Prospects for Year 2 Climate Predictions

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> ***"Model-analog" technique: Turn every climate model into a forecast model***
>
> Find ensemble of closest matches ("analogs") to observed SST/SSH anomaly from the anomalous states of *long climate model simulations*
>
> Evolution of analog ensemble → forecast ensemble, for leads of 1-36 months or more

Month 6 hindcast skill, 1982-2009

NMME hindcasts

NMME analogs

CMIP5 analogs
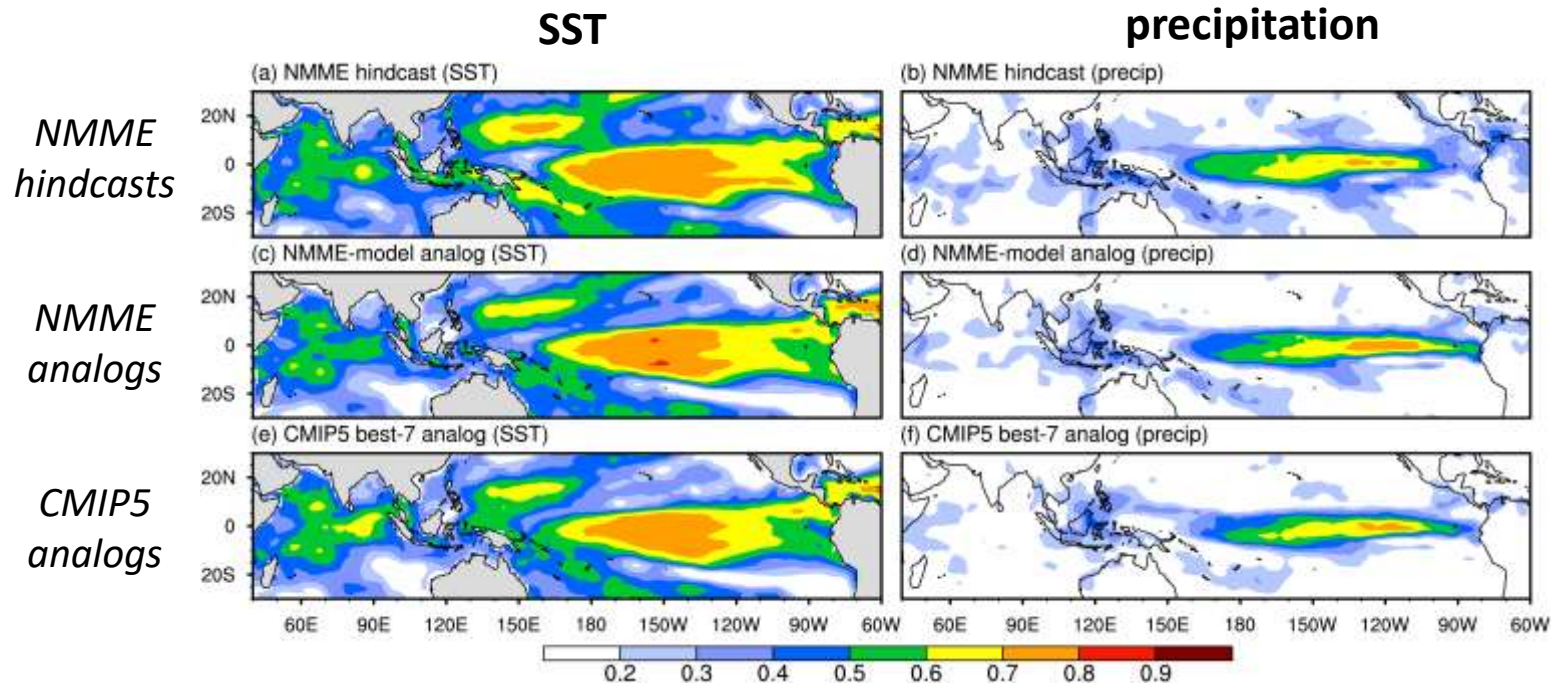
Ding et al (2018, 2019)

NMME model-analog ensembles for **tropical Indo-Pacific** based on 500 yr+ control runs of the same NMME models used for assimilation-initialized hindcasts (NCAR CESM1/CCSM4, GFDL CM2.1/ FLOR)

Some ENSO events are predictable at least 2 years ahead…

Tropical Pacific SST skill
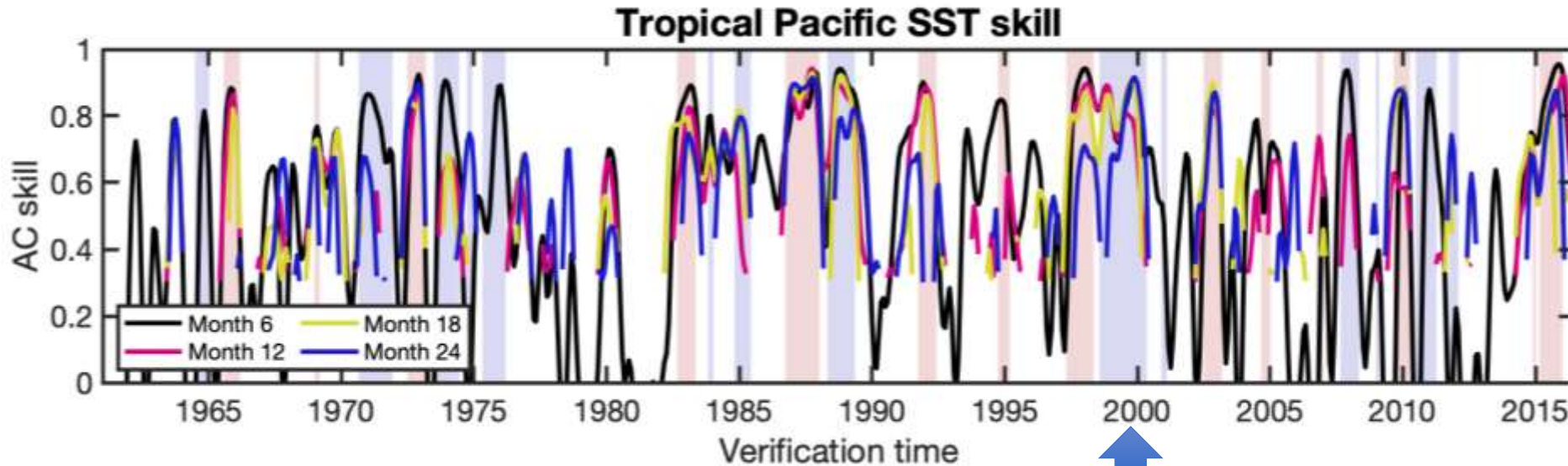
Skill measure: pattern correlation of model-analog SST hindcast ensemble mean to verification within **170E-70W, 20S-20N**

For leads >=12 months, only values above 0.4 are shown.

Niño3.4

DJF '99-'00 could have been predicted in July 1997

But average skill is low!

**How can we tell *in advance* when a forecast will be skillful?**
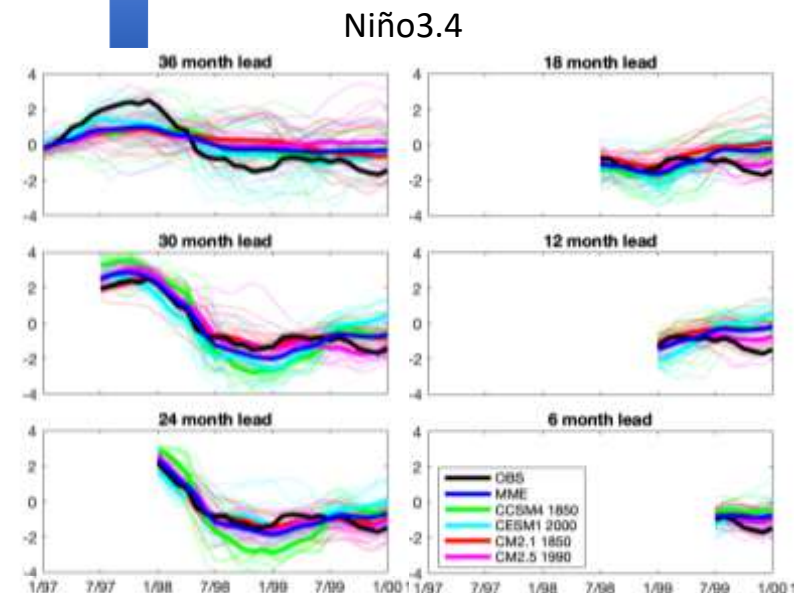
…and this skill can be identified *in advance*

Top: Niño3.4 observations (bottom row, same as black line in bottom panel), and model-analog hindcasts for leads of 1-36 months, all verifying at the same time.

*Contours show where 62.5% of hindcast ensemble members are predicted in the upper/lower tercile.*

Niño3.4 predictions (1-36 month forecast lead) and verifying observation
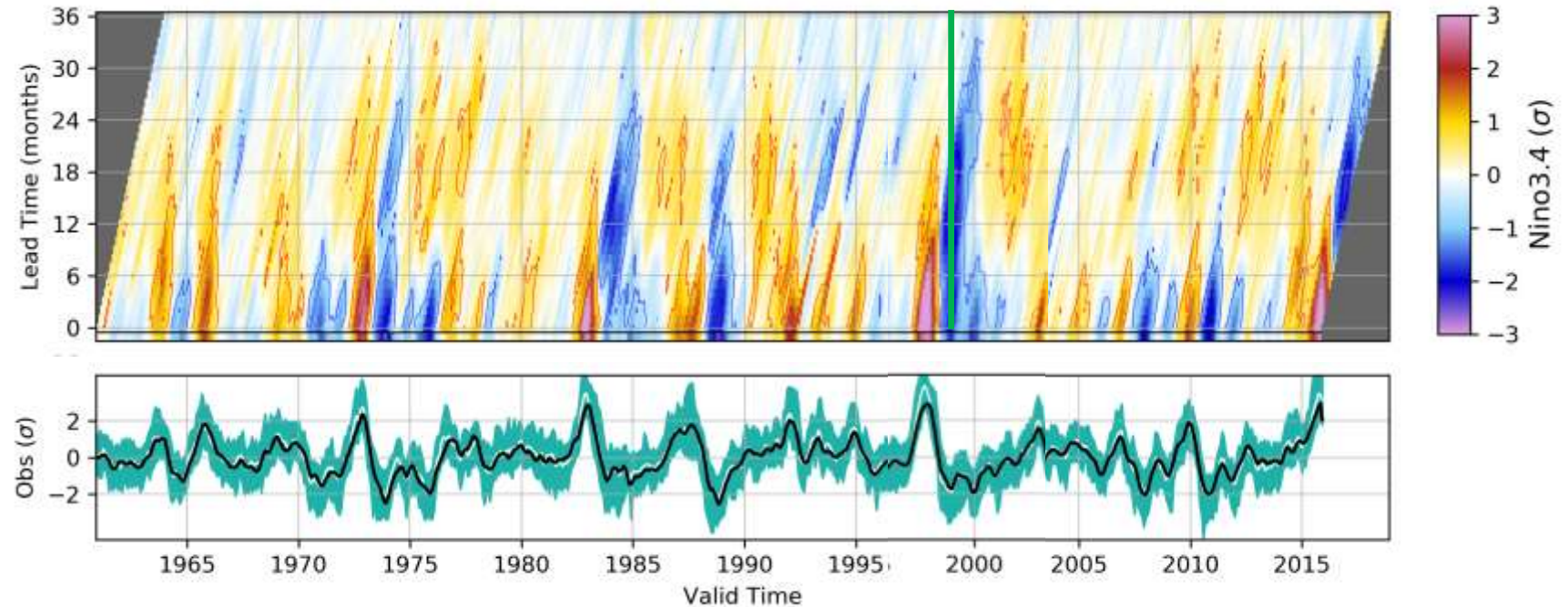
For Gaussian ensemble, signal-to-noise ratio = 0.75 → 62.5% ensemble members shifted to predicted tercile.
Above this threshold, **most model-analog ensemble-mean forecasts appear to be hits → we can avoid false alarms**

Multi-model ensemble-mean skill has strong seasonal dependence

AC skill (1961-2015) as a function of *initialization* month for 3-month running mean anomalies (lead is based on center month of 3-month mean; Month 0 shows reconstruction skill). All shaded values 95% significant (as estimated from bootstrapping)
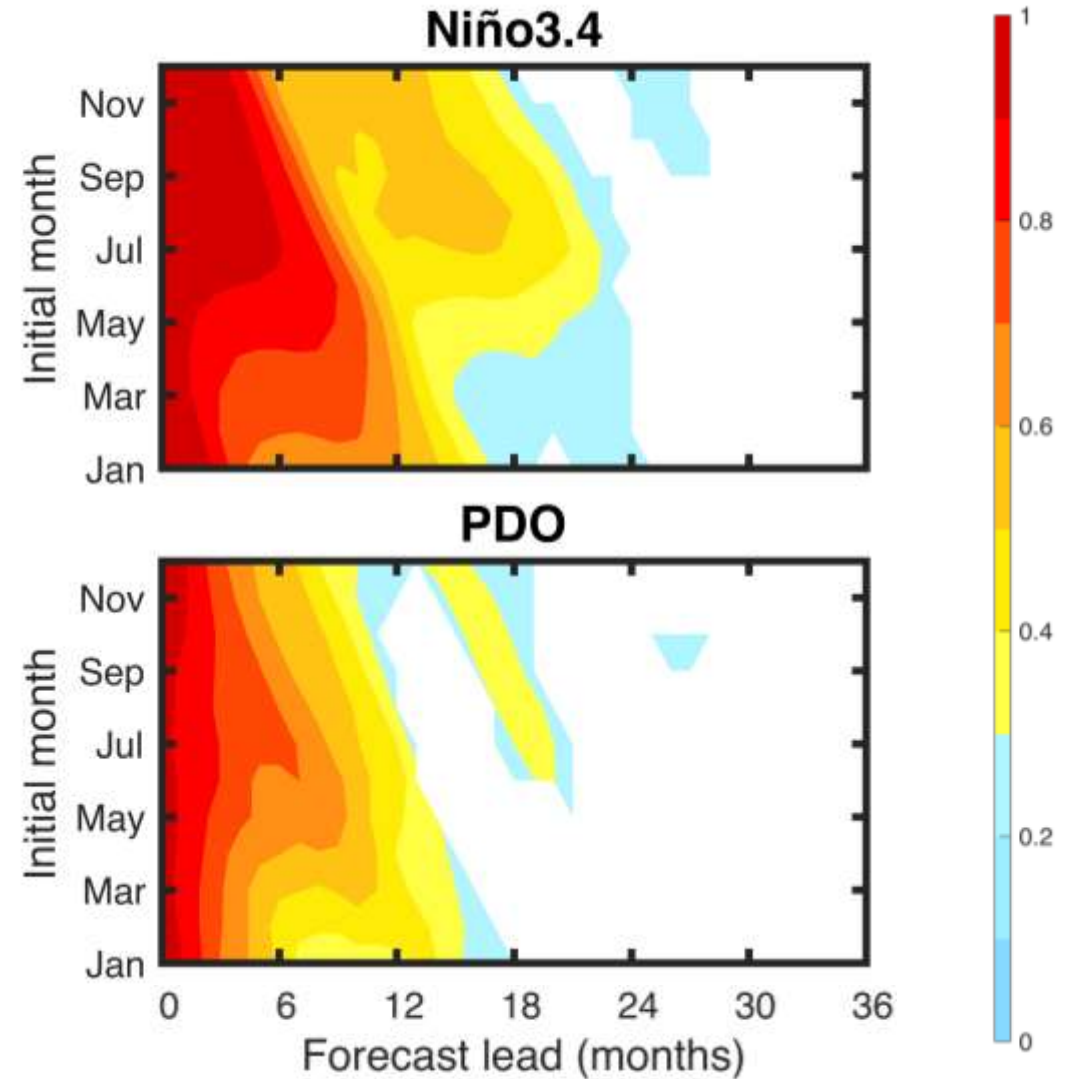
Concluding remarks

- Some ENSO events are predictable two or more years ahead, **and these may be "forecasts of opportunity" that can be identified beforehand**
  - However, these may be infrequent at best – need to avoid false alarms

- Forecasts run in realtime: **https://www.psl.noaa.gov/forecasts/seasonal/**