Meeting/Workshop Reports

Remote Effects of High Elevation Land Surface Temperature on S2S Precipitation Prediction: First Workshop on LS4P and TPEMIP

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The kickoff workshop for the "Impact of initialized land temperature and snowpack on sub-seasonal to seasonal prediction" (LS4P) Initiative and "Third Pole Experiment Multi-Model Intercomparison" (TPEMIP) Project was held just prior to 2018's annual American Geophysical Union meeting. Subseasonal to seasonal (S2S) prediction, especially the prediction of extreme climate events such as droughts and floods, is scientifically challenging and has substantial societal impacts and economic consequences. Despite the substantial progress that has been achieved in recent decades, the prediction skill for precipitation anomalies in spring and summer months has remained stubbornly low. The GEWEX/Global Atmospheric System Study (GASS) LS4P initiative put forward a new approach that complements sea surface temperature (SST), snow and soil moisture research by suggesting the effect of land memory in terms of the land surface/subsurface temperature (LST/SUBT) on S2S prediction. Most land-atmosphere interaction studies have focused on the local effect, while the possible remote effects of large-scale LST/SUBT anomalies in geographical areas upstream on S2S prediction have largely been ignored. The LS4P project intends to address the question of the impact of the initialization of large scale LST/SUBT and snow pack, including aerosols in snow, in climate models on the S2S prediction over different regions. East Asia has been selected as the focus area in the first phase because of the presence of the high elevation Tibetan Plateau (TP) and large-scale snow cover there, in addition to a significant amount of available observational data from the Third Pole Experiment (TPE). This provides an ideal geographical location for the first phase experiment. Regional Earth system (multi-sphere) modeling for the Third Pole region and its impact on the adjacent regions at different scales is also one of TPEMIP's main focuses.

Participants of the First Workshop on LS4P and TPEMIP

The workshop, held in Washington, D.C., USA with 36 participants from different institutions around the world and U.S. government agencies, was very productive with five sessions and many inspiring presentations. GEWEX, GASS, TPE and the University of California, Los Angeles (UCLA) sponsored the event. TPE and the National Science Foundation (NSF) provided financial support. Dr. Peter van Oevelen of the International GEWEX Project Office, GASS Co-Chair Dr. Xubin Zeng, Dr. Ailikun of the TPE Project Office and World Weather Research Programme (WWRP)/WCRP Subseasonal to Seasonal Prediction Project co-Chair Dr. Andrew Robinson expressed their support for the respective projects that they are leading for this workshop, and they also presented summaries of related research. Dr. Jennifer Saleem Arrigo of the U.S. Global Change Research Program presented a multi-federal agency effort, the Climate, Water, and Energy Exchanges (CWEX) program. CWEX facilitates U.S. inter-agency research seeking to enhance predictive understanding of the water cycle and energy fluxes of the changing Earth and global climate system, and to coordinate interactions with relevant efforts of WCRP, such as GEWEX. Dr. Vijay Tallapragada of the National Centers for Environmental Prediction (NCEP)/the National Oceanic and Atmospheric Administration (NOAA), Constantin Ardilouze of Meteo France, and Dr. Qi Tang of the Lawrence Livermore National Laboratory (LLNL)/U.S. Department of Energy (DOE) provided presentations or gave introductions on their respective institutions' relevant S2S research. Dr. Randy Koster of the Goddard Space Flight Center (GSFC)/National Aeronautics and Space Administration (NASA) introduced current soil moisture research and suggestions to the LS4P experimental design.

Studies on the LST/SUBT effect as well as aerosols in snow were presented and discussed in the workshop. After preliminary studies explored the relationship between spring LST/SUBT anomalies and the summer precipitation anomaly in downstream regions in North America and East Asia (Xue et al., 2016, 2018; Diallo et al., 2019), a number of studies have been carried out on this issue. Dr. Yuhei Takaya of the Meteorological Research Institute (MRI), Dr. Zhaohui Lin of the Institute of Atmospheric Physics (IAP) and Dr. Myung-Seo Koo of the Korea Institute of Atmospheric Prediction Systems (KIAPS) reported their initial tests on the LST/SUBT effect on East Asian S2S prediction. Since the LS4P initiative was approved by GEWEX in spring 2018, eight institutions including the Australian Bureau of Meteorology (BOM), Environment and Climate Change Canada, National Meteorological Center/the China Meteorological Administration, IAP/Chinese Academy of Sciences (CAS), the Indian Institute of Tropical Meteorology (IITM), MRI/Japan Meteorological

Agency (JMA), KIAPS/the Korea Meteorological Administration (KMA) and UCLA have provided preliminary LS4P results, which were presented at the workshop. These models' results show a consistent relationship between their May 2003 2 meter temperature (T2m) bias over the TP and June 2003 precipitation bias in many parts of the world. For instance, the models with warm bias in May T2m in the TP also have a wet bias in June precipitation over the region to the south of the Yangtze River. The workshop also reported on the observed global June precipitation difference between warm and cold TP spring T2m years. The results between these two (observation and model bias) are very consistent, as shown in Figure 1 for the eastern part of Asia, with similar results for many other parts of the world, suggesting a possible global remote effect of TP spring LST/SUBT on summer precipitation in many areas. Dr. Hailan Wang of GSFC/NASA reported that their model bias over the TP affects their model's simulation of the North American droughts.

Some presentations explored the source of the spring LST/SUBT anomalies. Dr. William Lau of the University of Maryland (UMD) showed that aerosols in TP snow may trigger large spring LST anomalies there, and Dr. Mike Burke of the University of Arizona also demonstrated the effect of snow on T2m. Dr. Yang Zhang of Nanjing University suggested that the linkage between TP spring snow and LST anomaly may be related to the Arctic Oscillation.

The TPE and the Third Tibetan Plateau Atmospheric Scientific Experiment (TIPEX-III) have conducted extensive and comprehensive measurements over the TP for decades and their activities were reported by Dr. Xin Li of the Institute of Tibetan Plateau Research and Dr. Ping Zhao of the Chinese Academy of Meteorological Sciences, respectively. TPE has four data centers and their four websites provide about 2,000 data sets covering glacier, permafrost, snow aerosol and near surface flux information, include data from a soil moisture and temperature network in the TP. TIPEX-III has established multiscale land-surface and planetary boundary layer (PBL) observation networks over the TP and a tropospheric radiosonde network over the western TP. Drs. Li and Zhao indicated that they will provide data services for LS4P and TPEMIP. Data availability and the TPE database for the storage of our projects' model outputs are two of the main reasons why we selected East Asia as the focus of the first phase. In addition, satellite data applications for the TP area have been reported by Dr. Shunlin Liang of UMD.

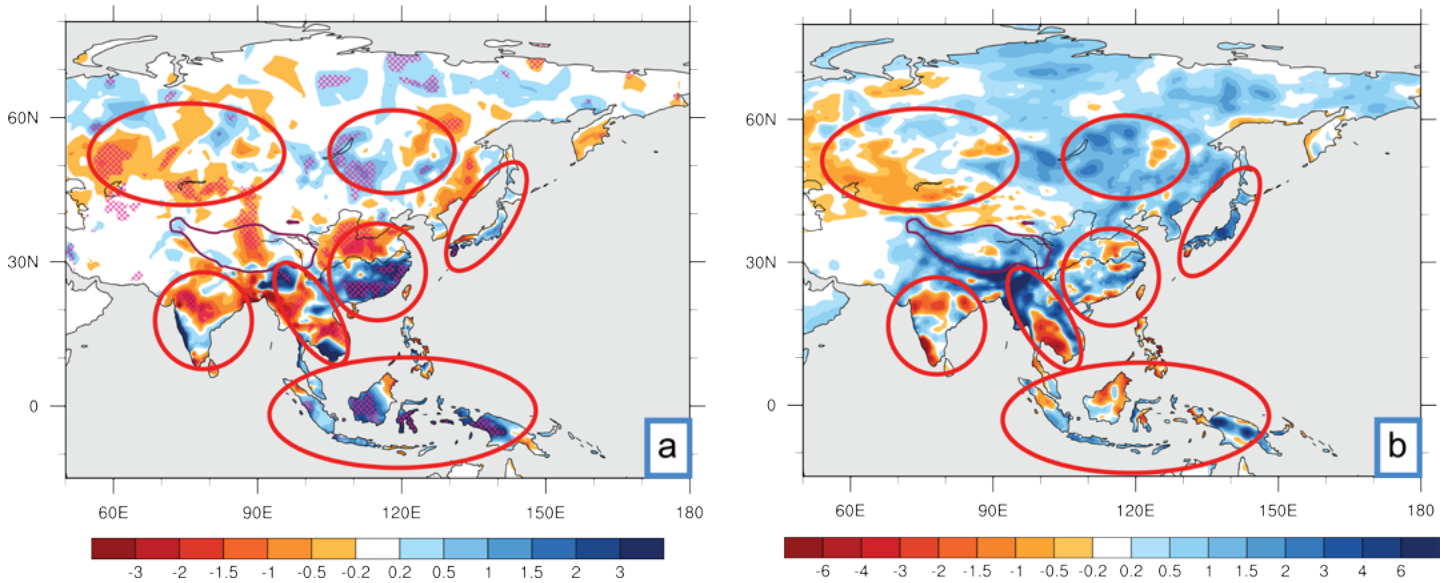

***Figure 1**. Comparisons of relationship between May T2m temperature in Tibetan Plateau and June precipitation from observed anomalies and model biases. Figure 1(a): Observed June precipitation difference between warm and cold years in May 2m Temperature (T2m) over the Tibetan Plateau. The anomaly year's selection is based on whether the year's May absolute T2m anomaly is larger than 0.5 standard deviation of May climatology. (b) Multi-model ensemble mean June precipitation bias when models have a warm bias over TP. Every model has a large T2m bias over the Tibetan Plateau area. For the model with negative T2m bias, the precipitation bias is multiplied by -1 to be included in the composite. The red circles highlight hot spots.*

The workshop attendees decided to change the project acronym name from the initial designation of "ILSTSS2S" to the more concise "LS4P." The workshop participants also discussed future prospects of the LS4P plan. One major task is to demonstrate the potential of using LST/SUBT for S2S prediction, which will include the following: i) Earth system model (ESM) experiments for selected regions and seasons to test the LST/SUBT effect (the first phase focuses on the TP LST/SUBT anomaly impact on surrounding Asian regions; in the second and third phase, ESMs will be used to identify Rocky Mountain and Andes Mountain LST/SUBT effects, respectively); ii) Data analyses to show the relationship between T2m/LST and precipitation for different major mountains and to identify hot spots over the globe where LST has significant impacts [a Ti-

betan Plateau Oscillation Index (TPO) will be proposed]; iii) The demonstration of regional climate model (RCM) dynamic downscaling effects on S2S prediction; iv) The improvement of land model physics and the refining of the land model LST/SUBT initialization strategy; v) The identification of the source of LST/SUBT anomalies and other mechanisms. Moreover, we will explore the role of snow and aerosols in snow with LST/SUBT in S2S prediction.

Major activities for 2019 were also discussed.

1. A paper will be submitted to Geoscientific Model Development to present the LS4P project early in the year.
2. We will accept model results for May T2m and June precipitation until May 31, 2019. The results will be for the year 2003 and for model climatology, if model climatology is available.
3. Most model results for the first stage sensitivity experiment are expected to be done by about August 31, 2019. A paper with multi-model results will be submitted to a journal early in 2020, and a special issue with relevant research from each group will be prepared by that time.
4. An LS4P and TPEMIP regional modeling group workshop will be held in summer 2019 in Nanjing, China. Nanjing University will host this workshop and limited travel support will be available. The announcement will be distributed soon.
5. A Tibetan Plateau Oscillation Index (TPO) that suggests a global impact of TP LST/SUBT will be proposed and a paper will be submitted in summer 2019.
6. A session in the next American Geophysical Union (AGU) Fall Meeting or American Meteorological Society (AMS) Annual Meeting will be proposed.

The LS4P workshop information and relevant materials can be found at the UCLA website, *https://ls4p.geog.ucla.edu*, and on the GEWEX website at *https://www.gewexevents.org/events/ilstss2s-kickoff-workshop-by-invitation-only/*.

References

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Process Evaluation Study on Upper Tropospheric Clouds and Convection: 2018 Highlights

Paris, France
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The GEWEX Upper Tropospheric Clouds and Convection Process Evaluation Study (UTCC PROES) working group was created in 2015 to ultimately advance our knowledge of the climate feedbacks of Upper Tropospheric (UT) clouds (*GEWEX News*, May 2017). As large-scale modeling is necessary to identify the most influential feedback mechanisms, it is important that the relevant cloud processes are well represented in climate models. Therefore, the UTCC PROES goals are to:

- Understand the relation between convection, cirrus anvils and radiative heating, and
- Develop observational diagnostic methods to probe processes that detrain UT clouds from convection.

The working group brings together scientists from several communities: satellite observations, radiative transfer and transport modeling, as well as small-scale process and climate modeling. 30 participants were hosted by the Sorbonne University in Paris for the 2018 UTCC PROES Workshop last October. During the two-day event, participants discussed observational analyses of mesoscale convective systems, water vapor and convective transport, process studies, climate variation and feedbacks, as well as parameterizations and model diagnostic studies.

On the first day, results from complementary observations were presented, which gave an interesting perspective on synergetic studies. Transport studies and the possibility of diagnosing convective transport were also examined. Vertical velocity is an important variable in process and climate modeling and it requires observations to be evaluated. The proposed National Aeronautics and Space Administration (NASA) D-Train mission will provide valuable insight, if the project is selected. The second day featured exciting observational studies coupled with modeling on cloud feedbacks to different climate modes, and on the role of convection in the maintenance of tropical margins. The last part of the meeting was dedicated to climate model sensitivity studies. Presentations are available at the UTCC PROES website (*https://gewex-utcc-proes.aeris-data.fr/*) and at the GEWEX website (*https://www.gewexevents.org/events/utcc-proes-workshop/*).