

# Preliminary IAM scenarios based on the RCP/SSP framework

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IMAGE: Detlef van Vuuren, Elke Stehfest, David Gernaart ...

MESSAGE-GLOBIOM: Volker Krey, Oliver Fricko, Petr Havlik, Shilpa Rao, Nils Johnson, ...

ReMIND-MAGPIE: Elmar Kriegler, Nico Bauer, Alex Popp, Benjamin Bodirsky,

WITCH-GLOBIOM: Massimo Tavoni, Johannes Emmerling, ...

*AGCI Workshop 5 August 2014, Aspen, Colorado*



**Pacific Northwest**  
NATIONAL LABORATORY

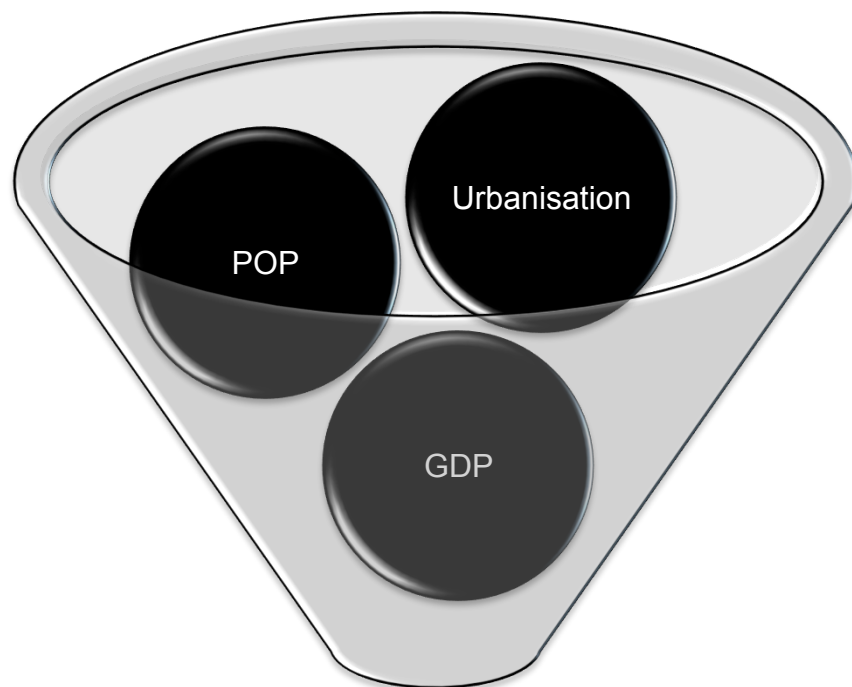
*Proudly Operated by **Battelle** Since 1965*



# SSP Process

- Conceptual framework and nature of the SSPs established
- Quantification of key elements of the SSPs has been completed
- Narratives completed
- Refined (but not final) IAM reference scenarios developed
- Preliminary SPAs defined
- Initial climate policy scenarios
- Preliminary IAM SSP marker selected
- Still to do:
  - Continue vetting and development of SSP IAM scenarios
  - Check SPAs for refined stabilization analyses

# The SSP-IAM Kitchen



IAM Models



SSP1



SSP2



SSP3



SSP4



SSP5



## Invent Your Platter...

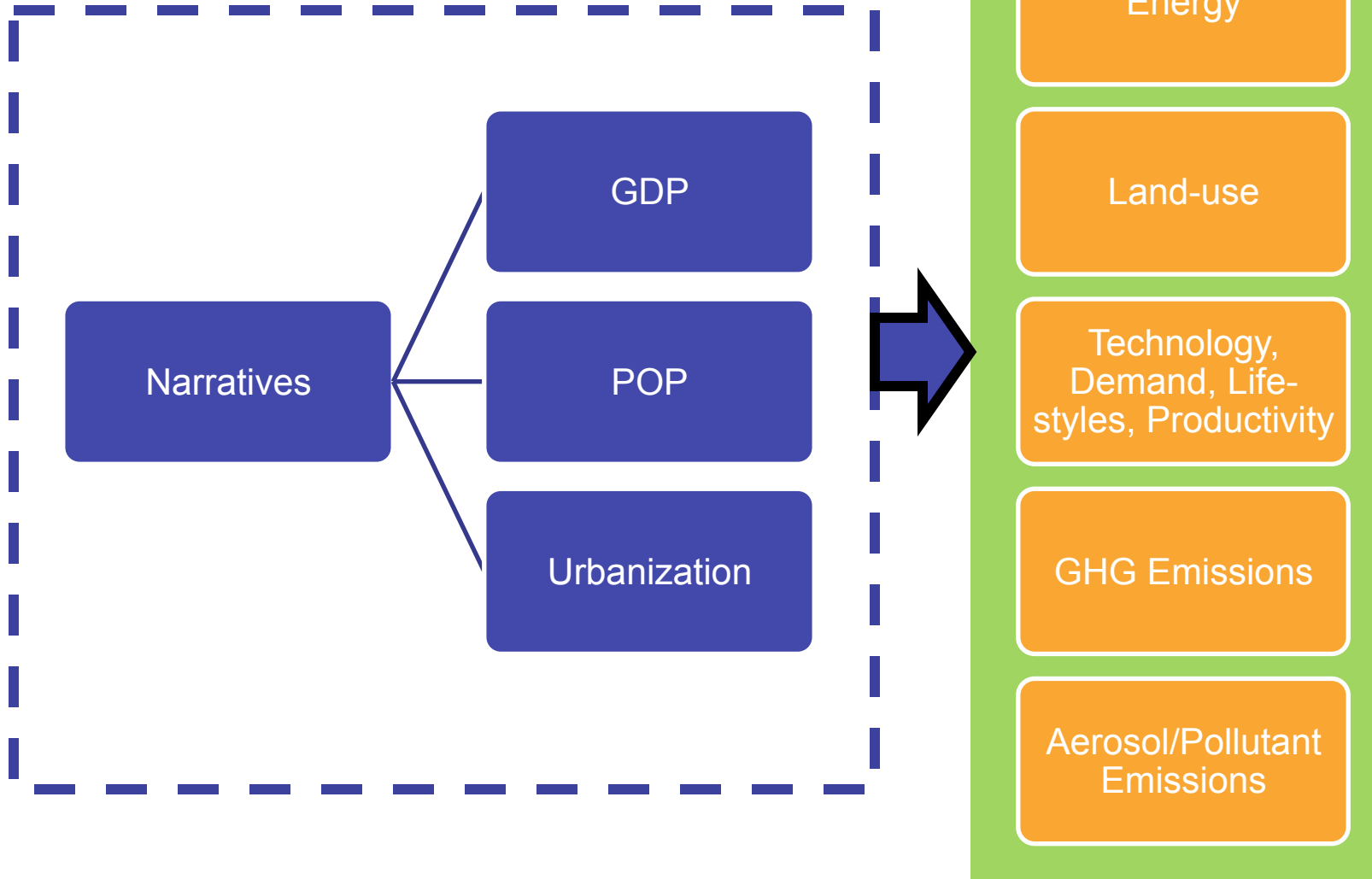
*Your choice of cheese & toppings, fries or rings, sautéed onions and choice of side salad or coleslaw.*

<b>Angus Burger Platter:</b>	
Fresh, never frozen 10 oz. patty .....	\$ ***
<b>Chicken Breast Platter:</b>	
Succulent grilled chicken breast .....	\$ ***
<b>Portobello Platter:</b>	
A hearty portion of portobello mushroom .....	\$ ***
<b>Turkey Burger Platter:</b> We give you all the choices ..	\$ ***
<b>Salmon Platter:</b> From the Pacific Northwest .....	\$ ***
<b>Veggie Burger Platter:</b> A meatless choice .....	\$ ***
<b>Chicken Finger Platter:</b> A generous portion .....	\$ ***
Add bacon, sautéed mushrooms, sautéed onions, or chili .....	ea. \$ **,

(Narratives)

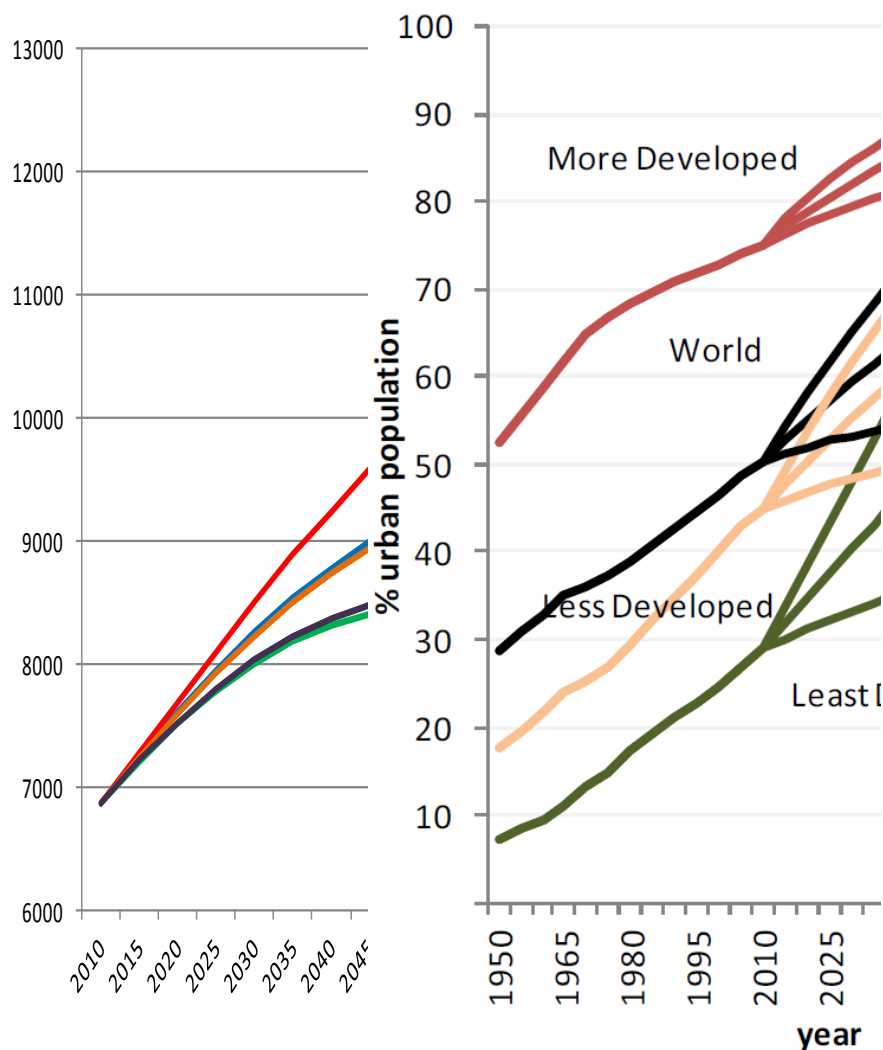
# IAM Models

## SSPs (Assumptions)



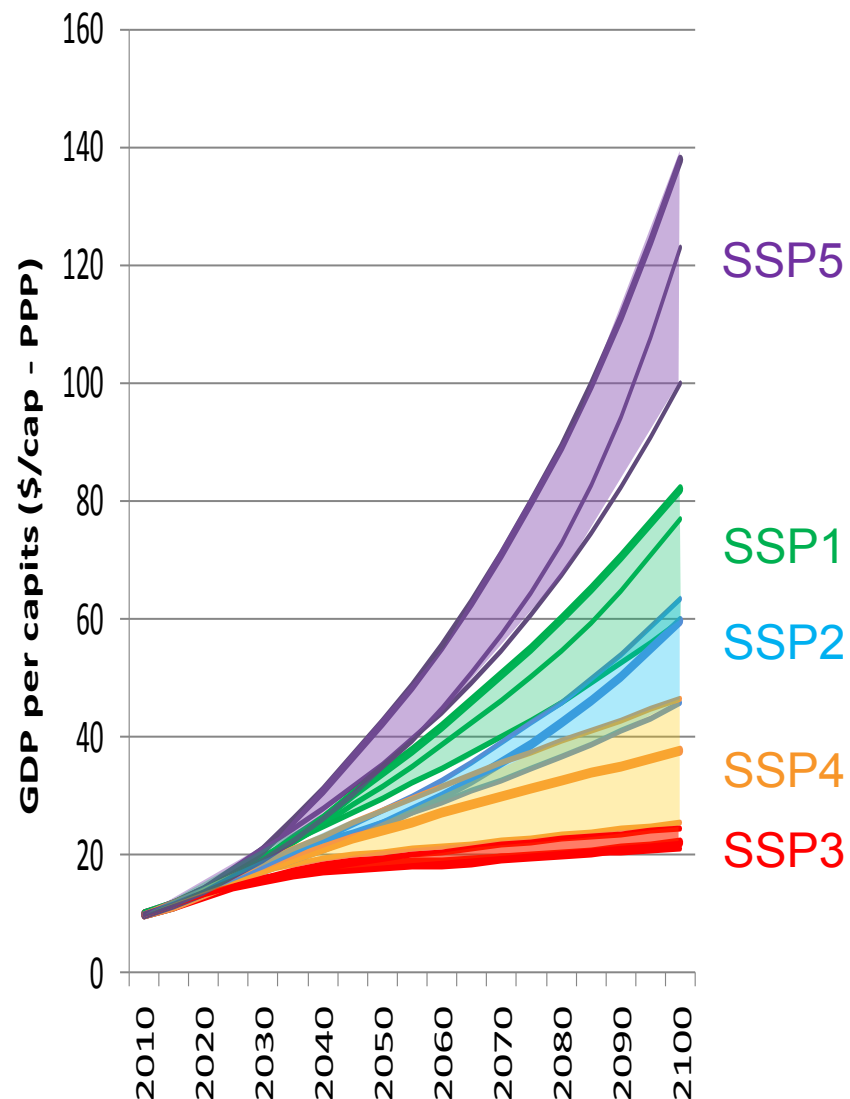
# **SSP ASSUMPTIONS**

# Global Driver Assumptions



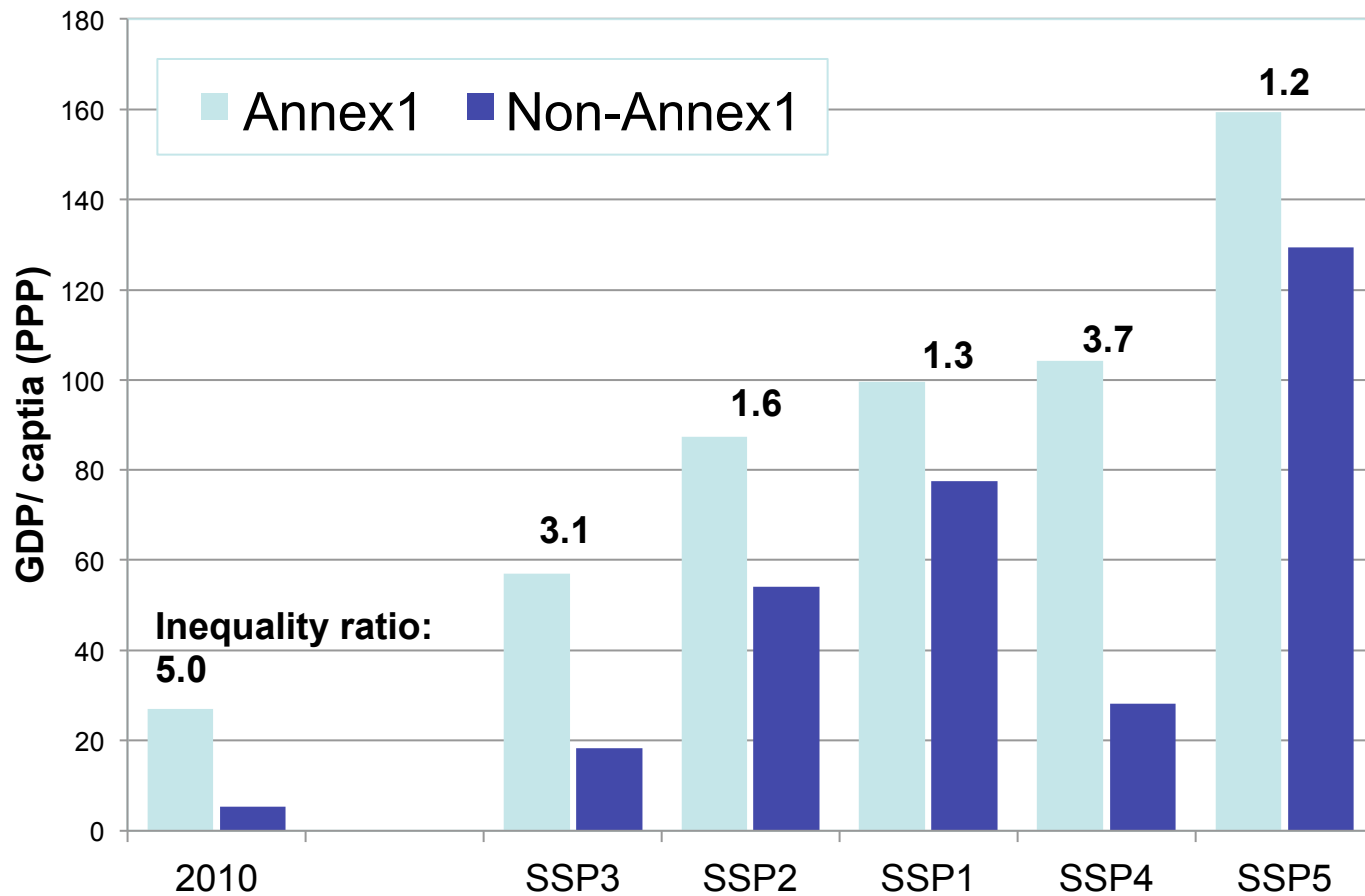
Lutz & KC, 2014

Jiang & O'Neill



OECD, PIK, IIASA

# Inequality assumptions across SSPs



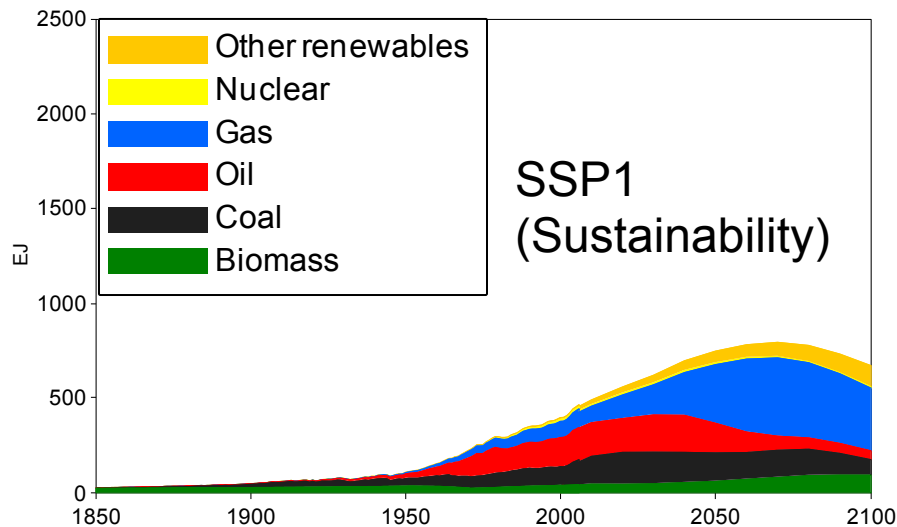
# **REFERENCE SCENARIOS (NO CLIMATE POLICY)**

All results are still preliminary

# Energy – SSP Reference Cases

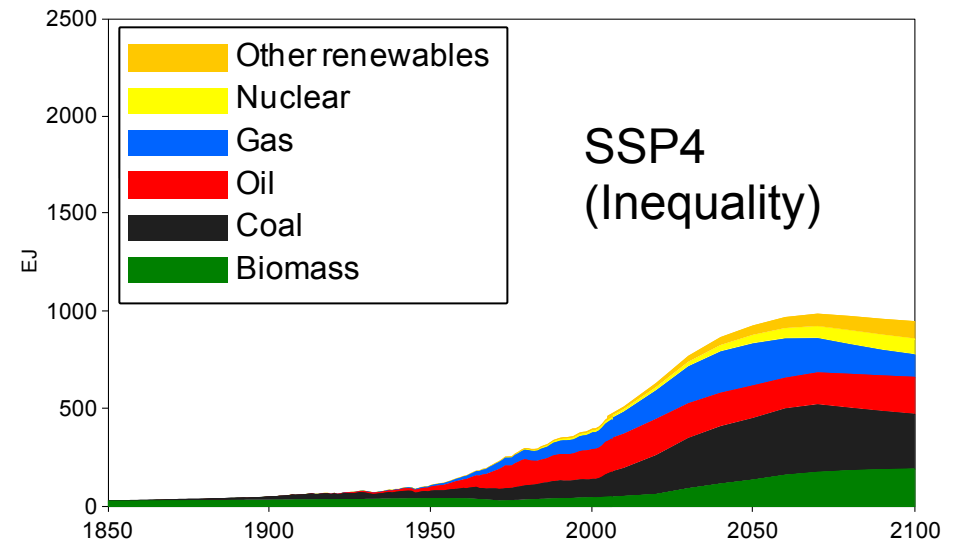
Two scenarios where mitigation is relatively easy

IMAGE



Transition away from coal/oil  
Low demand

GCAM

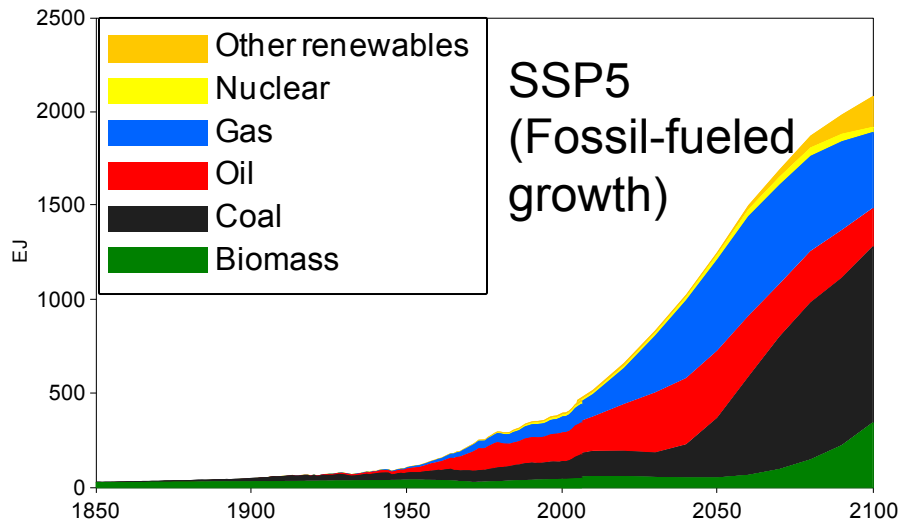


High share of poor with low emissions  
Low/intermediate demand  
Technology available to the “elite”

# Energy – SSP Reference Cases

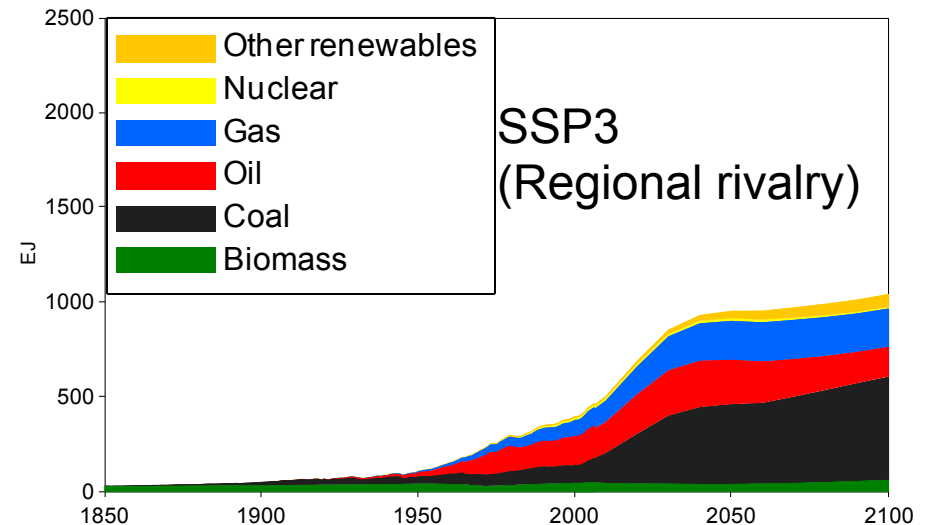
Two scenarios where mitigation is relatively difficult

REMIND-MAGPIE



Coal-intensive development  
Very high demand

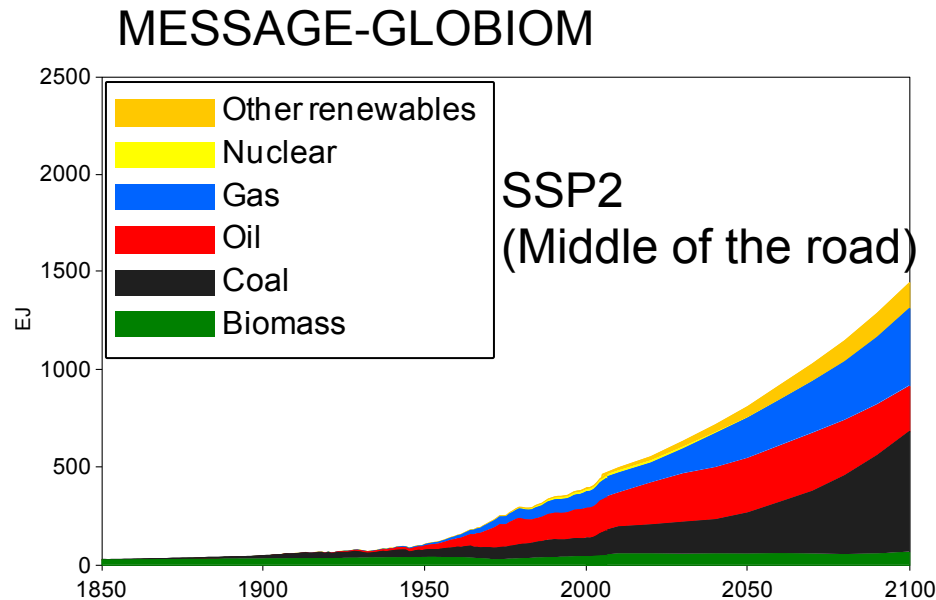
AIM



Fossil-intensive  
High poverty  
Slow technological change  
Strong fragmentation

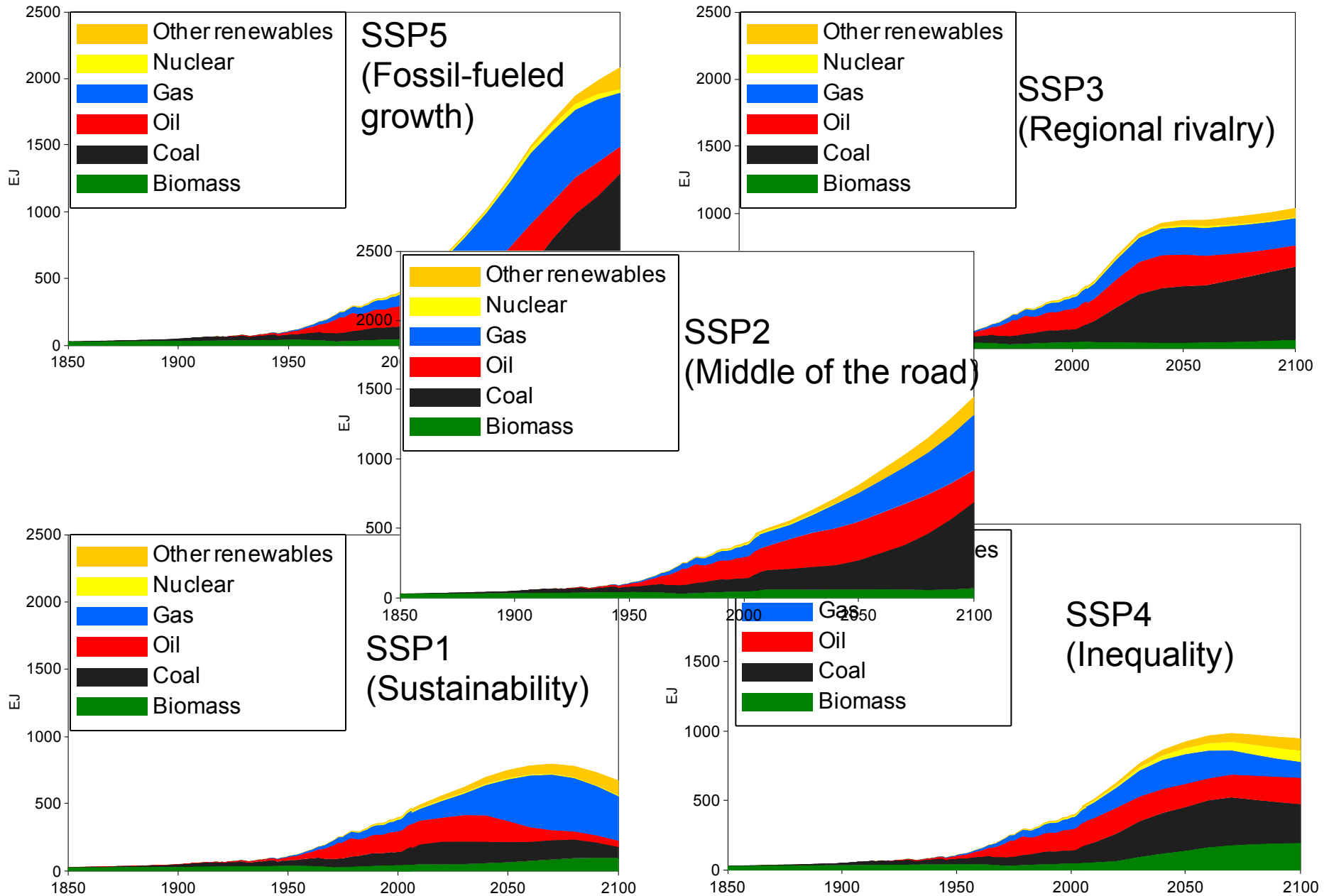
# Energy – SSP Reference Cases

**A central scenarios with intermediate mitigation challenge**



Balanced Technology  
Intermediate demand

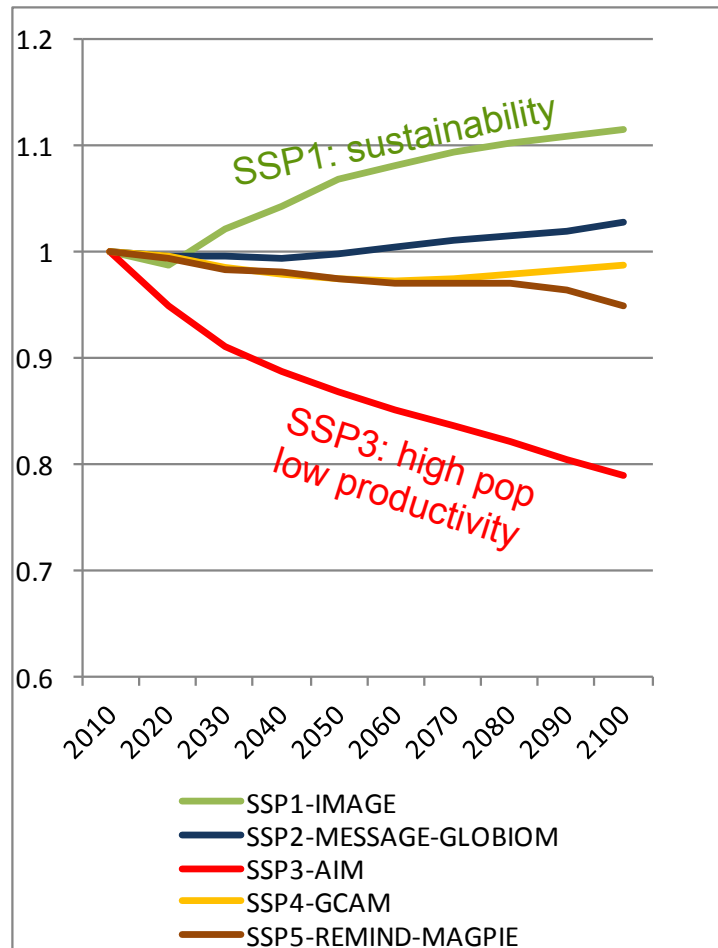
# Energy – SSP Reference Cases



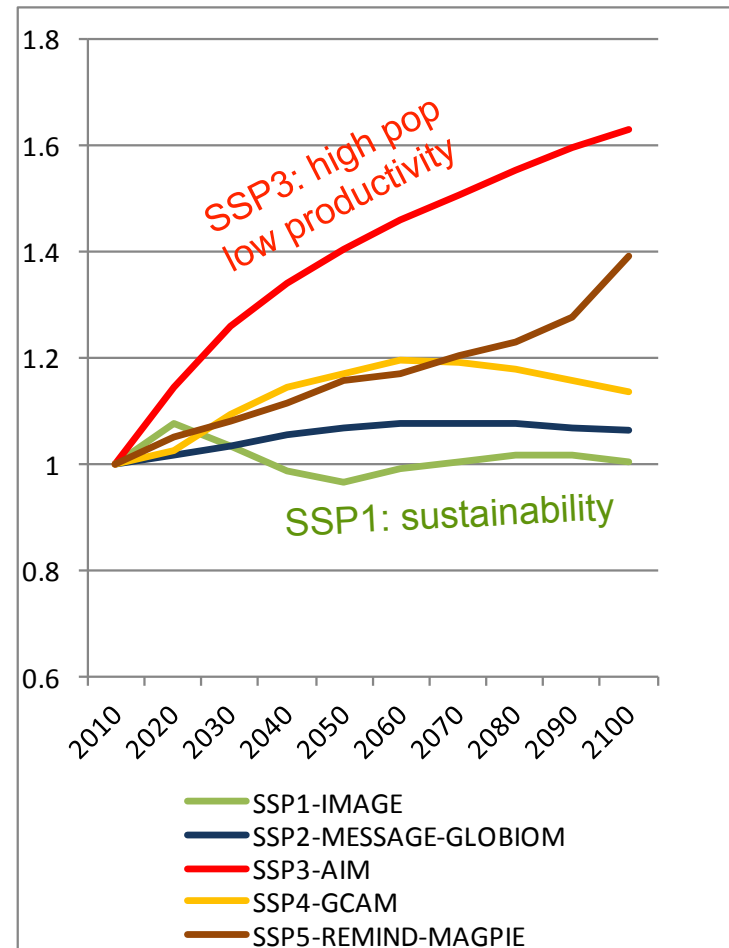
# Land-use Change

(index 1=2010)

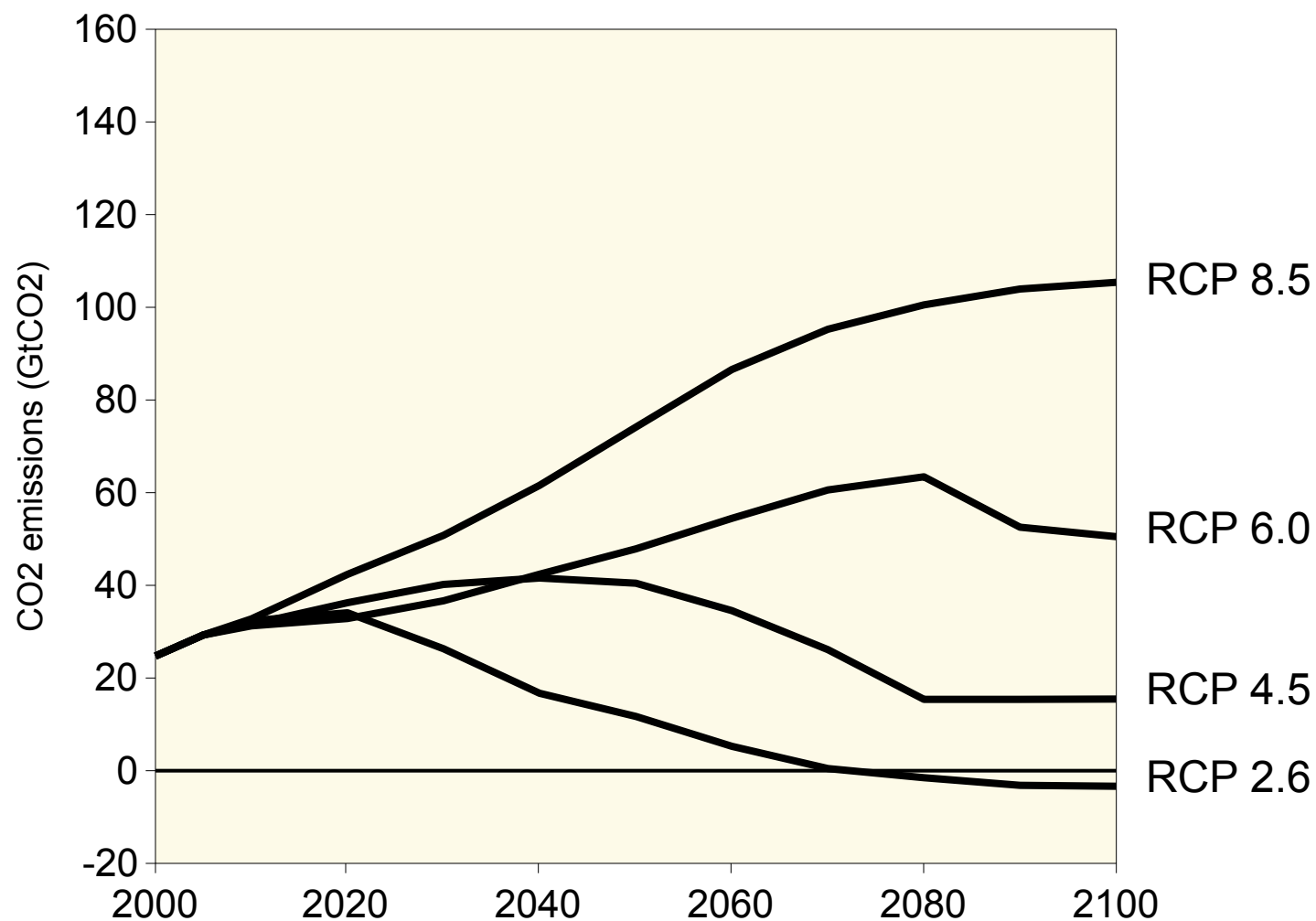
## Forest land



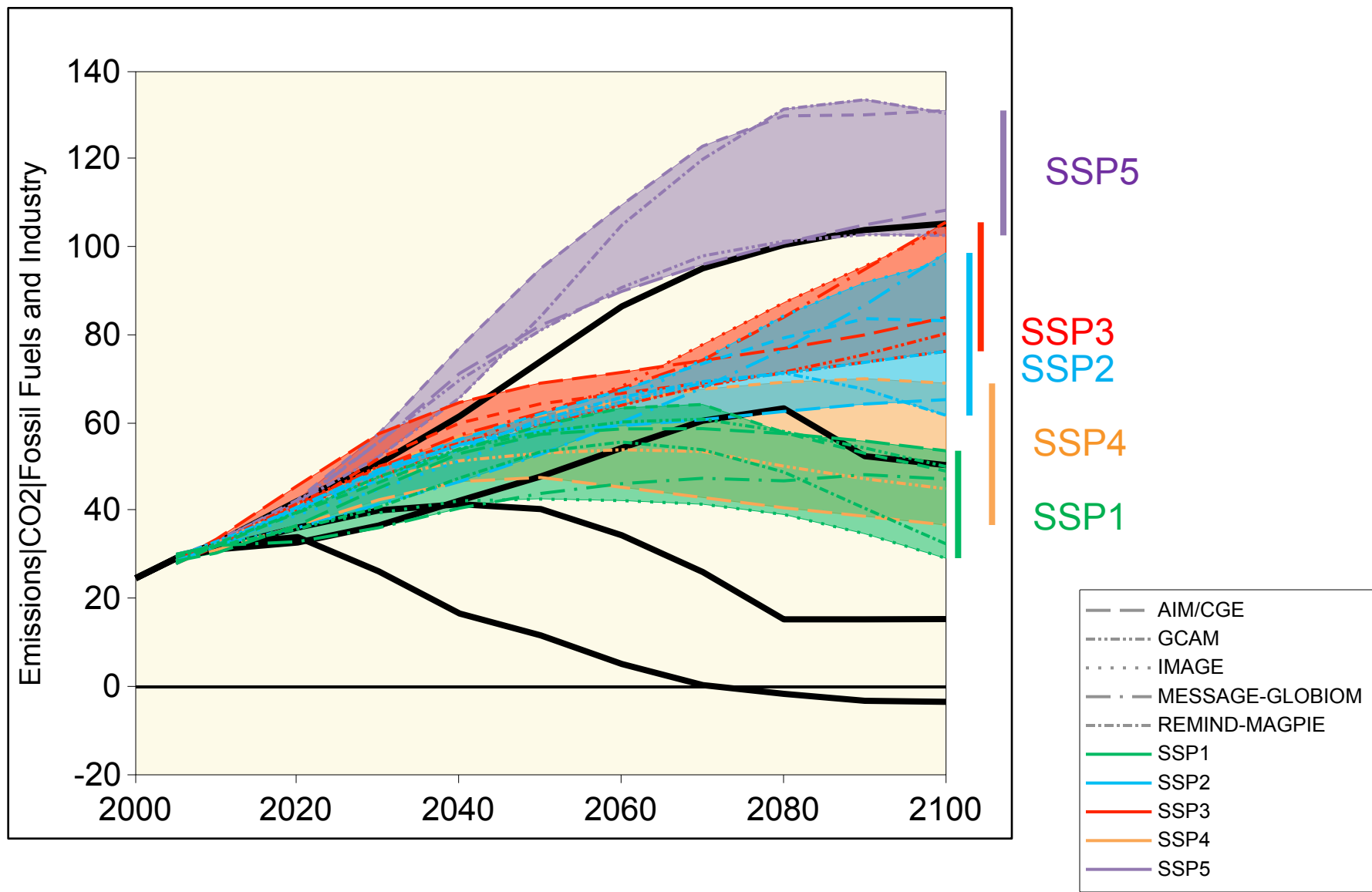
## Cropland



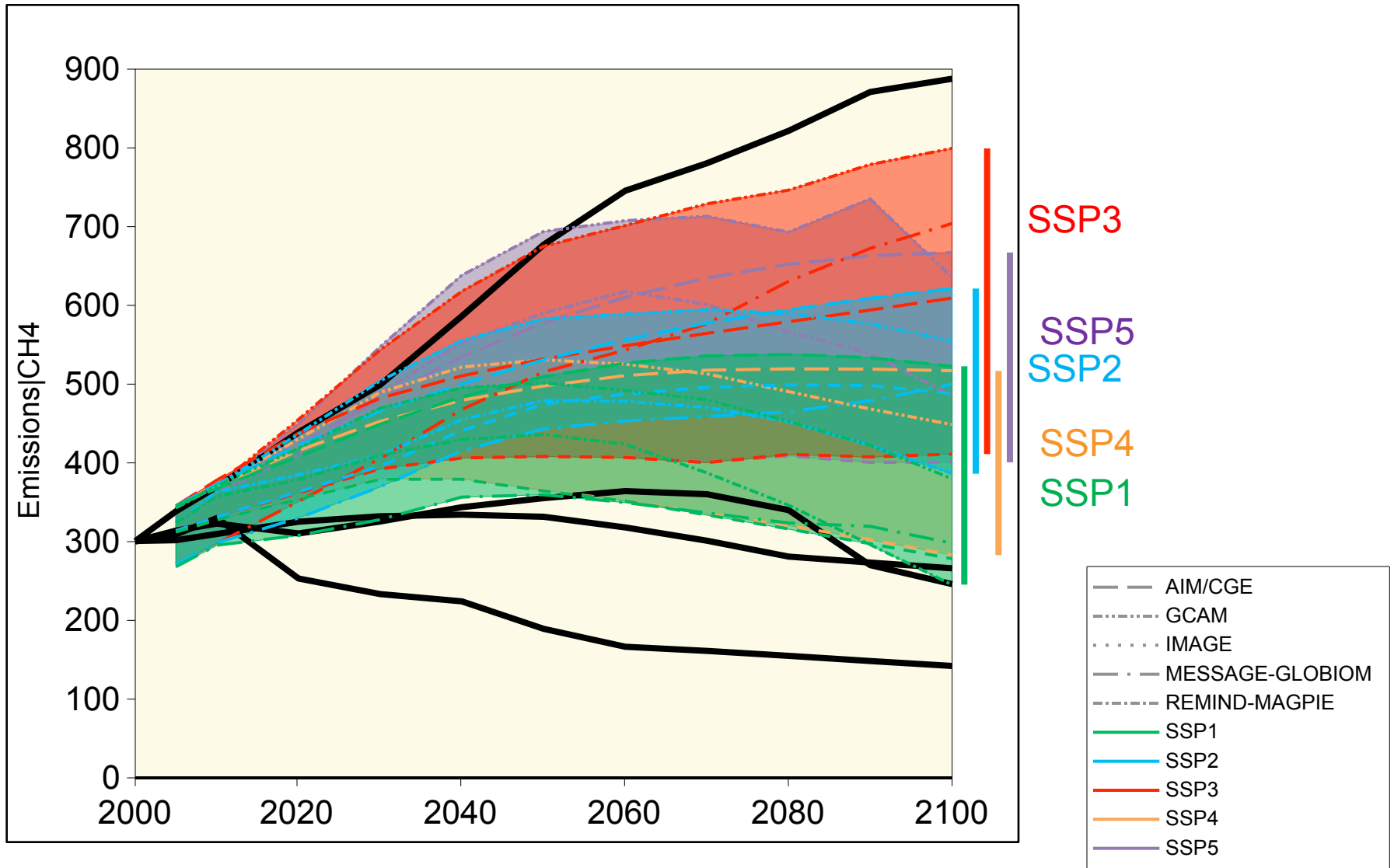
# RCP CO2 Emissions, World (Fossil fuels and Industry)



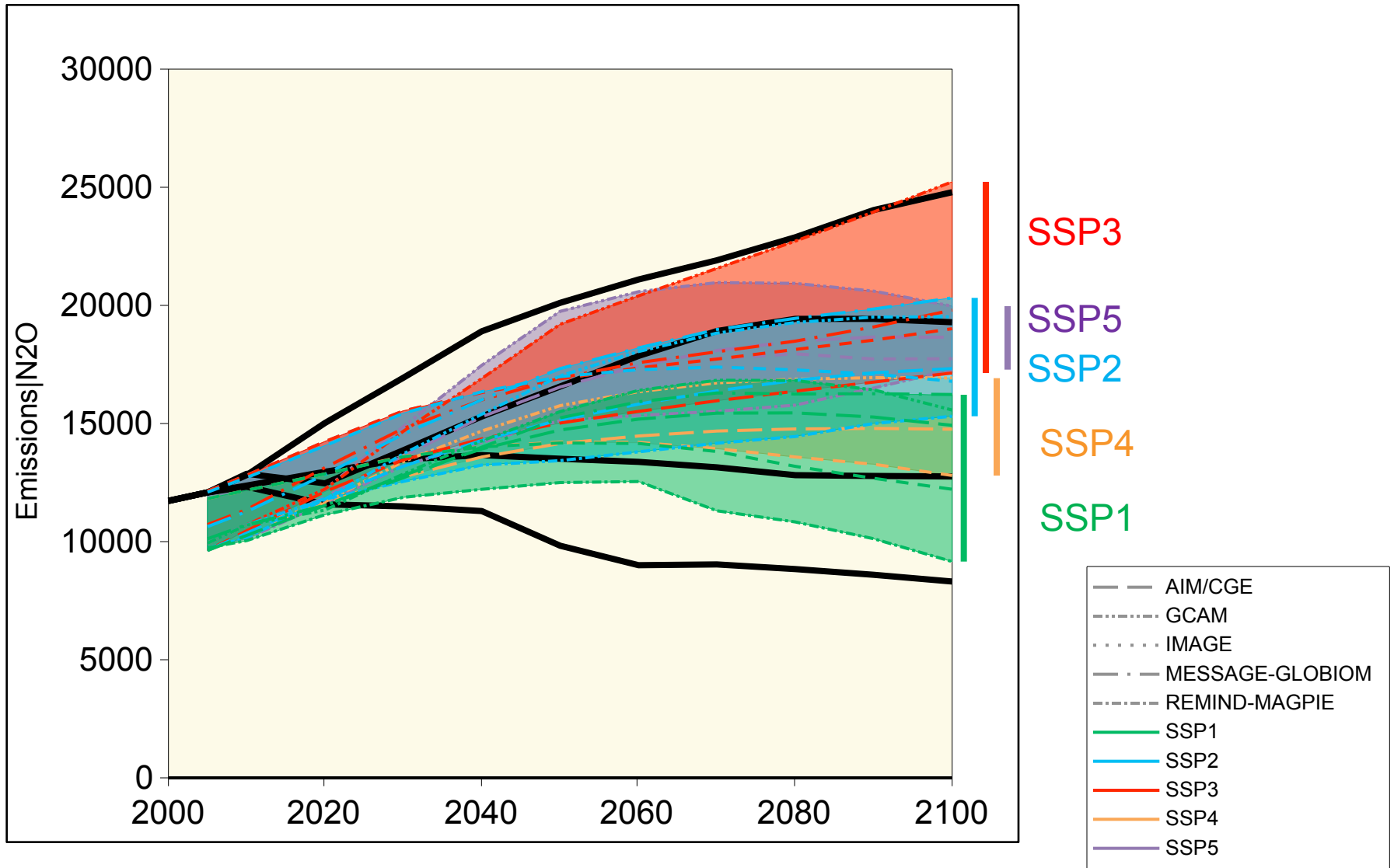
# Fossil fuels and Industry CO<sub>2</sub> Emissions, World (Reference Scenarios)



# CH<sub>4</sub> Emissions, World Reference Scenarios

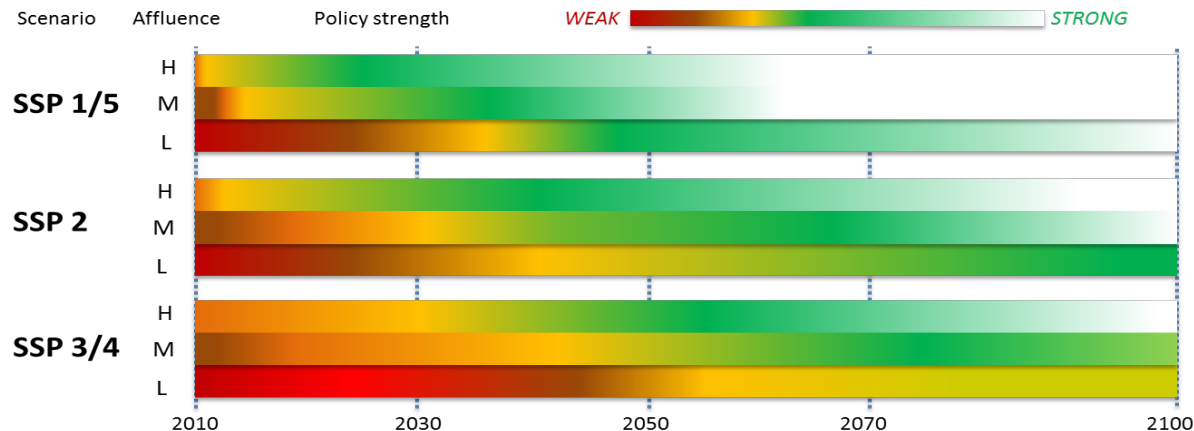


# N<sub>2</sub>O Emissions, World Reference Scenarios



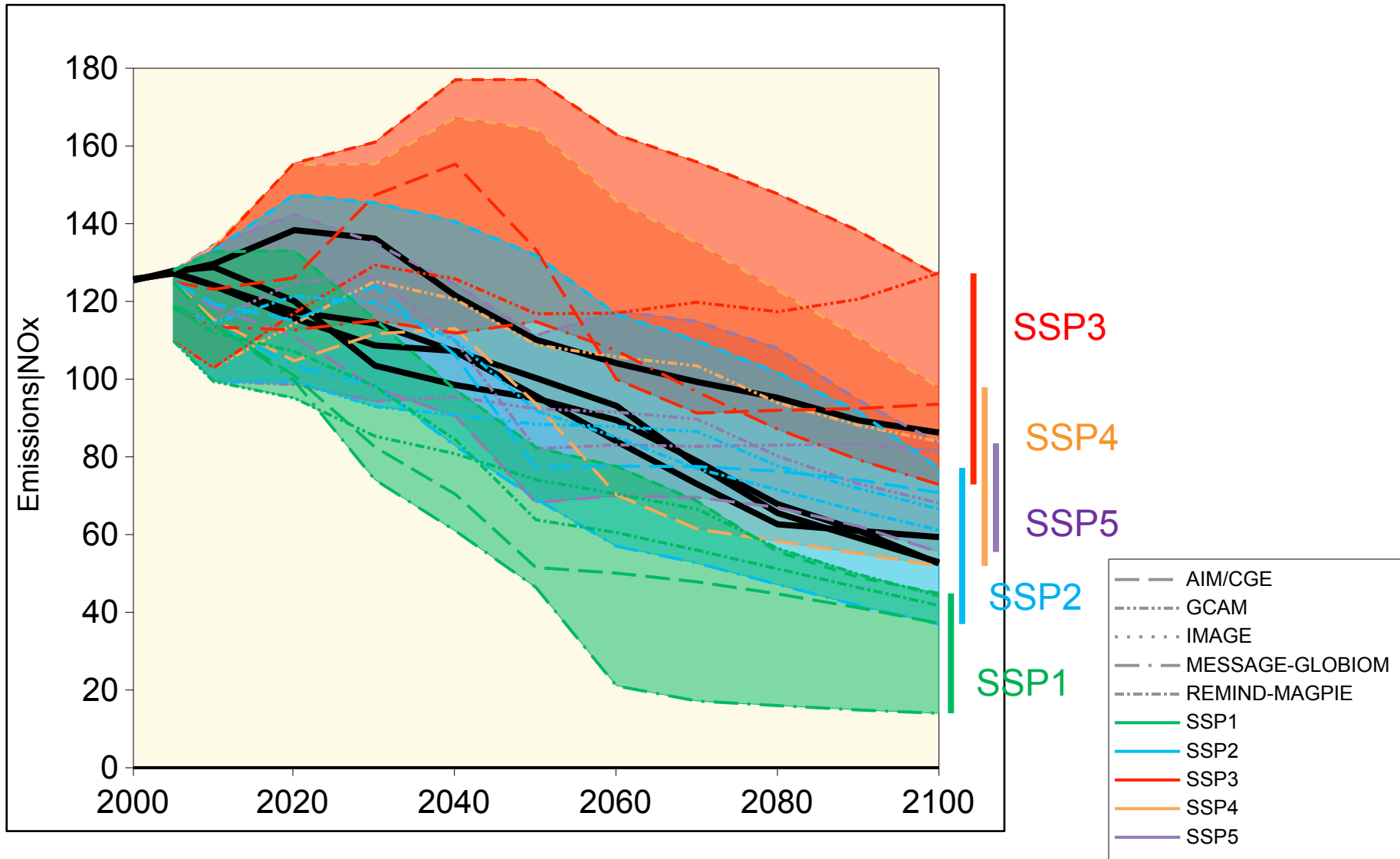
# Air pollution policy assumptions (Storylines, exposure, targets)

	Policy Targets (exposure/concentrations)		Technological Innovation
Policy Strength	<i>High Income Countries</i>	<i>Medium and Low Income</i>	
Strong	Much lower than current targets in order to minimize adverse effects on both general population, vulnerable groups, and ecosystems.	Comparatively quick catch-up with the developed world (relative to income)	Pollution control technology costs drop substantially with control performance increasing.
Central	Lower than current targets	Catch-up with the developed world at income levels lower than when OECD countries began controls (but not as quick as in the strong control case).	Continued modest technology advances.
Weak	Regionally varied policies.	High emissions levels and/or institutional limitations substantially slower progress in pollution control.	Lower levels of technological advance overall.

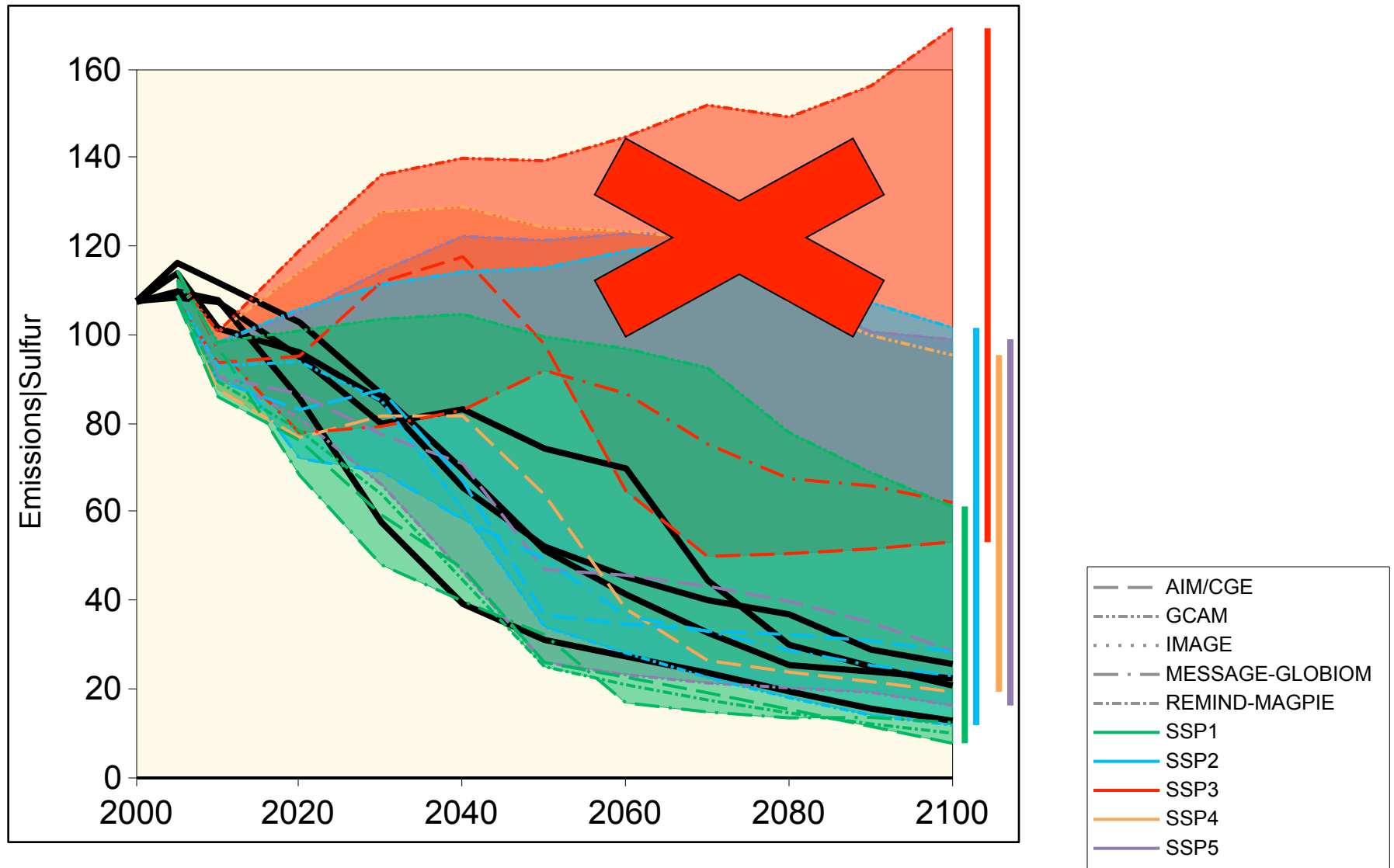


# World Emissions|NOx

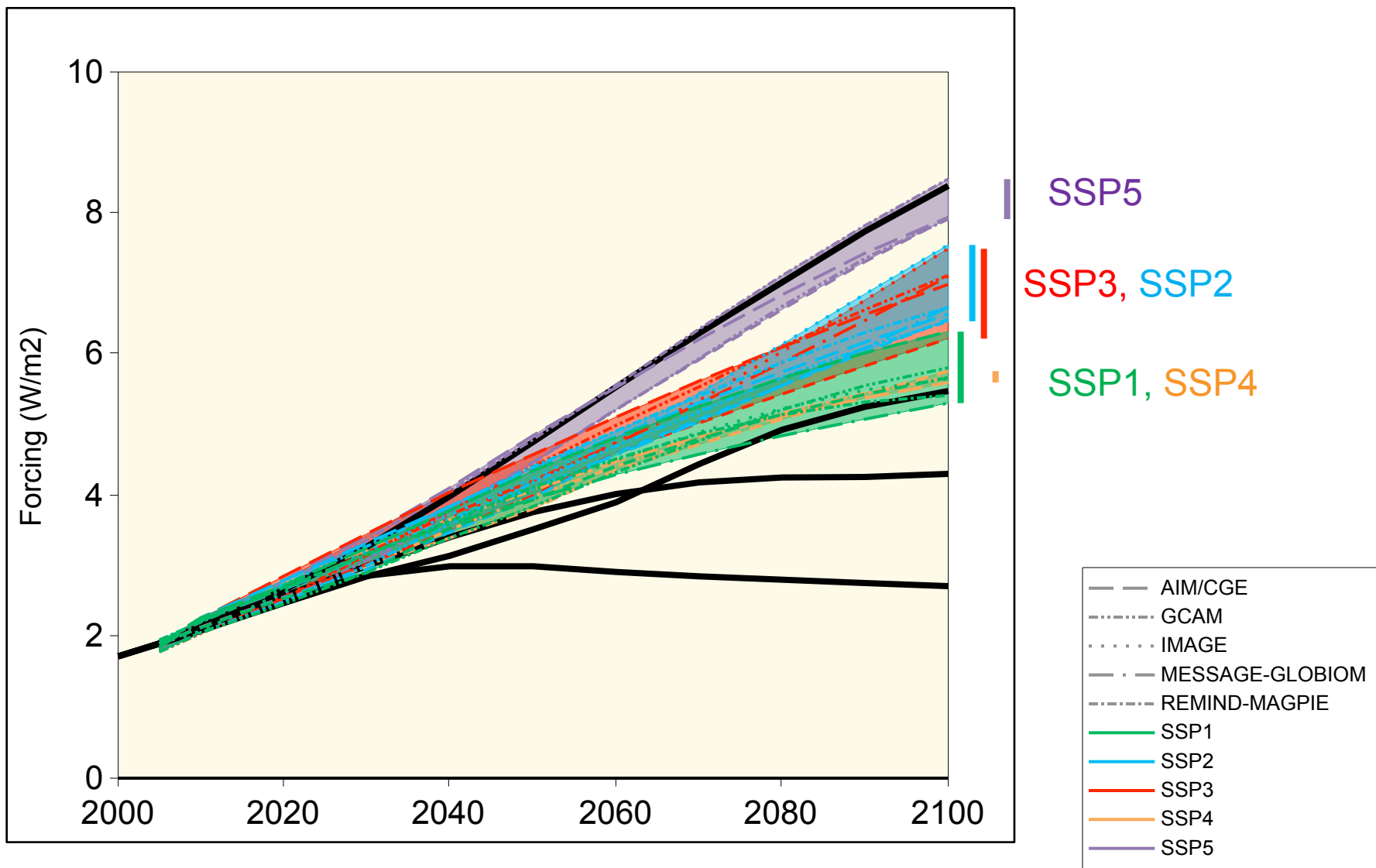
## SSP reference scenarios



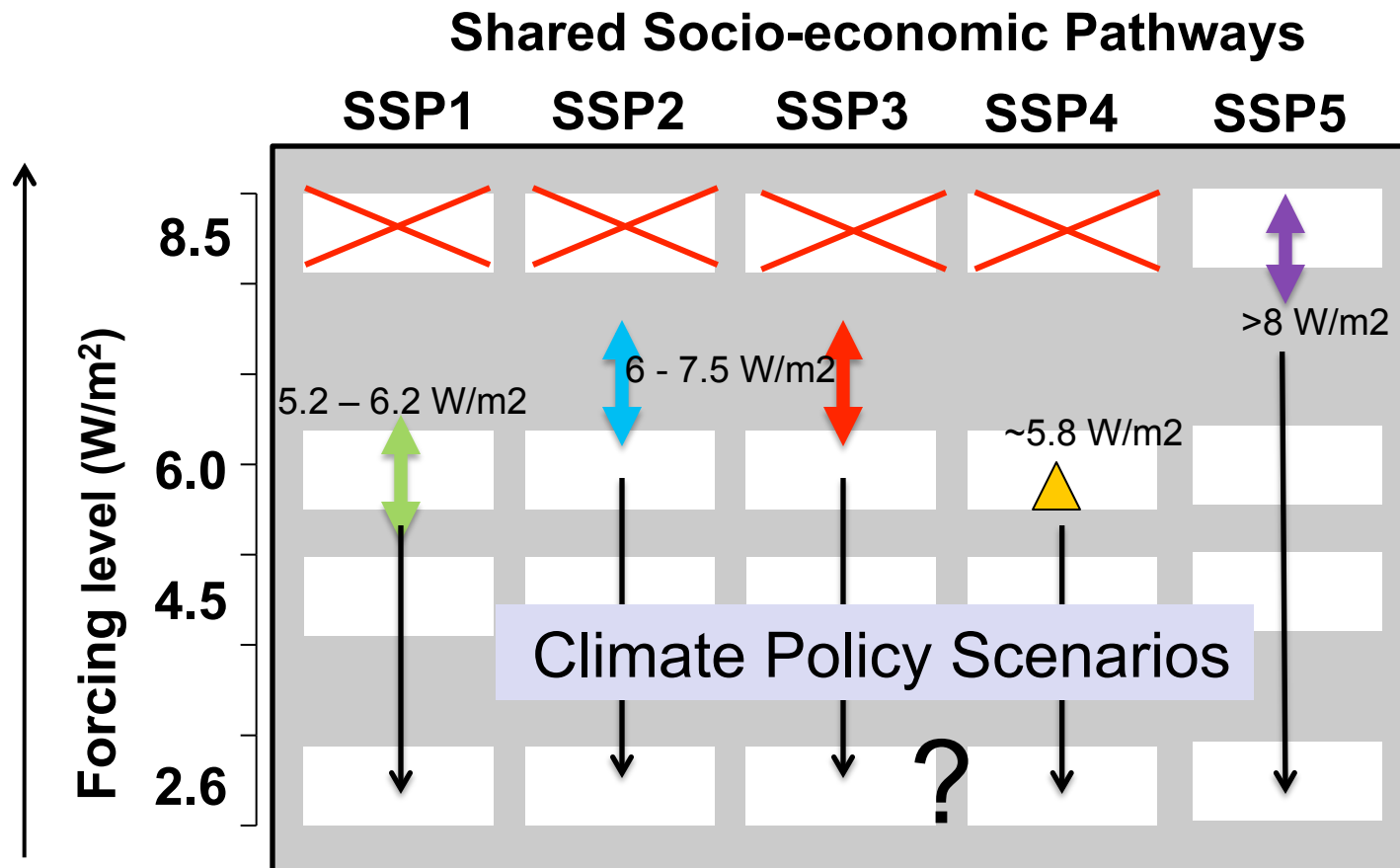
# World Emissions|Sulfur SSP Reference Scenarios



# World Radiative Forcing Reference Scenarios



# SSP/RCP combinations based on reference IAM scenarios



# CLIMATE POLICY SCENARIOS

All results are still preliminary

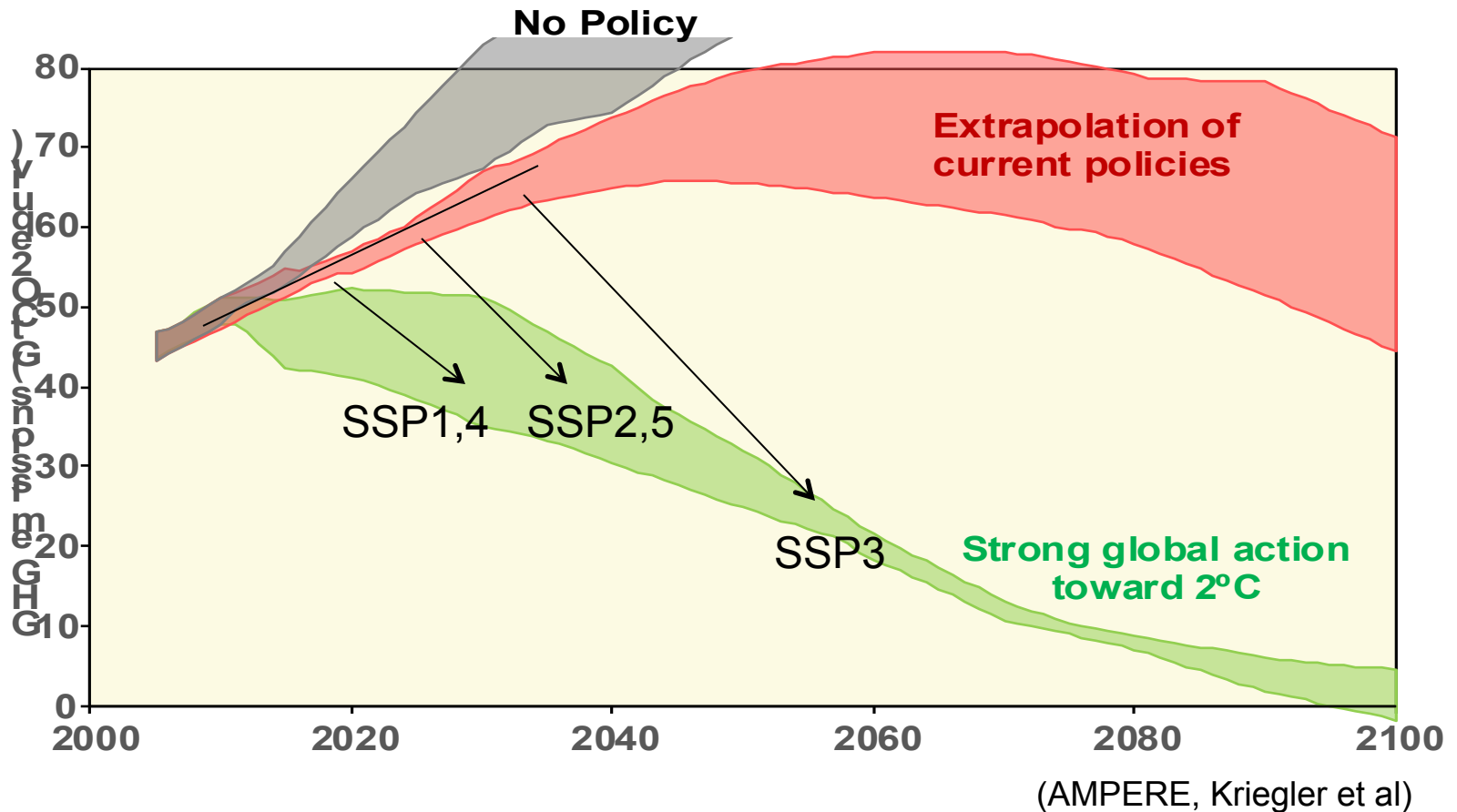
# Shared Policy Assumptions SPAs

SSPs describe worlds with widely different challenges to mitigation due to eg fragmentation, lack of institutions, inequity, lack of technology, etc..

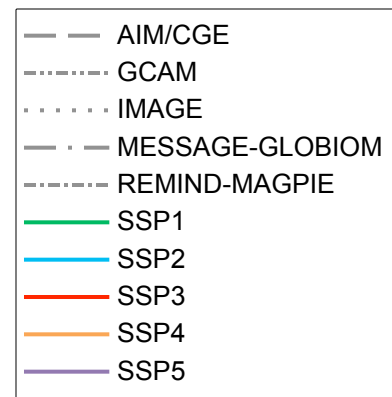
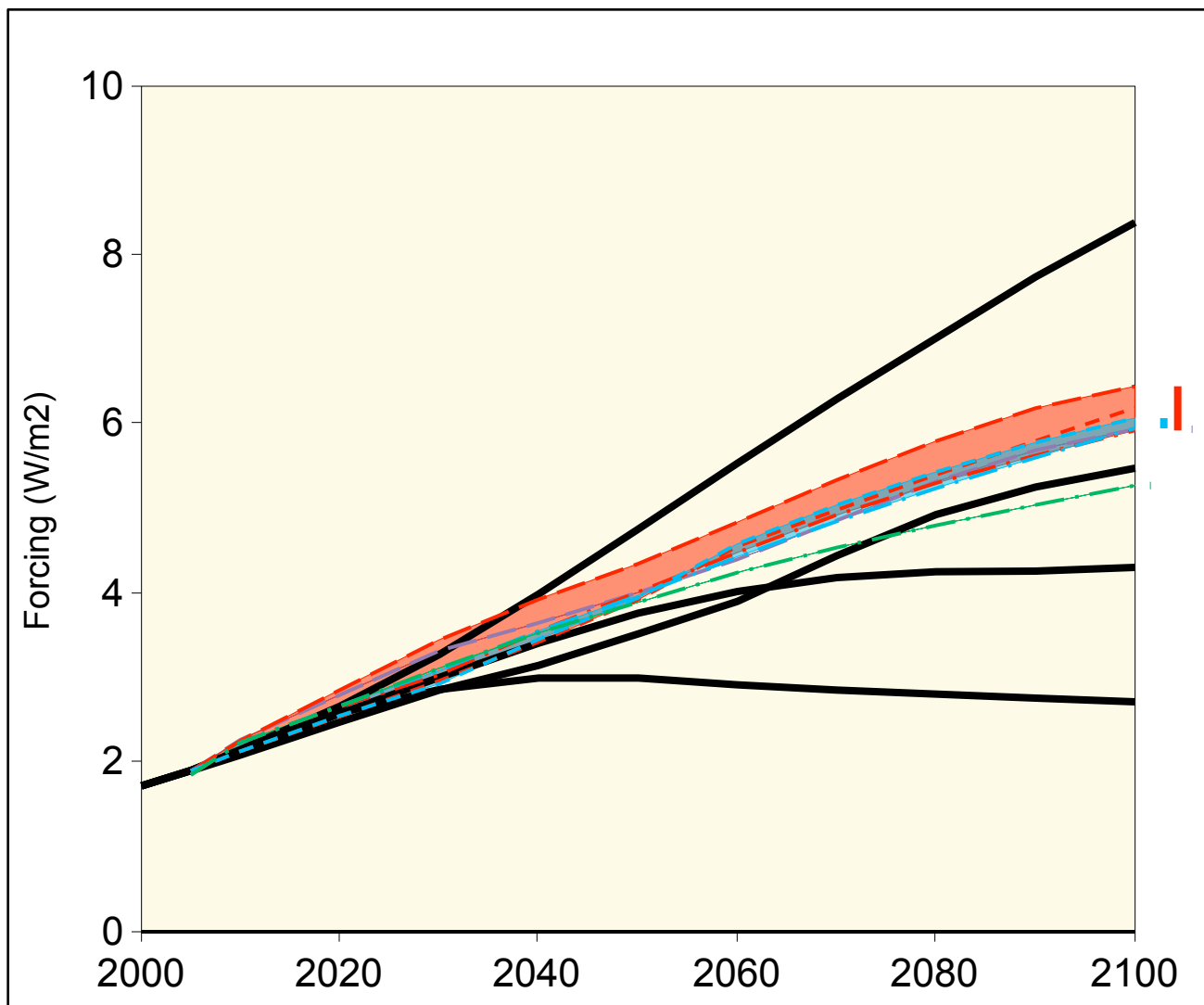
SPAs reflect these differences

Accession/ Regional Participation	Effectiveness of land policies
F1: Early Accession, Global collaboration as of 2020  SSP1, SSP4	L1 highly effective  SSP1
F2: Some delays, poor regions join in 2030  SSP2,5	L2 Intermediately effective (limited REDD)  SSP2,4
F3: Late Accession, poor regions join in 2040  SSP3	L3 Low effectiveness (implementation failures, high transaction costs)  SSP3

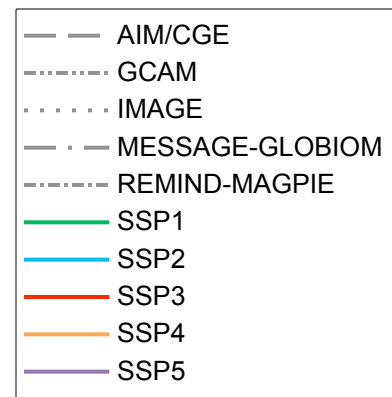
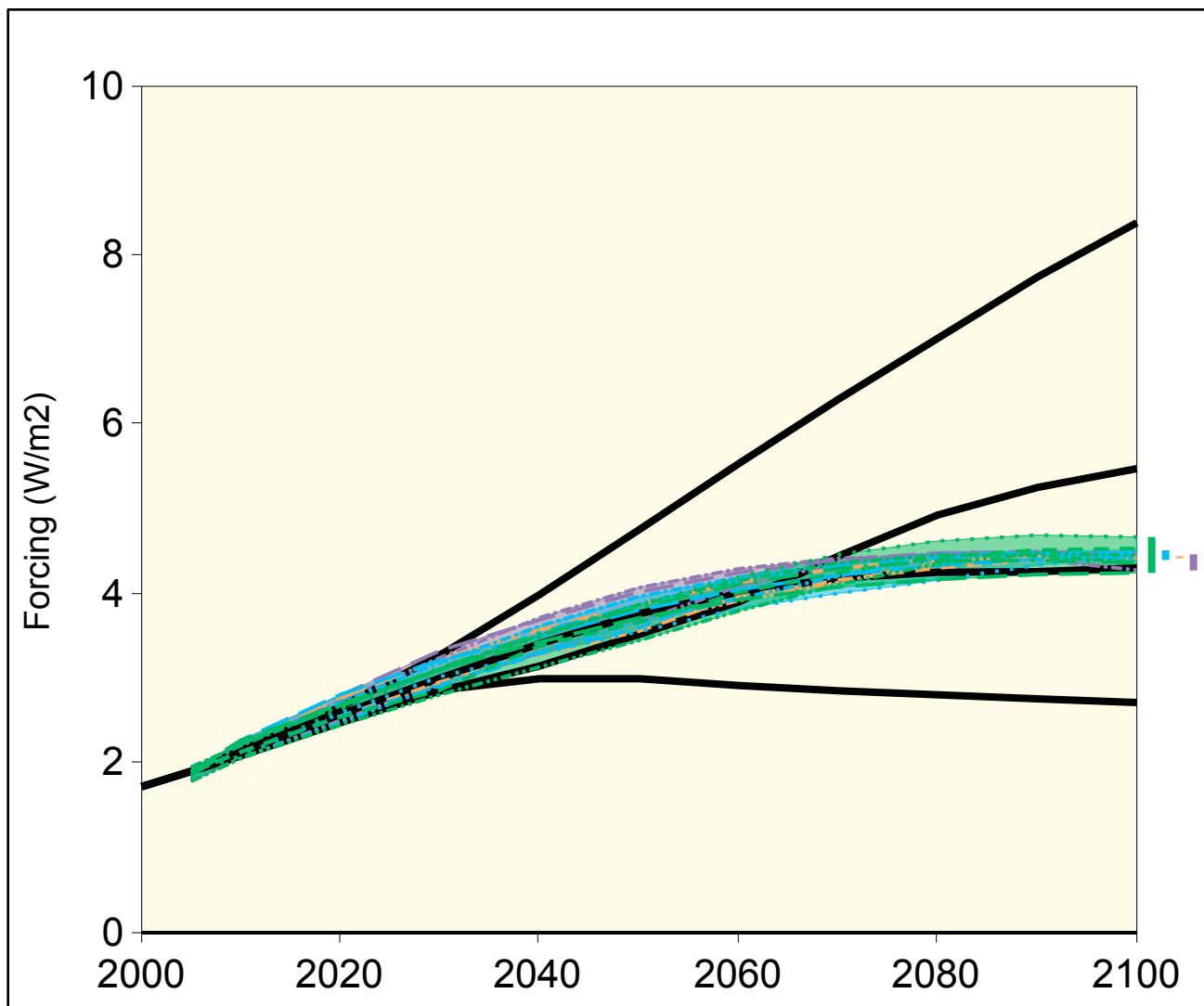
# Shared Policy Assumptions Accession



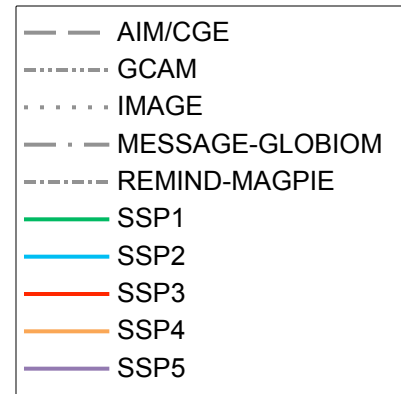
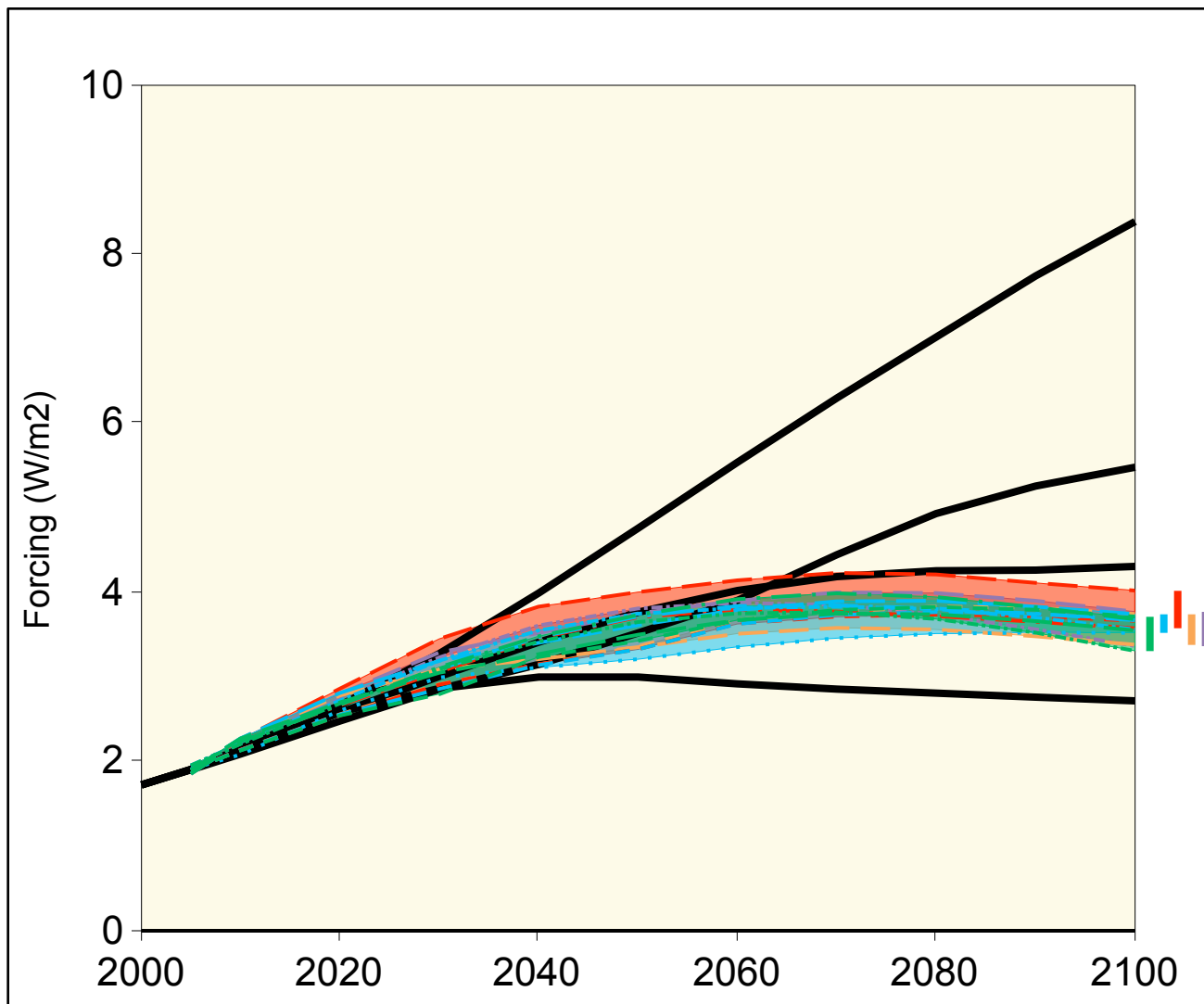
# World Forcing 6.0



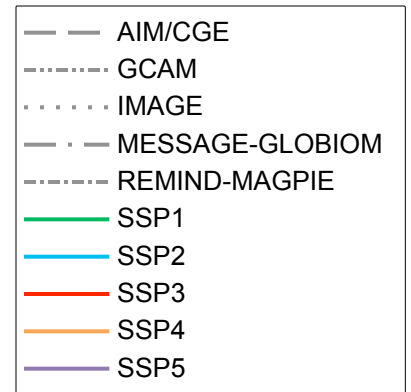
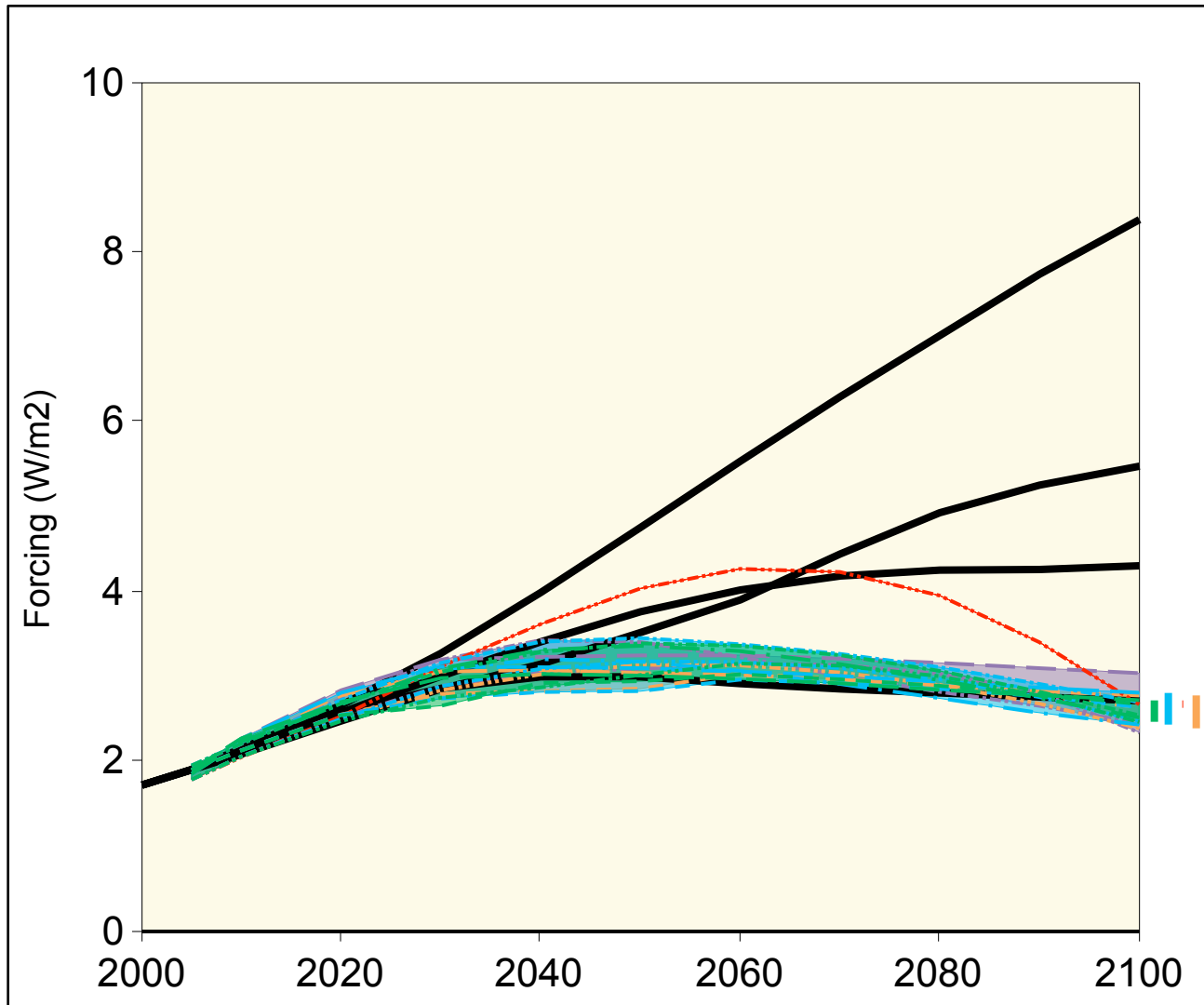
# World Forcing 4.5



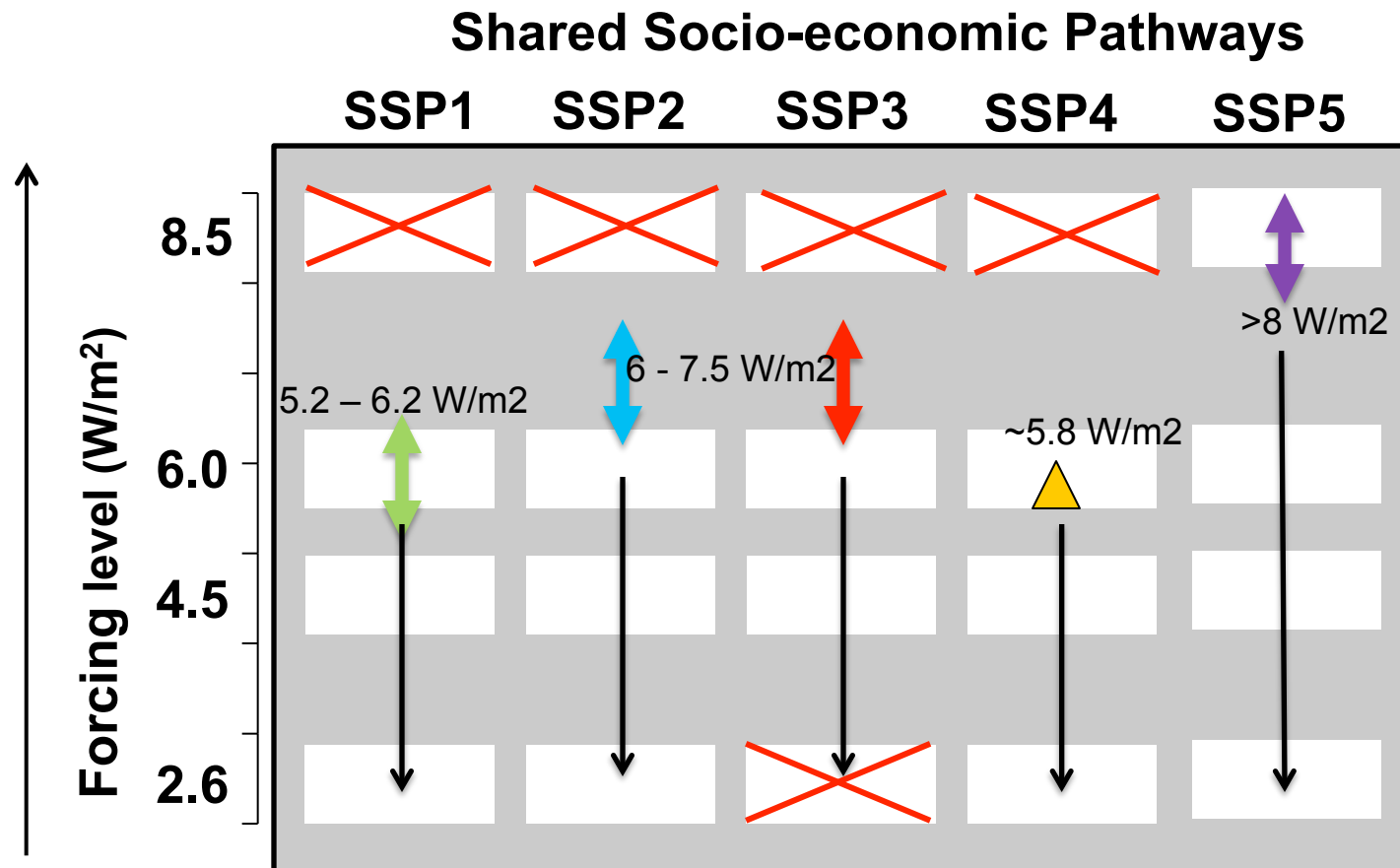
# World Forcing 3.7



# World Forcing 2.6



# SSP/RCP combinations based on reference IAM scenarios



# Special Issue in GEC SSPs + IAM Scenarios

- Narratives: O'Neill et al (**submitted**)
- Population: KC & Lutz (**accepted**)
- GDP: (1) Leimbach et al, (2) Dellink et al, (3) Crepo (**submitted**)
- Urbanization: Jiang & O'Neill (**submitted**)
- 5 x IAM marker papers
- Crosscut papers:
  - Energy
  - Land-use
  - Air Pollution/Aerosols

# Data availability and resolution

**All data will be publicly available at the SSP database**

**Already available (national data)**

*GDP*

*Population (structure, education, tot)*

*Urbanization*

***IAM scenario data by end of the year***

*Energy*

*Land-use*

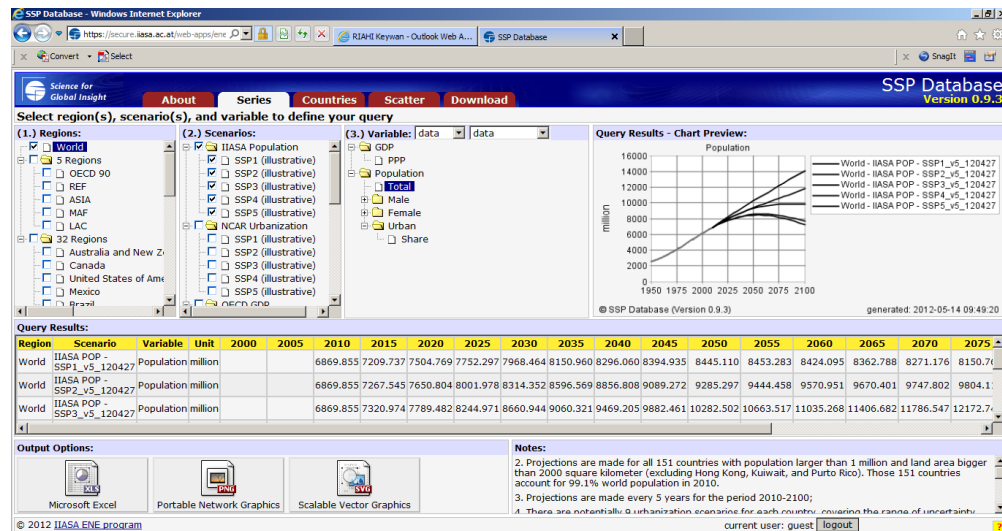
*Emissions*

*Forcing & Temperature*

*Other relevant indicators (energy/carbon price, economic feedbacks, etc..)*

***Resolution: 5 World Regions (more details available from IAM teams 10-26 regions)***

At the moment there are no concrete plans for spatial downscaling (assess on user needs)  
(individual efforts for downscaling: NCAR, IMPRESSIONs, IIASA, and other projects)



<https://secure.iiasa.ac.at/web-apps/ene/SspDb>

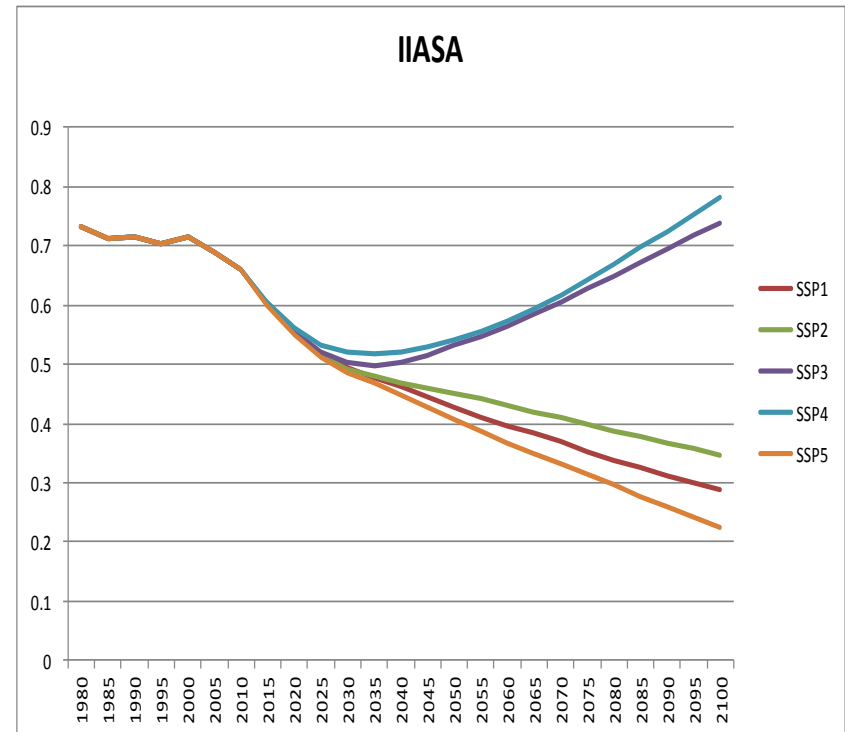
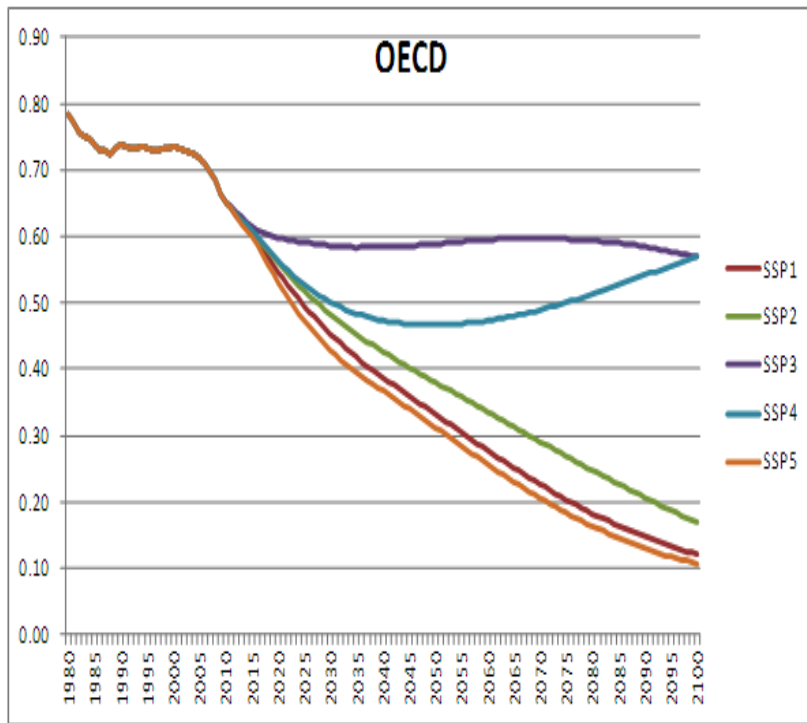
# Timeline

- Beta-version of IAM scenarios will become available for comments by end of 2014
- Submission of selected papers (eg overview paper) around the same time
- Parallel community/paper review
- Present beta-SSP scenarios at the IPCC Scenarios Meeting in February (not fixed yet!)
- Finalization of scenarios and SI mid 2015

# Additional Slides

# Inequality across models

## Global GINI



# Country Groupings

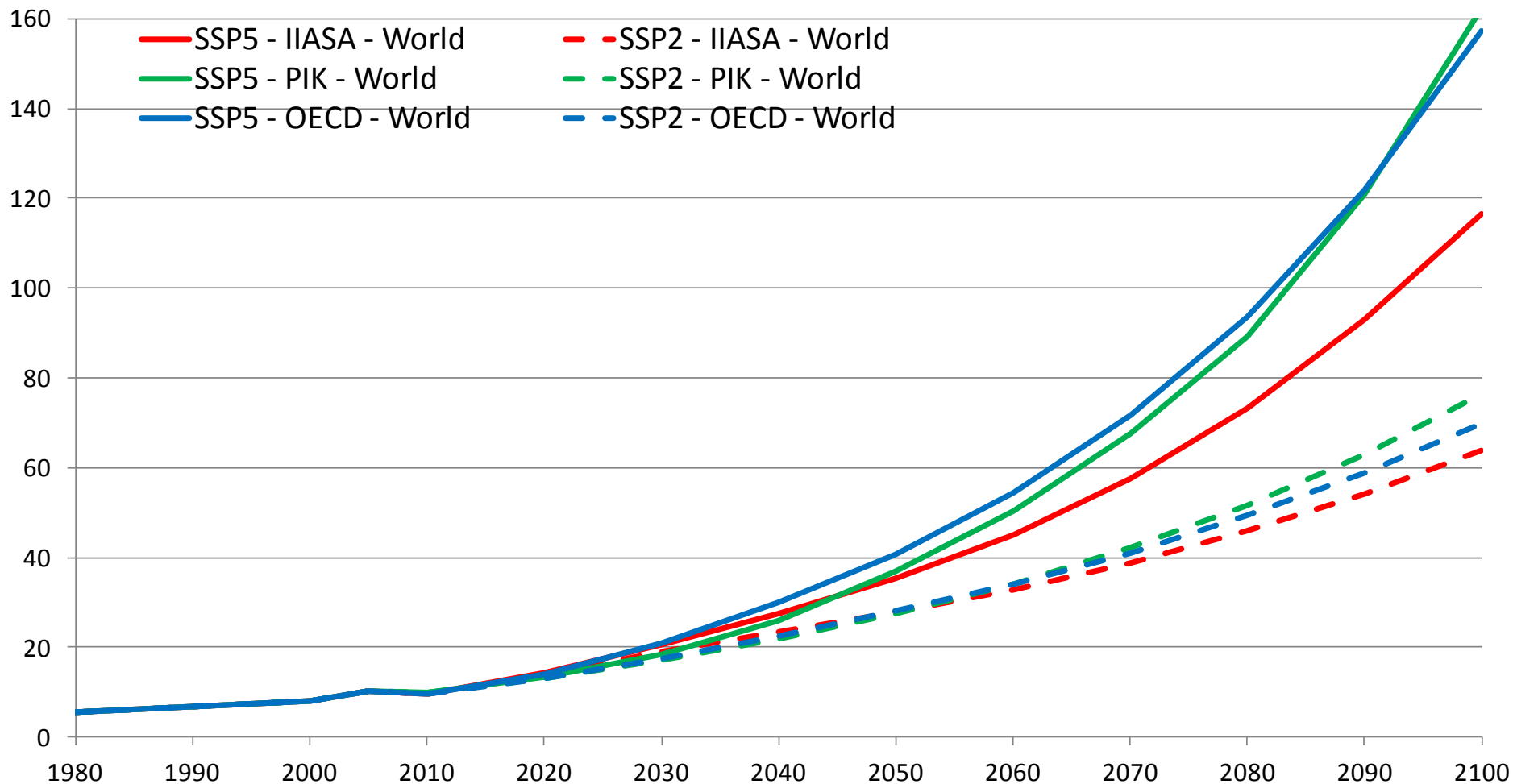
- For defining these scenarios we distinguish among three groups of countries:
- ***High Fertility Countries (HiFert)***: Countries with current level of fertility less than 2.9 children per woman (2005-2010).
- ***Low Fertility Countries (LoFert)*** Countries with current level of fertility less than or equal to 2.9 not belonging to Rich OECD countries (see below)
- ***High Income-OECD Countries (Rich-OECD)*** As per the definition of World Bank.

# Education Scenarios

- ***The fast track (FT)*** scenario is extremely ambitious; it assumes that all countries expand their school systems at the fastest possible rate, which would be comparable with best performers in the past such as Singapore and South Korea .
- ***The global education trend (GET)*** scenario is more moderately optimistic and assumes that countries will follow the average path of school expansion that other countries already somewhat further advanced in this process have experienced.
- ***The constant enrollment rate (CER)*** scenario assumes that countries only keep the proportions of cohorts attending school constant at current levels.
- ***The most pessimistic scenario, constant enrollment numbers (CEN)***, assumes that no more schools at all are being built and that the absolute number of students is kept constant, which under conditions of population growth means declining enrollment rates.

# Global GDP levels by scenario

SSP - Per Capita GDP (billion US\$2005PPP / million people)



Source: preliminary SSP database

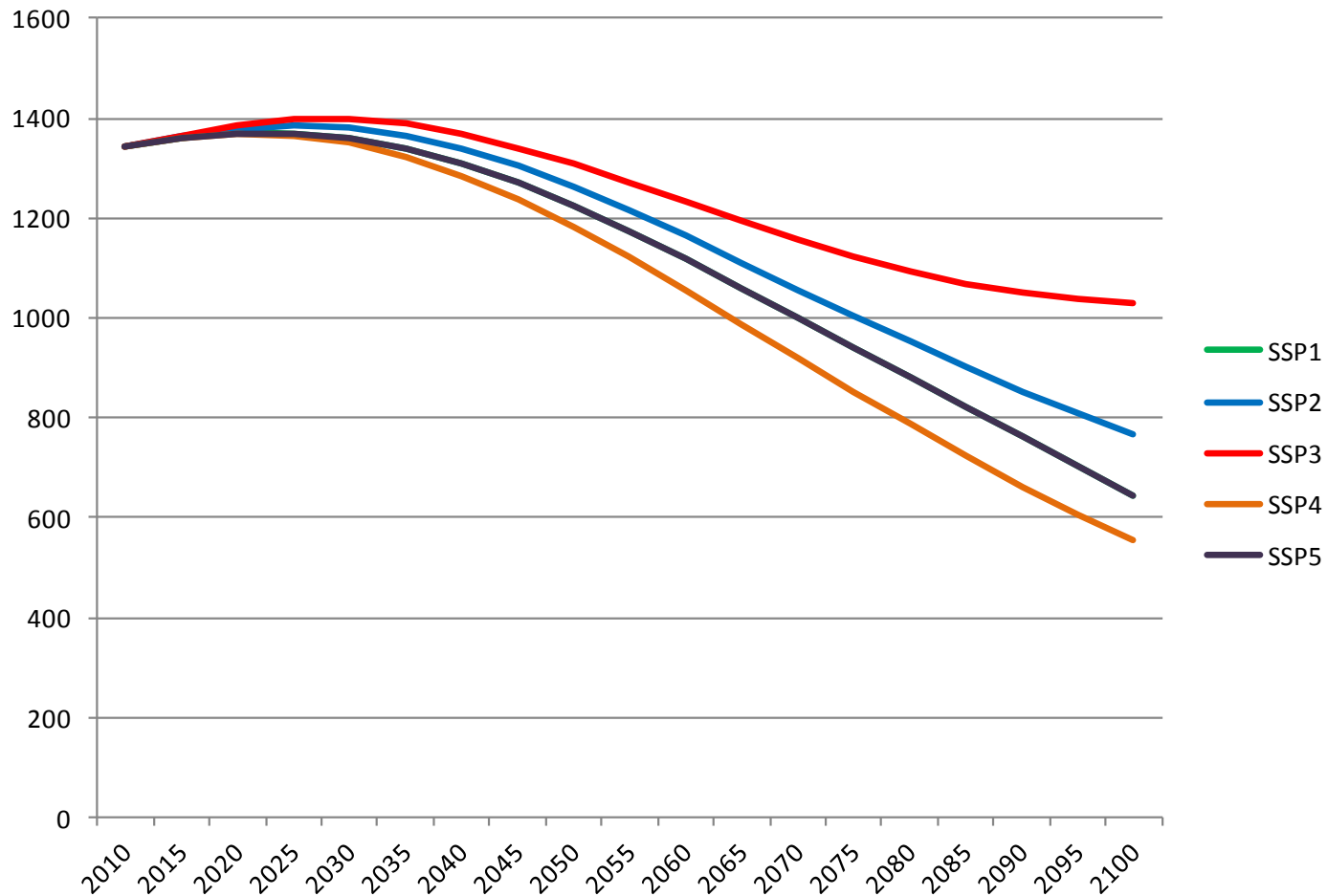
# Population assumptions consistent with SSP Storylines

SSP Element	SSP 1			SSP 2			SSP 3			SSP 4			SSP 5		
							Country Groupings								
	HiFert	LoFert	Rich-OECD	HiFert	LoFert	Rich-OECD	HiFert	LoFert	Rich-OECD	HiFert	LoFert	Rich-OECD	HiFert	LoFert	Rich-OECD
<b>Demographics</b>															
Population															
Fertility	Low	Low	Med	Med	Med	Med	High	High	Low	High	Low	Low	Low	Low	High
Mortality	Low	Low	Low	Med	Med	Med	High	High	High	High	Med	Med	Low	Low	Low
Migration	Med	Med	Med	Med	Med	Med	Low	Low	Low	Med	Med	Med	High	High	High
<b>Education</b>	High	High	High	Med	Med	Med	Low	Low	Low	Low	Low	Med	High	High	High
	(FT)	(FT)	(FT)	(GET)	(GET)	(GET)	(CER)	(CER)	(CER)	(CEN)	(CER)	(GET)	(FT)	(FT)	(FT)

High challenges for adaptation

Low challenges for adaptation

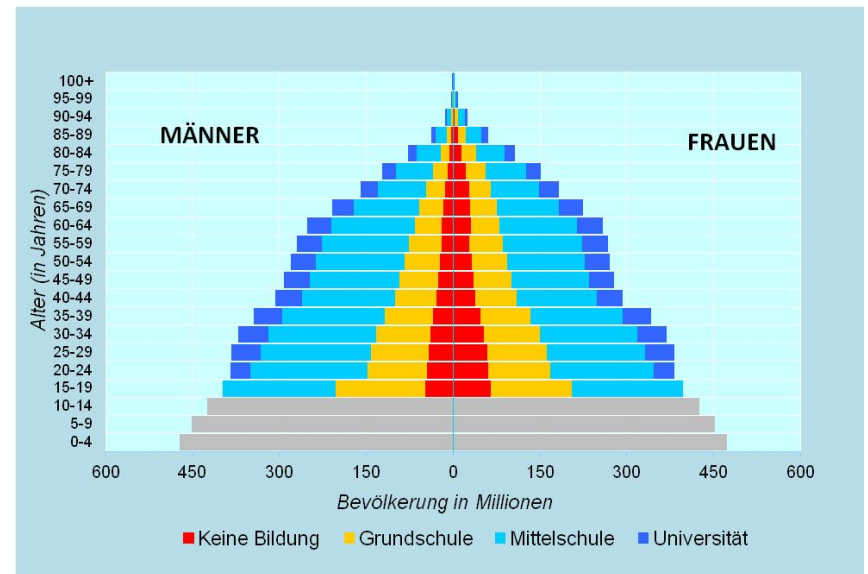
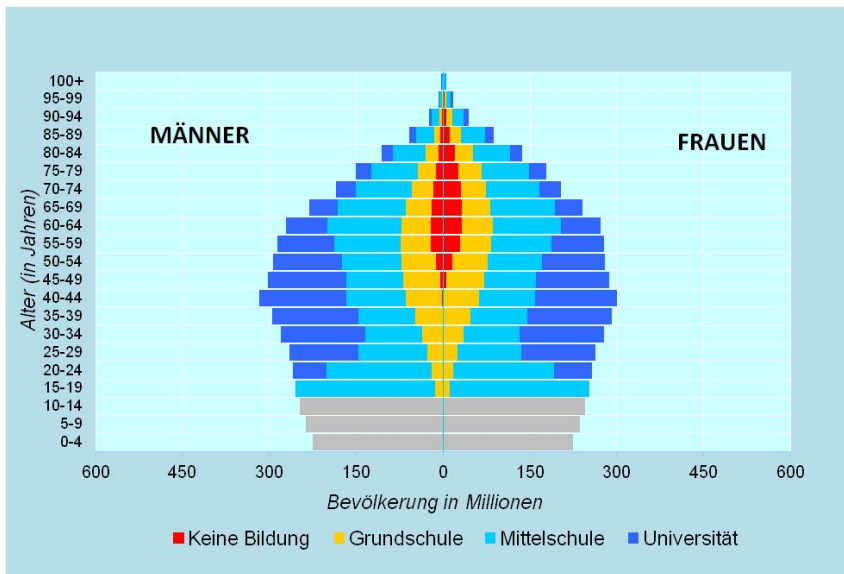
# China - population for five SSPs



# World 2050

**SSP1 Pop=8673 Mio**

**SSP3 Pop=10603 Mio**



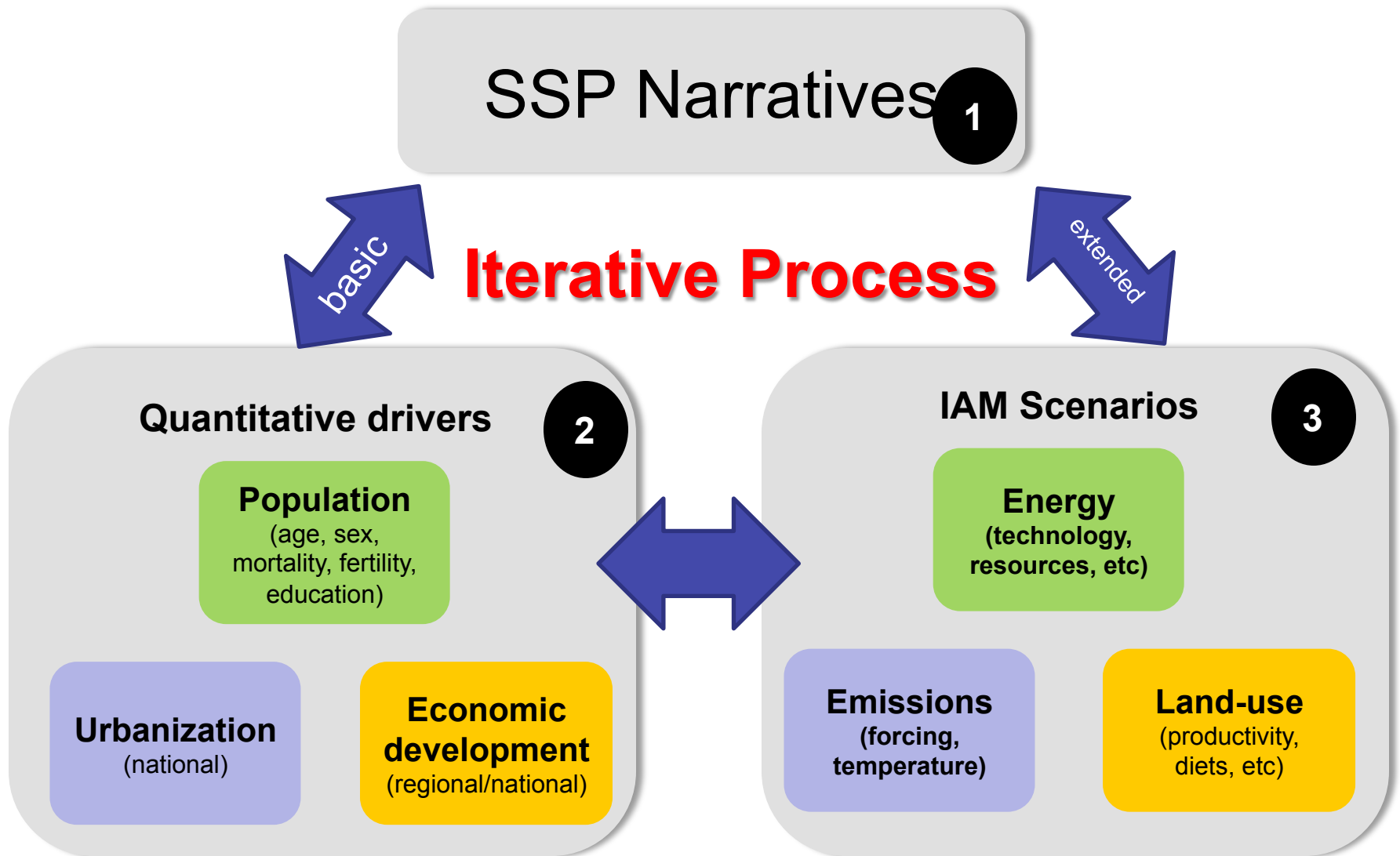
# Common interpretation of the SSPs

## OECD – IIASA - PIK

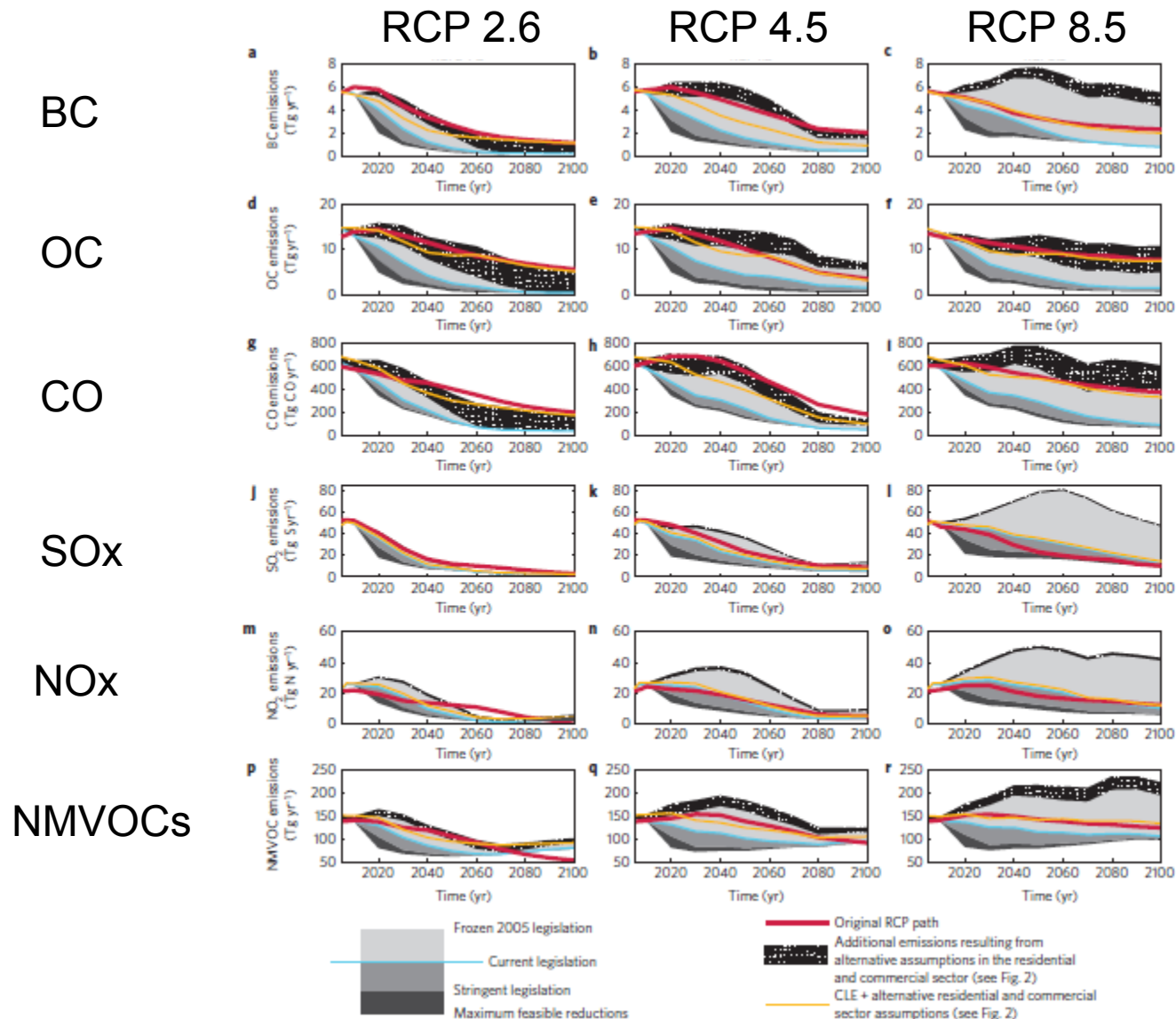
	Frontier TFP growth	Speed of convergence
SSP1: Sustainability	Medium high	High
SSP2: Middle of the road	Medium	Medium
SSP3: Fragmentation	Low	Low
SSP4: Inequality	Medium	Low Income: Low Middle Income: Medium High Income: Medium
SSP5: Conventional development	High	High

N.B. Quantitative interpretations and methodology differ between models, illustrating the uncertainties in making economic projections

# Key SSP elements (three main products + IAV variables)

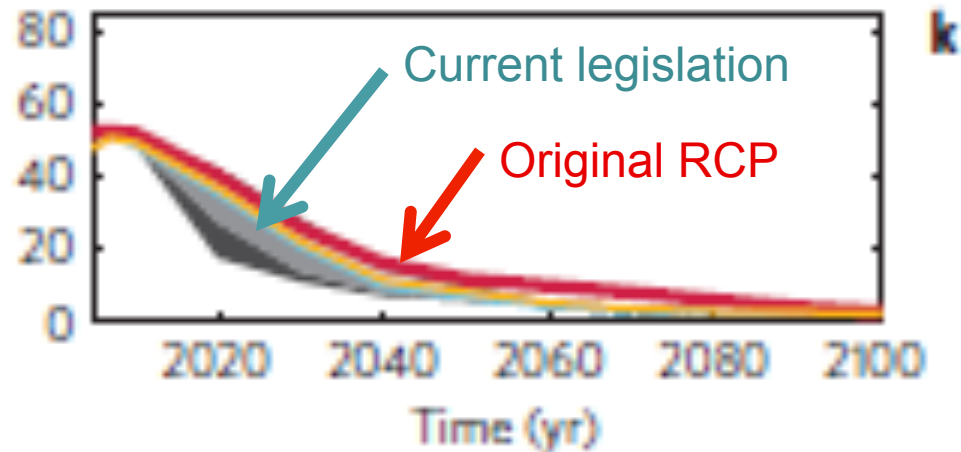


# Air pollutant Uncertainties of the RCPs

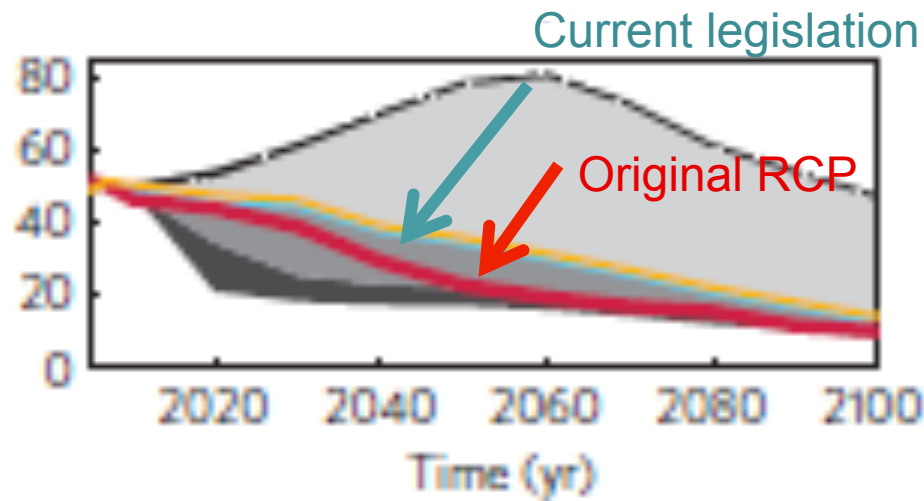


# Sulfur Emissions Uncertainties in RCP 2.6 and 8.5

**RCP 2.6**



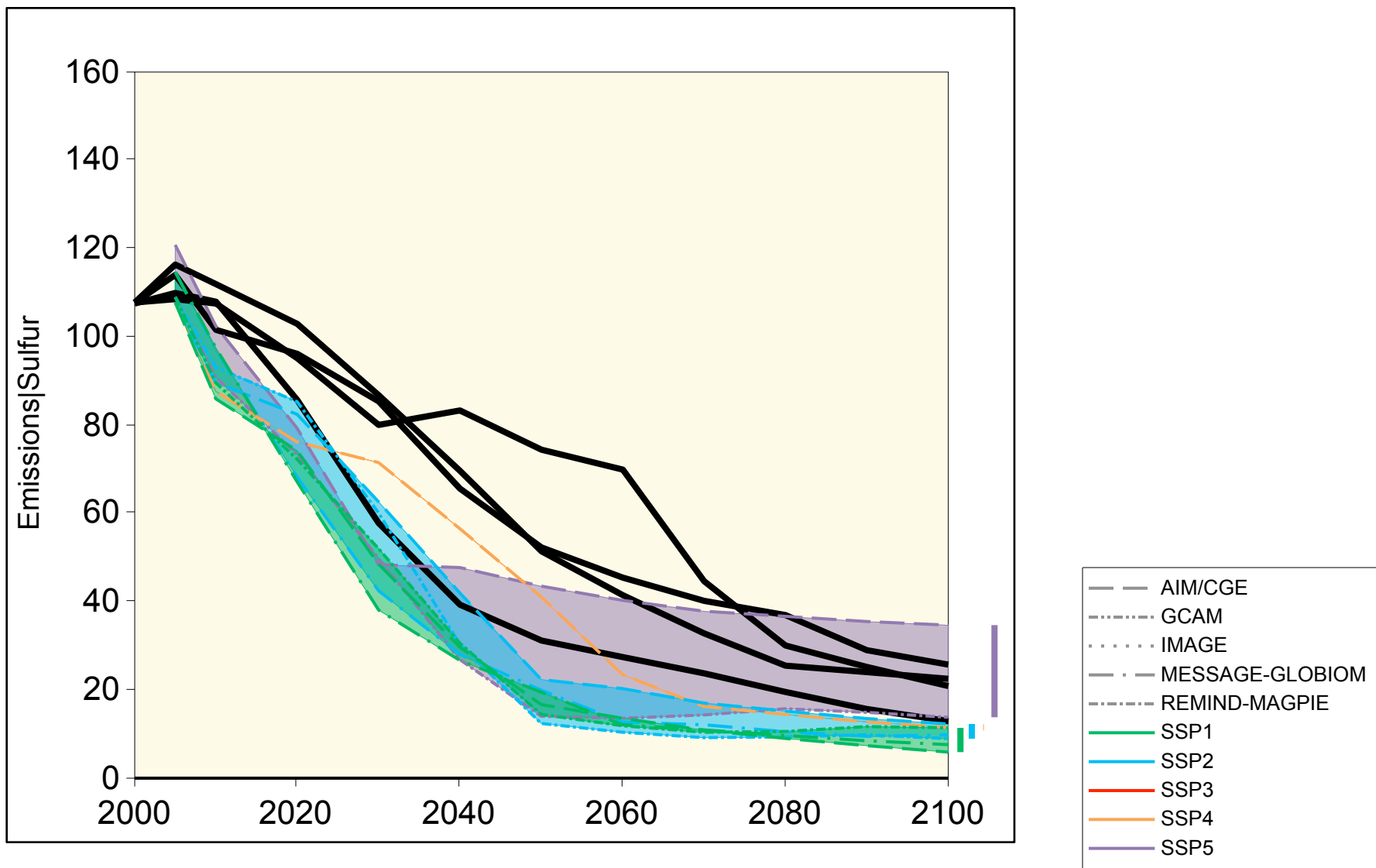
**RCP 8.5**



Rogelj et al  
(NCC, 2014)

# World Emissions|Sulfur

## 2.6



# Assumptions about other drivers

**Energy demand** (access, intensity of services, environmental awareness, etc..)

SSP Element	SSP 1			SSP 2			SSP 3			SSP 4			SSP 5			
	Country Income Groupings															
	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High	
Non-climate Policies																
Traditional Fuel Use	fast phase-out, driven by policies and economic development			intermediate phase-out, regionally diverse speed			continued realiance on traditional fuels			continued traditional fuel use		some traditional fuel use among low income households		fast phase-out, driven by development priority		
Energy Demand Side																
Lifestyles	modest service demands (less material intensive)			medium service demands (generally material intensive)			medium service demands (material intensive)			low service demands		modest service demands		high service demands (very material intensive)		
Environmental Awareness	high			medium			low			low		high		medium (low for global level/high for local level)		
Energy Intensity of Services																
Industry	low			medium			high			high		low		medium		
Buildings	low			medium			high			medium		low/medium		medium		
Transportation	low			medium			medium		high		low/medium		low		high	
General Comments				some regional diversity retained												

**Fossil resources** (availability, costs, trade, etc..)

	SSP 1			SSP 2			SSP 3			SSP 4			SSP 5		
							Country Income Groupings								
SSP Element	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High
Coal															
Macro-economy	cost driver			neutral			cost reducing			cost reducing neutral cost driver			cost reducing		
Technology	medium			medium			high			medium			very high		
National & environmental policy	very restrictive			supportive			very supportive			supportive supportive restrictive			very restrictive		
Conv. Hydrocarbons															
Macro-economy	neutral			neutral			neutral			cost driver			cost reducing		
Technology	medium			medium			medium			fast			very high		
National & environmental policy	restrictive			supportive			mixed (not supported in MEA/FSU)			supportive supportive restrictive			very restrictive		
Non-conv. Hydrocarbons															
Macro-economy	neutral			neutral			neutral			cost driver			cost reducing		
Technology	slow			medium			medium			medium			very high		
National & environmental policy	very restrictive			supportive			very supportive			supportive supportive restrictive			very restrictive		
General															
Trade barriers	Free			Barriers			High Barriers			Barriers			Free		

Qualitative descriptions

Modeling teams were flexible to make own interpretations

# More assumptions....

## Energy technologies (Innovation, acceptance, costs, etc...)

SSP Element	SSP 1			SSP 2			SSP 3			SSP 4			SSP 5		
	Country Income Groupings														
	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High
Conventional and Unconventional Fossil Fuel Conversion (synfuel and syngas in parenthesis if different)															
Technology Development	Med			Med			Low			Low	Med	Med	Med (High)		
Social Acceptance	Low			Med			High			High	Low	Low	High		
Commercial Biomass Conversion															
Technology Development	High			Med			Low			High	High	High	Med		
Social Acceptance	Low			Med			High			High	High	High	Med		
Non-bio Renewables Conversion															
Technology Development	High			Med			Low			High	High	High	Med		
Social Acceptance	High			Med			Med			High	High	High	Low		
Nuclear Power															
Technology Development	Med			Med			Low	Low	Med	High	High	High	Med		
Social Acceptance	Low			Med			High	High	High	High	Med	Med	Med		
CCS (under climate policy only)															
Technology Development	Med			Med			Med			High	High	High	High		
Social Acceptance	Low			Med			Med			High	Med	Med	Med		

## Land use change (productivity, regulation, trade, diets, etc...)

SSP Element	SSP 1			SSP 2			SSP 3			SSP 4			SSP 5		
	Country Income Groupings														
	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High
<u>Land use change regulation</u>	strong			medium			weak			weak medium strong			medium		
<u>Agriculture</u>															
Land productivity growth	rapid	rapid	medium	medium			slow			slow medium rapid			rapid		
Environmental Impact of food consumption	low			medium			high			medium			high		
International Trade	globalized			regionalized			regionalized			limited access globalized globalized			globalized		