Jan 21 Outline

Announcements –
  homework can be turned in as late as 4 pm to Amy (329 ATG)
Discuss Seattle Times article (Saturday, 19 Jan):
  2002 was the second hottest year on record (58.03˚F)
  evidence for global warming?
Spaceborne View of Earth
  Energy balance re-run
  Basic physics tool: Law of Conservation of Energy
  Energy Flux IN = 240 W/m² (key quantity; not in book)
  Effective Radiating Temp, Tₑ = 255.1K
  * Activity: turn up sun by 2% >> calculate new Tₑ
  What can a satellite measure from above the Earth?
  SW budget (solar constant and albedo)
  LW budget (planetary emission)
  but does not see the surface emissions

Jan 21 Outline – (cont)

Heat-trapping constituents in the atmosphere
  - gases (in order) H20, CO2, CH4, N2O
  - clouds (which are liquid H2O)
  Note that water (H2O) is dominant. However, water in the atmosphere must be put in a very different category from the other GHGs. Water is…
    - a feedback (not a forcing)
    - a dependent variable: [H2O] = f(T)

Jan 22 Outline

HW2 – went over a couple problems
Effective radiating level (ERL)
  - derived ERL = 5.5 km for Tₑ = 255K
  - discussed troposphere/stratosphere, decrease of temperature with height in the troposphere, and “lapse rate”
  Two-layer energy balance model from text
  - good conceptual illustration, but not very accurate!
One-dimensional fixed-lapse-rate model:
  - two ways to increase surface temperature, Tₛ, are turning up the sun and adding more GHGs to atmosphere
  - turning up the sun does not change the ERL (the ERL is a height which indicates the heat-trapping ability of the atmosphere) but does increase the temperature at the ERL
  - increasing GHGs increases the heat-trapping ability of the atmosphere and so raises the ERL.

Jan 22 Outline – (cont)

Heat-trapping constituents in the atmosphere (cont)
  - gases (in order) H20, CO2, CH4, N2O
  - clouds (which are liquid H2O)
  Note that water (H2O) is dominant. However, water in the atmosphere must be put in a very different category from the other GHGs. Water is…
    - a feedback (not a forcing)
    - a dependent variable: [H2O] = f(T)

Jan 23 Outline

Greenhouse effect and the role of water (recap)
  - water (vapor and liquid) dominants the natural greenhouse effect
  - water may dominate the global warming problem (that is, the anthropogenic enhancement of the greenhouse effect)
  - but water is part of climate feedbacks (not forcings)
Energy Budget of the planet [Fig 3-19 in text]
  Dual role of clouds
    - big-time reflectors (decrease the shortwave energy absorbed by the earth system)
    - big-time heat-trappers (increase the greenhouse effect, thereby warming the planet)
    - high vs low clouds (foggy days vs cloudy nights in Seattle)
Energy Balance as viewed from space
  - what can we measure?
  - results from ERBE and CERES satellites

http://asd-www.larc.nasa.gov/erbe/components2.gif
Jan 24 Outline

One-dimensional, fixed-lapse-rate model used to calculate the 'no-feedbacks' effect of doubling CO2

Earth's main feedbacks
- water vapor
- snow-ice-albedo
- clouds

Introduction to climate modeling

Review of Chap 3 and some key facts to know cold

1-D model of global climate

- just 3 types of matter: atmosphere with (1) gases (actually, GHGs) and (2) clouds plus, (3) Earth surface
- static (no time dimension)
- radiation processes only
- radiation is either SW or LW

3 types of matter  
× 2 types of radiation  
× 4 types of interaction  
24 processes! (potentially)

1-D model of global climate

\( \sqrt{\text{processes our model includes}} \)

\[
\begin{array}{cccc}
\text{Shortwave} & \text{transmit} & \text{absorb} & \text{reflect} & \text{emit} \\
gases & \checkmark & \bigcirc & \bigcirc & -- \\
clouds & \checkmark & \bigcirc & \checkmark & -- \\
surface & -- & \checkmark & \checkmark & -- \\
\hline
\text{Longwave} & \text{transmit} & \text{absorb} & \text{reflect} & \text{emit} \\
gases & \checkmark & \checkmark & -- & \checkmark \\
clouds & -- & \checkmark & -- & \checkmark \\
surface & -- & \checkmark & -- & \checkmark \\
\end{array}
\]

Complex models* include:
- the three processes circled
- gases into species (5-10)
- particles as well as clouds
- SW and LW into wavebands (30+)
- atmosphere in layers (3-30)

* still just radiation!