

# Marine climate change, responses and projections in the Arctic Ocean as the sea ice retreats

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PI - THE NANSEN LEGACY

# Status for much of the Arctic ecosystems

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Photo: Amanda Kowalski

Arctic Council - new  
*State of the Arctic  
Marine Biodiversity  
Report:*

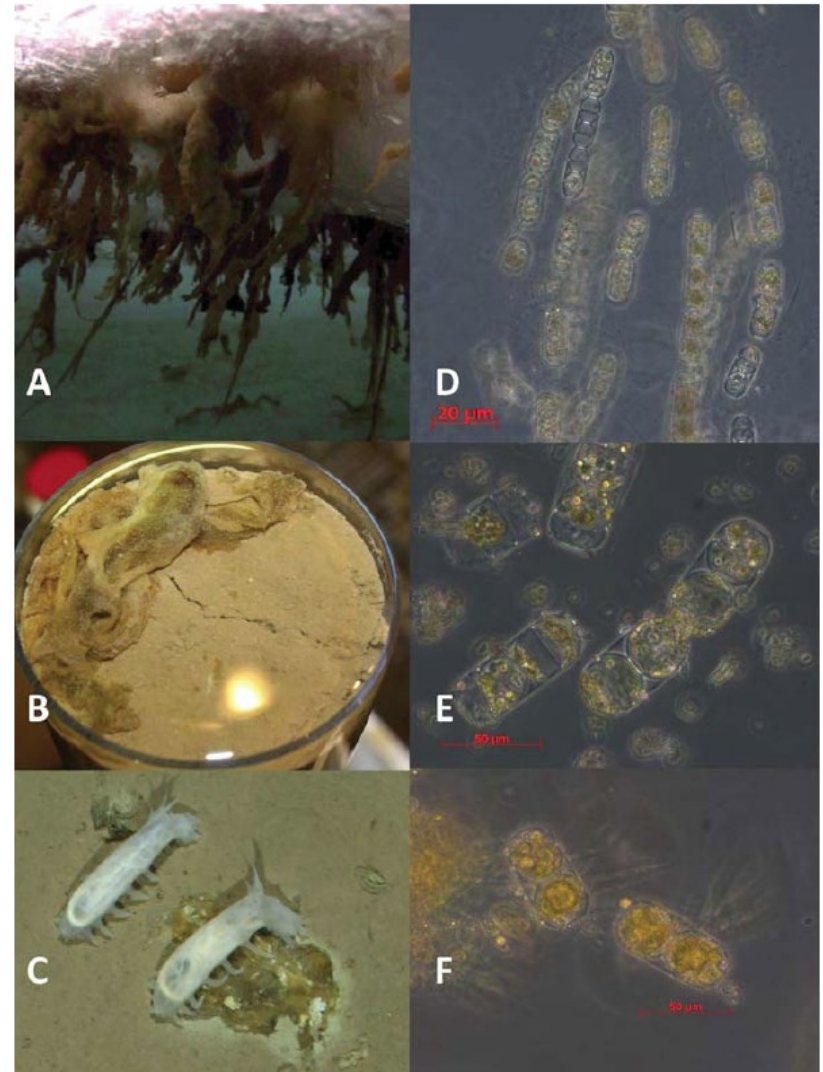
***"In this group, we can't even begin to talk about how the Arctic is changing because the window of what we know is so short"*** Russ Hopcroft (UAF) comments on the included 2000 phytoplankton species described for Arctic Ocean.

Arctic Now, 26 January 2018

# Rapid changes in the Arctic Ocean drive ecosystem

## responses

- Challenge:
  - **Unknown baseline** and status for very many organisms and processes in the Arctic
  - **Variability** in space and time versus change
  - Identification of **driving forces, cascading effects** and **multiple stressors**



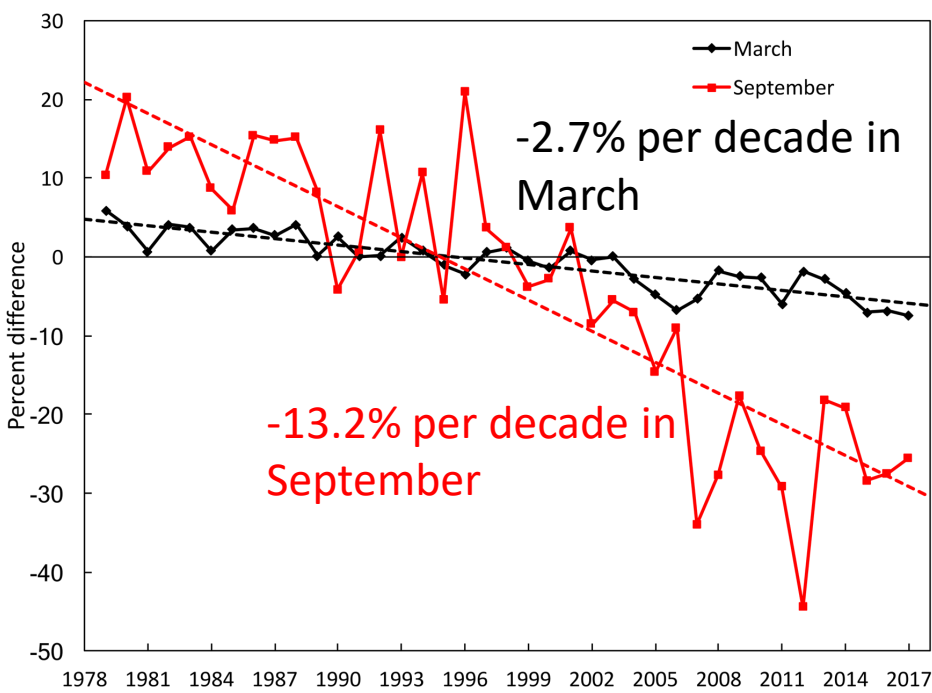
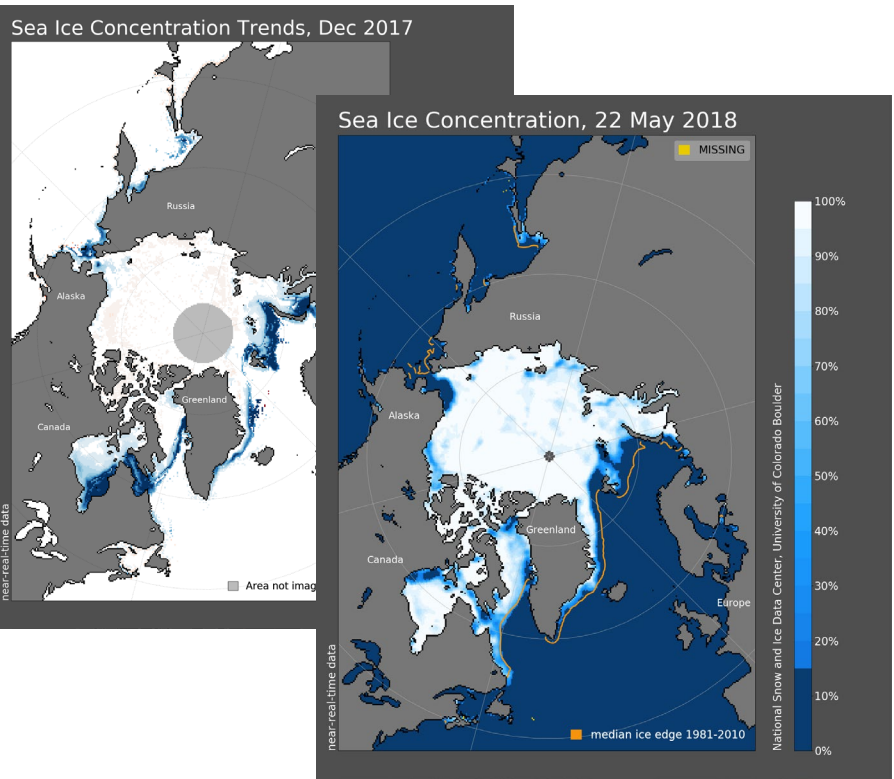
Under-ice algal mats sink to the Arctic Ocean sea floor at 4000 m. Boetius et al. 2013



# Changes in Arctic sea ice concentrations, extend and timing

Sea ice concentrations trend

Sea ice extent

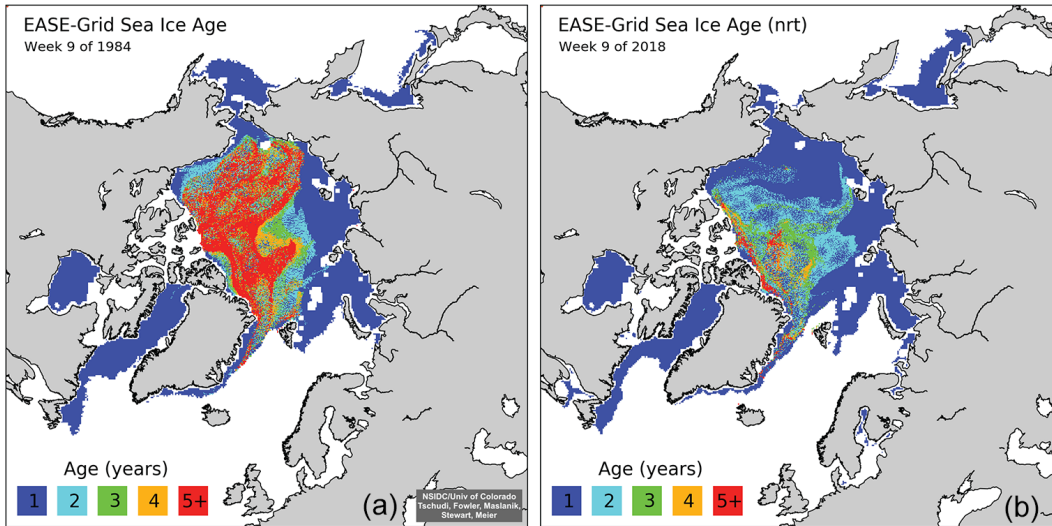


National Snow and Ice Data Center

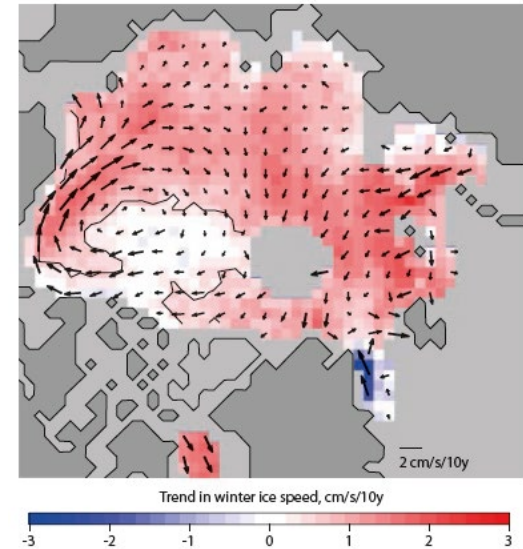
Perovich et al. 2017: Sea ice extent in Arctic (anomalies compared to the period 1981-2010)

# Arctic sea ice age gets younger (week 9, 1984 vs 2018)

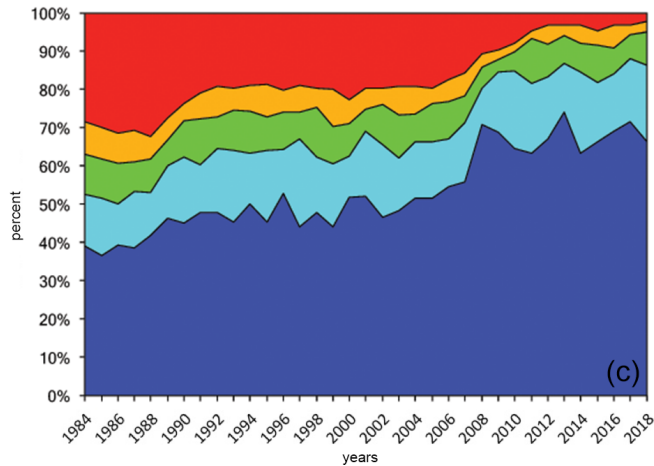
Ice Age Distribution During Week Nine in 1984 and 2018



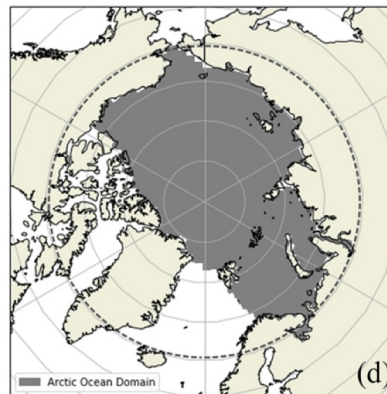
Winter ice speed trend



Percent of Sea Ice Extent During Week Nine for Different Age Classes



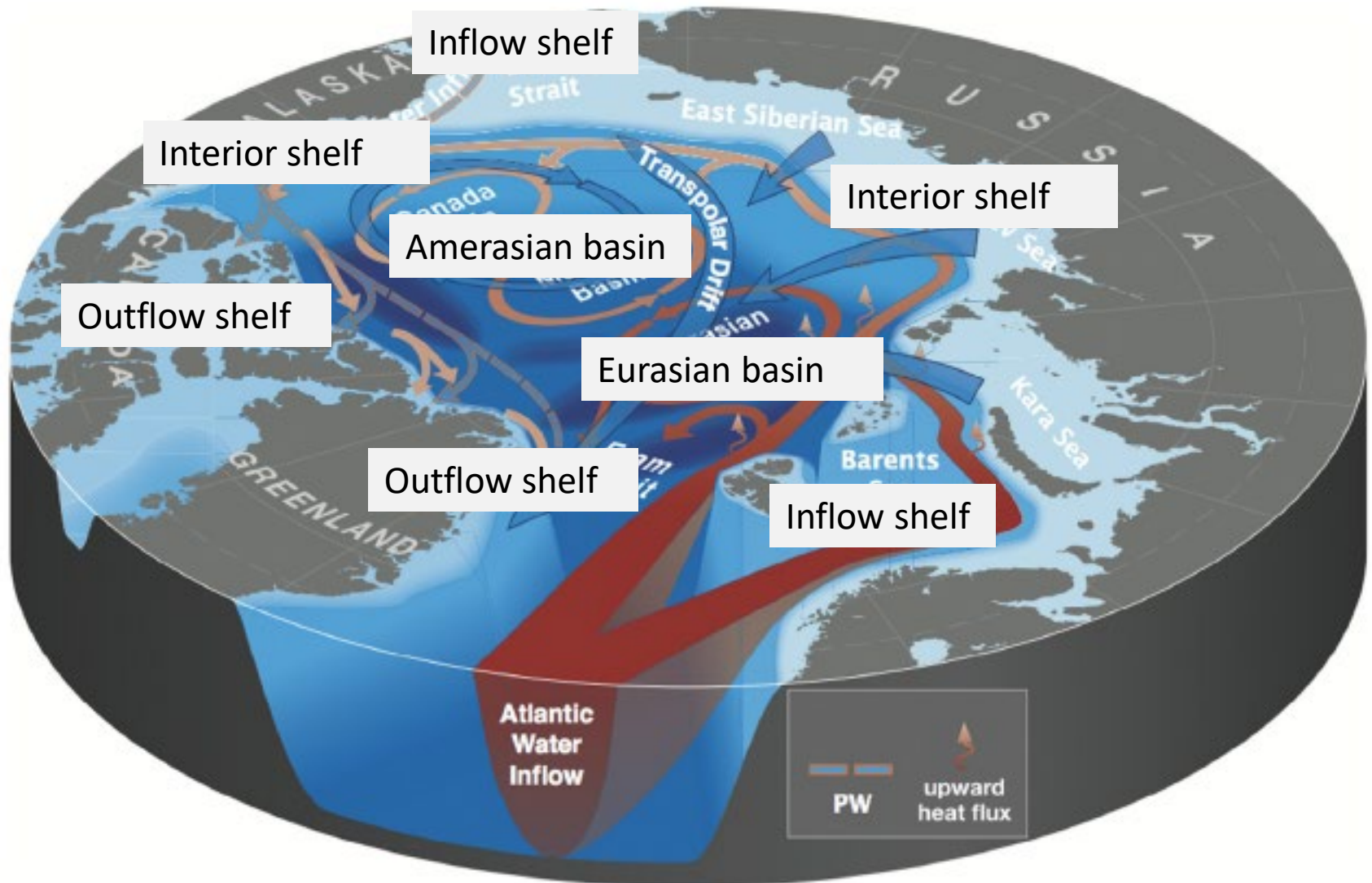
Arctic Ocean Domain



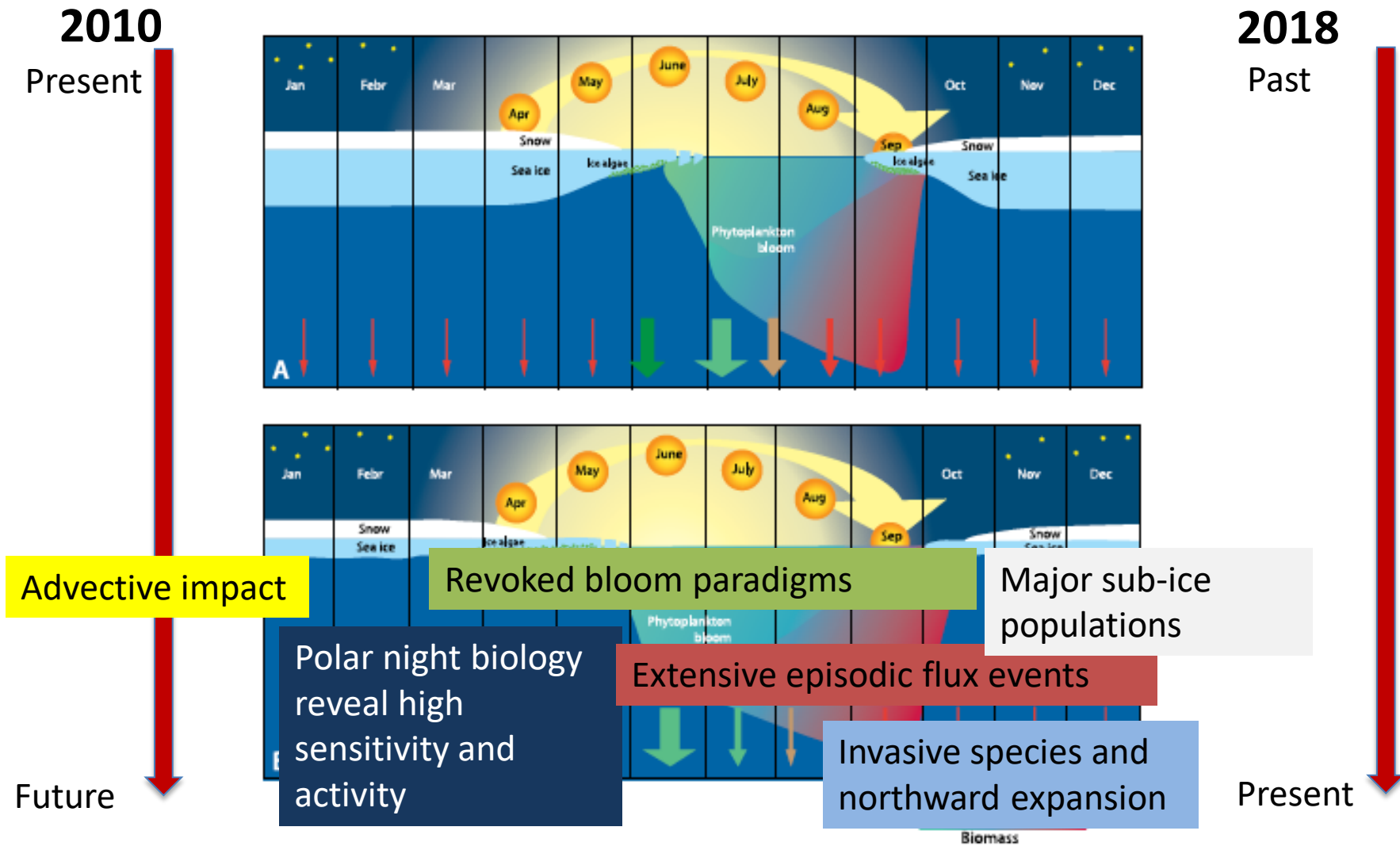
Images by M. Tschudi, S. Stewart, University of Colorado Boulder, and W. Meier, J. Stroeve, NSIDC

Barber et al. 2017 SWIPA report

# The heterogeneous Arctic Ocean: A complex “roadmap” of spatial variability



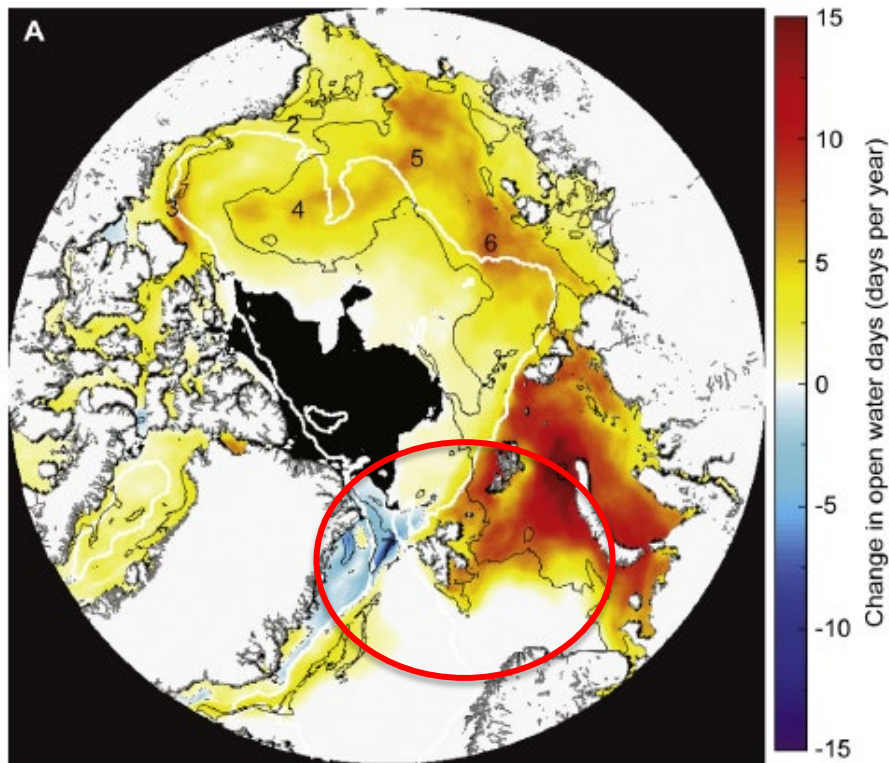
# The new future Arctic is here





# Increased open water days 1998-2012

Satellite based observations:



Arrigo & van Dijken, 2015

## Less sea ice

- More light
- More wind-stress
- Impact ocean temperature and air-sea flux

## Changed ocean temperature

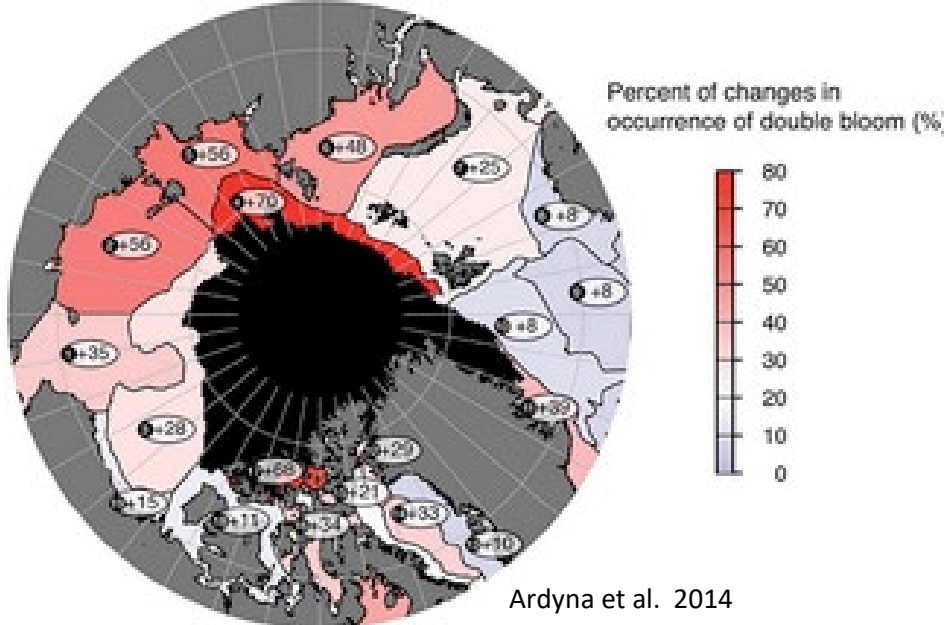
- Changed species distribution
- Changed timing
- Changed metabolic rates

**Eurasian region: MAJOR changes**

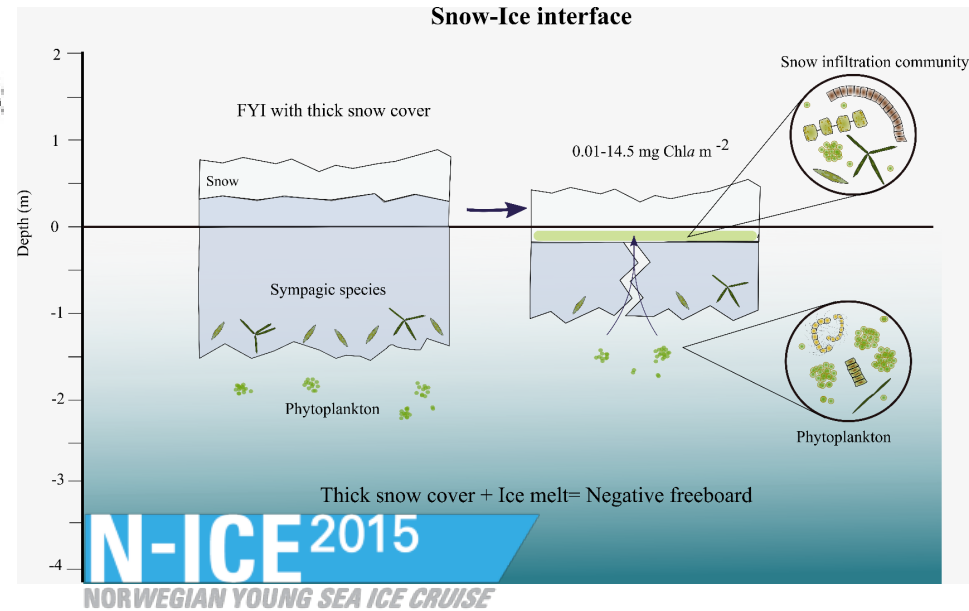


# Revoked paradigms – change in Arctic bloom patterns

## Double blooms

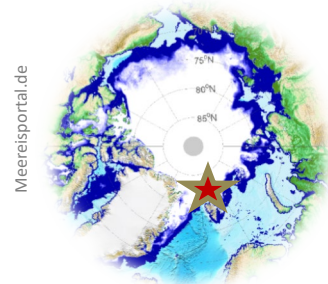


## Snow-infiltration blooms



## Under-ice blooms

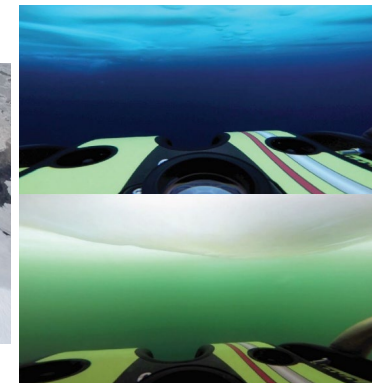
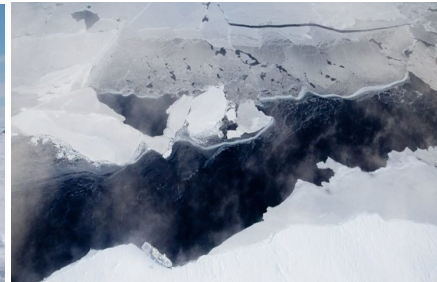
Pre-melt season



May 2015

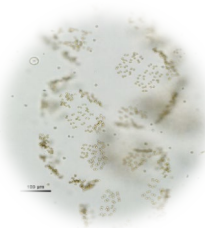


Assmy et al. 2017 *Scientific Reports*



© CJ Mundy

*Phaeocystis*

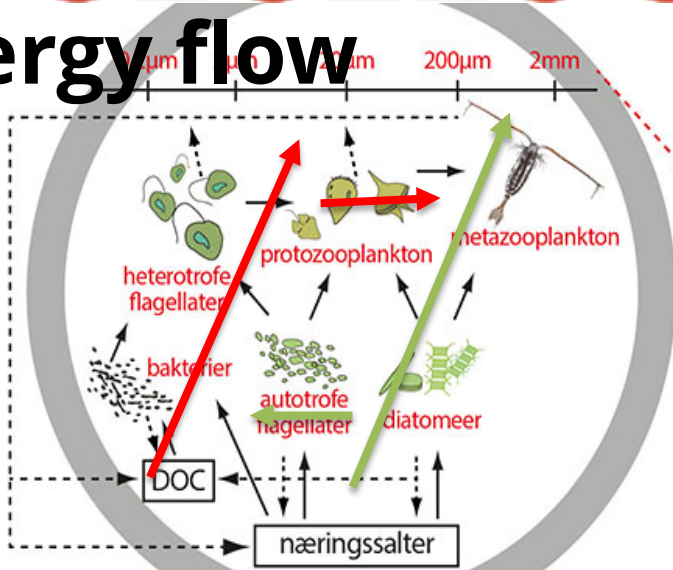


# Science

## es impact

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### energy flow

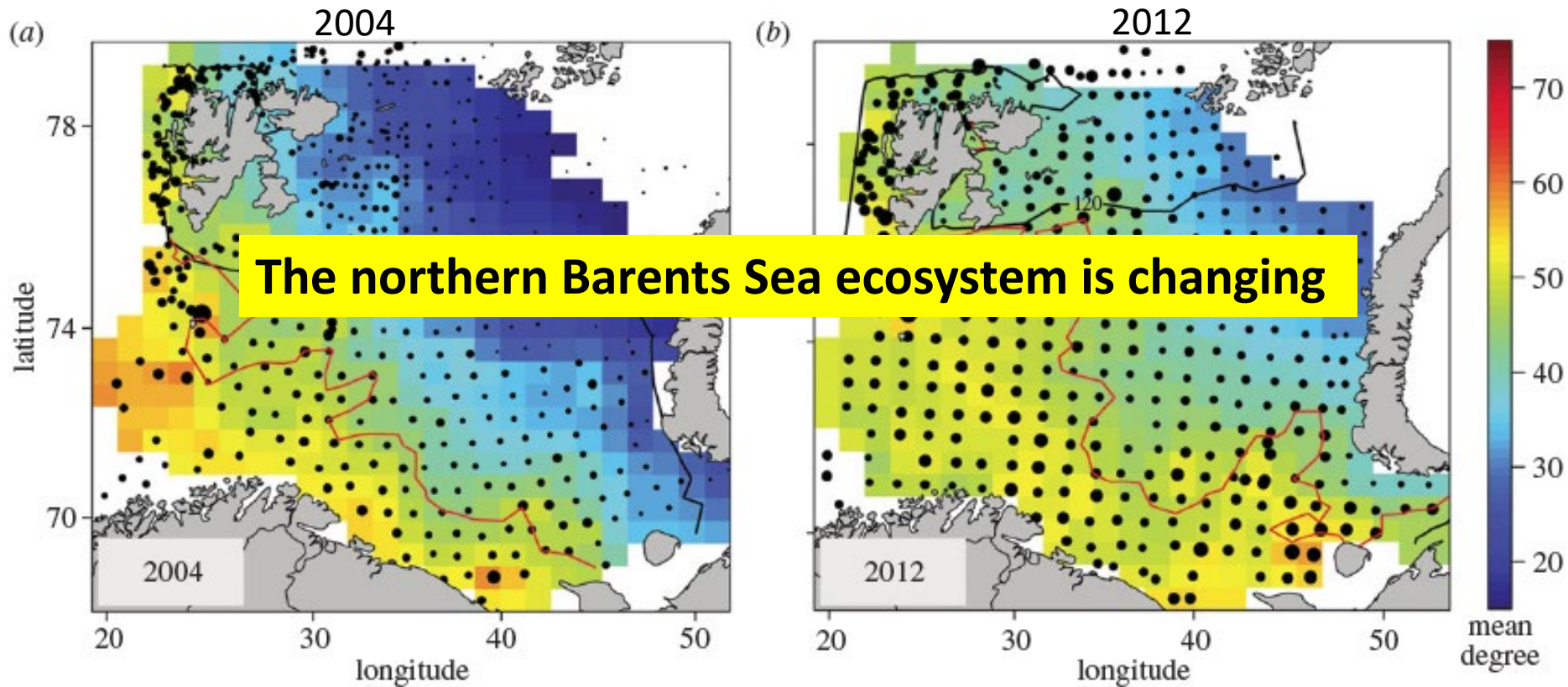


Stronger stratification and more limited nutrient conditions in the Pacific region compared to the Atlantic, where stratification at present is weakening, result in different ecosystem responses



Illustration: Reigstad & Cavers. UiT

# Sub-arctic generalists replace Arctic specialists in the Barents Sea



Kortsch et al. 2015



# Arctic near surface temperature increase projected for 2050 and 2080: 5-11 ° C

Cold season (Dec-Feb)

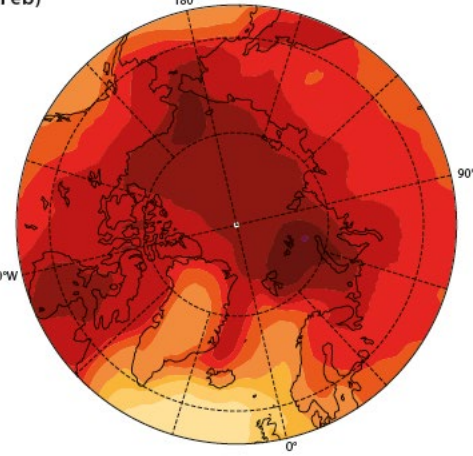
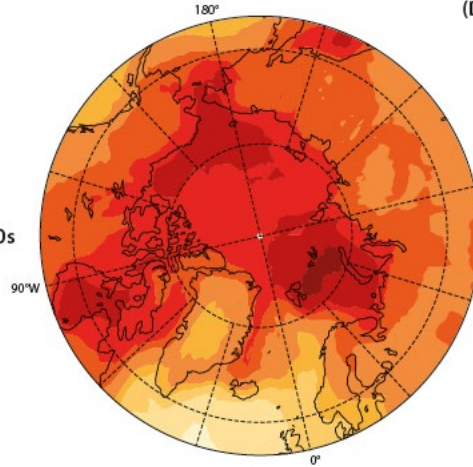
RCP4.5

Cold season  
(Dec-Feb)

RCP8.5

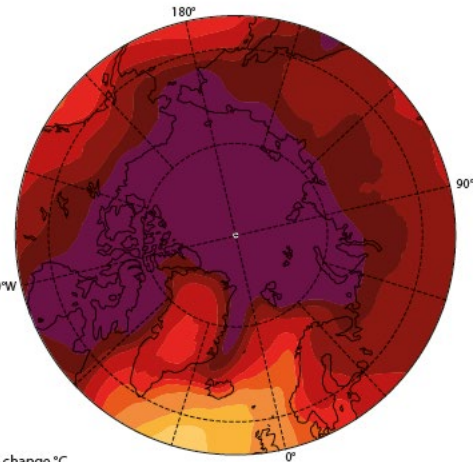
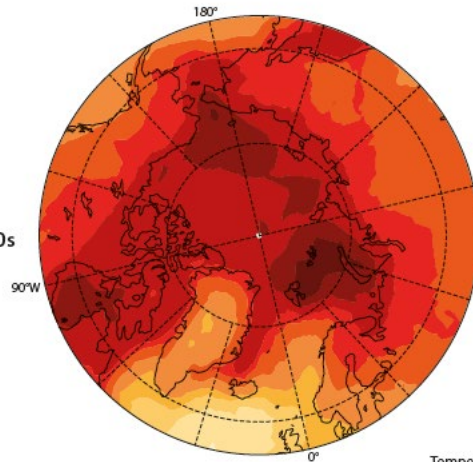
2050

2050s

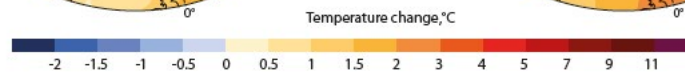


2080

2080s



Increase relative  
to 1986-2005



# Aim to improve scientific basis for sustainable management of natural resources beyond the present ice edge

Fragmented research



Climate changes seasonal ice zone

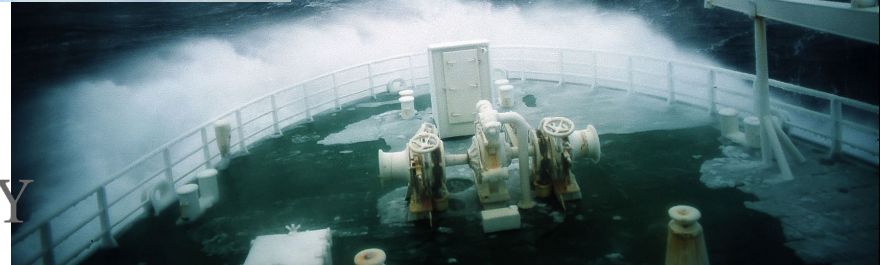
New harvestable resources



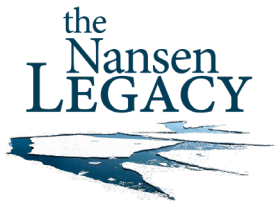
Challenging forecasts and logistics

Fisheries, petroleum and marine traffic

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# A new interdisciplinary research project on the northern Barents Sea – a gateway to a changing Arctic (2018-23)

PI Marit Reigstad (UiT)  
Co-PIs Tor Eldevik (UiB), Sebastian Gerland (NPI)

Research team:  
>130 scientists  
>50 recruitment positions  
10 institutions

Budget: 740 mill NOK  
50% in-kind

Funded by:

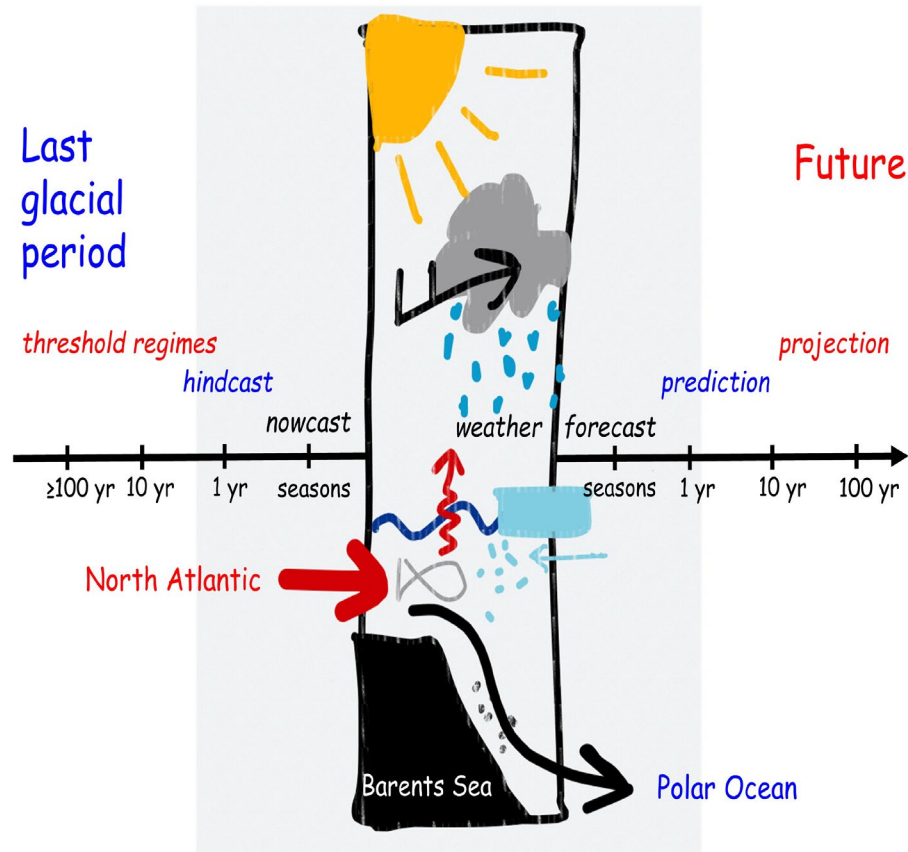
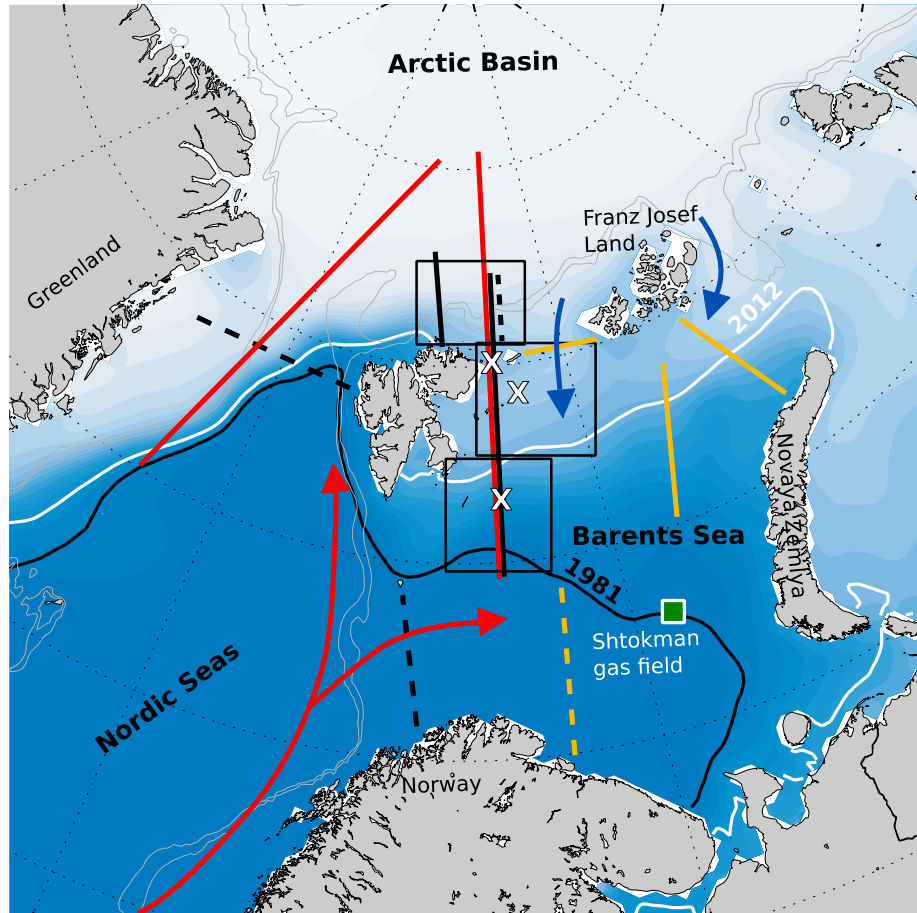


Illustration: T. Eldevik, UiB



# An interdisciplinary approach to investigate the living Barents Sea and adjacent Arctic Basin



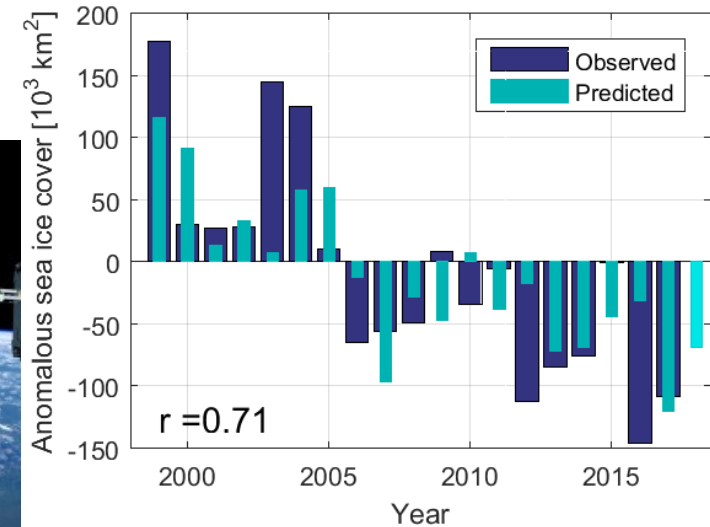
## Uses climatic gradients to investigate

- Physical-biological interactions
- Ecosystem characteristics, timing, productivity
- Contaminants, acidification, effects of fisheries
- Paleoproductivity- variability
- Use and development of new technology
- Observations for improved prediction
- Data legacy
- User and stakeholder involvement

**360 days field investigations 2018-2022: Annual and seasonal focus**

# Technological development

and use across disciplines will prepare the future observation strategies



Updated from  
Onarheim et al. 2015



Image: ESA/ATG Medialab

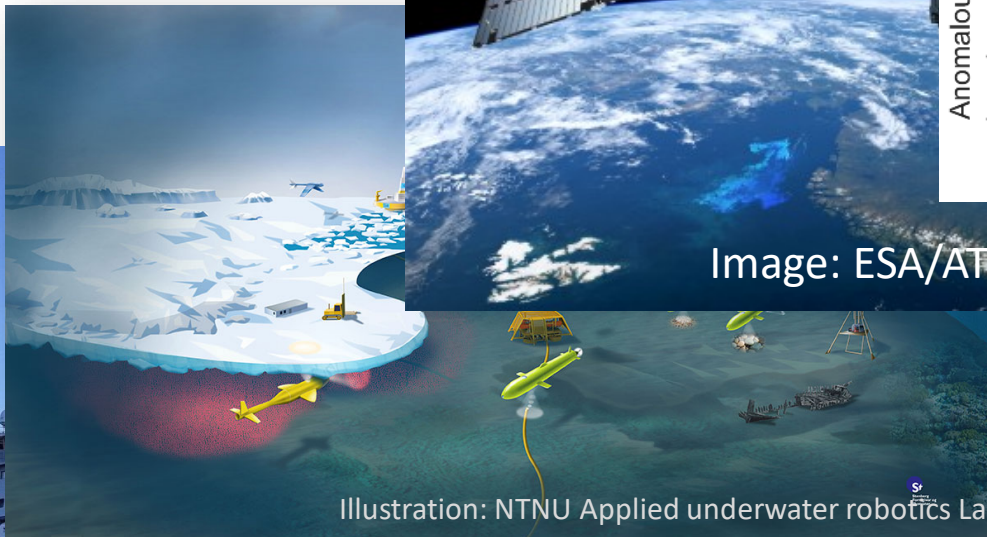


Illustration: NTNU Applied underwater robotics Lab

Optimize use of emerging technologies and infrastructure, <sup>the</sup>

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Kronprins Haakon



# The Nansen Legacy strengthen collaboration - present and future

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Connecting national polar research Educate a new generation polar researchers  
Norwegian Polar Research Evaluation 2017 Across disciplines and institutions

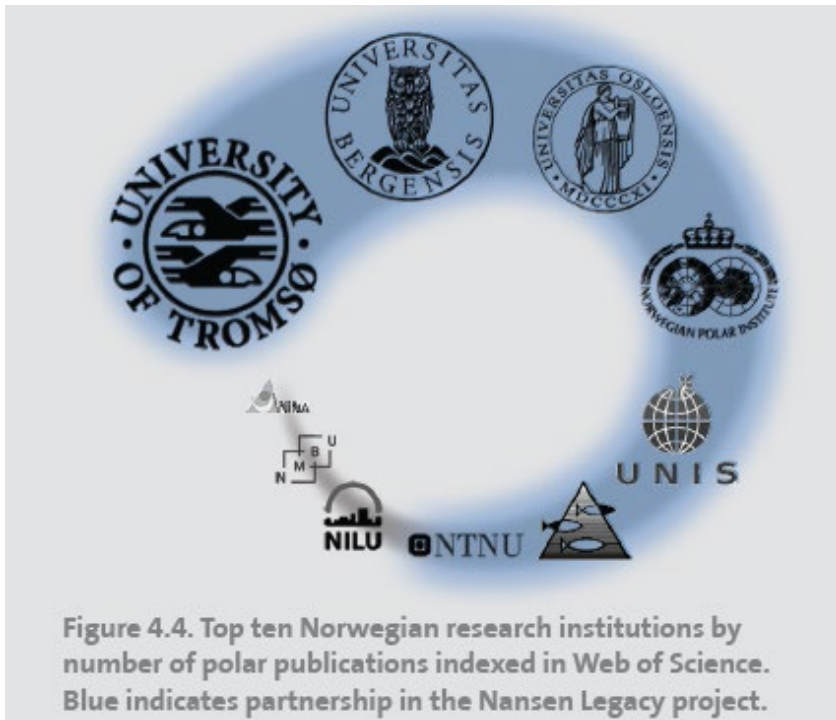


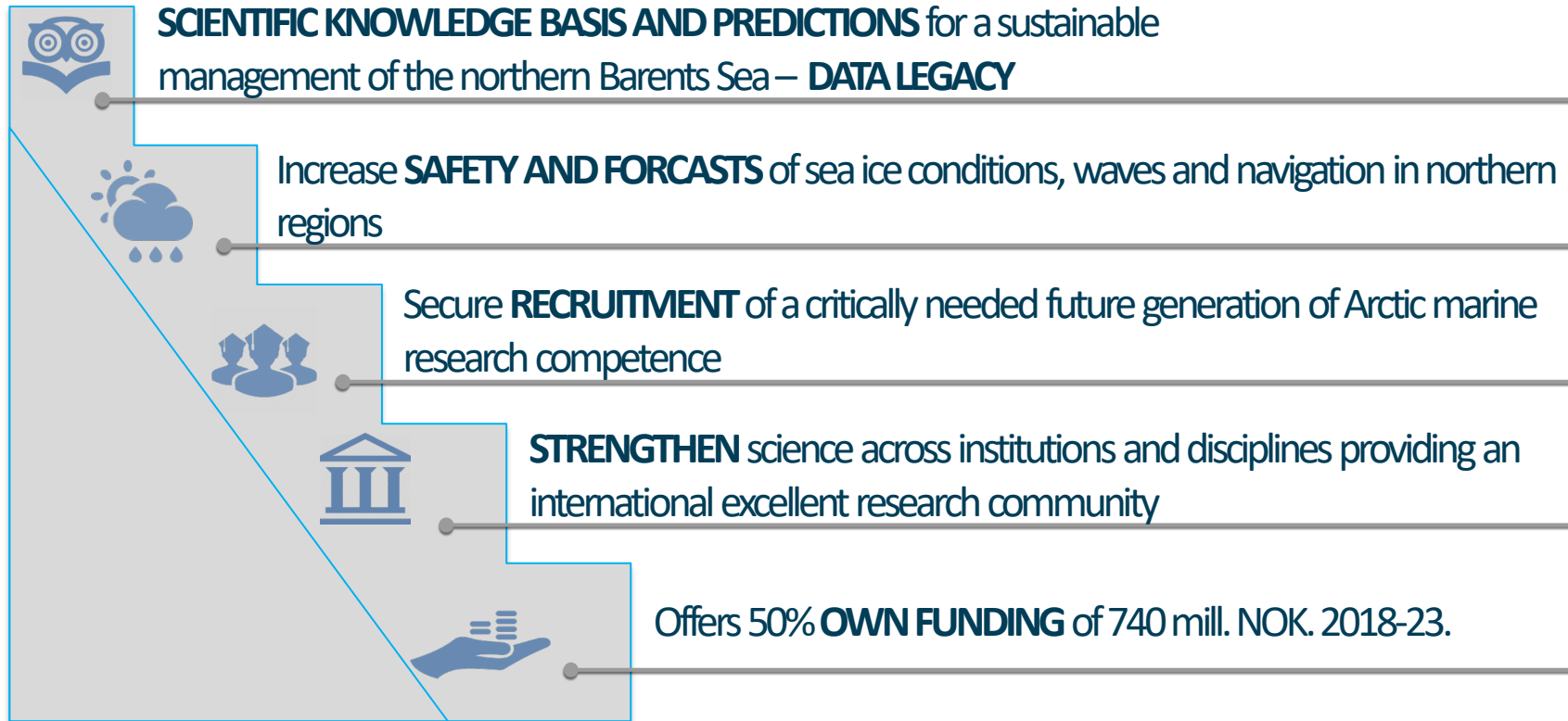
Photo: CarbonBridge, UiT





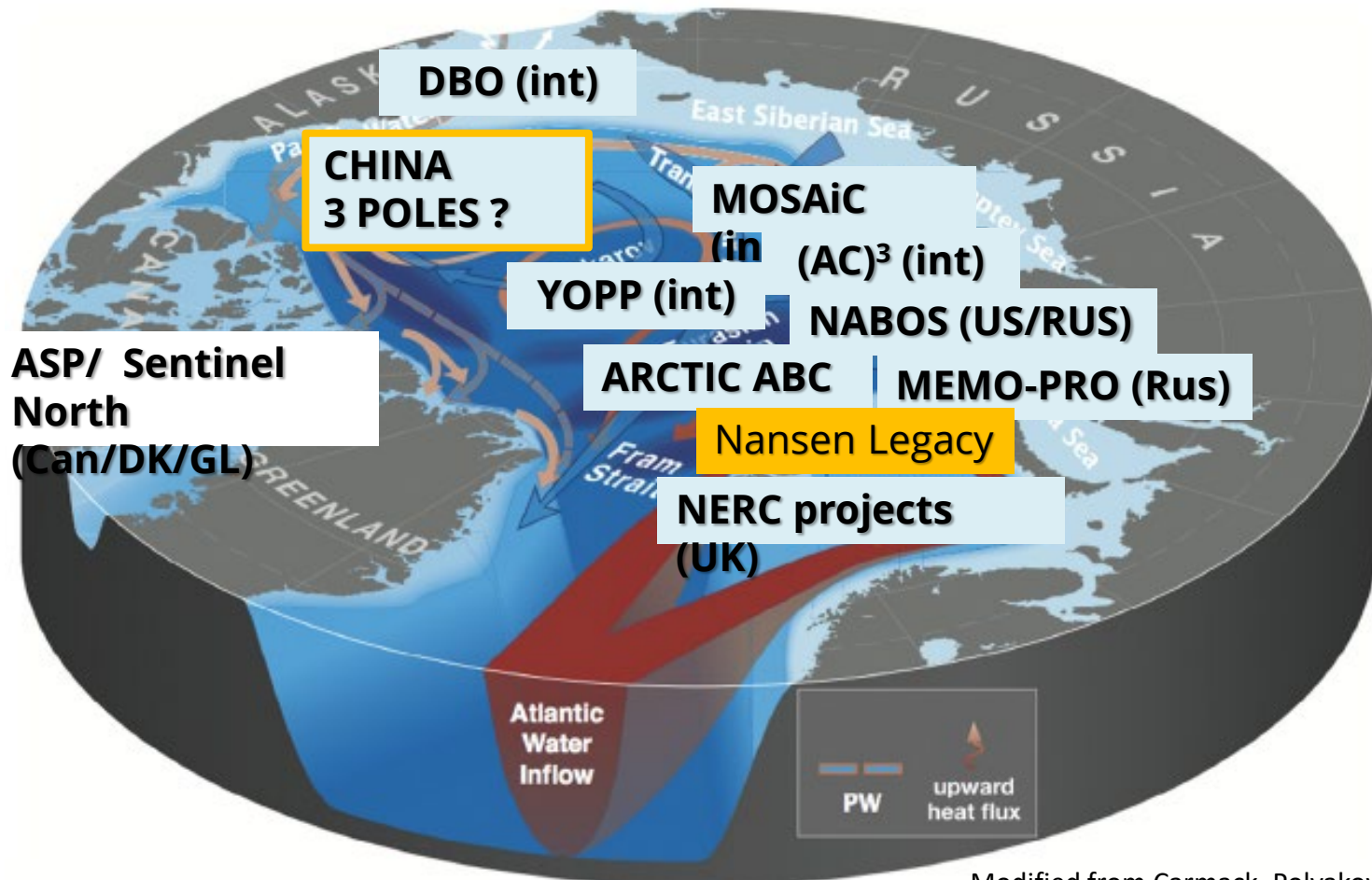
# The Nansen Legacy

prepare for a new Arctic future



# The changing climate, multiple responses and need for projections require Pan Arctic connection and collaboration

Examples of *Nansen Legacy* collaborative projects/ initiatives



Modified from Carmack, Polyakov et al. 2015