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Hydrology and Earth System Sciences
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Discussions

Interactive comment on "Model study of the impacts of future climate change on the hydrology of Ganges–Brahmaputra–Meghna (GBM) basin" *by* M. Masood et al.

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Hydrology and Earth System Sciences (HESS) editorial@copernicus.org http://www.hydrol-earth-syst-sci.net/

Dear Editor,

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Interactive Discussion
Discussion Paper

Please find enclosed our detailed point-to-point responses to Reviewers' comments on our manuscript entitled "Model study of the impacts of future climate change on the hydrology of Ganges-Brahmaputra-Meghna (GBM) basin". This manuscript has been submitted previously to HESSD as hess-2014-156 with the encouragement for resubmission from the Editor. We thank two anonymous Reviewers for their constructive comments, and accordingly we have revised our manuscript thoroughly, including re-running all the previous model simulations. We also have validated model simulations at three more streamflow gauging stations located at the upstream of the GBM basins in addition to the original three stations at the outlets of three basins. Also, we have followed Reviewer's suggestion to correct the bias of GCM data based on the more accurate monthly scaling factors instead of using previous annual scaling factor.

A summary of the major revision tasks we have been done to address Reviewers' comments is given as follows:

1. We have improved the model simulations by the calibration of additional two sensitive model parameters (i.e., the meandering ration and the effective flow velocity) following the comments of both Reviewers #1 and #2. 2. We have validated model simulations at three more upstream stations following the suggestion of Reviewer #2. 3. Following the suggestion of Reviewer #1, we have corrected the bias of GCM data based on the more accurate monthly scaling factors instead of using the previous annual scaling factor. 4. We have included a new Table 1 describing the major characteristics of three GBM basins according to suggestion of Reviewer #2. 5. We have included a new Table 3 providing the basic information of all six streamflow gauging stations used for calibration and validation. 6. We have revised Table 2 (former Table 1), Table 4 (former Table 2), Table 5 (former Table 3) and Table 6 (former Table 4) to be of higher quality. 7. We have revised Fig. 1, Fig. 4 (former Fig. 5), Fig. 5 (former Fig. 6), Fig. 6 (former Fig. 7), Fig. 7 (former Fig. 8), Fig. 8 (former Fig. 9), Fig. 9 (former Fig. 10) and Fig. 10 (former Fig. 11). 8. We have removed a figure (former Fig. 4) mainly due to the concern of Reviewer #1. 9. We have corrected all technical

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and grammatical errors as pointed out by both Reviewers #1 and #2.

We believe this manuscript will be of great interest to the broad HESS readers since it investigates the impacts of future climate change on the hydrologic cycle of the GBM basin through hydrologic modelling and also accounting for the significant model parameter uncertainty. Climate change impact on these basins is a matter of high global concern because it is obvious that the risk of water disasters has been increasing over recent years, but only very few hydrologic modeling studies have been conducted in the GBM basins, mainly due to the lack of observed data to validate model simulations. This paper successfully applies hydrologic modeling together with the long-term observed daily streamflow data to fill this research gap, and it investigates not only the runoff change due to climate change but also the overall basin-scale hydrologic change including evapotranspiration, soil moisture and net radiation. Ultimately, the research presented in this paper can provide a sound scientific basis for decision making regarding the climate change adaptation in the GBH basin.

Please let us know if there are any further questions we need to provide additional information. We will respond promptly.

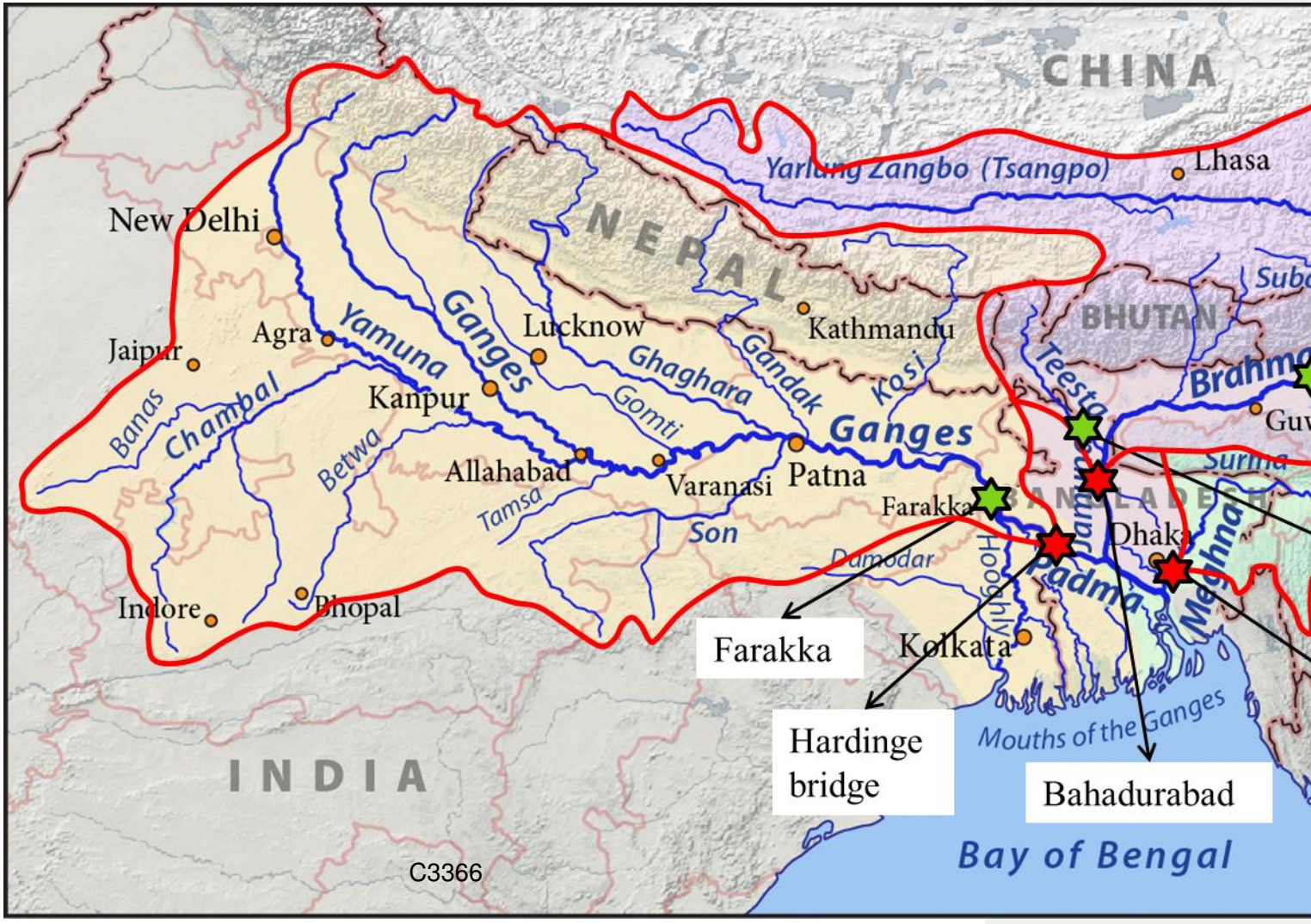
Thank you so much for your consideration.

Sincerely,

Muhammad Masood Pat J.-F. Yeh Naota Hanasaki Kuniyoshi Takeuchi

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/11/C3363/2014/hessd-11-C3363-2014-supplement.pdf

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 5747, 2014.


CHINA
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Lhasa
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NEPAL
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Jaipur
Agra
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Ghaghara
Gandak
Kosi
Teesta
Brahma
Banas
Chambal
Kanpur
Gomti
Ganges
Betwa
Allahabad
Varanasi
Patna
Tamsa
Farakka
Son
Dhaka
Damodar
Hooghly
Padma
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Mouths of the Ganges
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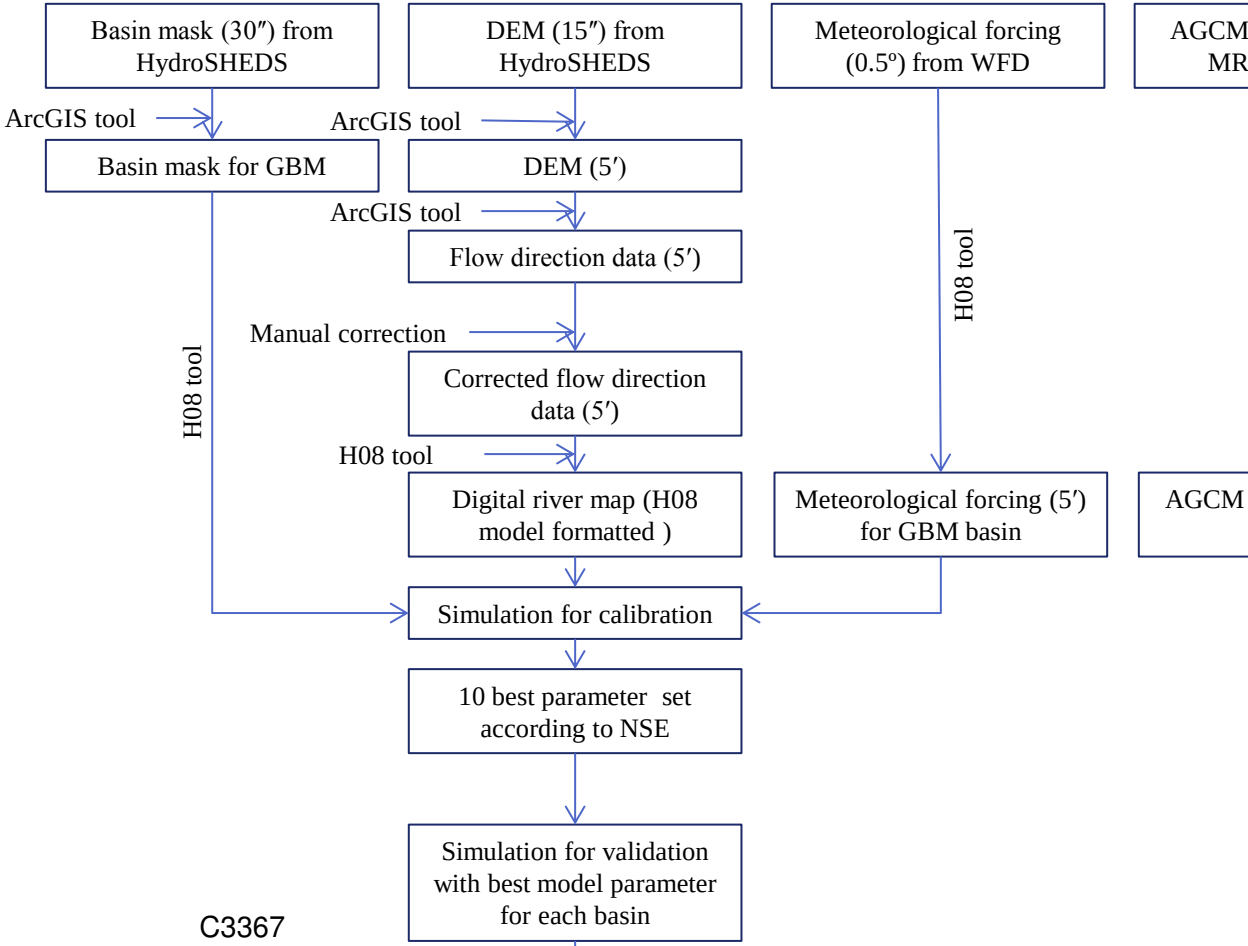
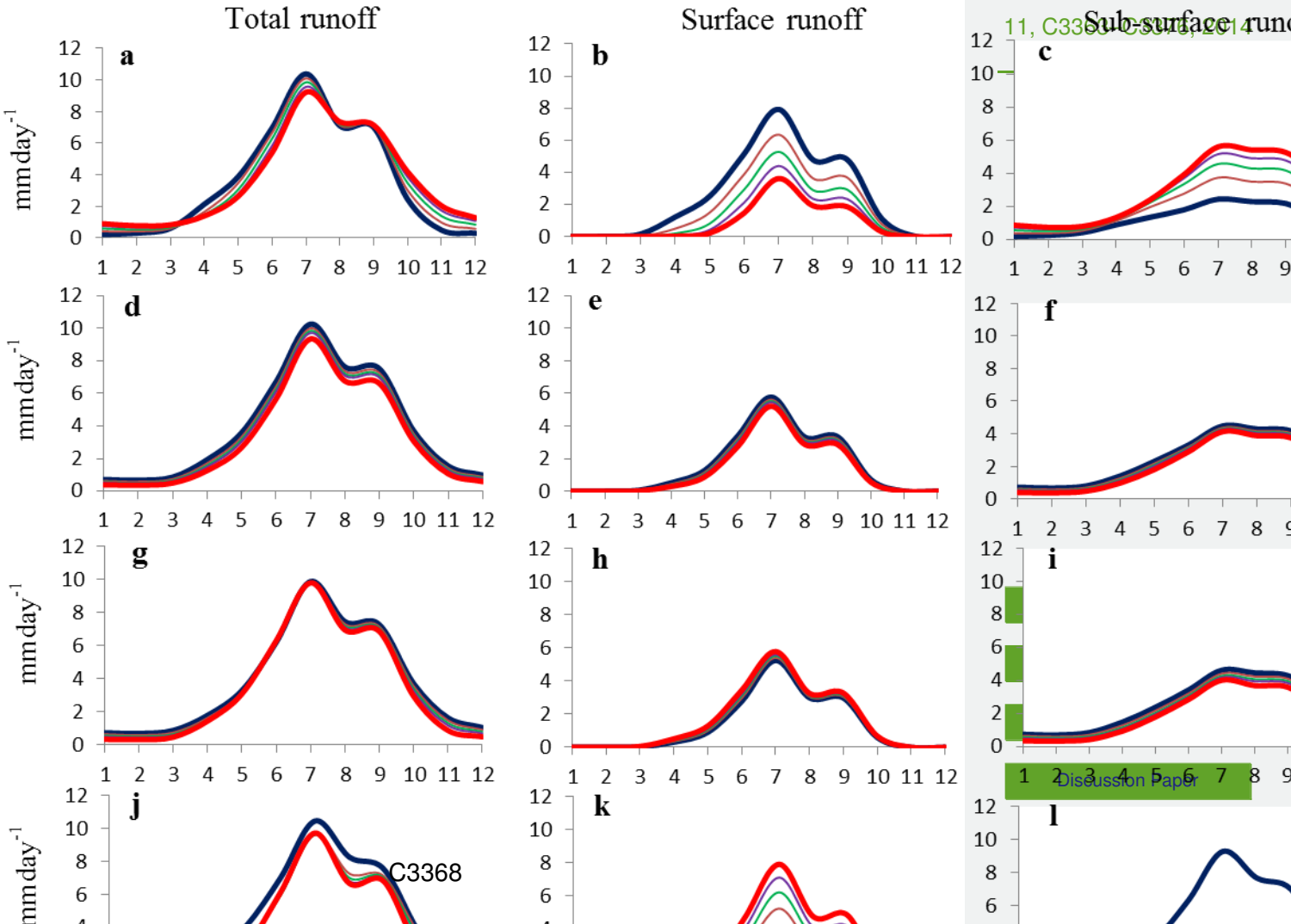
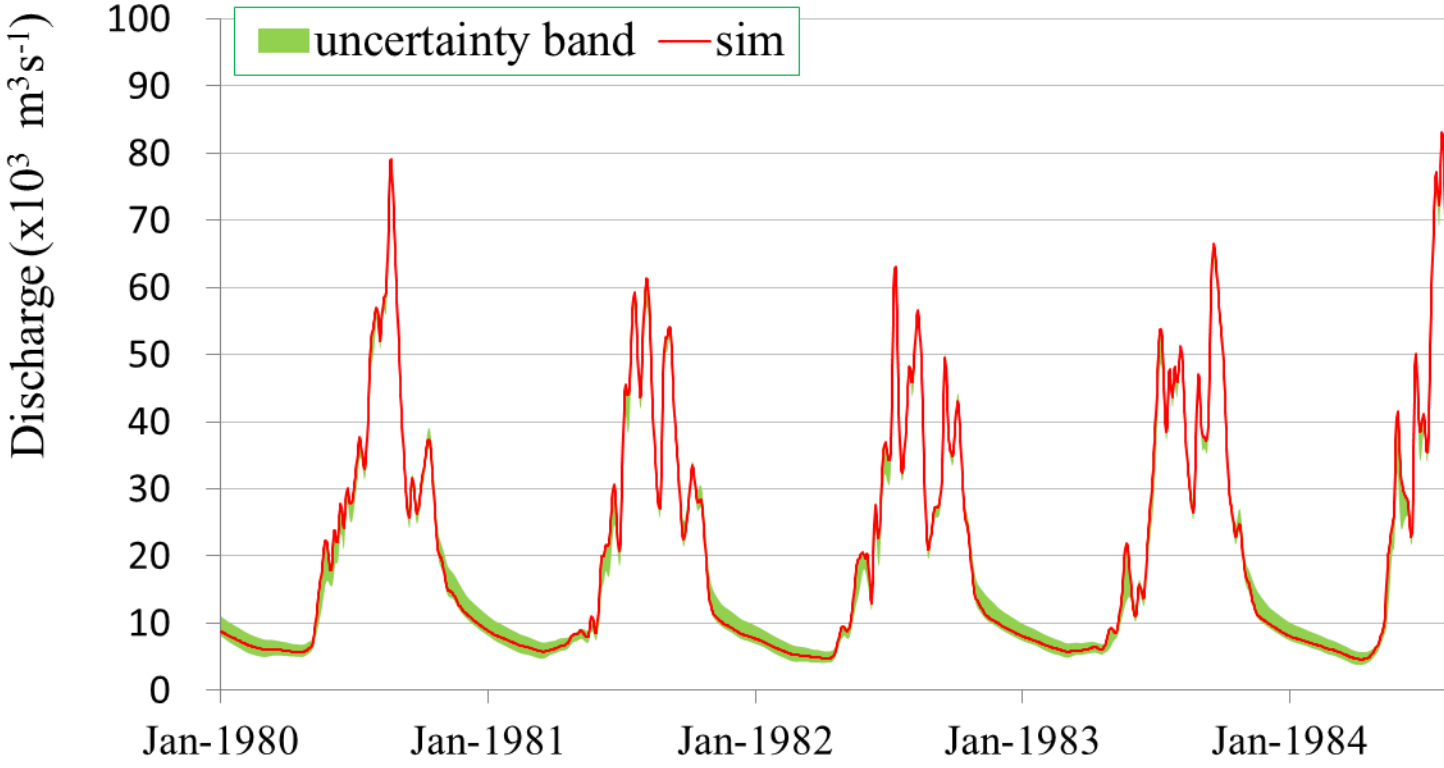
INDIA
Bay of Bengal
C3366

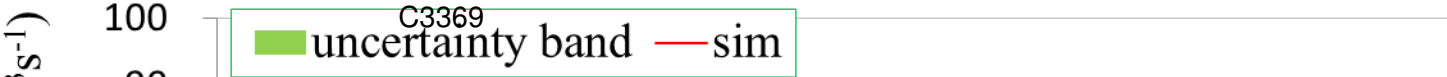

Basin mask (30″) from HydroSHEDS
DEM (15″) from HydroSHEDS
Meteorological forcing (0.5°) from WFD
AGCM MR
ArcGIS tool
ArcGIS tool
Basin mask for GBM
DEM (5′)
ArcGIS tool
Flow direction data (5′)
H08 tool
Manual correction
H08 tool
Corrected flow direction data (5′)
H08 tool
H08 tool
Digital river map (H08 model formatted)
Meteorological forcing (5′) for GBM basin
AGCM
Simulation for calibration
10 best parameter set according to NSE
Simulation for validation with best model parameter for each basin


Total runoff
Surface runoff
Sub-surface runo
a
b
c
d
e
f
g
h
i
j
k
l
mm day-1
C3368
Discussion Paper

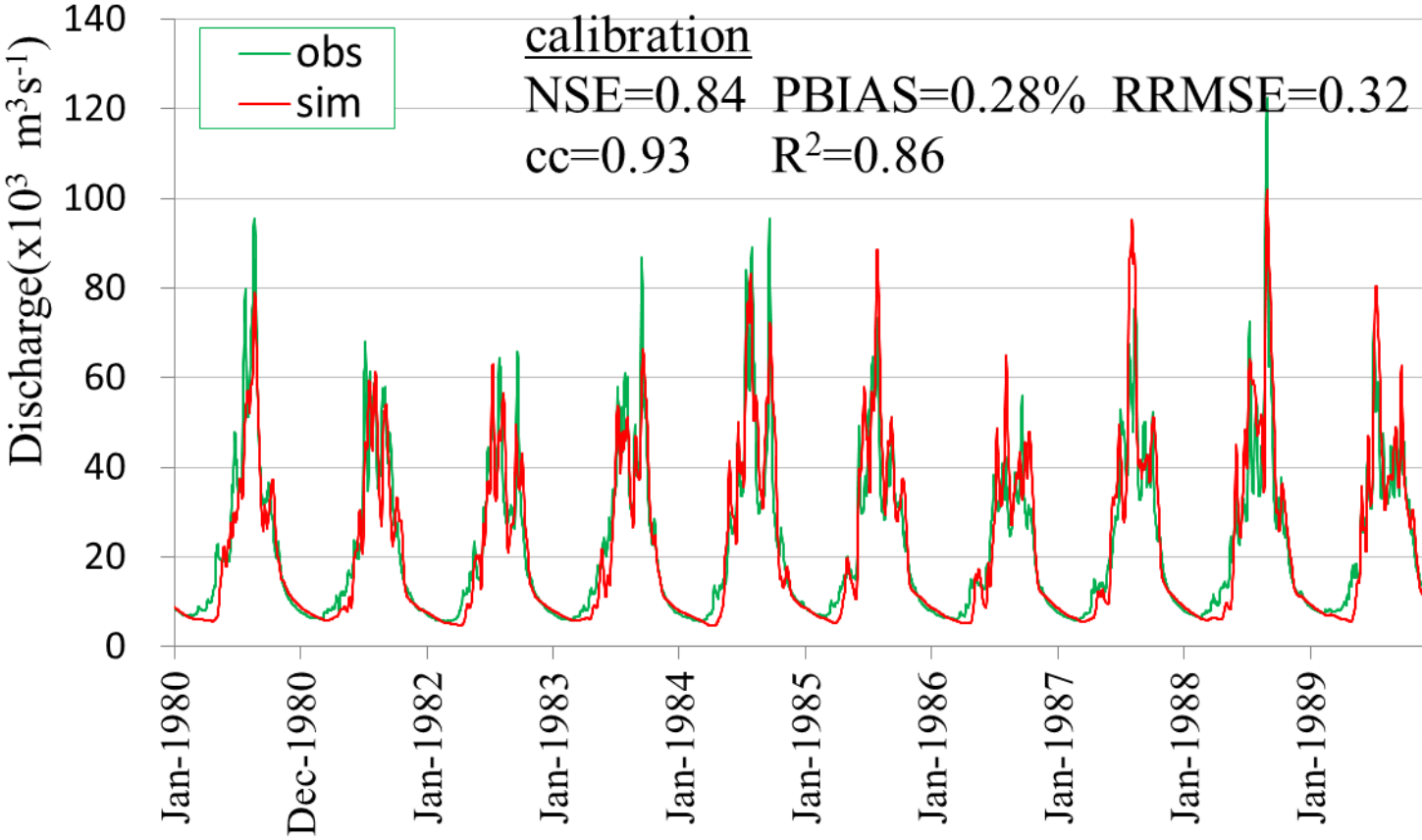
(a) Discharge of Brahma



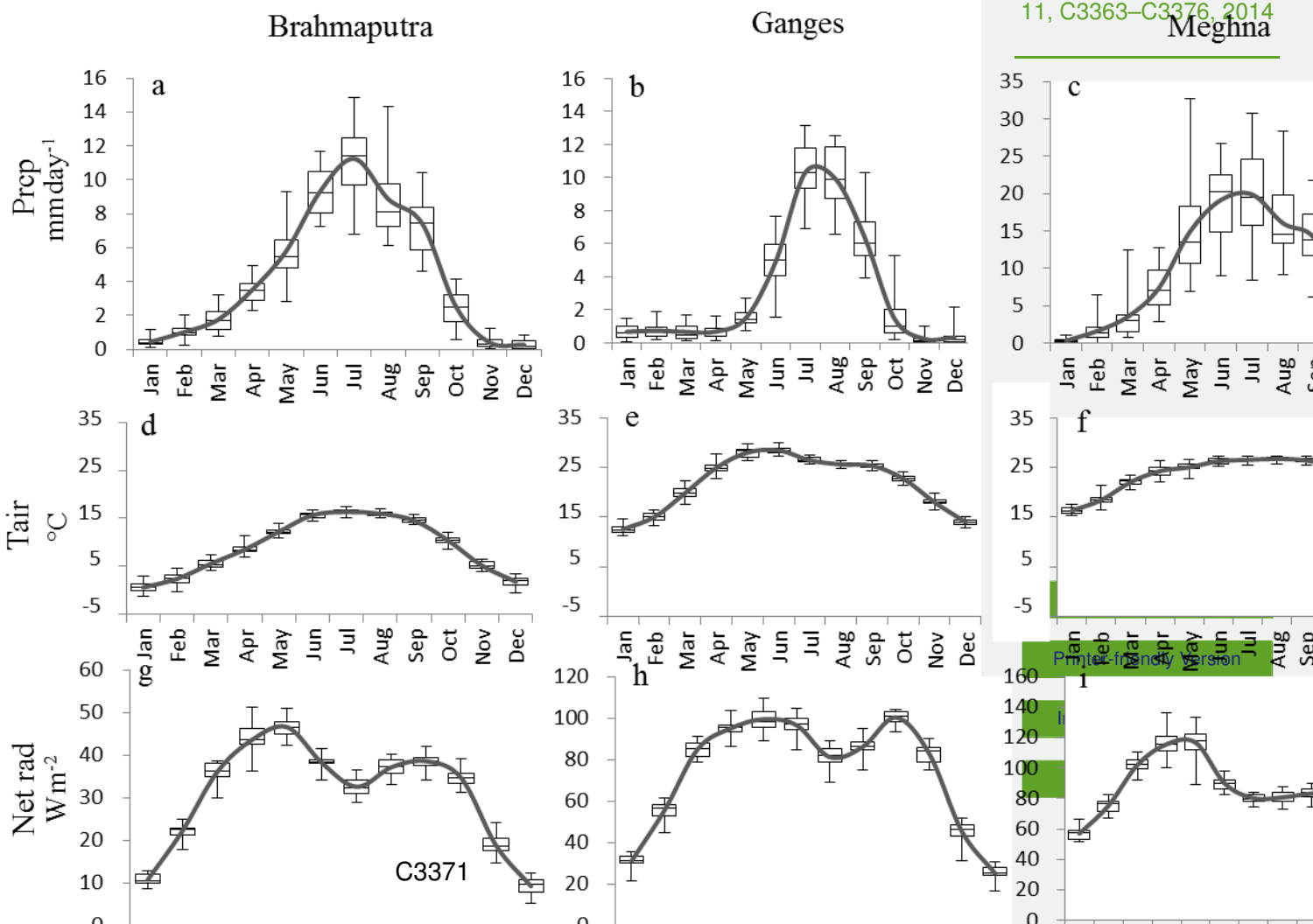
(b) Discharge of Ganges

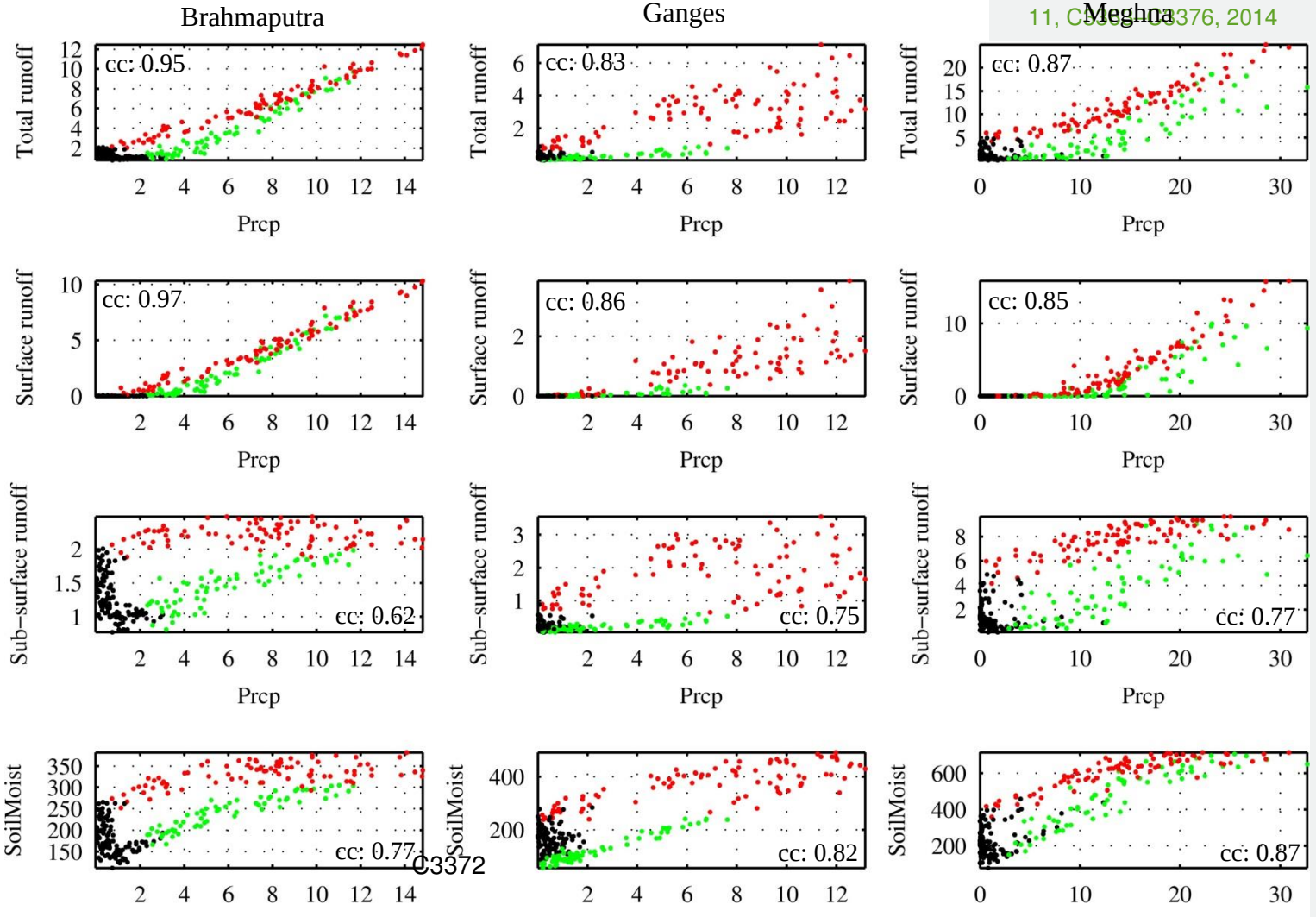


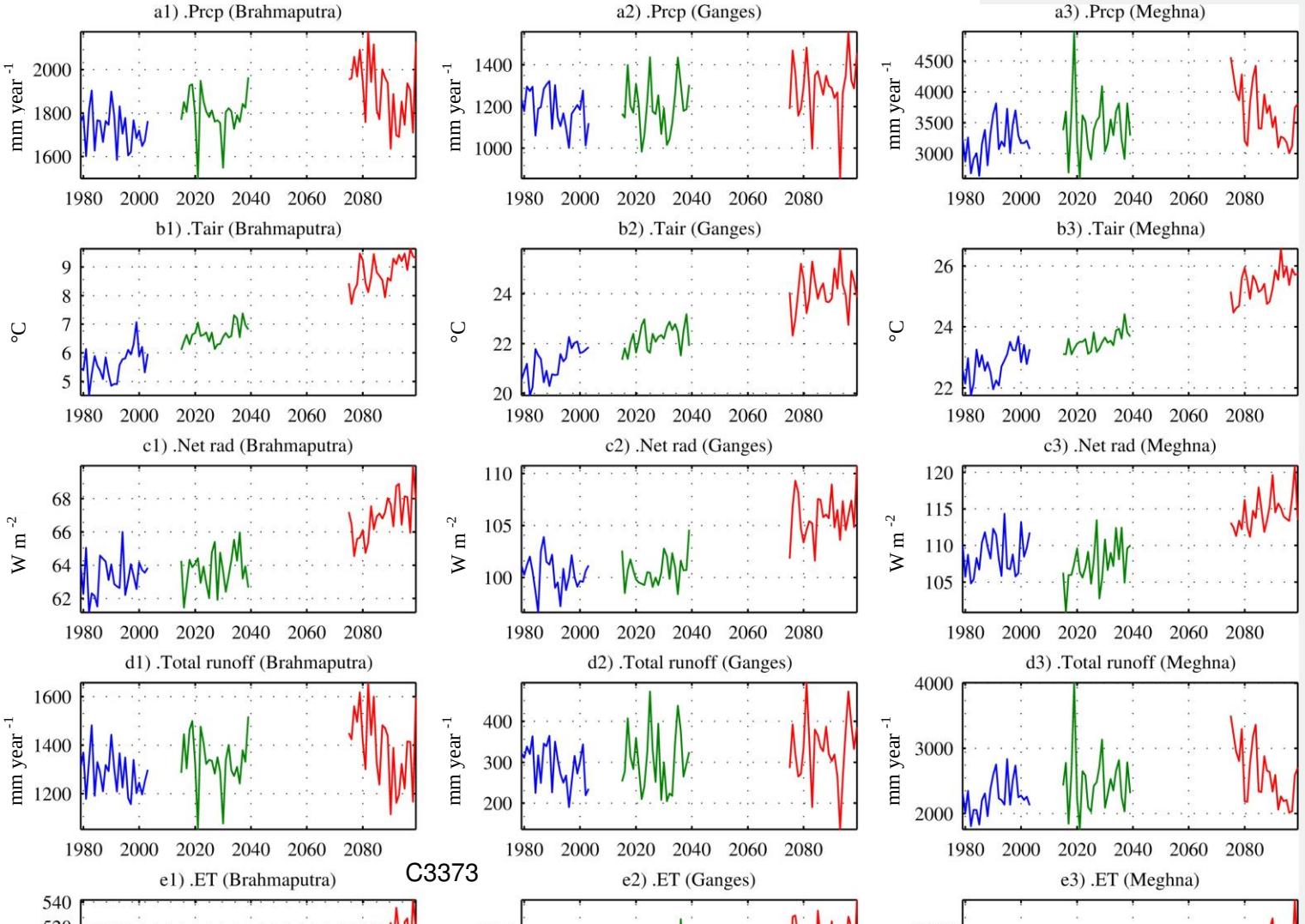
(a) Discharge of Brahmap

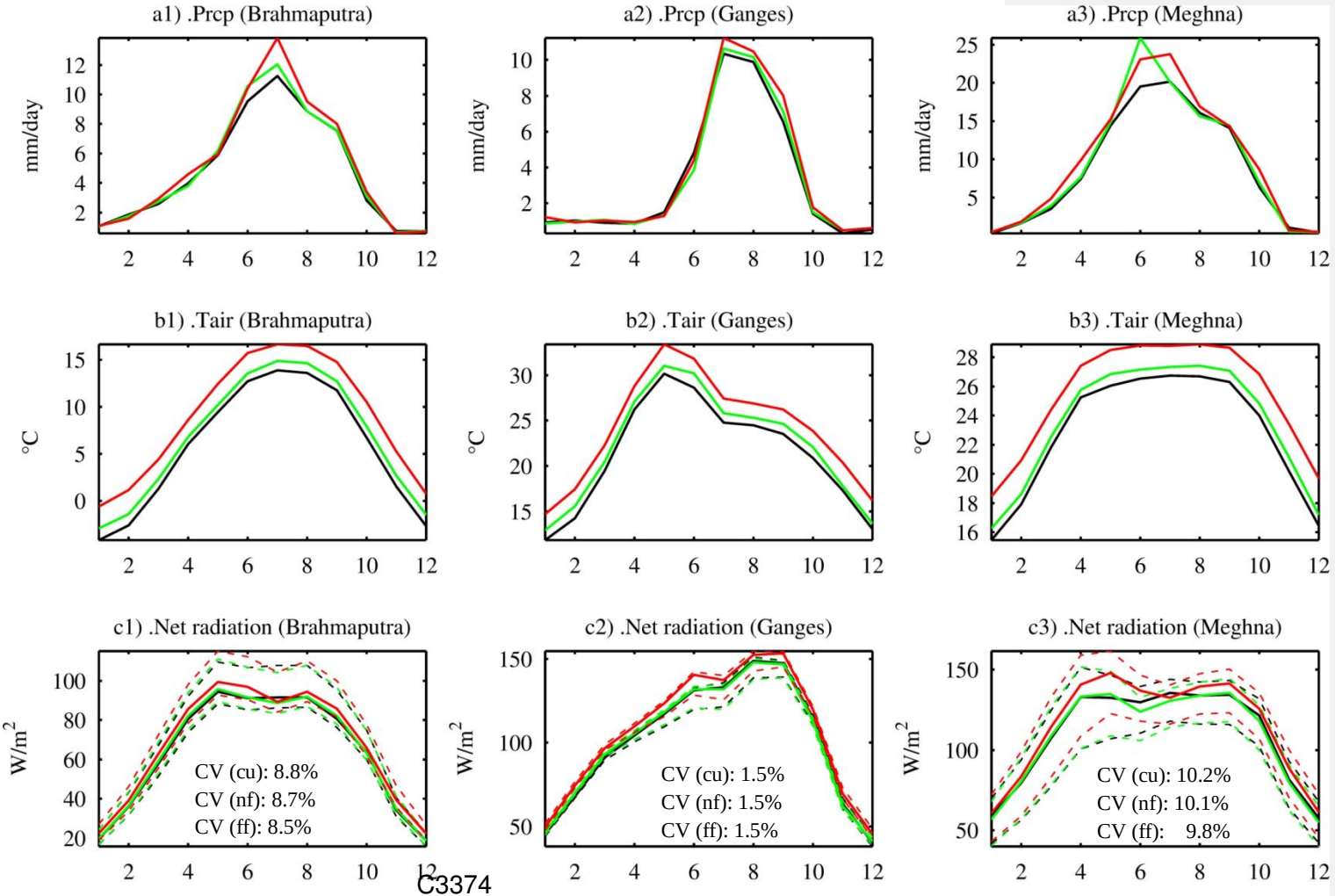


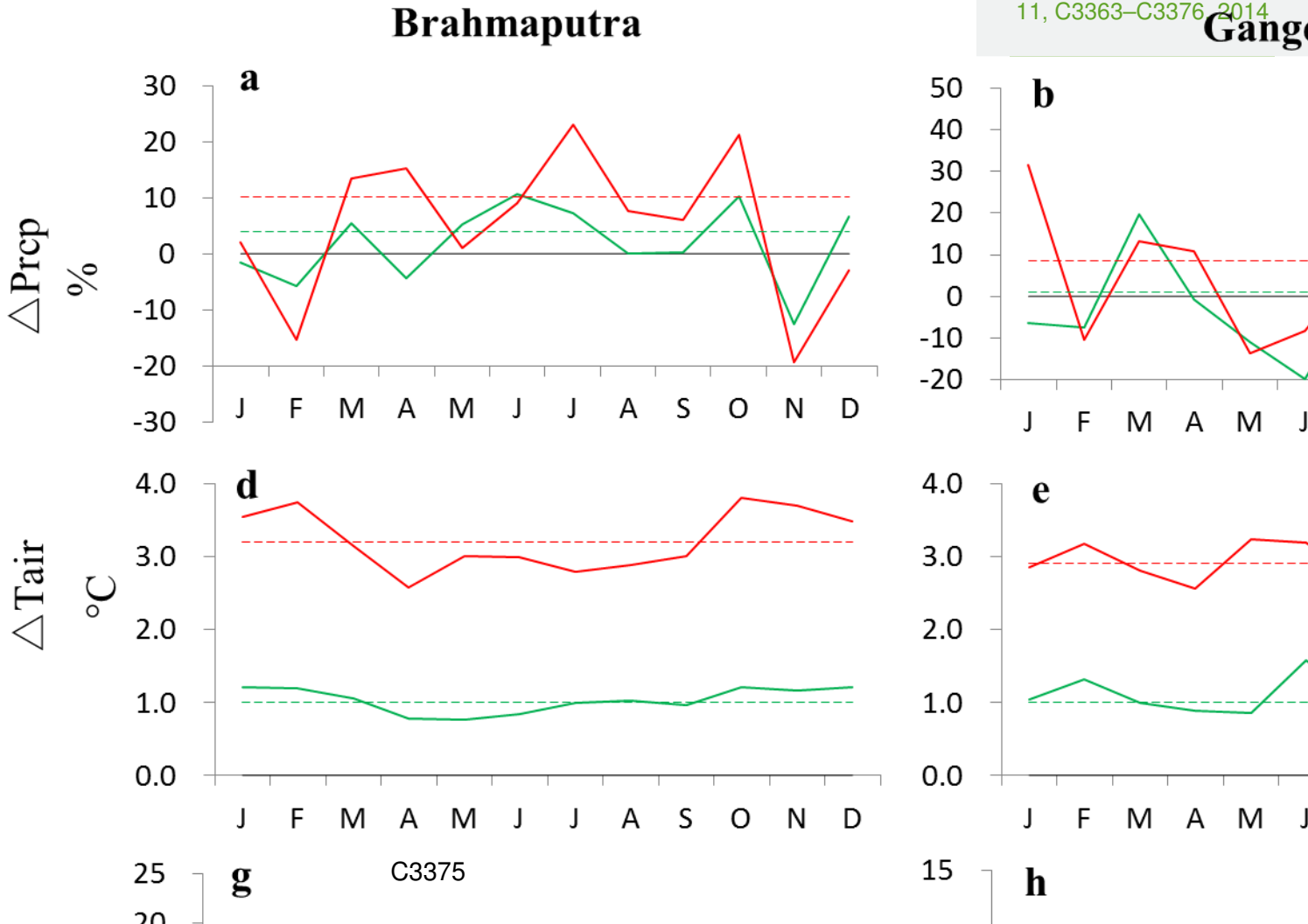
(b) Discharge of Ganges

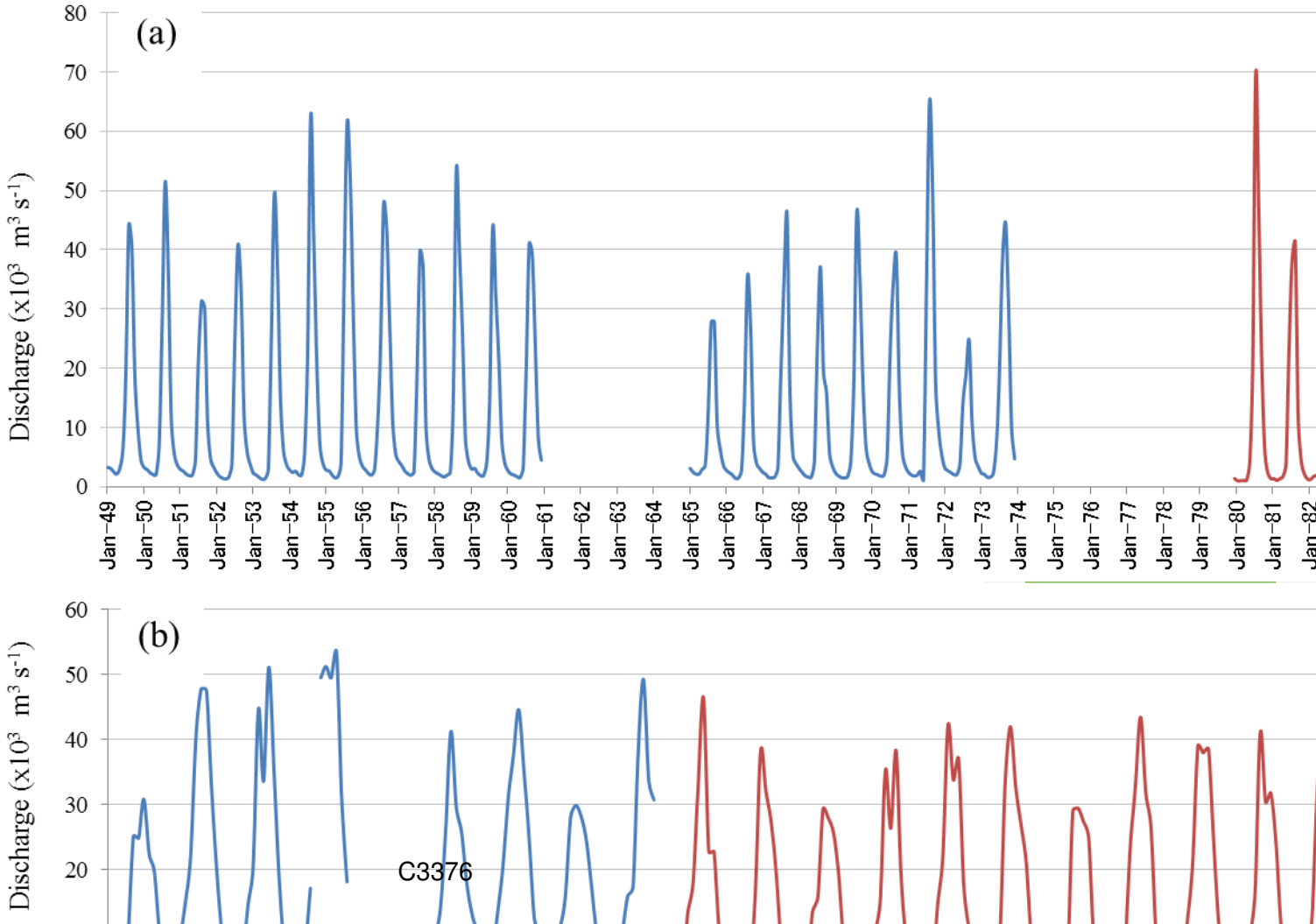

Brahmaputra
Ganges
Meghna
a
b
c
d
e
f
g
h
i
Prcp
mm day-1
Tair
°C
Net rad
W m-2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Brahmaputra
Ganges
Meghna
Total runoff
Surface runoff
Sub−surface runoff
SoilMoist
Prcp
cc: 0.95
cc: 0.83
cc: 0.87
cc: 0.97
cc: 0.86
cc: 0.85
cc: 0.62
cc: 0.75
cc: 0.77
cc: 0.77
cc: 0.82
cc: 0.87


a1) .Prcp (Brahmaputra)
a2) .Prcp (Ganges)
a3) .Prcp (Meghna)
mm year -1
b1) .Tair (Brahmaputra)
b2) .Tair (Ganges)
b3) .Tair (Meghna)
°C
c1) .Net rad (Brahmaputra)
c2) .Net rad (Ganges)
c3) .Net rad (Meghna)
W m -2
d1) .Total runoff (Brahmaputra)
d2) .Total runoff (Ganges)
d3) .Total runoff (Meghna)
e1) .ET (Brahmaputra)
e2) .ET (Ganges)
e3) .ET (Meghna)
1980 2000 2020 2040 2060 2080


a1) .Prcp (Brahmaputra)
a2) .Prcp (Ganges)
a3) .Prcp (Meghna)
mm/day
b1) .Tair (Brahmaputra)
b2) .Tair (Ganges)
b3) .Tair (Meghna)
°C
c1) .Net radiation (Brahmaputra)
CV (cu): 8.8%
CV (nf): 8.7%
CV (ff): 8.5%
c2) .Net radiation (Ganges)
CV (cu): 1.5%
CV (nf): 1.5%
CV (ff): 1.5%
c3) .Net radiation (Meghna)
CV (cu): 10.2%
CV (nf): 10.1%
CV (ff): 9.8%
W/m2


Brahmaputra
Gange
a
b
d
e
g
h
△Prcp
%
△Tair
°C
30
20
10
0
-10
-20
-30
50
40
30
20
10
0
-10
-20
4.0
3.0
2.0
1.0
0.0
25
15
J F M A M J J A S O N D
C3375


(a)
Discharge (x10³ m³ s⁻¹)
0
10
20
30
40
50
60
70
80
Jan-49
Jan-50
Jan-51
Jan-52
Jan-53
Jan-54
Jan-55
Jan-56
Jan-57
Jan-58
Jan-59
Jan-60
Jan-61
Jan-62
Jan-63
Jan-64
Jan-65
Jan-66
Jan-67
Jan-68
Jan-69
Jan-70
Jan-71
Jan-72
Jan-73
Jan-74
Jan-75
Jan-76
Jan-77
Jan-78
Jan-79
Jan-80
Jan-81
Jan-82
(b)
Discharge (x10³ m³ s⁻¹)
0
10
20
30
40
50
60
C3376