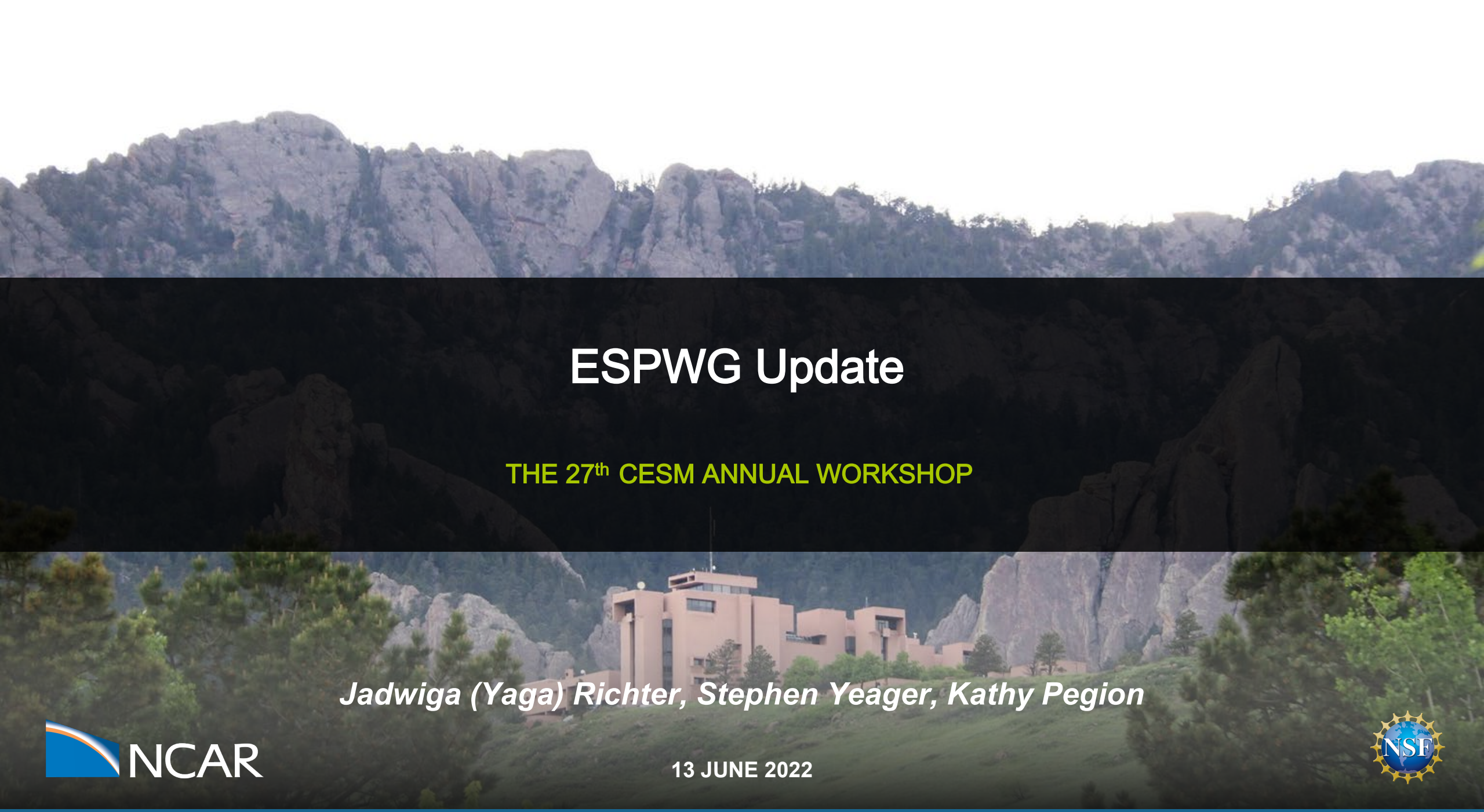


ESPWG Update

THE 27th CESM ANNUAL WORKSHOP

Jadwiga (Yaga) Richter, Stephen Yeager, Kathy Pegion

NCAR

13 JUNE 2022

This material is based upon work supported by the National Center for Atmospheric Research, which is a major facility sponsored by the National Science Foundation under Cooperative Agreement No. 1852977.

ESPWG: Established April 2020

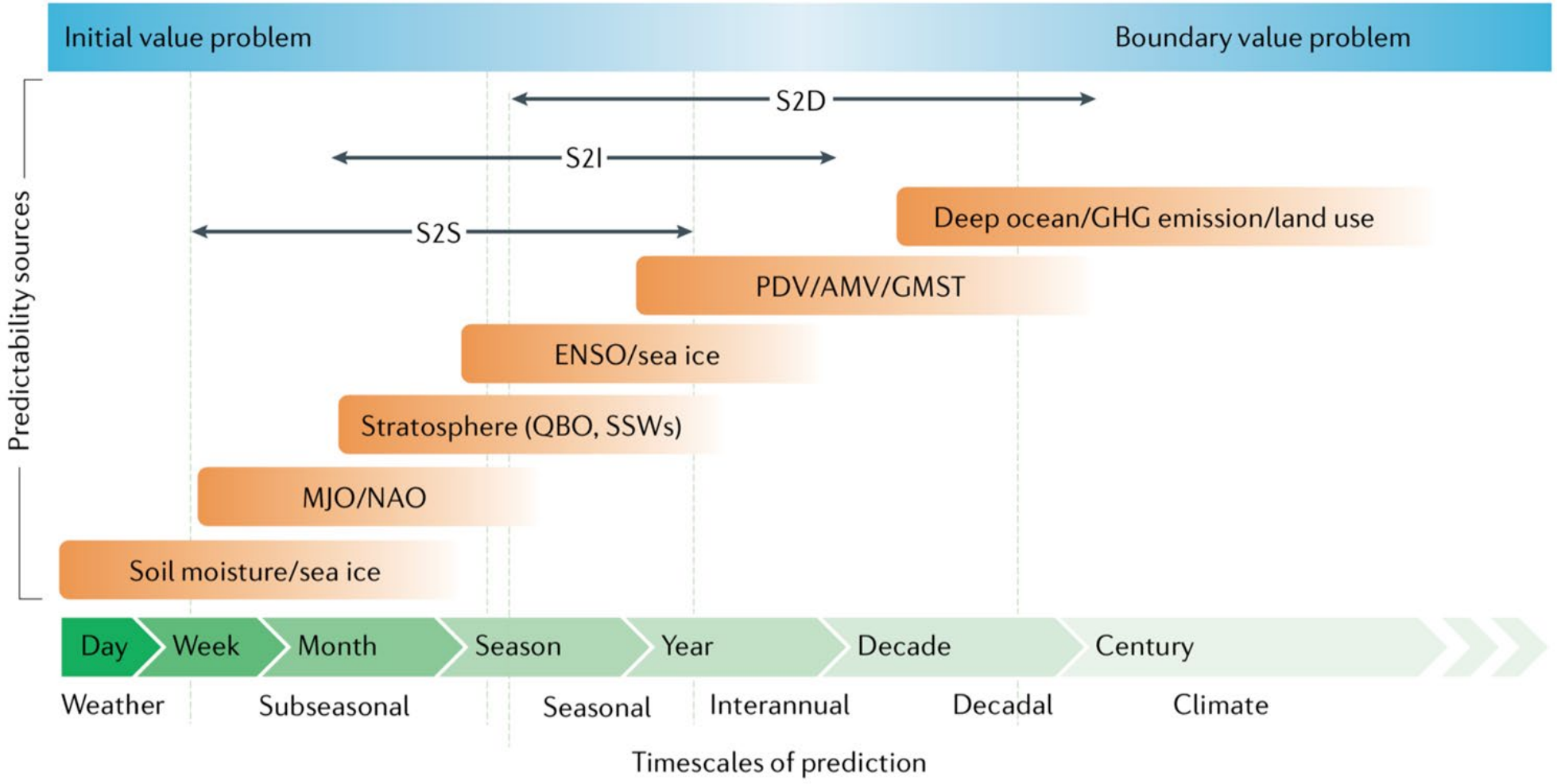
Goal:

"*Advance fundamental understanding of Earth system predictability on time scales ranging from subseasonal to decadal*"

How?

- Plan and execute large ensemble initialized hindcast/forecast sets with and for the community
- Serve and promote a collaborative multidisciplinary research hub on Earth system prediction
- Develop tools & frameworks to enable ESP research

Predictability Sources



Meehl et al. (2021) Nature Reviews Earth & Environment

ESPWG Key Accomplishments

- Completed & documented **Subseasonal-to-Seasonal (S2S)** reforecast sets with CESM2(CAM6) & CESM2(WACCM6)
  - datasets released and overview paper published

- Running **weekly real-time S2S forecasts** to contribute to NOAA's Weeks 3-4 Outlook

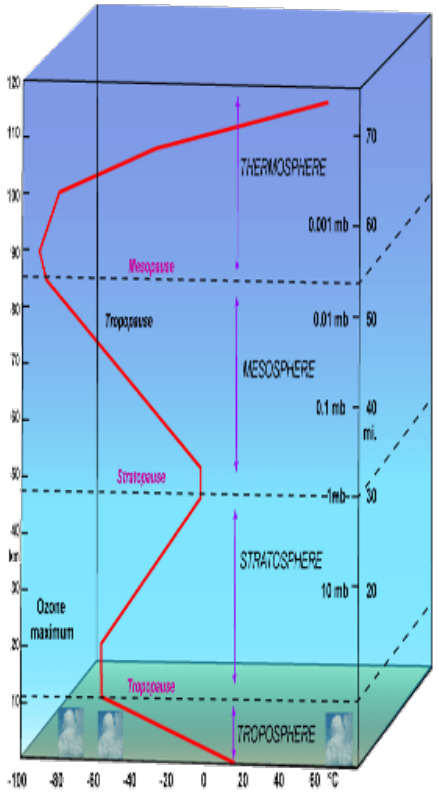
- Completed **Seasonal-to-Multiyear Large Ensemble (SMYLE)** Project
  - dataset released and overview paper available (in revision)

- Initiated **SMYLE extensions**
  - CESM2 decadal predictions, SMYLE w/ high-top CAM

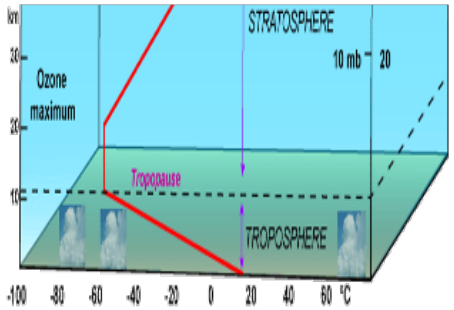
- Began work on ESP **diagnostics packages**

S2S with CESM2(CAM6) & CESM2(WACCM6)

CESM2(WACCM6)



CESM2(CAM6)



Weekly Reforecasts & Forecasts

45 days long

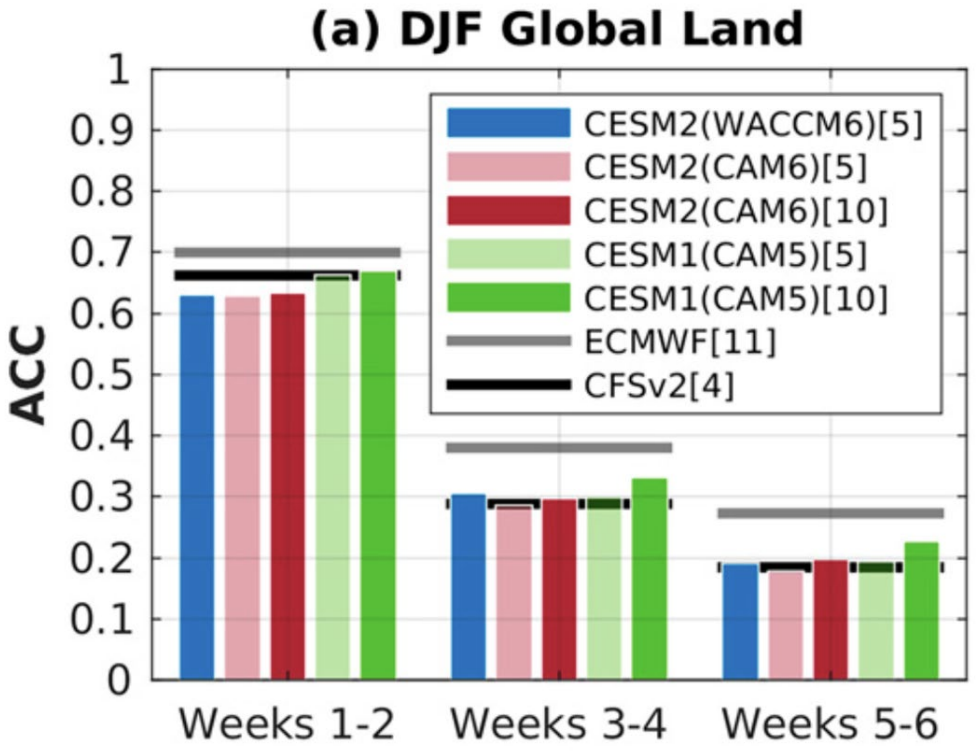
"Subseasonal Earth System Prediction with CESM2"

Richter et al. (2022)
Weather & Forecasting
https://doi.org/10.1175/WAF-D-21-0163.1

Complete system documentation. Weekly forecasts freely available every Thursday.

More details:
https://www.cesm.ucar.edu/working-groups/earth-system-prediction/

S2S with CESM2(CAM6) & CESM2(WACCM6)



Subseasonal prediction skill of CESM2 comparable to NOAA's CFSv2; a little lower than that of ECMWF

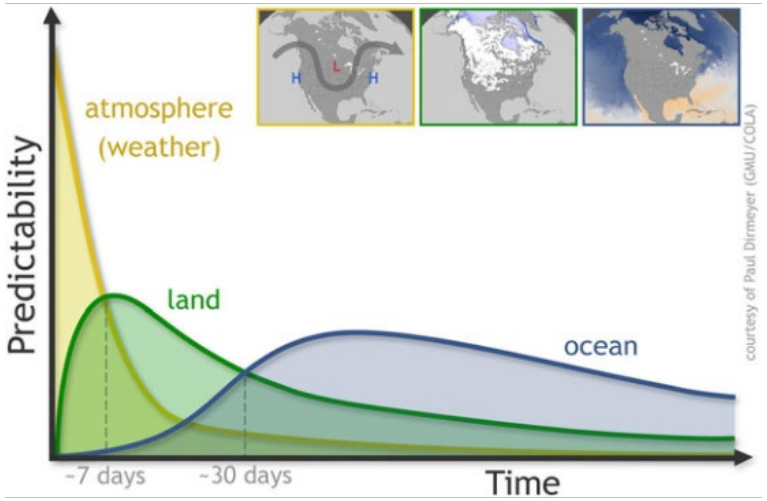
Real-time forecasts continue contributing to NOAA's Weeks 3-4 Outlook

S2S Sources of Predictability

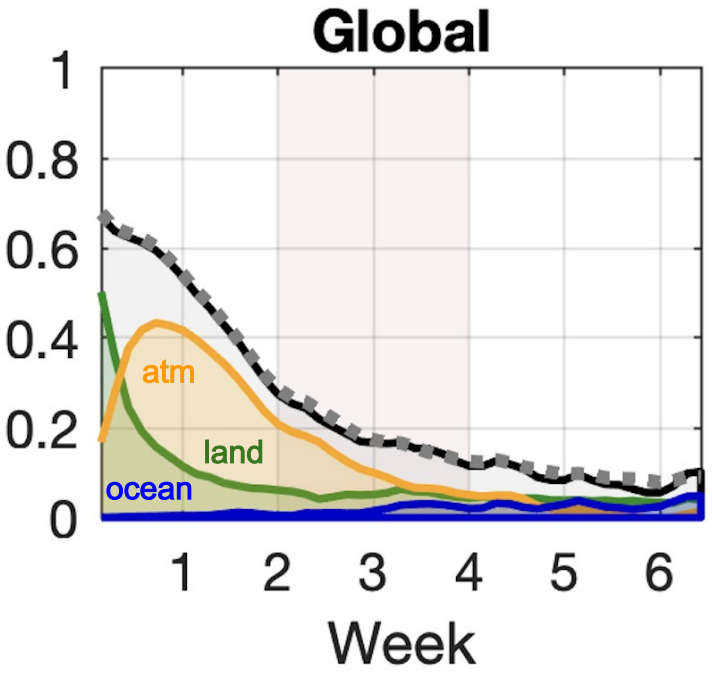
Carried out S2S reforecasts with altered initial conditions for various model components

- climoATM (complete)
- climoOCN (complete)
- climoATMclimoOCN (complete)
- climoLND (in progress)

"Accepted Cartoon"



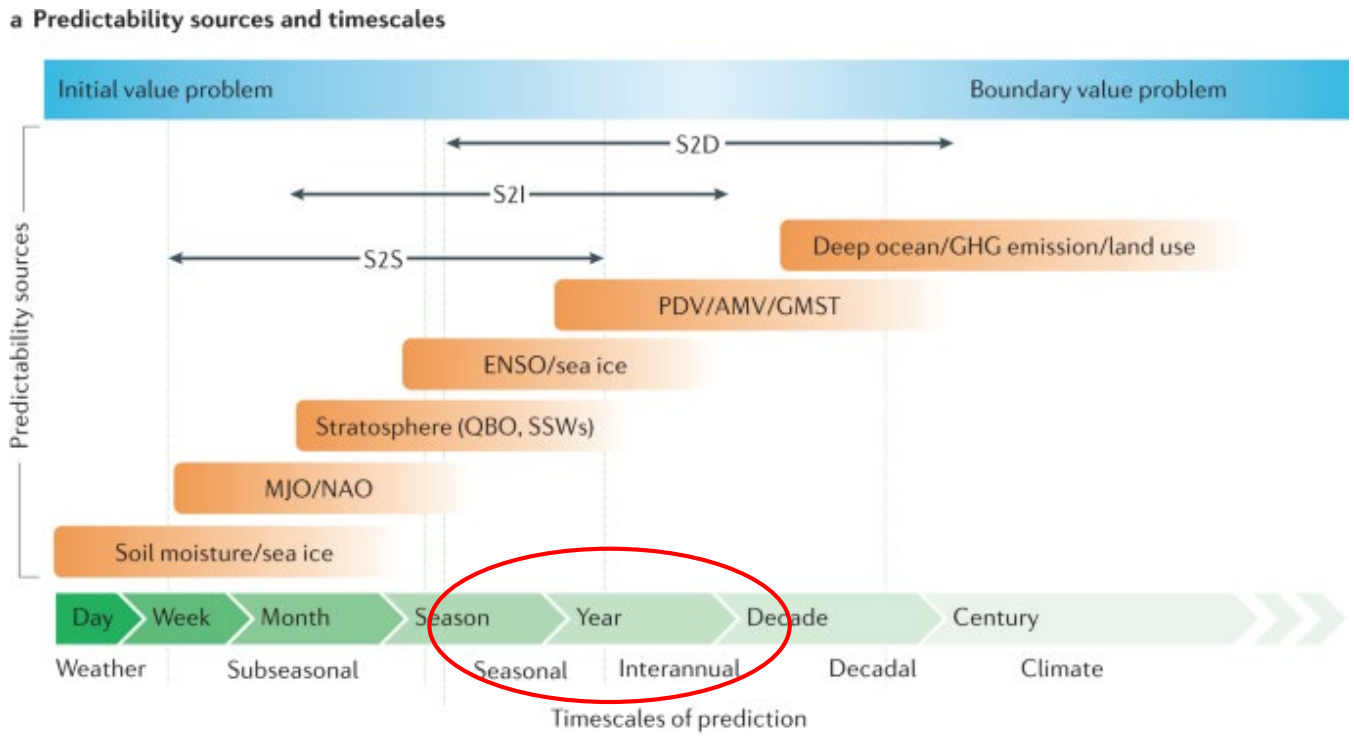
Inferred Predictability



Richter, Glanville, Kumar (2022), Nature Geoscience, In Preparation

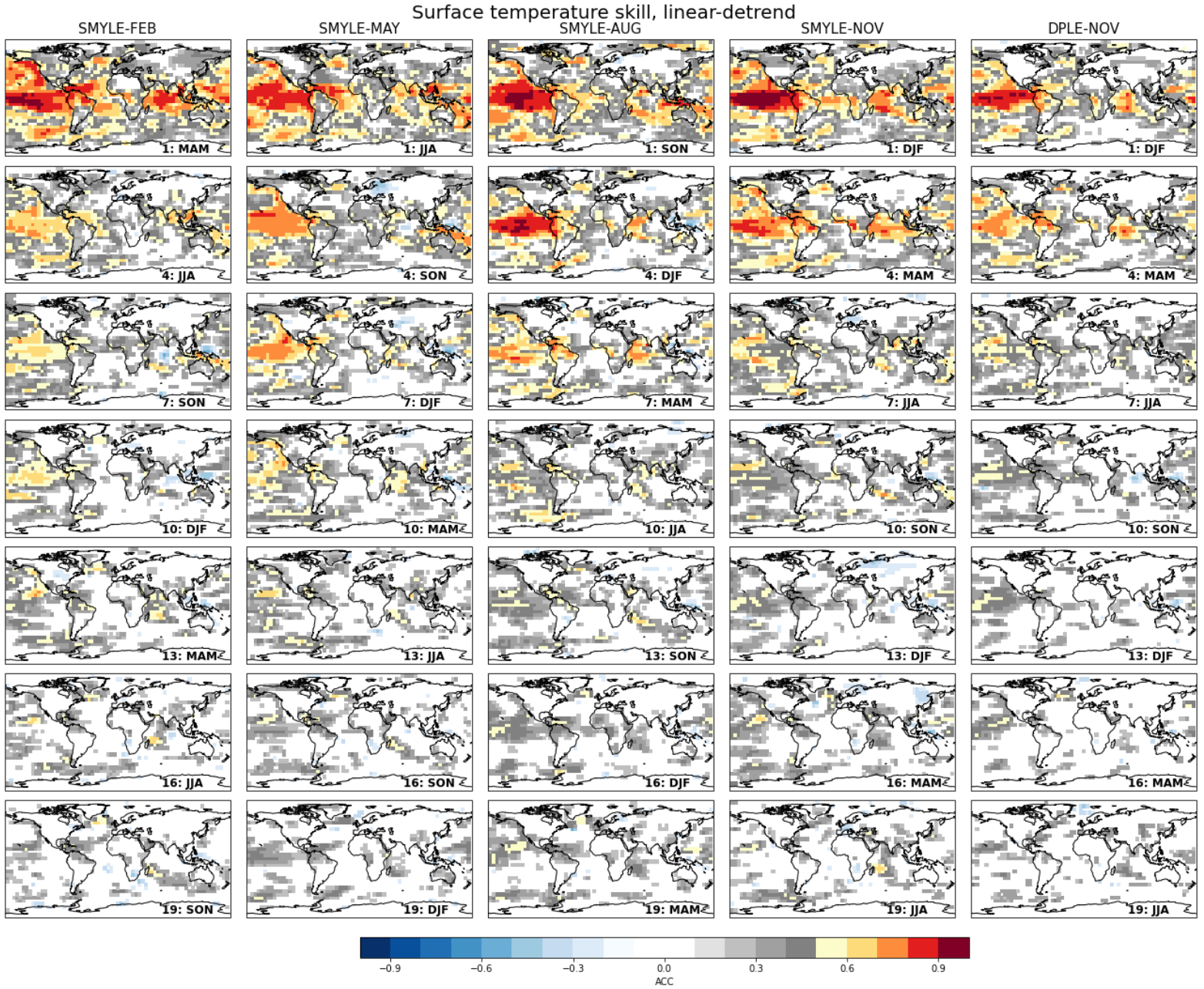
SMYLE: Seasonal -to-Multiyear Large Ensemble

- CESM2
- CAM6, POP2 w/ MARBL, CICE5, CLM5
- 1º horizontal resolution
- Prognostic ocean biogeochemistry
- 24-month simulations initialized from historical conditions in each component
- close collaboration with OMWG, AMWG, LMWG, PCWG
- 4x/year initialization (Nov, Feb, May, Aug) from 1970-2019
- 20-member ensembles



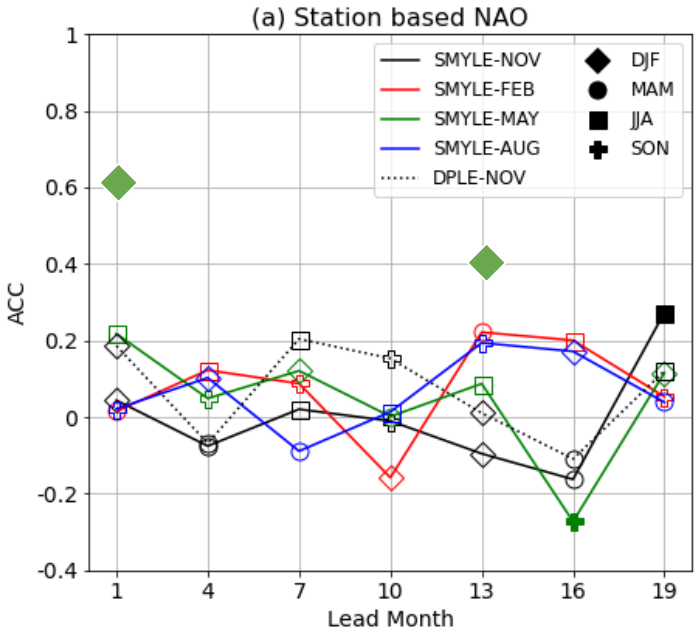
SMYLE Results

- detrended surface temp correlation skill
- Hints of potential for Year2 predictions
- Evidence of slight skill improvements over CESM1-DPLE (Nov starts)



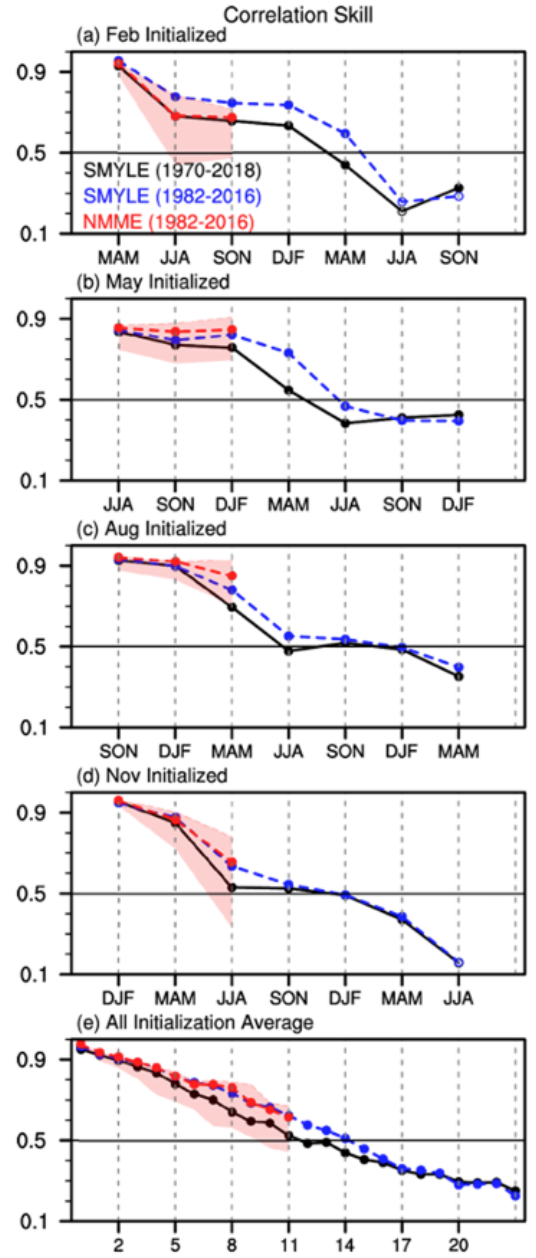
Yeager et al., 2022: The Seasonal-to-Multiyear Large Ensemble (SMYLE) Prediction System using the Community Earth System Model Version 2, *Geosci. Mod. Dev.*, in revision, https://doi.org/10.5194/gmd-2022-60.

SMYLE Results



Yeager et al. (*GMD*, 2022)

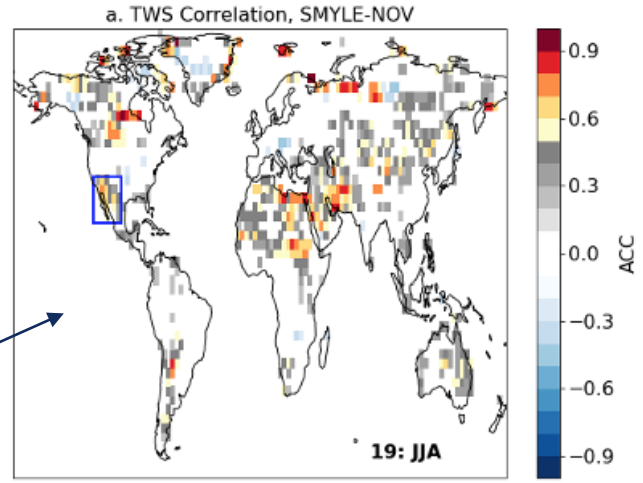
- Niño3.4 correlation skill
- SMYLE compares well to other seasonal prediction systems (NMME, ECMWF-SEAS5)
- Figure courtesy Xian Wu

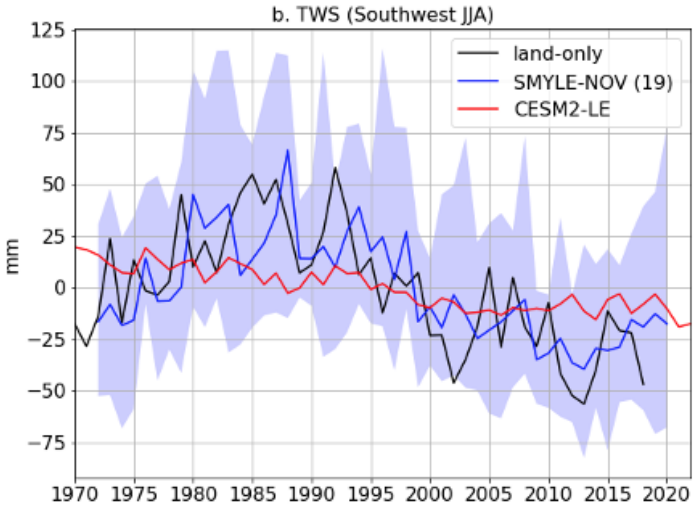


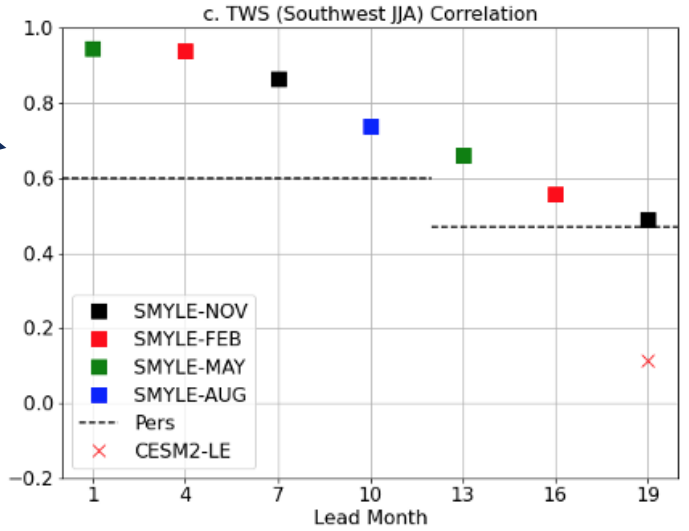
- NAO correlation skill
- SMYLE shows negligible skill, unlike some systems (**UKMO-DePreSys3**)
- Figure courtesy Isla Simpson

SMYLE Results

- Terrestrial Water Storage (TWS) skill
- Some regions, like the US Southwest, exhibit long leadtime (19-month) skill in SMYLE
- SMYLE beats persistence for US Southwest TWS well into Year2 of forecasts







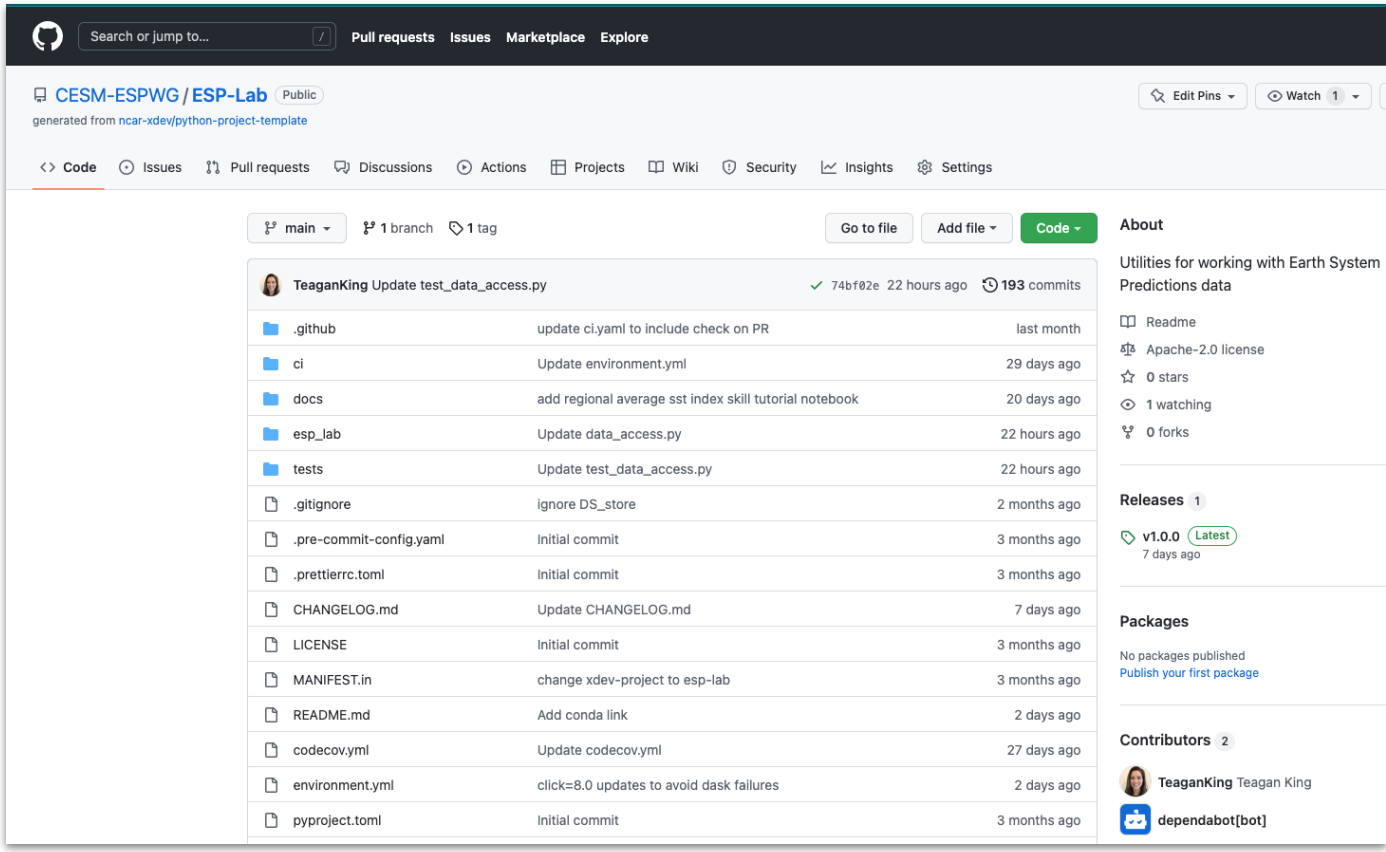
Yeager et al. (*GMD*, 2022)

ESP Diagnostics

- Efforts are ongoing to develop shared python tools for efficient interactive analysis of initialized prediction ensembles

- e.g., ESP-Lab package facilitates data ingestion and skill verification for datasets on glade (SMYLE, DPLE, etc.)

- Example S2S notebooks using climpred package (see Judith Berner's talk)



Upcoming ESPWG Session

Thursday, June 16: 8:30 am - 12:30 pm

- Identifying state-dependent **predictability of sea surface temperatures** in CESM2 with artificial neural networks (Emily Gordon)
- **Subpolar north Atlantic cold extremes** in CESM initialized predictions (Elizabeth Maroon)
- Using neural networks to predict temporary slowdowns in **decadal climate warming trends** (Zachary Labe)
- The **influence of biomass emissions on ENSO** and its teleconnections in CESM2 (John Fasullo)
- **Predictability of long-lived marine heatwaves**: a case study of the 2013-2015 Northeast Pacific (Evan Meeker)
- Robust Changes in North America's **Hydroclimate Variability and Predictability** (Sanjiv Kumar)
- Machine Learning-based Assessment of the Representation and **Predictability of North American Weather Regimes** (Maria Molina)
- Did stratospheric variability drive the **extreme cold air outbreak** in the United States in February 2021? (Nicholas Davis)
- Land surface initializations contribute most to the subseasonal **soil moisture forecast skill** (Yanan Duan)
- State-dependent predictability of S2S forecasts **using the python package climpred** (Judith Berner)

Get Involved!

- Would like to see **more community involvement** in analysis of existing datasets, planning and setting up new experiments, & contributions to diagnostics

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  Kathy Pegion: (kpegion@gmu.edu)