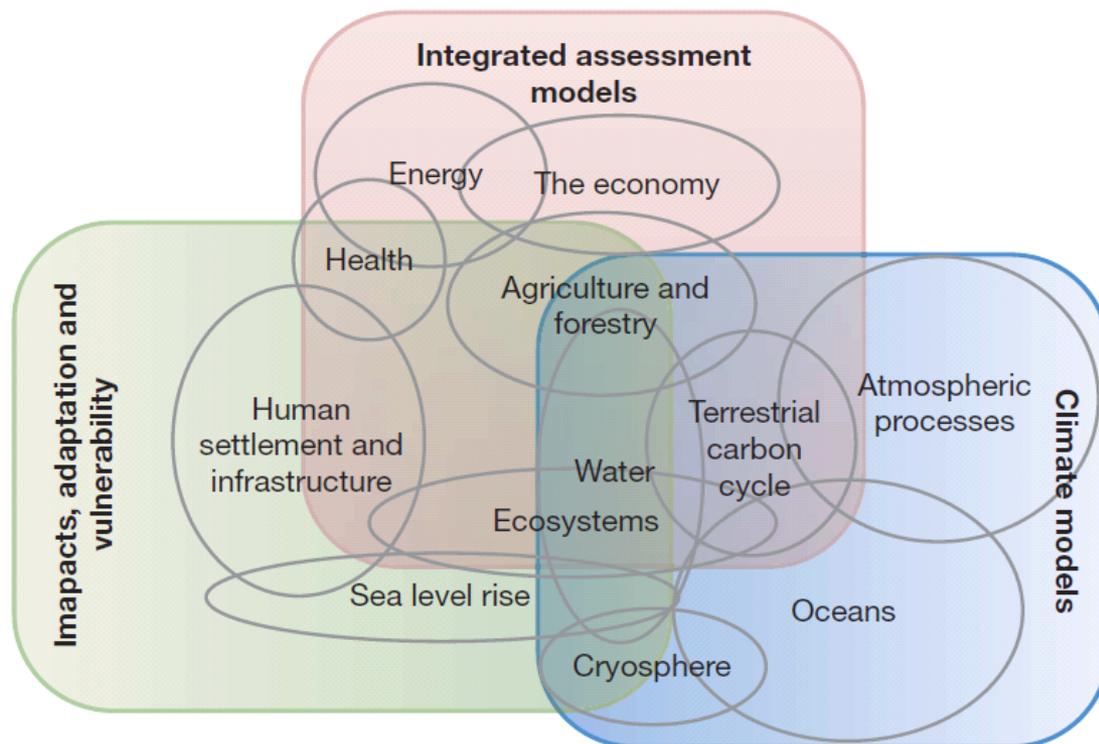
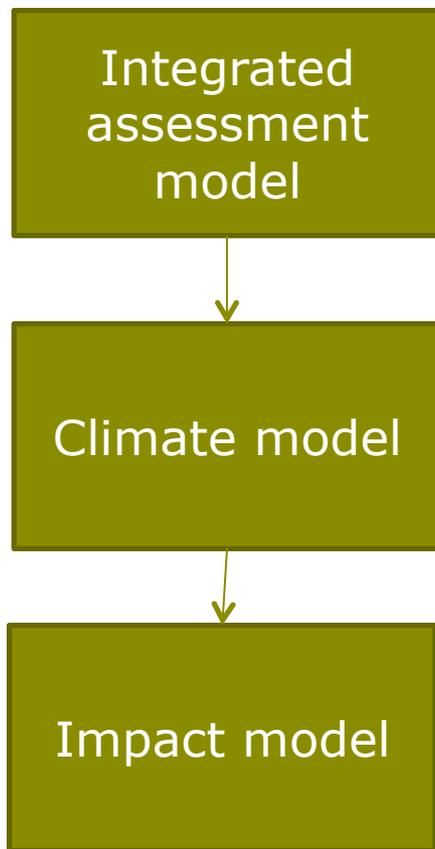




Planbureau voor de Leefomgeving

IAM Science Questions that Require Coupling and/or Inputs from IAV/ESM

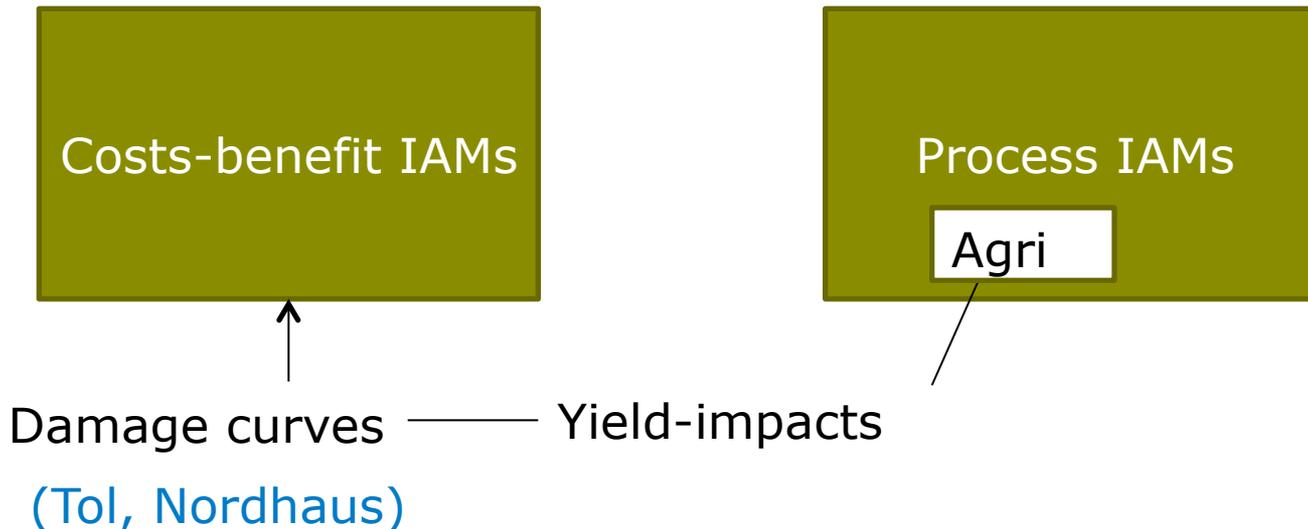
Detlef van Vuuren



What are IAMs and what does this imply for coupling

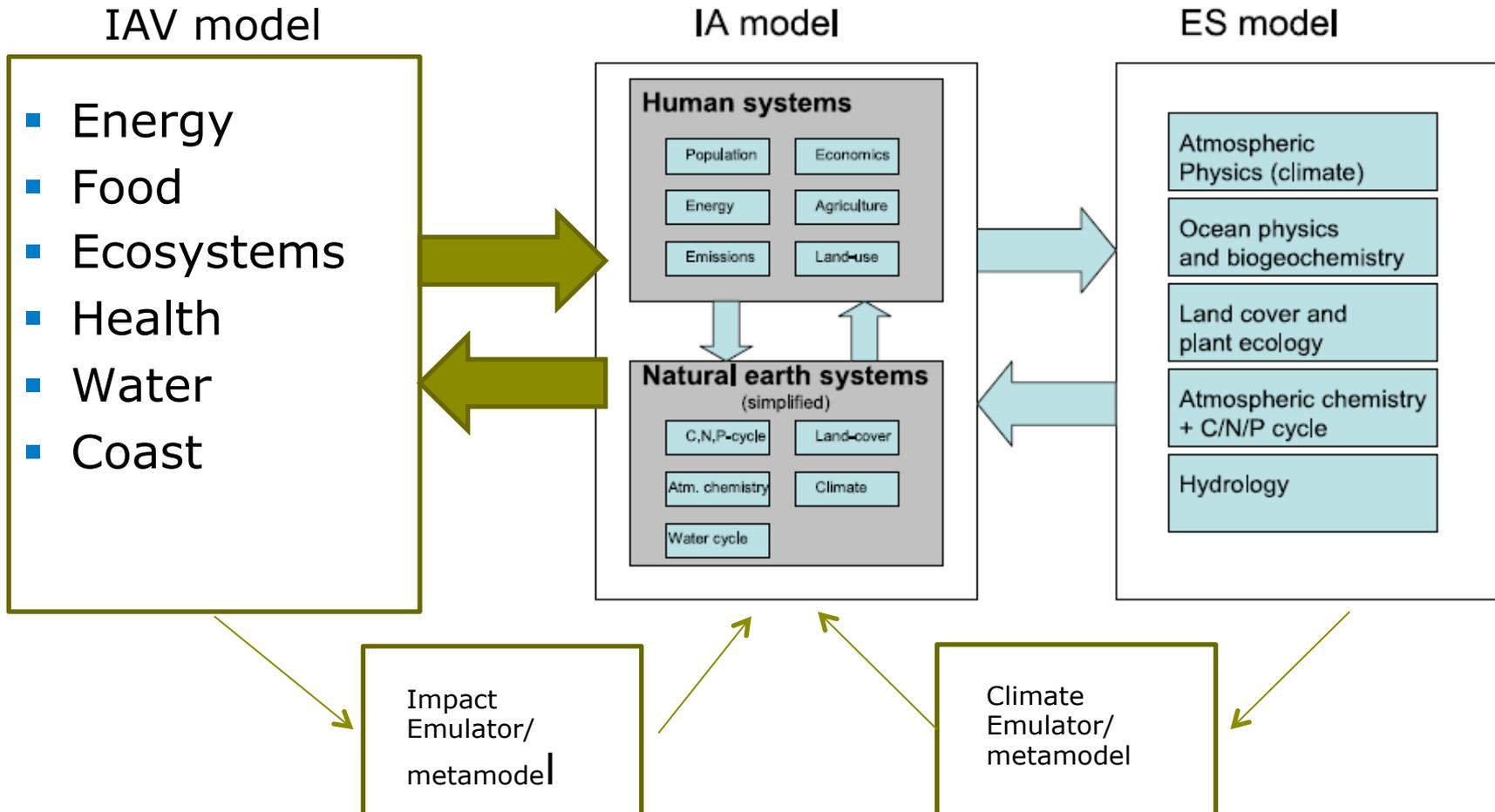
- Integrated assessment models
 - Interaction of human system – earth system (integration)
 - To support policy decisions (assessment)

Integrated models, preferably as simple as possible. Focussed on linkages and uncertainty



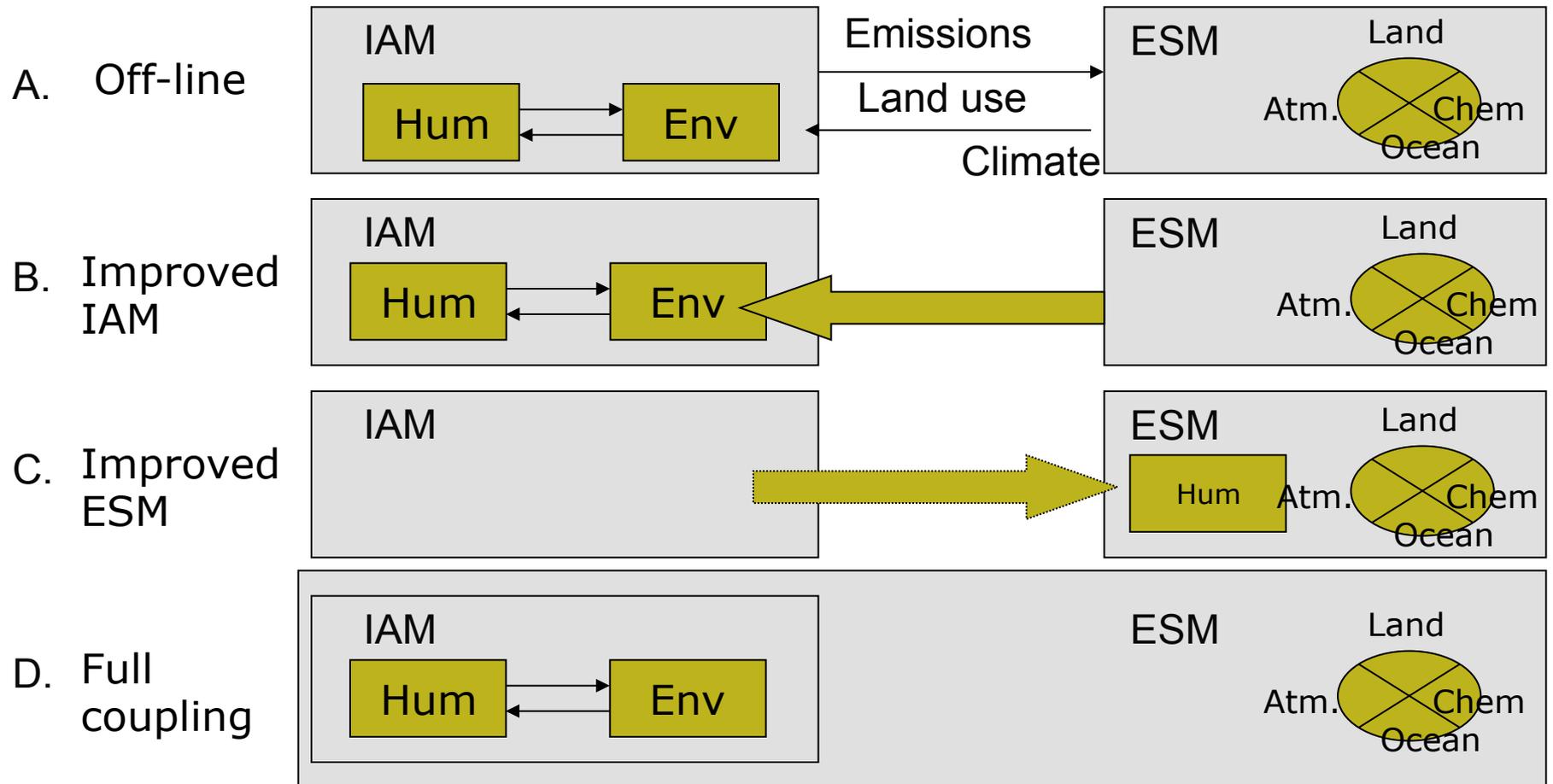


Consideration for best form of cooperation



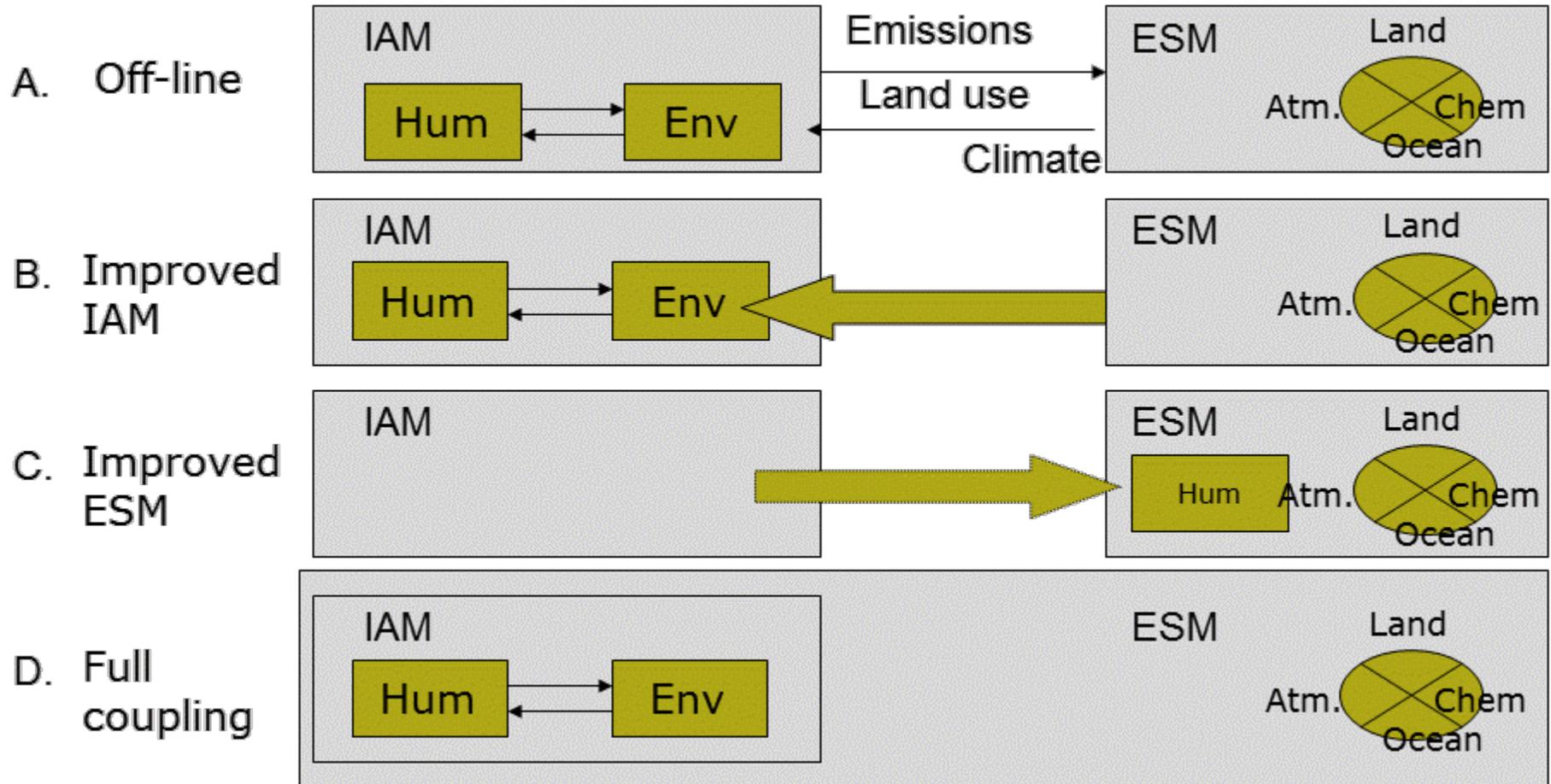


How to organize cooperation?



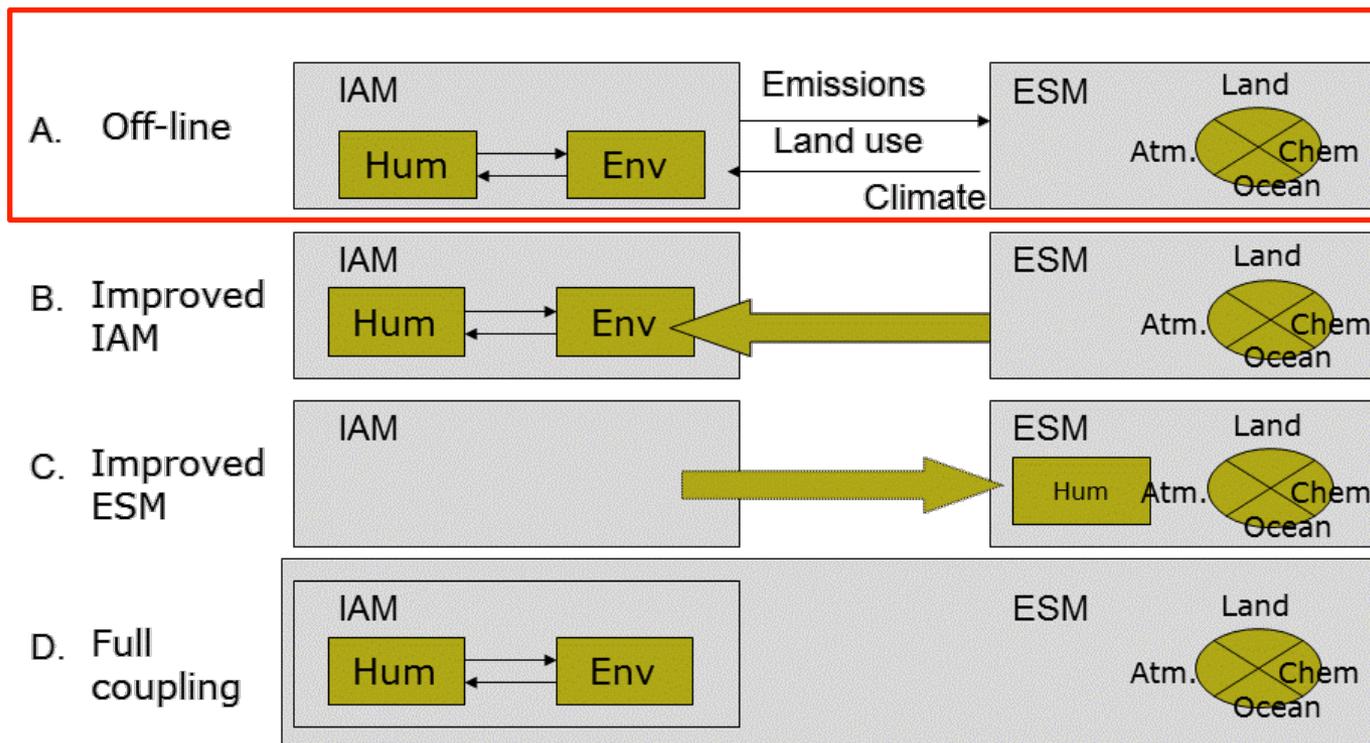


How to organize cooperation?





How to organize cooperation?



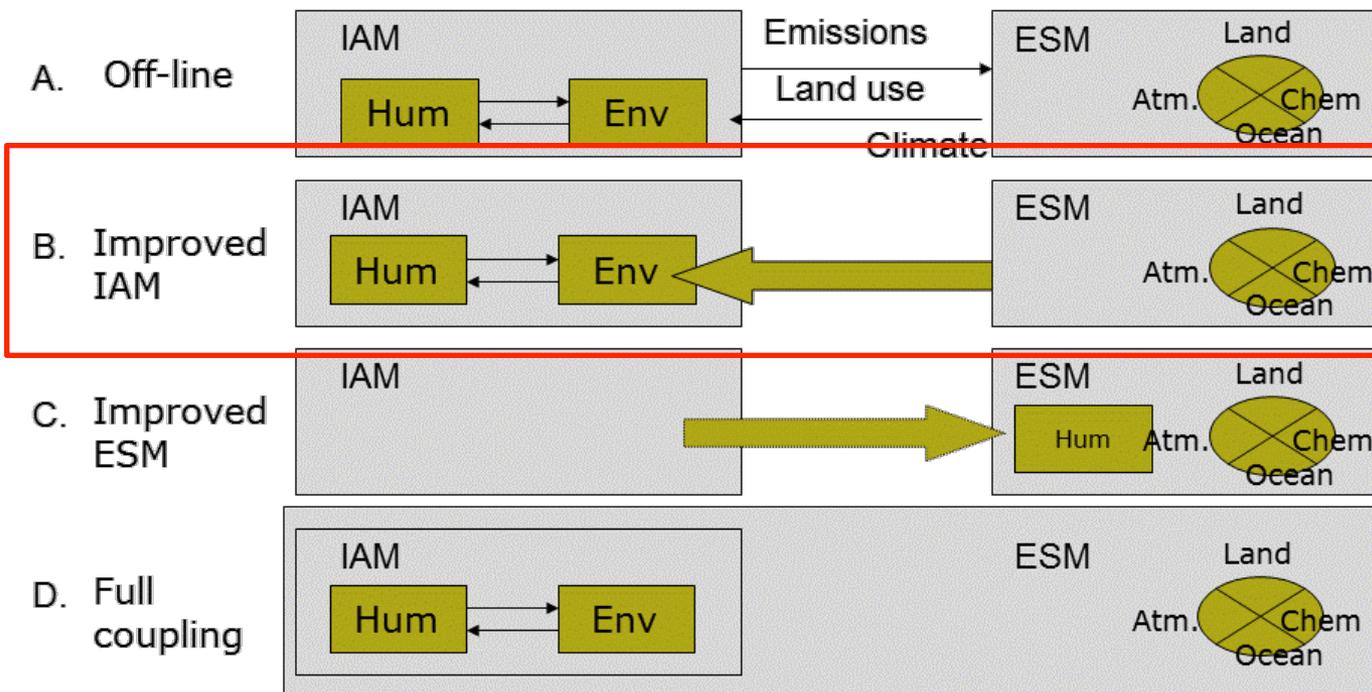
Comparable to current set-up CMIP5/RCPs

- work with existing terminology and tools
- transparent information exchange
- High flexibility : easy exchange of ESMs and IAMs
- separate research strategies
- Feedbacks are only captured via (one-single) iterations.
- potential inconsistencies



How to organize cooperation?

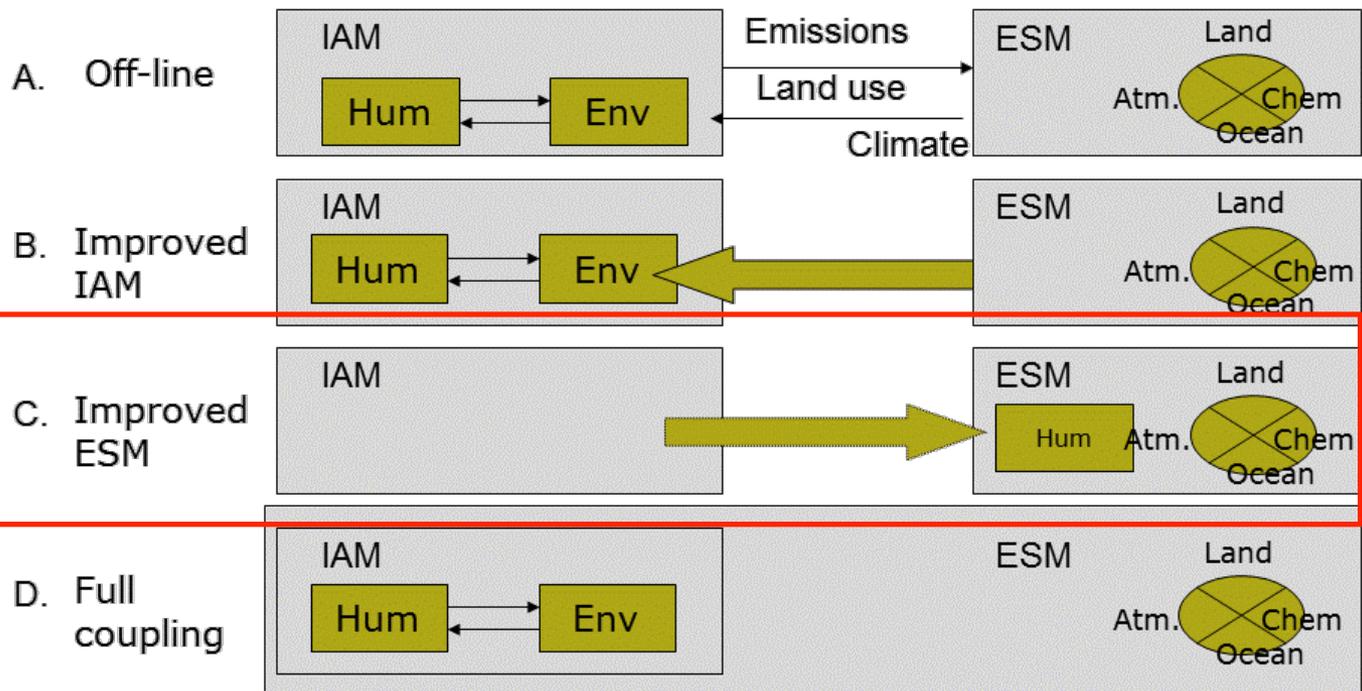
Further improve climate models in ESM (MAGICC emulation of CMIP4 models; pattern scaling; refined pattern scaling (sulphur, albedo etc))



- IAMs designed as integration platform
- allows for good representation of uncertainty
- Flexibility : different ESM might be represented
- model complexity tailored to question
- detail in treatment of socio-economic processes
- lack of detail in treatment of biophysical processes (often meta modeling)



How to organize cooperation?



Further include human system elements in ESMs (e.g. urban environment, land-use rules to better describe land-cover, water consumption rules)

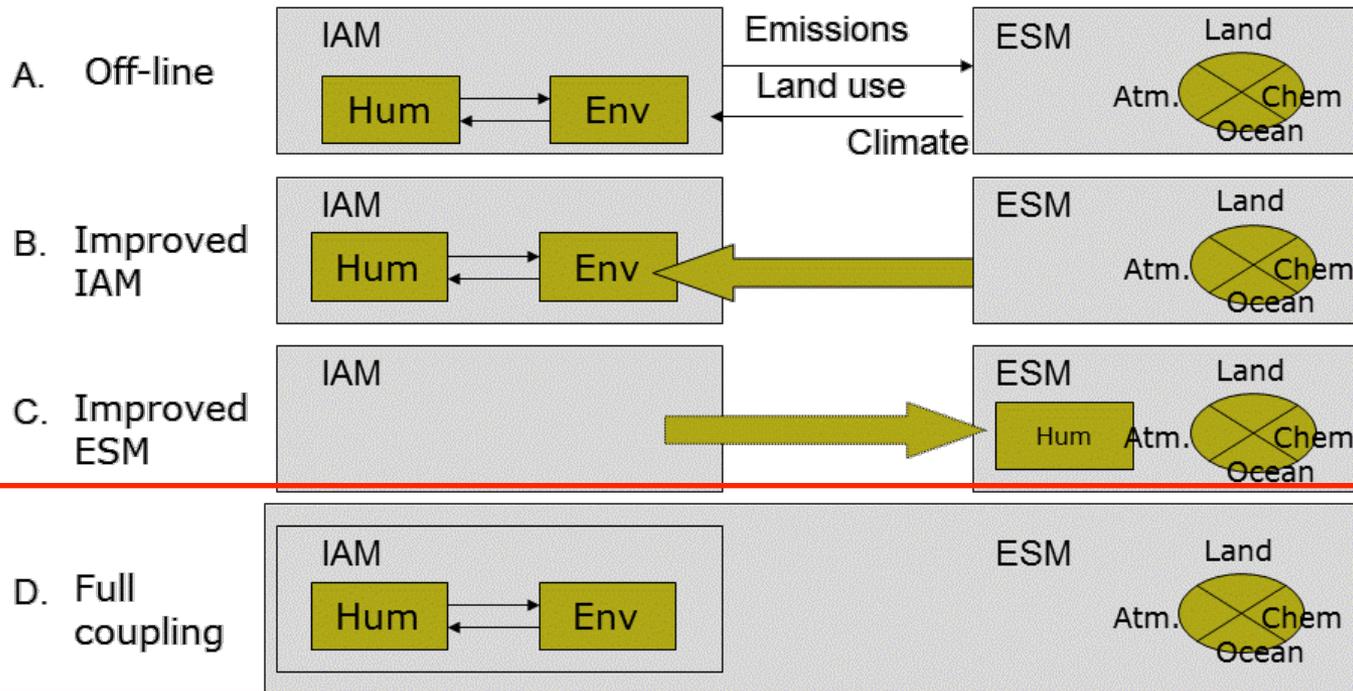
- higher resolution analyses than in IAMs
- detail in treatment of biophysical processes

- lack of detail in treatment of socio-economic processes
- limitation of model runs limits representation of uncertainty



How to organize cooperation?

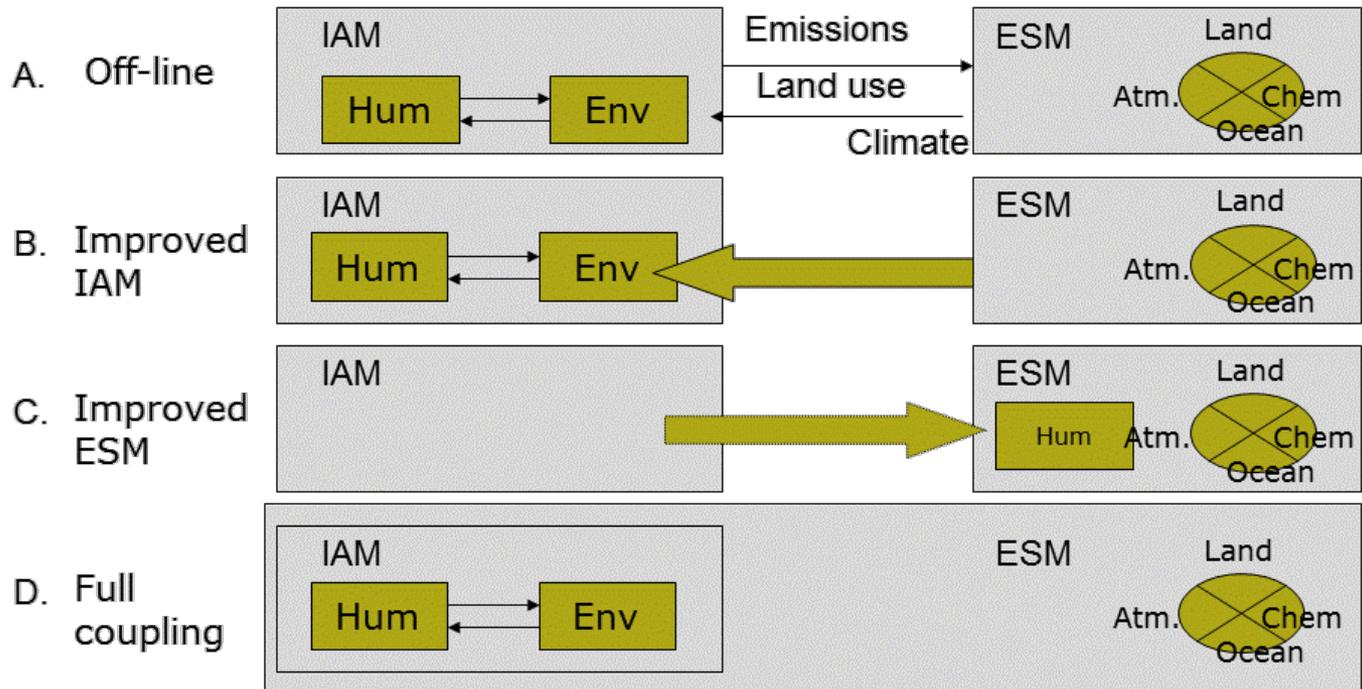
Include full IAMs in ESMs (e.g. iESM, IMAGE-CNRM).



- assessment of feedbacks
- highest degree of consistency
- technical difficulties
- complex cooperation
- lack of representation of uncertainty
- Inflexibility (one IAM, one ESM)
- complexity/ intransparency
- limitations in knowledge may hamper progress



How to organize cooperation?



No feedbacks on humans

Strong feedbacks on humans



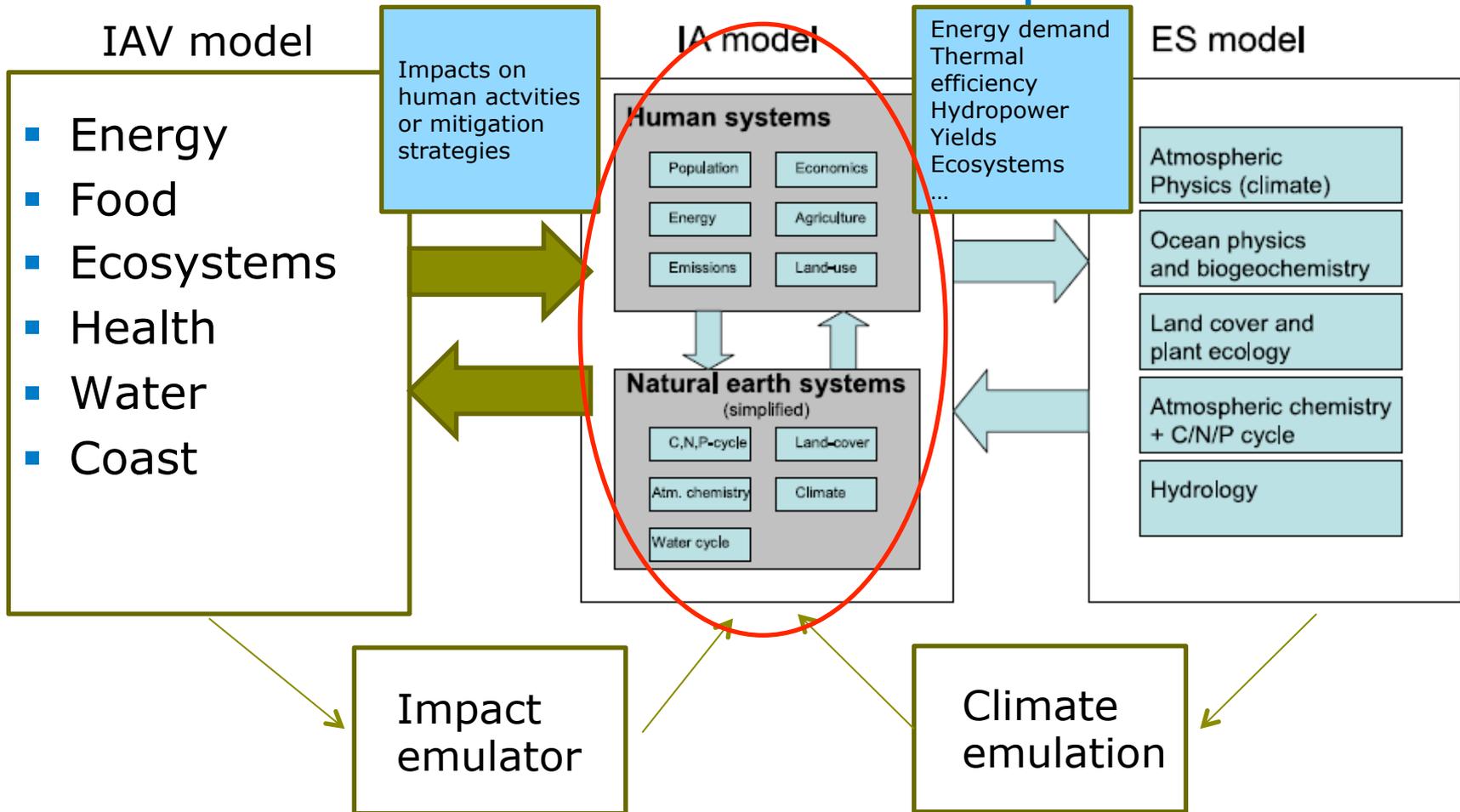
Consideration for best form of cooperation

- One-way linkage dominant (feedbacks are weak, very slow, or non-existent) → **category A**
- Interactions significant in both directions and simple formulation possible → **category B** (e.g. radiative forcing by long-lived greenhouse gases)
- Main focus natural system; simple human system representation possible → **category C** (e.g. land-use rules)
- Interactions (likely) significant and processes are complex (geographical, temporal) and/or cannot be adequately represented in simple models → **category D.**
- Non-linear threshold behavior --> **category D?**
- Uncertainty very large? → **category A or B**, at least to explore uncertainty range. Only if results indicate possible strong feedback → **C or D analysis.**

- In other words, it is only useful to consider complex coupling if potentially strong feedbacks are involved and the processes involved are rather well established.



Consideration for best form of cooperation





Key IAM questions that require coupling with ESMS

- *Interaction between climate change and land use*
 - *Carbon cycle responses (carbon intensity)*
 - *Albedo, heat / water exchange processes.*
 - › Examples: Amazon forest deforestation; monsoon consequences in South Asia.
 - › Use various methods: Method A for exploration; Method D for trying to find potential feedbacks.
- *Impact of climate change on energy use.*
 - Energy use
 - Cooling of thermal plants
 - Renewable energy
 - Relatively well-known, but mostly via aggregated processes. Small impacts (thus category B?).



Key IAM questions that require coupling with ESMS

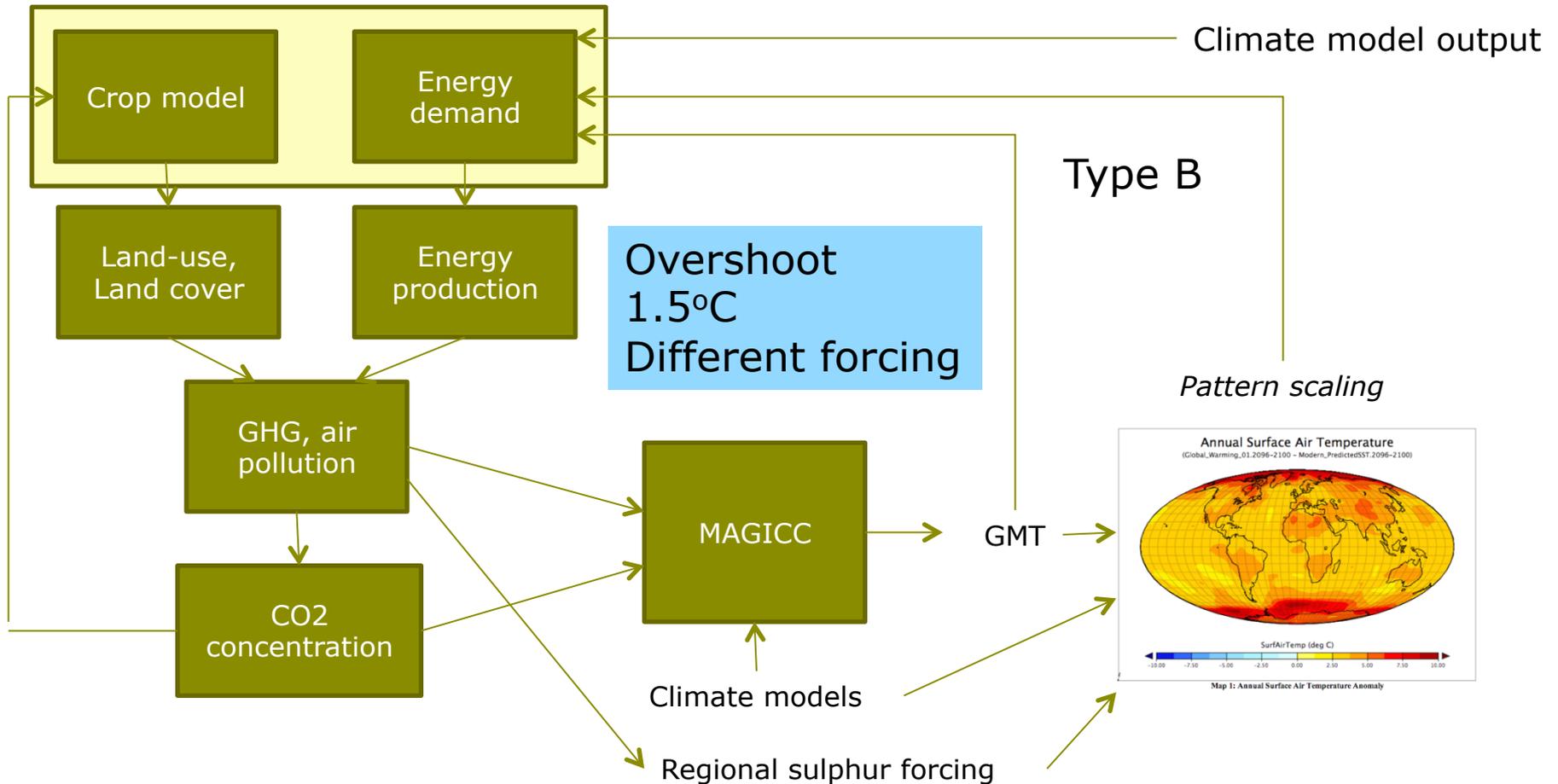
- *Impacts via air pollution (and indirectly climate change)*
 - *Impacts of N, P, S, O₃ on crops and vegetation*
 - *Impacts of aerosols, O₃, S on humans*
- *Impact of climate change on transport and shipping routes*
- *Droughts, availability of water and impacts on societies*
- *Extreme and catastrophic events*
- *Avoiding particular (regional) climate change outcomes or impacts*



Key IAM questions that require coupling with IAV

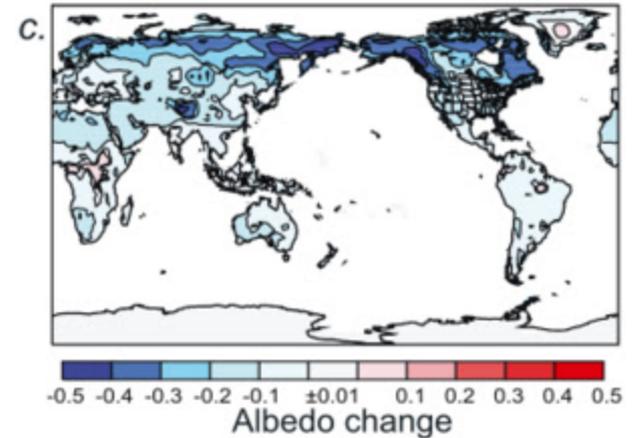
- *Impact of climate change on agricultural yields (temperature and precipitation change and CO2 fertilisation)*
- *Impact of climate change on water scarcity and thus agriculture and water choices*
- *Impacts on human health and thus economic growth and population*
- *Impacts on economic growth/infrastructure (also via adaptation investments)*
- *Natural vegetation/permafrost → C-cycle*
- *Sea level rise → Coastal infrastructure, cities*
- *[Fisheries]*

Including climate in IAMs



Optimal land-use land-based mitigation

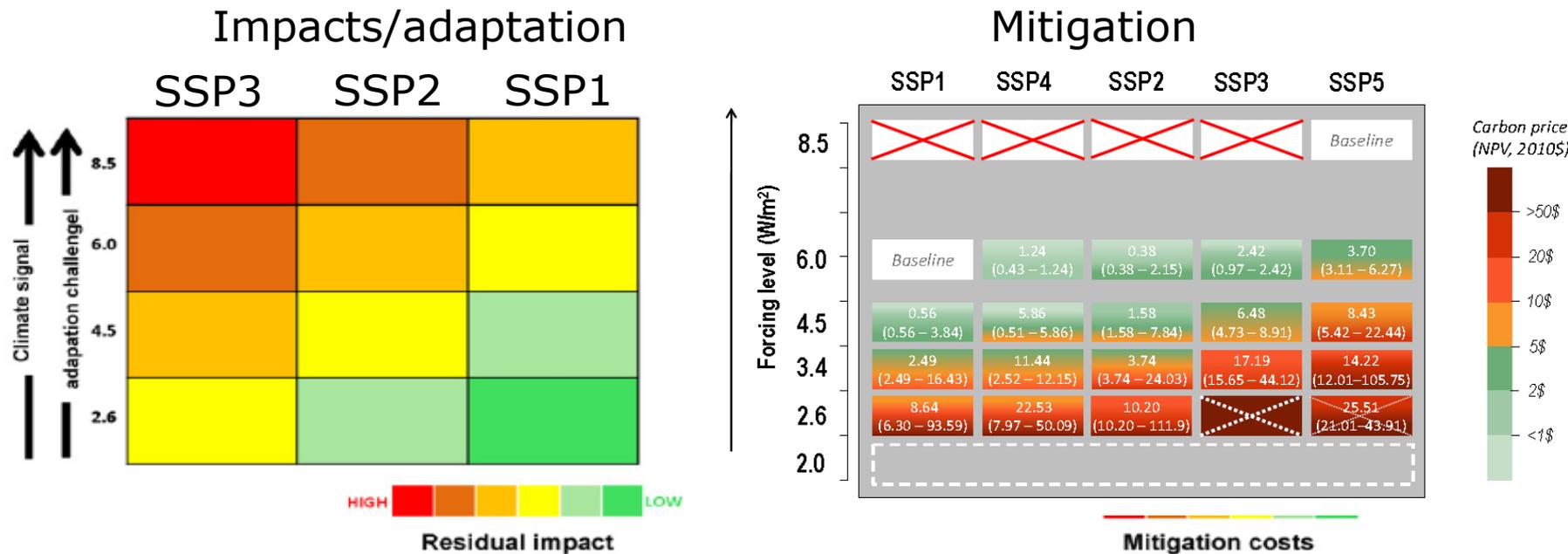
- Land-based mitigation (bio-energy, reforestation, REDD) has impacts on carbon cycle, albedo, local climate)
- Global impacts (via carbon cycle possibly via simple tools) but local effects much harder.
- IAM could optimise deployment based on net impact
- Could be extended to total land-use and also include water



Bonan et al. 2008

SSP integration phase

- Comparison of the costs of mitigation against avoided impacts based on consistent scenarios



This can be done by separate models (using SSPs as connecting element), but also in IAMs to couple possible interaction.



Work on damage curves

- Damage curves in CBA IAMs relatively old
- Would be nice if they can be based on more recent biophysical data (ISIMIP) and more regularly and transparently updated
- Possibly also interesting for process IAMs to built in.

Evaluation of SDGs (possibly with climate policy)

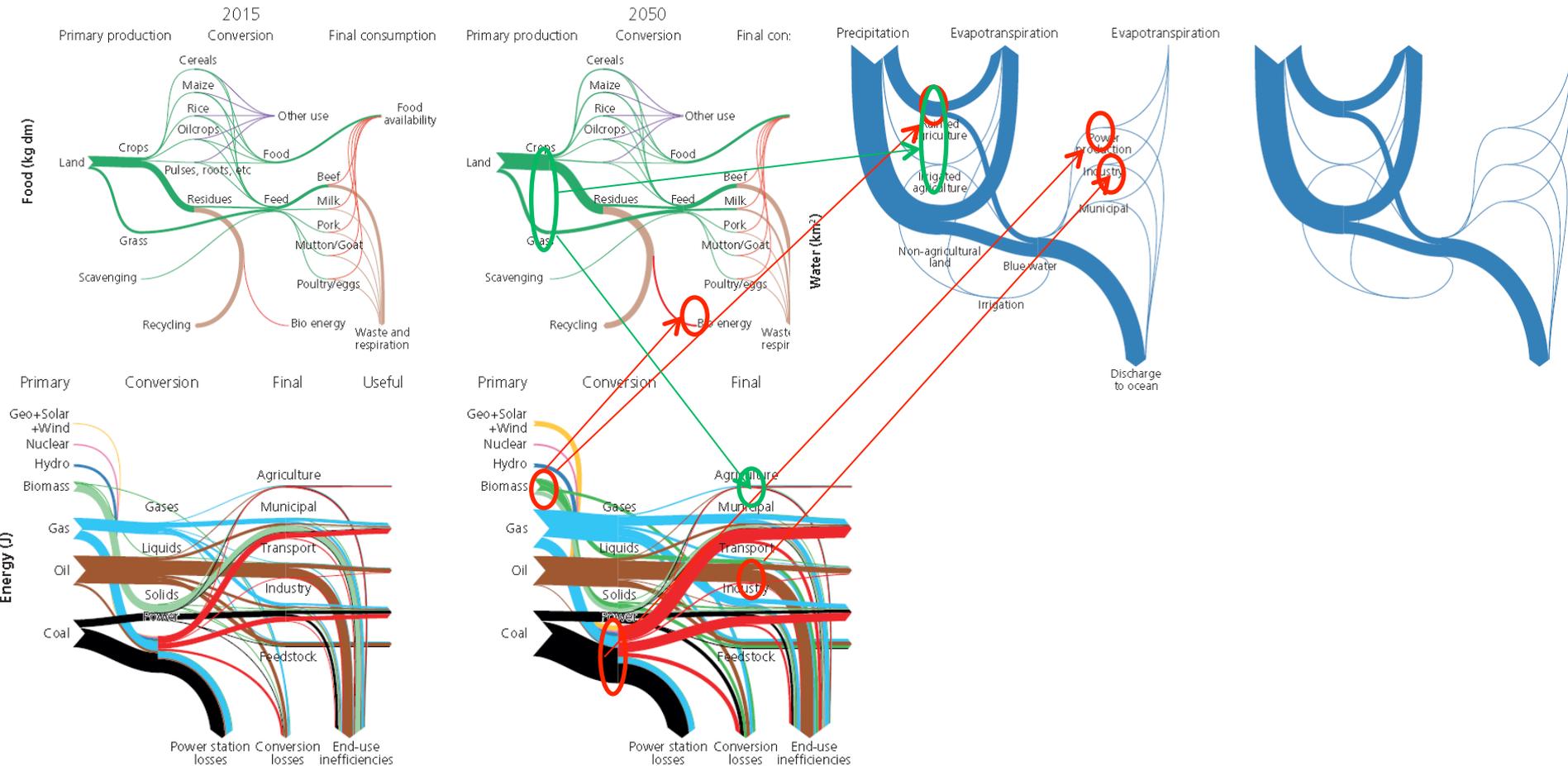
- SDG agreements: 17 goals that should be met at the same time



- What are trade offs?
- Coupling or including more impacts in IAMs
- Meta models or emulators?



Food – water – energy nexus





Conclusions

- Further cooperation between IAM/IAV/ESM needed; can answer more integrated questions.
- Often there are possibilities for more simpler coupling than full integration. Full integration could especially be useful in case of strong, local feedbacks that can be quantified
- Development of more integration tools attractive from IAM perspective
- Clear areas for more intense cooperation are mitigation strategies, integration phase SSPs, SDG evaluation, water-energy-land nexus