

Radiative heat balance (at equilibrium):

HEAT ABSORBED = HEAT EMITTED

$$R^2 E_s [1 - \alpha] = 4 R^2 [f T_s^4]$$

R = *radius of the Earth*

E_s = *solar irradiance*

α = *planetary albedo*

f = *effective infrared transmission factor (greenhouse effect)*

σ = *Stefan-Boltzman constant*

T_s = *surface temperature*

PLANETARY ALBEDO: The fraction of incoming radiation that is reflected back to space.

[sea water ~0.1; bare land ~0.3; sea ice ~0.6; fresh snow ~0.9]

ICE-ALBEDO FEEDBACK: For any imposed cooling (or warming), the resulting higher (or) albedo will cause further cooling (or warming). Thus, ice advance is self-stabilizing.

RUNAWAY ICE ALBEDO: If ice lines close to within ~30° of the equator, the ice albedo feedback becomes unstoppable and ice quickly covers the tropics.

see Budyko, M.I., The effect of solar radiation variations on the climate of the Earth; TELLUS 21: 611-619 (1969).