Development of Statistical Bias correction and Downscaling Scheme for Climate Change Impact Assessment at a Basin scale

ChoThanda NYUNT, Akio YAMAMOTO , Toshihoro NEMOTO, Masaru KITSUREGAWA , Mohamad Rasmy and Toshio KOIKE

Cho Thanda Nyunt
Ph.D student
River and Environmental Lab
University of Tokyo

Content

Background

A decade of Weather Extreme

Dim Coumou and Stefan Rahmstorf (2012)

Figure 1 | World map sh

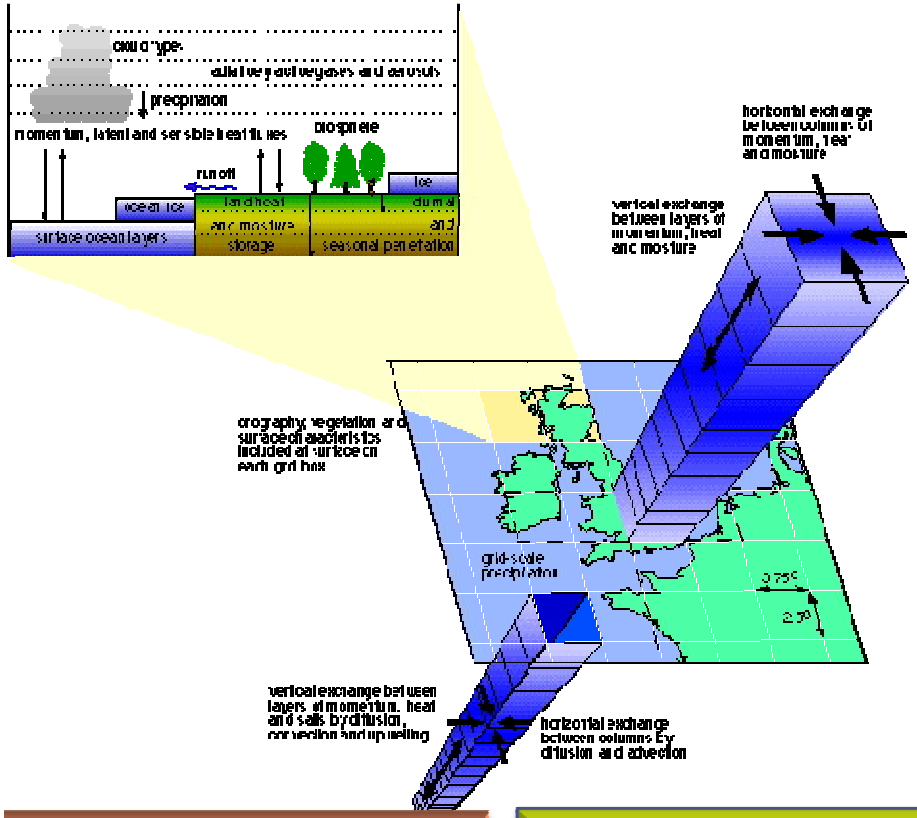
The numbers refer to the

represent rainfall; red symbo

symbols represent hurricanes/cy

tornado outbreak.

Global Climate Model



- Climate Change Impact Assessment
- Solution of Disaster Risk Management
- Guidance for Adaptation Measure
- Support for decision making and infrastructure planning

Regional Climate simulation	Bias	Low spatial resolution
GCM selection	Statistical Bias Correction	Spatial disaggregation (Downscaling)

Research Objectives

Establish the GCM selection method for multi-model ensemble simulation to reduce uncertainty

(GCM selection)

Develop a simple, comprehensive and effective Bias Correction method to minimize the error of GCM for climate change impact assessment at the basin scale

(Bias correction)

Accomplish the high temporal and spatial downscaling scheme for precipitation by using satellite data, GSMaP

(Downscaling or Spatial disaggregation)

Investigate long-term precipitation trend, frequency and subsequence changes in stream flow regimes under the global warming A1B scenario for the basin scale

(Analysis for impact assessment)

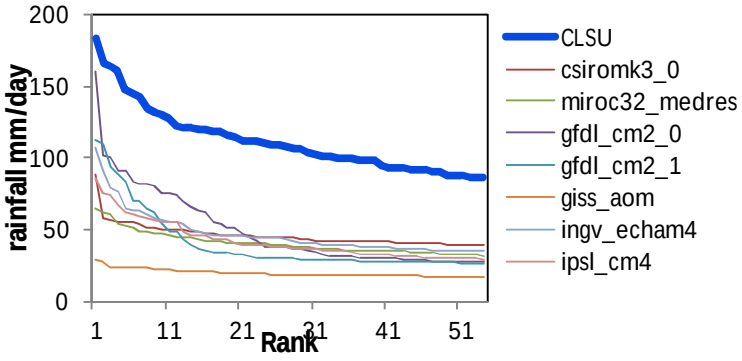
Provide usable knowledge and information to local policy makers for resilience society

(Decision making and planning for IWRM)

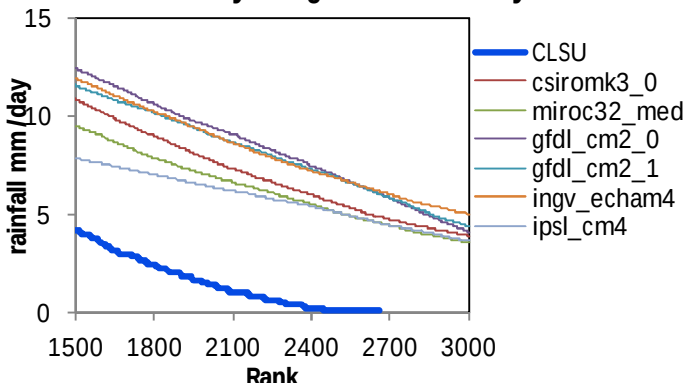
Bias in GCM

Extreme Value analysis

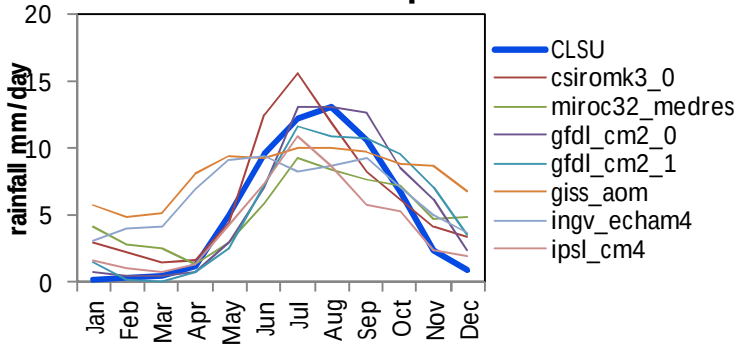
Extreme rainfall underestimation



Low intensity long drizzel rain day



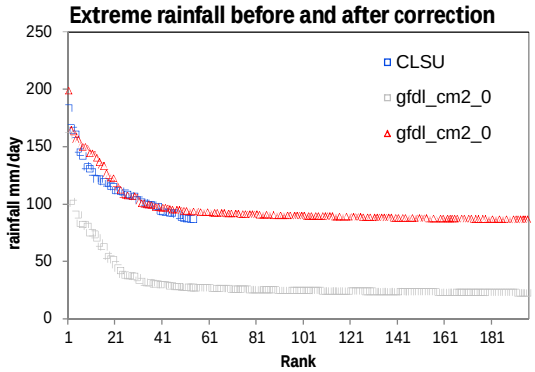
GCM seasonal rainfall pattern



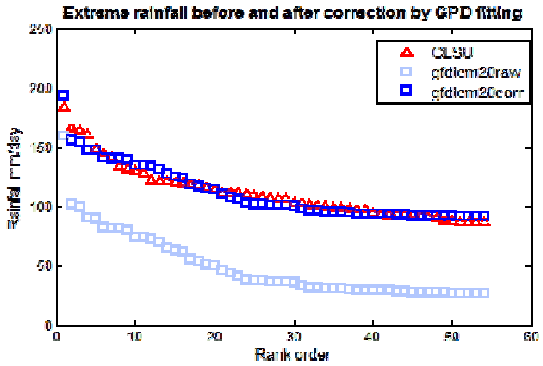
Annual maximum series
Gumble or Lognormal Distribution

Non every year statistics
Generalized Pareto Distribution

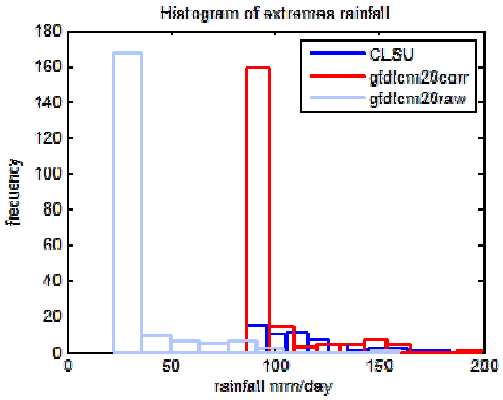
Extreme rainfall before and after correction



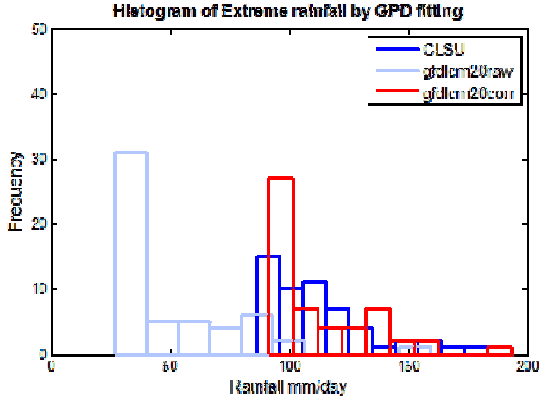
Extreme rainfall before and after correction by GPD fitting



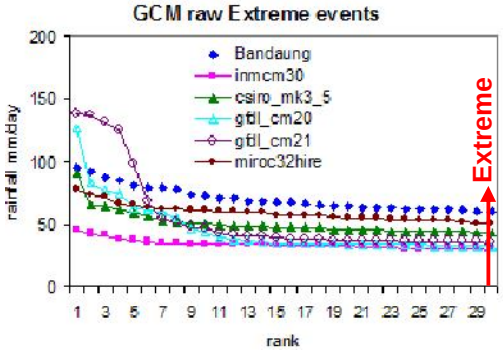
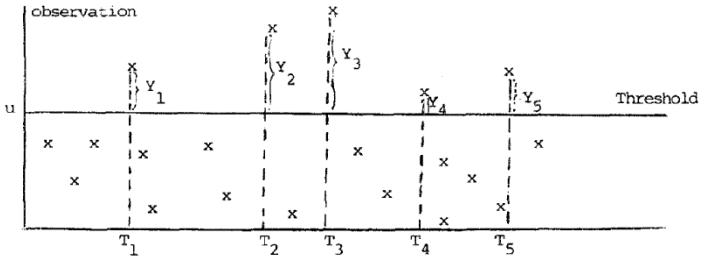
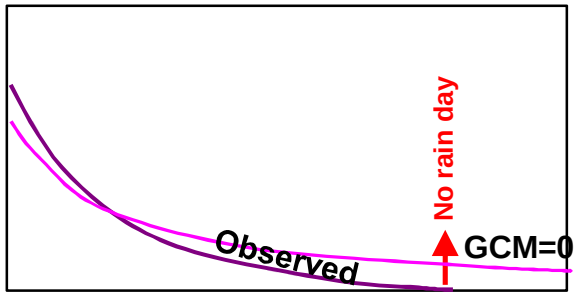
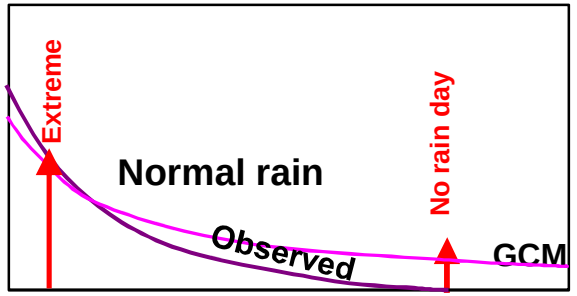
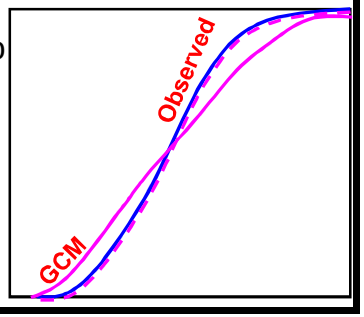
Histogram of extremes rainfall



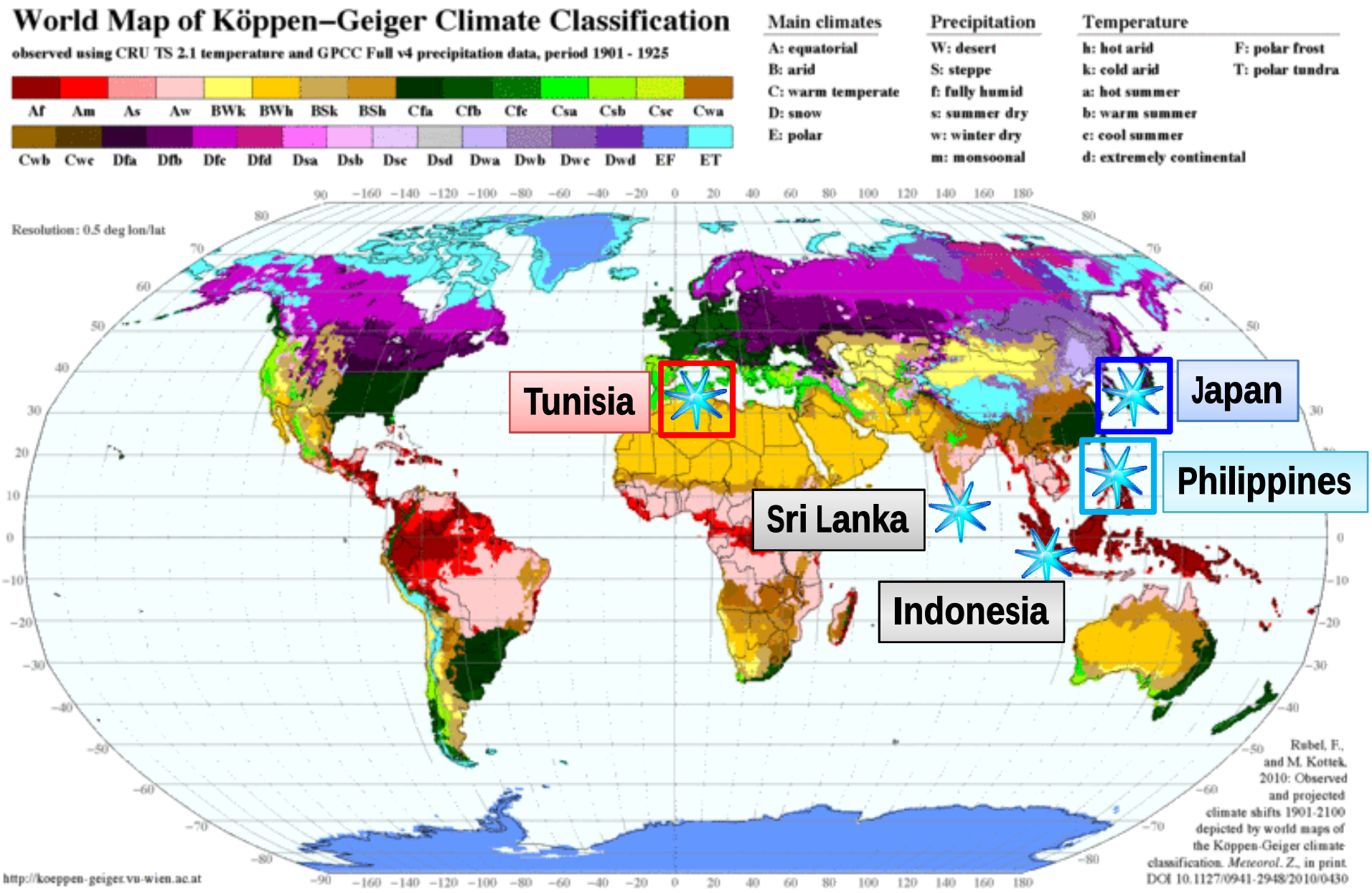
Histogram of Extreme rainfall by GPD fitting



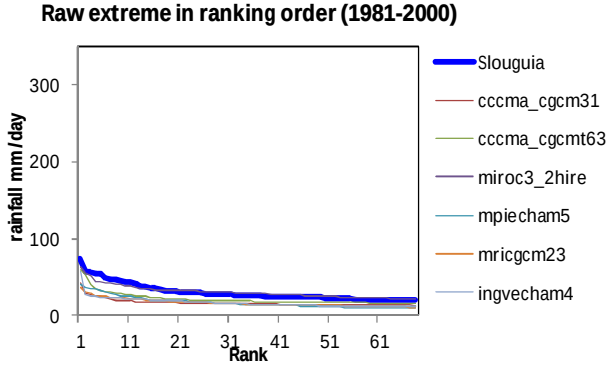
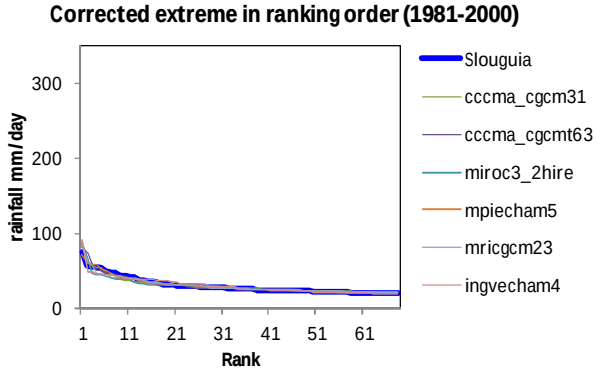
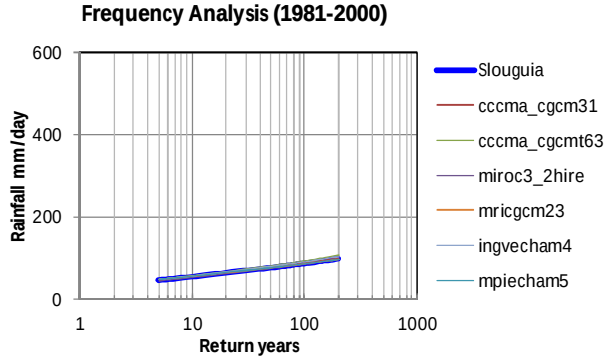
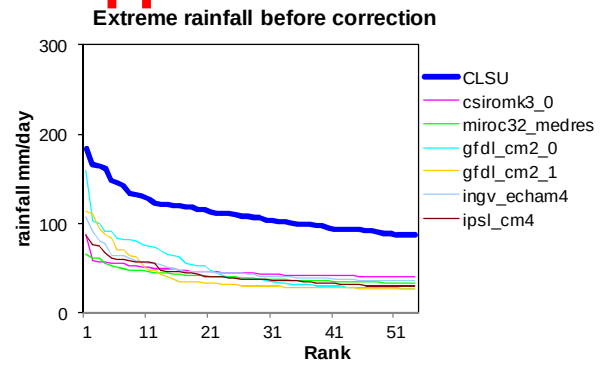
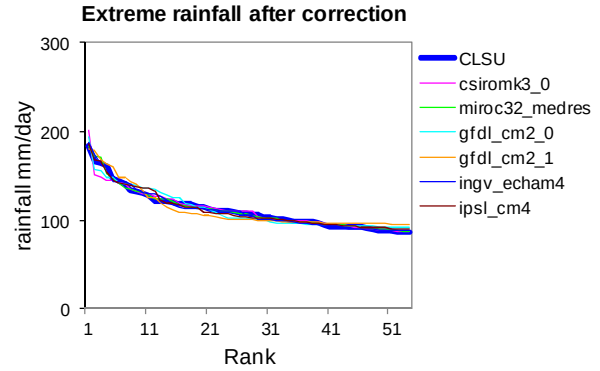
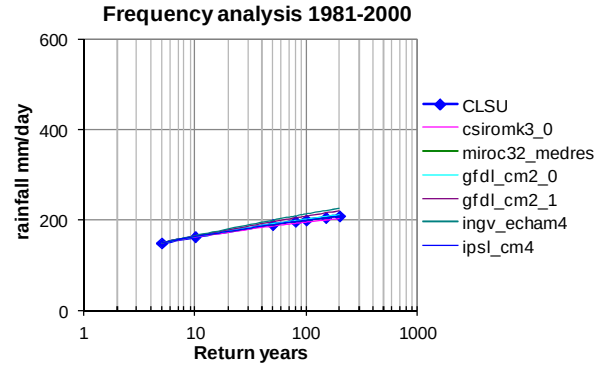
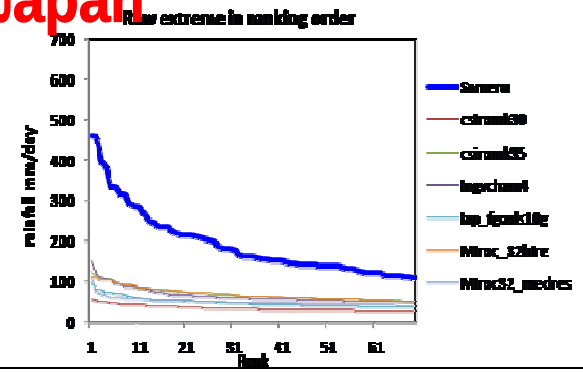
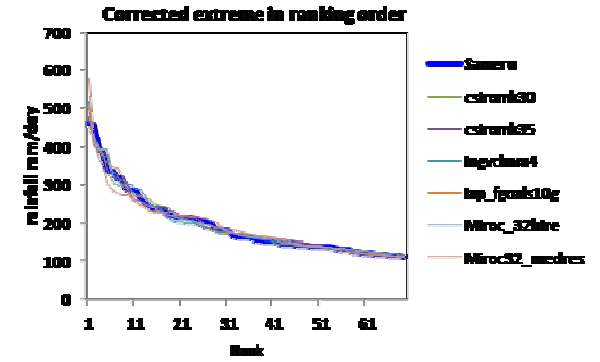
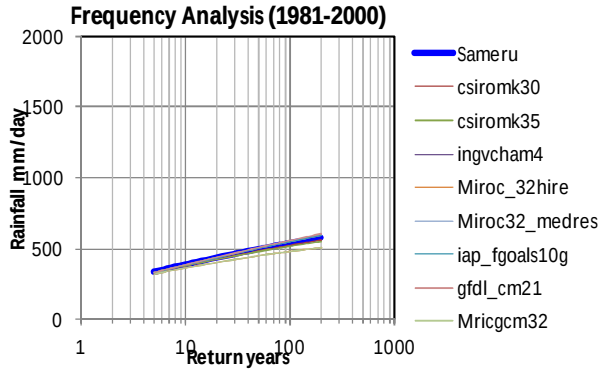
Bias Correction Scheme

Rain Type	Threshold	Correction
Extreme 	- > 99% of daily precipitation during analysis period - same frequencies of extreme as insitu station as in GCM 	**Generalized Pareto Distribution** -Non every year statistics -Extreme (long or short tailed) fitting -Peak over threshold method  Fig. 2. Illustration of threshold model.
No rain day 		**Ranking order statistics** - frequency of no rain day in GCM is same as station - less than no rain day threshold change zero rainfall.
Normal 		**Gamma Distribution** - monthly CDF of GCM mapping to monthly CDF of station - inverse of Gamma CDF in each month is corrected rain 

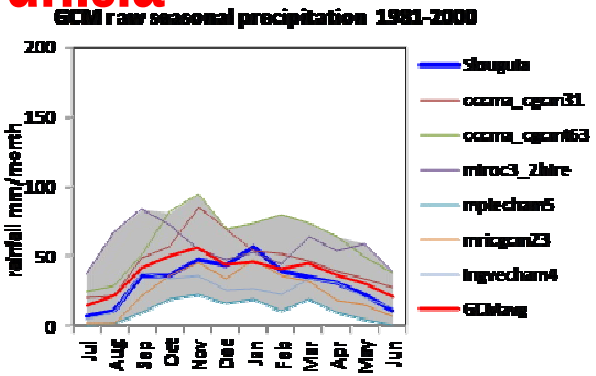
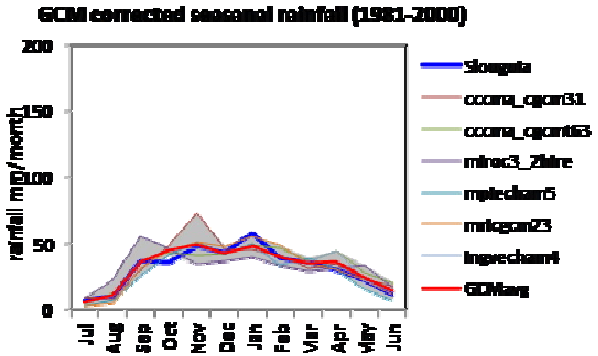
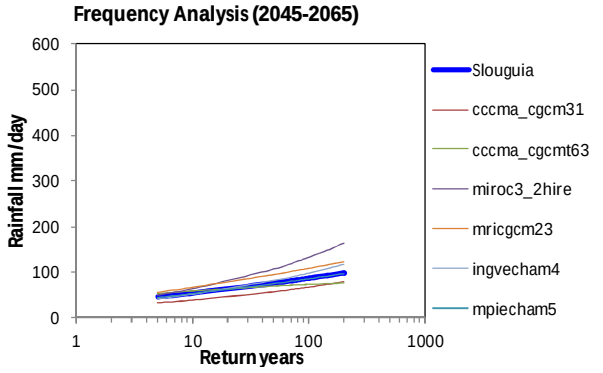
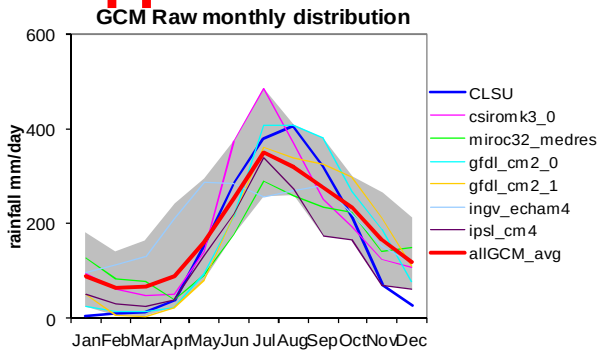
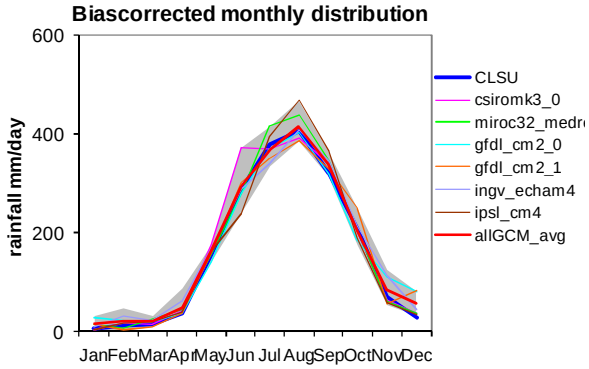
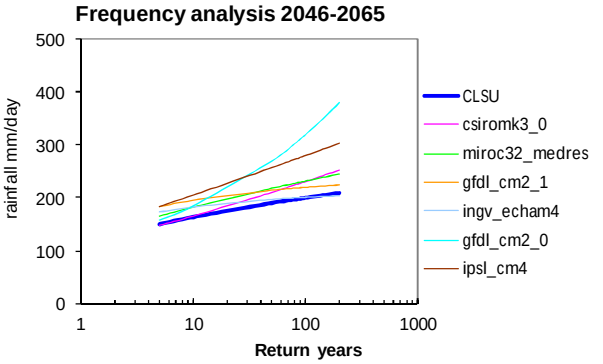
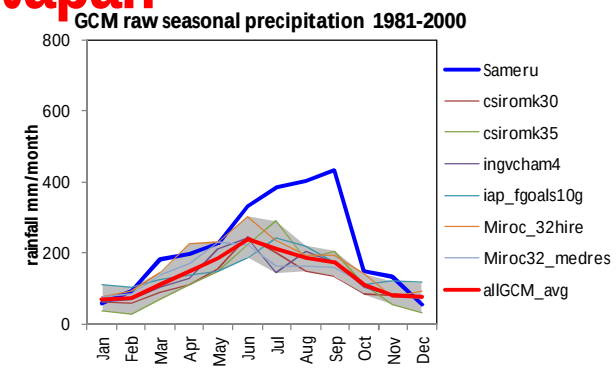
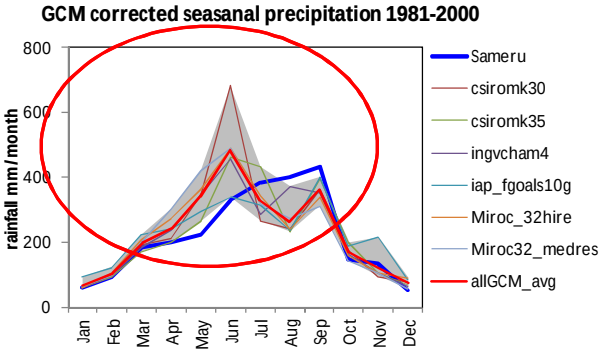
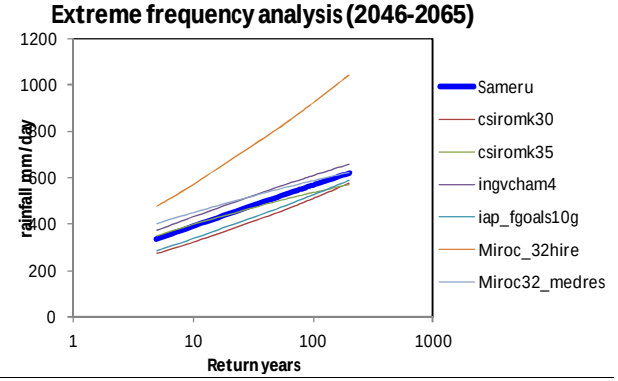
Application Bias Correction



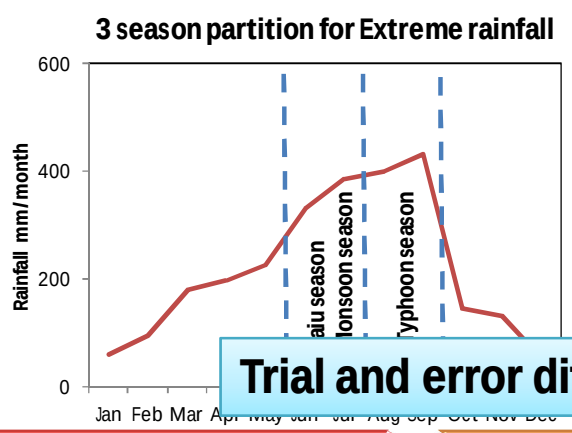
Validation Point Scale (Extremes)

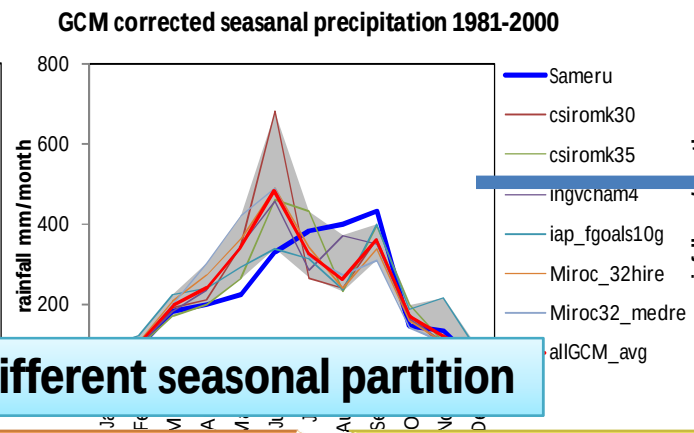
Before Bias-Correction	After Bias-correction	Extreme Frequency Analysis
Tunisia		
		
Philippines		
		
Japan		
		

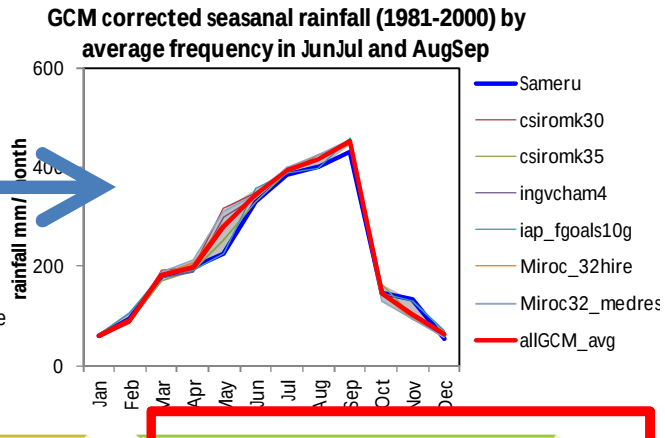
Validation Point Scale (Seasonal)

Before Bias-Correction	After Bias-correction	Future Extreme Frequency Analysis
Tunisia		
		
Philippines		
		
Japan		
		

Bias Correction Yoshino River (Japan)







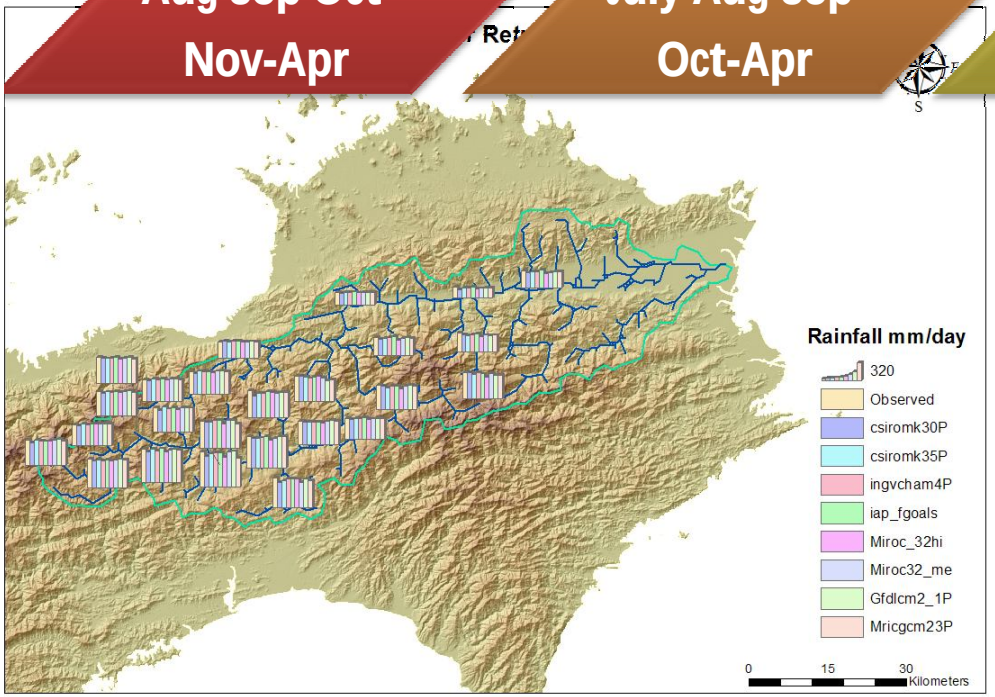
Trial and error different seasonal partition

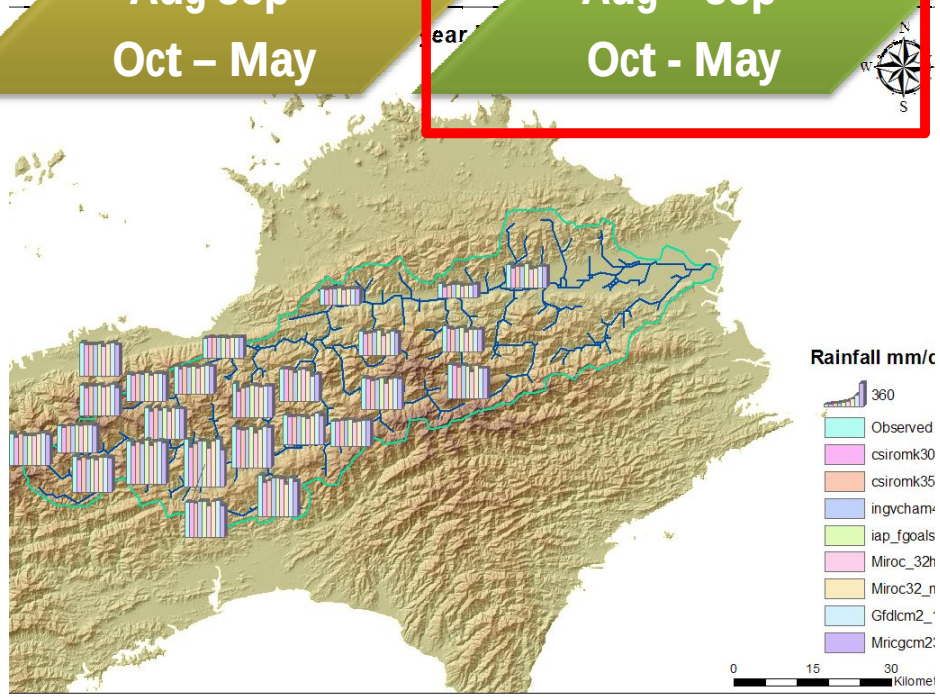
May Jun July Aug Sep Oct Nov-Apr

May Jun July Aug Sep Oct-Apr

June July Aug Sep Oct – May

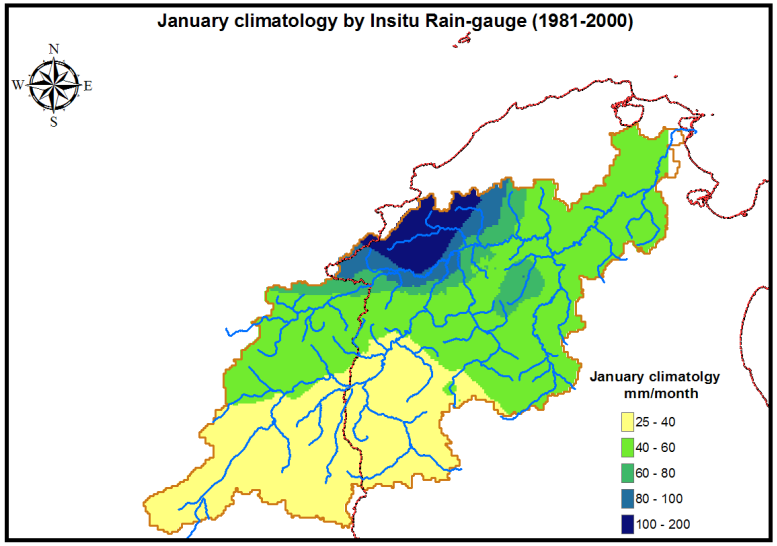
Jun = July Aug = Sep Oct - May



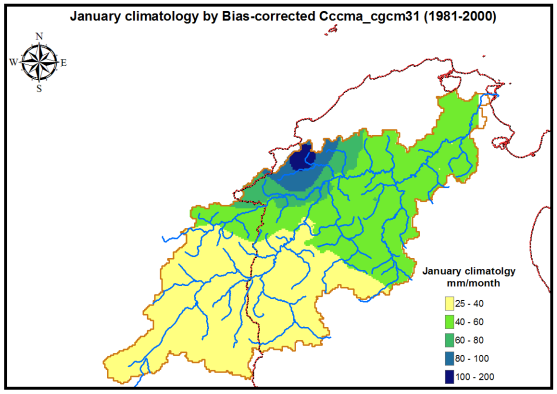


Validation Bain Scale

Tunisia
Medjerda River



Insitu Rain Gauge (Januray)



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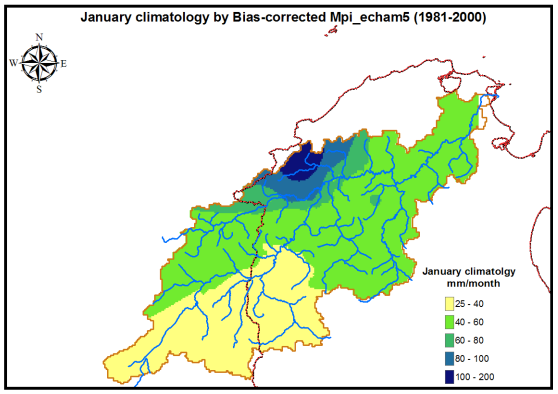

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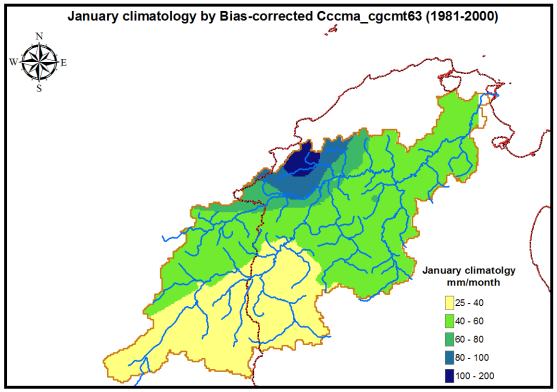

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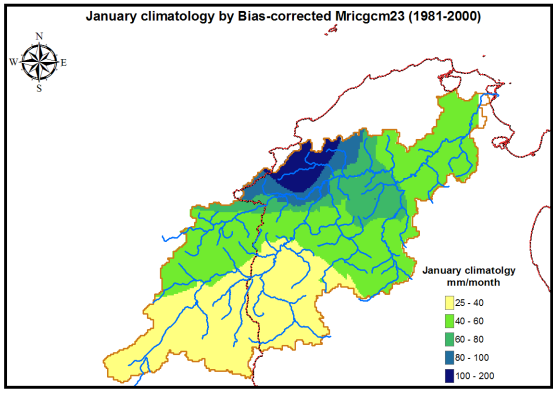

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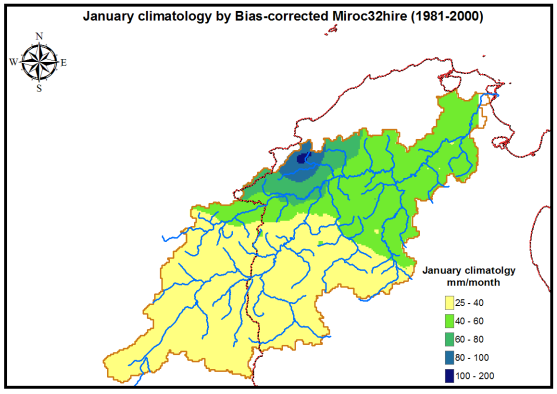
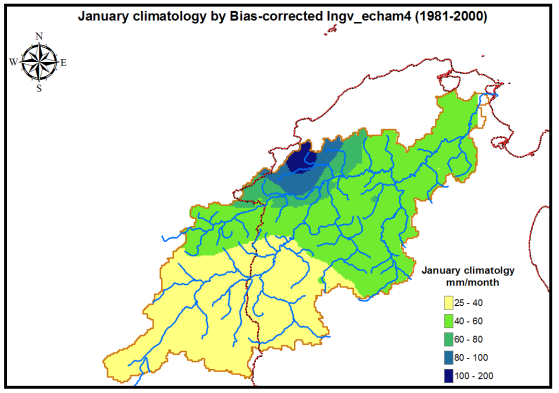


Miroc32_hires

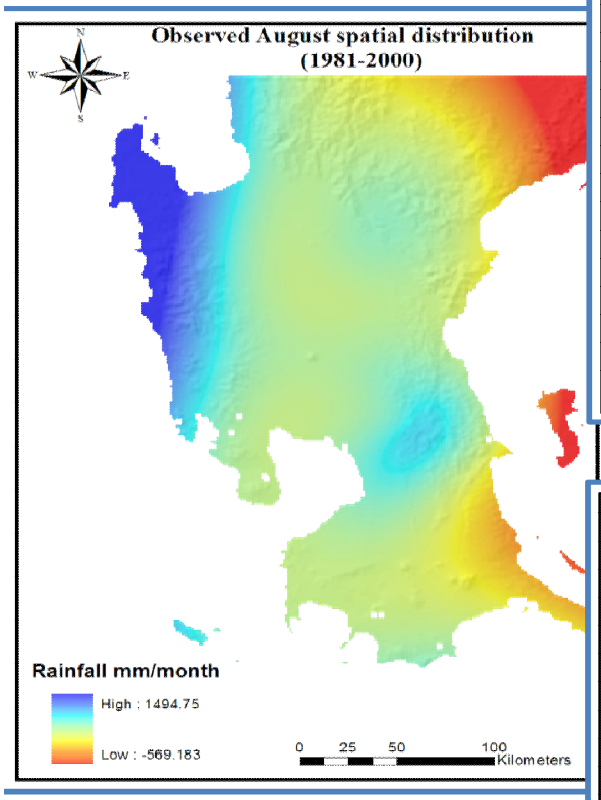


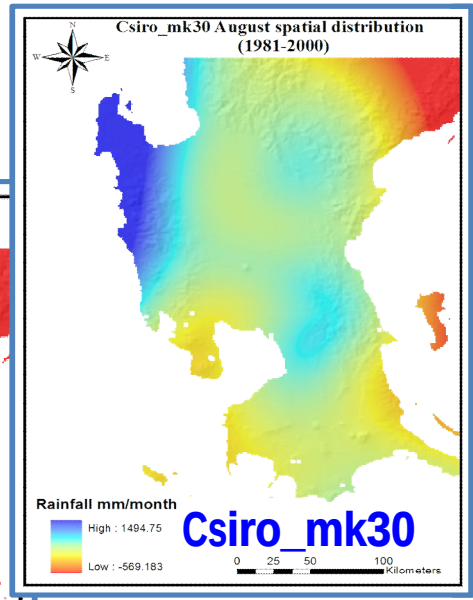
Ingv_ecnam4

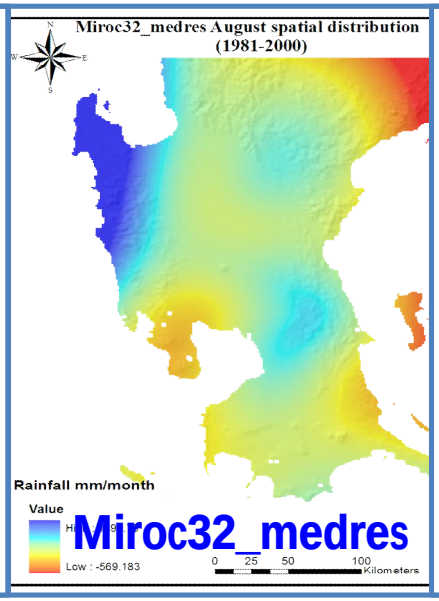
Validation Bain Scale (Climatology)

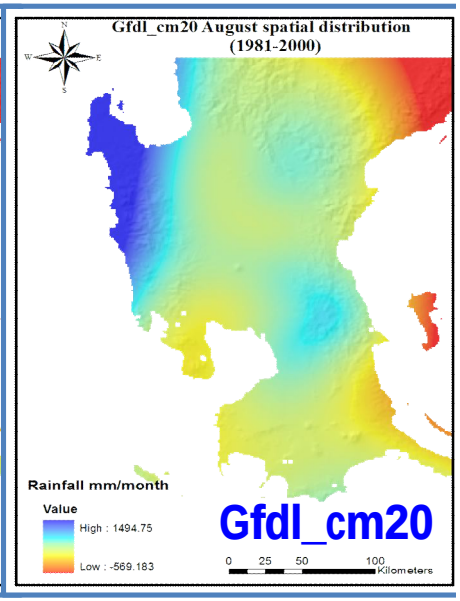
Philippines - Angat and Pampanga River

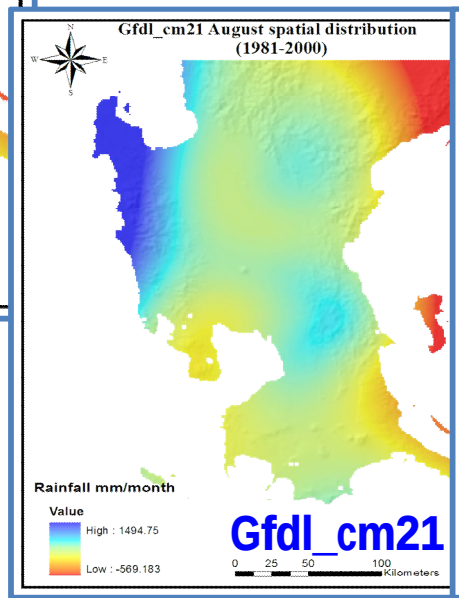
Observed (August)

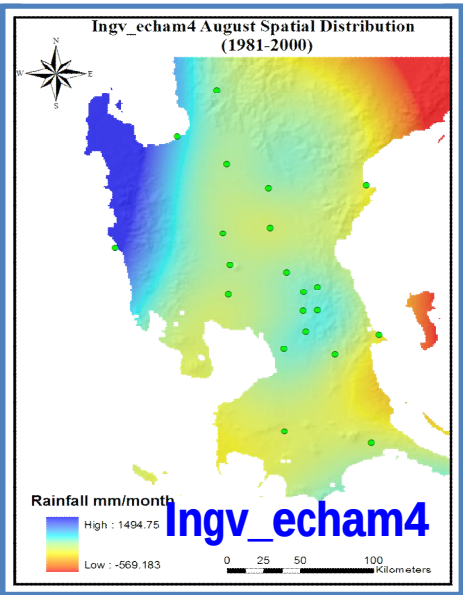


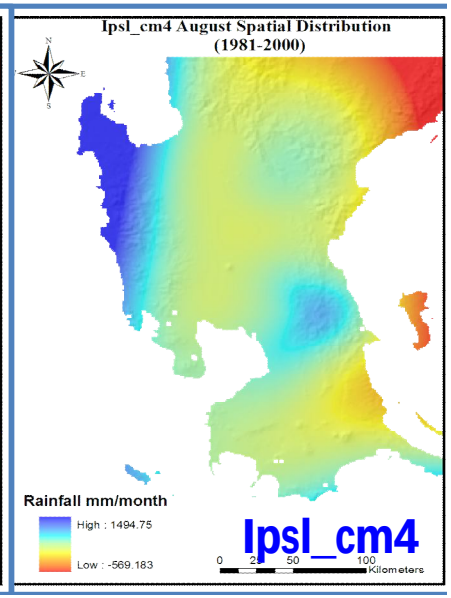






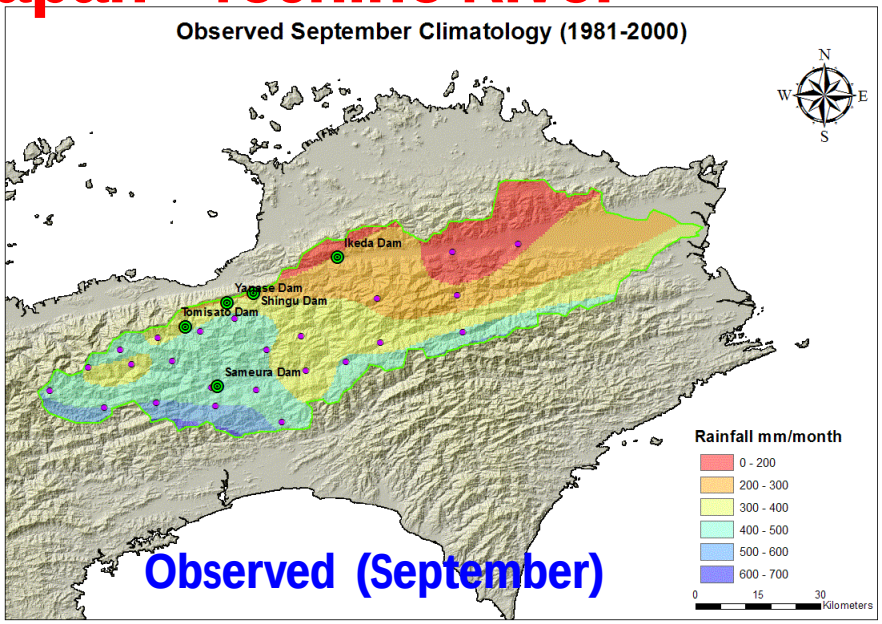


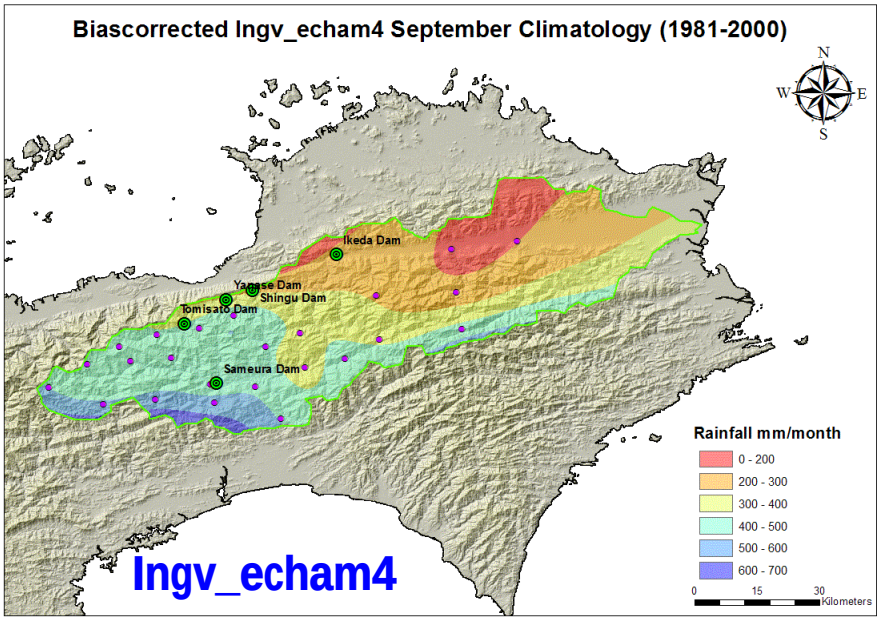


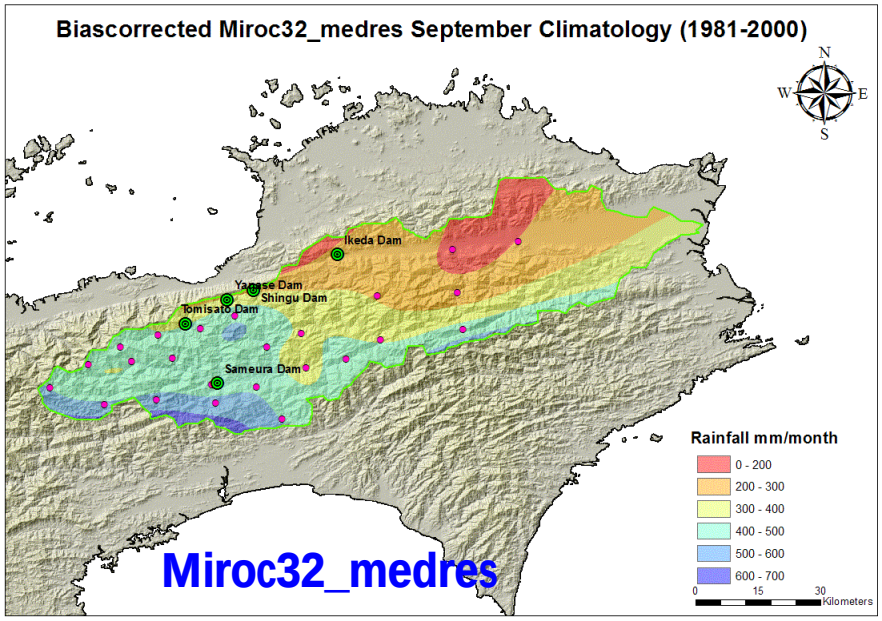


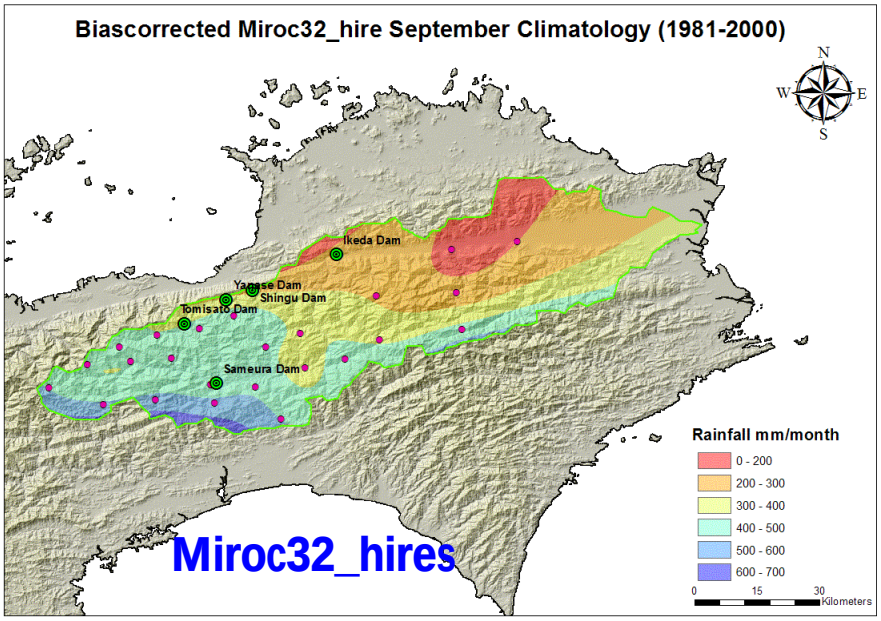
Validation Bain Scale (Climatology)

Japan - Yoshino River



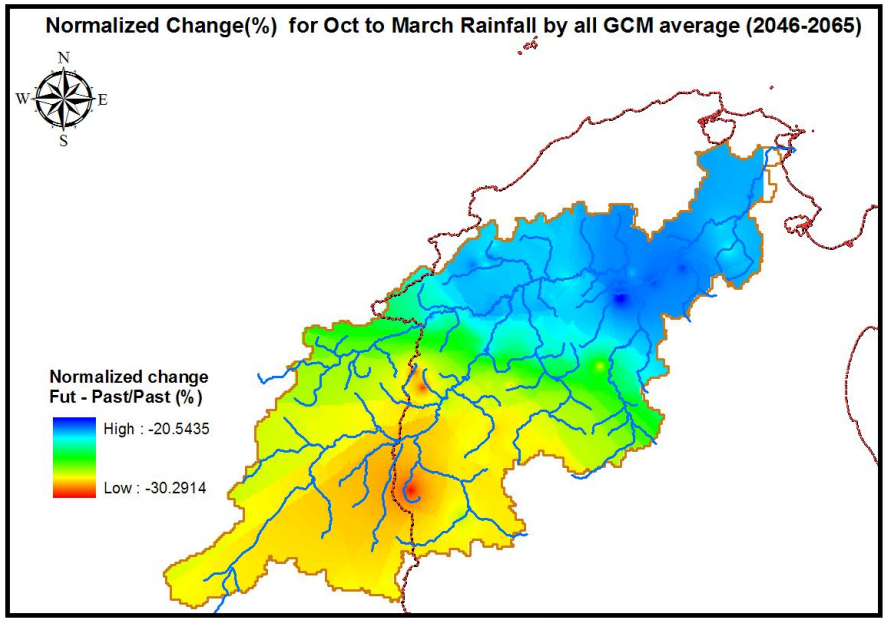


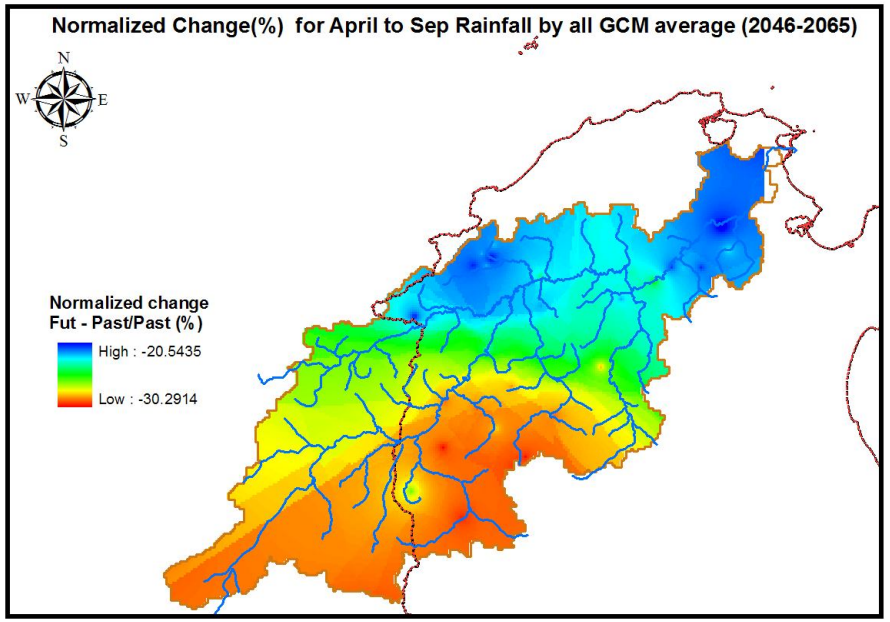


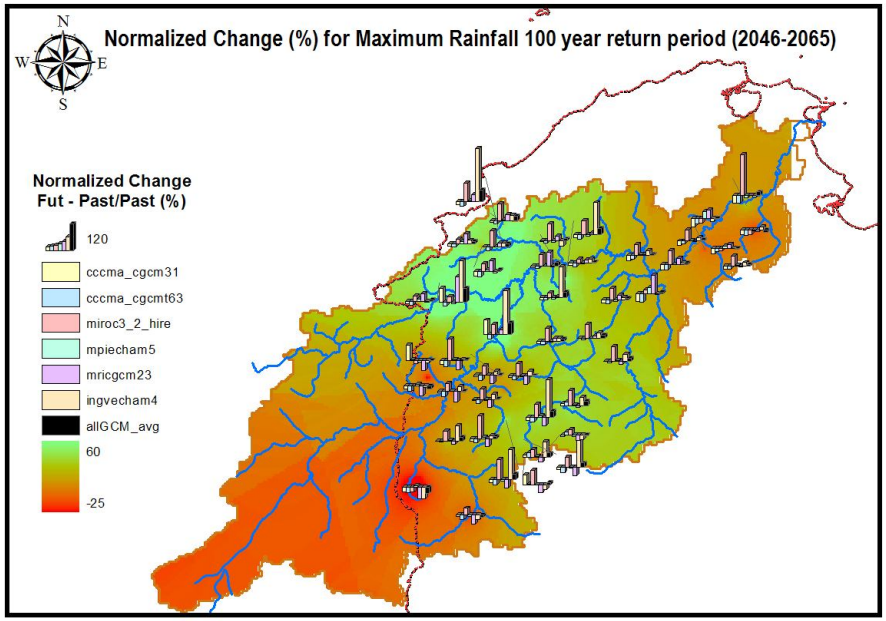


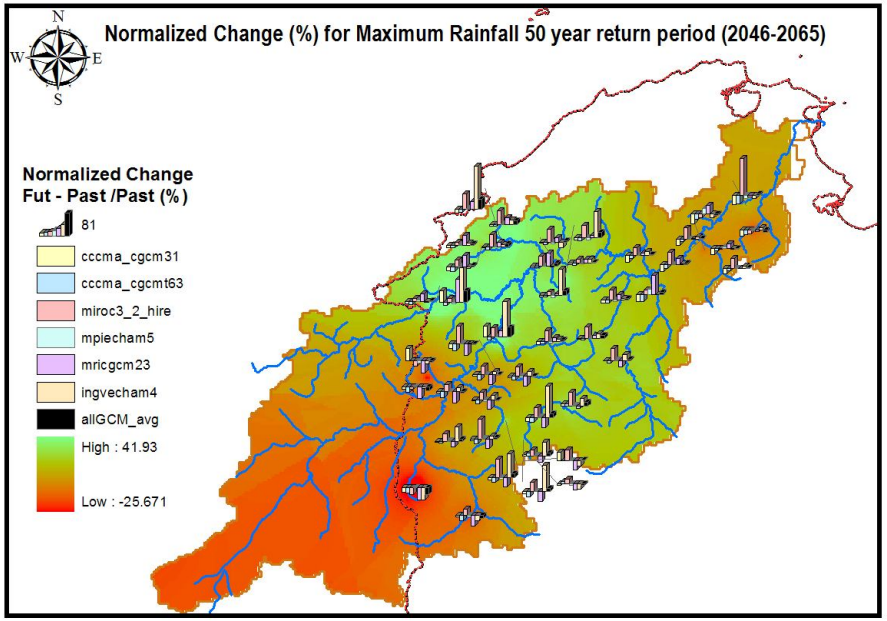
Projection Change in Bain Scale

Tunisia (Medjerda River)



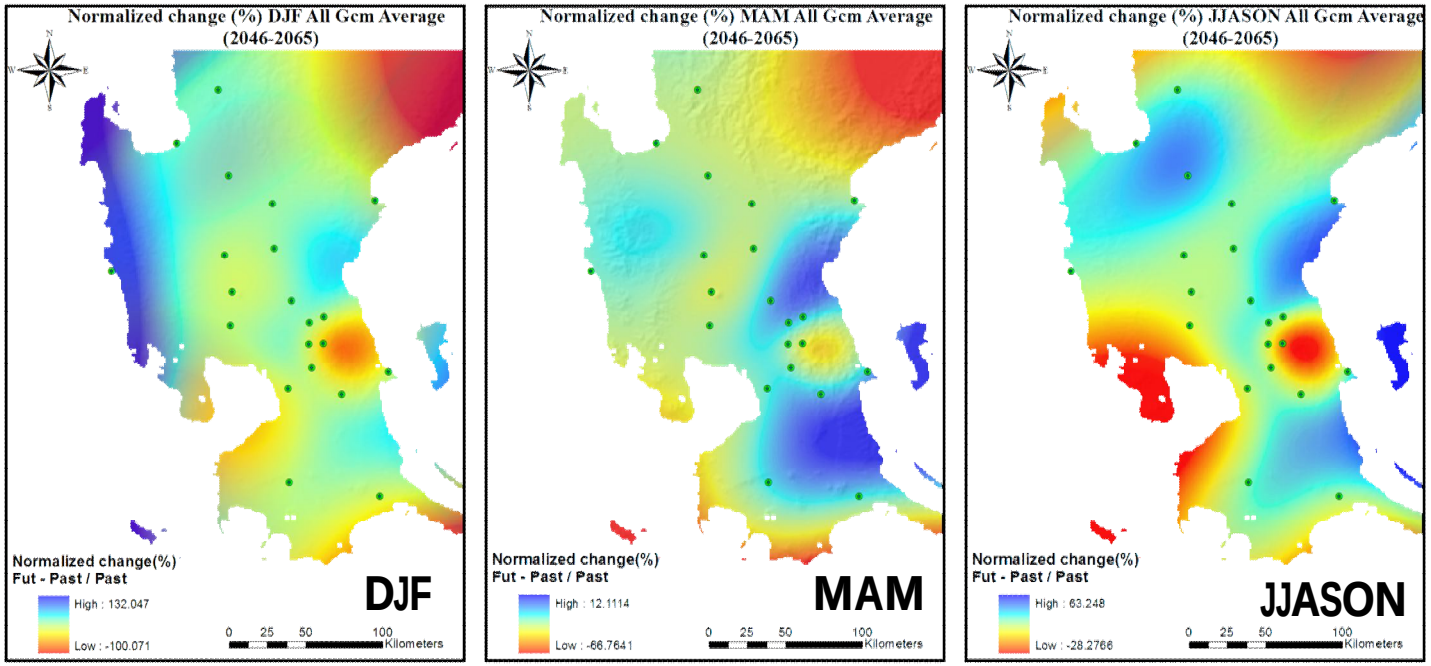




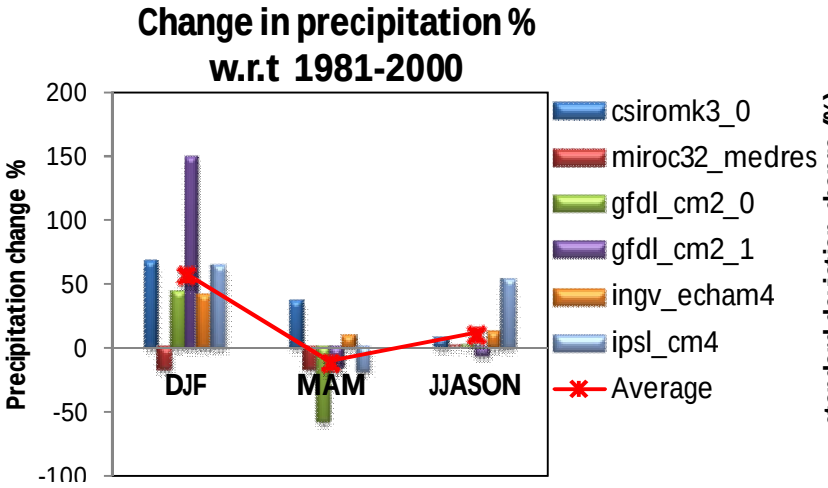


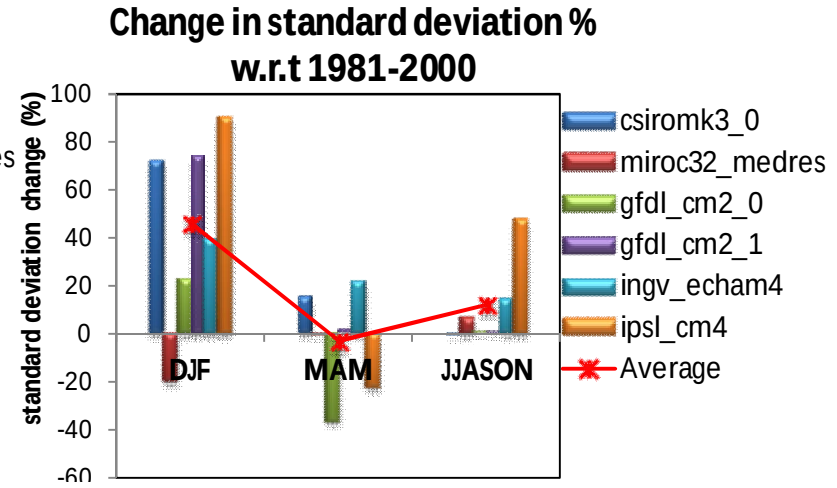
Seasonal Change in Bain Scale

Philippines - Angat and Pampanga River

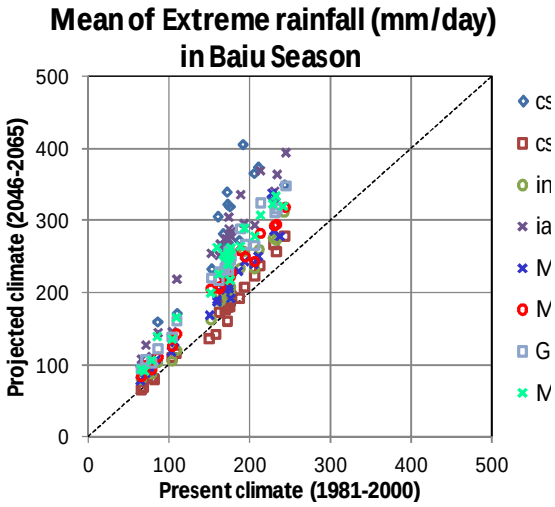


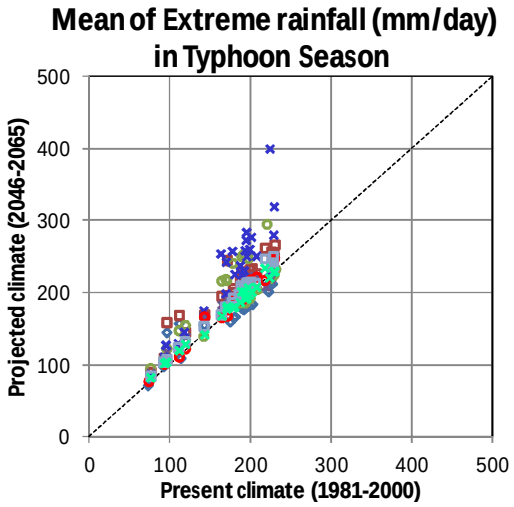
Central Luzon State University (CLSU)

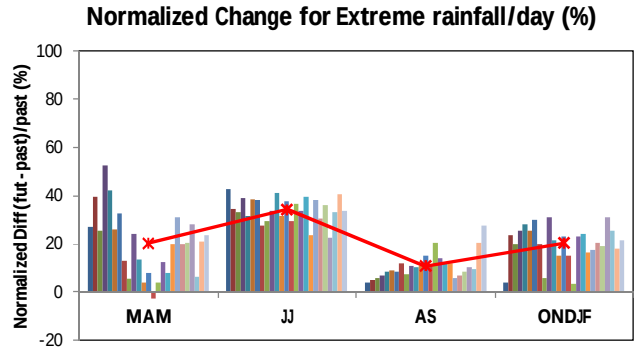


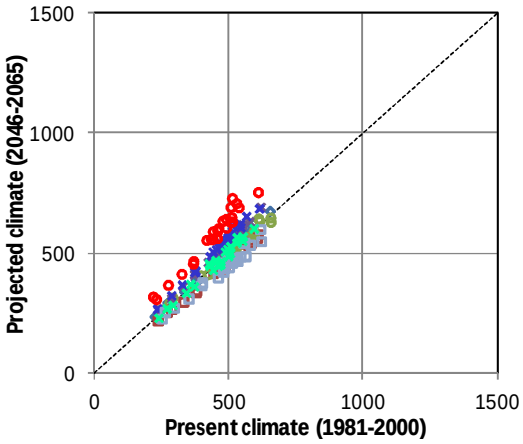


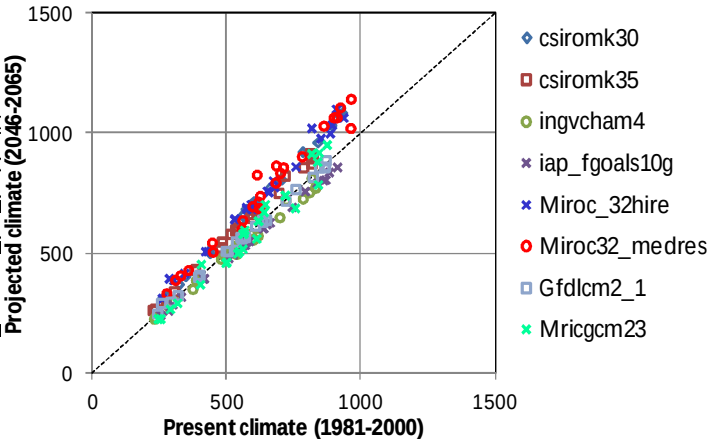
Japan - Yoshino River

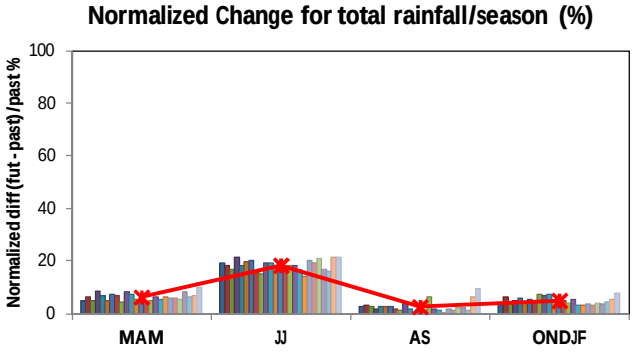












Downscaling or Spatial Disaggregation by GSMaP

Web Site Open (Since Nov. 2007)

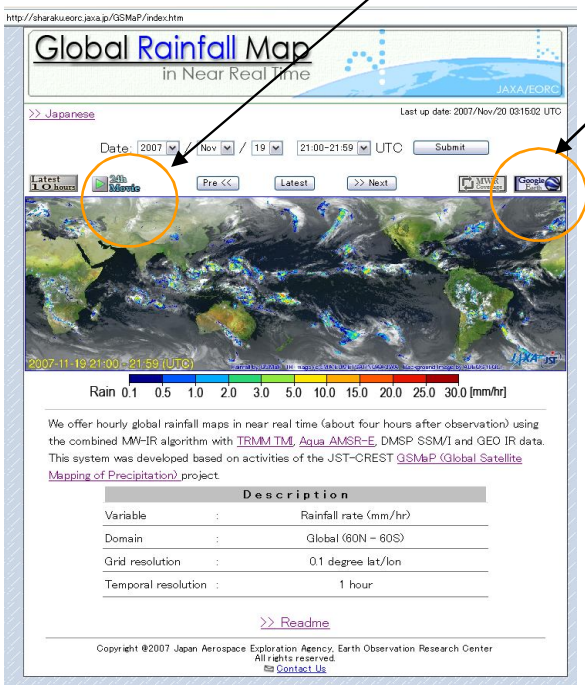
Global Rainfall Map in Near Real Time by JAXA/EORC

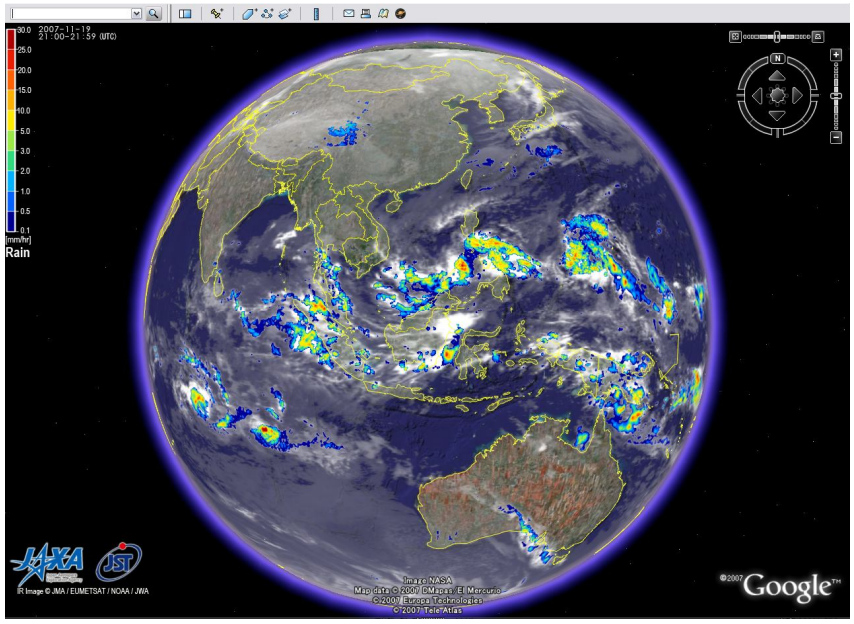
http://sharaku.eorc.jaxa.jp/GSMaP/

We have started to release hourly global rainfall data (0.1x0.1deg. lat/lon) in near real time (about four hours after observations) and visualize the latest data quickly.

Movie Button

Google Earth Button

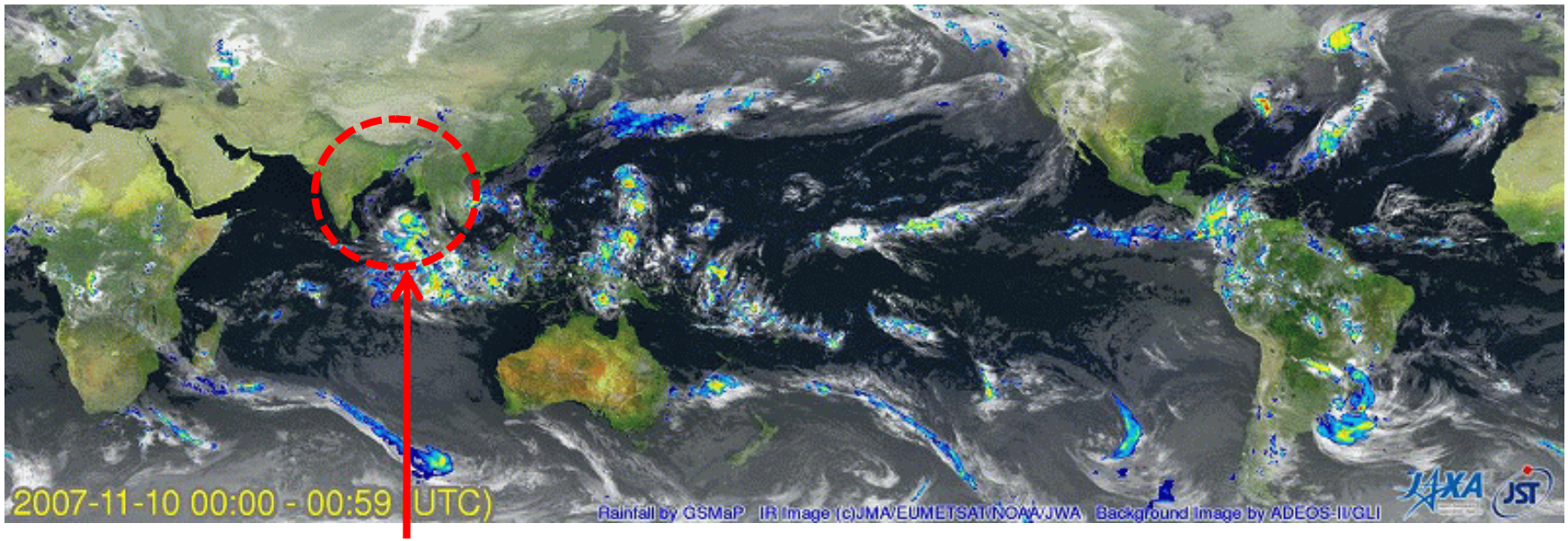




Examples of the global rainfall maps

Global rainfall maps (overlapped with IR images) in the Near-Realtime system

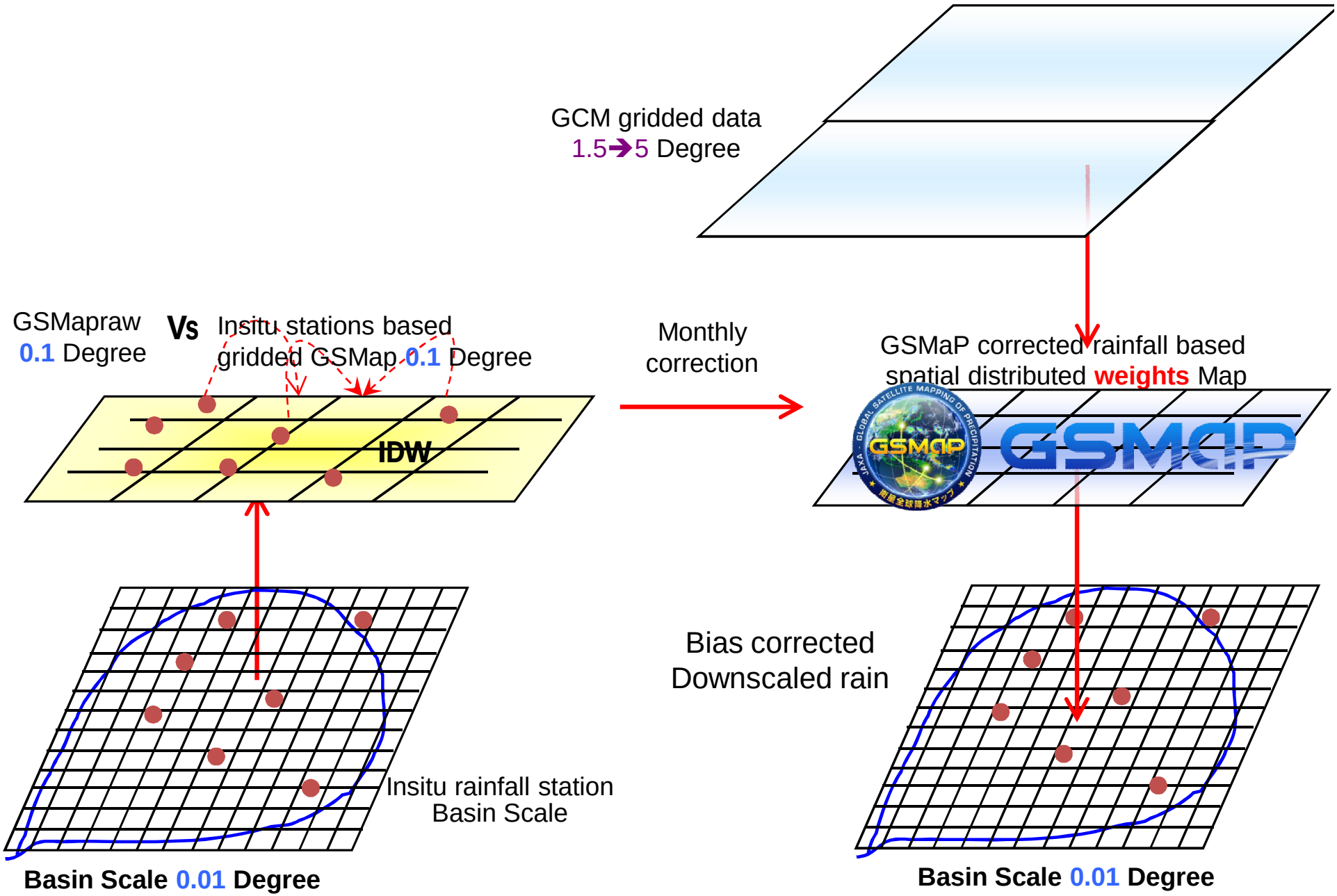
Animation from 10th to 16th November 2007



A cyclon “SIDR” hit the coast of Bangladesh from the Bay of Bengal.

A movie made using figures in http://sharaku.eorc.jaxa.jp/GSMaP/

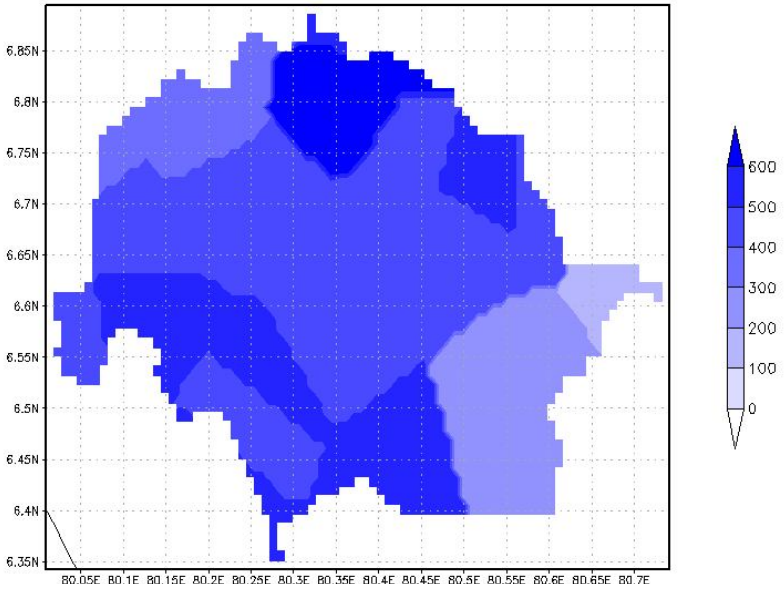
Monthly Downscaling Scheme



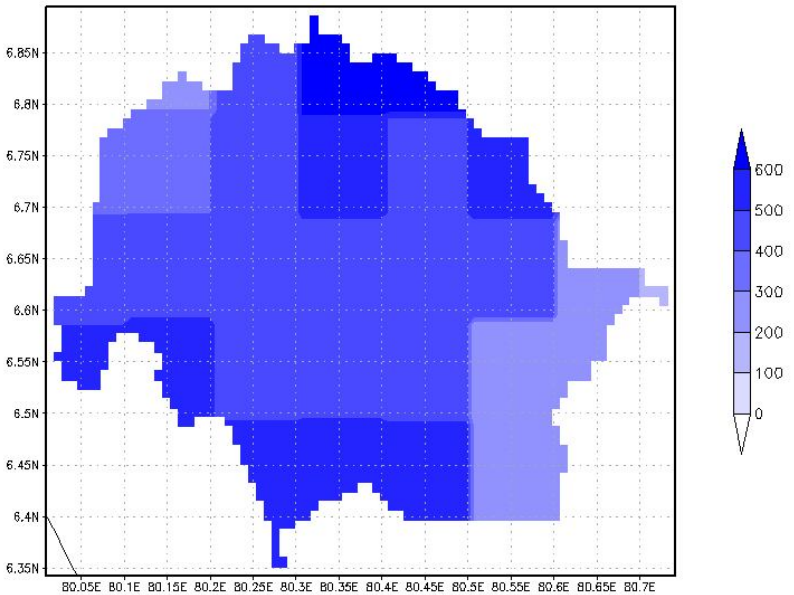
Observed Climatology

GSMaPcorrected Climatology

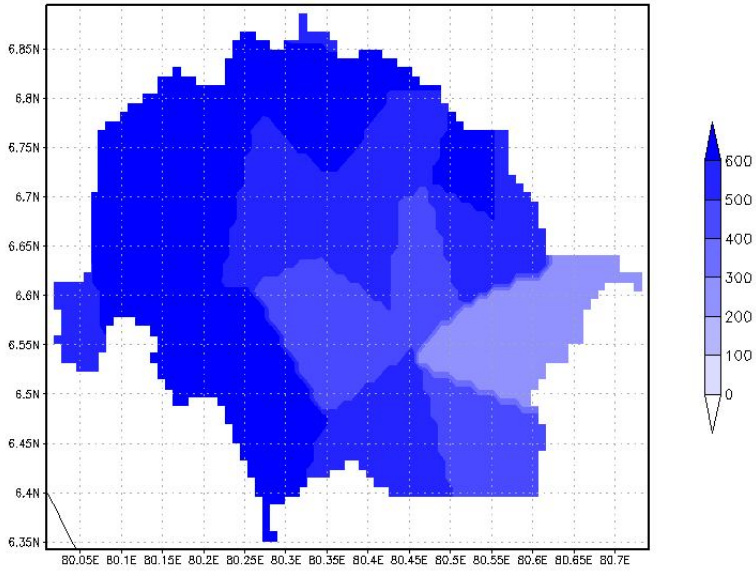
MAYclimatology 2003–08



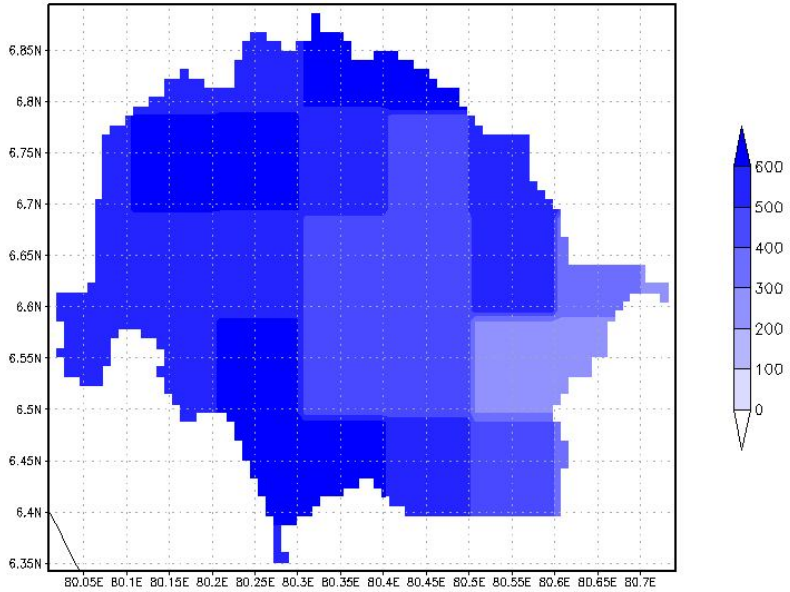
MAY GSMap corrected 2003–08



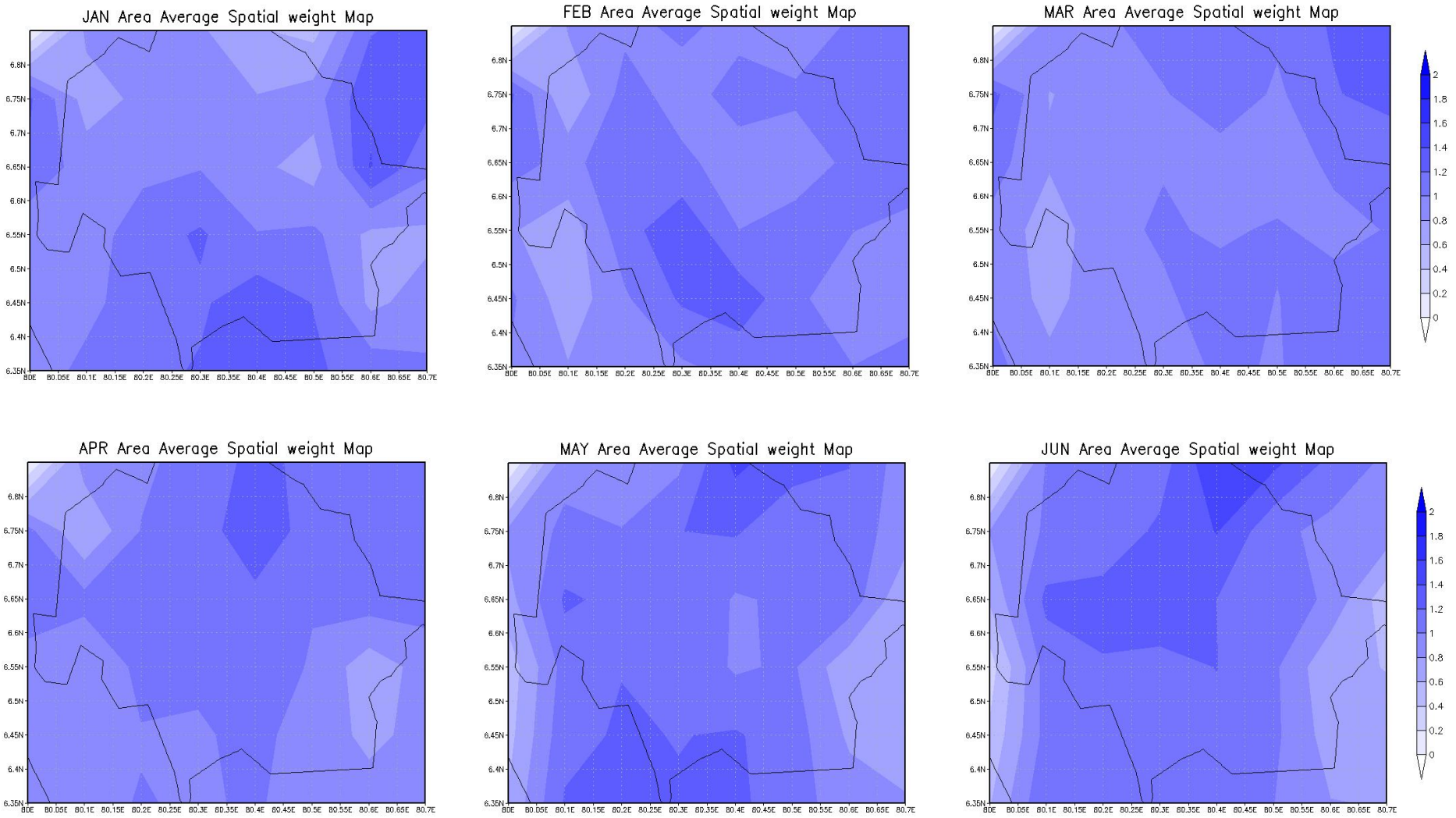
OCTclimatology 2003–08



OCT GSMap corrected 2003–08

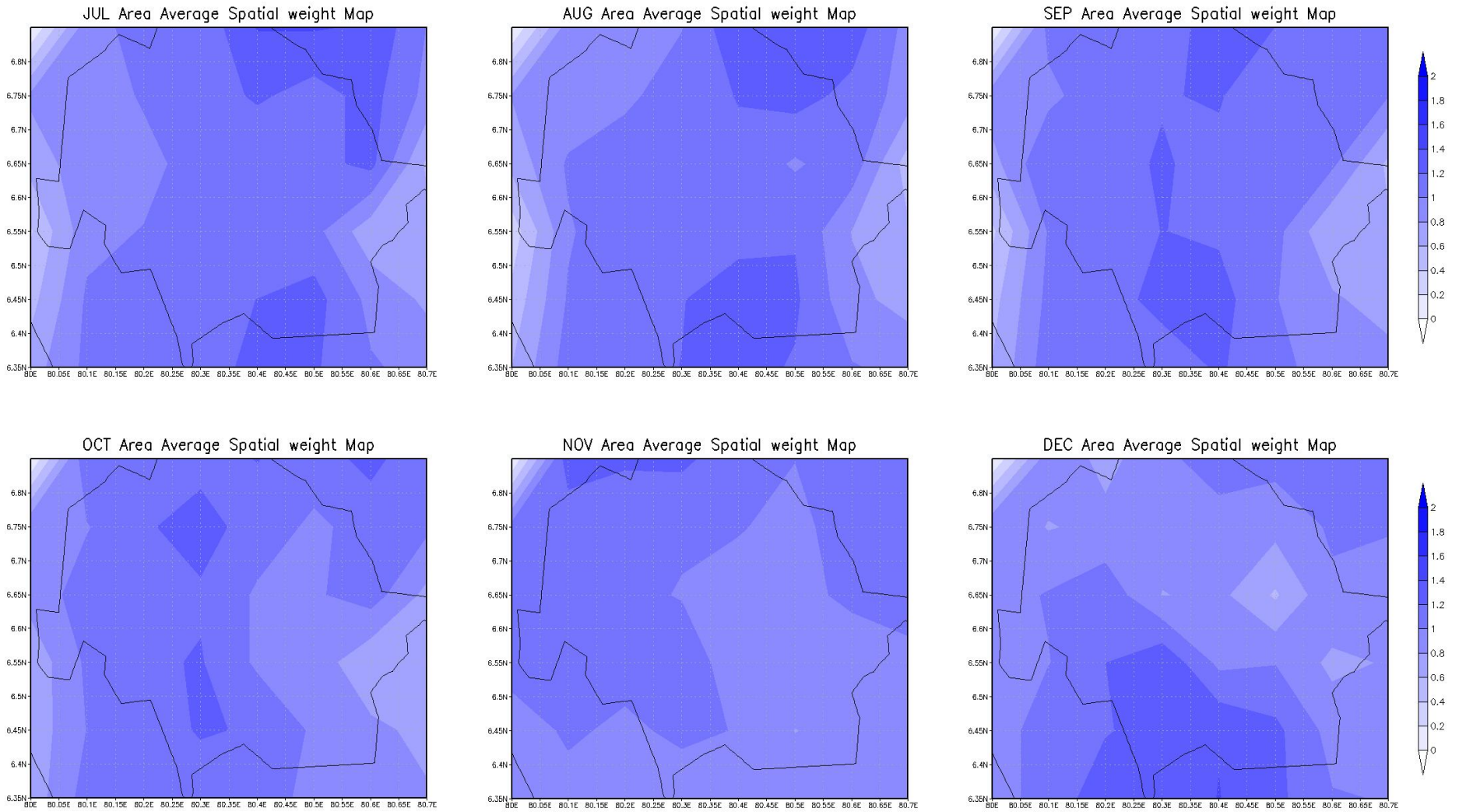


Monthly Downscaling Scheme



Basin Area Average Spatial Distribution Map

Monthly Downscaling Scheme



Basin Area Average Spatial Distribution Map

Downscaling or Spatial Disaggregation

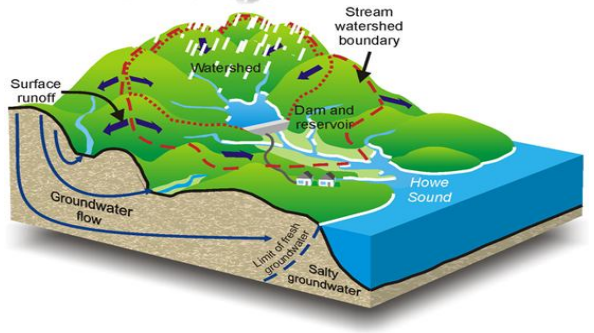
GCM gridded data

Bias corrected GCM Gridded data

Downscaled weight Map From GSMaP

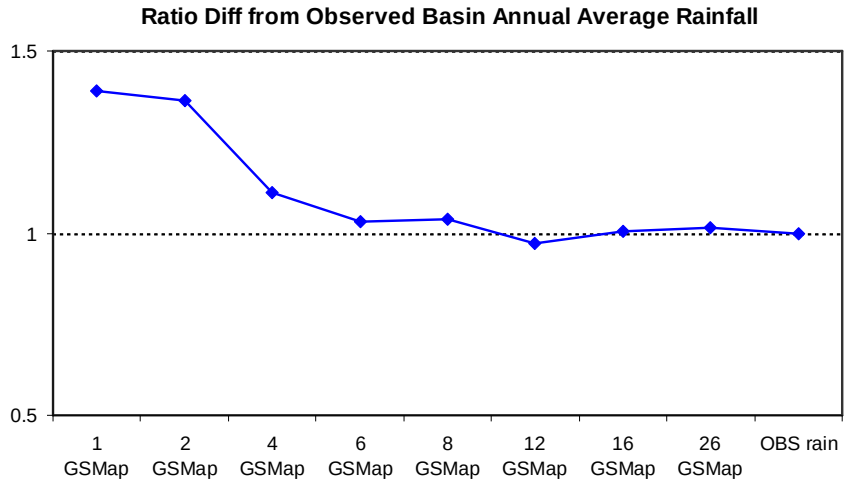
Insitu rainfall Basin Scale

Hydrological Model (WEB-DHM)

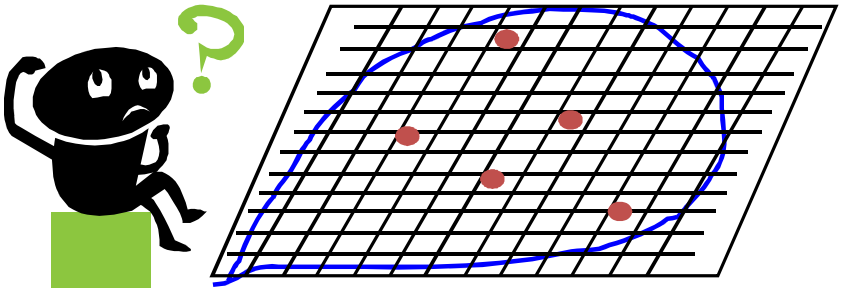


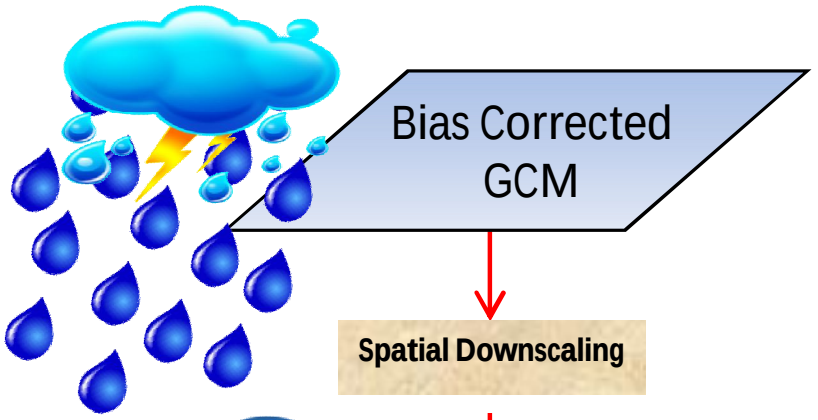
High temporal and Spatial Downscaling

Checking Sensitivity of Numbers of Rain gauges

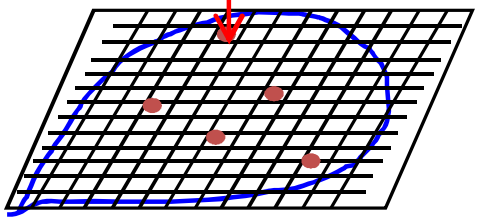


How about performance in
Poor Rain Gauge Basin ?



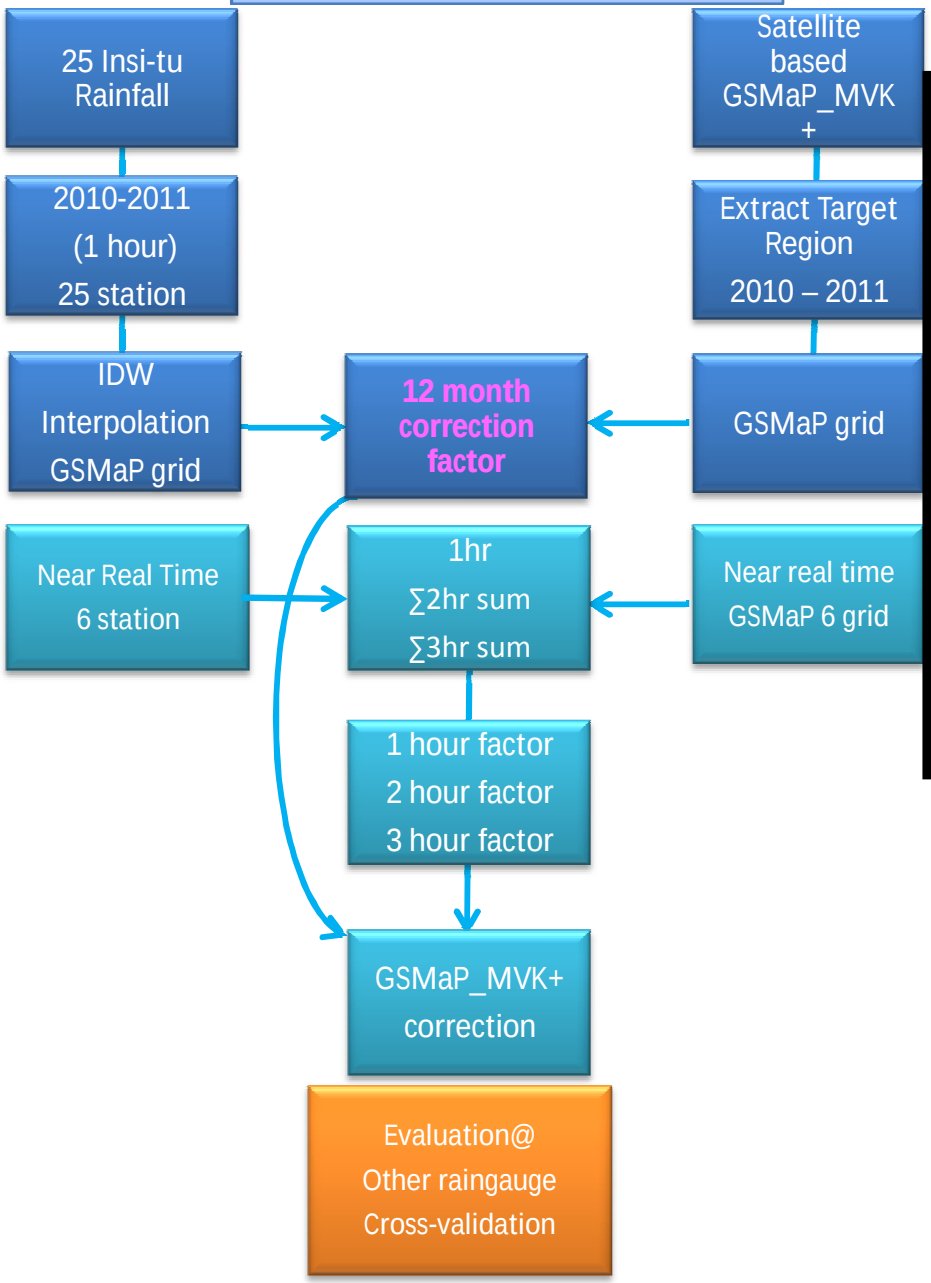


Extreme Rainfall Distribution?

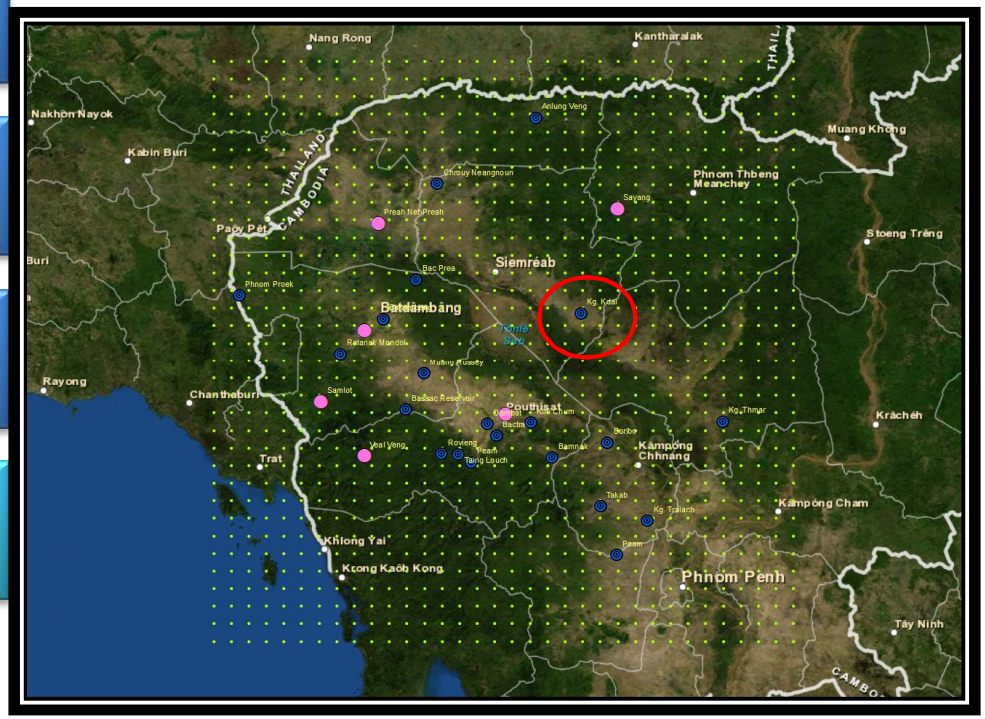


Basin Scale 0.01
Degree

GSMaP Bias Correction



Cambodia (Tone sap Lake Area)

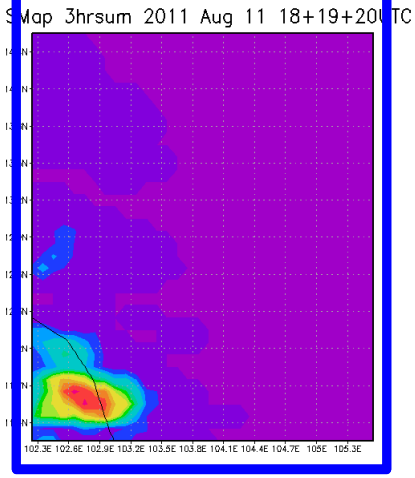


- Near real time stations
- 25 station(2010-2011)
- GSMaP grid center

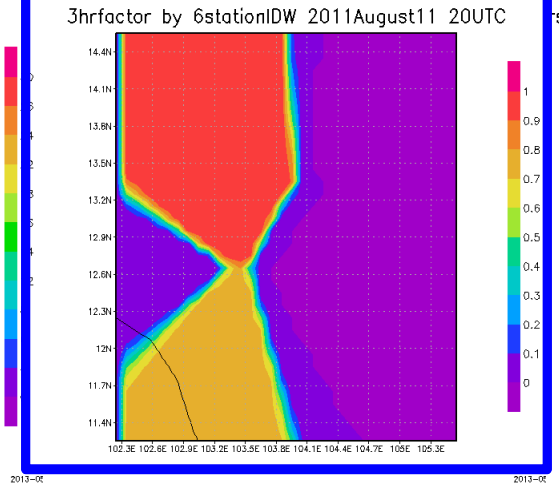
3 hourly & Daily downscaling scheme

GSMaP

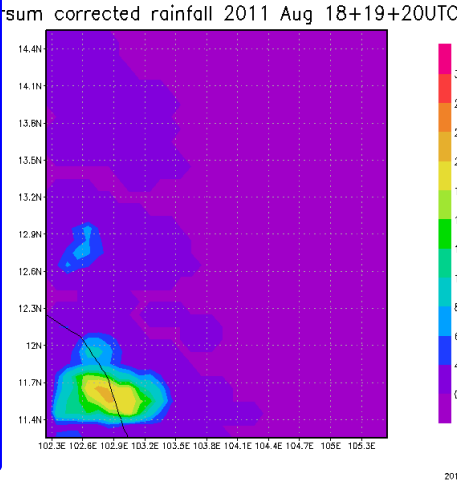
∑3hr



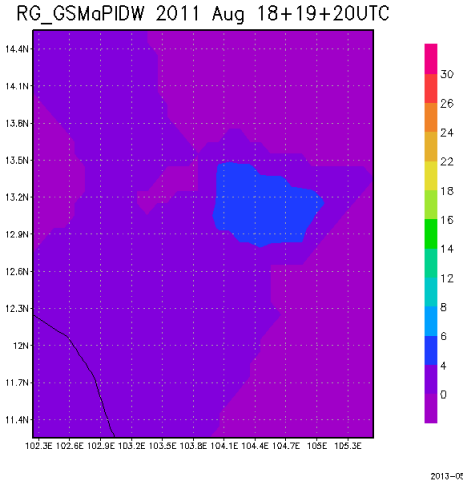
3hrfactor_6stationIDW



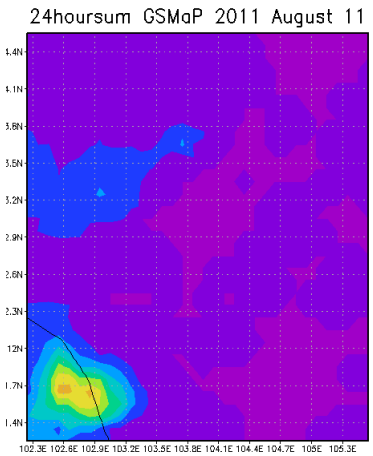
Corrected GSMaP

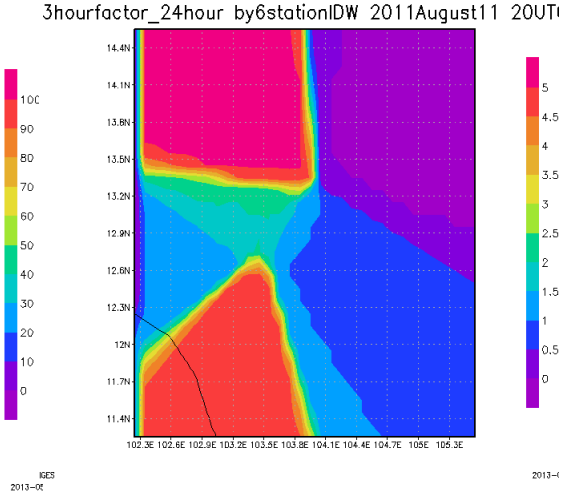


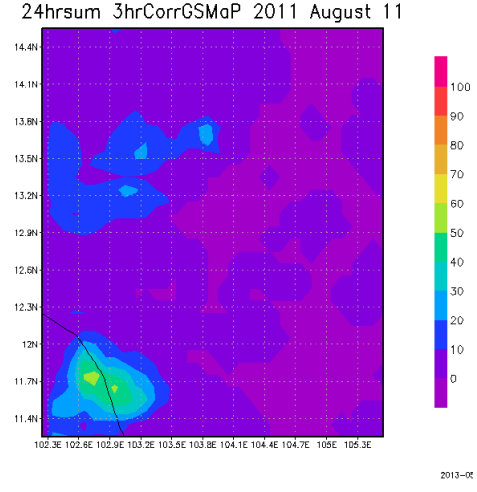
25Gauge IDW Rain

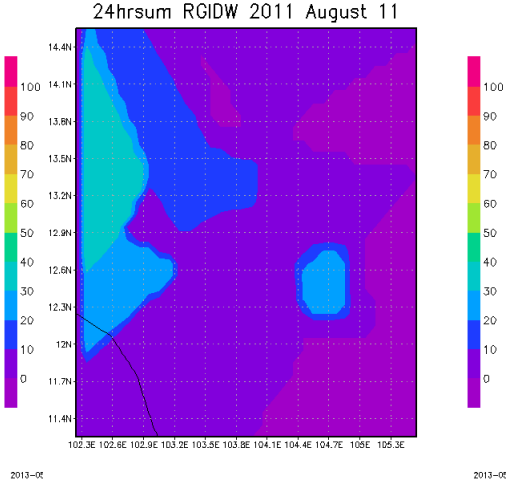


∑24hr









Conclusion

- Multi-model GCM selection method and a comprehensive and effective statistical bias correction method have been developed for the climate change study of a gauging model.
- The method have been validated its applicability through different river basin under various climate in the world such as semi arid, tropical monsoonal climate and temperate humid climate.
- High temporal and spatial downscaling approach is established by using satellite data , GSMaP, for downscaling of precipitation in the basin with poor rain gauge network.

Thanks for your attention

Acknowledgement: This research was carried out as a part of Research Program on Climate Change Adaptation (RECCA), Data Integration and Analysis System (DIAS) and EDITORIA science team. This Ph.D. study was supported by Ministry of education, culture ,sports, science and technology Japan (MEXT).