

Progress Towards a Better Understanding of Land Temperature Anomalies over High Mountains as a First-Order Source of Global S2S Precipitation Predictability in Summer and Winter: GEWEX/LS4P-II Highlights



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Third International Conference on Subseasonal to Seasonal to Decadal Prediction (S2S2D)
Reading, UK · 7-11 September 2026

LS4P-II Progress

- 1). More Cases and Exploration for Operational S2S Predictions
- 2). Dynamic and Physical Mechanism and Processes Investigations
- 3) Summer and Winter Hydroclimate Extreme Events
- 4). LS4P-II ESM Experiments (Ideas and Participants)

GEWEX: Global Energy and Water Exchanges

LS4P: Impact of Initialized Land Temperature and Snowpack on Sub-Seasonal to Seasonal Prediction

1). More cases and exploration for operational S2S predictions

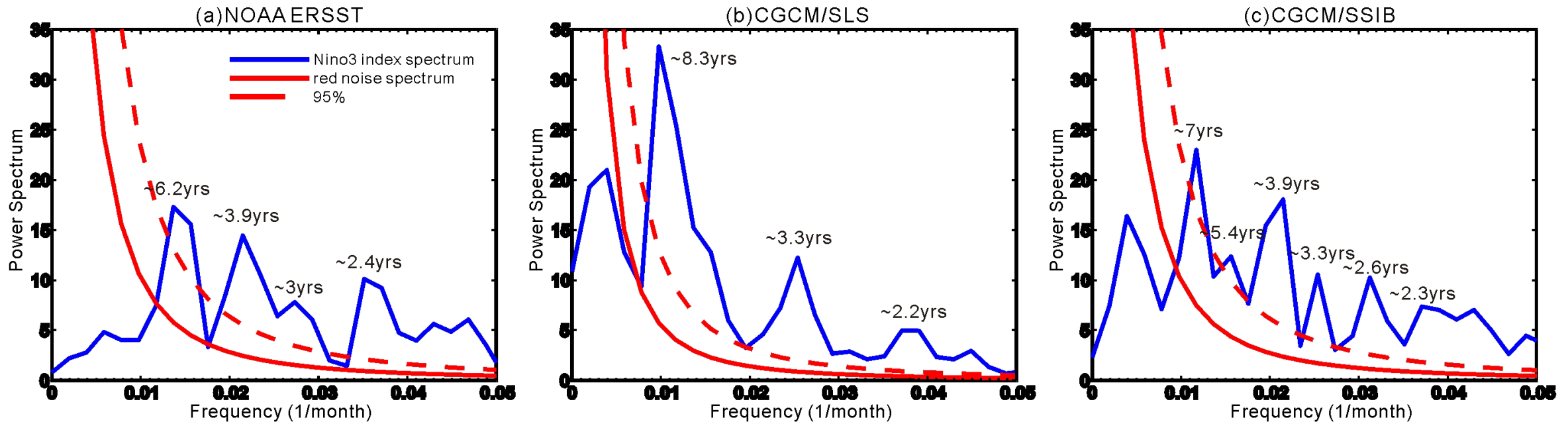
Fan, Y., J. Yang, et al., 2024: How does the Tibetan plateau land thermal initial condition influence the subseasonal prediction of **2020 record-breaking Mei-Yu rainfall**. **AGU JGR. Atmos.**

Kong X. H., A. Wang, et al., 2025: Predicting on the **extreme precipitation** in East and Southeast Asia **during summer 2022** from the antecedent soil temperature anomaly over the Tibetan Plateau. **AMS J. Climate.**

Li, Q., Y. Xue, et al., 2025: Excessive Tibetan Plateau Spring Warming Found to Cause **Catastrophic June 2024 Heavy Rainfall** in China. **CAS Science Bulletin**, 70, 1596-1600,

Nayak H. et al., 2025: Effect of **Rocky Mountain and Tibetan Plateau** Spring Land Temperature on N. American and East Asian Summer Precipitation Anomalies. **JGR. Atmos.** – **a prototype study for LS4P-II ESM experiment**

Effect of land-atmosphere interaction on decadal variability



Power spectra of the Niño 3 index (blue curves) from (a) NOAA ERSST for the ***period of 1901 to 2000***, and from (b) CGCM with specified soil moisture and albedo plus no vegetation, and (c) CGCM/SSiB for 00-year long simulations.

Ma et al., (2013, J. Climate)

2). Mechanisms and Processes

Lin C., K. Yang, et al., 2025: *Enduring local impact of the Third Pole's springtime **snow cover**. **npj Climate and Atmospheric Science**.*

Chen H, Z-X Liang et al., 2025: *Evolution of Tibetan Plateau Land-Surface Temperature Anomalies: **Warm–Cold Asymmetry in Model Sensitivity**.*

Li, Q., Y. Xue, et al., 2025: *Excessive Tibetan Plateau Spring Warming Found to Cause Catastrophic June 2025 Heavy Rainfall in China. **Science Bulletin**.*

Yu M., W. Wang et al., 2026: *Responses of June Precipitation in Eastern China to Spring Soil Temperature Anomaly over the Tibetan Plateau under Differing Jet-stream conditions.*

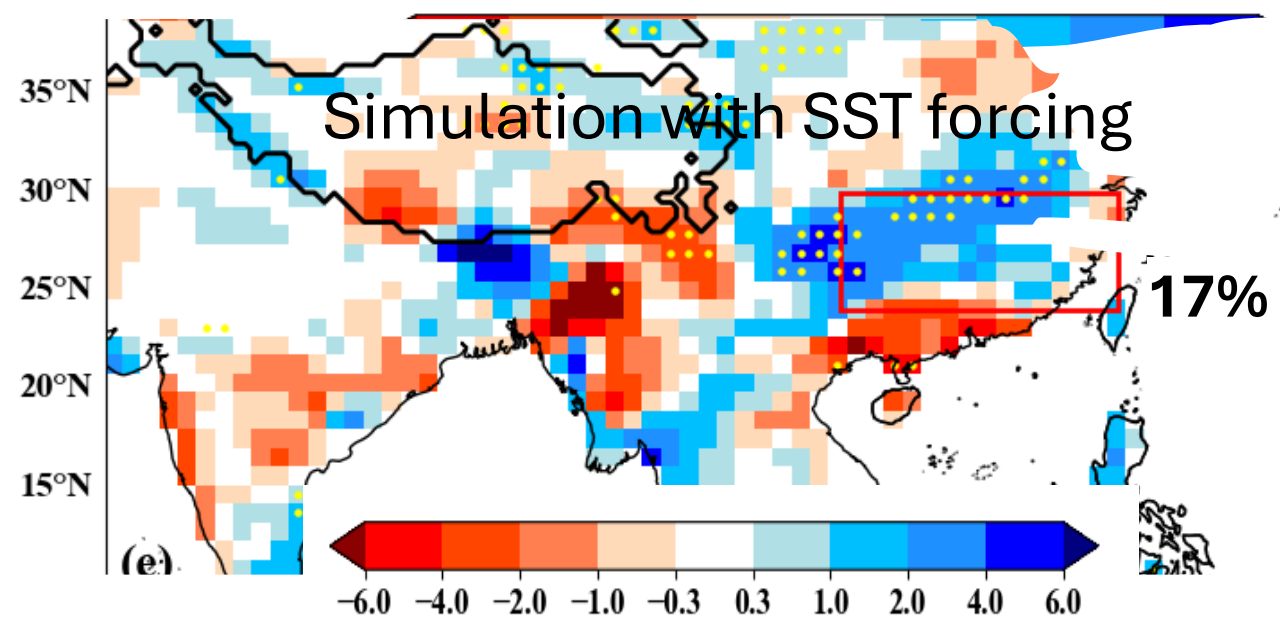
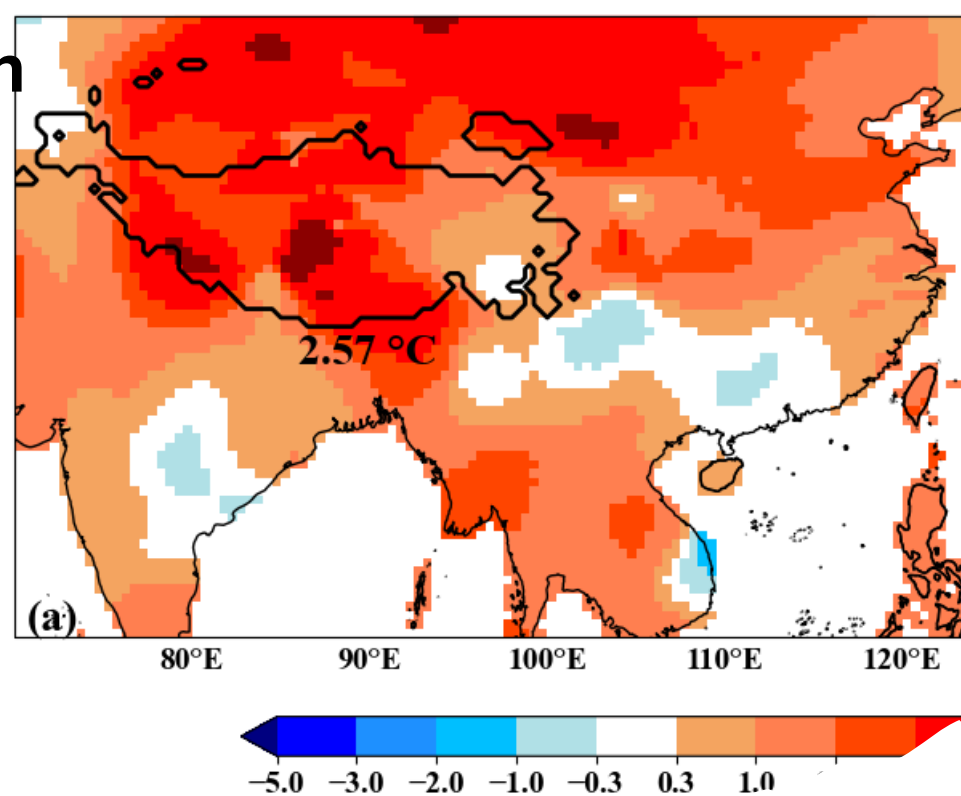
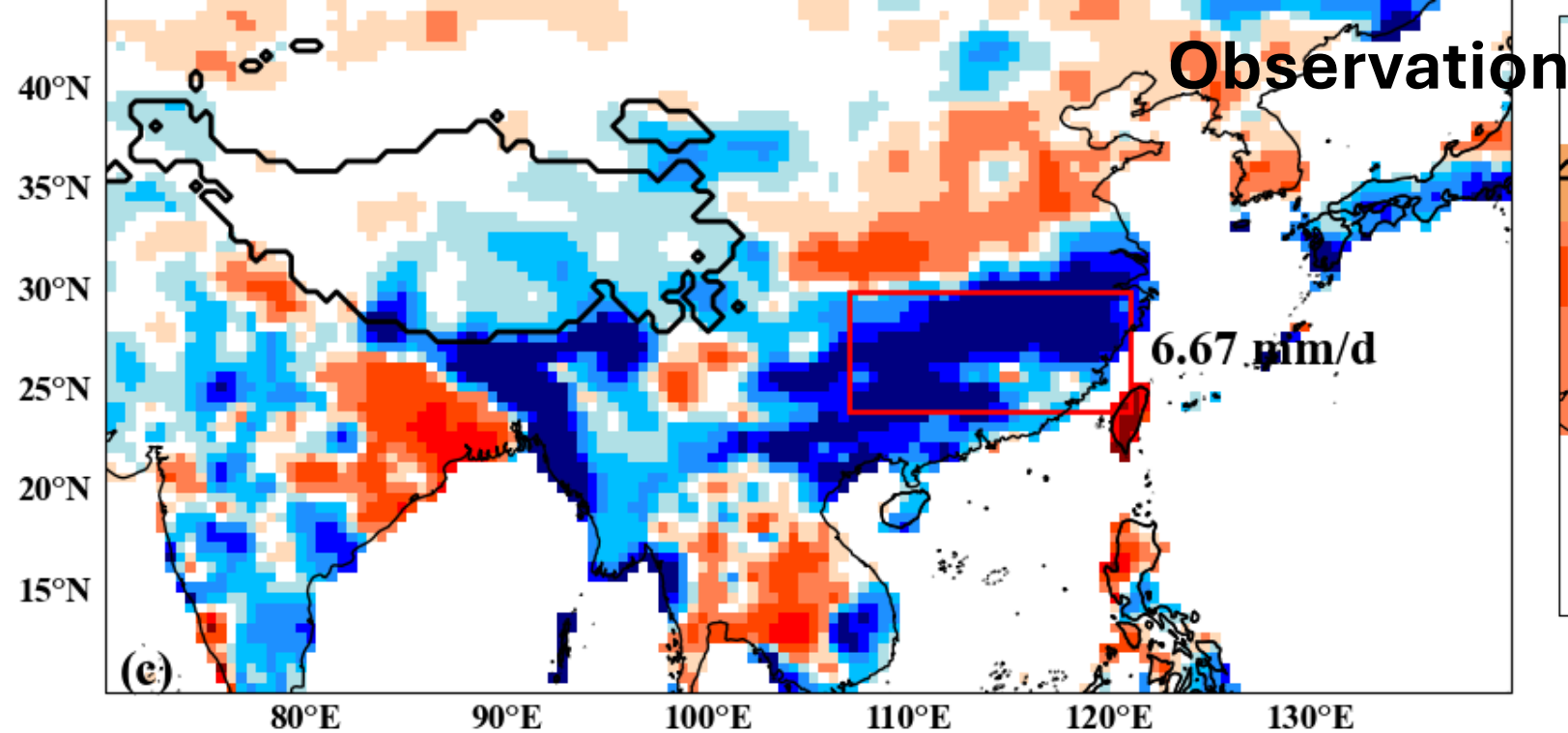
Xie, J., Q. Tang, et al., 2026: Improved representation of **subgrid orographic drag** enhances sub-seasonal precipitation predictability by strengthening jet–mountain coupling

3) Summer and Winter Hydroclimate Extreme Events

Relentless deadly June 2024 rainfall lash southern China
as flooding threatens millions



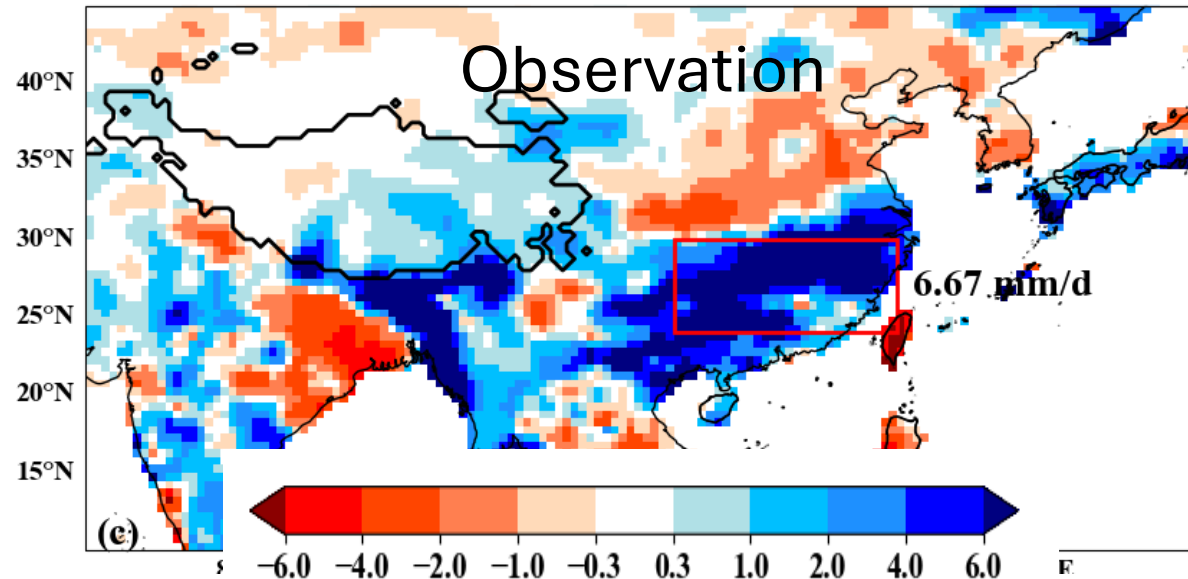
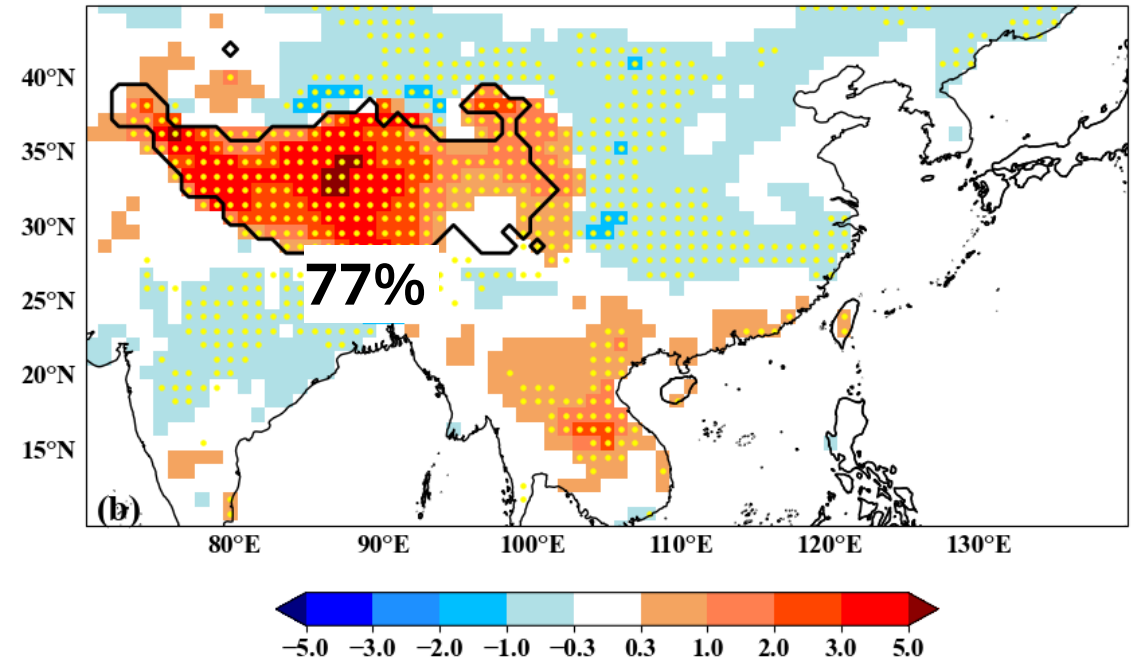
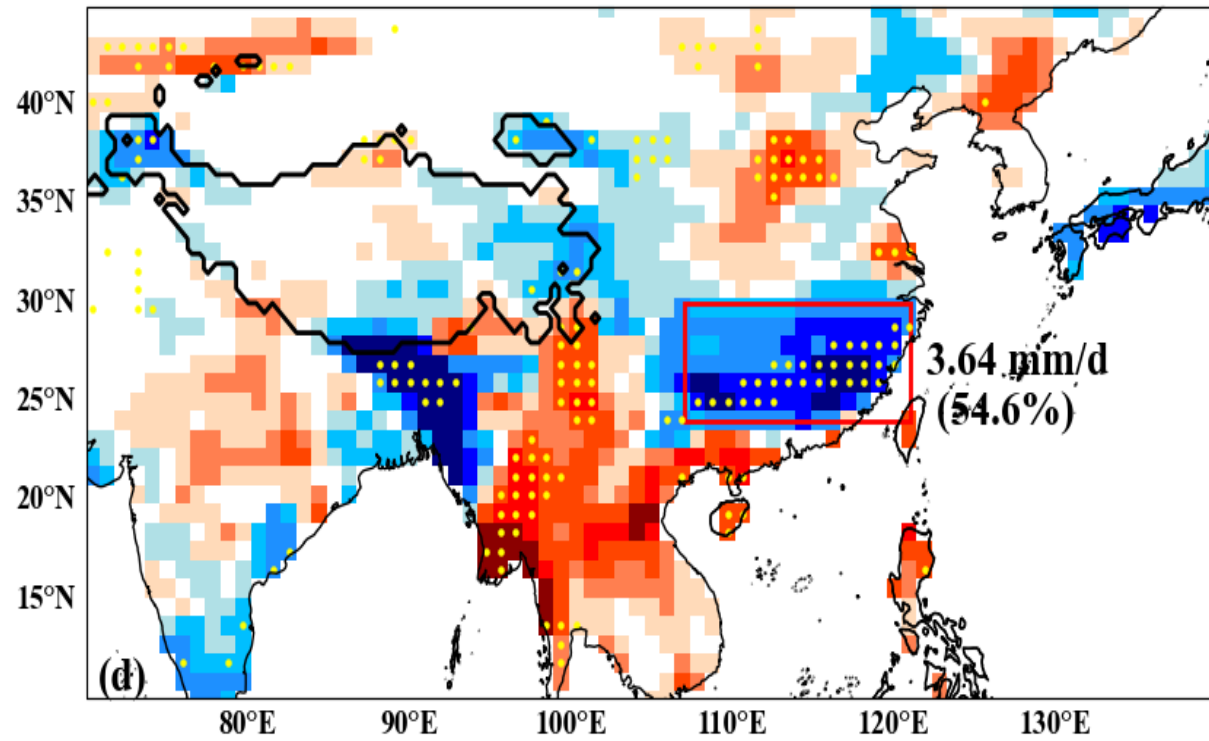
The precipitation in the Yangtze River Basin during June 10th-30th 50% above the long-term average. ***June 2024 had the highest rainfall in Southern China since 1980.***



Observed anomalies (top right) May T2m (°C); (top left) June Precipitation (mm/d); (bottom left) simulated June precipitation with SST forcing only (bottom)

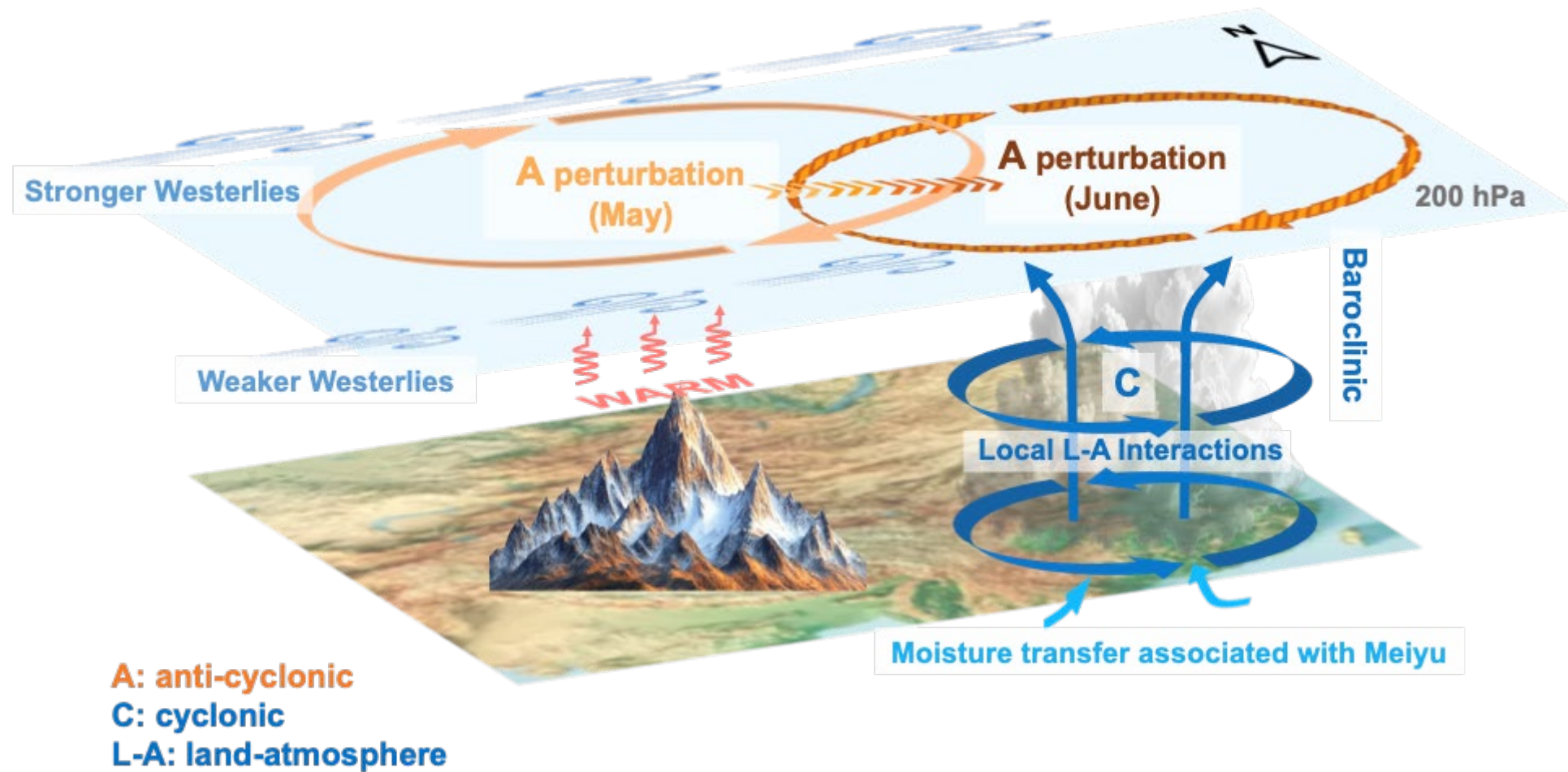
May 2024 was the warmest May since 1980

UCLA-GFS/SSiB2 Simulation (with TP LST/SUBT effect)



Observed (bottom left) and Simulated June 2024 Precipitation Anomaly (top left) after simulating May TP 2-m anomaly (top right)

Li, Xue et al., 2025. ***Science Bulletin***



Xue Y., et al. 2024: Remote effects of Tibetan Plateau spring land temperature on global subseasonal to seasonal precipitation prediction and comparison with effects of sea surface temperature: The GEWEX/LS4P Phase I experiment. ***Climate Dynamics***. 62, 2603-2628,

Li, Q., Y. Xue, et al., 2025: Excessive Tibetan Plateau Spring Warming Found to Cause Catastrophic June 2024 Heavy Rainfall in China. ***Science Bulletin***, 70, 1596-1600

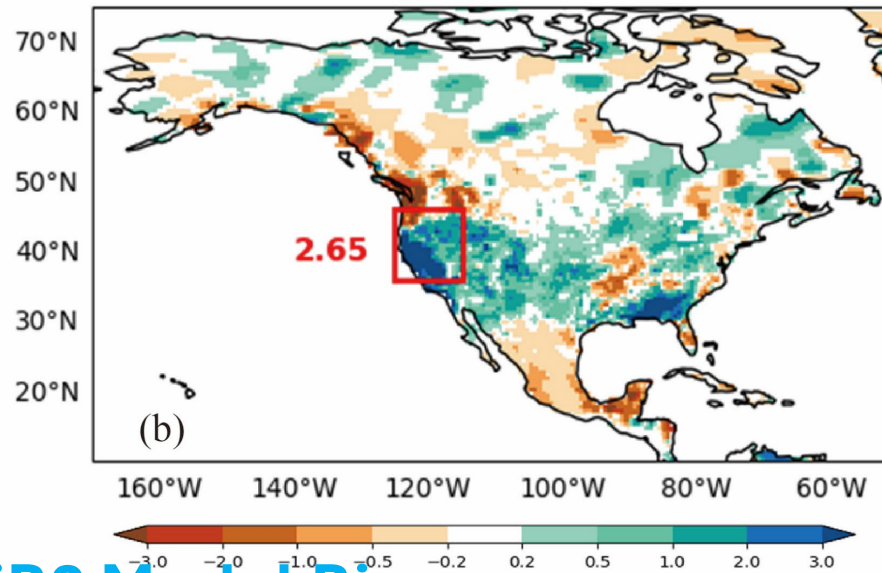
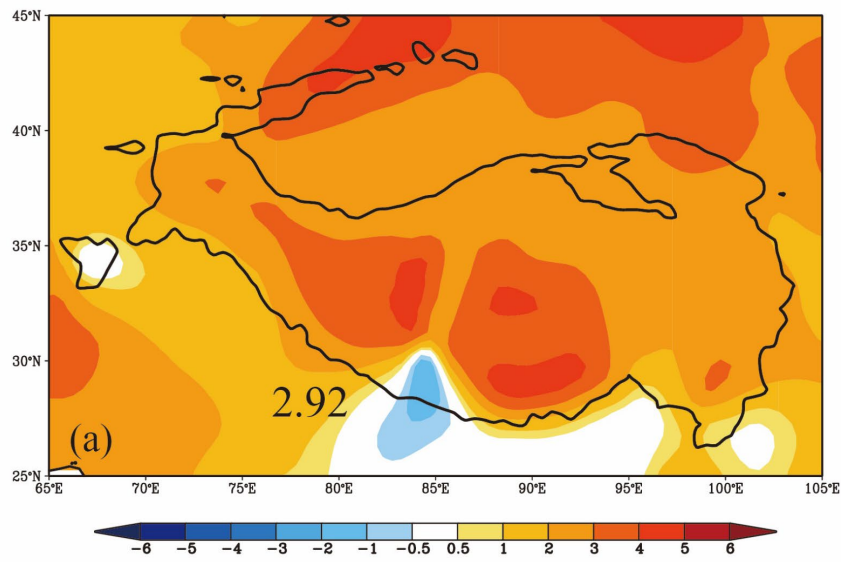
Catastrophic Californian Winter 2017 and 2023 Precipitation

California and adjacent regions received record-breaking precipitation in the winters of 2016–17 and 2022–23, causing extraordinary damage and severe societal impacts. Numerous studies have been conducted to investigate these events. These events have neither been successfully predicted at S2S timescales by forecast systems nor reproduced in hindcast or case-study simulations.

The 2015–2016 El Niño event, one of the strongest since 1950, was associated with an extraordinary Californian drought, while the 2016–2017 La Niña event has been related to record rainfall, effectively ending the 5-year California drought. The similar extreme precipitation event occurred again in winter 2023. Those events are contrary to established canonical SST–Californian drought/flood relationships.

The La Niña years' SST forcing produced a circulation response in ESMs that was essentially opposite of the positive PNA, **underscores the *fundamental lack of predictability*** of the event at seasonal time (Schubert et al., 2024, J. Climate)

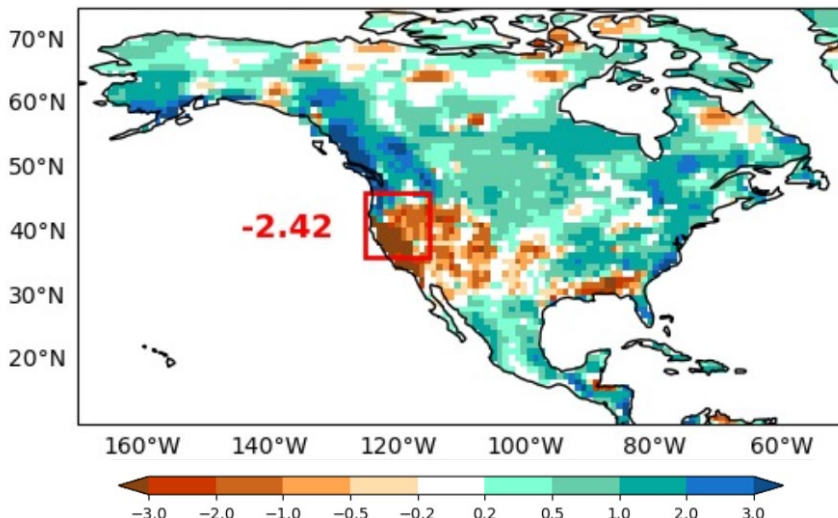
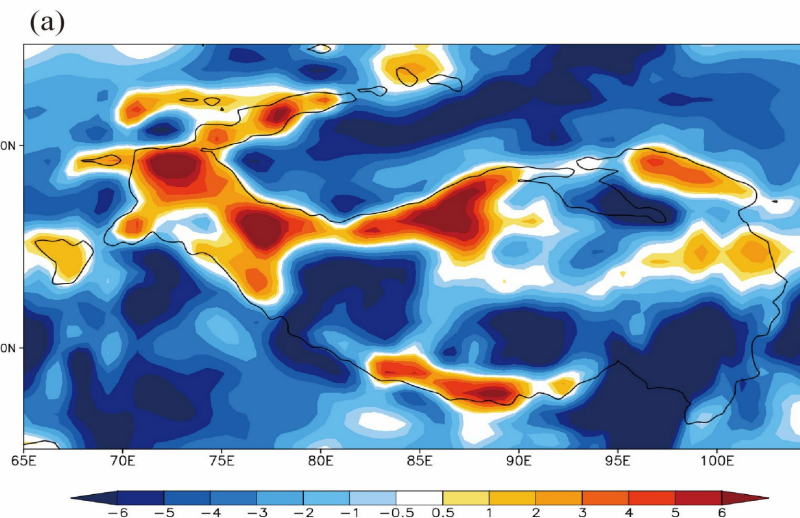
Observed (a) December 2016 T2m Anomaly; (b) January 2017 Precipitation anomal



Northern California experienced its wettest winter in nearly a century during the 2016-17 season

UCLA-GFS/SSiB2 Model Bias

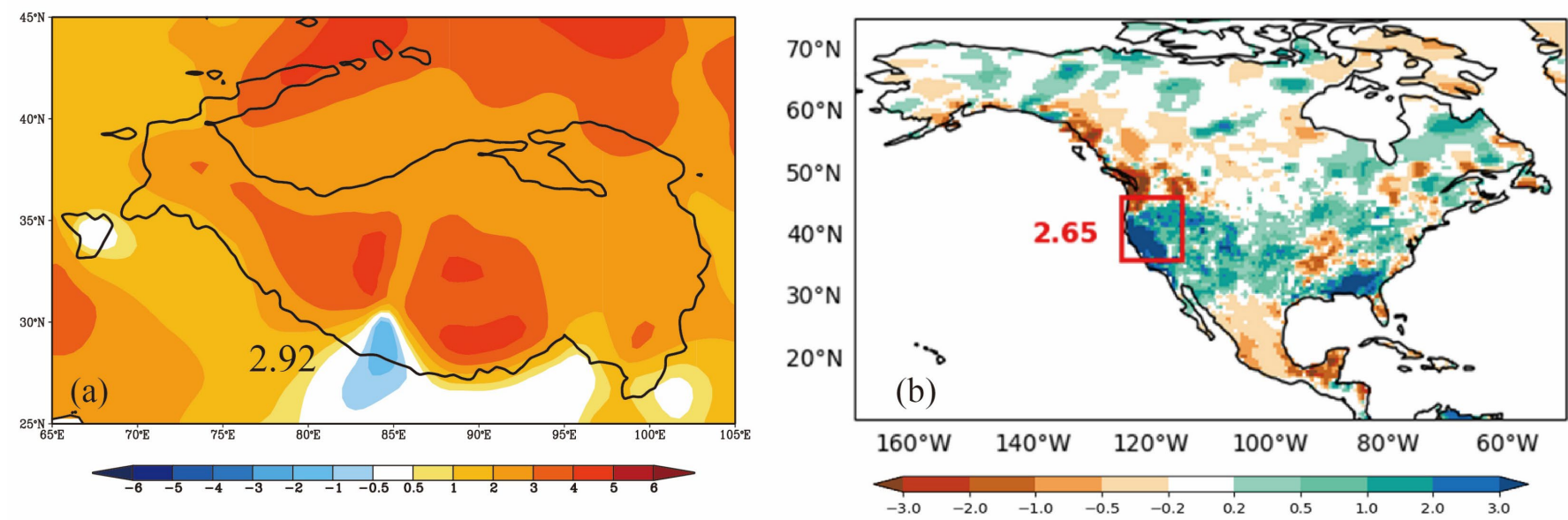
(b)



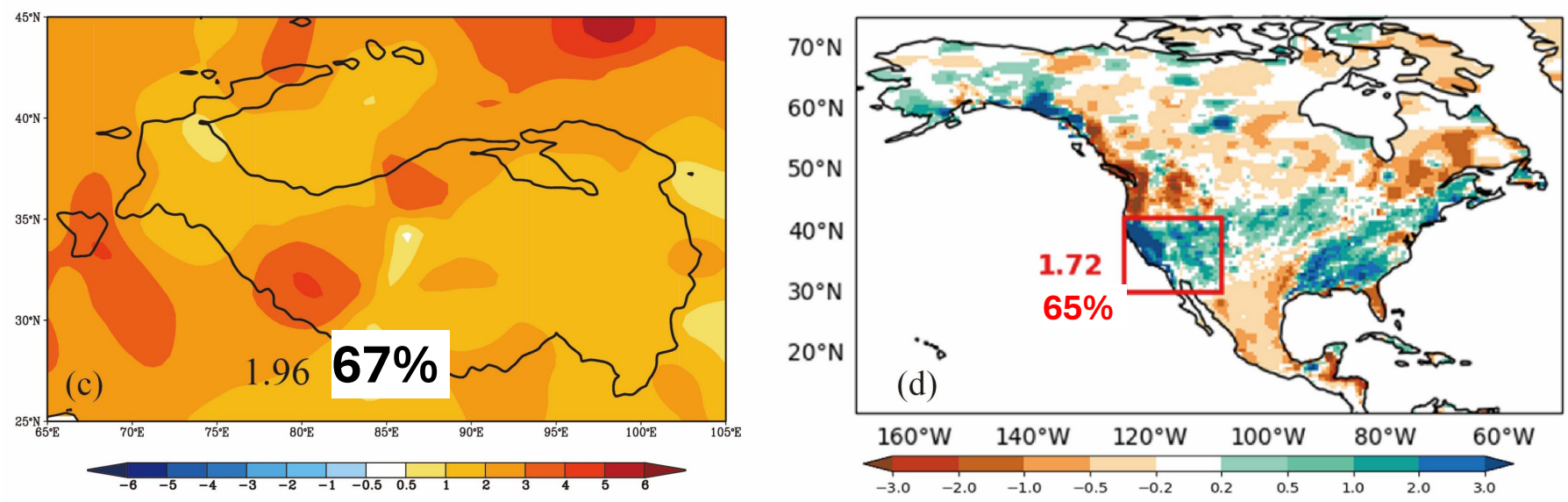
In December 2016, TP had warmest T-2m since 1980.

The numbers in (b) and (d) are biases averaged over 124.5°W-108°W, 30°N- 42°N.

Observed (a) December 2016 T2m anomaly; (b) January 2017 Precipitation anomaly



Simulated (a) January 2017 T2m anomaly; (b) January 2017 Precipitation anomaly
After imposing TV T2M mask in initial condition



Extraordinary Tibetan Plateau early-winter heating drove record-breaking winter precipitation in California and adjacent regions

Yongkang Xue, Qian Li, William K.-M. Lau, J. David Neelin, Xubin Zeng, Yang Zhang, Shuting Li, Xianghui Kong, Bin Guan, Aaron Boone, Zhijiong Cao, Aihui Wang, Yan Pan, Qi Tang, and Hara Prasad Nayak

Sci. Adv. 12 (37), eaeg3577. DOI: 10.1126/sciadv.aeg3577

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**Media Reports on LS4P website
under Outreach/2026**

Early-Winter Tibetan Plateau Heating

**Rossby
Wave Break**

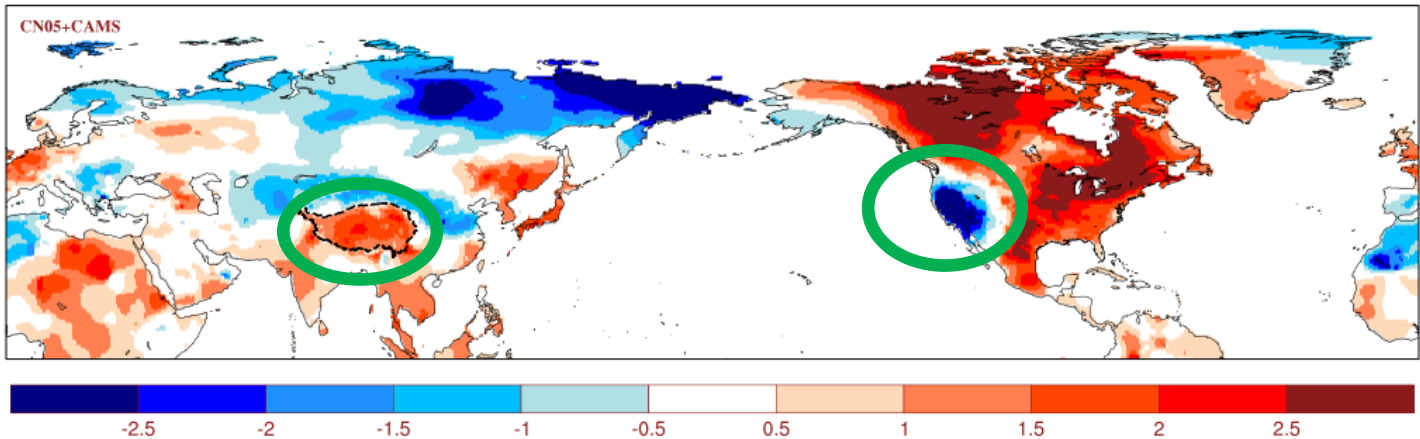
**Winter Extreme Precipitation
In California**



ZJ. Cao, YK. Xue, and ChatGPT (GPT-5.6 Sol), based on Xue et al., *Sci. Adv.*, September 9, 2026.

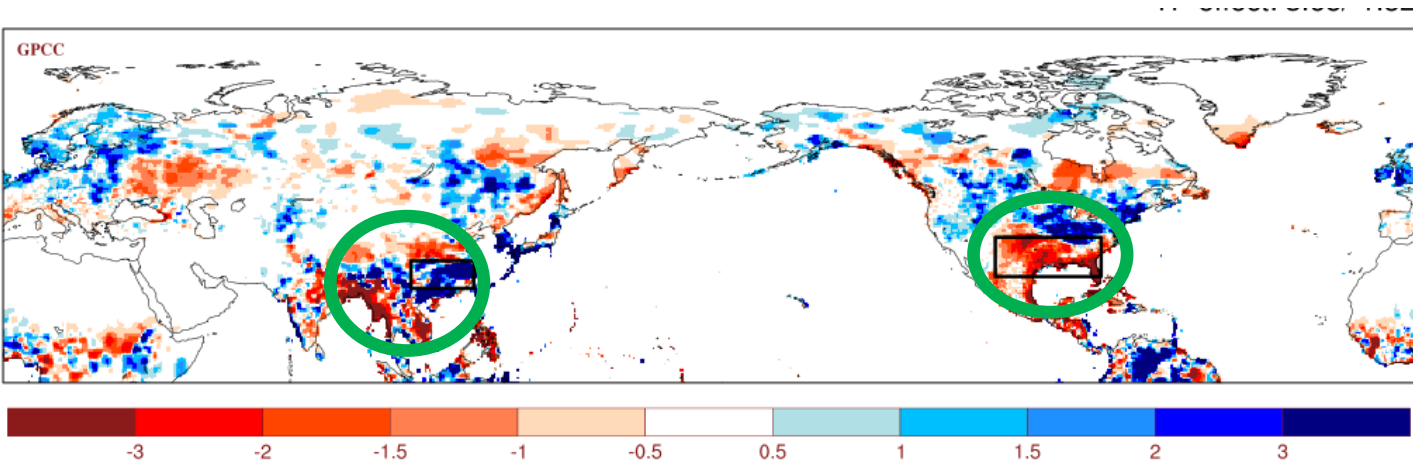
4. LS4P Phase II ESM Experiment for June 1998 Case

Observed May 1998 T2m Anomaly



TP: +1.45°C
WUS: -2.43 °C

Observed June 1998 Precipitation Anomaly



SYR: +3.68 mm/day
SUS: -1.52 mm/day

LS4P-II Experiments Modeling Groups

ID	Hor Res	Exp-ID	Contact persons
CMA BCC-AGCM	0.45°*0.45° 320000 grid points	Ctrl, Sen-RM, Sen-TP, Sen-SST	Xueli Shi, Qiaoping Li (China)
CNRM, Meteo-FRance	1.425°*1.425° 32768 grid points	Ctrl, Sen-RM, Sen-TP, Sen-SST, Sen-RM&TP	Constantin Ardilouze, Aaron Boone (France)
IITM-CFS	1.00°*1.00° 65160 grid points	Ctrl, Sen-RM, Sen-TP, Sen-SST, Sen-RM&TP	Subodh Kumar Saha (India)
KMA KIAPS-KIMNOAHMP	0.5°*0.5° 194,401 grid points	Ctrl, Sen-RM, Sen-TP, Sen-SST	Jaeyoung Song Myung-Seo Koo (Korea)
UCLA-GFS/SSiB2	~1.00°*1.00° 72960 grid points	Ctrl, Sen-RM, Sen-TP, Sen-SST	Hara Nayak, Yongkang Xue (U.S.)
LLNL-E3SM	1.00°*1.00° 64800 grid points	Ctrl, Sen-TP, Sen-RM, Sen-SST	Jinbo Xie, Qi Tang (U.S.)

ID	Hor Res	Exp-ID	Contact persons
JMA MRI-CPS3	~55x55 km 157792 grid points	Ctrl, Sen-RM, Sen-TP, Sen-SST	Tetsu Nakamura Yuhei Takaya (Japan)
U of Arizona CESM2	1.425°*1.425° 32768 grid points	Ctrl, Sen-RM, Sen-TP, Sen-SST	Michael Brunke Xubin Zeng (U.S.)
NCAR MPAS- NoahMP.8.3.0	60 x 60km 163842 grid points	Various cases	Zhe Zhang Cenlin He (U.S.)
ECMWF IFS/ NEMO4-SI3 Coupled Model	~36x36 km 421120 grid points	Various cases	Retish Senan Frédéric Vitart (E.U.)
CMCC SPS3.5	0.50° x 0.50°	Various cases	Antonella Sanna, Daniele Peano (Italy)
CAS-ESM2/IAP AGCM5	1.40° x 1.40° 7168 grid points	Various cases	Chenglai Wu, Xianghui Kong Zhaohui Lin (China)
GFDL-AM4- LM4.1	1.00°*1.00° 74800 grid points	Various cases	Enrico Zorzetto Elena Shevliakova (U.S.)

Prospect Future

- 1). LS4P-II ESM Experiments (complete in 2026)
- 2). LS4P-II RCM Experiments (complete in 2026)
- 3). LS4P-II group papers in 2027-2028; A book on S2S predictability due to land process will start to prepare in 2028.
- 4). More cases (scenarios, years, and seasons, soil moisture, snow, drought, flood, heatwave, fire), mechanism studies, and prototype operational application
- 5). Exploratory investigation of South American Andes effect (LS4P-III, 2029?)
- 6). LS4P Side Meeting and/or session in ***4th Pan-GASS Meeting Understanding and Modeling Atmospheric Processes (UMAP) Jul 5 - 9, 2027 | Bremerhaven, Germany***

LS4P Website: <http://ls4p.geog.ucla.edu>