Infra-Synoptic High Impact Events, ...the Forecaster's Obsessive Fear.

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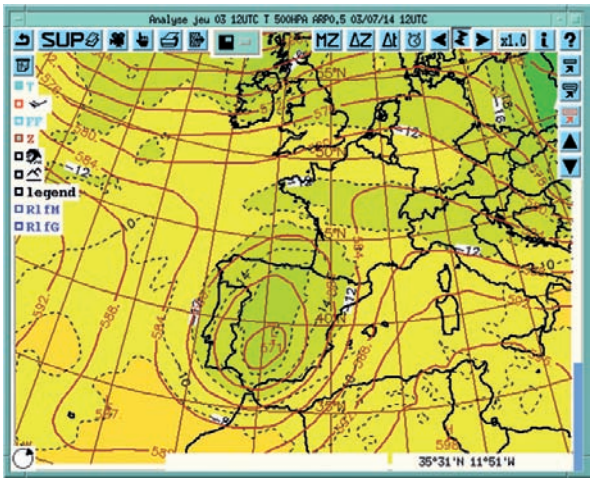
Introduction

Forecast errors are inherent elements of the forecaster's job. Some are inevitable. Some are unimportant. But some are fraught with consequences and make a deep impression. Nowadays the "synoptic" scale is widely under control. Numerical weather prediction models have become remarkably powerful, for the short range at least. Synoptic elements then often take all our attention; the "mesoscale" is sometimes put aside and remains a challenge. During the last few years, as a forecaster, I have been witness to several situations where violent small scale phenomena had a national impact. In some cases, these events were not anticipated and called into question the role of the forecasters. In this short article, a recent situation is described and issues raised by the events are discussed.

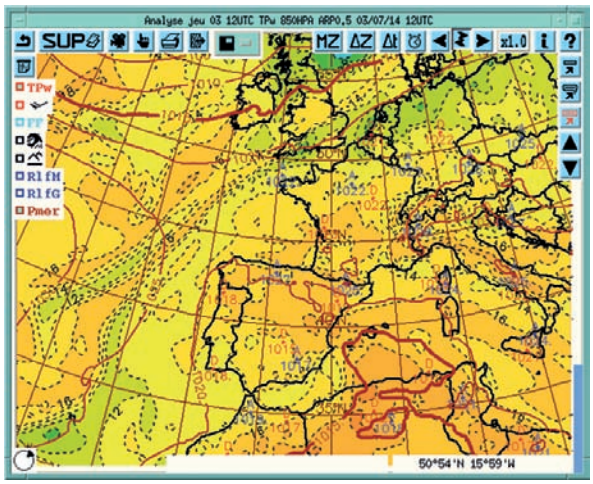
Scenario:

The situation took place in the summer of 2014. On Thursday, 3d of July, around midday, a cut-off low was situated over Iberia (Figure 1). At lower levels, a "barometric marsh" was spreading over a large part of Western Europe with warm air (Figure 2). It was mostly dry over France at that time except over the southern regions. Instability developed over Spain in response to diurnal heating and the presence of cold air in the mid and upper levels. Showers, thunderstorms and lightning were observed. Because of southerly flow, clouds and rain were crossing over the Pyrenees and were reaching the south western part of France in the evening (Figure 3). This was not expected - a sunny day had been forecast, an error that sometimes happens, fortunately in this case without damaging repercussions!

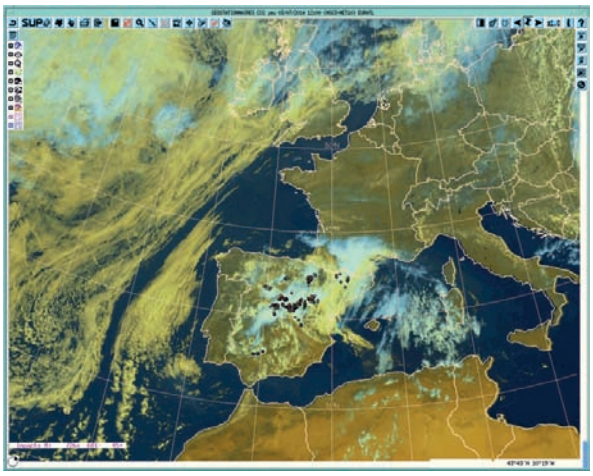
For the next day, models gave the following scenario: The cut-off low was predicted to turn to a dynamic short wave trough, moving quickly northeastwards to the Alpine regions (Figure 4). At lower levels, pressure was forecast to decrease, flow speeding up with continual warm advection



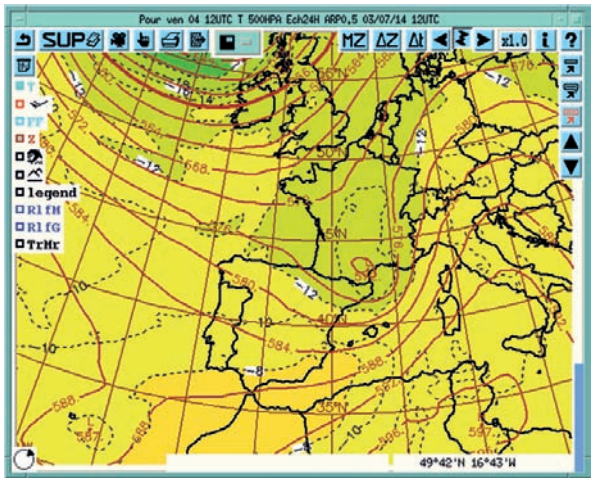
▲ *Figure 1: Thursday 3 July, 12 UTC, Geopotential height and temperature at 500 hPa, ARPEGE analysis.*



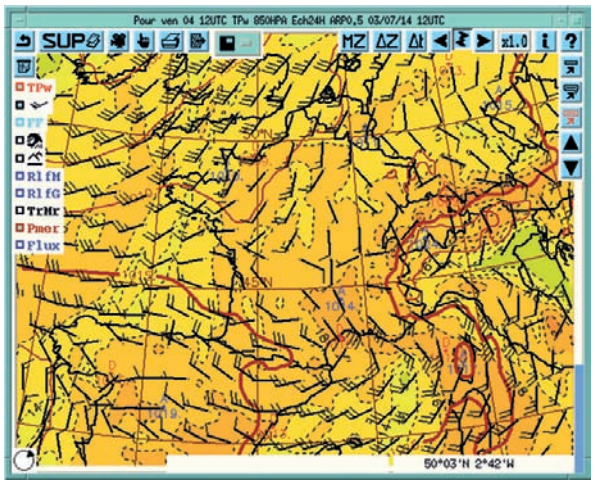
▲ *Figure 2: Thursday 3 July, 12 UTC, Mean sea level pressure and wet-bulb potential temperature at 850 hPa, ARPEGE analysis.*



► *Figure 3: Thursday 3 July, 12 UTC, MSG image and lightning strikes.*



▲ *Figure 4: ARPEGE forecast for 12 UTC, Friday 4 July, base time Thursday 3 July, 12 UTC, Geopotential height and temperature at 500 hPa.*

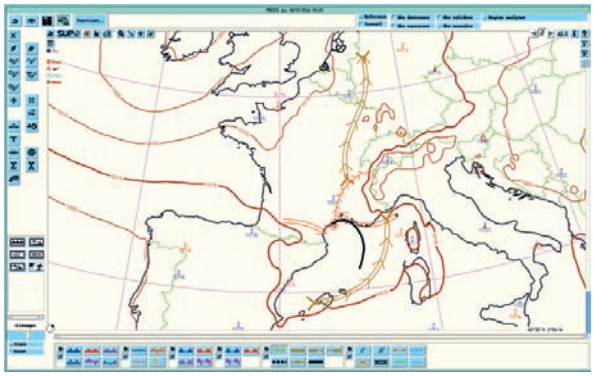


▲ *Figure 5: ARPEGE forecast for 12 UTC, Friday 4 July, base time Thursday 3 July, 12 UTC, Mean sea level pressure, 10 m wind barbs and wet-bulb potential temperature at 850 hPa.*

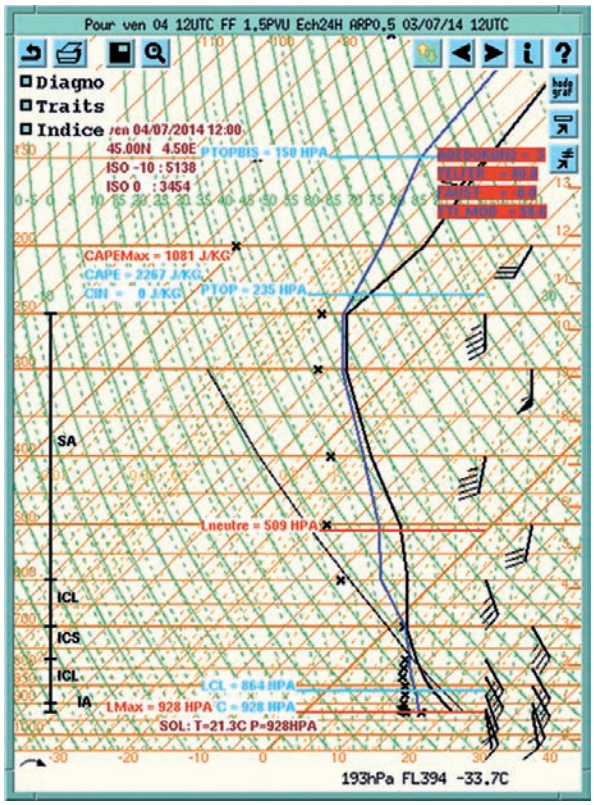
(increasing of wet bulb potential temperature). Moisture was brought from the Mediterranean Sea with south-easterly winds (Figure 5).

The graphical product below (PRESYG, Figure 6) summarizes these conditions and highlights the key synoptic elements: dynamic forcing with an active PV (Potential Vorticity) anomaly; strong upper level jet-streaks with an area of divergence (left exit, right entrance); low level convergence with strong westerly/south-easterly winds on both sides of this area. Finally, the vertical profile shows thermal instability with significant values of CAPE (Convective Available Potential Energy) and vertical wind shear (Figure 7).

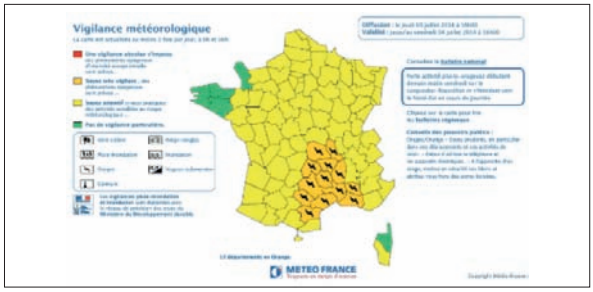
Models were in good agreement, and uncertainty was very low. Logically, a decision was made to issue an "orange" warning for violent thunderstorms accompanied by hail, heavy rainfall, and severe wind gusts. Several "Vigilance" watch maps



▲ *Figure 6: Conceptual view for Friday 4 July, mean sea level pressure, base time Thursday 3 July, 12 UTC.*



▲ *Figure 7: ARPEGE forecast for 12 UTC, Friday 4 July, base time Thursday 3 July, 12 UTC, vertical profile over South-East of France.*



▲ *Figure 8: "Vigilance" watch map base time Thursday 3 July, 4 p.m.*

were published for this situation. The first one was issued on Thursday, 4 p.m. The second one confirmed the warning with the threat extended to the east on Friday, 6 a.m. (Figures 8, 9).

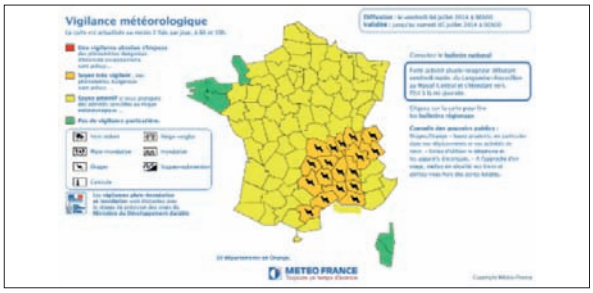


Figure 9: "Vigilance" watch map base time Friday 4 July, 6 a.m.

Right Decision:

This was the right decision to make. Over a wide part of eastern and south-eastern regions of France, thunderstorms were numerous and sometimes violent (Figures 10, 11). Various risk criteria were met: wind gusts more than 100 km/h, hailstones with a 2 cm diameter, heavy rainfall with accumulated precipitation above 40 mm within an hour. The thunderstorms caused little damage but occurred in numerous places. Local fire brigades had to step in because of fallen trees and branches, roof tiles blown down, flooding, and one house destroyed by fire after lightning strike. In short, this inventory indicates that the warning was completely justified thanks to an accurate synoptic forecast.

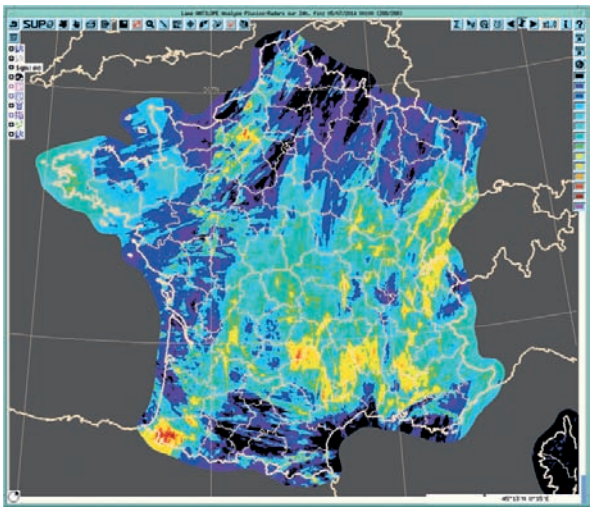


Figure 10: 24 h rainfall accumulation between Friday 4 July, oo UTC and Saturday 5 July, oo UTC.

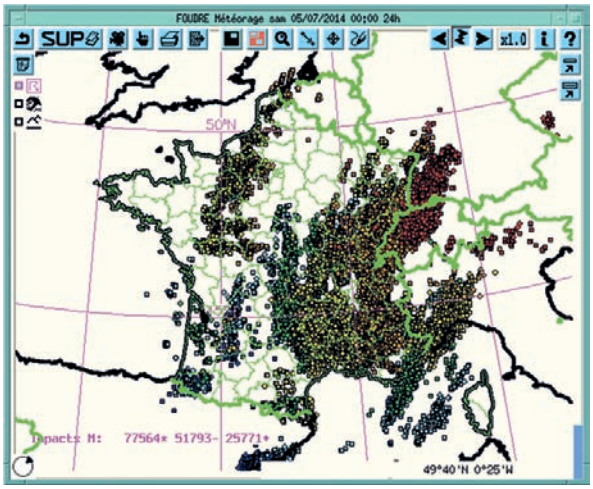


Figure 11: Lightning strikes between Friday 4 July, oo UTC and Saturday 5 July, oo UTC.

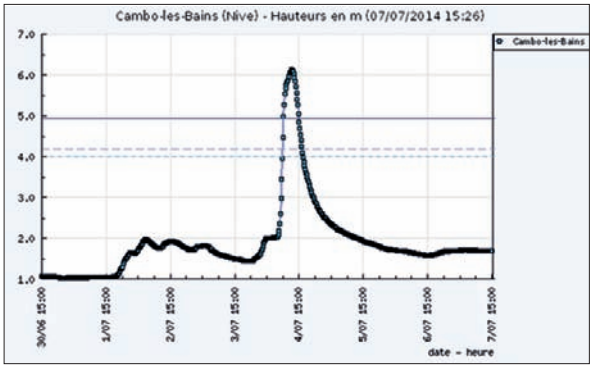


Figure 12: Time series of level of the "Nive" near "Cambo-les-Bains" with previous records (blue straight lines).

One can add that the forecaster's job was not so difficult taking into account the relevant synoptic elements.

However:

The reader with a sharp eye will have noticed that heavy rainfall also occurred in the south-western part of France (Figure 10), which became the hot issue of the time! Effectively, during the night, a strong stationary convective system gave excessive precipitation over a quite wide area. More than 100 mm were measured by a rain gauge in the village of "Bustince" (Pays Basque). Radar observations gave hourly intensity above 50 mm. Because the soils

Figure 13: Headlines of Newspaper "Sud-Ouest". Note the words "controversy", "surprise", "victims fulminate", "catastrophic toll".

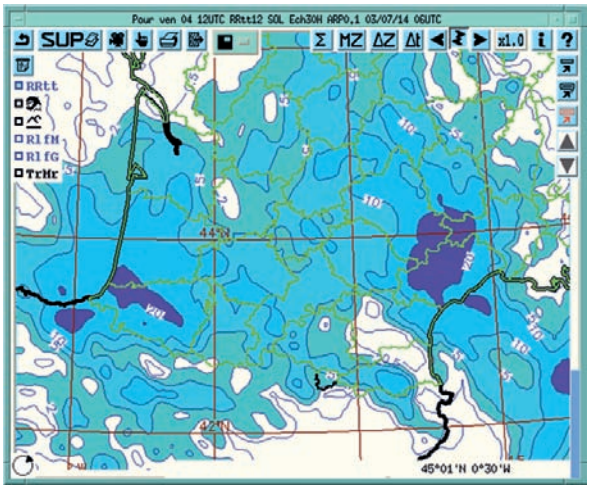
had already been saturated after a rainy spring, there was a destructive flash flood from the river "Nive"(Figure 12). The previous record, dating from 1915, was largely beaten. One person was killed, swept away by an actual wave. Several villages suffered a lot of damage along the riverside. People and the media quickly complained because the event had not been anticipated (Figure 13). As a result, Meteo France forecasting services were put under strain.

Late Signal:

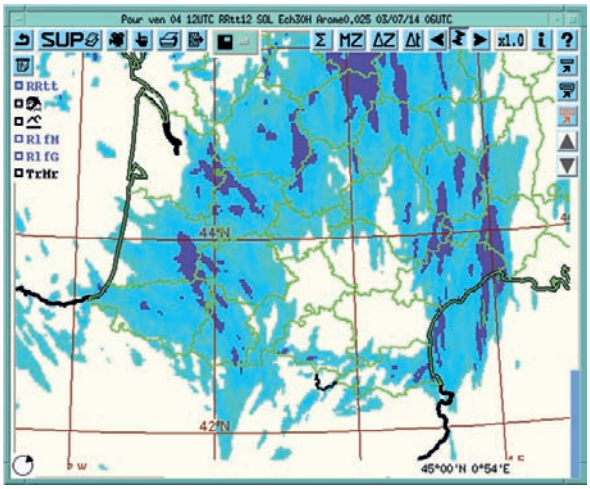
At this stage, it must be said with strength and honesty that this episode couldn't have been predicted the day before. Looking carefully at the accumulated precipitation charts from different models available at that time (Figures 14, 15), no signal emerged to bring to light an exceptional rainy event on the South-West of France. Rain was predicted, in the form of showers or thunderstorms, but the amount of precipitation remained under severe thresholds over this area.

Additionally, gaze was turned to the South-East side of the Country where deep convection was expected because of the synoptic context previously described. Some squall line features appeared in the mesoscale rain fields focusing eye on the threat in this direction.

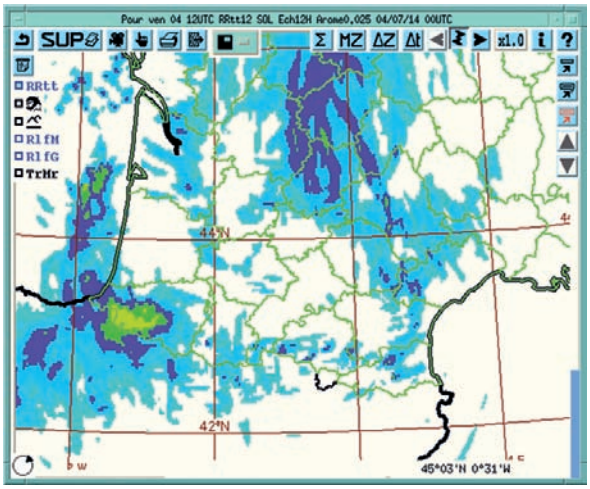
The right indication was only given at the end of the night by the fine-mesh model "AROME" (Figure 16), whereas the event had just started. This latest forecast proved to be perfectly accurate with a strong clear signal of heavy rainfall over the Pays Basque. Consequently, the warning for rain was issued on Friday, 7 a.m. (Figure 17), was updated twice during the day, including flood risk, and ended at 4 p.m. Unfortunately, this came a little too late to be really helpful for the population and civil protection services...



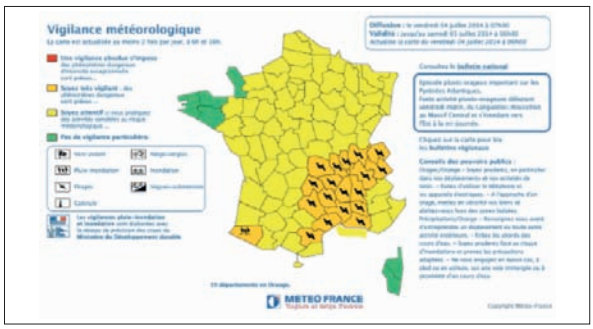
▲ *Figure 14: ARPEGE 12 h rainfall accumulation between Thursday 3 July, 18 UTC and Friday 4 July, 6 UTC, forecast base time Thursday 3 July, 6 UTC.*



▲ *Figure 15: AROME 12 h rainfall accumulation between Thursday 3 July, 18 UTC and Friday 4 July, 6 UTC, forecast base time Thursday 3 July, 6 UTC.temperature at 500 hPa, ARPEGE analysis.*



▲ *Figure 16: AROME 12 h rainfall accumulation between Friday 4 July, 00 UTC and 12 UTC, forecast base time Friday 4 July, 00 UTC.*



▲ *Figure 17: "Vigilance" watch map base time Friday 4 July, 7 a.m.*

Conclusion:

To be able to detect when and where models move away from reality and to be then in a position to correct the forecast is the primary task of the forecaster. Nevertheless, a diagnostic sometimes is not obvious. Furthermore, these unexpected situations correspond to those the forecaster is the least prepared for, by definition! Luckily, these conditions seem to remain rare. As far as I am concerned, in the past 15 years, I can remember 4 or 5 circumstances similar to the one described in this article. And no doubt that the improvements of numerical weather prediction will make them less and less frequent in the future. However, they are important because they can have detrimental consequences for the forecast team by creating conflicts between forecasters themselves and between forecasters and management.

These situations point up some psychological aspects:

Attention is often focused on a specific area where troubles are expected. Our mind is less attentive to what happens elsewhere.

These cases can occur most often at the worst times, such as at the end of a night shift, when tiredness is maximal. The ability to assimilate fresh information, to react in a proper way, and the motivation to trigger a new warning production cycle are minimal. The paradox is that a forecaster who is not aware of the situation (open-minded) could be more reactive!

The point of view presented in this article is not intended to make forecasters paranoid, nevertheless, writing this paper, the following quote came back to my memory:

"...il en ressort que celui qui doit prévoir le temps, s'il le fait avec conscience et application, ne peut plus avoir une vie tranquille et court un grand danger de voir craquer ses nerfs et devenir fou." *, by **Buys Ballots** (President of International Meteorological Organization), from the speech at the first International Meteorological World Conference (**1873, Vienna, Austria**).

* "...as a result, he who is in charge of predicting the weather, if he works conscientiously and carefully, can't lead a quiet life and is exposed to serious danger to mentally snap and go mad."