Planbureau voor de Leefomgeving

Coupling of IMAGE and CGM/ESMs

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Experimental set-up

Full coupling of IMAGE2.2 (IAM) / CNRM model (CGM) regarding land-use/land cover and climate system.

- Experiment in 2005/2006:
- A2 scenario (most land-use change)

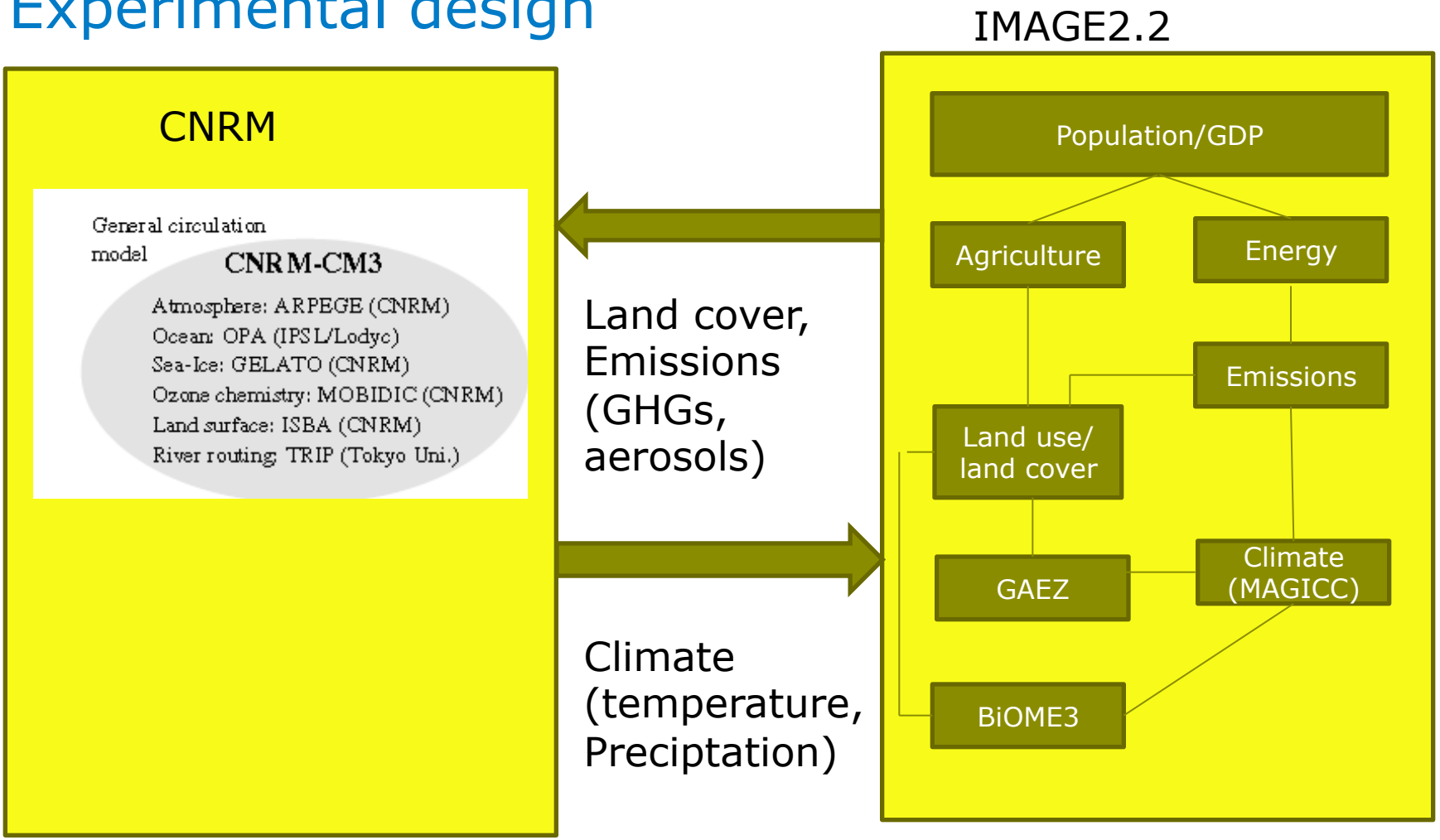
State-of-the-art:

- CNRM-CM3 had no DGVM;
- Other ESM just started including DGVMs, but had no land-use
- Feddema (2005) first to run prescribed land-use (IMAGE) from thru ESM.
- Other IAMs did not produce land-use maps yet.

Experiment thus introduces in CNRM both dynamic vegetation (land-cover) and land-use change

Question: Does this lead to important feedback.

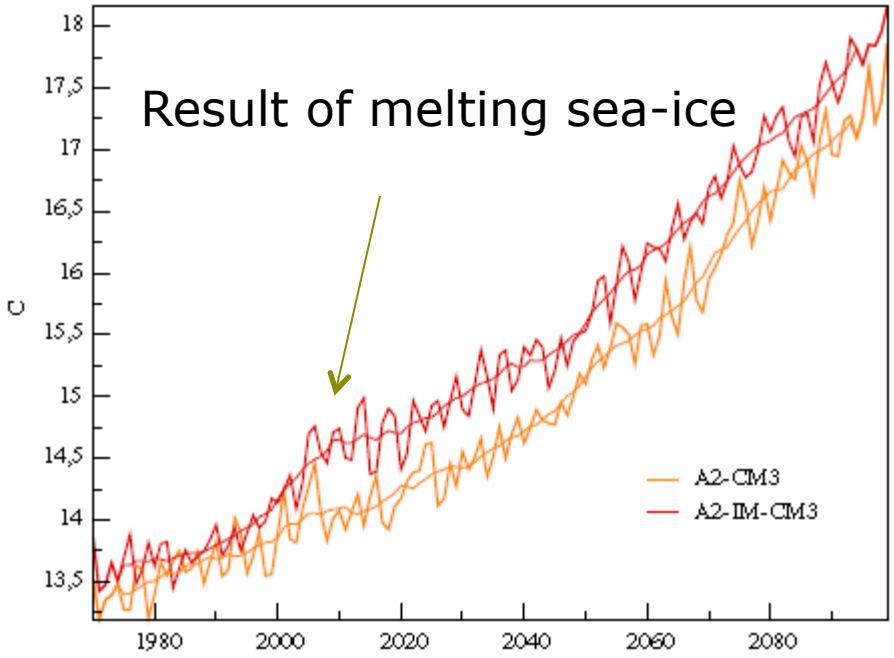
Experimental design



Results

Table 1 Experiments performed

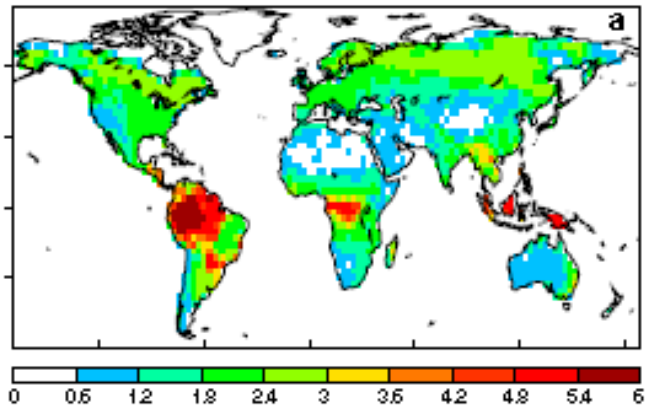
Experiment	Models used
A2-IM-CM3	New coupled system IMAGE2.2/CNRM-CM3
A2-CM3	CNRM-CM3 alone, prescribed forcings from IPCC
A2-IM	IMAGE2.2 alone, with its own climate module
A2-IM-forced	IMAGE2.2 forced with climate change given by A2-CM3

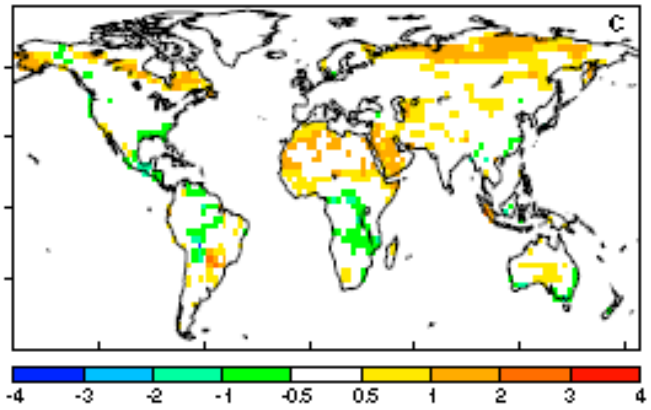


Introduction of new biome-scheme

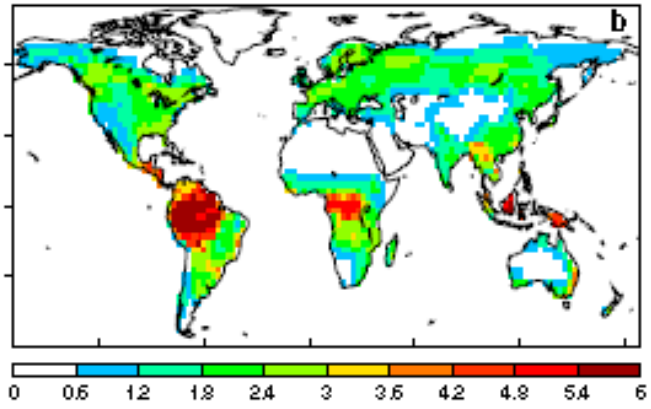
Annual leaf index

IMAGE Vegetation (A2-IM-CM3)





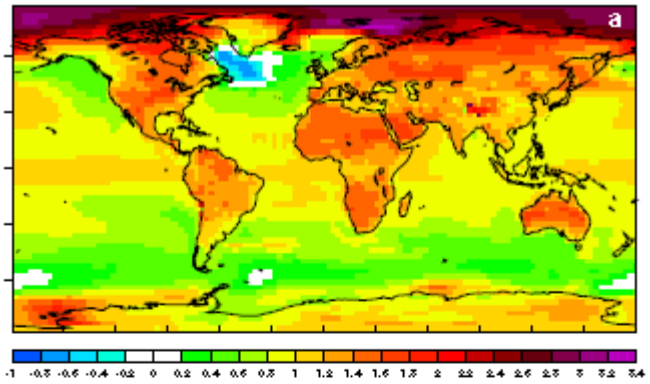
Satellite product (A2-CM3)

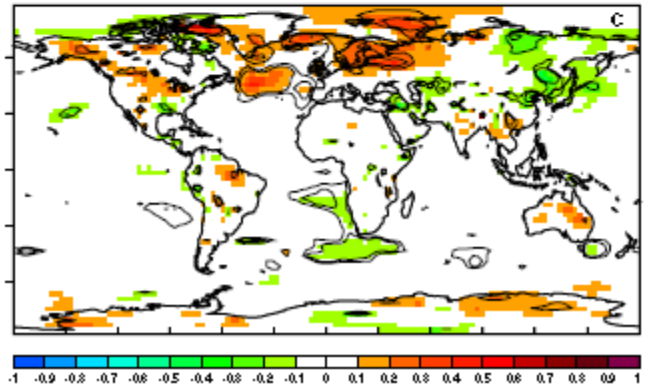


Results

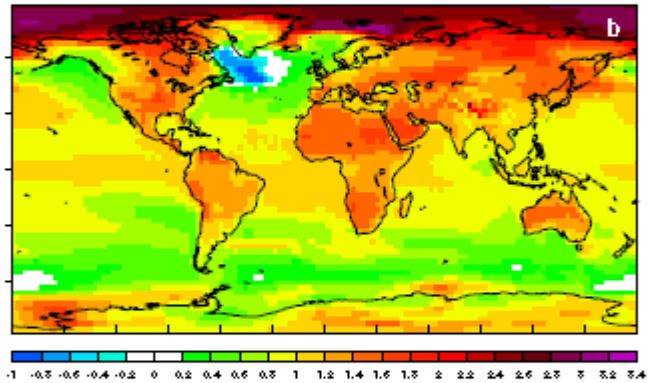
Annual near surface temperature

IMAGE Vegetation (A2-IM-CM3)





Prescribed land cover A2-CM3

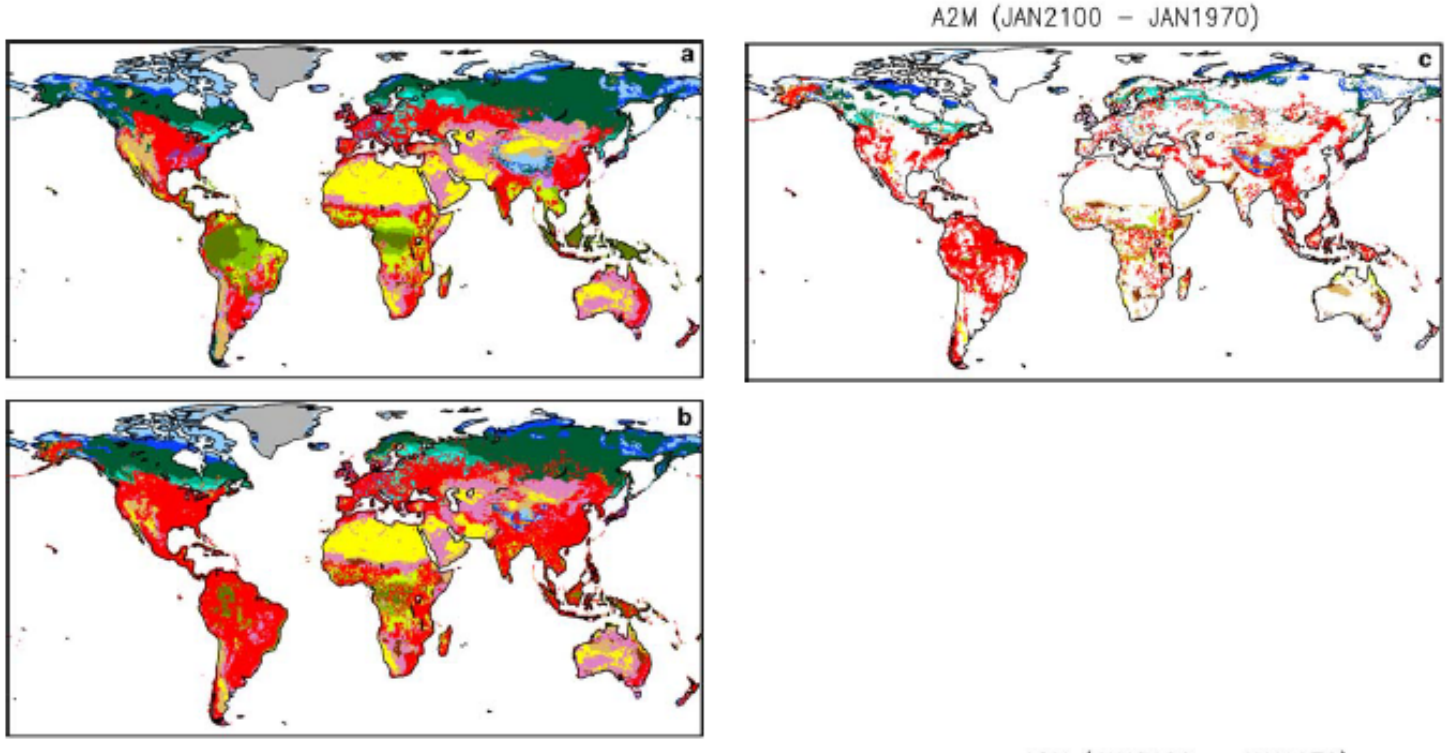


Result

Land use/land cover: Coupled run

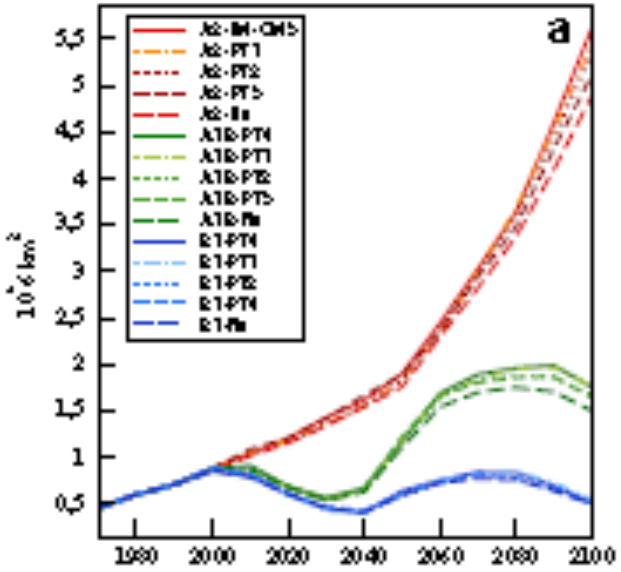
1970

2100



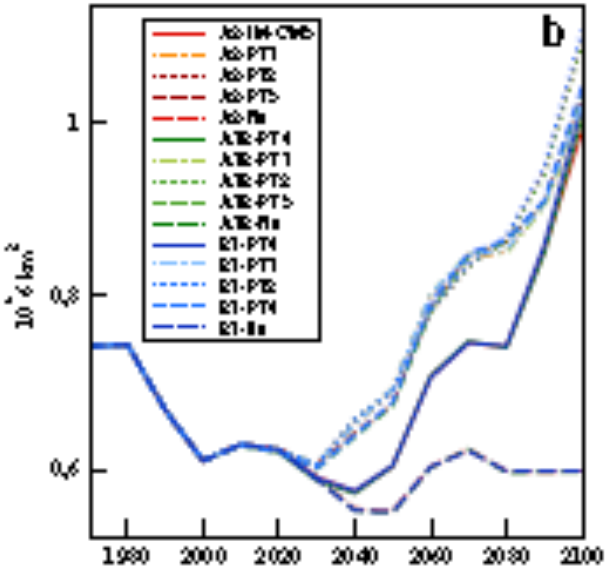
Impact of climate on land cover IMAGE 2.2

Agriculture area South America



Socio-economic drivers >> Climate

Boreal forest >70°N



Climate >> Socio-economic drivers

Conclusions

- New coupled IAM/Climate model able to calculate evolving emissions, climate, land-use/land cover in consistent way
- Some experimental problems
  - A2 scenario – hugh bio-geochemical forcing; strong population pressure.
  - Reference scenario has different 'land cover' in start year.
- Feedback on climate on land cover found to be important (argument for dynamic vegetation); feedback on economic system found to be relatively small.
- CNRM thus chose to continue by including dynamic vegetation with one-way coupling land-use

Cooperation IMAGE – ECEarth (EC-IMAGE)

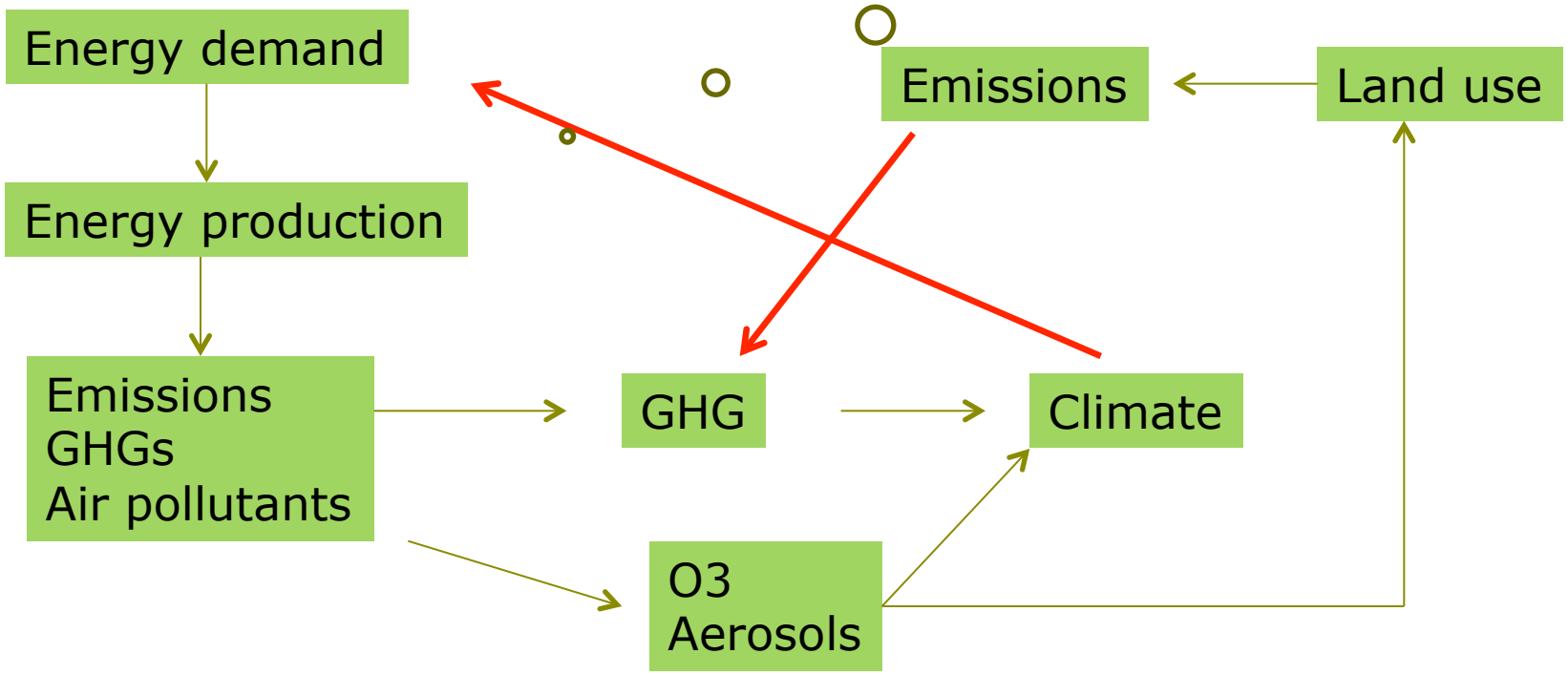
- Explore possible interactions via:
  - Land use/land cover (discontinued)
  - Air pollution

- Experimental set—up
  - First test one way coupling
  - Make conclusions on full coupling

Selected because the have local dynamics and might have strong impacts

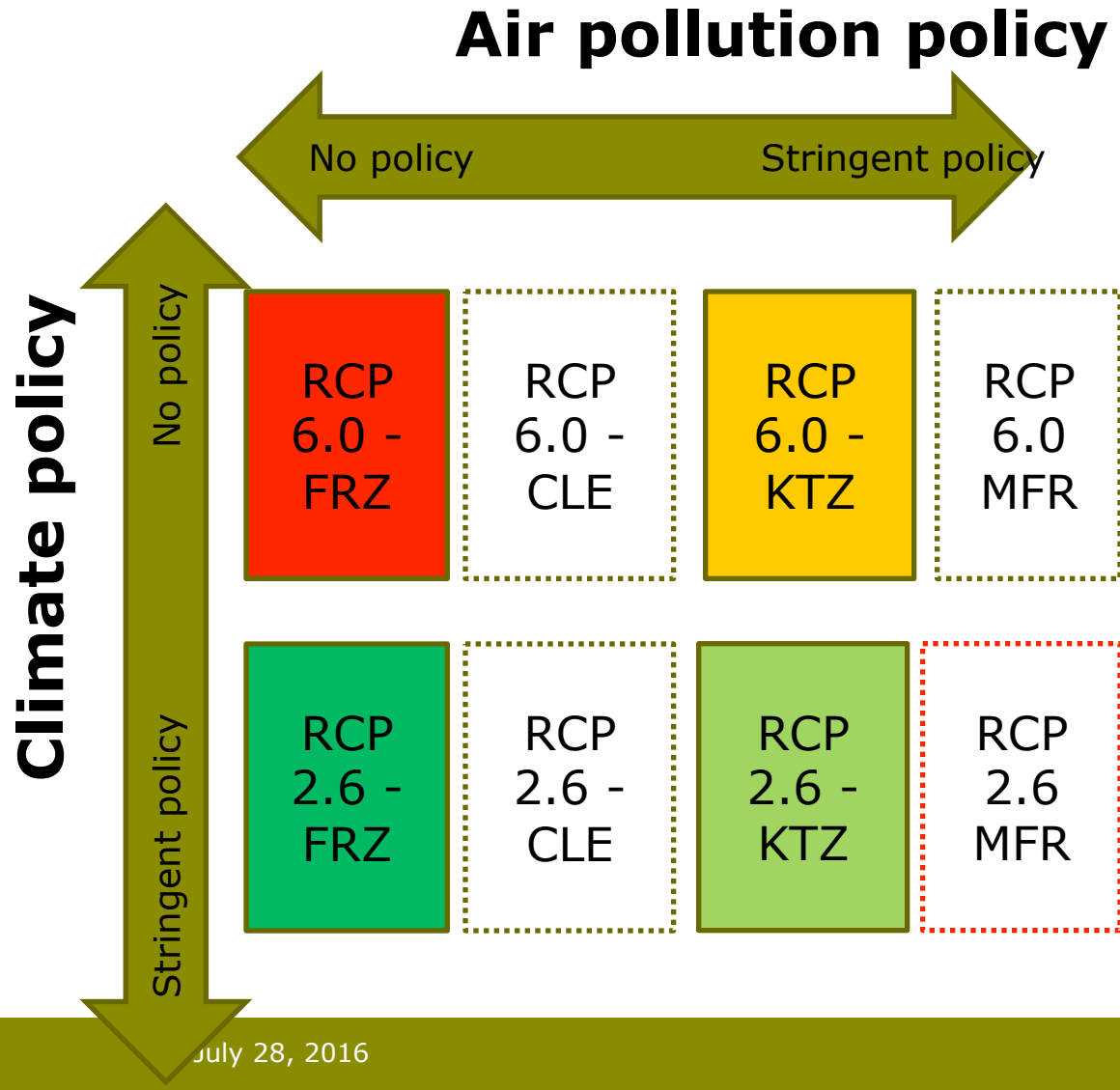
System of interest

Impacts can be important, but only if the red arrows are strong, the IAM is sensitive to these changes and the signal is certain → D

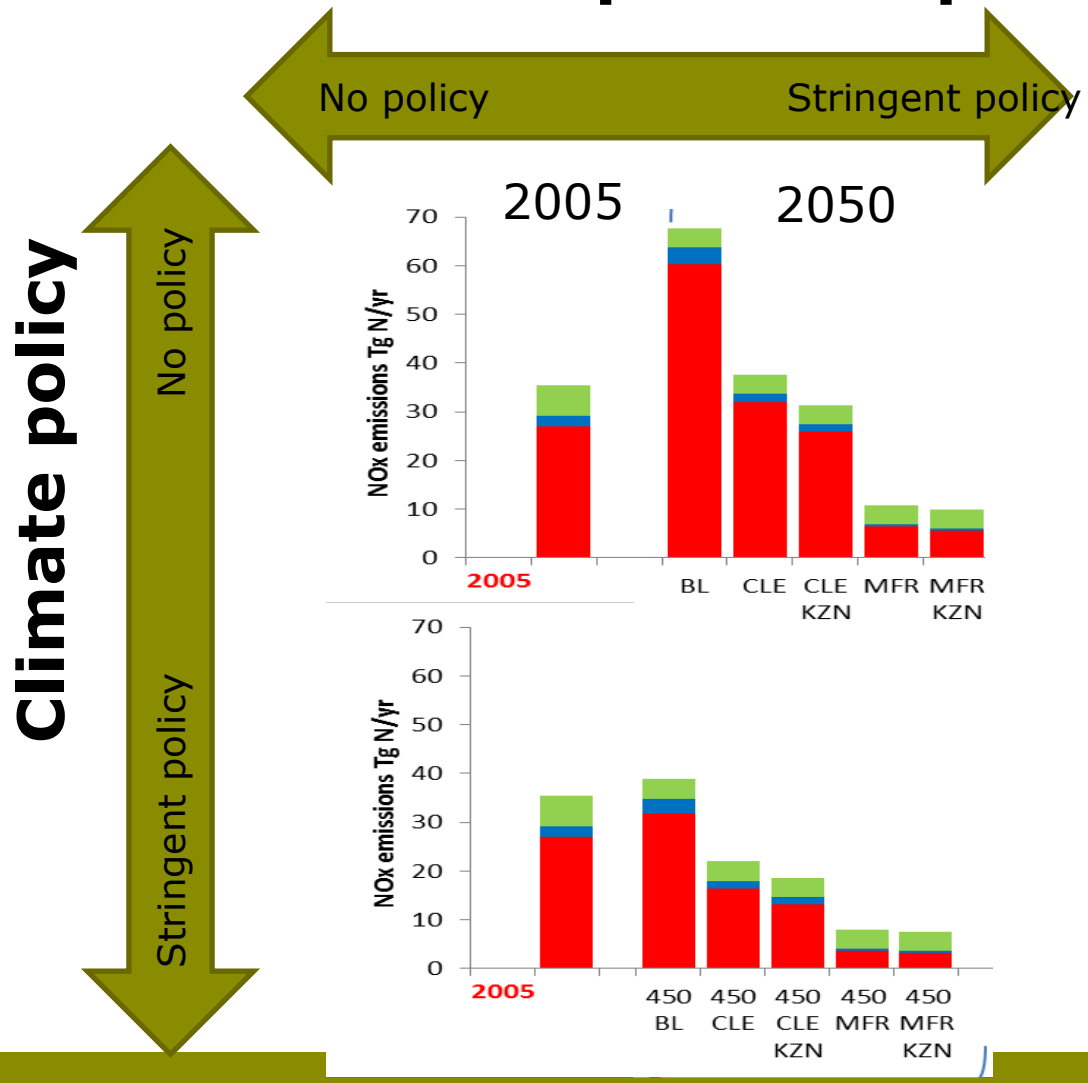


Scenarios (IMAGE)

- Two key determinants of future emissions are future climate and air pollution policies
- RCPs are useful scenarios for climate research, but do not include the option of less succesful air pollution control
- Thus systematic set of scenarios

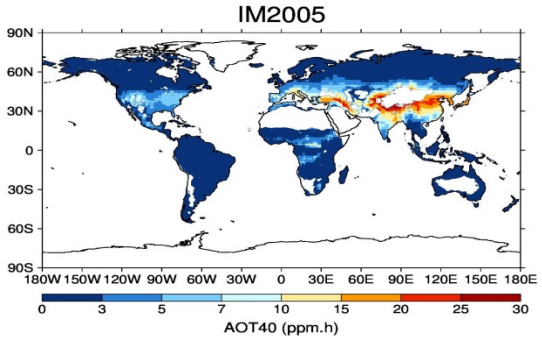


- Significant co-benefits of climate policy on future air pollution emissions



Impact on ozone concentrations

2005



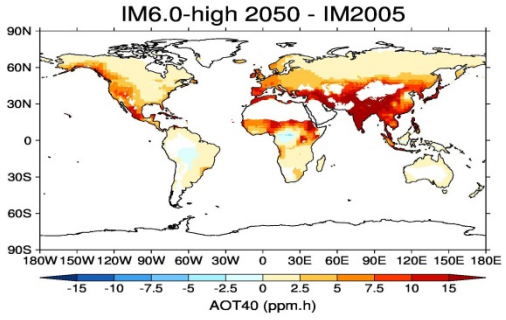
Air pollution

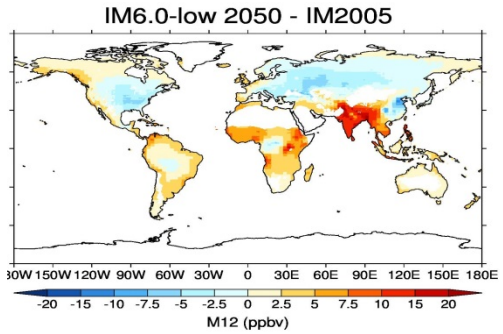
Climate policy

Frz

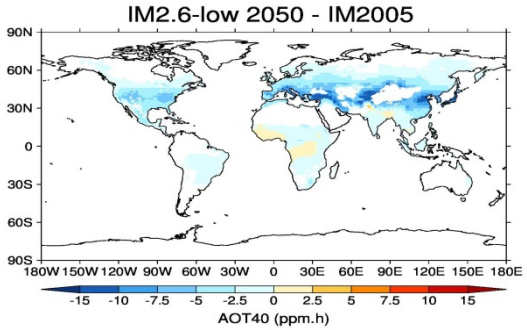
KZN

6.0

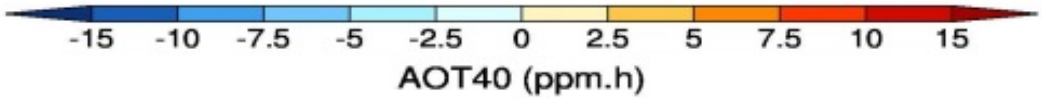




2.6

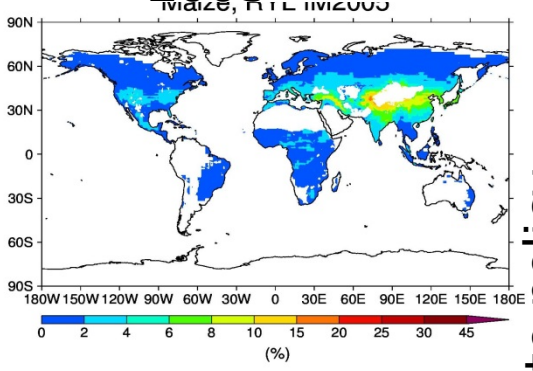


2050



Impact on yields (Maize)

2005



Air pollution

Climate policy

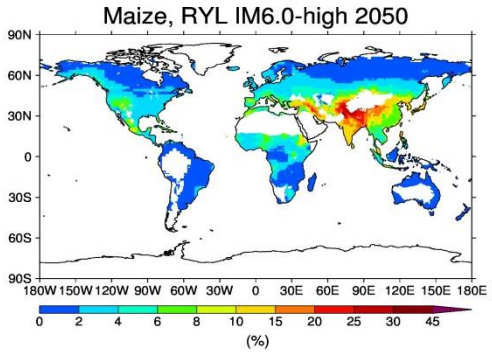
Frz

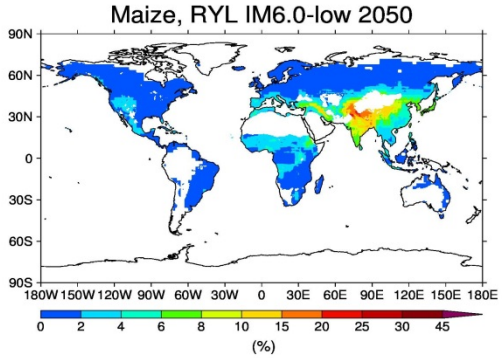
KZN

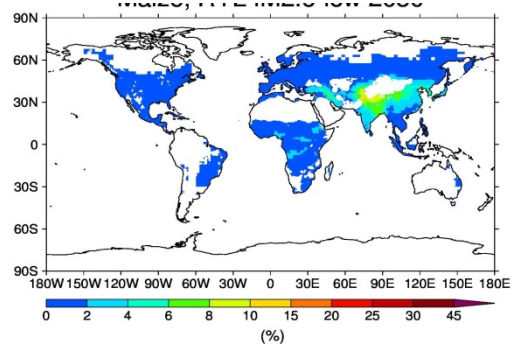
6.0

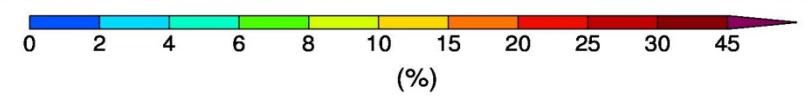
2.6

2050









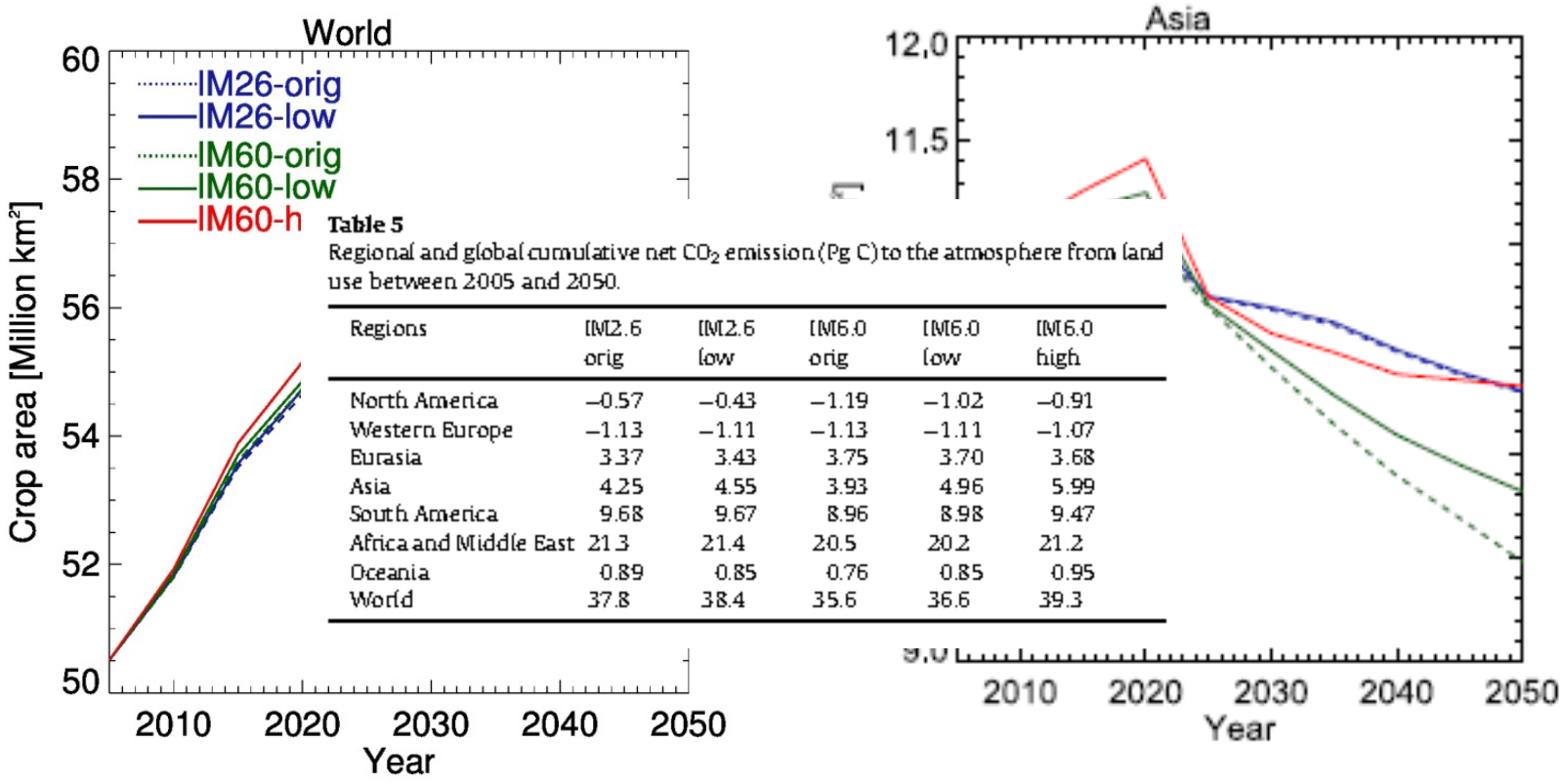


Table 5
Regional and global cumulative net CO_2 emission (Pg C) to the atmosphere from land use between 2005 and 2050.

Regions	IM2.6 orig	IM2.6 low	IM6.0 orig	IM6.0 low	IM6.0 high
North America	−0.57	−0.43	−1.19	−1.02	−0.91
Western Europe	−1.13	−1.11	−1.13	−1.11	−1.07
Eurasia	3.37	3.43	3.75	3.70	3.68
Asia	4.25	4.55	3.93	4.96	5.99
South America	9.68	9.67	8.96	8.98	9.47
Africa and Middle East	21.3	21.4	20.5	20.2	21.2
Oceania	0.89	0.85	0.76	0.85	0.95
World	37.8	38.4	35.6	36.6	39.3

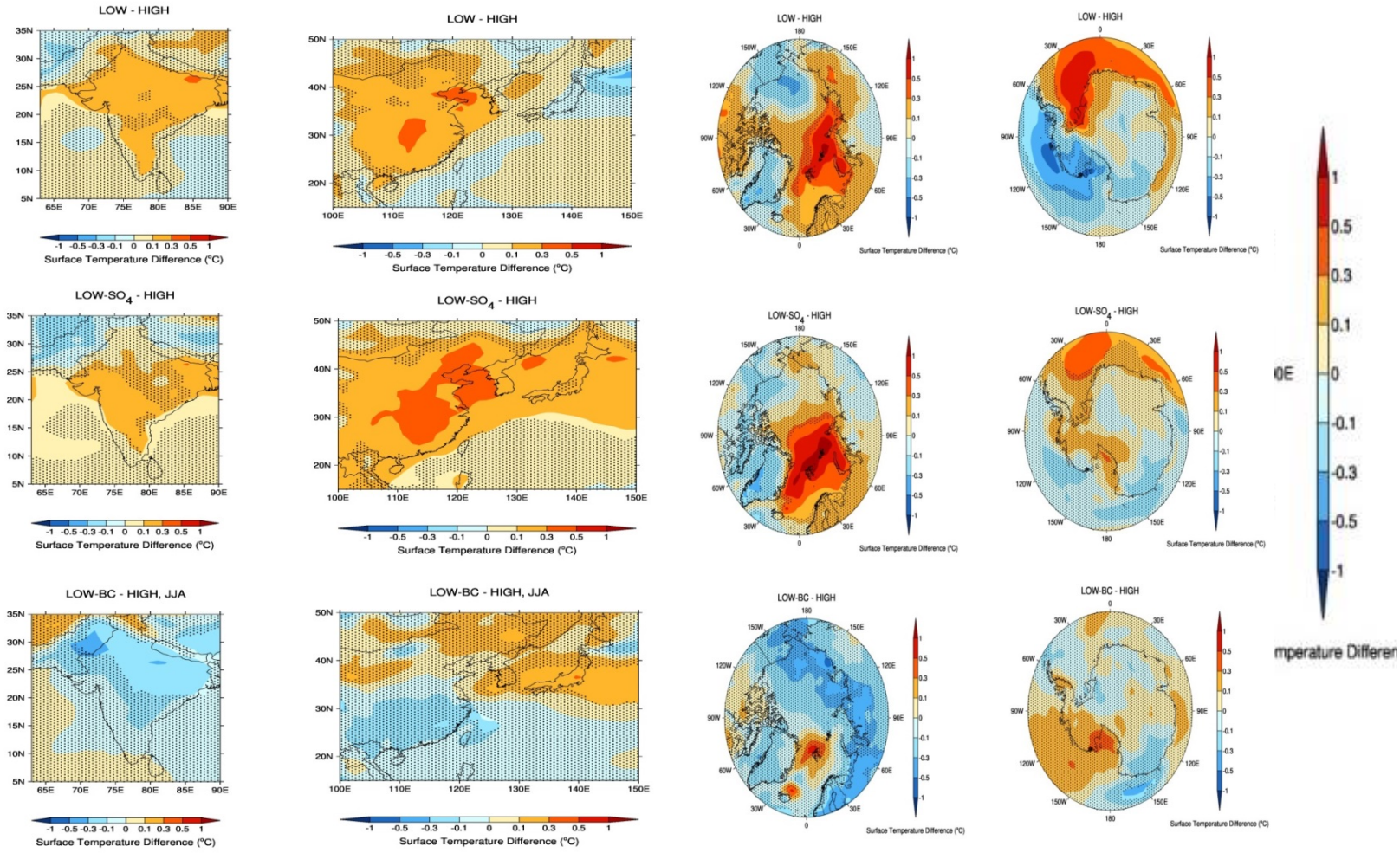
- Associated change in emissions, however, relatively small

Impacts in an ESM (6.0 – Low and High AP)

Total

Sulphur

BC



Conclusions

- Impact of air pollutant scenarios can be substantial (but extreme scenarios) → important for SSP matrix
- O3 impacts on yields maybe up to 20% locally; could be reduced to 10% by air pollution/climate policy combination
- Impacts on emissions 4 GtC in period 2015-2050 (10% of total land use emissions)
- We have increased ability to do 1-way coupling IMAGE – EC-EARTH allowing interesting experiments; but did not get to full coupling.