Global hydroclimate of the Last Interglacial – precipitation, river discharge, and floods –

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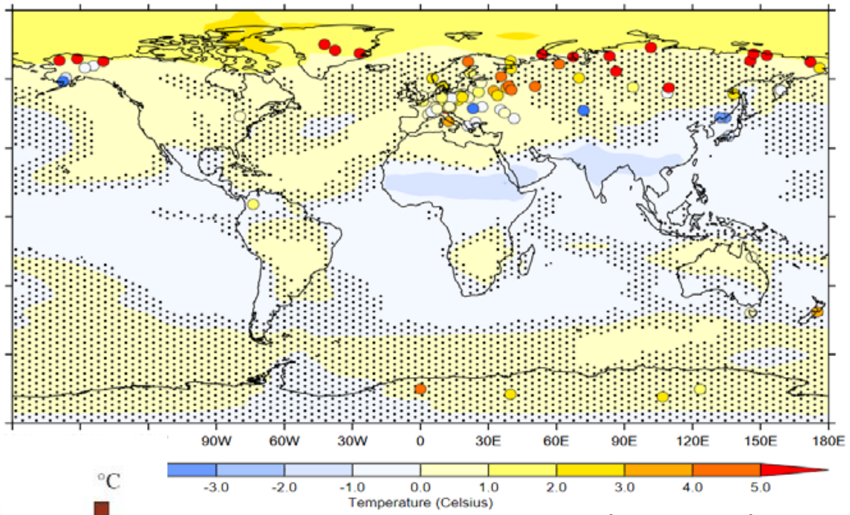
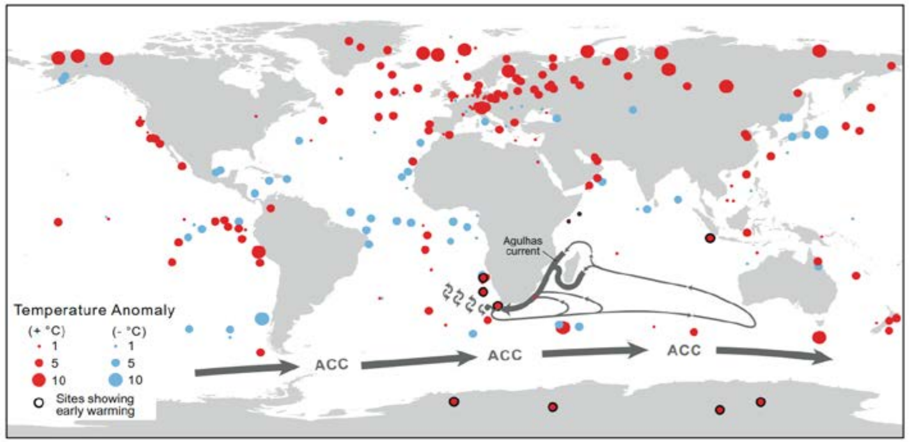
Motivation

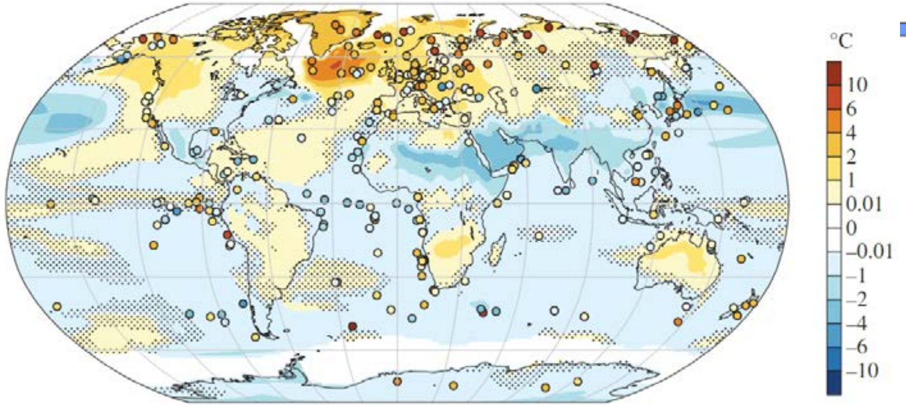
The Last Interglacial (LIG; 125,000 years ago) is the most recent time climate was **warmer than present** (at least in the Northern Hemisphere)



Lunt et al. 2013, Cli Past

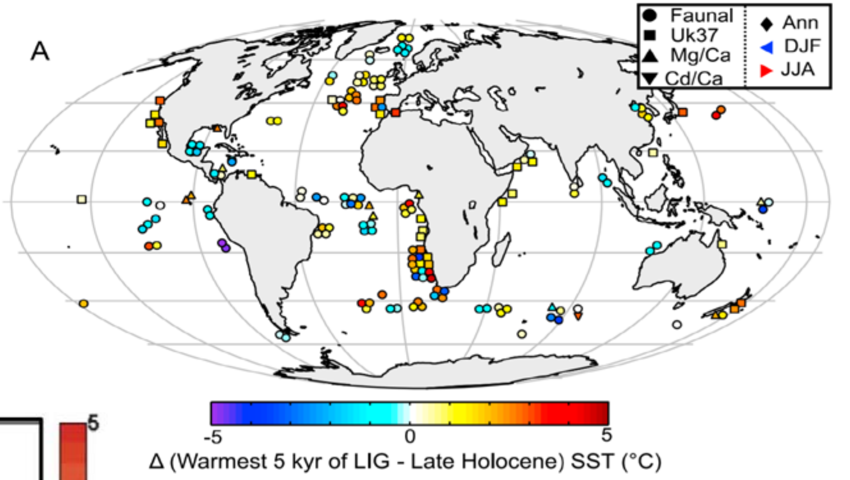


Turney and Jones 2010, JQS

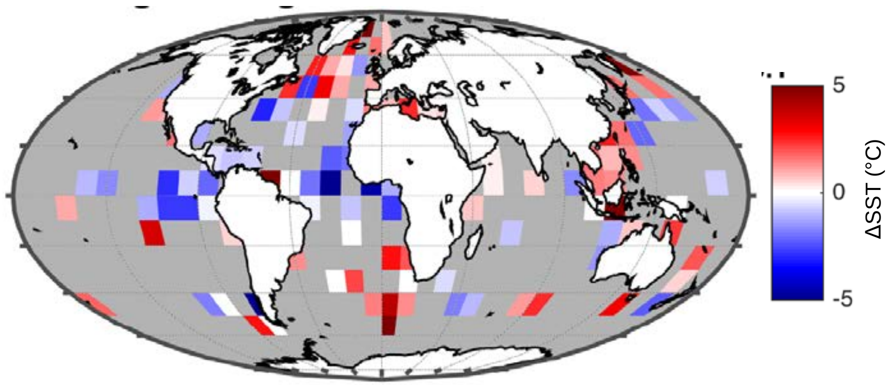


Otto-Bliesner et al. 2013, Philos Trans R Soc

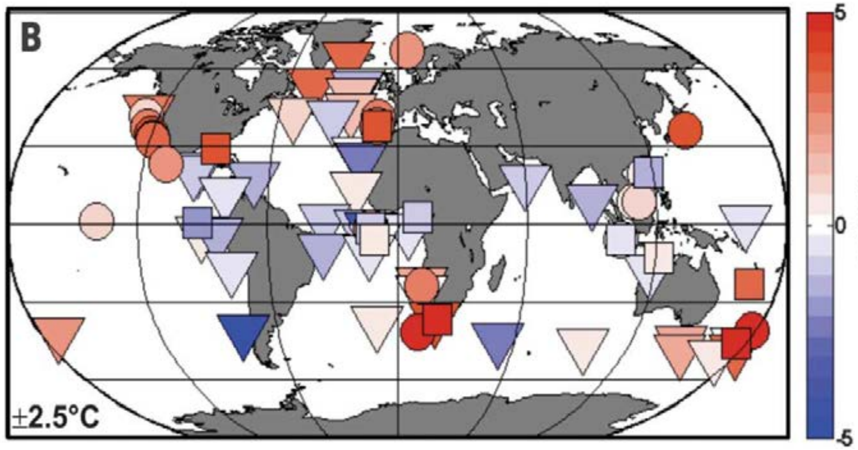
LIG temperatures



McKay et al. 2011, GRL



Turney et al. 2020, ESSDD



Hoffman et al. 2017, Science

Much focus has been dedicated to LIG temperatures
We can also use the LIG to understand the response of hydroclimate to warmer (hemispheric) conditions

Model ensemble

- *127k* run (PMIP4)
- pre-industrial run (CMIP6)

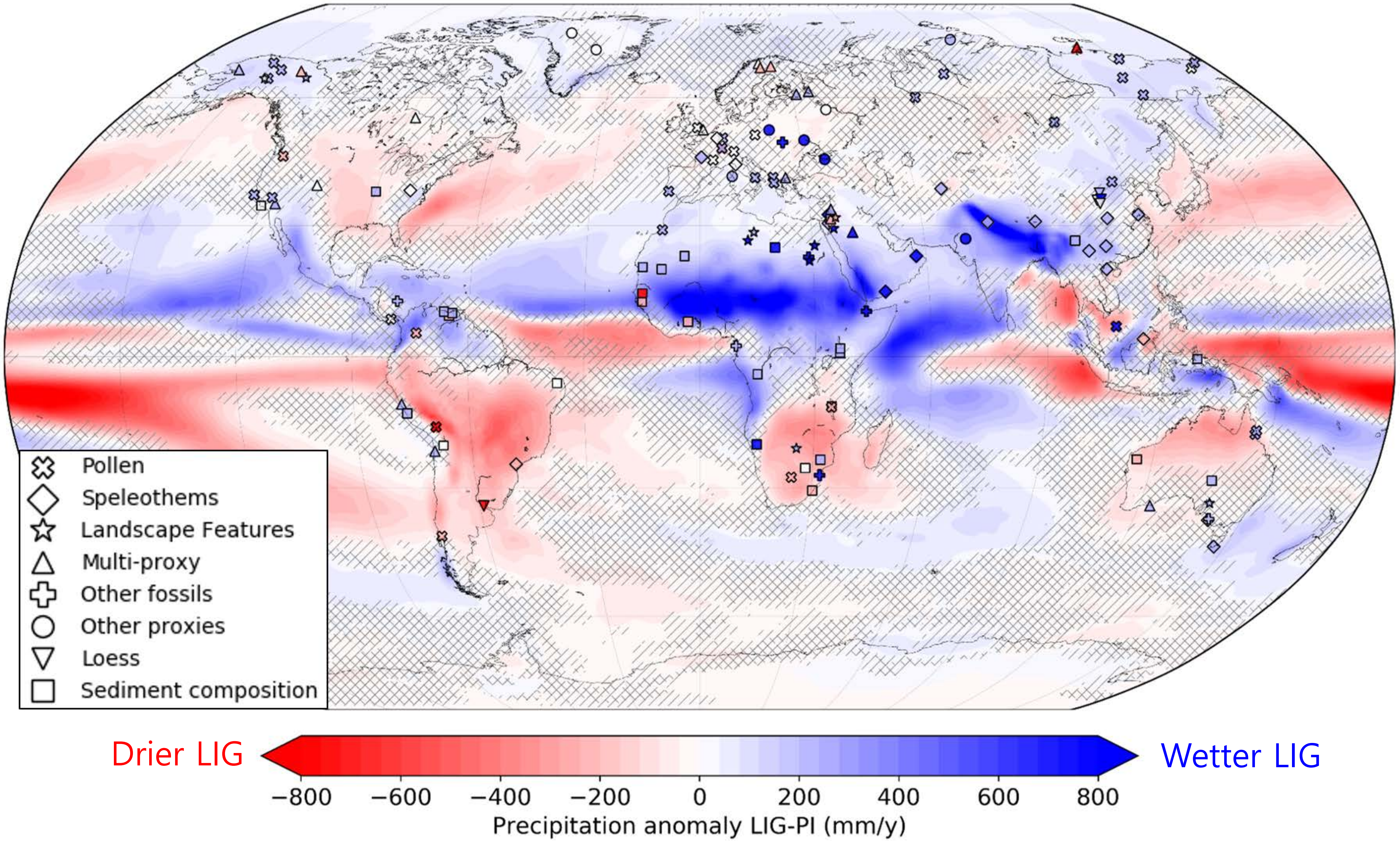
model	atmosphere	res. lat*lon, levels
CESM1.2	CAM5	0.93 * 1.25°, 30
EC-Earth3.2	IFS	1.1 * 1.1°, 62
IPSL-CM6-LR	LMDZ	1.26 * 2.5°, 79
MPI-ESM 1.2.01p1-LR	ECHAM6	1.875 * 1.875°, 47
NorESM1-F	CAM4	1.875 * 1.875°, 26
NUIST-CSM	ECHAM6.3-NUIST	1.875 * 1.875°, 47
HadGEM3-GC3.1	UM10.7	1.25 * 1.875°, 85

Proxies

New database of 138 records
at ca. 127 ka

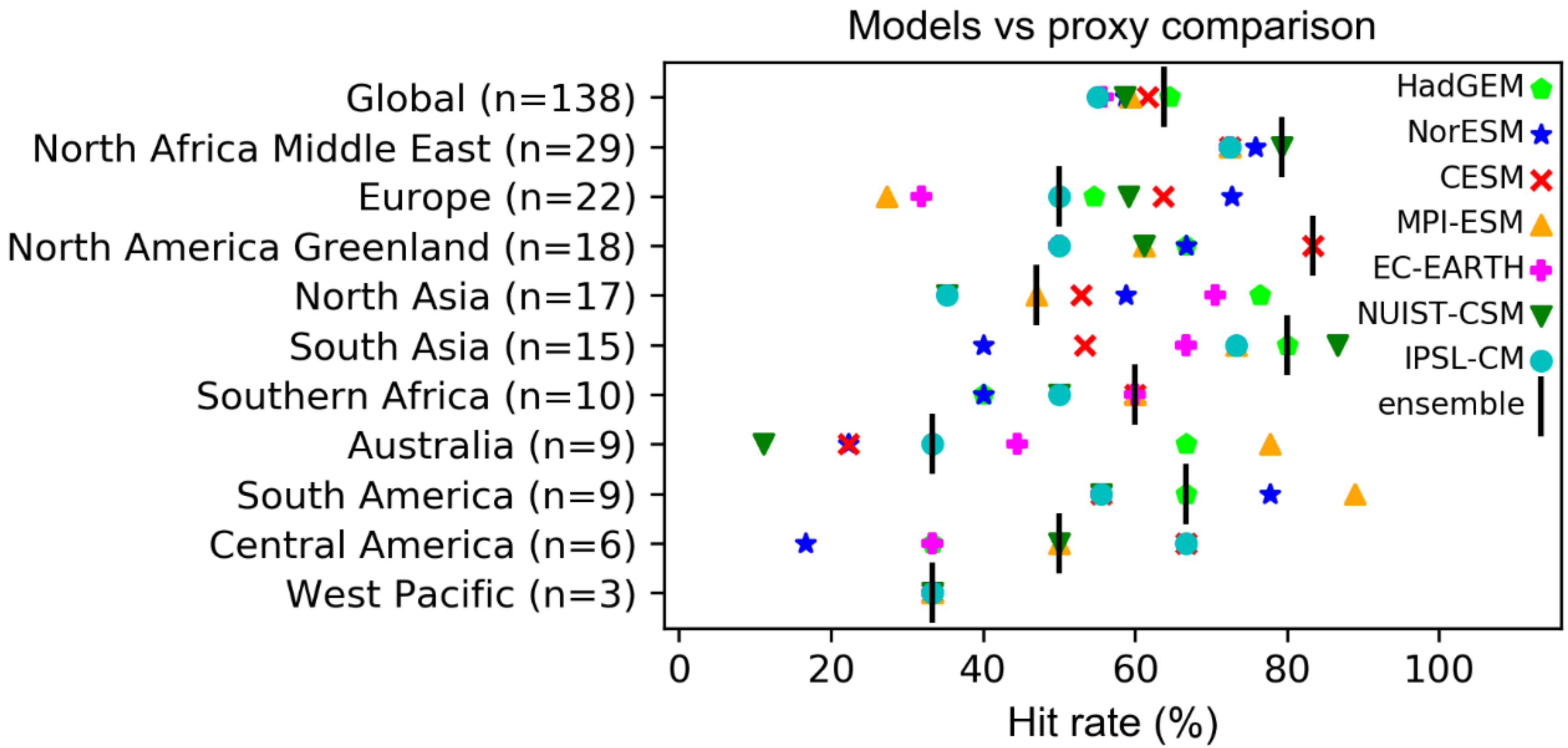
38 pollen
28 lake or sea sediment composition
21 speleothems
20 multiproxy
10 landscape features
9 other/unspecified
7 fossils other than pollen
5 loess

Model ensemble average vs proxies

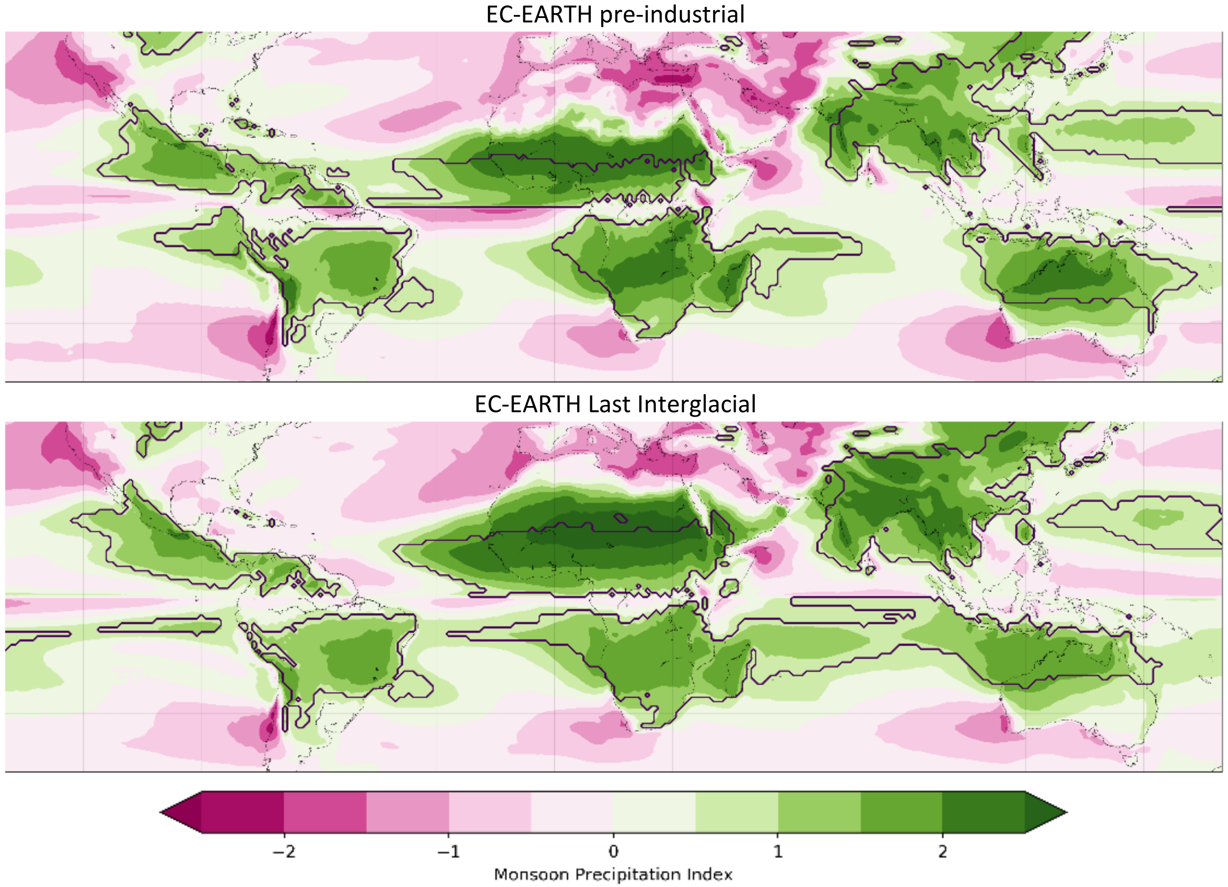


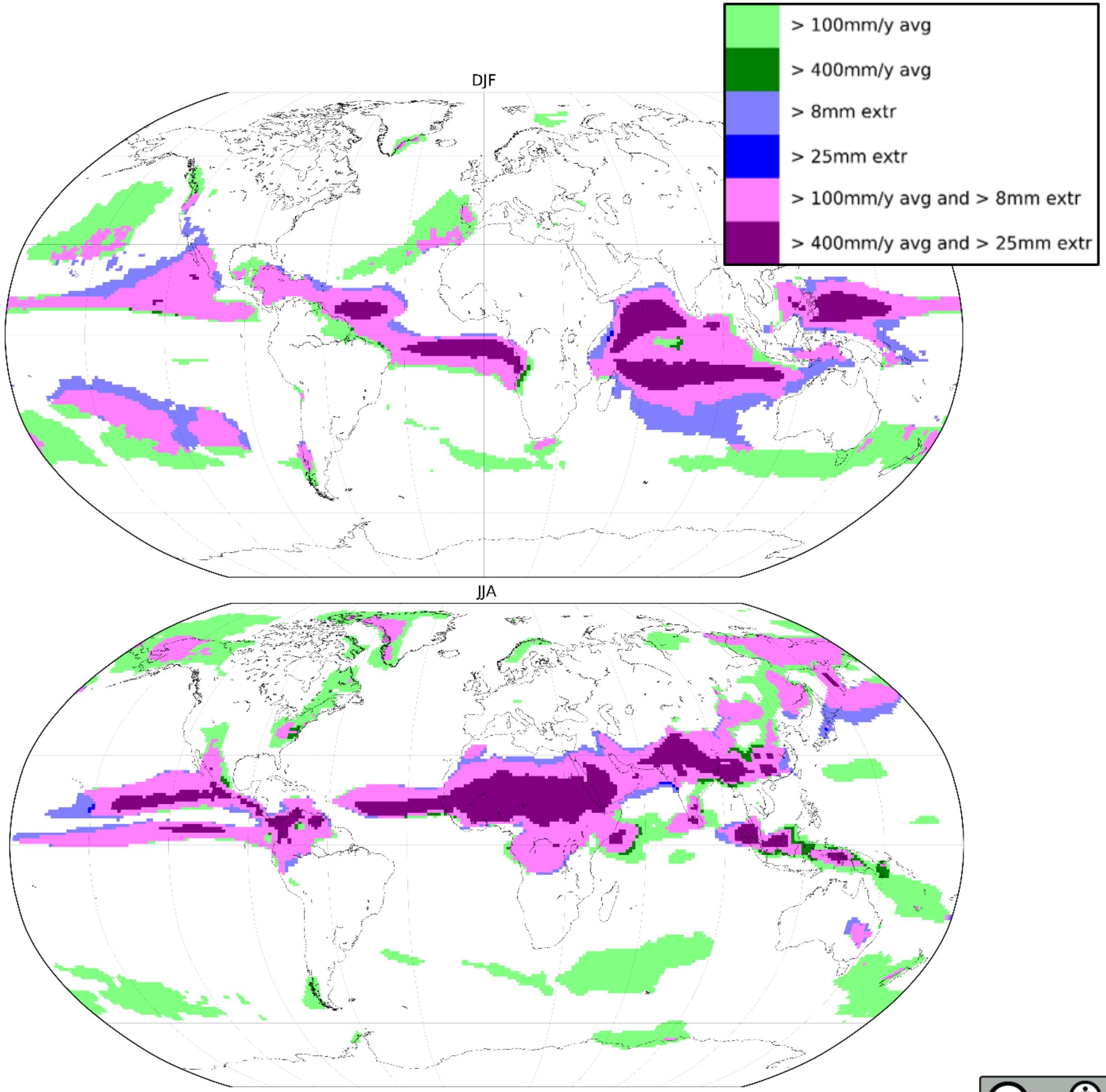
Scussolini et al. 2019, Sci Adv

Model ensemble agrees with 64% of proxies on sign of anomaly



Boreal LIG monsoons were larger and produced more (extreme) precipitation





How we look at hydrology

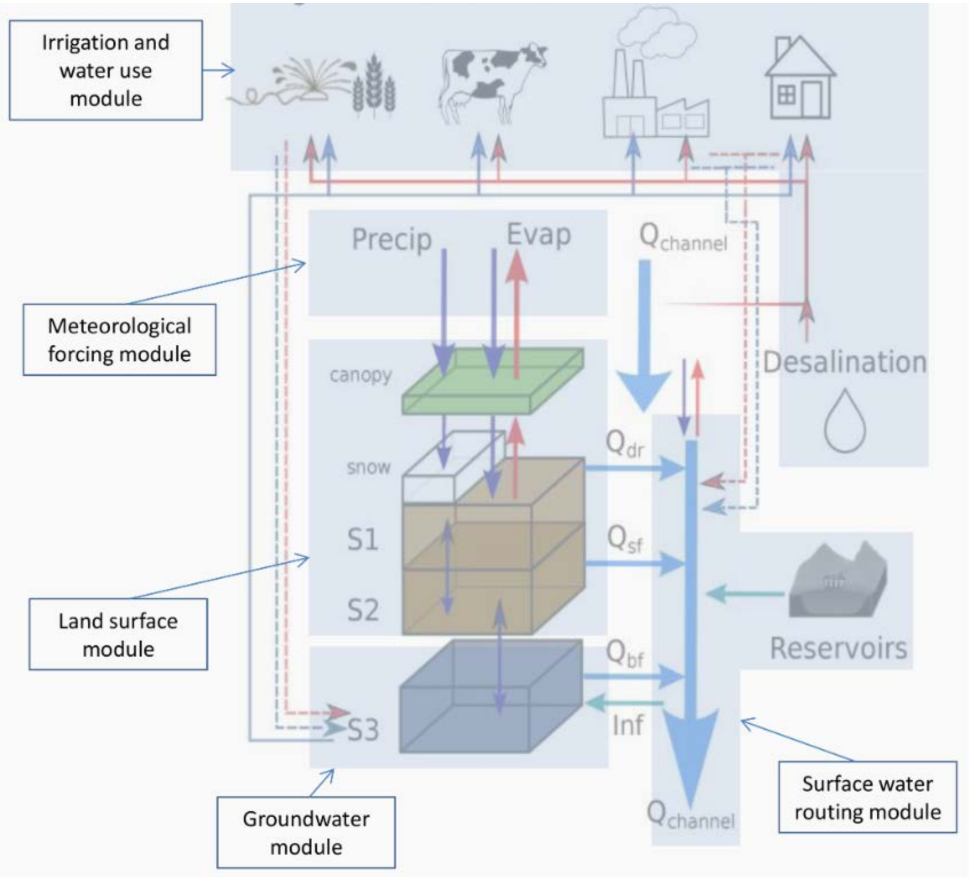
8 GCMs: daily precipitation, temperature

PCR-GLOBWB

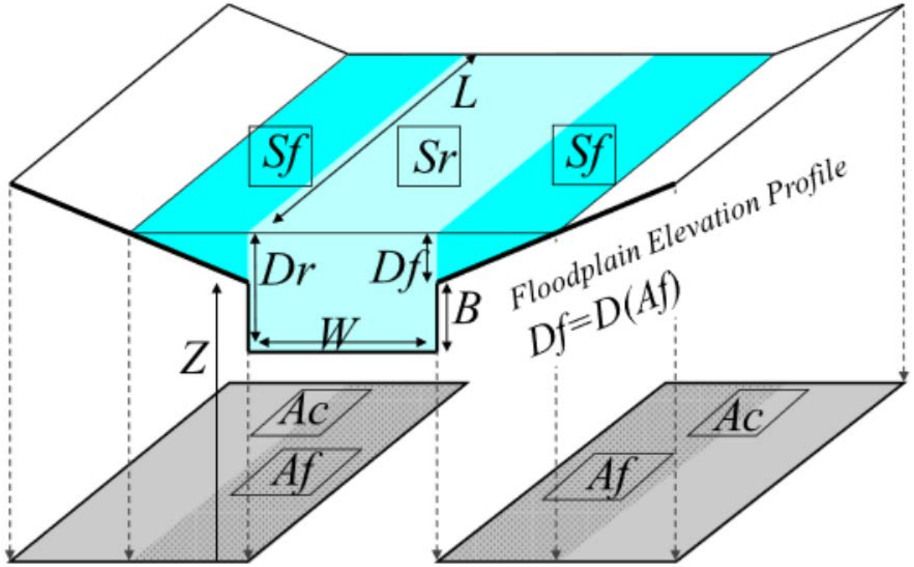
Global hydrological model

0.5° res.

Sutanudjaja et al. 2018, GMD



runoff



CaMa-Flood

Global hydrodynamic model

0.25° res.

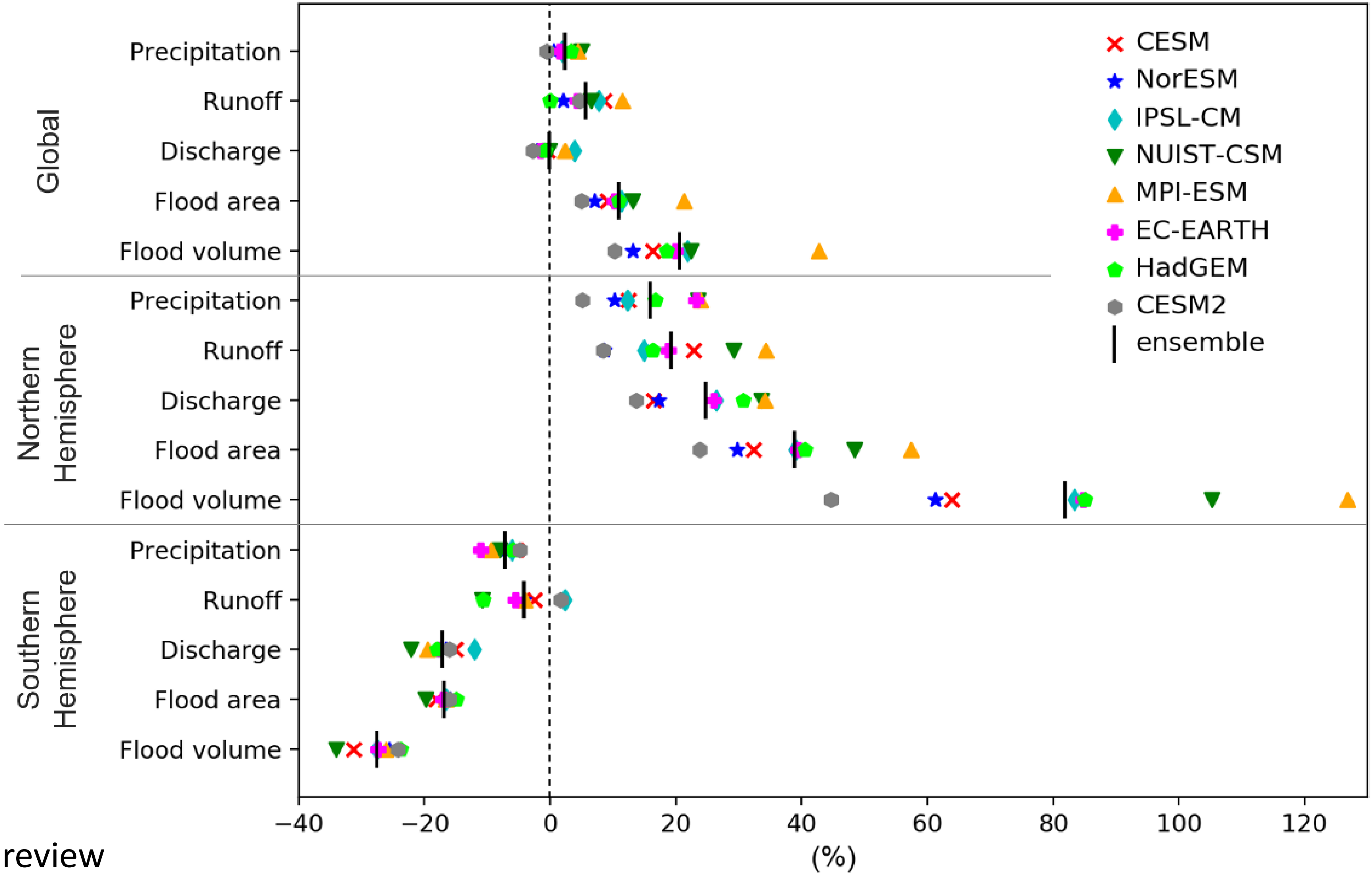
parametrization based on 1 km res.

Yamazaki et al. 2011, Wat. Res. Research

discharge, flood area, flood depth

In %, runoff and floods are larger in the LIG than in the pre-industrial

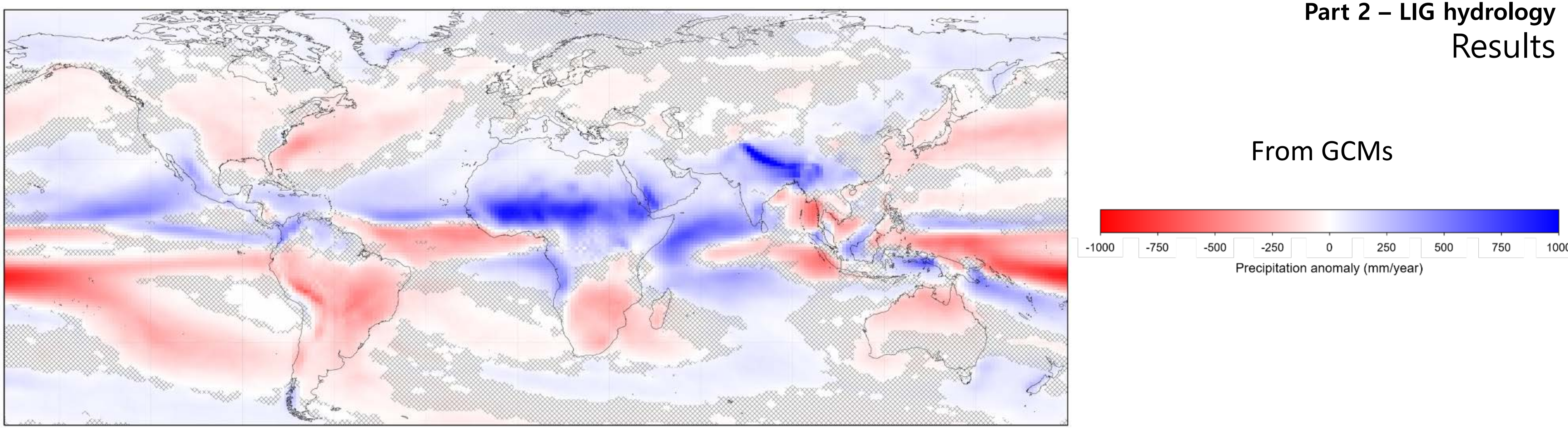
In the Northern Hemisphere all anomalies are strongly positive, with precipitation < runoff < discharge << floods in the LIG



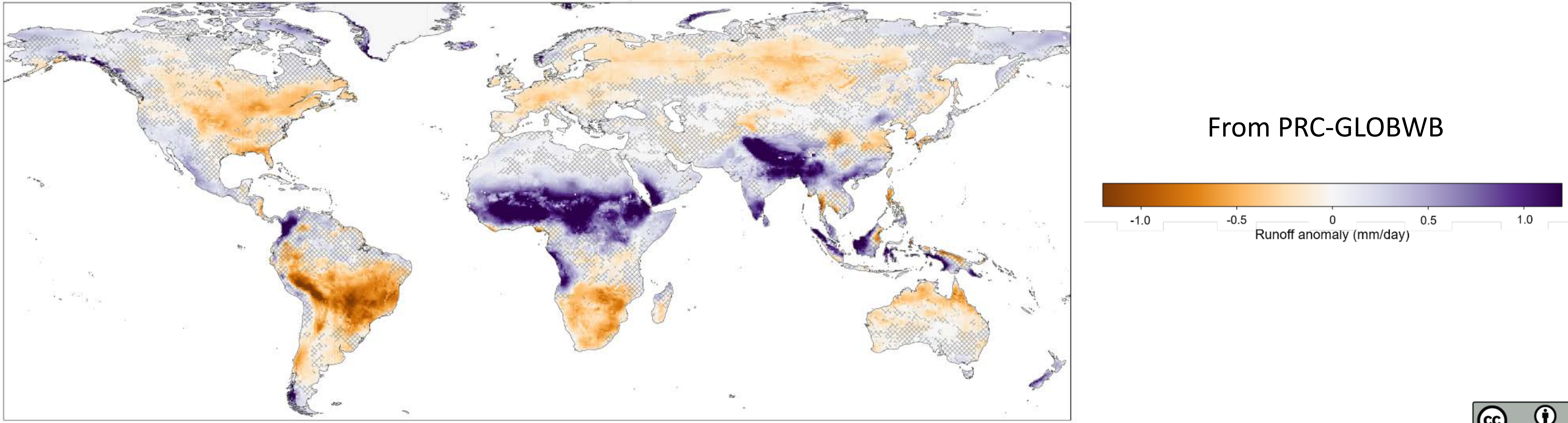
Scussolini et al, in review

Part 2 – LIG hydrology
Results

From GCMs

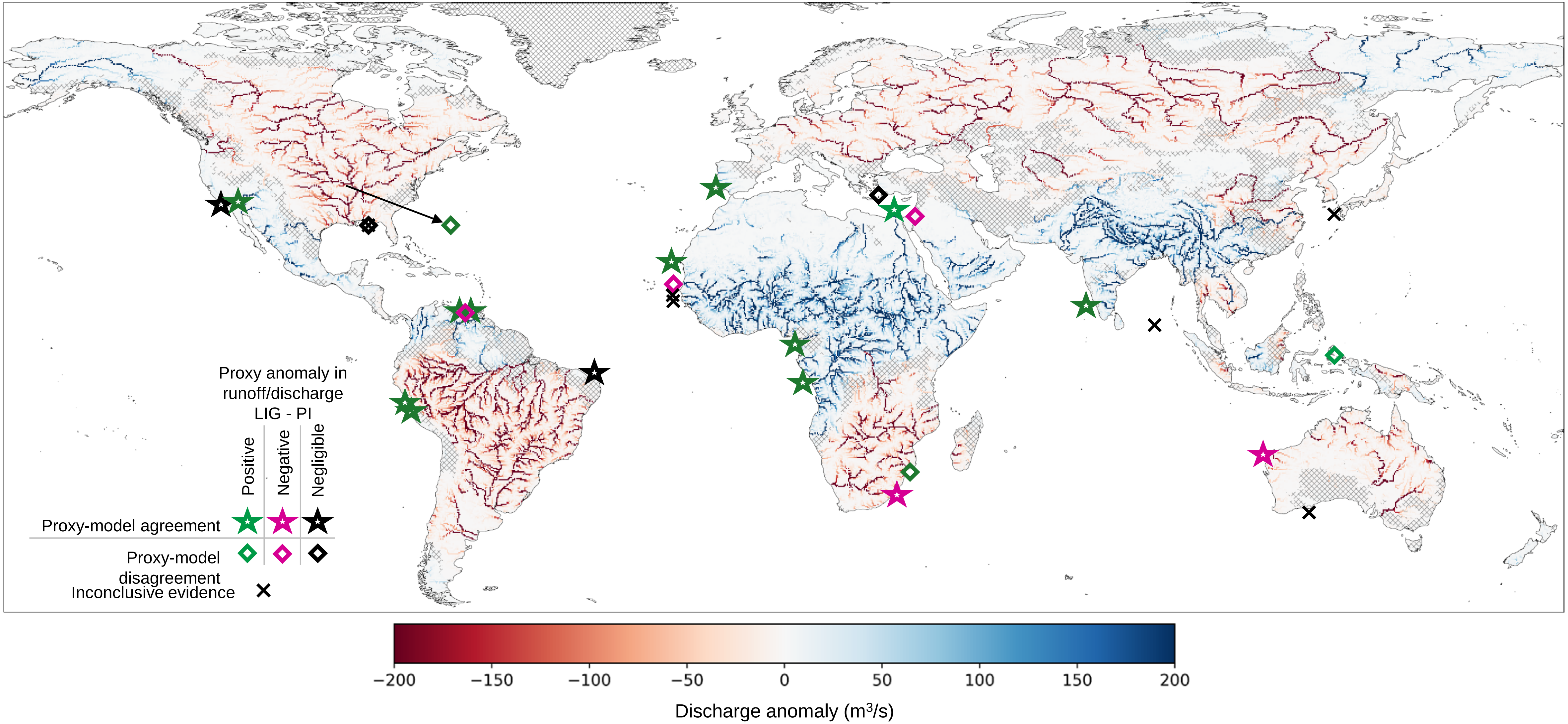


From PRC-GLOBWB

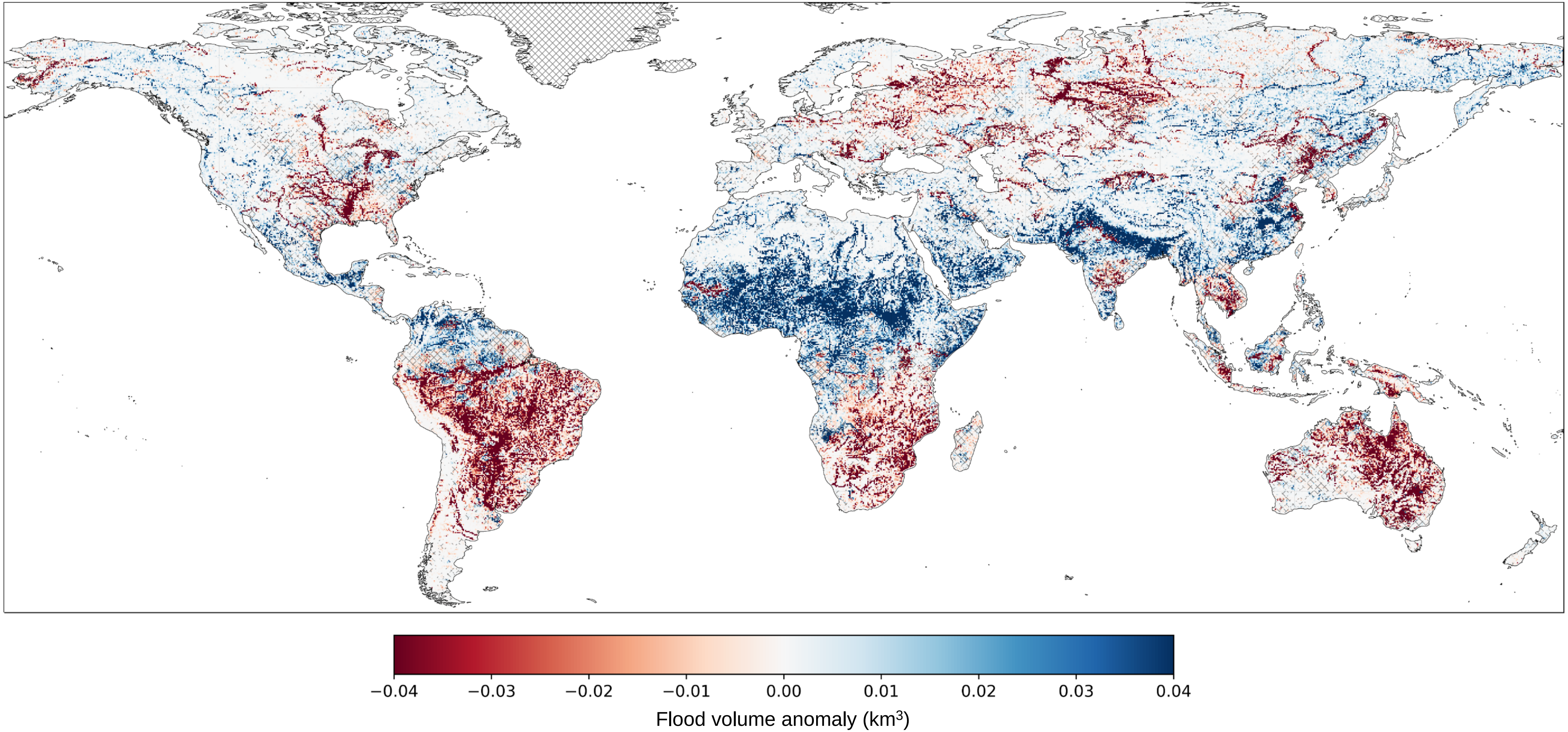


From CaMa-Flood

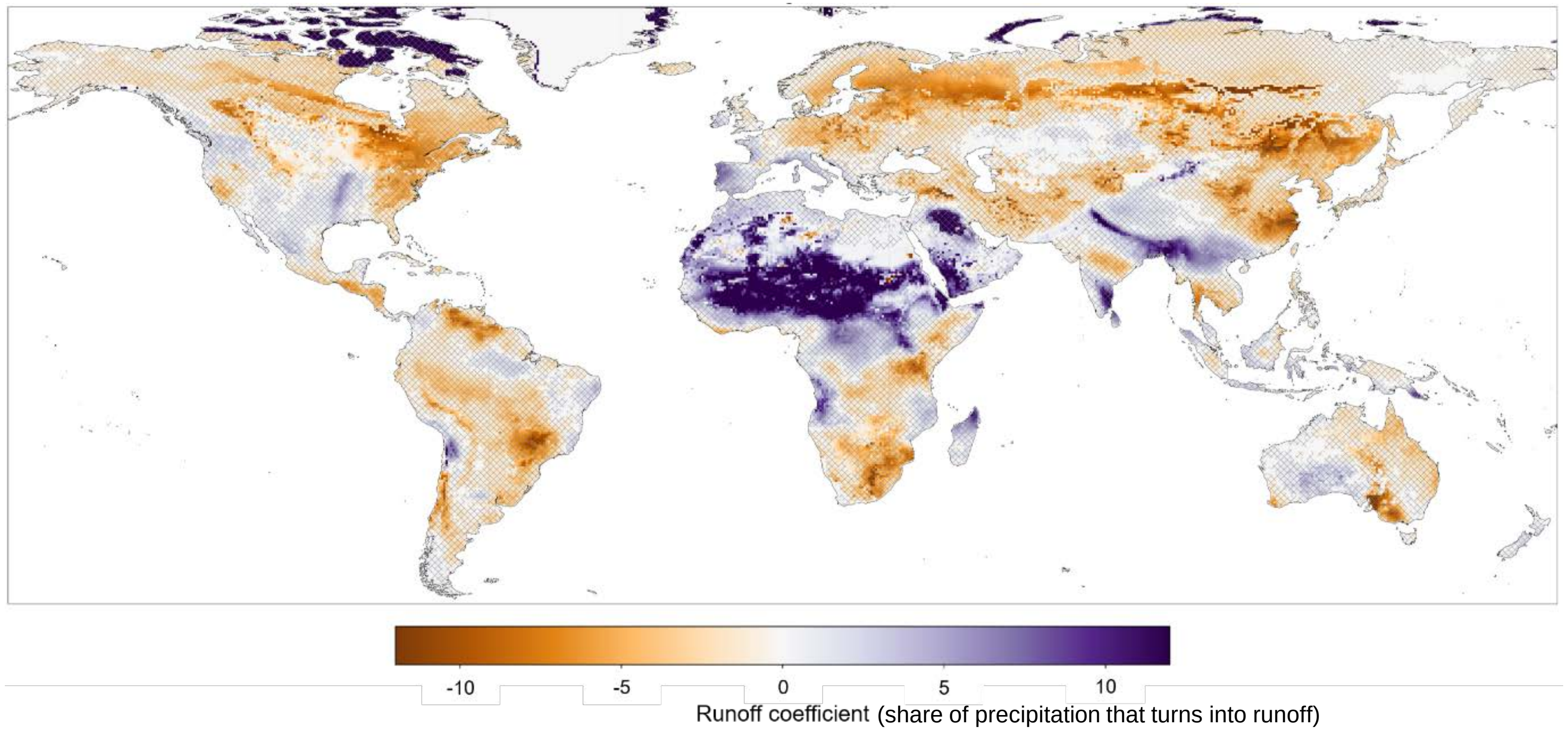
Mostly models and proxies agree, but too few comparison sites



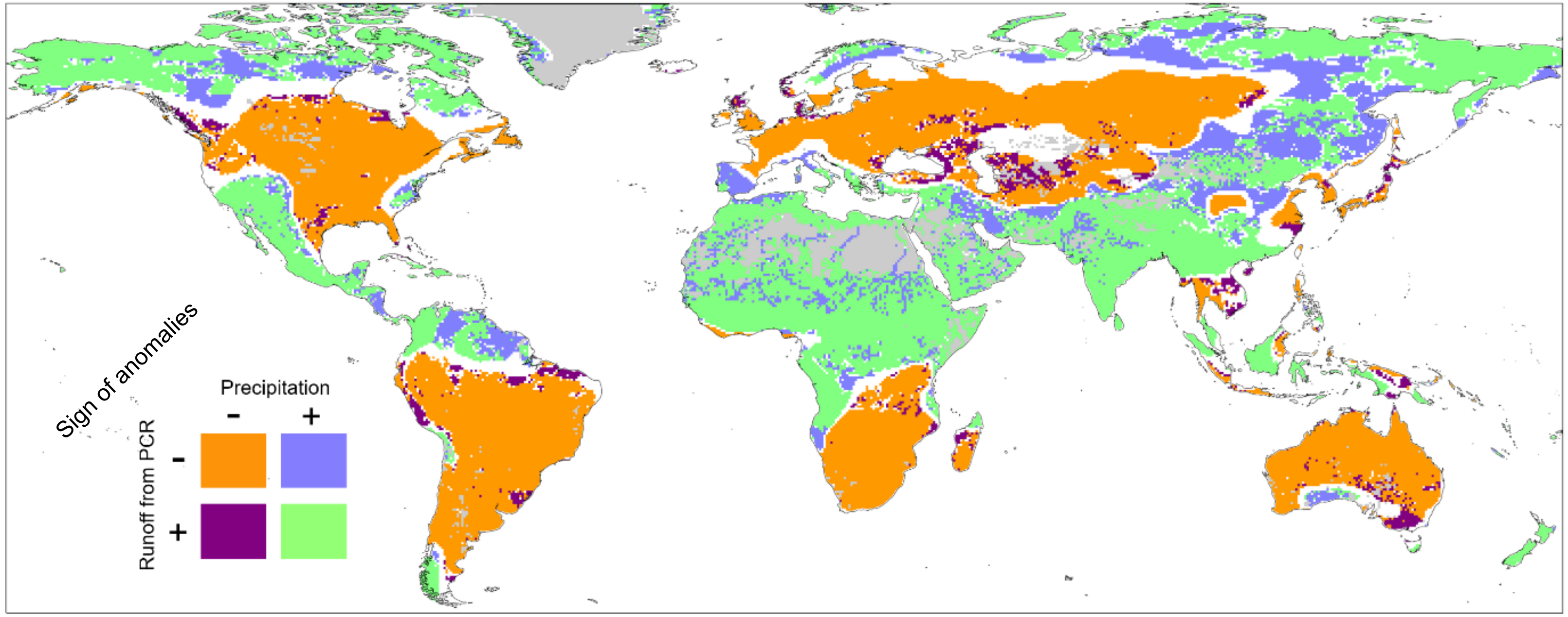
From CaMa-Flood



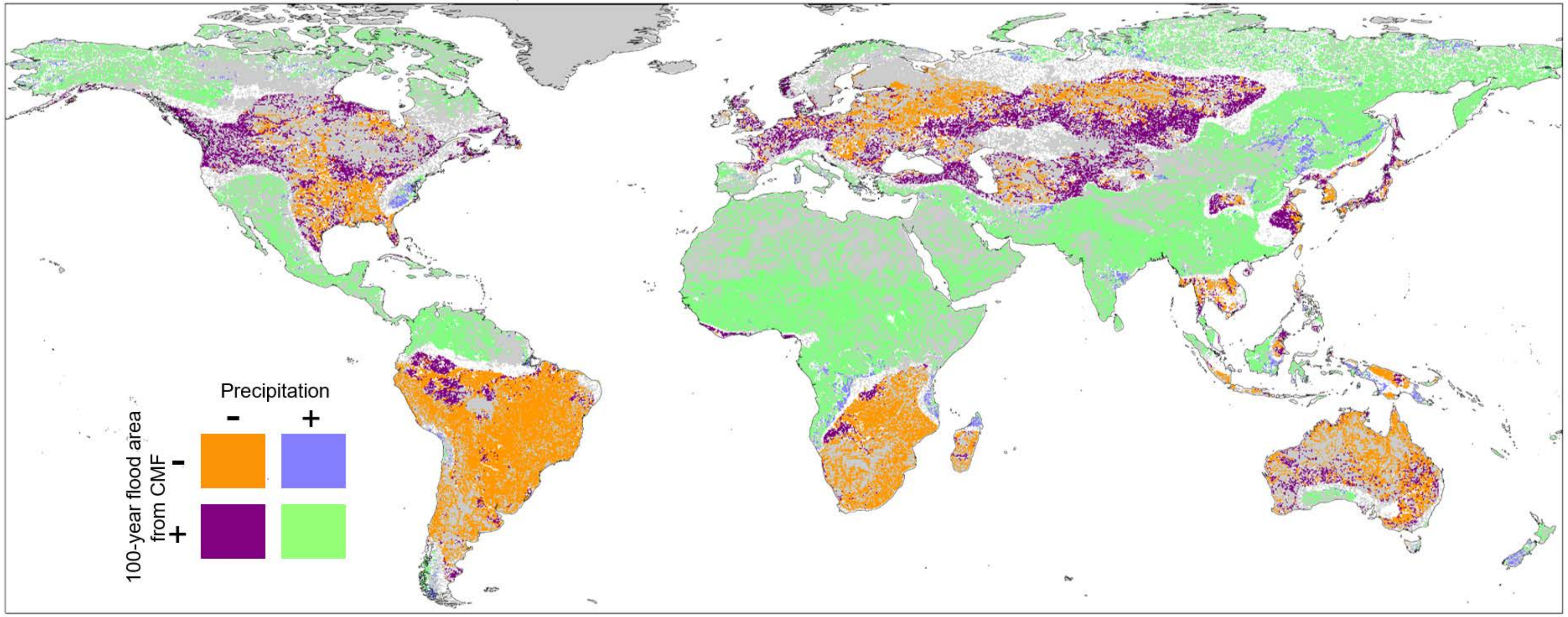
Results

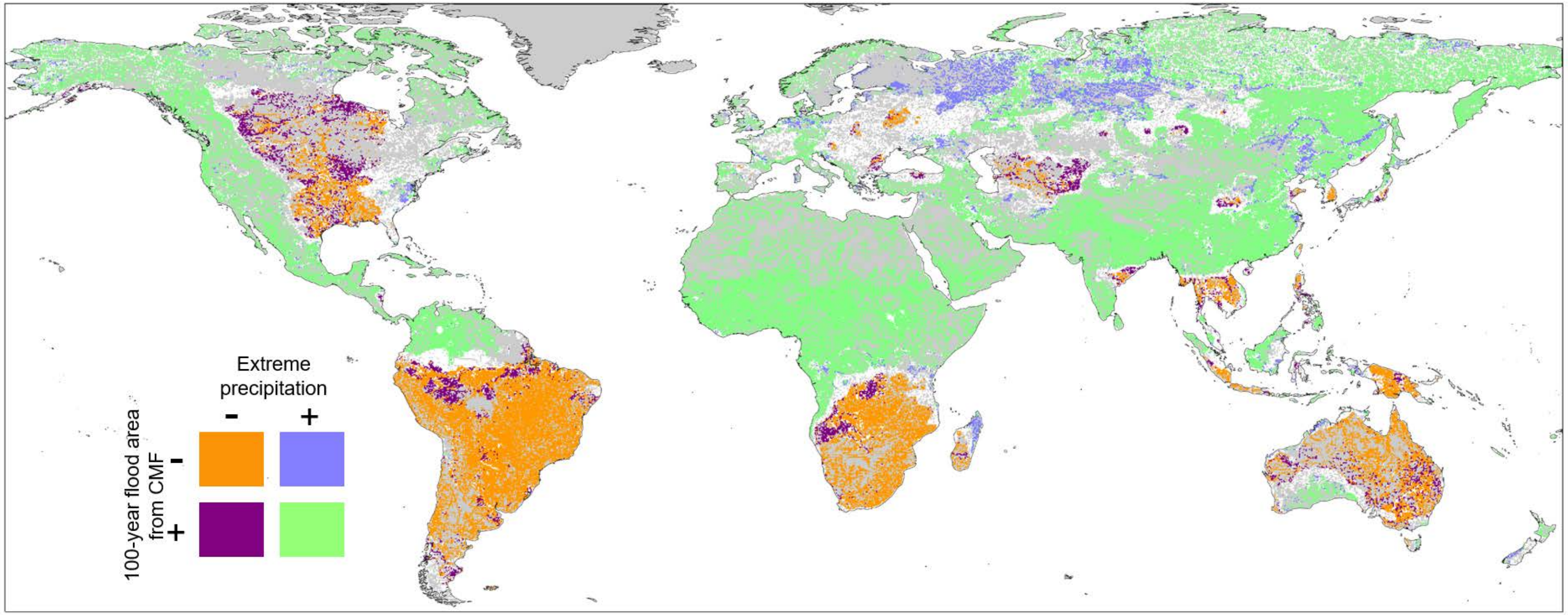


Where do anomalies diverge?



Results

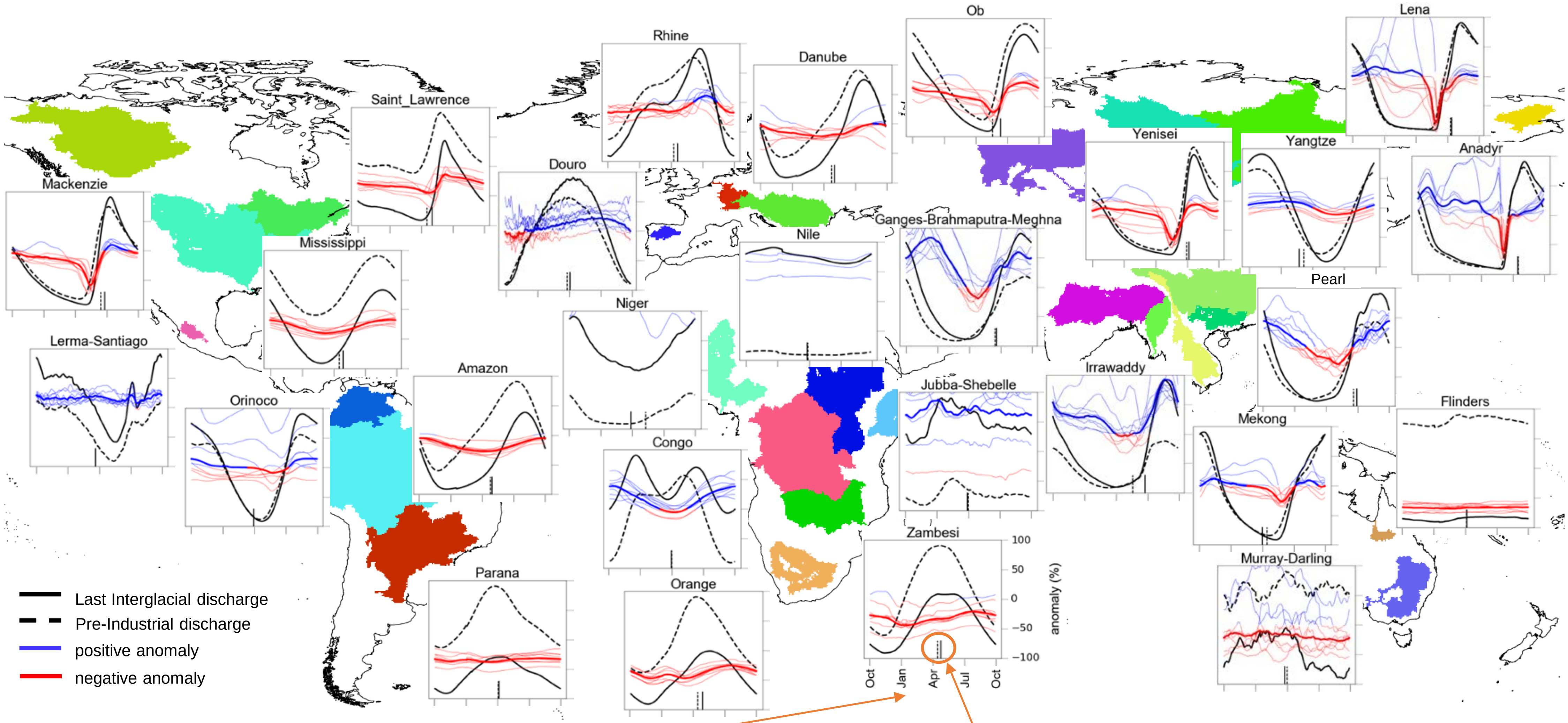




Where do anomalies diverge?

Annual discharge of large basins

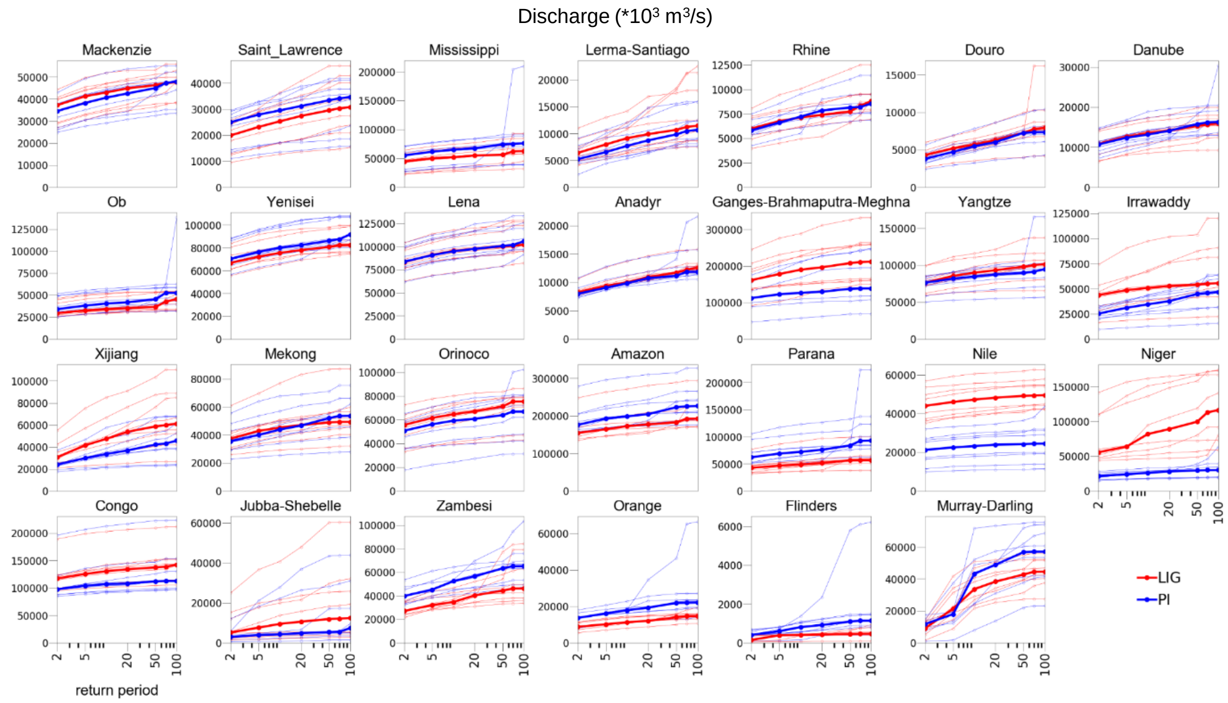
Seasonal pattern of discharge changes for some basins

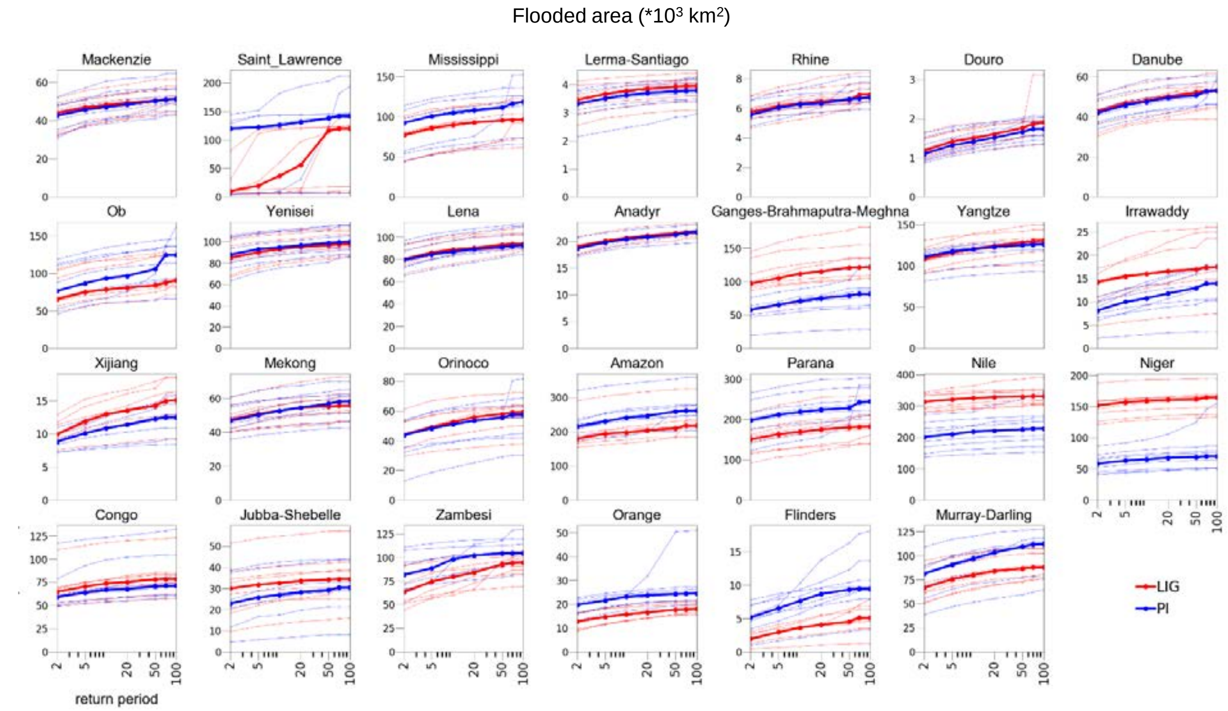


Water-year from October to September
Ensemble-average discharge, on left y-axis (scale differs per basin, not shown)
Discharge anomaly for each model, on the right y-axis (scale from -100% to 100%)

Timing of half annual discharge in LIG (solid) and pre-industrial (dashed)

Part 2 – LIG hydrology
Results



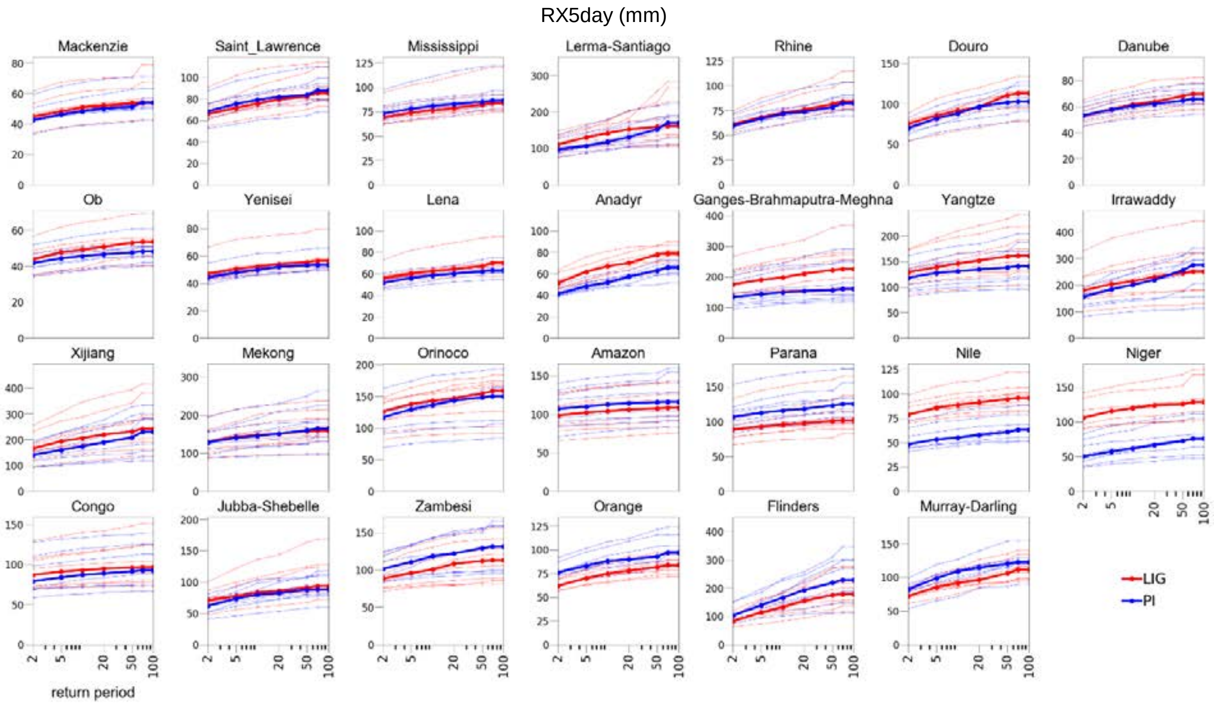


Extremes in discharge and floods of large basins

Return periods from 2-year to 100-year

Similar patterns for most basins

Part 2 – LIG hydrology
Results



Extremes in precipitation over large basins

Maximum annual precipitation in 5, 15 and 30 consecutive days (index RX5day etc.)

Mostly same patterns as discharge and floods