Operational management of heat stress and heatwaves in public weather bulletins using ECMWF products in Lombardy

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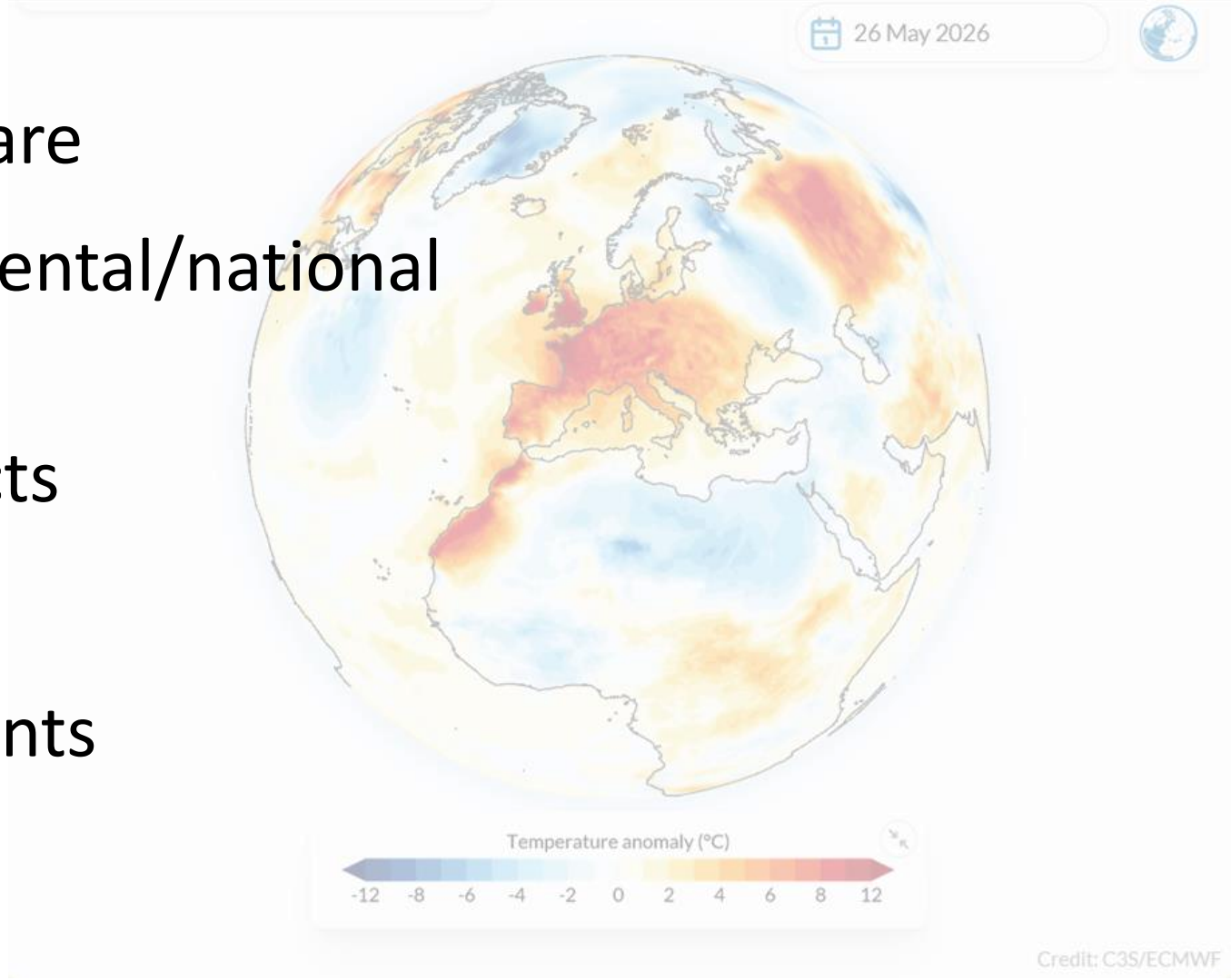
Outline

1. Who we are and where we are
2. Heat stress: from the continental/national scale to the local scale
3. Existing services and products
4. The new bulletin
5. Conclusions and developments

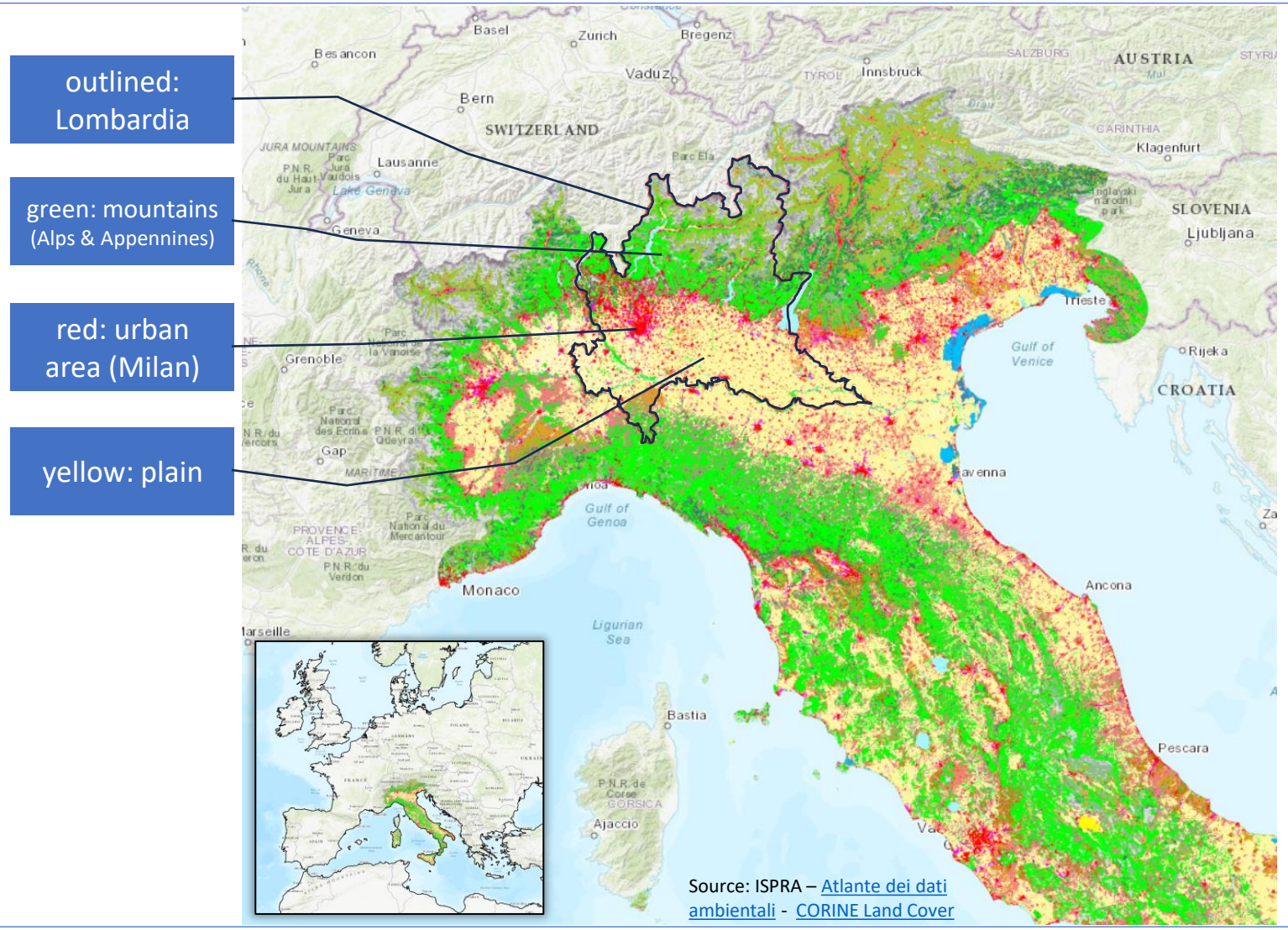


Who we are, where we are

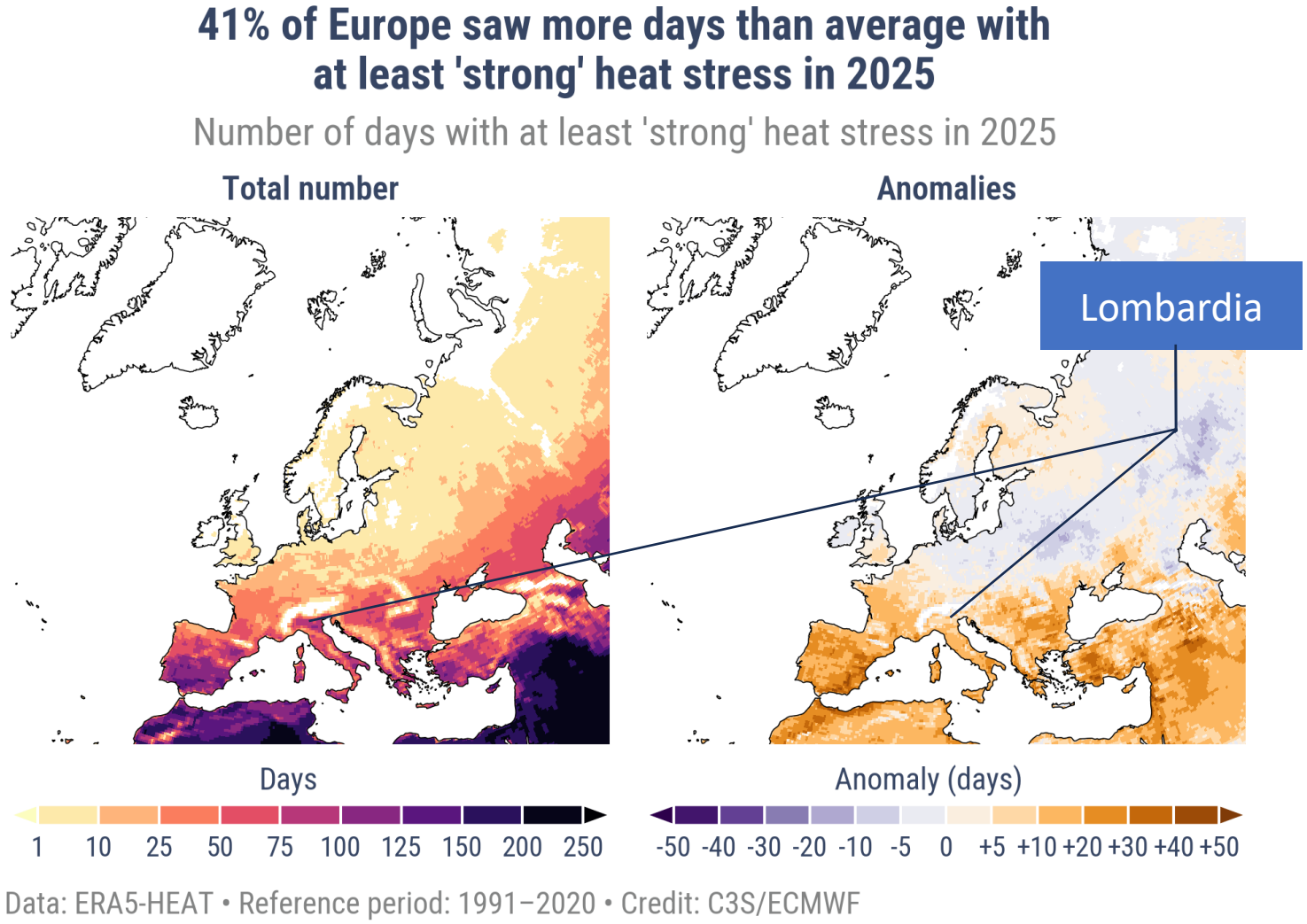
ARPA Lombardia is the Regional Agency for Environmental Protection, a public body which includes the local meteorological service.

Lombardy (10 million inhabitants) is characterised by mountains, lowland and large urbanised areas (Milan).

In particular, the plain (part of the Po Valley) has elevations starting from 10 m asl and is surrounded by the Alps and the Apennines, has little wind and and its temperatures are scarcely influenced by the sea (climate more continental than mediterranean)



The heat stress at the continental scale



On a continental scale, we are located in the southern belt, which is most prone to above-average temperatures with all the resulting consequences in terms of their impact.

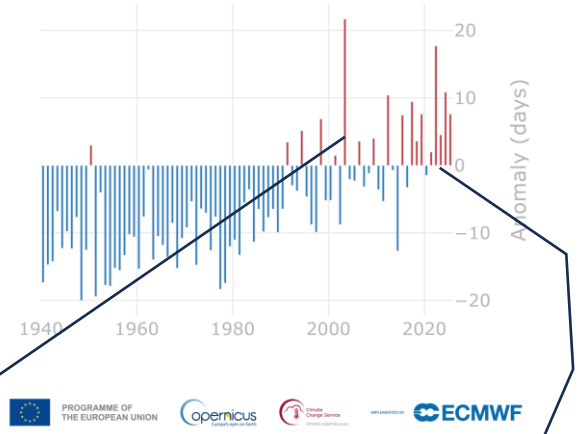
The image shows the situation in 2025, but this scenario is now a recurring one…

Source: European State of the Climate 2025

Warming trend in Lombardia

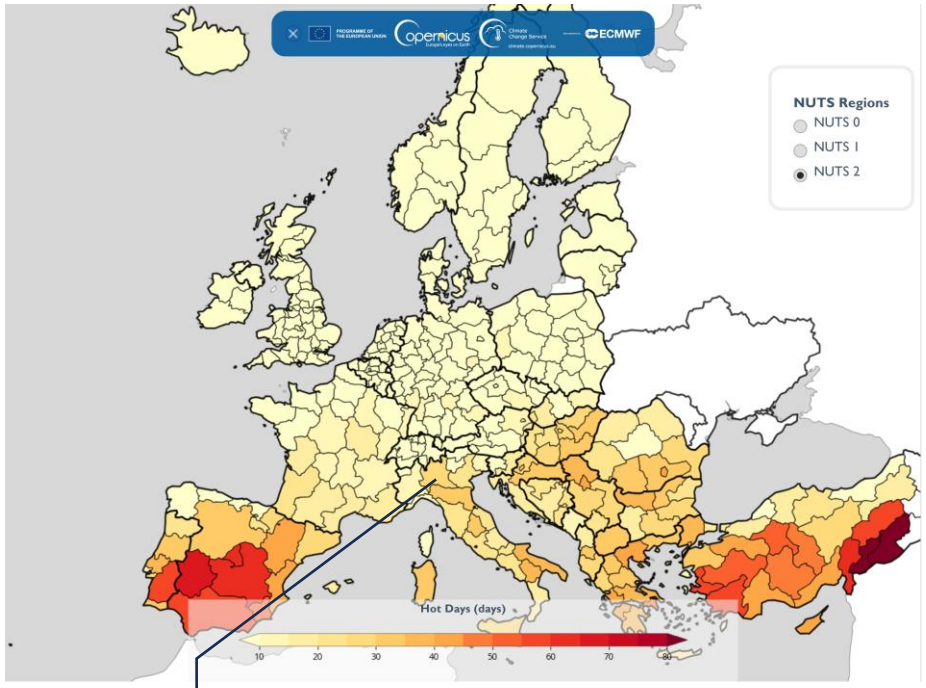
Historical variations of seasonal Hot Days (above 30°C) in Lombardia (Summer (JJA))

Interactive plot showing the deviations of the historical seasonal Hot Days from the 1991-2020 average (also called 'Anomaly') based on the ERA5 reanalysis.



2003: isolated anomaly

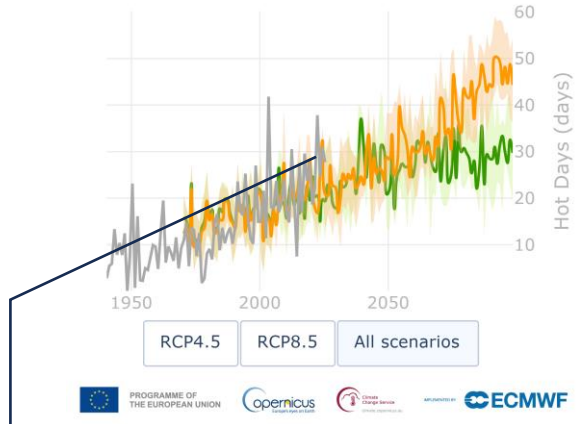
'20s: repeated anomaly



Lombardia

Historical and projected evolution of seasonal Hot Days (above 30°C) in Lombardia (Summer (JJA))

Interactive plot showing the observed seasonal Hot Days along with the median and likely values (66% probability of occurrence) envelope from an ensemble of climate models.

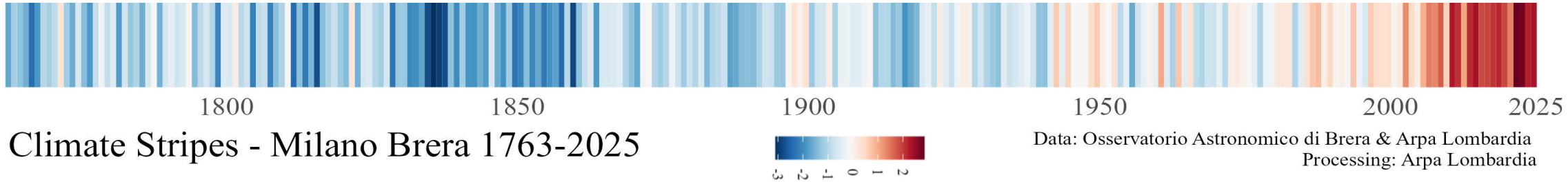


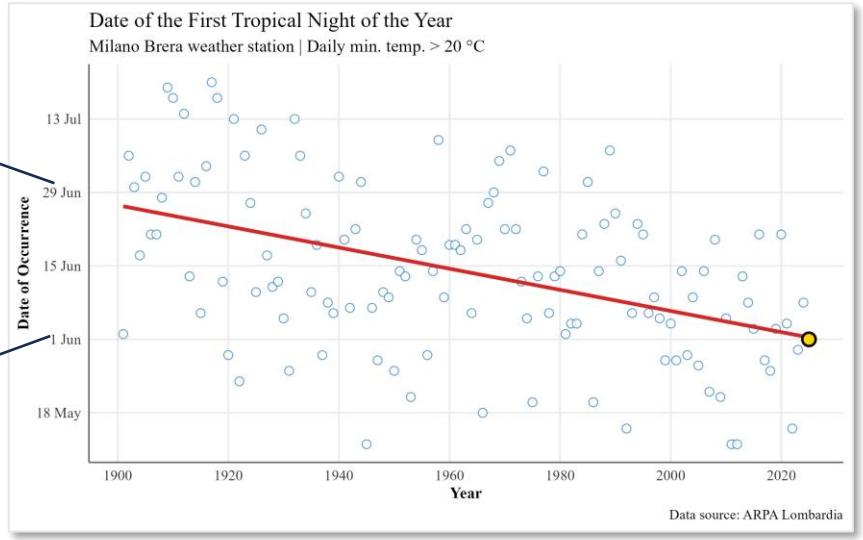
Following the worst scenario

Whichever way you look at it – in terms of heat stress, hot days or any other heat-related indicator – the trend is towards warming and an increase in episodes of extreme heat.

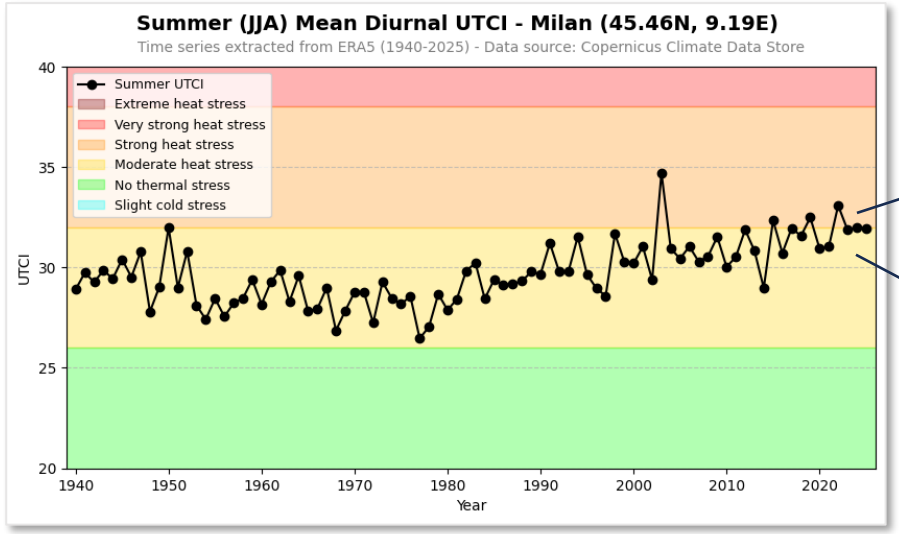
Source: https://climate-adapt.eea.europa.eu

Heat stress at the local scale





~ 1 month earlier in 1 century



1 level above

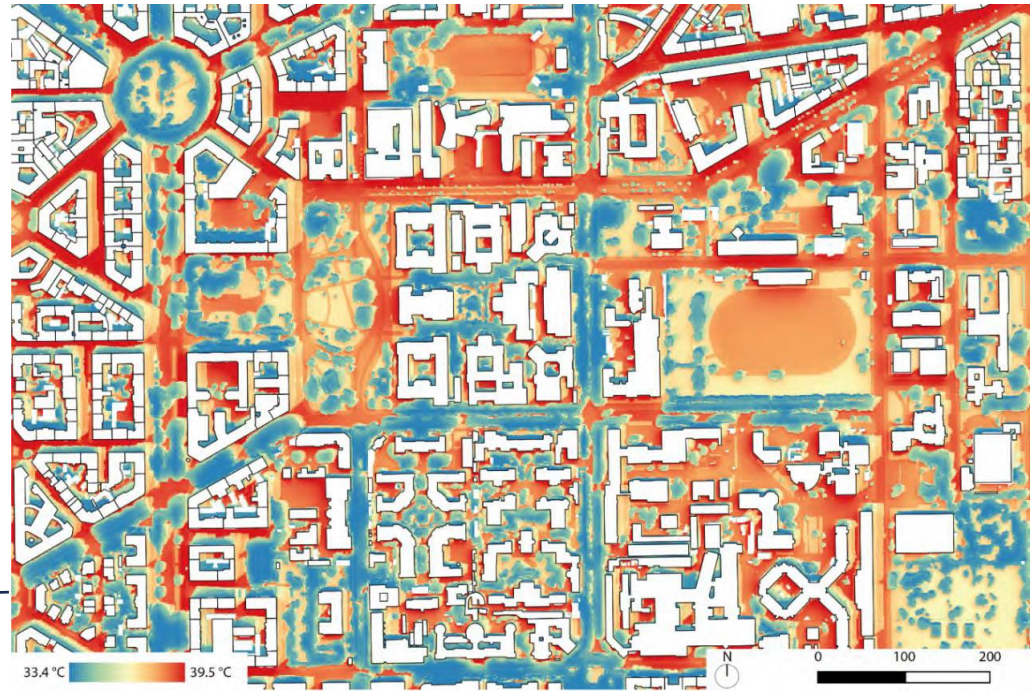
The date of the first tropical night in central Milan now occurs around a month earlier than it did a century ago. The average summer diurnal heat discomfort measured by the UTCI index is now consistently at a higher level (“strong”) compared to the last century (“moderate”)

Heat stress at the "street" scale

University district in Milan

Real view

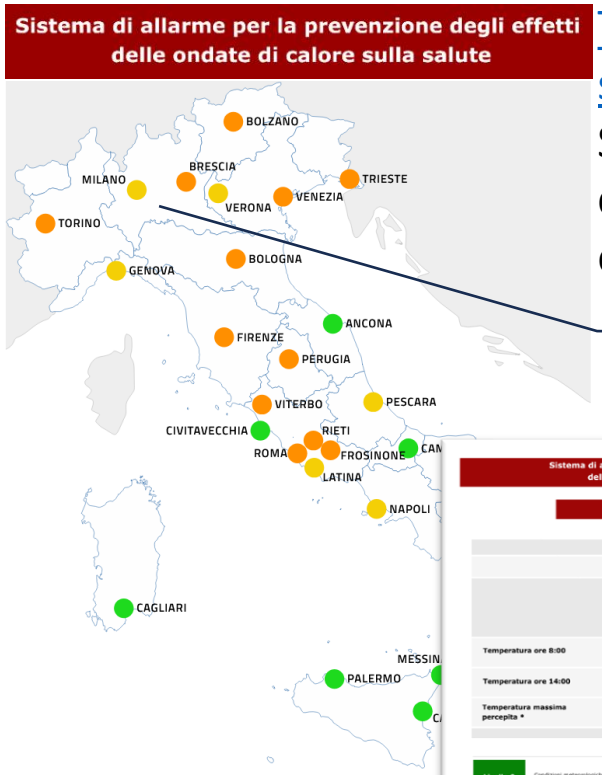
UTCI view

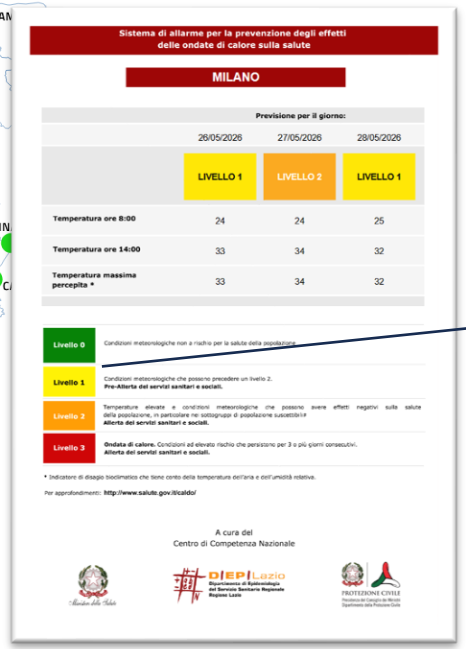


Urban **planning** and climate change **adaptation** plans: these are two of the main areas in which information at this scale is used. But that’s not the scale at which we operate…

Source: left, Google Maps; right, Piano di Adattamento ai Cambiamenti Climatici, 2025, Politecnico di Milano

Heat and the weather related bulletins





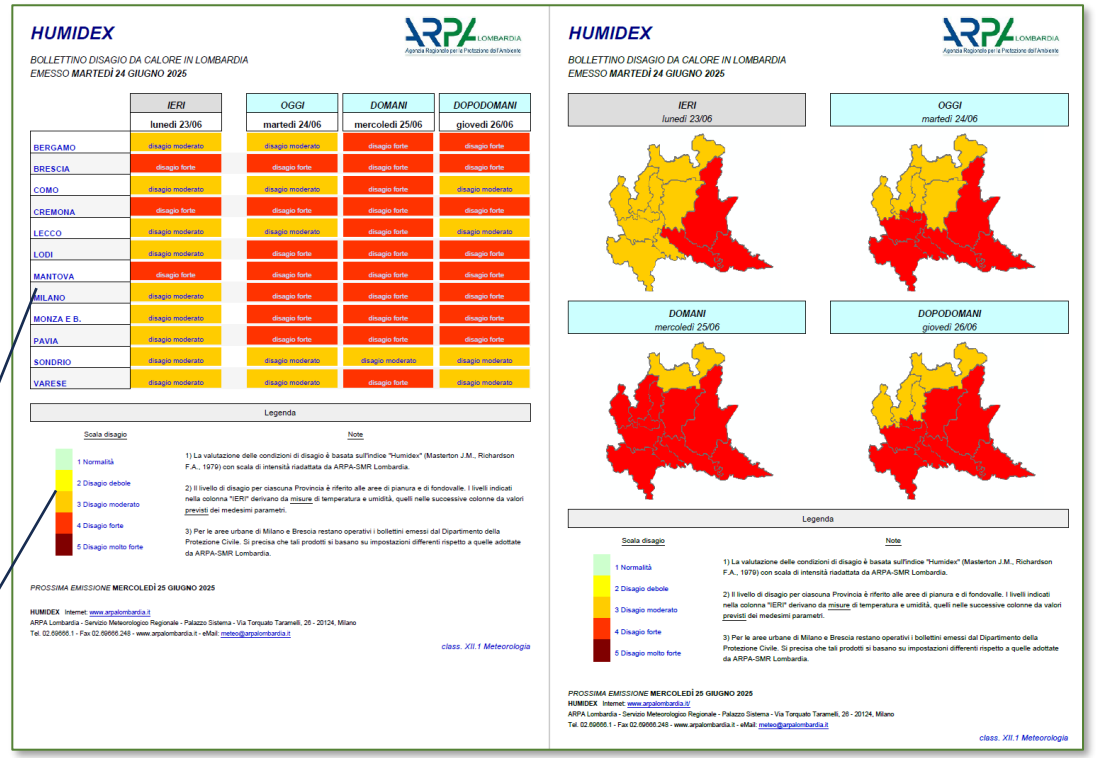
[The **national (Italy)** early warning system] is based on an HHWW System operating in 27 cities, which correlates weather conditions with excess mortality

City-oriented (27 cities)

Province-oriented (12 provinces)

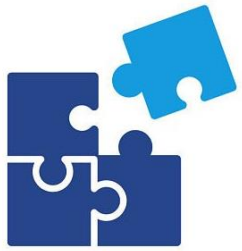
Alert level

Discomfort level



[The **regional (Lombardy)** bulletin] is based on the Humidex index and covers the low-lying areas of the region's 12 provinces. It's been published for over 20 years now and is well established among users; many healthcare facilities have incorporated it into their procedures

Evolving the service: integration and refinement



Expanding the indicators

- Humidex remains the reference index
- Introduction of UTCI
- Additional parameter: tropical nights
- Additional text: the forecaster's comment with additional information

Refining the information

- Improved temporal representation: from daily maximum to intra-day evolution
- Bi-hourly Humidex trends, hourly UTCI trends
- UTCI: altitude-based aggregation

This evolution is mainly driven by operational experience, aiming to provide a more complete and usable description of heat stress for end-users

New bulletin – THERMAL DISCOMFORT

‘Thermal Discomfort’

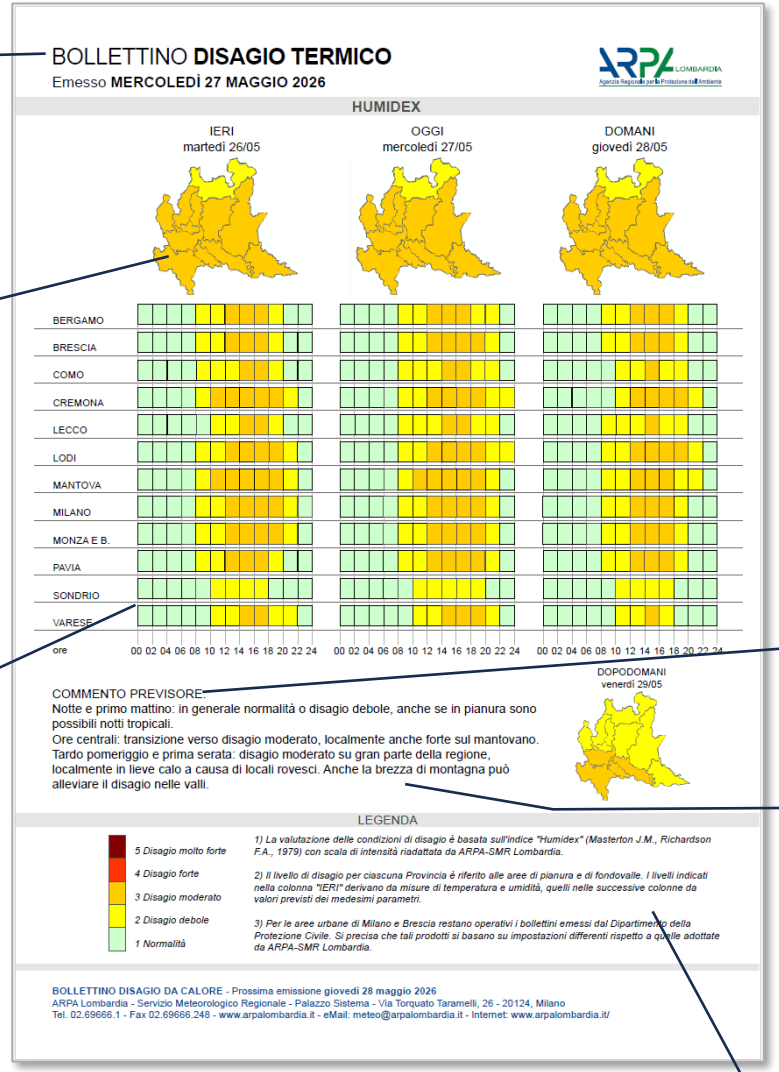
The title has no reference to the ‘heat’, so as to include more than one index and allow for the possibility of extending it to a ‘winter version’

‘Catch the eye’

Humidex daily maximum values are shown on maps, both observed (yesterday) and forecast (D0 to D2) tomorrow). They are aggregated on a province base and represented in colors as **discomfort levels**

Help plan activities

The **bi-hourly** development over 24 hours is shown in a table below



BOLLETTINO **DISAGIO TERMICO**

Emesso **MERCOLEDÌ 27 MAGGIO 2026**

HUMIDEX

IERI martedì 26/05 | OGGI mercoledì 27/05 | DOMANI giovedì 28/05

BERGAMO, BRESCIA, COMO, CREMONA, LECCO, LODI, MANTOVA, MILANO, MONZA E B., PAVIA, SONDRIO, VARESE

ore 00 02 04 06 08 10 12 14 16 18 20 22 24

DOPODOMANI venerdì 29/05

COMMENTO PREVISORE:
Notte e primo mattino: in generale normalità o disagio debole, anche se in pianura sono possibili notti tropicali.
Ore centrali: transizione verso disagio moderato, localmente anche forte sul mantovano.
Tardo pomeriggio e prima serata: disagio moderato su gran parte della regione, localmente in lieve calo a causa di locali rovesci. Anche la brezza di montagna può alleviare il disagio nelle valli.

LEGENDA

5 Disagio molto forte
4 Disagio forte
3 Disagio moderato
2 Disagio debole
1 Normalità

1) La valutazione delle condizioni di disagio è basata sull'indice "Humidex" (Masterton J.M., Richardson F.A., 1979) con scala di intensità riadattata da ARPA-SMR Lombardia.

2) Il livello di disagio per ciascuna Provincia è riferito alle aree di pianura e di fondovalle. I livelli indicati nella colonna "IERI" derivano da misure di temperatura e umidità, quelli nelle successive colonne da valori previsti dei medesimi parametri.

3) Per le aree urbane di Milano e Brescia restano operativi i bollettini emessi dal Dipartimento della Protezione Civile. Si precisa che tali prodotti si basano su impostazioni differenti rispetto a quelle adottate da ARPA-SMR Lombardia.

BOLLETTINO DISAGIO DA CALORE - Prossima emissione giovedì 28 maggio 2026
ARPA Lombardia - Servizio Meteorologico Regionale - Palazzo Sistema - Via Torquato Taramelli, 26 - 20124, Milano
Tel. 02.69666.1 - Fax 02.69666.248 - www.arpalombardia.it - eMail: meteo@arpalombardia.it - Internet: www.arpalombardia.it/

The first page of the new regional bulletin 2026, Thermal discomfort, issued by ARPA Lombardia.

'Humanising' the bulletin

The ‘forecaster’s comment’ is a text box where the meteorologist on duty can add information and details which, in his or her opinion, complement the forecast and help users to understand it. It may therefore include information on rain, wind, etc., and on the reliability of the forecast.

Cater to the media, but…

In the text, the forecaster may refer to **‘tropical nights’**, an expression very popular with the media due to its ‘exotic’ sound, but which remains a rigorously defined parameter. (Please note: we have removed expressions such as ‘perceived’ or ‘feels-like temperature' from our glossary, as they are often misunderstood or lead to errors).

Low altitudes

The Humidex discomfort level only refers to **lower altitudes**, that is the plain and the valley floors

Introducing the UTCI

UTCI

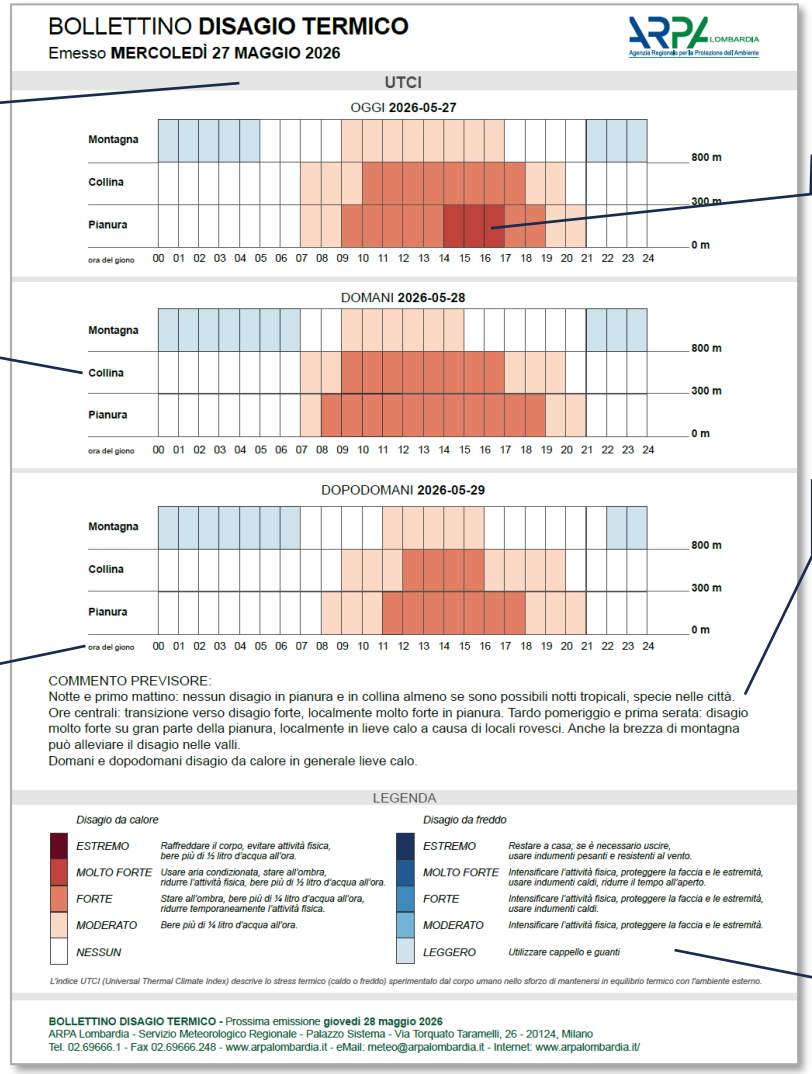
This index is gaining ground not only in academic research but also in practical application; here, it is primarily intended for use in managing outdoor work

Three altitude zones

The division of the territory into **lowland**, **hills** and **mountains** should cover all user scenarios, including those not covered by the Humidex index shown on the first page

Hourly trend

The hourly forecast over a 24-hour period is shown to help plan outdoor activities throughout the day



The second page of the new regional bulletin 2026, Thermal discomfort, issued by ARPA Lombardia.

Which value?

For all the gridpoint values of the altitude zones, the prevailing discomfort categories are visualised

The forecaster's take

As on the Humidex page, this is the box where a human input can supplement , clarify or contextualise the graphical forecast

The legend

The legend is taken from the **ECMWF** web page, because it is appealing and intuitive, and in line with other legends on the bulletins issued by ARPA Lombardia.

Layout and colors

Useful similaraties

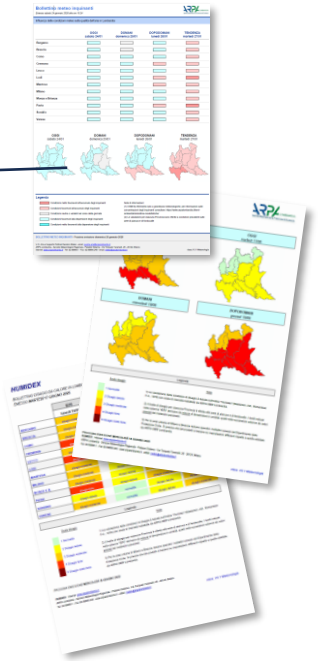
The layout on the first page is similar to the former Humidex bulletin to not add to much new elements and information to the users. It is also in line with other bulletins, as the one on pollutants

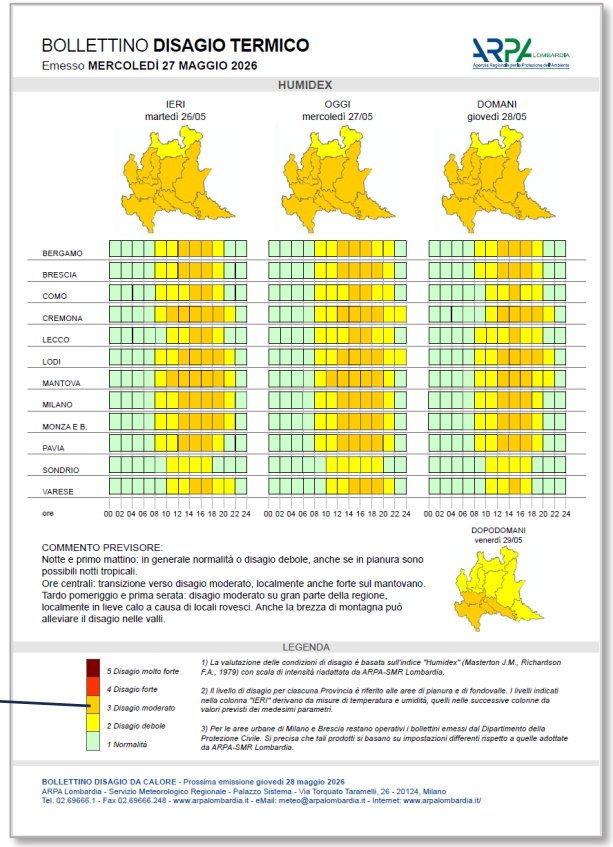
Color choices

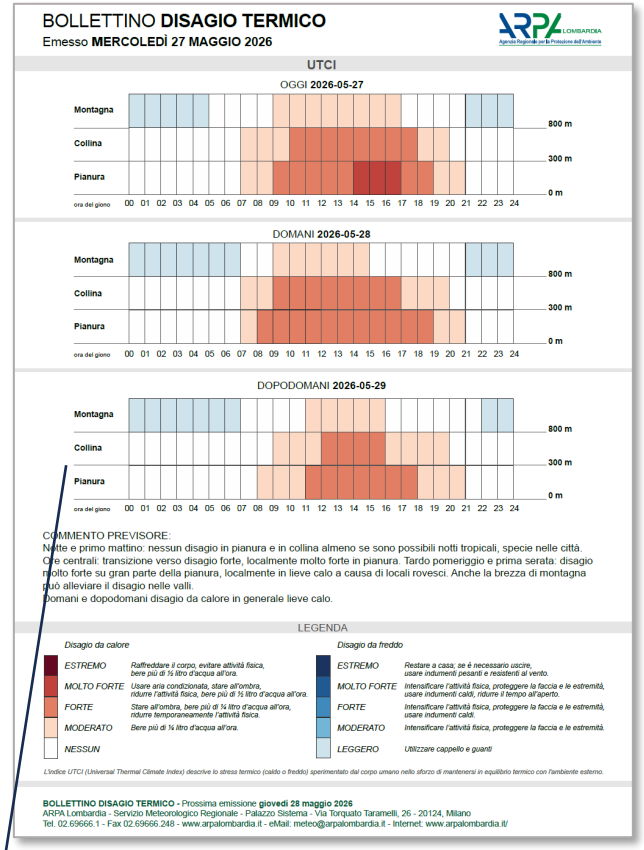
Text and background very neutral to make the important information ”pop”. Also, the legend is the same as the former bulletin and uses a warm color scheme, with a connection to weather warnings (yellow, orange, and red) even if there is no direct connection with advisories issued by other official bodies

Vertical perspective

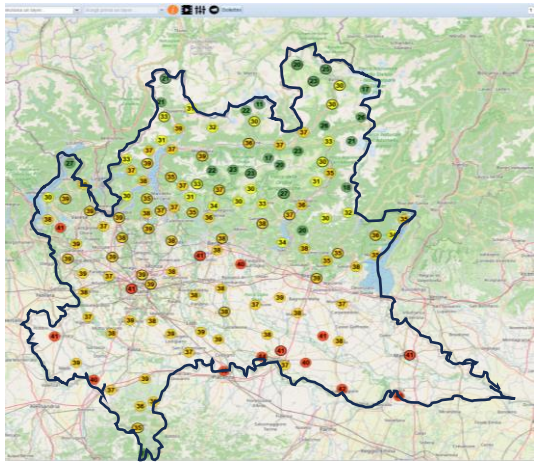
For the UTCI page, a different approach is applied. Taking into account native resolution of the forecast (ECMWF IFS), the data are visualized with homogeneous fields for the plain, the hills, and the mountains respectively





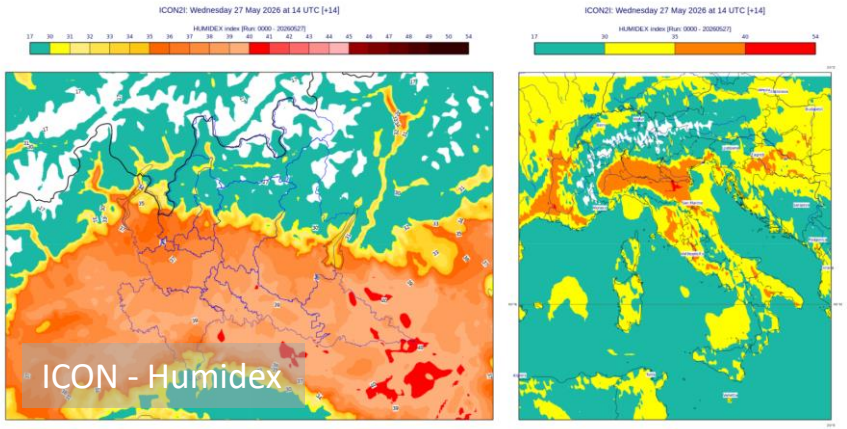


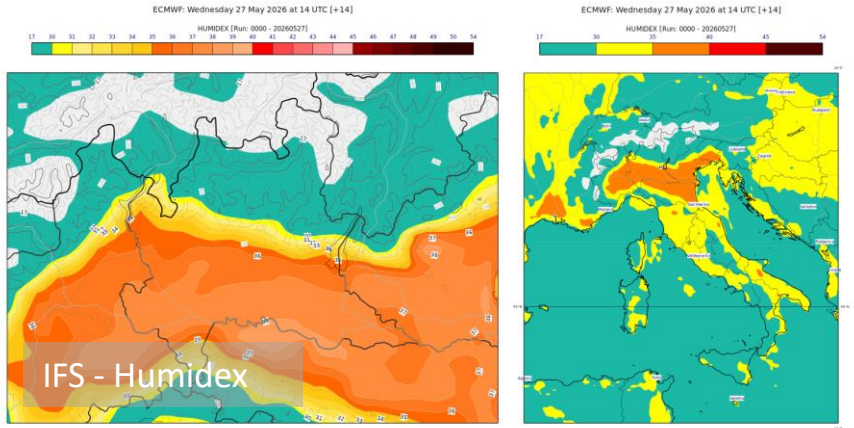
Observations and NWP



Regional monitoring network, Humidex-derived measures.

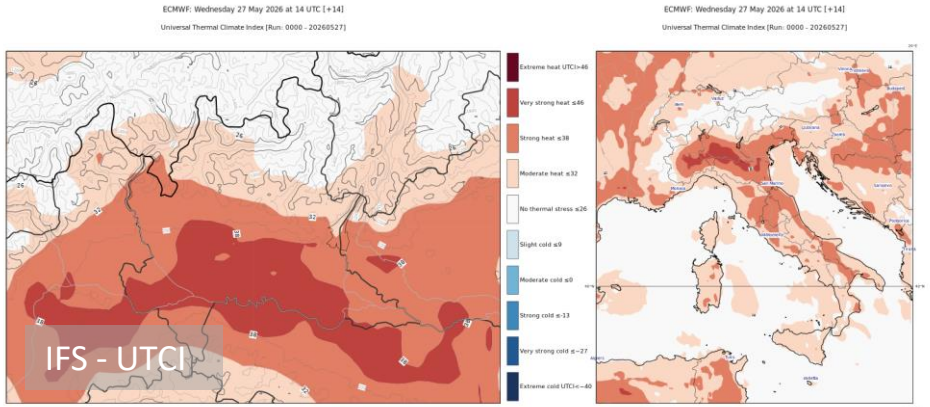
What about the UTCI?





A view of the ICON model at 2.2 km (above) and that of the IFS (below): quite obvious, at the IFS resolution our main valleys are not resolved, and the details of the field are smoothed out.

What about the UTCI?



Conclusions

Strengths:

- A solid scientific basis and authoritative data sources
- The communication style is straightforward but not superficial or vague.
- The use of “Humidex” and “UTCI” terms refers explicitly to specific scientific references, whilst “discomfort” refers to perception. This avoids misunderstandings, such as those associated with terms such as “feels-like temperature”
- Aggregation by province or altitude band degrade, in a sense, the raw data but makes it more usable
- High temporal resolution is more closely aligned with the user’s perception of variability than spatial resolution

Weaknesses:

- Our forecasters are not yet familiar with UTCI, adjusting the forecast isn't that straightforward
- The orography in the ECMWF-IFS does not account for valleys
- We can monitor Humidex (at stations), but not yet UTCI
- User feedback is not immediate; it takes time collect and convert it in operational changes

Developments

- Collecting advice and feedback, starting here at UEF2026
- Evaluating the production of a winter edition using UTCI
- Publishing next year's summer edition from 15 May
- Reviewing spatial aggregation methods in the bulletin
- Assessing the possibility of 'measuring' the UTCI
- Proposing to ECMWF the creation of EPSgrams for thermal comfort parameters

All that said…

(Images: Getty, Afp)

…we're on the side of outdoor workers!

Thank you.

email: g.minardi@arpalombardia.it