# CORRESPONDENCE

## COMMENTS ON "Structure of a Cold Front Near the Center of an Extratropical Depression"

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We refer to the article by Schwerdtfeger and Strommen [7] in which the authors show "that in this case the dynamically important change from one air mass to another throughout the entire troposphere occurred several hours after the passage of a weak surface cold front."

The frontal contour method of analysis employed in the Canadian Meteorological Service (Anderson, Boville, and McClellan [1], Crocker, Godson, and Penner [2], Galloway [3], Godson [4], and Penner [6]) readily handles apparent anomalies of this kind. Reference to the archives of the Central Analysis Office shows that on this occasion the initial cold front passage was that of the Maritime cold front (M-front), where, in frontal contour terminology, mP was replaced by mA, the true cold air (tcA) getting in later on the passage of the Arctic cold front (A-front). It is noted in figure 2 in the article [7] that the surface pressure continued to fall on the passage of the initial cold front: pressure rose only on the passage of the A-front. The pressure falls were due to a series of minor waves on both fronts in strong southerly upper flow.

An interesting relevant contribution on the "relation between upper wind structure and rainfall at fronts" was made by Parker [5].

In view of the clarity of analysis afforded by the frontal contour method it is surprising that greater use is not made of it outside Canada.

### REFERENCES

1. R. Anderson, B. W. Boville, and D. E. McClellan, "An Operational Frontal Contour-Analysis Model," *Quarterly Journal of the Royal Meteorological Society*, vol. 81, No. 350, Oct. 1955, pp. 588–599.
2. A. M. Crocker, W. L. Godson, and C. M. Penner, "Frontal Contour Charts," *Journal of Meteorology*, vol. 4, No. 3, June 1947, pp. 95–99.
3. J. L. Galloway [Comments on], "Wind, Temperature, and Humidity Distribution at Some Cold Fronts Over SE England," by M. K. Miles, *Quarterly Journal of the Royal Meteorological Society*, vol. 89, No. 379, Jan. 1963, p. 153.
4. W. L. Godson, "The Structure of North American Weather Systems," *Centenary Proceedings of the Royal Meteorological Society*, 1950, pp. 89–106.
5. A. E. Parker, "Relation Between Upper Wind Structure and Rainfall at Fronts," *Meteorological Magazine*, vol. 78, No. 927, Sept. 1949, pp. 247–258.
6. C. M. Penner, "A Three-Front Model for Synoptic Analysis," *Quarterly Journal of the Royal Meteorological Society*, vol. 81, No. 347, Jan. 1955, pp. 89–91.
7. W. Schwerdtfeger and N. D. Strommen, "Structure of a Cold Front Near the Center of an Extratropical Depression," *Monthly Weather Review*, vol. 92, No. 11, Nov. 1964, pp. 523–531.

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## REPLY

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We appreciate the comments of Messrs. Galloway and Shimizu. We entirely agree with them when they say that the Canadian frontal model responds well to the frequently observed phenomenon of two cold fronts associated with an intense depression. We might have employed the frontal contour method of analysis if hourly soundings of several stations had been available. Our main points, however, were the following: (1) to use the hourly soundings of one place in order to show the remarkable features of a front for which the concept of a wedge-shaped cold air mass would be quite unrealistic; (2) to point out the consequences of such features for the time variations of the upper wind field; (3) to call attention to the importance of the ageostrophic wind component (about perpendicular to the thickness lines) through which a nearly vertically oriented transition zone between two air masses can be maintained. These points are not considered, as far as we can see, in the descriptions of the Canadian model given in the papers to which Galloway and Shimizu refer.

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