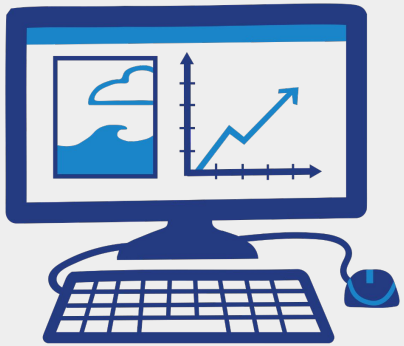


S2S Predictions at GFDL

Baoqiang Xiang

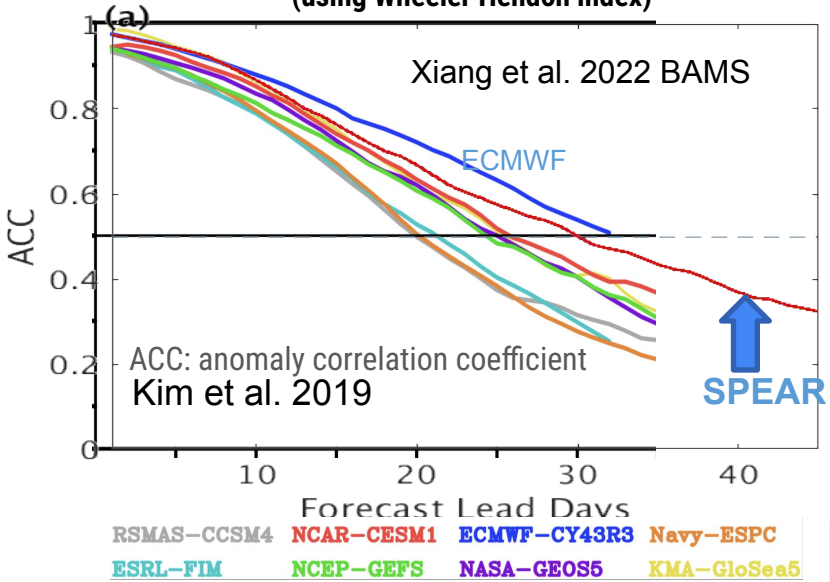
Q1: Concerning GFDL's core strength of building and improving models of the weather, oceans, and climate for societal benefits, how can GFDL leverage advances in science and computational capabilities to improve its key models? What are the strengths, gaps, and new frontiers?

SPEAR S2S Prediction System and MJO predictions

atmospheric initialization	ocean initialization	period	cases	integration	ensemble
Nudging U, V, T, Q to MERRA2 (6 hour)	**Nudging SST to NOAA daily SST**	2000-2019	Every 5 day	45 day	10

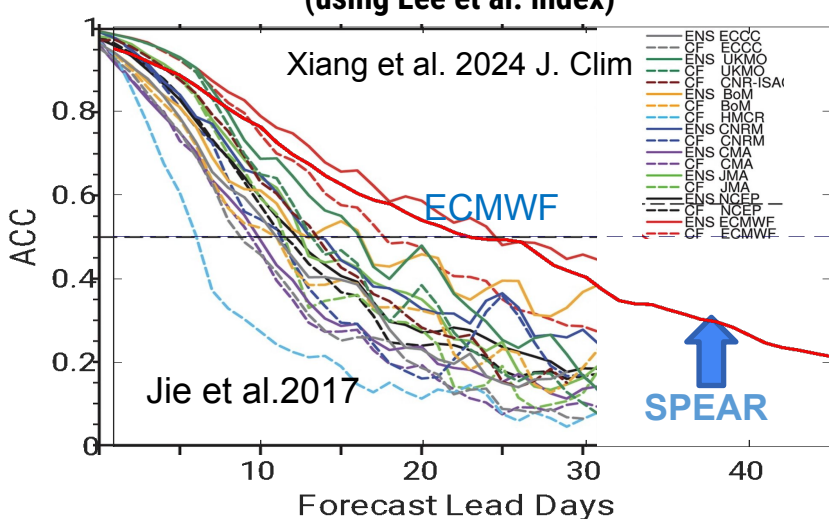
Wintertime MJO prediction (30 days)

(using Wheeler Hendon index)



Summertime MJO prediction (22 days)

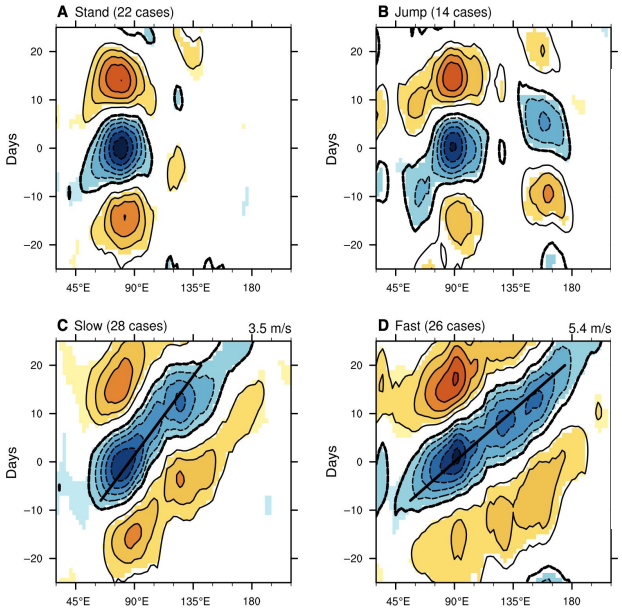
(using Lee et al. index)



SPEAR is a top model in predicting MJO

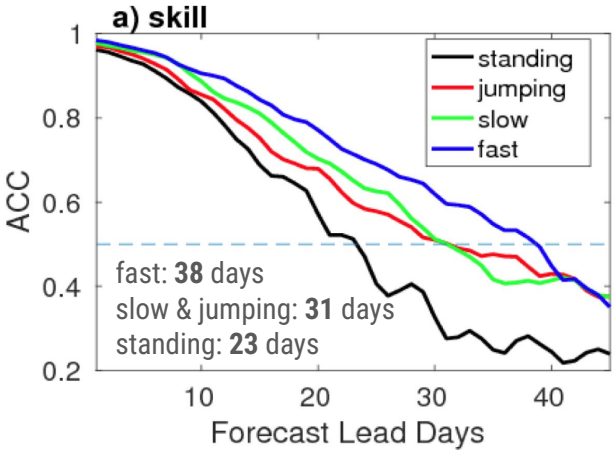
MJO diversity and its contrasting prediction/teleconnections

Observed MJO diversity



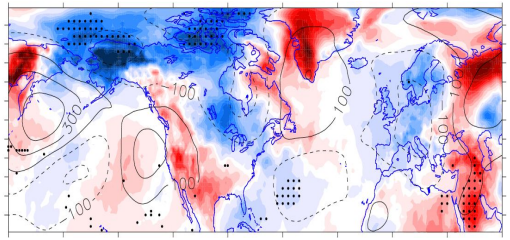
Longitude-time diagram of the equatorial OLR anomalies (Wang et al. 2019)

Skill dependence on MJO diversity in SPEAR

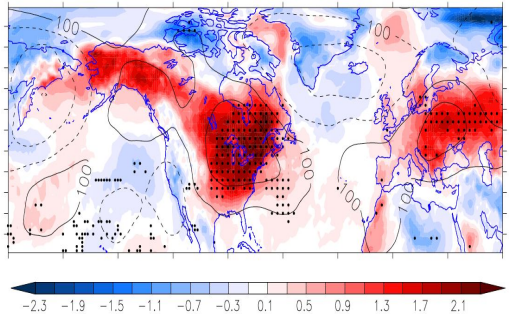


Contrasting teleconnections

Impacts of **standing** MJO



Impacts of **fast-propagating** MJO



Contours: 500 hPa geopotential height
shading: 2m temperature

Xiang et al. 2022 BAMS

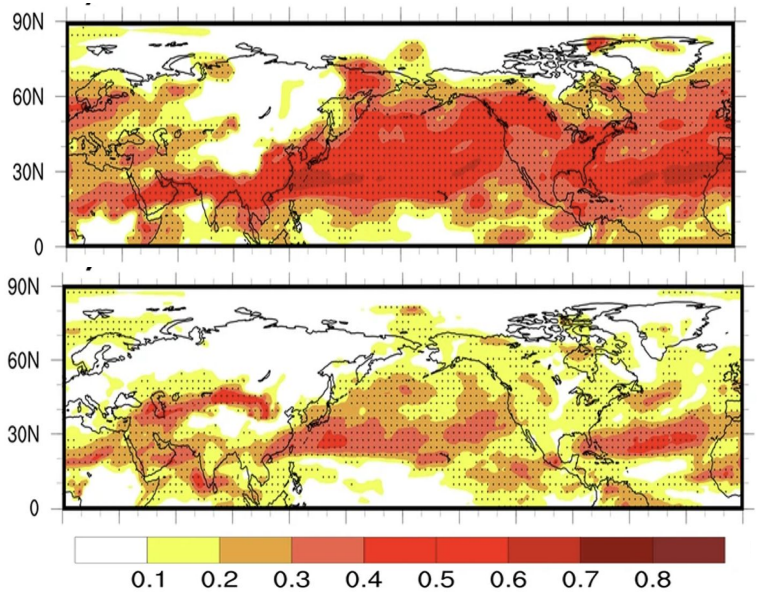
Forecasters need to monitor MJO diversity

S2S Prediction of Wintertime Atmospheric Rivers (AR) in SPEAR model

Correlation skill for AR frequency

week 2

week 3

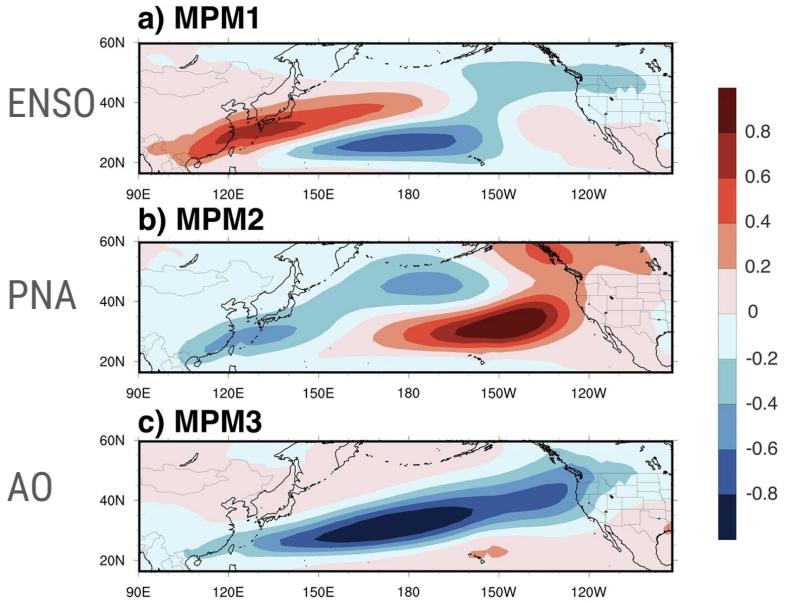


The first three most predictable modes

ENSO

PNA

AO

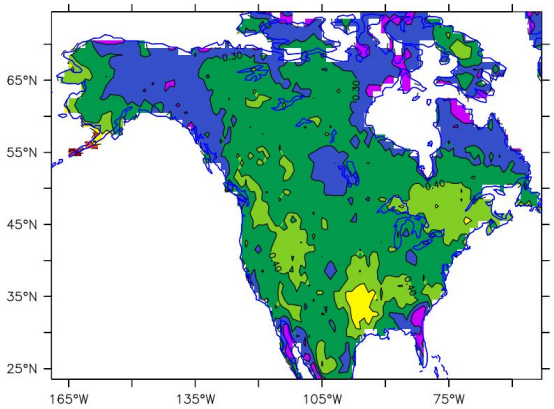


The AR prediction is strongly tied to the prediction of major climate modes

Zhang et al. 2024, NPJ Clim Atmos Sci

Prediction of heatwave over North America in SPEAR model

Correlation skill for the prediction of Extreme Hot Days (EHD) at week 2

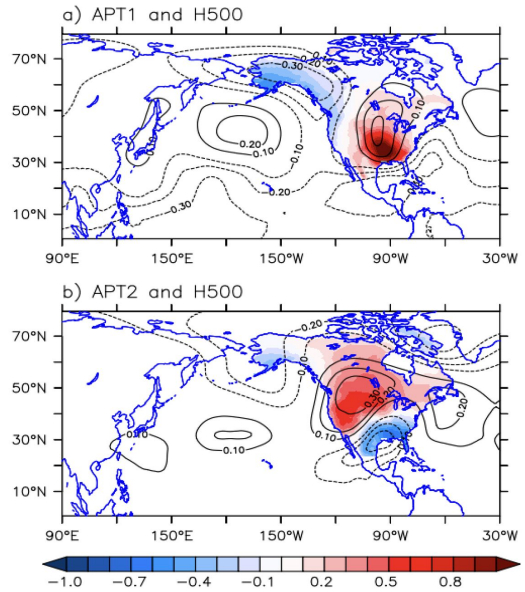


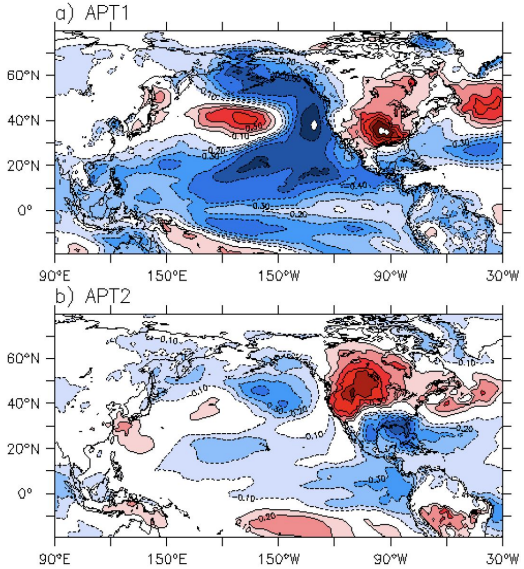
Highest skill in south U.S.
Almost no skill at week 3 (not shown)

The most predictable modes and their association with large-scale climate

Mode 1

Mode 2





shading: The first two most predictable modes of EHD
contour: correlation with 500 hPa geopotential height

Correlation with surface temperature

Predictability of EHD is related to 1) PDO-like SST forcing (mode 1); 2) atmospheric internal mode (mode 2)

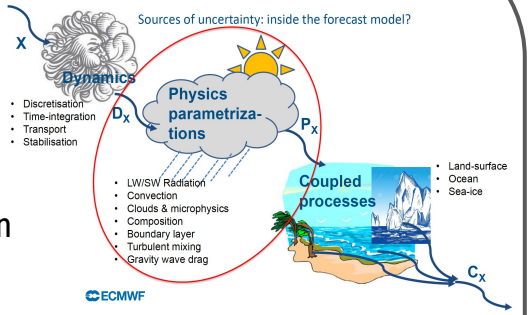
Xiang et al. in prep

Ongoing/future effort for S2S predictions at GFDL

Plans for *SPEAR* S2S Development

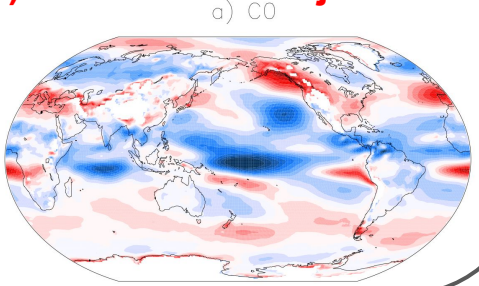
1) Stochastic Physics

- The introduction of stochastic physics aims to address the **underdispersion** issue in the SPEAR S2S prediction system



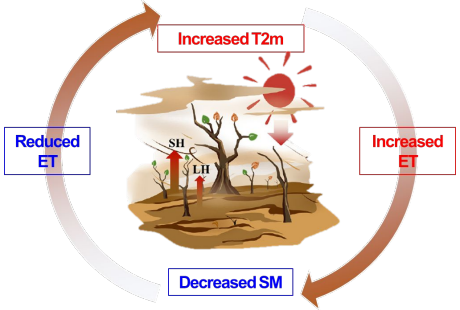
2) Mean State Adjustment

- **Atmospheric mean state adjustments** will be implemented to mitigate mean climate errors



Plans for *S-SHiELD* S2S Development

- **13-km S-SHiELD configuration** will be used for S2S predictions.
- Severe **drought-heat wave events** in subseasonal time scale will be first investigated based on the understanding of their medium range forecasts in the 13-km global SHiELD.



Occurrence of **compound drought-heatwave** from the **land-atmosphere interaction**

Hao et al. (2022); Yoon et al. (2024)