Decadal Climate Prediction Project (DCPP): Progress and Plans

Steve Yeager and Jon Robson (DCPP Co-Chairs)
A Brief History

CMIP5

Disparate uncoordinated DP efforts

Taylor et al. (BAMS, 2012)

CMIP6

DCPP Panel: coordinate the scientific and practical aspects of decadal climate prediction research within WCRP

Boer et al. (GMD, 2016)
Component A
- 5/10 year hindcasts every year from 1960
- 10+ member ensembles
- CMIP6 historical forcings + SSP2-4.5
- 10+ member set of uninitialized hist+ssp

Component B
- Real-time forecasts

Component C
Predictability, mechanisms, & Case Studies
- Idealized AMV and PDV experiments
- Atlantic & Pacific pacemaker experiments
- Perturbed initialization experiments
- Experiments with/without volcanic forcing
- Allows participation from groups not doing initialized prediction

Boer et al. (GMD, 2016)
Select CMIP6 DCPP Results

Robust skill of decadal climate predictions

Table 1. Forecast systems and ensemble sizes

<table>
<thead>
<tr>
<th>Forecast Centre</th>
<th>Model</th>
<th>Initialized ensemble size</th>
<th>Uninitialized ensemble size</th>
<th>References</th>
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<tr>
<td>Barcelona Supercomputing Center, Spain</td>
<td>GCMv8</td>
<td>5</td>
<td>10</td>
<td>[8, 9]</td>
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<td>Canadian Centre for Climate Modelling and Analysis, Environment and Climate Change Canada</td>
<td>CoCoR</td>
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<td>Geophysical Fluid Dynamics Laboratory, USA</td>
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<td>HadCM3</td>
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<td>Met Office Hadley Centre, UK</td>
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<tr>
<td>University of Tokyo, National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology, Japan</td>
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<td>Total</td>
<td>71</td>
<td>71</td>
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</tbody>
</table>

71-members

- Signal-to-noise paradox widespread in decadal prediction ➔ need for very large ensembles
- Significant benefits from initialization for decadal climate outlooks
- Hints of decadal NAO prediction skill (ACC ~ 0.5)
Select CMIP6 DCPP Results

North Atlantic climate far more predictable than models imply

Nature 2020

- 169-member ensemble
- Unrealistically low signal-to-noise (RPC>1) where ACC shows skill
- Lagged ensemble (676-member) yields high skill for decadal NAO (ACC ~ 0.8) & related impacts over Europe, N. America after calibration
- High decadal NAO skill also seen in some individual systems (e.g., CESM1-DPLE; Athanasiadis et al. 2020)
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Predictable Variations of the Carbon Sinks and Atmospheric CO₂ Growth in a Multi-Model Framework

- Advent of Earth system model contributions to DCPP permits assessment of carbon cycle predictability
- Essential for carbon monitoring programs in the presence of internal variability
- Multi-year skill also found for ocean acidification (Brady et al., 2020) & ocean net primary productivity (Krumhardt et al., 2020)
Select CMIP6 DCPP Results

- AMV warming linked to tropical Pacific cooling

- Other recent DCPP-C AMV studies:
  - Global monsoons (Monerie et al. 2019)
  - N. Atlantic storm track (Ruggieri et al. 2020)
  - Arctic sea ice (Castruccio et al. 2019)

- Ongoing debate regarding validity of experimental design
  (e.g., Kim et al. 2020; O’Reilly et al. 2022)
“The chance of global near-surface temperature exceeding 1.5°C above preindustrial levels at least one year between 2022 and 2026 is about as likely as not (48%). There is only a small chance (10%) of the five-year mean exceeding this threshold.”
DCPP Recent Activities

- 9 virtual meetings since 2019
- Data submissions to CMIP6
- Contributions to WGI Chapter 4 of AR6 Report (Merryfield + others)
- 2019 WCRP-DCPP AGU Townhall
- Coordinated analysis (e.g., DCPP-C volc/novolc experiments; Hermanson et al. 2020; Bilbao et al. 2022)
- New coordinated experiments:
  - DCPP-D (with/without COVID emissions reductions)
  - Volcanic Response Readiness Exercise (VolRes RE), a joint SPARC/DCPP effort
- Gaps in existing DCPP experimental protocol:
  - Seasonal-to-interannual (S2I) timescales
  - High-resolution DP
- Upcoming in-person meeting (WCRP EPESC/DCPP in Exeter, UK, March 2023)
DCPP in CMIP7

• Ideas for updates to Boer et al. (2016) protocol:
  • DCPP-A to include seasonal-to-interannual hindcasts in addition to decadal (e.g., CESM2-SMYLE; Yeager et al., GMD, 2022)
  • DCPP-A to include explicit protocol for high-resolution (0.1° ocean, 0.25° atmosphere) hindcasts to facilitate multi-model comparison/analysis
  • DCPP-C pacemaker experiments to utilize emerging techniques that circumvent SST restoring
  • DCPP-C no-volcano experiments to call for full hindcast set
  • Increased emphasis (higher tier) for “niff” (no information from the future) & single-forcing hindcasts sets to better understand predictability mechanisms
  • Initialized forecasts with geoengineering? (in coordination with GeoMIP)
  • Multidecadal (30-year hindcasts) protocol?

• Overlaps & collaborations with WCRP Lighthouse activities need scoping out
  • Explaining and Predicting Earth System Change
  • My Climate Risk

• Should uninitialized mechanisms experiments continue to be a DCPP activity?
• How should DCPP in CMIP7 synergize with ongoing WMO operational prediction activities?
DCPP Panel Membership

• Jon Robson (Co-Chair), U. Reading
• Steve Yeager (Co-Chair), NCAR
• Tatiana Ilyina, MPI
• Jerry Meehl, NCAR
• Bill Merryfield, ECCC
• Juliette Mignot, IPSL
• Rym Msadek, CERFACS
• Wolfgang Müller, MPI
• Terence O’Kane, CSIRO
• Pablo Ortega, BSC
• Doug Smith, UKMO
• Christophe Cassou, CERFACS
• Takashi Mochizuki, JAMSTEC
• Louis-Philippe Caron, BSC

Need broader representation from active DP-producing institutions moving forward