Sea ice features

Introduction

Sea ice can be a fickle and risky medium on which to travel. The risks can be reduced by good decision making and understanding of local sea-ice conditions. It is important not to get complacent over sea-ice conditions – always keep alert and continually assess the weather and the state of the ice. In the context of MOSAiC, sea-ice travel is necessary for scientific purposes as well as logistics. Relief at MOSAiC will be carried out onto sea ice and cargo will be offloaded onto the sea ice during resupply cruises. The ability to assess and make use of sea ice can have a significant impact on successful logistics.

> Note: Sea ice in the Antarctic and the Arctic has noticeably different characteristics. Multiyear sea ice is less common in the Antarctic compared with the Arctic.

Sea-ice formation

Seawater will freeze when it reaches a temperature of approximately -1.8°C. Once this water temperature becomes stable under the influence of cold air temperatures, ice spicules or small plates start to form in the water surface layer. These coagulate to form grease ice. This new ice may take on different forms according to influences such as sea state, wind strength and air temperature. In calm conditions fast ice forms in five stages:

• Grease ice – an oily appearance in the water

• Porridge ice – a slushy layer

• Pancake ice – circular plates of newly formed ice which usually have raised edges caused by the movement and contact between adjacent plates

• Young ice – where the pancakes have consolidated into a continuous sheet but only a few centimetres thick

• Fast ice – the ice matures and snow may cover the surface. By definition fast ice is connected to the land, although often with a tide crack

> Caution: This process can be shorter and pack ice can form by the consolidation of old sea ice, brash and bergy bits. These freeze into an irregular continuous surface of blocks and pressure ridges. Travel over such sea ice can be strenuous and time-consuming unless snow cover has levelled the irregularities. Ice that has formed in this manner is often weaker than when formed through the above five-stage process.

Newly-formed sea ice has resilience akin to soft rubber and this provides comparatively better support than freshwater ice. Before travel can take place on sea ice it will need to reach a suitable thickness (see below) and travel should not be undertaken on young sea ice until it has been tested by a significant storm (winds in excess of 40 knots for a long period). This is especially important if there is no safe alternative return route should the ice break out. Under stable conditions,first-year sea ice can form to a thickness in excess of 1.2m. Multi-year sea ice can be in excess of 3m thick.

These thicknesses include any layers of surface snow. The bearing capacity of rotten ice is at best only half that of good ice.

Hazards

There are many hazards unique to travel on sea ice that must be understood prior to carrying out a journey or work related operations.

Icebergs

Icebergs pose a significant hazard to sea-ice travel. The ice immediately around icebergs is always suspect and usually weaker than the rest of the sea ice. If floating in the sea and frozen in place as the water freezes the berg will continue to move slightly and can be affected by strong winds. This causes the ice around the berg to continually break up and refreeze so it is usually significantly thinner and therefore weaker than the other ice around it. If the berg has grounded on a feature beneath the sea then the tide will move up and down the berg and create the same affect as a tide crack. This ice may refreeze but will again always be weaker than other areas of ice. In addition to the above risks, chunks of ice can break off large icebergs creating danger if you are travelling too close. Give icebergs a wide berth or if possible avoid completely.

Ice edge

The ice edge is obviously hazardous as you become exposed to the open sea. In addition there is nothing holding the ice in to the land here so it will be the first area to break-out if conditions change. Predators such as orcas, leopard seals and polar bears, if in the Arctic, often patrol the ice edge, as this is where they are most likely to find food. It may seem unlikely but this is a risk not to ignore.

Surface melt/slush

Warm temperatures can result in ice decay on both the surface and the base of the ice. Surface water can form which is particularly hazardous to vehicles, which can get bogged down in the slush. A fresh layer of snow often masks this hazard.

Ice quality

There are many hard-to-see factors that can affect the thickness/quality of sea ice in localised areas. Currents and topography under the sea can cause irregularities that result in these suspect areas. Look out for any changes to the colour or texture of the ice surface and be particularly cautious around these spots. It may be that this change is not significant enough to make travel unsafe but it is important to identify and investigate this before blindly travelling over it. Measuring the thickness of the ice when assessing its suitability for travel only works if the ice itself is sound. Having sufficient thickness will not count for much if the ice is rotten and can’t support your weight.

Danger areas/signs are:

• Darker ice usually indicates newer and therefore thinner areas

• Dullish grey colour variations in the snow cover can indicate wet areas

• Dirt in or on the ice surface may be a result of wind-blown dust. This will cause an increase in the absorption of solar radiation and therefore the rate of melting

• Large masses of snow can cause flooding and boggy areas, especially near cracks in the ice

• Melt pools formed by ablation. If there is a need to cross melt pools on sea ice, drill the ice to ensure it is strong enough

• Flooded ice. Sea ice can be heavily loaded by water and wet snow. This meltwater can also come from snow melt on land that has flowed out onto the sea ice (and under the sea ice)

• Thaw holes. These are vertical holes in the sea ice formed when the surface pools melt through to the underlying seawater

• Rotten ice. Sea ice that has become honeycombed and is in an advanced state of disintegration

• Water sky – dark linear areas of sky close to the horizon line can be reflections of open water. This is known as water sky and can alert you to possible open water from a distance You should learn to recognise these types of ice. Remember that snow cover makes assessment difficult as it can mask danger areas.

Leads

Leads in the ice are essentially fractures of open water through the frozen sea ice. These leads can be caused by a variety of influencers but predominantly through stresses on the ice created by either wind or ocean currents. Leads can form anywhere and if the air temperature is cold enough they may freeze over entirely, but they will be much thinner than the surrounding sea ice.

Polynyas

Polynyas are areas of permanently unfrozen water. These areas are often kept ice-free by ocean currents and warm upwellings. Polynyas tend to form in the same areas year on year and local knowledge will prove useful.