A voyage in the Fram Strait in summer 2016 with two small unmanned 'sailboats' (SailBuoy)

Jenny Ullgren, NERSC

Inger Graves
David Peddie
Geir Pedersen, Rune Hauge
Anders Tengberg

Hanne Sagen, Asuka Yamakawa,
Jeong-Won Park, Espen Storheim

Aanderaa Data Instruments AS
Offshore Sensing AS
Christian Michelsen Research AS
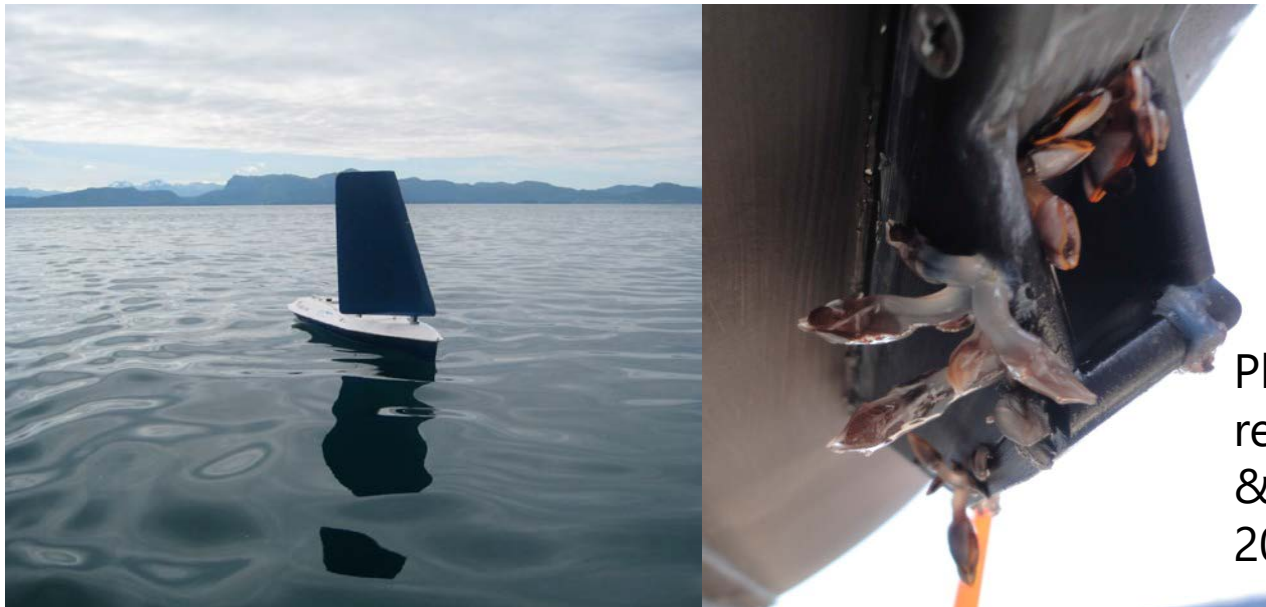University of Gothenburg

NERSC

Iskantseilas – "Ice edge voyage"
Measurements in the polar ocean with unmanned vehicles

Funded by the Regional Research Fund: industrial research project
Work foci:
- Mechanical adaption
- Integration of data collection system
- Anti-fouling
- Data usage

Photos from reports by Fer & Peddie, 2012

The project Iskantseilas "Ice edge voyage"

- Arctic Ocean: high primary production and biodiversity, but vulnerable

- Particularly sensitive to the increasing problem of acidification

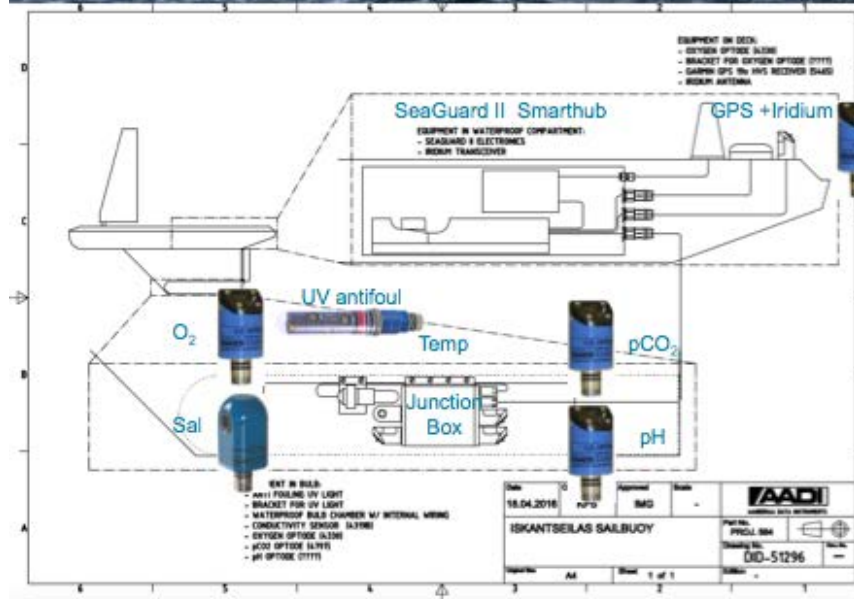- Demanding environment to make measurements in

Clione limacina limacina
Hopcroft/UAF/NOAA/CoML

Photo: http://www.arcodiv.org/

Goal: make a detailed description of the fine scale distribution of water masses and plankton in the polar ocean through the use of innovative measurement techniques

NERSC

The SailBuoy 'Ocean Acidification Vehicle (OAV)'

Voyage with SailBuoys, summer 2016

Research cruise on board Norwegian Coastguard vessel KV Svalbard June-July
Main objectives:
-recover moorings for UNDER-ICE/NICE projects
-deploy 2 SailBuoys for 'Ice edge voyage' project
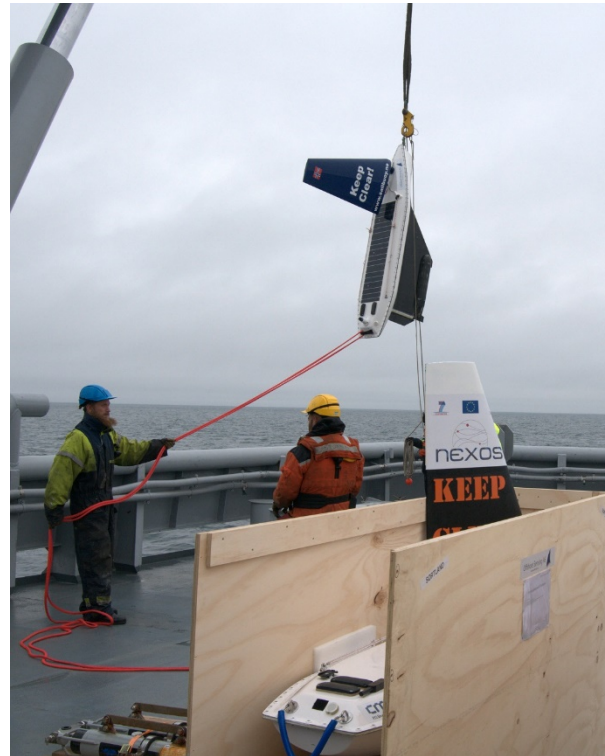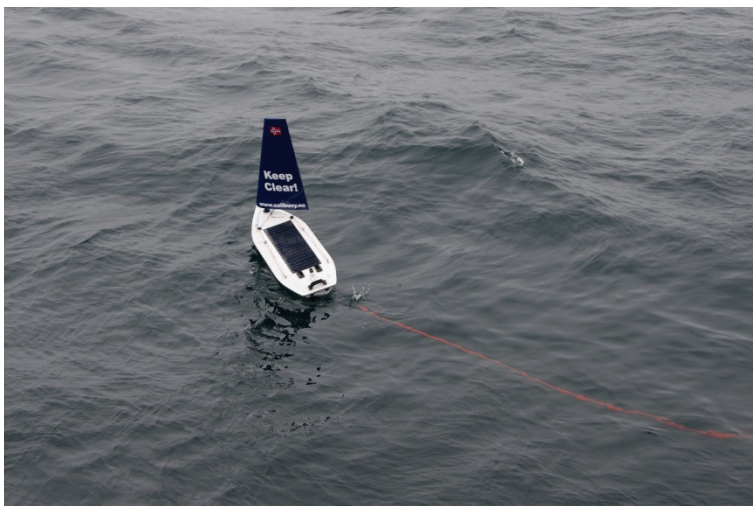-underwater acoustics experiments

Photos: Håkon Kjøllmoen

NERSC

Voyage with SailBuoys, summer 2016
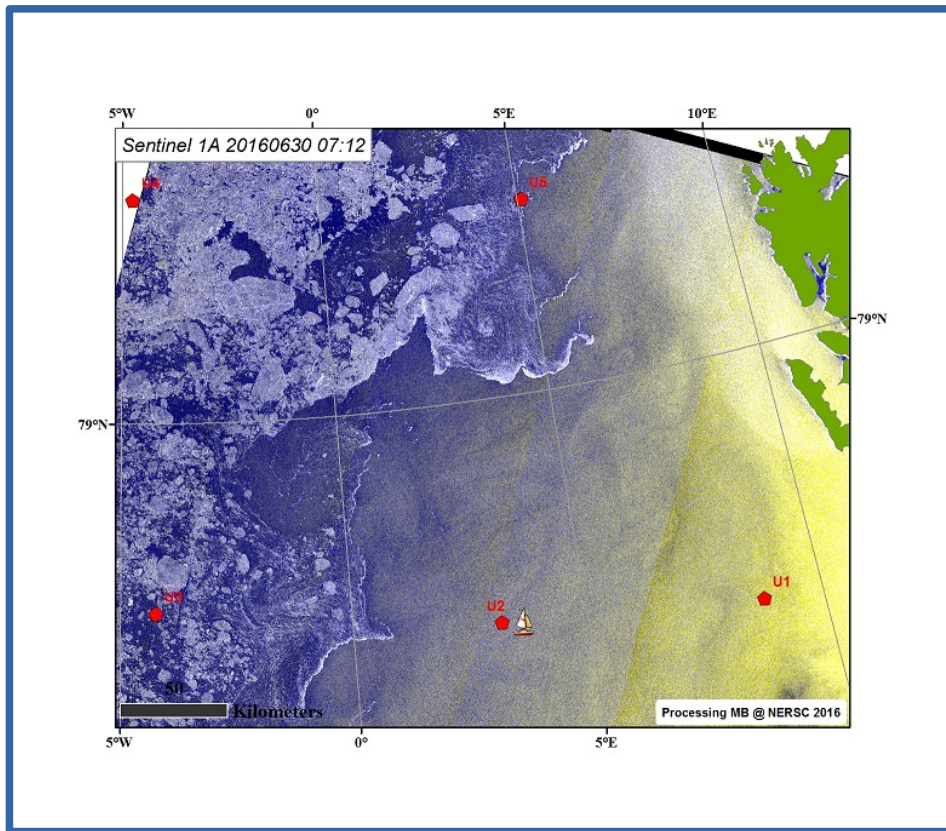## SailBuoys deployed from KV Svalbard on 30 June

- Ocean Acidification Vehicle (SB Iskant)
- Echo sounder sailbuoy (SB Nexos)

Photos: Espen Storheim

Voyage with SailBuoys, summer 2016
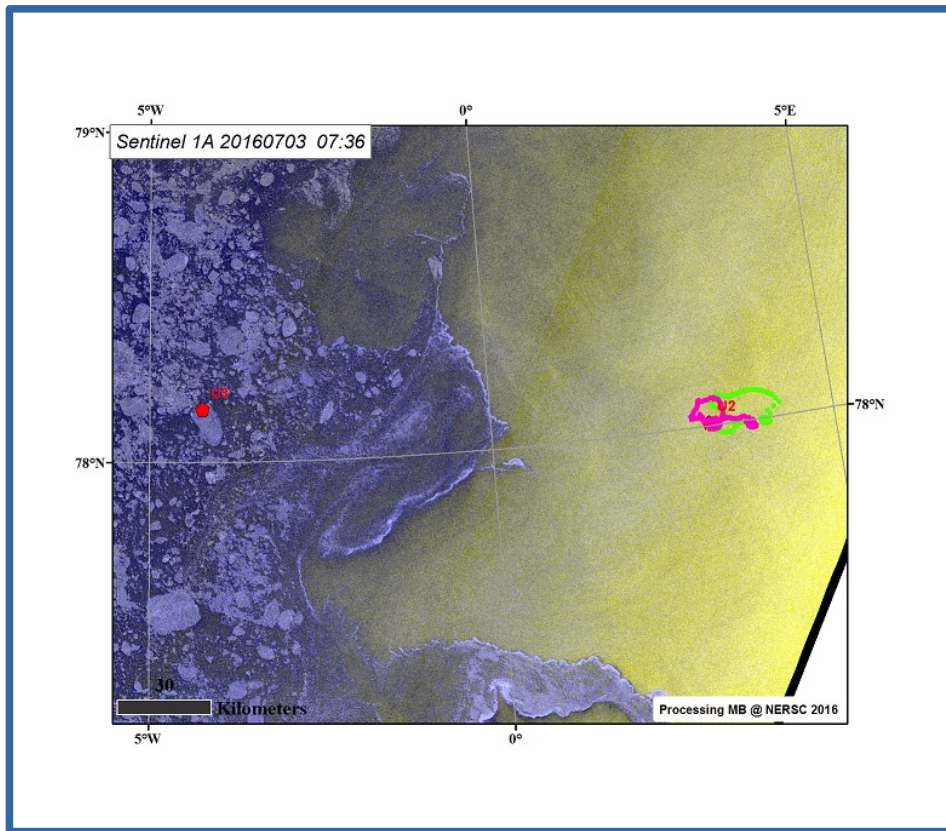
2016-06-30

Satellite image prepared by Mohamed Babiker

- The SailBuoys were remotely steered from shore

- Aim:
  repeated transects near ice edge

- Ice conditions carefully monitored

- The SailBuoy can maneouvre in wind speeds of 3-20 m/s

- Fair weather and very little wind for most of the 2016 deployment

Voyage with SailBuoys, summer 2016
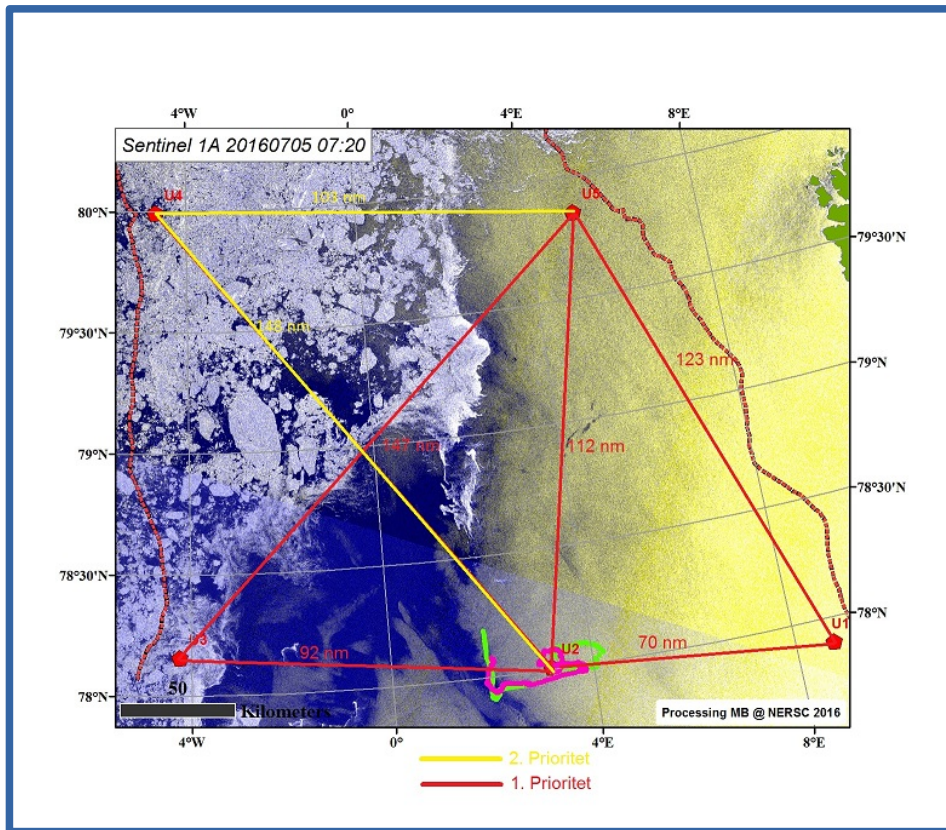
2016-07-03

Satellite image prepared by Mohamed Babiker

- The SailBuoys were remotely steered from shore

- Aim:
  repeated transects near ice edge

- Ice conditions carefully monitored

- The SailBuoy can maneouvre in wind speeds of 3-20 m/s

- Fair weather and very little wind for most of the 2016 deployment

Voyage with SailBuoys, summer 2016
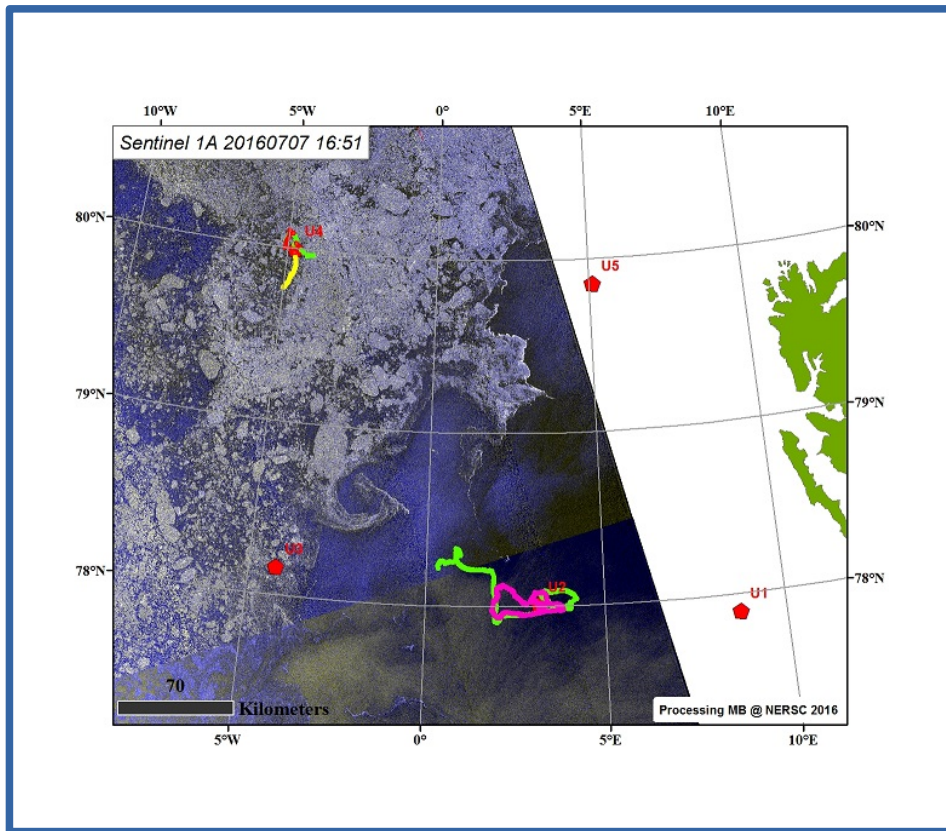
2016-07-05

Satellite image prepared by Mohamed Babiker

- The SailBuoys were remotely steered from shore

- Aim:
  repeated transects near ice edge

- Ice conditions carefully monitored

- The SailBuoy can maneouvre in wind speeds of 3-20 m/s

- Fair weather and very little wind for most of the 2016 deployment

Voyage with SailBuoys, summer 2016
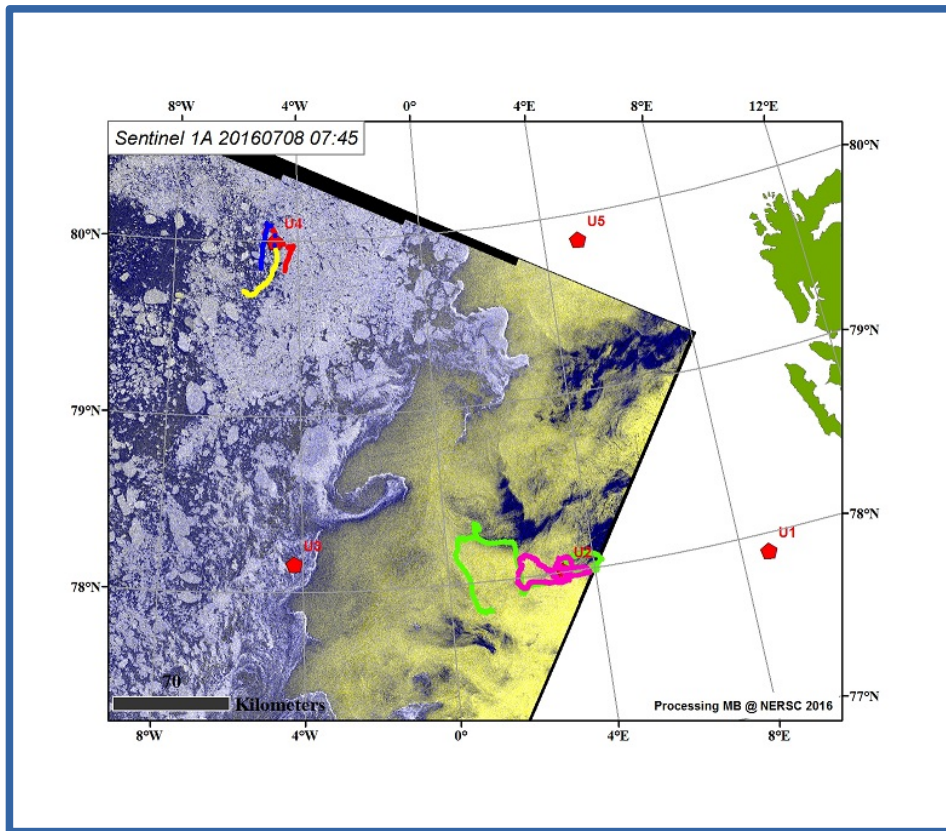
2016-07-07

Satellite image prepared by Mohamed Babiker

- The SailBuoys were remotely steered from shore

- Aim:
  repeated transects near ice edge

- Ice conditions carefully monitored

- The SailBuoy can maneouvre in wind speeds of 3-20 m/s

- Fair weather and very little wind for most of the 2016 deployment

Voyage with SailBuoys, summer 2016
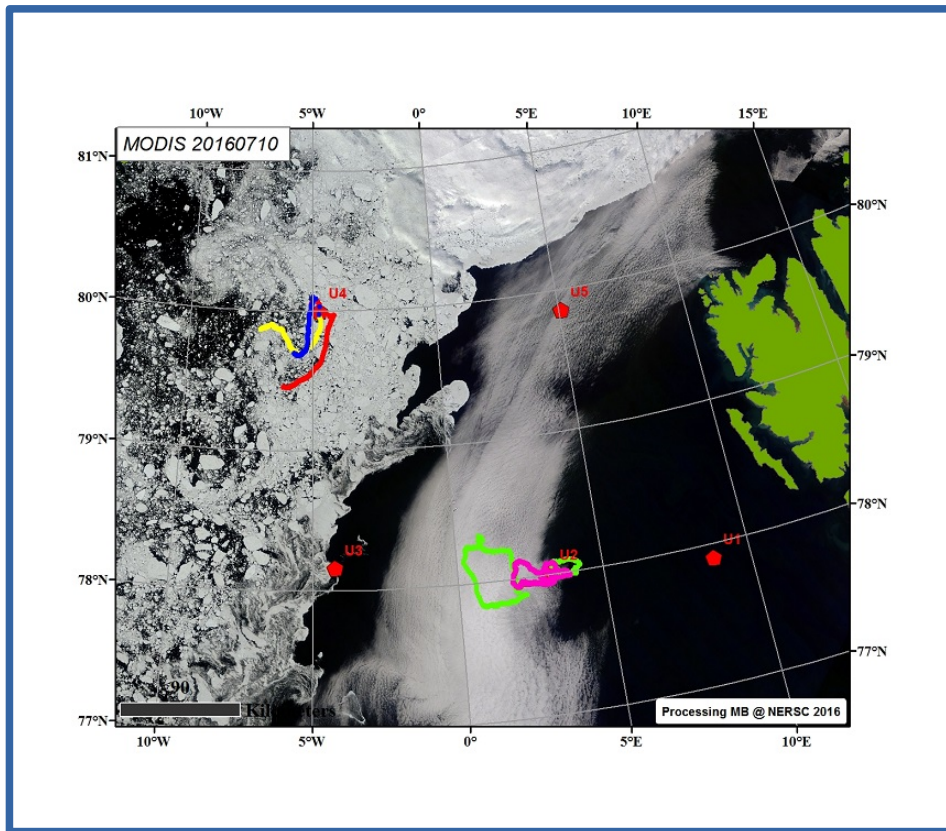
2016-07-08

Satellite image prepared by Mohamed Babiker

- The SailBuoys were remotely steered from shore

- Aim:
  repeated transects near ice edge

- Ice conditions carefully monitored

- The SailBuoy can maneouvre in wind speeds of 3-20 m/s

- Fair weather and very little wind for most of the 2016 deployment

Voyage with SailBuoys, summer 2016
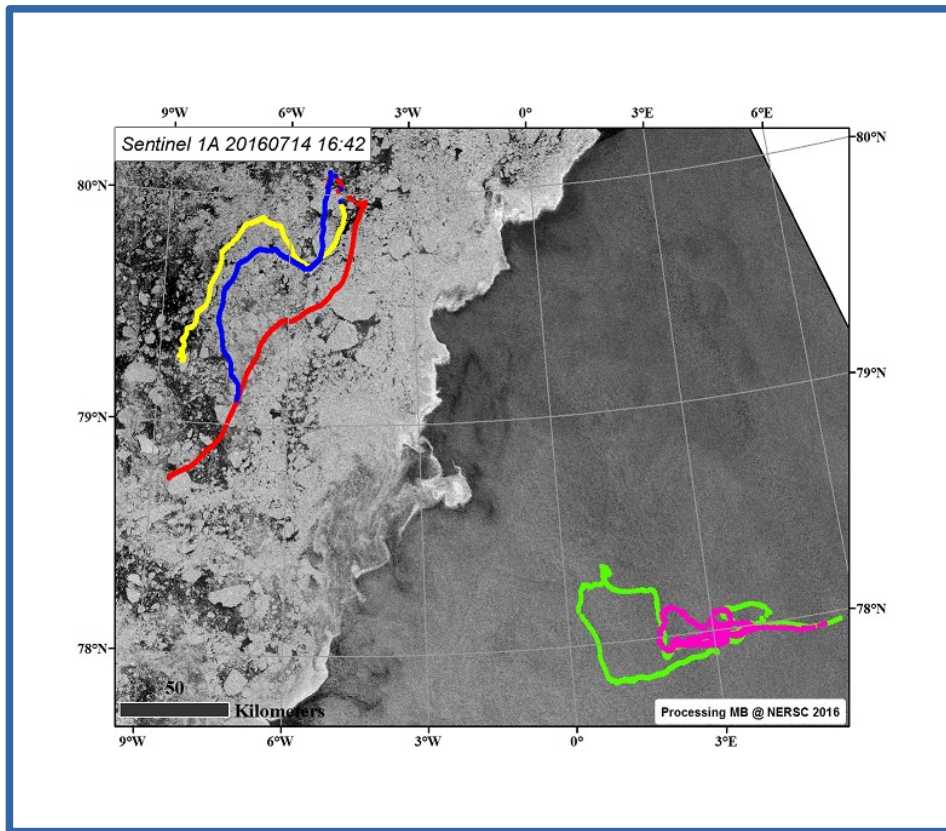
2016-07-10

Satellite image prepared by Mohamed Babiker

- The SailBuoys were remotely steered from shore

- Aim:
  repeated transects near ice edge

- Ice conditions carefully monitored

- The SailBuoy can maneouvre in wind speeds of 3-20 m/s

- Fair weather and very little wind for most of the 2016 deployment

Voyage with SailBuoys, summer 2016

2016-07-14

Satellite image prepared by Mohamed Babiker

- The SailBuoys were remotely steered from shore

- Aim:
  repeated transects near ice edge

- Ice conditions carefully monitored

- The SailBuoy can maneouvre in wind speeds of 3-20 m/s

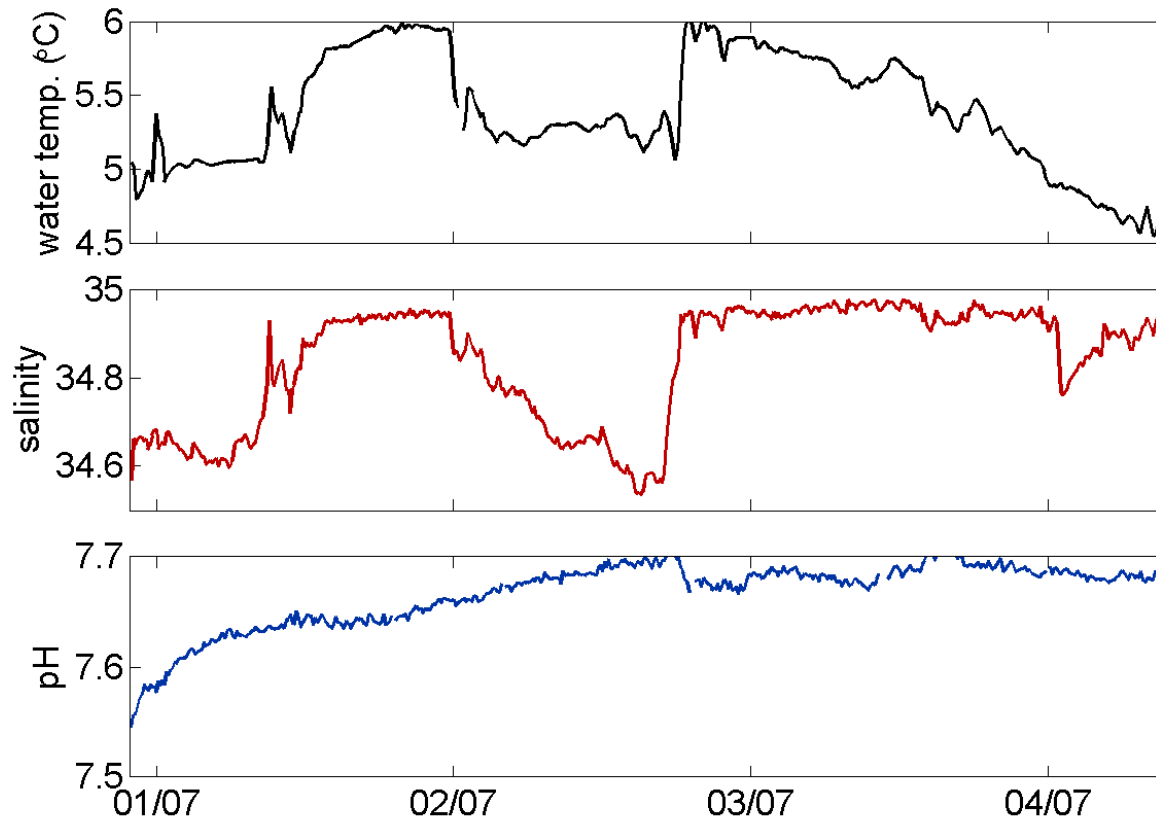- Fair weather and very little wind for most of the 2016 deployment

Voyage with SailBuoys, summer 2016

Both recovered 18 July
Complete track:

Echo sounder sailbuoy

Acidification sailbuoy
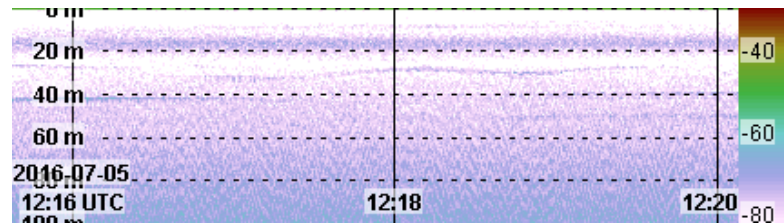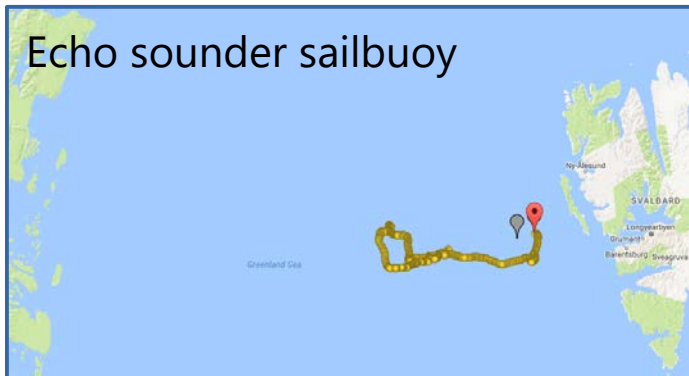
Echo sounder data stored locally, not transmitted.
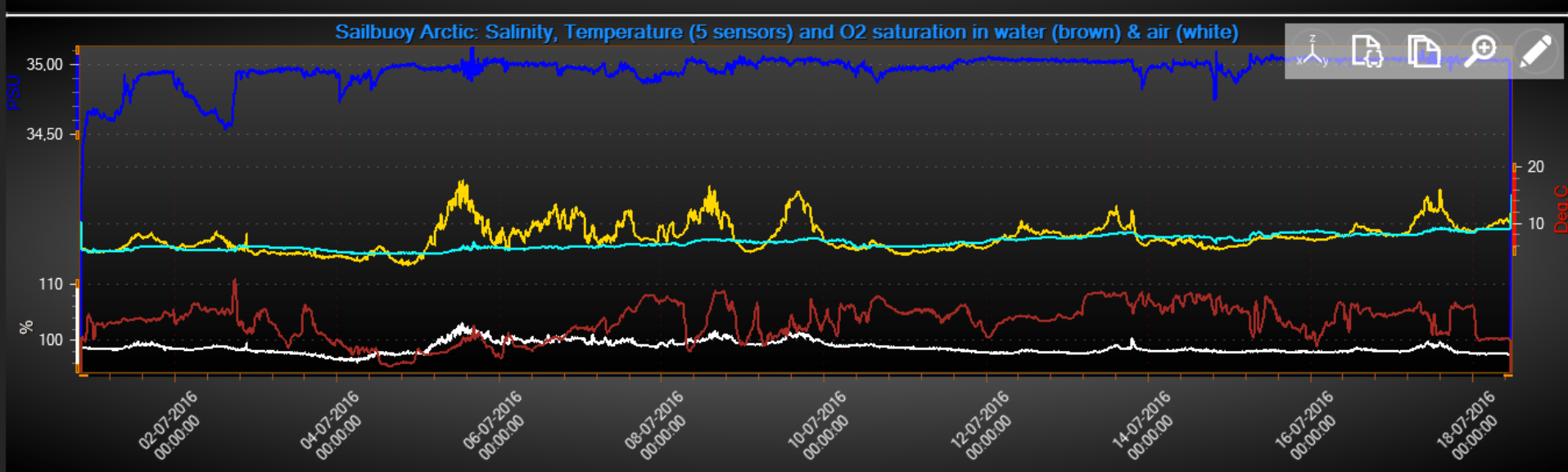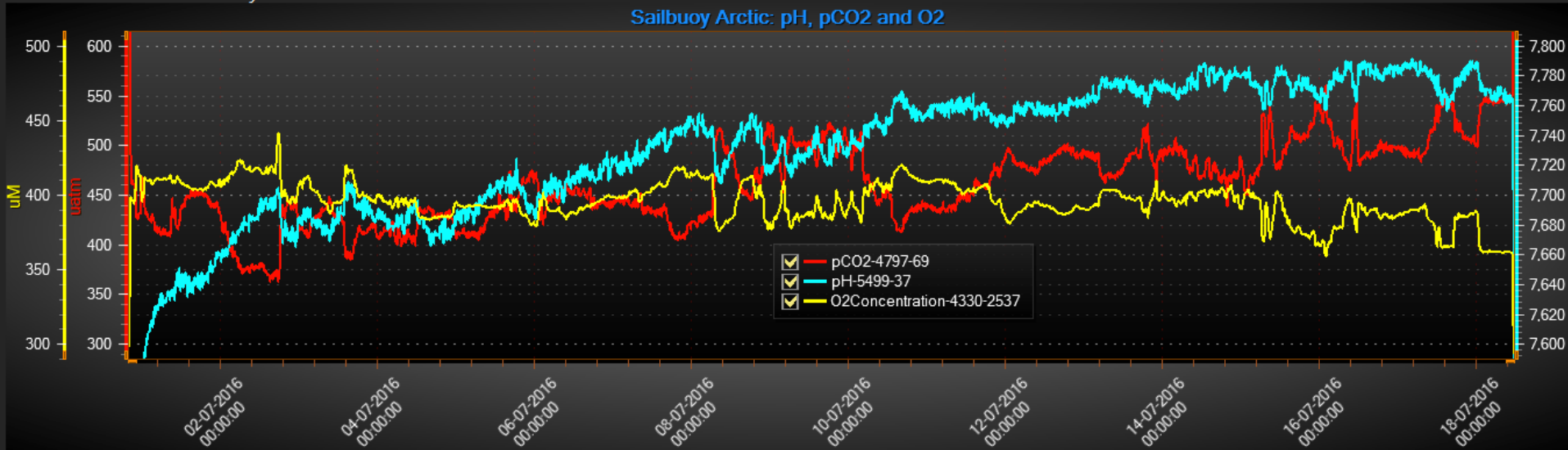
Preliminary data – first few days

- Water samples from deployment and recovery to be analyzed for DIC and alkalinity.
- Profiles with hand-held CTD taken at recovery.
- XBT sections along KV Svalbard cruise track.
- Satellite data: Winds, surface current field, ocean colour, SST...

Data quality check

Figure by Anders Tengberg

Data quality check
(by Anders Tengberg)

- Data from all sensors seem to be of high quality
- Clear, expected anti-correlation
  between O_2 (287-347 µM, S compensated ↓)
  and pCO_2 (365-560 µatm ↑)
- Also between pCO_2 and pH (7.7-7.8 ↑).

- pH has an initial stabilization time of about 1 day.

Reference data needed
- to adjust absolute values of pH and pCO_2
- to determine if there was drift

Data quality check
(by Anders Tengberg)

- All 4 T sensors (4.9-9.0°C) in water give same readings ±0.01°C.
- The T sensor on top of the hull (on 4330 O_2 optode) is exposed to the sun
  - shows higher average T and higher variations (3.0-17.3°C).

- Salinity varies between 34.5-35.1.

Data quality check
(by Anders Tengberg)

- Oxygen optodes show no sign of drift (~100% in air at start, end).
- O_2 mostly oversaturated (primary production) in the surface water.
- Comparing with atmospheric readings and taking into account wind speed
→possible to calculate export/import of O_2 to/from water/atmosphere.

- The resolution of the pCO_2 optode is better than 2 uatm
- ...and of the pH optode better than 0.005 units.

Next steps

- Divide track into «stations» and «sections»
- Analyse physical and chemical data
- Put into context with ancillary data – from KV Svalbard, satellite, other ships?

Echo sounder sailbuoy

Acidification sailbuoy
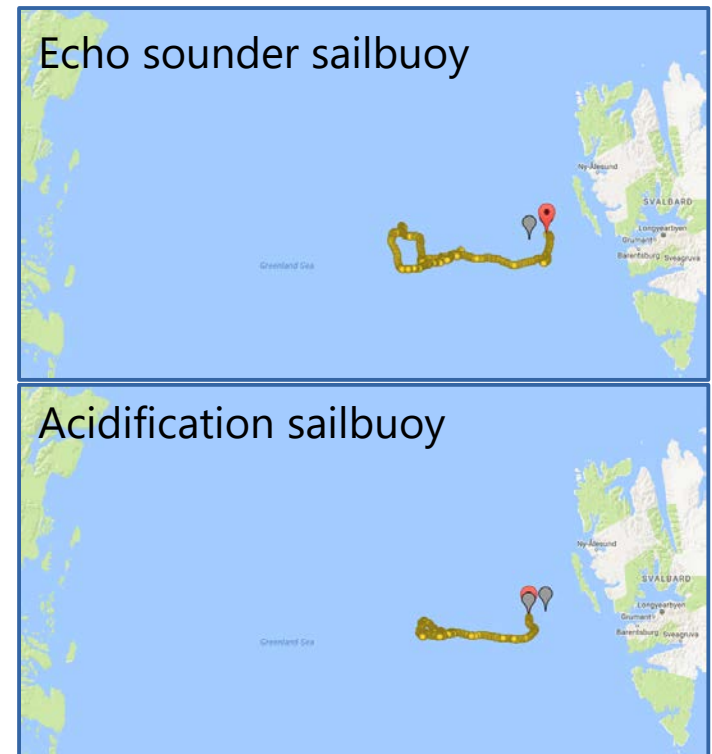
SailBuoys alternative careers: acting!

- Following in the footsteps of award-winning performances by non-human actors...
- ...the SailBuoys played the lead roles in a Search-and-Rescue exercise on KV Svalbard!

«Mr Kootrappali»

«Danish sailor»

Thank you!

The scientific party (WHOI, IOPAN, NERSC) on KV Svalbard July 2016
Foto: Håkon Kjøllmoen