

Climate Change Impact Assessment for Small Basins with 10-min Precipitation (P10M)

Kiyoung Seong & Taesam Lee

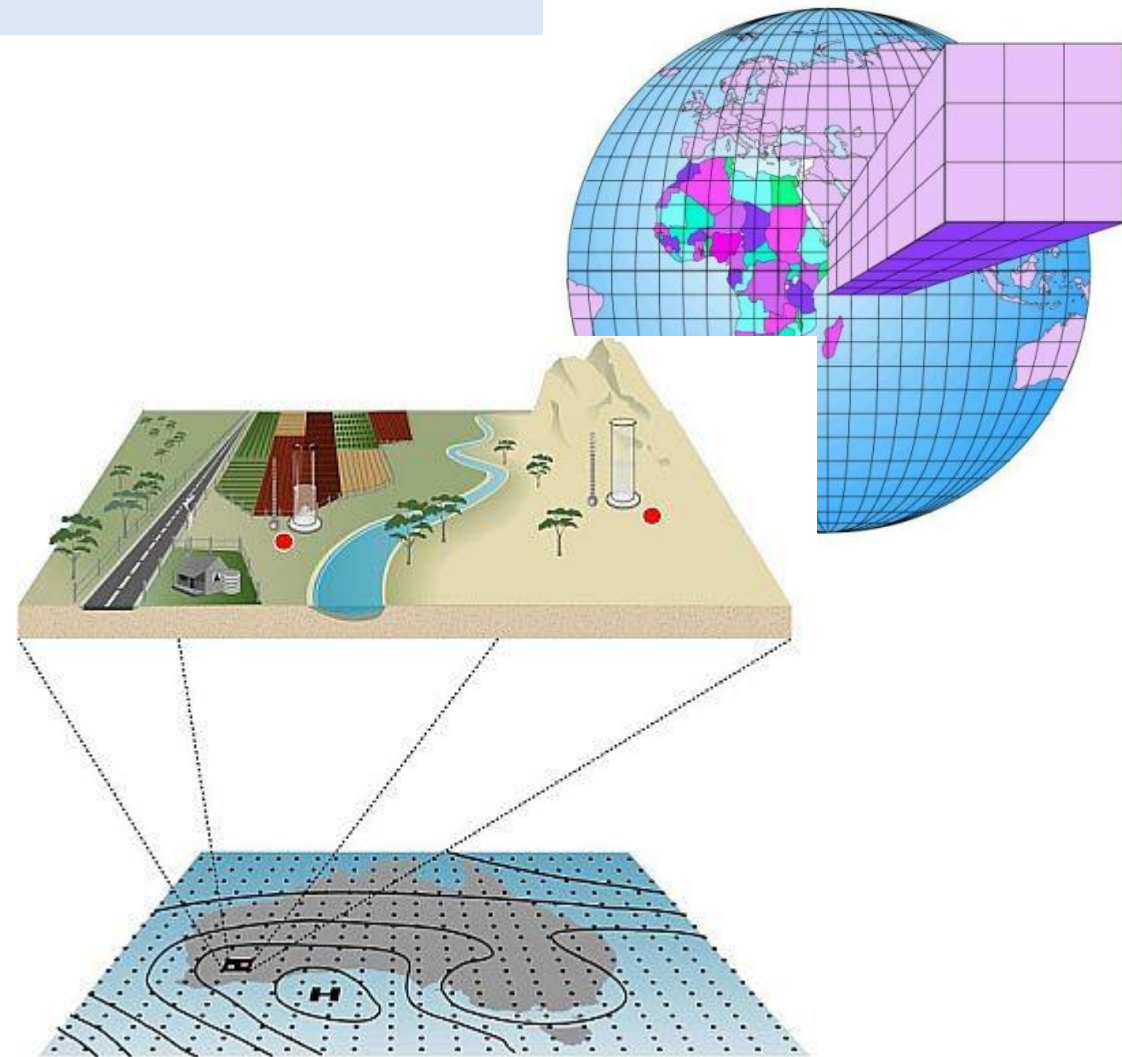
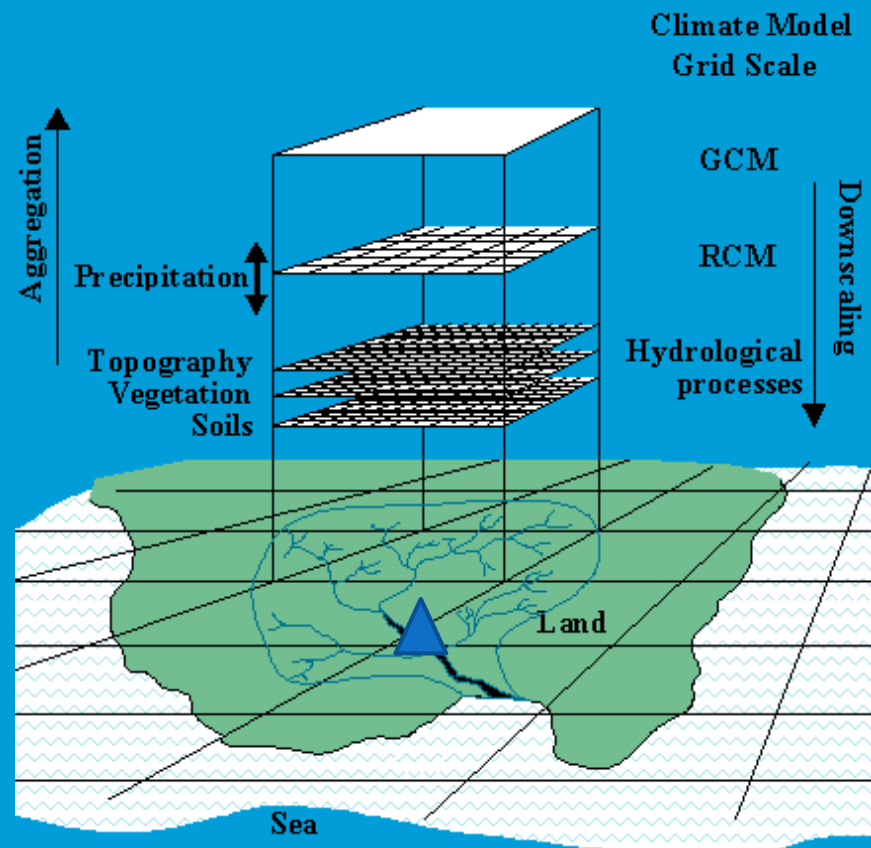
Gyeongsang National University





Introduction & Motivation

Downscaling GCM or Earth System Model (ESM)

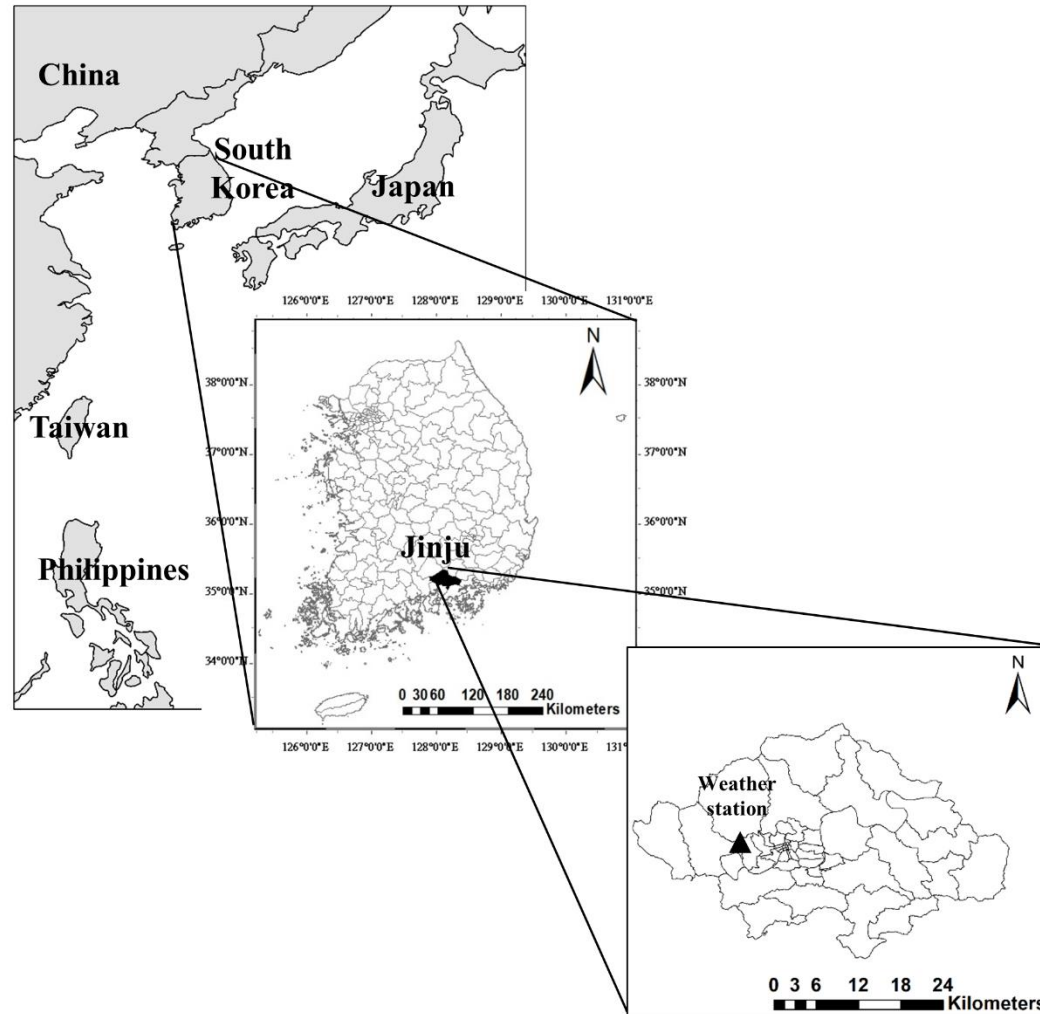


Temporal downscaling from daily to P10M

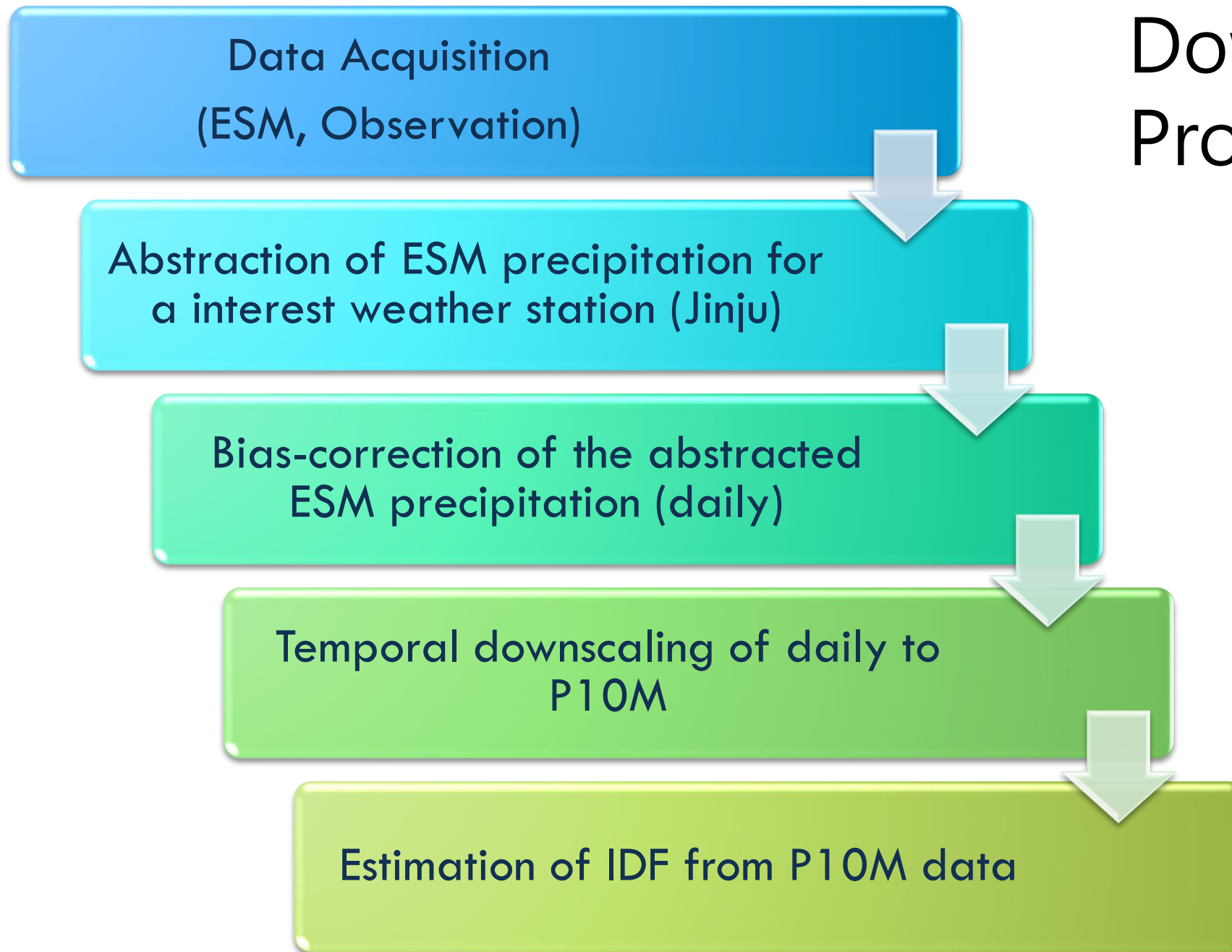
- Why up to 10minute precipitation (P10M)?
- Concentration time is sub-hourly for most of the small basins



Study Area (Jinju)



Downscaling Procedure



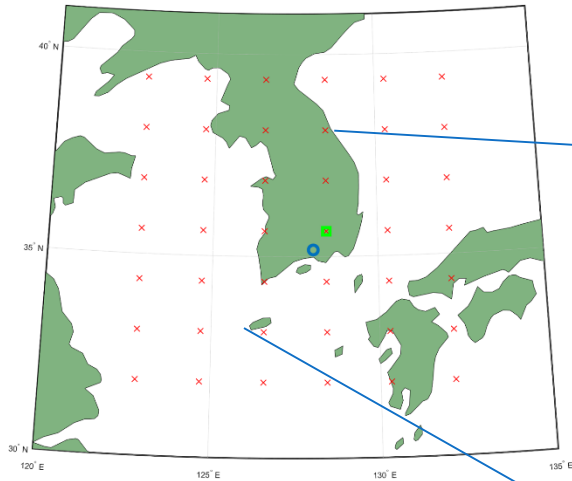


Data Acquisition (ESM, Observation)

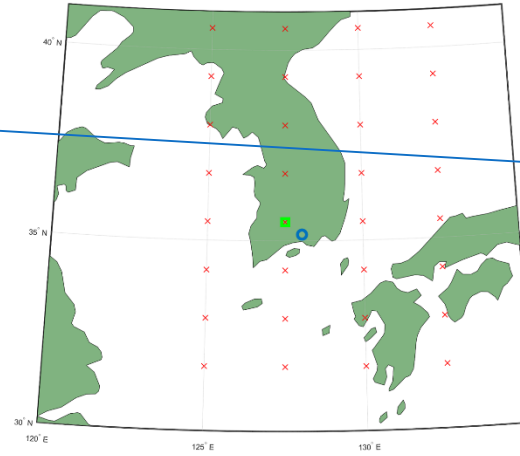
Employed ESMs

Order	ESM name	Order	ESM name	Order	ESM name
1	GFDL-ESM4	7	MPI-ESM1-2-LR	13	INM-CM5-0
2	MRI-ESM2-0	8	UKESM1-0-LL	14	EC-Earth3
3	CNRM-CM6-1	9	ACCESS-CM2	15	MIROC6
4	CNRM-ESM2-1	10	ACCESS-ESM1-5	16	MIROC-ES2L
5	IPSL-CM6A-LR	11	CanESM5	17	NorESM2-LM
6	MPI-ESM1-2-HR	12	INM-CM4-8	18	KACE-1-0-G

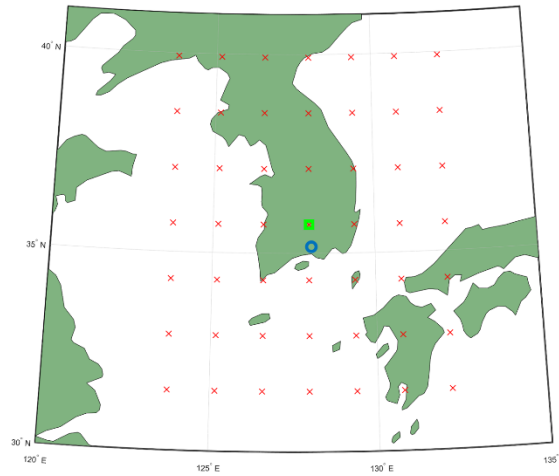
Extracting ESM data



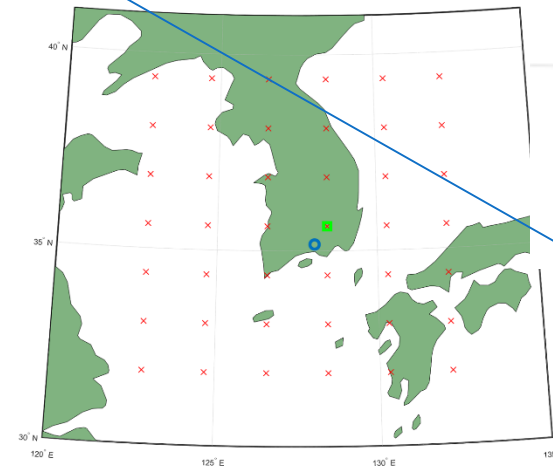
(a) ACCESS-CM2



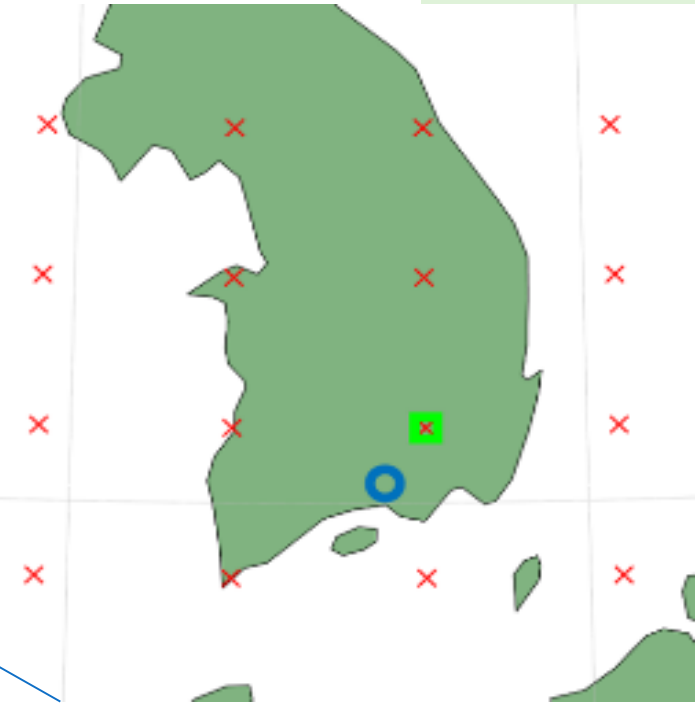
(b) IPSL-CM6A



(c) MIROC6



(d) UKESM1



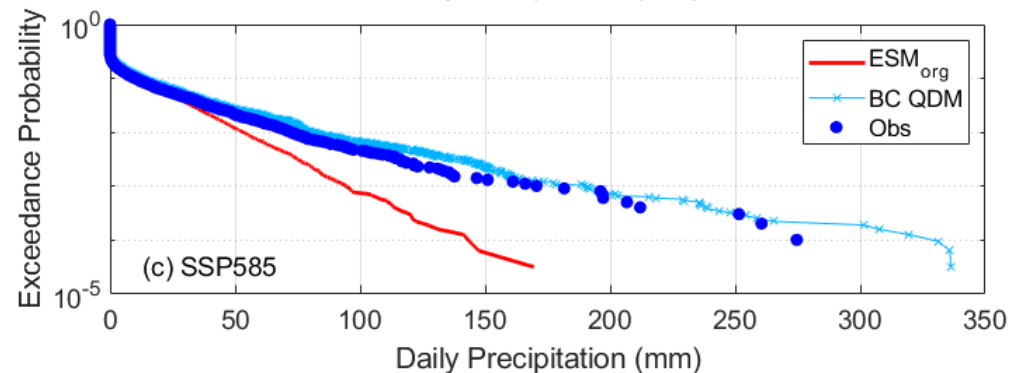
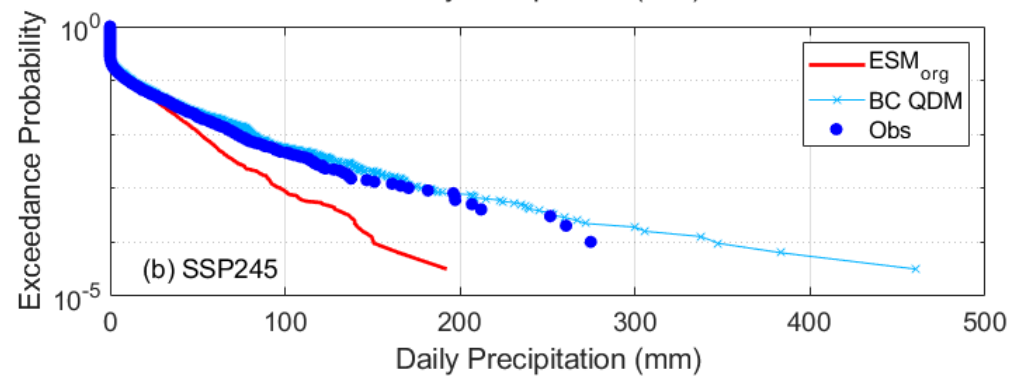
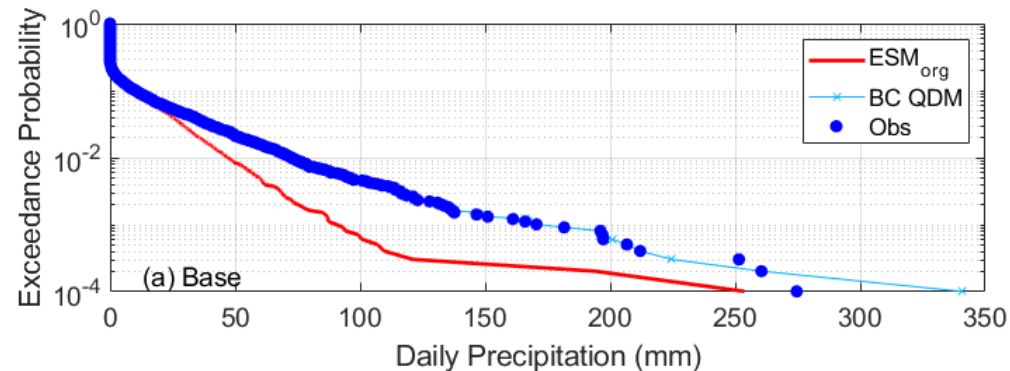
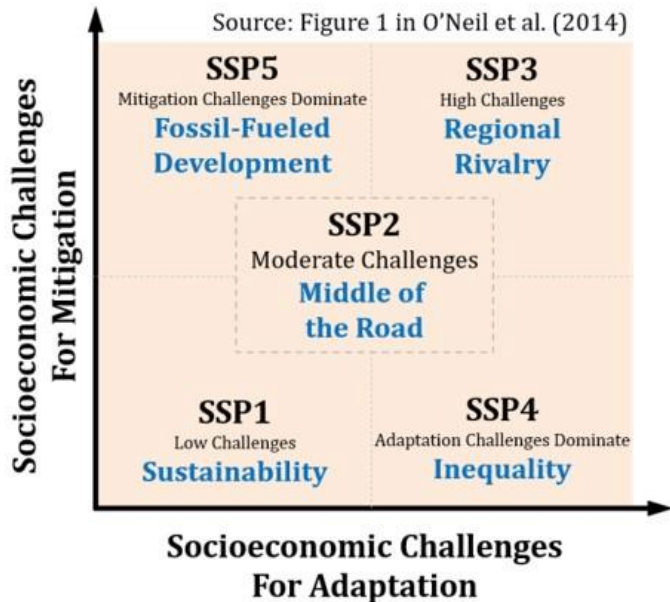


Bias-correction of the abstracted ESM precipitation (daily precipitation)

Bias-Correction of ESM to daily observations

Quantile Delta Mapping of Daily Precipitation

$$\hat{y}_{m,fut} = \frac{F_o^{-1}[F_{m,fut}(x_{m,fut})]}{F_{m,base}^{-1}[F_{m,fut}(x_{m,fut})]} x_{m,fut} = \delta \cdot x_{m,fut}$$



Bias-Corrected ESM precipitation w/ QDM

Annual Maximum Precipitation of Daily ESM Outputs/Obs

Jinju Station

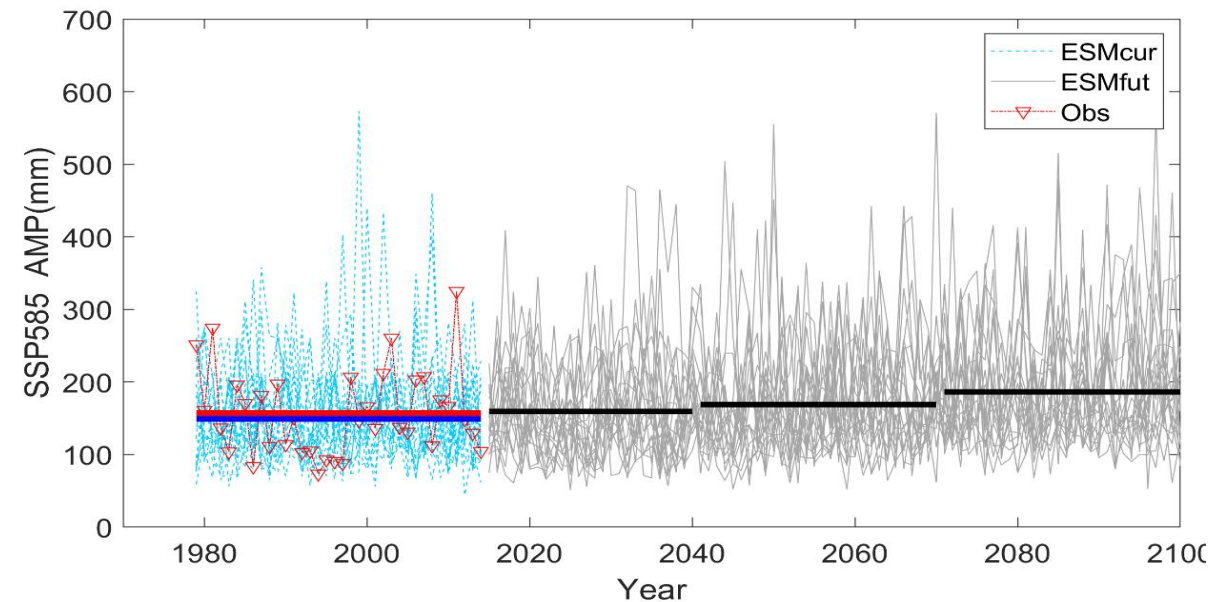
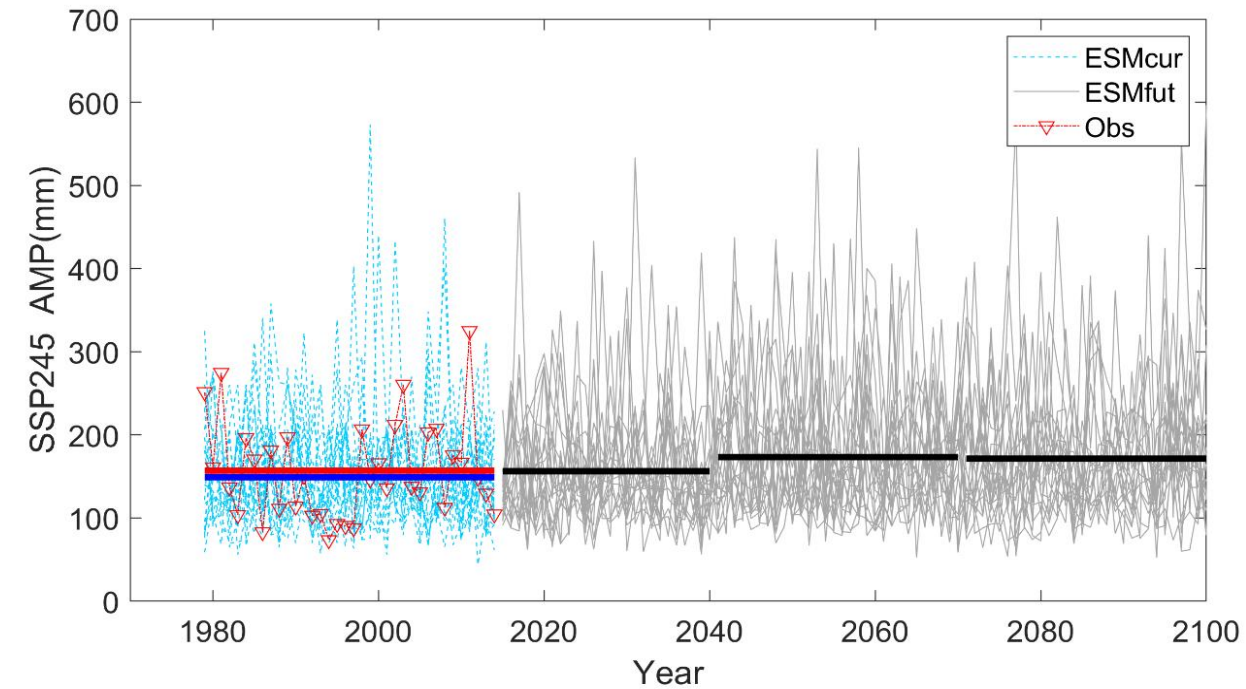
Period: 1979-2015 (base), 2016-2100

Base Period: 1979-2015

P1 Period : 2016-2040

P2 Period : 2041-2070

P3 Period : 2071-2100



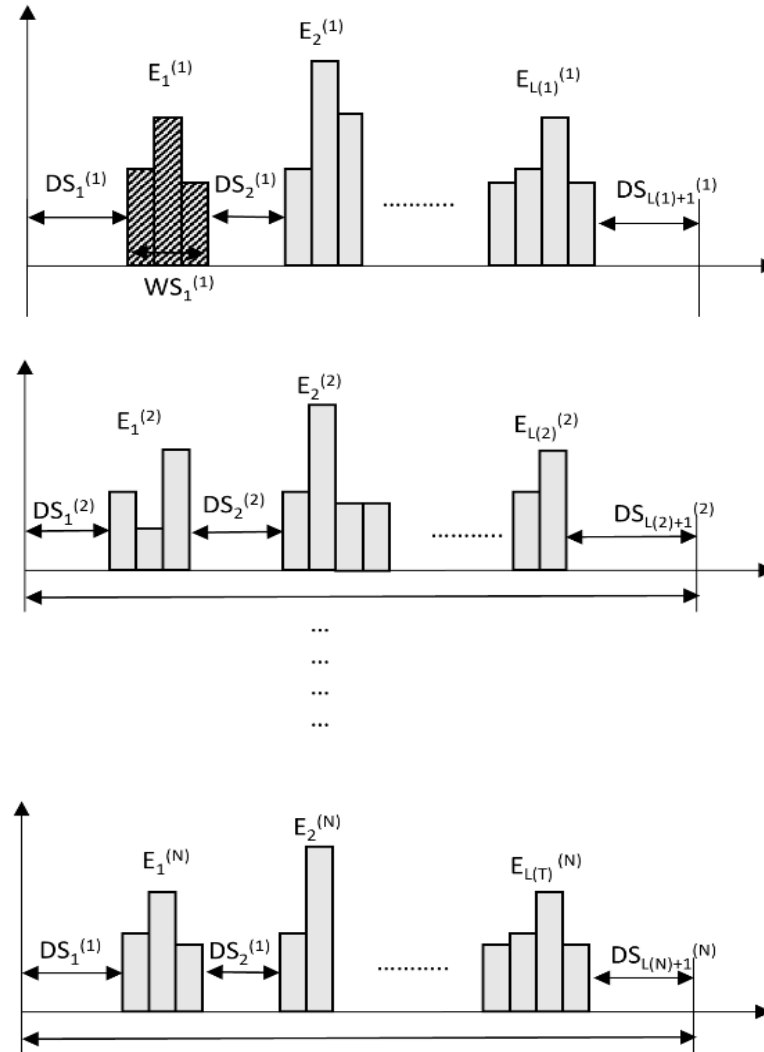


Temporal downscaling of daily to P10M

MPGA+NPD

Lee et al. (Under Review, Climate Dynamics)

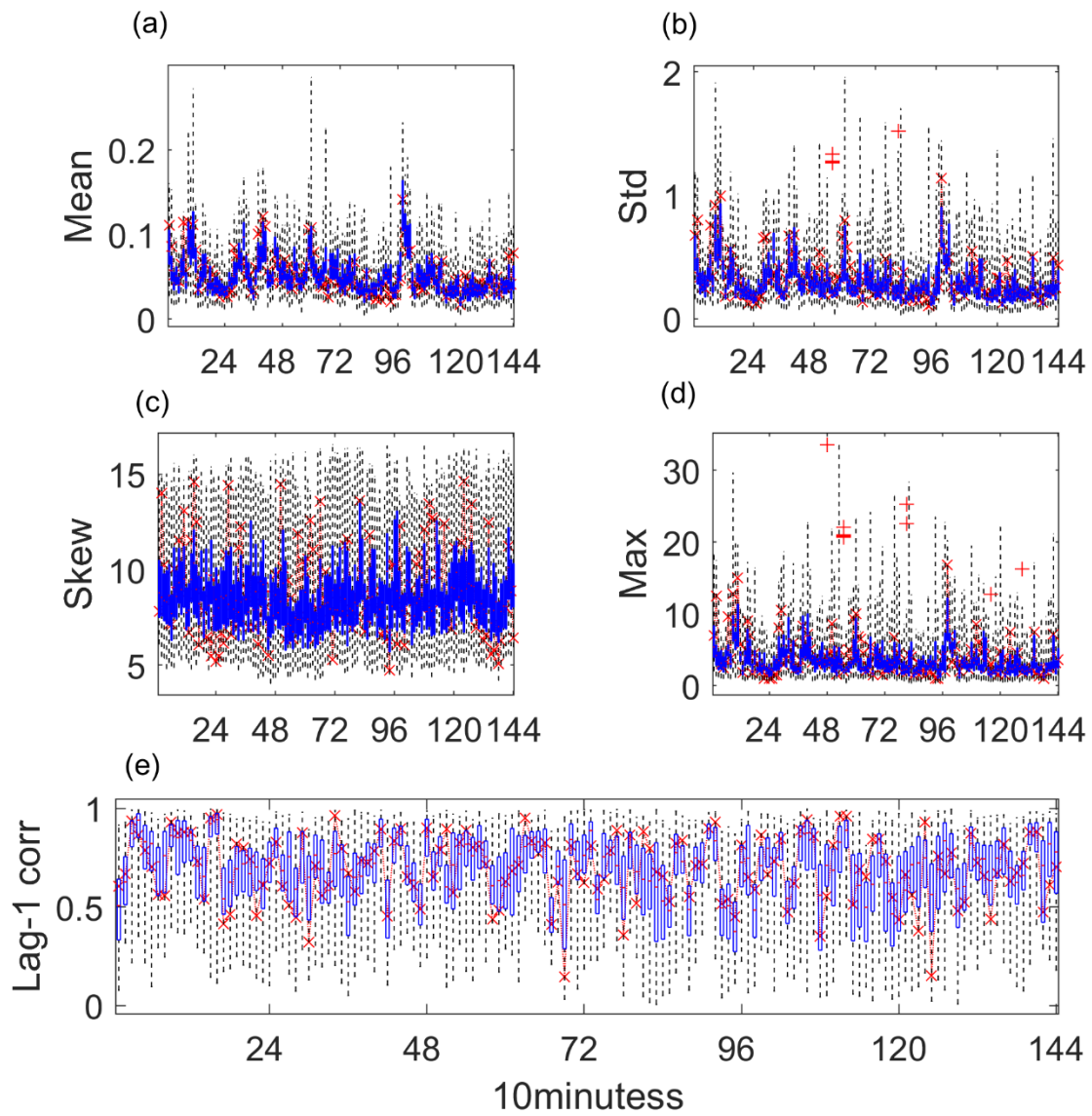
Precipitation event extraction (PEE) from observations



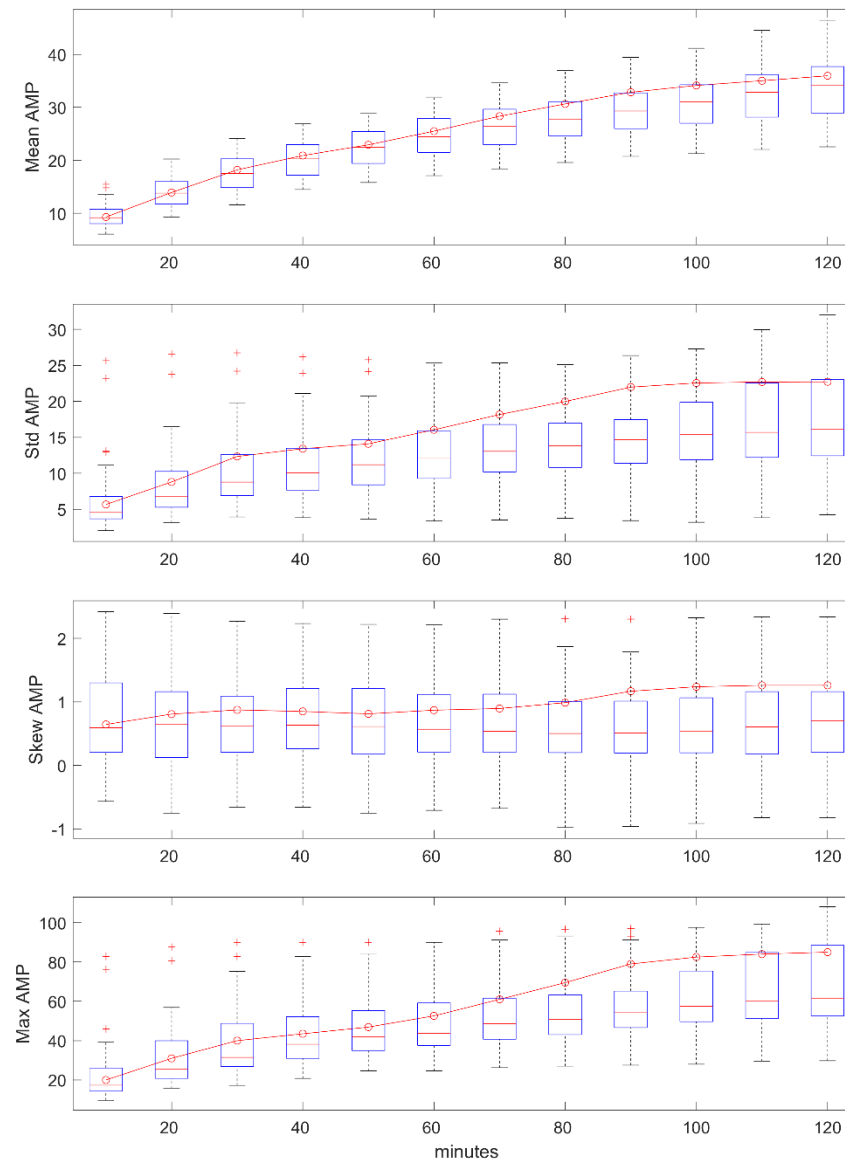
M-day pseudo-population generation algorithm (MPGA)

- (1) choose the first dry spell $DS_1^{*(1)}$
 $DS_1^{*(1)} = \text{DUnif}\{DS_1^{(1)}, DS_1^{(2)}, \dots, DS_1^{(T)}\}$
- (2) Randomly select a rainfall event $E_1^{*(1)}$
 $E_1^{*(1)} = \text{DUnif}\{E_1^{(1)}, E_2^{(1)}, \dots, E_{L(1)}^{(1)}, \dots, E_1^{(T)}, E_2^{(T)}, \dots, E_{L(T)}^{(T)}\}$
- (3) Select the following dry spell with KNNR as
 $DS_2^{*(1)} = \text{KNNR}\{DS_1^{(1)}, DS_2^{(1)}, \dots, DS_{L(1)}^{(1)}, \dots, DS_1^{(T)}, DS_2^{(T)}, \dots, DS_{L(T)}^{(T)}\}$
 $\text{dist} = \{EA_1^{*(1)} - EA_j^{(i)}\}, j=1, \dots, L(i); i=1, \dots, T$
- (4) Select the following well spell with KNNR as the step (3)
- (5) Repeat the steps (2) - (3) until $LR^{*(1)}$ is filled
- (6) Repeat the steps (1) - (4) until all the population set is simulated

Verification of Temporal Downscaling to P10M



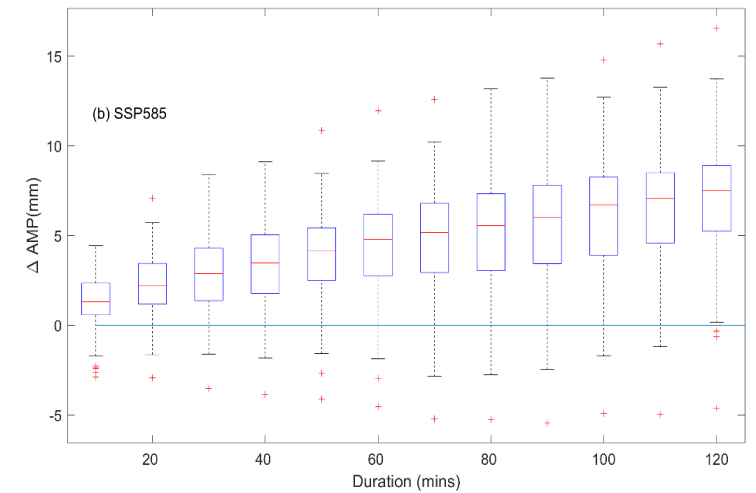
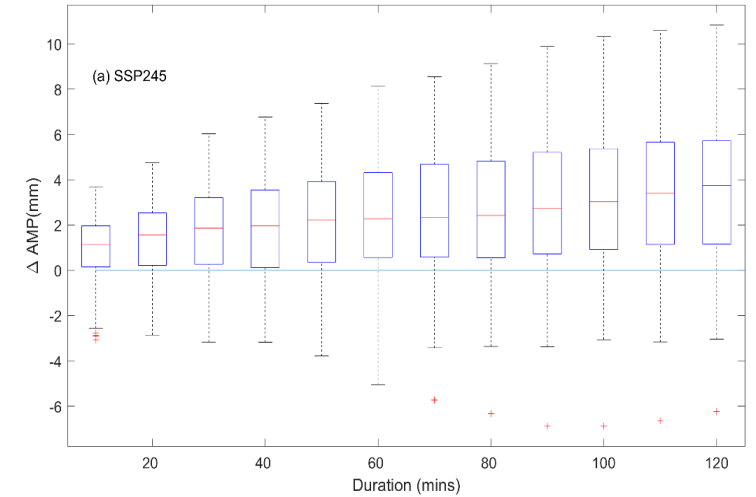
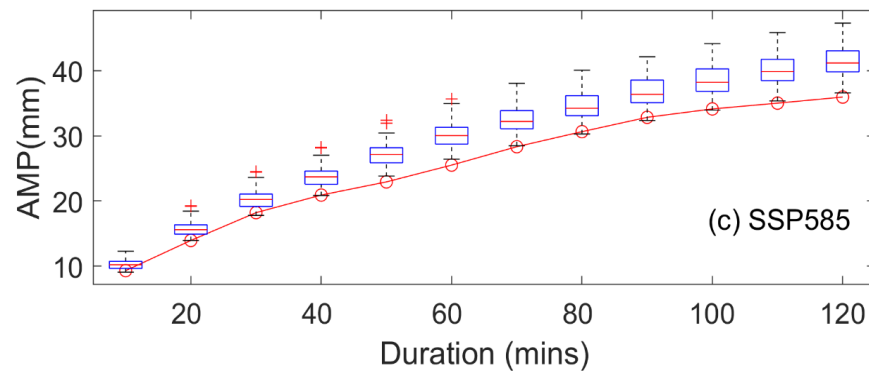
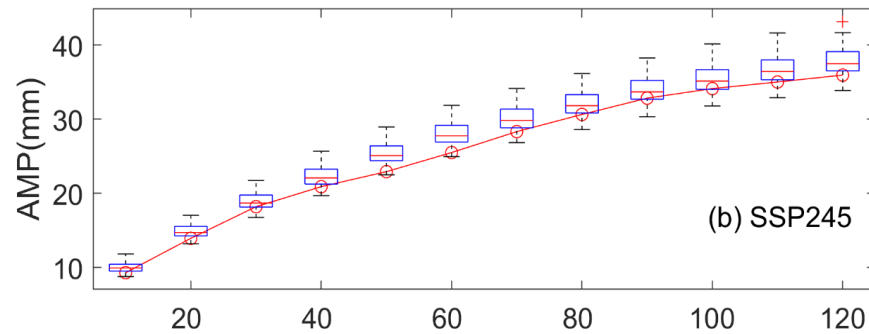
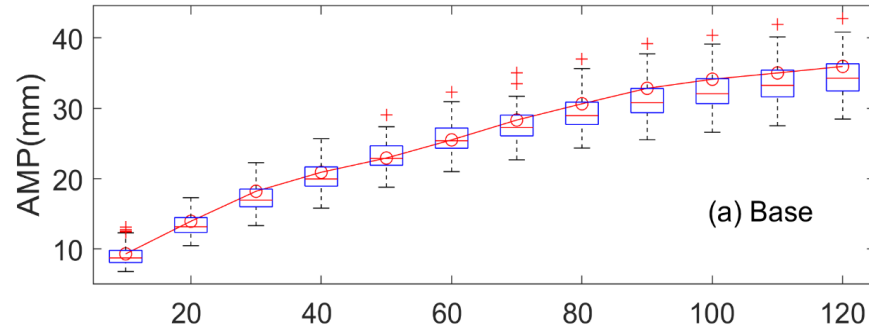
Annual Maximum Precipitation



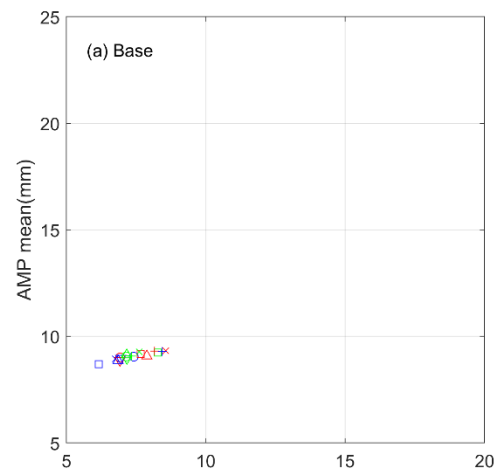
Downscaled data

**Downscaled P10M
Maximum for
SSP245
SSP585**

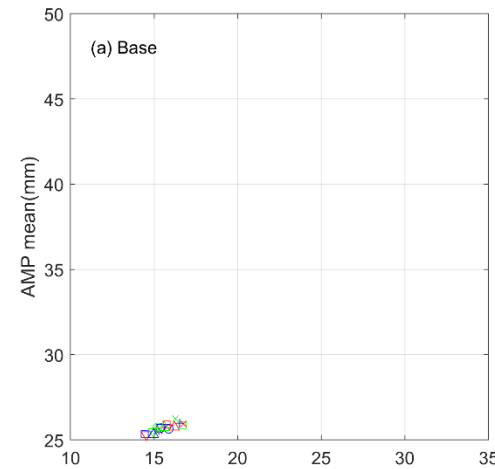
**Jinju Station
Obs. Period: 1979-2015
Future Period: 2016-2100**



AMP mean and std of the downscaled P10M for 10min and 60min



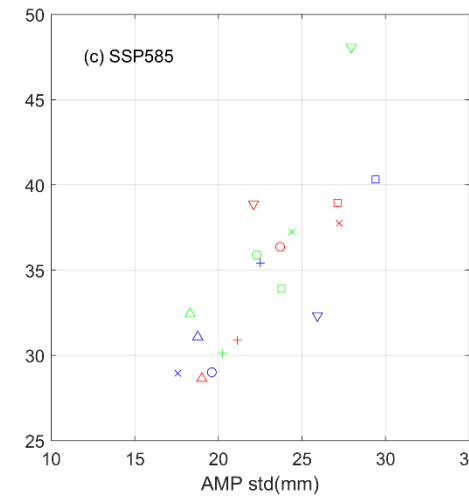
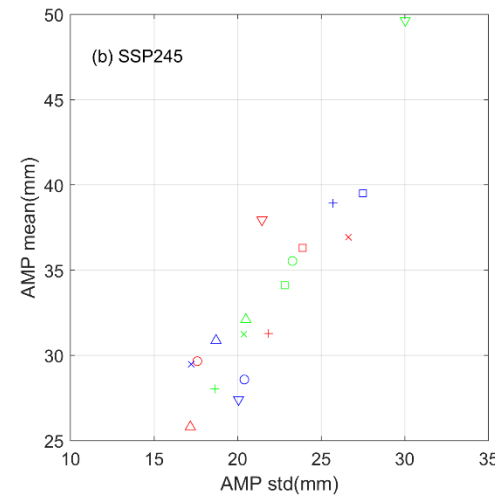
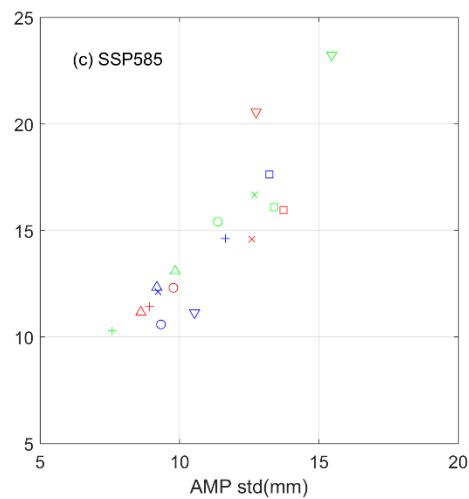
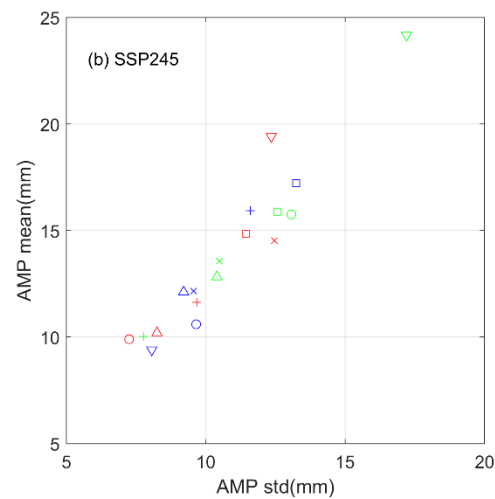
- ACCESS-CM2
- ACCESS-ESM1-5
- CNRM-CM6-1
- CNRM-ESM2-1
- CanESM5
- EC-Earth3
- × GFDL-ESM4
- × INM-CM4-8
- × INM-CM5-0
- ▽ IPSL-CM6A-LR
- ▽ KACE-1-0-G
- ▽ MIROC-ES2L
- △ MIROC6
- △ MPI-ESM1-2-HR
- △ MPI-ESM1-2-LR
- + MRI-ESM2-0
- + NorESM2-LM
- + UKESM1-0-LL



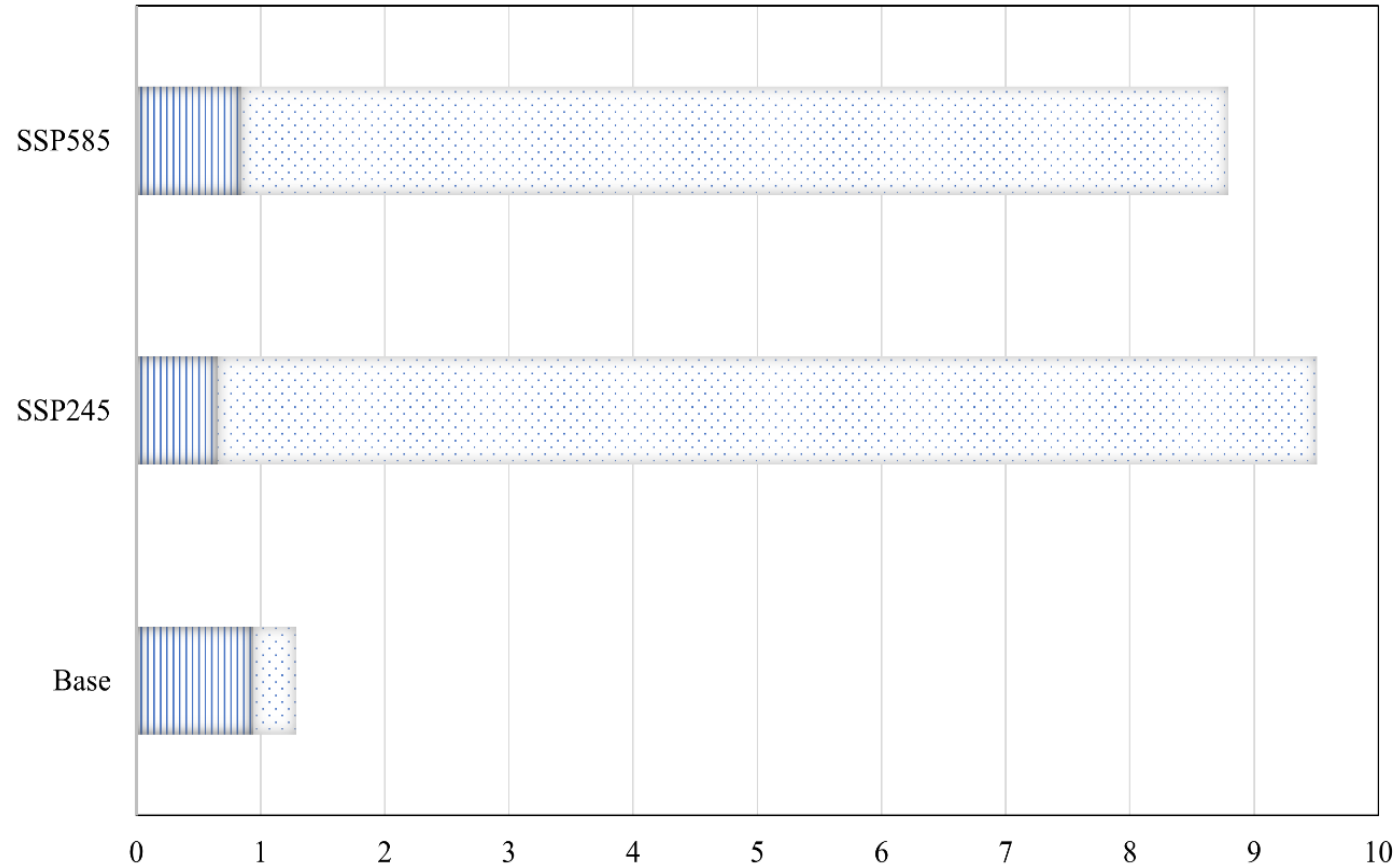
- ACCESS-CM2
- ACCESS-ESM1-5
- CNRM-CM6-1
- CNRM-ESM2-1
- CanESM5
- EC-Earth3
- × GFDL-ESM4
- × INM-CM4-8
- × INM-CM5-0
- ▽ IPSL-CM6A-LR
- ▽ KACE-1-0-G
- ▽ MIROC-ES2L
- △ MIROC6
- △ MPI-ESM1-2-HR
- △ MPI-ESM1-2-LR
- + MRI-ESM2-0
- + NorESM2-LM
- + UKESM1-0-LL

10min

60min



Interquartile range (IQR) of mean AMP (unit: mm) for uncertainty

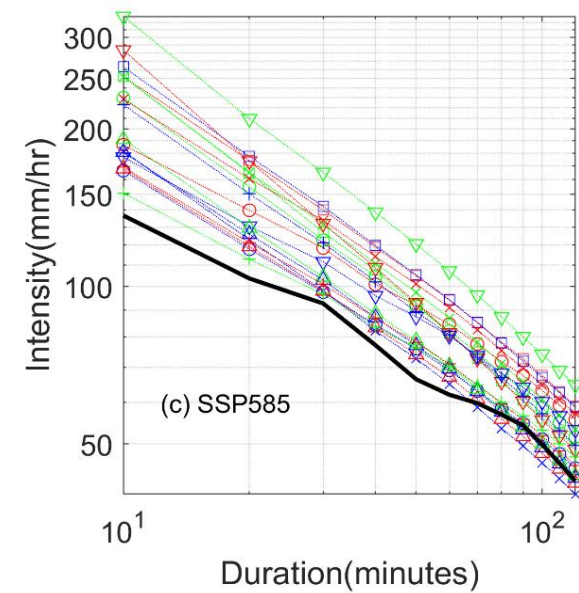
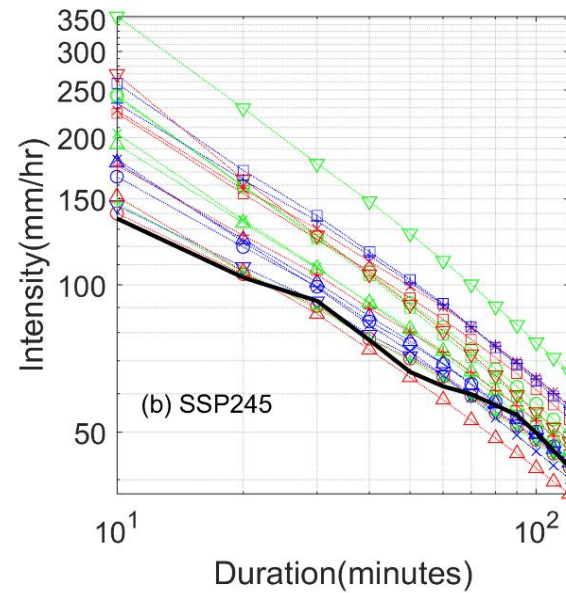
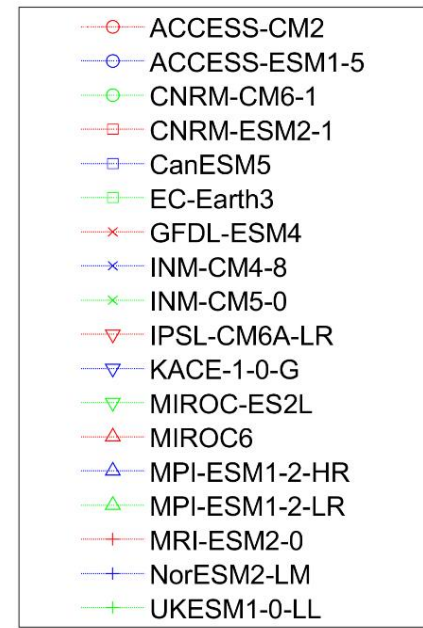
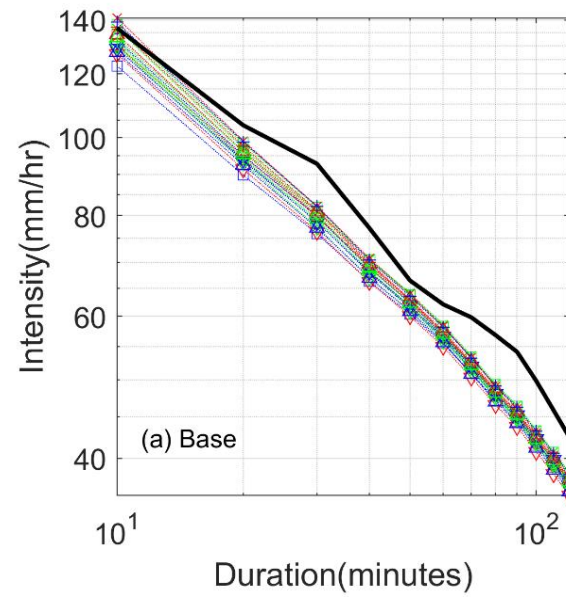


	Base	SSP245	SSP585
■ Temp. Downs	0.9404	0.6515	0.8434
■ ESMs	0.3495	8.8573	7.9498



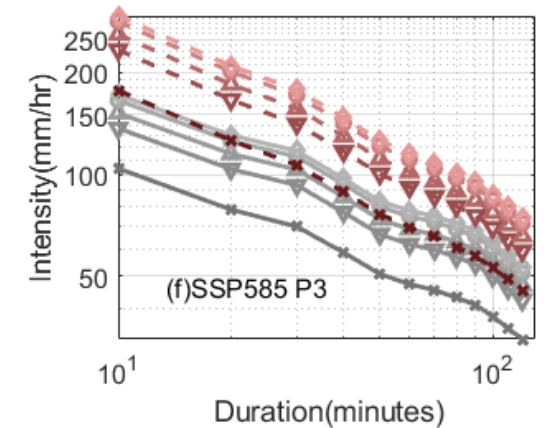
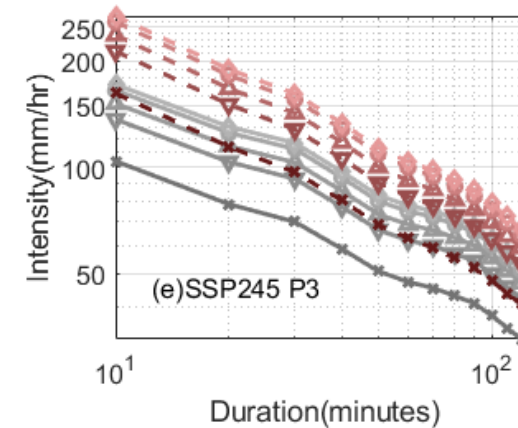
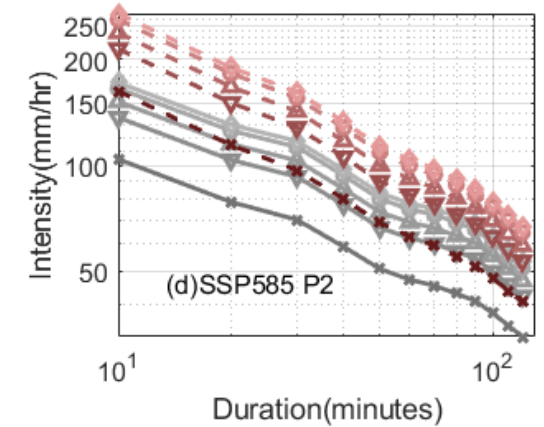
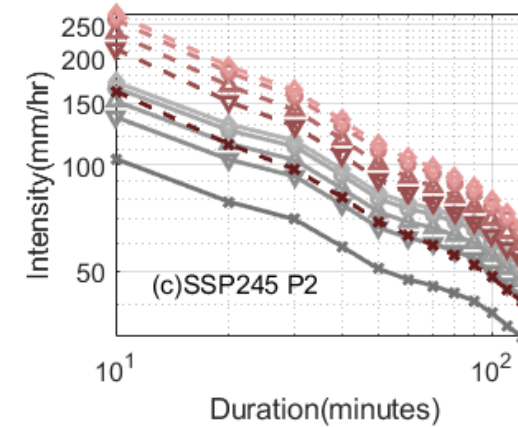
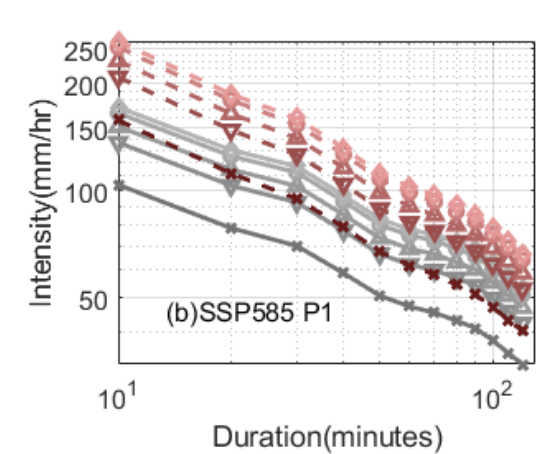
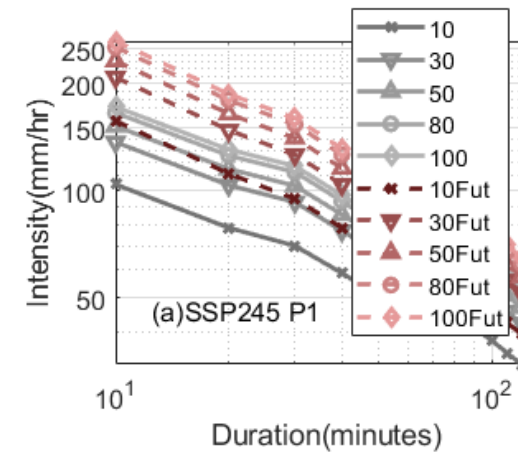
Estimation of IDF from P10M data

IDF curve in Jinju Station



Ave. IDF curve

Base Period: 1979-2015
P1 Period : 2016-2040
P2 Period : 2041-2070
P3 Period : 2071-2100



Conclusion

- ▶ The current study proposed an enhancement of the temporal downscaling of ESM daily precipitation to P10M data for a small basin.
- ▶ Results indicates that the proposed temporal downscaling model (MPGA-NTD) can be suitable for temporally downscaling daily ESM precipitation data to P10M data.
- ▶ The IDF curves reflecting future climate scenarios, such as SSP245 and SSP585, can be used for the design of hydraulic structures for small basins, depending on their vulnerability and the lifespan of structures.



Thank you!!!