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Floods of a warmer world: learning from the Last Interglacial

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I – We already had a warmer climate

Changes in the hydrological cycle have large consequences for society[1]. In particular, precipitation extremes and floods may get worse in a warmer climate. Besides relying on global climate models forced with greenhouse scenarios, we may look at past climates to understand how the hydrological cycle may rearrange under warmer conditions. **The Last Interglacial[2] (LIG, ~127,000 years ago)** may be the best candidate for this. Here we analyze the LIG precipitation and its extremes through an ensemble of climate models and through proxies. Then we will simulate LIG fluvial floods and their impacts.

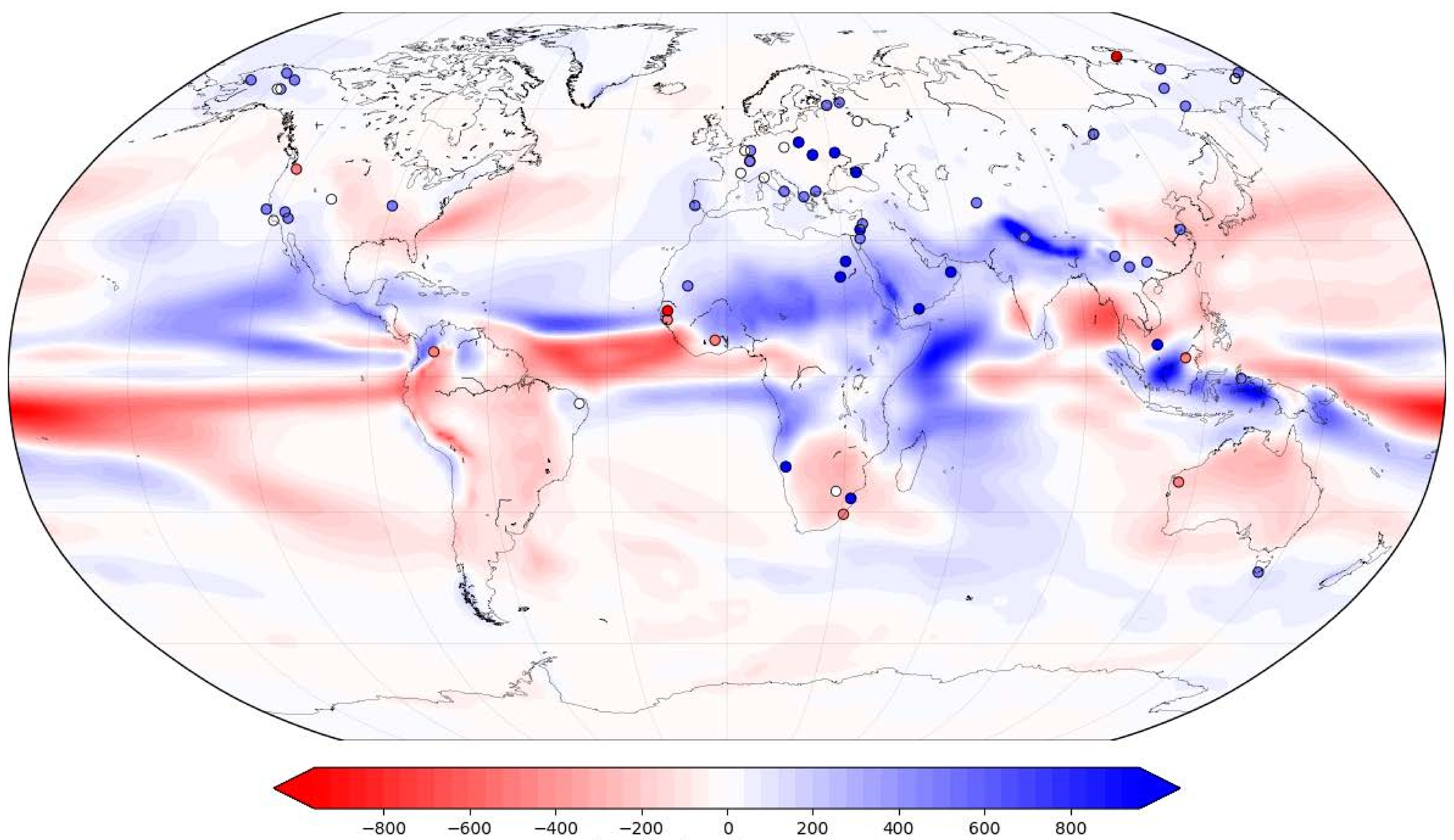

Fig. 1: Annual precipitation anomaly between Last Interglacial and preindustrial/ present, from models CESM1.2 and NorESM (contours; mm/year) and from proxies (circles; qualitative scale). Blue = wetter Last Interglacial

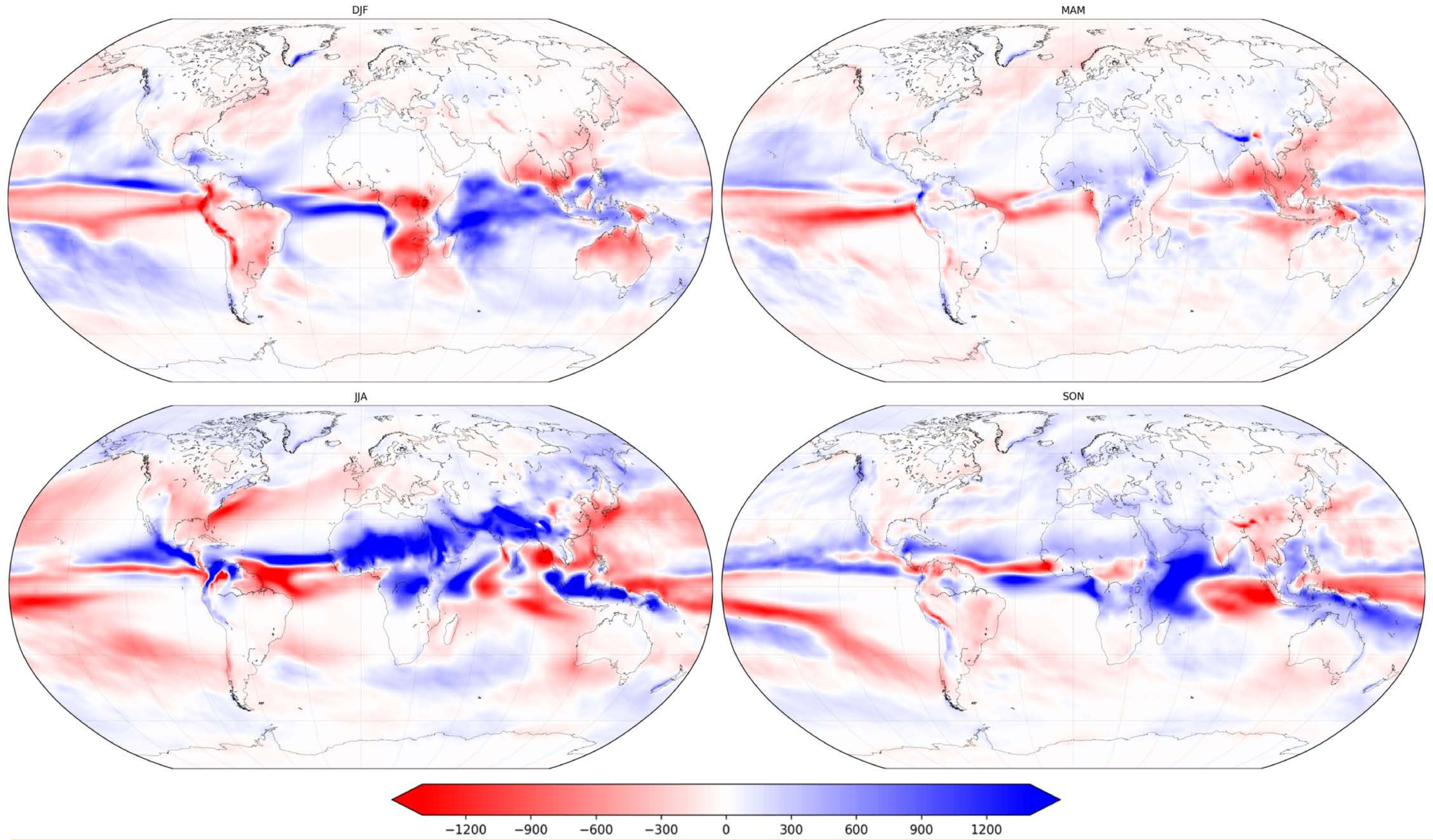

Fig. 2: Seasonal precipitation anomaly between Last Interglacial and preindustrial (mm/year), showing only CESM1.2. Blue = wetter Last Interglacial

II – Model vs proxy precipitation – fig. 1 - 2

We compiled the first global dataset of proxies for LIG precipitation. So far it contains 85 entries, with qualitative or quantitative precipitation anomaly between LIG and present/preindustrial. The CESM1.2 and NorESM **inter-model average agrees with ~60% of the proxies**, mostly in north Africa, Middle-East, central Asia, northeast Asia, northwest America and Australia. Seasonal precipitation anomalies from CESM1.2 show **much stronger LIG northern hemisphere summer monsoons** - North Africa, North America, Indian and Asian-Australian monsoon, and **diminished LIG Southern monsoons** - west of South American, South African, Australian monsoon, with regional variations.

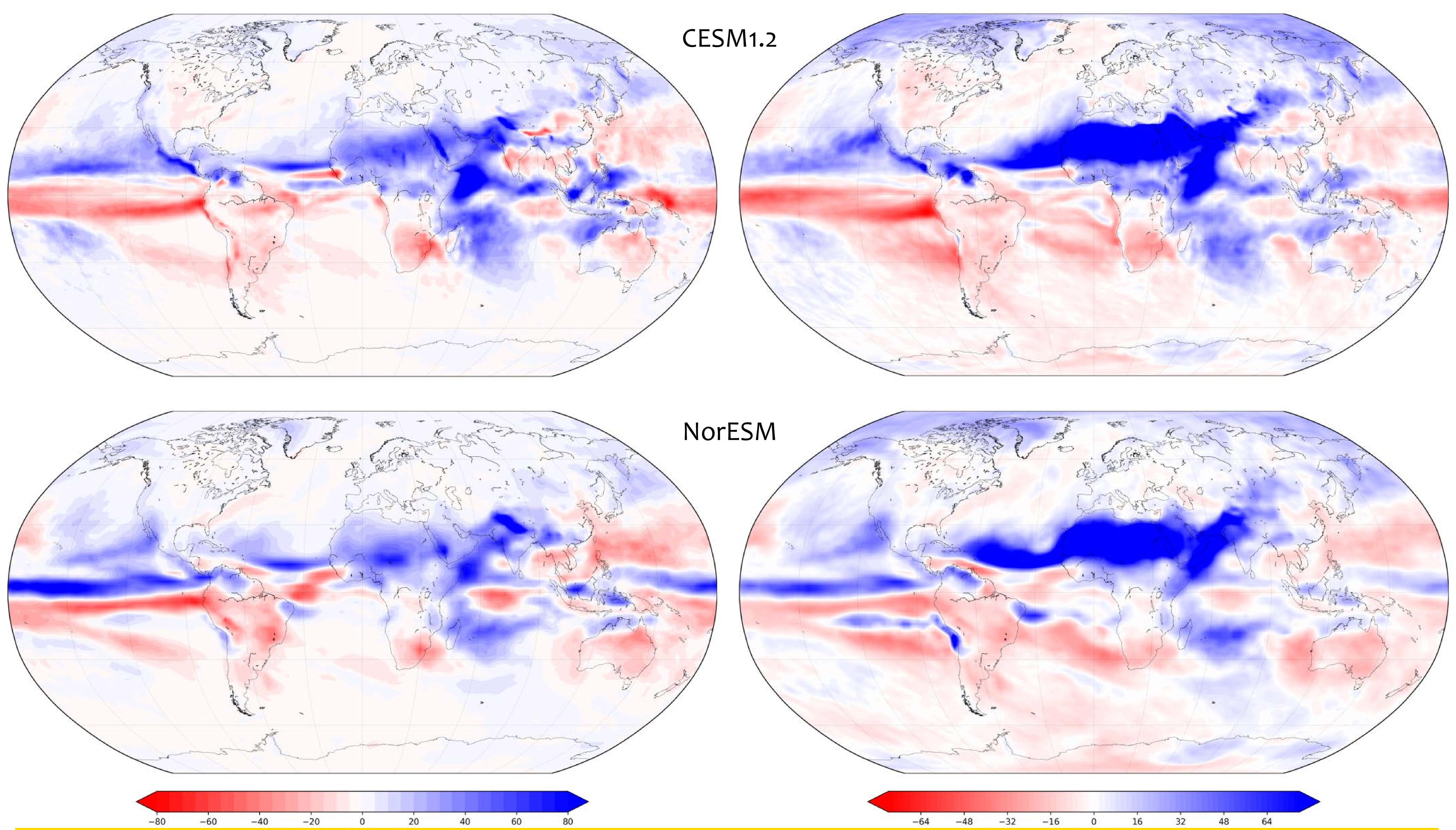

Fig. 3: Annual precipitation index RX5day anomaly. Left: mm in 5 days; right: as % change. Blue = more extreme precipitation in the Last Interglacial

III – Precipitation extremes – fig. 3

Annual precipitation extremes (5-day max precipitation: RX5day index) in the LIG are stronger in the whole north Africa and Middle-East, northwest India, in areas of east Asia and Indonesia, in western central and north America, northern South America and western Iberia.

IV – Further work – fig. 4

1) Include daily LIG **results from other PMIP4 models** - CESM2, EC-EARTH3.2, IPSL-CM6, MPI-ESM 1.2.01, NUIST-CSM and potentially more.

2) Input daily variables from the paleo climate models in a **hydrological model** (PRC-GLOBWB, CWATM[3]), to obtain river discharges, and in turn in a **hydrodynamic model** (CaMa-Flood[4]) to simulate river floods at 30" resolution.

3) Calculate **river flood risk**, as if the past climate were to replicate in the future. With the GLOFRIS framework[5], we will project flood impacts based on exposure of population and assets from socioeconomic scenarios.

4) Will also study changes in **storm surge and coastal flooding**, with the GTSM model[6-7]; plus we will look at changing patterns of meteorological **drought**.

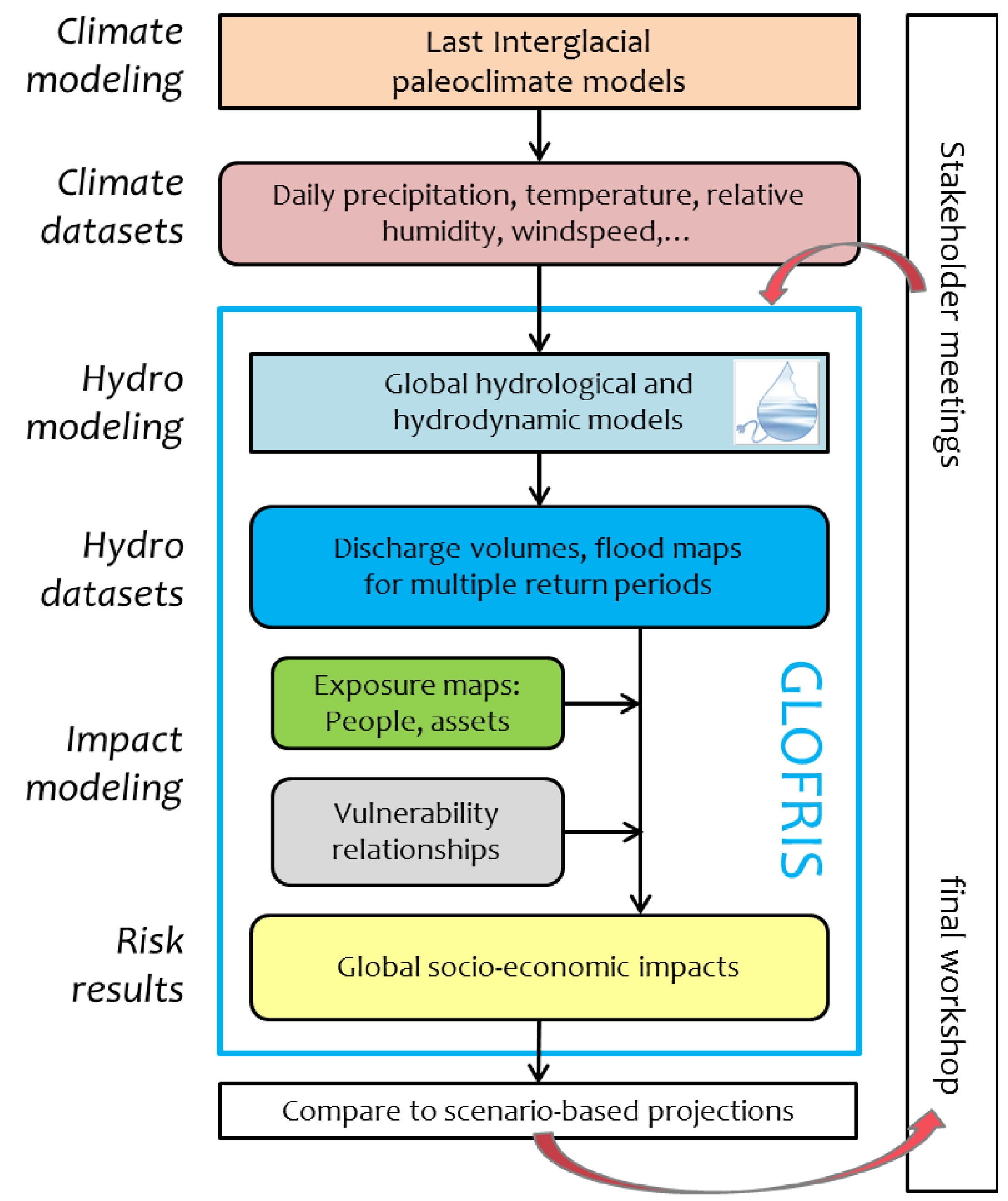

Fig. 4: Structure of the whole project

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