

Università degli Studi di Napoli Parthenope
26 Ottobre 2021

Il remote sensing del ghiaccio marino

Dott. Giuseppe Aulicino
giuseppe.aulicino@uniparthenope.it



AA 2021/2022

REMOTE SENSING DELL'OCEANO
(Insegnamento a scelta da 6 CFU – 48 ore)

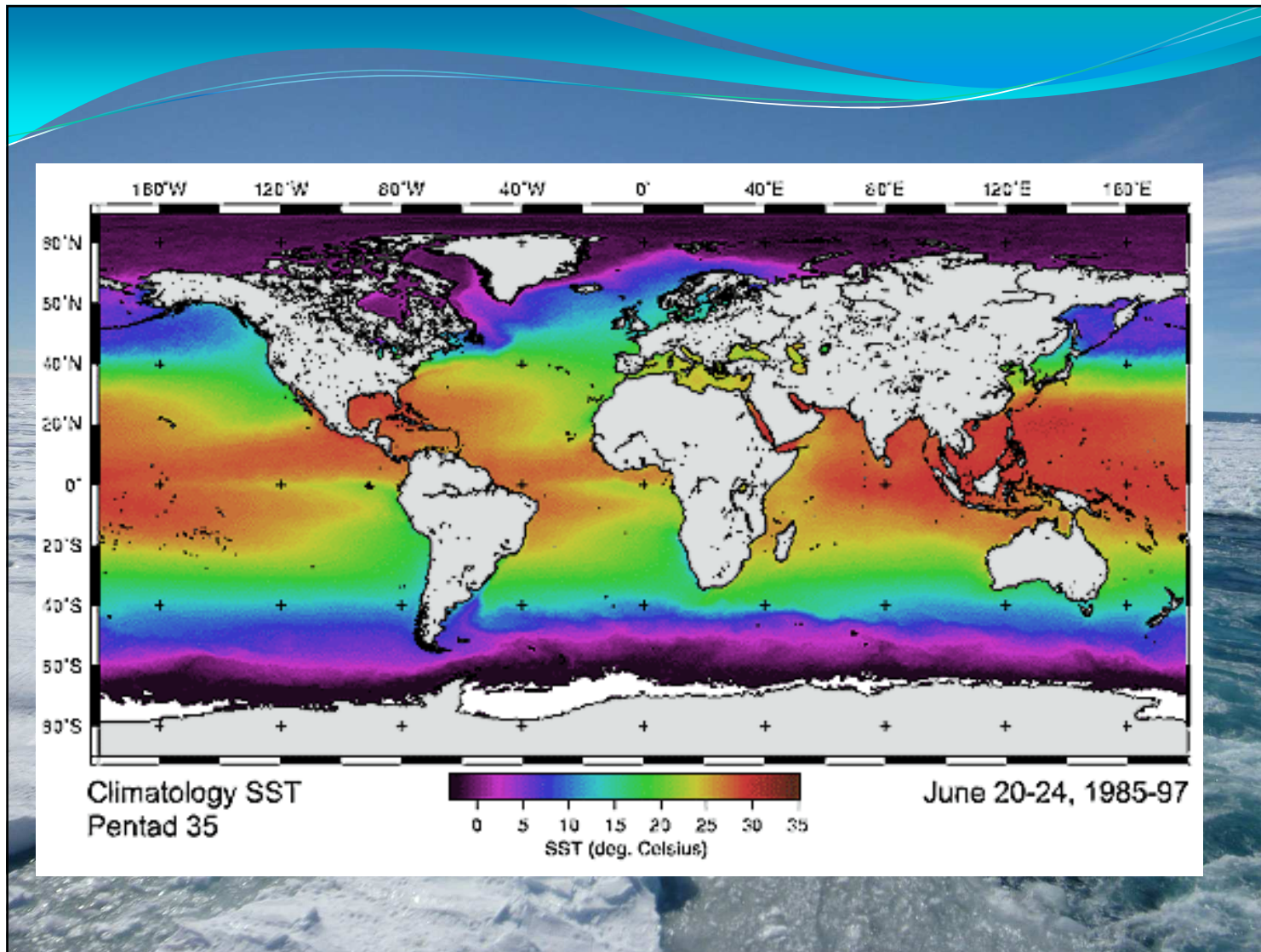
Mercoledì 15:30 – 17:30 (Aula 9)

Venerdì 13:30 – 15:30 (Aula 6)

Teams: **1od71rj**

Dott. Giuseppe Aulicino

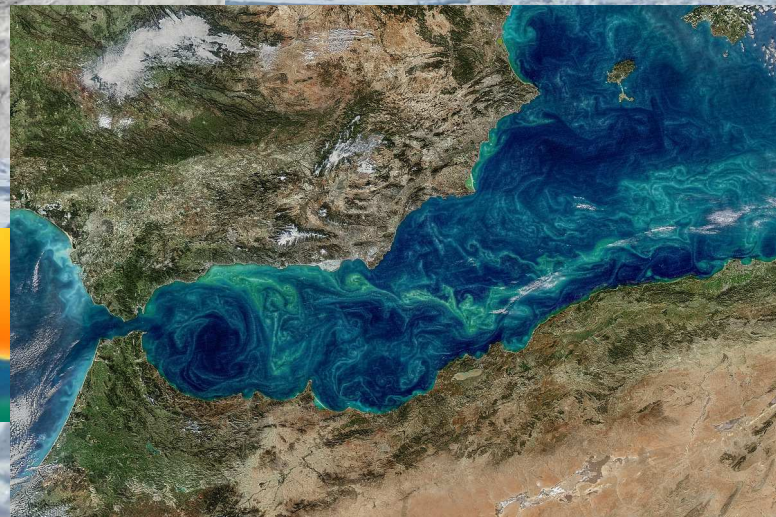
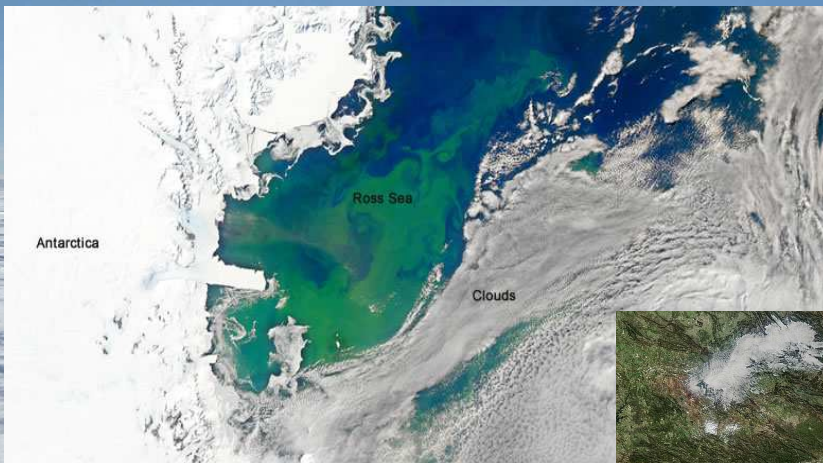
giuseppe.aulicino@uniparthenope.it



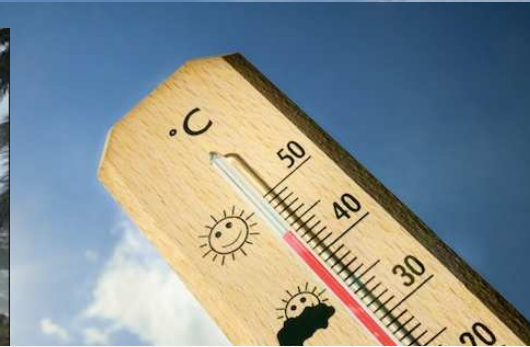
Parte V: Applicazioni ambientali e Climate change



Parte II: Ocean Color



CLIMATE CHANGE



POTENZIALE IMPATTO DEI CAMBIAMENTI CLIMATICI

TEMPERATURA



INNALZAMENTO DEL LIVELLO DEL MARE



TEMPERATURA

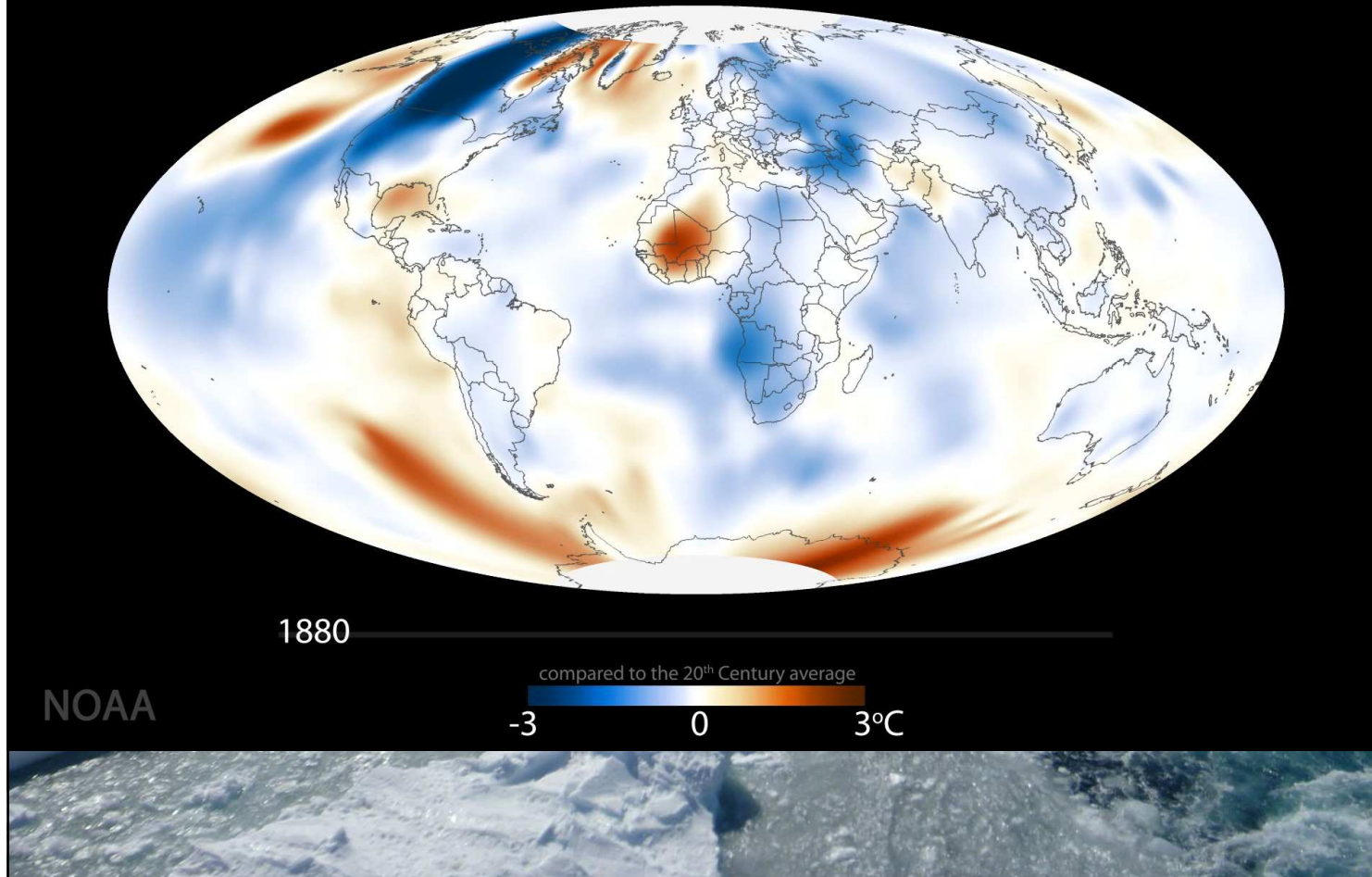


PRECIPITAZIONI

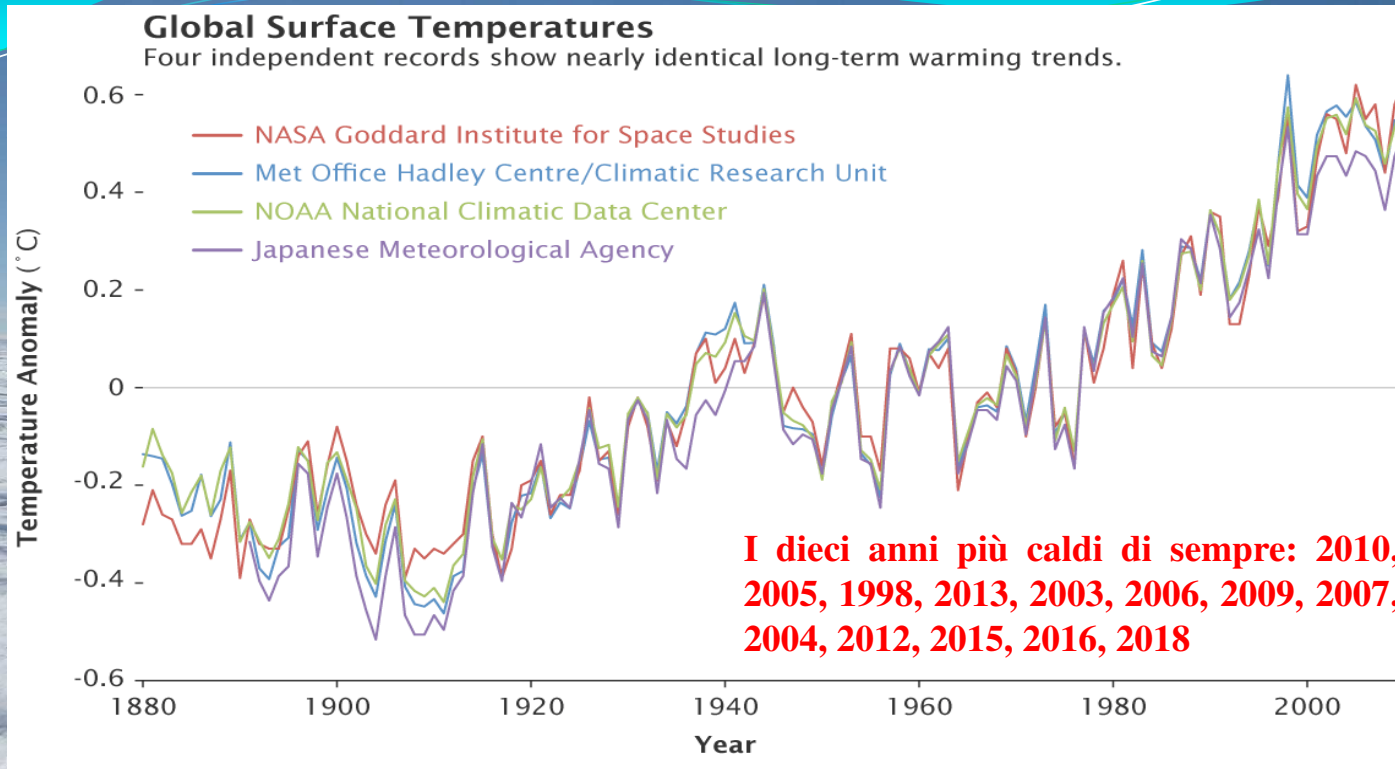
INFLUISCONO SU

Salute	Risorse idriche	Agricoltura	Aree di costa	Foresta	Specie e aree naturali
					
<ul style="list-style-type: none">• Mortalità legata al clima• Malattie infettive e respiratorie legate alla qualità dell'aria	<ul style="list-style-type: none">• Approvvigionamento d'acqua• Qualità dell'acqua• Competizioni per l'acqua	<ul style="list-style-type: none">• Rendita dei raccolti• Esigenza di acqua per l'irrigazione	<ul style="list-style-type: none">• Erosione delle spiagge• Inondazioni dei terreni costieri• Costi aggiuntivi per la protezione delle comunità costiere	<ul style="list-style-type: none">• Composizione della foresta• Estensione geografica delle foreste• Salute e produttività delle foreste	<ul style="list-style-type: none">• Scomparsa di habitat e specie• Criosfera: diminuzione dei ghiacciai

II global warming

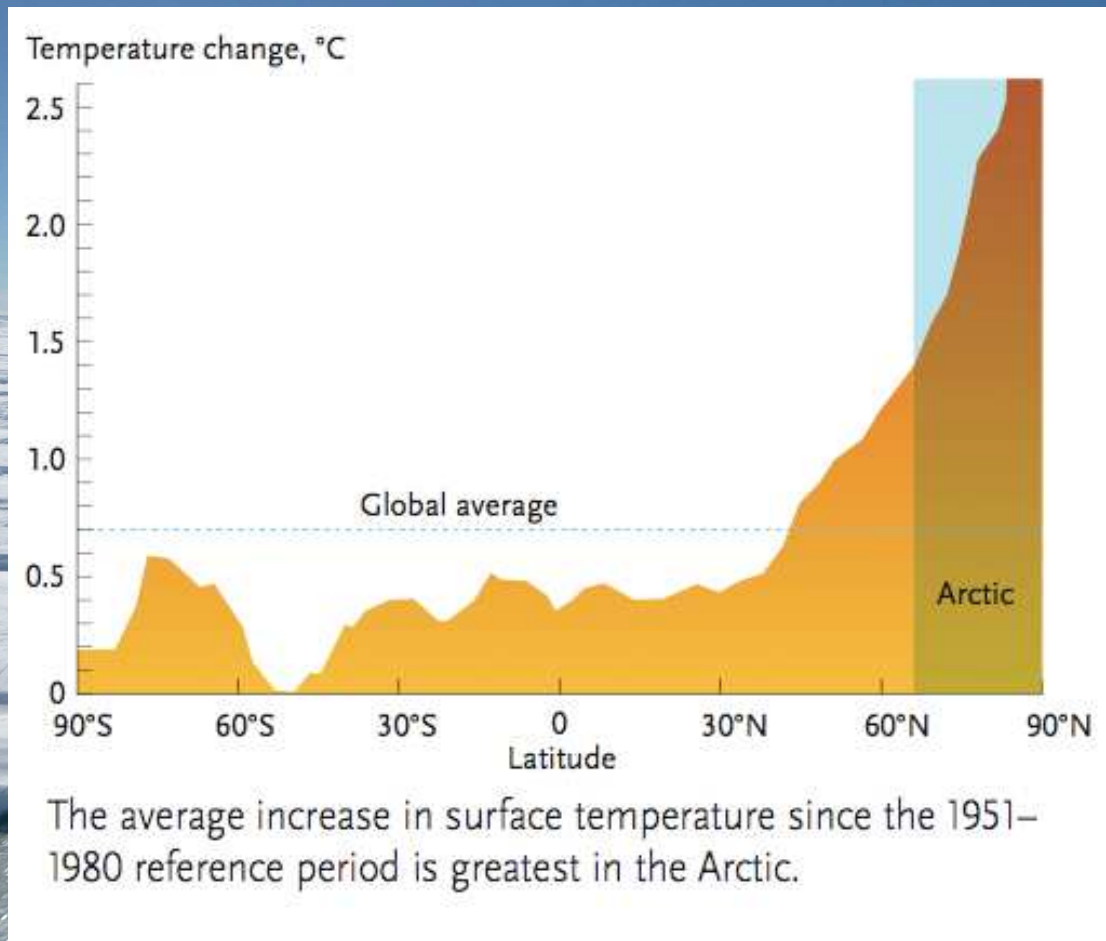


Il global warming

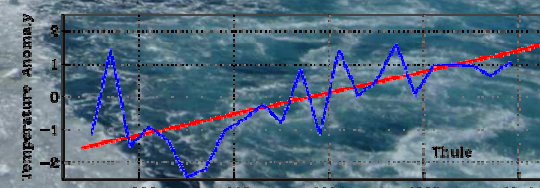
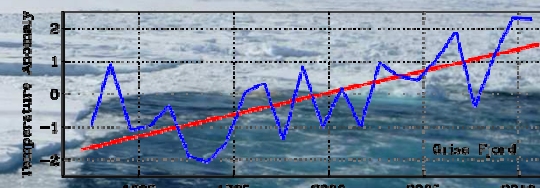
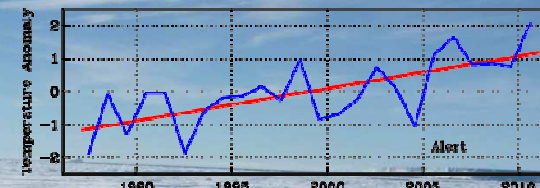
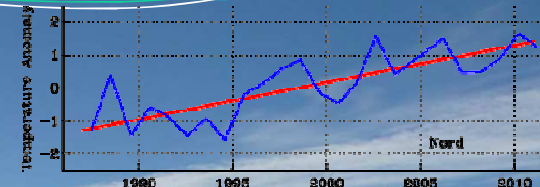
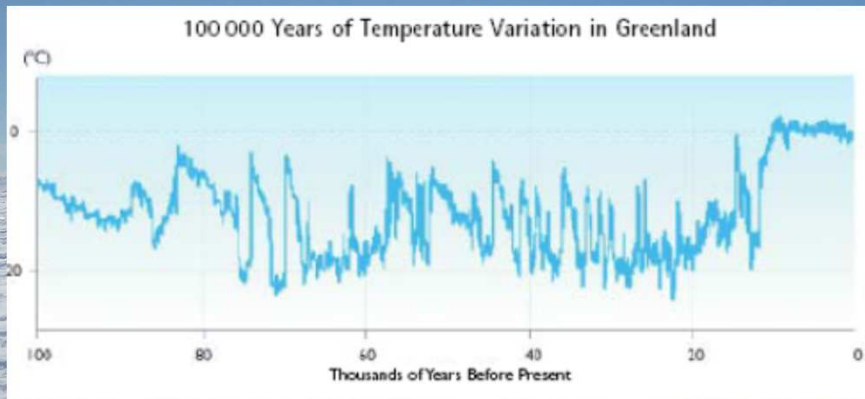


Rispetto alla fine dell'Ottocento la Terra è oggi **più calda di circa 1 grado**.
Mai, almeno nei tempi recenti, una simile variazione è avvenuta in così breve tempo.
Nessuno dei meccanismi naturali sembra in grado di spiegare un simile riscaldamento.

II global warming



Il global warming



Il cambiamento climatico è particolarmente intenso nell'Artide

La temperatura media sta crescendo a velocità doppia rispetto al resto del globo
 Negli ultimi 50 anni in Alaska e nell'ovest del Canada sono aumentate di circa 4-5°C

Evidenze climatologiche: il ritiro dei ghiacciai terrestri

Austria – ghiacciaio Pasterze

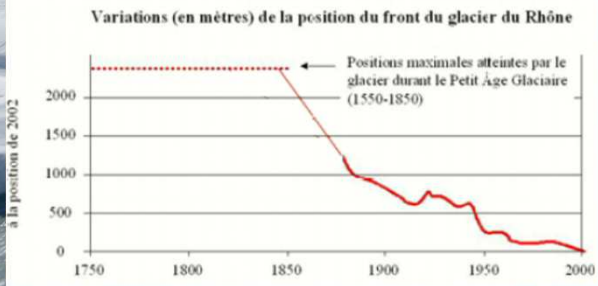


Svizzera – ghiacciaio del Rodano



Evidenze climatologiche: il ritiro dei ghiacciai terrestri

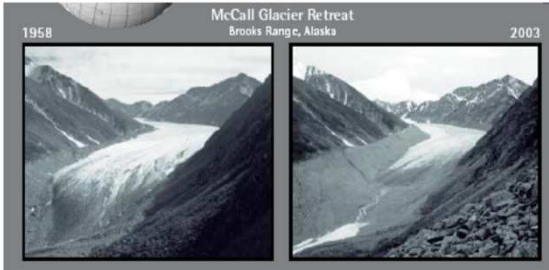
Uganda – ghiacciaio Orubare
 Rwenzori, 5109 metri
 Terzo punto più alto dell'Africa



Nuova Zelanda – ghiacciaio Franz Josef



Alaska – ghiacciaio McCall



Evidenze climatologiche: il ritiro dei ghiacciai terrestri

Alaska

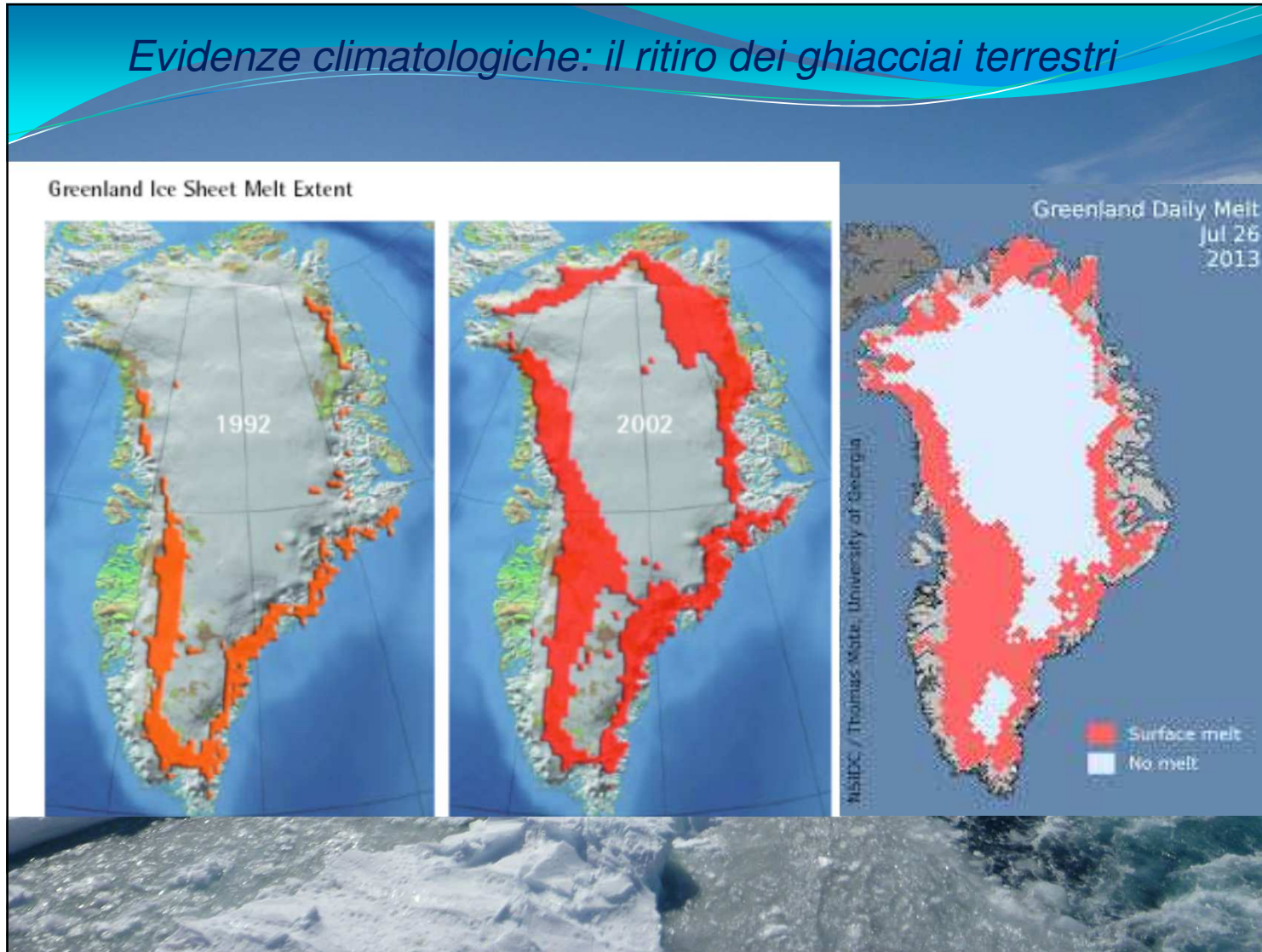
Foto storica: 1899 A.J. Brabazon



Foto moderna: 2013 © Fabiano Ventura

In 114 anni i due ghiacciai Gran Pacific e Johns Hopkins sono arretrati di oltre 15 km.

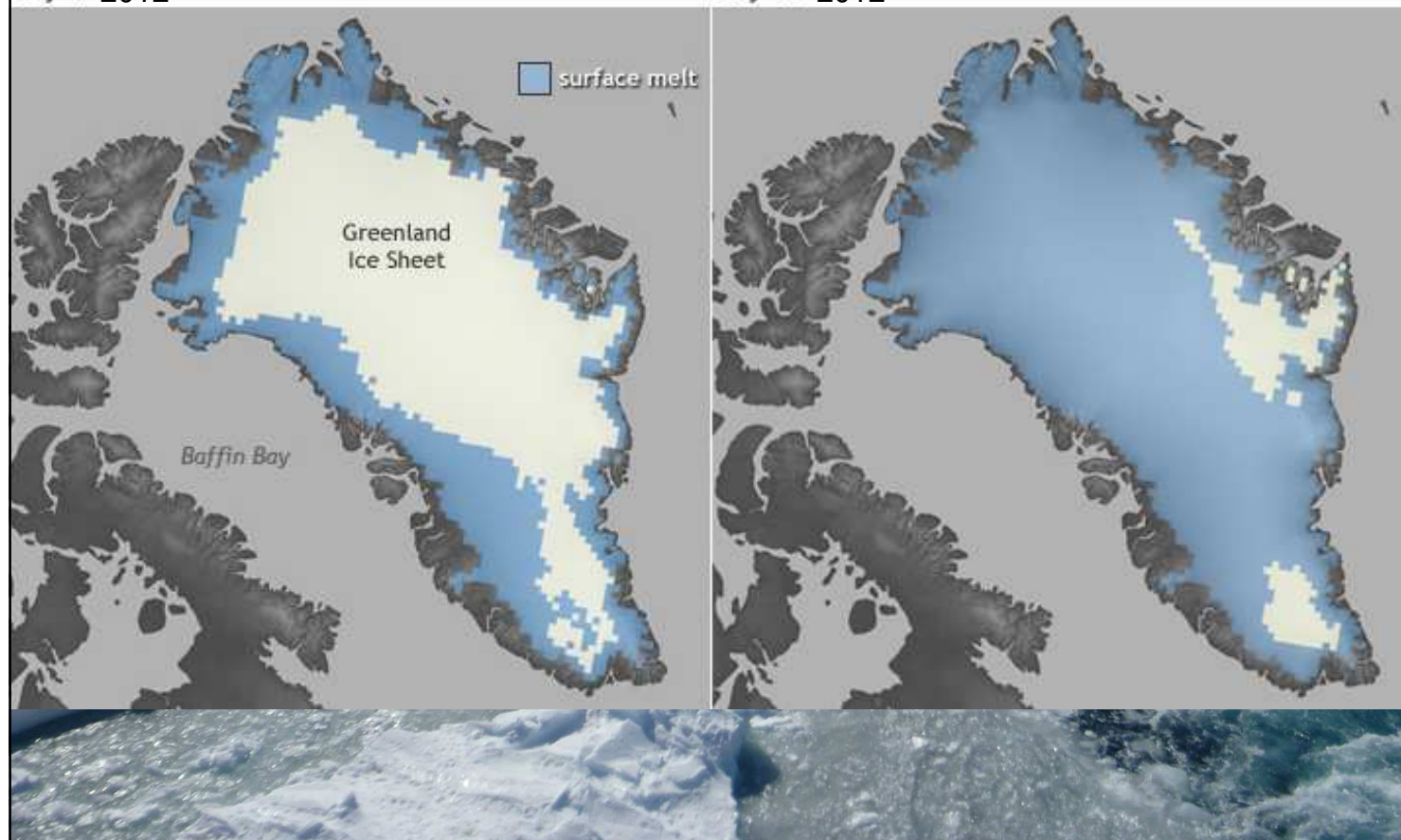
Evidenze climatologiche: il ritiro dei ghiacciai terrestri



Evidenze climatologiche: il ritiro dei ghiacciai terrestri

July 1 2012

July 11 2012



Evidenze climatologiche: il ritiro dei ghiacciai terrestri

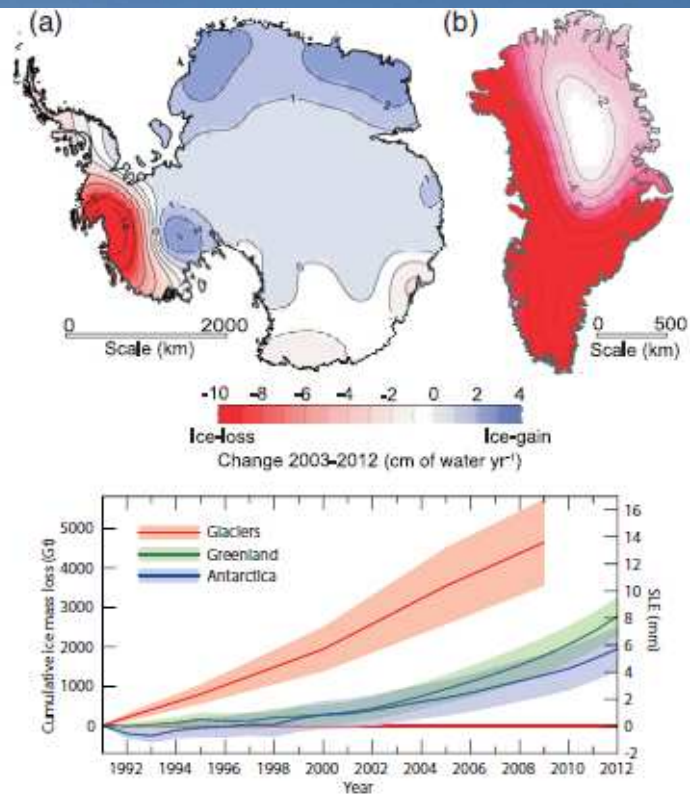
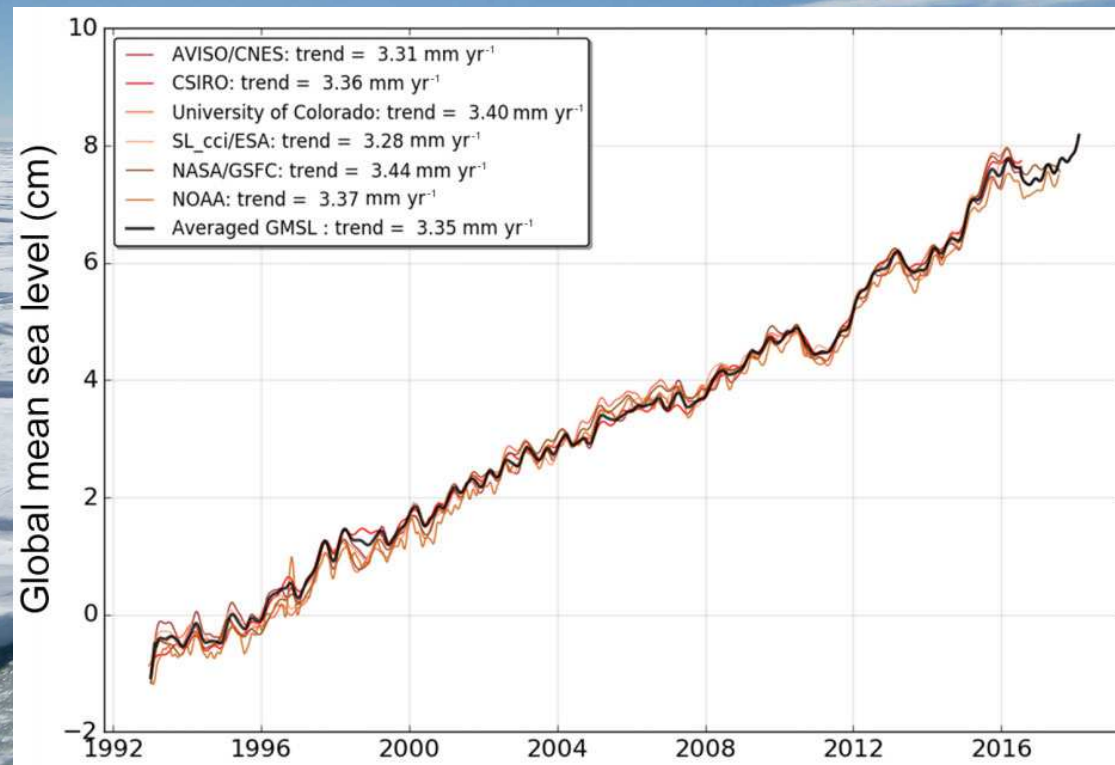


Figure TS.3 | (Upper) Distribution of ice loss determined from Gravity Recovery and Climate Experiment (GRACE) time-variable gravity for (a) Antarctica and (b) Greenland, shown in centimetres of water per year (cm of water yr⁻¹) for the period 2003–2012. (Lower) The assessment of the total loss of ice from glaciers and ice sheets in terms of mass (Gt) and sea level equivalent (mm). The contribution from glaciers excludes those on the periphery of the ice sheets. [4.3.4; Figures 4.12–4.14, 4.16, 4.17, 4.25]

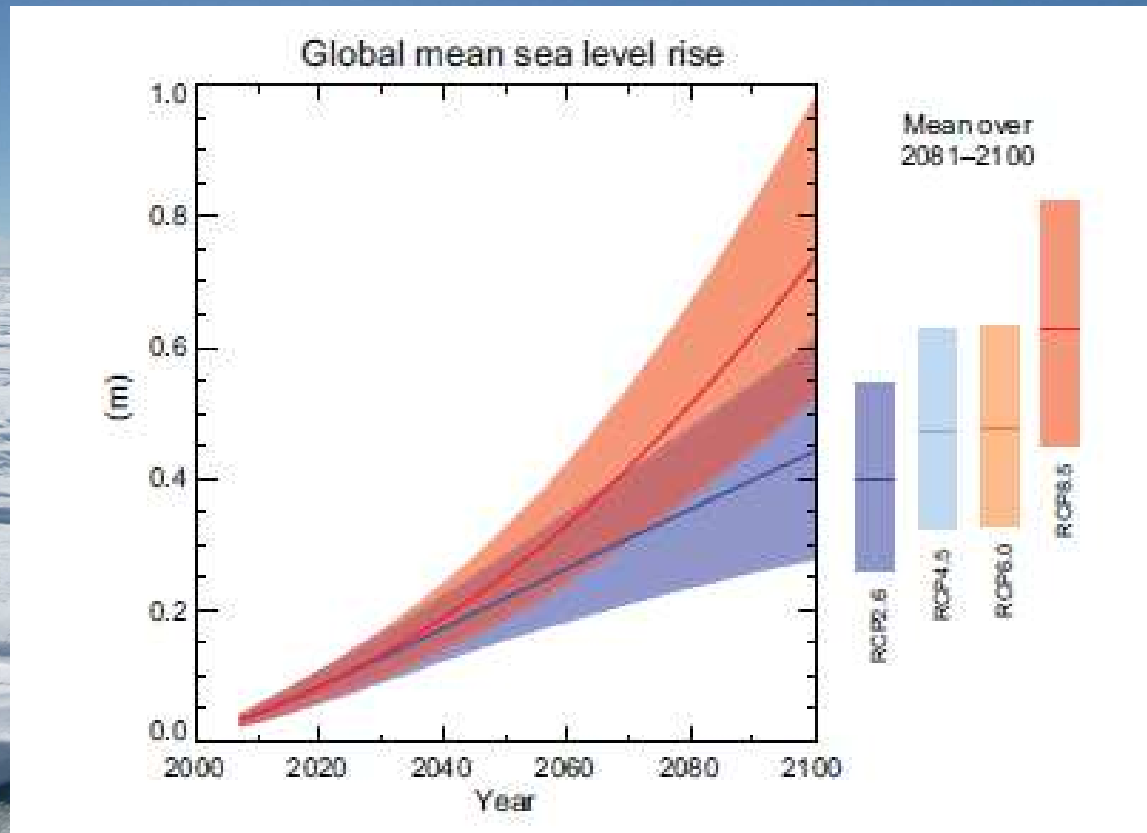
Lo scioglimento del ghiaccio continentale

- Durante gli ultimi 25 anni il livello dei mari è aumentato di oltre 8 cm



Lo scioglimento del ghiaccio continentale

Entro il 2100 l'ulteriore aumento potrebbe essere compreso tra 9 e 88 cm



Senza contare che la massa glaciale antartica (90% del ghiaccio mondiale) potrebbe da sola innalzare il livello globale dei mari di oltre 62 metri

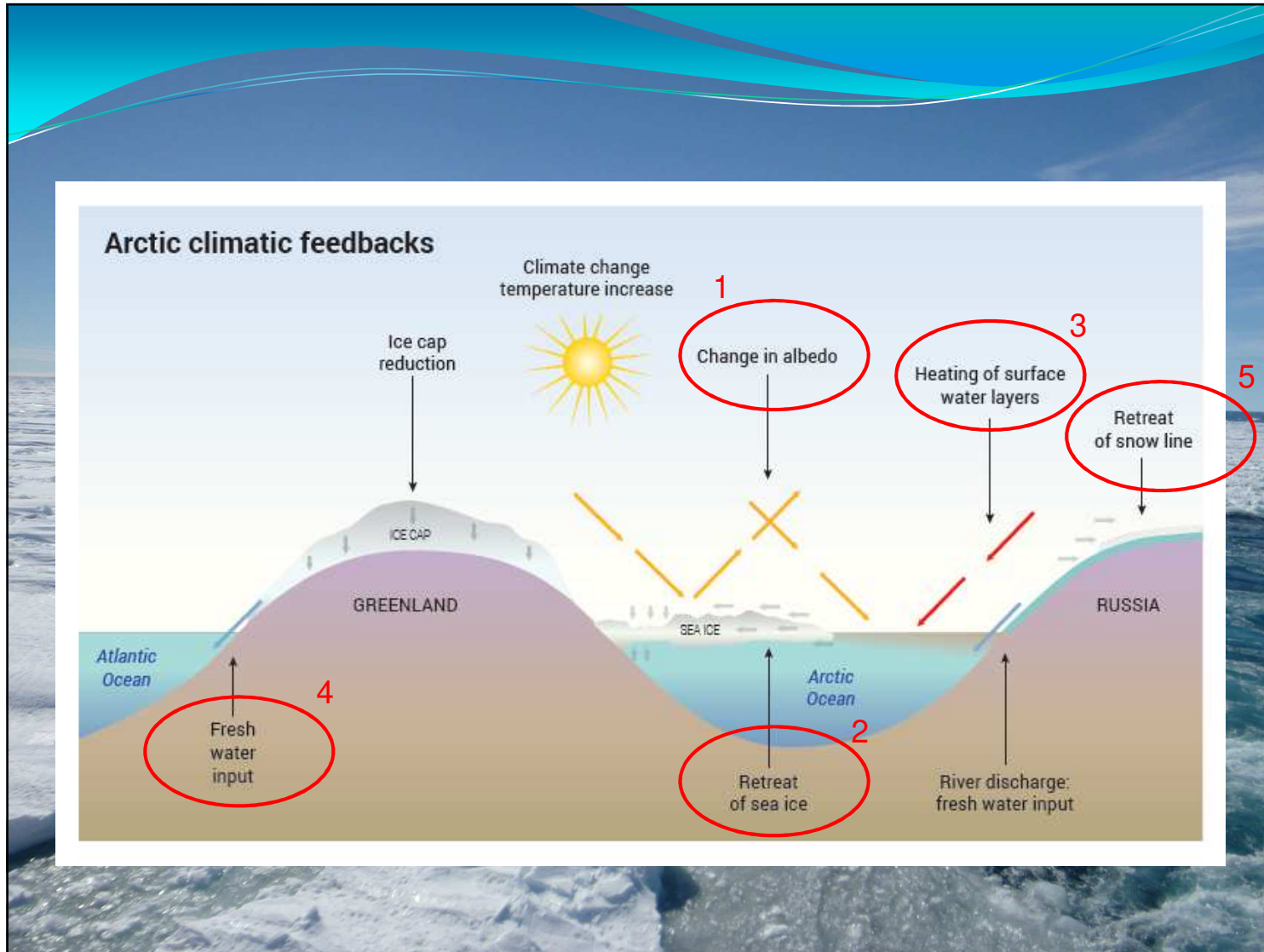
Lo scioglimento del ghiaccio continentale

- Più del 70 % della popolazione mondiale vive in pianure costiere
- 11 delle 15 città più grandi del mondo sorgono lungo coste o estuari

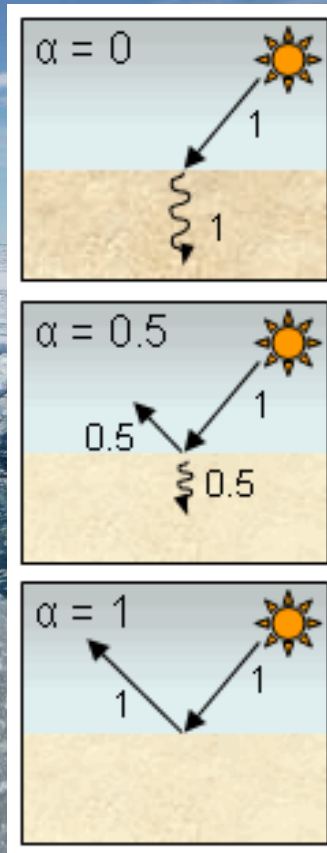
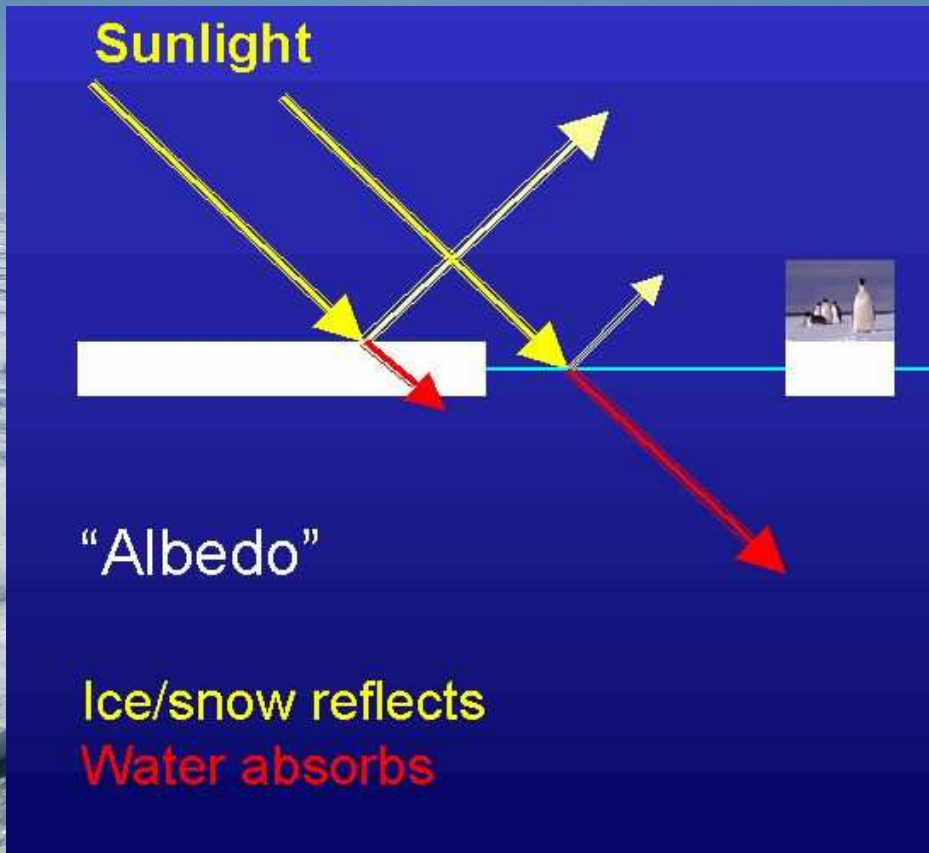
Cities with the 10 highest annual flood costs by 2050



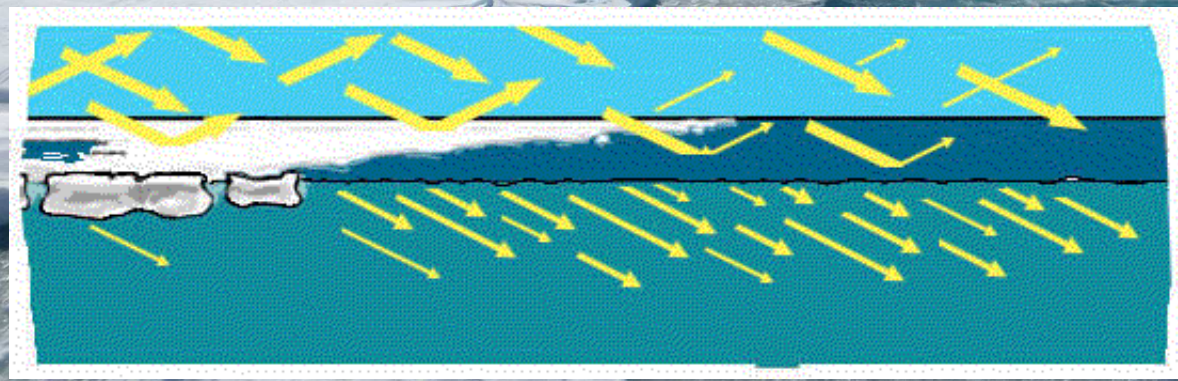
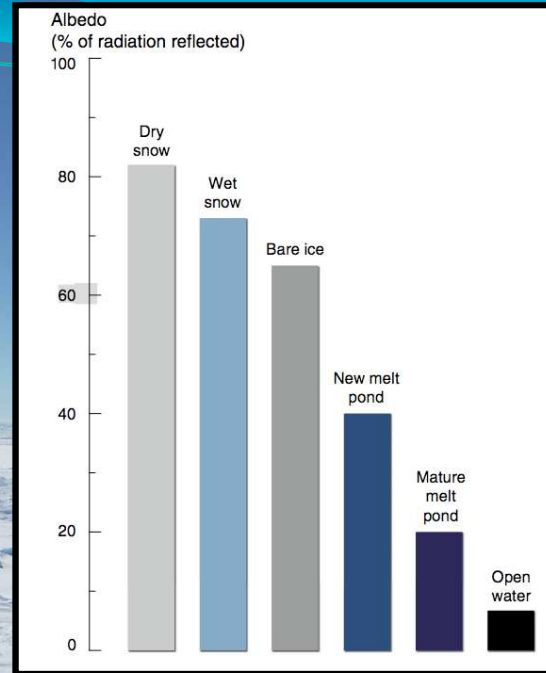


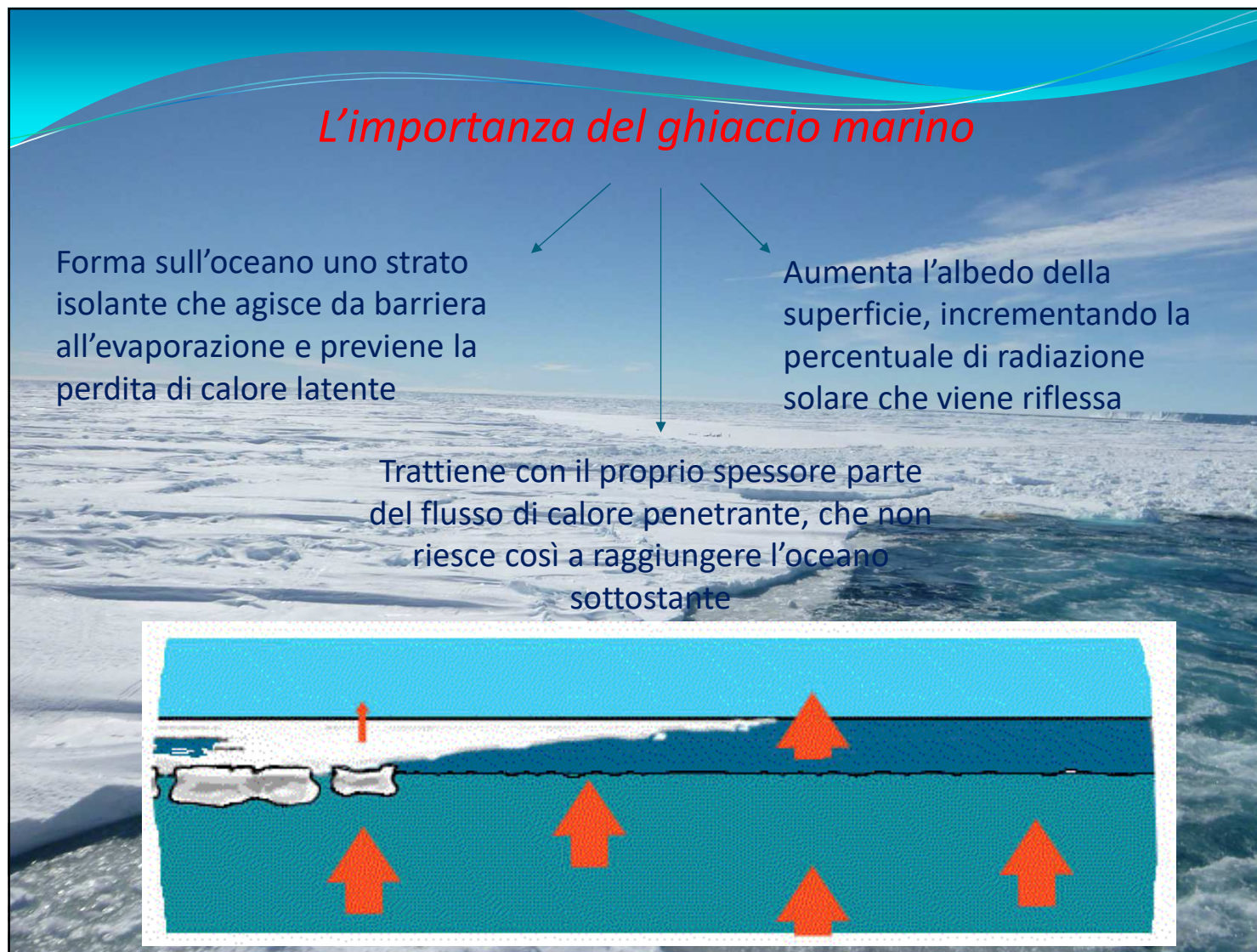


1 ALBEDO: The reflectivity of a surface

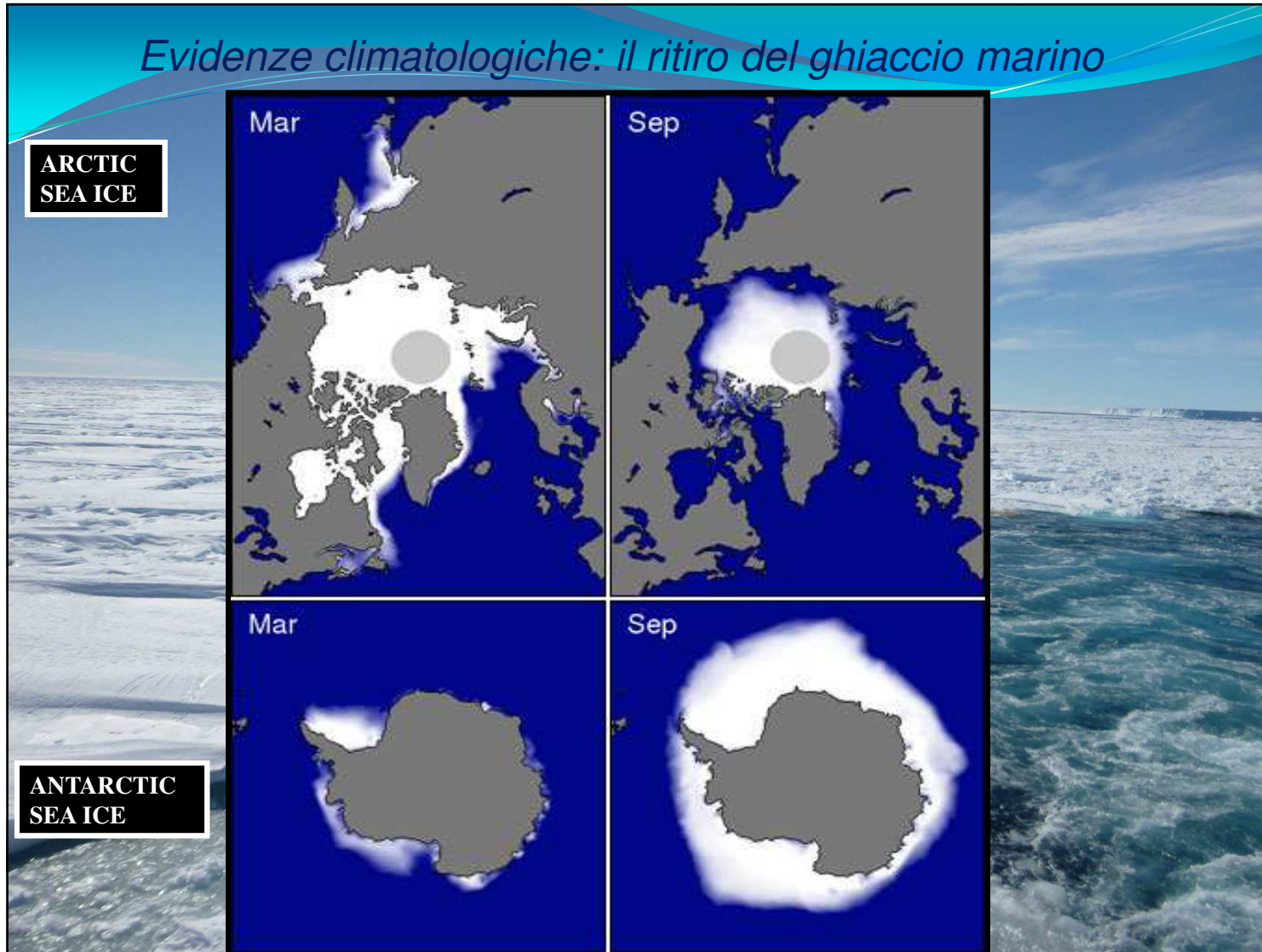


1 ALBEDO: The reflectivity of a surface

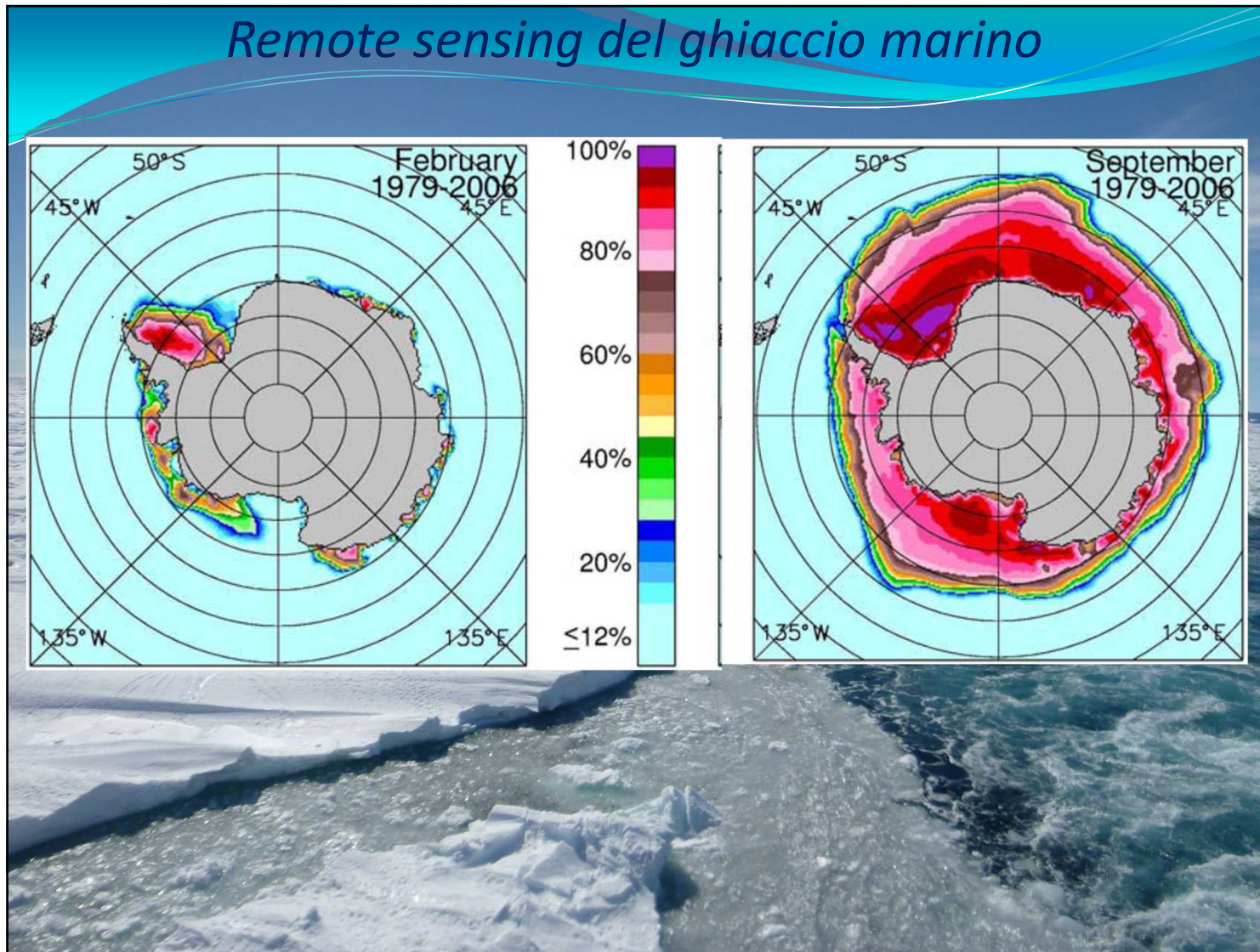




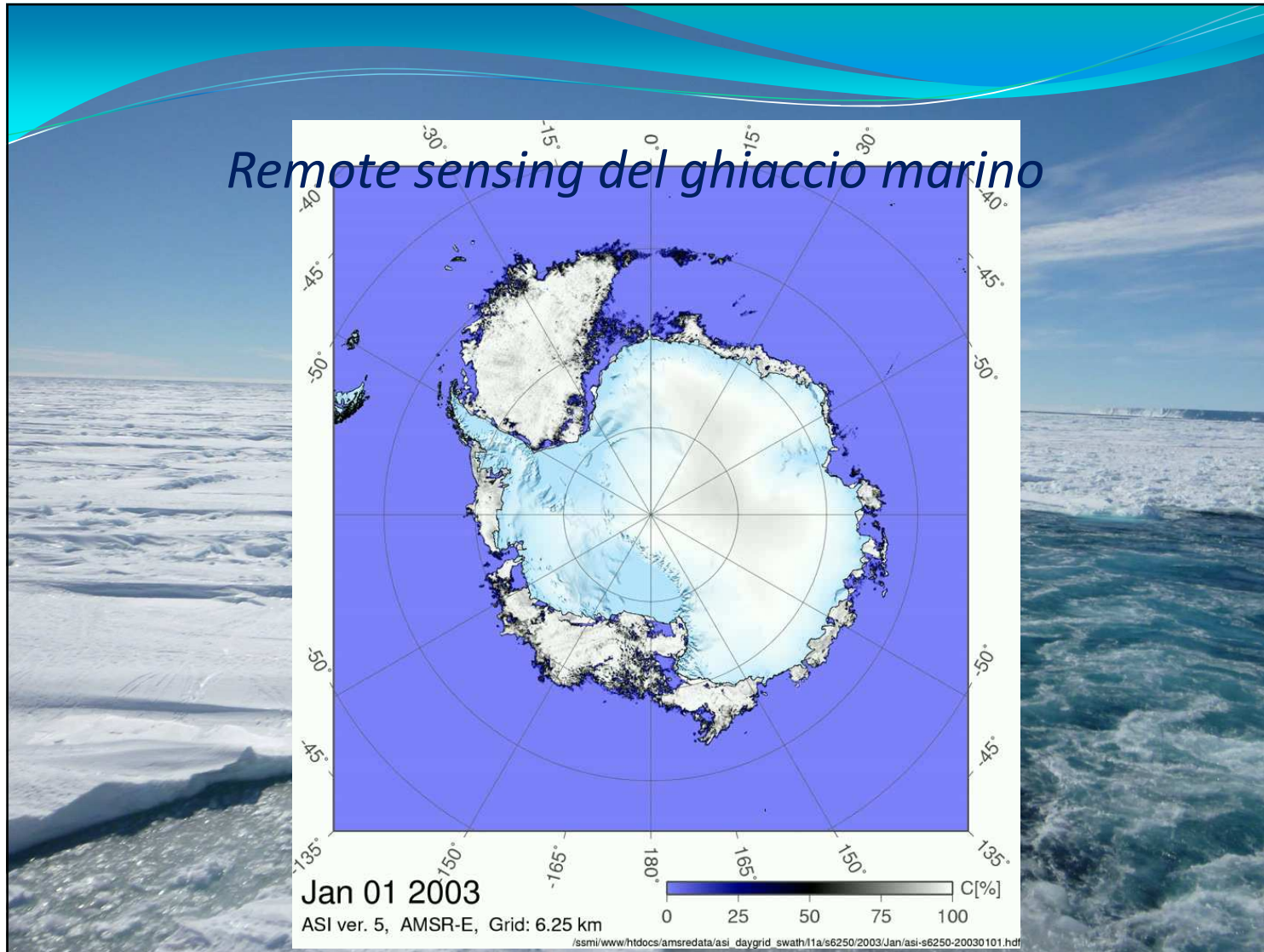
Evidenze climatologiche: il ritiro del ghiaccio marino



Remote sensing del ghiaccio marino



Remote sensing del ghiaccio marino



Monthly
Daily
 Blue Marble View

Sea Ice Extent, Oct 2020

near-real-time data

National Snow and Ice Data Center, University of Colorado Boulder

Extent
Concentration
Anomalies
Trends

The monthly Sea Ice Index provides a quick look at Antarctic-wide changes in sea ice. It is a source for consistently processed ice extent and concentration images and data values since 1979. Monthly images show sea ice extent with an outline of the 30-year (1981-2010) median extent for that month (magenta line). Other monthly images show sea ice concentration and anomalies and trends in concentration.

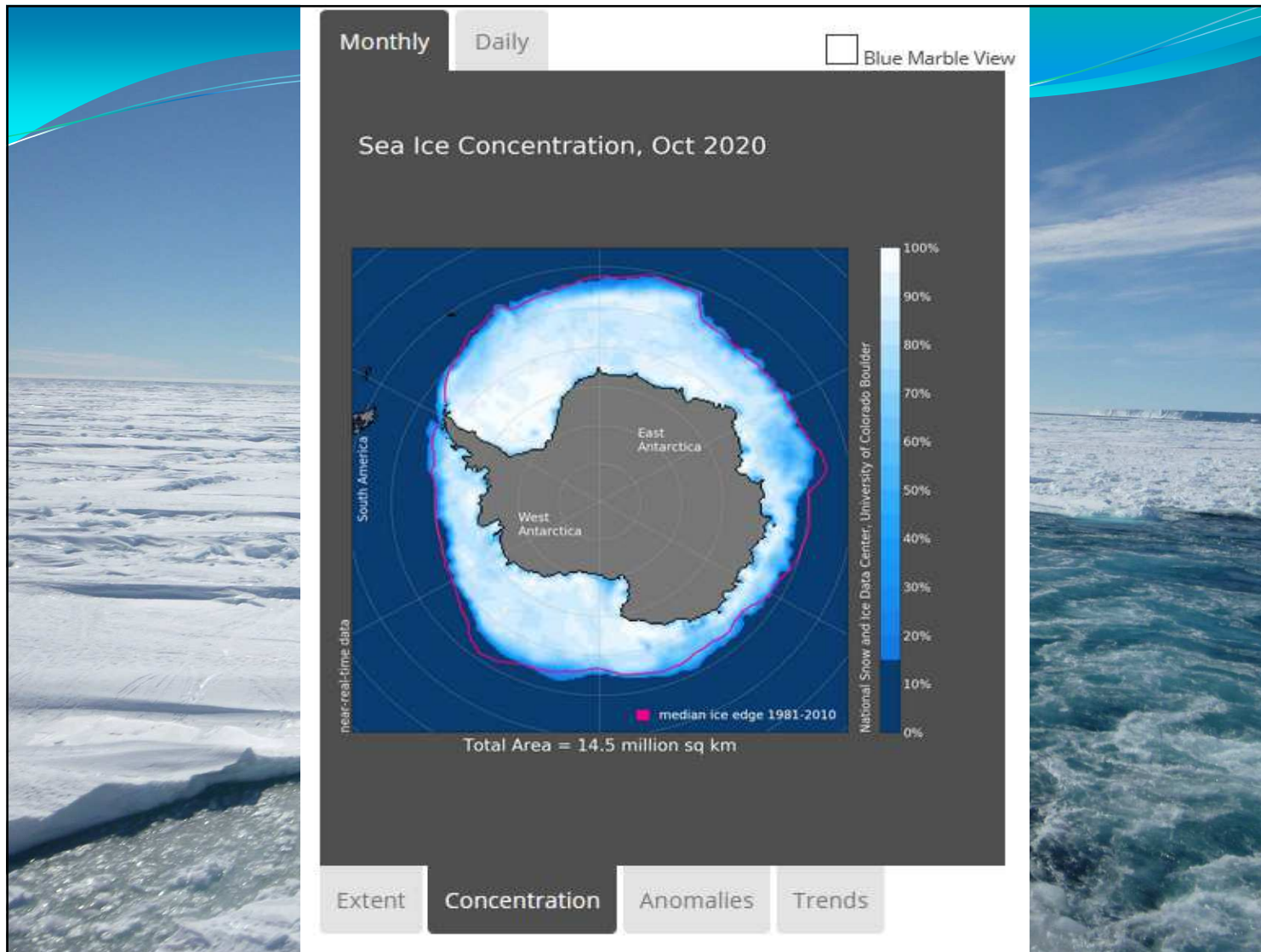
More about the monthly images

Monthly Sea Ice Extent Anomaly Graph i

Southern Hemisphere Extent Anomalies Oct 1979 - 2020

1981-2010 mean = 18.1 million sq km
slope = 0.6 ± 0.5 % per decade

National Snow and Ice Data Center, University of Colorado Boulder



Arctic Antarctic

Monthly Daily Blue Marble View

Sea Ice Concentration Anomalies, Oct 2020

near-real-time data

Total anomaly = 0.6 million sq km

Extent Concentration Anomalies Trends

The monthly Sea Ice Index provides a quick look at Antarctic-wide changes in sea ice. It is a source for consistently processed ice extent and concentration images and data values since 1979. Monthly images show sea ice extent with an outline of the 30-year (1981-2010) median extent for that month (magenta line). Other monthly images show sea ice concentration and anomalies and trends in concentration.

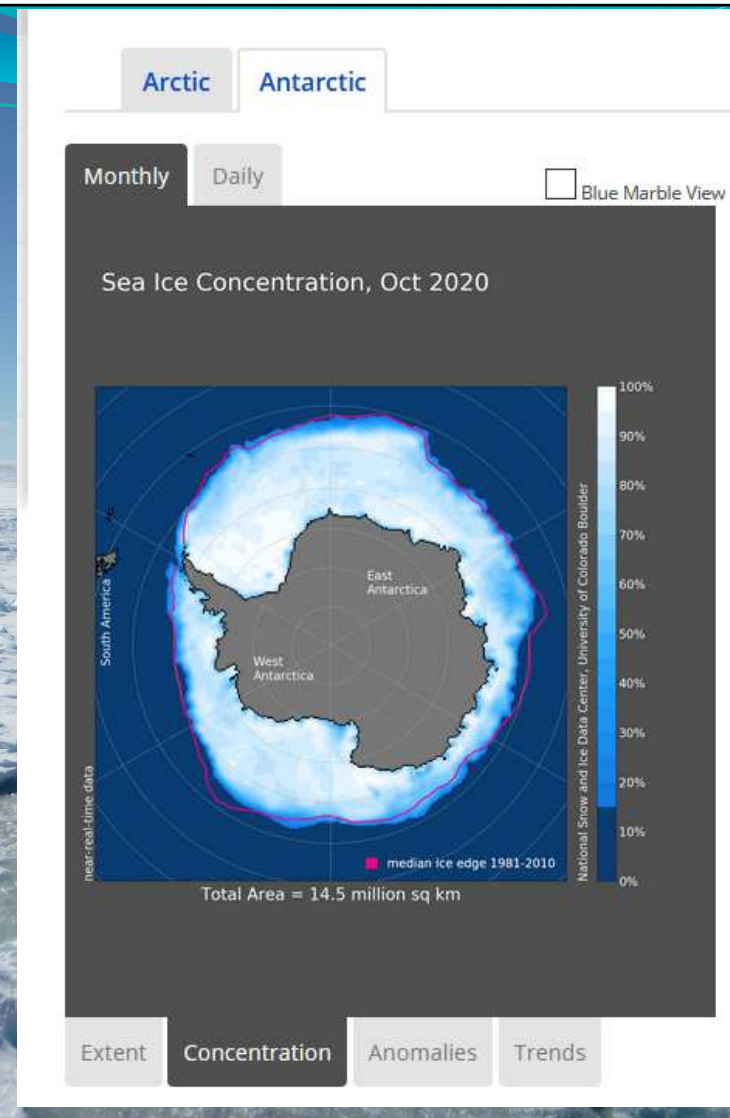
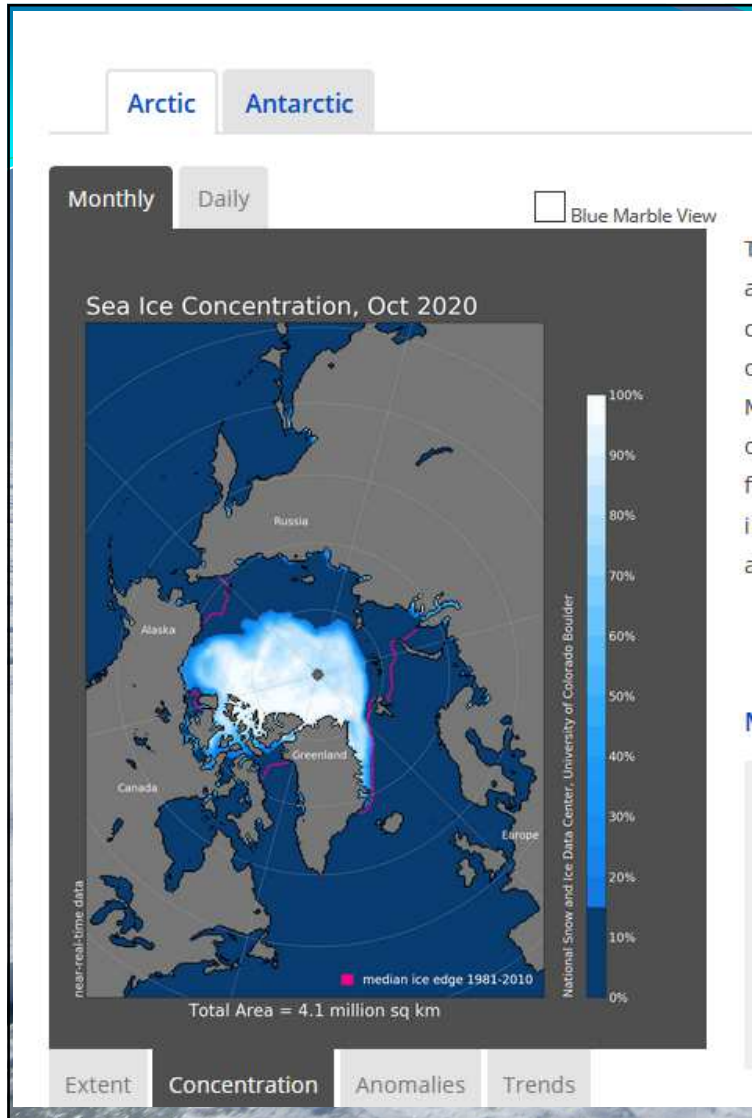
More about the monthly images

Monthly Sea Ice Extent Anomaly Graph

Southern Hemisphere Extent Anomalies Oct 1979 - 2020

1981-2010 mean = 18.1 million sq km

slope = 0.6 ± 0.5 % per decade



Arctic Antarctic

Monthly Daily Blue Marble View

Sea Ice Concentration Anomalies, Oct 2020

near-real-time data

Area not imaged by sensor

Total anomaly = -2.7 million sq km

National Snow and Ice Data Center, University of Colorado Boulder

Extent Concentration **Anomalies** Trends

The monthly Sea Ice Index provides a quick look at Arctic-wide changes in sea ice. It is a source for consistently processed ice extent and concentration images and data values since 1979. Monthly images show sea ice extent with an outline of the 30-year (1981-2010) median extent for that month (magenta line). Other monthly images show sea ice concentration and anomalies and trends in concentration.

[More about the monthly images](#)

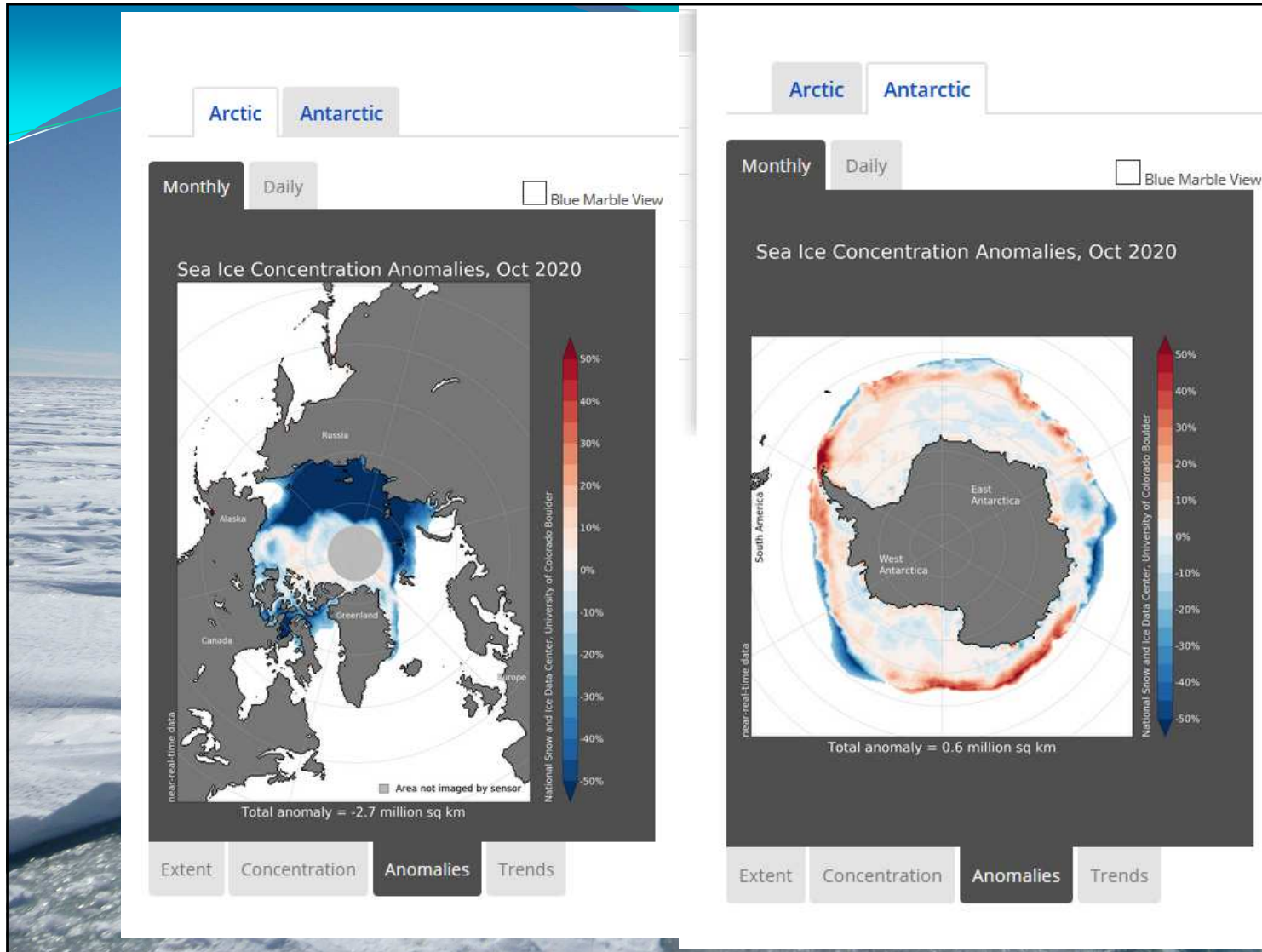
Monthly Sea Ice Extent Anomaly Graph

Northern Hemisphere Extent Anomalies Oct 1979 - 2020

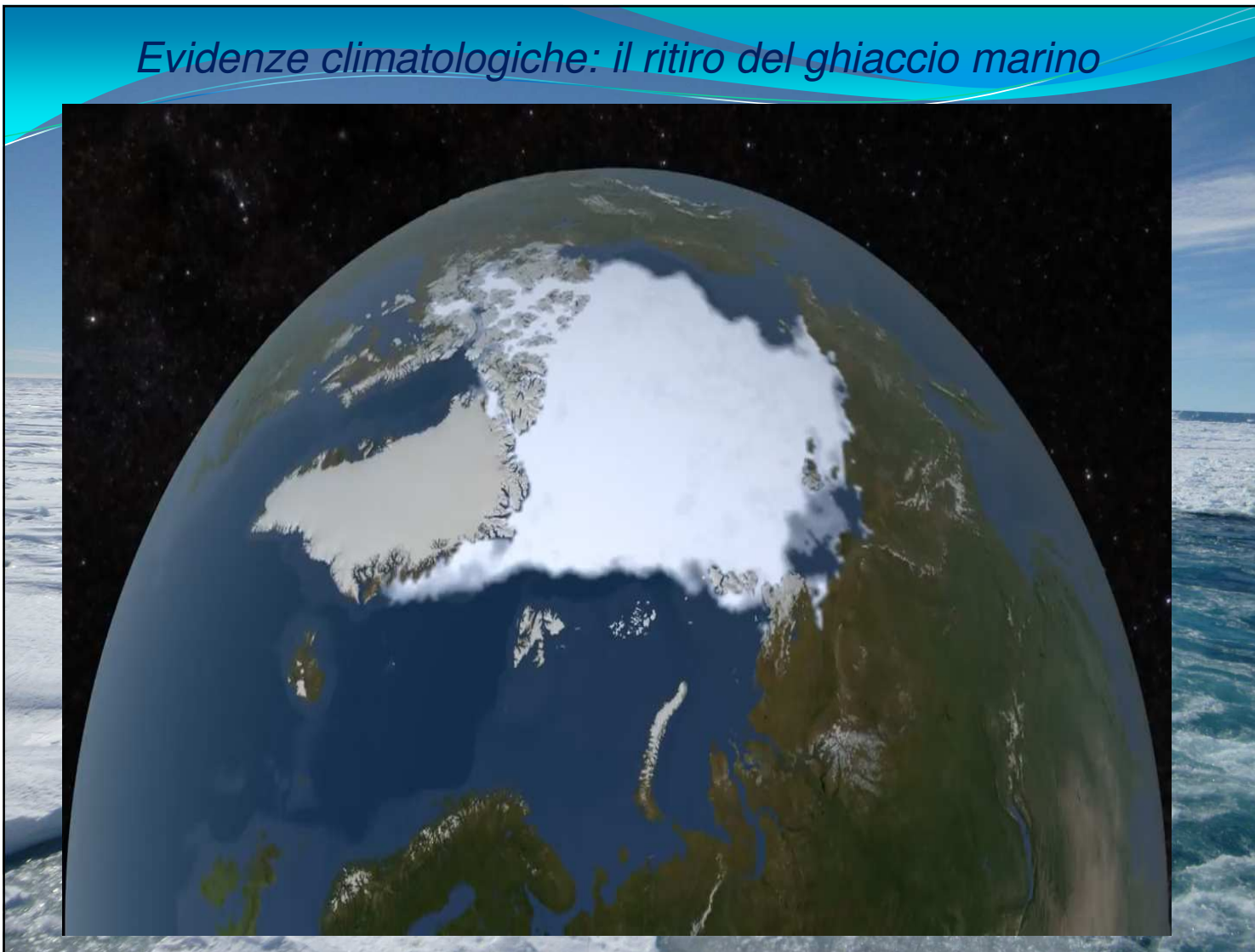
1981-2010 mean = 8.3 million sq km

slope = -10.1 ± 1.6 % per decade

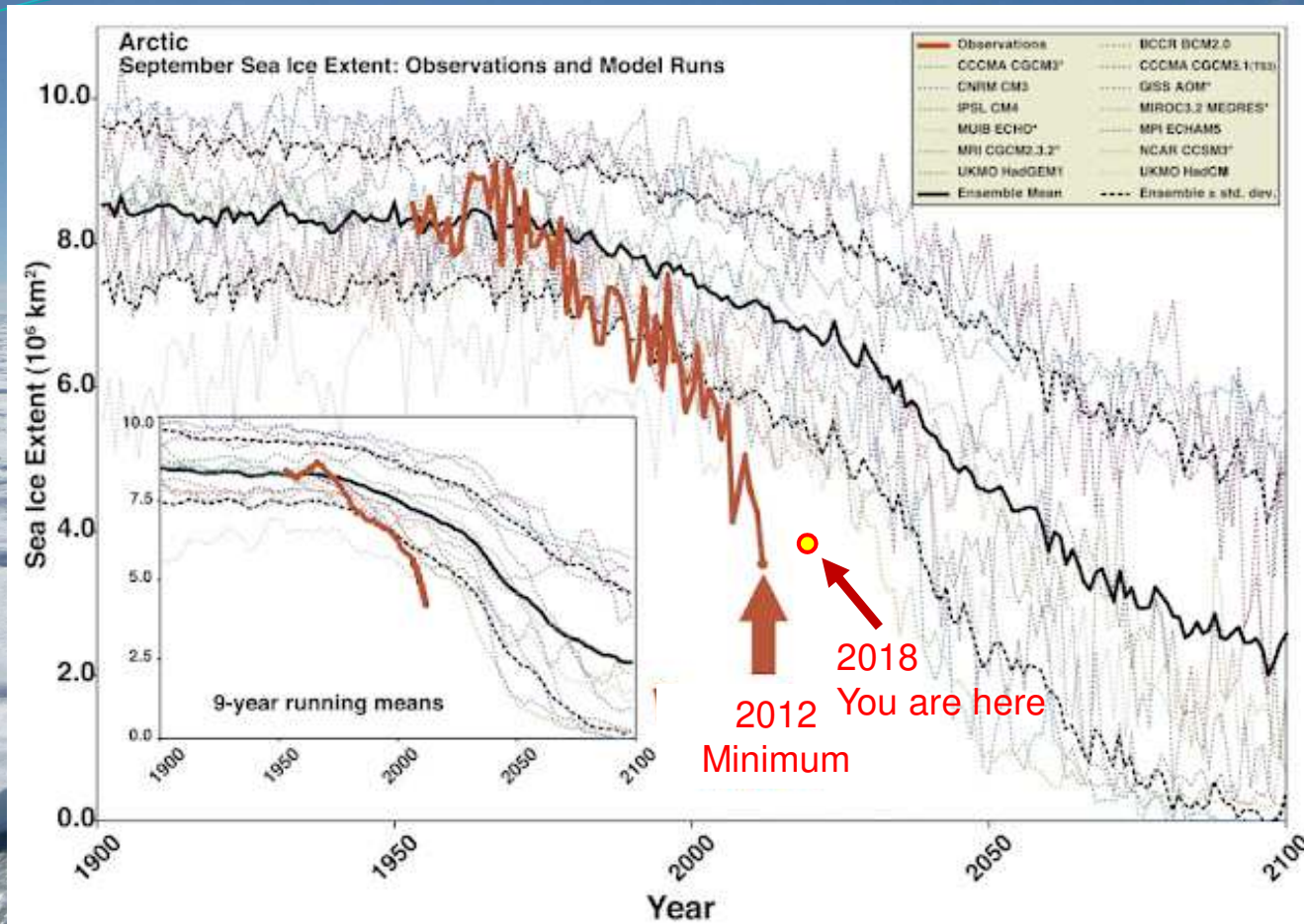
National Snow and Ice Data Center, University of Colorado Boulder



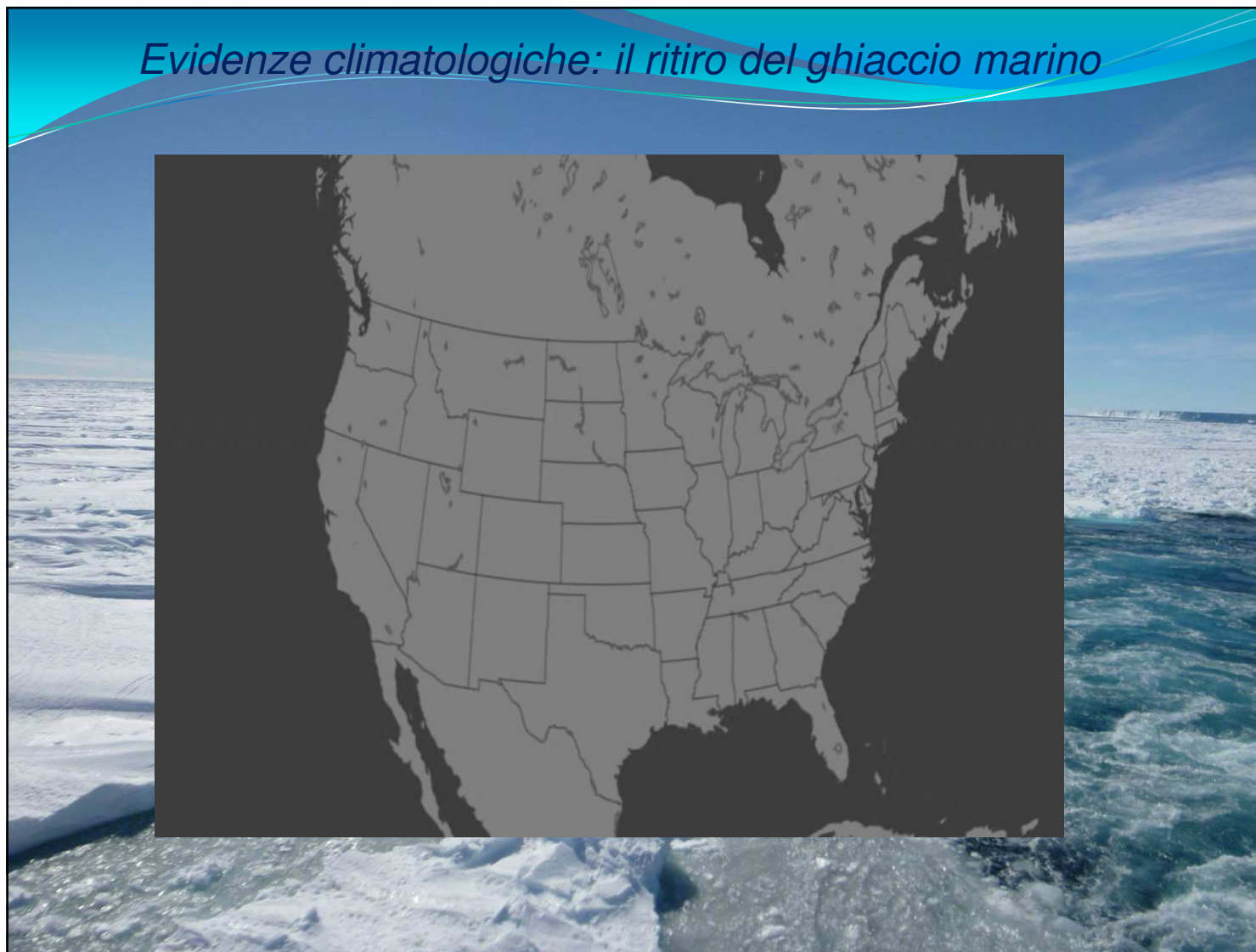
Evidenze climatologiche: il ritiro del ghiaccio marino



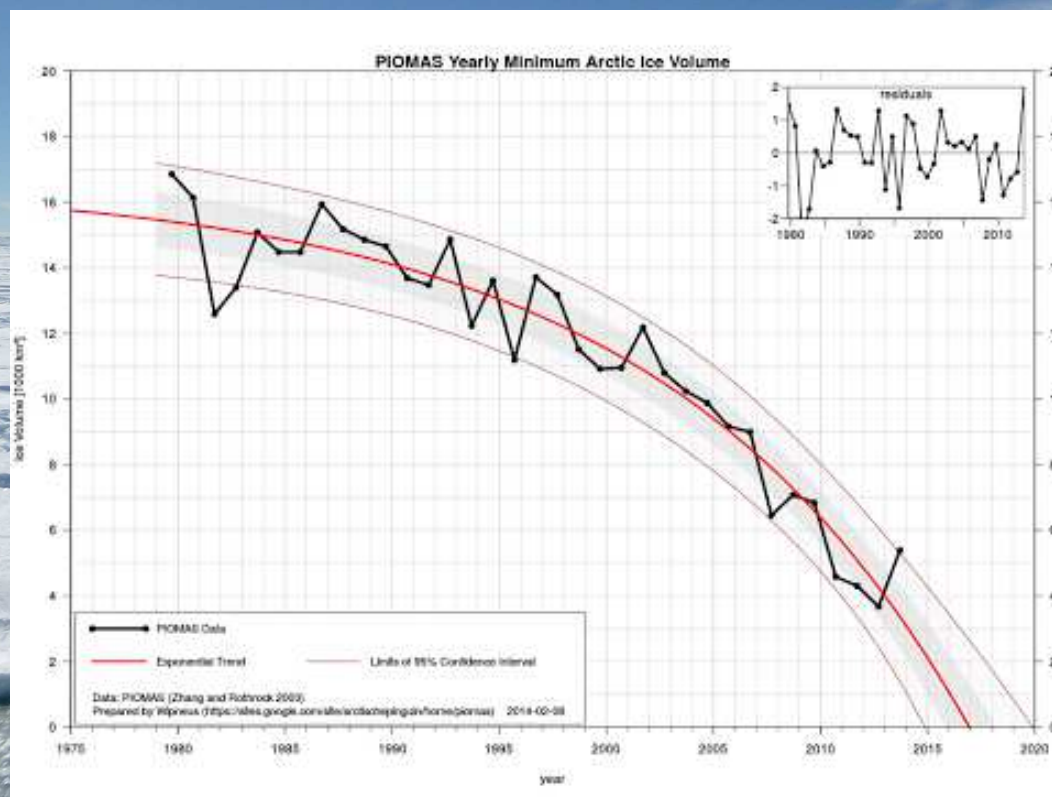
Evidenze climatologiche: il ritiro del ghiaccio marino



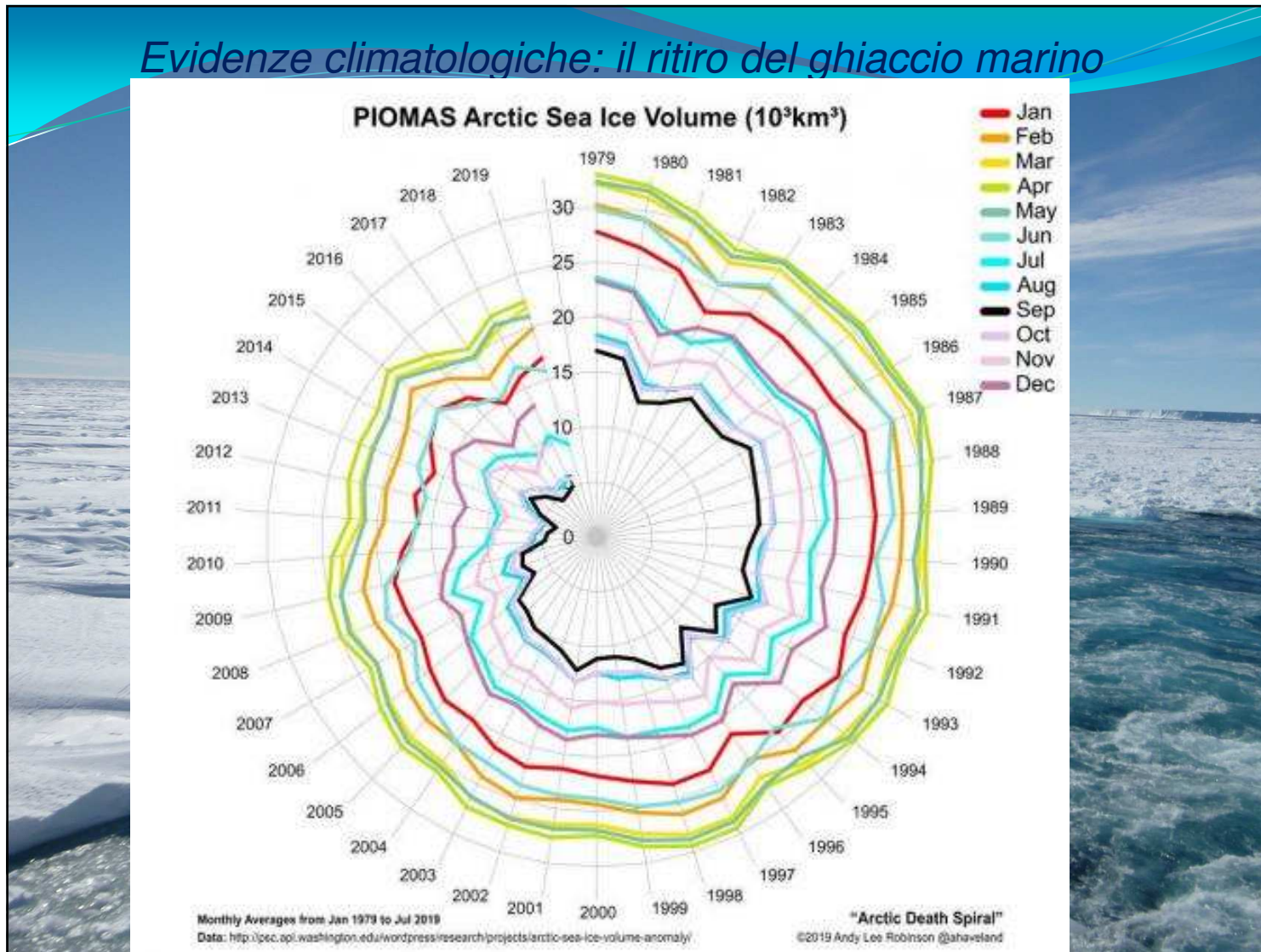
Evidenze climatologiche: il ritiro del ghiaccio marino



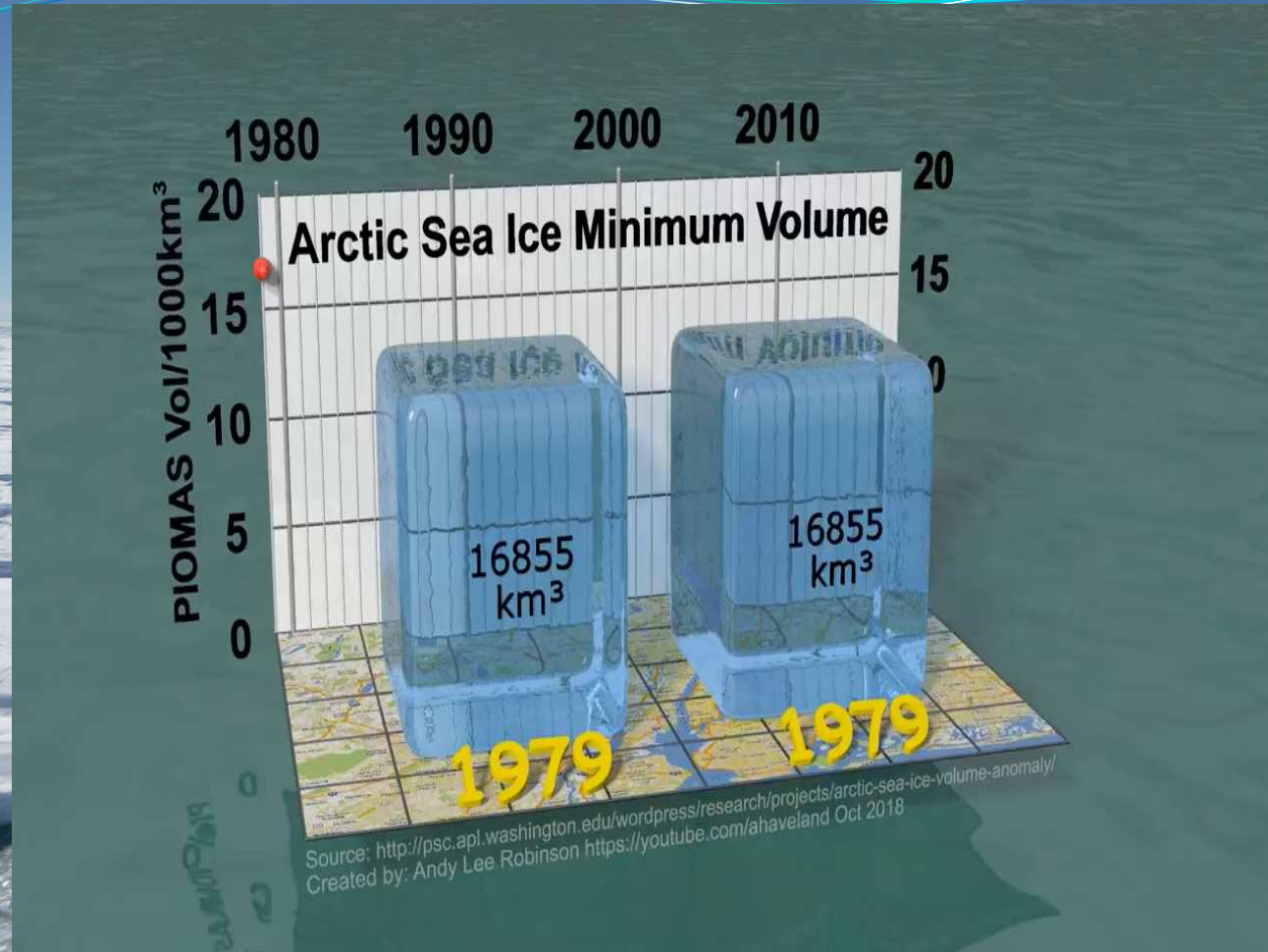
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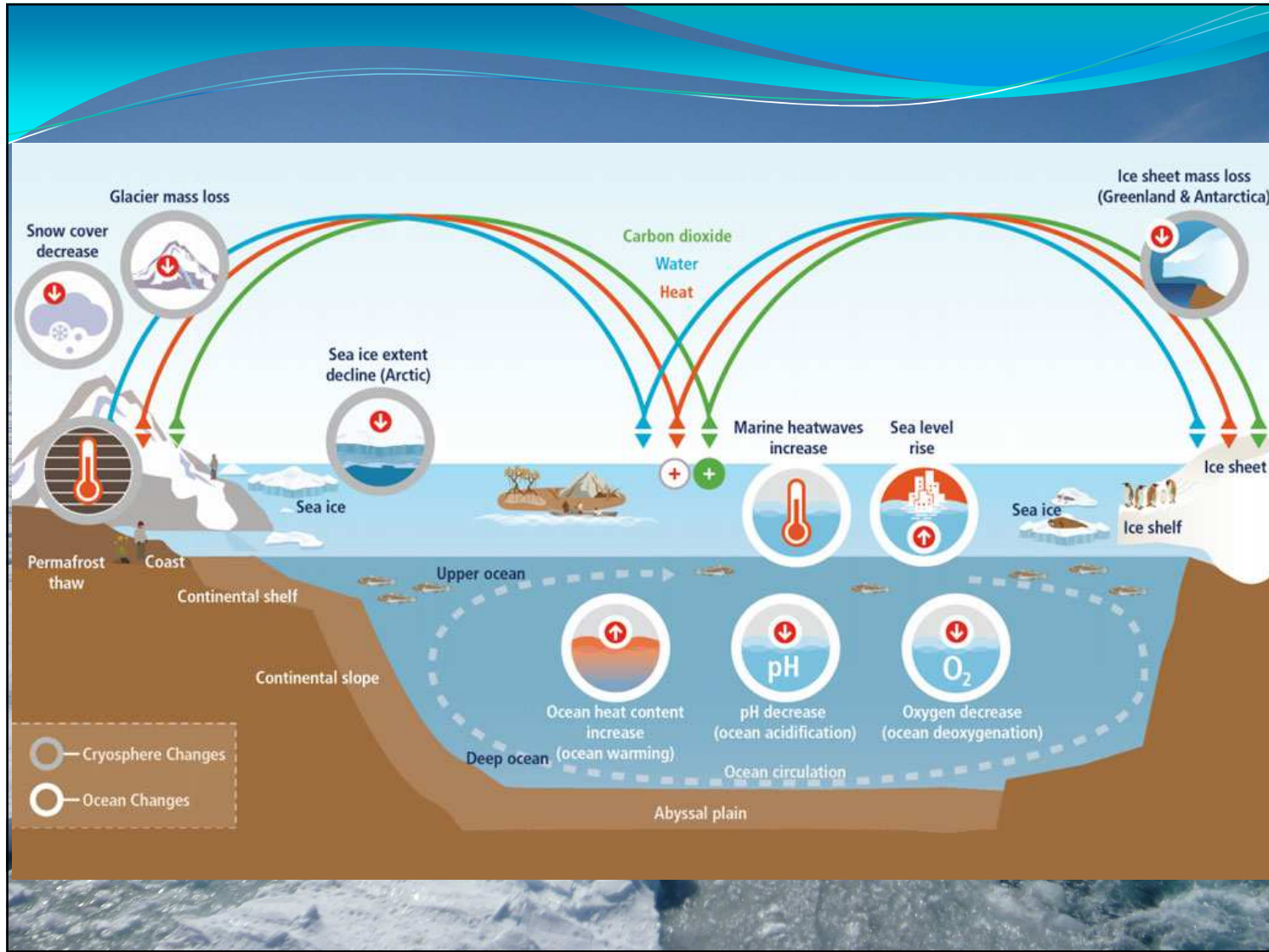


Evidenze climatologiche: il ritiro del ghiaccio marino

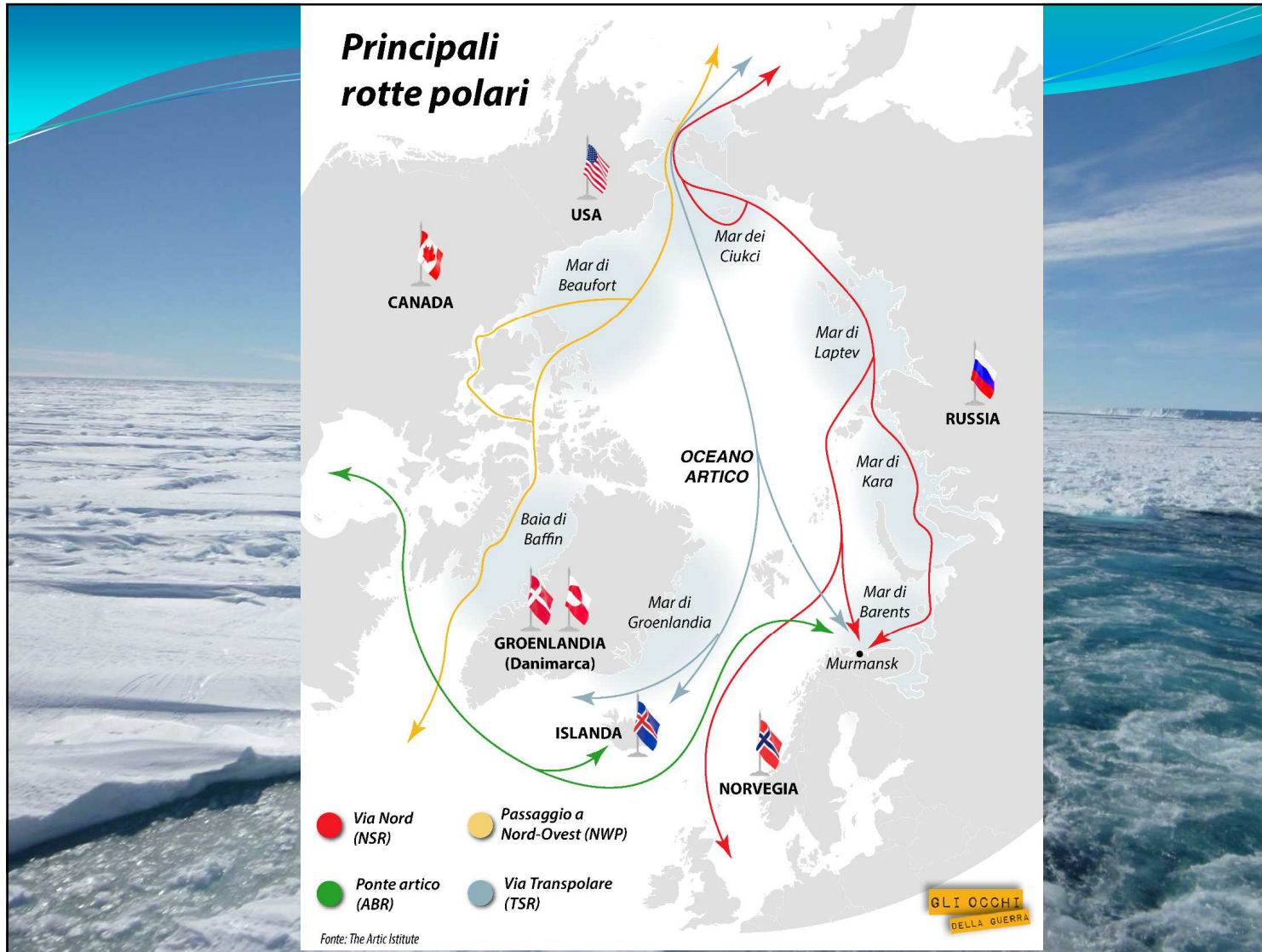


Evidenze climatologiche: il ritiro del ghiaccio marino

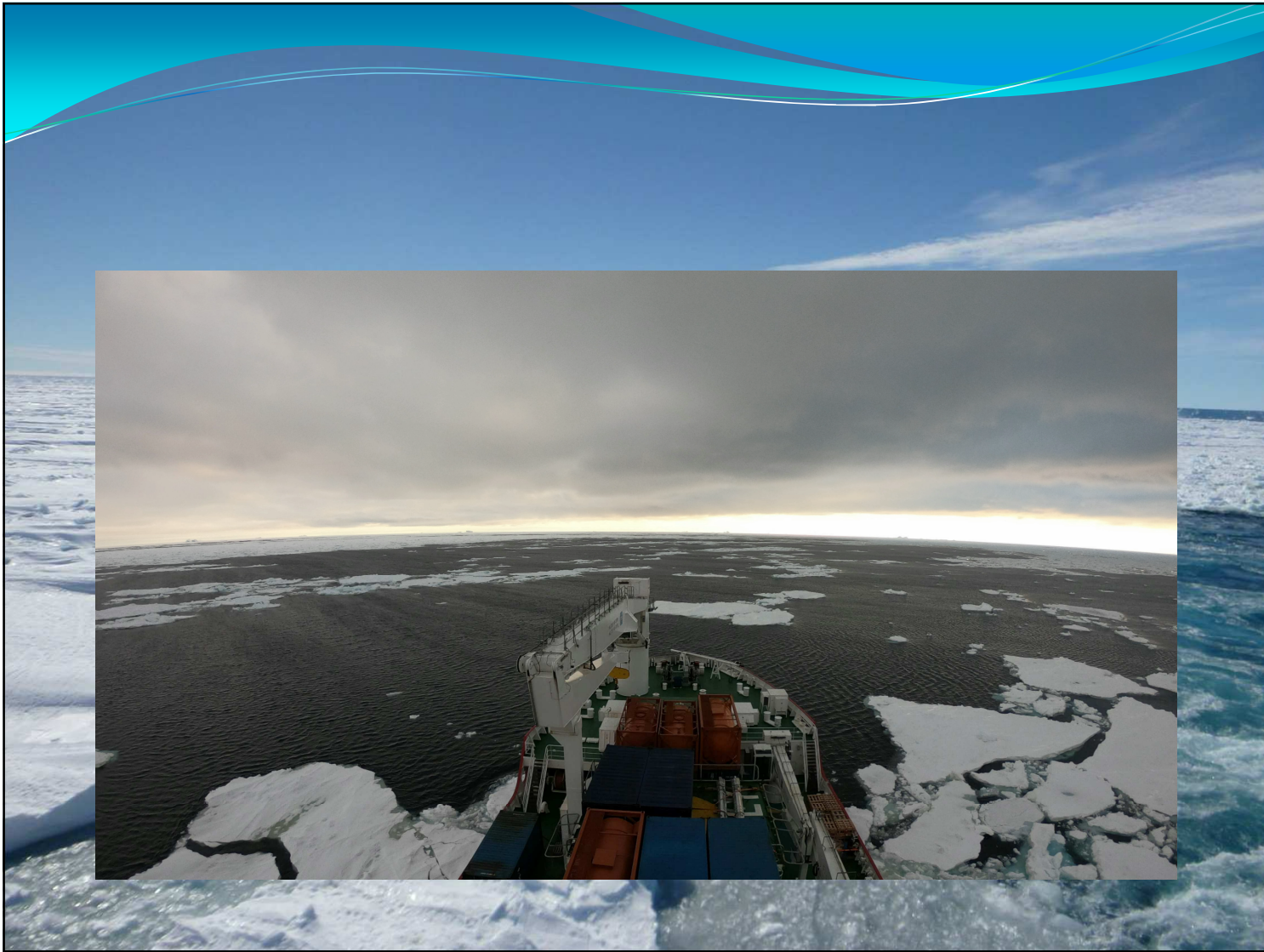




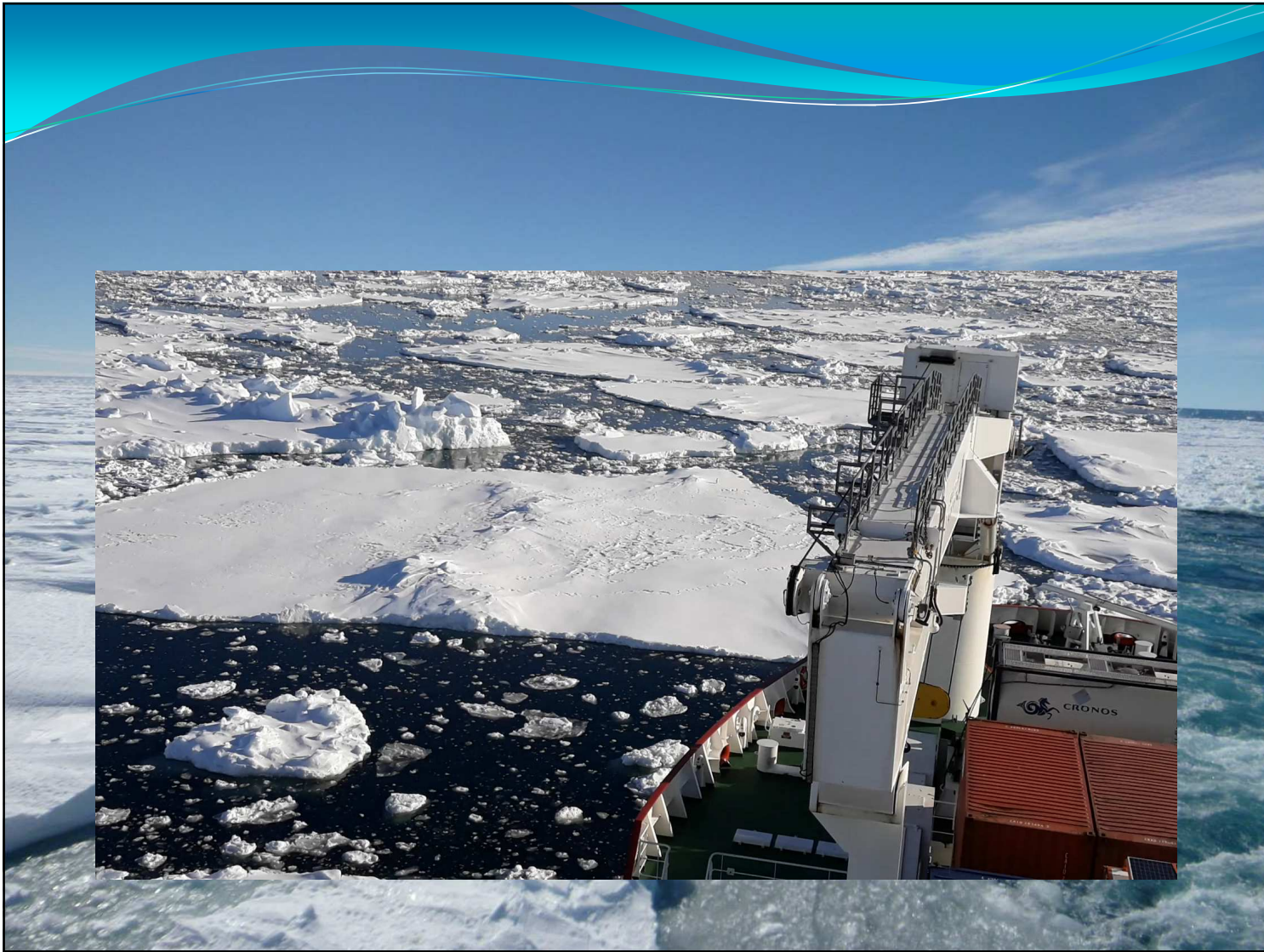






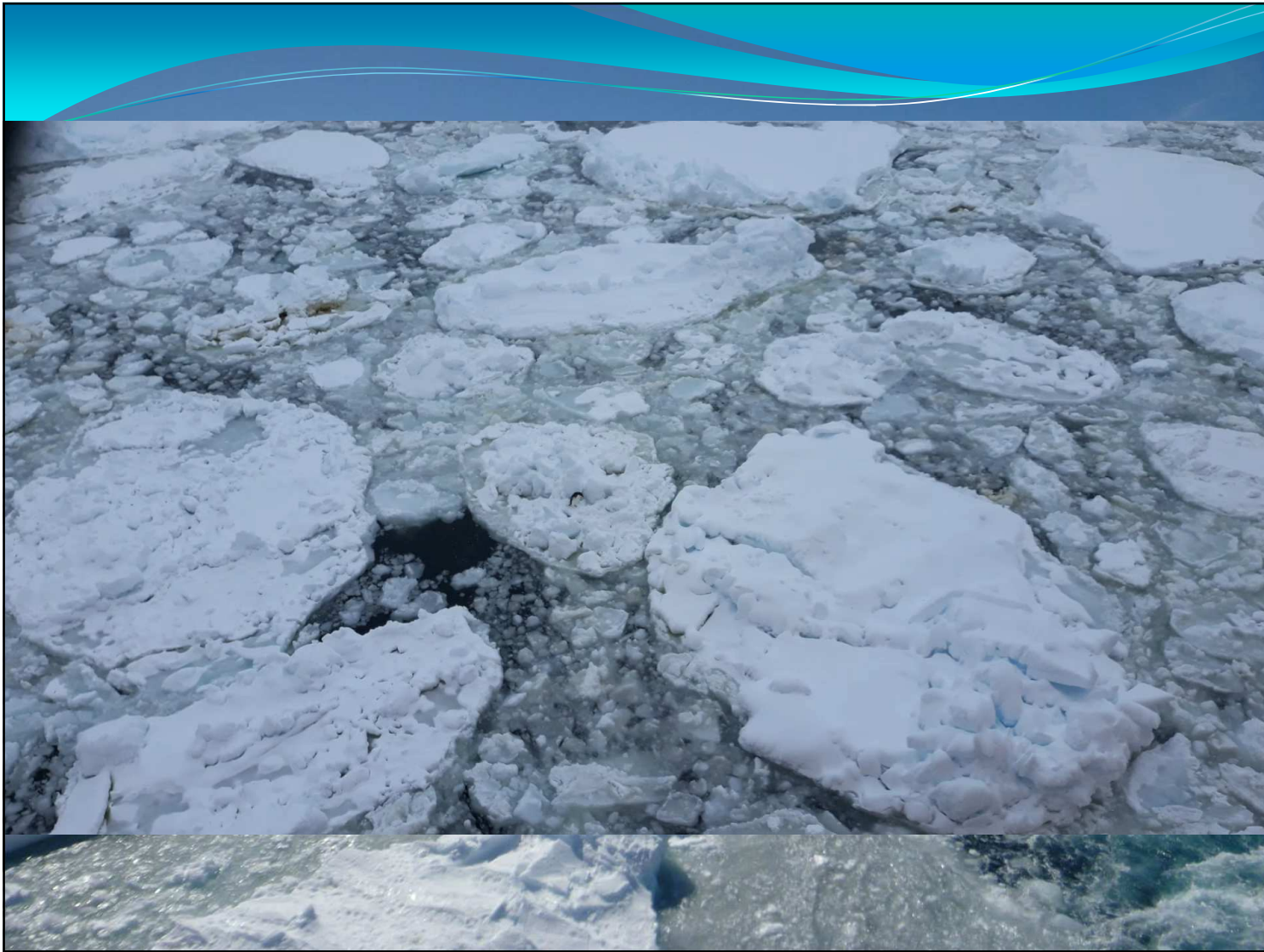




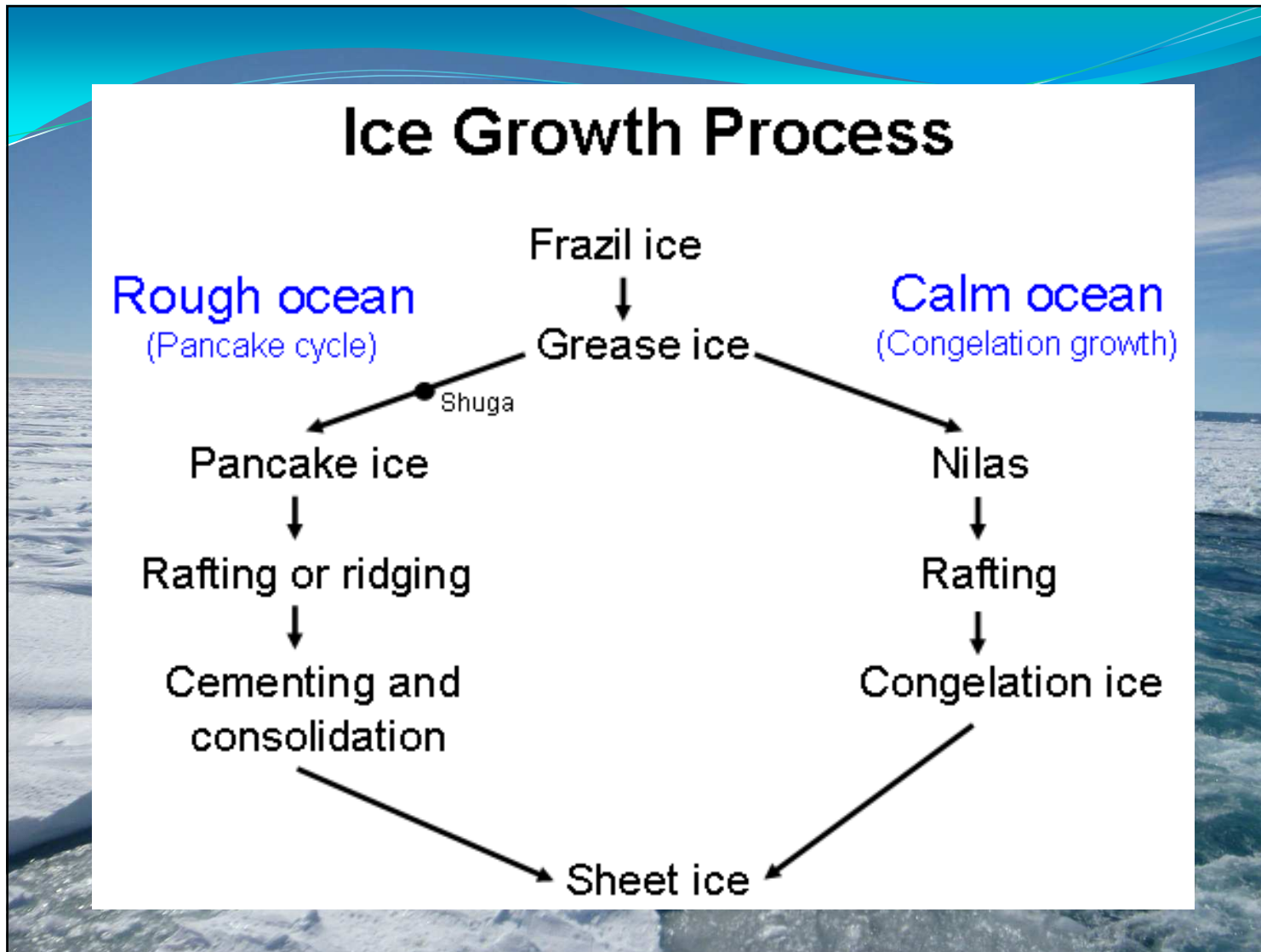












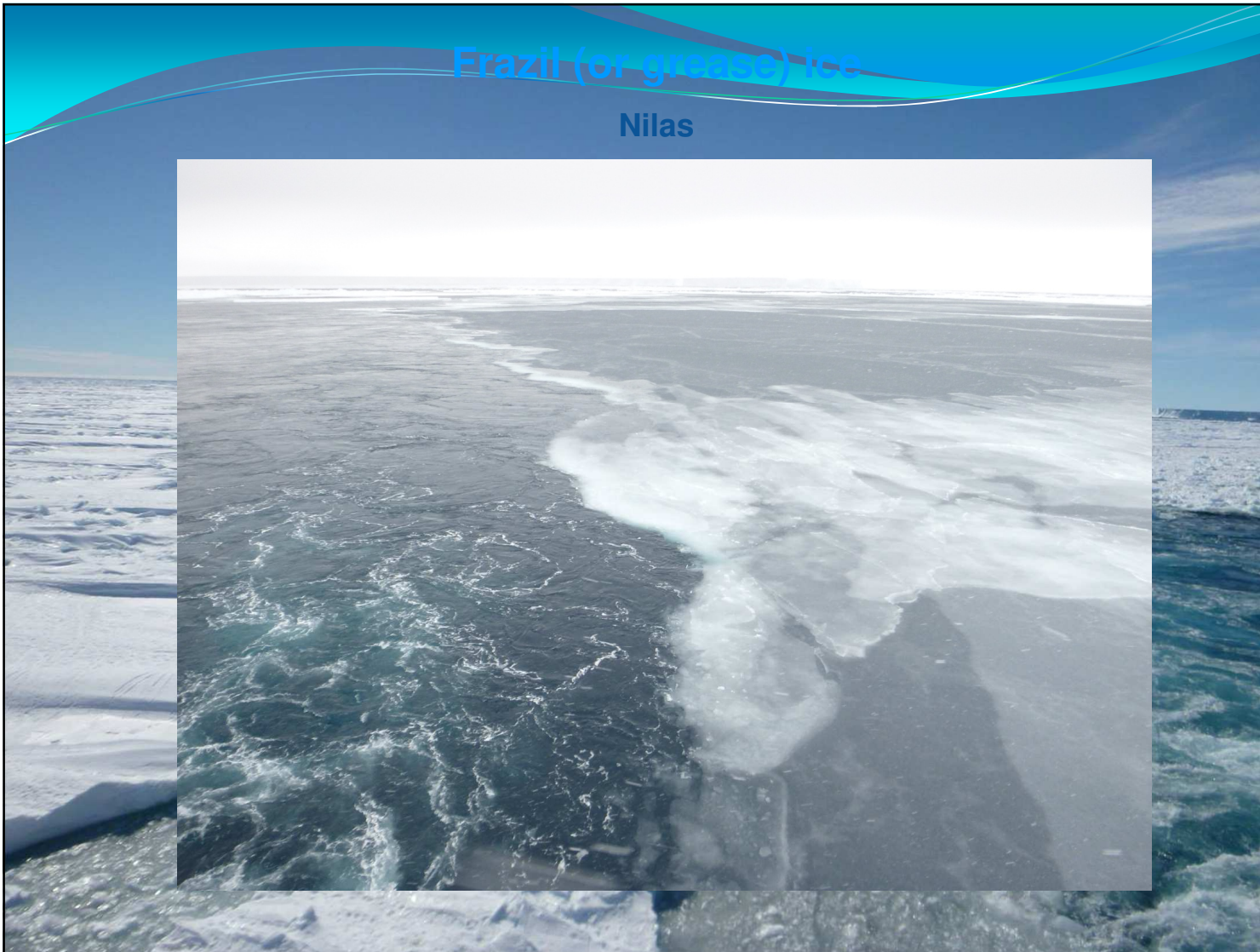


Grease ice



Frazil (or grease) ice

Nilas



Frazil (or grease) ice

Nilas





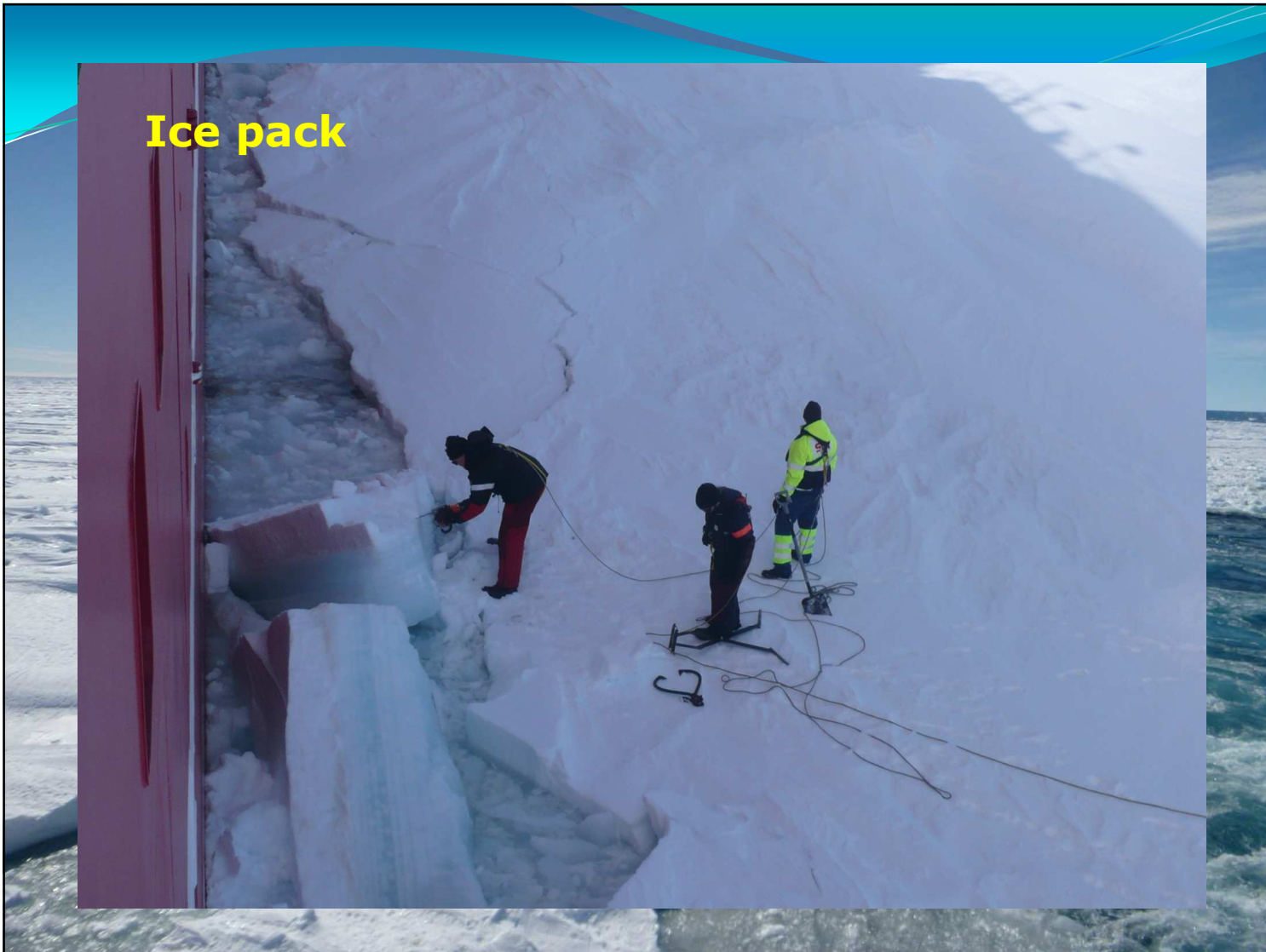


Pancake ice





Ice pack



Gaps in the ice pack are common and the open water conditions that develop are referred to as:

- **CRACKS**
- **LEADS** - long, linear gaps between ice floes
- **POLYNYE** (calore latente e calore sensibile)



CRACKS



LEADS



RE-FREEZING





MELTING

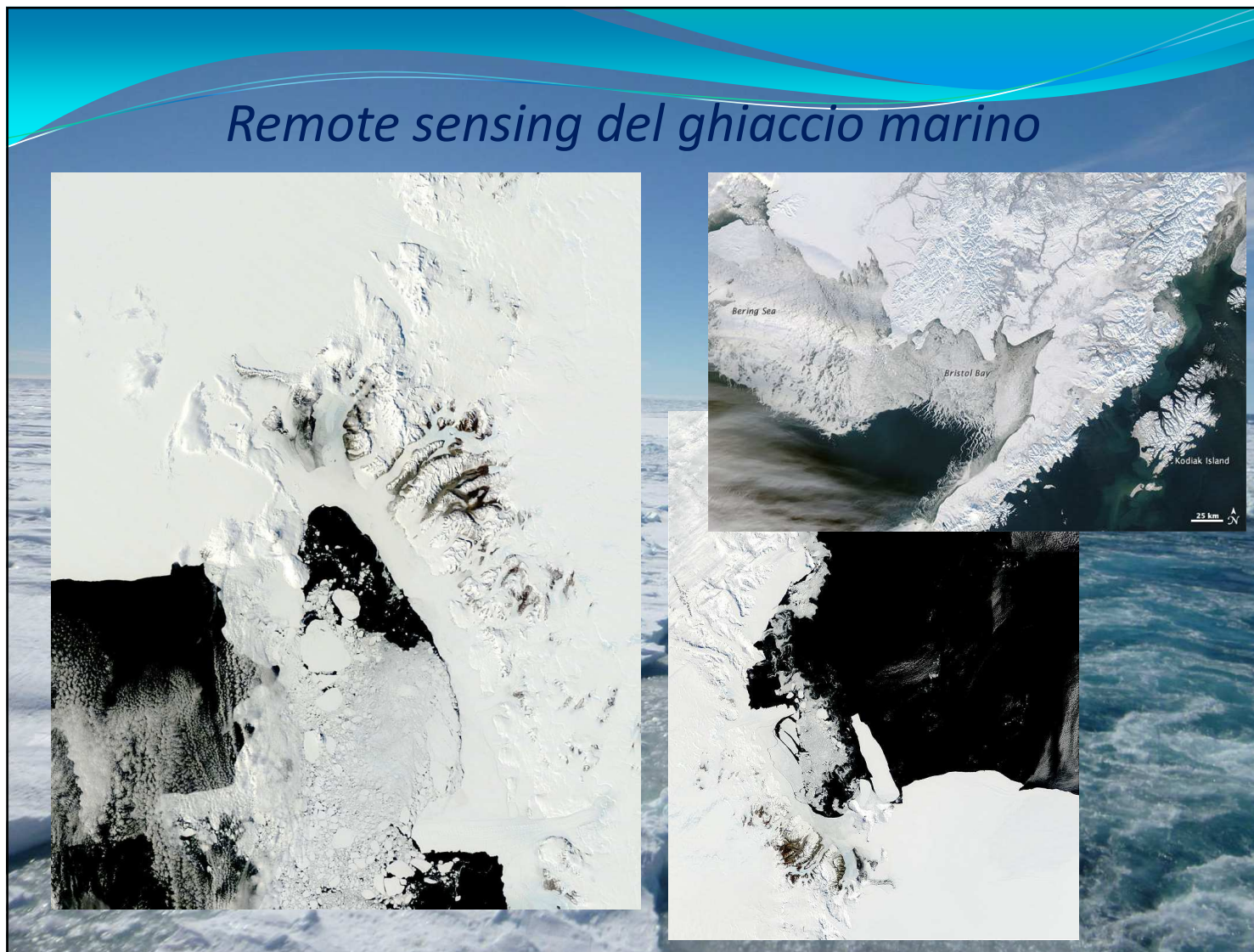


Remote sensing del ghiaccio marino

Wavelength m	Waveband description	Class of sensor
100nm — 10^{-7}	Ultra-violet	Ocean colour radiometer
1µm — 10^{-6}	Visible	
	(Near IR)	
10^{-5}	(Thermal IR)	IR radiometry
10^{-4}	Infrared (IR)	
1mm — 10^{-3}	Microwaves	Microwave radiometry
10^{-2}		
10^{-1}		
1m — 1	Radio waves	
10		



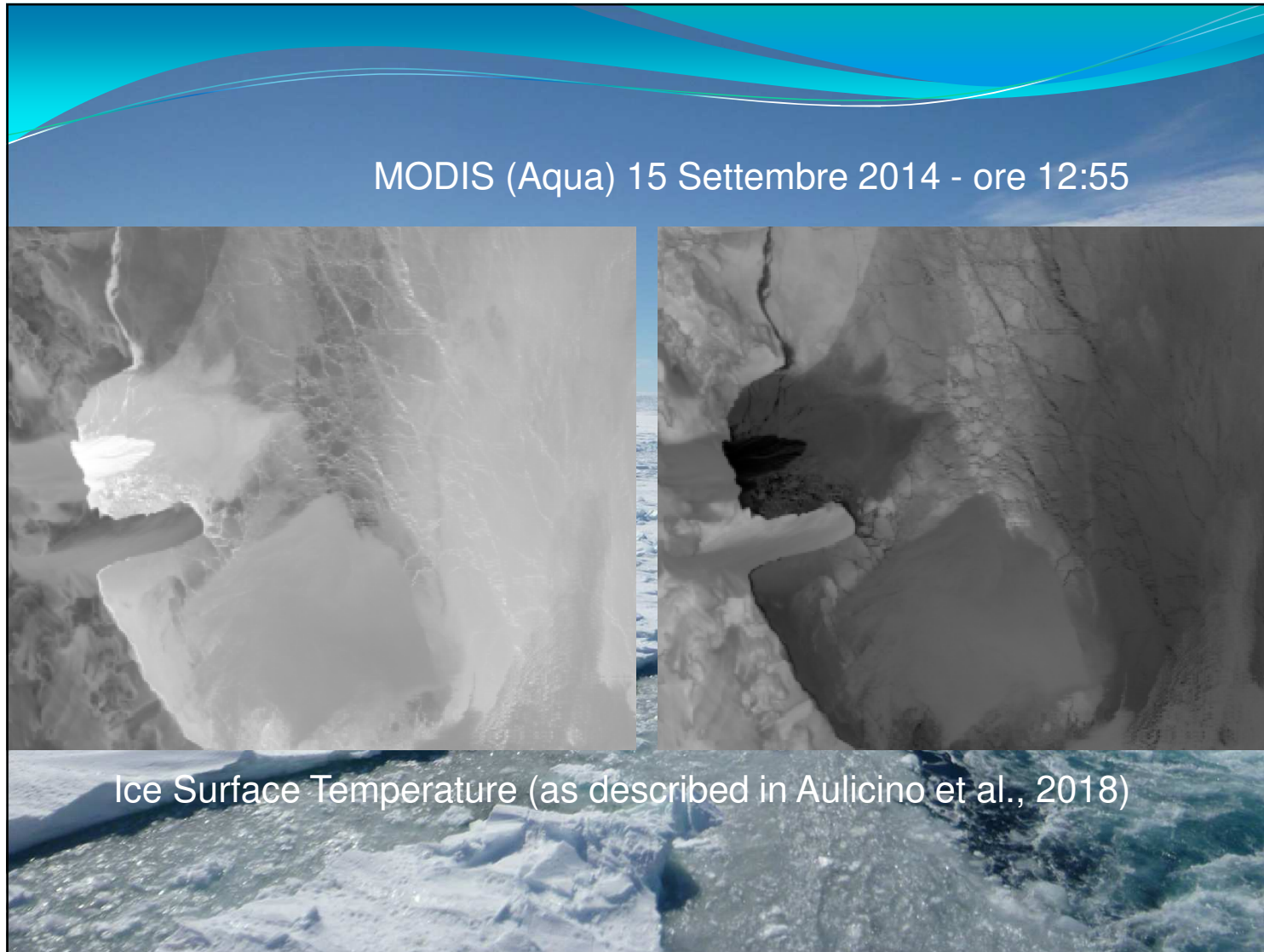
Remote sensing del ghiaccio marino

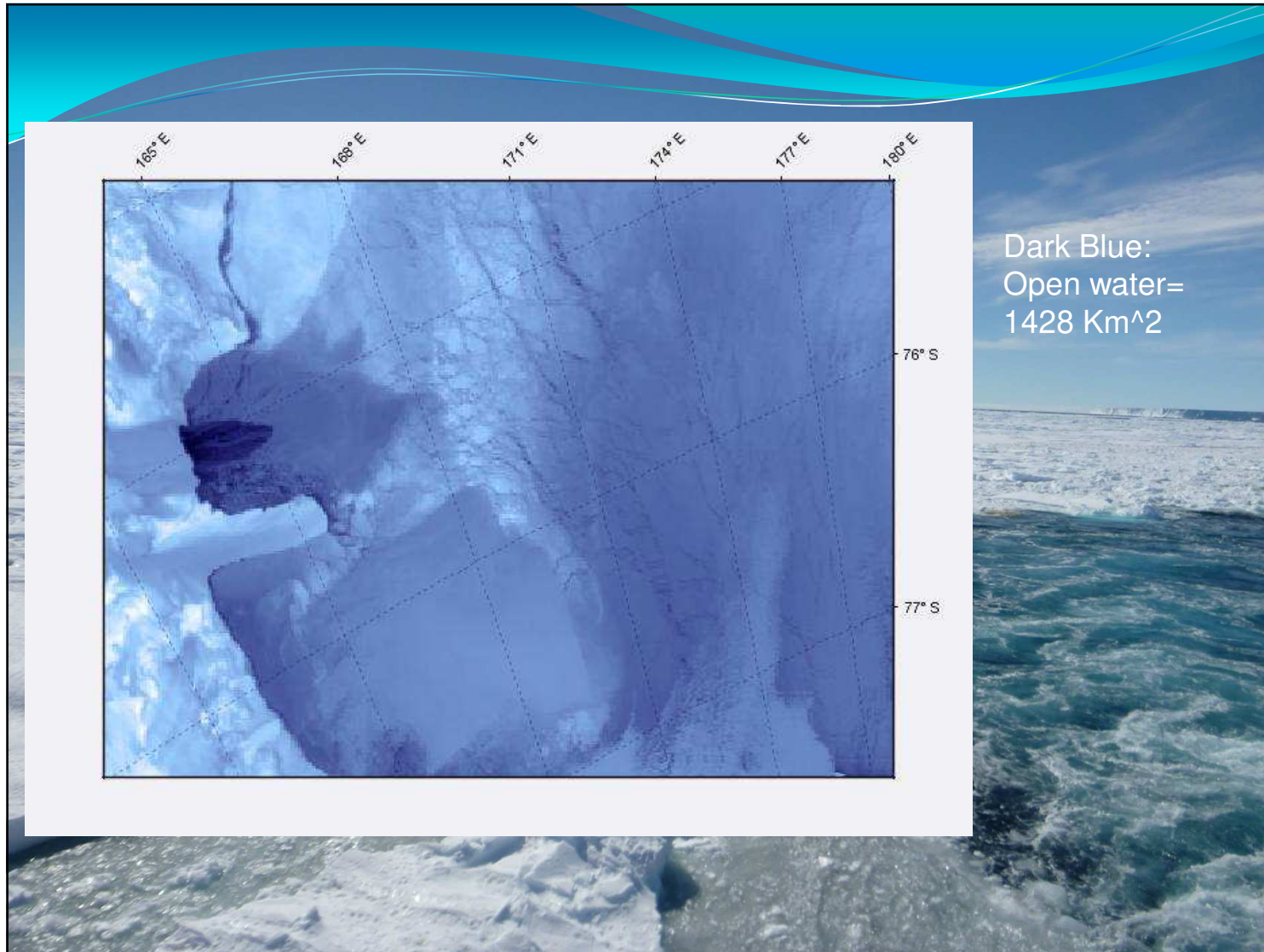


*MODIS True Color images
November 1st 2013 to February 5th 2014*

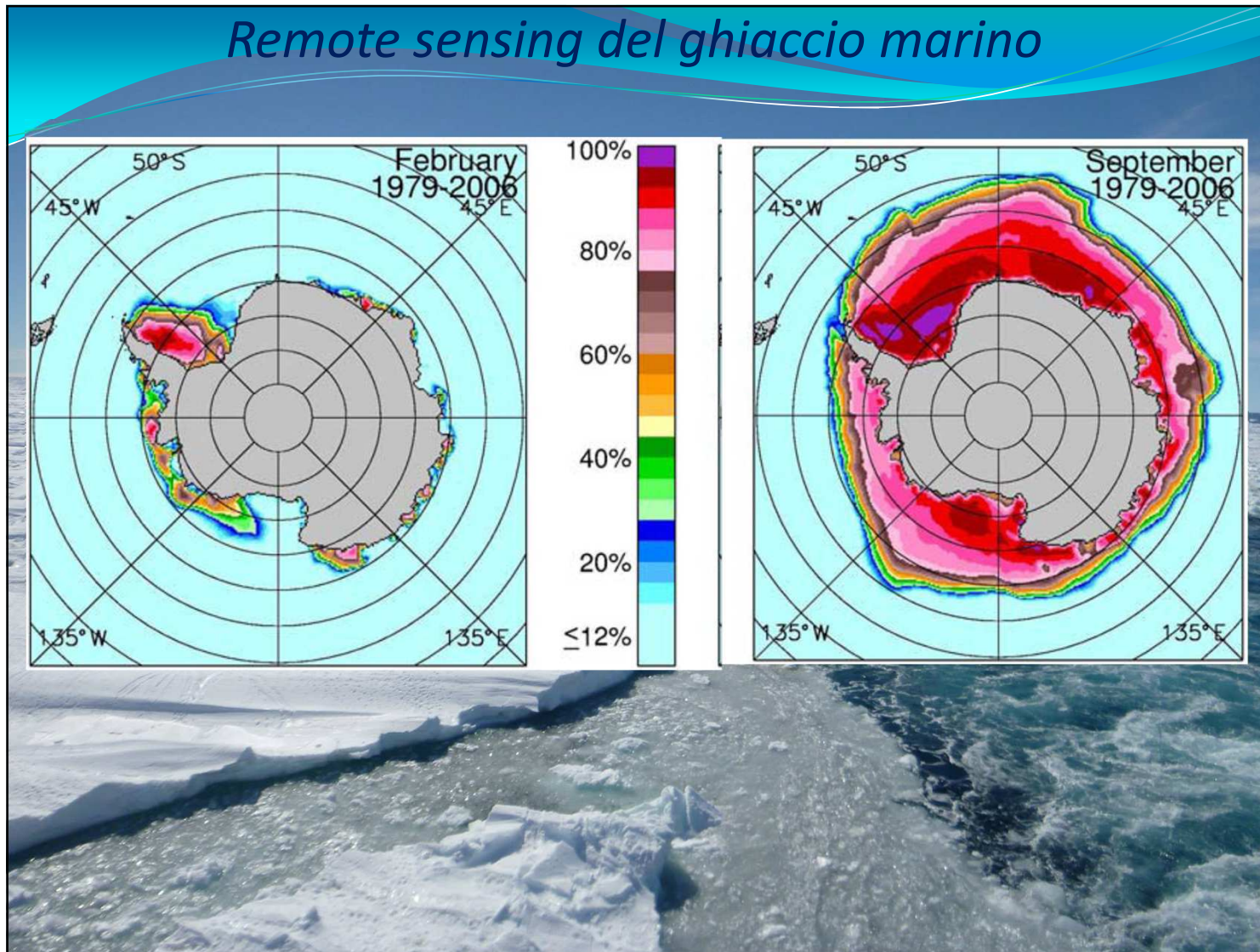


ROME





Remote sensing del ghiaccio marino



Journal of Geophysical Research: Oceans





RESEARCH ARTICLE

10.1002/2017JC013003

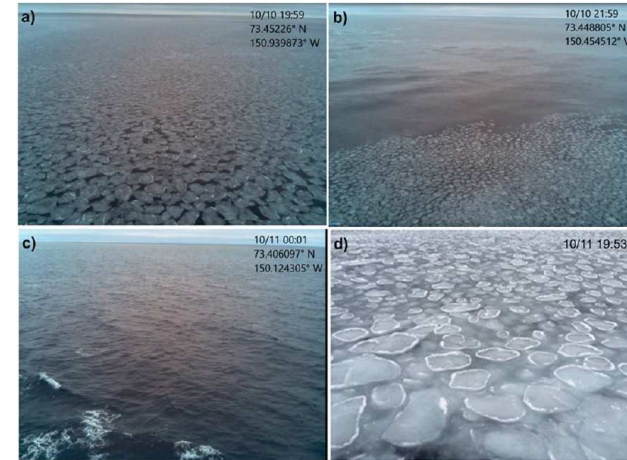
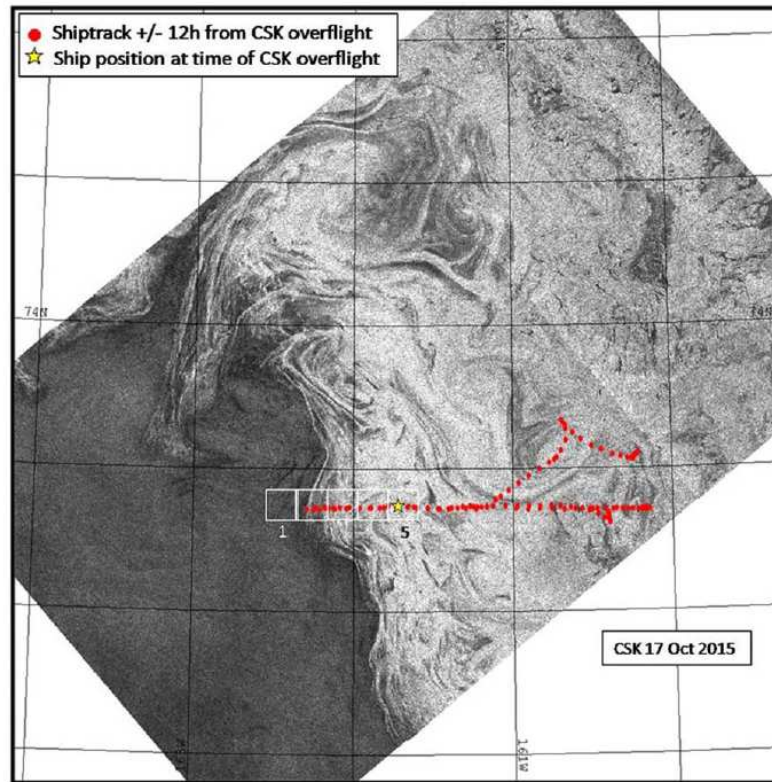
Pancake Ice Thickness Mapping in the Beaufort Sea From Wave Dispersion Observed in SAR Imagery

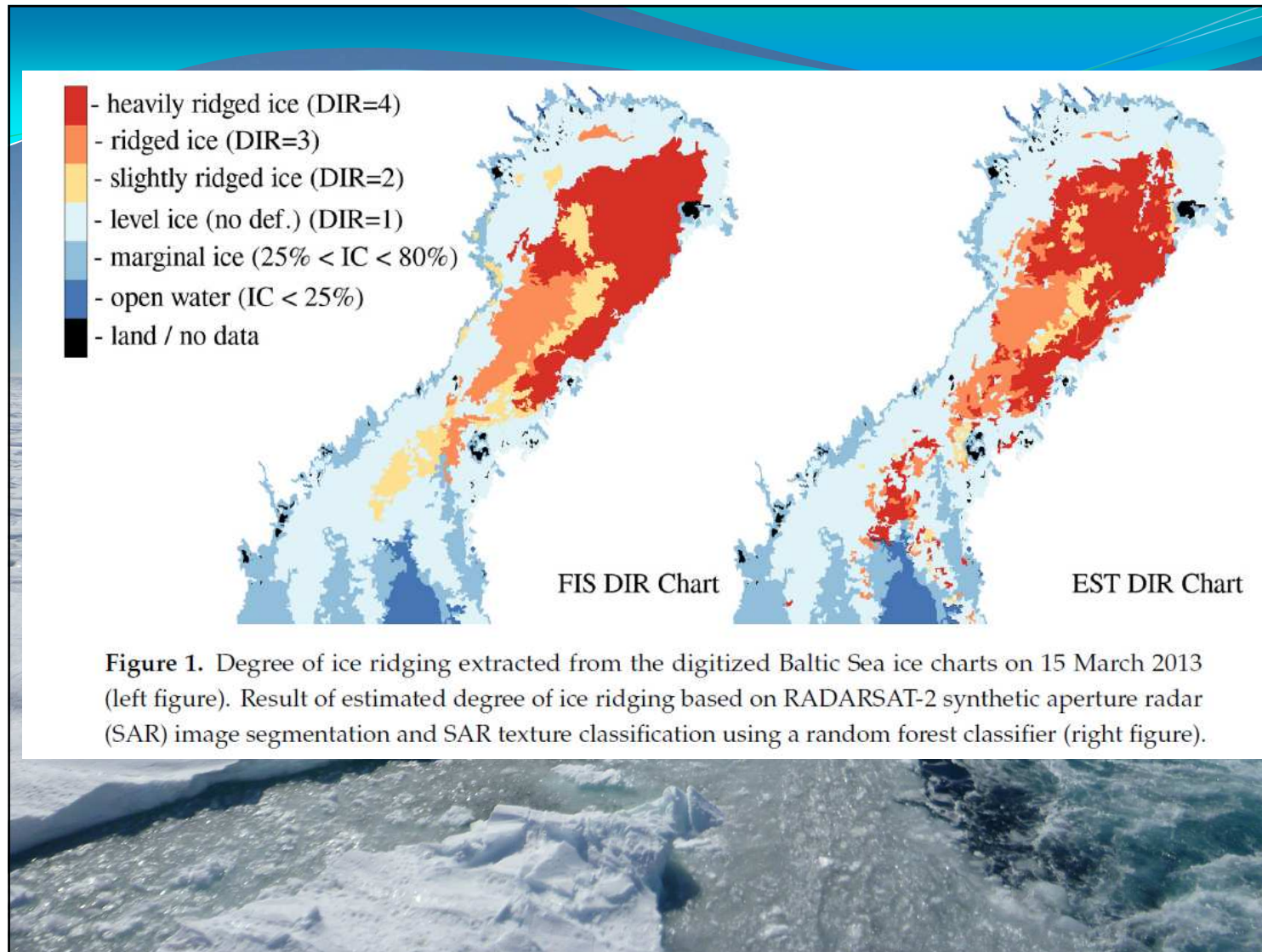
Special Section:

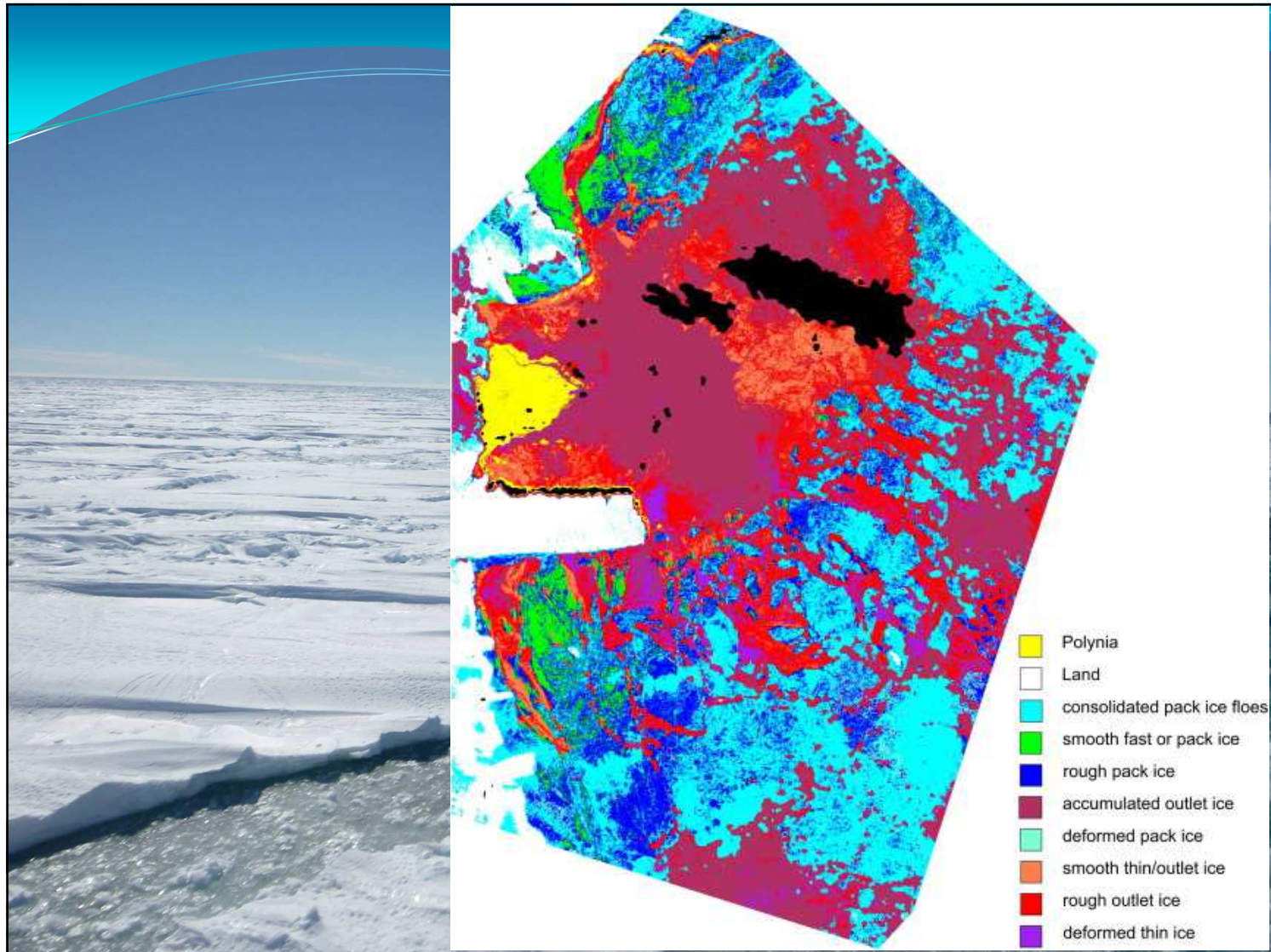
Sea State and Boundary Layer Physics of the Emerging Arctic

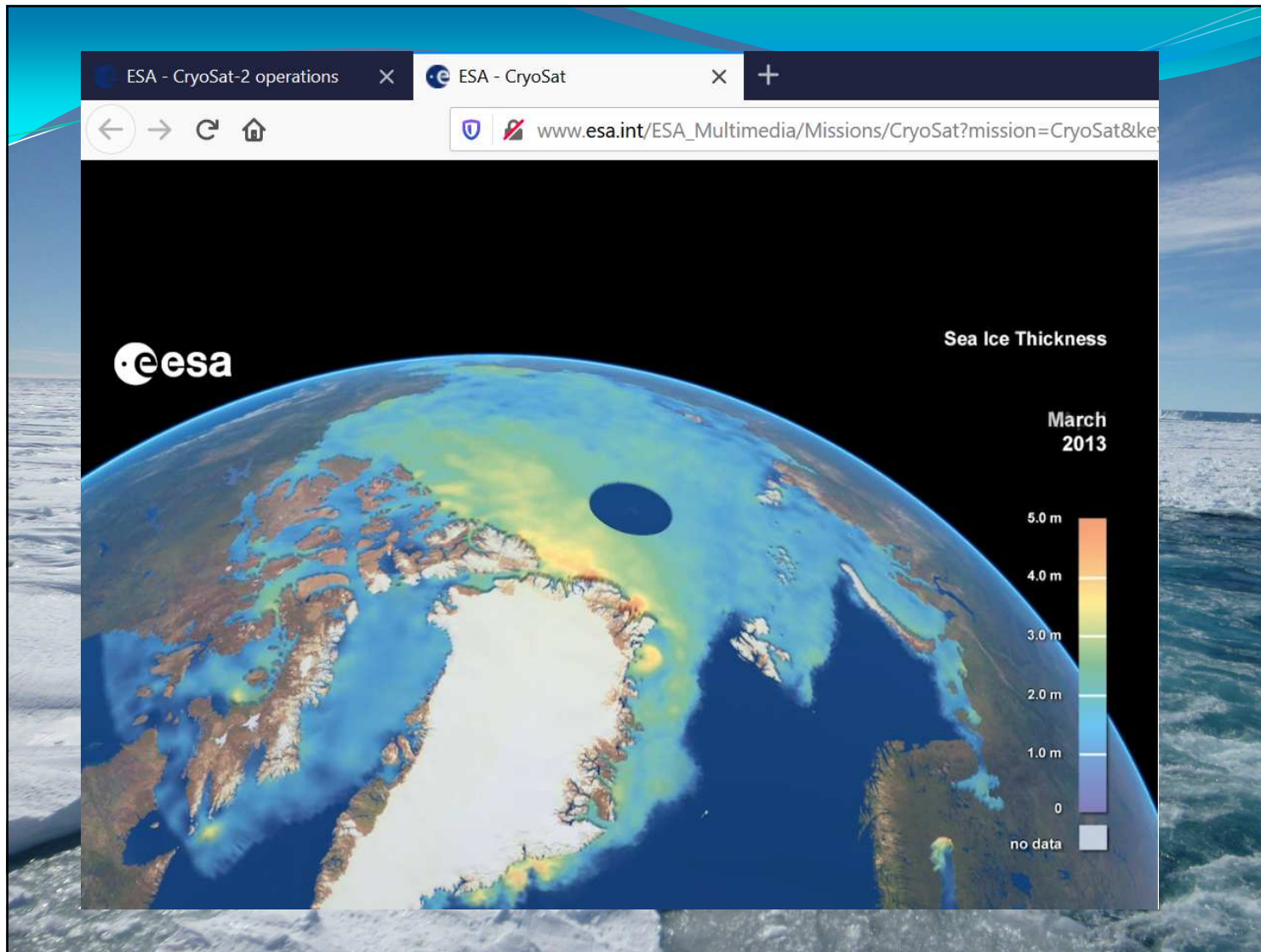
P. Wadhams^{1,2} , G. Aulicino² , F. Parmiggiani³, P. O. G. Persson⁴ , and B. Holt⁵ 

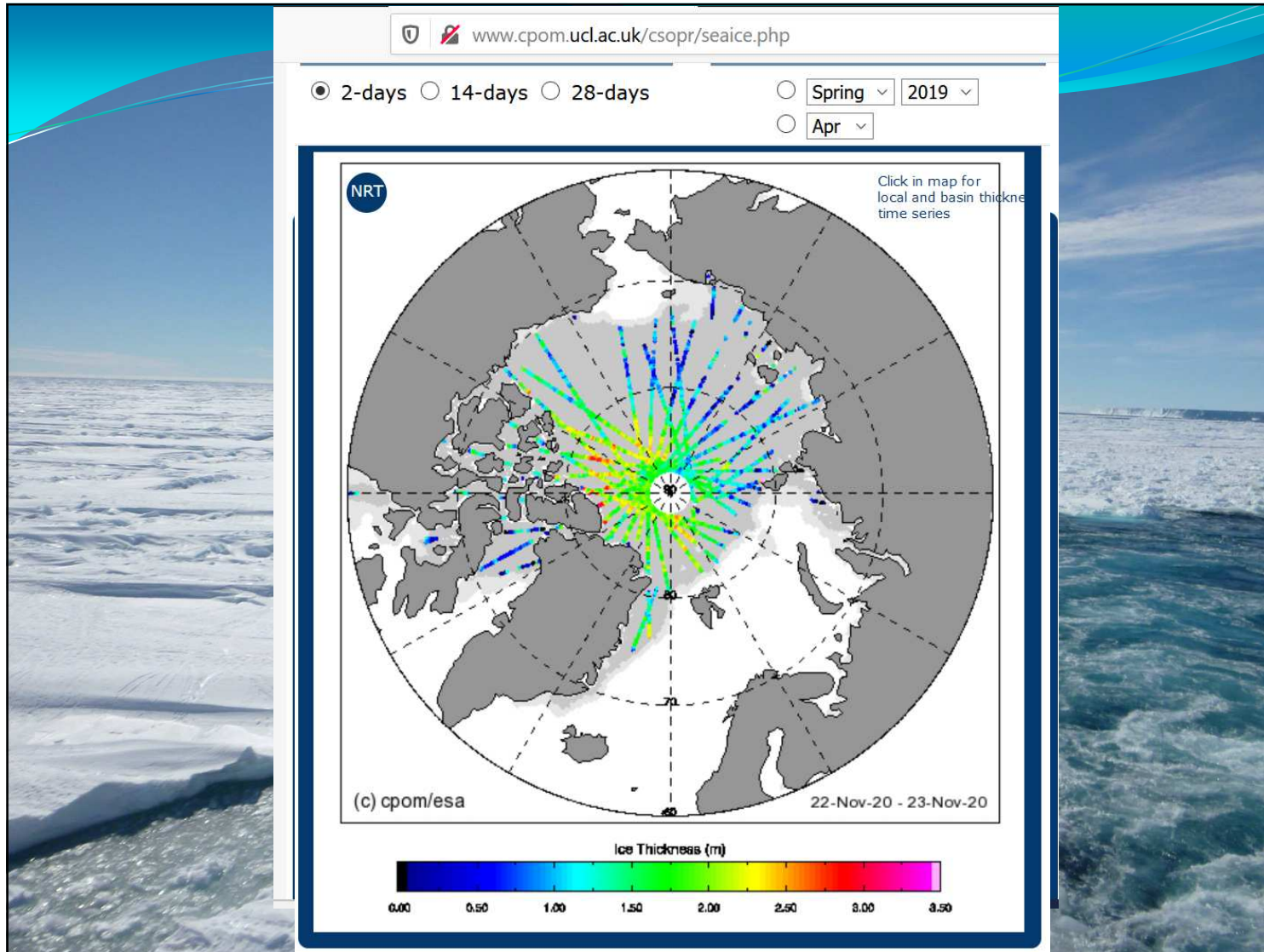
¹Cambridge Polar Consultants Ltd., Cambridge, UK, ²Università Politecnica delle Marche, Ancona, Italy, ³ISAC-CNR, Ancona, Italy, ⁴Colorado State University, Fort Collins, Colorado, USA, ⁵Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA











www.cpom.ucl.ac.uk/csopr/seaice.html

Sea Ice volume and thickness

Arctic Sea Ice Thickness Maps

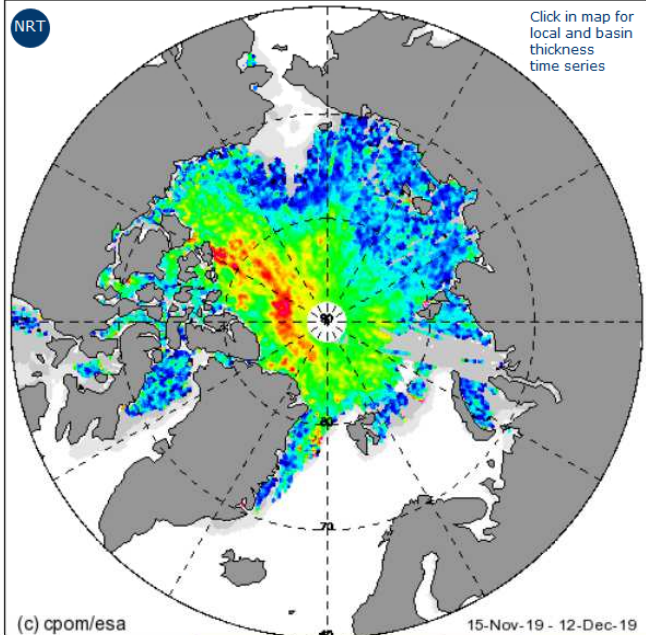
Arctic sea ice thickness processed at UCL from CryoSat's SAR mode data

Latest from Near Real Time Data Final Precise Data

2-days 14-days 28-days Spring 2019 Apr

NRT Service only operates during the Arctic winter season (Oct-May). During summer CryoSat's radar can not measure thickness effectively due to the formation of melt ponds in the sea ice.

Latest 5km Grid of 28-day Thickness : 15/11/19 - 12/12/19



(c) cpom/esa 15-Nov-19 - 12-Dec-19

Arctic Sea Ice Time Series

Display the change over time in sea ice thickness or volume over the whole Arctic, an ocean basin, or thickness at a point location:

Show : Volume Thickness

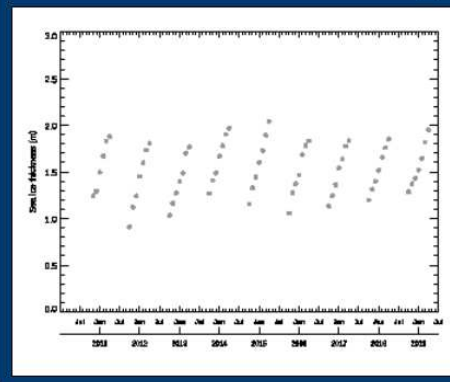
Select Location of Thickness Time Series or click on Map.

Lat: 60.0..9 Lon E: -180..3 Select

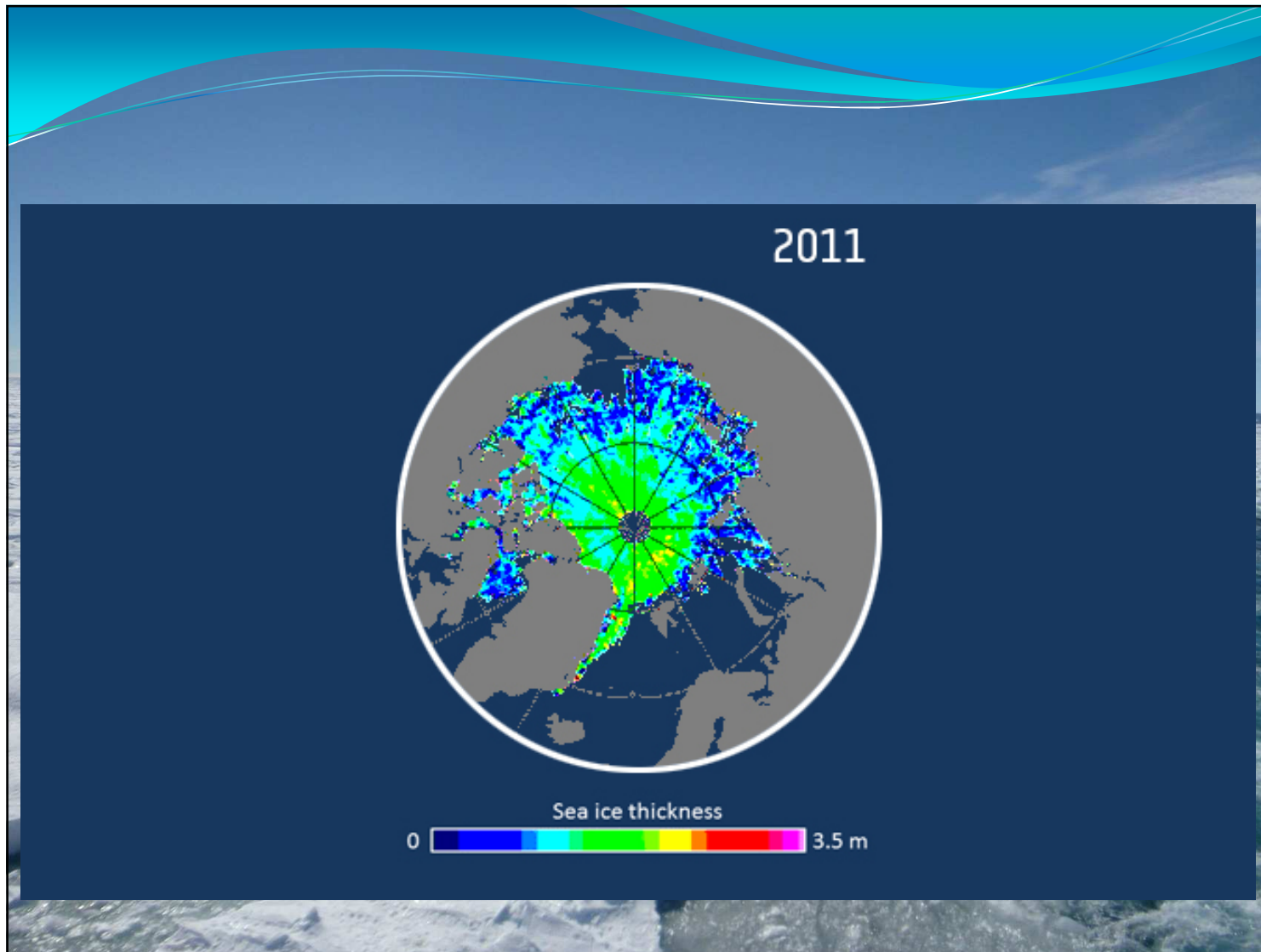
Select by Point All Arctic

The plot below shows the timeseries of Monthly mean sea ice thickness calculated from CryoSat precise and near real time (NRT) data over the whole Arctic area of sea ice extent.

Whole Arctic Thickness



A timeseries at a single location and Arctic basin can also be displayed by clicking on the sea ice



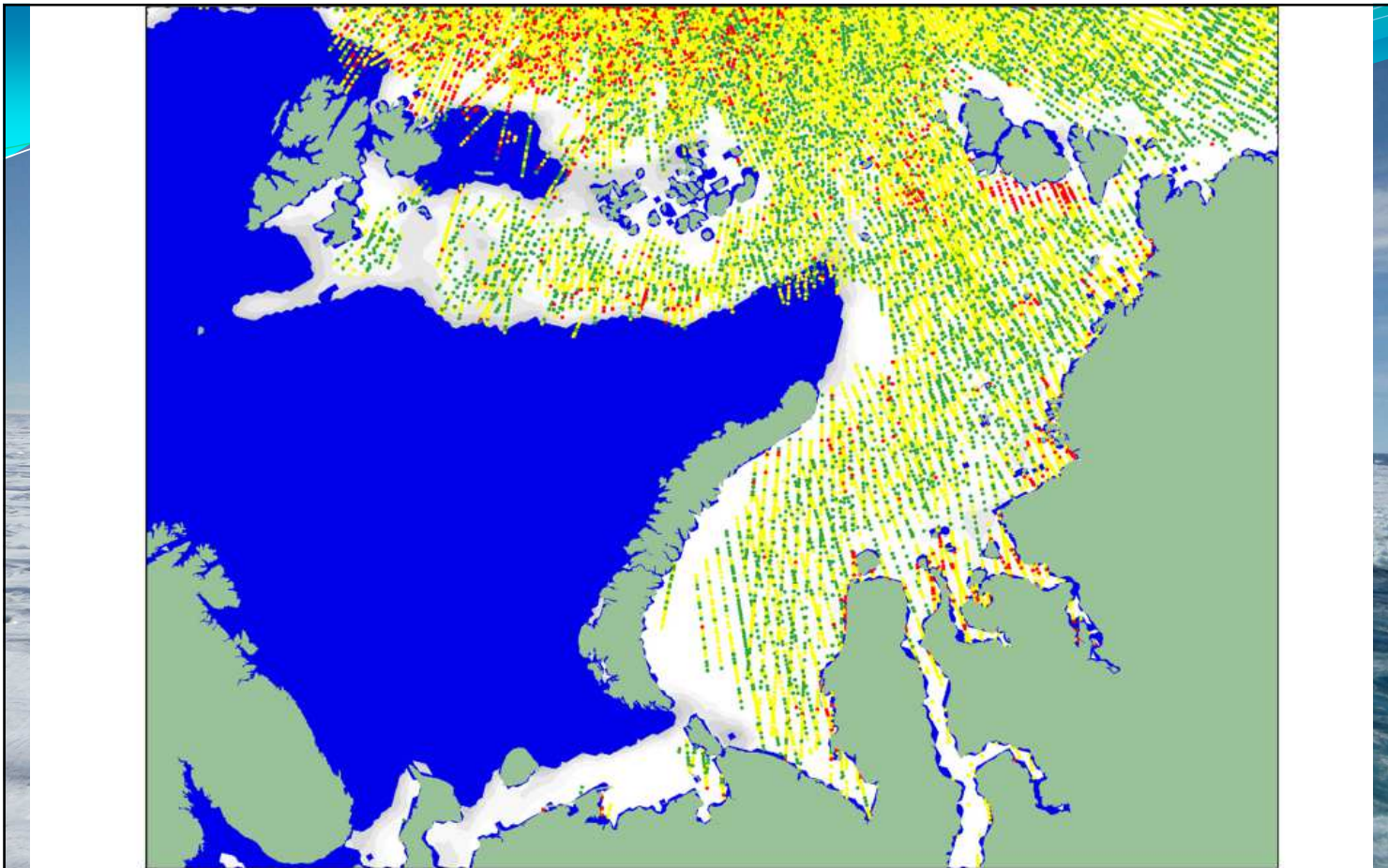


Figure 3. Estimate of risk index outcome (RIO) for the ship of polar class 5 in the Kara Sea. The analysis is based on CryoSat-2 SAR Interferometer Radar Altimeter (SIRAL) observations from 1 March to 1 April 2017. Colour code: red = Operations not permitted, yellow = Operations restricted, green = Operations allowed. White area shows the ice extent from EUMETSAT Ocean and Sea Ice Satellite

