

How do observation-based ISIMIP3a impact assessments compare with GCM-based fingerprinting?

Mel Thanatcha Brehon

ISIMIP-PROCLIAS workshop
April 26, 2024

ISIMIP3a - ATTRICI

Why ?

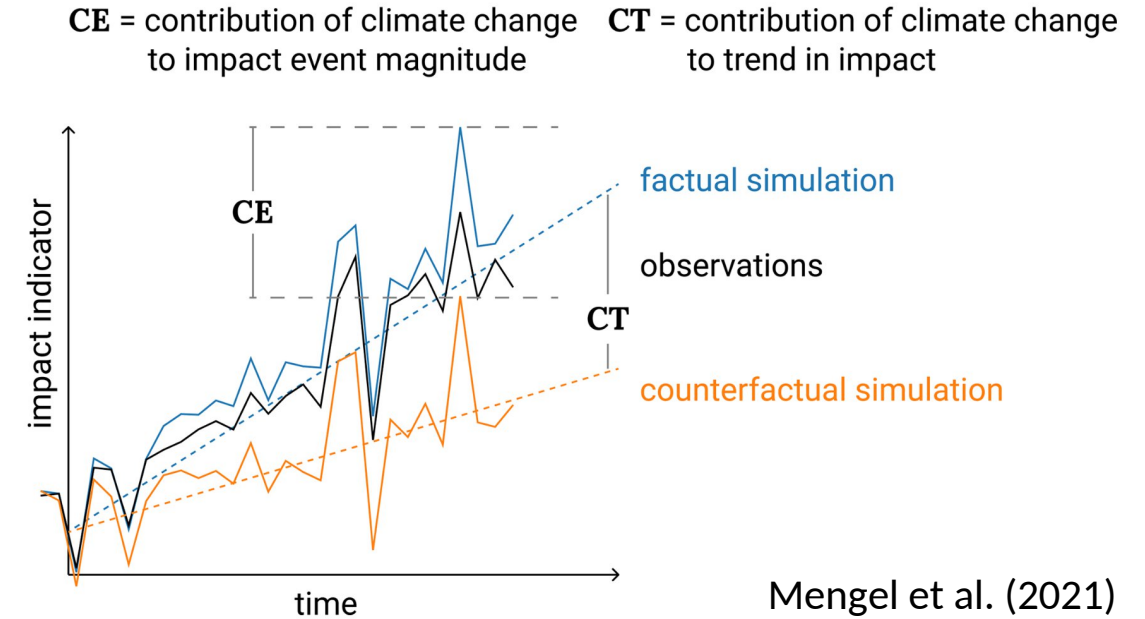
- Attribute realized impacts
- Day-to-day variability
- Climate model limitations

Available research

- Long-term changes in climate (1901-2019) in GSWP3-W5E5 (Mengel, 2021)

Proposed research

- Long-term changes in climate & river discharge (1901-2014) on other reanalysis products
- Impact attribution on 1901-2014 and 30-year sub-periods
- Comparison with historical GCM-based data from ISIMIP3b (CMIP6)



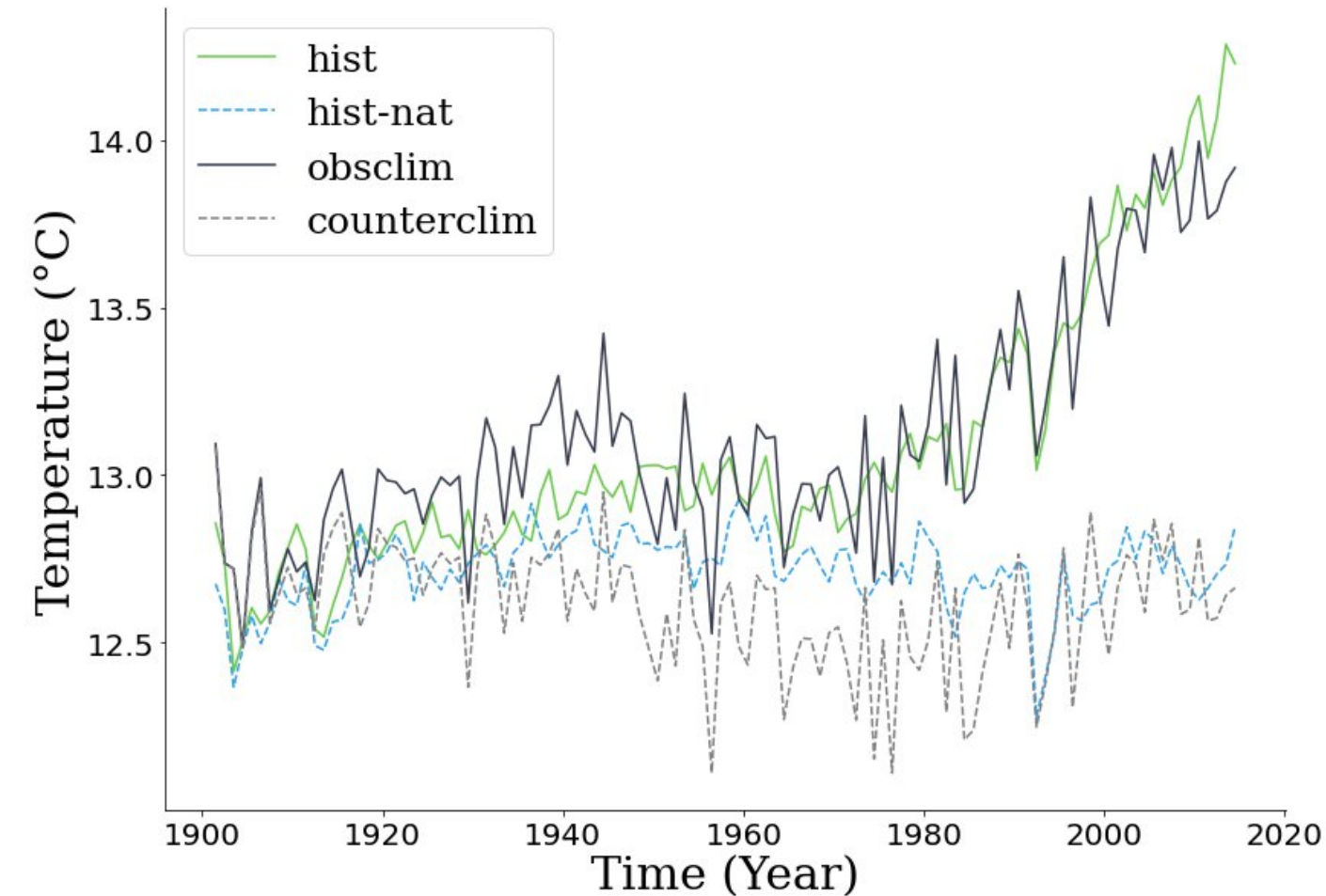
Data & Methodology

- Climate data
 - ISIMIP3a
 - obsclim
 - counterclim
 - ISIMIP3b
 - hist
 - hist-nat
- Impact data
 - WaterGAP – DHF histsoc
- Annual 0.5° resolution
- Ensemble means
- Long-term changes in climate and impacts over 1901-1914
- Attribution of trends in impact
 - Over 1901-2014, 1925-1954, 1955-1984, 1985-2014
- Attribution of impact event magnitude
 - Over 1985-2014

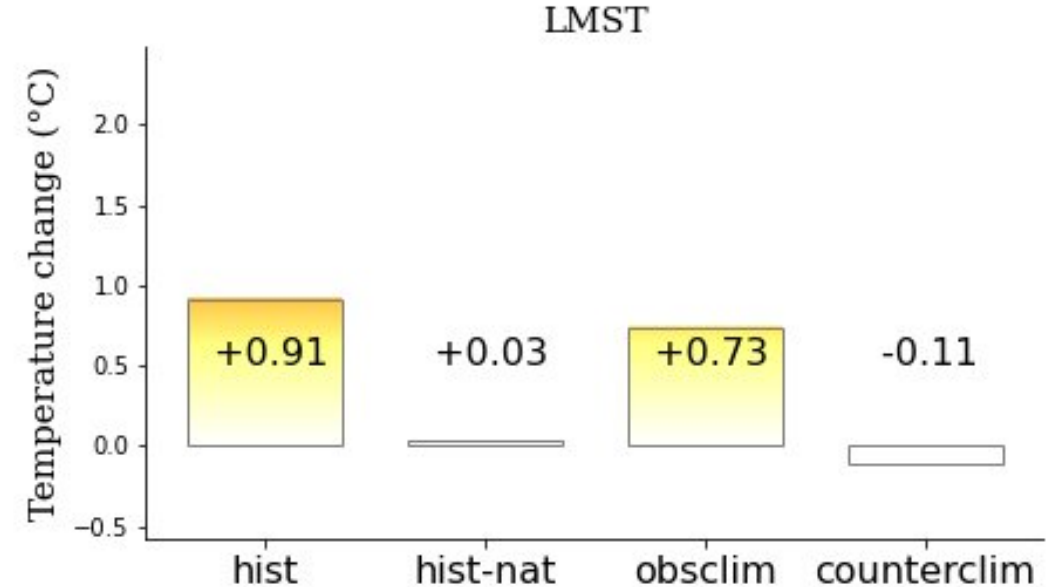
ISIMIP3a	ISIMIP3b
20CRv3-ERA5 20CRv3-W5E5 GSWP3-W5E5	GFDL-ESM4 IPSL-CM6A-LR MRI-ESM2-0 CanESM5 CNRM-CM6-1 MIROC6

Changes in large-scale mean temperatures (1901-2014)

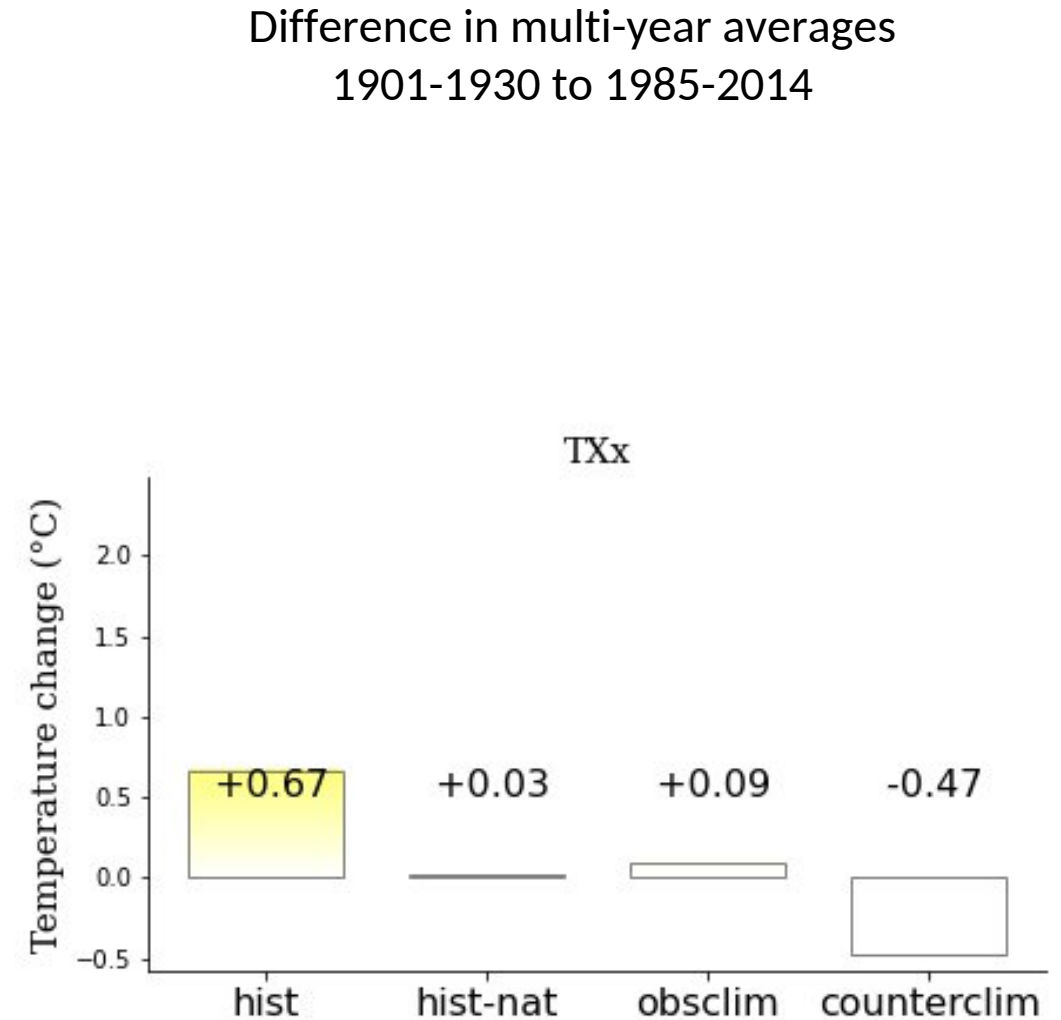
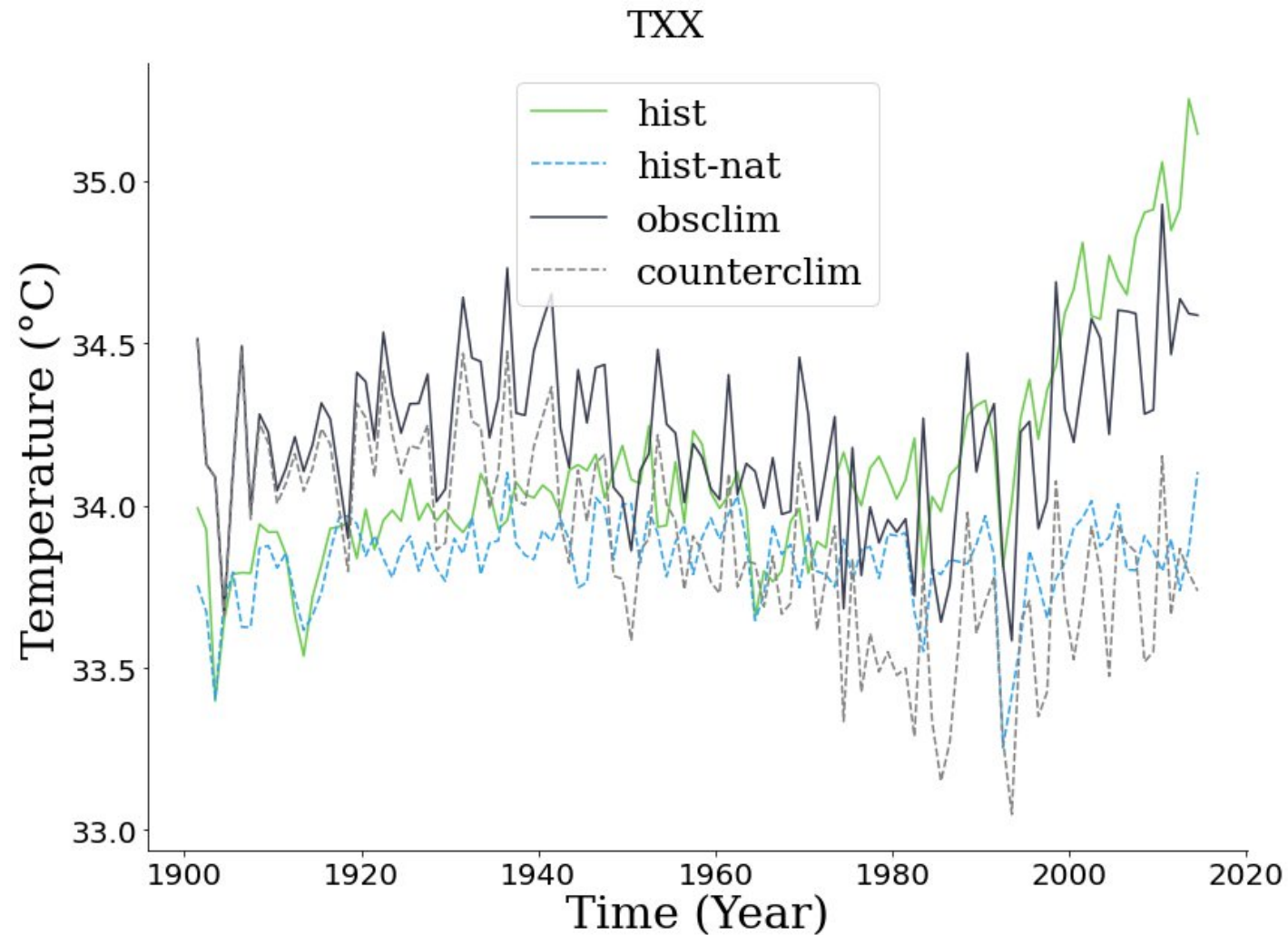
LMST



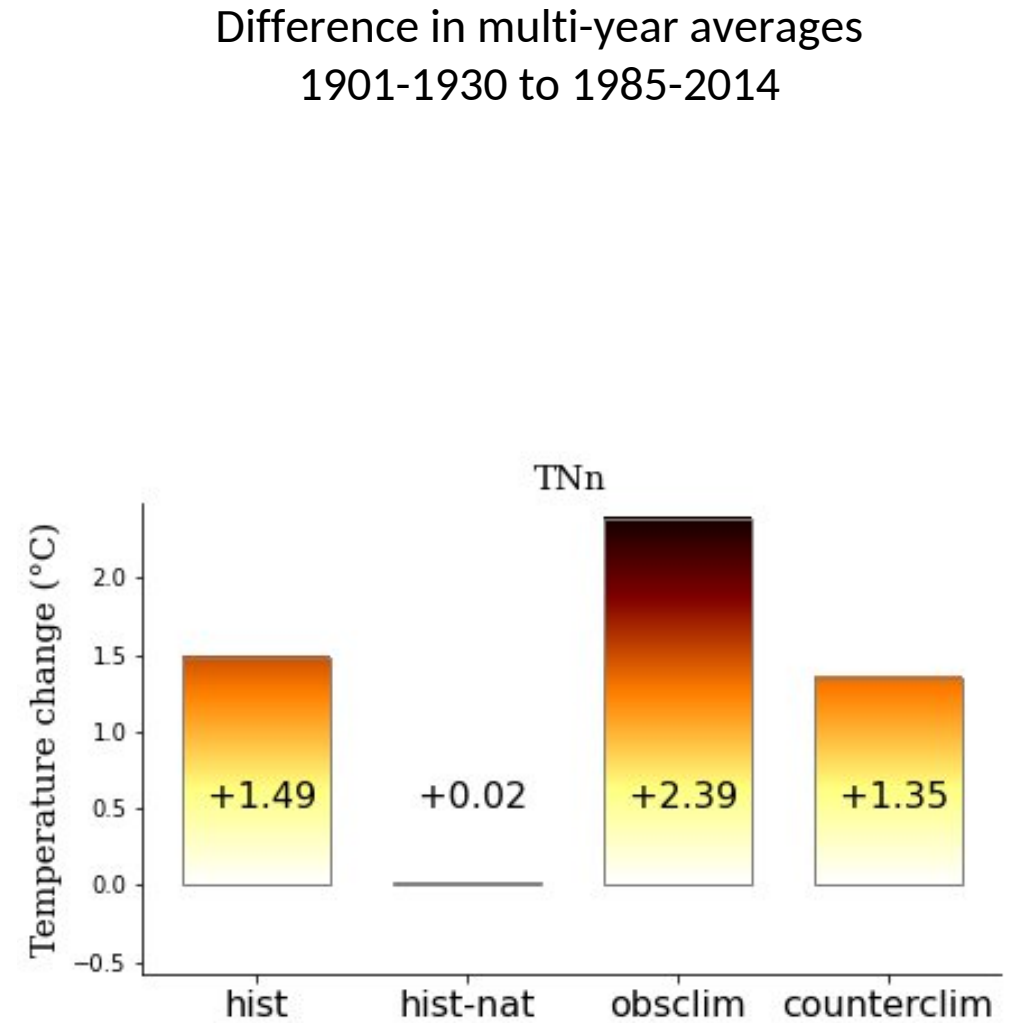
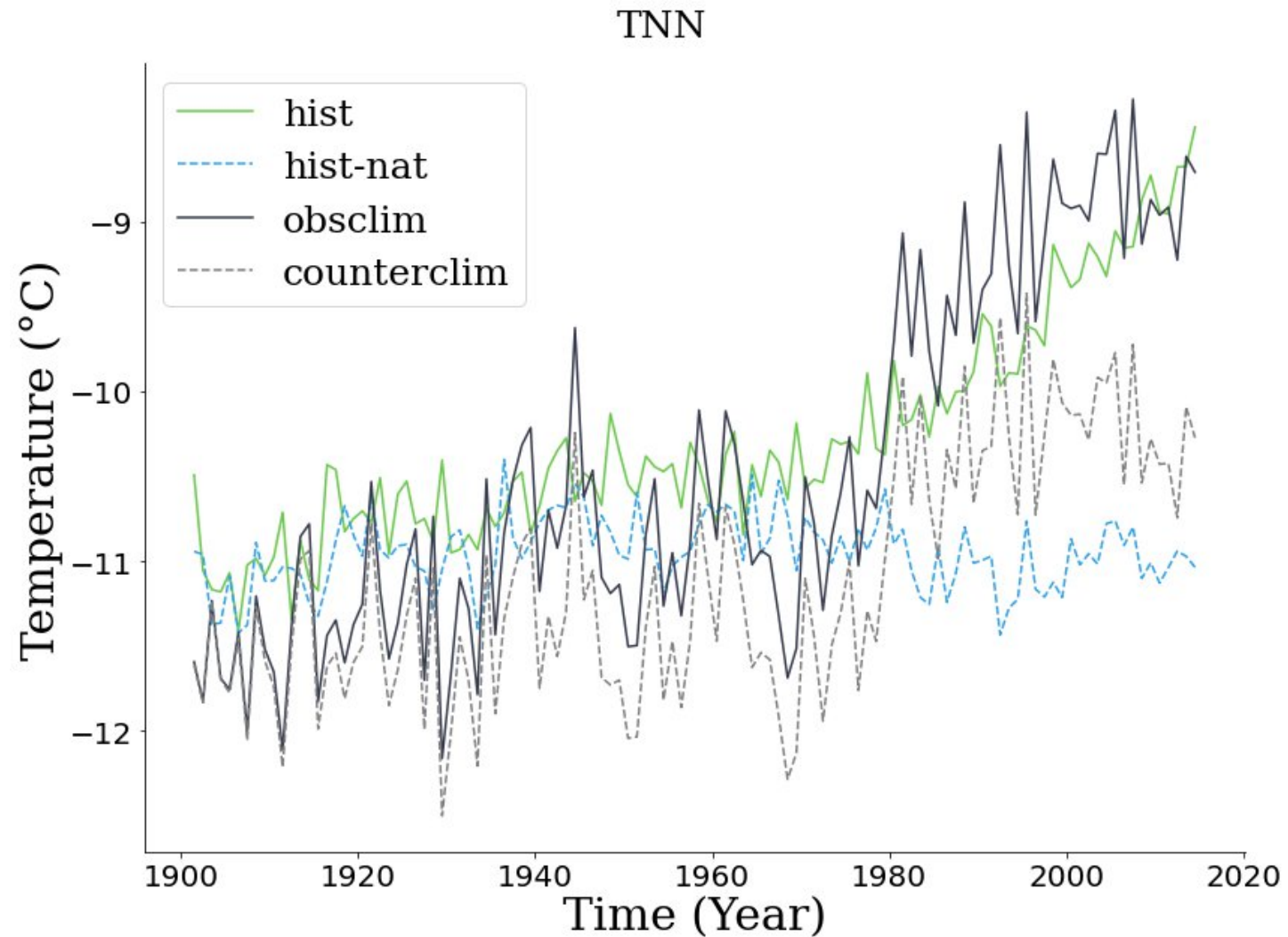
Difference in multi-year averages
1901-1930 to 1985-2014



Changes in large-scale extreme temperatures (1901-2014)

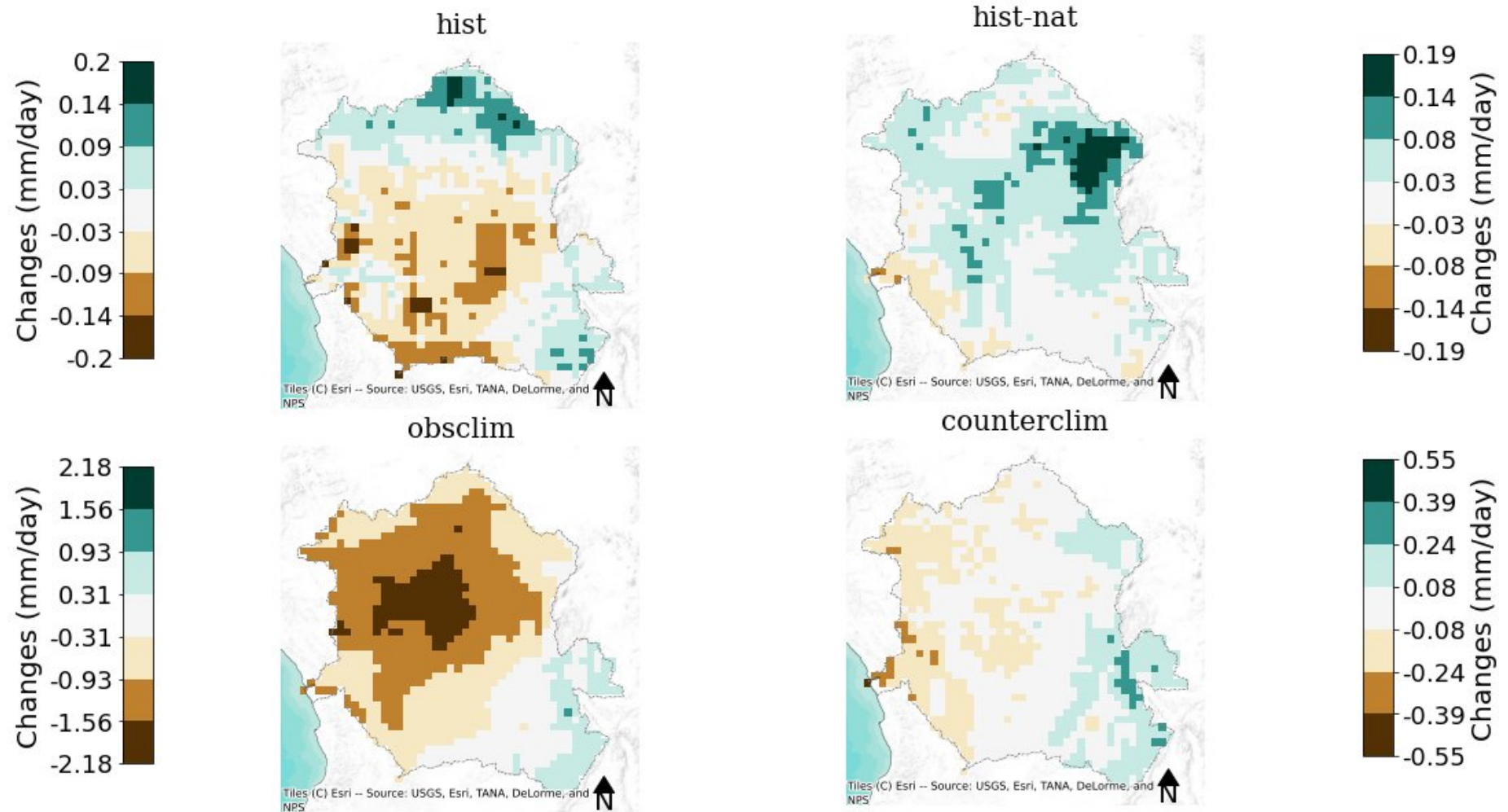


Changes in large-scale extreme temperatures (1901-2014)



Long-term changes in precipitation means

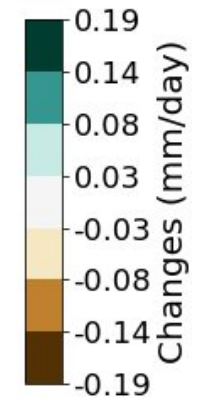
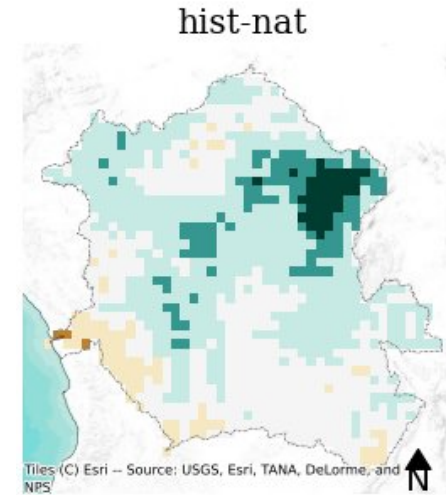
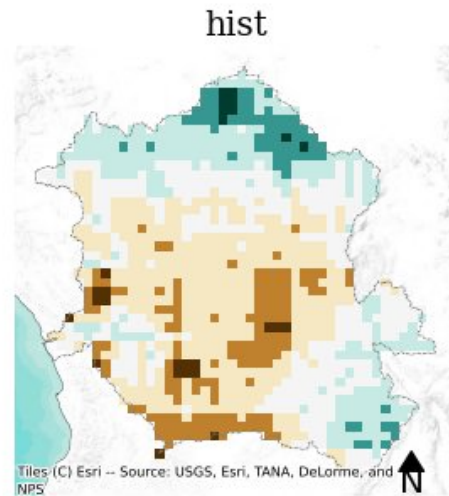
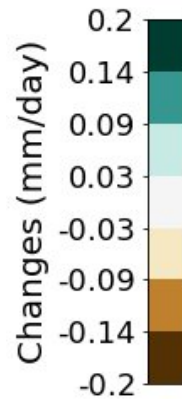
Difference in multi-year averages
1901-1930 to 1985-2014



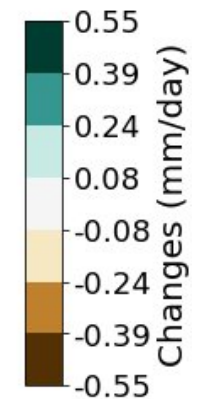
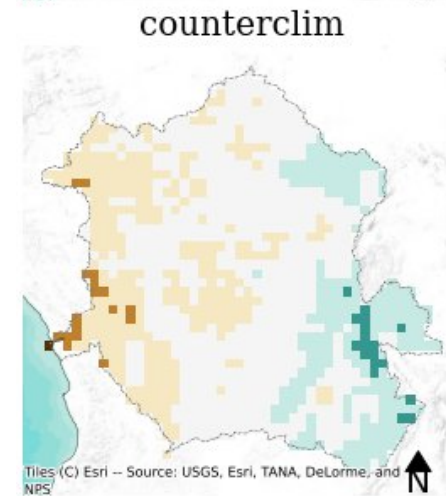
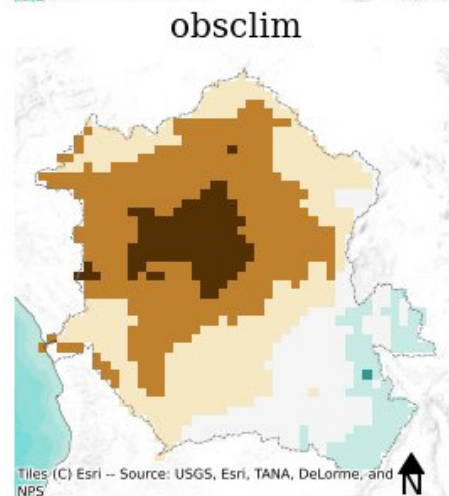
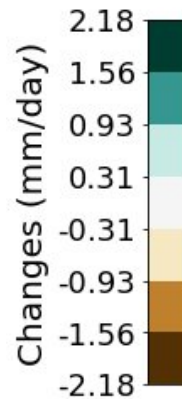
Long-term changes in precipitation means

Difference in multi-year averages
1901-1930 to 1985-2014

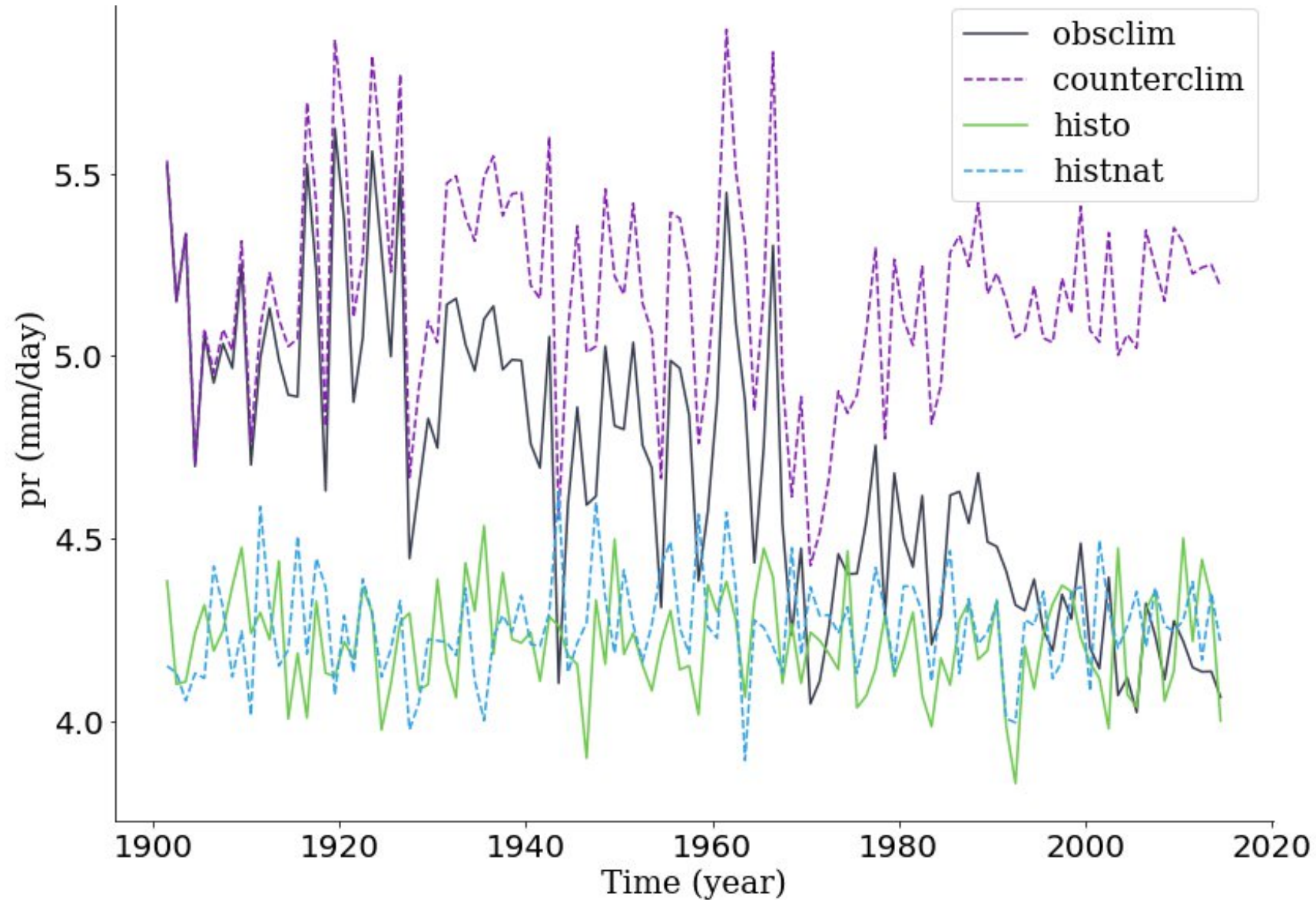
-0.07 mm/day
on 58 %



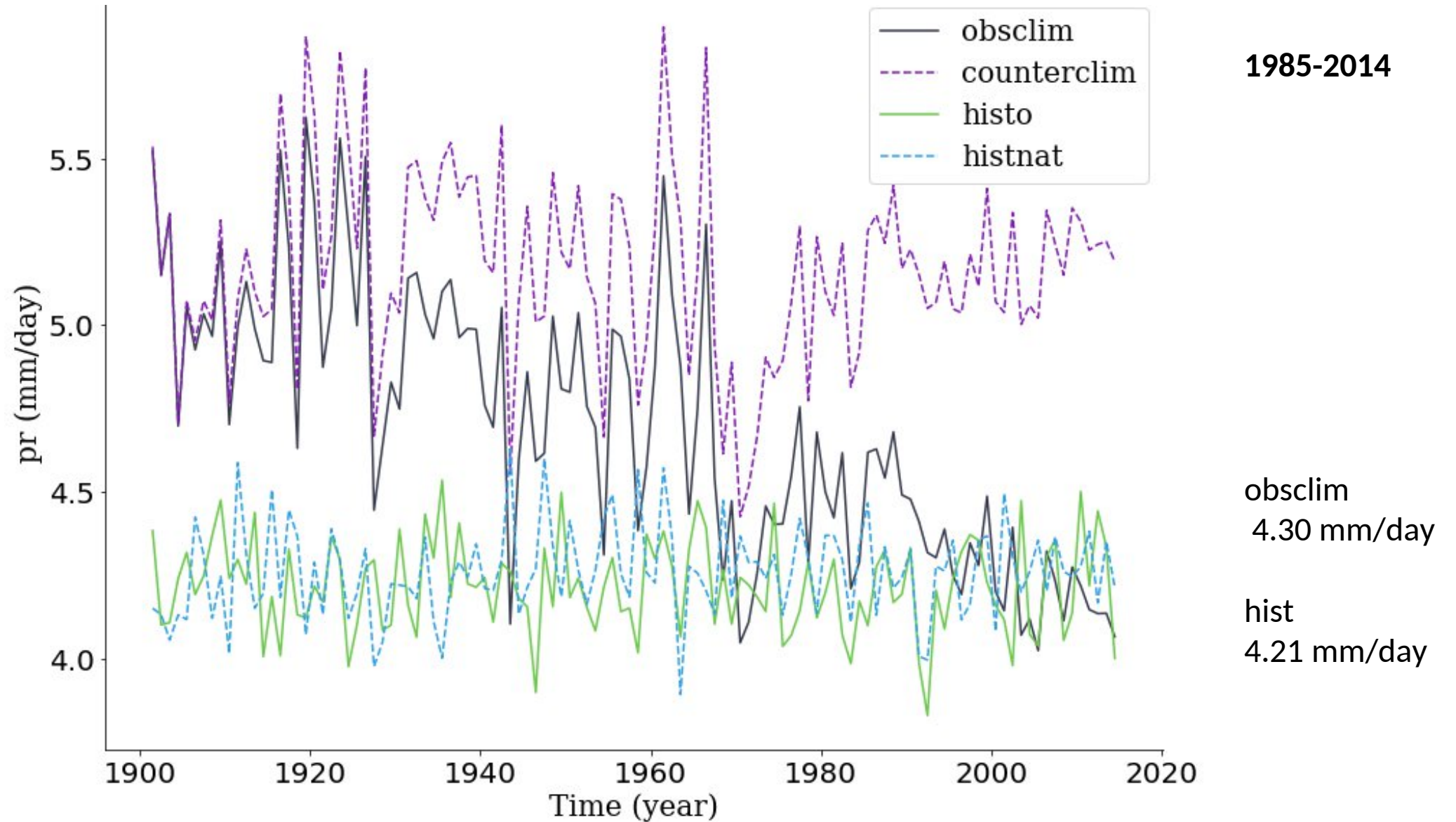
-1.00 mm/day
on 82%



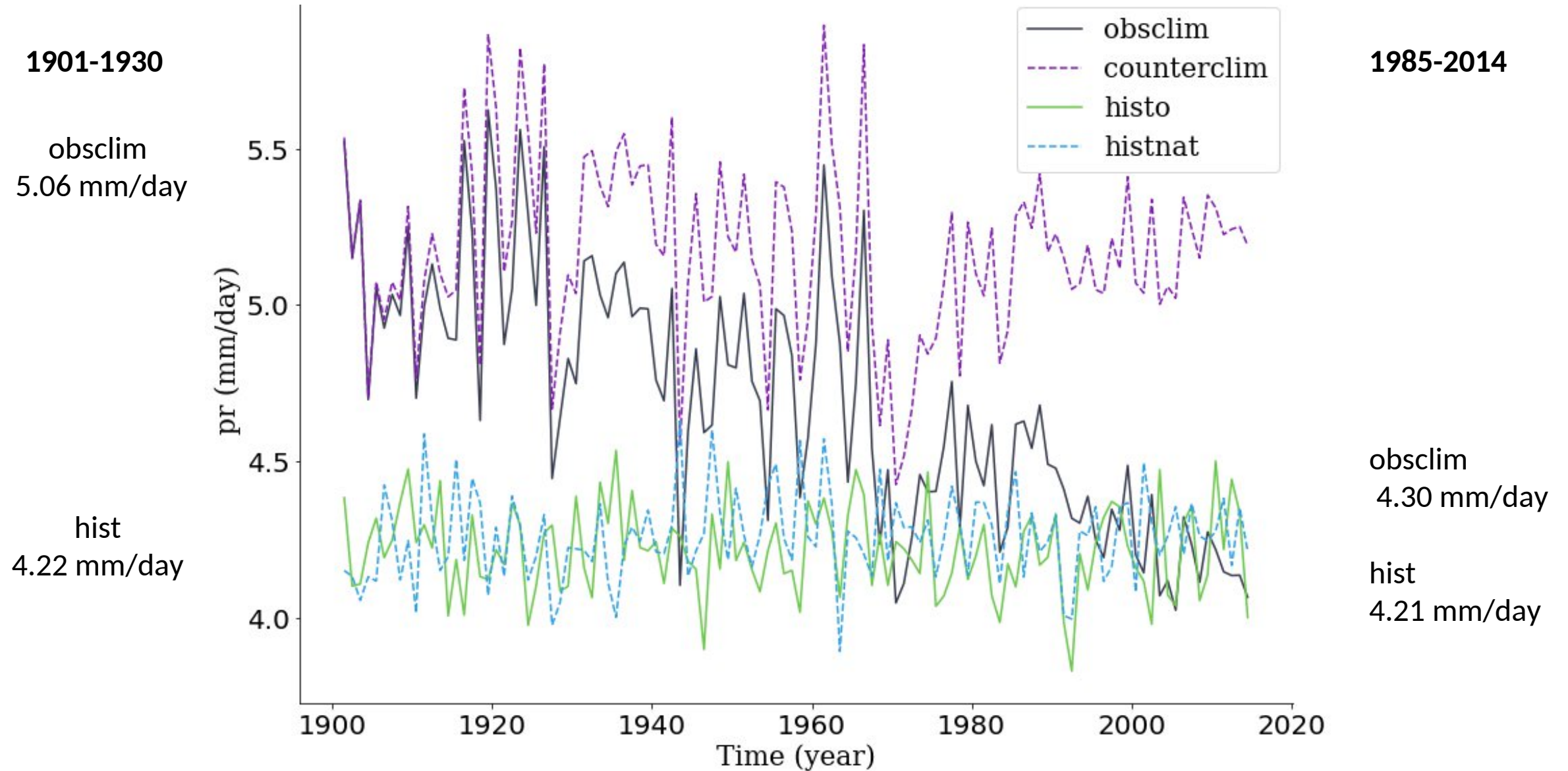
Regional mean precipitation – Congo basin



Regional mean precipitation – Congo basin

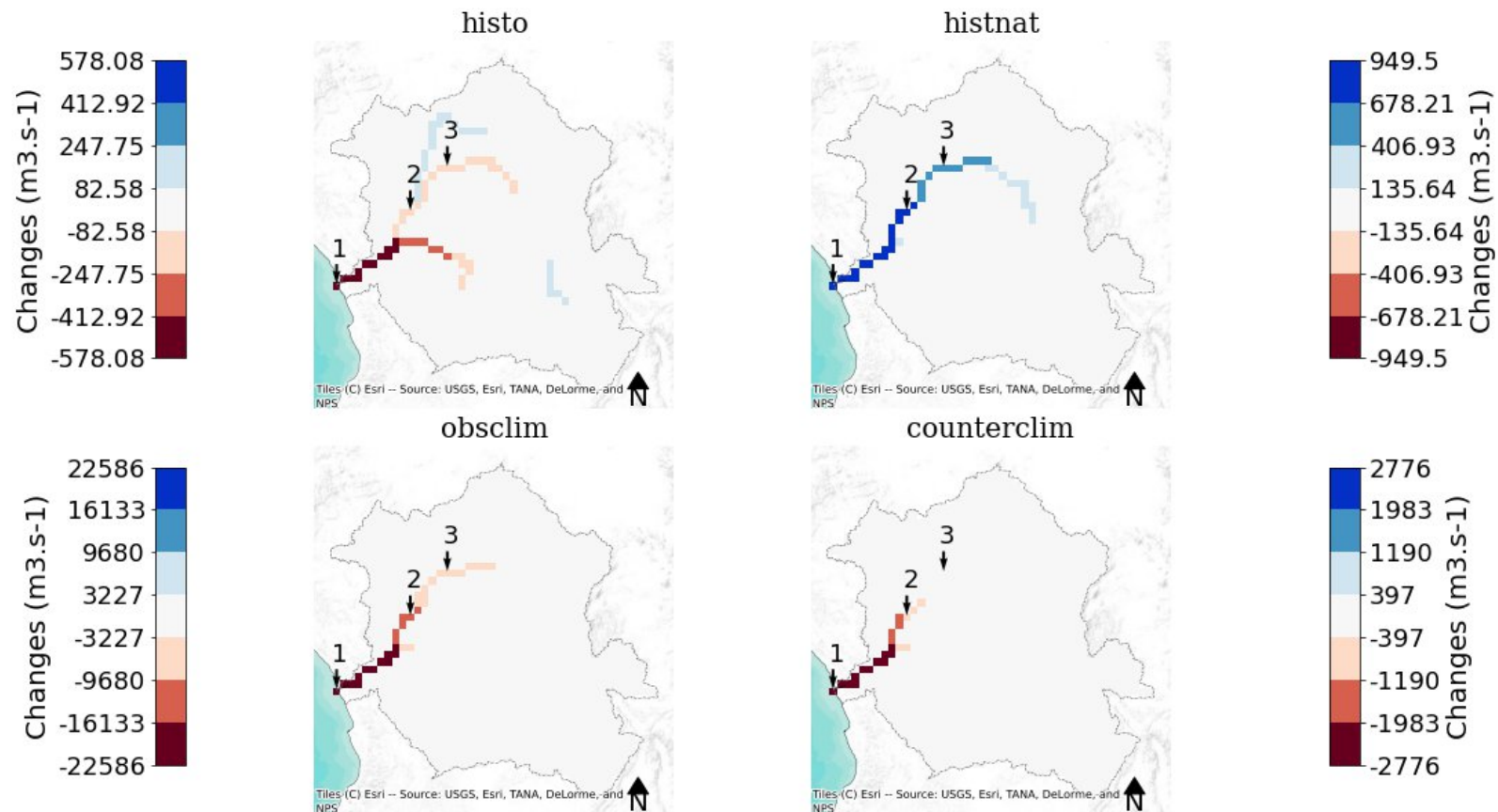


Regional mean precipitation – Congo basin



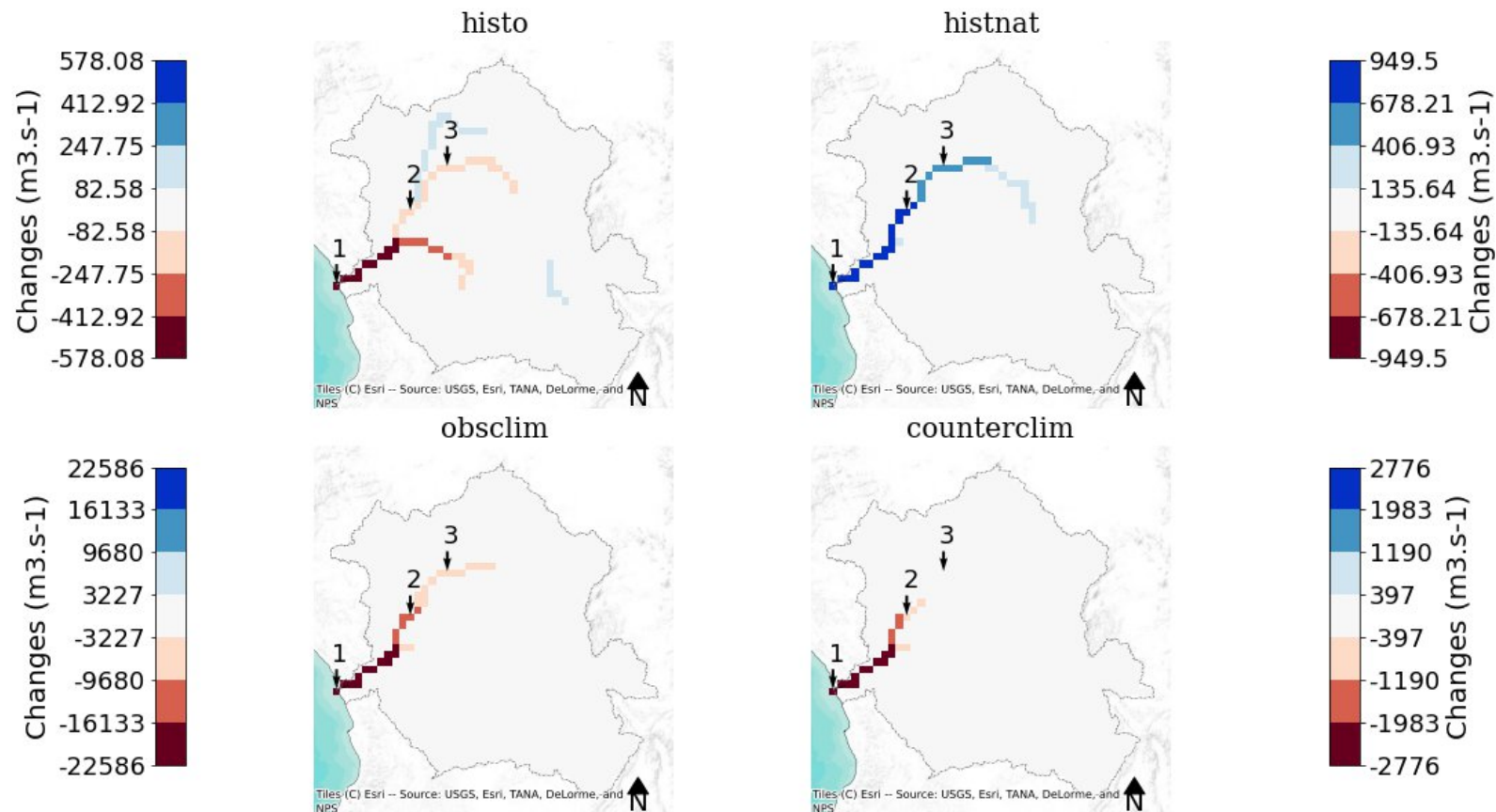
Long-term changes in river discharge means

Difference in multi-year averages
1901-1930 to 1985-2014



Long-term changes in river discharge means

Difference in multi-year averages
1901-1930 to 1985-2014



**Relative change
at the outlet**

hist-nat
+ 2.22%

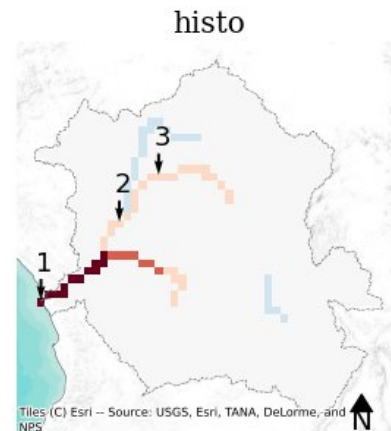
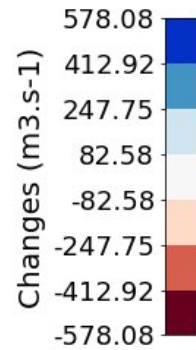
counterclim
- 4.22%

Long-term changes in river discharge means

Difference in multi-year averages
1901-1930 to 1985-2014

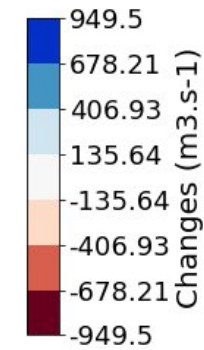
Relative change
at the outlet

obsclim
- 36.83 %

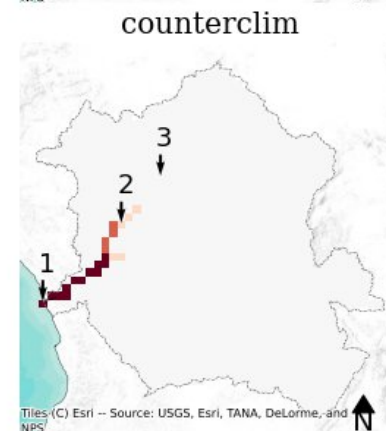
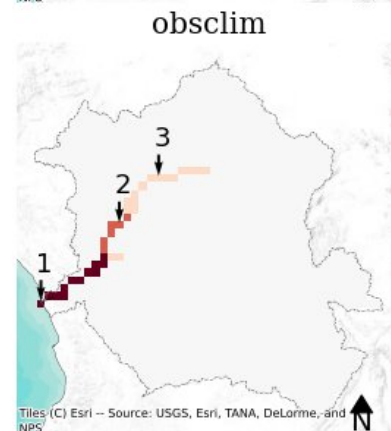
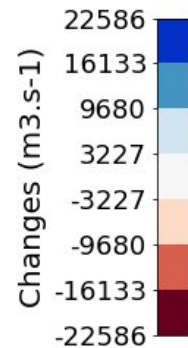


Relative change
at the outlet

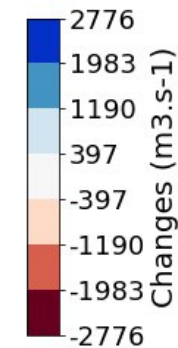
hist-nat
+ 2.22%



hist
- 1.40 %



counterclim
- 4.22%



Impact of observed changes in climate on river discharge means & extremes

Mean

	1925-1954	1955-1985	1985-2014	1901-2014
ISIMIP3a	-17.17%	-21.26%	-38.56%	-21.22%
ISIMIP3b	-1.33%	-4.84%	-4.29%	-3.07%

Impact of observed changes in climate on river discharge means & extremes

1925-1954

obsclim : $54443 \text{ m}^3/\text{s}$

hist : $41532 \text{ m}^3/\text{s}$

Mean

	1925-1954	1955-1985	1985-2014	1901-2014
ISIMIP3a	-17.17%	-21.26%	-38.56%	-21.22%
ISIMIP3b	-1.33%	-4.84%	-4.29%	-3.07%

Impact of observed changes in climate on river discharge means & extremes

1925-1954

obsclim : $54443 \text{ m}^3/\text{s}$

hist : $41532 \text{ m}^3/\text{s}$

Mean

	1925-1954	1955-1985	1985-2014	1901-2014
ISIMIP3a	-17.17%	-21.26%	-38.56%	-21.22%
ISIMIP3b	-1.33%	-4.84%	-4.29%	-3.07%

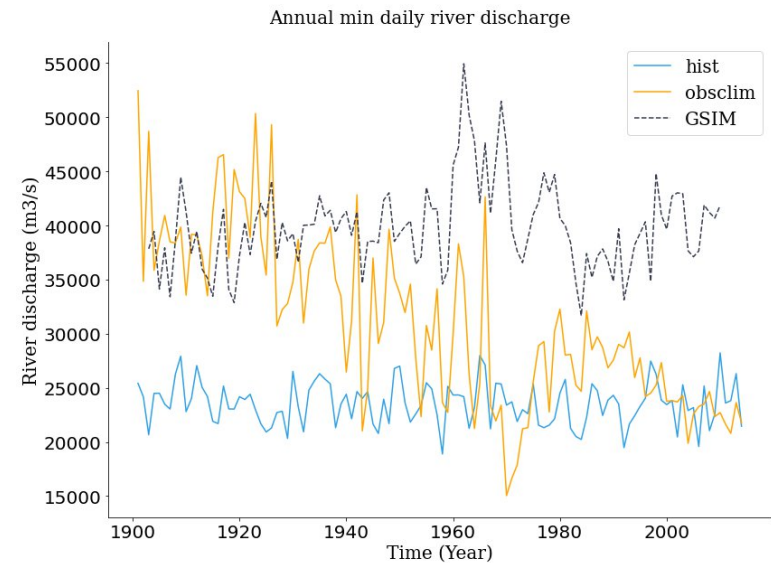
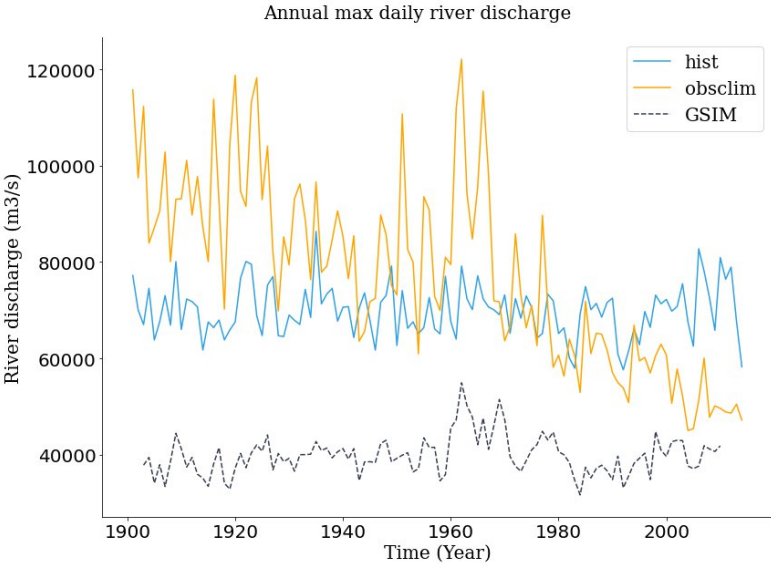
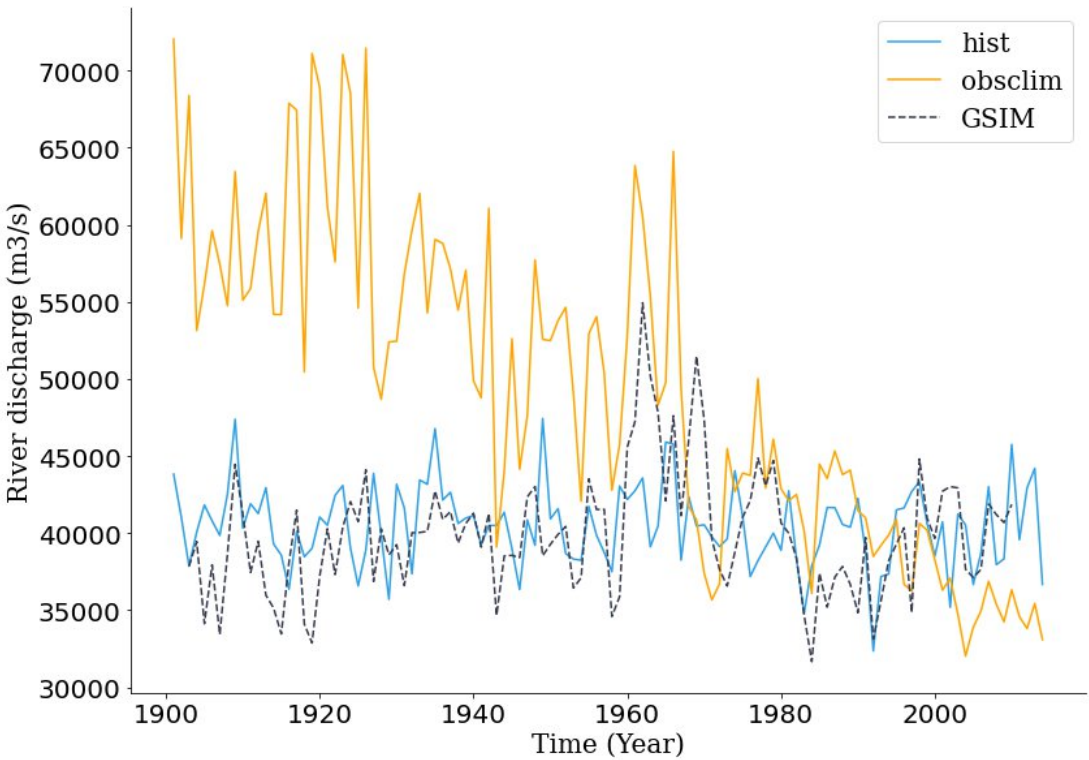
100-year low flow

	1985-2014
ISIMIP3a	-42.87%
ISIMIP3b	4.36%

100-year high flow

	1985-2014
ISIMIP3a	-32.90%
ISIMIP3b	0.81%

River mean discharge precipitation – Kinshasa station



Limitations

- No seasonal analysis
- One observed realization (ISIMIP3a) vs multiple simulated realizations (ISIMIP3b)
- Performance of impact model WaterGAP not assessed

Summary

- Dependence on the quality of observational data
- Substantial difference of (anthropogenic) climate change contribution to river discharge annual means and extremes **over 1985-2014**
 - € Further attribution to non-anthropogenic climate change?
- Disagreement between factual precipitation over the early 20th century
 - Disagreement between factual river discharge before
 - But river discharge forced by GCM-based historical climate closer to river discharge observations
 - Implication of the impact model performance ?
- Opportunity for further research on the treatment of climate extremes by ATTRICI