BASE OF THE CLIMATE AND PERSPECTIVE OF EVOLUTION

World congress of the Vine and the Wine, OIV; 2006

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1.1 CHALLENGES

Since the appearance of the life on ground, the climate did not cease evolving. The modification of the sea level associated with the presence with the fossils, the disappearance of certain species, are as many witnesses of the climate changes dependant on the natural cycles (astronomical factors) or on extraordinary events (meteorites, volcanic activities…). The geological traces of this evolution (sediment, alluvia, etc) are sometimes components of the specificity of certain soils.
Parallel To the natural evolution, it seems that the human activities and industrial lead to a fast acceleration of the warming.

The vine, plants liana is equipped with a capacitance of exceptional adaptation. In addition, the man can adapt his cultivation techniques to climatic diversities. Thus, probably born in the area of the Caucasus, near the Black Sea, the viticulture did not cease conquering new areas (the Middle East, Mediterranean Basin, septentrional Europe) during the expansion of the Greek civilization then Roman. More recently, the development of transport by boat, at the origin of colonizations allowed an establishment of the vineyards in the countries of the new world (North America, Asia, Southern Hemisphere).
Nevertheless, put except for some extreme situations, the vine found its ground of predilection only in specific zones of the terrestrial sphere (20 with 53° of latitude in the Northern hemisphere and 20 with 42° in the southern hemisphere). Thus, it is legitimate this to ask whether a significant variation of the climate would modify at the same time the farming conditions even the distribution of the vineyards and the characteristics of the wines

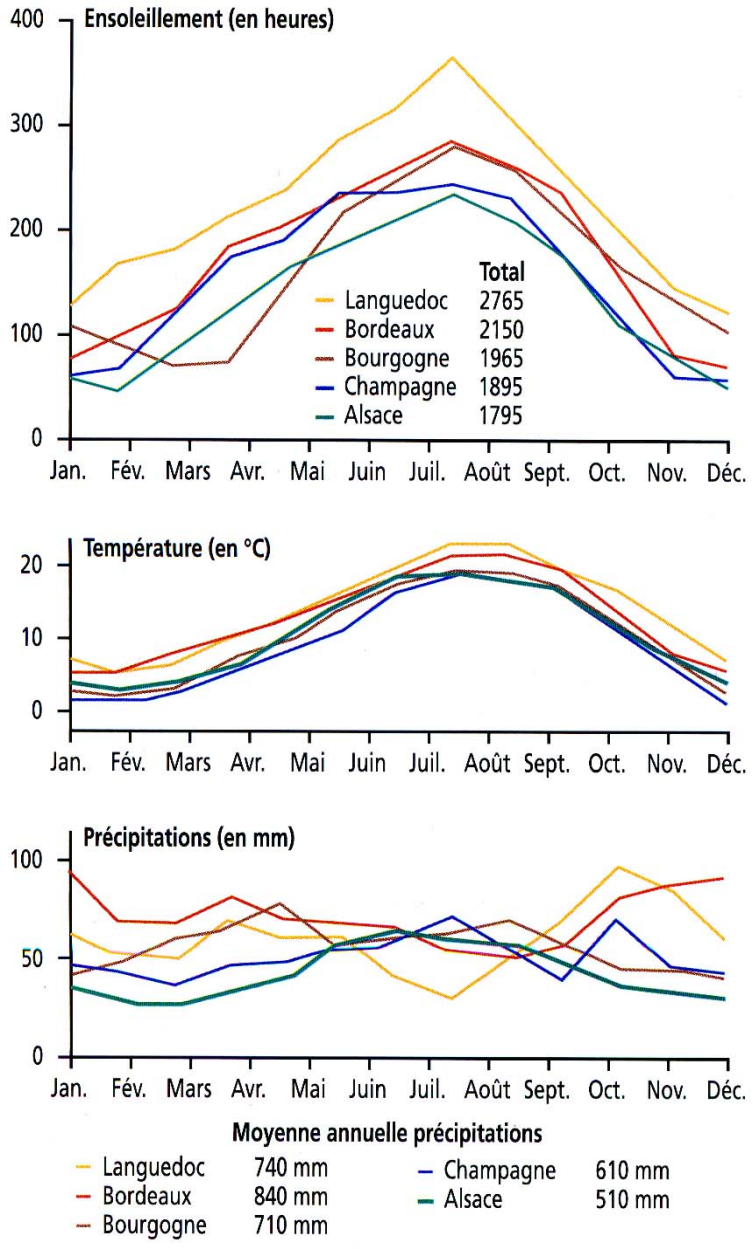


Figure 1: Climatic Characteristics of the principal viticultural areas of France (Source: Teroir, James E. Wilson, ED Mitchell Beazley)

1.2 DEFINITION OF THE CLIMATE

The word "climate" appeared at the 12th century, this word etymologically means slope but also latitude. Emmanuel OF MARTONNE defines the climate in 1909 in his treaty of physical geography "whole of phenomena which are held, temperature, wind, moisture, rain

are in a narrow correlation and gives to each country an aspect generally reflected by the vegetation.
Compared to the time which corresponds in a state of the atmosphere at a given time, the climate corresponds to a set of characteristics over one long period.

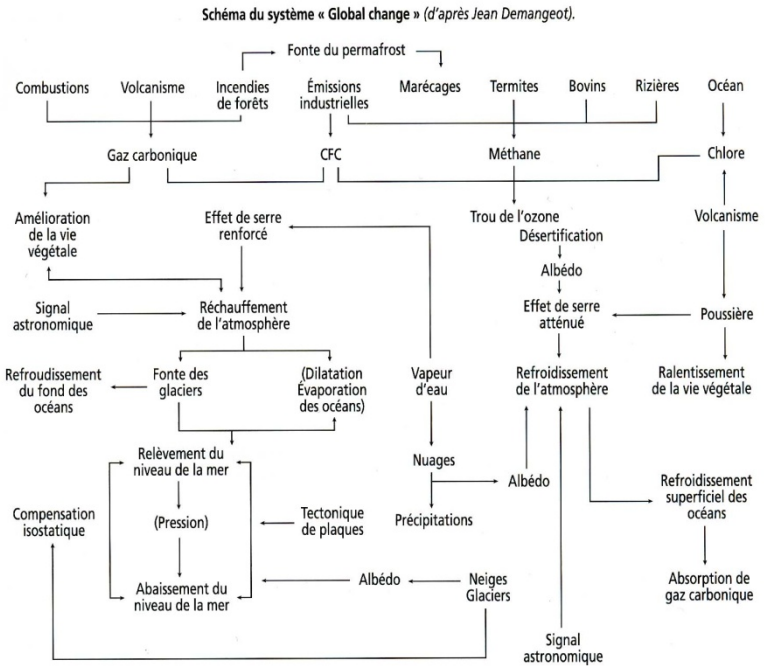


Figure 2: Diagram of Total system the "Changes"
According to Jean Demangeot)

1.3.1 Climatic Zones

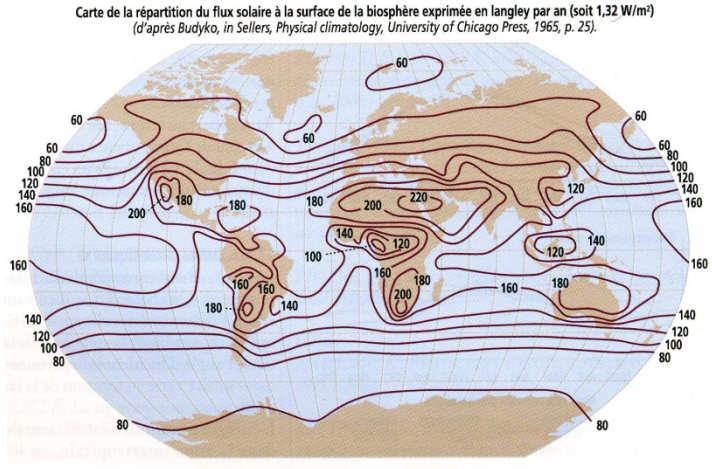


Figure 3: Card of the distribution of solar flow on the surface of the biosphere expressed in langley a year (either 1.32 W/m ²)
(According to Budyko, in Sellers, Physical climatology, University of Chicago Near, 1965, p.25)

that which it restores. Taking into account the sphericity of the ground, the angle of incidence of the solar radiation varies according to the latitude.
Accumulated energy is maximum in the intertropical zone, or the rays are vertical when the sun is with its zenith and decrease towards the poles, zones in which the rays are shaving. Locally, this variation of accumulation of heat according to the angle of incidence is put at profit by certain vineyards to profit from an optimum sunning in the sloping zones

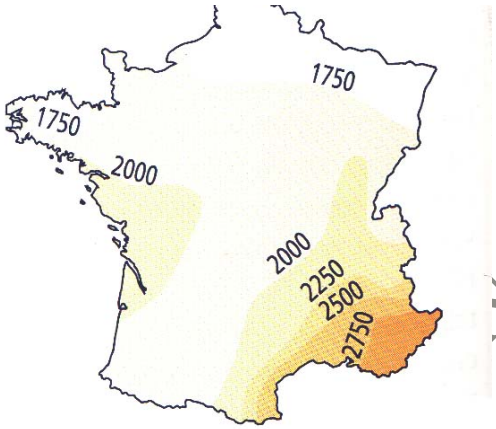


Figure 4: Annual average Sunning of France (in hour)
According to Estienne and Godart)

Compared to a potential of sunning of a defined zone, the radiative assessment depends on the role of the atmosphere in the rollout of the light rays incidental and reflected (greenhouse effect, aerosols).
In Parallel, the considered percentage of solar energy (albedo) varies according to the cover of the ground (important reflection for the snow-covered areas and the arid zones, weak for the oceans).

1.4 Origin of the seasons

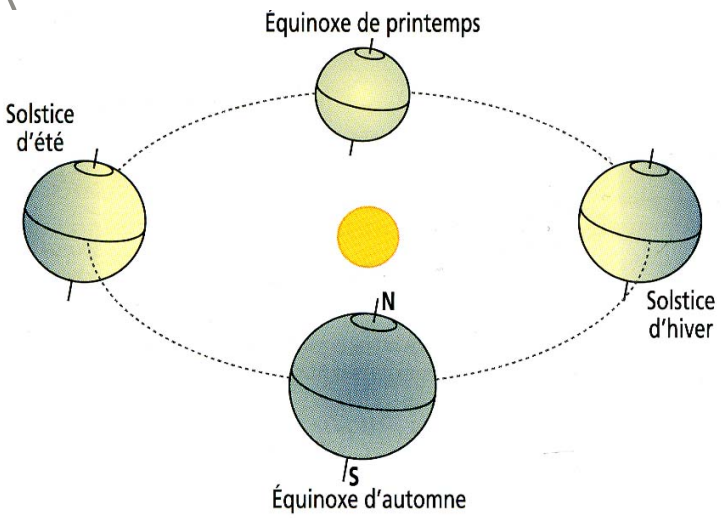


Figure 5: Astronomical Description of the seasons

They are related to two major phenomena: the slope of the ground and its revolution around the sun. The four seasons correspond to the intervals ranging between the solstices and the equinoxes. The solstice is the time to which the height of the sun to the top of the equatorial plan is maximum (summer solstice around on June 21st in the northern hemisphere) or minimal (winter solstice around on December 21st in the northern hemisphere). The equinox is the time of the year marking the beginning of spring when that of the autumn, or the duration of the day is equal to that of the night. The ground has a constant slope of 23.5 °. By its rotation, with the summer solstice, the north pole is slightly tilted towards the sun whereas it moves away from there at the time of the winter solstice.

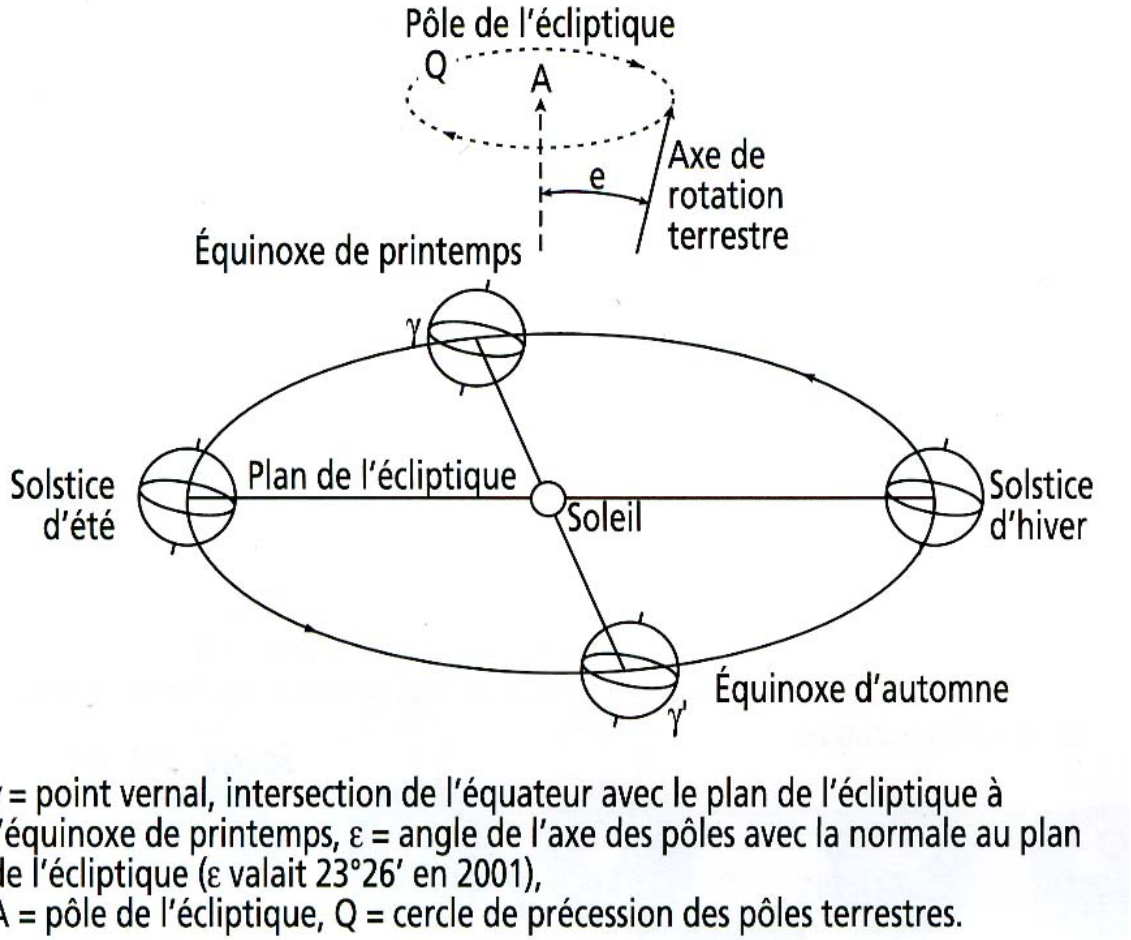


Figure 6: Diagram of the cycle of rotation of the ground around the sun with the position of the equinoxes and the solstices
(Source: F. Ramade, COp cit., 2nd ED., 1994, p.26)

1.5 Local Climate

The latitude predetermines the local climate.
However various factors can modify the climatic characteristics appreciably

- Proximity of the sea:

Taking into account the rotation of the ground, the masses of air move mainly in the northern hemisphere because of the forces of Coriolis. The Western faceplates of the continents are very influenced by the depression which are formed and which bring moisture and softness.

- Altitude

When altitude increases, the temperature decreases (0.5 with 1°C by 100 meters). The slope exposed to the south (adret) profits from a better sunning compared to the slope exposed to north (ubac). In Parallel, the mountains often play a part on precipitations

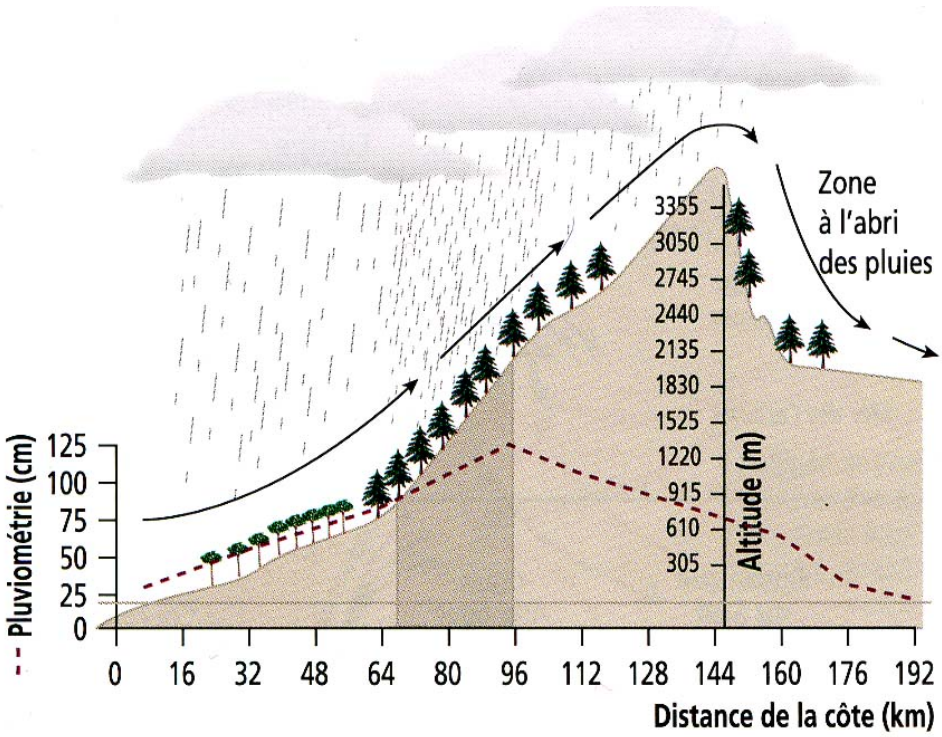
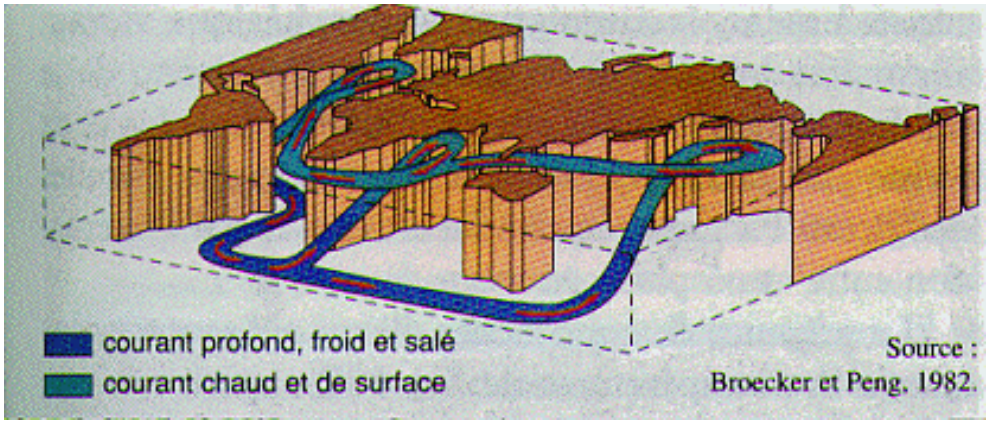


Figure 7: Role of the reliefs in the local climates of mountain
Example of the Sierra Nevada power station - the United States
Source: Chiras, Environmental Science Publi 1991

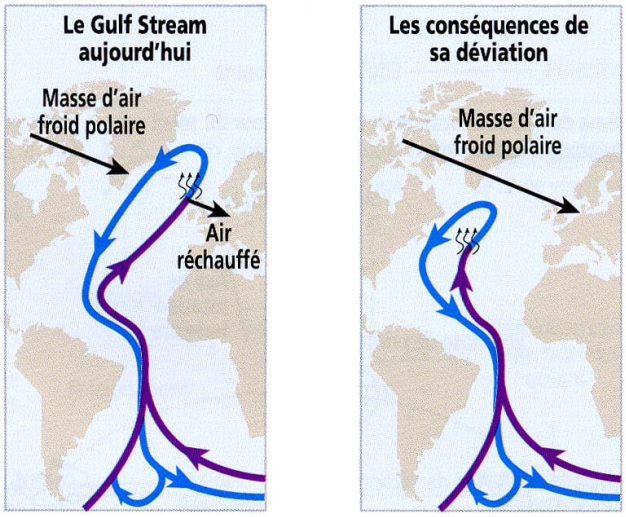
To the image of the Nevada Sierra in the United States, the oceanic air goes up on the mountainsides, cools by the effect of altitude and condenses. It results from it from the abundant rains. Contrary, along the opposed slope, the air goes down again while being heated along the continental opposite slope where it becomes very dry thereafter of the loss of moisture which it has sudden. Beyond altitude, the presence of mountains covered with snow near zone of plains or Piedmont led to fresh temperatures in particular during the night (case of the vineyards of Chile and Argentina).

- Running marine

The marine currents by volumes of cool water or warm water which they convey take part in the local climatic characteristics and contribute to their variation in time (season, multiannual cycle).



Exchanges between surface water and deep waters take place permanently.
The deep waters go up the nutritive elements (rock salt) essential to the marine animal-life of surface.



Source : J.M. Jancovici

A deceleration of this major circulation:

- Modify the distribution of heat on the surface of the sphere with a local impact or regional which can be massive (Europe in glacial period?),
- decrease the mineral contributions surfaces some and the oxygenation of the funds: pressure on the halieutic life

Figure 8: Modification of the marine currents

Thus, Gulf Stream ("running of the golf") contributes to the moderate climate of Western Europe.
It is a current heat of the North Atlantic which is born in the Caribbean Sea, where it receives the contribution of the Equatorial Southern current then enters the Gulf of Mexico and leaves by the strait Florida with a flow close to 26 million cubic meter a second. Skirting the American coasts incorporating of other currents, it bursts on the new

Ground level in several branches of which some come to heat under the influence of the winds of West the European coasts

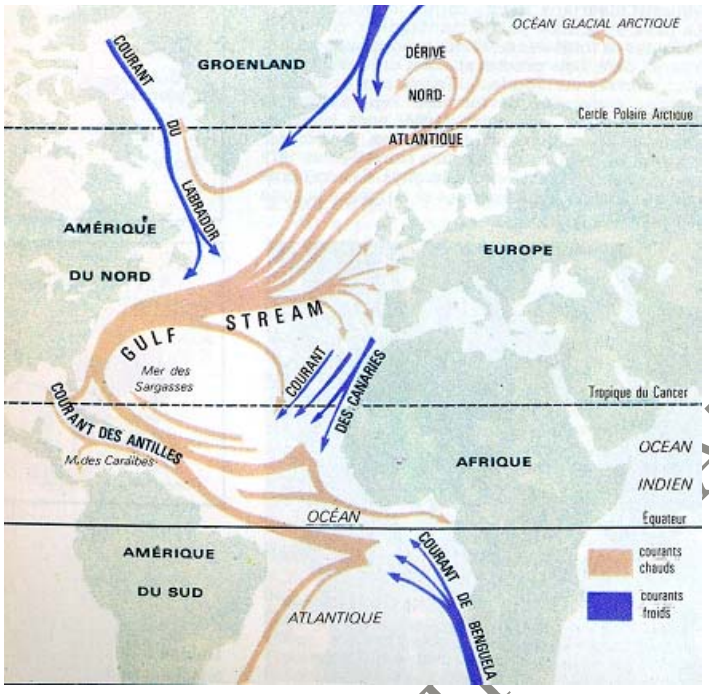


Figure 9: Types of currents

The French Atlantic littoral receives a heat equivalent to that which would provide 30 billion ton of oil (10 times worldwide production).
It seems that this current stopped several times during the climatic history of planet. For the future, it is possible to imagine an attenuation even an interruption of this current, which could lead to a cooling of the Atlantic face of Europe in spite of a total warming of the ground. However, the complexity of the mechanisms concerned makes difficult any reliable forecast.

- Wind

With a local level, the presence of dominant winds or on the contrary a protection by natural barriers (mountain, wind) defines a microclimate (temperature, moisture) which contributes to the characteristics of a soil and defines specific aptitudes developed by the wise choice of a type of vine, making of a kind of wine with sometimes of the single characteristics (condition of development of the noble rot)

- Slope

With the planetary scale, the incidental angle of the solar rays determines the difference in climate according to the latitude. At the local level, the slope also modifies the radiative assessment. Indeed the compaction energy of the tilted plan exposed to the solar rays is proportionally more important compared to a zone of plain.

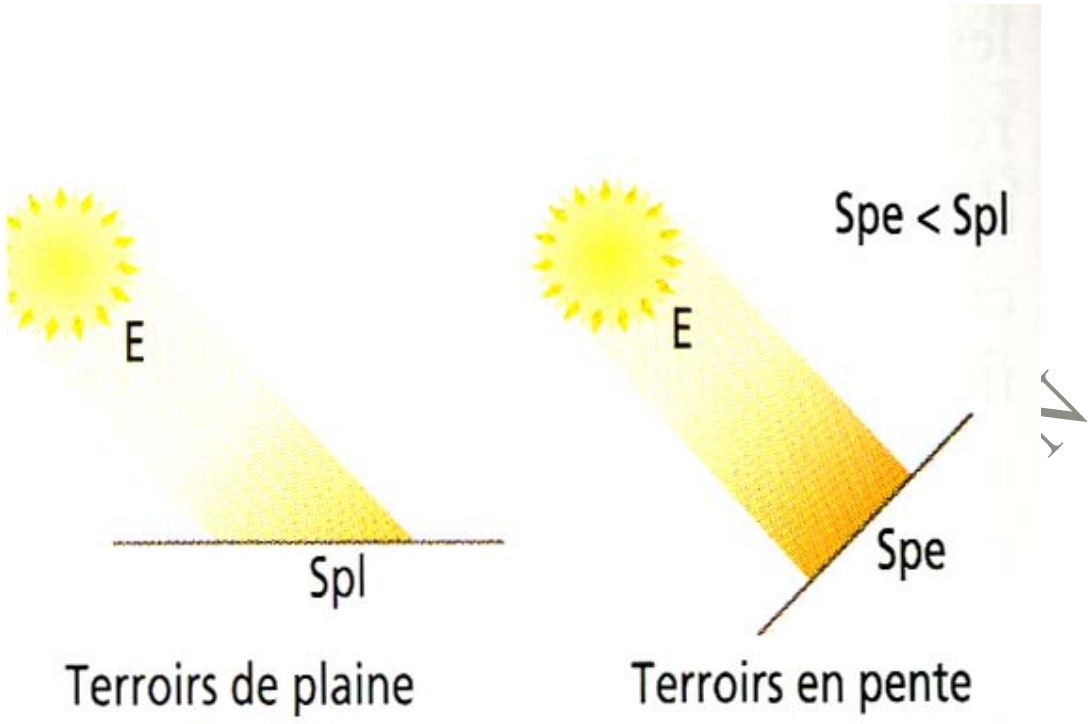


Figure 10: Tweaking of the sunning of a sloping zone

II HISTORY OF THE CLIMATE

2.1 Observation

Climate and religion

The climatic plagues were often associated with divine punishments. Thus, as it announces J. BERLIOZ, the devil and the demons are considered in a popular context of the sources of calamities. To entreat these plagues, it was not rare to call on magic practices, relayed by the superstitions. For the church this fear of the climatic risks was the occasion to sacrilize the prayers, psalms, litanies, speech in order to move away the calamities. The recourse to the saints is also registered like a analgesics of the human distress.

17.2.1 Observation

In Occident, they are the monks who by their observations testified to extraordinary events (flood, storms, freezing, etc) which reflect the climatic risks. Later, the observations of the geologists (old moraines, alluvial terraces) made it possible to determine the climatic variations of our planet. It is Albert PENCK, founder of the paleoclimatology, which in its work the Alps with old of gold of the ices (1901 to 1906) proposed to baptize the periods of glaciation by the affluents of the Danube (Günz, Mindel, Riss, Würm).

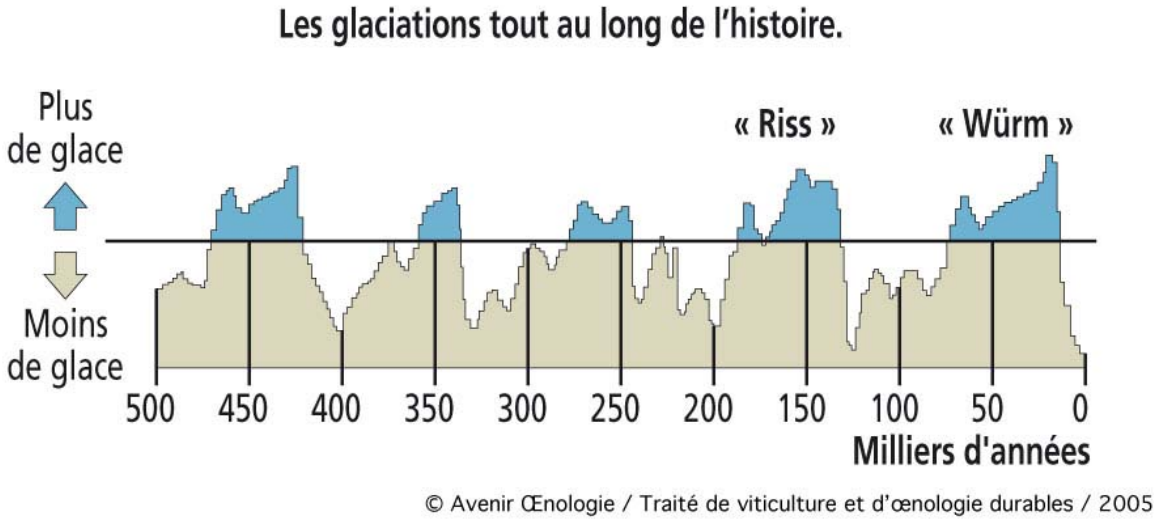


Figure 11: Glaciations throughout the history

To refine this knowledge, it is possible to use various methods:

- Analyzes bubbles of air of glacial carrots taken in the poles
- Circles of wood growth recovered on archeological sites (dendroclimatology)
- Study of pollens which underlines the presence of climatic indicating plants

2.2 Factors of evolution

2.2.1 Astronomical Factors

Work of Serb mathematician MILUSTI MILANKOVITCH (1941), experienced by more recent search, shows that variation of the position of the ground on its orbit induced of the major climatic variations:

- Eccentricity
  The terrestrial orbit passes from a perfect circle to a slightly flattened ellipse which modifies the distance from the ground to the sun and results in a variation of the terrestrial solar radiation. This cycle is established over one period of approximately 400,000 years

- Variation of the oblicity of the axis of the poles. Currently the axis of the poles forms an angle of 23,27° with the perpendicular. The angle varies from 22 with 25° every approximately 41,000 years. This slope which determines the cycle of the seasons contributes to modify the development of the continental icecaps.

- Climatic Precession
  The ground oscillates like a spinning top: its axis of rotation describes a cone around the direction perpendicular to the plan of the orbit.
  This movement slowly shifts the position of the equinoxes compared to the perihelion (not of the terrestrial orbit nearest to the Sun) and modulates the skew on the seasonal insolation with a double periodicity, 23,000 years and 19,000 years.

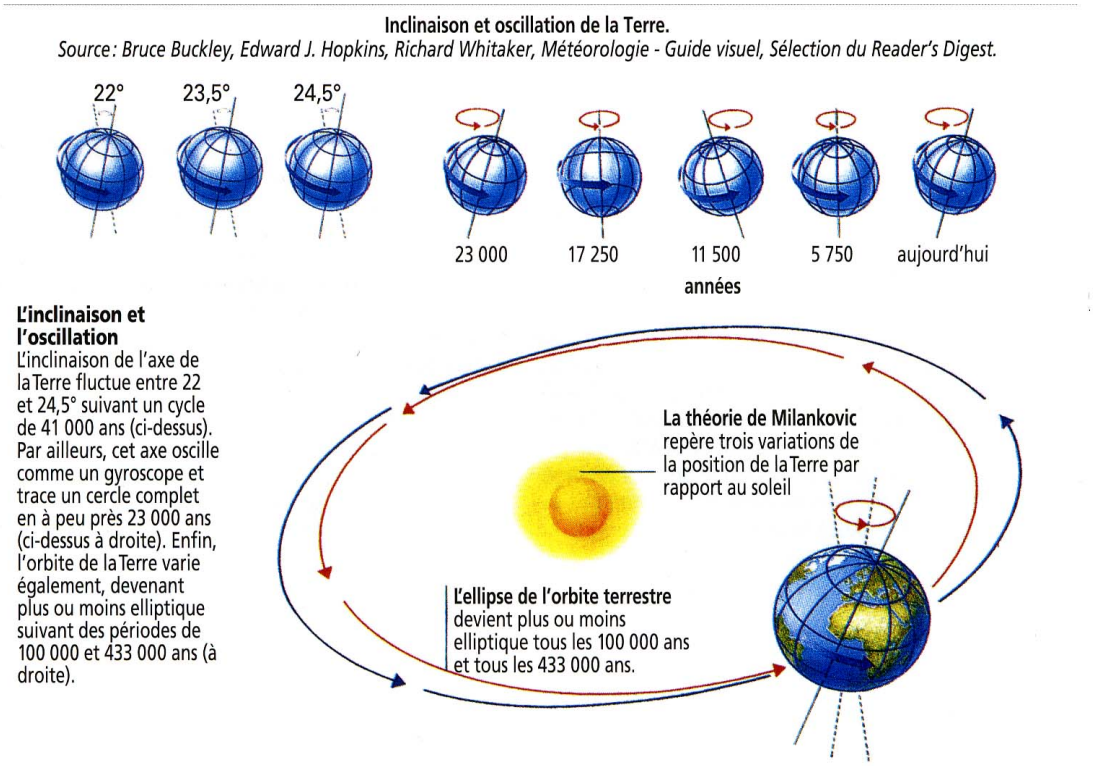


Figure 12: Slope and oscillation of the ground
Source: Bruce Buckley, Edward J. Hopkins, Richard Whitaker, Meteorology - visual Guide, selection of Reader' S Digest

2.2.2 Solar activity

The sunspots, dark zones, correspond to an intense emission at the origin of a high temperature. It seems that the periods of weak sunspots correspond to cold times (1600 to 1710.1790 to 1830, during small old glacial).
The scientists estimate that a variation of 1% of the solar quantity of heat reaching the ground could vary from a degree the average temperatures of planet.

2.2.3 Reflectivity of the continents

The presence of snow, of ice, the vegetation, the deserts are as many factors which modify the reflectivity (albedo) and consequently the terrestrial temperature. Thus, historically, the variation of the glaciation of the poles, the projection or the retreat of the glaciers could contribute to modify the albedo. In the same way, the evolution of husbandries (clearing) and generally the modification of the occupation of the territory are factors of variation of reflectivity and consequently of the climate.

2.2.4 Aerosols (fines particles)

The aerosols made up of the fine liquid particles or solids located in the roadbases of the atmosphere, reflect the rays of the sun and modify the solar share of flow which reaches the ground. It results a cooling or an attenuation from it from the warming. The various particles are described by F. RAMADE.

- The large sedimentable particles, whose size is higher than 2.5 microns and of median value of 20 microns. These particles are located in the low layers of troposphere, below 3000 m and fall down quickly (at most in a few days) in the vicinity of their source of emission.

- Particles semifine, sedimentable, of size ranging between 2.5 microns and 0.1 micron. This last dimension corresponds to the lower limit beyond which sedimentation is impossible in consequence of the Brownian movement, which confers to them an acceleration higher than that of the gravitation. The particles of 1 micron diameter are important with the weather plan because they constitute very effective kernels of condensation for the steam

- Infra-microscopic particles constituting the smallest elements of the airborne dusts of diameter lower than 0.1 micron. Their size can go down below 10 Angström. They are often named particles of Aitken. Their average diameter is of 300 Angtröm.

Introduced into average stratosphere, the particles insédimentables have there an average time of two years stay to 18 km of altitude.

Several factors contribute to the formation of aerosols (R. KANDEL):

- particles removed on the ground by wind erosion (approximately 1 billion tons of dust raised in the arid areas each year);
- various soots and ashes resulting from combustions (bush fires and forest fires: approximately 100 million tons a year)
- particles produced by the evaporation of the marine spray, mainly of the salt crystals (more than 1 billion tons a year)
- successive produced gas transformations by the decomposition of the algae and the marine plankton into compounds hydrated of the sulphuric acid (approximately 250 million tons a year)
- falls of meteorites: the terrestrial atmosphere plays a protective role with respect to the meteorites. However, most important can reach the ground and generate remains and dust which limits the passage of the light. Certain theories explain the provision of the dinosaurs by this phenomenon 65 million years ago.
- Volcanic eruption: the great eruptions rejètent in altitude in the stratosphere of dust and the sulfur dioxide which form a light veil of mist and intercepts part of the solar radiation thus.

Several volcanic events have seems it marked the climatic history of planet. In 1450 before J.C., the volcanic eruption of Santorin at sea Egée, the temperature east is seemed T it lowered approximately 0.5°C during the summer which followed
In 1815, volcano TAMBORA (island of SUMBAWA in Indonesia) exploded. Its altitude which exceeded 4000 meters reduced to 2200 meters after the eruption.
Its effect on the climate has seems T it be very significant: no the summer in England News and in Western Europe, temperature lower by 3 degrees compared to the normal, freezing and snow every month in certain European areas.
The Indonesian volcanos KRAKATOA (1883) and Augun (1963), the Holy Mount Helens (1980) in the United States, El Chichon (1982) in Mexico, and Pinatubo (1991) in Philippines also contributed to a significant cooling.

2.2.5 Greenhouse effect

Discoverers of the greenhouse effect
One of the very first scientists to be been interested in the calorific effects of the solar radiation is the Genevese Horace-Bénédict de Saussure (1740-1799): one must to this general-purpose naturalist, to physicist, to climatologist, to geologist and to mountaineer at his hours, an apparatus baptized “heliothermometer”, which is in fact the ancestor of the modern solar panel. Constituted by a series of encased cases the ones in the others, isolated thermically and whose glazed east coast, the heliothermometer, as the watch of Saussure, can have practical applications, for example to make boil water or to even cook food.

In 1824, the French physicist Joseph Fourier (17861830) publishes his Reina rques. general on the temperatures of the Globe and worldwide spaces, where he presents the idea according to which the atmospheric envelope of the Earth would behave like the glazing of a greenhouse. Jacques Joseph Ebelmen (1814-1852), professor at the école des Mines of Paris and administrator of the royal Manufacture of the Sèvres chinas, are the first to suggest that changes of the cycle of carbon could vary in the past the atmospheric content “carbon dioxide” and, by flies of consequence, the climate of the Earth. This pioneer of geochemistry writes in 1845 that “several circumstances tend nevertheless to prove that at the old geological times the atmosphere was denser and richer in carbon dioxide, and perhaps oxygenates some, that at the time current. To greater gravity of the gas envelope were to correspond a stronger condensation of solar heat, and atmospheric phenomena of a much greater intensity”.

But it is to the Irish chemist and engineer John Tyndall (1820-1893) that one owes the first experimental data on absorption and the emission of the infra-red raies by gases. It carries out meticulous persons experiments using a spectrophotometer of its design, whose tube can be filled up various mixtures of gas to variable pressures. Its analyses relate to the capacity of absorption of many gases, like the steam, carbon dioxide, various organic molecules, of the halogenous compounds and finally ozone (it is besides the first to write that ozone consists of groups of oxygen atoms). Also being interested in the terrestrial environment, Tyndall is convinced of the importance of the greenhouse effect in climatology.

It depicts with dramatic accents England from which the atmosphere would be deprived of greenhouse effect, “This steam is a cover even more essential to the vegetation of England than clothing is it to a man…” Joining Ebelmen without the knowledge, Tyndall affirms also which “all the transfers of the climate which search of the geologists reveals” can be related to variations of the atmospheric contents greenhouse gas.

Source: E. HAND-BARROW, nine keys to understand the greenhouse effect. Files of search n°17, January 2005

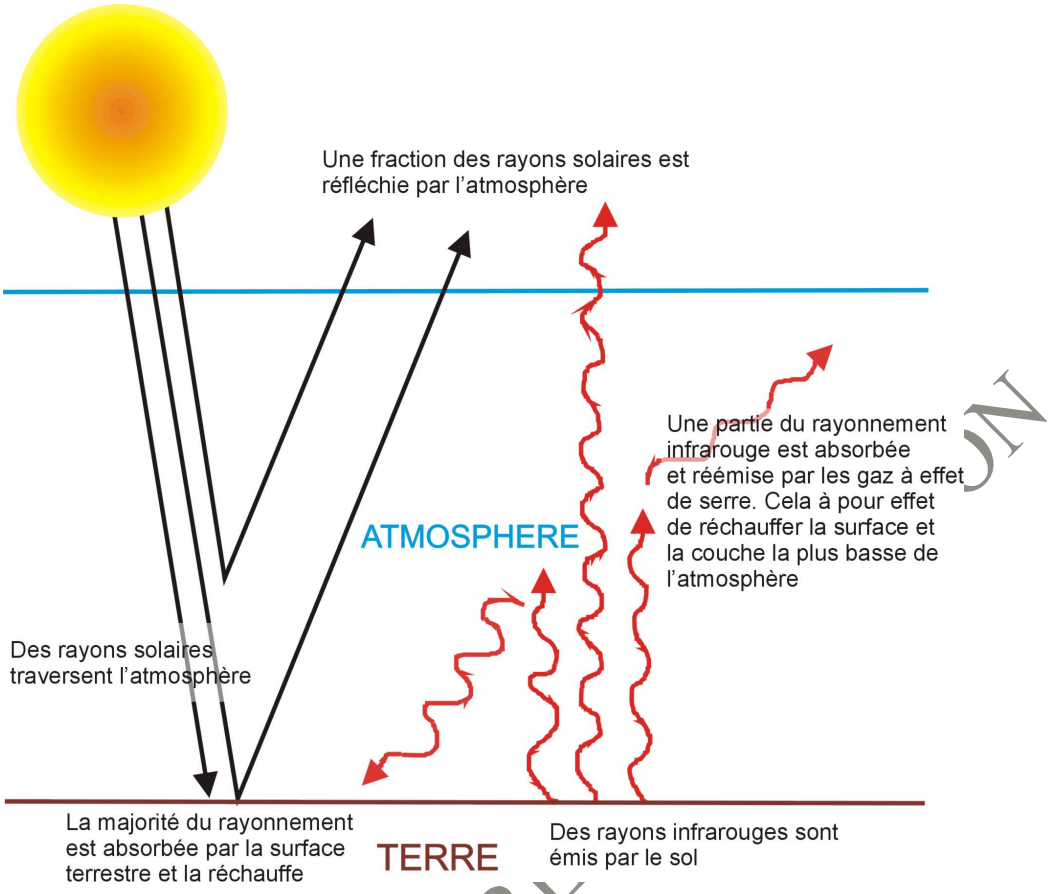


Figure 13: Principle of the greenhouse effect

The greenhouse effect is a natural phenomenon of trapping by the atmosphere of the fraction of radiation broadcast by the surface of the Earth (with the image of the rise in temperature inside a car exposed to the sun).
The greenhouse gases have the characteristic to be transparent with the light viewable and opaque for the main part of the infra-red radiation emitted by the ground. This opacity depends on the nature of the connections, the geometry of the molecules and the relative masses of their atom. Parallel To the steam, principal greenhouse gas (55%), CO2 accounts for 40% of the greenhouse effect. Other gases (methane, protoxide of nitrogen and ozone represent each one approximately 2% of the greenhouse effect.
The historical studies on the history of the climate seem to show a close link between the content CO2 and the average temperature. Thus, the greenhouse gases are in the middle of the debate related to the anthropic evolution of the climate. The CO2 concentration which was maintained with 280 ppm since hundreds of million years currently reaches a level of 380 ppm is an increase of almost 35% since the beginning of industry. Thus, in one century, the average temperature rose of 0.6°C and the sea level went up according to the areas from 10 to 25 centimetres.

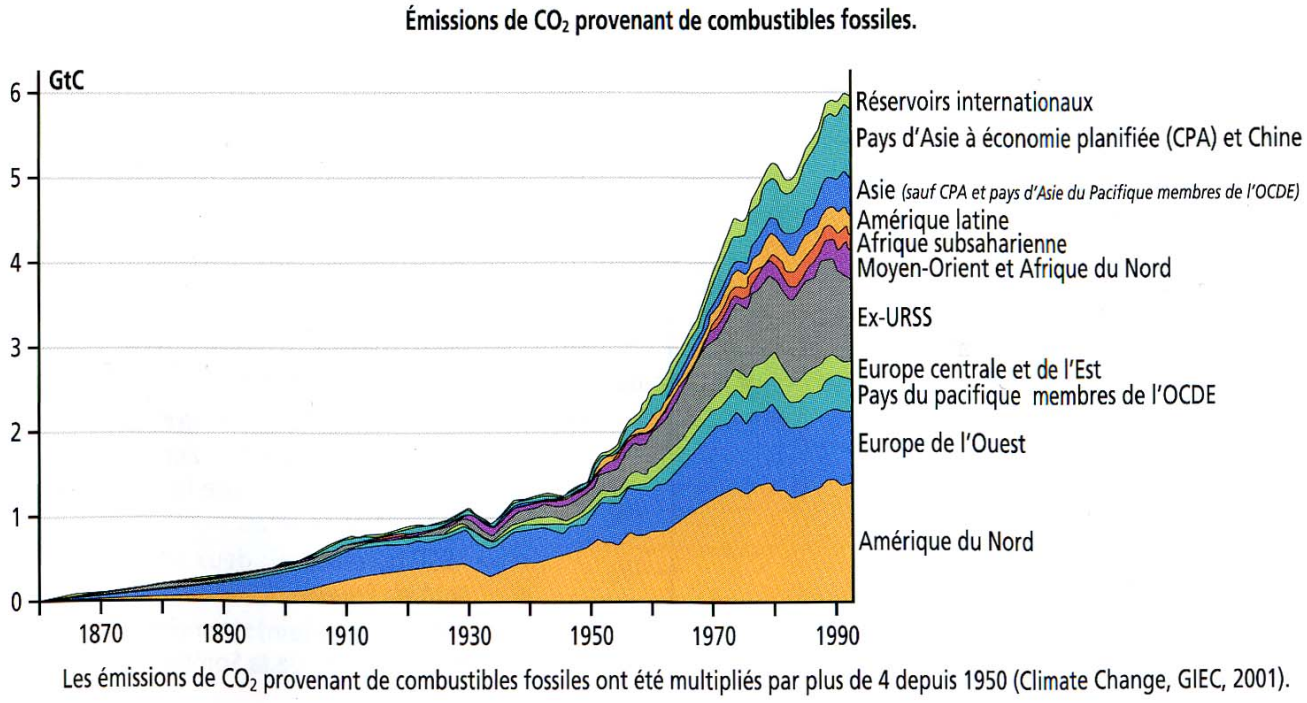


Figure 14: CO2 Emissions coming from fossile fuels

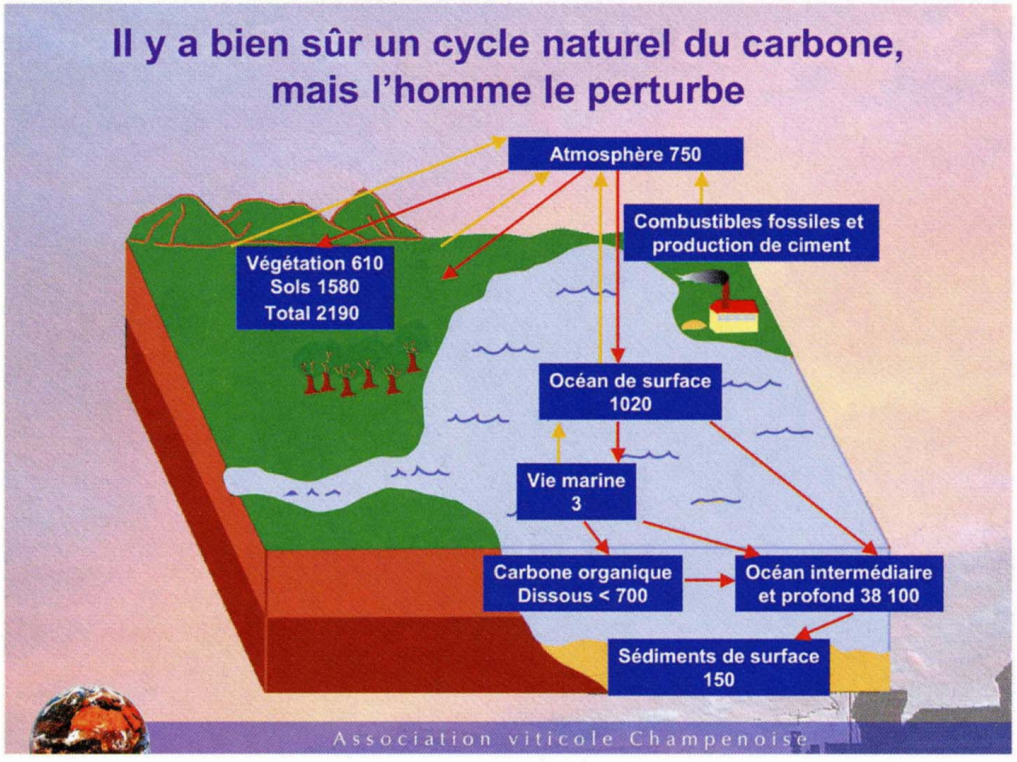


Figure 15: Exchange carbon (in gigatonnes)
Source: Champagne Wine Association

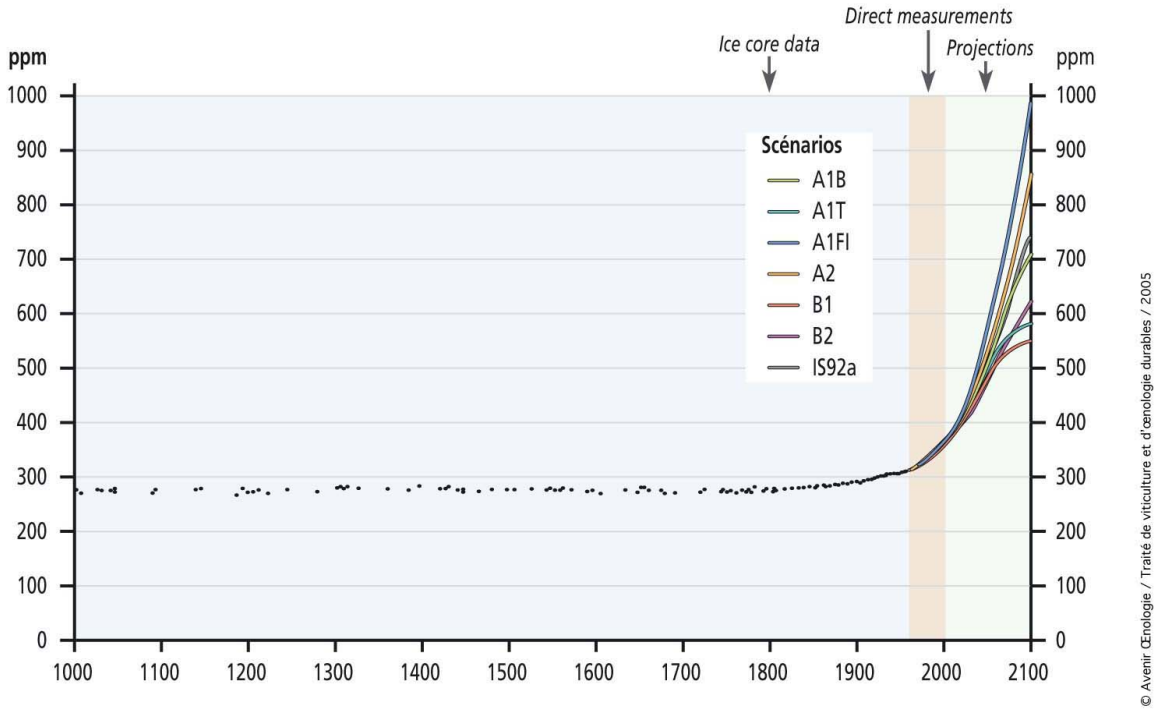


Figure 16: Evolution of the CO2 concentration for these various scenarios
Source: Climate Changes 2001, the scientific Basis, GIEC, 2001

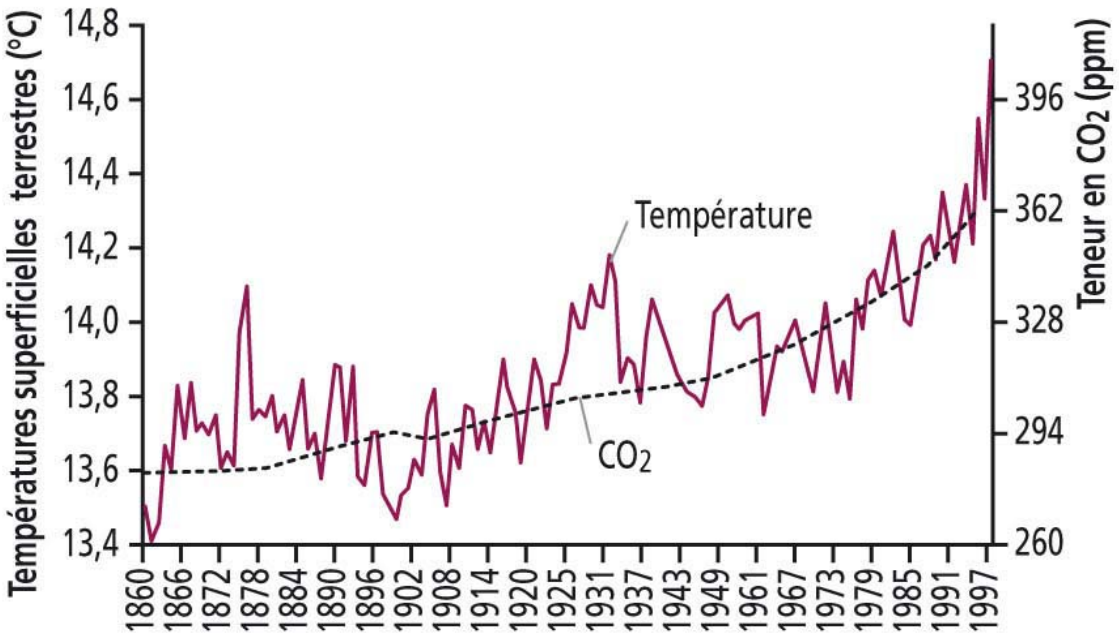


Figure 17: Correlation enters the cursory temperature variations and the content CO2 since 1860
Source: Karl and Trenberth, Saw. Land-mark., vol.281, 1999

2.3 Recent History

The recent history of the climate is described by R. DELORT. After the glaciations of time known as protohistoric, the last, Würm (which occurred between 80,000 and 10,000 years before our era approximately) saw to start a deglaciation, 14,000 years ago. The plants and the trees regained on the tundra, from the south towards north. One then has evidence of human activities on all the continents.
There are 8000 - 7500 years, one attended creation, cataclysmic, of the two most recent seas of the world: the North Sea invaded the chain of the lakes which was to there the Baltic, while the Mediterranean pushed its water through Dardanelles then the Bosphorus, transforming, there still, a lake in two seas, Black Sea and sea of Azov.

The observation of fresh water fossils immediately under the sea water fossils leave think that this phenomenon proceeded very quickly so much so that some suppose that this event was at the origin of the account of the flood describes in the Bible.

Currently, we are always in the old postglacial one who followed the last glaciation (Würm), old called party Würm IV or Holocene. This One breaks up itself into five periods.

- Theboreal one, between 8200 and 6800 before our era. The temperature goes up, the birch develops towards north, then the oak, the elm. One observes also the projection of the reindeers, musk oxen, the mammoths
- The boreal one, between 6800 to 500 before our era. Rather hot and dry, it is marked by the arrival of the coniferous trees and the hazel trees, while fauna becomes populated aurochs, bisons, wild boars, horses, deer tribe, rabbits. A saving of gathering and hunting develops.

- The Atlantic, between 5500 and 2500 before our era. Moderated and wet, he sees the sea level increasing quickly, sometimes of 4 meters per century. It is this rise of water which has creates the Baltic and the Black Sea but also cut British Isles of the continent. The man becomes sedentary. He starts to domesticate the sheep, the goats, the beef animals. It is the beginning of Neolithic agriculture and the copper age.

- Theboreal one, between 2500 and 700 before our era. Drier, a little less hot, he sees the retreat of the beeches, the spruces. The culture takes seat beside nature. The Indo-European ones bring, with the horse, the tank, the wheel, iron: it is very schematically, the Bronze Age then the age of iron.

- The sub-Atlantic finally which begins 700 years before our era. It is during this hot and wet time that we currently live.

During the last millenium after the optimum of the Middle Ages (fine of the 10th century until the 12th century) the climate gradually cooled for the period called “small old glacial (1550-1850).
Starting from 1880, the climate was heated significantly. The rise of temperature for one century estimated at 0.7°C, has seemed to have an origin, at least partially anthropic.

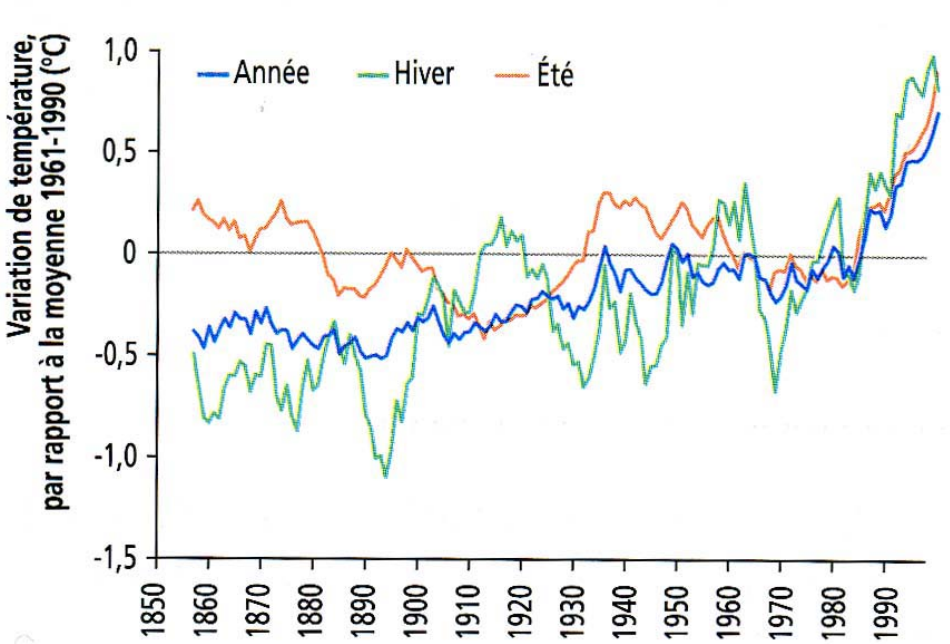


Figure 18: Evolution of the winter and estival annual average temperatures since 1850
Source: VINTAGE, 2003; Jones and Moberg, 2003

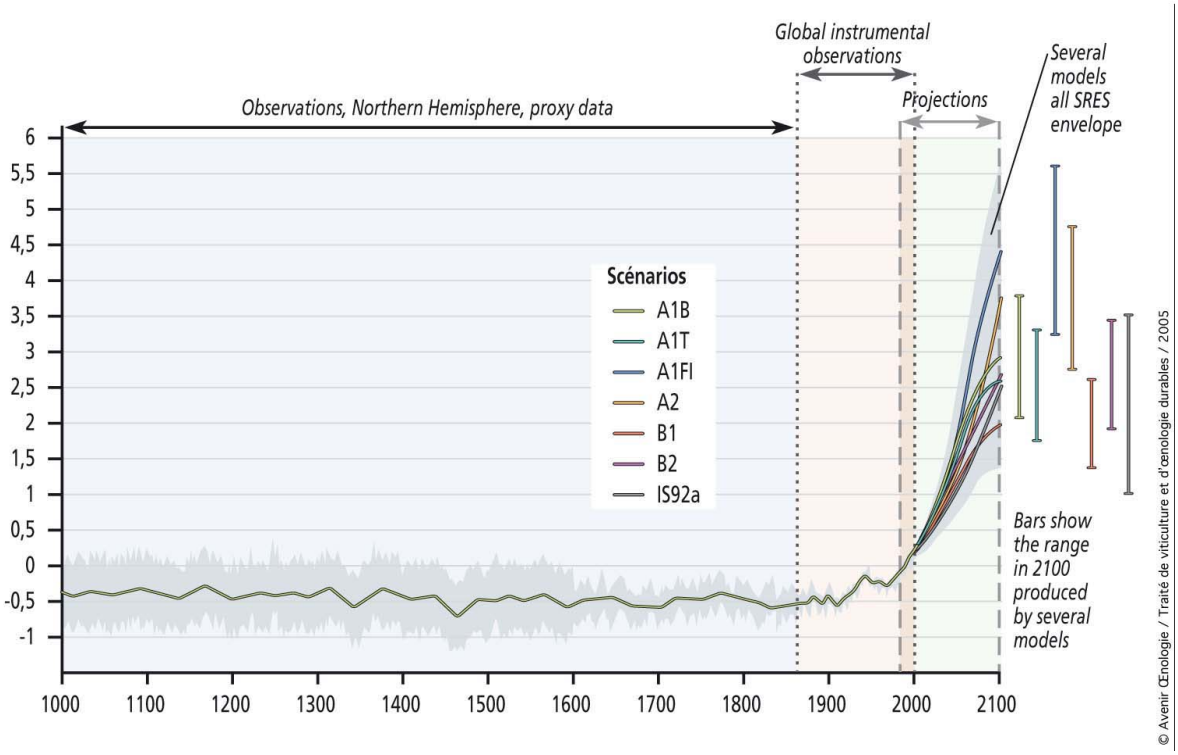


Figure 19: Evolution of the average temperature of have on the level of the ground
Source: Climate Changes 2001, the scientific Basis, GIEC

III PROSPECTS FOR EVOLUTION

3.1 Introduction

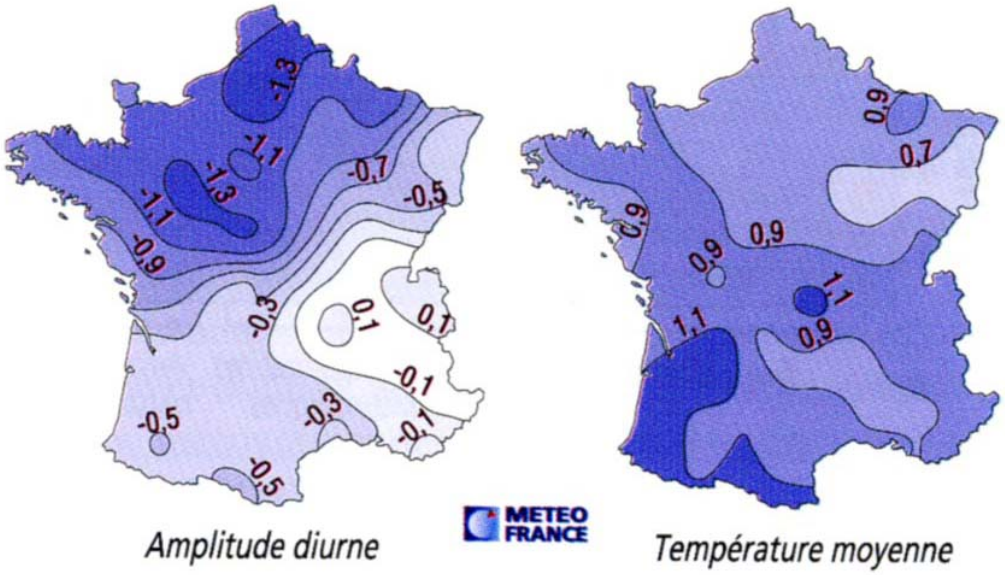


Figure 20: Variation of the temperatures in France (1901-2000)

The reality of the warming since 1860 is not any doubt (approximately 0.7°C) but the temperature curve does not follow a regular rise (R. KANDEL).
The warming marked (+ 0.2°C) between 1910 and 1940 a pause succeeds until 1975 and then a fast rise (0.4°C) of 1975 to 1999. By report this tendency of the more specific events has can be observed related to the variations of the phenomenon El Nino (point of heat in 1991 and 1992 then in 1997 and 1998 and cooling in 1992 following the eruption in 1991 of the PINATUBO in Philippines. It appears that overall the average temperatures of these last years exceeded the maximum level reached during the last four centuries. However, it seems that the weather was hotter approximately thousand years ago at the time of the optimum of the Middle Ages but with probably a slower evolution.

The Swedish scientist ARRHENIUS had by 1896 considered a warming of with the combustion of the fossil fuels, at the time considered like a mid-sized to counter the return of the ices. Nevertheless until 1975, a debate was established in the scientific community. However, a finer knowledge of the climate seems to lead to a consensus of the scientific world, formalized with the international level by the conferences of Rio De Janeiro in 1992 and Bonn in 1999. The current uncertainties taken into account by the Intergovernmental Grouping on the Evolution of Climate (GIEC) result in a rather important variability in the forecasts of the warming.

3.2 Protocol of Kyoto

This international protocol has the aim of implementing the Convention of the United Nations on the climate changes, adopted in 1992 at the time of the conference of Rio. Ratified in Kyoto in December 1997, this protocol aims to plan on a total scale the stop then the reduction of gas emissions for greenhouse effect.

It was ratified by many countries with requirements of reduction in emission but the commitments are not always held with the image of the position of the United States.
The European Union of the fifteen ratified the protocol of Kyoto, and thus began to reduce its gas emissions for greenhouse effect of 8% between 2008 and 2012. The European Agency of the Environment, AEE, raised and underlined in a report that the U.E had moved away from its objectives: In 1990, the gas emissions for greenhouse effect knew a light retreat of 1.7%, whereas in 2003 the rise of greenhouse gases amounted to 1.3% compared to the year 2002. Moreover in 2003, the gas emissions for greenhouse effect increased:

- 2.3% in the households and the services
- 2.1% in industry
- 0.7% in transport

3.2 Radiative Assessment

This method (J. HANSEN and Al) is based on a calculation of the climatic disturbances expressed in Watts per square meter (w/m ²).

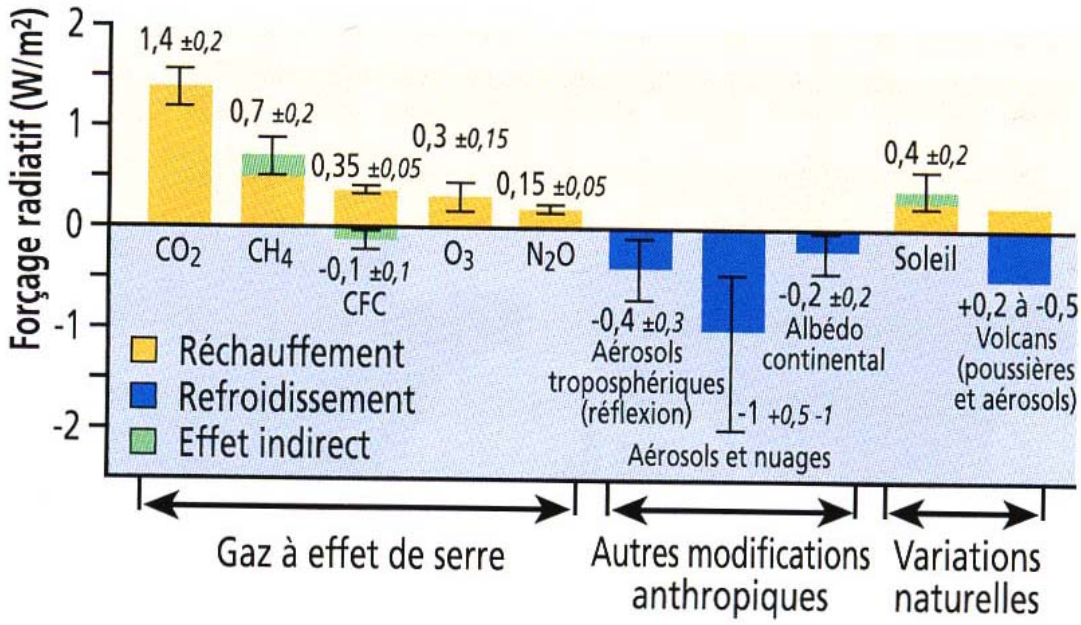


Figure 21: Radiative Assessment since 1850, according to J. Hansen and Al PNAS 2000

The ground receives on average 342 Watts per square meter in the form of light rays coming from the sun. The influence of the activities of the man of 1850 is estimated at + 1.3 w/m ² by deducting the effect of the factors of cooling compared to greenhouse gases.

CONCLUSION

Sustainable development falls under a worldwide and intergenerational prospect which escapes an immediate and local concrete perception sometimes. The potential evolution of the climate is revealing total impacts associated with the human activities. Obviously, the viticulture falls under this debate of the positive or negative contributions opposite in particular of the greenhouse effect.

The history of the humanity, associated with the development of sciences was registered until now in an expansionist context. Any scientific projection offered new prospects of development which seemed without limits. Force is to note now that the capacitances of adaptation of our planet are not infinite. Thus, our soils and each one among us will be subjected tomorrow for a purpose of worldwide boomerang, bound directly to the cumulative effect of our individual behaviors.

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