Characteristics of River Discharge Simulation Using NHRCM 5km Output by a Distributed Hydrologic Model in Thailand

TA113-1

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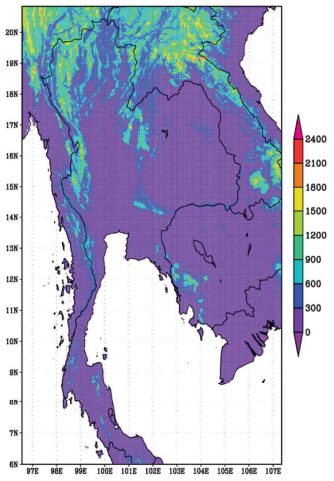
Outline

- Background and purpose
- Methodology
- Result and discussion
  a. Evaluation of rainfall
  b. Evaluation of river discharge
- Summary

Background and purpose

- The impact of climate change is clearly happening (IPCC's AR5). It is necessary to make an assessment for current and future climate under a changing climate.
- For basin-level assessment, a detailed projection of **climate data** and **hydrologic model** are required.
- **NHRCM** (Non-Hydrostatic Regional Climate Model) with **5km**-spatial resolution (Sasaki et. al., 2011) has been applied for **Thailand** area to simulate present and future climate condition.
- However, there is still lack of study about the output of this data, particularly from river discharge view point.

To evaluate the river discharge simulated by the output of NHRCM 5km in Thailand.



NHRCM 5km simulation area

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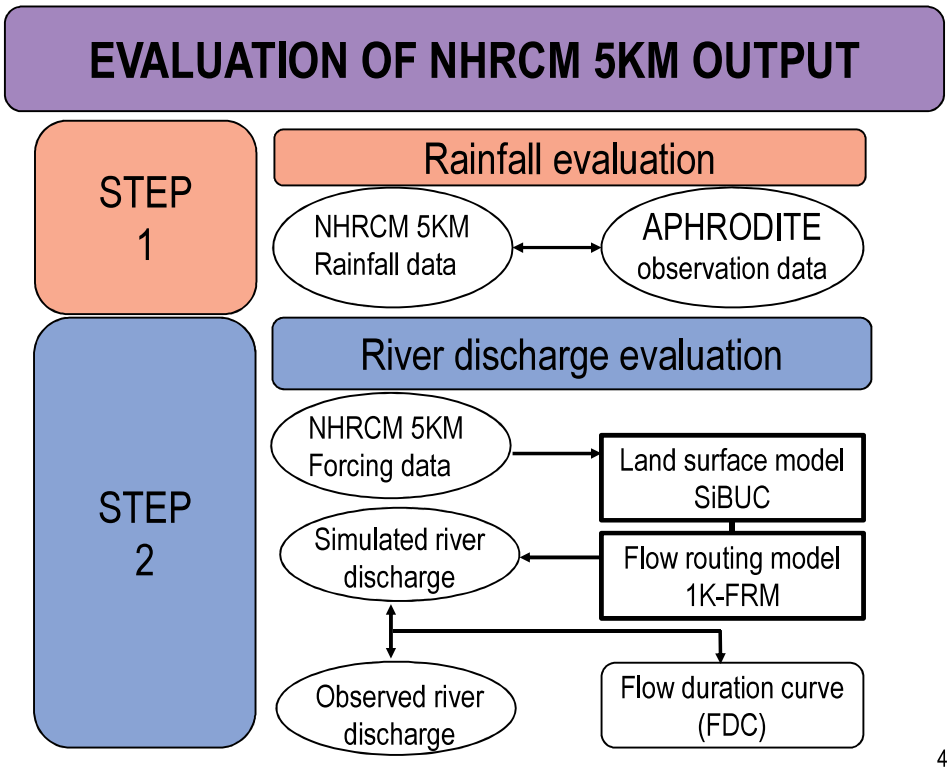
Methodology



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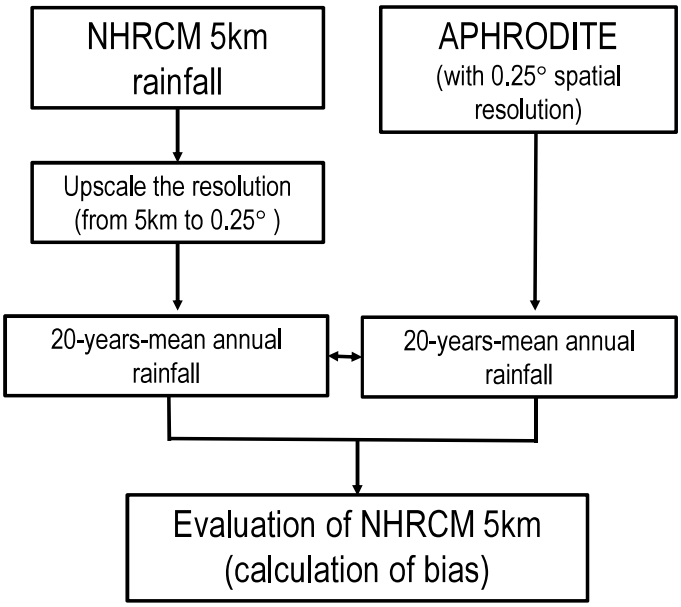
Methodology: Rainfall evaluation



NHRCM 5km

- Outer boundary : MRI-AGCM 60km
- Inner boundary : NHRCM 25km
- Past climate data : 1980-1999
- Future climate data: 2080-2099 under SRES A1B

APHRODITE observation data
(Asian precipitation – highly-resolved observational data integration towards evaluation of water resources)

- Spatial resolution: 0.25°
- Coverage area: Monsoon Asia
- Period of records: 1961-2007

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Methodology: River discharge evaluation

Output data from NHRCM 5km:

1. Rainfall
2. Air temperature
3. Humidity
4. Air pressure
5. Wind speed
6. Short-wave radiation ↓
7. Long-wave radiation ↓

Coupled model (Yorozu and Tachikawa, 2015)

Land surface model SiBUC → Calculation of runoff

Flow routing model 1K-FRM → River discharge simulation

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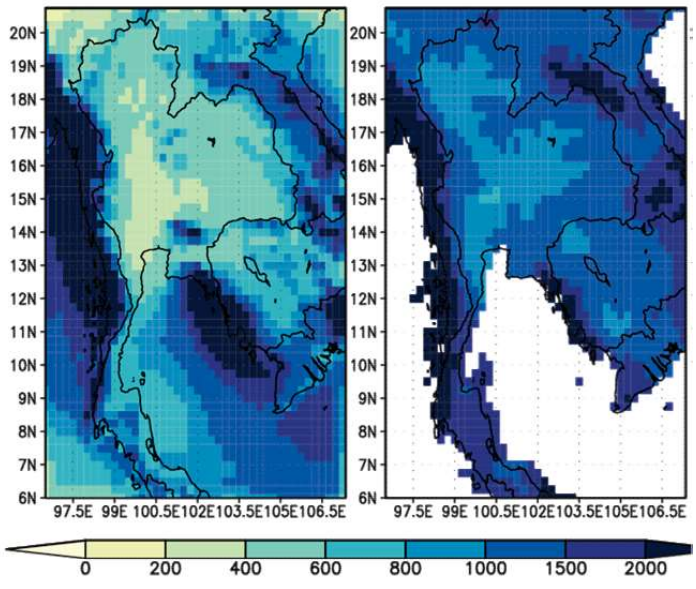
Result and discussion

a. Evaluation of NHRCM 5km rainfall

Evaluation of NHRCM 5km rainfall (1)

(a) NHRCM 5km (b) APHRODITE



20years-mean Annual rainfall (mm)

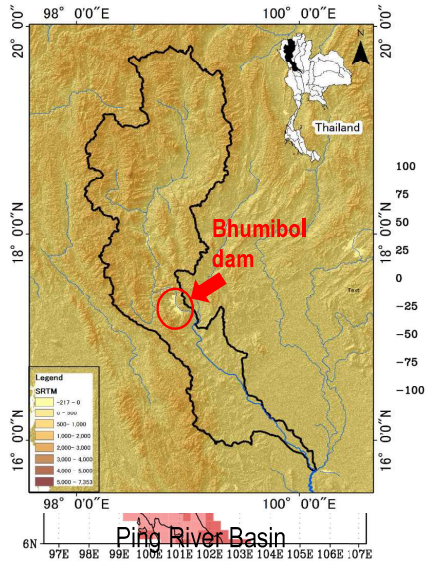
NHRCM05 rainfall shows the amount of rainfall in
- central region < northern region
- southern part of Thailand is the highest

which is similar to the APHRODITE observed rainfall.

NHRCM 5km rainfall output could catch the spatial distribution of the observed rainfall.

However, most of the region shows underestimated result.

Evaluation of NHRCM 5km rainfall (2)



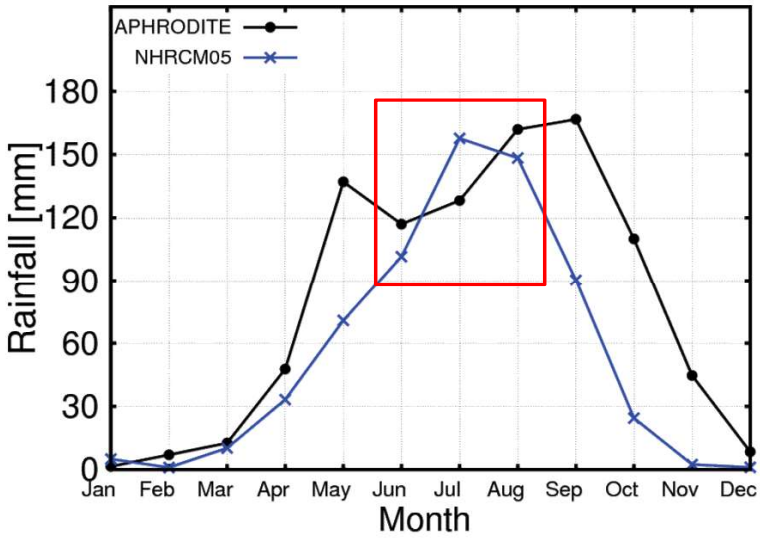
$$\text{Bias} = \frac{(\text{NHRCM} - \text{APHRODITE})}{\text{APHRODITE}}$$

The northern region have relatively smaller bias than other region.

For river discharge simulation, the **northern region** (which almost corresponds to Bhumibol dam catchment) is selected as target area.

Bias area: about 26,000 km ^{2} al rainfall

Evaluation of NHRCM 5km rainfall (3)



- The total amount of rainfall is mostly underestimated.
- June, July, August (JJA) shows better accuracy.
- Peak rainfall of NHRCM05 is on July, while the observed data shows peak rainfall on September.

20-years-mean basin average rainfall in upper part of Bhumibol dam catchment

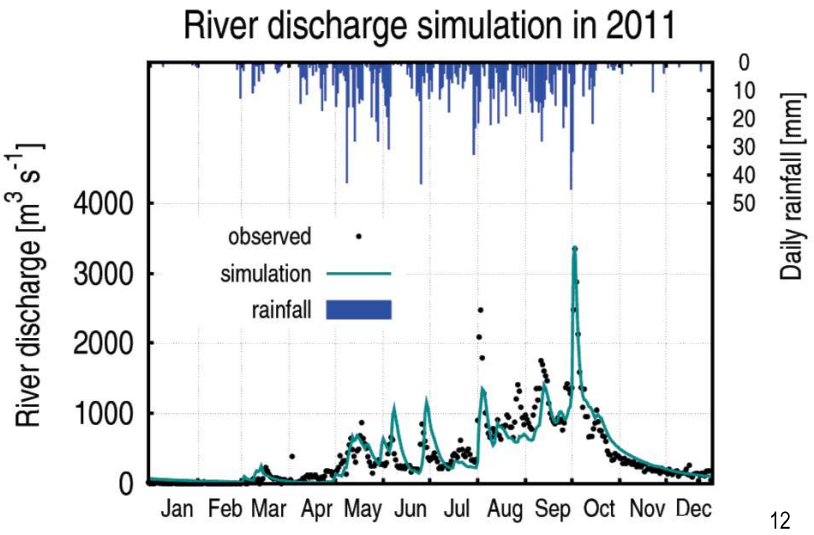
Result and discussion

b. Evaluation of river discharge

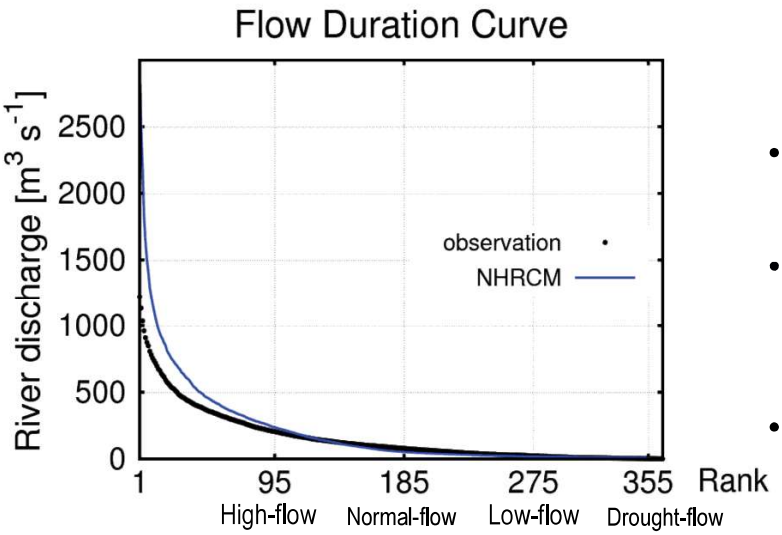
Evaluation of river discharge (1)

- SiBUC model is used with 3-minutes spatial resolution and 1-hour temporal resolution.
- 1K-FRM is utilized with 1-km spatial resolution and 1-hour temporal resolution.
- The model was evaluated for 2011 Thailand big flood and showed good performance for simulating river discharge.

Nash Index: 0.79



Evaluation of river discharge (2)



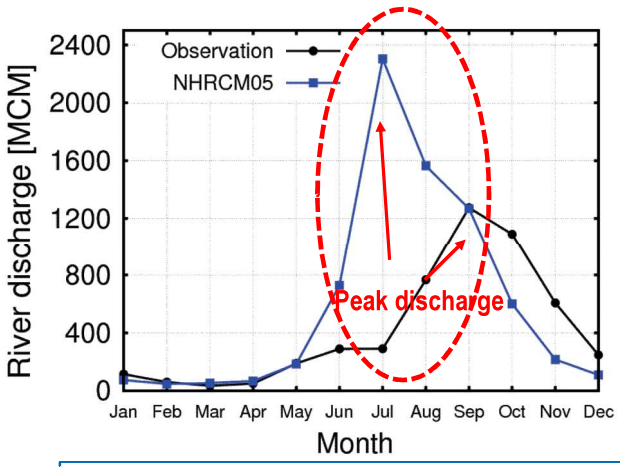
20-years-mean Flow Duration Curve

FDC is plotted by sorting the highest to the lowest daily river discharge within a year.

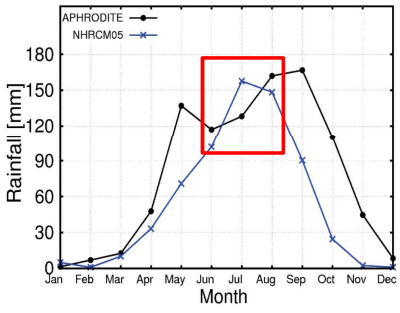
- In total, there are 20-FDCs for river discharge simulation during 1980 – 1999.
- During normal, low, and drought-flow period, the simulated flow was well compared with the observed data.
- However, in the high-flow period (95th day), the river discharge was about 15% overestimated by NHRCM.

Evaluation of river discharge (3)

Monthly river discharge: Accumulation of daily river discharge within a month.



20-years-average monthly river discharge

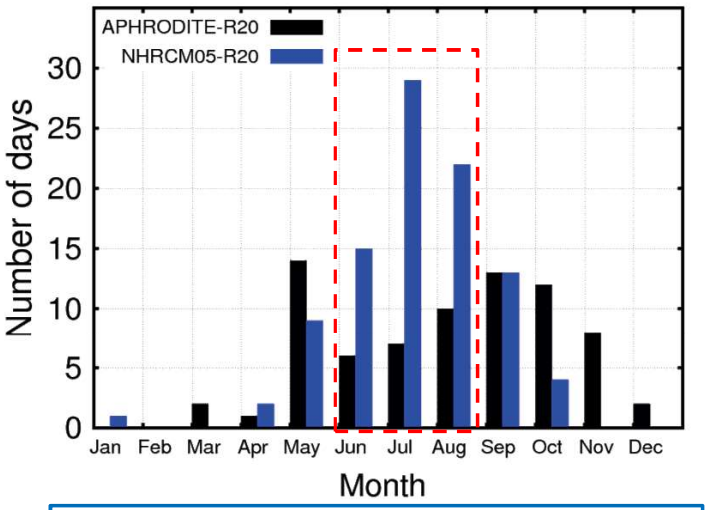


- The peak discharge simulated from NHRCM 5km was produced much earlier compared to the observed inflow.

  → This might be explained by earlier peak of the basin average of NHRCM 5km rainfall.
- However, only monthly-rainfall amount can not explain river discharge overestimation.

  → The NHRCM rainfall in July is only about 30% overestimated. While, June and August rainfall are a slightly underestimated.

Evaluation of river discharge (4)



Number of heavy rainfall days within 20 years

R20: rainfall which is more than 20mm/day

It is thought that large number of short-term heavy rainfall events from NHRCM 5km output might be one of the causes of the overestimated river discharge of NHRCM 5km.

However, the hydrological model itself might also have some influence on this overestimated result.

→The parameter settings or the model structure itself should also be examined to see its effect on the river discharge estimation.

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Summary

- In this research, the output data from NHRCM 5km simulated in Thailand region was evaluated.
- NHRCM 5km rainfall data showed underestimated result in most of region in Thailand. However, the northern region had smaller bias compared to other region, therefore this region was selected as target area for river discharge simulation.
- River discharge simulation in Bhumibol dam catchment was overestimated in the high-flow period. Extreme simulated flood discharge might be caused by large number of short-term heavy rainfall days.
- Further work should examine the effect of parameter settings or model structure on the river discharge estimation.

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Acknowledgment

We owe a deep gratitude for Dr. Patama who simulated the NHRCM 5km data used in this research under supervision of Dr. Hidetaka Sasaki from MRI/JMA.

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Thank you for your kind attention!

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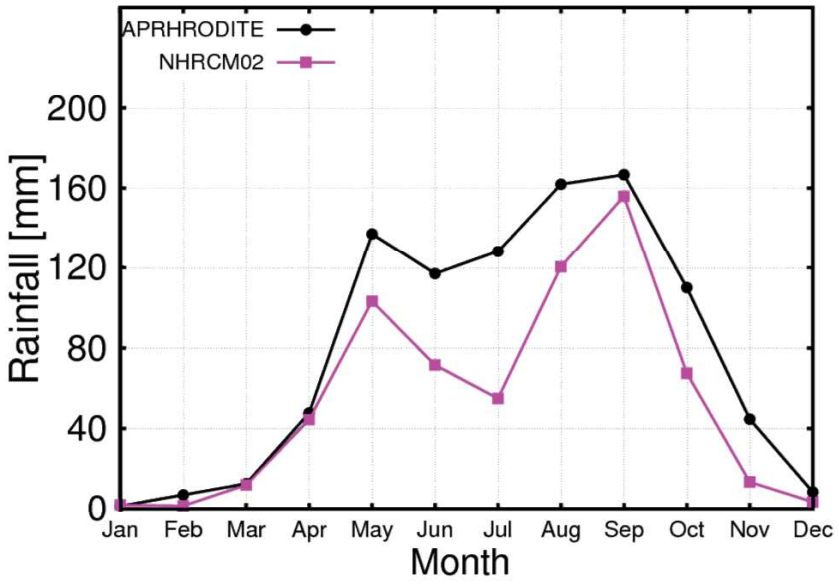
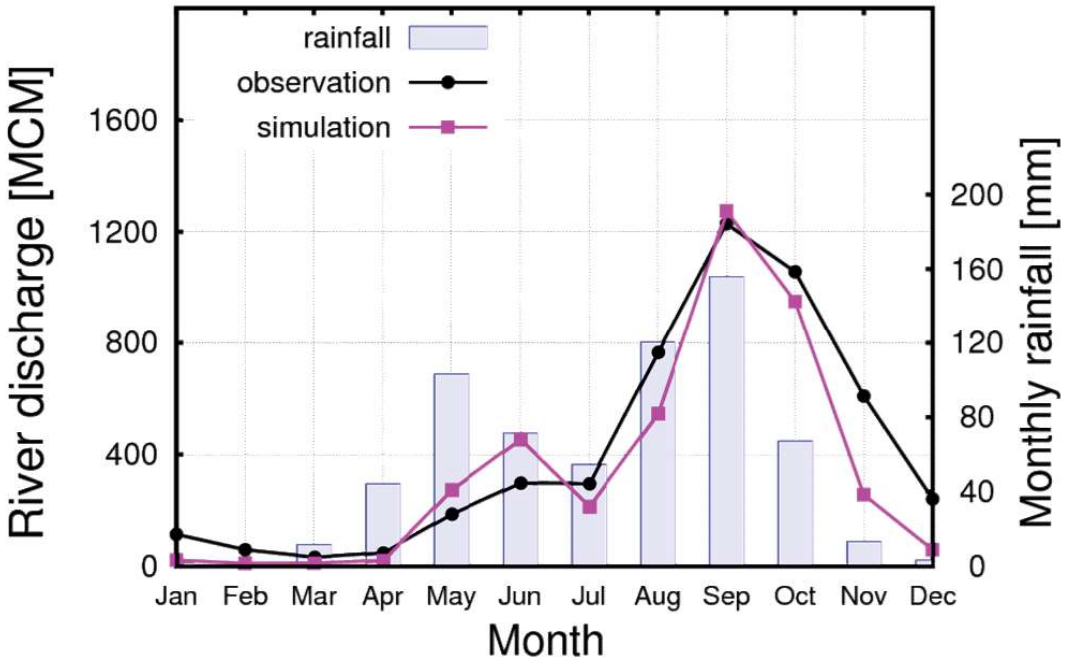
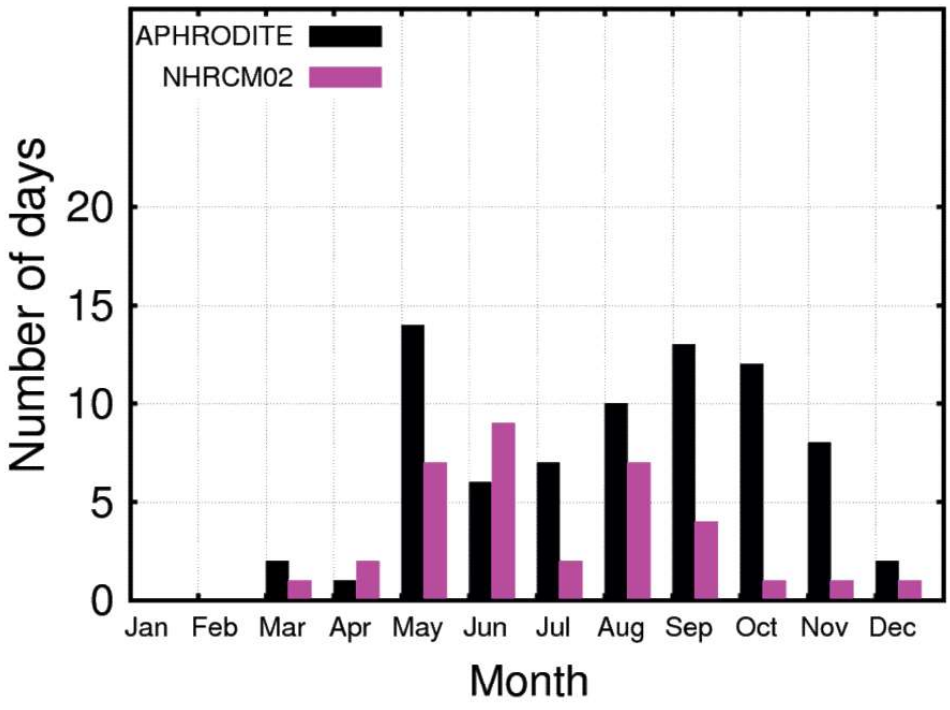


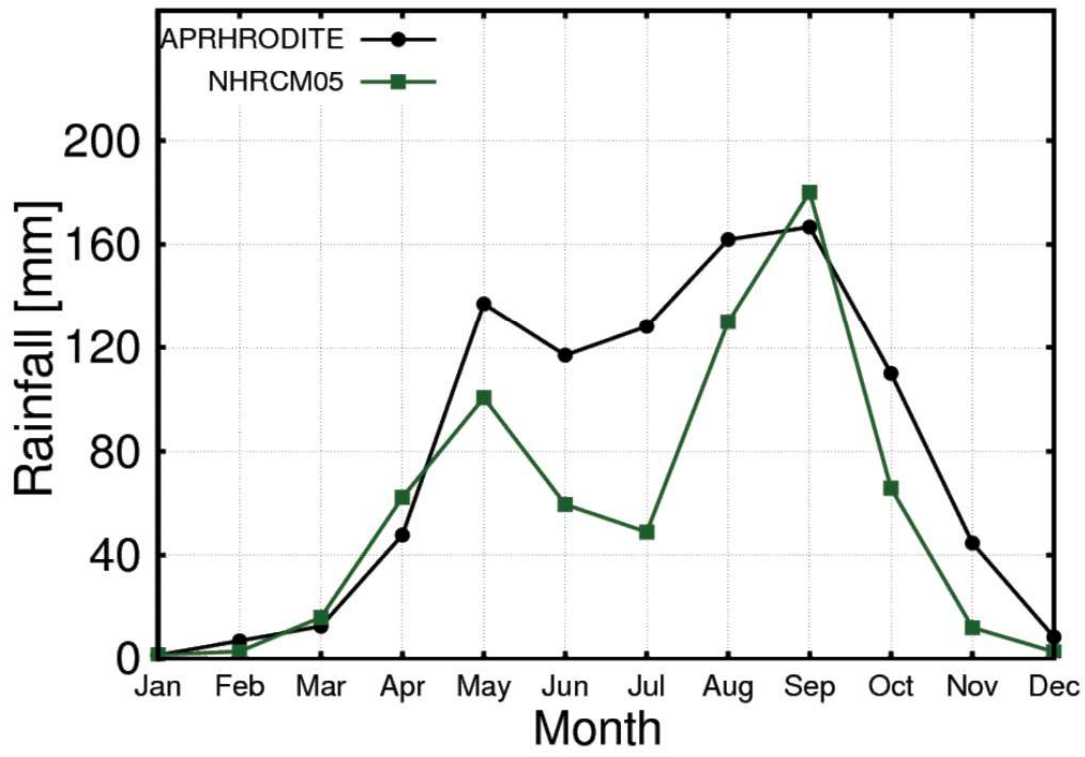
20-years-mean basin average rainfall of NHRCM 2km

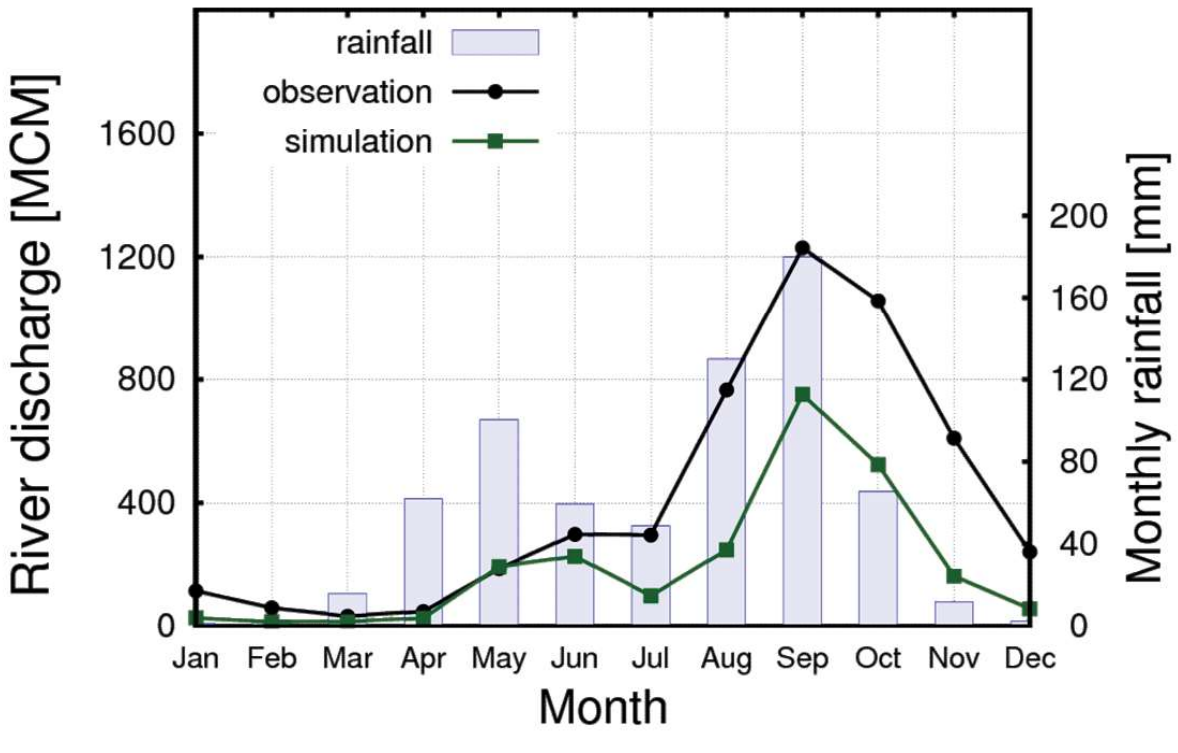


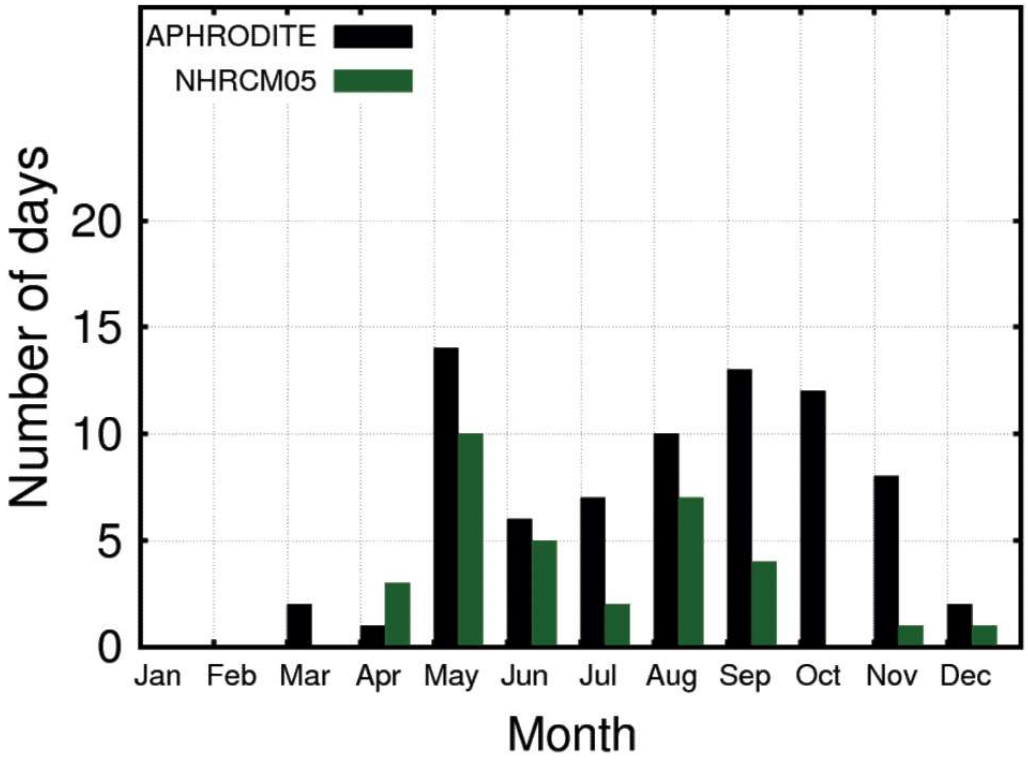
20-years-mean NHRCM 2km river discharge



Number of heavy rainfall days R20 during 1980-1999


APRHRODITE
NHRCM05
Rainfall [mm]
0
40
80
120
160
200
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


rainfall
observation
simulation
River discharge [MCM]
0
400
800
1200
1600
Monthly rainfall [mm]
0
40
80
120
160
200
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month


APHRODITE
NHRCM05
Number of days
0
5
10
15
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month