The Climate of the Earth during the Third Millenium

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Abstract

The global mean surface air temperature has increased over the last century by about 0.8°C, the rate over the last 25 years being 2 times as much. Year 1998 was the warmest year of the last 100 years for which instrumental data are available (0.59°C above the average of the conventional period 1960-1990). It is also the warmest year of the last millennium for which there is reliable reconstruction of climate change. The second warmest year is 2005 with 0.48°C above the mean. 2002 and 2003 come in third position (+0.47°C) followed by 2004 (+0.45°C). It is very important to note that 2005 was approaching the 1998 record, although there was no El Nino in 2005 contrary to 1998. In Europe, the warming since 1900 has reached 0.95°C. Temperature has increased more in winter than in summer and the warming was maximum in north-western Russia and in the Iberian Peninsula. Some regions experienced changes in climate variability and in extreme climate.

One of the consequences of the global warming is the melting of all the large continental glaciers. In addition, mean sea level was observed to rise by some twenty centimetres over the last 100 years. This sea-level rise reaches now 3mm per year, due to the thermal expansion of the oceans (1.8), melting of the glaciers (0.5), melting of Greenland (0.15) and western Antarctica (0.2) and the ever increasing use of underground water reserves. Moreover, sea ice over the Arctic Ocean becomes thinner and thinner and disappears.

The accumulation of carbon dioxide in the atmosphere due to fossil fuel burning for energy production, the release in the atmosphere of other trace gases that modified the radiative balance of the climate system, land use change for intensive farming related to population explosion, and massive deforestation makes the Human Being an important factor acting slowly but strongly on the climate changes for the next decades. Atmospheric CO_2 concentration is now over 380 ppmv. This is much more than what the Earth experienced over the last millions of years.

According to the Intergovernmental Panel on Climate Change (IPCC), the globally averaged surface temperature is projected to increase by 1.4 to 5.8°C over the 21st century, depending on the scenarios. The temperature over Europe would increase by 3 to 4°C. Consequently, global mean sea level is projected to rise by 9 to 88 centimetres and the hydrological cycle could be intensified. Precipitation over Northern Europe should increase by 1 to 2% per decade while in Southern Europe summer would become drier and winter more humid.

These changes would lead to in depth modification of the climate zones, and, therefore, of the regional climate, and its associated farming, economical and social infrastructure.

In 2004, the greenhouse gas emissions in Belgium were above the Kyoto target and emission projection shows that Belgium will be above its target by some 10 millions of tons in 2010. It is therefore urgent to question the Belgian policy (and at the European level) of energy production and consumption, e.g. nuclear, thermal and renewable electricity production.

At last, the projected global warming obliges us to think about its impacts on environment and Society, as well as about its long-term consequences (over the next millennia). Modeling experiments made in LLN show indeed that if the greenhouse gas concentration becomes larger than about 750 ppmv, Greenland ice sheet will melt in about 5 to 10 thousands years (with at least +6m in sea level) and the climate system will take 40 thousands years to recover from the perturbations created by human activities in the 20 and 21st centuries.