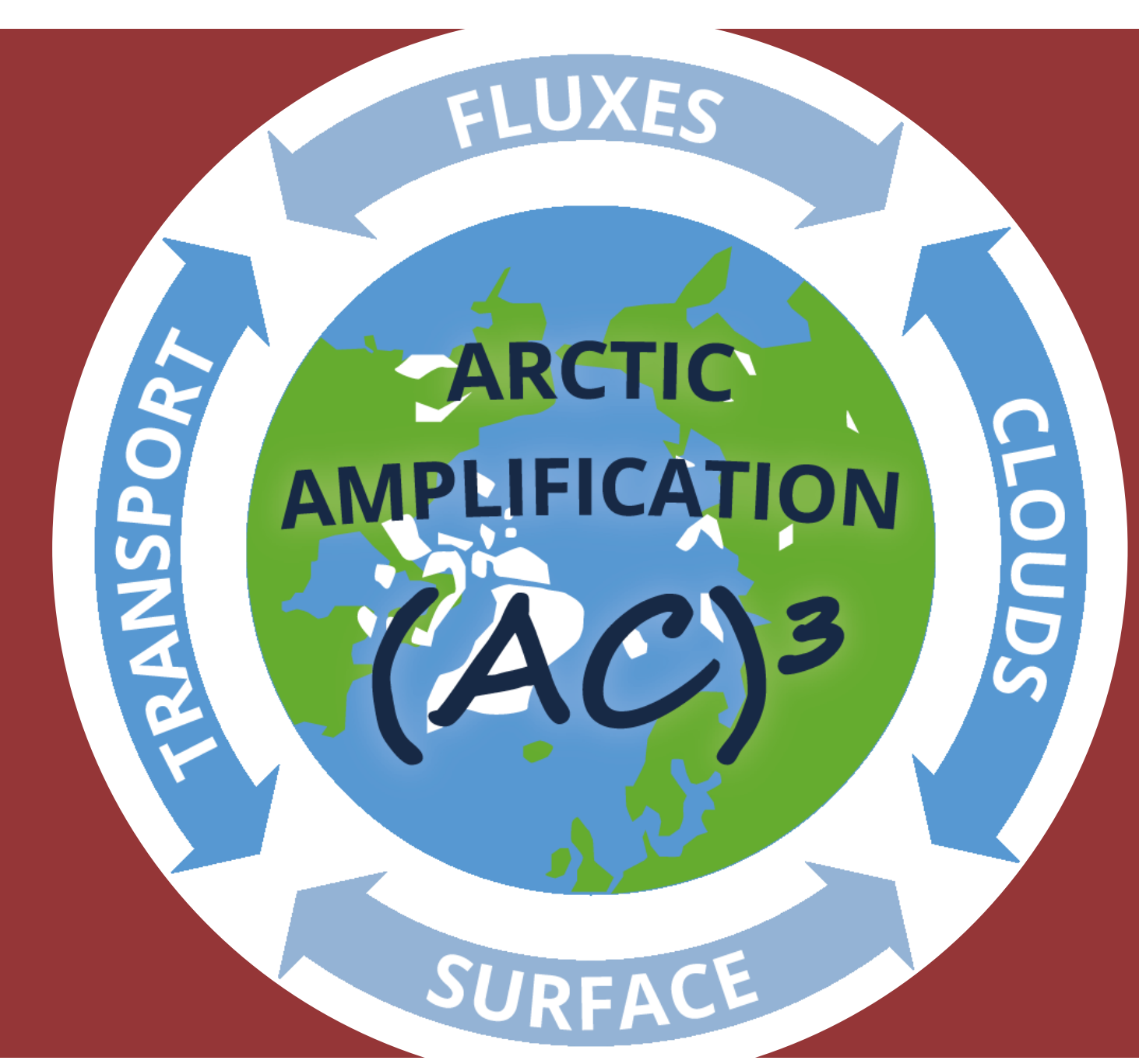


Coupling between atmosphere, mixed layer and pycnocline under Arctic amplification: the role of sea ice related processes

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C04

1. Summary

Research questions:

- Sea ice extent and thickness are changing dramatically under global warming. How does the upper ocean contribute to this change and to Arctic amplification?
- Q1** What are the vertical fluxes between atmosphere, mixed layer and pycnocline during events like storms, opening of leads and frontal decay?
- Q2** What is the role of meso- and submesoscale horizontal processes driven by sea-ice related and frontal processes in modifying vertical exchanges across the mixed layer?
- Q3** What is the potential of ocean mixed layer processes in the changing Arctic Ocean in modifying Arctic amplification?

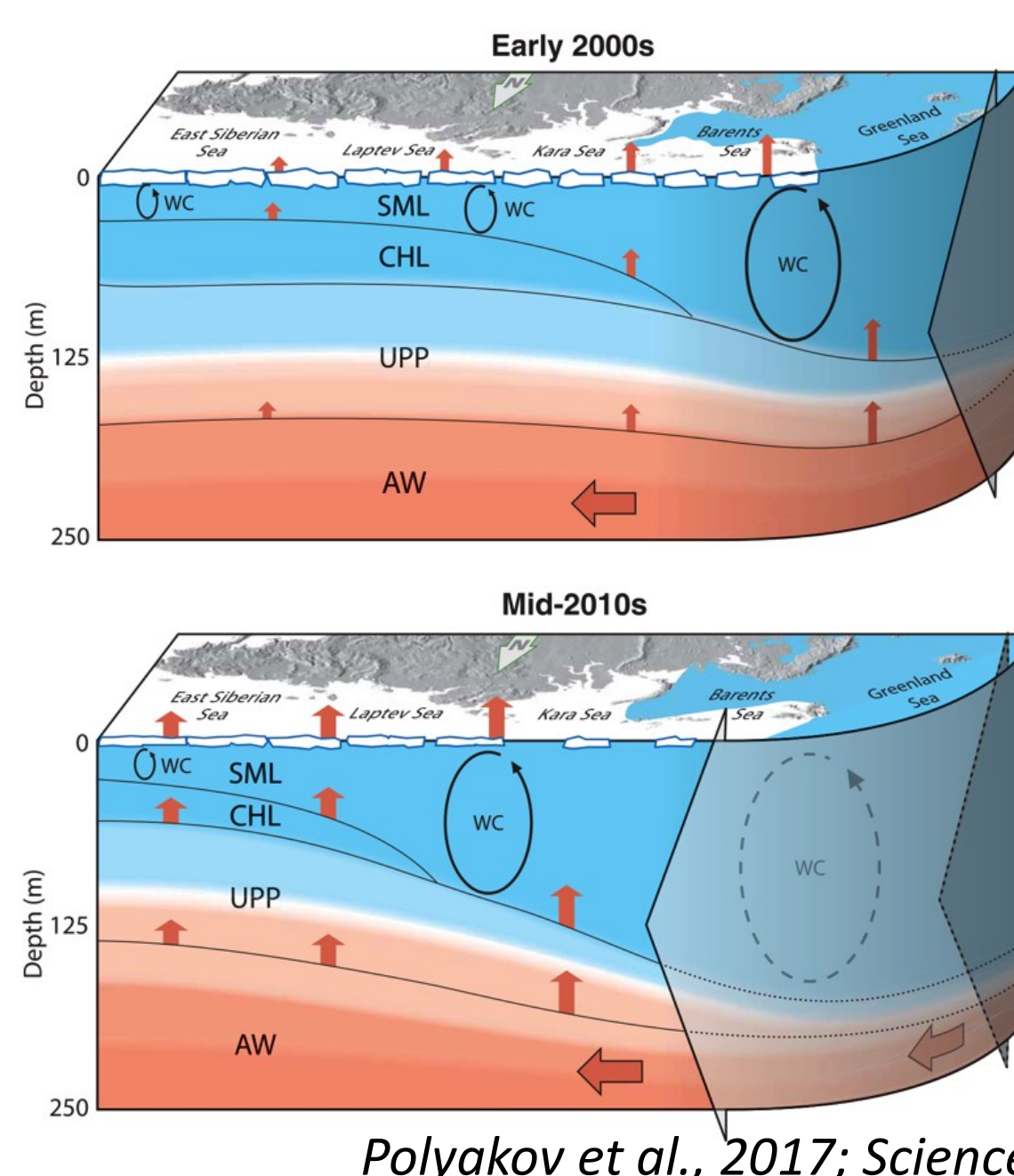
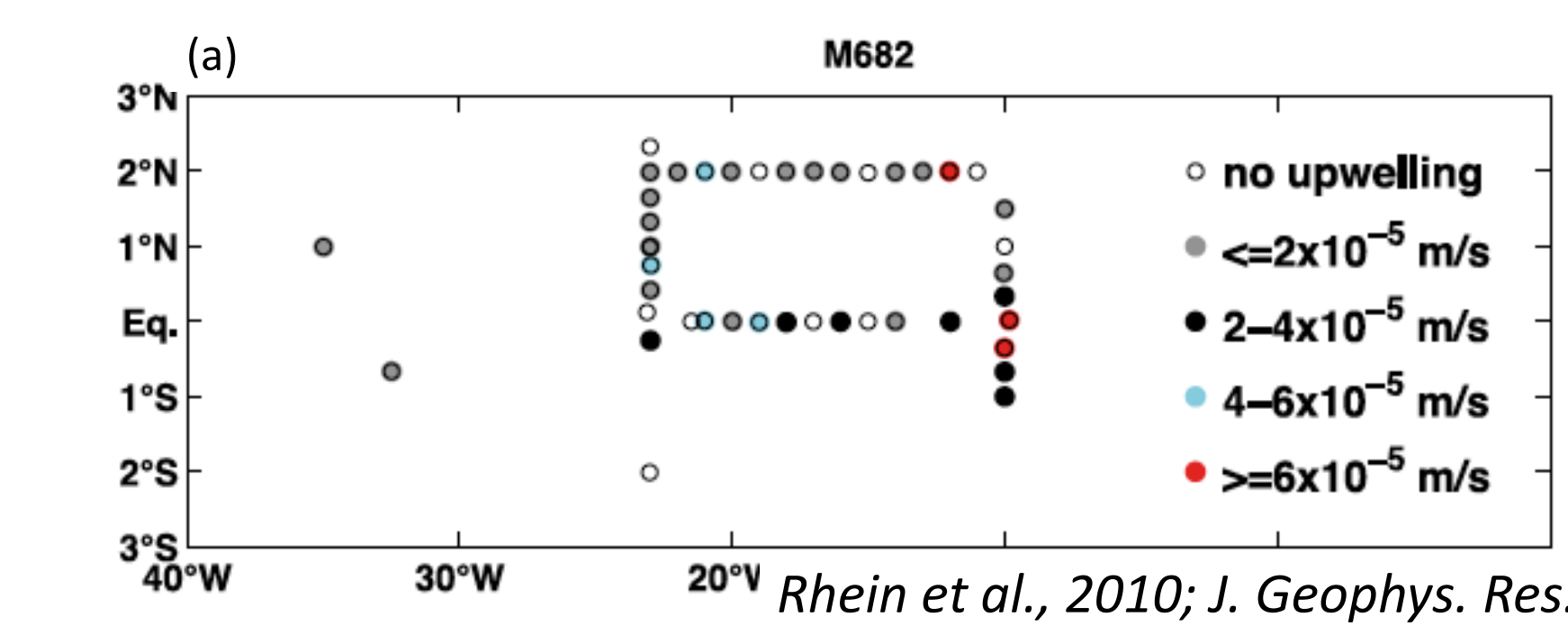
2. Research rationale

State of the art

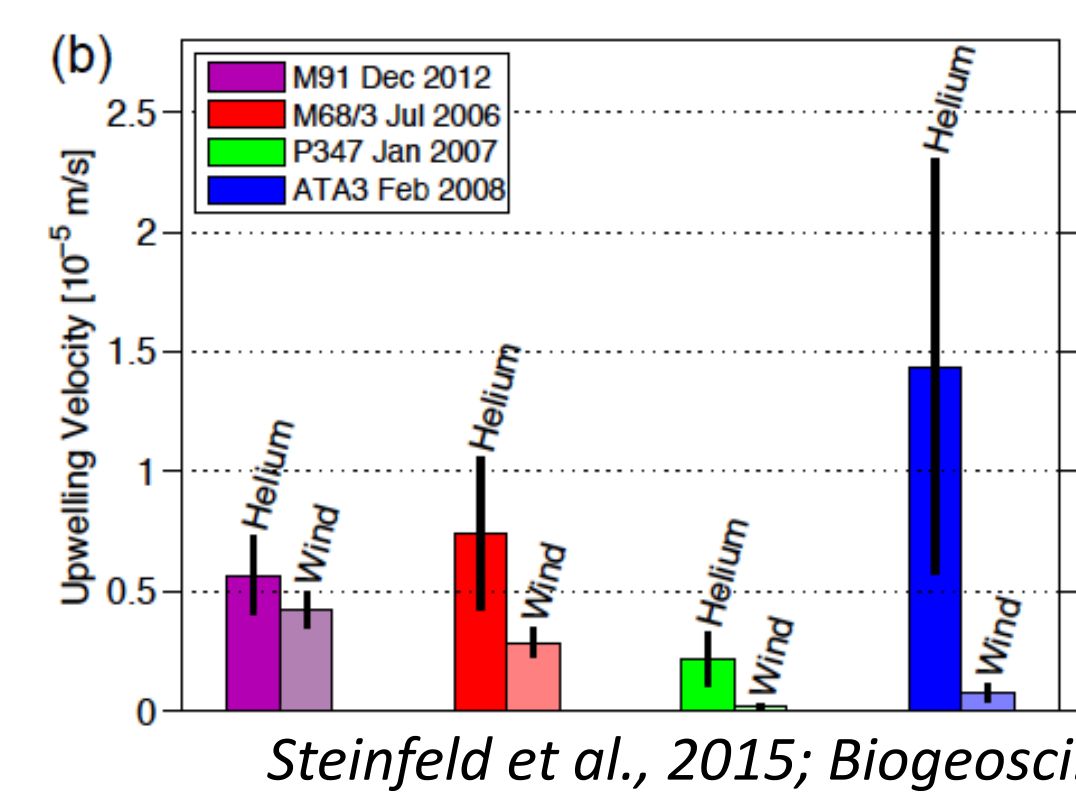
- Sea ice related processes are involved in many mechanisms leading to vertical heat fluxes
- Vertical and horizontal processes are linked
- 'Atlantification' of Arctic Ocean fundamentally changes dynamics

Preliminary work

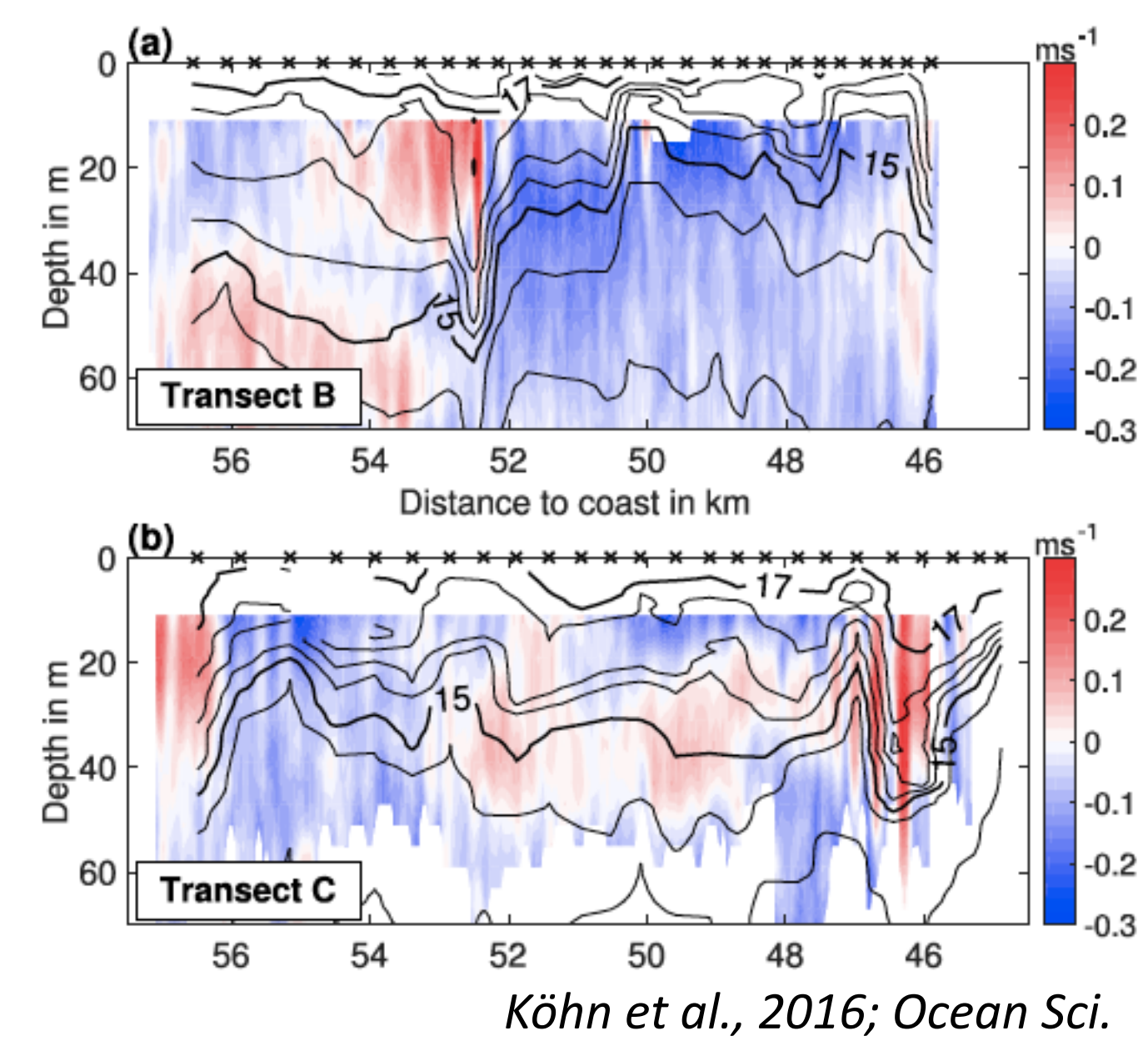
- Heat flux and upwelling from trace gas measurements:
- (a) Vertical heat flux at the equator across the base of the mixed layer.
- (b) Helium data reveal eddy-induced upwelling.



Polyakov et al., 2017; Science



Steinfeld et al., 2015; Biogeosci.



Frontal decay following weakening of along-front winds:
Along-front velocities (color) and across-front temperatures (black lines) on an (a) active and (b) decaying front. The decay had a strong impact on outgassing and air-sea heat flux.

Köhn et al., 2016; Ocean Sci.

4. Role within (AC)3 & perspectives

Collaborations within (AC)3

- Major cooperation with D03 (leads), D04 (modelling)
- C04 contributes data and process information to CCA2 (major contribution) and CCA4 (minor)

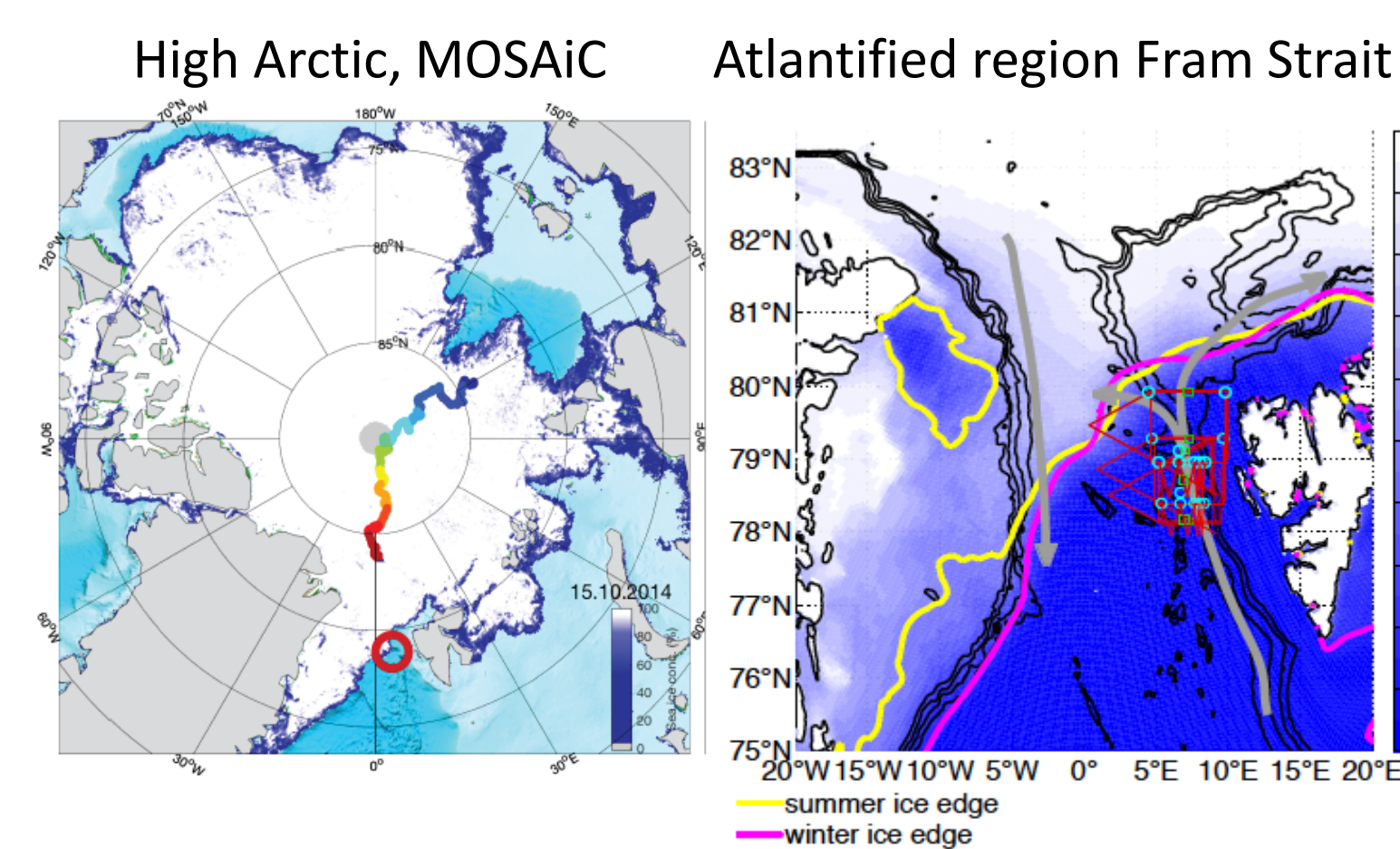
Perspectives

- Assess importance of event triggered fluxes and ML processes on the Arctic ocean energy budget and Arctic amplification
- Improve the parameterisation of small-scale processes in climate models

Hypothesis

Physical vertical and horizontal processes within the Arctic Ocean mixed layer are critical for the vertical heat flux between atmosphere and Atlantic layer, and thus for the change in Arctic sea ice and Arctic amplification.

3. Research plan phase II

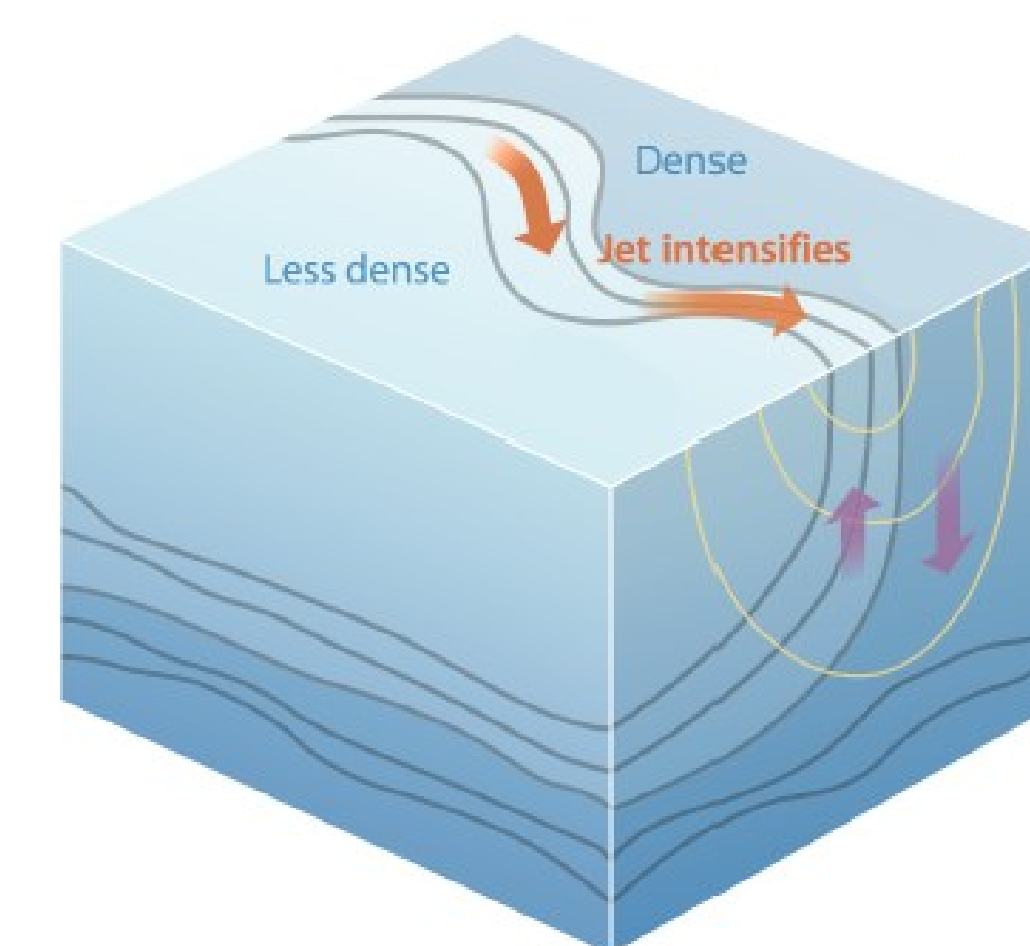
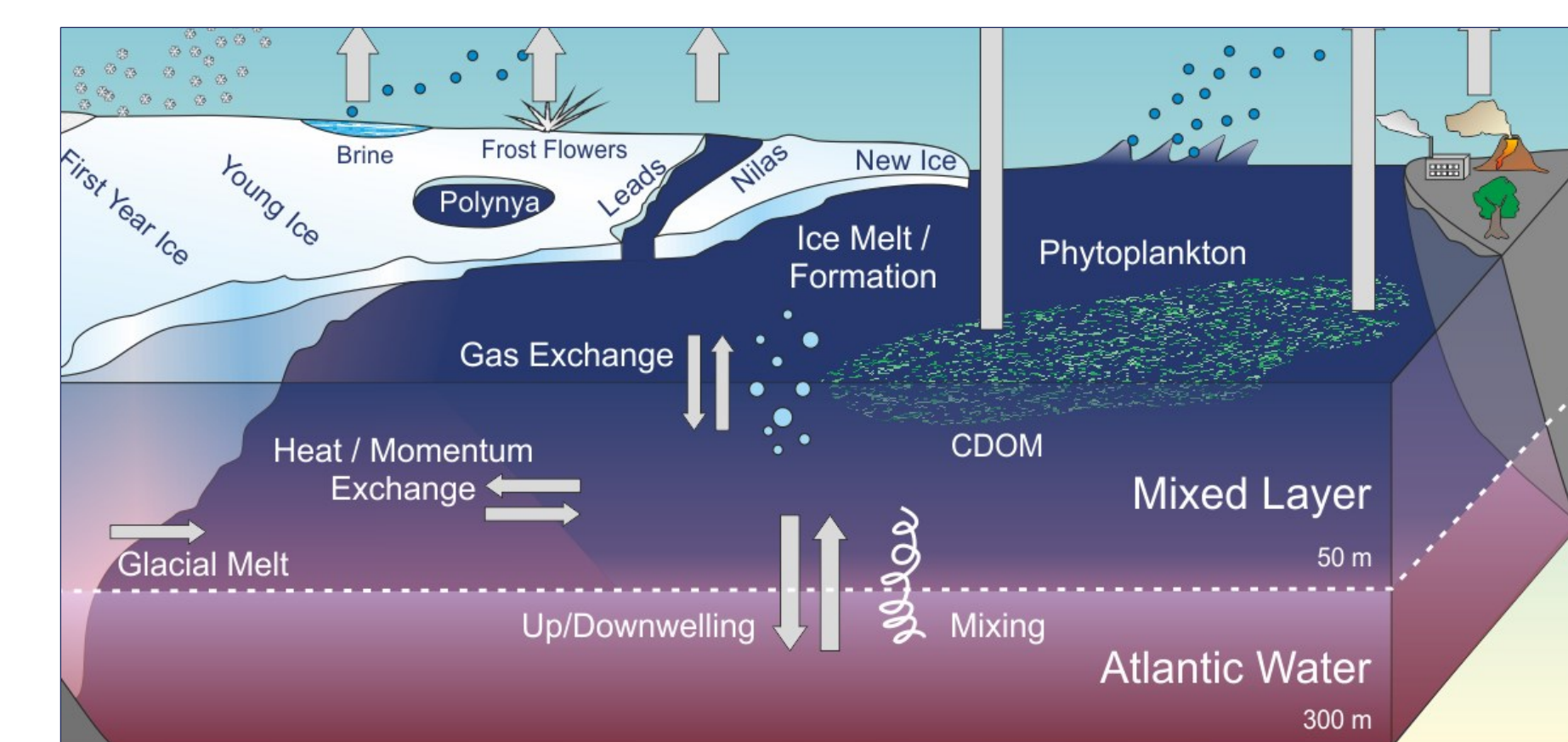


WP1 Observations

- He/Ne and CFC/SF₆ sampling, hydrographic and velocity observations in high Arctic and atlantified region
- Use Fram Strait as model region for atlantified regime
- Use tracer as integral measure to study processes
- Moored time series in Fram Strait

WP2 Event driven fluxes

- Effect of opening leads and storms in the high Arctic and in marginal ice zone on vertical heat flux
- Integral effect of events from tracers
- Effects of mixed layer re-stratification on heat fluxes



WP3 Role of sea ice and frontal variability

- Study impact of horizontal (sub)mesoscale variability triggered by sea ice formation, melt, and lead opening on vertical exchange across the mixed layer
- Compare high Arctic with atlantified region
- Representativeness of synoptic observations

WP4 Mixed layer evolution in the changing Arctic

- Combine results from WP2 and WP3 to interpret them for their role in Arctic amplification
- Contextualise using e.g. lead/event statistics and regional & large scale models
- Upscaling fluxes for Arctic and possible future scenarios

