Annual report 2024 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 modelling with a focus on mesoscale convective systems and associated precipitation over the Third Pole region", which was endorsed in 2019.

Scientific highlights

1) The first multi-model and multi-physics ensemble of kilometre-scale simulations of the hydrological year 2020 over the Third Pole region has been generated. The ensemble consists of 13 simulations with a horizontal grid spacing ranging from 2.2. to 4 km driven by ERA5 reanalysis. The simulations were compared to available gridded and in-situ observations and remote sensing data to assess the performance and spread of the model ensemble compared to ERA5 for the cold and warm seasons. The model evaluation was made difficult due to large differences between the gridded precipitation datasets that serve as reference over this region. Despite this issue the results from the ensemble evaluation show that the ensemble improves on many warm-season precipitation metrics compared with ERA5, including most wet-day and hour statistics, and adds value in the representation of wet spells in both seasons. This work has been published in ***Climate Dynamics*** under the title "The First Ensemble of Kilometre-Scale Simulations of a Hydrological Year over the Third Pole" (DOI: 10.1007/s00382-024-07291-2) and was led by **Emily Collier** from the University of Innsbruck.

2) The research group in Beijing performed two 12-year convection permitting simulations with a resolution of 3.3 km using the ICON model for the Tibetan Plateau region. The simulations consist of a retrospective simulation (2008–2020) with initial and boundary conditions from ERA5 reanalysis and a pseudo-global warming projection for the same period driven by modified reanalysis-derived initial and boundary conditions by adding the monthly CMIP6 ensemble-mean climate change under the SSP5-8.5 scenario. The experimental design and a preliminary analysis of the evaluation and projection of seasonal mean precipitation and surface temperature has been published in ***Advances in Atmospheric Sciences*** under the title "Convection-Permitting Simulations of Current and Future Climates over the Tibetan Plateau" led by **Liwei Zou** from LASG, Institute of Atmospheric Physics, Beijing. The retrospective simulation shows overall good performance in capturing the seasonal precipitation and surface air temperature. Over the central and eastern TP, the average biases in precipitation (temperature) are less than −0.34 mm d^{-1} (−1.1°C) throughout the year compared to data from 81 meteorological stations. The simulated biases over the TP are season and height dependent. Cold (wet) biases are found in summer (winter) above 5500 m. The future climate simulation suggests that the TP will be wetter and warmer under the SSP5-8.5 scenario. The general features of projected changes in ICON are comparable to the CMIP6 ensemble projection, but the added value from kilometer-scale modeling is evident in both precipitation and temperature projections over complex topographic regions.

3) The 12-year convection permitting retrospective ICON simulation with a horizontal resolution of 3.3 km (ICON_3.3 km) (see point 2) was further evaluated regarding its ability to improve the simulation of the spring water cycle in the Tibetan Plateau region in comparison to a 12-year ICON simulation with a horizontal resolution of 13.2 km (ICON_13.2 km) where convection was parameterized. It was found that the explicit handling of convection and the high spatial resolution led to a reduction of the wet bias found in the ERA5 reanalysis and ICON_13.2 km simulation and improved the simulation of surface evaporation. This work has been published in ***JGR Atmospheres*** under the title "How Does Regional Convection-Permitting Modeling

Improve the Simulation of the Atmospheric Water Cycle in Spring Over the Tibetan Plateau?" and was led by **Liwei Zou** from LASG, Institute of Atmospheric Physics, Beijing.

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 modelling, namely the "modelling 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.
   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) 5 publications in internationally renowned journals to present new findings from this project. 2) Organized a session at EGU 2024, 'From Mesoscale Convection to Convective-Scale Predictions: advances in process modelling, observations, data assimilation and machine learning' (https://meetingorganizer.copernicus.org/EGU24/session/48852). 3) 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. 4) 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.
3. Supervised master theses:
   - Laura Detjen, supervised by Julia Curio (University of Gothenburg): **Heavy and extreme precipitation events in the Sichuan Basin during the 2020 summer season in a set of kilometre-scale simulations**
   - Irene Bellagente, supervised by Hui-Wen Lai (University of Gothenburg): **Effects of cloud microphysics on precipitation simulation over the Tibetan Plateau,** currently being written up for publication
   - Nikolas Papagiannopoulos, supervised by Tinghai Ou (University of Gothenburg): **Position and strength of upper-troposphere Westerly Jet and its effects on precipitation over the Tibetan Plateau and surrounding regions in global reanalyses and regional climate model simulations.**
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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, now also works at Department of Geophysics, Faculty of Science, University of Zagreb
5. Rasmus Benestad, Norwegian Meteorological Institute, Norway
6. Marie Ekström, Cardiff University, United Kingdom (she left the project after leaving 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 (now works at ETH Zurich, Switzerland) 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 (now works at Centre for Climate Research Singapore) 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
Particpation in EGU and AGU by various participants of the project	Various participants	Grants of various participants
CORDEX-MAIRS-Future Earth workshop was held in Beijing, China, from 17-18 October 2024.	Kun Yang (in person), Tinghai Ou (online), Ali Shaukat (Online)	

Related publications during the year

Title, journal and link to publication	Author/-s	Date
How does regional convection-permitting modeling improve the simulation of the atmospheric water cycle in spring over the Tibetan Plateau? ***Journal of Geophysical Research: Atmospheres***, 129, e2024JD040964. https://doi.org/10.1029/2024JD040964	Zou, L., Zhou, T.,& Zhao, Y.	2024-08-06
The First Ensemble of Kilometre-Scale Simulations of a Hydrological Year over the Third Pole. ***Climate Dynamics***, **62**, 7501–7518 (2024), https://doi.org/10.1007/s00382-024-07291-2	Collier, E., N. Ban, N. Richter, B. Ahrens, D. Chen, X. Chen, H.-W. Lai, R. Leung, L. Li, A. Medvedova, T. Ou, P. K. Pothapakula, E. Potter, A. F. Prein, K. Sakaguchi, M. Schroeder, P. Singh, S. Sobolowski, S. Sugimoto, J. Tang, H. Yu, C. Ziska	2024-05-31
Discrepancies of kilometer-scale dynamic downscaling over the Tibetan Plateau: underestimation of nocturnal precipitation in summer. ***Climate Dynamics,*** **62**, 5909–5925 (2024). https://doi.org/10.1007/s00382-024-07183-5	Jiang, H., Gao, Y. & Wang, G.	2024-04-02
Convection-Permitting Simulations of Current and Future Climates over the Tibetan Plateau. ***Adv. Atmos. Sci.,*** **41**, 1901–1916 (2024). https://doi.org/10.1007/s00376-024-3277-9	Zou, L., Zhou, T.	2024-03-26
Decomposition and reduction of WRF-modeled wintertime cold biases over the Tibetan Plateau. ***Climate Dynamics***, **62**, 4189–4203 (2024). https://doi.org/10.1007/s00382-024-07126-0	Li, Y., Gao, Y., Chen, G., Wang, G., Zhang, M.	2024-02-29

Planned activities for next year

- Convene CPTP related EGU session AS1.11: **Mesoscale and severe convection over land: processes, modelling advances, predictability, and impacts** and have a small meeting of CPTP members attending EGU25
- Continue analysis of WY2020 simulations
- Run decadal hindcast simulations
- Field excursion and a project meeting in the Tibet Plateau region either in 2025 or 2026. We originally had planned to have an in-person or hybrid project meeting in China in 2024 but had to postpone it due to difficulties in finding a suitable date for everyone.
- Work on new proposals associated with the project framework
- Develop stakeholder outreach activities
- Continue seminar series

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

Master student Laura Detjen (University of Gothenburg, supervised by Julia Curio) won the EGU 2024 Outstanding Student and PhD candidate Presentation (OSPP) Award (https://www.egu.eu/awards-medals/ospp-award/2024/laura-detjen/) for her poster "*Heavy and extreme precipitation events in the Sichuan Basin during the 2020 summer season in a set of kilometre-scale simulations*".

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, now works at ETH Zurich, Switzerland) 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 at the website and on social media.

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