New Scenarios, New Challenges

A parallel iterative process for better integration of climate physics, socioeconomics and impacts,
(in IPCC-AR5 or equivalent)

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interactive model: www.climate.be/jcm

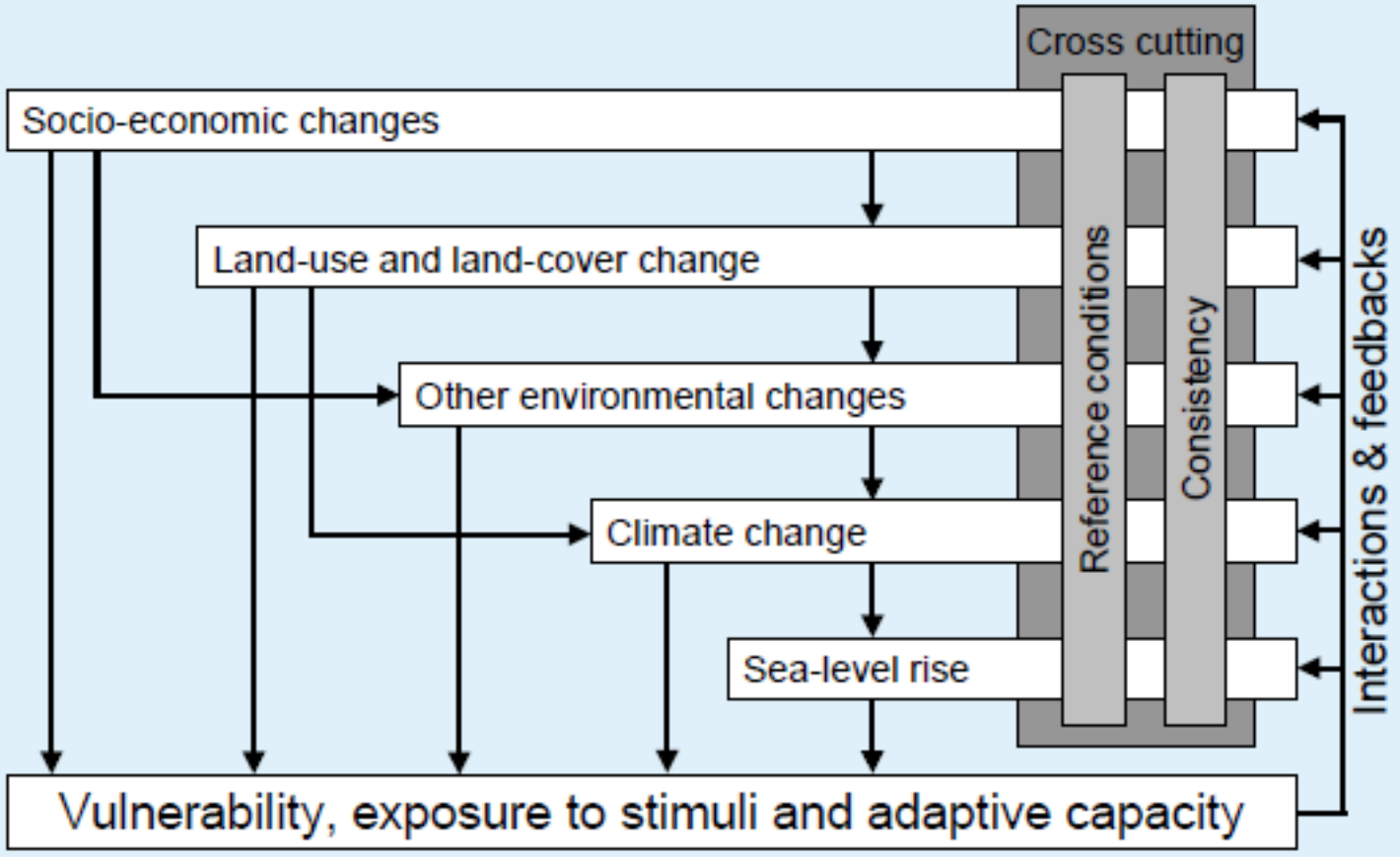
New Scenarios Process in IPCC

- Task Group on New Emissions Scenarios
  (steering committee – inc Jean-Pascal vanYpersele)
- Workshops:
  (100-200 participants each, modelers and users)
  - Laxenburg (Austria) June 2005
  - Sevilla (Spain) March 2006
  - Noordwijkerhout (Netherlands) September 2007
- Panel decision
  - in general IPCC catalyse rather than coordinate
  - first step: workshop / committee select "Benchmark Concentration Pathways"

why a new process…?

- Problems with SRES
  - "Fatalistic" - no climate policy only (mandate)
  - One-way process (no feedbacks)
    storylines => emissions => [big report] => climate =>impacts
  - Formal => slow – impacts lag behind, out of date
- Problems with AR4
  - "Scenarios used for AOGCM runs decided by WG1 without debate with users / other WG (hence no really high scenario, & no mitigation or stabilization runs)" This decreased the policy-relevance of AR4
  - Why?
    - Bad coordination/communication between Working groups, scientific communities, and users
    - Missing early decision on Synthesis report and the issues to be addressed across WG

Projecting climate alone is not sufficient



Source: Carter et al., 2001

How to include key feedbacks?

It's not a one way cause-effect chain (emissions =>climate...)

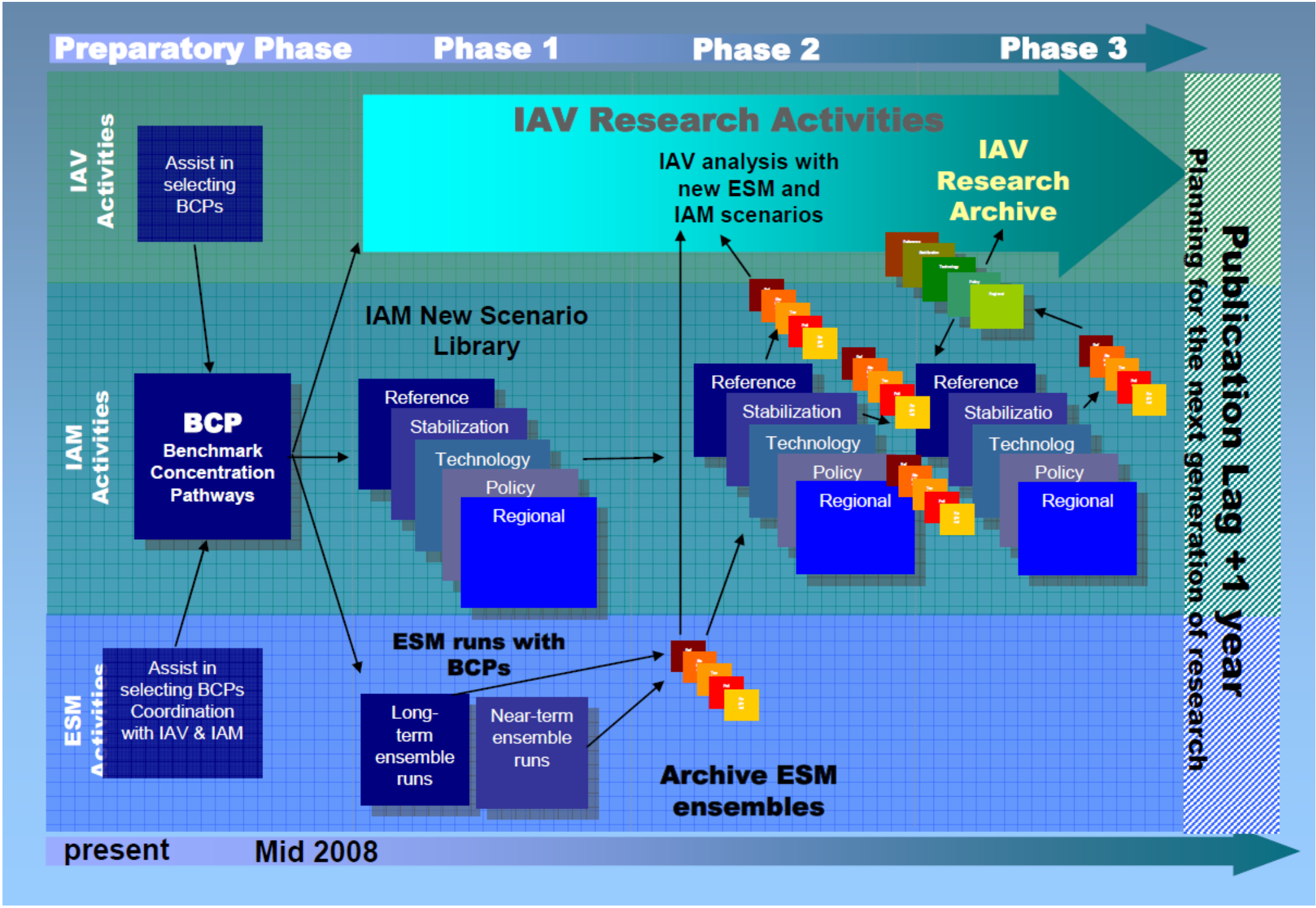
- Climate change => Carbon cycle => Emissions (for stabilisn) need ESMs to run stabilisation scenarios
- Climate Change => Water, Agriculture => Limits to Demographic and Economic growth => Emissions (particularly in high population “A2 world”)
- Climate Change => Potential Land Use => Emissions
- Climate Change => perceived “Dangerous” Impacts => Mitigation Policy => Emissions

=> need to know climate first, to analyse emissions pathways...

- Solutions:
  => Start in middle of cause-effect chain (concentration/forcing)
  => ESMs tune flexible integrated assessment models

More issues...

- Explore limits of pattern scaling
- Nonlinearity in response forcing =>impacts
  (critical for risk anor “guardrails”)
- => need at least 3 scalysis or “guardrails”) enarios to get a curve
  - 4 better, also avoids one in the “middle” (political)
- LUC and short lived gases / aerosols – need high resolution, shorter timescale
- *BUT* ESM community group say clearly
  - better to run many ensembles of fewer scenarios
  - scenarios need to be distinguishable

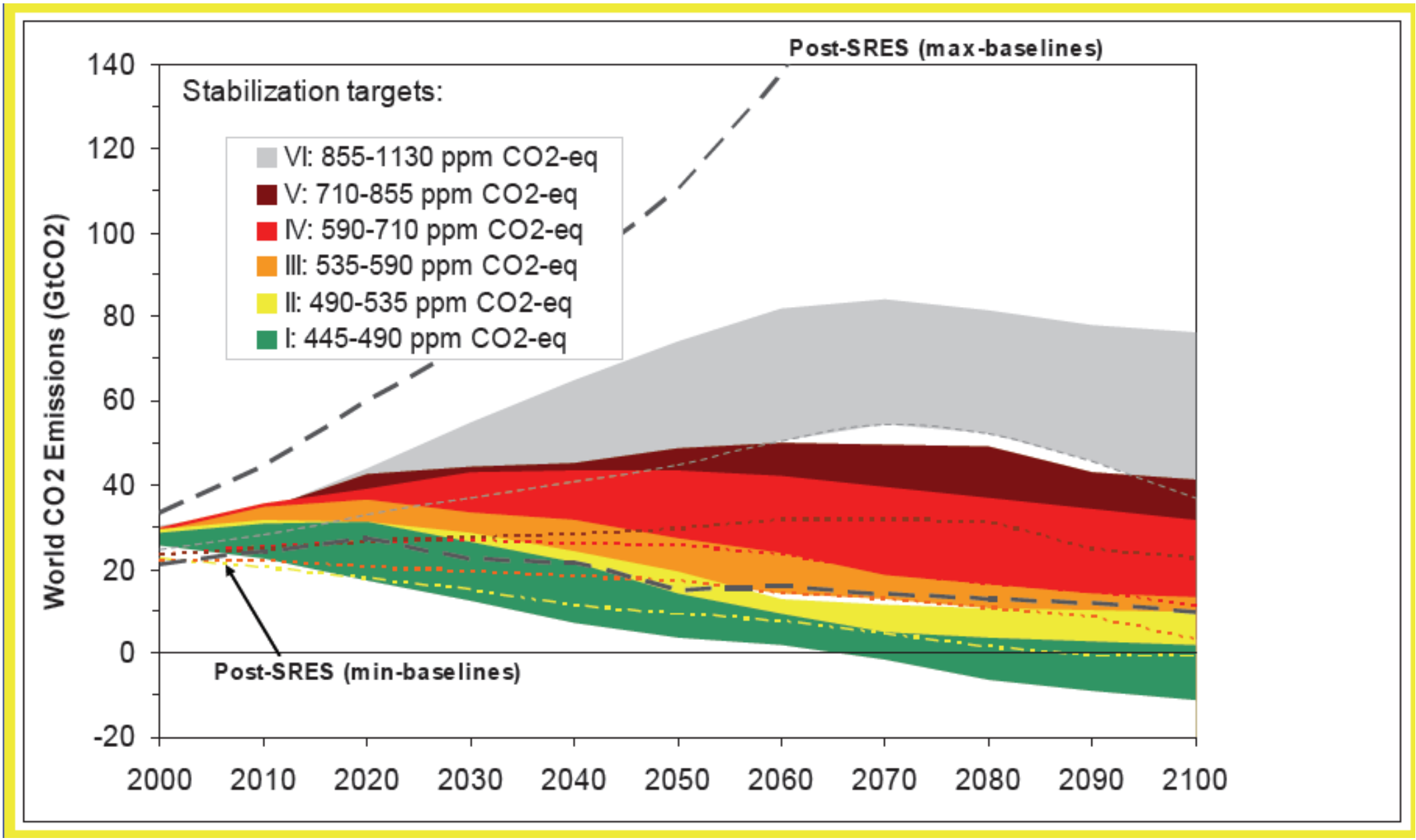

Preparatory Phase
Phase 1
Phase 2
Phase 3
IAV Activities
Assist in selecting BCPs
IAV Research Activities
IAV analysis with new ESM and IAM scenarios
IAV Research Archive
Publication Lag +1 year
Planning for the next generation of research
IAM New Scenario Library
IAM Activities
BCP
Benchmark Concentration Pathways
Reference
Stabilization
Technology
Policy
Regional
ESM Activities
Assist in selecting BCPs Coordination with IAV & IAM
ESM runs with BCPs
Long-term ensemble runs
Near-term ensemble runs
Archive ESM ensembles
present
Mid 2008

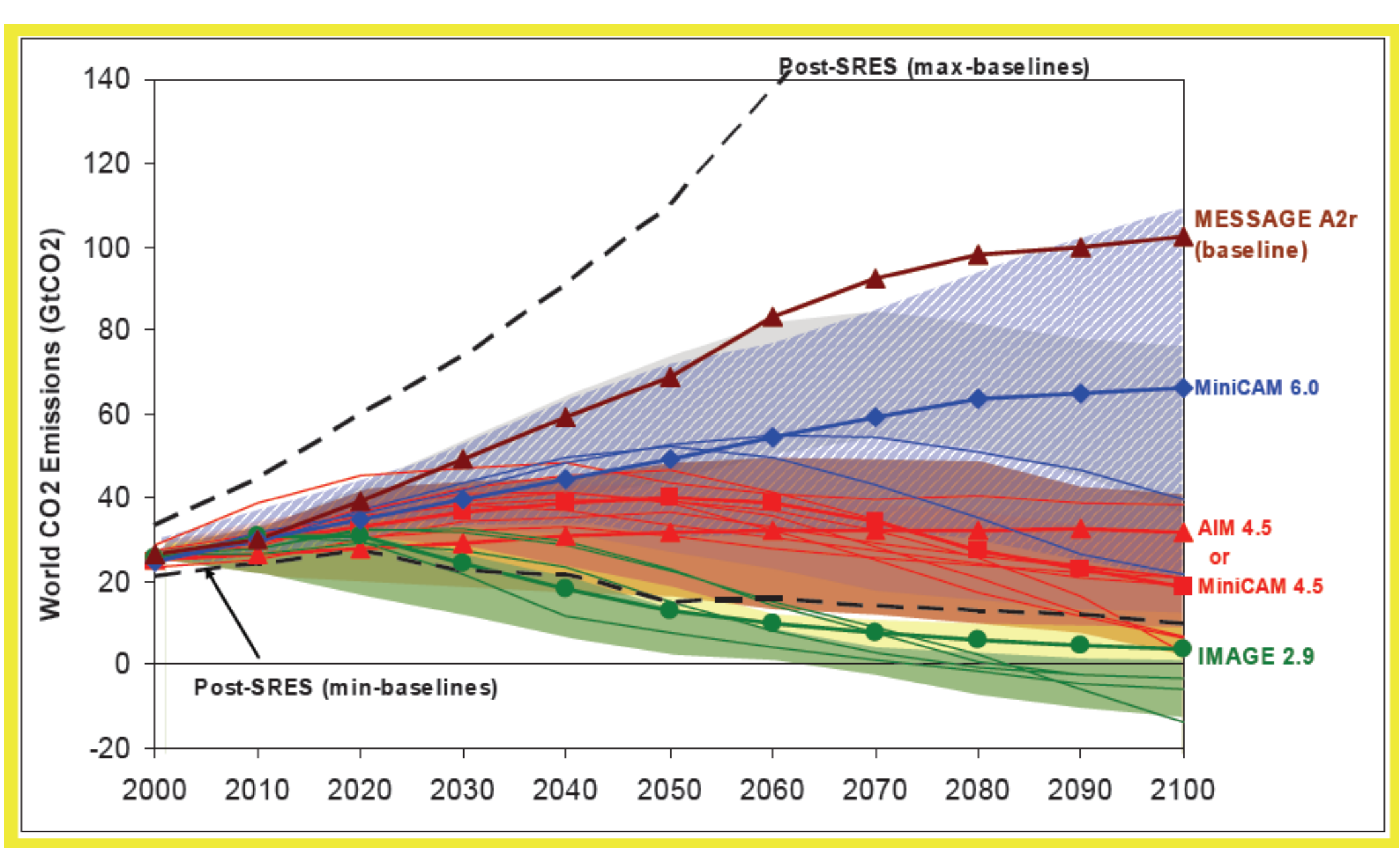
Choosing four “Representative Concentration Pathways”

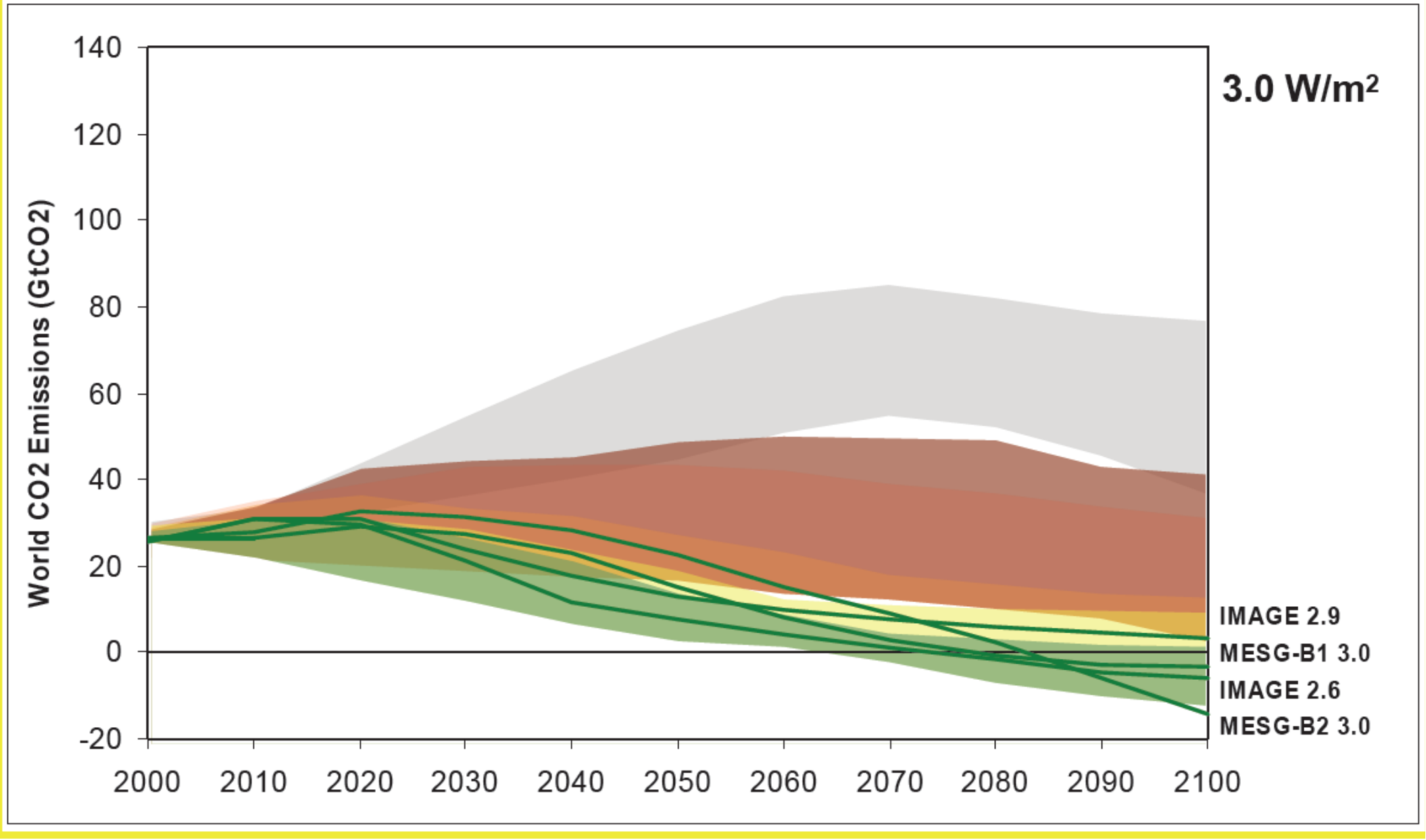
- Low stabilisation 2.5- 3 W/m2
- Two medium stabilisation
  - 4.5 W/m2
  - 6.0 W/m2
- High reference 8- 8.5 W/m2

to be selected from AR4 reviewed literature

*so – these RCPs are the first step, **NOT** the **NEW** scenarios*


Post-SRES (max-baselines)
Stabilization targets:
VI: 855-1130 ppm CO2-eq
V: 710-855 ppm CO2-eq
IV: 590-710 ppm CO2-eq
III: 535-590 ppm CO2-eq
II: 490-535 ppm CO2-eq
I: 445-490 ppm CO2-eq
World CO2 Emissions (GtCO2)
Post-SRES (min-baselines)
140
120
100
80
60
40
20
0
-20
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100


Post-SRES (max-baselines)
MESSAGE A2r
(baseline)
MiniCAM 6.0
AIM 4.5
or
MiniCAM 4.5
IMAGE 2.9
Post-SRES (min-baselines)
World CO2 Emissions (GtCO2)
140
120
100
80
60
40
20
0
-20
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100


3.0 W/m2
World CO2 Emissions (GtCO2)
140
120
100
80
60
40
20
0
-20
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
IMAGE 2.9
MESG-B1 3.0
IMAGE 2.6
MESG-B2 3.0

The lowest RCP....

- IPCC plenary mandate: «benchmark concentration scenarios should be compatible with the full range of stabilization, mitigation and baseline emission scenarios available in the current scientific literature»
- But are the most extreme cases “representative”?
- Proposal by Meinhausen & Hare – use IM2.6 instead of IM2.9 many participants signed.
- More peaking scenario => explore reversability / hysteresis
- Policymakers concerned about message re 2°C and 2050 targets
- both OK for 2°C, just depends on the probability/ acceptable - risk

The lowest RCP....

continued...

•concern – robustness – of course it's physically possible, but there will be sacrifices

•No risk impossible before AR4 printed: IM2.6 and IM2.9 they only diverge after 2025

•Key difference Biomass + Carbon Capture +Storage
=> implications biodiversity and agriculture – topical issue (eg biofuel)!

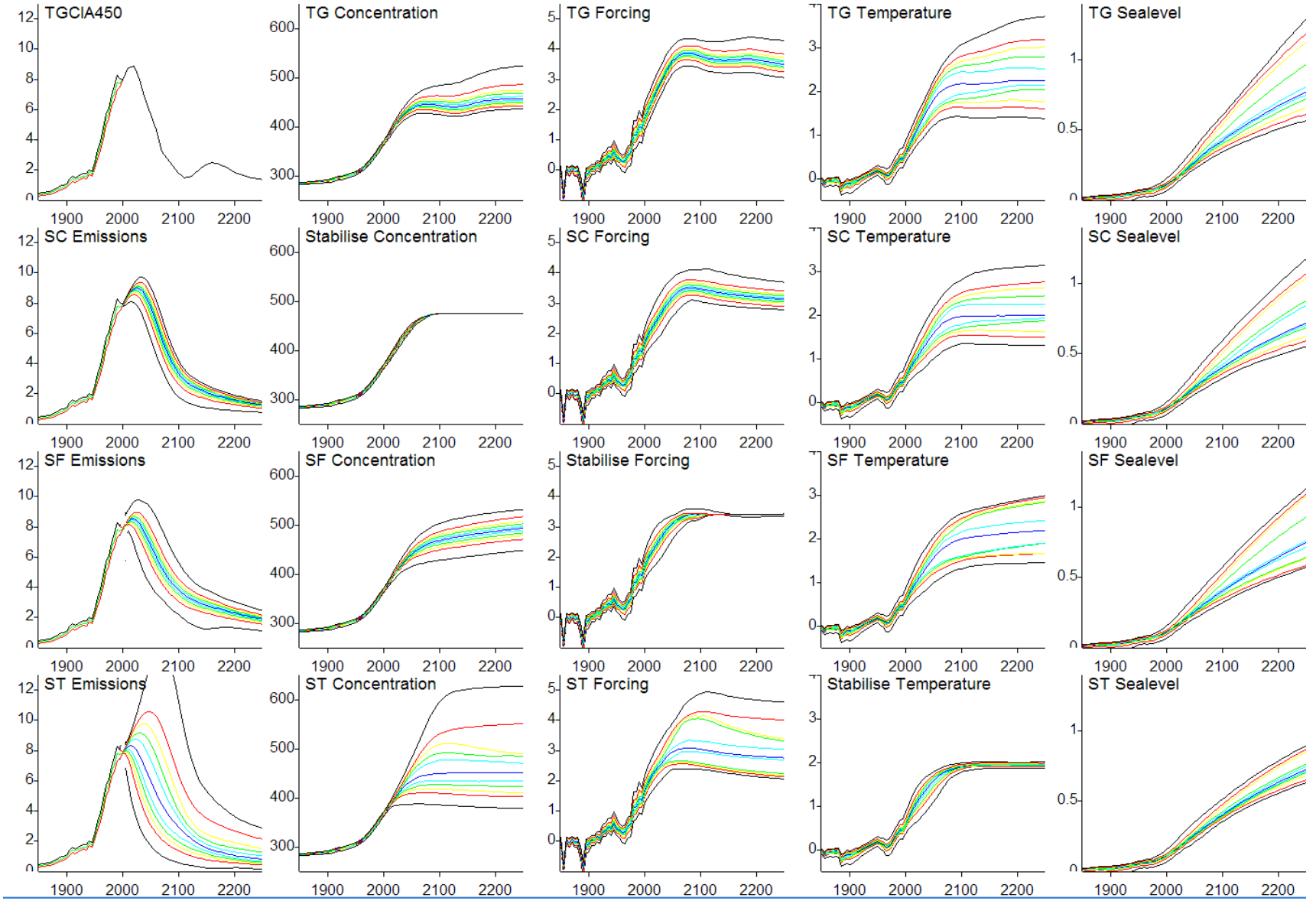
•concern – only one model – IMAGE team don't want all the pressure from skeptics alone

•Solution – wait until summer 2008, see whether other models can make a similar trajectory

JCM already demonstrated this approach: Example below from presention of Matthews & VanYpersele at WCCC 2003 Moscow, also to European strategy meeting Firenze

Stabilisation under uncertainty: fixing a concentration or temperature (EU 2C) target:

Defining the scenario by concentration or forcing spreads the cascade of uncertainty more evenly:

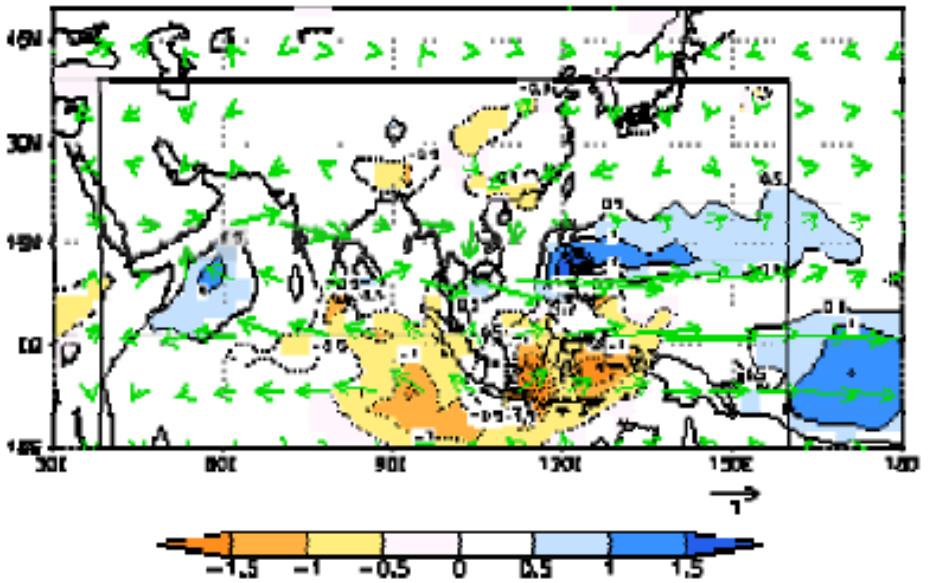


Extra shorter term scenarios

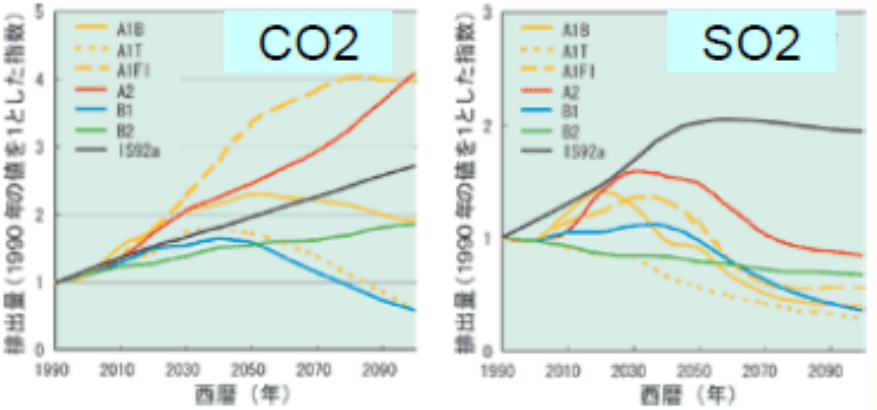
- Higher Resolution - 0.5°
- Focus on effects of aerosols, ozone , LUC etc.
- Only one central case (4.5 W/m2) + variants
- No need for carbon cycle feedbacks
- Should include aviation cirrus!
- ESMs run from reanalysis connected to future scenario – new experiment, problem drift?

Changes in Asian Monsoon Precipitation

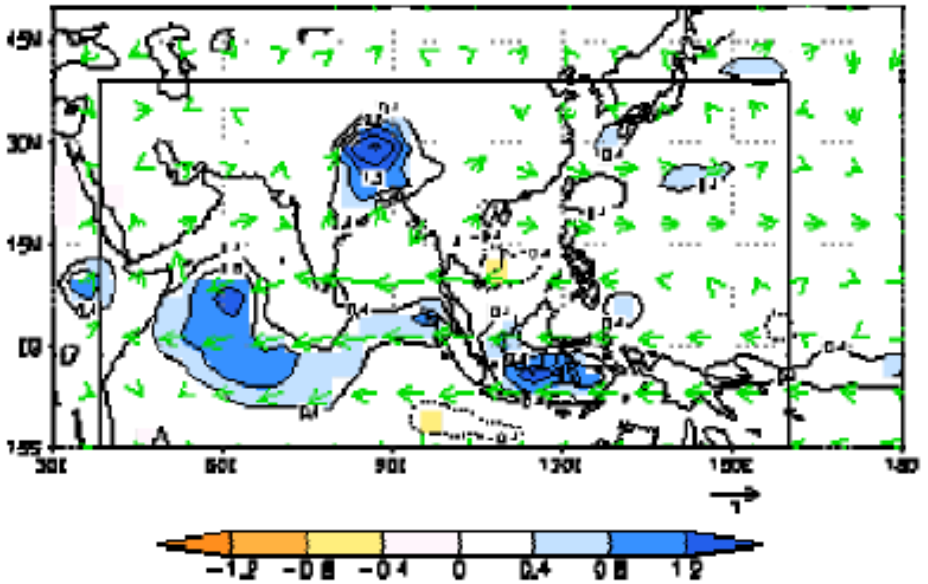
CGCM All forcings



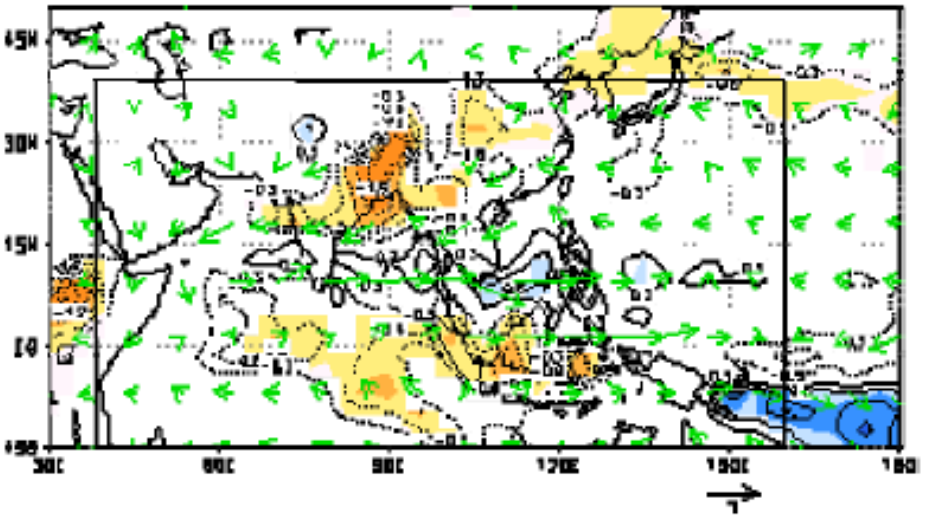
MIROC medium resolution model
JJAS linear trend yr 1901-2000
Precipitation [mm/day/100y] &
850-hPa winds [m/s/100y]



CGCM GHG only

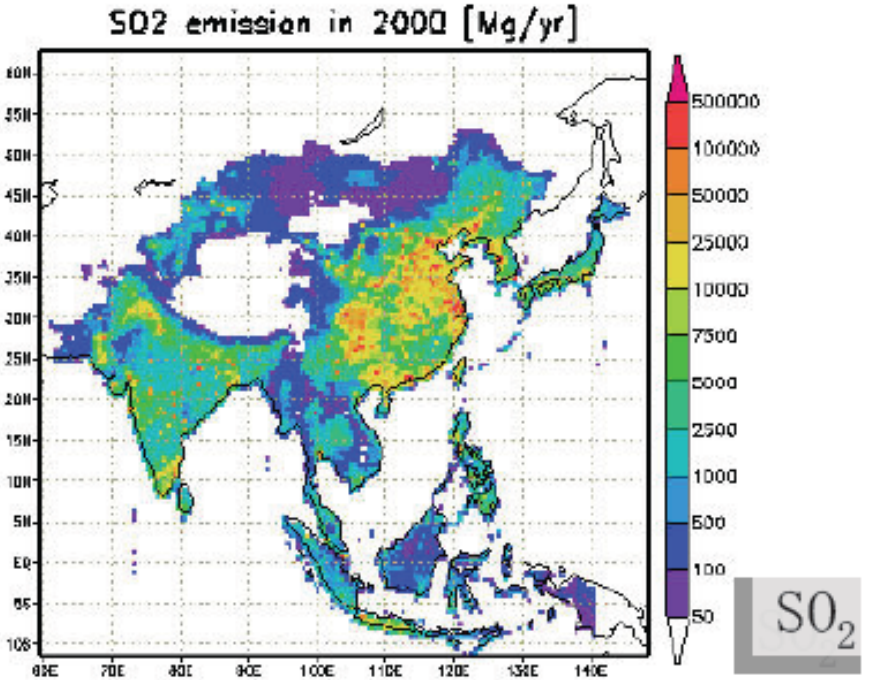


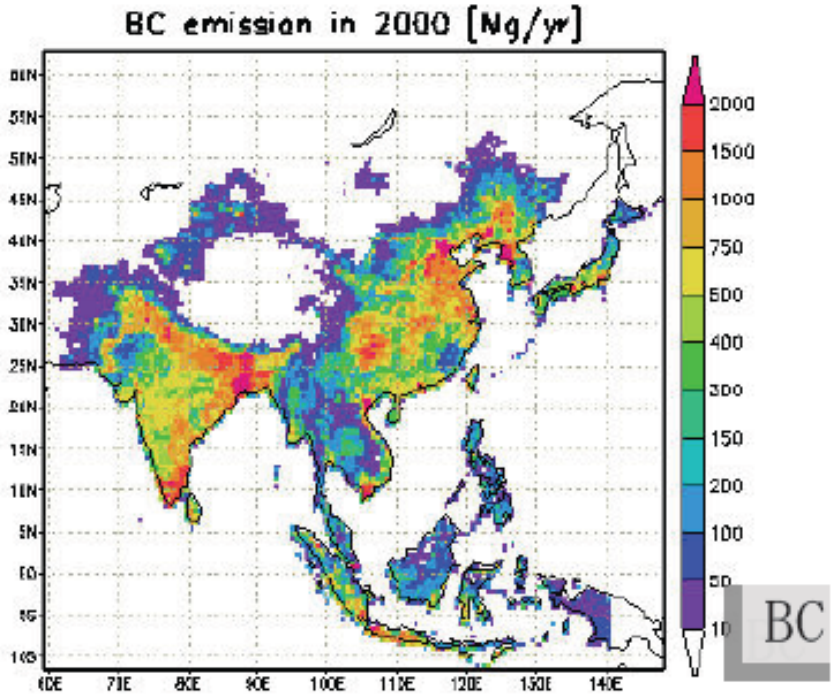
CGCM Aerosol only

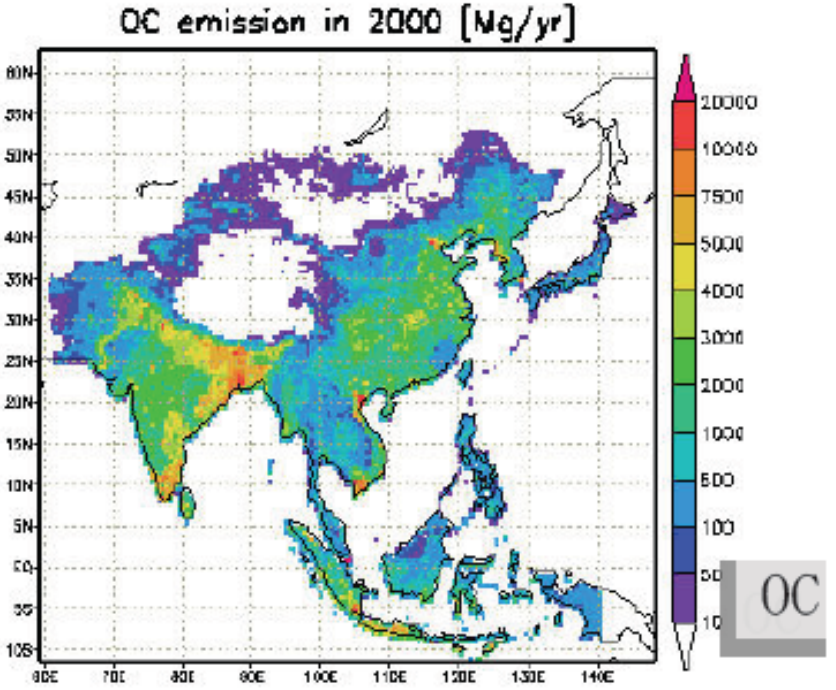


Regional Emission inventory in ASia

Emission for E. Asia: 1980-2030 (FRCGC/RIHN)

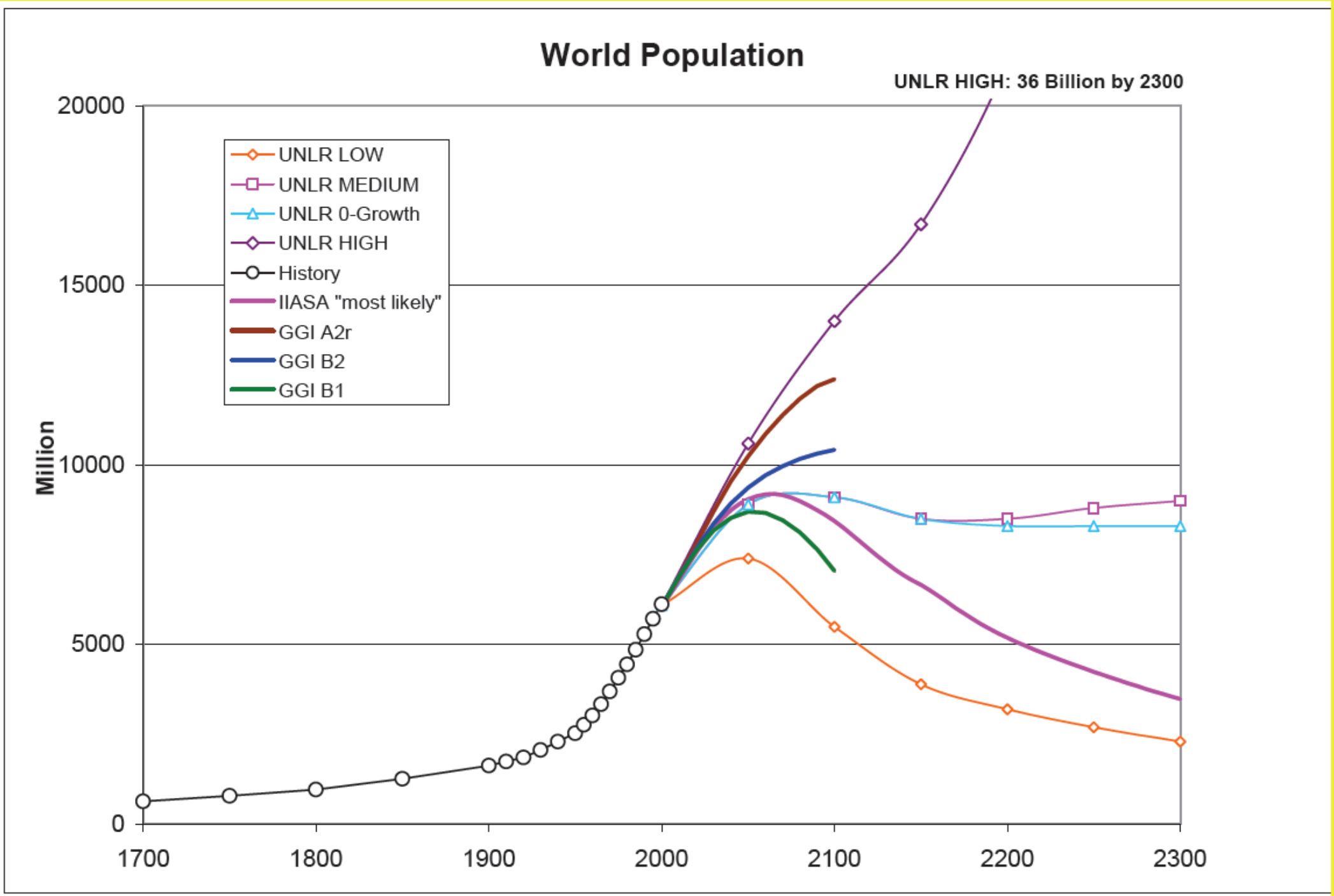






Extension to 2300

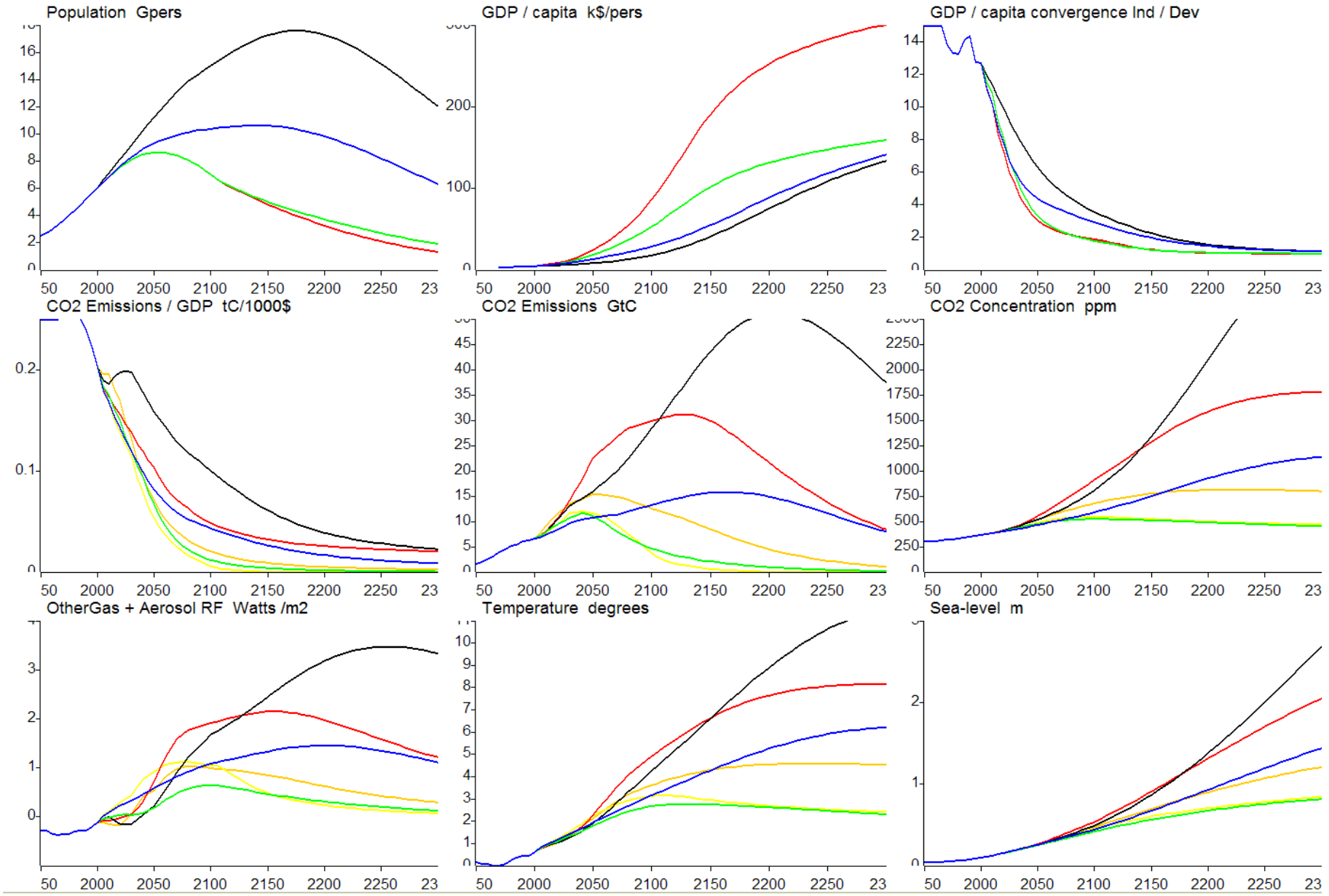
- Important for
  - Stabilisation
  - Some impacts such as Sea-level Rise
- Challenge to extend socioeconomic and emissions projections
  - in a stylized way – Less detail / resolution
  - especially difficult for high (non stabilisation) case


World Population
UNLR HIGH: 36 Billion by 2300
20000
15000
10000
5000
0
Million
1700
1800
1900
2000
2100
2200
2300
UNLR LOW
UNLR MEDIUM
UNLR 0-Growth
UNLR HIGH
History
IIASA "most likely"
GGI A2r
GGI B2
GGI B1

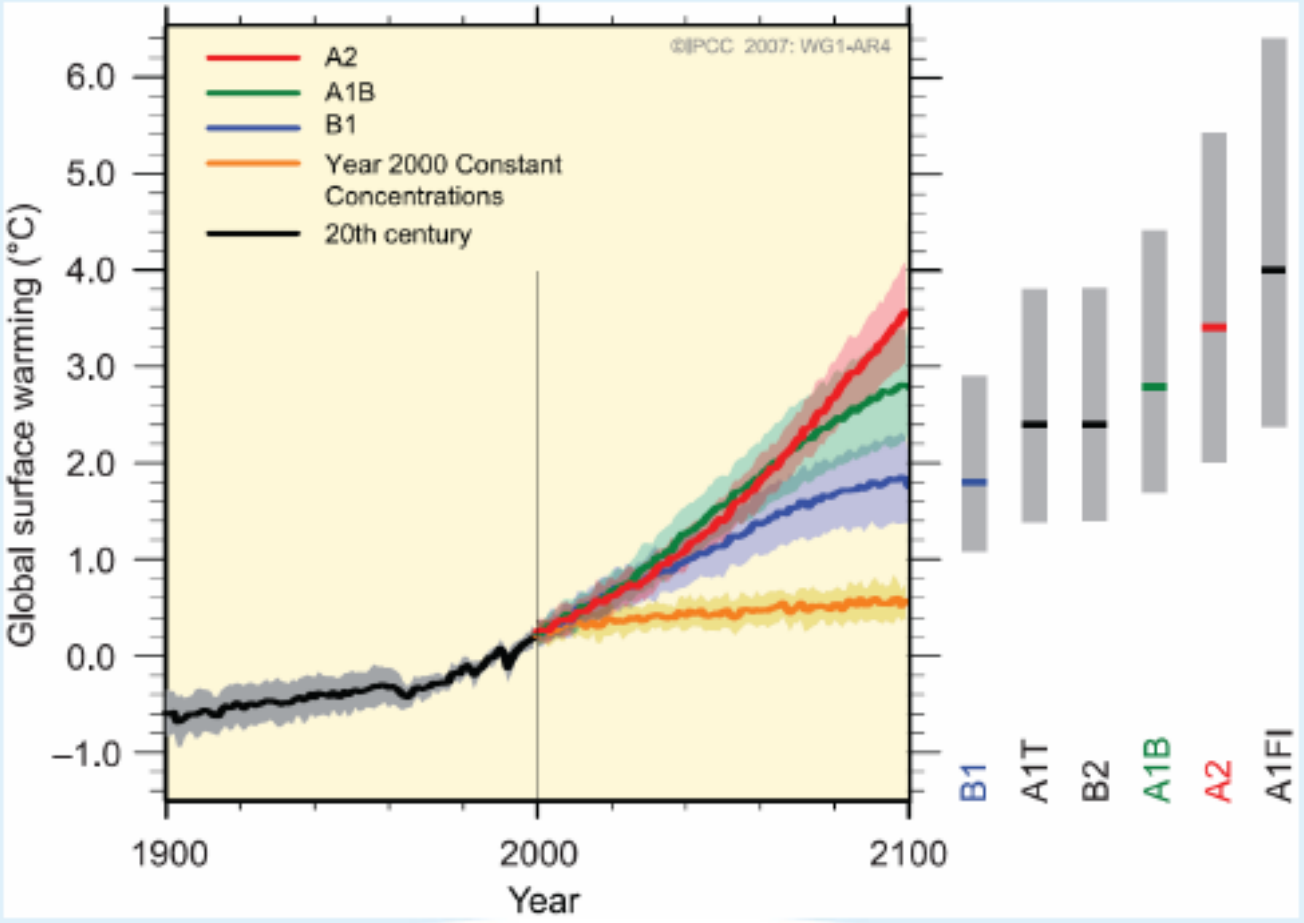
Example: Extension of SRES baselines: A1B A1T A1F A2 B1 B2

using regression of "Kaya" trends for each region

(JCM, developed for Climneg, presented in Trieste December 2004)



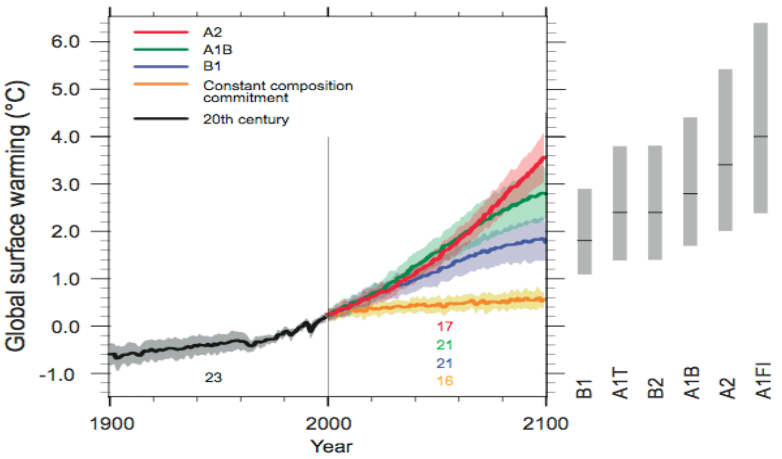
Multi-model global averages and uncertainties of surface warming (w.r.t. 1980–1999) for the scenarios A2, A1B and B1.



IPCC Scenarios - AR4

WG1 concept that GCMs should do everything
was inefficient way to compare scenarios
=> too few scenarios were run – 3 SRES are not enough!
(simple model still used for others)

Policymakers need mitigation scenarios
and to see the sensitivity to options (marginal effects)
=> GCMs should parameterise simpler flexible models



New IPCC Scenario Process towards AR5
(*meetings in Laxenburg, Sevilla, Noordwijkerhout*)

agreed that using special reports as a data interface between models too inefficient!
=> "new" parallel process concept to save time:

define simple stabilisation scenarios in the middle of cause effect chain (CO2eq concentration / forcing)
(at least three to cover full plausible (>likely) range and so GCMs identify nonlinearities in climate response and impacts)

• GCMs => forward to climate, impacts, adaptation

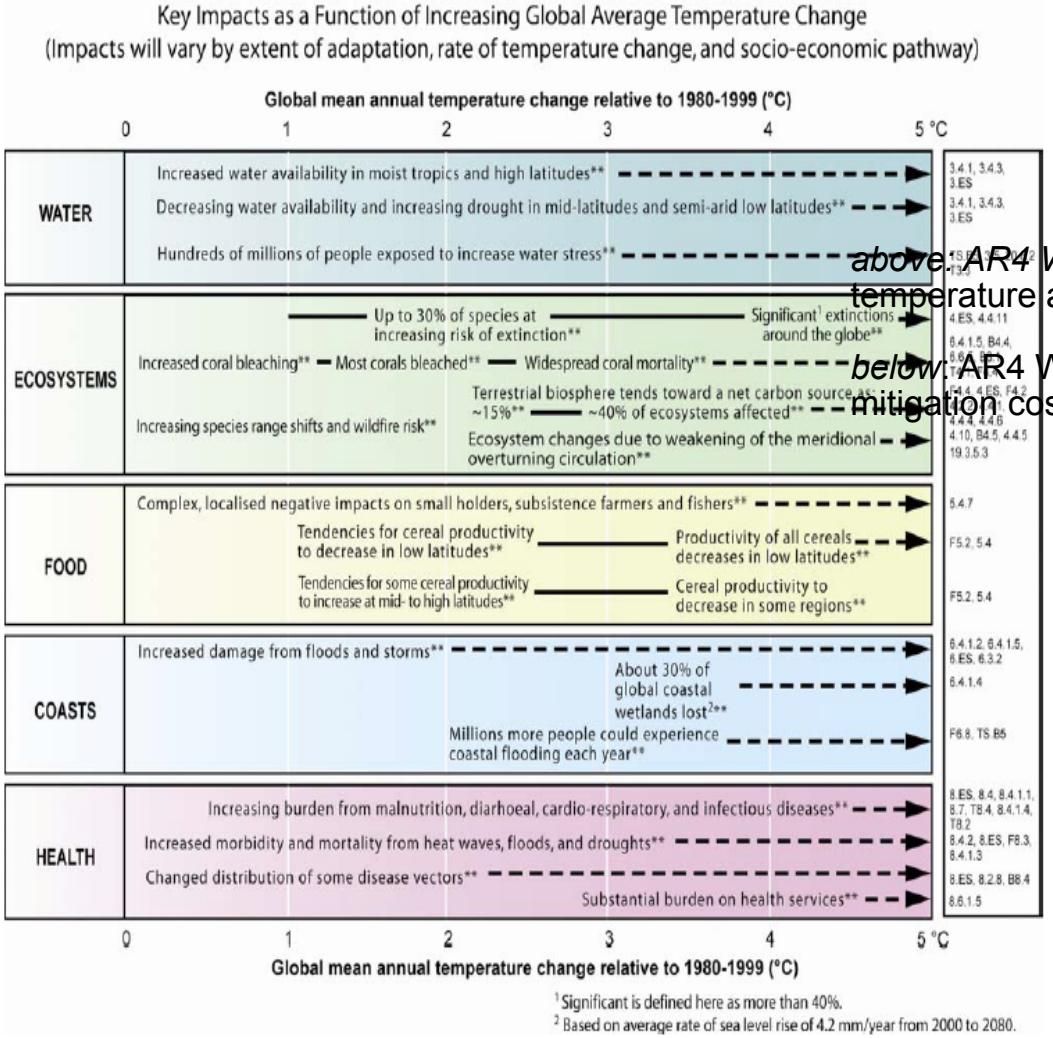
• Socioeconomic (& Biogeochemical?) models => inverse calculation to emissions and mitigation

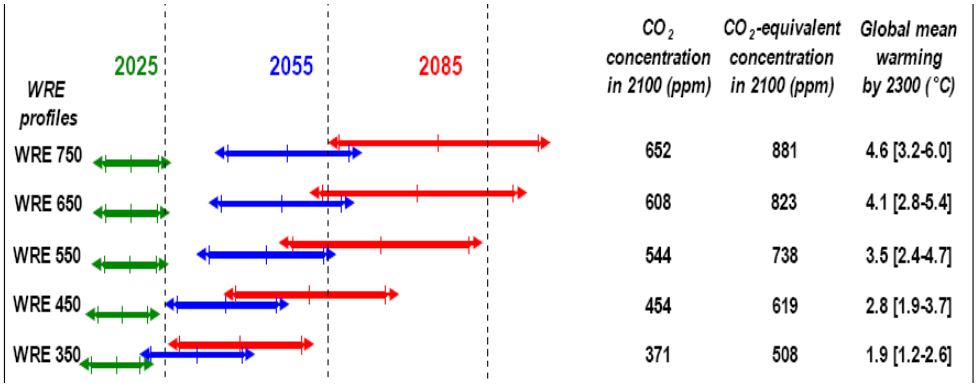
Challenges of this approach:
how to take account of cross-cutting feedbacks...?
• climate change => soil respiration, plant growth, methane release...
• climate change impacts => population, economic growth
(when these are between separate models/processes)

Integrated models might do it better...
.

Synthesis by connecting reports?
Examples from IPCC AR4:

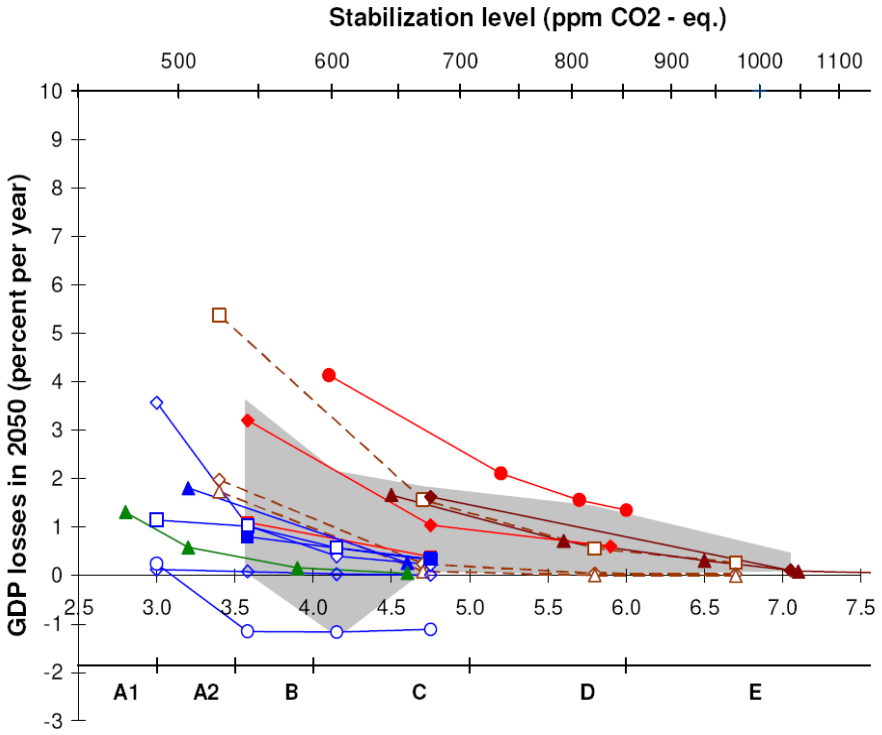
below: AR4 WG2 Table SPM-1:





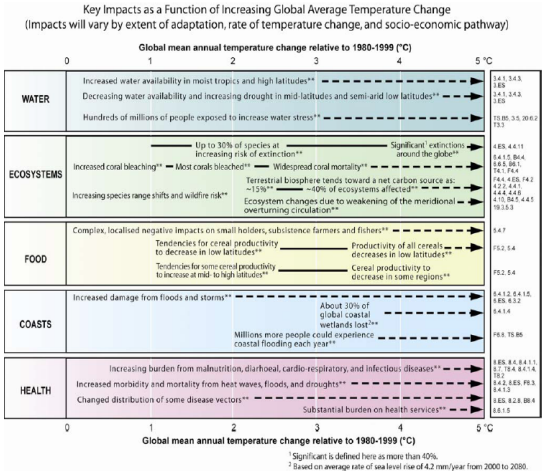
above: AR4 WG2 TS4:
temperature as function of CO2 stabilisation scenario and time

below: AR4 WG3 Fig 3.25
mitigation costs as a function of CO2eq stabilisation level

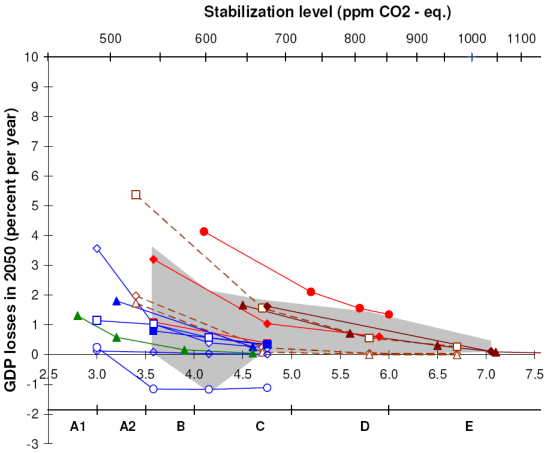


BUT making such synthesis based on single indicators can be misleading, for example:

Climate Change Impacts



Mitigation costs



not just a function of

Global Average Temperature level,

CO2 concentration

but also depend strongly on:

socioeconomic baseline
value assumptions in aggregation over space, time, sector & risk

timing of warming,

timing of investments,

learning by doing

regional effect of short-lived gases & aerosols

mixture of gases, flexible

mechanisms, etc.

Java Climate Model (www.climate.be / jcm)

Setup | View | Tools | Documentation | Curves | Maps | Active Params | Show

World 1

Normal

- World 1
  - Objectives and Scenarios
  - Regional Contributions
  - Land Use Change
  - Carbon Cycle, Sources and Sinks
  - Other Gases and Aerosols
  - Global Forcing, Climate, and Sea-L
  - Regional Climate and Impacts
    - Regional Climate Change

Welcome to JCM5

Langua Complexity Edit key welcome search

..... [OLD:]

model lets you explore the system and how we can change it, simply by moving controls with your mouse and observing the effect instantly on plots ranging from emissions to impacts. The core calculation methods are similar to those used in the Intergovernmental Panel on Climate Change Third Assessment Report, implemented efficiently in the java language to make this tool accessible to everybody via the internet.

Note that science from the Fourth Assessment Report will be used in the next version JCM6, in preparation

To get started see:

How to Use JCM5 (read this first!)

JCM Home Menu

Last updated 15th March 2007

SocioEconomic Regions Map

Projection SocioEconomic Regions

88 N 155 W

Fossil CO2 Emissions - Policy

giga ton carbon

Anthropogenic Carbon Stocks

giga ton carbon

Atmospheric CO2 Fluxes

giga ton carbon /year

FEP
LEP
TEP
AIM
AID
OS
LS
TS

Atmospheric CO2 Concentrations

concentration, parts p

AC
AM

Radiative Forcing -All contributions

Watts per square me

Global Average Temperature

degrees Celcius abov

AV
MT
PT
TR

Sea Level Rise

millimetres

TE
GL
GR
AN
IA
Other
TO

Regional Climate Change Map

Projection Region Set (this map) Reset Colors

0 1 2 3 4 5 6 7 8 9 10 11

Java Climate Model (www.climate.be / jcm)

Setup | View | Tools | Documentation | Curves | Maps | Active Params | Show

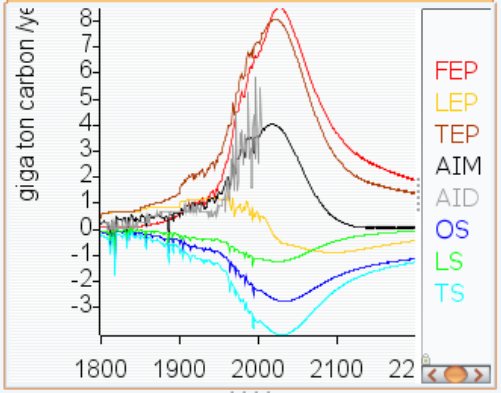
World 1

- World 1
  - Objectives and Scenarios
  - Regional Contributions
  - Land Use Change
  - Carbon Cycle, Sources and Sinks
    - Atmospheric CO2
    - Bern Carbon Model
    - Carbon Stocks
    - Ocean Chemistry
  - Other Gases and Aerosols
    - Other gas Emissions
    - Aviation Forcing
    - Aerosols and Solar
    - Atmospheric Chemistry
    - F-gases
  - Global Forcing, Climate, and Sea-L
    - Radiative Forcing
    - Global Warming
    - UDEB Model
    - Ocean Temperature
    - Sea-Level Rise Module
  - Regional Climate and Impacts

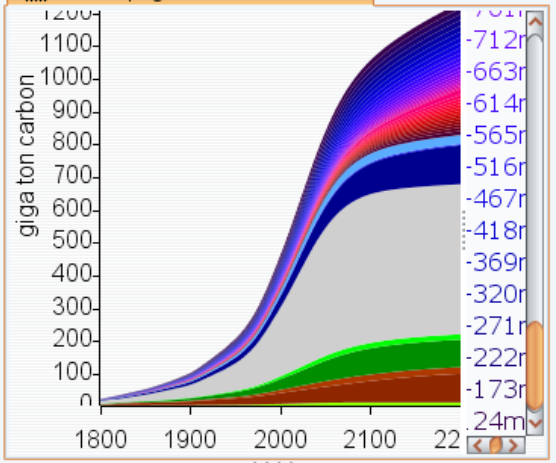
Aerosol and Solar Radiative Forcing

Aviation Radiative Forcing

Atmospheric CO2 Fluxes

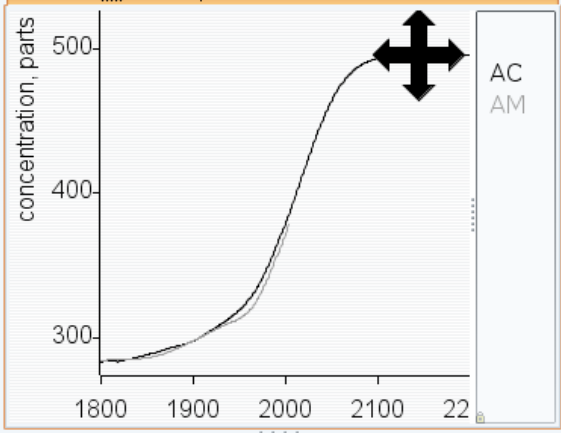


Anthropogenic Carbon Stocks

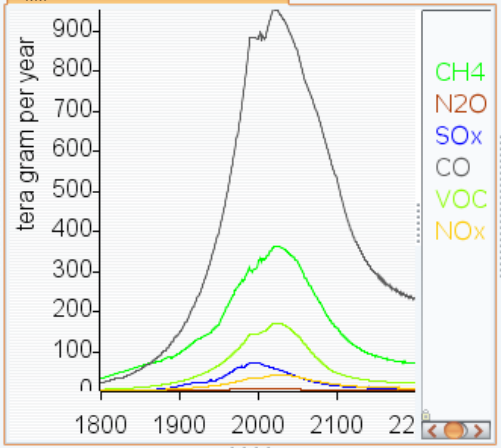


Ocean pH (acidity)

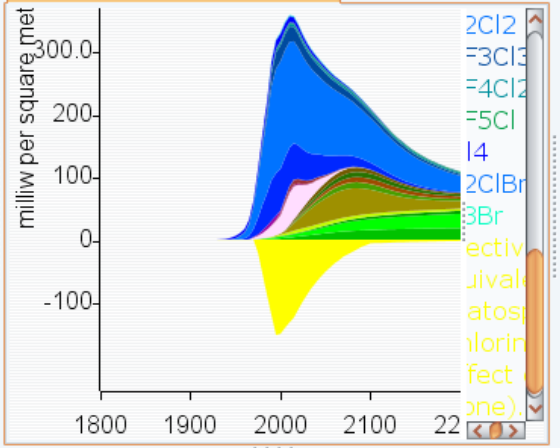
Atmospheric CO2 Concentrations



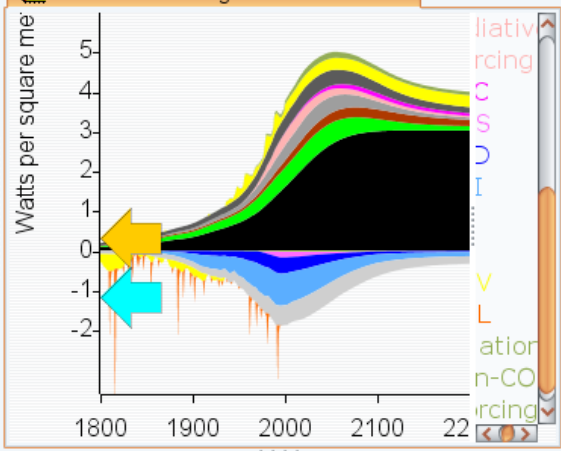
Other Gas Emissions



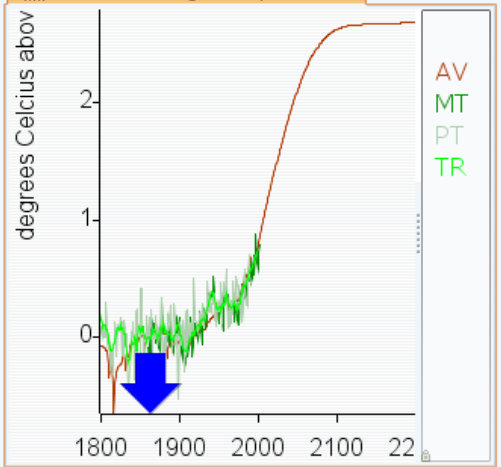
F-gases Radiative Forcing



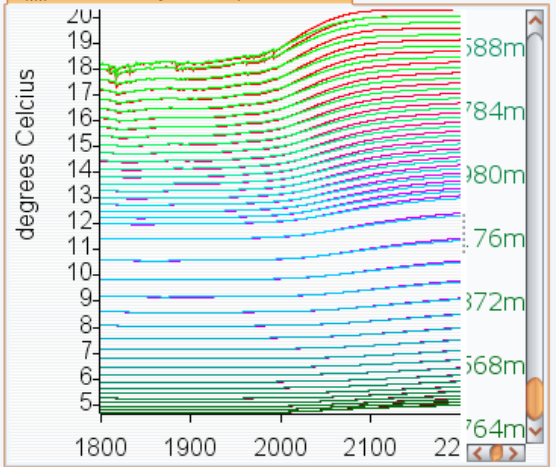
Radiative Forcing -All contributions



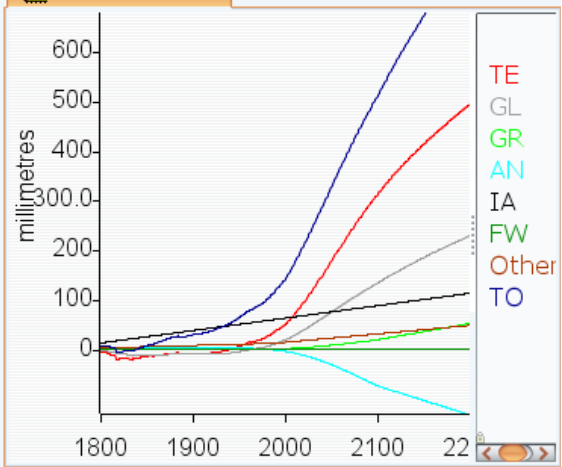
Global Average Temperature



Ocean Layer Temperatures



Sea Level Rise



Java Climate Model (www.climate.be / jcm)

Setup | View | Tools | Documentation | Curves | Maps | Active Params | Show

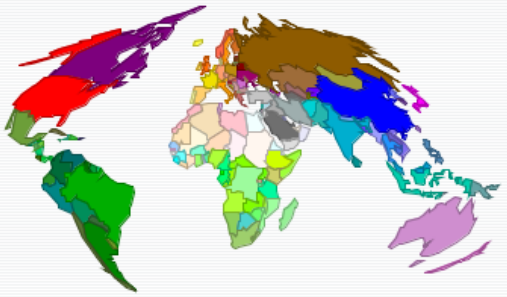
World 1

Expert

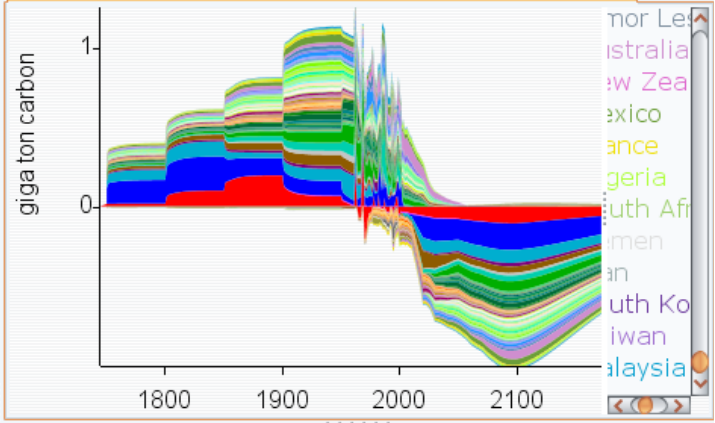
- Historical Data
- Responsibility
- Shares
- SocioEconomic Data
- Costs
- Land Use Change
  - Historical Land Use Change Emissions
    - B — Biome classification
    - Temperate Decidous Forest/Woodland — Bi
    - Brazil — Country cho
    - Biome B/ISAM carbon content
    - 20 — 95% soil decay time
    - 20 — LUC agriculture carbon loss from soi
    - IVIGmodel — luc emit dat
    - use FAO agric/past rates of change
    - 1 — Vegetation Carbon uncertainty factor
    - 5 — LUC pasture carbon loss from soil (%
    - ivig32 model luc emission
    - ivig32 model carbon stocks
    - Plot one biome in all countries
    - Plot all biomes in one country
    - 1 country faoxmodel areas plot
    - 1 Country all emissions datasets
  - LUCdata
  - futureLUC
- Carbon Cycle, Sources and Sinks
  - Atmospheric CO2
  - Bern Carbon Model
    - 1 — Ocean eddy diffusivity factor:
    - 1.85 — Ocean horizontal mixing factor:
    - 440 — Ocean upwelling rate: (millim /yr)
    - 38 — Ocean high-lat mixing rate: (m/yr)
    - 0.28 — CO2 fertilisation factor beta:
    - 1.2 — Temperature-respiration feedback fa

SocioEconomic Regions Map

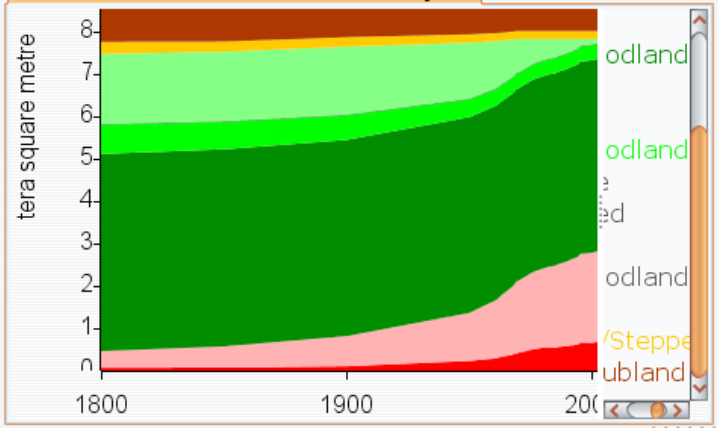
Projection SocioEconomic Regions



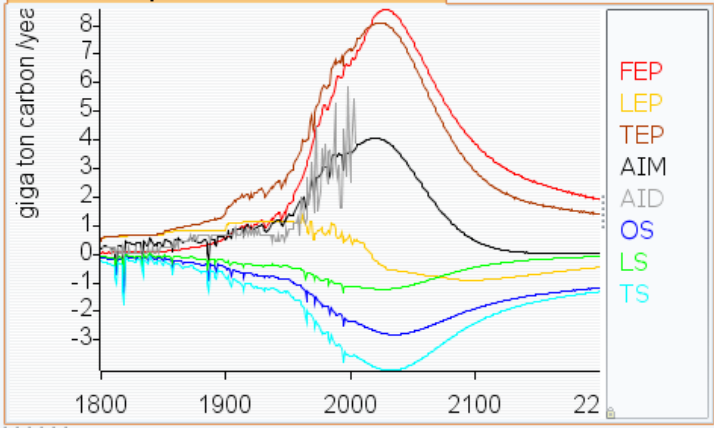
Land Use Change CO2 Emissions - Policy



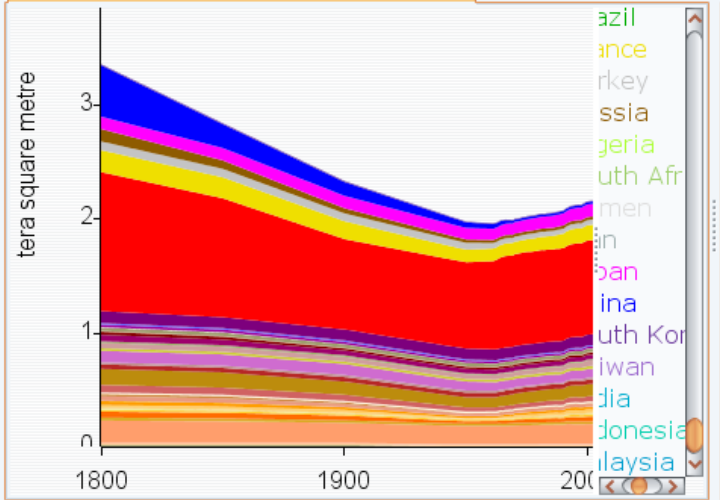
Plot all biomes in one country



Atmospheric CO2 Fluxes



Plot one biome in all countries



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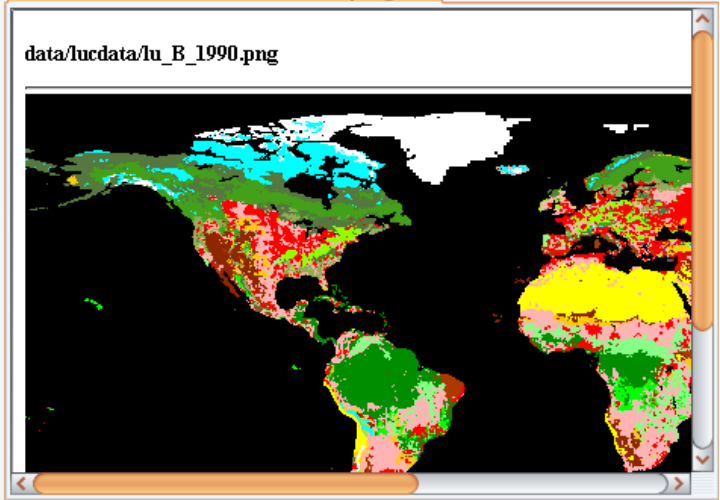


Java Climate Model (www.climate.be / jcm)

Setup View Tools Documentation Curves Maps Active Params Show

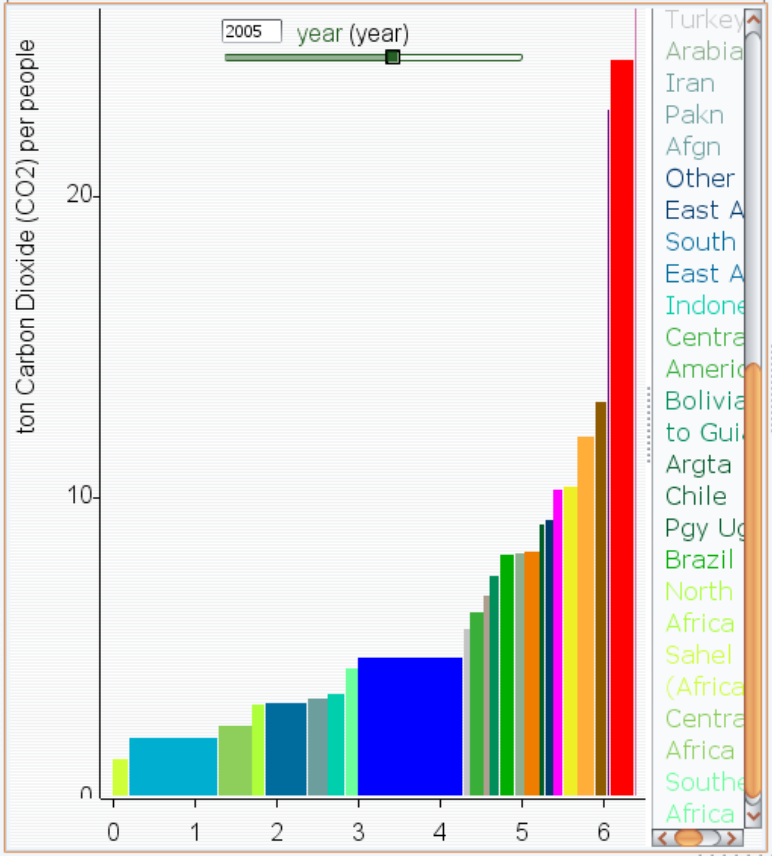
Fossil CO2 Emissions - Policy | World 1

Normal

- World 1
  - Objectives and Scenarios
    - Objective
    - Baseline Scenario
    - Global CO2 Emissions
    - Stabilisation
  - Regional Contributions
    - Regional Emissions
      - JCM 25 Region Set — SocioEconom
      - Fossil CO2 Emissions -Baseline
      - Fossil CO2 Emissions - Policy
      - LUC CO2 Emissions - Baseline
      - LUC Emissions - Policy
      - Methane Emissions
      - N2O Emissions
      - CO2 Equivalent (GWP) Emissions
        - co2 equivalent (gwp) emissions /
        - co2 equivalent (gwp) emissions /
    - Aviation and Shipping Emissions
    - Responsibility
      - 1867.3 Beginning of Attribution period
      - 2100.0 End of Attribution period
      - attributeLUC-CO2
      - attributeCH4N2O
      - Remove Unattributed
      - CO2 Concentration
      - CH4 concentration
      - N2O Concentration
      - CO2 Radiative Forcing
      - CH4 Radiative Forcing
      - N2O Radiative Forcing
      - Total Radiative Forcing
      - Global Average Temperature
        - Global Average Temperature /Re
        - Global Average Temperature /Re
      - Global Average Temperature relativ
      - Sea-Level Rise (Thermal Expansion
    - Shares

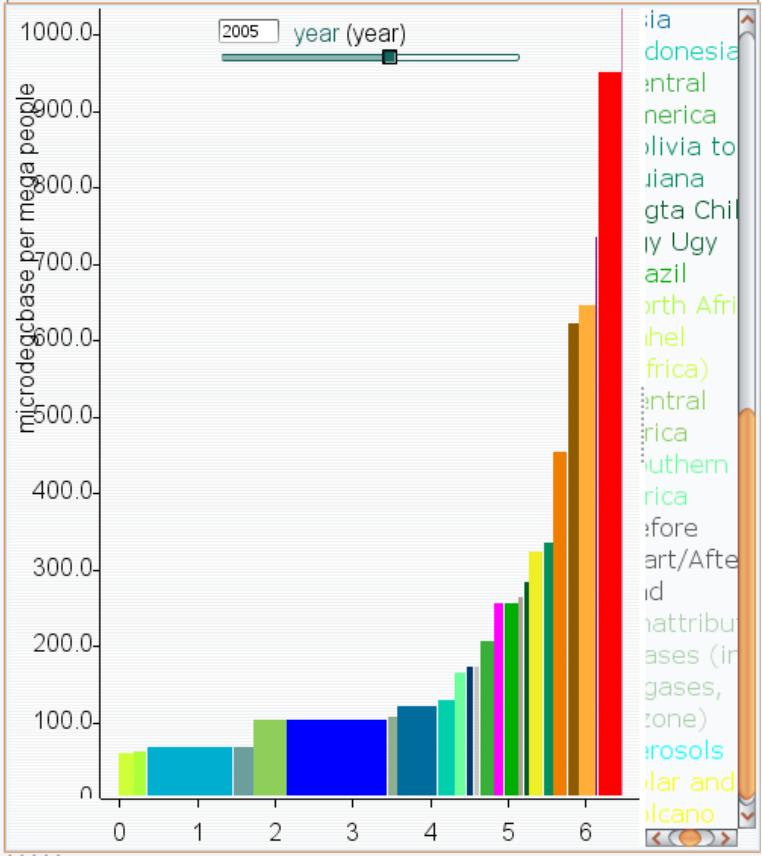
Histogram co2 equivalent (gwp) emissions /Regional Population

Global Average Temperature



Histogram Global Average Temperature /Regional Population

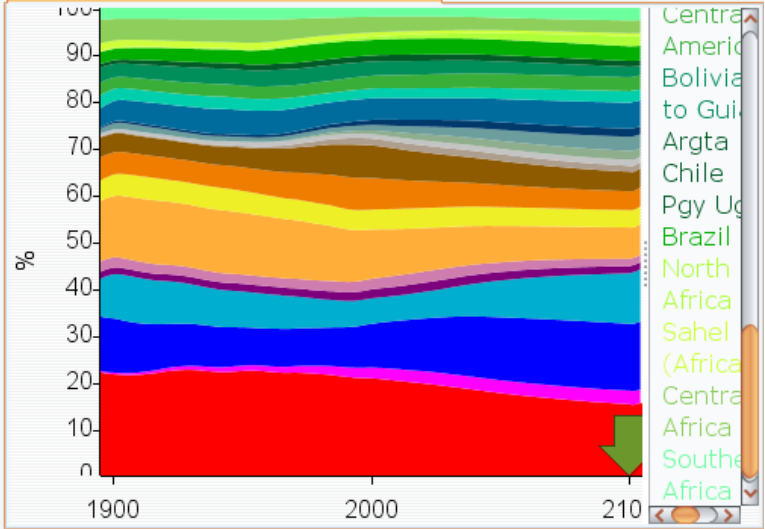
Global Average Temperature



SocioEconomic Regions Map

Projection SocioEconomic Regions

Global Average Temperature relative



Java Climate Model (www.climate.be / jcm)

Setup | View | Tools | Documentation | Curves | Maps | Active Params | Show

World 1

Normal

- World 1
  - Objectives and Scenarios
  - Regional Contributions
    - Regional Emissions
    - Aviation and Shipping Emissions
      - Fa1 — Aviation Scenari
      - Reduce for Stabilisation
      - aviation shipping co2 emissi
    - Responsibility
    - SocioEconomic Data
    - Costs
  - Land Use Change
  - Carbon Cycle, Sources and Sinks
  - Other Gases and Aerosols
    - Other gas Emissions
    - Aviation Forcing
      - Aviation Radiative Forcing
      - Radiative Forcing Index
    - Aerosols and Solar
    - Atmospheric Chemistry
    - F-gases
  - Global Forcing, Climate, and Sea-Le
    - Radiative Forcing
    - Global Warming
    - UDEB Model
    - Ocean Temperature
    - Sea-Level Rise Module
  - Regional Climate and Impacts

Aviation and Climate

Language | Complexity Level | Edit Doc | key: aviation_topic | search

[OLD:]

Aviation and Climate

This is an example of a "topic" documentation page, that might be opened directly from an external weblink concerned with that issue.
More such pages will be written soon, and integrated with the module documentation.

Two modules in JCM, **Aviation and Shipping Emissions** and **Aviation Forcing** have recently been developed within the Belgian project ABCI (see **Financial Support for JCM**).

The buttons below will setup the model to illustrate some applications of these modules, particularly relating to the effect of all-gases compared to CO2, and the incorporation of aviation within stabilisation scenarios.

*note: You can also access the same setups via the **Setup Menu** (top-left)*

Aviation Demo 2C

aviation.aviation_demo_stab2C

A simple demo of aviation emissions and forcing
(in a stabilisation scenario limited to 2C)

Radiative Forcing and RFI

aviation.aviation_RFI_5variants

Aviation Radiative Forcing, and the RFI index comparing the effect of all gases with that of CO2, comparing 4 different variants:

- Default,
- Use Efficacy
- Older IPCC Forcing factors
- Without Cirrus

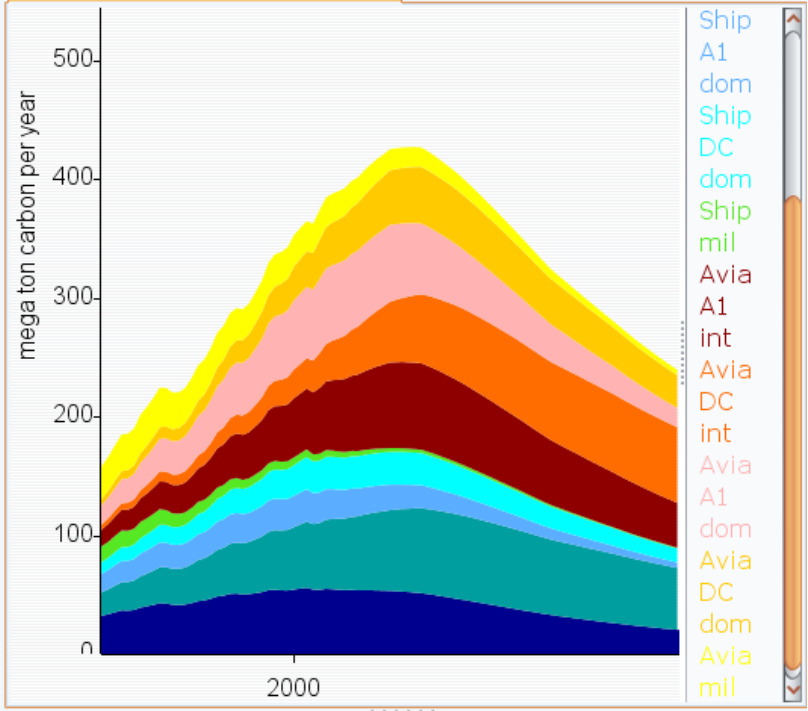
A fifth variant shows the effect of using a longer time horizon to calculate RFI
(see **Aviation Forcing** for more explanation)

Aviation Emissions Scenarios

aviation.aviation_scenarios

warning: this uses 12 parallel worlds, so it requires a lot of computer memory, and takes a long time to initialise!

aviation shipping co2 emissions



Aviation Radiative Forcing