

# Forcings and Feedbacks

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Energy balance at the top of the atmosphere

$$F_{TOA} = F_{Solar} - F_{TIR}$$

If the planet is in equilibrium, these two balance at the top of the atmosphere and the net top-of-the-atmosphere flux  $F_{TOA} = 0$

Now,  $F_{TOA}$  is a function of the surface temperature and many other variables.

$$F_{TOA} = F_{TOA}(T_s, x_1, x_2 \dots x_N)$$

By the chain rule,

$$\delta F_{TOA} = 0 = \frac{\partial F_{TOA}}{\partial T_s} \delta T_s + \sum_{i=1}^N \frac{\partial F_{TOA}}{\partial x_i} \delta x_i$$

Now let's call the  $N^{th}$  process a “forcing”,  $\delta Q$ :

$$\delta F_{TOA} = 0 = \frac{\partial F_{TOA}}{\partial T_s} \delta T_s + \sum_{i=1}^{N-1} \frac{\partial F_{TOA}}{\partial x_i} \delta x_i + \delta Q$$