

**Reply**

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I congratulate Mr. Julian on his useful results. In view of the stratosphere's well-known capacity to vary about its own norms, one cannot assume that a link between the sudden warmings and the primary index cycle is proven; but, at least, Mr. Julian makes such a link seem probable. It is *a priori* very likely that large-scale changes in the upper circulation will lead to reorganizations below. What Mr. Julian does is to suggest a probable pattern for the interaction.

The downward movement of the sudden warmings, as indicated in my own paper and by several other

workers, immediately suggests a mesospheric origin. Recent rocket soundings through the warming of 27–29 January 1958 (Stroud, Nordberg, Bandeen, Bartman and Titus, 1960) show northeasterly circulation from 45 km down to 20 km, with warm air to the west-northwest up to about 35 km, and a general descent and warming of the mesopeak from about 55 km to about 43 km in forty-eight hours. There is reason to believe, however, that this apparent descent may have been due to the *lateral* shift of a strongly tilted perturbation rather than to actual descent *in situ* (Boville, 1960)<sup>1</sup>. Whatever the mechanism, it is clear that the sudden-warming phenomena involve a very deep atmospheric column, extending at least from the mesopeak to the tropopause. Mr. Julian now shows convincingly that the effects are appreciable even at ground-level; the energy transformations may even be larger in the troposphere than in the stratosphere.

#### REFERENCES

- Stroud, W. G., W. Nordberg, W. R. Bandeen, F. L. Bartman, and P. Titus, 1960: *Rocket grenade measurements of temperatures and winds in the mesosphere over Churchill, Canada*. IAS Paper No. 60-47, Inst. Aeronaut. Sci., New York, N. Y., 33 pp.

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<sup>1</sup> Boville, B. W. 1960: Personal communication.