

MOTIVATION Due to global warming, extreme events increase in frequency and intensity. One of those extreme events are cold and heat waves, which affect people causing increased mortality and morbidity. The most important climate modifiers over Croatia are the Adriatic, the Mediterranean, the Dinarides orography and the Pannonian plain. Because of this strongest winds in the Adriatic coast of Croatia are jugo and bora which can sometimes reach gale strength. They bring different weather conditions and can also have an impact on morbidity. For improving its warnings for extreme events DHMZ also analyses several thermal comfort/stress indices.

Universal Thermal Climate Index - UTCI

- UTCI equivalent temperature for a given combination of **wind speed, radiation, humidity** and **air temperature** is the air temperature of the reference environment providing the same physiological response of reference person as the actual environment
- UTCI values are expressed in °C, interpreted in categories of **physiological stress**
- Applicable to human strain under a **wide range of climatic condition**
- Calculated by multi-node model of human thermoregulation, integrated with an adaptive clothing model - model simulations costly and complex
- **Simplified regression function** (Bröde et al., 2011) for operational use:
 - Procedures valid within the bounds of: $-50^{\circ}\text{C} \leq T \leq +50^{\circ}\text{C}$, $-30^{\circ}\text{C} \leq T_{\text{mrt}} \leq +70^{\circ}\text{C}$, $0.5 \text{ m/s} \leq v \leq 17 \text{ m/s}$, $5\% \leq \text{RH} \leq 100\%$ (with $p_a < 50 \text{ hPa}$)

METHODOLOGY

- The meteorological data used for the calculation of UTCI - hourly model values of **air temperature, relative humidity, wind speed** and **mean radiant temperature** from **ALADIN-HR** (4 km, 73 levels, ALARO-1 phys.; CANARI+3D-Var with 3h cycle; 72h fcst.; LBCs: IFS-3h; 4 runs per day)
 - 72 hour forecast of UTCI in thermal stress categories → over domain
 - 72 hour forecast of UTCI in index values for point data → 28 locations in Croatia
- Analysis of forecasted UTCI values for cases of strong local bora and jugo wind, heat wave and cold wave
- **UTCI** values are compared with **Thermal comfort index** and **PET** – indices for thermal comfort used operationally at DHMZ

RESULTS

Cold wave

7.-9.2.2022.

UTCI [physiological stress categories]

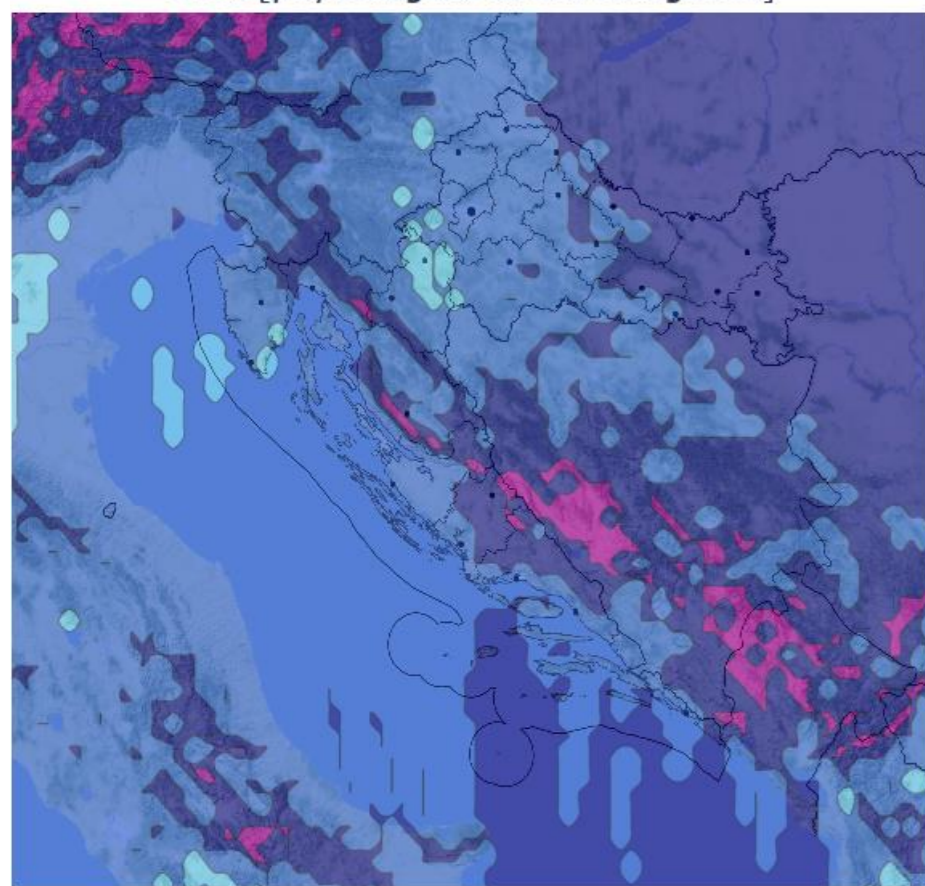


Figure 1. UTCI values in physiological stress categories over Croatian domain for case of cold wave.

- Observed - cold, with strong north and northeasterly wind and cloudy
- UTCI forecast (Fig. 1) shows strong and very strong cold stress in the mountains and south Adriatic and eastern Croatia
- Fig. 5 shows that UTCI values correspond to less cold categories of physiological stress than PET and TCI values for the case of cold wave

Heat wave

21.-23.7.2022.

UTCI [physiological stress categories]

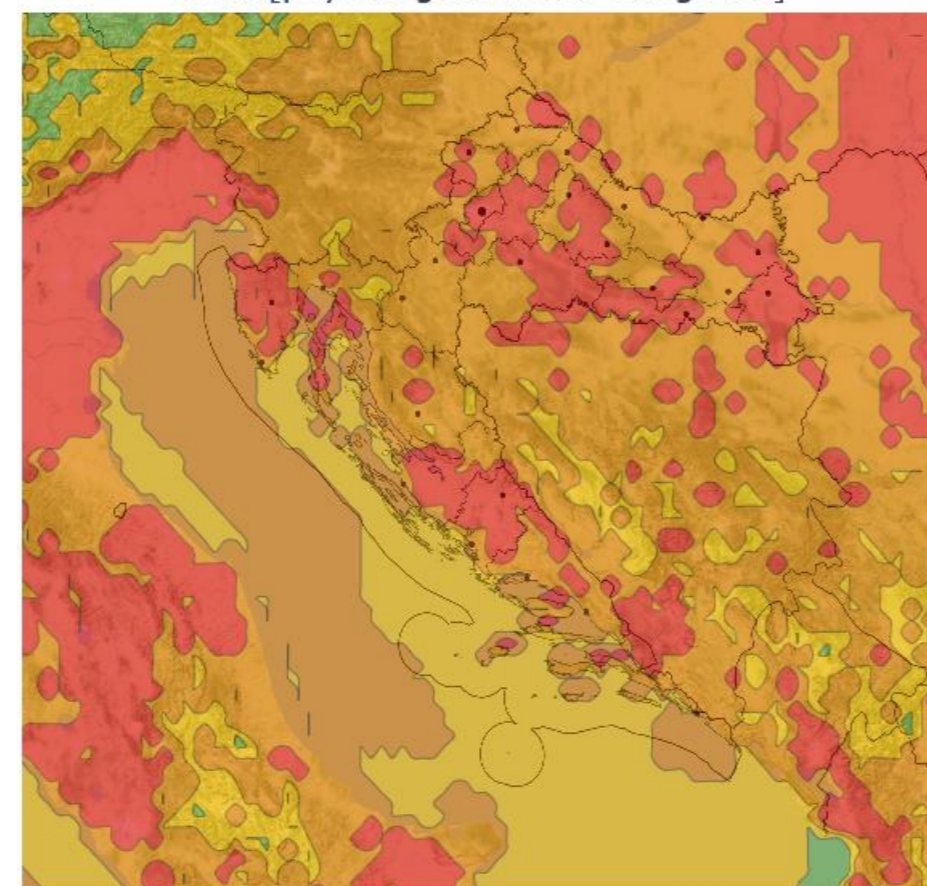


Figure 2. UTCI values in physiological stress categories over Croatian domain for case of heat wave.

- Observed - hot and sunny with the maximum air temperatures higher than 35°C
- UTCI forecast (Fig. 2) shows very strong heat stress in big parts of continental and costal regions while strong heat stress in the rest of the area over Croatia
- Fig. 6 shows good agreement between indices for station Knin – UTCI in next to last heat category in comparison to PET and TCI

Strong bora wind

25.-27.2.2022.

UTCI [physiological stress categories]

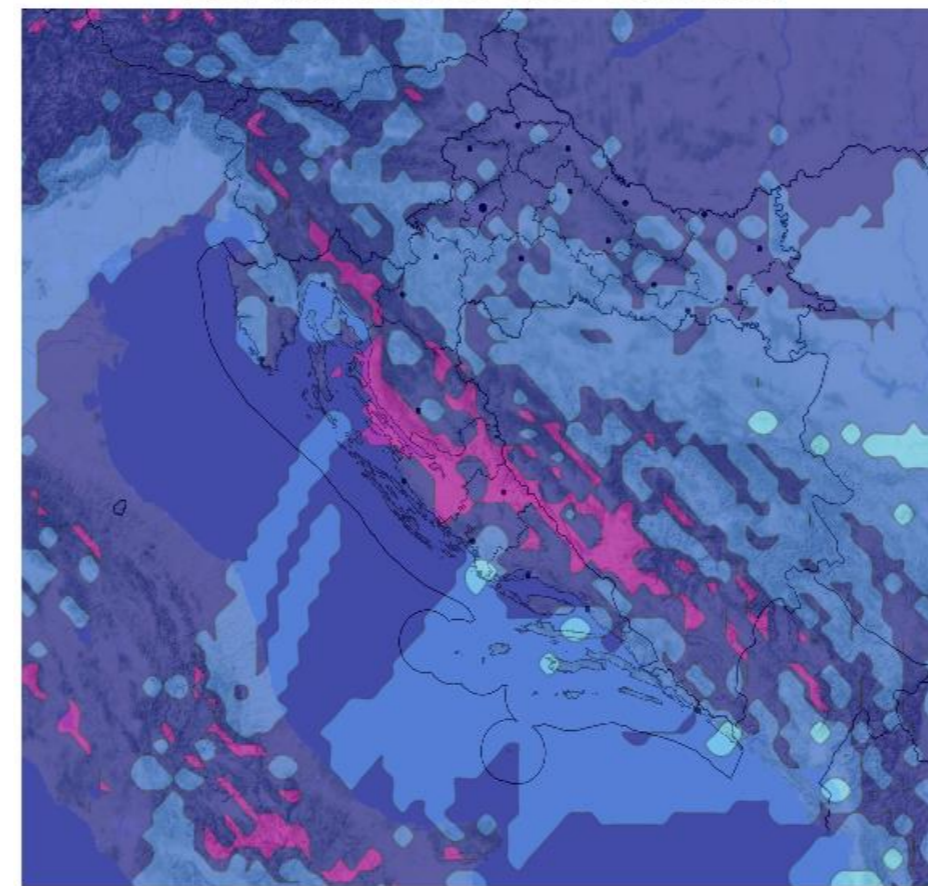


Figure 3. UTCI values in physiological stress categories over Croatian domain for case of strong bora wind.

- Observed - cold and cloudy. At the Adriatic coast very strong bora wind with gale gusts
- UTCI forecast (Fig. 3) shows very strong cold stress in areas with highest wind speed
- Fig. 7 shows very strong cold stress (next to last cold category) for UTCI at station Knin and coldest thermal comfort category for PET and TCI

Strong jugo wind

28.-30.12.2020.

UTCI [physiological stress categories]

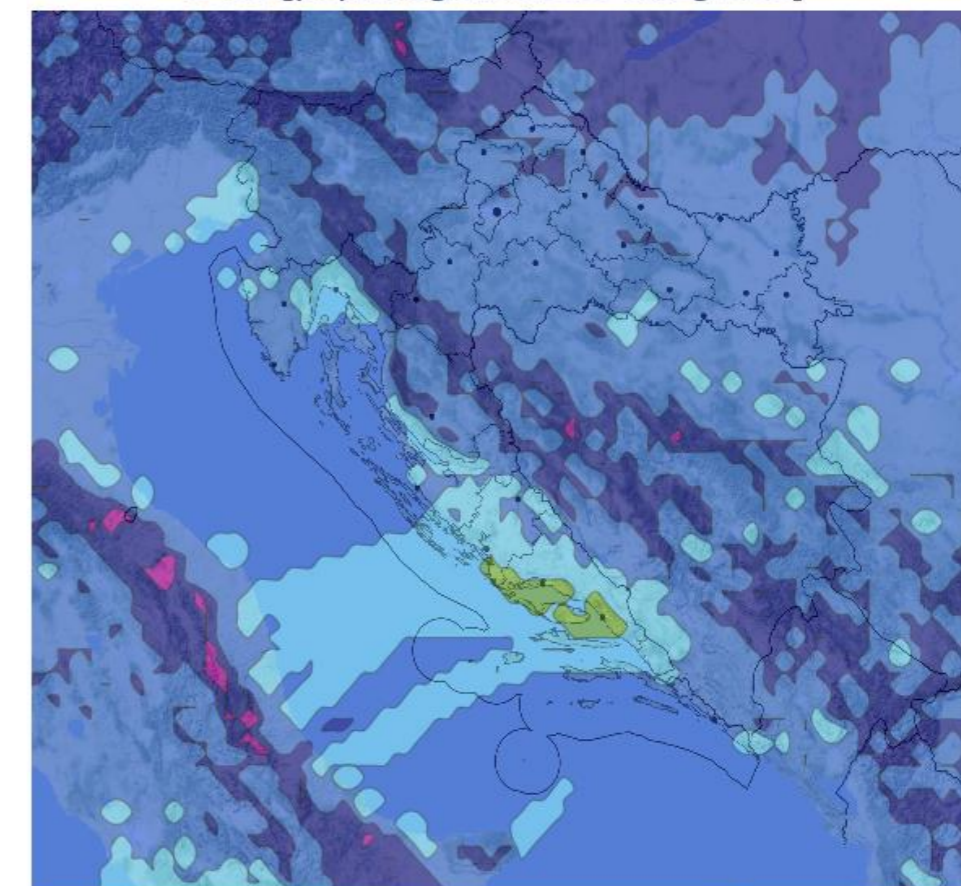


Figure 4. UTCI values in physiological stress categories over Croatian domain for case of strong jugo wind.

- Observed - cloudy with occasional rain and snow in the mountains and at the Adriatic gale strength jugo wind
- UTCI forecast (Fig. 4) shows warming of the islands and the coast at south of Adriatic
- Fig. 8 shows strong cold stress for conditions of 17.6 m/s wind speed, 13.3 °C temperature, 71.3% relative humidity and 10.5 °C mean radiant temperature

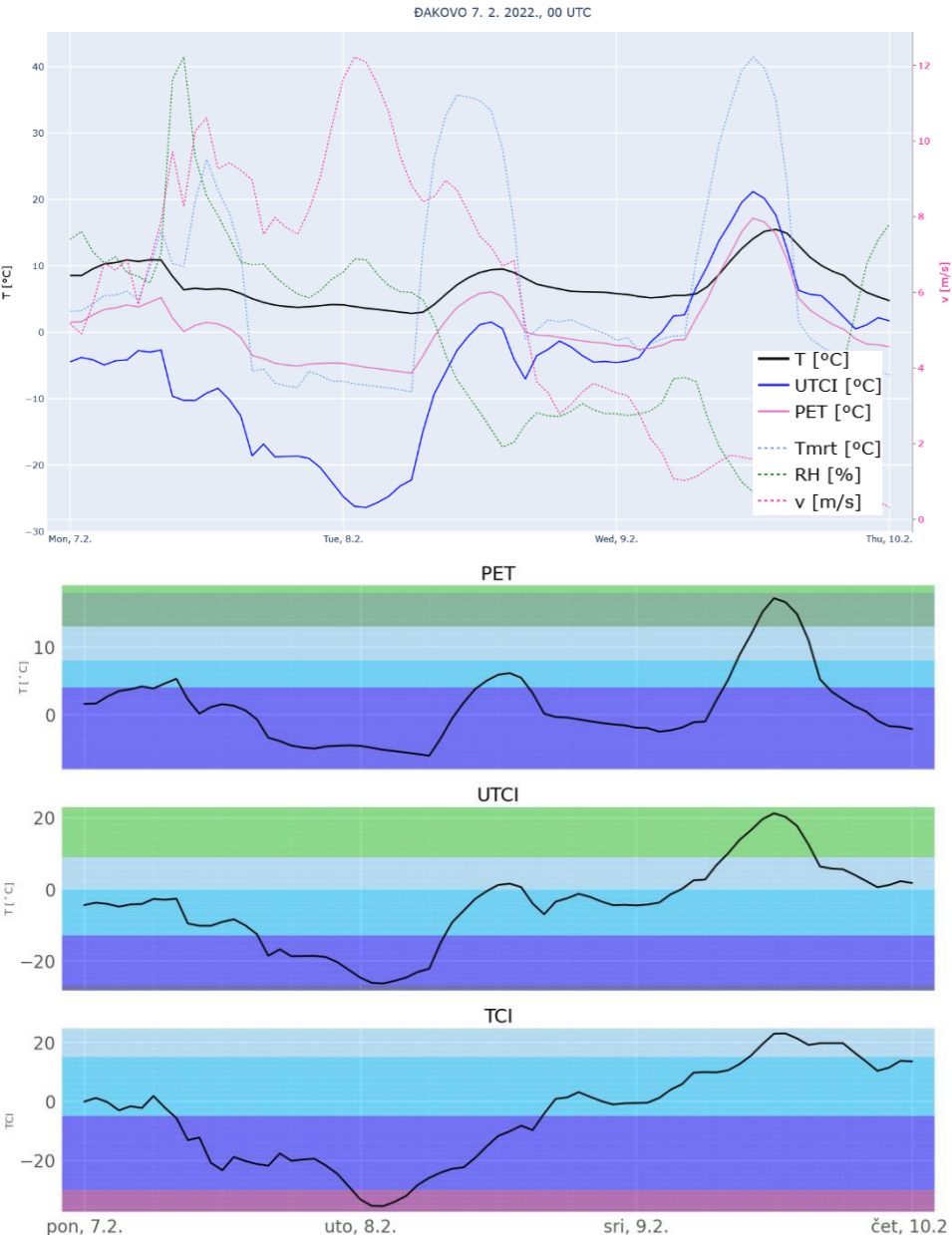


Figure 5. 72 h forecast of UTCI and PET with input variables (up), and UTCI, PET, TCI in thermal comfort categories (down) for station Đakovo

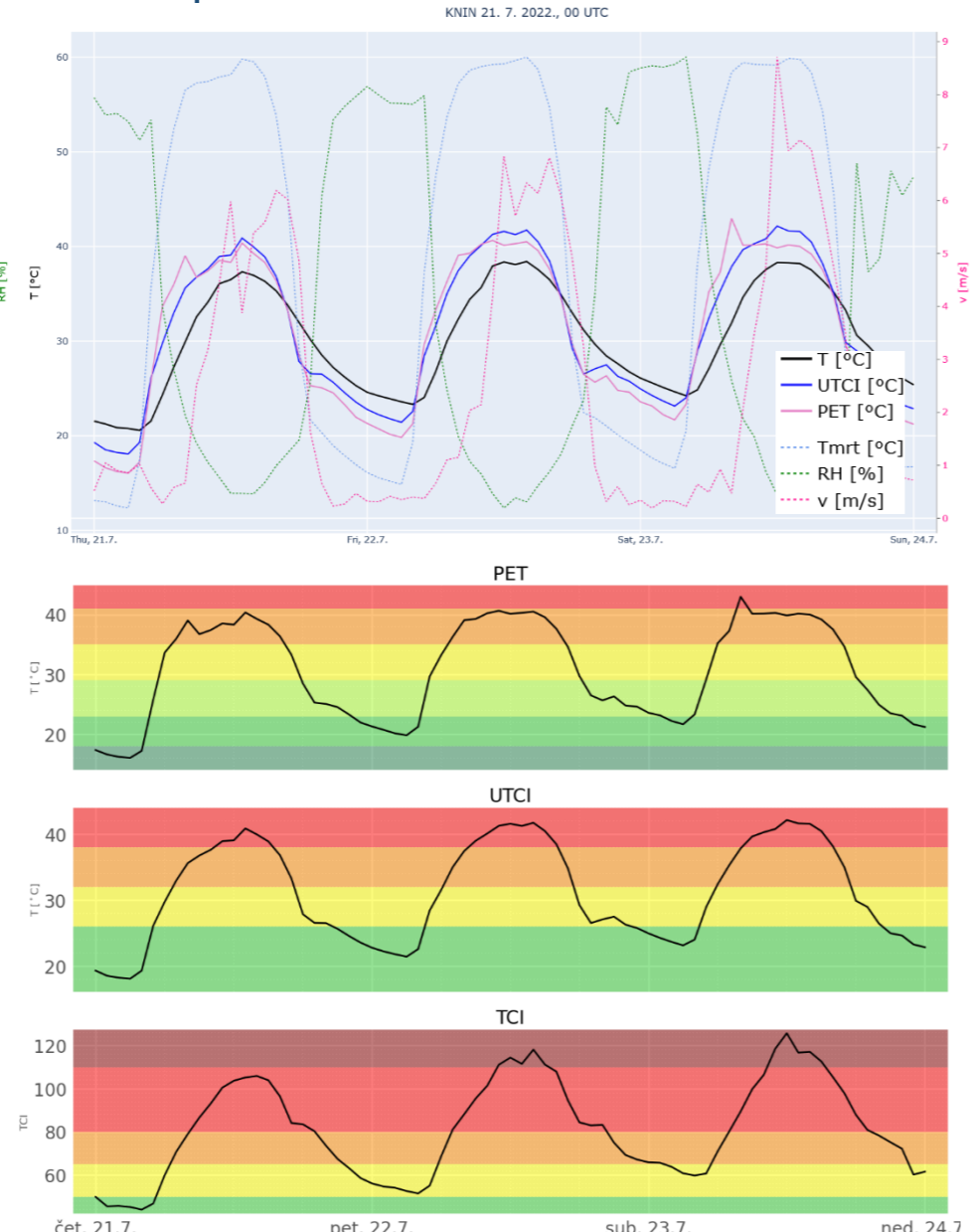


Figure 6. 72 h forecast of UTCI and PET with input variables (up), and UTCI, PET, TCI in thermal comfort categories (down) for station Knin

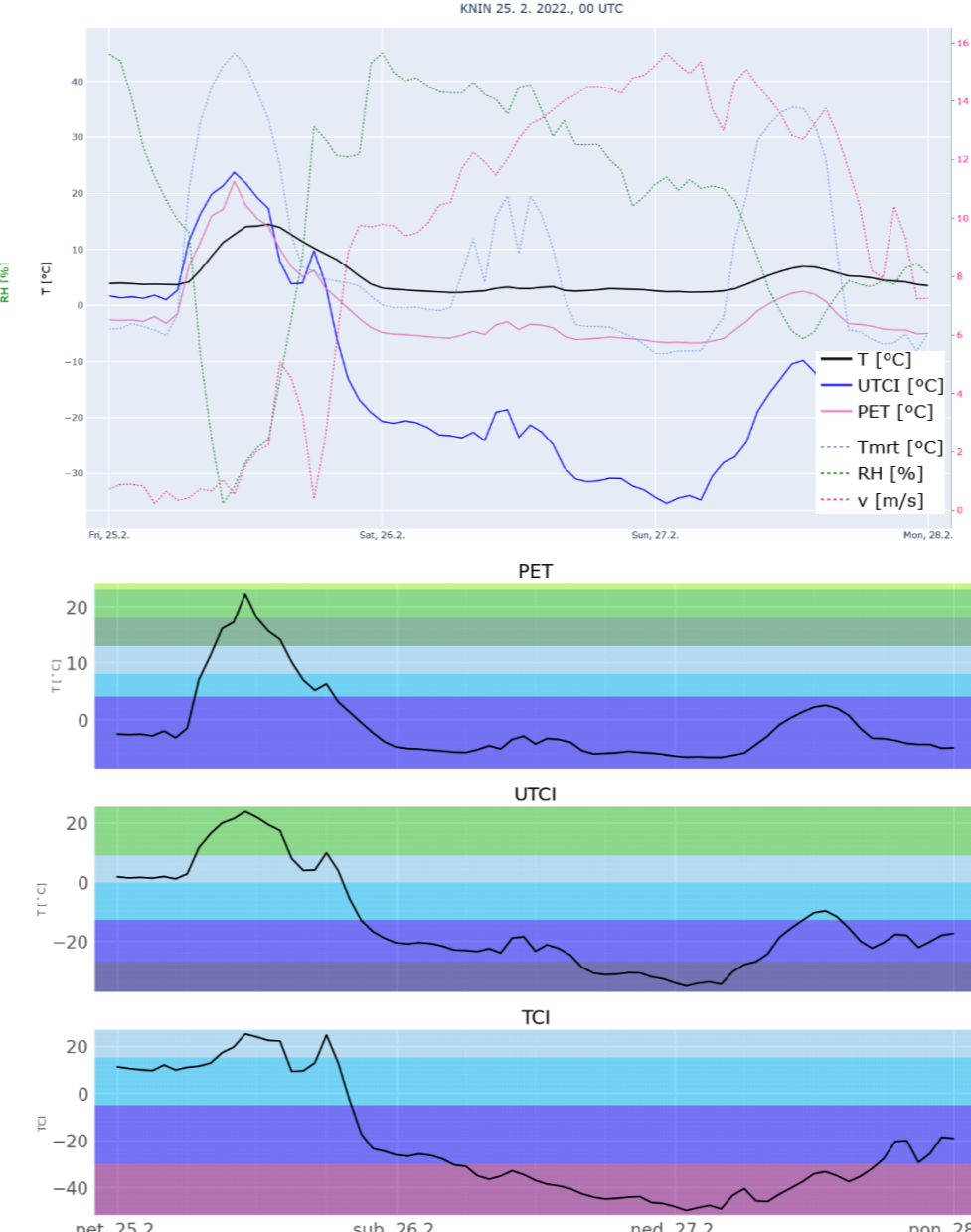


Figure 7. 72 h forecast of UTCI and PET with input variables (up), and UTCI, PET, TCI in thermal comfort categories (down) for station Knin

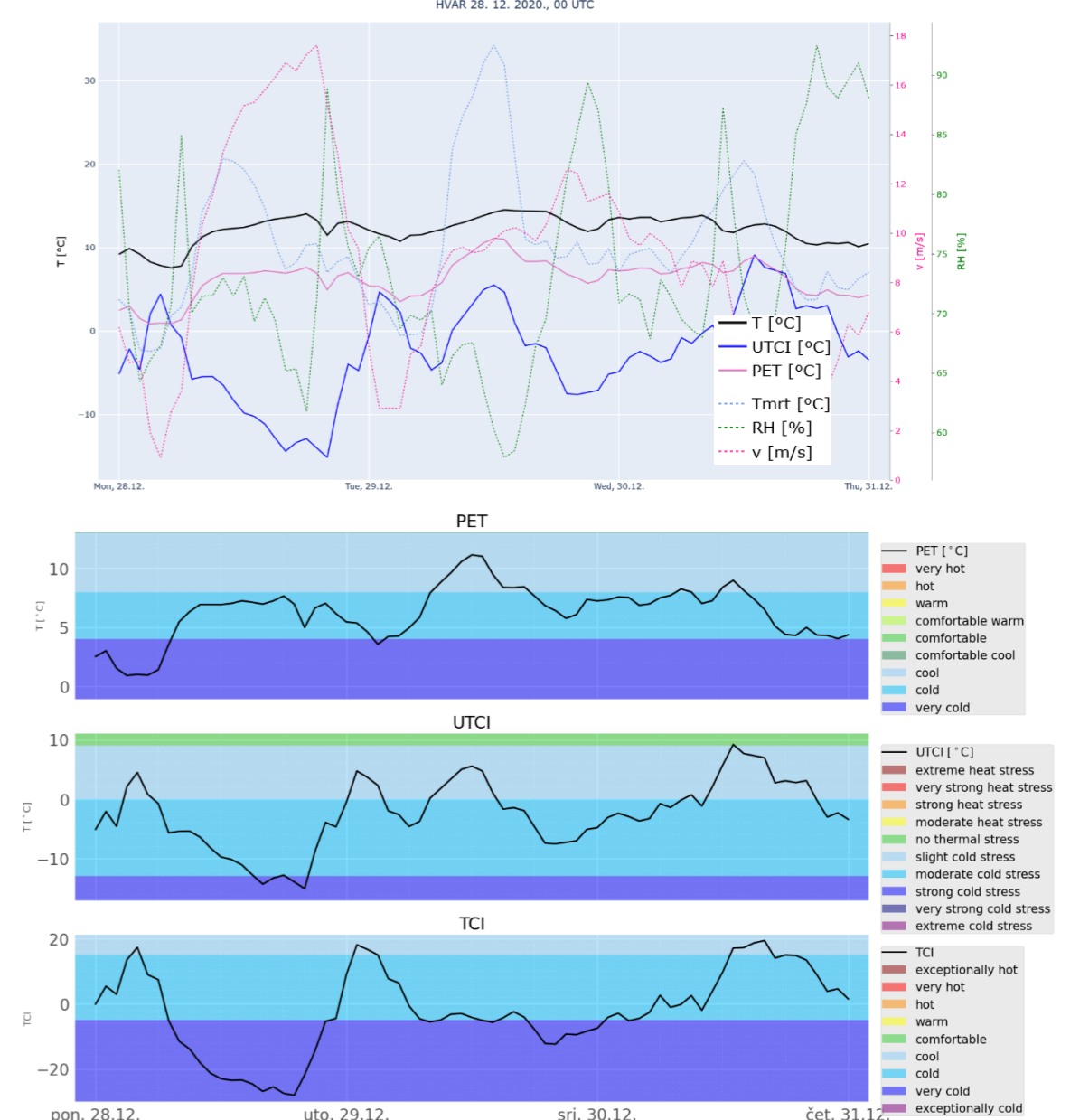


Figure 8. 72 h forecast of UTCI and PET with input variables (up), and UTCI, PET, TCI in thermal comfort categories (down) for station Hvar

CONCLUSION:

- Comparison of heat stress/thermal comfort categories to which UTCI, PET and Thermal comfort index values correspond to shows good agreement between indices – UTCI is not in last coldest/hottest category when in comparison to PET and TCI for all cases
- UTCI values show high sensitivity to strong wind, but depending on the air temperature primarily (in cases of strong jugo and bora wind – Figs. 7 and 8)

Acknowledgement to Lidija Srncic (DHMZ)

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