Background:

General Approach to Climate Impacts Assessment

Source: Snover et al., Cons. Bio., 2013
Global Climate Models (GCMs)

- GCMs have been developed by universities and others throughout the world.
- The Coupled Model Intercomparison Project, or CMIP, defines a set of specific model simulations that allow for apples-to-apples comparisons.
  - CMIP3 (2007): previous dataset
  - CMIP5 (2012): newer dataset
## GCM acronyms are weird

<table>
<thead>
<tr>
<th>Model</th>
<th>Center</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCC-CSM1-1</td>
<td>Beijing Climate Center, China Meteorological Administration</td>
</tr>
<tr>
<td>BCC-CSM1-1-M</td>
<td>Beijing Climate Center, China Meteorological Administration</td>
</tr>
<tr>
<td>BNU-ESM</td>
<td>College of Global Change and Earth System Science, Beijing Normal University, China</td>
</tr>
<tr>
<td>CanESM2</td>
<td>Canadian Centre for Climate Modeling and Analysis</td>
</tr>
<tr>
<td>CCSM4</td>
<td>National Center of Atmospheric Research, USA</td>
</tr>
<tr>
<td>CESM1-BGC</td>
<td>Community Earth System Model Contributors</td>
</tr>
<tr>
<td>CESM1-CAM5</td>
<td>Community Earth System Model Contributors</td>
</tr>
<tr>
<td>CESM1-FASTCHEM</td>
<td>Community Earth System Model Contributors</td>
</tr>
<tr>
<td>CESM1-WACCM</td>
<td>Community Earth System Model Contributors</td>
</tr>
<tr>
<td>CMCC-CESM</td>
<td>Centro Euro-Mediterraneo per I Cambiamenti Climatici</td>
</tr>
<tr>
<td>CMCC-CM</td>
<td>Centro Euro-Mediterraneo per I Cambiamenti Climatici</td>
</tr>
<tr>
<td>CMCC-CMS</td>
<td>Centro Euro-Mediterraneo per I Cambiamenti Climatici</td>
</tr>
<tr>
<td>CNRM-CM5</td>
<td>National Centre of Meteorological Research, France</td>
</tr>
<tr>
<td>CNRM-CM5-2</td>
<td>National Centre of Meteorological Research, France</td>
</tr>
<tr>
<td>CSIRO-Mk3-6-0</td>
<td>Commonwealth Scientific and Industrial Research Organization/Queensland Climate Change Centre of Excellence, Australia</td>
</tr>
<tr>
<td>EC-EARTH</td>
<td>EC-EARTH consortium</td>
</tr>
<tr>
<td>FGOALS-g2</td>
<td>LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences</td>
</tr>
<tr>
<td>FGOALS-s2</td>
<td>LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences</td>
</tr>
<tr>
<td>FIO-ESM</td>
<td>The First Institute of Oceanography, SOA, China</td>
</tr>
<tr>
<td>GFDL-CM3</td>
<td>NOAA Geophysical Fluid Dynamics Laboratory, USA</td>
</tr>
</tbody>
</table>
Downscaling

*Relates the large to the small*

Global Climate Model Air Temperature

- ~100-200 km (~60-120 mi) resolution
- ~6 km (~4 mi) resolution
Downscaling

**Statistical:**
Apply changes from global model projection to historical observations

**Dynamical:**
Use global model projections to drive a regional climate model

**Statistical approach**

**Physics-based approach**
Impacts Modeling

Translation from climate impacts to _____

e.g.: Hydrology, Vegetation
An important complement:

Best when combined with a bottom-up assessment of information needs

Source: Snover et al., Cons. Bio., 2013
Choosing & Using Scenarios

Choosing and Using Climate-Change Scenarios for Ecological-Impact Assessments and Conservation Decisions

AMY K. SNOVER,* ‡‡ NATHAN J. MANTUA,*† JEREMY S. LITTELL,*‡ MICHAEL A. ALEXANDER,§ MICHELLE M. MCCLURE,** AND JANET NYE††

*Climate Impacts Group, University of Washington, Box 355674, Seattle, WA 98195, U.S.A.
†National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center, 110 Shafter Road, Santa Cruz, CA 95060, U.S.A.
‡Department of Interior Alaska Climate Science Center, U.S. Geological Survey, 4210 University Drive, Anchorage, AK 99508, U.S.A.
§NOAA, Earth System Research Laboratory, R/PSD1, 325 Broadway, Boulder, CO 80305-3328, U.S.A.
**National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center, 2725 Montlake Boulevard East, Seattle, WA 98112, U.S.A.
††School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, NY 11794-5000, U.S.A.

Abstract: Increased concern over climate change is demonstrated by the many efforts to assess climate effects and develop adaptation strategies. Scientists, resource managers, and decision makers are increasingly expected to use climate information, but they struggle with its uncertainty. With the current proliferation of climate simulations and downscaling methods, scientifically credible strategies for selecting a subset for analysis and decision making are needed. Drawing on a rich literature in climate science and impact assessment and on experience working with natural resource scientists and decision makers, we devised guidelines for choosing climate-change scenarios for ecological impact assessment that recognize irreducible uncertainty in climate projections and address common misconceptions about this uncertainty. This approach involves identifying primary local climate drivers by climate sensitivity of the biological system of interest; determining appropriate sources of information for future changes in those drivers; considering how well processes controlling local climate are spatially resolved; and selecting scenarios based on considering observed emission trends, relative importance of natural climate variability, and risk tolerance and time horizon of the associated decision.

The most appropriate scenarios for a particular analysis will not necessarily be the most appropriate for another due to differences in local climate drivers, biophysical linkages to climate, decision characteristics, and how well a model simulates the climate parameters and processes of interest. Given these complexities, we recommend interaction among climate scientists, natural and physical scientists, and decision makers throughout the process of choosing and using climate-change scenarios for ecological impact assessment.

Keywords: climate change, freshwater, marine, risk assessment, threatened species

Source: Snover et al., Cons. Bio., 2013
The RMJOC-II project:

Climate Projections

- **Global model selection**
- **Statistical Downscaling**
- **Dynamical Downscaling**
GCM Evaluation: the “Quilt”

(Ordered by sum total of relative errors. All metrics treated equally.)
New projections closely resemble previous ones

**Temperature**

**Precipitation**

(2070-2099 relative to 1970-1999)
The RMJOC-II project: Climate Projections

- Global model selection
- **Downscaling Approaches**
- Downscaling Comparison
Downscaling

**Statistical:**

Apply changes from global model projection to historical observations

**Dynamical:**

Use global model projections to drive a regional climate model

**Statistical approach**

**Physics-based approach**
Downscaling

Statistical:
Two methods:
- MACA
- BCSD (monthly)

Dynamical:
One approach:
RegCM4

Figure 2. 6-hour accumulated precipitation simulated by ECHAM5/WRF for 27 Nov 2030; the left panel shows results for the outer, 36-km domain; right panel the inner, 12-km domain. (1966-2005, 2011-2050; RCP 8.5 only)
The RMJOC-II project:

Climate Projections

• Global model selection
• Downscaling Approaches
• Downscaling Comparison
Change in JJA temperature between 1970-1999 and 2020-2049, RCP8.5
Change in DJF precipitation between 1970-1999 and 2020-2049, RCP8.5
The RMJOC-II project: Climate Projections

- Global model selection
- Downscaling Approaches
- Downscaling Comparison
Thank you

gmauger@uw.edu
206.685.0317
@guillaumemauger
Greenhouse Gas Scenarios

Global CO₂ Emissions (GtC/year)

Year

RCP 8.5
A1FI
A2
RCP 6.0
A1B
RCP 4.5
B1
RCP 2.6
OBS
Results from **Statistical Downscaling**

Change in Flood Magnitude for 297 NW rivers 2040s, A1b scenario, ECHAM5 model

Source: Salathé et al 2014
Results from **Dynamical Downscaling**

Change in Flood Magnitude for 297 NW rivers
2050s, A1b scenario, ECHAM5 model

Source: Salathé et al 2014
GCM ranking for the PNW

Normalized Error Score

GCM

Less error  More error
Climate Projections for the Columbia River Basin

1970–1999 to 2030–2059

*Above The Dalles
10%-90% percentiles
Gray: CMIP3
Light blue: CMIP5
Blue: overlap
Change in MAM temperature between 1970-1999 and 2020-2049, RCP8.5
Change in JJA precipitation between 1970-1999 and 2020-2049, RCP8.5