PUBLIC COMMUNICATION FOR GLOBAL WARMING AND CLIMATE EXTREMES

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Abstract

Broadcasting meteorology is the part of meteorology which deals with communicating the data and information to the public. Nowadays it has gained momentum in parallel with the rise of extreme weather conditions, providing the beneficial opportunity to inform and educate the public. This implies breaking down abstract terminology and using the most advanced visual aids to simplify the complex language. However, the extreme weather perception is skewed due to climatic and meteorological illiteracy, the inability to comprehend the importance of the planetary energy budget and the overall contribution of greenhouse gases to the climate system. One of the greatest challenges for the broadcast meteorologists is the short lifespan of the forecasts – they may be verified in a few minutes, hours or days. Annually, it is not a rare occurrence that a frontal system is delayed or a convective storm degrades faster or changes the trajectory for which the broadcast meteorologist is crucified by the public. Therefore, narrow space and time references are often the biggest enemies. Another very recent issue is the colour bar scheme choice as the red and pink shades are to be the most fearmongering for the public and often used to be compared with past events. In July 2022, the conspiracy theories skyrocketed when the Met Office announced its first 40 °C in the UK, with the accusation of meteorologists being ǂharbingers of doom."However, this was not an isolated case, as in April 2023, due to an exceptional heatwave for the time of the year, meteorologists at AEMET (Spanish Hydrometeorological Service) faced life threats, severely raising the pressure and affecting their contribution to society. Moreover, the probabilistic approach pours the confusion in the traditional weather reports and applications to the end users, often which cannot be perceived by the public to decide whether they will need an umbrella if the rain is expected, or

not to stay dry. These issues remain the challenges for the foreseeable future, raising the concerns of presenting factual information, seeking alternative solutions for the numerical values in presenting the data to the public and the role of a broadcast meteorologist.

Key words**:** *Public speaking, meteorology and climatology terms, reference period, climate change, colour-coded schemes*

Përmbledhje

Meteorologjia e transmetimit është ajo pjesë e meteorologjisë e cila merret me komunikimin e të dhënave dhe informacionit tek publiku. Në ditët e sotme kjo pjesë e meteorologjisë ka fituar terren paralelisht me shtimin e kushteve ekstreme të motit duke ofruar mundësinë e mirë për të informuar dhe edukuar publikun e gjerë. Kjo nënkupton mënjanimin e terminologjisë abstrakte dhe përdorimin e mjeteve vizuale më të avancuara për të thjeshtuar gjuhën komplekse. Megjithatë, perceptimi i motit ekstrem është i shtrembëruar për shkak të padijes klimatike dhe meteorologjike, paaftësisë për të kuptuar rëndësinë e balancit energjitik planetar dhe të kontributit të përgjithshëm të gazeve serrë në sistemin klimatik. Një nga sfidat më të medhaja për meteorologët e transmetimit është skandenca e shpejtë e parashikimeve – ato mund të verifikohen në pak minuta, orë ose ditë. Nuk është e rrallë gjatë vitit që një sistem frontal të vonohet ose një stuhi konvektive të degradojë më shpejt apo të ndryshojë trajektoren dhe për këtë meteorologu i transmetimit kryqëzohet nga publiku. Prandaj, referencat e ngushta në hapësirë dhe kohë janë shpesh armiqtë më të mëdhenj. Një tjetër çështje shumë aktuale është zgjedhja e shiritit të ngjyrave të legjendës sepse nuancat e kuqe dhe rozë konsiderohen si më të frikshmet për publikun dhe shpesh përdoren për t'u krahasuar me ngjarjet e së kaluarës. Në korrik 2022, kur Zyra Britanike e Meteorologjisë njoftoi për here të parë 40°C si temperaturë maksimale në Mbretërinë e Bashkuar, teoritë konspiracioniste u ngritën në qiell me akuzimin e meteorologëve si "lajmës të dënimit". Megjithatë, ky nuk ishte një rast i izoluar, pasi në prill 2023, si pasojë e një vale nxehtësie të jashtëzakonshme për atë periudhës të vitit, meteorologët e AEMET (Shërbimi Hidrometeorologjik Spanjoll) u përballën me kërcënime për jetën gjë e cila rriti presionin në punën dhe kontributin e tyre në shoqëri. Për më tepër, qasja probabilistike shpërndan konfuzion në raportet tradicionale të motit tek përdoruesit që shpesh nuk mund të perceptohen nga publiku për të vendosur nëse do të nevojitet një çadër nëse pritet të bjerë shi, apo jo për t'u mbrojtur. Këto çështje mbeten sfida për të ardhmen e parashikueshme, duke ngritur

shqetësimin e paraqitjes së informacionit faktik, kërkimin e zgjidhjeve alternative për vlerat numerike në paraqitjen e të dhënave për publikun e gjerë dhe rolin e një meteorologu transmetues.

Fjalë kyçe: *Të folurit publik, termat e meteorologjisë dhe klimës, periudhat e referencës, ndryshimet klimatike, skema e kodimit të ngjyrave.*

Introduction

The rise of weather extremes and the adverse influence on society have recently heightened the public demand for weather forecasts on different timescales. The headlines related to record-breaking temperatures across the globe frequently drive the attention of the public, with technical terms (e.g. 'heat dome', 'El Nino Southern Oscillation (ENSO)', 'humidex', etc.) becoming more ubiquitous in the reports and often discussed how these phenomena affect different parts of the world. Traditionally, the perception of broadcasting meteorology among the public is to deliver a concise, informative and compelling weather report for the following day, usually under two minutes without leveraging complex technical language and terms. Nowadays, its role is not only the weather forecast for three or more days but also the educational purpose of raising awareness of the human-induced climate change driving and amplifying the weather extremes across the globe (Teather, 2010).

This approach urged journalists to break out of silos and tenaciously communicate with meteorologists daily, offering more on-air minutes in the news and other programme segments to leverage their knowledge, skills and creativity in producing weather reports with eye-attractive visual aids and suitable analogues to make it closer for the public. Whilst this approach has been welcomed in Albania and Bosnia and Herzegovina by the public, the lower climatic literacy and the rise in conspiracy theories often result in misinterpretation of general meteorological terms, leading the presenter, frequently in the position of leading forecaster and editor-in-chief, to bear with the consequences and accusation of falsifying the information (UNFCCC, 2023).

Although most of these issues are benign and rather isolated, public communication became more challenging and sensitive with the onset of the SARS-CoV-2 coronavirus pandemic, dominated by the infodemic of false information. Moreover, since 2020, numerous data sources have emerged, many of which are not subjected to fact-checking and/or verification, raising

concerns about false information spread among the public and the threat of the 'new infodemic' inherited from the SARS-CoV-2, showing the similarities to the problem of climate change (Fuentes et al. 2020). This implies the further degradation of science under the rise of conspiracy theories and the lack of trust in meteorologists and climatologist.

Method and data processing

This research employs a qualitative, phenomenological framework to explore the challenges faced by broadcast meteorologists in communicating weather information to the public. By drawing on personal experiences in media environments, expert insights, media discourse analysis, and case studies of meteorological controversies, the study aims to provide a thorough understanding of the evolving role of broadcast meteorologists and their communication strategies. In the context of increasing public skepticism toward weather forecasts and the proliferation of misinformation, this research offers a comprehensive perspective on these pressing issues.

The phenomenological approach serves as the primary research method, as it enables an in-depth investigation of the lived experiences of meteorologists and their interactions with audiences. By focusing on individual experiences, the study examines how meteorological messages are conveyed, interpreted, and sometimes misinterpreted by the public. Additionally, an evidence-based approach is incorporated to support findings with real-life examples and documented instances of public responses to weather forecasts. This mixed-methods strategy ensures that the study remains grounded in both personal perspectives and empirical data, providing a more holistic and accurate representation of the challenges encountered by meteorologists. The research integrates direct engagement in the media industry, offering unique insights into the pressures, responsibilities, and ethical dilemmas faced by broadcast meteorologists. Contributions from seasoned meteorologists involved in public communication further enhance the study's conclusions. Two key case studies are examined:

- The Met Office's 40 °C heatwave and red alert (July 2022): this event sparked widespread conspiracy theories, with accusations that meteorologists were exaggerating forecasts;
- Threats against AEMET meteorologists (April 2023): Following an exceptional spring heatwave warning, Spanish meteorologists faced significant public backlash and threats.

These cases provide critical insights into how weather forecasts can be perceived as politically or ideologically motivated rather than being received as objective scientific data. The study examines how different regions including Albania, Bosnia and Herzegovina, the UK, and Spain—respond to meteorological information. By contrasting public reactions across diverse cultural and socio-political settings, the research highlights variations in climate literacy, trust in meteorologists, and trends in misinformation. A systematic review of meteorological reporting across television broadcasts, social media, and news articles is conducted. The central focus is placed on:

- The impact of meteorological graphics, colour schemes, and probabilistic forecasts on public perception;
- Online discussions and social media interactions, revealing common misconceptions and misinformation patterns in meteorology.

The misinterpretation of fundamental terms

The public often confuse weather and climate, despite their distinct differences and interdependence. Whilst the weather is the perception of the current state of the atmosphere, the climate is the average or normalised state of the atmosphere traced for at least 30 years. The thirty-year reference period is defined under strict technical regulations, and it is updated every tenth year (e.g. 1961-1990, 1971-2000, 1981-2010, etc.) to monitor the differences between the preceding periods and their natural variability cycles (WMO 2017). This approach supports meteorologists and climatologists to monitor the frequency change of weather events and the possible cycle disruptions that could be potentially associated with climate change.

To understand the difference between the weather and climate, broadcast meteorologists usually leverage maps and graphs to show the importance of the underlying problem. However, the public's weather perception is often based on daily activities. Hence, reliance on tangible analogues derived from complex terminology is imperative for clear communication on climate change topics. For instance, the analogue of harvesting the potatoes leverages the array of variables consisting of input $X[a1, a2, \ldots an]$ (e.g. soil quality and moisture, insolation, frost risk, etc) monitored for the n-years ($n \geq 30$) to produce the output Y – i.e. the potato quality. Considering the n-decades of observation, insolation, soil moisture, and frost risk remain the variables of interest as they depend on other meteorological and atmospheric factors, while soil quality remains more or less a constant. These observations provide

pivotal insights for further statistical analysis to determine the relationship and their significance among the variables. Further delamination of the initial problem, the obtained outcomes are:

- The potato quality depends on the temporal changeable factors – sufficient amount of sunshine, adequate soil moisture and harsh winter frosts, considered as weather variables in the regular weather report;
- The potato quality, on average, reveals its predictability by registering the lowest and highest peaks based on the natural variability cycles in the monitored time scale of n-decades, considered as climate monitoring.

If a single variable from the array subtly deviates from the expectation, it directly affects the quality of the potato. This example can be further transferred to the weather report in which, depending on the temporal scale, the dominant air mass coming from the north or south results in very cold, cold, less cold, warm, very warm or hot weather, respectively. Similarly, if a frontal system is not advancing according to the preliminary expectations, the predicted rain is likely to fall later than previously forecasted. These challenges force active monitoring and in-depth analysis of the situation but frequently with limited opportunities to overturn the forecast given the time constraints.

The issue of the ’red colour’

Modern software systems (e.g. ECMWF’s Magics) implement attractive colour-coded visuals to ensure simple and effective data representation to the public and make easier daily decisions based on the final product. However, the choice of colours often finds space for the conspiracists who compare the past forecasts that did not consider this feature. Among all colours, red shades are generally accepted for temperatures exceeding the hot day threshold (i.e. ≥30 °C) and considered as the “fearmongering colour”, especially when blended with other shades on the right side of the bar, especially during summer. The most evident example was witnessed in July 2022 amidst the record-breaking UK heatwave which resulted in the temperatures reaching 40 °C for the first time in recorded history (Met Office 2022) and the highest mortality excess ever witnessed related to the excessive heat, exceeding the August 2003 levels (Johnson et al. 2005). Not only did this heatwave force the Met Office to use the dark red shade to show the 40 °C on the 16th of July, but it also forced the news presenters and journalists to consider the warnings from the national authorities with some degree of doubt, often comparing this

heatwave with the 2003 and 1976 when the highest temperatures were shown in amber shades. The GB News presenter, a right-wing populist media, went a step further by insulting the Met Office meteorologist, accusing it of being "a harbinger of doom" and claiming the baseless over-exaggeration of the hot conditions which lasted shorter than in 1976. (The Guardian, 2023). While this particular example has evidently highlighted the lack of understanding of the news presenter, it opened the discussion of two fundamental differences. During the summer of 1976, the UK was gripped by one of the longest heatwaves in the recorded meteorological national history which broke dozens of records, with the period between June 23 and July 08, 1976, consecutively reaching uncommon temperature levels (i.e. ≥32.2 °C) across the nation – hitherto the longest sequence ever recorded (Shaw 1977).

Despite lasting significantly longer than the 2022 episode (i.e. 15 days versus 5 days), it was preceded by the dry winter and spring, allowing lower dewpoint temperature, evaporation rates and relative humidity levels, making the heat more bearable (Ratcliffe 1977). Although the summer of 1976 posed exceptional challenges, the maximum peaked at 35.9 °C - contrary to 2022 which featured a 40.3 °C mark (Figure 1) – a delta of 4.4 °C, partially exacerbated by the feedback loops between the land and much warmer surrounding seas (Guinaldo et al. 2023).

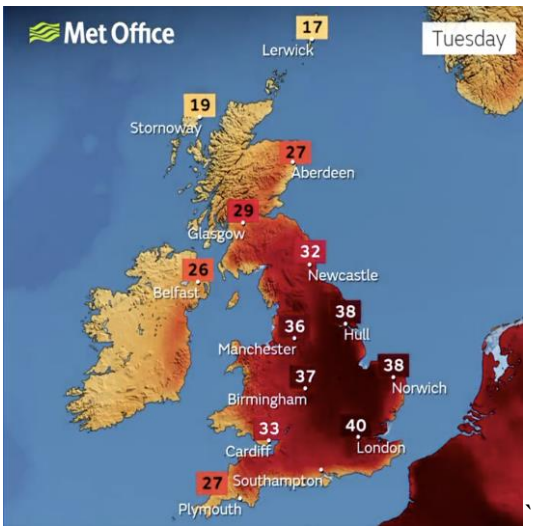

Figure 1: Forecasted maximum temperatures on July 19, 2022, when 40 °C (in dark red shading) was forecasted for the first time in the UK within the belt from London to Lincolnshire. Courtesy of Met Office.

This issue was clearly foreshadowed to the public, but the perception of heat stress could not have been accepted. A similar occurrence occurred in April 2023 during the early spring heatwave which resulted in the first 40 °C of 2023 and first heatwave warnings. The public threat magnitude was higher than in the UK, with meteorologists forced to seek police protection despite the factually correct forecast. Although red shades are nowadays widely accepted in meteorological circles, there is public criticism claiming that they affect emotions and raise alarmism.

Hence, alternative colour schemes were proposed to alleviate the sense of fear and concern (Schneider and Nocke, 2018). The example was found in the original figure from the IPCC AR5 report (IPCC 2014) and tested with the five different colour bar schemes, three of which did not include the red colour and consisted of cool and neutral colours (i.e. green and purple; grey and black – see Figure 2). The study conducted by Schneider and Nocke, (2018) examined 22 participants, with diverging results on the opinions of the most suitable colour-coded scheme.

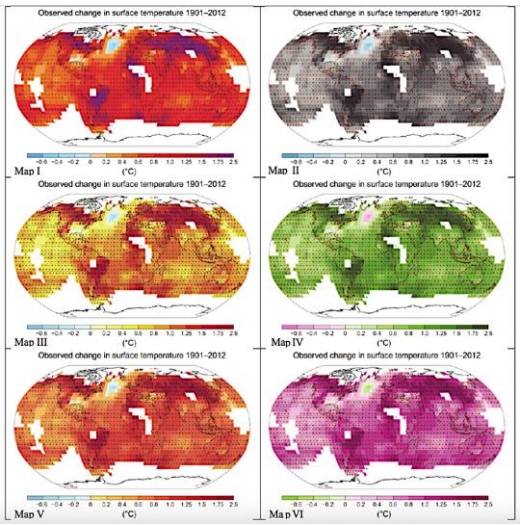

Figure 2: The original map from the IPCC AR5 report (Map I) modified with five different colour-coded schemes to visually depict the temperature deviation (Map II to Map VI). Adopted from Schneider and Nocke, (2018).

Unsurprisingly, the original IPCC figure with the dominant red colour scheme with purple shades resulted in being rejected and evaluated as ‘disillusioning and discouraging', while the colour bars with less dominant red shades and more yellow tones received more positive feedback with more balanced results and intuitive feeling. Interestingly, the colour-coded schemes which did not include red colour resulted in lower discernment of the colour bar limits, thus higher confusion. This reveals despite some of the red colour cons, it still shows its importance and valuable benefits to leverage it with balanced tones.

Why do the probabilities puzzle the public?

Whilst the probabilistic approach helps meteorologists and climatologists to minimise the forecasting uncertainties and derive expected weather scenarios, for the public, it is the concept that is hardest to perceive, and it has been well-documented (e.g. Sink 1995; Gigerenzer et al. 2005; Morss et al. 2008; Abraham et al. 2015; Zabini et al. 2015; Vaughn et al. 2024). The issue often prevails in spring and summer, when the convective systems (i.e. the localised thunderstorms triggered due to convection release of latent heat) add uncertainty to the weather forecasts and rely on the probabilities due to the limited temporal and spatial scale (e.g. Spiridonov et al. 2020; 2023).

An example that resolves this issue efficiently is the Novel Thunderstorm Alert System (NOTHAS), which minimises the uncertainty in the probabilistic algorithm by using the localised maximum signal at each step and visually presents the output on the map. The array of convective parameters is weighted for each time step using the Weibull distribution to produce the indices based on the defined thresholds for different climatic regions (Spiridonov et al. 2020; 2023). It also manages to achieve simplicity in delivering results to the end-users through the colour-coded categorisation (from 1 (Low) to 5 (Extreme) – see Figure 3).

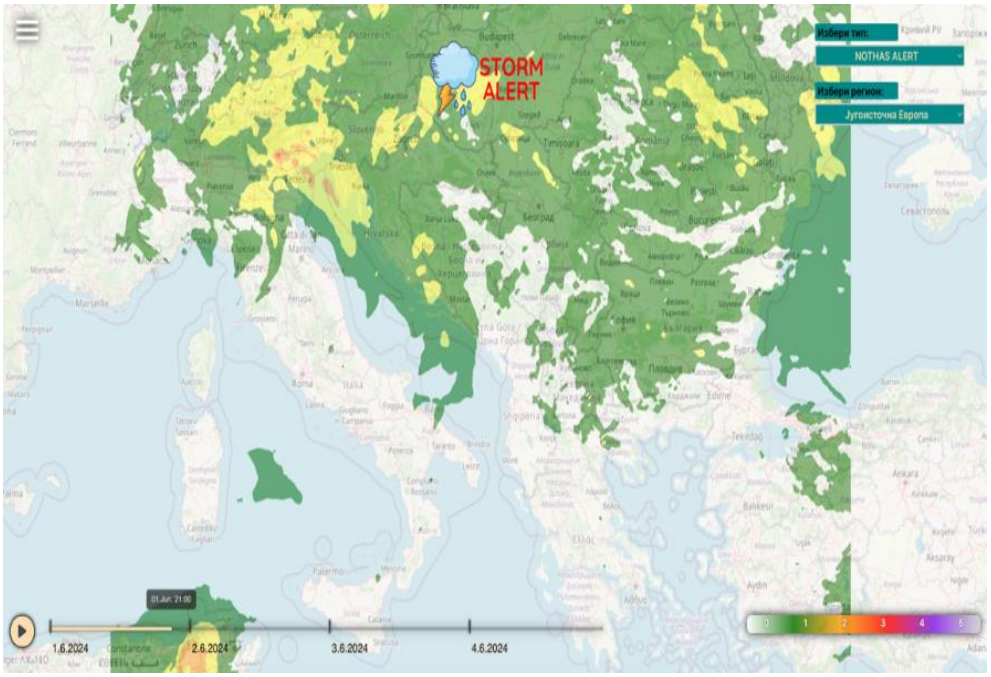

Figure 3: The NOTHAS categorisation output from the algorithm detecting the convective systems across southeastern Europe for Saturday, June 01, 2024, at 21:00. Adopted from https://nothas.finki.ukim.mk/

Even though NOTHAS is an example of excelling in simplicity and supremacy, especially for meteorologists, the main issue remains for the public that can only perceive the categorisation of weather extremes, not the precipitation intensity, even though these set of variables are documented but not integrated into the application. Thus, the users can deduct that at the given location there is a chance for a localised hazard, but without the specific details which will explicitly tell them they need an umbrella – the only answer the public is interested in.

Considering that probabilities are usually excluded from the broadcasting reports, in a lack of supportive answers, people strongly rely on mobile weather forecast applications that include the probabilistic approach for the expected precipitation M at the given location N. However, the public does not realise that the data-driven approach does not include raw model data correction by the meteorologist. This is an important issue due to the uncertain forecasting nature in which a model run can result in a bias (i.e. deviating from

the previous runs or set of ensemble members and its mean). Such outcomes, especially in periods of lower-than-usual predictability of weather models, can lead to inaccuracies and fluctuations in the expected weather conditions, making it harder to decide the daily activities. Consequently, a forecast with an initial 70 % chance of rain could lead to a false alarm and vice versa. Hence, the public's difficulty with understanding the probabilistic weather forecasts lies in the lack of detailed and intuitively presented information that will reduce the decision-making challenges.

Conclusions

This paper aimed to provide challenges in communicating scientific information to a broad audience by addressing three key issues from the introduction. The misinterpretation of fundamental meteorological and climatological terms offers a vast spectrum for breaking down the complex terminology using analogues from ordinary daily life (e.g. the impact of the quality of the harvesting culture based on the identified variables) and/or fundamentals from interdisciplinary studies (e.g. the human body temperature regulation to explain the excess in the global energy budget).

The red colour issue was discussed at the psychological level due to its prone to the rise in conspiracy theories. Whilst vibrant red shades have a negative impact on people's emotions and are less readable, the less dominant red shades in the colour-coded scheme are found to answer the issue effectively, conducive to a lower sense of alarmism and fear among the public, and the easier detection of warmest points on the map (Schneider and Nocke, 2018). The least likely solutions were found to answer the problem of the probabilistic forecasts. We identified two key issues: users' misinterpretation of probabilities and the lack of detailed information about precipitation intensity within existing forecast systems in terms of analogues.

While user-friendly interfaces like NOTHAS offer valuable information (Spiridonov et al. 2020; 2023), they might not provide enough specific details for decision-making for the broad audience. Although supreme and high-quality products are available to the public with intuitive and attractive graphical outputs, quantification misinterpretation and non-integrated fundamental variables without sufficient details or explanation often follow the accusation of meteorologists for not doing their job accordingly, leading to the main interest questions being unanswered.

Future work

The last question leaves the potential research space that requires external data leverage. Therefore, this work will be extended with the results from the surveyed participants and a set of tests of numerous weather applications to provide quantitative results and more insights into the general problems in addressing the probabilistic forecasts more efficiently, especially to the colour-coded scheme integration for the precipitation intensity categorization. The conducted survey shall provide the desired data representation format, reducing the redundancy and providing the answers to the public questions. The significance of this study shall impose better individual preparedness to mitigate the adverse influence of extreme weather in the ongoing light of climate change. In addition, based on the impact of climate change and/or extreme weather on the public's daily activity but even more, in the impact of the extreme atmospheric conditions on the human health, a very important task appears in front of all broadcast meteorologists; to inform in simple words and correct terminology to the public regarding the health consequences of an anomaly situation.

For this, the broadcast meteorologists in different medias should pursue a specific education and training regarding the effects of atmospheric and environmental conditions to the public health, why not also to specific groups that are vulnerable to an atmospheric or environmental situation.

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