

AIMES:

Analysis, Integration and Modelling of the Earth System

Peter Cox
Co-Chair of AIMS

AIMES Scientific Steering Committee



Sander van der Lueew



Gilberto Gallopin



Mark Rounsevell



Tim Lenton



Refugee from 70's



Pati Pinho



Jae Edmonds



Marko Scholze



Taka Hirata



Victor Brovkin



Kathy Hibbard



Kiyoshi Takahashi



Jim Randerson



Almut Arneth

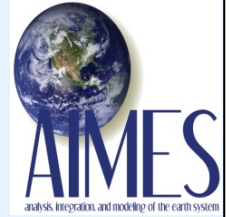


Dave Schimel

AIMES: Broad Themes

- Monitoring & Predicting Earth System Change.
- Human-Environment Coupling.
- Planet Earth as a Complex System.

AIMES: Activities & Expertise

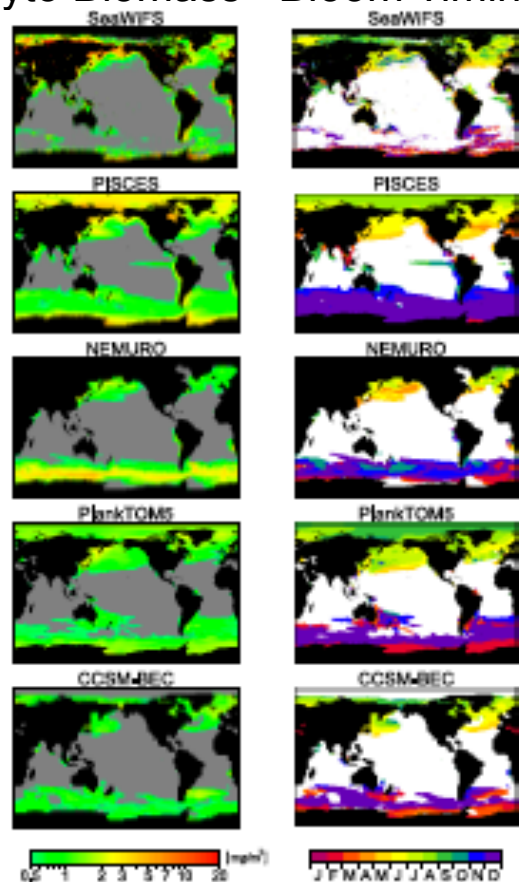


- Carbon Cycle Model intercomparison and bench-marking projects (e.g. iLAMB, MAREMIP) – *Jim Randerson, Taka Hirata*

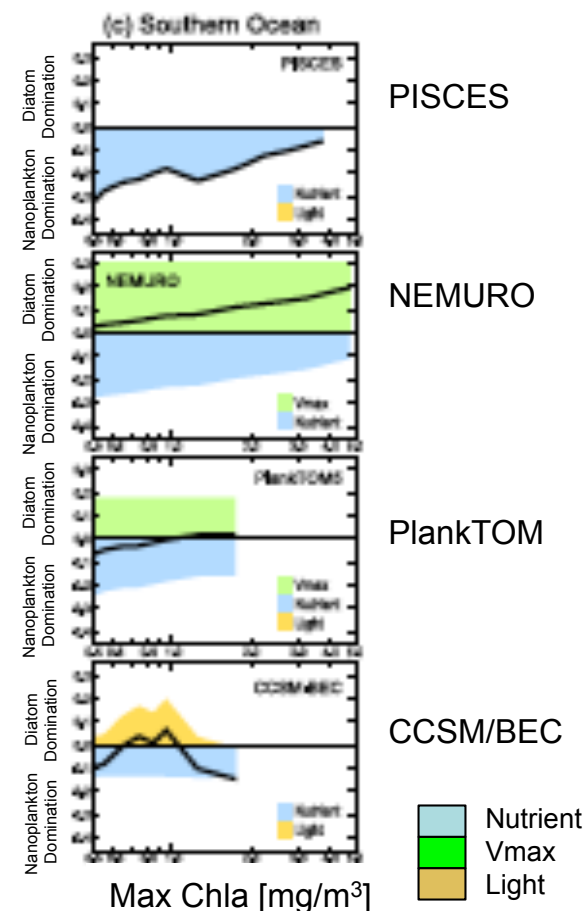
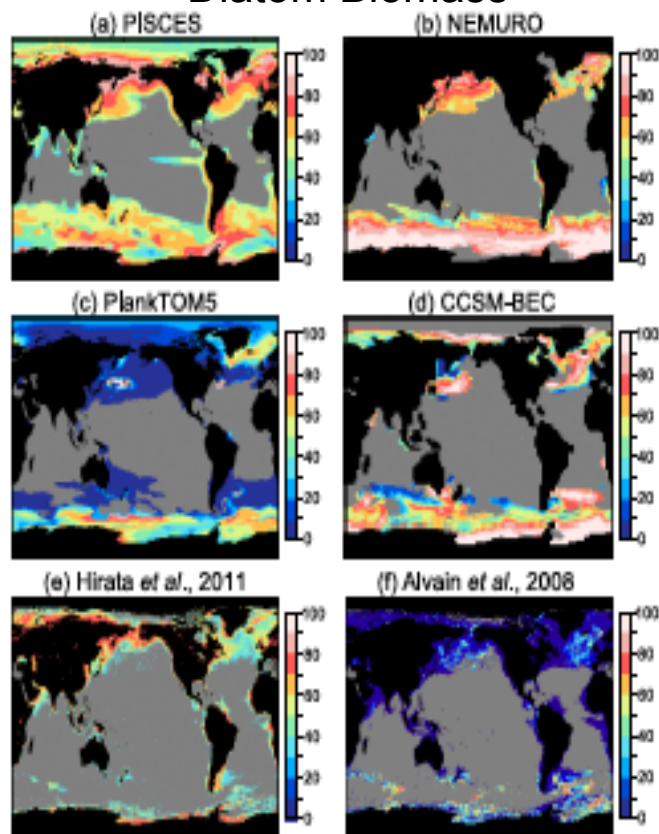
2012 Highlights: Model Comparison – Phytoplankton distributions obtained from different mechanisms

Similar total Phyto. Biomass & Bloom Timing, but different Diatom distribution, due to different growth limitation mechanism

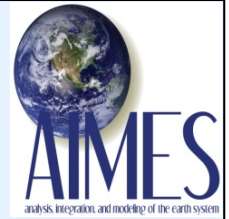
Phyto Biomass Bloom Timing



Diatom Biomass



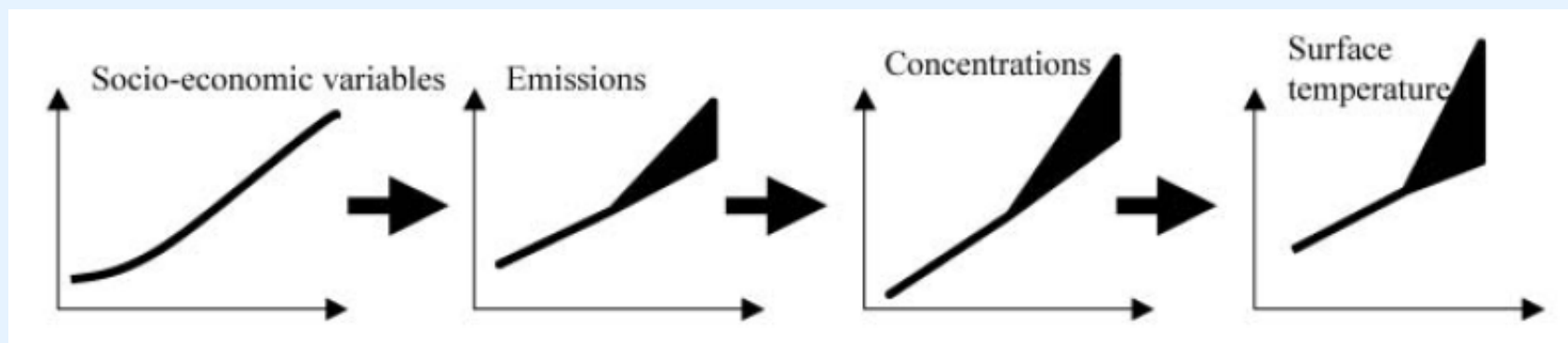
AIMES: Activities & Expertise



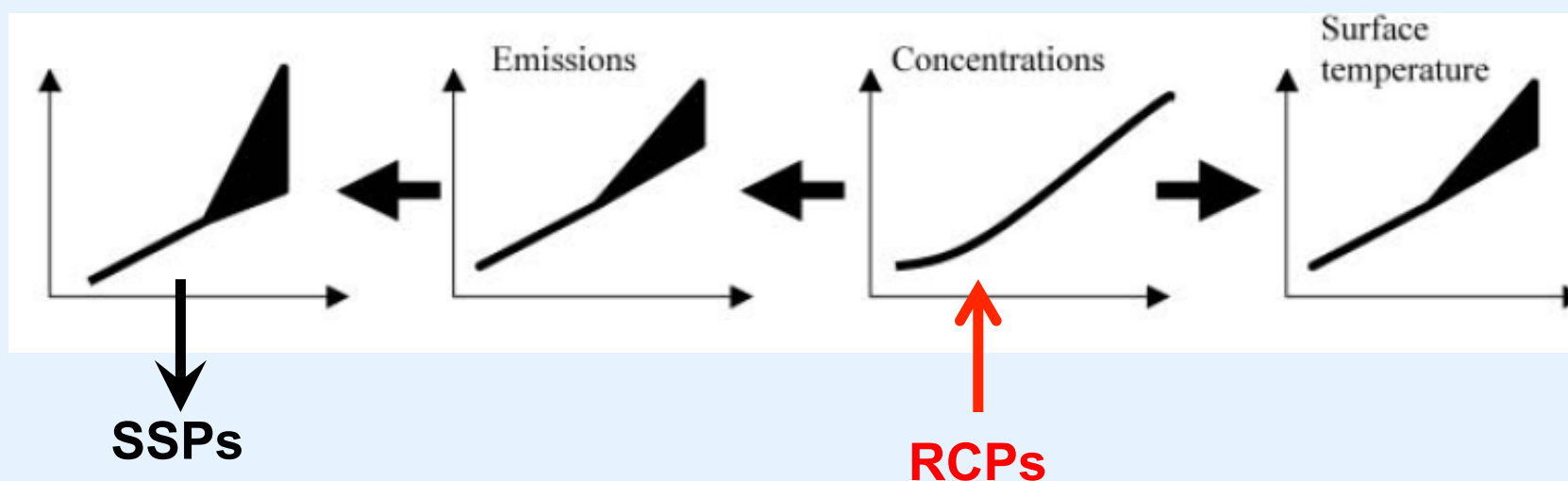
- Carbon Cycle Model intercomparison and bench-marking projects (e.g. iLAMB, MAREMIP) – *Jim Randerson, Taka Hirata*
- Understanding and modeling land-use change and its impacts – *Mark Rounsevell, Almut Arneth, Victor Brovkin.*
- Integrated assessment – *Kiyoshi Takashi, Jae Edmonds, Kathy Hibbard.*
- Development of more consistent Socioeconomic and Climate Scenarios (e.g. RCPs, Shared Socioeconomic Pathways) – *Jae Edmonds, Kathy Hibbard*

Strategy for Climate Stabilisation Experiments (Hibbard et al. 2007)

IPCC
AR4



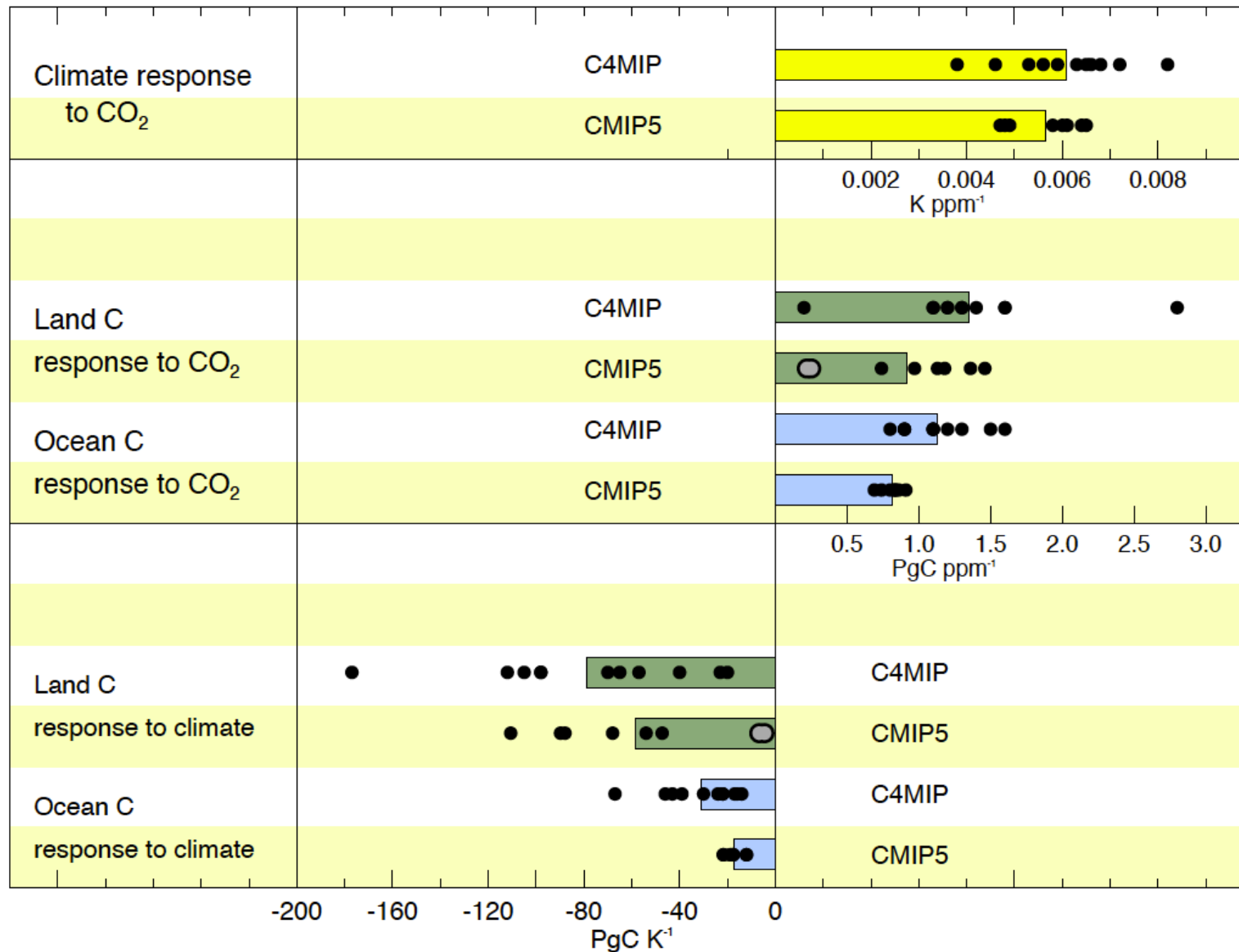
IPCC
AR5
(RCPs)



AIMES: Interests & Expertise

- Quantifying biospheric feedbacks – *Almut Arneth*

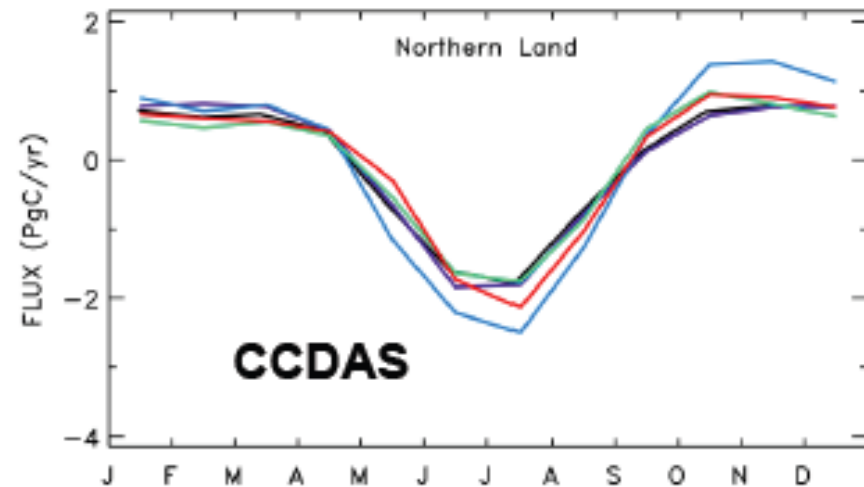
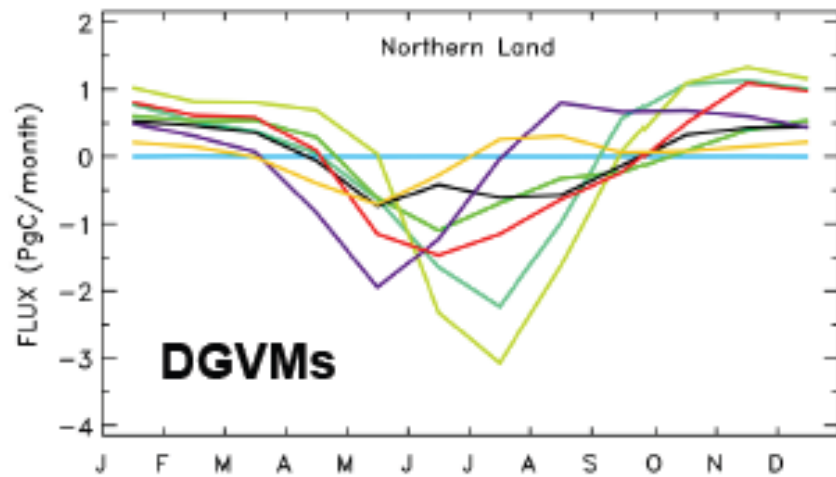
Carbon cycle feedbacks



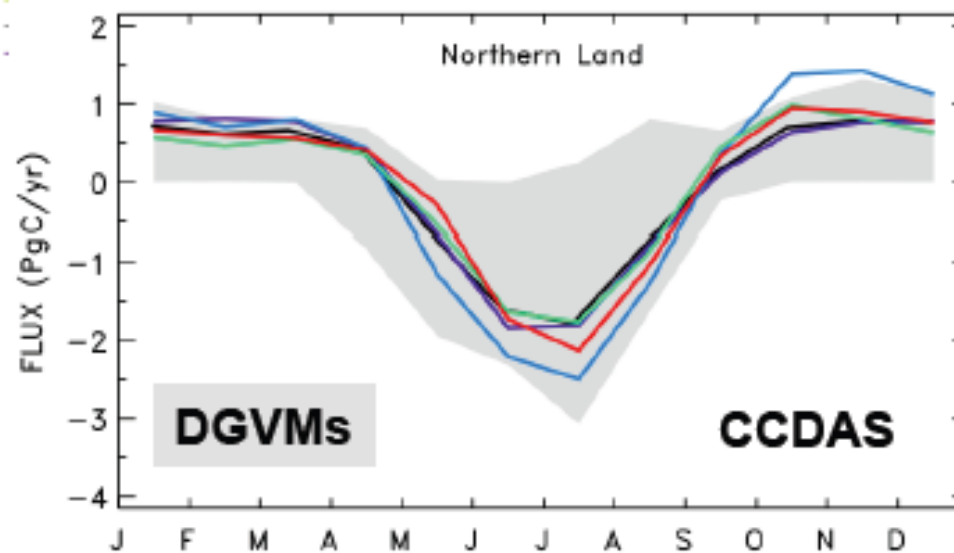
AIMES: Interests & Expertise

- Quantifying biospheric feedbacks – *Almut Arneth*
- Carbon Cycle Data Assimilation – *Marko Scholze*

Carbon Cycle Data Assimilation



— HYLAND
— VEGAS
— OCN



— JSB-CCDAS
— DALEC-CCDAS

— CTDAS-CCDAS

LSCE BETHY JSBACH CTDAS DALEC

— ORCHIDEE

— LPJ

— LSCE-CCDASv1

— BETHY-CCDAS

AIMES: Interests & Expertise

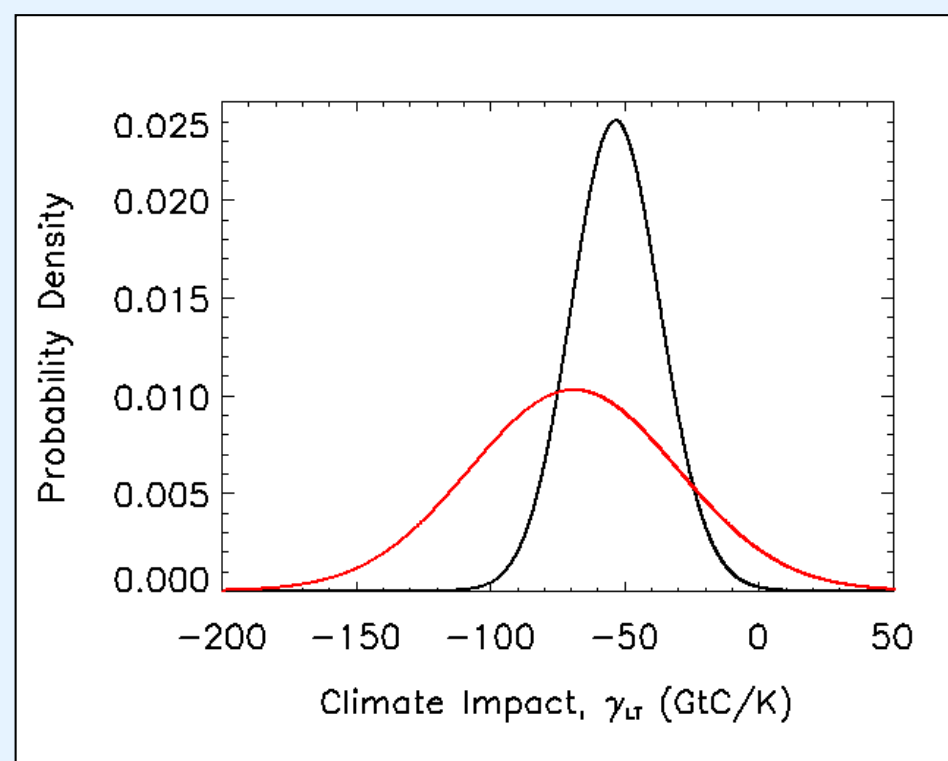
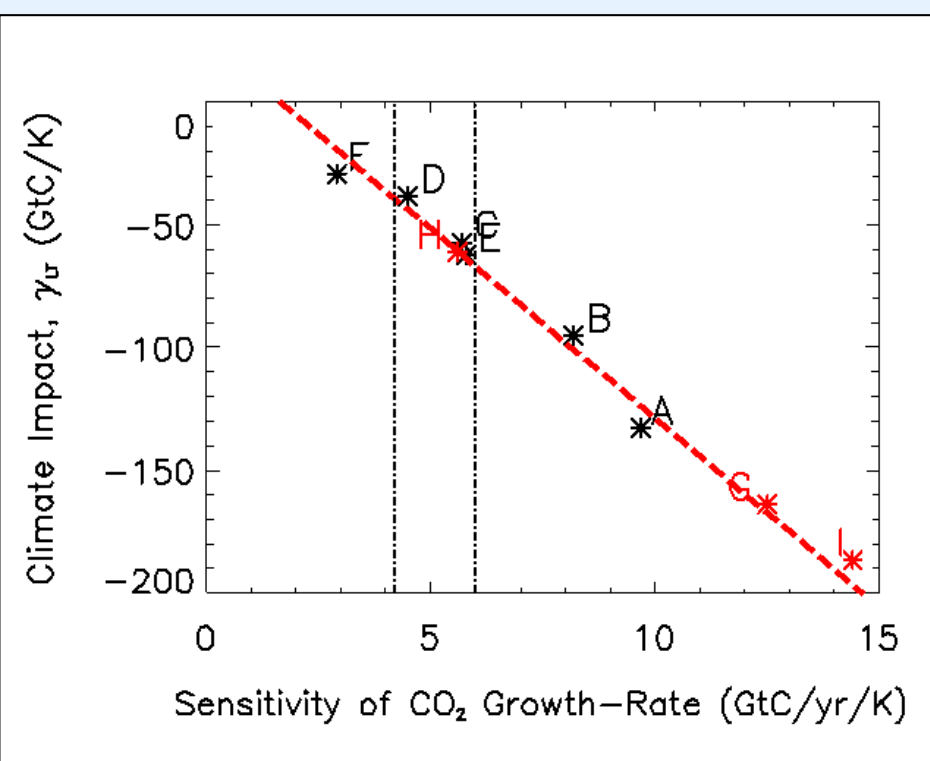
- Quantifying biospheric feedbacks – *Almut Arneth*
- Carbon Cycle Data Assimilation – *Marko Scholze*
- Emergent Constraints on Earth System feedbacks – *Peter Cox.*

Emergent Constraints:

Using an ensemble of ESMs to identify the relationships between observable contemporary variability and future sensitivity

Sensitivity of tropical carbon to climate change constrained by carbon dioxide variability

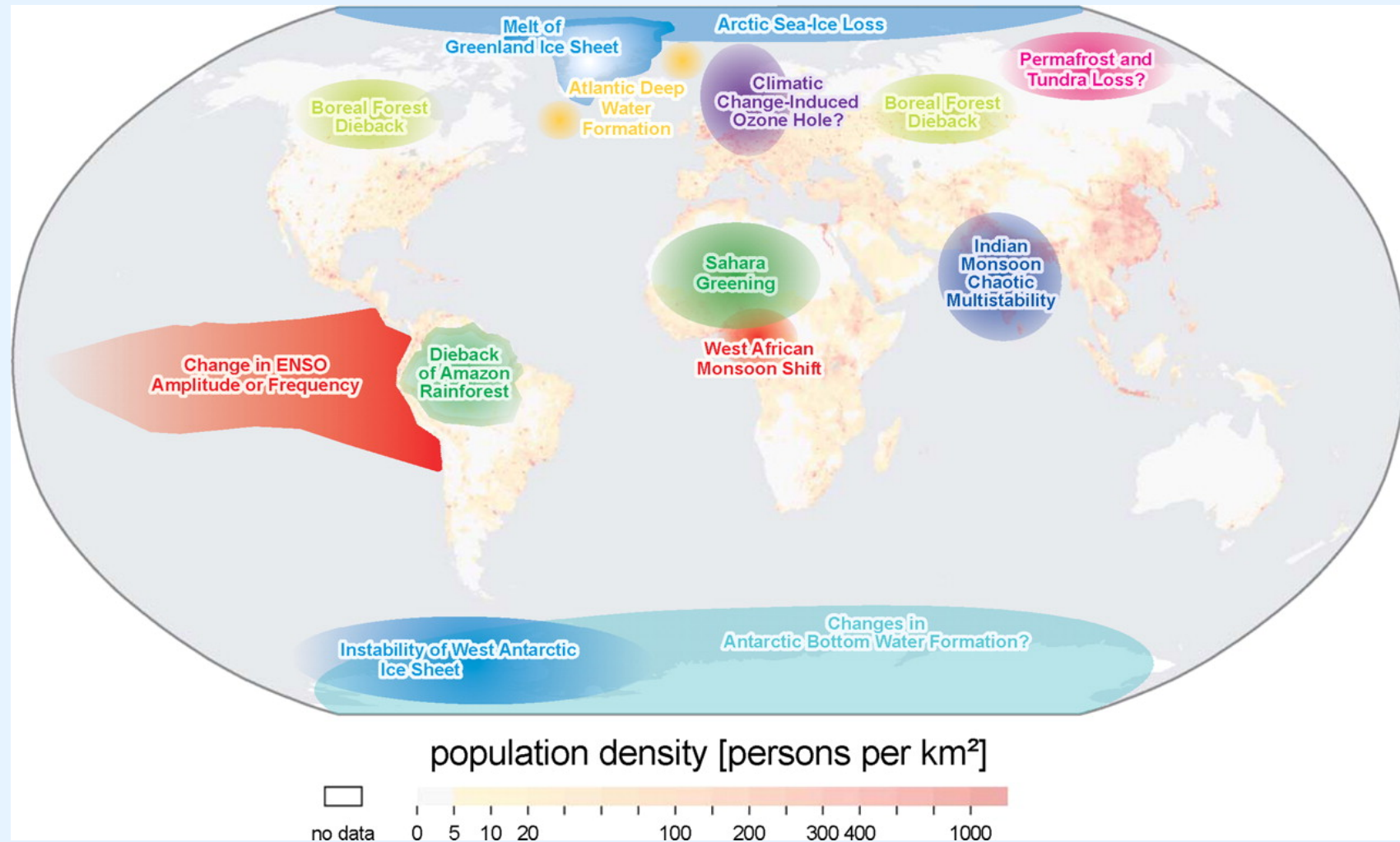
Peter M. Cox¹, David Pearson², Ben B. Booth², Pierre Friedlingstein¹, Chris Huntingford³, Chris D. Jones² & Catherine M. Luke¹



AIMES: Interests & Expertise

- Quantifying biospheric feedbacks – *Almut Arneth*
- Carbon Cycle Data Assimilation – *Marko Scholze*
- Emergent Constraints on Earth System feedbacks – *Peter Cox.*
- Tipping points and their potential precursors – *Tim Lenton*

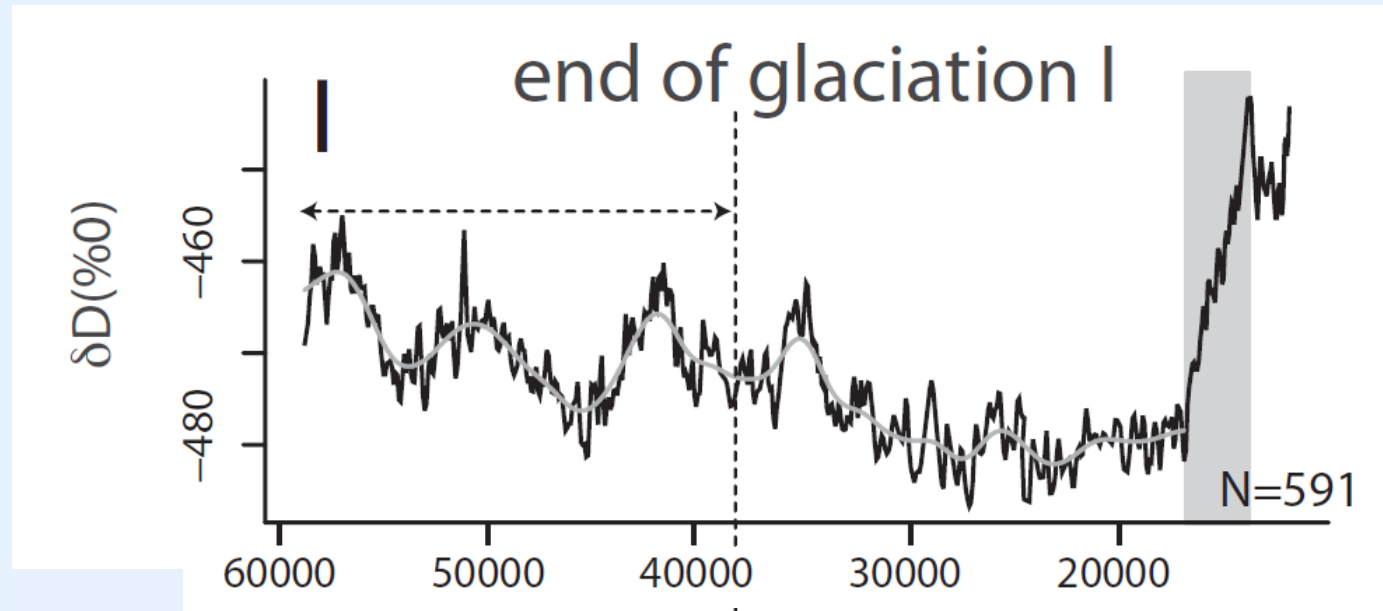
Tipping Points (Lenton et al., 2008)



Lenton T. M. et.al. PNAS 2008

PNAS

Detectable Precursors of Tipping Points ?



Dakos et al., 2008; Scheffer et al., 2009



photos: www.dawide.com

futureart+
research for global sustainability

To provide the **knowledge** required
for societies in the world to **face risks**
posed by global environmental
change and to seize **opportunities** in
a **transition** to global sustainability

IGBP Core Projects moving to Future Earth next year.....

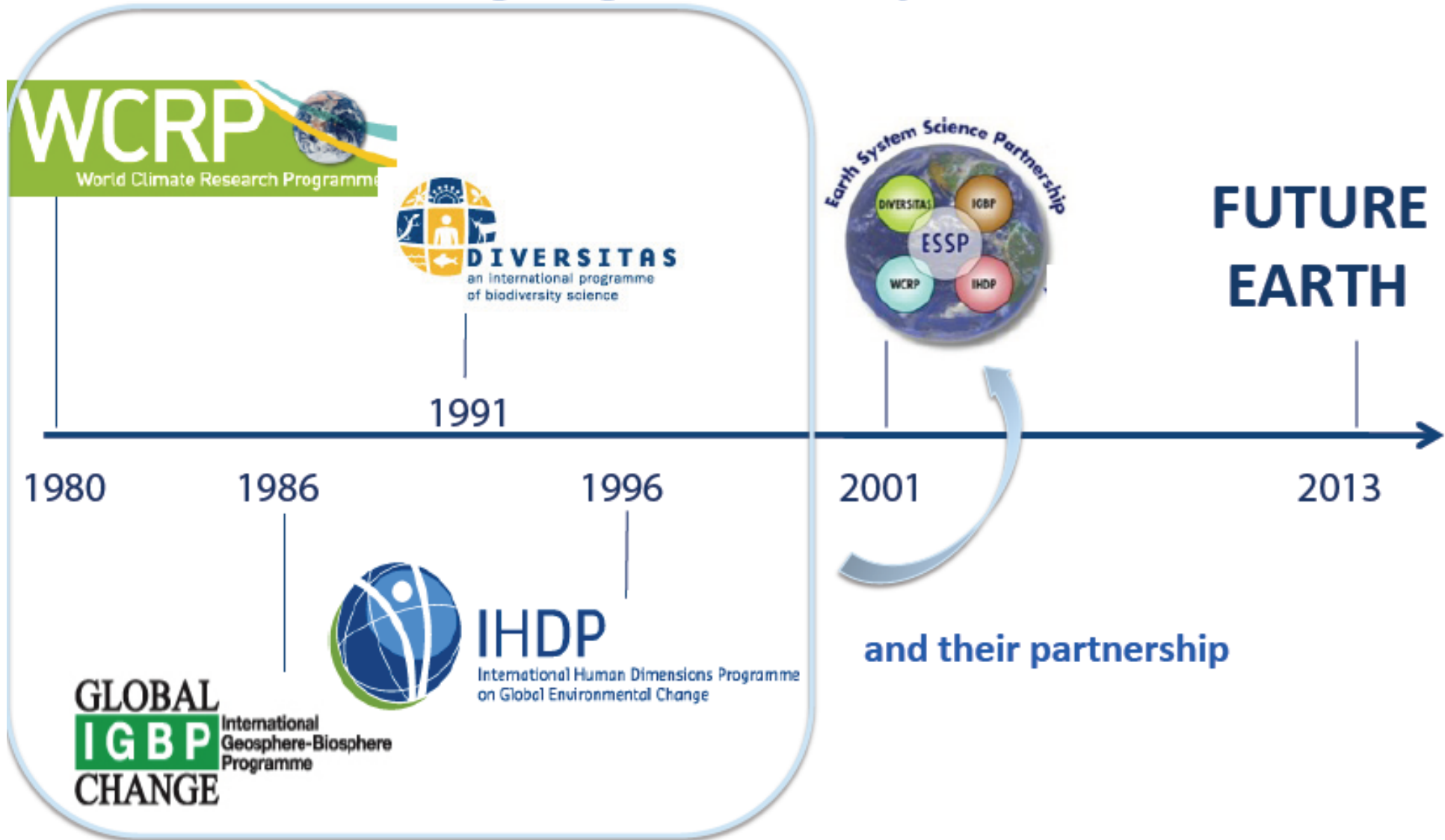
AIMES Perspectives on CMIP6



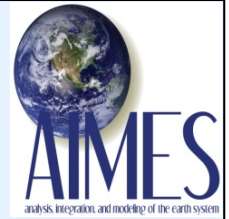
- Biospheric feedbacks and land-use change are special interests for AIMES.
- Would prefer to see carbon cycle feedbacks diagnosed in 1% per year runs.
- Need free CO₂ historical simulations (with land use change) to search for observational constraints on carbon cycle feedbacks.
- Would be interested to contribute expertise on land-use change modelling.

Future Earth: building from the GEC programmes

Global Environmental Change Programmes and Projects



Monitoring and Predicting Earth System Change:



Fusing Observations and Models

The Problem:

Building-up a complete picture of the Earth System requires a fusion of models and observations. Providing more useful projections requires the development of observational constraints on internal models parameters and feedbacks..

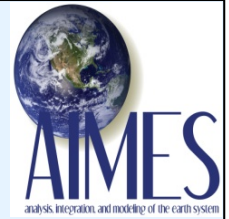
The Challenge: to develop and use model-data fusion techniques to diagnose and forecast changes in the Earth System.

AIMES Priorities:

- a) Consistent observations of biophysical and socioeconomic data (*Merton Initiative*).
- b) Carbon cycle data assimilation systems (CCDAS).
- c) Emergent constraints on Earth System feedbacks.

Human-Environment Coupling :

Humanity as part of the Earth System



The Problem:

There is still a distinction made between the “natural” and “human” world. Informing active management of the Earth System requires treating humans as internal components of the Earth System.

The Challenge: to understand and model socio-ecological systems and their contribution to human well-being.

AIMES Priorities:

- a) Impacts of past environmental changes on human well-being (*IHOPE*).
- b) Land-use change as an exemplar of Human-Environment interaction.
- c) Evaluating trade-offs in scenarios of the future.
- d) Advancing integrated assessment methods.

Planet Earth as a Complex System:

Organisational principles and Critical Transitions

The Problem:

The behaviours of the Earth System are richer than the behaviours of its components because new emergent behaviours arise from the coupling between the components. Of particular current concern are the possibility of critical transitions or “tipping points”.

The Challenge: to understand emergent behaviours and forecast critical transitions in the Earth System.

AIMES Priorities:

- a) Identification of critical transitions in the Earth System.
- b) Early warning indicators for tipping points in environment and society.
- c) Understanding adaptive learning.