

Air, Weather and Climate

Weather is the day to day fluctuations in the atmosphere while Climate describes temperature and humidity changes over long periods of time. Climates are not static- they cycle through yearly, centurial (is that a word?) and millennial patterns.

Initially the climate on Earth was a deadly mixture of Hydrogen, Helium and Methane from the outgassing of molten rock. 3 billion years ago oxygen was added to our atmosphere with the evolution of photosynthetic organisms.

Air pressure at sea level 14.5 lbs per square inch known as one Atm. Air pressure decreases with altitude. The surface of the Earth also experiences low pressure when warm air masses rises due to low density.

Air composition of the Troposphere today:

Nitrogen- 78%

Oxygen- 21%

Traces of Water Vapor, Argon and Carbon dioxide

The Atmosphere has four distinct layers.

Troposphere (roughly 10 km up)

The layer closest to earth. Holds 75% air mass.

Gets colder with altitude

Weather happens here, also only layer with water

Stratosphere

The top of the stratosphere contains ozone- O₃

Ozone absorbs high level UV radiation from the sun.

Temperature increases with altitude because of UV absorption

Ozone molecules are broken down by CFC (now outlawed ingredient in aerosol sprays, refrigerator coolants and electrical cleaning solvents)

Excessive UV light on the Earth causes skin cancer, cataracts and mutates and kills plankton (the ocean's bread basket).

(O₃ molecules on the Earth's surface from burning fossil fuels cause harmful lung irritation.)

Mesosphere

Temperature decreases with height

Thermosphere

Highly ionized gas interacts with magnetosphere to create Aurora borealis (Northern Lights)!

Global Energy Transfer- before man (and woman) global energy was in balance.

Most of the energy from the sun is in the high energy wavelengths- UV and visible light.

50% of this energy is absorbed at the surface.

Energy reflected from the surface is infrared (longer wavelengths)

Convection- the transfer of energy of a warm fluid (like gas or water) upwards into a cooler zone. The cycle of air upwards around and down is called Convection Currents.

Why it rains in a rain forest: The sun's energy is concentrated near the Equator. Rising hot air expands and cools (called Adiabatic cooling). Colder air can't hold as much moisture so after a certain altitude, the air dumps out its water vapor in the form of water droplets- the stuff of clouds. Rising air creates low pressure and lots of nasty weather, unless you are a tropical plant in which case you are very happy. As the water vapor condenses it gives up latent heat energy- this helps large cloud formations rise higher, cool more and build energy to form large storm systems like hurricanes.

Why it is dry in a desert: At 30 degrees North and South latitude the air is cooling, becoming more dense and sinking. Sinking air creates high pressure. High pressure days are cloudless great tanning weather kind of days, unless you are thirsty.

Global winds are caused by the constant balancing act going on in our atmosphere as moist, warm air travels upward from the Equator and then cools and sinks at the 30 degree latitude belt. The air rises again at the 60 latitude and sinks at the poles. When the air moves laterally across the Earth's surface from belt to belt (High to Low pressure) it creates winds- we live in the Westerly wind belt which is why all of our weather comes from West to East. Below us are the trade winds which blow towards the Equator.

All wind belts are curved to the rotation of the Earth known as the Coriolis Effect. In the Northern hemisphere the air curves to the right. In the south it curves to the left. These curving winds are also partially responsible for the direction of the major ocean currents of the world.

The Coriolis effect is also what spins tornadoes and cyclones. Cyclones are low pressure centers with winds that blow inwards in a counterclockwise direction. Weather conditions are very stormy.

Anticyclones are high pressure centers with cooler, sinking air that then spin clockwise outwards. Clear skies are created.

Jet Streams- 200 km/hr currents of air 10 km up. Responsible for guiding weather systems. Generated by temperature differences in upper atmosphere and the shear from Earth's rotation.

Types of Fronts

Cold Front

Cold air mass moves into warm. Sudden rise in air.

Creates large cumulonimbus rain clouds, lightening and hail

Powerful, but brief rainstorms

Warm Front

Warm air mass moves into cold

Creates cirrus clouds and later stratus clouds.

Sleet or long, light, cold rain created.

Occluded Front

Cold Fronts take over warm fronts by sandwiching and then pushing the warm air off the ground. The system begins to spin (cyclone) and rain like crazy.

Hurricanes (or Typhoon in the Pacific Ocean) are a hundred mile wide cyclones that last several weeks. Despite their relatively puny wind speeds (75- 200 mph) hurricanes are much more deadly than tornadoes. Between the heavy rain fall, mud slides and storm surges, people lose their lives by drowning.

Tornadoes- a mini cyclone that begin when the jet streams shear off the top of an especially large cumulonimbus cloud (cool, huh?). The cloud tightens as it sinks downward and spins faster due to angular momentum. The fastest tornado winds have been clocked at 318 mph. Most lives are lost in a tornado due to being struck by

something that has no business flying.

Monsoons- seasonal rains and droughts caused by the differential temperatures of land and oceans. In the summer, the land heats up faster than the sea, so a low pressure center develops on land. Moist air from the ocean rush in to "fill" in the pressure void and monsoon rains last for four months or more. Then, during the winter, the ocean, which has a higher heat capacity, is now warmer than the land and winds tend to move towards the sea. A long term drought ensues.

Milankovitch cycles-

Periodic shifts in earth's orbit (100,000 year cycle), tilt (40,000 year cycle) and axis wobble (a 26,000 year cycle). The timing of all three of these phenomenon are such that every 100,000 years or so the Earth finds itself very far from the sun- enough to trigger an ice age.

La Nina

The "normal" state of affairs with relatively cool ocean temperatures on the Equatorial Pacific Ocean. Trade winds blow warm water in the South Pacific towards the Western Pacific Ocean. This causes a low pressure system off of Australia and Indonesia which leads to lots of rain. Nutrient rich water upwells off the coast of South America feeding a burgeoning anchovie population.

Back in the states we experience warm winters in the SE and cold winters in NE and the Middle Atlantic. Southern California is sunny (the brats!) and Washington is rainy (poor Kurt).

El Nino- occur every 3-5 years. Used to last 2 weeks to a month, now lasts one month to over a year!!!

Unusually warm ocean temperatures on Equator (made worse by global warming) cause the Trade winds to weaken. Warm water is sloshed back to South America
No upwelling of nutrient rich water occurs off of Peru and the anchovie population falls.
Food chain disturbed

The jet stream splits over America causing lots of weird weather.

New Paltz gets mild winters while the South West US and Peru gets RAIN!!

Seattle goes dry as does the West Pacific causing large bush fires in Australia and Borneo-8 million acres burned just recently :(

Global Warming (now officially called Climate Change by our government)

The burning of fossil fuels creates greenhouse gases- especially carbon dioxide. Since 1800 we've gone from 280 ppm to 370 ppm of CO₂. Other gases implicated in global warming are water vapor, methane- cow farts-mooo! and microbial fermentation of organic matter in oil wells and coal mines (CH₄), N₂O (laughing gas), CFC's and sulfur hexafluoride. The massive deforestation around the planet also adds to the greenhouse effect because our natural carbon dioxide sinks are compromised... ok, dead. Seasonal fluxations of CO₂ are natural due to the increased photosynthesis in the summer which aborbs CO₂ and the dormant plant life in the winter.

These greenhouse gases trap infrared heat energy trying to exit the planet and the Earth is heated up- already we've noticed a 1.4 degree F (.8 degrees C) change. That doesn't sound like much but it only took 5 degrees F to trigger an ice age!

Effects of Global Warming include:

Glaciers melting and huge icebergs calving off ice sheets. The Arctic sea is now 30-40% thinner. Many alpine glaciers are shrinking quickly or melting altogether. Decreased snow pack on land also results in more sunlight energy being absorbed by the Earth's surface. Snow caused light to be reflected from the Earth's surface (albedo).

The increased temperatures are also causing the oceans to rise due to thermal

expansion (hot water expands). Creates sea level rise (6 inches projected in next 100 years). If all of the glaciers/ice sheets melted the sea would rise 300 feet. Sea level would also rise due to thermal expansion.

Drought/ fires due to changes in weather patterns. Already the seas have risen 15 cm in the last 100 years.

Crop failure- US bread basket is now moving to Canada- only problem is that the soil is thin and not particularly fertile.

More tropical disease will spread due to more tropical areas- malaria is coming- agghhh!

Extreme weather- contrary to popular misconception- winters get more ferocious and of course summers get hotter.

Coral reefs are being "bleached" by the hotter temperatures. That means that the algae that lives commensally on the coral is dying. It is projected that the reefs have 50 years left... poor Nemo!

Extinctions- animals and plants can't migrate fast enough to out pace environmental changes especially if you are trapped on a mountain or if you've reached the limit of your park land.

Kyoto Protocol

In 1997, 162 countries gathered together in Japan to figure out how to slow global warming. EVERY COUNTRY agreed to limit their carbon dioxide production and signed a treaty to that effect, except for the US and Australia. It really shocked and disturbed the world, especially when George Bush senior said, "We are going to put the interests of our own country first and foremost" and "The American lifestyle is not up for negotiation." We tried really hard to create a "CO2 credit" in exchange for the fair amount of land we have still forested, but the countries won't go for it. The US produces 24% of the world CO2, and yet have less than 5% of the world's population. Presently the government has responded to environmentalists' pressure by pledging lots of money to investigate the NATURAL causes of global warming (okay volcanoes do make CO2...). Many people argue that historically we've seen massive fluctuations in temperature on the Earth, but the point is that the present RATE of temperature change is unprecedented, and inconveniently coincides with human-caused increases in CO2 levels... The plot thickens.