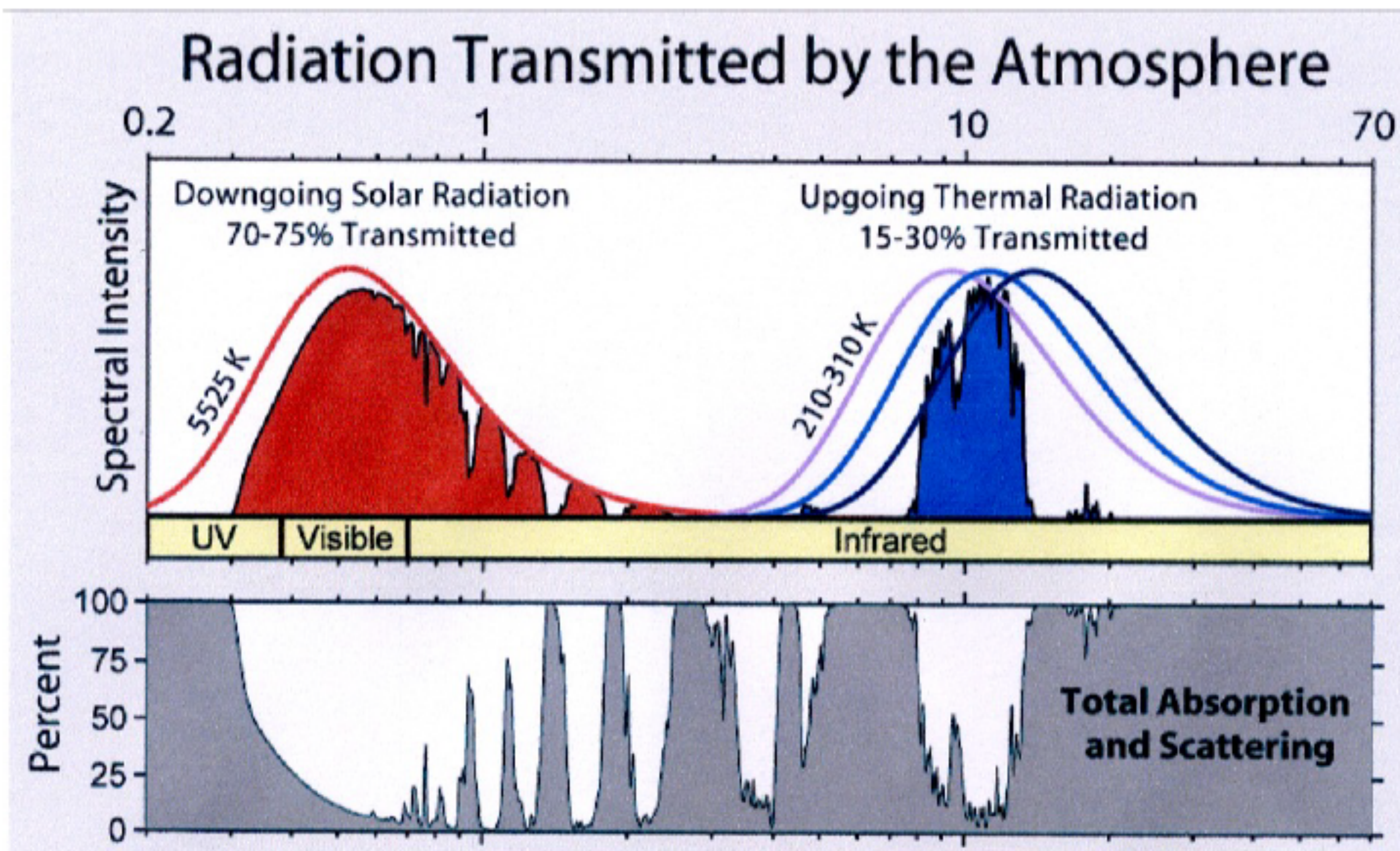
Global Warming
Lecture 4.1
One-Layer Model: Deviation

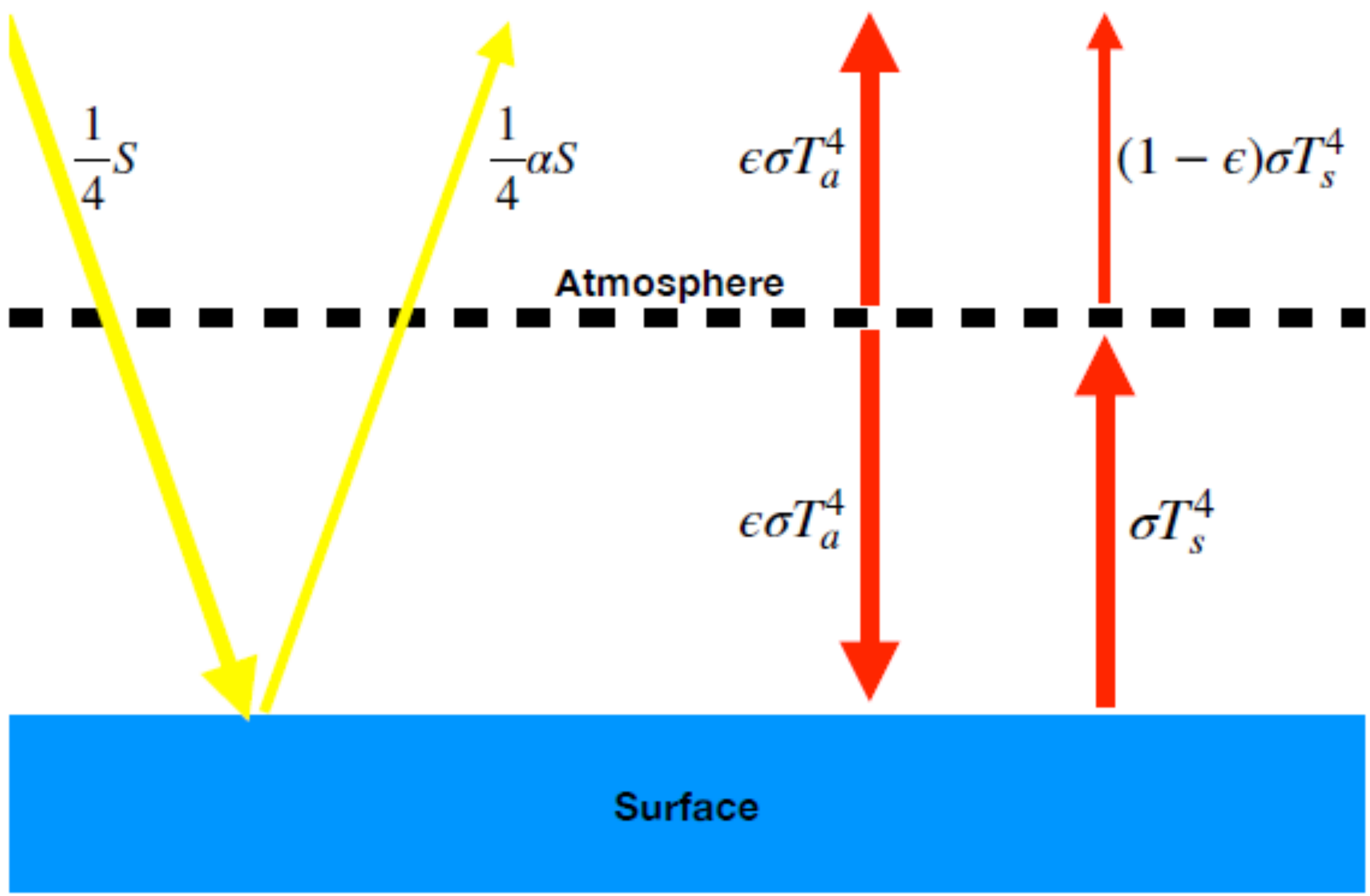
1. **Sun's shortwave radiation and Earth's longwave radiation can be treated separately;**
2. **The atmosphere is more transparent for the sun's shortwave radiation and is more opaque for the Earth's long wave radiation.**



1. **Sun's shortwave radiation and Earth's longwave radiation can be treated separately;**
2. **The atmosphere is more transparent for the sun's shortwave radiation and is more opaque for the Earth's long wave radiation.**
3. **Kirchhoff's law: absorptivity=emissivity ($a = \epsilon$)**
4. **3 + Stefan-Boltzman's law: if emissivity is ϵ and temperature is T, the radiative flux is $F = \epsilon\sigma T^4$ (W/m²)**

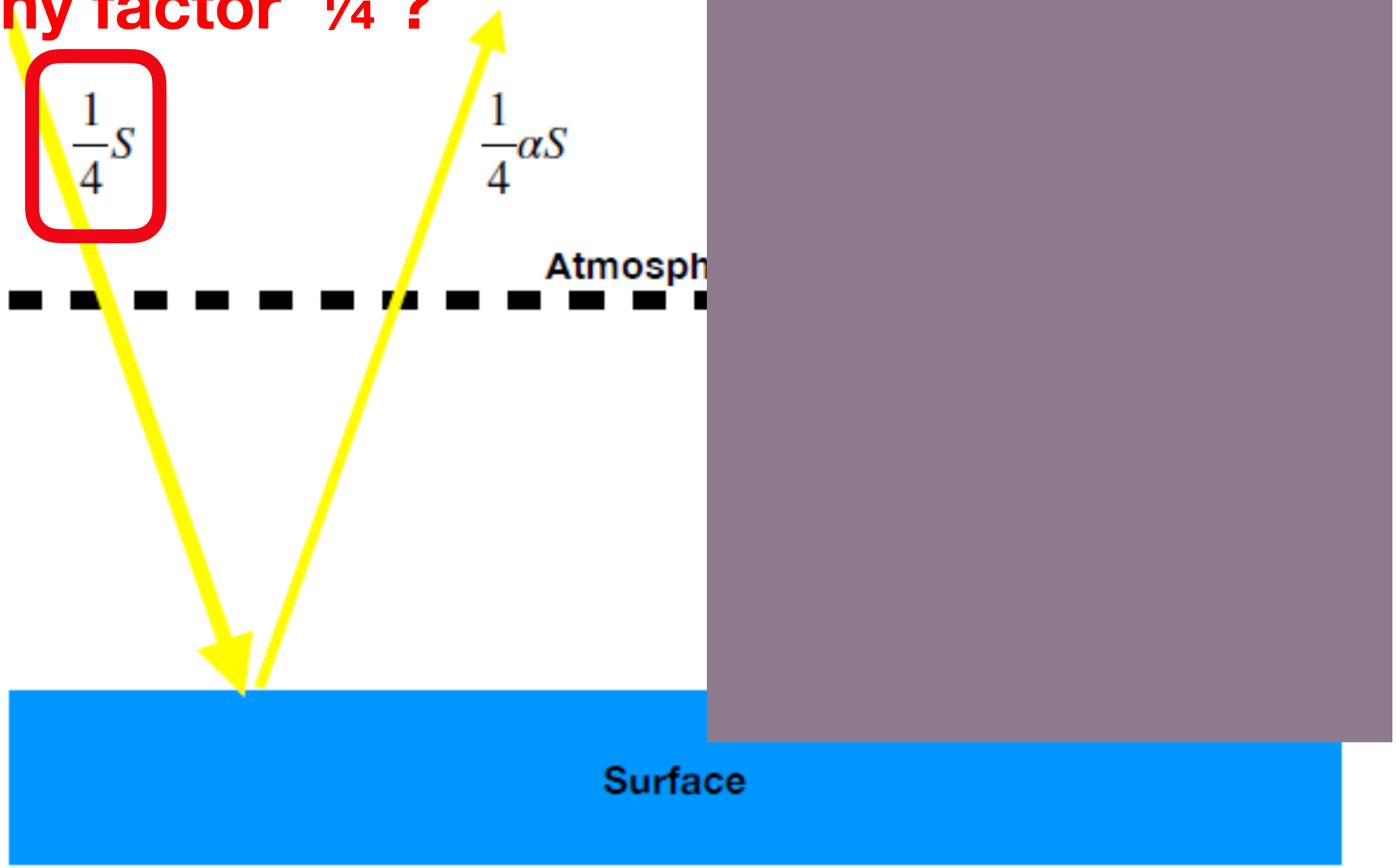
Assumptions:

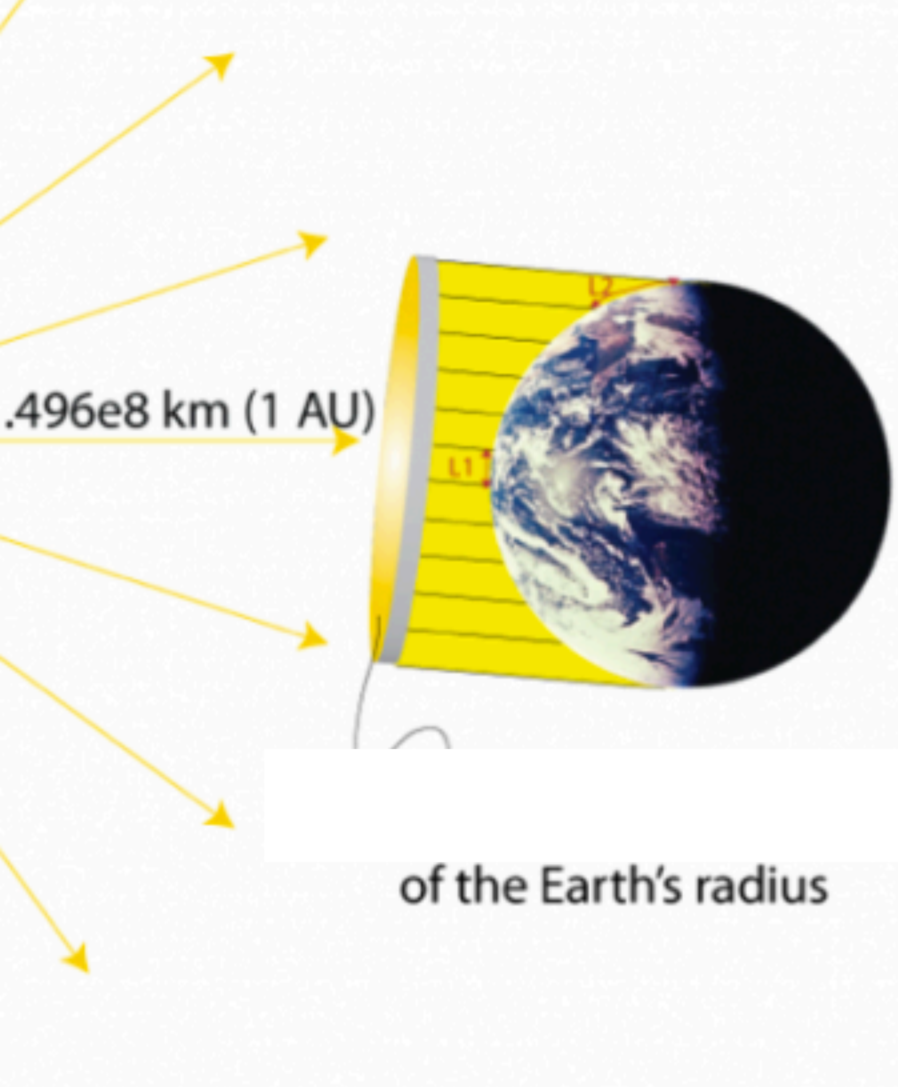
1. **Atmosphere is transparent to solar radiation, and the emissivity (=absorptivity) for the Earth's radiation is ϵ**
2. **The surface is emitting longwave radiation as blackbody, and has an albedo of α for the shortwave radiation.**

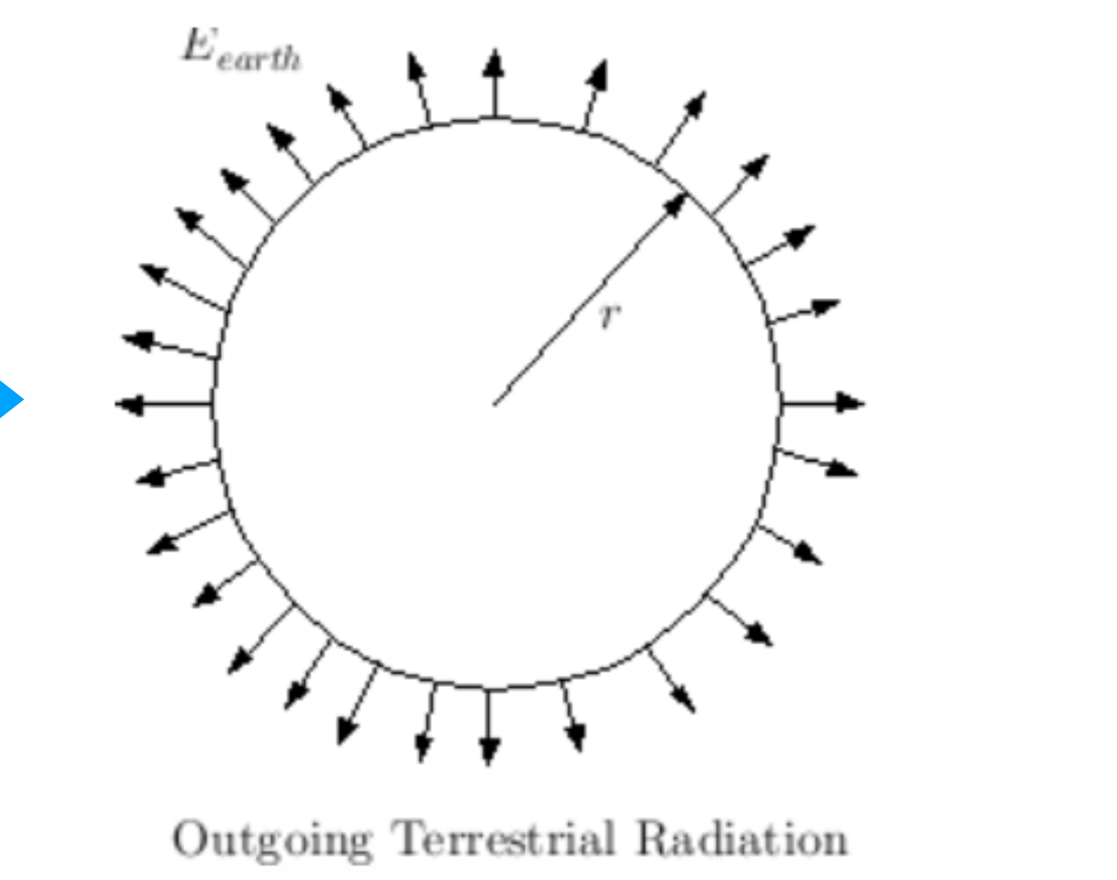


One-Layer Model

Why factor ¼ ?







$$\underbrace{S}_{W/m^2}\underbrace{\pi R^2}_{m^2} = [W]$$

Area : $4\pi R^2$

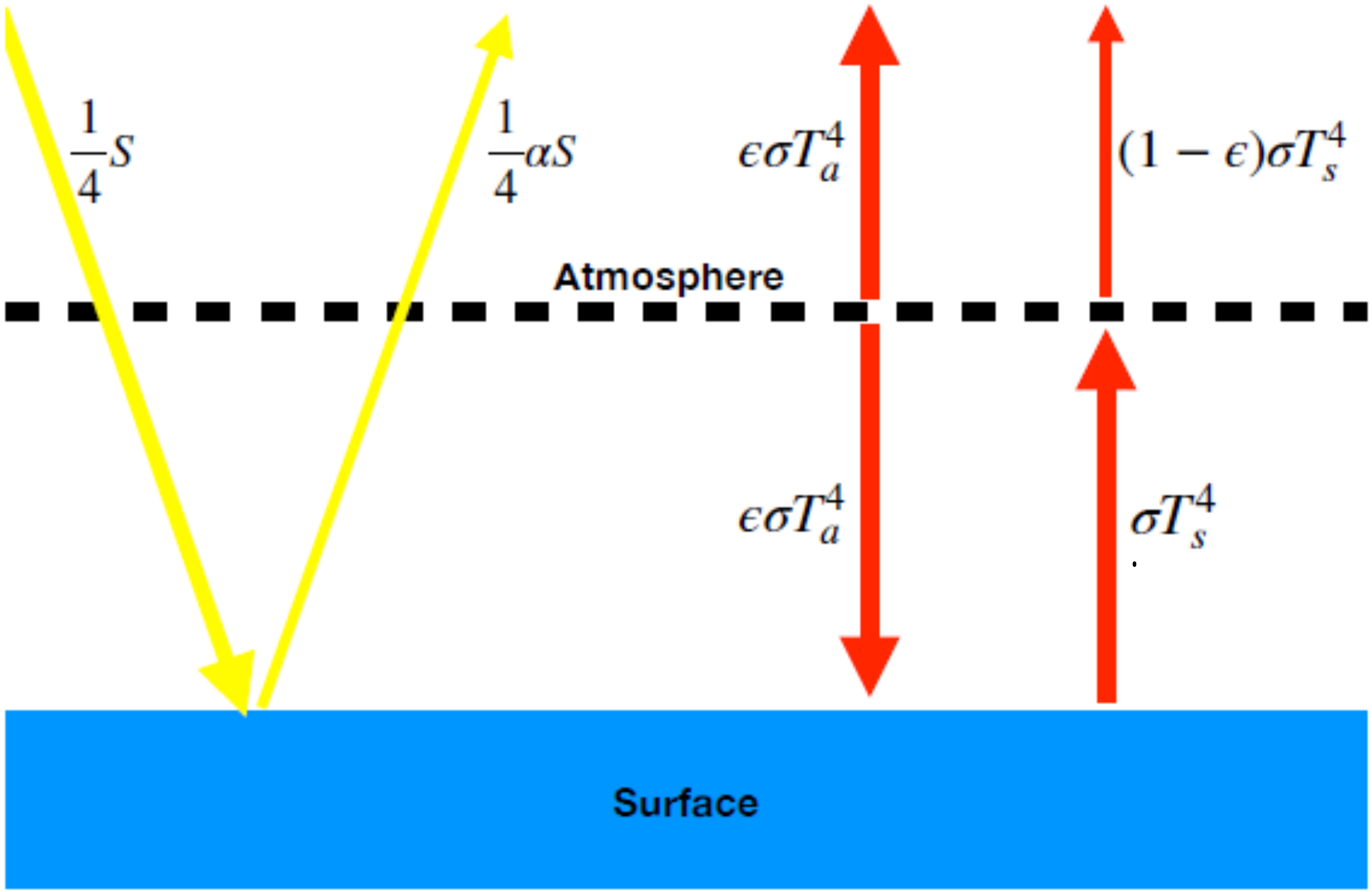
energy hitting Earth's surface per unit time per unit area (averaged over globe):

$$\frac{S\pi R^2}{4\pi R^2} = \frac{1}{4}S.$$

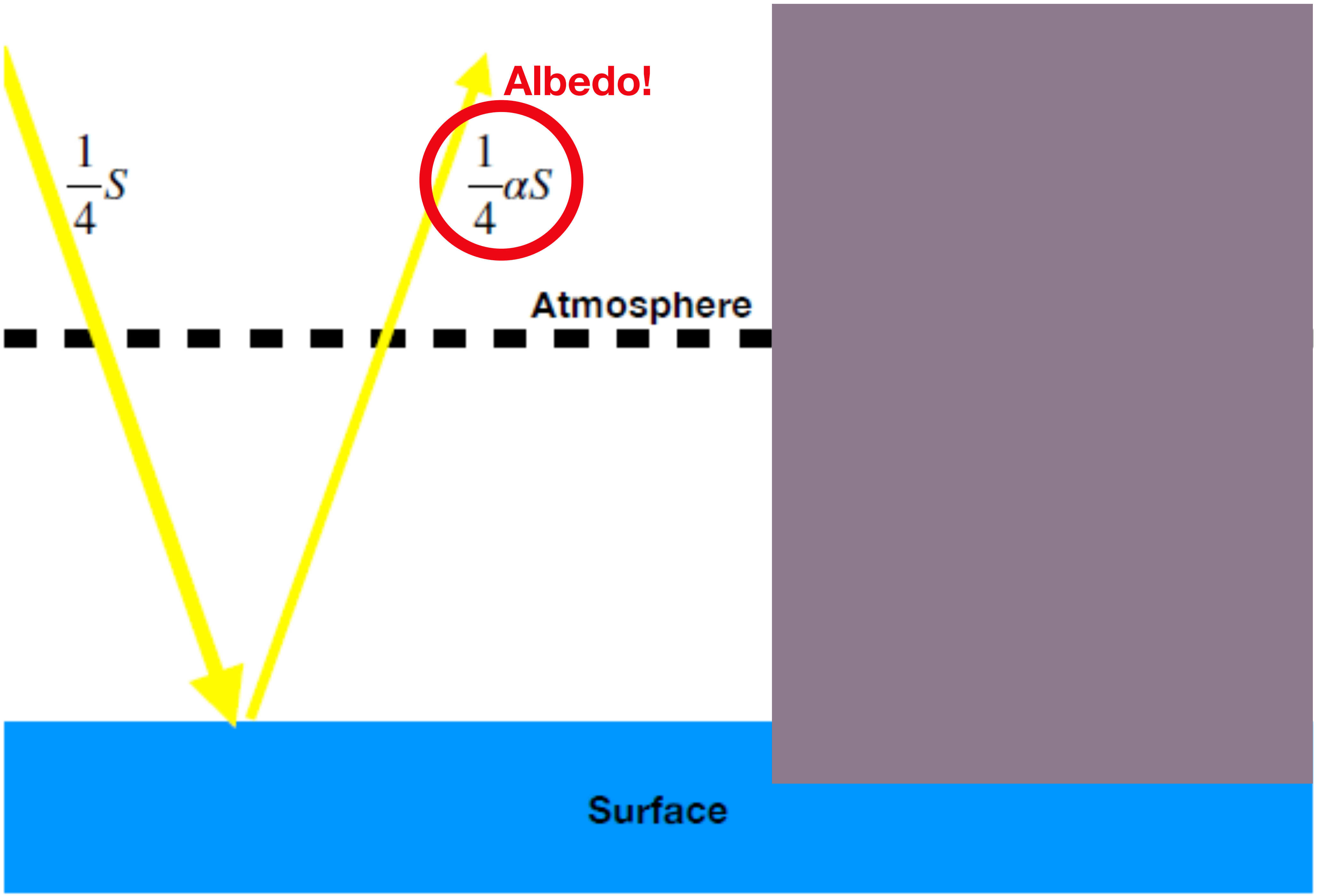
W

m²

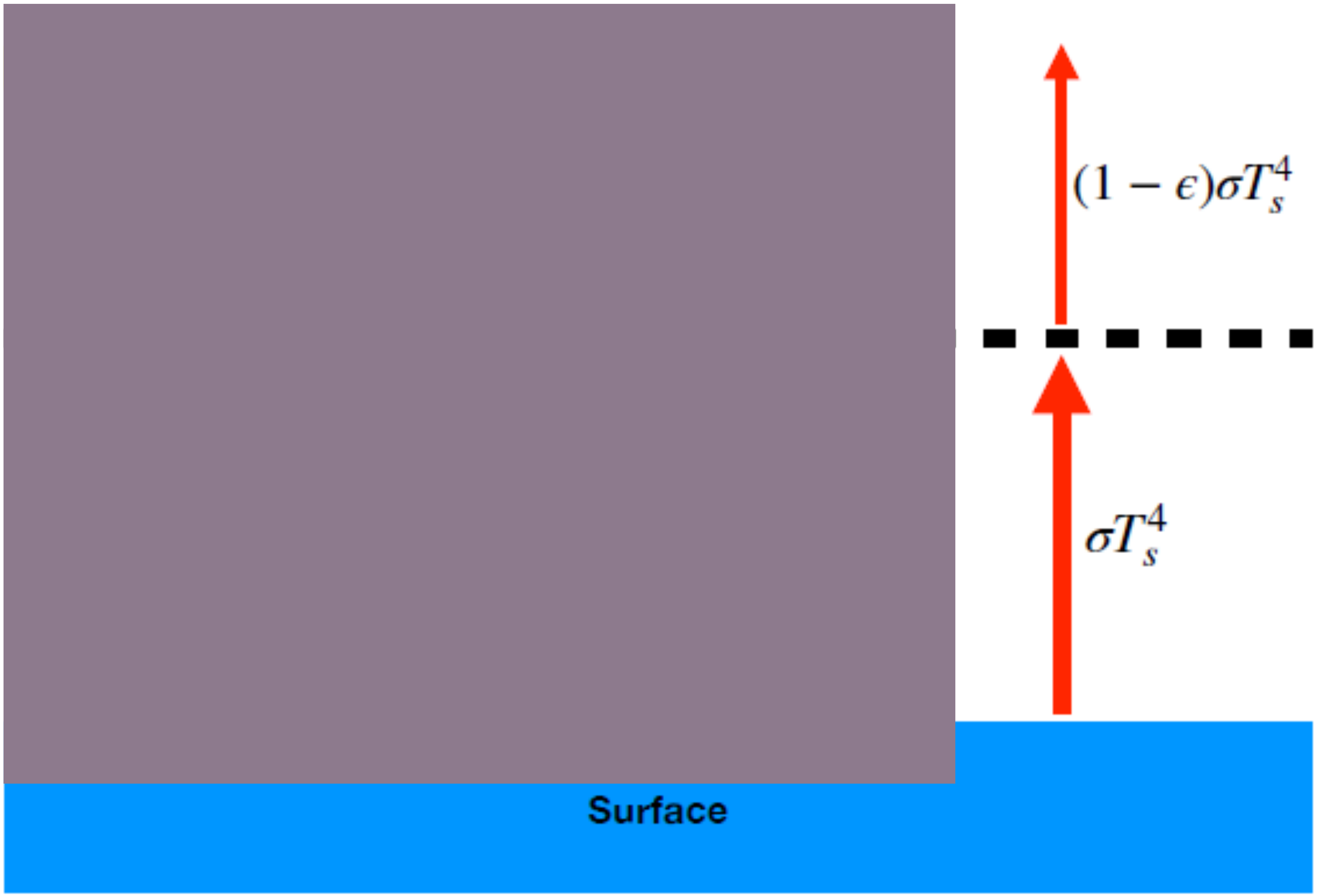
ONE-LAYER MODEL



1. Shortwave Radiation



2. Longwave Radiation



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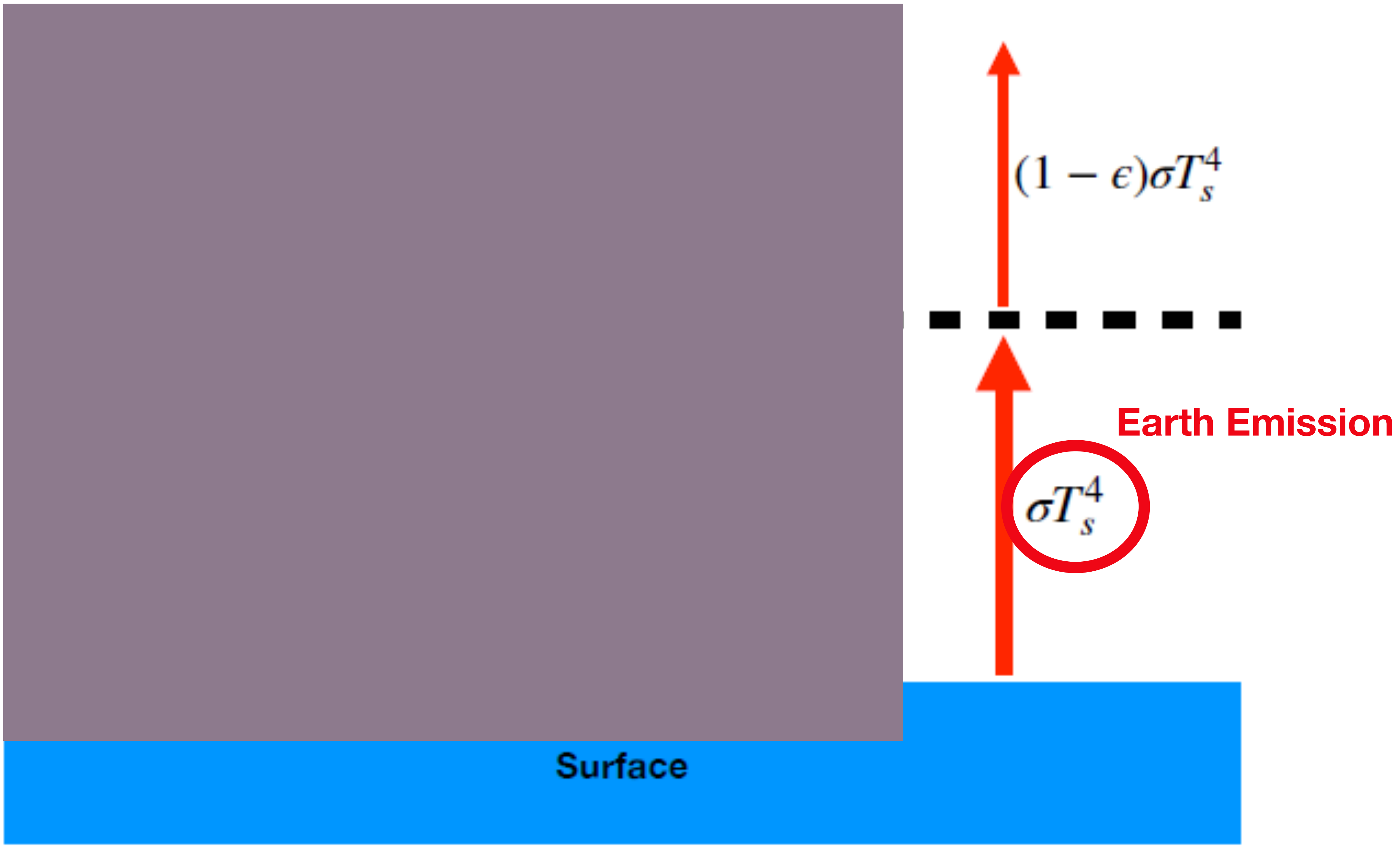

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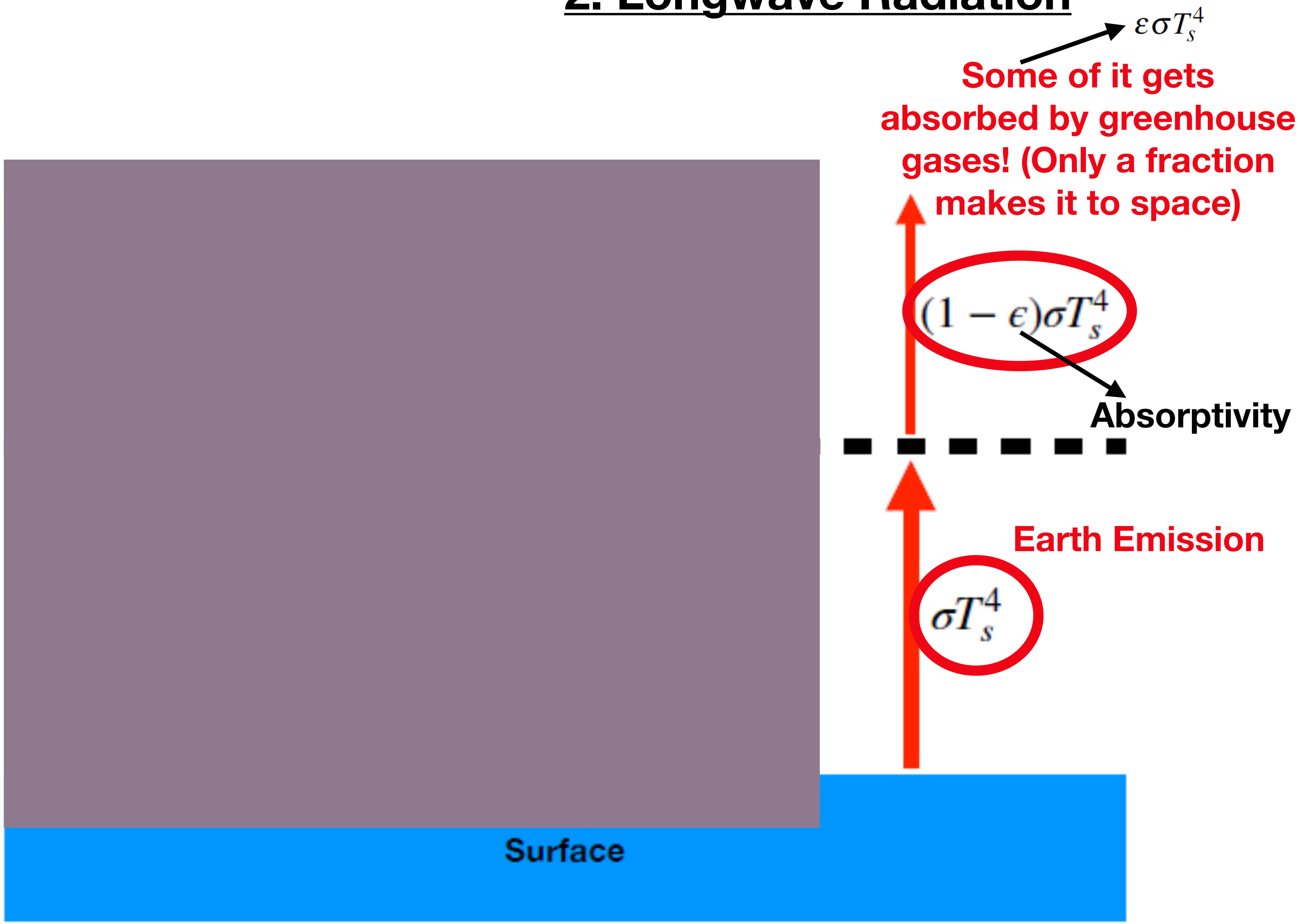

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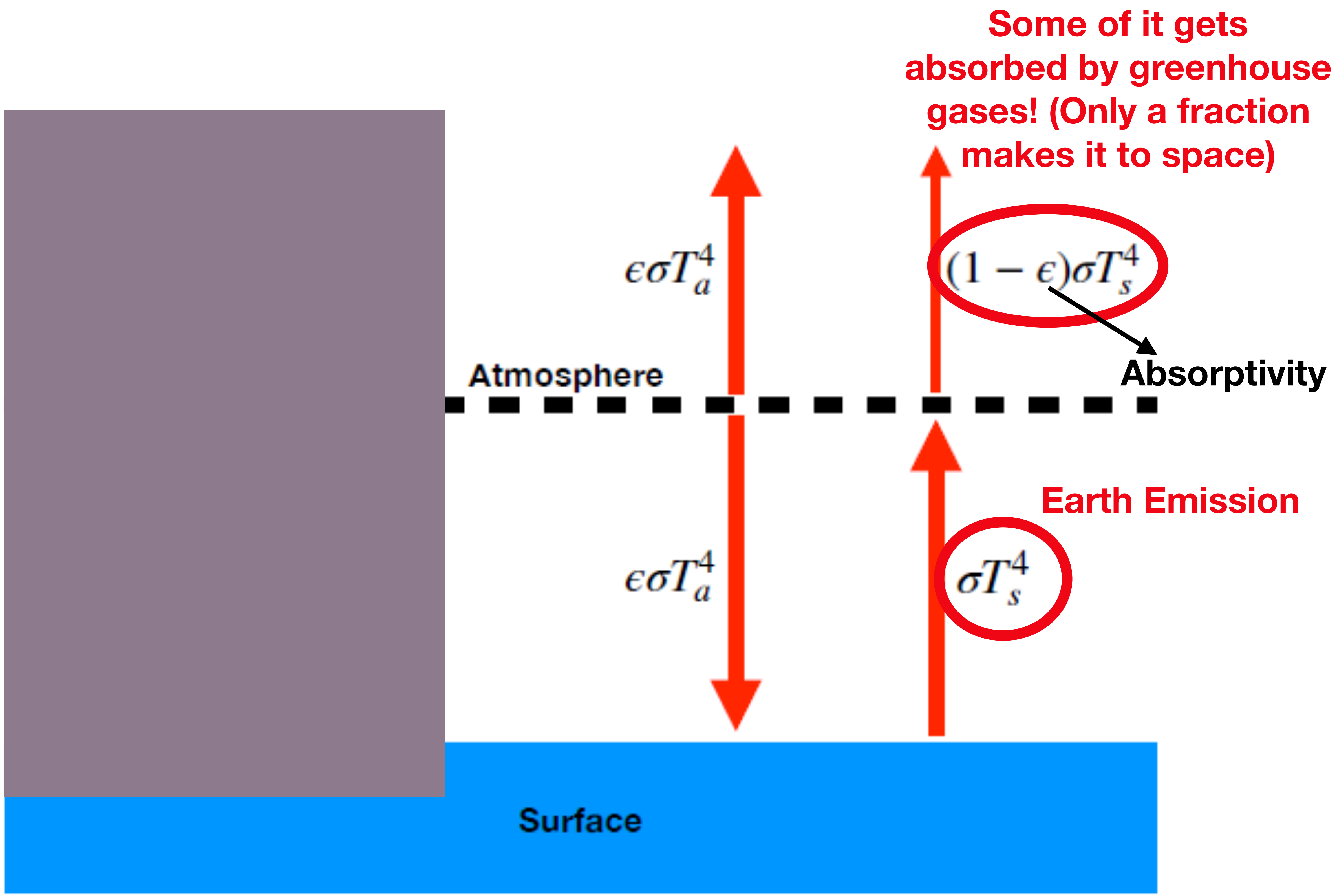

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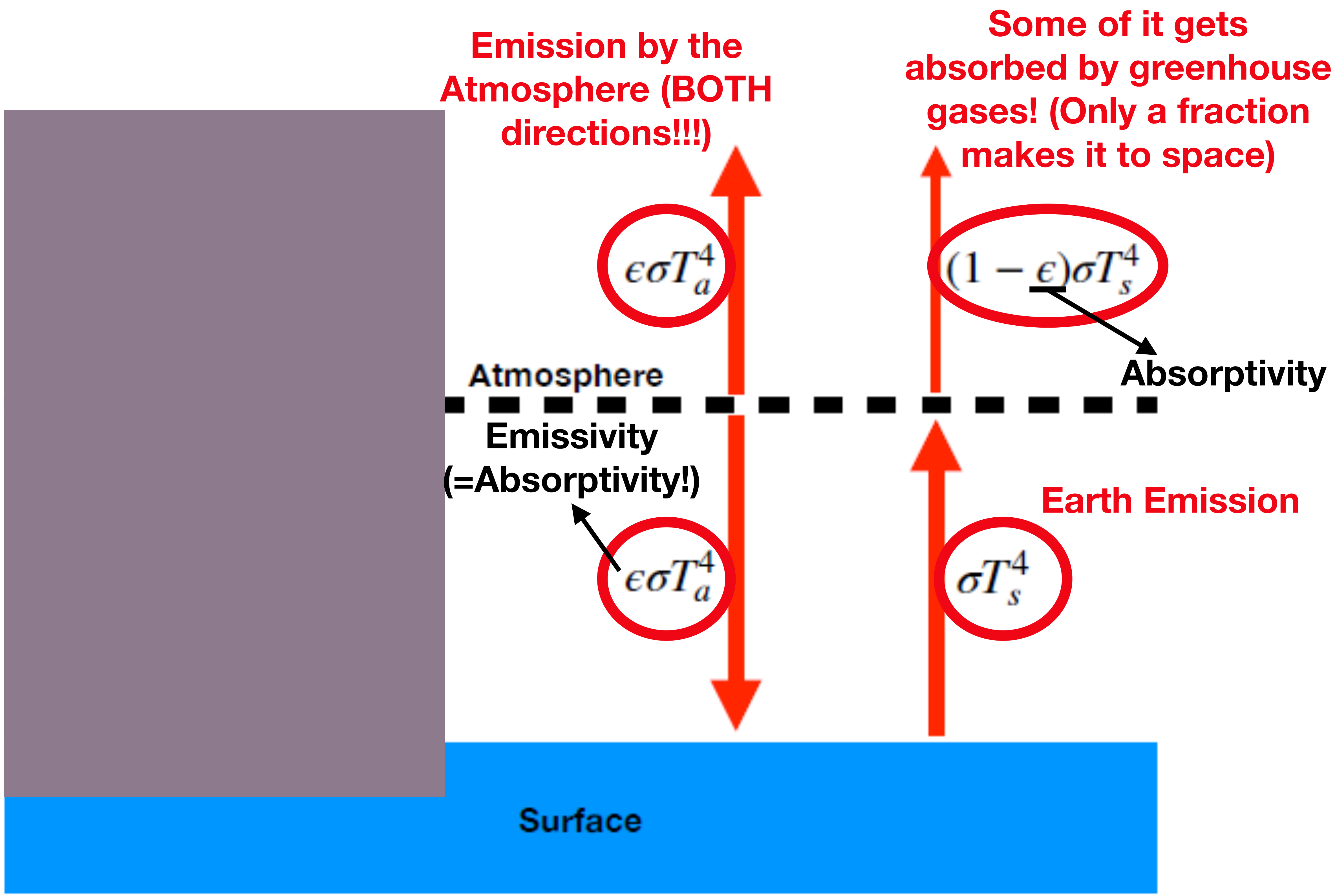

ONE-LAYER MODEL