MH0047 / **METEOROLOGICAL and HYDROLOGICAL / Temperature-related**

Heatwave

Definition

A heatwave is a marked warming of the air, or the invasion of very warm air, over a large area; it usually lasts from a few days to a few weeks (WMO, 1992).

Alternative definition: A heatwave is a marked unusual period of hot weather over a region persisting for at least two consecutive days during the hot period of the year based on local climatological conditions, with thermal conditions recorded above given thresholds (WMO, 2020).

References

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Annotations

Synonyms

Not identified.

Additional scientific description

The World Meteorological Organization (WMO) uses a definition that has practical utility in addressing human health impacts. It defines heatwaves as, "periods of unusually hot and dry or hot and humid weather that have a subtle onset and cessation, a duration of at least two to three days and a discernible impact on human activities" (WMO and WHO, 2015).

However, this definition is not sufficient to guide National Meteorological and Hydrological Services in developing practical methods and tools for a heatwave monitoring system that would allow comparisons across regional or international borders. Common characteristics of heatwaves such as magnitude, duration, extent, severity, and timing of the event during the heat season, are often used to compare heatwave events (Global Heat Health Information Network, 2020).

Heatwaves differ from warm spells. Similar to heatwaves, warm spells are defined as a persistent period of abnormally warm weather in a location. A warm spell can similarly be defined in terms of the 90th or 95th percentile of daily maximum temperature (Tmax). A warm spell occurs at any time of the year, whereas heatwaves can only occur in the warm season (WMO, 2020).

Metrics and numeric limits

It is not possible to adopt universal numeric limits to characterise heatwaves, because heatwave conditions are locally defined and can vary significantly at sub-national scales, due to influences of geography and topography, built environment, and atmospheric and other conditions. International technical efforts instead focus on the adoption of consistent approaches for allowing countries to define and monitor heatwaves on an operational basis, based on their local conditions, applications requirements, and other descriptive characteristics.

National warning systems use a range of diverse indices of multiple combined variables and locally defined thresholds to describe excessive or dangerous heat conditions. Examples of national parameters used to define heat warnings include those for Canada (Environment and Climate Change Canada, 2019), China (China Meteorological Administration, 2012), Switzerland (MeteoSwiss, 2019), United States (NOAA, 2019), Republic of Korea (KMA, 2019), and India (Government of India, 2020).

Many heatwave definitions use bio-meteorological or holistic indices to better characterise heat risk, including:

- *Bio-meteorological Indices*: heat index, humidex, apparent temperature, excess heat index, human energy-budget based indices (e.g., standard effective temperature, perceived temperature, physiological equivalent temperature, universal thermal climate index) (Zare et al., 2018).
- *Holistic approach:* wet-bulb globe temperature, health-related assessment of the thermal environment, Heat Stress Index, Excess Heat Index-acclimatization, Excess heat factor (Zare et al., 2018).

The WMO guidelines on the definition and monitoring of extreme weather and climate events (WMO, 2021) seek to provide guidance on defining, characterising, monitoring and reporting information on extreme weather and climate events on an operational basis. It is expected that adherence to these guidelines by the meteorological community will provide a basis for attributing extreme weather and climate events and for verifying forecasting and prediction services (WMO, 2020).

Key relevant UN convention / multilateral treaty

United Nations Framework Convention on Climate Change (UNFCCC) (UN General Assembly, 1994).

Sendai Framework for Disaster Risk Reduction (UNDRR, 2015).

United Nations Framework Convention to Combat Desertification (UNCCD, 1994).

Examples of drivers, outcomes and risk management

Drivers: Persistent, abnormally high temperatures can be caused by a variety of climate and weather phenomena, but the principal driver of a heatwave is a strong and slow-moving high pressure system that remains in place over an area for a period of time. In some cases, these systems are held in place by an atmospheric blocking pattern, such as an omega block, which is a pair of low pressure zones that surround a high pressure zone and serve to lock it in place for an extended period. Climate change is monitored through observed increases in heatwave frequency, intensity, and magnitude. Other drivers of heatwaves include longer-term climate patterns such as the El Niño Southern Oscillation (ENSO), weather extremes such as tropical storms, and climatic extremes such as droughts, which rob the soil of moisture and can increase the intensity of heat events (Global Heat Health Information Network, 2020).

Heatwave outcomes: Heatwaves, warm spells and high temperatures have significant impacts on human and animal health, worker productivity, agricultural production, ecosystems and economies. The built environment and critical infrastructure that supports society, such as buildings, water, transportation and energy systems are also adversely affected by heatwaves (Boyle et al., 2010).

Risk management: Heatwaves interact with and amplify the impacts, magnitude, and severity of other hazards such as wildfire, drought, cyclones, urban heat islands, and hazardous air quality. A multi-hazard risk management approach is therefore recommended for heatwaves, including early warning systems and planning. In urban areas, consideration of night-time temperatures and urban heat island effects is important for determining appropriate thresholds for heatwave advisories. Essential components of health impact-orientated warning systems and early action for heatwaves, include assessments of heatwaves and health impacts, definitions and methodologies, communication of warnings, intervention strategies, and longer-term planning perspectives for managing heatwave events (WMO and WHO, 2015).

References

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Coordinating agency or organisation

World Meteorological Organization (WMO).