The International Multi-Model Ensemble at NCEP

Malaquias Peña (EMC), Huug van den Dool (CPC), Suru Saha (EMC), Emily Becker (CPC), Qin Zhang (CPC); thanks to EMC, ECMWF, MetOffice and UK MetOffice

37th CDPW Workshop; October 25th, 2012
Project Overview

• Purpose: To prepare and make available bias-corrected numerical prediction guidances for CPC/NCEP particularly

• Routine collection and post-processing of seasonal forecasts from NCEP, ECMWF, MeteoFrance and UKMet Office

• Approach: Product generation and Verification procedures similar to NMME. Both NMME and IMME are mostly automatized
## IMME= CFS+ EUROSSIP MODELS

<table>
<thead>
<tr>
<th></th>
<th>NCEP/CFSv2</th>
<th>ECMWF</th>
<th>UKMET</th>
<th>METF</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Atmospheric Model</strong></td>
<td>T126L64</td>
<td>Syst 4: T255L91</td>
<td>Glosea4 (120km) L85</td>
<td>T42L91 (T63-linear grid)</td>
</tr>
<tr>
<td><strong>Ocean Model</strong></td>
<td>MOM4 L40 0.25 deg Eq, 0.5 deg global</td>
<td>NEMO 0.3 deg Eq 1 deg global</td>
<td>NEMO L75 0.3 deg Eq 1 deg global</td>
<td>ORCA 0.5 deg Eq 2 deg global</td>
</tr>
<tr>
<td><strong>Atmosphere/Ocean Coupling Frequency</strong></td>
<td>30 minutes</td>
<td>3 hr</td>
<td>IN</td>
<td>IN</td>
</tr>
<tr>
<td><strong>Land Model</strong></td>
<td>NOAA 4-layer</td>
<td>IN</td>
<td>IN</td>
<td>IN</td>
</tr>
<tr>
<td><strong>Sea Ice Model</strong></td>
<td>3-layer interactive Seaice model</td>
<td>IN</td>
<td>IN</td>
<td>IN</td>
</tr>
<tr>
<td><strong>Period of Hindcasts</strong></td>
<td>1982-2010 (29 years)</td>
<td>1981-2010 (30 years)</td>
<td>1989-2002 (14 years)</td>
<td>1981-2009 (29 years)</td>
</tr>
<tr>
<td><strong>Number of hindcast members</strong></td>
<td>24(28)</td>
<td>15</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td><strong>Number of Leads</strong></td>
<td>0-9 months</td>
<td>0-7 months</td>
<td>0-6 months</td>
<td>0-6 months</td>
</tr>
</tbody>
</table>

IN: Information needed
Monthly average variables

• SST, Precipitation rate and 2mT
• U,V wind components at 850hPa and 200hPa
• Some models with 850 Air Temperature
• Hindcasts:
  – Three models including CFS provide the full (12 months initial conditions) data
  – One model generates and delivers the hindcast in real-time
## IMME and NMME

<table>
<thead>
<tr>
<th></th>
<th>2.5x2.5 deg</th>
<th>1x1 deg</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product resolution</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lead time (months)</strong></td>
<td>0 - 6</td>
<td>0 – 7</td>
</tr>
<tr>
<td><strong>Hindcast</strong></td>
<td>1982-2009</td>
<td>1982-2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-2 wks in advance</td>
</tr>
<tr>
<td><strong>Ensemble Size</strong></td>
<td>3 models (130 members) Potentially 4 (170m)</td>
<td>7 models (~100 members)</td>
</tr>
<tr>
<td><strong>Generating institution</strong></td>
<td>Operational Centers</td>
<td>NCEP, US Research Institutes</td>
</tr>
</tbody>
</table>
## IMME hindccasts

<table>
<thead>
<tr>
<th></th>
<th>Years</th>
<th>Ens size</th>
<th>Start months</th>
<th>Lead (mo)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFSv2</td>
<td>1982-2010</td>
<td>24-28</td>
<td>12</td>
<td>0-8</td>
</tr>
<tr>
<td>EC/s4</td>
<td>1981-2010</td>
<td>15</td>
<td>12</td>
<td>0-7</td>
</tr>
<tr>
<td>UK/s4</td>
<td>1989-2002</td>
<td>12</td>
<td>RT</td>
<td>0-6</td>
</tr>
<tr>
<td>MetF/s3</td>
<td>1981-2009</td>
<td>11</td>
<td>12</td>
<td>0-7</td>
</tr>
</tbody>
</table>
European forecast data

• Tim Stockdale (ECMWF) receives the data from UKMO and MeteoF, processes them into a suitable grib format, then sends them on to NCEP
• ECMWF System 4 was put into operations last December
• MeteoFrance expected to upgrade its forecast system this year
• UKMO started sending real-time hindcast three months ago
ECMWF System 4

Tropospheric scores
Spatially averaged grid-point temporal ACC

ACC S3 and S4 (m2-4; 30y)

ACC S3 and S4 (m5-7; 30y)

From: Tim Stockdale (ECMWF)
Monthly routine process

- Data Collection and model climate generation
  - Variables: SST, 2mT and PRATE
  - CFS 40-mem lagged
  - Model Climatology: Average of 30yrs hindcast data for the current initial month

- Systematic Error Correction
  - Model climate is removed
  - No additional corrections
  - Skill masks

- Product generation
  - Monthly and seasonal anomaly forecast maps
  - Nino 3.4 Plume
Products Website

International MME Forecasts of Monthly Climate Anomalies

<table>
<thead>
<tr>
<th>Monthly Forecast Maps</th>
<th>Seasonal Forecast Maps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation Rate</td>
<td>Precipitation Rate</td>
</tr>
<tr>
<td>Precipitation Rate for North America</td>
<td>Precipitation Rate for North America</td>
</tr>
<tr>
<td>2m Temperature</td>
<td>2m Temperature</td>
</tr>
<tr>
<td>2m Temperature for North America</td>
<td>2m Temperature for North America</td>
</tr>
<tr>
<td>Sea Surface Temperature</td>
<td>Sea Surface Temperature</td>
</tr>
</tbody>
</table>

Nino3.4 plume

- As per ECMWF-NCEP agreement, only combined model products are available to the public
- APCC seasonal project also provide these data along with models from other centers
• Same format as NMME
• Products are interpolated to 1x1 resolution to depict important features over land
ENSO Plume
CFS and EC System 4

Useful skill out to 8 months for Nino 3.4 Index
CFS and EC System 4

Nino3.4 SST RMSE (K) Verification Period 1982–2010

- CFS_Split_SEC
- ECW_Split_SEC
- CFS_1982–2010_SEC
- ECW_1982–2010_SEC
- Persistence

Split model climate
Effect of Split model climate (30S to 30N) on AC
All initial months, all leads average
Gridpoint-wise Anomaly Correlation

ECWF

Area Average AC=0.436677

CFSv2 (Split Clim)

Area Average AC=0.423252

Systematic Error [K]

ECWF

SE=-0.125487, Abs SE=0.470820

CFSv2

SE=-0.562193, Abs SE=0.73067
All initial months
2mT over US and Europe

All initial months, all leads average
Gridpoint-wise Anomaly Correlation
Current developments

• Skill Masks
• Probabilistic forecast products
• New variables: wnd200hPa, wnd850hPa
• Ensemble spread adjustments
Lead 1, NA 2mT Forecast

MMA tmp2m Anom [K] for Nov 2012 IC=Oct 2012

NMME Forecast of TMP2m Anom IC=201210 for Lead 1 2012Nov
Lead 1, NA 2mT Forecast

WITH SKILL MASK

Complementary geographical regions of decent skill
Looking ahead

• MeteoFrance new seasonal forecast system
• EUROSIP model resolution at 1x1
• MetOffice data to be included in operational products
• Consolidation methods
• Trends
• Extremes
Summary

• NCEP receives the real time seasonal predictions by the Eurosip partners from by the 8\textsuperscript{th} of the month since December 2011
• In parallel with the NMME the IMME scripts and codes are developed as consistent as possible
• SE corrections and several performance statistics have been computed
• The assessments indicate that some products have useful skills