Annual Report 2023 for Flagship Pilot Study Convection-Permitting Third Pole (CPTP)

Status and progress during the year including scientific highlights (and images if possible), end-to-end perspective and participants engaged in the project

The Flagship Pilot Study Convection-Permitting Third Pole (CPTP) is the abbreviation for the project "High-resolution climate modeling with a focus on mesoscale convective systems and associated precipitation over the Third Pole region", which was endorsed in 2019.

Scientific highlights

1) An in-depth analysis of the Mesoscale Convective System (MCS) case from the CPTP project was conducted. This analysis aimed to investigate the key processes involved in MCS formation, and the associated precipitation, and to assess the capability of kilometer-scale regional modeling systems in reproducing these processes. The results show that the observed MCS case can be interpreted as a further development of a vortex moving off the Tibetan Plateau (TP). The preceding vortex evolution over the TP and water vapor fluxes into the Sichuan basin were identified as key processes that need to be accurately simulated to reproduce the MCS precipitation center at the correct location. A realistic representation of the westerly jet stream is necessary to simulate the vortex and subsequent downstream precipitation accurately. The statistics of MCS are further examined in a 1-year simulation, where the general statistics of storm systems around the TP are reasonably well captured, even though most of the models struggle to capture the selected storm case. This work has been published in the ***Journal of Climate*** under the title "Kilometer-scale multi-model and multi-physics ensemble simulations of a mesoscale convective system in the lee of the Tibetan Plateau: Implications for climate simulations" (DOI: 10.1175/JCLI-D-22-0240.1) and was led by **Julia Kukulies** from the University of Gothenburg.
2) Long-term changes in Mesoscale Convective Systems (MCSs) in the East Asian rainband are examined using a high spatiotemporal resolution satellite precipitation product and a novel MCS tracking method. The results reveal that both the frequency and intensity of MCSs over the East Asian rainband have increased by 21.8% and 9.8%, respectively, over the past two decades (2000–2021). These more frequent and intense MCSs contribute to nearly three-quarters of the total increase in precipitation. The changes in MCSs are attributed to more frequent large-scale environments rich in water vapor, which are likely to increase under global warming. The increased frequency and intensity of MCSs have significant impacts on the hydroclimate of East Asia, including the production of extreme events such as severe flooding. This work has been published in ***Geophysical Research Letters*** under the title "Intensification of Mesoscale Convective Systems in the East Asian Rainband Over the Past Two Decades" (DOI: 10.1029/2023GL103595) and was led by **Puxi Li** from the China Meteorological Administration.
3) The performance of the Weather Research Forecasting (WRF) model, with a 4 km horizontal grid spacing and various physical parameterization schemes (PPSs), is investigated. This investigation focuses on simulating precipitation, 2 m air temperature (T2), snowfall, and lake-effect snow for the CPTP snow case during October 4–8, 2018 over the TP. The results show that all simulations of the WRF model can reasonably capture the spatial distributions of precipitation, T2, and snow-related variables. The Milbrandt scheme slightly outperforms the other PPSs in simulating the magnitudes of the snow-related variables. However, none of the PPSs accurately reproduce the characteristics of lake-effect snow due to their inaccurate temperature and airflow modeling. Continuous improvements in both large-scale circulation and lake dynamics are needed for a better representation of the lake-effect snow over the TP. This work has been published in the ***Journal of Geophysical Research: Atmospheres*** under the title "Performance of the WRF model at the convection-permitting scale in simulating snowfall and lake-effect snow over the Tibetan Plateau" (DOI: 10.1029/2022JD038433) and was led by **Qian Lin** from Wuhan University.

End-to-end perspective

1) *Communications between project members*: In this project, two working groups (WSs) are formed to better coordinate and conduct the overall aims of the CORDEX Flagship Pilot Study CPTP. WG1 focuses on high-resolution modeling, namely the "modeling WG", while WG2 focuses on data (analysis), namely "data WG". Each WG has two co-leaders besides the lead investigator of the CPTP project. Both WGs have their own email list and organize meetings within the group. We also arrange joint meetings that bring all members from the two WGs together when necessary. This year we organized the first physical annual project meeting in Bergen after the pandemic, in which some main progresses are presented and some challenges are discussed. The plan for the next year and phase II of this project is also discussed. Minutes of the meeting and detailed documentation can be found in dedicated online storage through which all the project members can have a good view of the current status of both WGs. Data from both groups are shared through the Tibetan Plateau Data Center (TPDC, https://data.tpdc.ac.cn/en/) as well as a local page at the University of Gothenburg (http://biggeo.gvc.gu.se/).
2) *Outreach to stakeholders*: 1) 6 publications in internationally renowned journals to present new findings from this project. 2) Organized a session at EGU 2023, 'Mesoscale and severe convection over land: processes, modelling advances, predictability, and impacts' (https://meetingorganizer.copernicus.org/EGU23/session/46900). 3) Participated and presented outcomes at CPCM workshop 2023 (https://cpm2023.w.uib.no/). 4) Participated and presented outcomes at International Conference on Regional Climate ICRC-CORDEX 2023 (https://indico.ictp.it/event/10212/overview). 5) Information related to the progress of the project on the dedicated project page (http://rcg.gvc.gu.se/cordex_fps_cptp/) was and will be continually updated monthly. 6) Data generated by this project is archived and internally shared through the National Tibetan Plateau Data Center (TPDC: https://data.tpdc.ac.cn/en/), which will be publicly available after the internal evaluation has been finished.

Participants engaged in the project

Currently, 25 international research groups are participating in this FPS.

1. Deliang Chen, Tinghai Ou, Julia Curio, Hui-Wen Lai, Julia Kukulies (Now works at NCAR with Andreas F. Prein), and Xuejia Wang (Now works at Lanzhou University, China) University of Gothenburg, Sweden
2. Shaukat Ali, Global Change Impact Studies Centre, Pakistan
3. Cesar Azorin-Molina, Spanish National Research Council, Centro de Investigaciones sobre Desertificación (CIDE-CSIC), Spain
4. Danijel Belusic, Rossby Centre, Swedish meteorological and hydrological institute, Sweden
5. Rasmus Benestad, Norwegian Meteorological Institute, Norway
6. Marie Ekström, Cardiff University, United Kingdom (She left the project after she had left the university for a new job at the global re-insurance broker company Gallagher Re)
7. Xuejie Gao, Institute of Atmospheric Physics, Chinese Academy of Sciences, China
8. Yanhong Gao, Fudan University, China
9. William Gutowski and Dilli Bhattarai, Iowa State University, United States of America
10. Sanjay Jayanarayanan, Indian Institute of Tropical Meteorology, India
11. L. Ruby Leung, Pacific Northwest National Laboratory, United States of America
12. Andreas F. Prein and Hongyong Yu (now works at Beijing Normal University, China), National Center For Atmospheric Research (NCAR), United States of America
13. Madan Lall Shrestha, Nepal Academy of Science and Technology, Nepal
14. Hans Christian Steen-Larsen and Laura Dietrich, University of Bergen, Norway
15. Shiori Sugimoto, Japan Agency for Marine-Earth Science and Technology, Japan
16. Shuyu Wang and Jianping Tang, Nanjing University, China
17. Kun Yang, Tsinghua University, China

18. Tandong Yao and Xu Zhou, Institute of Tibetan Plateau Research, Chinese Academy of Sciences, China
19. Xingcao Chen, Penn State University, United States of America
20. Tianjun Zhou, Liwei Zou, Zhun Guo (Institute of Atmospheric Physics, Chinese Academy of Sciences), Puxi Li (Chinese Academy of Meteorological Sciences, China Meteorological Administration), China
21. Nikolina Ban and Emily Collier, University of Innsbruck, Austria
22. Stefan Sobolowski and Lu Li, NORCE Norwegian Research Centre, Norway
23. Kalli Furtado and Peter Sheridan, MetOffice, United Kingdom
24. Shabeh Ul Hasson, University of Hamburg, Germany
25. Bodo Ahrens, Goethe University Frankfurt, Germany

Summary of each workshop/activity held during the year

Title, date, short description, location, website, links	Responsible person/-s	Funder
Annual project meeting 2023, 1 September 2023, Lecture Hall (room 4020), Geophysical Institute, University of Bergen, Jahnebakken 5, 5007 Bergen	Julia Curio and Deliang Chen	TPE

Paticipation in The International Conference on Regional Climate-CORDEX 2023 (ICRC-CORDEX 2023) was held 25-29 of September 2023 in Trieste, Italy	Julia Curio and Deliang Chen	Swedish Research Council
Particpation in EGYU and AGU by various participants of the project	Various participants	Grants of various participants

Related publications during the year

Title, journal and link to publication	Author/-s	Date
Modeling Lightning Activity in the Third Pole Region: Performance of a km-Scale ICON-CLM Simulation. ***Atmosphere***. DOI: 10.3390/atmos14111655. https://www.mdpi.com/2073-4433/14/11/1655	Singh, P., B. Ahrens	2023-11-05
Kilometer-scale multi-model and multi-physics ensemble simulations of a mesoscale convective system in the lee of the Tibetan Plateau: Implications for climate simulations. ***Journal of Climate***, 36, 5963–5987. DOI: 10.1175/JCLI-D-22-0240.1. https://journals.ametsoc.org/view/journals/clim/36/17/JCLI-D-22-0240.1.xml	Kukulies, J. A. F. Prein, J. Curio, H. Yu, D. Chen	2023-09-01
Intensification of mesoscale convective systems in the East Asian rainband over the past two decades. ***Geophysical Research Letters***, 50, e2023GL103595. DOI: 10.1029/2023GL103595. https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2023GL103595#:~:text=MCS%20precipitation%20over%20the%20East,rainfall%20has%20also%20significantly%20increased.	Li, P., F. Song, H. Chen, J. Li, A. F. Prein, W. Zhang, T. Zhou, M. Zhuang, K. Furtado, M. Muetzelfeldt, R.Schiemann, C. Li	2023-08-18
Performance of the WRF model at the convection-permitting scale in simulating snowfall and lake-effect snow over the Tibetan Plateau. ***Journal of Geophysical Research: Atmospheres***, 128, e2022JD038433. DOI: 10.1029/2022JD038433. https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2022JD038433	Lin, Q., J. Chen, T. Ou, H.-W. Lai, A. F. Prein, D. Chen	2023-08-07
Mesoscale convective systems in the Third Pole region: Characteristics, Mechanisms and Impact on precipitation. ***Frontiers in Earth Science***. DOI: 10.3389/feart.2023.1143380. https://www.frontiersin.org/articles/10.3389/feart.2023.1143380/full	Kukulies, J, H. Lai, J. Curio, Z. Feng, C. Lin, P. Li, S. Sugimoto, T. Ou, D. Chen	2023-04-12
Wet bias of summer precipitation in the northwestern Tibetan Plateau in ERA5 is linked to overestimated lower-level southerly wind over the plateau. ***Climate Dynamics***. 61, 2139–2153. DOI: 10.1007/s00382-023-06672-3. https://link.springer.com/article/10.1007/s00382-023-06672-3	Ou, T., D. Chen, J. Tang, C. Lin, X. Wang, J. Kukulies, H.-W. Lai	2023-01-16

Planned activities for next year

- Start decadal hindcast simulations
- Continue seminar series
- Continue analyses of the WY2020 simulations
- Field excursion and a project meeting in the Tibet Plateau
- Work on new proposals associated with the project framework
- Supervise several master theses using the experiments conducted
- Develop stakeholder outreach activities

Any other positive news or stories within your FPS during the year

Most of the information related to the progress of this project can be found on the dedicated project page, http://rcg.gvc.gu.se/cordex_fps_cptp/.

Contact person/-s

- Lead investigator: **Deliang Chen** (University of Gothenburg, Sweden)
- Co-leaders for WGI (modelling): **Andreas F. Prein** (National Center for Atmospheric Research (NCAR), USA) and **Nikolina Ban** (University of Innsbruck, Austria)
- Co-leaders for WGII (data): **Tandong Yao** (Institute of Tibetan Plateau Research, Chinese Academy of Sciences, China) and **Hans Christian Steen-Larsen** (University of Bergen, Norway)

Please remember to inform IPOC about news, calls, activities or other information that can be shared with the community during the year! We want to show your work on the website and on social media.

If more space is needed just add rows in the table.
The report is due on the 15th of February each year and should be sent to ipoc@cordex.org.