OSI SAF over 25 years

- with a focus on satellite monitoring of sea ice in North and South

Signe Aaboe
Norwegian Meteorological Institute

EUMETSAT OSI SAF

Norwegian Meteorological Institute

Agenda

- Who am I?
- What is OSI SAF?
  - Why?
  - What?
  - Who?
  - When?
- Sea ice
  - What is it?
  - Where is it?
  - How do we monitor it?
  - What can we monitor?
- Final slide

Who am I?

- Signe Aaboe (PhD)

  @SigneAaboe @SigneAaboe@fediscience.org

  signe.aaboe@met.no

- Work at MET Norway *(Tromsø)*

  Division of Research and Development

- Remote sensing sea-ice scientist

  Engaged in OSI SAF, Copernicus services, +++

- Webpage: cryo.met.no

Norwegian Meteorological Institute

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What is OSI SAF?

OSI SAF - Why?

European Organisation for the Exploitation of **Met**eorological **Sat**ellites

- An **intergovernmental organization** based in Darmstadt, Germany,
- **Operates meteorological satellites** for the European Union and its member states.
- These satellites are used to **gather data on weather, climate, and the environment**,

➡ which is then **used for forecasting, warning, and research**.

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EUMETSAT

SAFs

Satellite **A**pplication **F**acilities

- dedicated centres of excellence for **processing satellite data**.

- Aim is to provide added-value products and services based on satellite data.

- deliverables can be
  1) **software** to be made available to users for use in their own environment, or
  2) **data and products** made available in near real-time or offline.

*"But **HOW** to make sure that the tons of satellite data get used for forecasting, warning, and research?" …*
→

Short answer is that the **SAFs help bridging the gap** between satellite data and the user.

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OSI SAF - Why?

EUMETSAT

8 SAFs

AC SAF

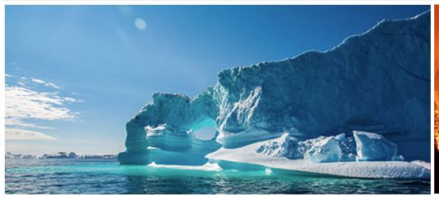
Atmospheric Composition Monitoring

The AC SAF processes satellite data on ozone, other trace gases, aerosols and ultraviolet data.

CM SAF

Climate Monitoring

The CM SAF generates and archives high-quality climate datasets.



OSI SAF

Ocean and Sea Ice

The OSI SAF provides comprehensive information on the ocean-atmosphere interface.

LSA SAF

Land Surface Analysis

The LSA SAF exploits remotely-sensed data on land, land-atmosphere interactions and biosphere applications.

NWP SAF

Numerical Weather Prediction

The NWP SAF supports the interface between satellite data and European activities in NWP.

ROM SAF

Radio Occultation Meteorology

The ROM SAF generates and archives high-quality GNSS Radio Occultation (RO) data for NWP.

NWC SAF

Nowcasting and Very Short Range Forecasting

Nowcasting is a weather forecast for the next few hours, based on current information.

H SAF

Operational Hydrology and Water Management

The H SAF generates and archives datasets and products for operational hydrological applications.

OSI SAF - Why?

EUMETSAT **OSI SAF**

AC SAF

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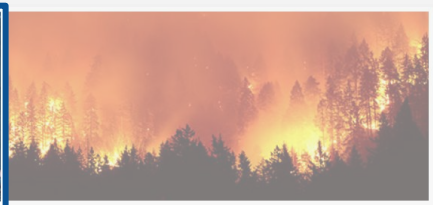

LSA SAF

Land Surface Analysis

The LSA SAF exploits remotely-sensed data on land, land-atmosphere interactions and biosphere applications.

NWP SAF

Numerical Weather Prediction

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What?

EUMETSAT OSI SAF

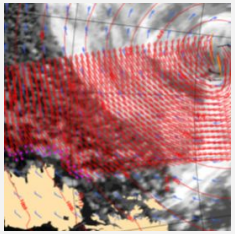
Ocean and **S**ea **I**ce **S**atellite **A**pplication **F**acilities

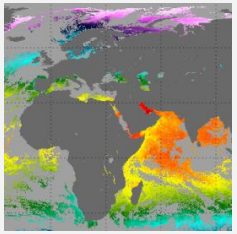
OSI SAF focuses on the products:

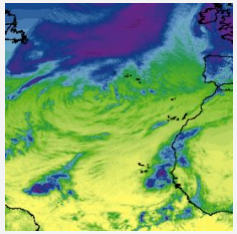
- sea surface **winds**,
- surface **temperature**
  - sea surface (SST),
  - sea ice surface (IST)
- **radiative fluxes**
  - downward longwave irradiance,
  - surface solar irradiance,
- **sea ice**
  - concentration,
  - type,
  - drift,
  - +++

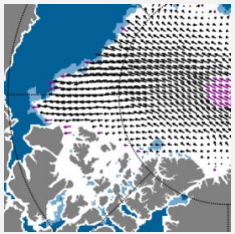
Observing Oceans from Space:

OSI SAF provides comprehensive information on the ocean-atmosphere interface based on satellite data.


WIND


TEMPERATURE


RAD. FLUXES


SEA ICE

Norwegian Meteorological Institute

Who?

EUMETSAT

OSI SAF

Ocean and **S**ea **I**ce **S**atellite **A**pplication **F**acilities
Consortium of five partners, led by Meteo-France


Kick-Off meeting, CDOP4, 2022

METEO FRANCE

Ifremer

Royal Netherlands Meteorological Institute
Ministry of Infrastructure and the Environment

Danish Meteorological Institute

Norwegian Meteorological Institute

Norwegian Meteorological Institute

Who?

EUMETSAT

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METEO FRANCE

Royal Netherlands Meteorological Institute
Ministry of Infrastructure and the Environment

Ifremer

Danish Meteorological Institute

Norwegian Meteorological Institute

SEA ICE TEAM

Norwegian Meteorological Institute

When?

EUMETSAT

OSI SAF

Ocean and Sea Ice Satellite Application Facilities

OSI SAF was **implemented in 1997**
- one of the first established SAFs -

In 2022, celebrated its 25th Anniversary.

Project phases

In march 2022, OSI SAF started it's 6th phase of activities.

- 1997 - 2002 : Development phase
- 2002 - 2007: IOP (Initial Operational Phase)
- 2007 - 2012: CDOP (Continuous Development and OP)
- 2012 - 2017: CDOP 2
- 2017 - 2022: CDOP 3
- **2022 - 2027: CDOP 4**

Norwegian Meteorological Institute

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Norwegian Meteorological Institute

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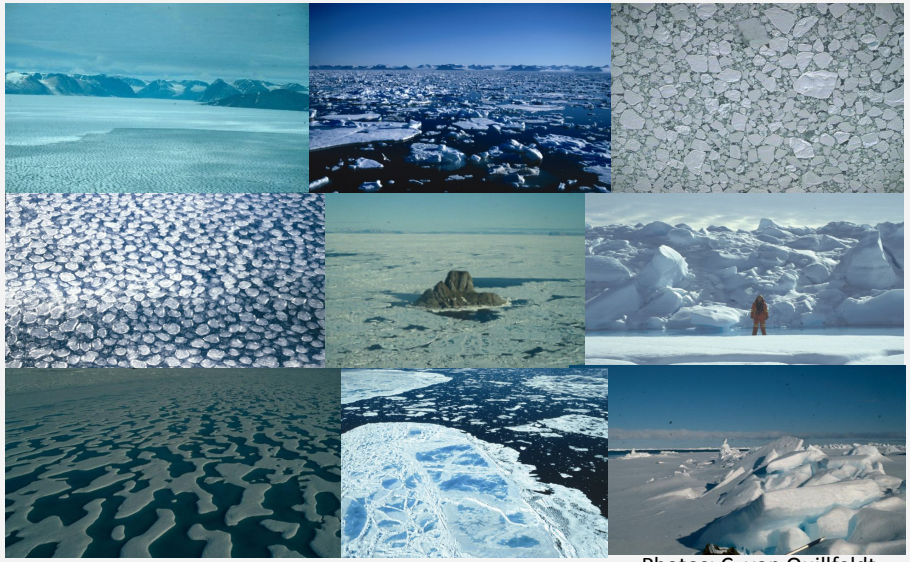
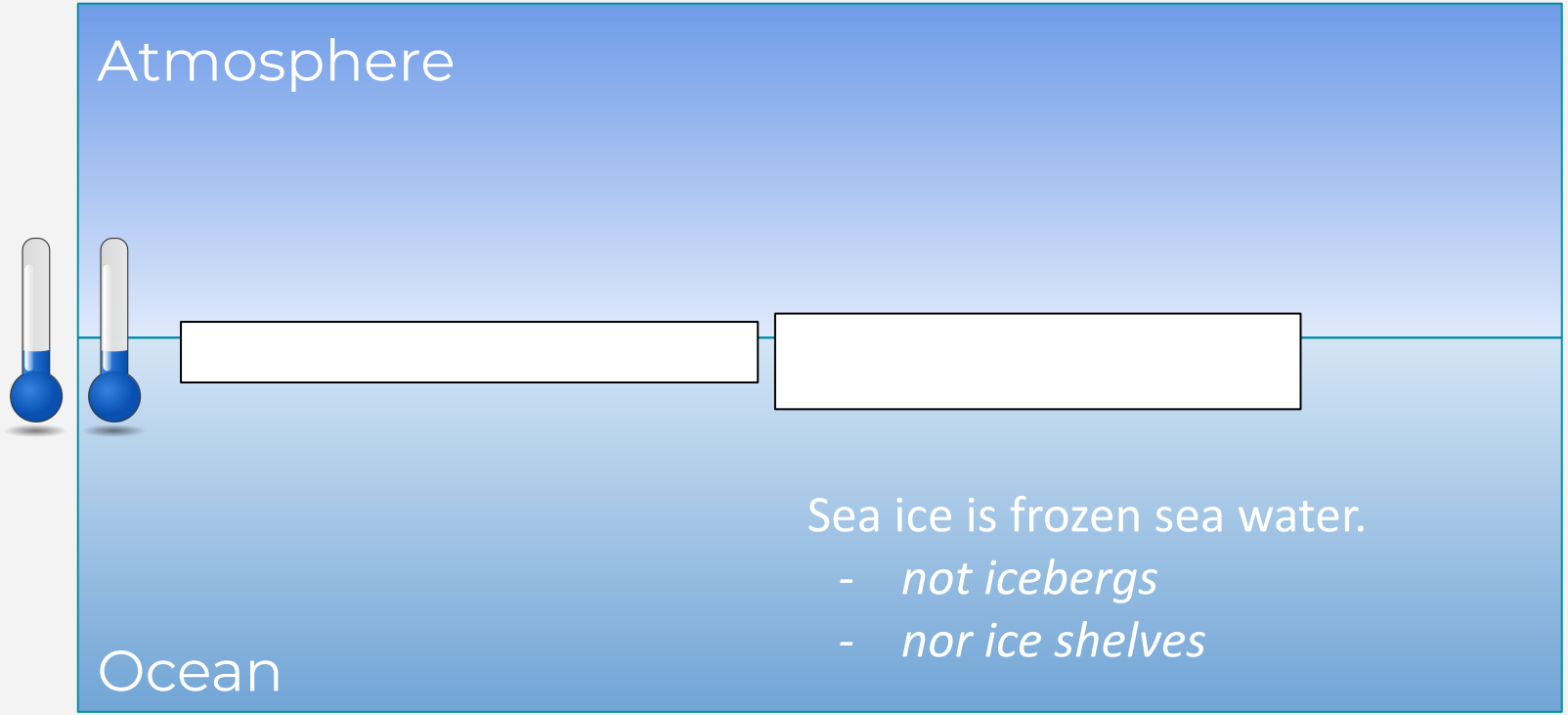


Photos: C. von Quillfeldt

What is sea ice?



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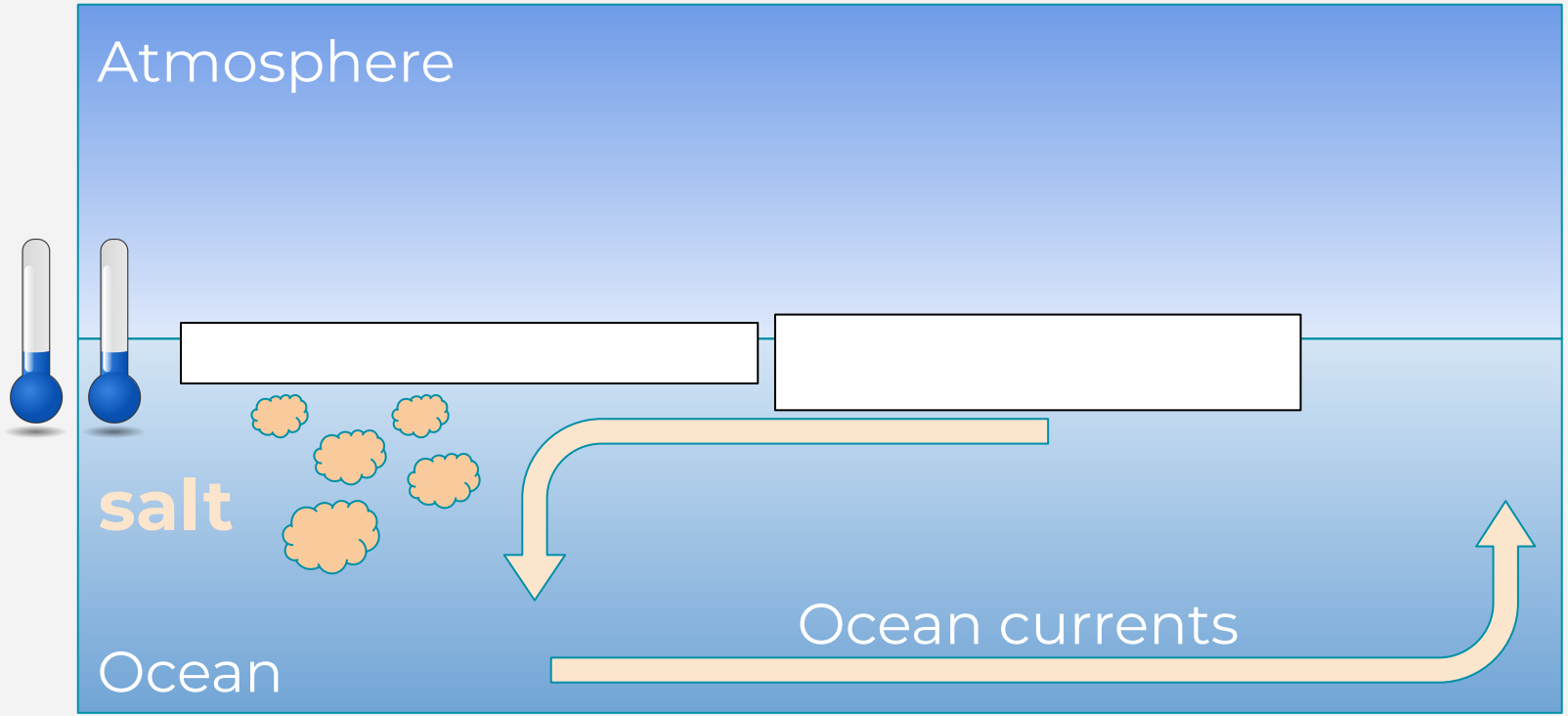
What is sea ice?



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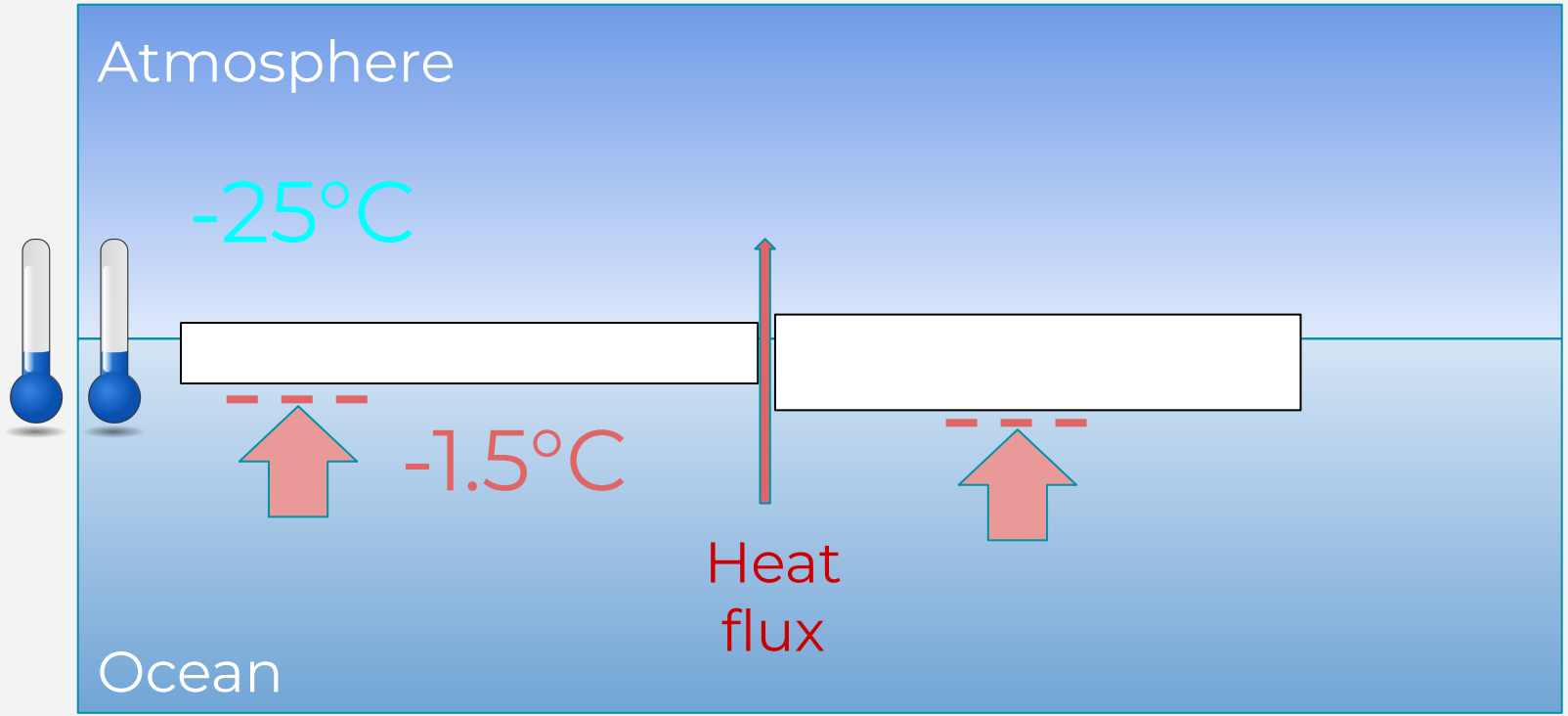
What is sea ice?



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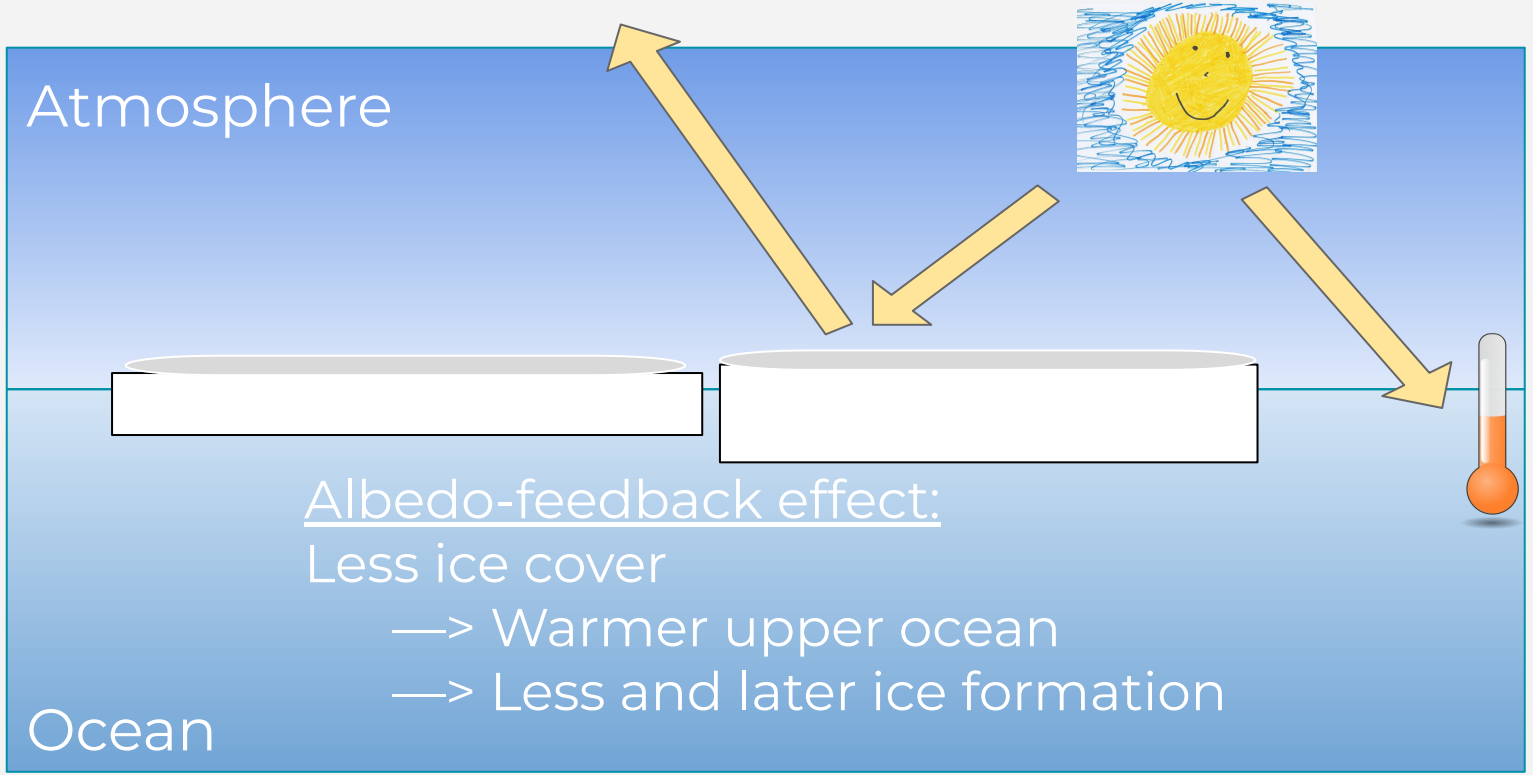
What is sea ice?



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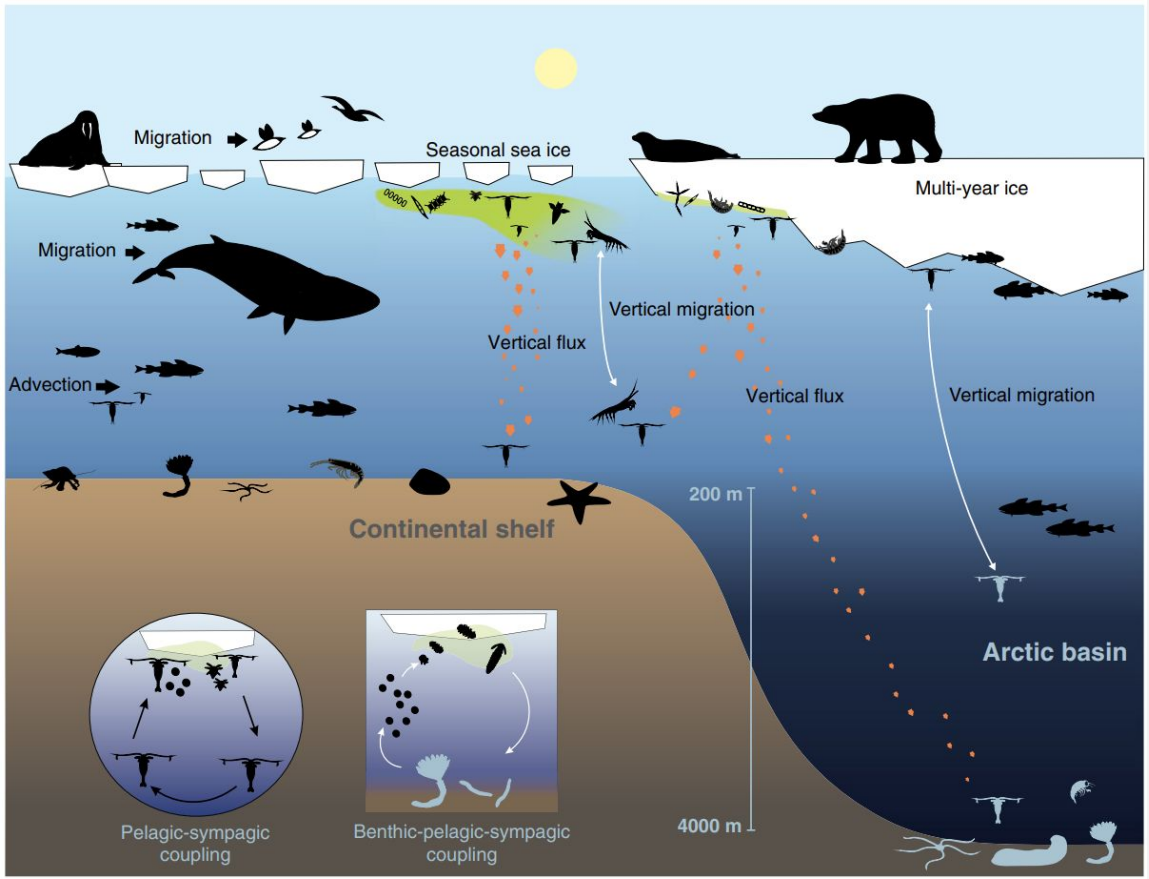
What is sea ice?

Sea ice is the habitat for many species



Daase, M., et al. (2021). In: Arctic Ecology. DOI 10.1002/9781118846582.ch9.

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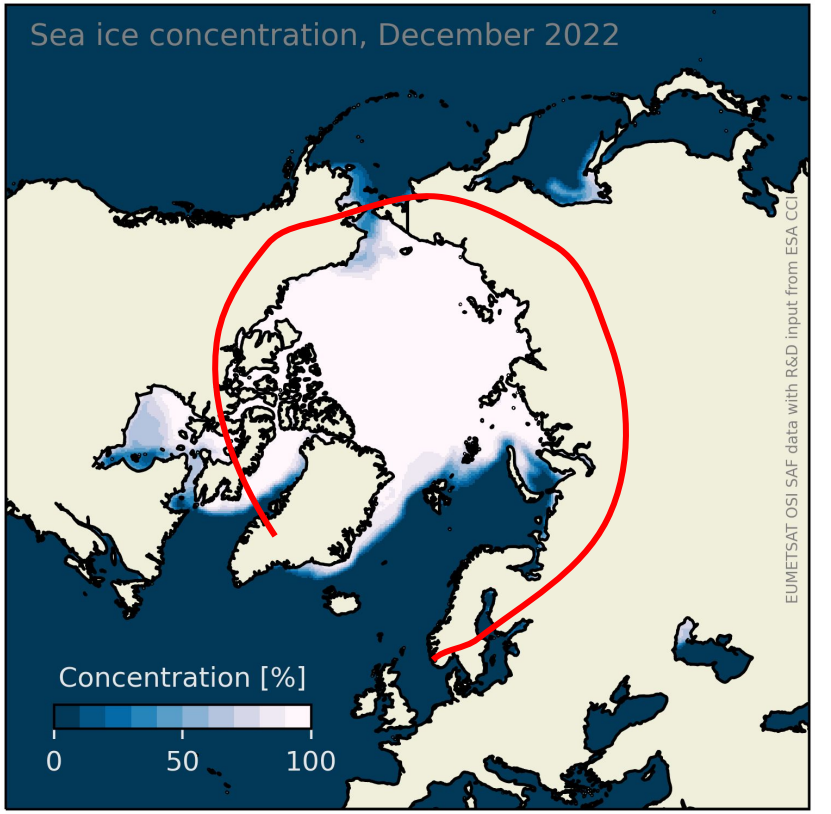
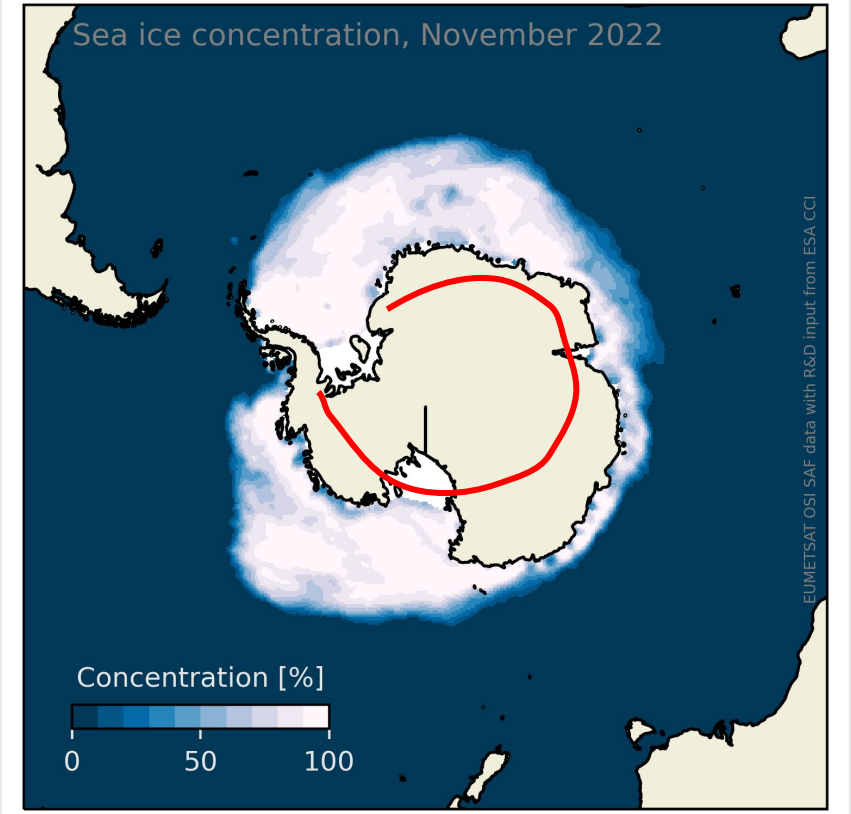
Where do we find sea ice?
NASA, 14. august 2011

North *versus* South





How do we monitor sea ice?

How do we monitor sea ice?

Back in the days …

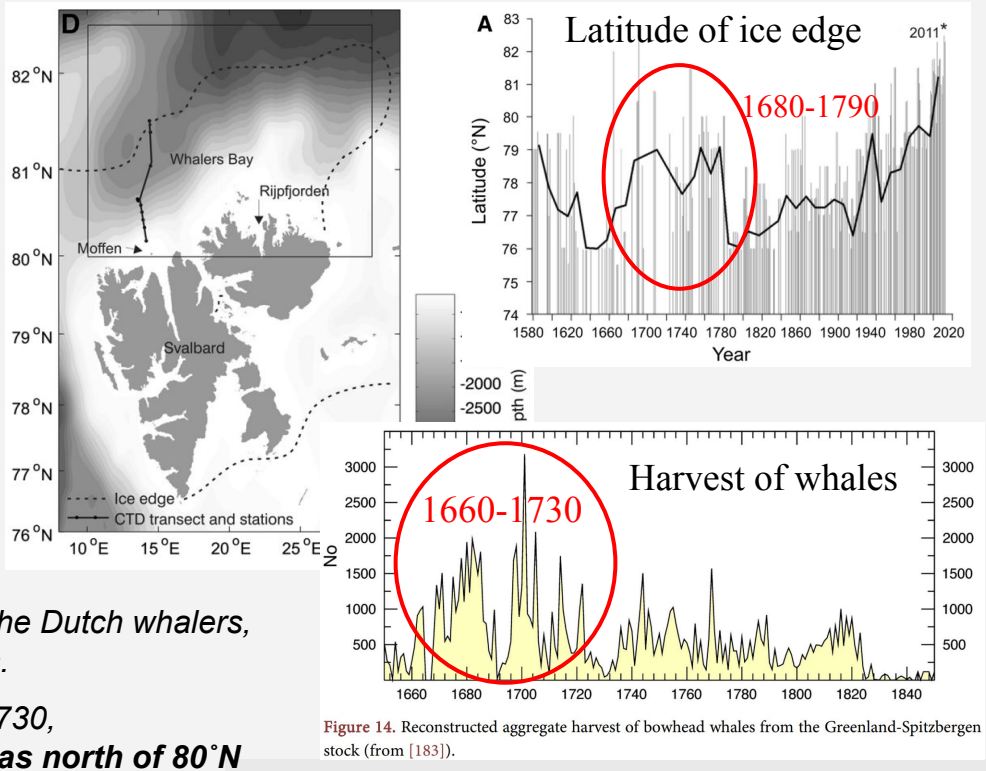


Figure 14. Reconstructed aggregate harvest of bowhead whales from the Greenland-Spitzbergen stock (from [183]).

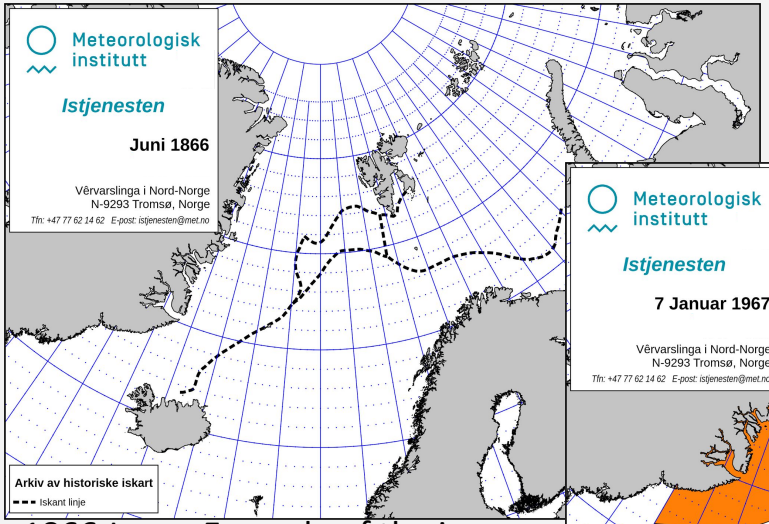
"*The area north of Svalbard was called the **Whalers Bay** by the Dutch whalers, who carried out intense whaling here for more than 100 years.*

- *The **peak of the whaling** period, between 1660 and 1730,*
- *coincided with a period where the summer **ice edge was north of 80˚N** for extended periods."*

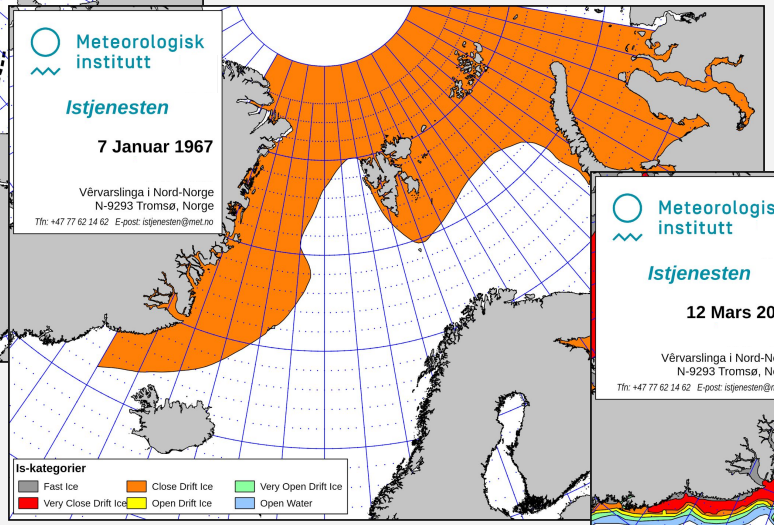
Ref: Falk-Petersen, S., et al. (2015), Mörner, N.-A., et al. (2020)

How do we monitor sea ice?

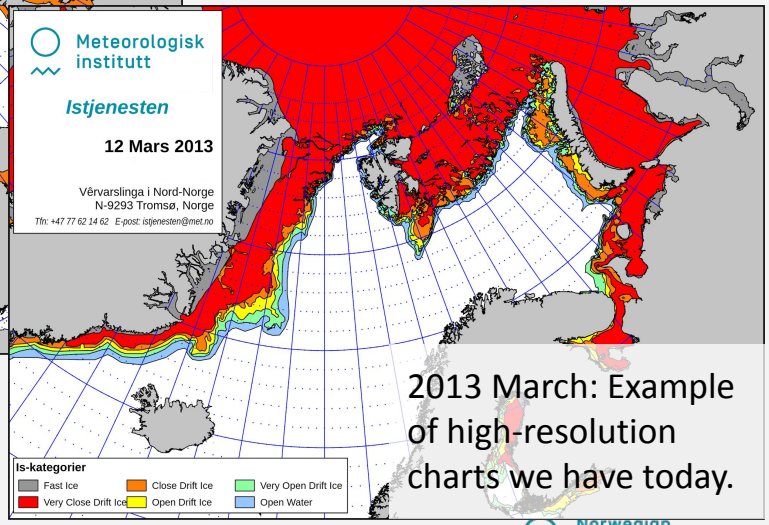
Ship→aircraft→satellite



1866 June: Example of the ice situation in June of the year that MET Norway was founded.



1967 January: The first routine Norwegian ice charts are produced (drawn on paper). These are weekly compilations of ship and aircraft observations, with the first satellite photographs becoming available winter 1969-70.



2013 March: Example of high-resolution charts we have today.

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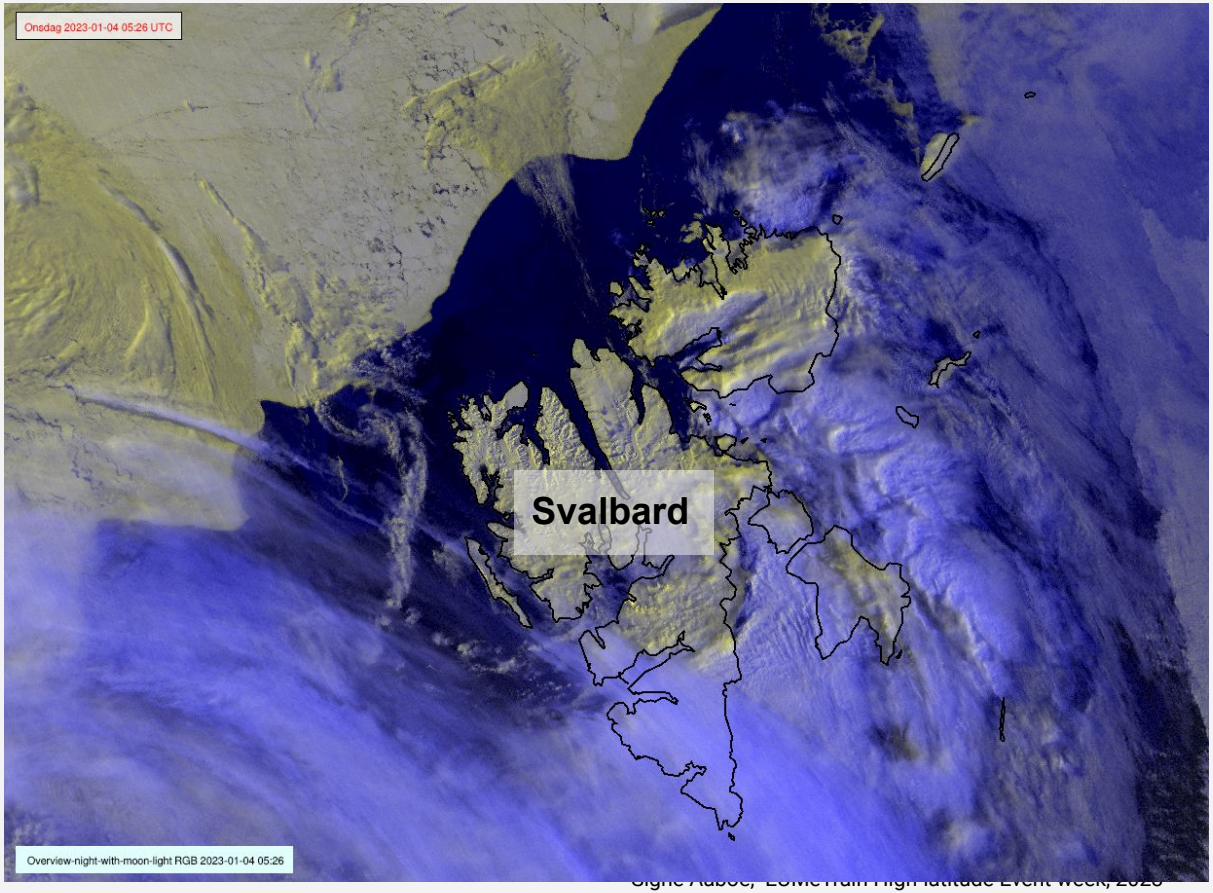
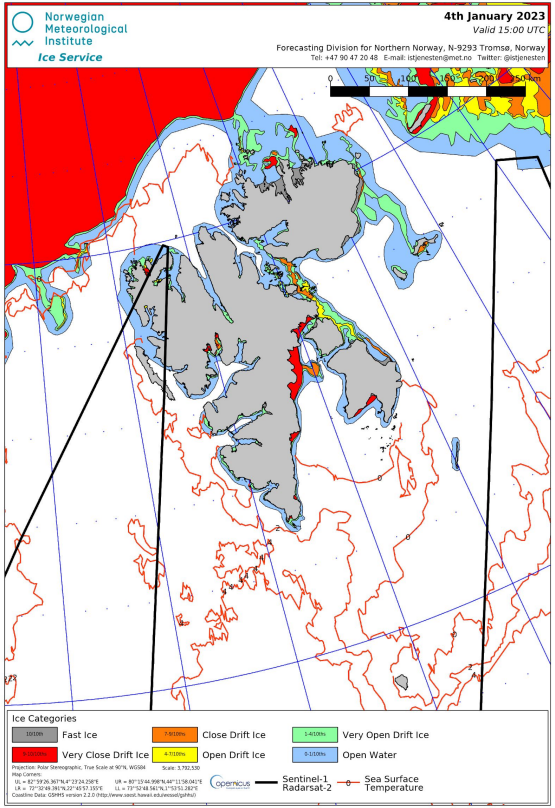
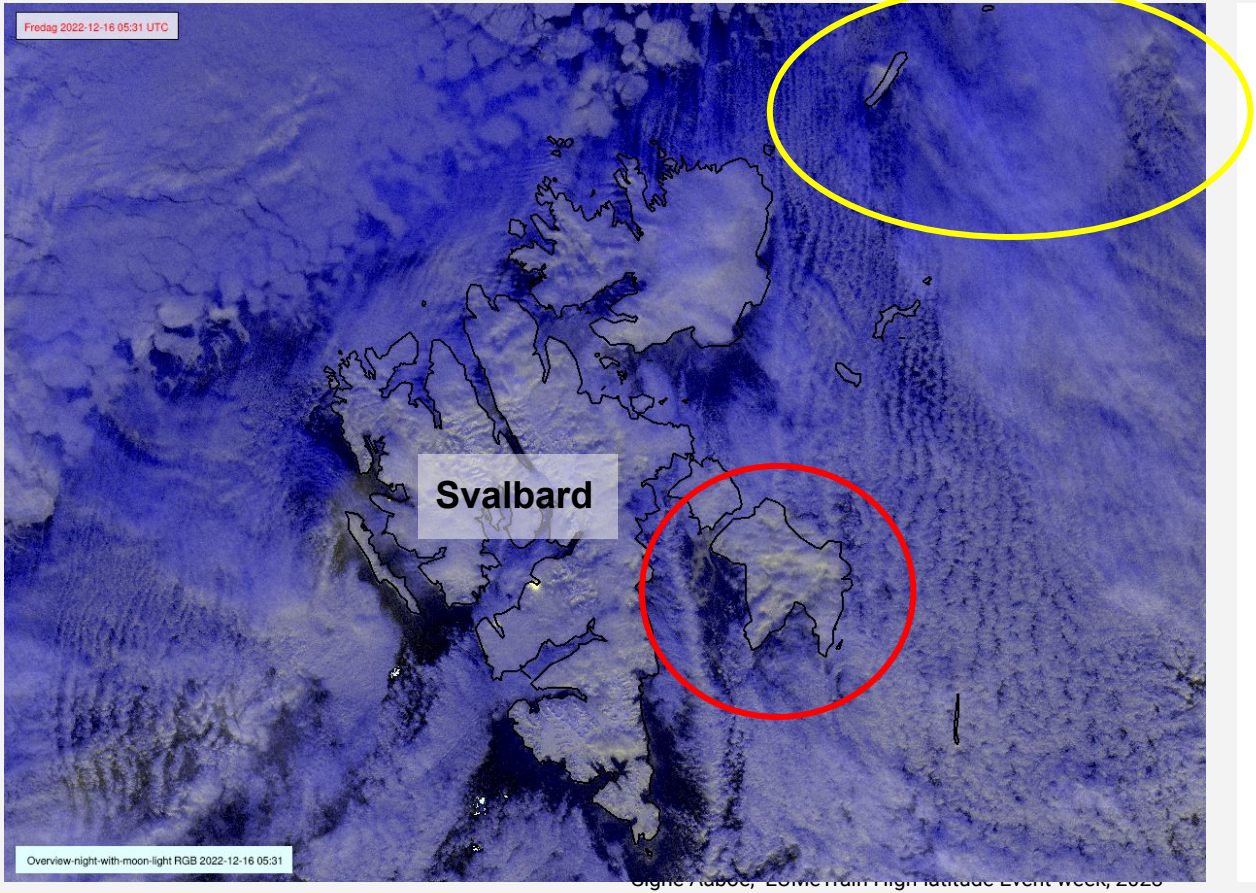
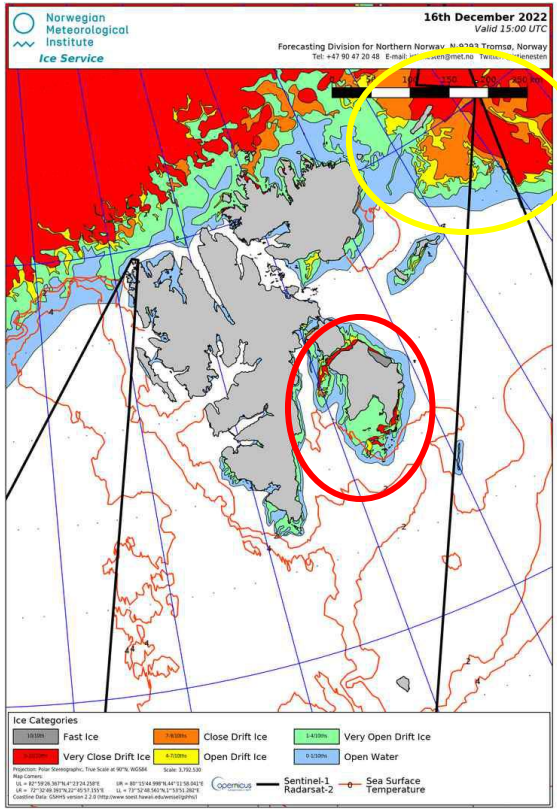
Locating the ice edge - Piece of cake!



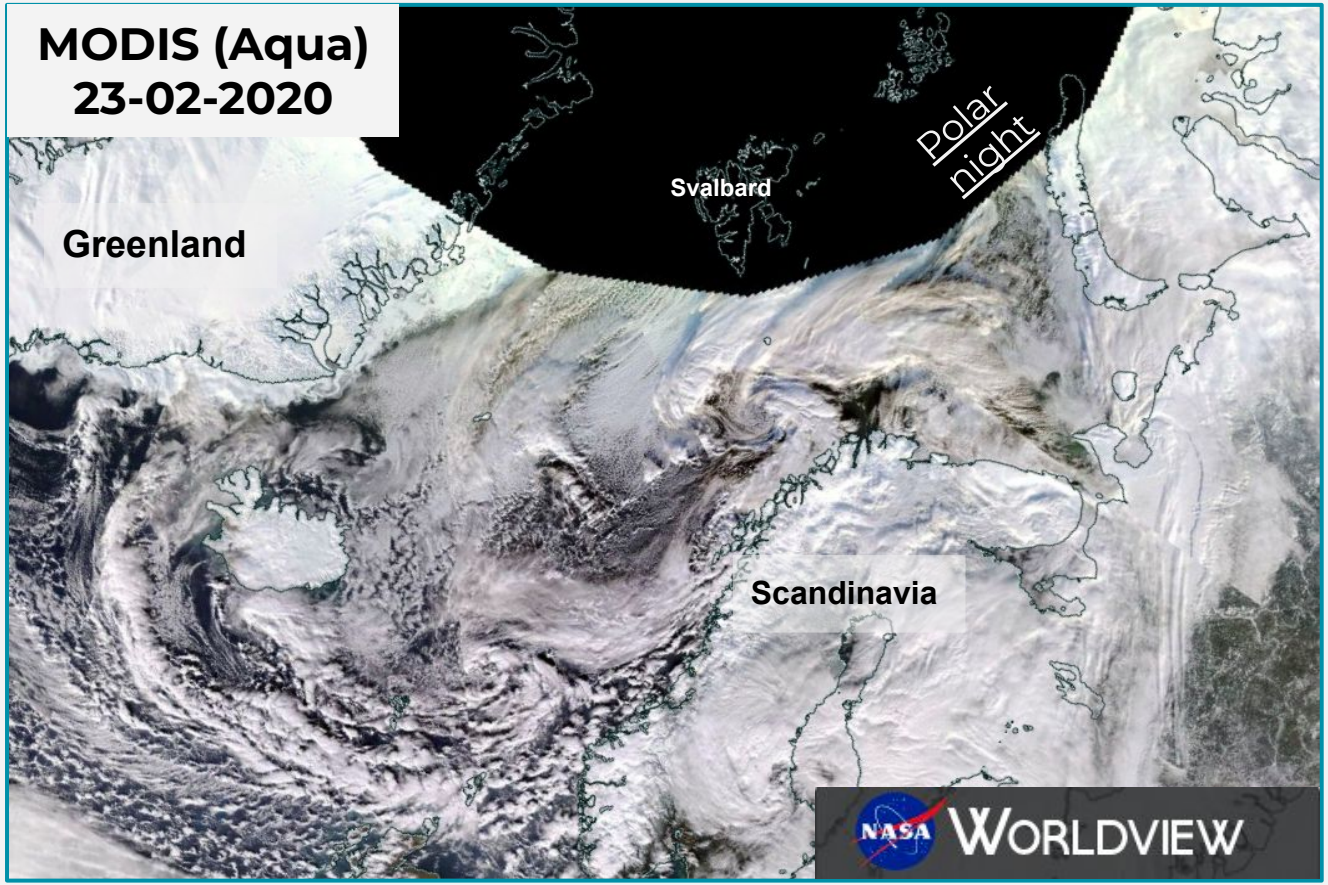


or … if just there wouldn’t be clouds …





We need microwave sensors !



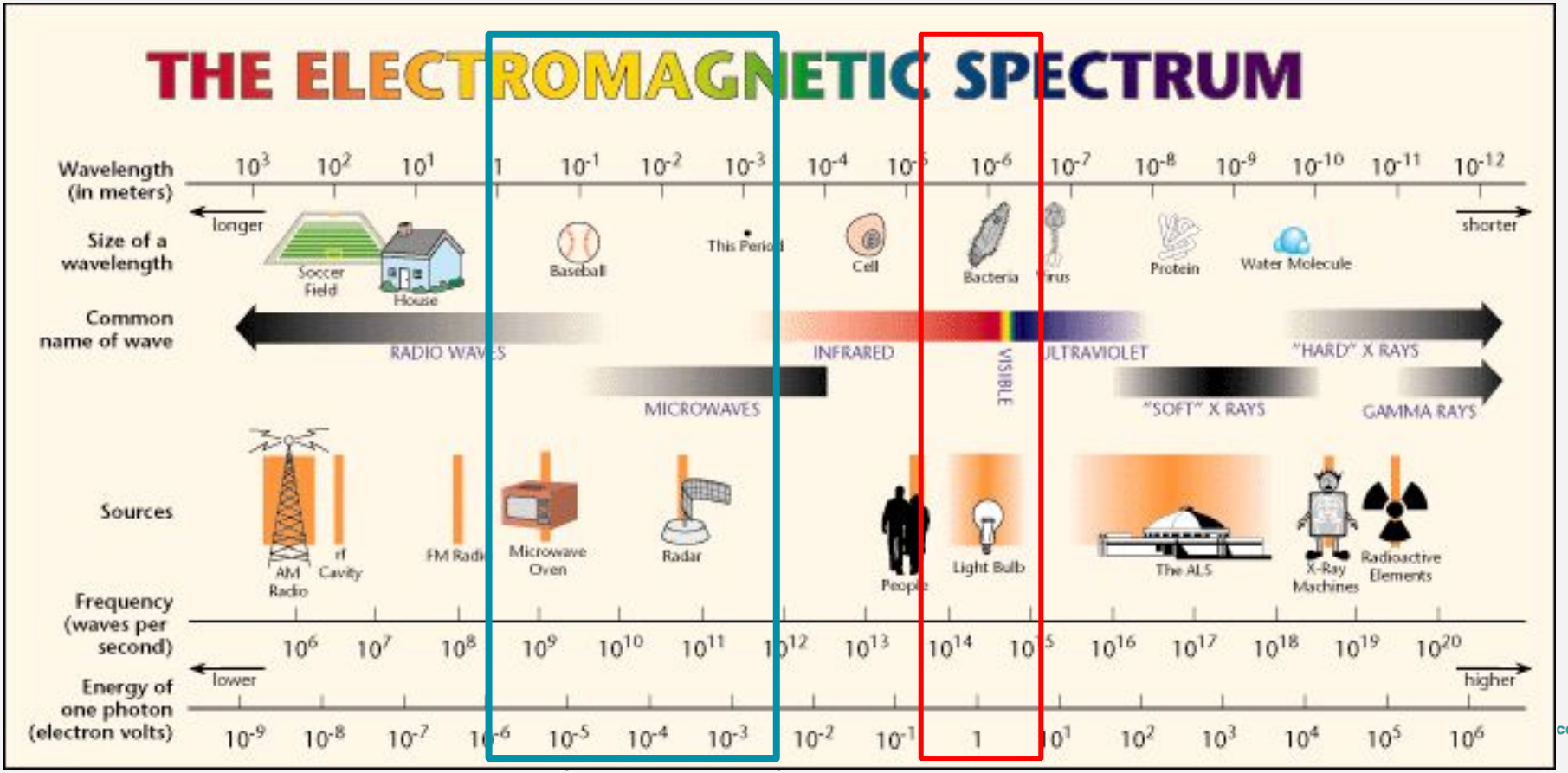
Satellites using the **visible or infrared light** (e.g. MODIS) do not see through **clouds**.

They also do not see during the **polar night**.

Therefore, they are not adapted for routine, year-round monitoring of the polar oceans.

How do we monitor sea ice?

We need microwave sensors !

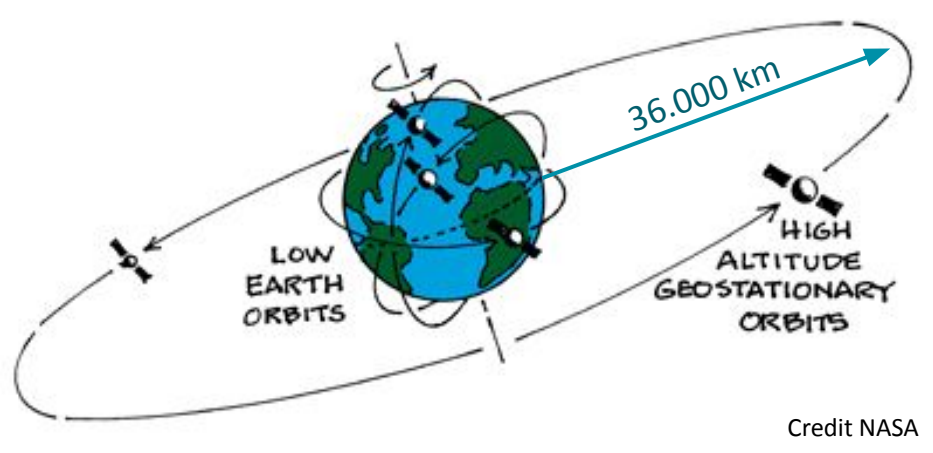


We need microwave sensors !

Earth Observation satellites

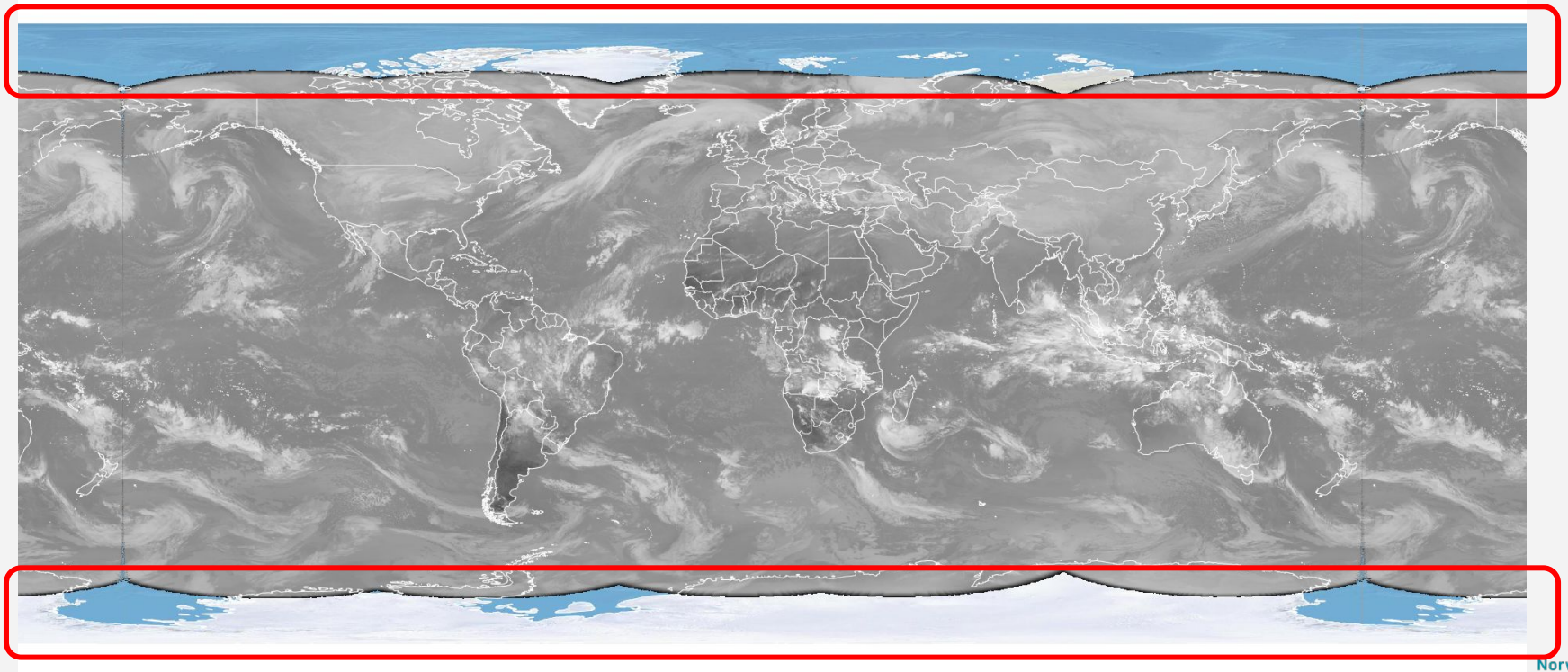
Polar Orbiting (LEO)

Geostationary (GEO)



Credit NASA

Geostationary No Good!



EUMETSAT 気象庁 Copernicus

2023-01-28 15:00:00 UTC

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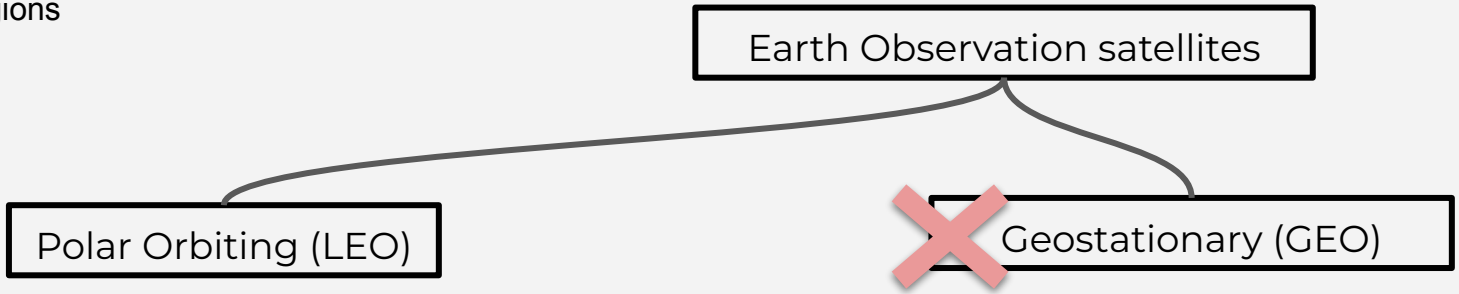
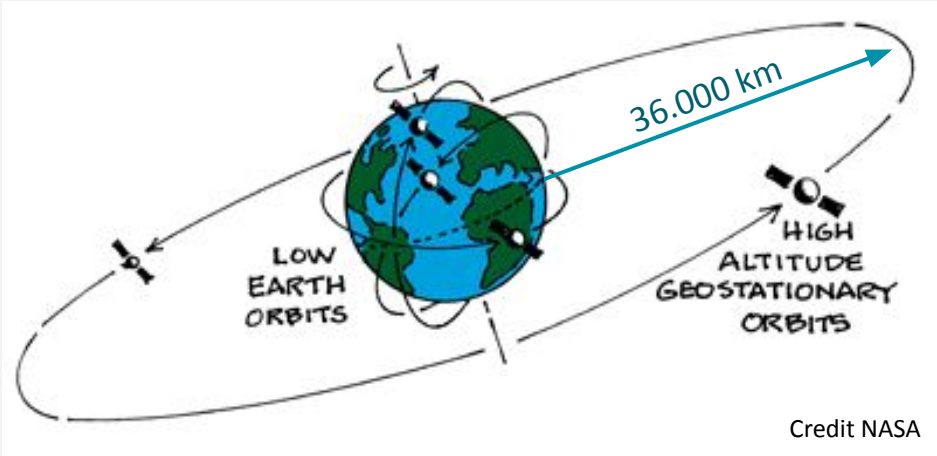
We need microwave sensors !

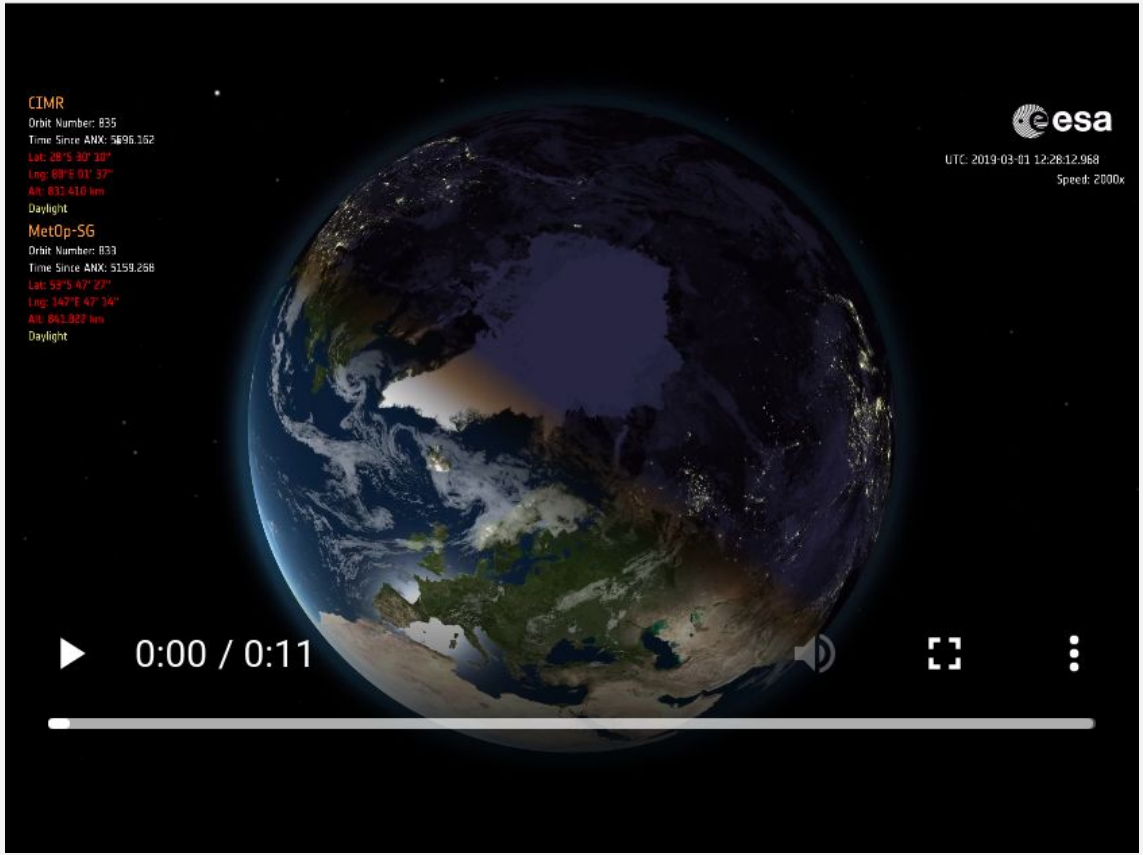
✗ don't see the polar regions





Credit NASA

Polar Orbiting



- Passes over both poles;
- Height: 700-800 km;

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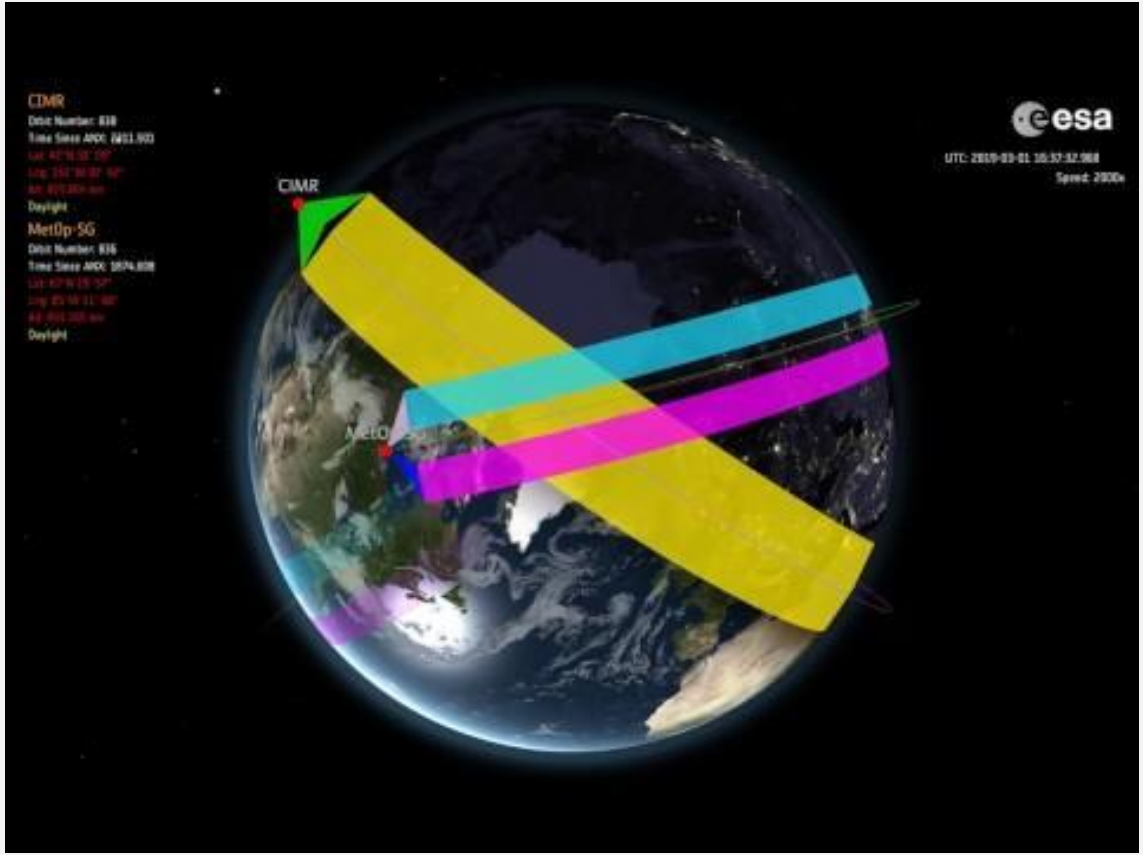
Polar Orbiting

Good coverage!



- Passes over both poles;
- Height: 700-800 km;
- speed: ~7.5 km/sec;
- Time for 1 orbit?
  - ➢ ~1.5 hour!

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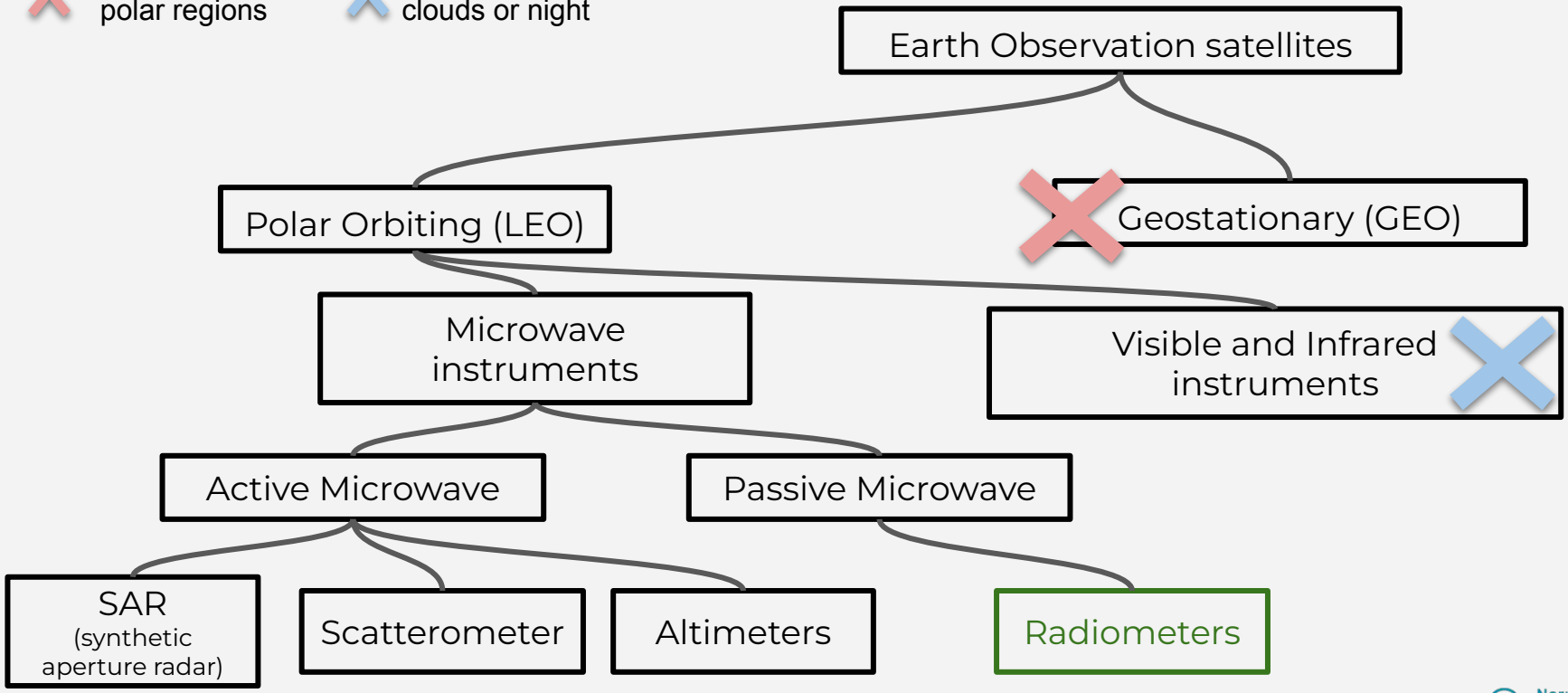
How do we monitor sea ice?

We need microwave sensors !

- don't see the polar regions
- don't see through clouds or night



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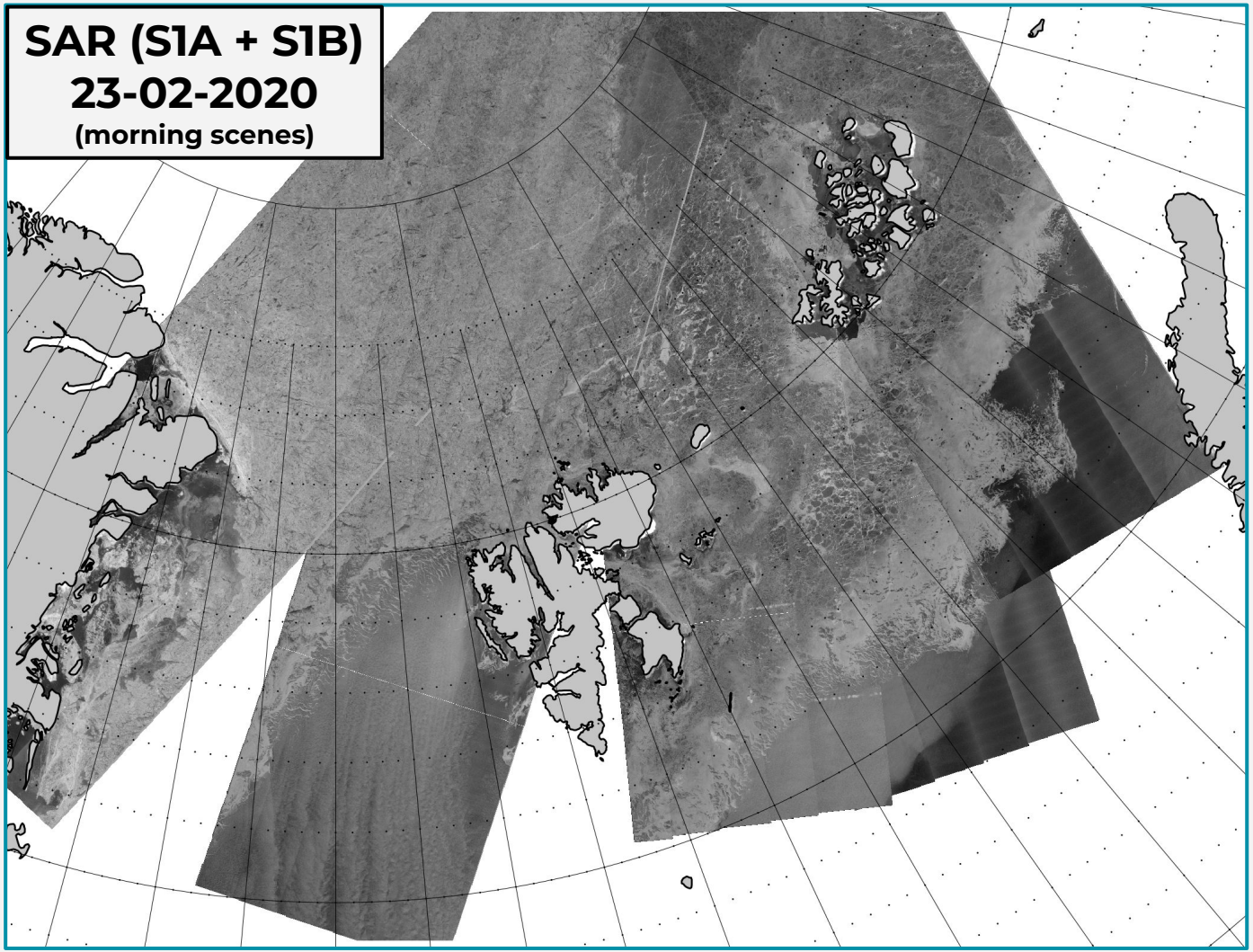

SAR

Synthetic Aperture Radar (**SAR**)

+ gives high spatial resolution (<100m),

+ through clouds, and polar night.

However,

% their classification for ice/no-ice is difficult, the images suffer from noise,

% and there are limited scenes per day

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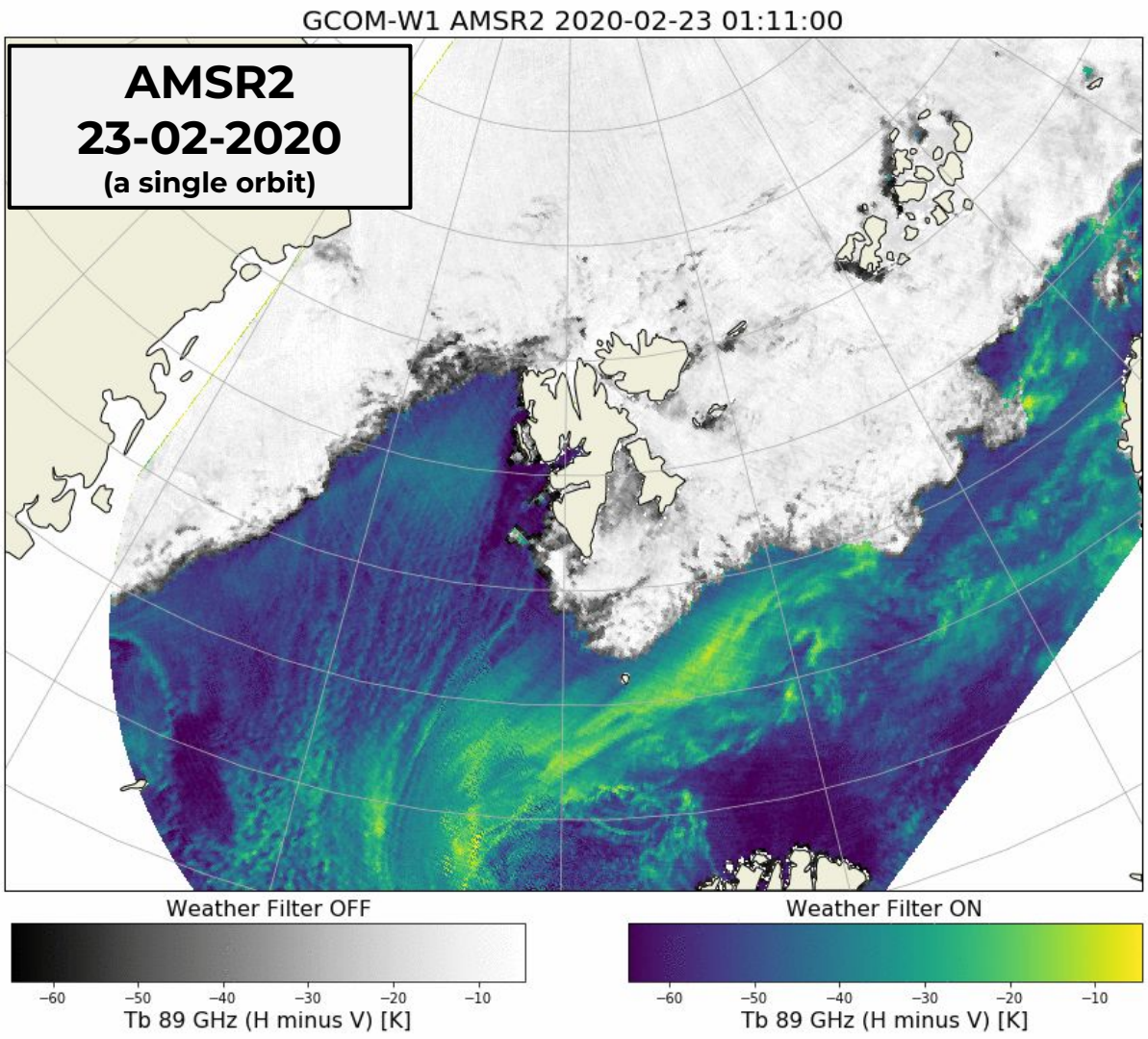

PMR

Passive Microwave Radiometry (**PMR**)

+ has 6-8 obs per day (in polar regions) for a single satellite.

+ signal is less ambiguous (multi-freq. , multi-polarization),

+ sea-ice classification easier (than with SAR).

However,

% has coarser resolution (> 5 km)

% Due to coarse resolution, issues along the coastlines and in fjords.

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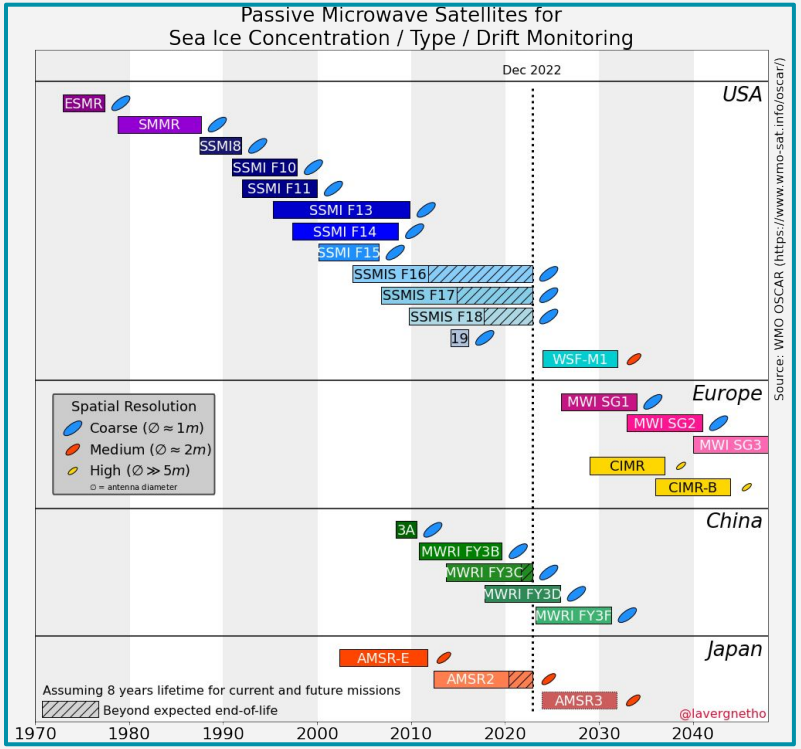
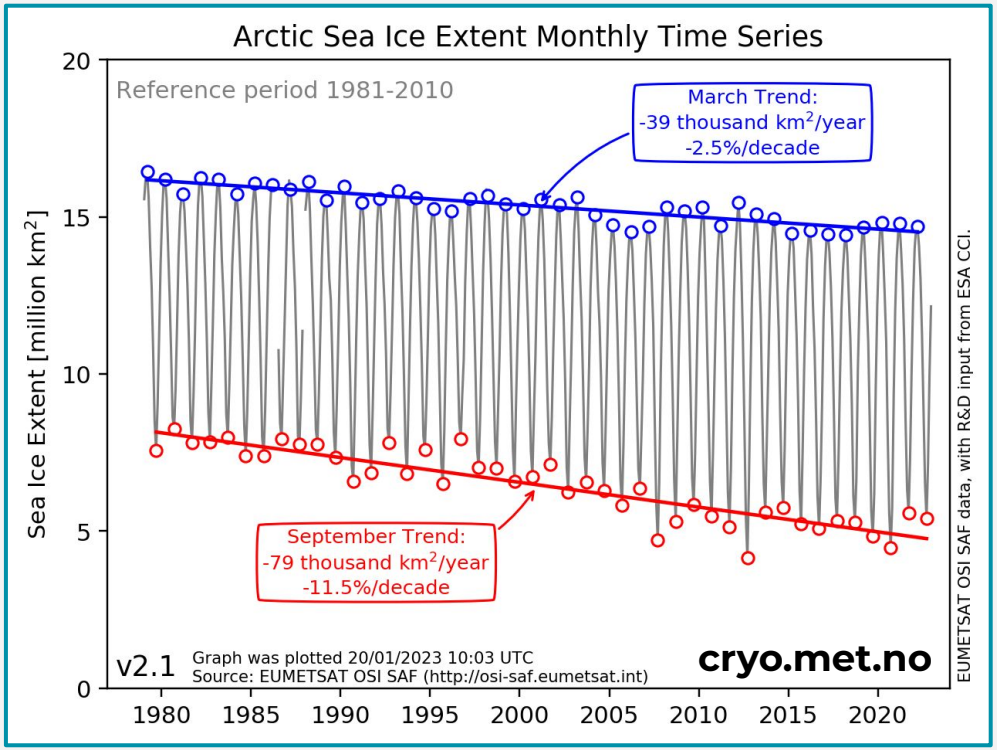
Passive Microwave Radiometry, a short intro.





40+ years of continuous monitoring of the polar regions and the sea ice.

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Passive Microwave Radiometry, a short intro.

- The Passive Microwave missions generally have **multiple microwave frequencies** (e.g. 3, 5, or 7 frequencies);
- The spatial resolution **is better** with higher microwave frequencies;
- The accuracy of the retrievals **is worse** with higher microwave frequencies;
- Modern & future satellite missions must accommodate **large rotating reflector** antennas to improve the spatial resolution.

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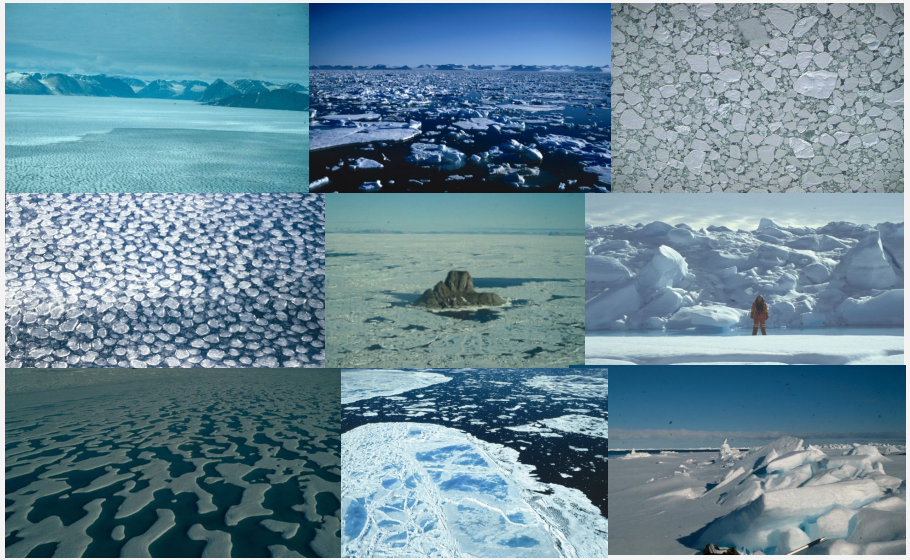
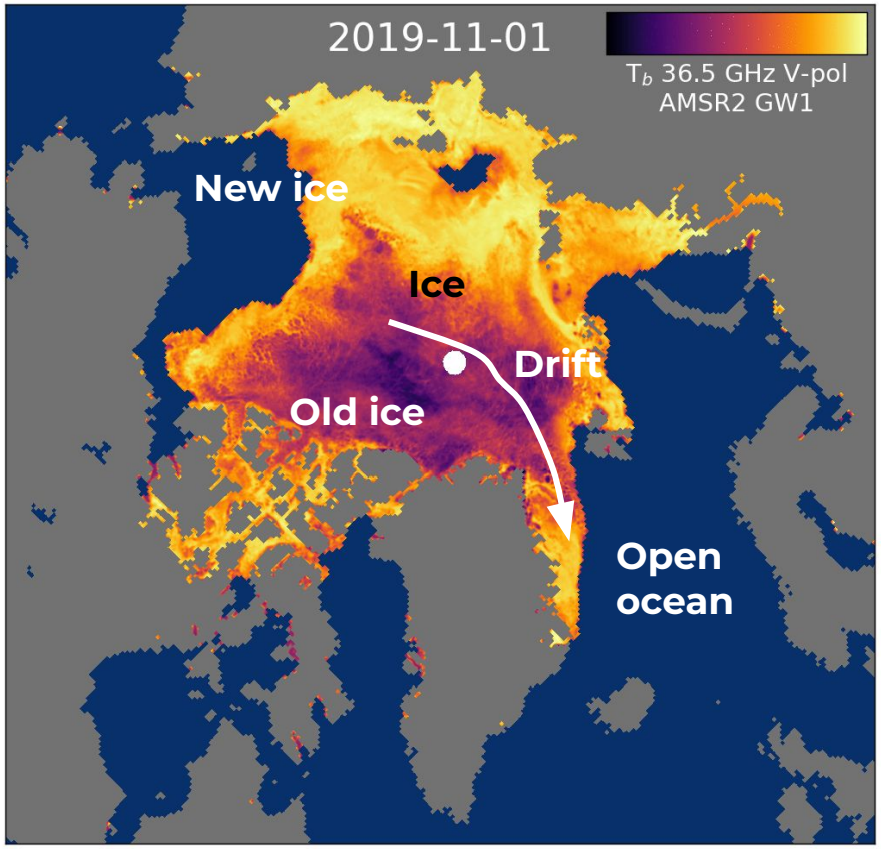
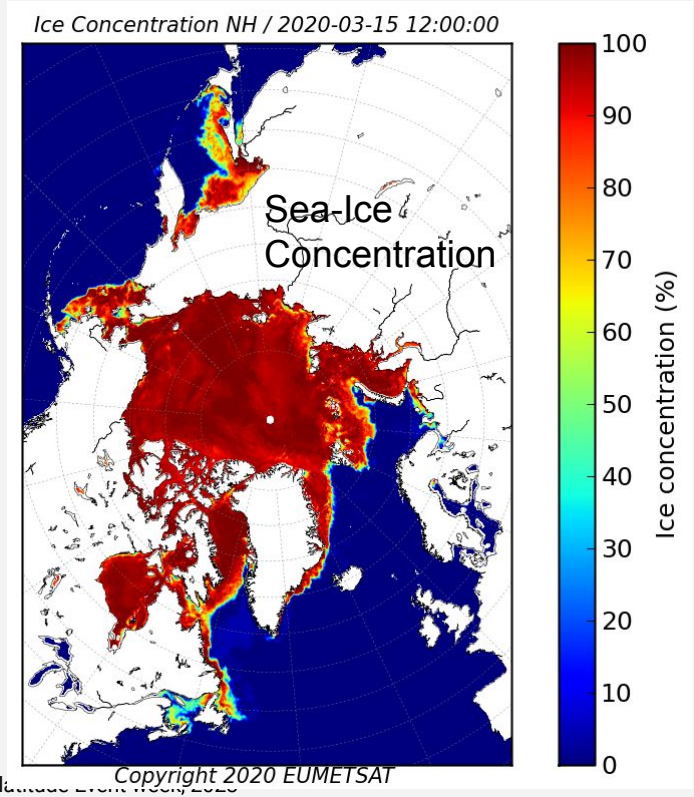
  - Where is it?
  - How do we monitor it?
  - **What** can we monitor it?
- Final slide



Arctic Sea Ice - AMSR 36.5 GHz (V).

Nov 2019 to April 2020





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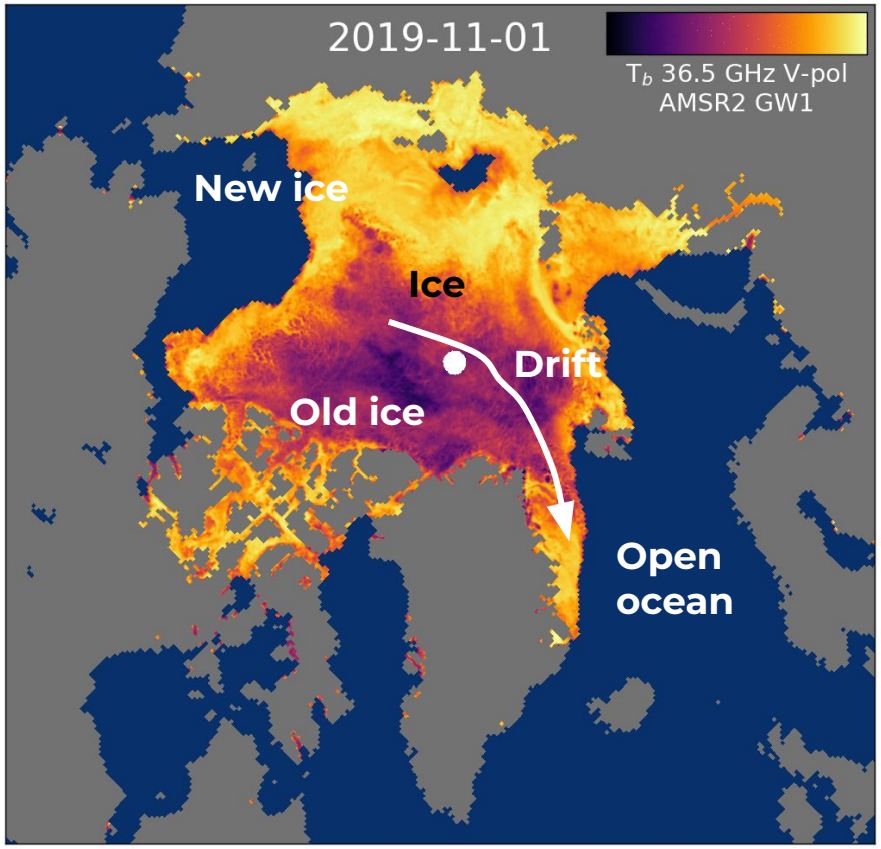
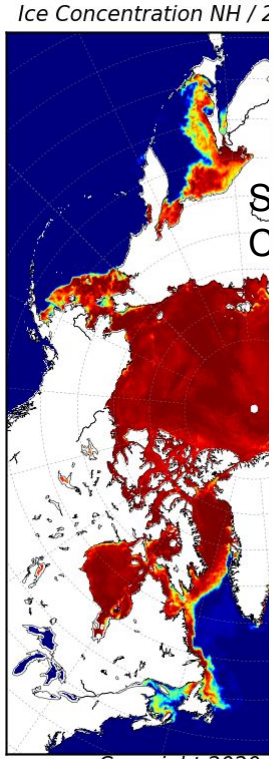
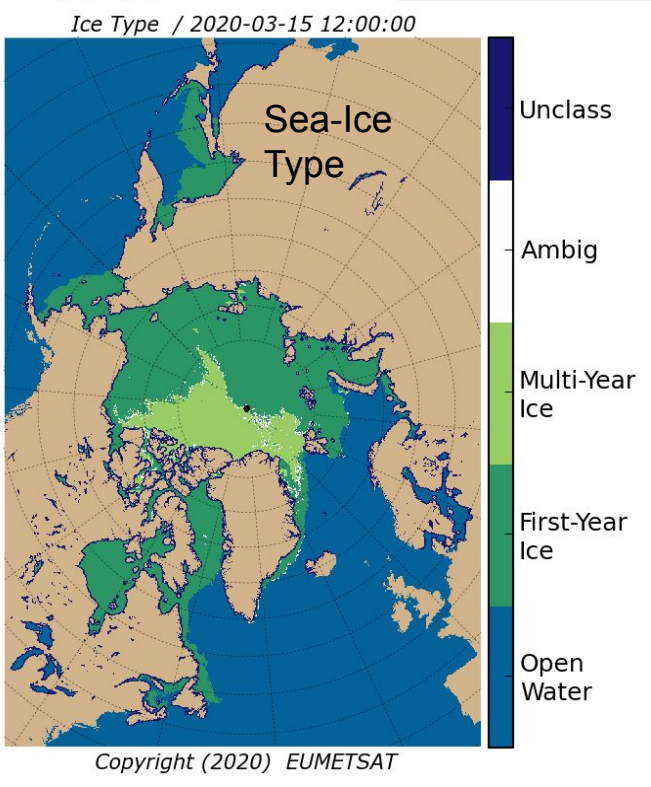
Arctic Sea Ice - AMSR 36.5 GHz (V).

Nov 2019 to April 2020



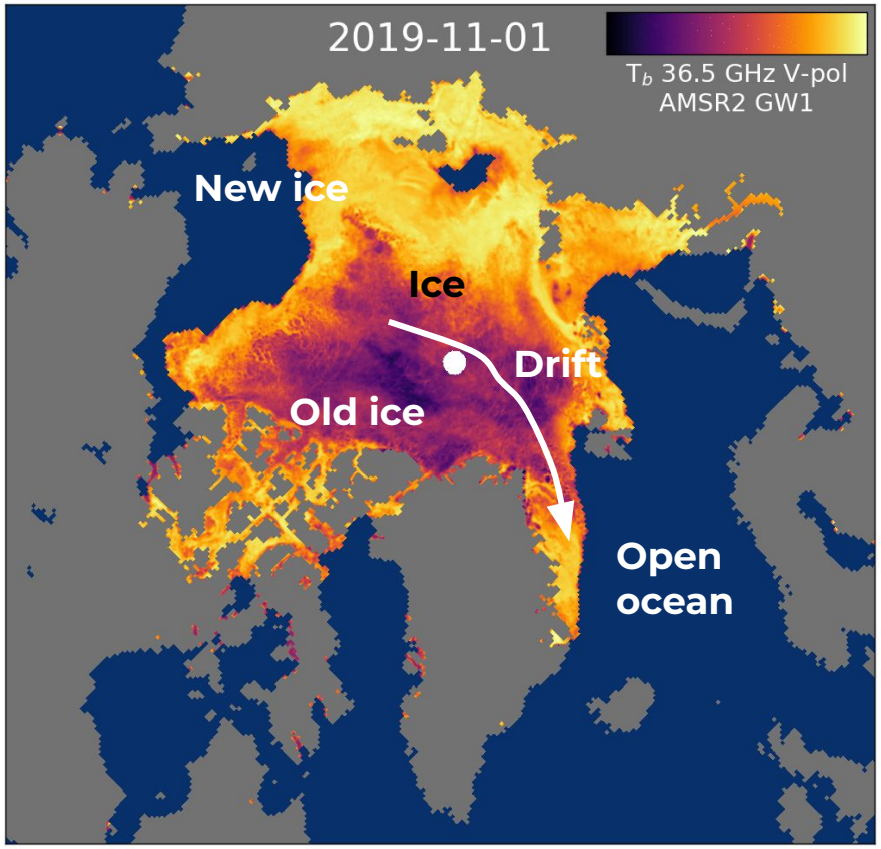


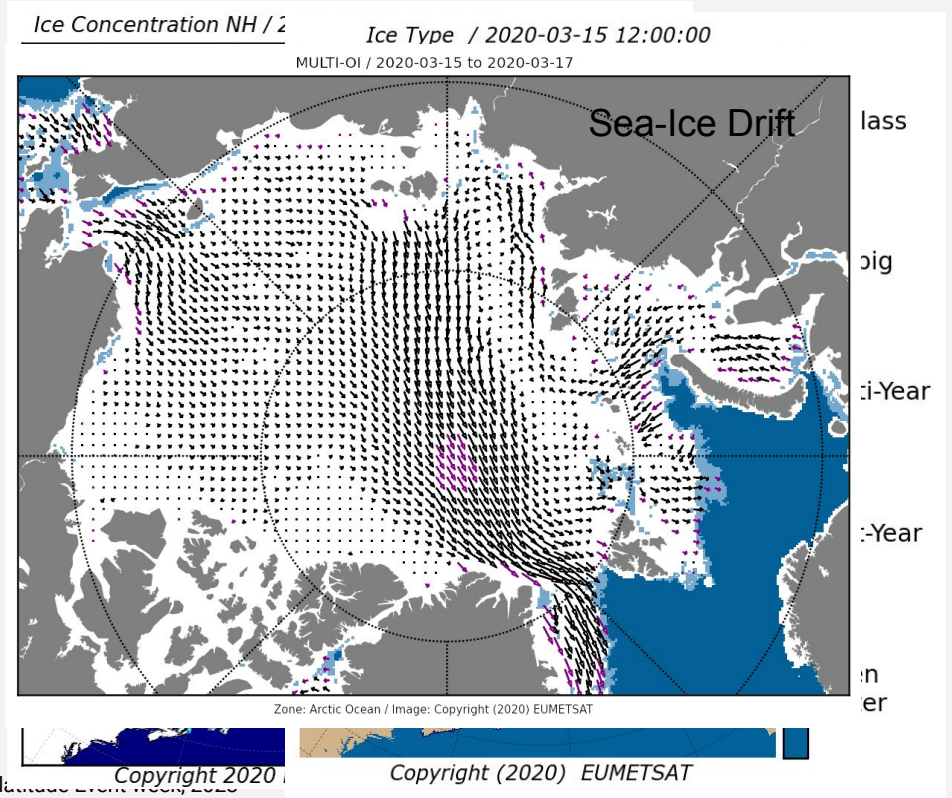


What can we monitor?

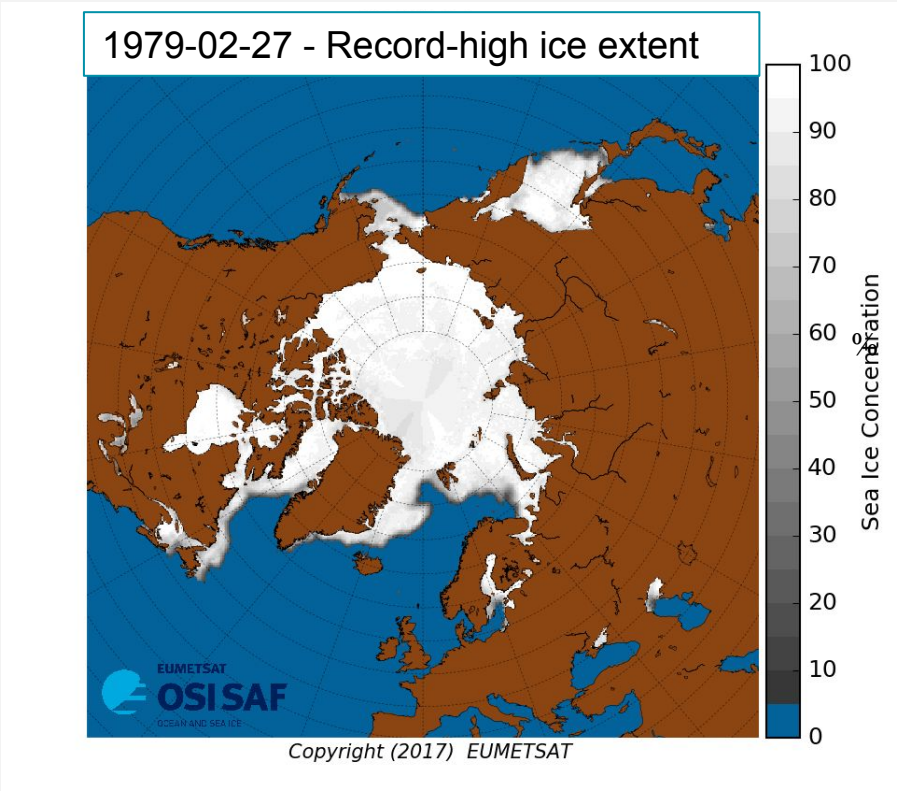
Arctic Sea Ice - AMSR 36.5 GHz (V).

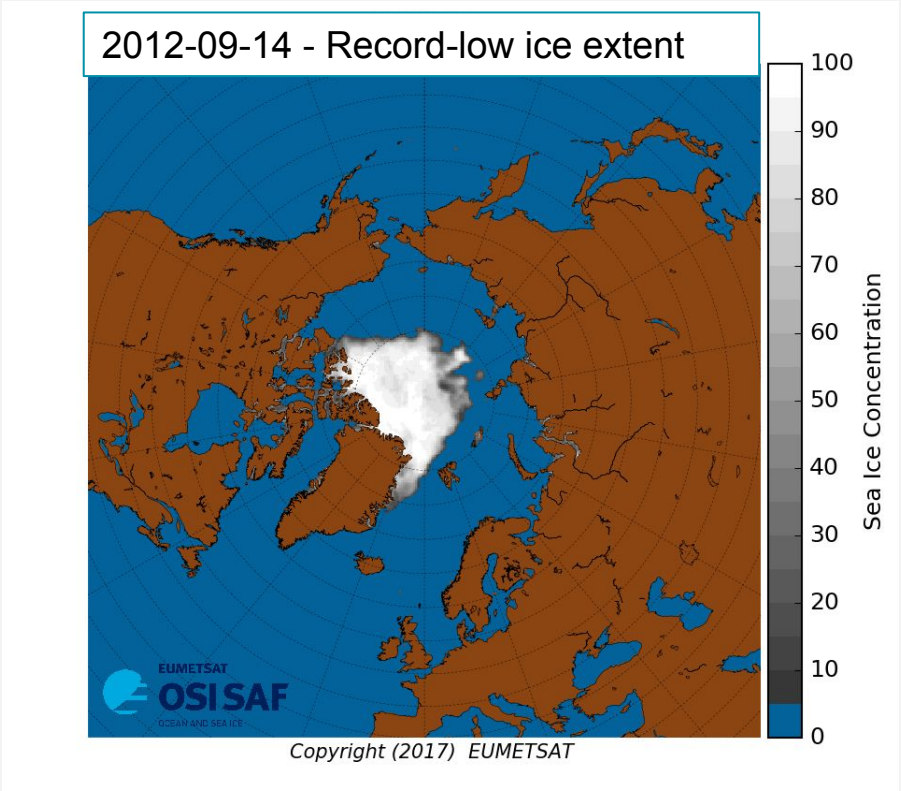
Nov 2019 to April 2020





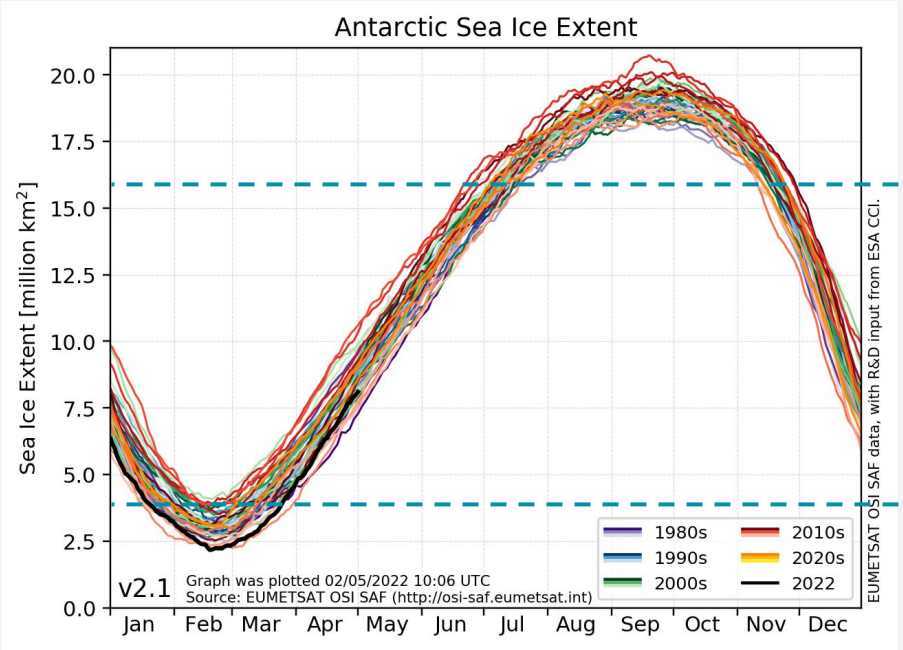
Sea ice concentration

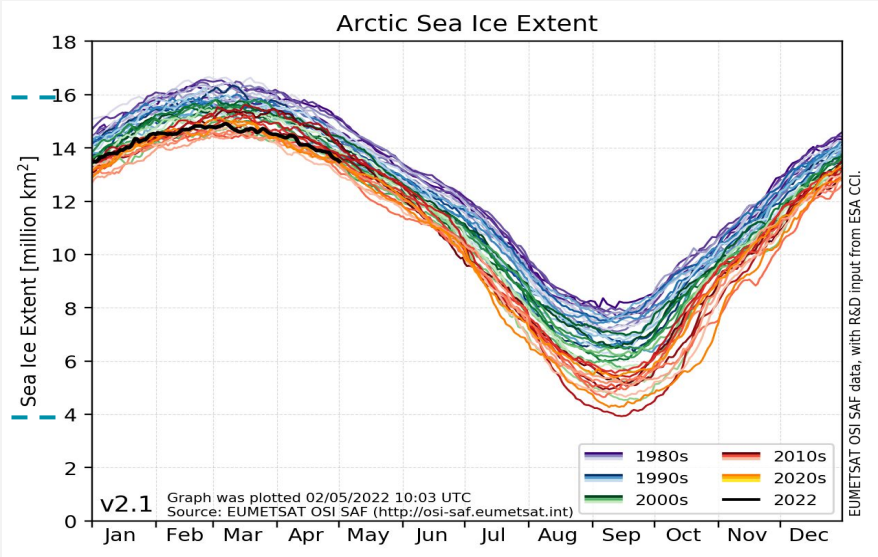




Sea ice extent

- *area of ocean surface covered with at least 15 % ice concentration*





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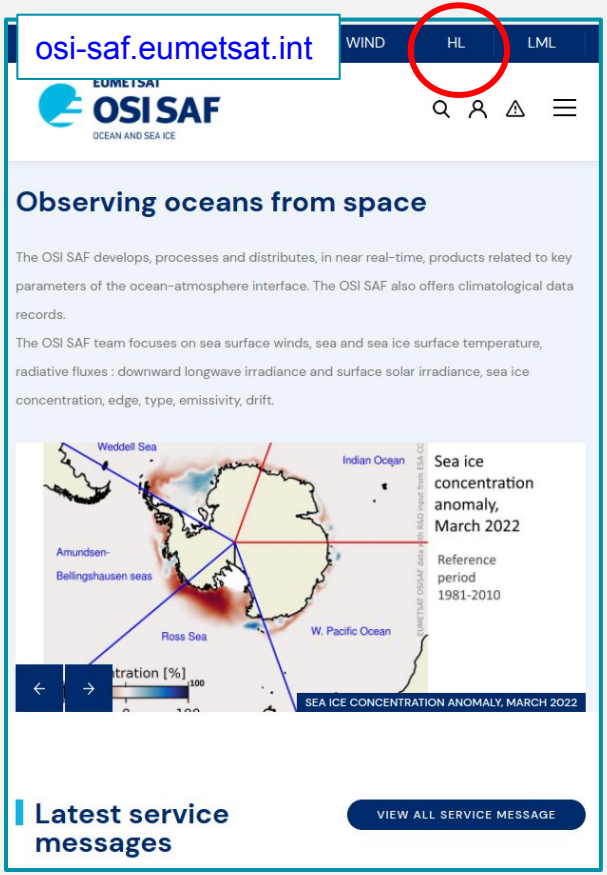
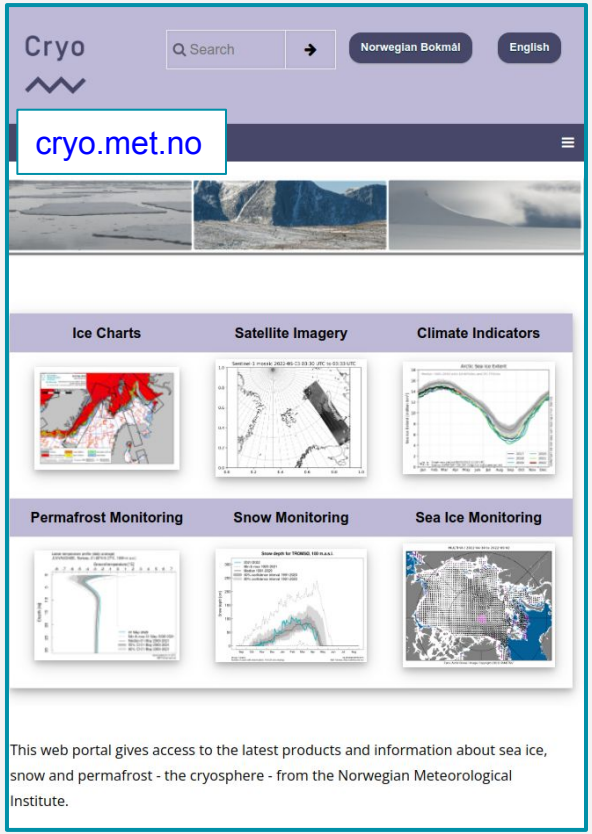
Summary - Take home messages





Thanks for listening !

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