The Universal Thermal Climate Index
Case Studies at Portuguese Meteorological Institute

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1- Objective

In this study some results are presented concerning the latest Biometeorological developments at the Portuguese Meteorological Institute (IM, I.P.), trough the application of "*Universal Thermal Climate Index*" developed in the frame of the COST 730 Action, (http://www.utci.org) in which this Institute participated.
This new index is specific to assess the outdoor thermal conditions in the major fields of human biometeorology, such as public weather services and civil defense planning. One of the advantages of UTCI is its assessment scale, which is measured in ºC and ranges from extreme cold stress to extreme heat stress categories.

2-Methodology

The **UTCI** index can be applied to all climates and to any spatial scale. It takes into account the exchange of heat flows and thermal regulation of the individual, reflecting a great concern in the modelling of energy balance, by considering the local thermal effects throughout the body. This index takes into account the reference activity of a moving person, being independent of the personal characteristics of each individual.

Figure 1 describes the way UTCI was developed, based on meteorological variables, the model of thermo-regulation Fiala (Fiala *et al*, 1999, 2001, 2003), and also the model developed for adaptive clothing (Richards & Havenith, 2007).

The reference terms for UTCI calculation are:

- Wind speed (v) 0.5 m / s at 10 meters height (approximately 0.3 m / s at 1.1 meters);
- Mean radiant temperature (MRT) is equal to air temperature;
- The activity (M) of a person moving with a speed of 4 km / h. This equates to a rate of metabolism of 135 W m-2;

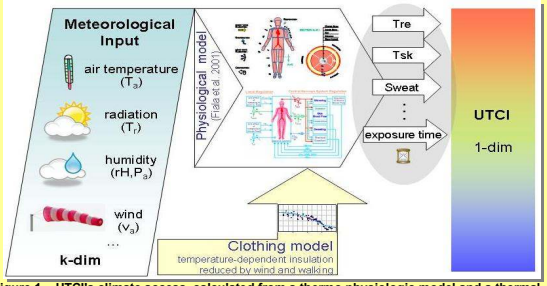


Figure 1 – UTCI's climate access, calculated from a thermo physiologic model and a thermal manikin (COST Action 730).

UTCI Equivalent Temperature (ºC)

UTCI ET (°C) range	Stress Category
above +46	extreme heat stress
+38 to +46	very strong heat stress
+32 to +38	strong heat stress
+26 to +32	moderate heat stress
+9 to +26	no thermal stress
+9 to 0	slight cold stress
0 to -13	moderate cold stress
-13 to -27	strong cold stress
-27 to -40	very strong cold stress
below -40	extreme cold stress

3 - Results

2003-2008

Meteorologic Elements	winter (09:00UTC)	summer (15:00UTC)
Air Temperature	0.71	0.97
Relative Humidity	0.56	-0.77
Wind Velocity	-0.55	-0.45
Ground Temperature	0.71	0.92
Global Radiation	0.23	0.33
Mean Radiant Temperature	0.58	0.85

Table 1 - Correlation between weather elements and UTCI winter and summer

Seasonal correlations of UTCI with meteorological elements (18 meteorological stations) are higher during summer at 15:00 UTC, when compared with correlation coefficients during winter at 09:00 UTC, excepting with wind velocity that shows a higher correlation in winter at 09:00 UTC.
UTCI has a negative correlation with relative humidity in summer (15:00 UTC) and a positive correlation in winter (09:00 UTC). In summer when the relative humidity increases, the comfort is greater. This situation can be explained because hot days may be influenced by eastern continental air masses, extremely dry. When occurs the penetration of maritime air in the mainland territory, with high moisture content, in particular in situations of extreme heat (UTCI high) the UTCI values drop and raises the human comfort.

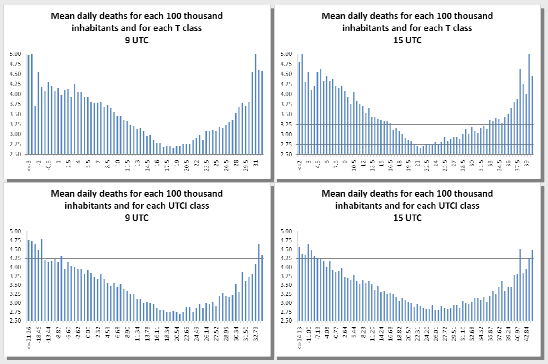


Figure 2 - Mean Daily Deaths for each 100 thousand inhabitants concerning T and UTCI class (9 UTC and 15 UTC).

Figure 2 shows the histogram of mean deaths for each 100 thousand inhabitants and for each air temperature class and UTCI class. The UTCI shows a U shape graphic which is in more accordance with the literature than the temperature U shape graphic. The comfort zone is around 22° C corresponding to a minimum of mean deaths.

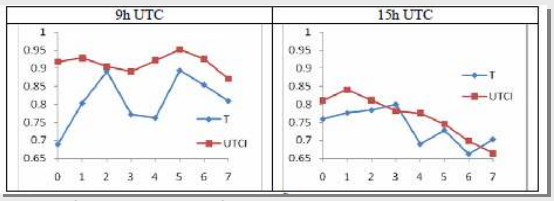


Figure 3 - Correlations between UTCI values and average lagged deaths.

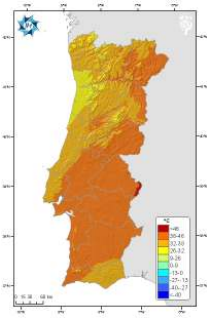
Correlations between UTCI values and average lagged deaths (Figure 3) exhibit a more consistent behavior and closer to what is referred in the literature than the correlation taking into account only the air temperature. At 9 UTC in winter, the UTCI presents a relative maximum with a one day lag and a more significant maximum for a 5 days lag. At 15 UTC in summer, UTCI presents the maximum correlation with one day lag. This is related with the fact that in cold situations the death cause is due to respiratory diseases and in hot situations is due to heart diseases.

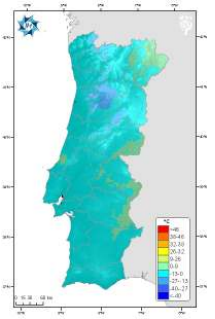
Heat and Cold Stress Case Studies

UTCI ET (°C) range	Stress Category	%
above +46	extreme heat stress	7.4
+38 to +46	very strong heat stress	56.9
+32 to +38	strong heat stress	30.3
+26 to +32	moderate heat stress	5.2
+9 to +26	no thermal stress	0.2

Heat wave

29 th july to 14 th august 2003





UTCI ET (°C) range	Stress Category	%
+9 to +26	no thermal stress	0.1
+9 to 0	slight cold stress	18.6
0 to -13	moderate cold stress	77.8
-13 to -27	strong cold stress	3.5

Cold wave

11 th to 17 th december 2007

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