Changing Arctic Ocean

Implications for marine biology and biogeochemistry

Photo by Jen Freer

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GLOBAL WARMING
RETREAT OF SEA ICE
NEW PHYSICAL STATE

Changing Arctic Ocean: Implications for marine biology and biogeochemistry
Average air temperature anomaly in Oct 2019 relative to 1951-1980 baseline

Figure from Zack Labe ~ @ZLabe ~ https://sites.uci.edu/zlabe/

Data: NASA/GISS GISTEMPv4
Average air temperature anomaly from Oct 2017 to Sep 2018
relative to 1981-2010 baseline

Figure from the 2018 Arctic Report Card
Sea ice extent in the Arctic Ocean

Beaufort + Chukchi + East Siberian + Laptev + Central Arctic

1979 1993 2007
1982 1996 2010
1983 1997 2011
1984 1998 2012
1985 1999 2013
1986 2000 2014
1987 2001 2015
1989 2003 2017
1990 2004 2018
1991 2005 2019
1992 2006

DATA: National Snow & Ice Data Center, Boulder CO (Sea Ice Index v3: 1979-2019*)
SOURCE: the/sites.uci.edu/zlabe/NIAD/SEASONAL/2019
GRAPHIC: Zachary Labe (@ZLabe)

Updated 25 Nov 2019
Loss of sea ice older than 4 years
comparison March 1985 to March 2018

Figure from the 2018 Arctic Report Card

NOAA Climate.gov
Data: ARC 2018
Arctic Sea Ice 1979-2019

Volume

Thickness

Figure from Zack Labe ~ @ZLabe ~ https://sites.uci.edu/zlabe/

Data: PIOMAS v2.1 (Zhang and Rothrock, 2003)
Chukchi Sea Ice - abnormal behaviour in 2019

Figure from Zack Labe - @ZLabe - https://sites.uci.edu/zlabe/

Data: National Snow & Ice Data Center, USA (Sea Ice Index v3)
Reconstruction of Arctic sea ice extent

Years AD

Extent ($\times 10^6$ km$^2$)

GRAPHIC: Zachary Labe (@ZLabe)

Kinnard et al. 2011, Nature  
Observations  
95% Confidence Interval

Reconstruction data: Kinnard et al., 2011
Warming

Reduction in sea ice extent, volume and thickness

Figures from Zack Labe ~ @ZLabe ~ https://sites.uci.edu/zlabe/
Warming

Record anomalies  No recent precedent

Reduction in sea ice extent, volume and thickness

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Warming

Record anomalies

No recent precedent

Extreme, unprecedented, rapid change

Reduction in sea ice extent, volume and thickness

Figures from Zack Labe ~ @ZLabe ~ https://sites.uci.edu/zlabe/
Why is it important to know about change in the Arctic Ocean?
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Mean winter (DJF) 2090-2099 sea ice fraction ~ RCP8.5 scenario

Representative Concentration Pathway 8.5:
- 8.5 Wm^2 in 2100
- 1370 ppm CO2 equivalent
- 4.9 °C temperature anomaly
Changing Arctic Ocean

Implications for marine biology and biogeochemistry
Understanding and quantifying the impacts of climate change on Arctic ecosystems and their global consequences
£20 million research

5-year programme
2017-2022

Dual national funding
UK and Germany

16 projects
32 research institutions

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2 KEY RESEARCH CHALLENGES

1. A quantified understanding
   To develop a quantified understanding of the structure and functioning of Arctic ecosystems

2. Sensitivity to change and future projections
   To understand the sensitivity of Arctic ecosystem structure, functioning and services to multiple stressors, and the development of projections of the impacts of change
4 LARGE PROJECTS
2017 - 2021

Arctic PRIZE
How does seasonal sea ice control Arctic productivity?
Prof Finlo Cottier

ARISE
Can we detect changes in Arctic ecosystems?
Prof Claire Mahaffey

ChAOS
How do changes in the surface ocean affect seafloor processes?
Dr Christian Maerz

DIAPOD
How does Arctic change affect Calanus, a key Arctic species?
Prof David Pond

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12 NEW PROJECTS

2018-2021

Coldfish
Key Arctic fish response

MiMeMo
Fishery yields

APEAR
Influx of Atlantic and Pacific waters

Eco-Light
Under-ice light field

Diatom-ARCTIC
Sea-ice algae

CHASE
Biological clock

PEANUTS
Ocean circulation and nutrients

Micro-ARC
Pelagic microbial ecosystem

CACOON
Permafrost thaw

LOMVIA
Ecosystem competition

EISPAC
Contaminant cycling

PETRA
Climate-active gases

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INTERNATIONAL COLLABORATION

>200 investigators at 32 research organisations

Collaboration with scientists in 15 other countries

Collaboration with policy makers

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INTERNATIONAL COLLABORATION

Bar chart showing the numbers of cruises by year from 2016 to 2020. The bars are color-coded to represent NERC CAO and International cruises.

Pie chart showing the distribution of international collaboration by country. The countries listed are:
- UK: 4%
- South Korea: 4%
- Canada: 7%
- USA: 13%
- Russia: 4%
- Germany: 15%
- Norway: 53%

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Climate change impacts on the Arctic Ocean

Environmental, Economic, Societal

Primary and secondary productivity
Ecosystem response to warming
Impact on fishery yields
Effects of species competition
Large-scale changes in ocean circulation
Sequestration of carbon
Cycling of contaminants

Image from the NASA Scientific Visualization Studio
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Distribution of fish stocks
Marine Protected Areas
Climate research and forecasting
Transport (shipping industries)
Pollution hazards
Resource exploration and development
Human health

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Existing and new connections to the international Arctic community
Membership of international expert groups
Direct information exchange with policy stakeholders

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Programme-level policy orientation briefing session in late 2020

Image from the NASA Scientific Visualization Studio
SIDE EVENT
FRIDAY 6 DECEMBER 2019, 10:00-11:30
CRYOSPHERE PAVILION, BLUE ZONE (HALL 8 ~ LEVEL 0)

Welcome by Dr Kirsty Crocket, University of Edinburgh, UK
Tim Eder, Federal Ministry of Education and Research, Germany
Mr Bo Storrank, Senior Specialist, Nordic Working Group for Climate and Air, Ministry of the Environment, Finland
Dr Martin Sommerkorn, Coordinating Lead Author of Chapter 3 SROCC, IPCC, and Head of Conservation, WWF Arctic Programme

Dr Carol Turley OBE, Plymouth Marine Laboratory, UK
Dr Yevgeny Aksenov, National Oceanography Centre, UK
Dr Jack Landy, University of Bristol, UK
Dr Geoffrey Abbott, Newcastle University, UK
Q&A/Panel Discussion