Seasonal forecasting developments at ECCC

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Topics covered

• ECCC is contributing to C3S seasonal forecast ensemble as of May 2021 (high-frequency hind/forecast data for ~35 single & multi-level variables)

• CanSIPSv2.1 upgraded multi-model ensemble

• Seasonal forecasting experiments with CanESM5 (CCCma’s CMIP6 ESM)

• Experimental online ocean bias correction in CanESM5
CanSIPSv2.1 upgraded MME

<table>
<thead>
<tr>
<th>System</th>
<th>Debut</th>
<th>Climate models</th>
<th>NWP models</th>
<th>Coupled?</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>HFP</td>
<td>1996</td>
<td>GCM2</td>
<td>SEF</td>
<td>N</td>
<td>3 mon</td>
</tr>
<tr>
<td>HFP2</td>
<td>2008</td>
<td>GCM2, GCM3</td>
<td>SEF, GEM</td>
<td>N</td>
<td>4 mon</td>
</tr>
<tr>
<td>CanSIPS</td>
<td>2011</td>
<td>CanCM3,CanCM4</td>
<td>-</td>
<td>Y</td>
<td>12 mon</td>
</tr>
<tr>
<td>CanSIPSv2</td>
<td>2019</td>
<td>CanCM4i</td>
<td>GEM-NEMO</td>
<td>Y</td>
<td>12 mon</td>
</tr>
<tr>
<td>CanSIPSv2.1</td>
<td>2021 Dec</td>
<td>CanCM4i</td>
<td>GEM5-NEMO</td>
<td>Y</td>
<td>12 mon</td>
</tr>
</tbody>
</table>

HFP = Historical Forecasting Project  CanSIPS = Canadian Seasonal to Interannual Prediction System

- GEM5-NEMO uses 1° Yin-Yang atmospheric grid (vs 1.4° lat-lon before), 85 vertical levels, 0.1hPa top
- Bechtold (2001) shallow convection scheme, stochastic perturbation of parameters (SPP), modified land init
Seasonal forecasting experiments with CanESM5

- CanESM5 = CCCma CMIP6 ESM
- Equilibrium climate sensitivity:
  - 3.7K CanESM2 (proxy for CanCM4)
  - 5.6K CanESM5
- Nino3.4 std dev vs month (freely running):

CanESM5 seasonal skills nonetheless competitive with CanCM4

*Global mean ACC averaged over all lead times, target months/seasons →*

<table>
<thead>
<tr>
<th></th>
<th>CanCM4i</th>
<th>CanESM5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nino3.4 (mon)</td>
<td>0.81</td>
<td>0.75</td>
</tr>
<tr>
<td>T2m land (seas)</td>
<td>0.30</td>
<td>0.32</td>
</tr>
<tr>
<td>Sea ice area (mon)</td>
<td>0.76</td>
<td>0.79</td>
</tr>
</tbody>
</table>
Experimental online ocean bias correction in CanESM5

- Methodology:
  - Nudge ocean T/S to ORAS5, letting atmosphere evolve freely (30d upper / 360d deep, including equator)
  - Calculate 1981-2010 monthly climatology of nudging terms
  - Apply as non-interactive correction to T/S tendencies

1981-2010 annual mean SST biases

CanESM5 historical run

Ocean bias correction
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1981-2010 equatorial Pacific SST seasonal cycle

![CanESM5 historical run](image1)

![ORAS5](image2)

![Ocean bias correction](image3)
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1981-2010 Nino3.4 monthly std dev

- Next steps:
  - Atmospheric model parameter adjustments → promising early results
  - Experiment with atmospheric online bias correction after Kharin and Scinocca (GRL 2012, [https://doi.org/10.1029/2012GL052815](https://doi.org/10.1029/2012GL052815))