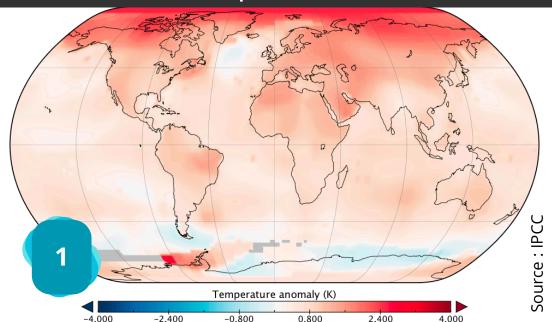
### Local air temperature increase







With the intensity decrease of the polar vortex, the air in the polar circle increases more in the summer and decreases less during the winter, causing the melt of ice sheets. This phenoma contributes to the polar amplification.

# Albedo change

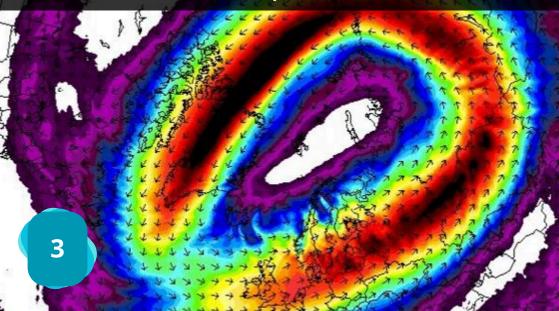
2



2 Albedo is the fraction of sunlight that is reflected by a body. Albedo change is caused by the change of surfaces and impacts mostly polar areas. Ice surfaces reflects 90% of the incident solar energy where oceans and liquid water reflects only 15% of it.

The decrease of albedo in the poles increases thus the sun energy absorbed by the surface which contributes to ice melting : it is a vicious circle.

## Decrease of polar vortices





The polar vortex helps to keep cold air temperatures around the arctic. With the increase of air temperature around the globe, its intensity decreases, causing cold waves to happen in the northern hemisphere and an increase of air temperature around the arctic ocean.

3

## New exploitable areas

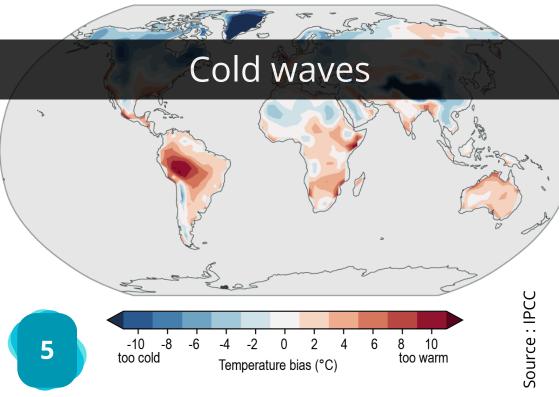






As the sea ice melts, new shipping routes are opening up, which could lead to an increase in world trade. In addition, the North Pole is an area of interest for the exploitation of oil and natural gas. New oil wells could then be exploited.



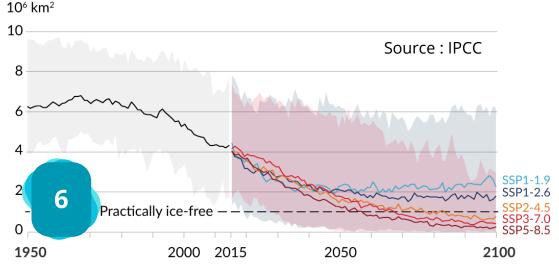




More and more cold winds can be expected in the coming years. These winds come from the poles, where they were held back by circular air currents, and move towards lower latitudes.

## Decrease of ice supply

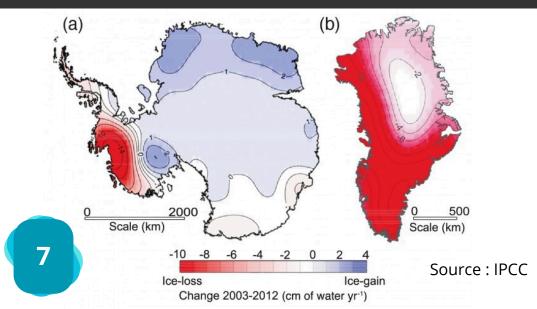
(b) September Arctic sea ice area





With the melting of ice sheets and sea ice, the snow does not land on a below 0°C surface. However, for snow to turn into ice, the surface on which it is deposited must have a temperature below freezing for at least 2 years.

## Melting ice sheets





Greenland and Antarctica are ice sheets (or continental glaciers). Melting ice sheets reduce the arctic Albedo. Also, if they were to completely melt, they will cause the sea level to rise by 7 metres for Greenland and 54 metres for Antarctica. During the last ice age, ice sheets were so much larger that the sea level was 120 metres lower than today.



# Melting sea ice

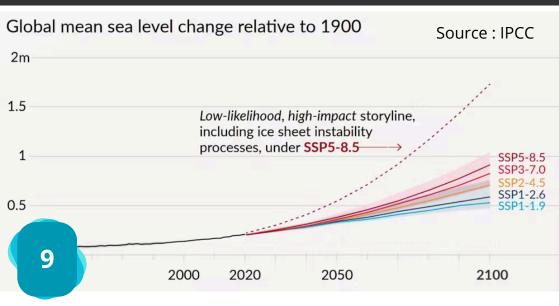




Sea ice melting does not make the sea level rise (just as a melting ice cube does not make a glass overflow). However, when it melts, the white ice gives way to much darker sea, which absorbs more sun rays and decrease the Albedo effect. It can also weaken the ocean currents.



## Rising sea levels

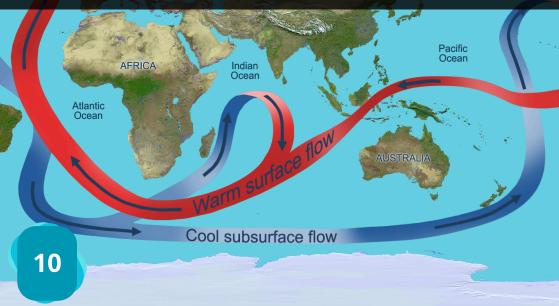




#### Since 1900, sea levels have risen by 20 cm. This is caused by the thermal expansion of ocean waters and the melting of glaciers and ice sheets.



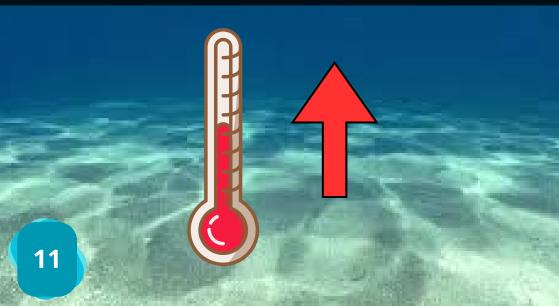
## Changes in ocean currents





Changes in ocean currents are occurring as a result of colder water goes into the water dur to ice melting. This could bring cold waves in the northern hemisphere countries such as USA.

# Rising water temperatures

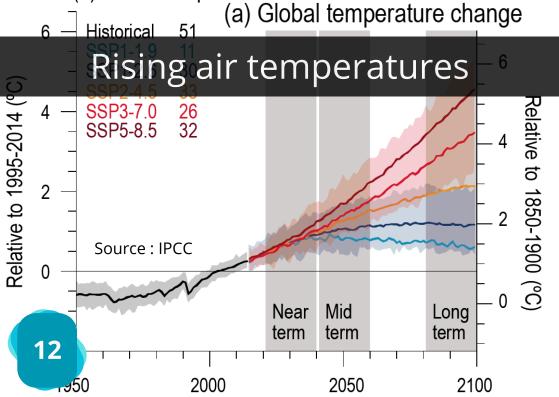






The temperature of marine waters has been rising over the years, particularly at the surface. This has an important impact on marine biodiversity.







The average air temperature at the surface of the Earth has increased by 1.2°C since 1900. Future emission scenarios predict that this increase will reach between 2 and 5°C by 2100. During the last ice age 20,000 years ago, the average air temperature was only 5°C lower than today and warming up took 10,000 years.

## Decrease of polar biodiveristy



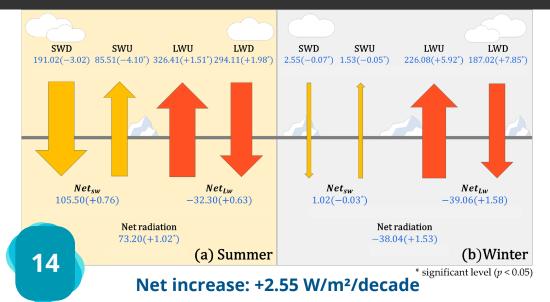


The change in water temperature and sea ice area will impact both terrestrial and marine biodiversity. With less ice surface for example, polar bears and seals will be forced to live on disrupted areas. Marine biodiversity will also be impacted by more fragile breeding areas and the heating of the sea.



Model : ERA5[W/m<sup>2</sup>] (W/m<sup>2</sup>/decade)

## Change of the radiation budget





The radiative budget changes with the albedo. With an albedo decrease, there is a change in short and longewave budget. Therefore, it is estimated that the radiative budget over a year increases by 2.55 W/m<sup>2</sup>/decade.



## **Carbon** particles sedimentation

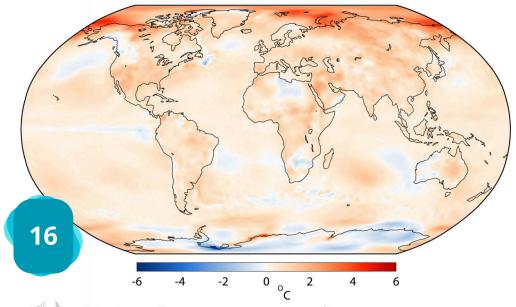




Carbon particles emitted by human activities (transport, industry, etc.) move into the upper atmosphere and begin to sediment. When these particles fall on ice, they absorb much more radiated energy, causing the ice to melt.

## Polar amplification

Temperature difference between 2017 and 1981-2010





Polar amplification is the name given to the phenomenon indicating that the North Pole is warming much faster than the rest of the planet.

