

Climate change in perspective by Stefan Rahmstorf (PIK)

Monday August 28th 2006 (day 2)

Resume by Katrine Hahn

This very informative and comprehensive talk - with an overwhelming amount of figures, data and sharp points - provided us with 1) an overview of basic facts of climate changes and 2) a basis for our upcoming discussions about ecosystems and their services.

Stefan started out by giving an overview of natural causes of climate changes:

- 1) Plate tectonics. Scale: million of years.
- 2) Earth's orbit (the Milankovich cycles) (due to eccentricity). Scale: tens of thousands of years (ice-age drivers).
- 3) Solar variability. Scale: tens to hundreds of years.
- 4) "Events", e.g. volcanic eruptions (aerosols + sulphur), meteorites. Scale: short-term .

In the following statements related to the above four causes and the importance of scale are given in more detail.

- The carbon cycle is a closed cycle of CO₂ and its variation between the atmosphere, the oceans, and the biosphere.
- Longterm data about the carbon-cycle cover 600 mio years but there is a huge variation and a high degree of uncertainty.
- Ice cores cover the last 700.000 years and are much more certain.
- A low CO₂ level causes low temperatures.
- Over the last 70 mio years there has been a general decrease in the CO₂ concentration => glaciation at the poles. However, there has been abrupt changes within that period, for example a sudden warming 55 mio years ago due to massive CO₂ release. The reason is unknown (suggestions include methane, meteorite, volcanic activity). This warming has been used as an analogy of the present day release of carbon from the earth crust – although the present day release is human induced.
- A long-term trend is that the global mean temperature influences the sea level

Now moving on to the anthropogenic climate changes, Stefan pointed out that this has two meanings:

- 1) "Anthropogenic emission of greenhouse gasses will lead to a significant global warming of 1.4-5-8° C in the period 1990-2100."
- 2) "Human activities have already noticeably changed the climate"

Only statement 1 is policy-relevant.

Evidence for statement 1):

- The CO₂ concentration in the atmosphere is rising from app. 280 ppm (last 600.000 years) to 360 ppm at present.
- This trend is anthropogenic. There has been an emission of 244 billion tonnes carbon over the last 100 years. 57% of this explains the atmospheric increase. 43% is taken up by oceans and the biosphere.
- The rise of CO₂ concentration in the oceans is causing an acidification.

Evidence for statement 2):

- Increase in global mean temperature has been + 0.8 °C since 1900.
- There are large glacial retreats.
- The ice cap is shrinking (melting).

The above documentation led Stefan to the conclusion that the cause is predominantly anthropogenic. Further:

- The warming magnitude is what we expect from the rise in greenhouse gasses
- Other possible causes, including solar activity, volcanic activity, cosmic rays, show no significant trends for the last 65 years.
- Pattern detection (fingerprints) show that warming patterns agree with the green house gas effect
- The warming is unusual within the last 100 years.

But what about the future? A vast number of sensitivity analyses of climate changes come to the following conclusions:

- A doubling of the CO₂ concentration => increase in temperature of 4-6 °C (Arrhenius 1896)
- Modern calculations using radiative forcing and physical feed-back predict an increase of 2-4.5 °C (IPCC)
- Predictions based on ice cores (including methane) predict 3-4 °C increase (but are a little uncertain because they are based on arctic temperatures rather than global mean temperatures)
- Models using last glaciation maximum predict a 1.2-4.3 °C increase.
- Models using only data from the last 100 years are problematic because they lack an upper constraint and end up with estimates like 11 °C increases.
- **Based on all these studies a rule of thumb is: A doubling of the CO₂ concentration in the atmosphere will lead to an increase in the global mean temperature of 3 ± 1 °C.**

It should be noted that the EU policy goal is an increase of maximum 2 °C and that the UN goal is to stabilise the development to avoid dangerous events.

The final part of the talk focused on the consequences of global warming. These consequences are two-sided as they include 1) changes marine and terrestrial ecosystems as well as 2) human suffering.

- Heat waves, e.g. Europe in summer 2003.
- Significant increase in winter precipitation (possible causing flooding) (warm air holding more water)
- Ice sheet melting (at an order of centuries rather than millenia!). This is presently causing a sea level rise of 3 mm/year.
- Tropical storms and hurricanes (more intense hurricanes in warmer climates)

It should be noted that there for all the above is regional variation.

The discussion was lively and covered issues like media-hype versus scientific facts, changes in terrestrial and marine ecosystems, reasons for flooding, and effects on biodiversity.

TAKE-HOME MESSAGE FROM THE TALK:

- There are long-term and large-scale natural changes in the carbon cycle
- CO₂ concentration in the atmosphere is rising fast at present
- Humans are playing a major role by carbon releasing activities
- Temperature is increasing and will increase in the future
- This has effects on our ecosystems due to changes in precipitation and temperature patterns, sea levels, and hurricane intensity.