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A METEOROLOGICAL FORECASTING PUZZLE

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Svmmarivm — Auctor quaesivit num in menstruis caloris variationibus per longum annorum spatium observatis talis comperiatur regula, ex qua possint in futuros annos similes menstruae caloris variationes conici.

The variability of weather is a well established phenomenon. Hundreds of articles have been published on this captivating subject. Many meteorologists have tried to devise a method for long range weather forecasting. Recently a promising « numerical technique » has raised great hopes. Nevertheless the success obtained up to now is rather limited and debatable. Somewhat reliable forecasts do not extend beyond five days. One month « advisories » are still tentative and too often contradictory.

We will not discuss these new approaches.

The purpose of this NOTE is to describe a rather new technique and find out if the results obtained make sense.

The common practice of meteorologists, interested in finding periodicities, is to consider the sequel of warmer or colder winters or summers and even years. The highest or lowest

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temperature values are examined and treated with the harmonic analysis and Fourier's series, in order to find out hidden periodicities. The «numerical technique» draws special «grids» and, by means of modern computers, strives to discover the atmospheric circulation during these colder or warmer than usual years or months.

Nevertheless, notwithstanding all these efforts, the results are unsatisfactory.

In order to improve such a discouraging state of the research on long range weather forecasting we have tried the following method, which, as far as we have been able to ascertain, has not yet been used by other meteorologists. We would apologize if this statement should be found wrong.

Our analysis has been that of the monthly variability of the temperature. The daily or yearly values were not considered.

In long series of monthly temperatures the author has checked the variation of the monthly temperature of each same month; for instance February, in the years series at hand. The variation looked for was a decrease of at least 3° F., degrees. Such a temperature fall was used as reference value; we believe that this figure can be accepted for distinguishing a colder month from a warmer one.

Of course such a choice can be debated. The results obtained would have been different if we had checked only variations of the monthly temperature of the order of 10° F. degrees.

Moreover this value of a 3° F. degrees fall was not referred to the mean or normal monthly value of all the same months (f.i. the Februaries) of the years series at hand. We think that the so-called « normal temperature » is too much dependent on the length of the series available.

Such a variation technique cannot help to find out the periodicity of colder or warmer seasons or years.

As we stated at the beginning of this paper we were interested in the variability; a phenomenon which could perhaps point out a kind of periodicity of the « gross weather » of German meteorologists.

As a matter of fact a kind of recurring monthly temperature decreases has been found. Can it be accepted as a real meteorological periodicity? That is the puzzle. The more so that we neglected the absolute temperature value of these somewhat periodical plunges.

The TABLES added here at the end of this NOTE, will clarify our statements.

Six long monthly temperature series were at hand. Four of these stations are located in North America and two in semitropical regions.

Here is the list.

Edmonton Air field. Lat. 53°,35′ N. long. 113°,30′ W Alt. 2200 ft. 41 years, 1881-1967. - *Dorval Air Field Lat.* 45°,28′, N. Long. 73°,45′ W. Alt. 102 m. 26 years, 1942-1967. - *McGill University Observatory, Montreal.* Lat. 45°,20′ N. Long. 73°,35′ W. Alt. 189 ft. 55 years, 1875-1929. - *Blue Hill Observatory, Mass. U.S.A.* Lat. 42°,13′ N. Long. 71°,07′ W. Alt. 629 ft. 37 years, 1931-1969. - *New Orleans Weather Office.* Lat. 29°,57′ N. Long. 90°,04′ W. Alt. 53 ft. 77 years, 1871-1947. - *Royal Observatory, Hongkong.* Lat. 22°.37′ N. Long. 113°,52′ E. Alt. 100 ft. 77 years 1884-1961.

The mean monthly temperatures examined total 3656.

The years' series used in this research are not simultaneous. Such a choice was made on purpose. If a real phenomenon recurring or not recurring should exist, it should be found independently of the lenght of the years contemplated. We think the reader will agree.

A remark concerning the following TABLES should be added. At the beginning of the first year of the series as well at the end, the location of the temperature fall is necessarily uncertain. So much so that, for instance, instead of having examined 41 years the author could consider only 40 or even 39.

TABLES

EDMONTON AIR FIELD. 41 YEARS

Month.	Successive intervals of years	Totals,	Mean interval Years
January . .	2.2.2.5.3.2.5.4.2.3.4.2.	12	3.1
February .	4.4.3.3.5.4.7.6.3.	9	4.1
March . .	8.3.4.4.5.3.3.5.2.3.2.	11	3.7
April . . .	9.5.5.3.6.6.6.	7	5.7
May . . .	4.5.3.5.2.9.5.3.4.	9	4.4
June . . .	8.5.4.8.9.6.	6	6.7
July . . .	7.6.12.10.6.	5	8.2
August . .	7.3.9.4.3.5.5.2.2.	9	4.4
September .	7.5.2.10.10.4.4.	7	6.0
October . .	2.2.7.7.5.6.2.7.2.	9	4.4
November .	4.3.2.3.2.3.5.5.8.3.2.	11	3.6
December .	2.4.4.5.3.4.2.4.3.3.3.4.	12	3.4
			Mean 4.8 years

* * *

McGILL OBSERVATORY. 55 YEARS

Month.	Successive intervals of years	Totals,	Mean interval Years
January . .	2.2.2.4.6.3.5.3.3.5.6.2.5.5.	14	3.8
February .	4.4.2.4.5.7.3.3.4.3.3.6.3.4.	14	3.9
March . .	5.5.2.5.4.4.4.2.6.4.7.3.2.	13	4.1
April . . .	5.3.3.2.3.3.2.7.4.4.5.6.3.5.	14	3.9
May . . .	6.4.2.2.10.3.4.2.4.4.3.4.3.3.	14	3.9
June . . .	4.2.4.4.4.4.5.6.2.2.2.2.4.4.4.4.	15	3.5
July . . .	4.5.4.3.4.5.2.7.5.6.3.2.5.	13	4.2
August . .	4.4.2.3.4.5.4.2.4.2.3.7.4.4.3.	15	3.7
September .	4.4.5.5.3.4.4.3.4.3.4.7.3.2.	14	3.9
October . .	6.2.5.7.3.4.2.3.2.7.6.3.5.	13	4.2
November .	5.4.3.3.4.3.4.3.6.3.3.4.4.6.	14	4.0
December .	4.6.4.3.3.2.2.4.2.4.4.3.2.5.2.4.	16	3.4
			Mean 3.9 years

DORVAL AIR-FIELD 26 YEARS

Month.	Successive intervals of years	Totals,	Mean interval Years
January . .	2.3.4.2.3.4.4.3.	8	3.1
February .	4.2.2.5.3.5.4.	7	3.6
March . .	2.5.2.6.4.3.2.2.	8	3.2
April . . .	2.4.3.4.2.5.4.2.	8	3.2
May . . .	2.2.2.5.2.2.2.3.2.4.	10	2.6
June . . .	3.2.4.3.2.2.3.4.3.	9	3.9
July . . .	3.5.4.2.4.2.3.3.	8	3.7
August . .	3.5.3.3.7.4.	6	4.2
September .	4.3.4.2.4.3.3.	7	3.3
October . .	5.3.4.3.3.2.5.	7	3.7
November .	2.2.2.2.4.4.3.3.3.	9	2.8
December .	2.3.4.4.3.2.3.3.	8	3.0
			Mean 3.2 years

* * *

BLUE HILL OBSERVATORY. 37 YEARS

Month.	Successive intervals of years	Totals,	Mean interval Years
January . .	4.5.5.3.6.3.4.4.3.	9	4.1
February .	3.2.6.6.2.5.3.5.4.	9	4.0
March . .	2.5.3.4.3.3.6.4.7.	9	4.1
April . . .	5.3.4.3.4.3.6.4.7.	9	4.3
May . . .	4.3.5.2.5.4.2.2.3.6.	10	3.6
June . . .	2.8.4.4.3.4.3.4.5.	9	4.0
July . . .	2.3.10.4.4.2.6.6.	8	4.6
August . .	6.6.4.4.3.6.6.	7	5.0
September .	3.5.7.3.4.7.2.2.3.	9	4.0
October . .	3.6.6.2.4.6.3.4.3.	9	4.1
November .	2.3.3.2.2.4.2.2.4.4.3.2.2.	13	2.7
December .	2.2.2.4.4.2.6.2.3.3.2.2.	12	2.8
			Mean 3.9 years

* * *

The figures of these four stations of North America have similar year intervals aspect. During summer the dispersion is greater than during winter, spring and autumn. The longer series for McGill Observatory (55 years) are more consistent. Probably the same would have happened also at the other North America localities if their records had been more extended.

The puzzling phenomenon is the fact that the mean year interval of the temperature monthly variations is mostly 4. Does such a recurring year interval mean anything? Such a figure is not strongly prevailing in the list of the successive year intervals. The figures 2 or 3 are just as frequent as the number 4.

An histogram would show that the year intervals of 2,3 and 4 are 70%, the most frequent. Why do we obtain a mean year interval of 4 years, and that, independently on the length of the years series at hand?

Are we entitled to state that in the past the probable interval of, for instance, colder Januaries, has been that of 4 years? We would be wrong. But then once more what can be the meaning of the figure 4? It would be just as deceiving to use this year interval for forecasting the future months temperature. One can see how much mean values can be misleading. Of course there is nothing new in such a statement.

The only admissible result of the TABLES is that in the past, at the stations examined, every 3 to 4 years the same type of month (e.g. January) has been colder than usually.

If we consider the figures for the New Orleans and Hongkong stations, which cover both 77 years, we notice that while in winter, spring and autumn they give a similar 5 to 4 years interval, in summer months the sudden falls of temperature are very few; there is practically no variation and the few ones show intervals of 30 to 70 years. The seasonal effect is very strong.

We add a few figures.

At the New Orleans Weather Bureau the mean year interval is of 9.7 years; for the summer months it increases to 16.5 years. Nevertheless for the winter, spring and autumn months it goes down to 4.6 years. Such a figure is rather close to that of 4, the general mean interval for all months of the North American stations.

At the Royal Observatory of Hongkong, the mean year interval for all the months is 18.8 years. That for winter, spring and autumn months is 5.4 years.

The puzzle is not solved.

Nevertheless the Tables we have offered to the reader, can give an idea of the monthly weather and temperature variations to be expected, in the successive months of the year. When one considers the dispersion of the figures no real consistent periodicity shows up. Only the maximum and the mean time interval of the temperature decreases, in successive years, for the same type of month, could be found interesting.

Of course one should consider the synoptic atmospheric circulation in order to find out if the storminess of weather shows a similar 3 to 4 years succession. Thousands of weather maps should be examined. Unhappily these are not available for all the years' series at hand. Moreover when checking only more recent publications for counting the atmospheric disturbances shown, one finds that maps, drawn by two different weather services, are too often-times not comparable, although covering the same regions of the earth.

Conclusions

The results obtained by means of a rather new technique for formulating long range « gross weather » variability forecasts, are perhaps debatable. The fact that during summer the weather conditions remain steady, while during winter, spring and autumn they are stormy, has already been well established.

Nevertheless the figures in years of the interval, separating the monthly temperature changes, given in the TABLES, can bring forth a new aspect of the variability of weather. Do they make sense? The reader will judge.

Dr. Landsberg in his « Physical Climatology (p. 158) gives the number of interdiurnal temperature variations for each month at the State College observatory (Pa), during 3 years. Several variations values are considered.

The interesting fact is that, if the interdiurnal temperature decrease considered is that of 4.1 to 6° F. degrees, the mean annual recurrence of the temperature variation is similar to the mean annual interval in years of our Tables; namely 4.6. variations per month.

Could it be just a fortuitous result? Nevertheless the long range forecasting of a monthly future temperature seems possible with a 85 to 90% probability for winter, spring and autumn months.