Colorado/Wyoming Front Range Study

The Chances Of Having Severe Weather... A Different Approach

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Local forecasters and attentive weather observers often develop subjective impressions of repetitive local weather behavior which provide valuable, supplementary input to the daily forecast. However, before leaning too heavily on such perceptions, the scientific forecaster should bolster his subjective impressions with statistical "fact." Such confirmatory studies not only lend weight to perceived tendencies, but can also provide additional insight into atmospheric phenomena.

A cautionary note must be sounded regarding such tests. There is a frequent tendency among scientists to look at data in the same kinds of ways. Such a tendency can produce misleading results if it causes us to override an experience-based forecast rule erroneously. As an example of how easily one can be misled by an incomplete look at a statistical data set, consider the following situation.

A popular perception among Colorado Front Range meteorologists is that severe weather is very frequent during the first three weeks of June, that it then diminishes for several weeks, and that this lull is followed by a period in late July and early August during which one can again expect severe weather to occur ... almost without exception.

To check this hypothesis, a data set was compiled of all reported occurrences of severe weather within a portion of the "Front Range Corridor" in north central Colorado and extreme southeastern Wyoming during the period 1959-1988. This area includes the portion of Wyoming from the Colorado border northward to 41.5°N and from the Nebraska border west to longitude 105.0°W. In Colorado, the area extends from latitude 39.5°N to the Wyoming border and from longitude 103.5°W eastward to the eastern foothills of the Rocky Mountains. Severe weather was defined as hail with diameter greater than or equal to 0.75 inches and/or tornadoes.

Figure 1 shows a plot of the number of occurrences of severe weather on each day for the 30-year period. Daily fluctuations are smoothed using a 3-point running mean. The results do show a higher frequency of severe weather during the first three weeks of June consistent with the perception of local forecasters. On June 13, for example, severe weather has been reported 10 times during the past 30 years (unsmoothed statistic) within this relatively small region — a remarkably high frequency for an individual day. However, the perceived secondary maximum later in the summer is not seen. In fact, these data actually indicate a small minimum near the end of July, apparently disproving a portion of the perceived seasonal distribution of severe weather.

Despite these results, local Front Range forecasters and weather watchers were not convinced. The local perception remained strong concerning the existence of a second maximum in severe weather events in late July and early August. We decided to more carefully evaluate what it was about that period that left such a strong impression. After considerable thought, we began to recognize that it was not a large number of severe weather events each year that had captured our attention. The early June period definitely has more frequent severe weather. Rather it was something to do with the consistency, or regularity, of this secondary maximum. It seemed that nearly every year at least one major severe weather event took place sometime during that late-July early-August period. Thus, we restructured our analysis to look more carefully at the regularity of severe weather instead of just the total frequency. We organized the severe weather data into 2-week periods at five-day intervals beginning May 1. We then counted the number of years in which severe weather occurred at least once during each 2-week period. Notice that overall severe weather frequency does not have to be high in order for a 2-week period to qualify. There only has to be one severe weather day.

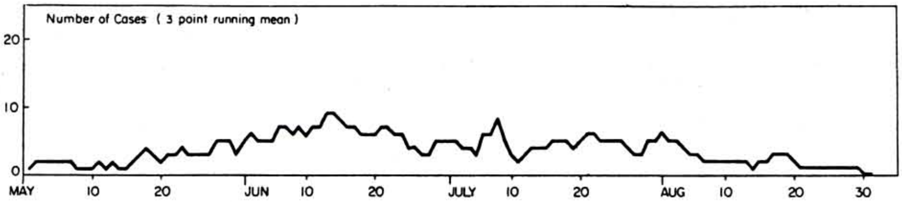


Figure 1.

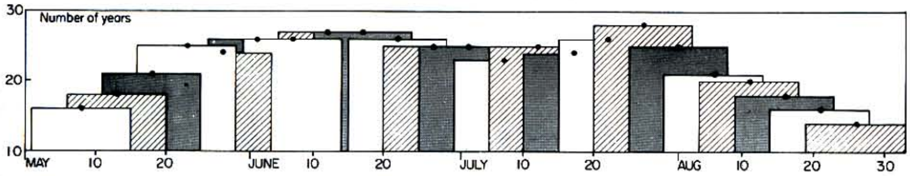


Figure 2.

Figure 2 shows the 2-week periods plotted as overlapping bar-graphs at 5-day intervals. The value for each 2-week period is plotted as a point at the center of the period. Notice that in this presentation — where we are looking at the recurrence frequency instead of the total number of severe weather occurrences — not only does the severe period in early June once again show itself clearly, but now we see the secondary maximums. In fact, notice that in terms of **recurrence** the secondary maximum is actually higher in amplitude.

The statistics associated with the secondary maximums are very interesting. A total of 28 out of the past 30 years have experienced severe weather in the Front Range Corridor on at least one day during the 2-week period. There is an average of 3 severe weather occurrences during that period (compared to 4 during the mid-June period). In terms of year-to-year regularity, no other time of year has a greater likelihood for severe weather.

It is also interesting that many of the most notable severe events have occurred during this period. This also effects our perception. For example, very large and damaging hailstorms in Fort Collins, Colorado, struck on 22 July 1973, 30 July 1979 (where one of the two confirmed U.S. hail-related deaths of this century was reported), and 2 August 1986. In Cheyenne, Wyoming, there have been many incidents, including the 1 August 1985 severe flood and hailstorm in which 12 people lost their lives, 70 were injured and damage to homes, cars and business was estimated at approximately $65 million. Although flash floods are not included in these severe weather statistics, the infamous Big Thompson Canyon flash flood also occurred during this period — on 31 July 1976. This event killed 139 people.

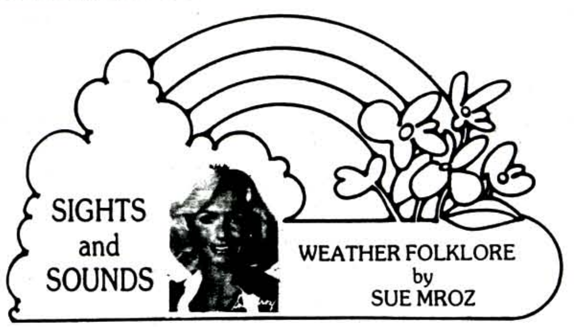
The causes of the reliable late season severe weather period have not been studied in detail. Some of the factors normally present in severe weather — strong frontal boundaries, airmass differences, strong vorticity advection, etc., are not normally present in late July and August in Colorado. Instead this maximum is closely related to the period of northernmost penetration of the Southwest Monsoon (Hales, 1974) which brings moist subtropical air into the southern Rocky Mountains each summer. In combination with weak frontal boundaries and the local convective instability (which occurs almost daily throughout the summer in and near the Rocky Mountains), this extra moisture source may be all that is needed to trigger severe weather.

We hope, by this discussion, to have made an important point. Our perceptions of weather and climate help form an experience-base from which we can draw as we observe and/or forecast the weather. These perceptions are based on combinations of many factors and can be misleading and even erroneous. Individual events often play an especially strong role in shaping our perceptions. As scientists it is imperative that we objectively evaluate our perceptions, being careful (as we have described above) to analyze the data fully. Then, and only then, are we truly justified to use and share our perceptions with confidence.

References:

Hales, John E. Jr., (1974): Southwestern United States Summer Monsoon Source — Gulf of Mexico or Pacific Ocean? *Journal of Appl. Clim., 13*, pp. 331-342.

(1) Submitted to *American Weather Observer*, October 1989



"Frost is heavier on moonlit nights."

This tends to be true in early spring and in autumn because frost does not form on cloudy nights. Frost developes best on clear (moonlit), cold nights when there is little or no wind to mix with the lower levels of the atmosphere.

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European Windstorms Witnessed

by Greg D. Mac Master
AAWO Member

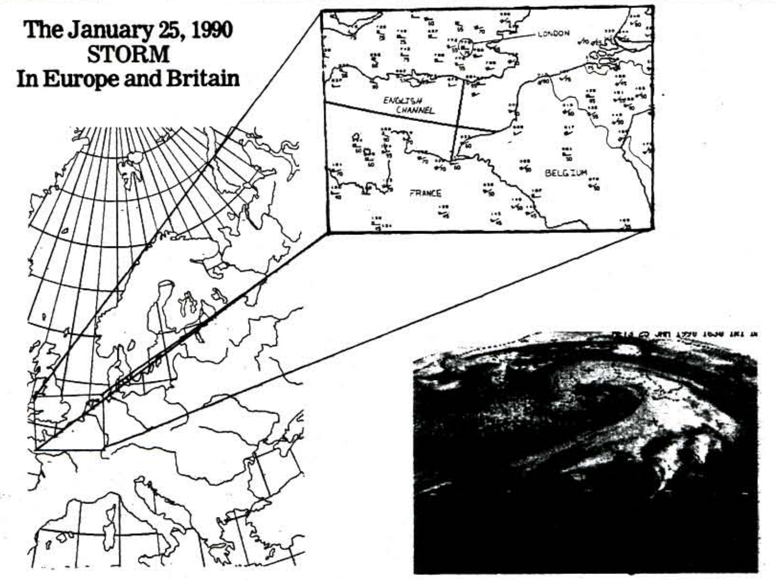
(Ed. note: No fewer than three major cyclonic storms have brought heavy damage to parts of Europe and The British Isles this winter. AAWO member Greg MacMaster, reporting from Germany, files the following reports.)

It was the 25th of January, late afternoon. We, here in Europe, witnessed an event that made the record books. Where else could you observe winds in excess of 116 mph ... a hurricane or a tornado you say? You're right! ... But this was no hurricane or tornado. This was a cold front extending out of a low pressure center estimated at 950 millibars. This type of phenomena isn't that rare when you see it year after year. The only difference is that it stays out in the Atlantic Ocean and slowly heads northeastward and dies before it ever hits land. There are those few that do make it this far south and that deep (950 mb), and when they do, they're monsters. I'm sure you've read it in most of the papers, lives were lost (London reported 96+ lives) and I'm sure there were quite a few more in or along the coastal regions of Europe.

> *"While the storm was raging, I had the opportunity to go outside and actually observe winds of 60+ mph. I had a blast! Literally!*
> **Greg MacMaster**

Gradient winds were expected to make landfall with speeds of up to 65-75 knots (74-86 mph). This was no surprise as we see it from time to time. They usually die or weaken slightly due to friction with the earth surface. This one kept on coming and increasing in strength. Stations inland began reporting speeds in excess of 80 knotts (92mph). Then the thunder began! You would think that winds this strong would shear off any type of thunderstorm development. Not this one. The convective clouds actually increased the gradient wind gusts (this is what gave us the 116+ mph report in northern Germany). As you can see from the satellite picture it is in fact a normal looking front with a low center located just east of England in the North Sea.

The January 25, 1990 STORM In Europe and Britain



While this storm was raging, I had the opportunity to go outside and actually observe winds of 60+ mph. I had a blast! Literally! I was tossed about a few times, lost my footing a number of times and was spun around not to mention my Team Chief, (Pete Engelmann) who also witnessed the event (we were forecasting it at the time). When we saw cold frontal passage (FROPA), the temperature dropped 5 degrees Celsius and the wind shifted (these are normal indications in a frontal passage environment). The front, by the way, was clocked at 60 mph, or one degree latitude per hour. The progs were off by 8 hours (too slow) so we had to base our forecast almost entirely off of satellite for the first 12 hours.

It was truly an experience I'll never forget. Not just the excitement of being in the wind but seeing it make landfall and increase to the point of no return. From my understanding, this was the strongest storm in nearly 20 years. Hundreds of thousands of people were left without power, trucks were blown on their sides with silos and trees toppled. A few stations had reported control tower evacuation. Hurricane force winds with the type of devastation only a hurricane could provide! Forecasting the weather in Europe is, in it's self, nowhere near as predictable as forecasting in the states.

We have this pond called the Atlantic Ocean that modifies the weather so much you actually see temperatures increase BEHIND a cold front!

This is just one of the special effects Europe has to offer. Come join us! It's a once in a lifetime adventure ... for the forecasters and observers in Europe, it's 365 days a year!

... and another storm in February

European weather, for the month of January and mid February, was by far a record setter. We usually experience wind storms of this force maybe two or three times a year. But three within two months? I no sooner finished an article on the 116 mph storm, when all of a sudden ...

Oddly enough, this was the third severe wind storm to grace the lands of France and Germany in over a one and a half month period. After the storm of Jan. 25, of which destroyed many coastal areas and cost many lives, this one started, benignly enough off the coast of Spain as a wave. This wave had the characteristics of an occlusion forming around a low ... but there was no low depicted on satellite nor did the observations report the usual cyclonic flow as would be definable in this type of situation. By the next afternoon (Feb 3 1600Z) winds increased gradually from the southwest and by 2100Z, winds in excess of 50 knots were reported by numerous stations. The low pressure center skirted the northern region of France with a 500mb cold trof linking up and thus, increasing the winds and convection.

The following morning, I had a chance to assess the damage. Groves of trees stood perfectly clean and undamaged except for a path measuring 160 feet in width, totally leveled (either snapped at the base or uprooted). It literally looked like a tornado had passed through the area! Trees with a diameter of 96 inches snapped! Winds were estimated in excess of 90 knots with no real solid observations to justify the damage. France was lucky. Winds were in the neighborhood of 35-48 knots with higher elevations reporting 60 knots. As the convection entered from the northwest, it was a matter of time before we would see 75+ knots.

STATION QUOTATIONS

Notes From The Pages Of Our AAWO DATA BANK

From AAWO member Patrick Folaron of Holland, New York

On February 13th, a temperature drop of 22 degrees in 6 hours, from an unusually warm high of 58 to 36. Dense fog then developed but then lasted only a couple of hours.

From AAWO member Maurie Nature of Simi Valley, California

On February 16th, a rainstorm came bringing about 2-4 inches to certain places. Another storm followed directly behind. The famous Santa Ana winds came once again and diverted all possible rain well to the north, thus causing another big letdown in precipitation.

From AAWO member John A. Heiser of Grassy Butte, North Dakota

The drought continues here with only .10 precipitation as compared to the normal of .50 for February. Through the first two months, we have only received .18 compared to normal of 1.05.