OptimESM

Optimal high resolution **Earth System Models** for exploring future climate change

ISIMIP

Inter-Sectoral Impact Model Intercomparison Project

Welcome to the Cross-sectoral OptimESM-ISIMIP Workshop

PIK, Potsdam - 05-08 May 2025

Katja Frieler

Leibniz Association

PIK

Funded by the European Union

2024 - Disasters in Numbers (EM-DAT)

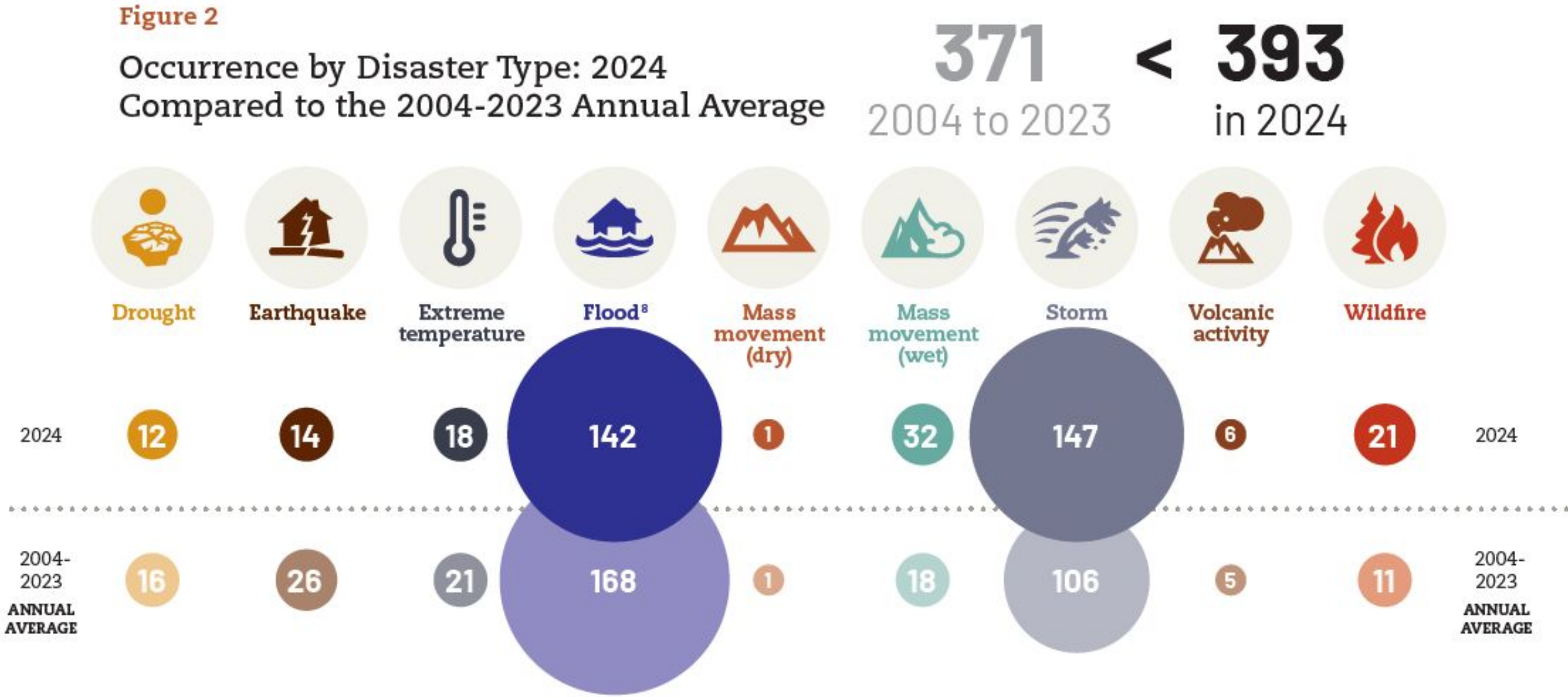


Figure 6

Number of Affected by Disaster Type: 2024 Compared to 2004-2023 Annual Average

168.7 2004 to 2023 **>** **167.2** in 2024

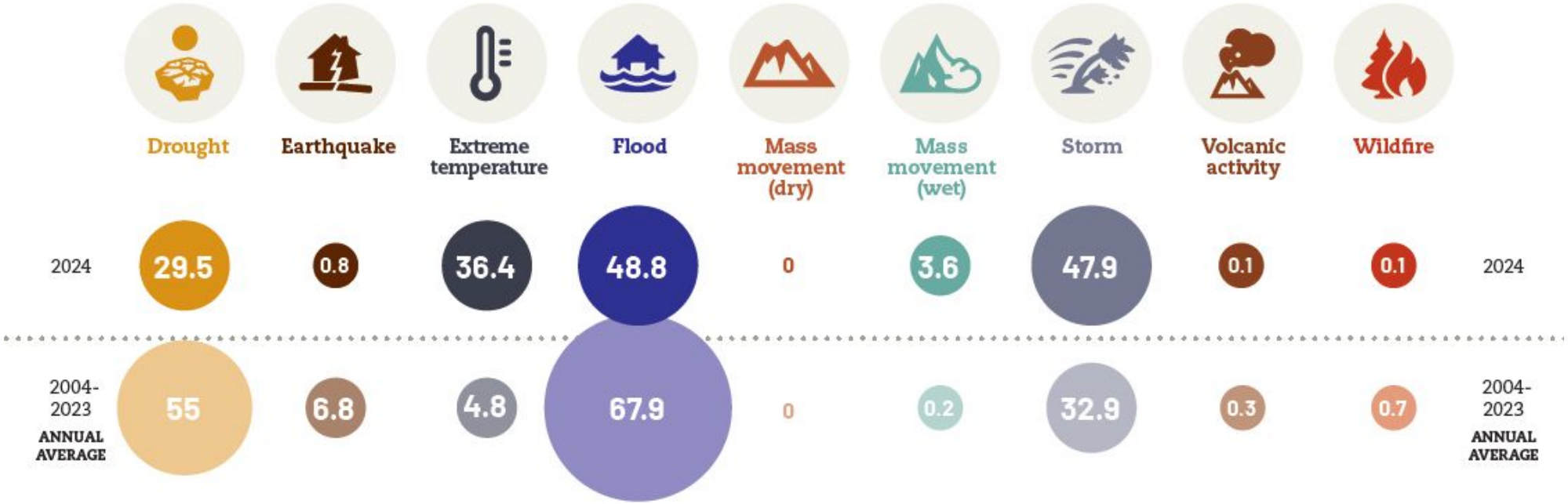


Table 2 Top 10 Total Affected – 2024

Bangladesh	Heat Wave	33 million
Zambia	Drought	9.8 million
Philippines	Typhoon Trami	9.7 million
India	Flood	8 million
Zimbabwe	Drought	7.6 million

Philippines	Typhoon Gaemi and Prapiroon	6.5 million
Malawi	Drought	6.1 million
Bangladesh	Flood (August)	5.8 million
Bangladesh	Flood (June-July)	5.1 million
Bangladesh	Tropical Cyclone Remal	4.6 million

11 Sum of people injured, homeless, and otherwise affected.

Figure 8

Economic Losses (US$ billion) by Disaster Type: 2024 Compared to the 2004-2023 Annual Average

209.6 2004 to 2023 **<** **242** in 2024

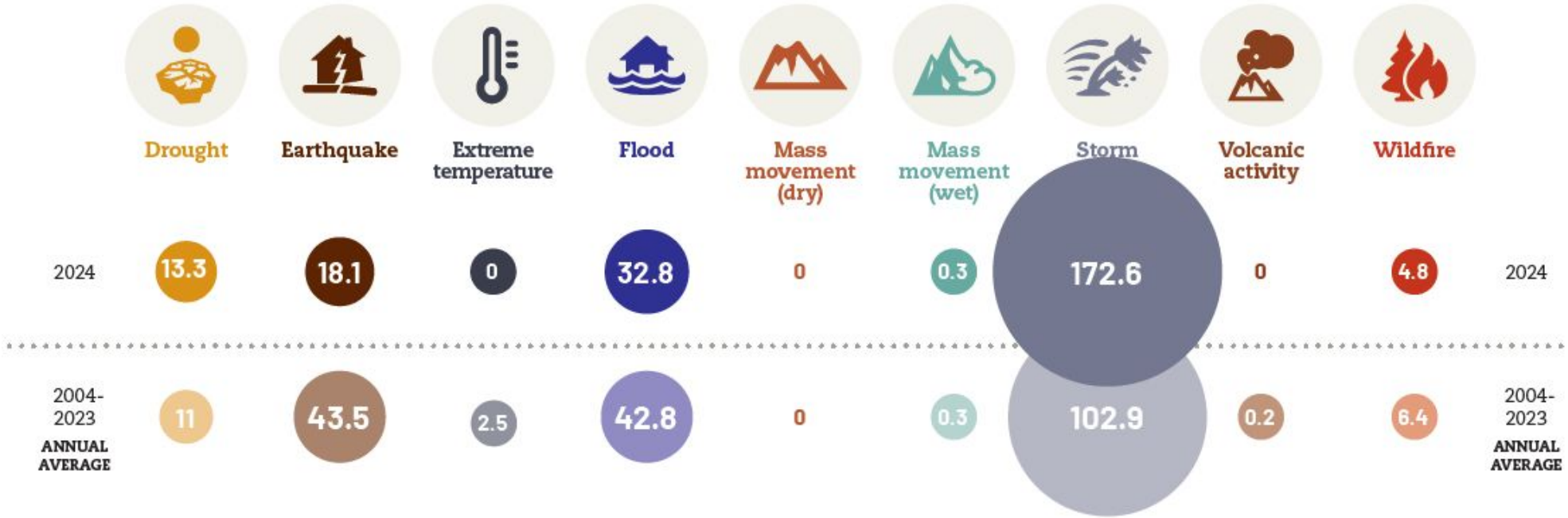
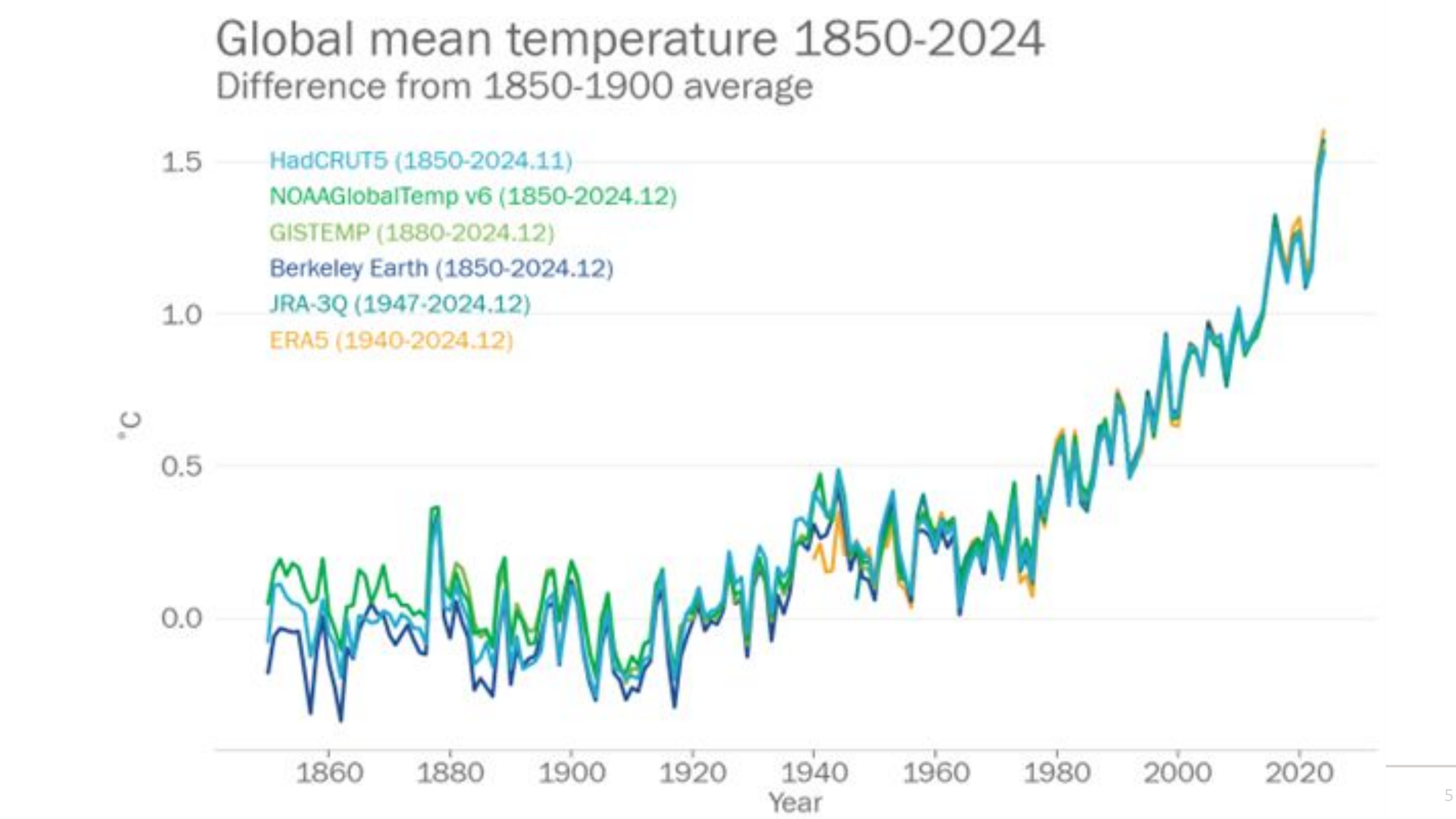


Table 3 Top 10 Economic Losses (US$) - 2024

USA	Hurricane Helene	56 billion	Brazil	Flood	7 billion
USA	Hurricane Milton	38 billion	USA	Storm (May)	6.6 billion
Japan	Earthquake	15 billion	Brazil	Drought	6 billion
Spain	Flood	11 billion	USA	Storm (March)	5.9 billion
USA	Hurricane Beryl	7.2 billion	USA	Drought	5.4 billion

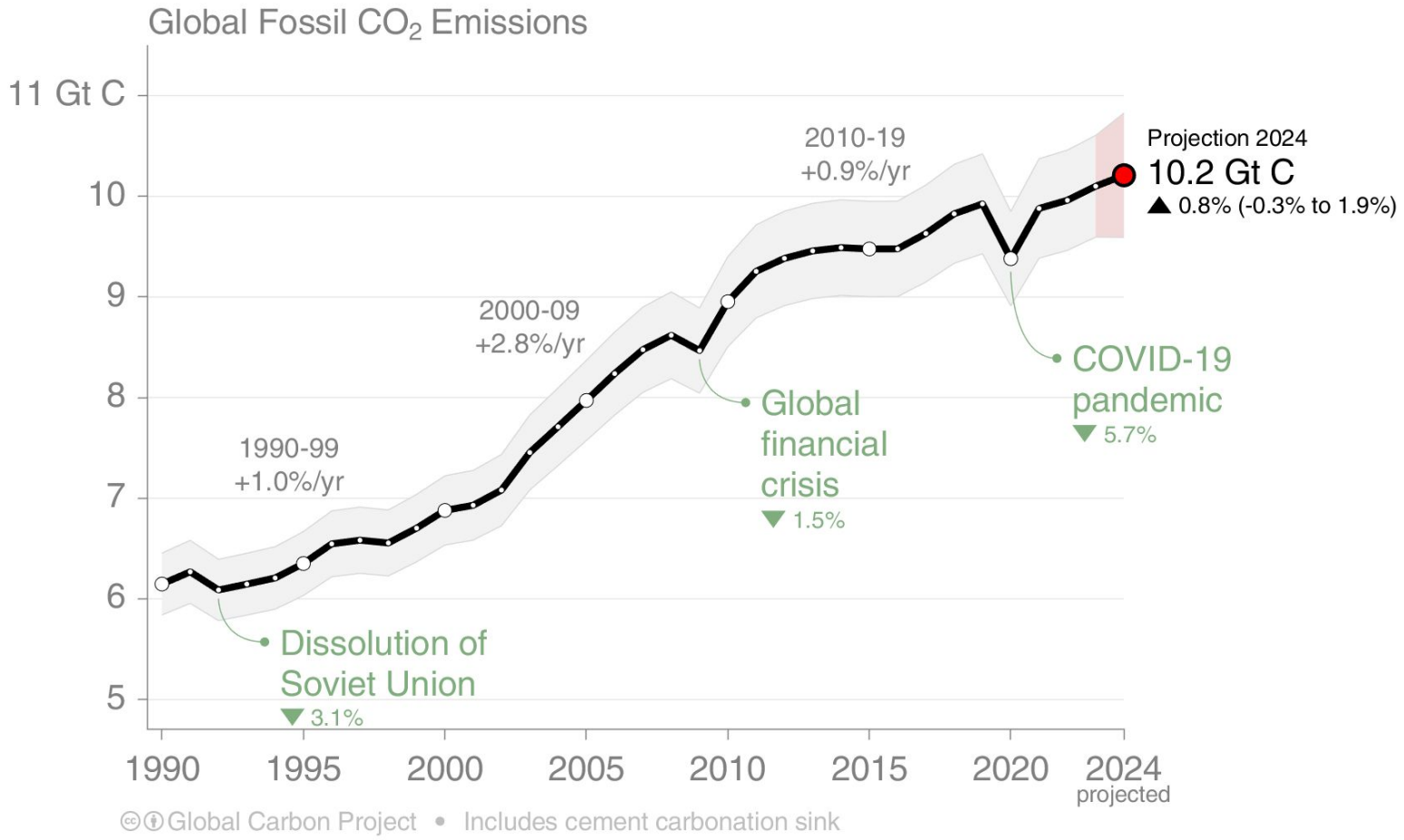
12 Historical figures for economic losses are adjusted using the annual consumer price index (CPI) from OECD.


Global mean temperature 1850-2024
Difference from 1850-1900 average
HadCRUT5 (1850-2024.11)
NOAAGlobalTemp v6 (1850-2024.12)
GISTEMP (1880-2024.12)
Berkeley Earth (1850-2024.12)
JRA-3Q (1947-2024.12)
ERA5 (1940-2024.12)
1.5
1.0
0.5
0.0
°C
1860
1880
1900
1920
1940
1960
1980
2000
2020
Year

Global Fossil CO_2 Emissions

Global fossil CO_2 emissions: 10.1 ± 0.5 GtC in 2023, 66% over 1990

Projection for 2024: 10.2 ± 0.5 Gt, 0.8% [-0.3% to +1.9%] higher than 2023

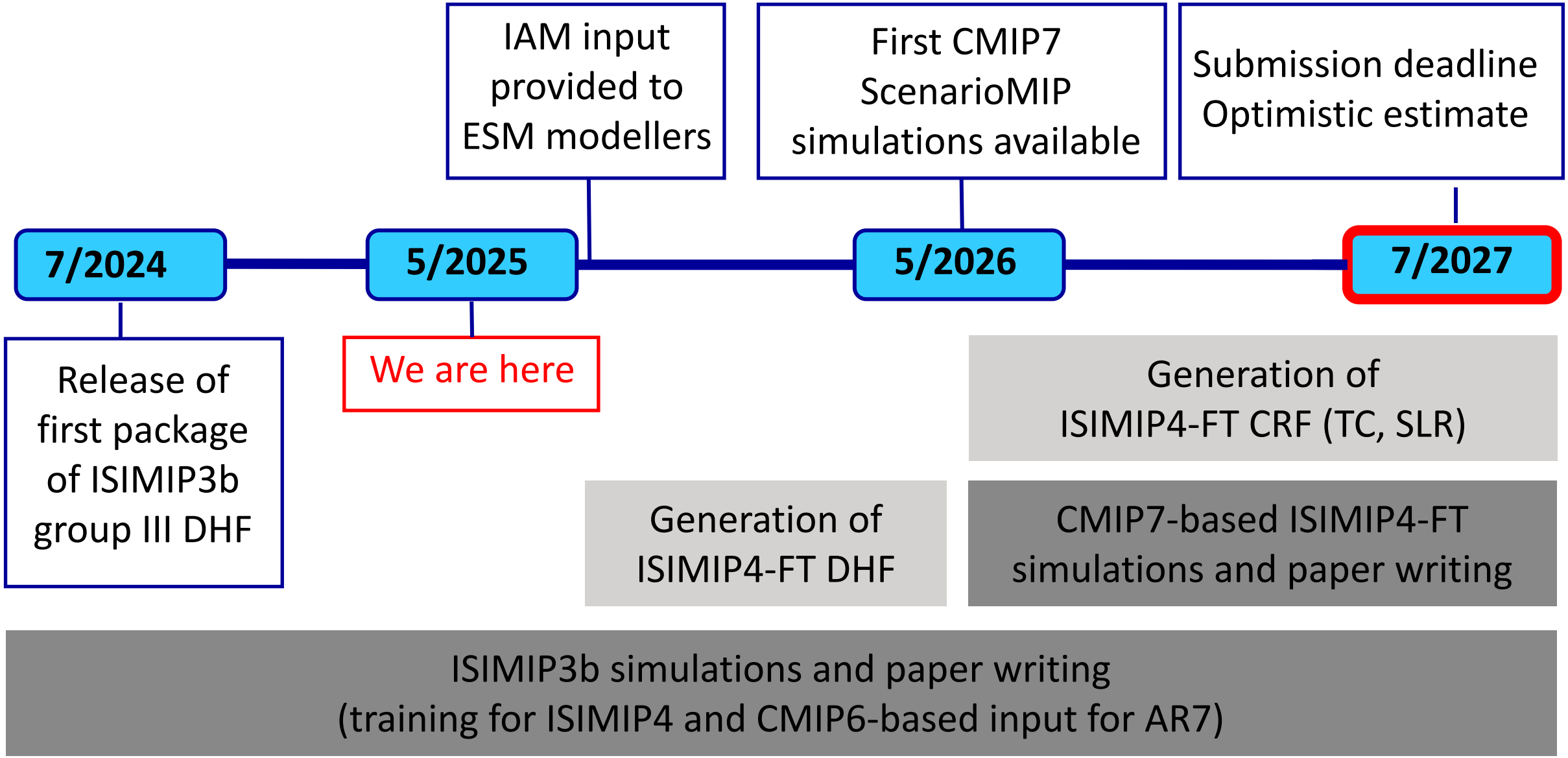


Uncertainty is ±5% for one standard deviation (IPCC "likely" range)

The 2024 projection is based on preliminary data and modelling. The global total includes a cement carbonation sink of 0.2 GtC.

Source: Friedlingstein et al 2024; Global Carbon Project 2024

ISIMIP3 / ISIMIP4 Timeline to AR7



Overall aims of the workshop

- **Future impact simulations accounting for socioeconomic changes**
  - What are the current status, issues and future plans?
    Session on “Future projections of climate impacts accounting for socioeconomic changes” (Wednesday, 11:45-13:00)

ISIMIP3b

Group III

- **Road towards CMIP7-based ISIMIP4 FT**
  - Which ESM-simulations will be available first, what will be new?
    Session on “Scenarios and Timelines” (Wednesday 14:30-16:00)
  - Which scenarios should we consider in ISIMIP4 FT?
    Session on “Sector perspectives” (Wednesday 16:30-18:30)
  - How can the necessary DHF data be generated in time?
    Session “Direct Human Forcing for climate impact simulations” (Thursday, 12:00-13:30)

Aims of the workshop

- **What do we want to contribute to the IPCC AR7**
  - Which studies are ongoing/planned? What are the gaps?
    Session “Advancing (cross-sectoral) paper ideas” (Thursday 9:00-10:30)
    -> Add you ideas to the Miro Board at https://tinyurl.com/paperIdeasAR7
  - Which simulations and scenarios to focus on for AR7?
    Session on “Sector perspectives” (Wednesday 16:30-18:30)

ISIMIP Results since last WS

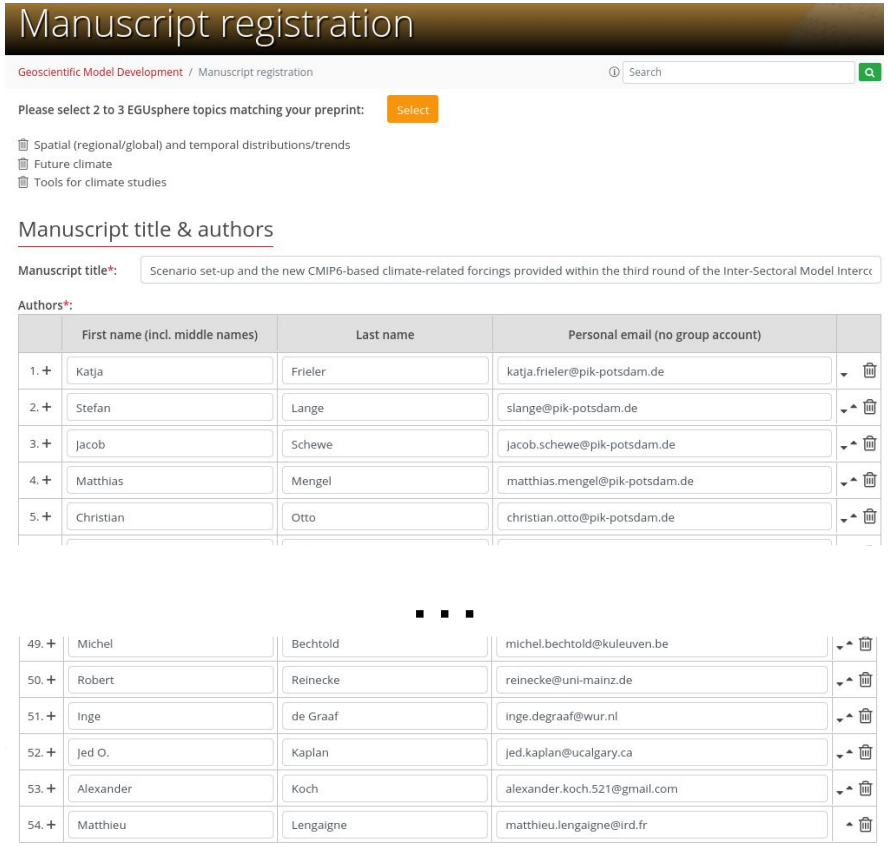
ISIMIP3-based

- *Jones E.R., et al* (2023) DynQual v1.0: a high-resolution global surface water quality model Geosci. Model Dev., 16, 4481–4500
- *Jones E. R., et al. (2023)* Sub-Saharan Africa will increasingly become the dominant hotspot of surface water pollution Nat Water 1, 602–613
- *Jones E.R, et al. (2024)* Current and future global water scarcity intensifies when accounting for surface water quality Nature Climate Change **14**, pages 629–635
- *Burton, C., et al (2024)* Global burned area increasingly explained by climate change Nature Climate Change 14, pages 1186–1192
- *Oluwafemi E., et al. (2024)* Climate change is intensifying rainfall erosivity and soil erosion in West Africa Science of The Total Environment, Volume 955, 2024, 177174
- *Gebremedhin G. H., et al. (2024)* Projected impacts of climate change on global irrigation water withdrawals Agricultural Water Management, Volume 305, 2024, 109144
- *Hugelius, G., et al. (2024)* Region Greenhouse Gas Budgets Suggest a Weak CO2 Sink and CH4 and N2O Sources, But Magnitudes Differ Between Top-Down and Bottom-Up Methods Global Biogeochemical Cycles, 38, e2023GB007969
- *Jones, M. W., et al. (2024)* State of Wildfires 2023–2024 Earth Syst. Sci. Data, 16, 3601–3685
- *Park, C. Y., et al. (2024)* Attributing human mortality from fire PM2.5 to climate change Nature Climate Change volume 14, pages 1193–1200
- *Vogt, T. et al. (2024)* Modeling surge dynamics improves coastal flood estimates in a global set of tropical cyclones Communications Earth & Environment volume 5, Article number: 529
- *Heinicke, S. et al. (2024)* Global hydrological models continue to overestimate river discharge, Environmental Research Letters 19:074005
- *Paprotny, D. et al. (2024)* Merging modelled and reported flood impacts in Europe in a combined flood event catalogue for 1950–2020 Hydrol. Earth Syst. Sci., 28, 3983–4010
- *Pietroiusti, R., et al. (2024)* Possible role of anthropogenic climate change in the record-breaking 2020 Lake Victoria levels and floods, Earth Syst. Dynam., 15, 225–264
- *O. Maury, O., et al. (2025)* The Ocean System Pathways (OSPs): A New Scenario and Simulation Framework to Investigate the Future of the World Fisheries Earths Future, Volume13, Issue3, e2024EF004851
- *Jansen, L., et al (2025)* Current and future adaptation potential of heat-tolerant maize in Cameroon: a combined attribution and adaptation study Environ. Res. Lett. 20 024027 (2025)
- *Mialyk, O., et al. (2024)* Evolution of global water footprints of crop production in 1990–2019 Environ. Res. Lett. 19 114015
- *Deng, Q., et al. (2025)* Deepening water scarcity in breadbasket nations Nat Commun 16, 1110
- *Zhao F, et al. (2025)* Benefits of calibrating a global hydrological model for regional analyses of flood and drought projections: a case study of the Yangtze River Basin Water Resources Research 61: e2024WR037153
- *Eddy, T., et al. (2025)* Global and regional marine ecosystem model climate change projections reveal key uncertainties Earth's Future 13, 3, e2024EF005537
- Luo, M.X. (in press) Role of forest biomass change in shaping future land use and land cover change

ISIMIP Results since last WS

ISIMIP2-based

- *Boyd, D. S., et al. (2025)* The future of decent work: Forecasting heat stress and the intersection of sustainable development challenges in India's brick kilns Sustainable Development, 33(2), 3099–3117.
- *Otta K, et al. (2025)* Towards the use of satellite remote sensing to validate reservoir storage in global hydrological models: methodology and pilot study in the CONUS Environmental Research: Water 1: 015002
- *R. Kiribou, et al. (2024)* Exposure of African ape sites to climate change impacts PLOS Clim 3(2): e0000345
- *Hong Wang, et al. (2024)* Anthropogenic climate change has influenced global river flow seasonality Science 383,1009-1014
- *M. Porkka, (2024)* Notable shifts beyond pre-industrial streamflow and soil moisture conditions transgress the planetary boundary for freshwater change Nature Water 2, pages 262–273
- *Woolway RI, et al. (2025)* Subsurface heatwaves in lakes Nature Climate Change
- Qiu, Y., *et al. (2025)* Enhanced heating effect of lakes under global warming. *Nat Commun* **16**, 3954
- *Müller Schmied H. M., et al. (2025)* Graphical representation of global water models. Geosci. Model Dev., 18, 2409–2425
- *Pelz, S., et al. (2025)* Delayed carbon debt drawdown fails younger generations Proceedings of the National Academy of Sciences, 122(13), e2409316122
- *Mandel, A., et al. (2025)* Mapping global financial risks under climate change Nature Climate Change **15**, pages 329–334
- *Smith MW, et al. (2024)* Future malaria environmental suitability in Africa is sensitive to hydrology. Science 384: 697–703



Submitted *to GMD:*

- *Frieler, K. et al.:* Scenario set-up and the new CMIP6-based climate-related forcings provided within the third round of the Inter-Sectoral Model Intercomparison Project (ISIMIP3b, group I and II)

ISIMIP Inter-Sectoral Impact Model Intercomparison Project

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What may help us

- HORIZON-CL5-03-2025-D1-01: Climate Simulations data and Knowledge for Optimal Support of IPCC Assessments and International Policy.
- HORIZON-CL5-2025-03-D1-04: The attribution to climate change, and improved forecasting of extreme climate- and weather-related events and their impacts
- HORIZON-CL5-2025-03-D1-05: Adaptation to Climate Change: Effectiveness and Limits
- HORIZON-CL2-2025-01-TRANSFO-11: Migration and climate change: building resilience and enhancing sustainability
- COST Action proposal submitted by Christopher! (decision expect 23 May)

Sector highlights

Groundwater. ISIMIP3a and 3b (group I and II) protocol finalized; first joint paper submitted

Regional water. Third Special Issue (10 articles) on "Impact attribution: exploring the contribution of climate change to recent trends in hydrological processes" published in Climatic Change. Preparation of new SI on "Climate change induced threats to Water Security" (15 articles suggested)

Biodiversity. Species distribution models for ISIMIP3 are ready (amphibians, birds, mammals) (Biodiversity); Damaris Zurell (University of Potsdam) and Dirk Karger (WSL) have joined Thomas Hickler as sector coordinators

Health. BREATHE-Project to integrate heat burden simulations into ISIMIP; development of ISIMIP3a/b protocol for vector-borne diseases, three health-related attribution studies within the cross-Nature journal collection on attribution

Sector highlights

Fire. 7-10 fire modeling groups on course of doing ISIMIP3b simulations by next summer.

Water quality. ERL-/ERW SI including at least 10 papers on water quality model intercomparison, and a community paper submitted with 7 large-scale models participated in four model intercomparisons

Energy. Energy Demand ISIMIP3b protocols finalized.

Labour. First comprehensive review of labour force impacts published. Model comparison exercise with MAgPIE, IMACLIM-R, and IMAGE underway.

nature climate change

Article

https://doi.org/10.1038/s41558-024-02140-w

Global burned area increasingly explained by climate change

Received: 13 July 2023

Accepted: 28 August 2024

Published online: 21 October 2024

Check for updates

Chantelle Burton[1,17], Seppe Lampe[2,17] ✉, Douglas I. Kelley[3], Wim Thiery[2], Stijn Hantson[4], Nikos Christidis[1], Lukas Gudmundsson[5], Matthew Forrest[6], Eleanor Burke[1], Jinfeng Chang[7], Huilin Huang[8], Akihiko Ito[9,10], Sian Kou-Giesbrecht[11], Gitta Lasslop[6], Wei Li[12], Lars Nieradzik[13], Fang Li[14], Yang Chen[15], James Randerson[15], Christopher P. O. Reyer[16] & Matthias Mengel[16]

Focus on Model Intercomparisons of Water Quality Under Global Change Impacts

Guest Editors

Martina Flörke, *Ruhr-Universität Bochum, Germany*
Nynke Hofstra, *Wageningen University, Netherlands*
Rohini Kumar, *Helmholtz Centre for Environmental Research (UFZ), Germany*
Maryna Strokal, *Wageningen University, Netherlands*
Michelle T. H. van Vliet, *Utrecht University, Netherlands*

Scope

Photo by Bernd Dittrich on Unsplash

Water quality is under threat in many places on Earth due to climate change and extremes (*e.g., droughts, floods*) that are integrated with socio-economic developments (*e.g., agriculture, urbanization*). Water quality models have been developed and combine our knowledge and data to estimate water pollution, its sources, and impacts of a wide range of pollutants such as salinity, nutrients, salinity, pathogens, plastics, and chemicals. These models are diverse in their temporal and spatial representation and their modelling approaches. Such diversity offers a great opportunity to compare model results to identify robust pollution hotspots, their sources and explore trends under global change across multiple pollutants, scales, scenarios, and sectors.

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Sector highlights

Regional Forest. Working on protocol and storylines for group III for simulating forests in selected European countries; Topical Collection on *"Climate impacts on European forests and their mitigation potentials and ecosystem service provisioning"* in Regional Environmental Change based on ISIMIP3;

Biomes/Permafrost. 8-12 active models working on 3b; 6-8 3a/3b papers ongoing, creating a database for Forest NPP based on ISIMIP2b (and 3b)

Peat. 3a runs ready/ongoing/uploading for 4 models, Three 3a/3b group-ii papers planned (evaluation paper, future carbon paper, co2-fertilization paper).

Sector highlights

Global water. Publication of model diagrams reflecting all processes included in ISIMIP2-model runs in GMD (poster by Simon Gosling)

6 papers since the last workshop on malaria risks, water scarcity, propagation of droughts, floods and model calibration, modeling of reservoirs and model validation

Yadu Pokhrel (Michigan State University) has joined Simon Gosling as new sector coordinator

Agriculture. 4 papers published on:

- Climate change impacts on productivity of crops vs. farmworkers
- Economics of cropland expansion in the Brazilian Cerrado
- The potential of food trade to mitigate or aggravate crop productivity losses
- Impacts of crop productivity changes on food security and climate change mitigation goals

ISIMIP3b Group III data updates

Show protocol for:

- ISIMIP3a
- ISIMIP3b

only Group III

Filter for sectors:

- Agriculture
- Biomes
- Energy (demand)
- Fire
- Food Security and Nutrition
- Groundwater
- Labour
- Lakes (global)
- Lakes (local)
- Fisheries and Marine Ecosystems (global)
- Fisheries and Marine Ecosystems (regional)
- Peatland
- Permafrost
- Water (global)
- Water (regional)

Provision of gridded GDP and disaggregated fertilizer inputs

Show protocol for:

- ISIMIP3a
- ISIMIP3b

only Group III

Filter for sectors:

- Agriculture
- Biomes
- Energy (demand)
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- Fisheries and Marine Ecosystems (regional)
- Peatland
- Permafrost
- Water (global)
- Water (regional)

The next days

- for presenters: upload your presentations to the owncloud (also posters and zoom)
- poster presenters: hang up your poster and meet Christopher during the 15:30 coffee break at the speakers table
- all sessions are in this building
- hybrid mode ⇒ please be on time
- Zoom: raise hand or use chat to ask questions
- tomorrow group picture before lunch
- dinner tomorrow at own cost