Heat Waves indicators

Definition : Due to the chaotic nature of the atmosphere, forecasting of the chronology of heat waves is not possible at seasonal scale. This product is rather based on a detection of heat wave events (period of at least 3 consecutive days over a threshold) : the number of heat wave days over a 3-month period is compared to its climatology.

Product description : the calculation is done on each grid point separately, and on each run of the ensemble forecast. The climatology is obtained by computing the number of days on the hindcast of the seasonal forecast model. We then draw three kind of maps :

- maps of the ensemble mean anomaly : difference between forecast and climatology, in number of days. So positive pixels correspond to areas where the model forecasts more heat wave days then in the climatology.
- Probabilities of the 67th percentile (highest tercile)
- percentage of runs above the 80th percentile (highest quintile)

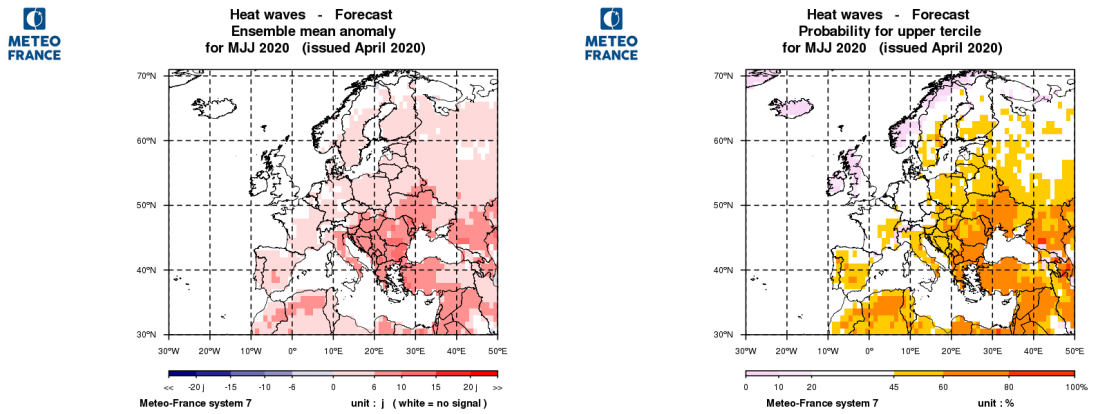


Figure 23 : Examples of the heat wave products for the MJJ 2019 forecast (initialisation month : April) : ensemble mean (left) and probability of the higher tercile (right).

Specification :

- **Geographic region**: NW Corner 70.5N/30W ; SE Corner 30N/40.5E
- **Temporal resolution:** Quarterly
- **Availability:** Each month
- **Format:** gif graphs
- **Units:** number of days or probability (%)

Data origin

- Seasonal Forecast Model MF Syst 7 and ECMWF-SEAS5
- Forecast mode with 51 runs
- Climatology : Hindcast period (1993-2016 for MF-S7 for instance)
- Daily mean surface temperature from the ERA5 reanalysis is used for the model temperature correction.

Methodology :

- Correction of the model data: Before proceeding to the heat wave diagnostic, daily mean surface temperature must be corrected. The method chosen is quantile-mapping, with ERA5 daily 2-meter temperature (T2M) as a reference.

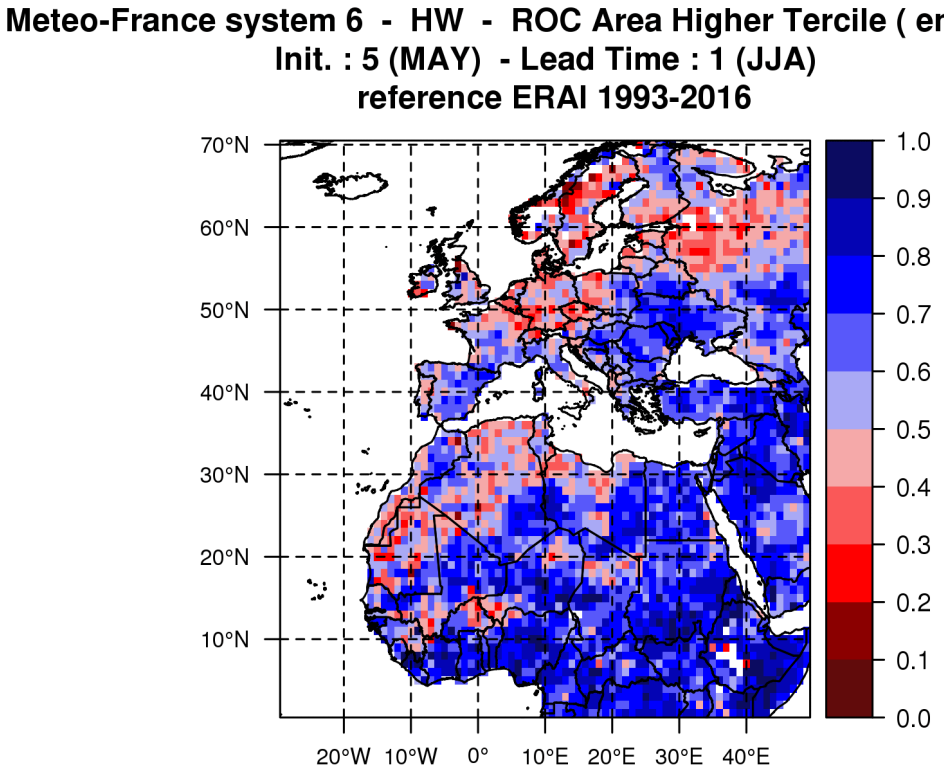
- Diagnostic of heat wave occurrence: for each grid point and each day, a heat wave is detected if the corrected T2M is above the daily 90^{th} percentile AND a fixed 20°C threshold, during at least 3 consecutive days. The 20°C threshold has been added in order not to detect heat waves in cold or mountain regions where the 90^{th} percentile is particularly low.

The number of heat wave days per season is computed, for each grid point, for all the runs over the hindcast period. Based on these heat wave days, some statistics are calculated : mean, 67^{th} and 80^{th} percentiles.

Performance : The performance of the product is estimated by using the same scores as the one used for any other parameters. They are calculated for each grid point. See below an example with MF-S6 .

For perfect forecasts, all ensemble members will correctly predict the event in all years and the ROC points will be normalised to 1.0, the maximum possible value. Forecasts with no skill will obtain a normalised ROC score lower than 0.5 (value obtained by a random forecast).

Globally the skill is better in Southern Europe (blue colour) than Northern Europe (red colour). And it is comparable to temperature's.



ROC score for the number of heat wave days (upper tercile) with MF-S6 hindcast (init May)

Recommended use : The interest of this product is to focus on extreme event, much more relevant than mean temperature for number of activities.

The using of these products has to take into account the level of predictability, variable and quite poor according to the regions.

Acknowlegdments : the development of this product was supported by the Copernicus Climate Services (C3S)