

Linking IA Models and ESMs

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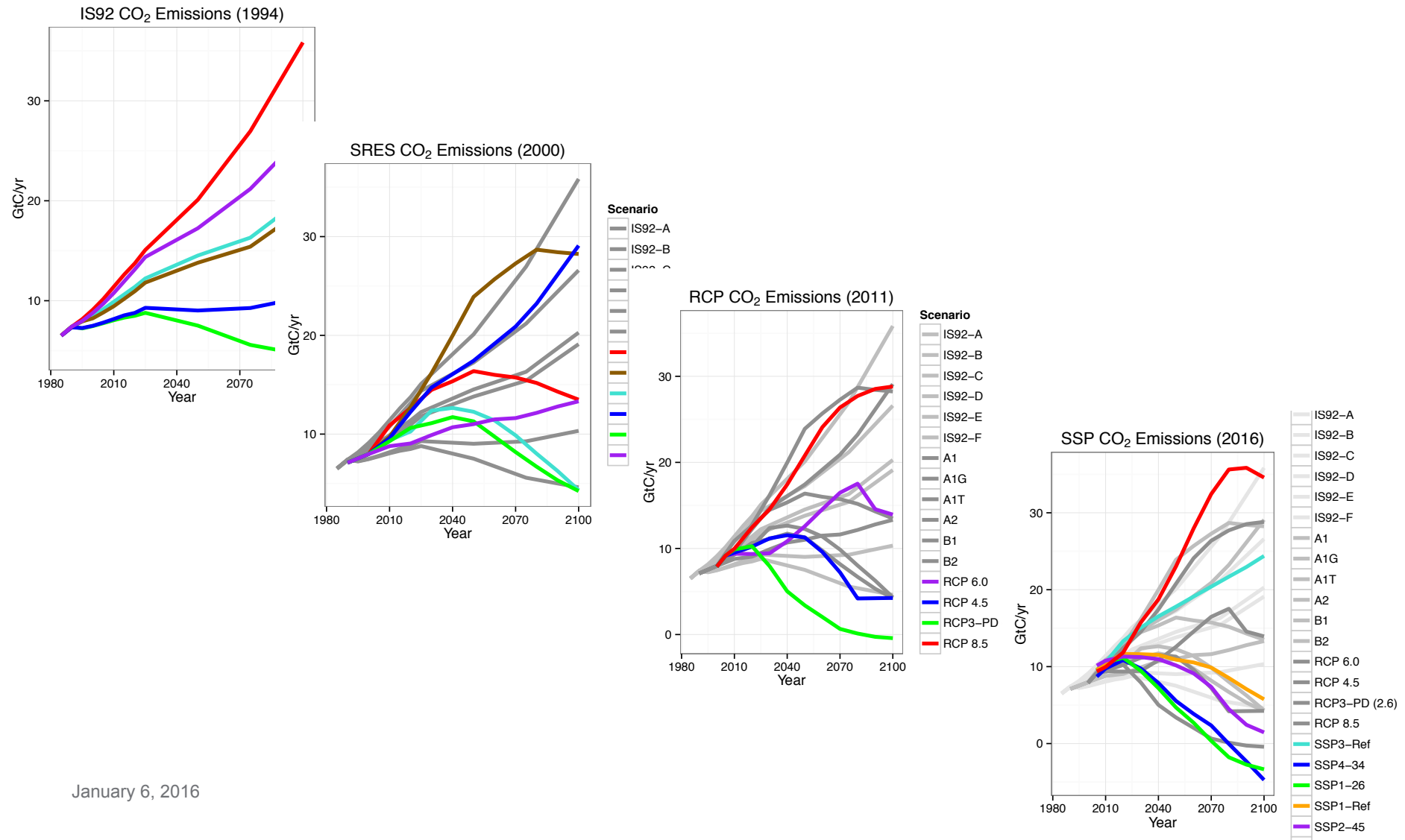
Types of IA-ESM Linkages

	Method	Advantages	Disadvantages	Examples
A	Off-line information exchange, one-way	<ul style="list-style-type: none"> • Work with existing terminology and tools • Transparent information exchange • Flexibility • Separate research strategies 	<ul style="list-style-type: none"> • Feedbacks are only captured via (one-single) iterations • Potential inconsistencies 	<ul style="list-style-type: none"> • CMIP • AgMIP
B	Improved IAMs	<ul style="list-style-type: none"> • Allows for good representation of uncertainty • Model complexity tailored to question • Detail in treatment of socio-economic processes 	<ul style="list-style-type: none"> • Lack of detail in treatment of biophysical processes 	<ul style="list-style-type: none"> • MAGICC calibration to CMIP • GCAM-Albedo
C	Improved ESMs	<ul style="list-style-type: none"> • Higher resolution analyses than in IAMs • Detail in treatment of biophysical processes 	<ul style="list-style-type: none"> • Lack of detail in treatment of socio-economic processes • Limitation of model runs limits representation of uncertainty 	<ul style="list-style-type: none"> • Urban/crop component of CESM
D	Full Coupling	<ul style="list-style-type: none"> • Assessment of feedbacks • Highest degree of consistency 	<ul style="list-style-type: none"> • Technical difficulties • Lack of representation of uncertainty • Inflexibility • Complexity/[opaqueness] • Limitations in knowledge may hamper progress 	<ul style="list-style-type: none"> • iESM • IMAGE-CNRM

Source: van Vuuren et al. (2012)

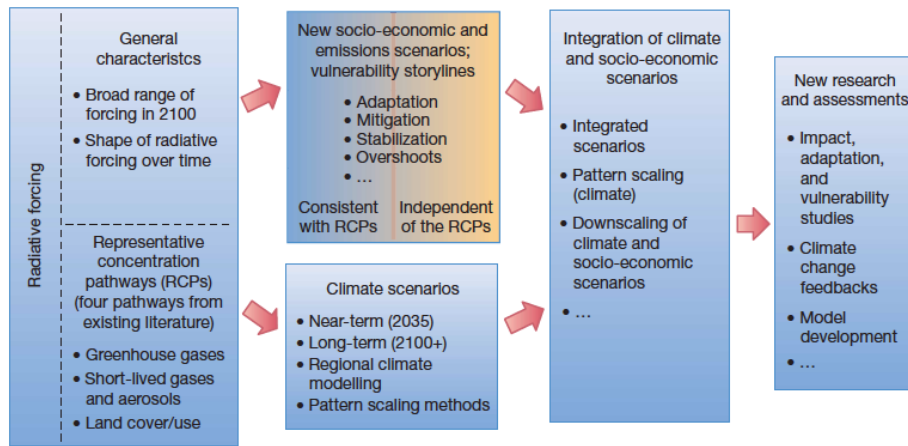
A. Offline One-Way Information Exchange: IAM to ESMs

IAMs Provide Scenarios for ESMs

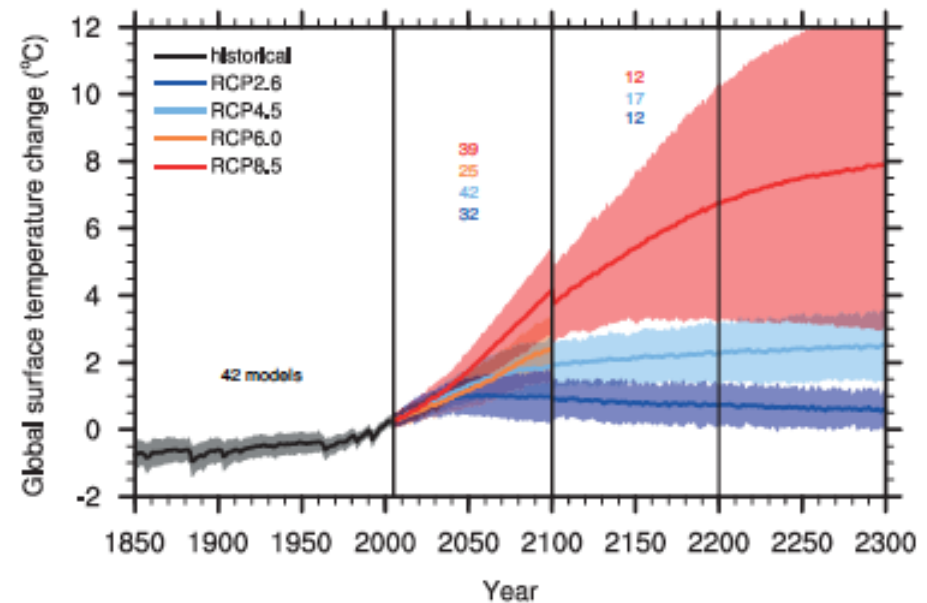


A. Offline One-Way Information Exchange: IAM to ESMs via CMIP

The CMIP5 Process



GMT Rise in CMIP5

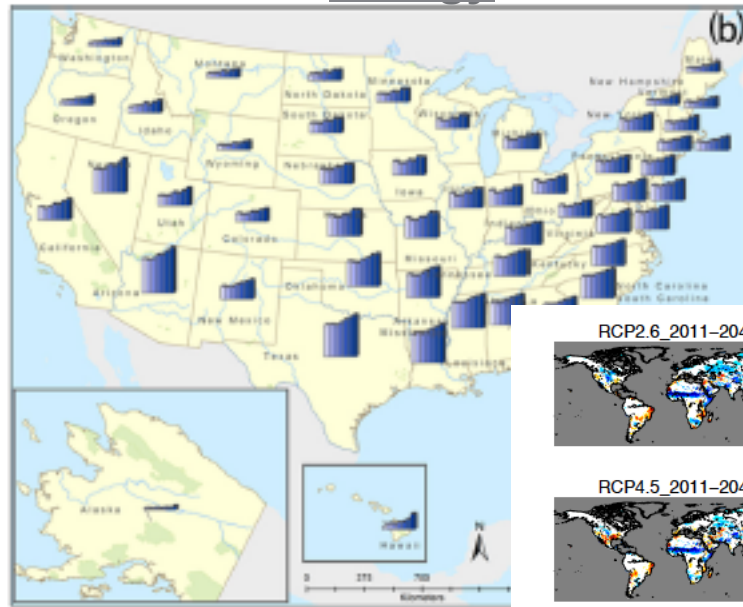


IPCC AR5 Chapter 12

A. Offline One-Way Information Exchange: ESMs to IAMs

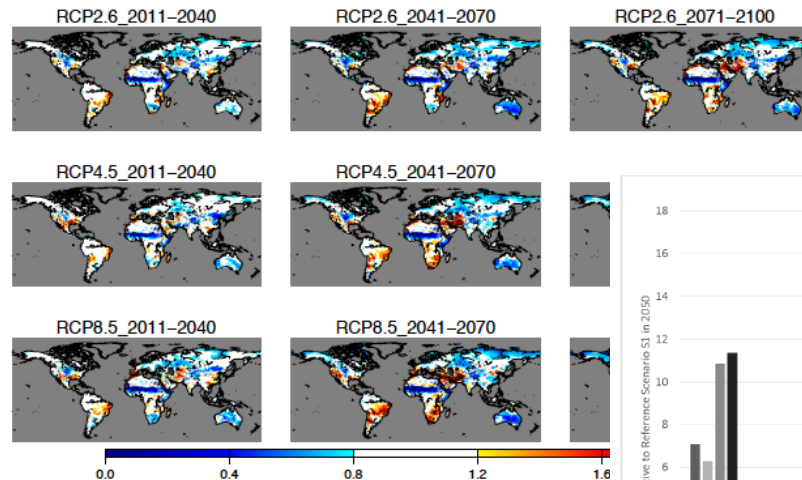
ESMs Provide Climate Information for IAMs

Energy



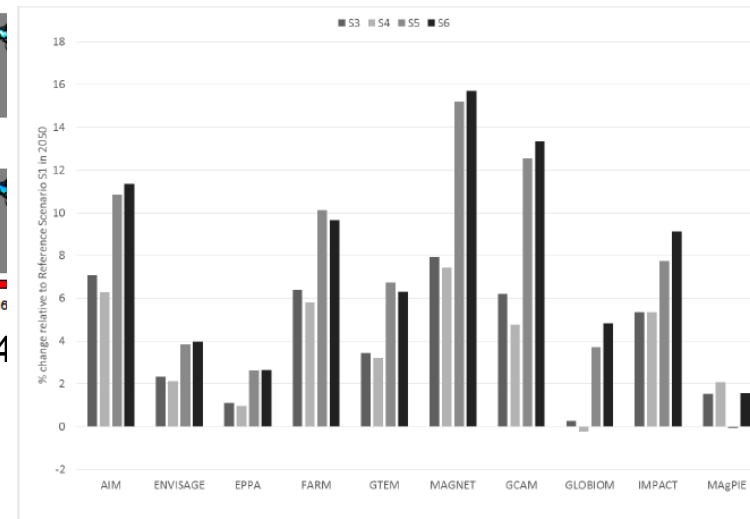
Zhou et al. (2014)

Water



Hanasaki et al. (2014)

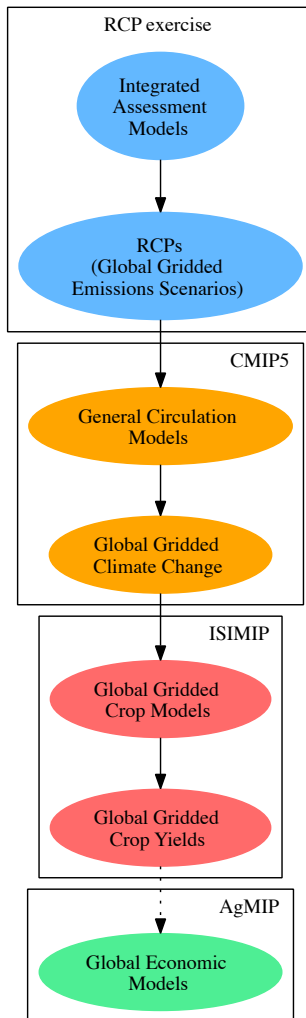
Land



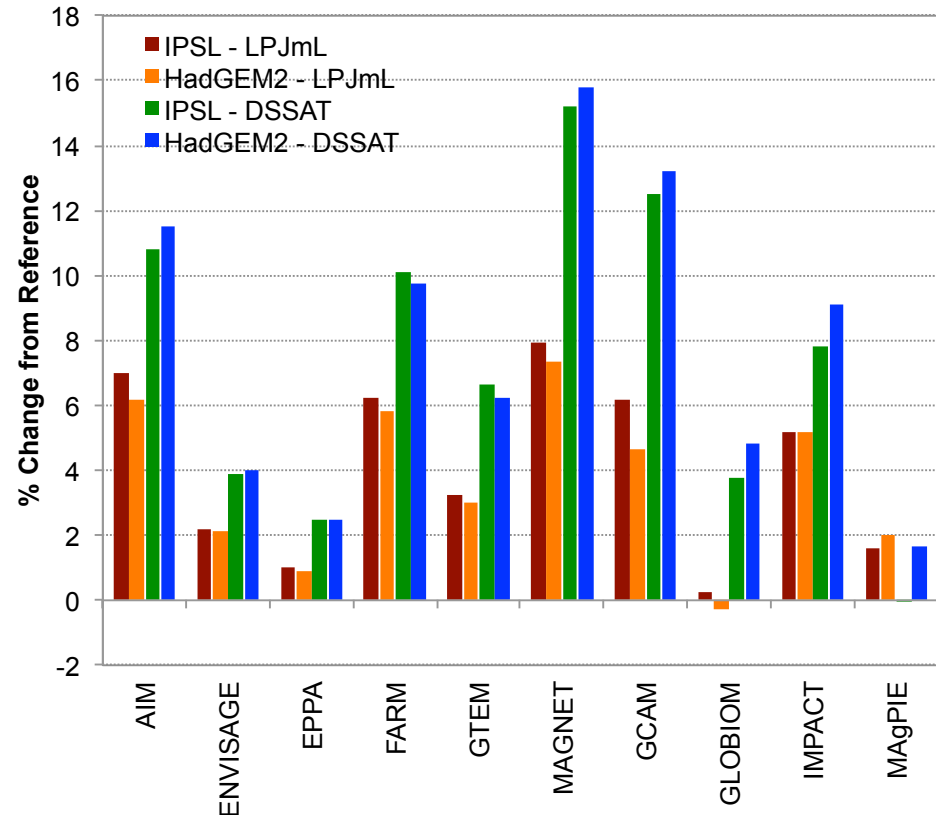
Nelson et al. (2014)

A. Offline One-Way Information Exchange: ESMs to IAMs via AgMIP

The AgMIP Process



Change in Cropland Area in 2050



Source: Redrawn from Nelson et al. (2014)
Results from the Agricultural Model Intercomparison Project

Types of IA-ESM Linkages

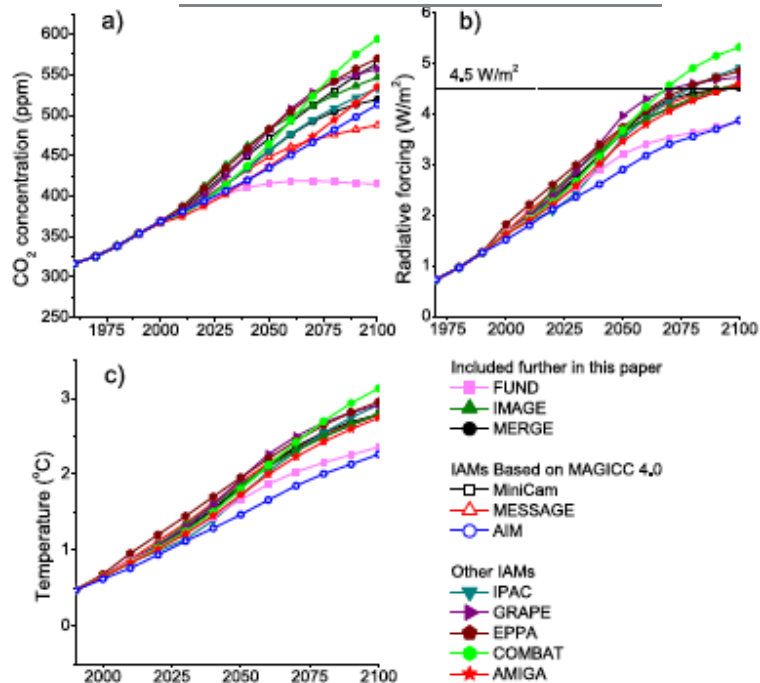
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Source: van Vuuren et al. (2012)

B. Improved IAMs

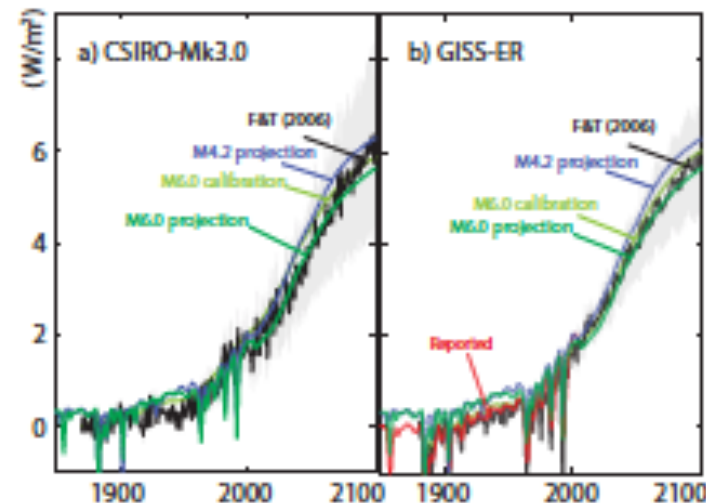
ESMs are used to develop parameterized components of IAMs

IAM Climate Modules



Van Vuuren et al. (2009)

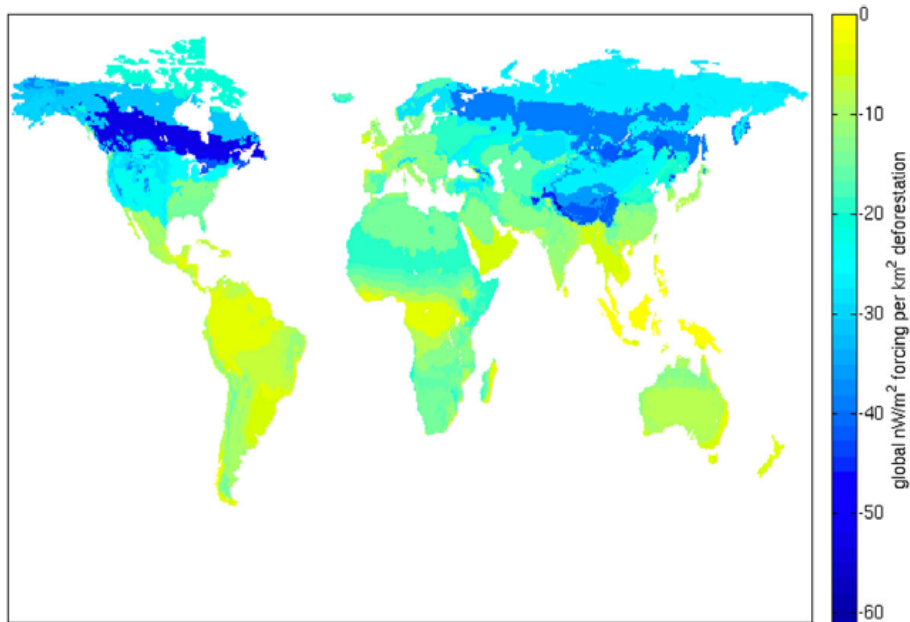
Updating IAM Climate Modules



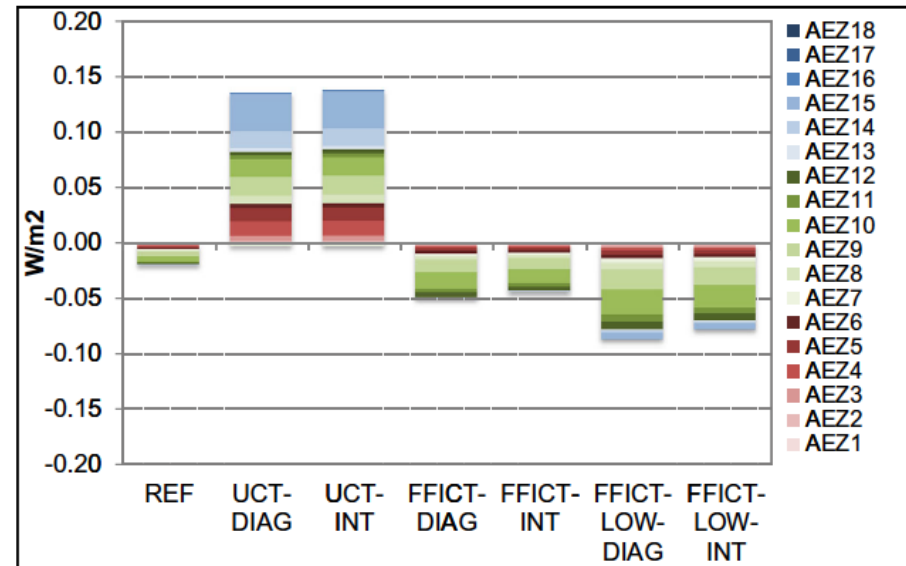
Meinshausen et al. (2011)

B. Improved IAMs

Used CLM to Parameterize GCAM



Radiative Forcing in 2100



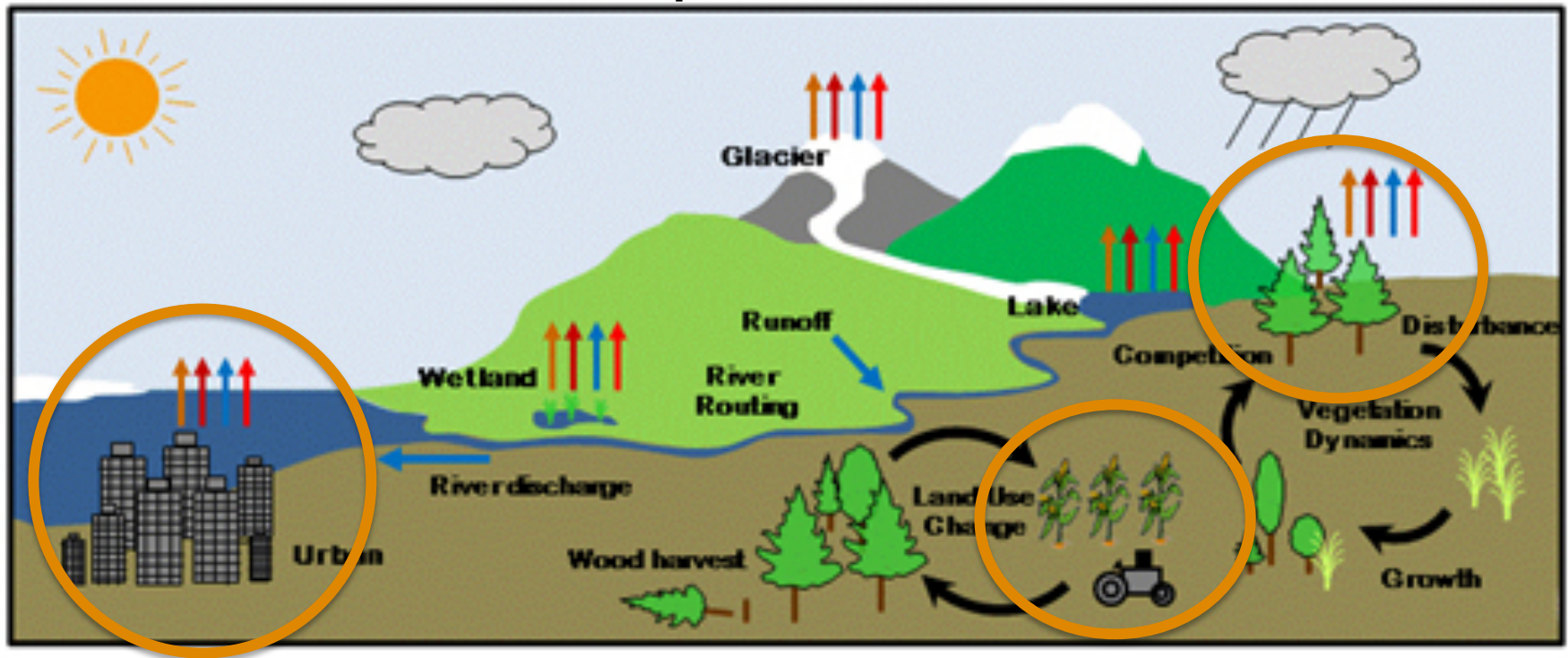
Source: Jones et al. (2015)

Types of IA-ESM Linkages

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Source: van Vuuren et al. (2012)

Land Component of the CESM



Source: NCAR

Types of IA-ESM Linkages

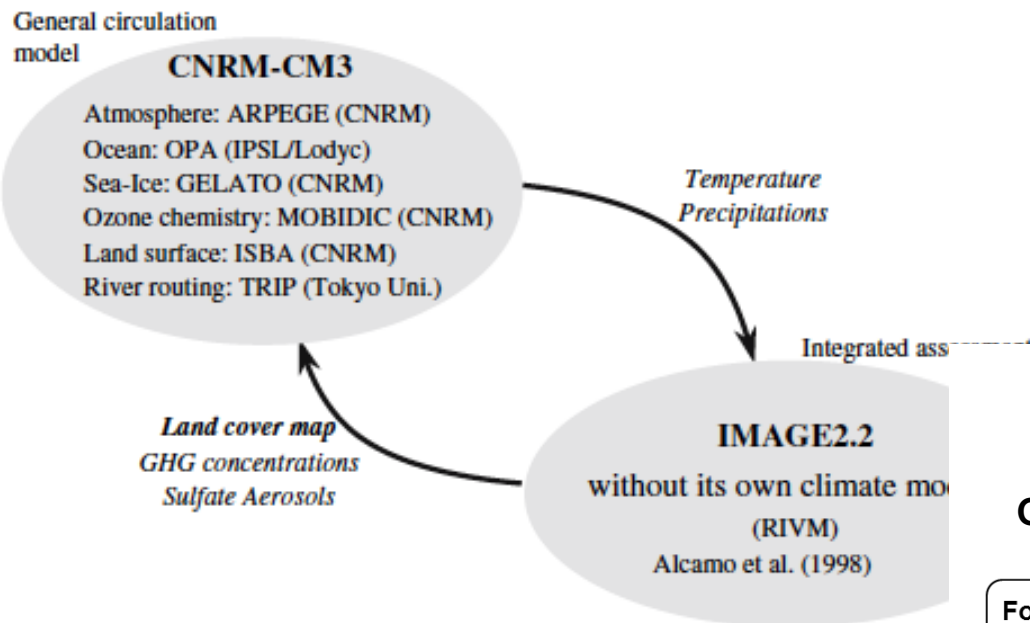
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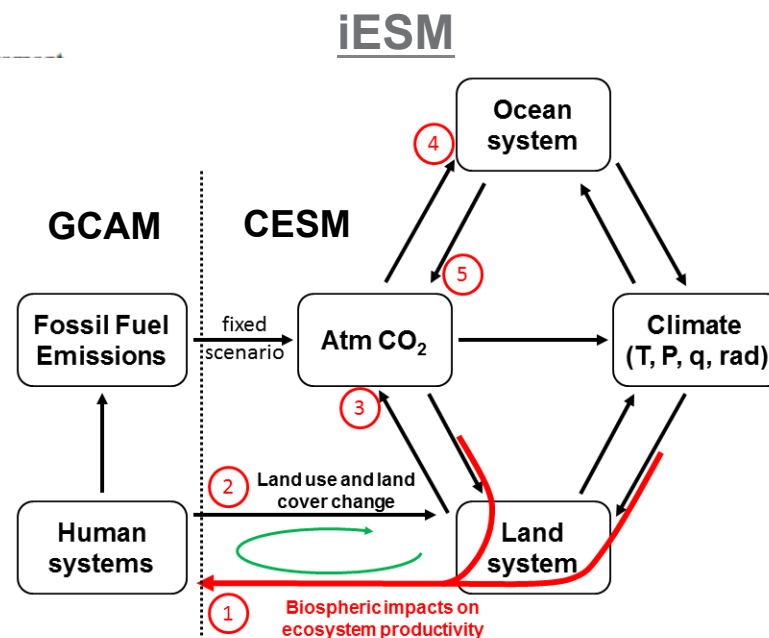
D. Full Coupling

IAMs and ESMs can be Fully Coupled

IMAGE + CNRM-CM3



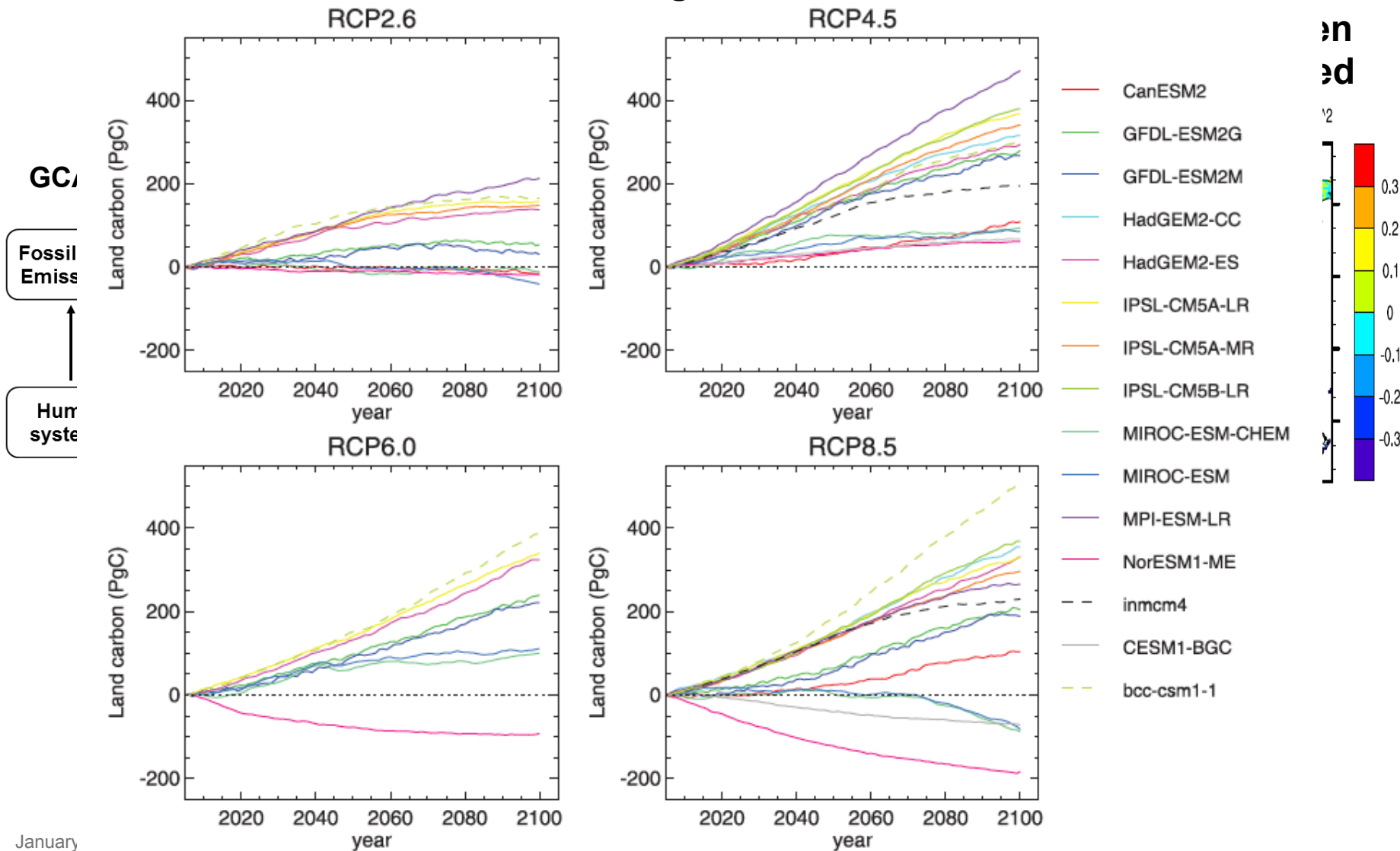
Voldoire et al. (2007)



Collins et al. (2015)

D. Full Coupling

Land Carbon Storage Across ESMs



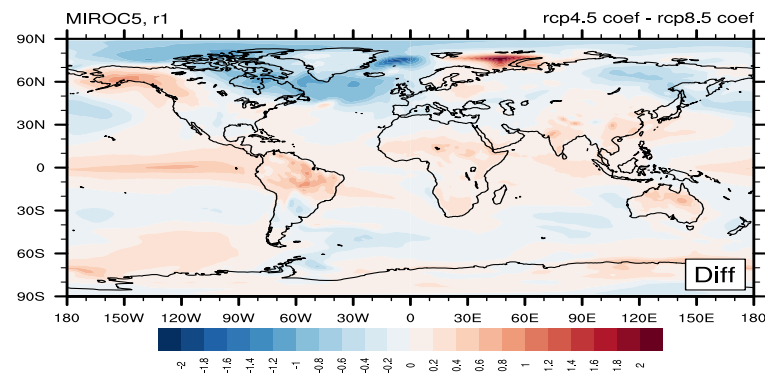
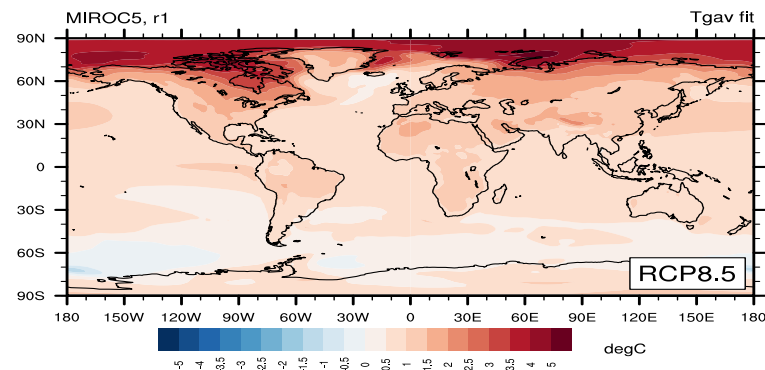
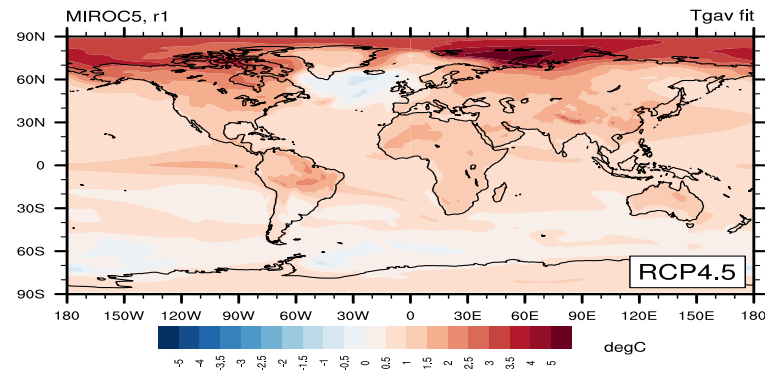
Jones et al. (2013)

Ongoing & Future Research Directions

- ▶ A. Offline, one-way coupling
 - CMIP6
 - ISI-MIP
- ▶ B. Improved IAMs
 - Emulators (including pattern scaling)
 - Natural emissions sources and other science insights
- ▶ C. Improved ESMs
 - Improved crop modeling
 - Water management
- ▶ D. Full Coupling
 - Continued experiments using iESM
 - Improved coupling

Ongoing & Future Research Directions

- ▶ Workshop on IA-ESM coupling
- ▶ Improved emulators
- ▶ Developing scenarios for improved climate science



THANK YOU!!!