Meteorology. *"On the relation between fluctuations in the strength of the Trade winds of the North-Atlantic Ocean in summer and departures from the normal of the wintertemperature in Europe".* By P. H. GALLÉ. (Communicated by Dr. J. P. VAN DER STOK).

(Communicated in the meeting of January 29, 1916).

1. In a former investigation [1]), the relation was shown between the strength of the Northeast Trade of the North-Atlantic Ocean and the intensity of some hydrographical phenomena in the northern European seas; about three months elapsed between cause and result.

Starting from this point it was obvious that it should be investigated if any relation could be demonstrated between fluctuations in the strength of the Trade wind in summer and those in the temperature of the succeeding winter in Europe.

It is a widely-spread and generally received opinion that the Gulfstream is one of the predominant, if not the most predominant, among the agents, responsible for the mild climate of Western-Europe.

The contrasting temperature-anomalies of the Norwegian coast and the North-American eastcoast and those of the northern and southern coasts of Iceland are brought forward as striking examples of Gulfstream-influence.

Thus, fluctuations in the intensity of this stream will logically cause fluctuations in temperature and in European climatological conditions generally.

The Gulfstream itself depending in a high degree upon the strength of the Northeast Trade, it is evident that a relation must exist between the Northeast Trade and the climate of Europe.

MEINARDUS and KÖPPEN [2]) gave an excellent explanation of the way in which the Gulfstream—or rather the offshoots of the North-Atlantic Current, as the stream is called to the east of New-Foundland—causes the mild winters in the greater part of Europe.

The presence of the water of relatively high-temperature alone is not sufficient.

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1) Kon. Akad v. Wetenschappen te Amsterdam. Proceedings of the Meeting of Saturday March 27. 1915. Vol. VXII.

2) WILHELM MEINARDUS. Der Zusammenhang des Winterklimas in Mittel- und Nordwest-Europa mit dem Golfstrom.

Zeitschrift der Gesellschaft für Erdkunde. Bd. XXXIII, p. 183.

W. KÖPPEN. Wodurch ist die hohe Wärme Europas und des Nordatlantischen Ozeans bedingt?

Annalen der Hydrographie und Maritimen Meteorologie 1911, p. 113.

As a first result of the presence of this water they consider the well-known distribution of atmospherical pressure and corresponding air-circulation; and this is a factor of far greater importance.

This pressure-distribution gives rise to the permanent Iceland-Faröer low and southwesterly winds are predominant over the greater part of Europe.

The air transported by these winds being relatively warm and highly-saturated, keeps up the once existing pressure-distribution and the type of weather will show a certain stability.

The northwesterly winds in the rear of the depressions, being very cold in Siberia and off the American coast, are however not accompanied by such sharp temperaturefalls on this side of the ocean, as, before reaching the European continent, they travelled over relatively warm water.

Society experiencing in all its stages the influence of severe or mild winters, it is not astonishing, that it has been tried more than once, to investigate the possibility of making a prognostication about the coming winter.

SABINE [1]) was among the first that took an interest in this question.

His attention was drawn by the remarkably mild winters of 1776—1777 and 1821—1822. In the autumn of 1776 FRANKLIN crossed the Atlantic; in January 1822 SABINE himself sailed as a naval officer in the Iphigenia to the Cape Verde Islands and by these voyages he got at his disposal observations about the water-temperature of a part of the Ocean between the Azores, the Cape Verde Islands and England's South-coast.

These observations generally showed a rather high watertemperature; the positive departures from the mean ranging between 3°.3 and 5°.0 C.

The mean obtained in 1825 agrees within 0°.1 C. with the one we determined in 1915; but the fluctuations calculated for January of every year over the period 1898—1915 are small, the maximum not exceeding + 0°.56 C. and those small fluctuations furnish us with other facts, than the rather exaggerated deviations found by SABINE.

In both cases the scanty observations which SABINE had at his disposal originated from one ship and in our opinion it is owing to this lack of material that he found these large departures.

When we consider single observations out of the great mass we

1) LT. COL. SABINE. On the cause of remarkably Mild Winters which occasionally occur in England.
Philosophical Magazine and Journal of Science. Vol. XXVIII 1846, p. 317.

had at our disposal, it is also possible to come to differences with the mean temperature of 2.°0 and 1.°9 C.

The winter of 1845—1846 being not only very mild, but resembling in more than one respect that of 1821—1822, he came to *the conclusion, that it must be possible to make a prognostication* about the coming winter, if at least he could obtain observations about the speed of the Gulfstream proper.

If the Gulfstream was strong in summer this should be followed in his opinion by a large amount of warm water of Atlantic origin on the European coasts in autumn and winter, and this warm water was the prime cause of mild winters.

In his days it was however not possible to ascertain the rôle performed by that warm water.

The question how it was possible to have the current-observations at his disposal in time, SABINE meets with the words:

"Ships sail faster than the water runs".

Our method — though quite independent of — starts from SABINE's principle of 1846.

OTTO PETTERSSON [1]) and MEINARDUS [2]), though not starting from the Gulfstream, but from the watertemperature off Norway, Iceland and the Faröer, have demonstrated the relation between the Gulfstream and the temperature in Sweden and Central-Europe. To their method we have the objection that the watertemperature in coastal waters is in no small degree affected by on- and off-shore winds. MEINARDUS found the largest correlation in the South of Sweden and the southern and western parts of the Baltic.

From the watertemperature of the Norwegian Sea in December he draws his conclusions about the temperature in Europe for the succeeding months. Without entering into details it is impossible to say any more about these fundamental investigations.

HANN [3]) has demonstrated the mutual relation between weather-conditions in Iceland and the Northwestern part of Europe.

Further investigations of MEINARDUS [4]), BRENNECKE and others enter

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1) OTTO PETTERSSON. Über die Beziehung zwischen hydrographischen und meteorologischen Phänomenen. Met. Zeitschrift 1896.

2) WILHELM MEINARDUS. Über einige meteorologische Beziehungen zwischen dem Nordatlantischen Ozean und Europa im Winterhalbjahr. Met. Zeitschrift 1898.

3) J. HANN. Die Anomalien der Witterung auf Island in dem Zeitraum 1851—1900 und deren Beziehungen zu den gleichzeitigen Witterungsanomalien in Nordwest Europa. Sitzungsberichte der Wiener Akademie. Bd. CXIII. Jan. 1904.

4) MEINARDUS. Periodische Schwankungen der Eistrift bei Island. Annalen etc. 1906.
MEINARDUS. Über Schwankungen der Nord-atlantischen Zirkulation und ihre Folgen. Annalen 1904.

into this question more or less fully and it appears that European climatological conditions substantially depend upon the pressure-distribution over the northern parts of the North-Atlantic Ocean and adjacent seas.

Since SABINE the greater part of the investigations were made for the purpose of finding out the relation between more or less simultaneous phenomena in parts of the globe not too far removed from one another.

It was CAMPBELL HEPWORTH[1]) who again took up the problem in a quite original manner, by investigating the relation between changes in the strength of the Trade winds of the North- and South Atlantic Oceans and those of the watertemperature in the North Atlantic.

He comes to the conclusion that positive departures from the average in the strength of the Trade winds are a year afterwards followed by positive departures in the temperature of the water.

Another study[2]) deals with the relation between the Gulfstream and the temperature of the air in Engeland.

The author demonstrates a rather feeble relation, with a lapse of two months, between the watertemperature of the North Atlantic Ocean and the airtemperature of three stations in England.

We find as the result of both studies considered together, that a relation is demonstrated though not numerically, between the Northeast Trade of the Atlantic Ocean and the airtemperature in Engeland.

2. Our standpoint was explained in a preceding investigation, it was shown that the effect of an impulse in the region of the Trade winds (15°—25° N./25°—45° W.) was traced after two or three months in some hydrographical phenomena in Northern Europe; the supposition is obvious that the wintertemperature (December—February) of Western-, Central- and Northern-Europe, will prove to depend upon Tradewind-agencies, having been active not later than October.

However this supposition alone is not sufficient. What we have to do, is to investigate over which period the Trade has to be taken into account to get the maximum correlation between fluctuations in the strength of the Trade winds and the wintertemperature of Europe.

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1) M. W. CAMPBELL HEPWORTH. Meteorological Office 203. The Trade-winds of the Atlantic Ocean, comprising a comparison in the Changes of the Watertemperature of the N. A. Ocean and in the strength of the Trade-winds.

2) The Gulfstream. Geographical Journal Vol. XLIV p 429 en 534.

This investigation was made over the period 1899/1900—1913/1914 for a combination of five Dutch stations, Flushing, Maestricht, de Bilt, Helder and Groningen, for three German stations together, Gorlitz, Ratibor and Posen and for a combination in the far North-West viz. Angmagsalik (Greenland), Akureyri and Stykkisholm (Iceland).

The choice of these combinations has not been an accidental one. Precursory calculations demonstrated that the largest *positive* correlation was found in East-Germany, the largest *negative* in North-Iceland and East-Greenland.

TABLE I.

	Trade-wind	*a.* Holland		*b.* Germany		*c.* Iceland and Greenland		½(*b*+*c*)
		C. factor	f.	C. factor	f.	C factor	f.	C. factor
		+		+		—		
1	March—Aug.	0.7641	0.0725	0.6796	0.0937	0.1587	0.1698	0.4192
2	July—Sept.	0.2791	0.1606	0.4732	0.1352	0.3801	0.1497	0 4267
3	April—Sept.	0.7029	0.0881	0.7030	0.0881	0.4664	0.1363	0.5847
4	Jan.—Sept.	0.6908	0.0910	0.6512	0.1003	0.1645	0.1695	0.4079
5	Oct.—Sept.	0.6016	0.1110	0.5558	0.1204	0.0635	0.1735	0.3097
6	Aug.—Oct.	0.3818	0.1487	0.6115	0.1094	0.4400	0.1404	0.5258
7	June—Oct.	0.6043	0.1106	0.7865	0.0664	0.4775	0.1345	0.6320
8	May—Oct.	0.6095	0 1094	0.7708	0.0707	0.5637	0.1188	**0.6673**
9	Febr.—Oct.	0.6144	0.1084	0.7222	0.0833	0.4006	0.1462	0.5614
10	Nov.—Oct.	0.5319	0.1249	0.6309	0.1048	0.2834	0.1602	0.4572
11	Dec.—Nov.	0.6179	0.1077	0.6322	0.1046	0.1889	0.1679	0.4106
12	June—Nov.	0.6948	0.0900	0 8127	0.0591	0.4299	0.1420	0 6213
13	⅓ (3+8+12)	0.7032	0.0880	0.8033	0.0617	0.5084	0.1291	0.6559
14	July—Dec.	0.3968	0.1467	0.4949	0.1315	0.0818	0.1730	0.2884

These results partially agree with MEINARDUS's conclusions, where he found the greatest correlation to exist, between fluctuations of the watertemperature in the Norwegian Sea and those of the air-temperature in South-Sweden and the Southern and Western parts of the Baltic.

When considering the table below the largest correlation for the whole of Europe — $^1/_2$ (Germany + Iceland) — will be found between fluctuations of the Trade-wind over May—October and those in the temperature over December—February.

When we consider the combined correlationfactors for Germany and Iceland — $^1/_2$ $(b + c)$ — with regard to the following periods, during which the Trade-wind was taken into account, we get a clear insight into the march of the correlation.

March—Aug.	April—Sept.	May—Oct.	June -Nov.	July - Dec.
0.4192	0.5847	0.6673	0 6213	0.2884

With the collaboration of the Directions of the steamship companies and of our staff of volunteer-observers, the observations about the strength of the Trade winds over May—October may be at our disposal about medio November and so it is possible to make in time a prognostication about the winter to come. From a closer examination of the correlation factors in Table I we learn that the Trade wind observations of April—September provide an approximation, which may be improved when the observations of October are at our disposal; for Germany we have to take the Trade-wind observations of May or June—October, for Iceland those of May—October.

For Holland the observations over the periods March—August, April—September or June—November give a good result, for Europe we can make use of the mean value of the observations $^1/_3$ (April—September + May—October + June—November).

When taking into account the Trade wind of March or of December, the value of the correlation-factor decreases rather fast.

Table II contains the correlationfactors between departures in the strength of the Northeast Trade over three periods and those of the temperatures during the following winter in Europe for 135 stations or districts. They apply to the period 1899/1900—1913/1914.

In charts 1 and 2 the iso-correlates have been traced, they are regular in their progress and they follow more or less the line of separation between the low-lying plain and the highlands as in the neighbourhood of the Alps, the Carpathian Mountains and the Apennines; chart 1 applies to the Trade winds of May—October, chart 2 to those of June—November.

Positive departures in the strength of the Northeast Trade are

TABLE II.

				Trade-wind					
				May-October		June-October		June-Nov.	
		Lat. N.	Long.Grw	corr. fact.	f.	corr. fact.	f.	corr. fact.	f.
1	Terschellingerbank	53°27′	4°52′ E	0.595	0.113	0.586	0.114	0.628	0.106
2	Haaks	52 58	4 18	0.403	0.146	0.448	0.139	0.424	0.143
3	Maas	52 1	3 54	0.540	0.124	0.558	0.120	0.591	0.113
4	Schouwenbank	51 47	3 27	0.595	0.113	0.551	0.121	0.638	0.103
5	Noord Hinder	51 35	2 37	0.309	0.158	0.281	0.160	0.440	0.140
6	Groningen	53 13	6 34	0.626	0.106	0.706	0.087	0.721	0.084
7	Helder	52 58	4 44	0.713	0.086	0.662	0.098	0.748	0.077
8	de Bilt	52 6	5 11	0.556	0.120	0.563	0.119	0.650	0.101
9	Maestricht	50 51	5 41	0 428	0.142	0 409	0.145	0.534	0.125
10	Flushing	51 27	3 36	0.585	0.115	0.494	0.132	0.653	0.100
11	Borkum	53 40	6 45	0.716	0.085	0.715	0.085	0.774	0.070
12	Sylt	54 55	8 20	0 548	0.122	0.593	0.113	0.620	0.107
13	Wilhelmshafen	53 35	8 10	0.613	0.109	0.663	0.098	0.716	0.085
14	Kiel	54 25	10 8	0.544	0.123	0.618	0.108	0.682	0.093
15	Hamburg	53 30	10 0	0.607	0.110	0.676	0.095	0.720	0.084
16	Wüstrow	54 5	11 3	0.659	0.099	0.663	0.098	0.735	0.080
17	Swinemünde	53 55	14 20	0.658	0.099	0.692	0.091	0.765	0.072
18	Rugenwaldermünde	54 30	16 25	0.645	0.102	0.658	0.099	0.715	0.085
19	Neufahrwasser	54 25	18 40	0.618	0.108	0.644	0.102	0.692	0.091
20	Memel	55 45	21 8	0.693	0 091	0.606	0.110	0.673	0.095
21	Trier	49 45	6 39	0.414	0.144	0.451	0.139	0.505	0.130
22	Cologne	50 56	6 57	0.486	0.133	0.529	0.125	0.599	0.112
23	Münster	51 58	7 37	0.554	0.121	0.624	0.106	0.673	0.095
24	Karlsruhe (i.B.)	49 1	8 25	0.475	0.135	0.505	0.130	0.577	0.116
25	Hannover (i.W.)	52 22	9 45	0.585	0.115	0.629	0.105	0.696	0.090
26	Erfurt	50 58	11 4	0.636	0.104	0.703	0.088	0.739	0.079
27	Potsdam	52 23	13 4	0.686	0.092	0.686	0.092	0.730	0.081
28	Berlin	52 31	13 24	0.687	0.092	0.705	0.088	0.786	0.067
29	Görlitz	51 10	15 0	0.736	0.080	0.791	0.065	0.816	0 058

TABLE II (continued).

				Trade-wind				
				May-October		June-October		June
		Lat. N.	Long.Grw.	Corr. fact.	f.	Corr. fact.	f.	Corr. fact.
30	Posen	52°25′	16°55′E	0.740	0.079	0.776	0.069	0.813
31	Bromberg	53 8	18 0	0.683	0.093	0.703	0.088	0.743
32	Ratıbor	50 6	18 13	0.763	0.073	0.791	0.065	0.793
33	Prague	50 5	14 24	0.728	0.082	0.802	0.062	0.795
34	Krakau	50 4	19 57	0.733	0.081	0.738	0.079	0.760
35	Lemberg	49 50	24 1	0.682	0.093	0.648	0.101	0 715
36	Vienna	48 15	16 22	0.630	0.105	0.735	0.080	0.714
37	Salzburg	47 48	13 2	0.406	0.145	0.381	0.149	0.450
38	Insbrück	47 16	11 24	0.323	0.156	0.369	0.150	0.392
39	Graz	47 4	15 28	0.582	0.115	0.714	0.085	0.669
40	Görz	45 57	13 37	0.496	0.131	0.594	0.113	0.612
41	Arco I	45 55	10 53	0.466	0.136	0.580	0.116	0.564
42	Fiume	45 19	14 27	0.610	0.109	0.616	0.108	0.668
43	Florence	43 45	11 15	0 349	0.153	0.507	0.129	0.479
44	Mamornita	48 10	26 8	0 644	0.102	0.597	0.112	0.689
45	Botosani	47 45	26 40	0.708	0.087	0.625	0.106	0.753
46	Falticeni	47 30	26 20	0.651	0.100	0.585	0.115	0.728
47	Baia de Arama	45 0	22 50	0.513	0.128	0.519	0.127	0.591
48	Bucurestı (Filaret)	44 25	26 0	0.538	0.124	0.552	0.121	0.596
49	Constanta	44 10	28 35	0.596	0.112	0.533	0.125	0.627
50	Sofia	43 42	23 20	0.441	0.140	0.445	0.140	0.486
51	Odessa	46 28	30 44	0.724	0 083	0.510	0.129	0.726
52	Kiev	50 26	30 37	0.669	0.097	0.472	0.135	0.672
53	Warsaw	52 0	21 0	0.733	0.081	0.713	0.086	0.753
54	Moscow	55 45	37 37	0.349	0.149	0.201	0.167	0.340
55	Riga	56 57	24 6	0.361	0.152	0.248	0.164	0.361
56	Petrograd	59 58	30 40	0.147	0.171	0.100	0.172	0.116
57	Kuopio	62 55	27 40	—0.121	0.171	—0.123	0.172	—0.186
58	Archangel	64 32	40 33	—0.214	0.166	—0.213	0.166	—0.264

TABLE II (continued).

				Trade-wind					
				May October		June-October		June-Nov.	
		Lat. N.	Long.Grw.	Corr. fact.	f.	Corr. fact.	f.	Corr. fact.	f.
59	Vardö	70°22′	31° 8′ E	—0.257	0.163	—0.171	0.169	—0.230	0.165
60	Alten	69 58	23 15	—0.330	0.155	-0.274	0.161	0.303	0.158
61	Tromsö	69 39	18 58	—0.423	0.143	—0.361	0.149	—0.446	0.140
62	Bodö	67 17	14 24	—0.246	0.164	-0.217	0.166	-0.192	0.168
63	Brönö	65 28	12 13	0.031	0.174	0.064	0.173	0.113	0.172
64	Kristiansund	63 7	7 45	0.147	0.170	0.304	0.158	0.355	0.152
65	Bergen	60 24	5 19	0.157	0.170	0.251	0.163	0 284	0.160
66	Skudesnaes	59 9	5 16	0.262	0.162	0.306	0.158	0.339	0.154
67	Mandal	58 2	7 27	0.307	0.158	0.358	0.152	0.364	0.151
68	Kristiania	59 55	10 43	0.433	0.142	0.589	0 114	0.480	0.134
69	Lund	55 42	13 12	0 574	0.117	0.650	0.101	0.650	0.101
70	Kalmar	56 40	16 22	0.547	0.122	0 629	0.105	0.636	0.104
71	Whisby	57 39	18 18	0.530	0.125	0.506	0 130	0.565	0.118
72	Karlstad	59 23	13 30	0.347	0.153	0.451	0.139	0.418	0.144
73	Upsala	59 51	17 38	0.307	0.158	0.438	0.141	0.358	0.152
74	Stockholm	59 21	18 4	0.449	0.139	0.515	0.128	0 505	0.130
75	Hernösand	62 37	17 57	0.197	0.167	0.205	0.167	0.241	0.164
76	Ostersund	63 11	14 39	0.195	0.168	0.241	0.164	0.253	0.163
77	Umea	63 49	20 17	—0.078	0.173	—0.035	0.174	-0.032	0.174
78	Haparanda	65 50	24 9	—0.109	0.172	—0.021	0.174	—0.084	0.172
79	Copenhagen	55 41	12′36	0.588	0.114	0.612	0.109	0.660	0.098
80	Skagen (The Skaw.)	57 44	10°38	0.416	0 144	0.456	0.138	0.505	0.130
81	Thorshavn	62 3	6°45 W	--0.386	0.148	—0.231	0.165	—0.284	0.160
82	Vestmannö	63 26	20 18	—0.488	0.133	—0.379	0 149	—0.327	0.156
83	Stykkisholm	65 5	22 46	—0.540	0.123	-0.398	0.147	—0.303	0.158
84	Akureyri	66 34	18 3	—0.588	0.114	—0.456	0.138	—0.437	0.141
85	Berufjord	64 40	14 15	—0.470	0.136	—0.349	0.153	—0.351	0.153
86	Angmagsalik	65 37	37 34	—0.565	0.119	—0.502	0.130	—0.428	0 142
87	Ivigtut	61 12	48 10	0.064	0.173	—0.024	0.174	—0.056	0.174

TABLE II (continued).

				Trade-wind				
				May-October		June-October		June
		Lat. N.	Long Grw.	corr. fact.	f.	corr. fact	f.	corr. fact.
88	Godthaab	64°11′	51°44′W	-0.211	0.166	—0.260	0.162	—0.250
89	Jacobshavn	69 13	51 2	—0.187	0.168	-0.145	0.171	—0.130
90	Upernivik	72 47	56 7	—0.197	0 171	—0.130	0.171	—0.145
91	Sumburgh Head	59 40	1 20	- 0.138	0 171	—0.023	0.174	—0.046
92	Aberdeen	57 10	2 6	—0.079	0.173	0.020	0.174	0.099
93	Valentia	51 56	10 15	—0.181	0.169	—0.056	0.174	—0.044
94	Kew	51 28	0 19	0.214	0.166	0.202	0.167	0.371
95	Falmouth	50 9	5 4	—0.086	0.173	0.068	0.173	0.124
96	North Scotland			—0.206	0.167	—0.115	0.172	—0.109
97	East Scotland			—0.083	0.173	—0.063	0.174	0.025
98	N.E. England			0.141	0.171	0.081	0.173	0.285
99	East England			0.194	0.168	0.199	0.167	0.350
100	Central England			0.204	0.167	0.153	0.170	0.336
101	S.E. England			0.151	0.170	0.138	0.171	0.320
102	West Scotland			—0.173	0.169	—0.162	0.170	—0 034
103	N.W. England			—0.152	0.170	0.085	0.173	0.264
104	S.W. England			—0.015	0.174	0.034	0.174	0.149
105	North Ireland			—0.191	0.168	—0.151	0.170	—0.089
106	South Ireland			—0.176	0.169	—0.136	0.171	—0.022
107	The Channel			—0.149	0.170	—0.096	0.173	0.015
108	Dunkirk	51 2	2 23 E	0.403	0.146	0.397	0.147	0.520
109	La Hève	49 31	0 4	0.398	0.147	0.390	0.148	0.545
110	La Hague	49 44	1 57 W	0.246	0.164	0.217	0.166	0.329
111	Brest	48 23	4 30	—0.145	0.171	—0.055	0.174	0.016
112	Nantes	47 15	1 34	0.179	0.169	0.235	0.164	0.364
113	Angers	47 28	0 34	0.160	0.170	0.200	0.167	0.396
114	Paris	48 49	2 29 E	0.327	0.157	0.313	0.157	0.425
115	Besançon	47 15	5 59	0.328	0.155	0.397	0.147	0.473
116	Nancy	48 42	6 11	0.365	0.151	0.355	0.152	0.447

TABLE II (continued).

				Trade-wind					
				May-October		June-October		June-Nov.	
		Lat. N.	Long.Grw.	corr. fact.	f.	corr. fact.	f.	corr. fact.	f.
117	Lyon	45°41′	4°46′ E	0.261	0.162	0.380	0.149	0.460	0.137
118	Puy de Dôme	45 46	2 58	0.278	0.161	0.360	0.152	0.460	0.137
119	Bordeaux	44 50	0 32 W	—0.033	0.174	0.068	0.173	0.214	0.166
120	Nice	43 43	7 18 E	0.305	0.158	0.409	0.145	0.437	0.141
121	Marseilles	43 18	5 23	0.198	0.167	0.341	0.154	0.358	0.152
122	Biarritz	43 29	1 34 W	—0.042	0.174	0.117	0.172	0.215	0.166
123	Pic du Midi	42 56	0 8 E	—0.013	0.174	0.039	0.174	0.148	0.170
124	Perpignan	42 42	2 53	—0.008	0.174	0.175	0.169	0.201	0.167
125	Toulouse	43 37	1 27	—0.069	0.173	—0.013	0.174	0.149	0.170
126	Basle	47 33	7 35	0.427	0.142	0.460	0.137	0.517	0.128
127	Zürich	47 23	8 33	0.376	0.150	0.449	0.139	0 509	0.129
128	Bern	46 57	7 26	0.352	0.153	0.397	0.147	0.467	0 136
129	Neuchâtel	47 0	6 57	0.379	0.149	0.447	0.139	0.509	0.129
130	Altdorf	46 53	8 39	0.128	0.171	0.182	0.168	0.219	0.166
131	Geneva	46 12	6 9	0.237	0.164	0.326	0.156	0.320	0.156
132	Lugano	46 0	8 57	0.437	0.141	0.577	0.116	0.589	0.114
133	Ona (Burgos)	42 44	3 30 W	—0.053	0.174	0.084	0.173	0.176	0.169
134	Coimbra	40 12	8 25	—0.139	0.171	—0.020	0.174	0.115	0.172
135	Infante Don Luiz	38 43	9 9	—0.198	0.167	—0.020	0.174	0.029	0.174

accompanied with positive departures of the wintertemperature in Holland, Belgium, France, Germany, Italy, Austria-Hungary, the Balkan-States, West- and South-Russia, South-Scandinavia, Denmark and the greater part of Great-Britain; at the same time negative temperature-departures occur in the North of Great-Britain, of Scandinavia and of Russia, further in Iceland and Greenland.

The regions of maximum and minimum positive and negative correlation need no further explanation. It has been mentioned before that CAMPBELL HEPWORTH has demonstrated a feeble connection between the strength of the Trades and the temperature in England; we have also found a rather small correlation, CAMPBELL HEPWORTH

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came to a phase-difference of about fourteen months, whereas we found only two months.

3. Charts 3 and 4 contain a representation of the synchronous mean-pressure distribution and temperature deviations for the months December—February, for 1902 and 1910 when it was "too warm" on the continent; charts 5 and 6 for 1901 and 1909 when the winter was "too cold".

Horizontal shading represents positive temperature-deviations, negative deviations are represented by vertical shading, the widest shading agrees with deviations ranging between 0° and 1°.4, the narrower respectively with deviations from 1°.5 to 2°.9, 3°.0 to 4°.4 and from 4°.5 to 6°.0 C.

Attention is drawn by the following points in the isobaric-charts:

a. relative low pressure in warm, relative high pressure in cold winters;

b. the centre of the Iceland-Faroer-low lies in warm winters to the east, in cold winters to the west of Iceland;

c. a rather sudden bend in the isobars in warm winters, which fails in cold ones;

d. the isobars are less undulated in warm winters than in cold ones;

e. to the north of the Iceland-Faroer-low the region of high pressure appears in warm winters, it fails in cold ones.

These facts generally govern the temperature-distribution.

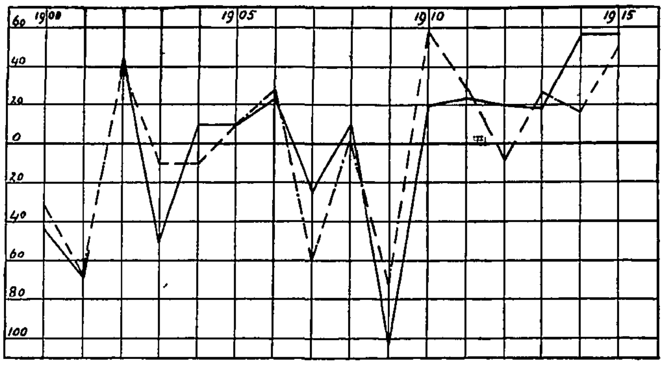
4. Finally the degree of certainty of a prognostication about the character of the coming winter has to be examined and also how far our knowledge about the numerical value of the standard-deviation is improved.

The greatest success of a prognostication may be expected for a region where the largest correlation-factor was found; in our case the part of Germany containing the stations Berlin, Görlitz, Posen, and Ratibor (Table II, chart 2). For the temperature-deviations over the period 1899/1900—1914/1915 with regard to the mean value over these 16 years and for those of the Trade winds over the months June—November the following values were found, they are given in hundredths of a degree Celsius and of Beaufort-units.

Deviations	1900	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Temperature	—103	—217	+123	—30	—33	+30	+93	—200	+ 7	—240	+193	+100	—27	+87	+53	+167
Tradewind	— 43	— 69	+ 43	—50	+10	+10	+24	— 23	+10	—102	+ 19	+ 23	+20	+18	+56	+ 56

Thus $r = + 0.8476$ and $f = \pm 0.0475$.

In the following diagram the full line represents the deviations of the Trade wind to their full magnitude; the stroke-dot line gives those of the temperature, but reduced to $^{3}/_{10}$ of their value.



In 14 out of 16 cases the deviations show a corresponding sign, and generally it would have been possible in seven out of eight cases to make a good forecast about the sign of the departure of the coming wintertemperature.

Let M be the average wintertemperature for the 4 stations over the period 1900—1915, the standard-temperature deviation σ_1, σ_2 that of the Trade wind.

From the observations the following numerical values result: $M = + 0°.027$ C., $\sigma_1 = \pm 1°.295$ C., $\sigma_2 = \pm 0.438$ Beaufort units; for the regression-equation we find:

$$x_1 = 2.508\, x_2$$

where x_1 represents the temperature-deviation, x_2 the corresponding one of the Trade wind.

The improved probable error in the prognostication of the temperature, being:

$$w = {}^{2}/_{3}\, \sigma_1 \sqrt{(1-r^2)} = \pm 0°.456,$$

it is evident, that our knowledge about the value of the standard-deviation is improved by

$$\{1-\sqrt{(1-r^2)}\} \times 100 = 46.93\ \%.$$

Over 1915 the strength of the Trade during Summer was about 3.27 Beaufort-units, the 17 years average amounts to 2.90; so that as far as the rather small number of years permits to make a prognostication, the following forecast was made:

A *mild* winter in Holland, Germany, Austria-Hungary, Switzerland, North-France, Belgium, Denmark, South-Scandinavia, East-England and West-Russia; in Iceland, Greenland, North-Scandinavia and North-Russia a *cold* winter.

Generally this prognostication was a success with rather large departures in temperature.

5. It is a well-known fact that for a number of years more than once large, even larger, correlationfactors than the above mentioned were found, between deviations of various meteorological elements, whereas during a following series the existence of a correlation could hardly be demonstrated. [1]) This proved to be the case when elements were considered between which not such a strong physical relation could be expected as between the Gulfstream and the European climate and this justifies the supposition that a following series of years will confirm the result given above.

The best plan would have been to repeat the same investigation before the year 1900 and indeed we tried to do so for the period 1884—1899, but had to give it up.

As far as temperature-observations were concerned there was no difficulty at all; the number of wind-observations also was sufficient and these observations were extracted and computed. They originated from sailing ships however and this was the reason why they proved to be unfit for our purpose. With feeble winds a ship remained for a longer time in the region in question, whereas with strong winds the region was quickly passed through. The result was a surplus of observations with lower figures, a deficit of higher ones; and not only the force, but also the direction of the Trade wind was a factor not to be neglected.

Till now we have not succeeded in applying a correction to the observations of sailingships so as to make them equivalent to those of the steamships, which practically always spent the same time to pass through the region and this was the reason why that part of the investigation, before 1900, was abandoned.

[1]) Southern Hemisphere Seasonal Correlations by R. C. Mossman F. R. S. E. Reprinted from Symons's Meteorological Magazine Vol. 48 1913.

P. H. GALLÉ: "On the relation between fluctuations in the strength of the Trade winds of the North-Atlantic Ocean in summer and departures from the normal of the wintertemperature in Europe".