Does the equatorial recharge/discharge increase ENSO predictability?

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Recent ENSO work

Takeaway: The South Pacific Meridional Mode can modulate ENSO amplitude by modulating the latent heat flux damping of ENSO events (alternative hypothesis to “SPMM triggers ENSO”)

Objectives

• Assess ENSO predictability in a specific model based on 3 different initial states
  o Warm preconditioned
  o Cold preconditioned
  o Neutral
• Construct idealized model framework
Considerations

• This is only one model (NCAR CCSM/CESM)
• Not in “forecast mode” – we are diagnosing model behavior
• Serve as motivation for how to:
  o estimate predictability in your model
  o determine the reliability of preconditioning as an independent *predictor* for ENSO in your model
• Caveat: your model may behave differently. How so?
Motivated to assess ENSO predictability in one of the NMME models

Started by looking at how quickly perturbations (that may reduce predictability) grow from a neutral-ENSO state

Larson & Kirtman 2015 JClim, 2017a Climate Dyn
Perturbation growth in CCSM4/CESM

Larson and Kirtman 2015, J Clim

1. The spread is large
2. Growth rate is sensitive to the initialization month
3. See seasonality in the growth rate, primarily due to Bjerknes feedback (July)
4. Growth from March doesn’t fully saturate the variance in the model, this is probably why we predict the ENSO phase forecast correctly at long leads but not the amplitude

Initialize in different months from neutral-ENSO initial conditions:
Dependence on initial state

- What happens if an ENSO cycle (e.g., preconditioning) is present in the initial conditions?
- Does the predictability change?
- How important is the precursor for El Nino versus La Nina?
A preconditioned initial condition

![Graph showing El Nino and Nino-3.4 SST variations over model years.
A preconditioned initial condition

Warm (+) precursor ensemble N=30
Let perturbations grow

Larson and Kirtman 2017 Clim Dyn
A preconditioned initial condition

La Nina
**All identically wind-forced

Cold (-) precursor ensemble N=30
Turn on wind coupling

Larson and Kirtman 2017 Clim Dyn
A preconditioned initial condition

Typical behavior of the model

**Warm** precursor shifts the mean distribution warm
**Cold** precursor shifts the mean distribution cold
**No** precursor mean is slightly cooler than Control

Spread
No Precursor > Warm Precursor > Cold Precursor

**Looking at full fields NOT anomalies!**
A preconditioned initial condition

Signal-to-ratio (SNR) = ensemble mean signal / ensemble spread

Relative to the No Precursor ensemble,
+Pre signal > –Pre signal (El Nino more predictable)
+Pre spread > –Pre spread (La Nina more predictable)

SNR: + Precursor > –Precursor → El Nino has higher predictability
A preconditioned initial condition

Key Ingredients:
1) Can reproduce the cold extremes without the cold precursor; moderate warm events
2) Warm precursor is a requirement to get warm extreme values

What types of events can we get without the subsurface precursor?

What types of events can we get just by random disturbances instigating perturbation growth?

Almost any type!
Piece together processes necessary for ENSO

What are the minimum processes needed to reproduce all types of ENSO in this model?

"No precursor" reproduces everything but the warm extremes

Cold precursor mechanism cannot generate any type of event that random disturbances cannot

It’s not fundamentally necessary for La Nina in this model
Subsurface precursor is only vital for extreme El Niño but does not guarantee it. Can generate all other ENSO events stochastically & with two processes:

1) Internal variability; weather wind stress
2) Atmosphere-ocean coupling

A lot – but precursors increase ENSO predictability by both increasing the signal and reducing the spread.

El Niño may be more predictable.

Useful pathway forward

• What happens in “forecast mode”?
• WWV as a predictor of ENSO in the NMME predictions
• Does initialization rob us of some of the predictability?
• Phase-2 NMME models include subsurface fields

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