SOUSEI Program for Risk Information on Climate Change
気候変動リスク情報創生プログラム

# Investigating climate stabilization scenarios using ESM, EMIC, and IAMs: An introduction of our activity in Program for Risk Information on Climate Change (or "Sousei")

Kaoru Tachiiri*
Ken'ichi Matsumoto**
Diego Silva Herran*

*Japan Agency for Marine-Earth Science and Technology
(JAMSTEC)
** Shiga Prefectural University

# "What is the Program for Risk Information on Climate Change?"

The aim of this program is to generate basic information required for managing various risks resulting from climate change.

Using the world-class supercomputers, such as Earth Simulator, we are pursuing research and development in which all themes are organically linked. Our research and development include prediction and diagnosis of imminent global climate change expected to occur within a few years or decades, research on greenhouse gas emission scenarios and associated long-term climate change projections, development of probabilistic climate change projection techniques, and development of technology for precise impact assessment, etc.

**Theme A**

**Prediction and diagnosis of imminent global climate change**

- Understanding mechanisms of climate variability and change
- Development of an integrated prediction system for global climate studies

**Theme B**

**Climate change projection contributing to stabilization target setting**

- Long-term global change projection based on diverse scenarios
- Obtaining scientific perceptions on large-scale variations and modifications of climate

**Theme C**

**Development of basic techno-logy for risk information on climate change**

- Probabilistic climate prediction for risk assessment
- Producing a standard climate scenario by using super high resolution models

**Theme D**

**Precise impact assessments on climate change**

- Climate change impacts on natural hazards
- Climate change impacts on water resources
- Climate change impacts on ecosystem and biodiversity

http://www.jamstec.go.jp/sousei/eng/index.html

supported by Ministry of Education, Culture, Sports, Science and Technology (MEXT)

# Team (Theme) B of the Program for Risk Information on Climate Change

SOUSEI

Climate change projection contributing to stabilization target setting

Theme (Task) (i):
Long-term global change projection based on diverse scenarios

Theme (Task) (ii):
Obtaining scientific perceptions on large-scale variations and modifications of climate

(i) a:
Development of an earth system model dealing with variations of greenhouse gasses, land use change etc.

(i) b:
Information gathering and examination on socio-economic scenarios toward stabilization target setting

(ii) a:
Development of technologies for numerical investigations on tipping elements and irreversibility of environmental changes (ice sheet collapse etc.)

(ii) b:
Development of technologies for numerical investigations on geoengineering (stratospheric aerosol injection etc.)

# Our sub-theme: goals and methods

Goals :

- Development of climate stabilization scenarios
- To run our ESM with that scenario
- To present the corresponding socio-economic scenarios

Models

Climate models

- MIROC-ESM
- JUMP-LCM (MIROC-lite-LCM)

IAMs

- CGE (like AIM)
- GCAM

# Analysis with climate models: focusing on TCRE*

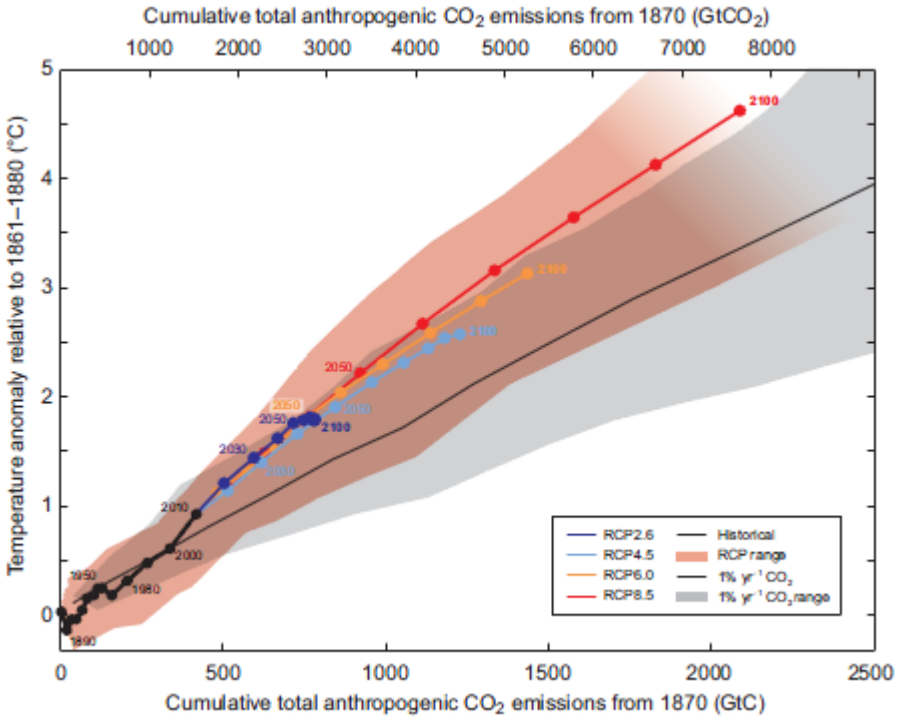
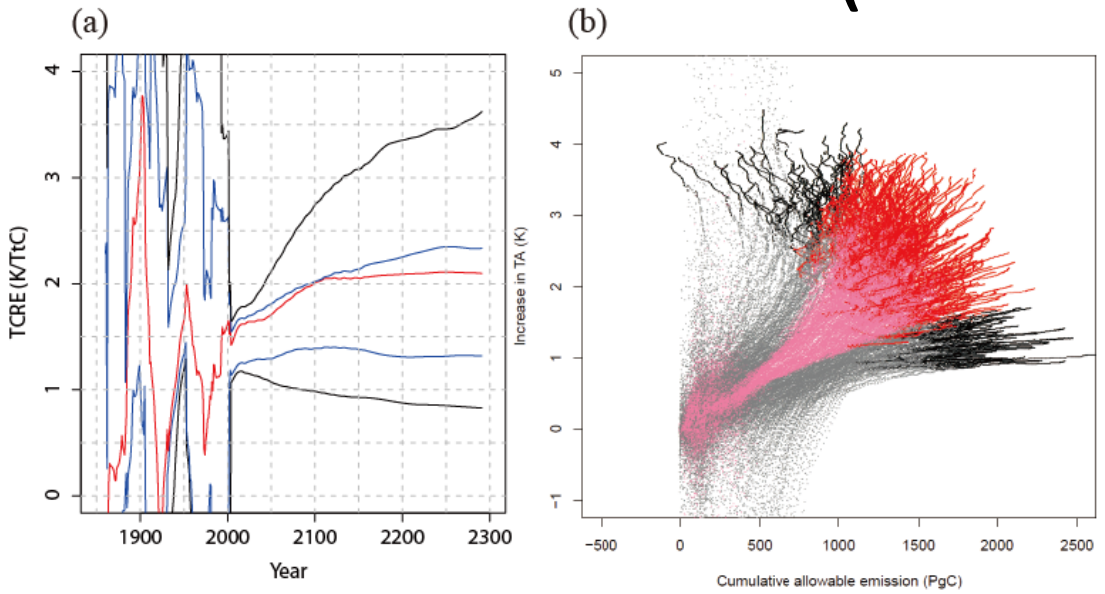


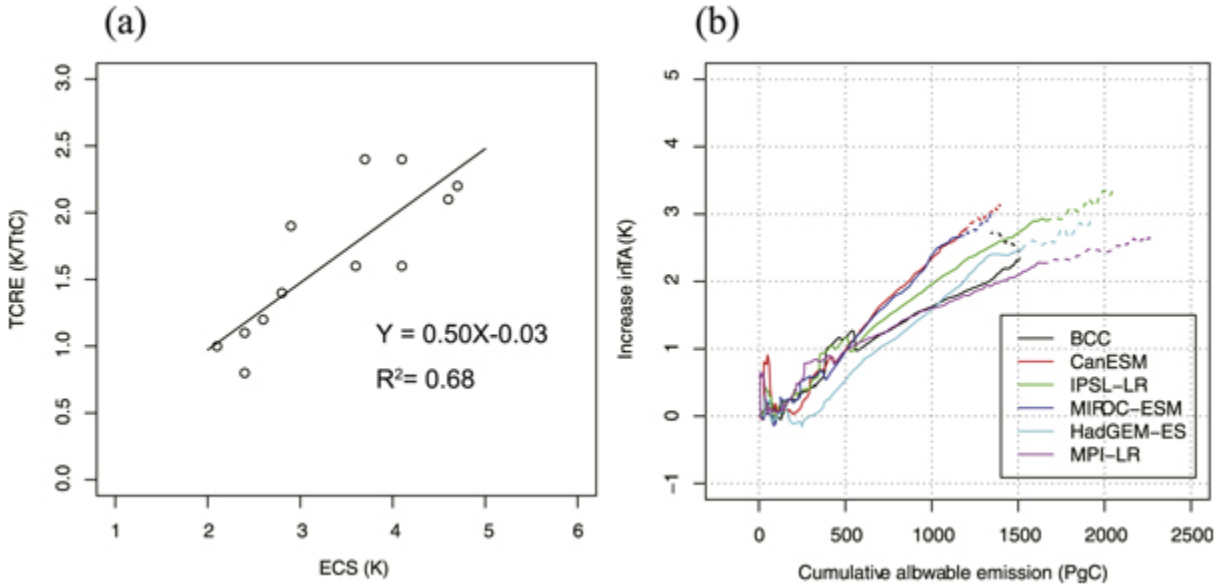

Fig SPM. 10 (IPCC AR5 WG1)

*: Transient Climate Response to Cumulative Carbon Emissions

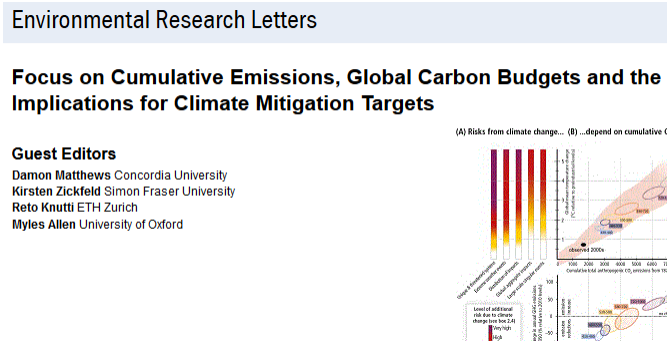
# Uncertainty in TCRE after the pCO2 is stabilized (in RCP4.5)




- EMIC data
- RCP4.5
- 512 member
- 12 parameters varied
- Constrained by observation data




Tachiiri et al. (2015, ERL)

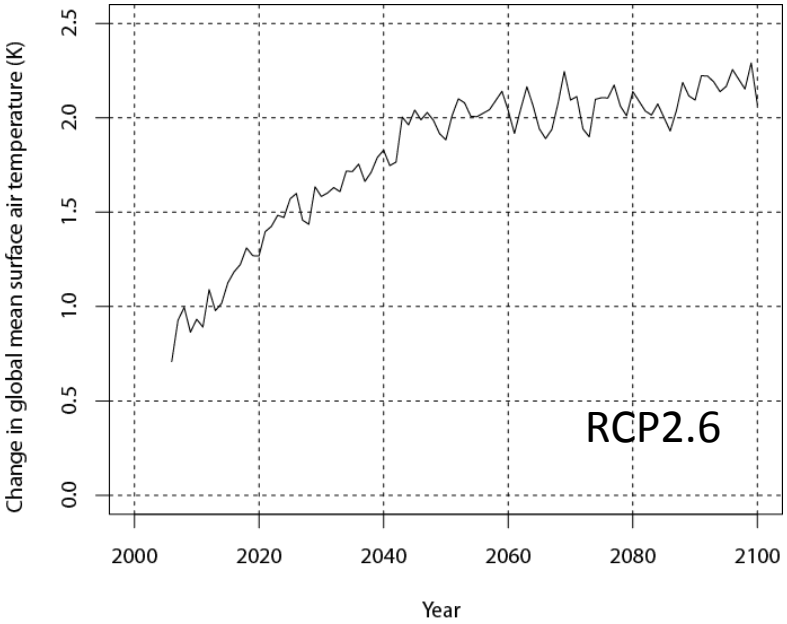

Environmental Research Letters

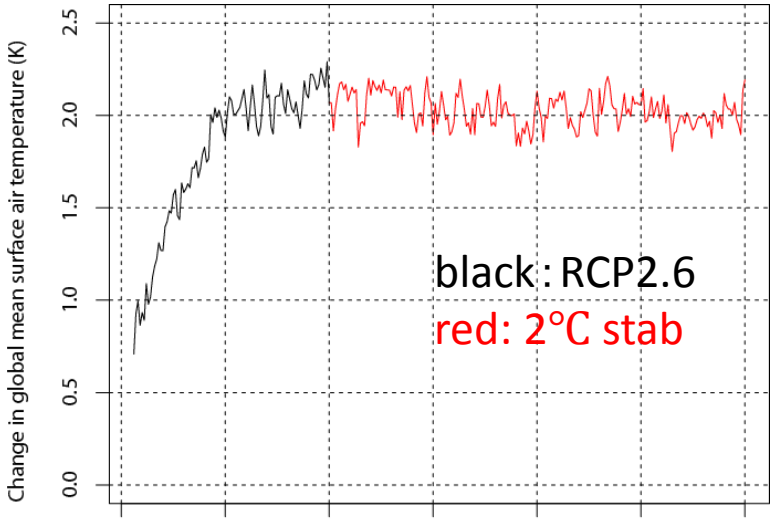
**Focus on Cumulative Emissions, Global Carbon Budgets and the Implications for Climate Mitigation Targets**

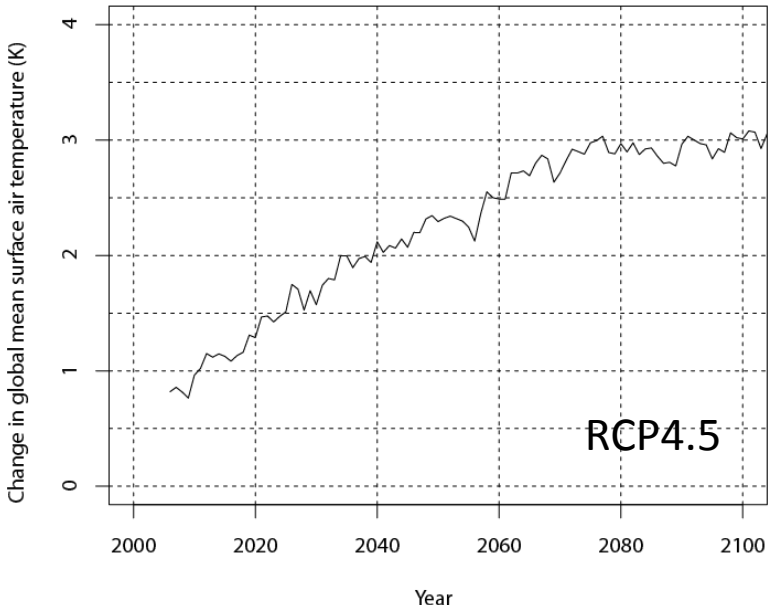
**Guest Editors**

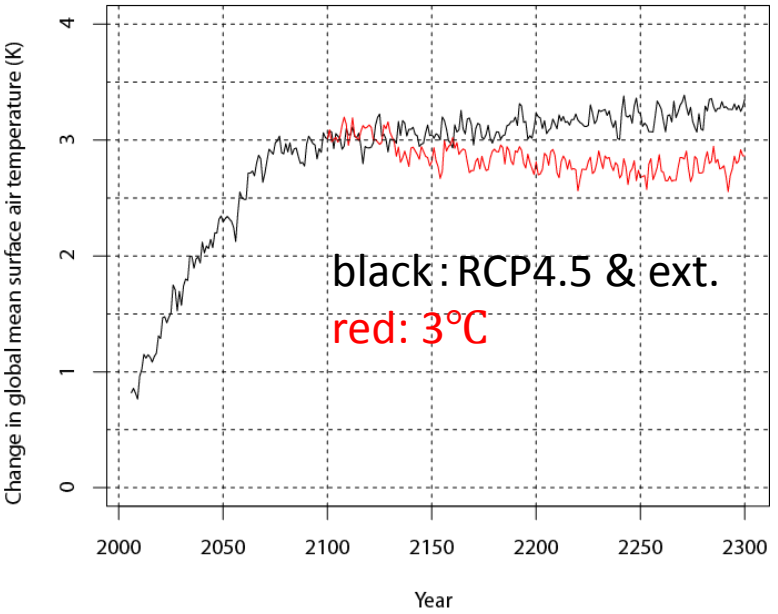
**Damon Matthews** Concordia University
**Kirsten Zickfeld** Simon Fraser University
**Reto Knutti** ETH Zurich
**Myles Allen** University of Oxford

# 2degree, 3degree stabilization

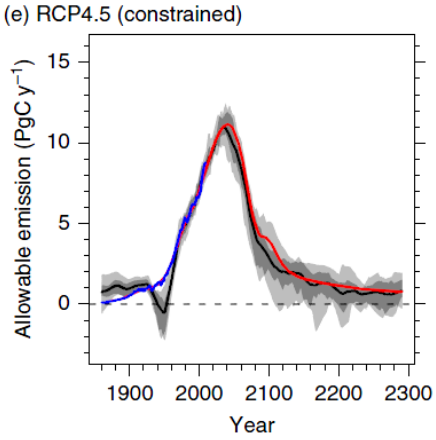


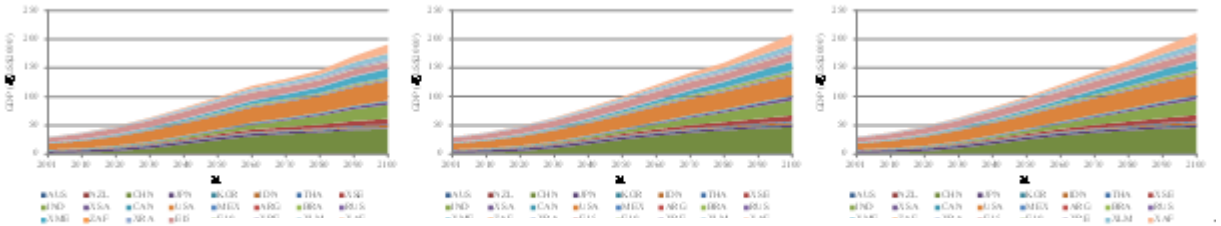



# RCP4.5 EMIC CGE/GCAM

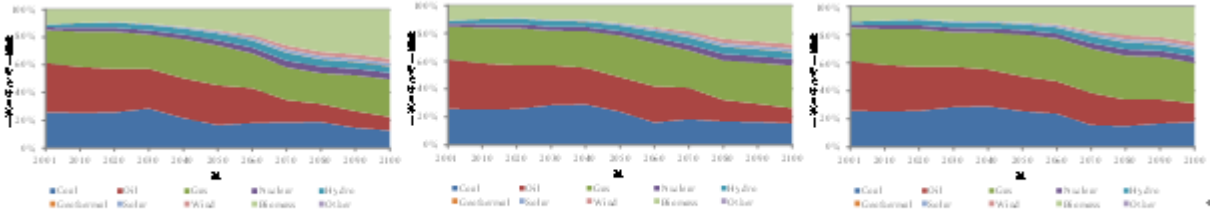



Tachiiri et al. (2013)

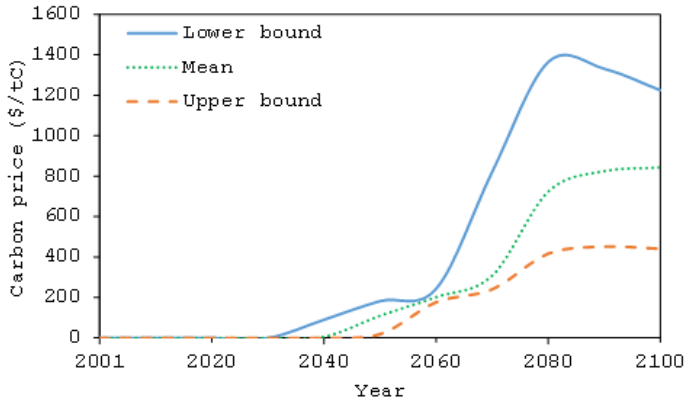
For RCP2.6, only high emission cases are feasible.



Regional GDP (5%, 50%, 95% from left)

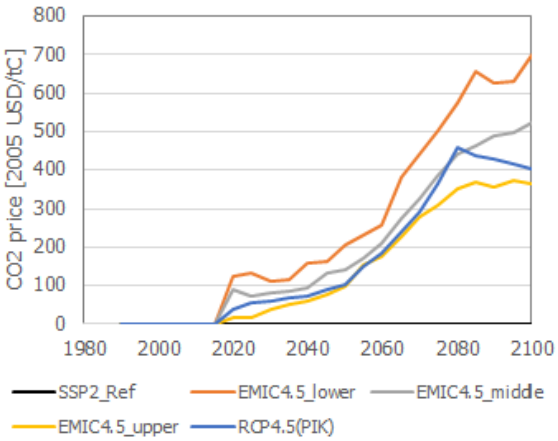


Primary energy for each type (5%, 50%, 95% from left)

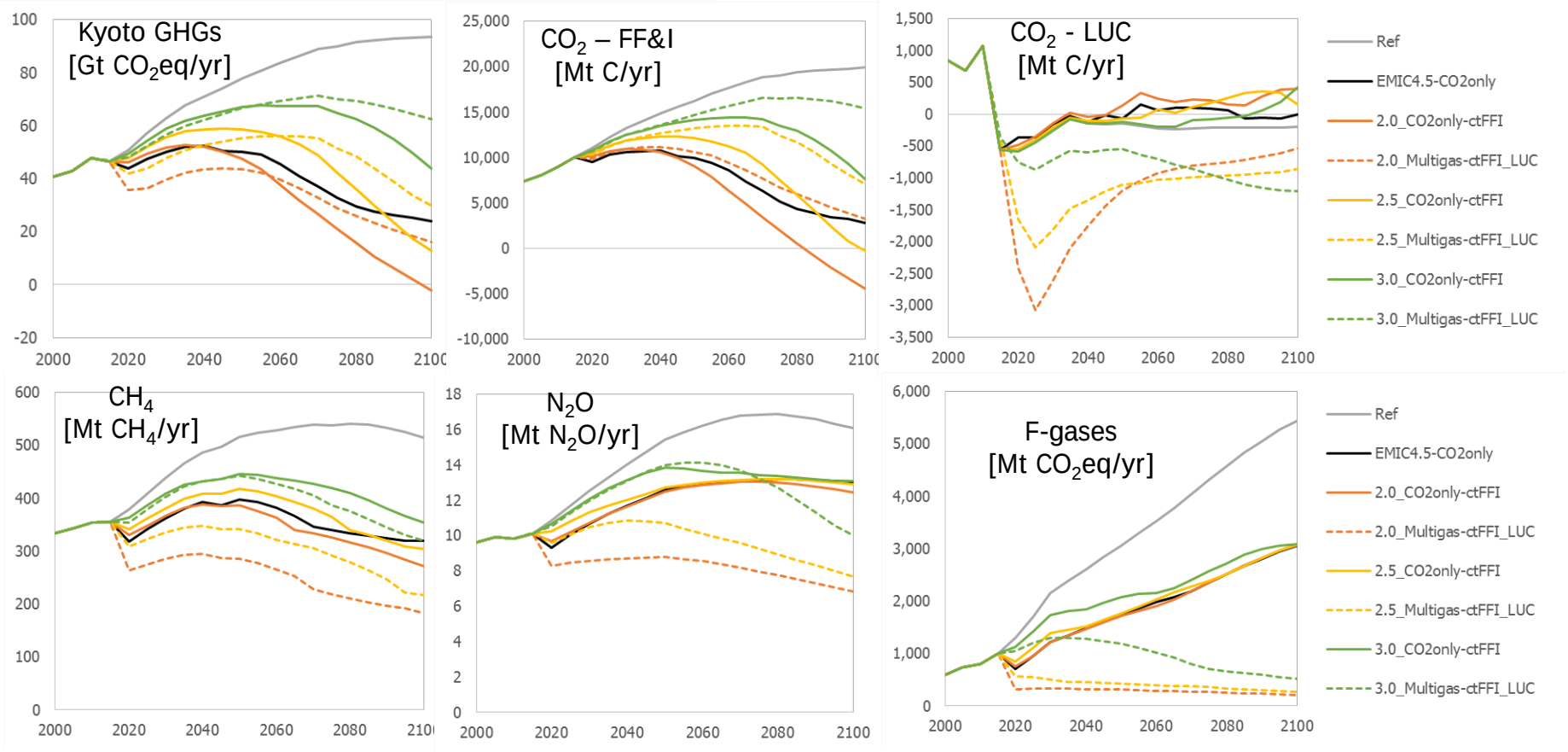



Matsumoto et al. (2015)

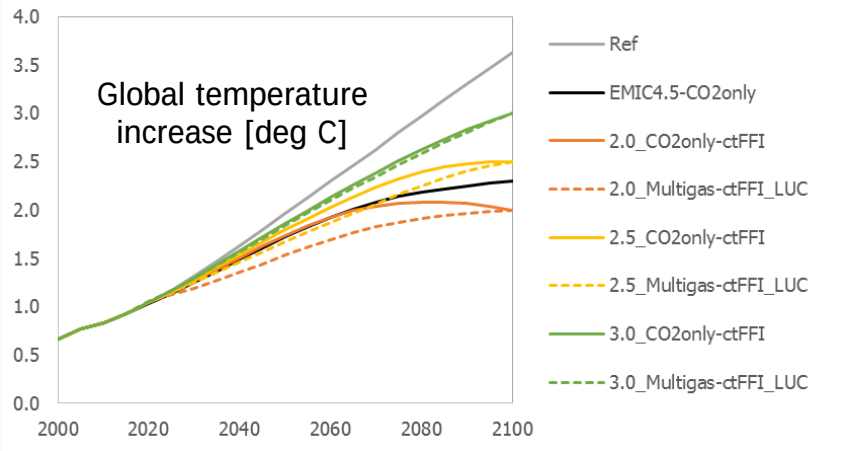
Result with GCAM

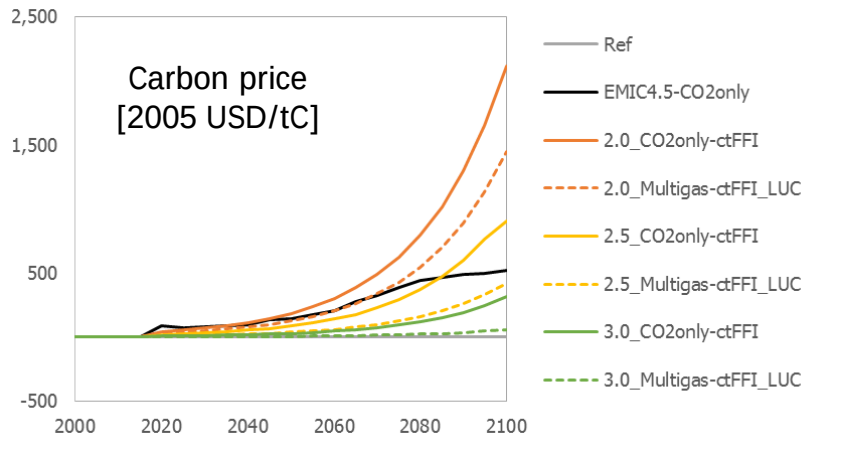


# Emissions - Price on LUC and non-$CO_2$ GHG emissions




With GCAM by Diego




- Remaining issues:
  - Stabilization of global temperature beyond 2100 needs to be checked (application on IAM beyond 2100?).
  - Uncertainty of climate models (climate sensitivity, carbon cycle feedbacks etc – by tuning MAGCC in GCAM, or using Hector model?) and IAMs

# CM-IAV-IAM community linkage

- We are keen on CM-IAV-IAM linkage.
- Scenario Initiative (lead by CRIEPI) provides the place to interaction among various field of scientists. Held 2-3 times a year. Information exchange, study meetings etc.
- Contribution to ScenarioMIP and C4MIP
- We are interested in your ongoing attempt to couple ESM and IAM.
- Recently we (NIES and JAMSTEC) had a meeting on future collaboration and had some discussion on this.
- Tentative conclusion is we have to investigate the merit of the coupling more carefully before full coupling.

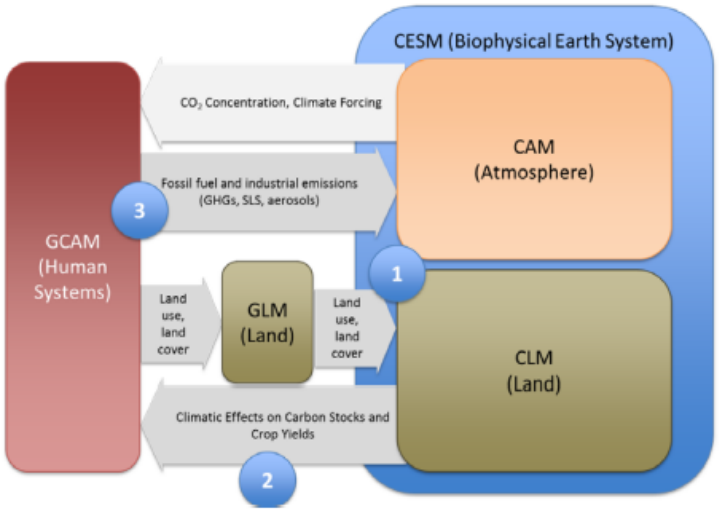



**Figure 2.** Schematic of the integrated Earth system model (iESM) showing its major component models GCAM, CESM, and GLM as well as the two-way connections between these models.

Collins et al. (2015, GMD)

# Ad: An AGU-JpGU session

- AGU and JpGU will have some joint sessions in the general assembly of JpGU (May)
- No: A-GC09
- Conveners : M Kawamiya, V. Arora（CCCma）, K Tachiiri, T Hajima
- Date : May 23 (Mon) 2016
- Venue: Chiba, Japan
- Title : Development and application of land and ocean biogeochemistry components of Earth system models
- Abstract deadline: Feb 18


Scope

Earth System Models (ESMs) include representations of biogeochemical cycles including the carbon and nutrient cycles, aerosols and atmospheric chemistry, and the coupling of these processes to the physical climate system, which itself is represented through atmosphere, land and ocean components. ESMs are comprehensive tools which allow to project the response of the physical climate system, as well as the associated biogeochemical cycles, to future changes in concentration of greenhouse gases and/or their anthropogenic emissions and other climate forcers. The 6th phase of Coupled Model Intercomparison Project (CMIP6) is an international research project which amongst its many model intercomparison projects (MIPs) will allow to compare climate change projections from participating ESMs. The Coupled Climate ? Carbon Cycle Model Intercomparison Project (C4MIP) which focusses on carbon cycle is one of the MIPs endorsed by CMIP6. Efforts such as those of the CMIP community allow for an organized cooperation among institutes from across the world and are expected to yield significant advances in the understanding of dynamics of carbon and nutrients cycles, atmospheric tracers, and future changes in the ocean and land ecosystems. The purpose of this session is to discuss the development and evaluation of ESMs and its components, and the scientific issues which can be addressed with them. It is hoped that such discussion will lead to refining the future scope of ongoing efforts such as C4MIP for investigating the role of, and changes in, biogeochemical cycles in affecting global change.

# Summary

- I introduced our activity in Program for Risk Information on Climate Change, encompassing climate model analysis, socio-economic analysis and inter-community linkage. We are using GCAM and may use Hector.
- This week I want to learn your activity, integrating climate, socio-dimension, and other aspects.
- Now we are discussing how the next project should be like. The Japanese government requires “Innovation”, and not easy for basic science to get big fund. We need some story, or “vision”. Happy if I can get hints for that.