



Analyze Weather in Cold Regions and Mountainous Terrain





Terminal Learning Objective

Action: Analyze weather of cold regions and mountainous terrain

Condition: Given a training mission that involves a specified route or location on the ground or a map in a cold region, a map sheet of the route/location, a current weather forecast for the general area, altimeter and/or barometer (if available) and any other pertinent weather information or data.

Standard: Analyze the weather for the route/location in terms of visibility, survivability and mobility and determine how each of these aspects affects the training/mission.



Forces that create weather:



Sun, air movement, earth's rotation, oceans and land masses, cold fronts and warm fronts

Weather depends upon:

Air temperature, humidity, air pressure, how air is being moved and if the air is being lifted or not

You should observe:

Clouds, air pressure, wind direction/speed, temperature and humidity to help predict weather

Some tools that you can use are thermometer, barometer/altimeter and wind meter.



The Sun:

- **is the major force behind the weather**
- **does not heat the earth evenly; at the equator it heats the earth's surface with greater intensity than it does at the poles**
- **uneven heating results in air movement; temperature variations are ultimately responsible for all weather**



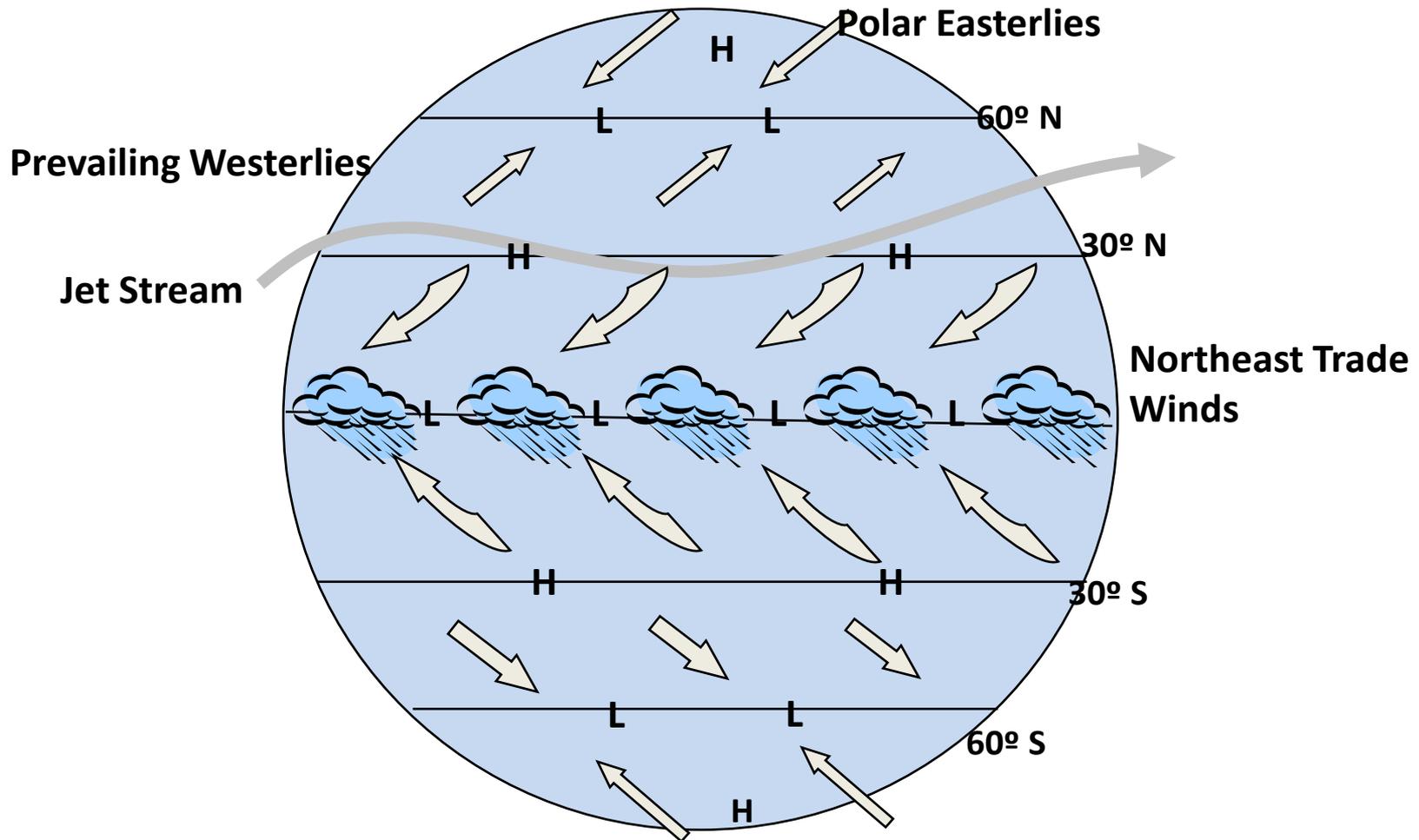
Air Movement



- Air pressure is the weight of the atmosphere at any given place.
- Air that is cooled, sinks and is dense (heavier) air – therefore the air pressure is high.
- Air that is heated is less dense and rises – therefore the air pressure is low.
- The higher in altitude you go, the lower the air pressure will be.



Earth's Rotation





Oceans and Land Masses



Maritime Zones:

- influenced by large bodies of water
- moderate to heavy precipitation is typical (deep snow pack)
- cool, wet summers and moderate, wet winters
- freeze thaw cycles more common in winter

Continental Zones:

- inland areas; influenced by large land mass
- moderate to light precipitation is typical (shallow snow pack)
- hot summers, very cold winters
- freeze thaw cycles are rare in winter



Fronts

Warm Front: warm air mass moves into and over a slower or stationary cold air mass; warm air is less dense and therefore moves up and over the cold air mass

Cold Front: cold air mass overtakes a slower or stationary warm air mass; cold air forces the warm air up

Occluded Front: Combination of warm front and cold front characteristics; occurs frequently over land

Stationary Front: no significant air movement is occurring



HUMIDITY

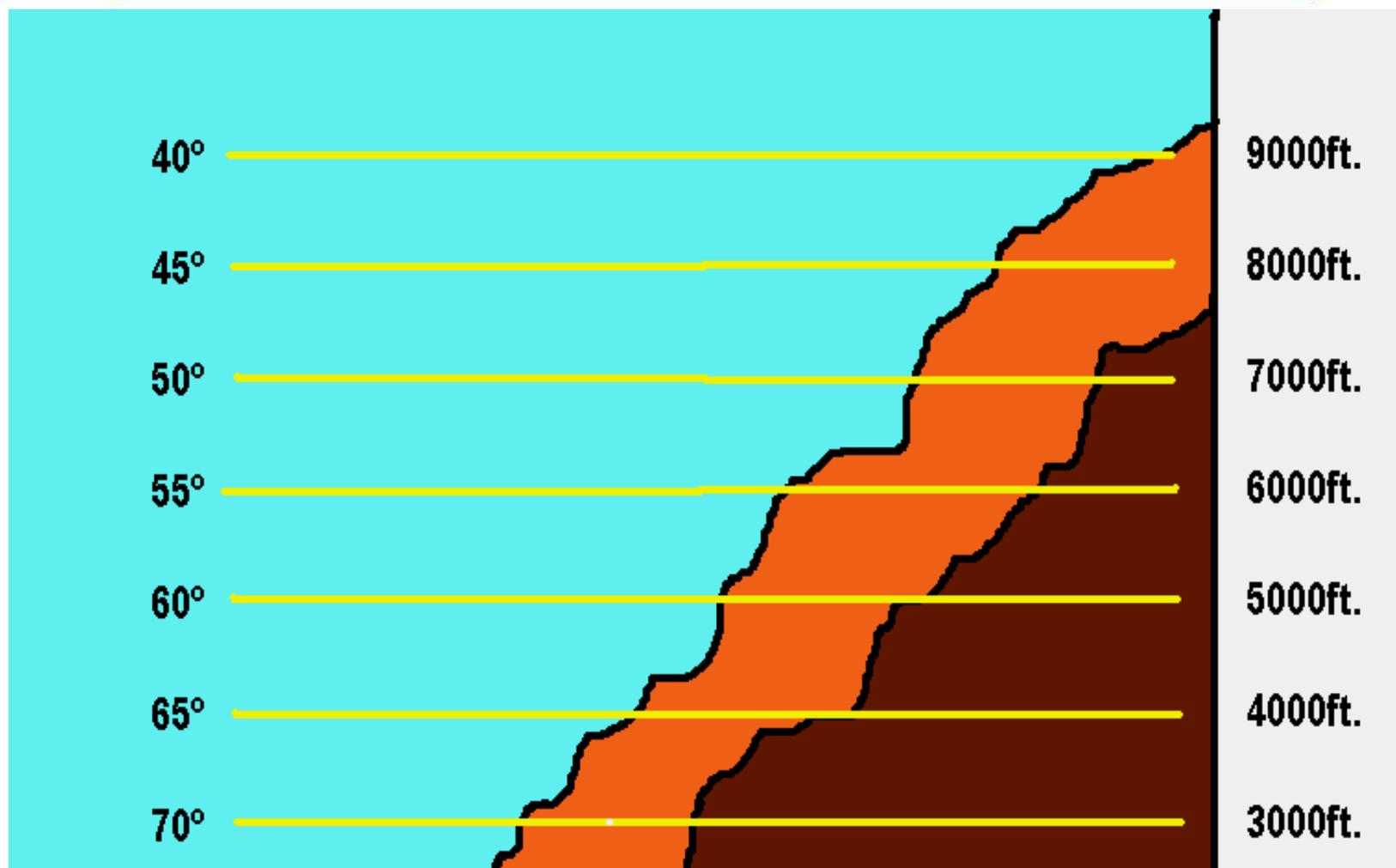


Humidity is the amount of moisture in the air

- **Warm air can hold more moisture. Saturation=100% humidity**
- **If air is cooled beyond saturation point it will be released. Fog, rain, snow etc.**
- **Dew point is the temperature at which condensation occurs. Either dew or frost.**
- **Adiabatic lapse rate- temperature drops 3-5 degrees Fahrenheit per 1000 feet of elevation.**



Adiabatic Lapse Rate





Formation of Clouds

Convective Lifting: Sun's heat radiating off the earth's surface causing air currents (thermals) to rise straight up and lift air to point of saturation.

Frontal Lifting: A front is formed when two air masses of different moisture content and temperature collide. Air masses will not mix, so the warmer air will lift until it reaches its saturation point. Produces majority of precipitation.

Cyclonic Lifting: An area of low pressure pulls air into its center from all over in a counterclockwise direction. When air reaches the center of low pressure, it has nowhere to go but up. Air continues to lift until it reaches the saturation point.



Formation of Clouds

Orographic Lifting: This happens when an air mass is pushed up and over a mass of higher ground such as a mountain. This is typical along coast regions with mountains. As the air mass moves up the mountain range, the moisture is released quickly and typically produces heavy precipitation. This is evident in the Cascade Range of the Pacific Northwest.



Cloud Types

Low Level

Mid Level

High Level

Vertical-Development Clouds

Less Common Clouds



Cloud Types

Low-Level Clouds: Either Cumulus or Stratus; mostly composed of water; two of the precipitating low level clouds are Nimbostratus clouds and Stratocumulus clouds. 0-6500 feet.



Cumulus Clouds: Low Level; Fair Weather





Stratus Clouds, Low Level: Fair Weather, Light Precipitation





Nimbostratus Clouds: Low Level



NORTHERN WARFARE TRAINING CENTER • "Battle Cold and Conquer Mountains"



Stratocumulus Clouds: Low Level



NORTHERN WARFARE TRAINING CENTER • "Battle Cold and Conquer Mountains"



Cloud Types

Mid-Level Clouds: Middle clouds generally indicate fair weather, especially if they are rising over time. These clouds have the prefix 'alto'. Deteriorating weather is indicated by lowering middle clouds though these storms are usually hours away. 6500 to 20,000 feet.



Alto cumulus Clouds: Mid Level





Altostratus Clouds: Mid Level





Cloud Types

High-Level Clouds: These clouds are in the upper reaches of the troposphere (+20,000ft) and indicate moisture aloft and that precipitation is 24-36 hours away. Cirrus and Cirrostratus are the most common. The only indicators of these clouds may be a halo or ring around the moon or sun.



Cirrus Clouds: High Level





Cirrostratus Clouds: High Level





Vertical Development Cloud Formations



- **Cumulonimbus:** generally in the shape of anvils. Produce the majority of thunderstorms.
- **+39,000 ft.**
- **Generally start as cumulus that bunch together and begin to build by convective lifting. The result is usually afternoon thunderstorms.**
- **Can be violent with high wind, hail, lightning and possibly tornados. Fairly short lived.**



Cumulonimbus Clouds: Thunderhead





Less Common Cloud Formations



Orographic or Lenticular Clouds: Look similar to contact lenses.
Indicate poor weather in the near future.

Contrails: Exhaust from jets creates clouds in the upper atmosphere;
evaporate quickly in fair weather; contrails that takes longer than 2
hours to evaporate indicate impending bad weather



Lenticular Clouds



NORTHERN WARFARE TRAINING CENTER • "Battle Cold and Conquer Mountains"



Lenticular Clouds



NORTHERN WARFARE TRAINING CENTER • "Battle Cold and Conquer Mountains"



Weather Prediction

Some of the indicators that weather conditions will change/deteriorate significantly in the near future are:

- **lenticular cloud formation**
- **cirrus clouds or halo around sun or moon (24-36 hours)**
- **thunderheads (cumulonimbus)**
- **thickening, lowering clouds**
- **falling barometer - decreasing barometric pressure**
- **general warming temperatures**
- **marked wind increases or direction shifts**
- **contrails that do not dissipate after 2 hours**



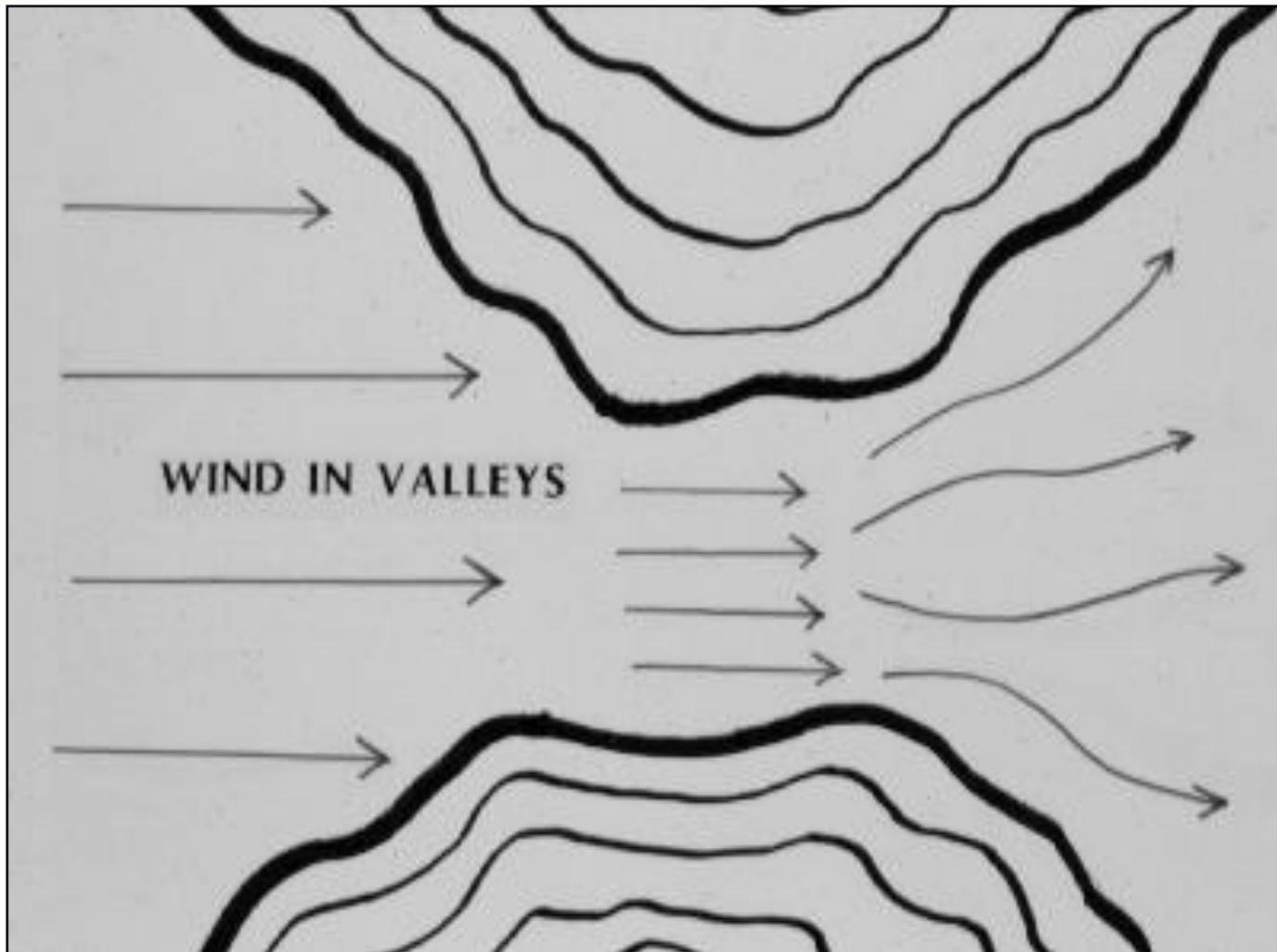
Winds



- **Velocity increases with altitude and is further enhanced by rapid rise over mountain barrier (orographic lifting)**
- **Velocity increases as wind funnels through narrowing valleys and passes (venturi effect)**
- **As the wind speed doubles, its force on an object quadruples**
- **Wind chill is another hazard created by winds**



Wind velocity increases as it moves through a narrow pass or col.





Wind Chill

AIR TEMPERATURE IN FAHRENHEIT

WIND SPEED	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95

WIND SPEED BASED ON MEASURES AT 33 FEET HEIGHT. IF WIND SPEED MEASURED AT GROUND LEVEL, MULTIPLY

BY 1.5 TO OBTAIN WIND SPEED AT 33 FEET IN HEIGHT AND THEN UTILIZE CHART.



Ice Fog



- **Temperatures are -30° F or colder; heat or vapor source present and still air conditions**
- **Obscures vision and target recognition**
- **Hinders movement**
- **Leaves signature when weapons are fired or vehicles are operated**
- **Numerous supplementary positions are needed for weapons**
- **Can be used to conceal your movement**



Blizzard



- **High winds**
- **Blowing snow**
- **Reduced visibility**
- **Usually lasts 24 hours or less**



Whiteout

Loss of Depth Perception

Units Should Stop and Wait Condition out





Temperature Inversion

- **Cold air settles in low areas; warm air settles on top of cold**
- **Can be 20°F difference**
- **Bivouac site selection in this narrow band of elevation.**
- **Expect to see it in river valleys especially during periods of calm winds.**
- **Can be visible from higher elevation in the form of ice fog filling a valley**



Looming

- **Optical illusion that causes objects to appear closer than they actually are; causes problems with range estimation**
- **Normally occurs in extreme cold or hot dry air**



Chinook Winds

These are warm, dry winds that occur in the lee of high mountain ranges. It is a fairly common wintertime phenomena in the mountainous west and in parts of Alaska. These winds develop in well-defined areas and can be quite strong.



Aurora Borealis

- **Caused by Charged Particles Produced by the Sun**
- **Occur All Year**
- **Aurora Borealis Activity Can Adversely Effect AM and satellite communications but may enhance FM communications**
- **In Southern Hemisphere Called Aurora Australis**



Aurora Borealis





Lightning

- **Thunderstorm conditions occur more frequently in continental ranges than maritime ranges**
- **Topography of mountains contributes to the formation of thunderstorms**
- **Ridges and peaks are focal points for lightning**



Precautions in a Lightning Storm



You should:

- **avoid high risk areas for bivouacs such as peaks and high passes**
- **take note of building cumulonimbus clouds and plan to be in a low risk area as the day progresses**
- **seek lower ground if you are caught by a fast moving storm**
- **avoid wet lichen covered rock, drainages, standing under tall trees, crouching in shallow caves or under overhangs and being connected to climbing ropes**
- **insulate yourself from the ground; squat or sit on a sleeping pad or a bunched up climbing rope for example**
- **be spaced at least 15 feet apart from other individuals**



Summary

Action: Analyze weather of cold regions and mountainous terrain

Condition: Given a training mission that involves a specified route or location on the ground or a map in a cold region, a map sheet of the route/location, a current weather forecast for the general area, altimeter and/or barometer (if available) and any other pertinent weather information or data.

Standard: Analyze the weather for the route/location in terms of visibility, survivability and mobility and determine how each of these aspects affects the training mission.