Datasets and Methods

TEMPERATURE

Six datasets (cited below) were used in the calculation of regional temperature.

Regional mean temperature anomalies were calculated relative to 1961–1990 and 1991–2020 baselines using the following steps:

1) Read the gridded dataset;
2) Regrid the data to 1° latitude × 1° longitude resolution. If the gridded data are higher resolution, take a mean of the grid boxes within each 1° ×1° grid box. If the gridded data are lower resolution, copy the low-resolution grid box value into each 1° ×1° grid box that falls inside the low-resolution grid box;
3) For each month, calculate the regional area average using only those 1° ×1° grid boxes whose centres fall within the region;
4) For each year, take the mean of the monthly area averages to obtain an annual area average;
5) Calculate the mean of the annual area averages over the periods 1961–1990 and 1991–2020;
6) Subtract the 30-year period average from each year.

The following six datasets were used:

- ERA5: Hersbach, H.; Bell, B.; Berrisford, P. et al. *ERA5 Monthly Averaged Data on Single Levels from 1940 to Present*; Copernicus Climate Change Service (C3S) Climate Data Store (CDS), 2023. https://doi.org/10.24381/cds.f17050d7.

- Berkley Earth: Rohde, R. A.; Hausfather, Z. The Berkeley Earth Land/Ocean Temperature Record. *Earth System Science Data* **2020**, *12* (4), 3469–3479. https://doi.org/10.5194/essd-12-3469-2020. The data are available here.

- GISTEMP v4: GISTEMP Team. *GISS Surface Temperature Analysis (GISTEMP), Version 4*; NASA Goddard Institute for Space Studies, 2022. https://data.giss.nasa.gov/gistemp/. Lenssen, N.; Schmidt, G.; Hansen, J. et al. Improvements in the GISTEMP Uncertainty Model. *Journal of Geophysical Research: Atmospheres* **2019**, *124* (12), 6307–6326. https://doi.org/10.1029/2018JD029522. The data are available here.

- HadCRUT.5.0.2.0: Morice, C. P.; Kennedy, J. J.; Rayner, N. A. et al. An Updated Assessment of Near-surface Temperature Change From 1850: The HadCRUT5 Data Set. *Journal of Geophysical Research: Atmospheres* **2021**, 126, e2019JD032361. https://doi.org/10.1029/2019JD032361. HadCRUT.5.0.2.0 data were obtained from http://www.metoffice.gov.uk/hadobs/hadcrut5 on 17 January 2024 and are © British Crown Copyright, Met Office 2024, provided under an Open Government Licence, http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/.

- JRA-3Q : Kosaka, Y.; Kobayashi, S.; Harada, Y. et al. The JRA-3Q Reanalysis. *Journal of the Meteorological Society of Japan. Ser II* **2024**, *102* (1), 49–109. https://doi.org/10.2151/jmsj.2024-004.

- NOAAGlobalTemp v6: Huang, B.; Yin, X.; Menne, M. J. et al. NOAA Global Surface Temperature Dataset (NOAAGlobalTemp), Version 6.0.0. *NOAA National Centers for Environmental Information*. https://doi.org/10.25921/rzxg-p717.

IN-SITU DATA

Temperature in situ data are provided by National Meteorological and Hydrological Services.

PRECIPITATION

The following Global Precipitation Climatology Centre (GPCC) datasets were used in the analysis:

- First Guess Monthly, https://doi.org/10.5676/DWD_GPCC/FG_M_100
- Monitoring Product (Version 2022), https://doi.org/10.5676/DWD_GPCC/MP_M_V2022_100
- Full Data Monthly (Version 2022), https://doi.org/10.5676/DWD_GPCC/FD_M_V2022_100
- Precipitation Climatology (Version 2022), https://doi.org/10.5676/DWD_GPCC/CLIM_M_V2022_100.

OCEAN ACIDIFICATION

European Union (EU) Copernicus Marine Service Product. *Surface Ocean Carbon Fields*; Mercator Ocean International, 2024.

SEA-SURFACE TEMPERATURE

EU Copernicus Marine Service Product. *Global Ocean OSTIA Sea Surface Temperature and Sea Ice Analysis*; Mercator Ocean International, 2023. https://doi.org/10.48670/moi-00165.

EU Copernicus Marine Service Product. *Global Ocean OSTIA Sea Surface Temperature and Sea Ice Reprocessed*; Mercator Ocean International, 2023. https://doi.org/10.48670/moi-00168.

EU Copernicus Marine Service Product. *ESA SST CCI and C3S Reprocessed Sea Surface Temperature Analyses*; Mercator Ocean International, 2024. https://doi.org/10.48670/moi-00169.

Huang, B.; Liu, C.; Banzon, V. et al. Improvements of the Daily Optimum Interpolation Sea Surface Temperature (DOISST) Version 2.1. *Journal of Climate* **2021**, *34*, 2923–2939. https://doi.org/10.1175/JCLI-D-20-0166.1.

MARINE HEATWAVES

EU Copernicus Marine Service Product. *Global Ocean: Real Time In-situ Observations Objective Analysis*; Mercator Ocean International,2024. https://doi.org/10.48670/moi-00037.

EU Copernicus Marine Service Product. *Global Ocean Physics Analysis and Forecast*; Mercator Ocean International, 2024. https://doi.org/10.48670/moi-00016.

SEA LEVEL

Regional sea-level trends are based on gridded C3S altimetry data (https://doi.org/10.48670/moi-00145) combined with near real time CMEMS sea level data (https://doi.org/10.48670/moi-00149) by the Laboratory of Space Geophysical and Oceanographic Studies (LEGOS).