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The Effect of Local Factors on the Meteorological Observations at Tórshavn

By

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In daily weather-forecasting, each of the few observations obtainable from the northern Atlantic, where cyclones frequently occur, is of considerable value. In the climatology of Europe, again, we often come to look for a typically oceanic place as the counterpart of the great Asiatic continent. Tórshavn may, on such an occasion, be considered the most representative place of its kind, as, situated in the middle of an ocean, on the small Faroe Islands, it is as free as possible from the influence of continents. From the year 1872 onwards, observations have been made there regularly, and this series is an unfailing source for many investigations. They cannot, however, be considered as ideal oceanic observations, this due to the range of mountains rising to the height of some hundreds of meters on the islands which are bound to have a meteorological effect of some kind. As I have had the rare occasion of following the weather phenomena at Tórshavn for over a year now, I am in the position of making an account of its special local features for the information of both synoptists and climatologists.

Surroundings of Tórshavn.

Tórshavn is situated on the island of Streymoy, on its southeastern coast. The map shows that the western side of the town from south to north is sheltered by an unbroken range of mountains, the height of which is 300—400 m in the south and the west. The island sticks out towards north-west with a 40 km range of mountains with an altitude of 600—800 m. In the north the southern points of the island Eysturoy are to be seen.

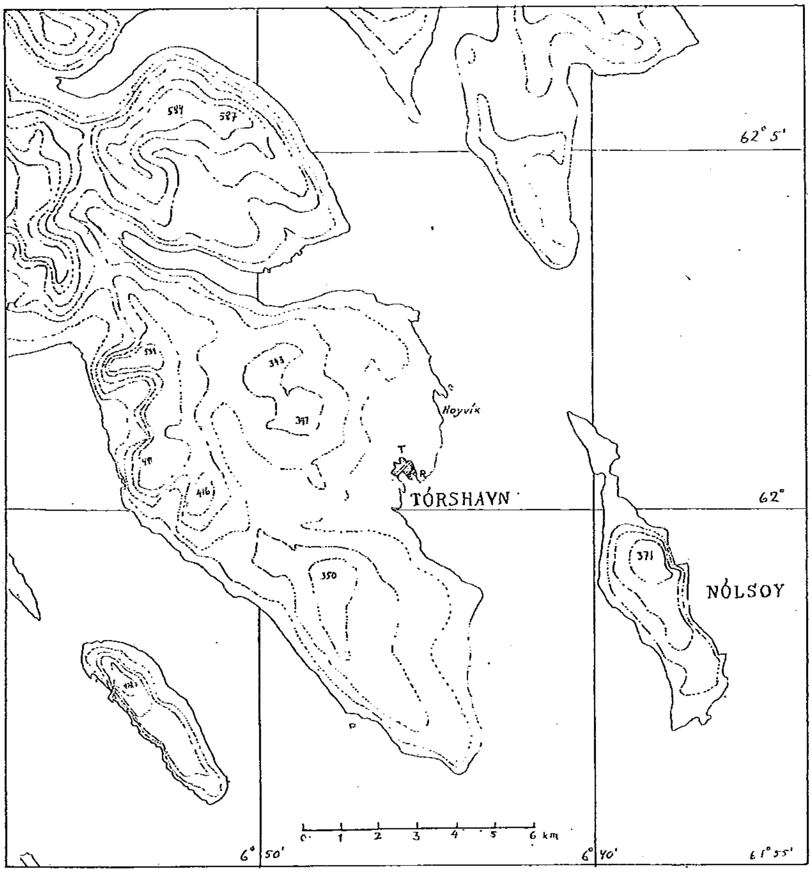

Fig. 1

It continues towards north-west, which is the direction of the other islands, too, and on it the highest mountain of the Farœ Islands, Slættaratindur, rises to the height of 882 m. In the east and south-east the town is sheltered by Nólsoy, and so the open sea is seen only in the north-east and south-south-east. The observation station was until the year 1906 in the town, after that time at the telegraph station which is marked with T on the map. The place of the present radiosonde station is marked with R.

Wind.

The altitudes make it clear that although west and south-west winds are the most prevalent and pronounced, they are restrained at Tórshavn. So the south-east winds are the most formidable as they blow with full force straight from the open sea to the harbour and thus make the ships there seek more sheltered harbors. The wind may naturally often blow along the fiords i.e. in tue from north-westly-south-est direction, but, as Tórsholm, is sheltered in the north-west by the range of mountains, the winds come there either from the north or from the west where the mountains are lower and the island narrower.

At soundings in winter strong vertical currents of air are striking. While a strong south or south-southwest wind is blowing, the pilot-balloon has to fly over two ranges of mountains. In such a case, two waves in the rise of the pilot-balloon occur regularly; the latter of them is in the altitude of 4—5 km still so strong that the pilot-balloon does not rise at all for a few minutes, which corresponds to a wind of ab. 5 m/sec downwards. In the clouds I have often observed enormous cylindrical whirl-formations. The greatest observed altitudes, 4—5 km, depend upon the distance of the mountains from the starting-place and thus greater altitudes than that cannot be observed with the pilot-balloon. Under favorable conditions, however, a wave of this kind may extend all through the troposphere, although its source is only a range of mountains of the length of a little over half a kilometer.

In summer when the equilibrium of air is stable, the conditions are totally different. The winds are, for the most part, very weak but the wind velocity can increase surprisingly abruptly upwards. The mountains can have the tendency of checking the cold air layer present down below. In the open sea the wind can reach its full force, although at Tórshavn only weak wind is observed as I have been able to notice from the light-ship observations.

Observations errors can also be considered since the anemometer and vane of the station are placed at the side of a big radio mast approximately in the middle of it, so that the shading effect of the mast may give rise to unexpected errors in the wind observations.

Cloudiness and rain.

Faroe islands are a very rainy place. The annual amount of rain in Tórshavn (1872—1920) is 1453 mm. The number of rainy days comes up to 285. The climate does not, however, seem so rainy as one might conclude from these numbers. The probability of rain is in all likelihood not particularly great as the rain usually comes down in powerful showers. Altogether rainless days are rare but so are sunless days, too, and during the whole year I have not once witnessed a rain lasting for a whole day.

The amounts of cloudiness are, compared with the great sum of rain, rather small. This is not an observation error, since the mountains cover about 4° only of the horizon and have an advantageous effect on the evaluation of cloudiness. Likewise, the clouds appear in distinct groups which are easy to observe, and the upper clouds that are observed with more difficulty are comparatively rare. The amounts of cloudiness are thus, in my opinion, exceptionally correct. Their small values depend upon the flow of the air downwards resulting from the surrounding mountains, near the town. As the mountains surround the town on all sides, a cloudless area above the town is a very common phenomenon.

The amounts of rain at different stations vary very much. Mykines on the west coast of the islands has only half of the amount of Tórshavn whereas Klaksvik on the northern islands has observed approximately twice so much rain as Tórshavn. Klaksvik has, indeed, the reputation of being the rainiest spot of the islands: according to an 8-yearly observation series the annual amount of rain is about 2800 mm. As the prevailing winds come from the southwest and west, it is regular that the amount of rain on the windward side of the mountains is much smaller than that behind the mountains, this being exactly the opposite to the cases in greater ranges of mountains, for example in Norway. The explanation of this is that the mountains rising from the sea occasion a whirl which extends very high up, this produces plenty of rain but, by the time the rain reaches the ground, the wind has transported it over the mountains to the other side. There the cloud may have vanished already due to the »Föhn» effect. Twice I have observed that a moderately strong shower of rain fell while the middle sky was quite cloudless. Klaksvik is, moreover, better sheltered by the mountains so that the phenomenon is there stronger still.

The measuring of precipitation in so rainy a region is uncertain. On the one hand, the wind can decrease the amounts of rain, on the other hand, again, it may increase it as the wind may carry sea water with itself to the gauge. On the 12th of October 1947 during a storm from WSW with a speed of 10 Beaufort, at Tórshavn, the windows of the houses were grey with salt crystals. The storm had, consequently, carried sea water all over the island. This has not very much influence on the amounts of rain at Törshavn, but the rain at Mykines can contain some salt water and thus the differences between the actual amounts of rain on the west and east coast may be greater still.

Temperature.

The influence of local circumstances on temperature is comparatively small which is quite opposite to the case of wind and precipitation. From the soundings we see that the inversion of earth's surface is a very rare phenomenon although small inversions have been observed also on the surface of the earth. Strong winds diminishes the differences of temperature and also have the effect that, even in old observations, no great radiation errors occur.

In climatological mean values, however, an effect of the ground may be detected. During summer months the average temperature of air is about $^1/_2{}^\circ$ greater than the surface temperature of the sea. This difference may disappear on the open sea. On the other hand, vertical currents of air can raise the temperature, especially in winter, and so reduce the annual amplitude. This might explain the fact that the annual amplitude in the Shetlands Islands is greater than that of Tórshavn, as the mountains of Shetland are lower. The temperatures of Tórshavn are apparently slightly greater than in the open sea, but, if we examine the annual amplitude, it is quite justifiable to take Tórshavn as a typical oceanic place as JOHANSSON[1] has done.

We can get some criticism by comparing the values of different observation stations with each other. Det Danske Meteorologiske Institut publishes the temperature observations made at the following stations in its year-book (Meteorologisk Aarbog 1930—1939):

1) Mykines (Myggenæs) $\varphi = 62°6'$, $\lambda = 7°40'$ W, $h = 110$ m. The station lies at the end of a narrow island sticking out to the sea, and thus the influence of the ground is very slight but the altitude from the sea-level remarkably great.

2) Hoyvik (Højvig) $\varphi = 62°3'$, $\lambda = 6°45'$ W, $h = 20$ m. This station is near Tòrshavn and may be considered identical with it.

[1] Osc. V. Johansson, Den årliga temperaturperiodens egenskaper och typer, främst i Europa, Mitt. des Met. Instituts d. Universität H:fors N:o 11.

3) Sandur (Sand) $\varphi = 61°52'$, $\lambda = 6°45'$ W, $h = 13$ m. The station lies at the bottom of a valley opening southwards.

The temperature of the coldest month τ, spring temperature V. The temperature of the warmest month τ_3, autumn temperature H, annual temperature μ and annual amplitude $A = \tau_3 - \tau$, are the following, recorded as the mean values of then years:

	τ	V	τ_3	H	μ	A
Mykines	3.5	5.0	10.5	7.1	6.5	7.0
Hoyvik	4.0	5.6	11.5	7.8	7.1	7.5
Sandur	3.9	5.7	11.4	7.7	7.1	7.6

JOHANSSON defines the following characteristics of temperature in the above-mentioned publication:

Degree of continentality .... $k = \dfrac{1.6\,A}{\sin\varphi} - 14$

Relative spring temperature ...... $v = \dfrac{V - \tau}{A}\,100 - 50$

Relative autumn temperature ...... $h = \dfrac{H - \tau}{A}\,100 - 50$

Phase transfer .... $d = \dfrac{h - v}{2}$

Asymmetrics .... $m = \dfrac{h + v}{2}$

Continentality index .... $K = 0.7 \,.\, k + v + 25$

At our stations the following values are obtained for them:

	k	v	h	d	m	K
Mykines	—1	—28	2	15	—13	—4
Hoyvik	0	—28	0	14	—14	—3
Sandur	0	—26	1	14	—13	—1

What mean values of temperature can we expect to get from the open sea? In winter the sea is considerably warmer than the air, and we may therefore assume that, in the vicinity of the sea-level, an adiabatic temperature gradient prevails. As Mykines lies in a very free place it shows best the temperature that is free from the influence of the earth surface.

We may thus estimate that the temperature on sea-surface is 1.1° warmer, or $\tau = 4.6$. Hoyvik and Sandur lie at more sheltered places so that the smaller values may be due to the effect of the earth surface. In spring and autumn the gradient may be assumed to be 0.5°/100 m, when Mykines gives $V = 5.5$ as the temperature on the sea-surface, $H = 7.7$. In summer the temperature equilibrium of the air is stable, and so the temperature of the air can be the same as that of the water. The following corrections should thus be made to the Hoyvik observations. $\Delta\tau = +0.6$, $\Delta V = 0.1$, $\Delta\tau_3 = 0.5$, $\Delta H = -0.1$. When these corrections are made in the mean temperature values of Tórshavn during 1872—1920, we obtain the following values for the ideal oceanic weather on the 62. latitude. $\tau = 3.5$, $V = 4.8$, $\tau_3 = 10.1$, $H = 6.7$, $A = 6.6$. From these we obtain the following climatological characteristics:

$k = -2$, $v = 3\,v$, $h = -3$, $d = 14$, $m = -16$, $K = -6$.

If we wish to define k and K so that they in the open sea get the value 0, their definitions have to be changed as is shown below:

$$k = \frac{1.57 \cdot A}{\sin \varphi} - 11.7$$

$$K = 0.65 \cdot k + v + 30.$$

It is significant that this definition of k is even more distant from Gorczynski's formula than the one into which Johansson changed it. Gorczynski's formula would, in the open sea, give the value — 8.

According to the new definition, Tórshavn's values would be $k = +2$, $K = +8$. The islands would occasion a distinct effect of continentality. If we consider how accurately the isolines of K follow the coast-lines, the result seems by no means incredible. On the Lake Ladoga the small island of Valamo occasions a value of k that is 4 units greater and a value of K that is 7 units greater than those given by the neighboring very small island Hanhipaasi. Compared with theses the numbers for Tórshavn are not impossible, although the point of comparison, temperature on the open sea, is to a large extent hypothetical, and is corroborated only when adequately long observation series are obtained from the open sea itself.

Tòrshavn, January 1948.