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ADAPTATION TO HEAT WAVES OCCURRENCE IN FRANCE[1]

R. Juvanon du Vachat[2], S. Planton[3], M. Gillet[4]

Abstract

During the summer 2003 a very intense heatwave occurred in France, with an exceptional duration. That exceptional event has caused a very great number of fatalities (about 15 000 for the first three weeks of August). After such an extreme event, a great number of studies and reports have investigated the origin of these "summer 2003" deaths, as well as other past heatwaves (1976, 1983, 1994). First the meteorological characteristics of such event are presented and we discuss its predictability at different ranges from some days up to two or three months (seasonal predictability). Then we compare this summer large-scale situation with three previous heatwaves (1976, 1983, 1994), which have occurred in France. The main conclusions of this meteorological analysis is that the summer 2003 heat wave is the hottest since at least 1880, and exceptional by the area concerned. Due to its very low predictability it is important to advice people of such an occurrence. A great number of reports have been written trying to determine the reason why a so huge number of fatalities occurred. A summary of these studies is given. They also include a whole analysis of the sanitary crisis. In such a case investigation of past heat waves is also very useful. Finally we present the "Plan Canicule" set up to prevent the consequences of such an heatwave in the future. Such an alert system is put in coherence with the vigilance map, used to alert people and authorities and developed after the two strong wind storms, which occurred in France in december 1999. At last a conclusion is given concerning the lessons learned by the occurrence of such an extreme event, in the frame of the strategy of the Observatoire National des Effets du Réchauffement Climatique (ONERC, french observatory of the impacts of climate change).

1. Meteorological and climatological analysis

When considering the summer period (June, July, August) from 1880 up to 2003, the year 2003 appears approximately 4°C higher than the average, concerning maximum temperatures as well as minimum or average ones. This is an unprecedented event over this period. Also the extent in France of such an heat wave appears largest, as compared to the previous heat waves. For example, about half of the surface of France has been concerned with maximum temperature greater than 35°C during ten days for the period (08/01/2004 to 08/18/2004). Then with a threshold of 40°C for maximum temperature, we find approximately 25% of the surface of France during at least 2 days of occurrence. See Figure 1 for details.

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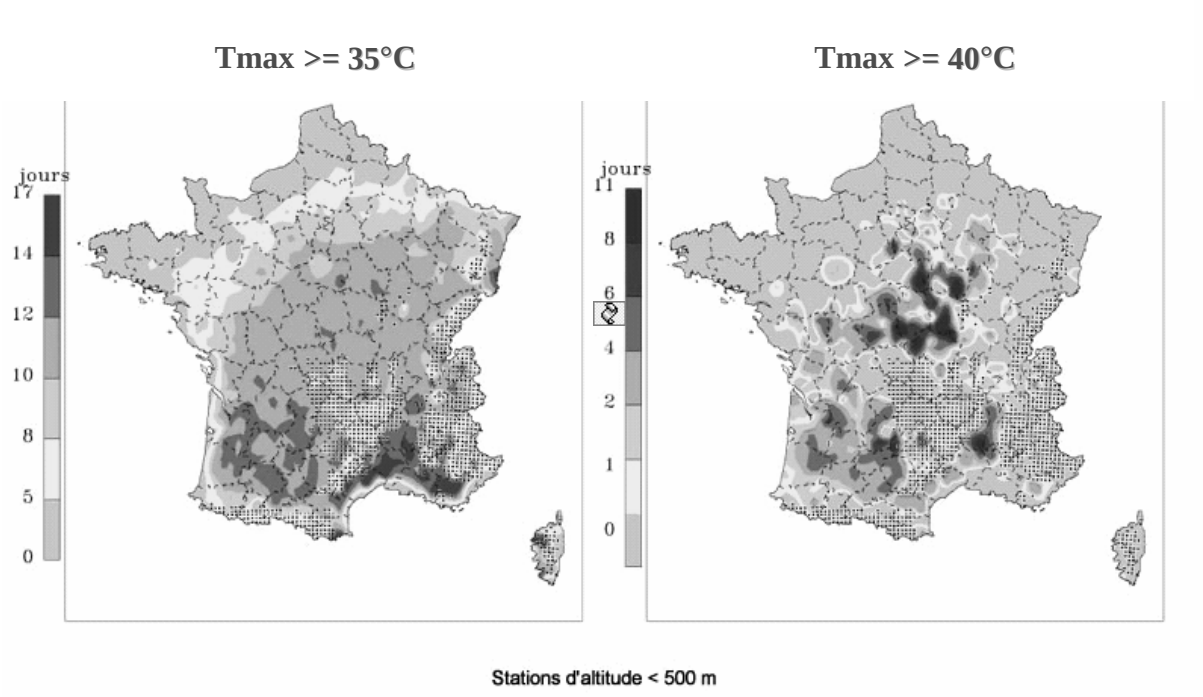
Figure 1 : Number of days with Tmax > 35°C , Tmax > 40°C Period from 08/01/2003 to 08/18/2003



Clearly this heatwave is exceptional by its intensity, duration and extent. These three factors had caused catastrophic health consequences. The importance of the area concerned by this event can also be compared with the analogous area of previous heat waves, which have occurred in 1976, 1983, 1994. If we consider the 850 hPa surface (about 1500 m altitude) and the temperature anomaly computed with the climatology (from ERA-40, European Re-Analysis for the period 1958-2002), a very large hot spot of 4°C occurred in 2003, covering the whole surface of France. That situation is quite different from that observed in the three previous cases (1976, 1983, 1994), when a smaller area was concerned by this 4°C temperature anomaly.

Another important feature can be mentioned concerning the statistical distribution of this event and its relation to the normal climatology, which is crucial for adaptation capacity. Over more than half of France, night minimum temperatures were more than 5°C above normal during the period 4-13 August, and maxima were more than 10°C above normal over the whole of metropolitan France, except for coastal areas in the south-east. Temperatures above 40°C were observed at about 15% of stations, and on 12 August, two stations measured 44,1°C, an absolute record for any station in France (Cornford, 2004; Bessemoulin et al., 2004).

1.1 *Short range and seasonal prediction*

A careful analysis of the prediction of surface temperature T(2m) has been investigated by Grazzini et al. (2003), using the european forecasting model (ECMWF), which can be considered as the best over the world, and which gives forecasts at various ranges from 24h up to ten days. The conclusion is the following for the Chartres station, taken as an example. First we consider the hottest period as running from the 5th up to the 14th of august. This period is defined by the two simultaneous criteria : Tmax greater than 35°C and Tmin greater than 20°C. At this point it is important to mention that the deaths during heat

waves are generally due to an occurrence of two or three days with high daily minimum temperature (Besancenot, 2002), in which case the body cannot rest from the hot days. Then forecasting of the beginning could be done only two days before, but forecasting of the end could be done five days before (Figure 2). So the short range predictability appears very low but may be sufficient to prevent some consequences of such an event. In addition we are led to consider seasonal predictability of a very hot summer (André et al., 2004). Some trials have been done in the main centres (ECMWF, Meteorological Office, IRI) developing such a technique by different methods, leading to the conclusion that ECMWF could have predicted such an anomaly of temperature three months in advance, but not consistently since it was not predicted one month in advance; Météo-France, which makes seasonal predictions (but not publically released) has experienced a similar result.

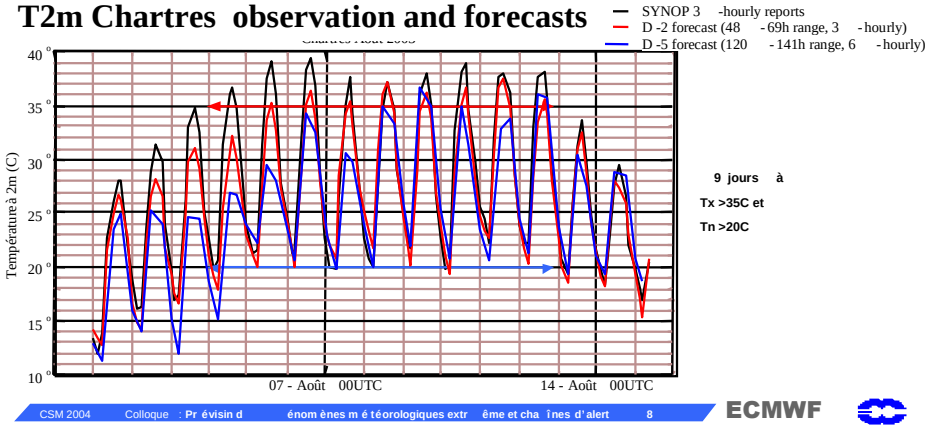


Figure 2 : The "canicule" period defined by Tmax > 35° C and Tmin > 20° C, begins on the 5th of August and ends on the 14th (———).

Forecasting of the beginning could be done only 2 days before (———) ;

Forecasting of the end could be done 5 days before (———).

(Courtesy F. Lalaurette, ECMWF)

The question whether the 2003 heat wave is a sign of climate change is often risen. But, this question is ill-posed since one isolated event cannot be representative of a climatic trend that can only be evaluated through statistics on an ensemble of events. However, climate simulations suggest that such an event could occur much more frequently by the end of this century as a result of human-induced greenhouse warming. As an example, a climate change scenario simulation performed with the Météo-France regional climate model (Gibelin and Déqué, 2003) shows that the probability of temperatures greater than 35° C might be multiplied by a factor from five to ten over the main part of France, at the end of XXIth century. In addition, this simulation shows, in accordance with a study concerning Switzerland (Schär et al., 2004), that summers as hot or hotter than 2003 summer could occur once every two years after 2050 (Déqué, personal communication).

A general conclusion can be drawn from these climatological and forecasting studies. For the period running from the first of june to the 31st of august, the year 2003 is the warmest ever recorded in France. The warming is singular by its amplitude and its extension over France, but also in terms of probability distribution. The hottest period appeared to be predictable only few days in advance. But if the

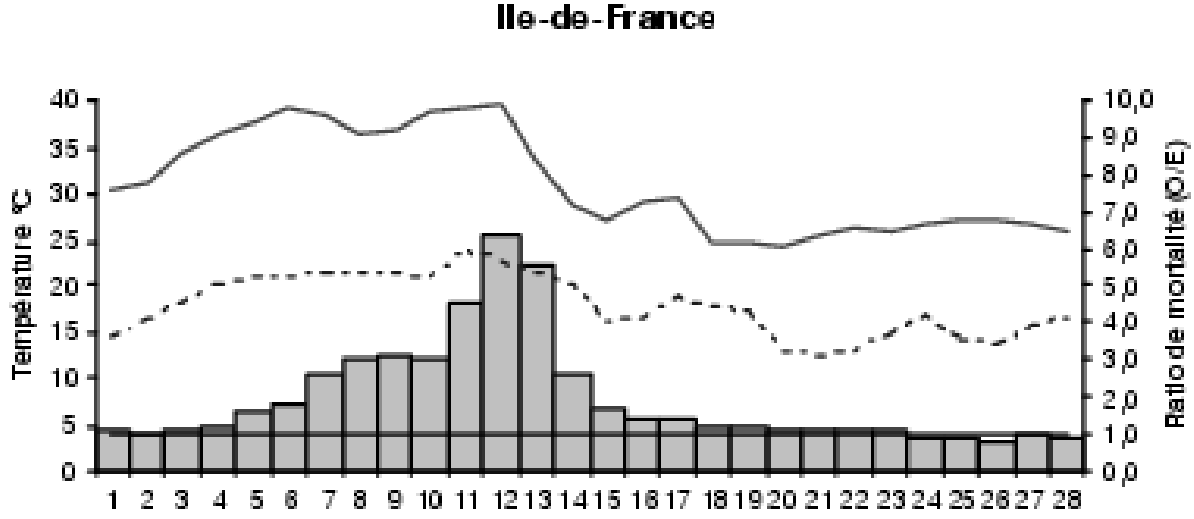
2003 heat wave is not a sign of climate change, it appears to be representative of what could occur much more frequently in the future. It is thus necessary to define adaptations measures to heat waves occurrence.

1.2 *Studies of past heat waves and reports*

Because of the great number of fatalities, the different institutions in charge of health (DGS, InVS, INSERM) have investigated the reason why such a great number of deaths has occurred in relation with the summer 2003 heat wave. We can quote the reports by InVS (29 August 2003), followed by INSERM (25 September 2003). Then appear other reports by local authorities (Ville de Paris, November 2003) and national assemblies (Sénat, 3 February 2004; Assemblée Nationale, 3 March 2004). These reports have given the matters to develop health action plans at different level (national or local) and also for the different hospitals or old people's houses. These plans were prepared in May, June 2004 to become operational on first of June 2004 (see next paragraph).

We just give an example of such a work by INSERM for illustration. So Hémon et Jougla (INSERM) presented on the same graphics the evolution of minimum (and maximum) temperature together with the overmortality (ratio of observed over estimated one) in various towns in France. We can see on these curves (Figure 3) the correlation with the increase of temperature, simultaneously with the overmortality. This correlation is especially visible when passing from 11 to 12 August, when a severe case of extramortality occurred particularly in Ile-de-France district with high levels of minimum temperature (Rousseau, 2004). As already mentioned, this is the obvious reason of death, because people cannot rest from the hot days, especially when these high levels persist two or three days (Besancenot, 2002).

Figure 3 : August 2003 temperature and mortality over Ile-de-France (INSERM, 2004)



Finally when we consider the summer 2003 heat wave and the regional distribution of the overmortality, it can be noticed that in the South France this ratio is not so important, due to a natural adaptation to the heat. But it must also be said that Marseille, as an example has used with success the experience of the 1983 heat wave (cf. the work by Prof. San Marco, see Thirion et al., 1992).

1.3 *"Plan national canicule"*

It is the national heat wave plan, which is made up of four levels of information or alert, towards general public and health authorities. At the first level we simply have a seasonal survey for the summer period (from 1 June to 30 September) to check up the different action plans and to inform the public for prevention. At the level 2, we mobilize public services from local to national scales when an overtaking of bio-meteorological thresholds is forecasted for the next three days. At level 3, we apply medical and social measures when a heat wave is occurring. If the heat wave is extending and lasting (level 4) exceptional measures are applied. This four levels alert system has been established by the Institut de Veille Sanitaire (InVS) and Météo-France to alert authorities with 3-days anticipation. The method for defining the threshold in case of level 2 is the following. A biometeorological indicator has been computed from a combination of daily minimum and maximum temperatures averaged over 3 days. Then a map of threshold values of this indicator for a given overmortality percentage has been drawn. As a consequence the level 2 is activated when forecasted indicators (one, two or three days in advance) overtake the threshold values.

1.4 *General conclusion*

This paper has presented the first adaptation measures to heat wave occurrence. It is a combination of decision levels from local to national with a national coordination. There is also a combination of anticipation levels from very short term (medical and social measures), to short term (3-days anticipation of heat waves) and to long term (prevention by public information). This has been considered as a mean of adaptation to climate change (Colloquium ONERC, 29 september 2004, to appear). Even if the summer 2004 was not hot, similar heat waves can occur in the future and it is necessary to be prepared to such event. In a similar way an action plan has been developed for cold spell during winter, with a collaboration between Météo-France and InVS and also using an alert system.

As a final conclusion it must be mentioned that due to the great number of fatalities of this summer 2003 heat wave, many works have been done and many reports have been written. One can especially mention the work by Ménard (2004), analysing the whole sanitary crisis with the different steps and the lessons which can be drawn from such a rigorous analysis. At last it can also be mentioned the hypothesis proposed by Valleron and Boumendil (2004), considering the overmortality of the summer 2003 heat wave as an "harvesting" effect. Such hypothesis suggests that death had favored people which were at any rate doomed to die soon, which has been evocated for the deaths associated with air pollution.

DGS : Direction Générale de la Santé : www.sante.gouv.fr

ECMWF : European Centre for Medium range Weather Forecast www.ecmwf.int

INSERM : Institut National de la Santé et de la Recherche Médicale www.inserm.fr

InVS : Institut de Veille Sanitaire www.invs.sante.fr

IRI : International Research Institute for Climate Prediction iri.columbia.edu

ONERC : Observatoire National des Effets du Réchauffement Climatique www.onerc.gouv.fr

REFERENCES

André J.-C., M. Déqué, Ph. Rogel et S. Planton, 2004 : La vague de chaleur de l'été 2003 et sa prévision saisonnière. Comptes Rendus de l'Académie des Sciences, Géo-Sciences, 336, 491-503.

Besancenot J.-P., 2002 : Vagues de chaleur et mortalité dans les grandes agglomérations urbaines. Environnement, Risques et Santé, 1, (4), 229-240.

Bessemoulin P., N. Bourdette, Ph. Courtier, et J. Manach, 2004 : La canicule d'août 2003 en France et en Europe. La Météorologie 8e série, 46, 25-33.

Cornford S. G., 2004 : Some socio-economic effects of high-impact weather events in 2003. WMO Bulletin 53, (3), 235-254.

Gibelin, A.-L., and M. Déqué, 2003: Anthropogenic Climate Change over the Mediterranean region simulated by a global variable resolution model. Clim. Dynam., 20, 327-339.

Hémon D. et E. Jougla, 2003 : Surmortalité liée à la canicule d'août 2003. Rapport d'étape INSERM, 59 p.

http://lesrapports.ladocumentationfrancaise.fr/BRP/034000581/000.pdf

Grazzini F., L. Ferranti, F. Lalaurette et F . Vitart, 2003 : The exceptional warm anomalies of summer 2003. ECMWF Newsletter 99, 2-8.

Ménard J., 2004 : Analyse critique de la crise sanitaire survenue en France lors de la vague de chaleur d'août 2003. Communication au Colloque « L'homme face au climat », Collège de France, 12-13 octobre 2004.

Rousseau D., 2004 : Variations régionales et chronologie des conditions météorologiques durant la canicule d'août 2003 en France comparées aux surmortalités. L'évènement météorologique de la nuit du 11 au 12 août 2003 en Ile-de-France. Submitted to « La Météorologie ».

Schär C. et al., 2004 : The role of increasing temperature variability in European summer heat-waves. Nature, 427, 332-336.

Thirion X., J. Simonet, F. Serradimigni, N. Delmas, R. Simonin, S. Morange, R. Sambuc, J.-S. Marco, 1992 : La vague de chaleur de juillet 1983 à Marseille. Enquête sur la surmortalité – essai de prévention. Santé publique, 1, 58-64.

Valleron A.J. et A. Boumendil, 2004 : Epidémiologie et canicules: analyses de la vague de chaleur 2003 en France. Comptes Rendus de l'Académie des Sciences, Biologies, 327, 1125-1141.