Projected Changes in the Characteristics of Precipitation and Temperature Trends in Java Island using AIMS Model Version 1.0

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Outline

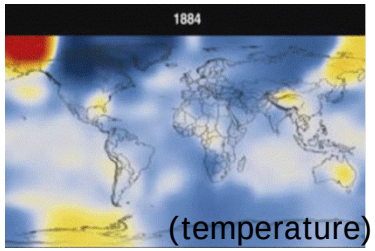
1. Introduction
2. Methodology
3. Results and discussion
4. Conclusions

1. Introduction

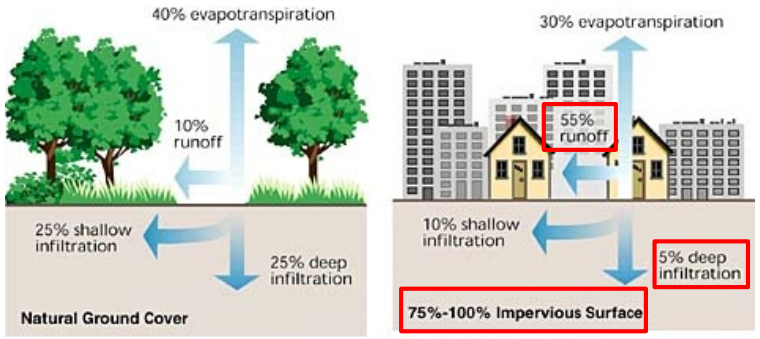
Changes

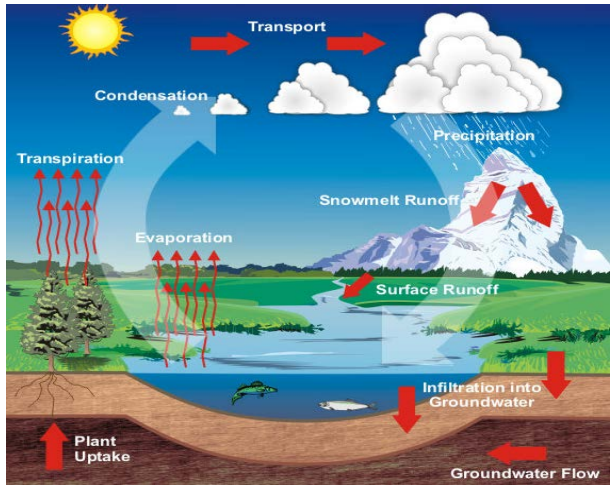
Land use (Urbanization)

Climate



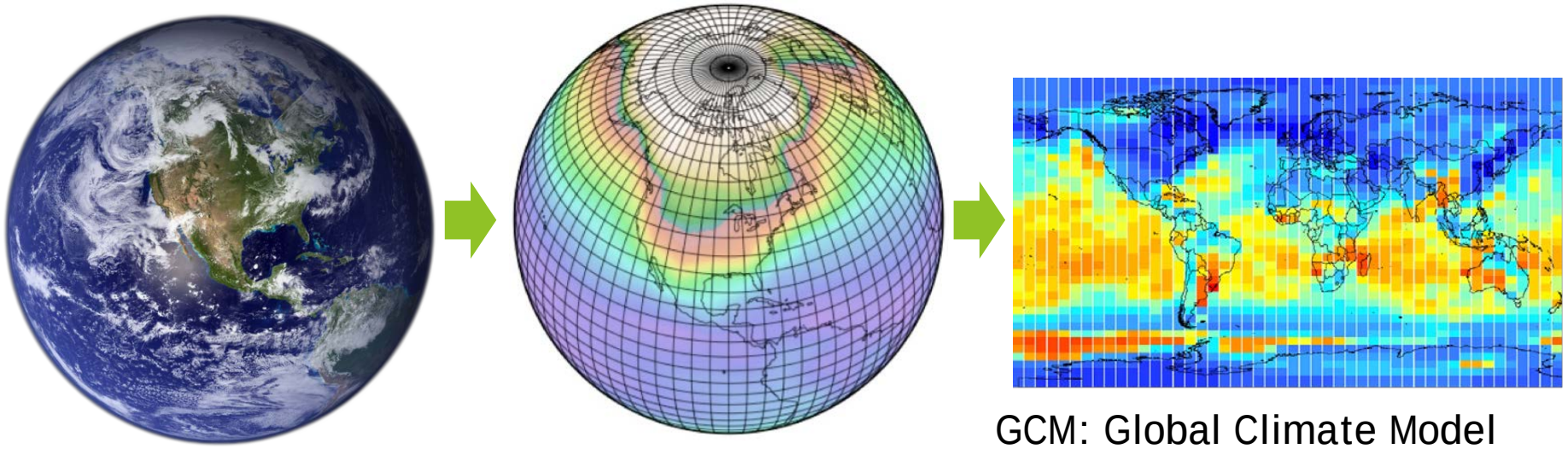
Processes





Impacts

Global climate models (GCM)



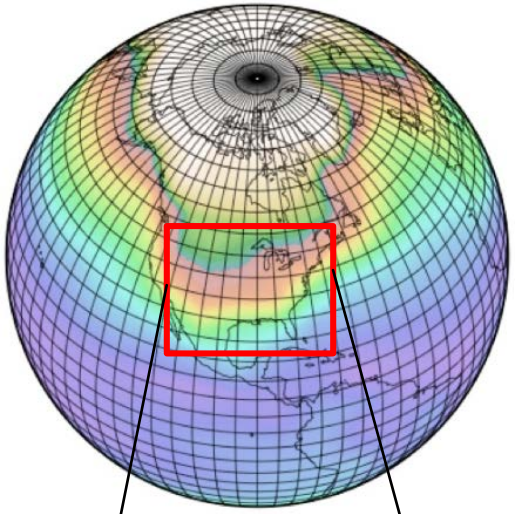
Real Earth System

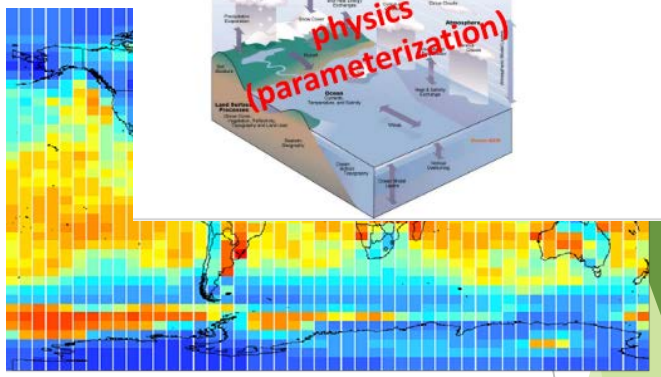
GCM: Global Climate Model

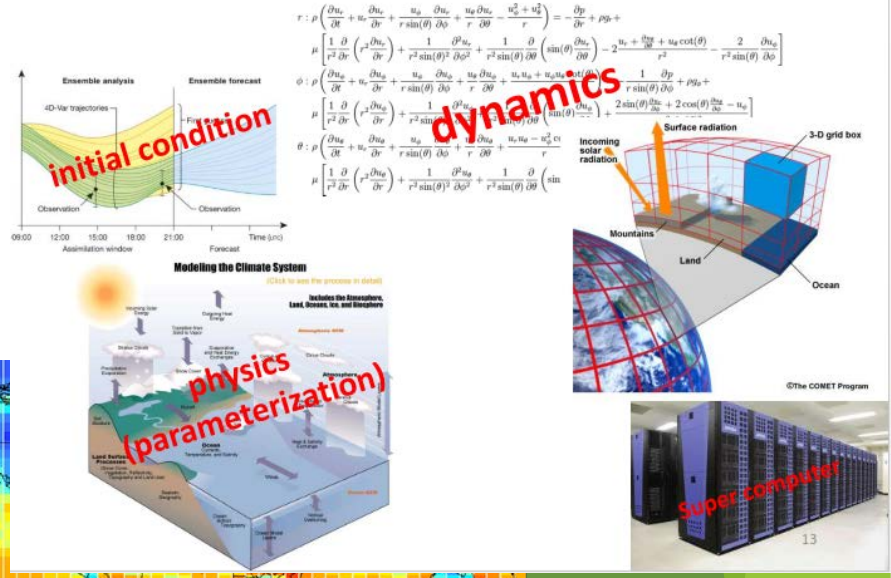
Global climate models (GCM) and regional climate models (RCM) provide climate change data at global and regional scales, respectively, for practical use, such as climate change adaptation policy-making. The GCM model is used to simulate monthly average rainfall, minimum temperature, and maximum temperature for baseline, medium term and long term. 30-year climate observation data, which is a minimal period for determining climate change. Climate change studies involve analyzing past climate, current climate conditions, and estimating future climate possibilities. As a result, studies on climate change require an integrated assessment of the climate system or the earth system.

Climate Information Created Using GCMs and RCMs

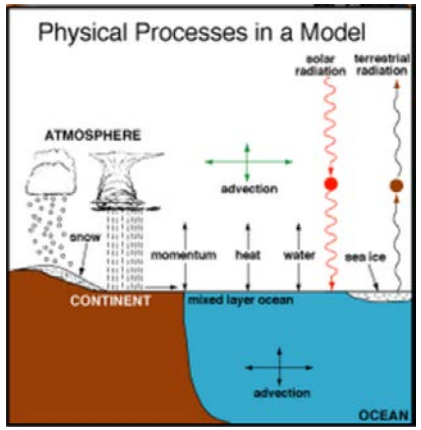
Real Earth System



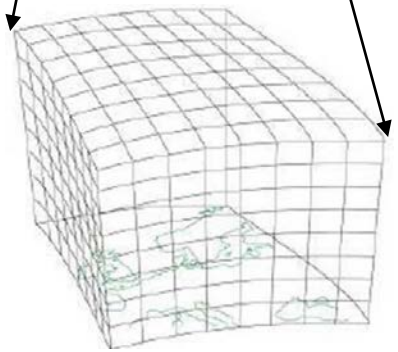


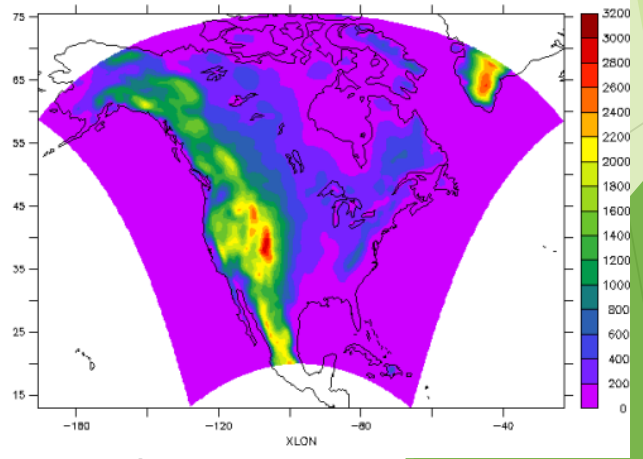


GCM: Global Climate Model



Processes in GCM



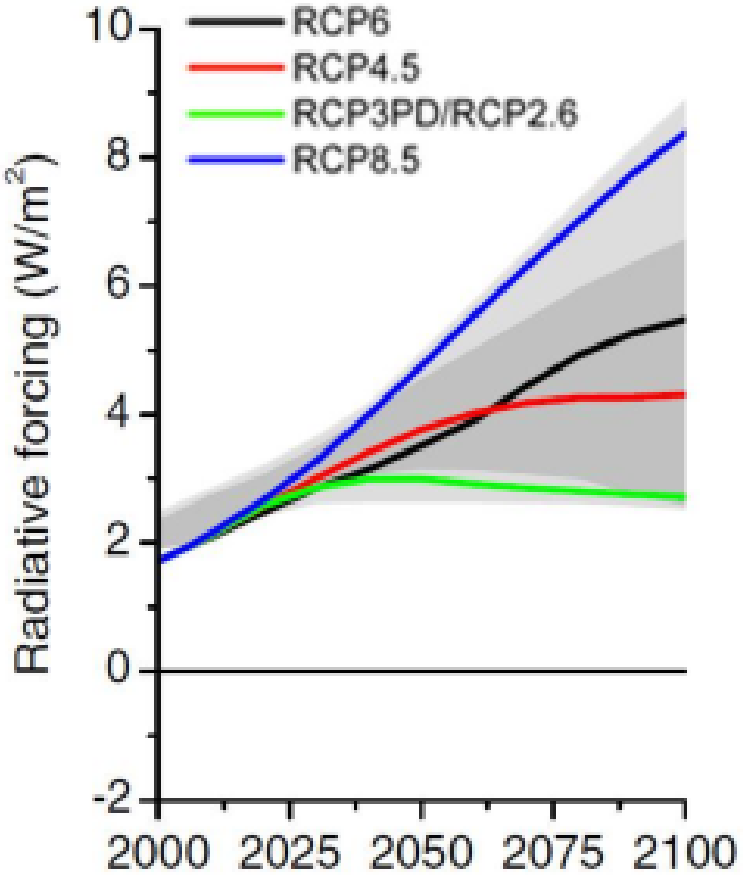


RCM: Regional Climate Model

Climate change scenario data

Coupled Model Intercomparison Project (CMIP) Phase 5

Representative Concentration Pathways (RCPs) scenarios



Source: IPCC

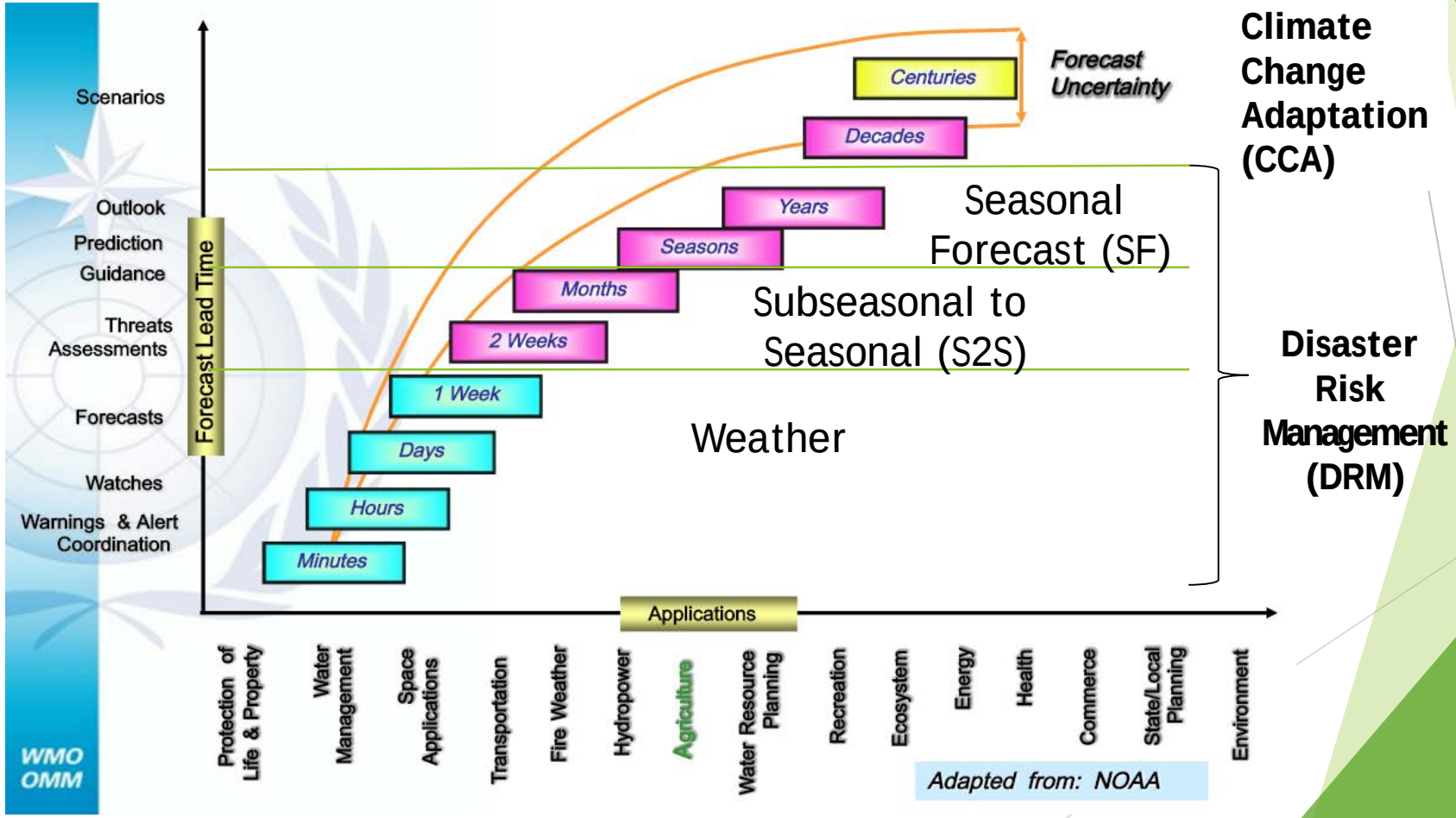
RCPs	Description
RCP8.5	Rising radiative forcing pathway leading to 8.5 W/m2 in 2100.
RCP6.0	Stabilization without overshoot pathway to 6 W/m2 at stabiliz ation after 2100
RCP4.5	Stabilization without overshoot pathway to 4.5 W/m2 at stabi lization after 2100
RCP2.6	Peak in radiative forcing at ~ 3 W/m2 before 2100 and decline

Total radiative forcing

cumulative measure of human emissions of GHGs from all sources expressed in Watts per square meter

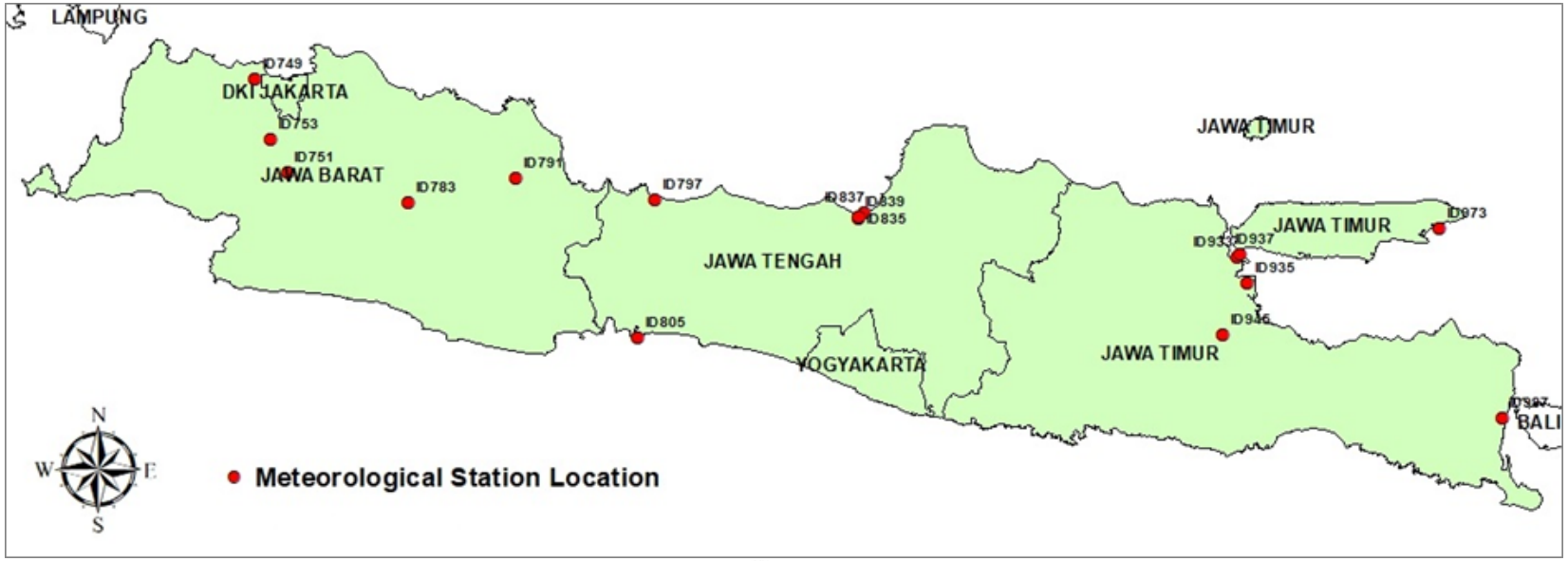
Seamless Climate Service

Seamless Prediction and Services Frameworke



Source: http://slideplayer.com/slide/1447561/

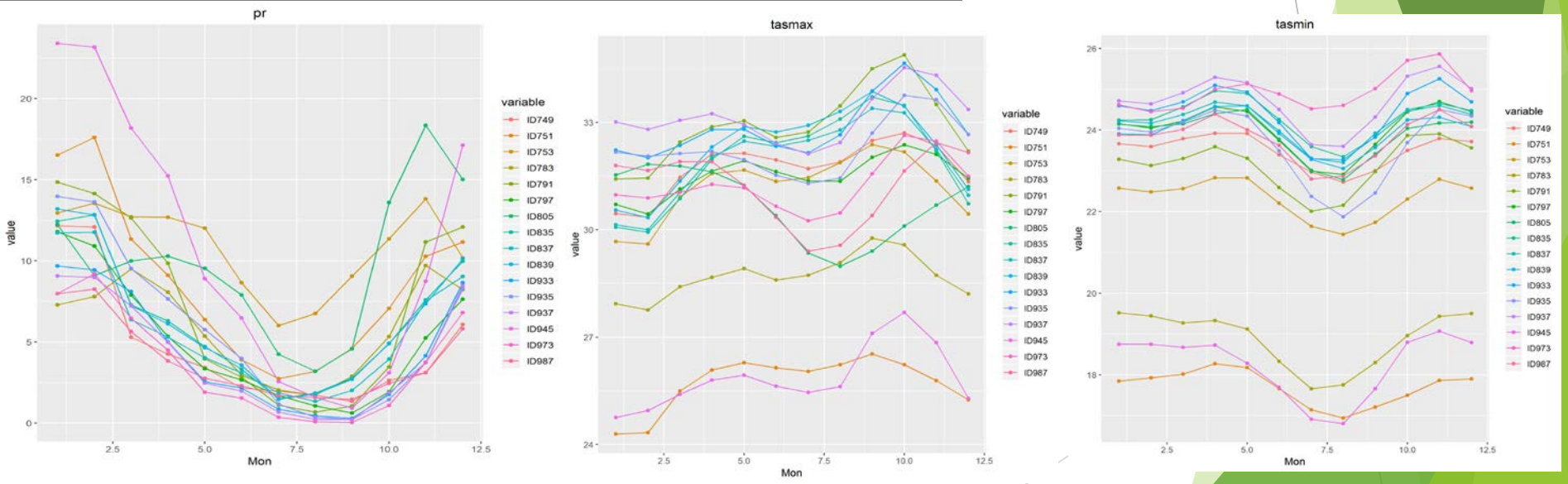
2. Methodology



Research area

17 Meteorological Stations in Java Island

Mountly Climatological Pattern



Prcp

Tmax

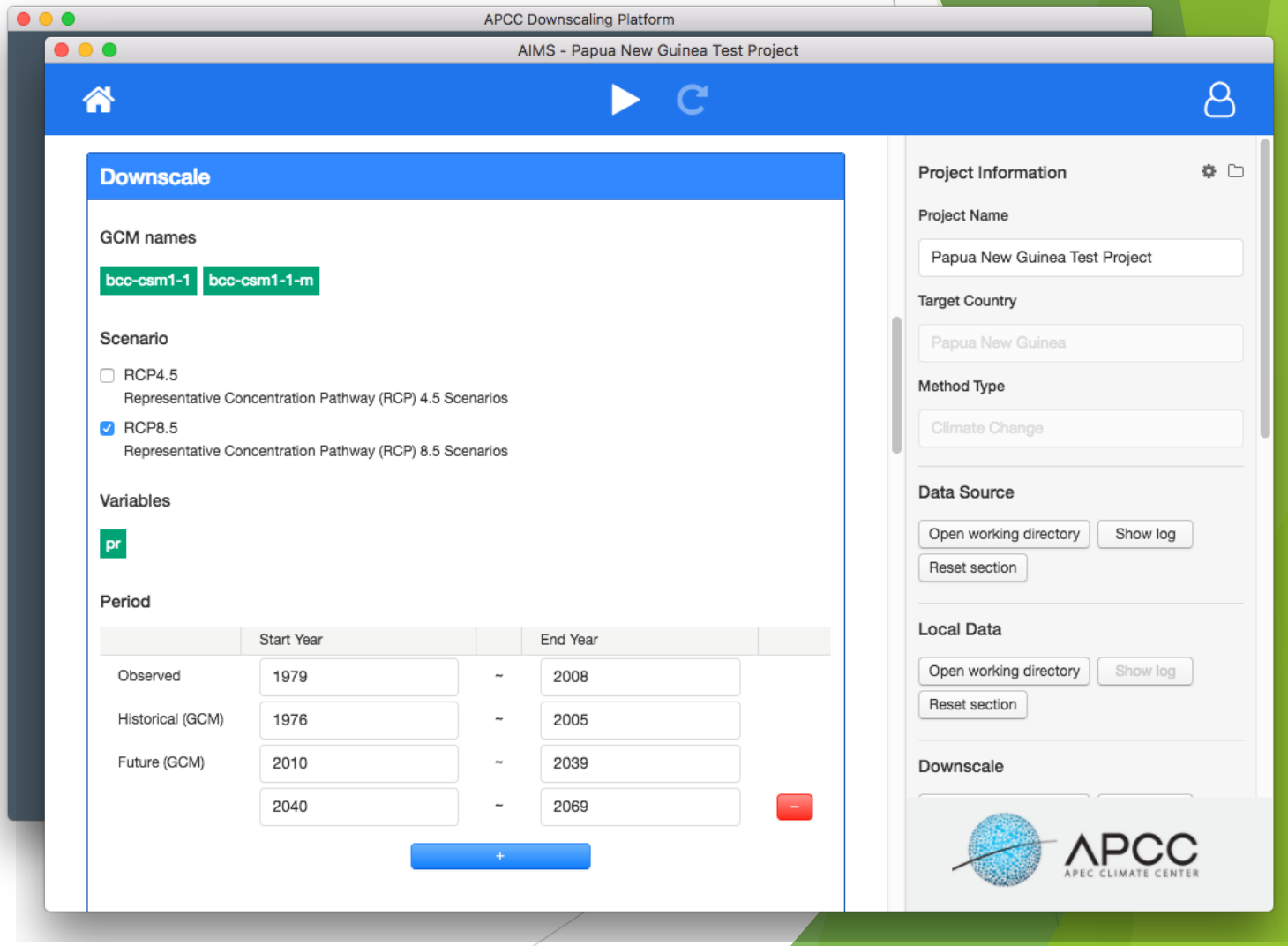
Tmin

Climate Service: Development of user-centered downscaling Tools

Software Optimization

- Dynamically optimize your software
- Run-time reduced by 60~70%
- Open Source (currently in closed Beta)
- Supports R, Javascript, Python

AIMS: APCC Integrated Modeling Solution



AIMS is a desktop application based on the open source R program which contains climate statistical donation methods made by APEC Climate Center. Conducts statistical downscaling of daily **CMIP5 (Coupled Model Intercomparison Project 5)** climate change scenario data at a station level using empirical quantile mapping method (Cho et al., 2016). quantile mapping was then applied to correct additional systematic bias by constructing the transfer functions under the cumulative density function framework between the model and observation using six types of transfer functions. Quantile mapping is routinely applied to correct biases of regional climate model simulations compared to observational data. If the observations are of similar resolution as the regional climate model, quantile mapping is a feasible approach.

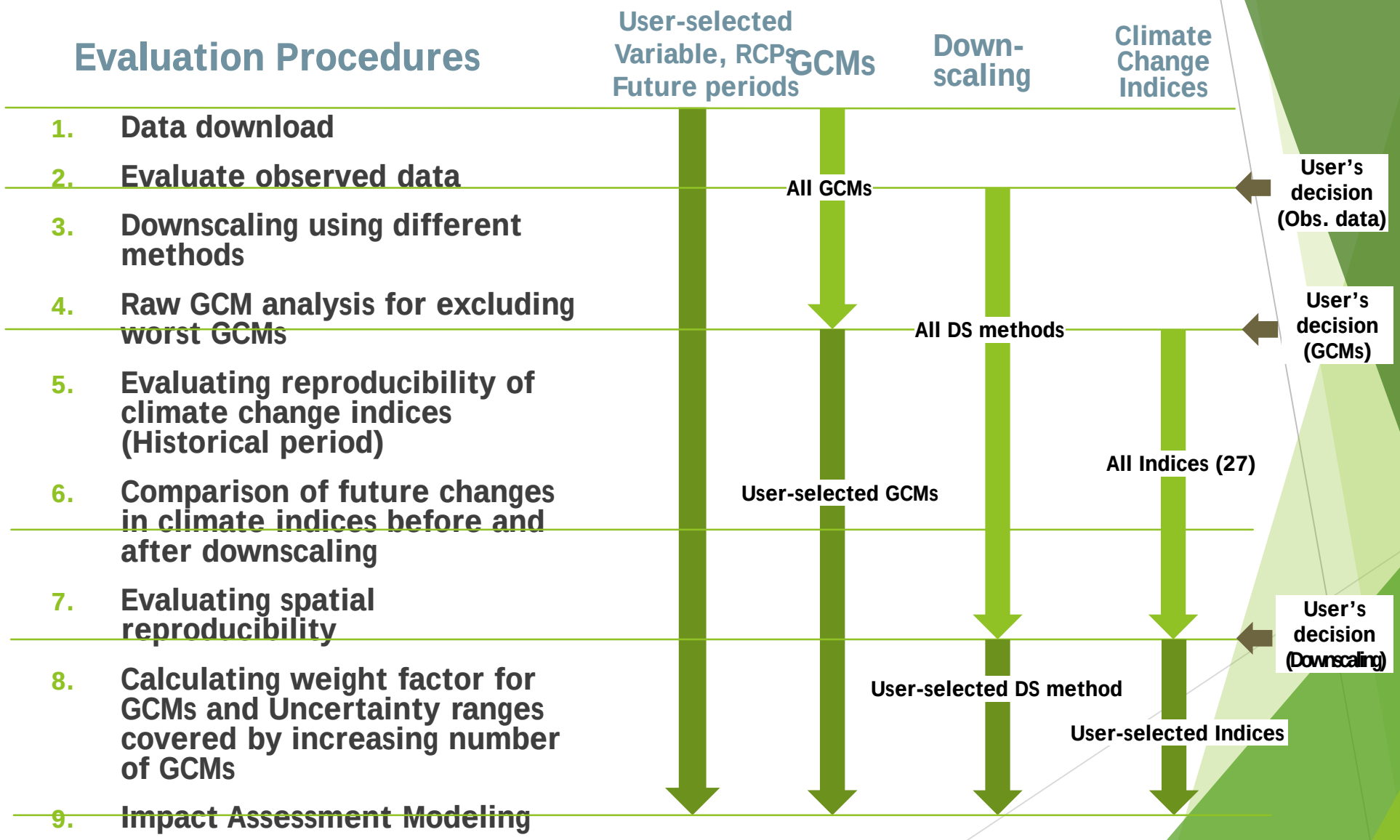
ID	Variable	Description	Unit
cdd	Precipitation	Consecutive dry days, PRCP < 1mm	Day
cwd		Consecutive wet days, PRCP ≥ 1mm	Day
prcptot		Annual total PRCP in wet days (daily PRCP ≥ 1mm)	mm
txn	TMAX (Maximum temperature)	Min TMAX	ºC
txx		Max TMAX	ºC
tnn	TMIN (minimum temperature)	Min TMIN	ºC
tnx		Max TMIN	ºC

Source:
Expert Team on Climate Change Detection and Indices (ETCCDI)
http://etccdi.pacificclimate.org/

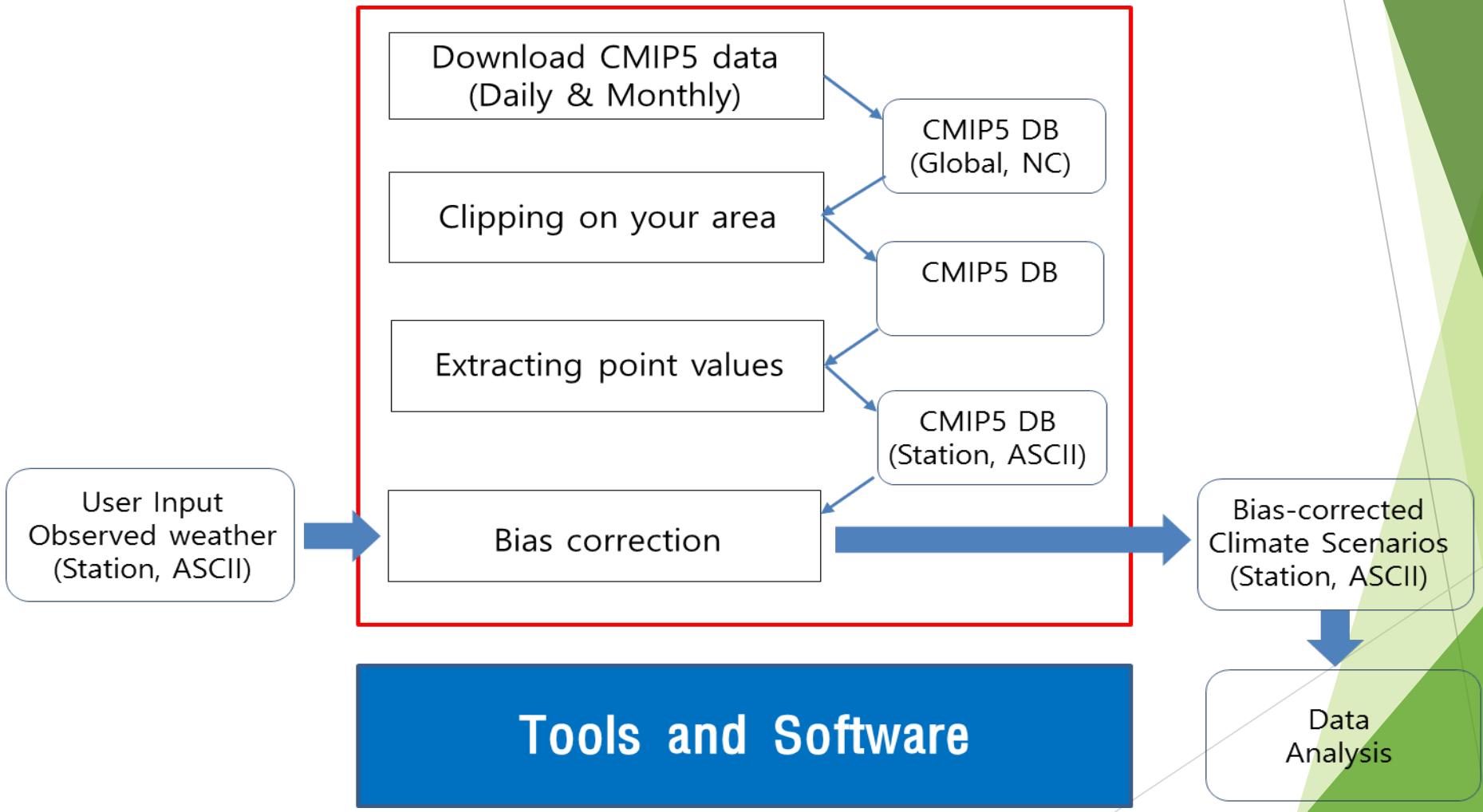
Characteristics of the CMIP5 models used in this study. (Rhee, 2015)

Model Name	Institution and Country	Grid Spacing
CanESM2	CCCma, Canada	2.8
CCSM4	NCAR, United States	1.25
CSIRO Mk3.6.0	CSIRO in collaboration with the Queensland Climate Change Centre of Excellence, Australia	1.9
FGOALS-g2	LASG, IAP, Chinese Academy of Sciences, and Center for Earth System Science, Tsinghua University, China	2.8
FGOALS-s2	LASG, IAP, Chinese Academy of Sciences, China	
GFDL-ESM2G	GFDL, United States	
GFDL-ESM2M	GFDL, United States	
HadGEM2-CC	Met Office Hadley Centre, United Kingdom, with additional realizations contributed by Instituto Nacional de Pesquisas Espaciais (INPE), Brazil	
HadGEM2-ES	Met Office Hadley Centre, United Kingdom, with additional realizations contributed by INPE, Brazil	
INM-CM4.0	Institute of Numerical Mathematics, Russia	
IPSL-CM5A-LR	IPSL, France	
MIROC5	Atmosphere and Ocean Research Institute at the University of Tokyo, National Institute for Environmental Studies, and JAMSTEC, Japan	
MIROC-ESM	Atmosphere and Ocean Research Institute at the University of Tokyo, National Institute for Environmental Studies, and JAMSTEC, Japan	2.8
MIROC-ESM-CHEM	Atmosphere and Ocean Research Institute at the University of Tokyo, National Institute for Environmental Studies, and JAMSTEC, Japan	2.8
MPI-ESM-LR	Max Planck Institute for Meteorology, Germany	1.9
MRI-CGCM3	Meteorological Research Institute, Japan	1.1
NorESM1-M	Norwegian Climate Centre, Norway	1.9

Climate Service: Guideline (procedure) for use of downscaled climate change scenario data

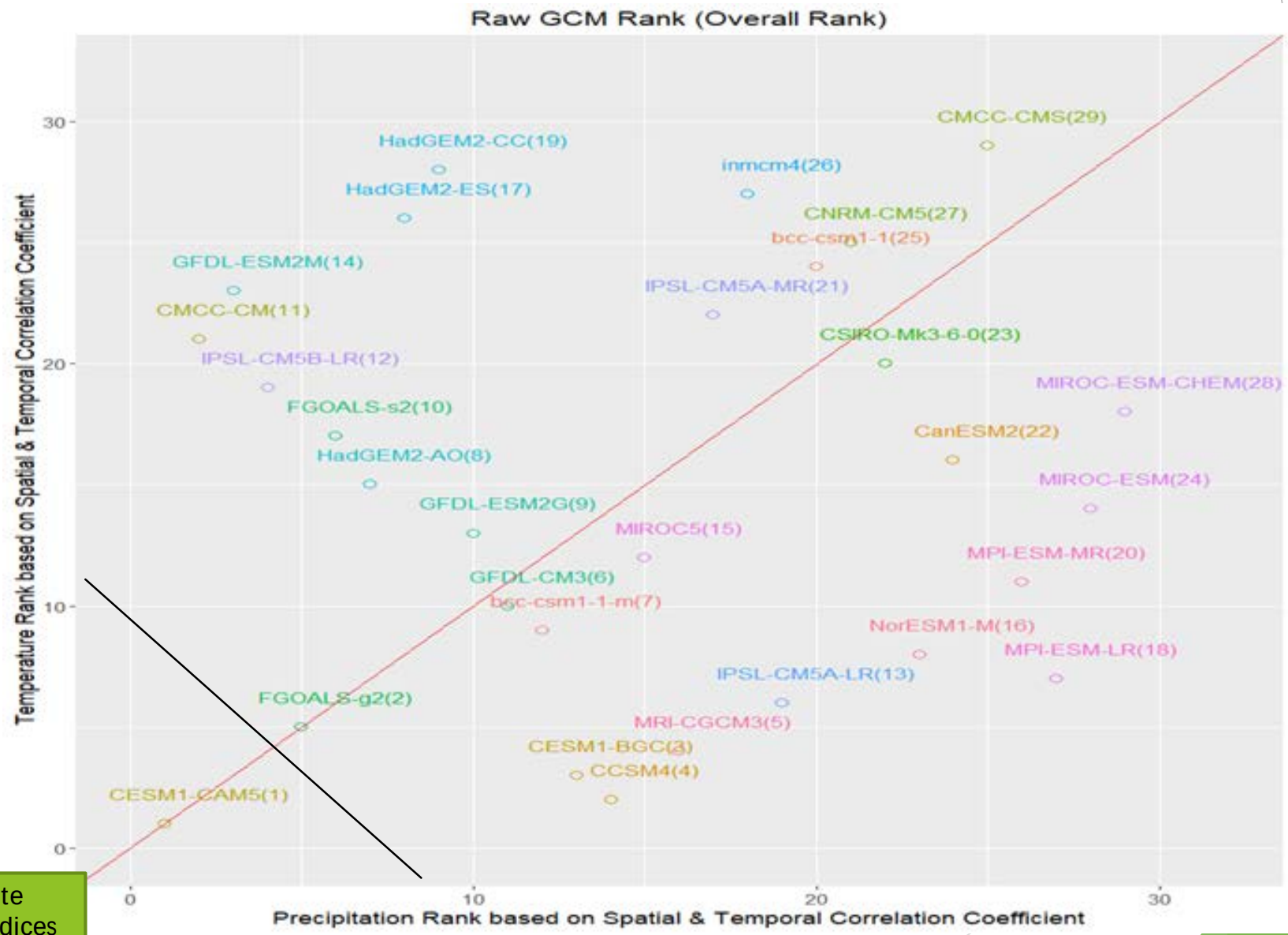


AIMS downscaling package



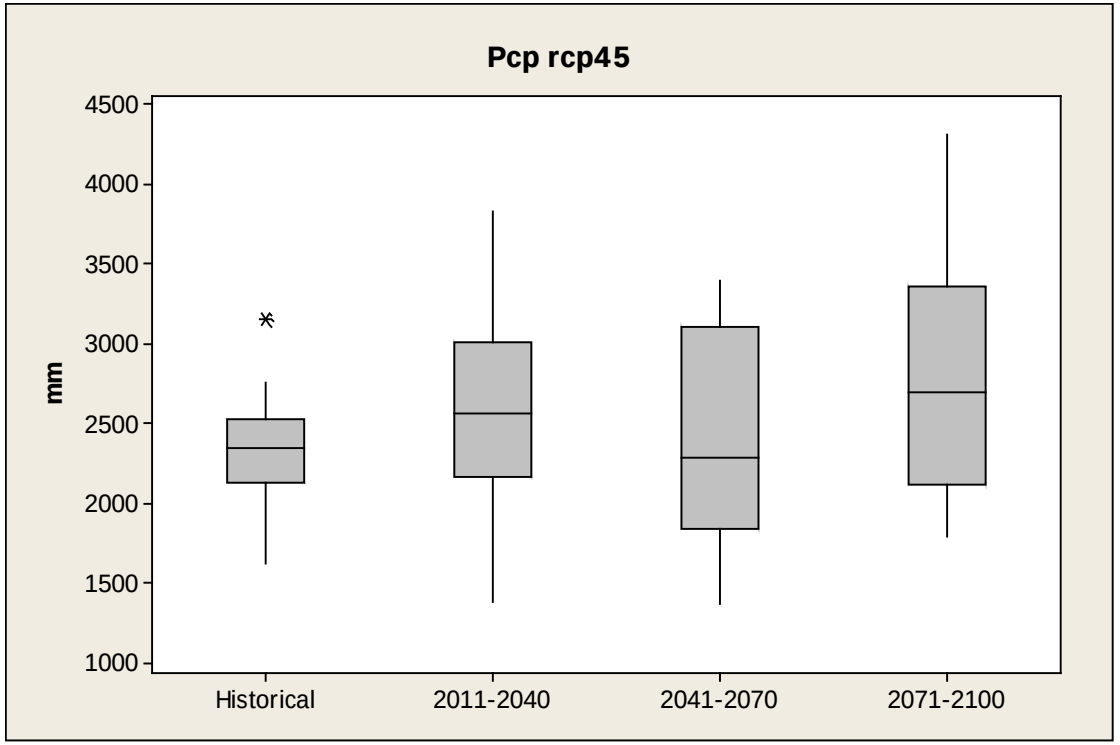
3. Results and discussion

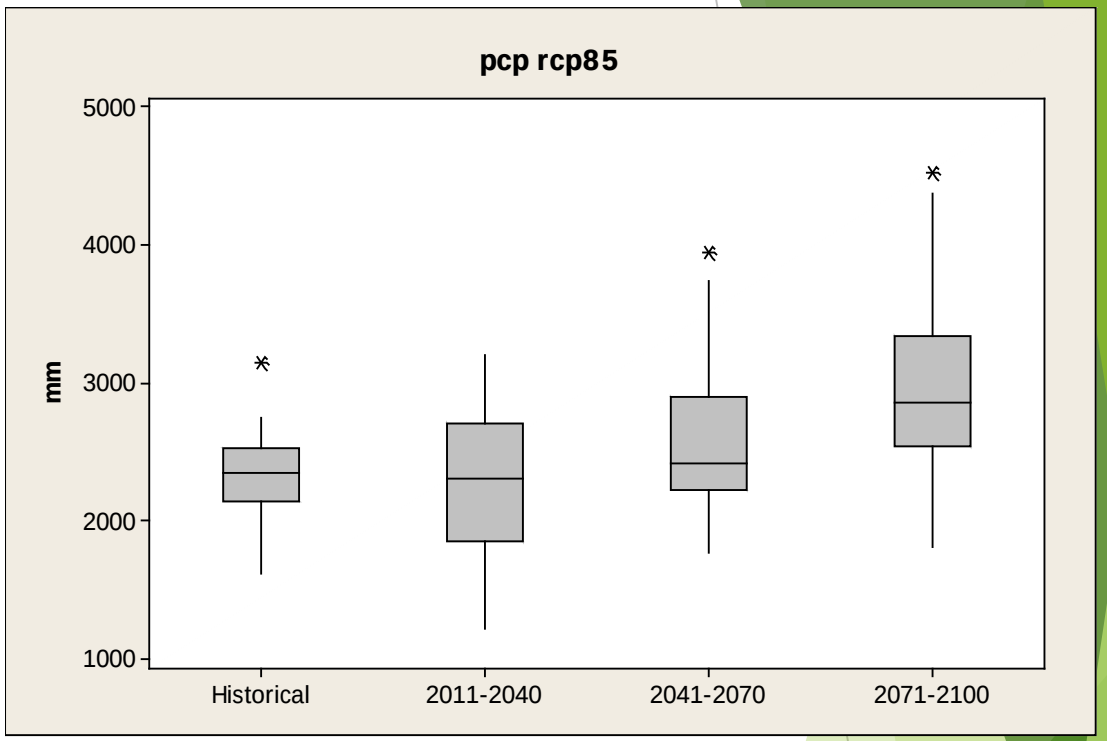
Raw_GCM_Rank_Both(Prcp-Temp)



Good for calculate ekstrime climate indices

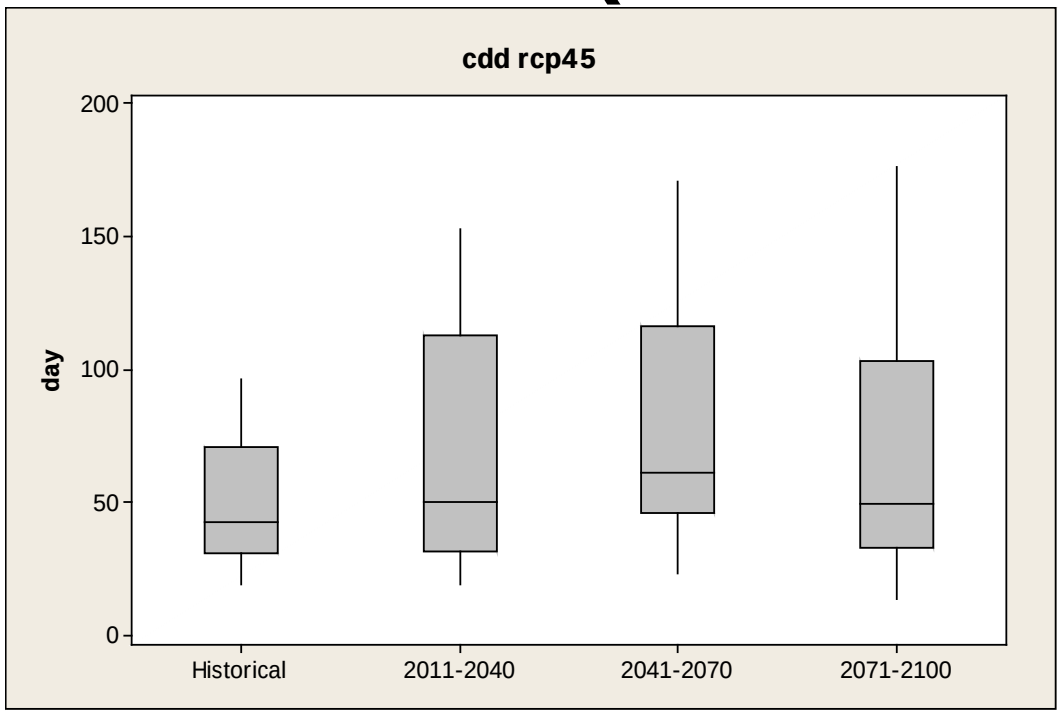
Future Change for Annual total precipitation

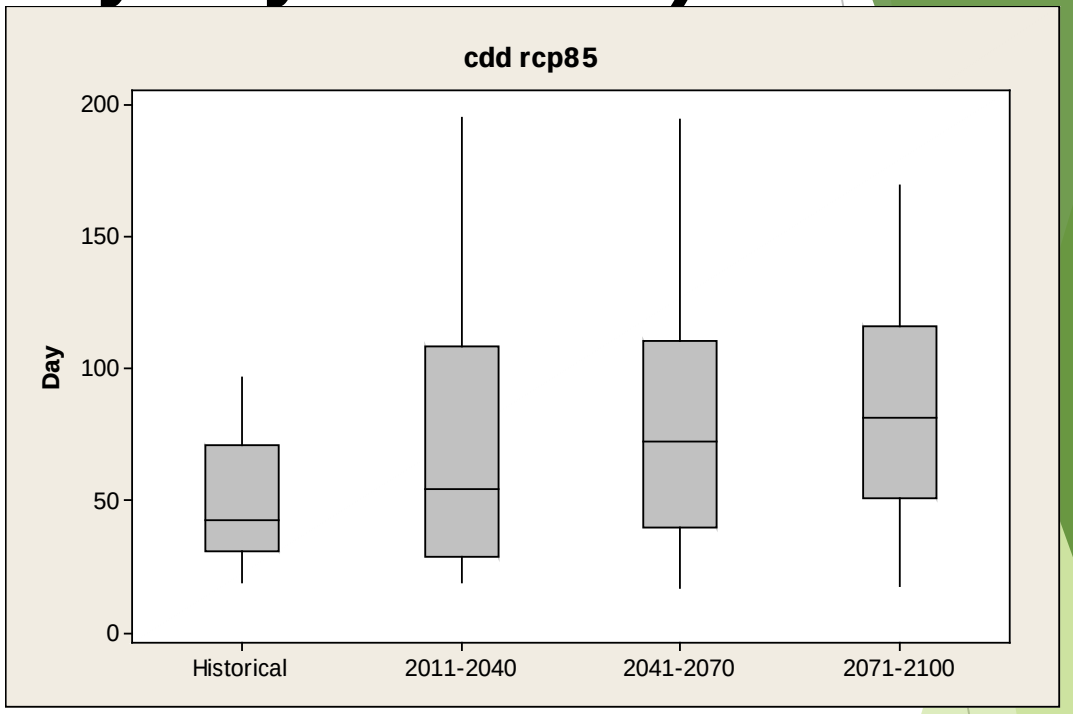




Prcptot (mm)	Historical	RCP45			RCP85		
	1981-2010	2011-2040	2041-2070	2070-2100	2011-2040	2041-2070	2070-2100
minimum	1625.4	1393.1	1372.2	1800.7	1229.5	1771.7	1811.0
1st Quantile	2140.9	2176.9	1840.7	2120.2	1863.3	2226.6	2545.7
Median	2349.8	2571.3	2295.0	2704.8	2305.9	2423.7	2863.5
Mean	2338.2	2580.3	2395.8	2765.2	2296.1	2594.8	3007.9
3rd Quantile	2531.8	3009.6	3107.0	3367.1	2711.6	2905.8	3338.7
Maximum	3156.2	3840.4	3396.8	4320.6	3210.0	3952.4	4530.0

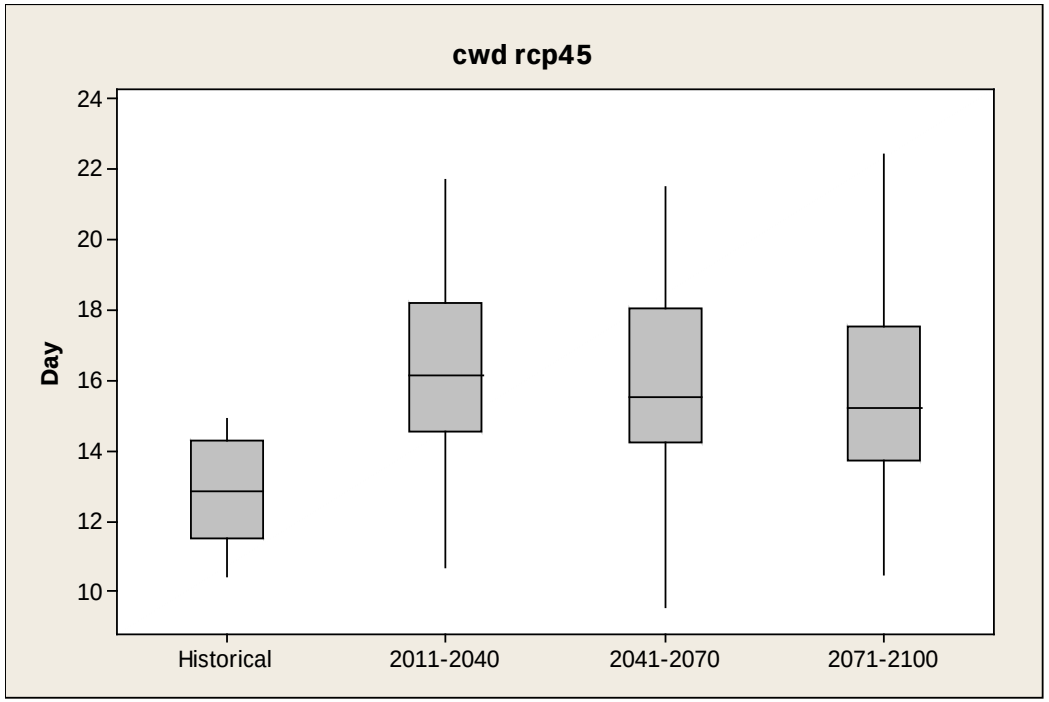
Future Change for (CDD) Maximum length of dry spell (consecutive dry days < 1 mm)

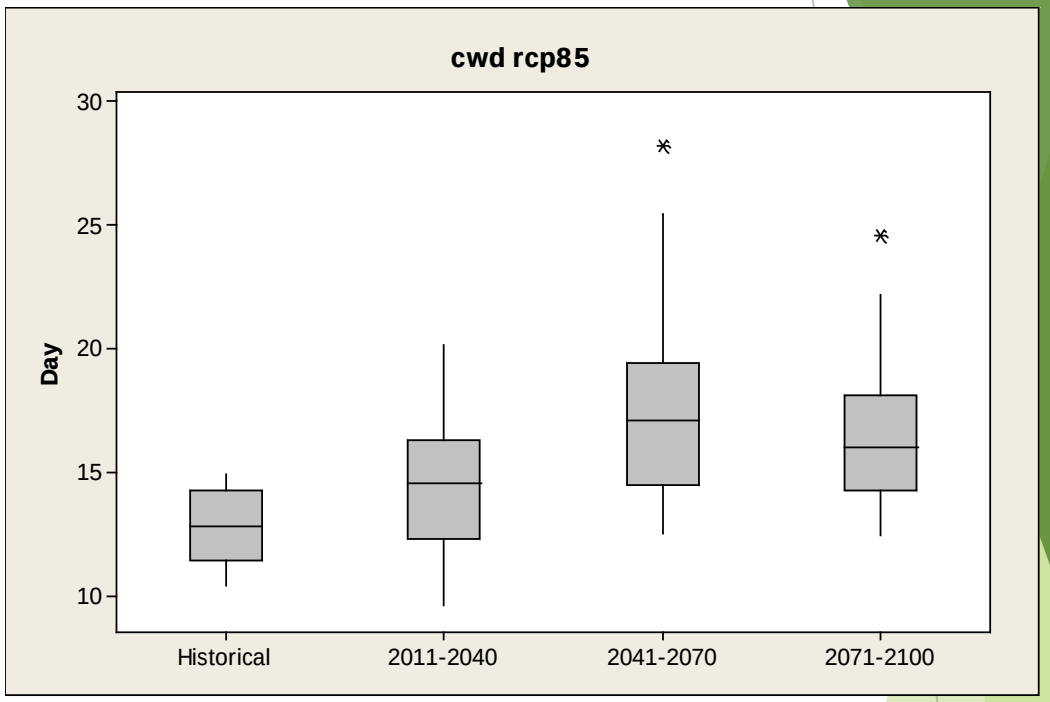




cdd (day)	Historical	RCP45			RCP85		
	1981-2010	2011-2040	2041-2070	2070-2100	2011-2040	2041-2070	2070-2100
minimum	19	19	24	14	20	18	18
1st Quantile	31	32	46	34	29	40	51
Median	43	50	62	50	55	72	81
Mean	51	69	78	69	74	79	84
3rd Quantile	71	113	117	103	108	111	116
Maximum	97	153	171	177	195	194	169

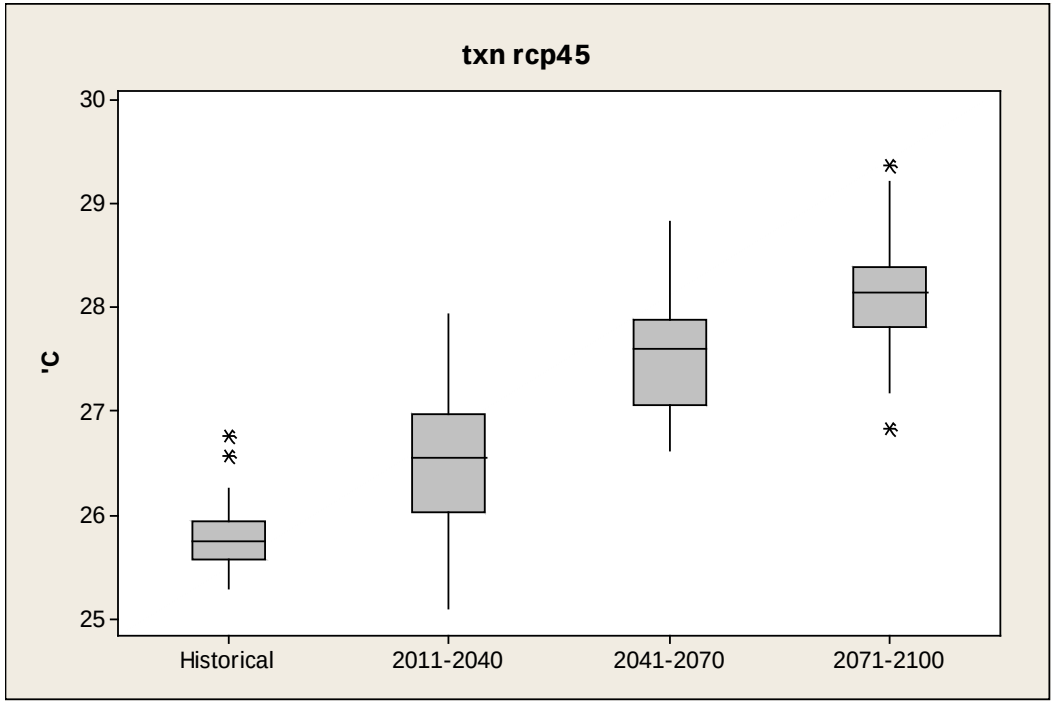
Future Change for (CWD) Maximum length of wet spell (consecutive wet days ≥ 1 mm)

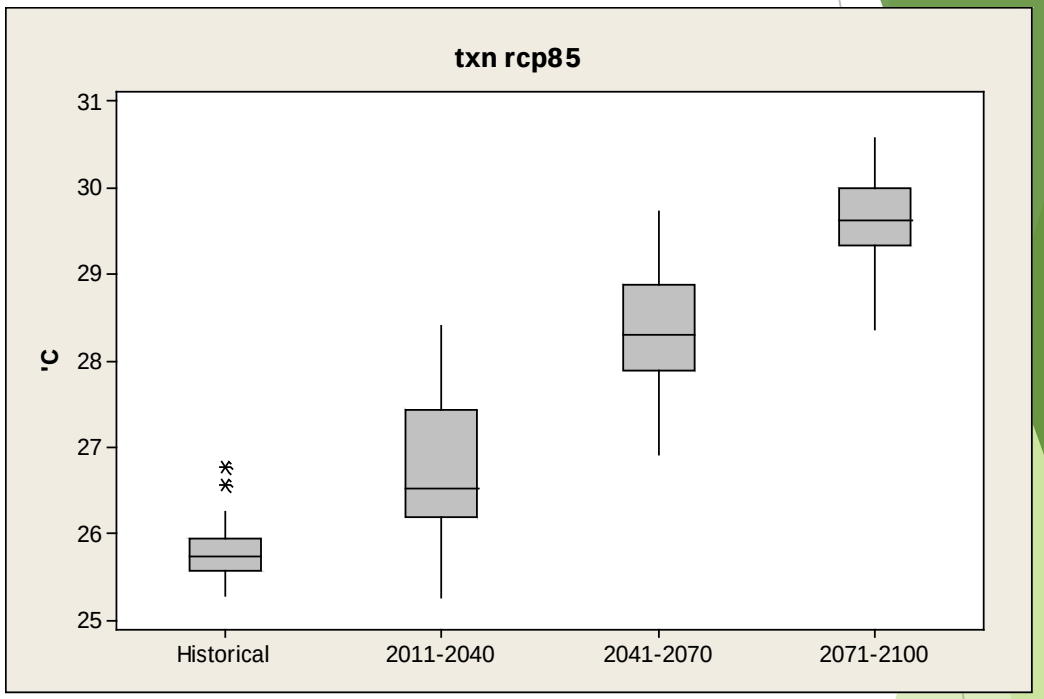




cwd (day)	Historical	RCP45			RCP85		
	1981-2010	2011-2040	2041-2070	2070-2100	2011-2040	2041-2070	2070-2100
minimum	10	11	10	11	10	13	13
1st Quantile	12	15	14	14	12	14	14
Median	13	16	16	15	15	17	16
Mean	13	16	16	16	15	18	16
3rd Quantile	14	18	18	18	16	19	18
Maximum	15	22	22	22	20	28	25

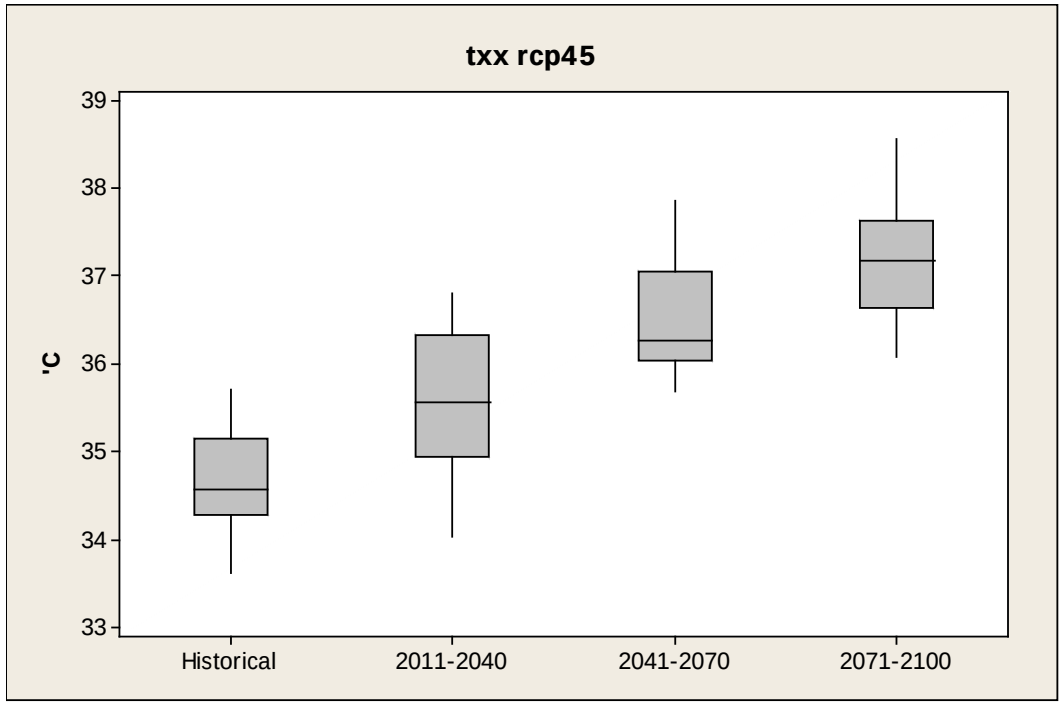
Future Change for Daily minimum from temperature of maximum

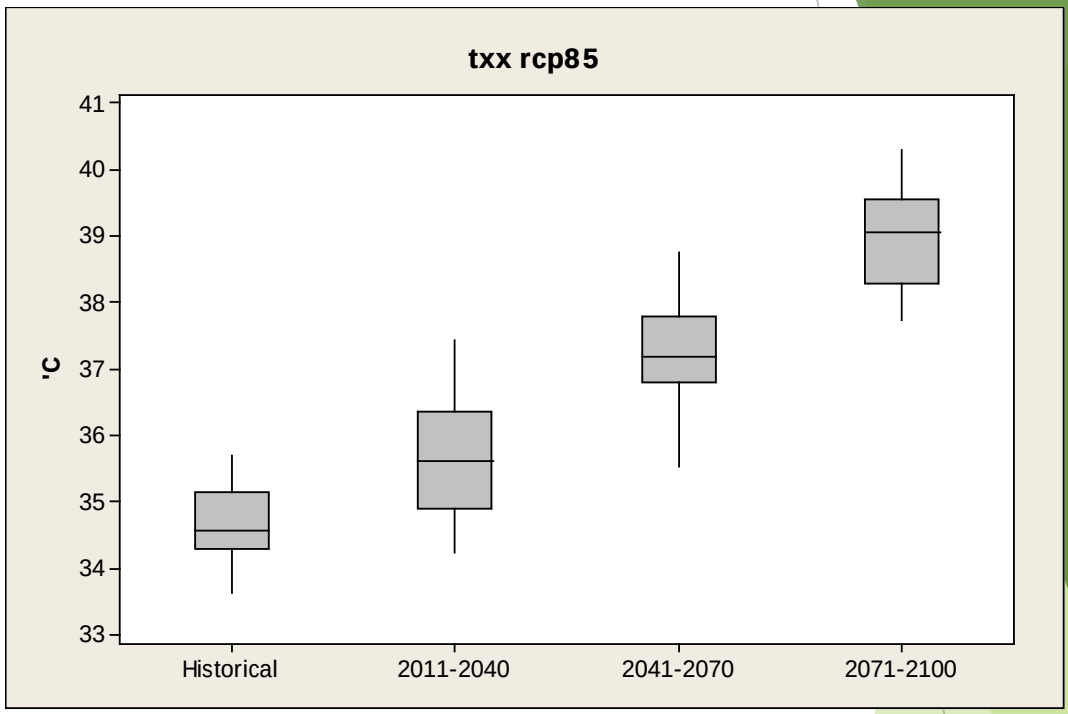




txn (ºC)	Historical	RCP45			RCP85		
	1981-2010	2011-2040	2041-2070	2070-2100	2011-2040	2041-2070	2070-2100
minimum	25.3	25.1	26.6	26.8	25.3	26.9	28.4
1st Quantile	25.6	26.0	27.1	27.8	26.2	27.9	29.3
Median	25.8	26.6	27.6	28.1	26.5	28.3	29.6
Mean	25.8	26.5	27.6	28.1	26.7	28.3	29.6
3rd Quantile	25.9	27.0	27.9	28.4	27.4	28.9	30.0
Maximum	26.8	27.9	28.8	29.4	28.4	29.7	30.6

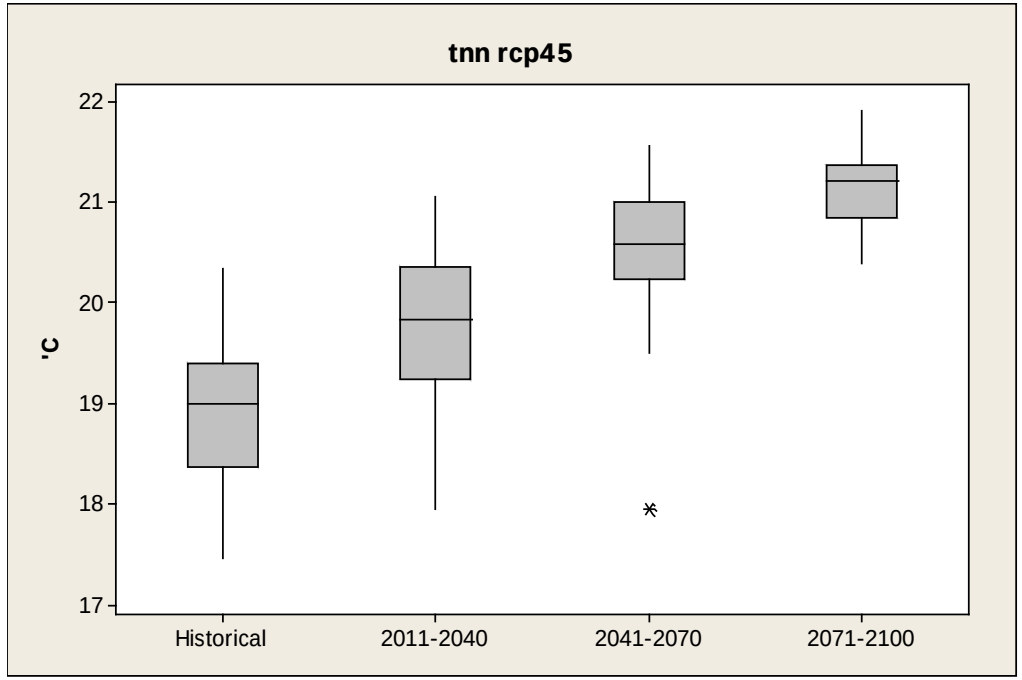
Future Change for Daily maximum from temperature of maximum

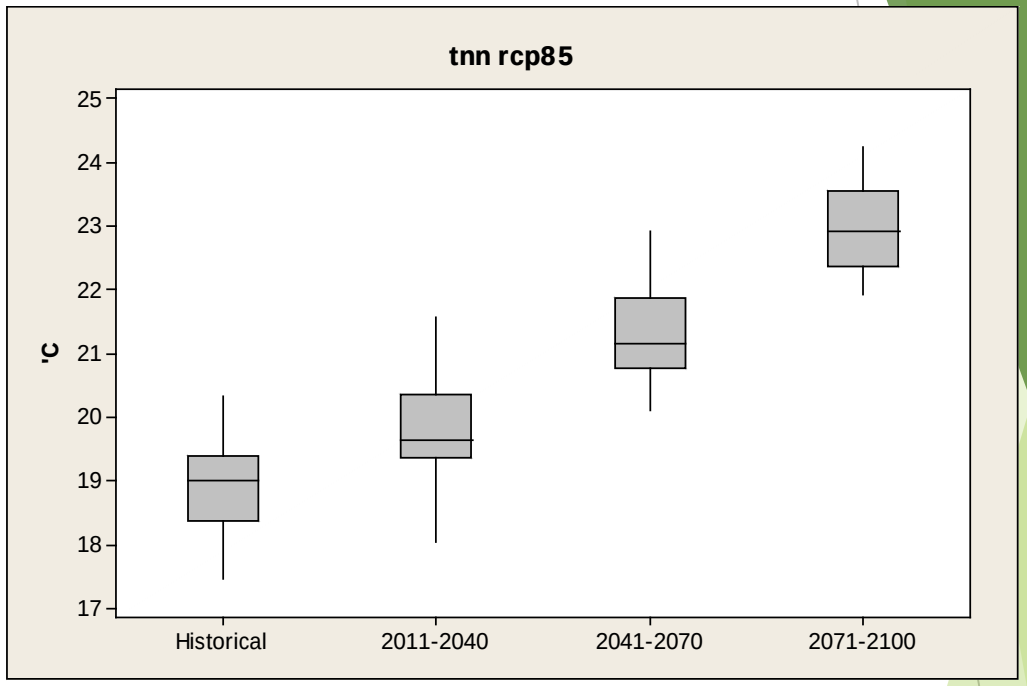




txx (ºC)	Historical	RCP45			RCP85		
	1981-2010	2011-2040	2041-2070	2070-2100	2011-2040	2041-2070	2070-2100
minimum	33.6	34.0	35.7	36.1	34.3	35.5	37.8
1st Quantile	34.3	35.0	36.0	36.6	34.9	36.8	38.3
Median	34.6	35.6	36.3	37.2	35.6	37.2	39.1
Mean	34.7	35.6	36.6	37.1	35.7	37.3	39.0
3rd Quantile	35.2	36.3	37.1	37.6	36.4	37.8	39.6
Maximum	35.7	36.8	37.9	38.6	37.5	38.8	40.3

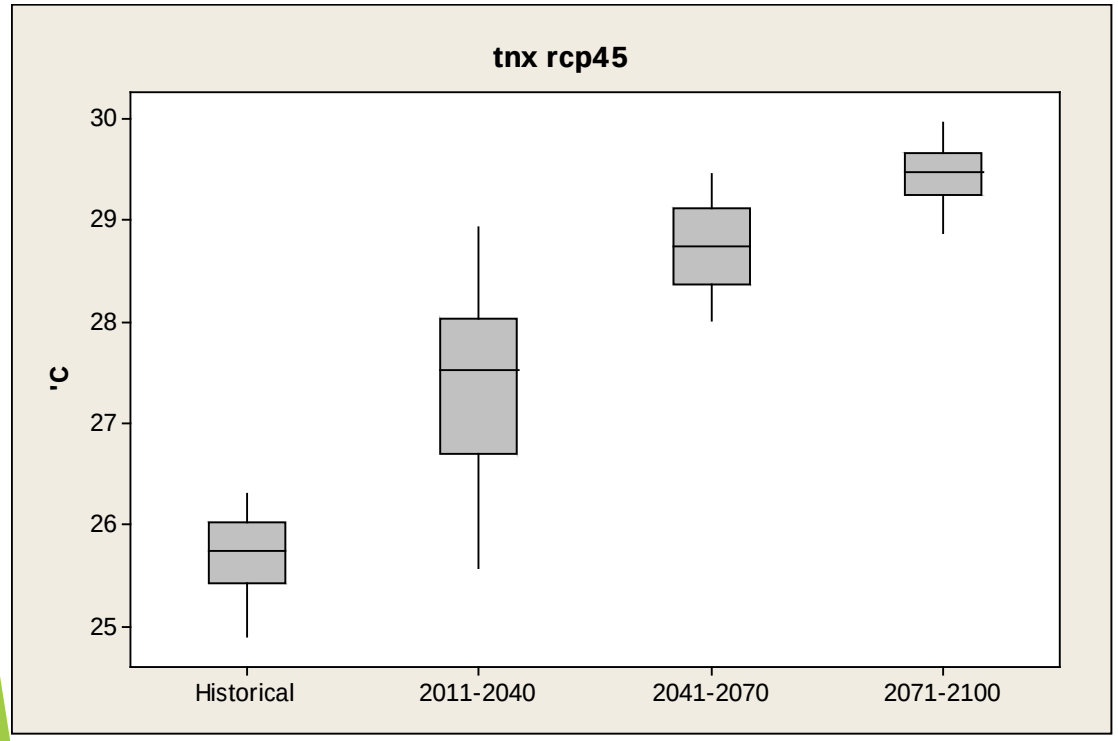
Future Change for Daily minimum from temperature of minimum

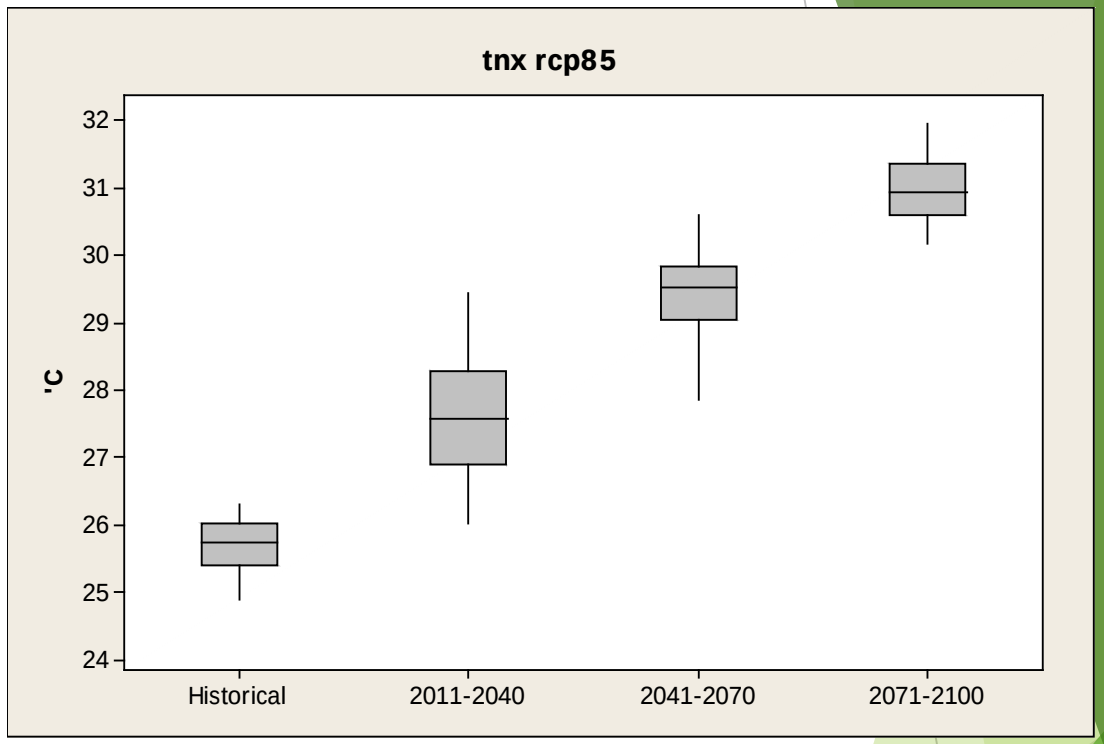




tnn (°C)	Historical	RCP45			RCP85		
	1981-2010	2011-2040	2041-2070	2070-2100	2011-2040	2041-2070	2070-2100
minimum	17.5	17.9	18.0	20.4	18.1	20.1	21.9
1st Quantile	18.4	19.2	20.2	20.8	19.4	20.8	22.4
Median	19.0	19.8	20.6	21.2	19.7	21.2	22.9
Mean	18.9	19.7	20.5	21.1	19.8	21.3	23.0
3rd Quantile	19.4	20.4	21.0	21.4	20.4	21.9	23.6
Maximum	20.3	21.0	21.6	21.9	21.6	22.9	24.2

Future Change for Daily maximum from temperature of minimum





tnx (°C)	Historical	RCP45			RCP85		
	1981-2010	2011-2040	2041-2070	2070-2100	2011-2040	2041-2070	2070-2100
minimum	24.9	25.6	28.0	28.9	26.0	27.9	30.2
1st Quantile	25.4	26.7	28.4	29.2	26.9	29.1	30.6
Median	25.8	27.5	28.7	29.5	27.6	29.5	30.9
Mean	25.7	27.3	28.7	29.4	27.7	29.4	30.9
3rd Quantile	26.0	28.0	29.1	29.7	28.3	29.8	31.3
Maximum	26.3	28.9	29.5	30.0	29.4	30.6	31.9

Percentage future climate change Indices

Climate Indices	(%) Future Change of RCP45			(%) Future Change of RCP85		
	2011-2040	2041-2070	2071-2100	2011-2040	2041-2070	2071-2100
prcptot	10	2	18	-2	11	29
cdd	35	51	33	44	54	64
cwd	27	25	21	15	38	28
txn	3	7	9	4	10	15
txx	3	5	7	3	7	12
tnn	4	9	12	5	13	22
tnx	6	12	15	8	15	20

The projection based on the best MME 3 GCM uses the SQM method after the bias correction is done, the dominant change in the rain climate index and temperature occurs with the trend of increasing percentage relative to the historical (1981-2010) in the period 2011-2040, 2041-2070 and 2071-2100. For more complete changes in the future on the island of Java, see Table Beside:

4. Conclusions

Based on the results of climate projections using the simple quantil mapping (SQM) method with bias correction using the AIMS version 1 model to obtain future climate conditions, it can be seen that there is an increase in rainfall and an increase in temperature trends in the period 2011-2040, 2041-2070 and 2071-2100.