SST Impacts on the Seasonal Precipitation over the Tropical Indian Ocean

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Outline

• What is the issue?
• The experimental set up
• Analysis and results
• Conclusions
• Prec skill is lower over IO;
• Prec skill decays more quickly over the tropical IO than E. Pacific;
Predictability of Precipitation over the Indian Ocean -- SST prediction skill from CFS

- SST skill is higher than that of Prec;
- SST skill decays in lead time;
- Decays more quickly in IO than in E. Pacific;
- SST skill is substantially lower over IO;
Predictability of Precipitation over the Indian Ocean -- Issues

• Is the lower precipitation skill over the IO and its faster decay, due to
  – Lower skill of SST predictions
  – Or due to inherent predictability limits (in that the interannual SST variability does not constrain the precipitation variability)

• Will precipitation skill over the IO go up if skill of SST prediction improves?
• Local interannual SST variability forces atmospheric variability
  – \(<\text{SST}, \text{P}> \) positive
  – High prediction skill for \( \text{P} \)
Local atmospheric variability forces the SST variability

- $<\text{SST}, P> \text{ negative}$
- Low prediction skill for $P$
Atmospheric variability is forced by remote SST variability (atmospheric bridge), that in turn forces local SSTs.

- $\langle\text{SST}, \text{P}\rangle$ negative
- Intermediate prediction skill for P
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Model Simulations

- **Coupled Predictions**
  - SST skill is not perfect and has its own predictability limits.
  - Coupled air-sea interactions, and feedback, is included.

- **AMIP simulations (forced with observed SSTs)**
  - SST is observed, and is perfect.
  - Coupled air-sea interaction, and feedback, is not included.

- **Design model simulations that are in between the above two extremes**
### Model Simulations (1996 - 2008)

<table>
<thead>
<tr>
<th>Simulation</th>
<th>SST Specification</th>
<th>Ocean-Atmosphere Feedback (IO)</th>
<th>SST Variability (IO)</th>
<th>Primary source for P variability (IO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSSTR</td>
<td>SST relaxed to Obs. (Global)</td>
<td>✓</td>
<td>Closed to Observed</td>
<td>(1), (2), (3)</td>
</tr>
<tr>
<td>PSSTR</td>
<td>SST relaxed to Obs. (Trop. Pac.)</td>
<td>✓</td>
<td>Predicted</td>
<td>(1), (3)</td>
</tr>
<tr>
<td>GOGA</td>
<td>Specified SST (Global)</td>
<td>x</td>
<td>Observed</td>
<td>(1), (2)</td>
</tr>
<tr>
<td>POGA</td>
<td>Specified SST (Trop. Pac.)</td>
<td>x</td>
<td>Climatology</td>
<td>(1)</td>
</tr>
</tbody>
</table>

**Primary source for P variability in IO:**

1. Dynamical response to remote ENSO-related SST variability via atmospheric circulation;
2. Local SST interannual variability;
3. Local SST interannual variability that itself is driven by the remote ENSO-related SST variability;
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Precipitation Skill

- The highest P skill in E. Pacific;
- Low P skill over IO;
- PSSTR > POGA due to SST variability from ENSO;
- GOGA > POGA, PSSTR, due to specification of correct SST;
- Small improvement in GSSTR comparing with GOGA;
- Both the accuracy of SST and the air-sea active coupling are important for P skill.
Seasonality of Precipitation Skill

- Distinct seasonality in P skill with higher skill in DJF/SON, lower in MAM/JJA;
- Diff simulation shows diff skill ➔;
- DJF/SON, POGA < GOGA /GSSTR ➔ importance of having correct SST;
- MAM, PSSTR shows more skill than others;
- JJA no much skill;
• <SST,P> shows considerable geographical and seasonal variation;
• DJF, positive over W. IO;
• MAM, positive over SE IO, and negative NE to the coast of Sumatra;
• JJA &SON, strong positive west coast of Sumatra;
• Near zero over large area of IO ➔
• GSSTR replicates the observed seasonal cycle;
• Positive everywhere in GOGA;
Precipitation Skill vs. P-SST Local Correlation (obs)

- A quasi-linear relationship P skill & <SST,P>;
  - <SST,P> positive → high P skill;
  - <SST,P> negative → low P skill;
  - <SST,P> negative → intermediate P skill;
Summary

• The conceptual model of SST-precipitation relationship, and its influence on the precipitation skill and $<\text{SST, P}>$ fits results from the model simulation.

• Precipitation skill and $<\text{SST, P}>$ relationship over the IO has considerable spatial and seasonal variation.

• Low precipitation skill over the IO may be because of inherent predictability limits (i.e., seasonal precipitation is controlled more by the atmospheric variability that is unpredictable).

• But the results could be model dependent, and need to be confirmed based on other models.