Mining large climate model data sets to make multi-year initialized global SST forecasts

M. Newman, H. Ding, S. Lillo, M. Alexander, A. Wittenberg

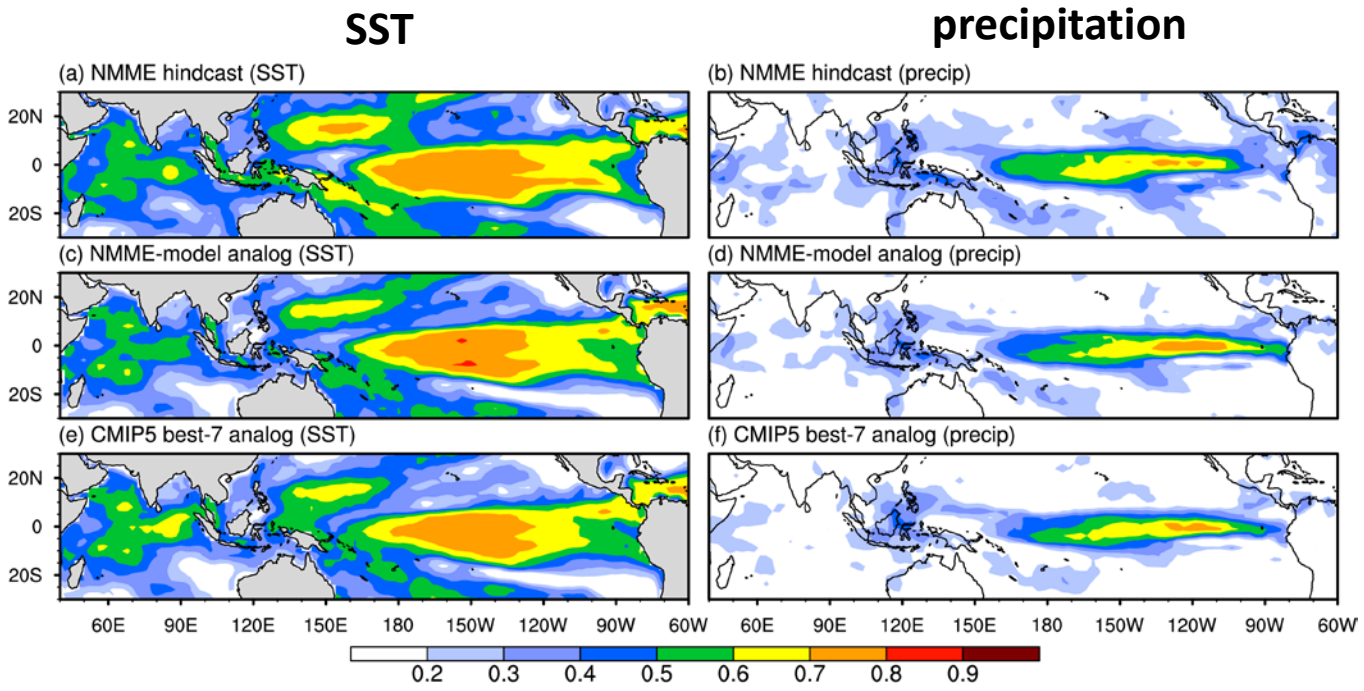
Project: "Mechanisms of Pacific Decadal Variability in ESMs" (DiLorenzo, Stevenson, Newman)

"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



Ding et al (2018, 2019)

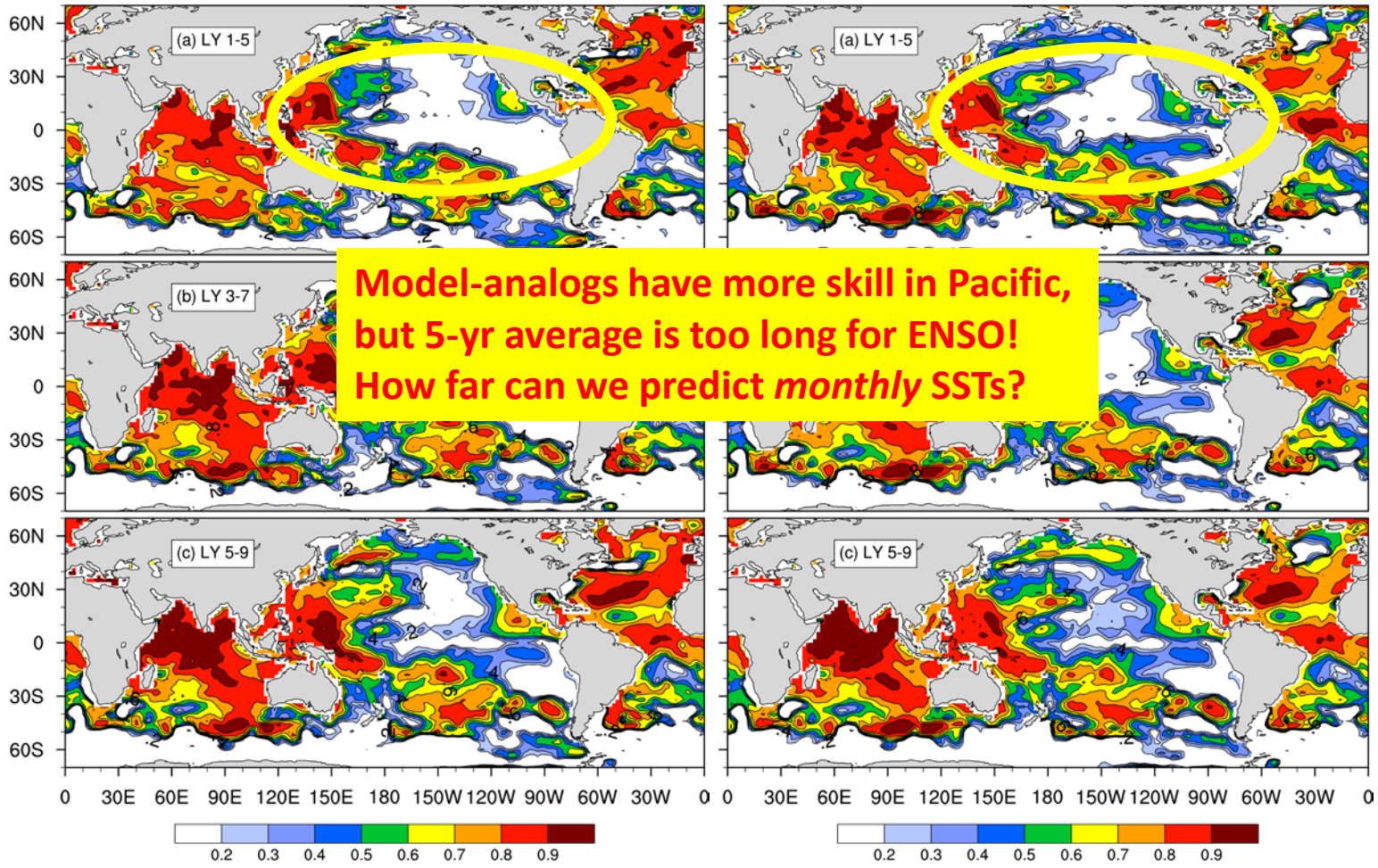
NMME model-analog ensembles for **tropical Indo-Pacific** based on 500 yr+ control runs of the same NMME models used for assimilation-initialized hindcasts (NCAR CESM1/CCSM4, GFDL CM2.1/ FLOR)

Model-analog decadal skill comparable to DPLE

SST skill (1958-2009 correlation), hindcasts initialized each November (DPLE) or October (analog)

DPLE

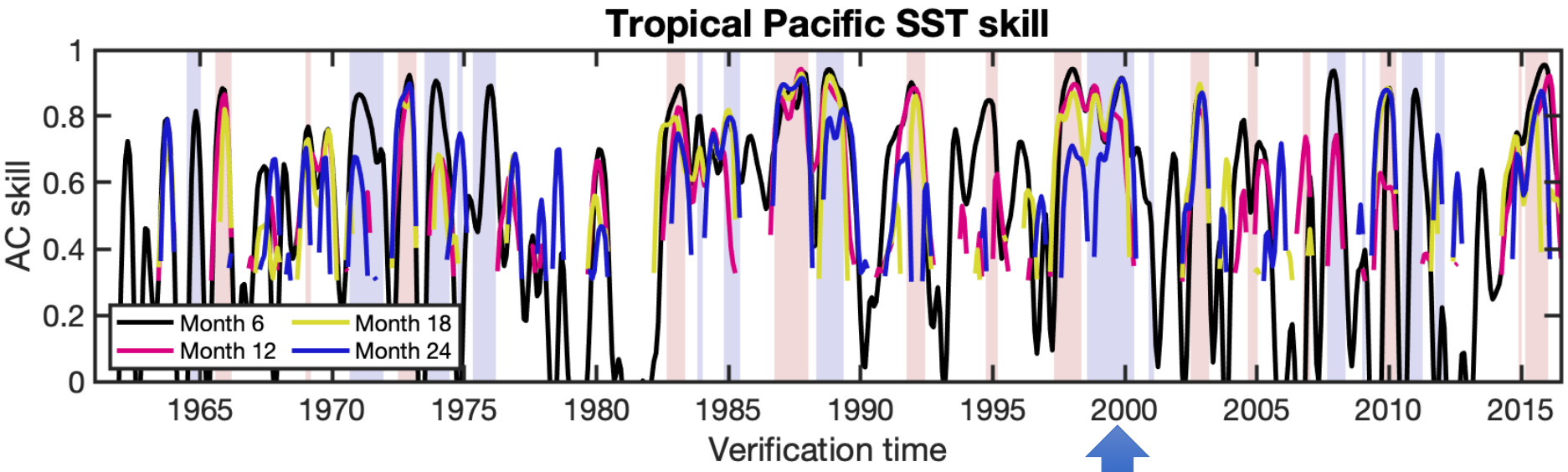
CESM-LE Model-analog



Model-analogs have more skill in Pacific, but 5-yr average is too long for ENSO! How far can we predict *monthly* SSTs?

Note that model-analog uses CESM-LE trend

Some ENSO events are predictable at least 2 years ahead, and this skill can be identified *a priori*



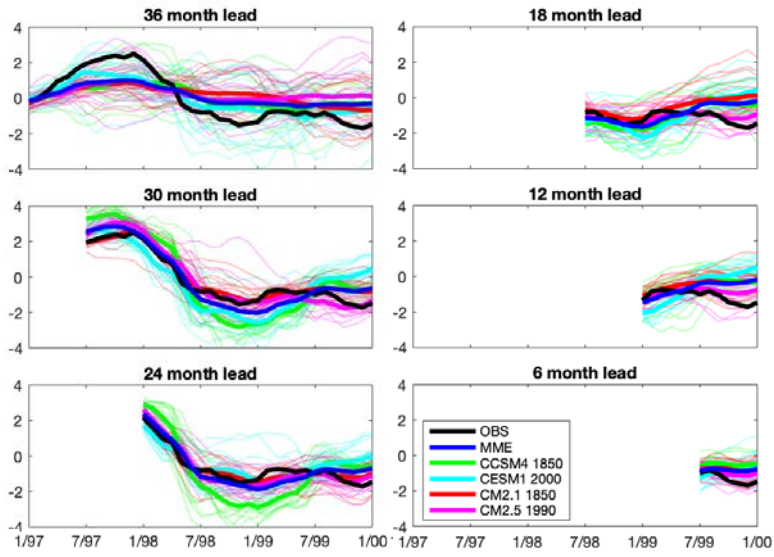
Skill measure: pattern correlation of model-analog SST hindcast ensemble mean to verification within **170E-70W, 20S-20N**

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

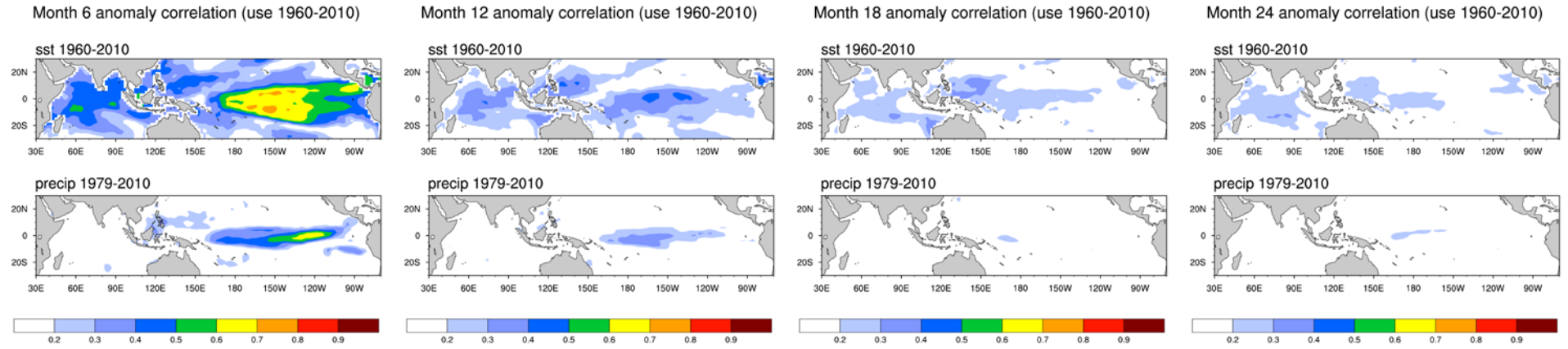
DJF '99-'00 could have been predicted in July 1997

Model-analog ensemble signal-to-noise ratio can identify this skill, so that false alarms can be avoided

Niño3.4



Applying model-analogs to new “E3SM large ensemble”



- ***Construct a <u>model of the model</u>, to estimate its attractor***
- ***Make initialized ensemble forecasts w/no additional integration needed***
- ***Use to evaluate***
  - ***potential for interannual to decadal skill***
  - ***impact of initialization shock (no bias; initialize directly in model space)***
  - ***predictability changes due to climate change***
  - ***impact of model error on forecast skill (Ding et al., GRL, 2020)***
- ***Apply machine learning techniques to climate model output first***