

Global Warming 2002

The Greenhouse Effect

Why is the Earth Warm?

April 15, 2002

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Last Week

- Asked to look at incoming radiation
 - (Shortwave)
- Consider seasonal effects + albedo
- Draw conclusion about where clouds form
- Clouds - one part of the hydrological cycle
 - The Cycle
 - Major mover of energy
 - Major supplier of water

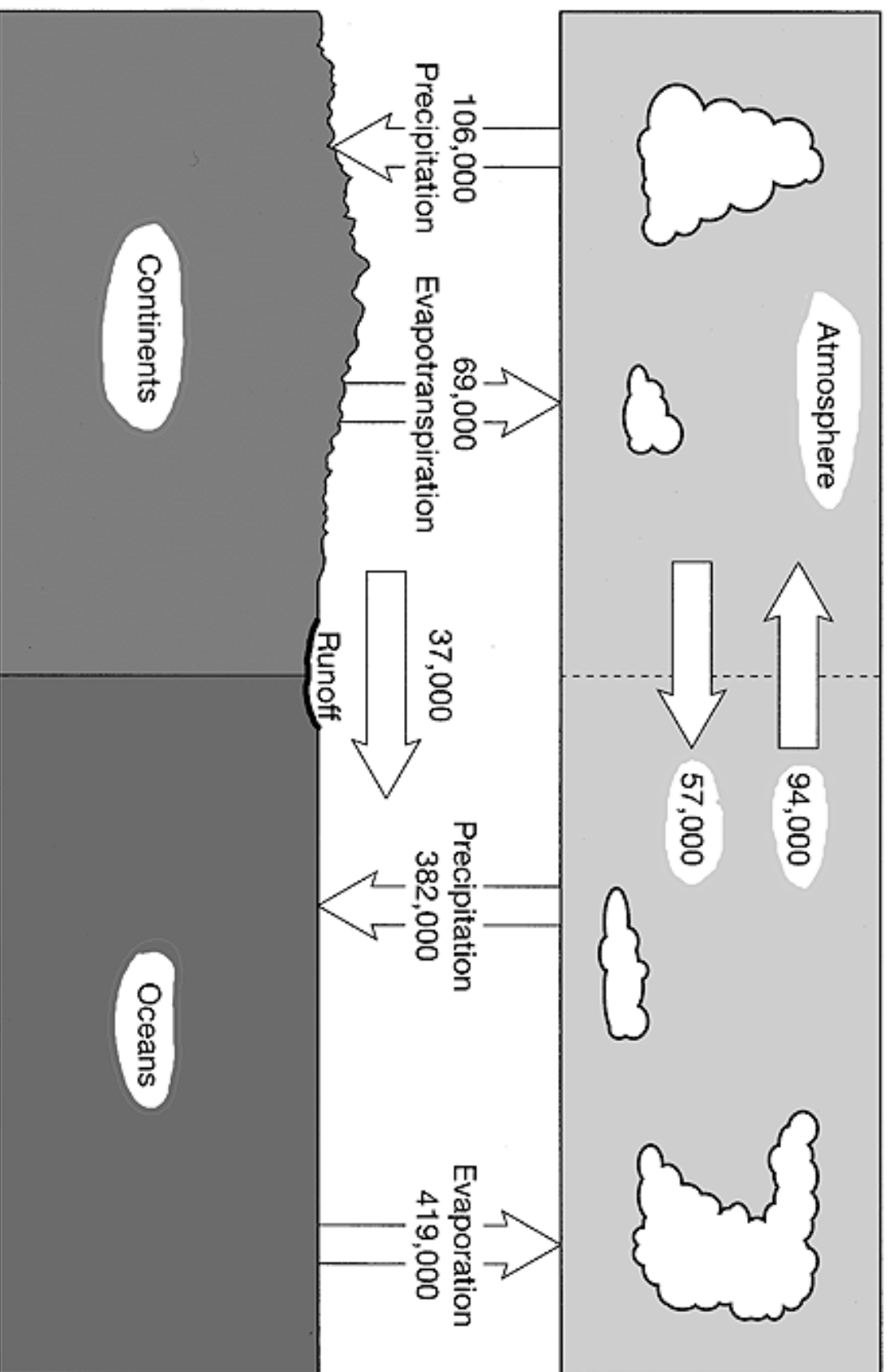


Figure 2.3 The global hydrological cycle, showing fluxes in Gt (billions of tonnes) of H₂O. Flux estimates were derived from Christopherson (1992, his Figure 7-10).

New Stuff

- Objective: explain how the Greenhouse effect works
- Take - Two properties of radiation:
 - Radiation = $f(\text{temperature})$
 - Wavelength = $f(\text{temperature})$
- Add - Effects of atmosphere chemistry window
- To get - Greenhouse Effect
- Remember - all systems must be in balance
 - Energy in must always = Energy out

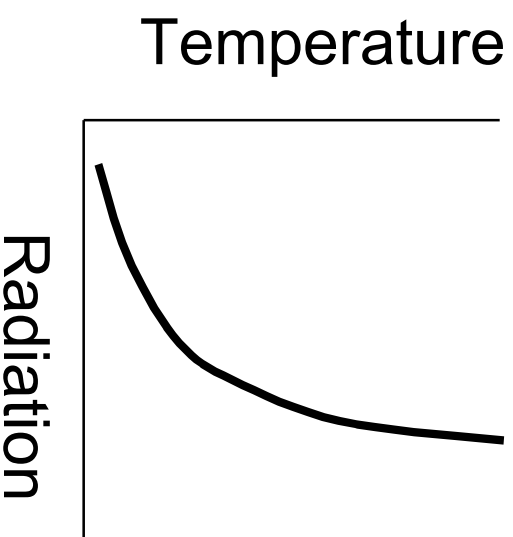
Radiation - 1st Property

- Black Bodies
- Hotter = more radiation

$$R = kT^4$$

$$2 \times \text{Temp} =$$

?? Radiation



Wavelength - 2ed Property

□ Wavelength function of temperature

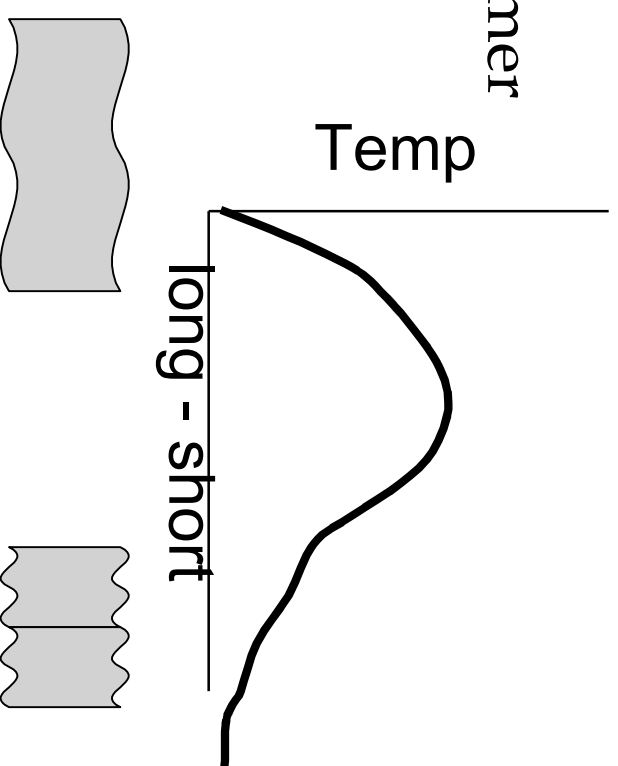
Higher temperature -->

Shorter wavelength radiation

Energy over band

Radiation from a warmer

Black body ?

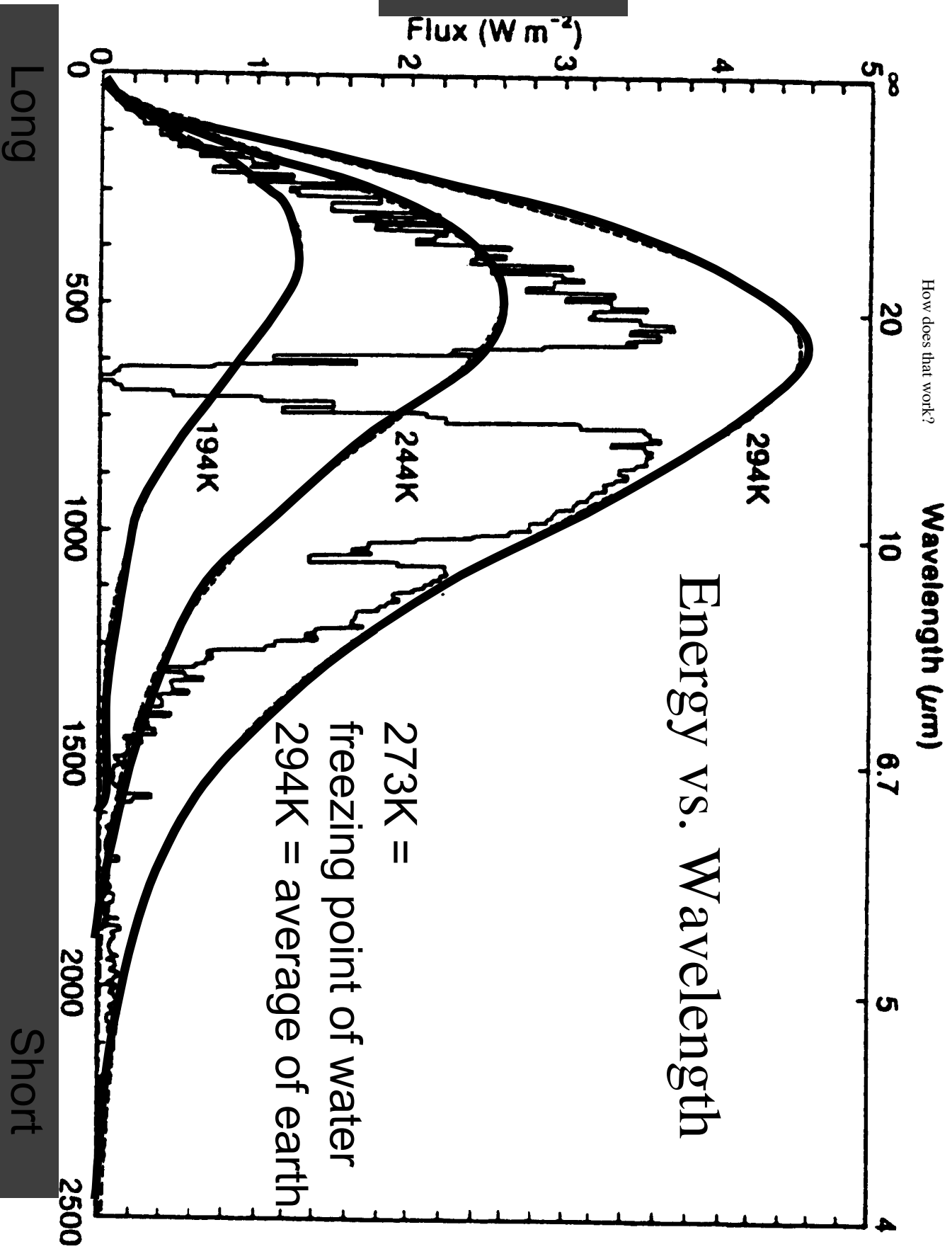


Solar Window

- Energy blocked at some wavelengths
- Radiation hits things and is absorbed
- Individual gases are the blocks
 - H₂O - about 75% of the effect
 - CO₂ - about 23% of the effect
 - Others
- This blockage takes place in the atmosphere

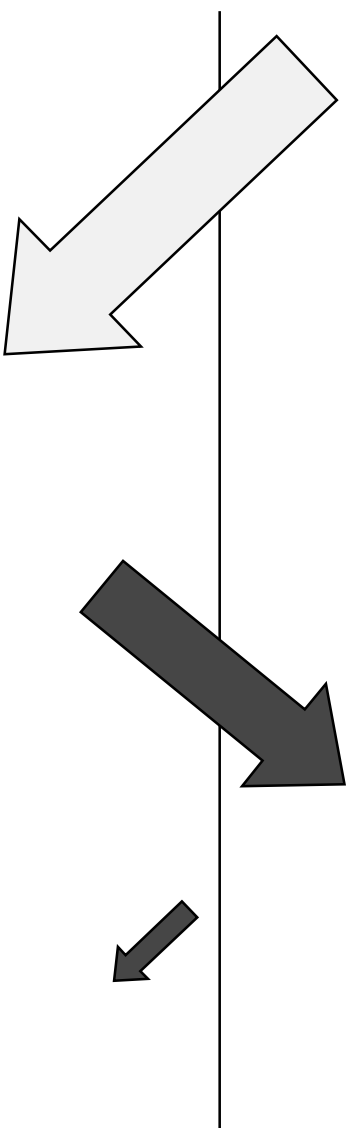
Energy

How does that work?



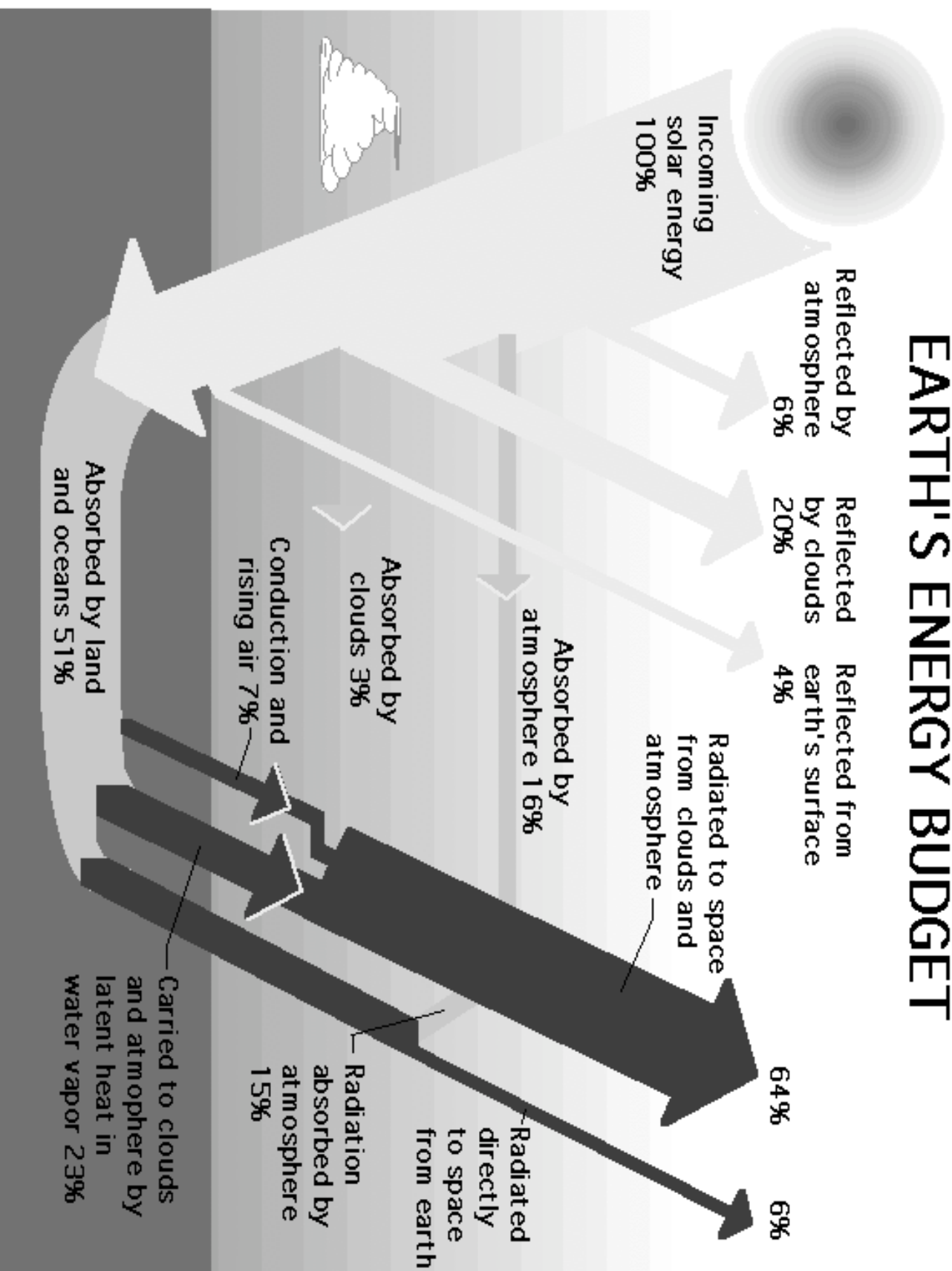
Natural Greenhouse Effect

- One way mirror



Only ~15% trapped,
but -Earth 30°C warmer than without it!
Do the math

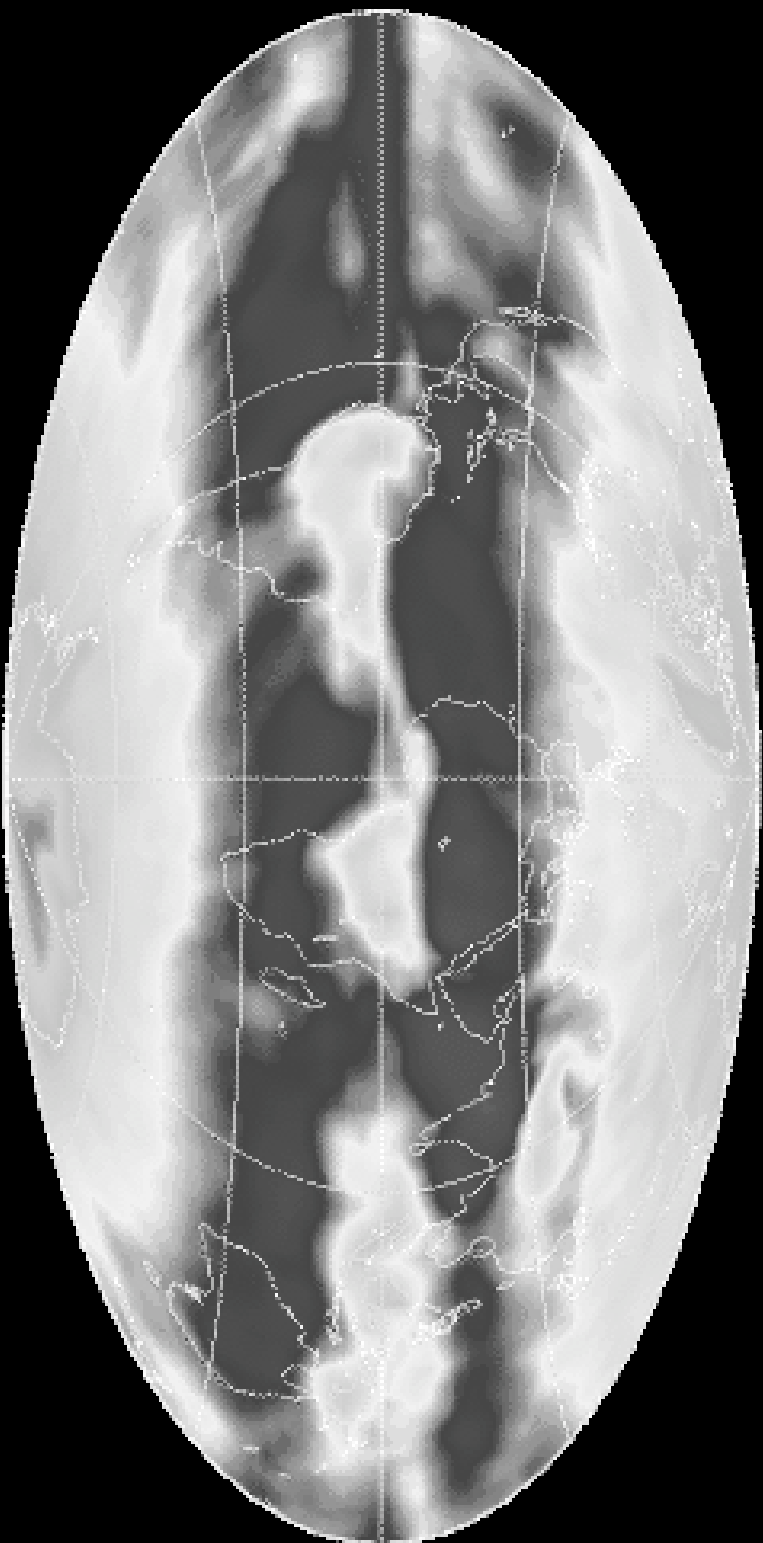
EARTH'S ENERGY BUDGET



April 15, 2002

<http://asd-www.larc.nasa.gov/erbe/components2.gif>

LONGWAVE RADIATION
ERBS + NOAA 8 APRIL 1995
PRQC: 6-30-88 hemo



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<http://asd-www.larc.nasa.gov/erbe/ASDerbe.html>

Enhanced Greenhouse Effect

- Increased warming from human activities
 - Specifically introduction of CO₂
 - H₂O is a far more important greenhouse gas
- If greenhouse effect traps all of this energy why does the Earth not keep warming up?

Summary

- Greenhouse Effect
 - Radiation
 - Windows
- Total Energy Balance
 - 15% extra keeps us warm
 - But in balance