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Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

UP
Environmental Physics
Department of Environmental Sciences

On the risk of overshooting 2°C

Scientific Symposium "Avoiding Dangerous Climate Change"
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pre-final

Overview

Context

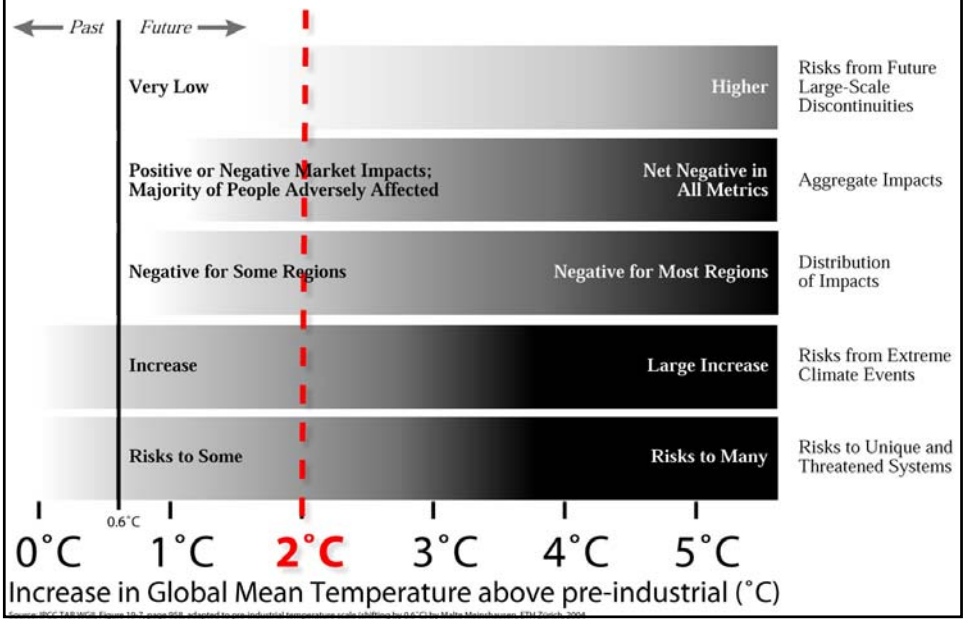
Part 1:

What CO_2 concentration corresponds to 2°C
(and other temperature limits)?

Part 2:

What are necessary (global) emission reductions?

Context: Reasons for Concern (IPCC TAR WGII)



Context: EU's 2°C target

*"[...] RECOGNISES that **2°C would already imply significant impacts** on ecosystems and water resources;*

*...EMPHASISES that the **maximum global temperature increase of 2°C over pre-industrial** levels should be considered as an overall long-term objective to guide global efforts to reduce climate change risks in accordance with the **precautionary approach**; [...]"*

(2610th Environment Council Meeting, Luxembourg, 14 October 2004)

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Part 1

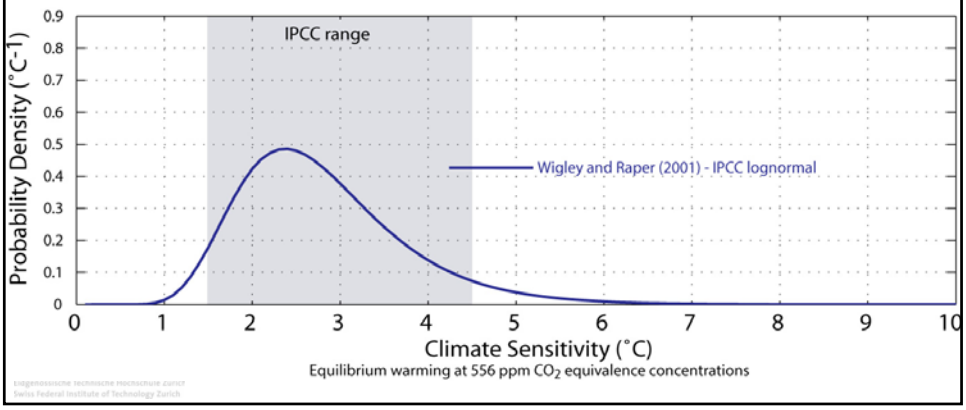
What CO_2 concentration corresponds to 2°C?

Expected warming for ~550ppm CO_2eq

Climate Sensitivity ...

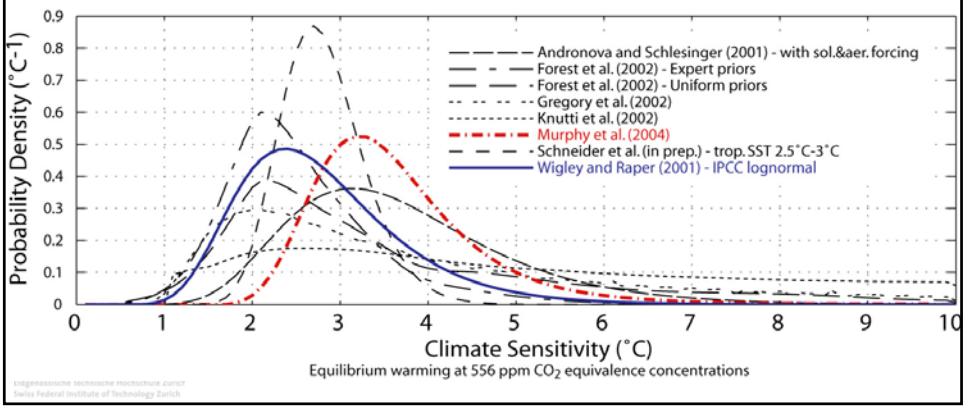
... summarizes key uncertainties in climate science for long-term projections

... is the expected average warming of the earth's surface for a doubling of CO_2 concentrations (556 ppm CO_2)

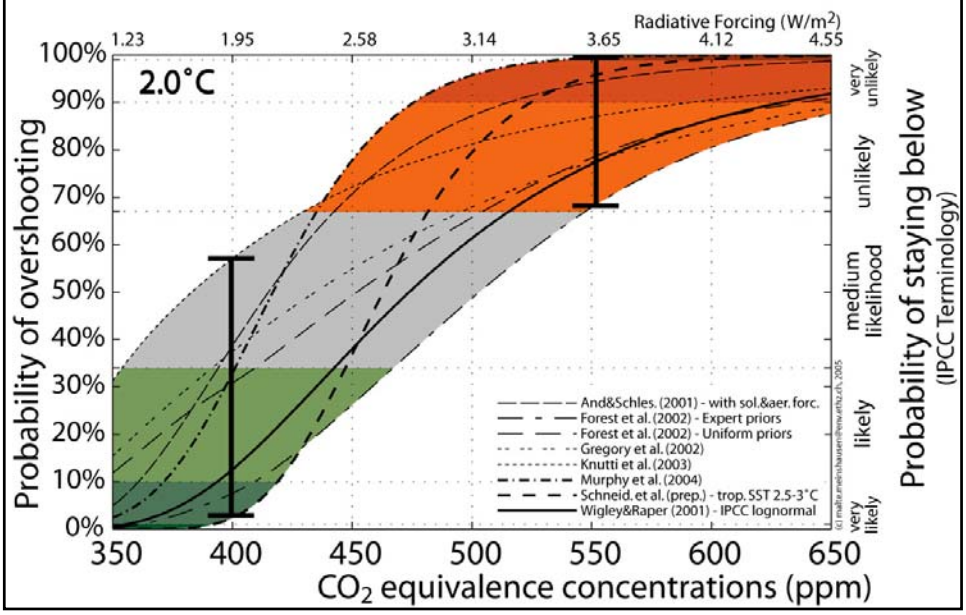


Expected warming for ~550ppm CO_2eq

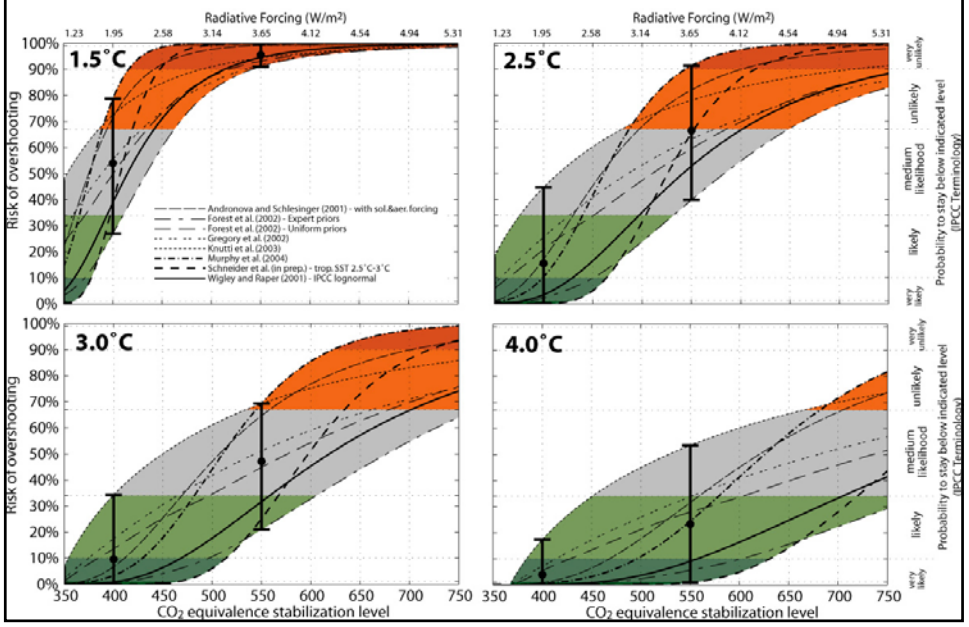
- Current research cannot exclude very high warming levels (e.g. > 4.5°C) for stabilization of greenhouse gases at 550ppm CO_2 equivalence
- see as well Stainforth et al. (Nature last week – climateprediction.net)



Risk of overshooting 2°C (stabilisation)



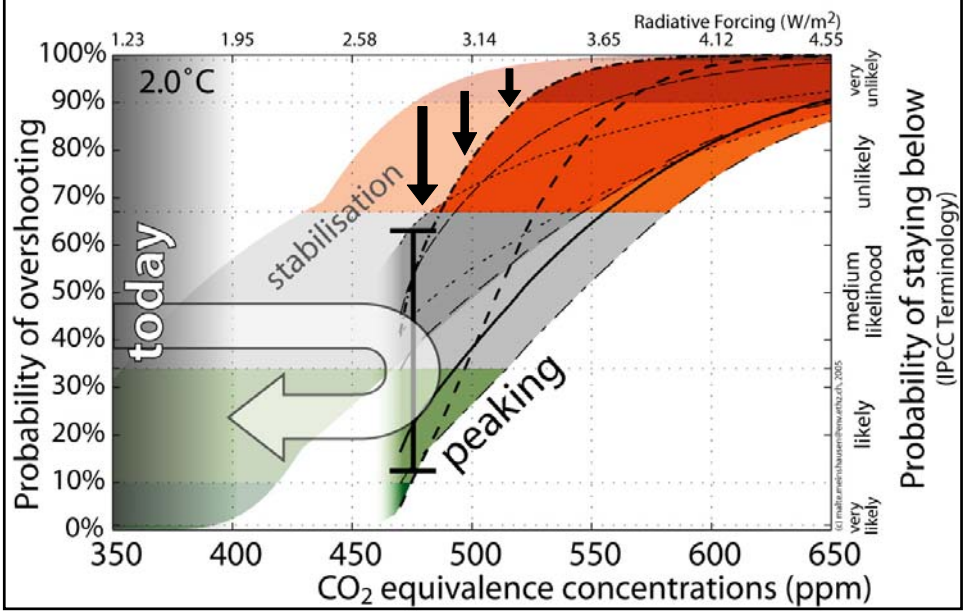
Risk of overshooting other limits



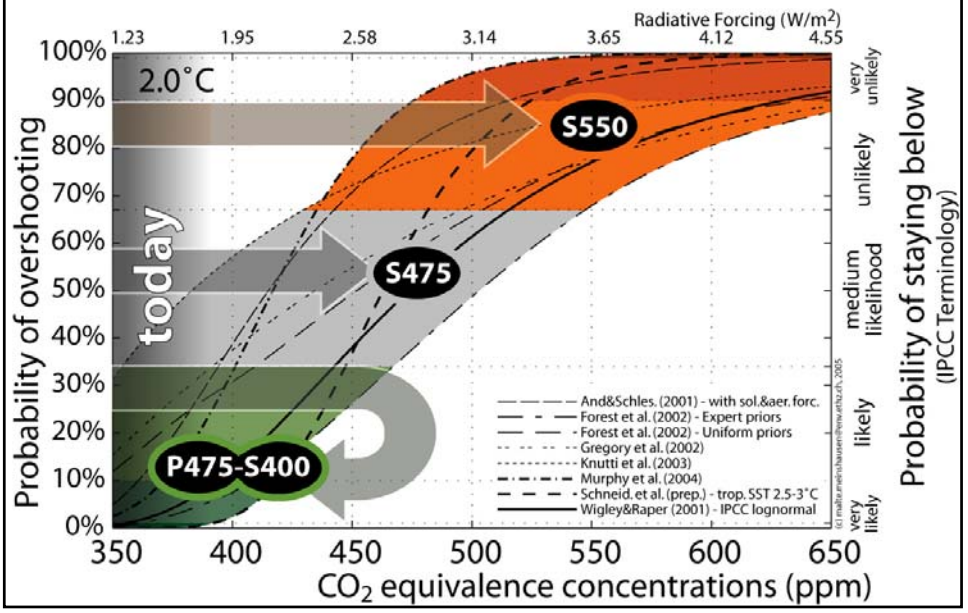
Safe greenhouse gas levels?

- Chance of staying below 2°C is “likely” only for stabilisation around 400 ppm or below.
- Risk of very high warming levels cannot be completely excluded for stabilisation scenarios other than pre-industrial or maybe 350 ppm CO_2eq.
- How to get to such low levels?

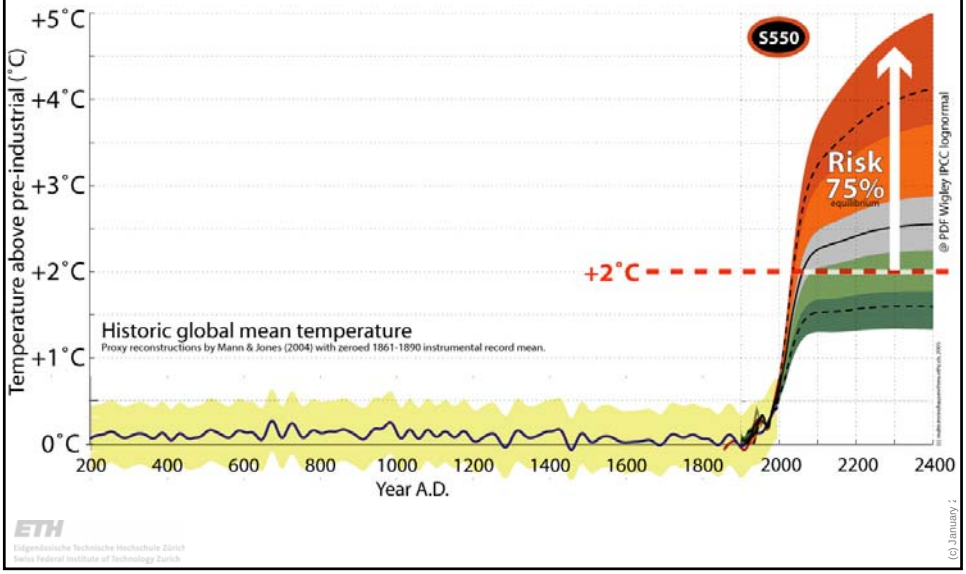
The way to get to low stab. levels: peaking



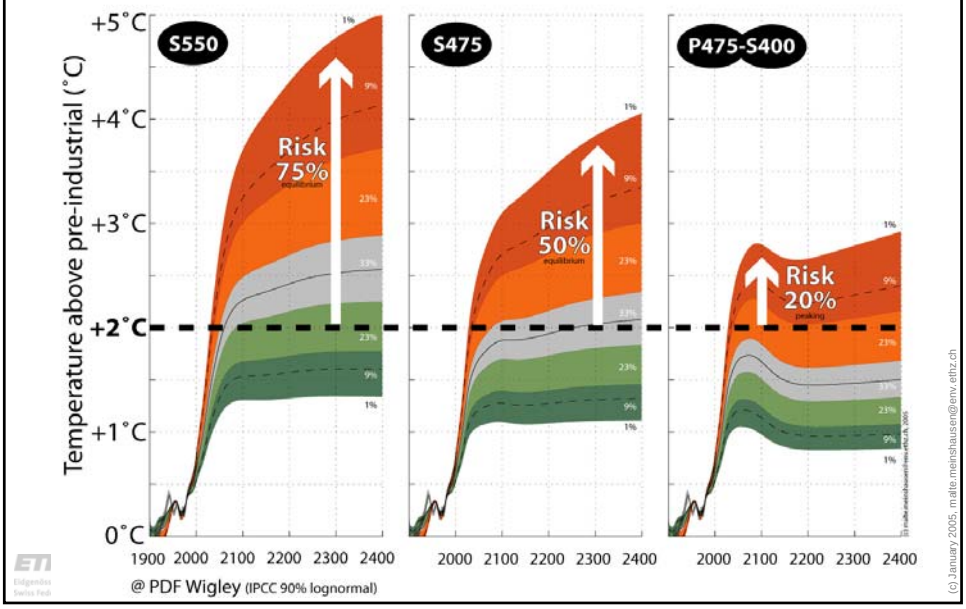
Three pathways



550 ppm CO_2eq stabilization



Risk decreases for lower peaking / stabilisation levels



Conclusions Part 1

- 550 ppm CO_2 equivalence is “unlikely” to meet the 2°C target (risk of overshooting = 70% to 99%)
- For stabilization at 550 ppm CO_2eq, the chance to stay below 2°C is about equal to the risk of overshooting 4.5°C (“mean” ~16%)
- There is a “likely” achievement of the 2°C target for peaking below 475ppm and stabilization below 400ppm CO_2eq.
- Keeping the option open for low stabilisation levels. → Concentrations will have to peak.

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Part 2

What are the necessary global emission reductions?

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Background

The presented stabilization pathways ("EQW")...

- are built on 54 published IPCC baseline and mitigation scenarios
- reflect emissions of 14 greenhouse gases and aerosols
- method is described in "Multi-gas emission pathways to meet climate targets" by Meinshausen, M., W. Hare, T. Wigley, D. van Vuuren, M. den Elzen and R. Swart, submitted June 2004

The used climate model ("MAGICC 4.1")...

- is the primary simple climate model used in IPCC's Third Assessment Report for global mean temperature and sea level rise projections
- is built by Wigley, Raper et al. and available online at http://www.cgd.ucar.edu/cas/wigley/magicc/

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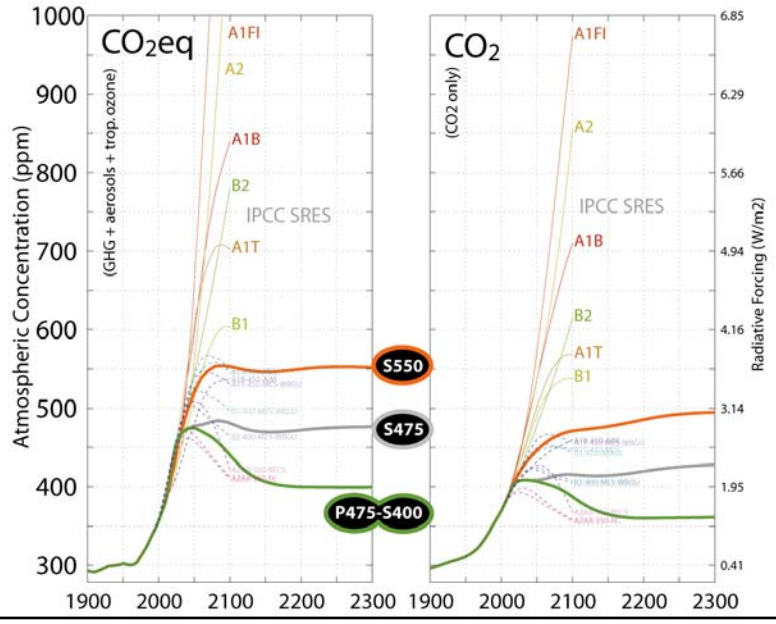
CO_2 equivalence and CO_2 concentrations



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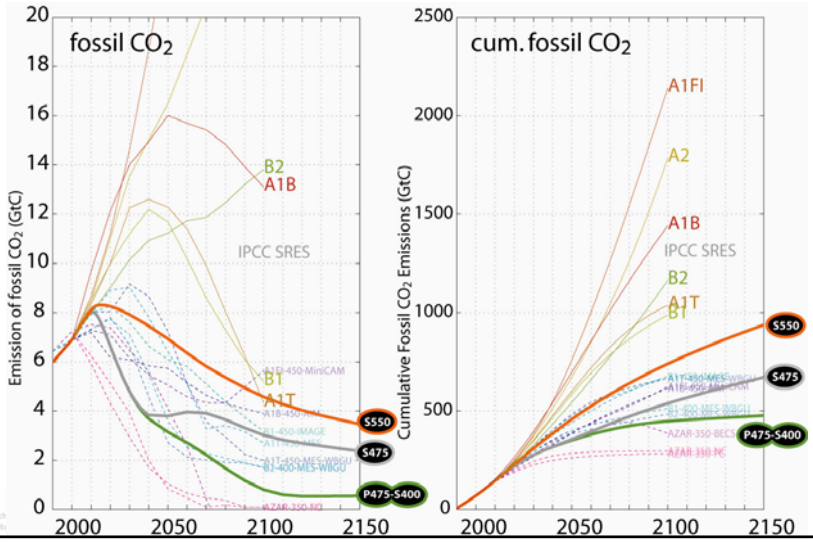
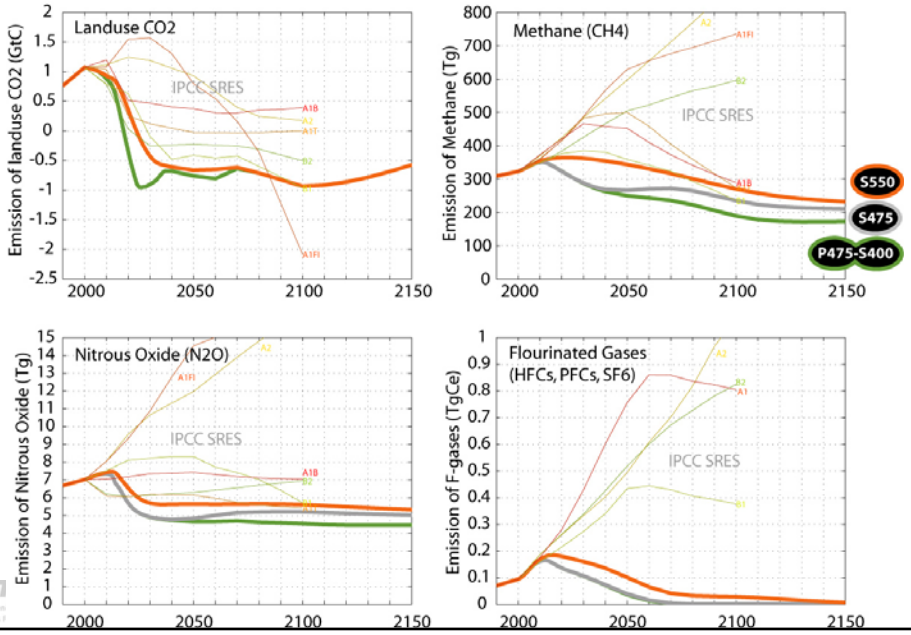
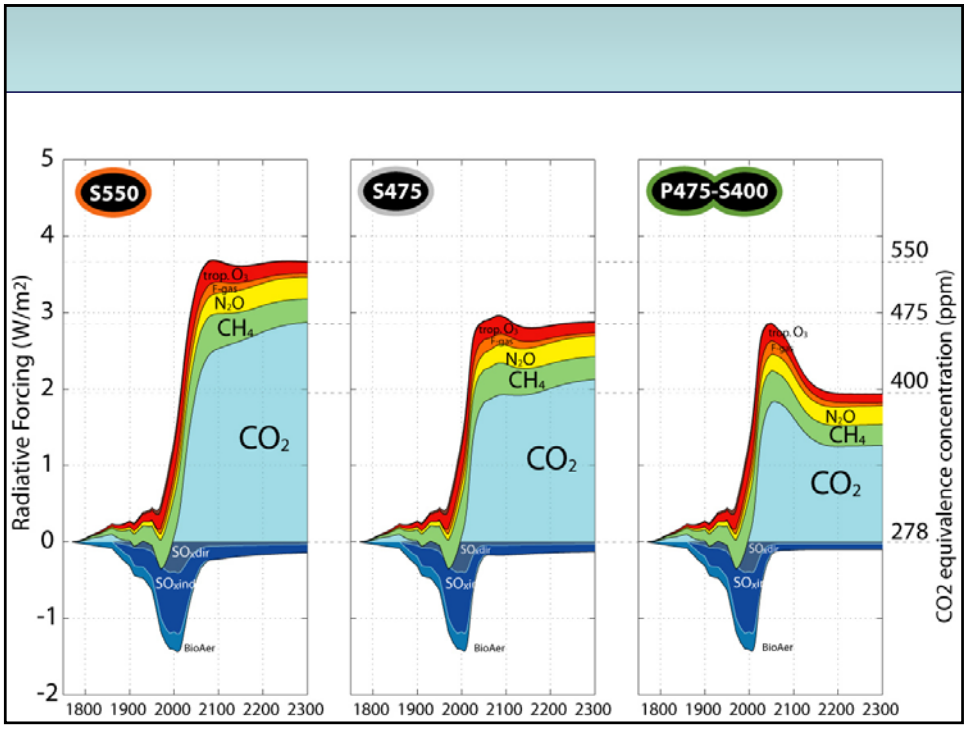
Fossil CO_2 emissions

- 475 peaking within range, but at lower end of existing mitigation scenarios
- Fossil carbon budget 400 GtC for stabilization at 400 ppm CO_2eq.

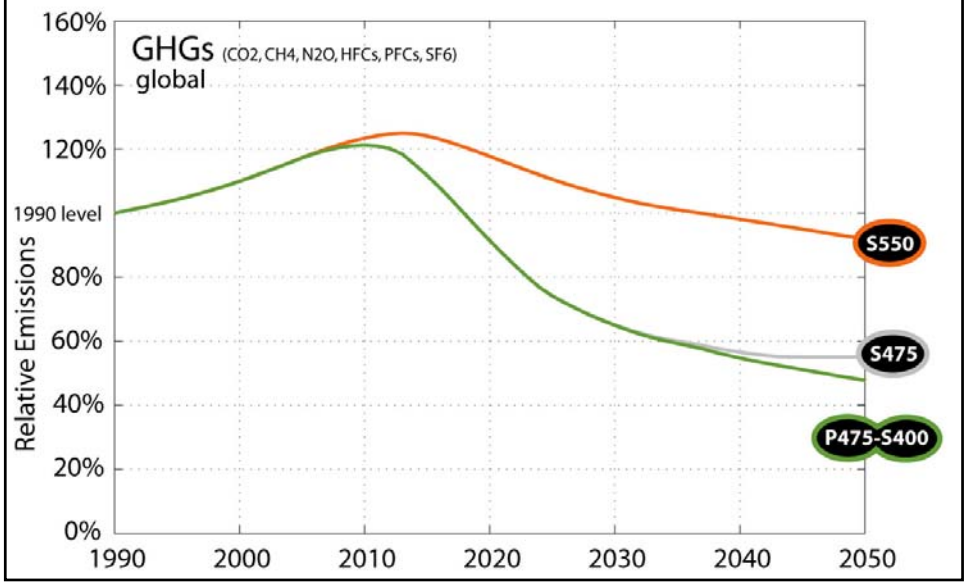


Other GHG Emissions

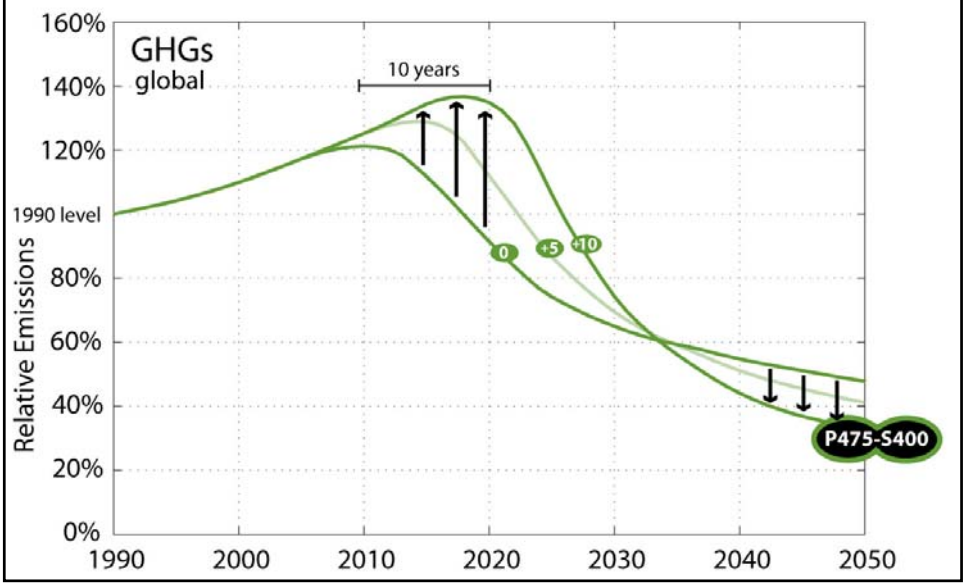




Emissions relative to 1990

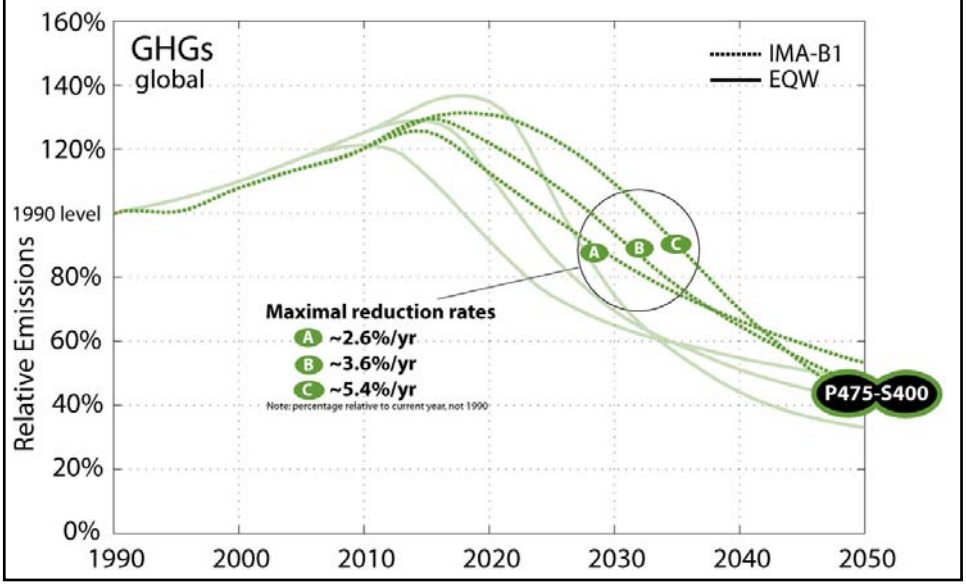


The Effect of Delay (same risk of overshooting)



The Effect of Delay (same risk of overshooting)

Source for IMA-B1 P480-S400: den Elzen & Meinshausen



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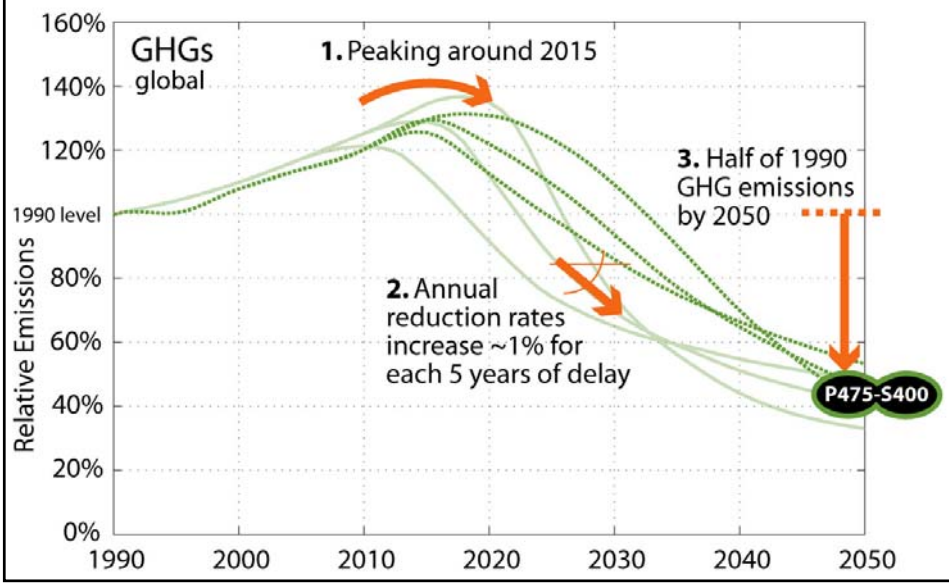

Sir David King

"Delaying action for a decade,
or even just years,
is not a serious option"
(Science, 9 January 2004)

Conclusions Part 2

- For stabilization at 550 ppm CO_2eq:
  - global GHG emissions have to be reduced by ~10% below 1990 levels by 2050.
- For peaking at 475ppm and stabilization at 400ppm:
  - global GHG emissions have to be reduced **by ~50%** below 1990 levels by 2050.
- A delay of just 5 years matters. A delay of global action by 10 years nearly doubles the required reduction rates around 2025.

EU's 2°C target

*"[...] NOTES that **scientific uncertainties** exist in translating a temperature increase of 2°C into greenhouse gas concentrations and emission paths; ...*

*... however, RECOGNISES that recent scientific research and work under the IPCC indicates that it is **unlikely** that stabilisation of greenhouse gas concentrations above 550 ppmv CO_2 equivalent would be consistent with meeting the 2°C long-term objective ...*

*... and that in order to have a reasonable chance to limit global warming to no more than 2°C, stabilisation of concentrations **well below 550 ppmv CO_2 equivalent** may be needed; ...*

*... NOTES that keeping this long-term temperature objective within reach will require global greenhouse gas emissions to **peak within two decades**, followed by substantial reductions in the order of at least 15% and **perhaps by as much as 50% by 2050 compared to 1990 levels**. [...]"* (2632nd Council Meeting, Brussels, 20th December 2004)

Lord Browne, CEO BP

"But if we are to avoid having to make dramatic and economically destructive decisions in the future, we must act soon."
(*Foreign Affairs*, July/August 2004)

Contact & download

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- Data and Presentation will be available at www.simcap.org

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Appendix: Methods & Credits

- **STABILIZATION EMISSION PATHSWAYS:**
  The presented stabilization emission paths EQW-S550Ce, EQW-S450Ce, EQW-S475Ce, EQW-S400Ce and its variants were developed with the "Equal Quantile Walk" (EQW) method. The EQW multi-gas method handles all 14 major greenhouse gases and aerosol emissions and is implemented in the SiMCaP pathfinder module. The method builds on the multi-gas and multi-region characteristics of 54 existing SRES and Post-SRES scenarios. For details, see "Multi-gas emission pathways to meet climate targets" by Meinshausen, M., W. Hare, T. Wigley, D. van Vuuren, M. den Elzen, R. Swart, submitted to Climatic Change. Available on request from the author.
- **CLIMATE MODEL:**
  The employed simple climate model is MAGICC 4.1 (by Wigley, Raper et al.). MAGICC 4.1 has been used in the IPCC Third Assessment Report for global mean temperature and sea level projections. MAGICC is an energy balance, upwelling-diffusion (simple) climate model.
- **DATA & GRAPHICS:**
  If not otherwise stated, all presented graphics and calculations were produced by Malte Meinshausen. Data is available on request. Slides might be used for non-commercial purposes, if source is acknowledged. Contact the author for any questions. (malte.meinshausen@env.ethz.ch).
- **ACKNOWLEDGEMENTS:**
  Thanks to Tom Wigley for providing the MAGICC climate model.

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- Meinshausen, M., W. Hare, T. Wigley, D. van Vuuren, M. den Elzen, R. Swart (submitted) "Multi-gas emission pathways to meet climate targets", submitted to Climatic Change, June 2004, available from the author.
- Hare, B. and M. Meinshausen (2004) "How much warming are we committed to and how much can be avoided?", PIK-Report No. 93, available online at http://www.pik-potsdam.de/publications/pik_reports

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- Andronova, N.G. and Schlesinger, M.E.: 2001, 'Objective estimation of the probability density function for climate sensitivity', Journal of Geophysical Research-Atmospheres 106, 22605-22611.
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