

European Extreme Events Climate Index: brief notes about the input dataset and the components' definition

The European Extreme Events Climate Index (E³CI) is a “in progress experiment” to define a synthetic index aimed at providing information about the areas affected by different types of weather-induced hazards and the severity of such events. Currently, based on the corresponding index developed for North America (Actuaries Climate Index, ACI; actuariesclimateindex.org), five components returning information about main hazards are included: cold and heat stresses, droughts, heavy precipitations, intense winds. The data will be made available on different Administrative unit levels; currently, data at Country level are produced.

The assessment of the components exploits ERA5 (Herbasch et al., 2020¹;doi:10.24381/cds.adbb2d47), the fifth-generation atmospheric reanalysis produced by European Centre for Medium-Range Weather Forecasts [ECMWF] (<https://youtu.be/FAGobvUGl24>). ERA5 covers the entire Globe on regular latitude-longitude grids at 0.25° x 0.25° resolution from January 1950 to present. Hourly data on many atmospheric parameters together with estimates of uncertainty are available on Climate Data Store of Copernicus Climate Change Service [C3S]. ERA5 is updated daily with a latency of about 5 days permitting a constant update of the components forming E³CI.

For each component, an indicator is used as proxy for several hazards. The reference value is computed on 1981-2010 time span while, at monthly basis, a standardized anomaly respect to the reference value is computed.

For what concerns the five components, they are defined as follows:

i) HEAT STRESS

BASELINE CALCULATION: On the reference period 1981-2010, for each calendar day, the maximum temperature of the surrounding five days is considered. The 95th percentile among the 150 values (5 days x 30 years) is computed and assumed as threshold. For each month j , the mean value $\mu(j, T_{max})$ and the standard deviation $\sigma(j, T_{max})$ of the number of days exceeding the corresponding threshold are calculated.

STANDARDIZED ANOMALY COMPUTATION: Each month j and year k , the number of days exceeding the corresponding threshold ($HS_{j,k}$) is standardized according to the formula:

$$HS_{std,j,k} = \frac{HS_{j,k} - \mu(j, T_{max})}{\sigma(j, T_{max})}$$

ii) COLD STRESS

BASELINE CALCULATION: On the reference period 1981-2010, for each calendar day, the minimum temperature of the surrounding five days is considered. The 5th percentile among the 150 values (5 days x 30 years) is computed and assumed as threshold. For each month j , the mean value $\mu(j, T_{min})$ and the standard deviation $\sigma(j, T_{min})$ of the number of days lower than the corresponding threshold are calculated.

STANDARDIZED ANOMALY COMPUTATION: Each month j and year k , the number of days lower than the corresponding threshold ($CS_{j,k}$) is standardized according to the formula:

¹ Hersbach H, Bell B, Berrisford P, Hirahara S, Horányi A, Muñoz-Sabater J, Nicolas J, Peubey C, Radu R, Schepers D, Simmons A, Soci C, Abdalla S, Abellan X, Balsamo G, Bechtold P, Biavati G, Bidlot J, Bonavita M, Chiara G, Dahlgren P, Dee D, Diamantakis M, Dragani R, Flemming J, Forbes R, Fuentes M, Geer A, Haimberger L, Healy S, Hogan RJ, Hólm E, Janisková M, Keeley S, Laloyaux P, Lopez P, Lupu C, Radnoti G, Rosnay P, Rozum I, Vamborg F, Villaume S, Thépaut JN (2020) The ERA5 global reanalysis. Q. J. R. Meteorol. Soc 146(730):1999–2049. <https://doi.org/10.1002/qj.3803>

$$CS_{std,j,k} = \frac{CS_{j,k} - \mu(j, T_{min})}{\sigma(j, T_{min})}$$

i) DROUGHT

BASELINE CALCULATION: Standard Precipitation Index (SPI) ² is assumed as reference indicator considering 3 months as accumulation period of interest (SPI-3). Over 1981-2010, for each month j , the 30 cumulated values are fitted to a gamma probability distribution which is then transformed into a normal distribution.

STANDARDIZED ANOMALY COMPUTATION: For each month j and year k , $SPI - 3_{j,k}$ value represents units of standard deviation from the long-term reference mean. According to the canonical approach, positive SPI indicate values greater than median precipitation and negative values indicate less than median precipitation. In E³CI, to maintain the consistency with the other components, the opposite of $SPI - 3_{j,k}$ is taken.

iv) EXTREME PRECIPITATION

BASELINE CALCULATION: On the reference period 1981-2010, for each month j , the 95th percentile of daily precipitation is computed. Then, the exceedance value at monthly basis is computed as:

$$EP_{j,k} = \sum_{i=1}^{n_j} \max[0; P_{i,j,k} - P_{95,j}]$$

where $P_{i,j,k}$ represents the daily precipitation (day i , month j , year k)

Over the reference period, for each month j , the mean value $\mu(EP_j)$ and the standard deviation $\sigma(EP_j)$ of the exceedance value are calculated.

STANDARDIZED ANOMALY COMPUTATION: Each month j and year k , the exceedance value is standardized according to the formula:

$$EP_{std,j,k} = \frac{EP_{j,k} - \mu(EP_j)}{\sigma(EP_j)}$$

v) EXTREME WIND

BASELINE CALCULATION: On the reference period 1981-2010, for each month j , the 95th percentile of daily maximum wind speed is computed, $w_{95,j}$. Then, at monthly basis, Local Loss Index (LLI, Donat et al., 2011; doi:10.5194/nhess-11-1351-2011) is calculated as:

² McKee, T.B., N.J. Doesken and J. Kleist. 1993. The relationship of drought frequency and duration to time scale. In: Proceedings of the Eighth Conference on Applied Climatology, Anaheim, California, 17–22 January 1993. Boston, American Meteorological Society, 179–184. Edwards, D.C. and T.B. McKee. 1997. Characteristics of 20th Century Drought in the United States at Multiple Time Scales. Climatology Report Number 97-2. Colorado State University, Fort Collins.

$$LLI_{j,k} = \sum_{i=1}^{n_j} \max \left[0; \left(\frac{w_{max,ij,k}}{w_{95,j}} - 1 \right)^3 \right]$$

Where $w_{max,ij,k}$ is the maximum wind speed computed considering mean hourly values. Over the reference period, for each month j , the mean value $\mu(LLI_j)$ and the standard deviation $\sigma(LLI_j)$ are calculated.

STANDARDIZED ANOMALY COMPUTATION: Each month j and year k , the exceedance value is standardized according to the formula:

$$LLI_{std,j,k} = \frac{LLI_{j,k} - \mu(LLI_j)}{\sigma(LLI_j)}$$

vi) E³CI

For each month j and year k , the European Extreme Events Climate Index is given by the mean of the different components. Different and more effective formulations are currently under development.