IPCC, Article 2, Sea-level rise, and Scenario Development

Jean-Pascal van Ypersele
IPCC Vice-chair

SBSTA Research Dialogue, Bonn, June 2011

Thanks to the Belgian Federal Science Policy Office for its support

WMO UNEP

UN Framework Convention on Climate Change Article 2 (***Ultimate objective):***

'...stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

Such a level should be achieved within a time frame sufficient
- to allow ecosystems to adapt naturally to climate change,
- to ensure that food production is not threatened and
- to enable economic development to proceed in a sustainable manner.'

inverse calculation

(technologies, lifestyles, policy instruments)

Emissions pathways

(biogeochemical cycles)

Critical Levels

(global temperature / radiative forcing)

Critical Limits

(regional climate changes)

Key Vulnerabilities

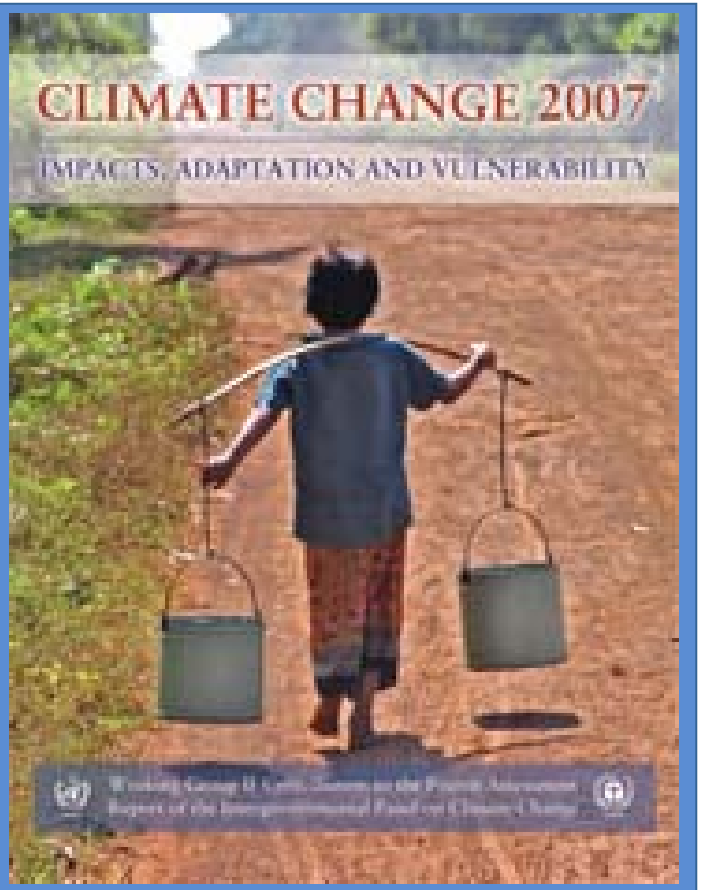
(socioeconomic factors)

Jean-Pascal van Ypersele and
Ben Matthews, UCL, Belgium,

The IPCC and the Article 2

Fourth Assessment Report (AR4, 2007)

WG II :Impacts, Adaptation and Vulnerability



ipcc
INTERGOVERNMENTAL PANEL ON climate change

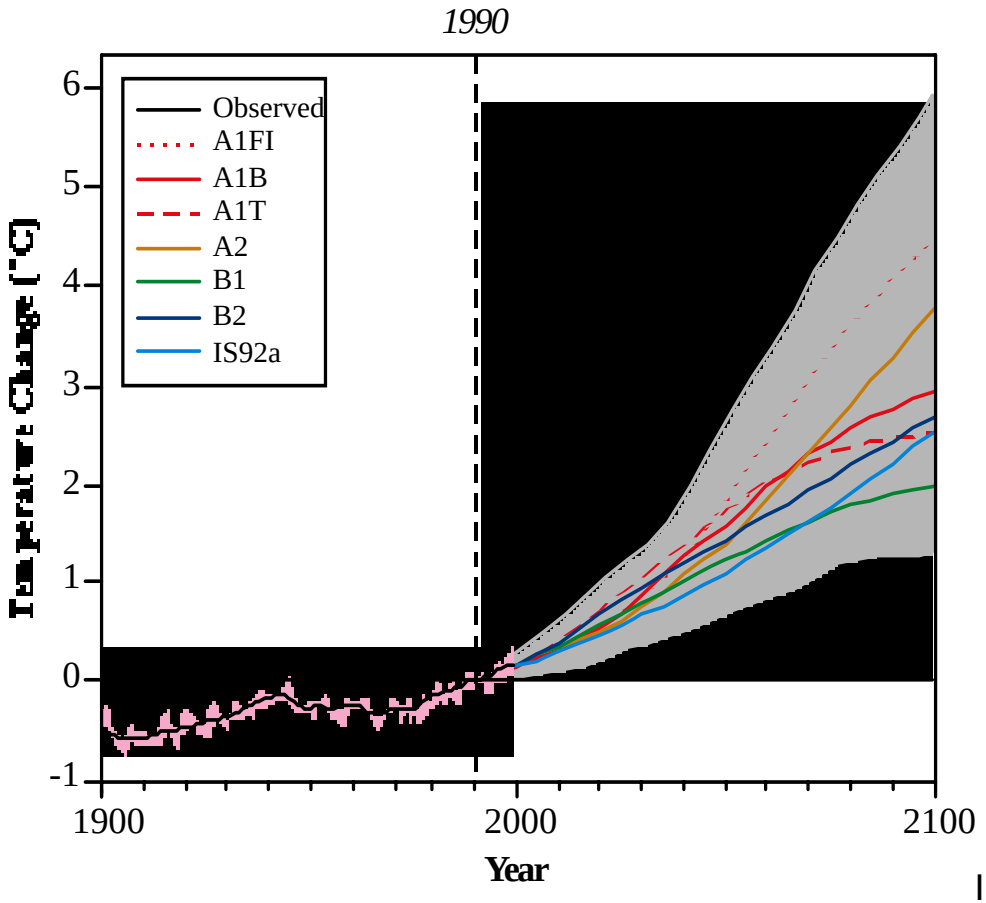
WMO UNEP

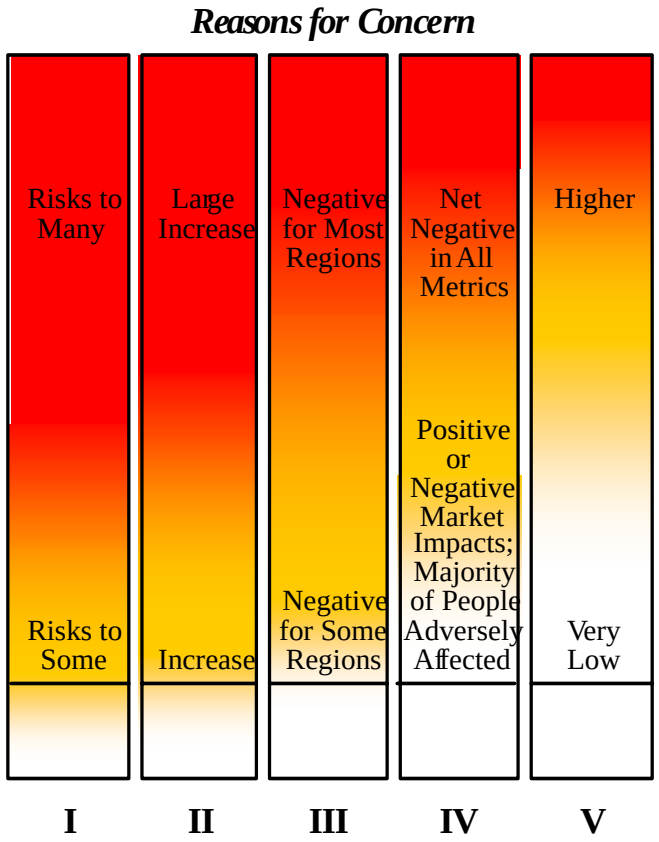
Dangerous anthropogenic interference

The identification of potential key vulnerabilities is intended to provide guidance to decision-makers for identifying levels and rates of climate change that may be associated with 'dangerous anthropogenic interference' (DAI) with the climate system, in the terminology of the UNFCCC Article 2. **Ultimately, the determination of DAI** cannot be based on scientific arguments alone, but **involves other judgements informed by the state of scientific knowledge**

IPCC, AR4, WGII, 2007, p. 781

Reasons for Concern

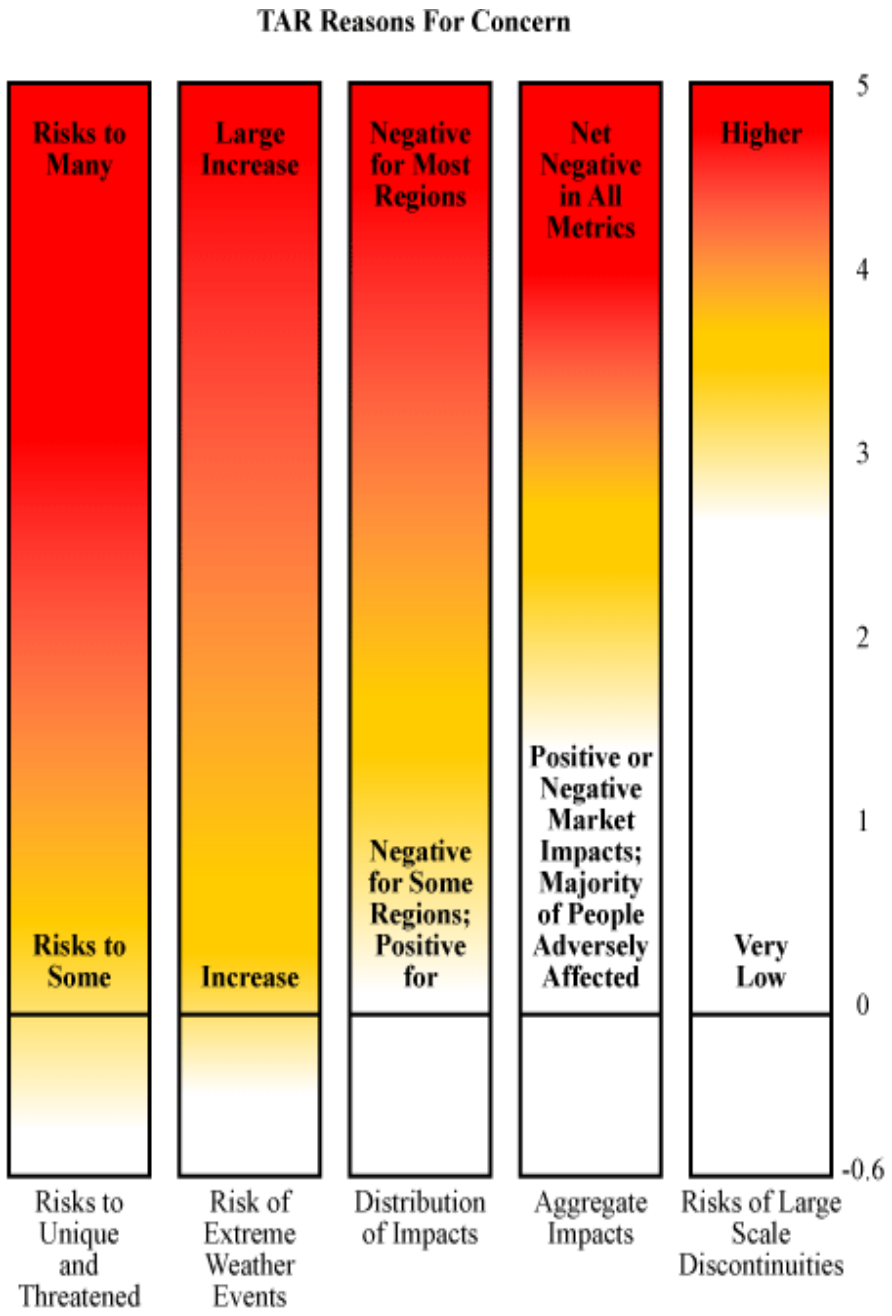




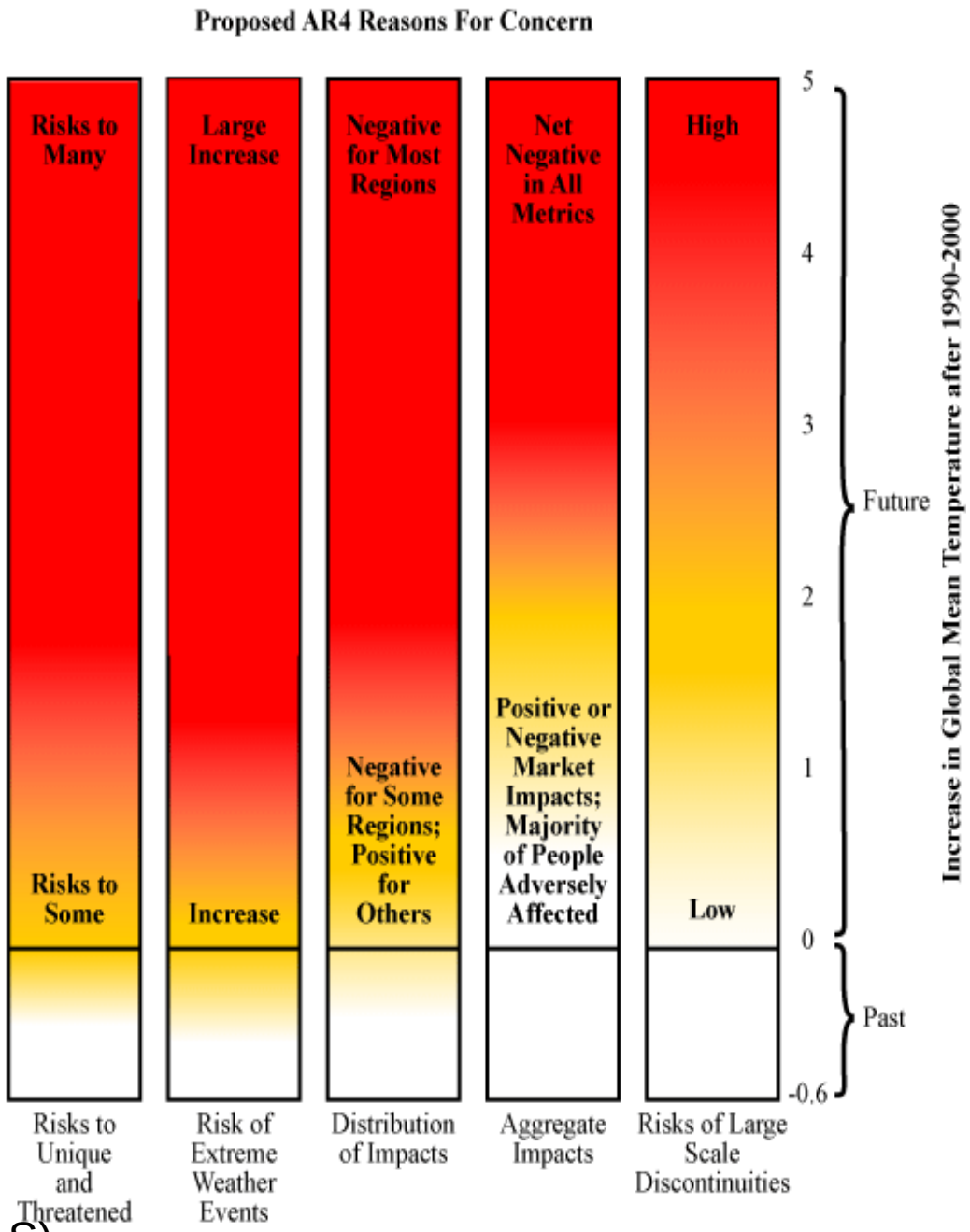
I Risks to unique and threatened systems
II Risks from extreme climate events
III Distribution of Impacts
IV Aggregate Impacts
V Risks from large-scale discontinuities

Source: IPCC TAR WG2 (2001)

TAR (2001)

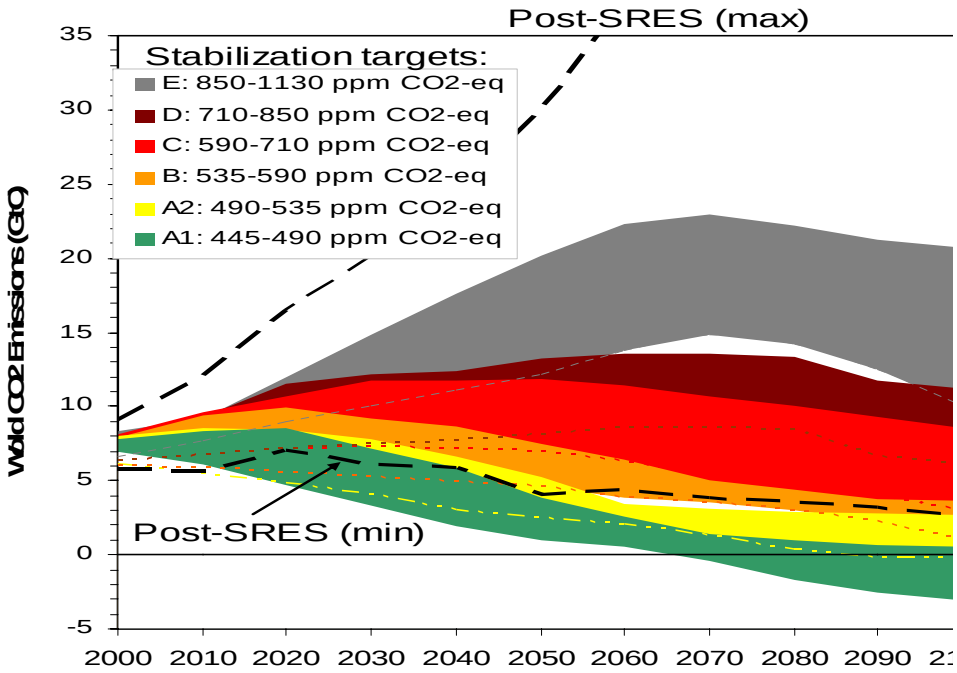

TAR Reasons For Concern
Risks to Many
Risks to Some
Large Increase
Increase
Negative for Most Regions
Negative for Some Regions; Positive for
Net Negative in All Metrics
Positive or Negative Market Impacts; Majority of People Adversely Affected
Higher
Very Low
5
4
3
2
1
0
-0.6
Risks to Unique and Threatened
Risk of Extreme Weather Events
Distribution of Impacts
Aggregate Impacts
Risks of Large Scale Discontinuities

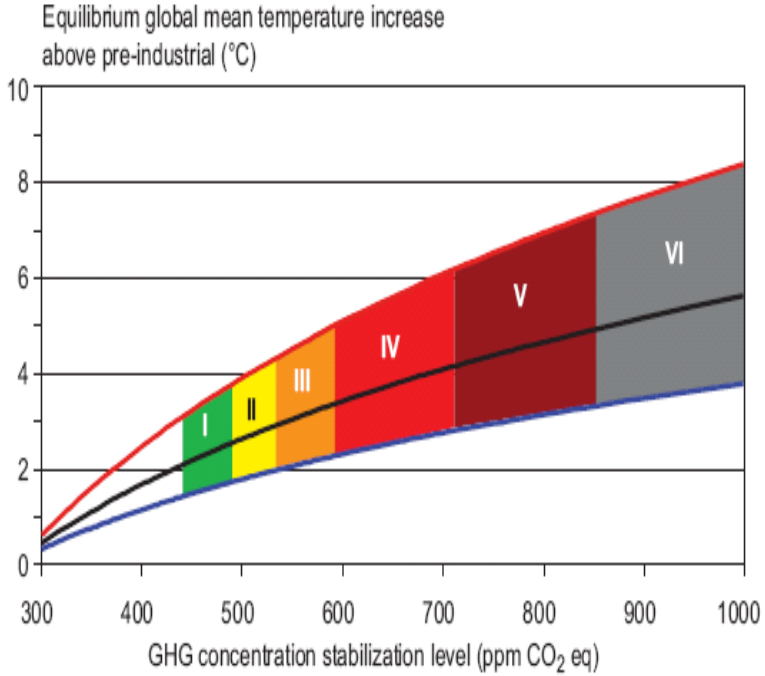
(Based on)
AR4, 2007



Smith et al, 2009 (PNAS)

The lower the stabilisation level the earlier global emissions have to go down





Multigas and CO2 only studies combined

Projected globally averaged surface warming and sea level rise at the end of the 21st century (IPCC WG1 AR4)

	Temperature Change (°C at 2090-2099 relative to 1980-1999) [a]		Sea Level Rise (m at 2090-2099 relative to 1980-1999)
Case	Best estimate	*Likely* range	Model-based range excluding future rapid dynamical changes in ice flow
Constant Year 2000 concentrations [b]	0.6	0.3 – 0.9	NA
B1 scenario	1.8	1.1 – 2.9	0.18 – 0.38
A1T scenario	2.4	1.4 – 3.8	0.20 – 0.45
B2 scenario	2.4	1.4 – 3.8	0.20 – 0.43
A1B scenario	2.8	1.7 – 4.4	0.21 – 0.48
A2 scenario	3.4	2.0 – 5.4	0.23 – 0.51
A1FI scenario	4.0	2.4 – 6.4	0.26 – 0.59

NB: add 0.5°C to get pre-industrial reference

AR4: Sea level rise estimates do not include the full effects of changes in ice sheet flow

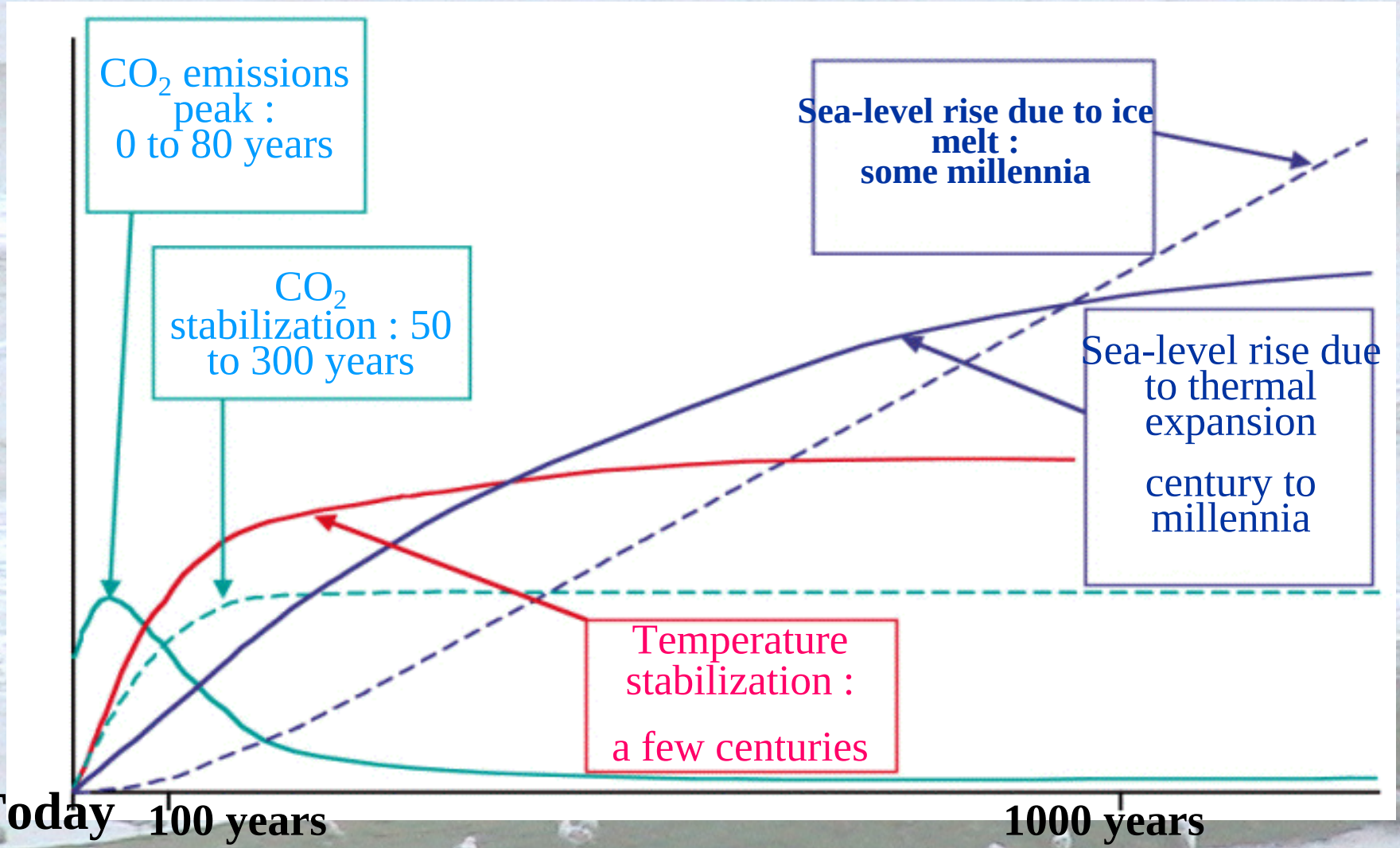
- The sea level projections do not include (,,,) the full effects of changes in ice sheet flow, because a basis in published literature is lacking.

- Therefore the upper values of the ranges given are not to be considered upper bounds for sea level rise.

- The projections include a contribution due to increased ice flow from Greenland and Antarctica at the rates observed for 1993-2003, but these flow rates could increase or decrease in the future. **AR4 SYR Table 5,1**

WMO UNEP

Significant inertia exists in the climate system



Source: IPCC (2001

AR4: Long-term sea level rise due to thermal expansion only

Long-term thermal expansion is projected to result in 0.2 to 0.6 m per degree Celsius of global average warming above pre-industrial.

(footnote f of Table 5, IPCC AR4 SYR)

,

WMO

UNEP

AR4: Sea-level rise due to thermal expansion

Category	CO_2 concentration at stabilisation (2005 = 379 ppm)[b]	CO_2-equivalent concentration at stabilisation including GHGs and aerosols (2005=375 ppm)[b]	Peaking year for CO_2 emissions[a,c]	Change in global CO_2 emissions in 2050 (percent of 2000 emissions)[a,c]	Global average temperature increase above pre-industrial at equilibrium, using 'best estimate' climate sensitivity[d,e]	Global average sea level rise above pre-industrial at equilibrium from thermal expansion only[f]
	ppm	ppm	year	percent	°C	metres
I	350 – 400	445 – 490	2000 – 2015	-85 to -50	2.0 – 2.4	0.4 – 1.4
II	400 – 440	490 – 535	2000 – 2020	-60 to -30	2.4 – 2.8	0.5 – 1.7
III	440 – 485	535 – 590	2010 – 2030	-30 to +5	2.8 – 3.2	0.6 – 1.9
IV	485 – 570	590 – 710	2020 – 2060	+10 to +60	3.2 – 4.0	0.6 – 2.4
V	570 – 660	710 – 855	2050 – 2080	+25 to +85	4.0 – 4.9	0.8 – 2.9
VI	660 – 790	855 – 1130	2060 – 2090	+90 to +140	4.9 – 6.1	1.0 – 3.7

AR4 SYR Table 5,1

WMO

UNEP

AR4: Ice sheet melting

- The (Greenland) surface mass balance becomes negative (net ice loss) at a global average warming (relative to pre-industrial values) in excess of 1.9 to 4.6°C.
- If such a negative surface mass balance were sustained for millennia, that would lead to virtually complete elimination of the Greenland ice sheet and a resulting contribution to sea level rise of about 7m.

With 8 metre sea-level rise: 3700 km^2 below sea-level in Belgium

(very possible in year 3000)

(NB: flooded area depends on protection)

Source: N. Dendoncker (Dépt de Géographie, UCL), J.P. van Ypersele et P. Marbaix (Dépt de Physique, UCL) (www.climate.be/impact)

IPCC (WGI) has acknowledged the relevance of this specific topic →

i) a chapter on ‘Sea Level Change’ in its contribution to the IPCC AR5

ii) a targeted IPCC Workshop on ‘Sea Level Rise and Ice Sheet Instabilities’ (Kuala Lumpur, Malaysia, from 21 to 24 June, 2010) - 93 invited experts from 38 countries attended the Workshop

Synthesis and Emerging Topics of the Workshop (1):

i) Scientific progress since the AR4 in the ability to estimate changes in the surface mass balance of the ice sheets of Greenland and Antarctica

ii) Stability properties of such systems are therefore difficult to estimate

iii) The marine ice sheet instability seems to be the most important and currently best studied process

iv) Improved data from the largest glaciers and ice caps and a more mechanistic understanding of glacier dynamics, are critically needed

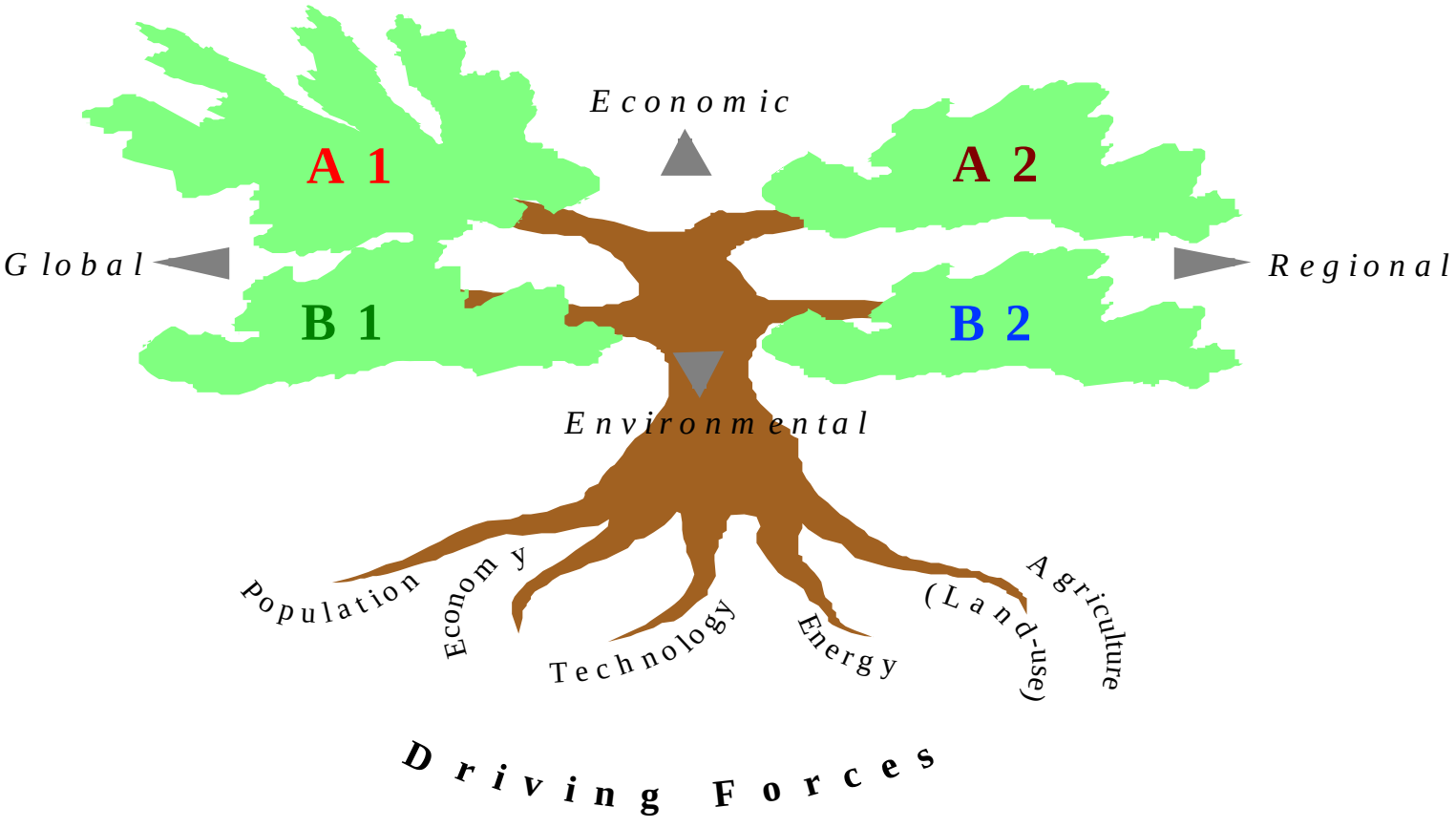
Synthesis and Emerging Topics of the Workshop (2):

v) Ocean warming and associated thermal expansion is major component of sea level rise

vi) The simulation of current and future sea level rise on regional to global scales requires the combination of the different components that contribute to sea level rise and their uncertainties, using comprehensive models

vii) Various attempts using semi-empirical models → to estimate globally averaged sea level rise for the 21st century

SRES Scenarios: Extensively used in CC Research and Assessments since 2000

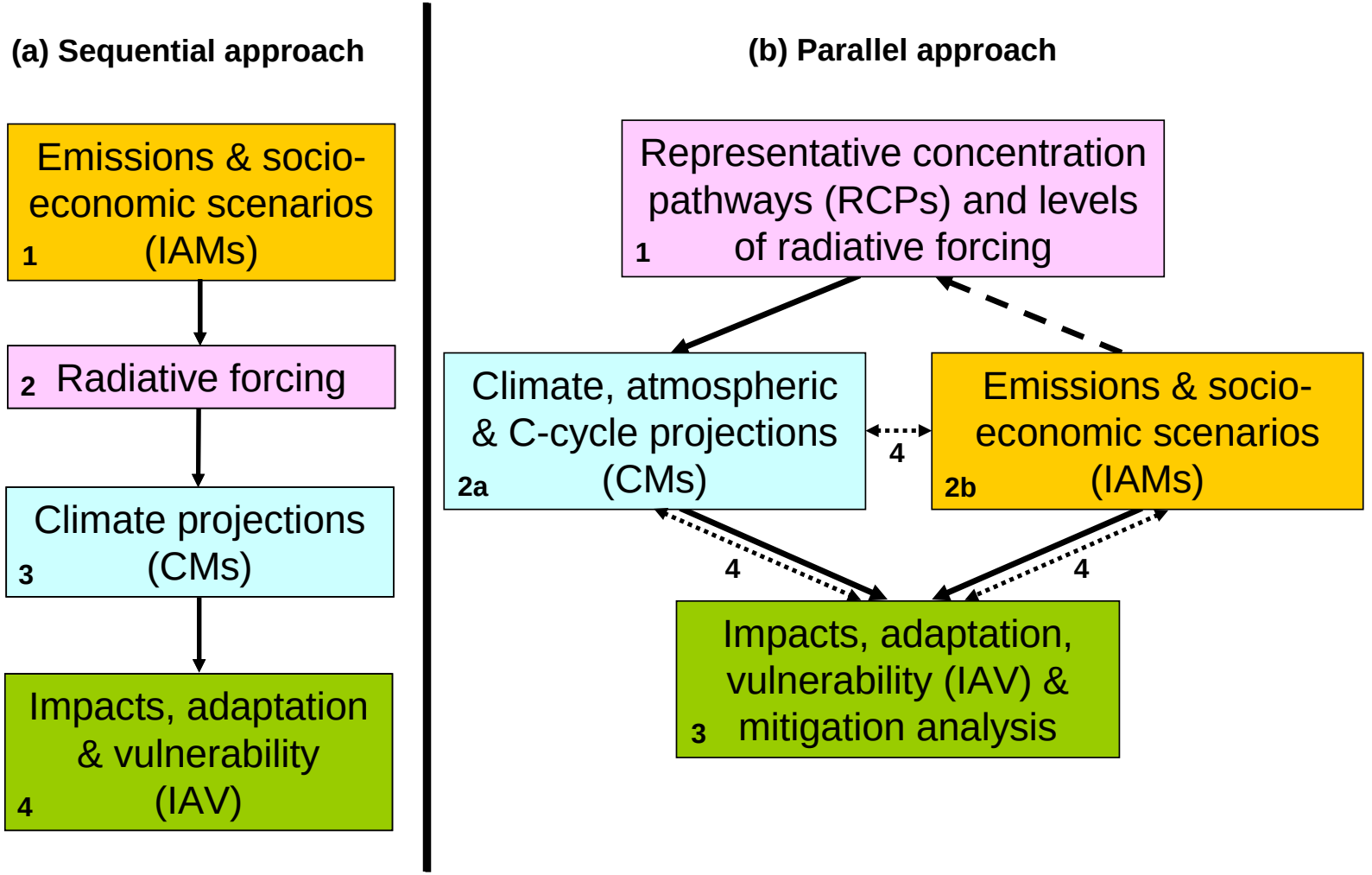


Scenarios : from AR4 to AR5

- Before AR4:
  - Few “low emission” scenarios potentially compatible with a limitation of global warming to 2°C or less were published
  - The analysis of their consequences on climate was limited: no in-depth analysis with 3D (general circulation) climate models was performed
- For the AR5:
  - Many climate simulations are conducted in the framework of new «representative concentration pathways» (RCPs) selected to allow investigating a wide range of possible futures
  - In parallel, studies on the associated socio-economic conditions are encouraged, and will be linked to the RCPs within AR5

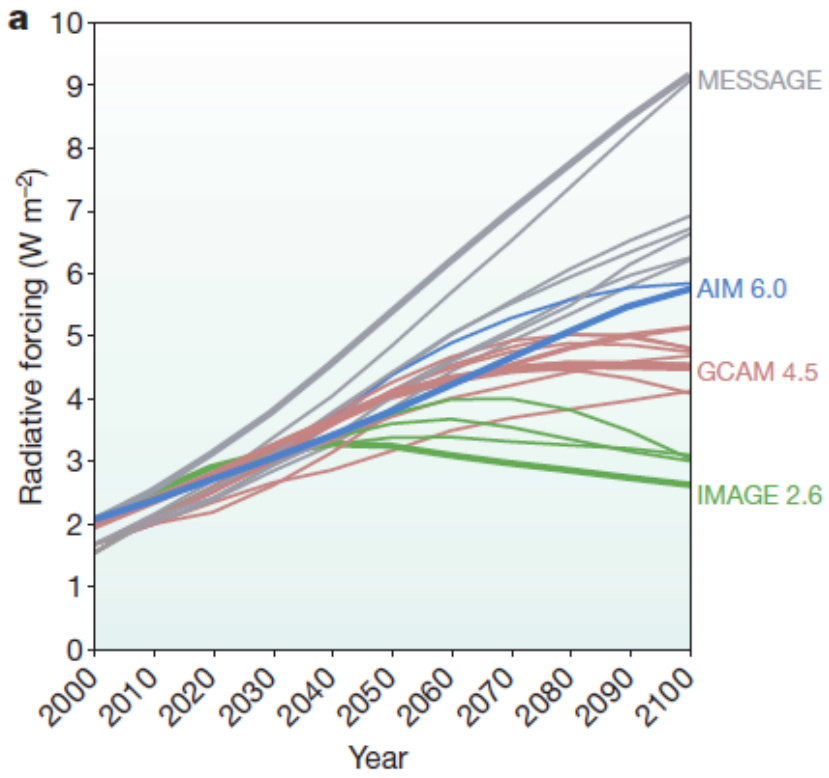
WMO UNEP ipcc

Scenarios: A new "Parallel Approach" Implies Much More Interaction Between the IAV, IAM and CM communities

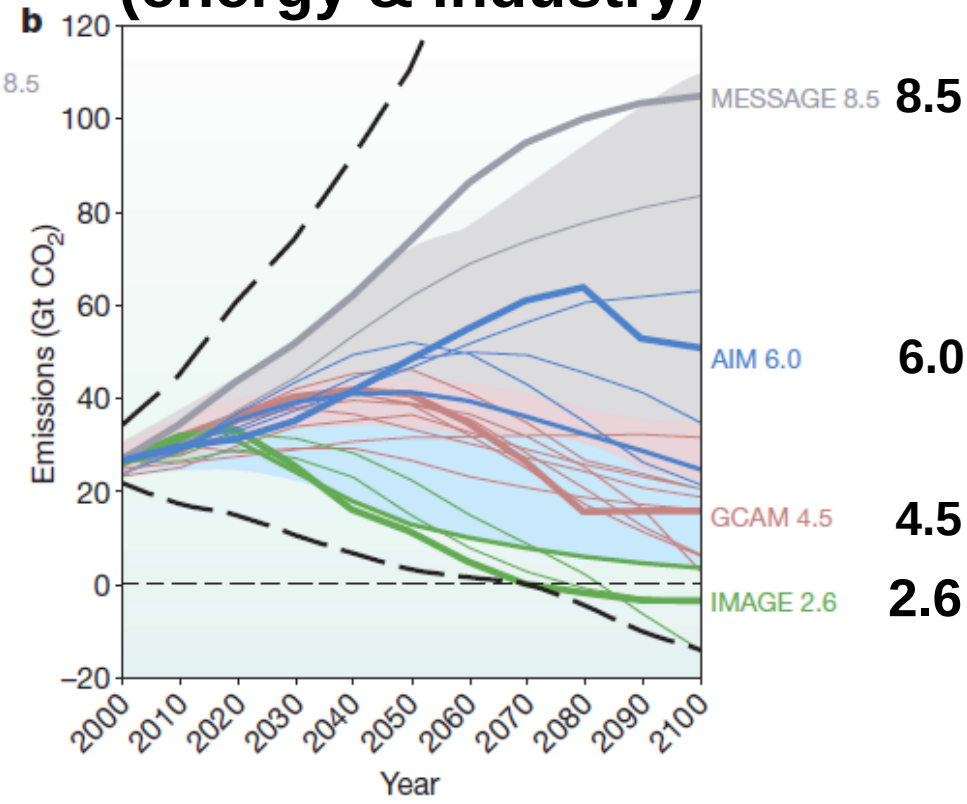


RCP: Radiative forcing and emissions

Radiative Forcing



CO_2 emissions (energy & industry)



Moss et al, 2010, Nature

ipcc
INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

What the RCPs (Representative Concentration Pathways) are:

- **Consistent sets of projections** of only the components of radiative forcing that are meant **to serve as input for** climate **modelling**, pattern scaling, and atmospheric chemistry modelling.
- **Named according** to their 2100 **radiative forcing** level (based on the forcing of greenhouse gases and other forcing agents)**.**
- Chosen for scientific purposes to represent the **span of the radiative forcing literature at the time** of their selection and thus facilitate the mapping of a broad climate space.

Adapted from the RCP database on www.IIASA.ac.at
JPvY

ipcc
INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

IPCC Workshop on Socioeconomic Scenarios for Climate Change Impact and Response Assessment (WoSES)

- **Berlin, 1-3 November 2010. Around 70 participants**
- **Jointly organised by IPCC WGs II and III**
- **Reference for AR5 authors**
- **General objectives:**
  - facilitate the discussions on new scenarios, as a cross-cutting issue for the IPCC AR5 Cycle
  - receive early inputs from the scientific community
  - enhance coordination across the IPCC WGs II & III

WoSES: Lessons for IAM & IAV Research Communities

- **Need for a common framework in mitigation and IAV research and assessment, avoiding oversimplification => allow for sufficient degrees of freedom for locally-driven analysis**
- **Exploring:**
  - **Shared Socioeconomic Pathways (SSP)**
  - **Shared Policy Assumptions (SPA)**
  - **Relationships between mitigation and adaptation capacity**
- **Close collaboration between IAM and IAV communities => Mechanisms for jointly developing narratives and scenarios that meet the needs of both groups**

Conclusion:

IPCC is eager to continue serving the UNFCCC process…

… with your help and collaboration

Thank you!

Useful links:

- www.ipcc.ch : IPCC
- www.climate.be/vanyp : my slides and other documents