The NCAR Climate and Human Systems Project

Brian O'Neill
NCAR
CESM Annual Meeting, Breckenridge, CO
June 16, 2015

What is CHSP? (https://chsp.ucar.edu/)

Cross-cutting project within NCAR Climate & Global Dynamics (CGD) division

Goals:

- Better integrate climate-related research on human and earth systems within CGD, across NCAR and with larger community
- Better connect NCAR research to SDWG

Mode of operation (so far):

- Coordinated study on common theme, involving CESM
- First topic: avoided impacts, BRACE project

CHSP timeline

June 2013	CHSP starts
June-Dec. 2013	NCAR meetings on mode of operation and choice of initial topic
January 2014	BRACE project begins
January 2015	First papers submitted to special issue
June 2015	About half of papers submitted
	Start considering next project
Fall 2015	Decide on next project
2016	Start next project

Desired characteristics of projects

Involve human AND earth systems, not just one or the other

Enough integration to make the whole greater than the sum of the parts

As a CGD (and therefore CESM-related) activity, should integrate across CGD and involve CESM (but works well with wider participation)

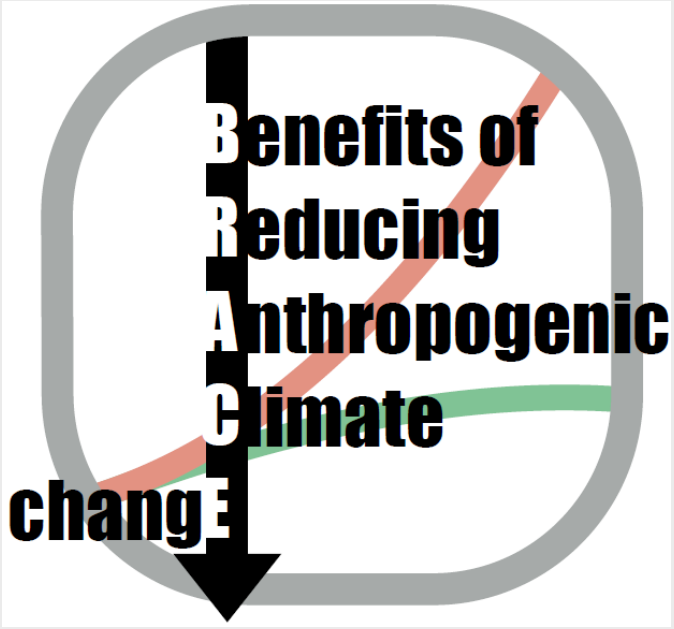
Allow for synergies with work people are already doing

Make use of new products/frameworks on the horizon

Advance the scientific frontier in an important area

Inform important societal questions

What is BRACE?



Benefits of Reduced Anthropogenic Climate changE

Participants within CGD, other parts of NCAR, university partners

Special Issue of *Climatic Change*
O'Neill & Gettelman, eds)

- **Scale: 23 papers, 50+ authors, 8 institutions**
- **Status: 12 submitted, 5 in internal review, 6 in preparation**

See SDWG session Thursday a.m. for four BRACE presentations

What are “avoided impacts”?

Impacts avoided by reducing or adapting to climate change

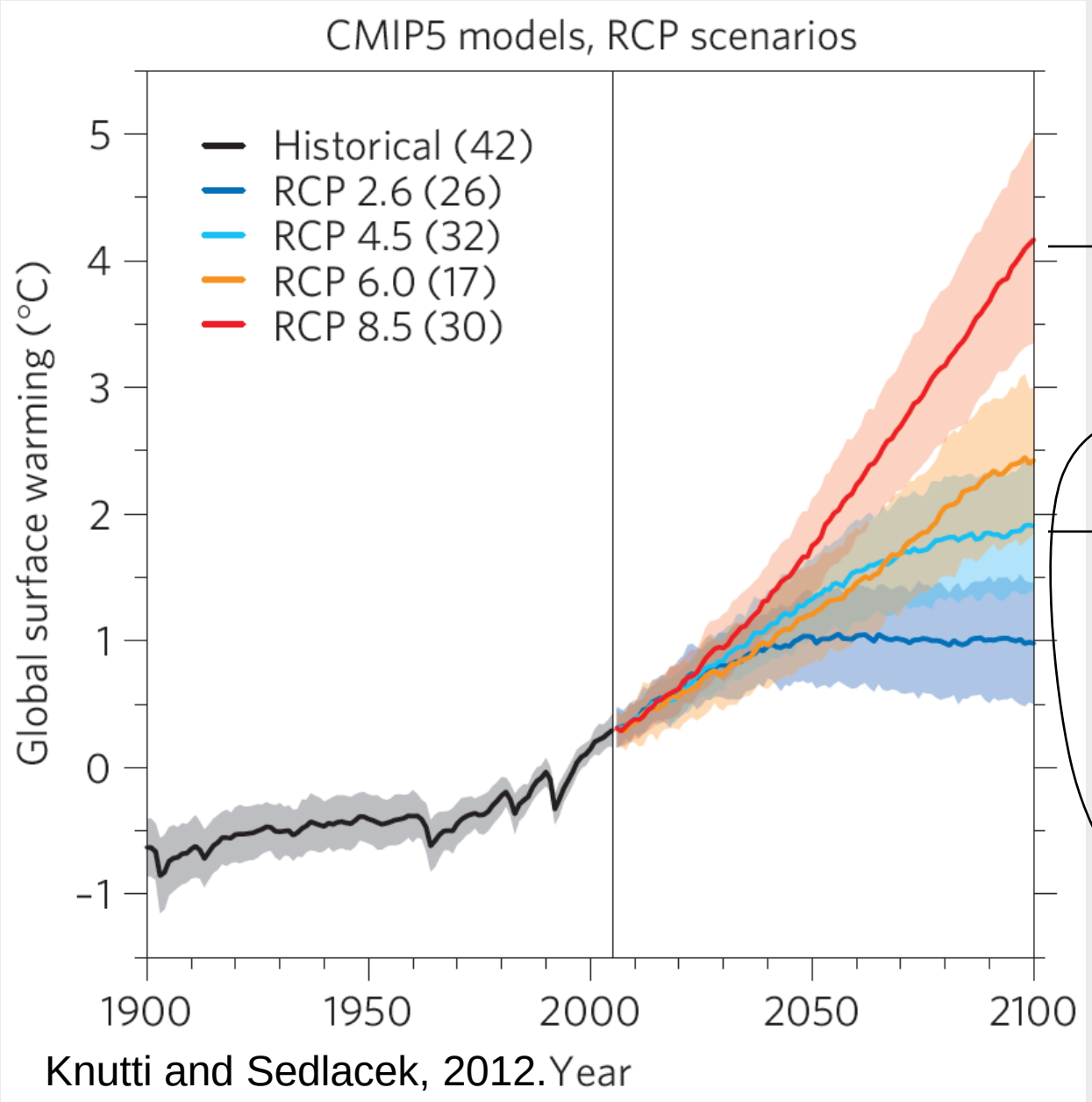
Reducing climate change either by emissions mitigation or geoengineering

Impacts terminology

Physical impacts (“hazards”): changes in temperature, precipitation, extreme events, sea level rise, sea ice cover, etc.

Impacts on society or ecosystems: increased hunger, adverse health outcomes, loss of life/infrastructure to extreme events, species extinction, ecosystem change, loss of ecosystem services, etc.

Why do they matter?



Knutti and Sedlacek, 2012.

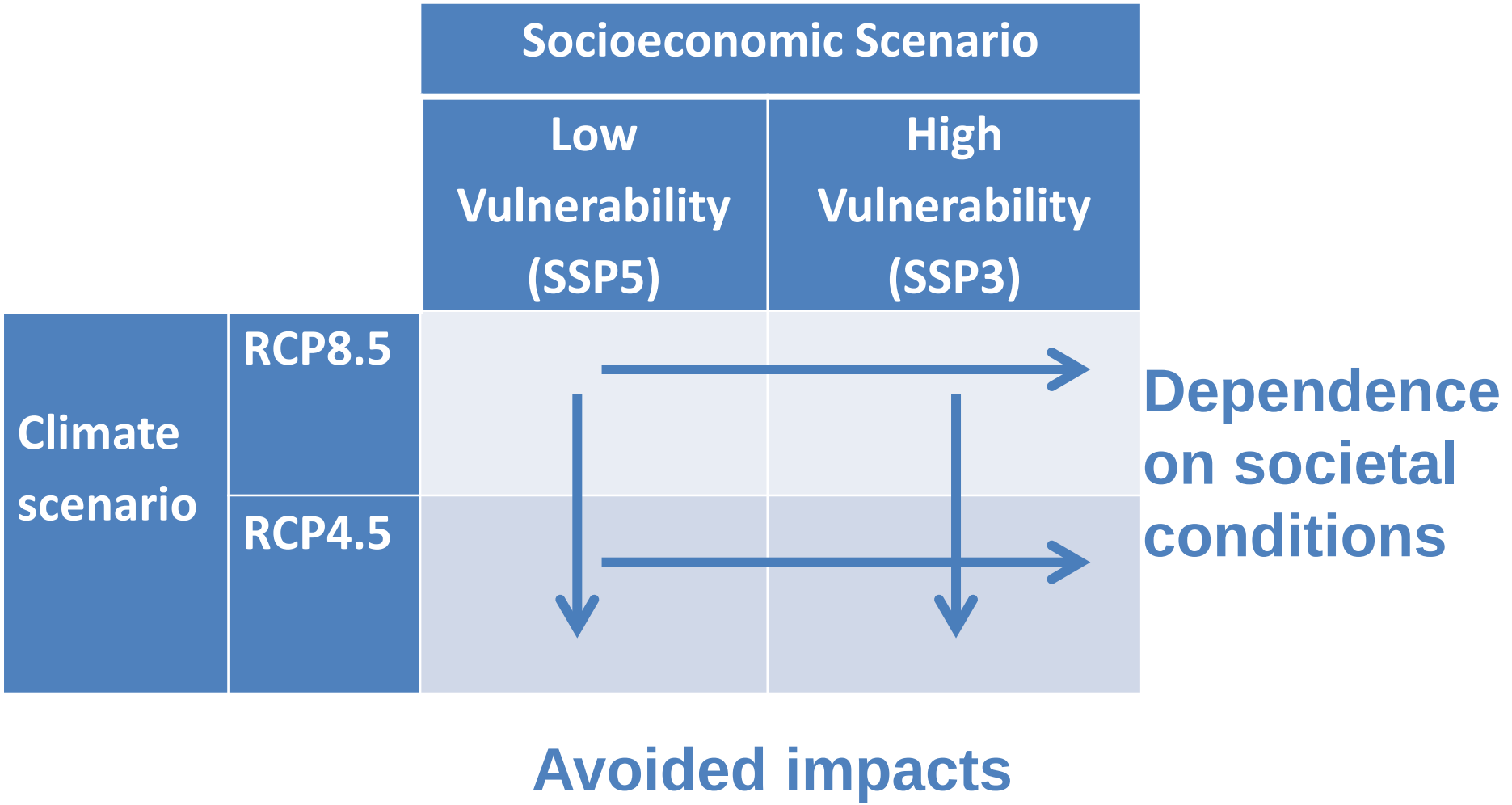
<u>RCP8.5</u>
No (or little) mitigation policy
High emissions
High impacts

<u>RCP4.5</u>
Mitigation
Low emissions
Low impacts

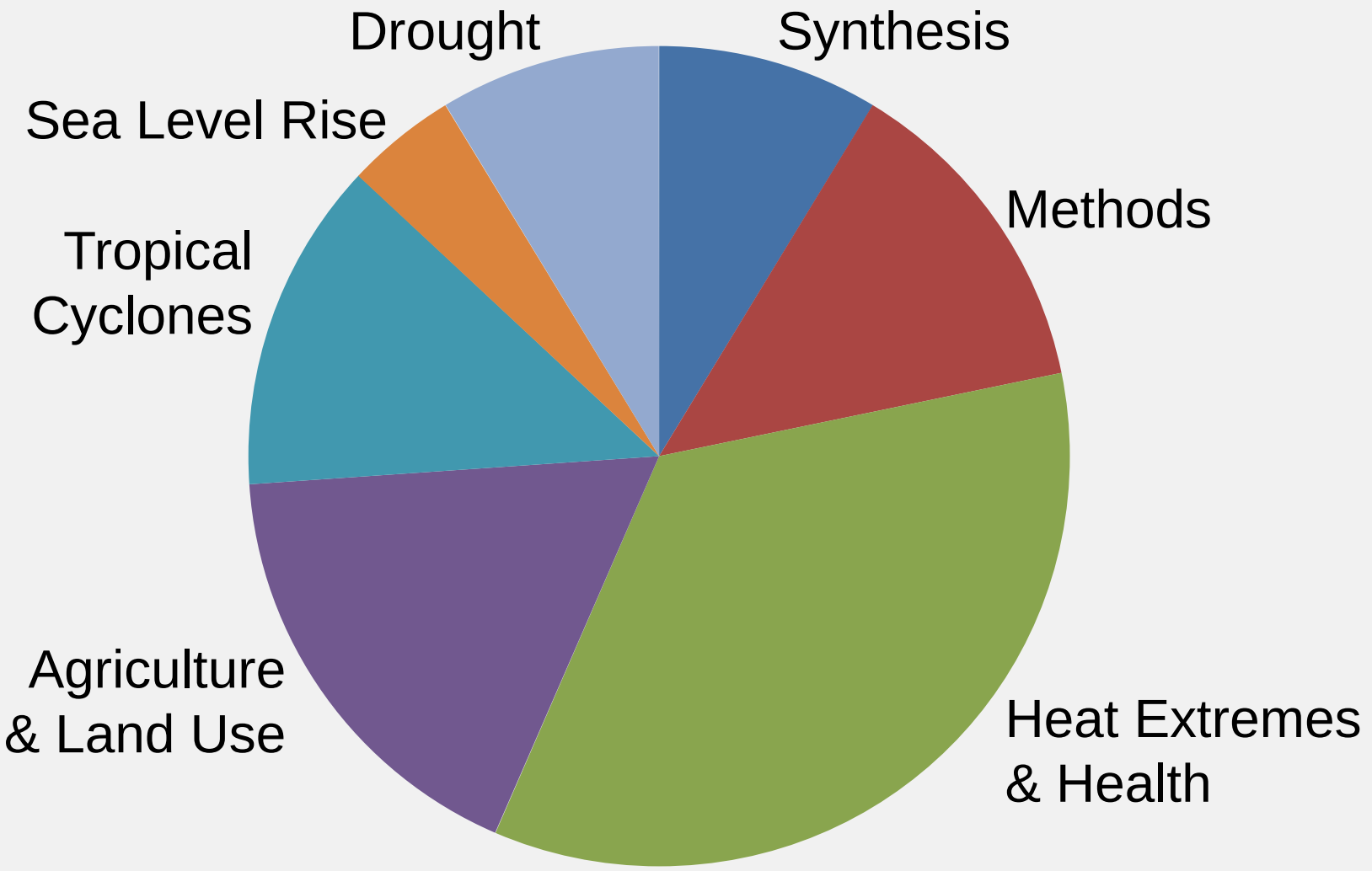
Cost: Mitigation, adaptation

Benefit: Avoided impacts

BRACE Design

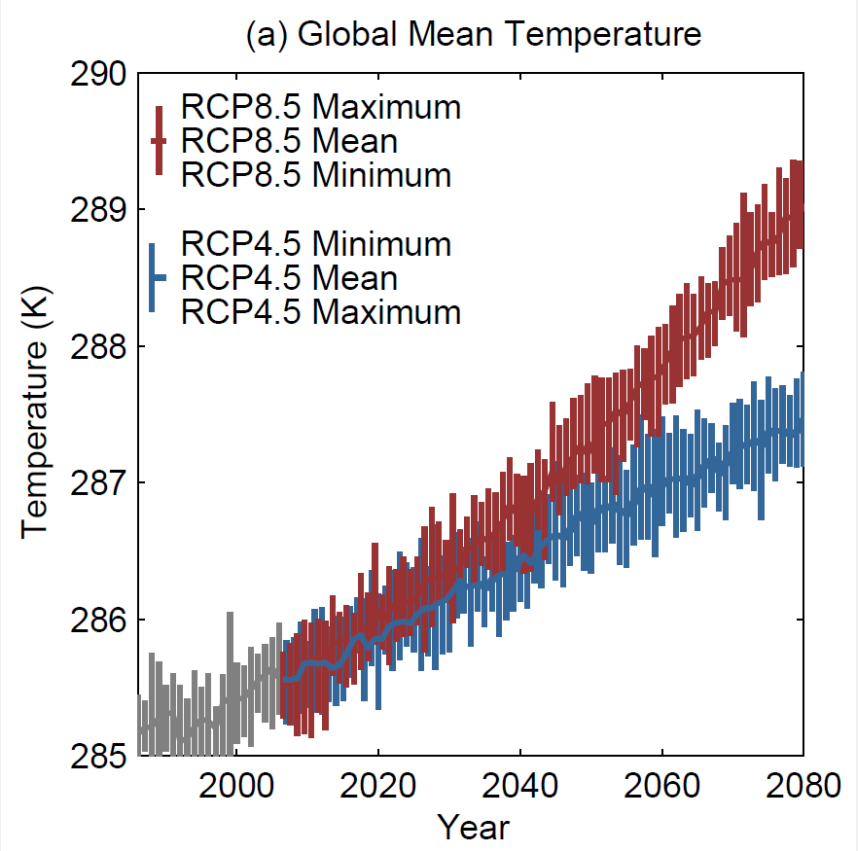


BRACE Paper Topics (23 total)



Methods

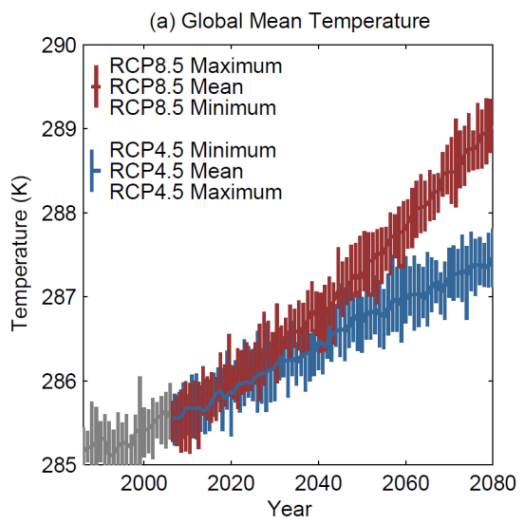
- Comparison of ensembles
  - Time of detection
  - Accounting for variability
  - Influence of aerosols
- Pattern Scaling
  - Seasonal avg temperature
  - Daily max precipitation



Sanderson et al., submitted.

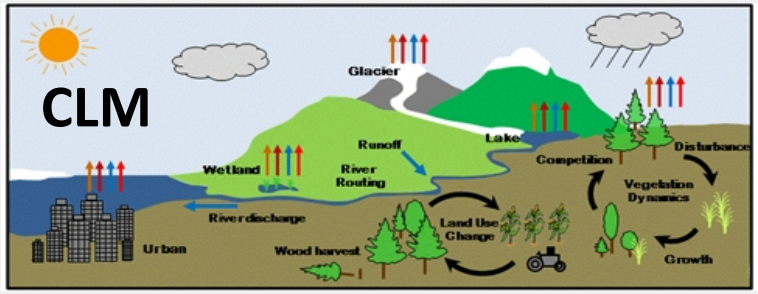
Extreme Heat & Health

Lg/Med Ensembles



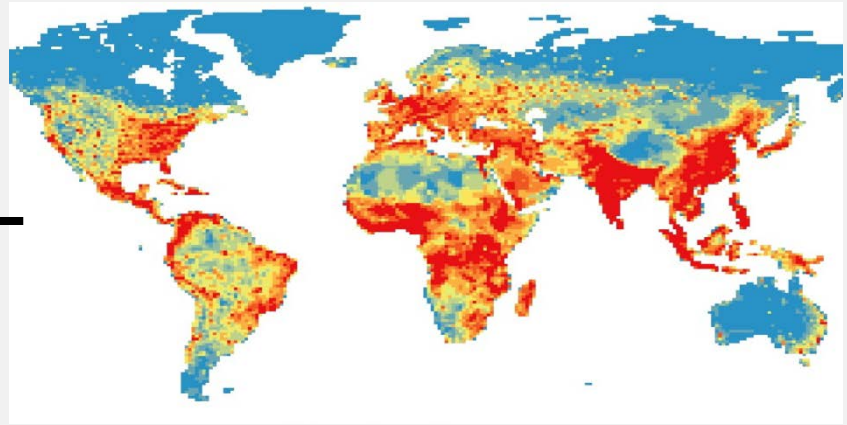
Sanderson et al.

CLM Rural/Urban Heat Waves



Oleson et al.

Global Population Exposure



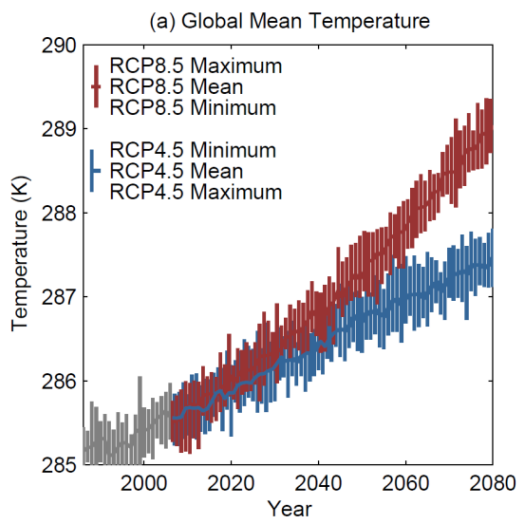
Jones et al.

Dangerous mortality, US cities

Anderson et al.

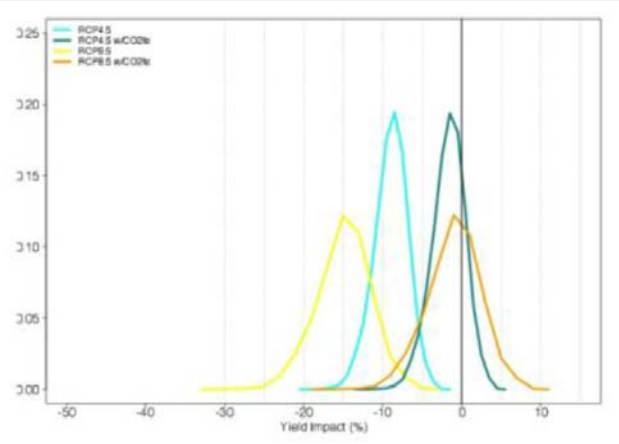
Ag & Land Use

Lg/Med Ensembles



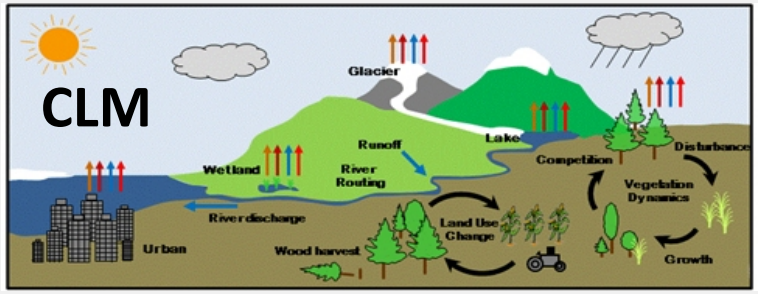
Sanderson et al.

Empirical Model Crop Yields



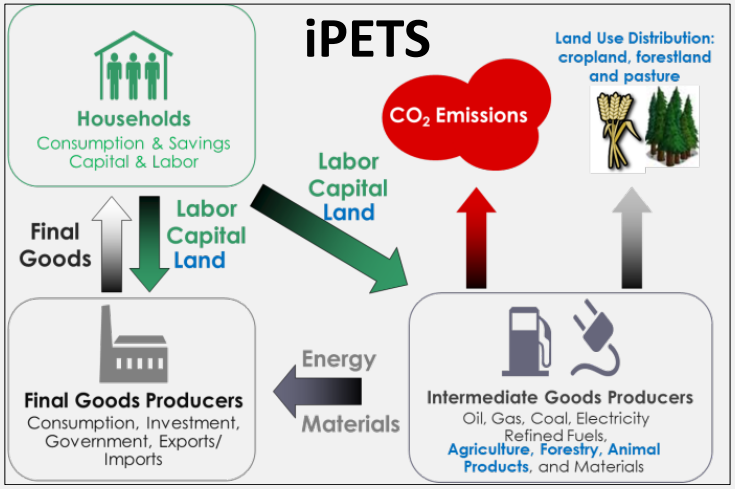
Tebaldi & Lobell

CLM Crop Yields



Levis et al.

iPETS Economic Impacts



Ren et al.

Example BRACE conclusions

Differences in extreme heat between scenarios begin to be detectable in next decade or two in some regions, more prevalent by mid-century

By second half of century, large increase in urban heat wave days; RCP4.5 reduces increase by half relative to RCP8.5

High mortality heat waves in US increase in frequency from 1 every ~4 years to 2-3 per year with no adaptation in RCP8.5

- **Adaptation assumptions (not climate or population) dominates mortality consequences of heat waves**

Example BRACE conclusions

- Relatively small increases in potential exposure to dengue virus vector, climate effect small compared to population effect
- Ag impacts can be positive or negative depending on CO2 fertilization and management assumptions
  - RCP4.5 can actually increase yield impacts relative to RCP8.5
- Damage potential from N. Atlantic tropical cyclones declines in both RCP4.5 and 8.5 in CESM
- SLR due to thermal expansion varies regionally; especially high on NE coast (and mitigation matters), especially low on west coast

Desired characteristics of projects

Involve human AND earth systems, not just one or the other

Enough integration to make the whole greater than the sum of the parts

As a CGD (and therefore CESM-related) activity, should integrate across CGD and involve CESM (but works well with wider participation)

Allow for synergies with work people are already doing

Make use of new products/frameworks on the horizon

Advance the scientific frontier in an important area

Inform important societal questions

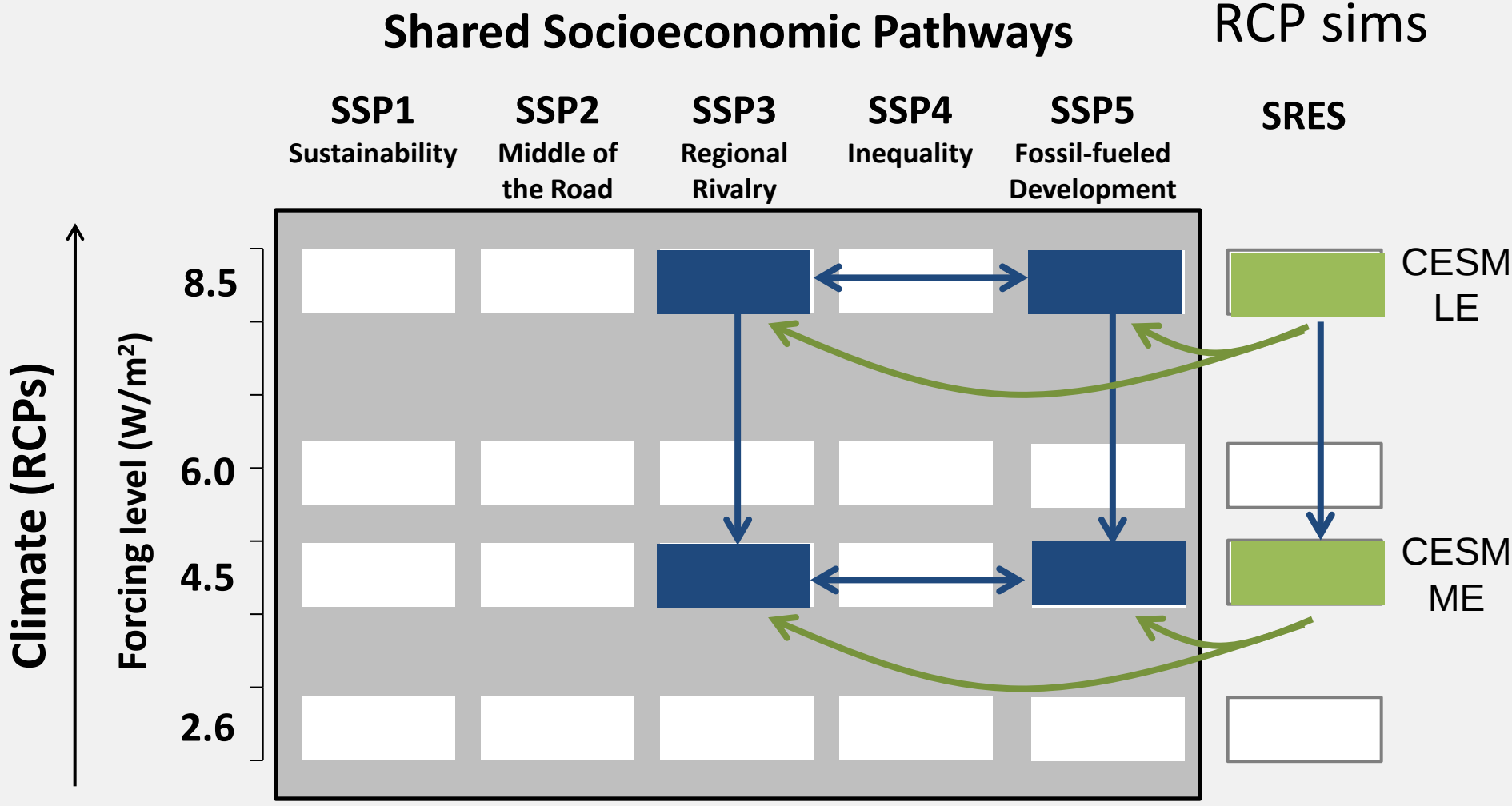
Questions for discussion

- What topics may be of interest to pursue in CHSP?
- What mode of operation would be most effective for carrying out coordinated studies and facilitating wider participation?
- How might CESM working groups be involved in CHSP activities?
- What scientists and institutions might be interested in participating?
- What resources (funding, computing, personnel, etc.) are needed to carry out effective studies, and what sources might be available?

Project Ideas

- BRACE 2
  - Avoided impacts across more climate outcomes (lower scenario?), societal futures (SSPs), sectors (energy, water), adaptation, or deeper look at topics already addressed
- Extreme events
- Geoengineering
- Methods/model development, e.g. hierarchy of climate models for use in impacts/IAM research
  - Pattern scaling, statistical emulators, improved simple models
- Water, in conjunction with ag, energy, extremes

BRACE design and the new Scenario Framework



CHSP Goals

From the CGD strategic plan….

- **Improve projections of societal trends that are relevant to assessing impacts and options for climate mitigation and adaptation.**
- **Improve capacity to link integrated assessment models to CESM for the investigation of human-Earth system interactions.**
- **Improve assessments of impacts, adaptation and mitigation by better accounting for socio-economic change and its interactions with the climate system.**

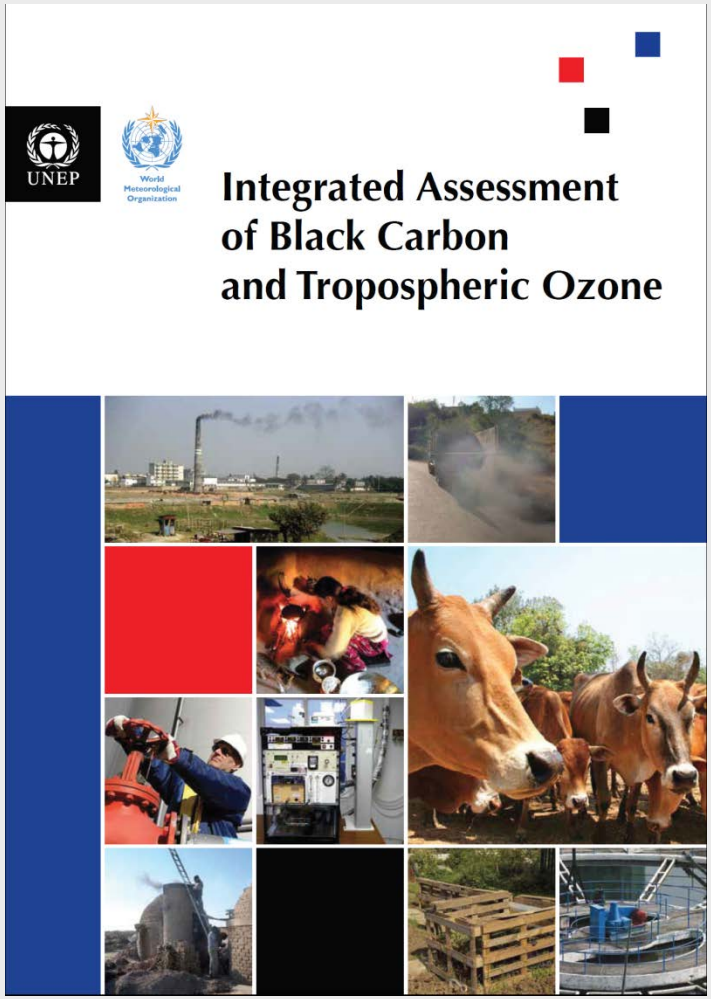
CHSP resources

- Current
  - CGD travel funds
  - CGD visitor funds
  - Borrowed website/project management assistance
- Future
  - Respond to funding calls?

Some open questions

- Single model ensemble vs multi-model ensemble
- Wide variation in crop yield outcomes
- Ice sheet contributions to SLR

Example: Large scale



- UNEP/WMO Assessment Report, 50 authors
- Assessment of literature
- New modeling exercises
  - -Mitigation options for reducing BC and O3
  - - impacts on air quality and forcing
  - - simulations with simple models and GCMs
  - - impacts and cost-benefit analysis

Science
AAAS

Simultaneously Mitigating Near-Term Climate Change and Improving Human Health and Food Security
Drew Shindell *et al.*
Science **335**, 183 (2012);
DOI: 10.1126/science.1210026

Example: Medium scale

&beyond 4degrees

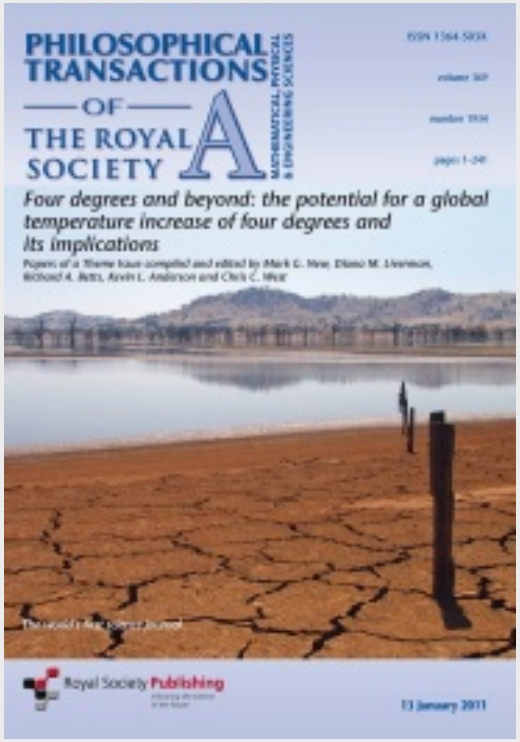
International Climate Conference
28-30 September 2009, Oxford, UK

Implications of a global climate change of 4+ degrees for people, ecosystems and the earth-system

UNIVERSITY OF OXFORD

Tyndall Centre for Climate Change Research

Met Office Hadley Centre



- international conference, 140+ attendees
- special issue with 11 papers, 3 introductory pieces
- diverse papers, all related to 4+ degrees
  - likelihood of large climate changes of 4 degrees
  - potential impacts of these changes
  - challenges involved in avoiding high levels of warming
  - challenges of adaptation should society fail to do so

Example: Small scale

Greenhouse Gas Initiative

The Greenhouse Gas Initiative (GGI) is a inter-program research activity that addresses questions critical to understanding and responding to the challenges of climate change.

Integrated Assessment of Greenhouse Gas Emissions and their Mitig

- Cross-cutting research project, 18 scientists, 7 programs
- New integrated modeling framework (energy, land use, ag impacts)
- Single common set of new emissions scenarios
  - costs of emissions reductions
  - probabilistic simple climate modeling
  - impacts on agriculture and irrigation water requirements

TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE

An International Journal