NORMAL MONTHLY CHANGE IN SEA LEVEL PRESSURE AND IN THE GRADIENT OF EFFECTIVE SOLAR RADIATION

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A basic problem of meteorology is to relate the fields of pressure and motion in the atmosphere to the distribution of the incoming solar energy. The purpose of this note is to present the sea level pressure and the solar radiation data in a way that may possibly have some bearing on this fundamental problem.

Table 1 shows the normal monthly change in the northward gradient of effective solar radiation over the northern hemisphere. The data were obtained from Table V of Simpson's study on "The Distribution of Terrestrial Radiation" [1], in which are tabulated by 10° latitude zones the intensity of the effective radiation, i. e., the intensity of the solar radiation absorbed by the earth and its atmosphere. Simpson's data were based on the mean of the relationships between cloud amount and albedo found by Aldrich and Ångström, and on the average cloudiness for each latitude zone according to Brooks. To allow for the large reflection of solar radiation from the extensive snow surfaces, a constant albedo of 0.65 was adopted for the polar cap. Although the value of the albedo used in Simpson's computations is now open to question [2], the general features of the seasonal and latitudinal distributions would probably not be materially altered by the use of a different value.

The northward gradient of effective radiation was defined as the intensity at a lower latitude zone minus the intensity at the adjoining higher latitude zone. The gradients are therefore in terms of a length unit which is 10° of latitude. The monthly changes in gradient represent the gradient at a given month minus the gradient at the preceding month. The data are presented in figure 1 as an isopleth analysis.

Table 2 shows the normal monthly change in mean sea level pressure at each latitude over the Northern Hemisphere. These values were obtained from the 40-year series of Historical Weather Maps [3], and are represented in analyzed form in figure 2.

It is apparent that the isopleth patterns in figures 1 and 2 show some similarity. The linear correlation between the patterns is 0.43. If the pressure change pattern is lagged one-half month the correlation is increased to 0.55; if the lag is extended a full month, the correlation drops to a value of 0.38. It should perhaps be emphasized that the best correlation between the change in sea level pressure and the change in gradient of radiation is not necessarily found at a lag of 2 weeks. If, for example, normal data were available for a period shorter than 1 month, the highest correlation might be found at a different lag; but it is not possible to determine the most suitable lag by the use of interpolated values. In general, however, it appears that at latitudes where the gradient of effective solar radiation is increased there is a tendency for the air to accumulate; where the northward gradient of radiation is decreased (or the southward gradient increased), air is removed. A marked discrepancy in the patterns of the two figures occurs at high latitudes in the late fall and early winter months, where a decrease in the radiation gradient is accompanied by a pressure rise. The longitudinal distribution of the monthly changes may be inferred by comparing figure 2 with the more detailed data in Brier's study of changes in the Northern Hemisphere sea level circulation [4].

The representation of the solar radiation and pressure

TABLE 1.—*Normal monthly change in northward gradient of effective solar radiation, cal. cm.$^{-2}$ min.$^{-1}$ (10° lat.)$^{-1}$*

North latitude	December to January	January to February	February to March	March to April	April to May	May to June	June to July	July to August	August to September	September to October	October to November	November to December
Degrees												
80	0.000	+0.011	+0.016	−0.020	−0.013	−0.001	+0.001	+0.010	+0.024	−0.014	−0.014	0.000
70	+.007	+.029	+.042	+.008	−.011	−.005	−.003	−.004	−.009	−.020	−.023	−.019
60	+.008	+.011	−.005	−.011	−.023	+.005	+.003	+.020	+.018	−.009	−.010	−.007
50	+.001	+.001	−.008	−.009	+.007	−.018	+.017	+.029	+.006	−.005	−.012	−.009
40	−.003	+.001	−.008	−.009	−.018	+.013	+.003	+.001	+.014	+.009	+.003	−.006
30	−.001	−.008	−.009	−.016	−.021	−.033	−.008	+.016	+.032	+.028	+.015	+.005
20	+.009	−.010	−.019	−.025	−.037	−.021	−.013	+.014	+.024	+.049	+.019	+.010
10	−.008	−.011	−.021	−.035	+.005	+.009	+.022	+.019	+.010	−.009	+.010	+.009
0	−.010	−.013	−.019	−.005	−.003	−.002	+.010	−.005	+.011	+.021	+.016	−.001

TABLE 2.—*Normal monthly change in sea level pressure, mb*

North latitude	December to January	January to February	February to March	March to April	April to May	May to June	June to July	July to August	August to September	September to October	October to November	November to December
Degrees												
90	−2.0	+2.0	+3.0	+1.0	−1.0	−4.0	−1.0	+1.0	−1.0	0.0	+2.0	0.0
80	−0.7	+1.2	+3.0	+0.1	−0.4	−2.4	−1.2	−0.3	−0.9	0.0	+2.0	+0.9
70	+0.2	+1.3	+1.2	−0.2	−0.3	−2.8	−1.4	−0.4	+0.8	−1.4	+1.4	+0.8
65	+0.7	+1.0	+0.4	−0.6	0.0	−2.5	−1.5	+0.4	+0.6	−0.3	+1.1	+0.7
60	+1.2	+0.7	−0.1	−0.8	−0.2	−1.9	−1.2	+0.4	+1.2	−0.3	+0.6	+0.4
55	+1.6	0.0	−0.4	−0.9	−0.7	−1.3	−0.5	+0.7	+0.9	−0.3	+0.3	−0.2
50	+1.5	−0.5	−0.6	−1.0	−1.1	−1.1	+0.1	+0.9	+2.0	+0.3	+0.1	−0.6
45	+1.1	−1.2	−0.6	−1.1	−1.1	−1.0	+0.5	+0.9	+1.9	+1.0	+0.3	−0.7
40	+0.5	−1.5	−0.6	−1.0	−1.2	−1.3	+0.8	+0.4	+1.8	+1.6	+0.8	−0.3
35	+0.4	−1.5	−0.8	−1.1	−1.3	−1.5	+1.5	+0.1	+1.6	+2.0	+1.6	0.0
30	+0.3	−1.3	−0.9	−1.4	−1.5	−1.5	0.0	−0.2	+1.4	+2.2	+2.7	+0.8
25	+0.4	−0.7	−1.2	−1.4	−1.6	−1.5	−0.4	−0.3	+1.2	+2.2	+2.1	+1.2
20	+1.0	−0.5	−1.2	−1.2	−1.3	−1.0	−0.6	−0.4	+1.8	+0.8	+1.7	+0.9
10	+0.6	−0.2	−0.5	−0.5	−0.3	−0.2	0.0	−0.7	+0.2	+0.2	−0.3	+0.6

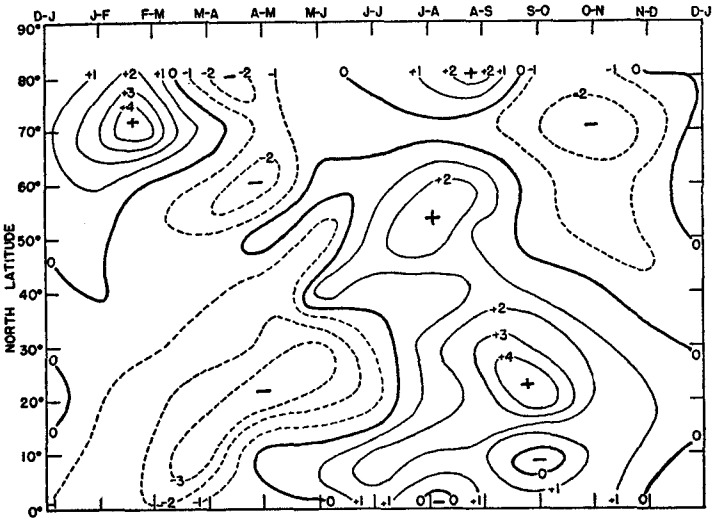

FIGURE 1.—Normal monthly change in northward gradient of effective solar radiation, 10^{-3} cal. cm.$^{-2}$ min.$^{-1}$ (10° lat.)$^{-1}$

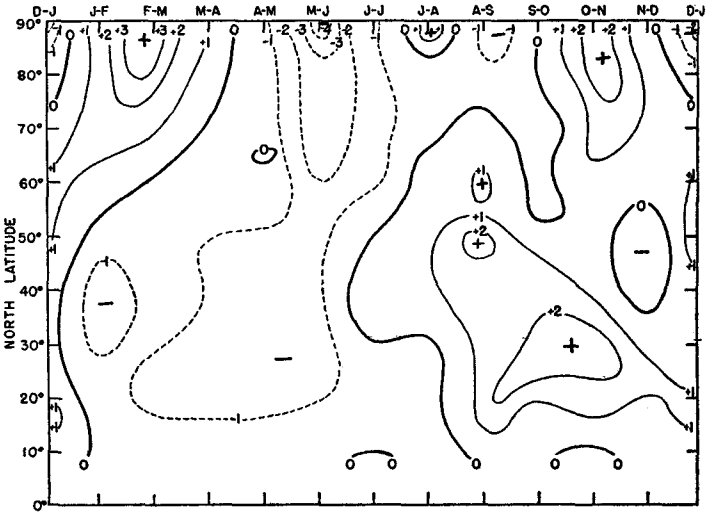

FIGURE 2.—Normal monthly change in sea level pressure, mb.

data in the form shown in figures 1 and 2, which appears to be novel, poses an interesting question, and it is for this reason the data are published.

REFERENCES

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