Robust evaluation of seasonal forecast quality using teleconnections

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Motivation of the work

Does forecast skill scores improve after model developments?

Is the model able to reproduce the responses (in terms of teleconnections) to the main variability modes at seasonal time scales?

Is the information given by the comparison of teleconnections more robust than traditional skill scores?
For this study:

- Atmospheric component initialised with ERA-Interim, ocean and sea-ice components initialised with an upscaled analysis of GLORYS.
- 24 start dates starting the 1st of November 1993-2016 (run for 7 months).
- 80 ensemble members generated with stochastic dynamic perturbations.
Niño 3.4 skill comparison for lead time 2 to 4 (DJF)

Niño 3.4 index is calculated as the area average over the region $120^\circ W-170^\circ W$, $5^\circ S-5^\circ N$. 
Niño 3.4 skill comparison for lead time 5 to 7 (MAM)

Niño 3.4 index is calculated as the area average over the region 120°W-170°W, 5°S-5°N.
Near surface temperature skill comparison

RMSE ratio sys5/sys6 calculated with ERA-Interim

Significant area of Sys 6 improvements : 7.84 %
Significant area of Sys 5 improvements : 0.67 %

Significant area of Sys 6 improvements : 2.53 %
Significant area of Sys 5 improvements : 0.06 %
Precipitation skill comparison

RMSE ratio sys5/sys6 calculated with GPCP

Significant area of Sys 6 improvements : 4.50 %
Significant area of Sys 5 improvements : 1.71 %

Significant area of Sys 6 improvements : 3.38 %
Significant area of Sys 5 improvements : 0.31 %
Comparison of covariances of precipitation with N3.4 for DJF

System 5 covariance

System 6 covariance

GPCP covariance

\[ C(x) = \frac{\sum_{y=1}^{24} N3.4_y \cdot Prec_y(x)}{24} \]
Comparison of covariances of precipitation with N3.4 for DJF

<table>
<thead>
<tr>
<th>Region</th>
<th>System 5</th>
<th>System 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic (60°W-20°E)</td>
<td>0.71</td>
<td>0.76</td>
</tr>
<tr>
<td>Indian (21°E-100°E)</td>
<td>0.21</td>
<td>0.70</td>
</tr>
<tr>
<td>Pacific (101°E-59°W)</td>
<td>0.74</td>
<td>0.80</td>
</tr>
</tbody>
</table>
Comparison of covariances of precipitation with N3.4 for MAM

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<th>System 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic (60°W-20°E)</td>
<td>0.55</td>
<td>0.63</td>
</tr>
<tr>
<td>Indian (21°E-100°E)</td>
<td>0.60</td>
<td>0.76</td>
</tr>
<tr>
<td>Pacific (101°E-59°W)</td>
<td>0.42</td>
<td>0.59</td>
</tr>
</tbody>
</table>
Comparison of covariances of precipitation with N3.4 for MAM

Definition of the regions from Giorgi and Francisco 2000 (Clim. Dyn. 16 : 169-182)
Distribution of the covariances of individual members for precipitation and N3.4
NAO skill comparison

NAO index is calculated as the leading EOF of geopotential height anomalies at 500 hPa over the region 20°N-80°N, 80°W-40°E.
Probability distribution of NAO correlation (subsamples of 50 members)

![Graph showing probability distribution of NAO correlation for System 5 and System 6. The graph plots correlation against density, with two overlapping normal distributions. System 5 is represented by a blue line, and System 6 by a red line. The peaks of the distributions are around 0.5, with System 5 slightly to the left.]

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Comparison of covariances of temperature with NAO

Pattern correlation in the region 30N-90N

<table>
<thead>
<tr>
<th></th>
<th>System 5</th>
<th>System 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERA-Interim</td>
<td>0.88</td>
<td>0.91</td>
</tr>
</tbody>
</table>

\[
C(x) = \frac{\sum_{y=1}^{24} NAO_y \cdot Temp_y(x)}{24}
\]
Probability distribution of pattern correlation for temperature with NAO (subsamples of 50 members)

![Graph showing the probability distribution of pattern correlation for temperature with NAO for System 5 and System 6.](image-url)
Summary: Is System 6 better than System 5?

- It is difficult to draw a robust conclusion with the usual scores.
  - System 6 improves the near surface temperature prediction in the tropical Pacific.
  - However it shows a degradation of skill for the NAO index, although there is some uncertainty about the score.
- System 6 improves the quality of teleconnections.
  - Higher pattern correlation is shown both in the covariances between precipitation and N3.4 and between temperature and NAO.
- Having a better representation of teleconnections ensures an improved consistency of System 6 with physical mechanisms.
Thank you!


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