

Climate through time

Climate on Earth

Through the centuries Earth has always had climate variations. What must be analyzed is how great they are, the impact that they have on our lives, and how long they last. In a human being's life time, one can experience seasonal or annual changes, such as years that are warmer or rainier than others. Throughout the centuries, in fact there have been much greater climate variations than we have nowadays. An increase in temperatures is always associated with the melting of polar and continental ices, with the consequent rise in sea levels. In the past 500 million years sea levels have varied by as much as a few hundred meters (200-300 meters) from nowadays level but with a much longer duration, roughly 300 million years, which means that they would not have been noticeable in a man's lifetime.

Sea level oscillation causes

There are several different causes involved in sea level oscillation but they are usually geological, climatic, astronomic or anthropical events.

The main ones are:

- variations in ocean basin capacity, meaning the areas occupied by water;
- variations in the amount of ocean water;
- minor variations such as: sea water density, sea water desiccation, marine meteorological parameters (atmospheric pressure and winds).

In the first case, variations in ocean basin capacity are caused by geological processes within the planet. We know that on the ocean floor there are belts called "oceanic ridges" where magma moves upwards, towards the surface swelling the earth's crust so the mass of water is displaced with the consequent rise in sea level. This is very slow process which causes the level to vary by approximately one centimeter every thousand years so man cannot notice it in a lifetime.

Ocean water quantity variation, instead, is brought about by climatic causes: during colder weather periods, a large part of the water of the oceans is trapped in the Arctic and Antarctic glacial caps as well as in continental glaciers, while during warmer weather, the ices melt causing the sea level to rise quickly, as much as one centimeter per year. In the past century large quantities of man made greenhouse gasses have been added to the natural causes which are bringing about climate changes at a much faster pace, and all this is having a big effect on us.

Quaternary or glacial era

Major climate variations have taken place during the Quaternary period (the past 2,5 million years), which is when man made his first appearance on Earth, caused by the massive expansion of the polar caps approximately every 100 thousand years, that made the sea level decrease by as much as 120 – 140 meters below what it is today.

We must bear in mind that the last glaciation allowed man to spread all over the world, thanks to the spits of dry land emerging from the lowered sea level. These periods were followed by other warmer ones with temperatures which were similar to the ones we have today which allowed the ice to melt and consequently increase the sea level. Shortly before the beginning of the Quaternary because of the tectonic plates which allows vast areas of dry land to shift, the distance between south America, Africa and the Antarctic continent induced an ocean current similar to a gigantic "river" moving a volume of water 100 times the size of the Amazon River. This river submerged from the north Atlantic, reaching the ocean floor and traveling the whole length of the Atlantic Ocean from north to south going around Africa to then spread into the Indian Ocean while part of it went as far as the Pacific Ocean. This enormous volume of water is still moving today and acts as a huge conveyor belt for heat, as though it were a gigantic air conditioning system that controls the weather on Earth. When the hot current reaches as far north as Iceland it encounters the cold winds from Canada so it cools off, releasing the heat into the air and mitigating the effect that these winds would have on northern Europe.

With the evaporation water becomes more dense and tends to sink, generating a cold deep current. The amount of heat

carried by this enormous “conveyor belt” depends obviously on how much is stored during its formation. At present the “conveyor belt” is near Iceland, but its latitude can vary, oscillating to the point of interruption, thus causing a break down of the heat distribution system.

As time passes, the sun’s heat reaching the surface of Earth and the sea, changes according to the orbital parameters of our Planet.

There are three main causes for latitude variations:

- shift in the axis inclination of Earth’s rotation: the Earth’s axis inclination has a slow oscillation that goes from 21,8° to 24,4° in a stable period spanning approximately 40,000 years. Currently the angle is 23.45° and is decreasing, thus diminishing the contrast between summers and winters.
- changes in the eccentricity of Earth’s orbit: the planet’s orbit changes from an almost perfect circumference to a marked ellipse. When it is an ellipse, the planet is closer to the sun, otherwise, it is more distant. A complete orbital cycle going from an almost round orbit to an ellipse one and vice versa, takes 100,000 years.
- precession of the equinoxes: this is the celestial phenomenon whereby the axis of our planet goes a complete circle around an imaginary cone every 26,000 years. This is the reason why the seasons have a slow tendency to come sooner and be modified. The same thing happens when one spins a spinning top which in fact is very difficult to keep straight with its axis perfectly perpendicular to the ground. It is more likely to have an eccentric spinning motion and its point will gradually design a cone as it goes around. Something similar happens to our planet although the forces that cause this are obviously different.

Therefore, over thousands of years, Earth changes its position with respect to the sun to then start all over again every 26,000, 40,000 and 100,000 years. The combination of these three elements will modify the amount of energy(Watt per m²): when the point of no return is reached, the heat is so intense that the glaciers melt and reach a peak, whereby the climate is similar to what we have nowadays and lasts for a time span ranging from 6,000 to 13,000 years, until Earth’s geometry gradually changes causing glaciers to build back up quite quickly (within just a few hundred years).

Recent ages

During the Roman era the climate was rather warm, and we have proof of this from the pools that Ancient Romans used to breed eel. In fact these pools had two holes, one at high tide level and the other at low tide level. At high tide fresh sea water would come in through the first hole while stagnant water left the pool through the second one at low tide, so that the pools had a constant fresh water turnover which worked the same way as modern day aquarium filtering systems. Tides in the Mediterranean sea range approximately 20 cm. so we can know exactly where the sea level was at in those times and consequently we also know what the climate was like.

In history we are told that in 218 b.C. Hannibal crossed the Alps with elephants, which gives us a reason to believe that at that altitude there was no snow, or better yet, perennial snow was easily accessible as opposed to nowadays.

In the Middle Ages they had a long warm period that spanned more or less from the 9th to the 12th century. At the time grapes were grown in England, 500 km further north compared to today.

From about 1200 to about 1850, Earth went through a long cold phase which affected particularly Europe. The Vikings left Greenland where the ports were blocked by ice. The glaciers crept forward and many alpine valleys were abandoned. This is the coldest time in the past 8,000 years, and is in fact called the “Small Glacial Era” and 1816 will go down in history as the year without a summer: In paintings from the 1700s Venice is portrayed as being completely frozen and Bethlehem is covered with snow. Apparently, even during the famous Waterloo Battle, heavy rains had blocked Napoleon and left his cavalry troops stranded in the mud. After that the temperature rose until it reached its peak in 1950.

Between the Small Glacial Era and today average temperatures have risen by 0.5 – 1.0 degrees. World glaciers are shrinking while sea levels are rising by about 2 mm. per year. This is the global warming which apparently has been caused by man. According to some scientists such as those from ICRAM (Istituto Centrale per la Ricerca Scientifica e Tecnologica Applicata al Mare), the current phase might indicate a part of the hot/cold cycle with a normal rise in

temperatures following a cold phase which peaked, as we mentioned, during the first half of the 19th century, one of the most obvious in the middle and recent Holocene age.