Weather Observations and Ice Assessment

Antarctic Weather

Weather in Antarctica is characterized by extremes: extreme temperatures, extreme winds, and extremely variable local conditions. Weather conditions vary widely, depending on elevation, topography, and distance from the ocean. Temperatures can vary from below -40°F (-40°C) to well above freezing during the course of an austral summer. The polar plateau is very cold because of its higher altitude and distance from the moderating effect of the sea, while areas near the coast can be subject to heavy precipitation and warm days with intense sunlight.

Winds can range from light to sustained hurricane strength, and it's an unusual day when there is not at least a breeze blowing. The wind takes its toll on people, making camp chores, such as setting up tents, difficult. Improperly anchored tents can blow away or be ripped apart. Tent guy-lines must be continually re-tensioned. More importantly, wind chill increases the risk of hypothermia and frostbite. (The wind chill chart in the reference section shows the effect of wind on perceived temperature.) All of this makes Antarctica a challenging place to work and live.

During the austral summer, conditions along the Antarctic Peninsula are characterized by wet, cold, windy weather. Palmer Station receives 28 inches of rain annually. During the summer, precipitation occurs approximately 22 to 24 days each month, and it can rain or snow at any time. Winds exceeding 20 knots are normal, and speeds in excess of 40 knots are not uncommon. Peninsula field camps can expect to experience similar weather conditions.

Past reports and weather data can help remote field parties plan for weather conditions at a given site. Still, it is best to expect the unexpected when it comes to weather.

Working in the Peninsula Environment

No matter what the weather is doing, boating or working aboard a research vessel are wet activities. No matter where researchers may find themselves along the Peninsula, combining wet conditions with just-above-freezing temperatures can create a work environment that varies from unpleasant to potentially dangerous if proper clothing is not worn.

The ability to install, service, or remove a field camp is heavily dependent on sea conditions. Rough seas or heavy surf can render a normally ideal location unsafe for operations. In addition, storms can radically change the shoreline by blowing in and grounding large icebergs or rafts of sea ice or brash ice.

In addition to weather and sea state considerations, many shore landings are tidally dependent; camp put-ins and pull-outs have to be timed around either high or low tides. A high or low tide can change the distance gear needs to be carried by several hundred feet. It can also turn a calm landing into one with breaking surf, or bring underwater hazards to the surface. Some camp installations will take many hours, and the landing site may change over the course of the operation.

These factors will also affect operations once the camp is installed. Conditions at a shoreline used for waste disposal or for transit to and from study sites may alter rapidly, as waves, storms, and ice remake the coastline. Since the easiest routes to transit at some locations will be along the shoreline, be aware of the initial tidal range at each location and remember that storms and lunar phases can increase that range.

Antarctic Weather Forecasting

Weather forecasting for U.S. Antarctic stations is done under the auspices of the National Science Foundation and is coordinated through the SPAWAR (Space and Naval Warfare) Systems Center in Charleston, South Carolina. SPAWAR also has a presence at McMurdo Station. Compared to most places in the world, Antarctic weather forecasters have fewer data collection sites upon which to base their forecasting models. Forecasters rely heavily on weather observations called in from remote field sites. They also use satellite imagery, data from automated weather stations, and a weather modeling system, the Antarctic Mesoscale Prediction System (AMPS), which produces twice daily forecasts for the Antarctic continent.

Both USAP research vessels receive weather forecasts for their current location and their expected location in 24 hours. If either vessel is working in the same area as a field camp, vessel personnel can relay weather forecasts to the field team.

If a field camp is located near Palmer Station, VHF marine radios can receive a continuous broadcast of weather conditions on Channel WX 1 (162.550 MHz). If a camp's daily check-in is with Palmer Station, station personnel can pass along a Palmer area forecast at that time.

For field camps not in the Palmer area, especially those farther north on the Peninsula, team members should check with the Peninsula field supervisor before camp put-in to determine if there are any international research stations nearby. These stations might have weather forecasting capabilities.

Field Party Weather Observations

Observing weather conditions at a camp is important for making safe decisions about daily activities. Field team members should maintain awareness of changing weather conditions and take particular note of drops in barometric pressure. Watch for changes in cloud coverage or appearance, changes in wind direction or intensity, rapid changes in temperature, decreasing visibility, increasing precipitation, and changing ocean conditions.

Take note of sea and ice conditions daily to ensure safe operations. As the pull-out date approaches, pay specific attention to the landing site. Assess beach, ice, and surf conditions. If they vary significantly from conditions at put-in, relay this information to the MPC. Any large icebergs, rafting ice, changes to snow and/or ice berms, or other changes to beach conditions should be reported. Scout out alternate landing sites if access to the primary site is obstructed.

Prepare early for shelter from storms. Have a pre-determined set of weather guidelines for field parties. Be aware of the increased risk of hypothermia due to wind chill. Blizzards and white-out conditions can make any travel hazardous. Double-check the camp area to make sure all equipment and supplies are secure. Check all tent anchors and guy lines before gale force winds arrive. Storms with strong winds may be accompanied by storm surges and ice deposition on the shoreline. Make sure all gear is secured well above the high tide line and any potential surge.

Setting Up the Handheld Weather Meter (Kestrel®)

Weather observers in remote locations often use a handheld weather meter to measure wind speed, temperature, dew point, and pressure. The handheld weather meter discussed in this manual is the Kestrel® 4000. Observers using a different meter should refer to the user instructions for that meter.

The Kestrel® 4000 is available from the Peninsula field supervisor. The field team member picking up the equipment should ensure the Kestrel is set to measure temperature in Celsius, wind speed in knots, and altitude in feet. Extra batteries should also be obtained, in case the installed batteries lose power in the field.

The Kestrel should be stored in an inside coat pocket or a warm area when not in use. The liquid crystal screen will function only at temperatures above -10°C (-14°F). At colder temperatures, the screen will be sluggish and eventually fade, although the device will still record data. The Kestrel should be returned to a warm, inside coat pocket as soon as possible after use.

Setting a Reference Altitude and Barometric Pressure on the Kestrel®

Most field camps put in by small boat from the vessels will be operating at or very near sea level. If a camp is supported by helicopter, obtain the site's altitude in feet from the pilot. (Be sure to notify the pilot in advance so he or she knows to provide this information before departing.)

1. Be sure the Kestrel is set with feet as its default altitude measurement.
2. Navigate to the barometric pressure (BARO) screen and press the center COMMAND button to enter.
3. On the screen, go to the reference altitude (Ref Alt) line.
4. Use the left and right buttons to increase or decrease its value to equal the altitude in feet (0 at sea level). Notice that the barometric pressure reading changes in response to changes in the altitude number.
5. Press the COMMAND button to save and exit the adjustment mode.
6. Next, go to the altitude screen and navigate to the reference pressure line.
7. Enter the barometric pressure number now shown in the BARO screen.

Since the Kestrel is used to monitor barometric pressure for weather reporting, it should be kept in the same location (i.e., at the same altitude), because the pressure will change with changes in altitude.

Sea Ice Assessment

There is no regular forecasting or analysis available for travel on Peninsula sea ice. Be extremely conservative. Pay attention to weather conditions, ice thickness, ice color, ice temperature, and cracks. The remoteness of a field camp means that other members of the field party will often be the only viable rescue option.

Field parties can obtain current and historical satellite imagery for research areas from the Polar Geospatial Center, the ASC remote sensing analyst, or the Palmer Station research associate. The remote sensing analyst can also provide near-real-time sea ice conditions for vessel movements.

Weather Considerations

Poor weather conditions will obscure surface definition, making it difficult or impossible to detect cracks in the ice. Use extra caution if surface definition or visibility is poor, especially in low light conditions. Strong winds can be particularly dangerous, especially at the ice edge, where large chunks of the sea ice can break off and blow away with little warning.

Ice Thickness

Strong currents can erode the ice from below. This is hazardous because there may be no obvious indication of thinning at the surface. Strong currents typically occur later in the season and usually over underwater shoals. Land formations that indicate a potential shoal are long, low-angle ridges or peninsulas that descend into the sea. However, shoals can also occur offshore of steep slopes. In addition, as the air and sea temperature rise later in the season, the sea ice becomes progressively weaker and thinner everywhere.

Ice Color

The color of the sea ice is a good indication of its thickness and safety. In general, white or milky blue ice is the safest. These colors indicate solid ice 24 or more inches thick. Ice that is sky blue and has a slick, scalloped surface is multi-year ice that is several feet thick.

Ice of different ages and thickness will be marked by a thin line on the surface and, usually, slight differences in elevation. If the color of the ice changes abruptly, travelers should stop immediately and investigate. Darker ice indicates a hazard. Ice that is young or has thinned to six inches or less will appear grayish, even beneath a thin crust of snow. This ice may support an adult on skis but should never be traversed in a vehicle. Gray ice can also form as a result of surface flooding and subsequent freezing of the surface water, which often occurs at tidal cracks. It is always important to investi gate areas of gray ice. Ice that appears black is very thin and should be avoided at all times.

When traveling on sea ice, field team members should drill the ice every 100 meters if the ice surface is consistent, and much more frequently if there are variations in color or texture.

Ice Temperature

The colder the ambient air temperature, the more the ice grows and the colder the sea ice becomes. The colder the ice, the stronger the overall structure. Just looking at the surface will not disclose the true strength of the ice. Sea ice strength is measured according to four ice temperature periods (see table below). Period 1 ice is the strongest. As the ice gets warmer, it requires more thickness to carry the same weight.

Period 1	Period 2	Period 3	Period 4
<14° F	14°- 23° F	23°- 27° F	27°- 28.5° F

Sea Ice Cracks

Cracks are fissures or fractures in the sea ice that form in response to environmental, geographical, and mechanical pressures, such as currents, wind, waves, tidal action, and the pressure applied by ice shelves and glaciers. Tidal cracks form along coastlines and around islands, grounded icebergs, and glacier tongues. Other cracks radiate out from the land, especially from headlands and glacier tongues, like the spokes of a wheel.

Cracks should be avoided whenever possible. If crossing one is unavoidable, cross it in a line perpendicular to the crack. Never cross a system of multiple, closely set cracks in a manner that places a snowmobile on more than one crack at a time or on a small piece of ice between two cracks. Avoid sets of cracks that form triangular wedges. These could break off and turn over under the weight of a snowmobile.

Snow cover on the sea ice can completely hide cracks or open water within cracks. Look for continuous linear features and sagging areas of snow, sometimes of different color tones. Watch for areas where snow has drifted differently, especially if the drifted area is in a long, straight line. Good visibility and lighting are essential to seeing these features. Also, pay attention to seals or signs of seals, such as feces, urine, seal shadows, and breathing holes. Their presence anywhere on the sea ice indicates the presence of a crack. Seal breathing holes may become covered and obscured by thin ice or snow. A small mound of ice or snow on the otherwise flat surface of the sea ice may indicate the presence of a breathing hole.

Crack Types

There are four general types of sea-ice crack:

- Tidal
- Straight edge
- Working (active)
- Pressure ridge

The Peninsula field supervisor will discuss these during sea-ice training, if applicable to a research team. Field party members working on the sea ice should learn to identify and evaluate each type.

How to Profile a Sea-Ice Crack

Stop the vehicle before reaching a crack and check for other cracks nearby.

1. Determine the nearest edge of the crack by removing snow down to bare ice.
2. Using an ice ax, probe for open water or weak spots to determine if it is safe to cross by foot.
3. If it is safe, shovel the snow out of the crack from edge to edge, clearing at least one shovel blade width.
4. Drill holes every 12 inches in a straight line, beginning outside one crack edge and ending outside the other, making certain to drill healed shelves and any visible fractures.
5. Drill each hole either to water level or to a full Kovaks drill flight length (>30 inches).
6. Measure the ice thickness in each hole.
7. Pay attention to the characteristics of the ice shavings (dry, moist, or slushy).

Sea Ice Crack Safety Standards

Effective crack width is the distance over which the sea ice in a crack is less than the minimum required for a vehicle, based on ice period. The effective width cannot exceed 1/3 of a snowmobile track length. Use the following guidelines to determine the required ice thickness and effective width for a snowmobile.

Sea Ice Crack Guidelines for Snowmobiles

Maximum Effective Crack Width (inches) for snowmobile	Minimum Ice Thickness (inches)			
	Period 1	Period 2	Period 3	Period 4
20	5	5	6	7
** If towing a sled or trailer, different ice thickness requirements may apply. Please contact the Peninsula field supervisor for more information.*				

Sea Ice Crack Profile Example