



Global Climate Change

BBC NEWS Science & Environment
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2017 'warmest year without El Niño'

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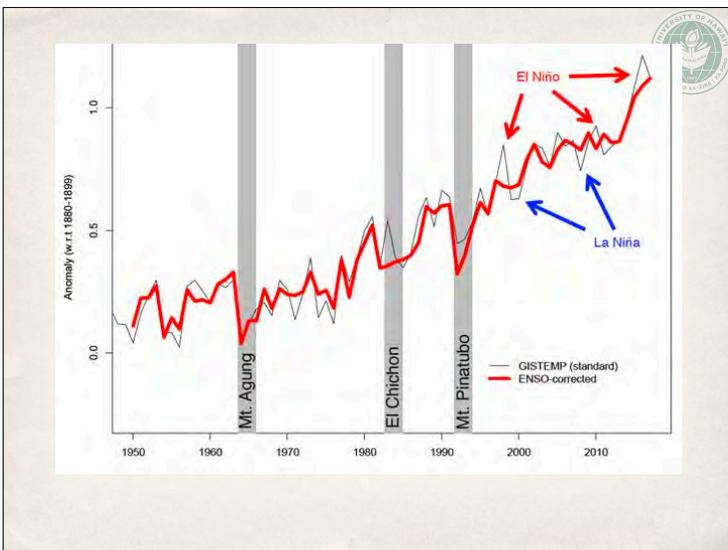
18 January 2018

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Manmade climate change is now dwarfing the influence of natural trends on the climate, scientists say.







Definition of Climate

According to Webster dictionary

“Climate: the average condition of the weather at a place over a period of years exhibited by temperature, wind velocity, and precipitation.”

IPCC report says the ‘classic’ period to average over for climate is 30 years.



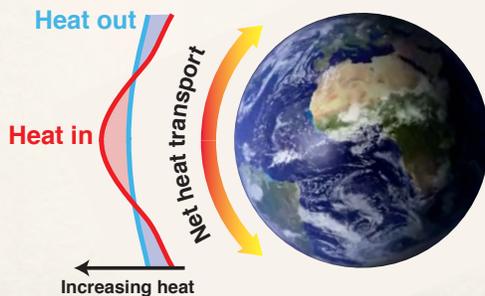
Weather vs Climate

- ❖ Weather has a chaotic nature, it is very dependent on the initial conditions.
- ❖ ‘Projecting changes in climate (i.e., long-term average weather) due to changes in atmospheric composition or other factors is a different and much more manageable issue.’ [IPCC AR4]



Climate is driven by solar radiation balance

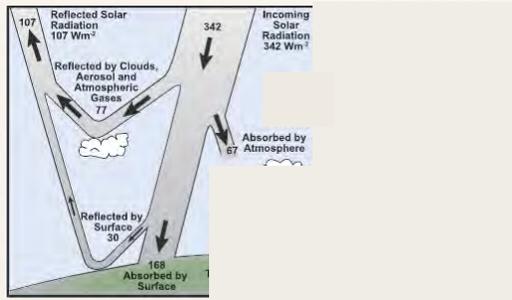
Heat in = Heat out, for earth as a whole



Global radiation budget

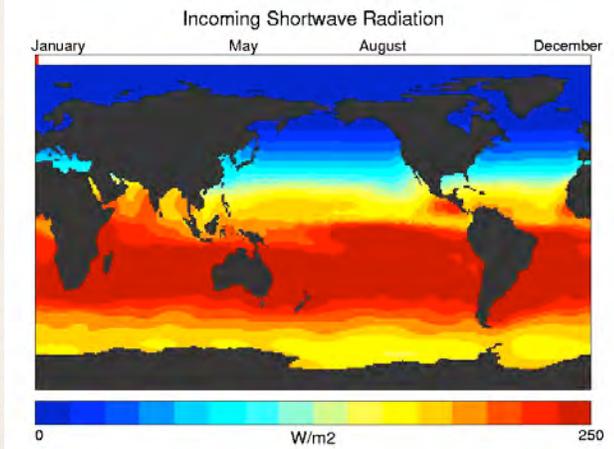


Shortwave

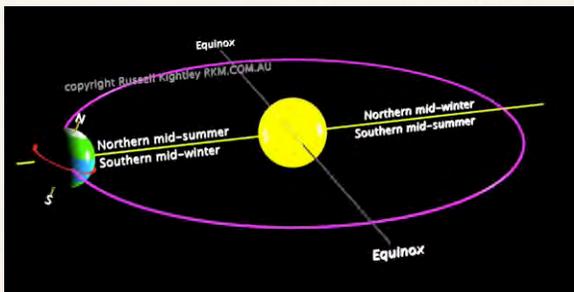


IPCC, AR4

Seasons



Seasons



Seasons are caused by the tilt of the Earth's axis



Incoming solar radiation



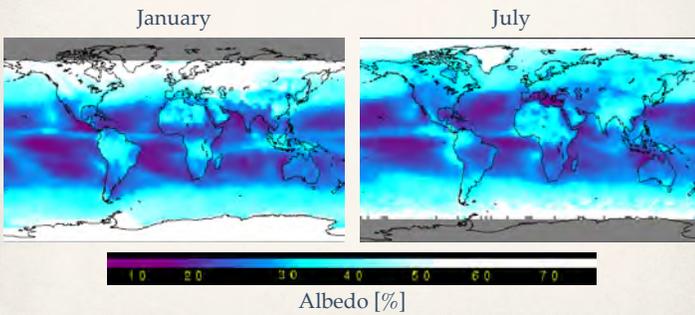
Average energy flux density perpendicular to sun's rays = 1366 W/m²

Average power per unit area of Earth's surface = 342 W/m²



Albedo

Fraction of incoming solar radiation reflected





Albedo

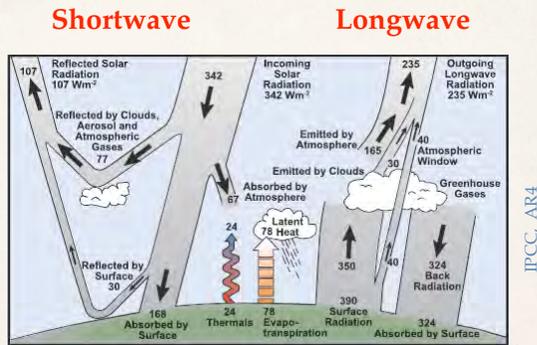
Fraction of incoming solar radiation reflected

TABLE 2.2. Albedos for different surfaces. Note that the albedo of clouds is highly variable and depends on the type and form. See also the horizontal map of albedo shown in Fig. 2.5.

Type of surface	Albedo (%)
Ocean	2–10
Forest	6–18
Cities	14–18
Grass	7–25
Soil	10–20
Grassland	16–20
Desert (sand)	35–45
Ice	20–70
Cloud (thin, thick stratus)	30, 60–70
Snow (old)	40–60
Snow (fresh)	75–95

Average albedo about 31%, so 235 Wm⁻² absorbed.

Global radiation budget



Solid Earth without atmosphere or ocean



Consider a solid planet receiving 235 Wm^{-2}
(i.e., with average albedo)

If it is in steady state, it radiates as
much energy as it receives.

Temperature at equator = -20°C

This is the temperature at an altitude of 5km.

A simple atmosphere



Think of the atmosphere as a sheet of glass that lets
all of the Sun's short wave energy go through.

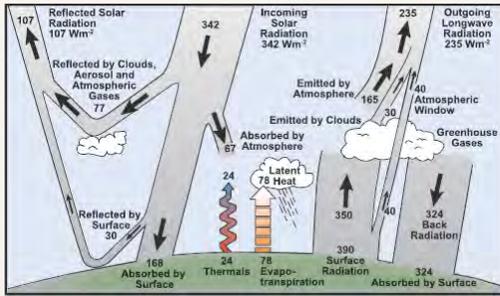
A fraction of our glass atmosphere perfectly
absorbs and radiates long wave radiation

Global radiation budget



Shortwave

Longwave



CO₂ is increasing



CO₂ levels are higher now than any time in last 440,000 years.



Don't confuse weather ... with climate





Some key ideas

- * Climate is 'average' weather.
- * Climate is easier to predict than weather.
- * Climate is driven by heat balance.
- * Albedo = fraction of incoming solar radiation reflected.
- * Some greenhouse effect is needed. Without an atmosphere average temperature would be about -20°C .
- * CO_2 , Methane, water vapor are all greenhouse gases. N_2 and O_2 are not.
- * CO_2 is increasing.
