

Weather conditions on Svalbard

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The weather is an important factor to take into account when planning field activities on Svalbard

There have been more or less continuous meteorological measurements since 1912 on Svalbard.

Most meteorological measurements are performed on the west side of Svalbard, where people live. This means there are vast areas where the weather conditions have not been investigated thoroughly, which have to be kept in mind when climatic conditions on Svalbard are discussed.

The most characteristic feature about the weather on Svalbard is that it is determined both by large scale factors as well as local factors. The weather can vary a lot over a short distance and it is important to understand why it is so for safety reasons when travelling in the field.

Most important things to remember about weather on Svalbard:

- The weather can change very fast.
- Weather forecasts are often uncertain and should be dealt with accordingly.
- The weather is influenced by many local factors, and even if the weather is fine in Longyearbyen, it does not have to be so a few kilometres away.
- It is usually not the low temperature itself that is dangerous on Svalbard, but the combination with strong wind and dry air.



Wind chill

The combination of wind and temperature is what really makes it cold to be outside on Svalbard, and this “effective” temperature is what you should consider when you dress for outdoor activities. For example, a strong breeze at -20°C will feel like -35°C on the skin.

<i>Wind</i>	<i>Temperature</i>			
	<i>0°C</i>	<i>-10°C</i>	<i>-20°C</i>	<i>-30°C</i>
<i>Light breeze</i> (1,6 – 3,3 m/s)	-3°C	-15°C	-27°C	-39°C
<i>Gentle breeze</i> (3,4 – 5,4 m/s)	-5°C	-18°C	-31°C	-43°C
<i>Moderate breeze</i> (5,5 – 7,9 m/s)	-7°C	-20°C	-33°C	-46°C
<i>Fresh breeze</i> (8,0 – 10,7 m/s)	-7°C	-20°C	-33°C	-47°C
<i>Strong breeze</i> (10,8 – 13,8 m/s)	-8°C	-21°C	-35°C	-48°C
<i>Near gale</i> (13,9 – 17,1 m/s)	-9°C	-22°C	-36°C	-50°C
<i>Fresh gale</i> (17,2 – 20,7 m/s)	-9°C	-23°C	-37°C	-51°C
<i>Strong gale</i> (20,8 – 24,4 m/s)	-10°C	-24°C	-38°C	-52°C

What determines the weather on Svalbard?

- The global circulation
- Land / water / ice interactions
- Topography
- Polar night / midnight sun
- Few fronts are passing Svalbard
- Many local weather systems

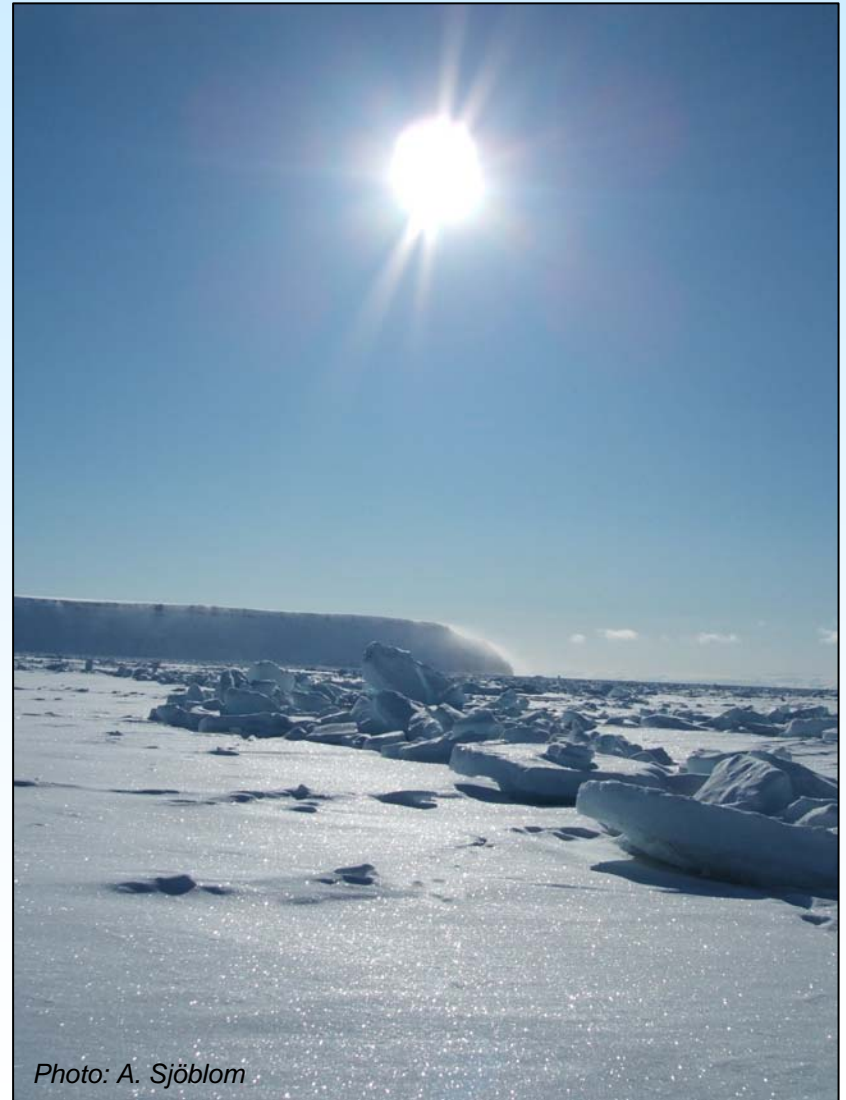


Photo: A. Sjöblom

Can the weather forecasts be trusted?

Forecasts are made to fit a certain area, and Svalbard is at the outer edge of most model areas, which makes the uncertainty of forecasts higher.

Due to all the local factors that influence the weather on Svalbard, it is very difficult to give a forecast for the whole archipelago. Forecasts are often given for the area around Longyearbyen, but even here the weather can change fast on a small distance due to mountains, valleys, water, land etc.

What to think about when reading forecasts

Many of the forecasts are computer generated and not quality checked by a meteorologist (for example meteograms). A few tips:

- The wind speed given is often too low.
- The wind direction given is the large scale wind direction which will then be steered locally by topography.
- A small mistake in the localisation of a weather system can give a large change in weather.
- The timing of weather systems can be wrong. Weather systems can come earlier or later.
- The weather can change very fast.
- Local factors will in the end determine the actual weather.

Why are the forecasts uncertain?

Forecast models use a description of the atmosphere and its physical phenomena when calculating the weather forecast.

These descriptions are based on processes on lower latitudes, simply because more research has been done there than in the Arctic.

In order to improve the weather forecast for the Arctic more measurements are needed to understand what is different here. This involves for example processes during the long polar night and local phenomena typical for the Arctic.

Understanding these phenomena is also important to decrease the uncertainty in global climate prediction models.

Statistics of the weather

When reading the following pages it is important to remember that these are average values and that the deviations can be large!

For example, in 2008 the warmest day of the year was as late as 15 September with a maximum of 12.4°C!

(Data from: Førland et. al, (1997), <http://eklima.met.no>, <http://www.met.no>)



Photo: J. H. Koren

Temperature



Annual mean temperature at sea level on Svalbard is about -5°C , but this decreases fast with altitude.

February and March are the coldest months and July is the warmest
The coldest temperature ever measured at Svalbard airport is -46.3°C
(March 1986)

The warmest temperature ever measured at Svalbard airport is 21.3°C
(July 1979)

Temperatures at Svalbard airport ($^{\circ}\text{C}$)

	<i>Jan</i>	<i>Feb</i>	<i>Mar</i>	<i>Apr</i>	<i>May</i>	<i>Jun</i>	<i>Jul</i>	<i>Aug</i>	<i>Sep</i>	<i>Oct</i>	<i>Nov</i>	<i>Dec</i>
<i>Normal</i>	-15.3	-16.2	-15.7	-12.2	-4.1	2.0	5.9	4.7	0.3	-5.5	-10.3	-13.4
<i>Min</i>	-38.8	-43.7	-46.3	-39.1	-21.7	-8.4	0.2	-3.9	-12.6	-20.8	-33.2	-35.6
<i>Max</i>	7.7	6.0	6.3	7.5	10.6	15.7	21.3	18.1	15.2	8.9	7.5	7.2

The largest variations in temperature occur in winter time. It is not uncommon that the temperature changes several tens of degrees over a few hours in winter, something which is highly unlikely in the summer.

As an example, the maximum and minimum temperature measured in July differs with approximately 20 degrees, while in March this difference is over 50 degrees.



Temperature varies over distance as well. For example, Svea is usually colder than Longyearbyen in wintertime, and on average Isfjord Radio has a milder climate than Longyearbyen.

<i>Normal temperatures on Svalbard in March and July (°C)</i>						
	<i>Svalbard airport</i>	<i>Svea</i>	<i>Isfjord Radio</i>	<i>Ny-Ålesund</i>	<i>Barentsburg</i>	<i>Hornsund</i>
<i>March</i>	-15.7	-16.2	-12.0	-14.2	-14.5	-12.7
<i>July</i>	5.9	5.8	4.8	4.9	5.5	4.0

Wind speed

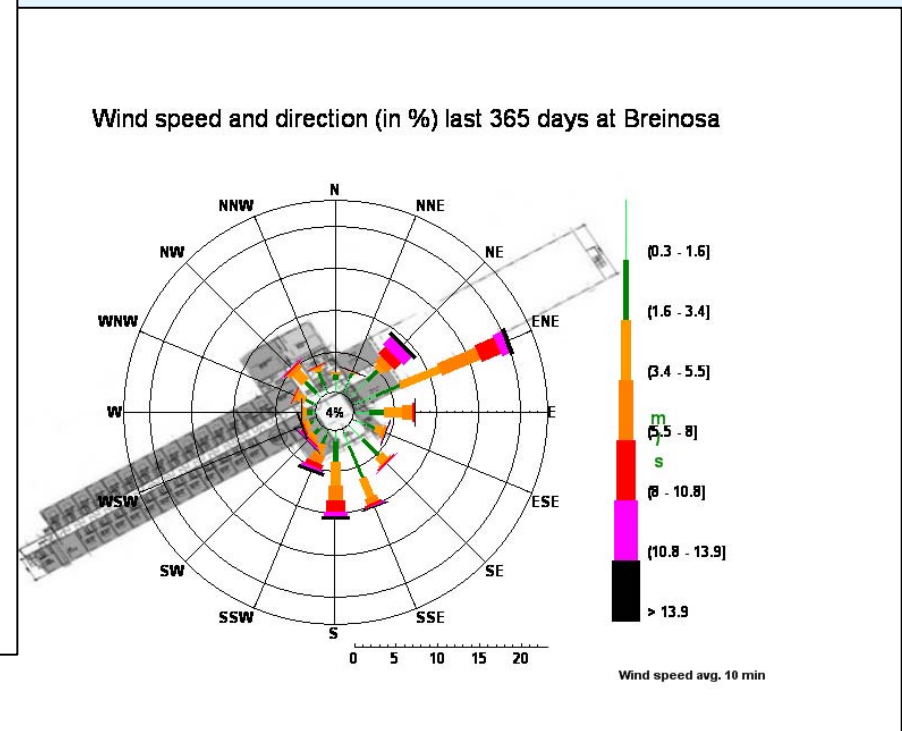
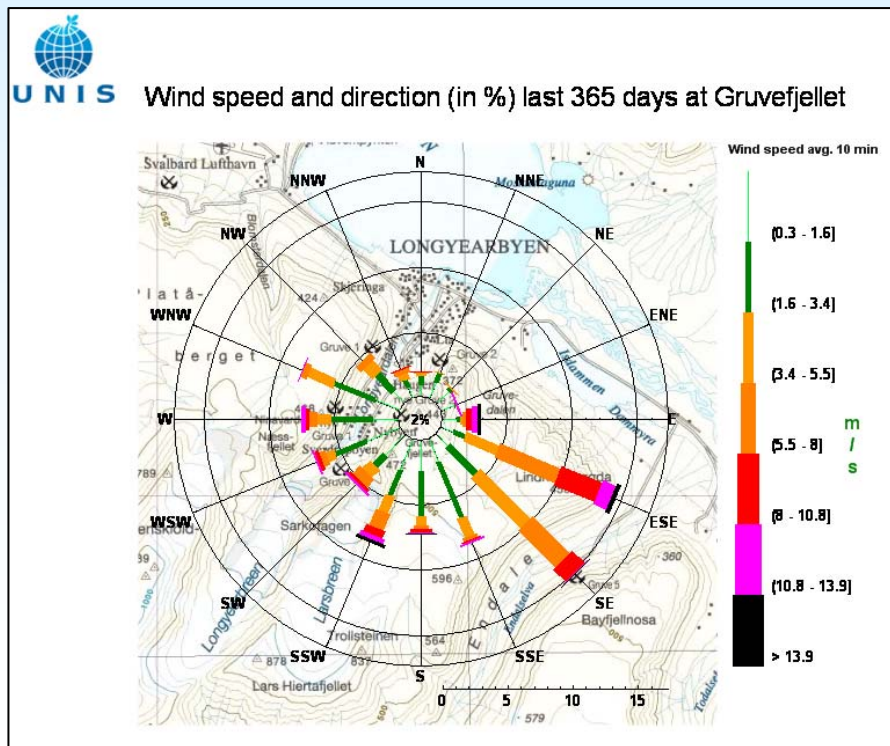
The wind can vary a lot over a short distance due to local factors, and it can also change fast, especially in the winter.

<i>Wind speed at Svalbard airport</i>			
<i>Number of days with wind > 10 m/s</i>		<i>Highest wind speeds</i>	
<i>Windyest month</i>	<i>Caldest months</i>	<i>Average wind (10 min)</i>	<i>Gust wind (2 sec)</i>
January ~ 15 days	June, July & August < 5 days	26.8 m/s December 1975 & March 1979	41.2 m/s November 1985

Wind direction

The global circulation on the Earth decides the dominant wind direction. On Svalbard this is east or south-east.

But, the wind is often controlled by local factors!



Precipitation

Svalbard is considered as an “Arctic desert”, at least in some parts. The precipitation also increases with altitude.

Average annual precipitation				
<i>Svalbard airport</i>	<i>Isfjord Radio</i>	<i>east coast of Svalbard</i>	<i>Oslo</i>	<i>Bergen</i>
~ 200 mm	~ 500 mm	up to 1200 mm	~ 800 mm	~ 2200 mm

Maximum precipitation in 24 h (Svalbard airport)	Wettest period	Driest period
36.1 mm (August 1981)	Spring, late summer and early autumn	May

Precipitation at Svalbard airport (mm)												
	<i>Jan</i>	<i>Feb</i>	<i>Mar</i>	<i>Apr</i>	<i>May</i>	<i>Jun</i>	<i>Jul</i>	<i>Aug</i>	<i>Sep</i>	<i>Oct</i>	<i>Nov</i>	<i>Dec</i>
<i>Normal</i>	18	24	24	11	7	11	18	23	20	16	18	20

The amount of snow is relatively small compared to for example areas in northern Norway on the mainland. But the variation in snow depth is large, and the snow drifts a lot due to high wind speeds and dry snow.

Precipitation is very difficult to measure correctly in the Arctic due to large local variations. In wintertime strong winds also make it difficult to determine if it is actual precipitation or horizontally drifting snow. All data regarding precipitation should therefore be handled with scepticism!

It should also be remembered that few measurements have been taken, and this contributes to the uncertainty.



Fog

Fog is common in summer, especially in coastal areas.

It can appear very quickly, and reduce visibility to only a few tens of meters. This is important to remember when you are in areas with for example polar bears.

Strong fog will make everything wet and you will rapidly feel much colder than earlier.

When travelling with boats during the summer, sudden fog will decrease your ability to navigate safely.



Photo: S. Coulson

Humidity

The specific humidity on Svalbard is very low, but the relative humidity is high.

This means that there is not much water vapour in the air, but the air is close to saturation. Relative humidity is closely connected to temperature, and air with a low temperature has a higher relative humidity than air with a high temperature.

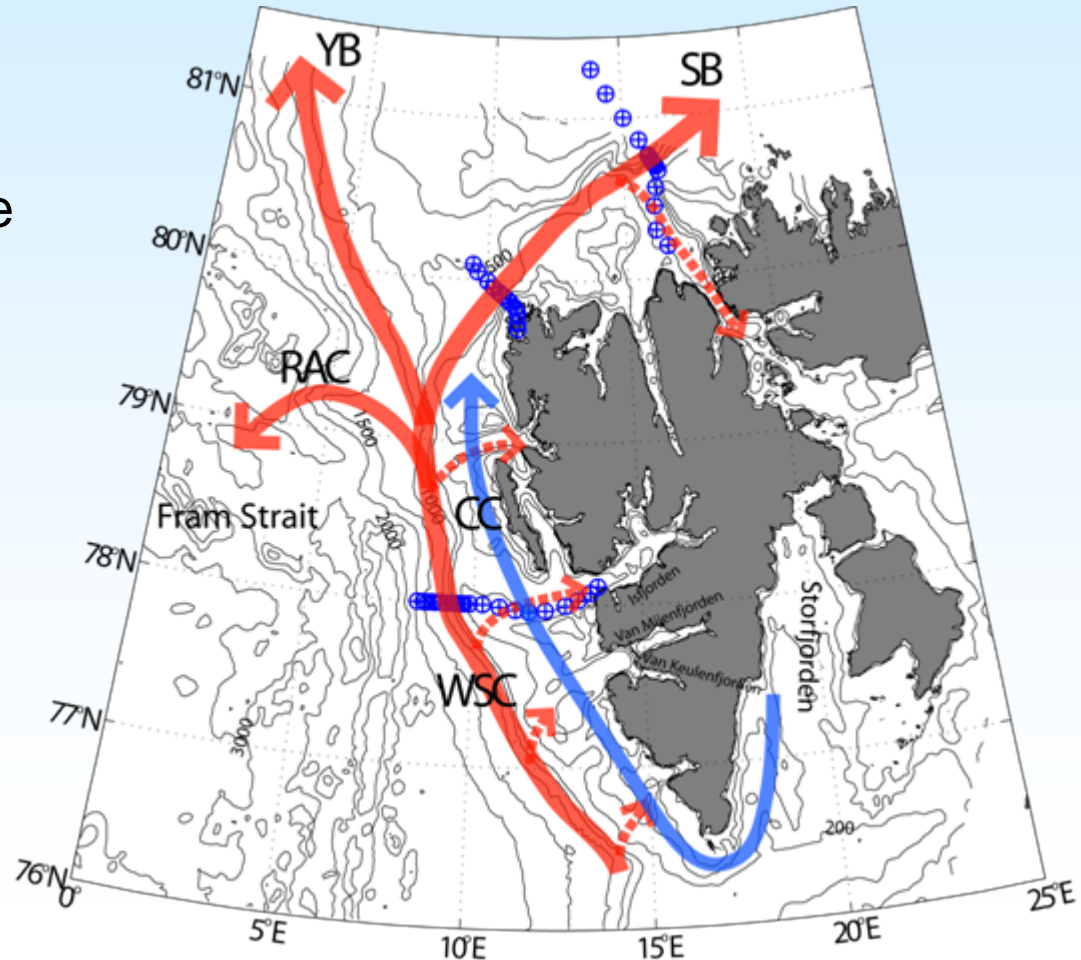
So, depending on which humidity parameter is used, Svalbard can have both high and low humidity.

However, the air feels very dry and the combination of dry air, low temperature and strong wind can dehydrate the body quickly in the field.

Warm ocean currents

Compared to other places at the same latitude, the climate on Svalbard is much warmer. The main reason is the warm ocean currents that bring warm water from the south past Svalbard.

The relatively warm water is also the main reason why coastal areas of Svalbard have a warmer climate than further inland.



CC: Coastal Current
 WSC: West Spitsbergen Current
 SB: Svalbard Branch
 YB: Yermak Branch
 RAC: Return Atlantic Current.
 Figure from F. Nilsen, UNIS

Strong temperature gradient in winter

During winter there is a strong temperature gradient (the temperature is changing fast over a short distance) between the southern and northern parts of Svalbard. The same thing is true for the pressure gradient in winter.

Both these factors contribute to the wind being much stronger in winter and that the weather can change very fast during the winter months!



Photo: UNIS



Photo: H. Christensen

Clouds

Clouds on Svalbard can be both cooling and warming. During summertime low clouds will stop much of the sun's radiation and thereby cause a cooling. In wintertime, however, low clouds will stop the radiation from the earth to escape and thereby cause a warming.



Temperature inversions

A cooling of the surface often give rise to a so called inversion, where the temperature is increasing with height, instead of decreasing which is most common in summer. But, if there is strong wind, the air is effectively mixed and so is the temperature.

When it is calm conditions in the winter, it can therefore be warmer on the mountain top than down in the valley.



Local wind systems

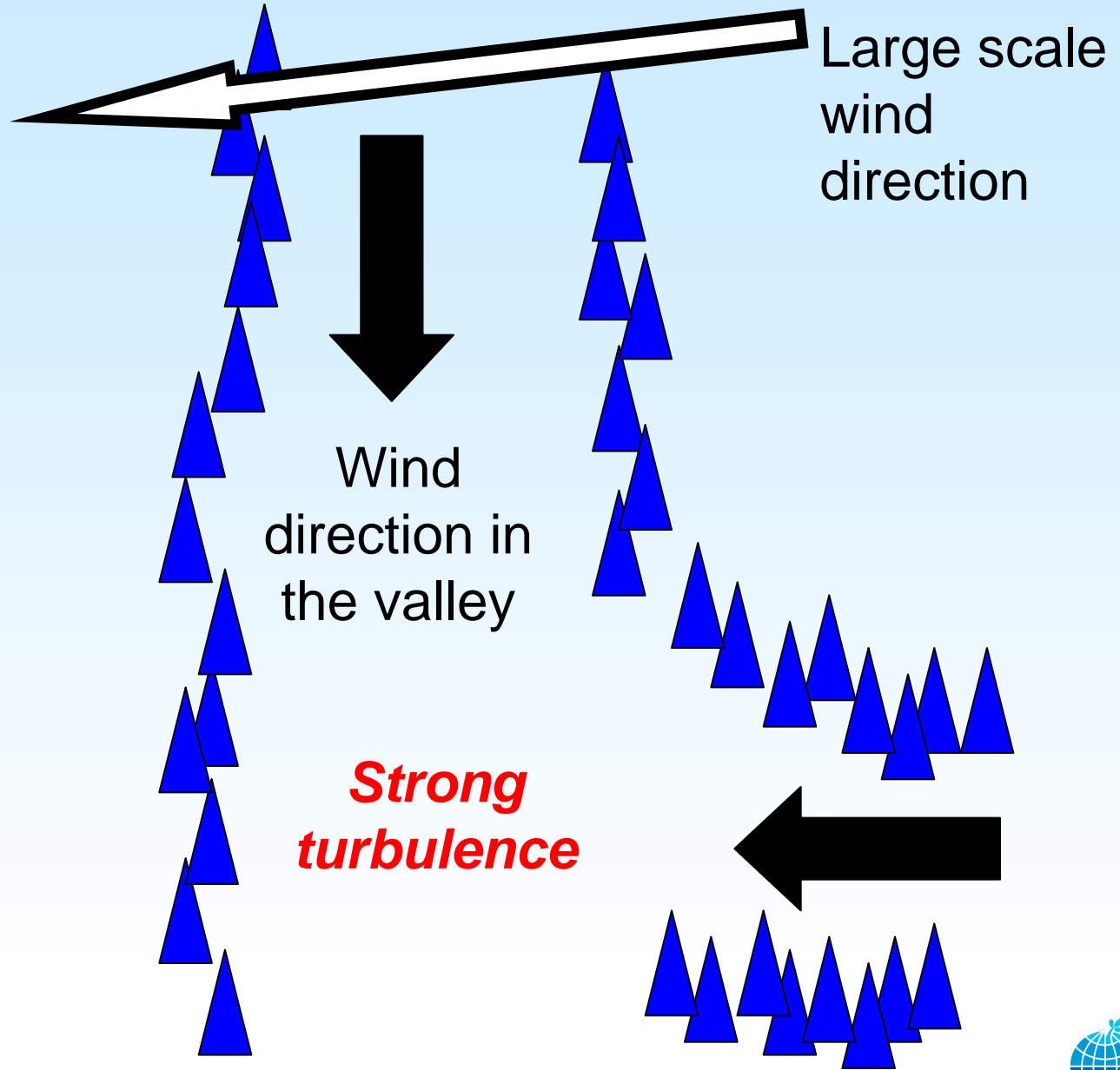
Local wind systems are very common on Svalbard. Most of these are driven by temperature differences and that cold air is heavier than warm.



Channelling

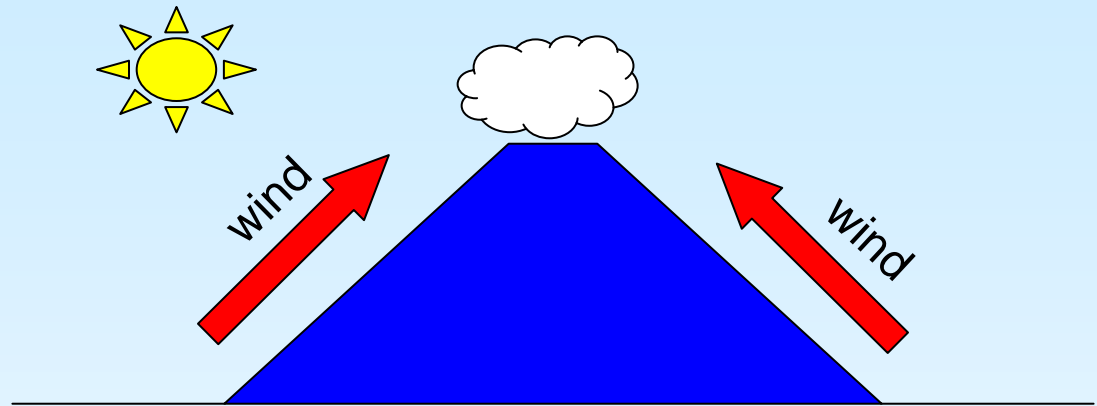
The wind is often steered through the valleys causing a channelling of the wind. In a narrow valley, the wind can be much stronger than the overlying large scale wind.

If two valleys meet, the result can be strong wind and a lot of turbulence.



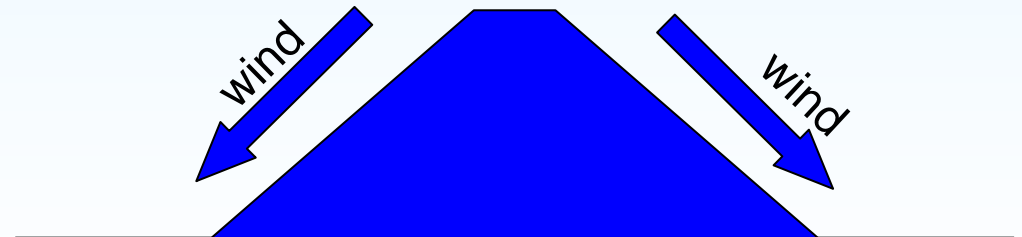
Mountain winds

Mountains can cause up and down slope winds, triggered by the heating of the air by the sun or cooling at night.



Day

Warm air rises and cold air sinks.



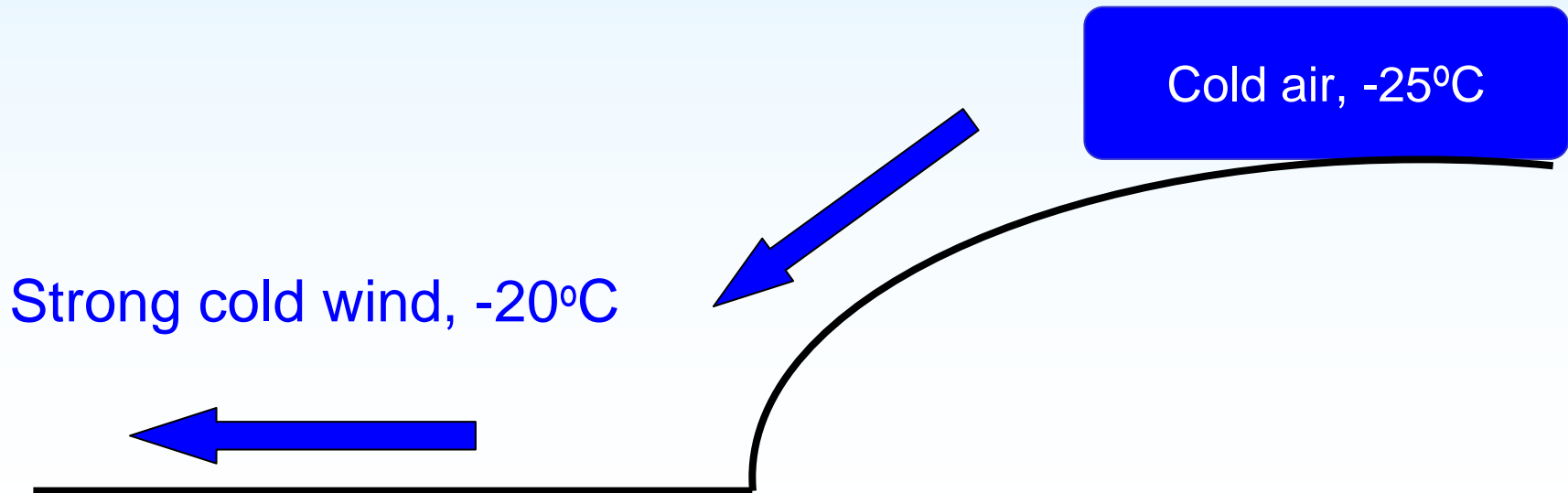
Night

This is why it is common to see clouds on top of mountains during daytime but not during the night.

Katabatic winds

Probably the most dangerous local wind phenomena when travelling in the field. It can start very rapidly and the wind is strong and cold.

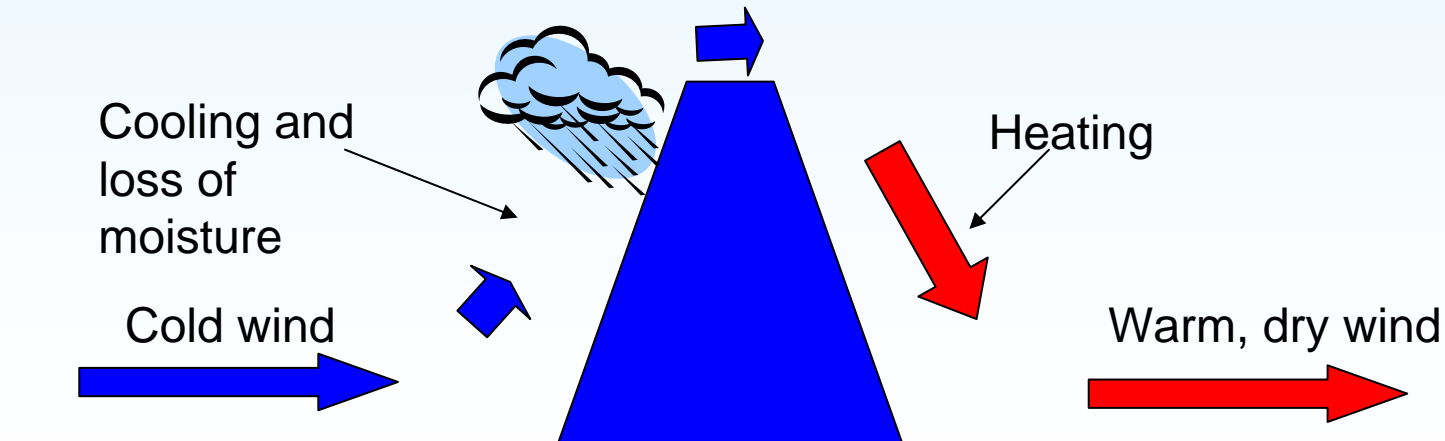
If the wind speed is weak and there are no clouds, the air above, for example, a snow covered plateau or a glacier can become very cold. Cold air is heavier than warm and when this cold air “spills” over the edge, it comes down as a cold strong wind. This is why you should never put up your tent in front of, for example, a glacier, especially during winter.



Föhn winds

Flow over mountains can cause a warm wind, known as “Föhn” or “Chinook”. The air is pushed over the mountain causing it to cool and lose some of its moisture in form of precipitation. The wind that comes down on the other side is a warm dry wind.

By knowing the most common wind direction, it is easy to know which side of a mountain is most likely to have precipitation. On Svalbard, where the main wind direction is east or south-east, it is most likely to have most precipitation on the east sides of the mountains. This is why the east coast of Svalbard has more precipitation than the west coast.

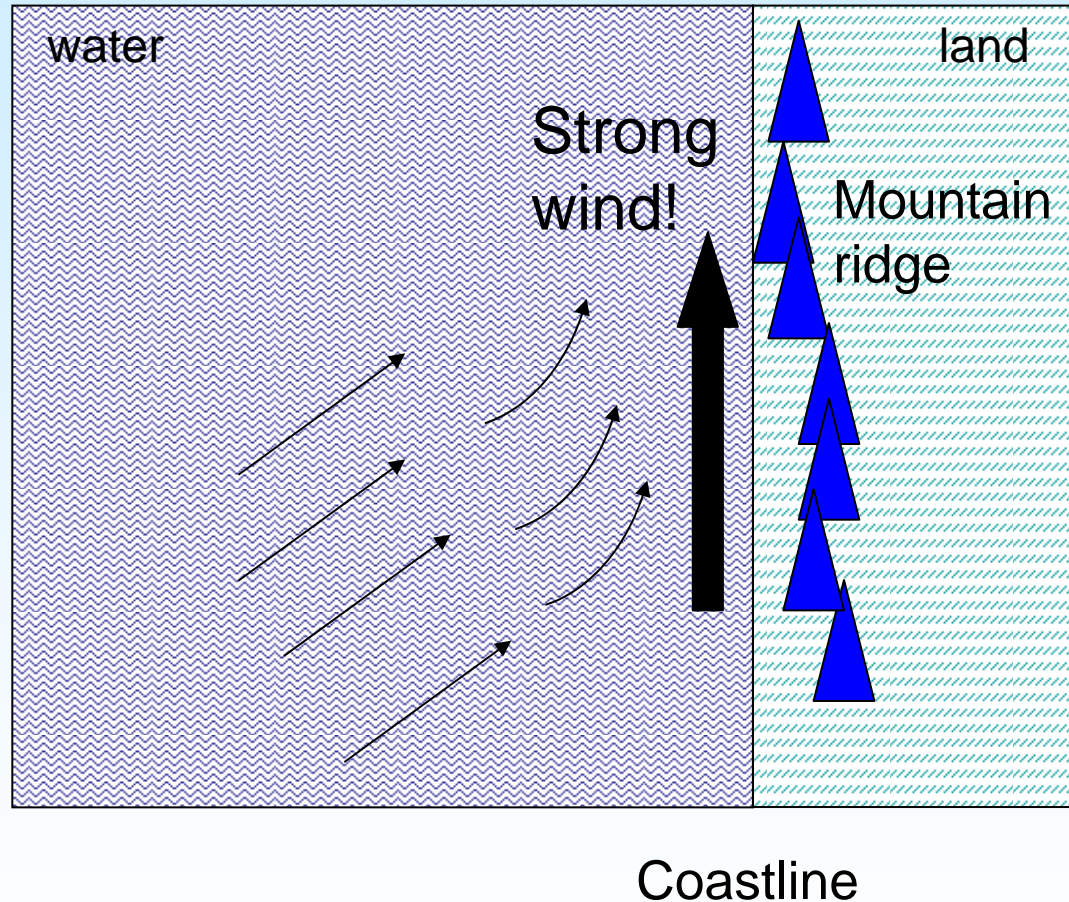


Coastal jets

Mountains can cause strong winds on the sea close to the coast.

If the wind is coming from the sea, the air is blocked by the mountains and steered along the ridge, causing the wind speed to increase.

Choosing a route further off the coast might be a good alternative in this case.

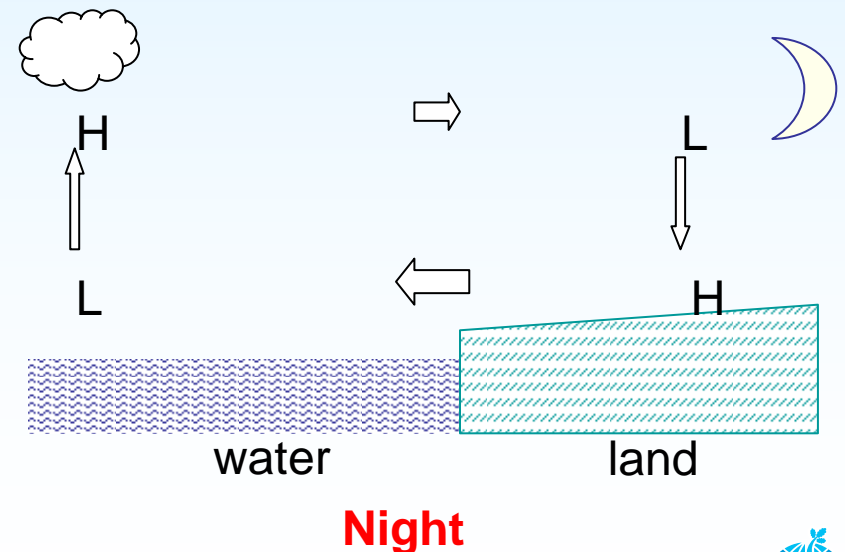
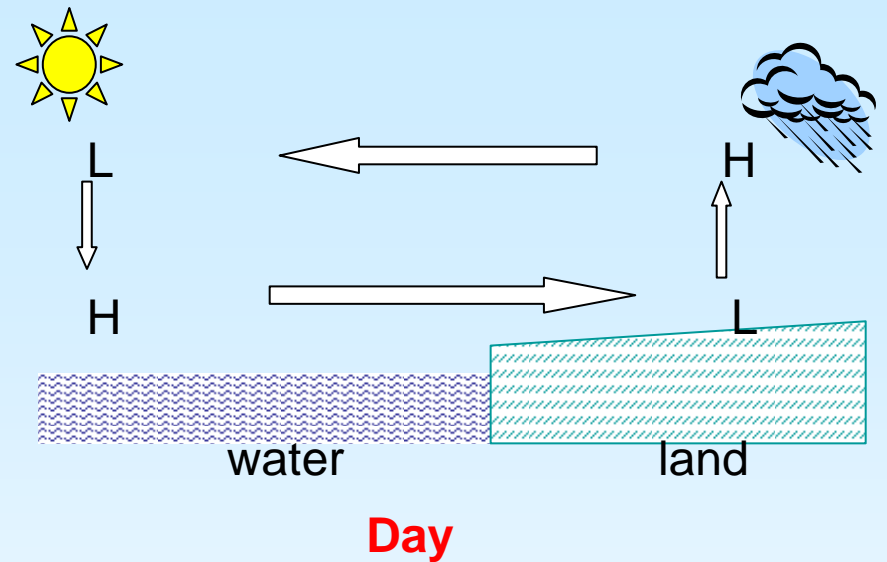


Sea and land breeze

Temperature differences cause wind, and the most classical one is sea and land breeze. These phenomena exist in the Arctic and can also be triggered at the border of other surfaces, for example ice and water, commonly known as “ice breeze”.

Land warms and cools faster than the water causing the land to be warmer than the water in daytime and colder than the water in night time. This causes a lower pressure over the warmest surface, thereby directing the wind towards the land in the day and towards the water in the night.

The original wind can not be too strong for this to start.



Fog

Defined as visibility less than 1000 m

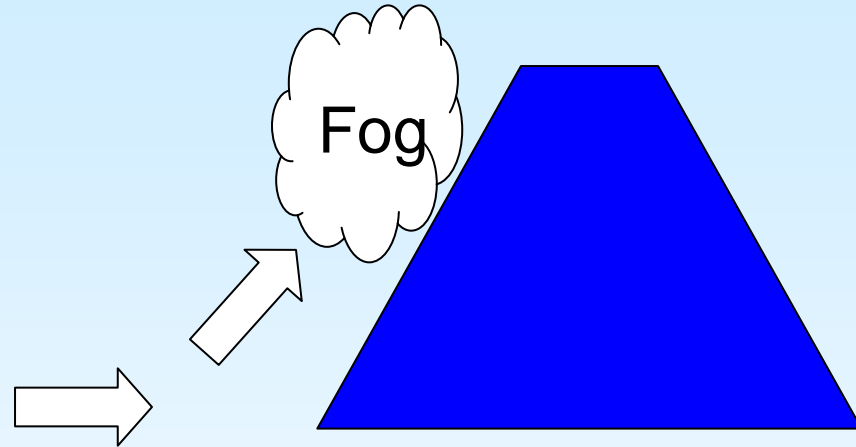
On Svalbard, fog is mainly created by three mechanisms:

- Flow over mountains and into valleys
- Horizontal flow over surfaces with different temperatures, or coastal areas
- Still standing air cooled by a cool surface, so called radiation fog

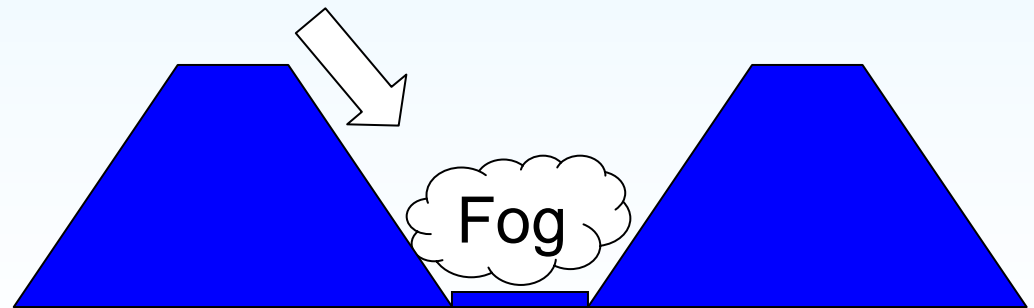


Fog related to flow over mountains and valleys

Moist air being lifted
and cooled

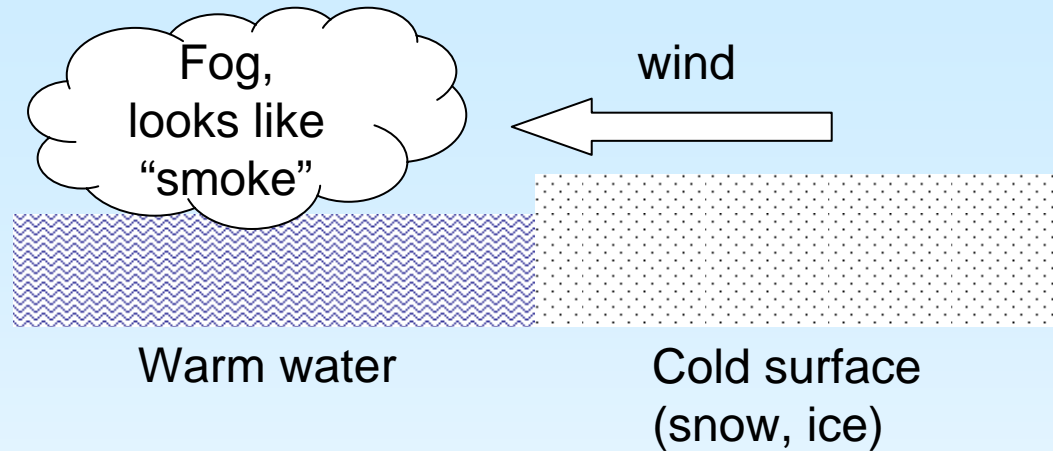


Cold air sinks to the
bottom of a valley

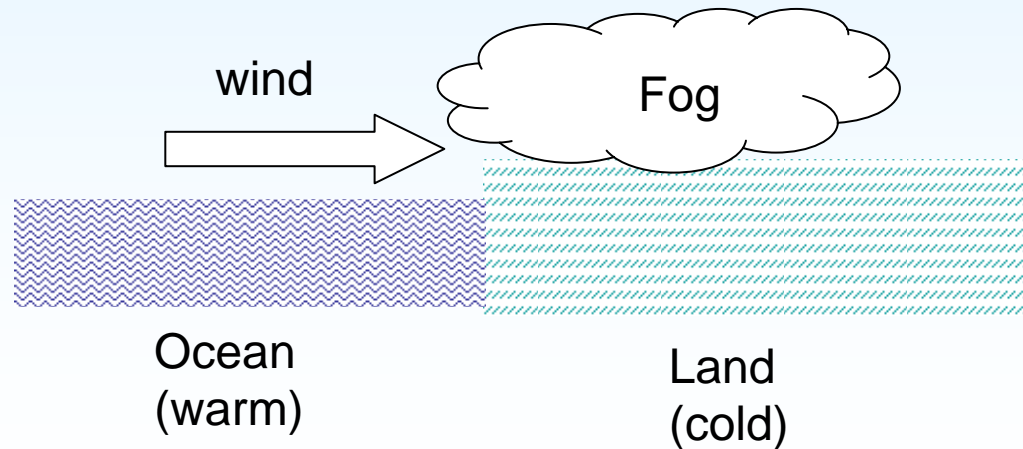


Fog in coastal areas

Cold air comes over warm water, can lead to severe icing!

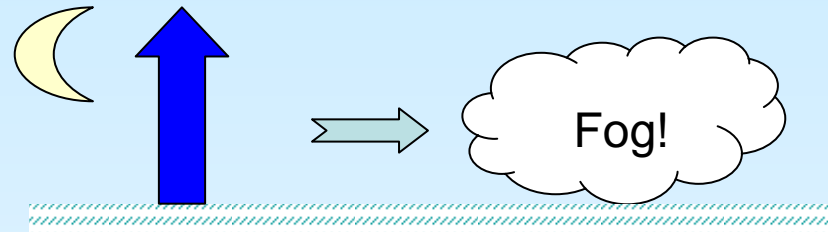


Warm moist air comes in over land and cools. Common in coastal areas and where ocean currents with different temperature meets



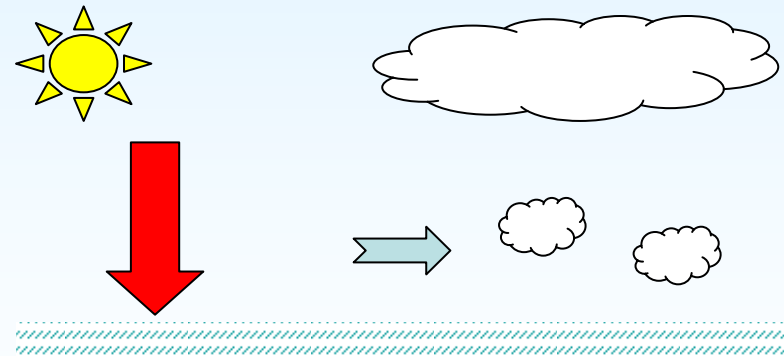
Radiation fog

Common over land during clear, cold nights with little wind



Large loss of heat from the ground

Disappears from below when the sun starts to heat the ground, which in turn warms the air. Only clouds remain



The sun heats the ground

To conclude:

- The weather can change very fast.
- Weather forecasts are often uncertain and should be dealt with accordingly.
- The weather is influenced by many local factors, and even if the weather is fine in Longyearbyen, it does not have to be so a few kilometres away.
- It is usually not the low temperature itself that is dangerous on Svalbard, but the combination with strong wind and dry air.
- Large scale patterns influence the dominant wind direction (east to south-east) and precipitation pattern

Some useful weather links on the internet:

UNIS has several weather stations on-line: <http://www.unis.no>

Yr.no gives weather forecasts and climatic data for many places around the world: <http://www.yr.no/>

The Norwegian meteorological institute has a lot of useful information: <http://met.no/index.shtml>

Climatic data can be found on: <http://eklima.met.no>

A lot of meteorological information can be found on <http://www.wetterzentrale.de/>

Satellite images: <http://www.sat.dundee.ac.uk/>

Current weather around the Arctic: <http://www.athropolis.com/map2.htm>

Some literature with more information:

Førland, E.J., I. Hanssen-Bauer, and P.Ø. Nordli, 1997: “Climate statistics and precipitation at Svalbard and Jan Mayen”. *DNMI-rapport, 21/97 KLIMA*.

McIlven, R., 1992: “Fundamentals of weather and climate”. *Chapman & Hau*.

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Wallace, J. M., and Hobbs, P. V., 2006: “Atmospheric Science, an Introductory Survey”. *Academic press*.