The Seasonal Footprinting Mechanism in CFSv2: Simulation and Impact on ENSO Prediction

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What is the Seasonal Foot Printing Mechanism (SFM)?

- **NPO in NDJ (-1)**
- **Winds & Heat Flux**
- **SST in FMA (0)**
- **Tropical Winds**
- **Feedback (e.g. WES)**
- **El Nino in NDJ(0)**

Vimont et al. 2001, GRL; 2003a&b, J. Climate
Extratropical Forcing of ENSO by the Seasonal Footprinting Mechanism

• Fluctuations in the north Pacific SLP anomalies in winter leave a SST footprint in the subtropics in spring and summer that impacts ENSO the following winter (Vimont et al. 2001, 2003a,b; Anderson 2003)

• The effectiveness of the SFM to force ENSO events depends on whether the Tropics are pre-conditioned (Vimont et al. 2003; Anderson 2007; Alexander 2010)
1. Sea Level Pressure Index (SLPI)
   - Identifies when the SFM is active
   - Nov(-1)-Mar(0)
   - [10°N-25°N;175°W-145°W]
   - Anderson 2003, 2007

2. Depth of 15°C isotherm Index (Z15I)
   - Identifies whether the Tropics are pre-conditioned
   - Dec(-1)-Feb(0)
   - [5°S-5°N;160°E-180°]
   - Anderson 2007, but for JJASO (12-18 months in advance of ENSO)
Does the NCEP/CFSv2 Simulate the SFM and its relationship with ENSO?

**COLA/CFSv2 Decadal Experiments**

<table>
<thead>
<tr>
<th>Model</th>
<th>Atm ICs</th>
<th>Ocn ICs</th>
<th>Land ICs</th>
<th>CO2</th>
<th>Duration</th>
<th>Initialization Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFSv2</td>
<td>CFSR</td>
<td>ECMWF/NEMO-ODA</td>
<td>CFSR</td>
<td>Time-varying</td>
<td>30 years</td>
<td>1,2,3,4, Nov 1960,1980,2005</td>
</tr>
</tbody>
</table>
Composites of SLP (hPa) & SST (°C)
SLPI (<1σ) minus SLPI (>1σ)

NCEPR1/Hadley (1958-2007)

CFSv2

DJF (-1/0)

MAM(0)

JJA(0)

SON(0)
Composites of 10m Winds (m/s) & Z15 (m)
SLPI (<1σ) minus SLPI (>1σ)

NCEPR1/SODA (1958-2007)

CFSv2

DJF (-1/0)
MAM(0)
JJA(0)
SON(0)
SLPI & Z15I have opposite sign

Anderson 2007 (JJASO)
OBS: -0.37/-0.72

Deser et al. 2012 (JJASO)
CCSM4: -0.22/-0.69

SLPI & Z15I have same sign

Anderson 2007 (JJASO)
OBS: -0.06/0.69

Deser et al. 2012 (JJASO)
CCSM4: 0.14/0.69
Can the NCEP/CFSv2 predict ENSO based on SFM-related pre-cursors?

### NCEP CFSv2 Retrospective Forecasts

<table>
<thead>
<tr>
<th>Model</th>
<th>AGCM</th>
<th>OGCM</th>
<th>Duration</th>
<th>Years</th>
<th>Initialization</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFSv2</td>
<td>GFS T126 ICs: CFSR</td>
<td>MOM4 ICs: CFSR</td>
<td>0-9 months</td>
<td>1982-2009</td>
<td>Every 5th day @ 0,6,12,18z 24 ensemble members per month (except Nov = 28)</td>
</tr>
</tbody>
</table>
CFSv2 Composite SST by SLPI Index for SON FCSTs Initialized in March

- **SLPI(+) > 1σ (N=5)**
- **SLPI(0) (N=14)**
- **SLPI(-) < 1σ (N=9)**
Forecast Reliability

Initialized: Feb, Mar, Apr 1982-2009  Valid: ASO, SON,OND
4-member Ensembles
Forecast Reliability

Initialized: Feb, Mar, Apr 1982-2009  Valid: ASO, SON, OND
4-member ensembles
Conclusions

• There is no strong preference for ENSO “flavor” in the model or reanalysis based on the SFM-related pre-cursors.

• The correct sign of the response to the SFM-related forcing is simulated and predicted by CFSv2 in a composite sense. However, its predicted amplitude is weak for El Nino and strong for La Nina.

• The CFSv2 does not produce reliable forecasts of ENSO based on the SFM-related pre-cursors. *Is this because of small ensemble, model deficiency, or fundamental predictability?*