Observing Climate Change from Space

PROJECT WEEK 3 -GROUP 2

AN IN-DEPTH EXPLORATION

xyc35, zma28, jh4025, xm482, hsb59

Table of Contents

INTRODUCTION

Purpose:

- Use satelite data collected from the ESA CCI
- Understand how different variables are changing.

Goal:

- Understand impact of climate change
- Use large datasets and analyse trends over long periods.

OUR QUESTION: How can we use SSS and SST from the whole globe to predict Sea Ice Thickness in the Arctic?

Importance:

- Better understand the planet + how it's changing.
- Helps scientists predict things like global warming and weather changes.

OUR CHOSEN VARIABLES

Sea Surface Salinity (SSS)

Sea Surface Temperature (SST)

Sea Ice Thickness

From the ESA CCI dataset global effort where scientists from around the world share climate change data collected from satelites.

SEA SALINITY - SATELLITES + INSTRUMENTS

1.SMOS (Soil Moisture and Ocean Salinity) Satelite

- Orbit: Sun synchronous, Polar orbit
- Organisation: ESA (European Space Agency)
- Instrument: MIRAS (Microwave Imaging Radiometer with Aperture Synthesis) - L band radiometer

2. Aquarius

- Orbit: Sun-synchronous
- Organisation: NASA
- Instrument: L-band microwave radiometer

3. SMAP (Soil Moisture Active Passive)

Orbit: Sun-synchronous
Organisation: NASA
Instrument: Passive microwave radiometer

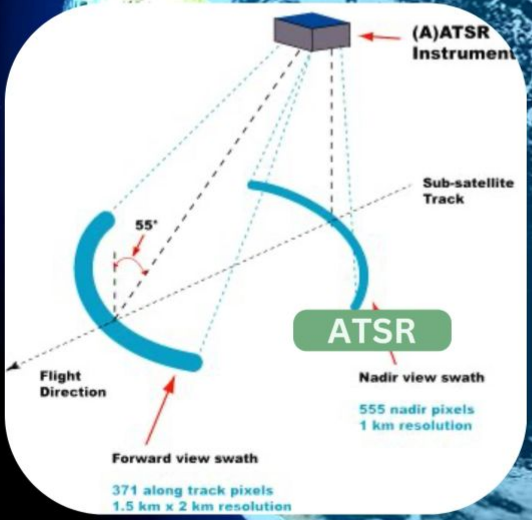
SEA SURFACE TEMPERATURE: SATELITES + INSTRUMENTS

AVHRR (Advanced Very High Resolution Radiometer)

- Orbit: Polar orbit
- Organisation: NOAA, EUMETSAT
- Instrument: Thermal infared radiometer

ATSR (Along-Track Scanning Radiometer)

- Orbit: Polar orbit
- Organisation: ESA
- Instrument: Dual-view radiometer



SEA ICE THICKNESS – SATELITES AND INSTRUMENTS USED

Satellite used: CryoSat-2 (SAR Interferometric Radar Altimeter - SIRAL): European Space Agency

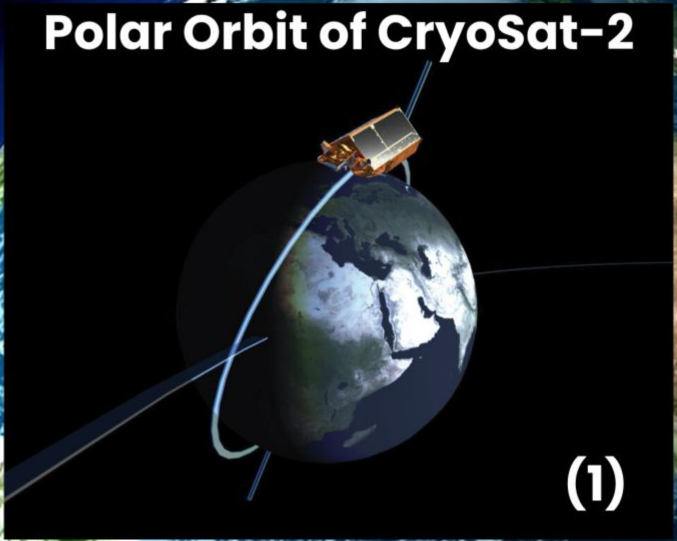
Launch Date: CryoSat-2: 2010 - 2020

Orbit:

- **Sun-synchronous orbit:** (passes over each point at the same time each day) - good for data consistency.
- **Polar Orbit (pole to pole):** Allows frequent measurements of arctic and Antarctic regions, where most satellites miss.

Imperfect polar orbit leads to some data being missed at the North Pole --›

Notice that lines do not pass through the Pole



DATASET 1: SEA SURFACE SALINITY

Trends: Winter —> Summer

- Increasing salinity in some regions, particularly Atlantic.
- Decreasing salinity in polar regions due to ice melt.
- Tropical areas shows higher salinity, polar regions have lower salinity due to freshwater input from melting ice.

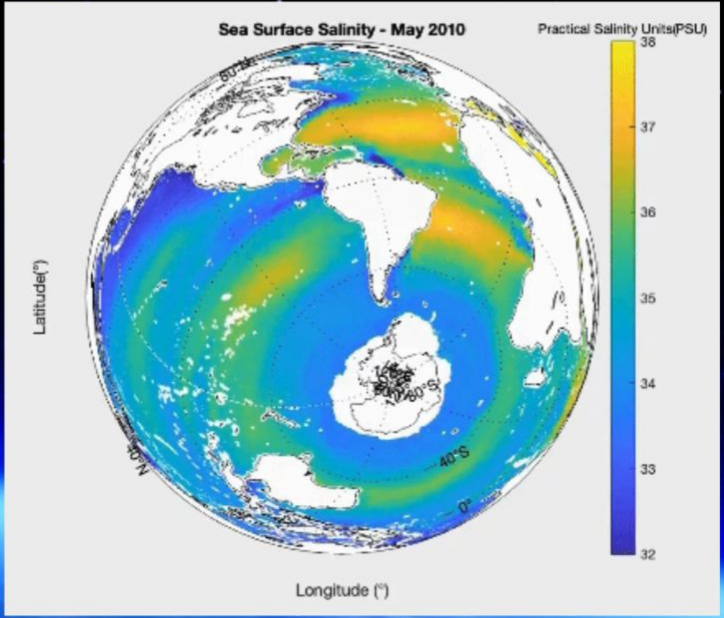


Figure 1: Sea Surface Salinity (SSS) Animation – June 2010 - Global SSS distribution in PSU across longitude and latitude.

SSS - SEASONAL FLUCTUATIONS

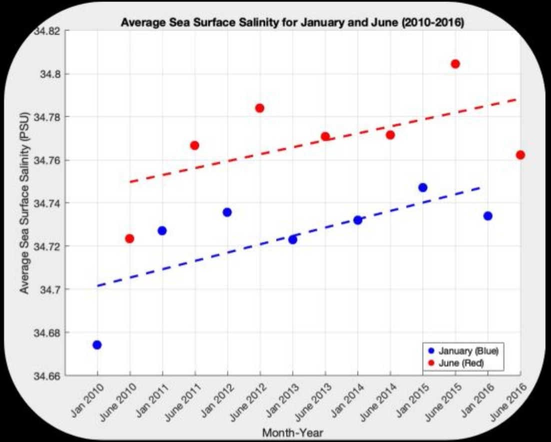


***Figure 2*:** Average Monthly Sea Surface Salinity (2010-2016)

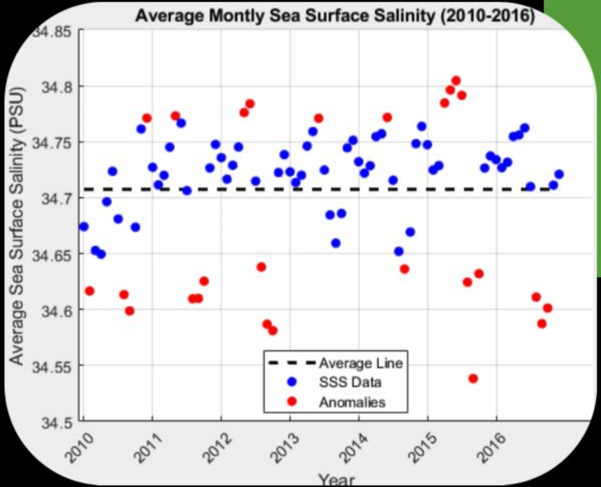


***Figure 3*:** Average Monthly Sea Surface Salinity (2010-2016)

Summer: Increased evaporation = higher salinity

Winter: Increased precipitation = lower salinity

Overall, the trends in SSS show both seasonal and long-term changes, driven by climate change and local processes.

SEA SURFACE TEMPERATURE

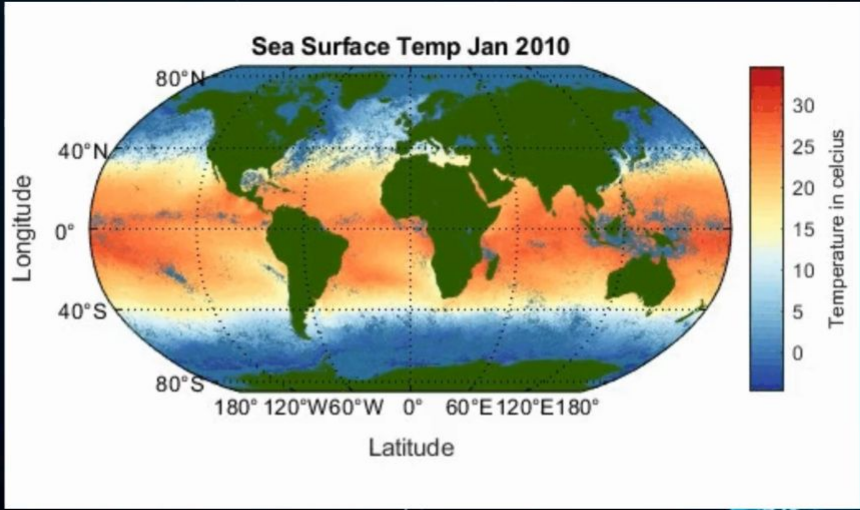


Figure 3 - Animation visual representation o sea surface temperature - the sea surface temperature using data taken from the ESA CCI climate office

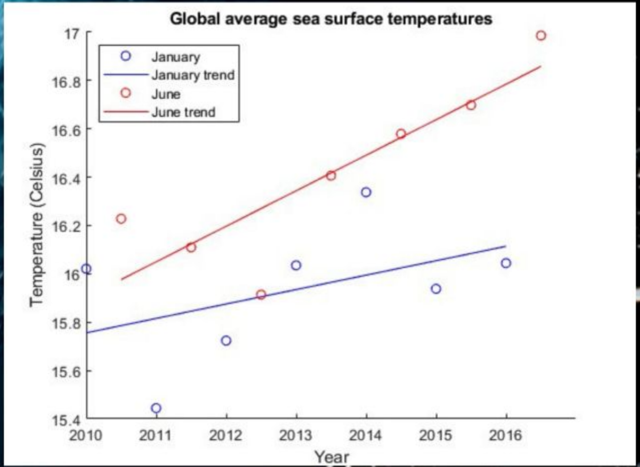


Figure 4 - Global average sea surface temperature - depicts an upwards trend over last 6 years, temperature increase in summer and major decrease in 2010-2012 due to La Nina.

Data taken from ESA CCI climate office

- **Upwards trend over last 6 Years**
- **Temperature increase in summer**

DATASET 3: SEA ICE THICKNESS

SEA ICE THICKNESS ANIMATION MAP (To show how Sea Ice varies throughout the year)

- Thickest ice -> Found around the central Arctic (up to 5 metres).
- Thinning ice -> Observed further from the Pole
- Seasonal pattern ->Ice generally reaches its greatest extent in March, and its smallest in October

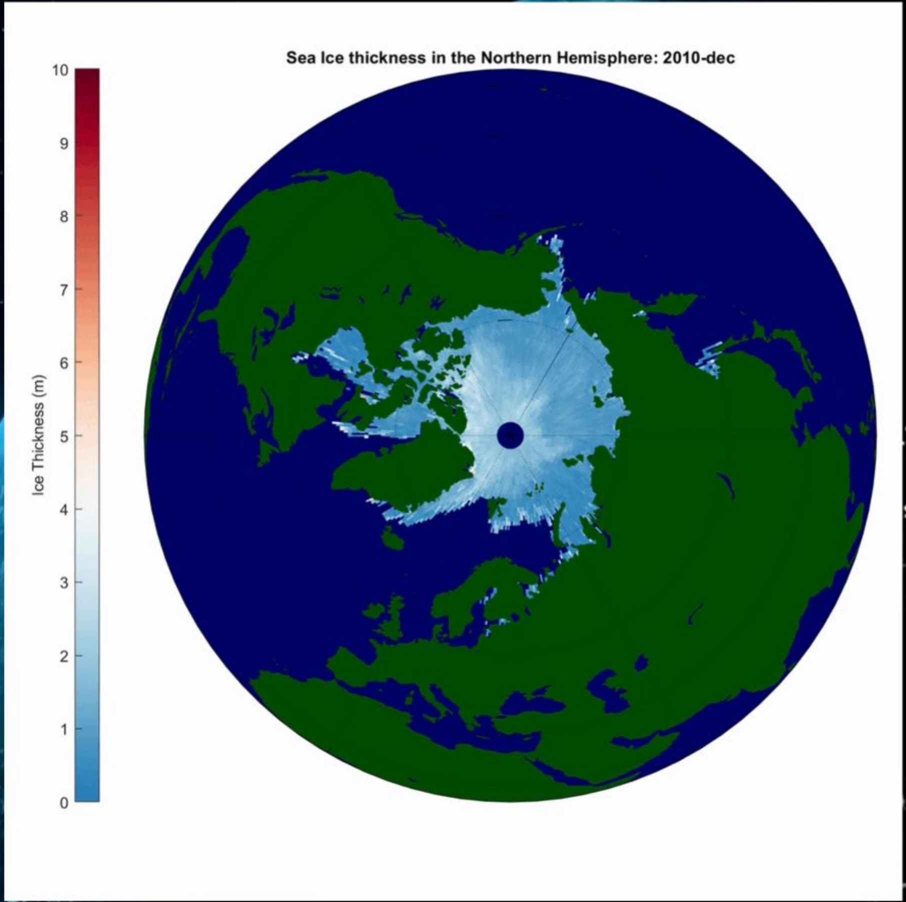


Figure 4: Sea Ice Thickness (Nov-2010 to Apr-2011) in the Northern Hemisphere.

COMPARING OUR DATA TO SATELLITE IMAGERY

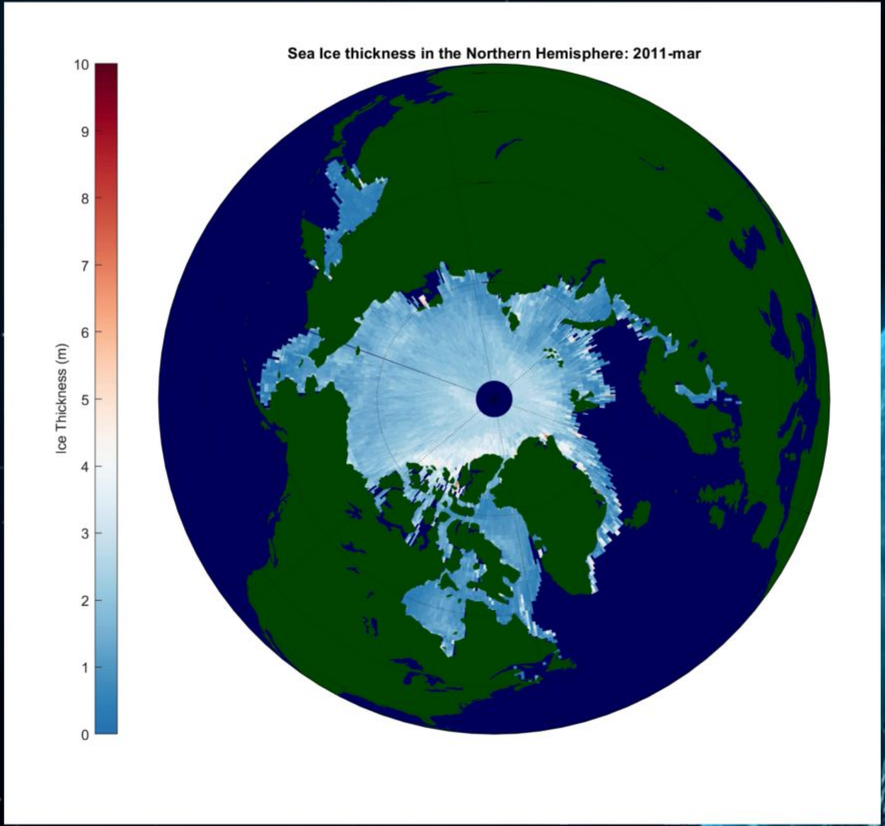


Figure 4: Sea Ice Thickness (Nov-2010 to Apr-2011) in the Northern Hemisphere.

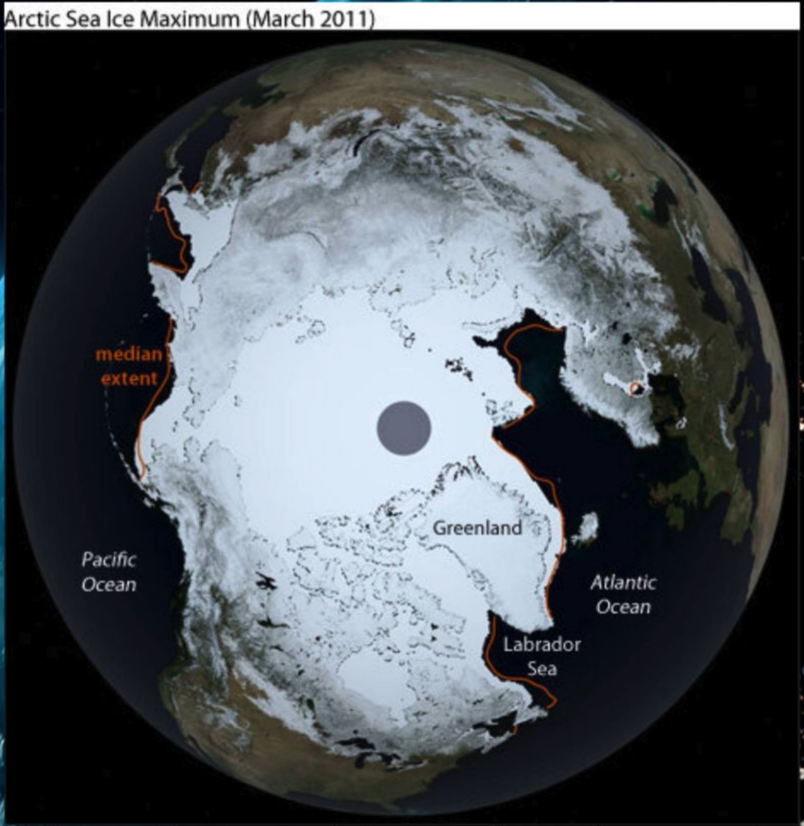


Figure 5: Photo of the Arctic region march 2011 (2)

FIGURE 6: SEA ICE LOSS IN MARCH BETWEEN 2011 AND 2019

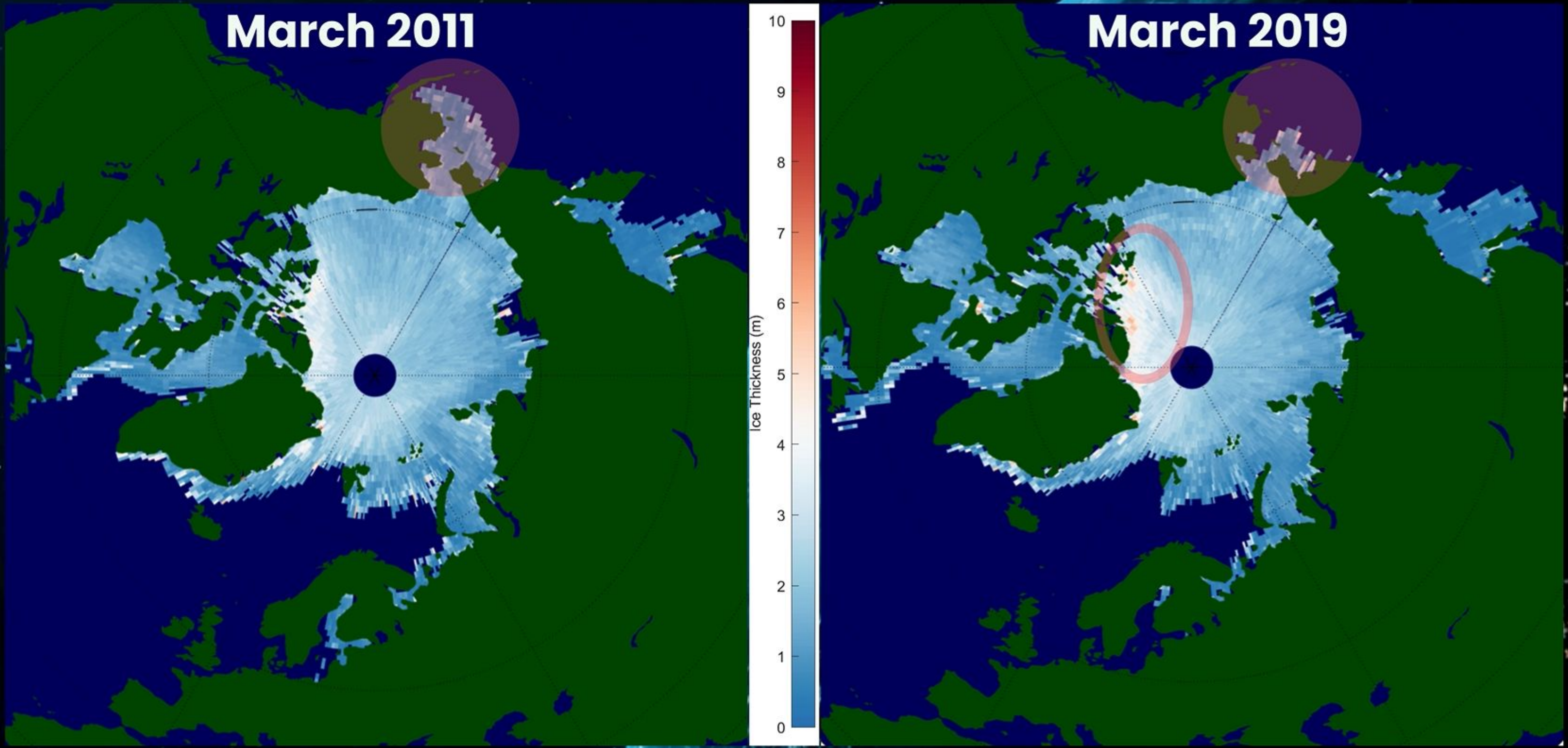


Figure 6: Sea Ice loss in March between 2011 and 2019

SEA ICE LOSS IN OCTOBER BETWEEN 2011 AND 2019

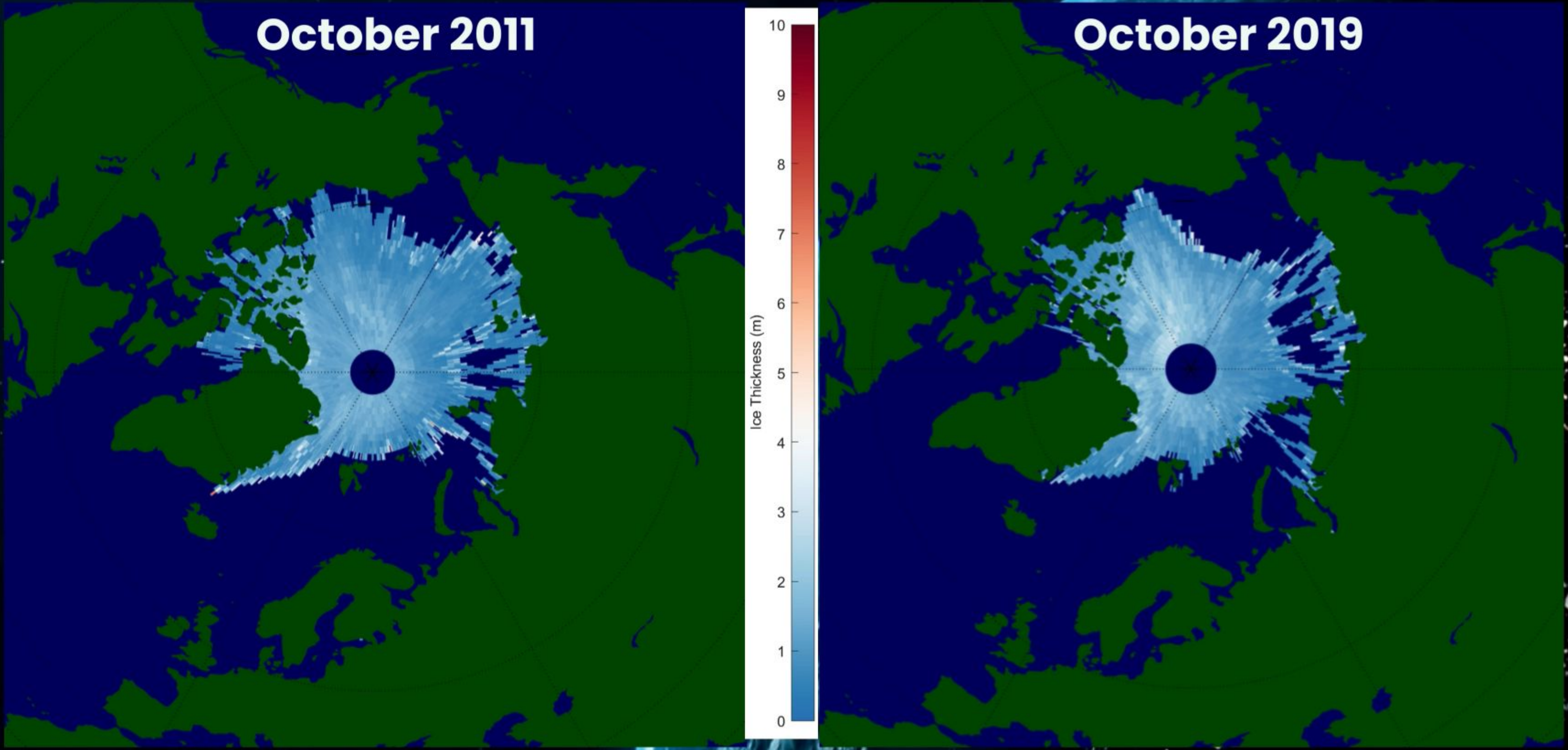


Figure 6: Sea Ice loss in October between 2011 and 2019

Correlation between SSS, SST, Sea Ice Thickness - Key Findings

Arctic

Summer

- Higher Sea surface Temperature & Lower Salinity
- Thinner sea ice

Winter

- Lower SST & Higher SSS
- Thicker Ice (peak in March)

Sea Surface Salinity- Arctic follows a seasonal reverse pattern due to influence of sea ice dynamics.

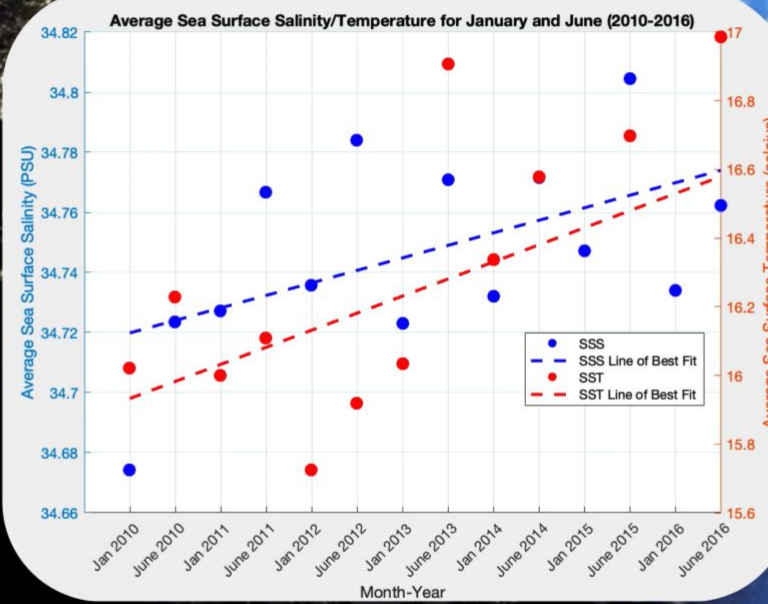


Figure 7: Average sea surface salinity/temperature for january and june (2010-2016) - Comparison

Predictive insights

- SST + SSS trends predict sea ice thickness
- Warmer SST and lower SSS -> thinner ice.
- Cooler SST and higher SSS -> thicker ice.
- Global ocean circulation and THC affect sea ice formation and melting.

ANY QUESTIONS?

References

1) ESA, CryoSat-2 technology: anatomy of a satellite [Online]. Available from:https://www.esa.int/Enabling_Support/Space_Engineering_Technology/CryoSat-2_technology_anatomy_of_a_satellite [06/03/2025].

2) Climate.Gov staff, 2011. March 2011 Ice Extent Second Lowest on Record [Online]. Available from: https://www.climate.gov/news-features/event-tracker/march-2011-ice-extent-second-lowest-record [06/03/2025].