ECCC seasonal & decadal update

Bill Merryfield

Canadian Centre for Climate Modelling and Analysis
## Current ECCC/GPC Montreal seasonal system

<table>
<thead>
<tr>
<th>System</th>
<th>Debut</th>
<th>Climate models</th>
<th>NWP models</th>
<th>Ensemble</th>
<th>Coupled?</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>HFP</td>
<td>1996</td>
<td>GCM2</td>
<td>SEF</td>
<td>2×6</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>4×10</td>
<td>N</td>
<td>4 mon</td>
</tr>
<tr>
<td>CanSIPS</td>
<td>2011</td>
<td>CanCM3, CanCM4</td>
<td>-</td>
<td>2×10</td>
<td>Y</td>
<td>12 mon</td>
</tr>
<tr>
<td>CanSIPSv2</td>
<td>2019</td>
<td>CanCM4i</td>
<td>GEM-NEMO</td>
<td>2×10</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>2×10</td>
<td>Y</td>
<td>12 mon</td>
</tr>
<tr>
<td>CanSIPSv3</td>
<td>Mid-2024</td>
<td>CanESM5</td>
<td>GEM5.2-NEMO</td>
<td>2×20</td>
<td>Y</td>
<td>12 mon</td>
</tr>
</tbody>
</table>

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


### Mid-2024: CanSIPSv3

#### Atmos
- CanESM5: CanAM5 T63/L49 + NEMO ORCA1/L45 + LIM2 + CLASS3.6 + CMOC/CTEM
- GEM5.2-NEMO: GEM5.2 1°/L85 + NEMO ORCA1/L50 + CICE4 + ISBA/SVS
ECCC long range ENSO outlook

Historical

Short lead

Long lead

Recent

Long-range El Niño hits
False alarms
New seasonal products based on daily/subdaily data

- Daily/subdaily seasonal hindcast & forecast data for >30 variables provided to Copernicus since mid-2021

- This opens possibilities for developing products such as
  - **cooling degree days** = accumulation of daily mean temperatures >18°C
  - **heating degree days** = accumulation of daily mean temperatures <18°C
  - **growing degree days** = accumulation of daily mean temperatures <N°C, N= 4, 5,10…
  - number of **wet days** exceeding threshold precipitation, e.g. 1 mm

- Potentially useful for energy, agriculture, etc.

- For DD, add daily T2m anomalies to 5-day smoothed daily ERA5 climatology for 1991-2020
CRPSS Heating/Cooling Degree Days vs T2m

DJF 1991-2020
Lead 0 months

CanSIPSv2.1
HDD

SON 1991-2020
Lead 0 months

CanSIPSv2.1
CDD

CanSIPSv2.1
T2m

CanSIPSv2.1
T2m
CanESM5 development for seasonal forecasting

- CanESM5, CCCma’s CMIP6 ESM, has been “slow-tracked” for seasonal/decadal operations due to:
  - Very high equilibrium climate sensitivity (5.6°C)
  - Inaccurate ENSO amplitude and seasonality →

- Have experimented with **online atm/ocn bias correction** using method of Kharin and Scinocca (GRL, 2012)
  - Nudge atmosphere to ERA5, ocean T/S to ORAS5, calculate 1981-2010 monthly climatology of nudging terms
  - Apply as non-interactive adjustments to tendencies

- Bias correction improves CanESM5 seasonal skills, which compare well to CanCM4i (except for ENSO)

*Global mean ACC averaged over all target seasons, 0-9 month lead (1991-2020) →*

<table>
<thead>
<tr>
<th></th>
<th>CanCM4i</th>
<th>CanESM5</th>
<th>CanESM5-BC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nino3.4</td>
<td>0.79</td>
<td>0.71</td>
<td>0.68</td>
</tr>
<tr>
<td>T2m land</td>
<td>0.33</td>
<td>0.36</td>
<td>0.37</td>
</tr>
<tr>
<td>Precip land</td>
<td>0.101</td>
<td>0.096</td>
<td>0.117</td>
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</tbody>
</table>
Extra slides
CRPSS Heating/Cooling Degree Days vs T2m

MAM 1991-2020
Lead 0 months
CanSIPSv2.1
HDD

CanSIPSv2.1
T2m

JJA 1991-2020
Lead 0 months
CanSIPSv2.1
CDD

CanSIPSv2.1
T2m
### NOAA Population weighted degree day outlook

https://www.cpc.ncep.noaa.gov/pacdir/DDdir/ddforecast.txt

**MONTHLY TOTAL DEGREE DAY FORECAST**

**BASE 65 F**

**NWS CLIMATE PREDICTION CENTER COLLEGE PARK MD**

**300 PM EDT THU 18 AUG 2022**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>MONTH</th>
<th>NEW ENGLAND</th>
<th>(CT ME MA NH RI VT)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>HEATING</td>
<td>COOLING</td>
</tr>
<tr>
<td></td>
<td></td>
<td>90%</td>
<td>MEAN</td>
</tr>
<tr>
<td>2022</td>
<td>9</td>
<td>57.</td>
<td>107.</td>
</tr>
<tr>
<td>2022</td>
<td>10</td>
<td>341.</td>
<td>425.</td>
</tr>
<tr>
<td>2022</td>
<td>11</td>
<td>588.</td>
<td>693.</td>
</tr>
<tr>
<td>2022</td>
<td>12</td>
<td>885.</td>
<td>1037.</td>
</tr>
<tr>
<td>2023</td>
<td>1</td>
<td>1006.</td>
<td>1204.</td>
</tr>
<tr>
<td>2023</td>
<td>2</td>
<td>882.</td>
<td>1005.</td>
</tr>
<tr>
<td>2023</td>
<td>3</td>
<td>814.</td>
<td>893.</td>
</tr>
<tr>
<td>2023</td>
<td>4</td>
<td>481.</td>
<td>546.</td>
</tr>
<tr>
<td>2023</td>
<td>5</td>
<td>182.</td>
<td>256.</td>
</tr>
<tr>
<td>2023</td>
<td>6</td>
<td>21.</td>
<td>47.</td>
</tr>
<tr>
<td>2023</td>
<td>7</td>
<td>1.</td>
<td>9.</td>
</tr>
<tr>
<td>2023</td>
<td>8</td>
<td>6.</td>
<td>20.</td>
</tr>
<tr>
<td>2023</td>
<td>9</td>
<td>61.</td>
<td>113.</td>
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<tr>
<td>2023</td>
<td>10</td>
<td>339.</td>
<td>426.</td>
</tr>
<tr>
<td>2023</td>
<td>11</td>
<td>580.</td>
<td>686.</td>
</tr>
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</table>
Probabilistic Ice-Free / Freeze-Up Date Forecasts
Dates that sea ice concentration falls below / rises above 50%

2022-23 Freeze-Up Date forecast from 1 Oct
Probability for Early, Near-normal, or Late FUD
CanSIPsv2, init: 10/2022 (cf 2013-2021)

CanSIPsv2.1 Historical FUD Skill, Init: October 1, 2000-2021
Relative to trend-adjusted climatology

Brier Skill Score (% improvement)

Ice-Free / Freeze-Up Dates (Probabilistic)

Dates that sea ice concentration falls below / rises above 50%

2022 Ice-Free Date forecast from 30 Apr

Probability for Early, Near-normal, or Late IFD
CanSIPSv2, init: 05/2022 (cf 2013-2021)

CanSIPSv21 Historical IFD Skill, Init: May 1, 2000-2021
Relative to trend-adjusted climatology

Brier Skill Score (% improvement)


Verification of 2021 Freeze-Up Date** from 30 Sep

Forecast

Observed

**compared to 2012-2020 average
Ice-Free / Freeze-Up Dates (Deterministic)

Dates that sea ice concentration falls below / rises above 50%

2022 Ice-Free Date forecast from 30 Apr

**compared to 2013-2021 average**

Sea Ice Probability

Calibrated probabilities that monthly sea ice concentration exceeds specified threshold

Sep 2021 forecast from 30 Apr

Historical skill (2000-2020) relative to trend-adjusted climatology

Verification