Internal and External Processes

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As far as I can tell, there may be 10,000 PhD dissertations already written or waiting to be written about rain, hail, snow, glaciers, hurricanes, typhoons, cyclonic storms, melting ice, sea level evaporation from the oceans, melting snow, melting ice, the movement of air across the globe, the influence of continental drift on weather patterns, and so forth. These subjects and their kin involve internal energy exchanges, and they describe how weather patterns move around the globe.

At equilibrium, the heat that goes into the atmosphere must equal the heat leaving the atmosphere. Disequilibrium cannot exist long, as the total amount of energy “trapped” in the atmosphere is equivalent to one day’s energy passing through it.

At equilibrium, the amount of heat absorbed by the surface equals the amount of heat released.

External Processes

By contrast, the heat balance of the earth as a whole—positive if we receive more heat from the sun than we radiate away as infrared (IR), and negative if the outgoing IR exceeds absorbed sunlight—depends on precisely three quantities.

First, the amount of sunlight at our orbit is greatest when we are closest to the sun (in early January) and least when we are farthest from the sun in early July. Since we know the orbit, we can calculate the solar intensity at any other place in the orbit, providing that the sun produces constant output. For climate, the year-round average is what matters. Any increase or decrease in year-round average sunlight can result in a positive or negative heat balance. For the heat balance diagram shown, the average solar flux is presently 340 +/- 0.1 W/m2.

The second quantity of interest is the amount of sunlight reflected. Presently, the globe reflects about 30% of the sunlight (albedo = 0.3), but that quantity can change with cloudiness, snow and ice cover, and amounts of aerosols in the atmosphere. In the diagram the present value is 99 +/- 1.0 W/m2.

The third quantity that helps determine the heat balance of the planet is the amount of infrared (IR) that leaves the planet. It is important that the only way for the planet to shed heat is though IR emission to space. The present value is 240 +/- 2 W/m2.

How Internal Processes Affect External Ones

Internal processes certainly affect weather, but they affect the heat balance of the planet only by affecting either the albedo (reflectivity) of the planet or the amount of IR emitted to space.

Climate scientists have taken to heart the Year Without a Summer (1816) following the 10 April 1815 eruption of Mount Tambora, which ejected an estimated 37 km3 (8.9 cu mi) of volcanic dust into the atmosphere, thereby decreasing the amount of absorbed sunlight. Climate models therefore predict an increase in albedo—meaning less absorbed solar energy—due to imagined scenarios in which humans cause particulate matter to be inserted into the atmosphere. The increase in albedo is regarded as something to “partially counteract” the imagined warming effects of dreaded CO2 emissions.

The surface of the earth emits a smooth spectrum of infrared radiation (IR) (a plot of intensity versus number of wavelengths per centimeter), but the planet as a whole emits a very jagged spectrum of IR to outer space, as shown in Fig. 1. (For this discussion, the shapes of the curves, not the unreadable numbers, are the important matters.) The change is due to the spectral properties of the IR-active gases in the atmosphere. They are lovingly called *greenhouse gases*.



Figure 1: The spectrum of IR from the surface follows a smooth blackbody curve. How does that become the jagged spectrum sent to space?