



Weather and Climate Extremes: Current Developments

Anita Drumond ^{1,*}, Margarida L. R. Liberato ^{2,3} , Michelle Simões Reboita ⁴ and Andréa S. Taschetto ⁵ 

¹ Instituto de Ciências Ambientais, Químicas e Farmacêuticas, Universidade Federal de São Paulo, Diadema 09913-030, Brazil

² Instituto Dom Luiz (IDL), Faculdade de Ciências, Universidade de Lisboa, 1749-016 Lisboa, Portugal; mlr@utad.pt

³ Universidade de Trás-os-Montes e Alto Douro, Quinta de Prados, 5000-801 Vila Real, Portugal

⁴ Instituto de Recursos Naturais, Universidade Federal de Itajubá, Itajubá 37500-903, Brazil; mireboita@gmail.com

⁵ Climate Change Research Centre and ARC Centre of Excellence for Climate Extremes, University of New South Wales, Sydney, NSW 2052, Australia; a.taschetto@unsw.edu.au

* Correspondence: anita.drumond@unifesp.br

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An increasing number of extreme events have been observed around the world over the past few decades, some of them attributed to global warming [1]. As global temperatures continue to rise and weather extremes are projected to worsen during the 21st century [1], there has been a growing interest from the scientific community in identifying, quantifying and understanding the processes behind extreme events as well as their links to climate change. This Special Issue aims to gather the latest understanding of weather and climate extreme events worldwide from a broad perspective.

Out of the twenty studies published in the current issue, one-quarter of them investigate extremes in temperature, precipitation and/or maximum annual flows under different contexts, data sets and regions; one-fifth of the papers focus on climate extremes associated with droughts; while the remaining range from atmospheric processes, statistical methods for extremes, Lagrangian approach to identify origin of specific events, climate model biases and projections to societal impacts.

On changes of climate extremes, the study by Nie et al. [2] reports new findings on observed trends of cold and hot temperature extremes in China during the winter season, with important implications for farmers of wheat growing areas in the country. On convection processes using surface radar precipitation data, Rickenbach [3] verified that mesoscale precipitation organization is more commonly associated with higher extremes in instantaneous rainfall in the southeastern US when compared to isolated convection. Regarding statistical methods for climate extremes, Molina-Aguilar et al. [4] propose a novel approach to improve performance for the determination of parameters of an extreme value distribution applied to three populations to analyze maximum annual flows in Mexico. Using climate models, Alvarez-Castro et al. [5] investigated the recurrence spectra of European temperature in historic simulations of the CMIP5 and of EUROCORDEX.

The impact of extreme weather on inland waterways transport of Yangtze River, China, is investigated by Liu et al. [6], which is of significant relevance for decision-making and regional management of navigation traffic. Disturbances in atmospheric pressure from extreme weather events can cause destructive long waves associated with meteotsunamis occurring in the Yellow Sea, as simulated in a numerical study by Heo et al. [7]. According to the authors, the Yellow Sea has one of the most powerful tidal currents in the world, thus compounding events of extreme synoptic events occur during high tide can potentially have devastating impacts for local coastal communities.

Climate extremes and droughts are recurrent topics in this Special Issue, being the theme of four climatological analyses presented here. Liu et al. [8] provide an exhaustive analysis of changes in

precipitation and drought extremes over the past half-century in China, verifying that precipitation extremes increased in almost all regions and that increasing trends of drought extremes prevailed. Also for China, Wu et al. [9] examine compound events resulting from droughts and hot extremes during summer, based on monthly precipitation and daily temperature data. They found that a high frequency of these type of events mostly occur in the regions stretching from northeast to southwest of China, and there is an overall increase in the frequency of these compound episodes across most parts of the country. For South America, Gozzo et al. [10] investigate the climatology and trend of severe drought events in the state of São Paulo, Brazil, during the 20th century. They verified a tendency of increasing drought events in the central and western portions of São Paulo state, while a decreasing trend is observed on the eastern side. Using Lagrangian techniques, Stojanovic et al. [11] analyze variations in moisture supply from the Mediterranean Sea during meteorological drought episodes over Central Europe. They show that negative anomalies of moisture coming from the Mediterranean Sea prevailed in the identified episodes, which lasted longer and were more severe with an increase in the negative anomaly of moisture supply from the sea.

As used by Stojanovic et al. [11], Lagrangian techniques have become a more common approach to effectively identify sources of moisture and understand pathways for extreme events. Cai et al. [12] used a Lagrangian model to track the path of autumn cold surges affecting North China from 1961 to 2014 as well as their changes and associated evolution of atmospheric circulation.

Also important from a seasonal forecasting point of view is to understand the processes and weather systems, such as tropical and extratropical cyclones, that may lead to extreme precipitation. Reboita et al. [13] describe the synoptic environment and adverse weather conditions during six subtropical cyclone events over the southwestern South Atlantic Ocean. Through a case study, Heo et al. [14] analyze the explosive cyclogenesis event around the Korean Peninsula in May 2016 from a potential vorticity perspective. Cao et al. [15] investigate extreme precipitation associated with tropical cyclones over mid-lower reaches of Yangtze River basin and their relationship with the El Niño–Southern Oscillation.

Indeed, interactions across different timescales, such as between synoptic systems and climate variability modes, are often explored in the literature to gain a deeper understanding of the dynamical mechanisms associated with extreme events. Wang and Wang [16] investigate the combined effects of East Asia-Pacific and Silk Road teleconnection patterns on summer precipitation in Southern China on synoptic to submonthly timescales. Rosso et al. [17] evaluate the role of the Antarctic Oscillation for precipitation associated with the South Atlantic Convergence Zone, the main summer-typical atmospheric phenomenon occurring in South America. Cordero Simões dos Reis et al. [18] show that heatwave events in Brazil subtropics have become more frequent and persistent since 1979 and also note that the statistics of those events are modulated by the Pacific Decadal Oscillation and El Niño–Southern Oscillation.

Extreme events are part of our past, present and future climate. In addition to the abovementioned studies on climate extremes observed in the present, extreme events are also investigated here in past and future climate via numerical simulations. Using a climate model with the last millennium volcanic forcing, Figueiredo Prado et al. [19] suggest a cooling response of the Tropical Atlantic during post-eruption years. They also note changes in South American and African monsoon precipitation related to the volcanic forcing. Hu et al. [20] assess projections of extreme low temperature events in Northern China under the IPCC stabilization pathways at 1.5 and 2.0 °C above preindustrial levels and show significant differences in the decrease of intensity, frequency and duration of cold extremes across the two scenarios.

Finally, on the environmental and societal side of climate change impacts, Stancioff et al. [21] provide an analysis of the local perceptions of communities from small island developing states, namely St. Kitts (Caribbean Sea) and Malé, Maldives (Indian Ocean), and discuss the importance of understanding and considering the impacts at a local level for formulating climate change policies and actions at regional and national levels.

This Special Issue presents a worldwide, broad perspective of the current status and main aspects and developments on weather and climate extremes as highlighted by the contributing scientific community. Although the results discussed here summarize cutting edge research on extremes, they also open additional scientific questions, confirming that the topic of weather and climate extremes still presents strong challenges that will certainly be the focus of other future editions.

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