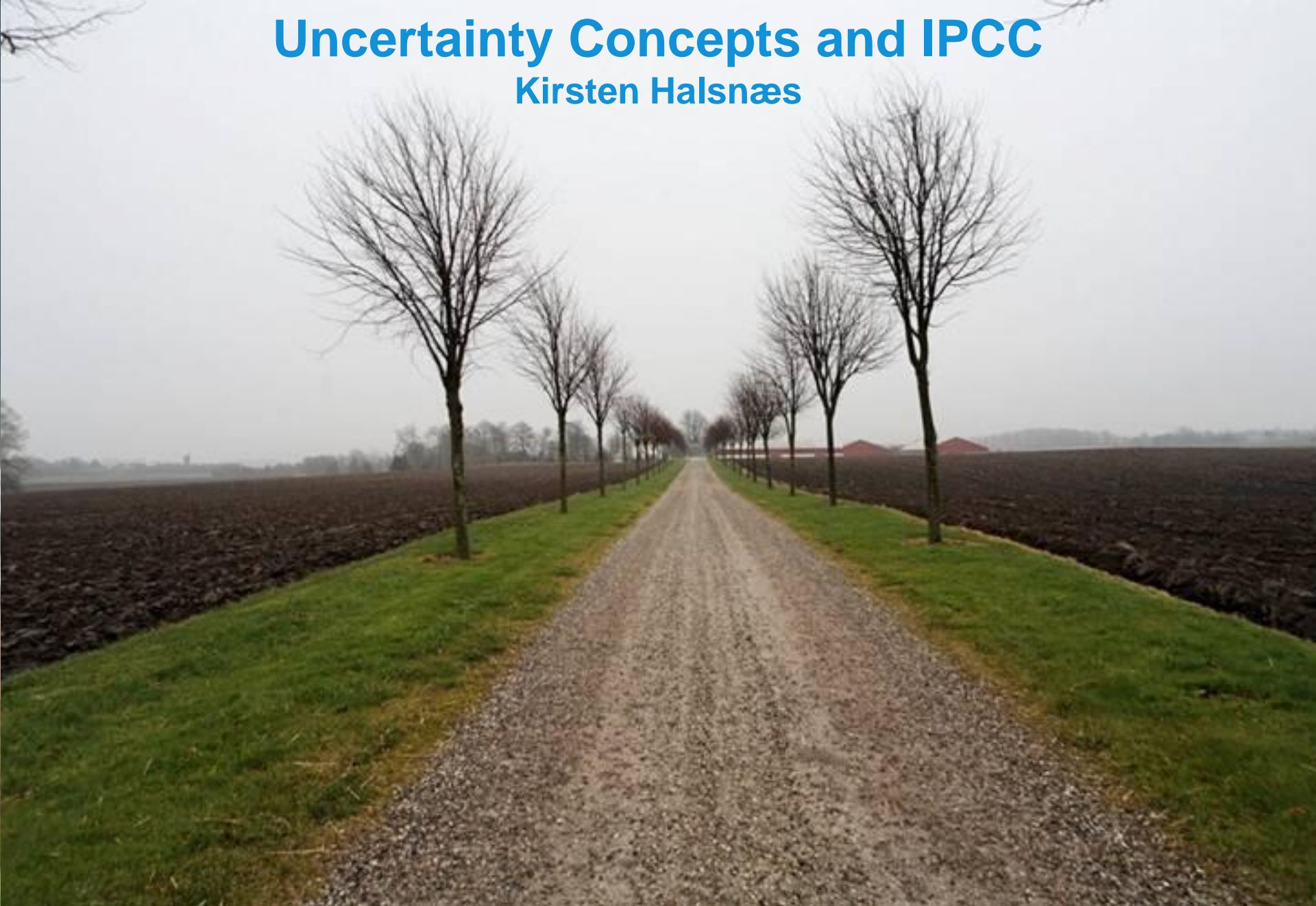


Uncertainty Concepts and IPCC

Kirsten Halsnæs



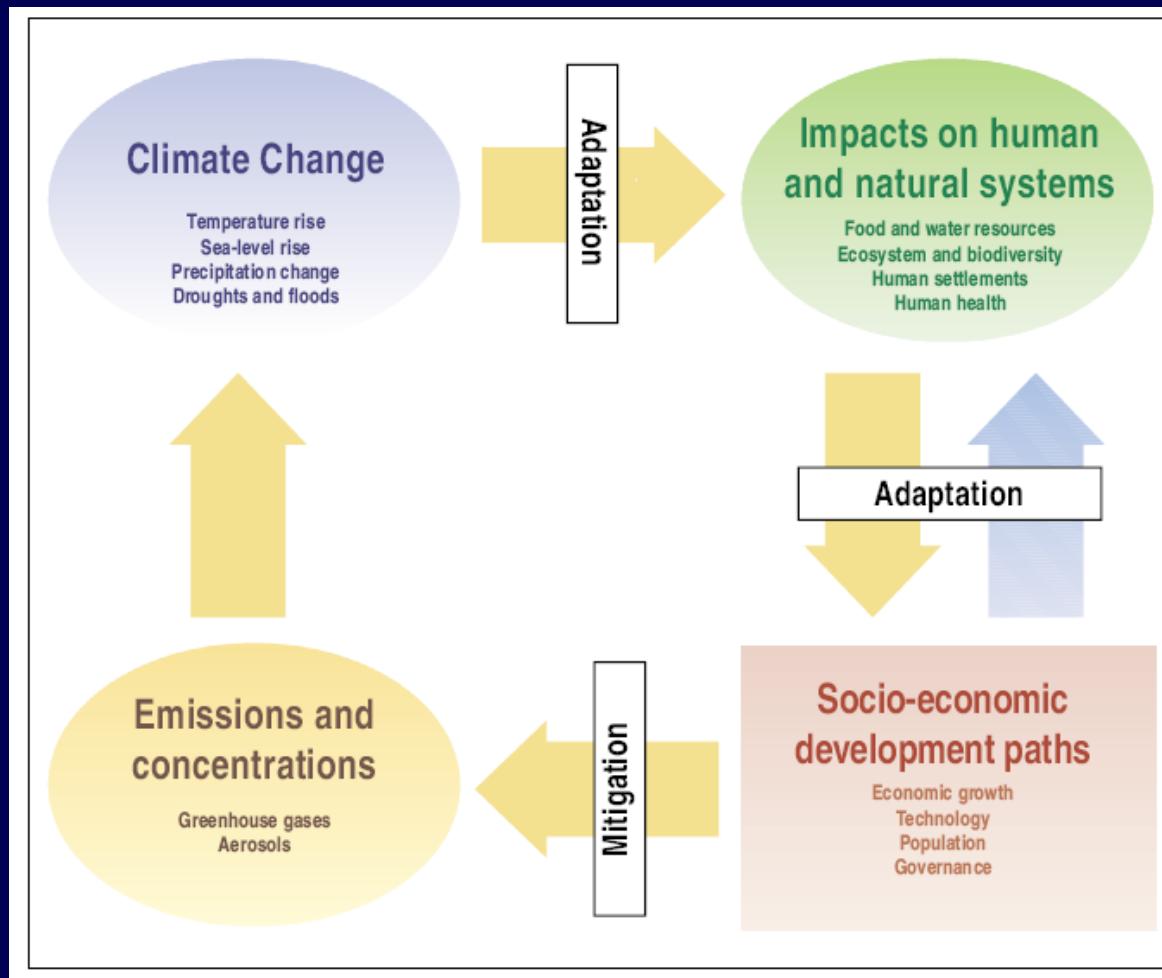


Table 1. A simple typology of uncertainties

| Type | Indicative examples of sources | Typical approaches or considerations |
|------------------------|---|---|
| Unpredictability | Projections of human behaviour not easily amenable to prediction (e.g. evolution of political systems). Chaotic components of complex systems. | Use of scenarios spanning a plausible range, clearly stating assumptions, limits considered, and subjective judgments. Ranges from ensembles of model runs. |
| Structural uncertainty | Inadequate models, incomplete or competing conceptual frameworks, lack of agreement on model structure, ambiguous system boundaries or definitions, significant processes or relationships wrongly specified or not considered. | Specify assumptions and system definitions clearly, compare models with observations for a range of conditions, assess maturity of the underlying science and degree to which understanding is based on fundamental concepts tested in other areas. |
| Value uncertainty | Missing, inaccurate or non-representative data, inappropriate spatial or temporal resolution, poorly known or changing model parameters. | Analysis of statistical properties of sets of values (observations, model ensemble results, etc); bootstrap and hierarchical statistical tests; comparison of models with observations. |

A *level of confidence*, as defined in Table 3, can be used to characterize uncertainty that is based on expert judgment as to the correctness of a model, an analysis or a statement. The last two terms in this scale should be reserved for areas of major concern that need to be considered from a risk or opportunity perspective, and the reason for their use should be carefully explained.

Table 3. Quantitatively calibrated levels of confidence.

| Terminology | Degree of confidence in being correct |
|-----------------------------|--|
| <i>Very High confidence</i> | At least 9 out of 10 chance of being correct |
| <i>High confidence</i> | About 8 out of 10 chance |
| <i>Medium confidence</i> | About 5 out of 10 chance |
| <i>Low confidence</i> | About 2 out of 10 chance |
| <i>Very low confidence</i> | Less than 1 out of 10 chance |

Box 2.1 Risk and uncertainty vocabulary used in this report

Uncertainty cannot always be quantified, and thus the vocabulary displayed in Table 2.2 is used to qualitatively describe the degree of scientific understanding behind a finding or about an issue. See text for discussion of Table 2.2's dimensions, the amount of evidence and the level of agreement.

Table 2.2: Qualitative definition of uncertainty

| | | | |
|--|------------------------------------|-----------------------------------|---------------------------------|
| | High agreement, limited evidence | High agreement, medium evidence | High agreement, much evidence |
| | Medium agreement, limited evidence | Medium agreement, medium evidence | Medium agreement, much evidence |
| | Low agreement, limited evidence | Low agreement, medium evidence | Low agreement, much evidence |

Level of agreement (on a particular finding) ↑

Amount of evidence (number and quality of independent sources) →

Source: IPCC Guidance Notes on risk and uncertainty (2005).

The understanding of anthropogenic warming and cooling influences on climate has improved since the TAR, leading to *very high confidence*⁷ that the global average net effect of human activities since 1750 has been one of warming, with a radiative forcing of +1.6 [+0.6 to +2.4] W m⁻² (see Figure SPM.2). {2.3., 6.5, 2.9}

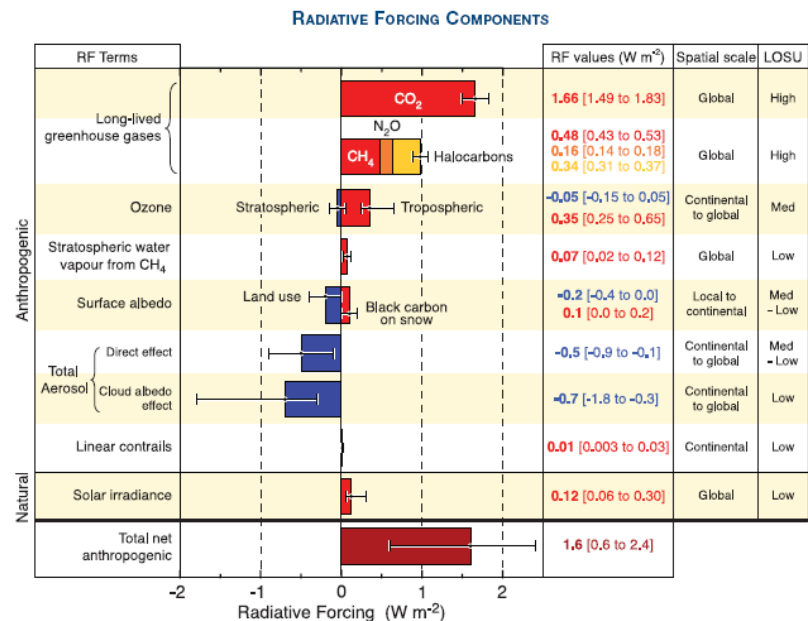


Figure SPM.2. Global average radiative forcing (RF) estimates and ranges in 2005 for anthropogenic carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O) and other important agents and mechanisms, together with the typical geographical extent (spatial scale) of the forcing and the assessed level of scientific understanding (LOSU). The net anthropogenic radiative forcing and its range are also shown. These require summing asymmetric uncertainty estimates from the component terms, and cannot be obtained by simple addition. Additional forcing factors not included here are considered to have a very low LOSU. Volcanic aerosols contribute an additional natural forcing but are not included in this figure due to their episodic nature. The range for linear contrails does not include other possible effects of aviation on cloudiness. {2.9, Figure 2.20}

In order to stabilize the concentration of GHGs in the atmosphere, emissions would need to peak and decline thereafter. The lower the stabilization level, the more quickly this peak and decline would need to occur. Mitigation efforts over the next two to three decades will have a large impact on opportunities to achieve lower stabilization levels (see Table SPM.5, and Figure SPM. 8)²⁶ (*high agreement, much evidence*).

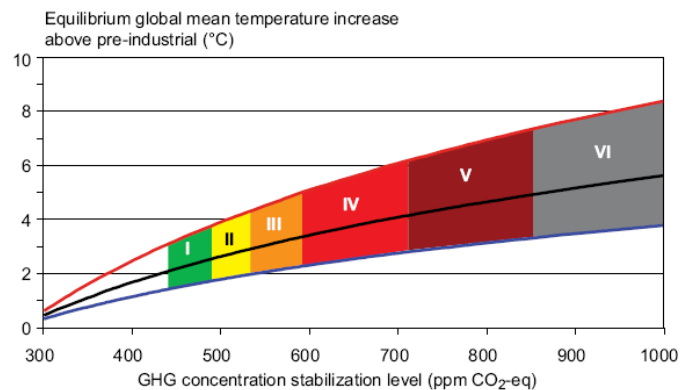


Figure SPM.8: Stabilization scenario categories as reported in Figure SPM.7 (coloured bands) and their relationship to equilibrium global mean temperature change above pre-industrial, using (i) "best estimate" climate sensitivity of 3°C (black line in middle of shaded area), (ii) upper bound of likely range of climate sensitivity of 4.5°C (red line at top of shaded area) (iii) lower bound of likely range of climate sensitivity of 2°C (blue line at bottom of shaded area). Coloured shading shows the concentration bands for stabilization of greenhouse gases in the atmosphere corresponding to the stabilization scenario categories I to VI as indicated in Figure SPM.7. The data are drawn from AR4 WGI, Chapter 10.8.

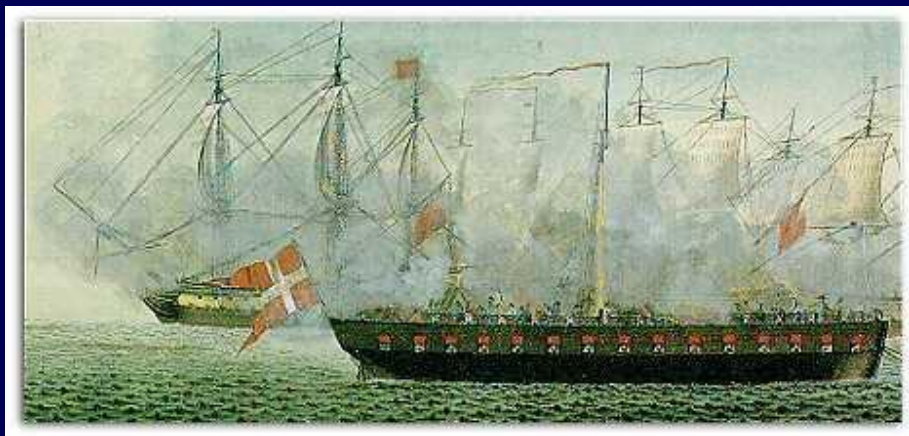
Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level (Figure SPM.1). *{1.1}*

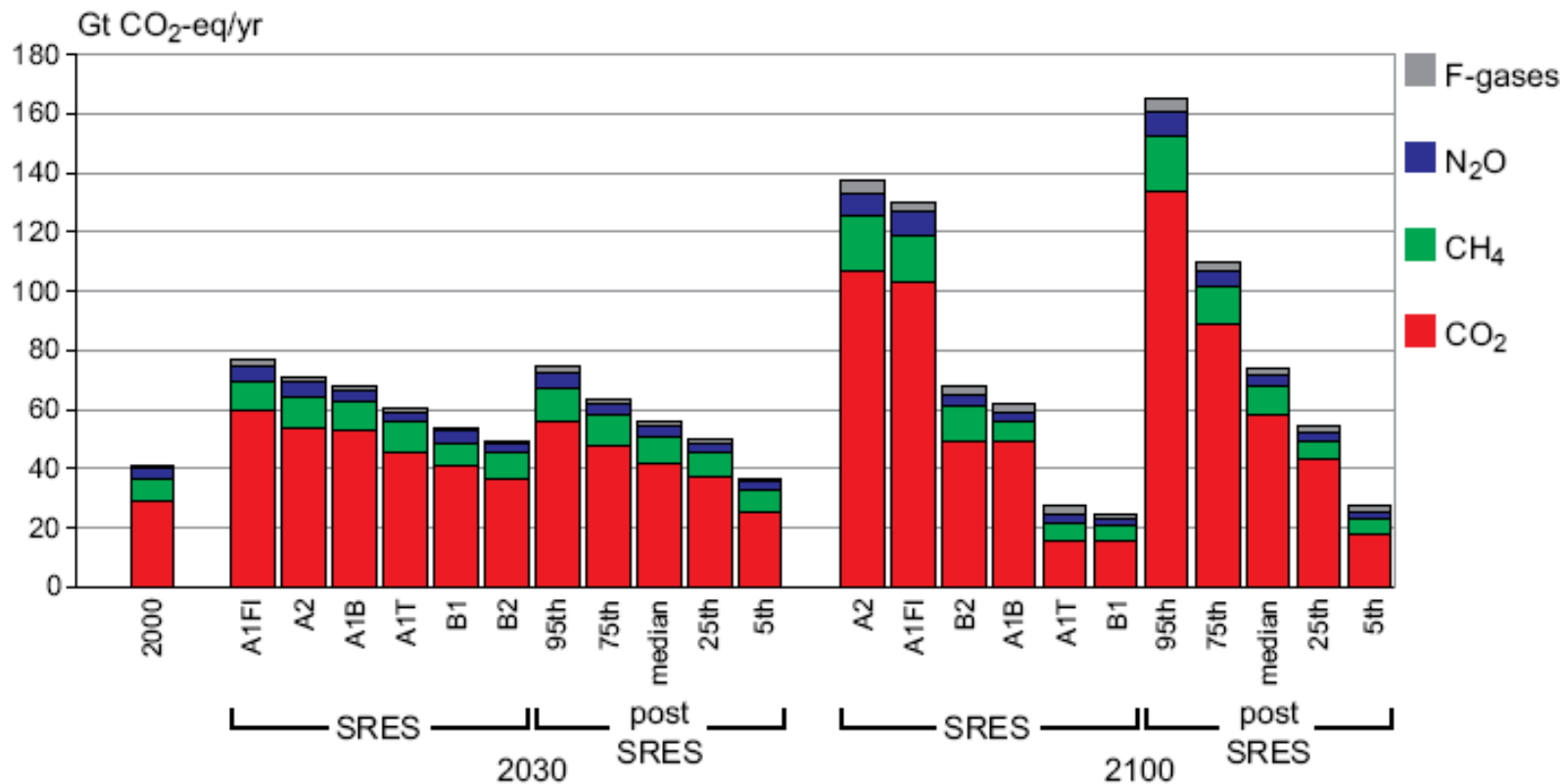
Determining what constitutes “dangerous anthropogenic interference with the climate system” in relation to Article 2 of the UNFCCC involves value judgements. Science can support informed decisions on this issue, including by providing criteria for judging which vulnerabilities might be labelled ‘key’. *{Box ‘Key Vulnerabilities and Article 2 of the UNFCCC’, Topic 5}*

Responding to climate change involves an iterative risk management process that includes both adaptation and mitigation and takes into account climate change damages, co-benefits, sustainability, equity and attitudes to risk. *{5.1}*

It is not always very easy to predict.....





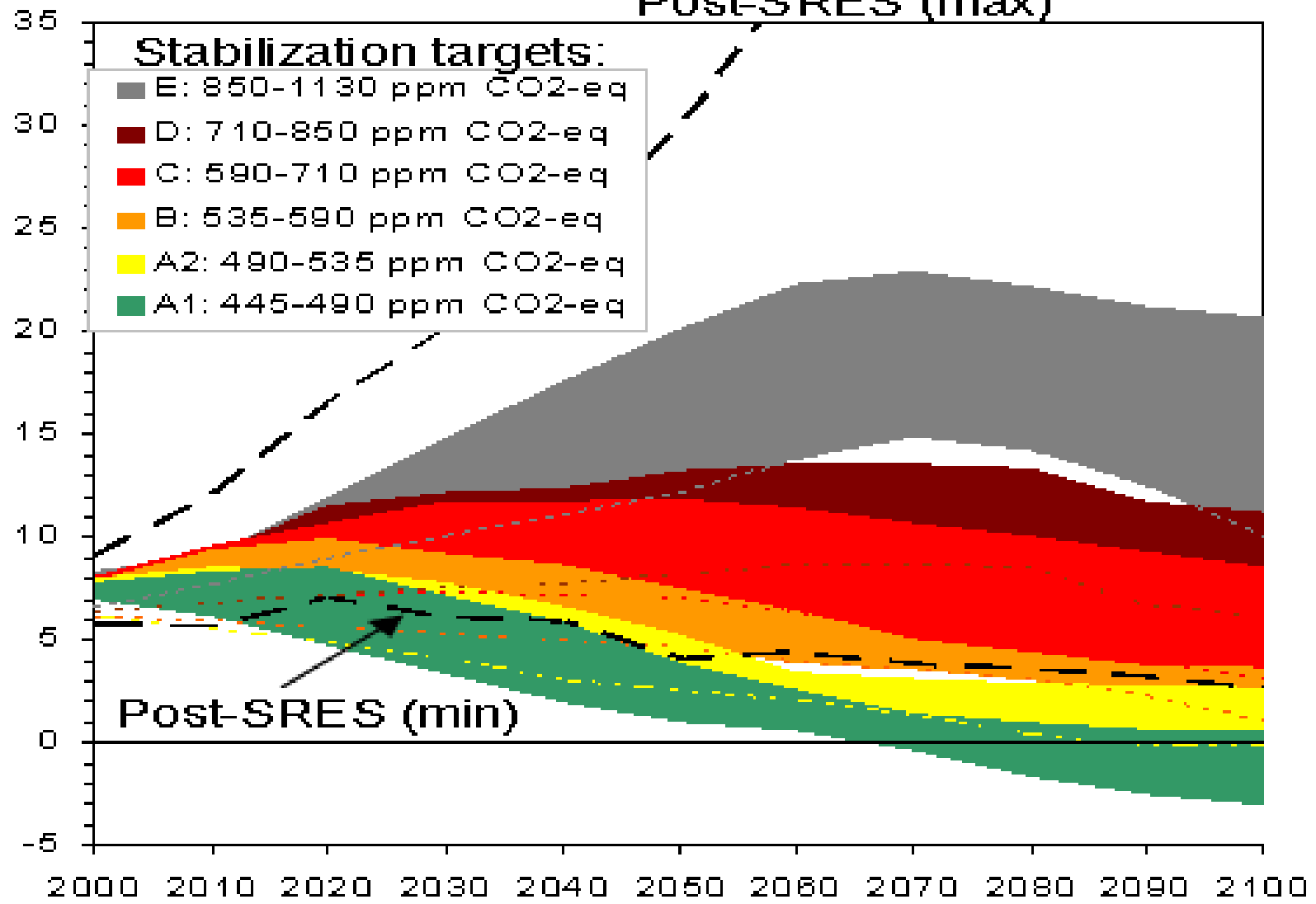


Post-SRES (max)

Stabilization targets:

- E: 850-1130 ppm CO₂-eq
- D: 710-850 ppm CO₂-eq
- C: 590-710 ppm CO₂-eq
- B: 535-590 ppm CO₂-eq
- A2: 490-535 ppm CO₂-eq
- A1: 445-490 ppm CO₂-eq

World CO₂ Emissions (GtC)



Post-SRES (min)

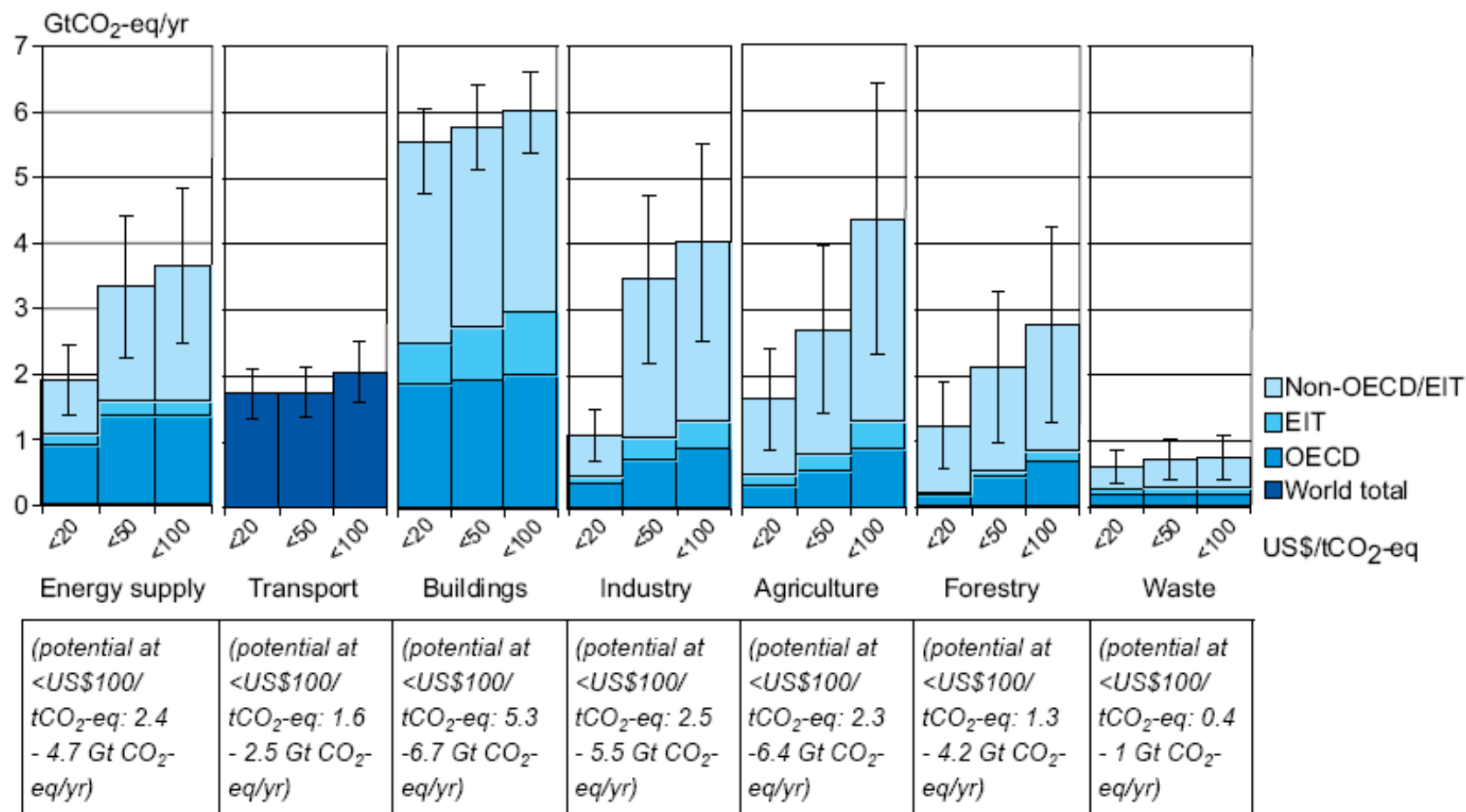
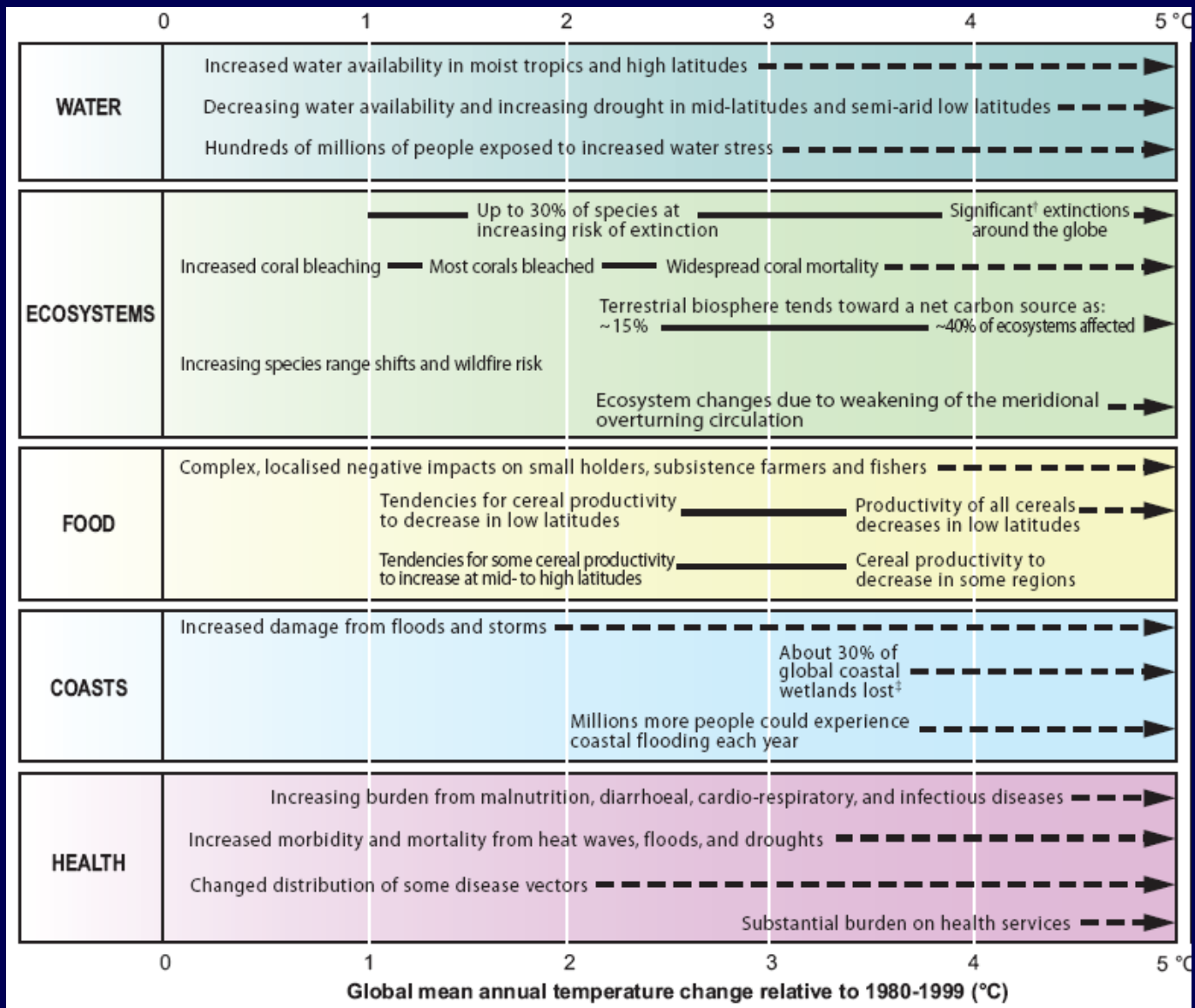


Figure SPM.6: Estimated sectoral economic potential for global mitigation for different regions as a function of carbon price in 2030 from bottom-up studies, compared to the respective baselines assumed in the sector assessments. A full explanation of the derivation of this figure is found in Section 11.3.

Mitigation Costs

- Kyoto: 2008-2012 GHG emissions 5,5 % below 1990 level for industrialised countries:
 - 0,1-1% of GDP, IPCC 3. Assessment
- 3⁰C stabilization scenario. 2050 cost:
 - 1,3% of GDP, IPCC 4. Assessment
- 2⁰C stabilization. 2050 costs:
 - 5,5% of GDP, IPCC 4. Assessment
- Costs of climate change impacts:
 - 3% of GDP BNP in 2100 for 3⁰C scenario, Nordhaus and Tol
 - 5% of GDP in 2100 for 3⁰C scenario, Stern







Øget (blå) eller reduceret (brun)

- | | | |
|---|---|--------------------|
|  |  | - kornproduktion |
|  |  | - husdyrproduktion |
|  |  | - træproduktion |

Uncertainties Related to Developing Countries

- Detailed Climate data is absent
- Short term forecasts are particularly valuable (precipitation)
- Climate change vulnerability follows from development issues
- Many development projects focus on climate sensitive sectors like water, agriculture, infrastructure, and health





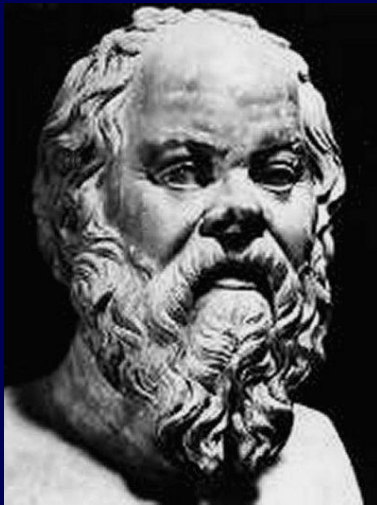
Time and Economic Valuation

- The utility of present generations related to activities causing GHG emissions has an impact on the utility of future generations
- Valuation of future assets are based on the preferences of present generations
- What is the utility of our ancestors of wetlands, churches, nature habitats etc, etc.:
 - Higher due to increasing income?
 - Lower due to new lifestyle patterns?
 - Based on substitutes?
- What should present generations be willing to pay today to save environmental values for the future?



Conclusions

- Climate is a multi disciplinary subject involving a broad range of uncertainty concepts
- Mitigation costs are covered by many studies, high degree of consensus
- Climate change impacts and adaptation costs are covered by few studies. There are little consensus, and “deep” uncertainty issues relate to theoretical and methodological limitations
- Uncertainties can be reduced by specific multidisciplinary studies of climate impacts: Water management, agriculture, health, infrastructure etc.



Sokrates: I know, what I do not know