

# Benchmarking Predictions and Predictability Limits: Estimating Predictability

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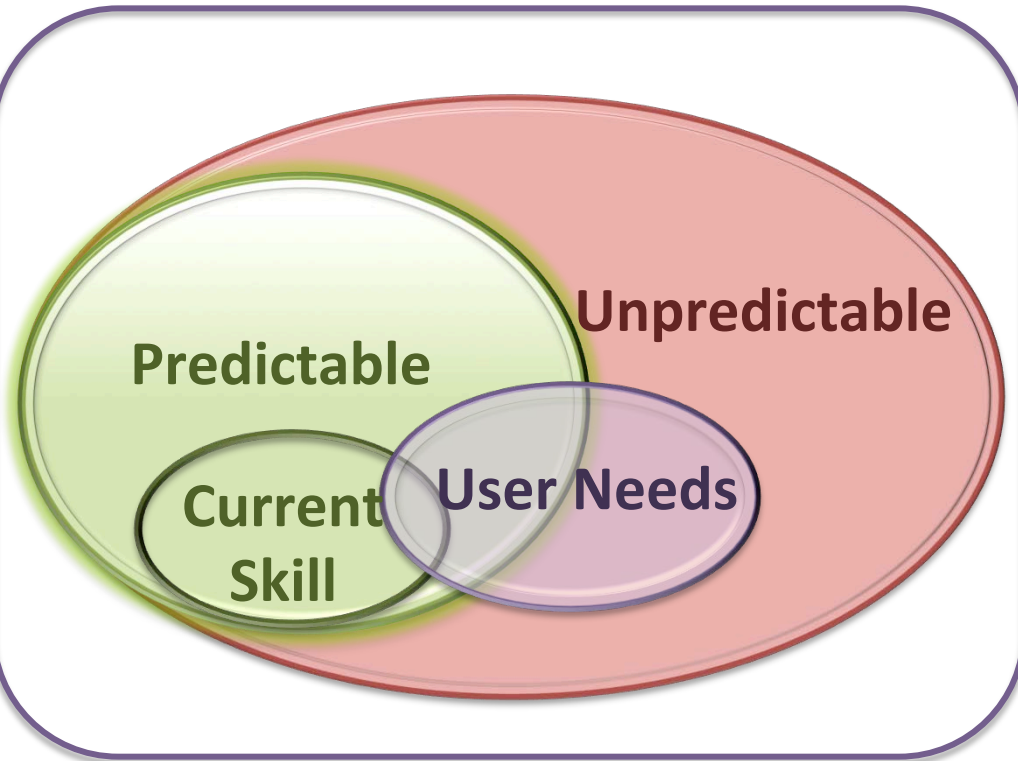
*Acknowledgements: Matt Newman, Tim DelSole*



*U.S. Clivar PPAI Panel July 2014*



# Fundamental Questions



- What is the upper limit of skill (i.e. predictability)?
- What is the current state-of-the-art prediction skill?
- How much room is there for improvement in skill and what are the limiting factors?
- How much do current skill and potential skill overlap with user needs?

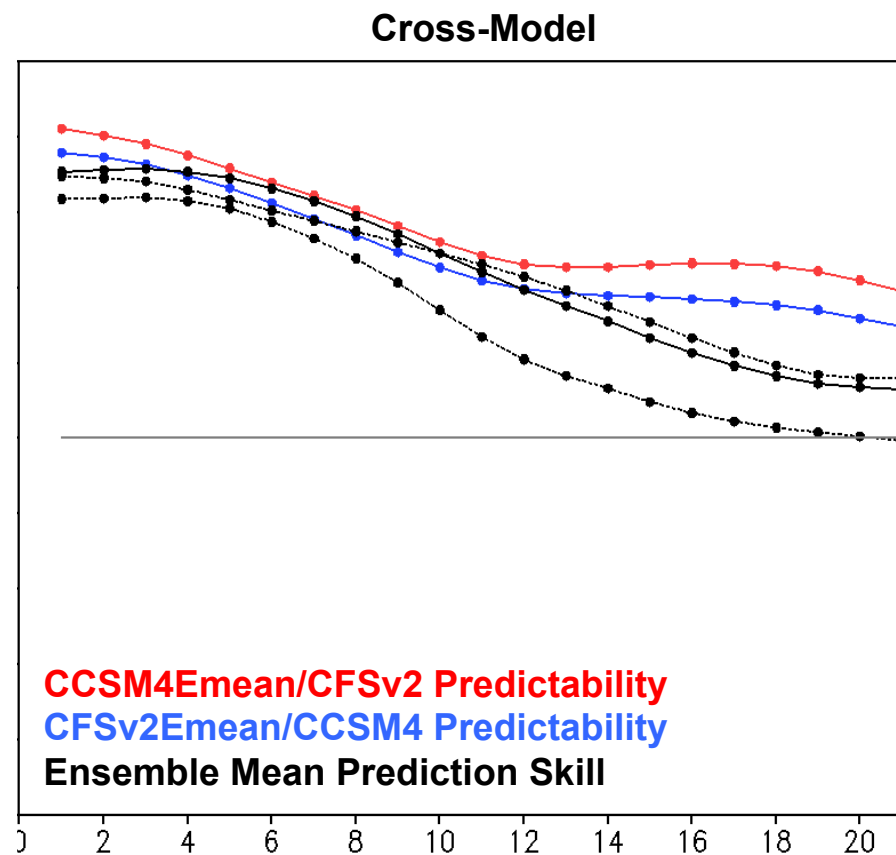
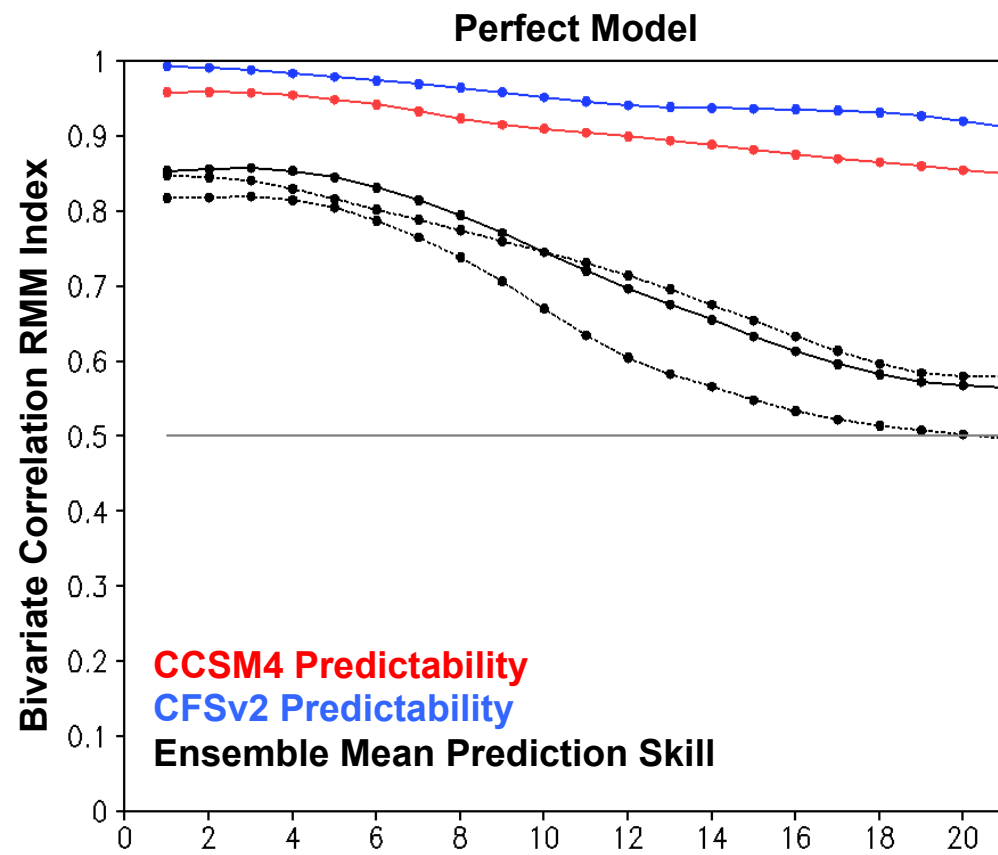
# What is the upper limit of skill (i.e. predictability)?

- a) Perfect model
- b) Cross-model
- c) Empirical/Statistical Model (e.g. LIM)
- d) Average Predictability Time



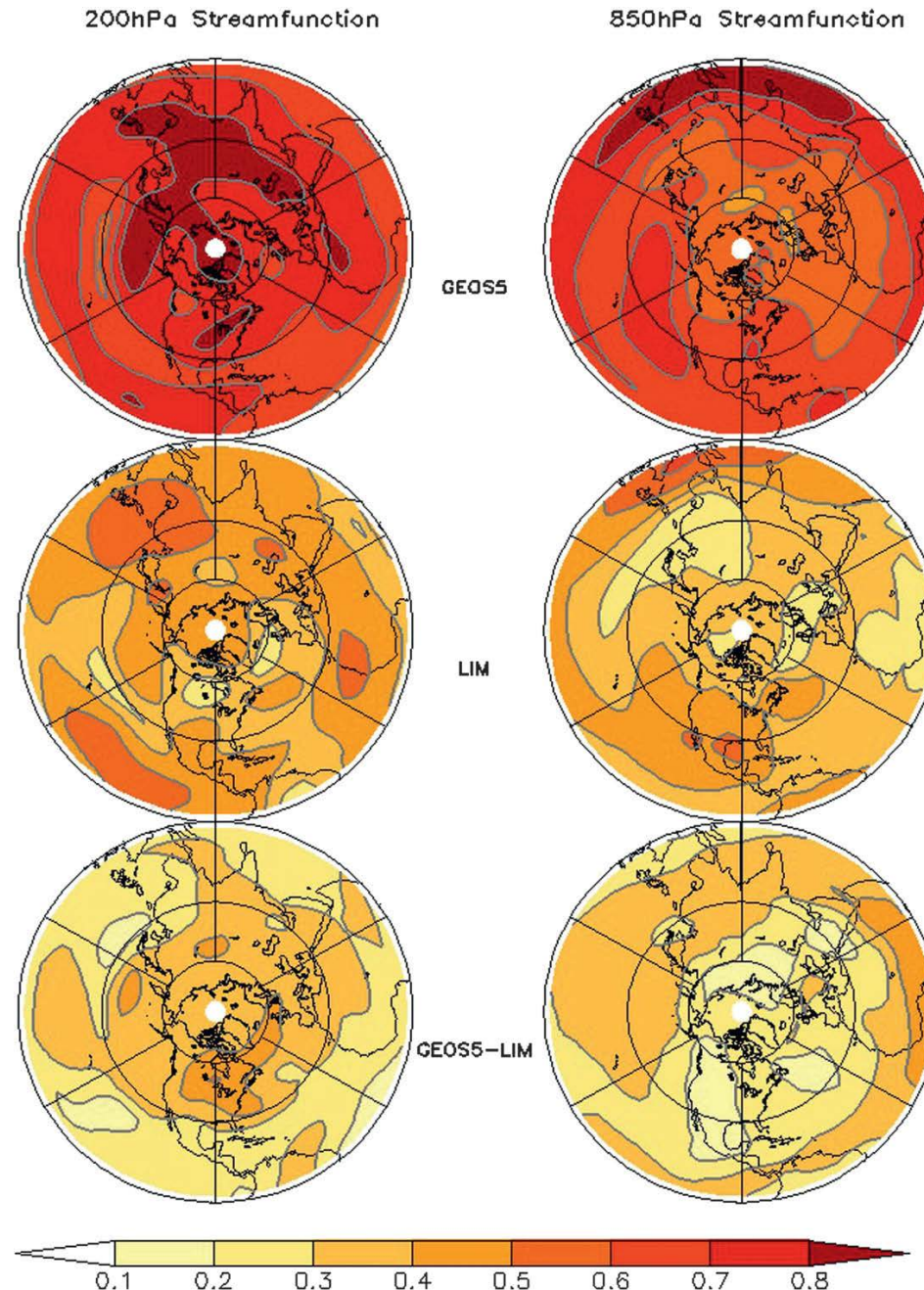
**Predictability limits are not known**

# Perfect and Cross-Model Predictability

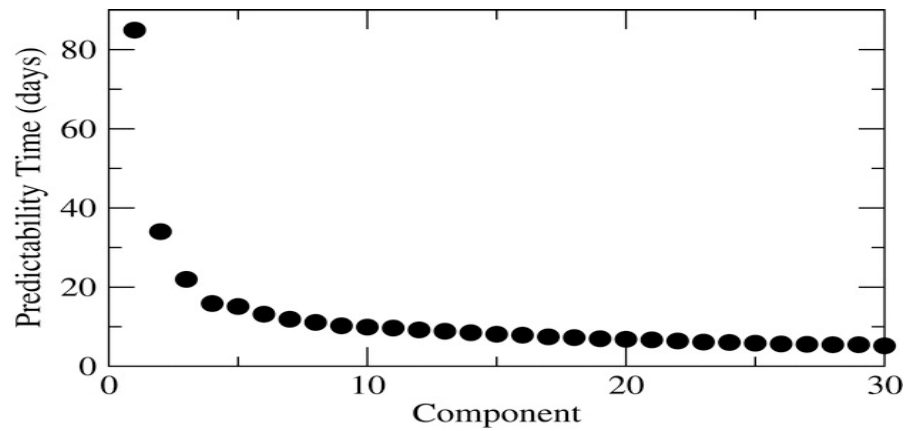


# Linear Inverse Model (LIM)

Week-3  
Forecasts

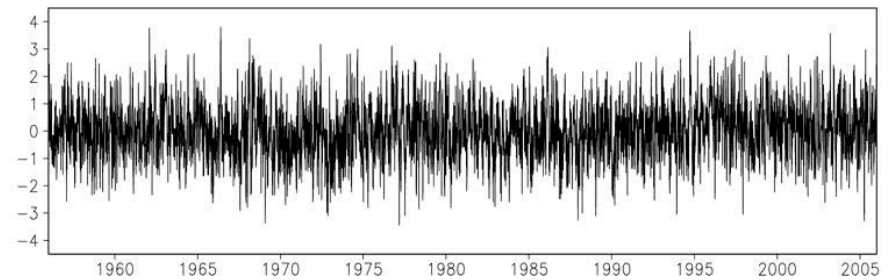
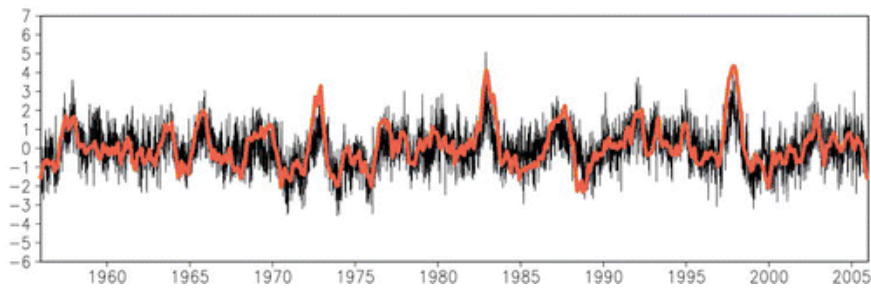
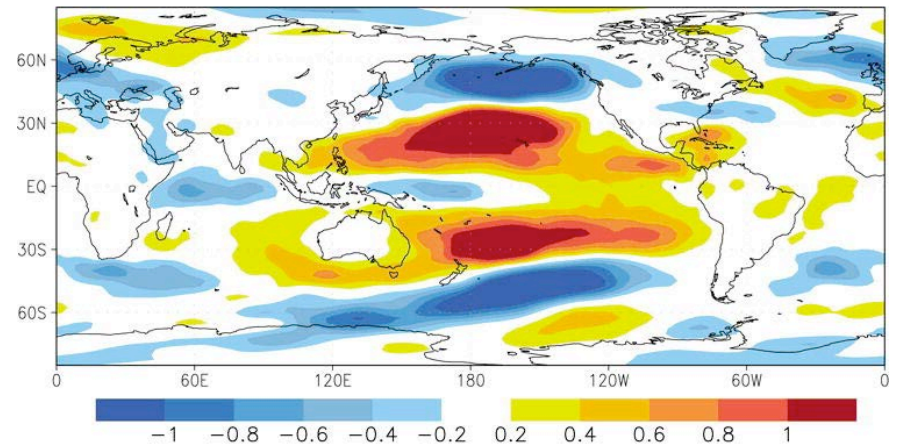
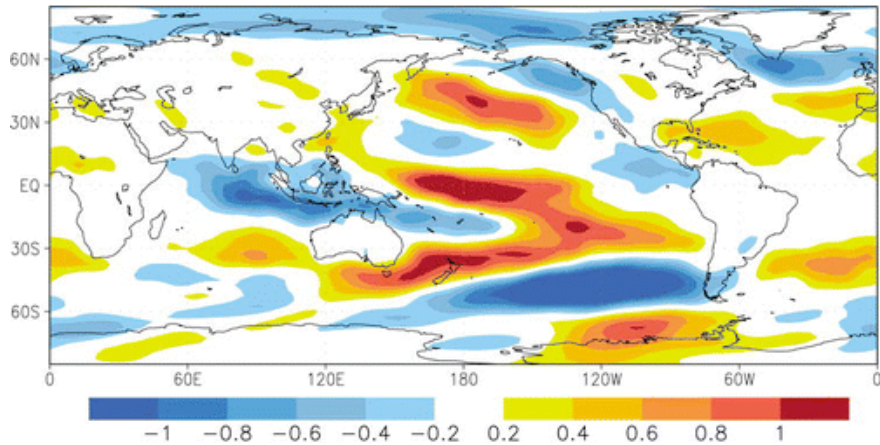






Predictable Component 2  
(U1000, APT=34days, 1.1%, 50EOFs)

Predictable Component 4  
(U1000, APT=15days, 1.2%, 50EOFs)



*from DelSole and Tippett 2009, JAS*

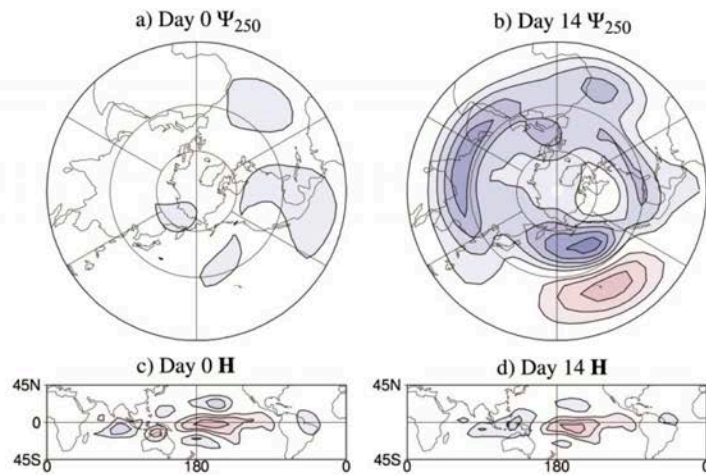
# Noise-Limited

## What if we are at the predictability limit?

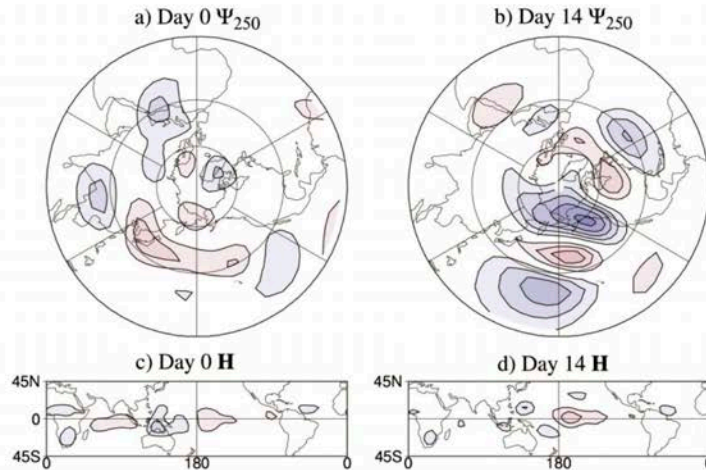
*A forecast of opportunity approach*

- Can we identify *a priori* times of potentially higher forecast skill?
- Do models already pick up on this and is it contained in the ensemble?
- Are we able to exploit this information?

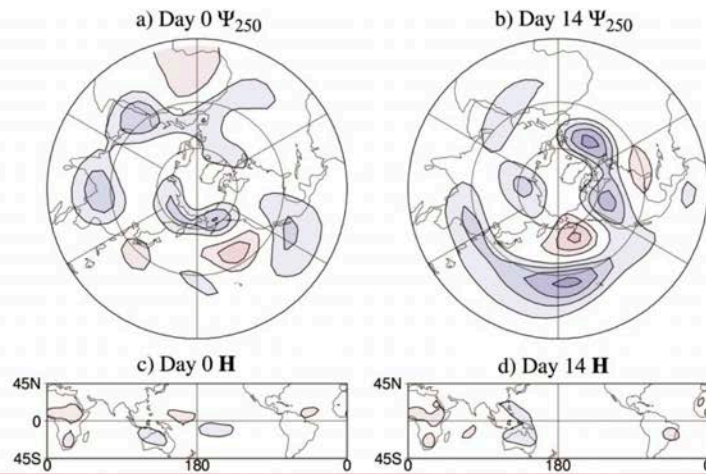
1



2



3



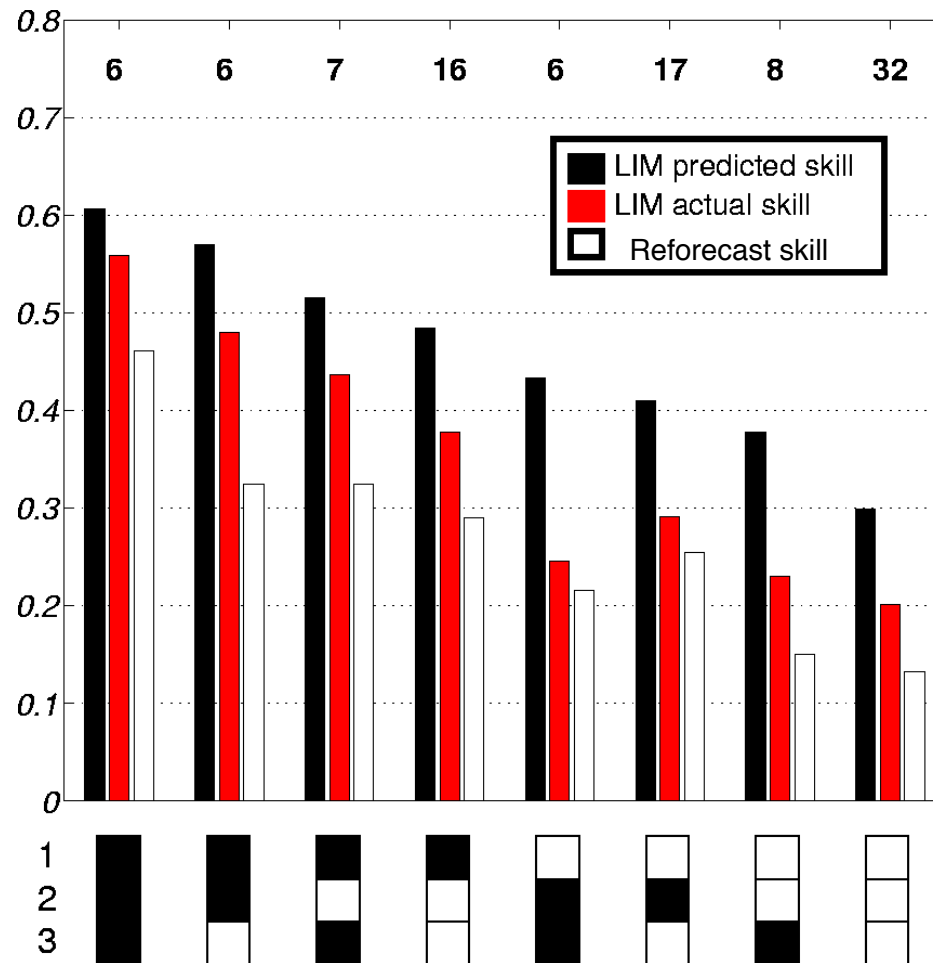
Structures leading to  
greatest anomaly  
amplification over a  
two-week period  
during winter

Leading 2-week “singular  
vectors” of wintertime LIM  
(similar for week 3)



# Predicting Week 3 wintertime skill

Comparing predicted LIM forecast skill with actual LIM and reforecast skill (pattern correlation of NH 250 hPa  $\psi$ )



# Science-Limited

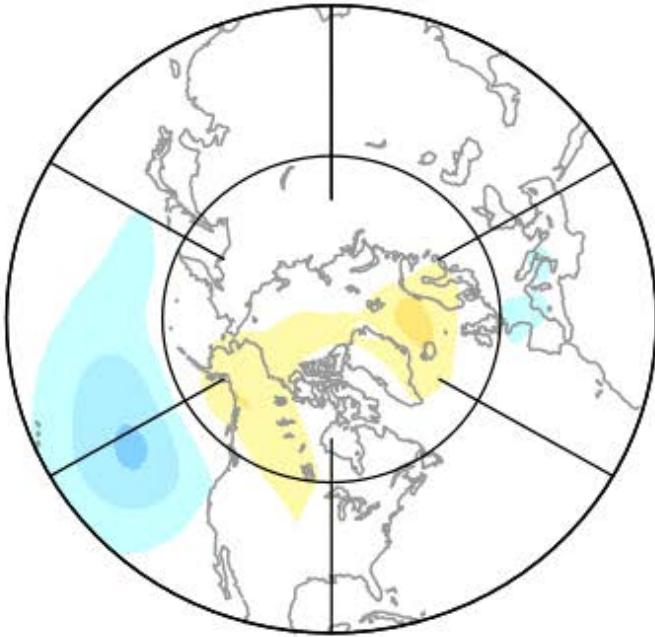
- (a) There is skill left to be realized, but we don't know how to do it**
- (b) We don't know for sure what the limit is**

## *A process-based approach*

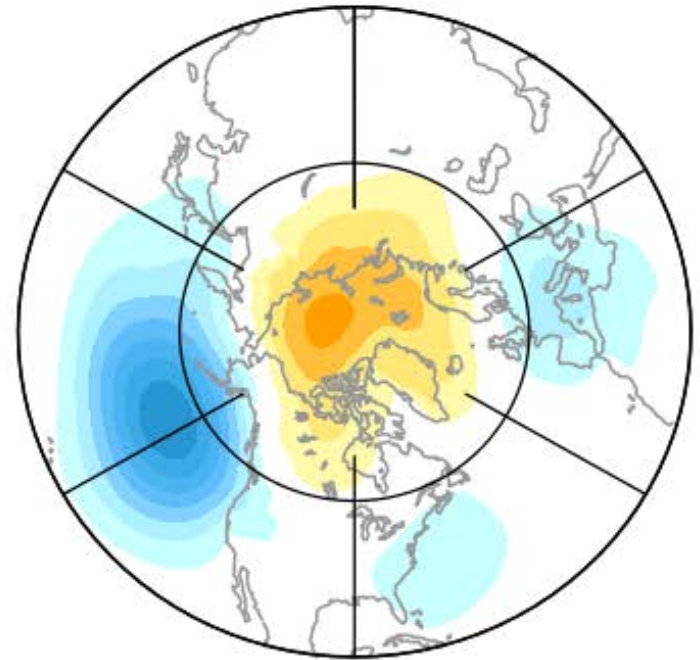
- Can models represent the relevant processes and phenomena?
- Do we understand why or why not?
- Where is our scientific understanding of these processes and what their predictability limit should be?
- How can we make the leap from finding errors in models to identifying real solutions to fixing those errors?

# Pacific Meridional Mode Regressions

NCEPR1

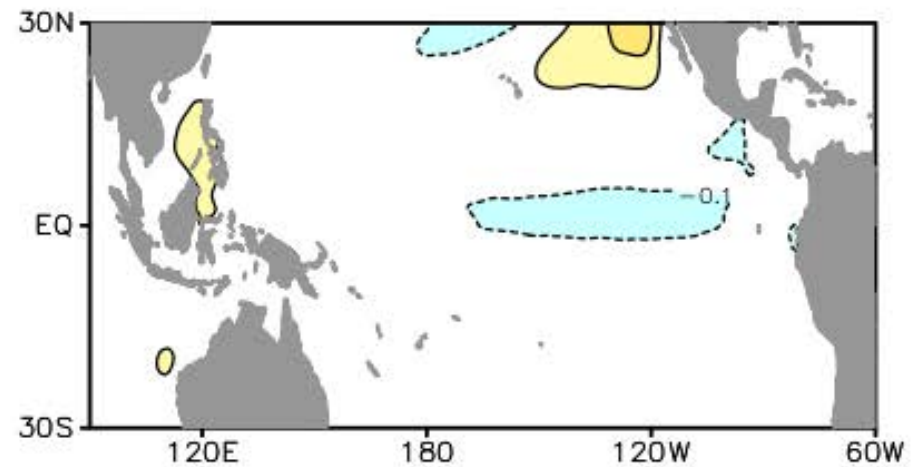
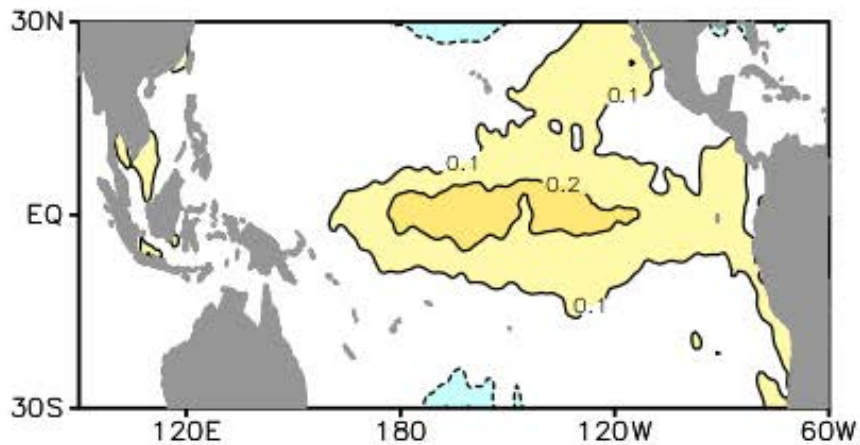


CCSM4



SLP (hPa)  
DJF(0)

SST (° C) DJF(1)



# Some Previous & Current Community Efforts

1. NAS Report on ISI
2. MAPP/Climate Prediction Task Force
3. North American Multi-model Ensemble Project (NMME)
4. Intraseasonal Hindcast Variability Experiment (ISHVE)

## Noise-Limited

**We are at the predictability limit**

*A forecast of opportunity approach*

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