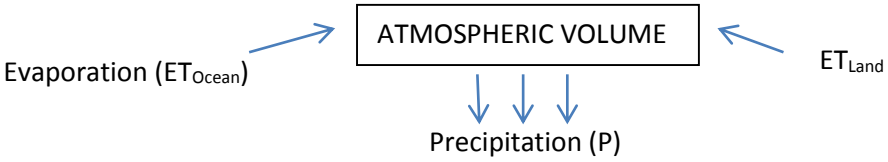
CVEN3501 Notes: Water Resource management

Week 1: Water and Energy Cycles

Hydrological cycle →model that describes storage and movement of water in earth system essentially between reservoirs
Water balance $W_{in}\,\Delta t = \Delta Storage = W_{out}\,\Delta t$



$$\frac{\Delta V}{\Delta t} = ET_{ocean} + ET_{Land} - P$$

Example 1

Residence time (replacement time)

- Amount of water 'stays' in storage component can be calculated by dividing the total vol (m^3) by the flux rate ($m^3.s^{-1}$).
- In rivers renewed 16 days, atmosphere 8 days. Slower rates in large lakes, ocean bodies etc.

Australian hydrology

- Rainfall the lowest
- Low P combined with high E leads to low flows and seasonal river system. Low-seasonal flows = problems of salinity, algal blooms and water shortages
- El Nino -southern oscillation (ENSO) high year to year rainfall variability. Every 2-7years either normal, wet or dry

Energy Cycles
Earths radiation balance
Vertical energy balance
Sun-radiation →emission of energy in form of electromagnetic waves

How much energy does the sun emit?

- Stefan-Boltzmann $E = \sigma T^4$
  σ = Stefan-Boltzmann constant = $5.67 \times 10^{-8}\ Wm^{-2}K^{-4}$
- Wein's Law $\lambda m T = 2877 \mu m K$
  Radiation peaks → Temp

Example 2

Global radiation balance

$$S = \left(\frac{R_s}{D}\right)^2$$

S_o = Energy leaving the sun = $65 \times 10^6\ wm^{-2}$

R_S = radius of sun = 700 x10^6 m
D = distance to earth = 150 x 10^9 m
Example 3.

Example 4. Why does the average solar radiation at the earth's surface equal S/4?

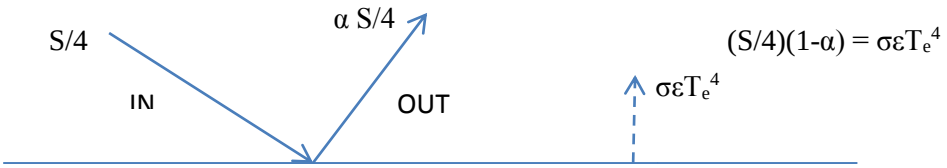
Percentage of incoming solar radiation (insolation) reflected (sunlight not absorbed by earth i.e. not heating) is called the albedo (α).

$$\alpha = \frac{Reflected\ solar\ rad}{Incoming\ solar\ rad}$$

Average earth albedo = 30%

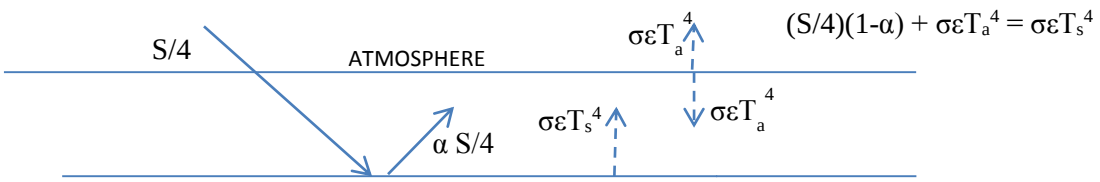
- Incoming solar radiation (shortwave)
- Outgoing is the reflected solar radiation + longwave radiation emitted by the surfaced
- Shortwaves radiation → sun
- Long wave radiation → earth

Energy absorbed by Earth = Energy emitted by earth
In = Out



Earth surface > average albedo of 30%

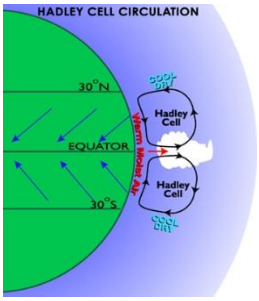
Now with atmosphere

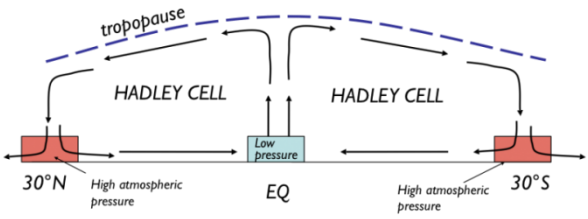


Earth surface > average albedo of 30%
This is the radiation balance of the earth's surface

Latitudinal energy balance
Seasonal and diurnal cycles

- changing position of the earth's axis cause the location of the sun to wander 47^0 across our sky
- these changes have a direct effect on the intensity of solar radiation incident upon the surface
- Hadley cell (circulation) – system that transports heat from the equator to the poles





- Sunlight warms the surface: convection moves heat/vapor from tropics (warm air rises, cold air sinks!)
- Circulation breaks up into 3 cells in each hemisphere.
- When the vapor condenses as rain (ITCZ), it releases latent heat, warming the air, and driving circulation

- Model is compromised by factors:
  1. Earth rotation from west-east leads to conolis force
  2. Changing seasons: poles are titled at 23.5^0
  3. Tropical uprising of heated air doesn't remain at equator but swings between the tropics

Week 2: Climate change, meteorological variables
Climate = general weather conditions over a long period of time
Weather = current atmospheric conditions at a given place and time
Natural climate variability. Changes are a result of:

- External influences: diurnal, seasonal, millennial cycles of insolation, sun spots
- Multiyear internal oscillations in the atmosphere – ocean system (e.g. El-Niño South Oscillation)
- Naturally occurring random fluctuations (e.g. volcanic eruptions)
- Anthropogenic changes

External influences

- Milankovitch cycles → cycles that change the amount of solar radiation received by earth, three parts to the cycle:
  a. Eccentricity → shape of orbit
  b. Obliquity → tilt of axis
  c. Precession of the equinoxes → which hemisphere is titled towards the sun

- Sun spots = uneven patterns of heat on the earth's surface
  →marked by lower temps on the sun
  Past studies = solar variability influenced past climate change

Multi-year internal oscillations in the atmosphere

- Ocean systems e.g. El-Nino south oscillation, Indian ocean dipole (IOD), interdecadal pacific oscillation (IPO)
- Internal climate variability: ocean circulation (THC density driven circulation of the oceans)

Naturally occurring variability → volcanoes

Summary of the types of natural variability