it is possible to arrive at a completely different picture of the thermal structure in the upper troposphere than that deduced by Schwerdtfeger and Strommen. Instead of a nearly vertical frontal zone, it would have been possible to draw a sloping zone more in line with the classical frontal model.

There are undoubtedly many frontal zones in the middle and upper troposphere which bear little resemblance to the Norwegian model and the writer agrees with Schwerdtfeger and Strommen that more realistic frontal models are needed. It is felt, however, that their model, in which the cold air advances in a nearly vertical wall, is unrealistic for the case presented. This model would have required compensating warming at levels above 100 mb. and it would presumably have required strong vertical motion patterns at a time when the weather distribution indicated relatively uniform, light precipitation.

REFERENCES

1. 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.
2. A. J. Kantor, "Tropopause Definition and Hourly Fluctuations," *Environmental Research Papers*, No. 41, Air Force Cambridge Research Laboratories, Office of Aerospace Research, L. G. Hanscom Field, Mass., 1964, 23 pp.

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REPLY

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In his interesting comments Dr. Jordan suggests that the results of one individual ascent appear to be doubtful, and that our conclusions (Schwerdtfeger and Strommen [1]) would be different if we had discarded this sounding.

The extenso publication of the data used (Court and Salmela [2]) can serve as evidence of the commendable care with which the Bedford series of 161 soundings has been evaluated. Neither Court and Salmela, nor A. J. Kantor [3] who discusses shortcomings of the radiosondes and cites two errors he found or suspects, expresses doubts about the sounding to which Dr. Jordan objects. A comparison with the preceding and following hourly ascents indicates little temperature change in the stratosphere, between 100 and 20 mb. Of course, when at the same time there is little surface pressure change and a strong cooling of the troposphere, the pressure-height changes must extend into the upper stratosphere. This indeed may be remarkable, but certainly is not impossible.

The pronounced change of thickness and the appearance of a slightly unstable lapse rate in unsaturated air between 600 and 540 mb., together with an absolutely stable structure of the atmosphere between the surface and 700 mb. were accompanied only by a temporary change from light to moderate rain at Bedford, by the occurrence of showers at Boston. See the hourly observations of these two stations plotted at the bottom of figure 1 in [1]. The fact that nothing more spectacular happened concurrently with the thickness change cannot, in our opinion, be construed as an argument against the reliability of the results of a sounding. On the other hand, the observed wind and its change with time in the middle and upper troposphere, as illustrated in figure 11 in [1] bear a closer relationship to the pressure-height changes computed *with* the questioned sounding than without.

Naturally, a radiosonde which is not recovered cannot be recalibrated, and therefore its reliability always remains, to a certain degree, a matter of conjecture. The more important question really is whether our general interpretation of the case would be "completely different" if the 2112 GMT sounding were non-existent, or if it had indicated 1° or 2° higher temperatures throughout the troposphere and correspondingly a smoother change of the affected thickness values. This suggestion must be emphatically declined. The beauty of the observational material used for our study really is that the soundings are so numerous, that is, one every hour. A fine, comprehensive graphical representation of all these soundings has been given by Kantor [3] in his figures 1 through 7. A rapid change of temperature in most of the troposphere already is put in evidence by the 1900 and the 2000 GMT soundings (see also our fig. 1 [1]). If we disregard the 2112 ascent as Dr. Jordan would prefer to do, we would have for the 400–900-mb. layer a thickness change of 159 g.p.m./3 hr.; the temperature at the 500-mb. level would change from −14.2° to −25.2° C. in the same time interval, 1900 to 2200 GMT. There still would be no indication of the cooling in the lower layers (say, 900 to 700 mb.) occurring prior to the cooling in the upper layers (say, 600 to 300 mb.) of the troposphere, and no evidence whatsoever for a wedge-like configuration of the colder air mass.

The experience of several thousand hours of flight as observer and navigator of weather reconnaissance airplanes has taught one of us that fronts in the real atmosphere frequently are at variance with their description and explanation in textbooks. Satellite cloud pictures, if not selected from the larger sample for apparent agreement with preconceived models, confirm this experience. Therefore, to disregard the (otherwise physically acceptable) results of an aerological ascent just because the atmosphere "should" behave in a different form, does not appear to further the understanding of atmospheric phenomena. If our study, including Dr. Jordan's and these comments, helps to convey this notion to our colleagues, we think the purpose of its publication is satisfactorily fulfilled.

REFERENCES

1. 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.
2. A. Court and H. A. Salmela, "Hourly Rawinsondes for a Week," *G R D Research Notes*, No. 60, Geophysics Research Directorate, Air Force Cambridge Research Center, Bedford, 1961.
3. A. J. Kantor, "Tropopause Definition and Hourly Fluctuations," *Environmental Research Papers*, No. 41, Air Force Cambridge Research Laboratories, Office of Aerospace Research, L. G. Hanscom Field, Mass., 1964, 23 pp.

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Comments on "Picture of the Month"

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The "Picture of the Month" in the January issue [1] shows a cloud pattern accompanying a large vortex and an associated front off the coast of East Antarctica. The description that accompanied the picture suggests that the front "has advanced very far to the east of the low center."

A continuing study, being conducted at the U.S. Navy Weather Research Facility [2], of daily composites of Southern Hemisphere nephanalyses indicates that such positioning of major cloud bands with respect to low centers over the Southern Ocean is rather common. It also appears that these major cloud bands rotate in a clockwise fashion around the Low and at some later time impinge upon the coast of Antarctica.

Vorticity centers behind these fronts, as noticed on the picture, are also relatively common; on some composites several such centers have been noticed in the area behind the major cloud bands.

REFERENCES

1. [Staff, National Environmental Satellite Center], "Picture of the Month," *Monthly Weather Review*, vol. 94, No. 1, Jan. 1966, p. 54.
2. C. Biter and B. Watson, "A Preliminary Investigation of Southern Hemispheric Cloud Systems," *NWRF Technical Paper*, 1966 (in preparation).

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