8a we find easterly additional gradient winds that are relative cold and bring negative temperature deviations.

Fig. 8b shows an excess of precipitation over Østlandet, up to 80 per cent, while the deficits on the leeward sides of the mountain-chains give deficits of up to 60 per cent.



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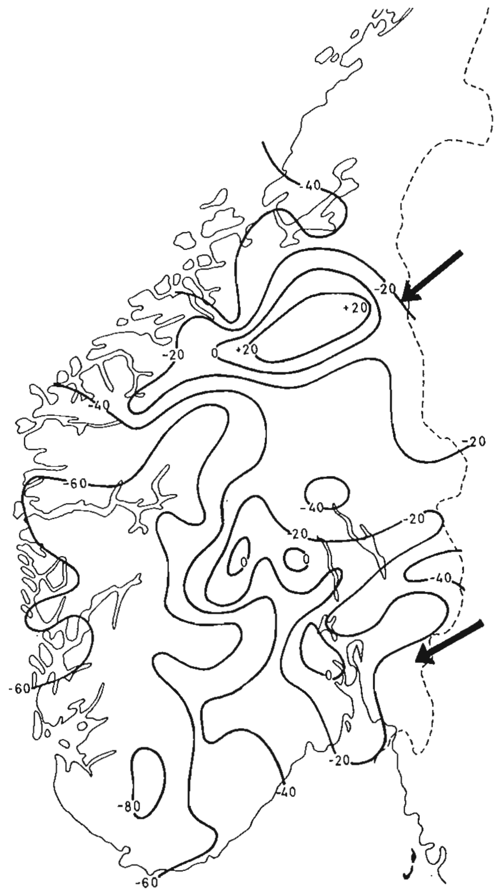

b

Fig. 9: Deviation maps for the autumn 1915, additional gradient winds from northeast.

Additional gradient winds from northeast in autumn 1915. Relative cold airmasses from northeast bring negative deviations of the air temperature (Fig. 9a).

As the airmasses are dry the amounts of precipitation are relative small all over the country (Fig. 9b). On the windward side of Dovre we have up to 20 per cent more than the medium, but elsewhere we find deficits even at the windward side of Langfjellene. But on the leeward side of these mountains there are deficits of up to 80 per cent, considerably greater than those on the windward side.

5. General discussion of the deviation maps. Under the discussion of the maps we should remember that the additional winds at the ground generally are turned to the left from the additional gradient winds.

Deviations of the air temperature. From the maps a in Figs. 2—9 we see that there are positive temperature deviations for additional gradient winds from NW, W, SW and S, and negative deviations for the additional gradient winds from SE, E, NE and N. The positive deviations are thus found for additional surface winds from W, SW, S and SE and negative deviations for the other directions.

The numerical value of the temperature deviations is 1—2 degrees. There is thus considerable differences in the heat transport from the warmer regions in west and south and those from the colder eastern and northern areas.

Deviations of the precipitation. The study of the maps b in Figs. 2—9 shows that there are relative high amounts of precipitation at the windward side of the great mountain-chains Langfjellene and Dovre in the central part of southern Norway, while there is a relative small precipitation at the leeward side of these mountains. The more local features of the topography cause a division of the areas with high precipitation into several local maxima, and correspondingly there is found many local minima in the areas with low precipitation.

The excess of precipitation is especially high and extensive for the westerly and southerly additional gradient winds that bring warm and wet airmasses.

Further it is found that the precipitation deviations vary from case to case with the physical conditions of the airmasses transported from the surroundings and also with the character of the flow over the country. We therefore find from map to map great variations of the absolute values of the deviations — it is chiefly the relative values that are determined by the topographical conditions.

It is found that the amounts of precipitation are essentially greater when the isallobars indicate a relative *Low* than when they surround a relative *High*. It is found that a cyclonic curvature brings higher values of the precipitation deviations than when the curvature is anticyclonic.

Influence of the topography on the isallobars. Where the isallobars pass the mountain-chains Langfjellene and Dovre they show a turn to the right and on the leeward sides of the mountains they more or less take up again the course from the windward side. In the maps a of Fig. 2—9 this place is indicated with a double drawn line, that indicates the place of the relative low pressure on the lee side.

Applying his vorticity theorem V. Bjerknes found that an atmospheric current passing a mountain-chain should get an anticyclonic curvature on the windward side of the mountain. When the ridge has been passed there should be a cyclonic accelleration and curvature of the stream. An illustration from Bjerknes' discussion of the matter

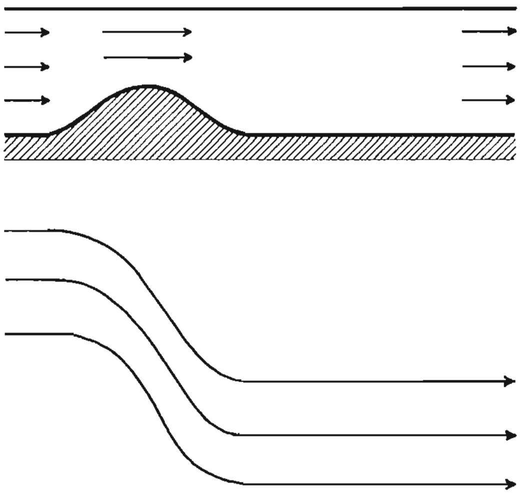

Fig. 10: Stationary flow over a mountain.

is reproduced in Fig. 10.* In the upper part of the figure there is a vertical projection of the stream with a maximum of velocity at the top of the mountain-chain. Below is the horizontal projection showing the anticyclonic curvature of the streamlines at the windward side and the cyclonic curvature at the leeward side.

The disturbances found in the isallobars at the crossing of the mountains are thus in close agreement with the theoretical results of V. BJERKNES. (Compare especially Fig. 4a with Fig. 10).

Prognostic value of the deviation maps. A comparison of successive deviation maps shows so great alterations that it is not possible to identify any characteristic feature in one map with those on the following map. They are apparently independent of each other. The time interval of three months seems thus to be too great and the extention of the areas in the map too small for a prognostic evaluation.

The maps show a clear physical relationship between the additional winds and the deviations of the mean temperature and of the precipitation. This is only what could be expected.

The state of the atmosphere and its changes are namely governed by the laws of the physics, and therefore the climatological conditions must be dependent on the same laws.

In many cases the use of mean values can even make a phenomenon more clear, because it can suppress the influence of other phenomena that have a dominating influence in individual cases.

* V. BJERKNES, J. BJERKNES, H. SOLBERG and T. BERGERON: *Physikalische Hydrodynamik.* Berlin 1933. Abb. 68, C, p. 492.

II. THE STATISTICS

6. Computation of summary tables. For this purpose the country was divided into districts. As such were chosen the 18 administrative counties. It seemed necessary to use so many districts because the deviation maps showed considerable variations of local character in the precipitation field.

For these districts mean values of the deviations of the temperature and precipitation for each of the periods of 3 months were computed.

In order to see if the 18 districts in a natural way could be grouped together in larger districts the precipitation deviations were arranged after the direction of the additional gradient winds and mean values were computed. The result is given in the upper part of Table 1.

Table 1. *Mean deviations of precipitation for the different directions of the additional gradient wind.*

District	Wind-direction							
	N	NE	E	SE	S	SW	W	NW
1. Hedmark	− 11	− 5	+ 14	+ 4	+ 18	+ 12	− 3	− 9
2. Opland	− 16	− 2	+ 2	+ 9	+ 19	− 4	− 10	+ 2
3. Buskerud	− 18	− 8	+ 2	+ 6	+ 22	+ 17	− 20	− 22
4. Akershus	− 19	− 20	− 7	+ 13	+ 27	+ 20	− 9	− 22
5. Østfold	− 21	− 20	− 8	+ 12	+ 17	+ 29	− 8	− 19
6. Vestfold	− 23	− 20	+ 8	+ 11	+ 18	+ 20	− 17	− 22
7. Telemark	− 24	− 16	− 8	+ 7	+ 20	+ 27	− 18	− 14
8. Aust-Agder	− 18	− 28	− 1	+ 3	+ 22	+ 26	+ 8	− 11
9. Vest-Agder	− 17	− 28	− 26	− 5	+ 20	+ 36	+ 27	− 3
10. Rogaland	− 6	− 24	− 9	− 22	+ 2	+ 32	+ 36	+ 13
11. Hordaland	− 1	− 28	− 16	− 24	− 10	+ 33	+ 31	+ 25
12. Sogn og Fjordane	+ 6	− 28	− 14	− 33	− 7	+ 24	+ 14	+ 28
13. Møre og Romsdal	+ 19	+ 1	− 25	− 30	− 18	− 13	+ 16	+ 36
14. Nord-Trøndelag	+ 16	+ 4	− 10	− 23	− 22	− 13	+ 10	+ 32
15. Sør-Trøndelag	+ 21	− 2	− 13	− 22	− 14	− 1	+ 21	+ 21
16. Nordland	+ 18	− 10	− 21	− 28	− 13	+ 12	+ 24	+ 20
17. Troms	+ 25	− 4	− 12	− 26	− 18	− 1	+ 15	+ 18
18. Finnmark	+ 21	+ 8	− 2	0	− 9	+ 1	+ 1	+ 12
Ø Østlandet	− 19	− 13	0	+ 7	+ 20	+ 19	− 18	− 16
S Sørlandet	− 18	− 28	− 14	− 1	+ 21	+ 31	+ 17	− 7
V Vestlandet	0	− 27	− 13	− 26	− 5	+ 30	+ 28	+ 22
T Trøndelag	+ 18	− 3	− 16	− 25	− 18	− 9	+ 15	+ 33
N Nordland	+ 21	− 7	− 16	− 27	− 15	+ 5	+ 20	+ 19
F Finnmark	+ 21	+ 8	− 2	− 6	− 9	+ 1	+ 1	+ 12

From this table we see that the division can be simplified to 6 main districts, each with tolerable uniform climatological conditions, namely (see Fig. 1):

Ø. Østlandet,
S. Sørlandet,
V. Vestlandet,
T. Trøndelag,
N. Nordland,
F. Finmark,

approximately the 6 principle districts of the country. The northern limit of Vestlandet is placed further to the south than usual, namely at the foreland Stadt, because there is here a marked change of the weather conditions.

For each of these districts the mean deviations were determined for all the three-monthly periods. The mean additional gradient wind $\overline{\triangle v}$ could be found directly from the deviation maps, while the mean values $\overline{\triangle T}$ and $\overline{\triangle R}$ of the temperature and the precipitation deviations were computed as the means of the values for the counties in the district. The result is given in the summary Table 2.

In the column $\overline{\triangle v}$ is here given not only the direction and the velocity of the additional gradient wind, but also the character of the flow. The letter A indicates that the flow has an anticyclonic curvature, the letter n that the flow is approximately straight (neutral) and the letter C indicates cyclonic curvature.

7. Mean deviations of the precipitation for different directions of the additional gradient wind. In the lower part of Table 1 we find the mean precipitation deviations for the different directions of additional gradient winds and in Fig. 11 there is a graphical representation. The districts are here indicated by the initials of their names.

For *Østlandet* the maximum deviation is found for winds from south and the minimum for winds from north. Low values are also found for winds from northeast, northwest and west, because the district is protected against precipitation from all these directions by the mountain-chains Dovre and Langfjellene.

For *Sørlandet* the maximum is removed to southwest, from where the wet seawinds come perpendicularly to the coast, and the minimum is found for the northeastern winds.

And when we come to *Vestlandet* on the windward side of Langfjellene and the coast running from south to north, we have the maximum precipitation for the humid winds from south-west and west. A part of the curve is stippled because it is based on only a few cases.

Trøndelag is situated north of Dovre and the direction of the coast is from southwest to northwest. Here we find the maximum of precipitation deviation for northwesterly winds and minimum for winds from southeast.

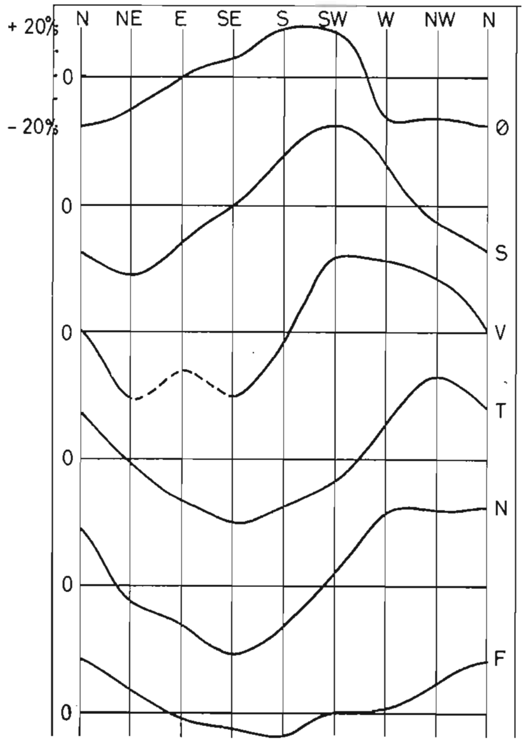

Fig. 11: Mean precipitation deviations for different directions of the additional gradient wind.

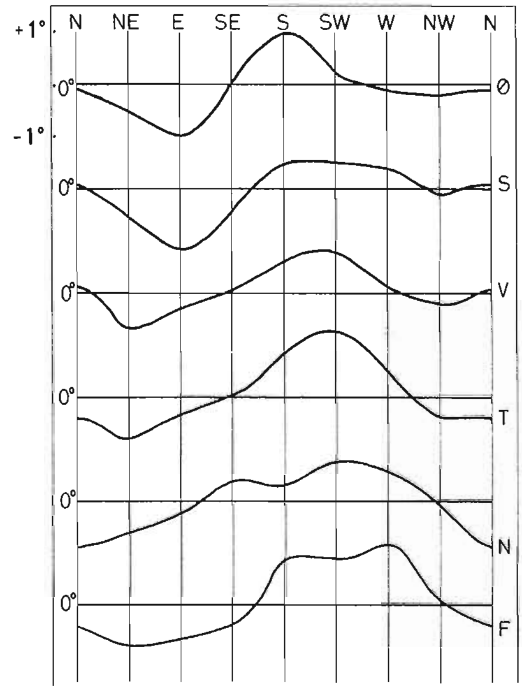

Fig. 12: Mean temperature deviations for different directions of the additional gradient wind.

Similar conditions we find in *Nordland* where the coast also runs from southwest to northeast, so does also the mountain-chain Kjølen.

For *Finmark* we finally see that the maximum of precipitation deviation is found for winds from north coming from the Arctic Sea perpendicularly against the coast that has a chief direction from west to east.

From this short discussion of Fig. 11 we see that the distribution of the precipitation deviations over Norway to a great extent is governed by the course of the coast and the mountain-chains.

8. Mean deviations of the air temperature for different directions of the additional gradient winds. A similar study as that for the precipitation deviations gives for the temperature deviations the results given in Table 3 and Fig. 12.

Also here we see the influence of the geographical conditions. For *Østlandet* we have the maximum of temperature deviation for additional gradient winds from south, while we find the maximum in *Sørlandet* for the direction south to southwest, and along

Table 2. *Summaries for the chief districts.*

Winter.

Year	Østlandet			Sørlandet			Vestlandet			Trøndelag			Nordland			Finnmark		
	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$
1901 .	NW2,A	− 1,2	− 35	NW2,A	− 0.8	− 23	N3,n	− 0.3	+ 5	N3,n	− 1.3	− 1	N3,n	− 0.4	+ 40	NE3,n	− 0.9	+ 28
02 .	N2,A	− 0,3	+ 2	N2,A	− 0.1	+ 3	N2,A	− 0.5	+ 12	NE2,A	− 0.7	+ 28	E2,A	− 1.3	− 10	E2,A	− 3.7	− 11
03 .	NW3,A	− 0,5	− 19	NW3,A	+ 0.2	+ 17	W3,A	− 0.3	+ 33	W4,A	− 0.2	+ 19	SW4,A	+ 1.2	+ 39	NW4,A	+ 3.0	+ 20
04 .	SE4,n	− 0.5	+ 20	SE4,n	− 0.7	+ 13	S4,n	− 0.4	− 52	S4,n	− 0.4	− 67	S4,n	+ 0.2	− 8	S1,n	+ 0.4	− 37
05 .	NW4,n	+ 0.9	− 42	NW4,n	+ 1.1	− 31	NW4,n	+ 0.4	+ 54	NW4,n	− 0.5	+ 92	NW4,n	− 1.0	+ 44	NW2,n	− 1.9	+ 29
1906 .	W2,C	+ 1,4	− 19	W3,C	+ 1.2	− 1	W2,C	+ 0.4	+ 26	W2,C	+ 1.1	+ 24	W2,C	+ 0.7	+ 4	SW1,C	+ 2.0	+ 1
07 .	NW3,C	− 0.3	− 9	NW3,C	− 0.2	− 27	NW4,C	− 0.5	+ 6	NW3,C	− 0.5	+ 53	NW2,C	− 0.2	+ 30	N1,C	+ 0.1	+ 39
08 .	NE1,C	+ 0.8	+ 15	N2,C	+ 0.7	+ 14	N2,C	+ 0.5	+ 18	NE2,C	+ 0.5	+ 42	NE2,C	− 0.5	− 4	E1,C	− 1.0	+ 22
09 .	NW1,A	+ 0.3	− 33	NW1,A	+ 0.6	− 27	W1,A	+ 0.6	− 4	W2,A	+ 0.8	− 8	W3,A	+ 1.1	+ 28	NW1,A	+ 2.4	+ 18
10 .	SE3,n	+ 0.1	+ 56	SW3,n	+ 0.2	+ 24	S3,n	0.0	0	SW3,n	− 0.1	− 28	SE2,n	+ 0.3	+ 13	− 1,n	+ 1.6	− 16
1911 .	N3,n	+ 1.3	− 6	NW3,n	+ 1.3	+ 12	NW3,n	+ 0.7	+ 18	NW3,n	+ 1.1	+ 48	NW2,n	+ 0.4	+ 21	NW2,n	+ 0.7	− 3
12 .	SE3,n	− 0.7	− 12	SE4,n	− 0.5	− 8	S4,n	+ 0.3	− 46	S3,n	+ 0.4	− 22	S3,n	− 0.8	− 36	− ,A	− 1.9	+ 2
13 .	SW2,A	+ 1.2	0	SW2,n	+ 1.3	+ 11	SW3,n	+ 0.7	+ 17	S3,n	+ 0.9	− 9	SE1,n	+ 0.4	− 27	− ,A	− 0.5	− 16
14 .	NW3,n	+ 0.9	− 5	NW3,n	+ 1.3	+ 22	NW3,n	+ 1.0	+ 55	NW3,n	+ 1.5	+ 36	NW2,C	+ 0.5	+ 32	E1,C	− 0.6	+ 55
15 .	SW5,n	+ 0.7	+ 70	SW5,n	+ 0.1	+ 48	W5,n	0.0	− 25	SW5,n	+ 1.0	− 54	SW4,n	+ 1.0	− 54	SW3,n	− 1.3	+ 2
1916 .	E2,C	− 1.0	+ 13	SW1,C	− 0.8	+ 20	NE2,C	− 0.7	+ 7	E2,n	− 1.6	− 32	E2,n	− 1.7	− 24	SE2,n	− 2.4	− 14
17 .	E3,n	− 2.3	− 16	E3,n	− 2.0	− 32	NE5,n	− 1.4	− 60	NE4,n	− 0.9	− 34	NE4,n	− 1.6	− 15	NE5,n	− 2.2	+ 21
18 .	NW3,n	− 0.7	− 36	NW4,n	− 0.6	− 34	NW4,n	− 0.6	+ 19	NW3,n	− 0.8	+ 25	N3,A	− 1.3	+ 29	− ,A	− 2.9	− 8
19 .	SE2,n	− 0.7	+ 9	SE1,n	− 0.9	− 12	SE1,n	− 0.5	− 52	SE3,n	− 0.2	− 46	SE3,n	− 0.6	− 40	SE3,n	− 0.2	− 3
20 .	SW2,C	+ 0.1	+ 20	W2,C	− 0.1	+ 21	SW3,C	− 0.3	+ 26	SW4,n	− 0.7	− 12	SW4,n	− 0.3	− 12	SW4,n	− 0.4	+ 30
1921 .	NW1,A	+ 0.6	− 13	N1,A	+ 0.7	− 7	NW1,A	+ 0.7	+ 22	NW1,A	+ 1.2	+ 11	NW1,A	+ 0.6	+ 10	NW1,C	+ 0.3	+ 22
22 .	SW1,n	− 0.8	− 20	SE1,n	− 0.9	− 20	S3,n	− 0.1	− 6	SE2,n	− 0.6	− 14	SW4,A	− 0.1	− 40	W3,A	+ 0.8	− 7
23 .	SE1,C	+ 0.7	0	SW1,C	+ 0.8	+ 14	SE1,C	+ 0.2	+ 11	SE1,C	+ 1.0	+ 26	SE2,n	− 0.3	− 20	N1,A	+ 0.8	+ 25
24 .	NE1,n	− 1.4	− 29	NE2,n	− 1.9	− 29	NW1,n	− 1.4	− 23	− ,n	− 1.1	− 5	SW1,A	− 0.4	− 17	SW2,A	− 0.5	− 5
25 .	S3,n	+ 3.5	+ 48	SW2,n	+ 3.4	+ 61	SW4,n	+ 2.5	+ 61	SW5,n	+ 3.6	+ 25	SW3,n	+ 2.5	+ 49	W2,n	+ 3.5	+ 17
1926 .	SE4,n	− 1.7	+ 7	SE4,n	− 2.0	− 11	SE4,n	− 0.7	− 40	SE4,n	− 1.1	− 45	SE3,A	− 0.8	− 38	W3,A	− 1.5	− 18
27 .	SE1,C	+ 0.8	+ 39	NW1,C	+ 0.7	+ 21	NW1,C	+ 0.6	+ 13	S1,C	+ 1.0	+ 19	SW1,A	− 0.4	+ 20	SW1,A	− 0.4	+ 21
28 .	SE2,A	− 1.5	− 14	S3,A	− 1.2	+ 8	SE1,n	− 0.7	− 15	−,n	− 0.4	− 33	SW1,A	+ 0.4	− 33	W1,A	+ 1.8	− 18
29 .	SE2,A	− 2.7	− 53	E3,A	− 2.8	− 56	S2,A	− 1.6	− 51	−,A	− 0.6	− 34	SW1,A	+ 0.3	− 5	NW4,n	− 0.4	+ 34
30 .	S2,n	+ 3.0	+ 46	S3,n	+ 1.8	+ 49	S3,n	+ 1.5	+ 4	SW4,n	+ 3.7	− 22	S3,A	+ 2.9	+ 4	W1,A	+ 4.5	+ 3

Spring.

Year	Østlandet			Sørlandet			Vestlandet			Trøndelag			Nordland			Finnmark		
	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$
1901 .	SE2,A	+ 0.5	+ 1	SE2,A	+ 0.2	+ 9	SE1,A	+ 0.4	− 26	SW1,A	+ 0.5	− 29	W1,A	− 0.3	+ 1	NW2,A	+ 0.1	+ 2
02 .	SE2,A	− 1.1	− 19	SE2,A	− 1.2	− 14	SE2,A	− 0.3	− 13	SE2,A	− 0.5	− 42	SE2,n	− 0.8	− 40	SE3,n	− 2.9	− 11
03 .	SW2,C	+ 0.7	+ 39	SW2,C	+ 0.7	+ 77	SW2,C	+ 0.4	+ 69	SW2,C	+ 0.8	− 8	S3,C	+ 0.7	− 30	SE3,C	+ 1.2	− 9
04 .	S2,A	− 0.9	+ 10	S2,A	− 1.0	+ 24	SW3,A	− 0.4	0	SW3,n	− 0.4	− 31	SW3,n	+ 0.7	− 28	SW2,A	+ 1.2	− 26
05 .	S1,n	− 0.2	+ 12	S1,n	0.0	+ 18	S1,n	− 0.5	− 17	S1,n	− 0.3	− 21	S1,n	− 0.4	− 28	SW1,n	+ 0.9	− 16
1906 .	NW2,C	+ 0.2	+ 21	NW3,C	+ 0.3	+ 23	NW3,C	− 0.2	+ 45	NW2,C	+ 0.1	+ 58	N2,C	− 0.9	+ 63	NE1,C	− 0.8	+ 17
07 .	E1,n	0.0	+ 1	E1,n	+ 0.1	− 21	E1,n	− 0.1	− 9	E1,n	+ 0.3	0	E1,n	+ 0.4	+ 3	E1,n	+ 1.6	− 18
08 .	SE2,A	− 0.8	+ 16	SE2,A	− 1.1	+ 2	SE3,A	− 0.2	− 48	SE3,A	− 0.2	− 55	S2,A	− 0.5	− 20	NW4,A	+ 0.5	− 14
09 .	SE2,n	− 2.9	+ 19	SE2,n	− 2.1	− 23	SE2,n	− 1.3	− 38	SE2,n	− 1.4	− 31	SE2,n	− 1.9	− 48	E1,n	− 2.3	− 21
10 .	SW1,C	+ 1.3	+ 47	SW1,C	+ 1.3	+ 12	SW1,C	+ 0.9	+ 13	SW1,C	+ 1.5	+ 13	SW1,n	+ 1.0	− 4	SW1,n	+ 1.0	− 13
1911 .	N1,A	+ 1.0	− 19	N1,A	+ 1.1	− 28	N1,A	+ 0.5	− 8	NW1,A	+ 1.3	− 19	NW2,C	+ 0.1	+ 4	NW2,C	+ 1.1	+ 30
12 .	N1,C	+ 0.6	+ 4	N1,C	+ 0.5	0	NE1,C	+ 0.3	− 5	NE2,C	+ 0.4	− 19	NE1,n	− 0.1	− 24	NE1,n	− 1.0	+ 17
13 .	SW3,n	+ 1.5	0	S2,n	+ 1.2	+ 29	SW3,n	+ 0.7	+ 30	SW4,n	+ 1.5	+ 4	SW3,n	+ 0.7	+ 12	SW2,n	+ 0.4	− 9
14 .	NW2,n	+ 0.3	+ 27	NW2,n	+ 0.6	+ 26	W2,n	+ 0.1	+ 28	W1,n	0.0	+ 12	NW2,C	0.0	+ 27	S1,C	+ 0.5	+ 28
15 .	NW4,n	− 1.1	− 45	NW4,n	− 0.2	− 41	NW4,n	− 1.3	− 9	NW4,n	− 1.5	+ 52	NW3,C	− 2.0	+ 50	W1,C	− 1.4	+ 24
1916 .	SE2,n	− 0.4	+ 1	SE2,n	− 0.9	− 17	E2,n	− 0.5	− 18	SE3,n	− 0.1	− 20	SE3,n	− 0.6	− 49	SE3,n	− 2.1	− 8
17 .	NE1,n	− 2.1	− 34	NE1,n	− 1.6	− 25	NE2,n	− 1.5	− 14	NE2,n	− 1.7	+ 5	NW1,n	− 2.2	− 1	NW2,n	− 3.7	+ 39
18 .	SE2,A	+ 1.0	− 67	SE3,A	+ 0.9	− 65	SE2,A	+ 1.2	− 55	S1,A	+ 1.2	− 26	SW3,A	+ 0.8	+ 15	NW4,A	+ 1.1	+ 1
19 .	N1,A	+ 0.3	− 25	N1,A	+ 0.5	− 16	N1,A	− 0.1	− 10	N1,A	0.0	− 1	NE1,A	− 0.4	− 16	E1,A	− 0.4	− 24
20 .	SW4,n	+ 1.8	+ 58	SW4,n	+ 1.2	+ 73	SW4,n	+ 1.2	+ 63	SW4,n	+ 2.8	+ 12	SW4,n	+ 2.1	+ 18	SW2,n	+ 3.4	+ 70
1921 .	NW3,n	+ 2.3	− 24	W3,n	+ 2.1	+ 4	SW4,n	+ 1.3	+ 98	SW4,n	+ 2.7	+ 62	SW3,n	+ 2.0	+ 52	SW2,n	+ 2.5	+ 14
22 .	NW2,C	− 0.8	− 9	NW2,C	− 1.0	+ 12	NW2,C	− 0.8	+ 40	NE2,C	− 0.1	+ 39	NE2,C	+ 0.2	− 13	NE2,C	+ 0.2	+ 42
23 .	SE2,n	− 0.8	− 2	SE3,n	− 1.3	+ 5	SE2,n	− 0.3	− 35	SE2,n	+ 0.4	− 39	SW1,A	+ 0.4	− 7	NW1,A	+ 0.3	− 13
24 .	NW1,C	− 2.2	− 3	NW1,C	− 2.1	− 13	N1,C	− 1.5	− 20	N1,C	− 1.2	− 5	NE1,n	− 1.1	− 10	NE1,n	− 0.8	− 2
25 .	SW1,n	− 0.1	+ 13	SE1,n	− 0.1	+ 17	− ,n	+ 0.5	− 7	− ,n	+ 0.6	0	SW1,A	+ 0.2	− 14	− ,A	+ 0.9	+ 6
1926 .	NW1,C	+ 0.6	+ 14	NW1,C	+ 0.7	+ 3	N1,C	+ 0.5	+ 17	N1,C	+ 0.4	+ 39	NE1,C	+ 0.4	+ 10	E1,C	+ 0.5	+ 9
27 .	NE1,C	− 0.5	+ 25	N2,C	− 0.3	+ 38	N2,C	− 0.5	+ 7	N2,C	− 0.1	+ 24	NE2,C	− 0.3	− 18	E2,C	− 0.6	− 10
28 .	SE2,A	+ 0.2	− 44	SE3,A	− 0.2	− 44	SE3,A	+ 0.5	− 71	−2,A	+ 0.6	− 58	− ,A	+ 0.7	+ 4	W1,A	+ 1.2	− 21
29 .	NW4,n	+ 0.4	− 28	N3,n	0.0	− 47	N4,n	+ 0.3	− 2	N5,n	+ 0.6	+ 59	NW4,n	0.0	+ 68	N3,n	− 1.3	+ 33
30 .	S1,A	+ 1.8	+ 5	SE1,A	+ 0.9	+ 2	S1,A	+ 1.0	− 23	S1,n	+ 2.0	− 17	S2,C	+ 1.7	+ 29	S2,C	+ 0.5	− 4

Summer.

Year	Østlandet			Sørlandet			Vestlandet			Trøndelag			Nordland			Finnmark		
	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$
1901 .	S1,A	+ 2.2	− 22	S1,A	+ 1.6	− 18	S1,A	+ 1.3	− 7	SW2,A	+ 2.6	− 14	SW2,A	+ 0.8	+ 27	SW2,A	+ 0.7	+ 8
02 .	NE2,C	− 1.3	− 8	NE2,C	− 1.6	− 20	NE3,n	− 1.5	− 36	NE3,A	− 2.1	− 5	N2,n	− 2.1	− 11	NE2,C	− 2.5	+ 5
03 .	− 2,n	− 0.7	+ 5	− 2,n	− 0.4	+ 3	− ,n	− 0.6	+ 7	NE1,C	− 0.9	+ 12	N2,C	− 1.3	+ 15	NE1,C	− 1.1	+ 30
04 .	N3,C	− 0.1	− 54	NW3,C	− 0.3	− 56	N3,n	− 0.5	− 17	N3,n	− 0.7	+ 2	NW1,n	− 1.4	+ 1	NE1,n	− 0.6	− 13
05 .	SE1,A	+ 0.5	− 3	SE1,A	+ 0.7	+ 18	SE1,A	+ 1.0	+ 3	S1,A	+ 0.6	+ 8	SW1,A	+ 0.3	+ 1	SW1,A	+ 0.4	− 16
1906 .	N1,A	+ 0.2	− 27	N1,A	+ 0.5	− 27	NW1,A	+ 0.1	+ 2	NW1,A	0.0	+ 11	NW1,A	− 0.5	− 8	NW1,A	− 0.8	+ 31
07 .	SW1,C	− 1.5	+ 17	SW1,C	− 1.8	+ 12	NE1,C	− 1.4	+ 9	NE1,C	− 0.8	− 4	E1,C	− 0.1	+ 2	SE1,C	+ 0.1	+ 33
08 .	SE1,A	+ 0.4	+ 15	SE1,A	+ 0.5	− 4	SE1,A	− 0.1	− 1	SE1,A	− 0.3	− 10	S1,A	− 0.7	− 8	NW2,A	− 0,6	− 22
09 .	NW2,n	− 0.7	+ 20	NW2,n	− 0.8	+ 16	NW2,n	− 1.2	+ 23	NW2,n	− 1.4	+ 41	N1,n	− 1.0	+ 7	N1,n	− 0.4	+ 14
10 .	SE4,n	+ 0.8	+ 25	S4,n	+ 1.1	+ 35	NE4,n	+ 1.1	− 31	SE3,n	+ 0.3	− 62	E2,n	− 0.6	− 37	NE1,n	− 1.8	+ 14
1911 .	N1,A	+ 0.7	− 54	NW1,A	+ 1.2	− 28	SE1,A	+ 0.9	− 17	NW2,A	+ 0.4	0	NW2,A	− 0.6	+ 16	NW1,A	− 0.5	+ 26
12 .	SE4,C	+ 1.2	+ 40	S4,C	+ 0.4	+ 34	NE3,C	+ 1.0	− 14	NE2,C	+ 1.5	− 34	E2,C	+ 0.8	− 28	SE1,C	− 0.5	0
13 .	NE3,A	+ 0.3	− 17	N2,A	+ 0.2	− 40	NE2,A	− 0.5	− 49	NE2,n	− 0.2	− 20	NE1,n	− 0.4	+ 10	NE1,n	+ 0.4	+ 8
14 .	SE1,A	+ 2.1	− 38	SE2,A	+ 1.9	− 20	S2,A	+ 1.9	− 22	S2,A	+ 1.8	− 26	SW1,A	+ 0.8	− 23	NW1,A	+ 0.1	− 4
15 .	N1,C	− 0.7	+ 14	NW1,C	− 0.2	− 14	N2,C	− 0.7	− 8	NW1,C	− 1.0	+ 18	− ,C	− 0.8	+ 8	SE1,C	+ 0.4	− 21
1916 .	SE1,C	0.0	+ 1	E1,C	− 0.3	− 4	NE1,n	− 0.4	− 26	SE2,n	+ 1.1	+ 3	E1,n	+ 1.0	− 29	NE1,n	− 0.4	− 33
17 .	S3,n	+ 1.3	+ 17	S3,n	+ 1.1	+ 51	S3,n	+ 1.5	− 2	S3,n	+ 1.7	− 16	SW3,n	+ 0.3	+ 7	NW2,A	− 0.1	+ 24
18 .	NE1,A	− 0.3	+ 11	W1,A	− 0.3	− 6	NE1,A	− 0.1	+ 28	E1,n	+ 0.4	+ 14	SE1,n	+ 0.8	− 33	SE2,n	+ 0.3	− 35
19 .	NW1,n	− 0.2	− 20	NW2,n	− 0.1	− 12	NW2,n	− 0.7	+ 1	NW1,n	− 0.7	+ 6	N1,C	− 0.4	+ 1	E1,C	+ 1.1	+ 4
20 .	− 1,A	− 0.5	+ 15	− ,A	0.0	+ 29	S2,A	+ 0.4	+ 15	SW2,A	0.0	+ 11	W1,n	0.0	+ 33	W1,n	+ 1.6	+ 30
1921 .	N3,n	− 0.1	− 34	N3,n	− 0.4	− 48	NW2,n	− 1.5	+ 9	NW2,n	− 1.9	+ 53	NW2,C	− 1.1	+ 69	− ,C	+ 0.4	+ 52
22 .	S1,C	− 1.0	+ 19	SW1,C	− 1.1	+ 9	S1,C	− 0.6	+ 14	SE1,C	+ 0.1	− 8	SE1,n	+ 1.5	− 12	SE1,n	+ 2.0	− 22
23 .	NW3,n	− 1.8	− 24	NW3,n	− 1.5	− 23	NW2,n	− 1.4	+ 19	NW2,n	− 1.5	+ 19	NE1,C	− 1.5	− 2	NE2,C	− 0.6	0
24 .	SW2,n	− 0.6	+ 45	S2,n	− 0.9	+ 46	S3,n	0.0	+ 17	SW2,n	+ 0.5	+ 3	SE2,n	+ 1.2	− 25	− ,n	+ 0.7	− 39
25 .	NE1,n	+ 1.5	− 24	NE1,n	+ 1.5	− 34	SE1,n	+ 1.6	− 10	− ,n	+ 1.8	+ 23	SW1,n	+ 1.5	− 7	SW2,n	+ 0.8	− 5
1926 .	SE1,C	+ 0.6	+ 19	SE1,C	+ 1.2	+ 2	S1,C	+ 1.5	+ 10	SW1,C	+ 0.8	− 1	S1,C	+ 0.3	− 14	NW1,C	− 0.7	− 13
27 .	S1,C	+ 0.2	+ 52	SE1,C	0.0	+ 55	S1,n	+ 0.8	− 4	SE2,n	+ 1.5	− 27	SE1,A	+ 2,0	− 30	SW1,A	+ 1.1	− 16
28 .	NW3,A	− 2.1	− 2	NW2,n	− 1.8	− 7	NW2,A	− 1.6	+ 41	NW2,A	− 2.2	+ 32	NW1,A	− 0.2	+ 28	SE2,A	− 0.5	+ 22
29 .	W2,n	− 1.5	− 11	W1,n	− 1.1	+ 4	W2,n	− 0.5	+ 45	N1,n	− 1.4	+ 12	N1,n	− 1.6	+ 9	− ,C	− 1.1	+ 15
30 .	SW2,C	+ 1.2	+ 28	SW3,C	+ 0.8	+ 28	SW2,C	+ 2.0	− 11	SE2,n	+ 2.6	− 25	SE1,n	+ 2.6	− 18	S1,n	+ 1.3	− 40

Autumn.

Year	Østlandet			Sørlandet			Vestlandet			Trøndelag			Nordland			Finnmark		
	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$	$\overline{\Delta v}$	$\overline{\Delta T}$	$\overline{\Delta R}$
1901 .	NE1,n	+ 1.1	− 21	NE1,n	+ 0.8	− 44	N1,n	+ 0.7	− 11	W1,n	+ 1.7	+ 16	SW2,n	+ 1.6	+ 23	W2,n	+ 1.1	+ 10
02 .	N1,A	− 1.3	− 41	E1,A	− 1.1	− 40	SE1,A	− 0.7	− 29	NW1,A	− 0.8	− 3	N1,A	− 0.9	+ 31	N2,A	− 1.4	+ 12
03 .	SE1,C	− 0.4	+ 9	SE1,C	− 0.6	+ 11	SE1,C	− 0.3	− 6	SE1,C	0.0	− 16	NE1,C	− 0.8	− 16	E3,C	− 1.4	− 27
04 .	N2,A	− 0.3	− 40	N3,A	− 0.1	− 17	NW1,A	− 0.1	− 9	N2,A	− 0.4	− 13	NW2,A	− 0.1	+ 3	NW1,A	0.0	− 14
05 .	NE2,C	− 1.4	− 15	NE2,C	− 1.2	− 9	NE2,C	− 1.1	− 18	NE2,C	− 1.4	− 20	NE2,C	− 1.2	− 16	NE1,n	− 1.2	+ 19
1906 .	SE2,A	+ 1.6	− 5	SE2,A	+ 1.4	+ 26	SE2,A	+ 1.3	+ 3	S2,A	+ 1.4	− 6	S2,A	+ 0.4	− 12	W1,A	+ 0.2	− 40
07 .	S3,A	+ 1.5	+ 13	SE3,A	+ 0.8	− 1	S3,A	+ 0.6	− 14	SW3,n	+ 1.2	− 18	SW3,n	+ 1.0	0	SW3,n	+ 1.7	− 8
08 .	S1,A	+ 0.3	− 36	S1,A	+ 0.4	− 31	S2,A	+ 0.8	− 20	W1,A	0.0	− 5	W2,A	+ 0.1	+ 28	NW1,A	− 0.5	+ 13
09 .	S1,C	+ 0.3	+ 31	W1,C	+ 0.2	− 1	N1,C	0.0	+ 5	SE1,C	0.0	+ 8	SE1,C	− 0.6	− 13	SE1,C	− 0.8	+ 14
10 .	NE2,C	− 0.2	+ 21	NE2,C	+ 0.1	− 2	NE3,n	− 0.2	− 28	NE4,n	0.0	− 9	NE1,n	− 0.9	− 2	E1,A	− 0.7	− 18
1911 .	N1,A	− 0.5	− 2	NW2,A	+ 0.2	+ 7	N2,n	− 0.5	+ 5	N2,n	− 0.9	+ 4	N1,A	− 0.2	− 6	E1,A	+ 0.2	− 14
12 .	N2,C	− 0.7	+ 1	N2,C	− 0.5	+ 8	N2,C	− 0.3	− 15	NE2,C	− 0.3	− 12	E2,n	− 0.6	− 6	SE1,n	− 1.3	− 8
13 .	SW2,A	+ 1.8	− 24	SW2,A	+ 1.4	− 18	SW3,n	+ 1.4	+ 12	SW2,A	+ 1.2	− 10	SW1,n	+ 0.4	0	SW1,n	− 0.2	+ 7
14 .	N1,A	+ 0.1	− 38	NE1,A	+ 0.1	− 6	− ,A	+ 0.4	− 5	NW1,A	+ 0.2	+ 9	NW1,A	+ 0.7	+ 1	NW2,C	+ 0.9	+ 11
15 .	NE5,n	− 2.9	− 24	NE4,n	− 1.7	− 63	NE4,n	− 1.2	− 64	NE5,n	− 1.6	− 24	NE2,n	− 1.3	− 27	NE3,n	− 1.2	+ 2
1916 .	S1,C	+ 0.3	+ 41	SW2,C	+ 0.4	+ 59	S2,C	+ 0.1	+ 25	SE2,C	+ 0.1	+ 4	E1,n	− 0.5	− 2	NW1,n .	0.0	− 9
17 .	SW2,C	+ 0,8	− 2	W2,C	+ 0.6	+ 30	NW2,C	+ 0.2	+ 71	W1,C	+ 0.3	+ 39	NE2,C	− 0.1	− 9	SE5,C	− 0.5	+ 14
18 .	SW3,n	+ 0,7	+ 24	SW3,n	+ 0.5	+ 31	SW2,n	+ 0.5	+ 16	SW3,n	+ 1.2	− 11	SW3,n	+ 1.4	+ 8	SW2,n	+ 2.2	+ 21
19 .	NE1,C	− 1.4	− 23	NE1,C	− 1.3	− 37	NE2,C	− 1.7	+ 7	NE1,C	− 1.8	+ 9	NE1,n	− 1.5	+ 16	E1,n	− 1.0	+ 25
20 .	SW3,A	+ 0,1	− 41	SE4,A	+ 0.1	− 37	S4,A	+ 0.9	− 28	SW4,A	+ 1.5	− 38	W2,n	+ 2.2	+ 11	W2,n	+ 1.8	− 10
1921 .	NW3,A	− 0,5	− 56	NW2,A	− 0.6	− 57	NW4,A	− 0.5	+ 12	NW2,n	− 0.5	+ 47	NW2,n	− 0.8	+ 35	NW1,n	− 0.9	+ 33
22 .	N4,A	− 0,5	− 48	N4,A	− 0.8	− 40	NW4,A	− 0.6	− 24	N4,n	+ 0.2	+ 40	NW2,n	+ 0.3	+ 21	NW1,n	+ 1.4	+ 7
23 .	SW2,C	− 0.6	+ 64	SW2,C	− 0.6	+ 77	SW2,C	− 0.7	+ 57	SW3,C	+ 0.1	+ 7	SE2,n	+ 0.2	− 27	SE1,n	+ 0.6	+ 11
24 .	SW1,C	+ 1.6	+ 56	S2,C	+ 1.4	+ 15	S2,n	+ 1.4	− 3	SW3,n	+ 2.2	− 19	SW1,n	+ 2.2	+ 19	W1,A	+ 2.1	+ 15
25 .	NW2,n	− 1.4	+ 3	N2,n	− 0.9	− 4	N2,n	− 1.0	+ 3	NE3,n	− 1.3	+ 43	N2,n	− 0.9	+ 15	E2,n	− 1.0	− 5
1926 .	SE2,C	− 0.2	+ 39	SE2,C	− 0.3	+ 40	SE2,C	− 0.5	− 3	SE2,n	− 0.7	− 15	S1,A	− 0.6	− 4	SW1,A	− 0.4	+ 1
27 .	SE1,C	− 0.6	+ 28	SE1,C	− 0.5	+ 7	S1,C	− 0.4	+ 1	− ,n	− 1.2	− 8	NE1,C	− 1.2	− 26	− ,C	− 1.7	− 20
28 .	SE1,C	− 0.1	+ 26	− ,n	+ 0.1	+ 22	S1,C	+ 0.1	+ 2	W1,A	+ 0.1	− 11	NE1,n	+ 0.1	− 24	NE2,n	+ 0.5	− 33
29 .	S2,C	+ 1.3	+ 59	SW3,C	+ 1.0	+ 49	SW3,C	+ 0.4	+ 47	SE3,C	+ 1.0	− 2	SE3,n	+ 1.0	− 22	S2,n	+ 1.8	+ 7
30 .	−,C	+ 0.8	+ 30	− ,C	+ 0.7	+ 42	− ,n	+ 0.5	+ 2	− ,C	+ 0.6	+ 15	SE1,C	+ 0.3	− 12	SE1,C	+ 0.8	+ 20

Table 3. *Mean deviations of the temperature for the different directions of the additional gradient wind.*

District	Wind-direction							
	N	NE	E	SE	S	SW	W	NW
Ø Østlandet	− 0°.1	− 0°.5	− 1°.0	− 0.0	+ 1.0	+ 0.2	− 0.1	− 0.2
S Sørlandet	+ 0.1	− 0.5	− 1.2	− 0.4	+ 0.5	+ 0.5	+ 0.4	− 0.1
V Vestlandet	+ 0.1	− 0.7	− 0.3	− 0.0	+ 0.6	+ 0.8	+ 0.1	− 0.4
T Trøndelag	− 0.4	− 0.8	+ 0.2	+ 0.0	+ 0.8	+ 1.3	+ 0.5	− 0.4
N Nordland	− 0.9	− 0.6	− 0.3	+ 0.4	+ 0.3	+ 0.8	+ 0.6	− 0.1
F Finnmark	− 0.4	− 0.8	− 0.7	− 0.4	+ 0.9	+ 0.9	+ 1.2	+ 0.1
Mean	− 0°.28	− 0°.65	− 0°.48	− 0.17	+ 0.66	+ 0.58	+ 0.54	− 0.34

the long coast from *Vestlandet* up to *Nordland* we find it for additional winds from southwest. The reason is clearly the influence of the warm sea in west.

The minimum of temperature deviations is in *Østlandet* and *Sørlandet* found for additional gradient winds from east, while it along the coast is found for northeast and north.

9. Difference in precipitation deviations by cyclonic and anticyclonic additional gradient flow. The study of the deviation maps showed that a cyclonic curvature of the additional gradient flow generally brings higher values of the precipitation deviations than was found when the curvature was anticyclonic. In order to examine this matter the cases were grouped after the character of the additional gradient flow, given in Table 2.

This was done separately for each of the main parts of the country. The result is given in Table 4, where *n* is the number of cases.

Table 4. *The mean precipitation deviations* $\overline{\Delta R}$ *for anticyclonic, neutral and cyclonic additional gradient flow.*

	Additional gradient flow					
	anticyclonic		neutral		cyclonic	
	n	$\overline{\Delta R}$	n	$\overline{\Delta R}$	n	$\overline{\Delta R}$
Østlandet	38	− 20	42	+ 2	40	+ 17
Sørlandet	38	− 15	43	0	39	+ 14
Vestlandet	32	− 10	50	− 1	38	+ 14
Trøndelag	34	− 25	55	− 2	31	+ 12
Nordland	33	0	62	− 4	25	+ 2
Finnmark	35	− 3	52	+ 2	33	+ 13
Whole country	210	− 12	304	0	206	+ 12

From this table we see that the flows with anticyclonic curvature have precipitation below the average, while those with cyclonic flow have precipitation above the average. The last line in the table shows for the whole country a mean precipitation deviation of 12 per cent over the average when the additional gradient flow has a cyclonic curvature and 12 per cent below the average for anticyclonic flow. The cases with straight flow have the average precipitation.

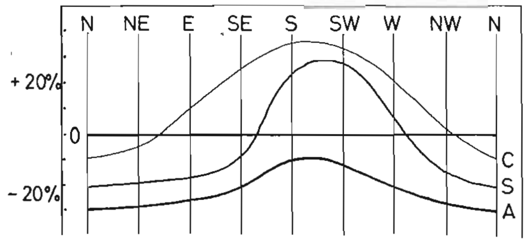

Fig. 13: Mean precipitation deviations for different directions of the additional gradient wind in Østlandet, divided in three groups: cyclonic (C), straight (S) and anticyclonic flow (A).

The influence of the character of the additional gradient flow is seen in a clear way in Fig. 13 where the variation of the precipitation deviation with the direction of the flow is given separately for the cyclonic (curve C), the straight (curve S) and the anticyclonic gradient flow (curve A).

10. The relations between the precipitation deviations of the different districts. The most characteristic feature of the deviation maps over southern Norway is that Langfjellene and Dovre to a considerable extent protect Østlandet against precipitation from west and north, and the districts Vestlandet and Trøndelag against precipitation from eastern directions. It therefore often happens that the weather and also the weather conditions are very different in Østlandet, Vestlandet and Trøndelag.

Further there is often different weather in northern Norway and in the southern part of the country, because of the great difference in latitude, and because cyclones with northern tracks and those with more southernly tracks influence the weather conditions in different ways in the northern and southern districts of the country.

Generally there should be a certain conformity in the variation of the deviations of adjacent districts, and we find thus a considerable parallelity between the variations of the precipitation deviations in Østlandet and Sørlandet. A computation of the correlations between the deviation give a correlation coefficient:

$$r_{Ø,S} = +\,0.70.$$

Further we find some parallelity between the variations of the precipitation deviations in Østlandet and Vestlandet in spite of the influence of Langfjellene. The correlation coefficient is here found to be:

$$r_{Ø,V} = +\,0.29.$$

For the precipitation in Trøndelag compared with that in Østlandet the influence of Dovre is, however, so great that below-normal precipitation in Østlandet in the average is accompanied by above-normal precipitation in Trøndelag, and vice versa. The correlation coefficient is here:

$$r_{Ø,T} = -\,0.18.$$

When the correlation coefficient is high (near + 1) there is a close parallelity between the variations of the deviations in the considered districts. With diminishing correlation coefficient there will be less parallelity, and when it is zero the two series of deviations are completely independent of each other. When we then group the cases after the size of the deviations in one of the districts, we will find that the mean values in the other district become zero for all these groups. When the correlation coefficient decreases further the deviation series in the two districts get increasing inverse variations and for a correlation coefficient near — 1.0 we have again a close connection between the two series, but with inverse variations.

This is clearly seen when we tabulate the precipitation deviations in the districts Sørlandet, Vestlandet and Trøndelag as function of the simultaneous values of the deviations in Østlandet.

For this purpose the precipitation deviations for Østlandet were divided in 6 groups:

Deviation more than	39%	below the normal,
Deviation	39 to 20%	—"—
Deviation	19 to 0%	—"—
Deviation	1 to 20%	over the normal,
Deviation	21 to 40%	—"—
Deviation more than	40%	—"— .

For these groups average values of the precipitation deviations were then computed for the districts in question. The result is given in Table 5.

Table 5. *The mean precipitation deviations as functions of those in Østlandet.*

Ø Østlandet	Deviations in per cent					
	< — 39	— 39 to — 20	— 19 to 0	1—20	21—40	> 40
Ø Østlandet	— 49	— 28	— 5	+ 11	+ 30	+ 54
S Sørlandet	— 43	— 27	— 1	+ 6	+ 28	+ 47
V Vestlandet.....	— 20	— 1	+ 4	— 6	+ 16	+ 21
T Trøndelag	+ 5	+ 8	0	— 7	— 8	— 6

From the two first lines of the table we see how close the connection between the precipitation deviations are in Østlandet and Sørlandet. These two districts will in the average have simultaneously deficit or surplus of precipitation.

Vestlandet is separated from Østlandet by the mountain-chain Langfjellene and here the precipitation deviations are rather different from those in Østlandet, and for Trøndelag, north of Dovre, the fourth line of the table indicates that the deviations are inverse, so that we there have on the average surplus of precipitation when Østlandet shows a deficit, and a deficit when Østlandet have a surplus of precipitation.

The statistical treatment of the material will be simplified when we do not compute the mean precipitation deviation for so many intervals as we have in Table 5. If we use only two groups, namely the cases with surplus of precipitation and those with deficit we get the data given in Table 6.

In the first column we find the mean deviations for the cases when there is a deficit of precipitation in Østlandet. For Østlandet we note that the mean deficit is 25%, and this shows how variable the amount of precipitation is. For Sørlandet where the precipitation deviations are closely connected with those in Østlandet ($r_{Ø,S} = +0.70$) the precipitation deficit is 20%, while it for Vestlandet ($r_{Ø,V} = +0.29$) is only 4% and for Trøndelag ($r_{Ø,T} = -0.18$) there is an excess of precipitation of 6%. Further towards north the excess is higher, for Nordland 8% and for Finmark 10%.

In the last column of Table 6 we find the mean precipitation deviation for the case that there is a deficit in Trøndelag. For Trøndelag we have then mean deficit of 22%, and a mean surplus in Østlandet of 2%.

Table 6. *Mean precipitation deviations for the cases that the amount is below the normal in respectively Østlandet, Sørlandet, Vestlandet and Trøndelag.*

	Deviations in per cent for the cases with negative deviations in			
	Ø Østlandet	S Sørlandet	V Vestlandet	T Trøndelag
Ø Østlandet	– 25	– 19	– 8	+ 2
S Sørlandet	– 20	– 23	– 11	0
V Vestlandet	– 4	– 11	– 22	– 16
T Trøndelag	+ 6	+ 3	– 16	– 22
N Nordland	+ 8			– 11
F Finnmark	+ 10			– 4

Table 7. *The 10 periods with the greatest deficit of precipitation in Østlandet.*

Time period	Part of the country					
	Ø	S	V	T	N	F
1918, spring	– 67	– 65	– 55	– 24	+ 15	+ 1
1921, autumn	– 56	– 57	+ 12	+ 47	+ 35	+ 33
1911, summer	– 54	– 28	– 17	0	+ 16	+ 26
1904, summer	– 54	– 56	– 17	+ 2	+ 1	– 13
1929, winter	– 53	– 56	– 51	– 34	– 5	+ 34
1922, autumn	– 48	– 40	– 24	+ 40	+ 21	+ 7
1915, spring	– 45	– 41	– 9	+ 52	+ 50	+ 24
1928, spring	– 44	– 44	– 71	– 58	+ 4	– 21
1905, winter	– 42	– 31	+ 54	+ 92	+ 44	+ 29
1902, autumn	– 41	– 40	– 29	– 3	+ 31	+ 12
Average	– 50.4	– 45.8	– 20.7	+ 11.4	+ 21.2	+ 13.2

In the second and third column we find the mean precipitation deviation for the cases that there is a deficit respectively in Sørlandet and in Vestlandet.

In Table 7 we find the 10 cases with greatest deficit of precipitation in Østlandet.

In the first column is indicated the periods in question and in the following columns precipitation deviations in our 6 main districts. In some of the cases (spring 1918, winter 1929 and spring 1928) the drought is so extended that we must go so far as to northern Norway to find normal precipitation or excess of precipitation.

On the average for the 10 cases (the last line of the table) we have for Østlandet a deficit of 50%, for Sørlandet a deficit of 46%, in Vestlandet of 21%, while we for Trøndelag and further to the north have a surplus of precipitation of 11 to 21 %.

We have gone so far into this matter because of the importance it has for the planning of the exchange of electric power from the waterfalls between the different parts of the country. It is, for instance, on the average a considerable advantage to exchange electricity between Østlandet and Trøndelag, because Trøndelag generally has more precipitation than normal when the precipitation in Østlandet is scarce, and on the other hand Østlandet has commonly an excess of precipitation when the precipitation in Trøndelag is less than normal.

(Manuscript received 8 June 1961)