

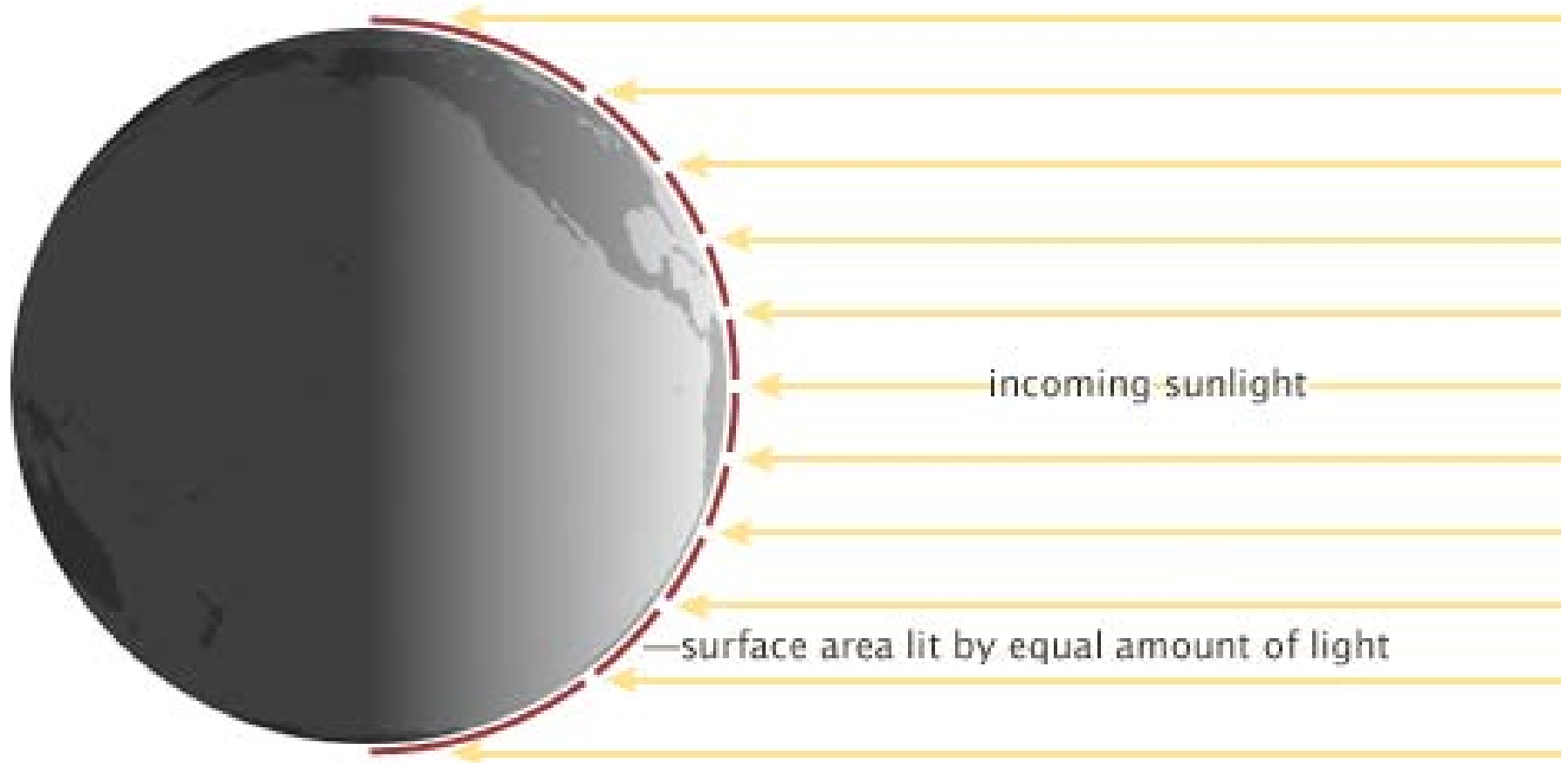


Earth's Energy Balance

We are Sun Powered

- Earth is warmed by the sun
 - Exception: geothermal energy
- The Sun adds 342 Watts of energy per square meter of earth every year
- Energy from the sun radiates through space as electromagnetic waves

The Sun's Rays Don't Heat Earth Evenly

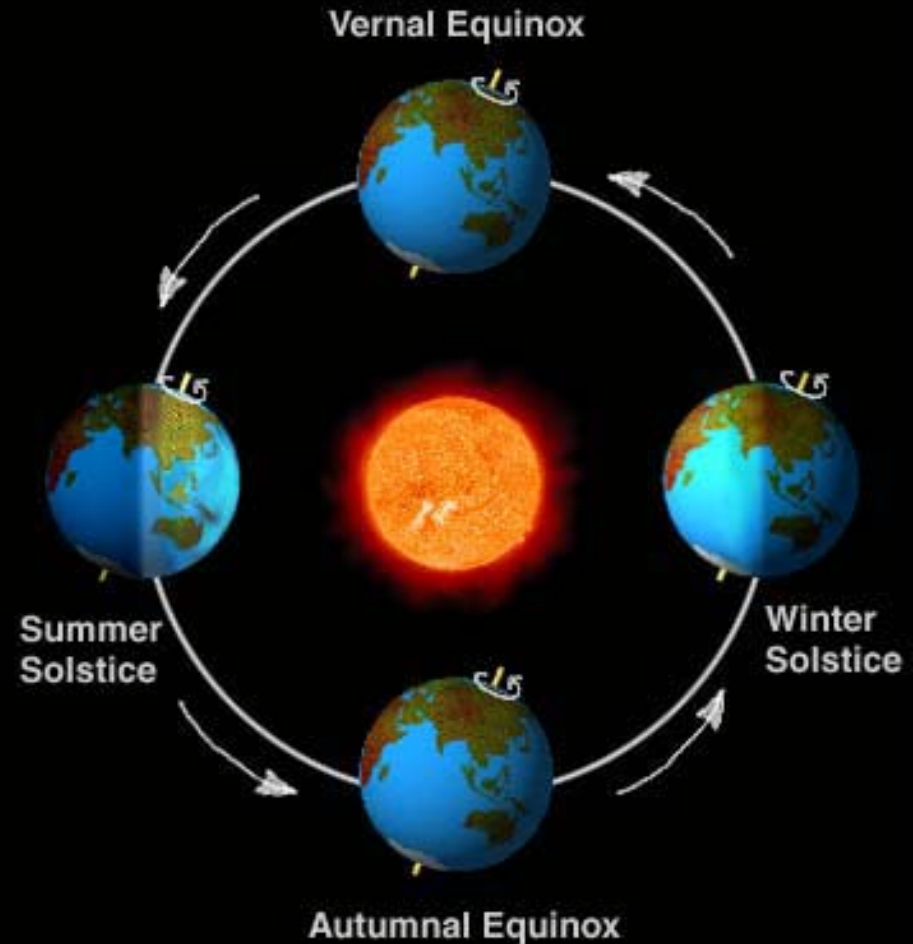


The Earth is not Warmed Evenly

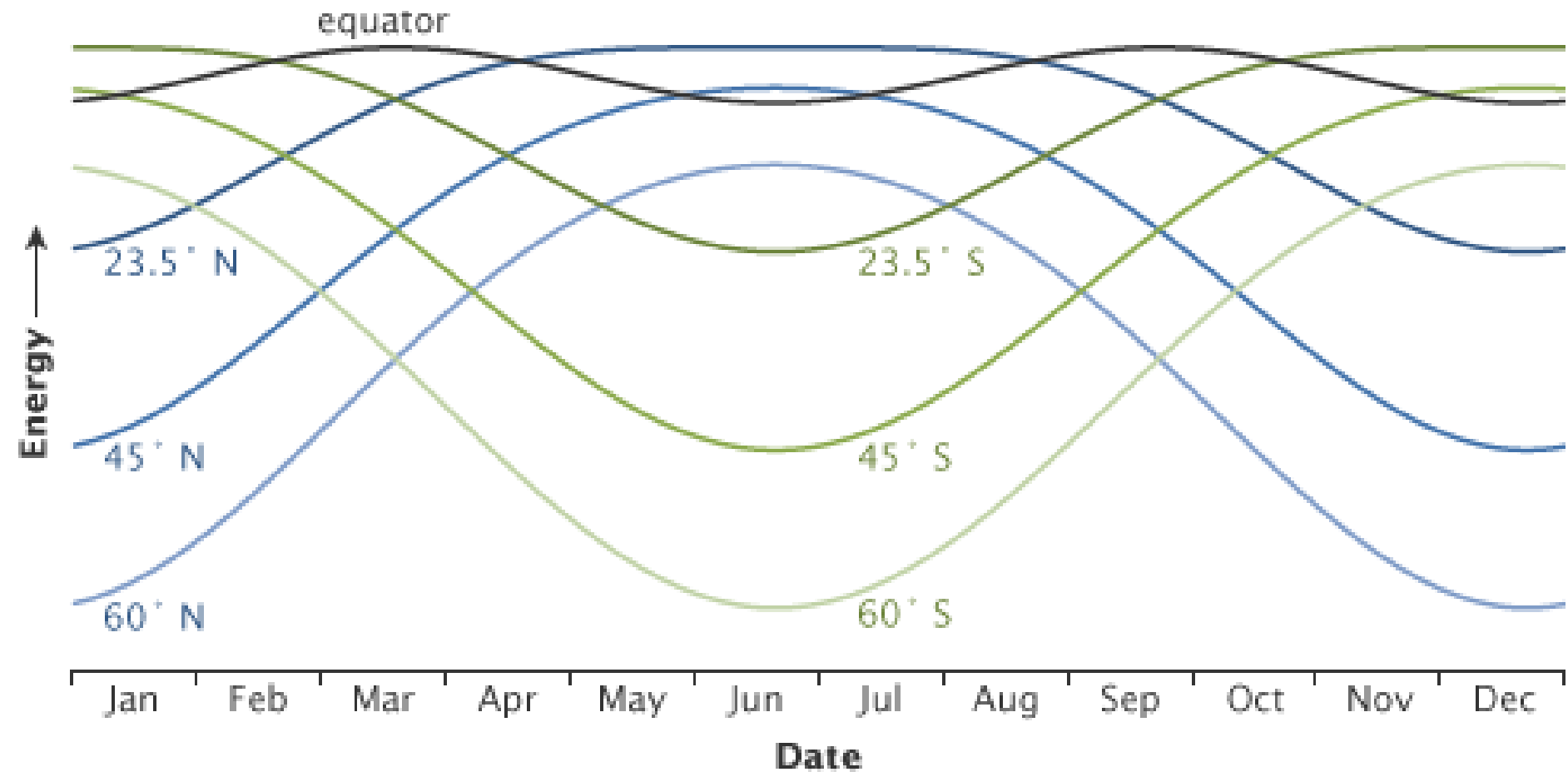
- **Areas near the equator receive more sunlight**
- **Sunlight received near poles is not as strong**

Tilt of Earth Causes Seasons

- Uneven heating of Earth is why we have seasons
- Always warm at equator because sun is nearly directly overhead
- Big variation in temps at poles because angle of sunlight varies greatly over the year
- These variations in heating drive Earth's climate and weather



Your Latitude determines your Solar Energy



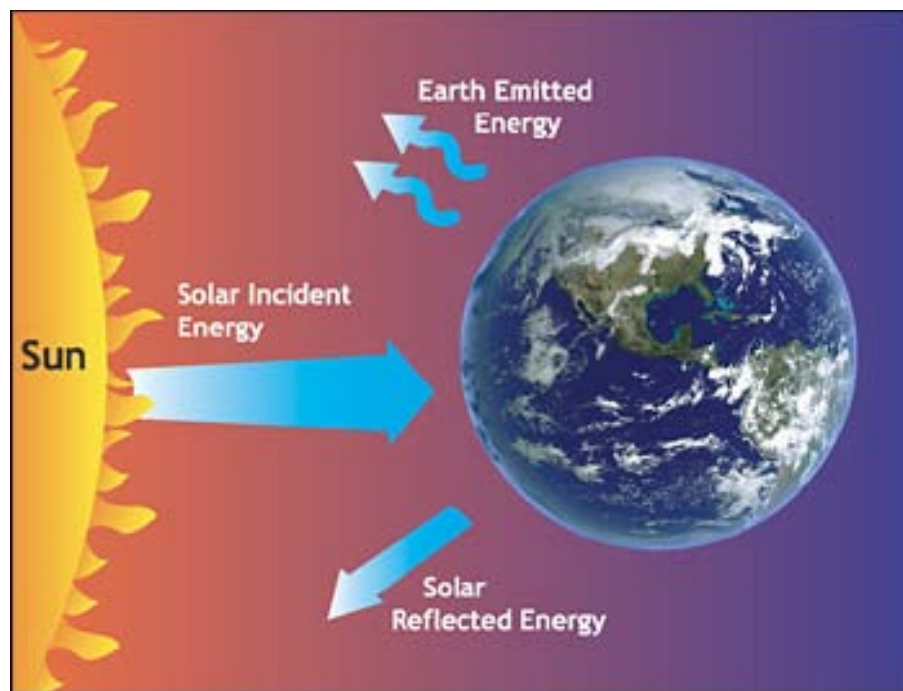
Overheating?

If Earth is receiving so much solar energy, why aren't we heating up like an oven?



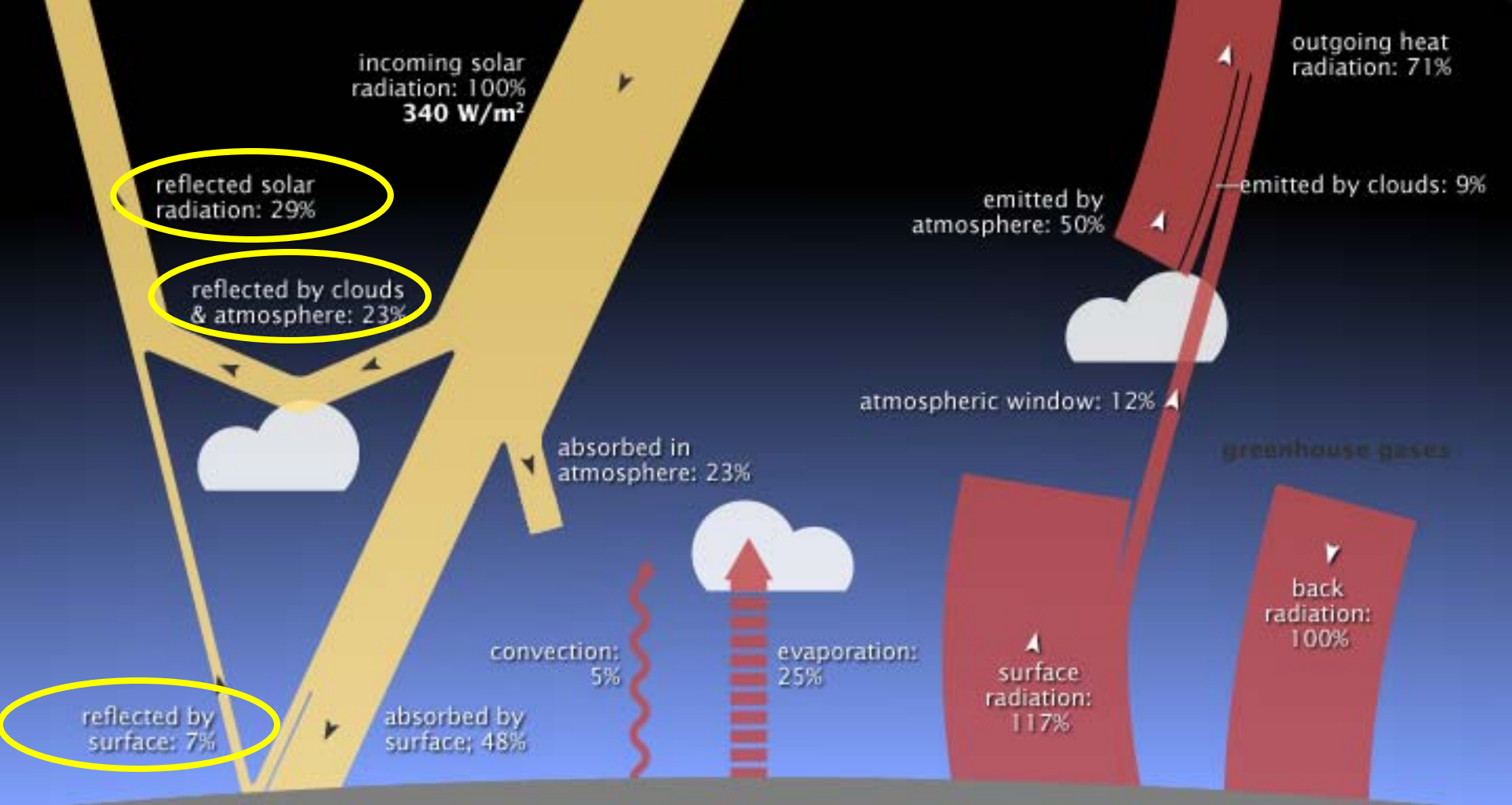
There's a Balance!

- Some solar radiation is reflected/absorbed by atmosphere before it reaches Earth.
- Solar radiation (short wavelength) warms the earth. Earth radiates some of that energy (long wavelength) back towards space.
- Incoming energy must equal outgoing energy to keep things in balance.

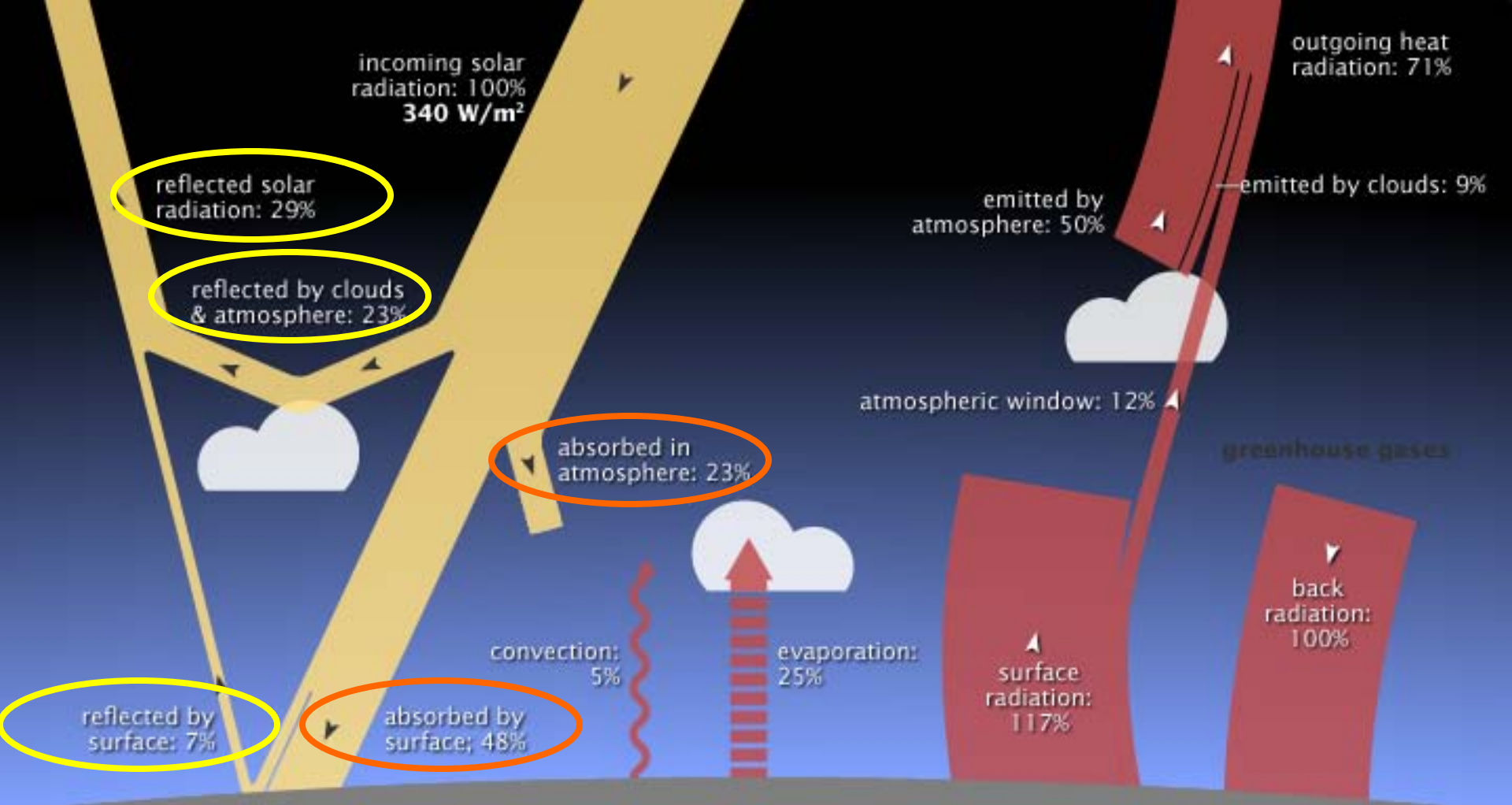


Of Course, It's a Bit More Complex...

- If the radiation emitted by Earth just escaped back into space, Earth's surface would be very, very **COLD!**
- The atmosphere is absorbing some of that radiation and keeping Earth comfortably warm. This is the **Greenhouse Effect** (see "Greenhouse Effect.ppt")

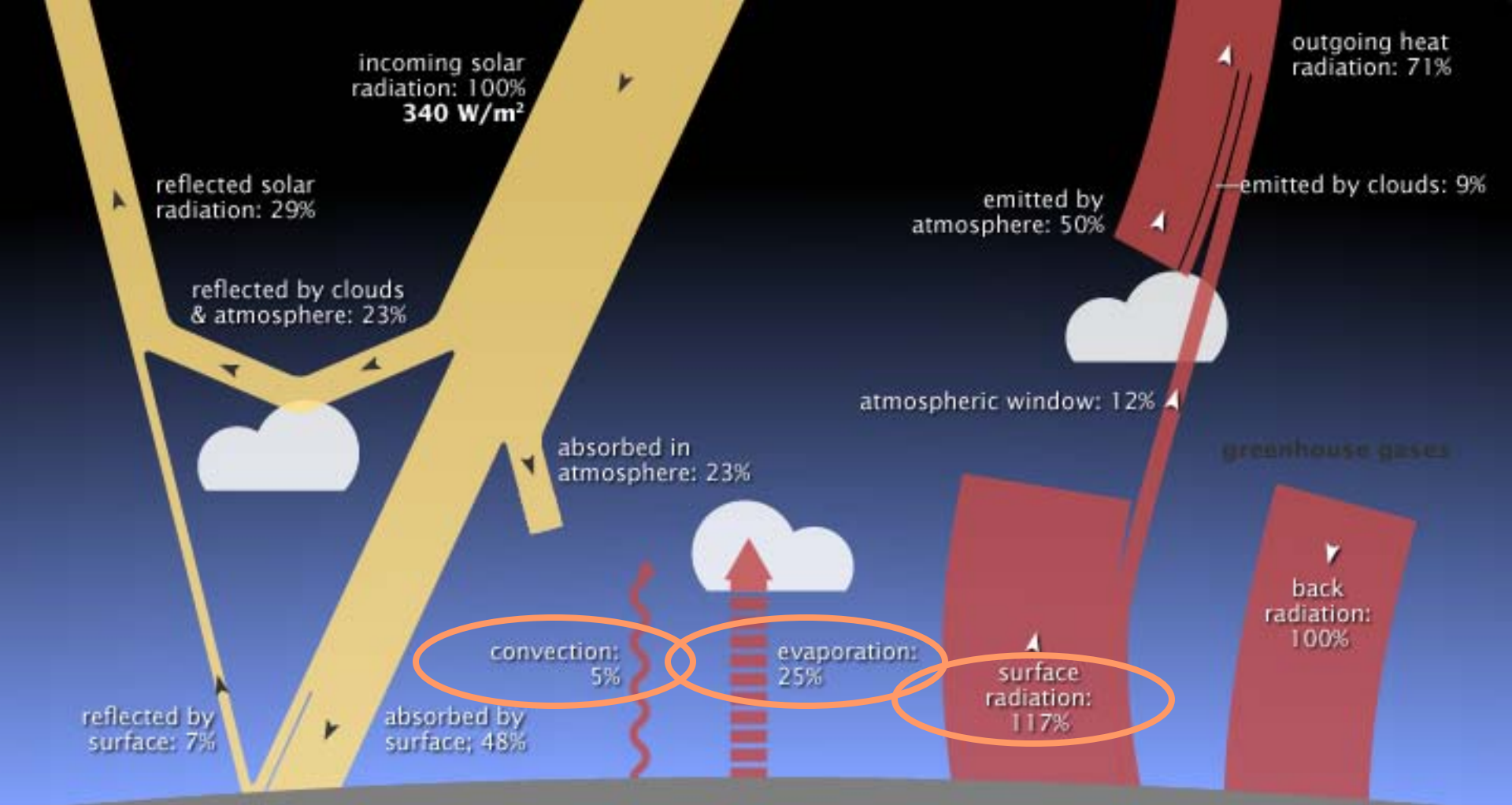


Incoming solar radiation is reflected

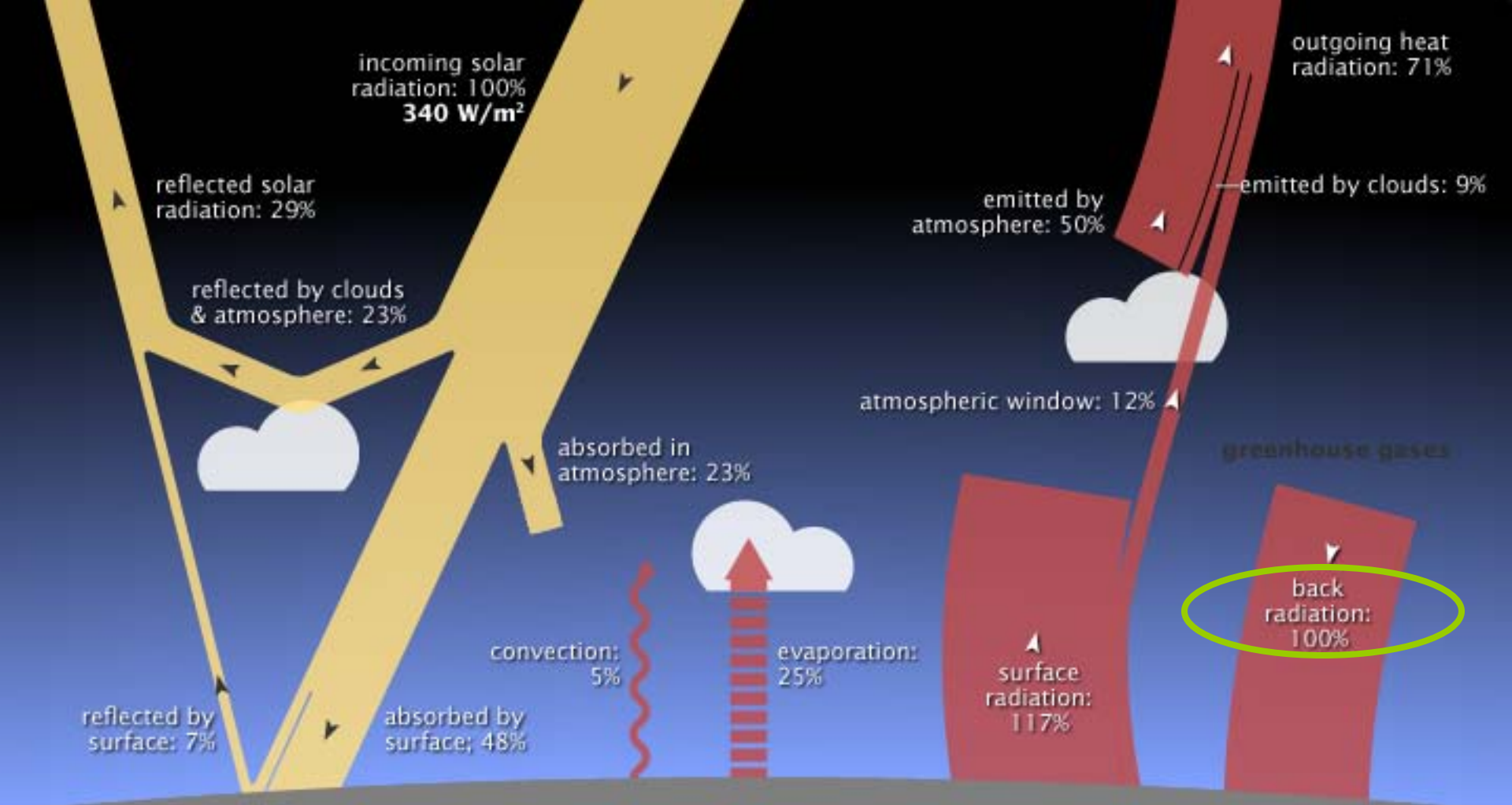


Incoming solar radiation is reflected

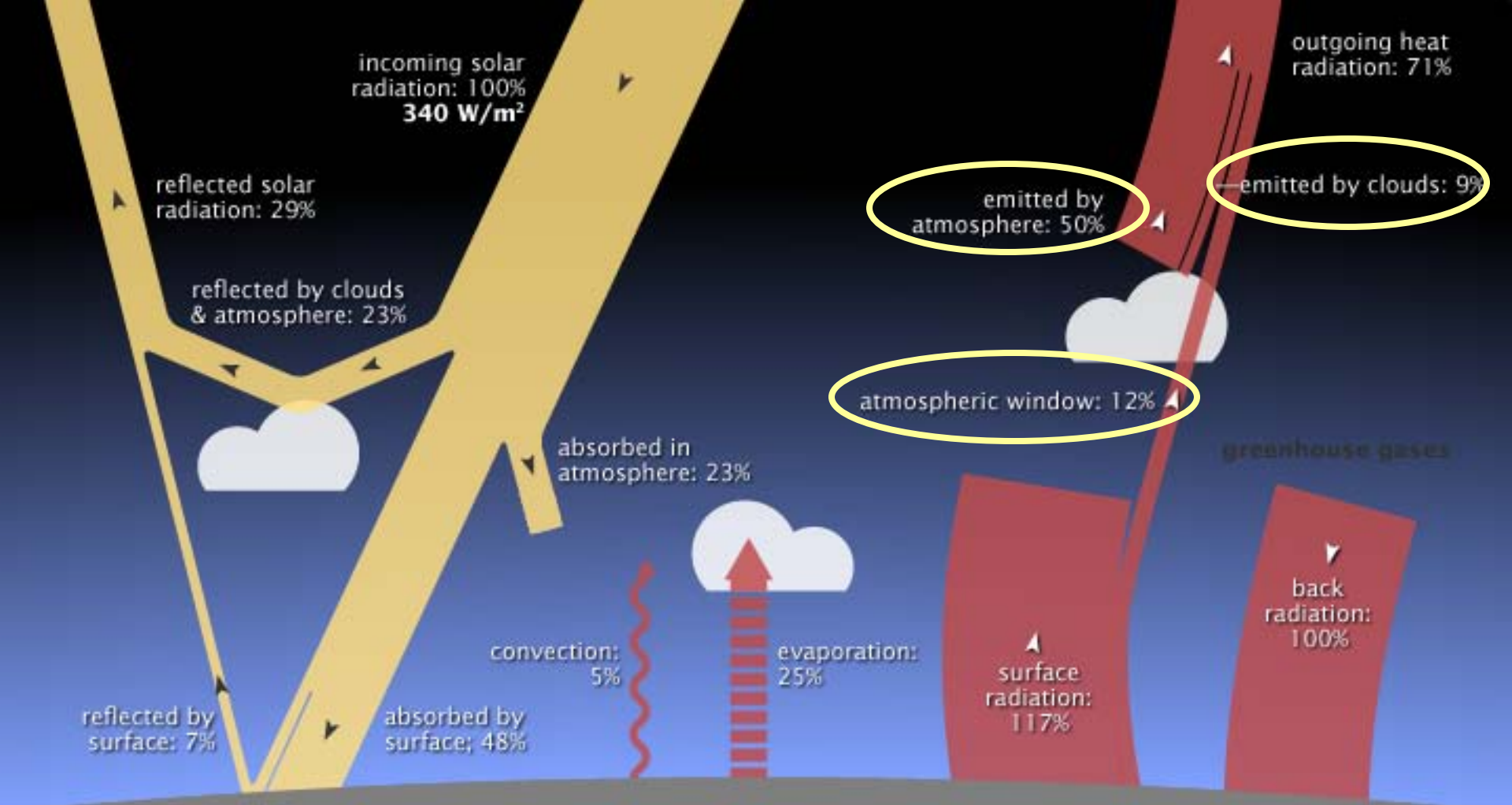
Or absorbed



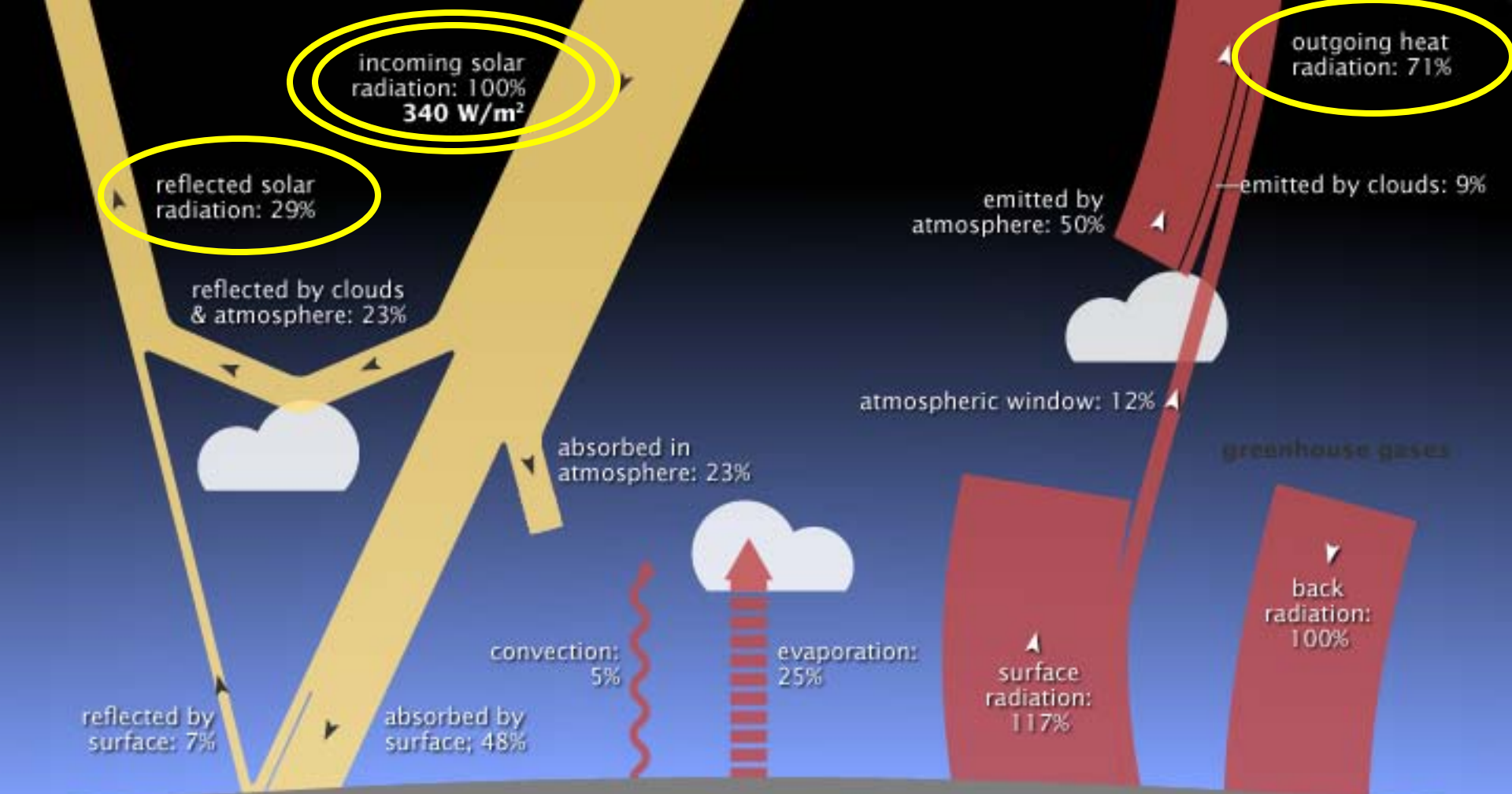
Solar radiation absorbed by earth is convected, evaporated and re-radiated back to atmosphere



The Greenhouse Effect causes some of earth's re-radiated energy to remain close to the surface.



Energy in atmosphere (from incoming solar radiation and earth's re-radiation) is emitted back out to space.



**Reflected solar radiation + outgoing heat radiation
= incoming solar radiation
A balance is maintained!**

Natural Climate Forcings

Changes to the Balance



- **Changes in the Sun's brightness**
- **Variations in Earth's orbit and tilt**
 - **Milankovitch cycles and ice ages**
- **Large volcanic eruptions**
 - **Add particles to atmosphere**

Manmade Climate Forcings

Changes to the Balance



- **Particle pollution**
 - Changes how radiation reflected/absorbed
- **Changing surface of earth (deforestation)**
 - Changes how radiation reflected/absorbed
- **Adding greenhouse gases**
 - Changes how heat is re-radiated to space