Meteorology

Dynamical downscaling for basin-scale climate change impact assessment

Ralph Allen ACIERTO, Research Specialist

UNESCO
United Nations
Educational, Scientific and
Cultural Organization

ICHARM
International Centre for Water
Hazard and Risk Management
under the auspices of UNESCO

PWRI
Public Works Research Institute,
National Research and
Development Agency, Japan

ICHARM Activity Plan

GCM projections
MRI3.2H - 60km
MRI3.2S - 20km

↓

Downscaling (5km)

↓

Hydrologic Modeling
using WEB-RRI
(Water Energy Budget Rainfall Runoff
Inundation Model, Rasmy et. al 2019)

↓

Flood and Drought
Impact Assessment

| Flood hazard | Drought Hazard |

↓

Adaptation measures
for climate change

TOUGOU PROJECT "Study on Climate Change Impact Assessment & Formulation of Adaptation Measures"
Theme D – Integrated Hazard Prediction

Solo   Pampanga   Davao

River basins	Basin area (Thousand km²)
Solo	16
Pampanga	11
Davao	1.7

ICHARM Activity Plan

GCM projections
MRI3.2H - 60km
MRI3.2S - 20km

↓

Downscaling (5km)

↓

Hydrologic Modeling
using WEB-RRI
(Water Energy Budget Rainfall Runoff
Inundation Model, Rasmy et. al 2019)

↓

Flood and Drought
Impact Assessment

| Flood hazard | Drought Hazard |

↓

Adaptation measures
for climate change

How will rainfall change in the future?

➢ rainfall climatology?

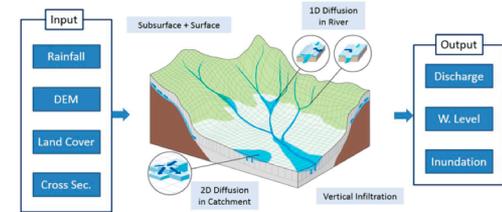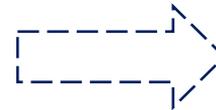➢ extreme rainfall events?
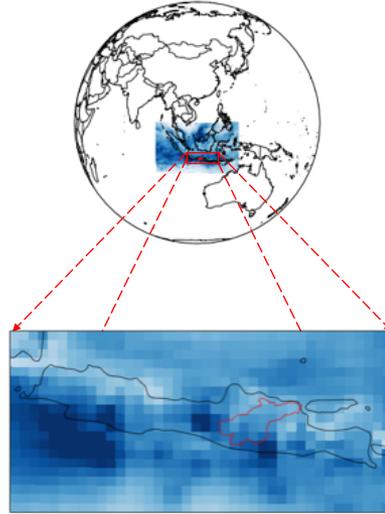
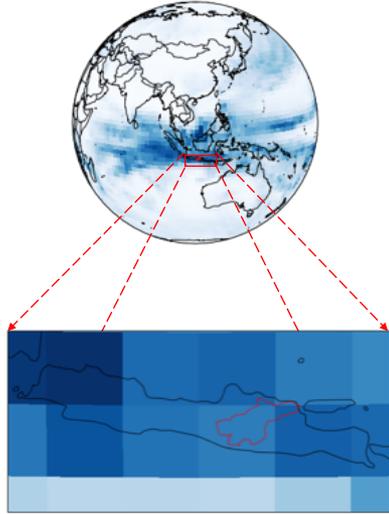How will hazard (flood, drought) change?

How do we manage the risk of future potential hazards?

Dynamic downscaling of global climate projections

Global Climate Model (GCM)

Regional Climate Model (RCM)

Impact, Adaptation, and Vulnerability (IAV) Models

Input	Subsurface + Surface	1D Diffusion in River	Output
Rainfall			Discharge
DEM			W. Level
Land Cover		2D Diffusion in Catchment	Inundation
Cross Sec.		Vertical Infiltration	

MRI 3.2S (20km) GCM
➢ Present Climate
➢ Future Climate (RCP 8.5)

MRI 3.2H (60km) GCM
➢ Present Climate
➢ Future Climate RCP 8.5
➢ Future Climate RCP 2.6

Weather Research and Forecast (5km) Model as an RCM
➢ Changes in Climatology
➢ Changes in Extremes

predict local scenarios

quantify uncertainty

IAV Models for Integrated Assessment and Analysis
➢ quantifying impact on water-related hazards and risks
➢ quantify impact on agriculture
➢ quantify impact on economy
➢ input for DRR feasibility planning on CC impacts investments

Dynamic downscaling of global climate projections

Step 1: Reanalysis-driven simulations
- Also called perfect boundary conditions or perfect prognosis
- Purpose: identify errors in model dynamics, physics, and domain of RCM
- Reanalysis datasets (JRA55, ERA-Interim, etc) are best estimates of atmospheric conditions through data-assimilation of various observations to Global Climate Models simulations
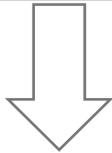
Step 2: GCM-driven historical projections
- Purpose: assess climate change signals and evaluate additional model errors induced by the GCM
- Note: the model evaluation against observations can be done only through climatological statistics
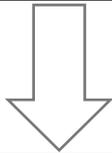
Step 3: GCM-driven future projections
- Purpose: compare statistics for future changes based from historical period statistics to assess GHG-forced change signals

Input Data

Regional Climate Model (RCM)
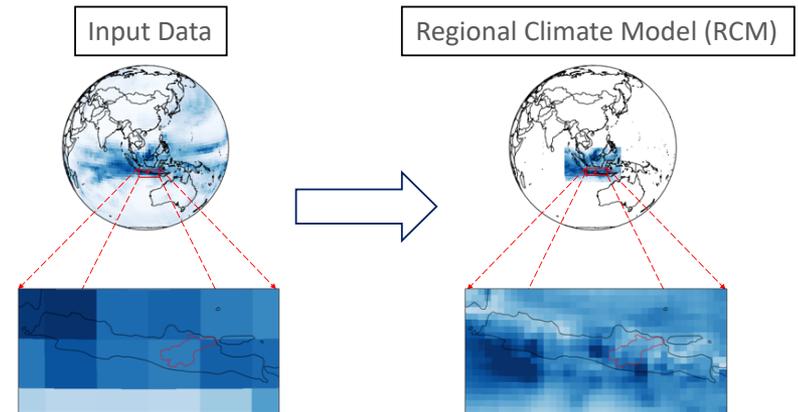
- ❖ Understanding the Rainfall Characteristics
- ❖ Setting up WRF model for downscaling
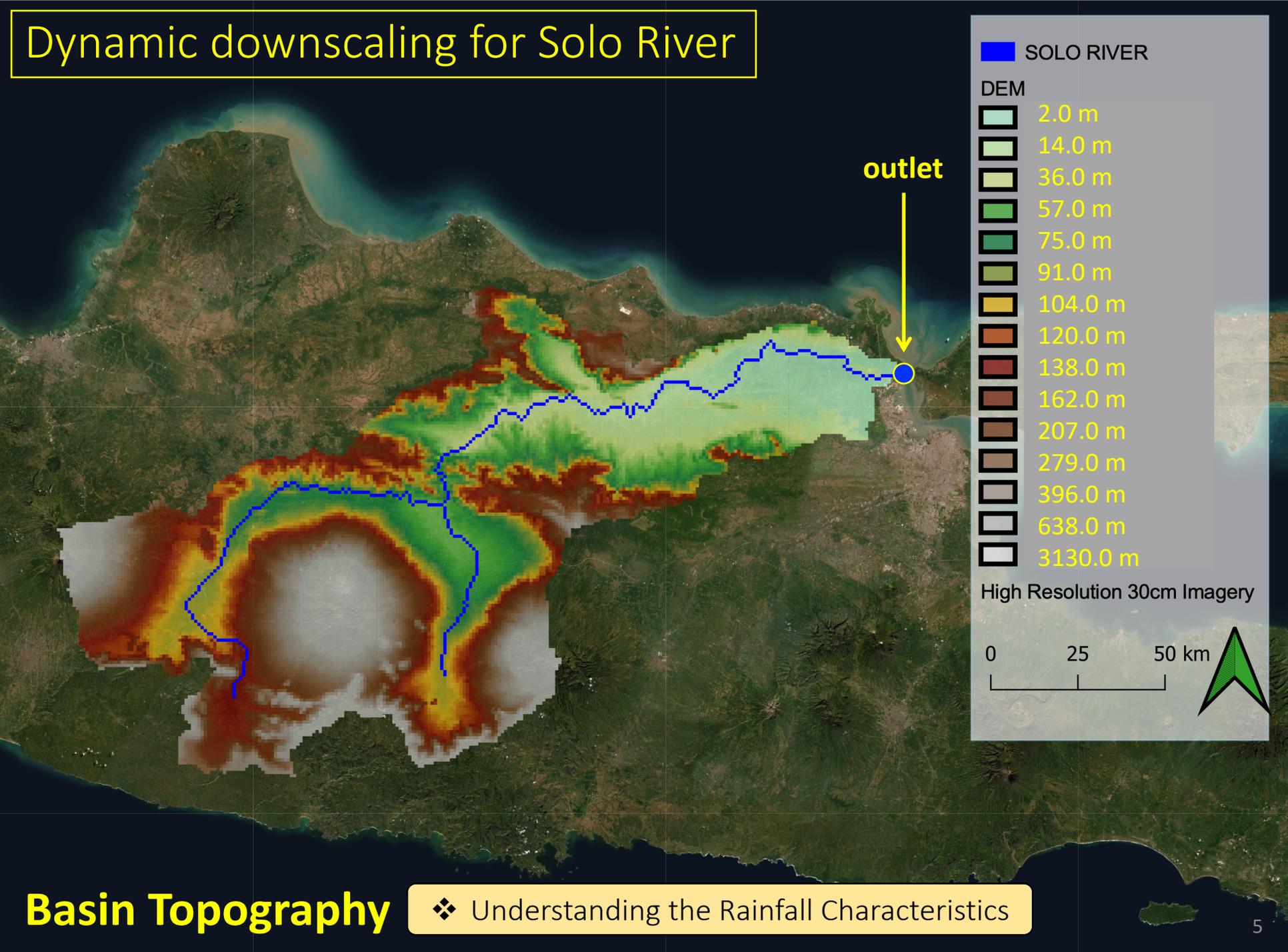- ❖ Selection of GCMs for climate projections
- ❖ Performing the GCM-driven downscaling
- ❖ Bias-correction of Rainfall
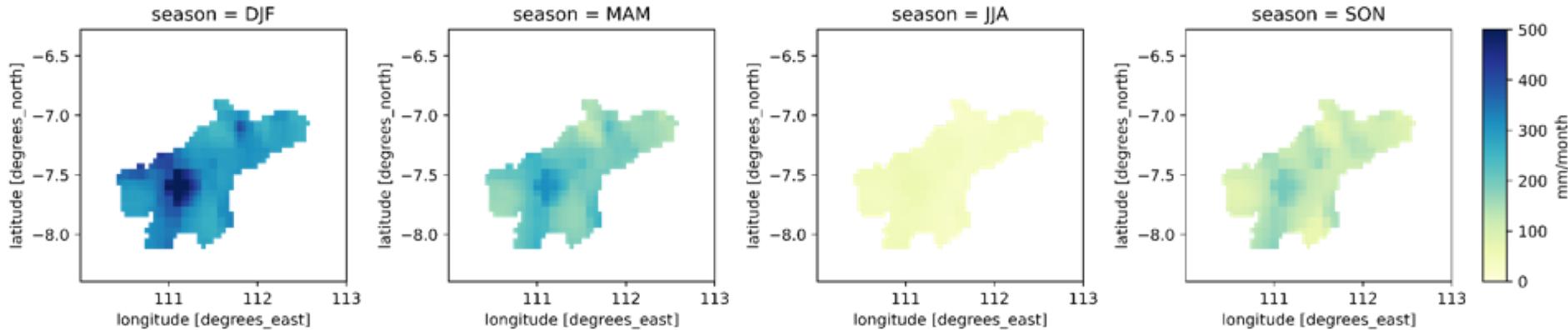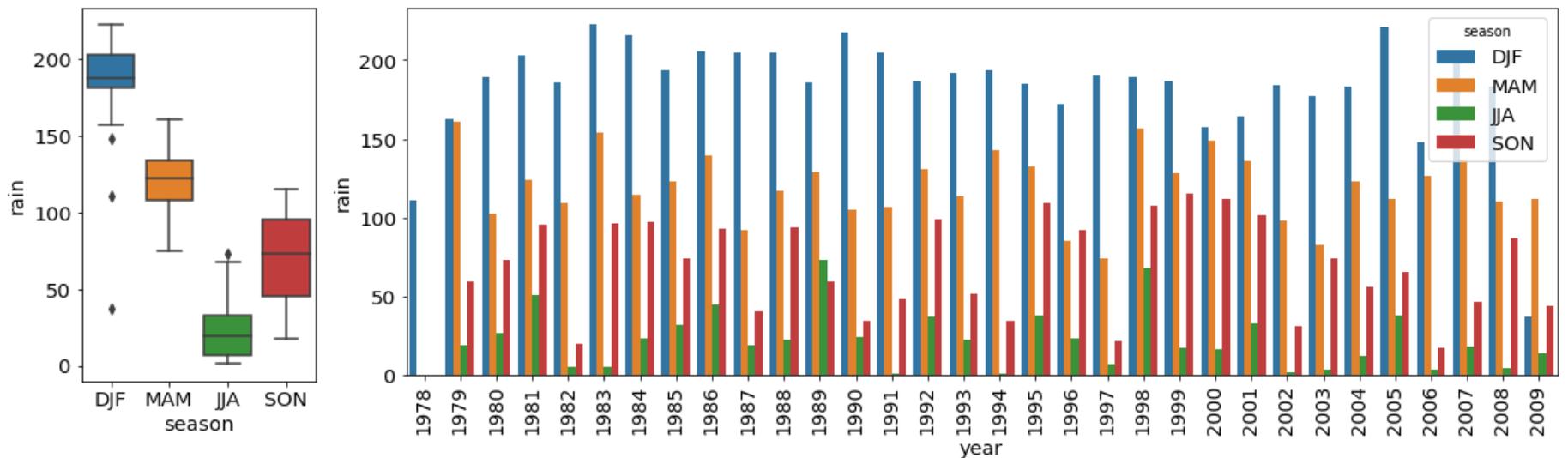
Dynamic downscaling for Solo River

Basin Topography ❖ Understanding the Rainfall Characteristics

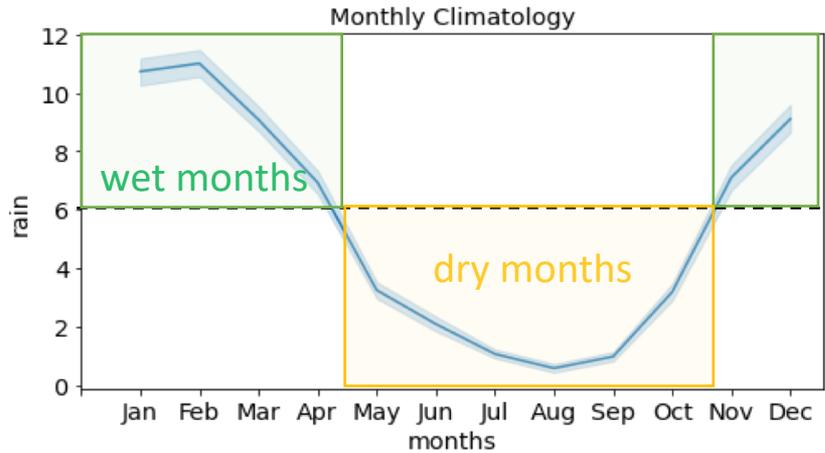# Dynamic downscaling for Solo River

Basin Seasonal Climatology

❖ Understanding the Rainfall Characteristics
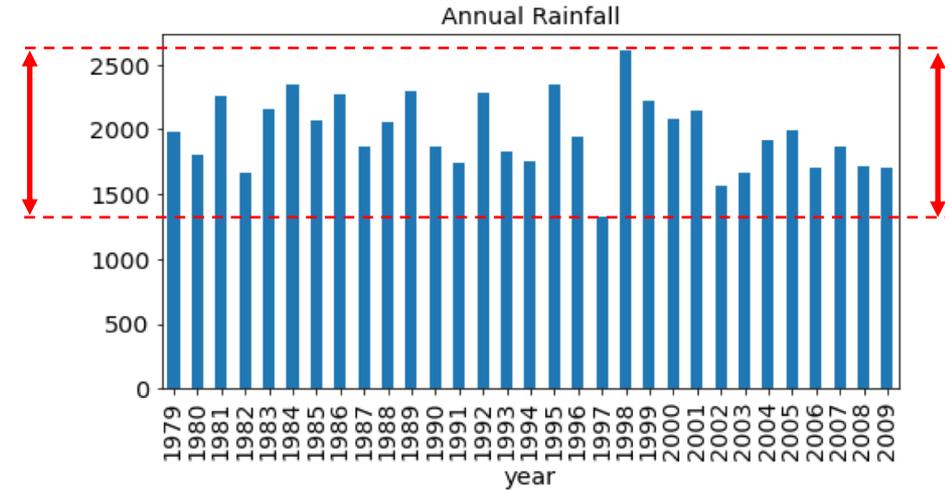

Intra-seasonal variability

Dynamic downscaling for Solo River
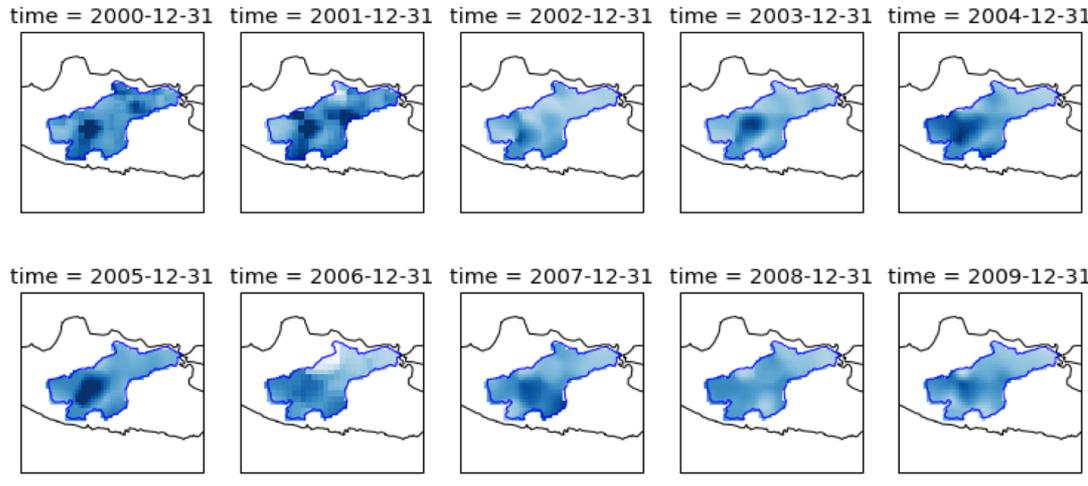
❖ Understanding the Rainfall Characteristics

Monthly Climatology

Inter-annual Variability

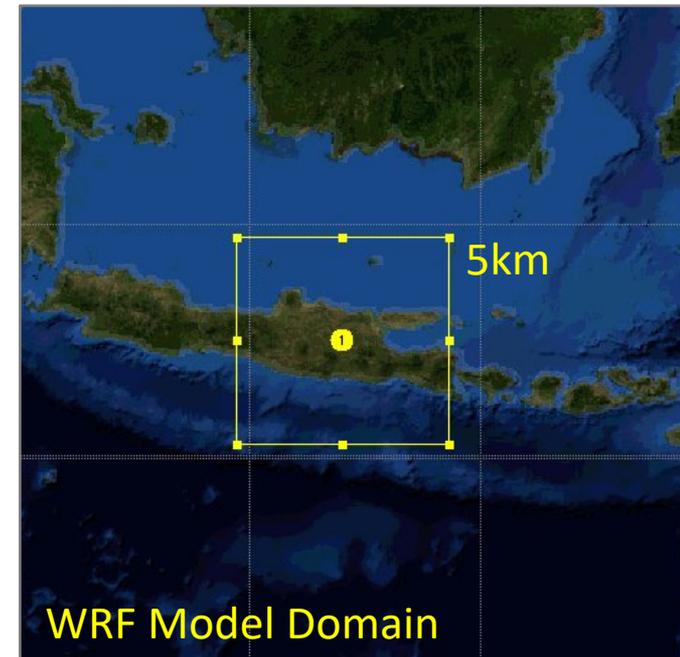## Spatial Distribution of Annual Rainfall in Solo River (2000 – 2009)

➢ Upstream region receives more rainfall amount than the downstream region

Dynamic downscaling for Solo River

❖ Setting up WRF model for downscaling

➢ resolution and domain
➢ critical phenomena for simulating rainfall
➢ metrics for evaluating good performance
➢ selection of model physics(convection, microphysics, etc)

WRF Model Settings	Data	Resolution
Domain Grid	100x100, 5km	5km
Present LBC	MRI 3.2S GCM MRI 3.2H GCM	20km 60km
Future LBC	MRI 3.2S GCM RCP 8.5 MRI 3.2H GCM RCP 2.6 MRI 3.2H GCM RCP 8.5	20km 60km 60km
Microphysics	WSM3	
Radiation	RRTM LW, Dudhia SW	
Boundary Layer	MYNN 2.5	
Land surface model	Noah LSM	
Convection Scheme	none	

5km

WRF Model Domain

Dynamic downscaling for Solo River

❖ Analysis after performing the GCM-driven downscaling and applying bias-correction on downscaled rainfall

➤ Quantifying Changes in Future Annual Rainfall
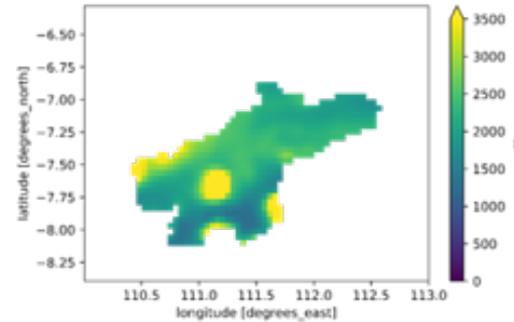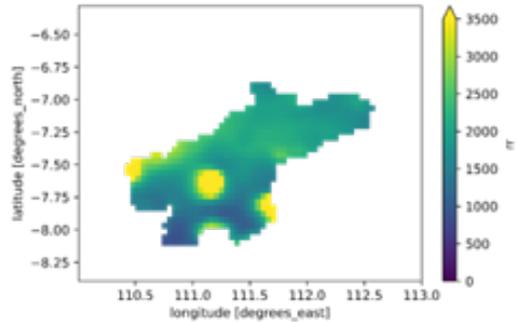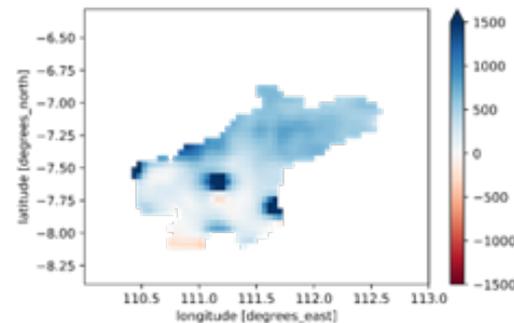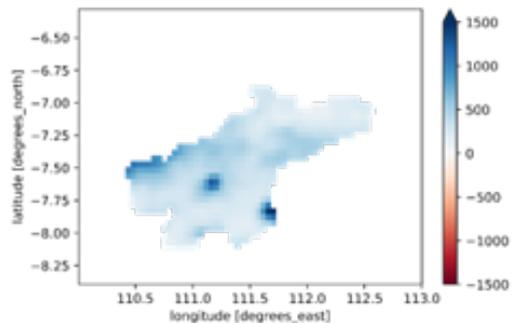
Dynamic downscaling for Solo River

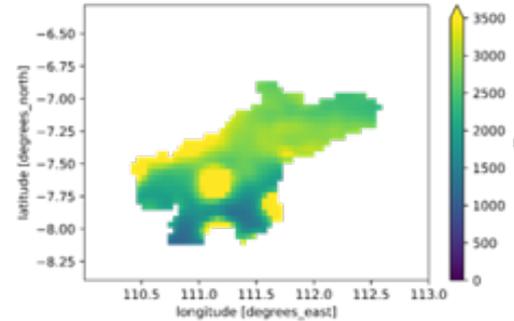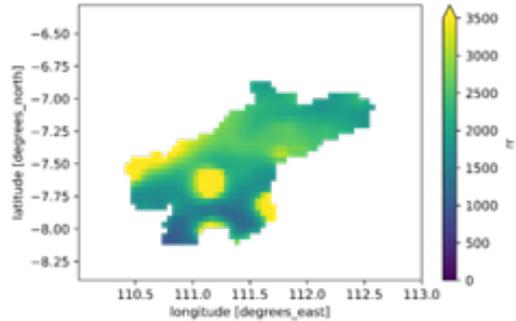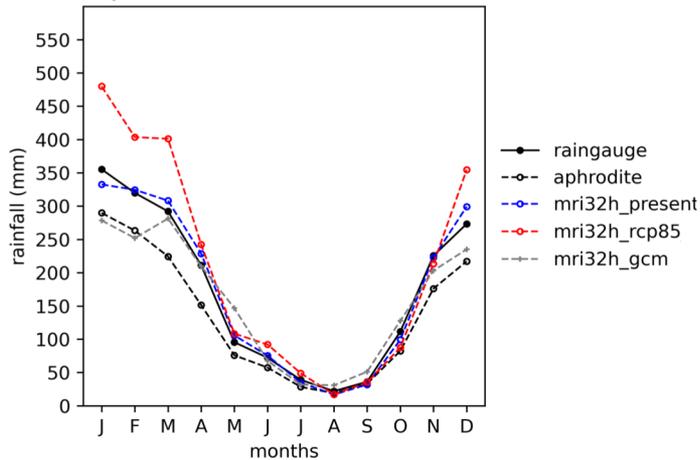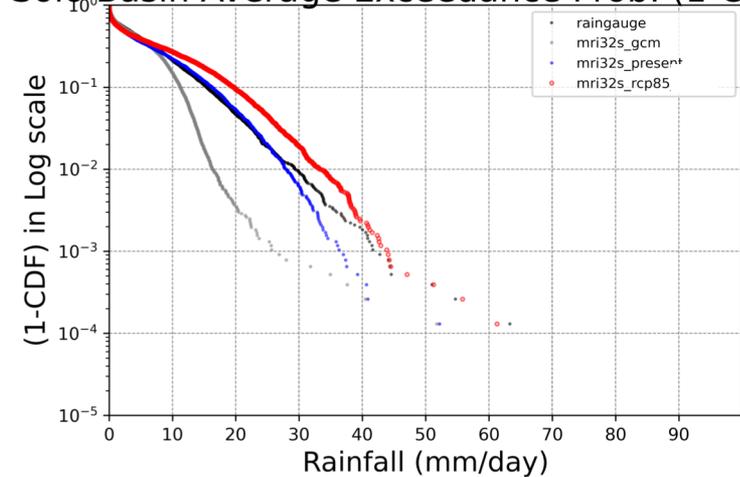❖ Analysis after performing the GCM-driven downscaling and applying bias-correction on downscaled rainfall

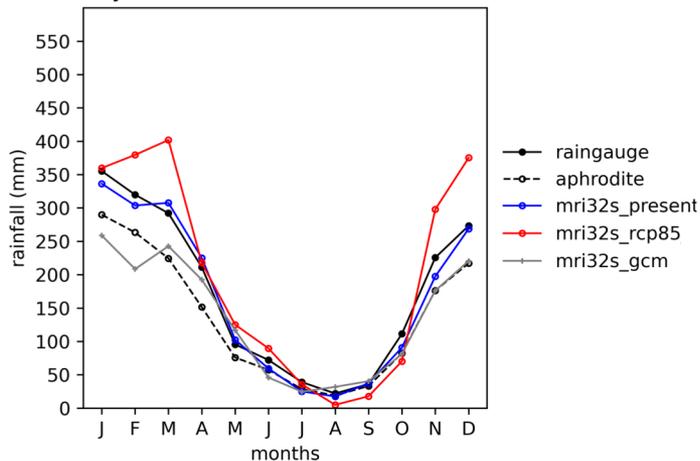➤ Quantifying Changes in Future Climatology and Frequency Distribution