Balancing the Energy *Budget*

Just like a family budget for finances, the energy budget of the Earth should be balanced. In equation form:

Energy In = **Energy Out**

This balance can be considered at several levels in the Earth system:

At the top of the atmosphere, the energy coming in from the Sun is balanced by sunlight reflected back to space and the net infrared emission from the Earth. The equation is:

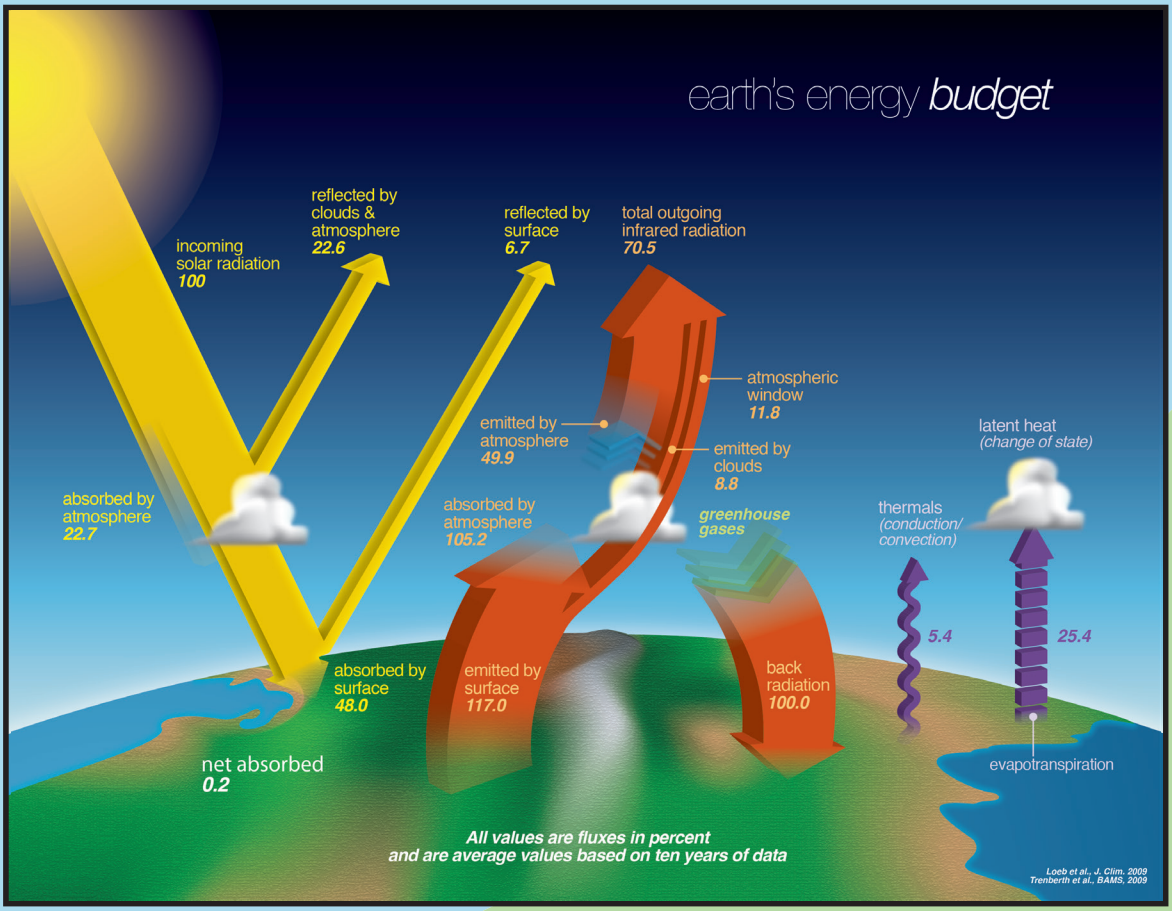
Sunlight In = Sunlight reflected from clouds/atmosphere + Sunlight reflected from surface + IR emission

At the Earth's surface, absorbed sunlight is balanced by the net IR emission and the conduction/convection and evapotranspiration. The equation is:

Sunlight absorbed + IR back radiation (greenhouse effect) = IR emission + Thermals + Evapotranspiration

The most complicated balance is in the atmosphere, where absorbed sunlight and energy absorbed from the surface are balanced by the net infrared emission. The equation is:

Sunlight absorbed + IR from surface + Thermals + Evapotrans = IR emitted to space + IR emitted to ground



These balance equations are for an equilibrium state of the Earth. Equilibrium would be expected for a planet that has spent a long time in a stable solar system, but sometimes changes occur that take the system out of balance. For example, the ice ages occurred because of long-term changes in Earth's orbit around the Sun, which resulted in a change to the "Sunlight In" term. Over time, reflected sunlight and IR emission changed to balance the first equation. The result was a colder surface and major glacial advances.