POTSDAM INSTITUTE FOR CLIMATE IMPACT RESEARCH

Comparing impacts of climate change on streamflow among four African regions

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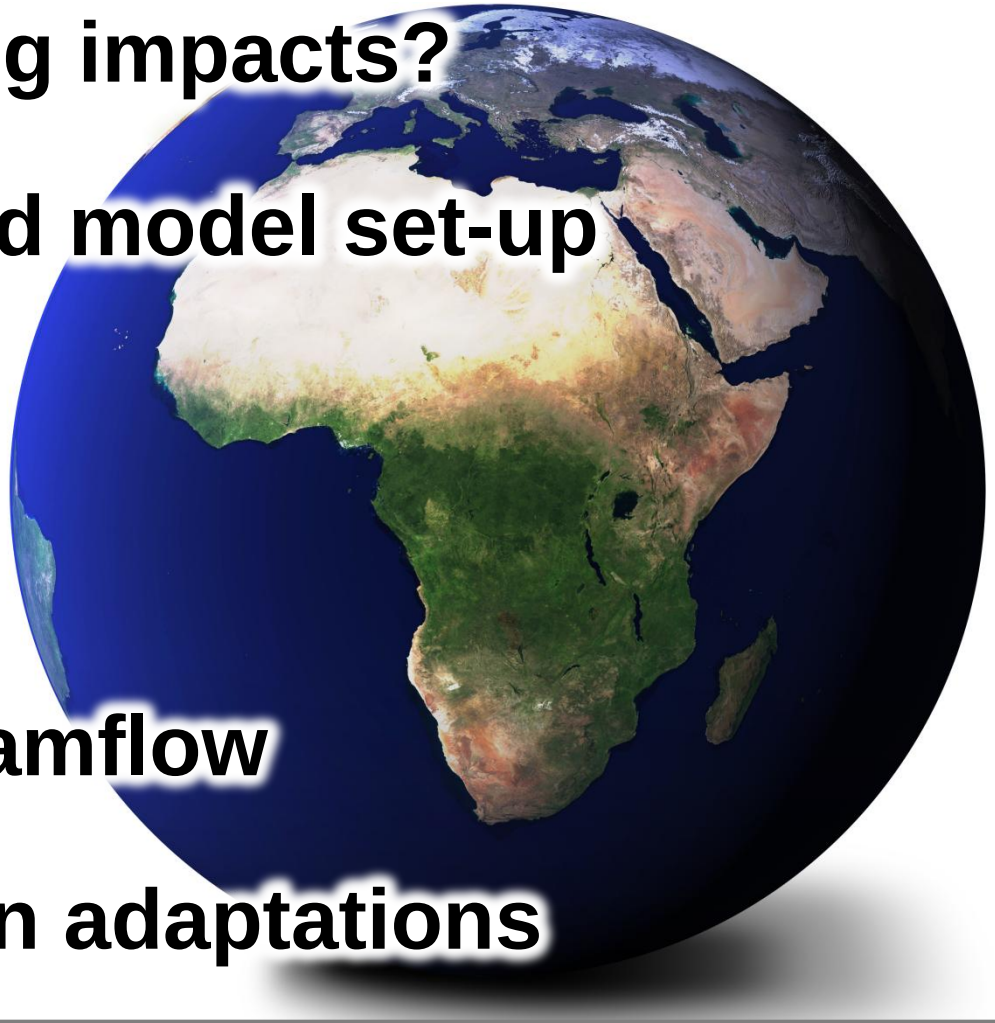
Potsdam Institute for Climate Impact Research
RD2 Climate Impacts & Vulnerability

Outline

1. Why comparing impacts?
2. Study sites and model set-up
3. Climate input
4. Validation
5. Trends in streamflow
6. Implications on adaptations



Why comparing impacts?

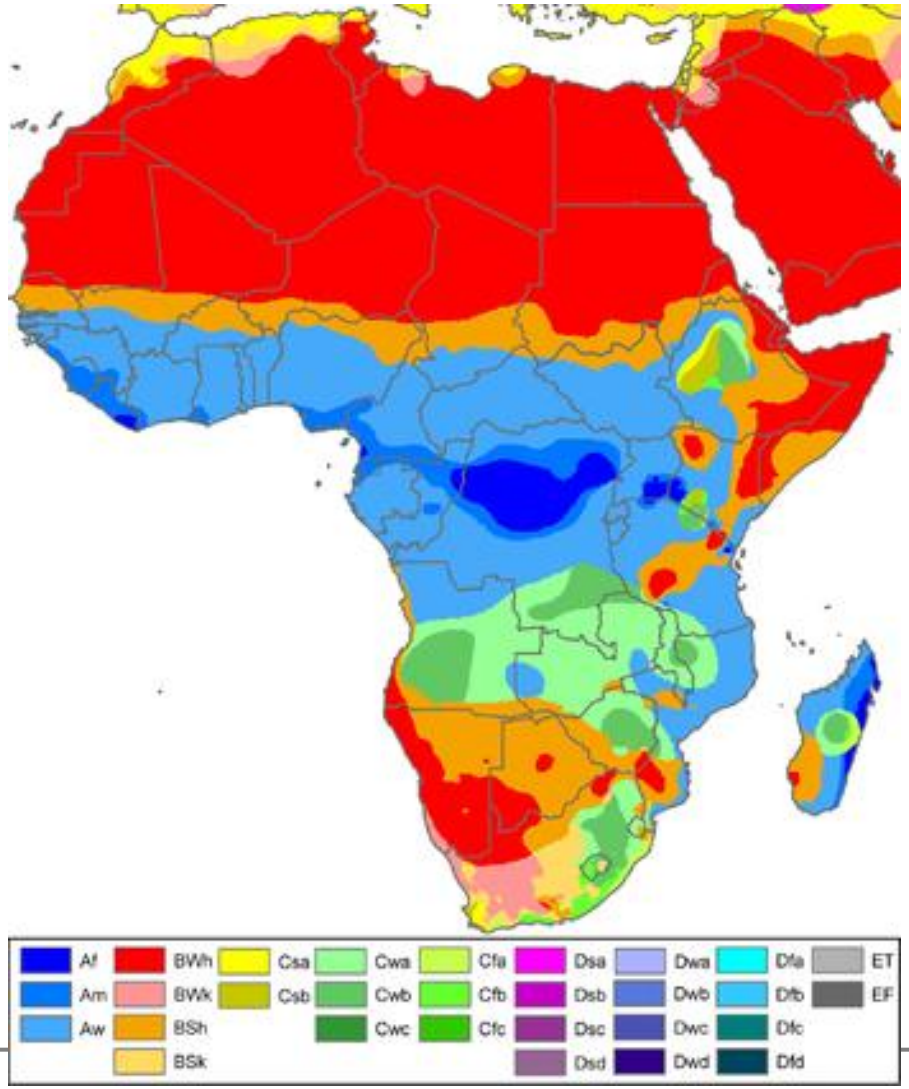
- “Africa is one of the most vulnerable continents to climate change and climate variability, a situation aggravated (…) by low adaptive capacity (high confidence).” (IPCC, AR4)
- Strong need for adaptation, but where?
- Continental studies, regional studies
- But inbetween?

➡ **SWIM model for 4 African regions** (Pilot study for RegMIP)

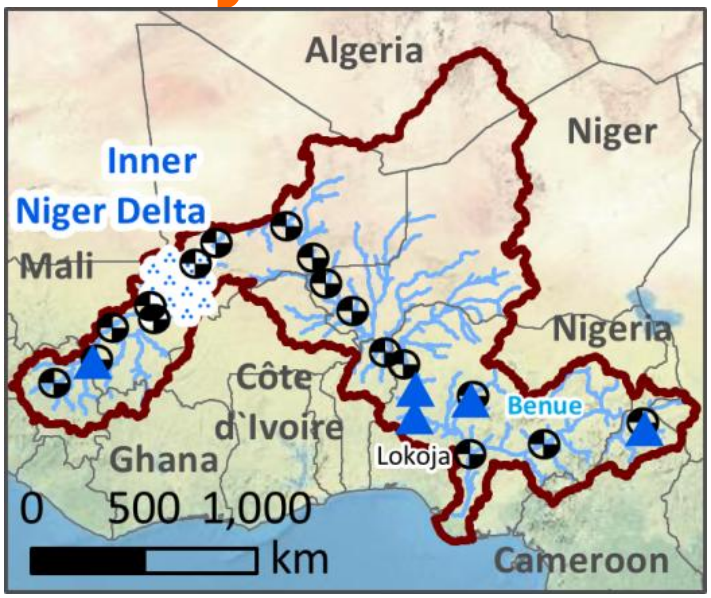
- 5 bias-corrected CMIP5 ESMs, 2 emission scenarios (RCPs)
- Still waiting for CORDEX Africa
- Trends of streamflow in means and extremes (1st half of 21st century)

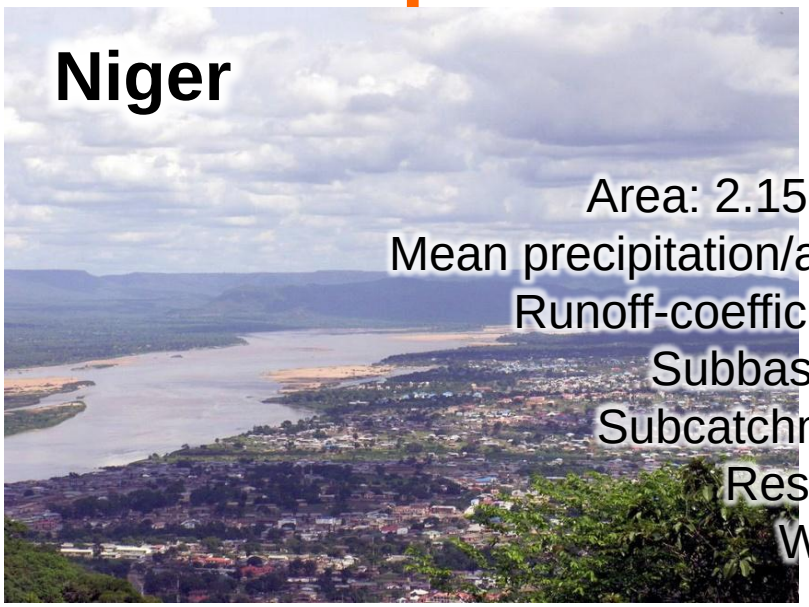
Study sites


10°W
0°
10°E
20°E
30°E
40°E
50°
30°N
20°N
10°N
0°
10°S
20°S
30°S
Niger
Upper Blue Nile
Ubangi
Limpopo

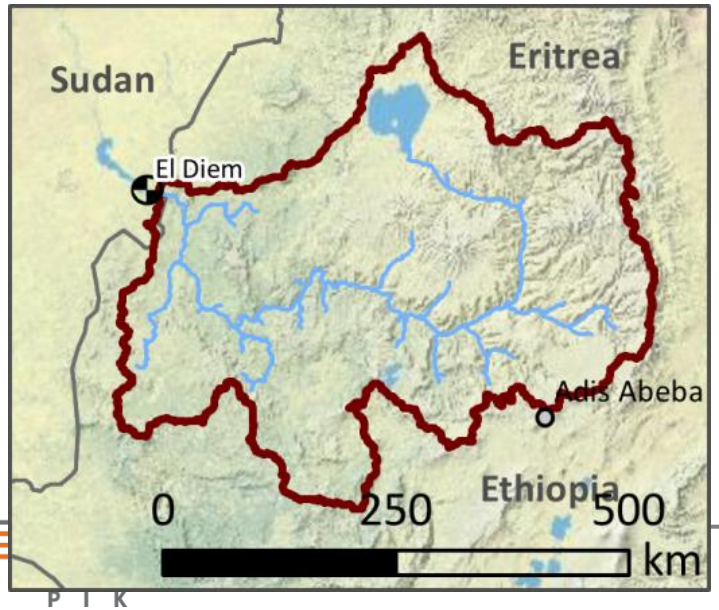

Af
Am
Aw
BWh
BWk
BSh
BSk
Csa
Csb
Cwa
Cwb
Cwc
Cfa
Cfb
Cfc
Dsa
Dsb
Dsc
Dsd
Dwa
Dwb
Dwc
Dwd
Dfa
Dfb
Dfc
Dfd
ET
EF

Study sites and model set-up



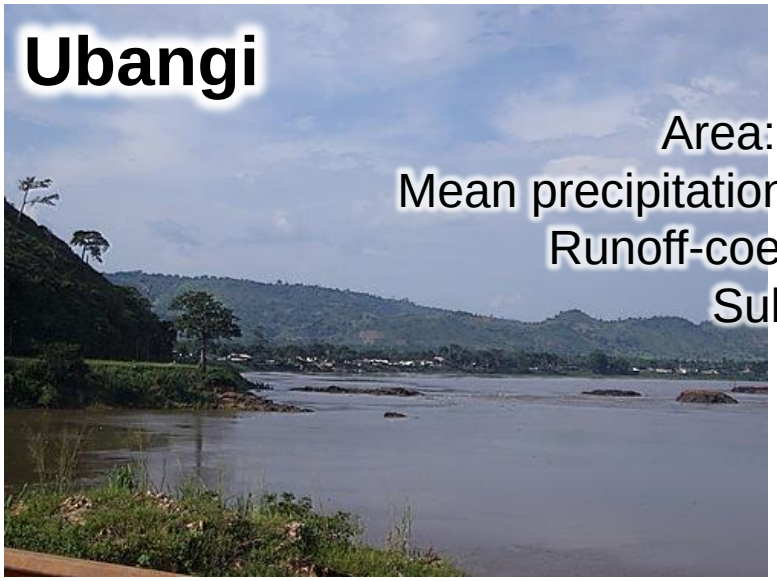


Area: 2.156.000km²
Mean precipitation/a: 682mm
Runoff-coefficient: 18%
Subbasins: 1921
Subcatchments: 18
Reservoirs: 5
Wetland: 1

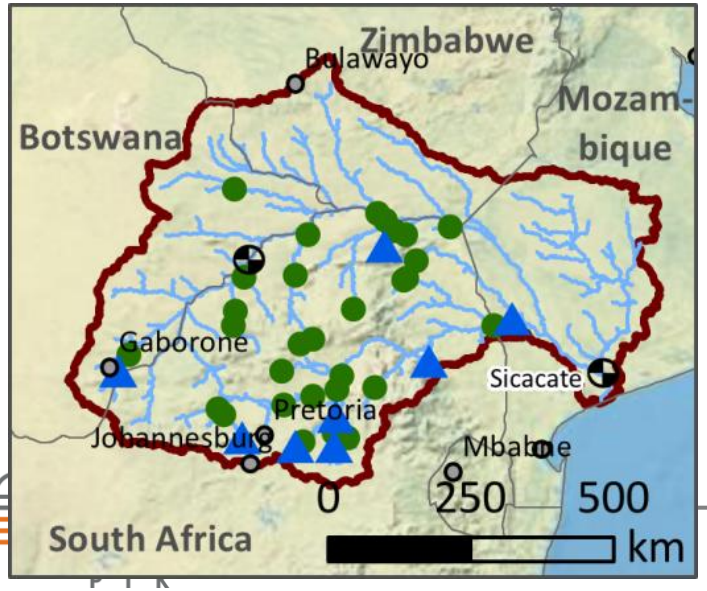


Area: 167.000km²
Mean precipitation/a: 1382mm
Runoff-coefficient: 17%
Subbasins: 558

Study sites and model set-up

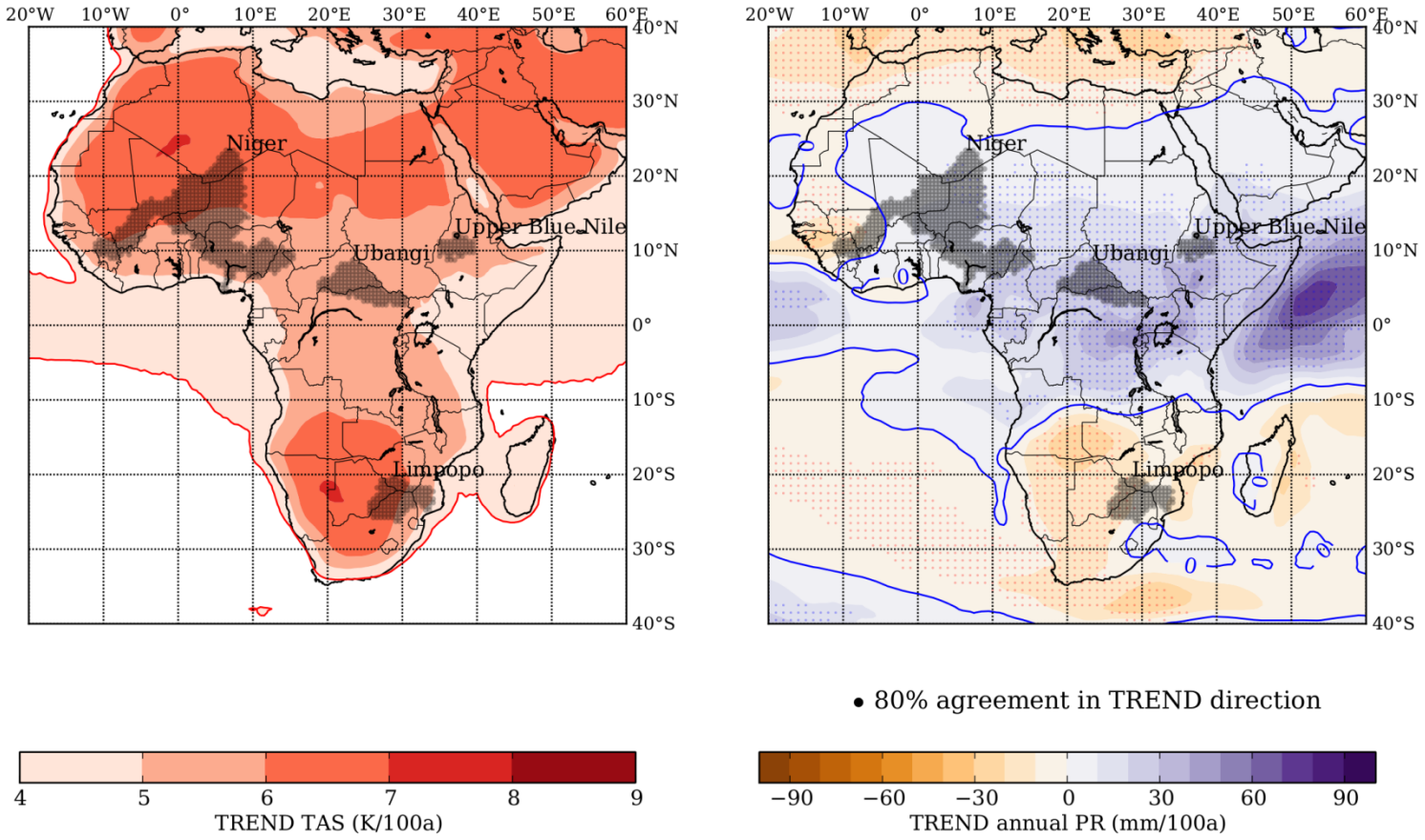


Area: 489.000km²
Mean precipitation/a: 1507mm
Runoff-coefficient: 21%
Subbasins: 377



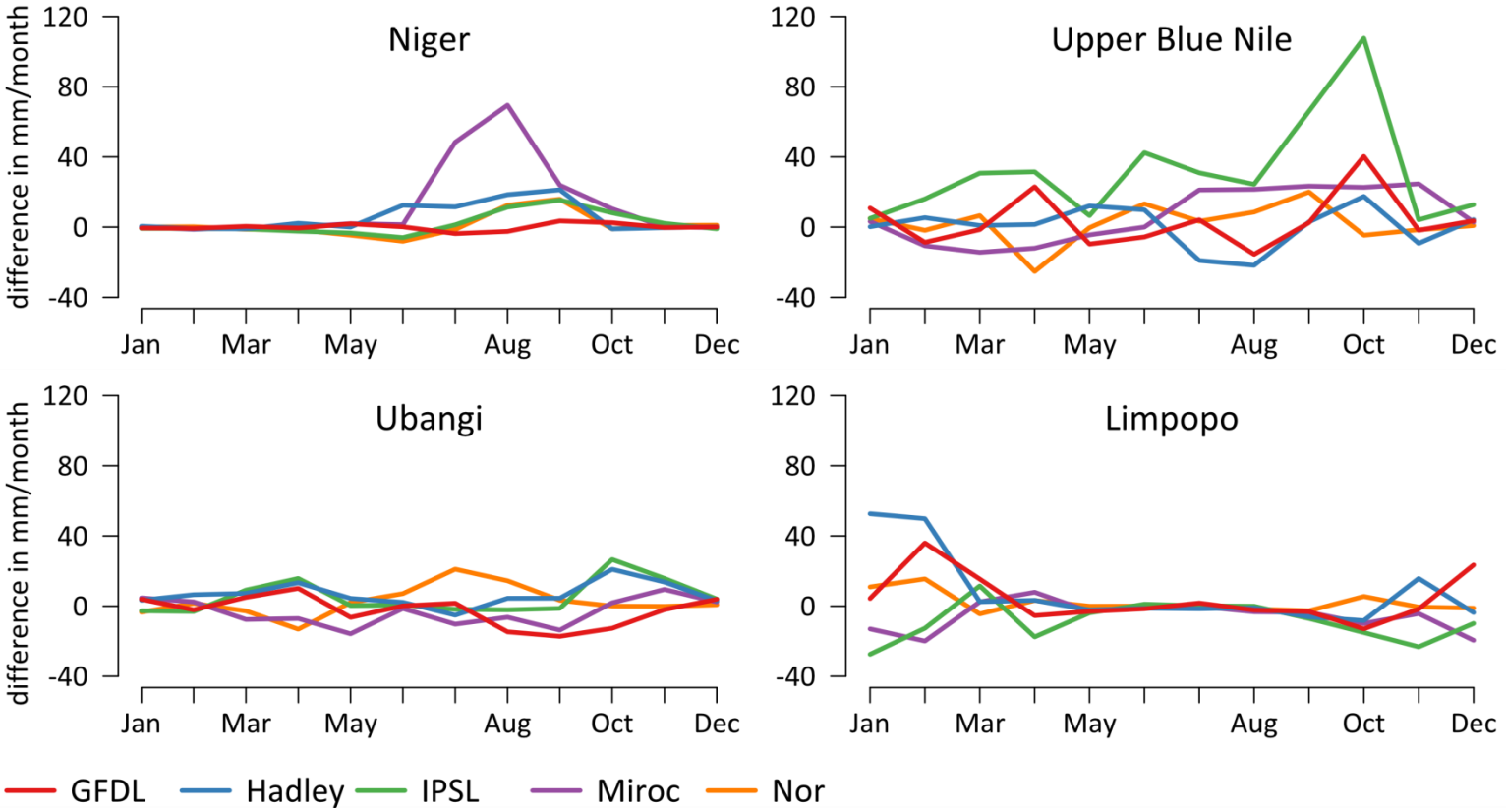
Area: 413.000km²
Mean precipitation/a: 530mm
Runoff-coefficient: 2%
Subbasins: 2020
Irrigation schemes: 31
Reservoirs: 8

Climate input



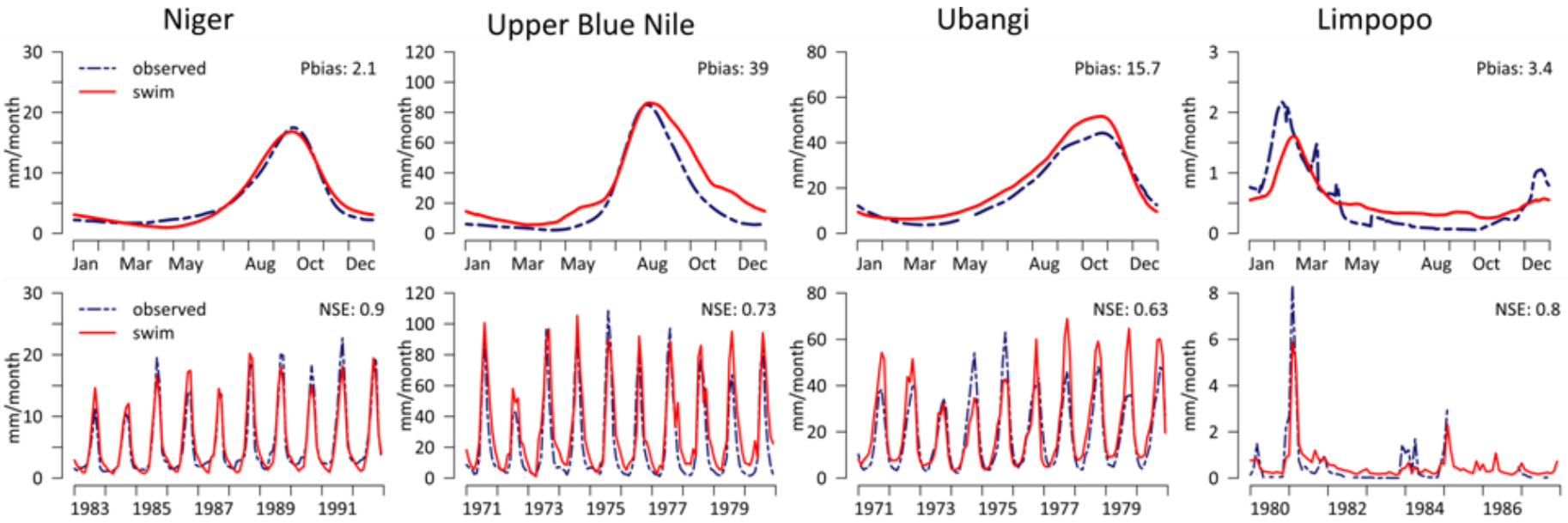
19 CMIP5 ESMs, RCP 8.5: Trend 2004-2099

Climate input



5 bias-corrected ESMs (Hempel et al. 2013)
Change between 2020-2049 and 1970-1999, RCP 8.5

Validation



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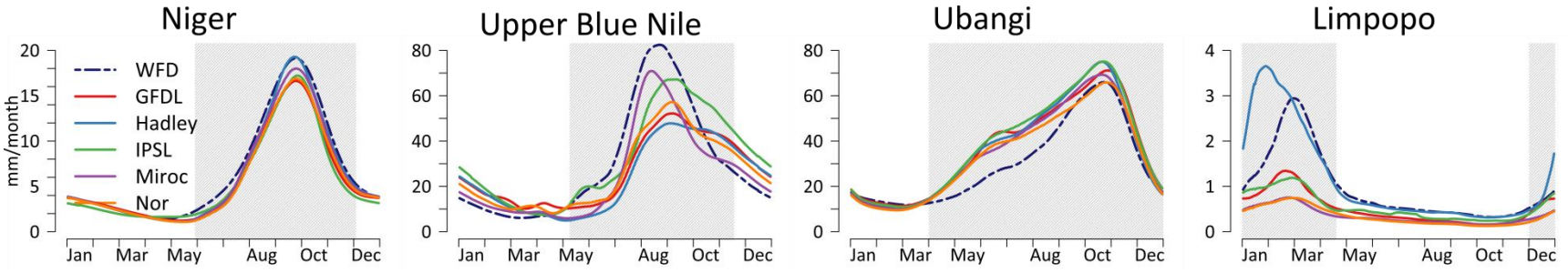
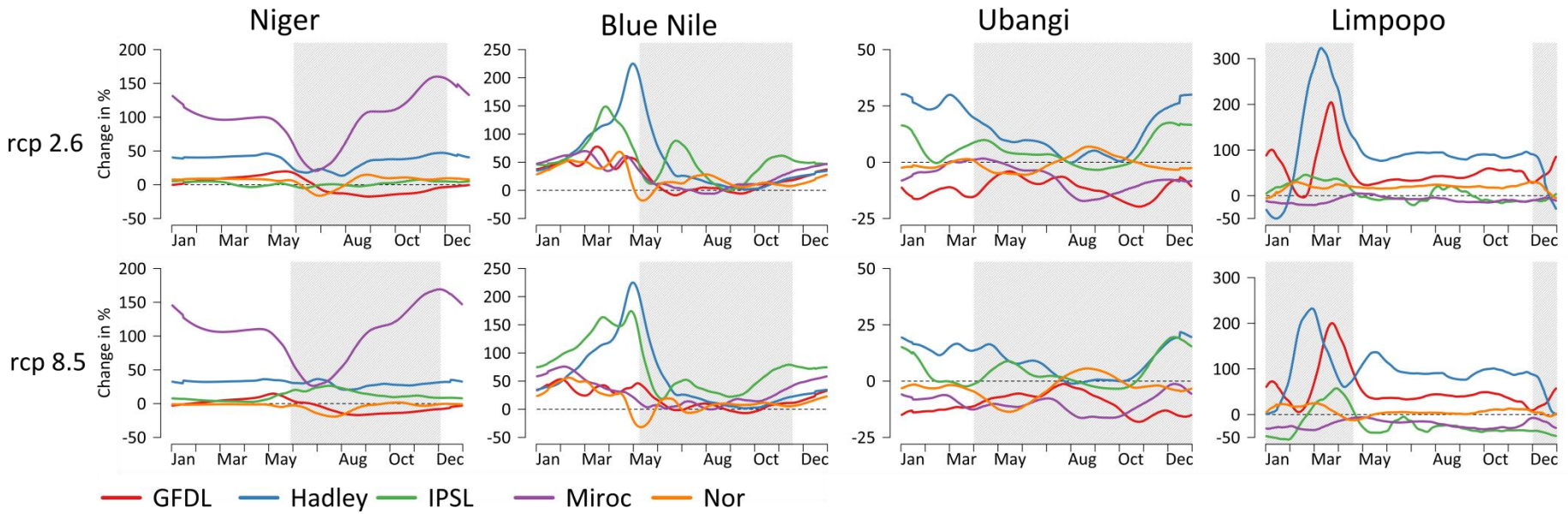
Trends in streamflow (means)

Scales differ!



Streamflow in base period 1970-1999, WFD and ESMs



Change of streamflow between 2020-2049 and 1970-1999, ESMs

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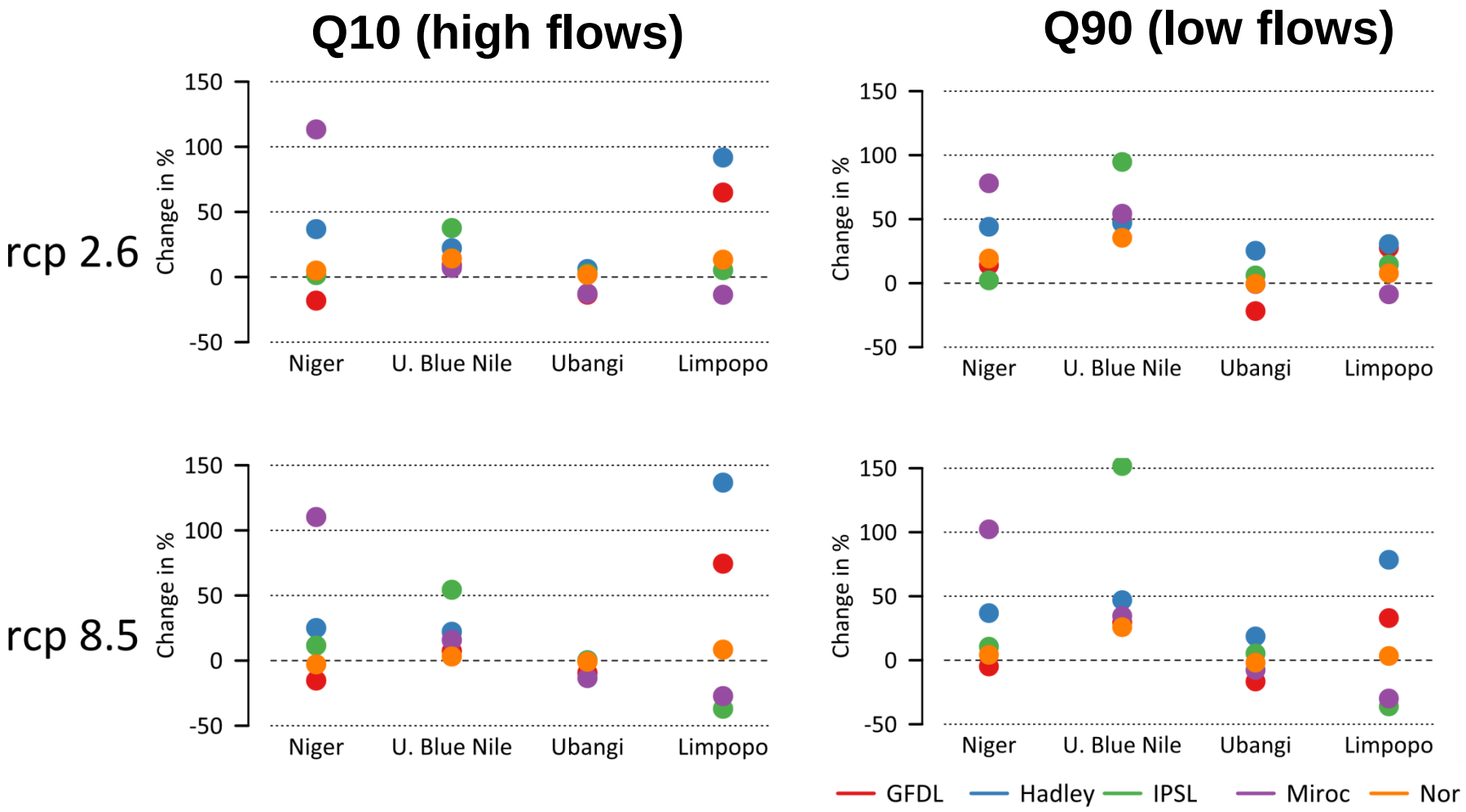
Trends in streamflow (extremes)



Change between 2020-2049 and 1970-1999

Implications on adaptations

2020-2049, mean of RCP 2.6 and 8.5, only 5 ESMs!

	Direction of trend agreement			Mean change		
	Mean	**Q10**	**Q90**	**Mean**	**Q10**	**Q90**
Niger	<50%	50%	70%	28%	31%	27%
Upper Blue Nile	100%	100%	100%	39%	57%	19%
Ubangi	<50%	<50%	<50%	-1%	1%	-4%
Limpopo	70%	60%	70%	27%	12%	31%

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Take away

1. **Impact comparison has added value as part of holistic approach:**
   - **least uncertainty in the Upper Blue Nile basin**
   - **in the Limpopo basin results are most extreme, but wide spread of projections, more likely to become „wetter“**
   - **In the basins of Ubangi and Niger, even the direction of trend is highly uncertain**

2. **State-of the art climate projections and modeling approaches could in none of the catchments reduce uncertainties for direct adaptation planning**

3. **High level of agreement on increasing flows, also highflows**

→ **Adaptation efforts on climate change in Africa should not neglect this thread**

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Thank you!

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Study sites

	Niger	Upper Blue Nile	Ubangi	Limpopo
Area in km²	2.156.000	167.000	489.000	413.000
Alt. range in m a.s.l.	0 – 2961	526 - 4187	341 – 2046	0 – 2326
Mean temp. in C	28	19	25	21
Mean temp. warmest/ coldest month in C	32 in May / 24 in Jan.	21 in April/ 17 in Dec.	26 in March/ 24 in Dec.	25 in Feb./ 15 in July
Mean prec. in mm/ a	682	1382	1507	530
Dominant land uses	cropland: 20% grassland: 18% savannah 14%	cropland: 57% savannah: 30%	forest: 50% cropland: 32%	forest: 34% cropland: 32%, savannah: 20%
Length of river in km*	~3650	~800	~1670	~1750
Mean annual discharge in mm/a	~170	~370		
Runoff- coefficient**	~18%	~17%	~21%	~2%

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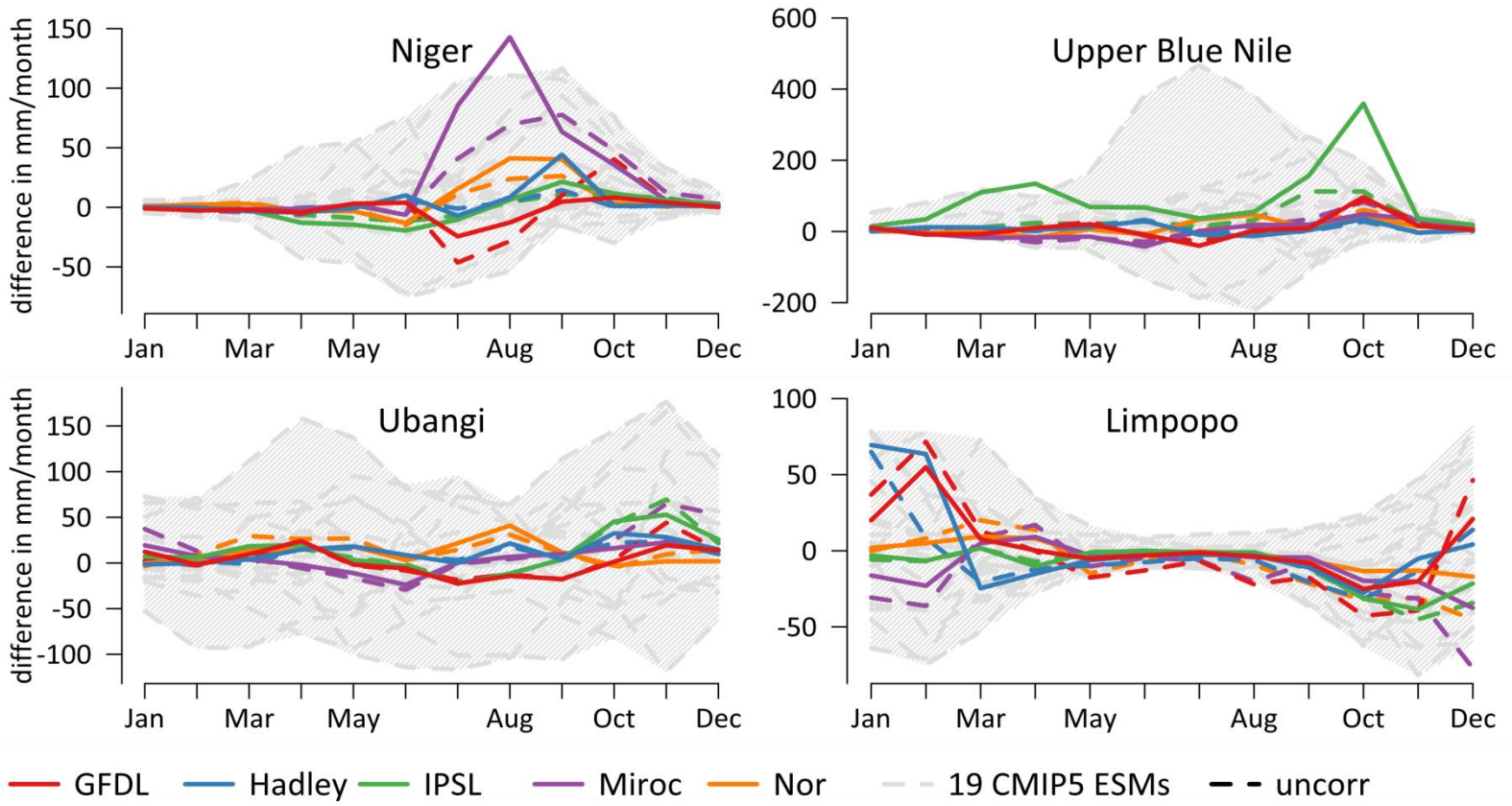
Climate input



5 downscaled/ bias-corrected (ISI-MIP method) ESMs
Change between 2070-2099 and 1970-1999, RCP 8.5

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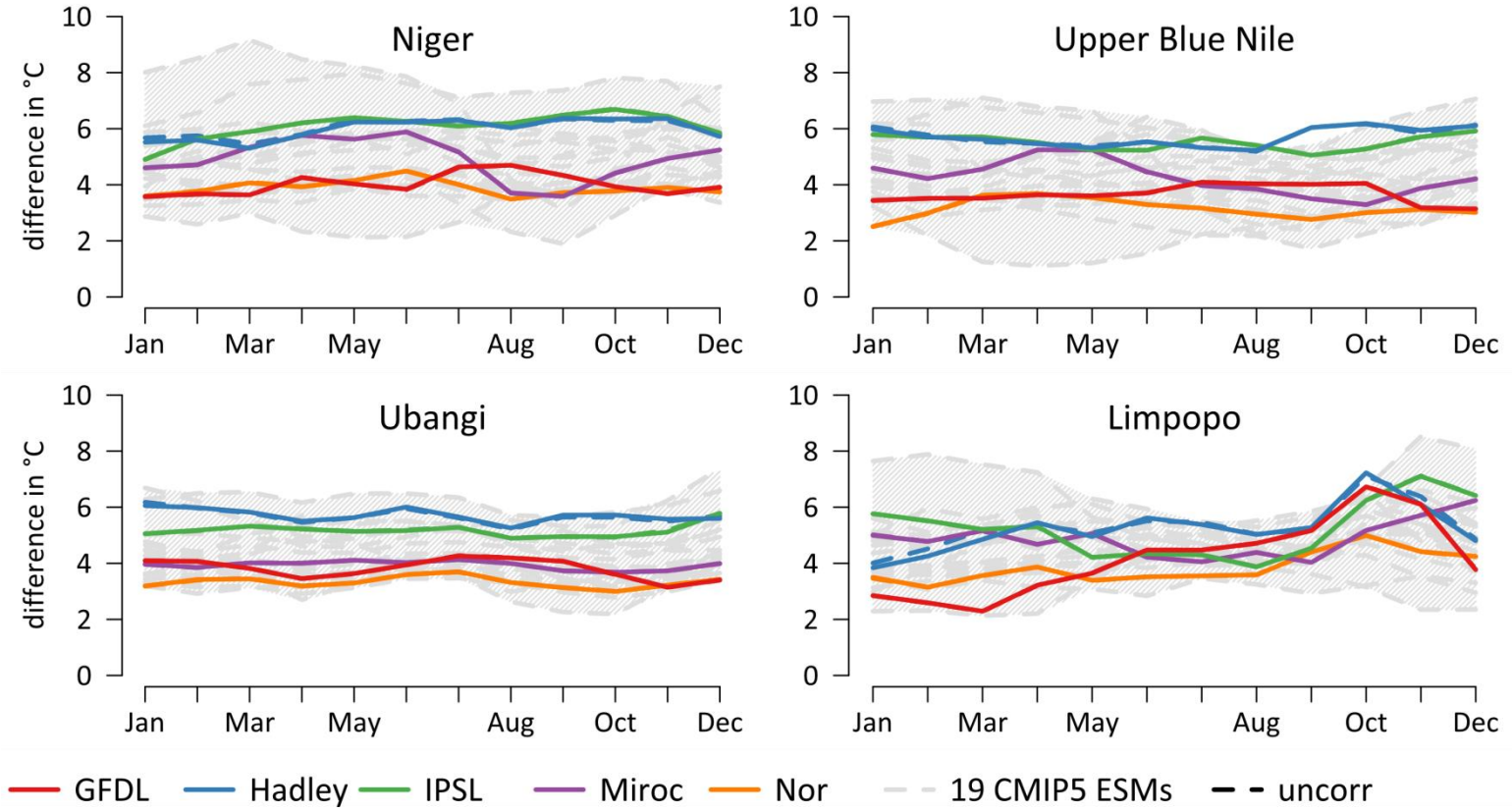
Climate input



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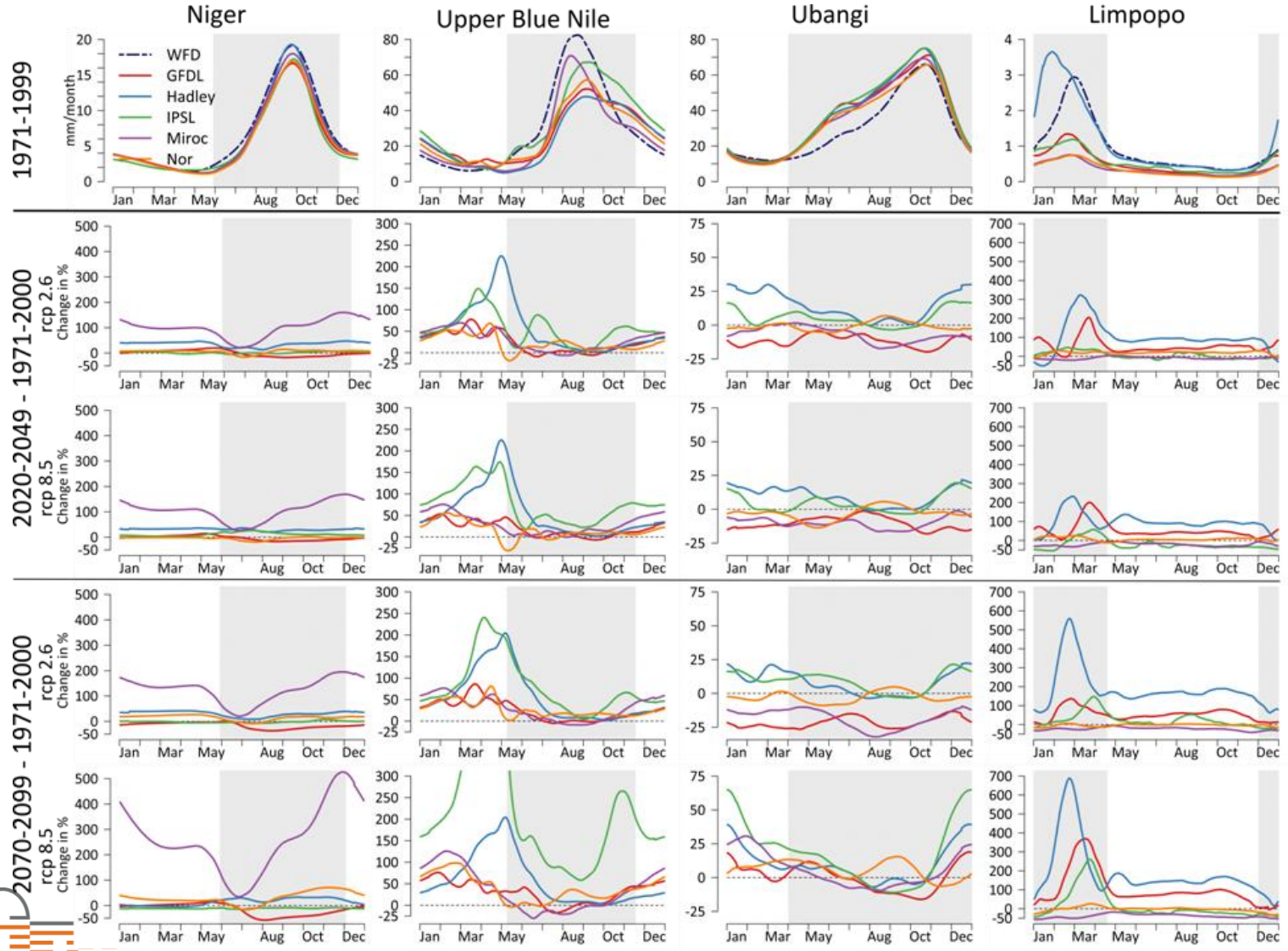
Trends in streamflow



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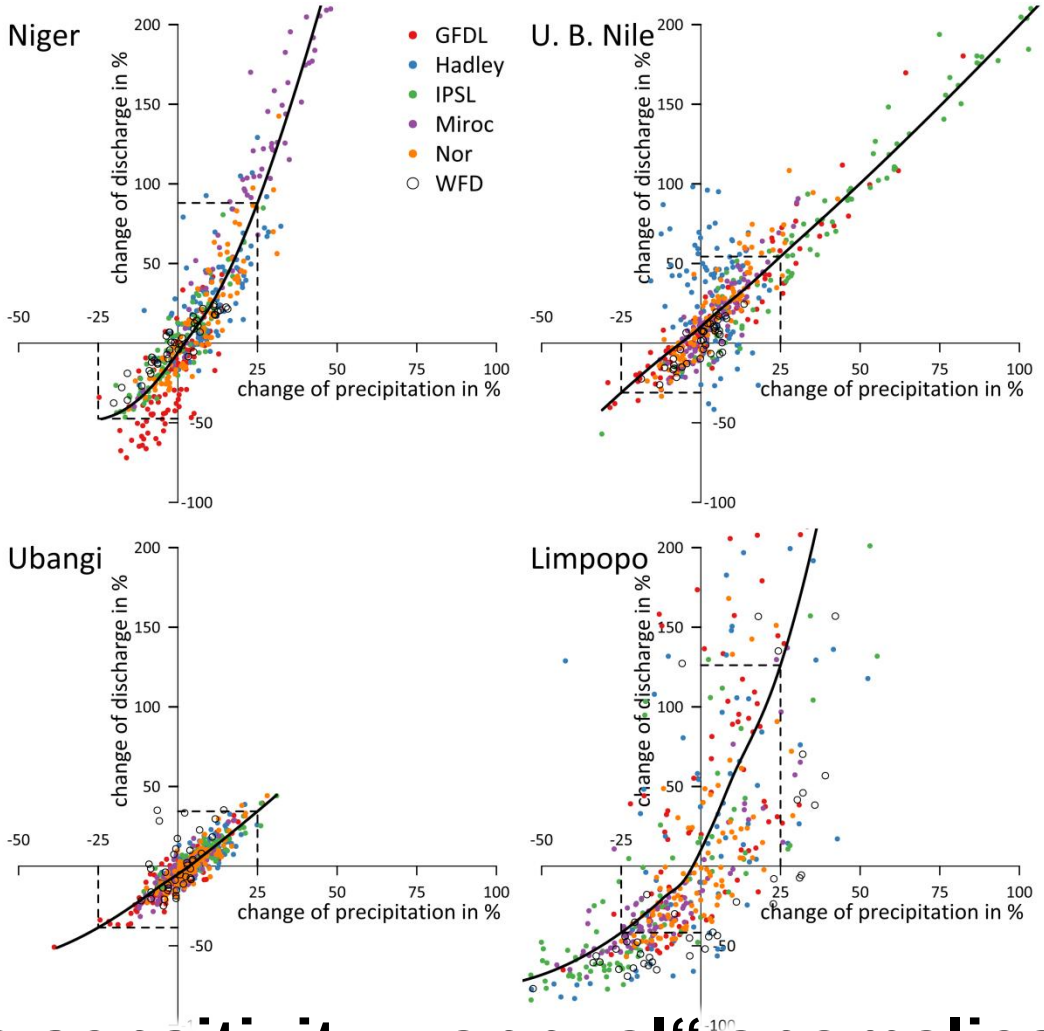
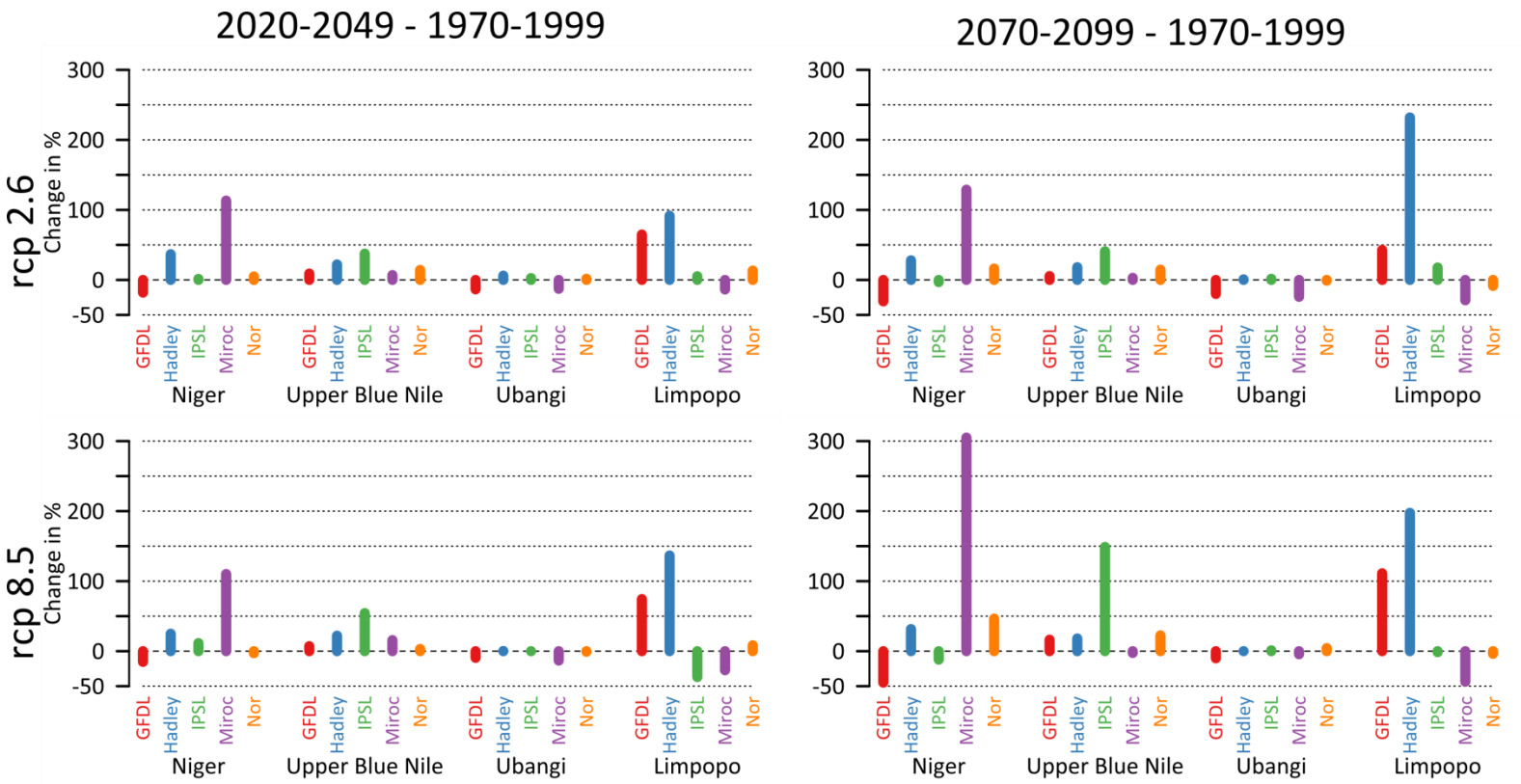
Trends in streamflow



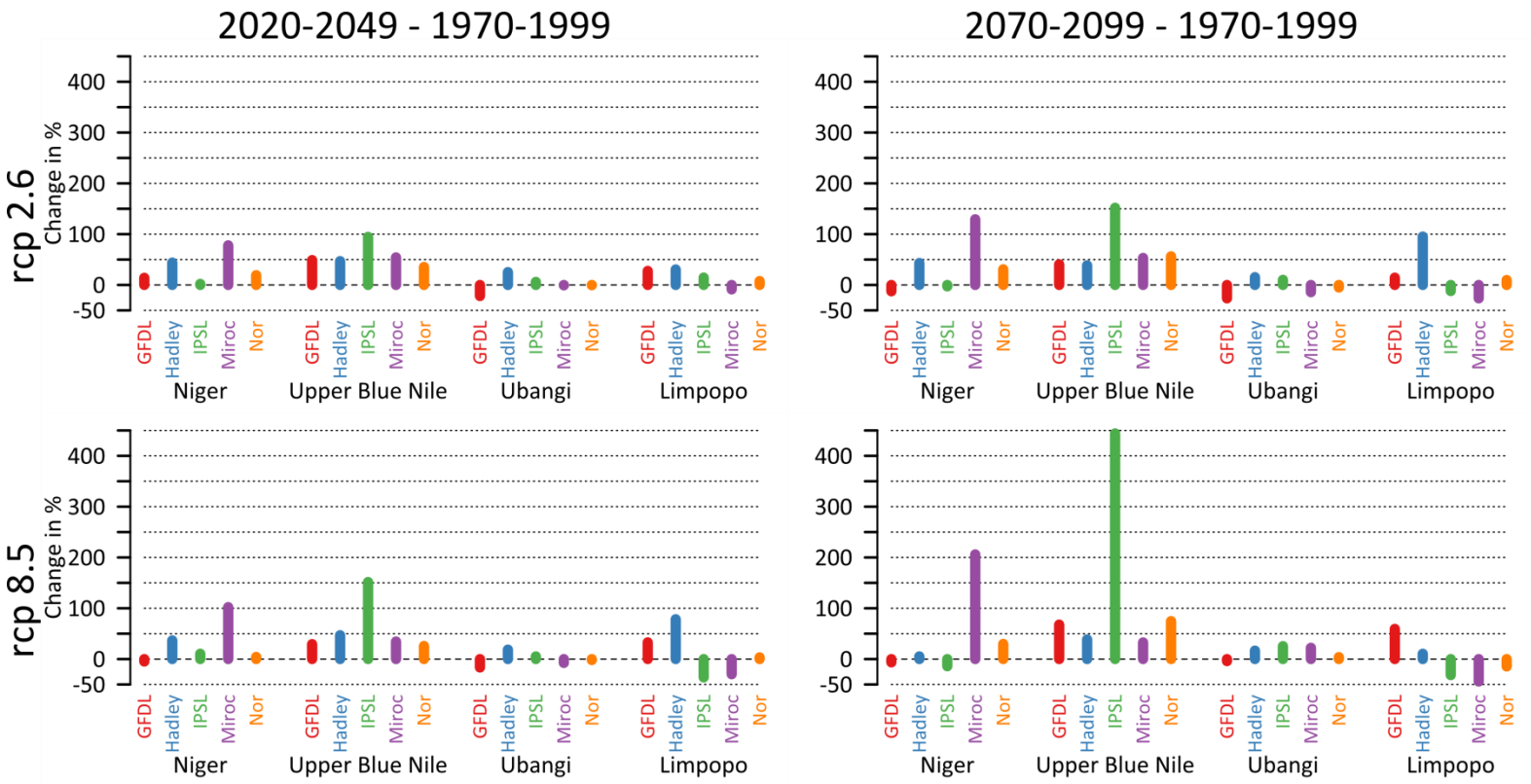
Climate sensitivity, „annual“ anomalies between 2004-2099 to base period 1970-1999, RCP 8.5

Trends in streamflow



Q10 (high flows)

Trends in streamflow



Q90 (low flows)

PIK