Datasets and Methods

TEMPERATURE

Six data sets (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 data set;
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 over land 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 data sets were used:

- Berkeley 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.
- ERA5: Hersbach, H.; Bell, B.; Berrisford, P. et al. The ERA5 Global Reanalysis. Quarterly Journal of the Royal Meteorological Society 2020, 146 (730), 1999–2049. https://doi.org/10.1002/qj.3803. The data are available here.
- 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.
- 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 NearSurface 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/.
- 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 .

PRECIPITATION

The following Global Precipitation Climatology Centre (GPCC) data sets 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

SEA ICE

In the present report, the estimation of sea-ice extent is based on an analysis of blended Arctic ice charts from the Arctic and Antarctic Research Institute (AARI) (Russian Federation), the Canadian Ice Service (Canada) and the U.S. National Ice Center (United States of America), using passive microwave estimates (SMMR, SSM/I and SSMIS) from the National Snow and Ice Data Center.

GLACIERS

Data are from the World Glacier Monitoring Service (WGMS) and the Chinese Academy of Sciences (CAS).

SNOW COVER

The Interactive Multisensor Snow and Ice Mapping System and data from the National Snow and Ice Data Center are used. To derive the monthly snow cover extent (SCE) anomalies for each grid, the number of monthly snow cover days is divided by the total number of days in that month and then multiplied by the area of the grid. Spatially, the mean SCE in spring for each grid is the average of the SCE in March, April and May for the grid in question. The area-averaged SCE over Asia is obtained by averaging the SCE of all the grids within the area bounded by the red line in Figure 9.

SEA-SURFACE TEMPERATURE

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.

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.

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*. 2021, *34* (8), 2923–2939. https://doi.org/10.1175/JCLI-D-20-0166.1.

OCEAN HEAT CONTENT

Copernicus Marine Service Product: Global Ocean – Delayed Mode Gridded CORA – In-situ Observations Objective Analysis in Delayed Mode, Mercator Ocean International, 2024. https://doi.org/10.17882/46219.

Good, S. A.; Martin, M. J.; Rayner, N. A. EN4: Quality Controlled Ocean Temperature and Salinity Profiles and Monthly Objective Analyses with Uncertainty Estimates; *Journal of Geophysical Research: Oceans* **2013**, 118 (12), 6704–6716. http://doi.org/10.1002/2013JC009067.

EN.4.2.2 data were obtained from https://www.metoffice.gov.uk/hadobs/en4/ and are © British Crown Copyright, Met Office, 2013, provided under a Non-Commercial Government Licence http://www.nationalarchives.gov.uk/doc/non-commercial-government-licence/version/2/.

Levitus, S.; Antonov, J. I.; Boyer, T. P. et al. World Ocean Heat Content and Thermosteric Sea Level Change (0–2000 m), 1955–2010. Geophysical Research Letters 2012, 39 (10). https://doi.org/10.1029/2012GL051106.

Cheng, L.; Pan, Y.; Tan, Z. et al. IAPv4 Ocean Temperature and Ocean Heat Content Gridded Dataset. Earth System Science Data 2024, 16 (8), 3517–3546. https://doi.org/10.5194/essd-16-3517-2024.

MARINE HEATWAVES

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

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 Copernicus Climate Change Service altimetry data (https://doi.org/10.48670/moi-00145) and near real time Copernicus Marine Service sea-level grid (https://doi.org/10.48670/moi-00149) by the Laboratory of Space Geophysical and Oceanographic Studies (LEGOS).

EXTREME EVENTS

Meteorological characteristics and statistics are based on reports from WMO Members in Regional Association II (Asia), Regional Climate Centres (RCCs) and Regional Specialized Meteorological Centres (RSMCs) in the region. Associated socioeconomic impacts are based on reports from WMO Members and reports from United Nations system entities.