Despite these large uncertainties in the lifetime of the sub-satellite, under average weather conditions around the world the Project MOONWATCH observers are expected to be able to obtain a sufficient number of sightings of the sub-satellite to give with adequate accuracy the rate at which it spirals back to earth, from which will be determined the resistance or drag experienced by the sub-satellite and the density of the air producing this drag.

From the determinations of satellite drag and air density that the sub-satellite experiment is expected to yield, not only will the extent of the earth's atmosphere be better known, but also the altitudes at which satellites of the future must fly in order to have sufficiently long lifetimes to be useful as world-wide radio and television relay stations, as weather observation stations, and to fulfil many other purposes, now only dimly foreseen, that will benefit all mankind.

3.3.11 *The radiation balance of the earth from a satellite**

(A) *Introduction.* Practically every text-book in meteorology, elementary or otherwise, mentions the fact that the kinetic energy of the atmosphere is derived from solar energy, with the atmosphere as the working substance of a giant heat engine. A simple yet accurate mathematical statement of this relationship has been given by FLEAGLE (1957). The key to our weather is this motion. Despite the recognition that the energy budget of the earth is fundamental to a better understanding of the world's weather, it is impossible at present to include these data in forecasting or research because adequate data are not yet available.

Meteorologists have long been interested in the observation of the world's weather from the outside. DANJON (1955) has obtained estimates of the earth's albedo from the earth-shine on the moon. The advantages for forecasting or research of having a complete set of observations from outside our atmosphere are not difficult to imagine. The first artificial satellites cannot, however, take a complete set of observations nor will they cover the entire earth. The strict size and weight limitations of the satellite launching rule out any complex or large power-consuming instruments. The choice of orbit (inclined 35–40° from the equator) will not provide a sampling of the whole earth. The purpose of this paper is to show that, despite these limitations, valuable data on the radiational budget for the major part of the earth's surface can be obtained from a relatively simple instrumented satellite, which can be launched within the limitations set by Project VANGUARD.

(B) *Radiation balance of the earth.* Except for long-term climatic change, the energy the earth intercepts from the sun over a period of years is balanced by the radiational loss to space. That is, the net radiation *for the entire earth* over a few years is very nearly zero. In general, tropical regions receive significantly more energy than they lose by radiation and the reverse is true at higher latitudes. This energy balance on an annual basis has been re-examined by HOUGHTON (1954). (See Fig. 162.) In order to maintain the existing average temperature equilibrium, heat transport from low latitudes to high latitudes must occur. This differential heating, with resulting heat transport by the atmosphere and by ocean currents, is the

* V. E. SUOMI, University of Wisconsin, A paper presented at the IGY Rocket and Satellite Conference Washington, D.C., 30 September–5 October 1957.

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