Background Paper for Session I: Climate Stabilization

Scientific understanding of Climate Change & Associated Risks, Consequences for a Global Deal

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1 Scientific Basis

Important insights of climate research have been well confirmed in recent decades and are now generally accepted as fact by the scientific community. Key findings include a rapid increase of carbon dioxide concentrations in the atmosphere during the last 150 years from 280 ppm (a value typical for warm periods during at least the past 700,000 years) to now 380 ppm. This rise is entirely caused by humans and is primarily due to the burning of fossil fuels, with a smaller contribution from deforestation. CO_2 is a gas that affects climate by changing the Earth's radiation budget: an increase in its concentration leads to a rise in near-surface temperature. If the concentration doubles, the resulting global mean warming will likely be between 2 and 4°C (the most probable value is ~3°C). Since 1900, global climate warmed by ~0.8°C. Temperatures in the past ten years have been the highest since measured records started in the 19th century and for many centuries before that (Fig. 1).

Most of this warming is due to the rising concentration of CO_2 and other anthropogenic gases.

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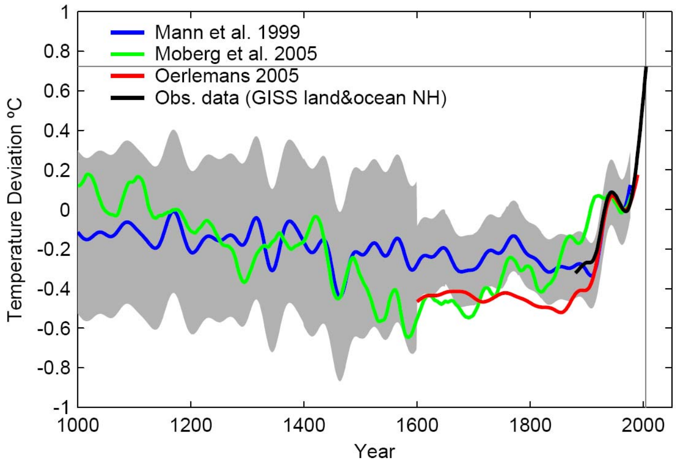

Fig. 1: Temperature in the Northern Hemisphere during the past millennium. Shown is the classic reconstruction of Mann et al. 99 (with its uncertainty band in grey) as well as two new reconstructions including sediment data (green) and using glacier extensions (red). Black is the land and ocean observations up to 2005 (NASA GISS). Curves are smoothed over two decades and show deviations relative to 1951-1980.

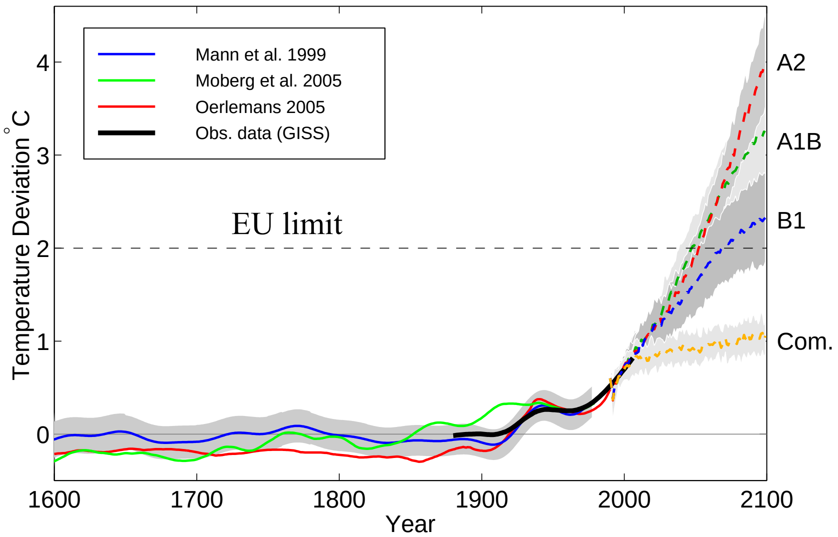

Fig. 2: IPCC projections for global mean temperature in the 21st century in comparison to past variability and reconstruction uncertainty from Fig. 1. Three different scenarios are shown: The red curve represents the "business as usual" case (A2) in which greenhouse gas emissions rise comparable to the present rate. The shading gives the standard deviation from the ensemble of different model simulations. Yellow is the so-called warming commitment, i.e., the temperature increase observed if greenhouse gas concentrations are kept fixed at the current level. The EU 2°C-target is shown as a horizontal dashed line.

It follows that a further increase in CO_2 concentration must lead to a further rise in global mean temperature (Fig. 2). For a range of plausible assumptions about future emissions (from 1990 to 2095), this rise will be in the range from ~2 to ~7 °C above pre-industrial .

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For comparison: The last major global warming happened at the end of the last great Ice Age (about 15,000 years ago); it involved a global warming of ~5°C over a time span of 5,000 years. Unchecked anthropogenic warming could reach a similar magnitude over a fraction of this time – and, of course, starting from an already warm climate.

2 Impacts and Risks

Whether this warming is considered "dangerous" change can, of course, not be determined by scientists alone, as it depends on societal value judgments about what is dangerous. However, science can help to clarify what are the risks that arise from such unprecedented warming. Amongst the most important risks are the following:

- **Sea level rise and loss of ice sheets.** In the 20th century global sea level rose by 15 – 20 cm. Currently, sea level is rising at 3 cm/decade, faster than projected in the scenarios of the IPCC Third Assessment Report. Future rise by 2100 will likely by less than one meter, but even if warming is stopped at 3 °C, sea level will probably keep rising by several meters in subsequent centuries in a delayed response (Fig. 3). Coastal cities and low-lying islands are at risk. What is now a once-in-a-century extreme flood in New York City (with major damage, including flooded subway stations) would statistically occur about every 3 years if sea level were just 1 meter higher.

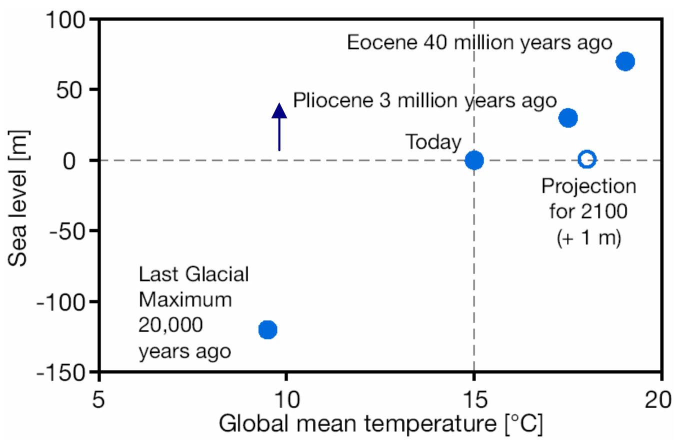

Fig. 3: Mean global temperature and sea level (relative to today's) at different times in Earth's history, with the projection for the year 2100 (1m above today's sea level). For the long term probably a much higher sea-level rise must be expected (blue arrow). Source: Archer, 2006.

- **Loss of ecosystems and species.** Global temperatures would reach a high never seen for millions of years, and the rise would be much too fast for many species to adapt. A large fraction of species – some studies suggest up to one third of species – could be doomed to extinction already by the year 2050. Life in the oceans is not only threatened by climate change but by the equally serious problem of the perpetual global ocean acidification, which is a direct chemical result of our CO_2 emissions independent of the warming effect.

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- **Risk of extreme events.** In a warmer climate, the risk of extreme flooding events will increase as warmer air can hold more water (~7% more for each degree °C of warming). Hurricanes are expected to become more destructive: an increase in energy, not frequency, of hurricanes is suggested in response to rising sea surface temperatures by both models and data (Fig. 4). A number of recent studies has shown that the observed rise of sea surface temperatures in the relevant areas of the tropics is primarily due to global warming, not to a natural cycle.

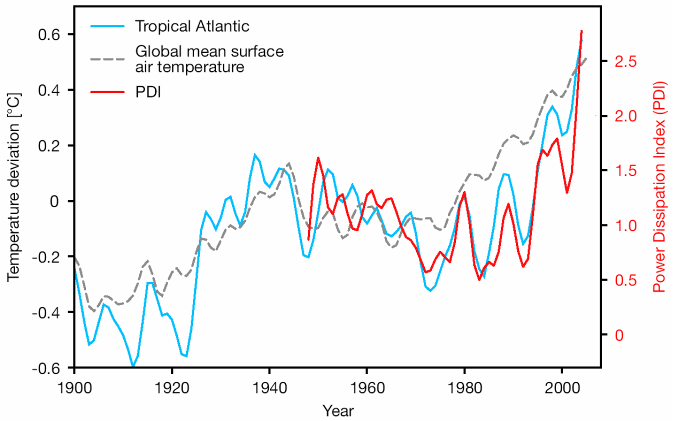

Fig. 4: Temporal development of the energy of tropical storms (Power Dissipation Index - PDI, red) and the average sea-surface temperature in the tropical Atlantic from August to October (blue). For comparison, the evolution of the globally averaged near-surface air temperature is shown (dashed grey line). Source: Emanuel, 2005

- **Risks to water and food supplies.** While the total global agricultural production may not decline in a warmer climate, many poorer and warmer countries can expect reductions in yields due to water shortages and weather extremes. The water supply of major cities like Lima is threatened when mountain glaciers disappear.

- **Non-linear responses - tipping points.** For some climatic subsystems, positive feedbacks have been identified, which may self-amplify the response to external disturbances. Among these are the large-scale ocean circulation in the Atlantic, the Arctic sea ice, the Greenland and Antarctic ice sheets, and the Indian monsoon circulation. Some of these changes can be irreversible.

These are only examples - the exact consequences of such a major change in climate are difficult to predict, and surprises are likely.

3 Avoiding Dangerous Climate Change

In the 1992 United Nations Framework Convention on Climate Change (UNFCCC), nations committed themselves to preventing a "dangerous interference" with the climate system. To avoid the most dangerous consequences of climate change, the European Union decided to keep global average temperature rise below 2°C in comparison to pre-industrial levels (EU limit, see Fig. 2). Though uncertainties regarding the carbon cycle remain, the necessary reduction in emissions is roughly 50% by 2050, compared to the

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level of 1990, ±10%. In addition, global emissions must peak and decline in the next 10 to 15 years.

According to latest economic modeling results (see special issue of the *Energy Journal*, 2006, edited by O. Edenhofer et al., as well as the *Stern Review* published in November 2006), this can be achieved with minimal costs (~1% lower GDP by 2100) by induced technological innovation, including increased energy efficiency and renewable energy technologies (wind, biomass, solar). The background paper for Session II outlines the various energy scenarios associated with targeted atmospheric concentration levels.

4 "The Global Deal"

The UNFCCC and the Kyoto Protocol have been guided by the IPCC findings. In order to avoid operational disruption after the first commitment period of the Kyoto Protocol (ending in 2012), the next round of focused negotiations should begin in December 2007 and be completed by 2009. Core elements of that post-2012 climate agreement are discussed below. The broader issues of how to achieve climate protection while sustaining the process of economic development in poor countries as well as the challenges of tackling climate change while operating in a modern society that defines its success on unending growth and resource use is addressed in the Session III background paper.

Criteria

In order to guide and evaluate the options for a global deal which addresses both mitigation and adaptation, a basic set of criteria has to be met. Clearly each society and constituency will rank the various criteria differently. While only twenty-five countries are responsible for 83% of emissions, a global package must also take into account interests of the most vulnerable countries':

Criteria for an adequate post-2012 regime include:

- Climate effectiveness. Limiting global mean temperature increase to a maximum of 2° C above the pre-industrial value.
- Inclusion of major economies. Focus on industrialized countries with fair contribution from other countries.
- Fairness. The principle of equity is a particularly important one for all, but especially for the developing countries who have contributed the least to this historic problem thus far.
- Consistency with achieving development and economic goals.
- Engagement of markets for economically efficient and effective solutions. Unleash innovation and shift investment.
- Inclusion of adaptation measures.

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I. Vision for international climate protection: low carbon development and 2°C

The goal of limiting global temperature rise to 2°C lends a strategic direction to economic development in this century. This goal calls for at least a halving of global emissions of greenhouse gases by 2050 compared to 1990 levels.

II. Creation of a global carbon market

Establishing a reliable and long-term price signal for carbon dioxide creates effective incentives for worldwide mitigation of greenhouse gas emissions. A carbon market generates this price signal and at the same time creates the flexibility which participating companies need with regard to when and where they wish to achieve the required emissions reductions. Alongside emissions trading, the Kyoto mechanisms should be scaled up and the European Emissions Trading Scheme linked up to comparable systems in other regions (e.g. North America, Australia, Japan and other countries, including emerging economies).

Furthermore, auctioning emission allowances and imposing charges on the use of the market can generate resources for financing adaptation measures, developing key technologies and/or reducing emissions from deforestation.

III. Ambitious emissions reduction commitments for industrialised countries

A stable and sufficiently high price level on the international carbon market presupposes ambitious absolute and binding emissions reduction targets for industrialised countries. Such binding targets are also a politically necessary sign by those countries primarily responsible for presently observed climate change. The group of industrialised countries should reduce its emissions by around 30% by 2020 compared to 1990. By 2050 the emissions of this group of countries must be reduced by ~80%. Countries with higher per capita emissions and a higher emissions intensity in their national economies should contribute more.

IV. Measurable, reportable and verifiable measures in developing countries

The involvement of developing countries must take their very varied starting conditions into account and requires attractive incentives for emissions mitigation. A staged international regime which varies in form for the different countries according to their historical emissions, per capita emissions and per capita income (multi-stage approach) would both bend emissions growth in emerging economies and ensure that sustainable development goals are met.

In detail, this means that the poorest countries are initially exempt from new commitments on emissions limitation and the most advanced countries (e.g. South Korea, Saudi Arabia) would be required to take on national caps. Middle income countries would commit to scaling up their efforts to decouple economic growth and emissions and quantifying and measuring these contributions internationally.

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After 5-10 years in each case, incentives and commitments of the countries concerned should be re-assessed in light of their economic development. Gradually, all countries will make increasingly ambitious contributions to global emissions reduction.

V. Technology: development, market development, market penetration

In addition to creating a binding and ambitious commitment framework, it is also necessary to strengthen the links between research, development, market diffusion and technology transfer. While a growing carbon market and a strong price signal for CO_2 will have a major influence on the use of currently available technologies, new measures and mechanisms are also needed in order to develop and disseminate emerging technologies.

At a multilateral level, industrialized countries must commit to making a larger contribution to funding technological progress in developing countries. This financial support will be provided through a **technology fund** to be set up. The fund will focus on joint R&D projects and the demonstration of key technologies, as well as deployment of already existing technologies.

In order to leverage private sector capital, the fund should grant co-financing for research, development and implementation, and receive applications for joint R&D projects from both private companies and developing country governments. By making it possible for these countries and companies to apply for co-financing from the fund, 50% to 75% of the total costs of "decarbonisation" could be provided by private sources from industrialized countries.

According to estimates in the Stern Report, an appropriate financing for decarbonisation (e.g., reversing the trend in the global emissions over the next 10-15 years) would be secured if industrialized countries committed to providing around 20 billion US dollars a year up to 2015 in addition to the revenues from the co-financing. The options for financing this fund include using part of the "assigned amount" of each country for the next commitment period for the fund; auctioning some of the allowances; and/or using public funds of the industrialized countries.

In parallel, trade and investment barriers should be dismantled for climate-friendly products so that a profitable market for such technologies and products would develop in the participating countries.

VI. Adaptation: climate-proof investments and risk management

Adaptation efforts must be significantly scaled up in the post-2012 regime, addressing the fact that many of the most vulnerable countries are already experiencing the impacts of climate change. Three key elements should be included:

1. An **international adaptation fund** to support adaptation in developing countries. Such a fund would cover a significant part of the expenditures of developing countries.

2. A **compensation mechanism for disasters** and other extreme weather events, especially in the poorest developing countries, e.g., through insurance mechanisms.

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3. A commitment by industrialized countries to make their **investments** in developing countries **climate-safe** without using funds from existing development aid programmes.

Industrialized countries should bear this extra cost instead of developing countries.

VII. Reducing emissions from deforestation, especially in developing countries

Accounting for around 18% of global greenhouse gas emissions, deforestation, especially in developing countries, contributes considerably to climate change. Furthermore, the conservation of primary forests in some regions could play a role in protecting against the consequences of climate change. Long-term mechanisms should be sought which can place financing on a solid footing – e.g., through a suitable and sustainable link to the global carbon market or through adequate and predictable public and private funding.

VIII. Inclusion of international air and maritime transport

The sector with the most rapidly rising emissions worldwide is international aviation and maritime transport. Up to now these sources are exempt from emissions restrictions. The post-2012 regime must include targets to reduce emissions from these sectors.

IX. Conclusions

In order to at least halve global emissions below 1990 by 2050 so as to increase the likelihood of avoiding the worst impacts of climate change, such as the complete melting of the Greenland ice sheet, an ambitious and inclusive post-2012 agreement is needed. This agreement should be based on the UNFCCC and the Kyoto Protocol and include a set of equitable commitments from all major economies to reduce or curb emissions of greenhouse gases. In order to stay below 2°C, global emissions must peak and decline in the next 10 to 15 years. While a carbon price and expanded markets should be a key element of the post-2012 regime, new and innovative technology deployment and adaptation funds should be created in order to both drive low carbon investment and ensure that the most vulnerable countries are able to adapt to the impacts. Time is short. Countries should have completed negotiations on the post-2012 regime by 2009.

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