The HIRISC project:
A new study for the Climate and Human Systems Project on determinants of high risk impacts of climate change

Brian O’Neill, NCAR
SDWG Session, CESM Workshop
June 22, 2017

Thanks to Ben Sanderson, Claudia Tebaldi, and CHSP/SDWG participants

https://chsp.ucar.edu/, sign up for email list!
Difference in physical and societal impacts between RCP8.5 and RCP4.5 (also two development pathways)

20 papers, special issue of *Climatic Change* (18 Published, 1 In Press, 1 In Review)
50+ participants from NCAR and 18 other institutions

CESM Large/Medium Ensembles

Avoided Impacts
- Heat Extremes
- Health
- Ag & Land Use
- Tropical Cyclones
- Drought
Difference in physical and societal impacts between 1.5 C and 2 C stabilization scenarios
Sanderson et al., in review, *ESD*
5-6 papers, special collection in *Environmental Research Letters* (underway)

**BRACe1.5**
Benefits of Reduced Anthropogenic Climate Change

**CESM 1.5/2 C Ensembles**

![Graph showing temperature changes](Image)

**Biophysical & Societal Impact Models**

**Avoided Impacts**
- Relevant climate system outcomes
- Health
- Agriculture
New CHSP Study: High Risk Impacts of Climate change

Motivation: UN FCCC aims to avoid “dangerous interference” with climate system

Improve understanding of “high risk” (or “dangerous”) climate impacts, particularly their determinants

Science can inform (but not determine) risk judgments
What is risk?

IPCC WG2 SPM
Overarching questions

How can “high risk” be defined for specific types of impacts? What metrics can we use as indicators?

What are key determinants of high risk outcomes for different types of impacts and regions?

- How does the level or other characteristics of climate change affect the potential for high risk outcomes?
- How important are societal factors to high risk outcomes?
- Are particular combinations of conditions especially dangerous?

What processes need to be better understood to improve projections of high risk?

What methods would best characterize risk for integrated human-earth systems?
Related work

IPCC WG2 Key Risks

<table>
<thead>
<tr>
<th>Timeframe</th>
<th>Risk &amp; potential for adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present</td>
<td>Very low</td>
</tr>
<tr>
<td>Near term (2030-2040)</td>
<td>Medium</td>
</tr>
<tr>
<td>Long term (2080-2100) 2°C</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>4°C</td>
</tr>
</tbody>
</table>

Reasons for Concern

Planetary Boundaries

Tipping elements
Possible types of content (papers)

How to define “high risk”, in general and for specific impacts
Projections of key aspects of climate system and how they vary across climate scenarios, regions, etc.
Uncertainty in key physical climate outcomes, what processes drive that uncertainty, prospects for reducing it
Methods for projecting potentially high risk outcomes: multi-model ensembles, perturbed physics ensembles, emulation
Determinants of high risk outcomes for specific types of impacts
Prospects for spatially and temporally correlated risks
Interactions of risks/impacts across sectors or regions
Example: Determinants analysis

**Socio-economic scenarios (many)**
Population, age, urban/rural, education, gdp/cap, income dist., tech. progress, land use, energy use, trade, consumption

**Climate scenarios (many)**
CESM CMIP6 runs IC, PP, or MM ensembles? Geoengineering? Emulation?

**Impact scenarios**
- Agriculture (e.g., risk of hunger)
- Health (e.g., risk of mortality)
- Coastal impacts (e.g., risk of building damages)
- Others?

**Definitions of high risk outcomes**
By impact, define H/M/L risk

**Determinants analysis**
Database of impact scenarios categorized by risk outcome and climate and societal conditions
Statistical analysis to identify determinants
Impact sectors/topics

BRACE topics: health, agriculture, cyclone damage
Sea level rise (see Tuesday side meeting)
Fisheries/marine ecosystems
  Ocean acidification
Societal vulnerability, limits to adaptation
Others?
Next Steps

Periodic (~monthly) CHSP meetings
   Further discussion/development of ideas for content, possibly form sub-groups
   Open to remote participation
   Join CHSP mailing list (see CHSP website)

Workshop on proposed content, participation and products
   SDWG winter WG meeting

Overall project timing
   Likely draw on CMIP6 runs (esp ScenarioMIP)
   Papers completed in time for AR6 (submitted Jan 2020?)
Example: Agriculture

High Risk definition: For a large world region, % of income spent on food >20%, for >10% of population, over a given time period

Food expenditure share determined by relative food prices and household income

Food prices determined by production, demand, trade
  Production determined by land use, yield; yield by climate, management, technology; land use by physical resources, climate, relative cost of land vs other production factors
    Climate aspects include seasonal mean temperature and precip, extreme temps, drought, CO2, ozone, ...
  Demand determined by population growth, food preferences (diet)

Household income determined by overall economic growth, income distribution
Simulations/analysis

Small Example: 1.5/2 C ag impact analysis
- Climate scenarios: 1.5, 2 C, multiple ensemble members
- Potential crop yield: CLM (strong CO2, N, Irr response), ISAM (weak CO2, N, Irr response), empirical model
- Societal scenario: SSP2, a few variants with parametric uncertainty in price response
- Total scenarios: 3 crop models x 2 (or 6?) climate scenarios x 3 iPETS/SSP variants

Larger analysis
- Are all combinations necessary?
- Sensitivity vs decomposition vs likelihood of high risk outcome?