LANCANG-MEKONG NEWSLETTER

December 2022, No. 9

Project Title:
Climate Change and Water Resources in Great Rivers Region in Southeast and South Asia

Principal Investigator:

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Junguo LIU, Southern University of Science and Technology, China

Participating Institutions:

Southern University of Science and Technology
Institute of Tibetan Plateau Research, CAS
Institute of Atmospheric Physics, CAS
Institute of Geographic Sciences and Natural Resources Research, CAS
Beijing Normal University
University of Gothenburg

Project Period:

March 2018 – February 2023

"Climate Change and Water Resources in Great Rivers Region in Southeast and South Asia"

Project Office

November 21

Professor Junguo LIU receives The World Academy of Science (TWAS) Award

Professor Junguo LIU, Chair Professor of Southern University of Science and Technology, China, wins the 2022 TWAS (The World Academy of Science) award for "**his fundamental contribution to policy relevant studies on water resources, climate change mitigation, and environmental management in China and other developing countri**es". The virtual awarding ceremony of 2022 honours administered by TWAS took place after the Opening Ceremony of the TWAS 16th General Conference, on 21 November 2022.

TWAS was founded in 1983 by a distinguished group of scientists from the developing world under the leadership of Abdus Salam, the Pakistani physicist and Nobel laureate. They shared a belief that developing nations, by building strength in science and engineering, could build the knowledge and skill to address such challenges as hunger, disease, and poverty. TWAS was given to talents who make an outstanding contribution in nine fields of sciences.

October 20

Professor Junguo LIU receives The World Academy of Science (TWAS) Award (continued)

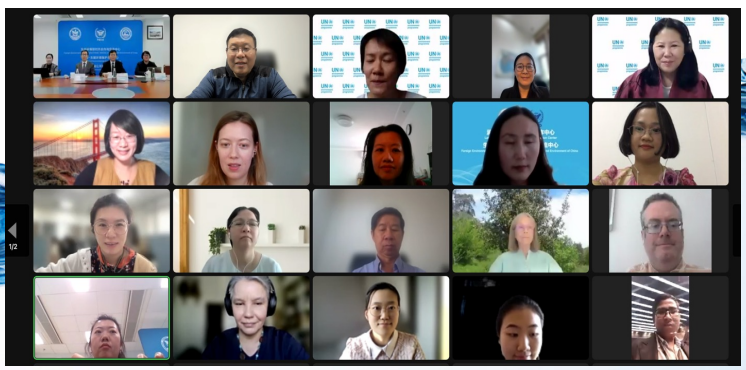
On October 20, **Professor Junguo LIU** was invited to participate in the TWAS Awards Webinar Series (Seminar 5: Social and Economic Sciences) and gave a keynote presentation. The webinars focus on the winners of TWAS awards and of awards in honor of TWAS Fellows. TWAS Awards Webinar Series gives an opportunity to TWAS Award winners to deliver brief presentations on their accomplishments. This webinar was chaired by the Canadian academic and education scholar Ratna Ghosh who has been elected to several Academies and received national and international honors and awards.

November 23

Green Lancang-Mekong Initiative: Towards COP15 – Senior-level Roundtable Dialogue

November 23, 2022, the United Nations Environment Programme - International Ecosystem Management Partnership (UNEP-IEMP) presented the "Ecosystem assessment in the Lancang-Mekong Basin for sustainable livelihoods" report as a critical knowledge product at the Green Lancang-Mekong Initiative: Towards COP15 – Senior-level Roundtable Dialogue on Integrated Ecosystem Management in the Lancang-Mekong Region Agenda. **Professor Junguo LIU** and **Dr. Yuehan DOU** were invited to the Senior-level Roundtable Dialogue as key authors and UNEP collaborators.

The "**Ecosystem assessment in the Lancang-Mekong Basin for sustainable livelihoods**" report was produced by Professor. Junguo LIU, Dr. Yuehan DOU and their team under the context of the project "Improving Ecosystem Management for Sustainable Livelihoods within the Framework of Lancang-Mekong Cooperation," aimed to assess the changes in the ecosystem for and the ecosystem service-dependent livelihoods with case studies demonstrated through pilot activities at selected areas in Cambodia and China and provided recommendations from the perspectives of both the case-study level and LMB regional level to comprehensively promote the improvement of ecosystem health, natural resources management, and sustainable livelihoods. The report will be published by UNEP in 2023.

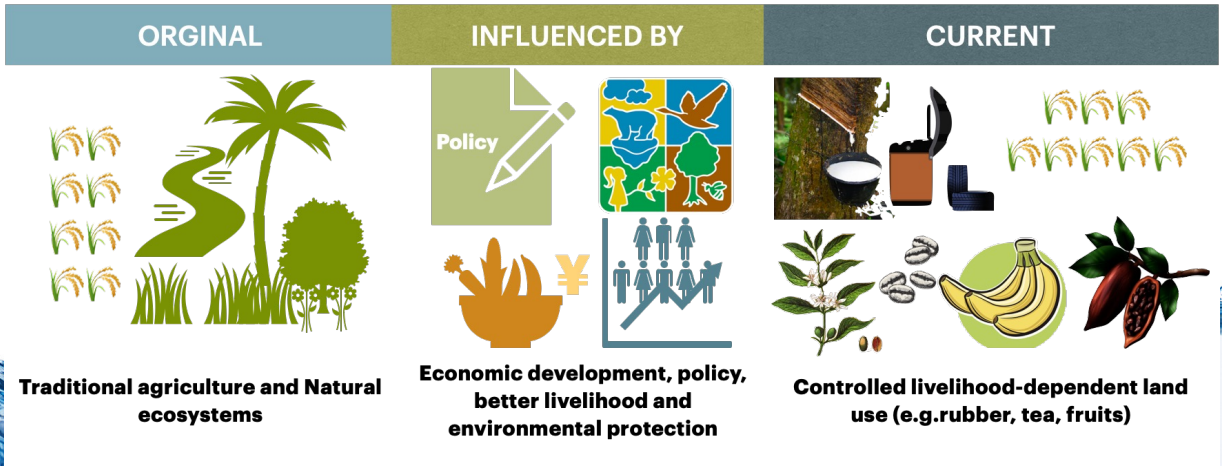


November 23

Green Lancang-Mekong Initiative: Towards COP15 – Senior-level Roundtable Dialogue (continued)

The project is funded by the Ministry of Ecology and Environment of the People's Republic of China, through the China Trust Fund to UNEP and partly supported by **the Strategic Priority Research Program of Chinese Academy of Sciences** (XDA20060402). Interventions are implemented jointly by the UNEP Regional Office for Asia and the Pacific, in partnership with UNEP- IEMP and the Lancang-Mekong Environmental Cooperation Centre, as well as the Biodiversity, People and Landscapes Unit of UNEP Ecosystems Division.

Example of results 1: Most frequently mentioned words regarding the quality of local lives by the inhabitants of Phnom Kulen National Park, the pilot of Cambodia



Example of results 2: Changes in livelihoods in Mengla County, the pilot of China

November 14

Project members amongst top 1% most cited worldwide

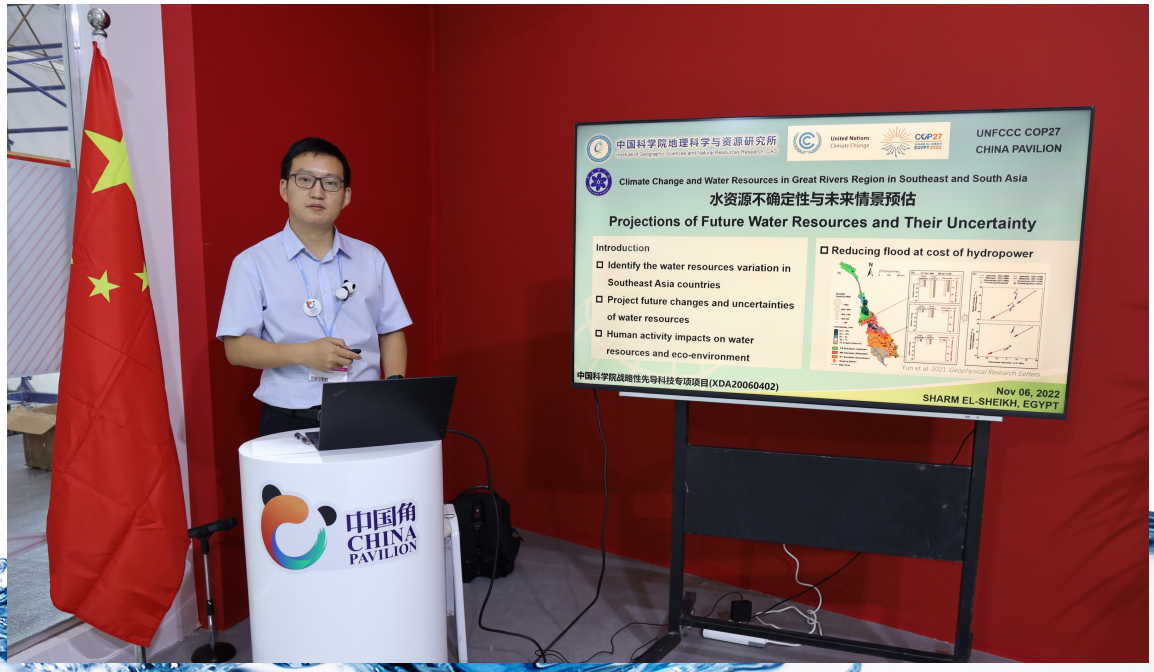
Professor Junguo LIU and **Associate Professor Zhenzhong ZENG** from Southern University of Science and Technolog are among the top 1% of the globally most scientifically influential authors. The renowned ranking is published once a year by Clarivate Analytics's science platform Web of Science. The ranking identifies scientists and social scientists who have demonstrated significant and broad influence reflected in their publication of multiple highly cited papers over the last decade, which has attracted great attention from many media and scholars at home and abroad.

November 06

UNFCCC COP27 CHINA PAVILION Side Event: Addressing Climate Change and Flood Risk Challenges

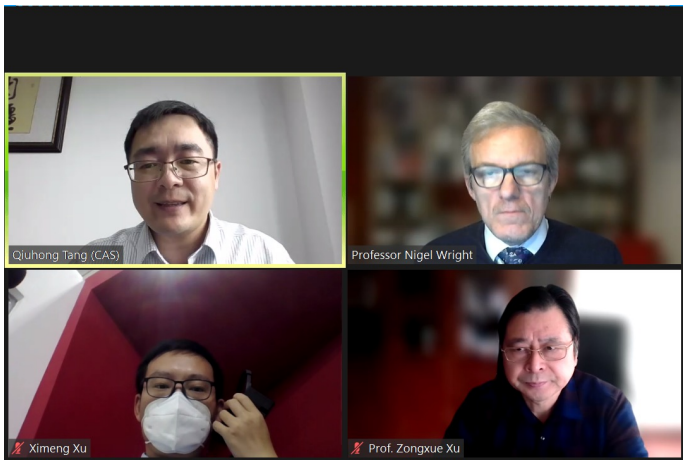
On November 06, the 27th Conference of the Parties (COP27) to the United Nations Framework Convention on Climate Change was opened in Sharm El-Sheikh, Egypt. The Project team organized a side event on the theme of "Addressing the Challenges of Climate Change and Flood Disasters" in the China Pavilion of COP27 on the opening day.

COP27 focus on "implementation" and expect countries to elaborate on how to implement the Paris Agreement through legislation, policies, projects and other channels**. Dr. Ximeng XU** attended the meeting on-site and publicized the research progress of “Projections of Future Water Resources and Uncertainties in the Lancang Mekong River Basin.



November 06

UNFCCC COP27 CHINA PAVILION Side Event: Addressing Climate Change and Flood Risk Challenges (continued)

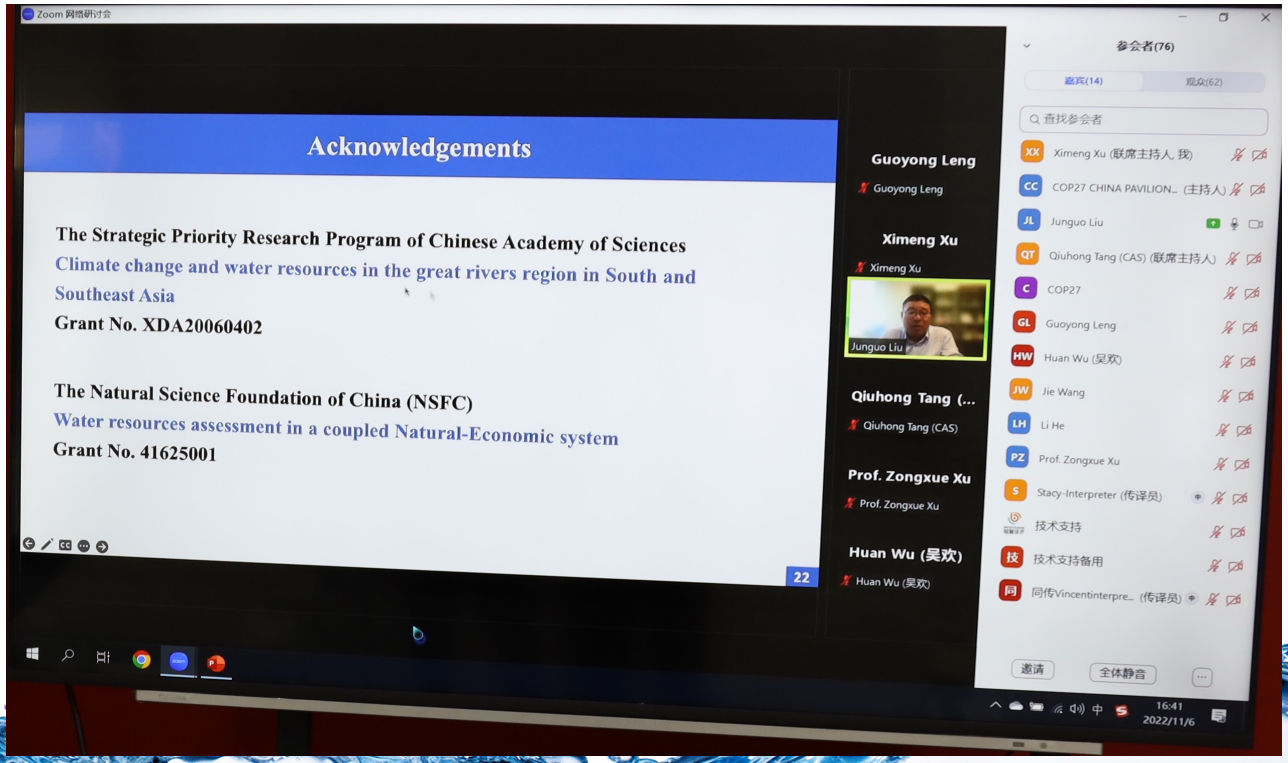


Organized by the Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, this side event brainstormed on how improved scientific knowledges can inform multi-level stakeholder engagement in flood risk management, and discussed the targeted mitigation measures for preventing and reducing the damages by fluvial, pluvial and coastal floods. **Professor Qiuhong TANG** chaired the meeting.

November 06

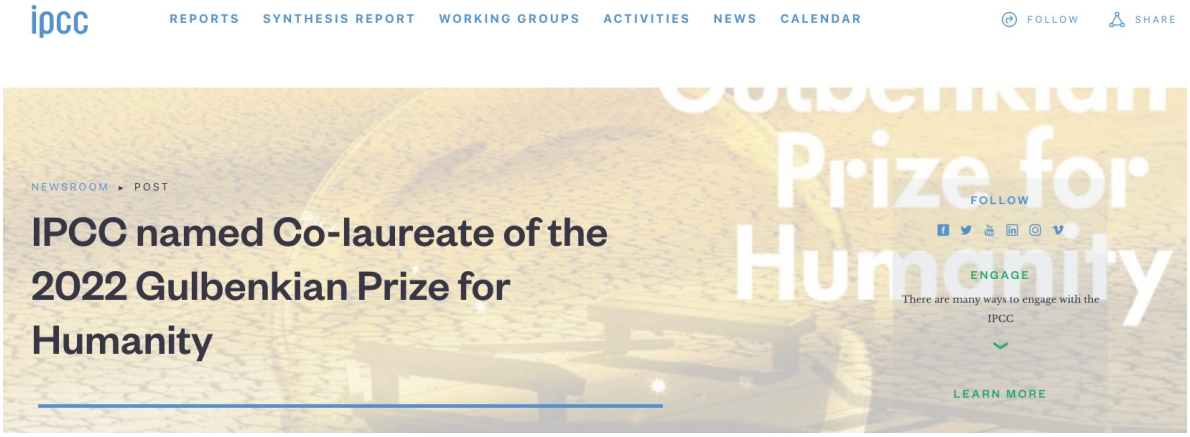
UNFCCC COP27 CHINA PAVILION Side Event: Addressing Climate Change and Flood Risk Challenges (continued)

Professor Junguo LIU was invited to the side event organized by the Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, and made a keynote speech entitled "**Water security and integrated management for the Lancang-Mekong River Basin**", which summarized the research progress and achievements of the project sponsored by The Strategic Priority Research Program of Chinese Academy of Sciences, and enhanced the international influence of the project.



October 13

IPCC named Co-laureate of the 2022 Gulbenkian Prize for Humanity



The Intergovernmental Panel on Climate Change (IPCC) is honored to have been declared a co-laureate of the 2022 Gulbenkian Prize for Humanity, together with the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).

The Jury of the Gulbenkian Prize for Humanity led by Dr. Angela Merkel, selected the IPCC and IPBES out of 116 nominations from 41 countries, in recognition of **"…the role of science on the front line of tackling climate change and the loss of biodiversity**."

Two project members actively engaged in the IPCC sixth Assessment Report (AR6). **Professor Deliang CHEN** is the Coordinating Lead Author of the IPCC AR6 Working Group I (WGI). **Professor Junguo LIU** is the Lead Author of the IPCC AR6 Working Group II (WGII).

October 13

IPCC named Co-laureate of the 2022 Gulbenkian Prize for Humanity (continued)

"**On behalf of IPCC scientists who deliver the most up-to-date and robust climate change knowledge to the world's policymakers, we are honored to receive this prominent award**," said Hoesung Lee, the Chair of the IPCC.

"**Science is our most powerful instrument to tackle climate change, a clear and imminent threat to our wellbeing and livelihoods, the wellbeing of our planet and all of its species. For IPCC scientists, this prize is an important recognition and encouragement. For the decision-makers, it is another push for more decisive climate action.**"

The prize was launched by the Calouste Gulbenkian Foundation in 2020 with the objective of distinguishing those persons and organisations from around the world whose work has greatly contributed to mitigating the impacts of climate change. It comes with a generous purse of 1 million Euros.

Past and Future Changes in Climate and Water Resources in the Lancang–Mekong River Basin: Current Understanding and Future Research Directions

The Lancang–Mekong River (LMR) is an important transboundary river that originates from the Qinghai–Tibet Plateau, China and flows through six nations before draining into the South China Sea. Knowledge about the past and future changes in climate and water for this basin is critical in order to support regional sustainable development. **Prof. Junguo LIU, Prof. Deliang CHEN, and an international team** published a review article in *Engineering*, an international open-access journal that was launched by the Chinese Academy of Engineering (CAE) in 2015. Its aims are to provide a high-level platform where cutting-edge advancements in engineering R&D. The study presents the scientific progress that has been made in understanding the changing climate and water systems and discusses outstanding challenges and future research opportunities.

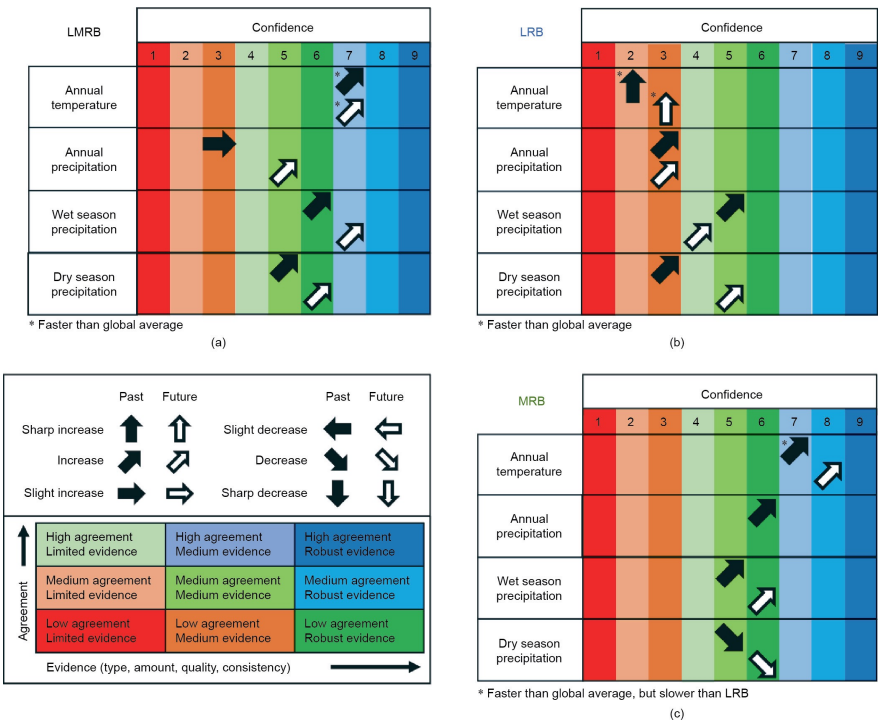


Figure 1: Changes in temperature and precipitation over (a) the LMRB, (b) the upper part of the LMRB (the LRB), and (c) the lower part of the LMRB (the MRB), based on the published literature.

Research

The existing literature suggests that: ① The warming rate in the Lancang–Mekong River Basin (LMRB) is higher than the mean global warming rate, and it is higher in its upper portion, the Lancang River Basin (LRB), than in its lower portion, the Mekong River Basin (MRB); ② historical precipitation has increased over the LMRB, particularly from 1981 to 2010, as the wet season became wetter in the entire basin, while the dry season became wetter in the LRB but drier in the MRB; ③ in the past, streamflow increased in the LRB but slightly decreased in the MRB, and increases in streamflow are projected for the future in the LMRB; and ④ historical streamflow increased in the dry season but decreased in the wet season from 1960 to 2010, while a slight increase is projected during the wet season. Four research directions are identified as follows: ① investigation of the impacts of dams on river flow and local communities; ② implementation of a novel water–energy–food–ecology (WEFE) nexus; ③ integration of groundwater and human health management with water resource assessment and management; and ④ strengthening of transboundary collaboration in order to address sustainable development goals (SDGs).

The results were published in ***Engineering***
Full article link: **https://doi.org/10.1016/j.eng.2021.06.026**

Research

Impacts of Summer Monsoons on flood characteristics in the Lancang-Mekong River Basin

The impact of monsoon on rainfall in the Lancang-Mekong River Basin (LMRB) has been well understood, but its impact on flood characteristic across the basin is still unclear. Recently, **Prof. Qiuhong TANG**'s group used the Variable Infiltration Capacity (VIC) hydrological model to generate the basin-wide discharge and extract flood characteristics. Indian Summer Monsoon (ISM), Western North Pacific Monsoon (WNPM), and their combined effect (ISWN) were considered and represented by monsoon index. The monsoon impact area was firstly obtained based on the monsoon impact on rainfall, followed by the anomaly analyses of flood characteristics within the impact area to quantify the monsoon impact on floods at local and spatial scales.

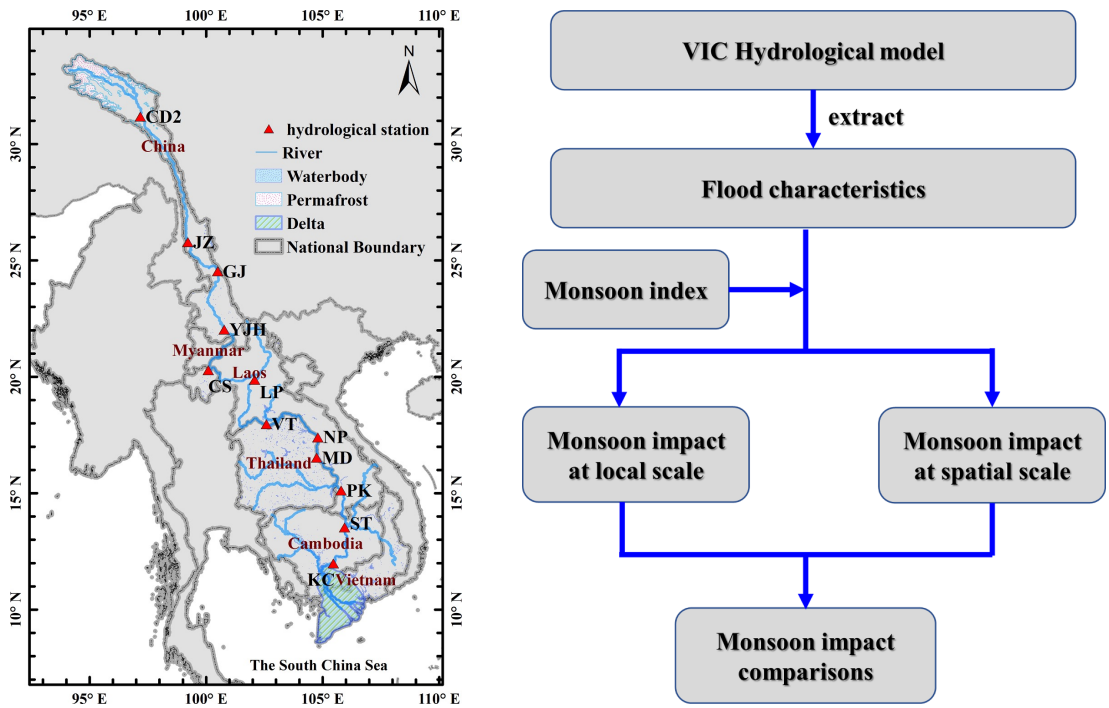


Figure 1: Overview of the Lancang-Mekong River Basin (LMRB), and the basic flowchart of the monsoon impact on flood.

Research

The results show that the ISM and WNPM (or ISWN) can significantly modulate up to 20% of the rainfall interannual variability in the western and eastern parts of the basin, respectively. The monsoon impact on flood is regionally distributed with impact in tributary larger than mainstream. Over half of the monsoon impact areas show the flood start date averagely advances (delays) 8–12 days, flood volume averagely increases (decreases) by 9%–17.5% and Q10 averagely increases (decreases) by 7.4%–14.4% during the strong (weak) monsoon years. Also, the comparisons between monsoon local and spatial impacts reveal that the trade-off of water from different areas can disturb the monsoon impact on flood, suggesting that more stations should be used when using the observed data to analyze the monsoon impact. This study could help to increase the knowledge of the impact of climate change on flood and help with the regional flood managements.

The results were published in ***Journal of Hydrology***
Full article link: **https://doi.org/10.1016/j.jhydrol.2021.127256**

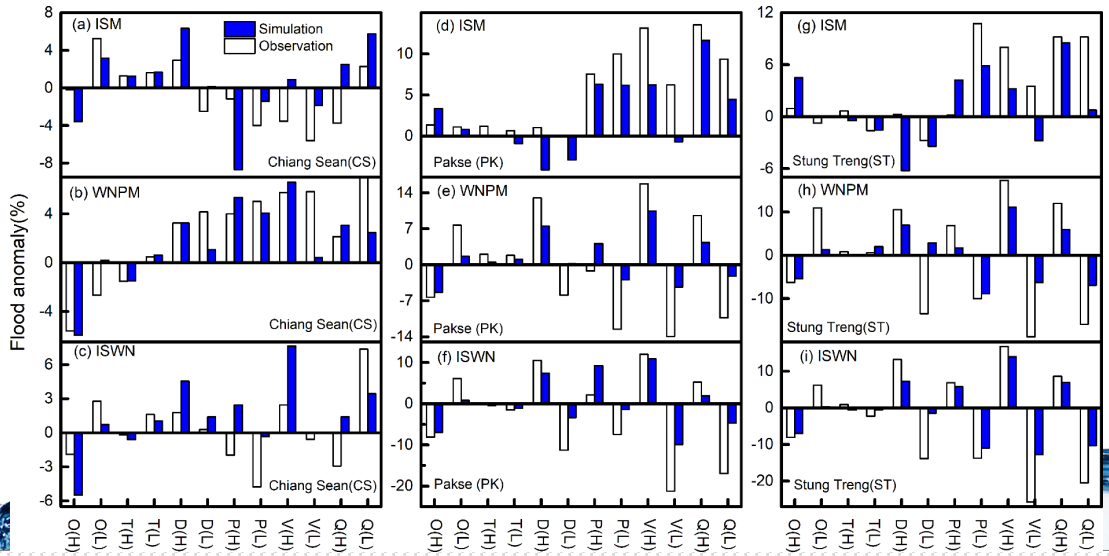


Figure 2: The flood characteristic anomalies at three representative stations during the strong and weak monsoon years. The signs O, T, D, P, V, Q separately refer to the Onset (start date), Termination (end date), duration, peak, volume, and Q10 for the convenience of drawing the figures.

Research

Past and future terrestrial water storage changes in the lower Mekong River basin: The influences of climatic and non-climatic factors

Climate change and human activity such as reservoir operation have altered the hydrological system in the transboundary Mekong River basin (MRB) over decades, urging a need to assess the historical changes and future projections of freshwater availability. **Prof. Deliang CHEN, and an international team** published an article on Journal of Hydrology, examined changes of terrestrial water storage anomalies (TWSA) from the Gravity Recovery and Climate Experiment satellites in the lower MRB during 2003–2020, and subsequently partitioned and attributed them into climate-driven and non-climate-driven components using the WaterGAP hydrological model (WGHM) with and without consideration of human activities, together with a statistical method driven by climatic forcing only. Further, integrated future TWSA was projected under different climate change scenarios during 2030–2099 forced with four downscaled and bias-corrected simulations of four global climate models.

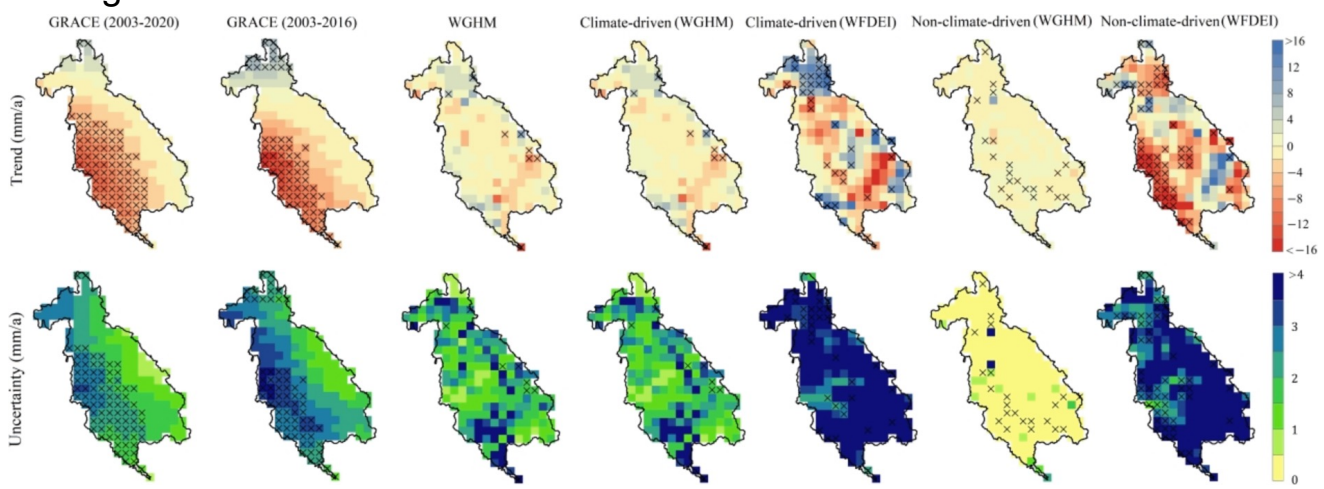


Figure 1: Spatial distribution of trends (upper panel) and uncertainties (lower panel) in TWSA, climate-driven TWSA, and non-climate-driven from the GRACE, WGHM, and statistical model in the lower MRB during 2003–2020. The black cross indicates the grid cells with significant trends ($p < 0.05$).

Research

Results show a decreasing TWSA trend of 3.7±1.8 mm/a during 2003–2020. The WGHM-based climate-driven TWSA, which is highly correlated with the statistical modeling results, and non-climate-driven part suggests a trend of 0.3±1.4 and 0.01±0.07 mm/a during 2003–2016, respectively. The climate-driven TWSA is well explained by the changes in decreasing precipitation (1.3±8.5 mm/a) and increasing air temperature (0.05±0.02 ℃/a) spatially and temporally, while the non-climate-driven component is closely linked to human activities such as growing sectoral human withdrawal (0.13±0.14 mm/a), increasing reservoir regulation (0.01±0.08 mm/a), and changing land cover. TWSA under future climate changes is projected to increase from 9.3±21.4 to 12.2±12.2 mm and from 1.6±41.2 to 12.3±30 mm in the near (2040–2059) and far future (2080–2099) under various scenarios comparing with the historical period (2003–2020). Future flood potential, estimated with TWSA and precipitation, was also projected to increase. This study provides important inferences for decision-makers and stakeholders to better understand the water cycle and manage water resources in a changing environment.

The results were published in ***Journal of Hydrology***
Full article link: **https://doi.org/10.1016/j.jhydrol.2022.128275**

Research

Climate change projection over Mainland Southeast Asia and the Lancang-Mekong River basin based on a set of RegCM4 simulations

Mainland Southeast Asia (MSEA, also known as the Indochina Peninsula) is the continental part of Southeast Asia and it includes Vietnam, Laos, Cambodia, Myanmar, Thailand, Malaysia (Peninsular part), and Singapore. Dominated by monsoon climate, the region suffers frequently from flood and drought disasters, and is considered as one of the most vulnerable regions to climate change due to its high exposure and low resilience. **Dr. Yuanhai FU** and **Prof. Xuejie GAO**, **and an international team** investigate the projected climate change over MSEA, a region with complex topography and unique weather and climate systems, but limited availability of published high resolution regional climate model (RCM) studies.

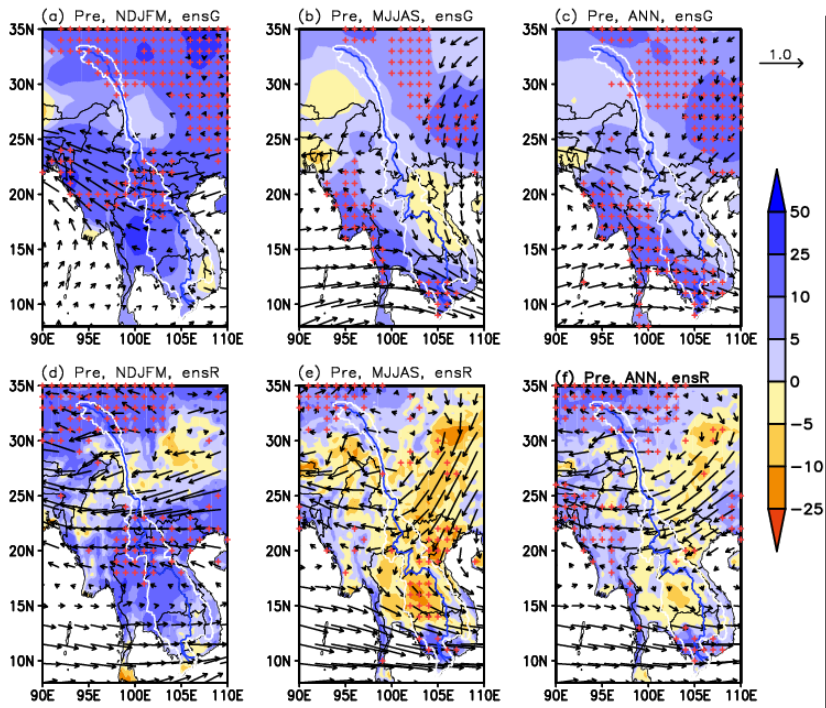


Figure 1: The projected changes in precipitation at the end of 21st century (2079–2098) relative to the present day under RCP4.5 pathway, the arrows indicating horizontal wind change at 700 hPa. By ensG in the dry season (a), and wet season (b), and the whole year (c); by ensR in the dry season (d), and wet season (e), and the whole year (f). The cross indicates at least four out of five models/simulations agree on the sign of change. Units: % and m/s.

Research

The study is based on an unprecedented ensemble of 21st century projections with the RegCM4 RCM driven by five different general circulation models (GCMs) at a grid spacing of 25 km under RCP4.5 and RCP8.5. Intercomparison between the RegCM4 simulations with the driving GCMs is provided to illustrate the added value of the RegCM4 experiments. RegCM4 reproduces greater and more realistic spatial detail of the present day temperature and precipitation distribution compared to the driving GCMs, but some biases are found, such as an overestimation of precipitation over high topography regions. The spatial pattern of biases show some consistencies across the GCMs and, for November–March the RegCM4, although weak correlation is found between the GCM and nested RegCM4 biases. A generally lower warming is projected in the future by the RegCM4 in different seasons and the whole year. For precipitation, while prevailing increases are found in the GCM projections, large areas of decrease occur in the RegCM ones, in particular during the wet season, possibly due to the more detailed topographical representation. The change patterns of precipitation show consistencies across the GCMs and the RegCM4, especially in May–September. The projected changes of extreme indices indicates a general decrease/increase of extreme cold/warm events. Drought events are projected to be more frequent over the southwestern, while a general increase of heavy rain events prevails over most parts of the region.

The results were published in *International Journal of Climatology*
Full article link: https://doi.org/10.1002/joc.7811

Research

Extreme precipitation variability across the Lancang-Mekong River Basin during 1952–2015 in relation to teleconnections and summer monsoons

The Lancang-Mekong River Basin (LMRB) is home to 70 million people whose life and livelihood are mostly dependent upon precipitation as the primary freshwater source. Hence, identifying potential oceanic–atmospheric drivers of regional precipitation variability is becoming increasingly important for the sustainable development of the LMRB. Led by **Dr. Masoud IRANNEZHAD**, this study first investigated spatio-temporal variability and trends in extreme precipitation characteristics (in terms of intensity, frequency, and duration) throughout the LMRB during 1952–2015, using gauge-based gridded daily precipitation time series. Then, the associations between the historical extreme precipitation characteristics and seven teleconnection and five summer monsoon indices were explored.

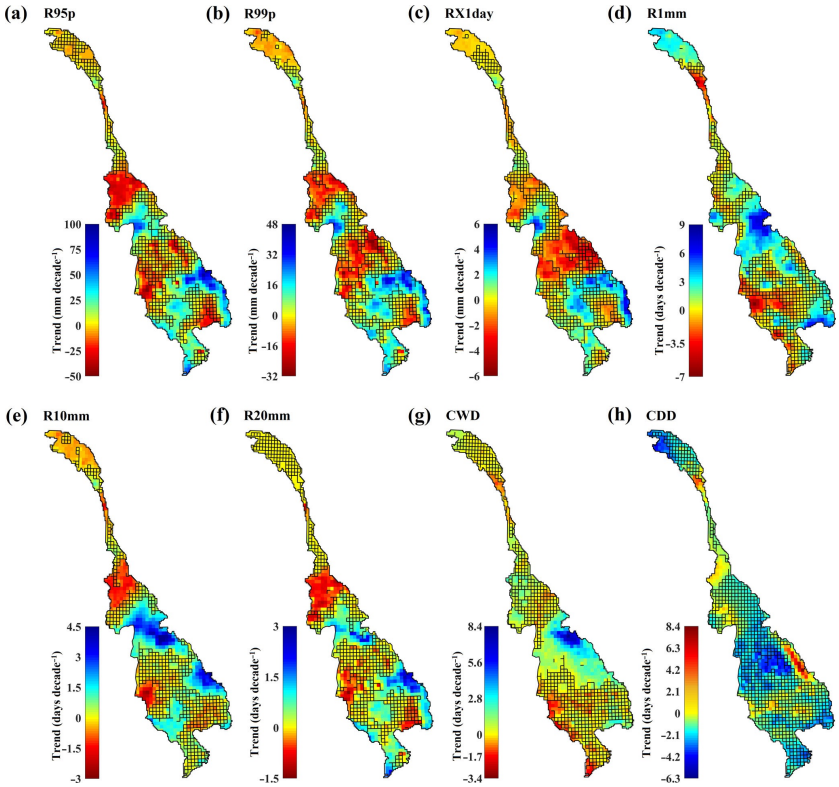


Figure 1: Spatial distribution maps of trends in (a) R95p, (b) R99p, (c) RX1day, (d) R1mm, (e) R10mm, (f) R20mm, (g) CWD, and (h) CDD, throughout the LMRB during the water years (November–October) 1952–2015. The stippling indicates areas where the trends are statistically insignificant ($p > .05$).

On the basin scale, no statistically significant ($p < .05$) trends were detected in annual extreme precipitation intensity, frequency, and duration indices. The number of wet days (R1mm) significantly increased in both the Mekong River Basin (MRB) and the Lancang River Basin (LRB), predominantly leading to longer wet spells in these two sub-basins. Spatially, the relatively high extreme precipitation intensity and frequency indices, as well as consecutive wet days (CWD), significantly increased in the south, east, and northwest of MRB, while decreased in the west of MRB and the north of LRB. The intensity and frequency of historical extreme precipitations over the LMRB were most significantly correlated with the East Asian Summer Monsoon Index, North Atlantic Oscillation, and East Pacific/North Pacific pattern.

The results were published in ***International Journal of Climatology***
Full article link: **https://doi.org/10.1002/joc.7370**

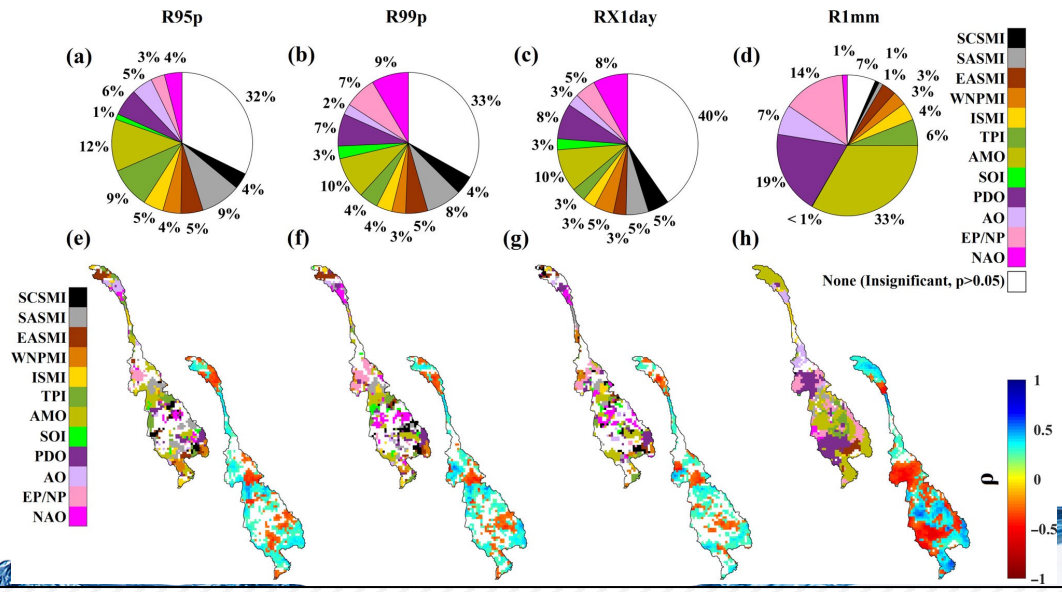


Figure 2: Percentage of most influential climate teleconnections (upper row) as well as spatial distribution maps (lower row) of their name (left) and Spearman rank correlation (right) with extreme precipitation indices of (a and e) R95p, (b and f) R99p, (c and g) RX1day, and (d and h) R1mm, throughout the LMRB during the water years 1952–2015.

Research

Bayesian retro- and prospective assessment of CMIP6 climatology in Pan Third Pole region

Pan Third Pole (PTP) region includes Tibet Plateau (TP), Central Asia (CA) and Southeast Asia (SEA) and it is one of the places on earth that are most sensitive to climate change. Meanwhile, PTP origins a series of large rivers such as Yangtze River, Yellow River and Lancang-Mekong River, which feed millions of people downstream. **Prof. Qingyun DUAN's** team published a research paper on Climate Dynamics to investigate the performance of CMIP6 models in simulating precipitation and temperature in Pan Third Pole region for both historical period and future under different scenarios.

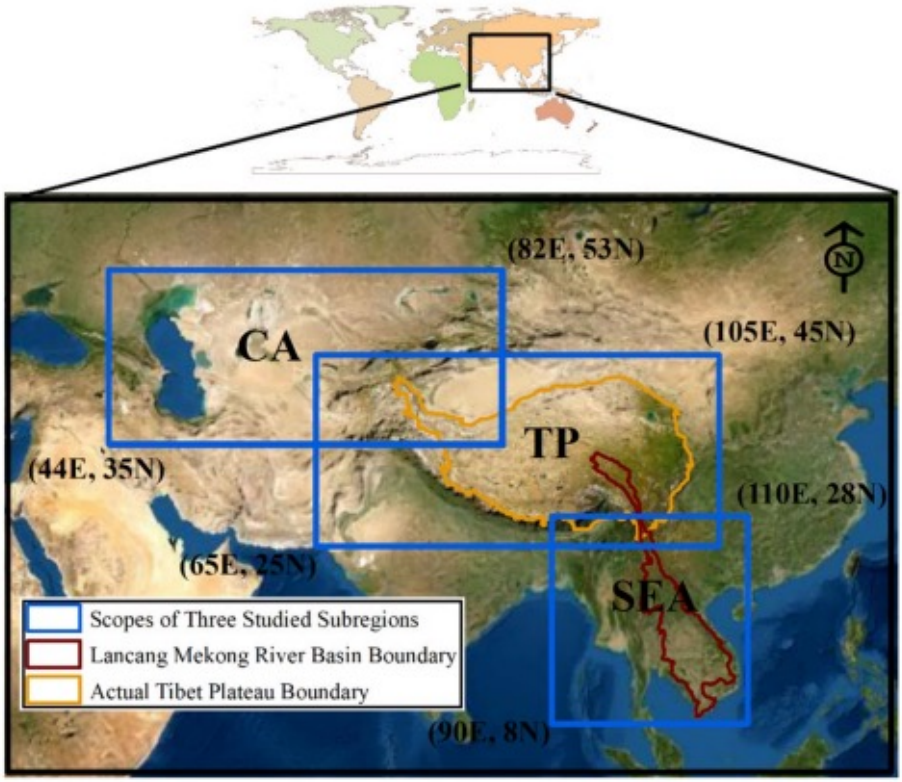


Figure 1: Layout map of Pan Third Pole region. The scopes of Central Asian (CA), Tibet Plateau (TP) and Southeast Asian (SEA) used in this study are displayed in three blue boxes

Research

CMIP6 models and CRU observations are used to evaluate historical precipitation and temperature climatology changes in PTP region. The BMA predictions are used to assess the climate variabilities in the near (2021–2050), middle (2046–2075) and far future (2071–2100) under four SSP-RCP scenarios. Results indicate that temperature is significantly underestimated by most CMIP6 models in TP especially IPSL-CM6A-LR and CanESM5 whereas precipitation is overestimated for CA and TP. Most CMIP6 models do not predict precipitation very well in SEA. In addition, Pan Third Pole region is projected to be warmer and wetter in the future and the trend is stronger under SSP5-8.5 scenario. The BMA predicted temperature uncertainty is larger for high latitude CA region whereas precipitation uncertainty is higher for low latitude SEA region.

The results were published in ***Climate Dynamics***
Full article link: **https://doi.org/10.1007/s00382-022-06345-7**

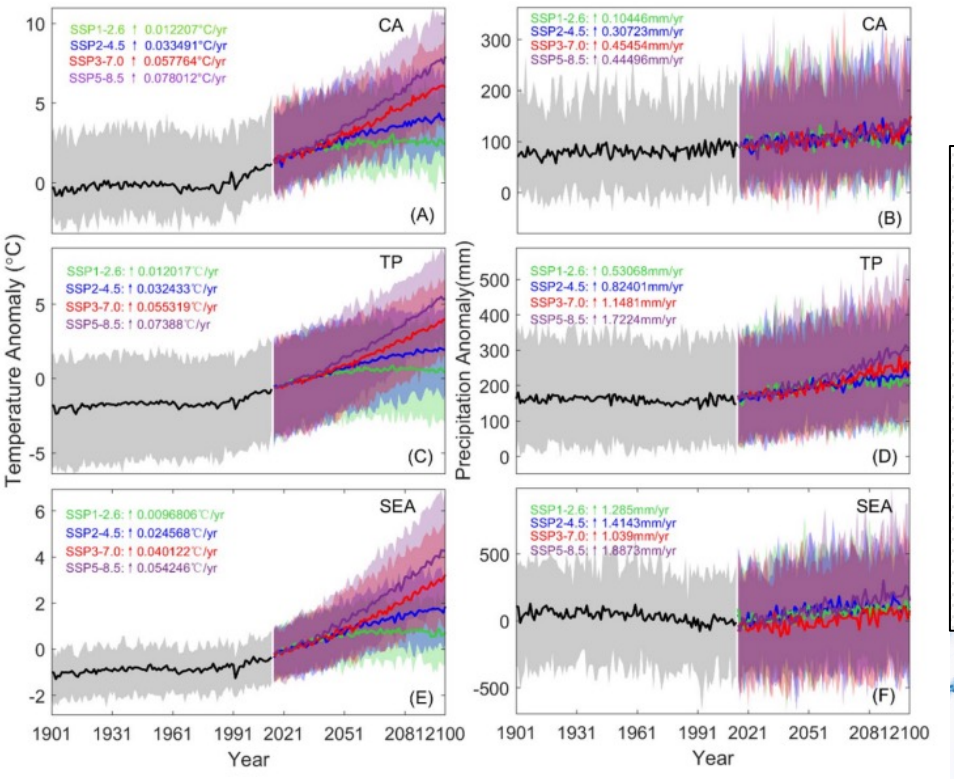


Figure 2: Time series of anomaly in annual mean temperature and annual total precipitation over CA, TP and SEA during 1901–2100 (baseline period: 1981–2010). The shaded areas are the spreads from the 5th to the 95th percentiles.

Publications

Selected Publications Since July 2022

- Liu, J., D. Chen, G. Mao, et al. (2022). Past and Future Changes in Climate and Water Resources in the Lancang–Mekong River Basin: Current Understanding and Future Research Directions. *Engineering*,13: 144-152. https://doi.org/10.1016/j.eng.2021.06.026
- Ehlers, T. A., D. Chen, E. Appel, et al. (2022). Past, Present, and Future Geo-Biosphere Interactions on the Tibetan Plateau and Implications for Permafrost. *Earth-Science Reviews,* 234, 104197. https://doi.org/10.1016/j.earscirev.2022.104197
- Fu, Y., X. Gao, Y. Xu, et al. (2022). Climate change projection over Mainland Southeast Asia and the Lancang-Mekong River basin based on a set of RegCM4 simulations. *International Journal of Climatology,* 1–19. https://doi.org/10.1002/joc.7811
- He, B., Z. Zhong, D. Chen, et al. (2022). Lengthening Dry Spells Intensify Summer Heatwaves. *Geophysical Research Letters*, 49, e2022GL099647. https://doi.org/10.1029/2022GL099647
- Irannezhad, M., J. Liu, D. Chen. (2022). Extreme precipitation variability across the Lancang-Mekong River Basin during 1952–2015 in relation to teleconnections and summer monsoons. *International Journal of Climatology*, 42 (5), 2614–2638. https://doi.org/10.1002/joc.7370

Publications

Selected Publications Since July 2022 (continued)

- Liu, S., Z. Liu, Q. Duan, et al. (2022). The performance of CMIP6 models in simulating surface energy fluxes over global continents. *Climate Dynamics*. https://doi.org/10.1007/s00382-022-06595-5
- Liu, Z., Q., Duan, X. Fan, et al. (2022). Bayesian retro- and prospective assessment of CMIP6 climatology in Pan Third Pole region. *Climate Dynamics*. https://doi.org/10.1007/s00382-022-06345-7
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