Life After the RCPs: Future Coordination With the CM Community

Integrated Assessment Modeling Consortium

Tsukuba, Japan

Jae Edmonds and Nebojsa Nakicenovic
September 15, 2009

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

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:
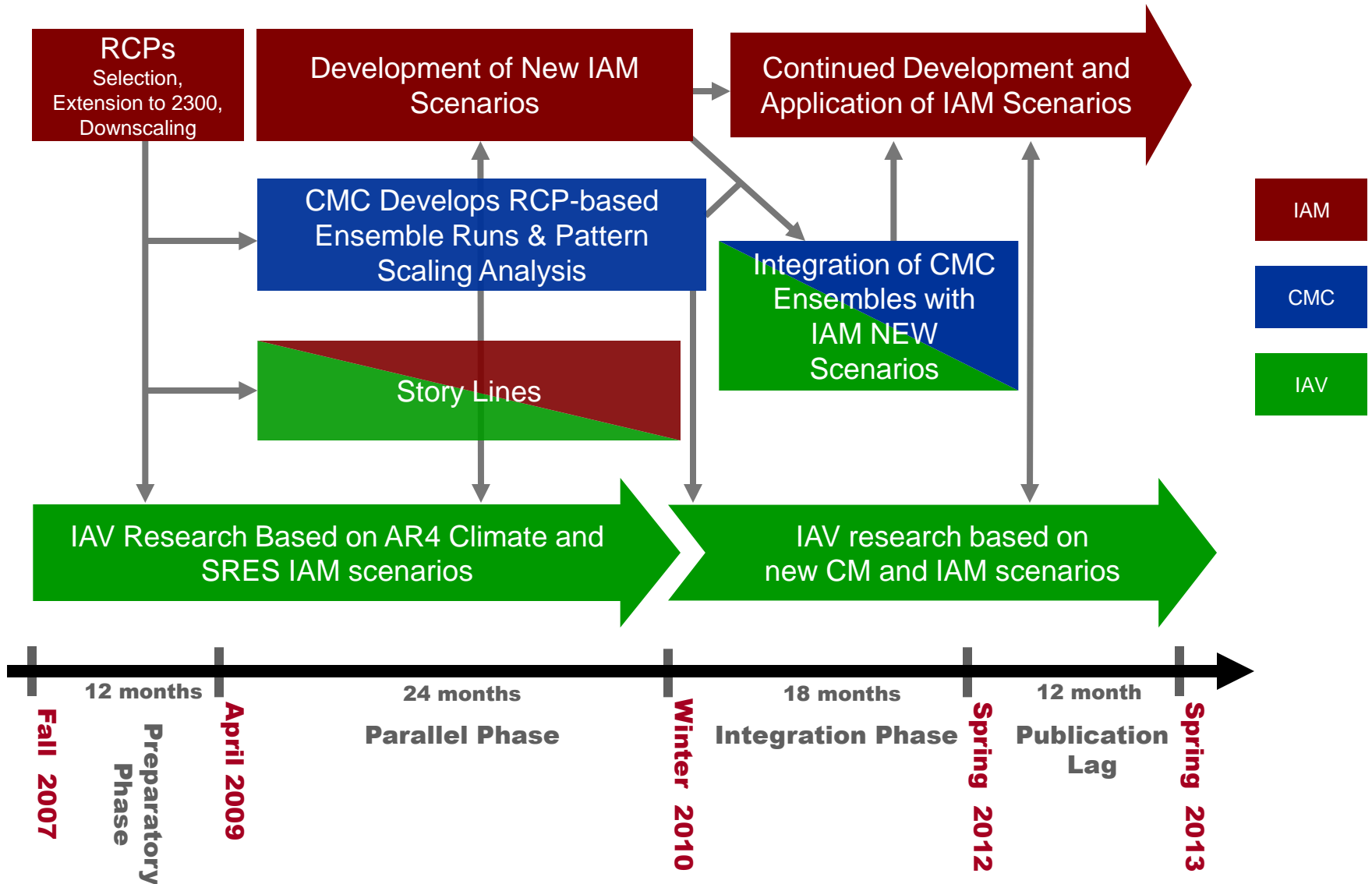
1. Multi-temporal phase for climate model runs:

    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:
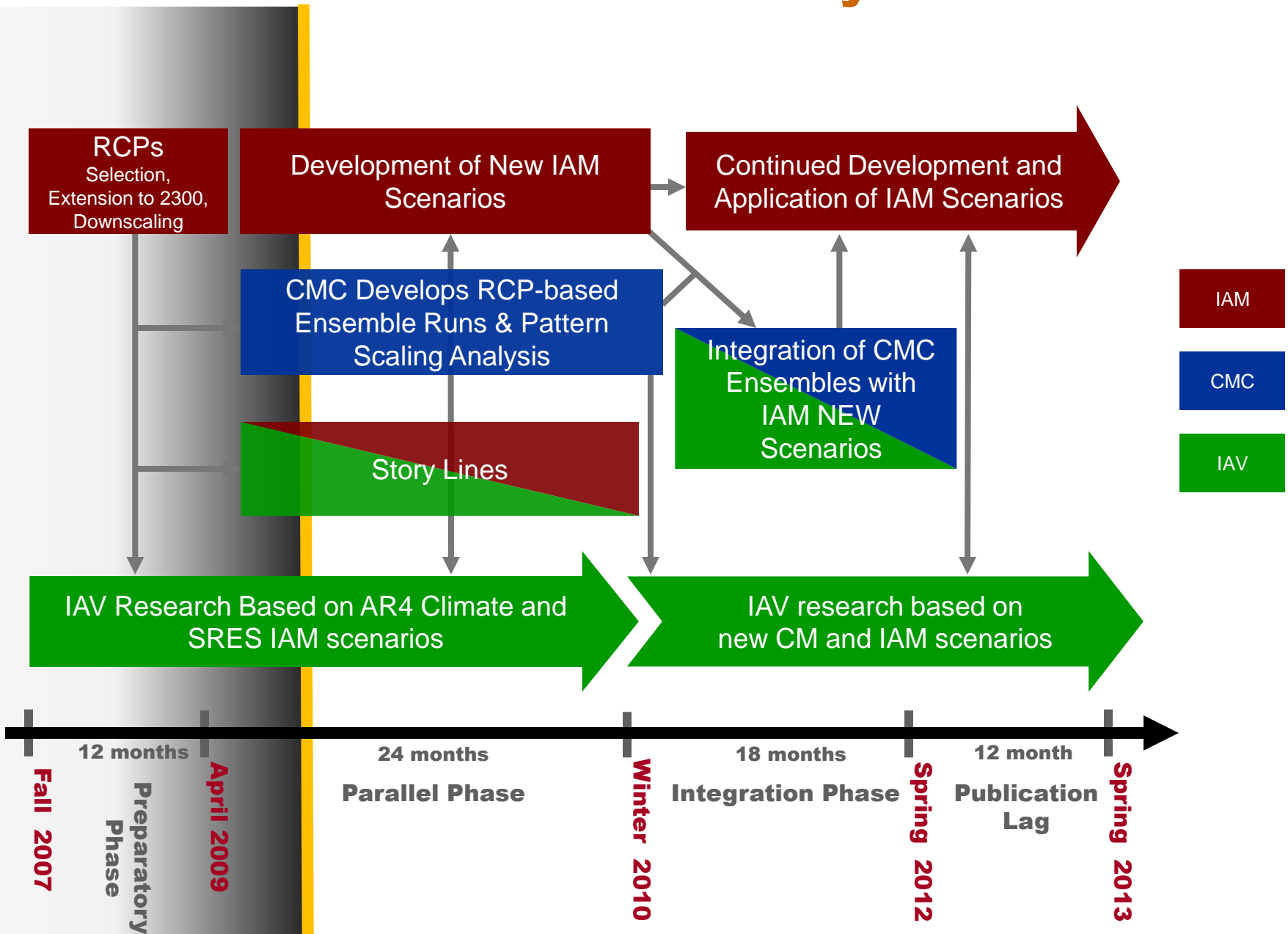   Representative Concentration Pathways (RCPs)

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.
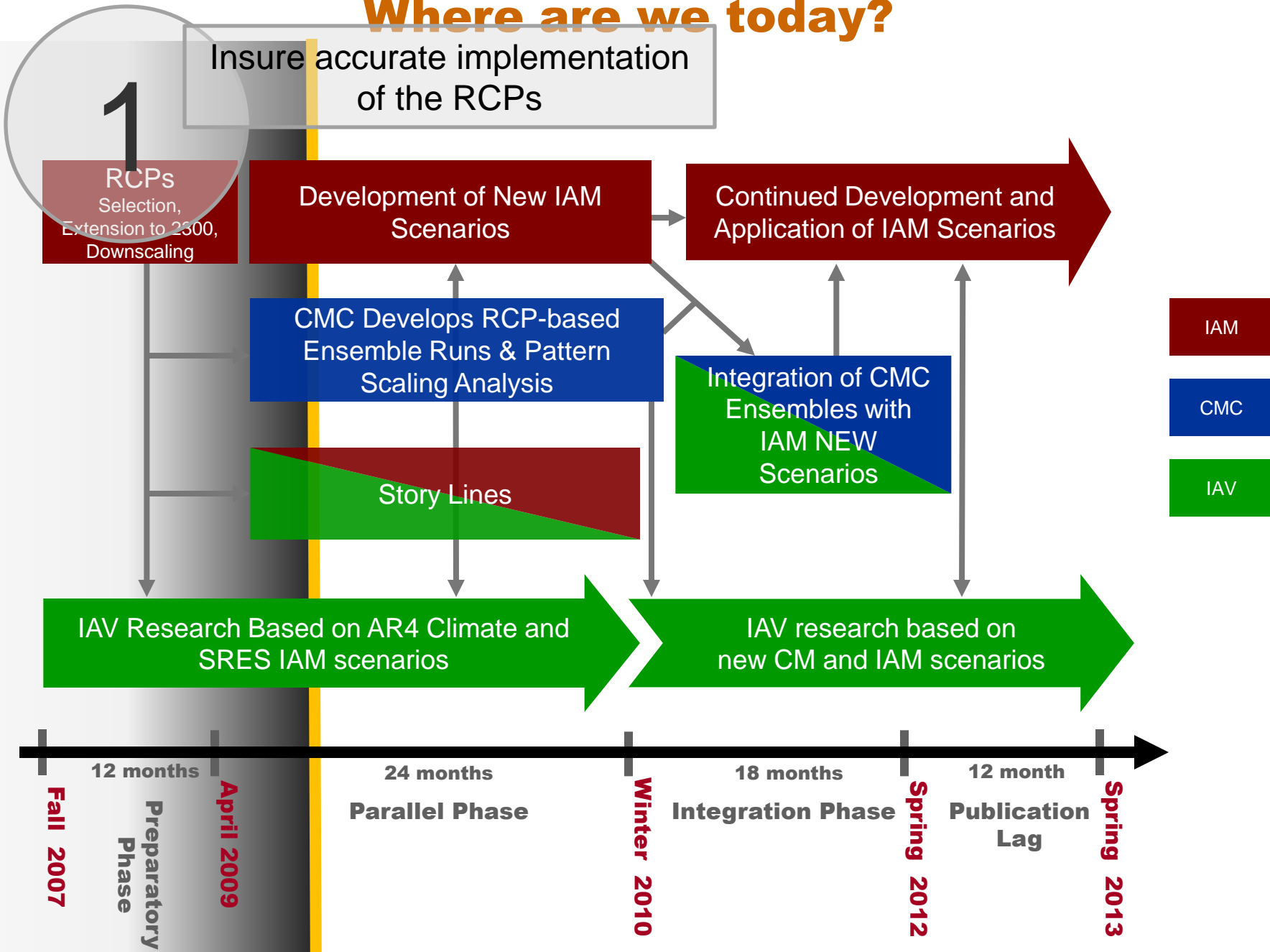
▶ This presentation is about what comes next.

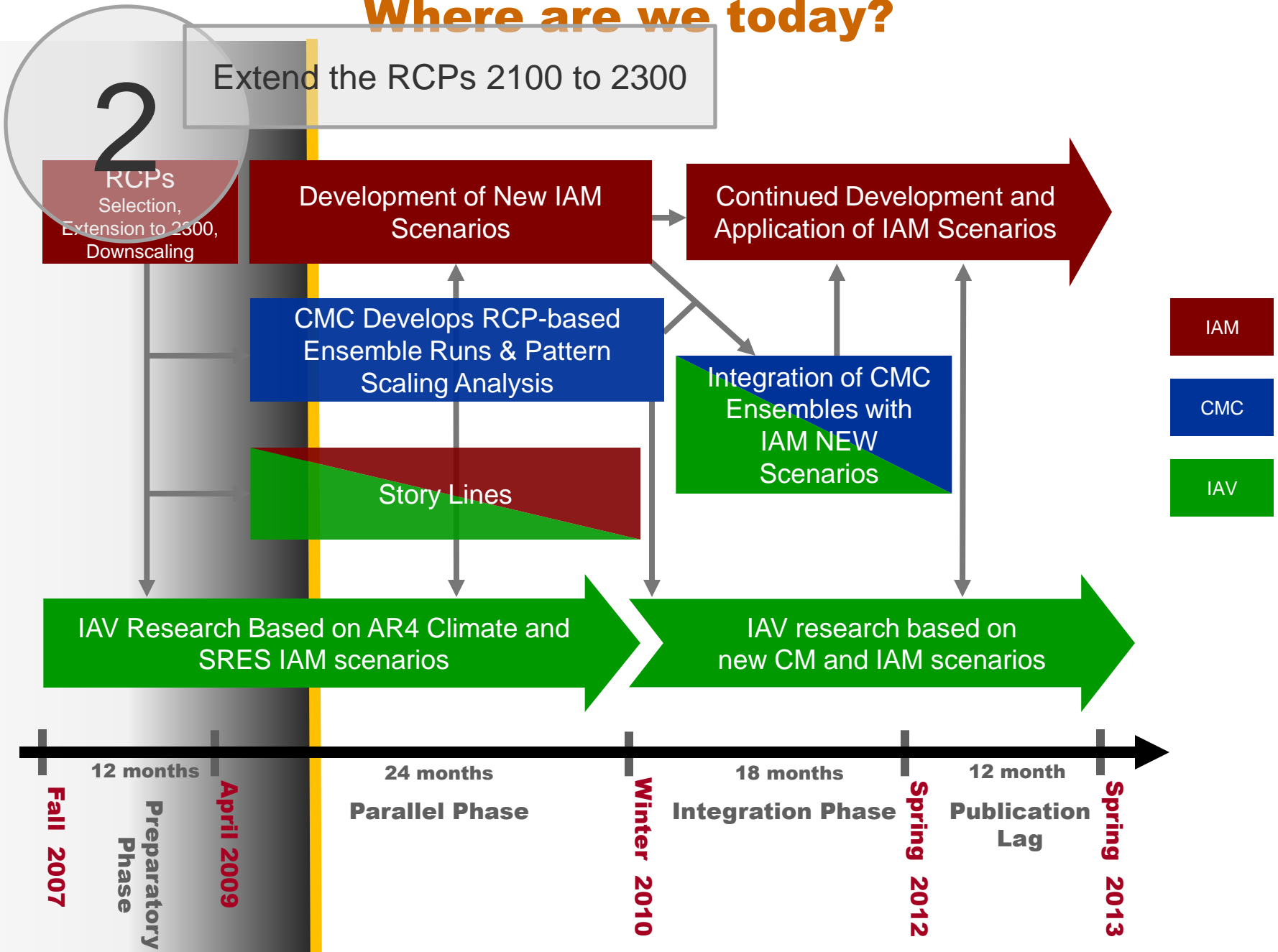# Time Line & Critical Path of Scenario Development

RCPs
Selection, Extension to 2300, Downscaling

Development of New IAM Scenarios

Continued Development and Application of IAM Scenarios

CMC Develops RCP-based Ensemble Runs & Pattern Scaling Analysis

Integration of CMC Ensembles with IAM NEW Scenarios

Story Lines

IAV Research Based on AR4 Climate and SRES IAM scenarios

IAV research based on new CM and IAM scenarios

IAM

CMC

IAV

12 months	24 months	18 months	12 month
Preparatory Phase	**Parallel Phase**	**Integration Phase**	**Publication Lag**

Fall 2007 — **April 2009** — **Winter 2010** — **Spring 2012** — **Spring 2013**

Where are we today?

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12 month
Publication Lag

Spring 2013

Where are we today?

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Insure accurate implementation of the RCPs

RCPs Selection, Extension to 2300, Downscaling

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Where are we today?

Extend the RCPs 2100 to 2300

2

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Work Within the Noordwijkerhout Framework

3 Development of new IAM Scenarios

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Work Within the Noordwijkerhout Framework

Integration of CM Ensembles with new IAM scenarios

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Selection, Extension to 2300, Downscaling

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Story Lines

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IAM

CMC

IAV

IAV Research Based on AR4 Climate and SRES IAM scenarios

IAV research based on new CM and IAM scenarios

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Work Within the Noordwijkerhout Framework

Work Within the Noordwijkerhout Framework

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

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Integration of CMC Ensembles with IAM NEW Scenarios

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IAM

CMC

IAV

Story Lines

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1 Insure accurate implementation of the RCPs.

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

"HEY, I THOUGHT WE WERE WORKING WITH THE SAME DATA..."

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

Forest Difference in Tropics between 2005 and 2100 - RCP4.5 Stabilization Scenario
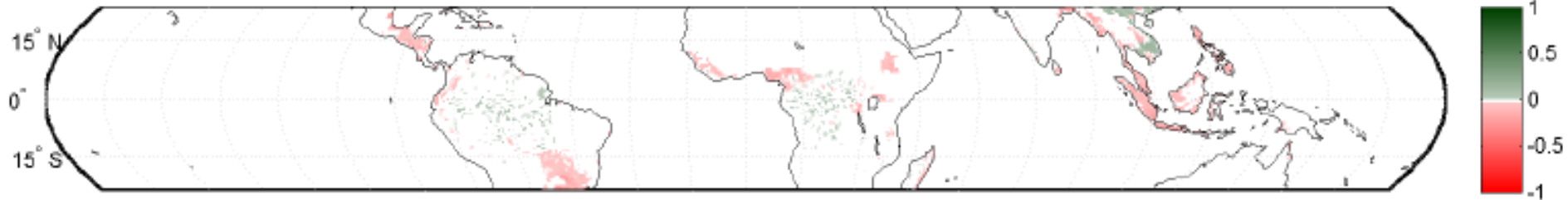
Crop Difference in Tropics between 2005 and 2100 - RCP4.5 Stabilization Scenario
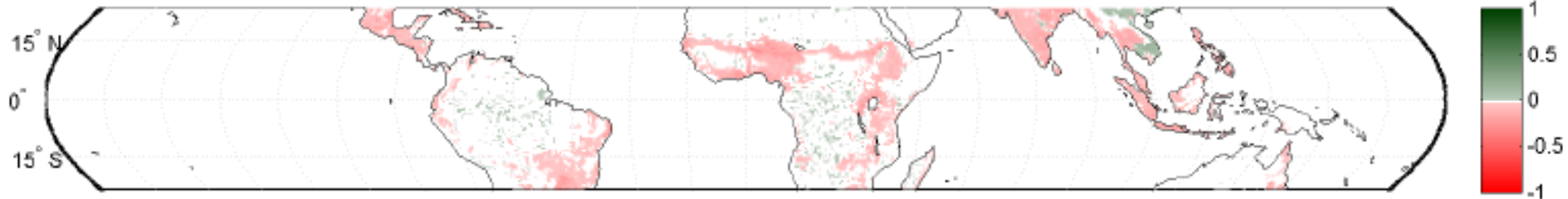
Implementation: Issues of definitions

e.g. What is Pasture/Grazing?

Defining Classes:
What is Urban?
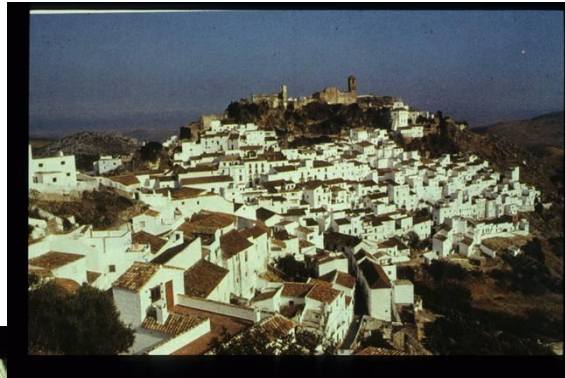
2 Extend the RCPs 2100 to 2300

Radiative Forcing (anthropogenic & natural)

RCP8.5 reaches 8.5W/m2 by 2100.

RCP4.5 reaches 4.5W/m2 by 2100.

RCP3-PD After initial peak at 3W/m^2, RCP3-PD declines to ~2.6W/m^2 by 2100

No one is modeling the post-2100 period. So, extensions will be done using ad hoc methods.

(W/m^2)

RCP8.5

RCP4.5

RCP3PD

malte.meinshausen@pik-potsdam.de

18
16
14
12
10
8
6
4
2
0

1800   1900   2000   2100   2200   2300   2400
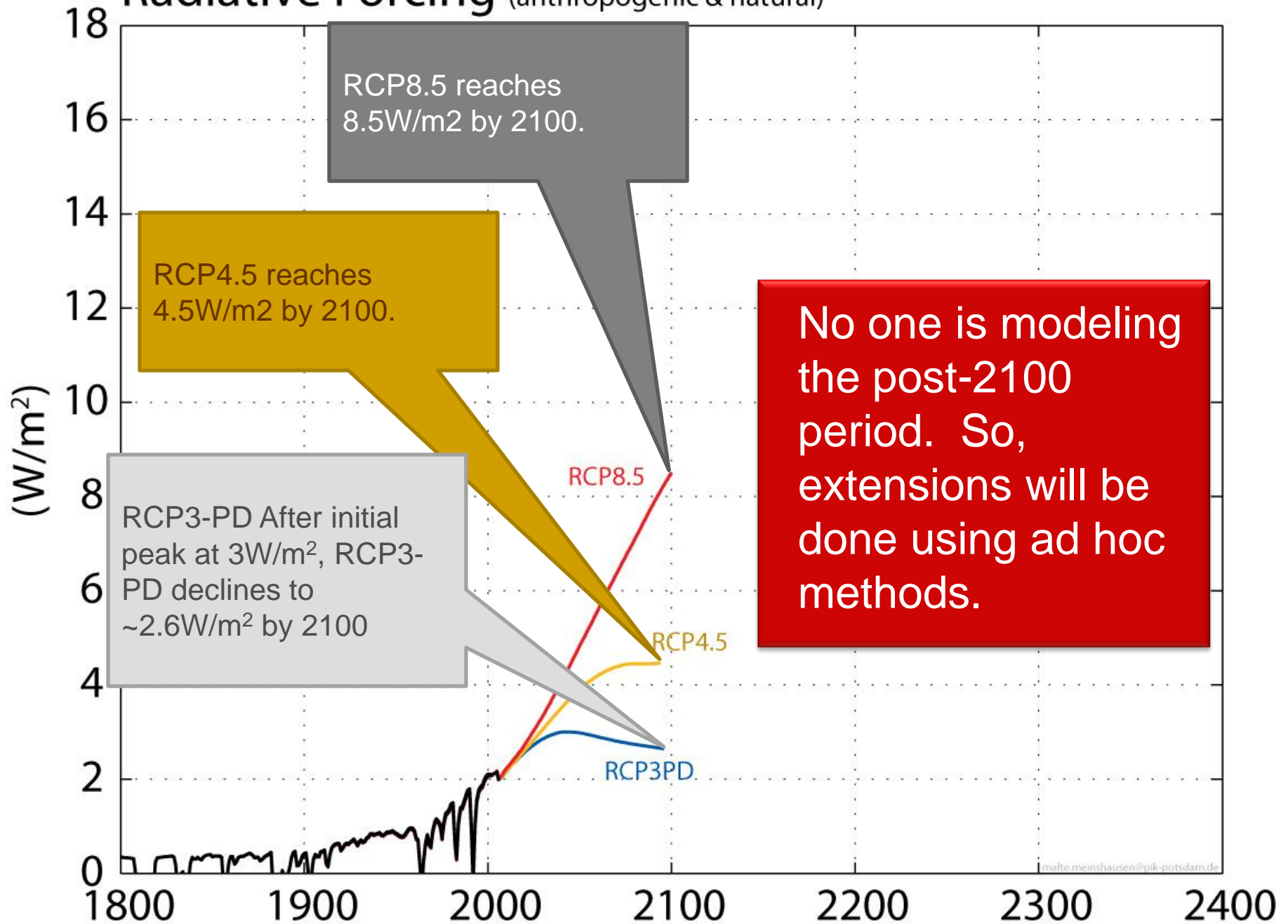
Overview of the options

		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

3 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.

Crop Difference in Tropics between 2005 and 2100 - Reference Scenario with Zero APG

Forest Difference in Tropics between 2005 and 2100 - Reference Scenario with Zero APG
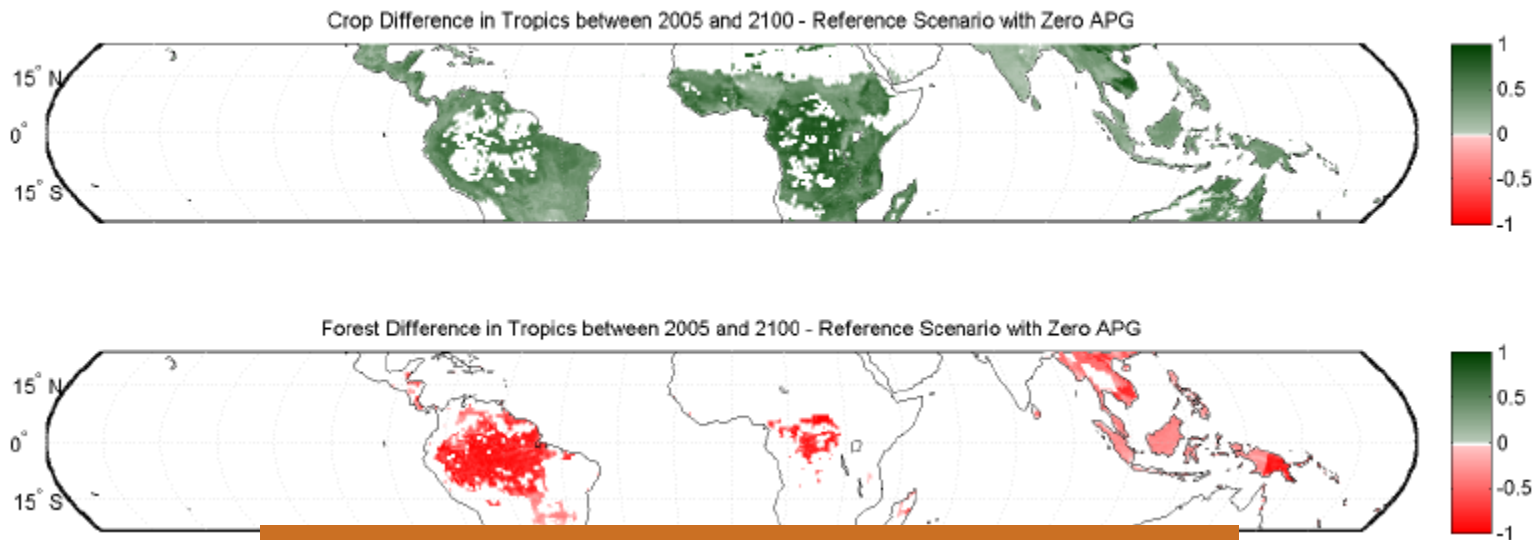
Different scenarios can yield very different inputs to climate models, e.g. RCP4.5 Reference with ZERO agricultural productivity change 2005 to 2100

- 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

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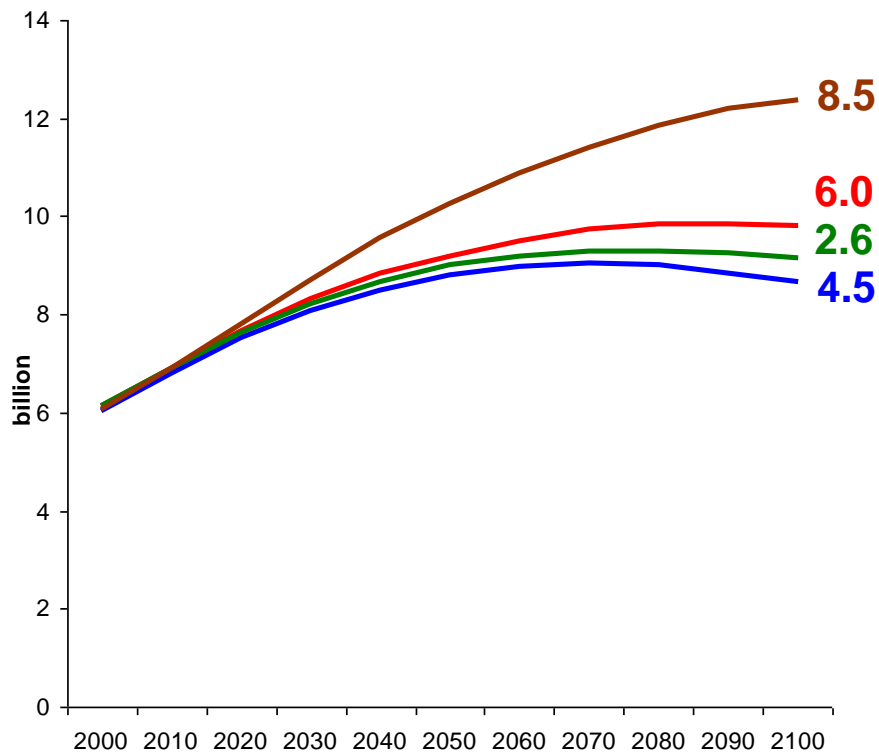
GDP
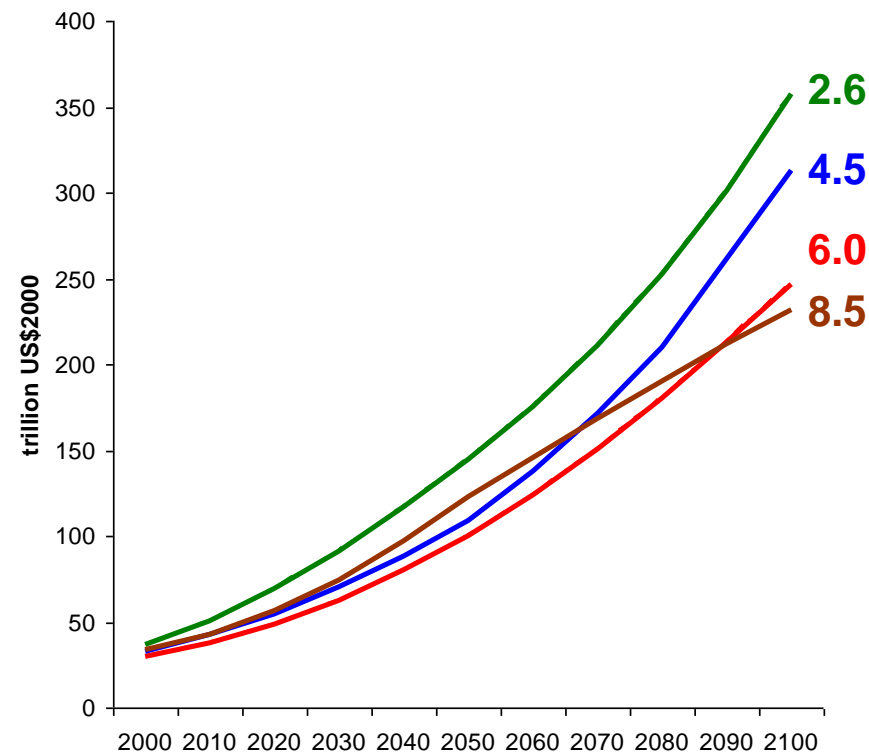
Climate characteristics were the only criteria for the selection of individual RCPs

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

RCP 8.5

RCP 6.0

RCP 4.5

RCP 3PD (2.6)
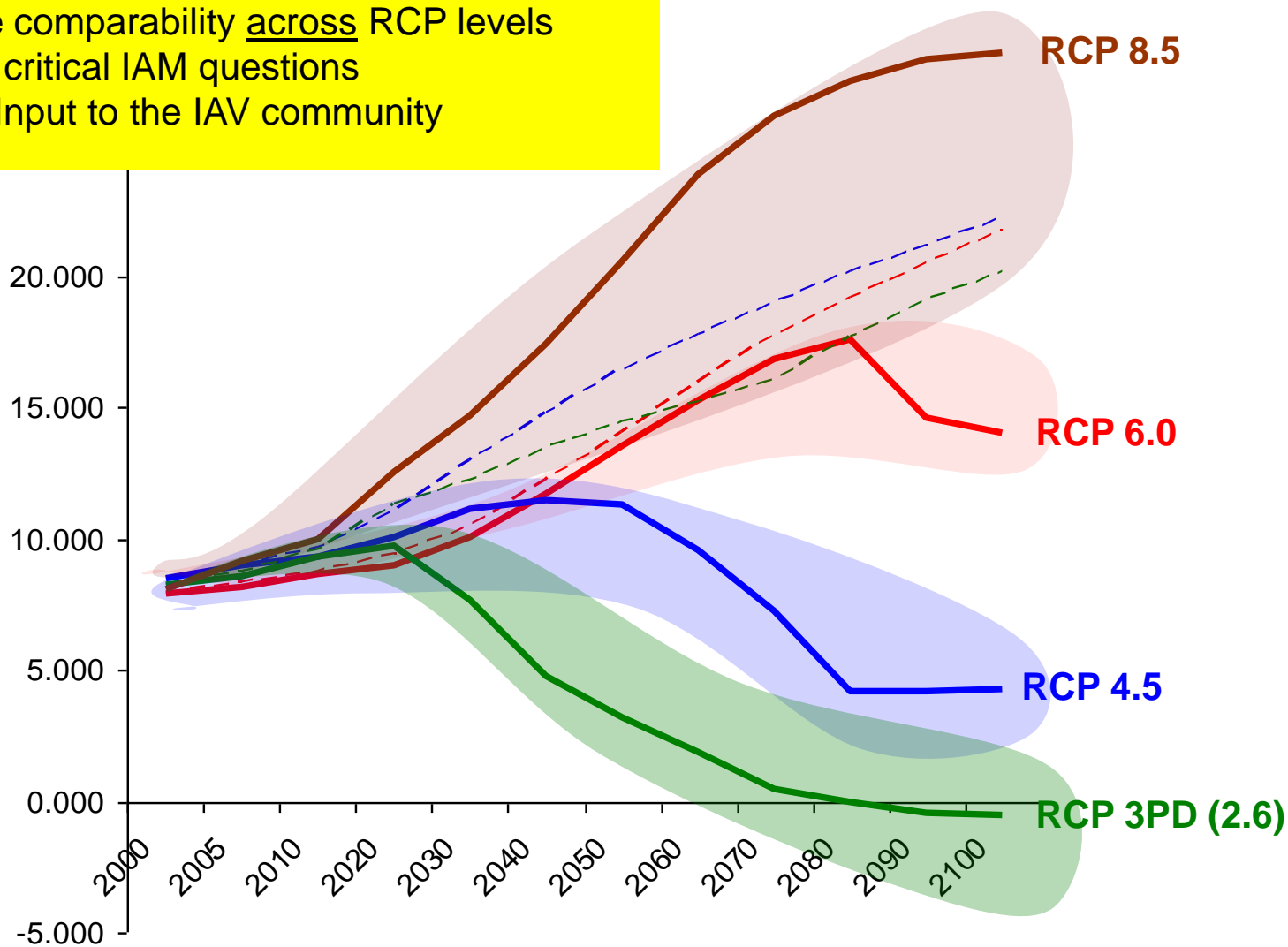
An Initial Activity

▶ 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 "Post-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

Energy System Costs

Riahi, 2004

4 Integration of CM Ensembles with new IAM scenarios

The Parallel Process

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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?

5 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.

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

Bringing impacts, adaptation and mitigation together
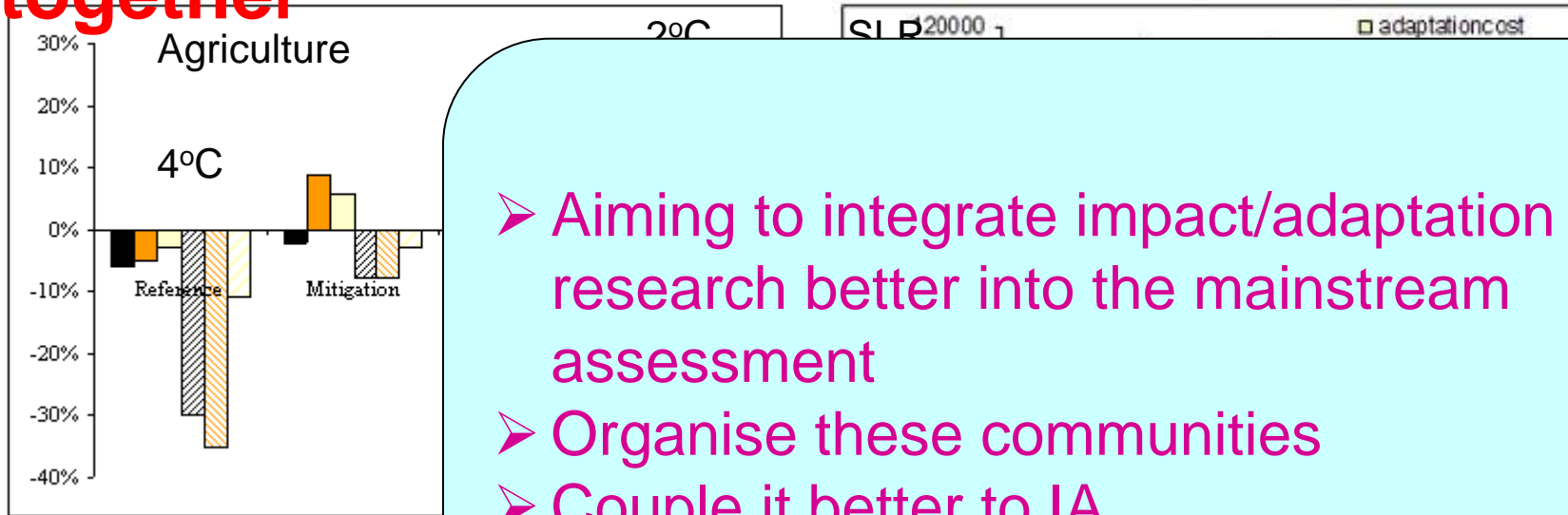
> ➤ Aiming to integrate impact/adaptation research better into the mainstream assessment
> ➤ Organise these communities
> ➤ Couple it better to IA
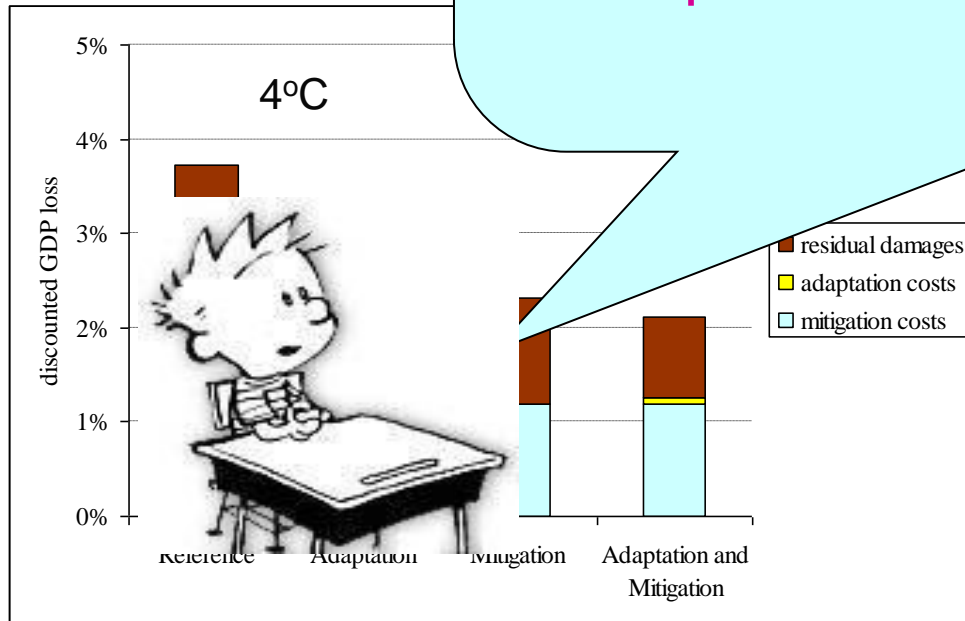
(keep risk approach / monetary approach connected)

Make adaptation explicit

Looking at climate feedbacks to agriculture in GCAM: The total cost of land-use change emissions over the century
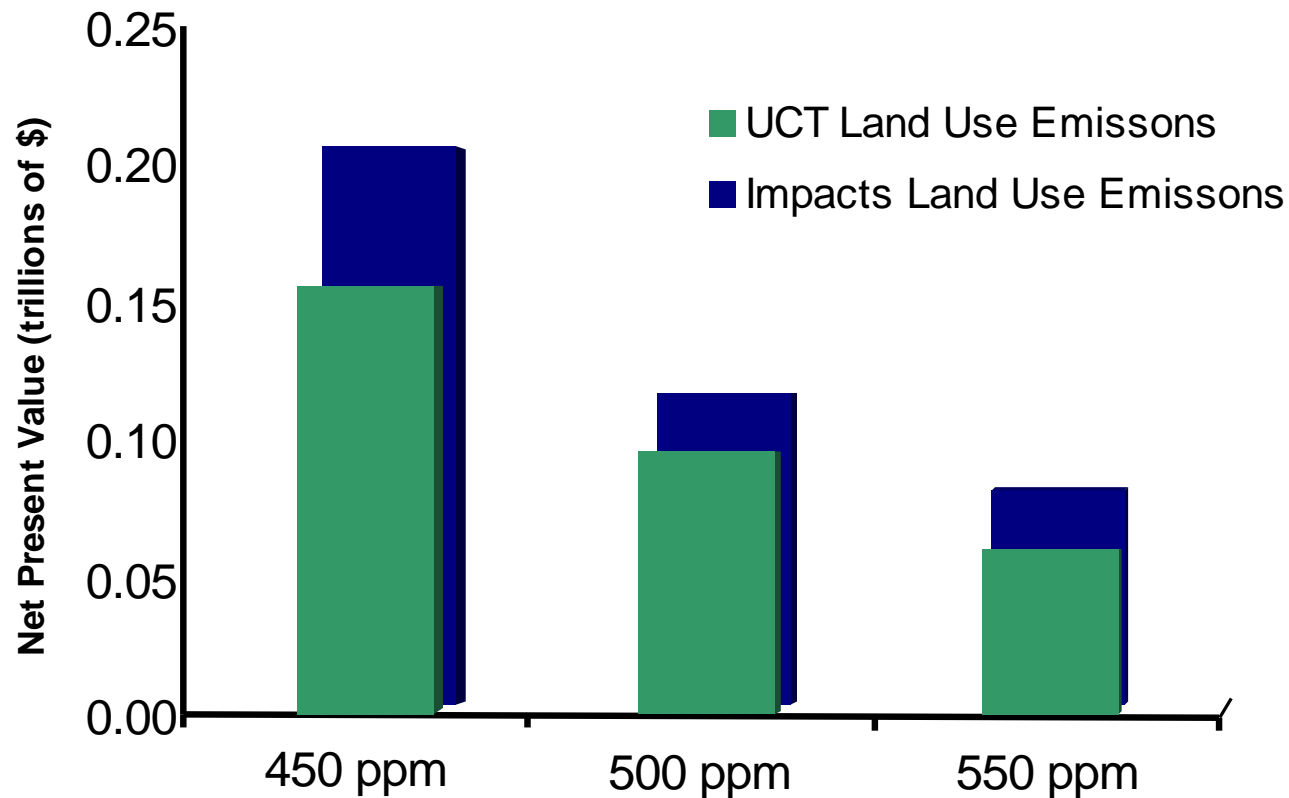
GCAM: Climate and stabilization impacts on the price of wheat

Global wheat price under four cases: Reference, Reference with Climate Change, Stabilization of CO_2 concentrations at 450 ppm
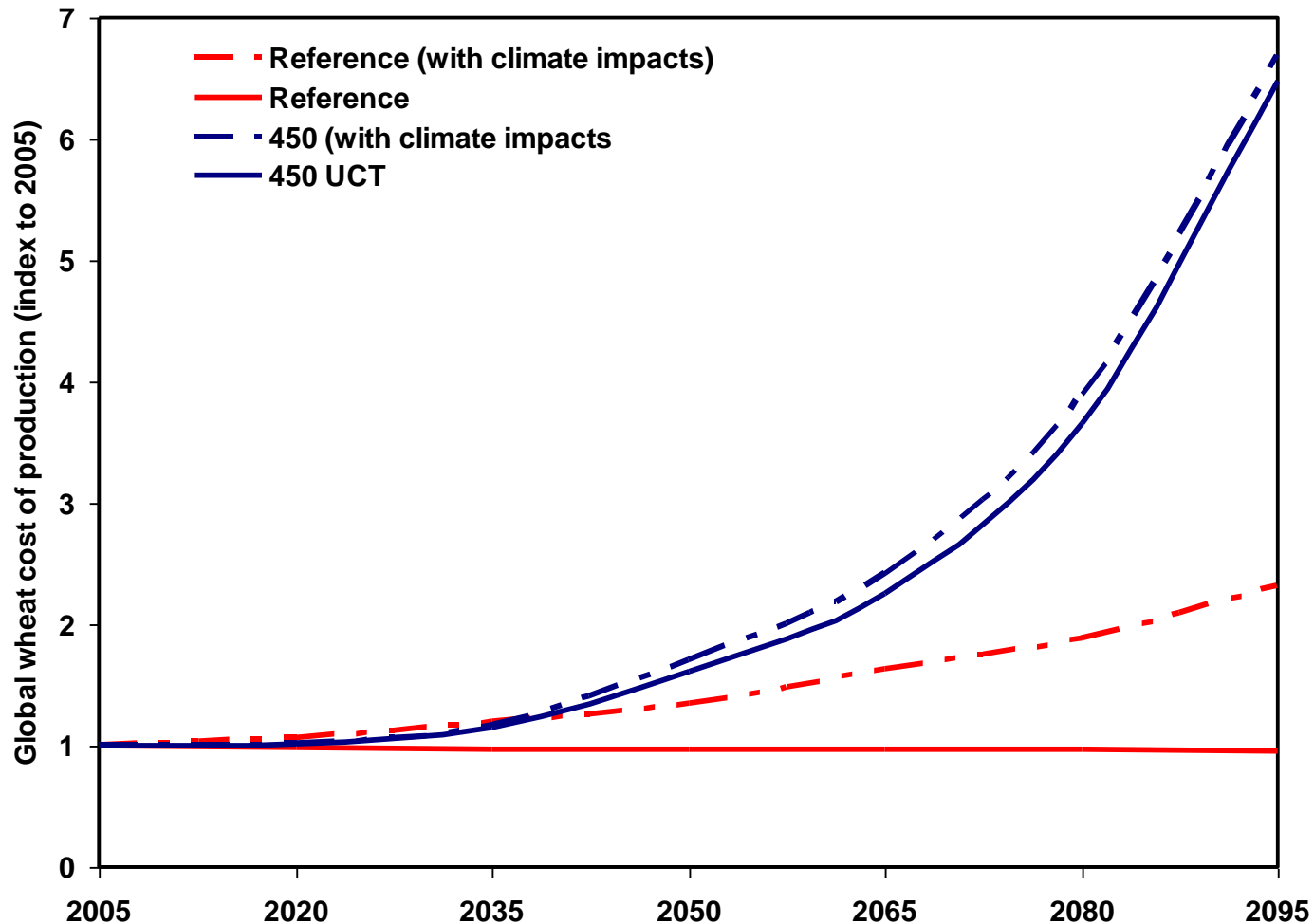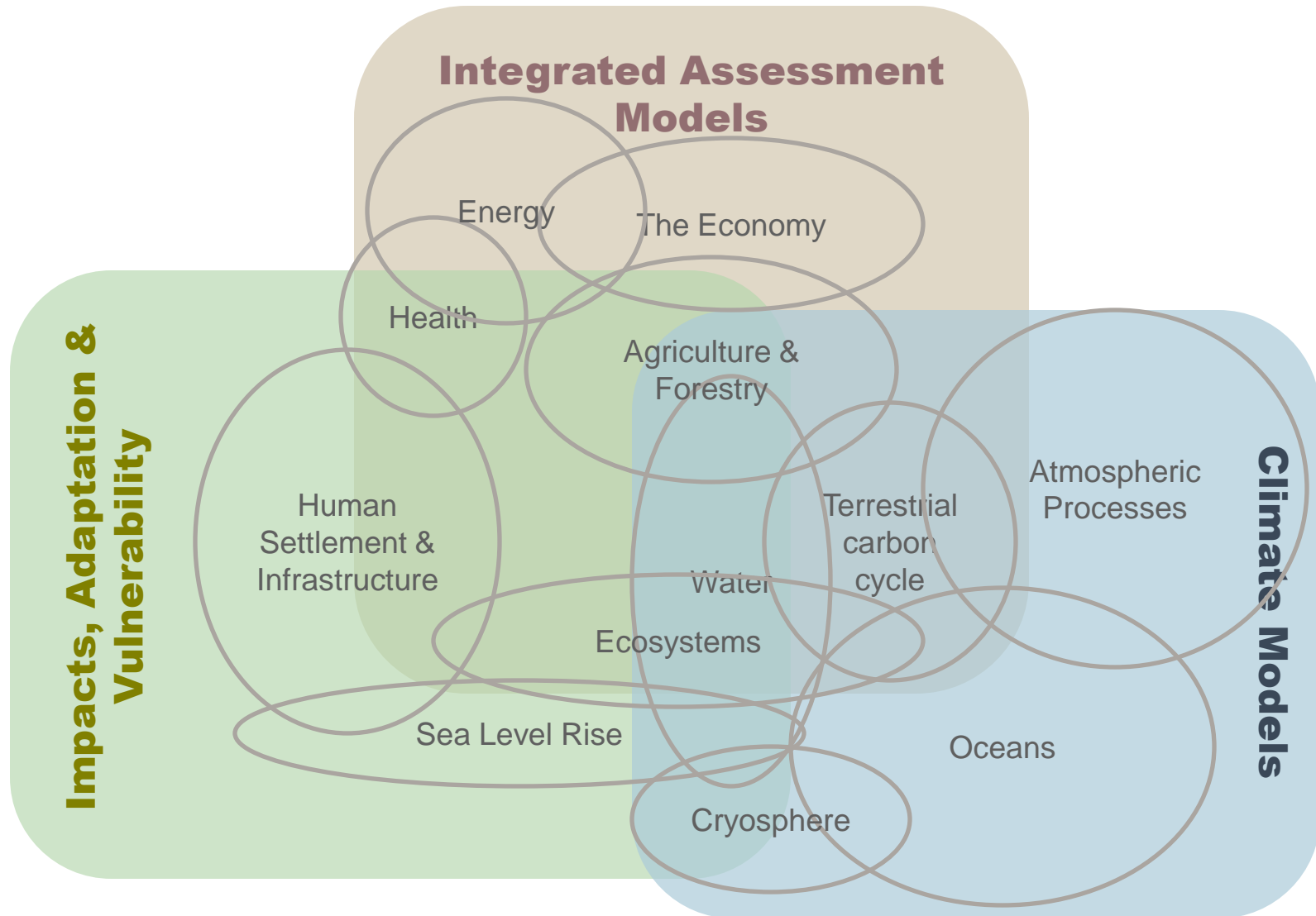
Growing Overlap in Domains
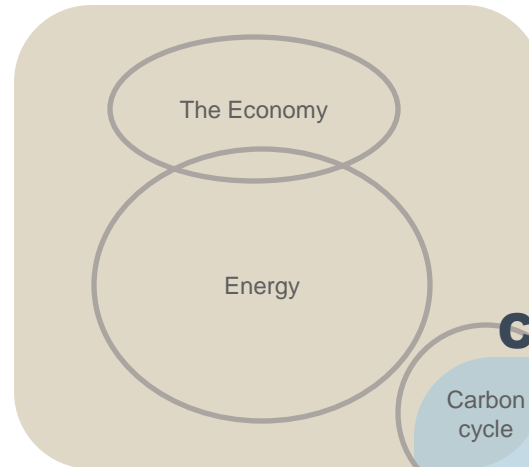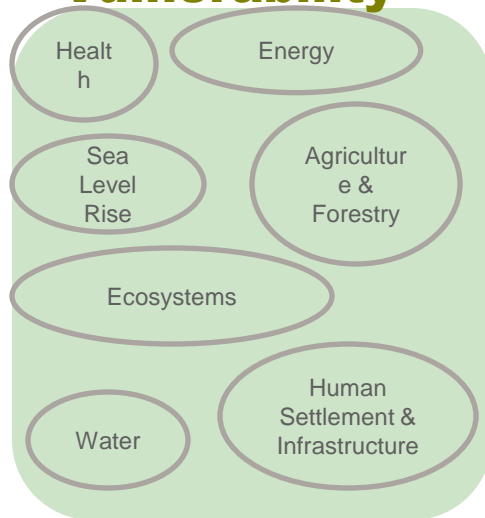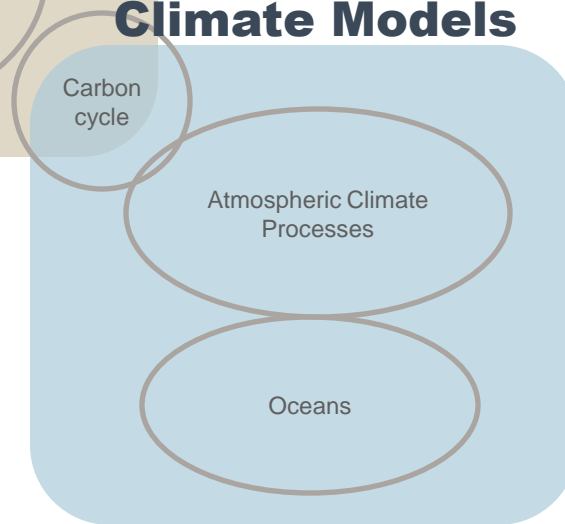
iESMs

▶ 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
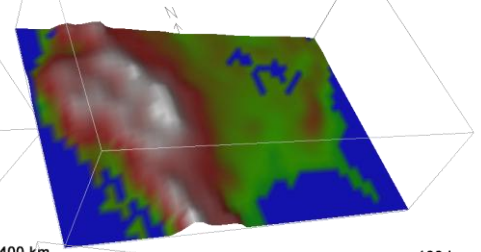 - A new generation of research, which includes feedbacks in all directions will come into being.

Complexity & resolution: ALL groups

Climate Models circa early 1990s
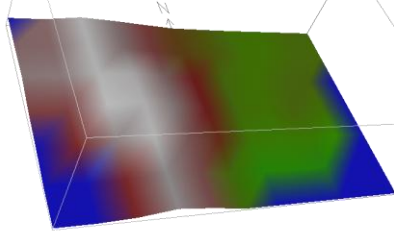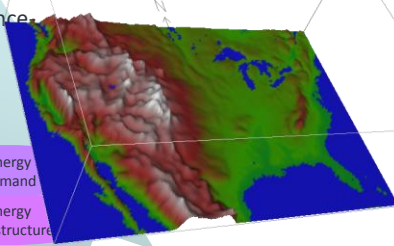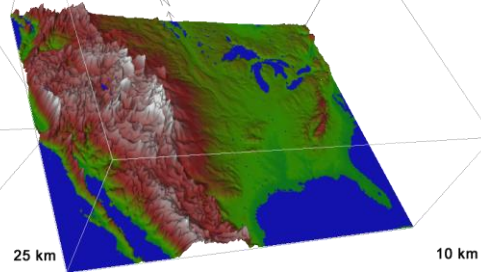
Global coupled climate models in 2007
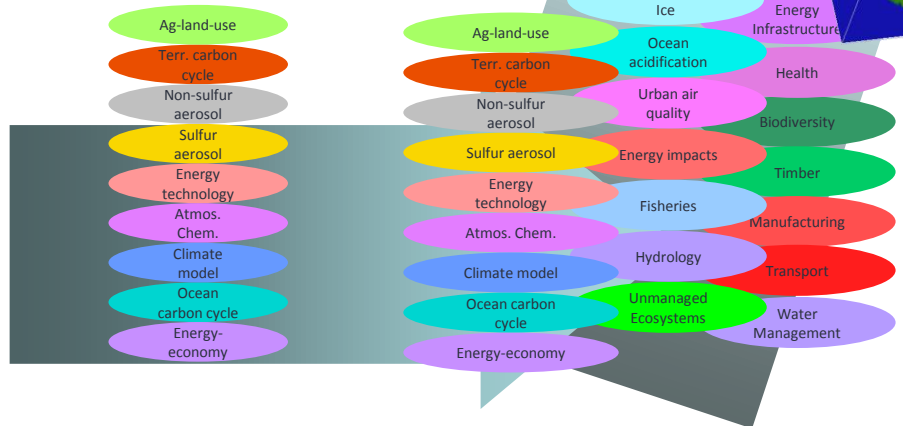
400 km

100 km

Regional models

Global models in <5 yrs

25 km

10 km

Present Day

In the Decade Ahead

Fully integrated (emissions, climate, impacts and adaptation), science-based, decision support tools

Energy-climate multigas+landuse models

Fully closed systems

Coastal zones

Energy Demand

Sea level and Ice

Energy Infrastructure

Ag-land-use

Ag-land-use

Ocean acidification

Terr. carbon cycle

Terr. carbon cycle

Urban air quality

Health

Non-sulfur aerosol

Non-sulfur aerosol

Sulfur aerosol

Sulfur aerosol

Biodiversity

Energy impacts

Energy technology

Energy technology

Timber

Atmos. Chem.

Atmos. Chem.

Fisheries

Manufacturing

Climate model

Climate model

Hydrology

Transport

Ocean carbon cycle

Ocean carbon cycle

Unmanaged Ecosystems

Water Management

Energy-economy

Energy-economy

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