
WEATHER
AND SEA ICE

Antarctic Weather

Weather in Antarctica is characterized by extremes in temperature, wind and the variability of local conditions, making Antarctica a challenging place to work and live. Weather conditions also depend substantially on elevation, topography and distance from the ocean. Temperatures can vary from below -40°C (-40°F) to above freezing (0°C, or 32°F) during the austral summer. Unlike the polar plateau, which is extremely cold due to its higher altitude and distance from the moderating effects of the seas, Peninsula areas can be subject to heavy precipitation and warm days with intense sunlight.

Winds can range from light to sustained hurricane strength. It is an unusual day when there is not at least a breeze. The wind can take its toll on people, making tent setup and other camp chore difficult. Improperly anchored tents can blow away or rip apart. Tent guylines must be continually retensioned. And wind chill raises the risk of hypothermia and frostbite. The wind chill chart in the References section shows how wind affects how we experience temperature.

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

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

Working in the Peninsula Environment

Regardless of the weather or where you are on along the Peninsula, boating, field work or working aboard a research vessel are wet activities. Combined with just-above-freezing

temperatures makes for a work environment that ranges from unpleasant to dangerous.

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

Many shore landings also depend on tides. Camp put-ins and takeouts must be timed around high or low tides, which can change the distance that gear needs to be carried by several hundred feet. Tides can also turn a calm landing into one with breaking surf or bring underwater hazards to the surface. Some camp installations take many hours, and the landing site may change throughout the operation.

These factors 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. For some locations, the easiest transiting routes are along shore, so be aware of the initial tidal range at each location and remember that storms and lunar phases can increase that range. Mark high and low tide levels with flagging, and make daily observations.

Forecasting

Weather forecasting for USAP is done under the auspices of NSF and coordinated through the Naval Information Warfare Center Atlantic (NIWC). NIWC also has a presence at McMurdo Station. Antarctic weather forecasters have fewer data collection sites to feed their forecasting models than do forecasters elsewhere in the world. Antarctic forecasters rely heavily on weather observations called in from remote field sites. They also use satellite imagery, data from automated weather stations, and the Antarctic Mesoscale Prediction System, which produces twice daily forecasts for the Antarctic continent. USAP support 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 am area forecast at that time.

For field camps outside Palmer Station, the Peninsula field supervisor can help determine the best location and method for transmitting a weather forecast to the camp. Nearby international research stations may have weather forecasting capabilities, or weather may be relayed during the daily camp check-in.

Weather Observations in the Field

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 note drops in barometric pressure, which signal changing weather and potentially an approaching storm. Watch for changes in cloud cover or appearance, changes in wind direction or intensity, rapid changes in temperature, decreasing visibility, increasing precipitation and changing ocean conditions.

Note sea and ice conditions daily to ensure safe operations. Late in the field season, sea ice can form quickly and cut off boat access. As the takeout 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 POC. Report any large icebergs, rafting ice, changes to snow or ice berms or other changes to beach conditions. Scout out alternate landing sites if access to the primary site is obstructed.

Prepare early for shelter from storms. Have a predetermined set of weather guidelines for field parties. Be aware of the increased risk of hypothermia due to wind chill. Blizzards and whiteout conditions can make any travel hazardous. Double-check the camp area to ensure all equipment and supplies are secure. Check all tent anchors and guylines before gale force

winds arrive. Storms with strong winds may be accompanied by storm surges and ice deposits on the shoreline. Secure all gear well above the high tide line and any potential surge.

Kestrel Setup

Weather observers in remote locations often use a Kestrel handheld weather meter to measure wind speed, temperature, dew point and pressure. This manual covers the Kestrel 4000. Observers using a different meter should refer to its user instructions.

The Kestrel 4000 is available from the Peninsula field supervisor during gear issue in Punta Arenas. The field team member picking up the equipment must ensure the Kestrel is set to measure temperature in degrees Celsius, wind speed in knots, and altitude in feet. Also carry extra batteries in case the installed batteries lose power in the field.

Store the Kestrel 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 is sluggish and eventually fades, although the device will still record data. Return the Kestrel to a warm, inside coat pocket as soon as possible after use.

Reference Altitude and Barometric Pressure

Most field camps put in by small boat from a vessel will be operating at or 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 they know to provide this information before departing.

Navigate to the barometric pressure (BARO) screen and press the center COMMAND button to enter. On the screen, go to the reference altitude (Ref Alt) line. Use the left and right buttons to increase or decrease its value to equal the altitude in feet (0 at sea level). Ensure the Kestrel is set with feet as its default altitude measurement. Notice that the barometric pressure reading changes in response to changes in the

altitude number. Press the COMMAND button to save and exit the adjustment mode.

Next, go to the altitude screen and navigate to the reference pressure line. 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 altitude. Read the pressure from the BARO screen.

Sea Ice Assessment

There is no regular forecasting or analysis available for travel on Peninsula sea ice, so 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, ASC remote sensing analyst or Palmer Station research associate. The remote sensing analyst can also provide sea ice conditions at near real time for vessel movements. The Palmer Station research associate can pull the following data.

Low-resolution visible imagery: This is published daily, but sea ice may be obscured by cloud cover. Historical imagery is available to 2000.

High-resolution visible imagery: This is published five to six times a year, mostly during the summer. The last two years of historical imagery are available.

Radar (SAR) imagery: This is typically published each week and can see through clouds. Only four or five days of historical imagery is available.

Sea ice concentration: This is published daily with a two-day lag. Historical imagery is available to 2002.

Thickness

Strong currents can erode sea ice from below. This is hazardous because there may be no obvious indication of ice 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 temperatures rise later in the season, the sea ice becomes progressively weaker and thinner everywhere.

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 that is at least 24 inches thick. Ice that is sky blue and has a slick, scalloped surface is multiyear ice that is several feet thick.

Ice of different ages and thickness are 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 by 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 investigate areas of gray ice. Sea ice that appears black is thin and must always be avoided. 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.

Temperature

Colder ice is stronger. The colder the ambient air temperature, the more the ice grows. The colder the ice, the stronger the overall structure. Just looking at the surface will not indicate

the true strength of the ice. Sea ice strength is measured according to four periods of ice surface temperature:

Sea Ice Periods

Period	Surface Temperature	
	Celsius	Fahrenheit
1	< -10°C	< 14°F
2	-10°C to < -5°C	14°F to < 23°F
3	-5°C to < -2.78°C	23°F to < 27°F
4	2.78°C to < -1.94°C	27°F to < 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 (e.g., wind, waves, tidal action, 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.

Avoid cracks whenever possible. If one must be crossed, do so in a line perpendicular to the crack. Never cross a system of multiple, closely set cracks in a way that places a vehicle on two or more cracks at once or on a small piece of ice between cracks. Avoid sets of cracks that form triangular wedges, which could break off and flip over under a vehicle's weight.

Snow cover on the sea ice can hide 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 (e.g., feces, urine, seal shadows, 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.

Poor weather conditions and snow can hide or 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.

There are four types of sea ice cracks:

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

Each is described and discussed during sea ice training. Field party members working on the sea ice must learn to identify and evaluate each type of crack.

Sea Ice Travel and Work

Peninsula sea ice must be at least 12 inches thick to allow for travel within 300 meters (~985 feet) of shore or vessel. Ice must be 20 inches thick to allow for travel beyond 300 meters. These thicknesses are the same for ski, foot and snowmobile travel due to the distributed pounds per square inch of ground pressure for each method.

The 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 the ice surface temperature's period. The effective width cannot exceed one-third of a snowmobile track length. Use the following guidelines to determine the required ice thickness and maximum effective width for a snowmobile.

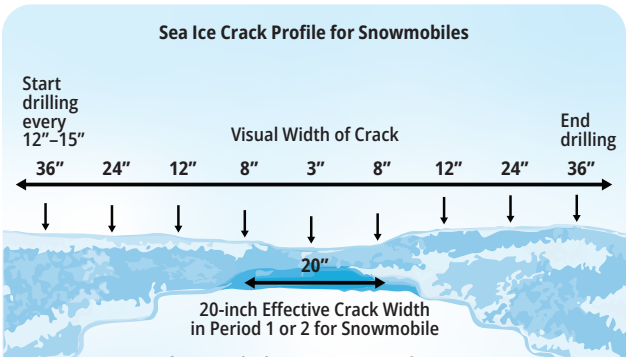
Sea Ice Crack Guidelines for Snowmobiles

Guideline	Inches
Maximum Effective Crack Width	20
Minimum Ice Thickness by Ice Surface Temperature	
Period 1 (< -10°C)	5
Period 2 (-10°C to < -5°C)	5
Period 3 (-5°C to < -2.78°C)	6
Period 4 (-2.78°C to < -1.94°C)	7
Note: If towing a sled or trailer, different ice thickness requirements may apply. Contact Field Safety & Training at x2345 for more information.	

Profiling a Sea Ice Crack

1. Stop the vehicle before reaching a crack, and check for other cracks nearby.
2. Determine the nearest edge of the crack by removing snow down to bare ice.
3. Using an ice ax, probe for open water or weak spots to determine if it is safe to cross by foot.
4. If safe, shovel the snow out of the crack from edge to edge, clearing at least one shovel blade's width of snow.
5. Drill holes every 12 inches in a straight line, beginning outside one crack edge and ending outside the other. Be sure to drill healed shelves and any visible fractures.
6. Drill each hole either to water level or a full Kovacs drill flight length (> 30 inches).

7. Measure the ice thickness in each hole.
8. Pay attention to the characteristics of the ice shavings (i.e., dry, moist or slushy).



Marine Ice Floe Work

Marine ice floes must be at least five meters (16 feet) long and wide and at least 30 centimeters (12 inches) thick for a person to work on them directly. Small boat operators will assist in making the call whether a floe is safe for work.

Take great care to not overload one side of a floe, so it does not break or flip over. If a small boat is utilized, it must remain adjacent to the floe in case someone ends up in the water and requires immediate rescue.

The following are required for marine ice flow work:

- Personal flotation or immersion suit (with flotation) for each participant
- Ice probe

- Two throw ropes minimum, either attached to the small boat or personnel basket
- VHF radio carried by each participant

Also highly recommended are skis, snowshoes or traction devices, depending on what is available and best suited for the location.