Unit One

Earth Science

READ THE FOLLOWING TEXTE:

The Earth Sciences include the study of the atmosphere, hydrosphere, oceans, biosphere, and the solid Earth, including the interactions among these spheres. Earth scientists use concepts and tools from physics, chemistry, biology, chronology, and mathematics to construct a quantitative understanding of how the Earth system works, and how it evolved to its current state.

The study of the Earth's conductive heat flow has helped us understand the Earth's "heat engine" that derives its energy from the primordial energy of planetary accretion, the segregation and solidification of the Earth's core, and the decay of radioactive uranium, thorium, and potassium. Irish chemist Robert Boyle published the first recorded increase in temperature with depth in the Earth (1671), while Lord Kelvin was the first to estimate both the geothermal gradient and thermal conductivity (1883). The first heat flow measurements for the continents and oceans came in 1939 and 1952, respectively. American geologists David Chapman and Henry Pollack produced the first map of global heat flow (1975), and by the 1990s there were more than 20,000 sites that provide geothermal data.

The study of atmospheric energetics is the basis for the modern understanding of weather and climate. English astronomer Edmond Halley showed that low latitudes receive more solar radiation than higher ones and proposed that this gradient provides forcing for the atmosphere's general circulation (1686). In his book "The Philosophy of Storms," American meteorologist James Espy gave the first correct explanation of cloud formation and growth, and also stated the convection theory of cyclone energy (1841). In "On the energy of storms," Austrian Max Margules was the to use mathematics, thermodynamics, and meteorology to describe the formation of storms. Building on the work of Margules, American meteorologist Edward Lorenz provided a more complete explanation of the nature of available potential energy in the atmosphere, and its role in the general circulation of the atmosphere (1903). American meteorologist D. Brunt published the first comprehensive empirical description of the Earth's atmospheric energy budget, including an estimate of the fractional dissipation of kinetic energy, which is often used as a value of the intensity of the atmospheric energy cycle. American meteorologist James Spar made one of the first detailed empirical calculations of the energy budget of the Northern Hemisphere using data from the United States Weather Service. He created maps and tables of the average kinetic energy per unit volume for the surface and its atmosphere to an altitude of 20 km.

Energetics also is central to our understanding of ocean circulation, including the important role oceans play in moving energy from the equator to the poles. Swedish oceanographer J. W. Sandström proposed that thermal circulation can cause vigorous, steady circulation only if heating occurs at greater depths than cooling (1908). Sandström's theorem became a focal point of debate for the next century. American oceanographer Walter Munk's quantitative assessment of the rate of mixing in the abyssal ocean in maintaining oceanic stratification included the importance of the energetics of tidal energy dissipation (1966). Building on the atmospheric research of Margules (1903) and Lorenz (1955), American oceanographer R. O. Reid and colleagues provided a theoretical explanation of the role of available potential energy in the oceans' energy budget (1981). American meteorologist Abraham Oort and colleagues produced the first clearly documented values of the available gravitational potential energy and the kinetic energy in the oceans, and compared them with those in the atmosphere. They concluded that the ocean is a “comparatively passive medium driven largely by the turbulent atmosphere” (1989). Munk and Carl Wunsch updated Munk’s (1966) work on ocean circulation, concluding that the equator-to-pole heat flux of 2,000 TW associated with ocean circulation would not exist without the comparatively small mechanical mixing energy of tides (0.6-0.9 TW) and wind (1 TW) available for mixing.

Exercise

At the highlight of the previous, write a paragraph summarizing the importance of earth science.

Paragraph:

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Unit two

Earth’s energy

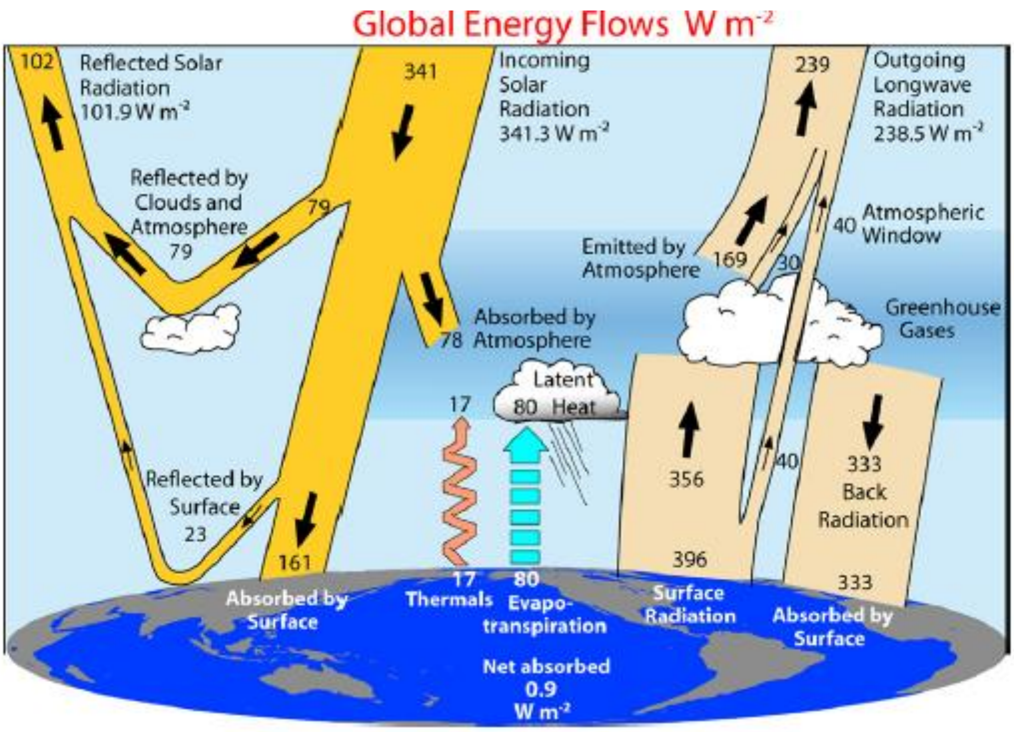

Figure. The global annual mean Earth’s energy budget for the March 2000 to May 2004 period (W m–2). The broad arrows indicate the schematic flow of energy in proportion to their importance.

Source: Trenberth, Kevin E., John T. Fasullo, Jeffrey Kiehl. 2009. Earth’s Global Energy Budget, Bulletin of the American Meteorological Society, Volume 90, Issue 3, 311-323.

Exercise

What natural phenomenon is shown in this picture explain it?

Paragraph:

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