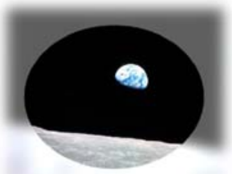


Moving towards a sustainable world

Prof. Dr. Olav Hohmeyer

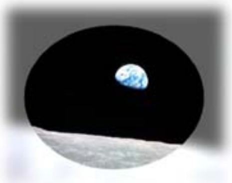
Universität Flensburg

Vice Chair WG III IPCC

Latest Results on Climate Change and Implications for Road Transport

PIARC XXIII World Road Congress

Paris, September 19th 2007



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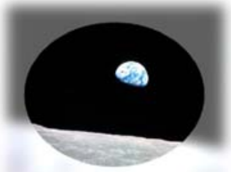
Structure of the presentation

- Anthropogenic climate change
- New results on climate change in 2007 (WG I)
- New results on climate change mitigation 2007 (WG III):
  - The need for mitigation
  - The timeframe for mitigation
  - The means for mitigation
  - The cost of mitigation
- Mitigation in the transport sector
- Conclusions

Anthropogenic climate change



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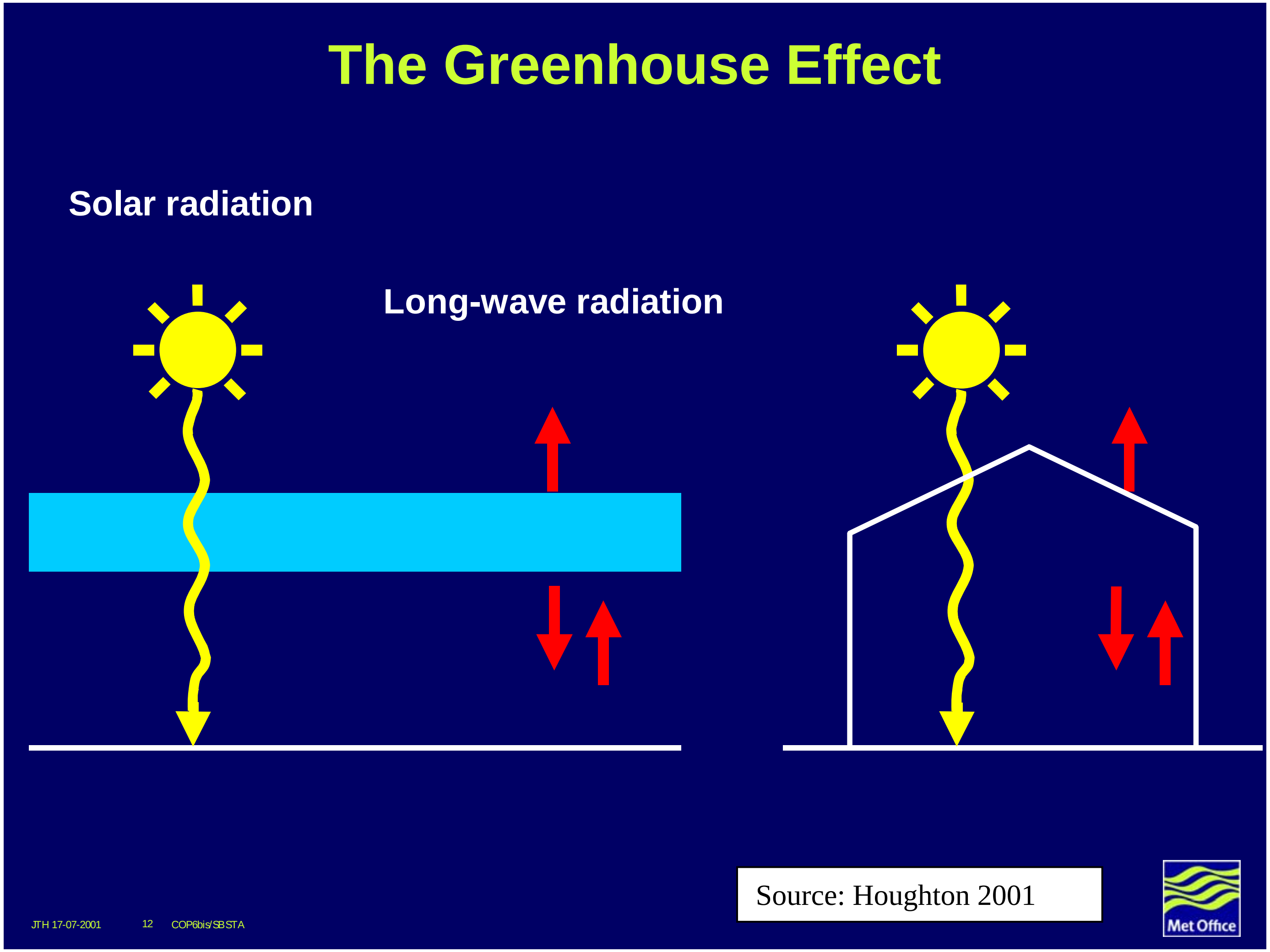
The greenhouse effect



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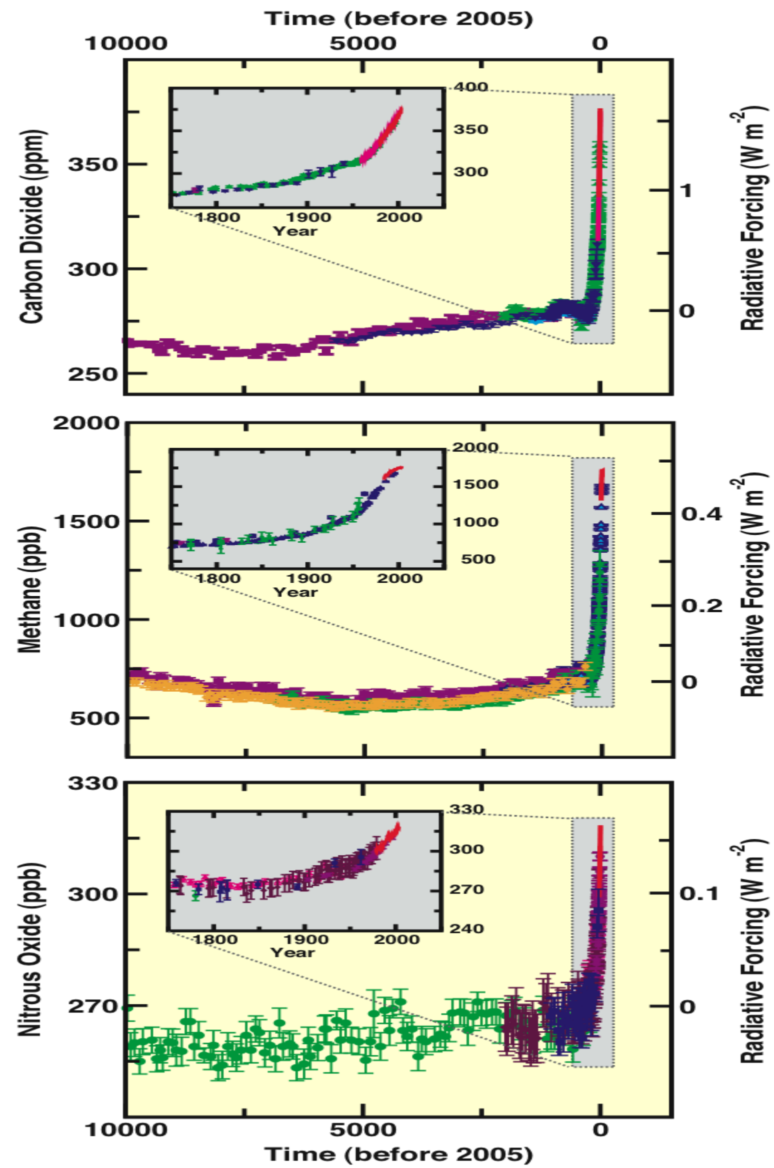
Anthropogenic Influences on Climate Change

CO_2, CH_4 and N_2O Concentrations

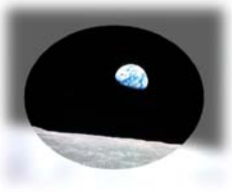
- far exceed pre-industrial values
- increased markedly since 1750
  due to human activities

Relatively little variation before the industrial era



Source: IPCC 2007a (WG I, SPM, p. 3)

New results on climate change in 2007 (WG I)

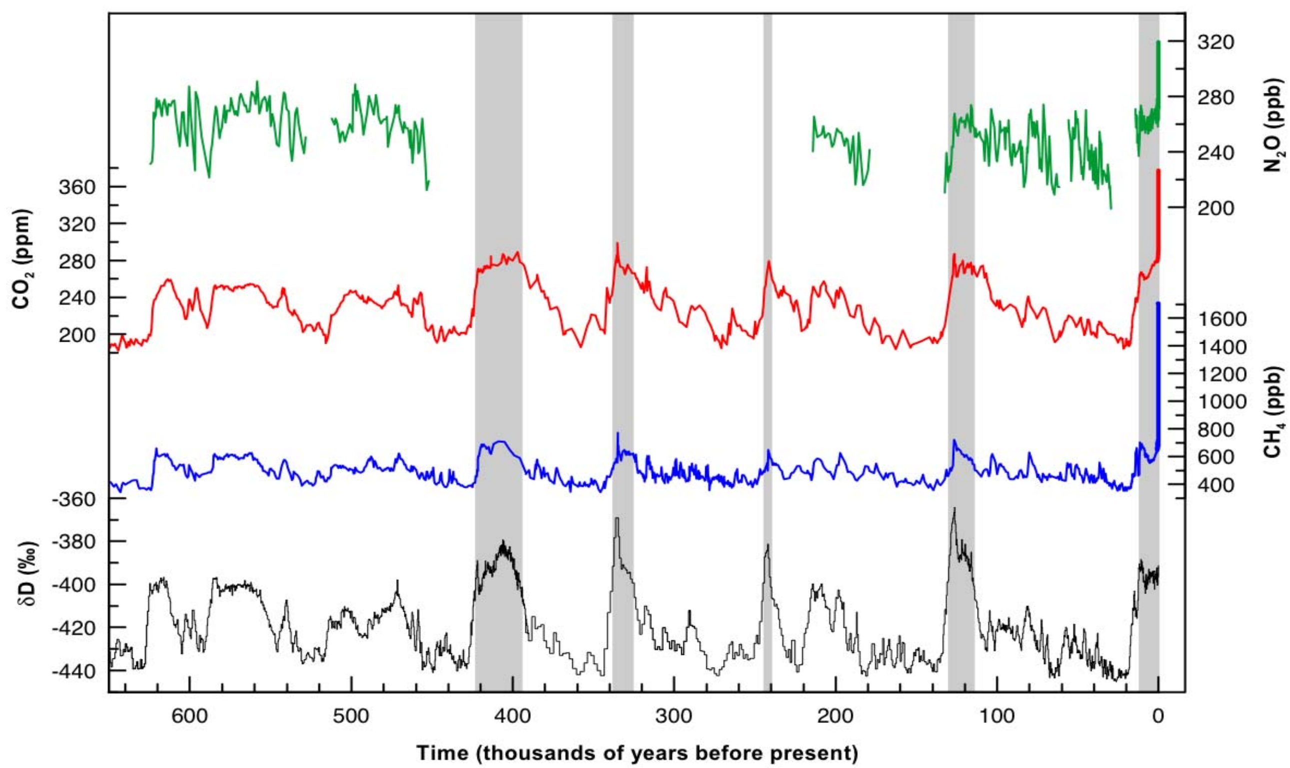


Long term changes in THG concentrations

Glacial-Interglacial Ice Core Data

CO_2

CH_4



The atmospheric concentration of CO_2 and CH_4 in 2005 exceeds by far the natural range of the last 650,000 years

Source: Pachauri und Jallow, 6.2.2007

Global GHG emissions 1970 - 2004

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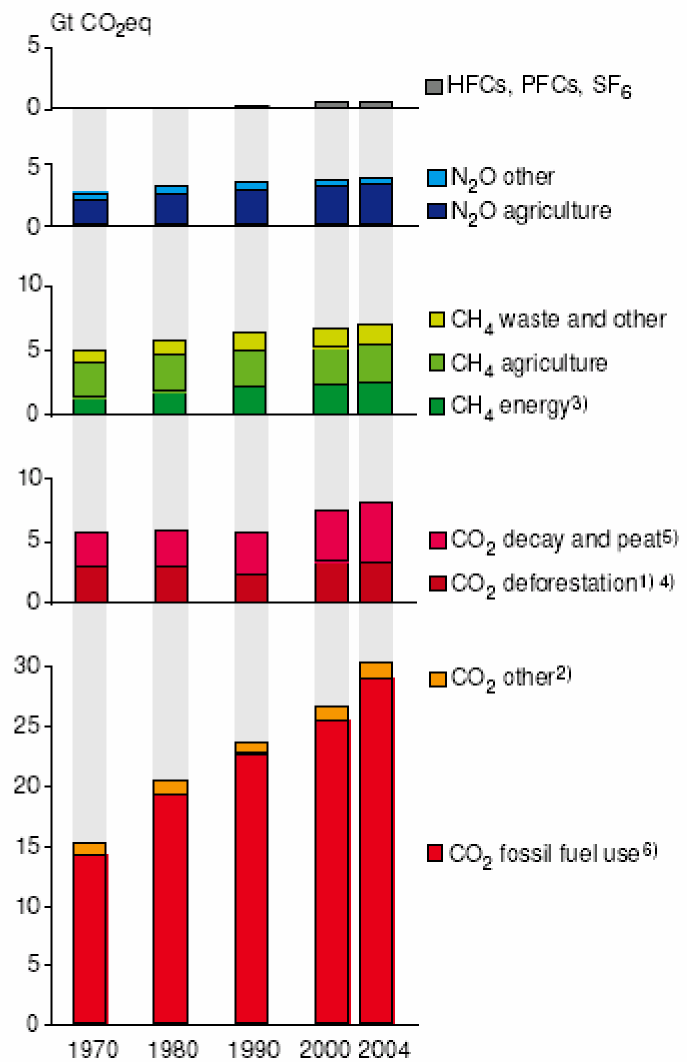

***Figure TS 1a**: Global anthropogenic greenhouse gas trends, 1970-2004 [Figure1.1a].*

Note: 100 year GWPs from IPCC 1996 (SAR) were used to convert emissions to CO_2-equivalents (cf. UNFCCC reporting guidelines). Gases are those reported under UNFCCC reporting guidelines. The uncertainty in the graph is quite large for CH_4 and N_2O (of the order of 30 to 50%) and even larger for CO_2 from agriculture and forestry.

1) *Including traditional biomass combustion at 10% (assuming 90% sustainable production). Feedstocks, steel manufacturing & other non-energy use of fossil fuel is included. Corrected for 10% carbon of burned biomass that remains as charcoal.*
2) *Cement production and natural gas flaring.*
3) *Including from biofuel production and biomass use*
4) *For large-scale forest and scrubland biomass burning averaged data for 1997-2002 based on Global Fire Emissions Data base satellite data.*
5) *CO_2 emissions from decay (decomposition) of aboveground biomass that remains after logging and deforestation and CO_2 from peat fires and decay of drained peat soils (excluding fossil fuel fires).*
6) *Fossil fuel use includes emissions from feedstock*

Source: IPCC 2007 (TS WG III, p. 4)

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Global GHG emissions by sector in 2004

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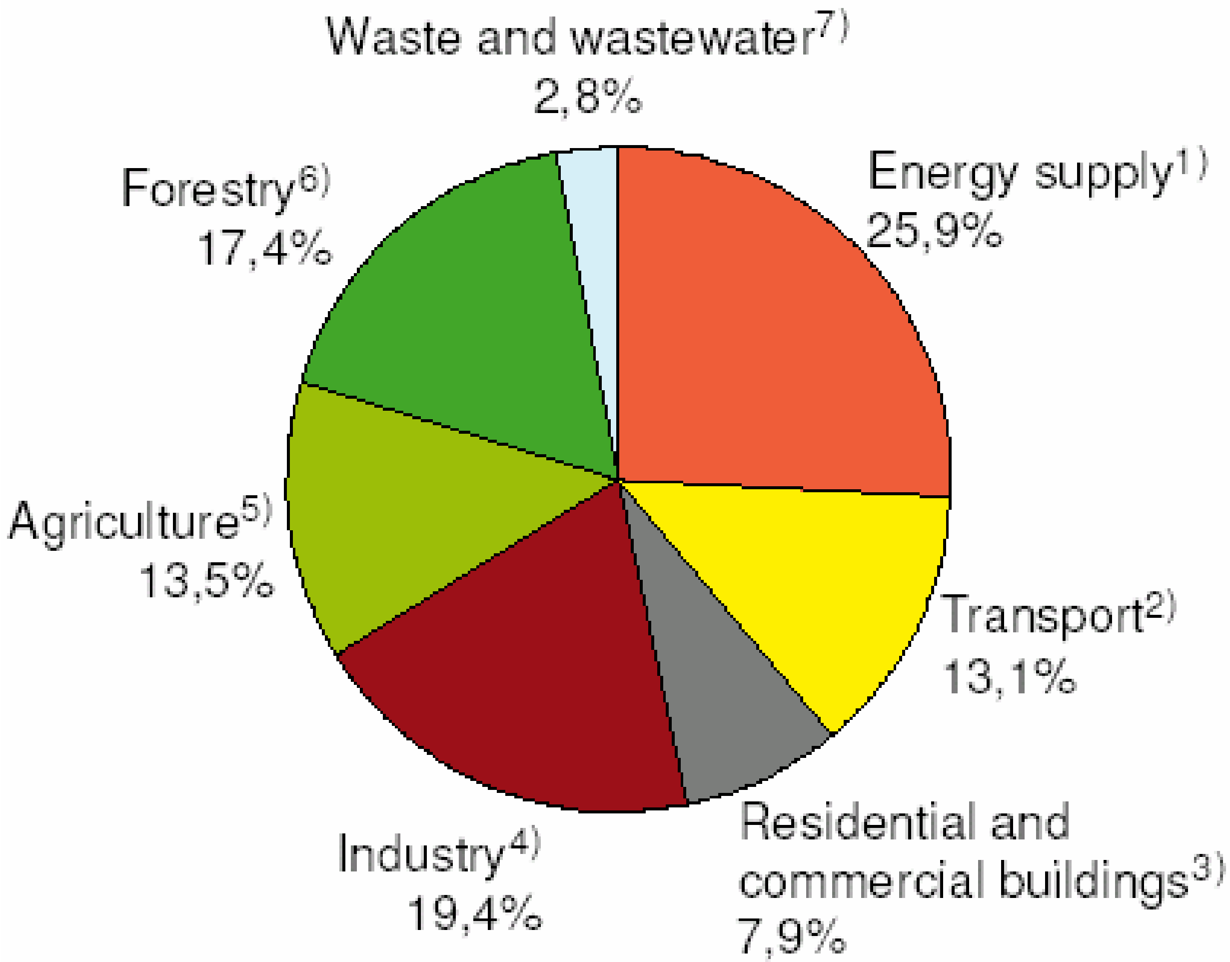

Source: IPCC 2007 (TS WG III, p. 5)

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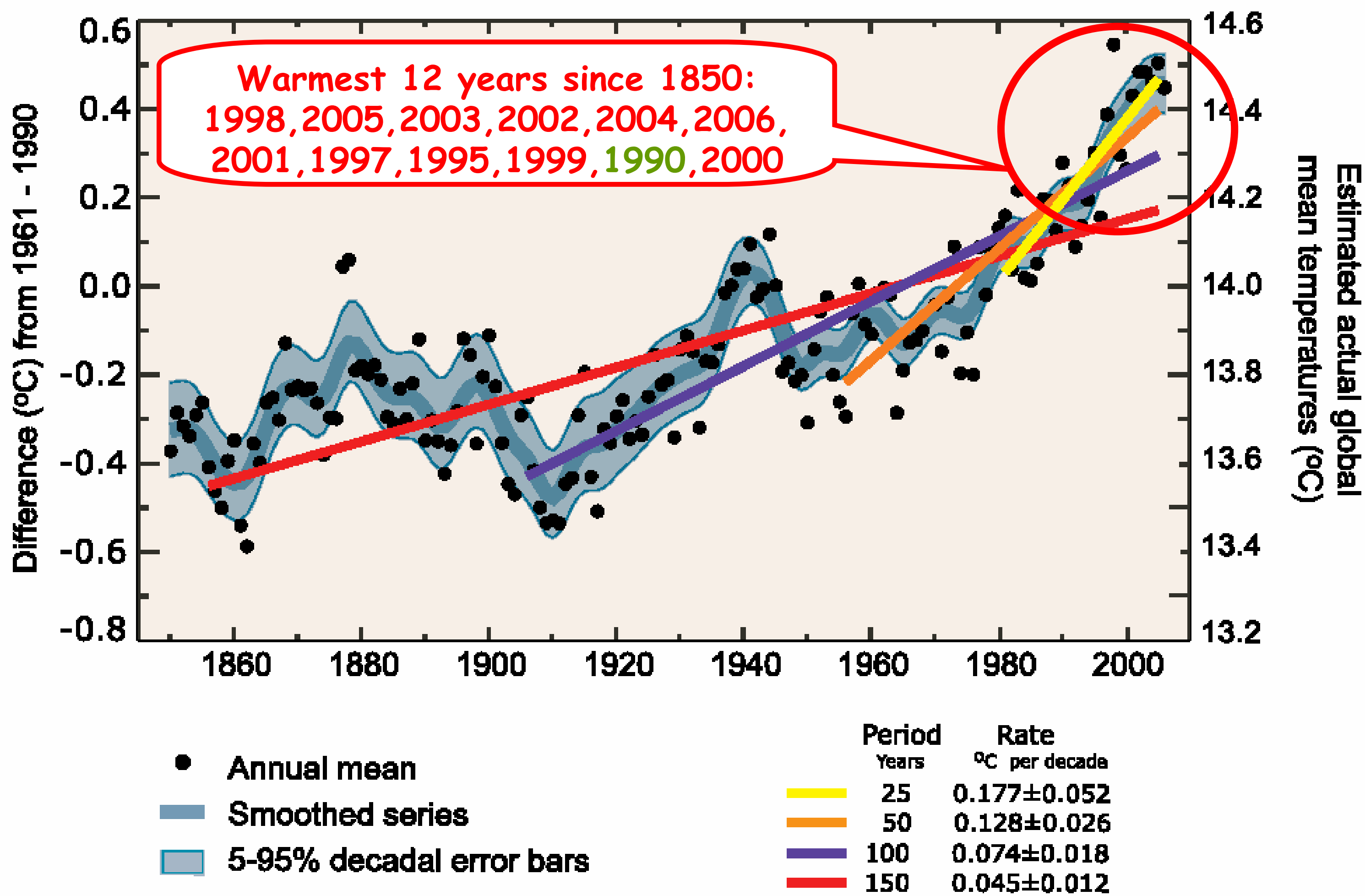
Increased global temperature change



Source: IPCC 2007a (WG I TS p, 37)

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Components of radiative forcing

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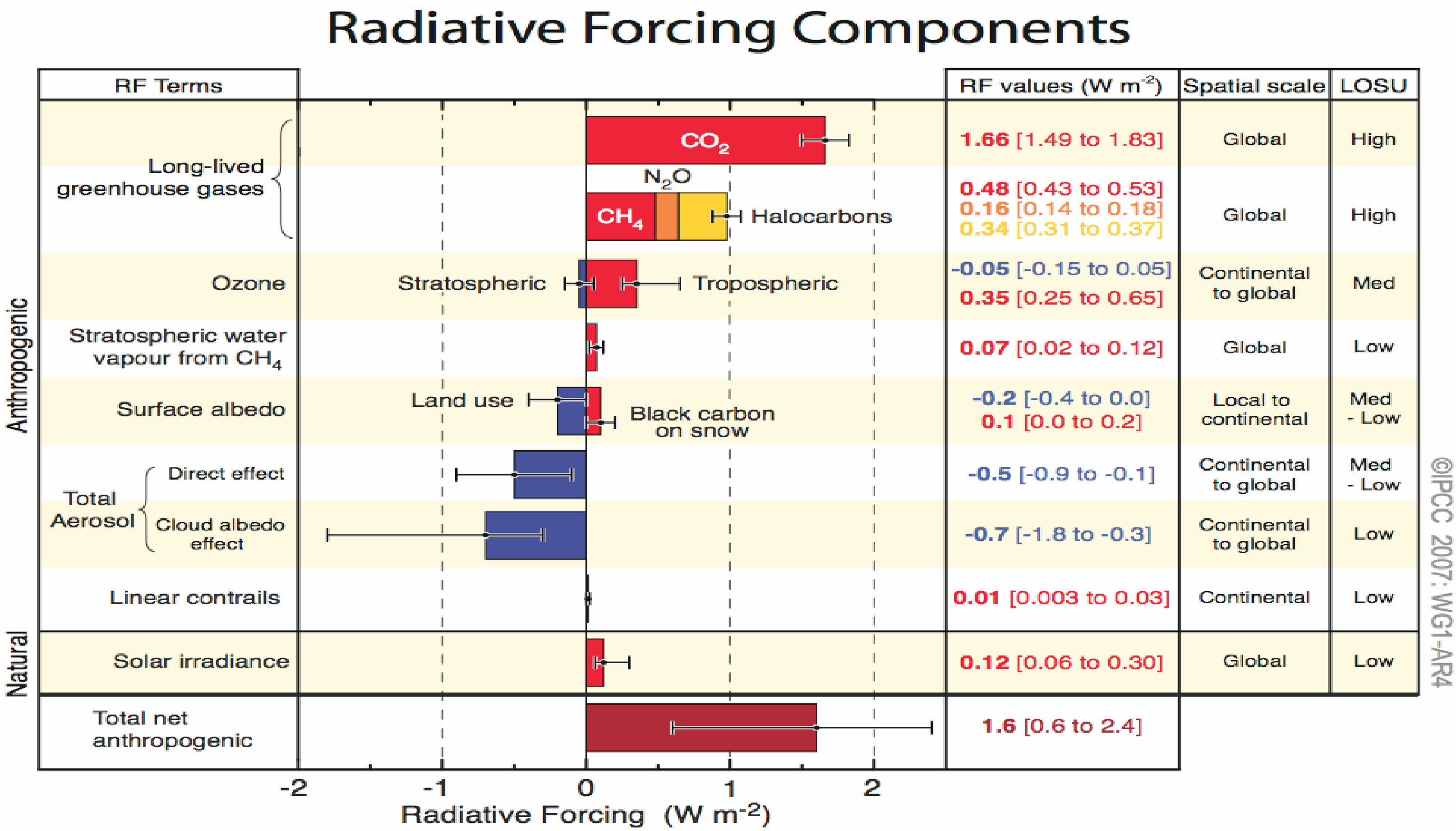

Source: IPCC 2007a (WG I, SPM p.4)

New results on climate change mitigation 2007:

- **The need for mitigation**

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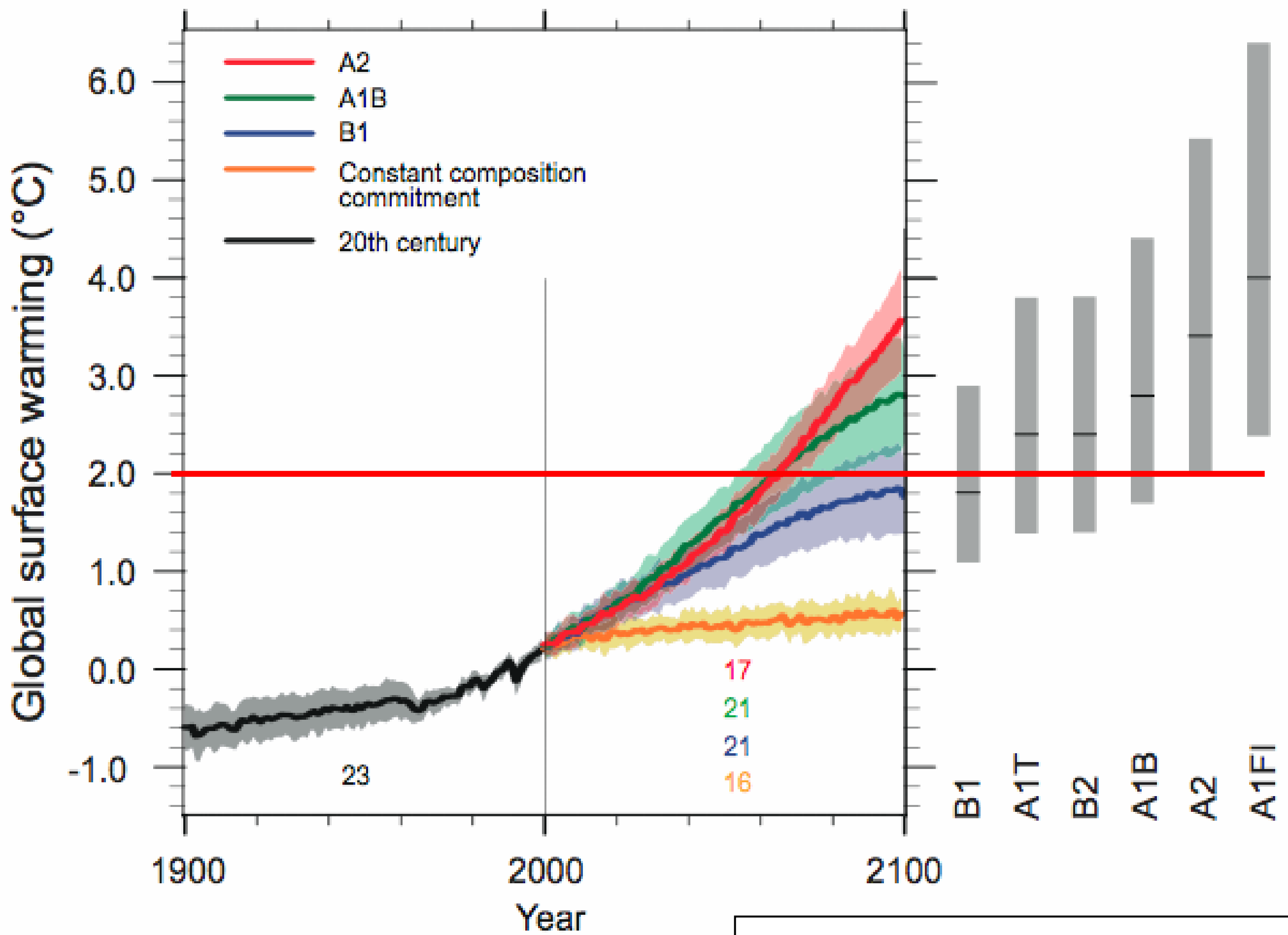
Projections of Future Changes in Climate

Best estimate for low scenario (B1) is 1.8°C (*likely* range is 1.1°C to 2.9°C), and for high scenario (A1FI) is 4.0°C (*likely* range is 2.4°C to 6.4°C).

Broadly consistent with span quoted for SRES in TAR, but not directly comparable



Source: IPCC 2007a (WG I, SPM p.14)

New results on climate change mitigation 2007:

- **The timeframe for mitigation**

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New stabilization scenarios

Table TS 2: *Classification of recent (Post-Third Assessment Report) stabilization scenarios according to different stabilization targets and alternative stabilization metrics [Table 3.5]*

Category	Additional Radiative forcing	CO_2 concentration	CO_2 - eq. Concentration	Global mean temperature increase above pre-industrial at equilibrium, using best guess climate sensitivity [1,2]	Peaking year for CO2 emissions [3]	Change in global emissions in 2050 (% of 2000 emissions) [3]	No. of scenarios
	W/m2	ppmv	ppmv	Celsius	Year	percent	
A1	2.5 – 3.0	350 – 400	445 – 490	2.0 – 2.4	2000 - 2015	-85 to -50	6
A2	3.0 – 3.5	400 – 440	490 – 535	2.4 – 2.8	2000 - 2020	-60 to -30	18
B	3.5 – 4.0	440 – 485	535 – 590	2.8 – 3.2	2010 - 2030	-30 to +5	21
C	4.0 – 5.0	485 – 570	590 – 710	3.2 – 4.0	2020 - 2060	+10 to +60	118
D	5.0 – 6.0	570 – 660	710 – 855	4.0 – 4.9	2050 - 2080	+25 to +85	9
E	6.0 – 7.5	660 – 790	855 – 1130	4.9 – 6.1	2060 - 2090	+90 to +140	5
Total							177

[1] Note that global mean temperature at equilibrium is different from expected global mean temperatures in 2100 due to the inertia of the climate system

Source: IPCC 2007 (TS WG III, p. 19)

Emissions for stabilization levels of 445 – 570ppmv CO_2eq.

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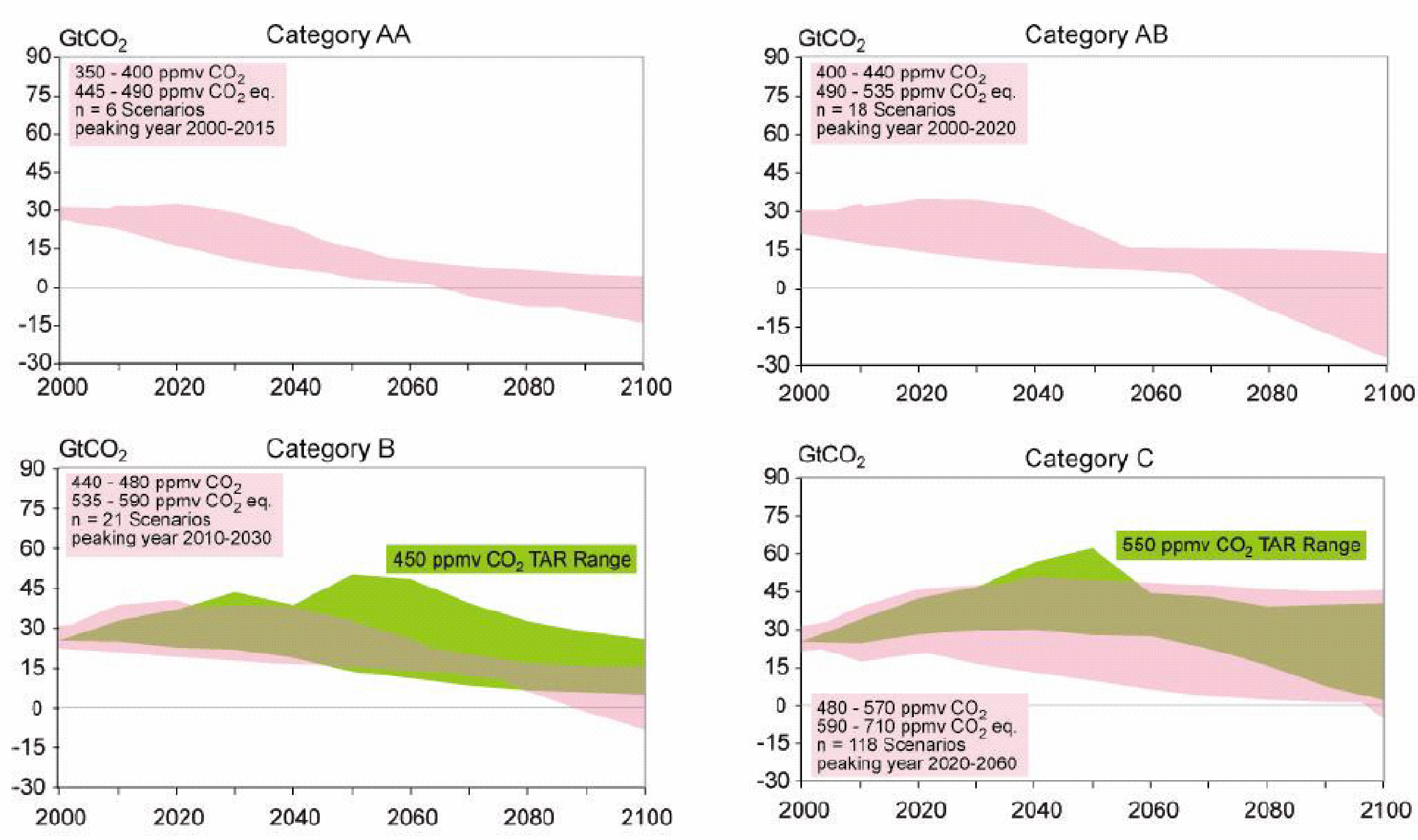


Source: IPCC 2007 (SPM WG III, p. 23)

Arctic ice loss faster than forecast by AR4

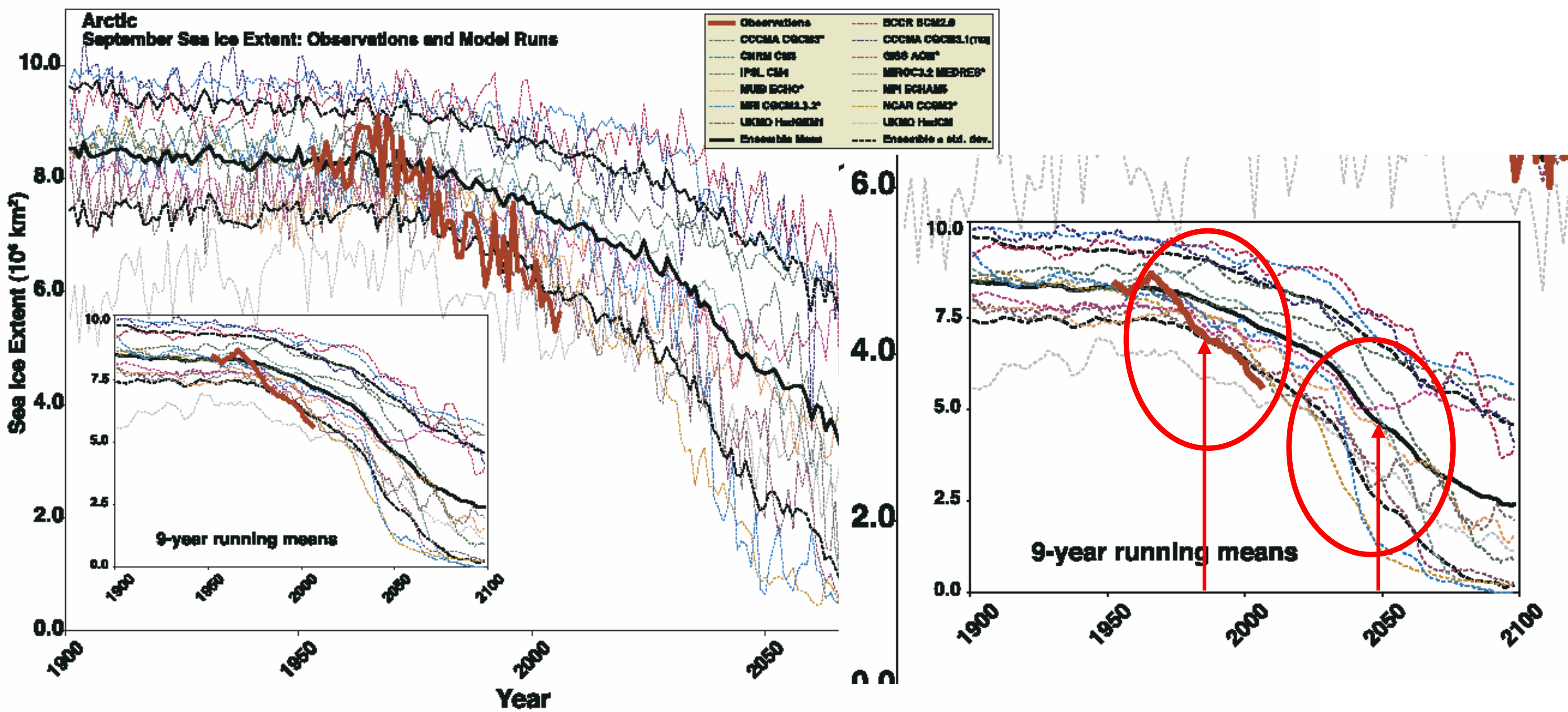
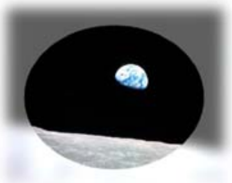


Figure 1. Arctic September sea ice extent ($\times 10^6$ km^2) from observations (thick red line) and 13 IPCC AR4 climate models, together with the multi-model ensemble mean (solid black line) and standard deviation (dotted black line). Models with more than one ensemble member are indicated with an asterisk. Inset shows 9-year running means.

Quelle: Stroeve et al. 2007 S.2

New results on climate change mitigation 2007:

- **The means for mitigation**



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Global economic mitigation potential 2030

***Table SPM 1**: Global economic mitigation potential in 2030 estimated from bottom-up studies.*

Carbon price ($US\$/tCO_2$-eq)	Economic mitigation potential ($GtCO_2$-eq/yr)	Reduction relative to SRES A1 B (68 $GtCO_2$- eq/yr) %	Reduction relative to SRES B2 (49 $GtCO_2$- eq/yr) %
0	5-7	7-10	10-14
20	9-17	14-25	19-35
50	13-26	20-38	27-52
100	16-31	23-46	32-63

Source: IPCC 2007 (SPM WG III, p. 11)

5. **Both bottom-up and top-down studies indicate that there is substantial economic potential for the mitigation of global GHG emissions over the coming decades, that could offset the projected growth of global emissions or reduce emissions below current levels** *(high agreement, much evidence).*

Source: IPCC 2007 (SPM WG III, p. 10)

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Global sectoral economic mitigation potential 2030

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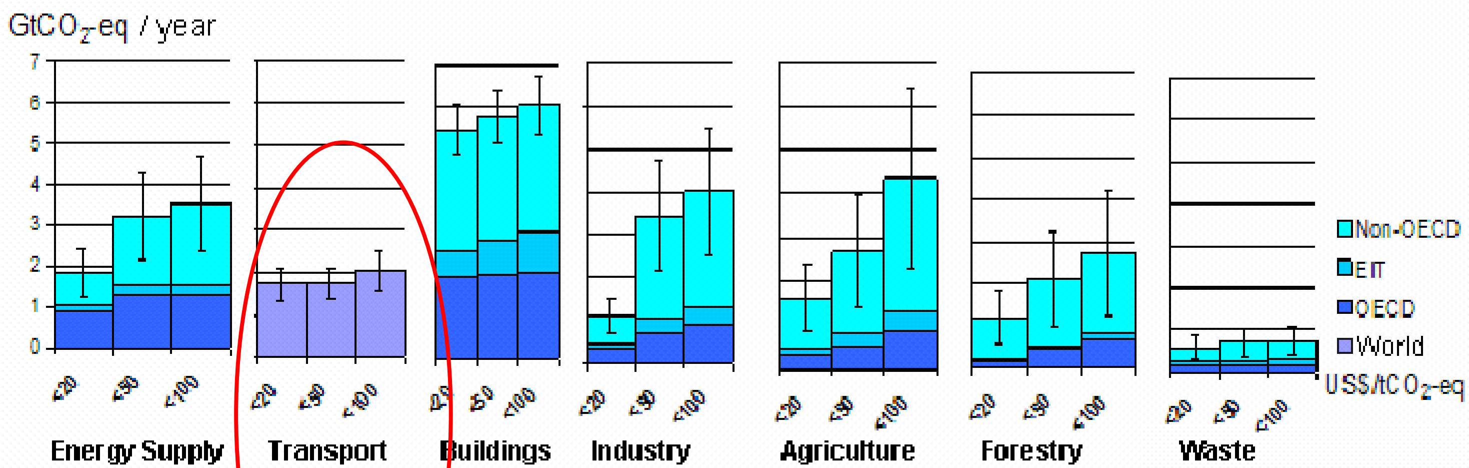
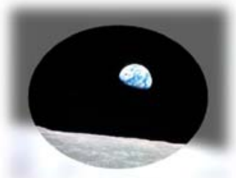


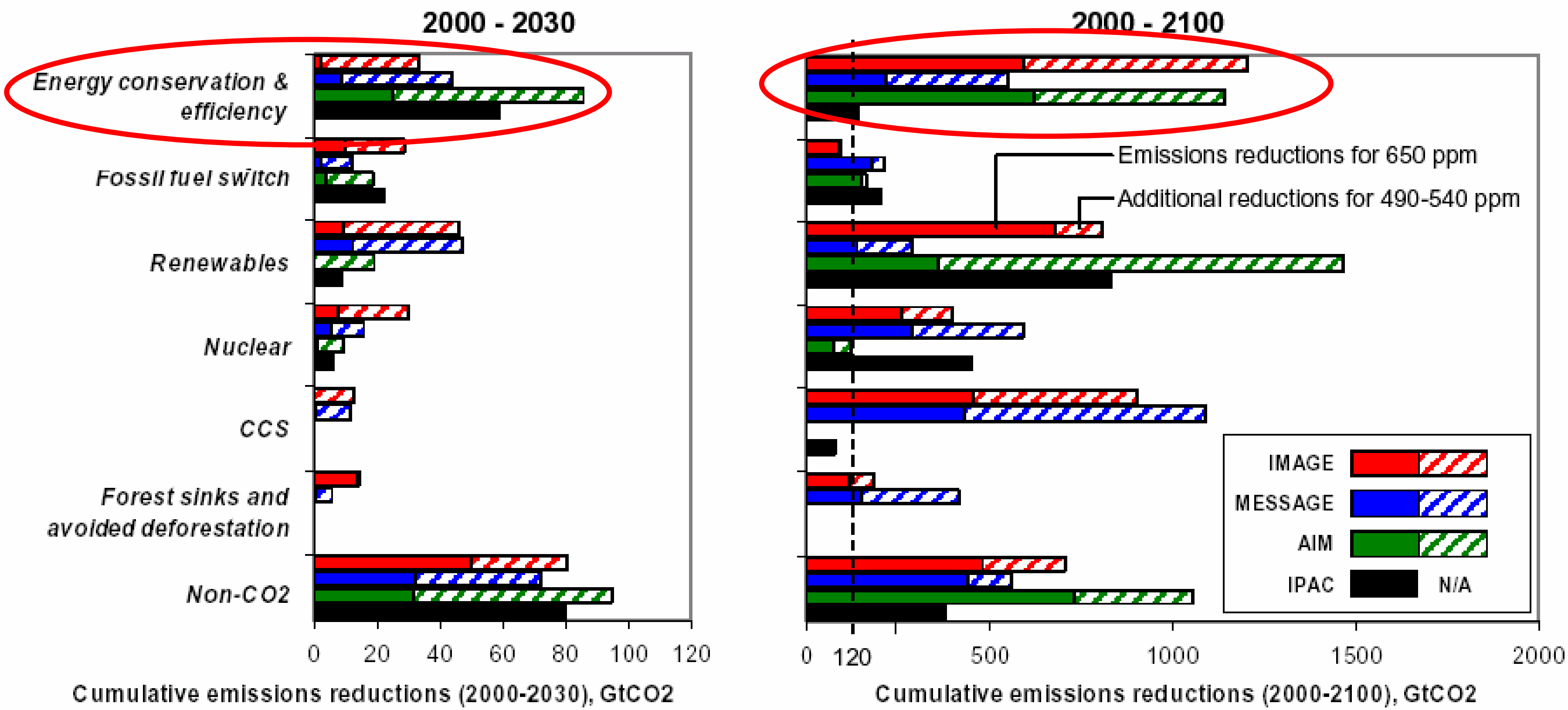
(potential at <US$100/tCO2-eq: 2.4 - 4.7 Gt CO2-eq/yr)	(potential at <US$100/tCO2-eq: 1.6 - 2.5 Gt CO2-eq/yr)	(potential at <US$100 /tCO2-eq: 5.3 -6.7	(potential at <US$100/tCO2-eq: 2.5 - 5.5 Gt CO2-eq/yr)	(potential at <US$100/tCO2-eq: 2.3 - 6.4 Gt CO2-eq/yr)	(potential at <US$100/tCO2-eq: 1.3 - 4.2 Gt CO2-eq/yr)	(potential at <US$100/tCO2-eq: 0.4 - 1 Gt CO2-eq/yr)

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 11.3.*

Quelle: IPCC 2007 (SPM WG III, p. 14)



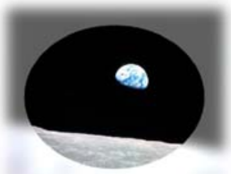
Contributions to cumulated emission reductions until 2030 and 2100 - 650 and 490-550ppmv CO2-eq



Source: IPCC 2007 (SPM WG III, S. p5)

New results on climate change mitigation 2007:

- **The cost of mitigation**



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Global macro-economic mitigation costs for 2030 and 2050

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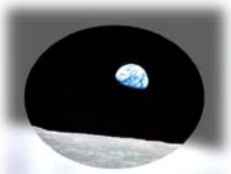
Table SPM.6: *Estimated global macro-economic costs in 2050 relative to the baseline for least-cost trajectories towards different long-term stabilization targets[42] [3.3, 13.3]*

Stabilization levels (ppm CO_2-eq)	Median GDP reduction[43] (%)	Range of GDP reduction[43, 44] (%)	Reduction of average annual GDP growth rates (percentage points)[43, 45]
590-710	0.5	-1 – 2	< 0.05
535-590	1.3	slightly negative – 4	<0.1
445- 535[46]	Not available	< 5.5	< 0.12

20. In 2050[41] global average macro-economic costs for multi-gas mitigation towards stabilization between 710 and 445 ppm CO_2-eq, are between a 1% gain to a 5.5% decrease of global GDP (see Table SPM.6). For specific countries and sectors, costs vary considerably from the global average. (See Box SPM.3 for the methodologies and assumptions and paragraph 5 for explanation of negative costs) *(high agreement, medium evidence).*

Source: IPCC 2007 (SPM WG III, p. 26)

Mitigation in the transport sector



Energy consumption of different modes of transportation (Intercity travel in Canada)

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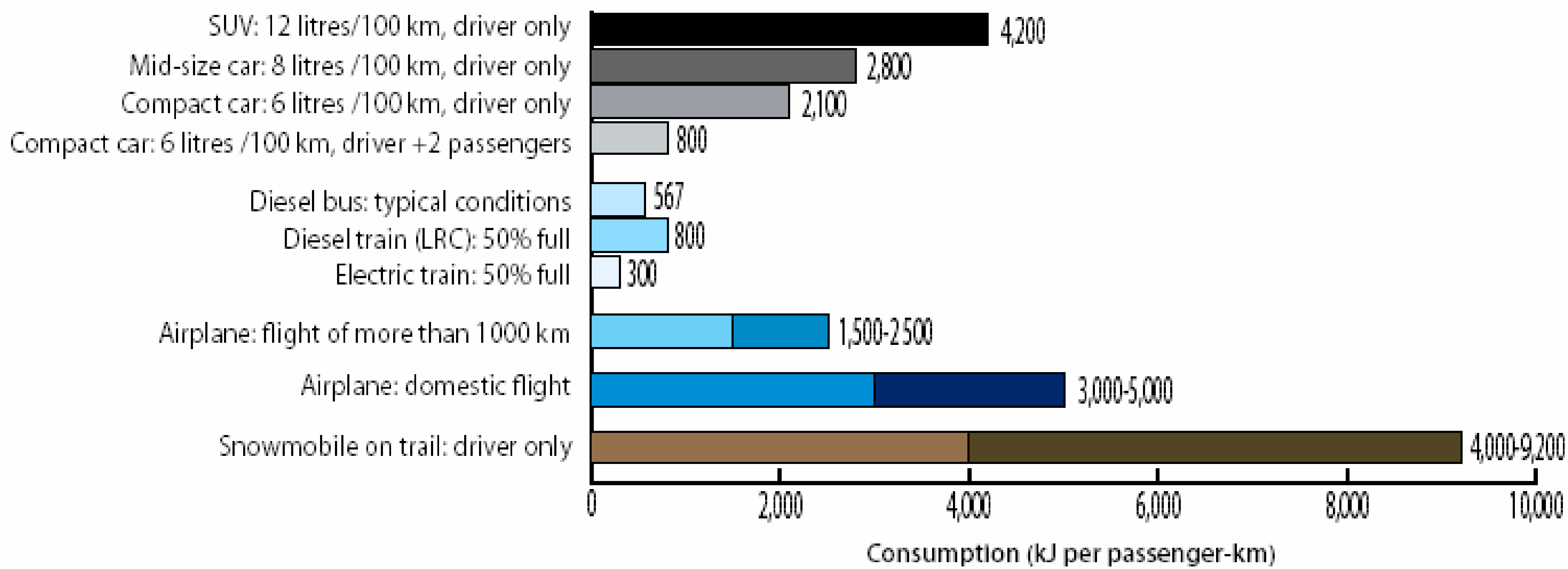
Figure A: Efficiency of passenger transport modes – Intercity travel



Source: Hydro Quebec 2006, p. 2

Energy consumption of different modes of transportation (Urban travel in Canada)

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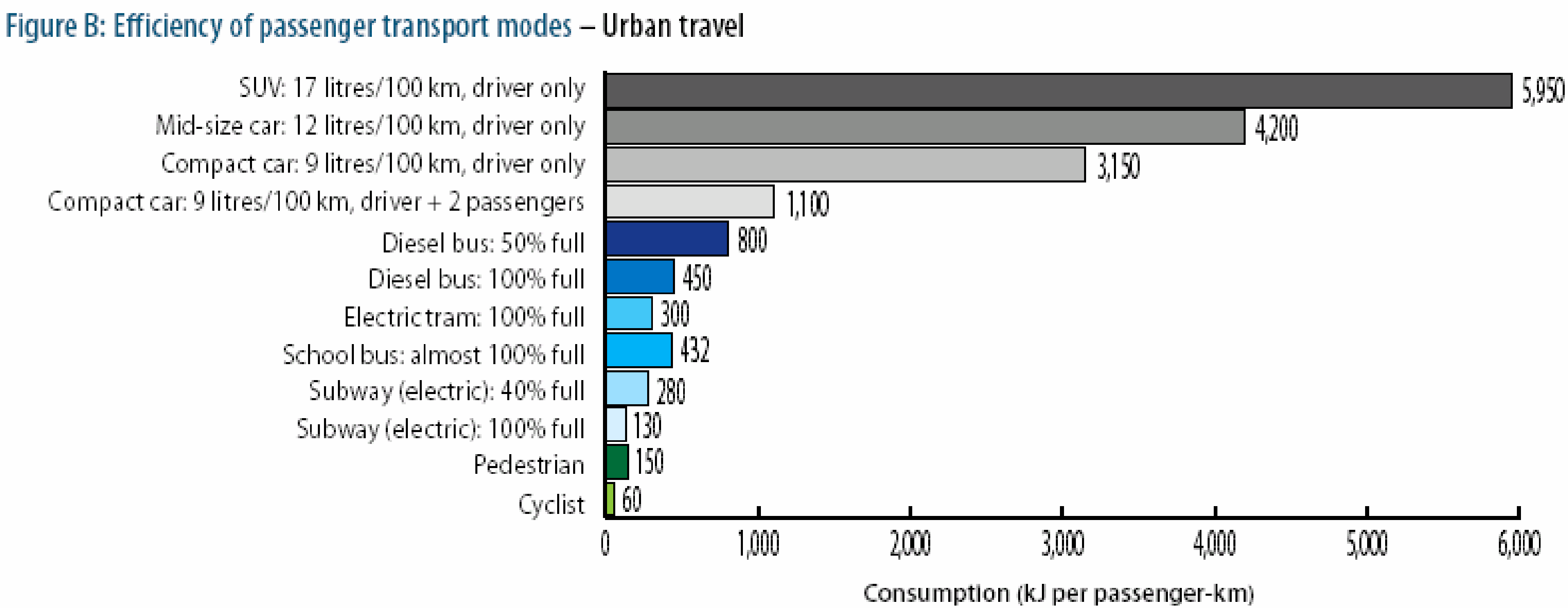

Source: Hydro Quebec 2006, p. 2

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Key mitigation technologies and practices currently commercially available

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11. There are multiple mitigation options in the transport sector[28], but their effect may be counteracted by growth in the sector. Mitigation options are faced with many barriers, such as consumer preferences and lack of policy frameworks *(medium agreement, medium evidence).*

Source: IPCC 2007 (SPM WG III, p. 18)

- More fuel efficient vehicles
- hybrid vehicles
- cleaner diesel vehicles
- biofuels
- modal shifts from road transport to rail and public transport
- non-motorised transport (cycling, walking)
- land-use and transport planning

Source: IPCC 2007 (SPM WG III, p. 13)

Conclusions

Conclusions

- Climate change is developing faster than we thought
- GHG concentrations need to be stabilized at even lower levels (455 – 490 ppmvCO2eq) to avoid serious damages
- The transport sector will have to share the burden of GHG reductions
- By 2050 the emissions from transportation need to be cut down to 50% of the 1990 global emissions
- Vastly improved efficiency will be the main contributor
- Changes to more efficient modes of transport will play a key role in urban areas
- Bio fuels will play an important role in the longer run

Thank you for your attention!

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Anthropogenic and natural forcings

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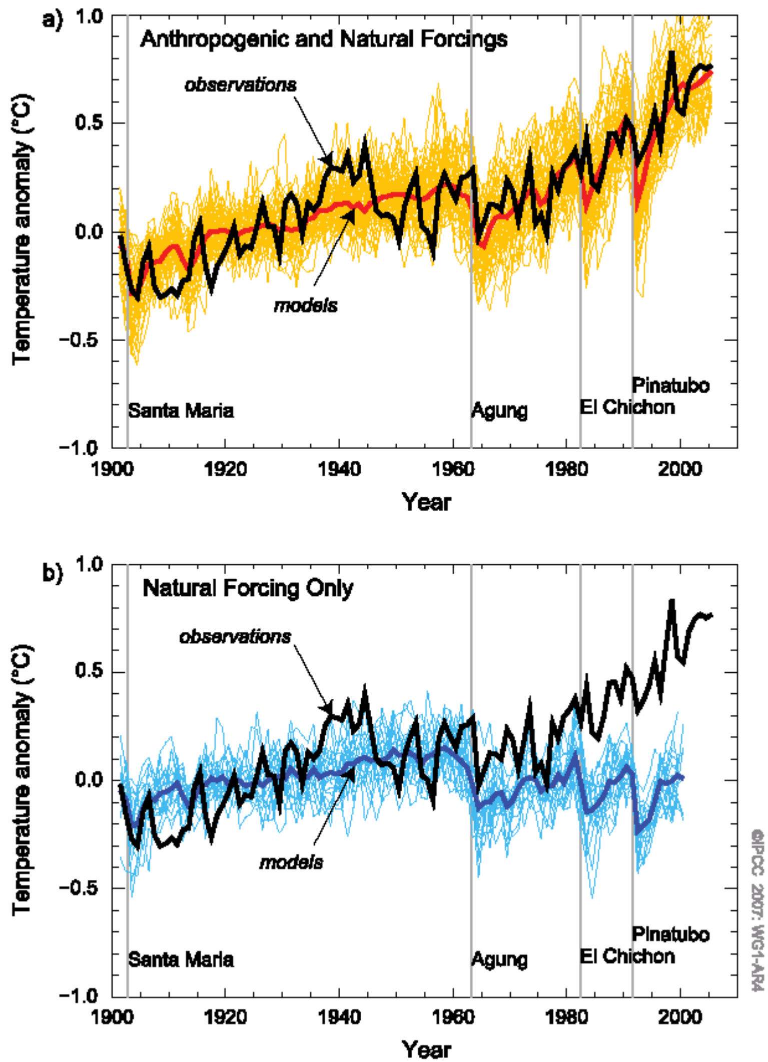

Figure TS.23. *(a) Global mean surface temperature anomalies relative to the period 1901 to 1950, as observed (black line) and as obtained from simulations with both anthropogenic and natural forcings. The thick red curve shows the multi-model ensemble mean and the thin lighter red curves show the individual simulations. Vertical grey lines indicate the timing of major volcanic events. (b) As in (a), except that the simulated global mean temperature anomalies are for natural forcings only. The thick blue curve shows the multi-model ensemble mean and the thin lighter blue curves show individual simulations. Each simulation was sampled so that coverage corresponds to that of the observations. {Figure 9.5}*

Source: IPCC 2007a (WG I TSp.62)

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Table 3: Transportation options – Energy consumption and CO_2 emissions

Mode	Number of passengers, or load factor	Consumption (kJ per passenger-km)	Energy source	Direct** CO_2 emissions (g per passenger-km)
Intercity passenger transportation				
SUV 12 litres/100 km	one	4,200	gasoline	286
Mid-size car: 8 litres/100 km	one	2,800	gasoline	190
Compact car: 6 litres/100 km	one three	2,100 800	gasoline	143 54
Diesel bus	average*	567	diesel	40
Train: Diesel (LRC) Electric	50% 50%	800 300	diesel hydro	56 0
Airplane: Flight of more than 1,000 km Domestic flight	average	1,500-2,500 3,000-5,000	kerosene kerosene	102-170 204-340
Snowmobile on trail	one	4,000-9,200	gasoline	272-626
Urban passenger transportation				
SUV: 17 litres/100 km	one	5,950	gasoline	405
Mid-size car: 12 litres/100 km	one	4,200	gasoline	286
Compact car: 9 litres/100 km	one three	3,150 1,100	gasoline	214 75
Diesel bus	50% 100%	800 450	diesel diesel	56 32
Electric tram	100%	300	hydro	0
School bus	average	432	gasoline	29
Subway (electric)	40% 100%	280 130	hydro	0
Pedestrian		150	cereals	wheat = 2
Cyclist		60	cereals	wheat = 1
Freight transportation	**Load factor**	**kJ per tonne-km**	**Energy source**	**g per tonne-km**

Source: Hydro Quebec 2006, p. 5