

SMExRain



STATISTICAL MODELING OF EXTREME RAINFALL PROCESSES IN THE CONTEXT OF CLIMATE CHANGE



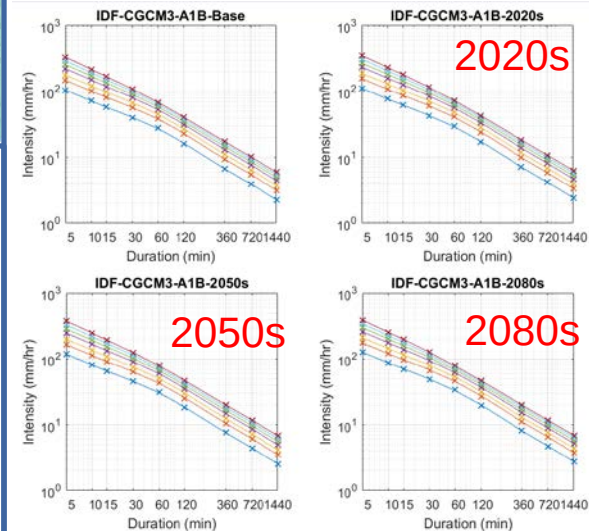
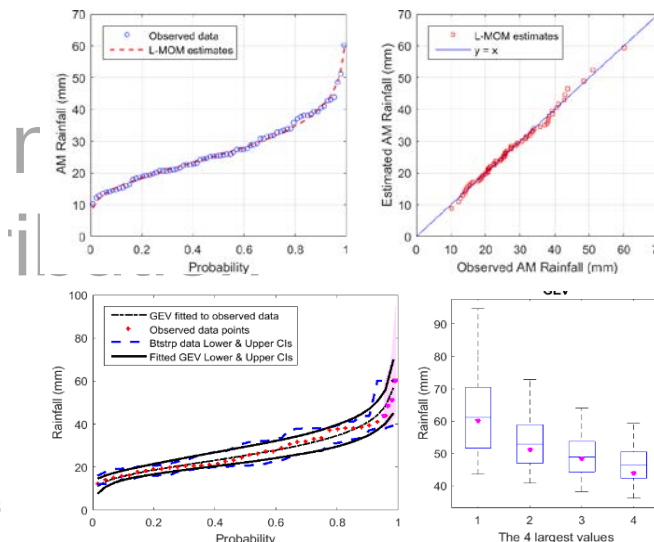
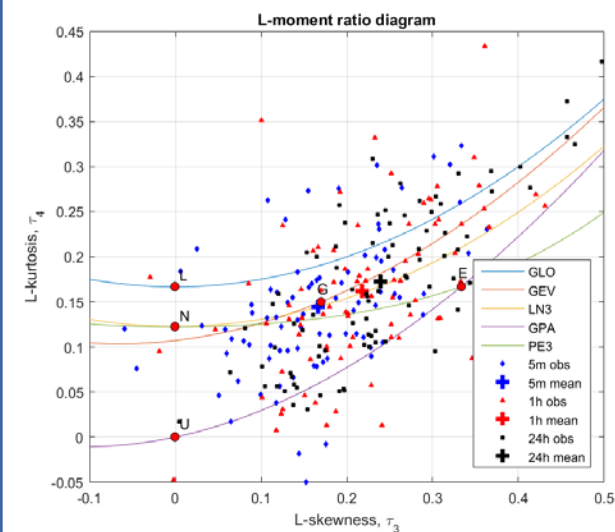
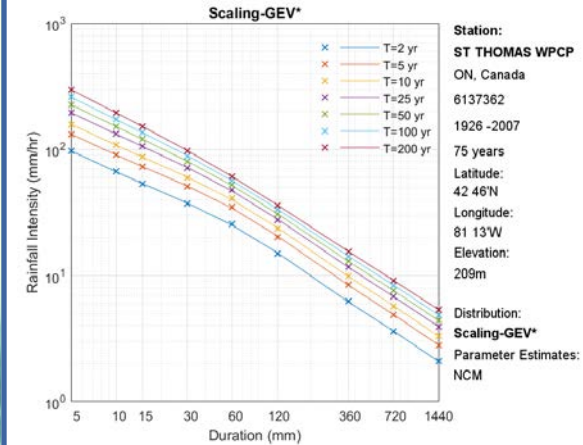
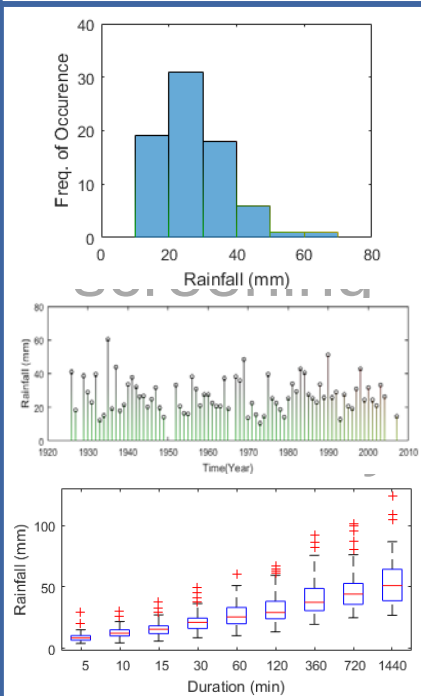
Truong-Huy Nguyen, PhD Candidate¹

Van-Thanh-Van Nguyen, Professor¹

¹Department of Civil Engineering & Applied Mechanics, McGill University

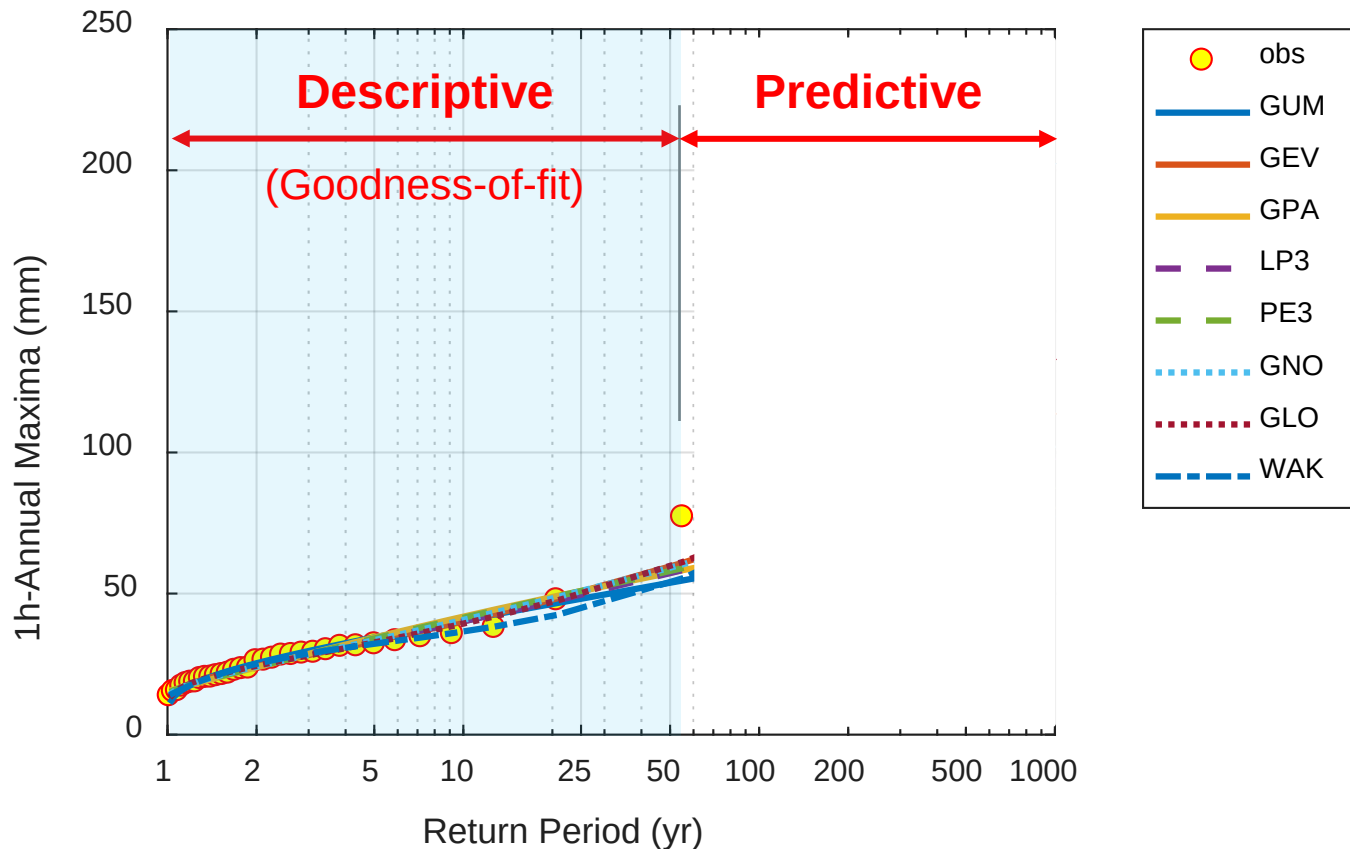
Software Description

IDF Relations



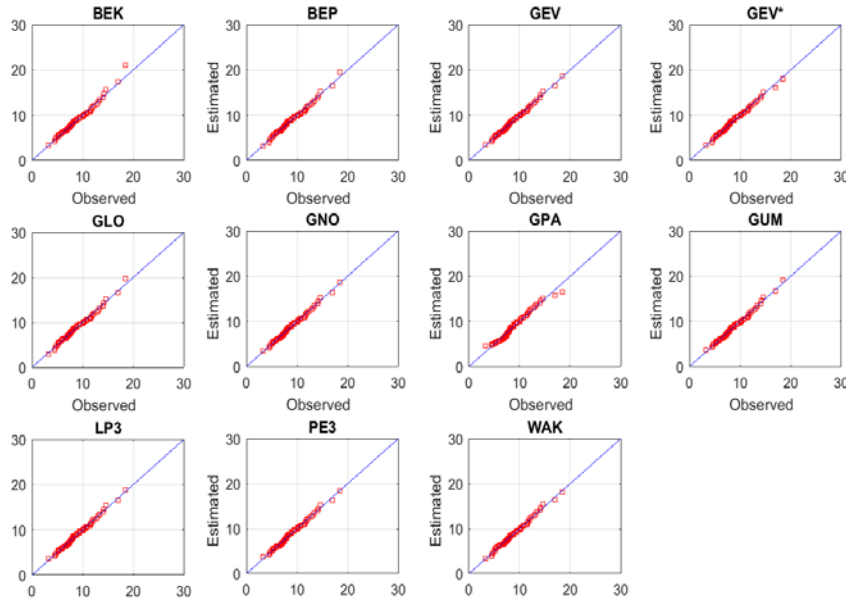
Introduction

- **Probability distributions**
 - Gamma family
 - (2) GUM || (3) GEV, GPA, PE3, LP3, GNO, GLO || (5) WAK ...
 - Extreme values family
 - Normal family



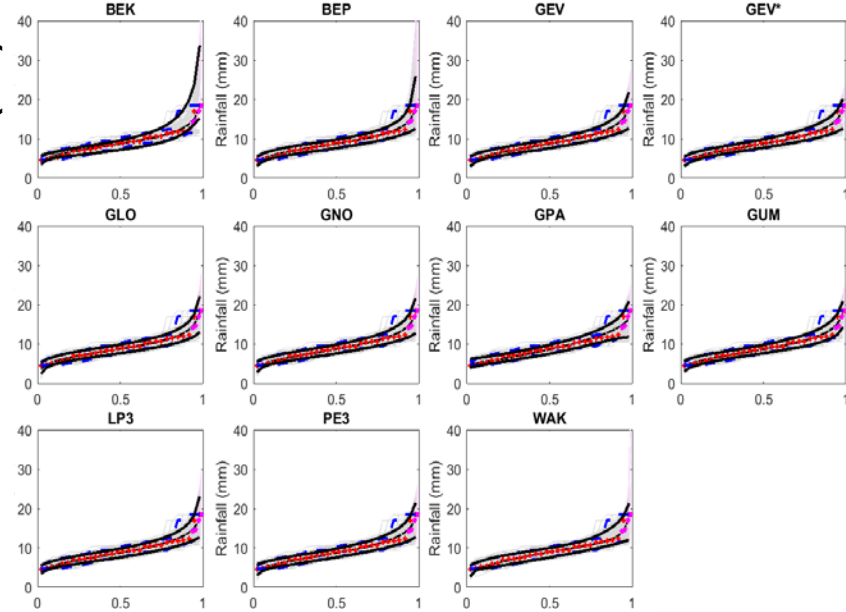
SMExRain Descriptions

Estimated Rainfall (mm)



Observed Rainfall (mm)

Observed & Estimated Rainfall (mm)



Probability

Comparison

Filtered AMS/POT Series: Complete Series, AMS, POT, L-MOM Diagram

Descriptive Ability: Single PD, Multiple PDs

Predictive Ability: Single PD, Multiple PDs

Toolboxes: Advanced Setting

Data series: ☒ AMS, ☐ POT

Empirical vs. theoretical probability distributions

Enter number of distributions compared: 11

Select an empirical plotting position formula: Cunnun...

EPP coefficients: A = 0.4, B = 0.2

Analyze... PB Plots... Save as... Q-Q Plots... Export...

Up to 12 Distributions

01 BEK, 02 BEP, 03 GEV, 04 GEV*, 05 GLO, 06 GNO, 07 GPA, 08 GUM, 09 LP3, 10 PE3, 11 WAK, 12 Sele...

Table 1. Statistical Criteria Test Results

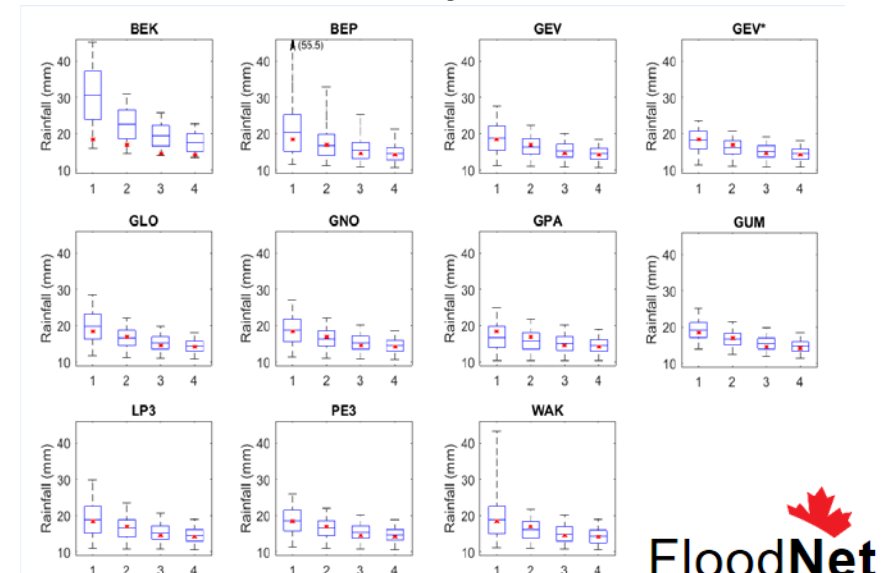
	BEK	BEP	GEV	GEV*	GLO	GNO	GPA	GUM	Min	Max
RMSE	0.465	0.311	0.244	0.269	0.347	0.268	0.461	0.269	0.2430	NaN
RRMSE	0.037	0.028	0.028	0.028	0.037	0.031	0.031	0.031	0.0280	NaN
MAE	2.667	0.998	0.720	0.929	1.265	0.889	1.895	0.847	0.6830	NaN
CC	0.991	0.995	0.997	0.997	0.994	0.997	0.989	0.996	NaN	0.9970

Table 2. Ranking of Statistical Criteria Test Results

	BEK	BEP	GEV	GEV*	GLO	GNO	GPA	GUM	LP3	PE3
RMSE	10.0	8.0	2.5	3.0	8.0	8.0	11.0	6.5	1.0	4.0
RRMSE	9.0	8.0	1.0	1.0	8.0	8.0	11.0	5.5	2.5	5.5
MAE	11.0	8.0	3.0	7.0	9.0	2.0	10.0	6.0	4.0	1.0
CC	10.0	8.0	3.5	3.5	9.0	3.5	11.0	7.0	3.5	3.5

Table 3. Ranking of Distributions based on Statistical Test Results

	1	2	3	4	5	6	7	8	9	10
RMSE	LP3	GEV	GNO	PE3	WAK	(GEV*)	(GUM)	BEP	GLO	BEK
RRMSE	GEV	(GLO)	PE3	LP3	WAK	GEV*	BEP	GLO	GPA	BEK
MAE	PE3	GNO	GEV	LP3	WAK	GUM	GEV*	BEP	GLO	GPA
CC	(GEV)	(GEV*)	(GNO)	(LP3)	(PE3)	(WAK)	GUM	BEP	GLO	BEK

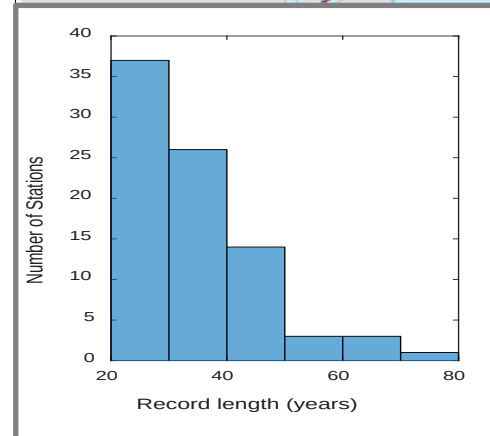


Largest values

Model Test and Application



84 stations in Ontario
x 3 durations (5m, 1h, 24h) = **252 datasets**

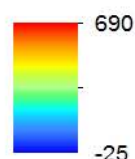


Record length

- 20-29 years
- 30-39 years
- 40-49 years

- 50-59 years
- 60-69 years
- 70-79 years

Elevation (m)

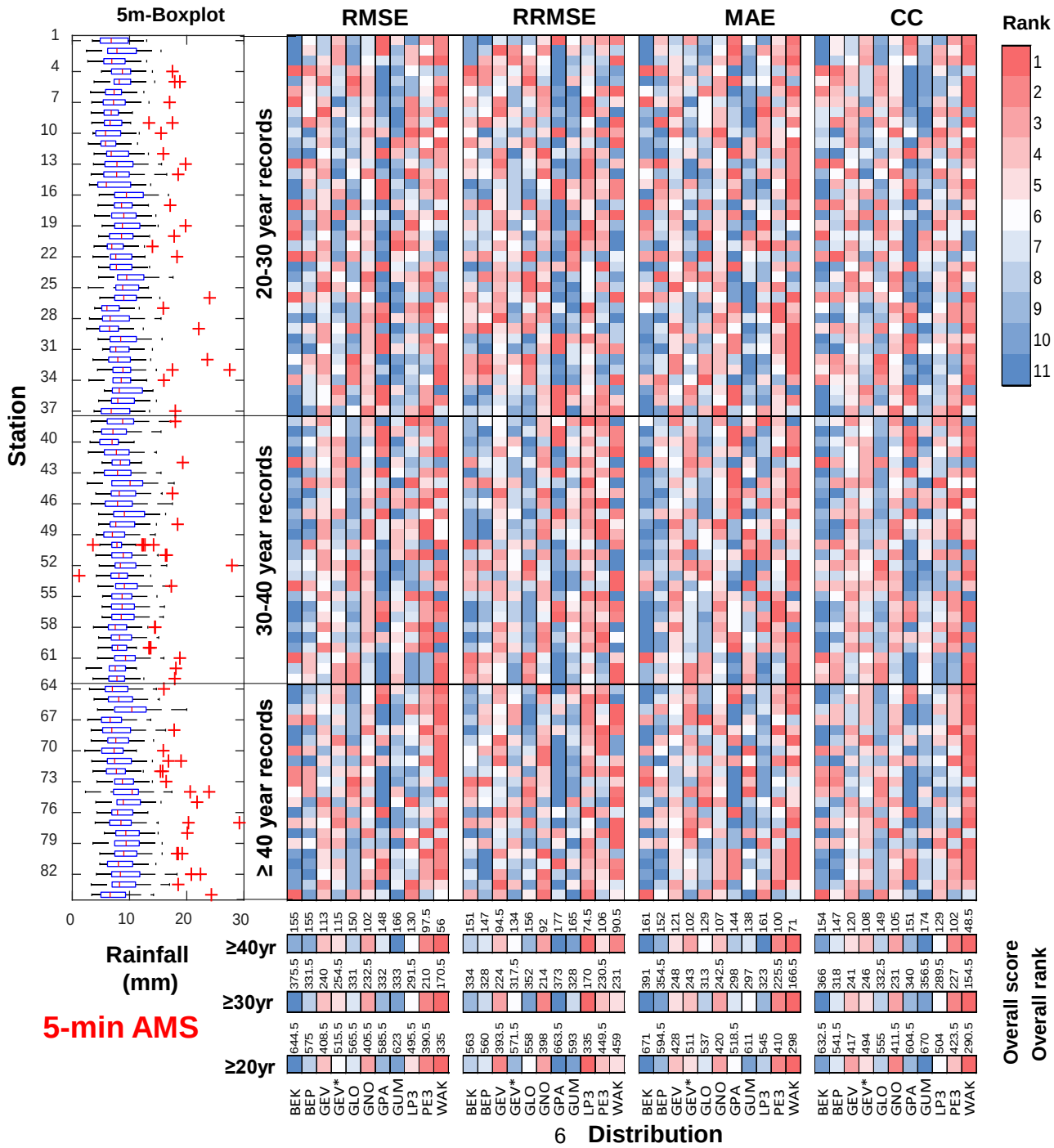


0 85 170 340 510 680

Km

Model Test and Application

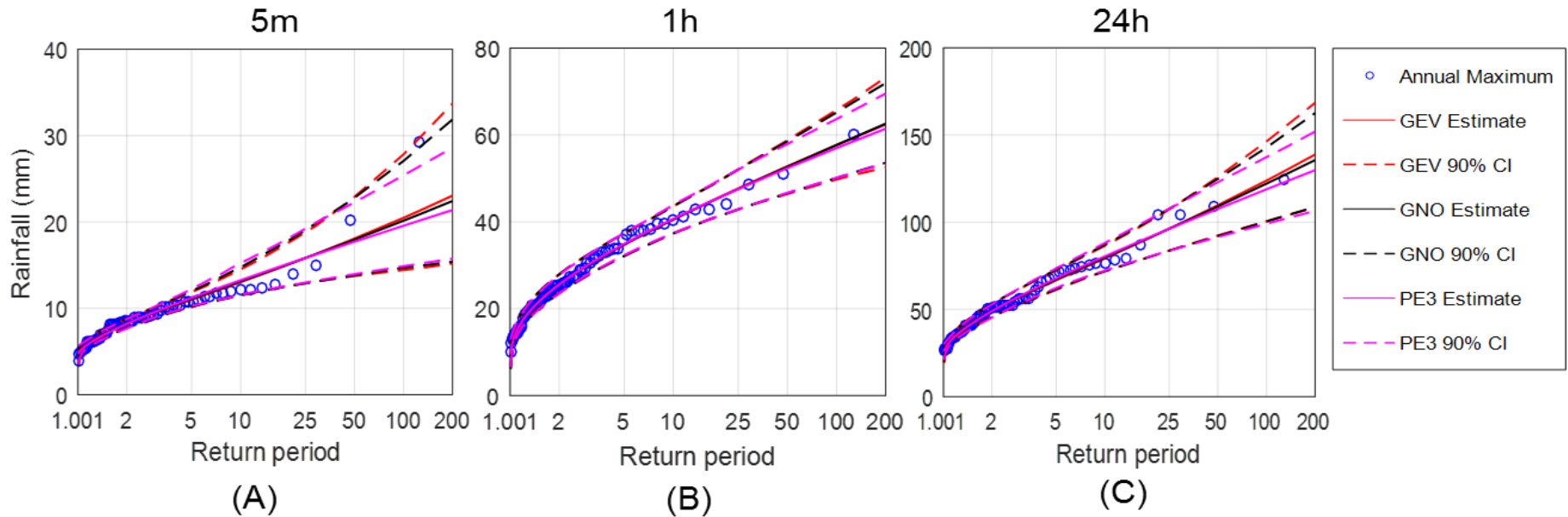
➤ Descriptive Ability Comparison



IDF Relations

Top 03 distributions based on both the descriptive and predictive performance

GEV, GNO, PE3

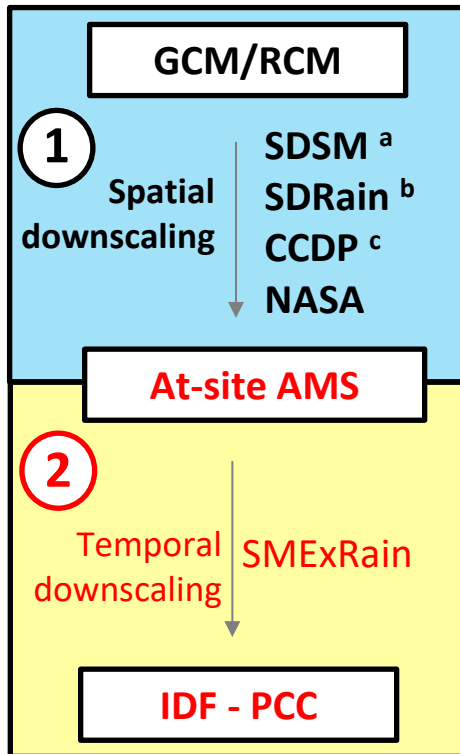


Frequency curves and 90% Confidence Intervals

➤ **GEV tends to produce more conservative results**

IDF . Projected Climate Change

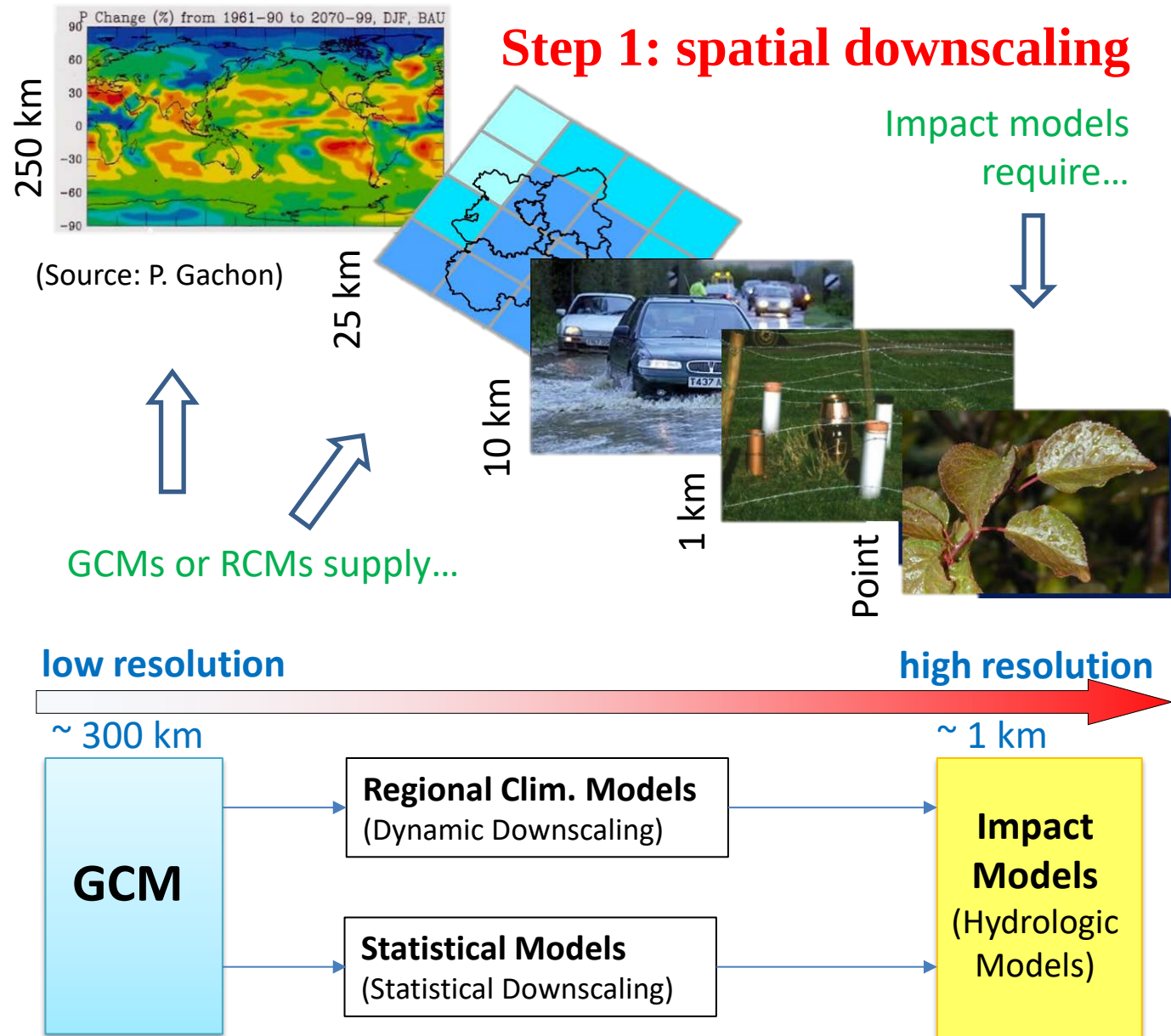
2 steps:



^a Wilby et al (2002)

^b Yeo and Nguyen (2011)

^c Wang X. (2015)



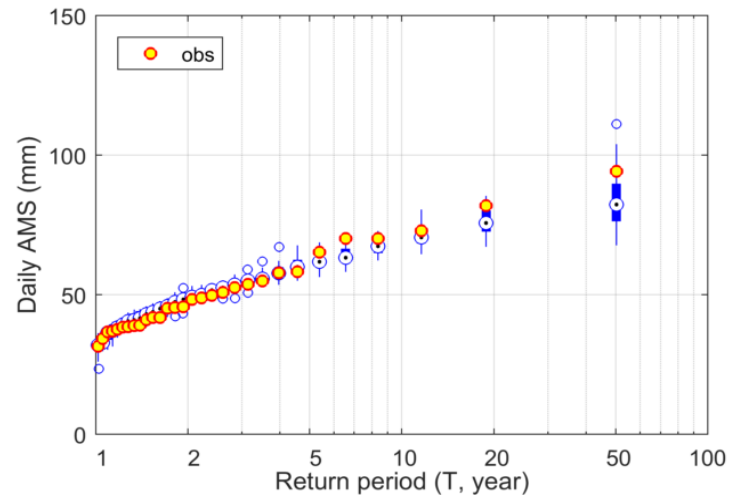
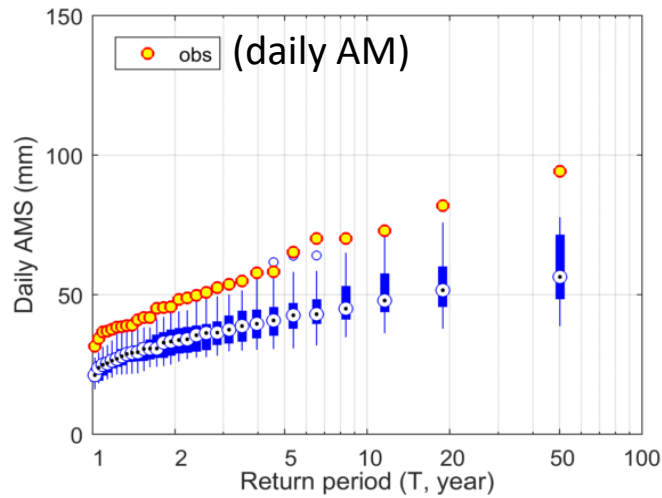
IDF . Projected Climate Change

Montreal Int. Airport station

Before BC

After BC

Calibration

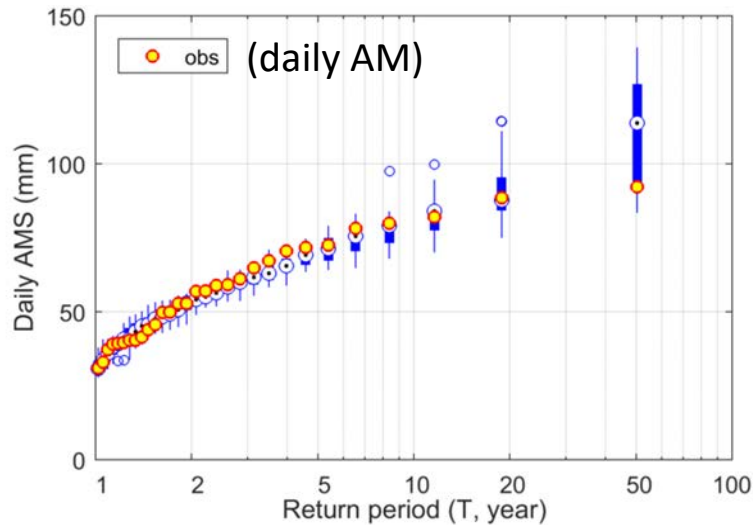


1961-1990

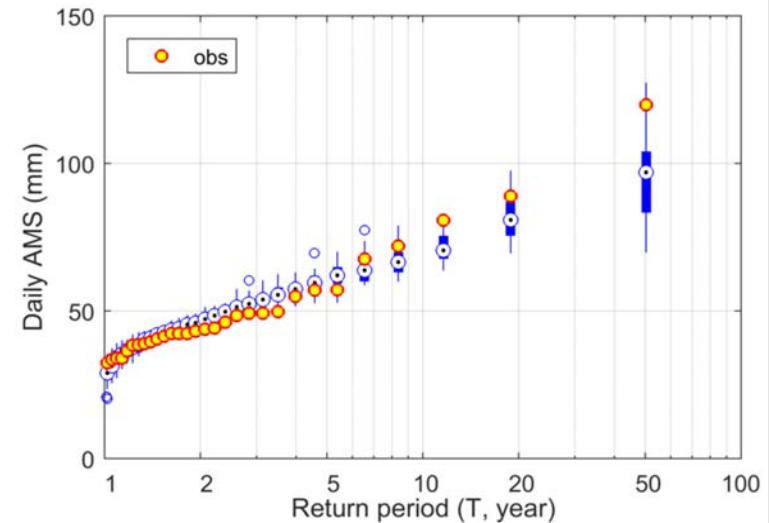
IDF . Projected Climate Change

Calibration

Winsor station

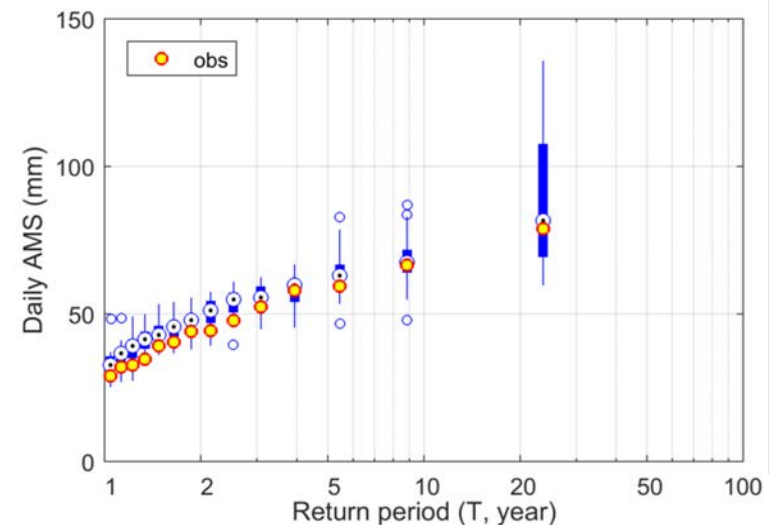
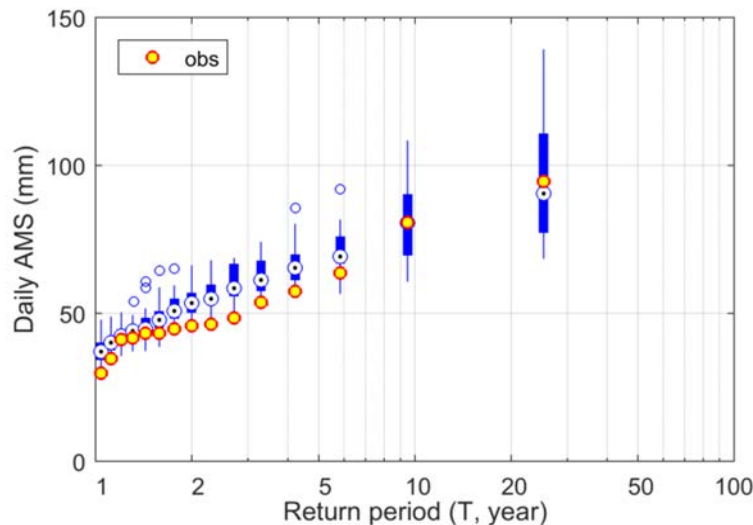


Toronto Int. A. station



1961-1990

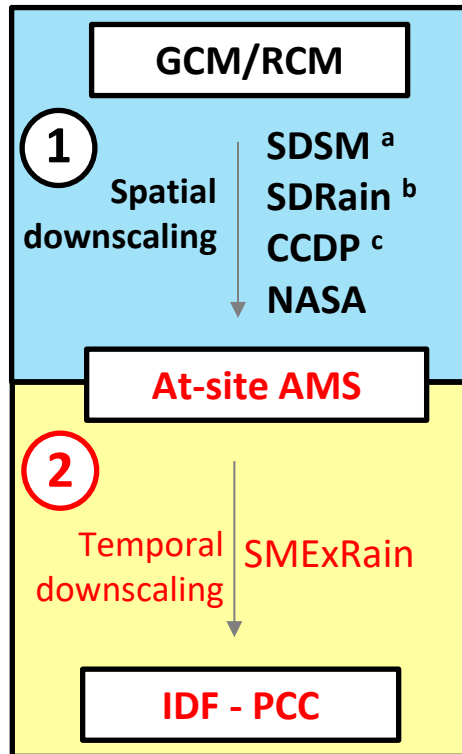
Validation



1991-2005

IDF . Projected Climate Change

2 steps:



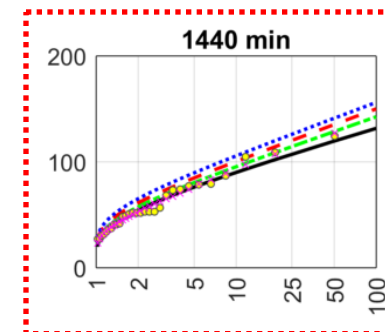
^a Wilby et al (2002)

^b Yeo and Nguyen (2011)

^c Wang X. (2015)

Step 2: temporal downscaling

Rainfall (mm)



Return Period (years)

Legend

- obs
- × dscl-adj
- base
- - - 2020s
- - - 2050s
- ... 2080s

Distribution
Scaling-GEV*

Station Info

ST THOMAS WPCF

ON, Canada

6137362

Latitude: 42 46'N

Longitude: 81 13'W

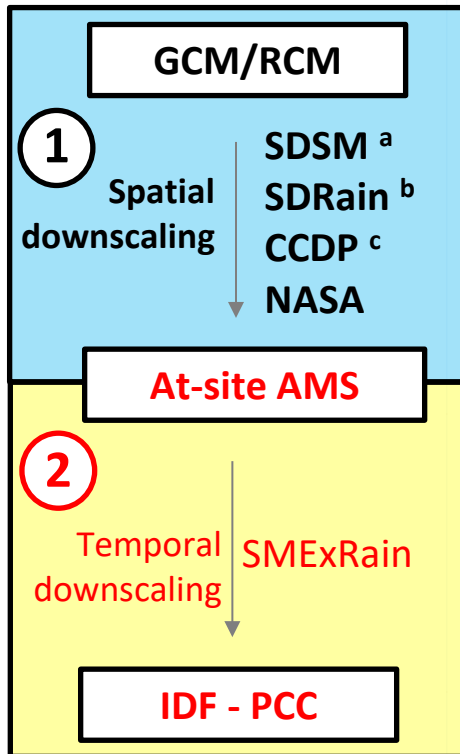
Elevation: 209m

CGCM3 – A1B

Note: Statistical downscaling using SDRain (Yeo, 2016)

IDF . Projected Climate Change

2 steps:

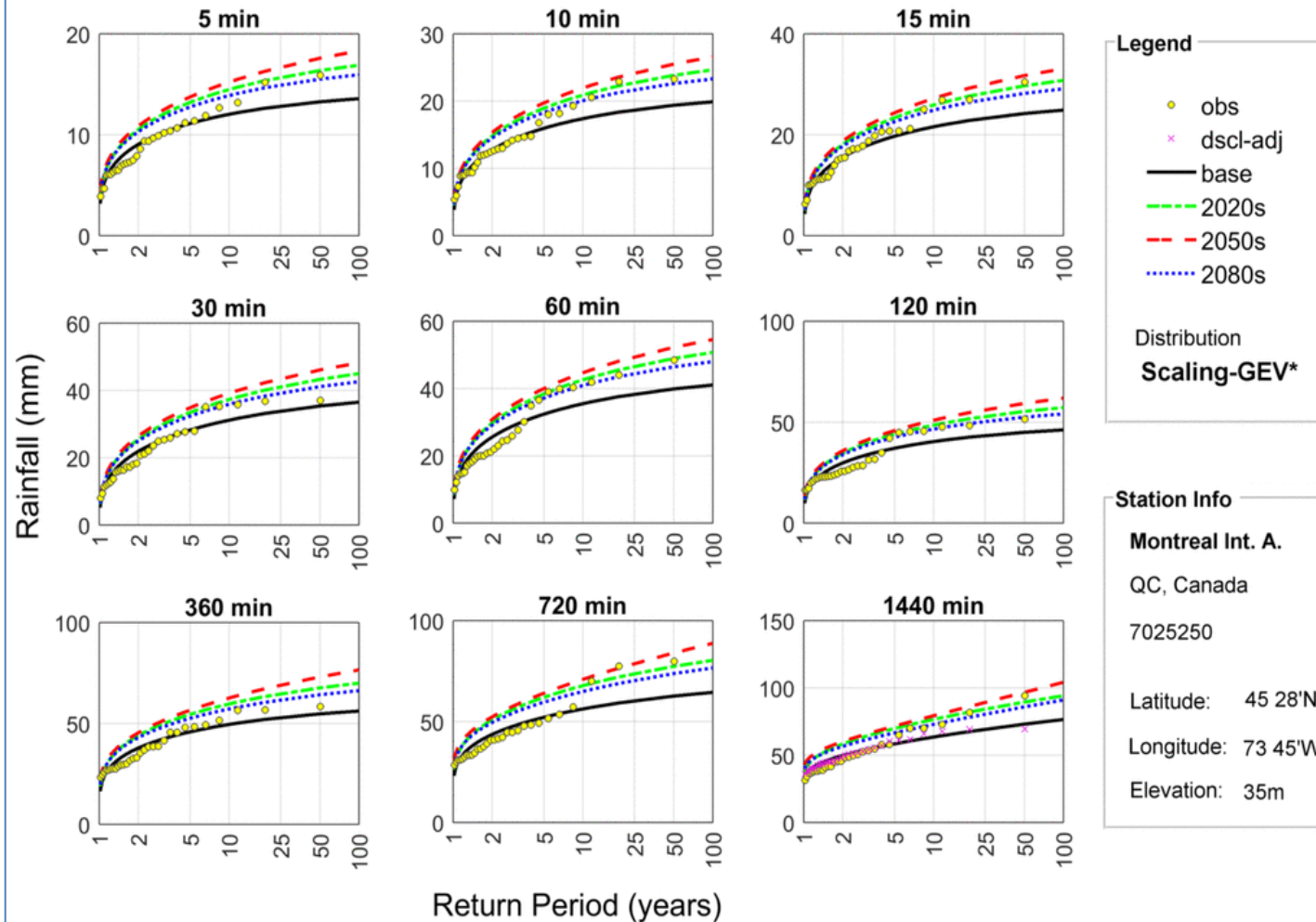


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Step 2: temporal downscaling

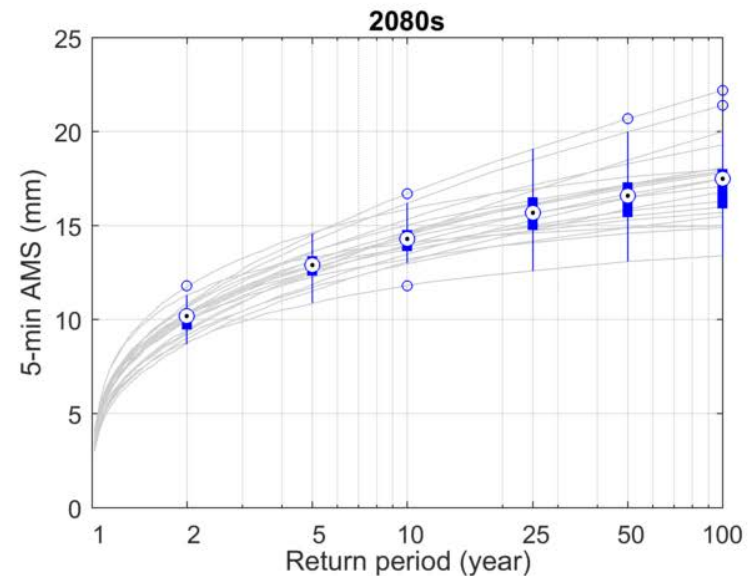
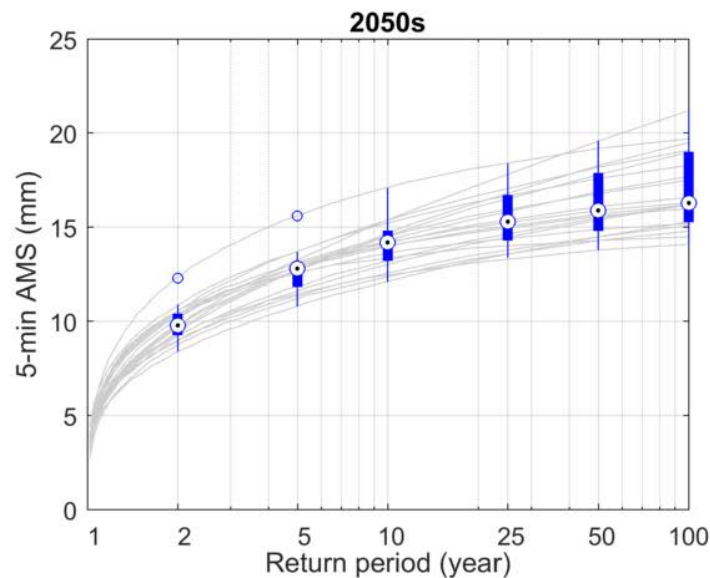
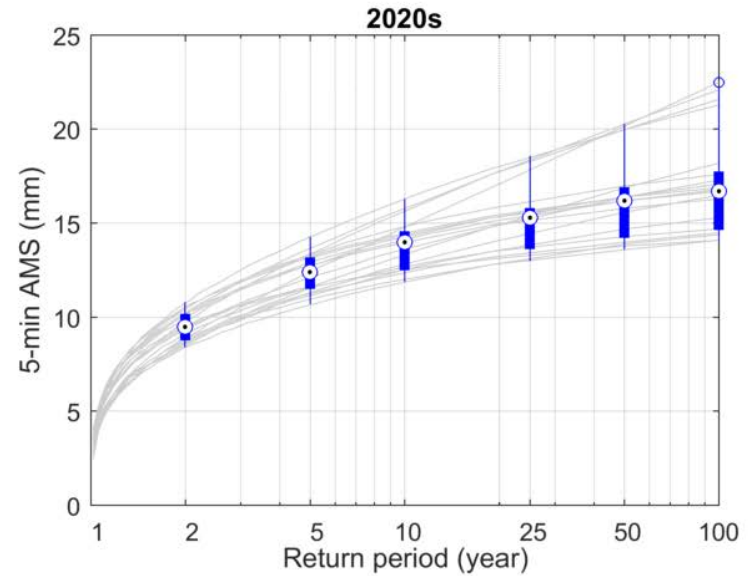
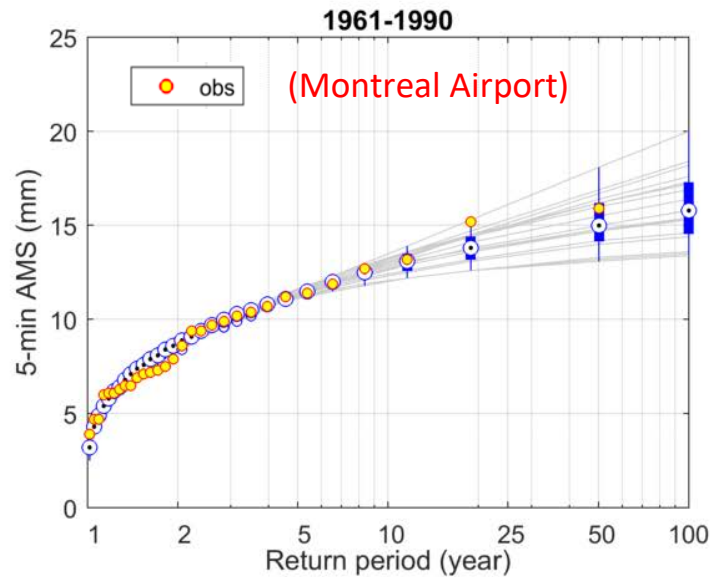


CMIP5 models – RCP 4.5

Note: Dynamic downscaling using RCMs

Baseline (1961-1990) & Projected (2020s, 2050s, 2080s)

5-min Annual Maxima (mm)





THANK YOU!



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