

ESPWG Update

THE 27th CESM ANNUAL WORKSHOP

Jadwiga (Yaga) Richter, Stephen Yeager, Kathy Pegion



13 JUNE 2022

This material is based upon work supported by the National Center for Atmospheric Research, which is a major facility sponsolity 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/ hightop CAM
- Began work on ESP diagnostics packages



S2S with CESM2(CAM6) & CESM2(WACCM6)



CESM2(WACCM6)

"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/

Weekly Reforecasts & Forecasts

45 days long



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

Inferred Predictability Global 0.8 atmosphere (weather) Predictability 0.6 0.4 land ocean 0.2 land ocean ~7 days ~30 days Time 2 3 5 Week

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

6



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





SMYLE: Seasonal -to-Multiyear Large Ensemble

- CESM2
- CAM6, POP2 w/ MARBL, CICE5, CLM5
- 1° 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



a Predictability sources and timescales



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.



NCAR UCAR

SMYLE Results

(a) Station based NAO SMYLE-NOV DJF SMYLE-FEB MAM 0.8 SMYLE-MAY IIA SMYLE-AUG SON ······ DPLE-NOV 0.6 0.4 ACC 0.2 0 -0.2 -0.4 7 10 13 16 19 Lead Month

- 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



Yeager et al. (GMD, 2022)



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 \bigcirc

generated t

- 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)

Search or jump to	7 Pull requests Issues M	arketplace Explore		
M-ESPWG / ESP-L rom ncar-xdev/python-proje	ab Public cc-template			☆ Edit Pins ▼
e 🕑 Issues ຼູ່ໃງ Pu	Ill requests 🖓 Discussions 🕑 Action	s 🗄 Projects 🖽 Wiki 😲 Security 🗠	Insights 🔯 Settings	
	<pre></pre>		So to file Add file - Code -	About Utilities for working with Earth System
	TeaganKing Update test_data_acces	s.py ✓ 74	bf02e 22 hours ago 🕚 193 commits	Predictions data
	ci	Update cl.yami to include check on PR	29 days ago	₫ Apache-2.0 license
	docs	add regional average sst index skill tutorial notebo	ok 20 days ago	☆ 0 stars ⊙ 1 watching
	esp_lab	Update data_access.py	22 hours ago	양 0 forks
	tests	Update test_data_access.py	22 hours ago	
🗋 .gitigi	🗋 .gitignore	ignore DS_store	2 months ago	Releases 1
	.pre-commit-config.yaml	Initial commit	3 months ago	V1.0.0 Latest
	.prettierrc.toml	Initial commit	3 months ago	
	CHANGELOG.md	Update CHANGELOG.md	7 days ago	Packages
	LICENSE	Initial commit	3 months ago	No packages published
	MANIFEST.in	change xdev-project to esp-lab	3 months ago	Publish your first package
	C README.md	Add conda link	2 days ago	
	Codecov.yml	Update codecov.yml	27 days ago	Contributors 2
	environment.yml	click=8.0 updates to avoid dask failures	2 days ago	TeaganKing Teagan King
	pyproject.toml	Initial commit	3 months ago	📩 dependabot[bot]





Upcoming ESPWG Session

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

- Identifying statedependent 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 indecadal 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 Learningbased Assessment of the Representation an 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 subseasonadoil moisture forecast skill (Yanan Duan)
- State-dependent predictability of S2S forecastsusing the python package climpred (Judith Berner)



Get Involved!

• Would like to seemore community involvement in analysis of existing datasets, planning and setting up new experiments, & contributions to diagnostics

Email: Yaga Richterj<u>(ichter@ucar.ed)</u> & Steve Yeager<u>(eager@ucar.ed)</u>
Kathy Pegion: <u>kpegion@gmu.ed</u>)

