Forecasting Forecast Skill: Can an ENSO Conditional Skill Mask Improve Seasonal Predictions?

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What is a Skill Mask?
A simple model for forecasting forecast skill

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CFSv2 T2M Forecast

CFSv2 Forecast w/Skill Mask Applied

- Skill Mask is Determined from Re-forecasts
- Average anomaly correlation skill over 1982-2009
- Function of initial month and lead-time
- Average AC skill < 0.3 is considered not skillful

From NOAA/NWS/NCEP/CPC (http://www.cpc.ncep.noaa.gov/products/people/wwang/cfsv2fcst/)
Data & Methodology

Data

• CFSv2 Re-forecasts (24 ensemble members per month, 1982-2009)
• 0, 3, 6-month leads
• U.S. 2m Temperature & Precipitation

Perfect Model Approach

• Withhold one ensemble member as “truth” and determine forecast using the other 23 members. Repeat for all members.
"Unconditional" or Average Correlation Skill
0-month lead CFSv2 Perfect Model Forecasts (1982-2009)

Temperature

Precipitation

a) MAM

b) JJA

c) SON

d) DJF

-0.5 -0.4 -0.3 0.3 0.4 0.5 0.6 0.7 0.8 0.9
Conditional (Year-to-Year) Perfect Model Skill over U.S.
Can we Predict the Skill Associated with the ENSO Signal?

\[ y(\text{seas, year}) = m(\text{seas}) \times x(\text{seas, year}) + b(\text{seas}) \]
Regression between Conditional Skill and Normalized ABS(NINO34) (units: correlation/factor of std)

0-month lead

Temperature

Precipitation

(a) MAM

(b) JJA

(c) SON

(d) DJF
"Canonical ENSO"

"Trend and/or decadal variability"

"Central Pacific ENSO"
Regression between Conditional Skill and Normalized ABS(PC1) (units: correlation/factor of std)

0-month lead

Temperature

Precipitation

(a) MAM

rms=0.04, r=0.89

rms=0.03, r=0.91

(b) JJA

rms=0.06, r=0.76

rms=0.05, r=0.82

(c) SON

rms=0.02, r=0.87

rms=0.02, r=0.87

(d) DJF

rms=0.06, r=0.80

rms=0.10, r=0.36

Legend:

-0.4 -0.35 -0.3 -0.25 -0.2 -0.15 -0.1 -0.05 0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4
Global Regression Model RMSE Fit

Temperature

Precipitation

Correlation

3-month Lead

6-month Lead

Initial Month

Average  Nino34  PC1
PC1+2  PC1+PC2+PC3
Do ENSO-Conditional Masks Improve on Average Mask? No!

Differences in Modified Heidke Skill Score Winter
(Verified against obs)
Does including Additional PCs improve Skill over Nino3.4 as Predictor? Not systematically.

Temperature Heidke Skill Score Differences Winter (Perfect Model)

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<th>0-month</th>
<th>3-month</th>
<th>6-month</th>
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Nino3.4 is better predictor  PCs are better predictor
Conclusions

1. Including additional PCs that represent the trend and/or decadal variability, as well as central Pacific variability of tropical Pacific SSTs does not offer any systematic improvements over Nino3.4 in the ability to predict forecast skill associated with ENSO.

2. The ENSO conditional skill mask does not improve upon the average skill mask.

3. This is due to the fact that there are many more “equal chances” forecasts using the conditional masks than using the average mask (not shown).

It is hard to skillfully forecast the forecast!