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Tropical Forecasts and Predictability for Week 3 and Beyond

Matt Newman

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Establishing useful subseasonal forecasts

- Week 3 and beyond: the subseasonal-to-seasonal ("S2S") forecast problem where daily weather variations can no longer be predicted
- Need to quantify forecast uncertainty (predictability), including at the process level
  - What skill can (and should) we expect?
  - Is skill naturally higher for some places and at some times?
  - If so, can we identify "forecasts of opportunity" a priori?
- We apply a distinctive PSD approach, competitive with state-of-the-art forecasting systems, to make both **forecasts *and* forecasts of forecast skill**

Linear Inverse Model (LIM)

Empirically model the *evolution* of climate anomalies with the linear stochastically forced dynamical system

$$d\mathbf{x}/dt = \mathbf{L}\mathbf{x} + \mathbf{F}_s$$

$\mathbf{x}(t)$: series of maps, $\mathbf{L}$: stable operator, $\mathbf{F}_s$: white noise (also maps)

- (Ensemble mean) forecasts for lead τ : $\mathbf{x}(t+\tau) = exp(\mathbf{L}\tau)\mathbf{x}(t)$
- "Forecast the forecast skill": based on forecast signal-to-noise

"C-LIM": 5-day running mean tropical anomalies (1982-2011)

Ocean: ***SST/20°C isotherm depth***

Atmosphere: ***OLR/200&850 mb wind***

Low-order model (prefiltered in reduced EOF space)

Determine LIM from 0 and 5-day lag covariance of **x** (as in AR1 model)

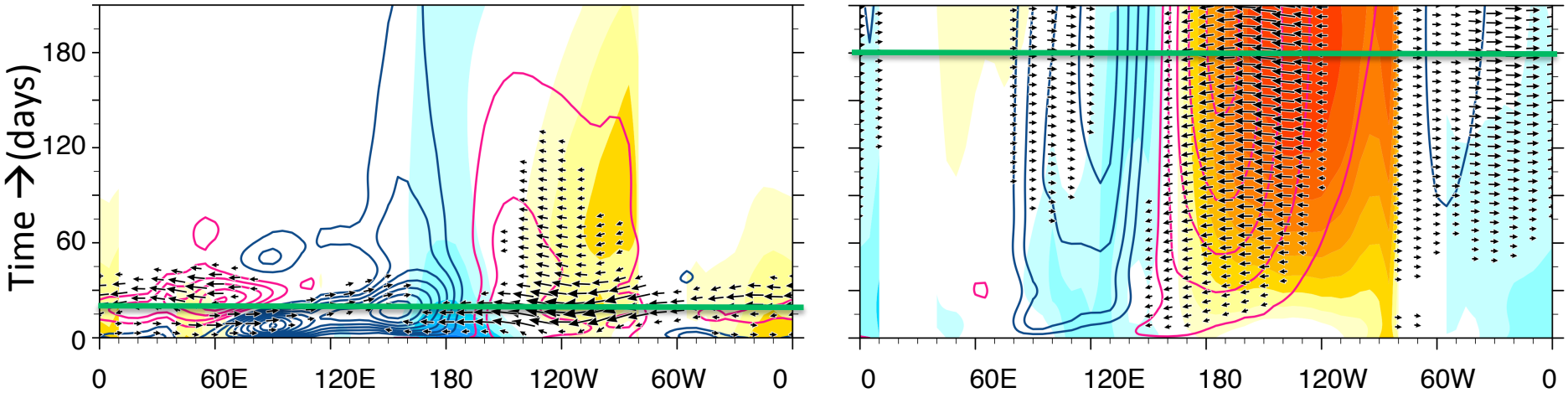
Hindcasts: determined from cross-validation (10% data withheld)

Near real-time forecasts and predicted skill available on PSD website, soon at CPC

In LIM: maximum forecast signal leads to maximum forecast skill

OLR "optimal" amplification over 20 days

SST "optimal" amplification over 180 days



Hovmoller: equatorial (8S-8N) average

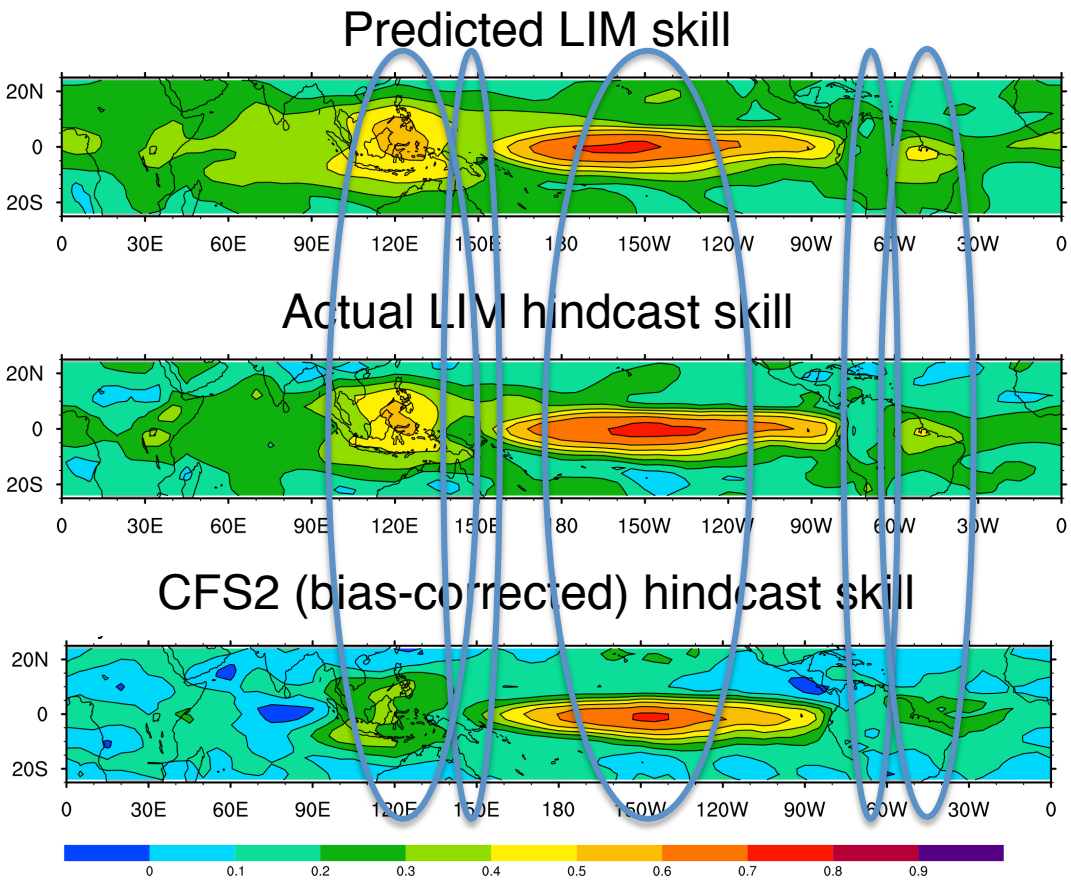
Contours: OLR
Shading: SST
Vectors: 850 hPa winds
Z20 not shown

LIM and CFS2 have similar pattern of OLR skill: some places are more predictable than others

OLR Days 16-20 hindcast skill

Average skill has spatial structure because so does average signal-to-noise variance

LIM forecasts are competitive with coupled GCMs



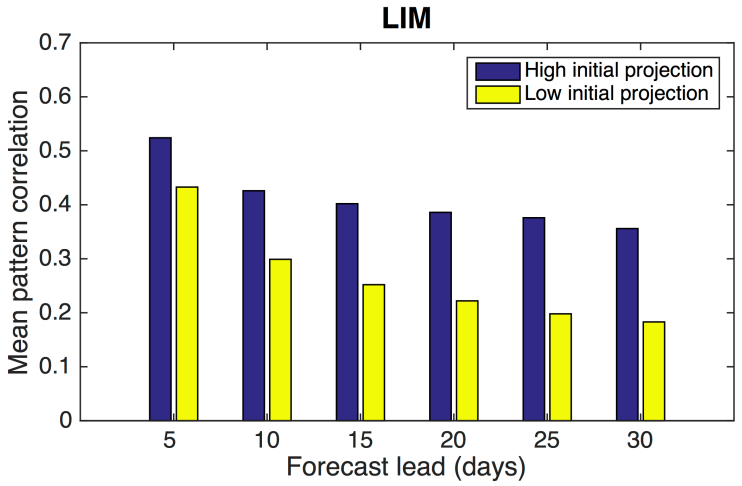
Skill is higher when initial conditions strongly project on optimal growth structure

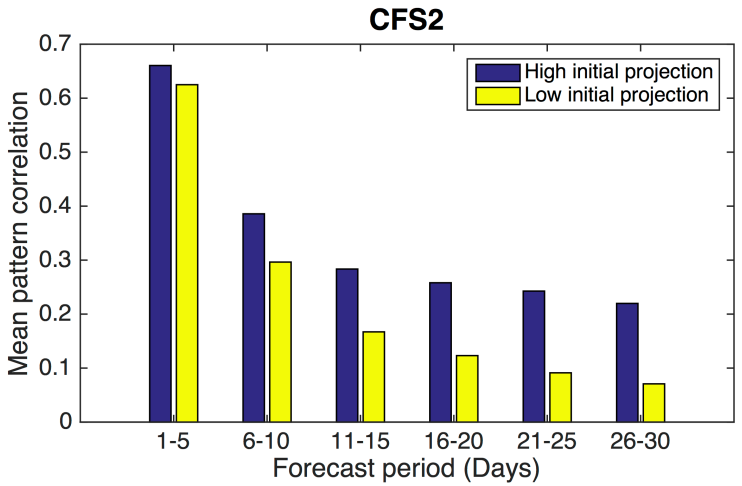
Tropical OLR skill split into cases with either **high** or **low** initial projection on optimal growth pattern.

On average, LIM predicted skill is realized by hindcasts (when predicted skill > 0.4)

Skill measure: pattern correlation of Tropical IndoPacific OLR anomaly forecast with verification

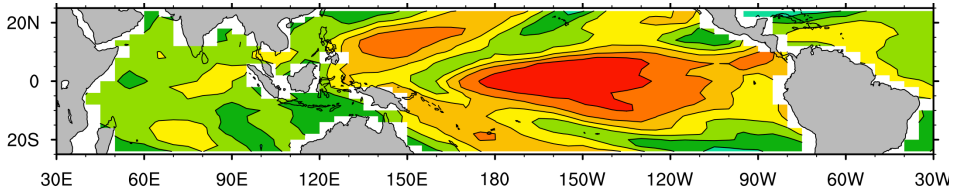
LIM identifies more skillful forecast cases *a priori*



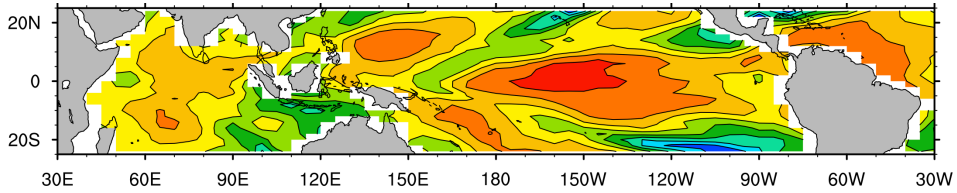


LIM and NMME have similar patterns of SST skill: some places are more predictable than others

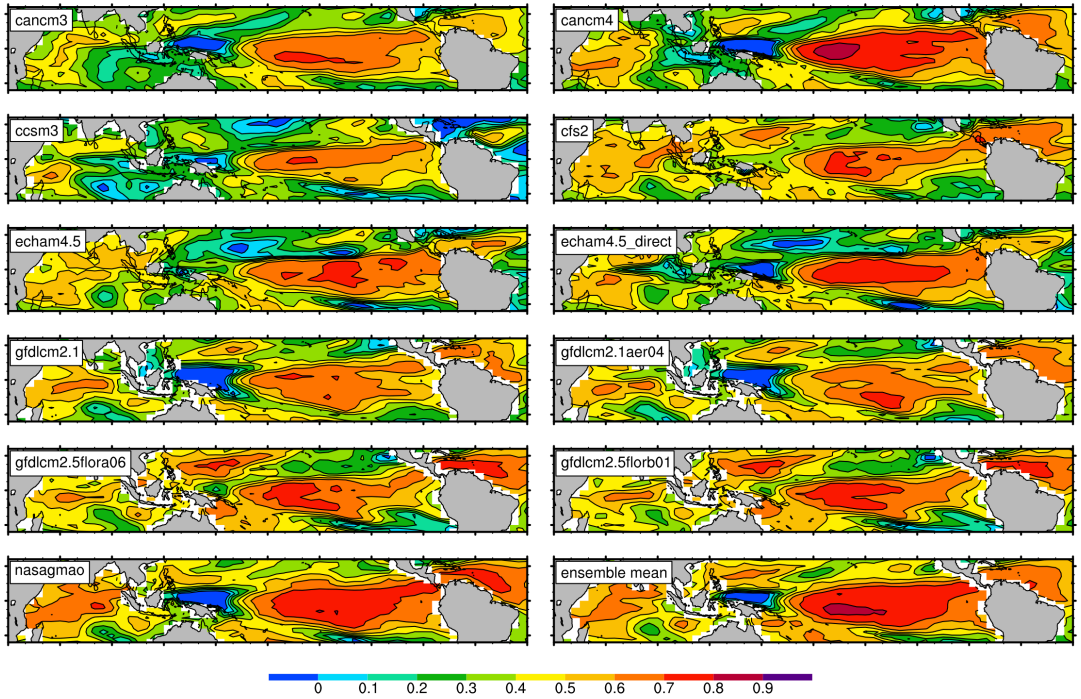
Predicted Month 6 LIM skill



Actual Month 6 LIM skill



Individual NMME models (bias corrected by model)



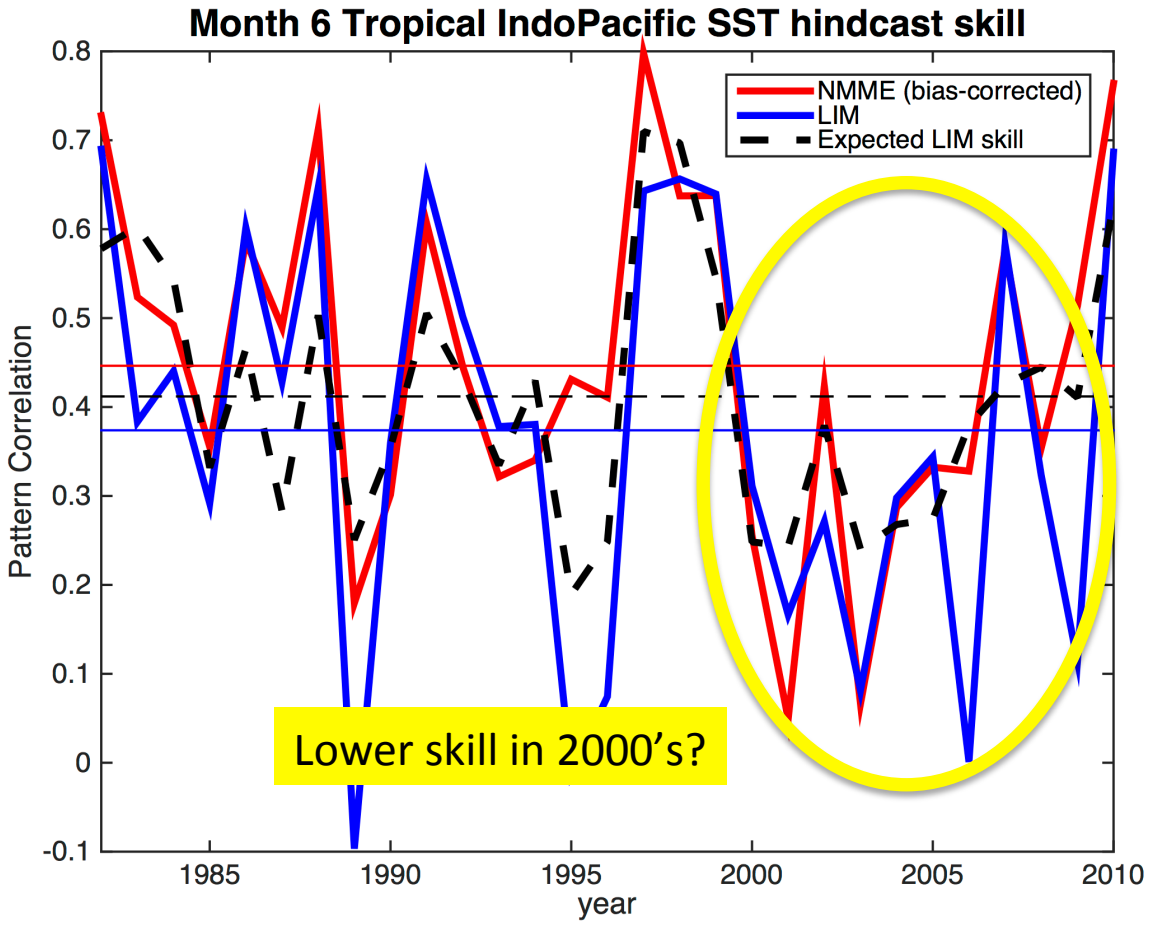
← NMME ensemble mean

LIM and NMME show similar variations in SST skill: some years are more predictable than others

Month 6 skill averaged by year (based on initialization date)

r(LIM/NMME skill, expected skill) = 0.8

Thin horizontal lines represent mean skill



LIM dynamics fixed → variations in skill due to variations in noise

Summary and Conclusions

- LIM is useful for forecast uncertainty quantification **because** its forecast skill is comparable with coupled GCMs (also provides key benchmark for GCM skill)
- Subseasonal-interannual forecast skill may be *predicted* based on LIM signal-to-noise
  - Forecasts of opportunity can be identified *a priori*
  - Recent reduced tropical SST forecast skill: random variations in initial conditions rather than long-term changes?
- Tropical "C-LIM" currently transitioning for new Weeks 3/4 CPC forecast guidance (operational by end of FY15) http://www.esrl.noaa.gov/psd/forecasts/clim/