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Considerations on possible ScenarioMIP design and timeline

ScenarioMIP group



Objectives of the ScenarioMIP scenarios

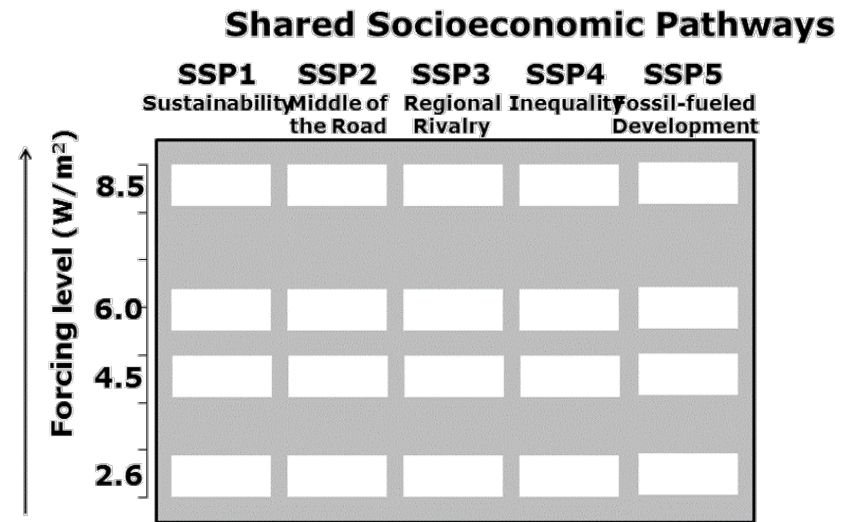
Most important objective: provide a set of scenarios that can support integrated among the main communities involved in climate research.

- A wide range of scenarios, that allow research by IAV, IAM and climate science researchers and provide link
- Combine these scenarios as much as possible with ‘paired’ scenarios in other MIP to look into more targeted questions

ScenarioMIP should focus on plausible future scenarios rather than idealized experiments

Scenario design for CMIP6

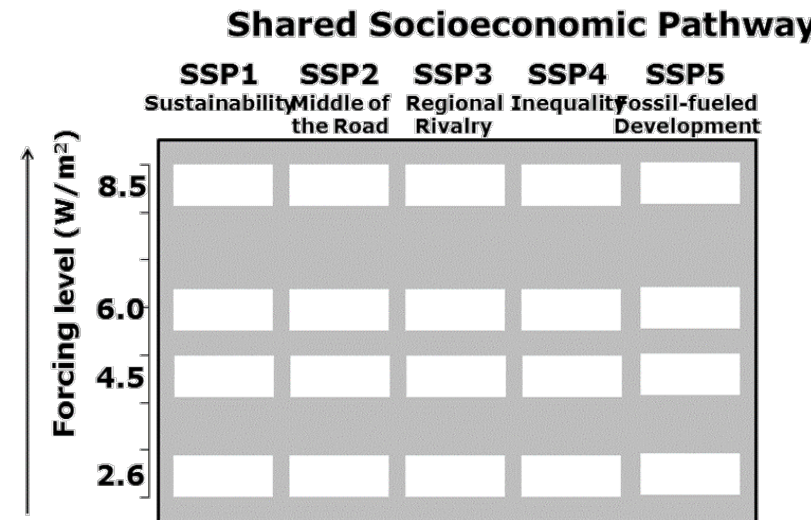
- Scenarios need to be relevant for 'matrix'
- Insights so-far : alternative methods considered last year do not substitute scenario run (statistical sampling, pattern scaling) but might be used to support selection)
- Scenarios need to 0.3 deg C ($\sim 1 \text{ Wm}^{-2}$) apart to be meaningful;
- For LU/Aerosols we have seen some examples of sensitivity – but not related yet to the range of ScenarioMIP scenarios
 - More interesting to look specific into larger differences in targetted MIPs



Scenario design for CMIP6

Different options:

- SSP-based RCPS
 - Pro: very policy relevant forcing levels
 - ESMs models likely to be better
 - IAV researchers can use latest results)
 - But open questions
- New forcing levels (baseline, intermediate)
 - Allows expanding current set; use with CMIP5 results
- More targetted scenarios (overshoot)



Most likely a combination of these, including indication of priority.



Proposal Scenario MIP

- Support idea of keeping original RCP8.5 in DECK
 - Allows understanding the difference in projected climate change using CMIP6 models compared to CMIP5 models, driven by the same scenario of future forcing from multiple gases, land use, and aerosols.
 - But: if SSP5 baseline, which has a similar global average forcing pathway to the RCP8.5 (see further) will produce comparable climate outcomes, the two scenarios are redundant and maybe SSP5 should be in the DECK?
- Decision needed on DECK runs – will influence ScenarioMIP design.
- Insight into final SSP5 run (Feb. 2015)



Proposal Scenario MIP (entry requirement)

1a. High forcing, SSP baseline scenario (SSPX baseline, $X=2, 3$, or 4 ; RCP ~ 7.0)

- Solve for $x = 2$: Intermediate scenario.
- Solve for $x = 3$: provides pessimistic development pathway to contrast with optimistic SSP5 pathway, useful for impact studies of high forcing with alternative societal development; high aerosols, so good for anchoring AerChemMIP variants

1b. Low forcing, SSP-based RCP (SSPX-RCP2.6) or mitigation gap scenario (SSPX-3.7)

- RCP2.6 only scenario relevant for 2 deg C target; would be the lower bound. RCP2.6 cannot be ruled out before 2020.
- RCP3.7 interesting intermediate level, policy relevant
- Both could be chosen to contrast land use and/or aerosols with scenario 1a
- $X = 1$ or 4 would make most sense here?



Proposal Scenario MIP (tier 2 scenarios)

- 2a. Medium forcing, SSP-based RCP (e.g. SSPX-4.5)
 - SSP2: middle of the road scenario, matching middle of the road RCP4.5?
 - Maybe RCP6.0
- 2b. Low forcing, SSP-based RCP (SSPX-RCP2.6) or mitigation gap scenario (SSPX-3.7)
 - SSP1 or 4 may make most sense here, especially for a scenario anchoring LUMIP variants
 - Choice depends on choice made for 1b.
 -

Proposal Scenario MIP (tier 3 scenarios)

3a. Overshoot scenario (SSPX-RCPX w/ overshoot)

- Important science questions for climate research and IAM
- But maybe not ready yet for ScenarioMIP? Plausibility of significant overshoot scenarios not well known (for this reason currently lower priority)
- Could be of interest to C4MIP and/or GeoengineeringMIP (team-up ... IAM create scenarios and do further research; runs done in Emission-driven mode in one of these other MIPs)

3b. High forcing, SSP-based RCP (SSP5 baseline, ~RCP8.5 pathway)

- See earlier remarks on similarity with RCP8.5 (low priority based on similarity); will differ in terms of recent emissions, future ghg composition, land use, and aerosols. Could be used to see impacts of these?
- Higher CO₂ (lower non-CO₂ gases) may be significant for ag impacts?
- Should we take it out? Only run it with ESMs if proven different?



Proposal Scenario MIP (tier 2 scenarios)

Tier 3.

- RCP6.0 – SSPx

- $X = 5$?
- Depends on our choice regarding 4.5 in tier 2
- Not well covered CMIP5
- Would possibly comply current policy projections

Proposal Scenario MIP

- Linking with AerChemMIP
 - Start with SSP3 baseline (?) scenario 1a above), and compare to air pollutant variants
 - High variant: counterfactual in which no air pollution policy is implemented
 - Low variant: SSP1-RCP2.6 or low emission factor run on SSP3?
- LUMIP scenarios related to ScenarioMIP
 - Likely that medium or low RCP (2.6-4.5) is best anchoring scenario for LUMIP variants, given wider variety of land use outcomes
 - Choose SSP1 / SSP3 as contrast?

Open science questions

- How much are the new climate model runs going to be different in CMIP6 and CMIP5
 - Difficult to know! More resolution, new LU schemes, sea-ice.
- Sensitivity for LU/Aerosols for realistic ranges → Ask LU-MIP/ Aerosol MIP members to write little literature reviews (December?)
- Potentially combine into special issue with our earlier findings:
 - Scenario distance
 - Role of pattern scaling
 - Role of statistical sampling
 - Role of older model versions (faster runs)
- How do final model runs of SSPs come out (early 2015)

Open questions

- How important is a 6.0 run?
- What is our current preferred grouping of scenarios into Tiers?
 - What are the arguments for/against SSPX-2.6 vs SSPX-3.7 as the Tier 1 low scenario?
 - Should we have two or more scenarios in Tier 1?
 - Is SSP5 really a Tier 3 scenario?
- What are the pros/cons of specific SSP/RCP combinations for each scenario?

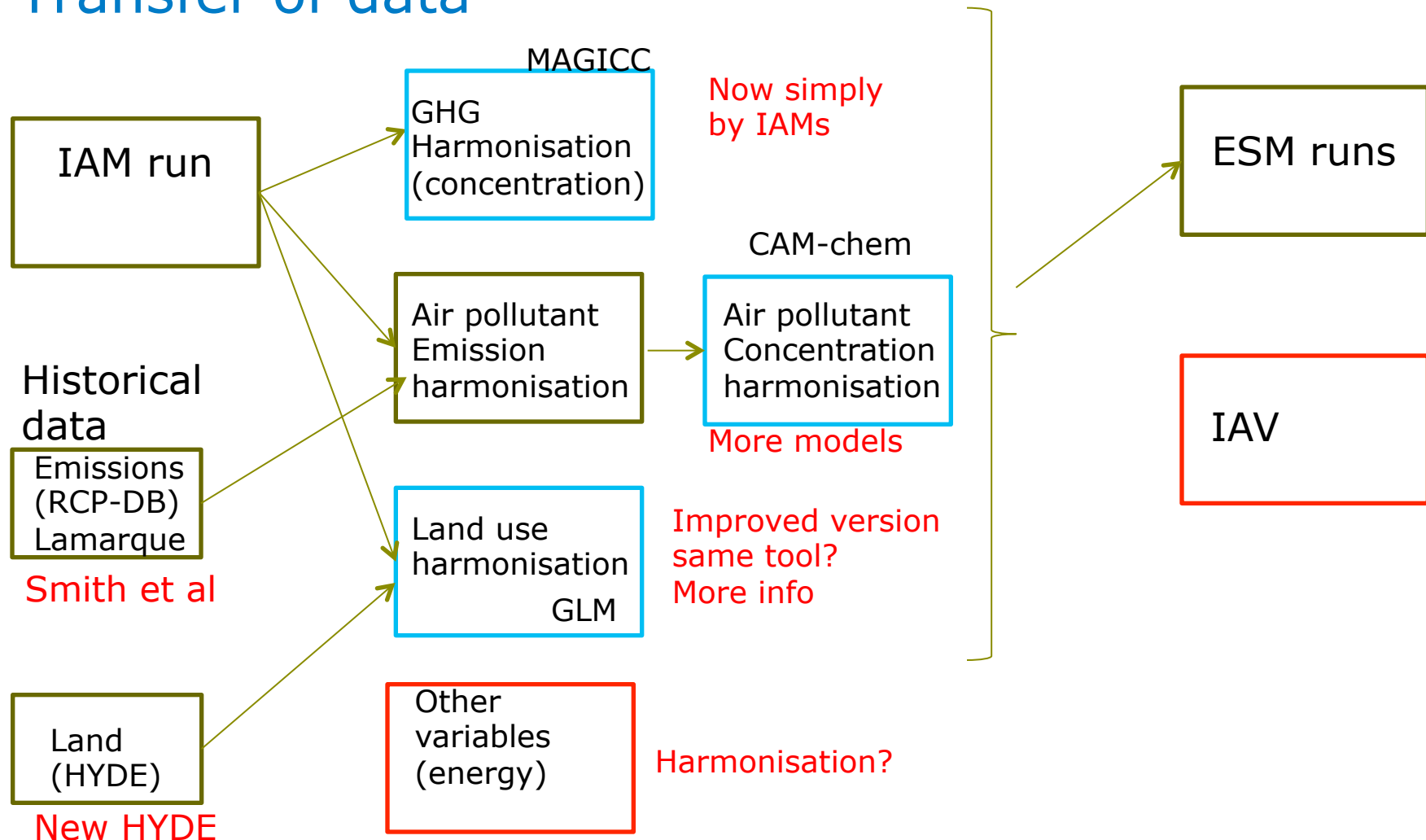
Open questions

- What is our view on emissions- vs concentration-driven scenarios? Should we make a specific request on this to C4MIP?
- What is our view on the desirability of long-term extensions?
- Which run should be done with high-resolution model?
 - High scenario 7.0 / 8.5
- High number of ENSEMBLES
 - To assess internal variability of ESM models
 - Support impact studies taking into variability
 - SSP2/RCP4.5 (from 1970? End period 2050?)
 - Part of ScenarioMIP or ScenarioMIP recommendation?
- Which should be run for decadal projections?
 - SSP2/RCP4.5

Open questions

- What is our view on recommended IC ensemble sizes?
 - What ensemble size is necessary to evaluate regional climate consequences of differences in land use and aerosol forcing? This size would apply both to the anchoring scenarios in ScenarioMIP and the variants in LUMIP/AerChemMIP (although presumably the request to run larger ensembles would be for those models participating in LUMIP/AerChemMIP).

Transfer of data

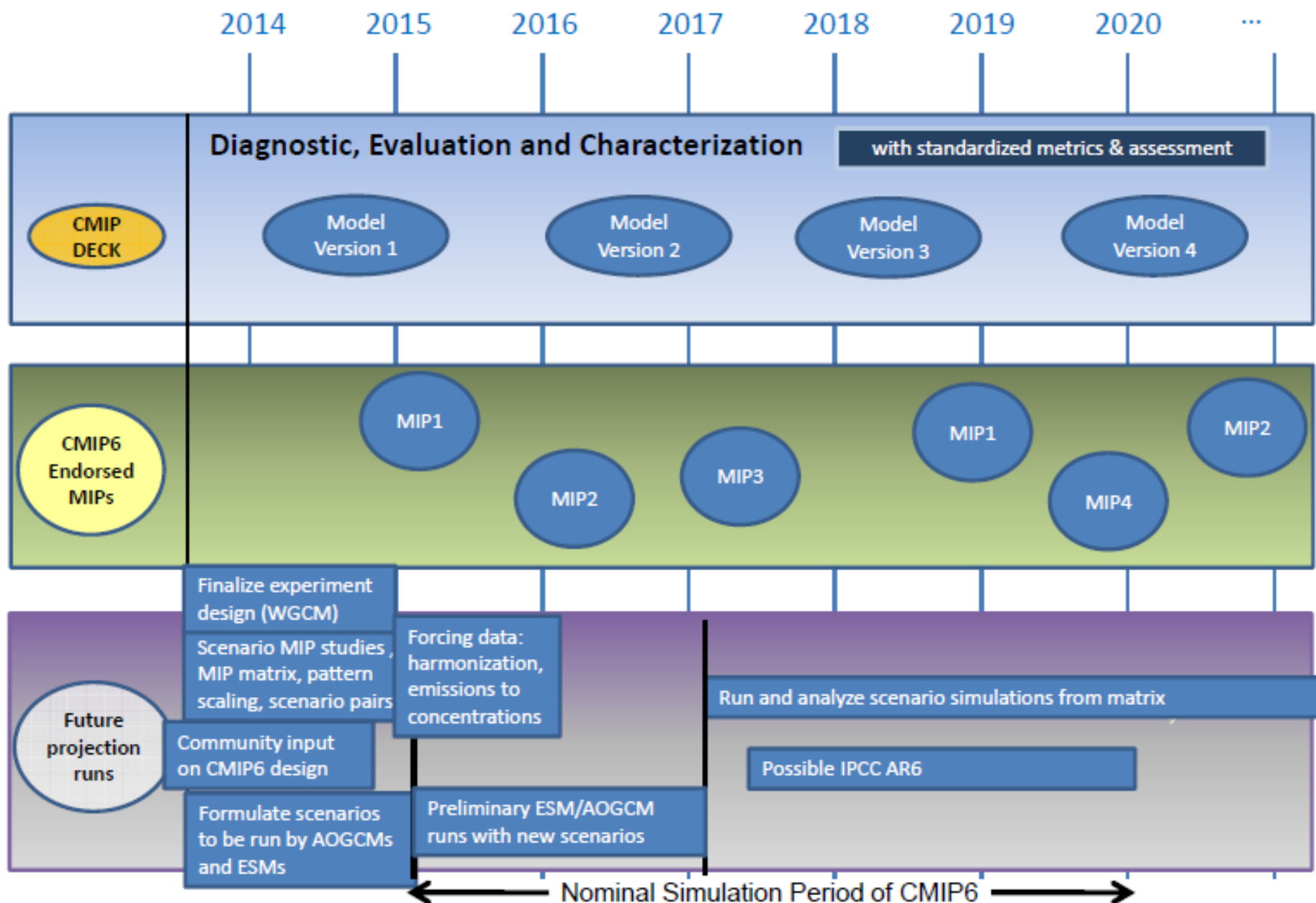




Time line ScenarioMIP

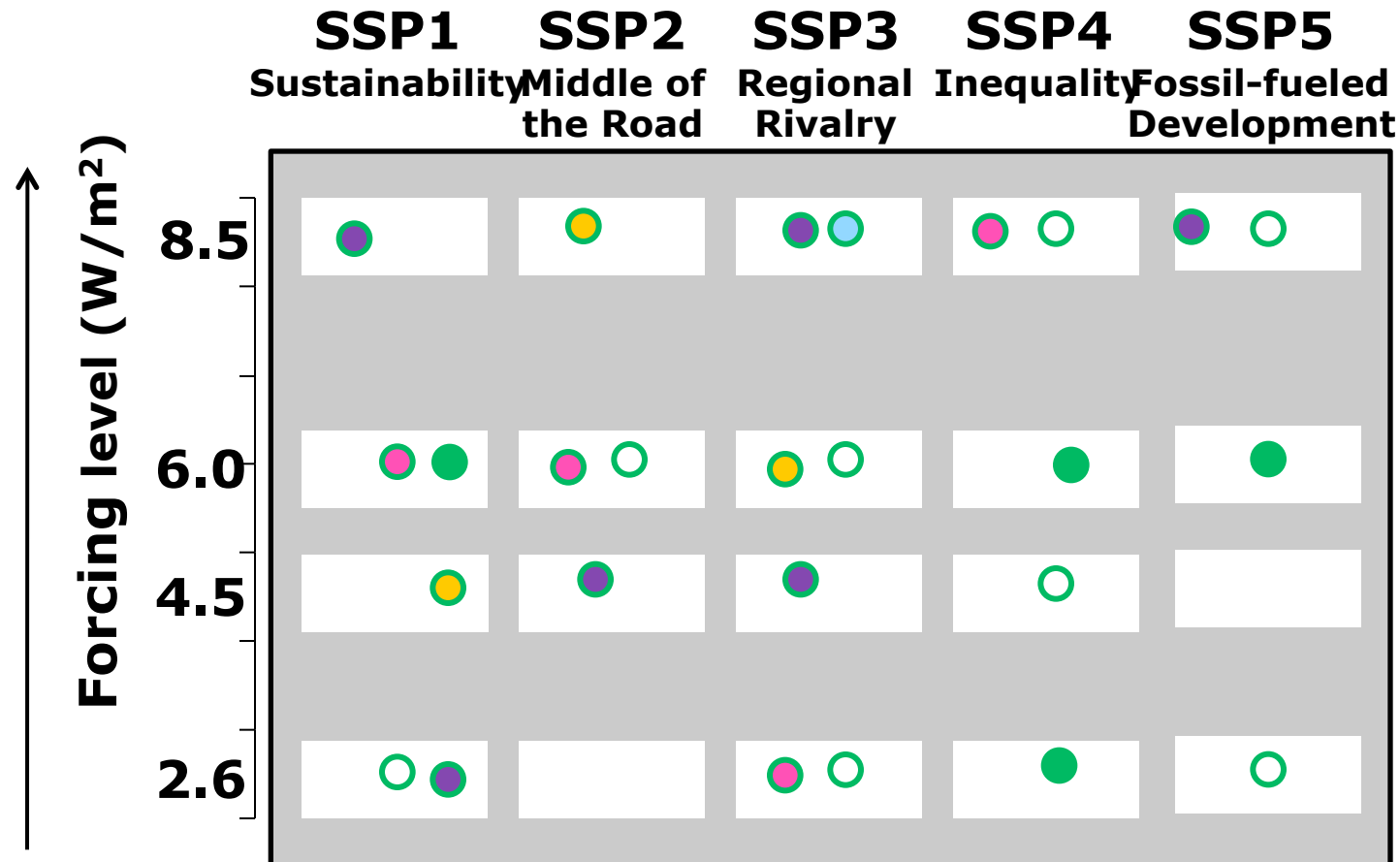
- Aug/Sep 2014: Interaction with IAM/IAV community on Aspen ideas
- Sep 2014: Submission ScenarioMIP proposal
- Oct. 2014: WGCM meeting
- Dec. 2014: Final submission beta-version IAM scenarios
- Feb. 2014: IPCC meeting on scenarios?
- >Mar. 2014: Final IAM scenarios
- >Mar. 2014: Data conversion to ESM input

CMIP6 Timeline



● Different models

Shared Socioeconomic Pathways



Statistical sampling

Pros

- Would allow
- Innovative r

Cons

- Complex
- Comparison of different models, dimensions etc. complicated by the presence of models, many other dimensions etc. complicated for impact assessment
- Institutionally difficult



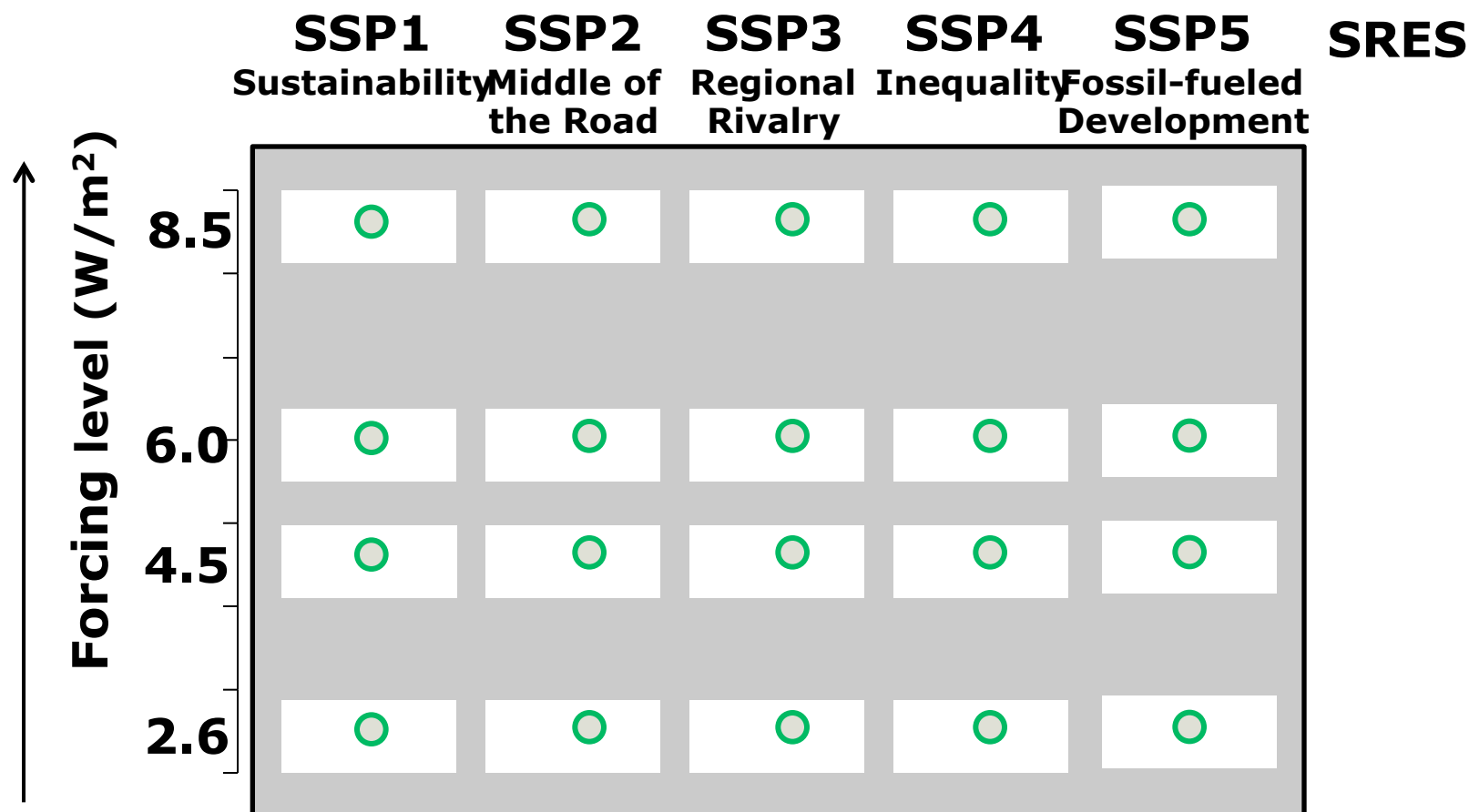
Use previous generation models



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○ Same model

Shared Socioeconomic Pathways



Use previous generation models

Pros

- Would allow filling in cells
- Provides very complete models

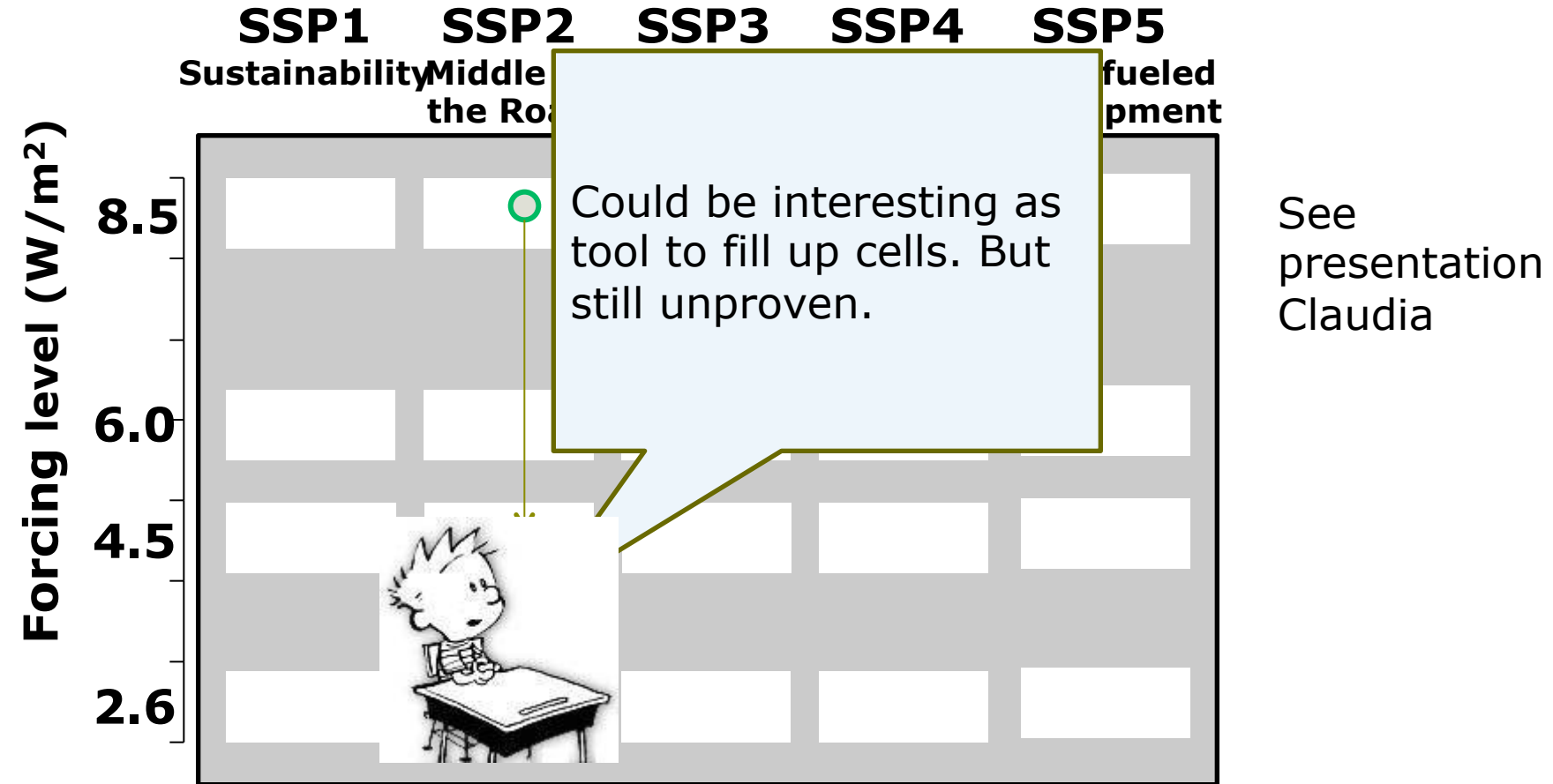
Cons

- Not the “latest and greatest” models
- Maybe not feasible to maintain them.

Interesting to combine with other options to fill in cells. But probably not an alternative to models maintained



Shared Socioeconomic Pathways





Possible Scenario Sets

Scenario sampling

Running more cells using older model version

Other proposals are all based on selection

Updated RCPs (4 forcing pathways similar to RCPs)

Baseline/new mitigation (4 new forcing pathways)

2-stream mitigation (Some new, some similar pathways)

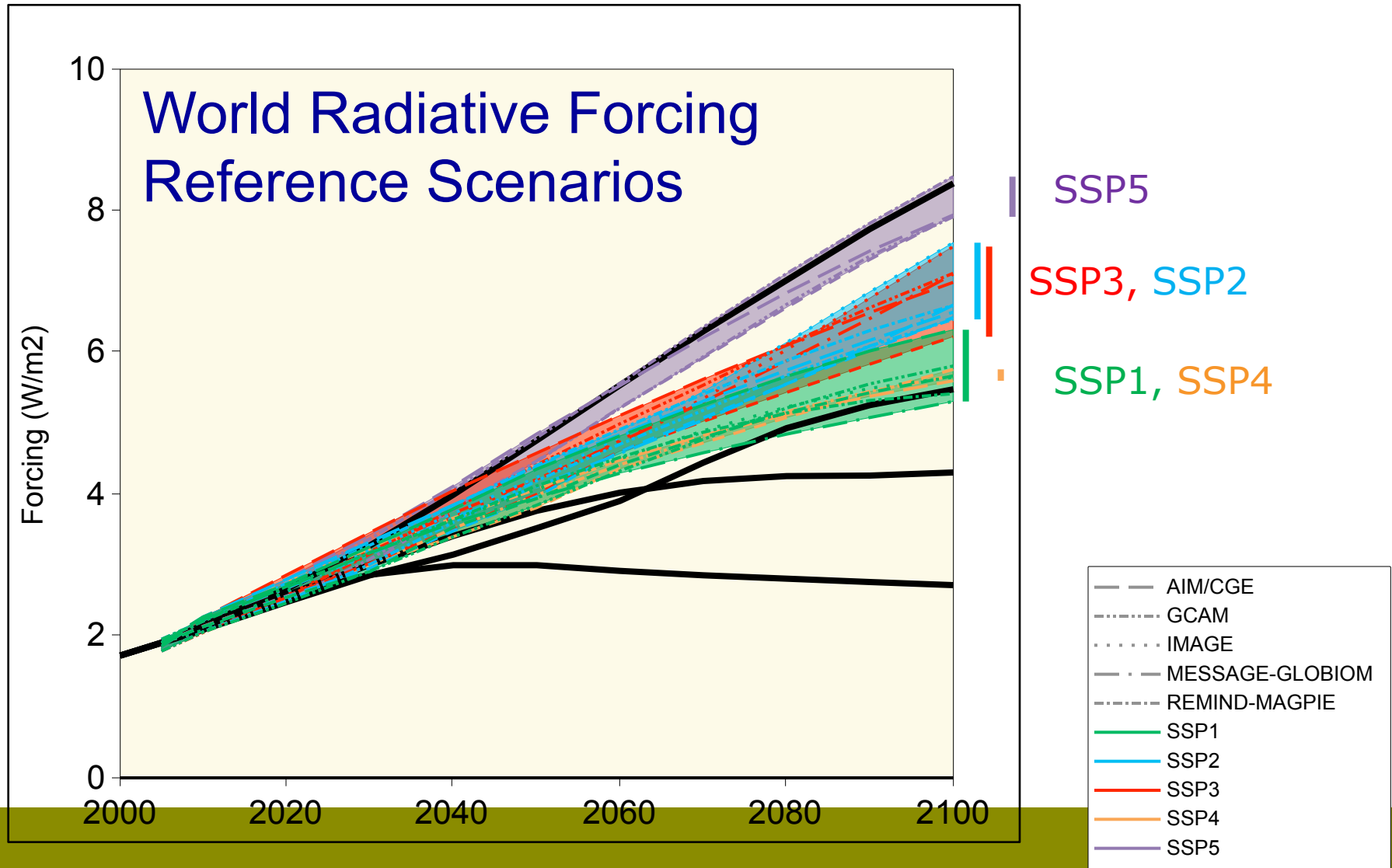
Bounding scenarios?

Scenario pairs?

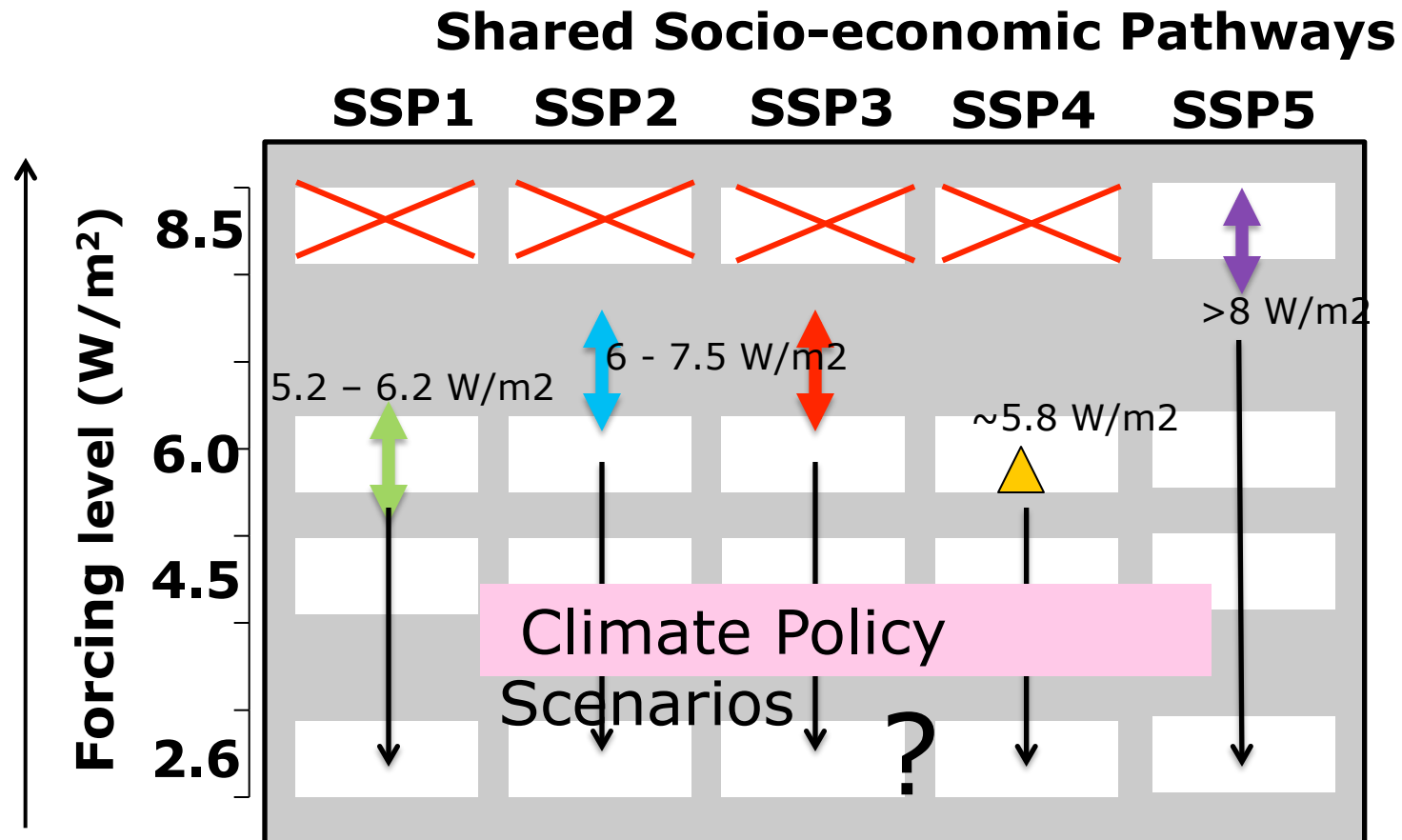
Some considerations regarding selection based methods

- If we select only four scenarios, this becomes pretty much a game of musical chairs: we have lots of wishes but only a limited set of options
- Scenarios need to be reasonably apart (around 1 W/m² at least)
- Select scenarios that can be used as representation of a wider range of cases

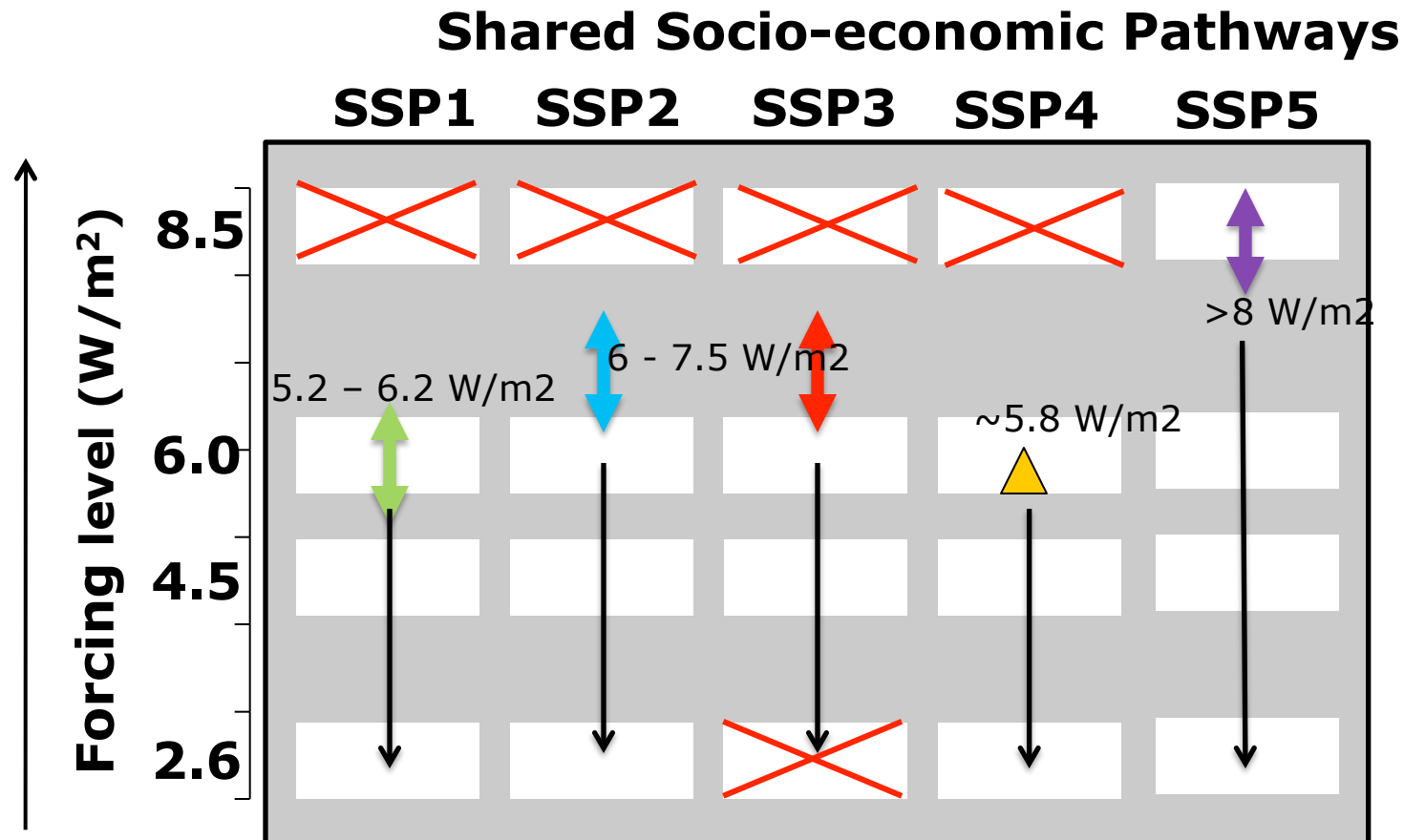




SSP/RCP combinations based on reference IAM scenarios



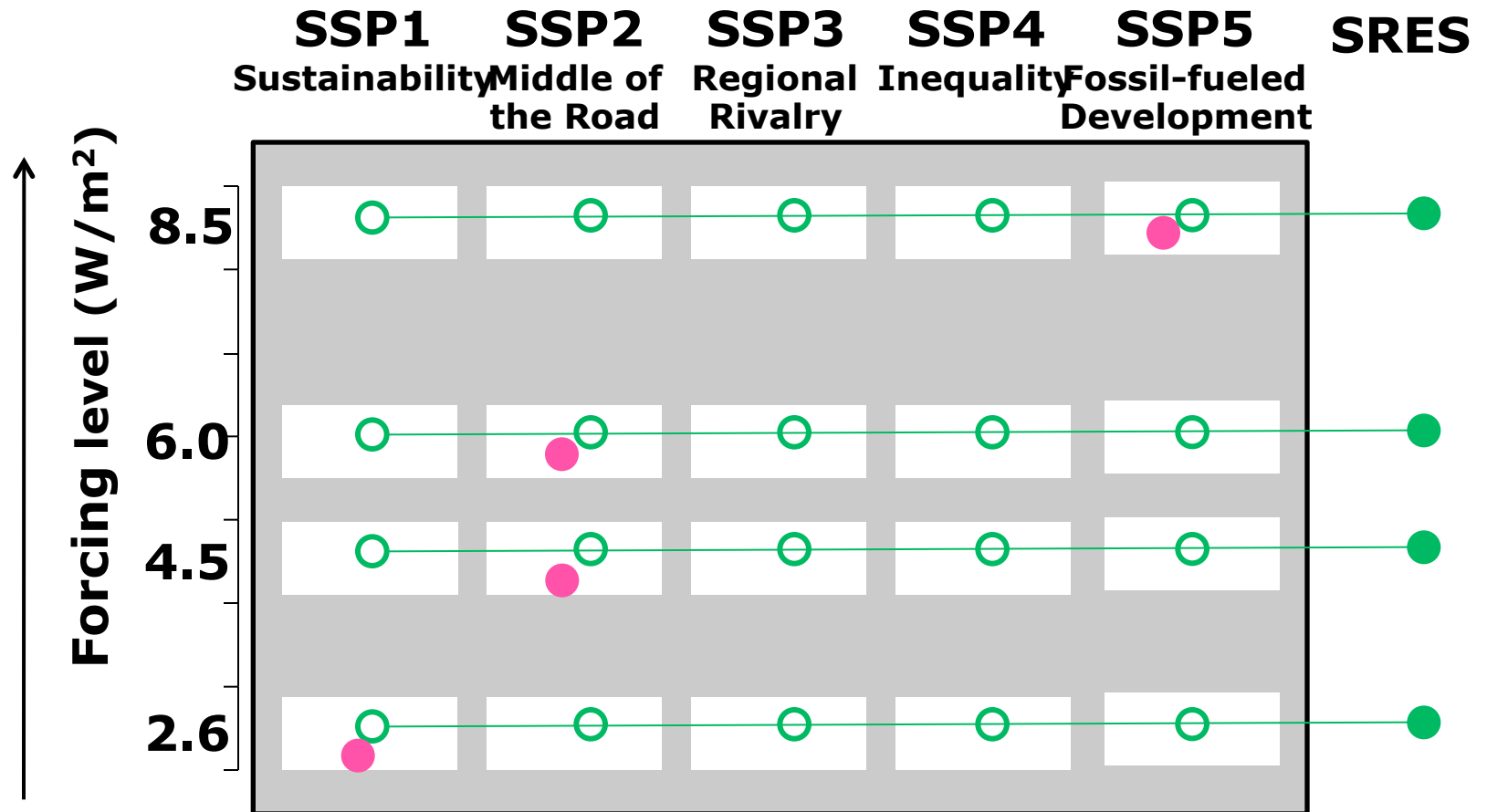
SSP/RCP combinations based on reference IAM scenarios





● Original RCPs ● Updated RCPs

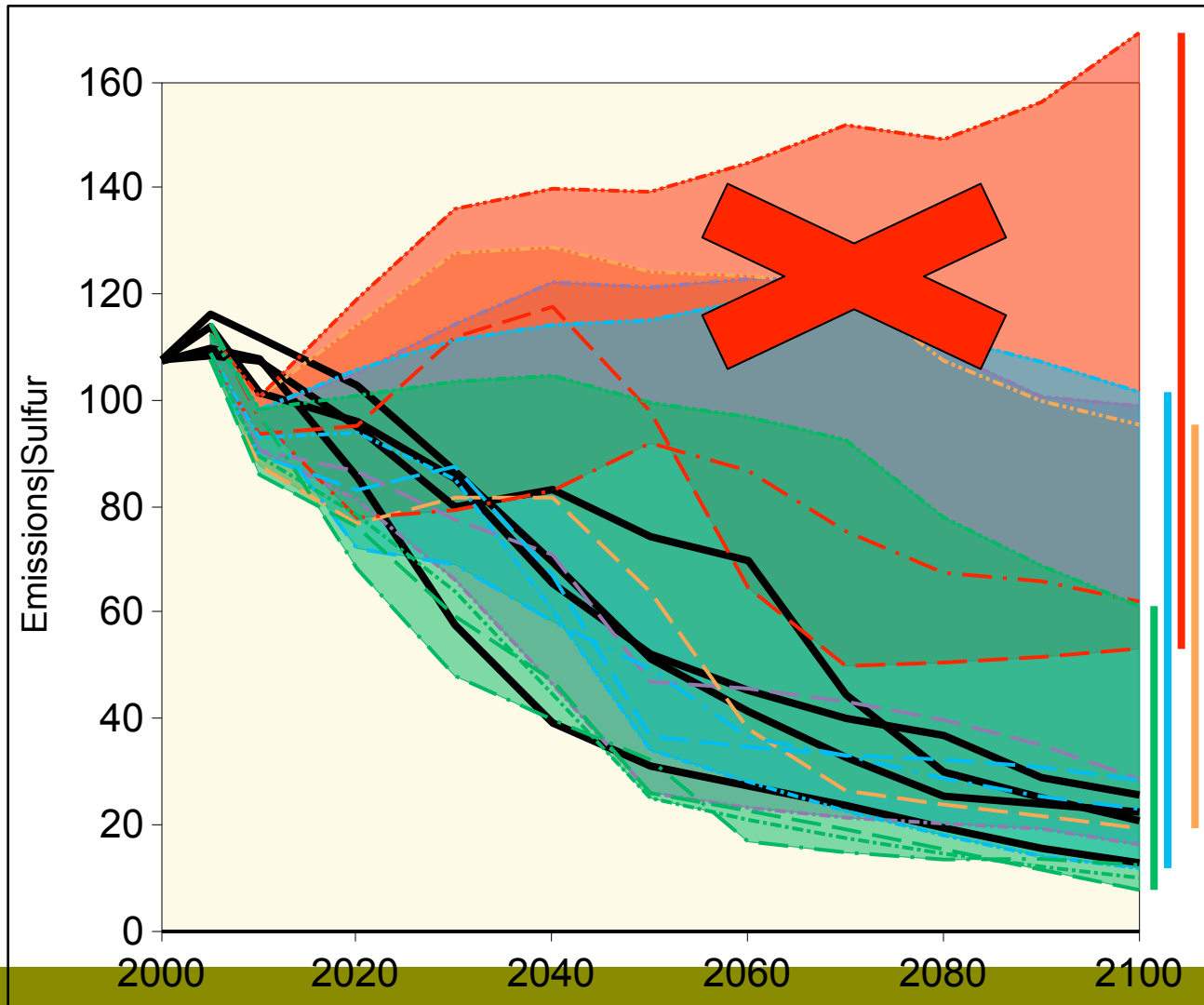
Shared Socioeconomic Pathways



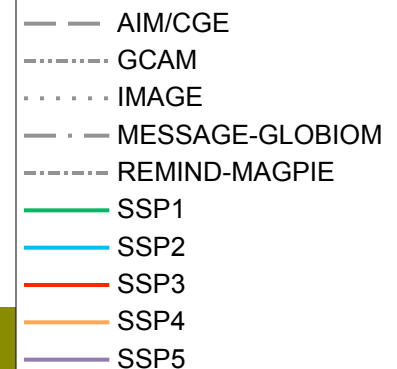
World Emissions|Sulfur SSP Reference Scenarios



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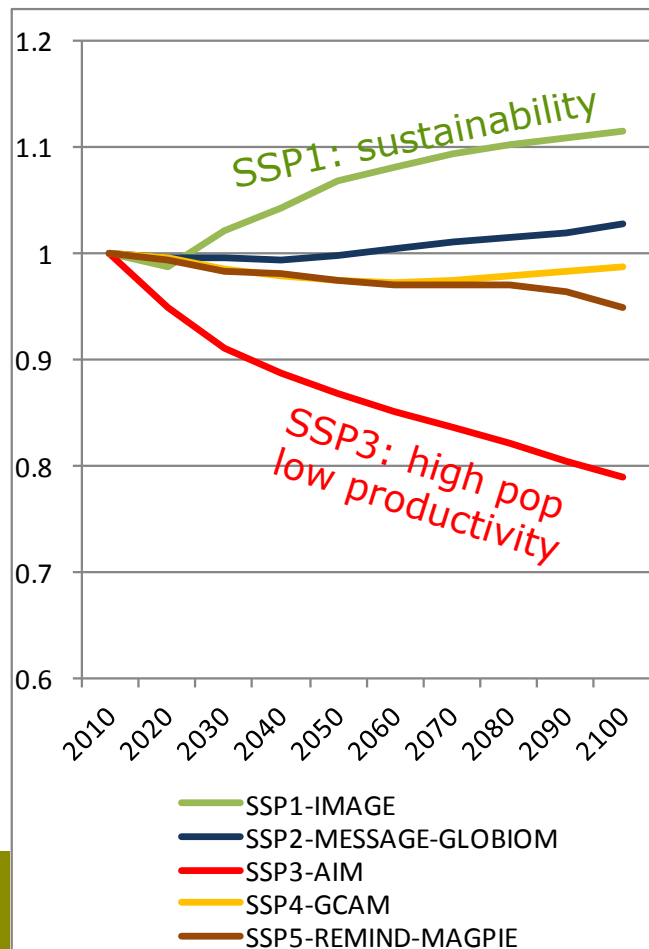
- High SO₂ emissions mostly in SSP3, also somewhat in SSP5
- High SO₂ will offset somewhat GHG signal



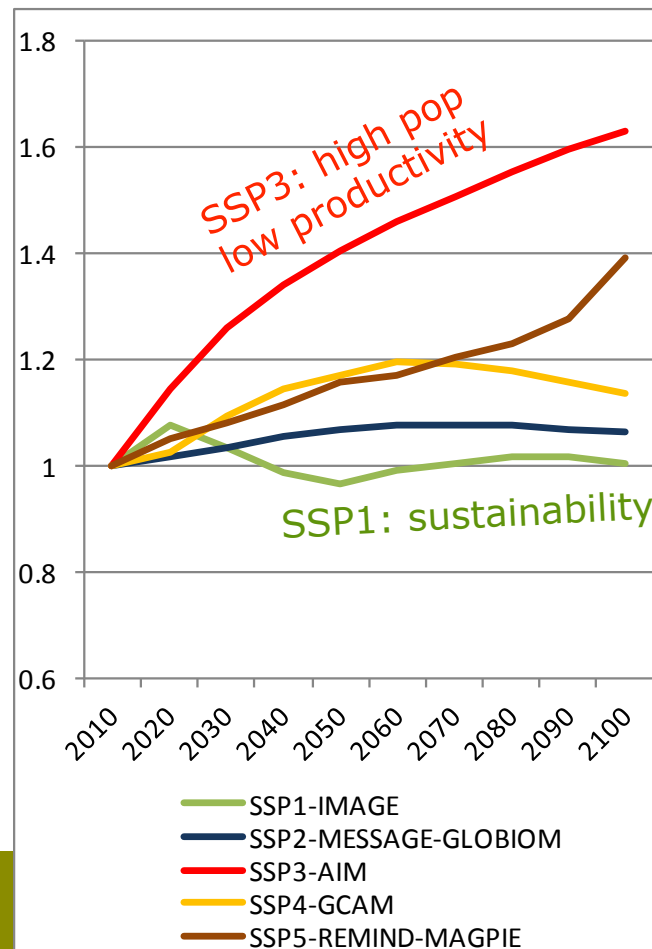


Land-use Change (index 1=2010)

Forest land



Cropland



Deforestation signal highest in SSP3 (mostly in tropical region?)

Reforestation in SSP1 (mostly in developed?)



Updated RCPs

Pros

- RCPs based on SSPs rather than SRES
- updated IAM (and climate) models
- consistency between new climate outcomes and new SSP-based IAM scenarios
- More clever selection of land use/aerosol impacts possible

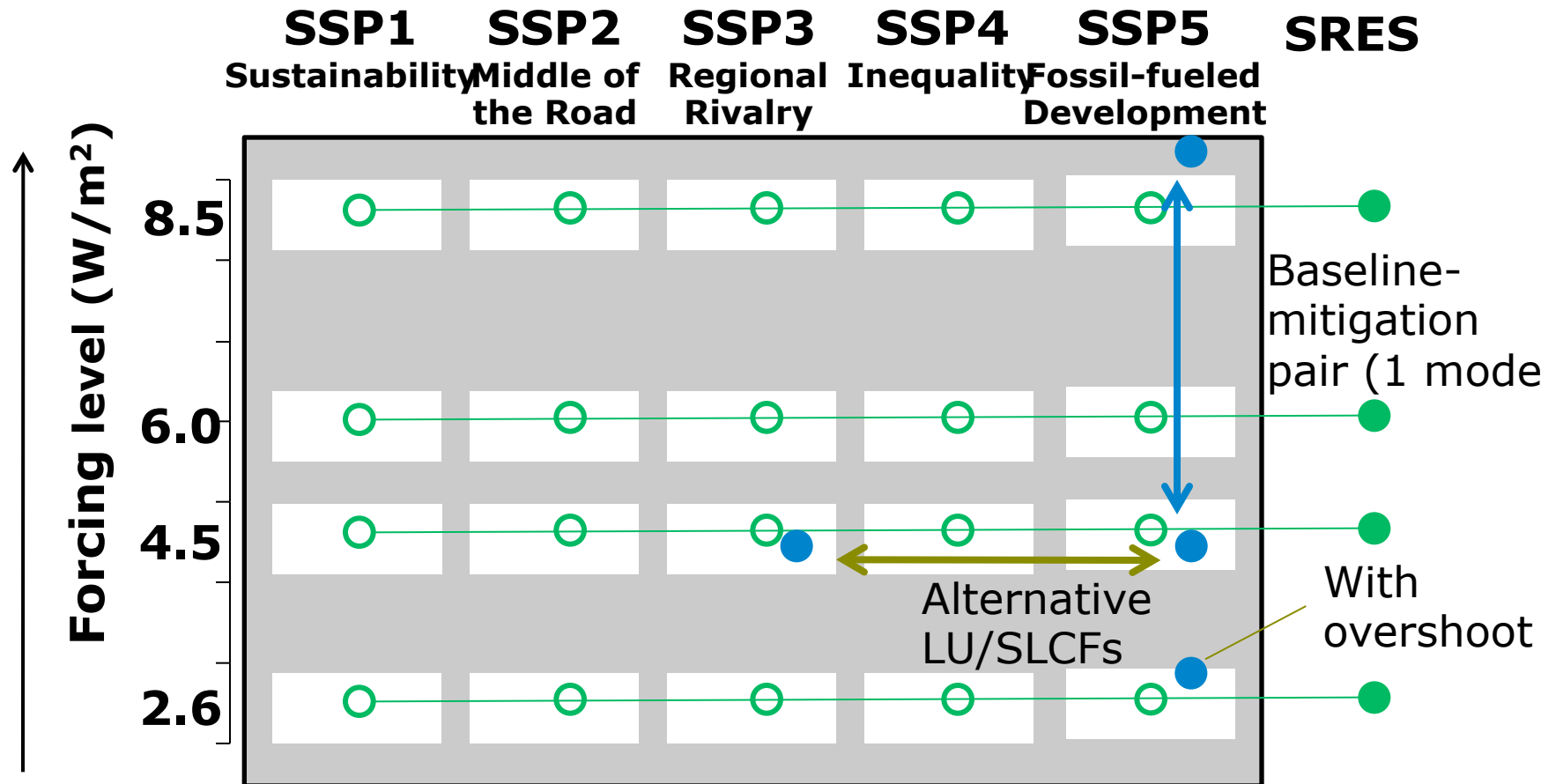
Cons

- unclear whether updated RCPs will differ significantly from current RCPs
- won't be able to learn from climate differences between CMIP5 and CMIP6 RCPs (too many things changed at same time)



- Original RCPs
- 2-stream mitigation

Shared Socioeconomic Pathways





2-stream mitigation

Pros

- Provides climate information for (at least) one SSP baseline
- Provides climate information for one new mitigation scenario (overshoot)
- Baseline-mitigation pair
- Mitigation-mitigation pair to evaluate sensitivity to how forcing level is achieved

Cons

- Not a clean comparison of land use or SLCF influences
- Are two updated RCPs significantly different from existing RCPs?
- Misses several SSPs (reduction of uncertainty)

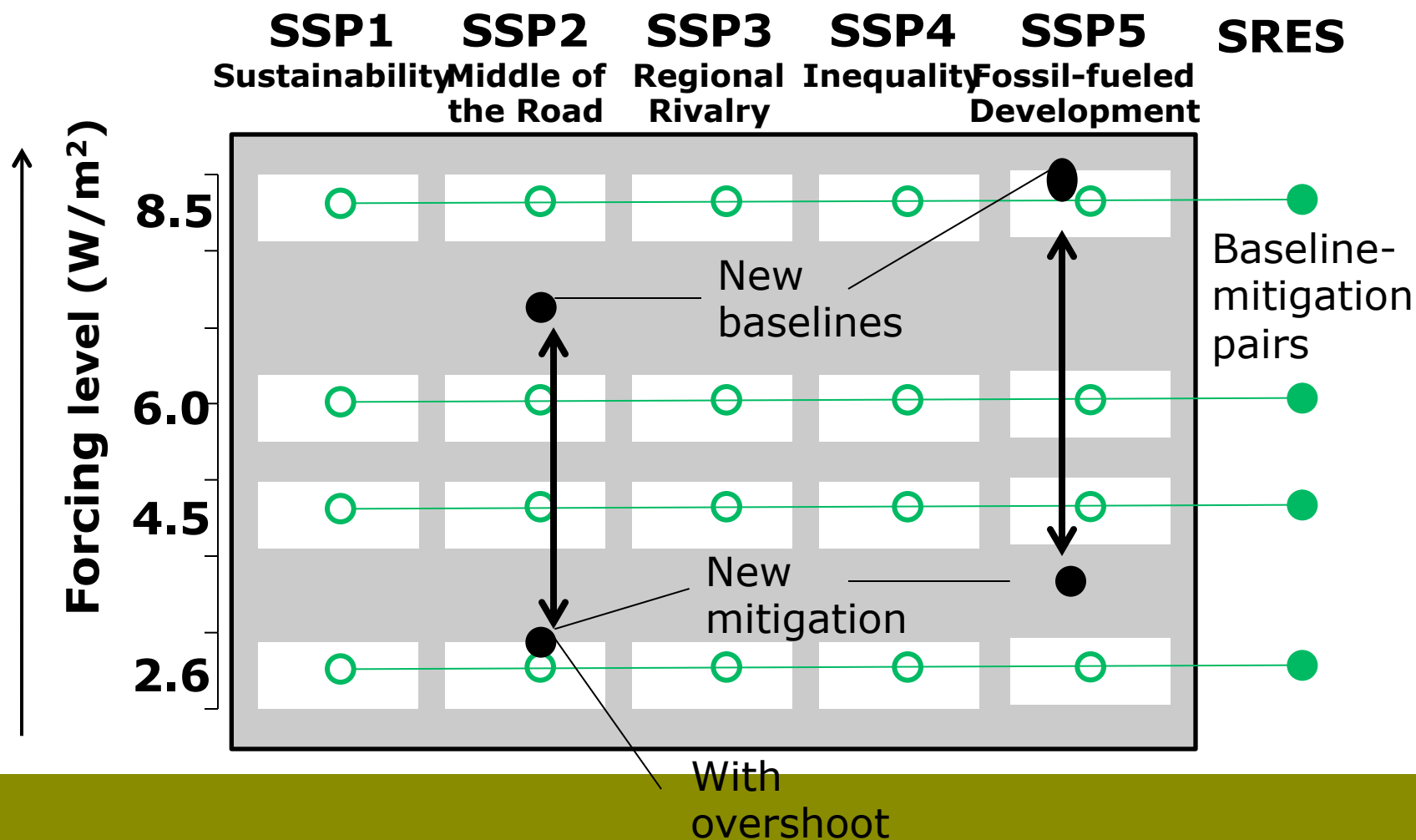
New baseline/new mitigation



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- Original RCPs
- Baseline + new mitigation

Shared Socioeconomic Pathways





Baselines/new mitigation

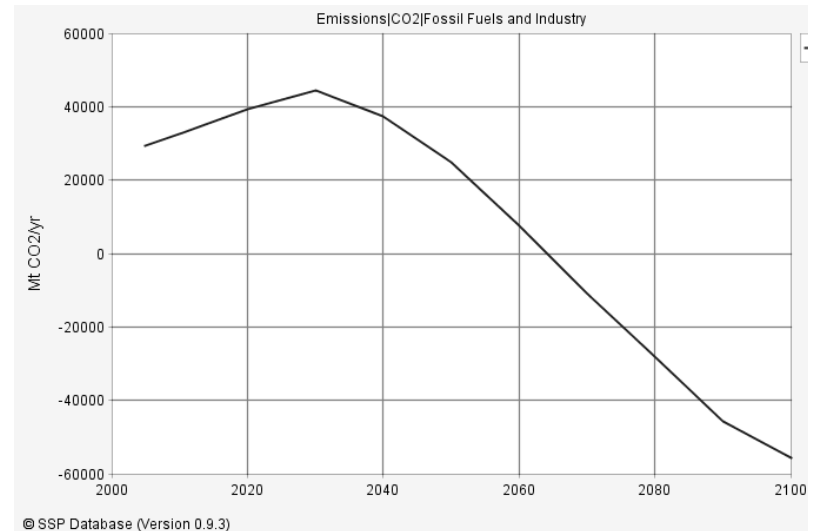
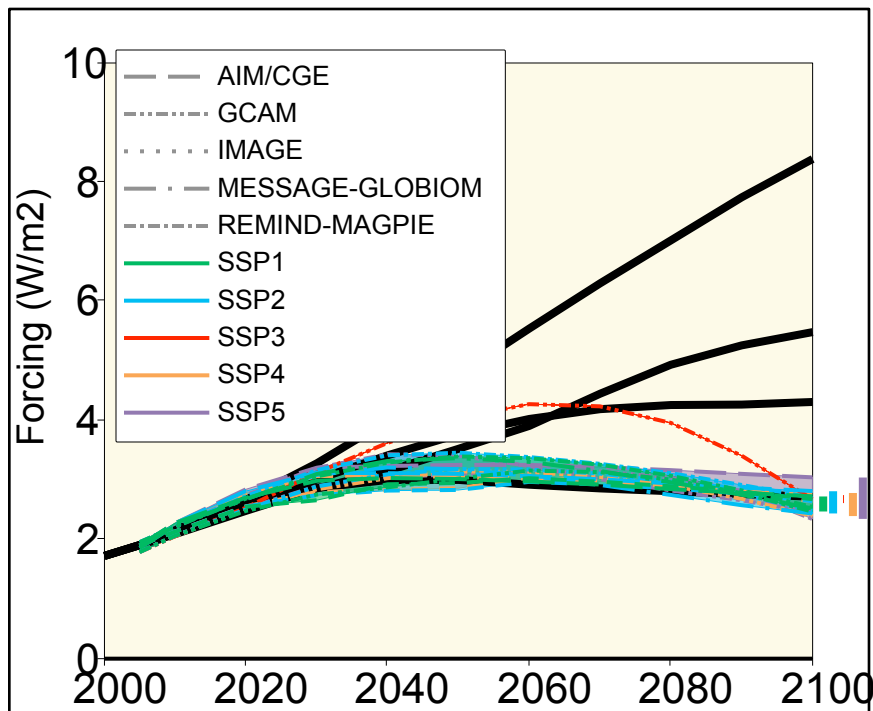
Pros

- Provides climate information for (at least some) SSP baselines
- Provides climate information for mitigation scenarios not previously covered, including overshoot
- Baseline-mitigation pairs support avoided impacts work
- RCP3.7

Cons

- No explicit focus on land use or SLCF issues
- Are baseline and mitigation scenarios significantly different than existing RCPs? (do not comply to 1 W/m²)
- No new runs for RCP levels (not the latest and greatest models)

Overshoot scenario



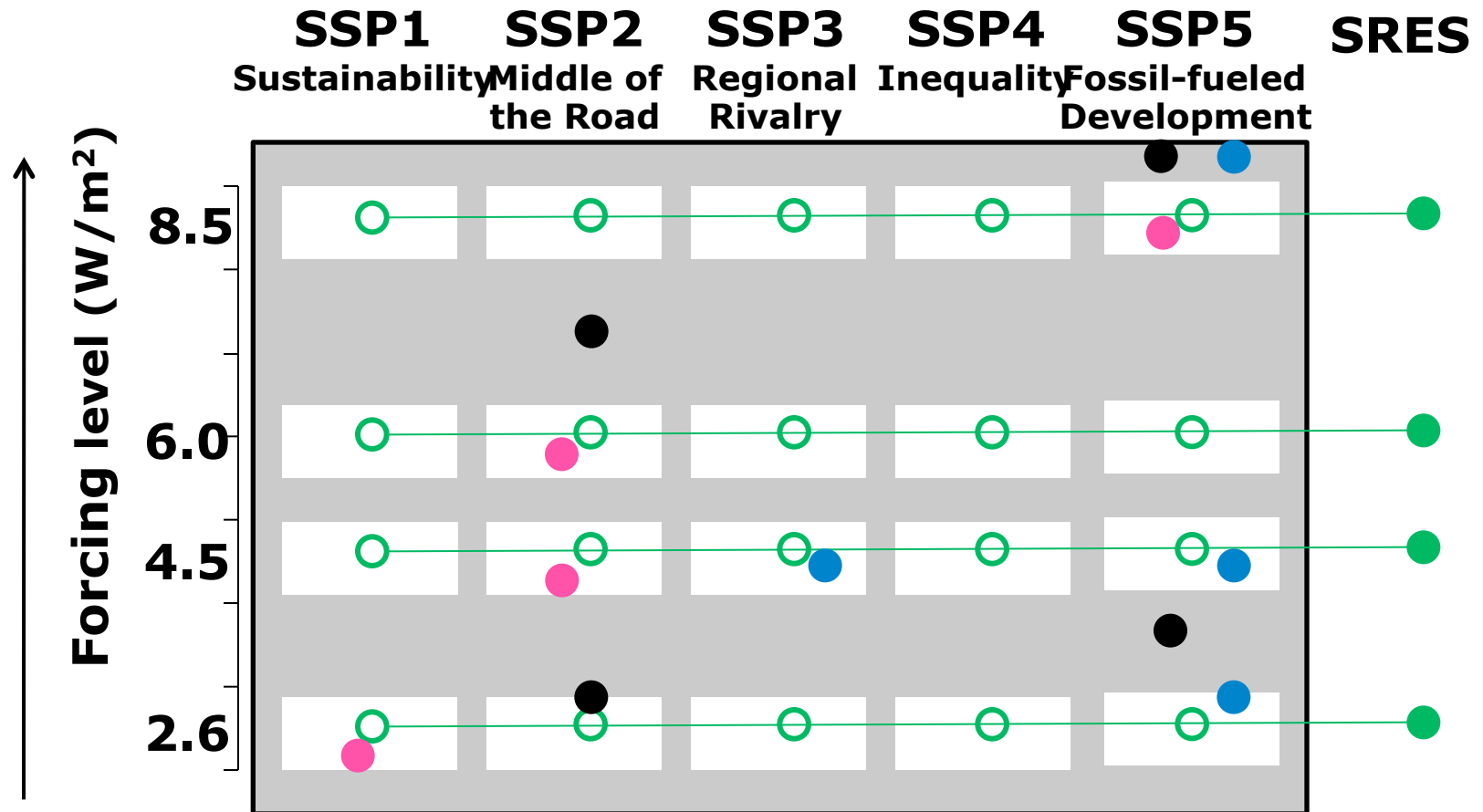
Interesting for science and policy reasons – but question whether overshoot should be this large.

- Original RCPs
- Updated RCPs
- 2-stream mitigation
- Baseline + new mitigation



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Shared Socioeconomic Pathways





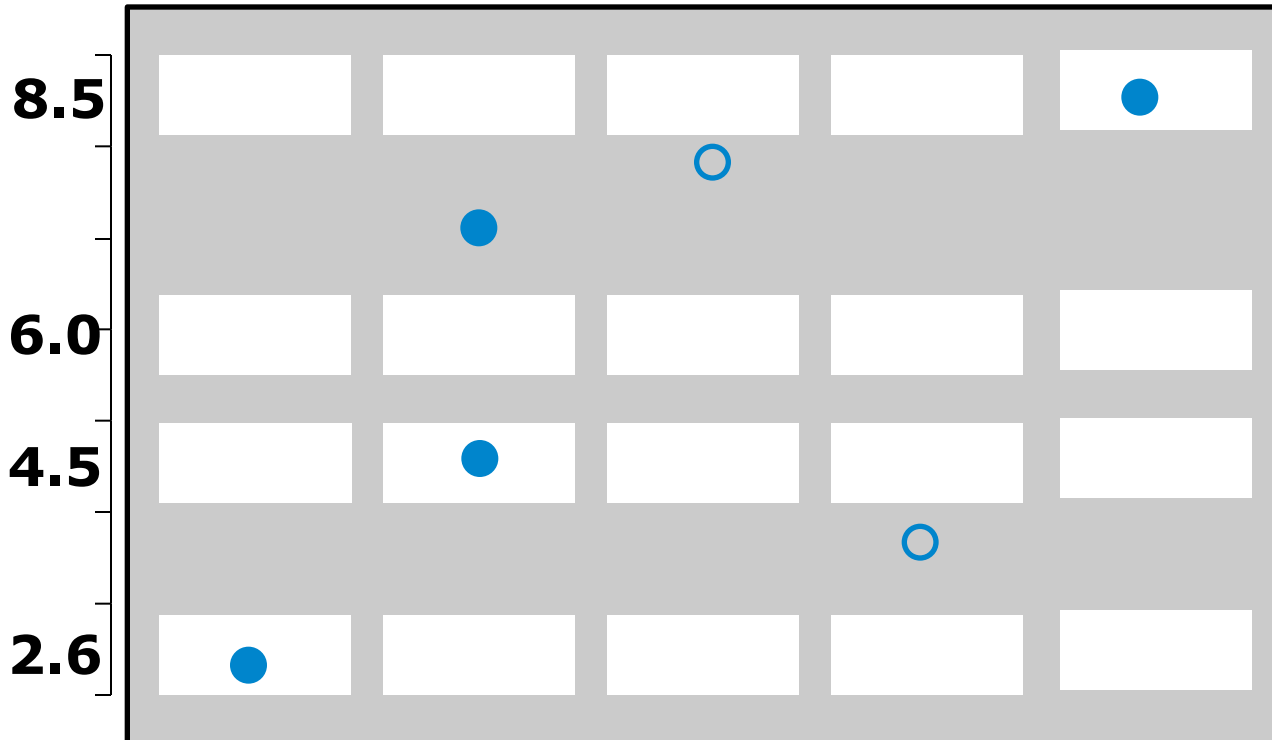
- What are the implications of the highest and lowest plausible forcing scenarios?
- What impacts are avoided by mitigation?
- What are the relative contributions to uncertainty in outcomes (climate, impacts) of societal pathway (SSP), IAM model, impact model, climate model, model parameters?



Shared Socioeconomic Pathways

SSP1	SSP2	SSP3	SSP4	SSP5	SRES
Sustainability	Middle of the Road	Regional Rivalry	Inequality	Fossil-fueled Development	

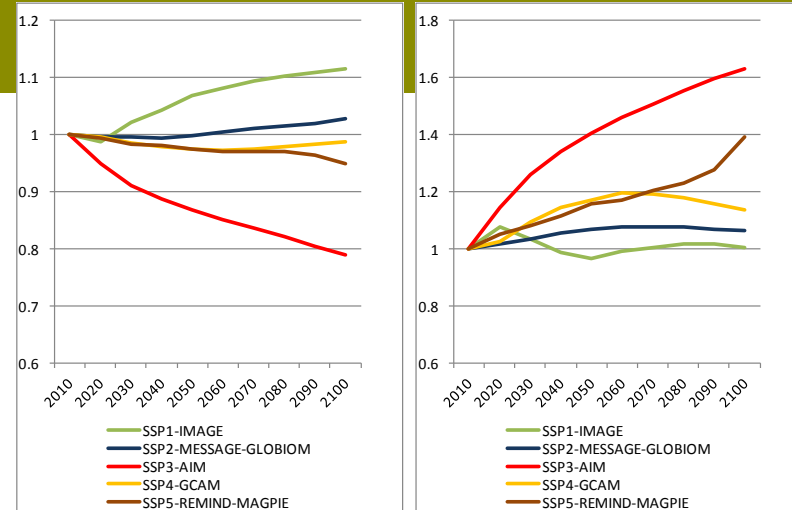
Forcing level (W/m^2)



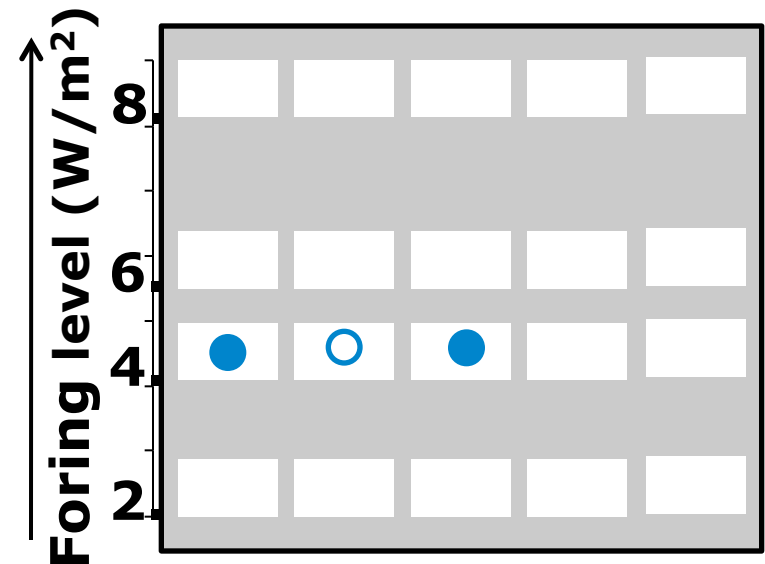


Relation to LUMIP

- Select intentionally 2 scenarios with extreme land use – but same forcing (but if from marker-matrix one also varies ghg-signal, air pollution, model)
- Combine 2 extreme land use patterns with 1 GHG/air pollution forcing path
- Combine idealised land use pattern with 1 GHG/air pollution forcing path.



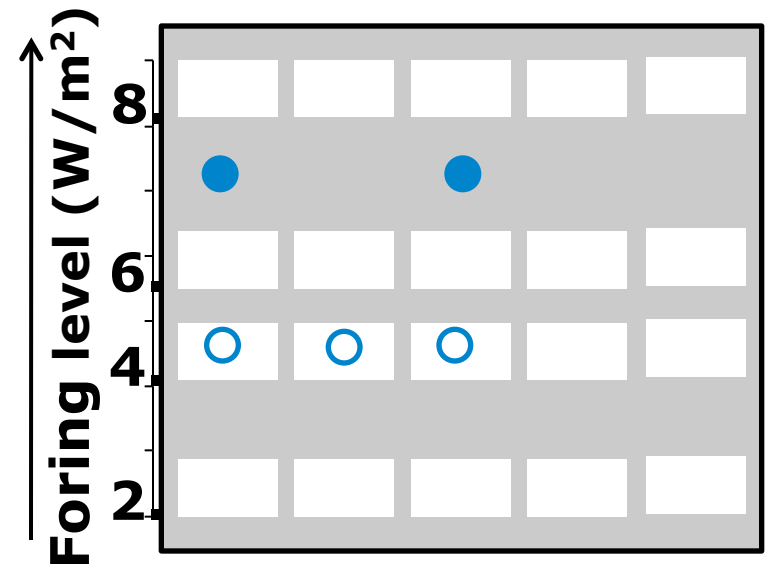
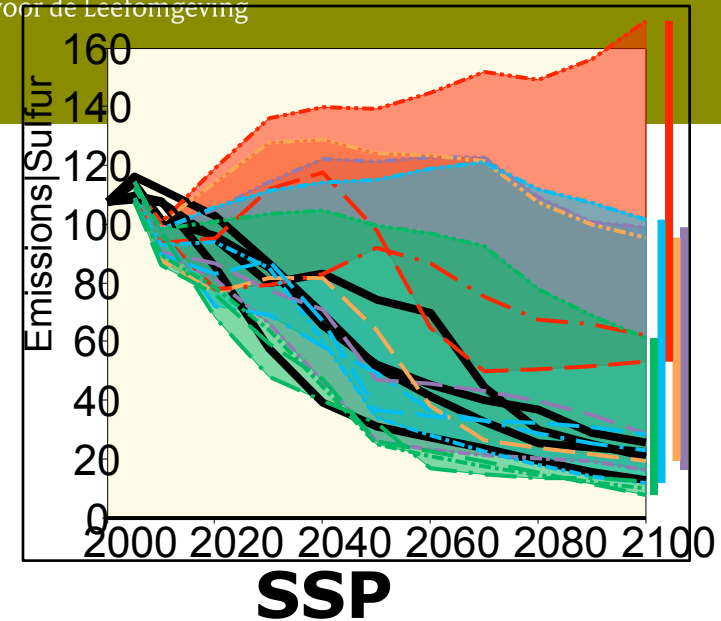
SSP





Relation to aerosol mip

- Select intentionally 2 scenarios with low / high aerosol emissions – but same forcing
- Combine 2 extreme aerosol emission pathways with 1 GHG/air pollution forcing path
- Combine idealised aerosol pattern with 1 GHG/air pollution forcing path.
- Runs specifically designed SLFC scenario.





Additional issues

- Interest of IAV/Climate modelling community: Run ensembles for 1 cell – maybe?
- Use of priority and non-priority runs
- Further development of pattern scaling
- Detailed evaluation of RCP runs

Conclusions

- Selection seems to be best strategy
 - Get enough spread in runs (highest / lowest)
 - Use other runs to address other issues (influence of overshoot, land-use/sulphur, intermediate levels)
- Combine with further development pattern scaling and fast ESM model runs
- Delay final selection – do some further experiments to help making optimal choice.



Additional slides



Objectives session

- Provide an opportunity for IAM/IAV discussion of priorities for scenario experiments to be run in the CMIP6 process, as inputs to the AGCI session the next week to continue developing CMIP6.

- Among the topics that could be addressed are:
 - Which scenarios should be run by ESM models
 - Would there be advantages to focusing on specific time frames, e.g. to mid-century
 - Would it be especially valueable to improve understanding of particular attributes of climate, e.g. extreme events
 - Is there interest in 'overshoot' or other scenario types?

CMIP6

JF

Ongoing CMIP Diagnostic, Evaluation and Characterization of Klima (DECK) experiments:

a small set of standardized experiments that would be performed whenever a new model is developed.

- an AMIP simulation (~1979-2010);
- a multi-hundred year pre-industrial control simulation;
- a 1%/yr CO₂ increase simulation to quadrupling to derive the transient climate response;
- an instantaneous 4xCO₂ run to derive the equilibrium climate sensitivity;
- a simulation starting in the 19th century and running through the 21st century using an existing scenario (RCP8.5).

Characterizing forcing

Paleo-climate

Response to Forcing

Ongoing CMIP Diagnosis, Evaluation, and Characterization of Klima (DECK)

Infrastructure, documentation, coordination

predicta-scenarios

Scenarios

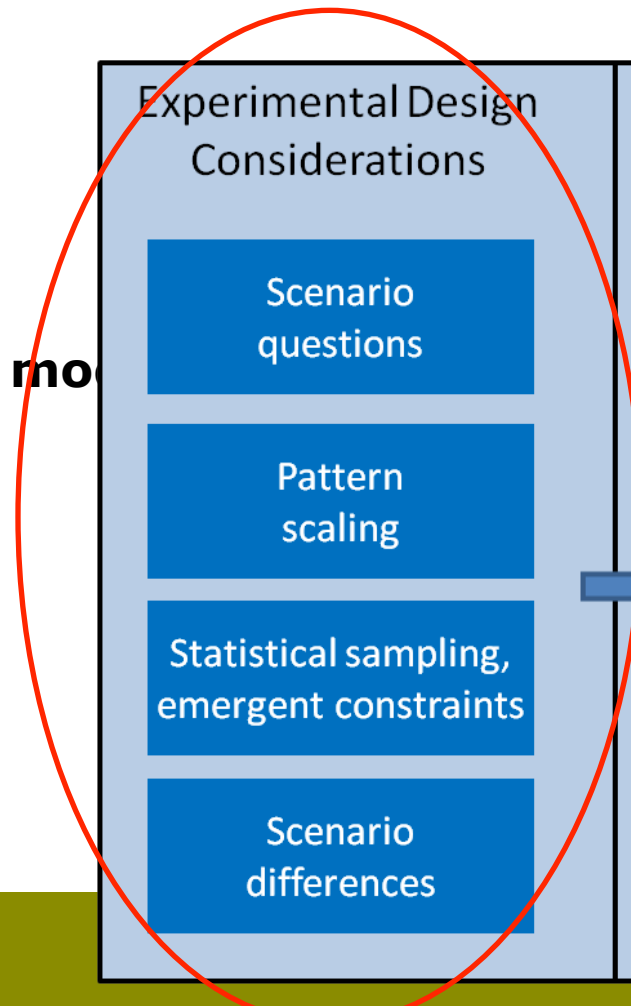
Decadal prediction

- **CMIP6-Endorsed MIPs** would propose additional experiments, and modeling groups could choose a subset of these to run according to their interest, computing and/or human resources and funding constraints.
- The MIPs would also likely have additional experiments that would not be part of CMIP6 but would be of interest and relevant to their respective communities.

Kate

Tasks ScenarioMIP

experimental design



Key questions that needed to be answered before design choices could be made:

- What are actually the questions that we are addressing?
- How important is the range of new scenarios? Could pattern scaling help?
- Could statistical sampling help in designing scenarios?
- How different would scenarios need to be before there are interesting for climate research? Radiative forcing, land use, air pollution?

Brian

Claudia