Do asymmetries in ENSO predictability arise from different recharged states?

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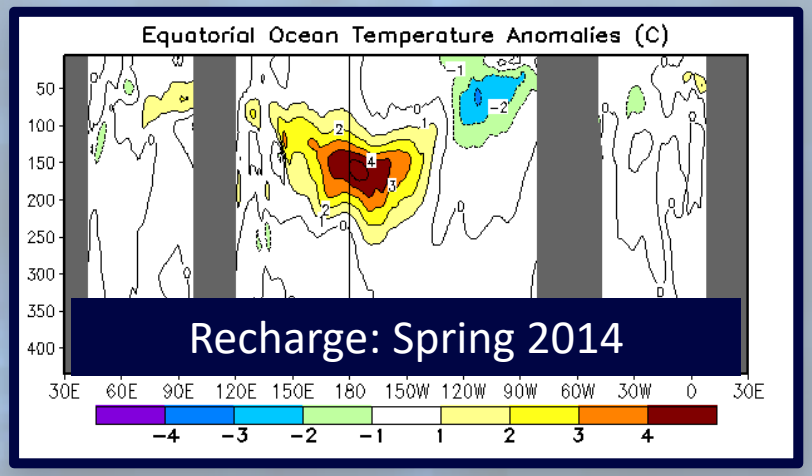

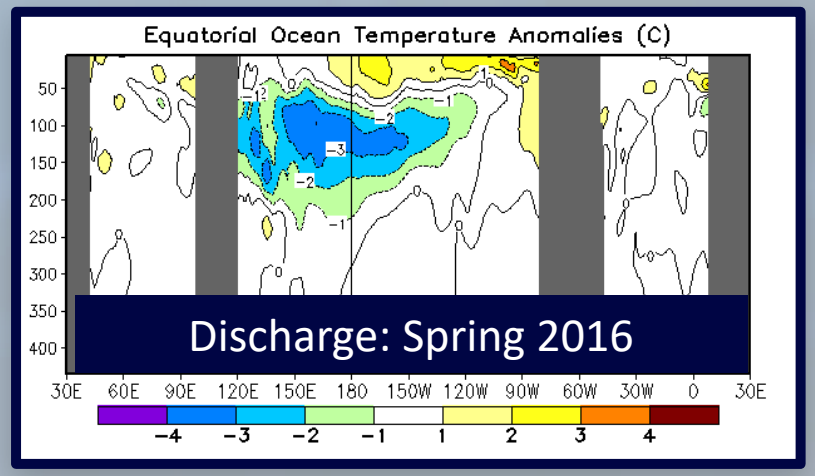

45th Climate Diagnostics and Prediction Workshop

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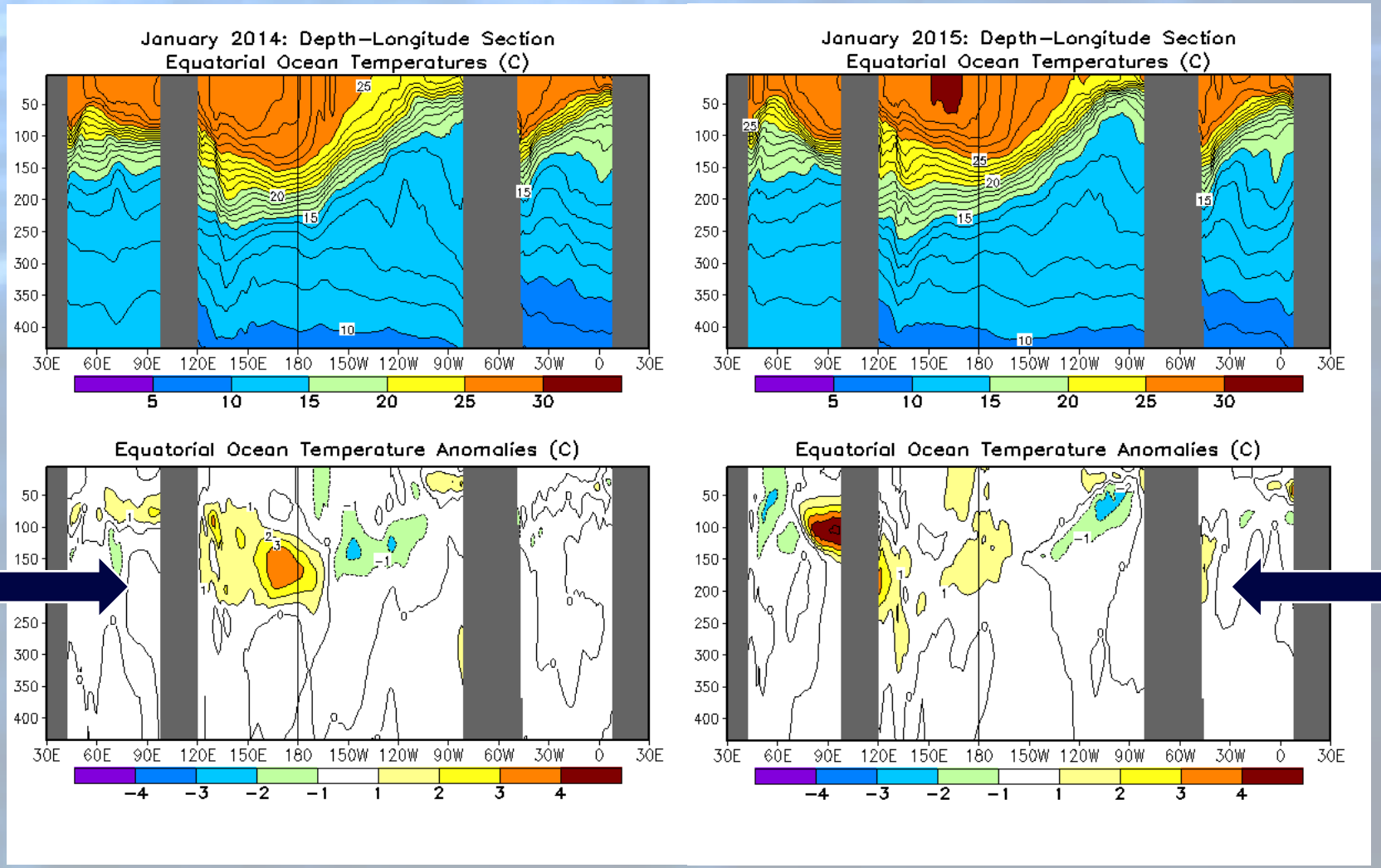
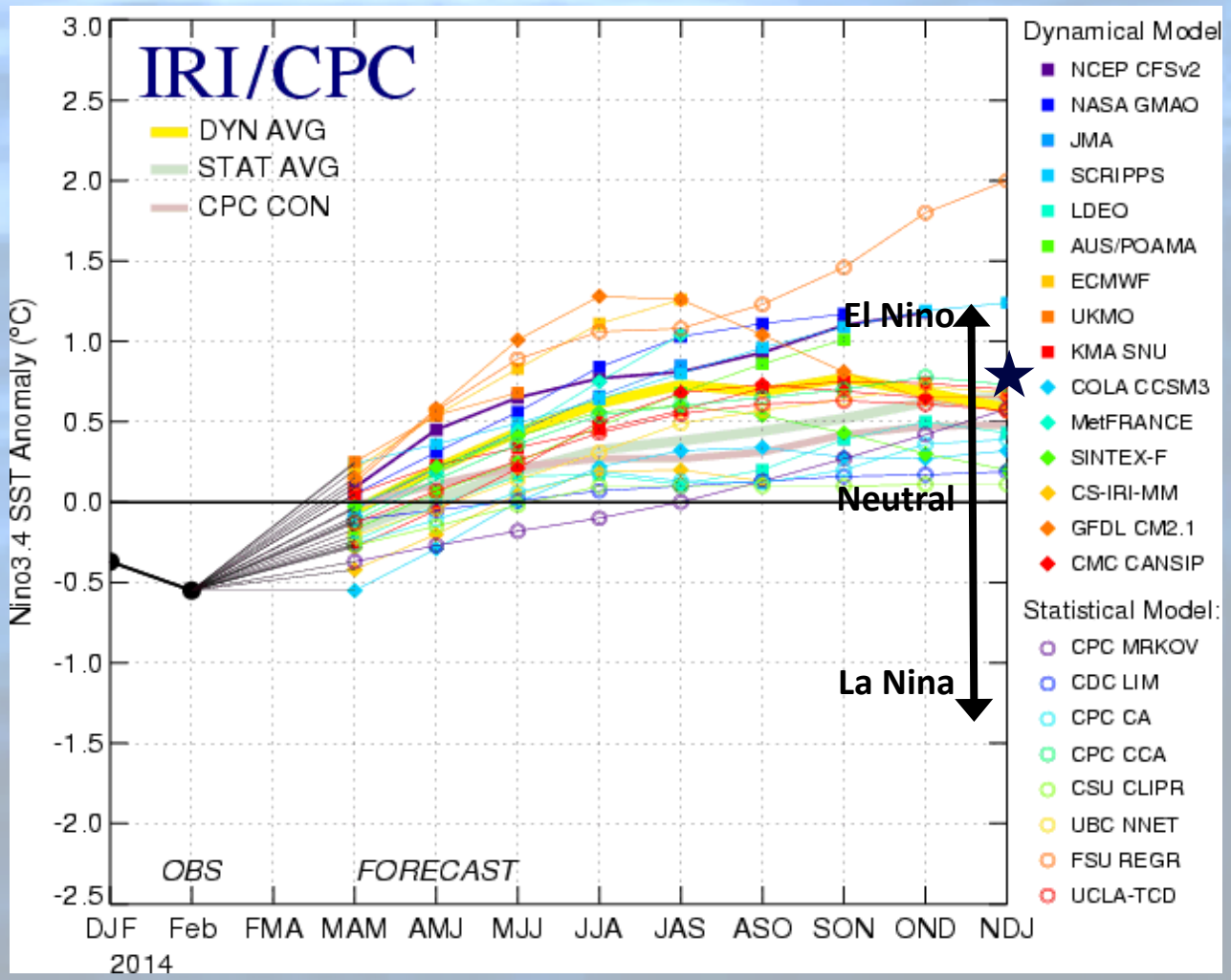
Recent evolution of 2 recharged states

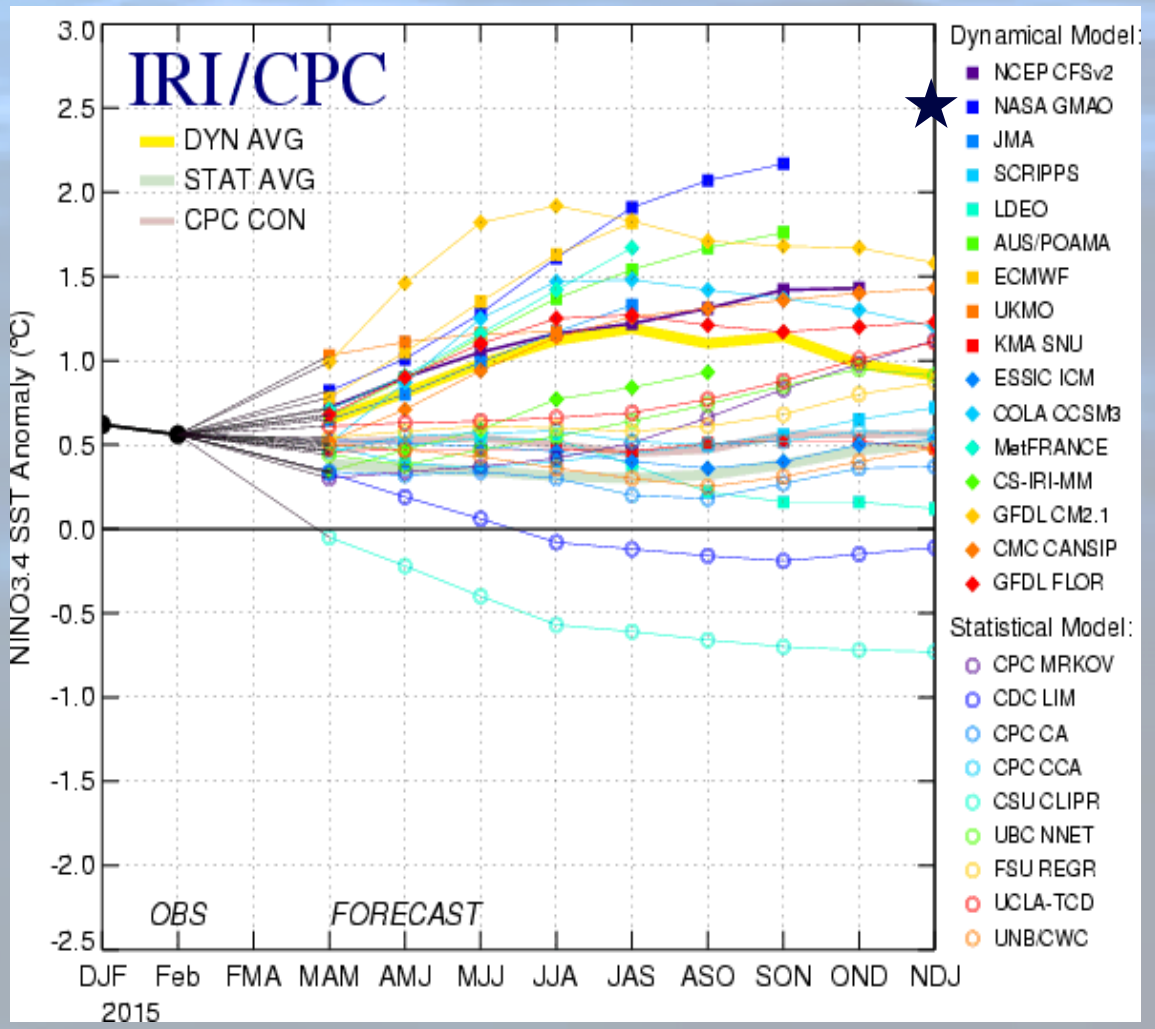
Evolves into Weak El Nino



Evolves into Extreme El Nino

Subsequent ENSO predictions

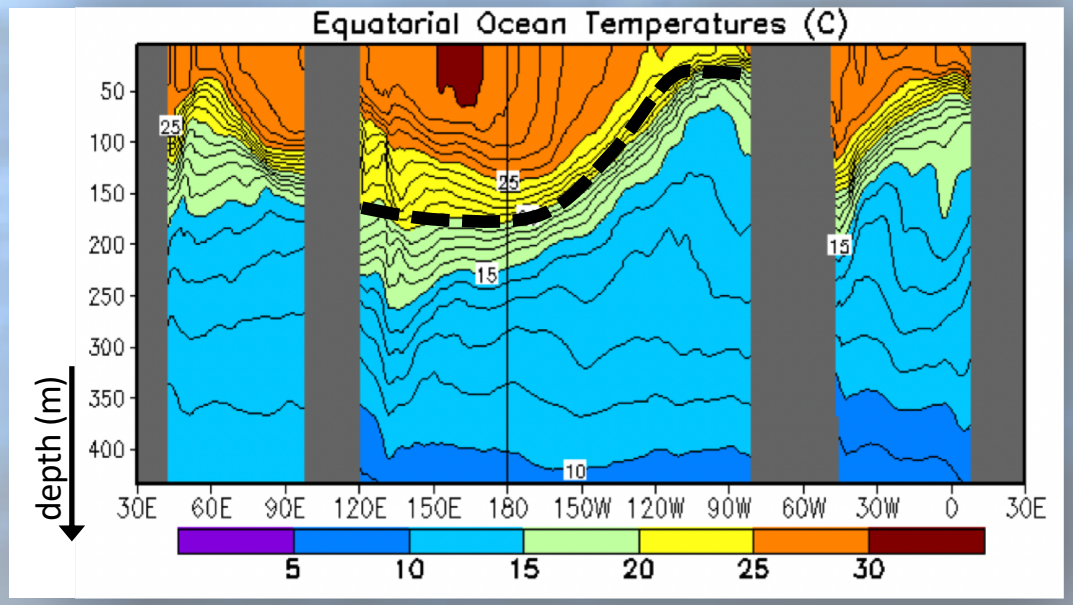


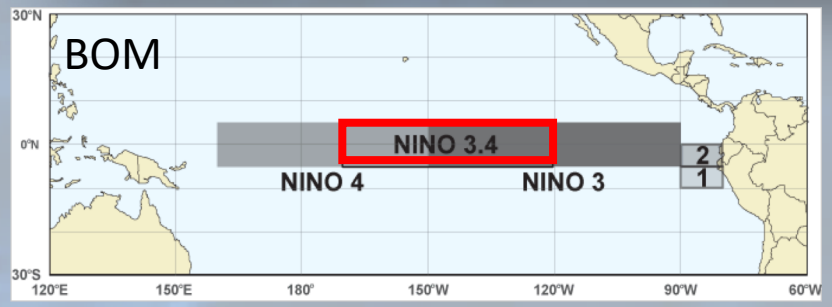


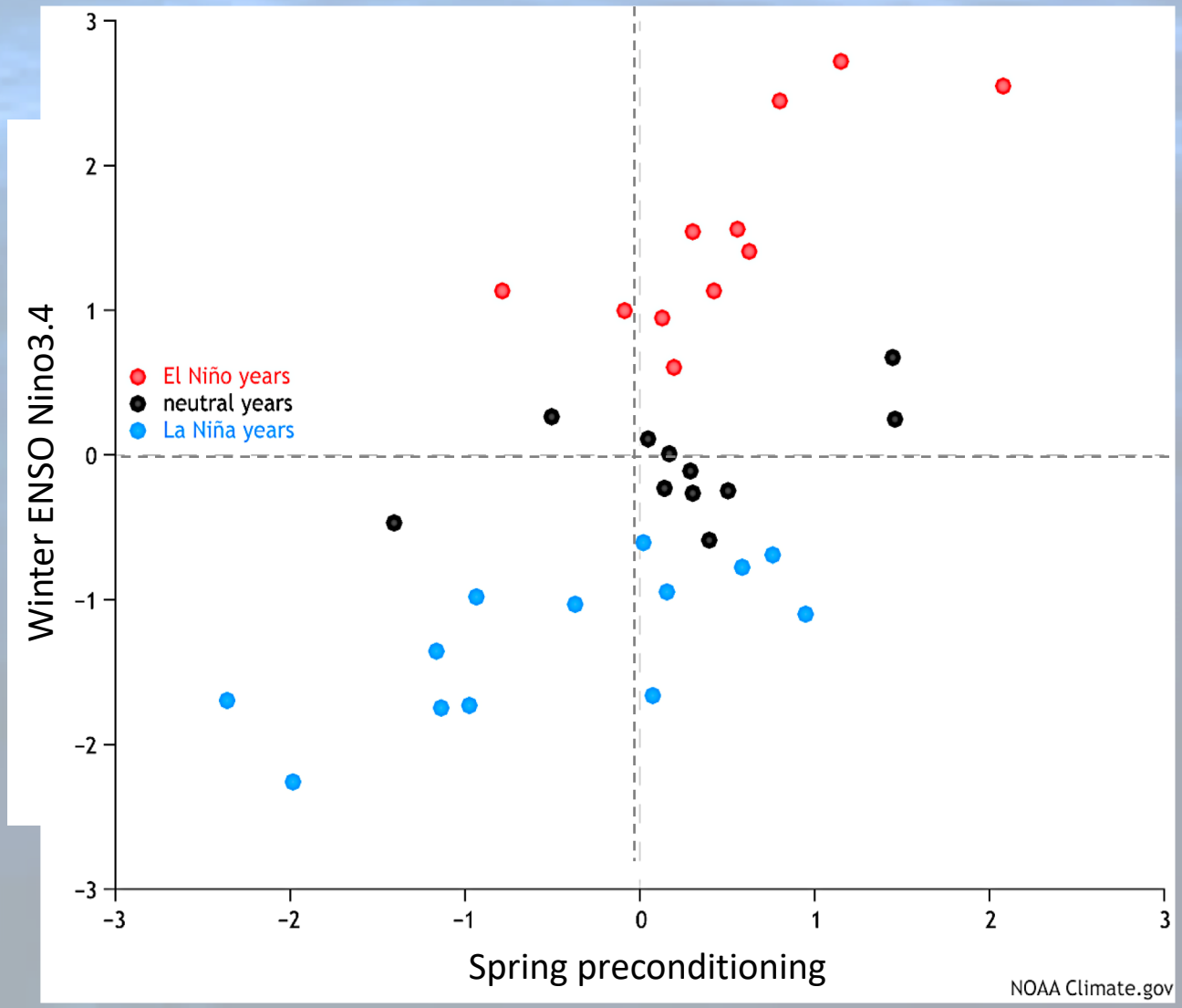
Large range of possibilities following recharged state

“Preconditioning” is a our best ENSO predictor

Preconditioning – catchall phrase meaning that the equatorial system is “primed” for an ENSO event

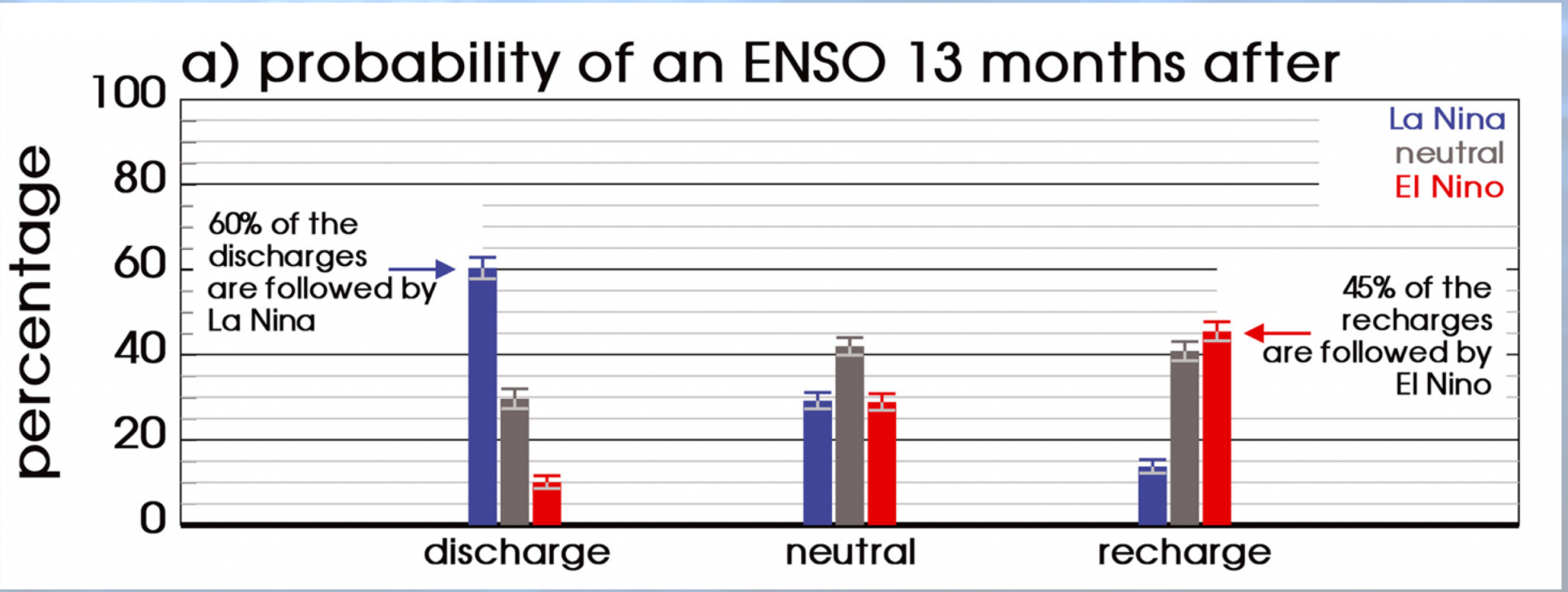






Aaron Levine, for NOAA ENSO blog

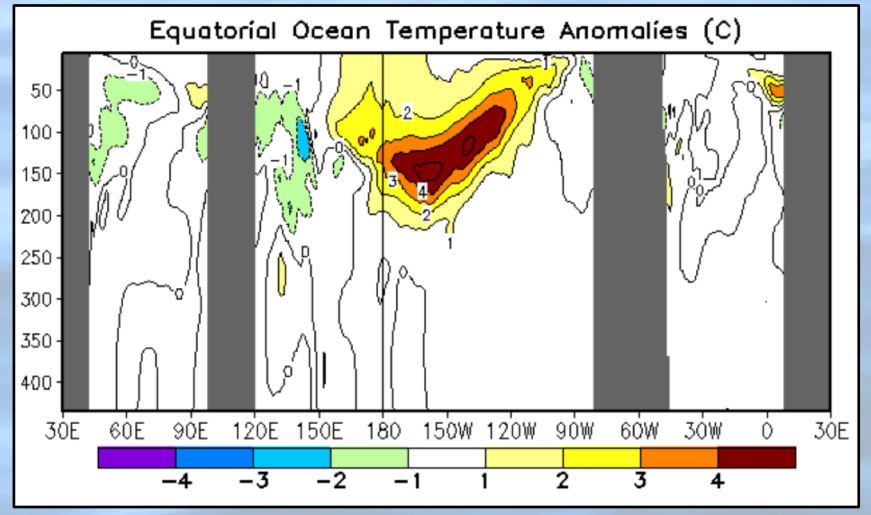
Model Studies – Smaller range of possibilities following discharge



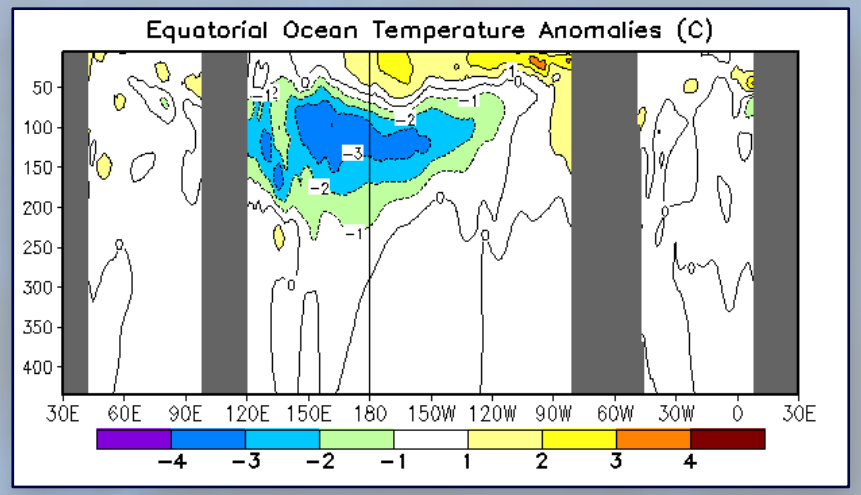
- CMIP5 free-running simulations
- Very long-leads
- LN spread < EN spread → LN more predictable

Planton et al. 2018, GRL

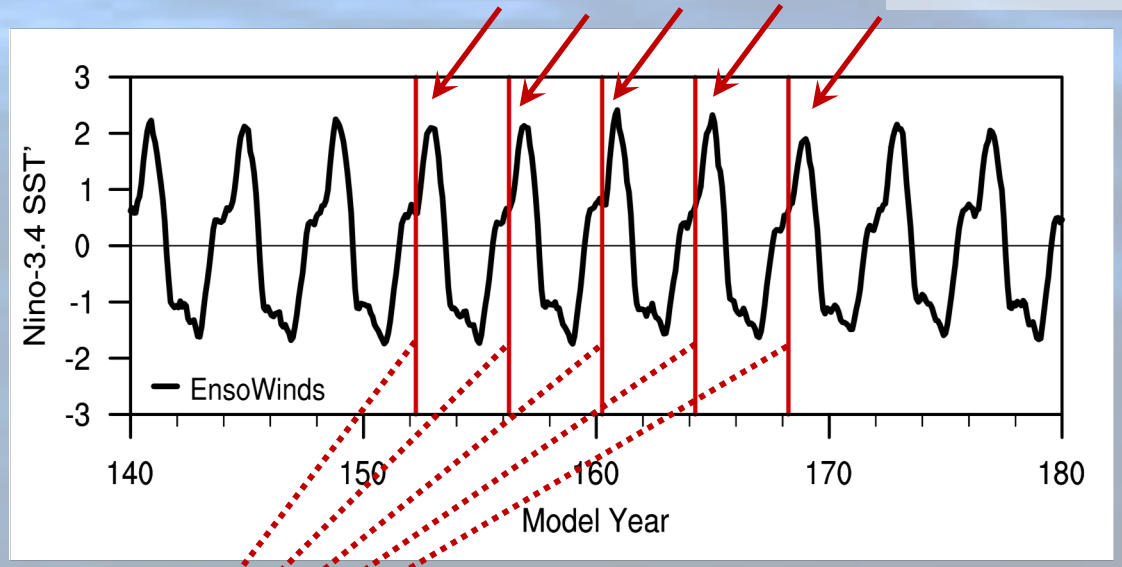
Perfect Model Predictability Studies



Repeat for 30 ”discharged” states & 60 neutral



El Nino

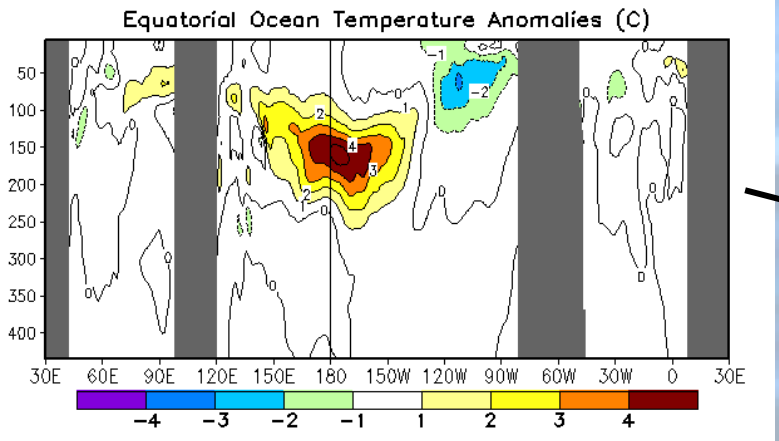


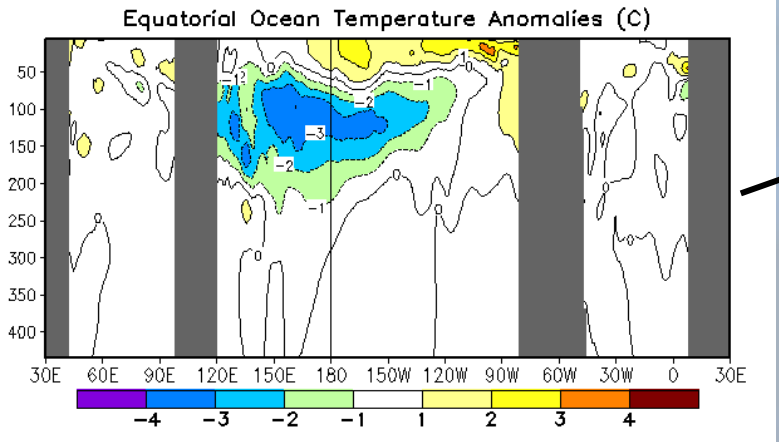
Initial conditions from the previous Mar-1st

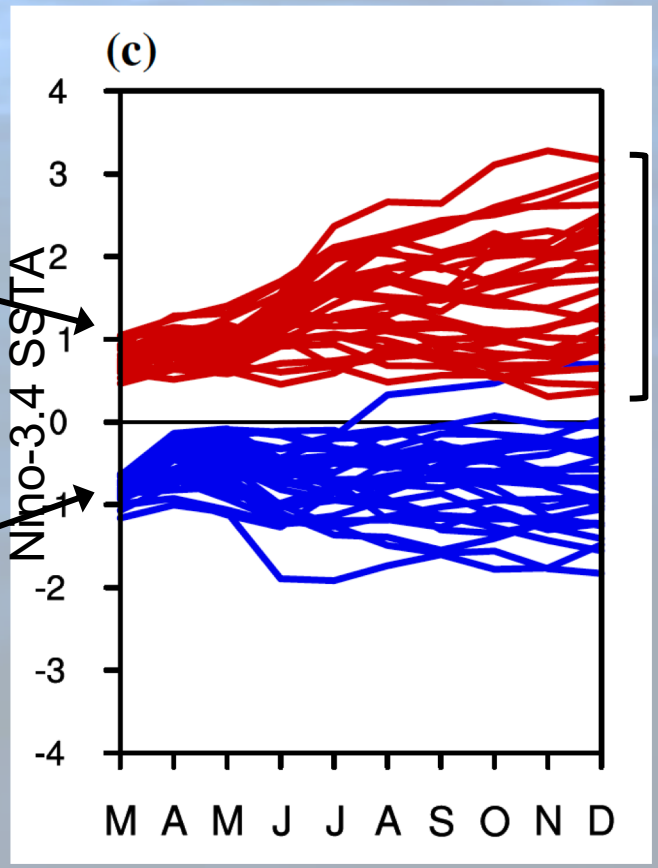
Warm (+) precursor ensemble N=30
All identically wind-forced
Let them evolve with full air-sea coupling

Larson and Kirtman 2019, Climate Dynamics

Perfect Model Predictability Studies







Spread: EN > LN
Signal: EN > LN

S2N ratio for EN > LN → recharged state leads to a more predictable outcome

Larson and Kirtman 2019, Climate Dynamics

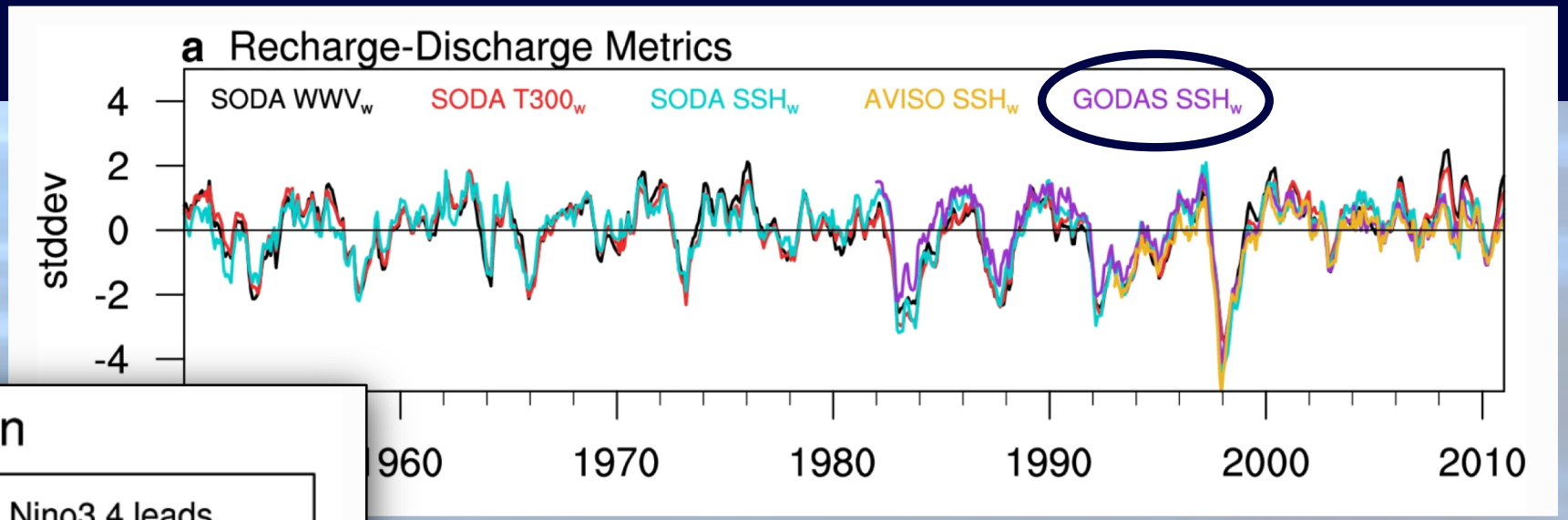
Caveats to these studies

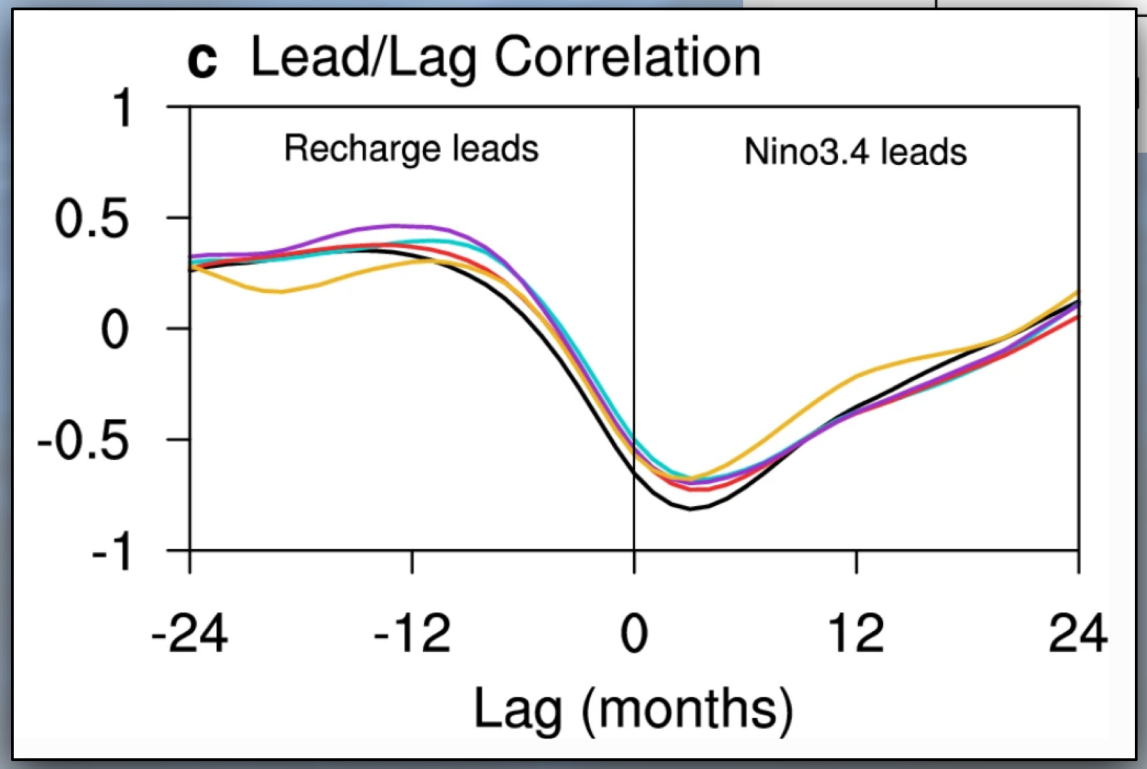
- Lacking realism - No initialization with observationally-based fields
- Ignore the impact of initial condition errors
- Initialized predictions can have strange behavior – “excessive momentum” *Tippett et al. 2020, GRL*

Our Approach: NMME initialized predictions

- Long leads (Jan-Init) enough for spring recharge-discharge prediction and ENSO
- Use hindcasts for instant forecast verification: 1982-2010
- 4 models provide SSH from which we can estimate the recharge-discharge
  - CanCM3, CanCM4, CCSM4, GFDL-FLORB-01

Metrics

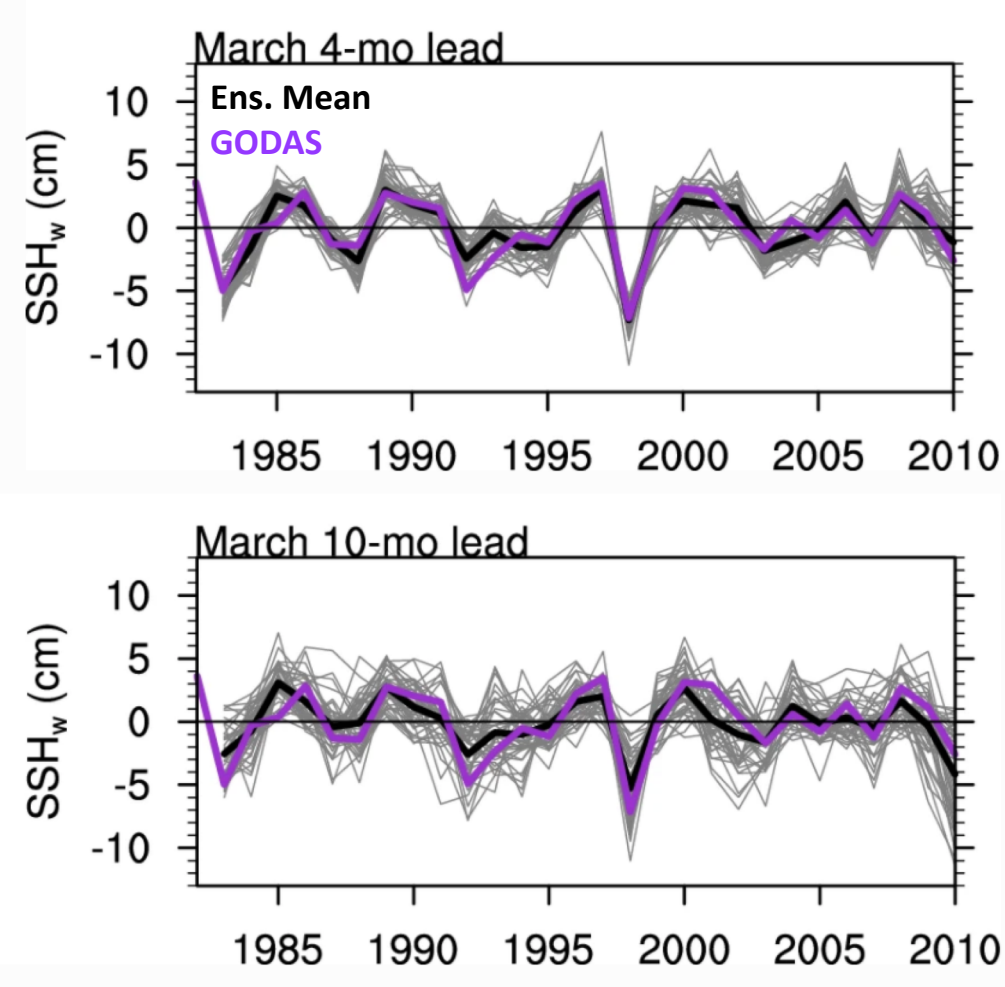


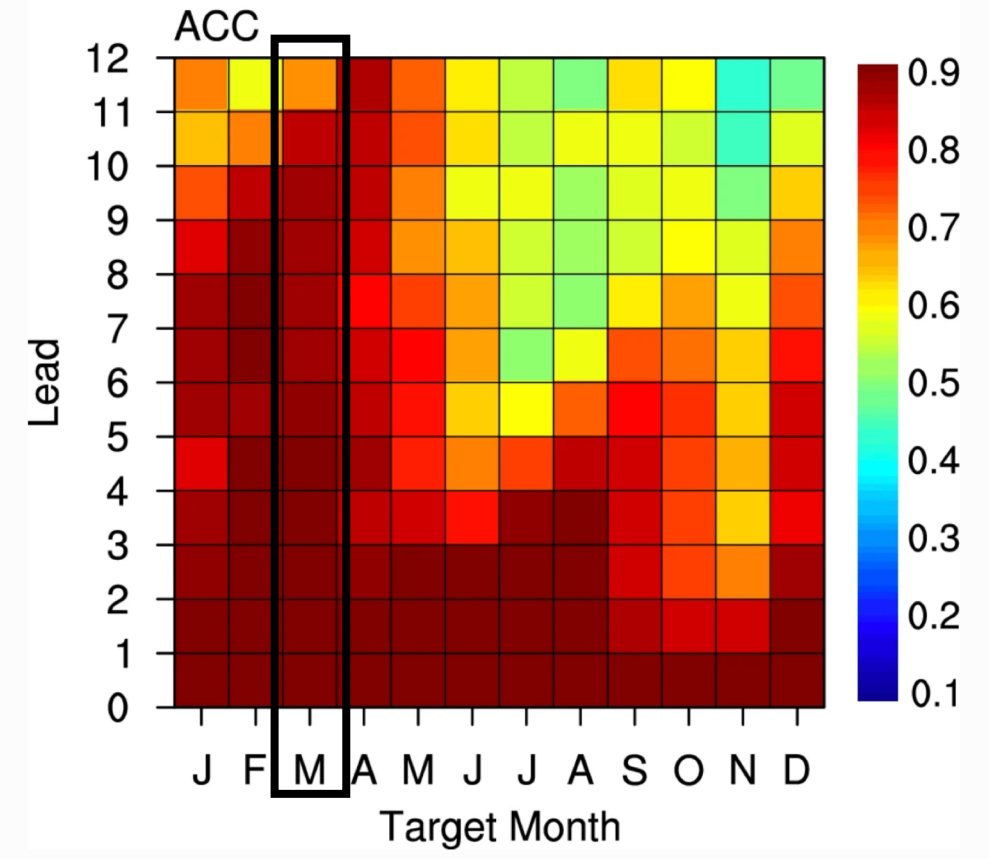


- Don't use typical WWV at long leads, slide your eastern domain further to the west to exclude fast wind-driven effects on preconditioning – *McGregor 2016, Izumo et al. 2018*
- Warm water volume, T300, SSH all give you the same answer

Larson and Pegion, 2020 Climate Dynamics

Can we predict springtime preconditioning?

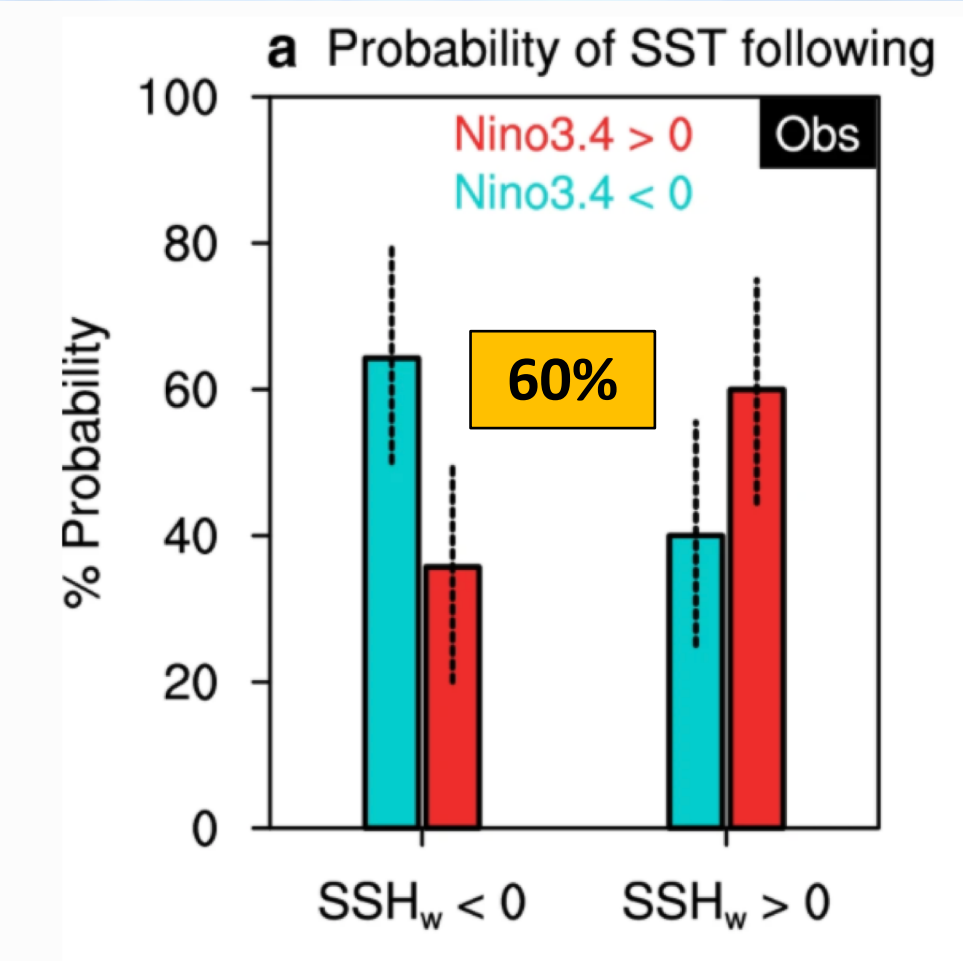


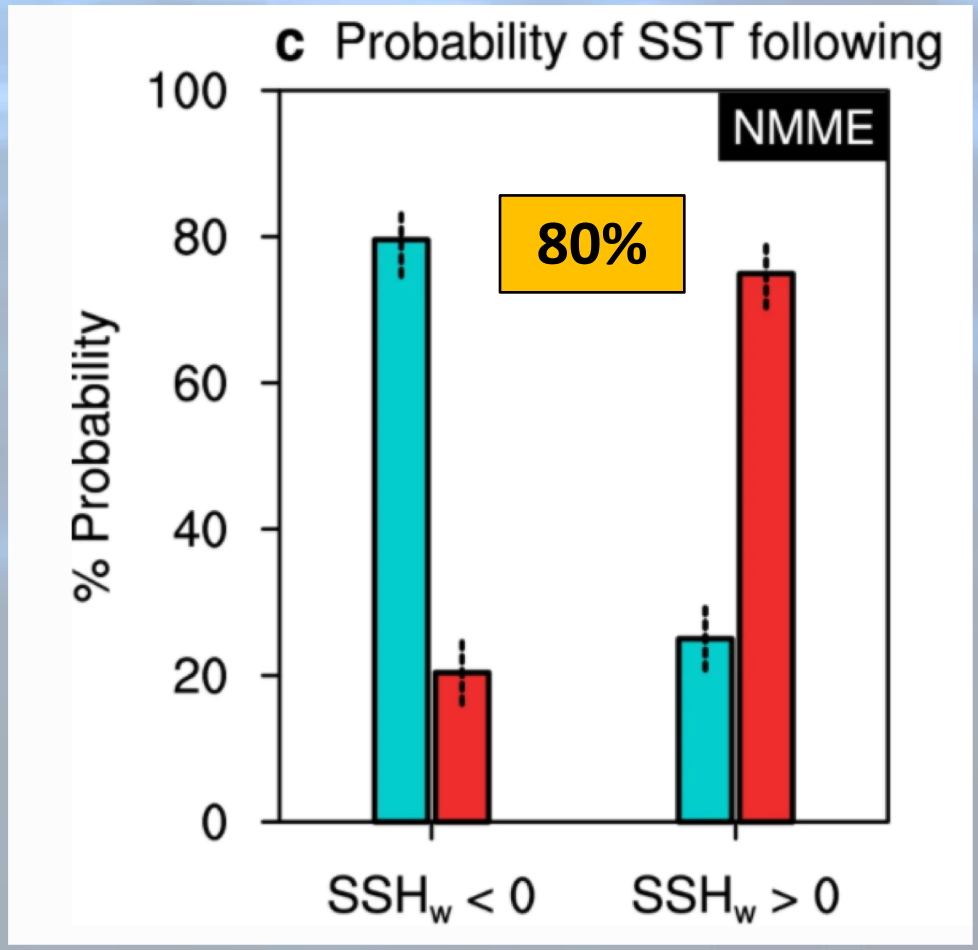


Yes, and with high skill (March target month)

Larson and Pegion, 2020 Climate Dynamics

Subsurface sign predicting Nino3.4 sign

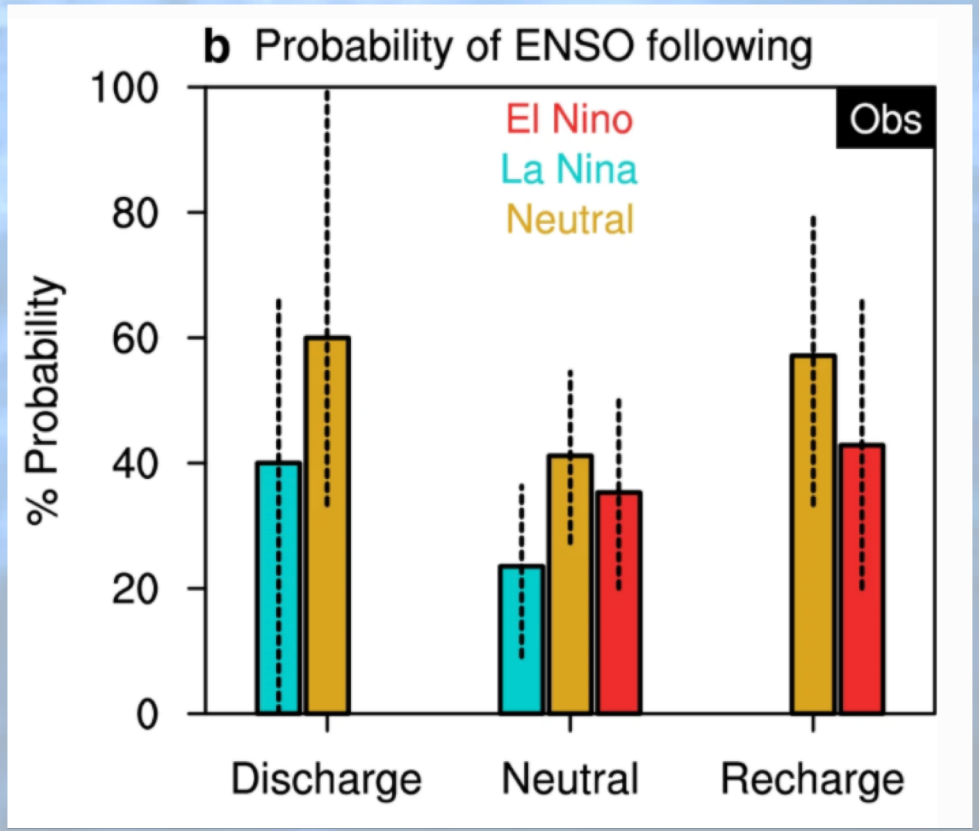


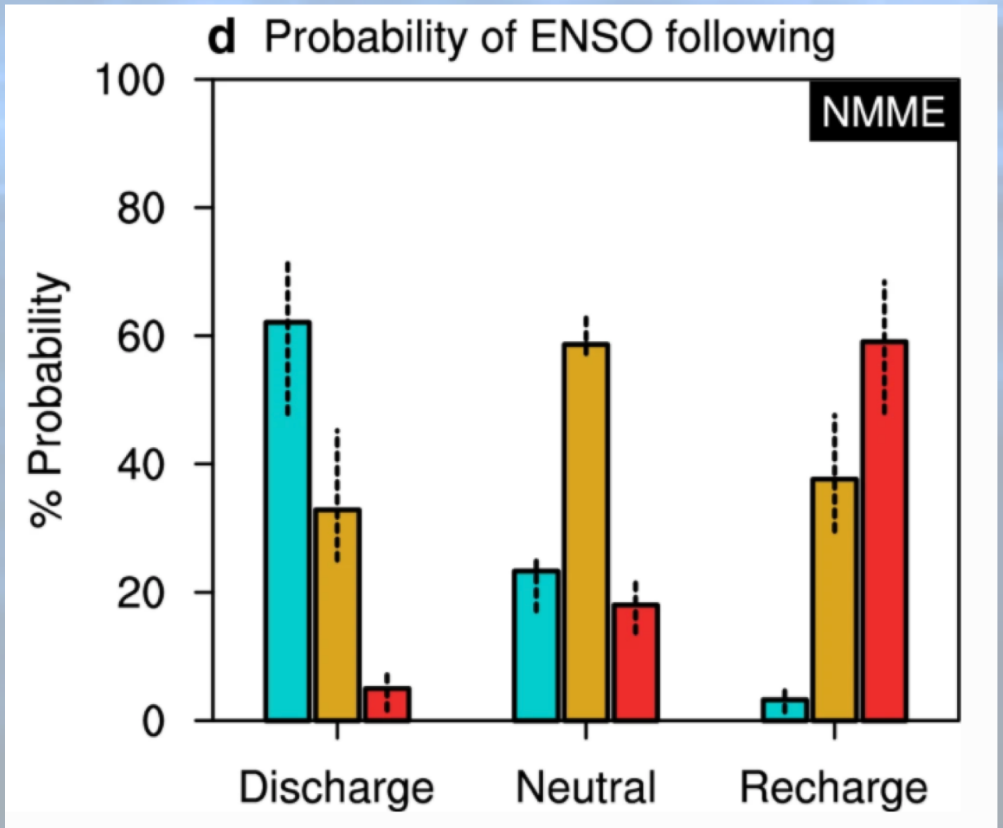


- Like-sign Nino3.4 tends to follow like-sign preconditioning
- Error bars: Models underestimate the uncertainty in nature

Larson and Pegion, 2020 Climate Dynamics

Probability of ENSO following…





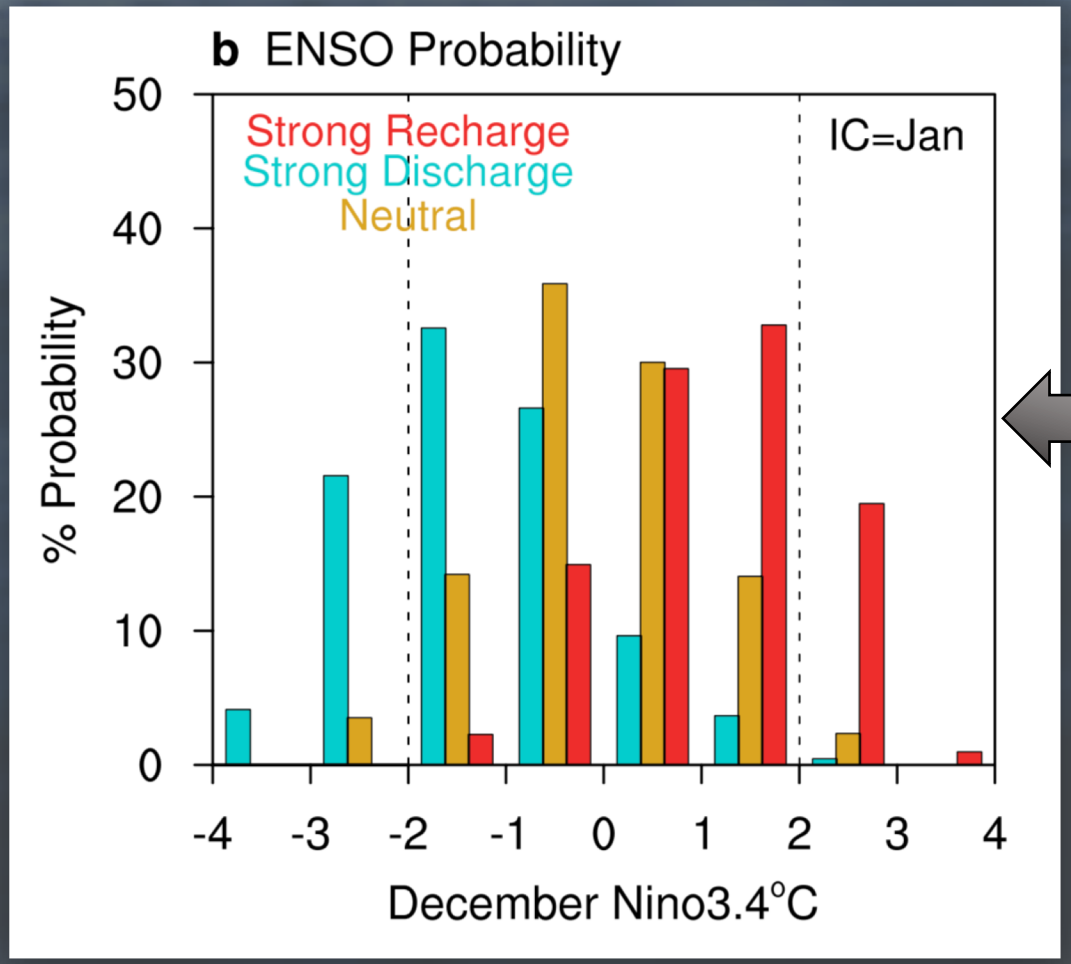
More often than in nature, models predict:

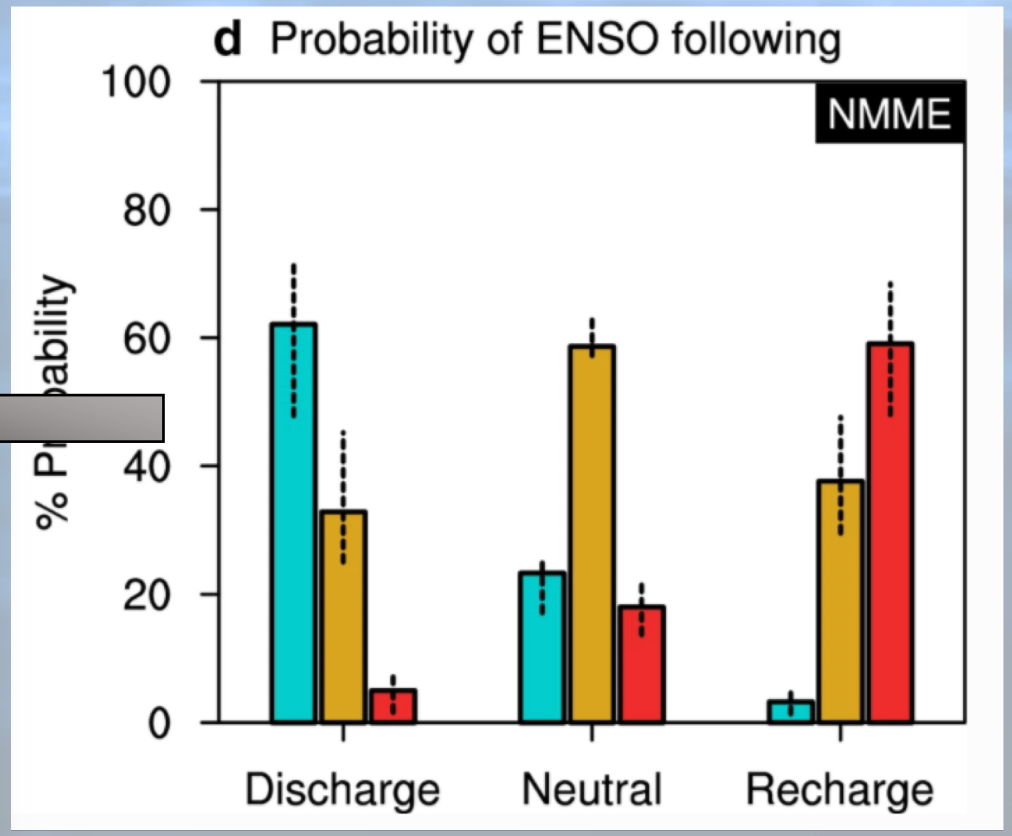
- LN following discharge
- ENSO-Neutral following neutral
- EN following recharge

1) **Error bars: Models underestimate uncertainty in nature**
2) **"Excessive momentum"**

Larson and Pegion, 2020 Climate Dynamics

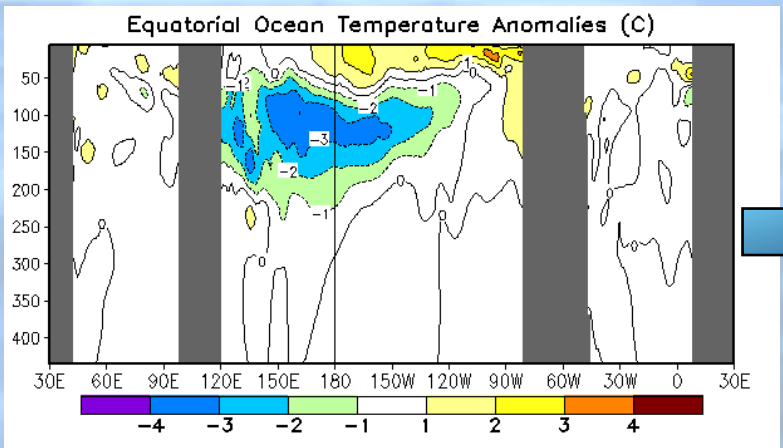
Probability of ENSO following…

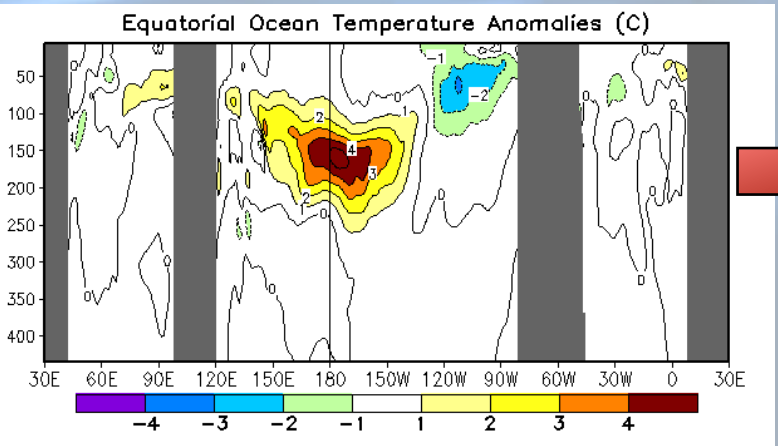


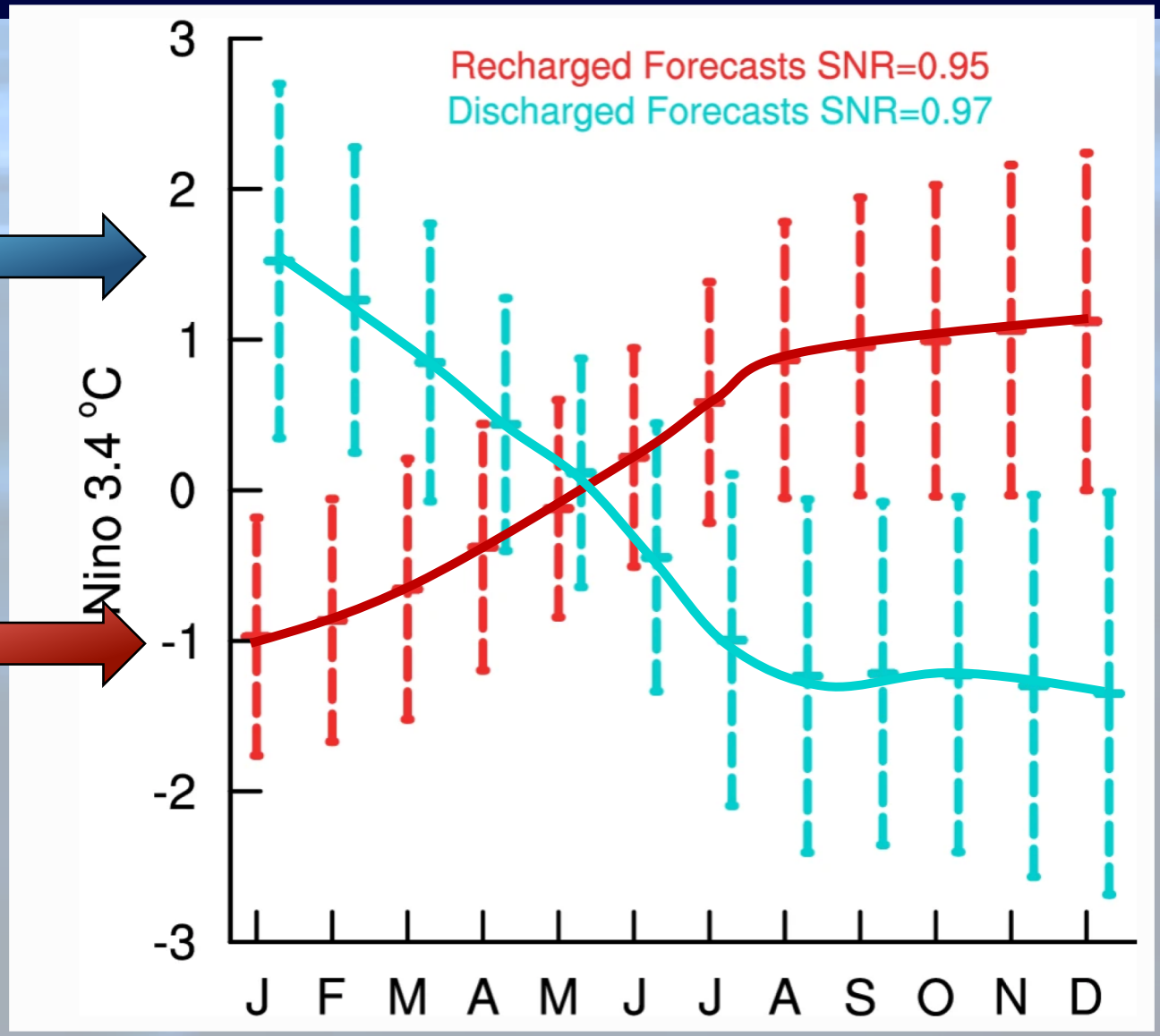


- More often than in nature, models predict EN following recharge, LN following discharge, Neutral following ENSO-neutral

Subsequent ENSO predictability







No obvious winner

Larson and Pegion, 2020 Climate Dynamics

Conclusions

Ens. Mean recharge/discharge predictions are highly skilled, even at long leads

When considering initialized coupled model predictions:

1) Neither a recharged nor a discharged initial state produces a more predictable ENSO outcome
2) Models too often predict like-sign ENSO following like-sign preconditioning… excessive momentum?
3) Models underestimate the uncertainty in nature (or overestimate the predictability)

Do asymmetries in ENSO predictability arise from different recharged states? Not according to these initialized predictions…

Now what? 1) Figure out why, 2) Need more NMME modeling groups to archive SSH

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Questions?

This presentation:

Larson, S. M., and K. V. Pegion (2020): Do asymmetries in ENSO predictability arise from different recharged states? *Climate Dynamics*, 54, 1507-1522.

Other studies referenced:

Larson, S. M., and B. P. Kirtman (2019): Linking Preconditioning to Extreme ENSO events and reduced ensemble spread. *Climate Dynamics: Special Collection on ENSO Diversity,* 52, 7417-7433.

Planton Y, Vialard J, Guilyardi E, Lengaigne M, Izumo T (2018) Western Pacific Oceanic heat content: a better predictor of La Niña than of El Niño. Geophys Res Lett 45:9824–9833.