PHYSICAL PROCESSES IN ARCTIC SEA ICE

ISTAS workshop session :

Sea Ice in the Arctic Ocean: From Microphysics to Large Scale Dynamics

Authors

Angelika Renner[1], Matthieu Chevallier[2], Alexey Pavlov (alexey.pavlov@npolar.no)[3], Andreas Preusser[4], and Marcel Nicolaus[5]

Overview

Sea ice retreat and thinning in the Arctic Ocean are major indicators of ongoing climate change. While Arctic sea ice is expected to decline further, substantial uncertainties still exist in climate model projections due to a lack of understanding of sea ice processes and drivers of change. To tackle these uncertainties, a synergy between numerical and observational studies is crucial due to complexity of the Arctic system. Such complexity arises from numerous interactions within the ocean-ice-atmosphere-biosphere system on a large span of spatial and temporal scales (see also other ART priorities**). Sea ice has also vast socio-economic relevance and is a vital component of life in the North. Reliable projections of the Arctic sea ice state are therefore needed to elaborate future sustainable development strategies in the Arctic. Many examples of implications of sea ice retreat to socio-economic development exists, one of them being the future of shipping through the Arctic Ocean (Fig. 1).**

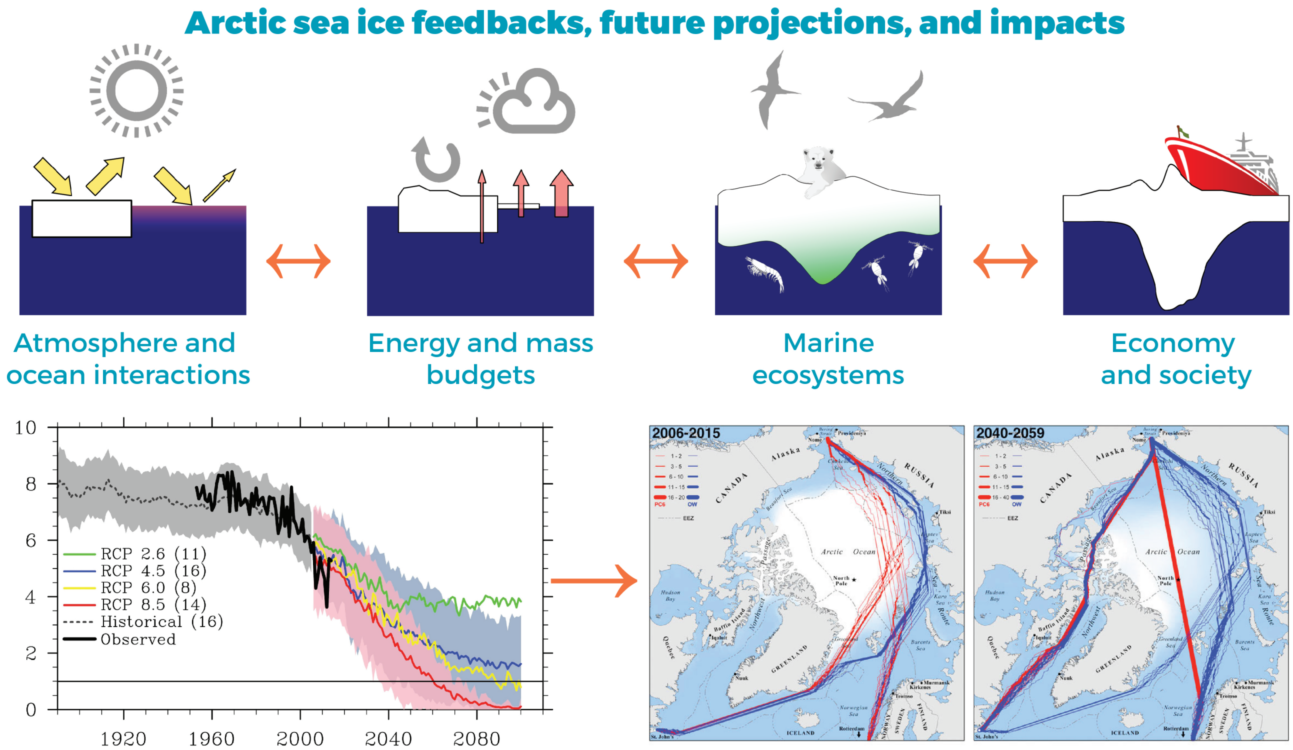

Fig 1. Top: Sea ice impacts, feedbacks and interactions with other components of the Arctic system. **Bottom left:** Projections of September sea-ice extent (millions square km) under various future greenhouse gas emission levels (IPCC's Representative Concentration Pathways, RCPs). Limiting the warming in 2100 to about 1 to 2°C under the RCP 2.6 emission scenario could help to stabilize ice conditions at levels seen today. The RCP 8.5 emission scenario (warming by about 4°C by the end of this century) would result in a seasonally ice-free Arctic by 2100 (Credit: Julienne Stroeve, NSIDC). **Bottom right:** Optimal September navigation routes for vessels crossing the Arctic Ocean between the North Atlantic and the Pacific during consecutive years 2006–2015 and 2040–2059. This analysis is based on ensemble-average GCM projections of sea-ice concentration and thickness assuming RCP 4.5. Red lines show fastest available trans-Arctic routes for Polar Class 6 (PC6) ships; blue lines show fastest available transits for common open-water ships. Line weights indicate the number of successful transits using the same navigation route. White backdrops indicate period-average sea ice concentrations in 2006–2015 and 2040–2059, respectively (Credit: Laurence Smith, UCLA; Smith and Stephenson, PNAS, 2013).

The ISTAS interdisciplinary and international workshop (Integrating spatial and temporal scales in the changing Arctic System: towards future research priorities) was organized in October 2014 by the Arctic in Rapid Transition (ART) network at the IUEM in Plouzané, France. The overarching objective of the workshop was to bring together Arctic scientists of different areas of expertise and experience level in order to discuss future research priorities for the Arctic Ocean and adjacent coasts from an early and mid career researchers' perspective. This set of priority sheets summarizing the workshop's discussions is one of the contributions of the ART network to the 3rd International Conference on Arctic Research Planning (ICARP III) in Japan.

PHYSICAL PROCESSES IN ARCTIC SEA ICE

RESEARCH PRIORITIES
APPROACHES AND RECOMMENDATIONS

▶ Improve our knowledge of the sea ice thickness distribution in the Arctic Ocean on different scales

- Use of remotely operated vehicles, under ice gliders (underwater robotics, in general).
- In situ validation of remote-sensing observations (both satellite and airborne).
- Improve thickness retrieval of different types of sea ice from satellite and develop combined products (challenge of resolutions).
- Improve the representation of the ice thickness distribution in global climate models.

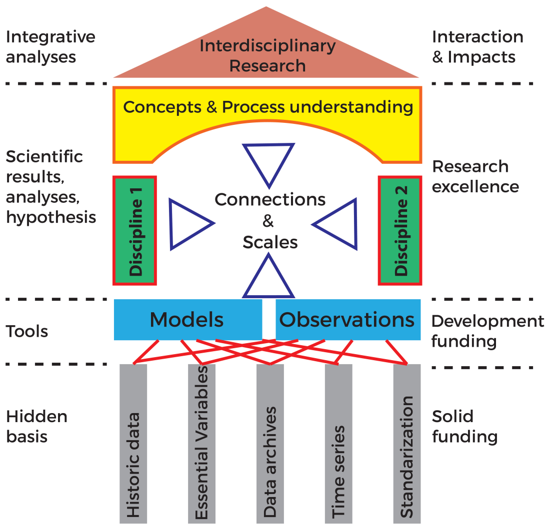

Fig 2. Key elements of sea ice research with respect to future needs and strategies. The house design illustrates different levels of elements that need to be maintained and build up to allow successful and sustainable interdisciplinary research on sea ice topics in the coming decades. Research needs are to be based on existing data sets and methods that have to be continued and developed further. This foundation is mostly discipline specific, but has to be (continuously) funded and maintained. Excellent research within the disciplines will allow to connect the various approaches, and to establish new and to extend existing connections. Bridges over temporal and spatial scales, enhanced communication, and personal links are key elements for this interaction. Finally, this will lead to advances in our process understanding, including innovative concepts and ideas, of Arctic sea ice.

Affiliations:

[1] Institute of Marine Research, Norway
[2] CNRM-GAME, Météo-France, France
[3] Norwegian Polar Institute, Norway
[4] University of Trier, Germany
[5] Alfred Wegener Institute, Germany

Contributors:

Stefanie Arndt, Dmitry Divine, Fanny Girard-Ardhuin, Kevin Guerreiro, Stefan Hendricks, Ivan Sudakov, Anastasia Tarasenko

▶ Develop tools and techniques for up- and down-scaling of numerical model output, in-situ and remotely sensed observations

- Develop and use appropriate statistical tools.
- Build up on existing experience and expertise in other disciplines (oceanography, meteorology).
- Develop Arctic sea ice reanalyses.

▶ Improve our knowledge on surface state and properties of sea ice, including the snow cover

- Further develop cutting edge techniques to measure snow thickness and state on various scales: from space, in-situ and with autonomous platforms.
- Develop advanced parameterisations of snow and melt ponds for inclusion in global climate models.
- Combine models and observations to derive new data products.

▶ Quantify spatio-temporal uncertainties and biases in data products from model outputs, remote sensing products, and observational records

- Agreement and requirement within sea ice community for standardized error assessments in all data products (in-situ observations, remote sensing, modelling).
- Agree on standardized metrics and procedures in upcoming international field campaigns.

▶ Initiate sea ice data recovery, time-series building and continuation of current time-series for essential sea ice variables

- Improve data access.
- Identify sea ice essential variables.
- Guarantee continuation of data products for identified essential variables (e.g. melt ponds).

▶ Reassess and evaluate established but old conceptual models of Arctic sea ice

- Foster collaboration between modellers and observationalists to obtain relevant measurements from field campaigns.
- Facilitate access of modellers to the field.
- Make funds available for review work needed to update established work.

iuem · APECS Association of Polar Early Career Scientists · labex MER · Fondation Total · IASC · ICARP III