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Deducing Earth's Global Mean Energy Flow System from a Simple Greenhouse Model

Miklos Zagoni
Eotvos Lorand University, Faculty of Natural Sciences, Budapest, Hungary (zagoni@ggki.hu)

Examining CERES (Clouds and the Earth's Radiant Energy System) synoptic (SYN1deg) and Energy Balanced and Filled (EBAF) data sets, robust internal patterns and energetic relationships can be recognized, separately for all-sky and clear-sky conditions. These regularities include direct surface – top-of-atmosphere (TOA) energetic interconnections and equalities (identities) of certain flux elements with other radiative or non-radiative components of the global energy flow system. The revealed arithmetic structure is far too regular and well-organized to be a mere coincidence; on the contrary, the ratios and equations, together, describe a coherent and self-consistent energetic structure; the clear-sky flux ratio system is justified by independent high-resolution radiative transfer computations as well. — A possible physical explanation of these regularities lies in the simplest idealized greenhouse model, comprising a planetary surface surrounded by a single-layer shortwave-transparent, longwave-opaque, non-turbulent "glass-shell" atmosphere where the energy absorbed (and emitted) by the surface is exactly twice the outgoing longwave radiation (OLR) at TOA, simply because of geometric reasons. Earth's atmosphere is neither SW-transparent nor LW-opaque; but as the all-sky infrared (IR) atmospheric window is only about 5.5% of the surface longwave emission, it does not seem meaningless to try to approximate Earth's real energy flow system from the IR-opaque limit. — Starting from that limit, this presentation gives a deduction of the annual global mean surface and atmospheric energy flow system by introducing partial atmospheric SW absorption, partial LW transparency, and turbulence in the course of the deduction, while keeping the basic two/one ratio fixed in the SFC/TOA flux structure. The resulted energy flow distribution is actually identical to the observed one; all the flux values are within the one-sigma range of observation uncertainty. One of the remarkable features of the system is the inherited small-number integer ratios that apparent between the internal surface and atmospheric radiative and non-radiative fluxes. — The underlying theoretical interpretation might be found in the radiative effect of the cloud cover: if our quasi aqua-planet – for any physical reason like a minimum or maximum principle (such as least action or maximum entropy production) – tends to close the atmospheric window, it has all the means and tools to do so by the longwave effect of clouds. In that case, from a surface perspective, the energy being lost in space through the open atmospheric window is gained back by the greenhouse effect of clouds; and the surface will see an effectively IR-opaque ceiling above itself. The resulted energy flow system then is awaited to be similar to a wave propagation in a cavity where the wave numbers are modulated by the longwave cloud radiative effect (LWCRE), hence the observed fluxes might be integer multiples of a unit flux which, in turn, ought to be close to the greenhouse effect of clouds. — It should be emphasized that the validity of the disclosed quantitative flux relationships does not depend on the validity of this possible theoretical explanation.