The Use of the Community Earth System Model in Human Dimensions Climate Research and Applications

Emily Laidlaw, Brian O’Neill - NCAR/CGD/IAM
CESM SDWG Winter Meeting
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SDWG Mission:
Improve understanding of the interactions between human and earth systems by enhancing CESM and its application through studies of climate change impacts, adaptation, and mitigation that use CESM output in their analyses.

To improve model development and application, we need to know who uses CESM in human dimensions work and for what purpose.
What do we know about use of CESM in human dimensions work? No synthesis exists.

- In what research areas is CESM used?
- How often used for physical vs societal assessments?
- Mostly single simulations? Multi-model ensembles?
- Output always downscaled? Never downscaled?
- Areas where use could be improved?
- Areas where not used?
- Global analysis?
  Regional analysis?
GOALS FOR THIS REVIEW

✓ Develop framework to quantify use of CESM

✓ Answer questions relevant to the SDWG

✓ Present a synthesis on the use of CESM output

✓ Provide recommendations to SDWG and CESM community on facilitating, improving, and increasing the use of CESM
A FEW CHALLENGES & CAVEATS

✓ Broad topic
✓ Still in early stages
✓ CESM history
   Names
   Components
✓ Papers not written with review in mind
✓ Overlap/gray areas
✓ Not exhaustive
✓ Not a modeler

"No, I don't take any drugs, but I do have a $50 a day latte habit."

Truth in advertising
What do we mean by “human dimensions climate research and applications”?

• Research or applications whose results are directly relevant to improving understanding of how society contributes to climate change, is influenced by it, or takes action to respond to it.
• Human dimensions-related goal must be explicitly stated in abstract or title.
BOUNDARIES FOR THIS REVIEW

Timeline: 2004-2016

CESM Versions: CCSM 3, CCSM 4, CESM 1

System categories: Societal systems, managed systems, ecosystems, relevant physical systems

Literature types: Major scientific assessments, research projects, and reports; multi-model ensemble efforts; journal articles

Manageable approach: Informative but not exhaustive
### What Information Am I Collecting?

- Currently in Google sheet
- Possibility of online database

<table>
<thead>
<tr>
<th>BASIC INFO</th>
<th>PRIMARY/SECONDARY SYSTEM</th>
<th>SYSTEM OUTCOME</th>
<th>PRIMARY/SECONDARY RES. AREA</th>
<th>TYPE OF OUTPUT</th>
<th>MODEL SPECIFICS</th>
<th>STUDY SCOPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Title</td>
<td>✓ Societal system</td>
<td>✓ Health</td>
<td>✓ Impacts</td>
<td>✓ Single simulation</td>
<td>✓ Model version</td>
<td>✓ Timeframe</td>
</tr>
<tr>
<td>✓ Author</td>
<td>✓ Managed system</td>
<td>✓ Economy</td>
<td>✓ Mitigation</td>
<td>✓ Initial cond. ensemble</td>
<td>✓ Resolution</td>
<td>✓ Global</td>
</tr>
<tr>
<td>✓ Affiliation</td>
<td>✓ Ecosystem</td>
<td>✓ Crops</td>
<td>✓ Adaptation</td>
<td>✓ Small multi-model ensemble</td>
<td>✓ Offline, component</td>
<td>✓ Regional</td>
</tr>
<tr>
<td>✓ Source</td>
<td>✓ Relevant physical system</td>
<td>✓ Managed forests</td>
<td>✓ Emissions</td>
<td>✓ Large multi-model ensemble</td>
<td>✓</td>
<td>✓ City</td>
</tr>
<tr>
<td>✓ Year</td>
<td>✓ Sea level rise</td>
<td>✓ Biodiversity</td>
<td></td>
<td>✓ Downscaled?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>✓ Summary</td>
<td>✓ Tropical cyclones</td>
<td>✓ Species range</td>
<td></td>
<td>✓ Bias-corrected?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

• Currently in Google sheet
• Possibility of online database
Impacts of climatic population changes on human exposure to the virus vector mosquito Aedes aegypti (A. Monaghan)

Estimated impacts of emission reductions on wheat and maize crops (C. Tebaldi)

Environmental stratification to model climate change impacts on biodiversity and rubber production in Yunnan, China (R. Zomer)

The importance of aerosol scenarios in projections of future heat extremes (Y. Xu)

Detection and attribution of temperature changes in the mountainous western U.S. (C. Bonfils)
## EXAMPLE PAPER USING FRAMEWORK

<table>
<thead>
<tr>
<th>Title</th>
<th>Primary Author</th>
<th>Affiliation</th>
<th>Source</th>
<th>Year</th>
<th>Summary</th>
<th>Primary System</th>
<th>Secondary System</th>
<th>System Outcome</th>
<th>Primary Research Area</th>
<th>Secondary Research Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projecting trends in high-mortality heatwaves in 82 US communities in 2061-2080 under climate, population, &amp; adaptation</td>
<td>G. B. Anderson</td>
<td>Colorado State University</td>
<td>To be published</td>
<td>To be published</td>
<td>Applies health-based models to project trends in high-mortality heatwaves in 82 US communities in 2061-2080. Results suggest RCP4.5 could substantially decrease exposure to high-mortality heatwaves.</td>
<td>Societal System</td>
<td>N/A</td>
<td>Health</td>
<td>Impacts</td>
<td>Adaptation</td>
</tr>
</tbody>
</table>

### Notes
- **Model Version:** CESM 1.0
- **Resolution:** 1 degree
- **Scale of Analysis:** City level
- **Timeframe:** 2061-2080
- **Type of output:** Initial condition ensemble
- **CESM Component (if offline):** N/A
- **Offline or Coupled:** Coupled
- **Downscaled:** Yes
- **Bias-corrected:** No
- **Notes:** Used gravity-type downscaling model (Jones and O’Neill 2013) to create gridded projections of the US population for two Shared Socioeconomic Pathways (SSP3 and SSP5).
PRELIMINARY RESULTS

Primary System

n=30

- Ecosystem: 3
- Societal system: 7
- Managed system: 9
- Relevant physical system: 11
Primary Research Area
n=30

- Adaptation: 0
- Emissions: 2
- Mitigation: 3
- Impacts: 25
PRELIMINARY RESULTS

Type of Output
n=30

- Large multi-model ensemble: 2
- Small multi-model ensemble: 3
- Single simulation: 8
- Initial condition ensemble: 17
HOW CAN YOU HELP?

- Your input can help refine this review
- Want to collect right information initially

FEEDBACK WANTED & APPRECIATED

Research Questions:
What would you like to know from this review?
What kind of recommendations would be useful to SDWG/CESM?

Literature
Do you have papers that would fit into this review?

Additional Feedback
Other suggestions and feedback?
THANK YOU!

QUESTIONS? COMMENTS?

Email: Laidlaw@ucar.edu
Twitter: @emilyklaidlaw

EMILY LAIDLAW
ASSOCIATE SCIENTIST
Integrated Assessment Modeling Group
Climate and Global Dynamics Laboratory
National Center for Atmospheric Research
WHERE AM I FINDING THIS INFORMATION?

MAJOR SCIENTIFIC ASSESSMENTS
- IPCC
- Millennium Ecosystem
- U.S. National Climate Assessment

CESM PUBLICATIONS LISTS
- CESM journal pubs. list online
- CLM journal pubs. list online
- Other similar lists

MAJOR RESEARCH PROJECTS
- BRACE
- ISI-MIP
- AgMIP
- EU Projects

SCHOLARLY LITERATURE REVIEW
- Searchable database
- Targeted keyword strategy

MODEL INTERCOMPARISON PROJECTS
- CMIP 3
- CMIP 5

NGO REPORTS