Eco-Light

Ecosystem functions controlled by sea ice and light in a changing Arctic

Germany: Giulia Castellani*, Hauke Flores*, Michael Karcher, Frank Kauker, Marcel Nicolaus* + Post-Doc/s

UK: Jeremy Wilkinson*, Julienne Stroeve + Post-Doc/s + Masters

London
17 April 2018

* Present at London meeting

In collaboration with:

KOPRI: Ship time on 2018 and 2019 Arctic cruise, additional platforms, complementary/background measurements and data sharing. Strong collaboration with the Korean Arctic Ocean Observing program (K-AOOS). August 3-23, 6 day ice camp. Contact: Joo-Hong Kim

AWI: Multidisciplinary Ice-based Distributed Observatories (MIDO). Additional platforms. Contact: Benjamin Rabe

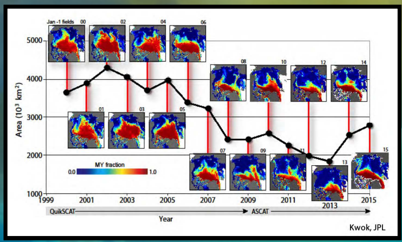
Post-award collaborations

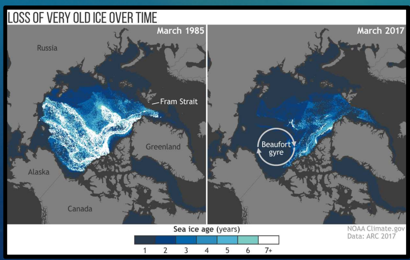
University of Victoria: Randy Scharien
Lead detection in SAR imagery.

UT: Jorgen Berge
ArcticABC project member

AWI: 2018 Oden North Pole assets (MIDO). Contact: Mario Hoppman

Region of interest





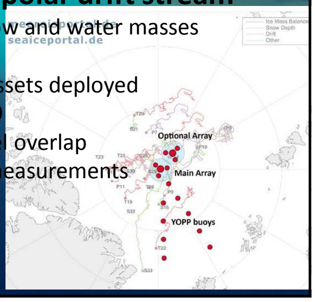
Beaufort/ Chukchi Sea region

- Region that has seen the biggest decrease in MYI and snow holding.
- Two cruises supported by KOPRI
  - August 2018 and 2019
  - Full support from KOPRI team

Additional area of study: Transpolar drift stream

Different ice/snow and water masses

- Oden 2018
  - Similar assets deployed
- MOSiAC, 2019
  - Personnel overlap
  - Similar measurements



Objectives:

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Ecosystem functions controlled by sea ice and light in a changing Arctic

OBSERVATIONS ⟺ MODELING

Changes in the **timing** and duration of **primary production** events, as well as changes in the **grazing** habits of zooplankton, mirror the variability in the **light** climate, which is driven by changes in the **snow and sea-ice** regimes

- WP 1: Integrated bio-physical observations on local and pan-Arctic scale
- WP 2: Understanding the seasonality of light-driven processes in the sea-ice ecosystem
- WP 3: Simulating and upscaling the biophysical system to pan-Arctic scale
- WP 4: Project Governance

Infrastructure/assets:

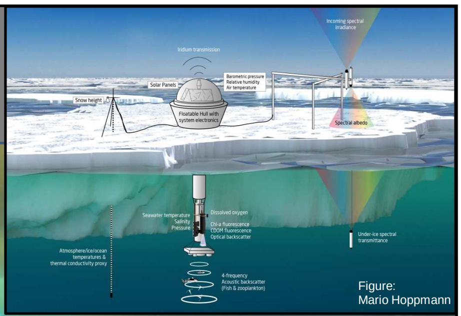


Figure: Mario Hoppmann

Need for year round presence/measurements: Role for Autonomous platforms

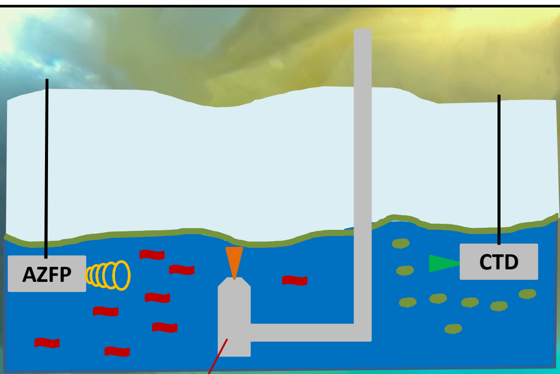
All instruments deployed in a cluster from *Araon*:

- **2 x IMB-SRs :**
  - sea ice and snow thickness + camera, up and down-looking radiometers, salinity, barometric pressure air/snow/ice/water temperature.
- **2 x Snow Buoys:**
  - 4 x snow measurement + Barometric Pressure, Air Temperature and Sea Surface Temperature.
- **1 x Spectral Radiation/Ice-Tethered Bio-Optical Buoys***
  - IMB (with snow pinger), 2 x TriOS RAMSES radiometer above ice, TriOS RAMSES radiometer below ice - Wetlabs Eco Triplet-W fluorometer- Aanderaa Optode 4330- Seabird SBE37-SIP Microcat
- **1 x Zoo Plankton Buoy**
  - ASL-AZFP: Acoustic Zooplankton Fish Profiler + other sensors

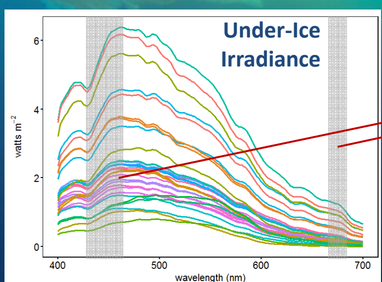
Two realisations of our clusters.

One in 2018 & 2019 (third cluster from Oden 2018).

All data freely available from the AWI and BAS websites

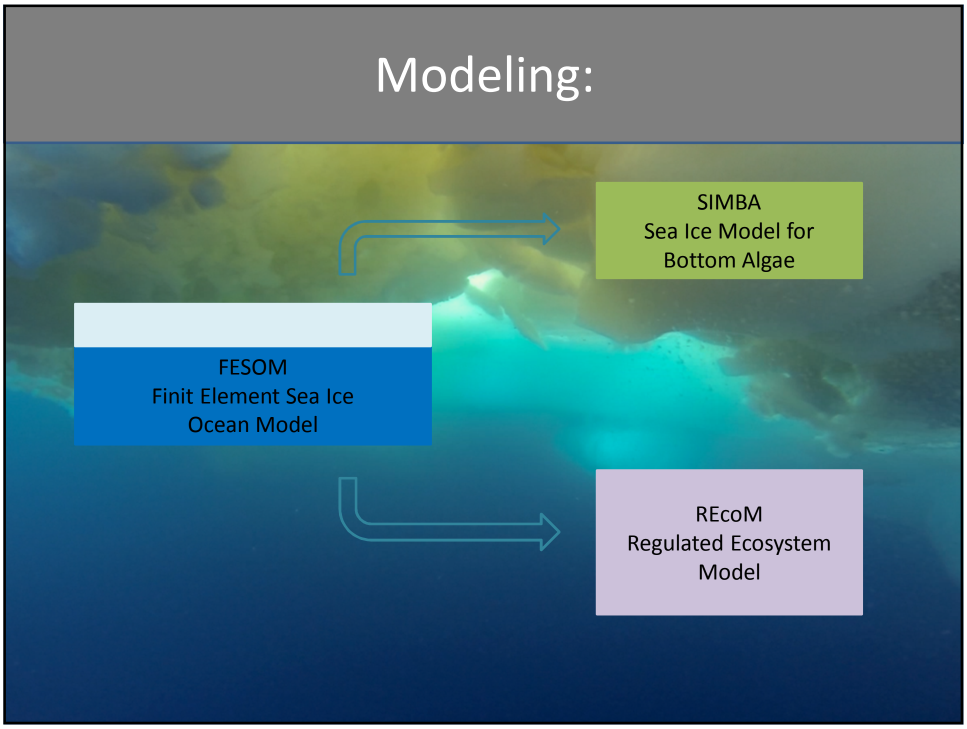


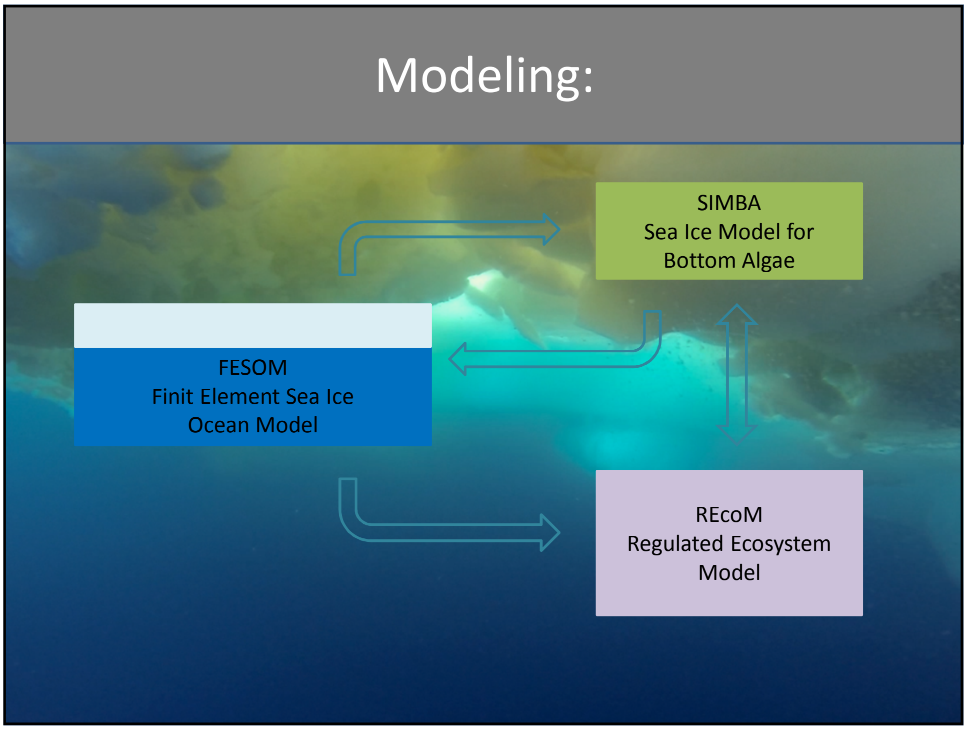
- **CTD** surface water properties and phytoplankton standing stocks
- **AZFP** vertical migration of grazers → grazing pressure on sea-ice algae and phytoplankton



Chl *a* absorption bands

Bio-optical model for retrieval of in ice chlorophyll *a*


Modeling:
SIMBA
Sea Ice Model for
Bottom Algae
FESOM
Finit Element Sea Ice
Ocean Model
REcoM
Regulated Ecosystem
Model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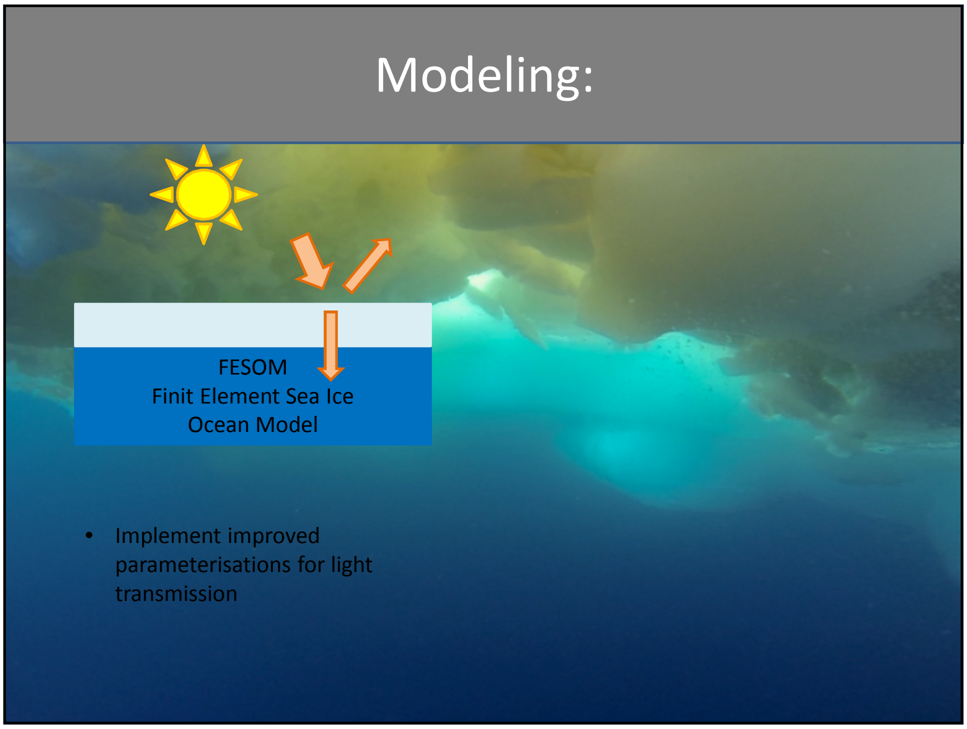
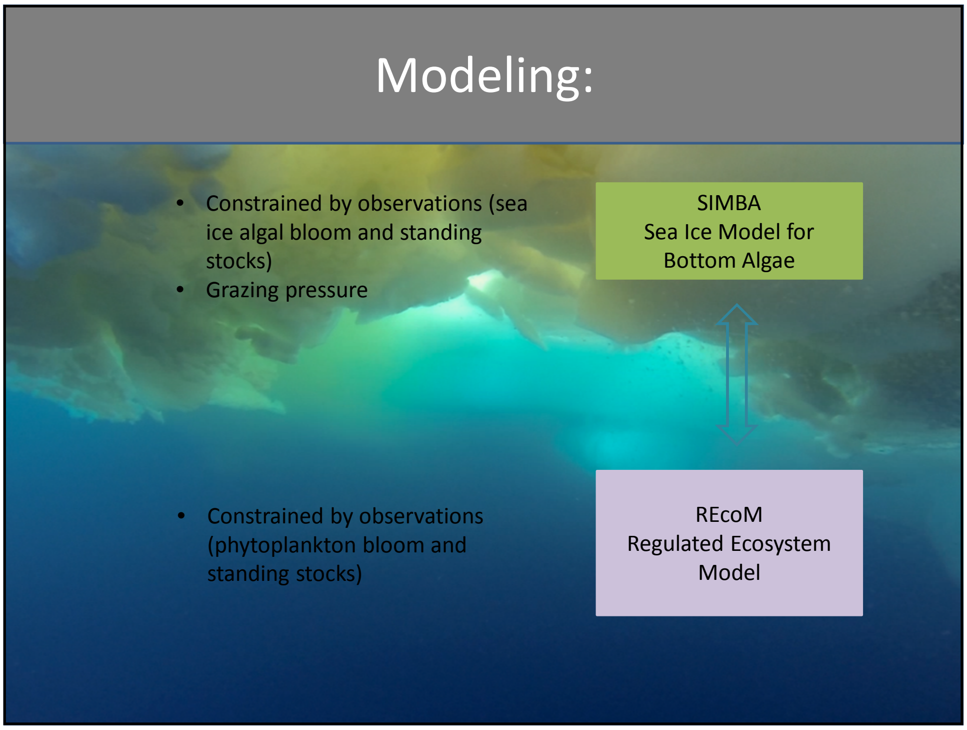

Modeling:
FESOM
Finit Element Sea Ice
Ocean Model
• Implement improved parameterisations for light transmission


Modeling:
• Constrained by observations (sea ice algal bloom and standing stocks)
• Grazing pressure
SIMBA
Sea Ice Model for
Bottom Algae
• Constrained by observations (phytoplankton bloom and standing stocks)
REcoM
Regulated Ecosystem
Model

Modeling:

SIMBA
Sea Ice Model for Bottom Algae

FESOM
Finit Element Sea Ice Ocean Model

REcoM
Regulated Ecosystem Model

- Decadal simulations to investigate response of ecosystem functions to changes in sea ice and under-ice light field

THANKS !!!

Main Scientific contact points:

Germany: Giulia Castellani, giulia.castellani@awi.de
UK: Jeremy Wilkinson, jpw28@bas.ac.uk

WP structure:

WP 1: Integrated bio-physical observations on local and pan-Arctic scale

Task 1.1 Quantify the partitioning of multi-spectral components of solar energy budget as a function of temporal variability in snow and sea ice morphology and ocean properties.

Task 1.2 Production of a time-series of key ice and snow properties from remotely sensed and the *in-situ* measurements.

Task 1.3 Calculate and parameterise spectral irradiance attenuation coefficients for snow/ice in order to provide observationally-constrained transfer functions to numerical models.

WP 2: Understanding the seasonality of light-driven processes in the sea ice ecosystem

Task 2.1 Quantify seasonal change of sea ice algal biomass and phytoplankton in relation to physical properties of sea ice and upper ocean via bio-physical sea ice observatories.

Task 2.2 Analyse seasonal and diurnal patterns in the near-surface distribution of zooplankton in relation to seasonal changes in light regime and food availability.

Task 2.3 Validation and improvement of an existing sea ice algae model (SIMBA) including the introduction of a grazing term, the tuning of key parameters such as mortality and remineralization rates, and its coupling with an ocean biogeochemical model (REcoM).

Workpackage3 Simulating and upscaling the biophysical system to pan-Arctic scale

Task 3.1 Use new and existing in situ and remotely sensed observations to upscale the light regimes to pan-Arctic scale.

Task 3.2 Implement improved and newly developed parameterizations in a numerical model to simulate the large scale effect on the under ice light regime

Task 3.3 Analysis of the effects that the newly parameterized under-ice light field has on the sympagic ecosystem on a pan Arctic scale.

Task 3.4 Decadal simulations of the fully-coupled physical and biological system

Task 3.5 Use sea ice predictions from IPCC emission scenarios, in combination with new parameterisations to determine how under-ice the light climate will vary according to the future snow and ice properties.

Task 3.6 Synthesize the gained knowledge to ensure its usefulness to further the NERC/ BMBF Arctic strategy, and improve understanding of how changes in the physical environments influence the pan-Arctic sympagic ecosystem.

Work package 4: Project Governance

Ensure that procedures are in place to allow for the efficient flow of data, analysis and scientific discussion both inside and out-with the project. This ensures that the objectives of the UK/German programme are being met.

Objectives:

Our overall goal is to demonstrate how the Arctic ecosystem may change in the future, because of changes in timing and duration of primary production events and grazing habits of zooplankton. We will evaluate how these ecosystem functions mirror changing snow and sea ice regimes in the Arctic Ocean, as they continue their transition from thick MYI to thinner and more dynamic FYI.

With this information in mind we have the following two sub-objectives:

1. The determination of how the distribution of light/radiation relevant for the biology of the sea ice matrix varies on the pan-Arctic scale, and its dependence on snow thickness, sea ice type and state and season.
2. The upscaling of the observed/investigated light regimes in and below the sea-ice matrix to the pan-Arctic scale for improving numerical simulations of the sympagic ecosystem and prediction of its changes.