Short-duration extreme precipitation in future climate

PROJECT SUMMARY

This project is providing users with new insights on the physical processes affecting short-duration (less than 24 hours) extreme precipitation and their possible changes in the future warming world.

CONTACT:
Yanping Li: yanping.li@usask.ca
Francis Zwiers: fwzwiers@uvic.ca

Short-duration extreme precipitation in future climate

Project progress

A few examples are:

•The binning scaling and trend scaling for precipitation extremes were analyzed across different durations (3-hour, 12-hour, and 24-hour), temporal scales (annual, winter, and summer), and spatial scales (local and regional scales).

•Trends of annual maximum daily precipitation over global land have been updated. We collected annual maximum 1-day precipitation (RX1day) and annual maximum 5-day precipitation amount (RX5day) from 43813 stations over global land during 1900-2018 period. A detection and attribution analysis have been conducted to quantify the impact of human influence on the observed changes in extreme precipitation.

•The Object-based algorithm MODE-TD has been applied to our western Canada 4-KM WRF simulation as well as CaPA, NARR and MSWEP to get additional spatiotemporal information of convective system in addition to the information such as precipitation amount and intensity which can be got at grid point.

•WRF CONUS I historical simulation (CTRL) and future climate simulation (PGW) were examined to identify the potential changes of light, moderate and heavy precipitation systems in the future.

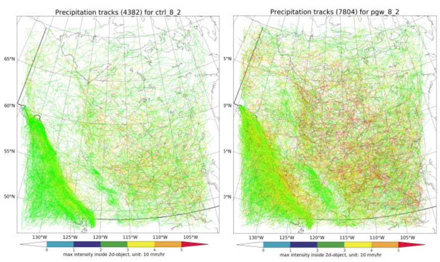

Fig. 2: Changes in the MCSs tracks between the current and future warmer climate using western Canada 4-KM simulations. Color represents max precipitation intensity of the MCS.

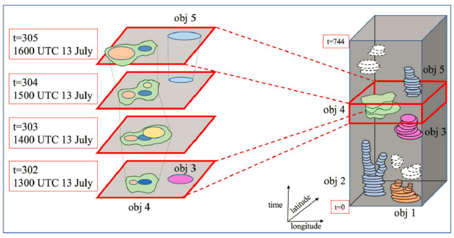

Fig. 1: Schematic diagram shows how MTD works. The right cuboid indicates input data for MTD and slices of data are shown as planes to the left. Five objects are represented in individual colors (MCSs) and each slice of the object shows the continuous object at a specific time (hourly). White-colored objects are non-identified MCSs that could not pass the threshold (i.e., 2000 pixels in this study).

User Engagement

•Long-term, various type of precipitation data collected and archived, advanced analyses of variables for the short-duration precipitation extremes over Canada has been shared with the GWF community.

•Validation of the western Canada and CONUS I 4-KM WRF simulation for Canada.

•Scientific results have been communicated with the community via conferences (AMS, AGU, CMOS, CGU), meetings and workshops; and via publications on scientific journals (AMS, AGU, EGU journals).

•Collaborate with community partnerships, communicate with users, interact with scientists on multidiscipline study such as the water management decision making, share results with the GWF research community and policy makers.

•The project has worked closely with Environment and Climate Change Canada, Agriculture and Agri-Food Canada regarding extreme precipitation over the Canadian Prairies in particular.

Results

•Strong evidences have demonstrated that the binning scaling cannot project the long-term change in precipitation extreme, with the disagreement of spatial pattern and magnitude between the binning scaling and trend scaling regardless of the durations, seasons, and spatial scales.

•The nonstationary extreme value analysis showed a statistically significant positive association with global mean temperature, with 6.7%/°C and 5.54%/°C of the sensitivity of RX1day and RX5day to global warming respectively.

•Our western Canada WRF simulation can well depict precipitation features such as its size, track length, duration, and propagation speed [Fig. 1]. The statistical results derived from the WRF historical simulation (CTRL) and future climate (PGW) were compared to identify the potential changes in MCSs and characteristics of storms that may be caused by climate change [Fig. 2].

•Our analysis of CONUS I and western Canada 4-KM WRF dataset shows that heavy precipitation events over the plains east of the Rockies are the main contributor to the eastward propagation of precipitation systems. The future PGW simulations demonstrate additional occurrence of extreme precipitation in the central region (over 100 mm/hr) [Fig. 3].

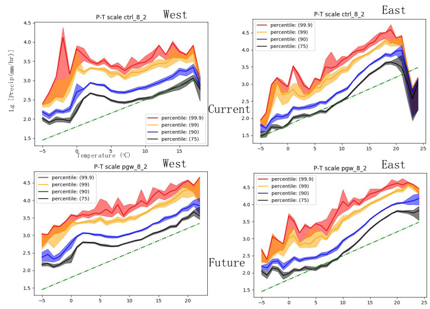

Fig. 3: Changes in Precipitation-Temperature scaling between current and future warmer climate for west and east part of the Canadian Rockies using western Canada 4-KM WRF simulations.

Outcomes and application uptake

Insights into future changes of short-duration extreme precipitation are being utilized including:

•A comprehensive understanding of the projected changes in shot-duration extreme precipitations events under changing climate conditions.

•The comparison of statistical results derived from the WRF historical simulation (CTRL) and future climate (PGW) identified the potential changes in MCSs and characteristics of storms that may be caused by climate change.

•Our trends of annual maximum daily precipitation over global land have made an important contribution to the extreme chapter of the forthcoming IPCC Working Group 1 contribution to the 6th Assessment Report.

•Through examining how extreme precipitation features scale across resolution from GCMs to RCMs to convective permitting WRF, our study provides scientific foundation for the proper interpretation and use of future projections produced by various climate models.

CANADA FIRST RESEARCH EXCELLENCE FUND | APOGÉE CANADA FONDS D'EXCELLENCE EN RECHERCHE
UNIVERSITY OF SASKATCHEWAN
UNIVERSITY OF WATERLOO
McMaster University
LAURIER Inspiring Lives.