TEMPERATURES IN THE LOWER 5 KILOMETERS OF THE TROPOSPHERE ABOVE RIO DE JANEIRO

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The data obtained from aerological soundings made at Rio de Janeiro since 1930 disclose certain interesting differences from those obtained in the Northern Hemisphere.

The average temperatures for winter (June, July, and August) and summer (December, January, and February) when the surface pressure was greater than the normal value by 2.5 mm, less than normal by 2.5 mm, and normal plus or minus less than 2.5 mm, are given in table 1 and in figure 1.

All observations were made with Marvin and Friez meteorographs placed on airplanes, and all computations were made in accordance with the United States Weather Bureau practices. The numbers of observations used for the calculation of the temperature normals are as follows:

	Summer	Winter
High pressure	9	30
Normal pressure	55	36
Low pressure	6	6

The normal temperatures are higher in summer than in winter, the difference between the means of the two seasons averaging 4.4° C.

In both winter and summer, above regions of low surface pressure, the upper-air temperatures are higher than over surface high pressure. That is, in general, cyclones are relatively warm and anticyclones relatively cold. It should be noted, however, that the classification of surface pressures is on the basis of departures from normal, disregarding the actual cyclonic or anticyclonic situation; in this respect the results are comparable to those given for Europe by Humphreys,[1] but they are not strictly comparable with the corresponding results for the United States,[2] where well-pronounced HIGHS and LOWS were compared sector by sector. The relation of the relative temperatures over Rio de Janeiro to the surface pressures is the exact opposite of that found in Europe; in the United States HIGHS were found to average colder than LOWS in corresponding sectors, except in the winter at upper levels over southern and eastern stations where the reverse was true.

TABLE 1.—*Normal temperatures at Rio de Janeiro*

Seasons (pressure)	Surface	200	500	750	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000
Summer:													
High	27.1	24.4	21.8	20.3	18.8	15.7	13.5	11.8	9.3	6.9	4.4	2.8	------
Normal	29.0	26.7	24.8	23.4	22.0	19.4	16.4	13.6	10.9	8.1	6.0	2.6	1.0
Low	30.2	29.1	26.8	25.7	24.1	21.2	17.7	14.4	11.4	9.4	6.8	3.3	−.6
Winter:													
High	21.3	19.4	17.8	16.4	15.3	12.7	10.8	8.9	6.7	4.7	2.4	2.2	------
Normal	23.4	22.5	20.6	19.0	17.4	14.9	12.2	9.0	6.4	5.0	2.9	−.3	−4.8
Low	25.2	25.7	24.0	23.0	21.7	18.1	14.8	11.1	6.9	4.9	.2	−1.6	−3.0
Normal:													
Summer	28.8	26.6	24.6	23.2	21.8	19.0	16.2	13.4	10.7	8.0	5.9	2.8	.6
Winter	22.7	21.5	19.7	18.3	16.9	14.2	11.9	9.2	6.6	4.9	2.6	.0	−4.5

It will be noticed that near the surface, due to the influence of the sea, which acts as a thermostat, the differences between the temperatures of depressions and anticyclones are smaller than they are immediately above and up to at least 2 km. Moreover, in winter the depressions produce an increase of temperature greater than in summer.

The differences between the above results and those obtained in the Northern Hemisphere may, perhaps, be explained as follows. In the Southern Hemisphere conditions similar to those in Europe and the United States occur only near the antarctic circumpolar circle, where families of cyclones are continually passing, according to Bjerknes, and producing rainy weather and "the brave westerlies." In the Rio de Janeiro region, however, the depressions are generally extensions from the semipermanent LOW which occupies the center of South America, and is produced by the intense insolation there. This region is occupied, therefore, by a warm air mass.

A fusion with the so-called "continental depression" (permanently hot center of the continent) is frequent in winter when a depression from high latitudes reaches Rio de Janeiro; in that case the temperatures remain relatively high, as far as 3,000 m, but the Northern Hemisphere "cold LOW" appears above this level. Doubtless there is at this level a predominance of the low temperatures of cold depressions coming from the south, the "continental depression" being weakened at this time by the less intensity of insolation which limits convection to lower levels.

The anticyclones are colder because they come down from the tropical centers of action of the Atlantic Ocean (coming to Rio from the northeast) and of the Pacific Ocean (normal anticyclones of SW.-NE. track). These high-pressure centers are formed of relatively cold air from polar maritime currents, with a consequent deflection of the isotherms toward the Equator.

We may conclude from this temperature study that South Brazil anticyclones are not generally of polar origin but are formed in the oceanic centers of action.

The differences of temperature between the surface and 4,500 meters are:

Summer		Winter	
Anticyclone	Depression	Anticyclone	Depression
24.3° C.	26.9° C.	19.1° C.	26.8° C.

We conclude, therefore, that the fall of temperature is always the same in depressions, both in summer and

[1] W. J. Humphreys, Physics of the Air, 2 ed., p. 54.

[2] L. T. Samuels, MONTHLY WEATHER REVIEW, May 1926, p. 208–209, tables 11 and 12.

winter, which seems to show that convection and turbulence are equally strong in the two seasons.

The fall of temperature is greater in depressions than in anticyclones because in the first case convection is more active. For the same reason, the decrease of temperature in anticyclones is greater in summer than in winter.

The correlation coefficients between pressure and temperature, calculated by Dines from soundings in England, gave high positive values, that is to say, high pressures correspond to high temperatures. The results obtained by us are quite different. (See following table.)

Seasons (levels)	Means		Standard deviations		Correlation coefficients	Probable errors
	Pressure	Temperature	Pressure	Temperature		
Summer:						
Surface	1,008.9	28.8	3.1	2.9	−0.26	±0.08
2,000 m. s. l.	804.6	16.2	2.1	2.8	+.23	±.08
4,000 m. s. l.	633.7	5.9	2.1	1.7	+.42	±.10
Winter:						
Surface	1,017.6	22.7	4.2	2.7	−.55	±.06
2,000 m. s. l.	808.1	11.9	2.4	3.3	−.03	±.08
4,000 m. s. l.	634.2	2.6	3.1	3.5	+.91	±.03

From an examination of the mean values we may conclude that in winter the surface pressure is normally 8.7 mb higher than in summer. The difference becomes 3.5 mb at 2,000 m, and 0.5 mb at 4,000 m.

Pressures higher in winter than in summer are common above the continents at low levels, on account of the warming of the surface during the latter season.

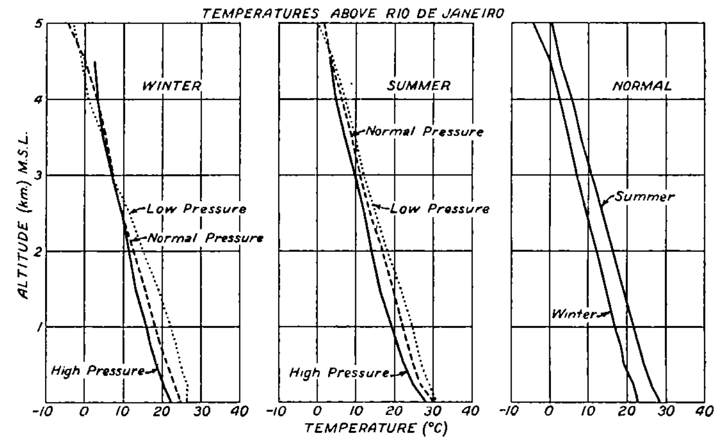
In summer, however, at very high levels, the heating is less and therefore the fall of pressure is also less than at the surface.

The standard deviations of pressure are higher in winter than in summer, because in winter there is great activity in the passage of depressions and anticyclones, while in summer this is weakened.

The decrease in the standard deviation at high levels seems to indicate that the original oscillations of pressure are amplified at low levels by the effect of the surface temperature. It also indicates that cyclones and anticyclones reach at least 4,000 m.

The standard deviations of temperature are higher in winter on account of the great activity of the secondary circulation, with consequent frequent passages of air masses with different temperatures.

The significance of the correlation coefficients is somewhat uncertain. There is, perhaps, positive correlation at 4,000 m in summer (+0.42), that is, high pressure at 4,000 m corresponds to high temperature. However, having seen that high temperatures correspond to low pressures at the surface, we may conclude that depres-



sions at the surface have, at 4,000 m, relatively high pressure, and vice versa. This conforms to the classic theory that depressions are formed by local heating.

There is also a negative correlation coefficient (−0.55) at the surface in winter (depressions warmer than anticyclones.) At 4,000 m there is a very high positive coefficient (+0.91), already explained, and similar to those obtained in the Northern Hemisphere. This means that at that level, in winter, surface depressions are still depressions, and not anticyclones.

At the other levels there appears to be no correlation at all; probable errors are generally small.

These notes are the first study of upper-air temperatures in South America.

CLOUD PHOTOGRAPHY AT THE MANILA OBSERVATORY

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[Philippine Weather Bureau, Manila, May 1935]

In order to correlate clouds with the various types of air currents that reach the Philippines, the Manila Observatory in May 1934 started a year's photography of clouds. Now that the program has been successfully completed, a few words as to the plan of campaign and the results achieved may be of interest.

It was quite a problem to decide upon the best method of procedure. Many have advocated the use of a cylindrical or "fish-eye" lens, of the type suggested by Wood in his Physical Optics, or at least some very-wide-angle lens, to enable the photographer to cover most of the sky in one picture. This would be an advantage, of course, if it could be done cheaply and efficiently. However, a lens of this type would be very expensive, and a special shutter would be imperative to get proper distribution of light intensity. Experience, moreover, has shown the writer that the sky very often shows remarkable contrasts in light intensity, especially in stormy weather, and no shutter would be equal to the task of bringing out properly all parts of the sky in one picture. Even with an ordinary camera, with its limited field of view, certain pictures have to be consistently rejected, unless the photographer when printing is prepared for the task of delicate "dodging", i. e., of shading parts of the negative. To take several pictures at a time of *ordinary size*, say 4 by 5 inches, or 5 by 7 inches, and select characteristic parts of the sky, is another alternative, but the cost would be very high, if one wishes, as I did, to take some 20 or more pictures a day, and often, in striking situations, 5 or 6 in rapid succession. The frequent loading of the ordinary rolls of 6 or 8 pictures would also be very inconvenient.

After much deliberation the following scheme was adopted and has proved quite satisfactory; the cost, though considerable, has not been prohibitive, considering the ambitious nature of the project. A Contax camera was purchased, using movie film, 36 pictures to a roll, but taking a picture twice as large as the ordinary