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Anthropogenic Contribution to the Rainfall Associated with the 2019 Ottawa River Flood

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This section contains additional details about data processing. Rainfall accumulations were calculated for each grid box for each consecutive 30-day period contained in March–May. A day's precipitation total contributed to the period accumulation when that grid box's daily mean temperature exceeded 0°C. Difference anomalies were calculated for the grid box relative to a 1981–2010 mean calculated for each model (averaging across multiple realizations if available). These anomalies were remapped to a common 1.5° rectangular grid. Regional averages were calculated for each remapped realization. The first region is a rectangle that just encompasses the ORB. The second region captures a larger area, using the Ontario border in the west, while the north–south extent attempts to limit the influence of the different climate regime of the far north and the wetter region to the south. The maximum 30-day accumulation was determined for each year for each region-average series. To ensure comparability, each regional-mean time series was standardized by subtracting the mean and dividing by the standard deviation $[(x_i - \bar{x}_{\text{model}})/s_{\text{model}}]$. One mean and standard deviation was calculated for each model from a pool of ALL realizations, and used for each realization (both ALL and NAT) from that model. A 10-yr period (2014–23) for calculation of the ALL probability provides enough data to estimate probabilities without covering too many years in a nonstationary climate. The NAT period (1996) begins after the influence of major volcanic eruptions and ends in the final year of the simulations (2020).

Table ES1. list of models and number of realizations.

Model	ALL with SSP3–7.0	NAT
BCC/BCC-CSM2-MR	1	3
NCAR/CESM2	2	3[a]
CNRM-CERFACS/CNRM-CM6.1	3	3
CCCma/CanESM5	50	30
IPSL/IPSL-CM6A-LR	11	6
MRI/MRI-ESM2.0	5	3
NCAR/CESM2-WACCM	3	0
CNRM-CERFACS/CNRM-ESM2.1	3	0
EC-Earth-Consortium/EC-Earth3	1	0
EC-Earth-Consortium/EC-Earth3-Veg	1	0
MPI-M/MPI-ESM1.2-LR	10	0
Total simulations (No. of models)	90 (11)	48 (6)

[a] Simulations end in 2014.

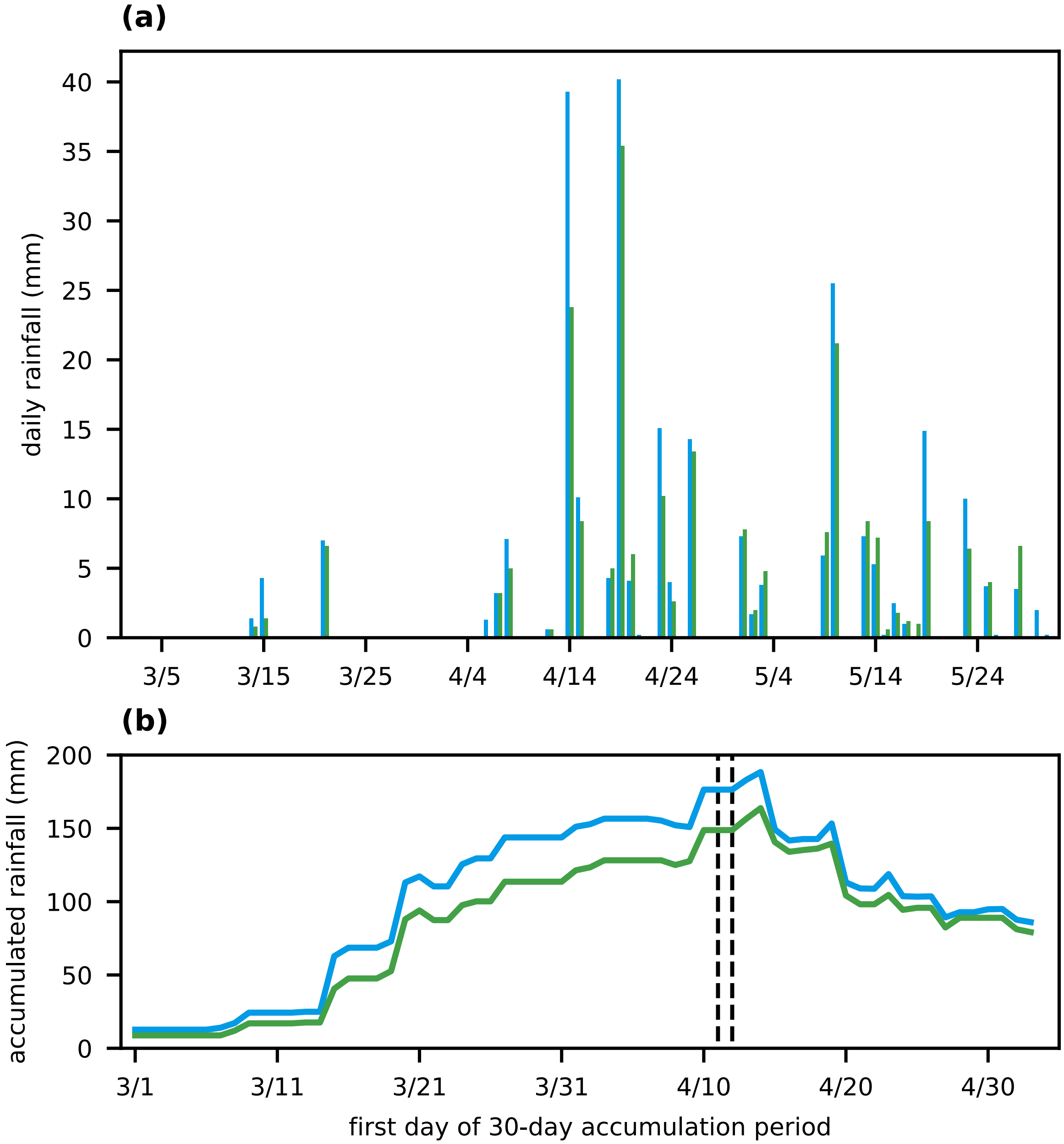

Fig. ES1. (a) Daily rainfall accumulation in spring (March–May) 2019 from two different stations (Ottawa Canadian Department of Agriculture Reference Climate Station in green and Ottawa International Airport in blue) located near Ottawa, Ontario (white circle in Fig. 1). Amounts were included when the daily mean temperature was greater than 0°C. (b) Accumulated 30-day rainfall during spring, plotted by the first day of the 30-day period. The dashed lines represent the maximum 30-day period chosen in 2019 using ERA5 for the two different regions.

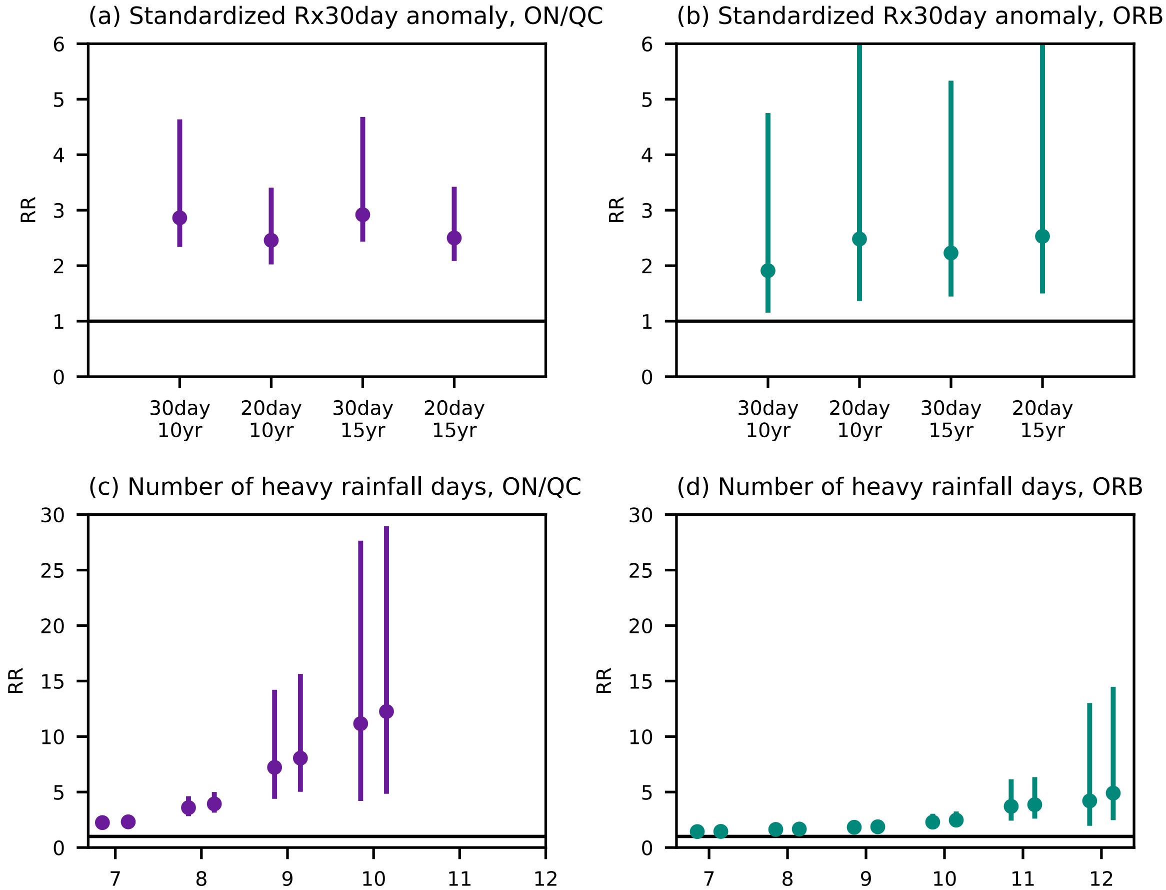

Fig. ES2. (top) PR sensitivity test for the standardized maximum rainfall anomaly and (bottom) the counts of heavy rainfall events for (left) the larger Ontario/Quebec region and (right) the smaller ORB region. In addition to the results using a 10-yr ALL period and Rx30day (also shown in Fig. 2), a 15-yr ALL period 2012–26 and an Rx20day metric were also tested. For the heavy rainfall events, the 10-yr period is on the left and the 15-yr period is on the right.