Climate changes

Climate

What is climate?

The word climate derives from the Greek word κλιμα, or inclination. Climate, in fact, is partly determined by the inclination of the sun's rays on the Earth's surface, which varies with the latitude and seasons. The term "climate" is often used as a synonym of meteorological "weather" even though their meanings are quite different.
Meteorological weather is the set of meteorological elements that characterize the atmosphere at a precise moment. If we look out of the window we can immediately see what the weather is like. The climate, instead, is defined as the "set of meteorological phenomena (e.g. temperature, precipitation, winds, etc.) that characterize the average state of the atmosphere at a particular point of the Earth's surface", (according to the definition given by J. Hann an Austrian meteorologist). Due to the extreme variability of meteorological parameters, the World Meteorological Organization has established that, in order to identify climatic characteristics, and therefore the "average state of the atmosphere", of a particular location, the minimum duration of the historical time-series of meteorological data must be at least 30 years. The discipline that studies the climate, its elements and its factors, and classifies the types of climate is called climatology.

Sun and climate

If the Earth rotated around the sun in a perfectly vertical way like a spinning top, the weather wouldn't vary during the year, in other words there wouldn't be any seasons, because the amount of solar radiation reaching the planet' surface would always be the same. If the earth's axis wasn't at an angle with respect to the orbital plane, not only would there be no seasons, but neither could there be any differences between one hemisphere and the other and obviously the tropics would not exist. Instead, fortunately for us, during the year the inclination of earth's axis with respect to the solar rays changes thus varying the angle at which they reach the planet. Therefore on the 21st of June, summer solstice, the solar rays are perpendicular to the imaginary line called Tropic of Cancer in our hemisphere; while the 22nd of December, which is winter solstice in our hemisphere whereas it is summer in the Austral one, solar rays are perpendicular with respect to the imaginary line called Tropic of Capricorn which is in the southern hemisphere. During each equinox, instead, solar rays are perpendicular to the Equator. Rays that reach the ground perpendicularly have the maximum atmosphere penetration power and the maximum thermal effect at both tropics, which is why the tropical belt is the area with the hottest and most constant climate all year round. Climate variation increases as one goes north towards the boreal hemisphere and south towards the Austral one. The temperature difference among the various latitudes trigger the complex climatic thermodynamics which actually are influenced by many other factors: local geology, the presence of large water masses or high altitudes and atmospheric conditions. A clear example of how the local geography influences climate is the Assuan dam that created the Nasser Lake, PIC21 a huge artificial basin that had deep implications not only on the region's weather, but also on the southern Mediterranean area. Before it was built it was impossible to imagine that it would affect the weather so heavily and from that we have learned that weather dynamics are really complex phenomena to foresee with mathematical precision.

Radiation Balance and Greenhouse effect

Apart from a small amount of energy that comes from inside the Earth, the energy that feeds the climate system of our planet comes mainly from the Sun. In fact the Earth receives the radiant energy of the Sun (i.e. transported by electromagnetic radiation), about half of which is visible light, a small part is ultraviolet light, and the remaining part is infrared light.

The solar radiation that hits the Earth's surface in one hour is equal to approximately 342 w/m^2; out of which only 235 w/m2 are actually absorbed by the Earth's surface, while the remaining 107 are immediately reflected into space. The percentage of total incident radiation reflected from the Earth's surface is known as albedo. The Earth's albedo, therefore, is equal to 30% (342/107=30%). Out of these 107 w/m^2, 77 are reflected by the clouds, by gases and by the micro-particles that are present in the atmosphere (aerosol), while the remaining 30 w/m2 return to the atmosphere as they are reflected by light-coloured surfaces present on the Earth, consisting prevalently of glaciers, snow and deserts. Snow has a very high albedo, equal to 0.9, which means that 90% of the radiation that hits the snow is reflected.

The energy that is not reflected into space, equal to 235 w/m^2, is absorbed by the Earth's surface and by the atmosphere, and is re-emitted in the form of infrared radiations (heat). The atmosphere, which consists prevalently of nitrogen and oxygen, that are transparent to infrared thermal radiation, let these radiations escape into space. However there are some gases (known as greenhouse gases) that absorb thermal radiation and prevent their dispersion, and this causes a warming of the atmosphere. This natural physical phenomenon, called greenhouse effect is very important for life on Earth because it allows the Earth's surface to have an average temperature of 14°C instead of -18°C which would be the case without greenhouse gases in the atmosphere.