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I. COMMENTARY

"Chase '82" is well underway, judging by telephone reports ST has received from its reporters-in-the-field. The 2nd week of May has been dynamite for Oklahoma and Texas chasers: 50+ tornadoes in the Texas panhandle and western Oklahoma, moving slowly northeastward (15 MPH) in excellent light!! (Aah, the misery for we who must wait our turn and bear up against such accounts from those who have already seen and filmed and filed away a lifetime of memories).

ST has received several favorable responses on its Commentary in the last issue. I hasten to add that, while it is close to what, was intended, such a statement can be rewritten many times and still not quite hit the mark. It speaks only for myself. While some may share these views, each chaser comes to the tornado on his or her own terms. Each challenge, each testing, each vision and encounter is a very personal one, and ST only tries to touch some kindred sentiments, not exclude or limit anyone's experience.

II. ROSTER

III. LETTERS TO THE EDITOR

Randy Zipser sent a copy of Gary England's tips on tornado safety rules (Gary is the KATV Channel 9 weather forecaster in Oklahoma). Here is a summary of his advice:

- If no cellar or basement, take shelter in a small room in the center of your home (closet or bathroom is best). Wrap yourself in a blanket, to protect the face and eyes.

- In an office or factory, go to an interior hallway. Avoid hallways opening south or west to an outside window/door. Avoid west and south walls and all windows. Absolutely avoid buildings with large free-span roofs.

- Avoid mobile homes (Period).

- In the open, go to a ditch or depression; cover your face and eyes.

- Don't try to outrun a tornado in your car (Especially in congested urban areas where your escape route may be blocked -leaving you out in the open and exposed - Editor).

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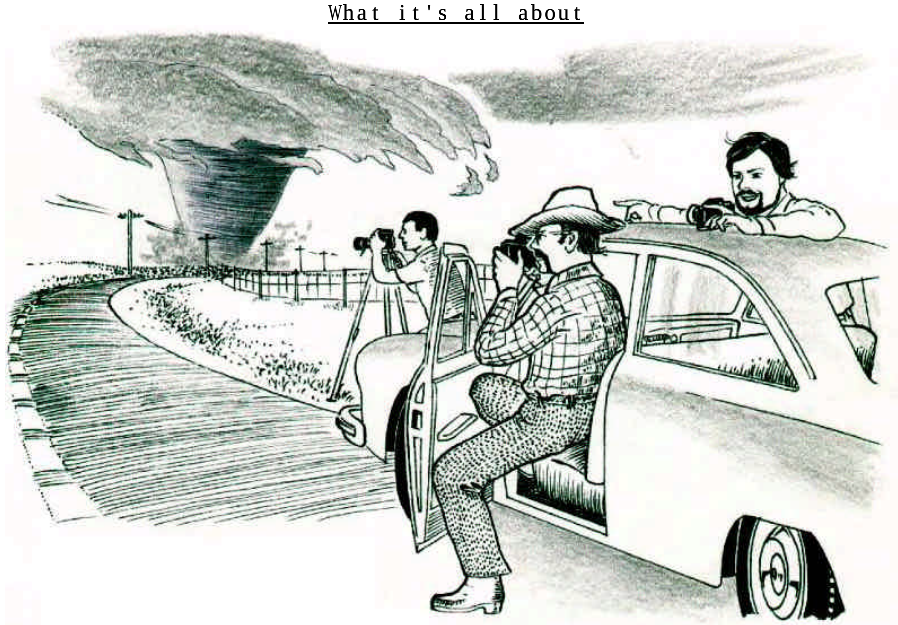
What it's all about



In this hypothetical confluence of chasers, we find Don Burgess, Chuck Doswell, and Al Moller doing their thing . . .

IV. BULLETIN BOARD/COMMERCIAL MARKET -$- FOR PICTURES

V. CAMERA TIPS

Henry Lansford has published an excellent, short article on "Photographing the Sky" in Kodak's "The 11th Here's How" book, available in camera stores and in a recent, issue of Weatherwise. Aside from some advice that is fairly obvious or logical to those who have used cameras for any period of time, here are some points that either were new to me or bear repeating:

- Consider "framing" your subject with foreground trees, structures, etc. (A tornado with some house, structure or people in the foreground will be more interesting than looking over an empty prairie. Not, that we always have the luxury of picking our shots, but a little thought ahead of time can improve what you take.)

- Shoot a lot of film and vary exposures on those important scenes by within 1/2 f-stop on either side of that specified by your meter.

- Use a fast shutter speed, tripod or both.

- Slightly under-expose to get good rainbow pictures.

- Use a 35 mm wide angle or 80-200 zoom lens.

Much more good advice is given and some exquisitely beautiful Colorado cloud pictures in both books. You are encouraged to add this to your storm reference library.

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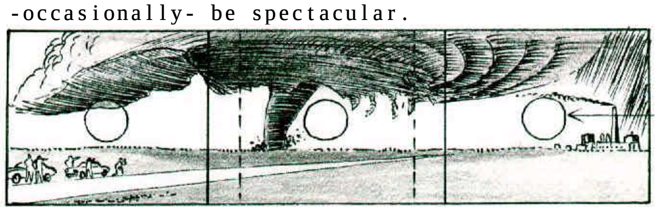
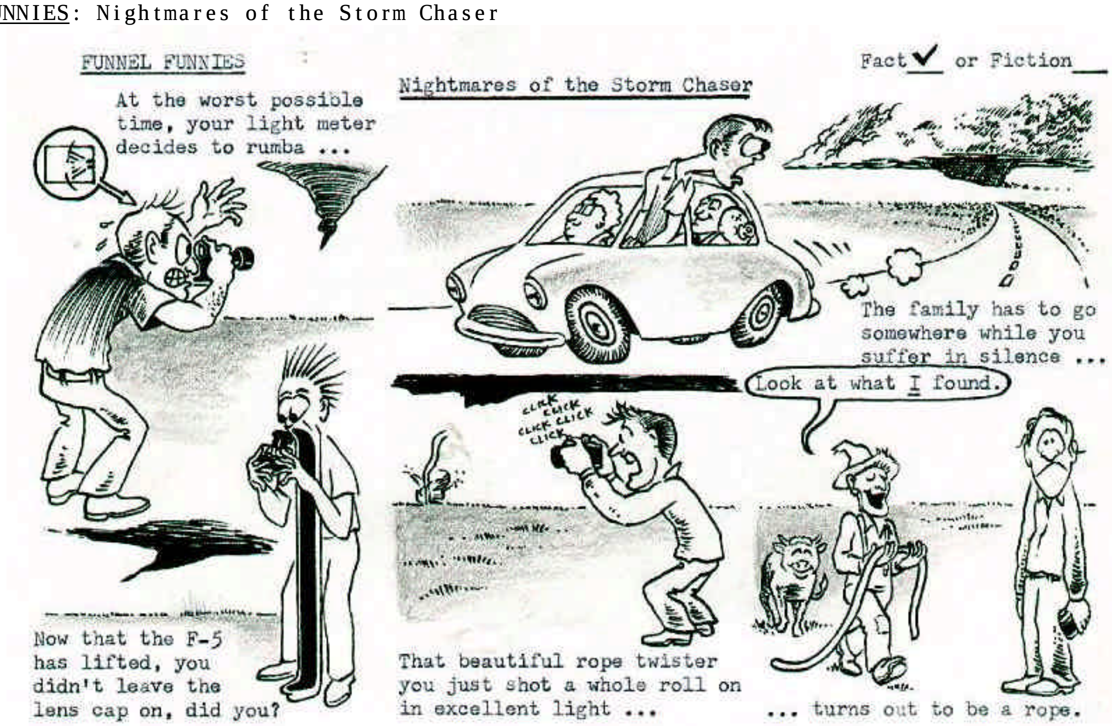
I would also add to this -try shooting overlapping panorama shots of wide horizon storm scenes. Be sure to locate the horizon line in the same part of your aperture each time, so that processed slides/prints will line up approximately the same. Some trimming of prints may be necessary but the less -the better. Unless you are or become very adept at splicing prints, don't try to overcome the inevitable exposure differences between adjoining pictures by increasing the amount of overlap. You could lose more in a scene with 6 non-professional splices than in the same scene with only 2 Try the panoramas, the results can -occasionally- be spectacular.



Focusing ring shown in center

FUNNEL FUNNIES: Nightmares of the Storm Chaser



VI. TRAVEL TIPS

VII. FEATURE

## HISTORY OF THUNDERSTORM FORECASTING
### Part IV: The General Circulation (to 1900)

By John F. Weaver

The modern forecaster begins his daily task with a look at the weather maps. He studies the general pattern of the air aloft and searches it for perturbations. Surface maps are constructed to track extra-tropical cyclones and their associated frontal systems. As the forecast progresses, analyses, soundings and computer products are synthesized and studied, until finally the forecaster formulates a conception of how the atmosphere is configured on that particular day, and how it is changing with time. A forecast is made. But...notice how we take for granted terms like 'upper flow', 'extra-tropical cyclone', 'fronts', etc. How did these concepts come to be formed, and how self-evident, are they? In this section, we shall look at the development of our notions concerning the larger-scale atmospheric circulation. By so doing, we shall become a bit more aware of the complex nature of the task the forecaster tackles.

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The Renaissance brought, with it not only an upsurge in science but a new spirit of adventure and exploration in many arenas. Trade began to expand, and sailors ventured out, into the vast oceans to search out potential riches. One result of these journeys (which began with Columbus in 1492) was an ever increasing understanding of the prevailing winds over the oceans. The body of knowledge began as isolated entries in ship's logs, expanded into a 'word of mouth' climatology, was formalized by a request for data by the Royal Society of London, and culminated in the 1680's with a scientific theory. In 1686, Sir Edmund Halley published the first, comprehensive map of the prevailing winds over the oceans, with particular regard for the quasi-permanent,, easterly trade winds. The map was the first known meteorological chart to be published. More importantly, Halley attempted to tie the observations together with a global circulation theory (or 'model') to explain them, another first. Through his model, Halley suggested that, the sun heats the air most efficiently near the equator, causing it to rise there. The point of maximum heating, because it, follows the sun from east to west during the day, generates a current of wind as surrounding air moves in to fill the rarefied region. The trade winds were the result.

In 1735, George Hadley expanded Halley's model by adding to it the effects of deviation due to the rotation of the earth. He felt that a basic fallacy existed in Halley's theory. Were the winds to follow the sun, one would expect northwesterly winds in the morning and northeasterly winds in the afternoon. Instead, Hadley postulated a large-scale circulation wherein air rises at, tne equator, then, moving poleward, deviates toward the east by virtue of the turning of the earth on its axis. The air, being well above the earth's surface, eventually cools and sinks toward the ground. Here, it begins an equatorward journey, being drawn there by the vertical evacuation of tropical air, and deviates toward the west, again, due to the earth's rotation.

Hadley's model is still accepted as the basic mechanism which drives the global circulation. However, several refinements have been added over the years as more complex details of this circulation have become known. One important modification by 'William Ferrell in the late 1800's showed that the general pole to equator flow was modified by three component circulations (per hemisphere), which interact to perform, in steps, the overall transfer envisioned by Hadley. Ferrell also suggested a large, polar circulation aloft, about which the mid-latitude westerlies travel.

But we're getting ahead of the story. Before we continue with the upper flow, let's back up a bit and consider the large-scale circulations at the surface.

For those unfamiliar with history, it might seem odd that this portion of the story begins with the American statesman Benjamin Franklin (1706-1790). Franklin, however, was much more than a statesman. During his lifetime, he was also a cutler, a printer, an author, a philosopher and a scientist. As an amateur meteorologist, he is most remembered for his pioneering work with lightning. perhaps just as important was his insight in realizing the worth of simultaneous weather observations. The Duke of Tuscany did begin collecting weather observations over a small network in Europe in 1653.

However, possibly because of the small size of the network and/or the great number of other projects with which his group was involved, no discoveries concerning atmospheric circulation resulted at the time). By assembling a set of 'after the fact' reports in 1743, Franklin was able to discover that hurricanes are large, traveling circulations. He spent many years trying to get a network of observers set up, but met with only partial success.

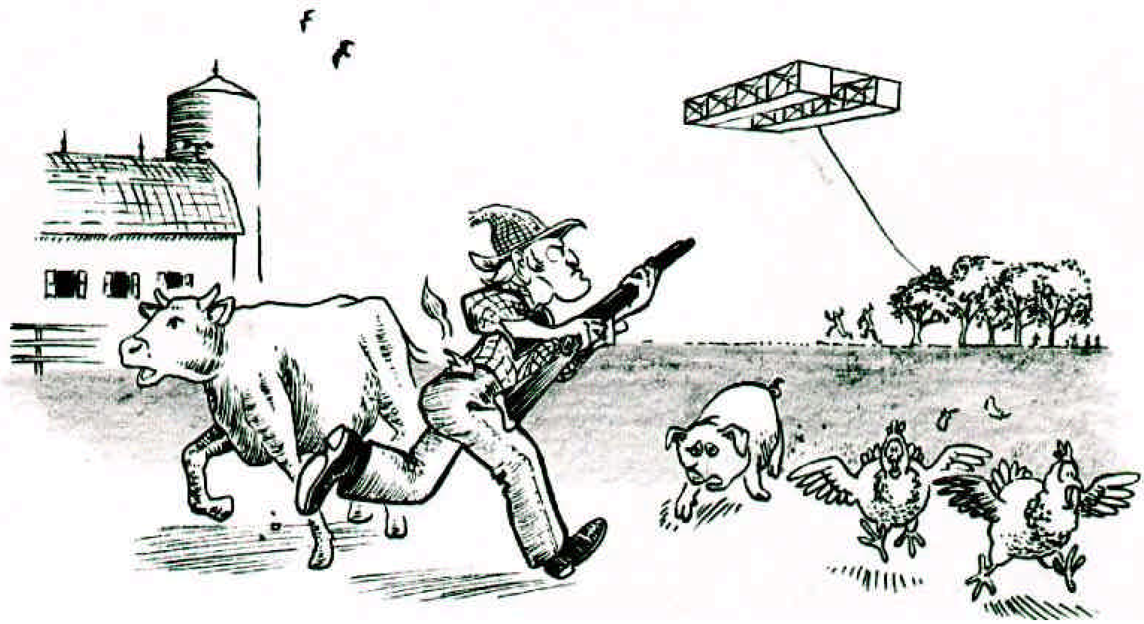
In Europe, however, observations were being collected at many locations by the end of the 18th century, and the data were being used. In 1817, Alexander van Humboldt conceived the idea of 'analyzing' weather maps with lines of constant temperature (isotherms). In 1816, H. Wilhelm Brandes (using data collected in the late 1700's) had discovered that inclement weather occurred systematically over broad regions. He found these weather 'systems' to be associated with low barometric pressure (a fact first noted by Otto van Guericke in 1660 and confirmed by Halley in 1686) and cyclonically rotating winds. In 1820, Brandes utilized the new analysis technique to construct isobars and isotherms for his research into these systems. Another basic suggestion around the same time was made in 1827 by Heinrich Dote. He proposed that perhaps the polar and equatorial currents were responsible for moving these great weather systems about the globe.

The first simultaneous (official) weather observations in the United States were begun in 1816, after the U.S. Hospital Surgeons received a government mandate in 1814. Beginning in 1820, the Surgeon General's Office produced composite maps as data arrived from the field (usually weeks later). Utilizing this new weather data, William Redfield discovered in 1831 that Atlantic coast weather systems were actually closed circulations (or, as he called them, 'large whirlwinds'), similar in that respect to hurricanes. In 1834, he further noted that weathsr disturbances were associated with cyclonic circulations in the northern hemisphere and anticyclonic in the southern.

All of these discoveries were quite exciting to researchers, but because of the long delay in transporting the observations to a central location, they found little real-time application. The invention of the telegraph in 1837 by Samuel Morse changed all that. By 1849, the United States, as well as several European countries, were transmitting telegraphic weather reports, and weather maps thus became more commonplace (although it wasn't until 1870 that an official telegraphic weather service was set up). Using these new data, as well as some of the older Hospital Surgeons' observations, James Espy noted several facts in 1850 regarding weather systems. His findings included the fact that U.S. weather systems travel generally from west to east, they cover large geographical areas, they (like their European counterparts) are accompanied by barometric depressions near the center, and that the lower the relative central pressure, the stronger were the winds. He further pointed out that if air from surrounding regions were all converging toward the center of the disturbance (which he felt was the case), then upward motion must be occurring near that center.

In 1853, George Erman showed mathematically that the wind associated with extratropical cyclones is in direct proportion to the pressure gradient. However, Christopher Buys-Ballot noted that winds do not typically blow directly towards the lowest pressure and pointed out (in 1857) that if one stands with his back to the wind, the lowest pressure will be off to the left (Buys-Ballot's law). He felt that surface friction might be causing it to veer off course. Finally, in 1858, Elias Loomis deduced the complete kinematic nature of the circulation in cyclones. He was the first to suggest that differing air masses might meet in converging zones, where upward motion of air would then result. A Scottish meteorologist, FRS Fitzroy, confirmed Loomis' model in 1863. He conceived the notion of constructing 'streamlines' in his analysis of a weather system and used them to verify the advection of polar and subtropical air masses.

By 1898, enough curiosity about the upper atmosphere (and its relationship to surface weather) had been aroused to cause the U.S. Weather Bureau to begin sending up a few instrumented-kite flights. These kites were flown on a rather irregular basis, to altitudes generally as high as 8,000 ft., from sixteen locations in the United States. Furthermore, weather enthusiasts in many European countries were also trying out different ways to probe the three-dimensional structure of the atmosphere. The true nature of the global circulation was about to come under close scrutiny. But, before we move forward into the twentieth century, let's pause a moment and review what all was known to this point.



The upper air was the greatest mystery. It was known that (1) an equator to pole circulation existed, (2) an eastward deviation to the poleward flow aloft is induced by the rotation of the earth, (3) several sub-circulations comprise the overall pattern, and (4) the resulting flow -at mid-latitudes- is a quasi-permanent band of westerlies.

Closer to the surface, it was known that inclement weather occurs systematically in the form of large, extra-tropical cyclones at mid-latitudes. These weather systems include (1) eastward moving centers of low pressure about which the winds blow cyclonically inward, (2) winds which act in response to a combination of pressure force and frictional effects, (3) convergence which forces upward motion near the center of the system, (4) different air masses that meet in distinct convergence zones as cold air is drawn southward and warm air is drawn north, and (5) upward motion near these convergence zones. All in all, not bad, considering the handicap of having very little upper air data to study.

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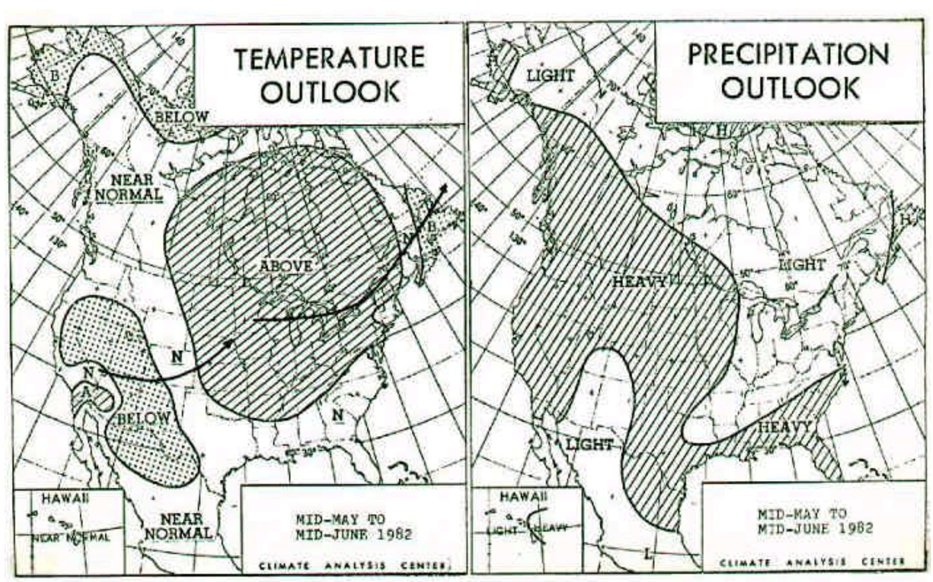
For those of you still planning to chase this season, here's the 30 day outlook from the World Weather Building from mid-May to mid-June. The solid line with arrow shows the principal cyclonic track through this period.

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Next issue of ST will feature storm encounters of "Chase '82" and Part V of John Weaver's continuing series on the History of Thunderstorm Forecasting: The General Circulation in the Twentieth Century.