New Emissions Scenarios in AR4 and for AR5

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Emissions Scenarios

- Scenarios are descriptions of possible future developments.
- They are *visions* of how main driving forces underlying the salient future developments might evolve and interact with each.
- They are also descriptions of what such developments might imply about possible future states and how the near-term decisions might affect these.
- Scenarios are context specific.
- How they are developed and used depends very much on what the main purpose is and what are the main questions they are intended to inform.

Previous IPCC Scenarios and Future Outlook

- 1990 — Four SA90 scenarios
- 1992 — Six IS92 scenarios
- 1995 — Evaluation Scenarios
- 1996 — Panel decision new scenarios
- 2000 — Special Report Emission Scenarios (SRES)
- 2001 — TAR mitigation scenarios
- 2004 — AR4 assessment of stabilization scenarios
- 2014 >2007 — AR5 Completion? Based on ???????

Characteristics of IPCC Scenarios

	SA90	IS92	SRES	TAR	AR4*
Scenarios	4 (1f)	6	40 6i+4n	80 4s+4n	20 2n+2new
Models	2	1	6	9	6
Population	1	3	3	3	2 (+)
GDP	1(2)	6	6:20+4_{ppp}	6 (+)	5 (+)
GHGs	4+2	6+4	6+4	CO_2	6+4
Intervention	2	0	0	80	12 ~5,4.5,3W/m^2

* Assessed by WGIII for WGI

AR4 Illustrative Scenarios*

Reference 8	Stabilization <5W/m2	Stabilization ~4.5W/m2	Stabilization <3W/m2	Stabilization >3W/m2
AIM		AIM 4.5		
IPAC		IPAC 4.5		
MiniCam		MiniCam 4.5		
MIT		MIT Mitigation		
MESSAGE 1		MESSAGE 4.6		
MESSAGE 2		MESSAGE 4.6	MESSAGE 3.2	
IMAGE 1	IMAGE 5.3	IMAGE 4.5	IMAGE 3.7	
IMAGE 2				IMAGE 2.9

* Assessed by WGIII for WGI

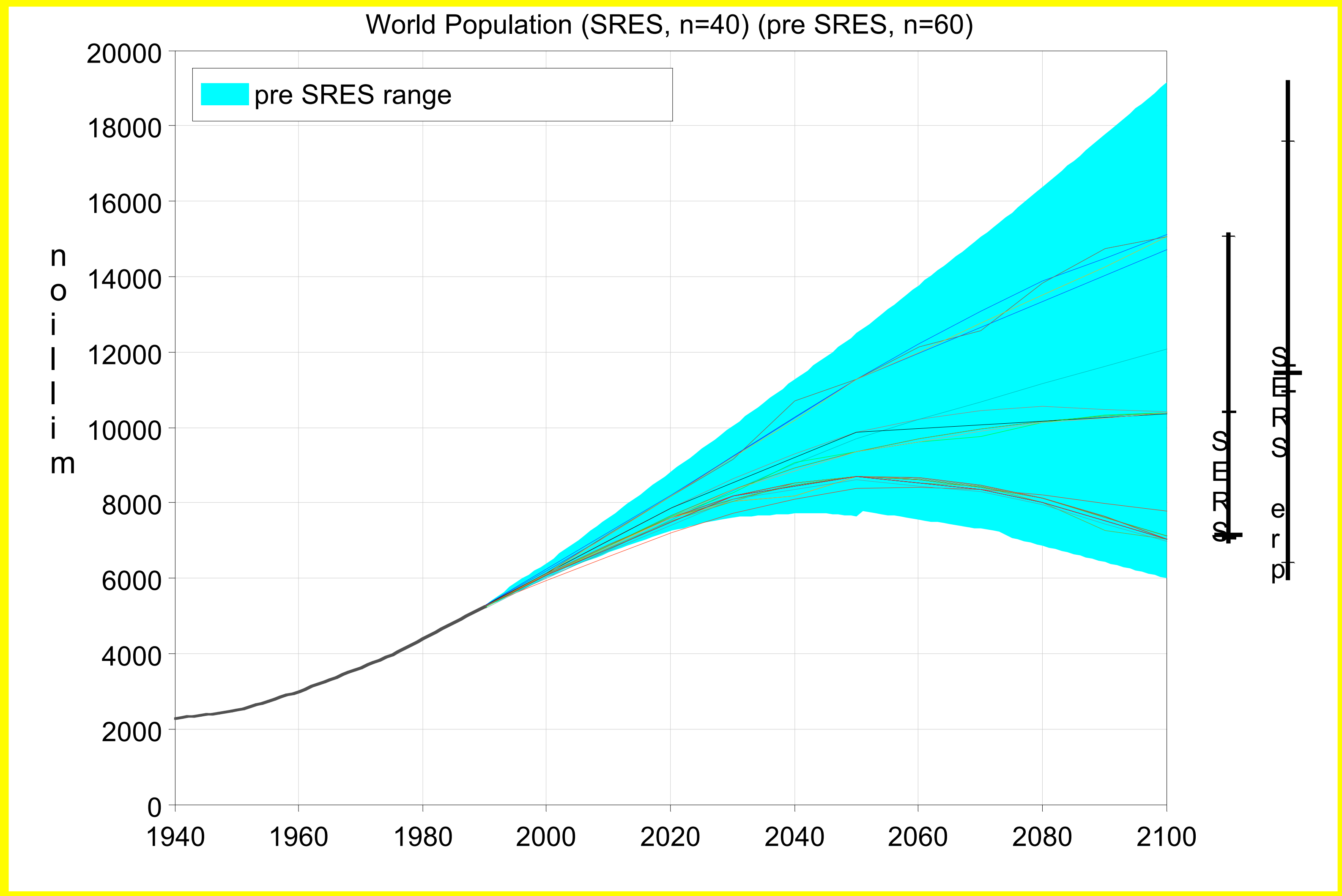
Summary of Scenario Characteristics

	1800	Factor	1900	Factor	2000	Factor	2100
Population (billion)	1	x1.6	1.6	x3.8	6	x1.2 x2.5	7- 15
GDP PPP (trillion 1990$)	0.5	x4	2	x18	36	<x3 x18	85- 530
Primary Energy (EJ)	13	x3.3	40	x11	440	x1.1 x6.1	500- 2700
CO_2 Emissions (GtC)	0- 0.3	x3.0	0.5- 1.0	x6- x12	6.4	<0.5 x5	3- 33

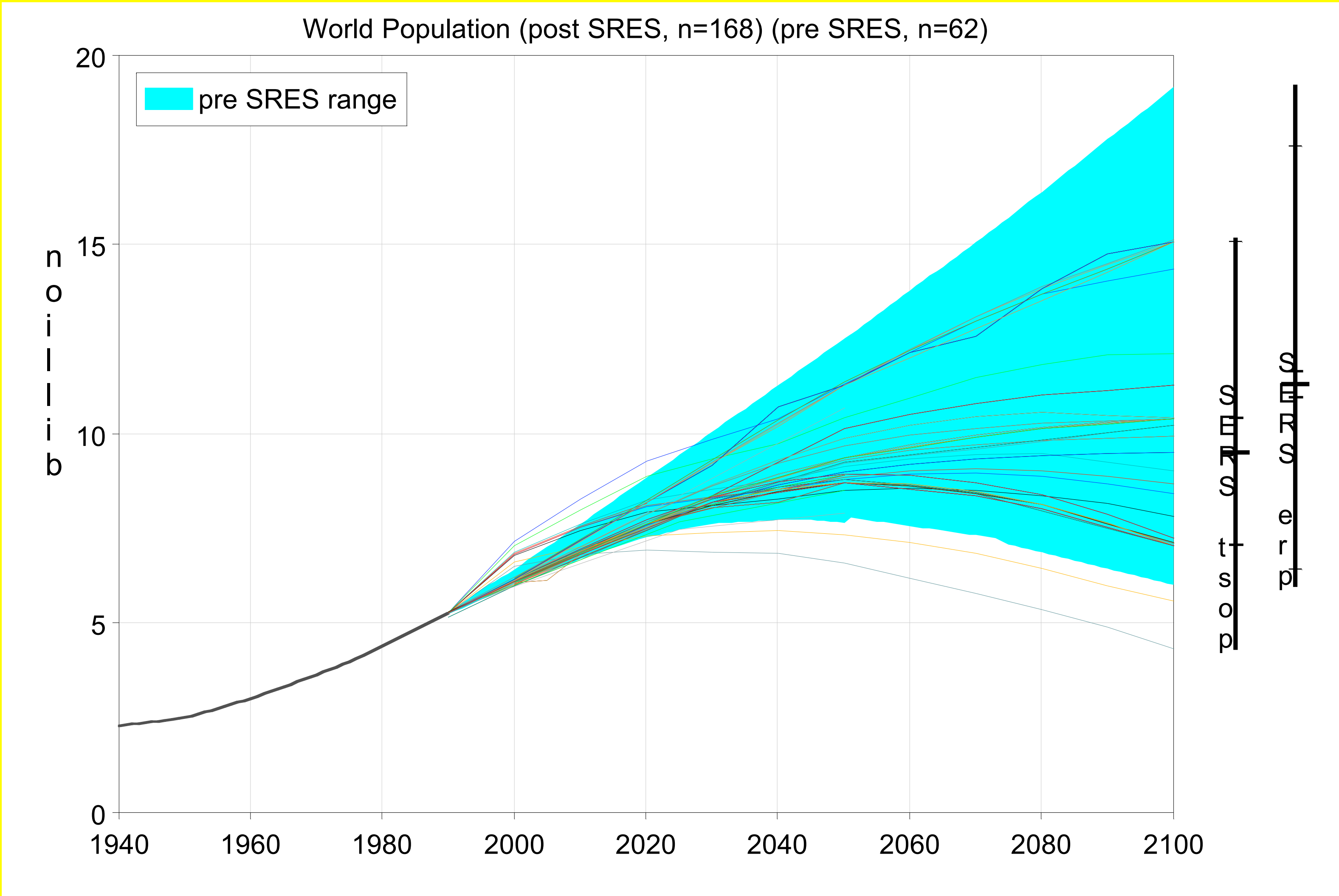
Baseline Emissions Scenarios

- SRES scenarios are widely used for the assessment of climate change and impacts (WG1&WG2)
- WG3 conclusions comparing new baseline emissions scenario literature with SRES (Ch 3):
  - No significant change in ranges (uncertainty) of future emissions and underlying driving forces compared to SRES
  - Main difference concerns downward correction of demographic projections (not yet implemented in the majority of new emissions scenarios)
  - The majority of the new emissions scenarios employ MER-based GDP assumptions. A few studies in the literature reporting PPP, indicate that the impact on emissions is small (problems: lack of comprehensive PPP data)

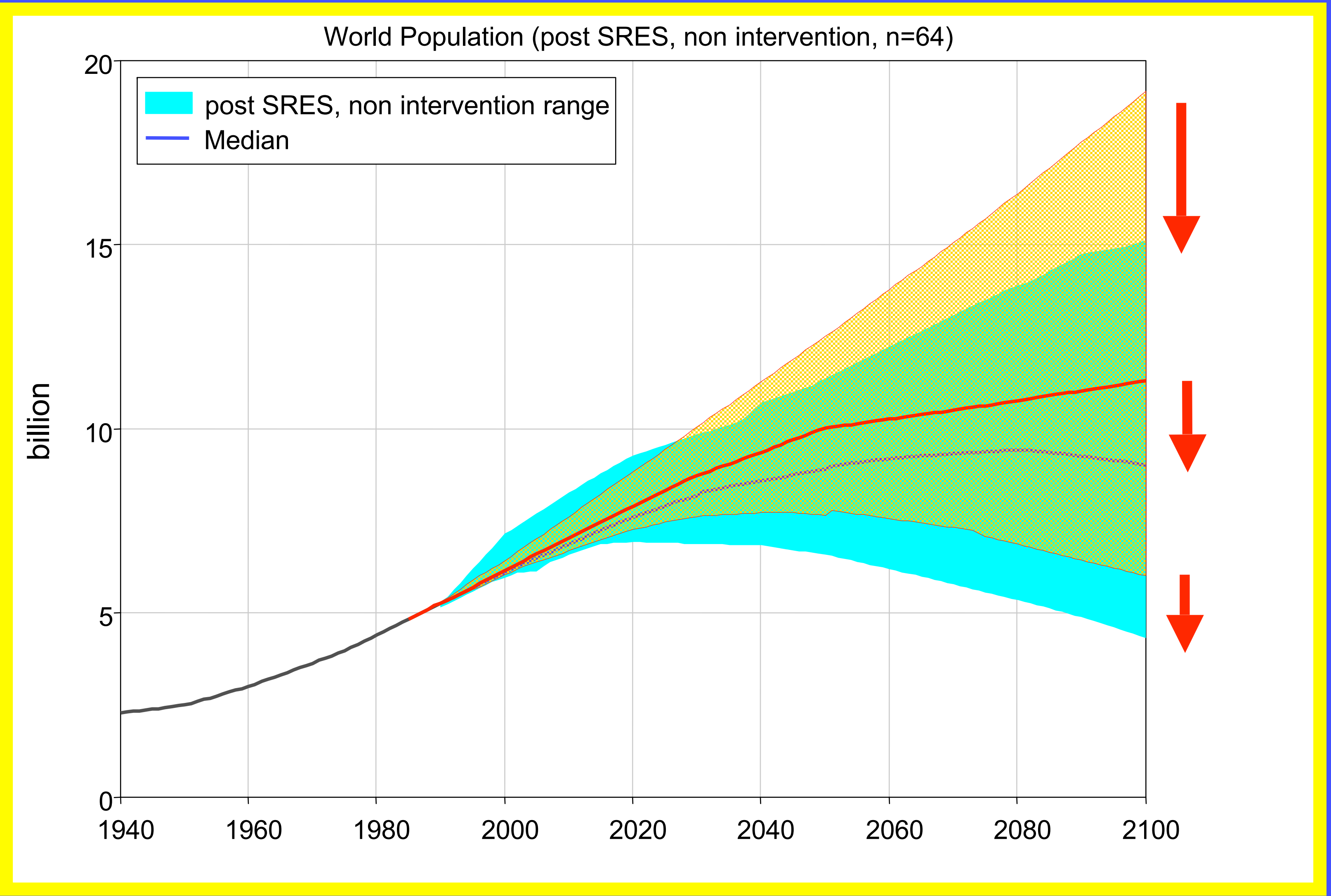
Global Population Projections



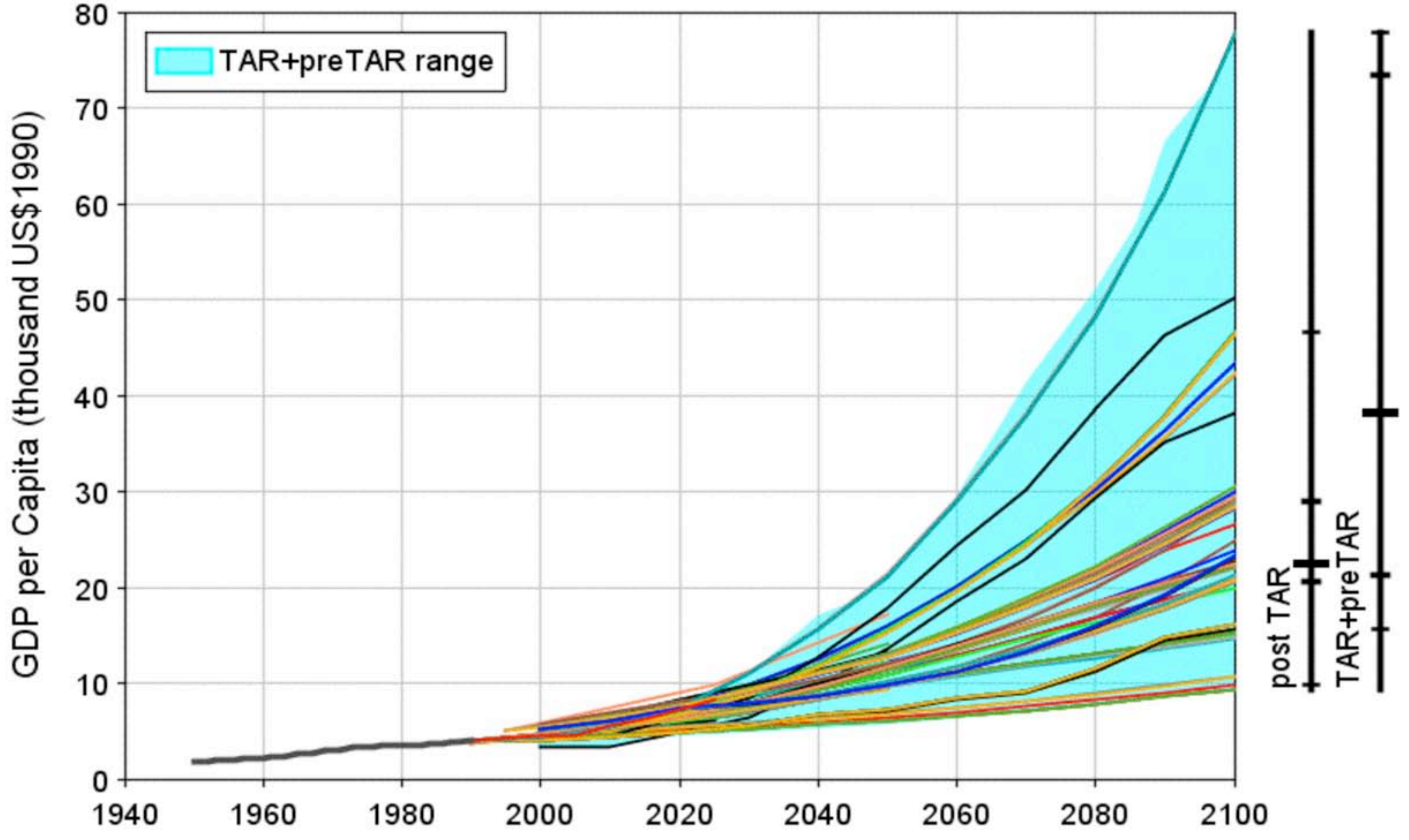
Global Population Projections



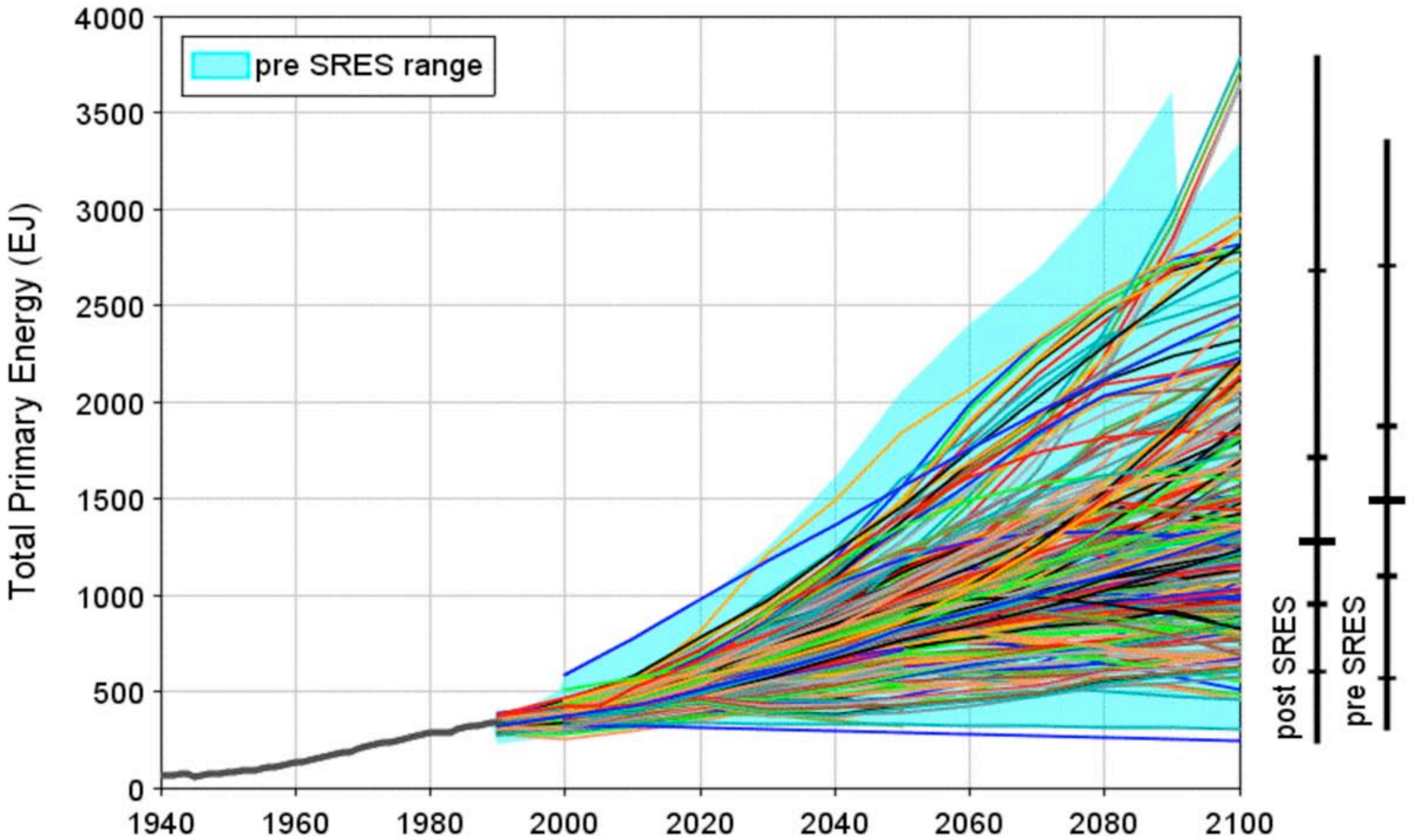
Global Population Projections



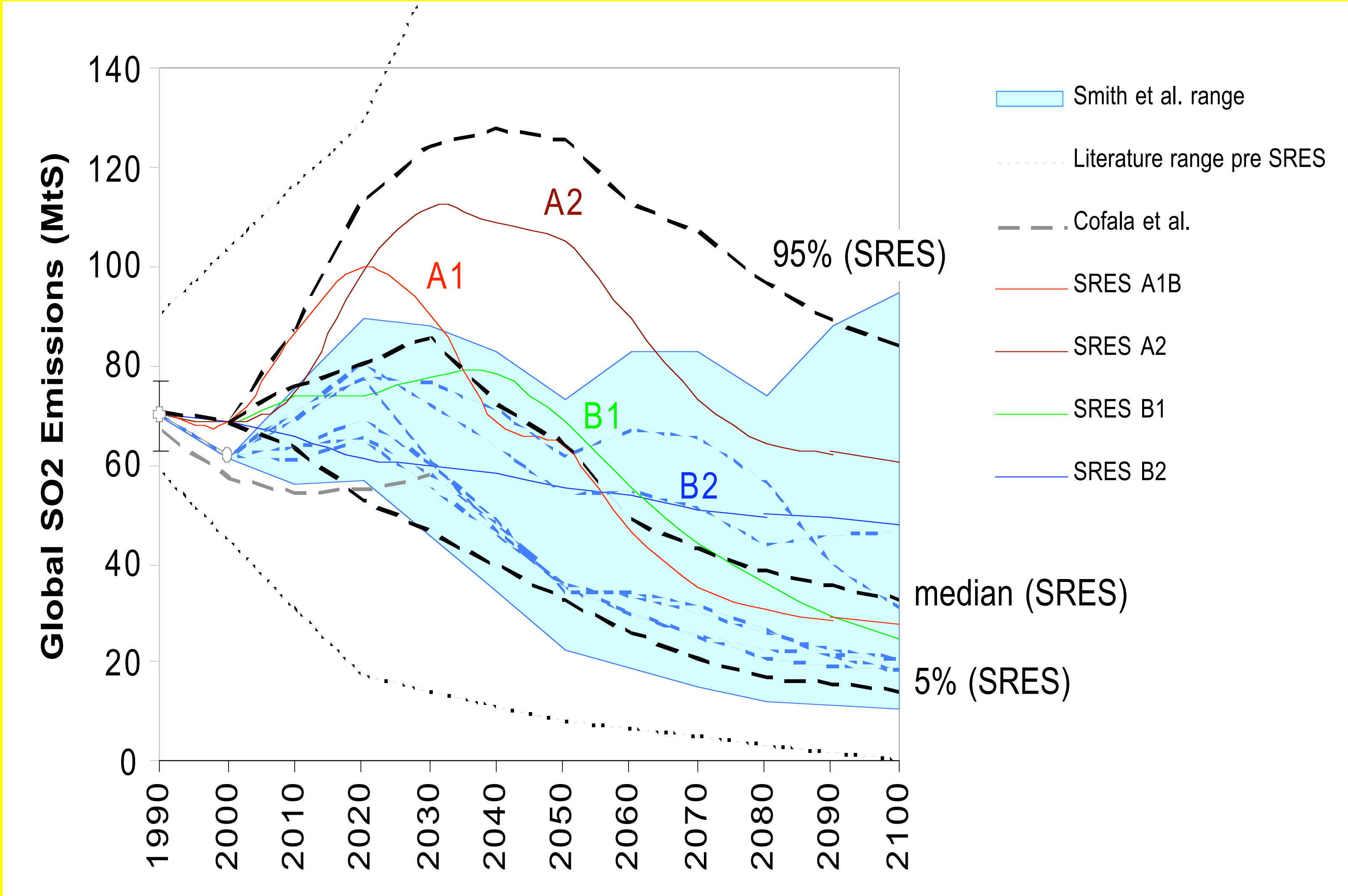
Global GDP Scenarios



CO_2 Emissions Baselines



Sulfur Emissions Baselines



Emissions pathways for alternative ranges of CO2 and CO2-eq. stabilization targets.

All stabilization scenarios in the scenario database

Scenario Category	CO2-only concentrations by 2100	CO2-equivalent concentrations by 2100	Year when global emissions peak	Year when global emissions fall below 2000 levels	Change in global emissions in 2050 relative to 2000 levels	Change in global emissions in 2100 relative to 2000 levels
	ppmv	ppmv	year	year	%	%
The 90th precentile range of the stabilisation scenarios in the literature						
A	< 420	<510	2000 - 2040	2000 - 2060	-86 to +18	-161 to -67
B	420 - 490	510-590	2000 - 2050	2000 - 2060	-41 to +33	-91 to -38
C	490 - 570	590-710	2010 - 2080	2010 - dnr	-3 to +73	-85 to +47
D	570 - 660	710-860	2030 - 2100	2060 - dnr	+27 to +116	-24 to +81
E	> 660	>860	2040 - 2090	2100 - dnr	+67 to + 143	-5 to +186

Stabilization and Mitigation Scenarios

- Major difference to TAR: studies suggest that it is technically feasible to stabilize GHG concentrations at levels significantly lower than TAR (450 CO_2-eq.)
- Most of the low scenarios imply a temporal overshoot of the target
- Potential challenge for consistency – climate outcomes of these low stabilization scenarios are not analyzed in WGI (TS and SPM)
- New multigas literature indicates that for a specific stabilization target, emissions might peak later in time compared to TAR

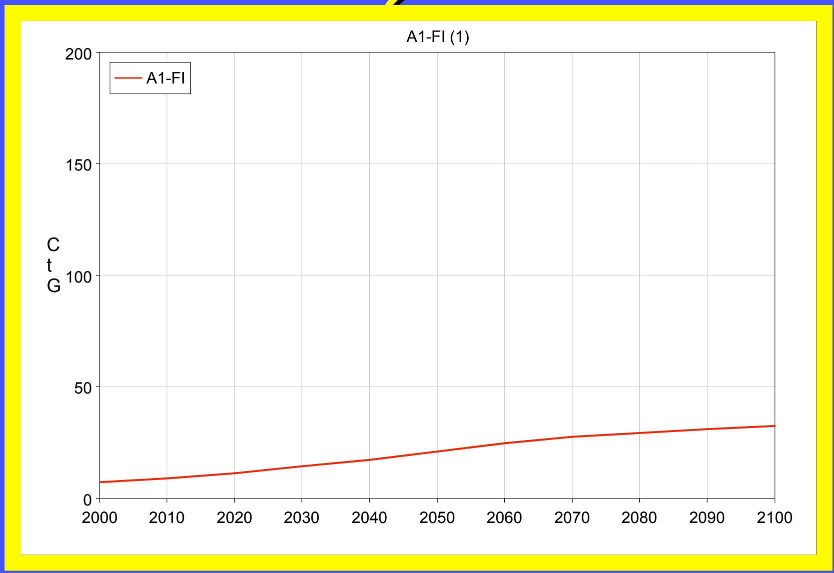
Mitigation costs and adaptation

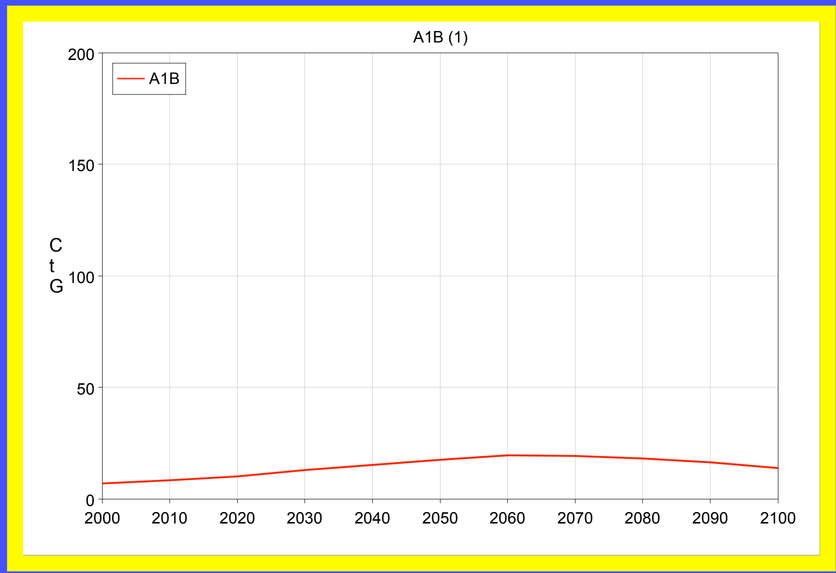
- Mitigation and adaptation complement each other
- Gaps concerning (economic) trade-offs between mitigation, adaptation, and “residual” impacts
- Mitigation costs:
  - depend strongly on the long-term socio-economic and technological development path and assumptions (baseline dependency)
  - Costs of stabilization rise generally with the stringency of the target
  - Costs are subject to large uncertainties
- (Climate policy) induced technological change leads to significant mitigation cost reductions (however no reduction in overall cost uncertainty/ranges)
- Importance of “multigas” strategies for the cost-effectiveness of achieving stabilization

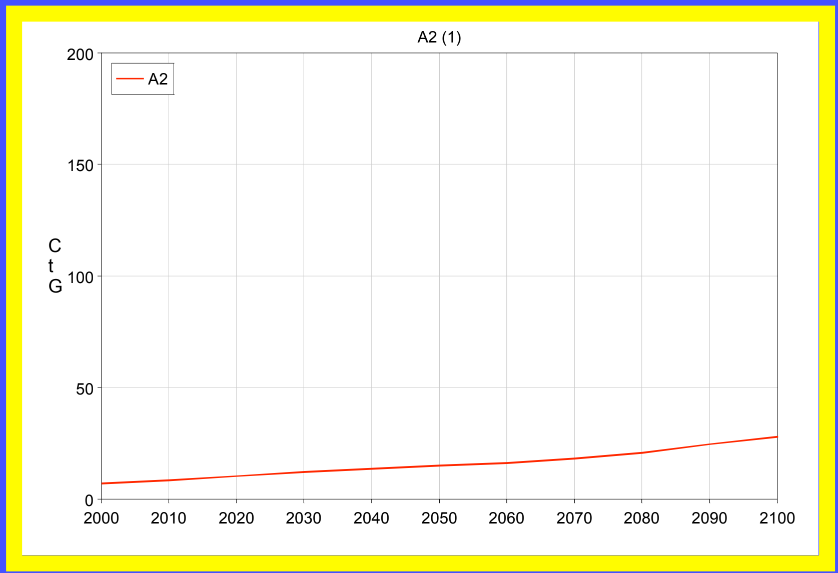
Technology

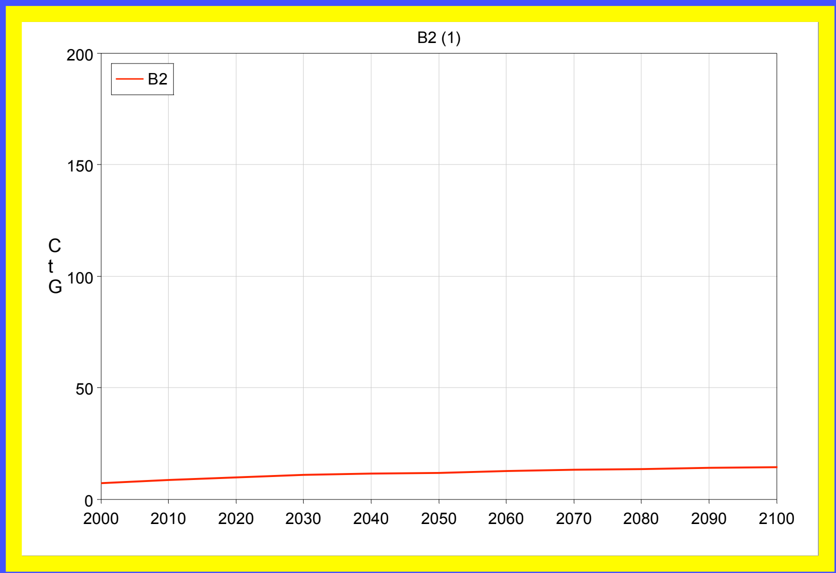
- Improved understanding of the complexity of the multiple driving forces of technological change (supply push, demand pull, R&D, and deployment policies complement each other) Ch2 & Ch11
- A wide portfolio of emissions reductions measures/technologies are necessary to achieve stabilization cost-effectively. TS
- Technology diffusion is characterized by inertia and "lock-in" – challenge for low stabilization, which requires emissions to peak over the next decades. Ch 2,3 & Ch11
- Large short-term (2030) economic potential for reductions at relatively low prices (< $20/tCO2-eq). Whether it will be deployed depends on investment decisions and policy incentives. Ch 3-10

CO_2 Emissions Baselines

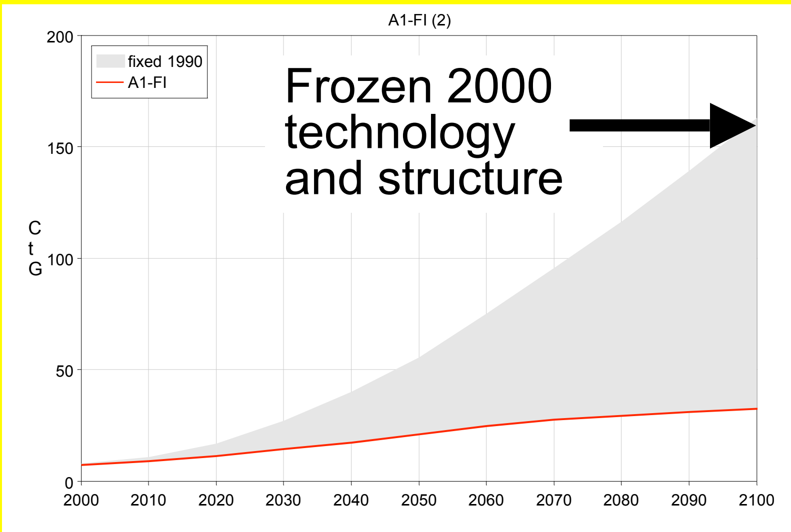


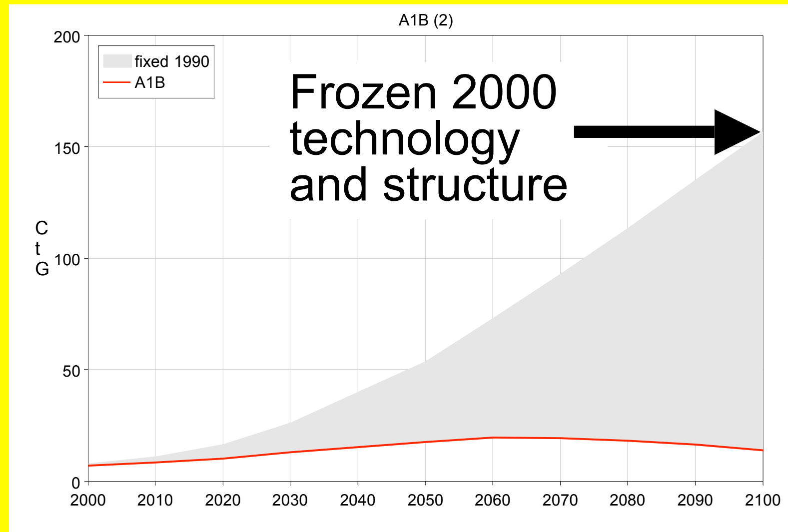


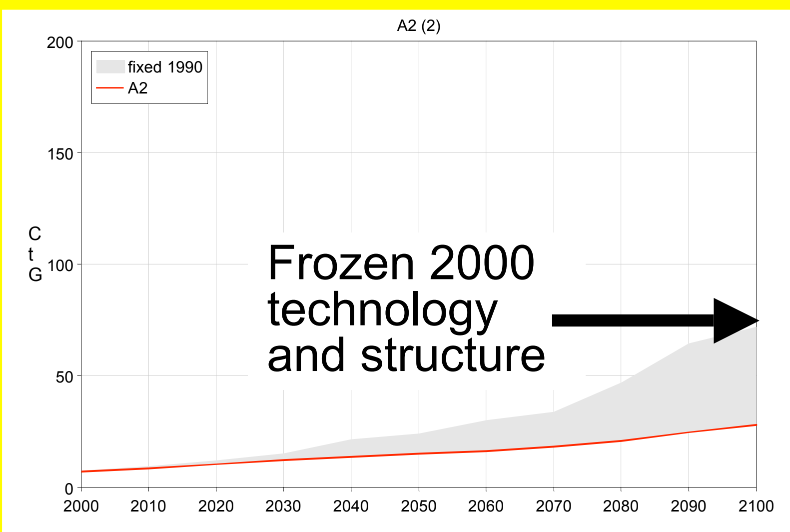


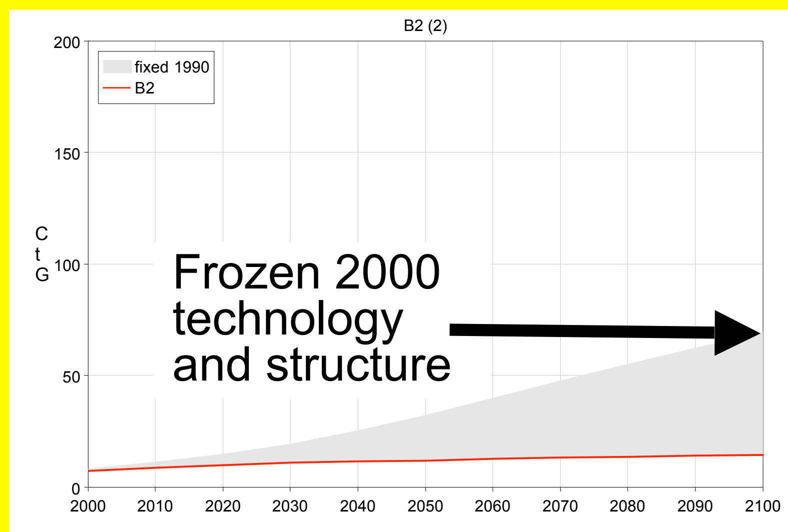


CO_2 Emissions (Hypothetical)

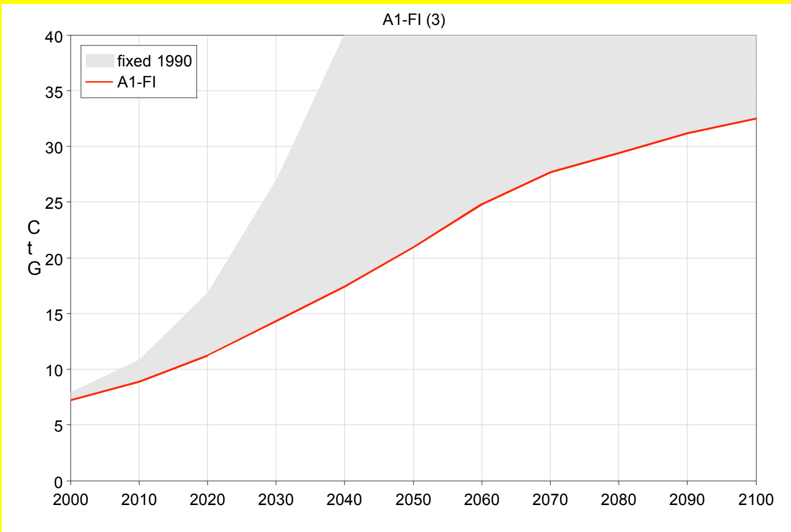


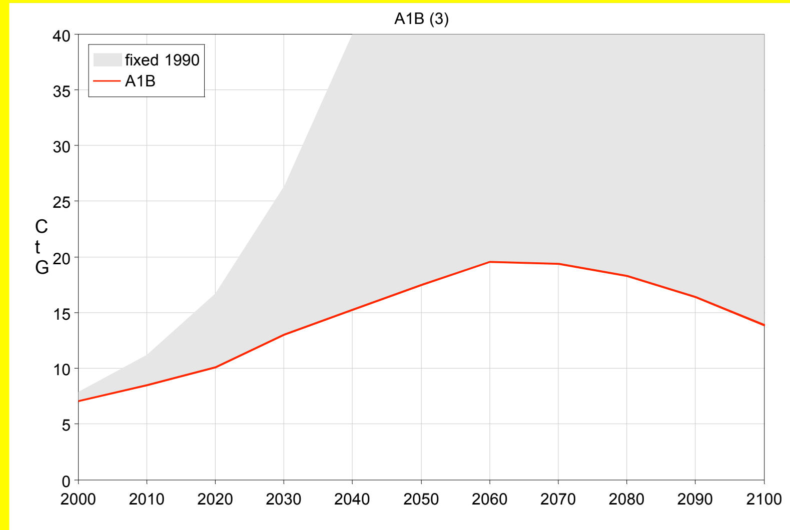


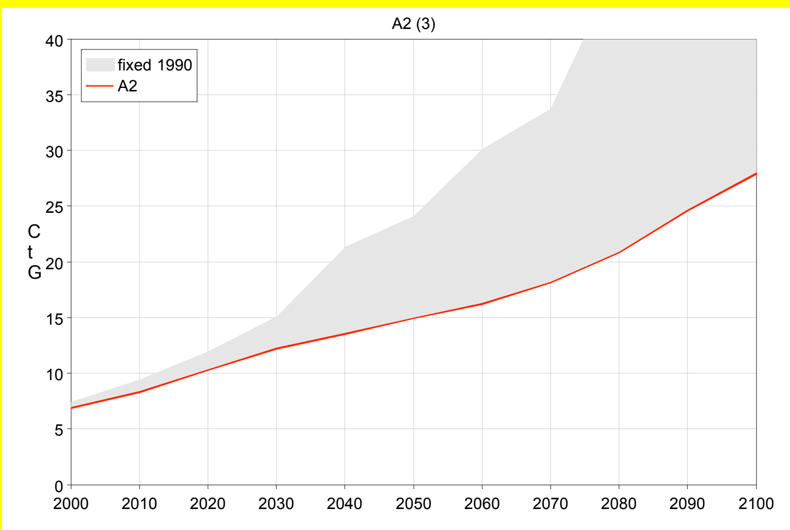


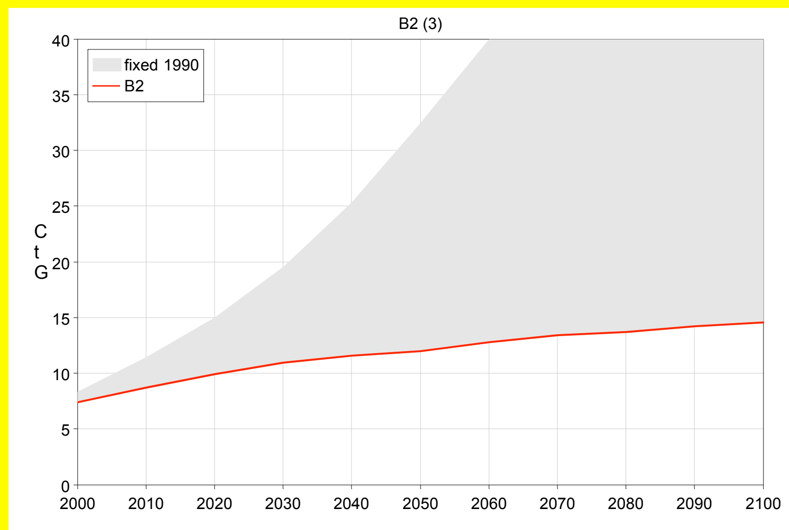


CO_2 Emissions

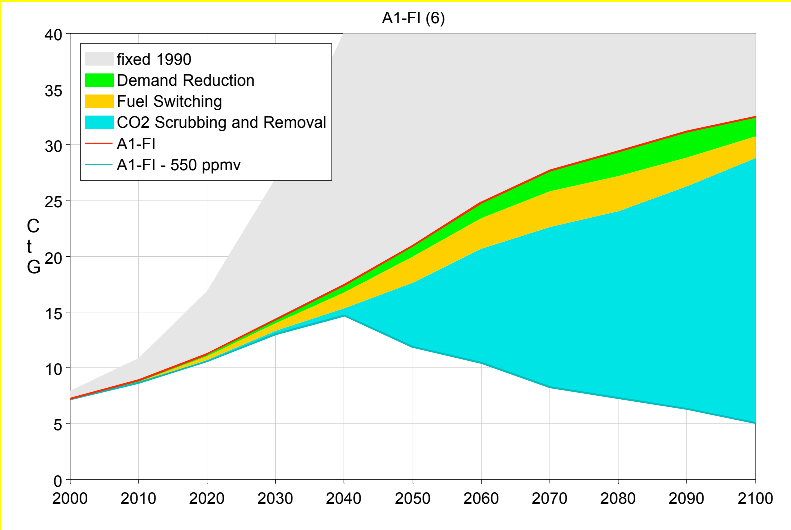


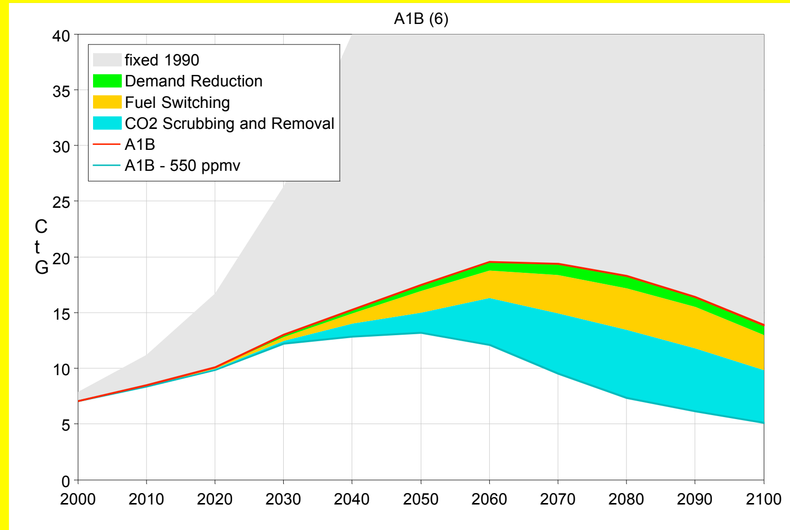


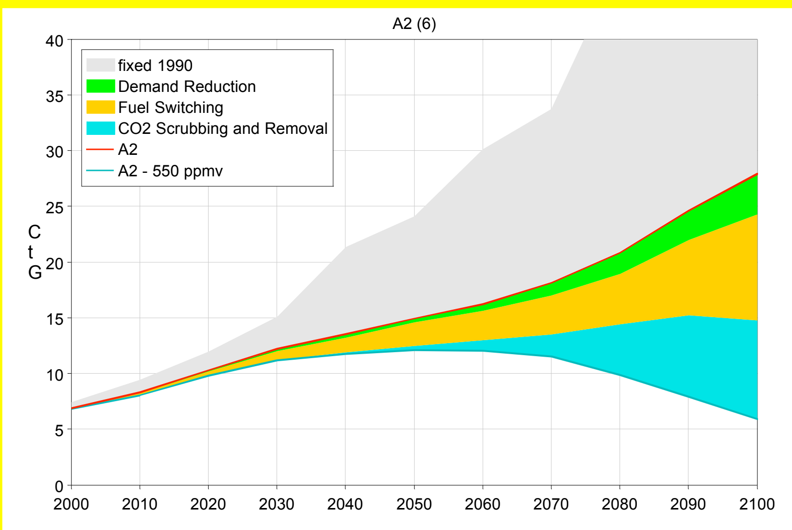


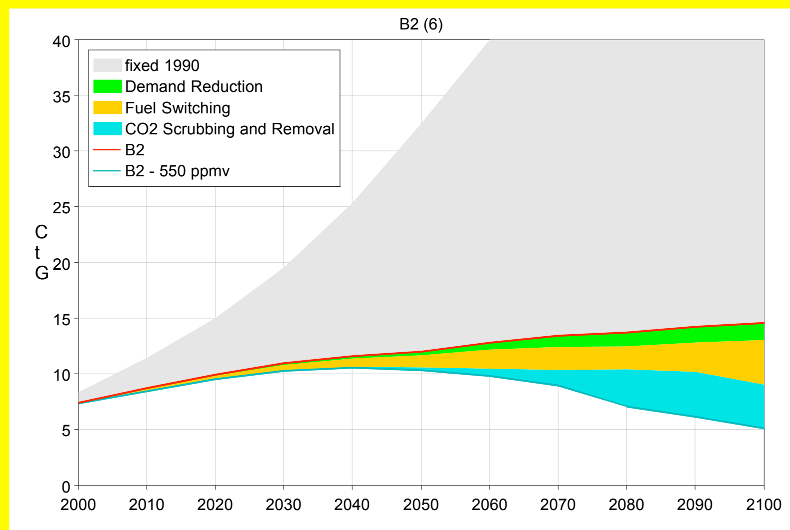


CO_2 Stabilization at 550ppm

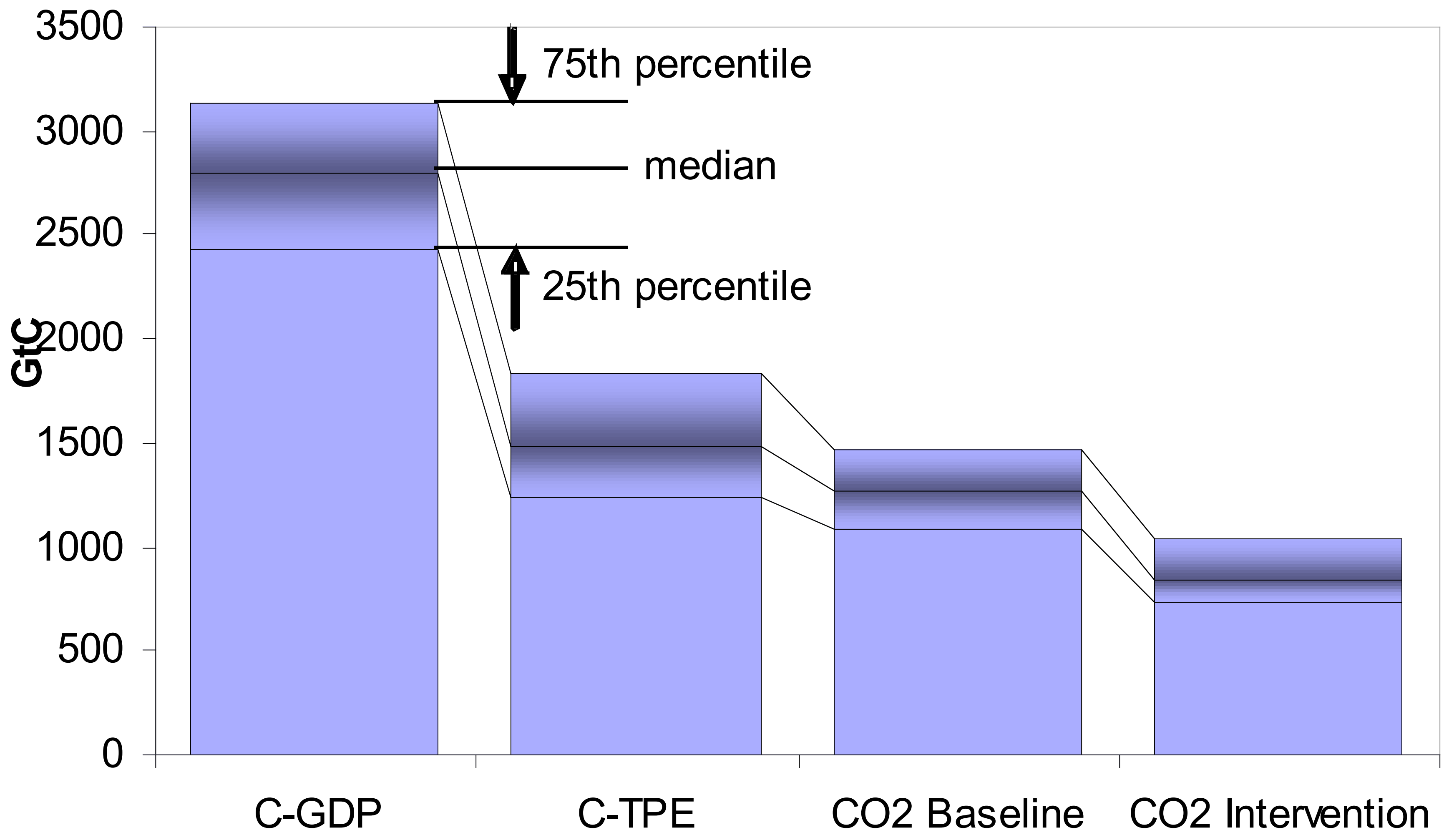








Global cumulative carbon emissions by 2100 in the scenarios developed since 2001



Linking short-term to long-term:

Table 3.17: *Global Emission Reductions in 2030 by Sector for Lower Stabilization Targets*

		MiniCAM	MERGE	IMAGE[b]	IMAGE[b]	MESSAGE
Model		MiniCAM	MERGE	IMAGE[b]	IMAGE[b]	MESSAGE
Model Time Horizon		Long-term	Long-term	Long-term	Long-term	Long-term
Stabilization Target		3.5 W/m^2 from pre-Industrial	3.4 W/m^2 from pre-Industrial	3.7 W/m^2 from pre-Industrial	3.0 W/m^2 from pre-Industrial	B2 Scenario, 3.2 W/m^2 from pre-Industrial
Marginal Cost (2000 U.S. $/tCO2 eq)		$53	$192	$48	$112	$115
Reference Case Emissions in 2030 Global Total All Gases (MtCO2 eq)		54,217	47,243	59,735	59,735	57,801
Sector Mitigation Potential in 2030 (Total All Gases $MtCO_2$ eq)	Energy Supply: Electric	11,945	9,533	3,853	8,736	4,296
	Energy Supply: Non-Electric	3,308	3,188	2,252	3,669	2,242
	Transportation Demand	627	Included in another sector	1,491	2,840	2,238
	Buildings Demand	1,372	Included in another sector	522	1,000	1,420
	Industry Demand	5,222	Included in another sector	1,612	3,188	795
	Industry Production	270	3,580[a]	1,126	2,024	811
	Agriculture	604		980	1,208	1,656
	Forestry	0		173	247	604
	Waste Management	768		1,041	1,105	896
	Global Total	**23,848**	**16,302**	**13,039**	**24,018**	**14,959**
Mitigation as % of Reference Emissions		**44%**	**35%**	**28%**	**[illegible]0%**	**26%**

Synergies and trade-offs with other policies

- Increasing evidence that climate mitigation measures may create synergies for sustainable development and other policy objectives
- Potential synergies are:
  - Reduction of local air pollution and related health impacts
  - Improvement of energy security
  - Avoid displacement of local populations
  - Benefits for biodiversity, soil, water conservation (avoided deforestation)
  - Reduction of wasteland and soil degradation, manage water run-off, benefit rural economies, etc.. (forestation)
- Potential tradeoffs exist as well
  - E.g., loss in biodiversity and competition for agricultural land (bioenergy)

TGNES Recommendations

The three IPCC WG should use a common base:

- The assessments of impacts, adaptation and vulnerability should be consistent with views on the evolution of climate change, which in turn should be consistent with views on emissions trajectories.
- The assessment of emissions should be consistent with views of socio-economic drivers and land-use change and take account of feedbacks from climate change impacts and policies to reduce them.
- Finally, impacts, adaptation and vulnerability are in their turn dependent on those socio-economic drivers and land-use change.

TGNES Recommendations

Three options for the role of IPCC in the development of scenarios:

- B1A: Development left to the scientific community (may or may not self-organise, eg EMF)
- B1B: IPCC involved in facilitating (catalyzing) the establishment of a coordinating mechanism for development of new scenarios
- B2: IPCC provides coordination of scenario development

IPCC Plenary Decision

- The Panel recognized that the development of scenarios for AR5 would be undertaken by the scientific community. The IPCC may catalyze such work so as to promote its readiness in time for the AR5 cycle
- Prepare a Technical Paper to summarize relevant material from the AR4 and to identify a small number of "benchmark" emission scenarios for potential use by climate modeling groups IPCC; Steering Committee to organize a meeting involving relevant communities
- IPCC to catalyze the establishment of a coordinating mechanism (The Earth System Science Partnership: DIVERSITAS, IGBP, IHDP and WCRP)

What's New?

- New demographic perspectives (lowering of "high" population projections)
- Low (EU) targets included (2^{o}C)
- Consistent multi-gas multi-sector analysis (land use conflicts, impacts,..)
- New technological options included (e.g. biomass CCS)
- Assessment of impacts (climate AND mitigation)
- "Downscaling": spatially explicit scenario indicators available (POP, GDP, FE)
- Linkage to national policy frameworks (GAINS)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