Pacific Arctic Group 2015 Fall Meeting
October 28, 2015
at KOPRI, Incheon, Japan

Update of 2015 field results & preliminary 2016 plans (+ additional information)

Japan

Takashi Kikuchi & Shigeto Nishino (JAMSTEC)

with inputs from other Japanese scientists

Japanese Arctic Ocean observation in 2015

1) Japanese research vessel cruise

- **R/V Mirai Arctic cruise in September-October 2015**

→ Shige's presentation

2) Participations in ice-breaker cruises

- **IBRV Araon Arctic cruise;**
- **CCGS Louis S. St.- Laurant cruise;**

Sea ice observation, hydrography & water sampling

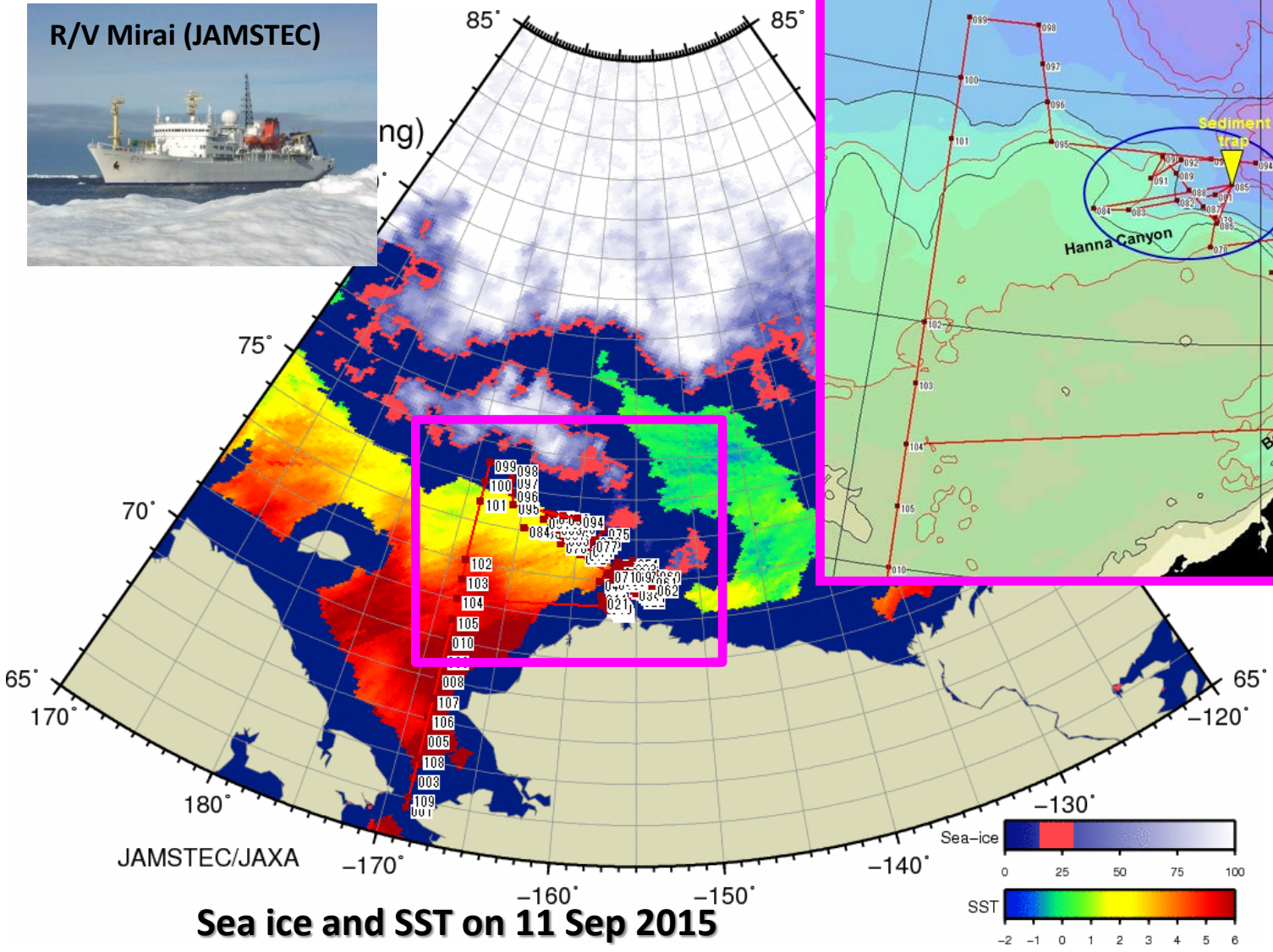
3) Others

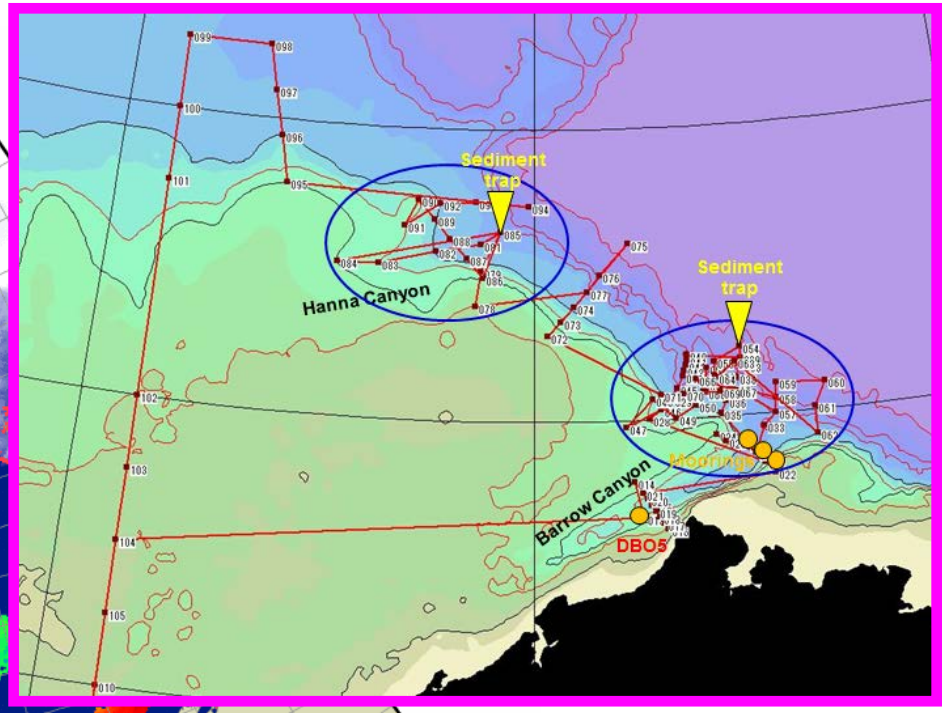
- **Ice thickness monitoring off Barrow, Alaska**
- **XCTD observation in the Arctic Ocean (CCGS L. S. St.- Laurant & FS Polarstern cruises)**

and more ?. . .

Japanese research vessel cruise in 2015

R/V Mirai Arctic cruise in September-October 2015





Sea ice and SST on 11 Sep 2015
& observed stations of MR15-03

Courtesy from Dr. Nishino (JAMSTEC)

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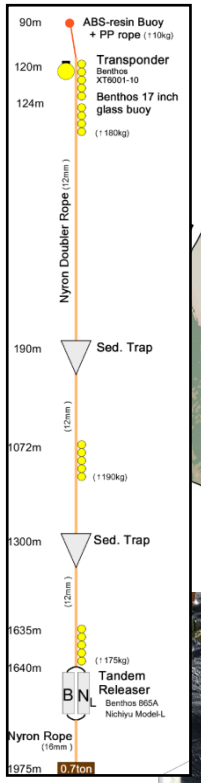
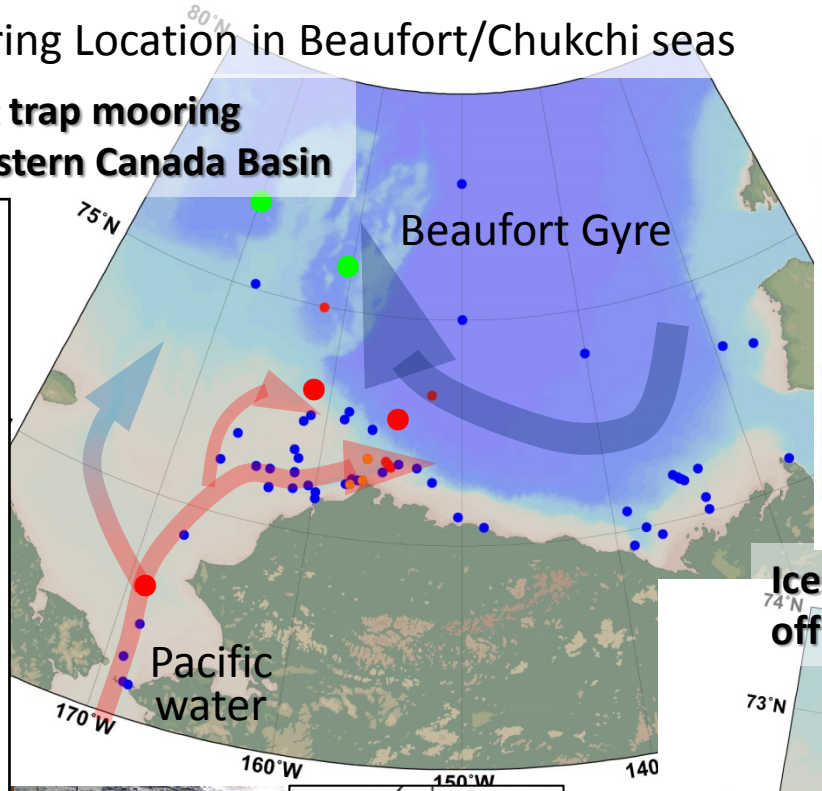
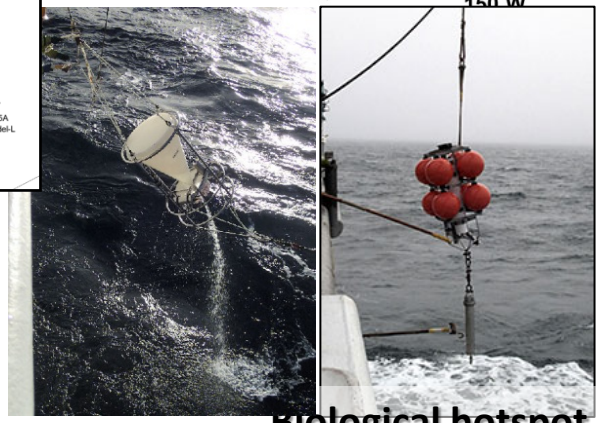
2015 Mooring missions in the PAR region

Mooring Location in Beaufort/Chukchi seas

Sediment trap mooring in the western Canada Basin

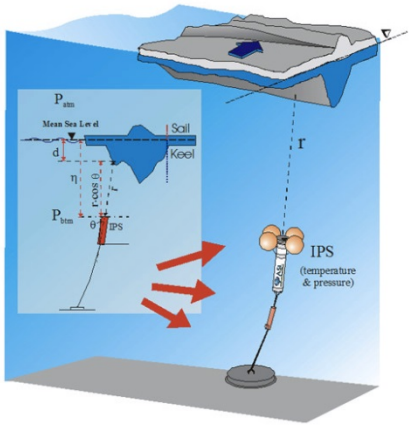


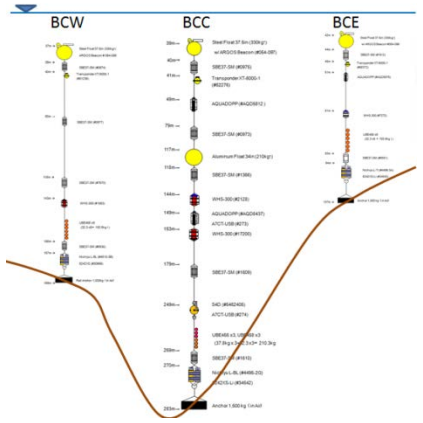




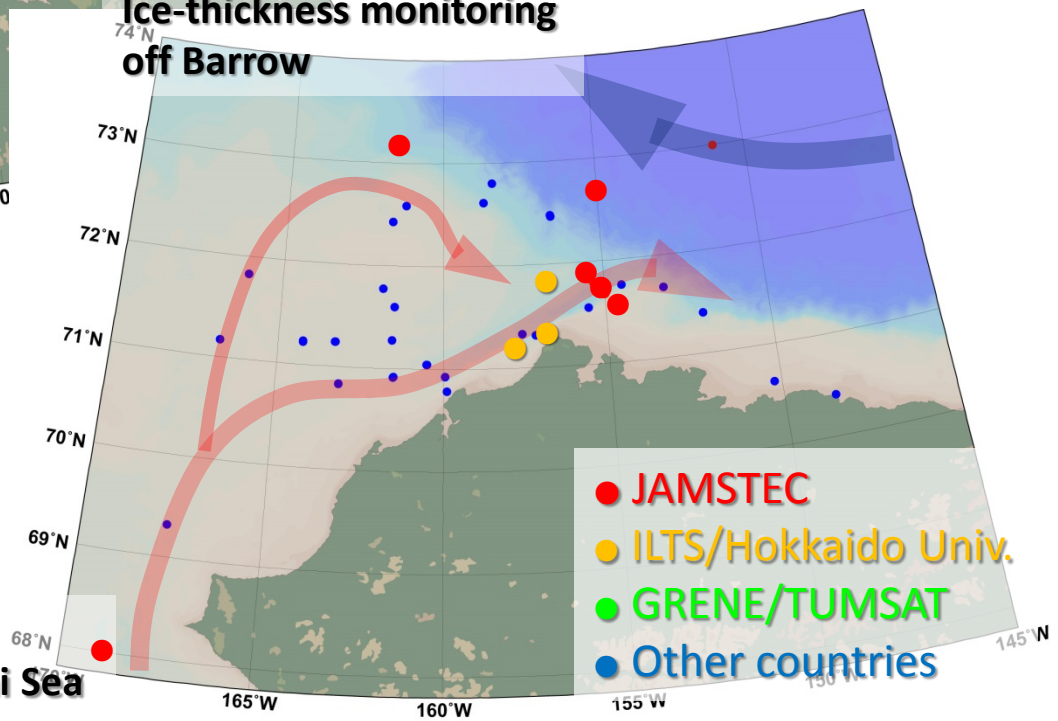
Biological hotspot in the southern Chukchi Sea

Long-term monitoring At the mouth of Barrow Canyon





Ice-thickness monitoring off Barrow



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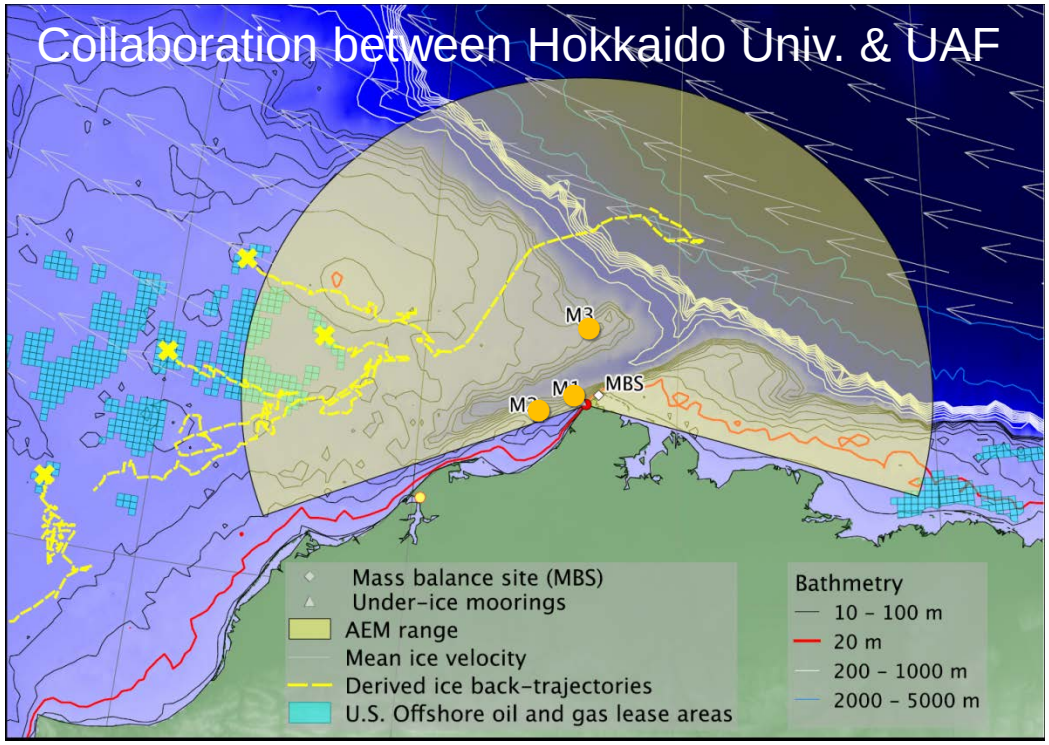
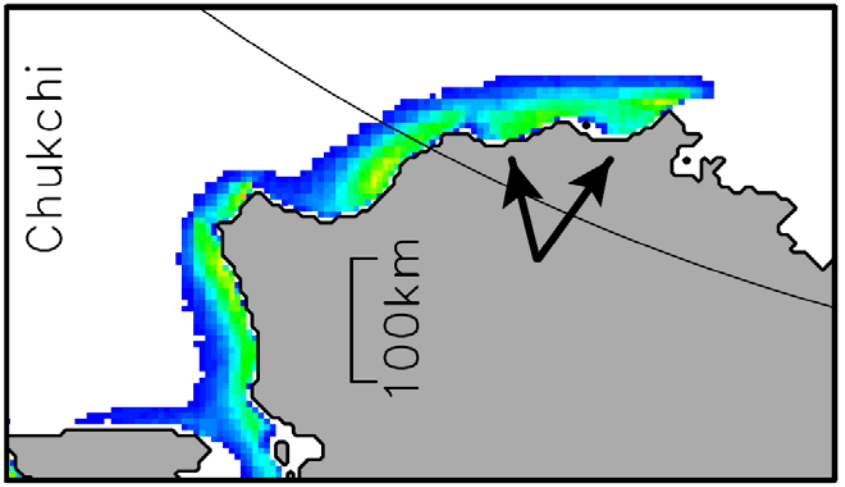
Ice thickness monitoring off Barrow



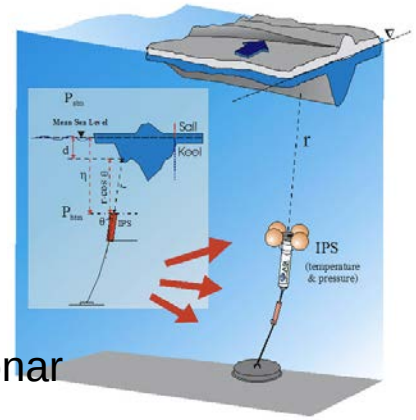
Courtesy of Dr. A. Mahoney (UAF)

Sea-ice production mapping by AMSR-E

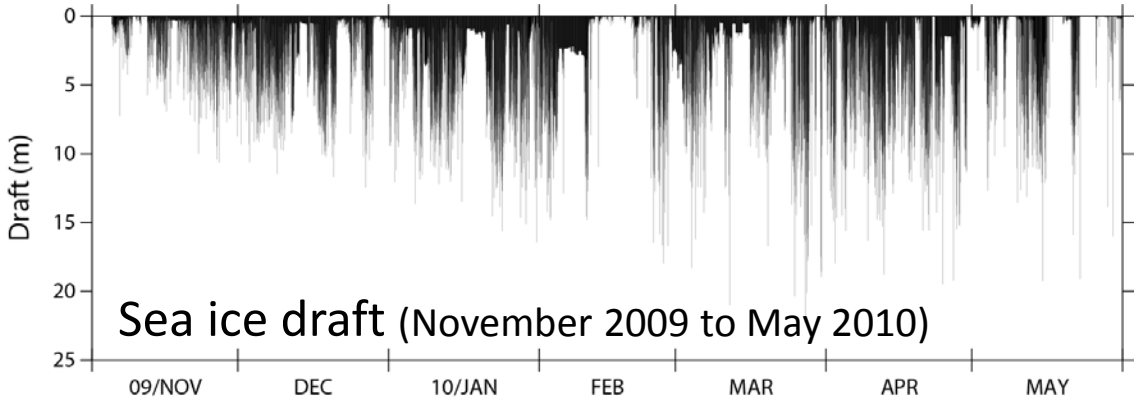


Annual cumulative production over 2002/03-2010/11

Iwamoto et al. (2014, JGR)

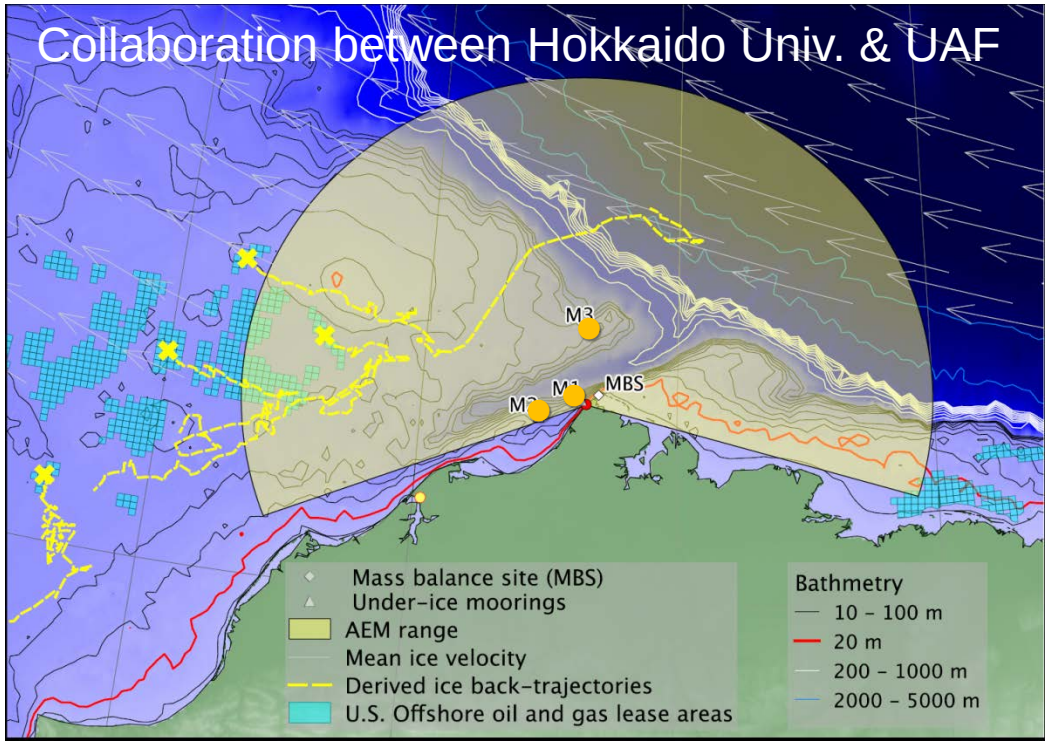


Ice-Profiling Sonar



Courtesy from Dr. Fukamachi (Hokkaido Univ.)

Ice thickness monitoring off Barrow



Courtesy of Dr. A. Mahoney (UAF)

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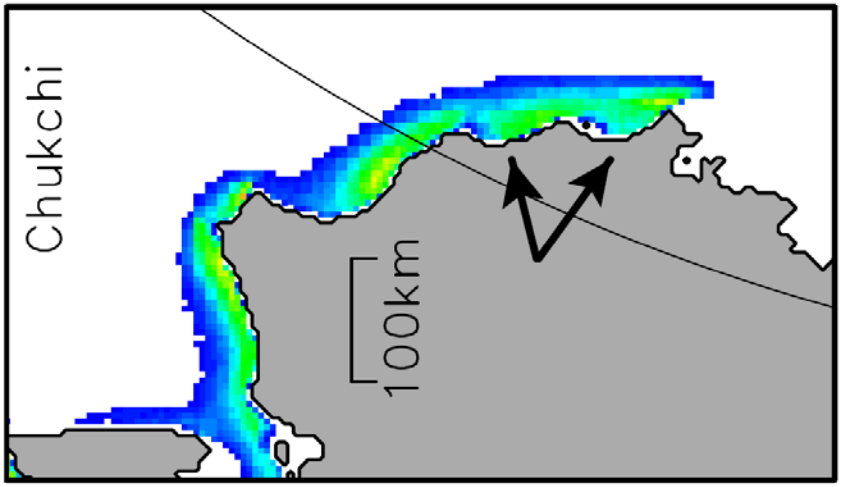


Annual cumulative production over 2002/03-2010/11

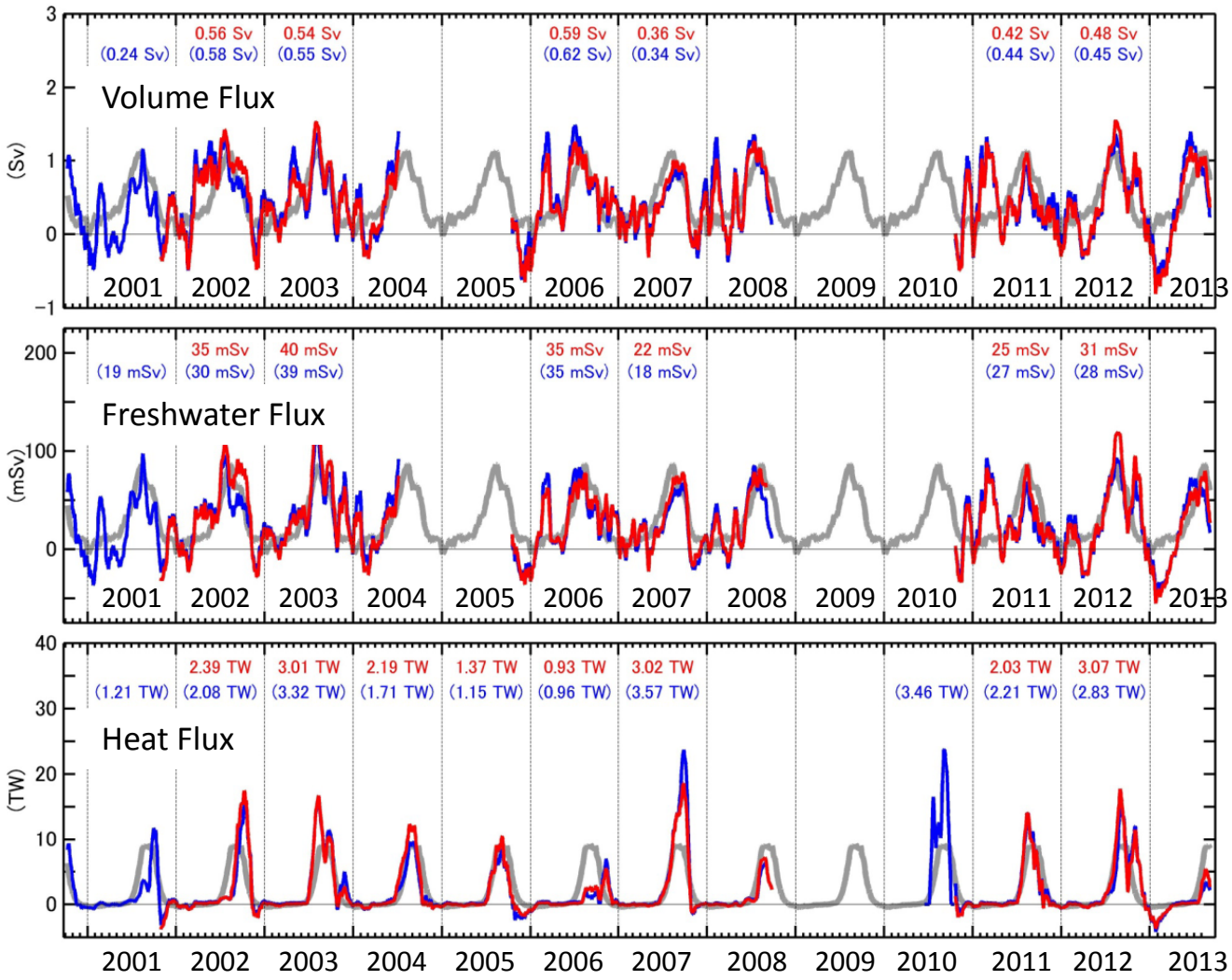
Iwamoto et al. (2014, JGR)

August 2015:

- Replace mooring M2 and recover mooring M1
- Deploy mooring M3 further offshore for the first time
  - →Capture sea ice less influenced by coast and polynya
  - →Comparison with airborne EM data

Courtesy from Dr. Fukamachi (Hokkaido Univ.)

Monitoring of volume, heat and freshwater fluxes through Barrow Canyon by long-term moorings (2000 to present)

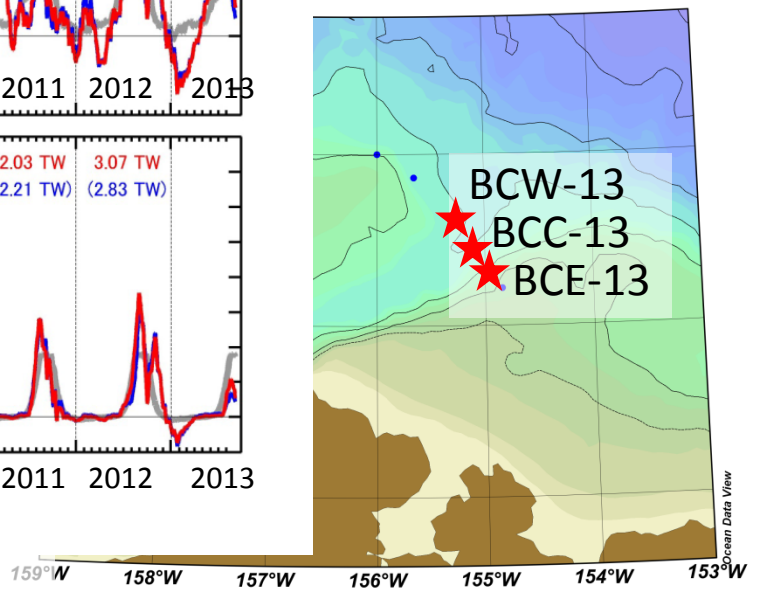


Update from Itoh et al. (2013, *J. Geophys. Res.*)

Yearly averaged fluxes through Barrow Canyon between 2001 and 2012

Volume: 0.48 Sv
Freshwater: 31 mSv
Heat: 2.25 TW

(Updated from Itoh et al., 2013)



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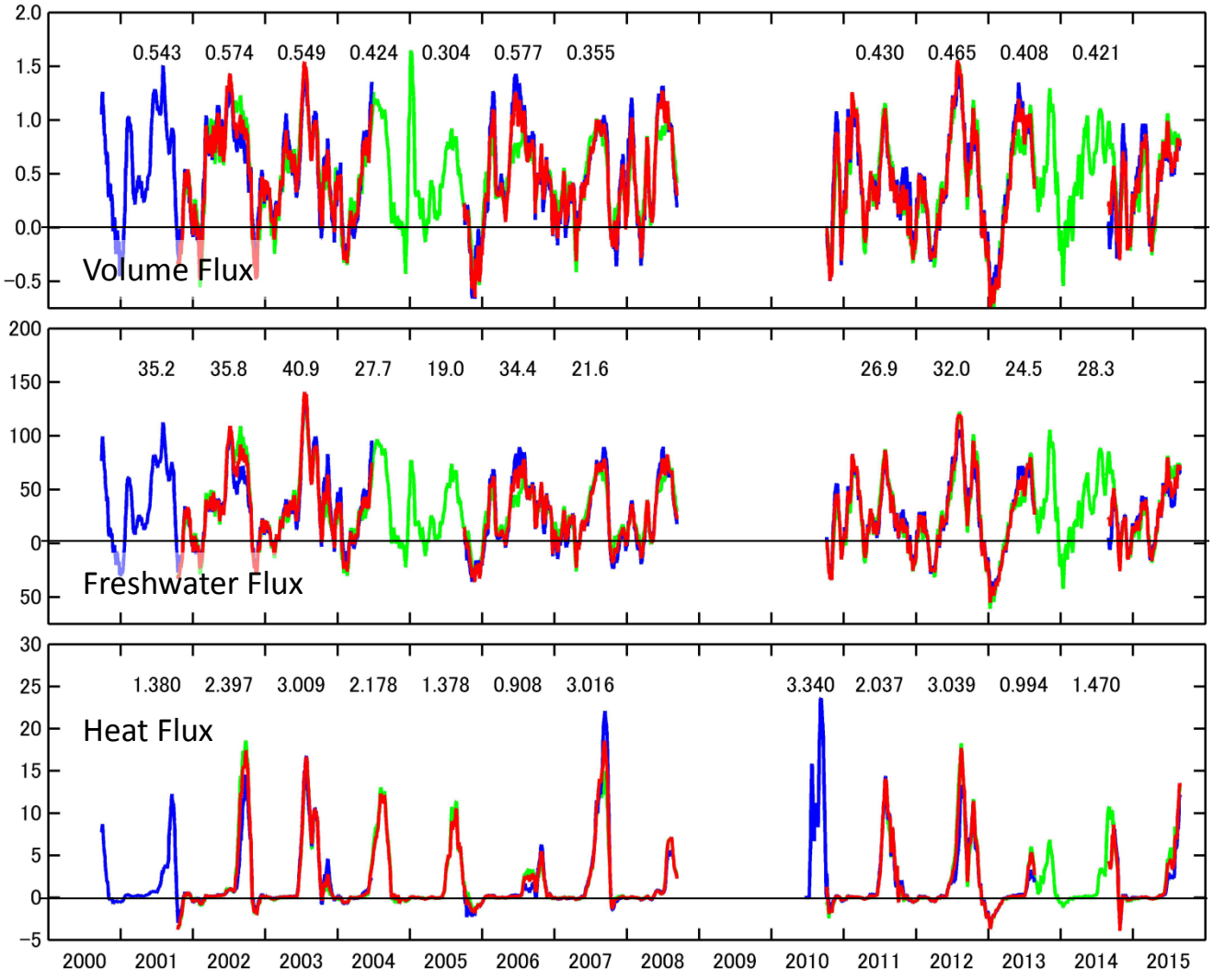
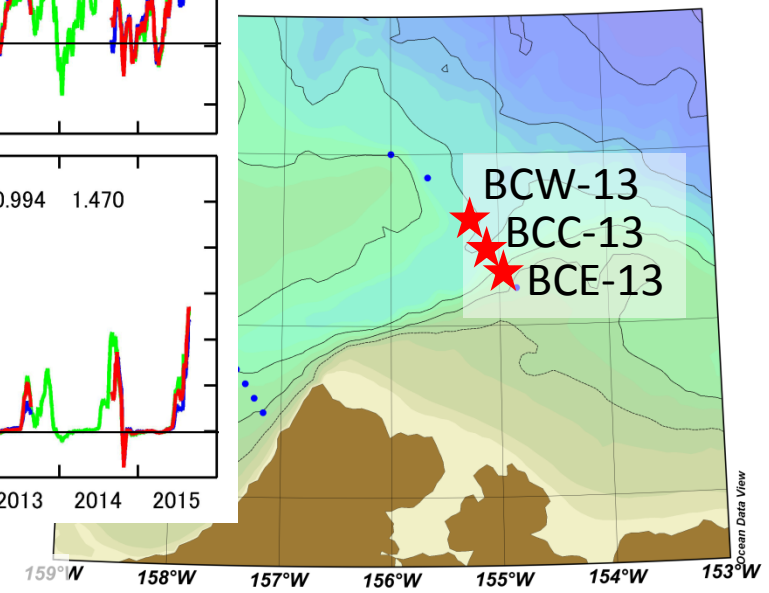


Yearly averaged fluxes through Barrow Canyon between 2001 and 2014

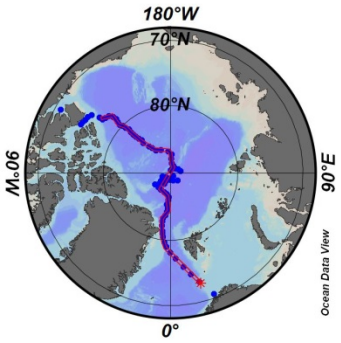
Volume: 0.46 Sv
Freshwater: 29.4 mSv
Heat: 2.10 TW

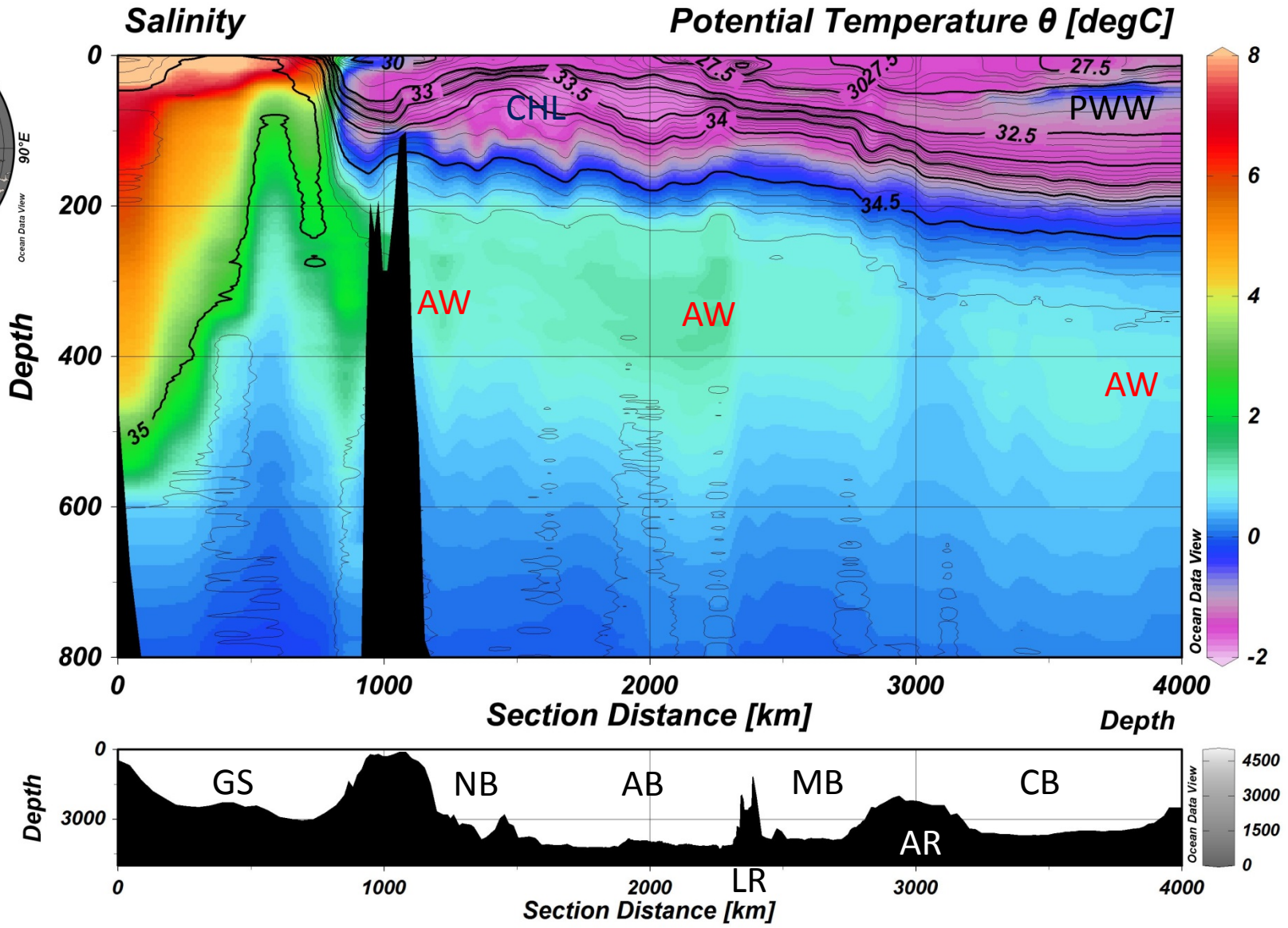
(Updated from Itoh et al., 2013)



Newly update from Itoh et al. (2013, *J. Geophys. Res.*)

XCTD observation across the central Arctic Ocean during CCGS L. S. St.-Lawrant UNCLOS cruise in 2015





Japanese Arctic Ocean observation plan in 2016

1) Japanese research vessel cruise

- **R/V Mirai Arctic cruise in September-October 2016**
  → New Arctic research project, ArCS (Arctic Challenge for Sustainability)

2) Participations in/collaborations with ice-breaker cruises

- **IBRV Araon Arctic cruise;**
- **CCGS Louis S. St.- Laurant cruise;**

Sea ice observation, hydrography & water sampling

3) Others

- **XCTD observation in the Arctic Ocean**
  (CCGS L. S. St.- Laurant & FS Polarstern cruises)

and more ?. . .

Pacific Arctic Group Spring Meeting
April 25, 2015
in Toyama, Japan

北極域研究
推進プロジェクト
Arctic Challenge for Sustainability

Brief introduction of Japanese new Arctic Research Project; ArCS

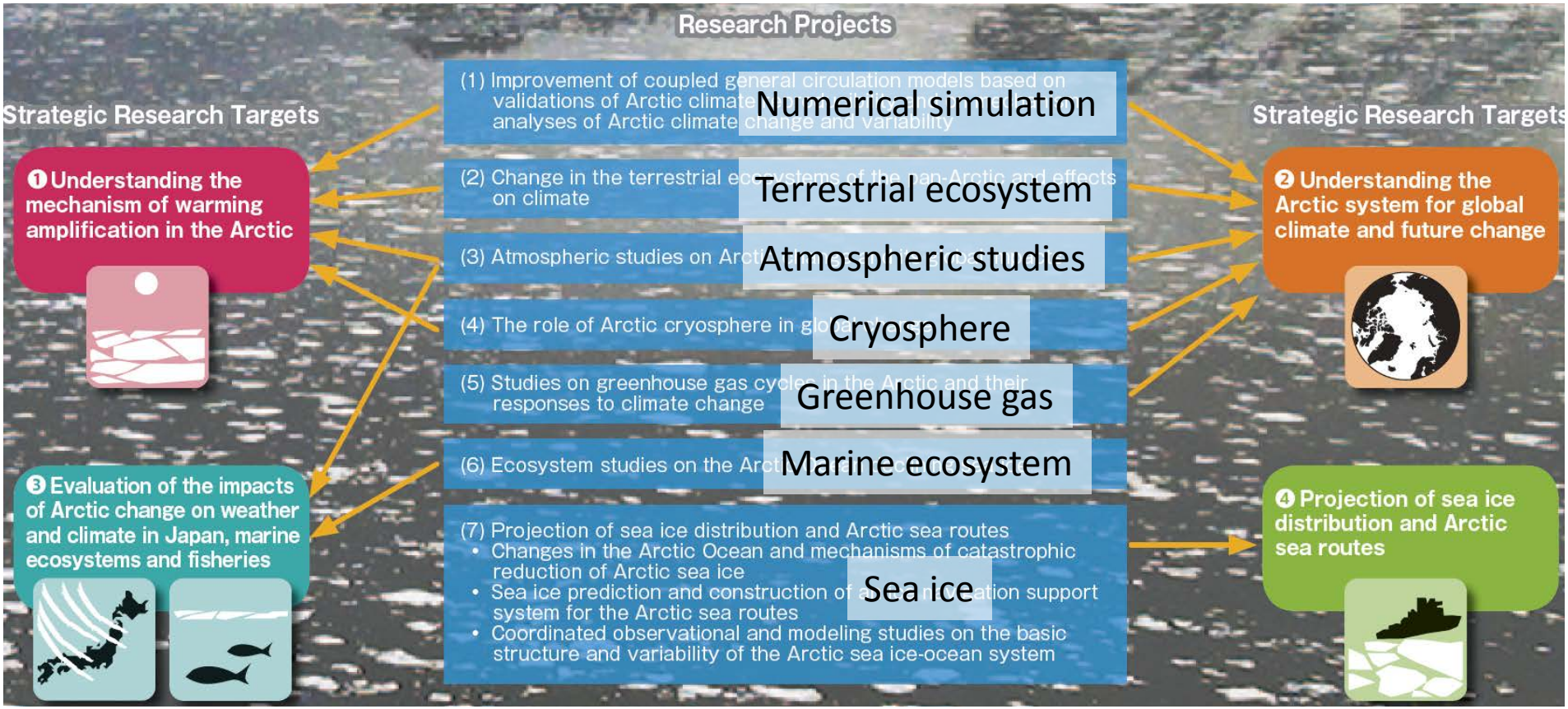
(Arctic Challenge for Sustainability)

Photo at 77.9N, 169.5W on August 30, 2008
during FS Polarstern (Germany) Arctic cruise

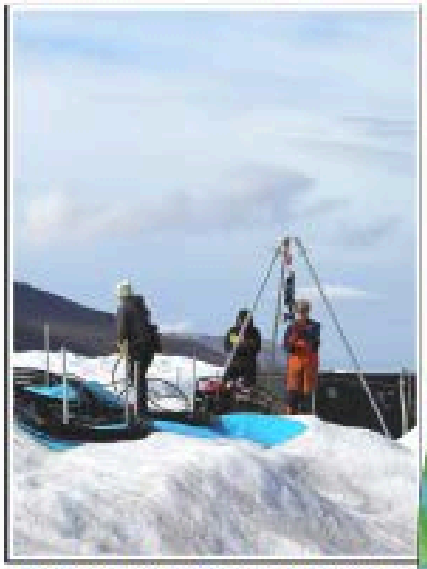
Introduction of GRENE Arctic Research Project (2011-2016)

Green Network of Excellence Program
Arctic Climate Change Research Project (2011-2016)

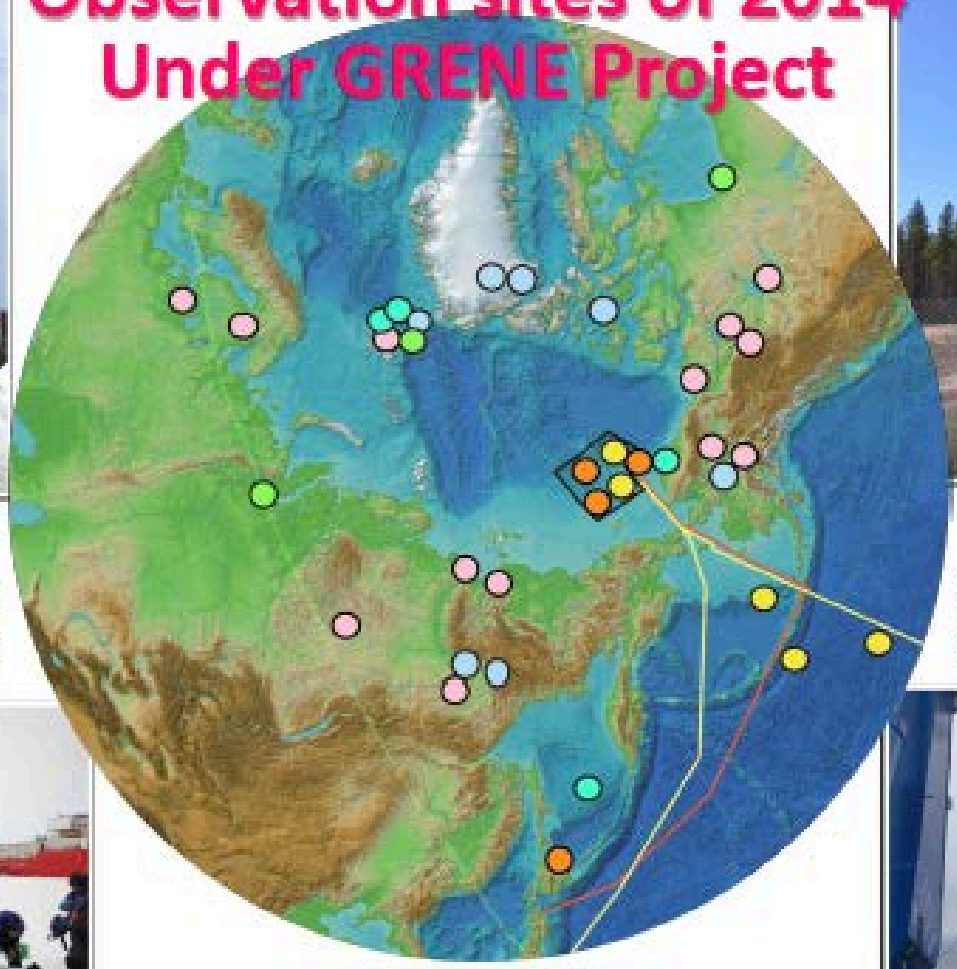
"*Rapid Change of the Arctic Climate System and its Global Influences*"

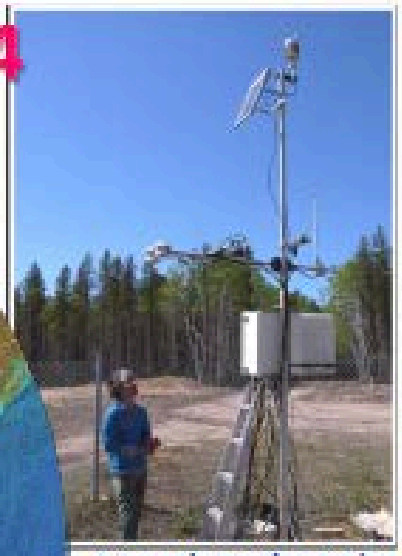


Pan-Arctic observation sites



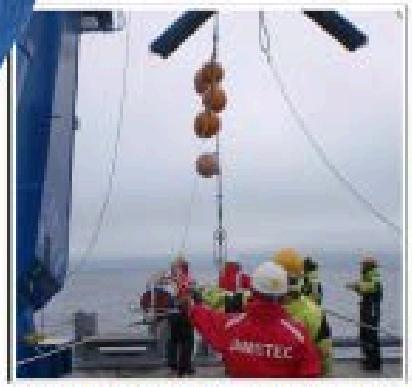
Shallow core drilling on glacier ice
(Cryosphere Theme)





Automatic Weather Station
(Terrestrial Theme)

Sea ice observation near ice breaker
(Sea Ice and Arctic Sea Routes Theme)

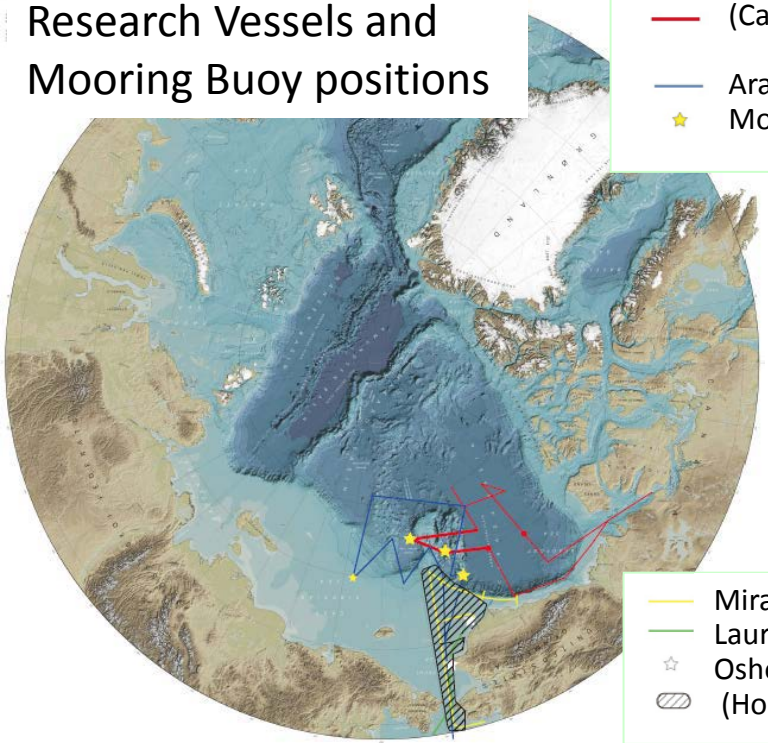


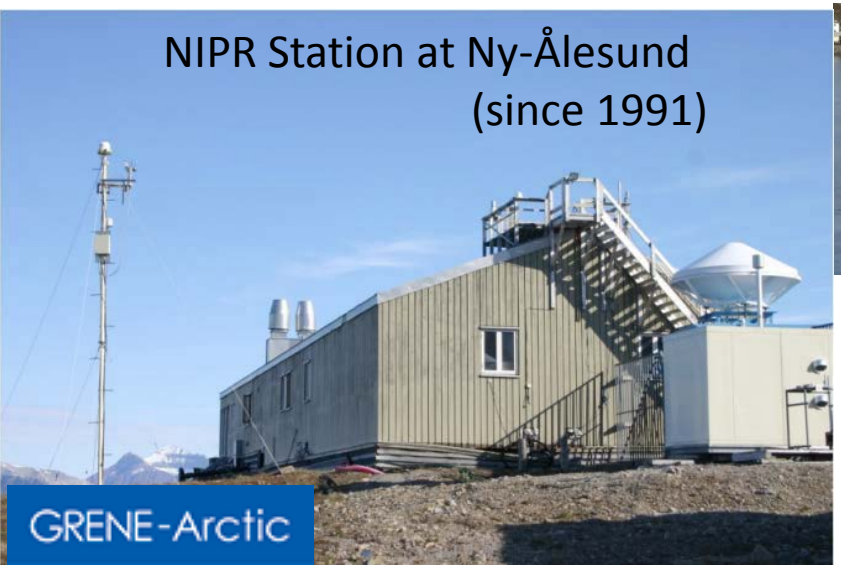
Buoy deployment from R/V "Mirai"
(Marine Ecosystem Theme)

GRENE-Arctic

Infrastructure: Research vessel, icebreaker and mooring buoy

Research Vessels and Mooring Buoy positions





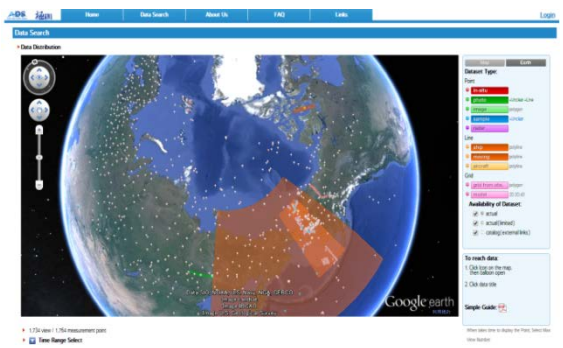
※ Participation in/ collaboration with Icebreaker cruises.
CCGS Louis S. St-laurent (Canadian Coast Guard): Heavy icebreaker
CCGS Amundsen (Canadian Coast Guard): Icebreaker
CCGS Sir Wilfrid Laurier (Canadian Coast Guard): Light Icebreaker
RV Araon (Korea): Icebreaker, USCGC Healy (US): Icebreaker,
FS Polarstern (Germany): Icebreaker,

Infrastructure: Data archive System(ADS)

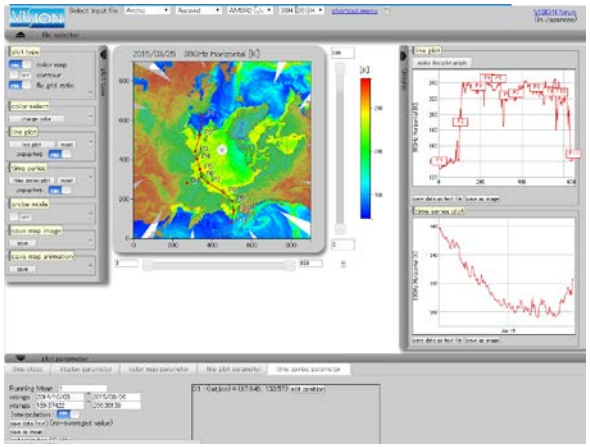
(https://ads.nipr.ac.jp/)

NiPR National Institute of Polar Research → ADS Arctic Data archive System

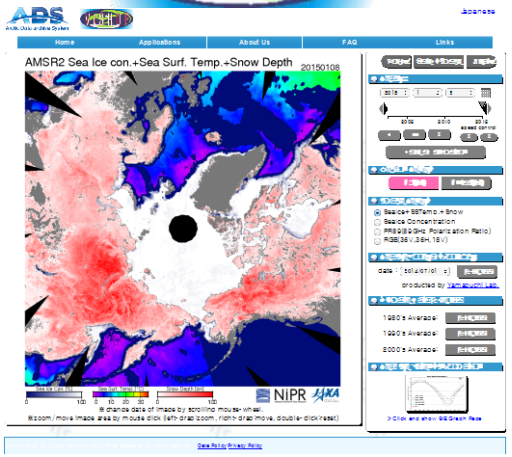
(Visualization service to view satellite data)



Research data registration system and Metadata search service.
Registered more than 250 datasets



Online visualization application for Climate, Satellite and Simulation data



Semi-real-time polar environ. obs. Monitor and Sea Ice prediction

+ Correcting the data also from the previous projects (Data rescue).
+ Joining the project to invest *doi* number to dataset (to encourage data registration).
+ continued after the GRENE Arctic project.

New initiative for the research promotion in the Arctic

- **Japan was granted observer status at the Arctic Council, in 2013.**

  → Enhanced contribution to the Arctic international community with Science & Technology

- New project started in FY2015

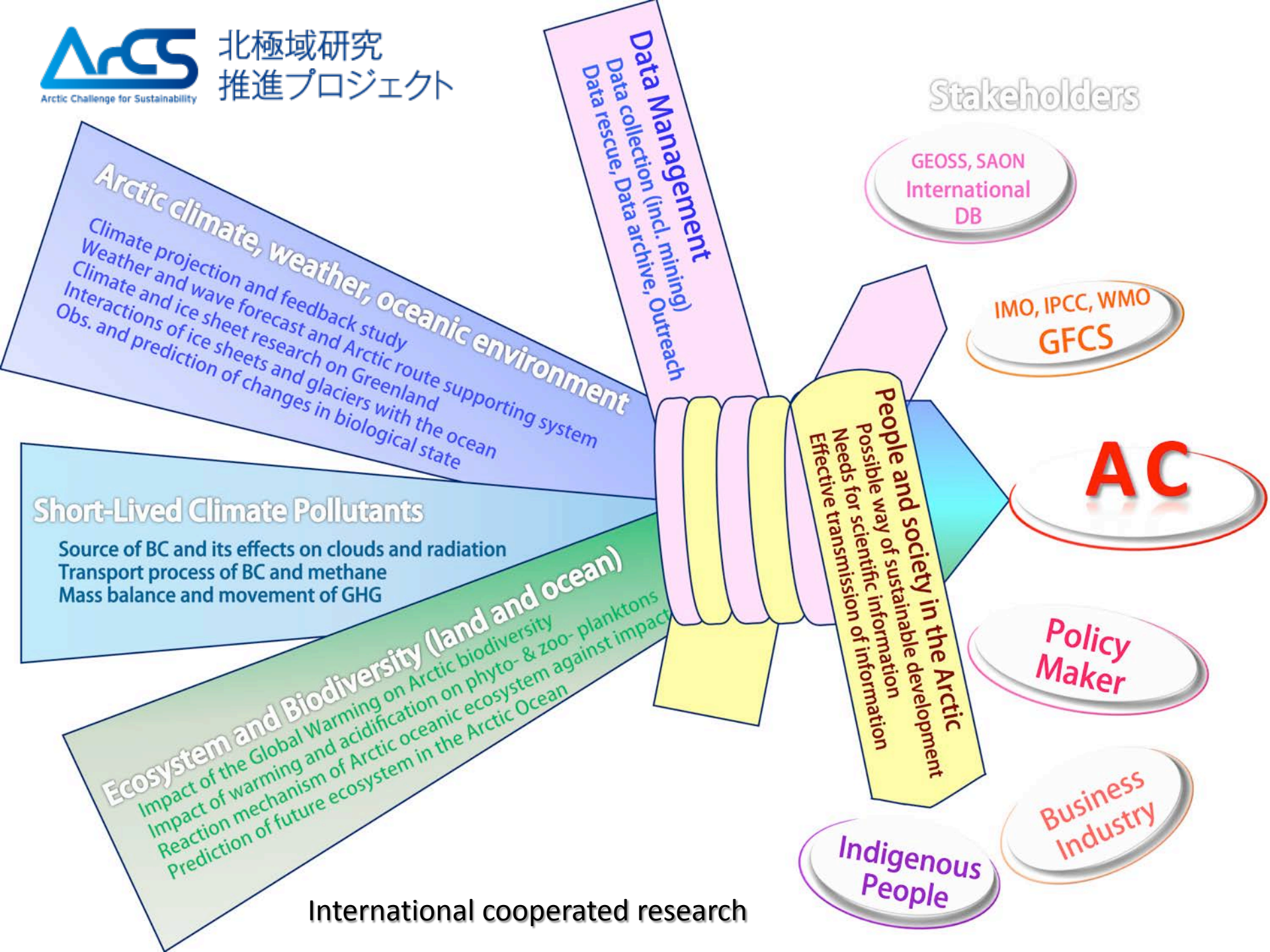
  → **ArCS (Arctic Challenge for Sustainability)**

- To deliver **the robust scientific information to stakeholders** (policy makers, AC WGs &TFs, industries, users, people, etc) for decision making and problem solving

- **Following points will be stressed;**

  - Proactive international cooperation
  - Stakeholder linkage
  - Trans-disciplinal team(incl. social science)
  - Science communication
  - Data management
  - Inter-link to “global” studies

ArCS Arctic Challenge for Sustainability 北極域研究推進プロジェクト


ArCS
Arctic Challenge for Sustainability
北極域研究
推進プロジェクト
Data Management
Data collection (incl. mining)
Data rescue, Data archive, Outreach
Arctic climate, weather, oceanic environment
Climate projection and feedback study
Weather and wave forecast and Arctic route supporting system
Climate and ice sheet research on Greenland
Interactions of ice sheets and glaciers with the ocean
Obs. and prediction of changes in biological state
Short-Lived Climate Pollutants
Source of BC and its effects on clouds and radiation
Transport process of BC and methane
Mass balance and movement of GHG
Ecosystem and Biodiversity (land and ocean)
Impact of the Global Warming on Arctic biodiversity
Impact of warming and acidification on phyto- & zoo- planktons
Reaction mechanism of Arctic oceanic ecosystem against impact
Prediction of future ecosystem in the Arctic Ocean
People and society in the Arctic
Possible way of sustainable development
Needs for scientific information
Effective transmission of information
Stakeholders
GEOSS, SAON
International
DB
IMO, IPCC, WMO
GFCS
AC
Policy
Maker
Business
Industry
Indigenous
People
International cooperated research

Contribution to AMAP (& other AC WG) activities

1. Experts contribution for making the science reports to AC

[Previous contributions]

- Arctic Climate Impact Assessment (ACIA), 2004
- Snow, Water, Ice, and Permafrost in the Arctic (SWIPA), 2011
- Arctic Ocean Acidification (AOA), 2013

[On-going contributions]

- Adaptation Action for Changing Arctic (AACA) -C regional reports
  e.g., Beaufort/Chukchi/Bering regional report
- SWIPA Follow up report for AC 2017
- AOA Follow up report for AC 2017

2. Participation in the AC WG meetings as observers
   - ✓ AMAP, CAFF, PAME, and other expert groups (e.g., EBM expert)

※ Contribution to the IASC Council and WG since 1991
   - ✓ Hosting ASSW 2015 in Toyama

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and more ?. . .

Courtesy from Dr. Watanabe (JAMSTEC)

Method

Pan-Arctic Eddy-resolving Model

Pan-Arctic Sea Ice-Ocean Model COCO

Center for Climate System Research Ocean Component Model version 4.9

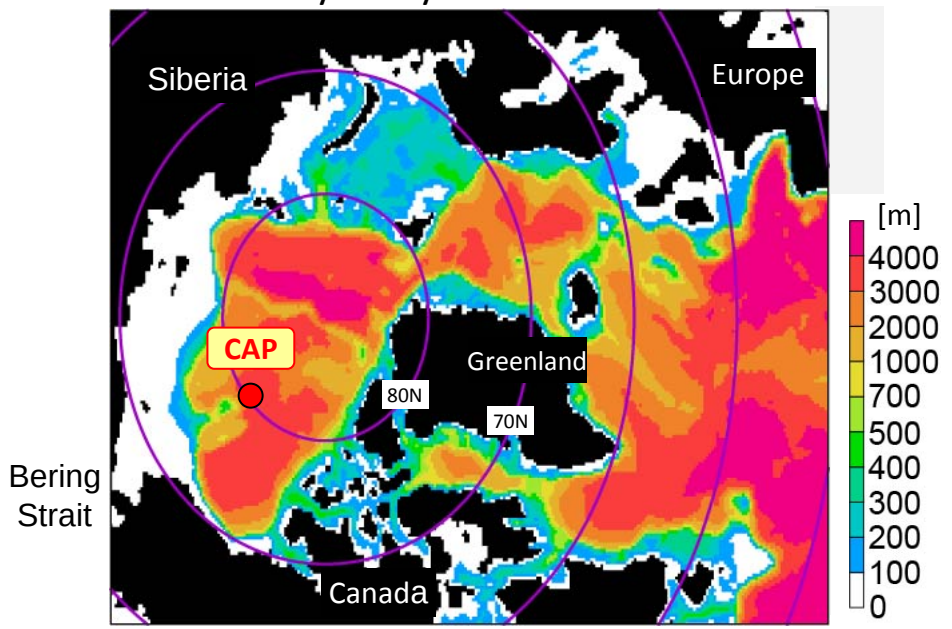
Sea Ice Part
- 1 layer thermodynamics [Lipscomb et al., 2001]
- EVP rheology [Hunke and Duckwicz, 1997]
- 7 thickness category [Bitz et al., 2001]

Ocean Part
- free surface general circulation model
- UTOPIA/QUICKEST advection scheme
- turbulence closure scheme [Noh and Kim, 1999]

(for eddy-resolving configuration)
- Smagorinsky harmonic viscosity [Griffies, 2000]
- Enstrophy preserving scheme [Ishizaki and Motoi, 2001]

Experimental Design
- NCEP/CFSR atmospheric daily forcing
- AOMIP river water discharge
- Pacific water inflow at Bering Strait
- Sponge layer in Atlantic side
- Shelf-break water tracer

Model bathymetry



Spin up exp. 1979 forcing — 10 yrs

Decadal exp. 1979-2014 — 36 yrs

25 km

EARTH SIMULATOR

Interannual exp. 2010 Jan. - 2014 Dec. — 5 yrs

5 km

1280 x 1024 x 42 grids

nature COMMUNICATIONS

ARTICLE

Received 12 Dec 2013 | Accepted 25 Apr 2014 | Published 27 May 2014

DOI: 10.1038/ncomms4950

OPEN

Enhanced role of eddies in the Arctic marine biological pump

Eiji Watanabe[1,*], Jonaotaro Onodera[1,*], Naomi Harada[1], Makio C. Honda[1], Katsunori Kimoto[1], Takashi Kikuchi[1], Shigeto Nishino[1], Kohei Matsuno[2,3], Atsushi Yamaguchi[3], Akio Ishida[1,4] & Michio J. Kishi[1,3]

The future conditions of Arctic sea ice and marine ecosystems are of interest not only to climate scientists, but also to economic and governmental bodies. However, the lack of widespread, year-long biogeochemical observations remains an obstacle to understanding the complicated variability of the Arctic marine biological pump. Here we show an early winter maximum of sinking biogenic flux in the western Arctic Ocean and illustrate the importance of shelf-break eddies to biological pumping from wide shelves to adjacent deep basins using a combination of year-long mooring observations and three-dimensional numerical modelling. The sinking flux trapped in the present study included considerable fresh organic material with soft tissues and was an order of magnitude larger than previous estimates. We predict that further reductions in sea ice will promote the entry of Pacific-origin biological species into the Arctic basin and accelerate biogeochemical cycles connecting the Arctic and subarctic oceans.

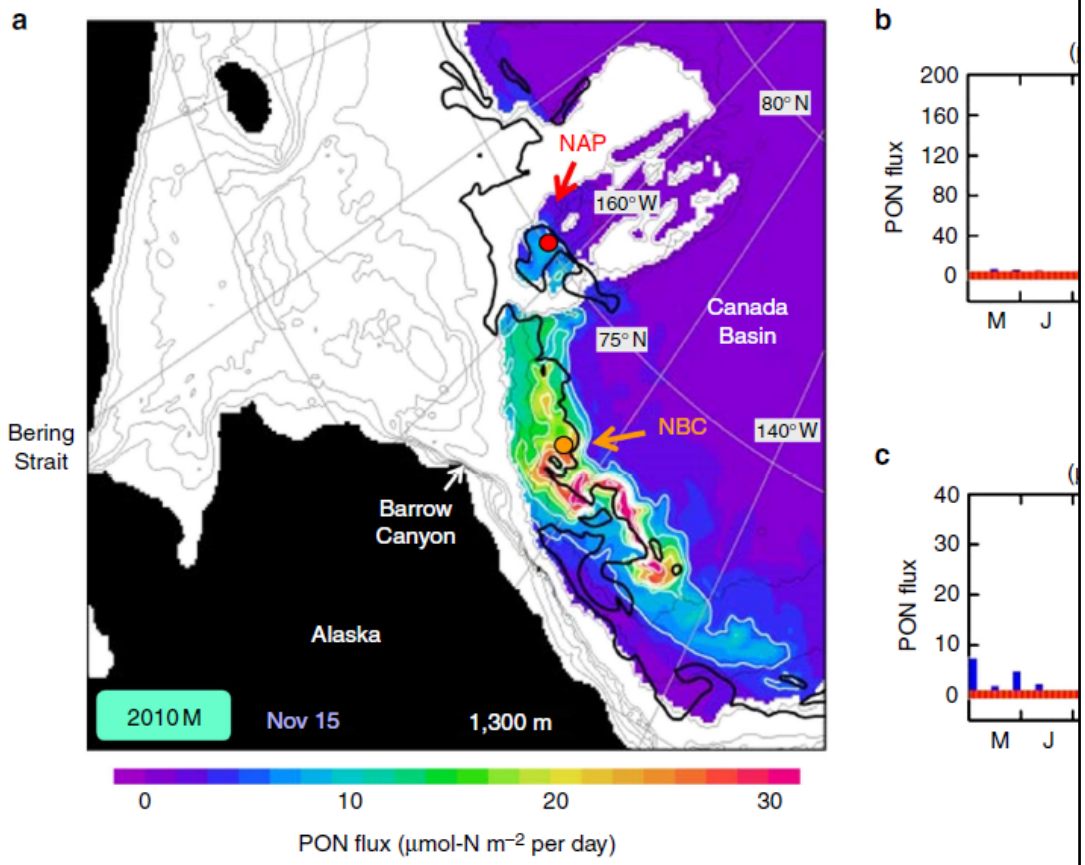


Figure 3 | Modelled PON flux. (**a**) PON flux at a depth of 1,300 m on 15 November in the 2010 M case (μmol-N concentration of shelf bottom water at 150 m depth is 0.1 along black contours. Thin grey contours show sea bottc series at (**b**) 180 and (**c**) 1,300 m depths; pink and blue bars represent the observed fluxes in 2010 and 2011, resp 2010 M case at Station NAP and north of Barrow Canyon (NBC) are shown by solid red and dashed orange lines,

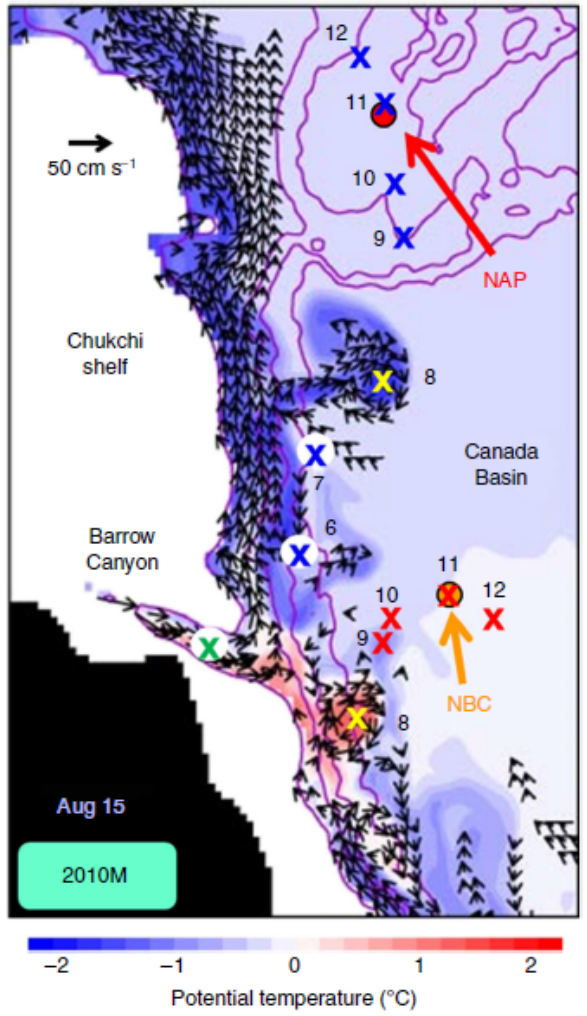


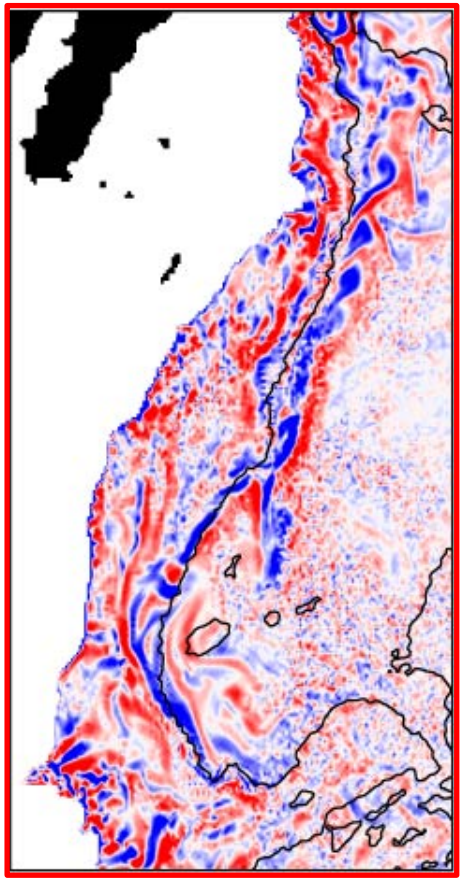
Figure 4 | Pathway of shelf-break eddies. Potential temperature (°C) (colour bar) and ocean horizontal velocity at a 100 m depth on August 15 in the 2010 M case. The unit vector is 50 cm s^{-1} and vectors of velocity less than 5 cm s^{-1} are hidden. Blue (red) crosses indicate the locations of cold (warm) eddy centres in each month (for example, '6' denotes 15 June, '7' denotes 15 July and so on). Yellow crosses are those on August 15, which is the same date as temperature and velocity plots. A green cross in the Barrow Canyon is referred in Supplementary Fig. 5. Purple contours show water depths of 100, 500, 1,000 and 2,000 m.

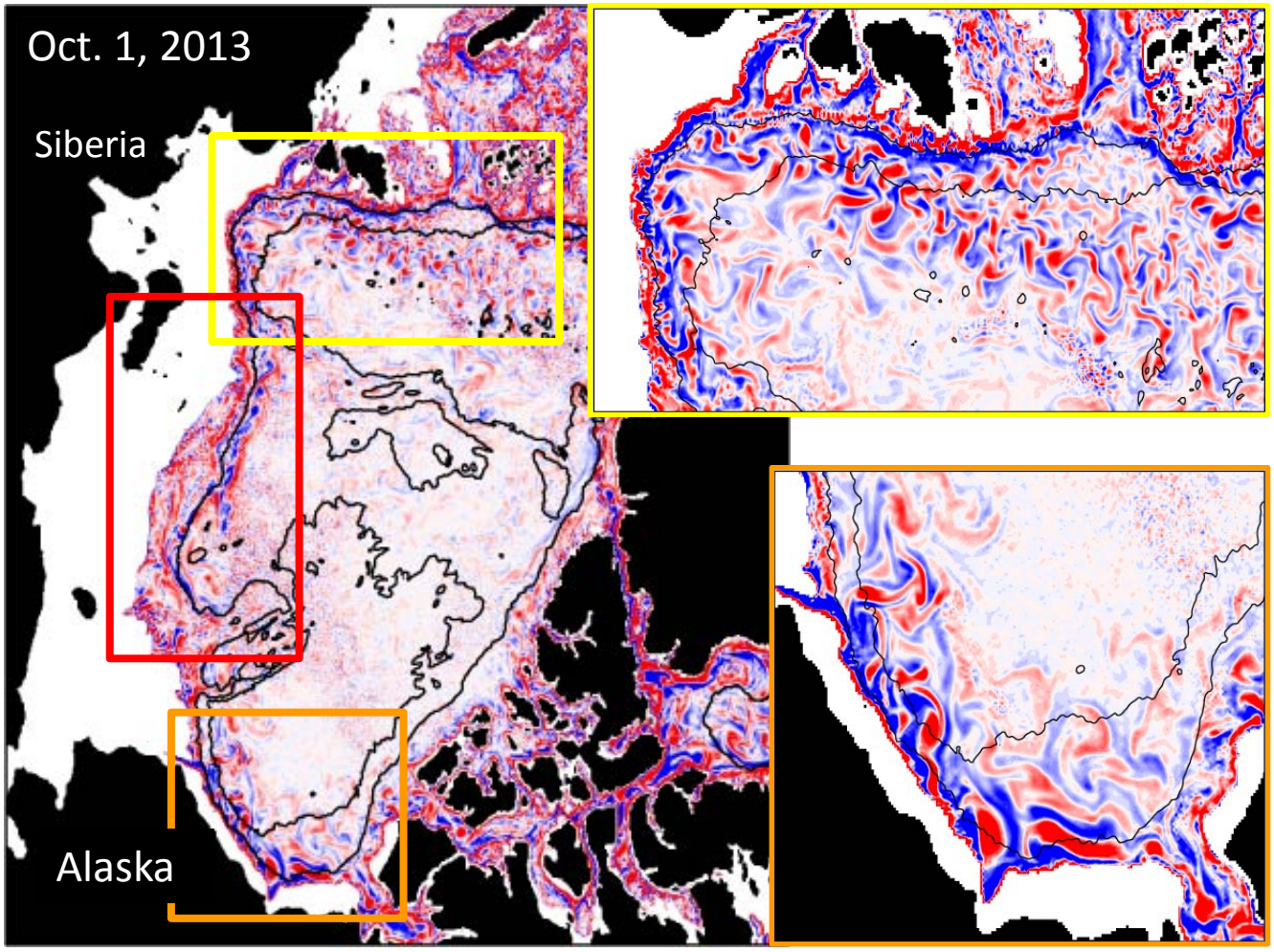
Watanabe, Onodera, et al., 2014
Enhanced role of eddies in the Arctic marine biological pump,
Nature Communications, 5, 3950, doi: 10.1038/ncomms4950

Courtesy from Dr. Watanabe (JAMSTEC)

Result

Shelf-break Eddy Properties





Relative vorticity
at 100m depth

-0.1f anti-cyclonic 0 cyclonic 0.1f