PSMIP DISCUSSION, led by Kris Karnauskas

Special Science Session: ENSO Monitoring, Analysis, and Prediction Challenges
Conveners: Arun Kumar, Yan Xue, & Bruce Anderson
Tuesday, August 4, 9:45 AM – 12:00 PM

- Introduction (Arun Kumar)
- ENSO theory & predictability (Mike McPhaden)
- Building the bridge between ENSO theories and operational predictions (Ben Kirtman)
- ENSO precursors and building an operational ENSO monitoring system (Bruce Anderson)
- Facilitated discussion (Yan Xue)

Arun Kumar's introduction

Why now?

- Spectacular ENSO prediction failures in recent years (2012/13 and 2014/15).
- A "feeling" that ENSO prediction skill (esp. w.r.t. amplitude) has plateaued despite advances in observing and forecasting systems.
- Some ENSO characteristics are changing.
- Issues in maintaining observing systems (precipitous decline of TAO in ~2013).
- ENSO prediction skill cannot be attributed directly to the observation systems (more related to amplitude of events).
- Design underway for the future TPOS.

Mike McPhaden's talk

Mike gave a general overview of ENSO dynamics and predictability, and a more detailed look at the observations and predictions of the ENSO system during 2014/15 and into current conditions. Mike wrapped up with three research imperatives motivated by 2014-15.

Observed vs. predicted in 2014/15

- 2014 was looking very similar to 1997 in terms of WWBs, KWs, subsurface T, etc.
- Predictions of big El Nino did not pan out.
- 2015 looking like it could be similar to 1987 (protracted warming with peak in summer)

Understanding what transpired

Who killed the big 2014 El Nino?

- The atmosphere did not respond to the SST anomalies (no coupling).
- Why not? Speculations: WWBs too weak. Early onset of negative feedbacks (westward propagating upwelling Rossby waves [DO theory]). Negative IOD. IPWP warming trends. PDO in cold phase.

How did it resurrect in 2015?

- Lingering warm SST anomalies from 2014 so the WWBs in 2015 can initiate the Bjerknes feedback. Tropical cyclones are strong in the western Pacific right now, which generate WWBs.

Communications with the media/public was a mess.

Research imperatives

- Understanding physical processes accounting for unusual 2014-15.
- Determining why forecasts were so off the mark.
- Characterizing ENSO in all its diversity.

Discussion

- Comment: Decadal variability need not be predicted, necessarily, for information to be useful in ENSO prediction (Billy)
- Question: Did the drop in TAO data in 2014 contribute to the low predictive skill? Not able to tell.

Ben Kirtman's talk

Ben outlined several examples to illustrate the need to marry predictability research with operational prediction. One of Ben's main points is that spread is our measure of predictability, but it has little relationship to forecast skill. Ben argues that we are severely underestimating the size of the spread/plume, which means even the forecast for 2014 wasn't so bad; it was just toward the end of the distribution.

- Troubled by the notion that predictability is used qualitatively, not quantitatively, difficult to quantify the true limit of predictability. Difficult to see how predictability research impacts operational forecasts.
- Need to marry predictability and prediction research.
- Example: Meridional mode as a precursor for El Nino. Does the predictability research actually lead to a better operational forecast.
- Semi-empirical WWBs (state-dependent WWBs) are essential for getting the "big" eastern Pacific El Ninos (based on CCSM study) while most forecast models do not have WWBs.
- Ben not surprised that the models predicted a big El Nino in 2014, because models are built to take a warm anomaly (which existed) and propagate it eastward as a KW.
- Example: coupled run with suppressed atmospheric variability (impose climatological wind stress).

Bruce Anderson's talk

Bruce focused on ENSO "precursors" in the ocean and atmosphere—basically by using lead regressions on fields such as subsurface heat content, winds, SLP, etc, and described implications for the operational monitoring system.

- Four indices capture the precursor phenomena. Precursors appear to show modulation (in terms of their 30 year correlation) but that might actually be more due to observational limitations early in the reanalysis period than the ENSO system become more sensitive to certain precursors.
- Continue monitoring subsurface ocean temperatures, wind stress in the western equatorial Pacific, meridional mass transport, and air sea interaction (basically, the medium range ENSO precursors).
- Charges and questions for PSMI: (Q1) What monitoring products are needed to evaluate processes within models? (Q2) What monitoring products are needed to better initialize models? (There were also a couple of charges, but the slide did not stay on long enough for me to copy them down here.)
- Billy emphasized the importance of WBCs in meridional mass transport (not just the central Pacific)
- Manu cautioned that we might not yet know whether the meridional mode is a good precursor or not.

Panel discussion following special science session on ENSO challenges

- Ben pondered why the WWV in the western Pacific is not a good predictor of amplitude, despite good correlation. Bruce: Precursors are probably not what you want when you're making quantitative ENSO forecasts. For that, you need to be well into the evolution of the system because there's too much that can change.
- Mike brought up the analogy between weather prediction and ENSO prediction. Model resolution, parameterizations, etc. Arun: Models are improving and leading to better skill—this can be shown with frozen model versions for the past 15 years. Low-frequency variability is an issue.
- Mike asked Arun what is the value of observations to an operational prediction center. Arun said it's there, but too hard to pin it down and assign a dollar value. Mike asked whether observations have helped improve models. Arun said yes, but again it's difficult to tease out quantitatively.
- Bruce: Different monitoring products are needed for evaluation vs. initialization of models. (Targeted comment to PSMI)
- Agreeing with Mike's point that observations are important and valuable, Billy commented that ocean models have persistent biases … those models need observations and process studies to guide model improvement.
- Mike and Arun discussed the skill of forecasts not really being known because we don't have enough events to faithfully characterize success rate (80% forecast). Ben suggests if you account for the spread, it's not that bad… but Mike pointed out that those are in hindcast.
- Manu raised the issue of model resolution and asked whether people have embedded regional high resolution models into global models. Ben responded that we are on the cusp of global high-resolution, but initialization is a problem. Ben notes that this is a global problem that requires global modeling.

Possible questions for PSMIP to consider and discuss

- ENSO is an emergent *phenomenon* built on many diverse *processes* (*i.e.*, across spatiotemporal scales). Moreover, there is a huge amount of people working on ENSO from all angles. What can PSMIP do, if anything, to facilitate by *e.g.*, coordination between modelers and observationalists/process studies?

- What are the important model biases/weaknesses that can be addressed through *targeted* observation?

- What process studies, current or planned, might contribute to model improvement of ENSO simulation and prediction (both seasonal forecasting and climate projection issues like "how will ENSO change")?

  Idea from Tom → diurnal cycle/warm layer

  Example → Billy emphasizes the communicaiton between the thermocline and the surface, and between the surface and the free troposphere.

  Also → Recall Mike's research imperatives

- How can PSMIP be proactive in the context of future process studies piggy-backing on TPOS-2020?

- Should we be encouraging more interaction between physical and ecosystem scientists, especially in the context of process studies, *possibly using ENSO as a natural laboratory?*