

Wilderness Weather

The weather has a tremendous impact on the wilderness search and rescue mission. It influences the survivability of the lost person as well as the safety and comfort of the rescuers.

There are several potentially hazardous weather situations that searchers need to be aware of in order to conduct a safe search. **Lightning** is the most dangerous weather hazard that is commonly encountered during searches in Virginia. More people are killed in the U.S. yearly by lightning than by tornadoes or by floods and hurricanes combined. **The largest percentage of people killed by lightning are hikers, campers, golfers and others engaged in outdoor recreation.** The greatest number of deaths from lightning occur in the Mid-Atlantic states (Cooper, 1989). Most people who are struck will survive (70 % survive). Prompt CPR is very effective in the resuscitation of lightning victims.

Safety Rules for Lightning

1. NEVER BE THE HIGHEST OR NEAR THE HIGHEST OBJECT IN THE AREA; Lightning will normally strike the highest object in an area. Since a lone tree is usually the highest object, do not stand under a lone tree in a field (Remember that Mom told you not to stand under a tree during a thunderstorm). All other lightning rules are simply a variation of this theme.

2. Mountain Tops-GET OFF THE RIDGE LINE; the ridge line is one of the most dangerous locations during a thunderstorm, especially if it is an exposed ridge. Get as far down into the valley as quickly as possible staying away from exposed areas (where you will be the highest object) and single trees. A thick cluster of trees offers fair protection in most cases. Caves and ditches are good locations as long as they are not flooded and thus capable of carrying an electrical current. Once in a low protected place, crouch down and minimize your exposure to the ground (Ahrens, 1988).

3. Open Fields-SEEK SHELTER; In all cases, the best protection is inside of a sturdy building or in an all metal vehicle such as a car. Tents are virtually useless (Cooper, 1989). If it is impossible to get to proper shelter, stay away from isolated trees, metal objects (such as a fence) and hill tops. A nearby forest is also a good choice for a natural shelter but make sure you are not near the tallest tree (Scheidegger, 1975). As above, ditches and caves can offer good protection as long as they are not flooded. Once again crouch down when you get to a protected place and minimize your exposure to the ground. Take off metal spike shoes such as golf shoes.

3. Lakes and Rivers-GET TO SHORE; you are the tallest object on the water. Some shelter is possible under a bridge but remember that metal attracts lightning. Large boats should be properly grounded.

Another weather concern for searchers is **flooding**. Flash flooding can occur from thunderstorms or from a prolonged period of rain in which the ground becomes saturated. Flash flooding is a particularly serious problem

in the mountainous regions of Virginia. There is an early warning system in some mountain counties.

Safety Rules for Flooding

1. NEVER TRY TO DRIVE THROUGH A FLOODED ROAD; this is the major cause of death associated with floods. The water can lift the car and carry it down stream thus making escape dangerous if not impossible. It is much harder to estimate the true depth of water across a flooded roadway due to muddy water obscuring dips in the roadway.

2. NEVER TRY TO WADE OR SWIM ACROSS A SWOLLEN STREAM OR ROADWAY; For the same reason as in rule 1. The tremendous force of the water will sweep one down stream, and there is the possibility of being struck by rubble in the water.

Forecasting the Weather

The best way to get weather forecast information for SAR missions is to use a radio that receives official NOAA forecasts. These inexpensive radios can be found at electronic/radio stores. Many of the radios have alarms that are activated by NOAA in the case of severe weather. Many sections of Virginia are served by NOAA weather radio stations.

The first step in forecasting weather is to know the normal weather for the season. Summer weather is the least variable. During the summer (June, July and August), one can expect highs in the 80's and lows in the 60's throughout most of the Commonwealth. Mountainous regions will be cooler depending on the elevation. The temperatures decreases at a rate of about 7 degrees per 1000 feet increase in elevation. There is a chance of scattered thunderstorms many summer afternoons and evenings.

Winter (December, January and February) in Virginia generally is associated with highs in the 40's and lows in the 20's. The mountains will be colder. Temperatures around zero are not uncommon in the mountains. Total snowfall will range from over 40 inches in the southwest mountains to less than 10 inches in the tidewater and eastern shore. Snowfall is very variable from year to year.

Spring (March, April and May) and Fall (September, October and November) are transitional seasons and the weather is highly variable from day to day. This variability adds extra concern to the SAR mission. When the lost person disappeared, the weather might have been warm and dry, however it can quickly change to cold and wet. Also the combination of warm days and cold nights is very dangerous for the missing person who often is prepared for the warm daytime temperatures only. During the warmest months of these transitional seasons (May and September), highs will normally be in the 70's and lows in the 50's. During the coolest months (March and November) highs will normally be in the 50's and lows in the 30's and the 20's not uncommon. As always, the mountains will be colder.

Cloud types can be used to forecast precipitation and temperature changes up to 36 hours in advance. Fair weather is associated with the "cottonball" cumulus humilis clouds. A predictable cloud sequences is associated with the approach of warm and cold fronts.

Cold fronts are associated with a brief period of heavy rain (1-3 hours) followed by rapid clearing, northwesterly winds and colder temperatures.

1. 24 to 36 hours in advance of a cold front very high, thin cirrus clouds begin to move in from the southwest. The surface winds will also be from the south to southwest.
2. 6 to 18 hours in advance of a cold front, the thin high-level clouds completely cover the sky (cirrostratus) although the sun or moon are still visible. The surface winds are southwesterly.
3. As the cold front gets near, the clouds become much closer to the ground and thicker with obvious vertical development. A few hours before the cold front reaches the area, cumulus clouds will become very common. Cumulonimbus clouds (thunderstorms) may also be present. The surface winds are gusty with the approach of the front and become northwesterly with the cold frontal passage.

Warm Frontal passages are associated with 18 to 24 hours of light to moderate rain, fog and light southeast to south surface winds. With the passage of the warm front, the surface wind becomes south to southwest and there is a gradual clearing and a gradual warming.

1. 36 to 48 hours before the passage of a warm front, high thin cirrus clouds will begin to move in from the southeast.
2. From 24 to 30 hours before the warm front passage, the clouds will gradually thicken and lower, changing from cirrostratus to altostratus (middle level clouds that almost completely obscure the sun) to nimbostratus (the low level rain or snow clouds).
3. 24 hours to warm frontal passage, light to moderate rain (or snow) from nimbostratus clouds and fog.

Cloud movement can be used to forecast the temperature trend. If the upper layer of clouds is from the southwest and the lower layer of clouds is moving from the southeast, there will be a general warming trend. If however, the upper layer clouds are moving from the west and the lower level clouds are from the northwest, there will a general cooling trend. In general, winds from the south bring warmer weather and winds from the north bring cooler weather.

Windchill Temperature and Wind Speeds

Windchill temperature is a measure of the rate which heat is convected away from exposed skin. The greater the wind speed, the greater the heat loss from exposed skin. The windchill temperature is temperature of still air that will produce the same heat loss from exposed skin as the current combination of ambient temperature and wind (Reifsnnyder, 1980). In order to estimate the windchill temperature, both the temperature and wind

speed must be known. A well known method of estimating the wind speed in the wilderness is the Beaufort Scale.

The windchill chart below is from Reifsnyder (1980) and the Beaufort Scale is from Lutgens and Tarbuck (1986).

Table 5-1. Windchill temperatures

Air temperature °F	Wind speed, mph						
	3	5	30	15	20	25	10
60	60	56	50	48	46	44	43
55	55	51	45	41	38	36	35
50	50	45	37	33	30	28	26
45	45	39	32	27	23	19	17
40	40	34	23	20	15	11	9
35	35	29	18	12	7	3	0
30	30	24	12	3	-1	-5	-9
25	25	17	3	-4	-9	-15	-17
20	20	12	-4	-13	-18	-23	-25
15	15	5	-11	-20	-24	-33	-35
10	10	0	-17	-27	-33	-38	-41
5	5	-6	-23	-33	-39	-46	-50
0	0	-13	-29	-40	-46	-53	-57
-5	-5	-17	-37	-47	-53	-61	-66
-10	-10	-23	-42	-53	-60	-68	-72
-15	-15	-28	-48	-60	-67	-77	-81
-20	-20	-33	-55	-67	-76	-85	-89
-25	-25	-40	-62	-75	-83	-93	-98
-30	-30	-45	-67	-81	-92	-100	-105

Table 6-2 BEAUFORT SCALE

Beaufort Number	m/s	mph	International Description	Specifications
0	< 1	< 1	Calm	Calm; smoke rises vertically
1	1	1-3	Light air	Direction of wind shown by smoke drift but not by wind vanes
2	2	4-7	Light breeze	Wind felt on face; leaves rustle; vanes moved by wind
3	4	8-12	Gentle breeze	Leaves and small twigs in constant motion; wind extends light flag
4	7	13-18	Moderate	Raises dust, loose paper, small branches moved
5	10	19-24	Fresh	Small trees in leaf begin to sway; crested wavelets form on inland waters
6	12	25-31	Strong	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty
7	15	32-38	Near gale	Whole trees in motion; inconvenience felt walking against wind
8	18	39-46	Gale	Breaks twigs off trees; impedes progress
9	20	47-54	Strong gale	Slight structural damage occurs
10	26	55-63	Storm	Trees uprooted; considerable damage occurs
11	30	64-72	Violent storm	Widespread damage
12	≥ 33	> 73	Hurricane	

ANNOTATED REFERENCES

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The Wilderness Environment

I. Weather

A. Weather Terminology

1. Weather Watches and Warnings

☛ **Watches** are issued by the National Weather Service whenever there is an indication that dangerous weather is possible. Watches are normally issued before the dangerous weather develops in order to give the public time to make the necessary precautionary arrangements to protect life and property. It is during the watch period that all steps to protect life and property should be taken. One should listen to NOAA weather radio or the local news for updated information and warnings.

☛ **Warnings** are issued whenever dangerous weather is occurring within the warning area. Persons within the warning area should immediately take the necessary steps to protect lives.

a. ☛ **Severe Thunderstorms** are violent thunderstorms with frequent lighting, strong and gusty winds, and damaging hail. Severe thunderstorms can be as dangerous as tornadoes and much more common. Do not under estimate this weather threat.

1. ☛ **Severe Thunderstorm Watch** means that severe thunderstorms are possible within or near the watch area. Persons within the watch area should be on the lookout for threatening weather and be prepared to take needed precautionary measures (see safety tips below). If one notices threatening weather, take appropriate action even if a warning has not been issued.

2. ☛ **Severe Thunderstorm Warning** means that severe thunderstorms are actually occurring in the warning area. One should immediately take the proper precautions.

b. ☛ **Tornadoes** are violent, rotating thunderstorms with a funnel or rope shaped cloud protruding from the base of the thunderstorm.

1. **Tornado Watch** means that tornadoes and/or severe thunderstorms are possible within or near the watch area. As with all watches, this is time to take necessary precautions to protect life and property. Also, as with all watches, if threatening weather approaches your area, take immediate cover. Assume that any threatening weather is a tornado. **DO NOT WAIT FOR A WARNING TO BE ISSUED!**
 2. **Tornado Warning** means that a tornado has been spotted (or is indicated by a hook echo on a weather radar) within the warning area. Immediately precautions should be taken to protect lives. Precautions to protect property should have been done during the watch phase. Since tornado warnings are only issued after a tornado has developed, treat any threatening weather during a the watch phase as if it was a tornado.
- c. **Flash Flood** is when water rises rapidly and flows out of the stream/river channel with little or no warning. Urban flash flooding occurs when the precipitation rate is greater than the storm sewers can handle.
1. **Flash Flood Watch** means that flash flooding is possible within or near the watch area. Persons who are in areas that are prone to flooding should take necessary action to protect life and property.
 2. **Flash Flood Warning** means that flooding is occurring within the warning area. Immediate action should be taken to protect life. Action to protect property should be taken during the flash flood watch phase.
- d. **Winter Storm** is a storm that produces at least 4 inches of frozen precipitation.
1. **Winter Storm Watch** is issued whenever there is a possibility of a winter storm within 24 hours. As with all watches, this is the time to take precautionary measures to

protect life and property.

2. **Winter Storm Warning** is issued when a winter storm is expected within 12 hours. As with all warnings take appropriate actions to protect life.
- e. **Snow Advisory** is what used to be called a traveller's advisory. A snow advisory is issued whenever weather conditions are expected to impede or make travel dangerous, but not at the level of a winter storm. Usually 1 to 3 inches of frozen precipitation.
- f. **Hurricane** is a tropical storm with winds in excess of 74 miles per hour.
 1. **Hurricane Watch** is issued up to several days before the possibility of a hurricane arriving. At this time, all preparations to protect property and preparations for evacuation should be done.
 2. **Hurricane Warning** is issued within 24 hours before the arrival of a hurricane. At the issuance of a hurricane warning, evacuation should occur. In some communities, evacuation may occur before a warning is issued due to the large number to be evacuated or because escape routes may become blocked early by rising water. Listen to local directives in this matter.

2. Physical Terminology

- a. **High Pressure System** is a region of relatively high pressure. Usually associated with clear skies. Circulation around a high is clockwise. With the wind to your back, the center of a high pressure system will be to your right. High pressure systems usually move from the northwest to the southeast.
- b. **Low Pressure System (Cyclone)** is a region of relative low pressure. Is is usually associated with clouds and precipitation. Circulation around a low pressure system is counterclockwise. With the wind to your back, a center of low

pressure will be to your left. Low pressure systems generally move from the southwest to the northeast.

- d. **Cold Front** is the dividing line between two air masses with the colder air replacing warmer air. The passage of a cold front through a region is usually associated with a brief (a few hours) period of precipitation which may include thunderstorms. Thunderstorms are more likely east of the Blue Ridge than west with a cold frontal passage.
- e. **Warm Front** is the dividing line between two air masses with the warmer air mass replacing the colder air mass. The passage of a warm front is usually associated with several hours of gentle rain and possible fog. Thunderstorms can occur but are less frequent than with a cold frontal passage.
- f. **Stationary Front** is the dividing line between two air masses in which neither air mass moves into the region occupied by the other air mass. The weather around stationary fronts can be unsettled for days at a time with periods of precipitation and periods of clearing. During the winter, the weather on either side of the front can vary a great deal over a very short distance with snow in the cold air and rain in the warm air and mixed precipitation around the front.
- g. **Precipitation** → liquid or solid water which falls from the sky and reaches the ground.
 - 1. **Rain** → liquid water that reaches the ground and is larger than drizzle.
 - 2. **Fog** → a cloud at ground level. Associated with very low visibility.
 - 3. **Snow** → frozen water vapor that forms into crystals.
 - 4. **Sleet** → frozen water pellets (also called ice pellets).

5. **Freezing Rain**→rain that freezes after it hits an exposed surface.

B. Weather Hazards

1. **Lighting**→a discharge of electricity during a thunderstorm.

- a. **Deaths** † or ☆ and **Injuries** *→ lighting is responsible for between 150 and 300 deaths a year in the U.S. In 1943, lighting killed 430 people in the U.S. Fifty-five percent (55%) more people are killed by lighting than by tornadoes and 44% more than by floods and hurricanes combined. The largest percentage of people killed by lighting are hikers, campers, golfers and others engaged in outdoor recreation. The greatest number of deaths from lighting occur in the Mid-Atlantic states (Auerbach and Geehr, ???; Golde and Lee, 1976). Most people who have been struck by lighting are not killed. Only about 30% of those struck by lighting will die due to the lighting strike. Roy "Dooms" Sullivan, a former ranger in the Shenandoah National Park, has been struck 7 times (Ahrens, 1988).
- b. **Occurrence**→lighting only occurs with a thunderstorm or tornadoes (or with thunderstorms or tornadoes associated with tropical storms).
- c. **Safety Tips**→
1. **Mountain Tops - GET OFF THE RIDGE LINE**, the worst place for someone to be in a lighting storm is on the ridge line, especially if it is an exposed ridge (Scheidegger, 1975). Get as far down into a valley as quickly as you can staying away from exposed areas and single trees. Thick growth of trees offer decent protection in most cases. Caves and ditches are also good as long as they are not flooded and thus capable of carrying a current. Once one is in a low protected place, crouch down and minimized your exposure to the ground (Ahrens, 1988).
 2. **Open Fields - SEEK SHELTER**; In all cases, the best protection is inside a sturdy building or a all metal vehicle such as a car. Tents are virtually

useless (Auerbach and Geehr, ???). If this is not possible, stay away from isolated trees, metal that would be a good conductor and hill tops. A near by forest is also a good choice for a natural shelter (Scheidegger, 1975). Take-off metal spiked shoes such as golf shoes. As above, ditches and caves can offer good protection as long as they are not flooded. Once you are in as a protected place as possible, crouch down as described above.

3. **Lakes and Rivers -GET TO SHORE**, you are the tallest object on the water. Some shelter may be possible under bridges, but remember, metal attracts lighting. Large boats should be properly grounded.

2. **Flooding**

a. **Deaths † or ‡ and Injuries ***→Flooding is responsible for the death of over 150 people a year in the U.S. In 1969, 114 people were killed and 37 remained missing in Nelson County, Virginia due to the flooding from remnants of Hurricane Camille.

b. **Occurrence**→Flash flooding can occur from thunderstorms or from a prolong period of rain in which the ground becomes saturated. Flash flooding is a particularly serious problems in the mountains of Virginia. An early warning system is presently being installed in some of the mountainous counties of southwestern Virginia. Urban flash flooding is also a problem in areas in which there has been a great deal of development. In this situation, streets can quickly flood and make driving very dangerous.

c. **Safety Tips**→ 1. **NEVER TRY TO DRIVE THROUGH A FLOODED ROAD**; this is one of the major causes of drowning associated with floods. The force behind water is tremendous. If the car stalls or is lifted by the water, the car could be washed down stream and the driver unable to escape. It is much harder to judge the true depth of water across a flooded road than most people realize. Go

around or wait until the water is gone.

2. DO NOT TRY TO WALK OR SWIM ACROSS A SWOLLEN STREAM OR STREETS. For the same reason above, the force of rushing water is very large and you will mostly likely be swept away.

3. ⚡Severe Thunderstorms

a. ⚡Deaths † or ☆ and Injuries ✱→Deaths due to severe thunderstorms are in excess of 300 per year in the U.S. The deaths are caused by lightning, flying debris, flooding and hail stones. Tornadoes may also form in severe thunderstorms. The damage from a severe thunderstorm is often mistakenly attributed to tornadoes. Severe thunderstorms are very dangerous even if they are not as "glamorous" as tornadoes.

b. ⚡Occurrence→Severe Thunderstorms can occur in any month and within any part of the Commonwealth. However, they are most common east of the Blue Ridge from April to September. They are associated with cold frontal passage and tropical storms. They can also develop from the afternoon and evening thunderstorm.

c. ⚡Safety Tips→Are basically the same as for lightning. A good sturdy building offers the best protection from lightning, flying debris and hail stones. For more details, look at the safety tips for lightning since this is the greatest danger in thunderstorm.

4. ⚡Tornadoes

a. ⚡Deaths † or ☆ and Injuries ✱→Around 100 people are killed every year in the U.S. by tornadoes. Injuries from tornadoes average several hundred a year.

b. ⚡Occurrence→Tornadoes are most common during the spring in the southeastern states except Virginia where the peak season is from July to September. The majority of tornadoes in Virginia are associated with tropical storms. Tornadoes can occur any time of the year and any place within the state but are most common east of the Blue Ridge. Virginia averages 5.5 tornadoes per year.

c. **☛Safety Tips☛** 1. **Open Field - Seek Shelter**; in a well constructed building (see building instructions below). If shelter is not possible, move at right angles to the movement of the tornado. Culverts, tunnels and under bridges are good location. If none of these is available, find a ditch and lie down in it and protect your head.

2. **Motor Vehicle - GET OUT OF YOUR VEHICLE**; Tornadoes will throw cars and trucks around like toys. If you are caught in traffic culverts offer the best protection on the side of the road. Strong sturdy buildings are also good choices.

3. **Buildings - INTERIOR BASEMENT OF A WELL CONSTRUCTED BUILDING - NEVER USE A MOBILE HOME FOR PROTECTION FROM A TORNADO**. Traditionally people were told the southwest corner of a house, however, recent research has shown this to be the worst place in a building. The safest location is the northeast corner of the basement. Second choice is the northeast corner and central part of the first floor (Eagleman, 1985). Stay out of auditoriums, gyms, movie theaters, "factory " type structures, etc. because their roofs are usually not well enough supported to withstand tornadoes.

C. Other Weather Hazards

1. Cold Weather

a. **☛Wind Chill Temperature☛** Is how cold the air feels to exposed skin. The higher the wind, the more heat that is moved away from the body and thus the harder the body must work to stay warm. Please note, the air has the physically properties corresponding to the actual temperature. Thus if the actual temperature is 40 F and the wind chill temperature is 20 F, water will not freeze; it will remain at 40 F (see handout).

b. **Beaufort Scale**→A method to estimate wind speed using smoke, flags, trees, etc. (see handout).

2. Hot Weather

a. **Humidity and Temperature**→Under hot and humid conditions the body must labor to stay cool. The combination of heat and humidity will lead to heat exhaustion and heat stroke. The National Weather Service had developed a humidity temperature index (HTI) for livestock. This also can be used to give an indication of the danger of outdoor activities (see handout).

b. **Sunburn**→For every 1000 ft. increase in elevation, ultraviolet light increases between 4 and 6 %. Therefore, the risk of sunburn is higher at higher elevations. Sunburns are also a hazard on cloudy days. It is not uncommon for people to be burned very severely on cloud days because clouds are not a good filter of uv light. On cloudy days, the normal warning of sunburn (heating of the skin) is not detected by our body.

D. Weather Forecasting In Virginia

1. **General Weather Patterns**→Precipitation occurs on average one day in three throughout the state. The wettest part of the Commonwealth is the tidewater area and the driest part is the Shenandoah Valley.

a. **December→February**→Highs generally in the 40's and lows in the 20's. Total snowfall will range from over 40 inches in the southwestern mountains to less than 10 inches in the tidewater and eastern shore. Temperatures in the mountains will be about 15 degrees lower. Lows around zero in the mountains are not uncommon.

b. **March→May**→A period of change. With winter weather possible through mid-April, while summer weather is common in May. March highs will generally be in the 50's with lows in the 30's. May highs are generally in the 70's and lows in the 40's. Temperatures in the mountains will be about 10 degrees lower.

c. **June→August**→Scatter afternoon and evening showers and thunderstorms. Highs around 90 and lows around 70. Temperatures

will be cooler in the mountains.

d. **September→November→Virginia at its finest.** In general, highs in the 70's and lows in the 50's during September. Highs in November in the 50's and lows in the 30's. Fall is characterized by low humidity and many clear days. Temperatures in the mountains will be about 10 degrees cooler.

2. **Topographic Effects**

a. **Large Scale Effects→**

1. **Temperature** - Temperature will normally decrease at a rate of 6 F per 1000 ft. Thus the crest of the Blue Ridge just outside of Charlottesville will normally be about 15 degrees colder than Charlottesville. The cooling rate of saturated air (fog) is around 3 F per 1000 ft. This effect of cooling with increasing elevation is due to the decrease in pressure with height and the ideal gas law relationship ($PV=nRT$). At night, localized depressions will act as cold sinks with temperatures running as much as 10 degrees colder than nearby high ground. This effect is due to the fact that cold air is more dense than warm air and thus will settle into low spots. These two effects work in tandem and often lead to the warmest night-time temperatures at around 1500 ft.

2. **Wind** - Is generally higher at higher elevations. Wind is also usually higher near or on large bodies of water.

3. **Rainfall** - The mountains can enhance or diminish the amount of precipitation an area gets. The eastern flank of the Blue Ridge is known to have a major enhancement effect when lower pressure systems move up from the south. Remnants of hurricanes have caused tremendous loss of life and property in the counties on the eastern slopes of the Blue

Ridge. The mountains of West Virginia had the effect of decreasing the amount of precipitation that Virginia receives from storms move in from the west. The Shenandoah Valley, being protected on both sides by mountains is the driest place in the eastern U.S.

b. Microclimate

1. **☞ Temperature**→At night, anything that will block radiation escape from near the ground will serve to keep the micro-environment warmer. In the outdoors, trees (especially if they have leaves) will serve this purpose if shelter is not available. Also, anything that will prevent mixing of the air by the wind will help keep it warmer. The coldest places on calm clear nights will be localized depressions or valleys while small hills will normally be warmer. Everything else being equal cloudy days will be colder than clear days and cloudy nights will be warmer than clear nights.

2. **☞ Wind**→Will be less in protected areas such as in a forest or a depression. Wind will be greatest on tops of hills.

3. Weather Forecasting Tips

a. **☞ Rising Or Falling Barometer For Several Hours**→An indication of an approaching low pressure system with a falling barometer; precipitation is thus possible. A rising barometer is associated with clearing or with the weather remaining clear.

b. **☞ Surface Winds**→From the north, remaining cold. From the south, a warming trend. Winds from the northwest are associated with a cold frontal passage, thus a cooling trend can be expected.

c. **☞ Upper Altitude Winds**→Brisk upper level winds from the southwest are indication that a cold front is near by and will probably move through the area within 12 to 24 hours. Northwestern winds aloft are a indication that a cold front has moved through aloft.

d. ☞ Cloud Types

1. ☞ Cirrus → Rain in 24 to 36 hours.

2. ☞ Cumulonimbus → Thunderstorms

3. ☞ Stratus → Long (12 hours +), steady, light to moderate rain

4. ☞ Cumulus → Fair weather clouds (unless they are towering, then thundershowers or thunderstorms).

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Wind speed (mph)	Actual thermometer reading (°F)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent temperature (°F)											
5	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
10	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
15	40	28	16	4	-9	-21	-33	-46	-58	-70		
20	36	22	9	-5	-18	-36	-45	-58	-72			
25	32	18	4	-10	-25	-39	-53	-67				
30	30	16	0	-15	-29	-44	-59					
35	28	13	-2	-18	-33	-48	-63					
40	27	11	-4	-20	-35	-49	-67					
	26	10	-6	-21	-37	-53	-69					
Wind speeds greater than 40 mph have little additional effect	<div> <div>Little danger (for properly clothed person)</div> <div>Increasing danger</div> </div>											

FIGURE 13-7 Wind-chill equivalent temperatures.

Beaufort Scale

FORCE	DESCRIPTION	HUMAN ACTIVITY	WHOLE PLANTS	SEED & LEAF	BIRDS	INVERTEBRATES
0	CALM	Smoke rises vertically	Still	Plumed seeds fall in less than 10 secs.	All active	Gossamer seen in air
1	LIGHT AIR	Smoke drifts	Still	Light plumed seeds airborne	Thermals with many soarers	Aphids fly Spiders take off
2	LIGHT BREEZE	Wind felt on face	Leaves rustle	Willow seeds in clouds	Few thermals	All species active
3	GENTLE BREEZE	Dust raised	Twigs move	Winged seeds glide	No thermals	Hoppers, aphids spiders grounded
4	MODERATE BREEZE	Hair disturbed Clothing flaps	Small branches move	All plumed seed airborne	Peak activity for sea soarers	Beetles grounded Mosquitoes, gnats stop biting
5	FRESH BREEZE	Eye discomfort from airborne matter	Tumbleweed roll Small leafy tree sways	Leaves airborne	Nocturnal migrations stop	Flies grounded, except horse & deer flies
6	STRONG BREEZE	Arms blown out from sides	Large branches move	All leaves & seeds airborne	Few small perching birds in flight	Moths & bees grounded
BIOLOGICAL WIND THRESHOLD						
7	MODERATE GALE	Walking becomes difficult	Whole trees move	Loose matter airborne	Small perching birds grounded	Butterflies & deerfly grounded
8	FRESH GALE	General progress impeded	Twigs break	Remains so	Swifts, ducks, swallows, few raptors flying	Only dragonflies still airborne
9	STRONG GALE	Children blown over	Branches break	—	Only swifts airborne	All insects grounded
10	WHOLE GALE	Adults blown over	Trees uprooted	—	All birds grounded	—

Watson.
1984.
Heaven's
Breath: A
Natural
History of
Wind.

Rosenberg, Bland and Verma, 1983. Microclimate^a The Biological Environment

Table 12.8 Livestock Weather Safety Index^a

Dry-bulb temperature (°C)	Relative humidity (%)																			
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
23.9									70	70	71	71	72	72	73	73	74	74	75	75
24.5								70	70	71	72	72	72	73	74	74	74	75	76	76
25.0						70	70	71	71	72	72	73	73	74	74	75	75	76	76	77
25.5					70	70	71	71	72	72	73	74	74	75	75	76	76	77	78	78
26.1				70	70	71	72	72	73	73	74	74	74	76	76	77	77	78	78	79
26.7			70	70	71	72	72	73	73	74	74	75	75	77	77	78	78	79	79	80
27.2		70	70	71	71	72	73	73	74	75	75	76	76	77	78	78	79	80	80	81
27.8		70	71	71	72	73	73	74	75	75	76	77	77	78	79	79	80	81	81	82
28.3		71	71	72	73	73	74	75	75	76	77	78	78	79	80	80	81	82	81	83
28.9		70	71	72	72	73	74	75	75	76	77	78	78	79	80	80	81	82	83	84
29.4		71	72	72	73	74	75	75	76	77	78	78	79	80	81	81	82	83	84	85
30.0		71	72	73	74	74	75	76	77	78	78	79	80	81	81	82	83	84	84	86
30.6		72	73	73	74	75	76	77	77	78	79	80	81	81	82	83	84	85	85	87
31.1		72	73	74	75	76	76	77	78	79	80	81	82	83	84	85	85	86	86	88
31.7		73	74	74	75	76	77	78	79	80	80	81	82	83	84	85	86	86	87	89
32.2		73	74	75	76	77	78	79	79	80	81	82	83	84	85	86	87	87	88	90
32.8		74	75	76	76	77	78	79	80	81	82	83	84	85	86	86	87	88	89	92
33.3		74	75	76	77	78	79	80	81	82	83	84	84	85	86	87	88	89	90	
33.9		75	76	77	78	79	80	80	81	82	83	84	85	87	88	89	90			
34.4		75	76	77	78	79	80	81	82	83	84	85	86	88	89	90				
35.0		76	77	78	79	80	81	82	83	84	85	86	87	88	89	90				
35.6		76	77	78	79	80	81	82	84	84	86	87	88	89	90	91				
36.1		77	78	79	80	81	82	83	84	85	86	88	88	90	91					
36.7		77	78	79	80	82	82	84	85	86	87	88	89	90						
37.2		78	79	80	81	82	83	84	86	87	88	89	90							
37.8		78	79	80	82	84	84	85	86	87	88	90	91							
40.6		80	82	83	84	86	87	89	90	91										

^a The values in the table correspond to each combination of temperature and relative humidity. Values between the lines indicate alert, danger, and emergency categories. See text for explanation. Adapted from U.S. National Weather Service (1976).