Population Geography Course, by W. W. Munroe (2010)

Chapter 3 - Earth Description

Main points: Earth formation, oceans, life, anerobic bacteria, chlorophil, oxygen waste, aerobic bacteria, plate tetonics, pangaea, and ice ages.

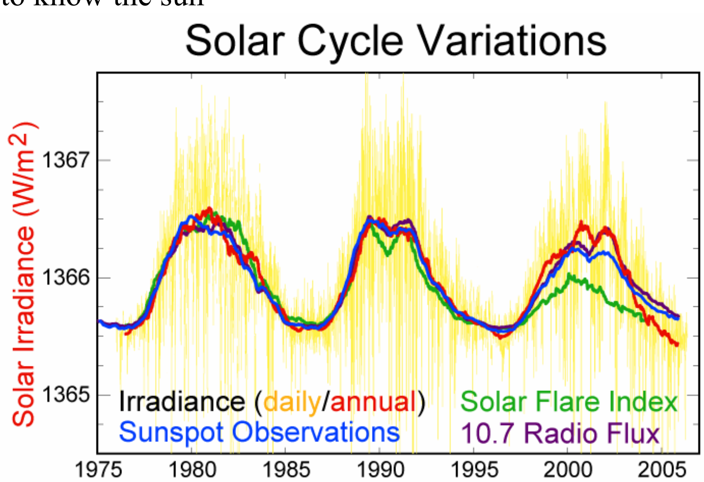
Earth Description

What is it?
When did it start and when will it end?
Where is it?
How is it different from Venus and Mars?
Why is it?
Physical characteristics
Lithosphere, Biosphere, Aquasphere, Atmosphere

Mapping - Cartography,

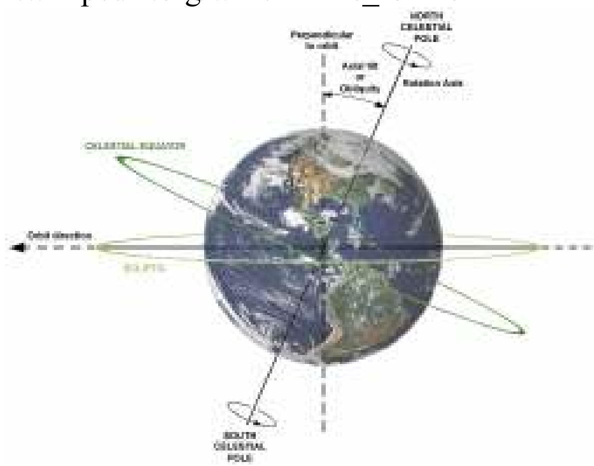
Snapshot
Moment in time
Average over time period
North arrow? Time! Must be very aware of time
The study and practice of map making, and vicariously geography, have historically been the disciplines devoted to depicting the Earth. Surveying, the determination of locations and distances, and to a lesser extent navigation, the determination of position and direction, have developed alongside cartography and geography, providing and suitably quantifying the requisite information. (wikipedia)

To know the Earth is to know the sun



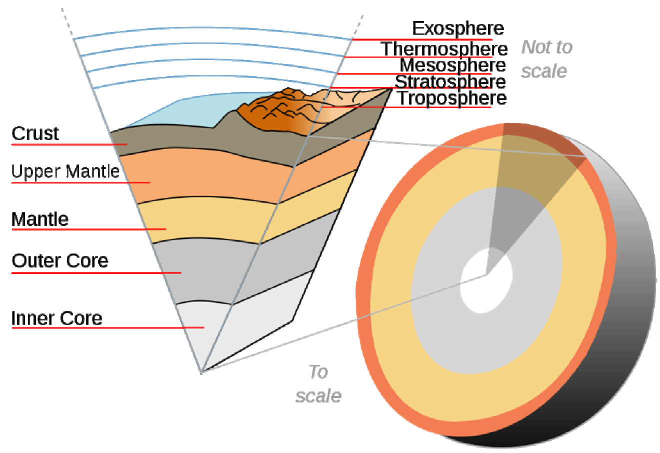
Solar system,
Milky Way,
Distance from suns for planets to support life,
Life cycle of the sun,
Solar wind,
Orbit

Orbit...speed,
http://en.wikipedia.org/wiki/File:AxialTiltObliquity.png
Rotation .gif
http://en.wikipedia.org/wiki/Earth's_rotation



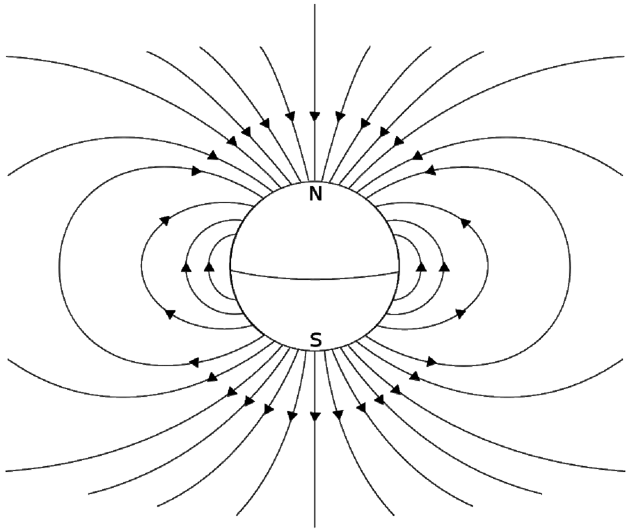
Earths magnetic pole movement

Why is there life on Earth and not on closest planets?
What is the difference between Mars, Venus, and Earth
Earth’s core is the difference



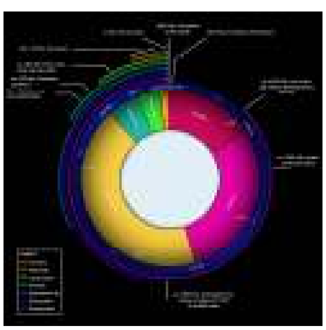
Rotation,

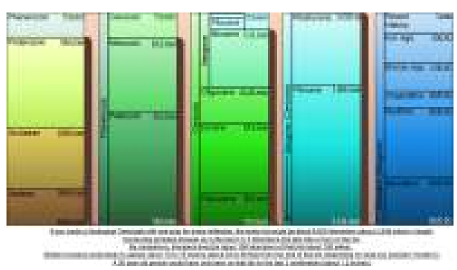
Magnetic field....Mars core not rotating,



Home to millions of species,[11] including humans, Earth is the only place in the Universe where life is known to exist. The planet formed 4.54 billion years ago,[12] and life appeared on its surface within a billion years. Since then, Earth's biosphere has significantly altered the atmosphere and other abiotic conditions on the planet, enabling the proliferation of aerobic organisms as well as the formation of the ozone layer which, together with Earth's magnetic field, blocks harmful radiation, permitting life on land.[13] The physical properties of the Earth, as well as its geological history and orbit, have allowed life to persist during this period. The world is expected to continue supporting life for another 1.5 billion years, after which the rising luminosity of the Sun will eliminate the biosphere.[14]
http://en.wikipedia.org/wiki/Earth
Earths magnetic pole movement

Geological time





http://en.wikipedia.org/wiki/Geological_era#Terminology

Tectonic plates

The mechanically rigid outer layer of the Earth, the lithosphere, is broken into pieces called tectonic plates. These plates are rigid segments that move in relation to one another at one of three types of plate boundaries: Convergent boundaries, at which two plates come together, Divergent boundaries, at which two plates are pulled apart, and Transform boundaries, in which two plates slide past one another laterally. Earthquakes, volcanic activity, mountain-building, and oceanic trench formation can occur along these plate boundaries.[71] The tectonic plates ride on top of the asthenosphere, the solid but less-viscous part of the upper mantle that can flow and move along with the plates,[72] and their motion is strongly coupled with patterns convection inside the Earth's mantle.

As the tectonic plates migrate across the planet, the ocean floor is subducted under the leading edges of the plates at convergent boundaries. At the same time, the upwelling of mantle material at divergent boundaries creates mid-ocean ridges. The combination of these processes continually recycles the oceanic crust back into the mantle. Because of this recycling, most of the ocean floor is less than 100 million years in age. The oldest oceanic crust is located in the Western Pacific, and has an estimated age of about 200 million years.[73][74] By comparison, the oldest dated continental crust is 4030 million years old.[75] http://en.wikipedia.org

Mantle convection

Mantle convection is the slow creeping motion of Earth's rocky mantle caused by convection currents carrying heat from the interior of the earth to the surface.[3] The Earth's surface lithosphere, which rides atop the asthenosphere (the two components of the upper mantle), is divided into a number of plates that are continuously being created and consumed at their opposite plate boundaries. Accretion occurs as mantle is added to the growing edges of a plate, usually associated with seafloor spreading. This hot added material cools down by conduction and convection of heat. At the consumption edges of the plate, the material has thermally contracted to become dense, and it sinks under its own weight in the process of subduction at an ocean trench.[4] http://en.wikipedia.org

Pangaea

Pangæa, or Pangea (pronounced /pæn□dʒ i□ə/, pan-JEE-ə[1], from Ancient Greek π□ν pan "entire", and Γα□α Gaia "Earth", Latinized as Gæa) was the supercontinent that existed during the Paleozoic and Mesozoic eras about 200 million years ago, before the component continents were separated into their current configuration.[2]

http://en.wikipedia.org/wiki/Pangaea

Natural and environmental hazards

Large areas are subject to extreme weather such as tropical cyclones, hurricanes, or typhoons that dominate life in those areas. Many places are subject to earthquakes, landslides, tsunamis, volcanic eruptions, tornadoes, sinkholes, blizzards, floods, droughts, and other calamities and disasters.

Many localized areas are subject to human-made pollution of the air and water, acid rain and toxic substances, loss of vegetation (overgrazing, deforestation, desertification), loss of wildlife, species extinction, soil degradation, soil depletion, erosion, and introduction of invasive species.

A scientific consensus exists linking human activities to global warming due to industrial carbon dioxide emissions. This is predicted to produce changes such as the melting of glaciers and ice sheets, more extreme temperature ranges, significant changes in weather and a global rise in average sea levels.[136]

Ice Ages (from WikiPedia)

Causes of ice ages

The causes of ice ages are not fully understood for both the large-scale ice age periods and the smaller ebb and flow of glacial–interglacial periods within an ice age. The consensus is that several factors are important: atmospheric composition (the concentrations of carbon dioxide, methane); changes in the Earth's orbit around the Sun known as Milankovitch cycles (and possibly the Sun's orbit around the galaxy); the motion of tectonic plates resulting in changes in the relative location and amount of continental and oceanic crust on the Earth's surface, which affect wind and ocean currents; variations in solar output; the orbital dynamics of the Earth-Moon system; and the impact of relatively large meteorites, and volcanism including eruptions of supervolcanoes.

Some of these factors influence each other. For example, changes in Earth's atmospheric composition (especially the concentrations of greenhouse gases) may alter the climate, while climate change itself can change the atmospheric composition (for example by changing the rate at which weathering removes CO_2).

Maureen Raymo, William Ruddiman and others propose that the Tibetan and Colorado Plateaus are immense CO_2 "scrubbers" with a capacity to remove enough CO_2 from the global atmosphere to be a significant causal factor of the 40 million year Cenozoic Cooling trend. They further claim that approximately half of their uplift (and CO_2 "scrubbing" capacity) occurred in the past 10 million years.[34][35]

Changes in Earth's atmosphere

There is evidence that greenhouse gas levels fell at the start of ice ages and rose during the retreat of the ice sheets, but it is difficult to establish cause and effect (see the notes above on the role of weathering). Greenhouse gas levels may also have been affected by other factors which have been proposed as causes of ice ages, such as the movement of continents and volcanism.

The Snowball Earth hypothesis maintains that the severe freezing in the late Proterozoic was ended by an increase in CO_2 levels in the atmosphere, and some supporters of Snowball Earth argue that it was caused by a reduction in atmospheric CO_2. The hypothesis also warns of future Snowball Earths.

The August 2009 edition of Science provides further evidence that changes in solar insolation provide the initial trigger for the Earth to warm after an Ice Age, with secondary factors like increases in greenhouse gases accounting for the magnitude of the change.[36]

William Ruddiman has proposed the early anthropocene hypothesis, according to which the anthropocene era, as some people call the most recent period in the Earth's history when the activities of the human race first began to have a significant global impact on the Earth's climate and ecosystems, did not begin in the 18th century with the advent of the Industrial Era, but dates back to 8,000 years ago, due to intense farming activities of our early agrarian ancestors. It was at that time that atmospheric greenhouse gas concentrations stopped following the periodic pattern of the Milankovitch cycles. In his overdue-glaciation hypothesis Ruddiman states that an incipient ice age would probably have begun several thousand years ago, but the arrival of that scheduled ice age was forestalled by the activities of early farmers.[37]

Position of the continents

The geological record appears to show that ice ages start when the continents are in positions which block or reduce the flow of warm water from the equator to the poles and thus allow ice sheets to form. The ice sheets increase the Earth's reflectivity and thus reduce the absorption of solar radiation. With less radiation absorbed the atmosphere cools; the cooling allows the ice sheets to grow, which further increases reflectivity in a positive feedback loop. The ice age continues until the reduction in weathering causes an increase in the greenhouse effect.

There are three known configurations of the continents which block or reduce the flow of warm water from the equator to the poles:

A continent sits on top of a pole, as Antarctica does today.

A polar sea is almost land-locked, as the Arctic Ocean is today.

A supercontinent covers most of the equator, as Rodinia did during the Cryogenian period.

Since today's Earth has a continent over the South Pole and an almost land-locked ocean over the North Pole, geologists believe that Earth will continue to endure glacial periods in the geologically near future.

Some scientists believe that the Himalayas are a major factor in the current ice age, because these mountains have increased Earth's total rainfall and therefore the rate at which CO2 is washed out of the atmosphere, decreasing the greenhouse effect.[35] The Himalayas' formation started about 70 million years ago when the Indo-Australian Plate collided with the Eurasian Plate, and the Himalayas are still rising by about 5 mm per year because the Indo-Australian plate is still moving at 67 mm/year. The history of the Himalayas broadly fits the long-term decrease in Earth's average temperature since the mid-Eocene, 40 million years ago.

Fluctuations in ocean currents

Another important contribution to ancient climate regimes is the variation of ocean currents, which are modified by continent position, sea levels and salinity, as well as other factors. They have the ability to cool (e.g. aiding the creation of Antarctic ice) and the ability to warm (e.g. giving the British Isles a temperate as opposed to a boreal climate). The closing of the Isthmus of Panama about 3 million years ago may have ushered in the present period of strong glaciation over North America by ending the exchange of water between the tropical Atlantic and Pacific Oceans.[38]

Analyses suggest that ocean current fluctuations can adequately account for recent glacial oscillations. During the last glacial period the sea-level has fluctuated 20–30 m as water was sequestered, primarily in the northern hemisphere ice sheets. When ice collected and the sea level dropped sufficiently, flow through the Bering Strait (the narrow strait between Siberia and Alaska is ~50 m deep today) was reduced, resulting in increased flow from the North Atlantic. This realigned the thermohaline circulation in the Atlantic, increasing heat transport into the Arctic, which melted the polar ice accumulation and reduced other continental ice sheets. The release of water raised sea levels again, restoring the ingress of colder water from the Pacific with an accompanying shift to northern hemisphere ice accumulation. [39]

Uplift of the Tibetan plateau and surrounding mountain areas above the snowline

Matthias Kuhle's geological theory of Ice Age development was suggested by the existence of an ice sheet covering the Tibetan plateau during the Ice Ages (Last Glacial Maximum?). The plate-tectonic uplift of Tibet past the snow-line has led to a c. 2.4 million km^2 ice surface with a 70% greater albedo than the bare land surface. The reflection of energy into space resulted in a global cooling, triggering the Pleistocene Ice Age. Because this highland is at a subtropical latitude, with 4 to 5 times the insolation of high-latitude areas, what would be Earth's strongest heating surface has turned into a cooling surface.

Kuhle explains the interglacial periods by the 100 000-year cycle of radiation changes due to variations of the Earth's orbit. This comparatively insignificant warming, when combined with the lowering of the Nordic inland ice areas and Tibet due to the weight of the superimposed ice-load, has led to the repeated complete thawing of the inland ice areas. [40][41][42]

Variations in Earth's orbit (Milankovitch cycles)

The Milankovitch cycles are a set of cyclic variations in characteristics of the Earth's orbit around the sun. Each cycle has a different length, so at some times their effects reinforce each other and at other times they (partially) cancel each other.

It is very unlikely that the Milankovitch cycles can start or end an ice age (series of glacial periods):

Even when their effects reinforce each other they are not strong enough.

The "peaks" (effects reinforce each other) and "troughs" (effects cancel each other) are much more regular and much more frequent than the observed ice ages.

Past and future of daily average insolation at top of the atmosphere on the day of the summer solstice, at 65 N latitude.In contrast, there is strong evidence that the

Milankovitch cycles affect the occurrence of glacial and interglacial periods within an ice age. The present ice ages are the most studied and best understood, particularly the last 400,000 years, since this is the period covered by ice cores that record atmospheric composition and proxies for temperature and ice volume. Within this period, the match of glacial/interglacial frequencies to the Milanković orbital forcing periods is so close that orbital forcing is generally accepted. The combined effects of the changing distance to the Sun, the precession of the Earth's axis, and the changing tilt of the Earth's axis redistribute the sunlight received by the Earth. Of particular importance are changes in the tilt of the Earth's axis, which affect the intensity of seasons. For example, the amount of solar influx in July at 65 degrees north latitude varies by as much as 25% (from 450 W/m^2 to 550 W/m^2). It is widely believed that ice sheets advance when summers become too cool to melt all of the accumulated snowfall from the previous winter. Some workers believe that the strength of the orbital forcing is too small to trigger glaciations, but feedback mechanisms like CO2 may explain this mismatch.

While Milankovitch forcing predicts that cyclic changes in the Earth's orbital elements can be expressed in the glaciation record, additional explanations are necessary to explain which cycles are observed to be most important in the timing of glacial–interglacial periods. In particular, during the last 800,000 years, the dominant period of glacial–interglacial oscillation has been 100,000 years, which corresponds to changes in Earth's orbital eccentricity and orbital inclination. Yet this is by far the weakest of the three frequencies predicted by Milankovitch. During the period 3.0–0.8 million years ago, the dominant pattern of glaciation corresponded to the 41,000-year period of changes in Earth's obliquity (tilt of the axis). The reasons for dominance of one frequency versus another are poorly understood and an active area of current research, but the answer probably relates to some form of resonance in the Earth's climate system.

The "traditional" Milankovitch explanation struggles to explain the dominance of the 100,000-year cycle over the last 8 cycles. Richard A. Muller and Gordon J. MacDonald [1] [2] [3] and others have pointed out that those calculations are for a two-dimensional orbit of Earth but the three-dimensional orbit also has a 100,000-year cycle of orbital inclination. They proposed that these variations in orbital inclination lead to variations in insolation, as the earth moves in and out of known dust bands in the solar system. Although this is a different mechanism to the traditional view, the "predicted" periods over the last 400,000 years are nearly the same. The Muller and MacDonald theory, in turn, has been challenged by Jose Antonio Rial [4].

Another worker, William Ruddiman, has suggested a model that explains the 100,000-year cycle by the modulating effect of eccentricity (weak 100,000-year cycle) on precession (26,000-year cycle) combined with greenhouse gas feedbacks in the 41,000- and 26,000-year cycles. Yet another theory has been advanced by Peter Huybers who argued that the 41,000-year cycle has always been dominant, but that the Earth has entered a mode of climate behavior where only the second or third cycle triggers an ice age. This would imply that the 100,000-year periodicity is really an illusion created by averaging together cycles lasting 80,000 and 120,000 years (Nature 434, 2005, [5]). This theory is consistent with a simple empirical multi-state model proposed by Didier Paillard [6]. Paillard suggests that the late Pleistocene glacial cycles can be seen as jumps between three quasi-stable climate states. The jumps are induced by the orbital forcing, while in the early Pleistocene the 41,000-year glacial cycles resulted from jumps between only two climate states. A dynamical model explaining this behavior was proposed by Peter Ditlevsen [7]. This is in support of the suggestion that the late Pleistocene glacial cycles are not due to the weak 100,000-year eccentricity cycle, but a non-linear response to mainly the 41,000-year obliquity cycle.

Variations in the Sun's energy output

There are at least two types of variation in the Sun's energy output:

In the very long term, astrophysicists believe that the sun's output increases by about 10% per billion (109) years.

Shorter-term variations such as sunspot cycles, and longer episodes such as the Maunder minimum, which occurred during the coldest part of the Little Ice Age.

The long-term increase in the Sun's output cannot be a cause of ice ages.

Solar variation refers here to changes in the amount of total solar radiation and its spectral distribution. There are periodic components to these variations, the principal one being the 11-year solar cycle (or sunspot cycle), as well as aperiodic fluctuations.[1] Solar activity has been measured by satellites during recent decades and estimated using 'proxy' variables in prior times. Scientists studying climate change are interested in understanding the effects of variations in the total and spectral solar irradiance on the Earth and its climate.

The variations in total solar irradiance remained at or below the threshold of detectability until the satellite era, although the small fraction in ultra-violet wavelengths varies by a few percent. Total solar output is now measured to vary (over the last three 11-year sunspot cycles) by approximately 0.1% [2][3][4] or about 1.3 W/m^2 peak-to-trough during the 11 year sunspot cycle. The amount of solar radiation received at the outer surface of Earth's atmosphere averages 1366 watts per square meter (W/m^2).[5][6][7] There are no direct measurements of the longer-term variation and interpretations of proxy measures of variations differ. The intensity of solar radiation reaching the Earth has been relatively constant throughout the last 2000 years, with variations of around 0.1-0.2%.[8][9][10] The combination of solar variation and volcanic effects are likely to have contributed to climate change, for example during the Maunder Minimum. Apart from solar brightness variations, more subtle solar magnetic activity influences on climate from cosmic rays or the Sun's ultraviolet radiation cannot be excluded although confirmation is not at hand since physical models for such effects are still too poorly developed.[11]

Volcanism

Volcanic eruptions may have contributed to the inception and/or the end of ice age periods. One suggested[who?] explanation of the Paleocene-Eocene Thermal Maximum is that undersea volcanoes released methane from clathrates and thus caused a large and rapid increase in the greenhouse effect. There appears to be no geological evidence for such eruptions at the right time, but this does not prove they did not happen.

http://en.wikipedia.org/wiki/Ice_age

Environmental Effects of Increased Atmospheric Carbon Dioxide

A review of the research literature concerning the environmental consequences of increased levels of atmospheric carbon dioxide leads to the conclusion that increases during the 20th and early 21st centuries have produced no deleterious effects upon Earth's weather and climate. Increased carbon dioxide has, however, markedly increased plant growth. Predictions of harmful climatic effects due to future increases in hydrocarbon use and minor greenhouse gases like CO_2 do not conform to current experimental knowledge. The environmental effects of rapid expansion of the nuclear and hydrocarbon energy industries are discussed.

http://www.oism.org/pproject/s33p36.htm

Volcanic Carbon

Comparison of CO_2 emissions from volcanoes vs. human activities.

Scientists have calculated that volcanoes emit between about 130-230 million tonnes (145-255 million tons) of CO_2 into the atmosphere every year (Gerlach, 1991). This estimate includes both subaerial and submarine volcanoes, about in equal amounts. Emissions of CO_2 by human activities, including fossil fuel burning, cement production, and gas flaring, amount to about 27 billion tonnes per year (30 billion tons) [(Marland, et al., 2006) - The reference gives the amount of released carbon (C), rather than CO_2, through 2003.]. Human activities release more than 130 times the amount of CO_2 emitted by volcanoes--the equivalent of more than 8,000 additional volcanoes like Kilauea (Kilauea emits about 3.3 million tonnes/year)! (Gerlach et. al., 2002)

http://volcanoes.usgs.gov/hazards/gas/index.php

Seasonal celebrations

- Change in sunrise to winter solstice celebrated
- Change in sunrise to summer solstice celebrated