

# *ISSE Research Frontiers* Climate Change

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# ISSE Climate Change Research Initiative

## ➤ Mission:

- Climate change is one of the most critical challenges faced by humans and our planet.
- Researchers at ISSE, working closely with the Climate Change Science Institute at Oak Ridge National Lab, are *advancing our understanding of climate change and its impacts on human and natural systems.*

## ➤ Research Area

Vegetation, wildfires, water availability, drought, soil moisture, etc.



[Whitney Forbes](#)



[Rongyun Tang](#)



[Yaoping Wang](#)



[Yulong Zhang](#)



[Jiafu Mao](#)



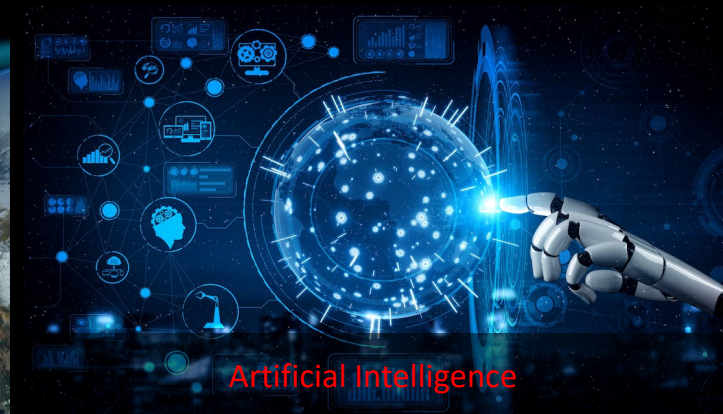
[Joshua Fu](#)



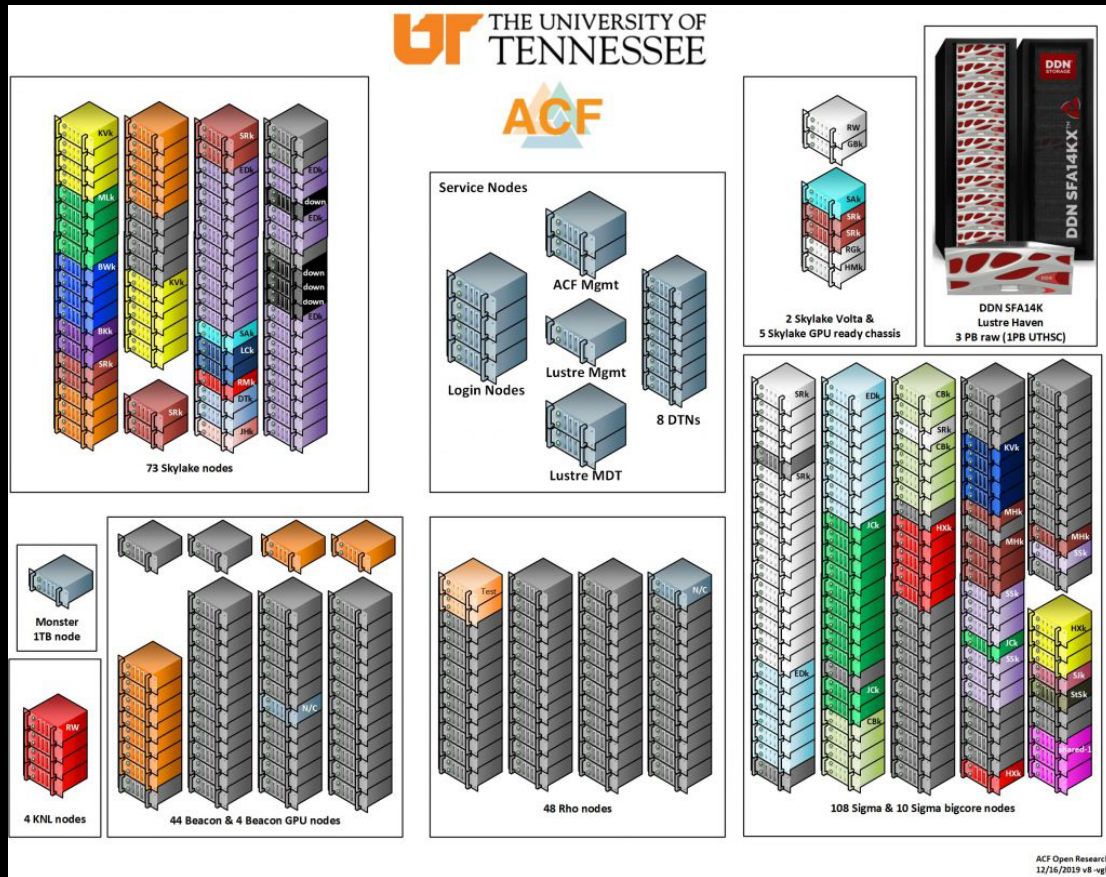
[Mingzhou Jin](#)



# Key feature of ISSE Climate Change Center: Conjunction of RS, AI & ESM



# Empowered by High Performance & Scientific Computing Resources from UT & ORNL



- CPU
- GPU
- Massive storage
- Parallel computing

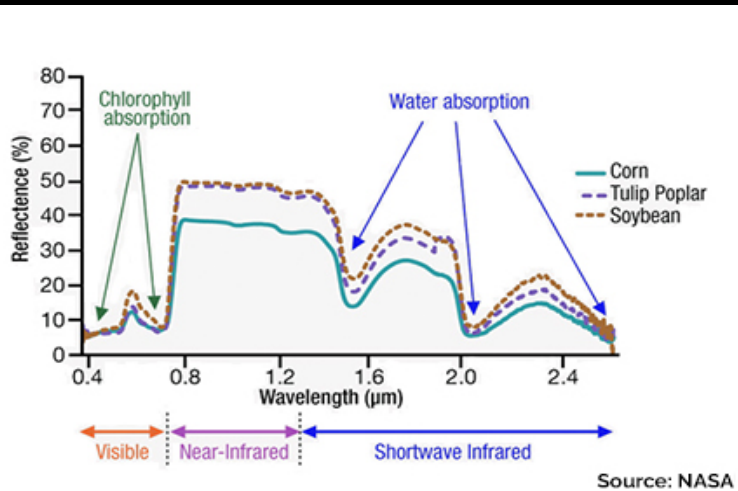
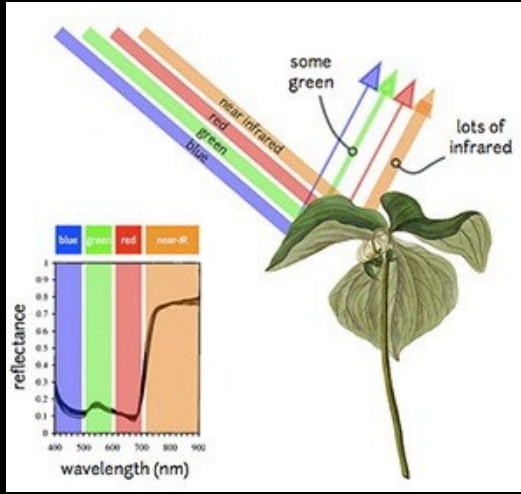


## UT: Advanced Computing Facility (ACF)

The former ACF has been rebranded and is now called **ISAAC** (Infrastructure for Scientific Applications and Advanced Computing)



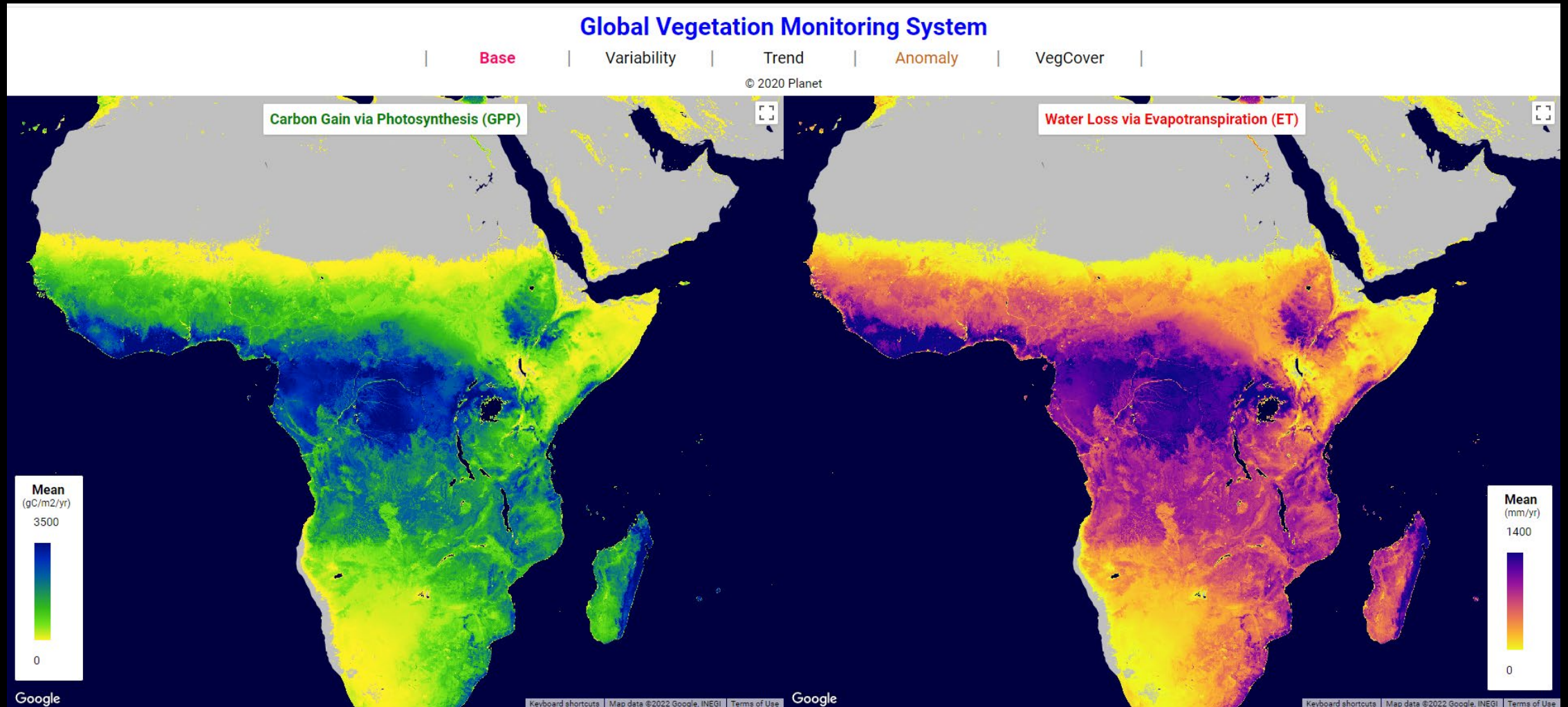
# Monitoring Global Vegetation Activity Based on Remote Sensing



Full Animation: <https://www.youtube.com/watch?v=Kvh--ydNVR8>

Mao et al. (2016, *Nature Climate Change*)  
Zhang et al. (2017, *Remote Sensing of Environment*)

# Quantify Global Carbon & Water Dynamics



GEE App: <https://planetlab.users.earthengine.app/view/gvmsccw>

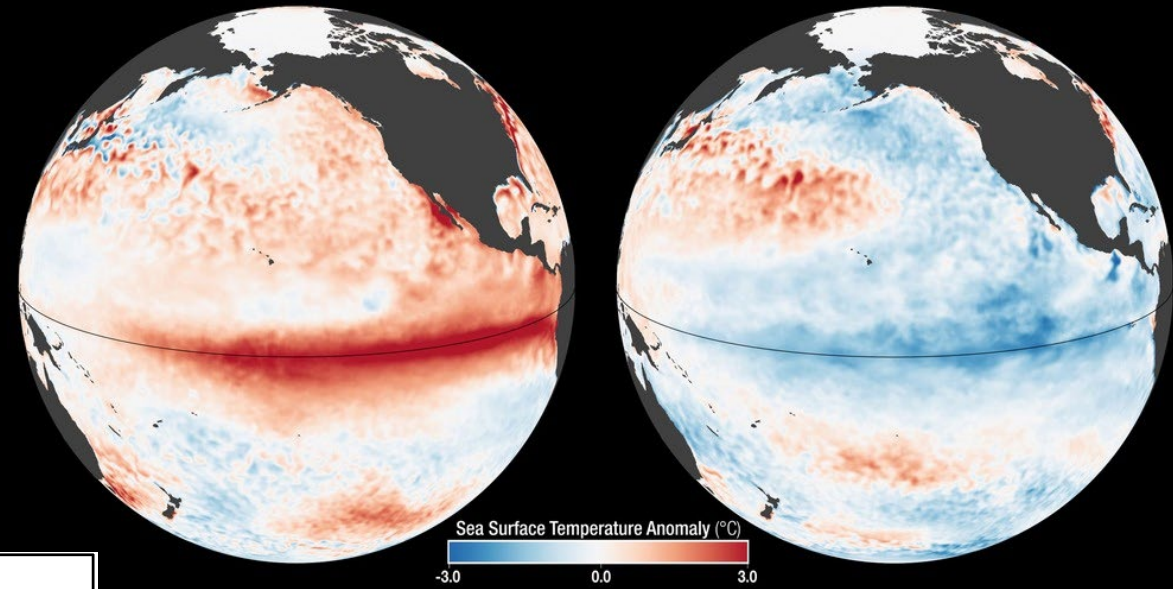
Zhang et al. (2019a, JGR-B)



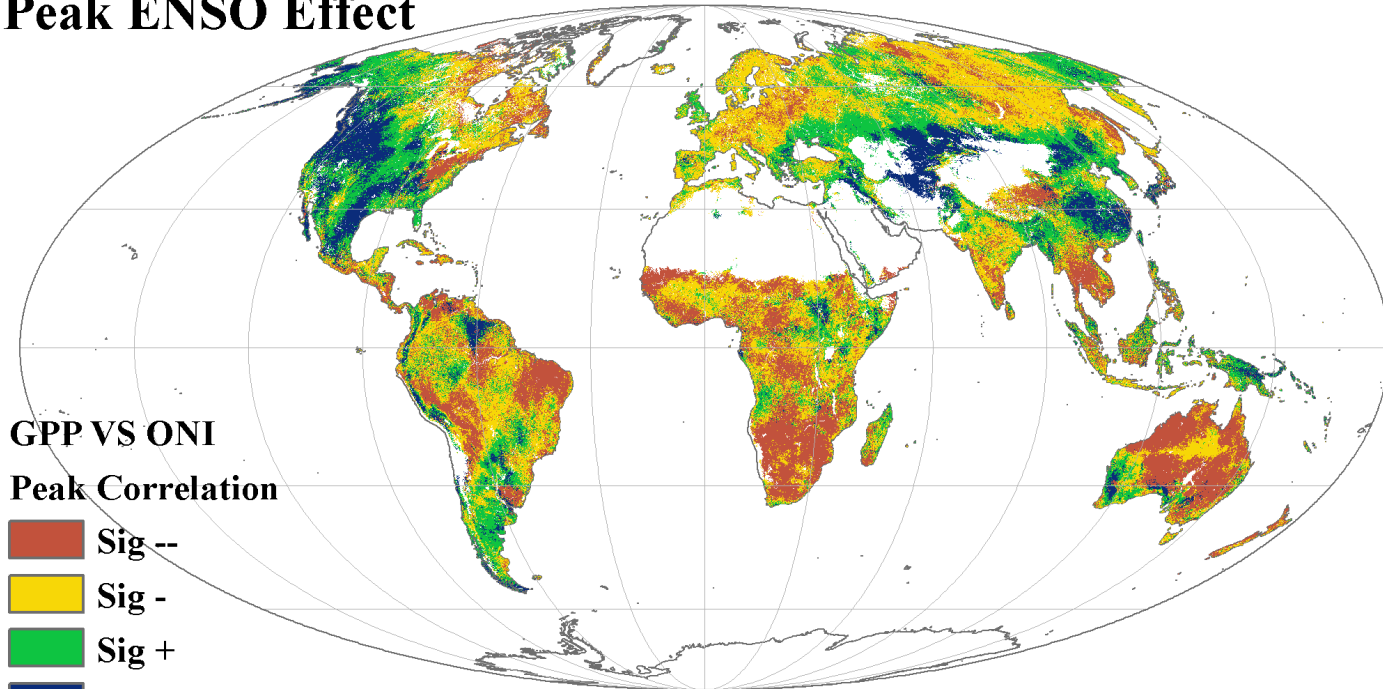
# Impacts of ENSO on Global Carbon Uptake

El Niño  
December 2015

La Niña  
December 1999



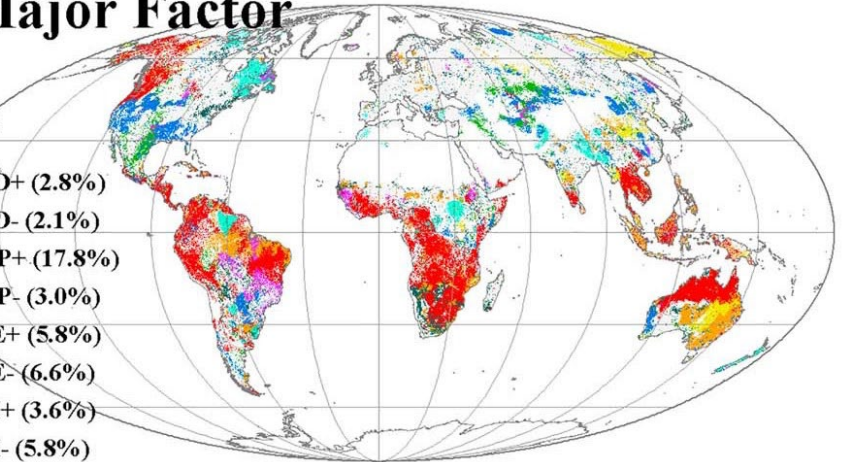
## Peak ENSO Effect



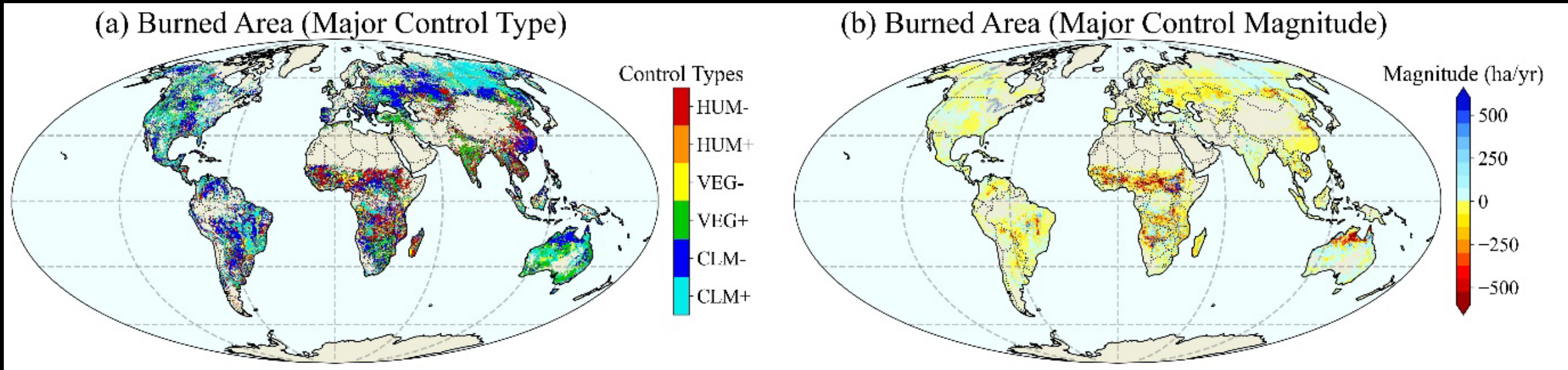
## (e) Major Factor

### Factor

- RAD+ (2.8%)
- RAD- (2.1%)
- TMP+ (17.8%)
- TMP- (3.0%)
- PRE+ (5.8%)
- PRE- (6.6%)
- LAI+ (3.6%)
- LAI- (5.8%)



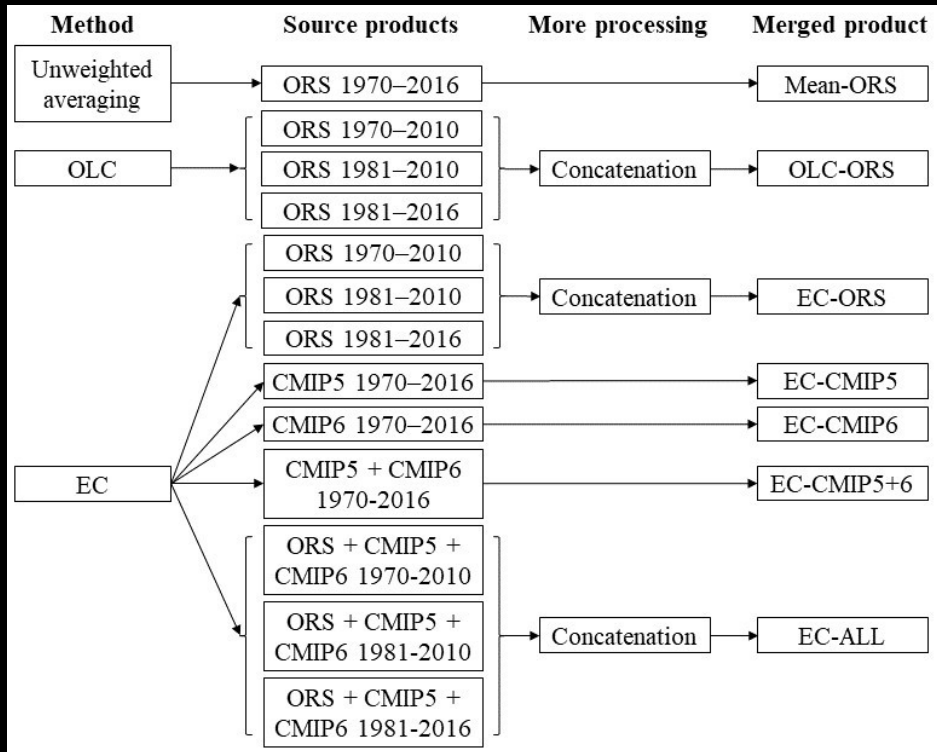
# Global Wild-fire Modeling & Control Attribution



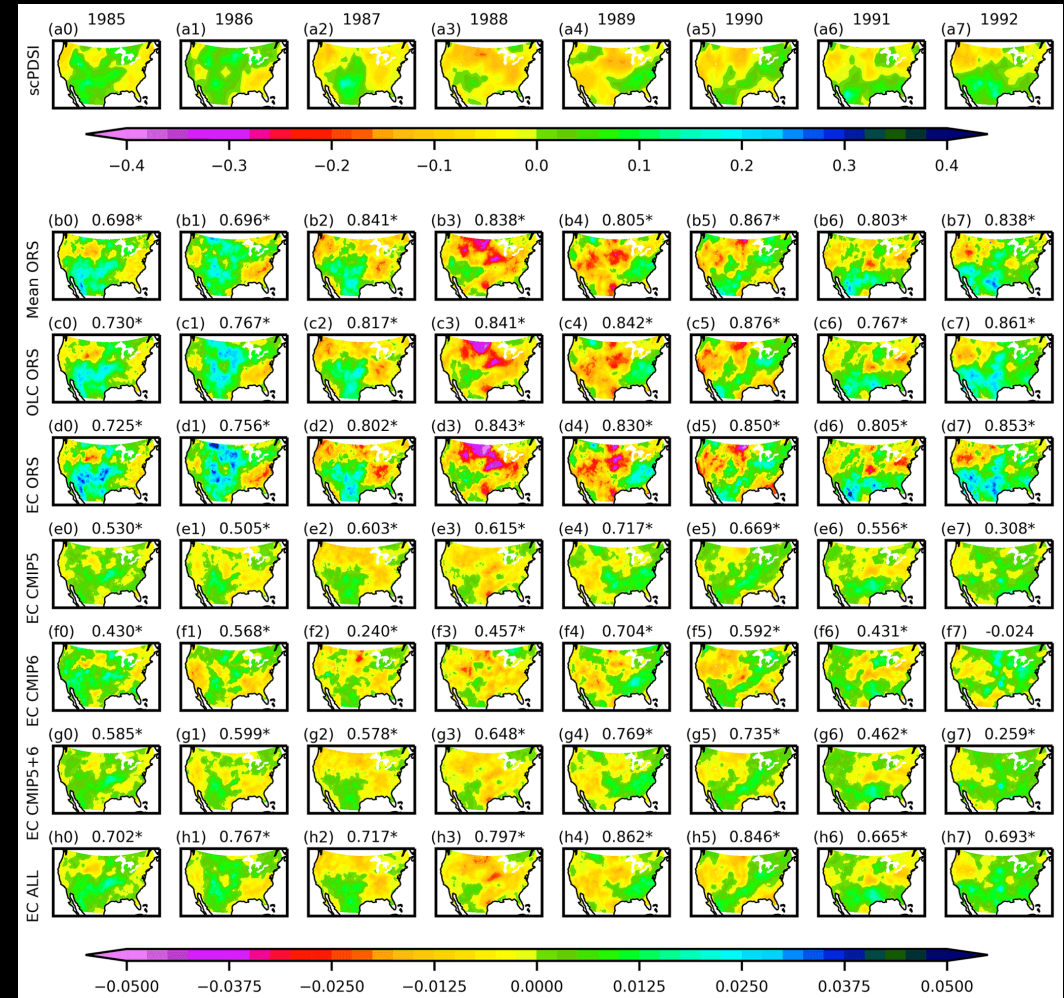
*Machine-learning-based approach revealed global fire controls related to climate, vegetation and human activity*



# Development of Observation-based Global Multilayer Soil Moisture Products

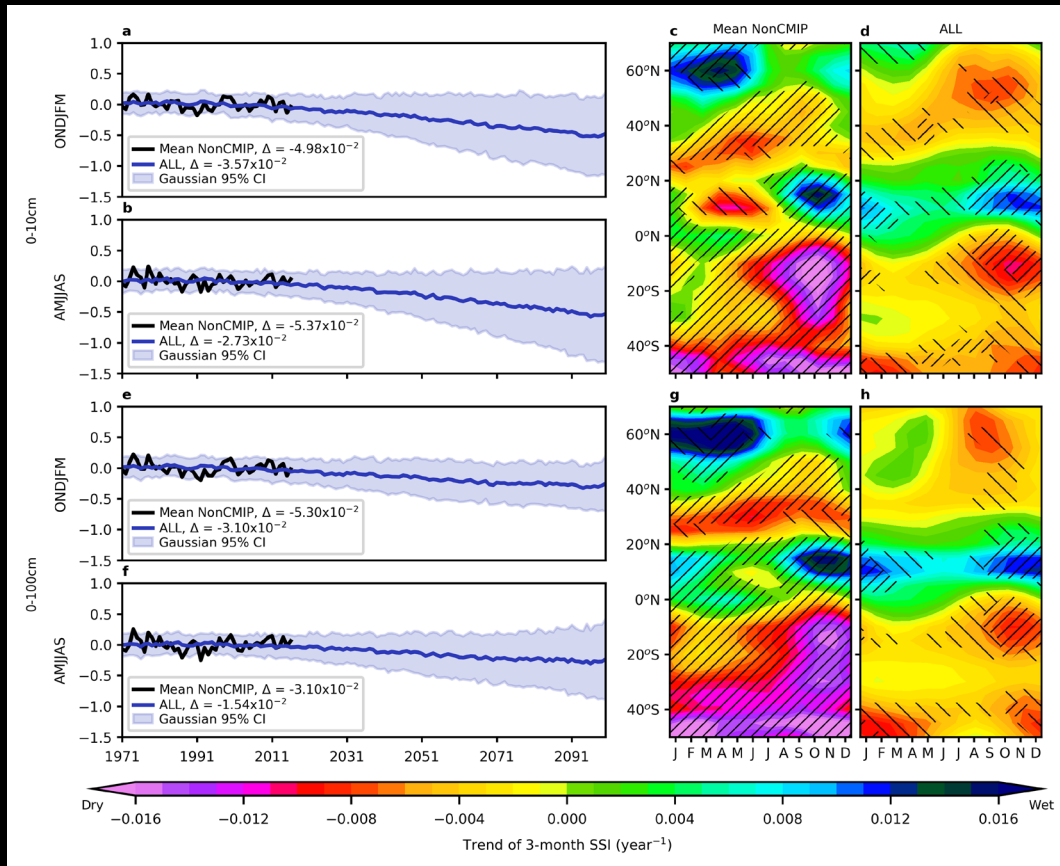


Seven global, gap-free, long-term (1970–2016), multilayer (0–10, 10–30, 30–50, and 50–100 cm) SM products at monthly 0.5° resolution

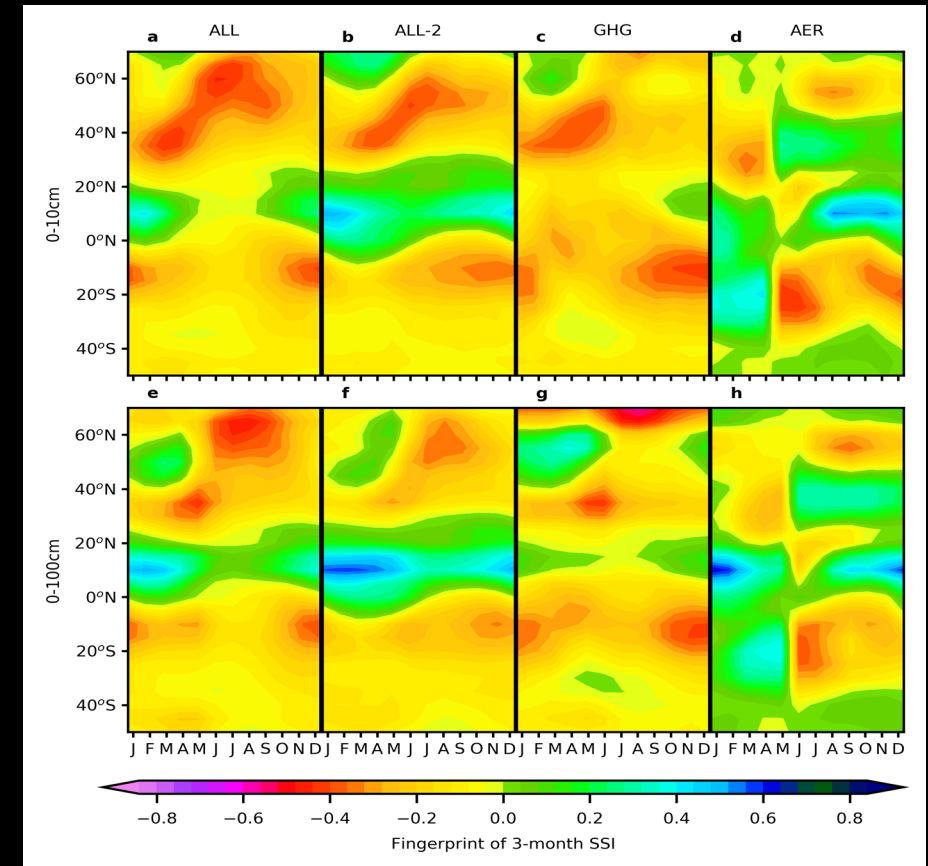


Wang et al. (2021, Earth Syst. Sci. Data)

# Quantification of human contribution to soil moisture-based droughts



Global mean time series of the 3-month SSI values and the associated latitude-by-month 1971–2016 trends in the zonally averaged 3-month SSI of the pseudo-observation (Mean NonCMIP) and the CMIP6 ALL simulations.

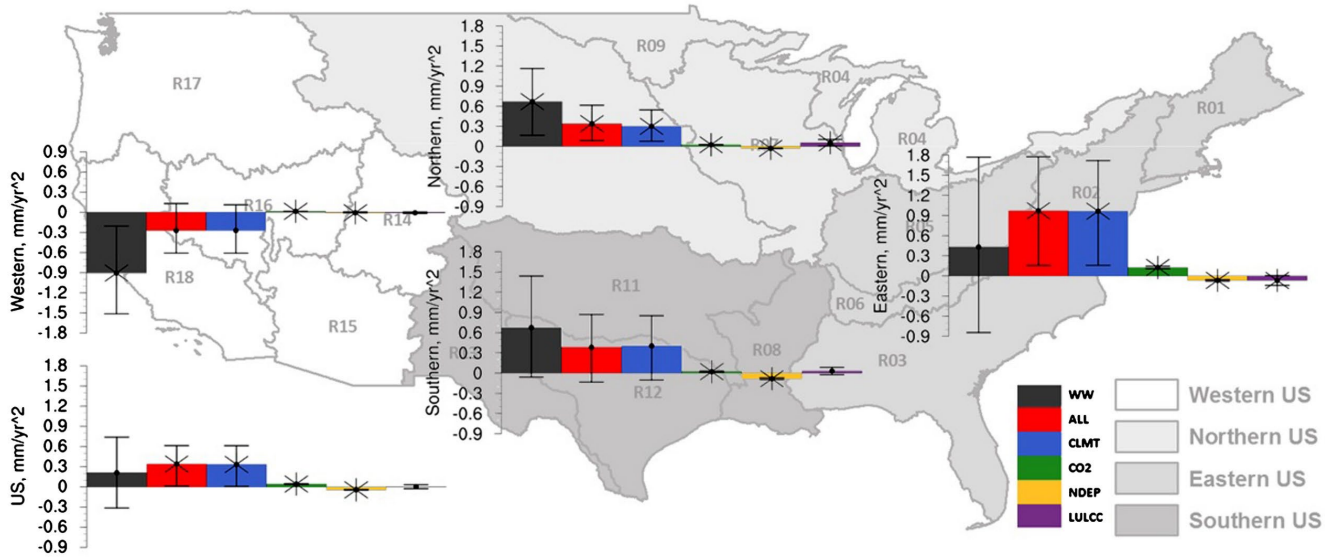


Fingerprints of the CMIP6 simulations under different forcings for the 3-month SSI.

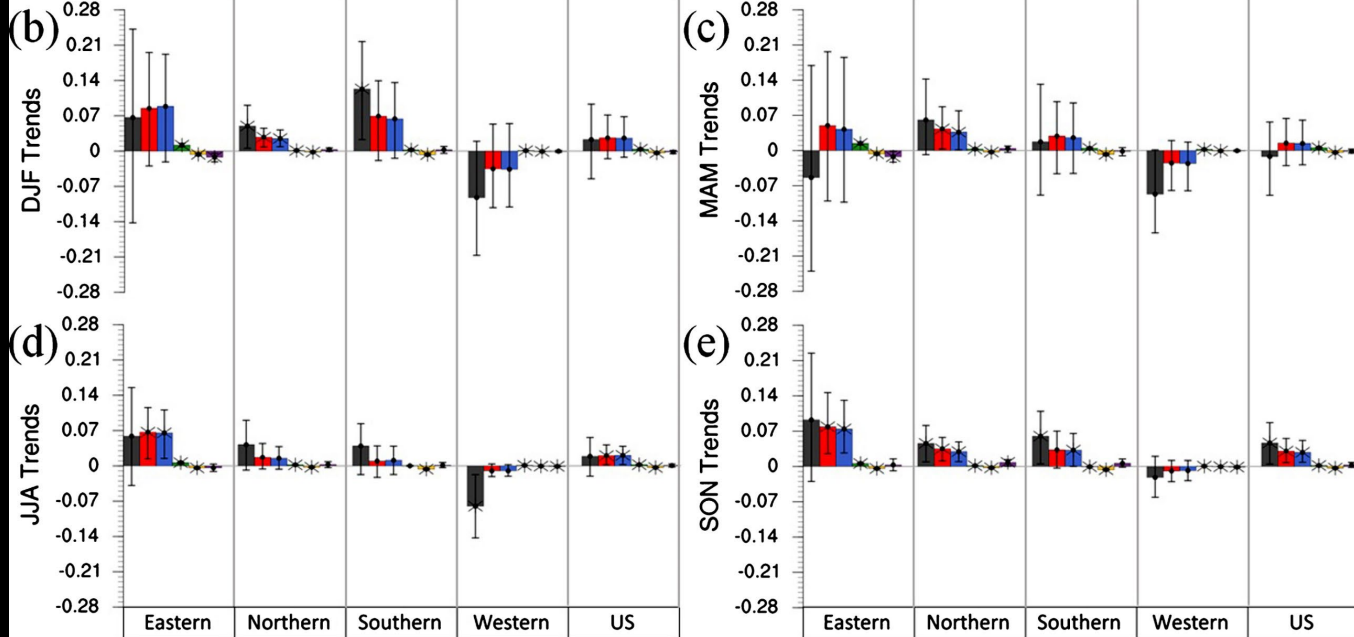
Wang et al. (2022, Nature Communications, Accepted)



(a)



# U.S. Runoff Changes & Relevant Controls (1950-2010)



Forbes et al. (2018, Environmental Research Letters)  
Forbes et al. (2019, Water Resources Research)  
Wang et al. (2018, IJC)

# Summary

- Diverse climate change researches including vegetation activity, carbon & water dynamics, hydrological change, wildfire modeling etc have been conducted from regional to global scales.
- Remote sensing, AI, and Earth System Modeling based on high-performance computing resources are key features of past and ongoing climate change studies in ISSE.
- Feel free to contact and seek potential collaborations with research scientists in ISSE (<https://isse.utk.edu/isse-research/climate-change/>)
- For questions or references in the PPT, please contact me (ylzhang@utk.edu)