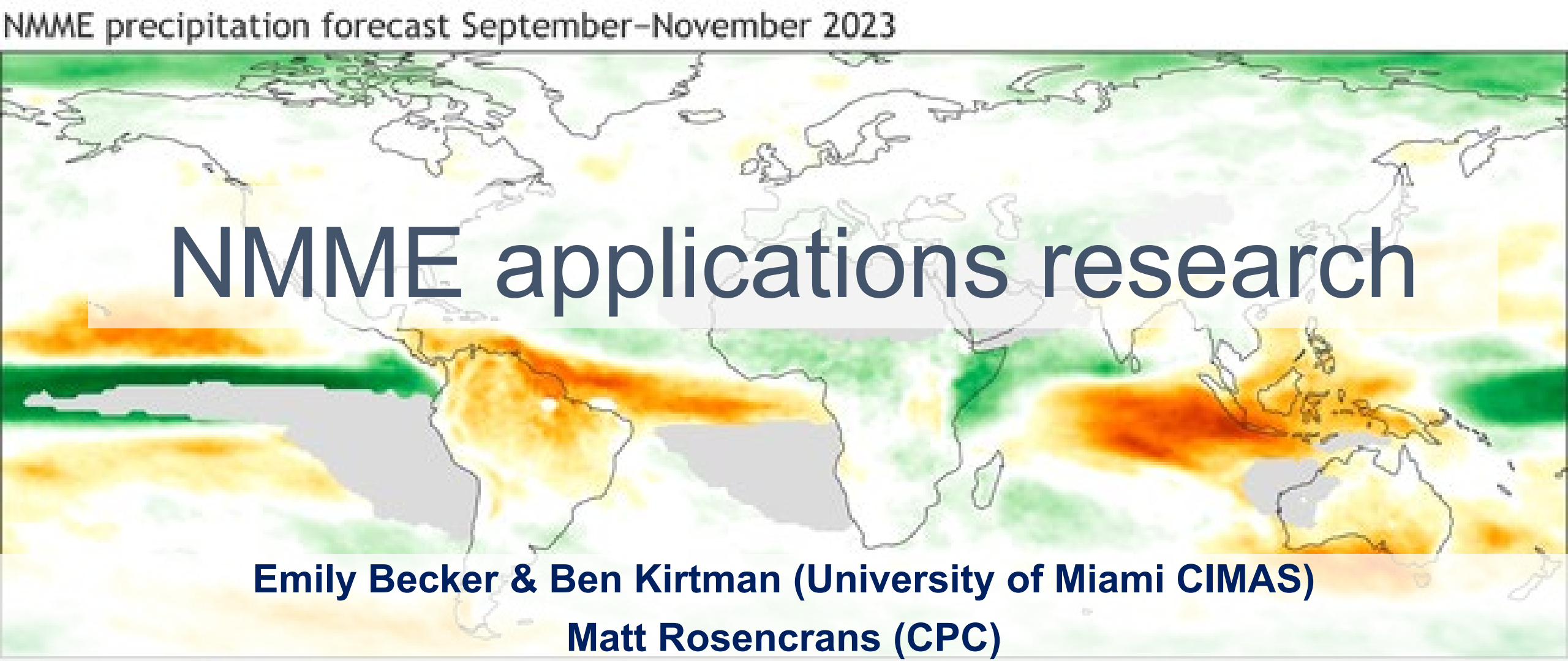


NMME applications research

Emily Becker & Ben Kirtman (University of Miami CIMAS)

Matt Rosencrans (CPC)

For the NMME "Meeting Future Needs" Workshop

June 21, 2023

Citations of original BAMS paper (Kirtman et al. 2014)

421
Meteorology Atmospheric Sciences

96
Geosciences Multidisciplinary

78
Environmental Sciences

67
Water Resources

23
Multidisciplinary Sciences

15
Environmental Studies

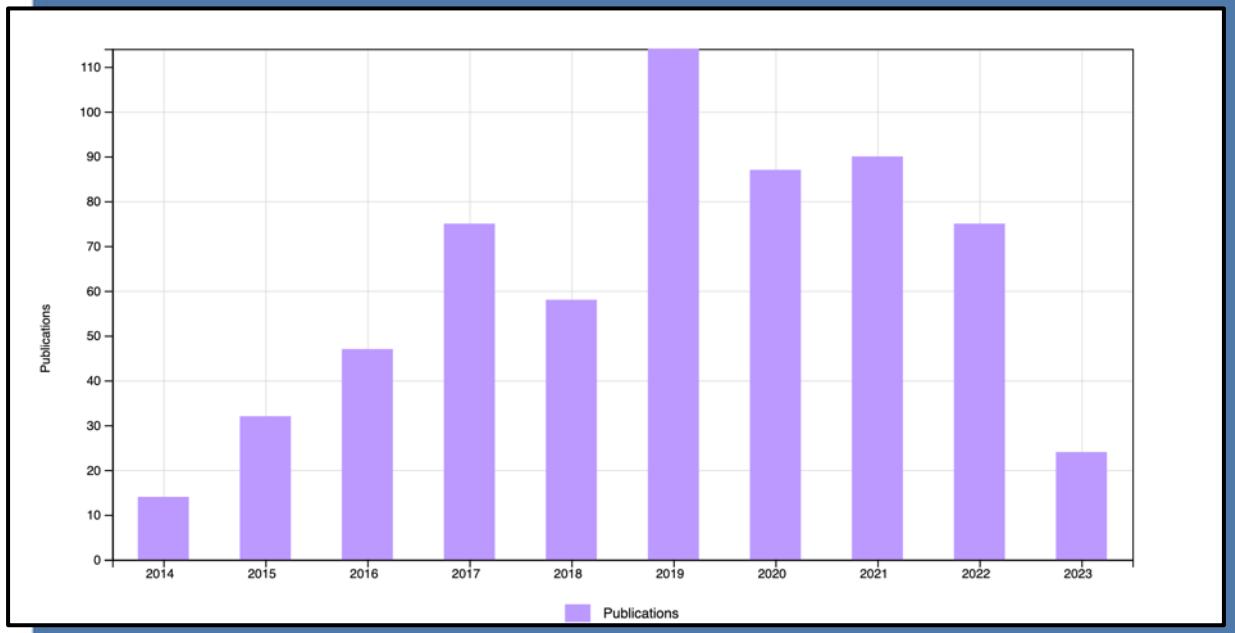
22
Oceanography

12
Limnology

10
Mari
Fresh
Biology

19
Engineering Civil

Web of Science
Total: 624



"The **N**ASA **Hy**drological **F**orecast and **A**nalysis **S**ystem (NHyFAS; Arsenault et al., 2020) was developed to provide seasonal drought forecasts that are relevant for USAID and USACE activities in the Middle East and Africa, based on existing NASA Earth science capabilities."

Hydrological forecasts

NASA GSFC

https://lis.gsfc.nasa.gov/projects/nhyfas

Arsenault et al. (2020)

Slides from K. Arsenault and Abheera Hazra, NASA GSFC

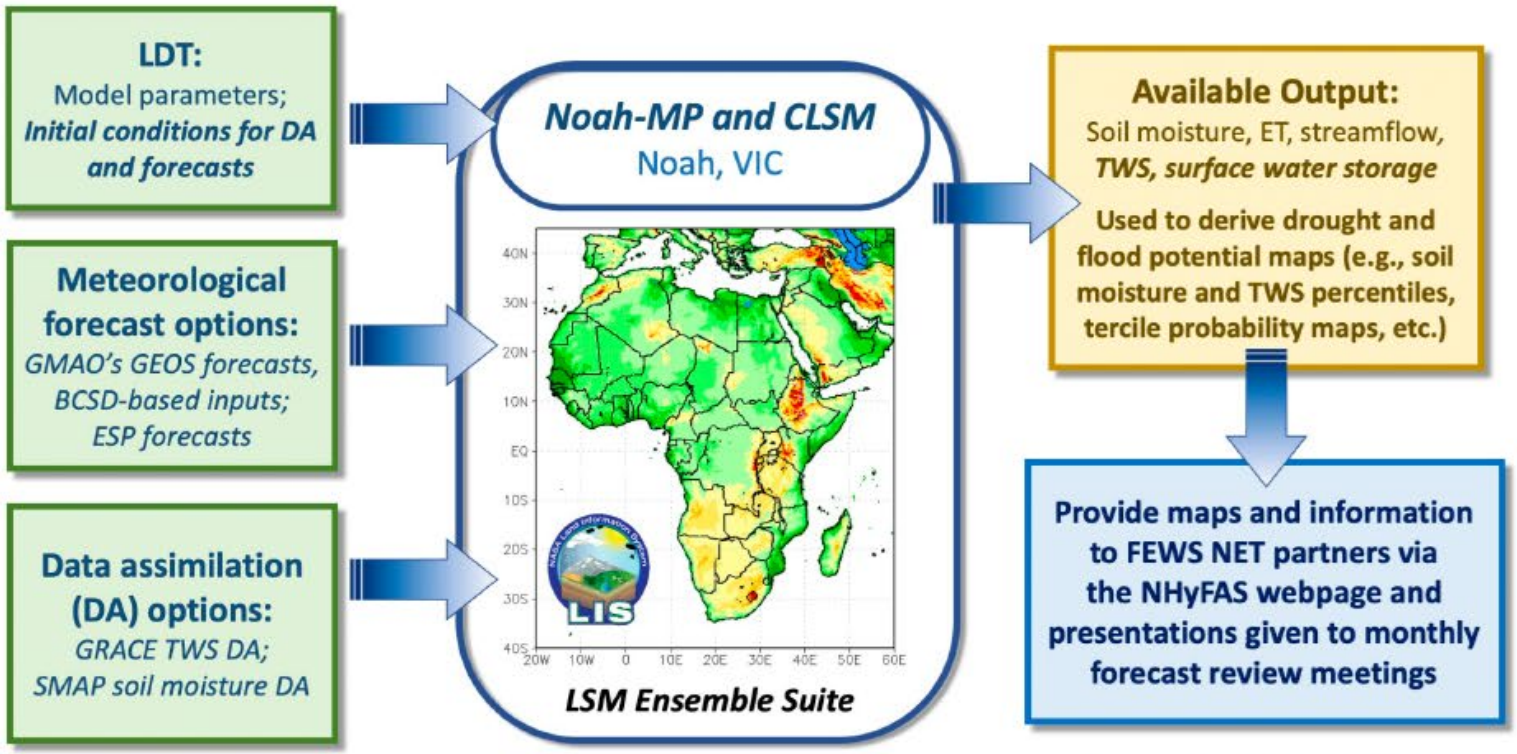
NMME+NHyFAS Background

The North American Multi-Model Ensemble (NMME) provides PRECIPITATION and SURFACE TEMPERATURE forecasts and has been shown to have significantly improved skill over GEOS-only precipitation and surface-temperature forecasts (Shukla et al. 2016 *doi:10.1007/s00382-016-3296-z*).

GEOS - 4 hindcast ensembles
10 forecast ensembles
NMME- 68 hindcast ensembles
98 forecast ensembles

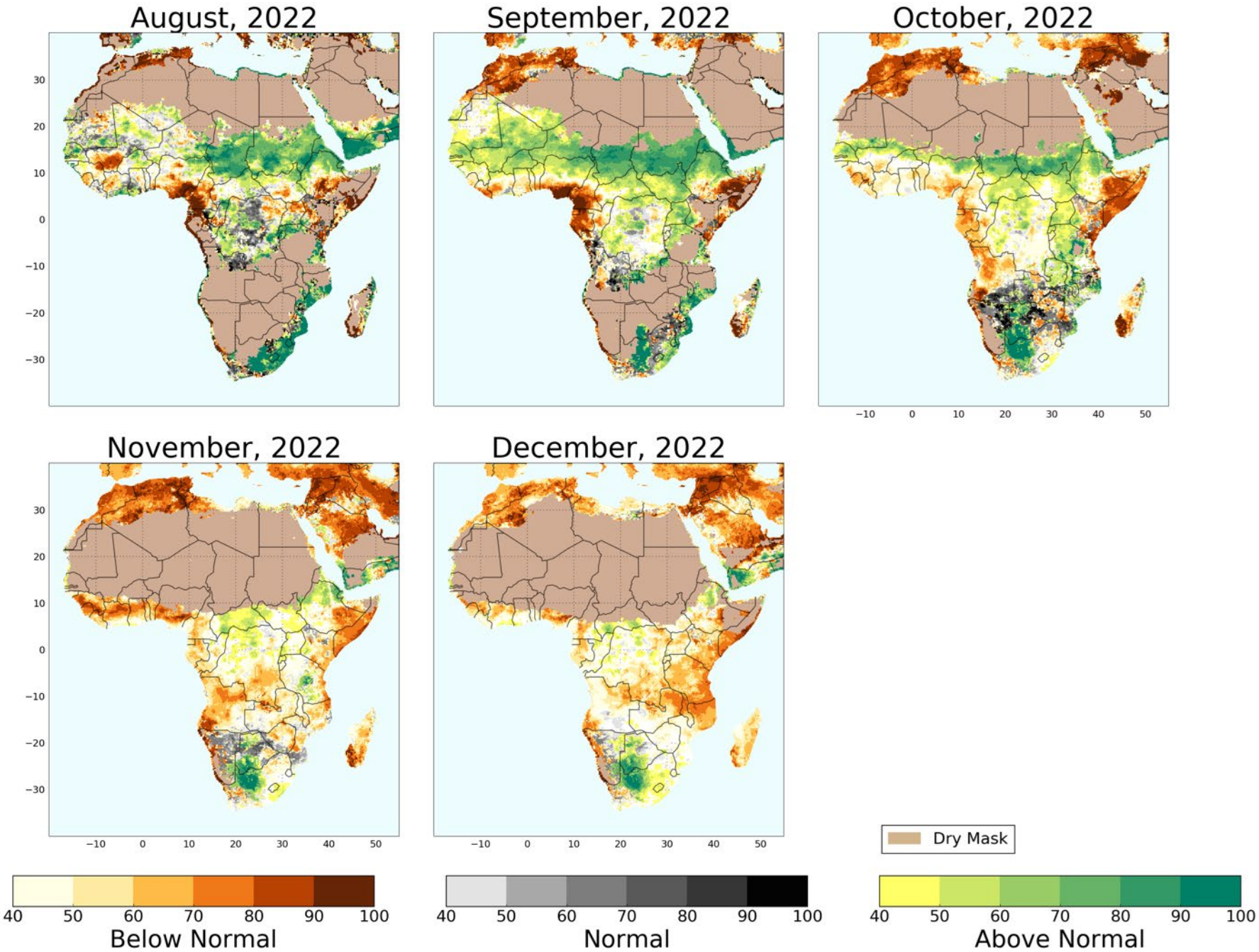
NMME precipitation forecasts

Models	Centers	Hindcast Ens. Mem.	Forecast Ens. Mem.
CFSv2	NOAA/NCEP	24(12)	24
GEOSv2	NASA	4	10
CanCM4i	Environment Canada	10	10
GEM-NEMO	Environment Canada	10	10
CCSM4	NCAR	10	10
GFDL	GFDL	10	10
GFDL-Flor	GFDL	24(12)	24



Arsenault, K. R., Shukla, S., Hazra, A., Getirana, A., McNally, A., Kumar, S. V., ... & Verdin, J. P. (2020). The NASA hydrological forecast system for food and water security applications. *Bulletin of the American Meteorological Society*, *101*(7), E1007-E1025.

NMME Based RootZone-SM Forecasts, Initialized on August 01, 2022



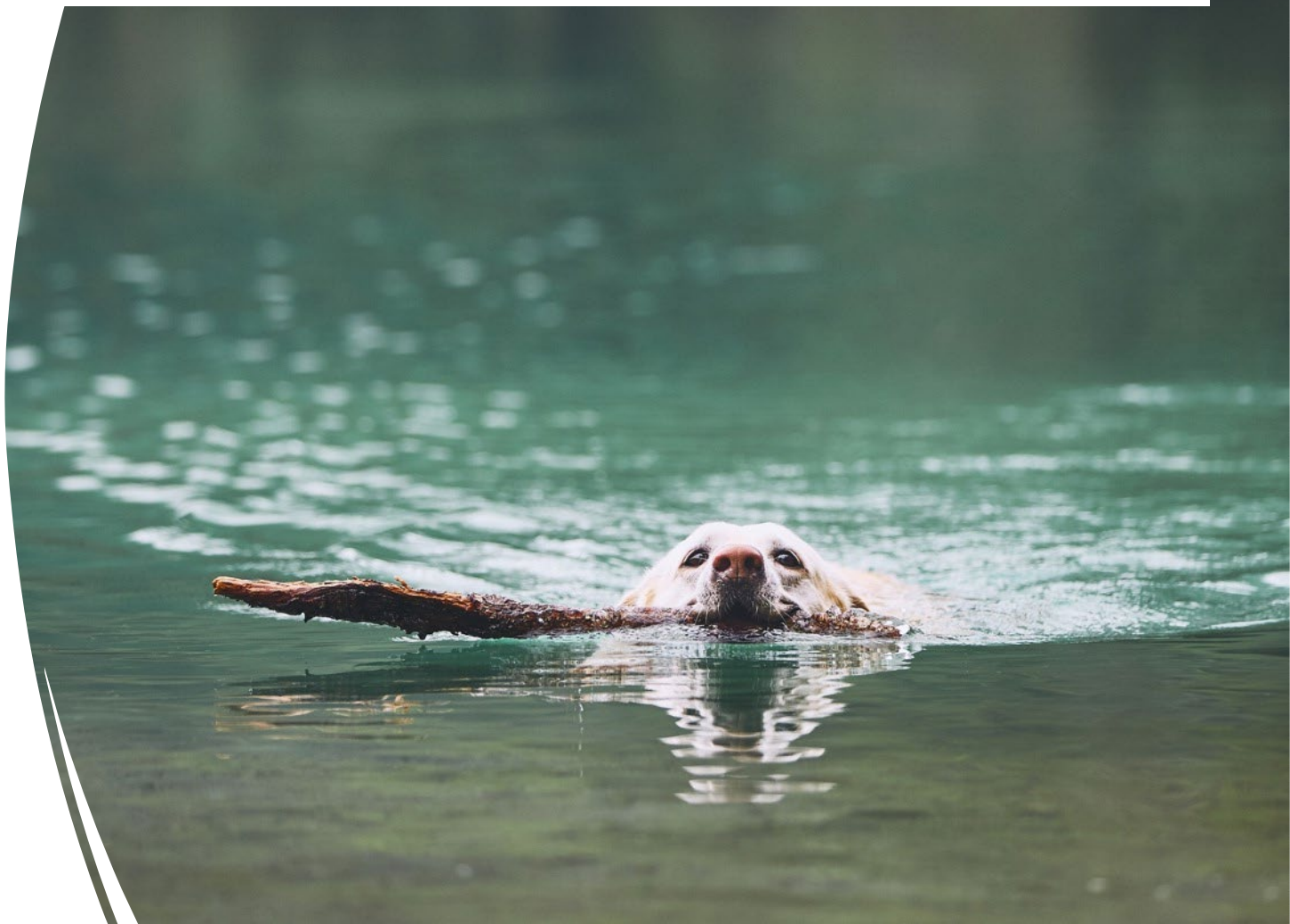
"… we developed a Region-Specific Seasonal Climate Forecast (RSCF–NMME) tool by combining NMME forecasts with regional climatological data. The tool has been applied to the Great Lakes region and utilized as part of operational water-level forecasting procedures by the U.S. Army Corps of Engineers, Detroit District (USACE-Detroit)."

Great Lakes Seasonal Climate Forecast Tool

NOAA-Great Lakes Environmental Research Laboratory

https://www.glerl.noaa.gov/data/climateForecasts/index.html

Bollinger et al. (2017)



Great Lakes Seasonal Climate Forecast Tool (Version 2)

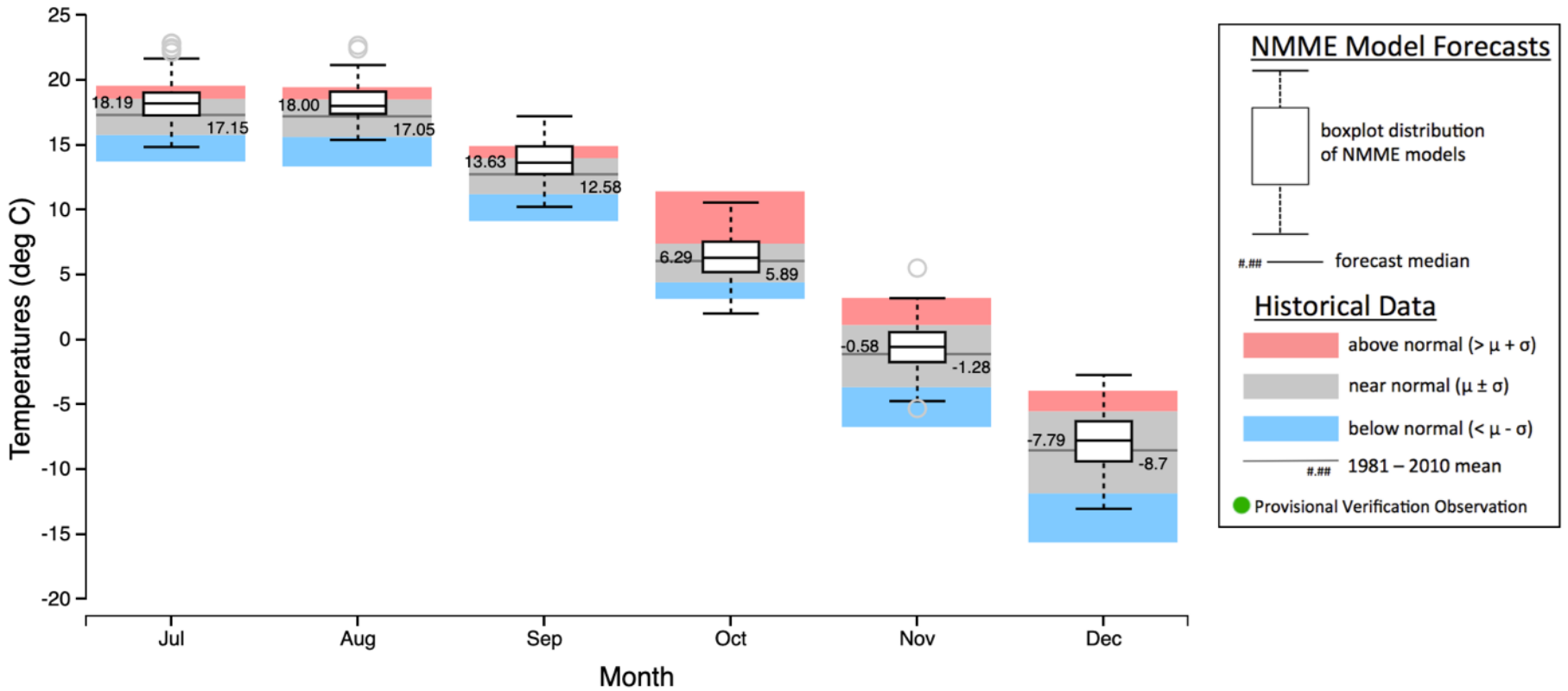
More information and guidance on this product

CSV Archive

Target Basin: Superior | Forecast Initiation Year: 2023 | Month: 6 | GO!

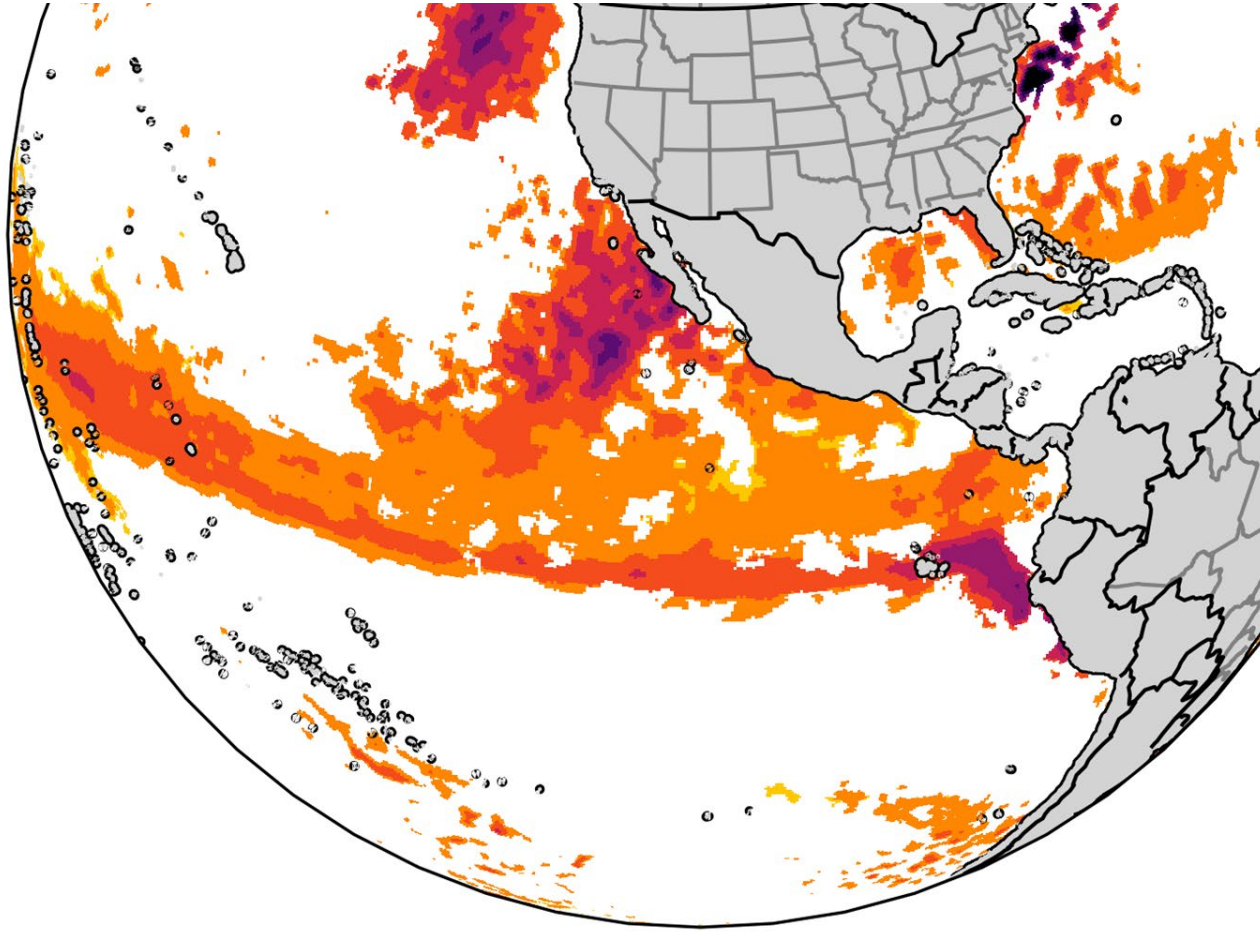
CFSv2 (32) CanCM4i (10) GFDL_SPEAR (30) NASA_GEOS5v2 (10) NCAR_CCSM4 (10) GEM5_NEMO (10)

Select All | Clear All



“Marine heatwaves are periods of persistent anomalously warm ocean temperatures, which can have significant impacts on marine life as well as coastal communities and economies. Scientists at PSL are working to characterize marine heatwaves, understand how they form and dissipate, and predict them in advance. On this page, we will provide current ocean maps, forecasts of heatwaves, interactive tools for users to explore ocean heatwaves themselves, links to research results and to webpages at other institutions.”

Marine heatwaves

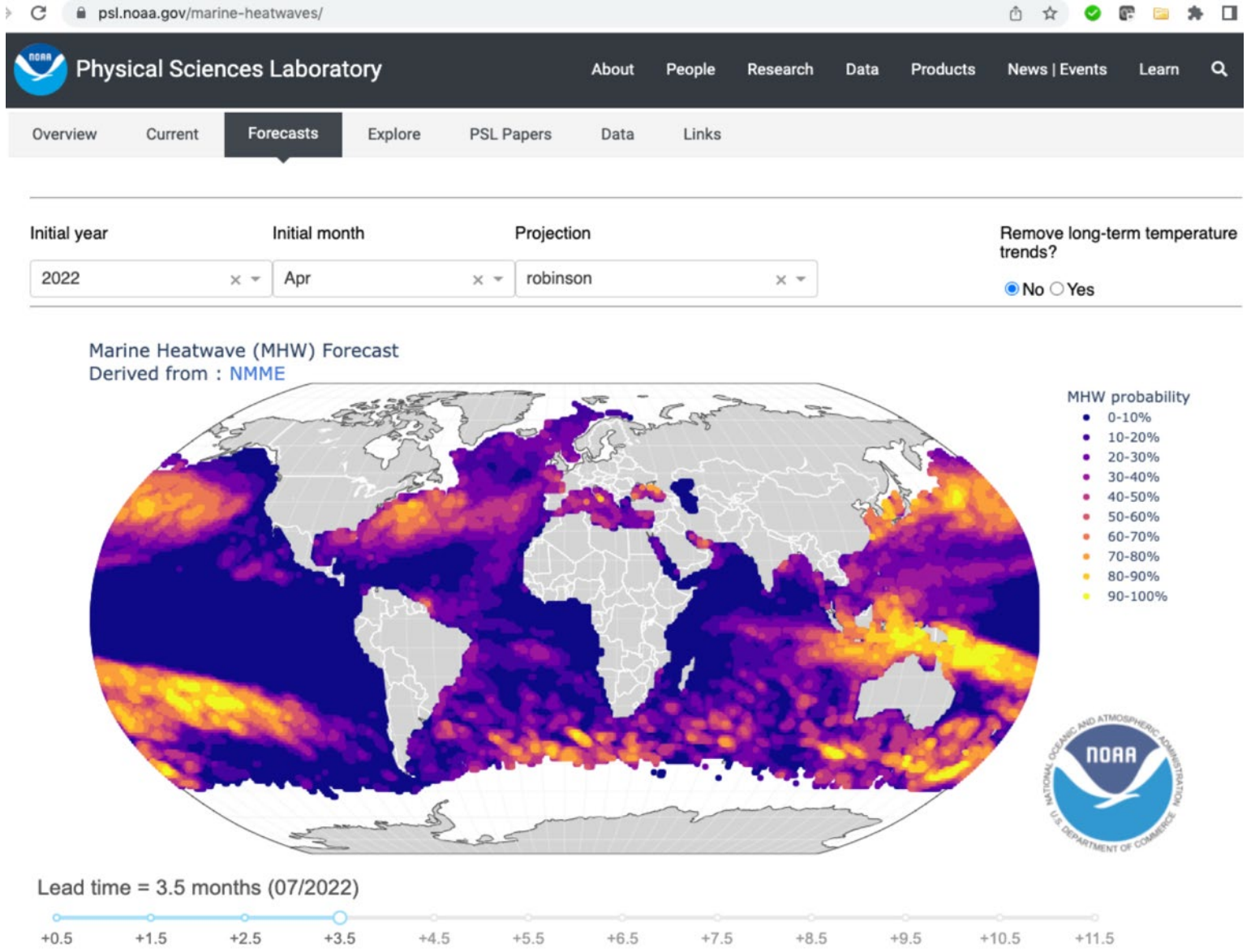


NOAA PSL

https://psl.noaa.gov/marine-heatwaves

Jacox et al. (2022)

- Built on output from the NMME
- >70-member forecast ensemble, using six global climate models
- Forecasts issued monthly
- Lead times up to one year
- Current and past forecasts available online



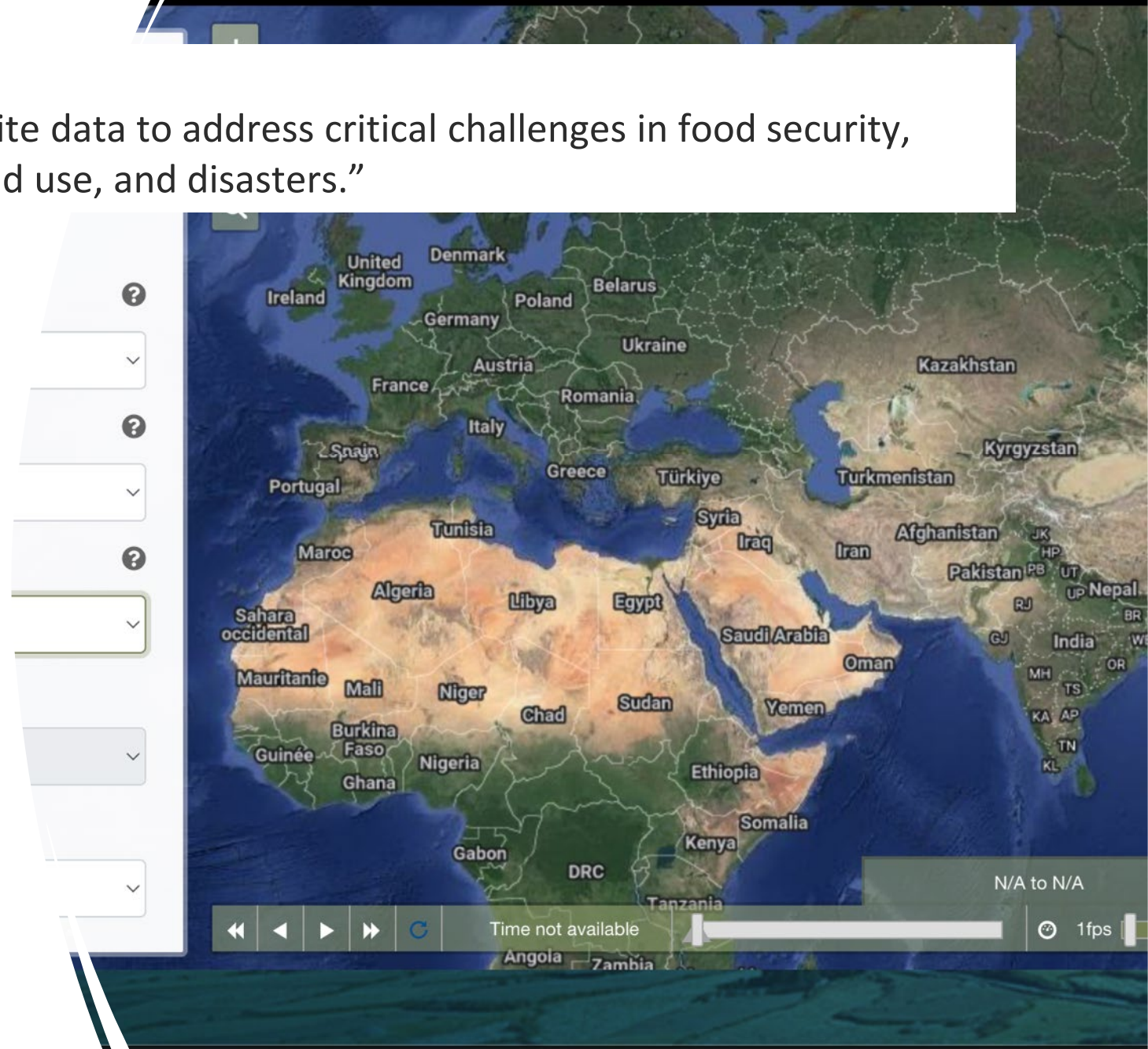
Jacox, M.G., M.A. Alexander, D. Amaya, E. Becker, S.J. Bograd, S. Brodie, E.L. Hazen, M. Pozo Buil, D. Tommasi (2022), Global seasonal forecasts of marine heatwaves, Nature 604, 486-490.

“SERVIR connects space to village...
by helping developing countries use satellite data to address critical challenges in food security, water resources, weather and climate, land use, and disasters.”

SERVIR Global

NASA, USAID, international organizations

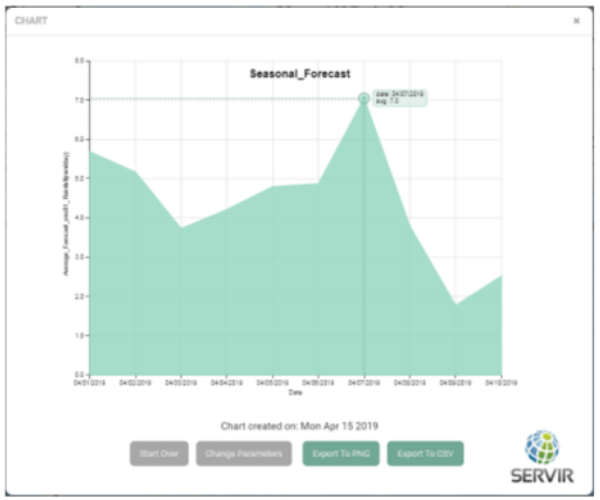
https://climateserv.servirglobal.net/



SERVIR GLOBAL REGIONS SERVICE CATALOGUE DATA & MAPS TRAINING ABOUT SERVIR NEWS MULTI

Data Catalog

SERVIR GLOBAL



NMME Seasonal Forecasts

The North American Multi-Model Ensemble (NMME) generates global, seasonal forecasts every month for several important climatic variables. Forecasts of precipitation and temperature are bias corrected and downscaled to a higher resolution (0.5x0.5) to support application models (e.g. hydrologic and crop production models). Ten individual ensembles are extracted from a subset of the NMME models. These are bias corrected to the Princeton Global Meteorological Forcing Dataset (PGF) climatologies for precipitation and temperature. The monthly, bias-corrected data are then dis-aggregated to daily resolution using a bootstrap re-sampling of the PGF dataset for corresponding months from the historical record. Each month of the forecasts is dis-aggregated independent of one another. The forecasts are available out to 6 months and the data can be viewed or downloaded from the SERVIR ClimateSERV application referenced below.For more information on SERVIR, visit https://www.servirglobal.net

DOWNLOAD METADATA PRINT METADATA DOWNLOADS

"This facility aims to explore and inform users about the climate-health relationship with an emphasis on the seasonal nature of that relationship, where appropriate."

Environmental suitability for Aedes-borne disease

https://iridl.ldeo.columbia.edu/maproom/Health/index.html

Muñoz et al. (2020)

The International Research Institute for Climate and Society

Climate and Diseases: AeDES

Climate and Aedes: Environmental Suitability Flexible Seasonal NextGen Forecast

Region: ---

Field: Environmental Suitability Monitor

Options: This year so far

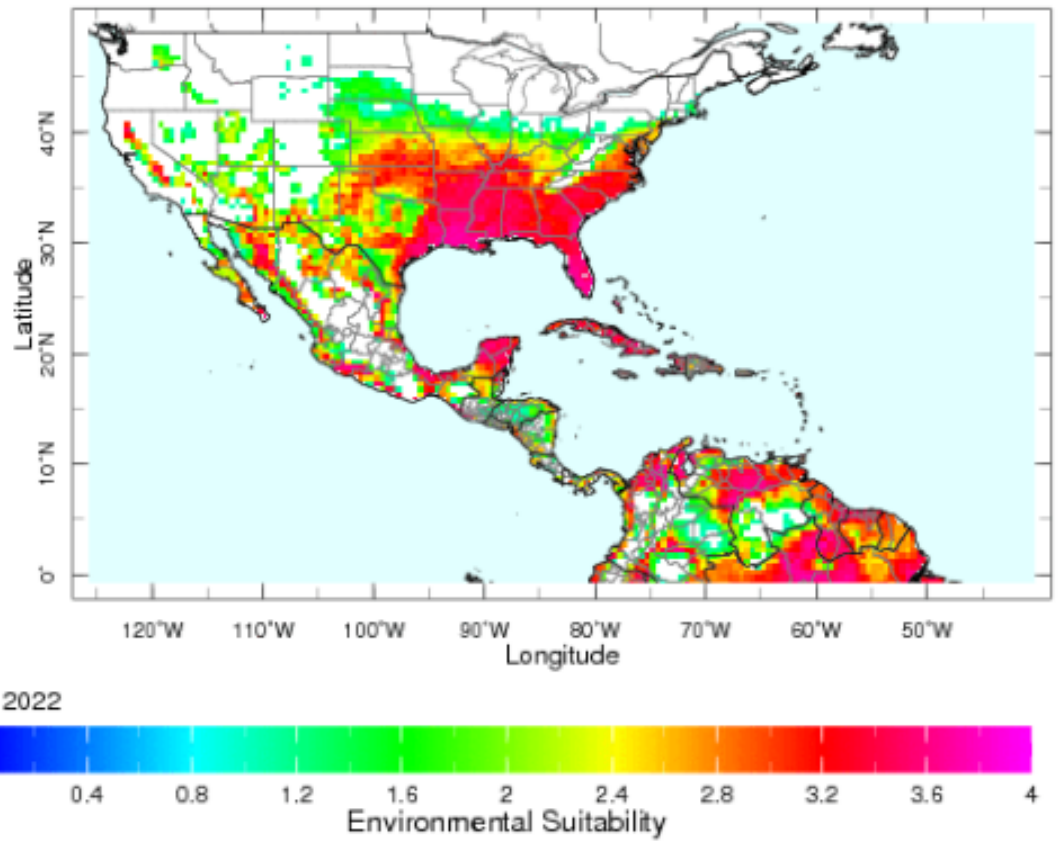
Description | Dataset Documentation | Instructions | Contact Us

Environmental Suitability Flexible Seasonal NextGen Forecast

The Aedes-borne Disease Environmental Suitability (AeDES) Maproom offers interactive maps showing environmental suitability for the conterminous US, Mexico, Central America, northern South America and the Caribbean, for the 1948 to present, at a monthly timescale. It also includes additional information to provide context to the user: infant mortality, population density, and typical seasonality of key climate variables.

The forecast sub-system offers environmental suitability seasonal (3 months) forecasts of the actual expected values for a location, and also probabilistic forecasts to convey prediction uncertainties. Furthermore, probability of exceeding user-defined thresholds are also computed on the fly for the entire region of interest or for particular locations.

Use the mouse to define regions or to click over a particular location, and the upper menu to select the fields and thresholds of interest.



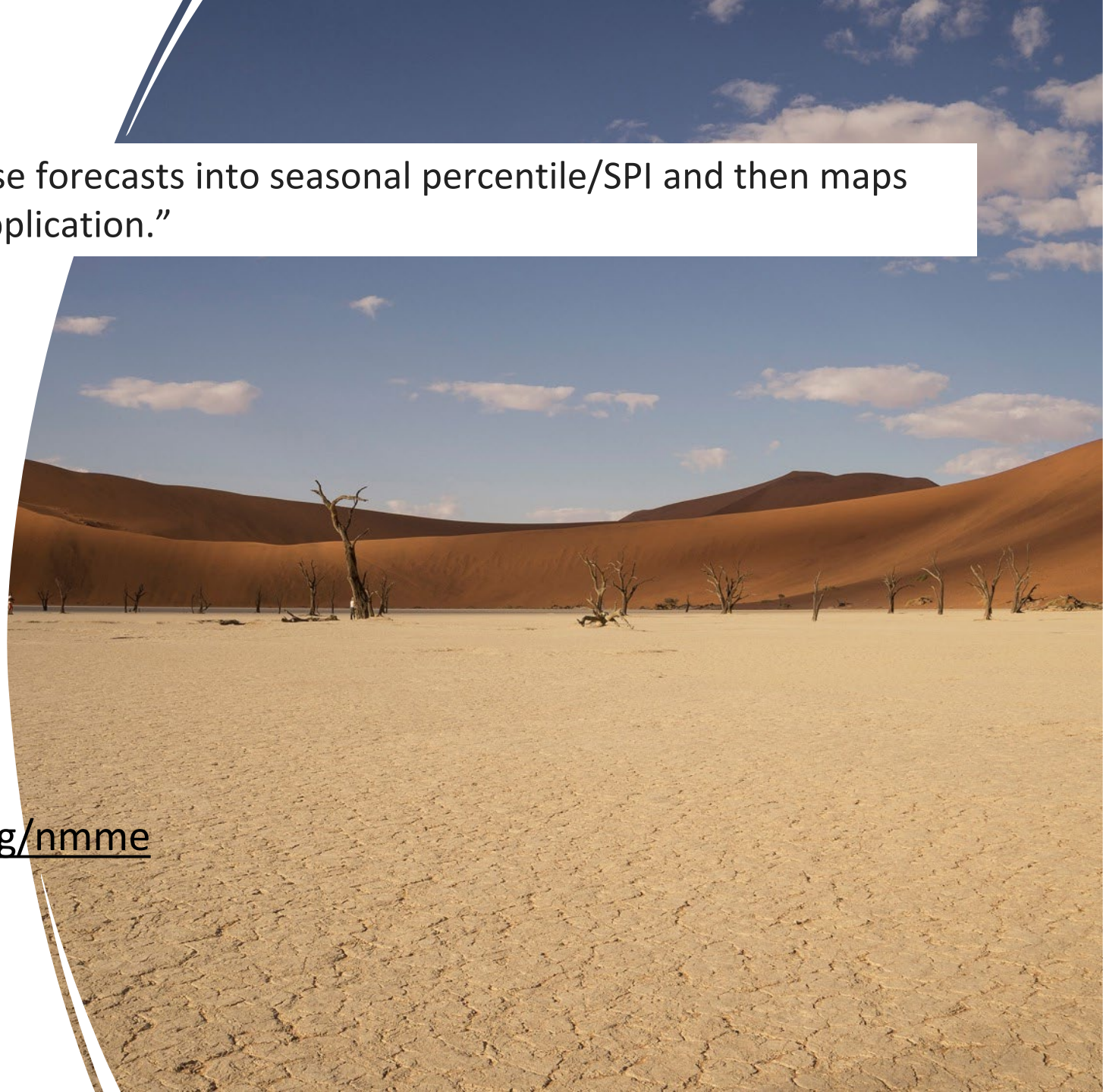
“The Climate Hazards Center converts these forecasts into seasonal percentile/SPI and then maps them to allow for easy visualization and application.”

Climate hazards

UCSB Climate Hazards Center

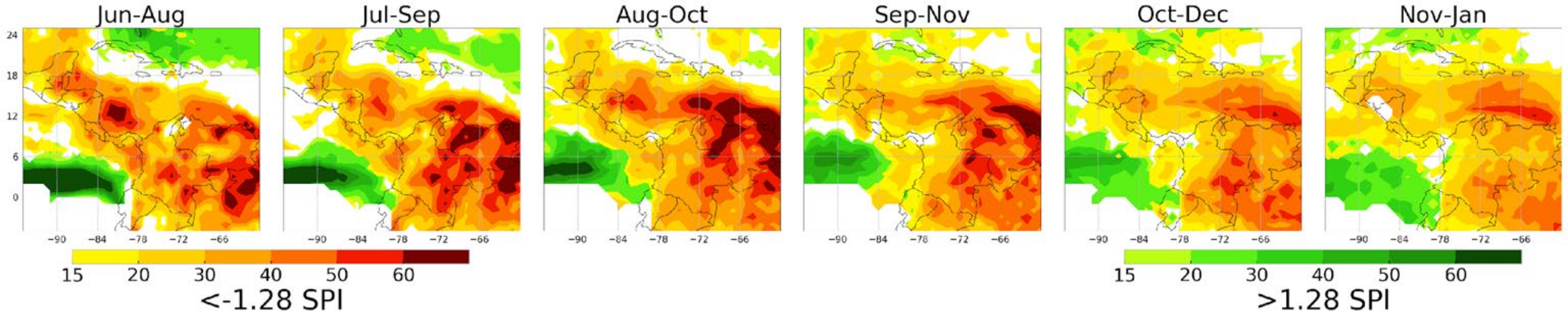
https://www.chc.ucsb.edu/monitoring/nmme

Shukla et al. (2016)



3-month SPI forecast starting in Jun,2023

Based on 44 ensemble members



3-month SPI forecast starting in Jun,2023

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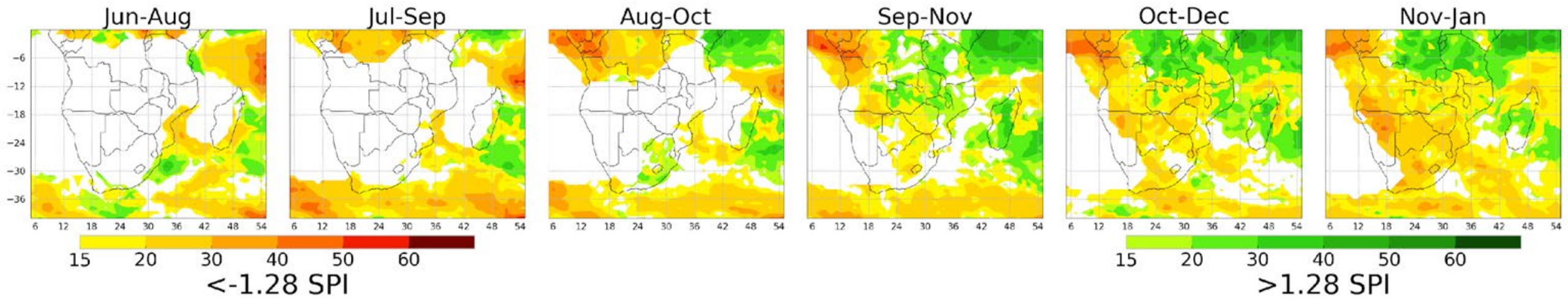
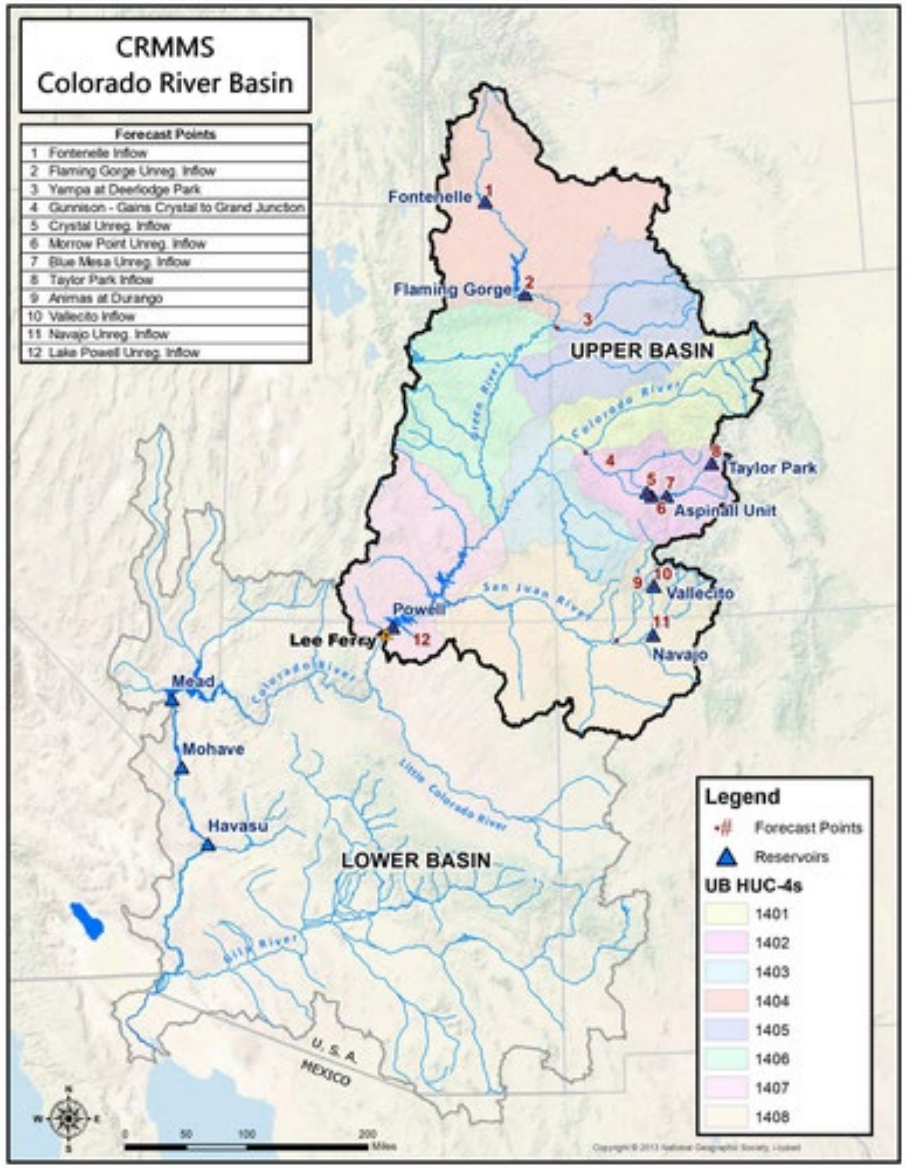
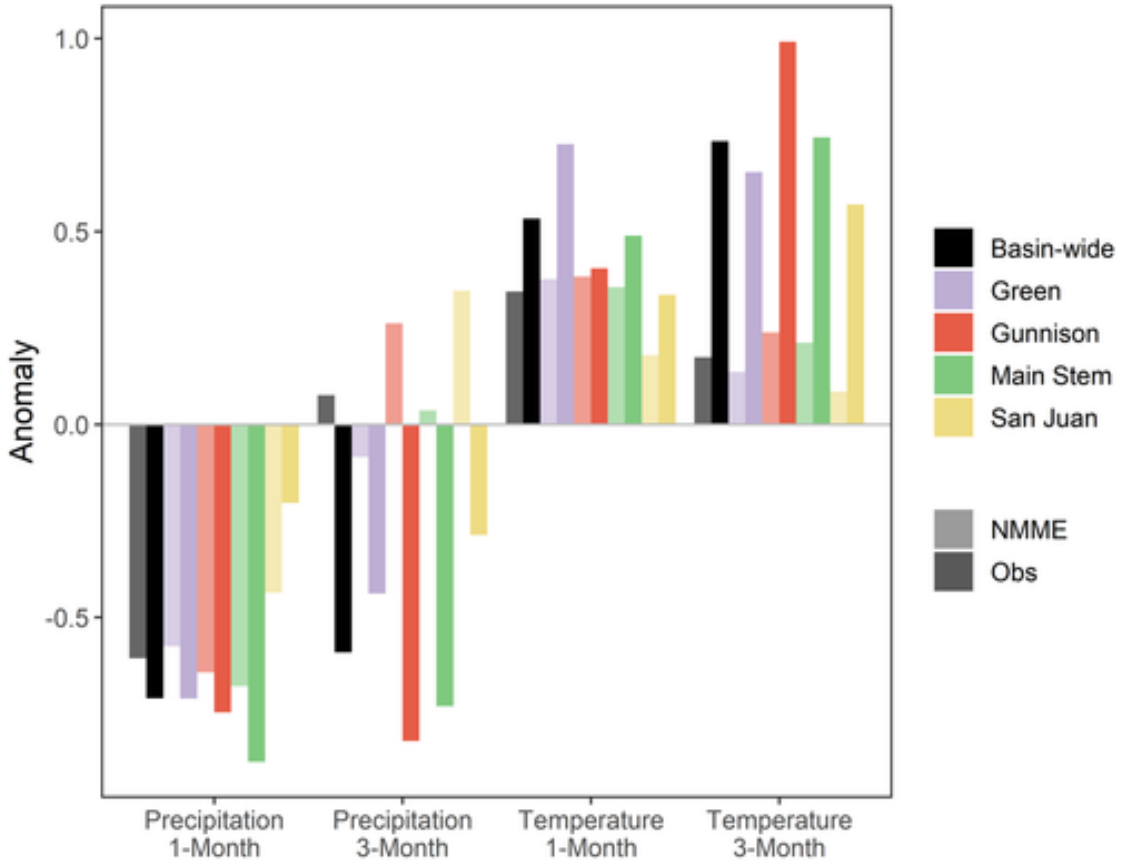


Potential application: Colorado River Basin

Slides from Sarah Baker, Bureau of Reclamation

Baker et al. (2021)





Baker, S. A., Rajagopalan, B., & Wood, A. W. (2021). Enhancing Ensemble Seasonal Streamflow Forecasts in the Upper Colorado River Basin Using Multi-Model Climate Forecasts. *JAWRA Journal of the American Water Resources Association*, *57*(6), 906-922.

Potential application: coastal sea level

Slides from Thomas Frederikse

Frederikse et al. (2022)

A hybrid dynamical approach for seasonal prediction of sea level:

A pilot study for Charleston, South Carolina

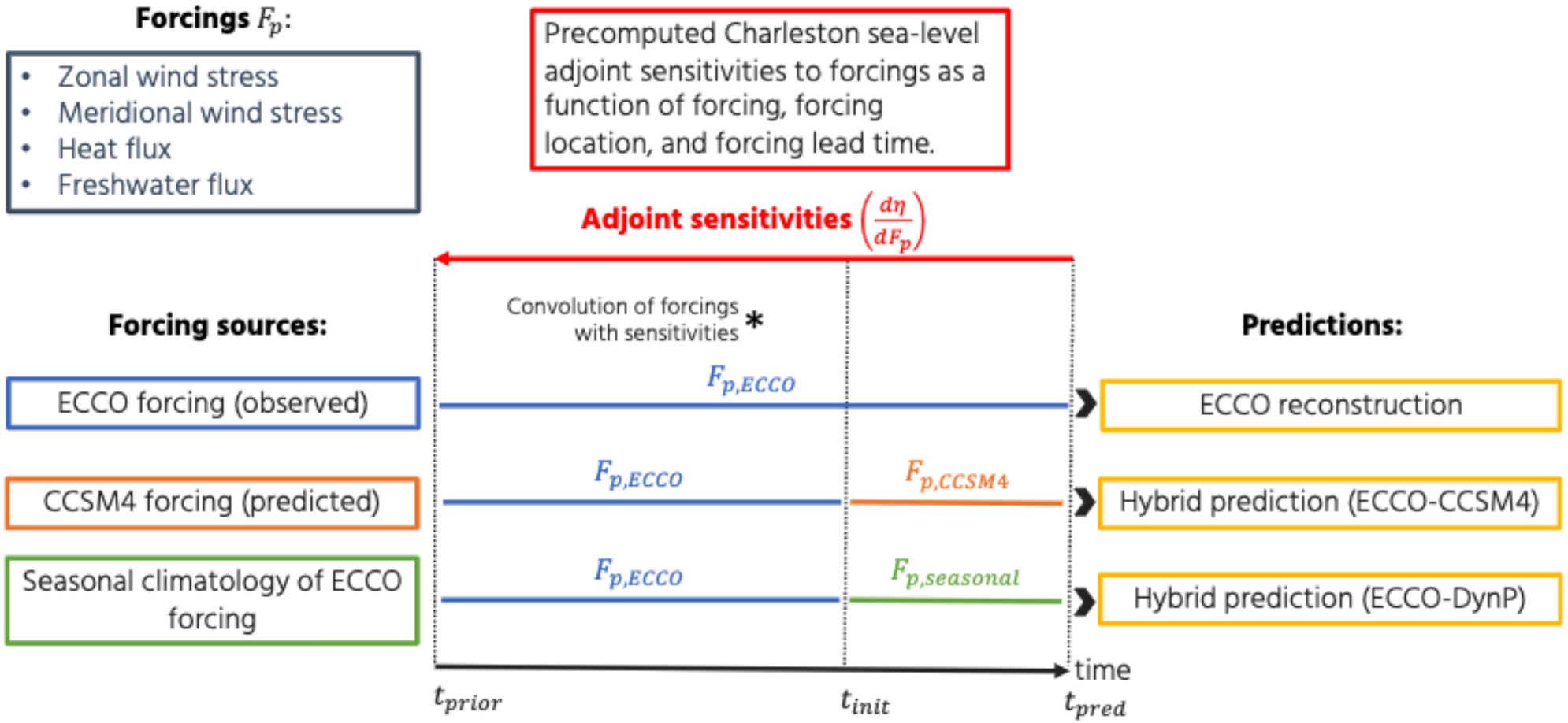
JPL:
Thomas Frederikse, Tong Lee, Ou Wang, Ben Hamlington, Daniel Limonadi, Duane Waliser,

University of Miami:
Ben Kirtman, Emily Becker

Main idea of this approach:

Combine pre-computed sea-level sensitivities to forcings with predicted forcing anomalies

Jet Propulsion Laboratory
California Institute of Technology

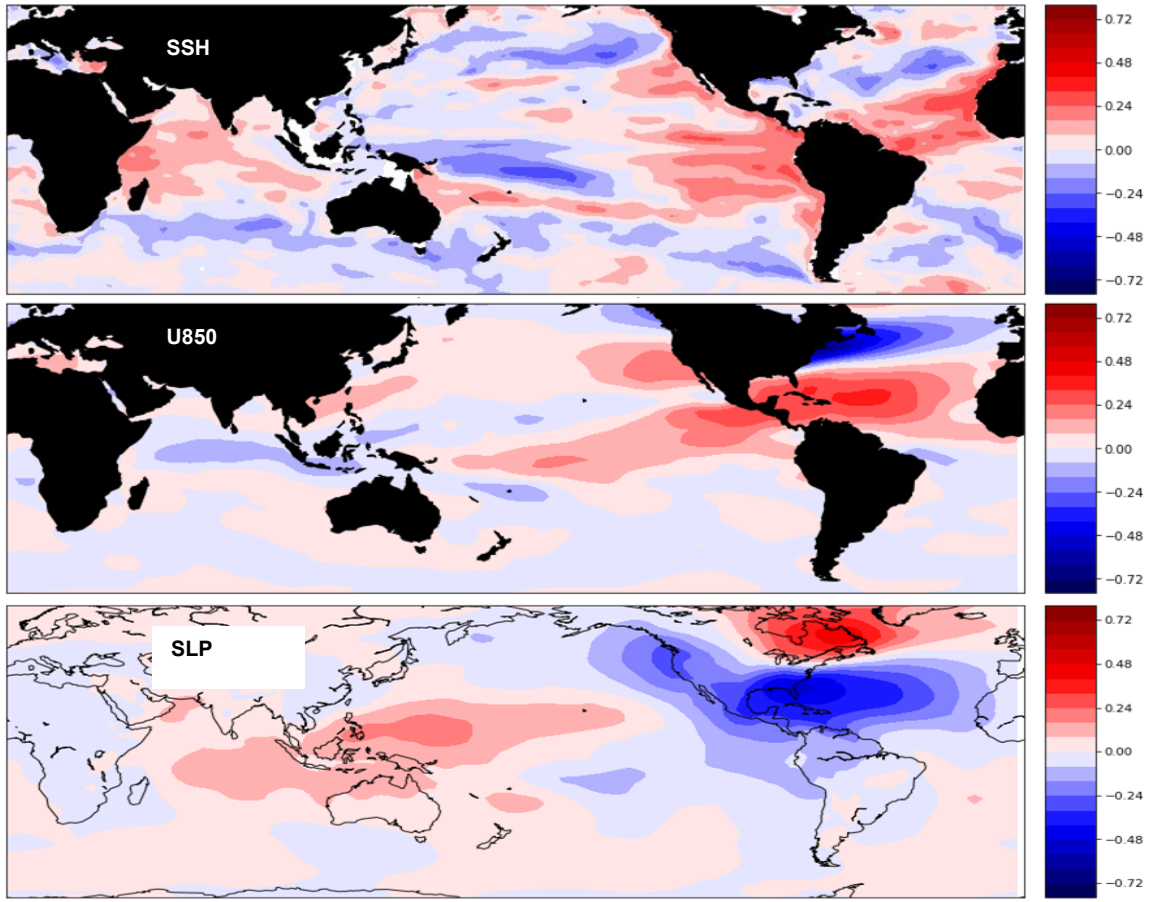


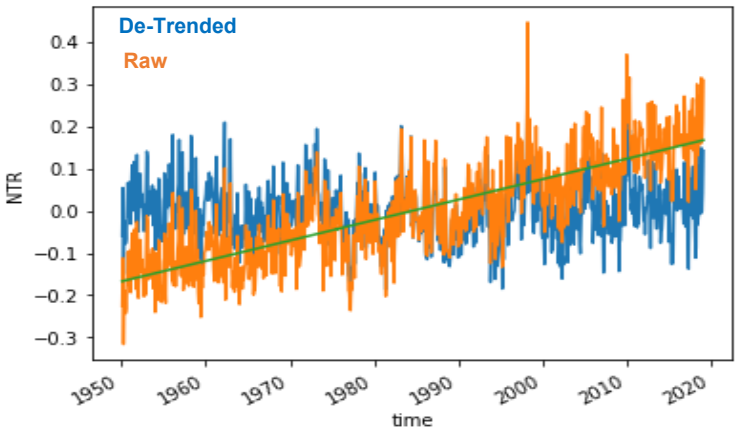
Frederikse, T., Lee, T., Wang, O., Kirtman, B., Becker, E., Hamlington, B., ... & Waliser, D. A hybrid dynamical approach for seasonal prediction of sea-level anomalies: A pilot study for Charleston, South Carolina. *Journal of Geophysical Research: Oceans*, e2021JC018137.

Potential application: coastal flood risk

University of Miami
Rosenstiel School

1. *Diagnose the monthly to seasonal to interannual sources and mechanisms of predictability from internal climate variability, including ocean current variability*
2. *Development of a prototype system for actionable coastal flood risk prediction using the NMME*





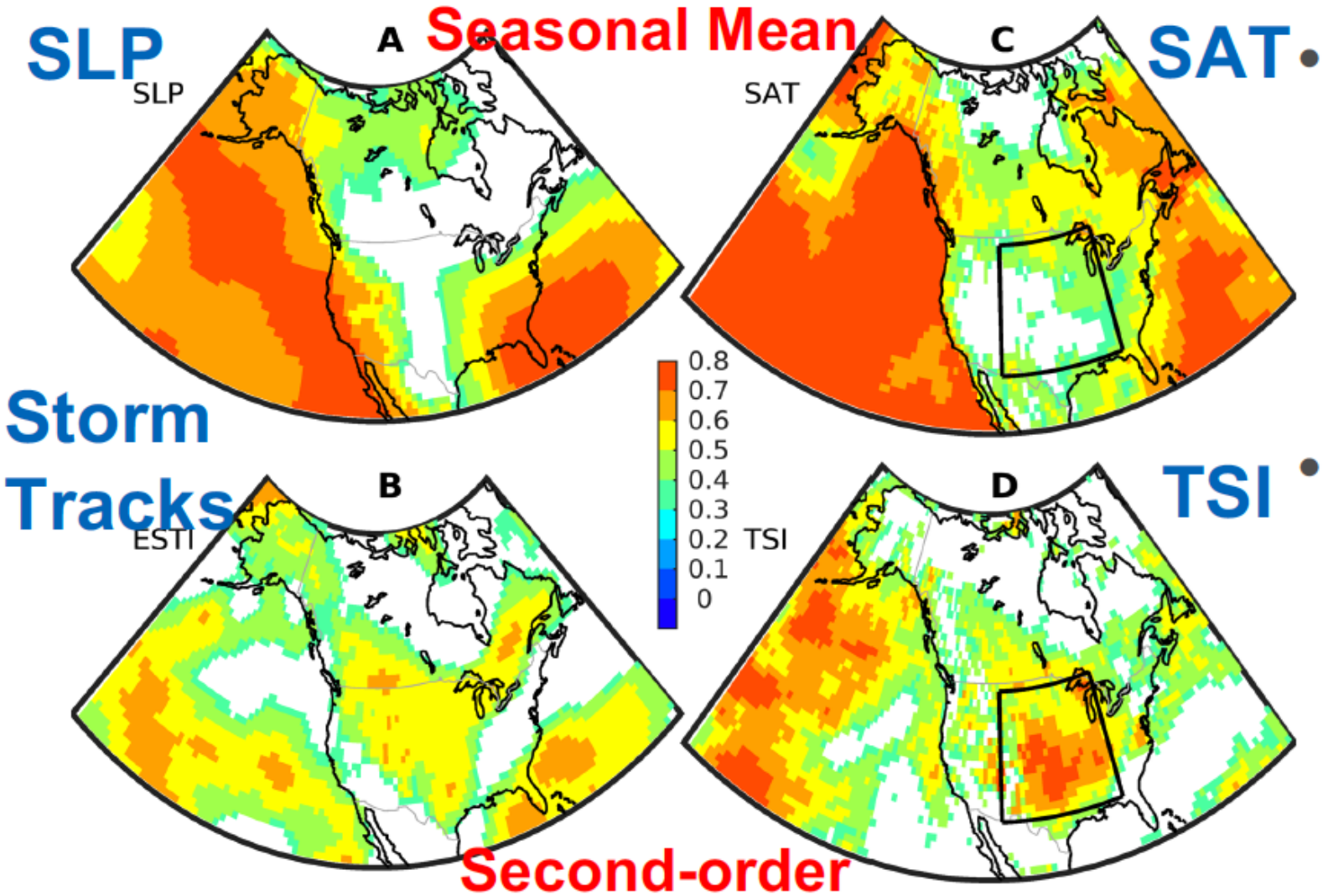
Right: raw and de-trended monthly mean non-tidal residual (NTR) for Norfolk Virginia. Above: linear correlation coefficients between monthly mean February NTR and SSH, 850mb zonal winds (U850), sea level pressure (SLP), respectively. Data is for 1982-2015.

Potential application: winter temperature swings

Slides from Xiaosong Yang, GFDL

Yang et al. (2022)

Correlation Skill of predicting extratropical storm tracks and temperature swings during the DJF season



- The skill patterns of both ESTI and TSI, as second-order climate statistics, shows geographically distinct from those of their corresponding first-order statistics, i.e., the seasonal mean SLP and SAT.
- The combination of seasonal mean and second-order statistics provides complementary useful climate predictions for a variety of end users.

Outlook for 2022-23 winter: Storm tracks and TSI

Stormy and above-normal TSI over central North America