Changing Arctic Carbon cycle in the cOastal Ocean Near-shore (CACOON)
Who are we all?

- Multinational: 11 scientists with 8 different nationalities are involved in the core group
- Multidisciplinary: marine geochemistry, terrestrial geology and multi-scale modelling
Rationale behind CACOON?

Increased runoff

Expected annual mean runoff to the AO based on CMIP5 models using RCP 8.5. Red = ensemble median. Left 2005 - 2100. Right 2100 – 2300.

Increased permafrost thaw

Expected permafrost lost until 2100. Grey area shows the recent permafrost distribution.

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Permafrost

Predicted permafrost loss (2100)

Schaefer et al. 2011; McGuire et al. 2009; Euskirchen et al. 2006
“core” CACOON aims:

Quantify effect of:
- changing freshwater export & terrestrial permafrost thaw on organic matter delivered to AO

Quantify
- resultant changes on ecosystem functioning in the coastal AO
CACOON focus region
CACOON field work program 2019

- March/April: Lena Delta, CACOON ice expedition
- July/August: Lena Delta: inner-to-outer Delta traverse
- June September: Kolyma Delta
Next milestone: CACOON ice expedition

- Departing Potsdam/Newcastle on 20.03, back on 09.04.
- 14 field days (starting from our logistical base Tiksi) with Vezdekhod (Russian all terrain vehicle) and cabin on sledges (balok) including tractor
- Staff: 4 scientists, 3 driver

Planned sampling:
- water profile below ~2m
- 2 m ice cores
- sediment cores (surface sed.)
Next milestone: CACOON ice expedition

Data: Sentinel 2 MSI, Copernicus Mosaic created by B. Juhls
CACOON Lena Delta traverse

Data: Sentinel 2 MSI, Copernicus
Mosaic created by B. Juhls
CACOON Kolyma Delta

Planned sampling:
- Water across salinity gradient
- Repeat under ice (coast)
- Sediment samples
- Light profile across gulf
Impact of changing DOM and freshwater

*Arctic* ERSEM –
Requires: coupled modelling system of hydrodynamics, sediments, and biogeochemistry
- 3 models (FVCOM, CSTM, ERSEM) and a coupler (FABM)

This modelling system
- baseline simulation (present day)
- future scenario of increased freshwater and terrestrial DOM input

*Examine resultant changes on ecosystem functioning in the coastal AO*
Model structure

Hydrodynamics

FVCOM
- unstructured grid model to allow resolving of complex coastlines and estuaries
- simple ice model using prescribed ice extents

Framework for Aquatic Biogeochemical Models (FABM)

Biogeochemistry

ERSEM
- variable stoichiometry
- resolves DOM processing and the major biogeochemical cycles

Sediments
CSTMS
Variable stoichiometry (in bacteria and DOM)

Labile, semi-labile and semi-refractory DOM

Bacteria RDOM production and variable BGE (Allen et al. 2002; Blackford et al., 2004; Polimene et al., 2006 and 2007)

Model characteristics:
- Variable stoichiometry (in bacteria and DOM)
- Labile, semi-labile and semi-refractory DOM
- *Bacteria RDOM production* and variable BGE

CACOON related developments:
- Implement new terrestrial input DOM module (developed in NERC LOCATE project)
- Develop parameters for one or more permafrost DOM classes

*(Allen et al 2002; Blackford et al., 2004; Polimene et al., 2006 and 2007)*
Modelling progress

Work on Laptev sea (Lena) model

- Collating bathymetry
- Preparing forcing (river input, boundary tides, atmospheric forcing)
- Mesh generation

Terrigenous DOM code testing in 1-d ERSEM setup

Next steps:

Refine Laptev sea mesh and run physics only simulation

Test terrigenous DOM code in 3-d setup
Processes

Model parameters will be derived from field/labwork:

- Key processes examined:
  - Microbial degradation
  - Photodegradation
  - Flocculation

Polimene et al., 2017
Laboratory progress

MoDIE: Moderate dissolved inorganic carbon (DIC$^{13}$C) isotope enrichment for improved evaluation of DIC photochemical production in natural waters

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STEM outreach

Developing workshops for 8-12 year olds

- Understand the impact of climate change on permafrost thaw in Siberia
- Use shadowgram techniques to interpret data (Man Ray-esque—right)

3-d representation of Siberia river catchments for students to use
Collaborations

1Free University, Amsterdam; 2Jena University; 3Potsdam Uni & AWI; 4Free University, Berlin & AWI; 5Massachusetts Institute of Technology & Woods Hole Oceanographic Institution