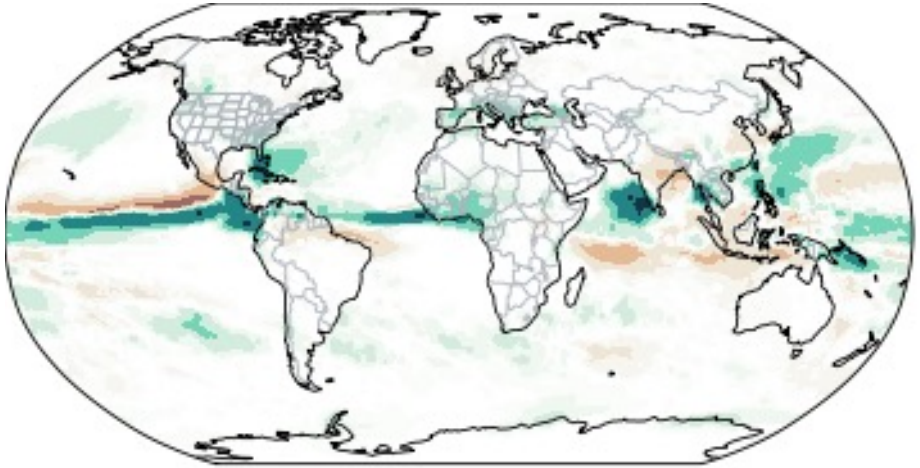
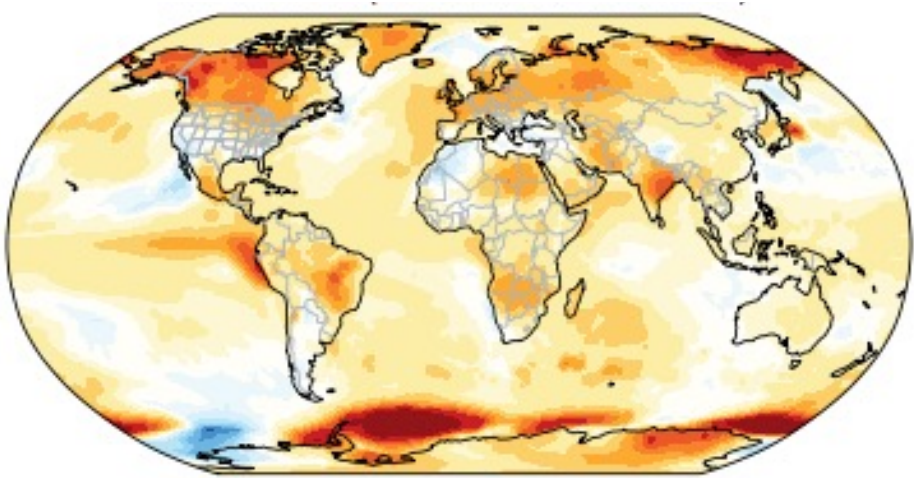
Benefits & Uses of Ensemble Hindcasts for Subseasonal to Seasonal (S2S) Research



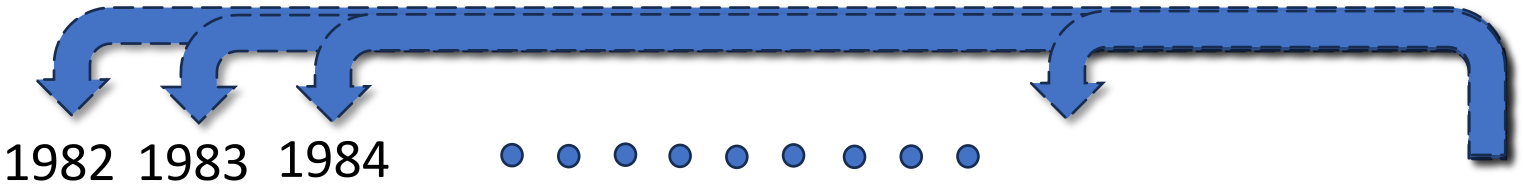


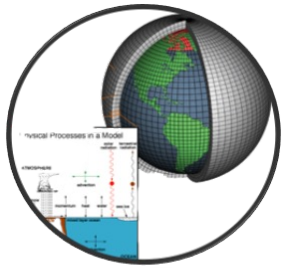
Kathy Pegion

Associate Professor & Williams Chair

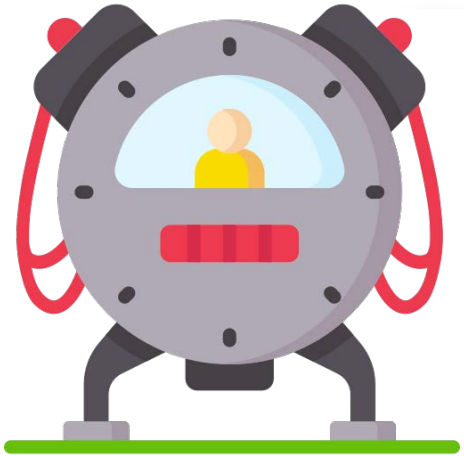
University of Oklahoma, School of Meteorology

What are Hindcasts?





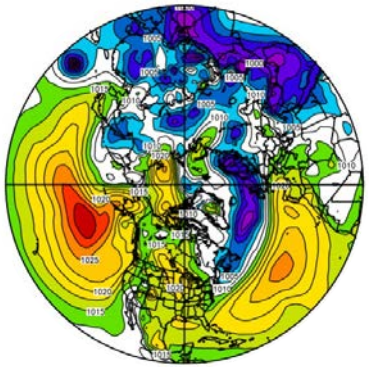
What would the forecast be if we had today's modeling system back then?

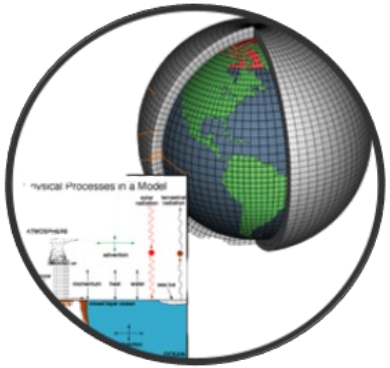


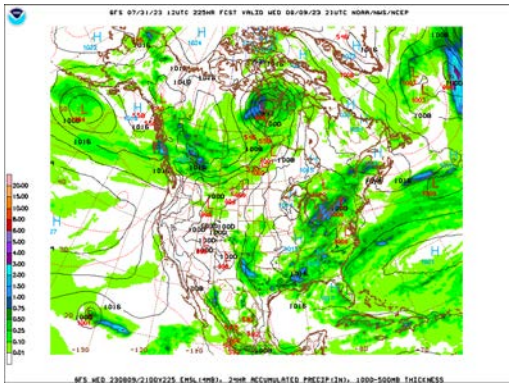
Based on initial conditions
Has already happened
Robust statistics

How are they different from Forecasts?

What does our model think will happen in the future given today's information?



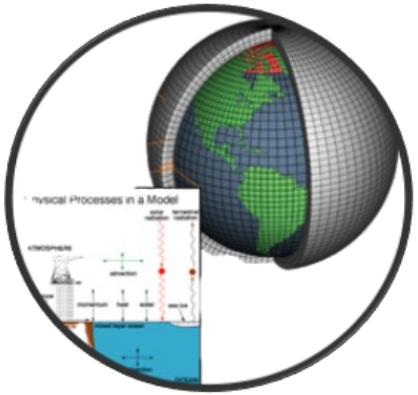


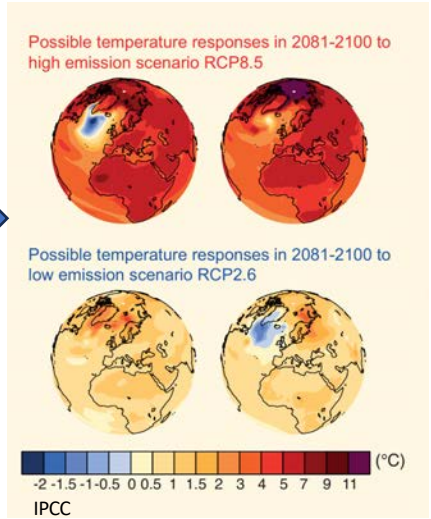


Based on initial conditions
Has not happened yet
Lack of robust statistics

How are they different from Simulations & Projections?

What does our model think could happen under different external forcing situations?





Not based on initial conditions
Entirely model-world

How are hindcasts used for S2S Prediction?

Bias Correction & Calibration

- Make the best forecast we can given the current system and biases

Model Verification

- Quantify skill
- How well can I trust this model for my problem?

Testing potential applications

- Is it possible to make useful/skillful forecast products for my specific application?
- Statistical & dynamical downscaling for specific applications

How are hindcasts used for S2S Research?

Identify & understand model biases

- How do those biases evolve from initial conditions?
- How could they be fixed in the model?
- How do they impact a forecast?

Identify & understand sources of predictability

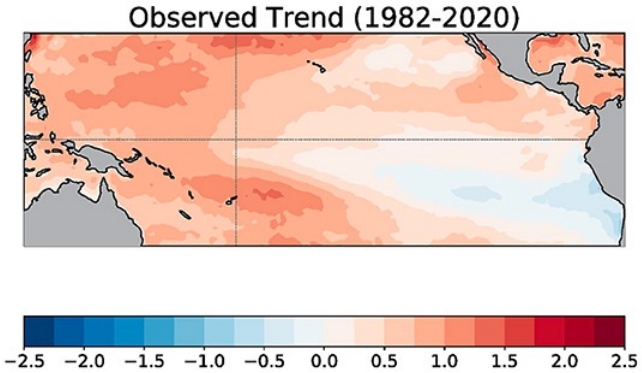
- Identify forecasts of opportunity
- What phenomena provide predictability at different timescales?

S2S Multi-model Ensemble Hindcasts: NMME & SubX

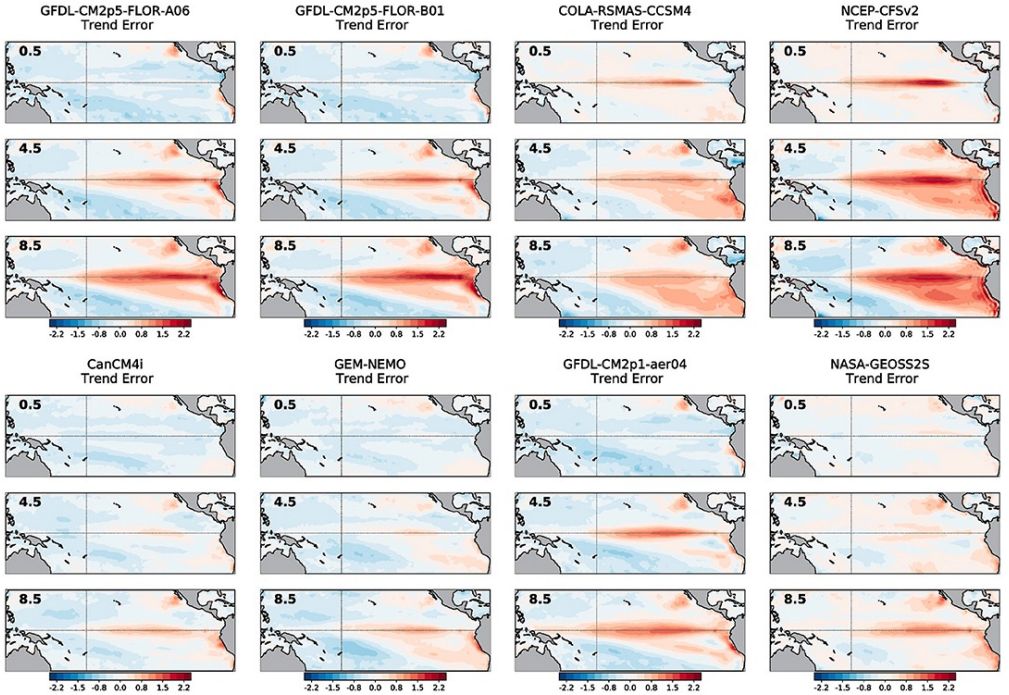
North American Multi-model Ensemble (NMME)
11 Global Models
30 years of *monthly* re-forecasts
9-month forecasts
Monthly Output

The Subseasonal Experiment (SubX)
7 Global Models
17 years of *weekly* re-forecasts
4-week forecasts
Daily Output

Monthly/Seasonal: Model Biases in SST Trends

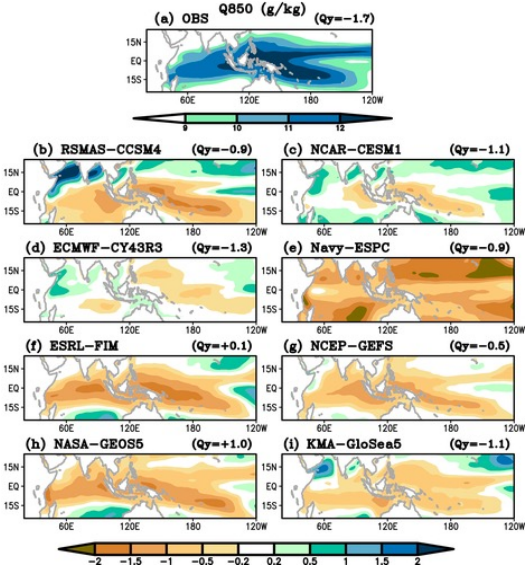


Overly strong SST Trend with increasing lead time in NMME Models-> El Nino prediction errors

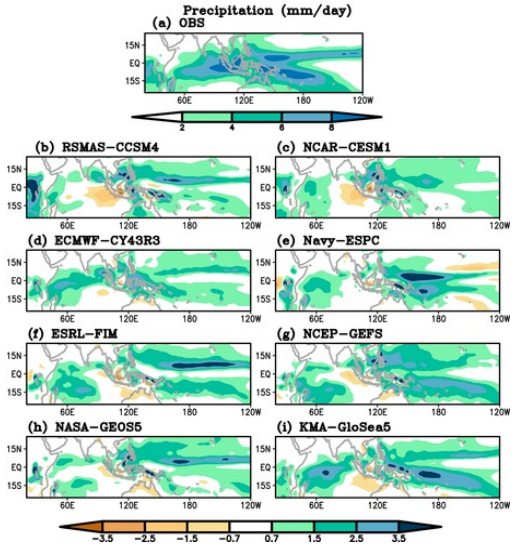


L'Heureux et al. 2022, Frontiers in Climate

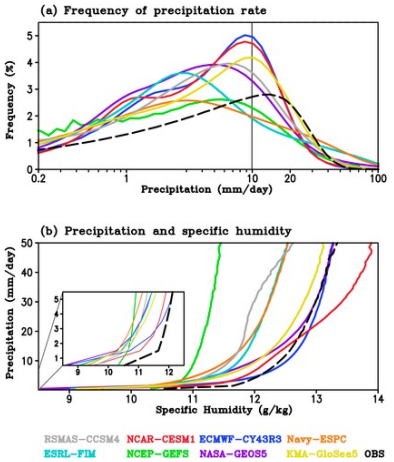
Subseasonal: Model biases impact MJO Propagation



Dry low troposphere



Excess Surface Precipitation

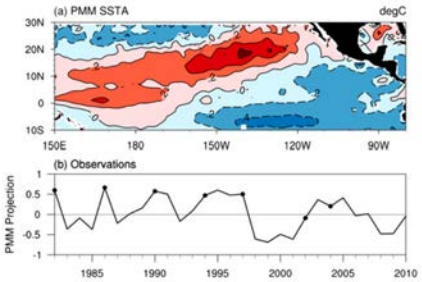


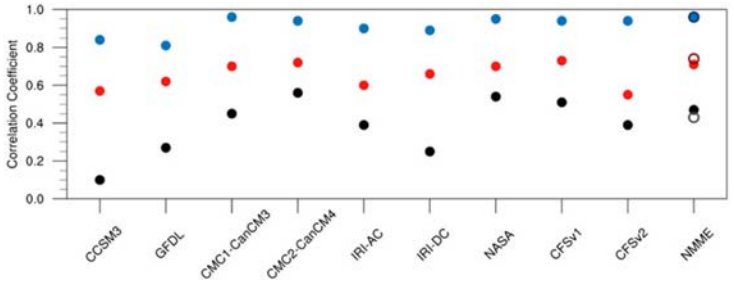
Too frequent light precipitation

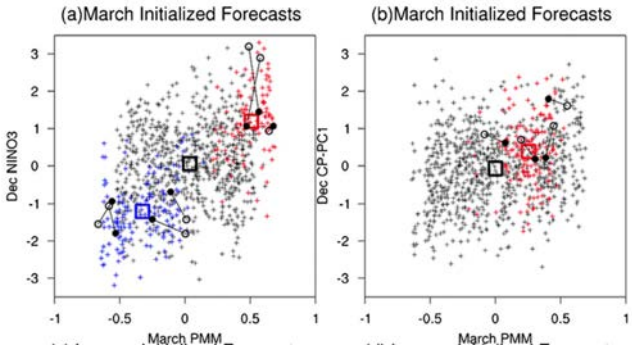
Too strong precipitation at low-humidity

Kim et al. 2019 JGR Atmospheres

Seasonal: The Pacific Meridional Mode as a Source of ENSO Predictability







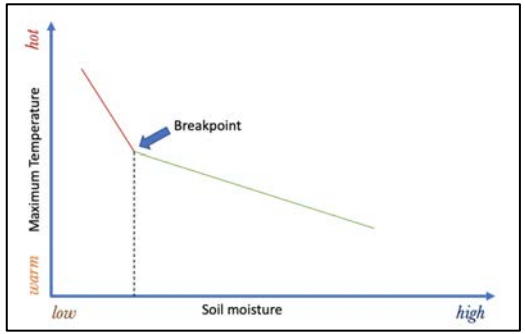
Previous studies identify a precursor relationship between the PMM & ENSO, implying a potential predictive relationship

PMM variability is well predicted at 1 and 3-month lead times.

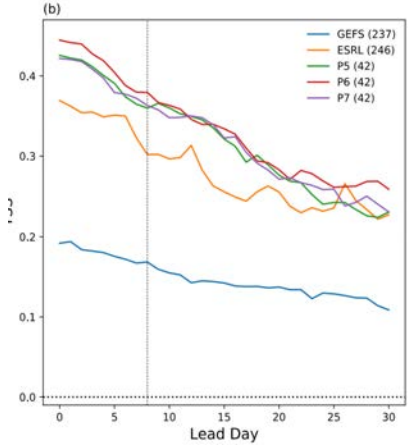
+PMM is a promising predictor of EP El Nino, but not CP El Nino in the NMME models; -PMM events show no skill in predicting La Nina.

Larson and Kirtman 2014. J Clim

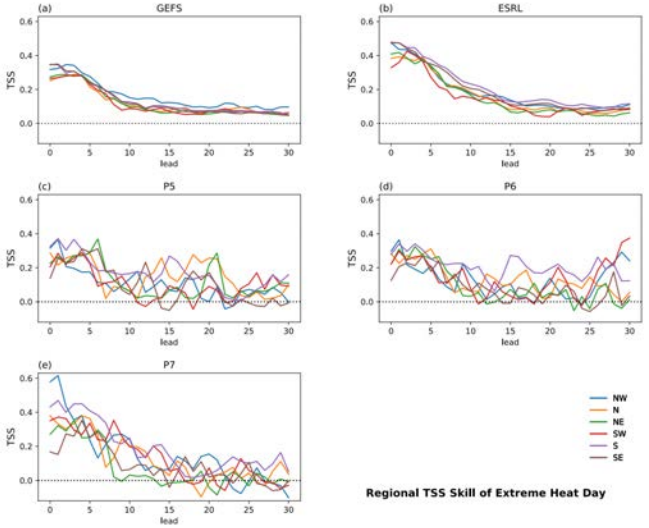
Subseasonal: Predictability of Heatwaves based on soil moisture feedback



Hypersensitive soil moisture regimes that can persist or intensify heatwaves occur: “breakpoints”



SubX + other models show skill in forecasting the dry side of the breakpoint



They link this to the ability of the models to forecast extreme heat days in different regions of CONUS

Benson and Dirmeyer 2021, 2023, J Clim

Why do we need multi-model ensemble hindcasts for S2S Research?

Identify & understand model biases

- Model Improvement

Identify & understand sources of predictability

- Identify what can and cannot be predicted

Based on initial conditions
Has already happened
Robust statistics