# Annual report 2020 for Flagship Pilot Study Convection-Permitting Third Pole (CPTP)

**Status and progress during the year including scientific highlights, 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**

- Based on the Met Office Unified Model (MetUM), mesoscale model experiments (MSMs; with horizontal resolutions of 13 and 35 km) have notable wet biases over the Tibetan Plateau (TP) and can overestimate the summer precipitation by more than 4.0 $mm \cdot day^{-1}$ in some parts of the Three Rivers Source region. Moreover, the two MSMs have more frequent light rainfall; increasing the horizontal resolution of the mesoscale experiments alone does not reduce the excessive precipitation. Compared to the MSMs, convection-permitting model (CPM; with 4 km grid spacing) removes the spurious afternoon rainfall and thus significantly reduces the wet bias simulated by the MSMs. In addition, the CPM also better depicts the precipitation frequency and intensity and is therefore a promising tool for dynamic downscaling over the TP.
- Through a High-Resolution Land Data Assimilation System, the simulated snow-cover fraction was greatly underestimated using merged satellite and gauge precipitation datasets over the Brahmaputra Grand Canyon (southern TP). However, simulations using precipitation from 28 km dynamical downscale models and 4 km CPM by the Weather Research and Forecasting (WRF) outperformed those using other gridded precipitation data, showing lower biases, higher pattern correlations, and closer probability distribution functions than runs driven by the merged precipitation. The findings support the assumption that high-resolution CPM-produced precipitation has an added value for use in land surface and hydrology simulations in high-mountain regions without reliable in situ precipitation observations.
- Based on WRF, the scale-aware cumulus parameterization scheme (CU) outperforms other CUs in simulating precipitation in terms of both the mean intensity and diurnal cycles over the TP at the gray-zone grid spacing (9 km). However, all the CU experiments tend to overestimate the mean precipitation and simulate an earlier peak of precipitation frequency when compared to observations. The results demonstrate simulation without a CU outperforms those with a CU at the gray-zone spatial resolution in regard to the precipitation diurnal cycles.

**End to end perspective**

- *Communications within project members*: In this project, two working groups (WSs) are formed to better coordinate and conduct the overall aims of this project. One WG focuses on high-resolution modeling, namely the modeling WG, while the other WG 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 will organize meetings within the group. We will also organize joint meetings that bring all members from the two WGs together when necessary. We have dedicated online storage for minutes of each meeting and important document, through which all the project members can have a good view of the current status of both WGs. Data from both groups will be shared.

- *Outreach to stakeholders*: 1) Publications in internationally renowned journals to present new findings from this project. 2) Organize international meetings, for example, we are going to organize a session in EGU 2021, 'Meso-scale convection and disturbances in high-mountain environments' (https://meetingorganizer.copernicus.org/EGU21/session/40838). 3) Frequently updated information related to the progress of the project on the dedicated project page (http://rcg.gvc.gu.se/cordex_fps_cptp/). 4) Data generated by this project will be publicly

available. We are now in communication with the National Tibetan Plateau Data Center (TPDC: https://data.tpdc.ac.cn/en/), through which we are going to publish our simulations.

- *Outreach to potential users*: TPCP has established contacts with several potential users for its high resolution climate modeling results. One such an example is communication with an ongoing research project entitled "Understanding snow, glacier and rivers response to climate in High Mountain Asia (ASCENT)". The project is led by Dr. Francesca Pellicciotti from WSL and aims at unraveling the hydrological functioning of representative high elevation glacierised catchments across High Mountain Asia and identifying the causes for different glacier retreat rates and contribution to basin runoff in individual climate regimes. The planned high-resolution climate simulations by TPCP may be useful to ASCENT and future cooperation between the two projects is being discussed.

**Participants engaged in the project**

This project is a community effort and contribution from anybody in any way and at any time is more welcome.

Currently, there are 24 international research groups participated in this FPS.

- Deliang Chen, Tinghai Ou, Xuejia Wang, Julia Curio, Hui-Wen Lai, and Julia Kukulies, University of Gothenburg, Sweden
- Shaukat Ali, Global Change Impact Studies Centre, Pakistan
- Cesar Azorin-Molina, Spanish National Research Council, Centro de Investigaciones sobre Desertificación (CIDE-CSIC), Spain
- Danijel Belusic, Rossby Centre, Swedish meteorological and hydrological institute, Sweden
- Rasmus Benestad, Norwegian Meteorological Institute, Norway
- Marie Ekström, Cardiff University, UK
- Xuejie Gao, Institute of Atmospheric Physics, Chinese Academy of Sciences, China
- Yanhong Gao, Fudan University, China
- William Gutowski, Iowa State University, USA
- Sanjay Jayanarayanan, Indian Institute of Tropical Meteorology, India
- L. Ruby Leung, Pacific Northwest National Laboratory, USA
- Andreas F. Prein, National Center For Atmospheric Research (NCAR), USA
- Madan Lall Shrestha, Nepal Academy of Science and Technology, Nepal
- Hans Christian Steen-Larsen, University of Bergen, Norway
- Shiori Sugimoto, Japan Agency for Marine-Earth Science and Technology, Japan
- Shuyu Wang and Jianping Tang, Nanjing University, China
- Kun Yang, Tsinghua University, China
- Tandong Yao and Xu Zhou, Institute of Tibetan Plateau Research, Chinese Academy of Sciences, China
- Xingcao Chen, Penn State University, USA
- Tianjun Zhou, Liwei Zou, Zhun Guo (Institute of Atmospheric Physics, Chinese Academy of Sciences), Puxi Li (Chinese Academy of Meteorological Sciences, China Meteorological Administration)
- Nikolina Ban and Emily Collier, University of Innsbruck, Austria
- Stefan Sobolowski, Lu Li, and, Laura Dietrich, NORCE Norwegian Research Centre, Norway
- Kalli Furtado, MetOffice, UK
- Shabeh Ul Hasson, University of Hamburg, Germany

Among the participated research groups, there are two newly engaged groups, namely, Kalli Furtado (MetOffice, UK) and Shabeh Ul Hasson (University of Hamburg, Germany). There are also new members from research groups who joined the project.

**Summary of each workshop/activity held during the year**

| Title, date, short description, location, website, links | Responsible person/-s | Funder |
|---|---|---|
| **1st annual meeting, January 22, 2021, online meeting**<br>In the first annual meeting, Deliang Chen gave a general update of the project and plan for 2021. Andreas Prein gave an update on the coordinated experiments of modeling WG and results from some case studies. Yanhong Gao and Puxi Li presented their Convection-Permitting Modeling work over the TP. Hans Christian Steen-Larsen presented their work related to Water isotopes. | Deliang Chen and Julia Curio | TPE<br>STINT |
| **2nd Modeling Working Group meeting, June 29, 2020, online meeting**<br>In the meeting, domains for all experiments have been updated and the final decision has been made. Three case studies have been presented and discussed. Details in the model set up, including IC/BC have been discussed and decided. Information on the three cases and model domain can be found on the project web page (http://rcg.gvc.gu.se/cordex_fps_cptp/) under "Experiments". | Andreas F. Prein and Nikolina Ban | TPE<br>STINT |
| **1st Data Working Group meeting, January 29, 2020, online meeting**<br>In the meeting, the introduction of this FPS has been given by Deliang Chen. Andreas F. Prein and Nikolina Ban presented the summary from modeling WG. Available data sets that can be used for model evaluations are discussed. Three events of case studies are to be selected and sent to modeling WG.<br>Information on available data for model evaluation can be found on the project web page (http://rcg.gvc.gu.se/cordex_fps_cptp/) under "Data available". | Hans Christian Steen-Larsen and Tandong Yao | TPE<br>STINT |
| **1st Modeling Working Group meeting, January 10, 2020, online meeting**<br>In the modeling, a brief introduction and aim of the WG have been given. The discussion has been focused on details in model sit up, including participated model groups and RCMs to be used. The maximum horizontal grid spacing for convection-permitting simulations over the TP has been set to 5 km. A minimum domain size for convection-permitting simulations has been set down. CORDEX standards output variables and data formats are to be adapted.<br>Information of RCMs to be used can be found on the project web page (http://rcg.gvc.gu.se/cordex_fps_cptp/) under "RCMs used". | Andreas F. Prein and Nikolina Ban | TPE<br>STINT |
| **1st project meeting (kick-off meeting), November 22, 2019, online meeting**<br>In the kick-off meeting, the overall aims and plans of this project were discussed. Two WGs, modeling WG and data WG, were suggested to better coordinate and conduct the overall aims of this project. Co-leaders for each WG are selected. Overall experiment design for the first year was also discussed. A dedicated web page (http://rcg.gvc.gu.se/cordex_fps_cptp/) has been created afterword based on the design of this project. | Deliang Chen | TPE<br>STINT |

**Related publications during the year**

| Title, journal and link to publication | Author/-s | Date |
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|---|---|---|
| Convection-permitting modelling improves simulated precipitation over the central and eastern Tibetan Plateau. ***Q J R Meteorol Soc.*** 1-22, doi:10.1002/qj.3921. https://rmets.onlinelibrary.wiley.com/doi/full/10.1002/qj.3921 | Li, P., K. Furtado, T. Zhou, H. Chen, J. Li | 2020-09-28 |
| Evaluation of a Convection-Permitting Modeling of Precipitation over the Tibetan Plateau and Its Influences on the Simulation of Snow-Cover Fraction. ***J. Hydrometeor***., 21, 1531-1548, doi:10.1175/JHM-D-19-0277.1. https://journals.ametsoc.org/view/journals/hydr/21/7/jhmD190277.xml | Gao, Y., F. Chen, Y. Jiang | 2020-07-01 |
| Simulation of summer precipitation diurnal cycles over the Tibetan Plateau at the gray-zone grid spacing for cumulus parameterization. ***Climate Dynamics***, doi:10.1007/s00382-020-05181-x. https://link.springer.com/article/10.1007/s00382-020-05181-x | Ou, T., D. Chen, X. Chen, C. Lin, K. Yang, H.-W. Lai, F. Zhang | 2020-02-27 |
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**Planned activities for next year**

- Submit a paper about the planned project design
- Submit a paper about modeling strategy
- Analyze results from coordinated experiments for three case studies
- Start a regular seminar series
- Finish the one-year test experiments
- Start the multiple-year simulations, if possible
- Find a data collection and sharing solution
- Work on new proposals associated with the project framework

**Additional relevant information**

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)

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The report is due the 15th of February each year and should be sent to ipoc@cordex.org.