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CORRESPONDENCE

Horizontal divergence and convective cloudiness

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Some brief comments may be of interest with reference to Mr. G. P. Cressman's article on "The influence of the field of horizontal divergence on convective cloudiness" appearing in the September 1946 issue of the JOURNAL [3, 85–88].

In the first place, at least as regards rising air, we think the equations would be simpler and clearer if the term $\Delta w'$ were dropped altogether, and only the term w_0' used. Eq. (1) then becomes:

$$Mw + M'w_0' = 0 \qquad (1)$$

entirely analogous to the Petterssen treatment. w_0' is readily visualized as the velocity of the upward moving air mass to compensate for the downward moving air. Equations (9, 11, 12, 13) now become, using only w_0', and dropping $\Delta w'$:

$$S = C_p w' M'[\beta - \alpha(M'/M)(w_0'/w')] \qquad (9)$$

$$S = C_p M'(w'\beta + \alpha w) \qquad (9a)$$

$$F_a = \frac{M'/M}{1 + M'/M} \frac{\beta/\alpha + w/w'}{1 + \beta/\alpha} \qquad (11)$$

$$M'/M = -1 + [1 + \beta w'/(\alpha w_0')]^{\frac{1}{2}} \qquad (12)$$

$$M'/M = \beta w'/(\alpha w_0') \qquad (13)$$

Notice in passing that if we use the original $\partial T/\partial t$ and $\partial T'/\partial t$, then (12) takes the interesting form:

$$\frac{M'}{M} = \frac{\partial T'/\partial t}{\partial T/\partial t} - 2.$$

Of course (13) becomes: $\partial T'/\partial t = \partial T/\partial t$.

Figs. 1 and 2 can be used as before, with the same significance, only in place of $\Delta w'/w_0'$ we now use: $\Delta w'/w_0' + 1$, i.e. w'/w_0'. The two fractions differ only by unity.

We confess that we do not quite follow the deductions contained in the last paragraph of column one, page 88. There it is said: "If the actual lapse rate exceeds the moist-adiabatic value only slightly, there will be only a small production of solenoids, as shown by (11) and (17), and w_0' and w_0 will have their smallest values." With all the variables in (11), it is hard to see that the number of solenoids will be small if β/α is small, for other factors will vary also, i.e. M'/M and the fraction $\Delta w'/w_0'$. Furthermore, is the deduction: "w_0' and w_0 will have their smallest values" deduced from the fact of few solenoids or directly from (11) and (17)?

Finally, we take the sentence: "Since w_0' and w_0 are the denominators of the fractions $\Delta w'/w_0'$ and $\Delta w/w_0$, these fractions may then become relatively large for given values of the net mass transport, and the resulting effect on M'/M will be large, as shown by Figures 1 and 2." Admittedly, if w_0' and w_0 are small, then the fractions $\Delta w'/w_0'$ and $\Delta w/w_0$ will be large if w' and w remain constant, but in the expressions for (12) and (13) (confer preferably my forms of these equations above) this fraction w'/w_0' (or its equivalent $\Delta w'/w_0'$) is only a part of the whole term $(\beta/\alpha)(w'/w_0')$. Notice that if w'/w_0' becomes large as w_0' gets small, on supposition β/α also gets small. In other words, both numerator and denominator decrease; which overweighs the other is not at all apparent.

Reply

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Father Deppermann's alternate derivation naturally gives the same results as the original since only a substitution of symbols is involved. Concerning the discussion on the number of solenoids, equation (11) in its original form shows that if β/α is small the term F_a can be positive only when M'/M is small also, with respect to β/α and to unity. Therefore for any reasonable value of $\Delta w'/w'$ the term F_a must also be small. This question is discussed on page 71 of Petterssen's *Weather analysis and forecasting* for the condition that $\Delta w' = 0$. The small values of w_0' and w_0 depend on the small amount of energy available when there are but few solenoids.

The question on the fractions $\Delta w'/w_0'$ and $\Delta w/w_0$ can be answered by reference to figs. 1 and 2, which represent equations (12, 13, 18, 19) in graphical form. They show that the proportional effect of the above ratios on the cloud amount depends only slightly on the lapse rate, as stated on page 88 of the JOURNAL article.