Life After the RCPs: Future Coordination With the CM Community

Integrated Assessment Modeling Consortium

Tsukuba, Japan

Jae Edmonds and Nebojsa Nakicenovic
September 15, 2009

PNNL-SA-60765

Acknowledgements

- Thanks to Kathy Hibbard for use of her slides from the Snowmass presentation of IAM-CM interactions.

- Thanks to Detlef van Vuuren Keywan Riahi for use of their slides.

A Brief Recap from this Morning

Three major user communities:

1. Climate modeling community—need scenarios to provide a coherent, internally consistent, time-paths for Earth System Models.
2. Impacts, adaptation & vulnerability modeling community—need scenarios to provide a coherent, internally consistent, time-paths to assess the consequences of potential climate changes and to set the context for adaptive strategies.
3. Integrated assessment community—to provide a coherent, internally consistent, time-paths to assess the costs of emissions mitigation

Origins of the IAM-CM Collaboration

WCRP REPORT
World Climate Research Programme




AIMES and WGCM

AIMES/WGCM led series of workshops towards the use of Earth system models in climate change assessments.
In 2006, a joint meeting with representatives from IA and IAV communities


AIMES

WCRP World Climate Research Programme

AGCI Aspen Protocols

Three major outcomes:

1. Multi-temporal phase for climate model runs:
   - Near-Term (2005-2030) – e.g., extreme events, air quality
   - Longer term (to 2100 and beyond) – climate inertia.

2. Carbon Cycle Diagnostic Experimental Design

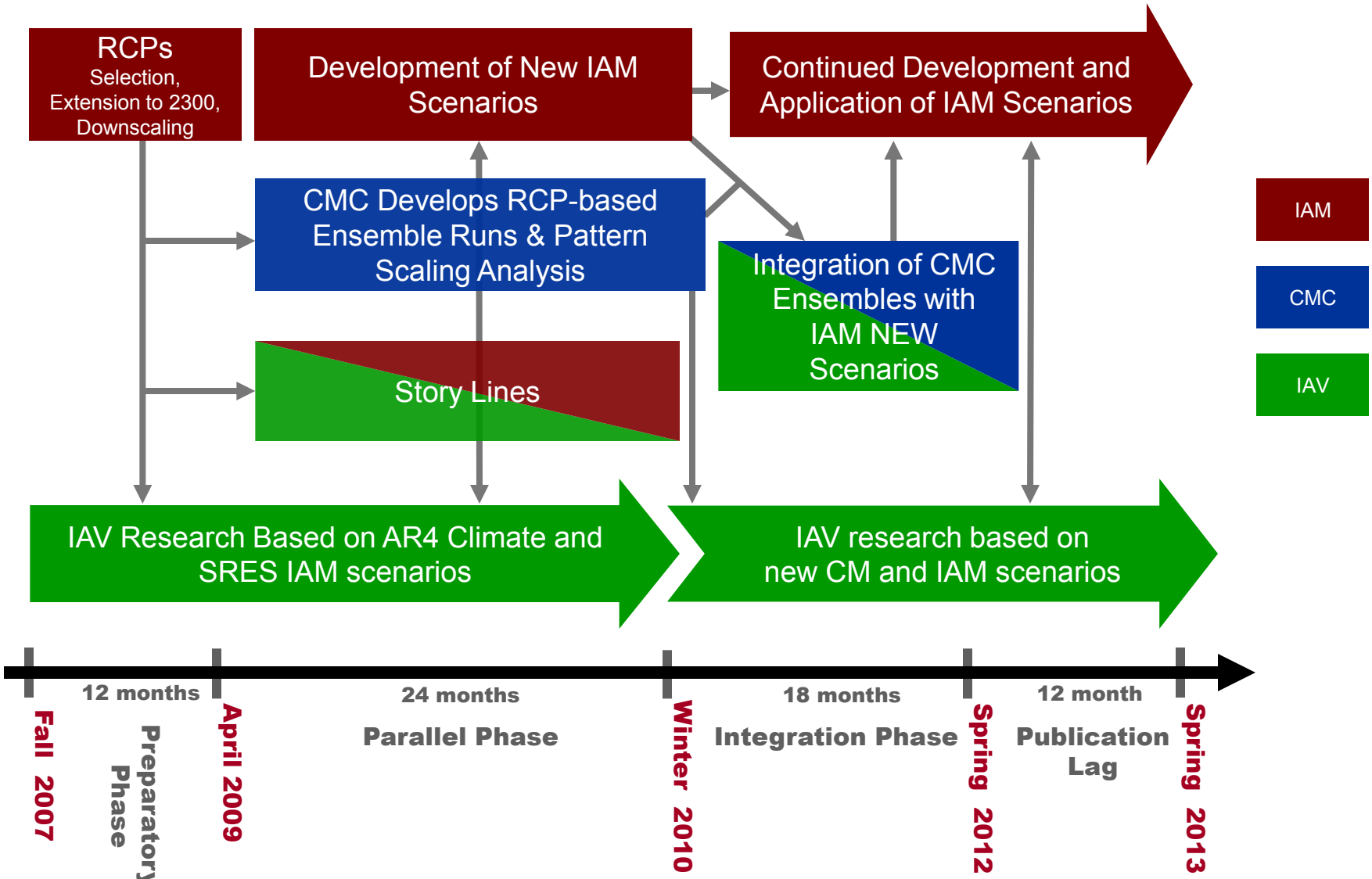
3. Coordinated IAM/CM New Scenarios:
   Representative Concentration Pathways (RCPs)

Beyond the RCPs

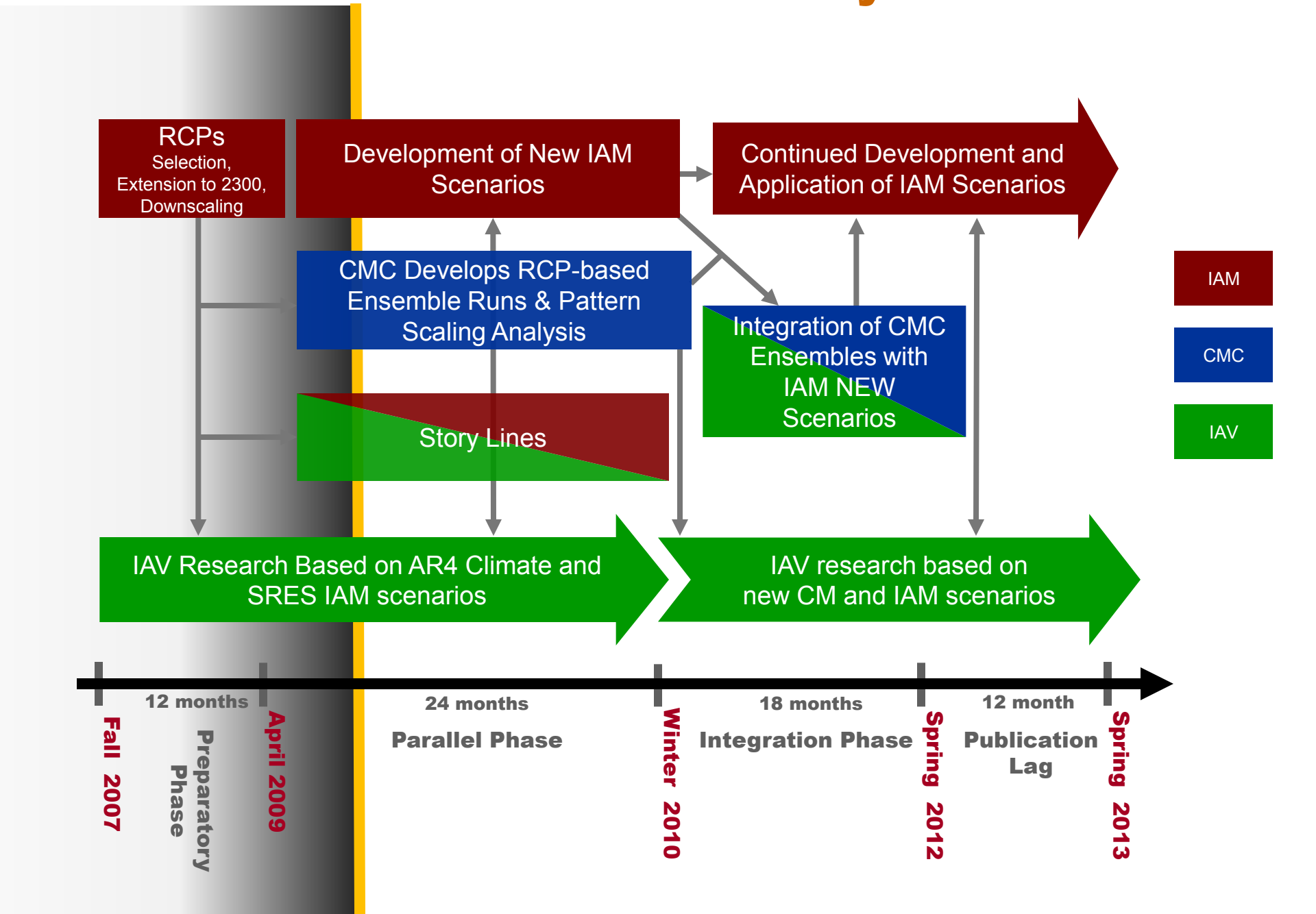
- Representative Concentration Pathways were the —down payment" by the IAM community in terms of development of a —scenarios-based" literature that could be assessed by the IPCC in the AR5.

- This presentation is about what comes next.

Time Line & Critical Path of Scenario Development



Where are we today?



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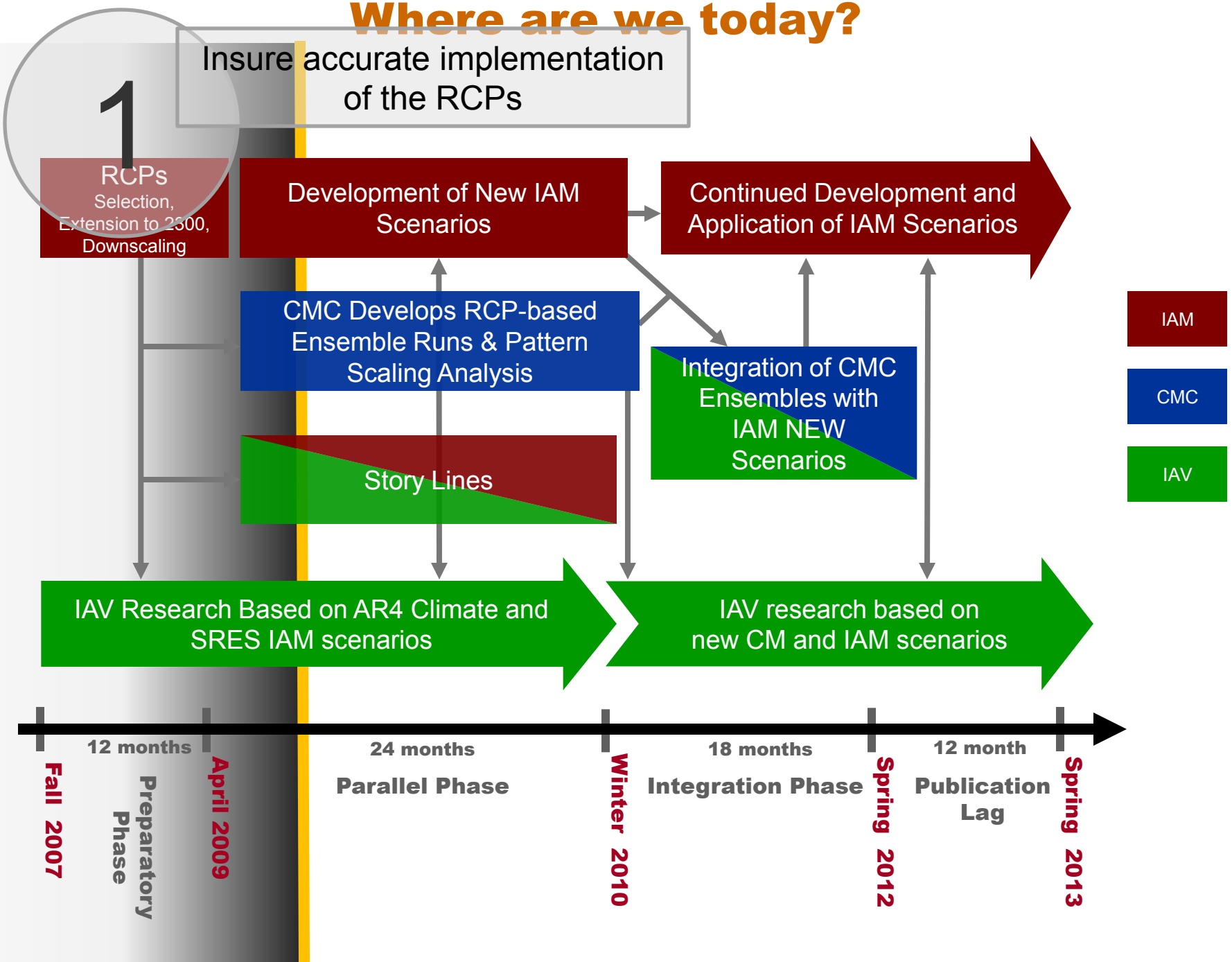

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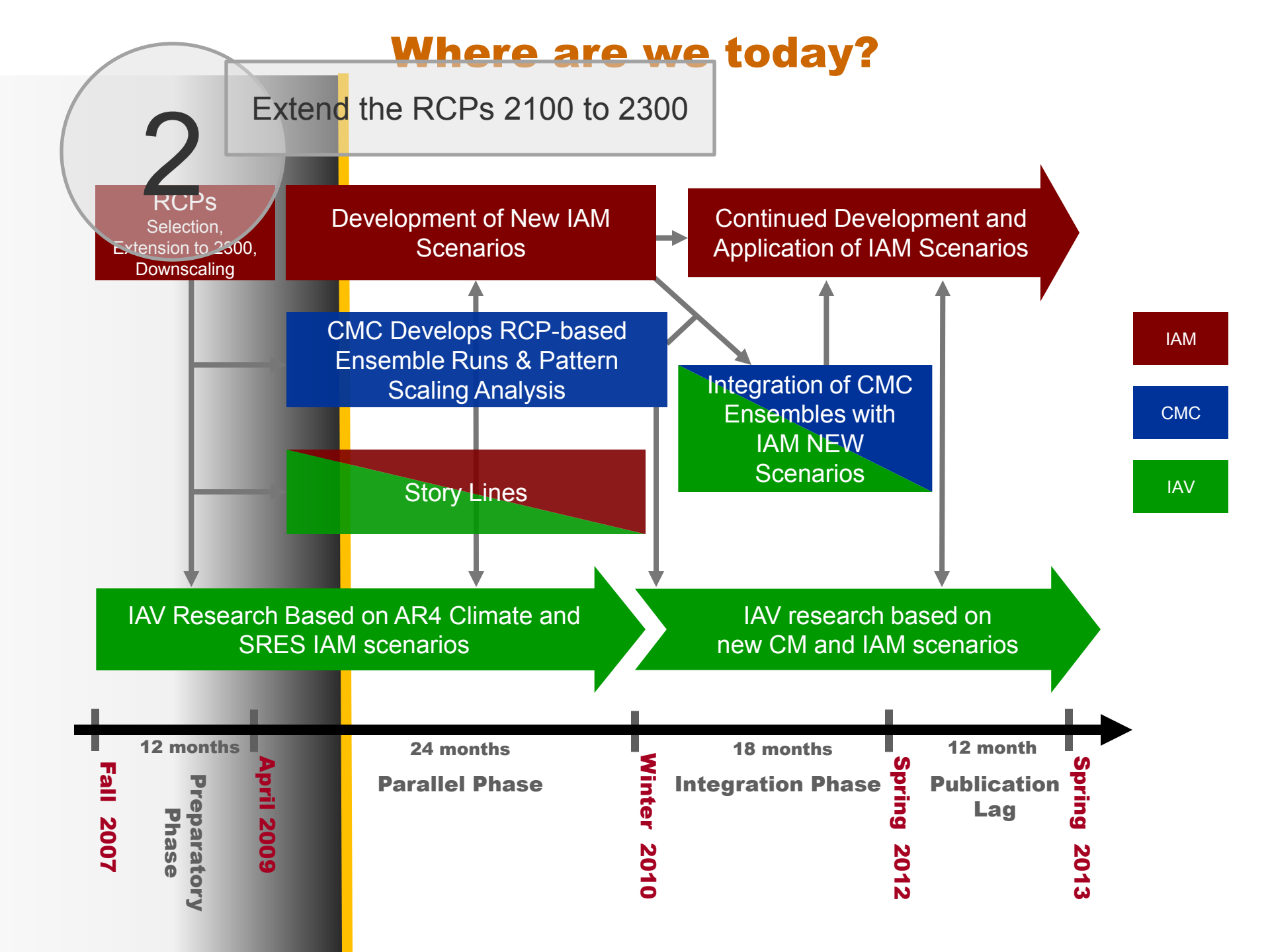
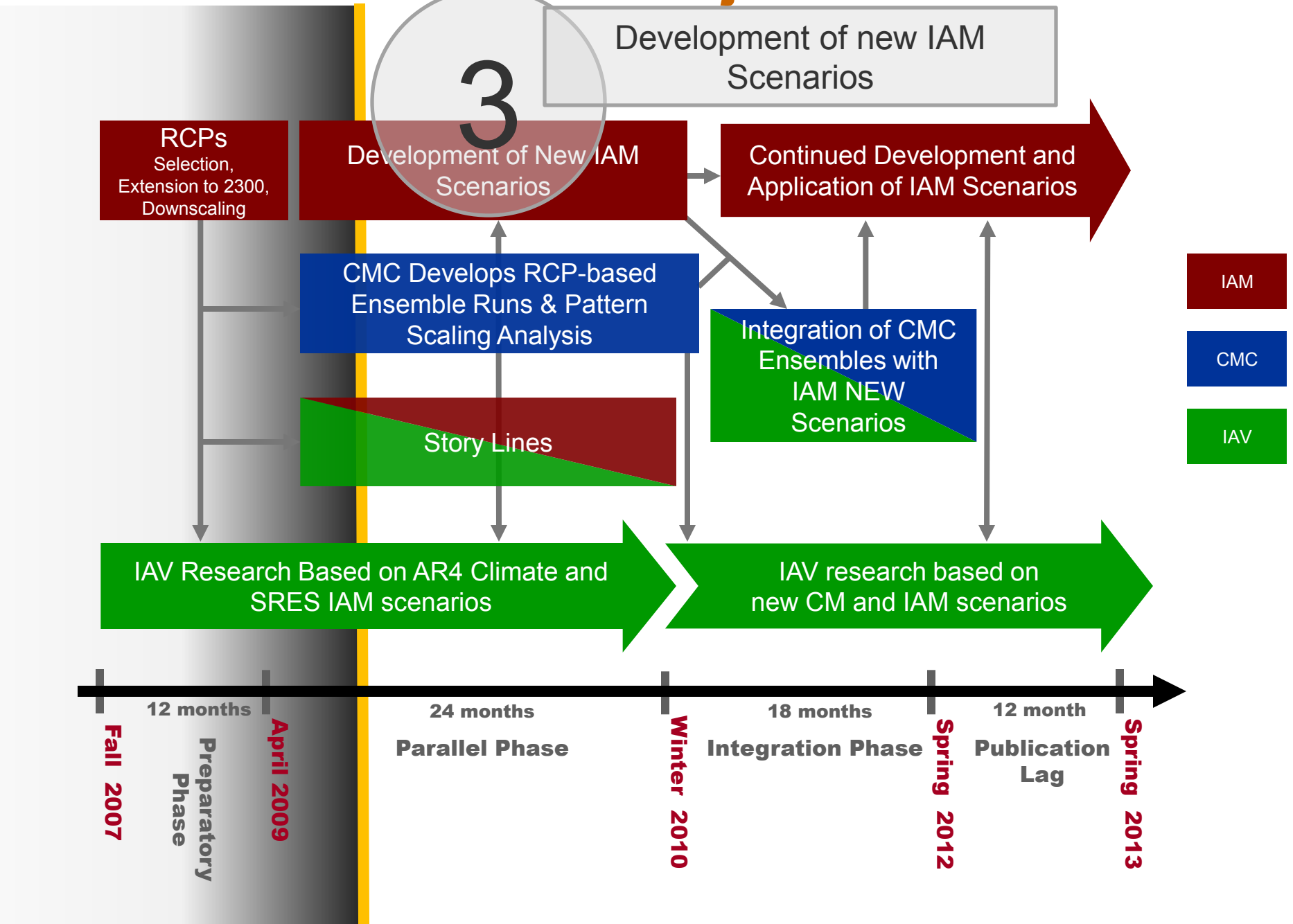


Work Within the Noordwijkerhout Framework



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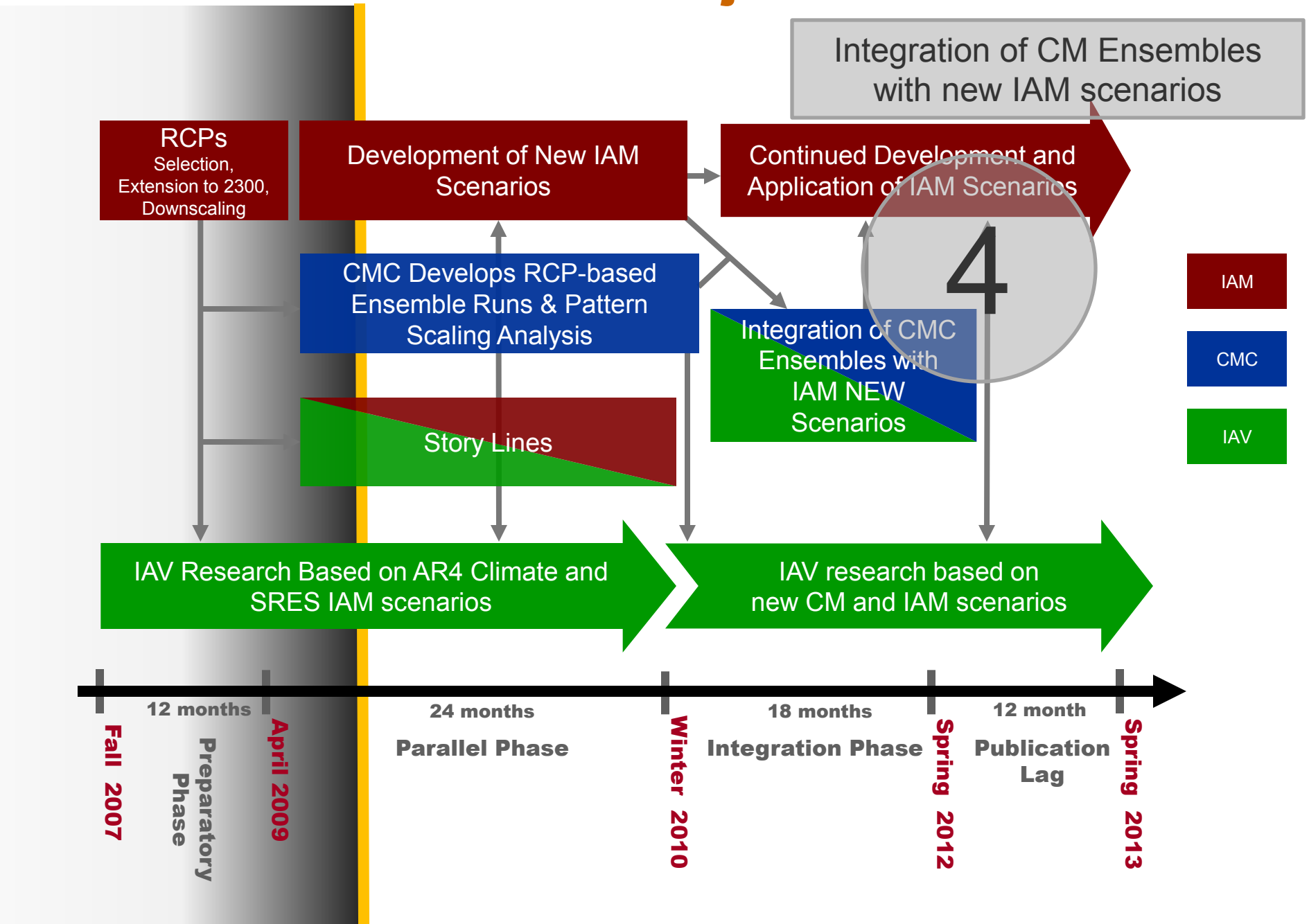

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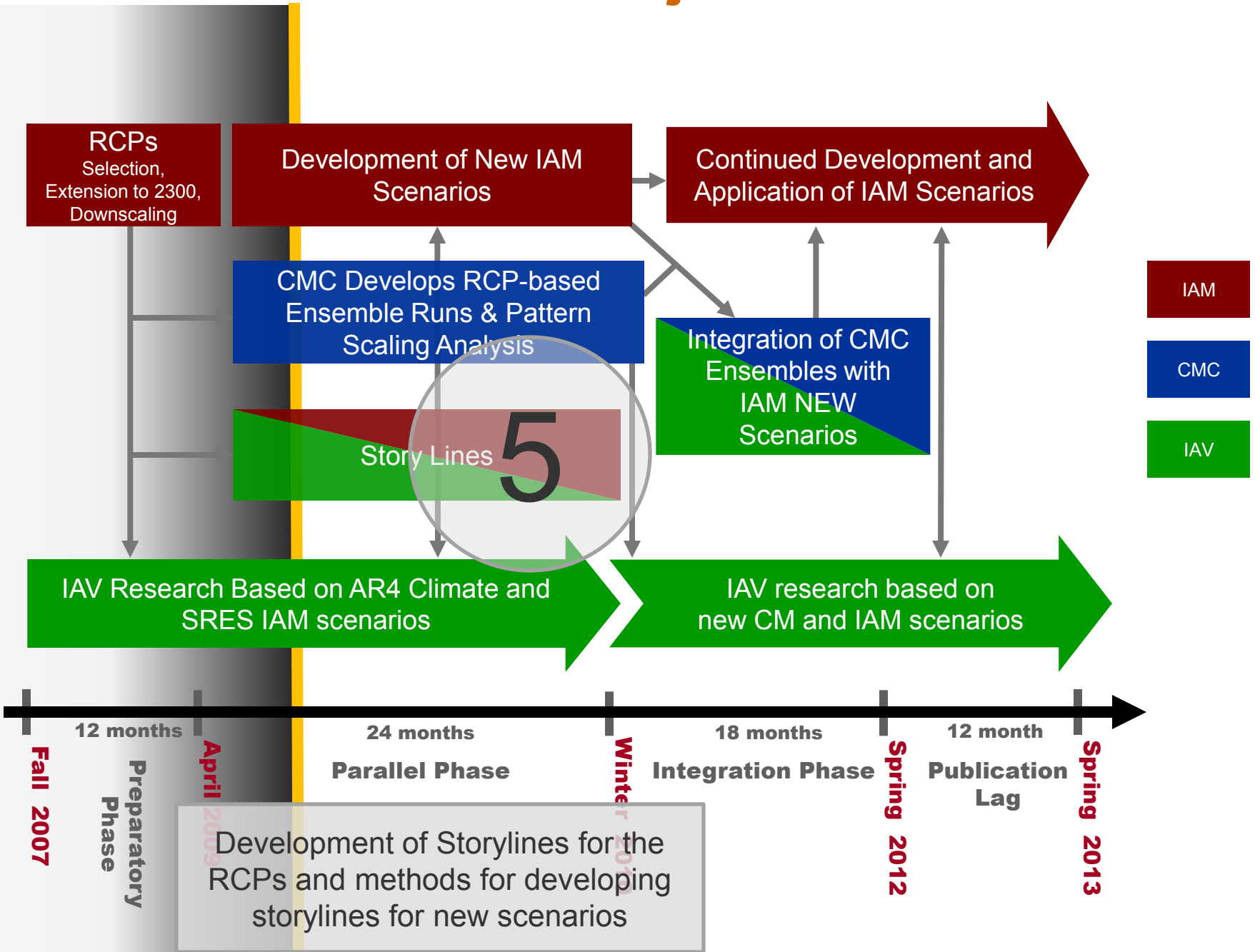

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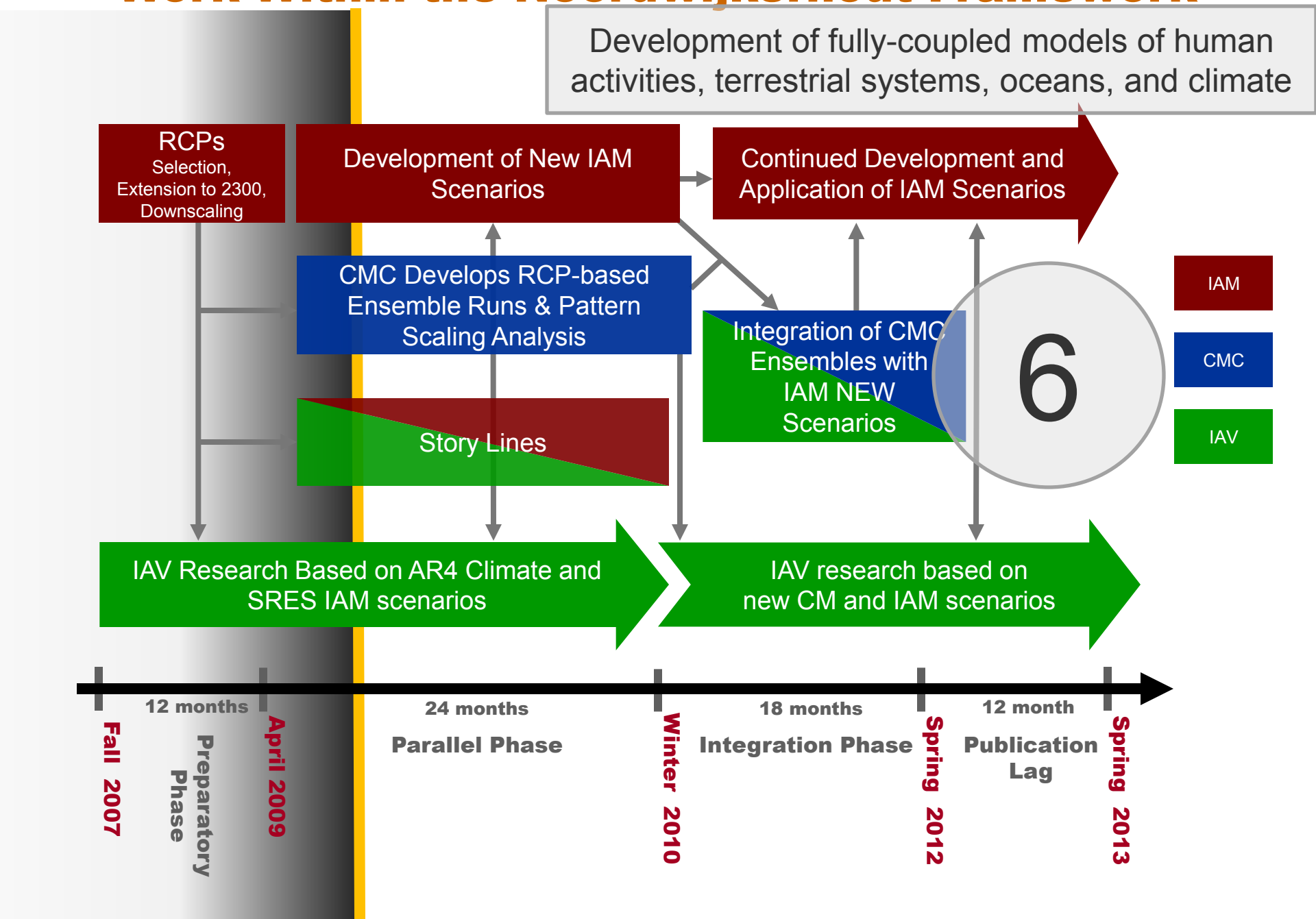
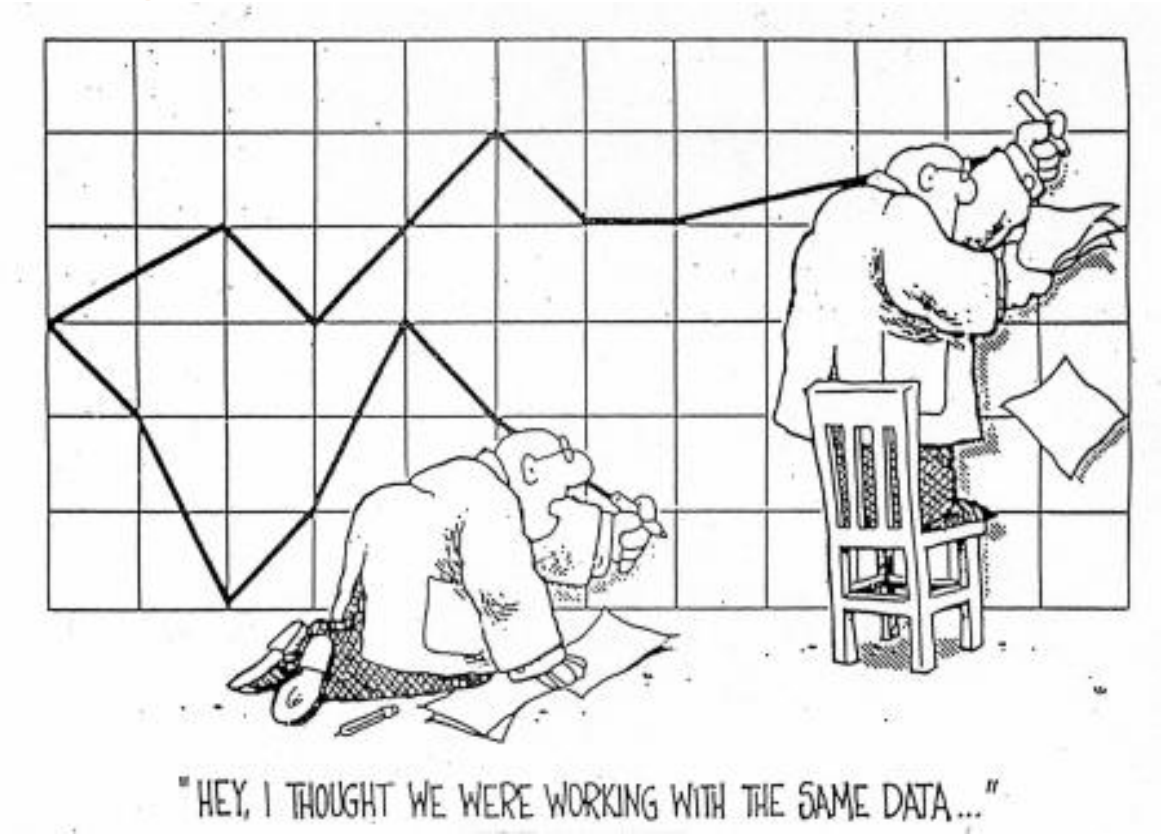


Insure accurate implementation of the RCPs.

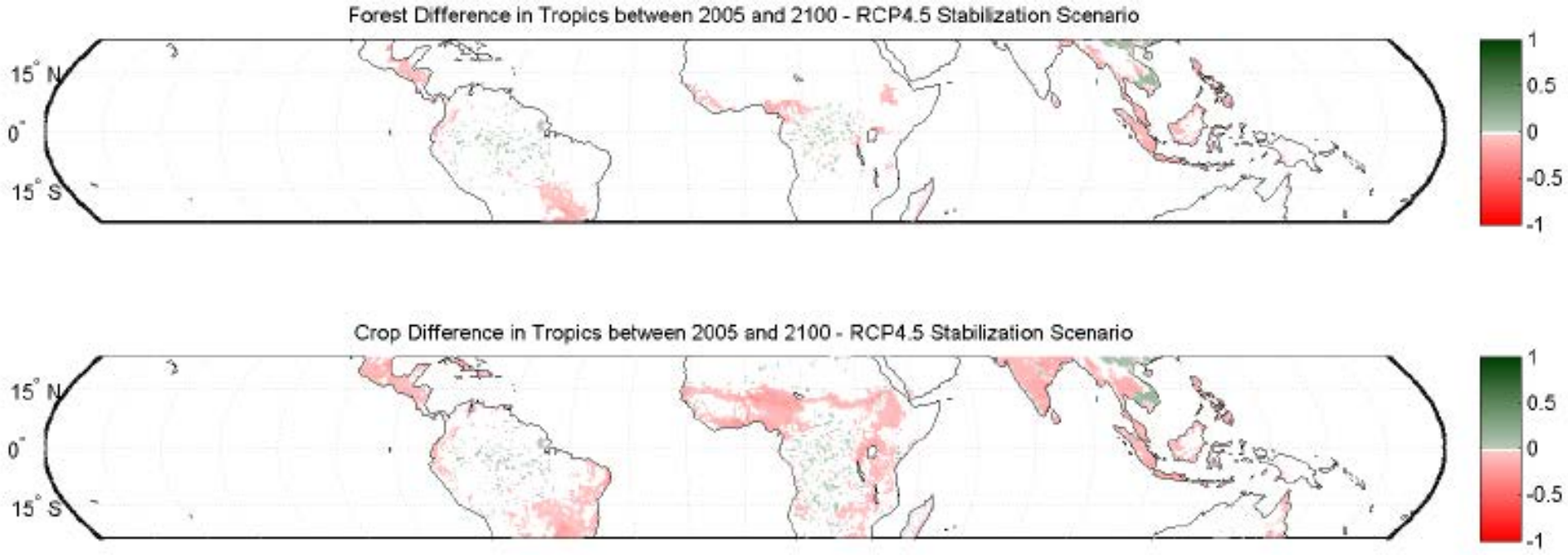
ESM implementation of RCP land use/land cover change through UNH harmonization



1. Insure accurate implementation of the RCPs

- The RCPs aren't finished until the climate models finish the ensemble calculations.
  - Right now we are in the process of reconciling the scenarios that the climate models run with the RCPs that were produced by the IAMs.
    - At Snowmass Kathy Hibbard's presentation included an update on the downscaling of land-use and land-cover data from RCP4.5 by UNH and its initial implementation by CLM modelers at NCAR.
    - Kathy stated that in the NCAR implementation RCP4.5 had DEFORESTED the Amazon Basin.
    - The RCP4.5 authors in the room rose up in arms.
    - RCP4.5 is an afforestation scenario that protects and expands both managed and unmanaged forests.
    - **Immediate reconciliation followed.**
  - **This is a simple example of the post-RCP issues that need to be worked out with the climate modeling community.**

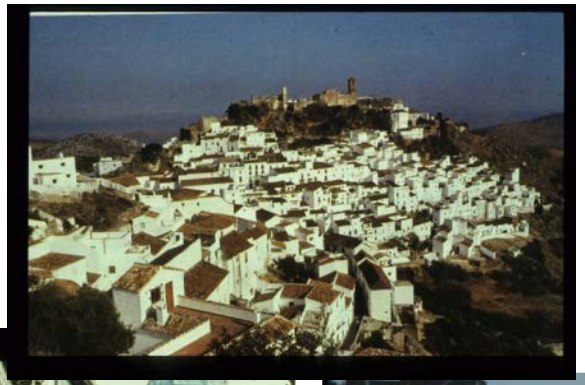
UNH Forest and Crop Maps for RCP4.5, September 11, 2009



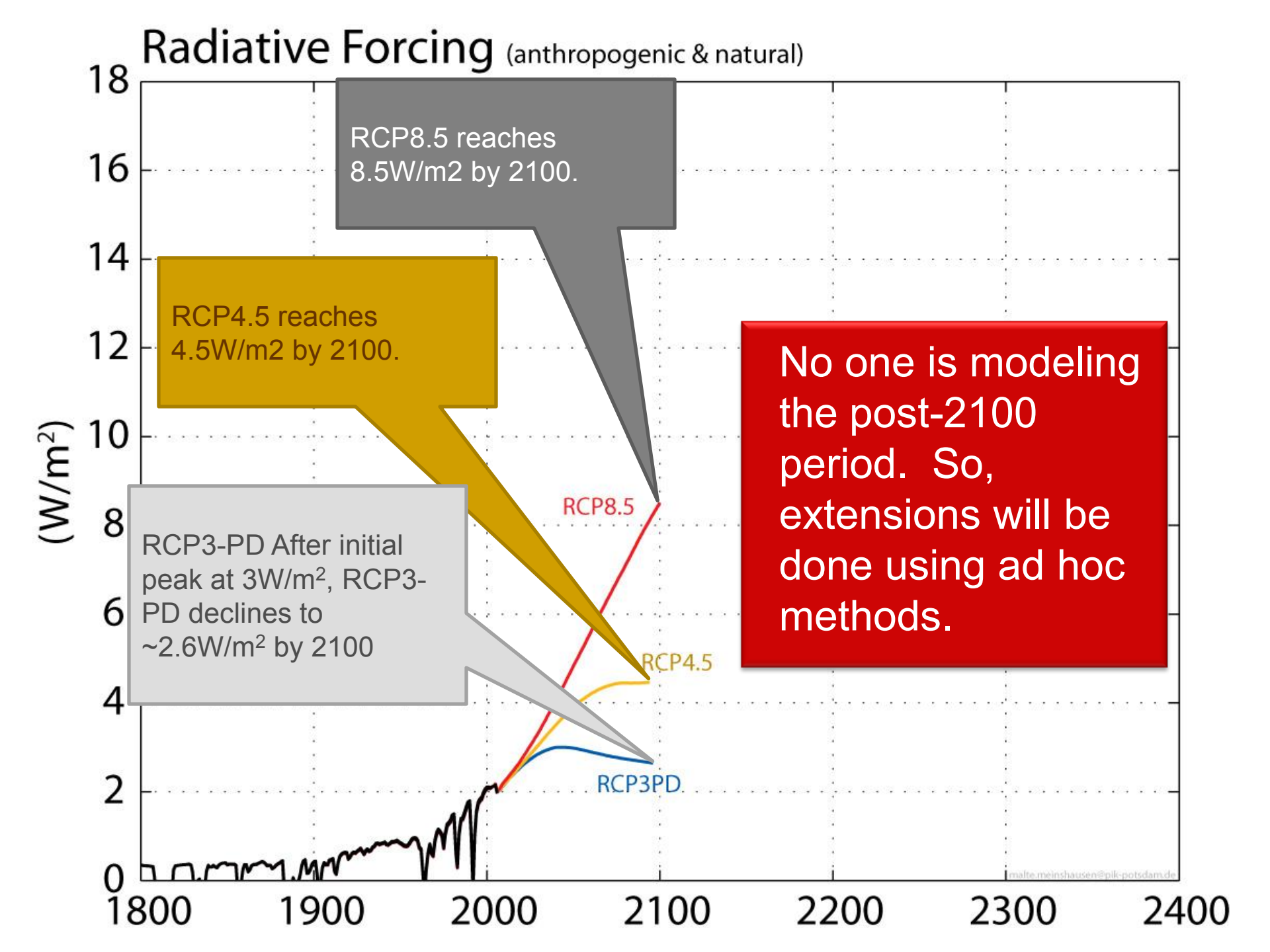
Implementation: Issues of definitions

e.g. What is Pasture/Grazing?

Defining Classes: What is Urban?



Extend the RCPs 2100 to 2300


Radiative Forcing (anthropogenic & natural)
(W/m²)
18
16
14
12
10
8
6
4
2
0
1800
1900
2000
2100
2200
2300
2400
RCP8.5 reaches 8.5W/m2 by 2100.
RCP4.5 reaches 4.5W/m2 by 2100.
RCP3-PD After initial peak at 3W/m², RCP3-PD declines to ~2.6W/m² by 2100
No one is modeling the post-2100 period. So, extensions will be done using ad hoc methods.
RCP8.5
RCP4.5
RCP3PD
malte.meinshausen@pik-potsdam.de

Overview of the options

		High RCP 8.5	Medium-high (RCP6.0)	Medium-low RCP4.5	Low RCP3-PD
1	Constant Forcing	Roughly 1000 ppm CO_2 → Kink in emissions	Roughly similar to SRES A1B → ‚Stabilisation' case	Roughly 550ppm CO_2	No decline of forcing after 2100. → contradicting Peak & Decline design specs
2	Adapted Emissions	2a: roughly 1500ppm CO_2 2b: roughly 2000 ppm CO_2 → Middle ground?	Could return to RCP4.5 by 2100 or later. → 'overshoot' RCP 4.5 path		Decline of forcing up to e.g. 2200. → Shorter decline
3	Constant Emissions	3000ppm CO_2 by 2300 and increasing → Too high?			Decline of forcing until 2300 or 2400. → Longer decline

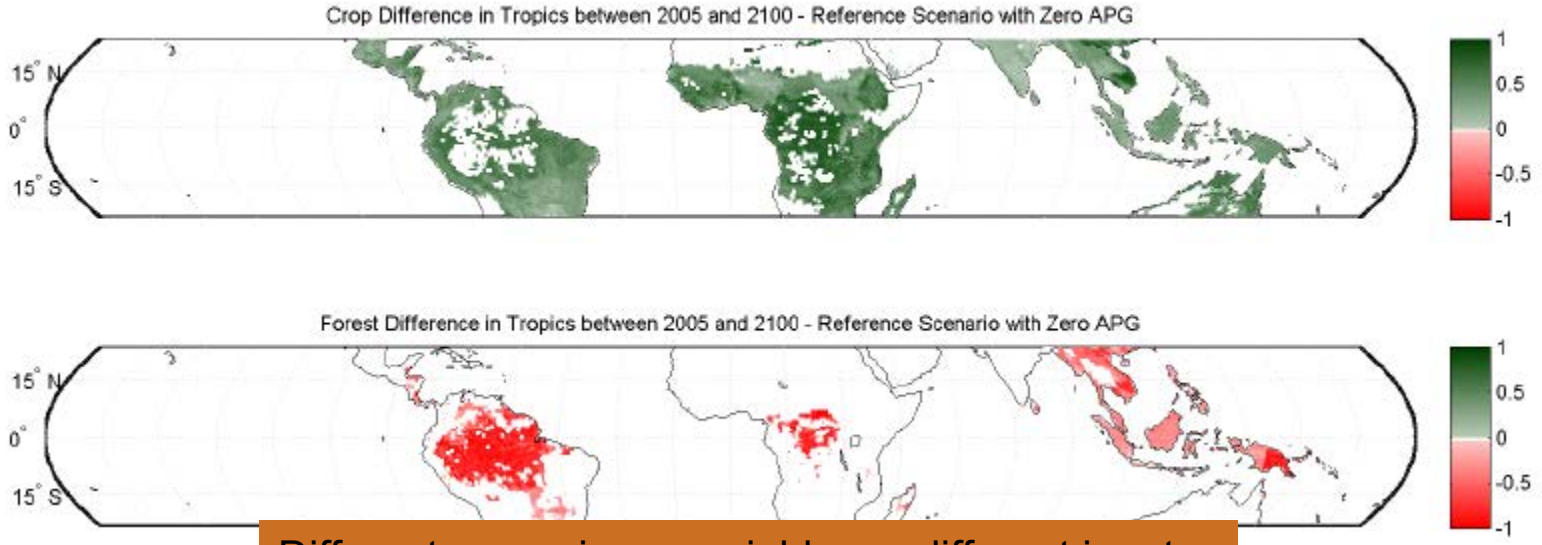
Development of new IAM scenarios

The Parallel Phase: New IAM Scenarios

- New scenarios are a central feature of IAM activity that will feed into the AR5.
- That process is already underway.
  - The Low Carbon Society Project in Japan
  - EMF22—Stabilization, Sequenced Accessions, Overshoots
  - The ADAM/RMCP project in Germany
  - The Global Energy Assessment at IIASA
  - The Asia Modeling Exercise
  - EMF 24—Technology and Stabilization

New IAM Scenarios

- This is not inherently an interface issue with the CM community except to the extent that
  - The CM community wishes to run additional scenario post-RCP.



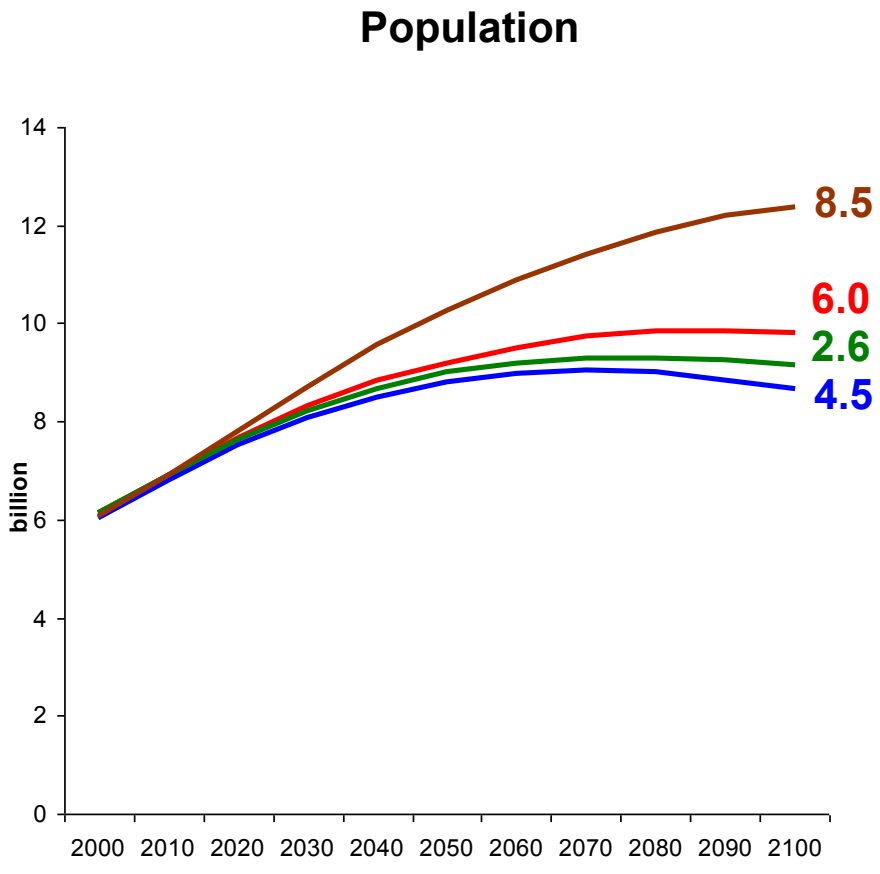
Different scenarios can yield very different inputs to climate models, e.g. RCP4.5 Reference with ZERO agricultural productivity change 2005 to 2100

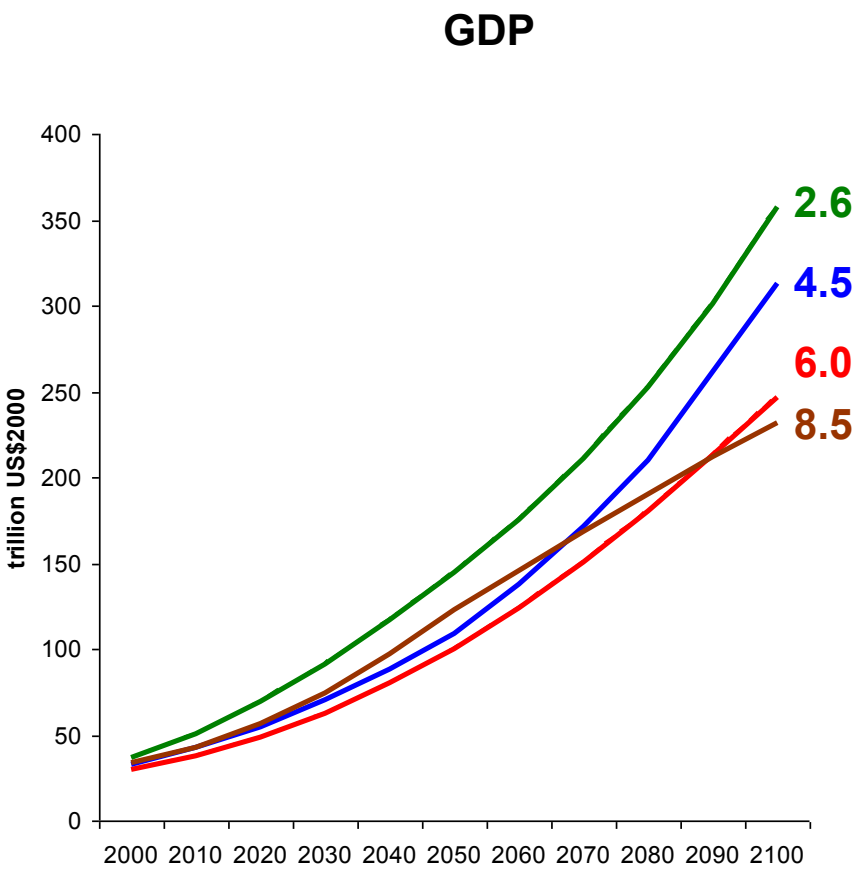
  - The IAM … te-terrestrial system fe…
    - E.g. fires, agriculture productivity, etc.
- We will discuss the new scenarios process tomorrow.

Some issues that go on our list for discussion tomorrow

- Alternative reference scenarios and socioeconomic backgrounds
- Alternative stabilization regimes—broadening the range.
- Alternative policy regimes—not just universal carbon taxes any more.
  - Staggered accession
  - Non-tax-non-cap-and-trade policies
  - Energy security
- Regional detail
- Technology options
- Overshoot scenarios
- Integrating mitigation and climate impacts into new scenarios.

Baseline Assumptions



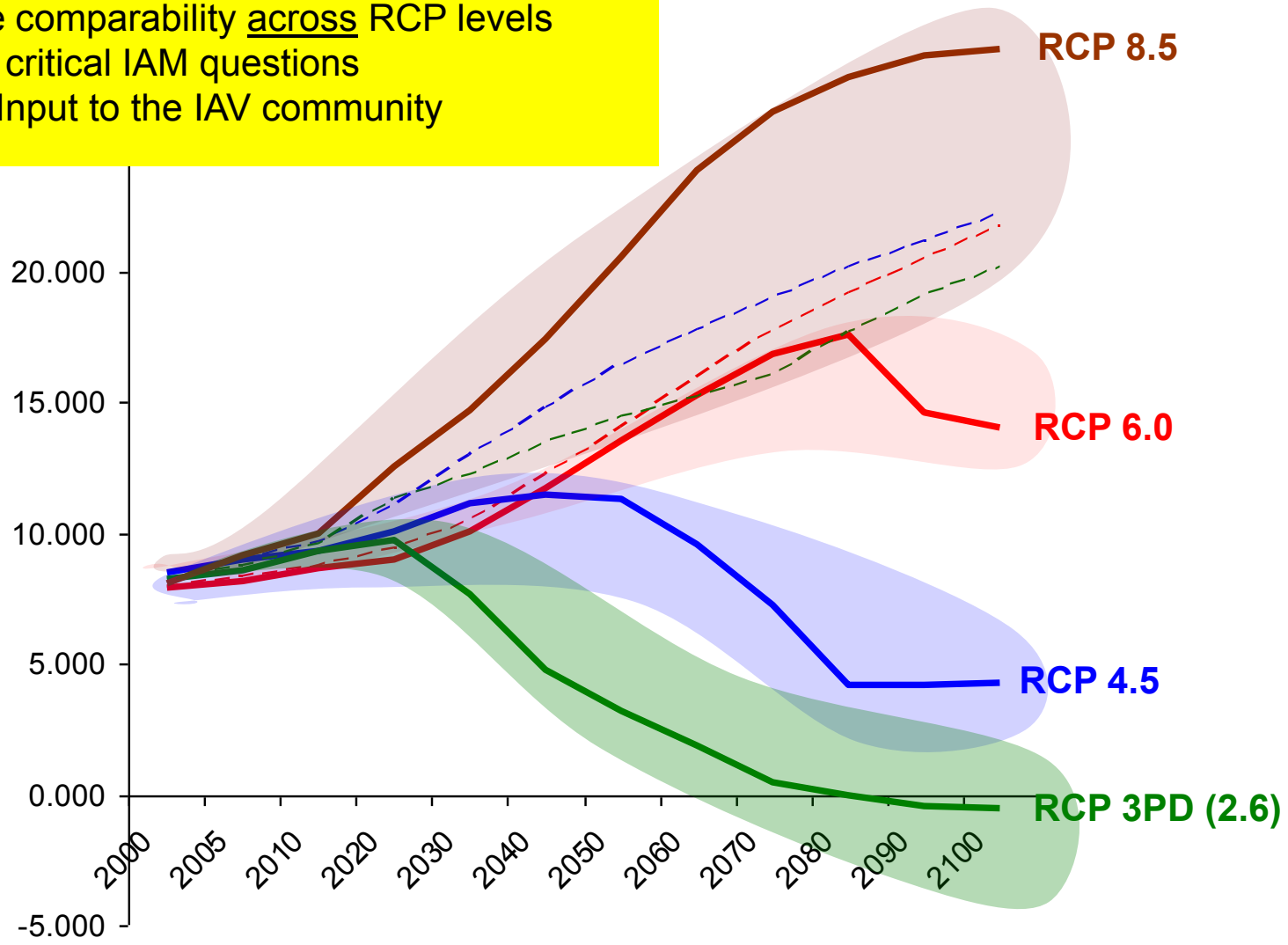


Climate characteristics were the only criteria for the selection of individual RCPs

CO2 Emissions (World)

Additional scenarios needed:

1) To bracket uncertainties
2) Enhance comparability <u>across</u> RCP levels
3) Address critical IAM questions
4) Provide Input to the IAV community



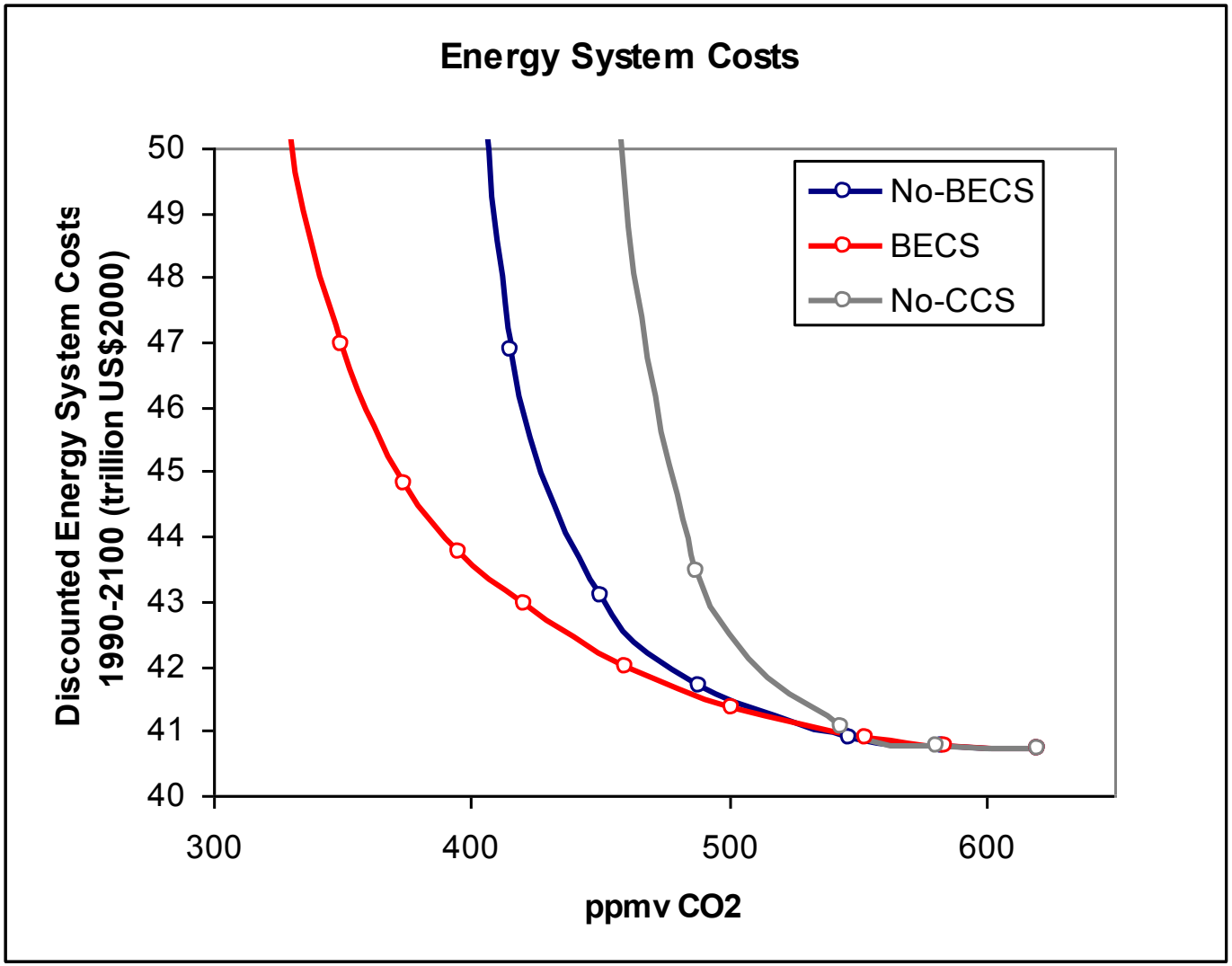
An Initial Activity

- Collect recently developed scenarios, eg:
  - 2.6 feasibility studies: ADAM, IMAGE/MESSAGE
  - EMF-22
  - IPCC Renewables Report
  - Etc..
- Establish reporting standards (protocols, definitions) that can be shared for alternative studies
- Development of a ~~"P~~ost-RCP" scenario database (eg for IAM-IAM and IAM-IAV exchange)
  - Including socioeconomic and technology specific information
  - Fully interactive and automized
    - for IAMC modeling teams to upload/download scenario data
    - evolutionary growing and thus maintained by the community
  - Quality check routines (eg, central climate model)

Modeling Comparison Projects

- —Second-best" scenarios
  - Non-participation (EMF22)
  - Technology (uncertainty and possible failure)
    - Explore feasibility of targets and costs without eg CCS/nuclear
    - Negative emissions technologies
  - Explore synergies and trade-offs with other policy priorities:
    - Energy Security
    - Energy Access
    - Hunger
    - Etc…

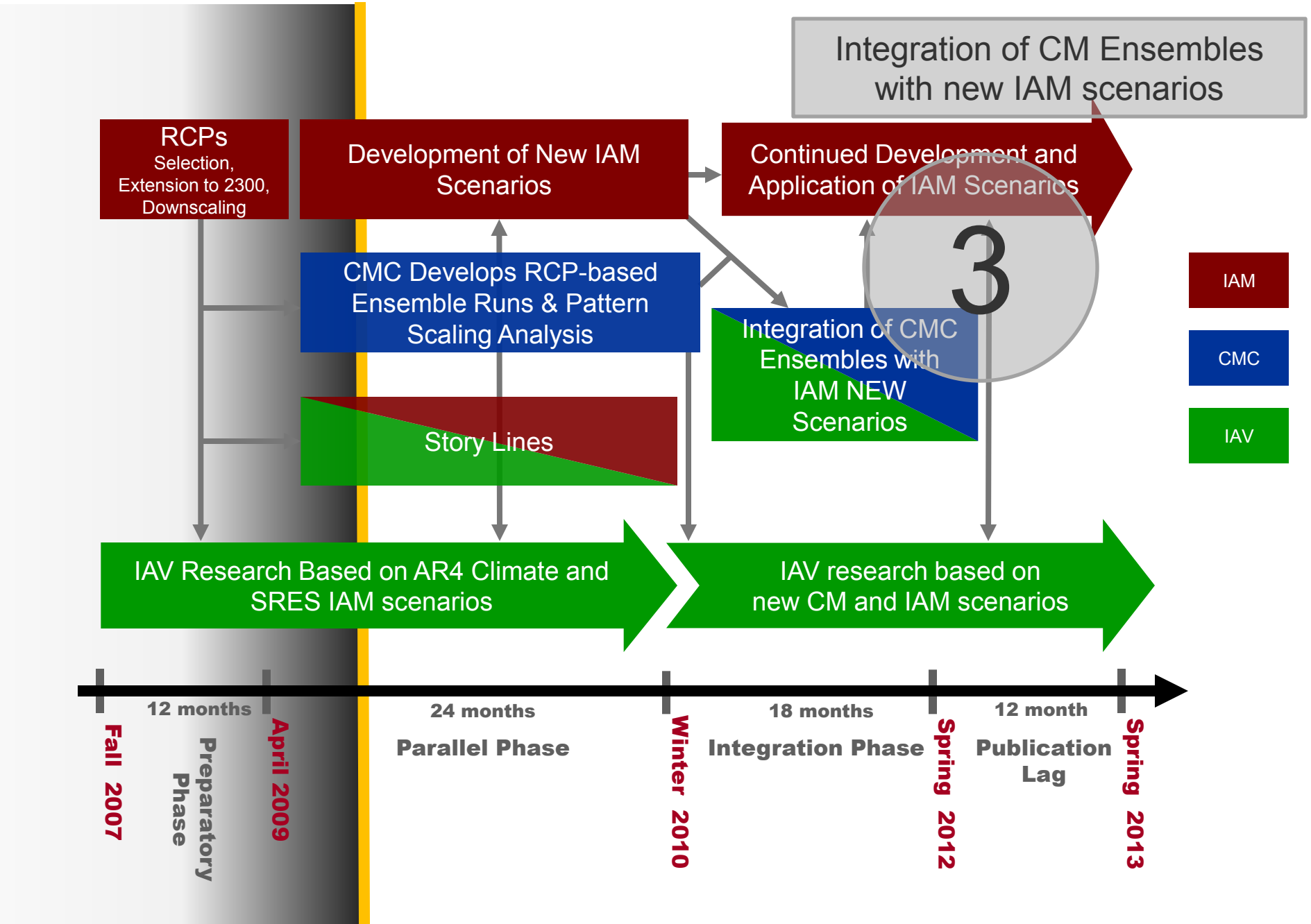
Attainability and costs of stabilization depends on the available technology options



Riahi, 2004

4 Integration of CM Ensembles with new IAM scenarios

The Parallel Process



The Parallel Process

- The IAM community is expected to take climate model ensembles and combine them with new scenarios to produce new ensembles of anthropogenic climate change scenarios.
  - Pattern scaling—will it work?
    - What about for —overshoot” scenarios?
  - Which new scenarios to use?
    - Who will pick them?
    - Need to work with the customers—IAV.
  - Can everything be done in time for the IAV community to find it useful?

Story Lines

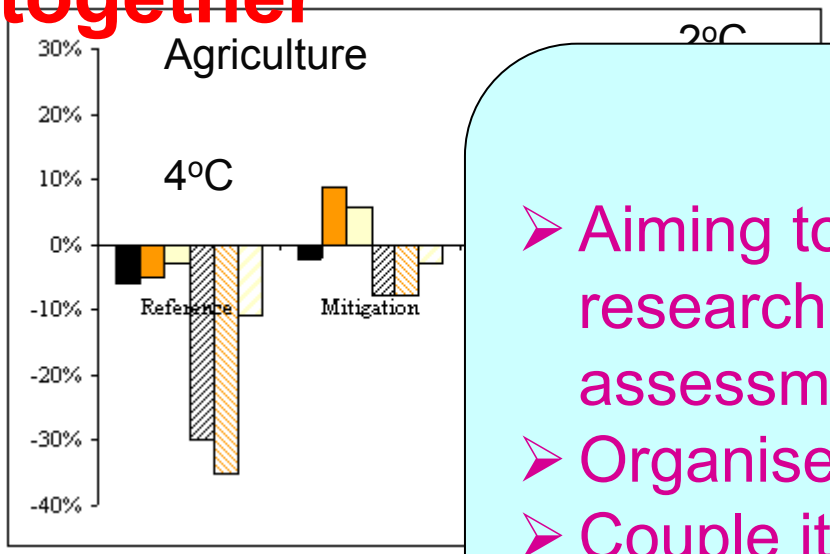
Storylines

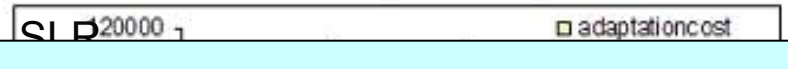
- What constitutes a story line?
  - A narrative descriptions?
  - Methods for downscaling climate and scenario outputs to specific places and times?
- More discussion in the next presentation.

Development of fully-coupled models of human activities, terrestrial systems, oceans, and climate—iESMs

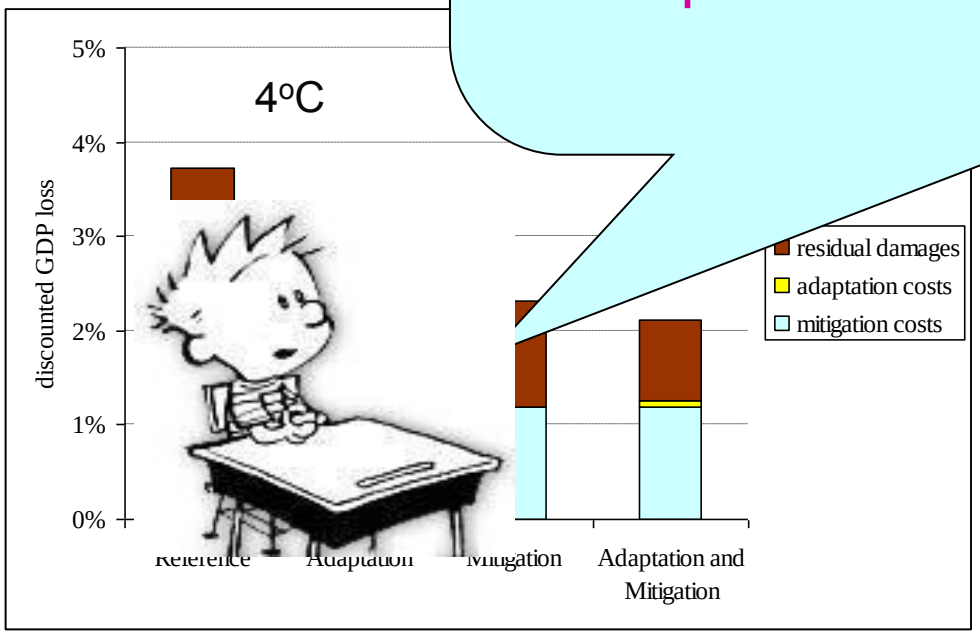
Research question based on RCP2.6 (7/7)

Bringing impacts, adaptation and mitigation together





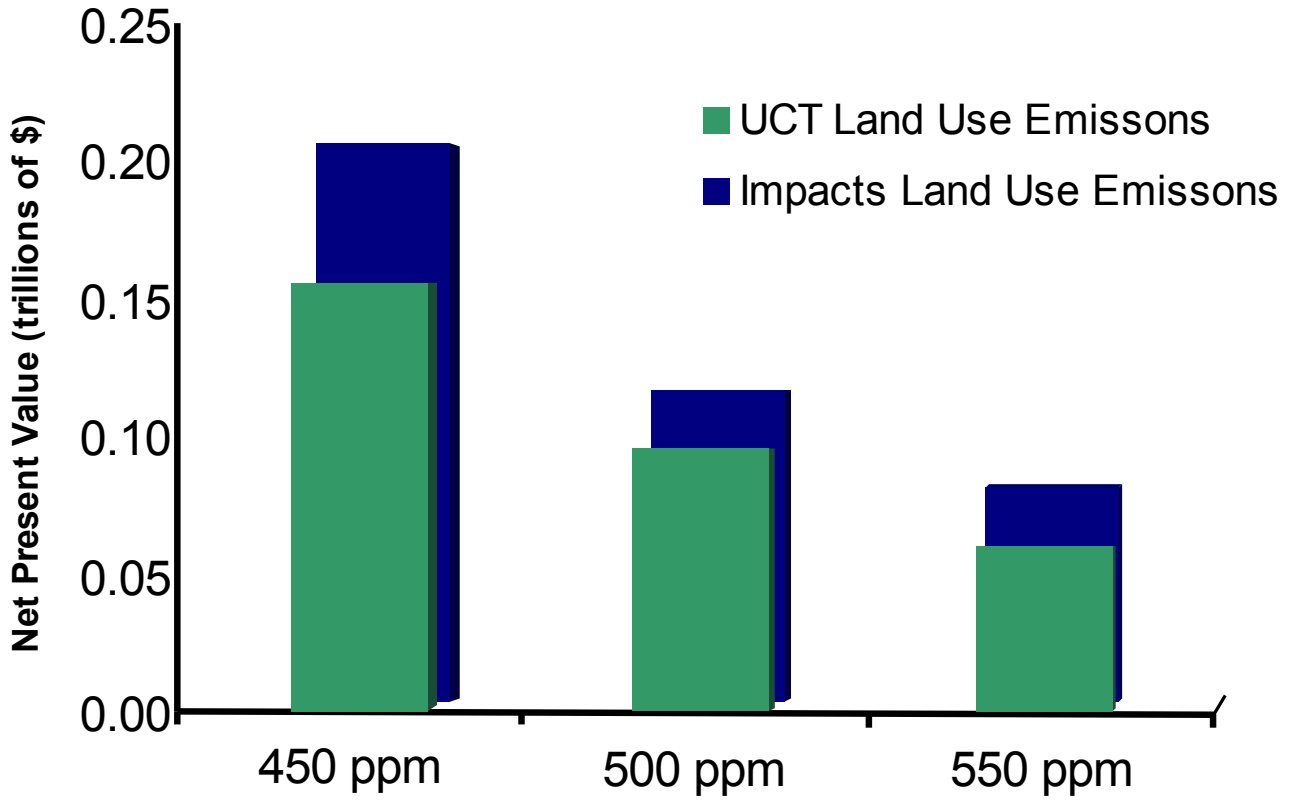
- Aiming to integrate impact/adaptation research better into the mainstream assessment
- Organise these communities
- Couple it better to IA



(keep risk approach / monetary approach connected)

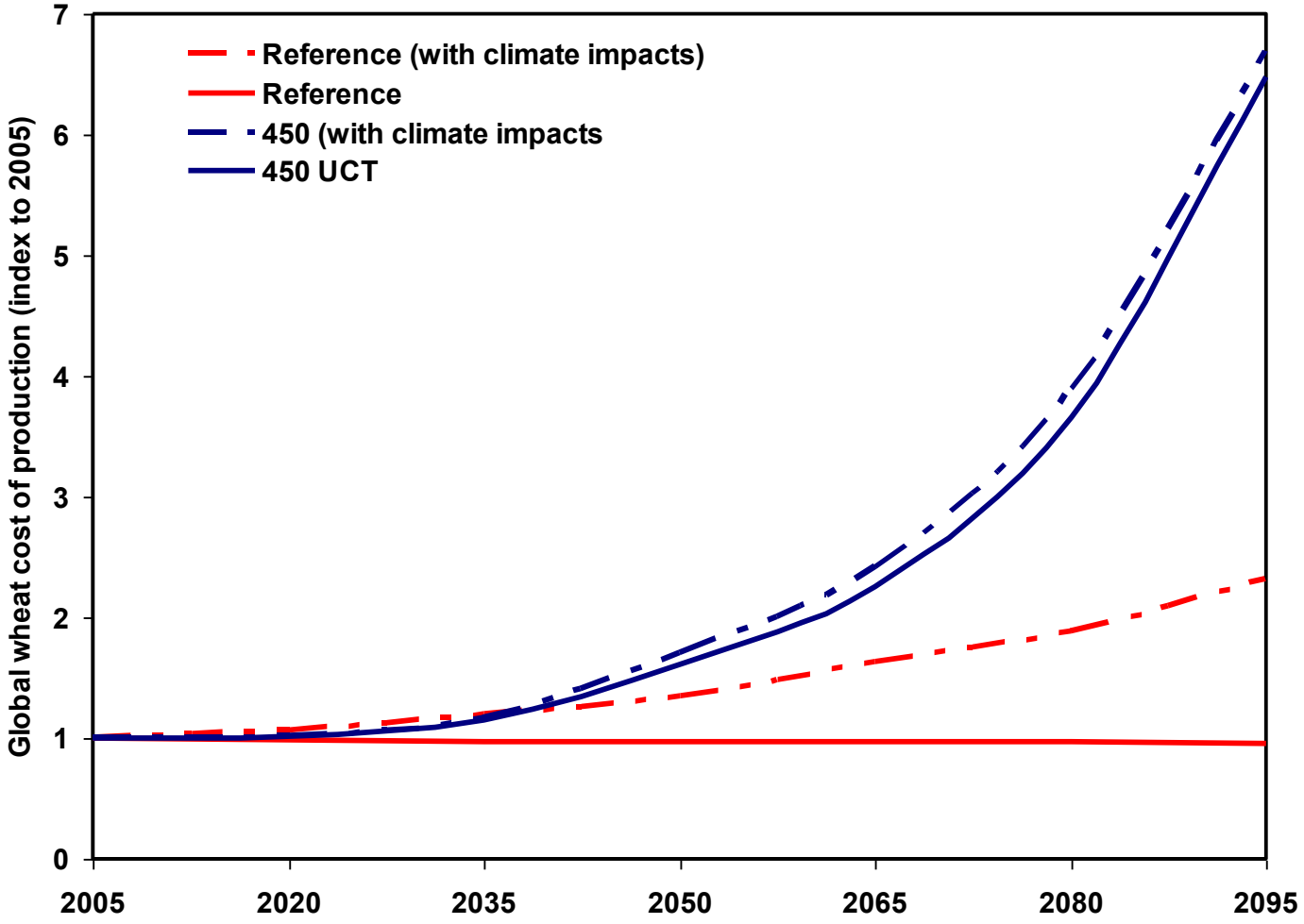
Make adaptation explicit

Looking at climate feedbacks to agriculture in GCAM: The total cost of land-use change emissions over the century

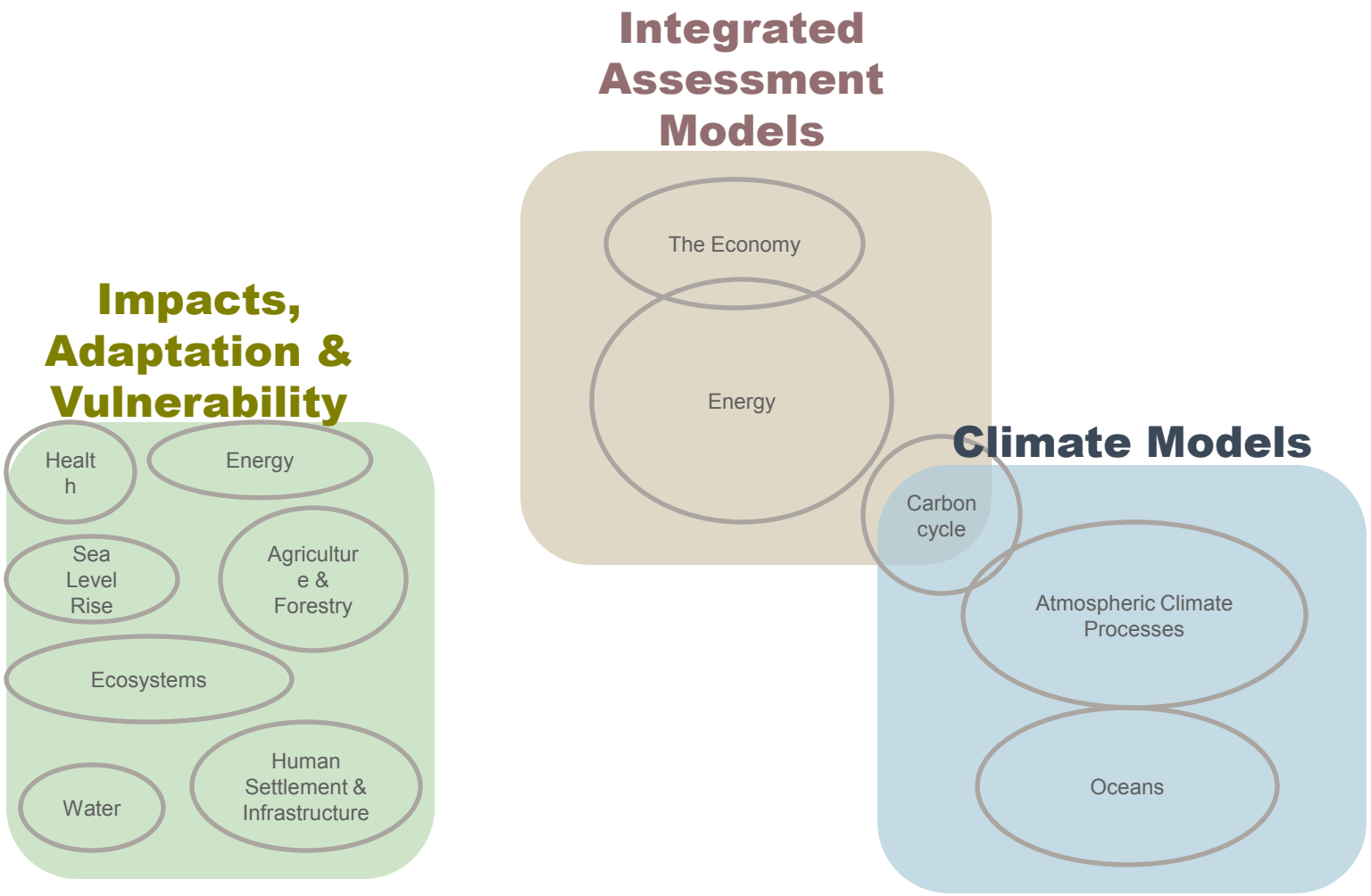


GCAM: Climate and stabilization impacts on the price of wheat

Global wheat price under four cases: Reference, Reference with Climate Change, Stabilization of CO_2 concentrations at 450 ppm



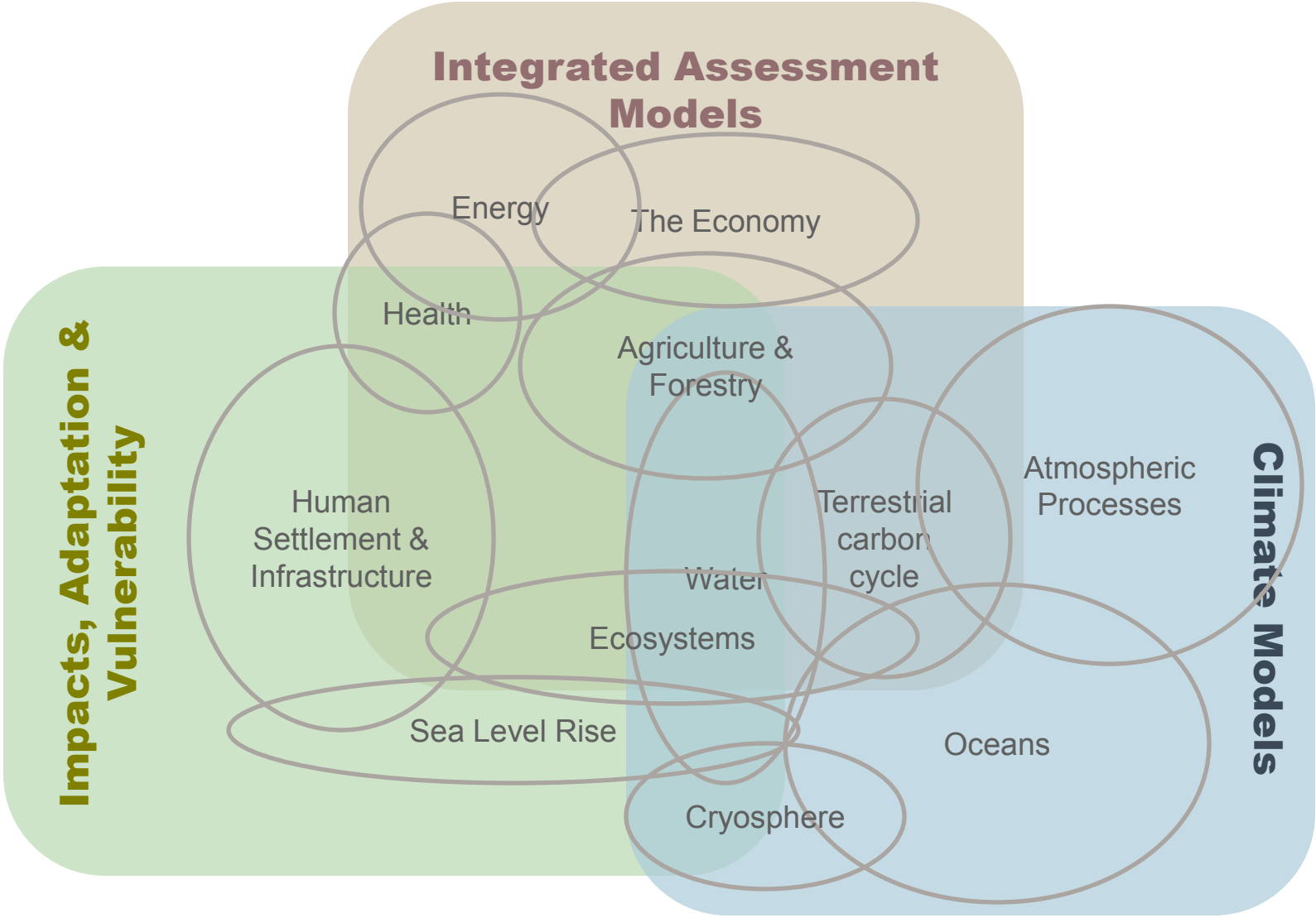
Growing Overlap in Domains



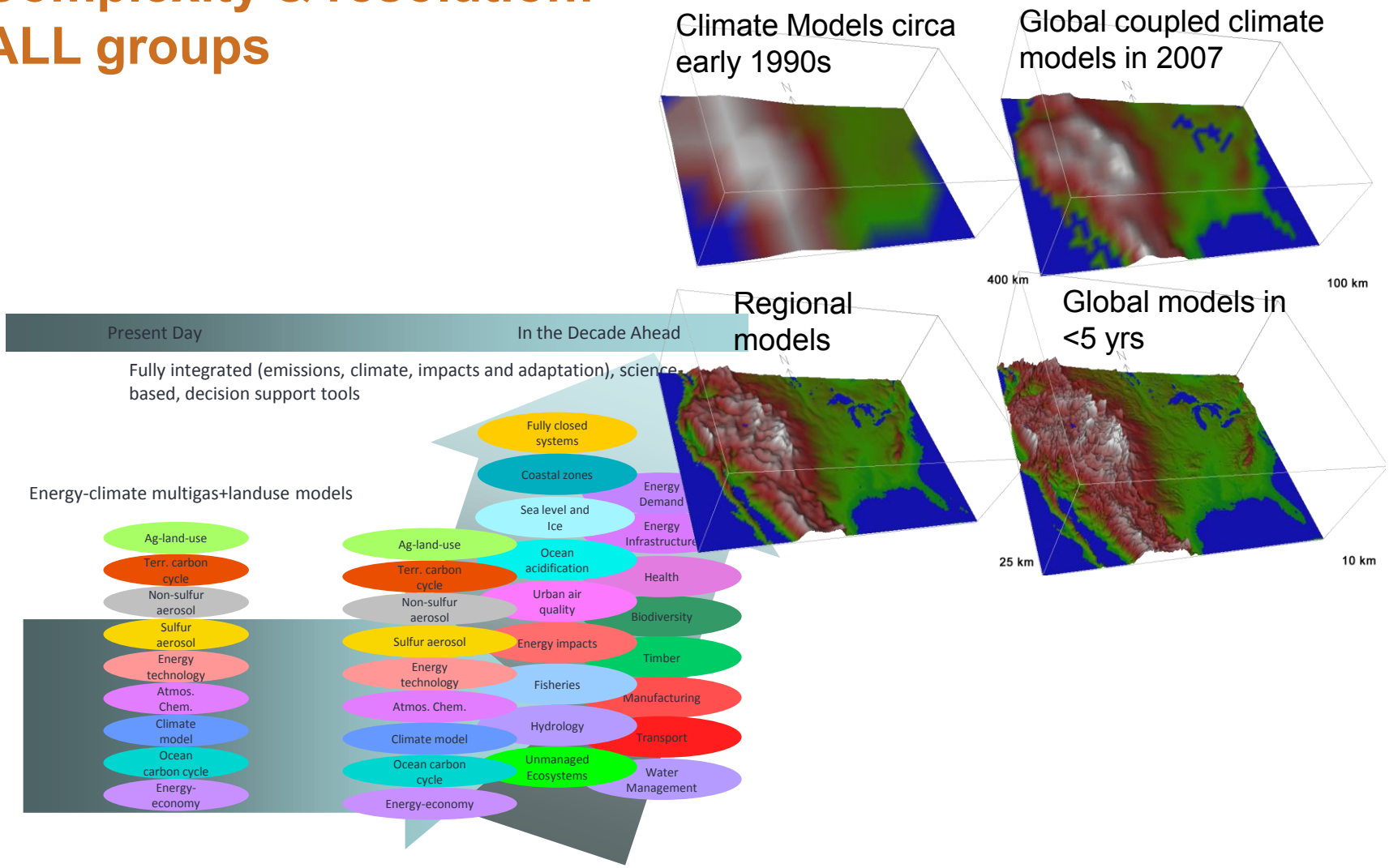
iESMs

- Before AR5 is published, fully coupled integrated Earth system models (iESMs) will emerge.
  - iESMs will couple emissions, land-use and land-cover, carbon and nitrogen cycles, with energy, agriculture, and the economy in internally consistent ways.
  - The advent of the iESM will begin to blur the lines between CM, IAM, and IAV communities.
    - It is not that the research specialties that congregate within each of these communities will disappear.
    - Rather, model codes will increasingly draw on the full spectrum of research disciplines, and
    - A new generation of research, which includes feedbacks in all directions will come into being.

Growing Overlap in Domains



Complexity & resolution: ALL groups



The conversation with between IAM and CM continues both formally and informally.

WGCM, San Francisco

28-30 September 2009

- **Review RCP issues from past year, post-2100 issues, readiness issues, evaluate process (N. Nakicenovic)**
- —…insights from the IAMC meeting from Tsukuba that you could share”
- Geo-engineering (A. Robock)
- Air quality and climate change (J.F. Lamarque)
- Connections to WG1, WG2, IGBP, CRC Workshop report (G. Meehl, K. Hibbard)
- Connect to modelling in other parts of WCRP, WCRP re-org, (G. Meehl, G. Asrar)
- **Coupling IAMs to ESMs (N. Nakicenovic)**

END