Dissipation of Energy by Atmospheric Turbulence

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Some calculations on the rate of energy dissipation, ϵ, by atmospheric turbulence were recently provided by Gifford (1957a, 1957b). These calculations came from re-evaluations of smoke-puff data from several investigations (Charnock, 1951; Frenkiel and Katz, 1956; Kellogg, 1956; Seneca, 1955; and Tank, 1957) ranging from near the earth's surface to the lower stratosphere.

All calculations of ϵ were based on Batchelor's (1950) similarity predictions. Only the data can be used whose time scale includes t_1, which represents the time after which the dispersion, though still dominated by eddies in the inertial subrange, is no longer dependent on the initial size of the smoke puff.

Because observational and analysis techniques are comparable for all of these data, it is interesting to graph them in order to obtain a notion of the variation of ϵ with height. This is shown in fig. 1. A hyperbolic curve is drawn to make a reasonable fit to all but Tank's surface data. It may be that Tank's data are biased toward conditions of low turbulence, since such conditions are preferred in the objectives of his research. The only other available surface measurements of ϵ are those computed by the author (Wilkins, 1958) from the separation rates of zero-lift balloons. These measurements confirmed the similarity predictions but yielded values of ϵ that seem to be at least an order of magnitude too high.

Despite its speculative nature, the curve in fig. 1 is of interest by virtue of the fact that it is the only

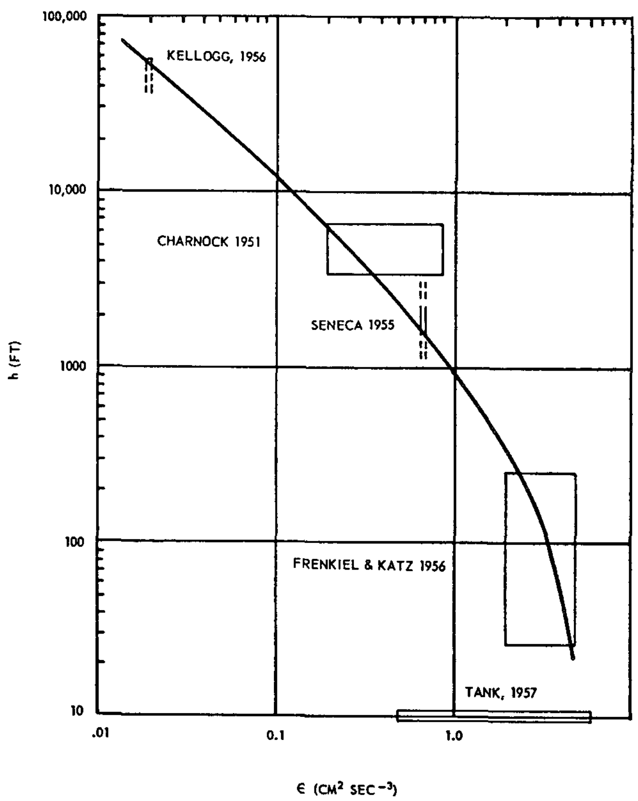

Fig. 1. Variation with height of the rate of dissipation of kinetic energy by atmospheric turbulence.

existing experimental representation of the height relationship of the turbulent energy dissipation rate. The curve is represented by the equation

$$\epsilon = \frac{1238}{h + 238} \qquad (1)$$

when h is given in ft. If h is in meters, the equation is

$$\epsilon = \frac{378}{h + 73.2}. \qquad (2)$$

Fig. 1 indicates that 55 per cent of the total kinetic energy dissipated by turbulence in the troposphere occurs in the lowest kilometer. This is in excellent agreement with Brunt's (1934) estimate (60 per cent below one kilometer).

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