Expert Team on Monitoring and Communicating Climate Variability and Change

ET-MCCVC team members

Astana Workshop 23rd-26th June 2025

WORLD METEOROLOGICAL ORGANIZATION

1950-2025 SCIENCE for ACTION

Members

- John Kennedy - Co-chair- (UK)
- Jessica Blunden - Co-chair- (USA)
- Freja Vamborg - Core member- (ECMWF)
- Markus Ziese - Associate expert- (Germany)
- Mostafa, Awatif Ebrahim - Core member- (Egypt)
- Serhat SENSOY - Core member- (Türkiye)
- Atsushi MINAMI - Core member- (Japan)
- Blair TREWIN - Core member- (Australia)
- Renata LIBONATI - Core member- (Brazil)

- Mr Silva, Jose Alvaro Mendes Pimpao Alves - Associate expert- (Portugal)

Terms of Reference

Assess good practices in **communication** and outreach regarding providing and using authoritative climate information for **policy- and decision-making**, (including climate financing; to be further clarified with consideration of advising WMO on their fit for purpose, policy relevance, political sensitivity and scientific robustness). **Attribution** is one of key communication subjects that needs to be further addressed

Define, adopt and monitor an up-to-date measure of the current global temperature rise for timely policy responses at the global level

Support and quality control the production of annual Global State of the Climate Report, and annual regional State of Climate Reports

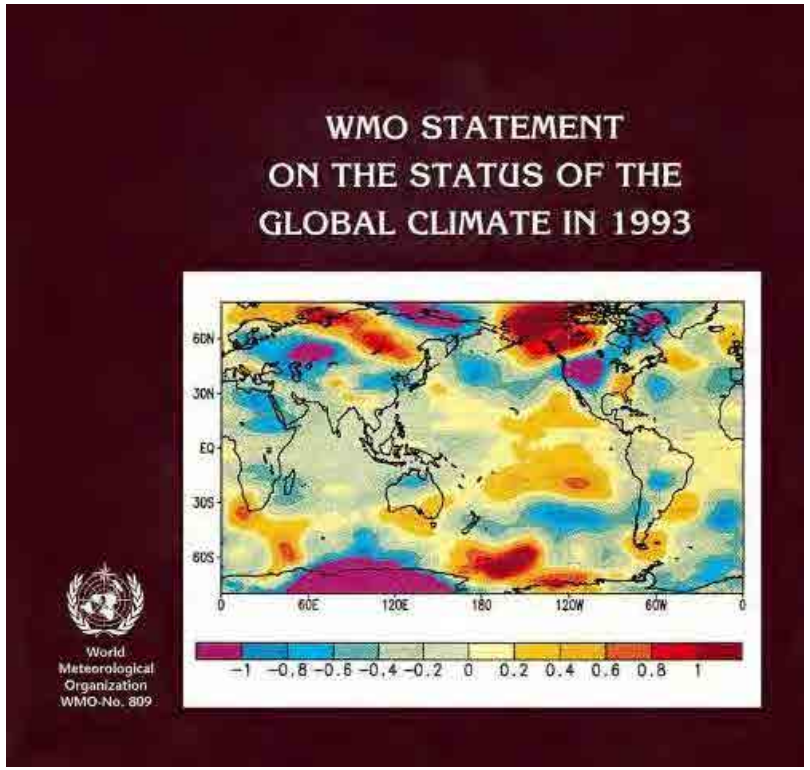
Support monitoring of extreme climate events, including through extreme climate indices, guidance on the collection and quality control of national climate records, and the evaluation of World Records; the latter is under the Rapporteur on World Records of Weather and Climate Extremes

Guide the implementation of Climate Watch Systems, particularly at regional and national levels, and integrate them with the EW4All initiative.

State of the Climate reporting

WMO State of the Global Climate Reports 1993-present

In June 1993, the 45th session of the Executive Council of WMO decided that greater efforts were needed **to promote the WMO role as a provider of credible scientific information on climate and its variability** and requested that arrangements be made for the regular wide distribution stating in 1994 of WMO statements on the status of the global climate.



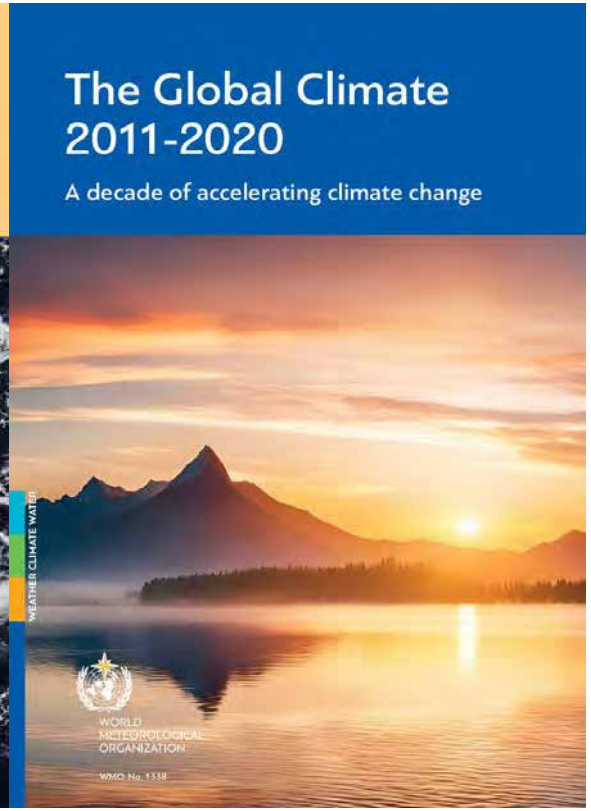
State of the Climate Update for COP

Released at COP enters formally into the process

Global annual 1993-present

Released on World Met Day

Regional x 6: Africa, Asia, Latin America and Caribbean, Southwest Pacific, Europe, Arab States
2019-present



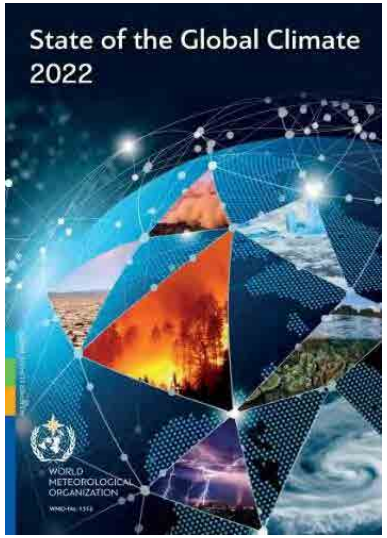
Multi-year reports e.g. decadal, five-year

Five-year reports were subsumed into United in Science

Released in conjunction with relevant meetings

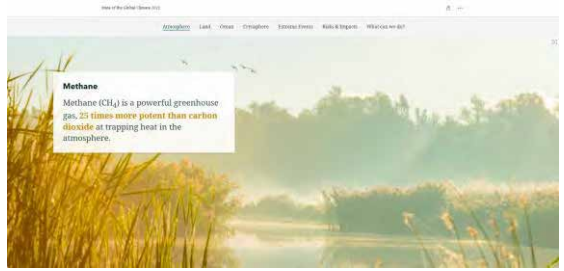
WMO IMO-WMO 1873 2023

Key Outputs



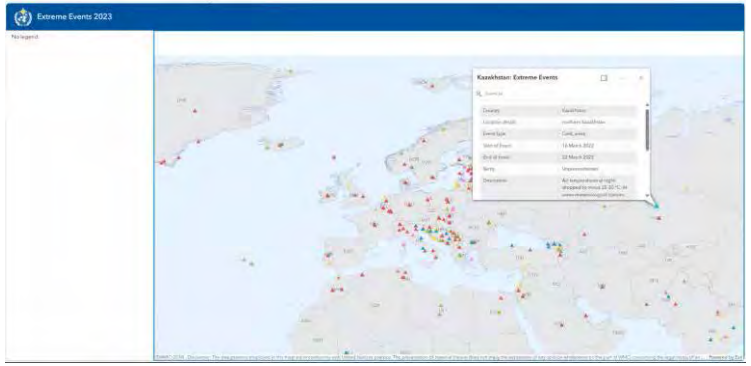
Report (+extreme supplement +state of climate services supplement)

Press release



Story map

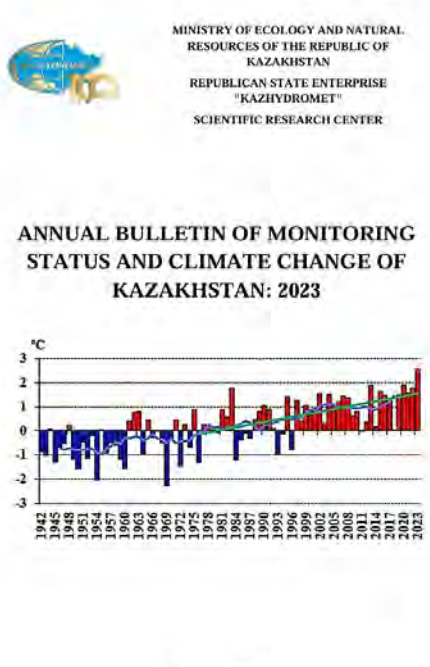
Social Media

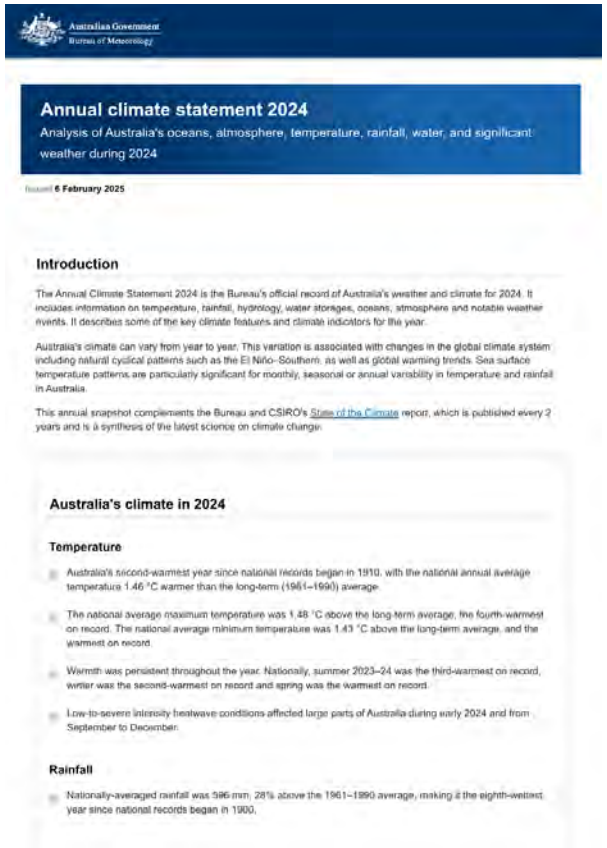


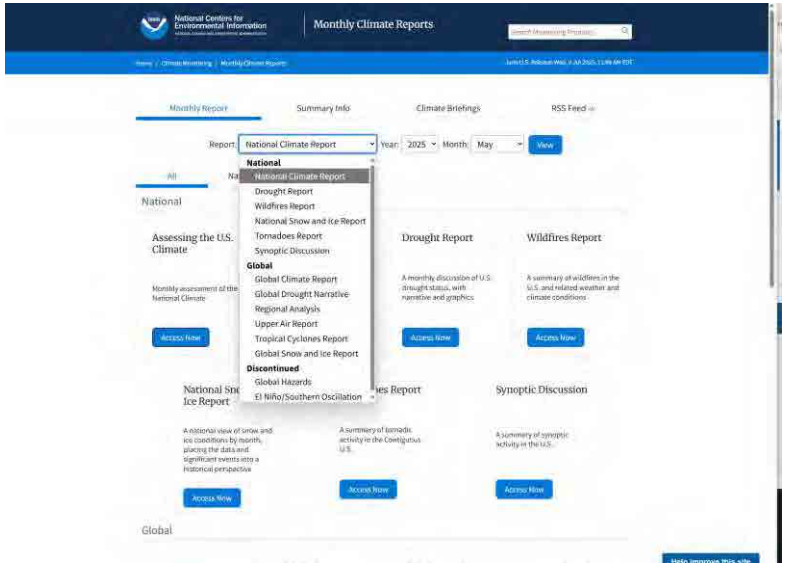
Extreme events map

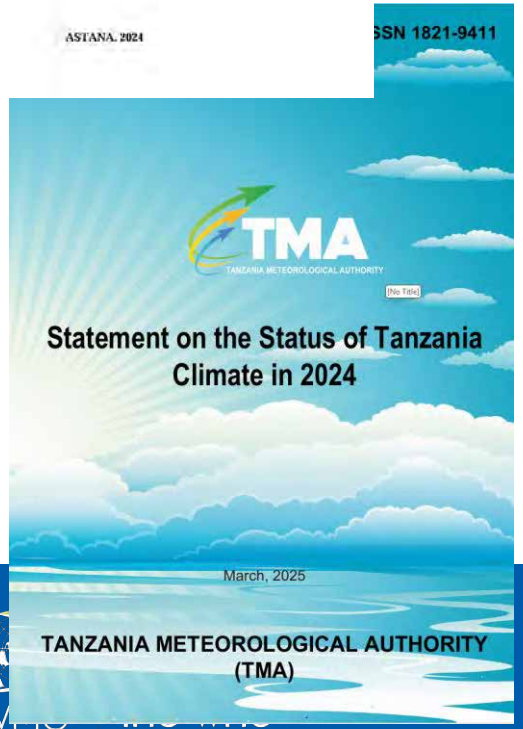
Data
Dashboard
Source of material

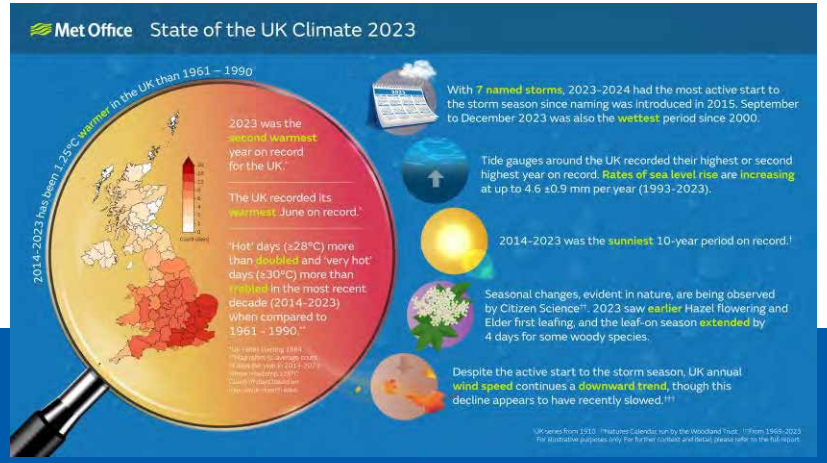
WMO IMO-WMO 150 1873 2023

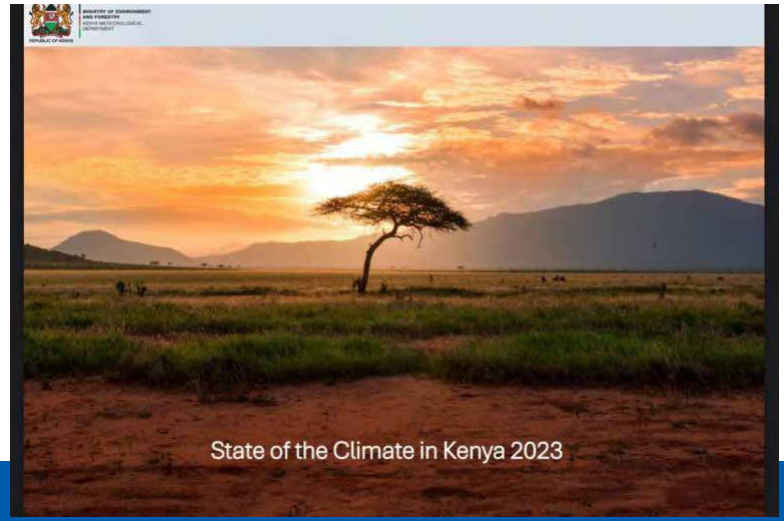

MINISTRY OF ECOLOGY AND NATURAL RESOURCES OF THE REPUBLIC OF KAZAKHSTAN
REPUBLICAN STATE ENTERPRISE "KAZHYDROMET"
SCIENTIFIC RESEARCH CENTER
ANNUAL BULLETIN OF MONITORING STATUS AND CLIMATE CHANGE OF KAZAKHSTAN: 2023
°C
3
2
1
0
-1
-2
-3
1942 1945 1948 1951 1954 1957 1960 1963 1966 1969 1972 1975 1978 1981 1984 1987 1990 1993 1996 1999 2002 2005 2008 2011 2014 2017 2020 2023


Australian Government
Bureau of Meteorology
Annual climate statement 2024
Analysis of Australia's oceans, atmosphere, temperature, rainfall, water, and significant weather during 2024
Issued 6 February 2025
Introduction
The Annual Climate Statement 2024 is the Bureau's official record of Australia's weather and climate for 2024. It includes information on temperature, rainfall, hydrology, water storages, oceans, atmosphere and notable weather events. It describes some of the key climate features and climate indicators for the year.
Australia's climate can vary from year to year. This variation is associated with changes in the global climate system including natural cyclical patterns such as the El Niño–Southern, as well as global warming trends. Sea surface temperature patterns are particularly significant for monthly, seasonal or annual variability in temperature and rainfall in Australia.
This annual snapshot complements the Bureau and CSIRO's State of the Climate report, which is published every 2 years and is a synthesis of the latest science on climate change.
Australia's climate in 2024
Temperature
Australia's second-warmest year since national records began in 1910, with the national annual average temperature 1.46 °C warmer than the long-term (1961–1990) average.
The national average maximum temperature was 1.48 °C above the long-term average, the fourth-warmest on record. The national average minimum temperature was 1.43 °C above the long-term average, and the warmest on record.
Warmth was persistent throughout the year. Nationally, summer 2023–24 was the third-warmest on record, winter was the second-warmest on record and spring was the warmest on record.
Low-to-severe intensity heatwave conditions affected large parts of Australia during early 2024 and from September to December.
Rainfall
Nationally-averaged rainfall was 586 mm, 28% above the 1961–1990 average, making it the eighth-wettest year since national records began in 1900.


National Centers for Environmental Information
Monthly Climate Reports
Monthly Report
Summary Info
Climate Briefings
RSS Feed
Report: National Climate Report
Year: 2025
Month: May
View
National
National Climate Report
Drought Report
Wildfires Report
National Snow and Ice Report
Tornadoes Report
Synoptic Discussion
Global
Global Climate Report
Global Drought Narrative
Regional Analysis
Upper Air Report
Tropical Cyclones Report
Global Snow and Ice Report
Discontinued
Global Hazards
El Niño/Southern Oscillation
Assessing the U.S. Climate
Drought Report
Wildfires Report
Synoptic Discussion
Access Now
Global


ASTANA. 2024
SSN 1821-9411
TMA
TANZANIA METEOROLOGICAL AUTHORITY
No Title
Statement on the Status of Tanzania Climate in 2024
March, 2025
TANZANIA METEOROLOGICAL AUTHORITY (TMA)

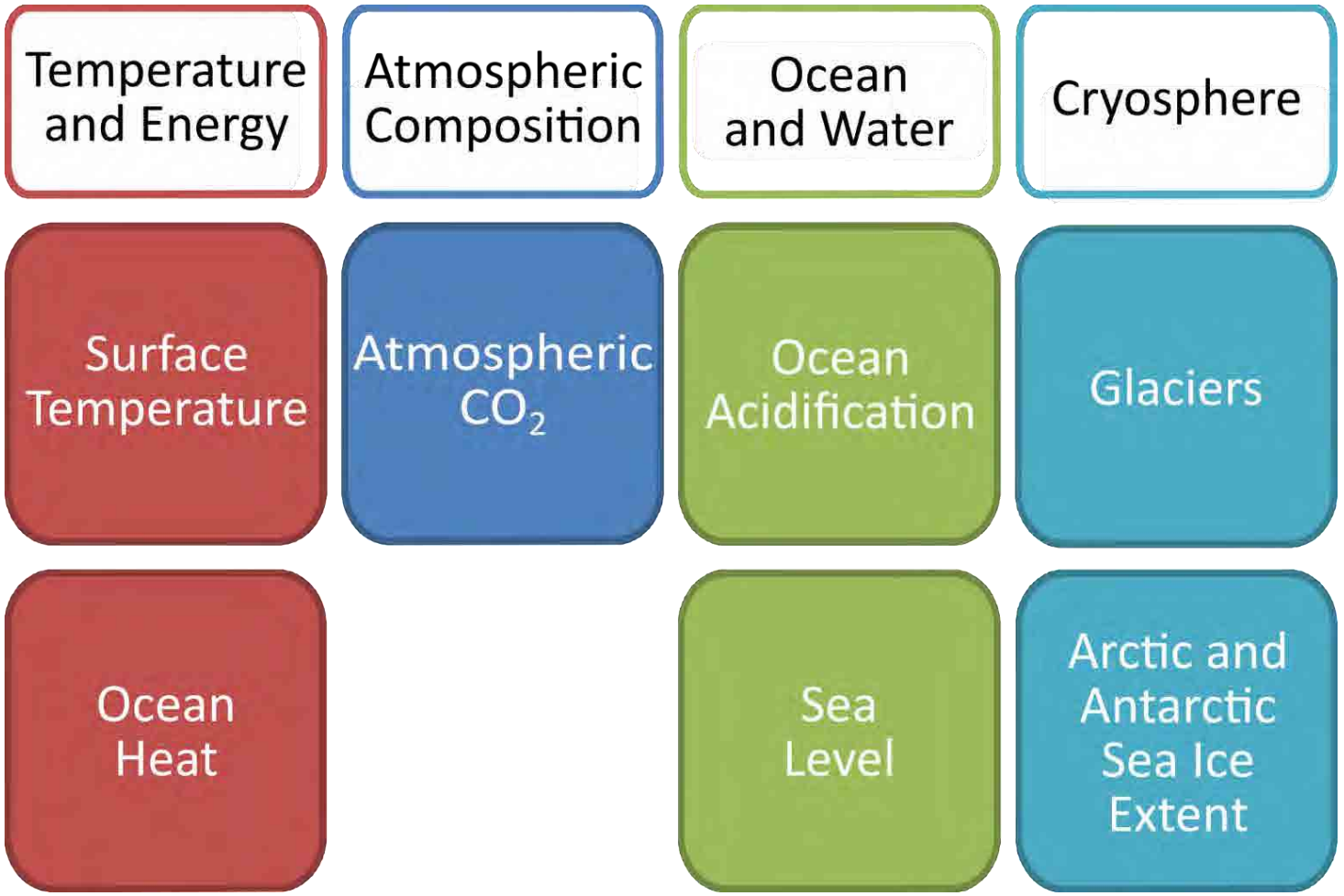

Met Office
State of the UK Climate 2023
2014–2023 has been 1.25°C warmer in the UK than 1961 – 1990
2023 was the second warmest year on record for the UK.*
The UK recorded its warmest June on record.*
'Hot' days (≥28°C) more than doubled and 'very hot' days (≥30°C) more than tripled in the most recent decade (2014–2023) when compared to 1961 – 1990.**
With 7 named storms, 2023–2024 had the most active start to the storm season since naming was introduced in 2015. September to December 2023 was also the wettest period since 2000.
Tide gauges around the UK recorded their highest or second highest year on record. Rates of sea level rise are increasing at up to 4.6 ±0.9 mm per year (1993–2023).
2014–2023 was the sunniest 10-year period on record.†
Seasonal changes, evident in nature, are being observed by Citizen Science††. 2023 saw earlier Hazel flowering and Elder first leafing, and the leaf-on season extended by 4 days for some woody species.
Despite the active start to the storm season, UK annual wind speed continues a downward trend, though this decline appears to have recently slowed.†††


State of the Climate in Kenya 2023

What is in the reports?

Key Indicators

- Based on GCOS Global Climate Indicators:
  1. Relevant
  2. Representative
  3. Traceable
  4. Timely
  5. Adequate data
- For more detail see Trewin et al. 2021 Headline Indicators for Global Climate Monitoring



Land temperature, SST, (marine) heatwaves, EEI

Methane, Nitrous Oxide

Deoxygenation, Blue carbon

Antarctic and Greenland ice sheets

Key indicator - Global mean surface temperature

Key messages

- The annually averaged global mean near-surface temperature in 2024 was 1.55 ± 0.13 °C above the 1850-1900 average used to represent pre-industrial conditions.
- 2024 was the warmest year in the 175-year observational record, clearly surpassing the previous warmest year, 2023 at 1.45 ± 0.12 °C above the 1850–1900 average.
- The past ten years, 2015-2024, were the ten warmest years on record.

Indicator Update

The annually averaged global mean near-surface temperature in 2024 was 1.55 ± 0.13 °C above the 1850-1900 average. 2024 was the warmest year in the 175-year observational record. The previous warmest year was 2023 with an anomaly of 1.45 ± 0.12°C. The past ten years 2015-2024 were the ten warmest years on record. The analysis is based on a synthesis of six global temperature datasets (Figure 2).

A single year with an annual global mean temperature over 1.5 °C above the 1850-1900 average does not indicate that we have exceeded the warming levels from the Paris Agreement (see Monitoring global temperature for the Paris Agreement).

Global mean temperature in 2024 was boosted by a strong El Niño which peaked at the start of the year. However, temperatures were already at record levels in 2023 (see The cause of exceptional global temperatures in 2023 and 2024). In every month between June 2023 and December 2024, monthly average global temperatures exceeded anything recorded prior to 2023.

Indicator Background

Global mean temperature is an index of the temperature near the surface of the Earth averaged across its whole surface. It is estimated using air temperatures measured at weather stations at a height of around 1.5 to 2 m, and sea-surface temperatures measured by ships and ocean buoys. Data are quality controlled, corrected for changes in how temperatures were measured, and gaps are filled using statistical methods. Global mean temperature can also be calculated using reanalyses, which use a weather forecasting system to combine many kinds of measurement including satellite measurements. Reanalysis-based estimates are representative of air temperature across land and ocean.

Six datasets, including two reanalyses, were used to assess global temperature in this report (see Datasets and methods). Together they cover the period from 1850 to the present, though not every dataset covers the whole period from 1850 (Figure 2). They show largely the same variations during the period in which they overlap but differ somewhat in their assessment of long-term change.

Global mean temperature is the basis for the Paris Agreement long-term temperature goal. However, the Paris Agreement is generally considered to refer to long-term changes (decadal or longer) and not individual years. There are other difficulties with the interpretation which are currently being studied by a WMO Task Team. A summary of the issues can be found in the sidebar Monitoring global temperature for the Paris Agreement.

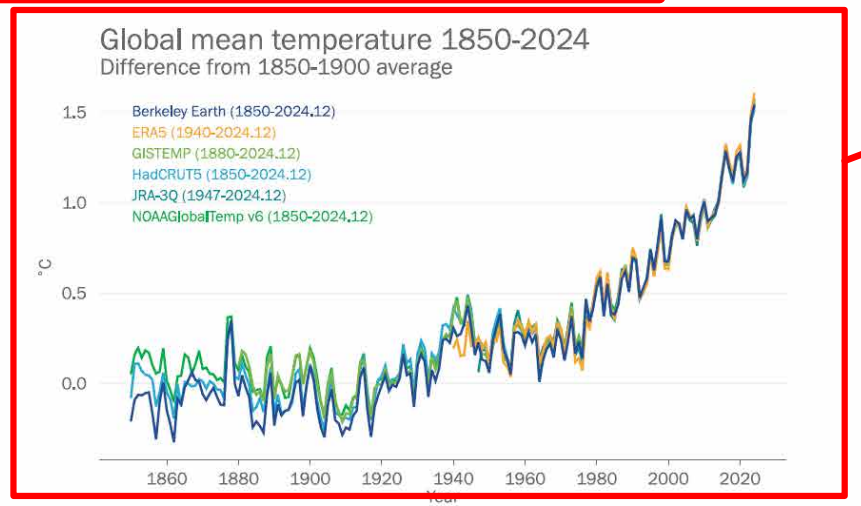
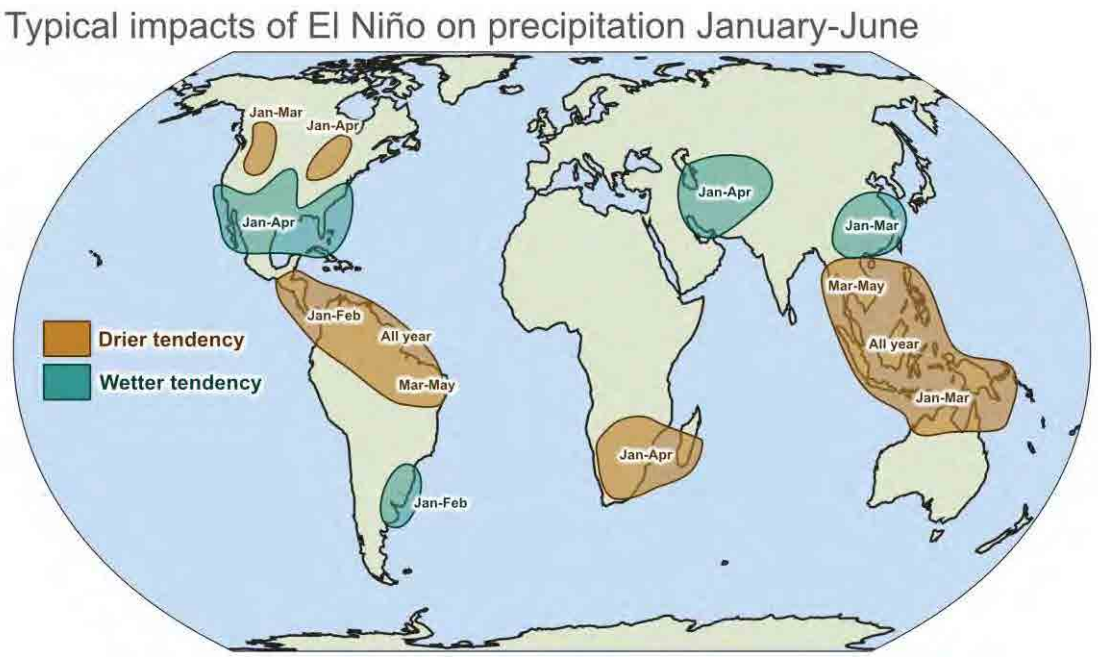
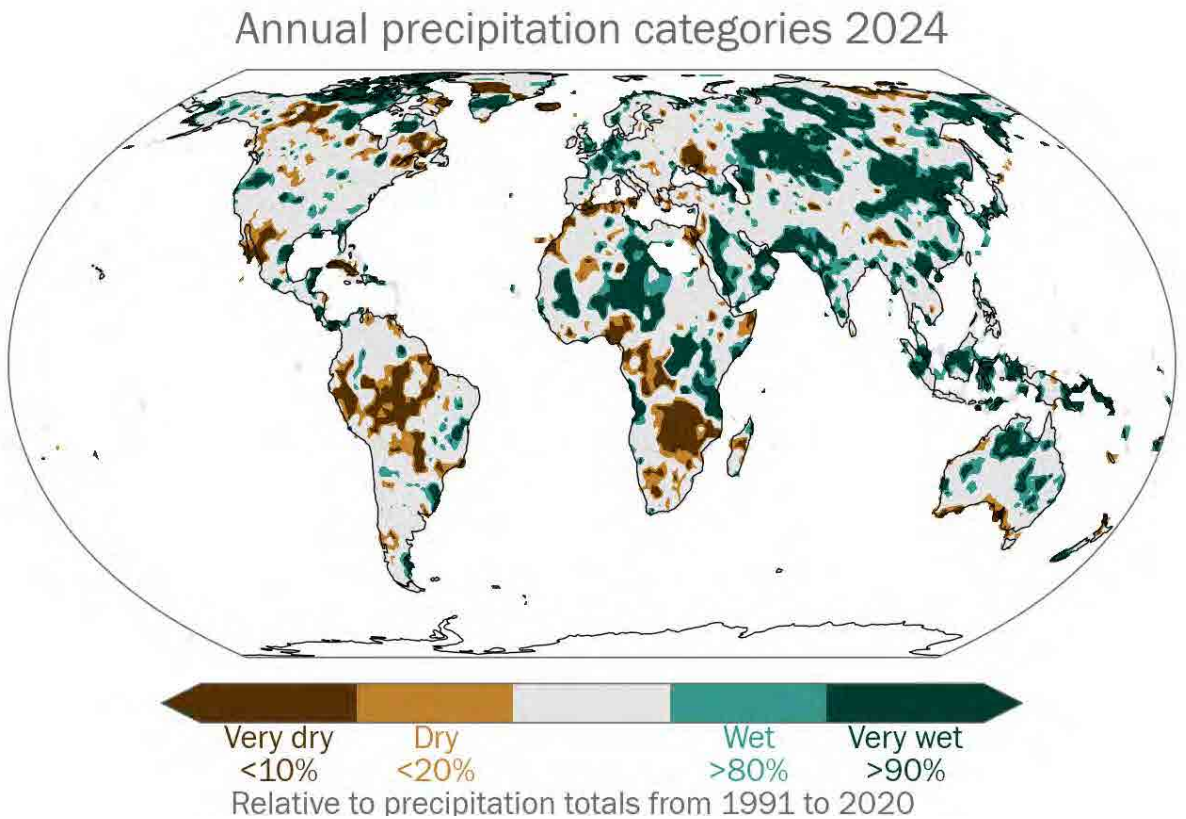


Figure 2: Annual global mean temperature anomalies relative to a pre-industrial (1850-1900) baseline shown from 1850 to 2024. Data are from six datasets indicated in the legend.

For details see Datasets and methods.

Climate drivers, regional temperature and precipitation





High-impact events

- A section, a supplement, and a map
- Selection of high-impact events chosen based on:
  - Regional balance
  - Event type balance
  - Impact
  - Data availability
- Information **principally from NMHSs via online survey** but also
  - UN agencies
  - EM-DAT and
  - Other official sources
- Not a systematic assessment of extremes
- Impact information has large uncertainties and there is often conflicting information.

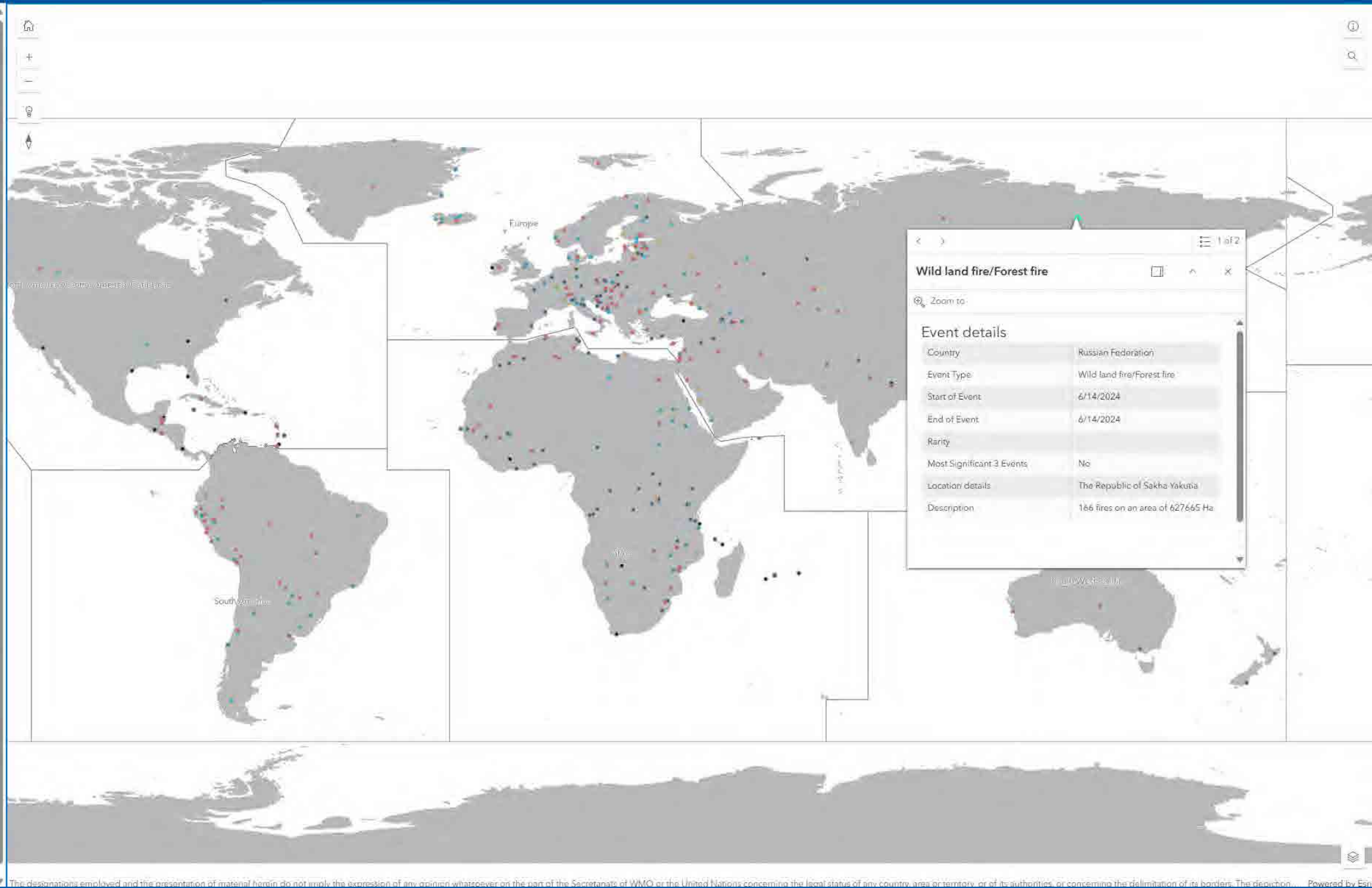
Extreme Events 2024 - StoryMap

Extreme Events 2024

Extreme events

Show all

- Heat wave
- Drought/Dry spell
- Wild land fire/Forest fire
- Flood
- Thunderstorms/Squall lines
- High seas/Rogue waves
- Rain/wet spell
- Hail
- Cold wave
- Snowstorm
- Snow
- Wind
- Pollen pollution/polluted air
- Fog/Haze/Smog
- Dust storm/Sandstorm
- Landslide/mudslide & debris flow
- Tropical cyclone
- Extra-tropical cyclone
- Tornado
- Lightning
- Other



Powered by Esri

Socio-economic impacts

- Developed in partnership with UN and international agencies
  - FAO, WFP – food security
  - UNHCR, IMO, IDMC – human displacement
  - UNEP – environmental impacts
  - IOC UNESCO – ocean acidification, oxygenation, blue carbon
- Challenges with how to integrate information
  - Greater amount of general material not specific to the year
  - Socio-economic impacts have complex causes
  - Each agency has evolved a careful use of language

Climate policy

- Focus on concrete measures that have been taken where possible
- Europe 2024: Climate resilience and adaptation initiatives
- LAC 2024:
  - Early warning services for disaster risk reduction: an example from Cemaden in Brazil
  - WMO weather, climate and hydrological services fro energy in Latin America and the Caribbean
- Africa 2024:
  - Financial resource challenges continue to hamper progress in climate adaptation in Africa
  - Digital transformation to enhance data collection and service delivery in Africa

Sidebars

- Sidebars are a mechanism for including other material
  - Case studies
  - Open science questions (Why was 2023 so warm? Paris Agreement)
  - Introduce new indicators
  - Introduce new topics (Attribution)
  - Background material and explainers (GCOS)
- Some concerns over the status of these sidebars
  - Reviewed but not peer-reviewed in the traditional sense
  - Typically very short so can be hard to get everything in
- But they exist to quarantine spicy information

Timeliness

- Data sets do not update instantly
- Update delay varies between a day or two and a year or two
- Can cause problems for consistent reporting, e.g. mixing years
- A major issue for:
  - Greenhouse gases (~10 month delay)
  - Ocean pH (1+ year delay for global)
- Also an issue for:
  - Ocean heat content (a few days to a few years)
  - Glaciers (several months)
  - Global temperature (a few weeks)

Where are we going and what are we working on?

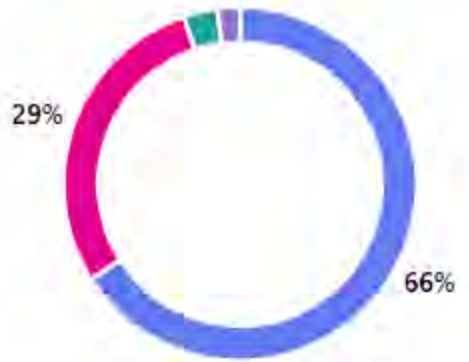
ToR	Tasks	Deliverables (max pages)	Lead (time scale)	Volunteers
No1. **Communication**	1.1 Assess good communication practices focusing on WMO SoTC Comm team	Report (3 pages) – lessons learned one pager. Reprioritise the longer document (2026)	Claire (2026)	Alvaro, Freja, Jessica
	1.2 Defining communication relevance to policy	Report (3 pages)	John (6 months)	Jessica
	1.3 Communication of Attribution science and results	Report (3 pages)	Freja (12 Months) 2025 (not by COP)	Serhat, Blair, John, Jessica
No.2 **Monitoring Global Temperature for Policy**	2.1 Linkage with existing groups and IPCC on Tracking Paris Agreement Temperature levels	Report on progress in methodologies and outcomes	Blair (Ongoing)	Freja, Secretariat
	2.2 Operational monitoring of GMST at monthly-sub-monthly scales 2.3 – resilience of monitoring	Proposal for routine monitoring	John (June 2025)	Blair, Alvaro, Freja, Awatif, Atsushi
No.3 **Oversee production of Global and Regional State of the Global Climate**	3.1 Review reports	Review of global, 6*regional reports and climate update for COP.	No lead, ongoing	All
	3.2 Climate datasets / Dashboard	Regular update	John ongoing	Blair, Freja, Markus
	3.3 Regional State of the Climate hub	Proposal for its content and hosting	John (2025)	Blair, Freja, Omar, Jessica, Claire
	3.4 Methodologies and production of National State of the Climate reports	Guidance document (5 pages)	Claire (end of 2025)	Blair, Freja, Markus, Atsushi, Jessica
No.4 **Monitoring Extreme Events**	4.1 Review of extreme indices definition and operational production	Scientific peer review paper	Blair (2025)	Serhat, Alvaro, Markus
	4.2 Collection and QC of National Climate Records	Guidance to countries	Serhat (2025)	Blair, Markus
	4.3 World Extreme Archive	Collaboration with WMO lead Rapporteur on the future of the Archives	Alvaro (ongoing)	Blair

Enhancing communications practices

- Content

9. How effective do you find the report in making climate information accessible to non-expert audiences?

Very effective – the explanations are clear and useful	64
Somewhat effective – but could be simplified further for example	28
Not effective – too much technical language and complex data	3
I do not use the report for non-experts	2



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Guidelines on attribution – why, what and how?

Task: Produce ***guidelines*** that addresses whether information on ***extreme event attribution*** should be considered for inclusion in the ***State of the Climate (Soc) reports*** and if so, ***recommendations*** on how to do so.

Why? When monitoring extreme weather events, as in the SoC reports, the question of how and if that event was influenced by human-induced climate change inevitably arises.

What and How?

The methods of **extreme event attribution** address questions of the kind:

- How rare was the event?
- Was it made more likely, more intense or of longer duration due to climate change?

Including information from such studies is thus what is being considered here.

Guidelines on attribution – challenges

General challenges

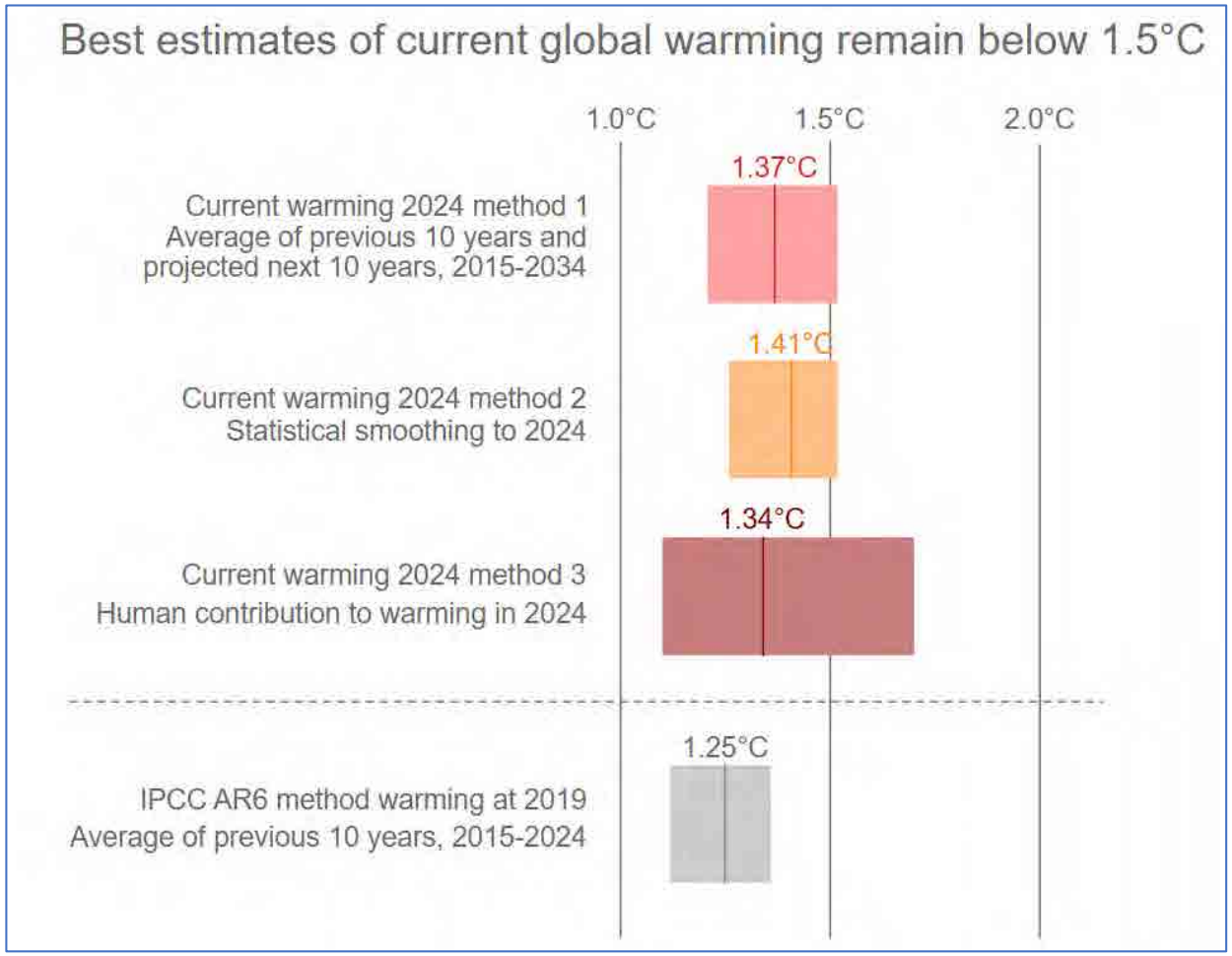
- Results are sensitive to the framing (event definition, methodology, models/obs)
- Methods more or less mature depending on type of event considered
- Uncertainties can be large
- **Data availability / quality**
- Model error/bias
- Communication challenge

Challenges related to SoC

- Need criteria to assess which studies to include and which not
- Need for timely information of results
  - ➢ Rapid studies - peer-reviewed method, but not p-r results
  - ➢ Only a few actors (WWA, ClimaMeter…)
- Difficulty to capture all studies associated to chosen events
- Need to include minimal, but still sufficient information, plus give due credit → risk of oversimplification and risk of misinterpretation

Task 2.1 Reporting on current warming levels

- WMO has established a Task Team to assess current warming levels
- Reported in SOTC for the first time in 2024
- Currently reports using a range of methods
- Ongoing work to develop methods, including possibly a unified estimate



Task 2.2 Sub-annual monitoring of global temperature

- Monthly monitoring https://jkclimate.fr/MonthlyDashboard/dashboard.html
- Lot of focus since mid 2023 on global temperature particularly Paris Agreement levels and daily data.
- How can we maintain consistency of messaging from daily to multidecadal timescales, across multiple datasets?

Centennial:
- HadCRUT
- NOAAGlobalTemp
- Berkeley Earth
- Other non-operational datasets

Annual:
- HadCRUT
- GISTEMP
- NOAAGlobalTemp
- Berkeley Earth
- ERA5
- JRA3Q
- Possibly others in future

Monthly:
- HadCRUT (?)
- GISTEMP
- NOAAGlobalTemp
- Berkeley Earth (?)
- ERA5
- JRA3Q

Daily:
- ERA5
- JRA3Q
- Berkeley Earth (experimental)

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Task 2.3 Resilience of monitoring

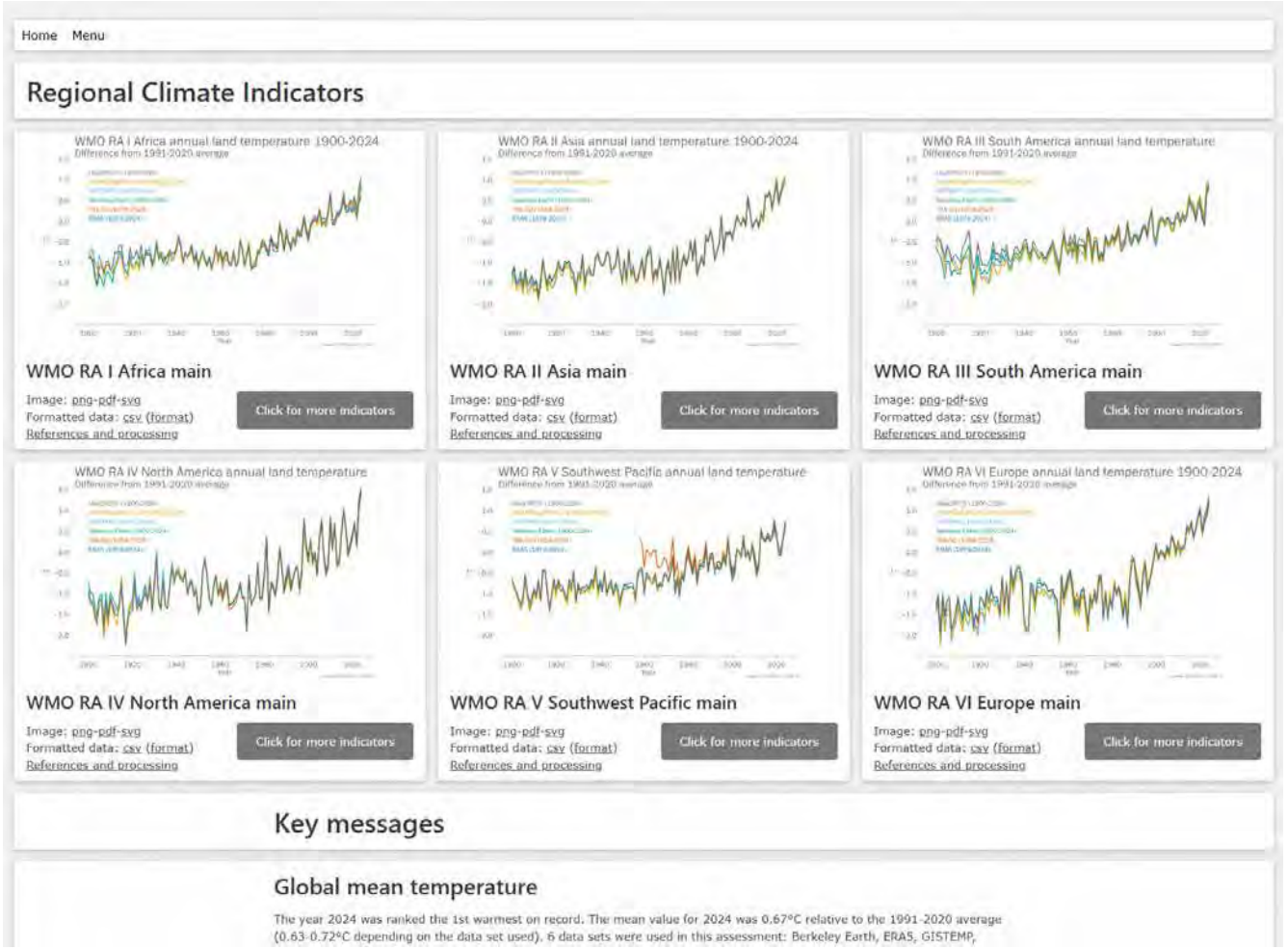
- Many indicators are based directly or indirectly on a small number of datasets
- Recent events in the US have underscored the fragility of some of the systems we depend on
- What data sets should we be using to monitor global temperature is a particular concern. Need to satisfy a lot of constraints
  - IPCC, 1.5C monitoring, daily monitoring, annual monitoring, consistency with operationally available datasets.

Task 3.1 Review

- ET-MCCVC reviews all reports
- This work is concentrated in the first few months of the year.
- Would like to grow the range of reviewers

Task 3.2 Climate data dashboard(s)

- Key Climate Indicators
- Regional Climate Indicators
- Regional Temperature Indicators (test back to 1850)
- Design:
  - For report authors
  - Contain data used in the report
  - And methods and metadata
  - Automated as far as possible
  - Standard presentation of data
  - Provide transparent link to input data



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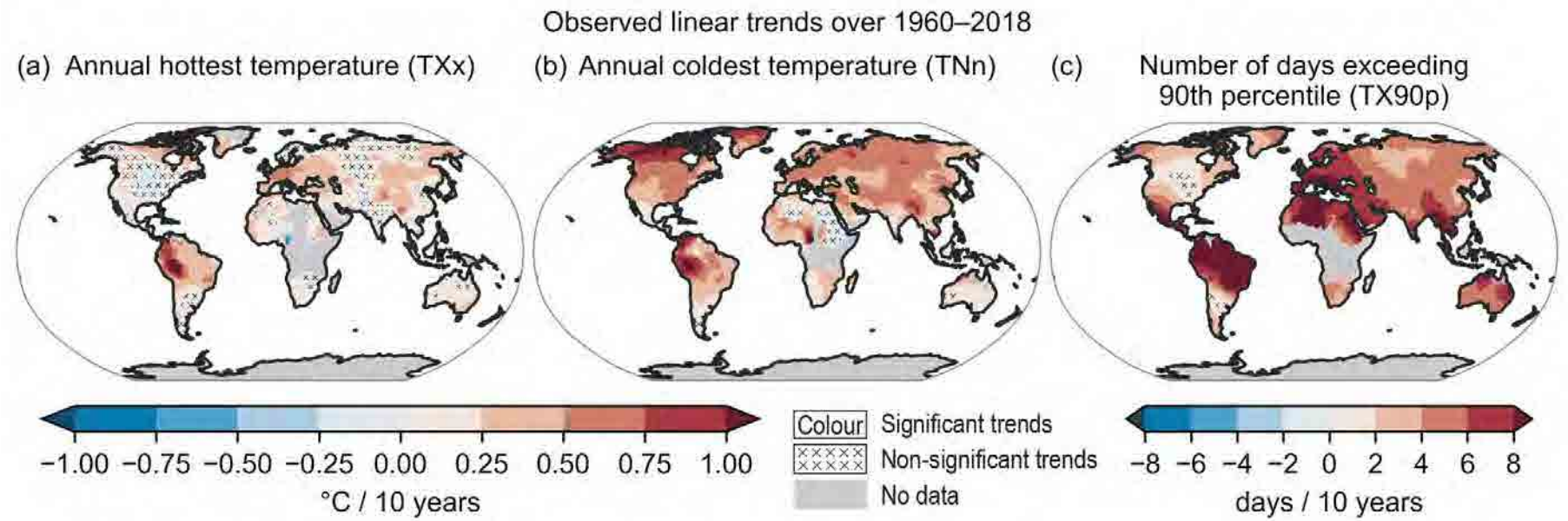
Task 3.4 Guidance on National State of the Climate

- Need for capacity building in some areas
- Short guidance based on existing guidelines for regional reports
- Considering different approach – using video guidance rather than yet another pdf.
- WMO is working with Kenya and Samoa on their National State of the Climate reports

Task 4.1 Reviewing climate indices

- The "ETCCDI" indices have been important in assessing changes in extremes
- Largely unchanged in last 20 years (but wide proliferation of additional indices)
- Reviewing to see if still fit for purpose, and scope to include new indices (e.g. humid heat, fire weather)
- Potential for use in SOTC reporting and would fill a critical gap, but needs better data for global coverage



IPCC AR6 WG1 Fig. 11.9

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Task 4.2 Collection and QC of national record-breaking weather and climate events

- Record breaking climate and weather events, such as heatwaves, hurricanes, or floods, are critical for understanding climate variability and change.
- Records often contain errors or inconsistencies due to the challenges of collecting data during extreme events.
- This is particularly true of events which are sufficiently extreme to constitute national records. These are often heavily scrutinised.
- Quality control (QC) and other processes are essential to ensure the reliability and accuracy of these datasets for scientific research and policy-making.

Quality Control Techniques

- Automated QC Systems and manual review
- Metadata Validation
- Homogenization
- Cross-Referencing
- Metrology and calibration

Task 4.3 World Extreme Archive

- Collaborate with WMO lead Rapporteur on the future of the Archive
- Prof Randall Cerveny, ASU
- World Weather and Climate Extremes Archive
- Notification from an official body or authoritative source
- Rapporteur assembles group of experts
- Investigate and write up for publication
- Two extremes currently under review
  - Lightning and temperature records
- ET-MCCVC can help in nomination of experts

WMO Regional Climate Centres

The World Meteorological Organization (WMO) Regional Climate Centres (RCCs) are centres of excellence dedicated to providing regional climate products and services. Their mission is to enhance the capacity of WMO Members in each region, enabling them to deliver high quality climate services to national users.

RCCs produce mandatory regional products, including climate data sets, climate monitoring tools and long-range forecasts, which serve as critical regional inputs for National Meteorological and Hydrological Services (NMHS) climate operations. Additionally, RCCs undertake various highly recommended functions to address the needs of their respective regional domains.

Thank you!
Спасибо

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