A Study on Bias Correction Method for Runoff Generation Data based on Reference Data Created by Land Surface Model

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Outline

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- Methodology
- Simulation Design
- Bias Correction for Runoff Generation Data
- Revision of Bias Correction
- Conclusion

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Introduction -Background

- In recent years, it has been said that **climate change** has an impact on hydrological cycle and water resources.
- To estimate the impact of global climate change, we generally use **GCM(General Circulation Model)** output.
- Although there are considerable improvements in GCM outputs, the outputs still suffer from **systematic errors, or biases**.
- It is effective to **correct biases of GCM outputs** for improving reliability of climate prediction.

Introduction -Background

- However, compared with bias correction for precipitation and temperature, there are **few studies on bias correction related to river discharge**.
- Bias correction method for the MRI-AGCM3.2S 3-hourly runoff generation data **using reference data created by land surface model SiBUC** was initially proposed by Duong(2014).
- Though the correction showed an improvement on river discharge, Duong pointed out **further works needed to be done**.

Introduction -Objectives

- The purpose of this study is to **revise bias correction method** for runoff generation data and **simulate river discharge more precisely**.
- In this study, bias correction is performed for the **MRI-AGCM3.2S**, which is a kind of GCM developed by MRI (Meteorological Research Institute), 3-hourly runoff generation by following Duong's study and the effect of bias correction is evaluated by simulating river discharge utilizing flow routing model 1K-FRM.

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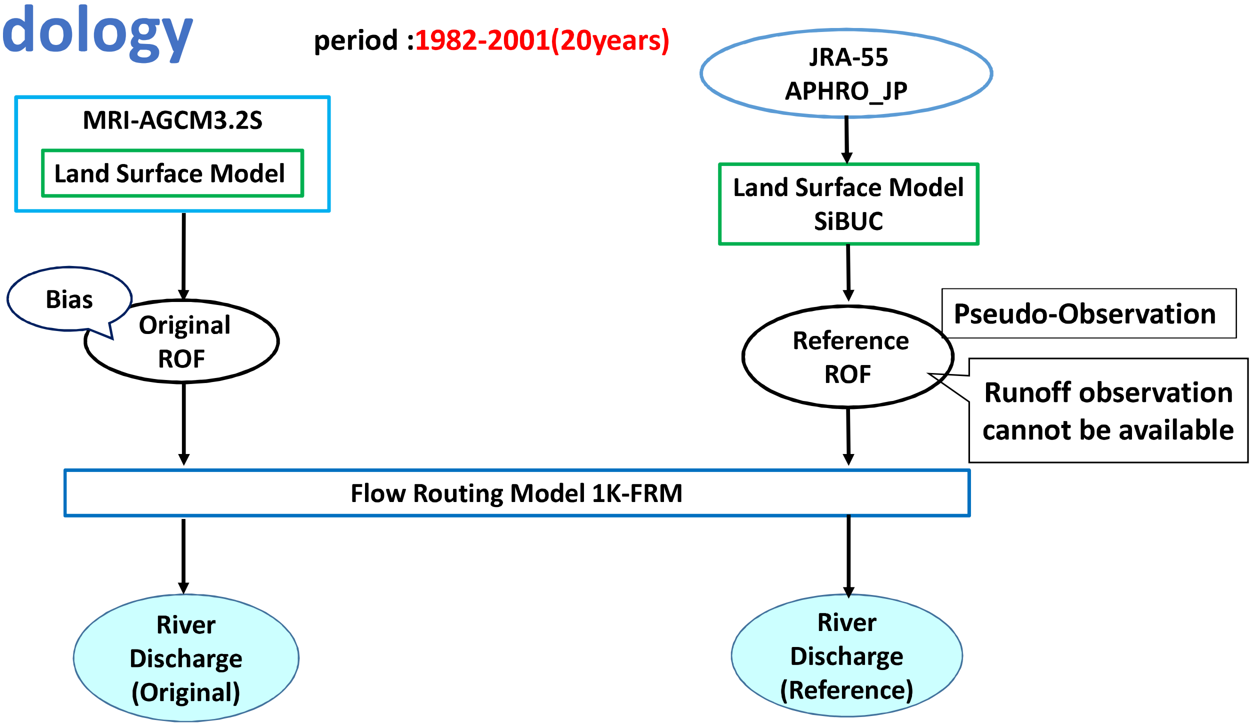
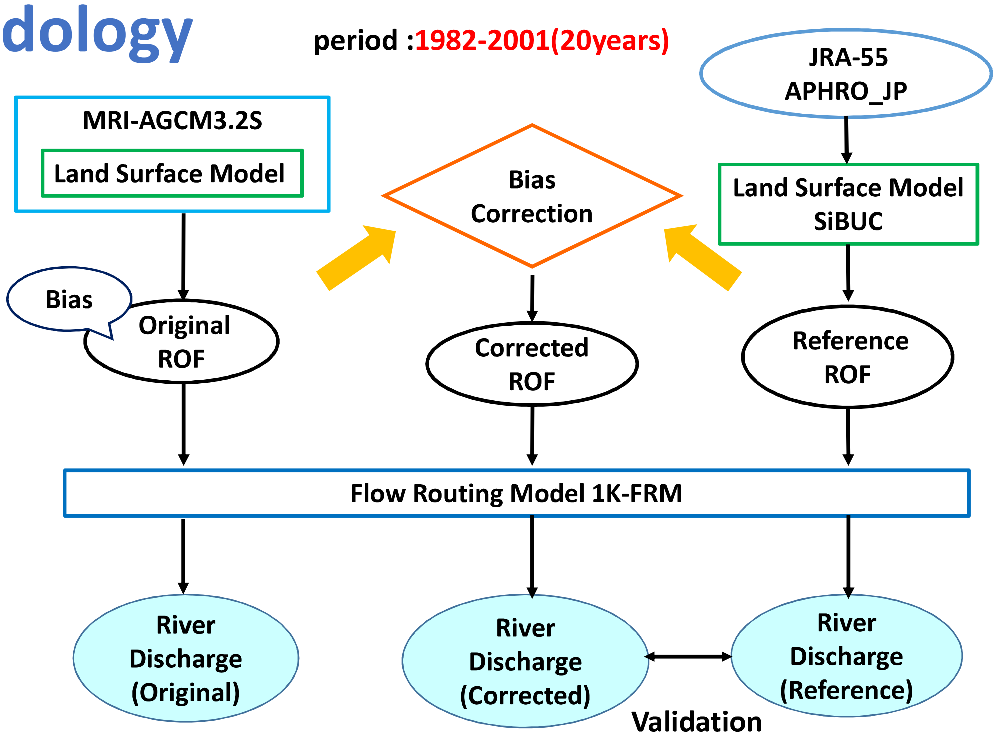
Methodology

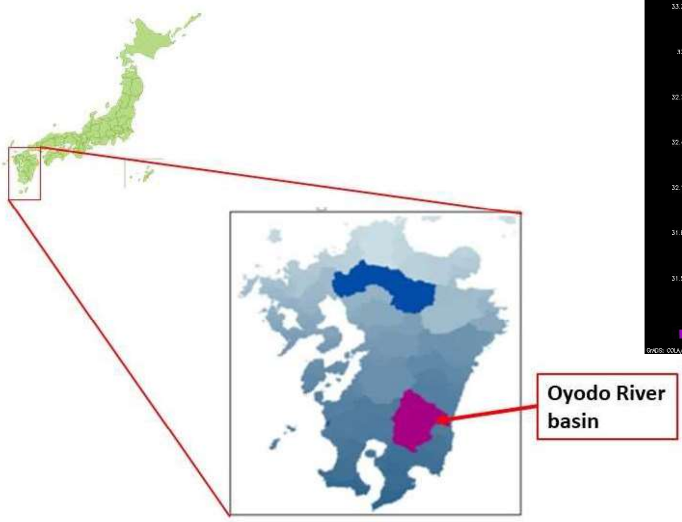


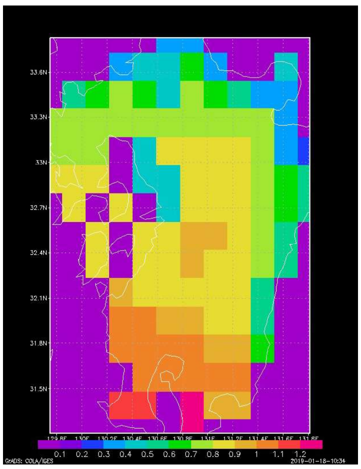
Methodology



Simulation Design –Study Area

Oyodo River basin, Kyushu Island, Japan





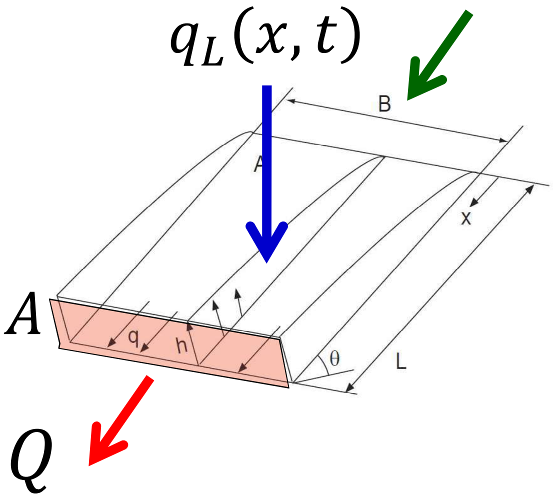
ROF distribution in Kyushu Island

Area Map

Simulation Design –Flow Routing Model 1K-FRM

1K-FRM is a flow routing model based on kinematic wave theory.

Developed by Hydrology and Water Resources Research Laboratory of Kyoto University



Kinematic wave theory

$$\frac{\partial A}{\partial t} + \frac{\partial Q}{\partial x} = q_L(x,t)$$

$$Q = \alpha A^m \ , \ \alpha = \frac{\sqrt{i_0}}{n}\left(\frac{1}{B}\right)^{m-1} \ , \mathrm{m} = \frac{5}{3}$$

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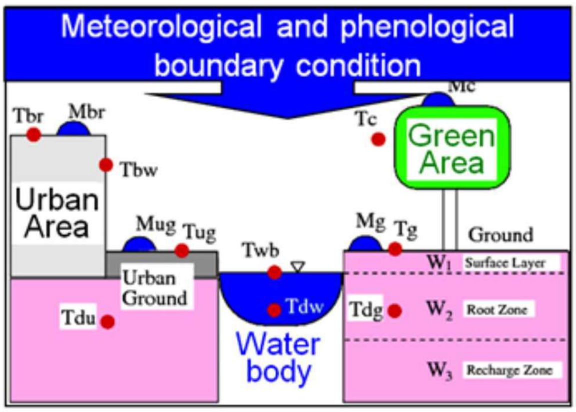
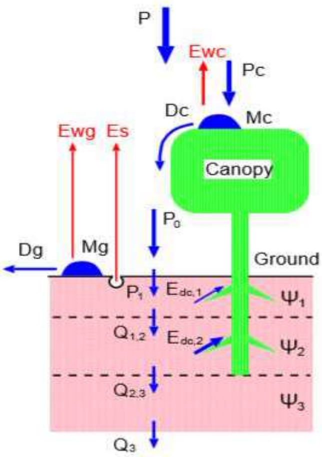
Simulation Design –Land Surface Model SiBUC

Land surface model SiBUC (Simple Biosphere including Urban Canopy) uses "mosaic" approach to incorporate all kind of land use into land surface scheme. In SiBUC model, each land surface grid is classified into three land use categories, **urban area**, **water body**, and **green area**.



Schematic Image of SiBUC model



Water Budget in green area model

Runoff generation is the total sum of **surface runoff** and **sub-surface runoff**. It is used as input into flow routing model 1K-FRM.

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Bias Correction for Runoff Generation Data

The process of bias correction

①Producing Reference datasets of ROF

②Correcting by Quantile-Quantile Mapping(QQM) method

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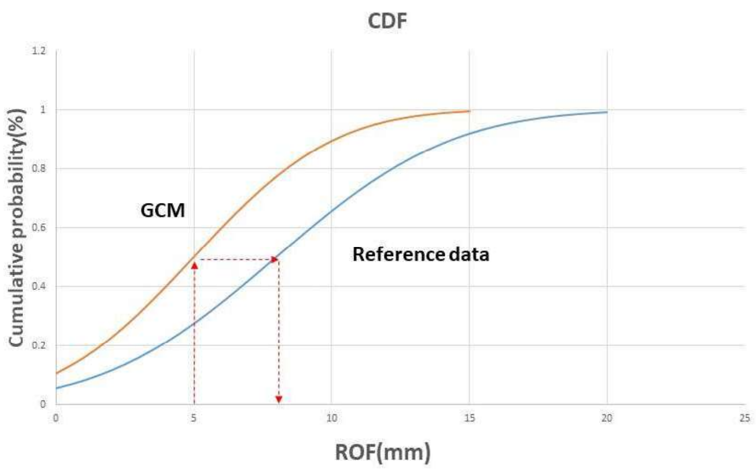
Bias Correction for Runoff Generation Data

Quantile-Quantile Mapping(QQM) method

By applying QQM method to GCM, the GCM value is substituted with those of the identical quantile from the reference datasets.



Ex. In this figure,
5mm(GCM)→8mm(Ref)

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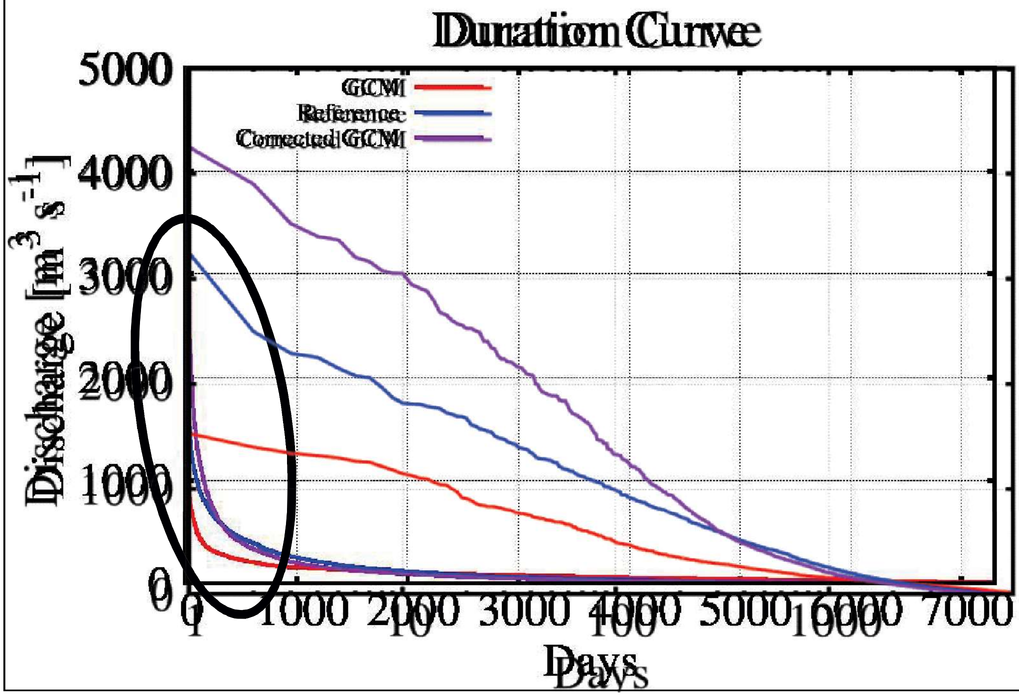
Bias Correction for Runoff Generation Data

The result of bias correction



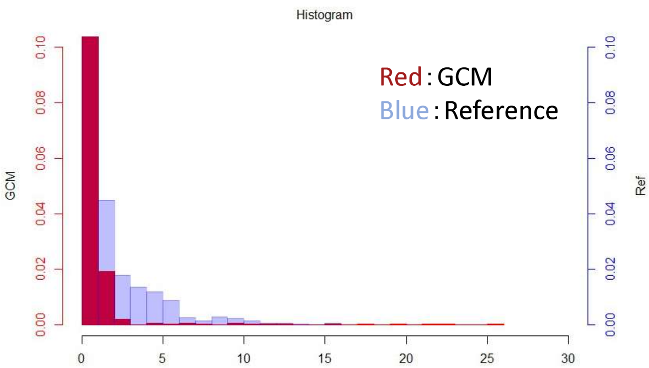
The result was almost **good**!

However, river discharge estimated by corrected GCM was **overestimated** in high peak discharge compared to reference data.

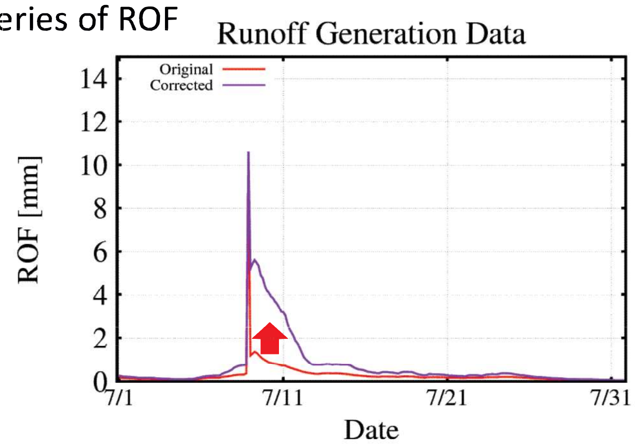
Bias Correction for Runoff Generation Data

Why is the corrected GCM overestimated in high peak discharge?

Histogram of ROF



Time Series of ROF



The frequency of high runoff amount is higher in reference data than that in GCM outputs.

Therefore, by applying QQM method, large ROF value from Reference(mainly surface runoff) is substituted with small ROF value from GCM(mainly base runoff) .

Revision of Bias Correction

Grouping QQM Method

- In order to improve the overestimation, a revision of bias correction was considered to be effective. The purpose of this revision is **to reduce the frequency of high runoff generation data** that contribute to flooding after bias correction and to **improve the overestimation of river discharge**.
- In consideration of the difference in frequency distribution in the two kinds of data, **a threshold value is set for each data** and divides each data into high runoff generation data contributing to flooding and low runoff generation data not contributing to flooding.
- After that, QQM method is applied for high runoff data and low data independently.

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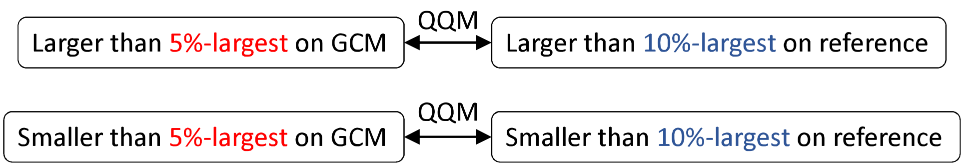
Revision of Bias Correction

The pattern of threshold values

	Threshold value of original GCM runoff	Threshold value of reference runoff
Pattern 1	5% value from largest	10% value from largest
Pattern 2	2.5% value from largest	10% value from largest

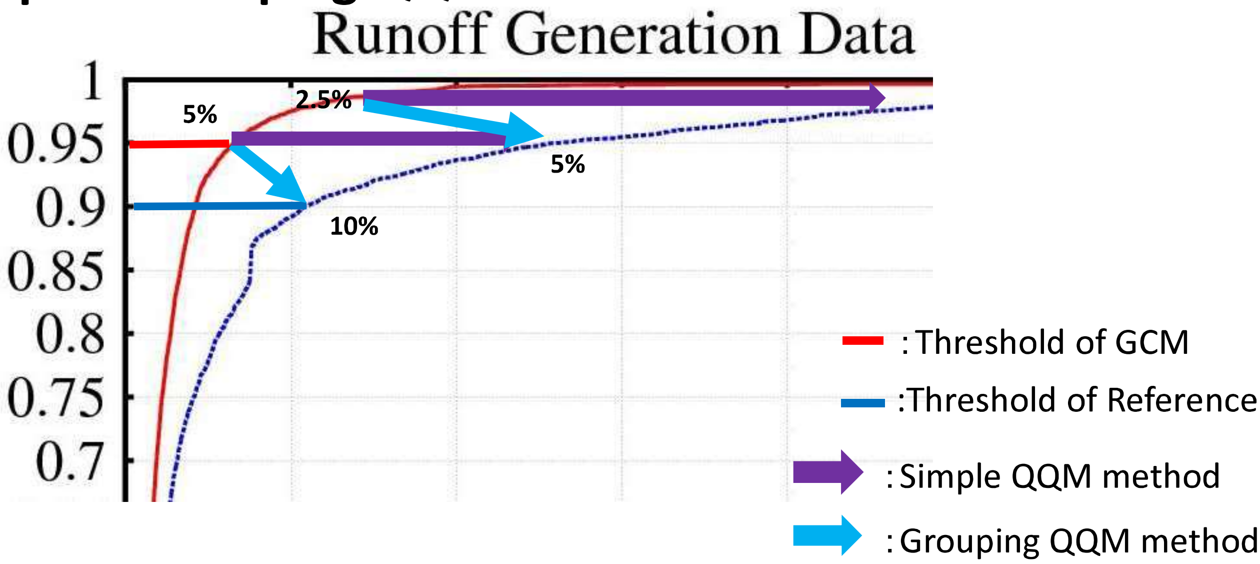
For each month and for each cell

Pattern 1



Revision of Bias Correction

The concept of Grouping QQM Method



The purpose of this revision is to correct high peak discharge more precisely.
(To reduce the peak ROF value)

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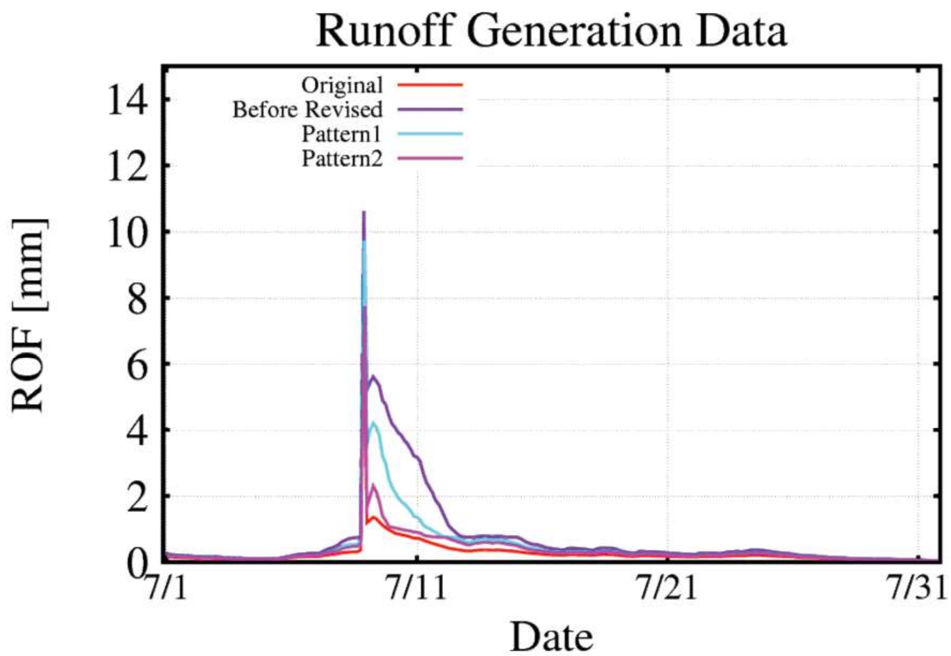
Revision of Bias Correction

The result of revision



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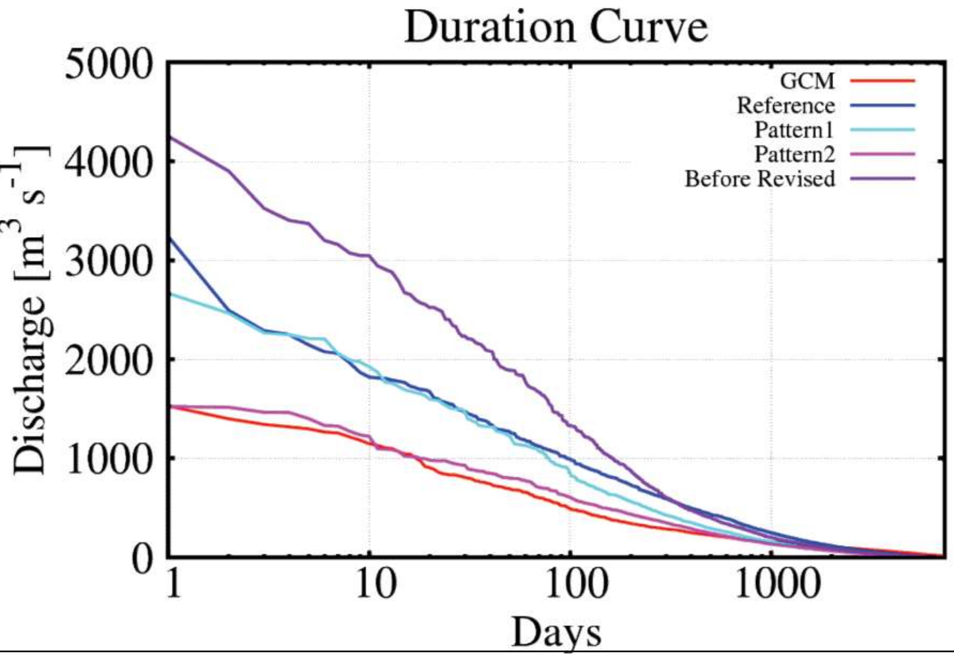
Revision of Bias Correction

The result of revision



Conclusion

- Bias correction applying the QQM method is effective by creating reference data of runoff generation data.
- However, it was found that the river discharge simulated using bias-corrected runoff was overestimated compared with that using reference data especially on high flood events.
- Therefore, the QQM method was revised by setting threshold values for runoff generation data and the overestimation was improved.

Thank you for your kind attention!

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Introduction -Background

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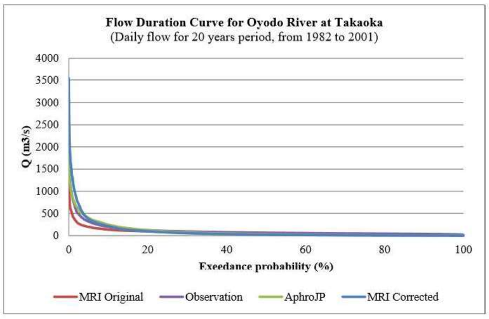

Fig. 6.11 Total period flow duration curve of daily flow for Oyodo River at Takaoka

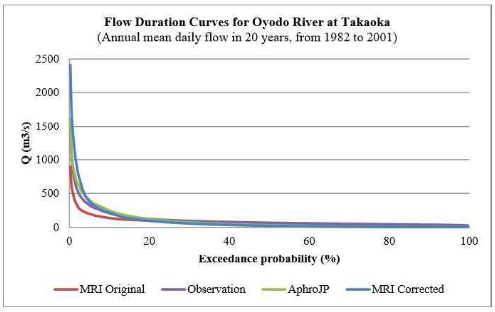

Fig. 6.12 Calendar-year flow duration curve of daily flow for Oyodo River at Takaoka

Revision of Bias Correction

The pattern of threshold values

	GCM	Reference
Pattern1	Applying **5%** value from largest on each month of each cell	Applying **10%** value from largest on each month of each cell
Pattern2	Applying **2.5%** value from largest on each month of each cell	Applying **10%** value from largest on each month of each cell