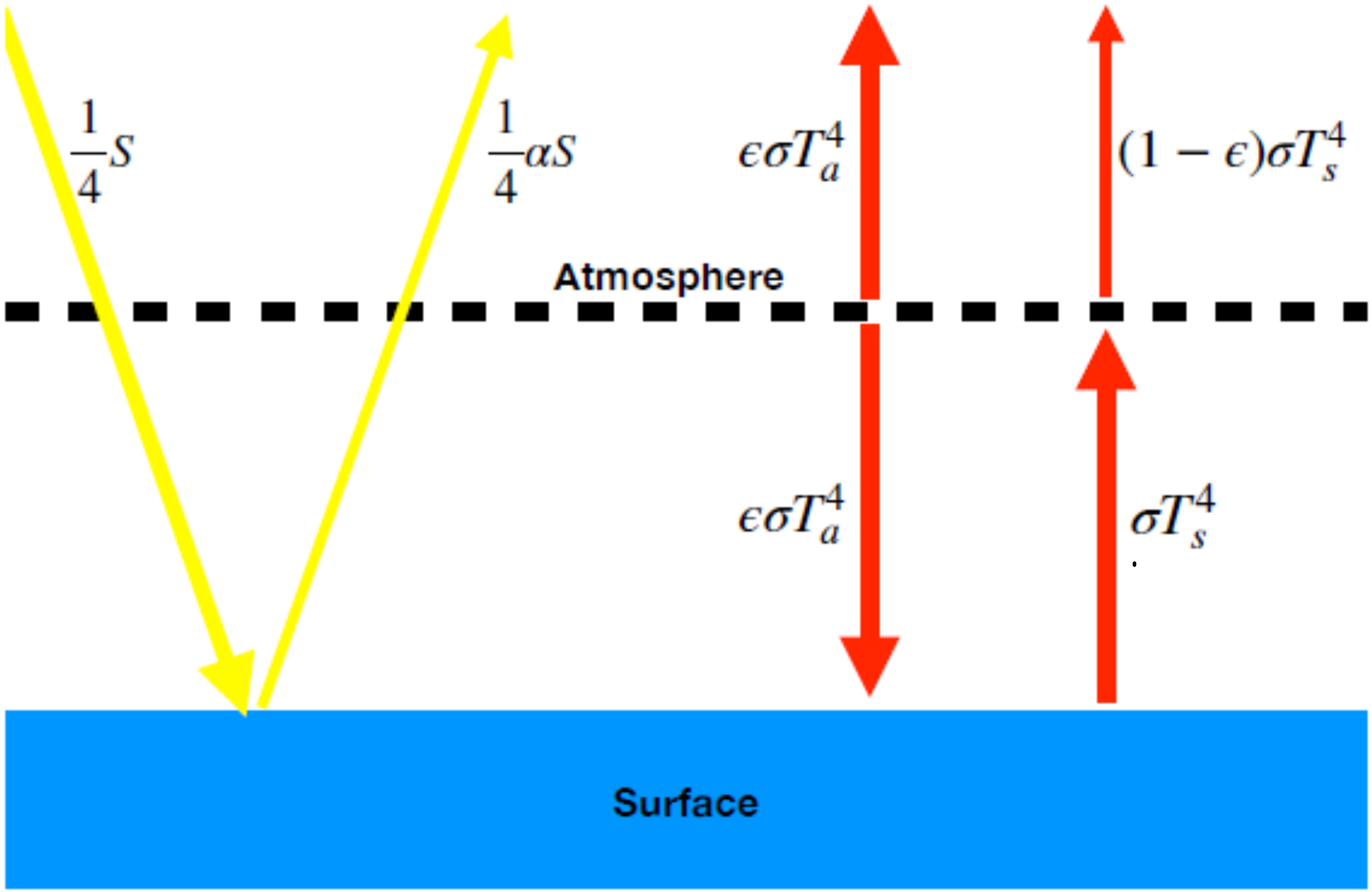

Global Warming
Lecture 4.2
One-Layer Model: Praxis

ONE-LAYER MODEL



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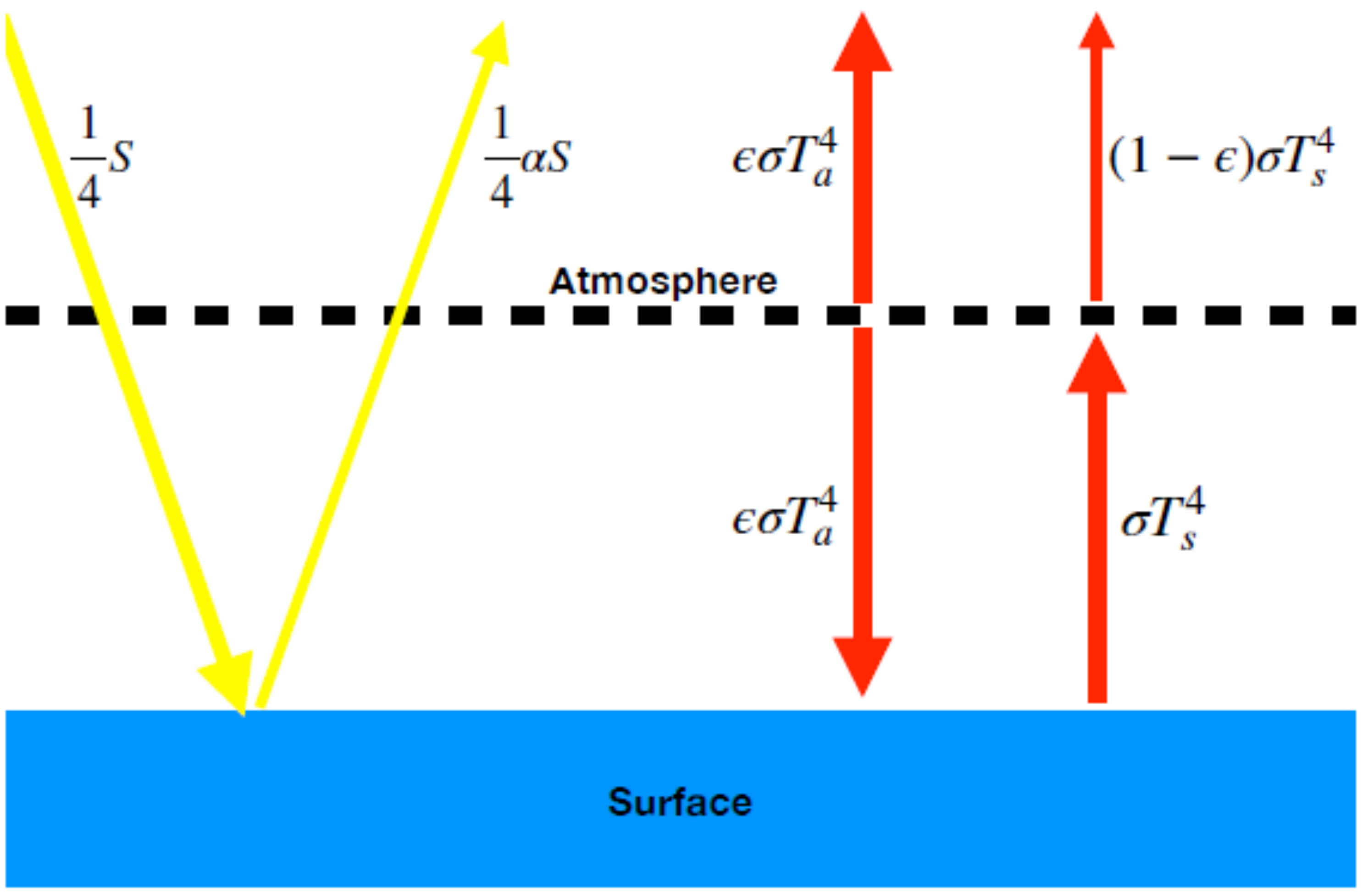

$$\mathbf{\frac{1}{4}(1-\alpha)S + \frac{\varepsilon}{2}\sigma T_s^4 = \sigma T_s^4}$$

$$\mathbf{\frac{1}{4}(1-\alpha)S = (1-\frac{\varepsilon}{2})\sigma T_s^4}$$

$$\mathbf{T_s = \left(\frac{(1-\alpha)S}{4(1-\frac{\varepsilon}{2})\sigma}\right)^{\frac{1}{4}}}$$

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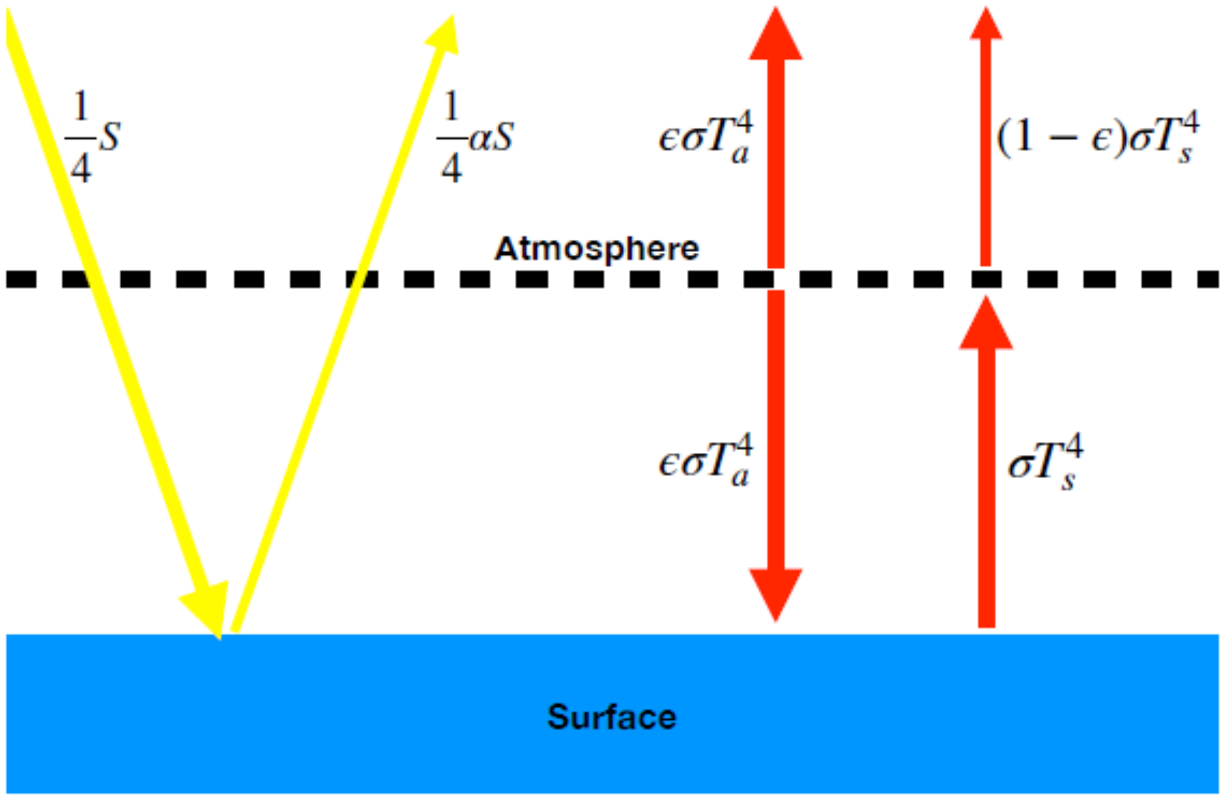

$$\frac{1}{4}(1-\alpha)S+\frac{\varepsilon}{2}\sigma T_s^4=\sigma T_s^4$$

$$\frac{1}{4}(1-\alpha)S=(1-\frac{\varepsilon}{2})\sigma T_s^4$$

$$T_s=\left(\frac{(1-\alpha)S}{4(1-\frac{\varepsilon}{2})\sigma}\right)^{\frac{1}{4}}$$

1. Mars has an insolation of $S = 586$ W m^{-2} and an albedo of $\alpha = 0.25$. It has a very thin atmosphere, so we can approximate $\varepsilon = 0$. Remember that $\sigma = 5.67\times10^{-8}$ W m^{-2} K^{-4}. Use the one-layer model to estimate the surface temperature of Mars, and compare to the actual value of 210 K.

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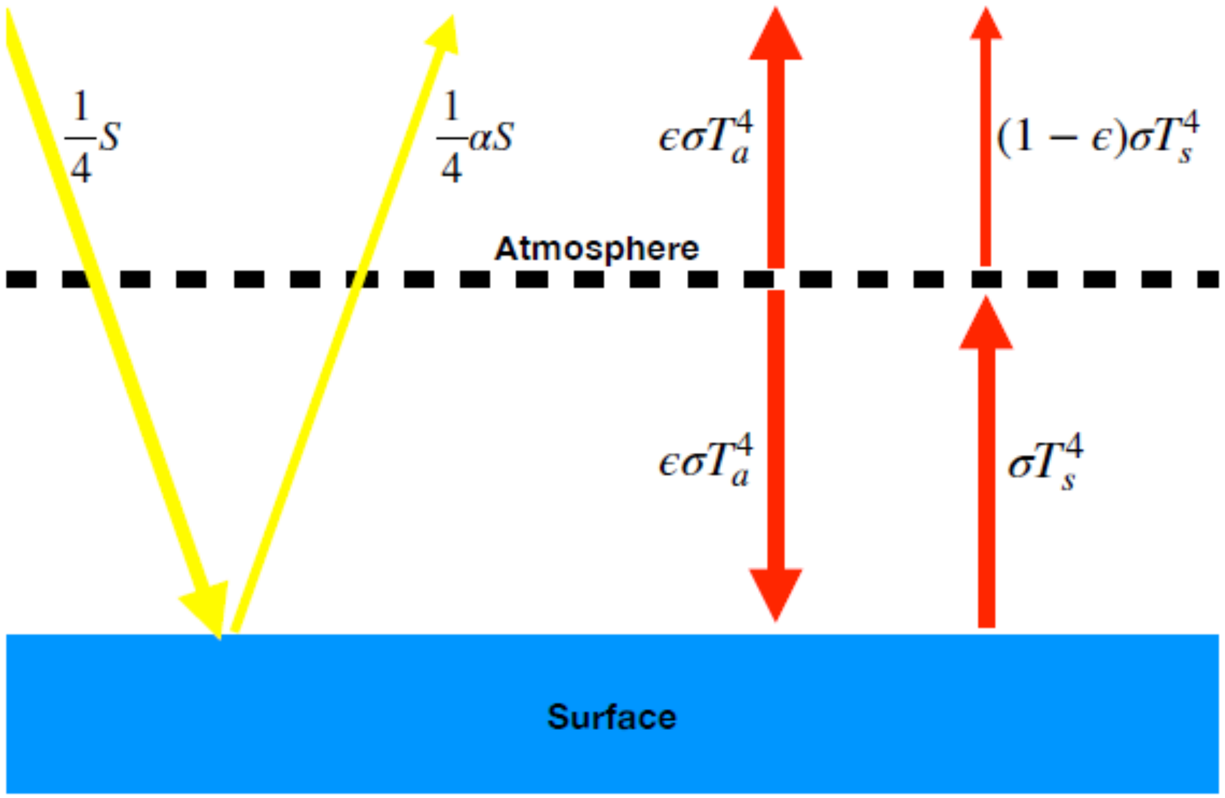

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1. Mars has an insolation of $S = 586$ W m^{-2} and an albedo of $\alpha = 0.25$. It has a very thin atmosphere, so we can approximate $\varepsilon = 0$. Remember that $\sigma = 5.67 \times 10^{-8}$ W m^{-2} K^{-4}. Use the one-layer model to estimate the surface temperature of Mars, and compare to the actual value of 210 K.

$$T_s = \left(\frac{(1-0.25)586\ \mathrm{W\ m^{-2}}}{4 \times 5.67 \times 10^{-8}\ \mathrm{W\ m^{-2}\ K^{-4}}}\right)^{\frac{1}{4}} = 210\ \mathrm{K}$$

This is actually a 0-layer model since we assume there is no atmosphere!