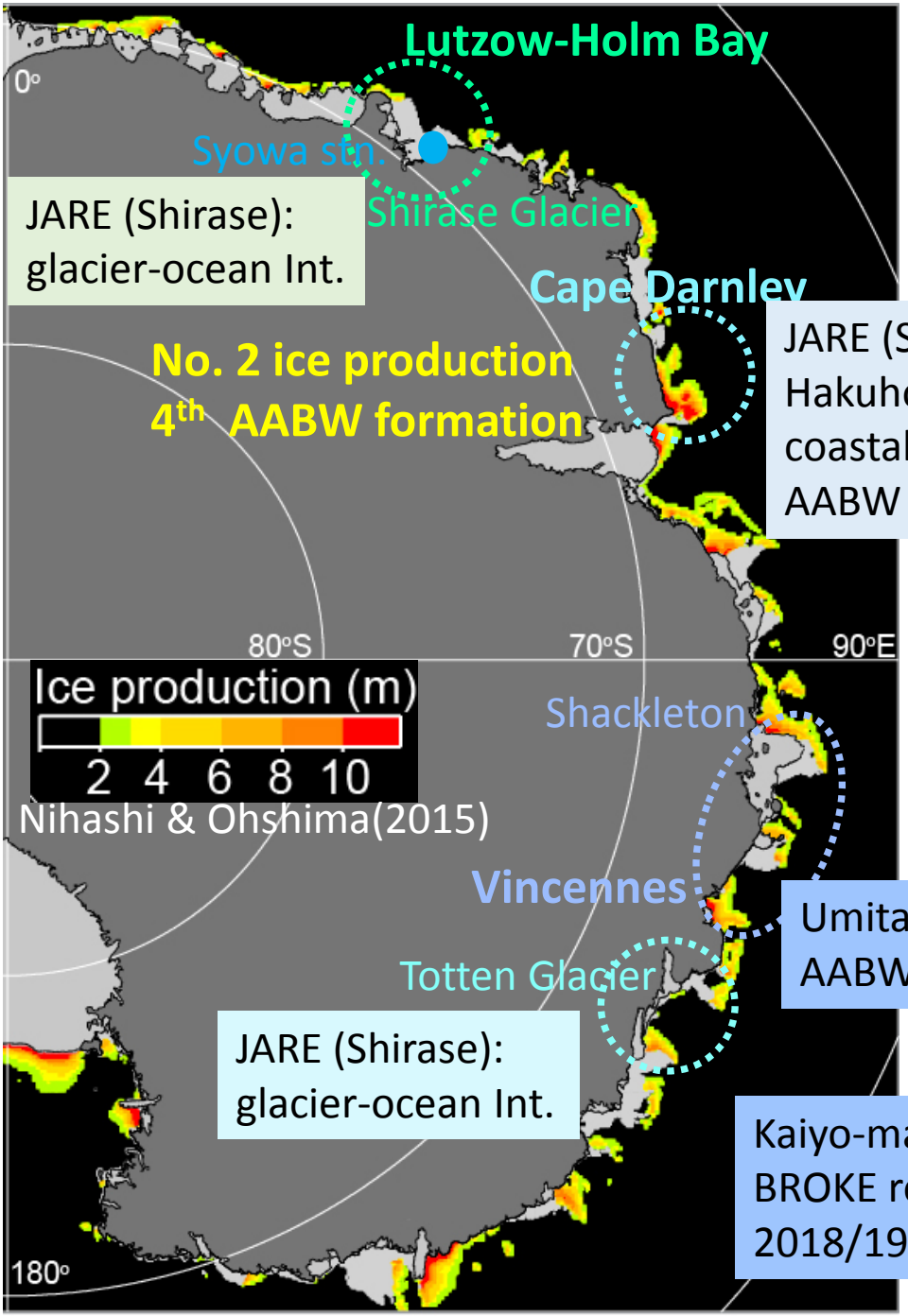
Japanese recent activities and future plan:

Direct observations of coastal polynyas and glacier-ocean interaction in the East Antarctica

K. I. Ohshima (Hokkaido University)



Field observations

1. Cape Darnley: Polynya ice production→ AABW formation
   on-going Mooring array, CFC & SF6 measurements
2. Lutzow-Holm Bay: Shirase Glacier- sea ice-ocean interaction
   on-going Polar Ocean Profiling System (POPS)
3. Vincennes & Shackleton: AABW formation?
   on-going Mooring of huge CTD chain
4. Totten Glacier: Glacier- sea ice-ocean interaction
   planned(2020)

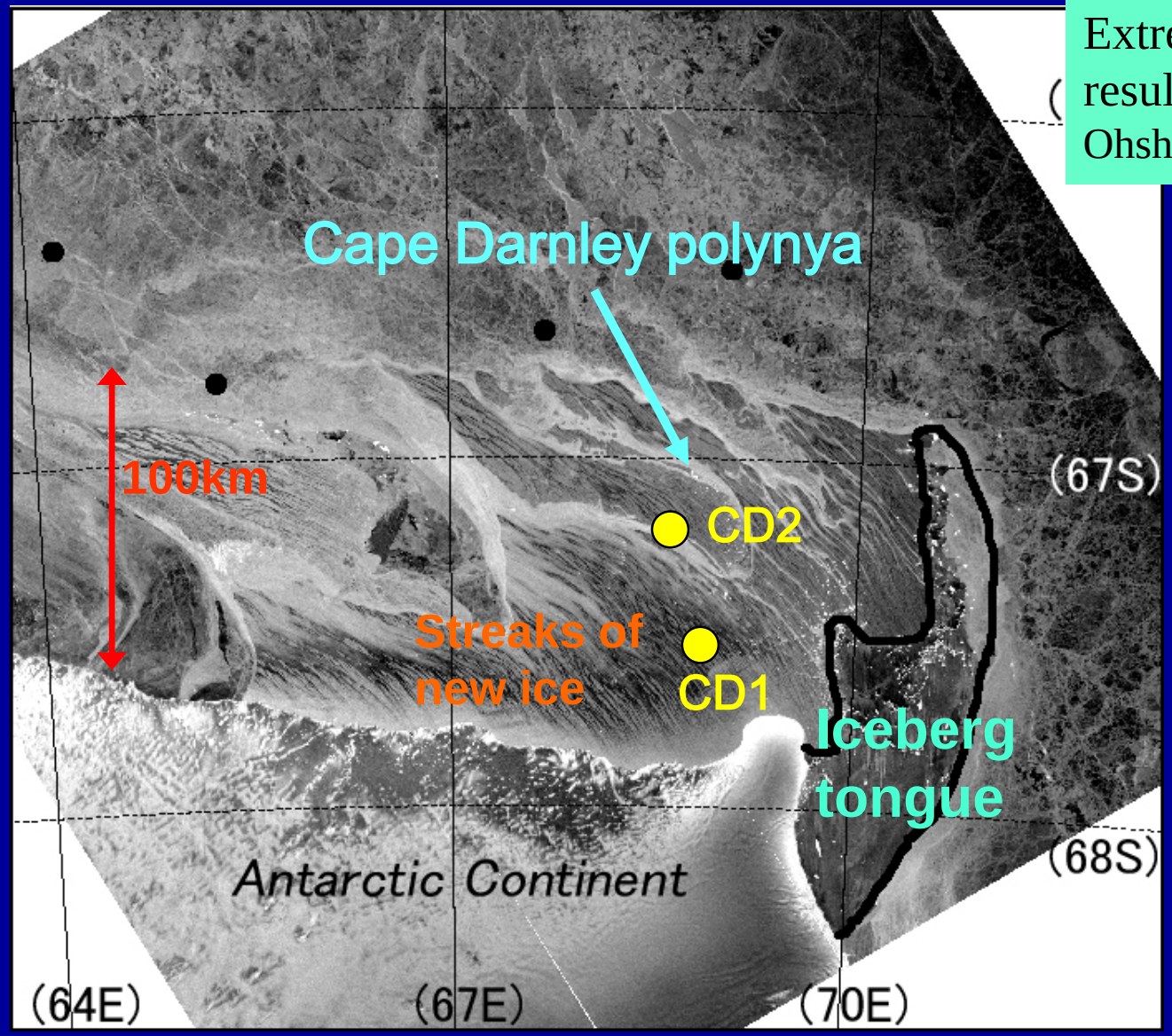
Projects of 1,2, 4 are conducted by ROBOTICA, JARE(Japanese Antarctic Research Expedition)

Satellite observations

Circumpolar mapping of sea-ice production

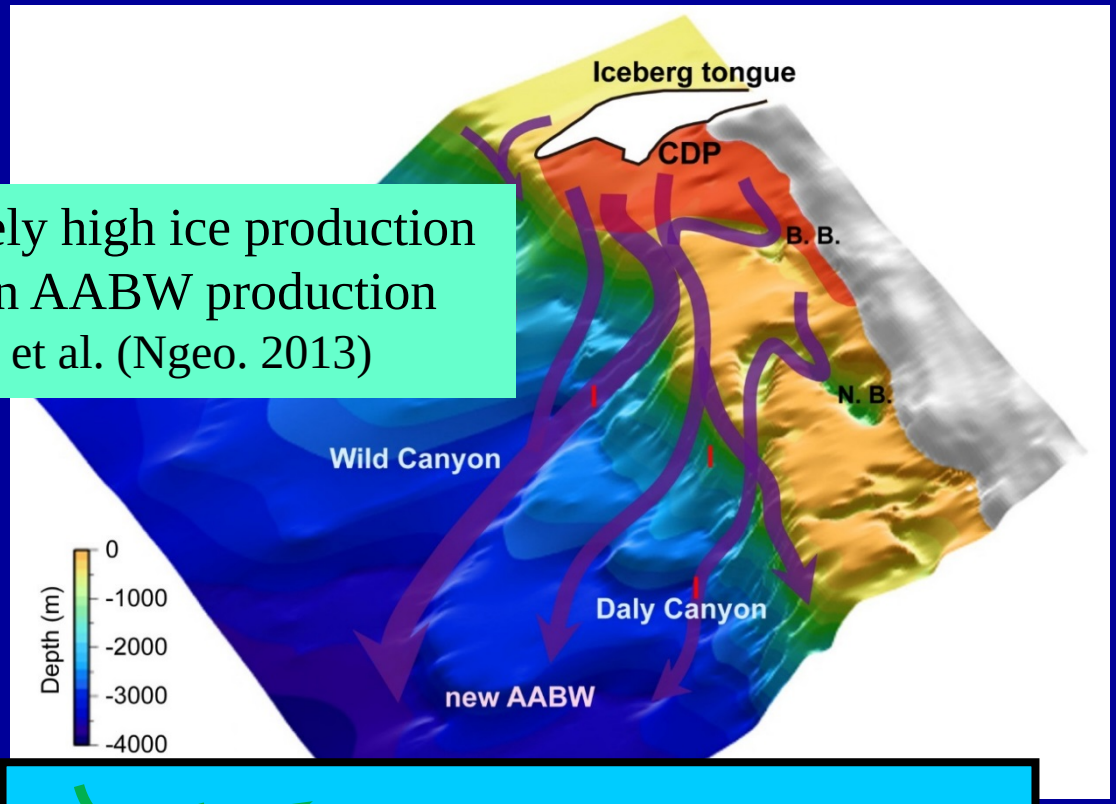
- Long-term variability (SSM/I → AMSR-E →AMSR2 → ?
- Discrimination of ice type: Detection of frazil ice

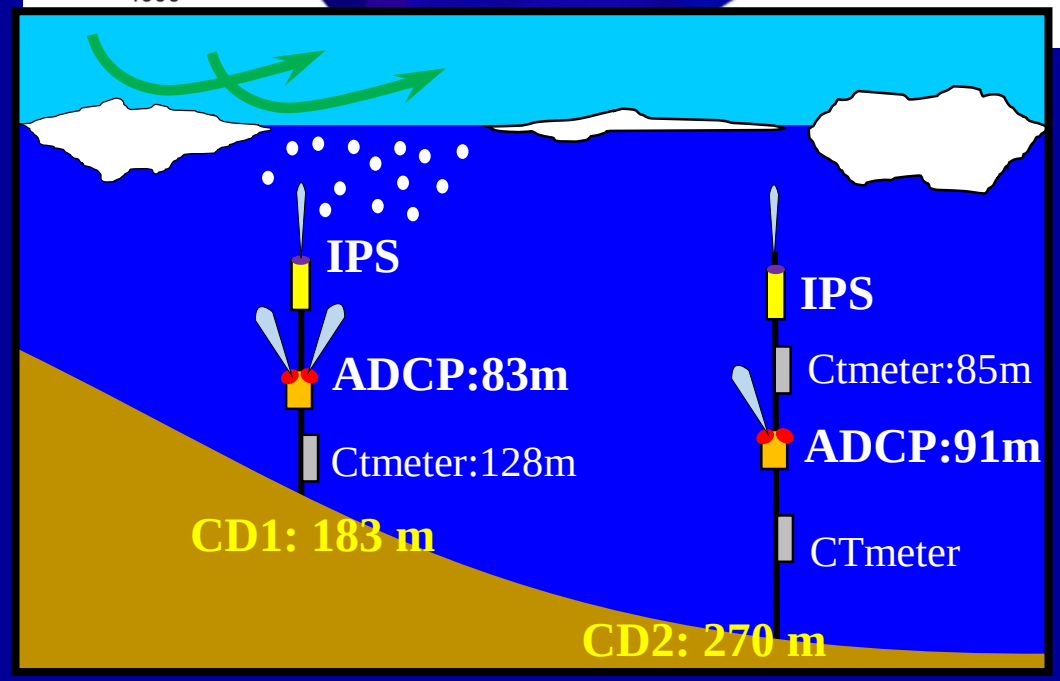
Cape Darnley Polynya→ 4th AABW
Why such high ice production occur?



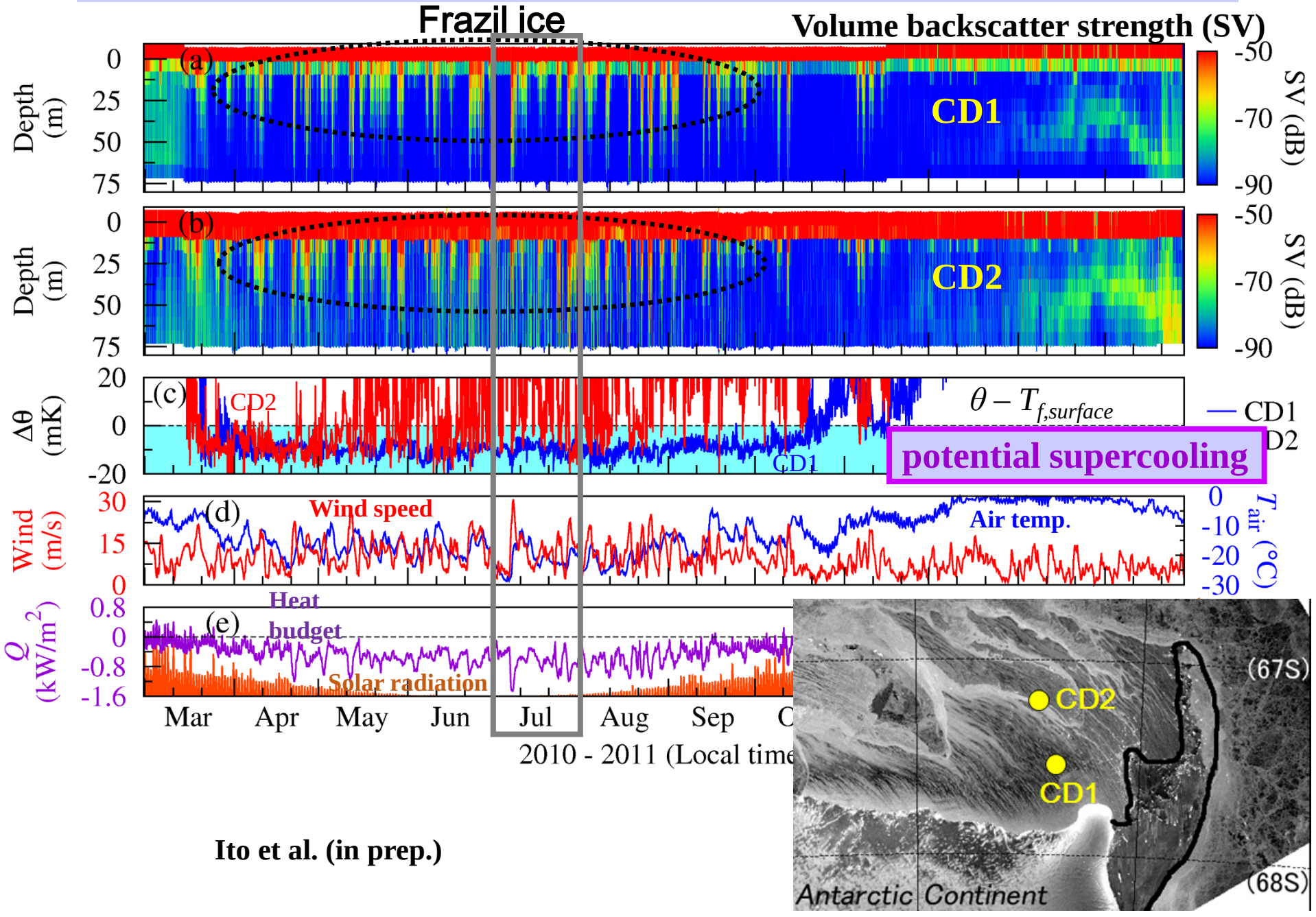
ALOS PALSAR

Extremely high ice production results in AABW production
Ohshima et al. (Ngeo. 2013)



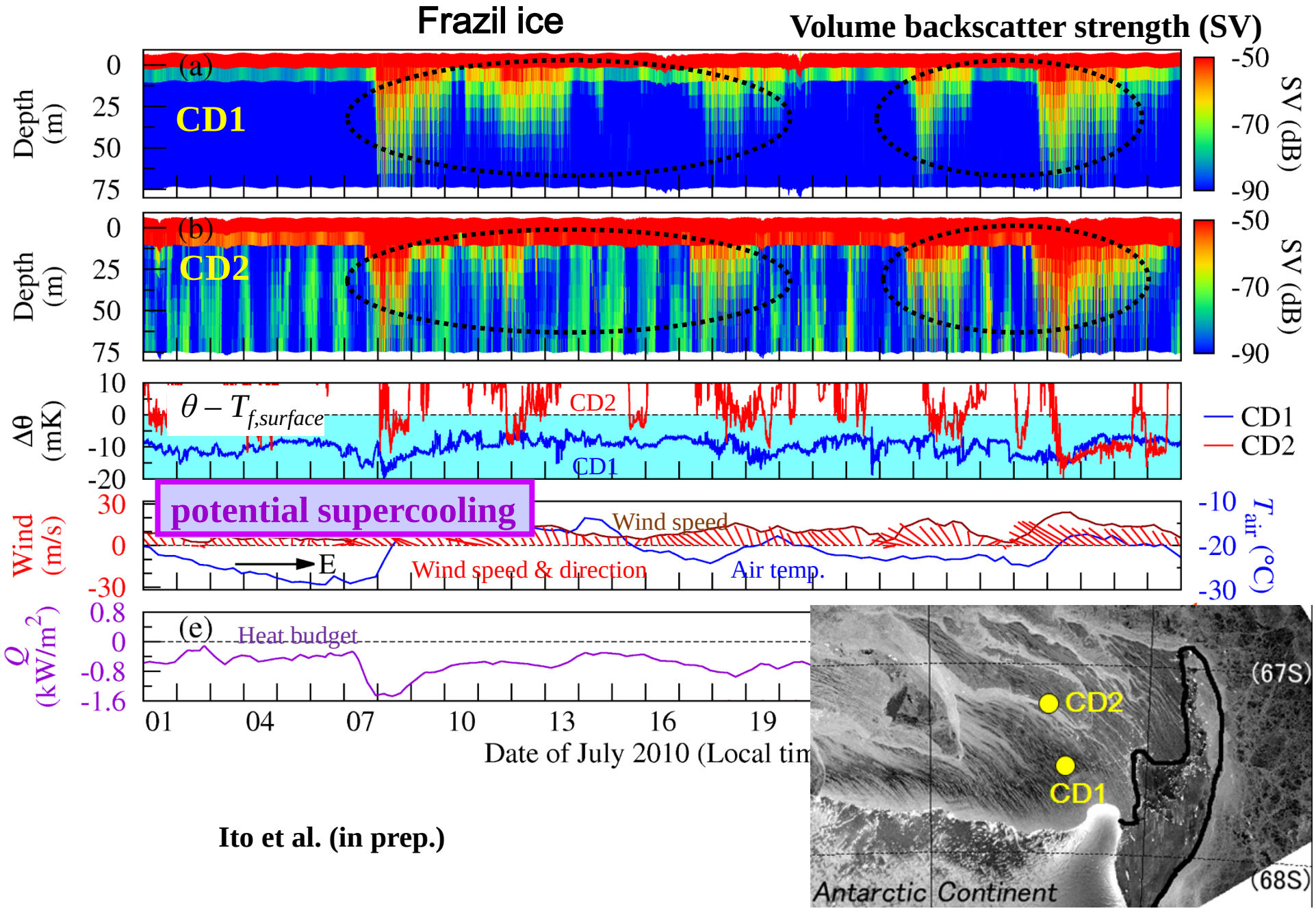


Backscattering of ADCP moored at Cape Darnley polynya, Antarctica



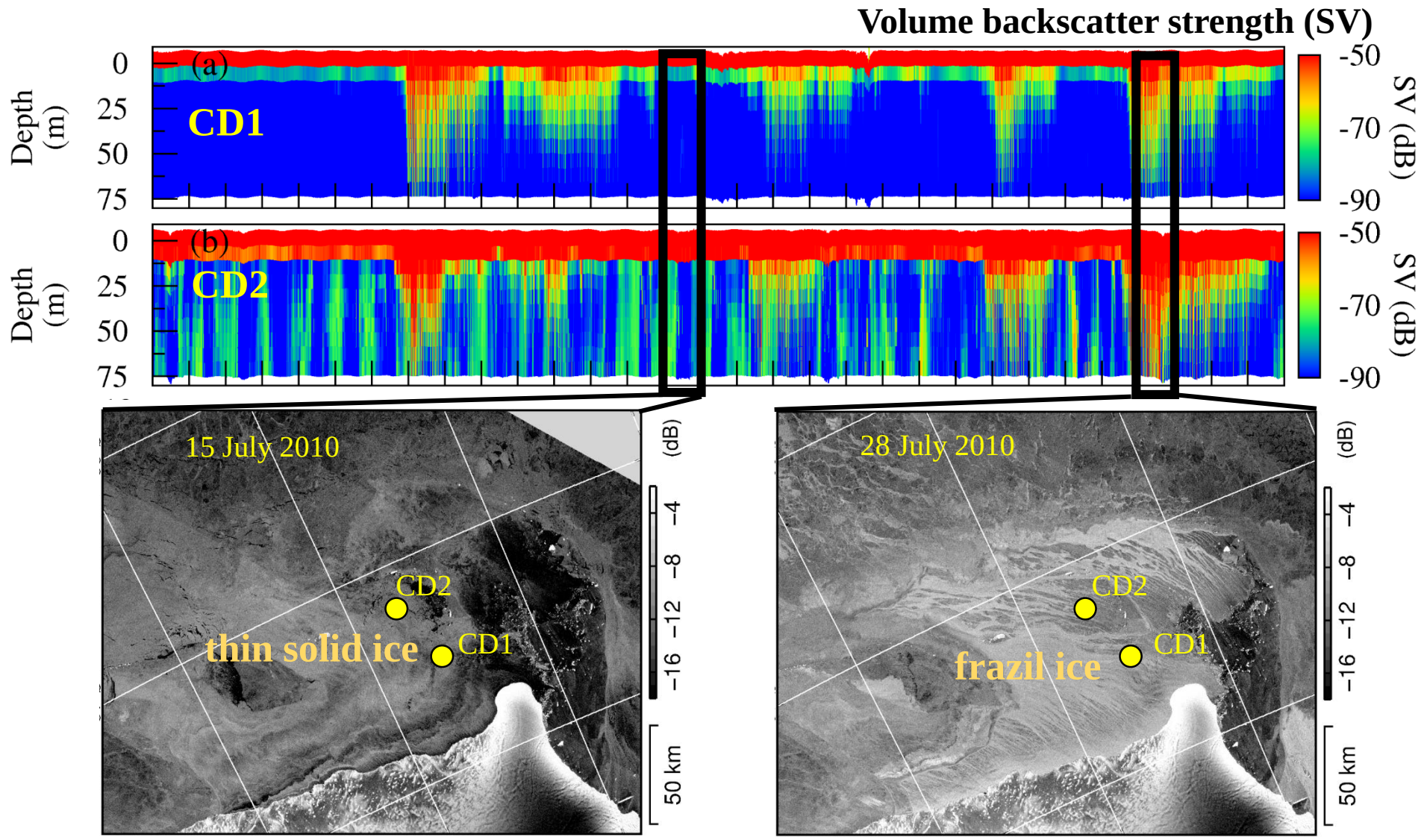
Ito et al. (in prep.)

Backscattering of ADCP moored at Cape Darnley polynya, Antarctica



Ito et al. (in prep.)

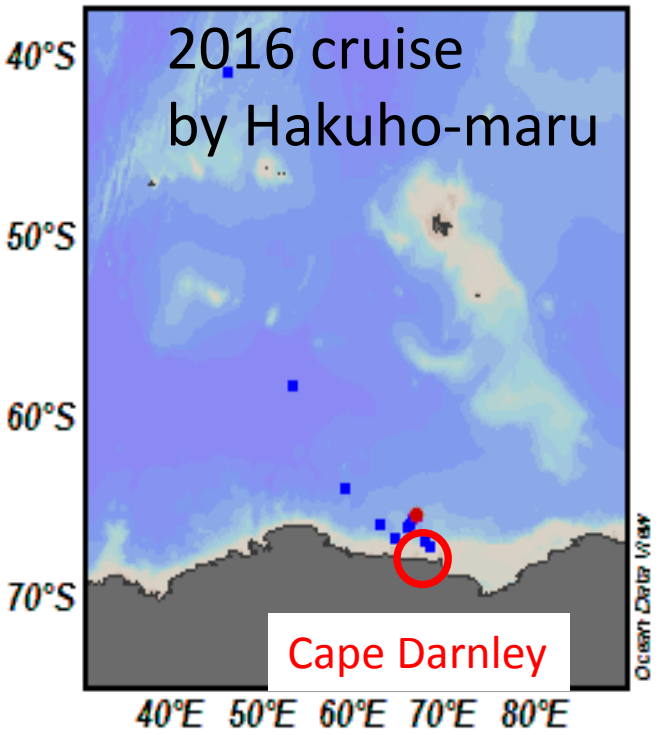
Backscattering of ADCP moored at Cape Darnley polynya, Antarctica



ASAR from ESA

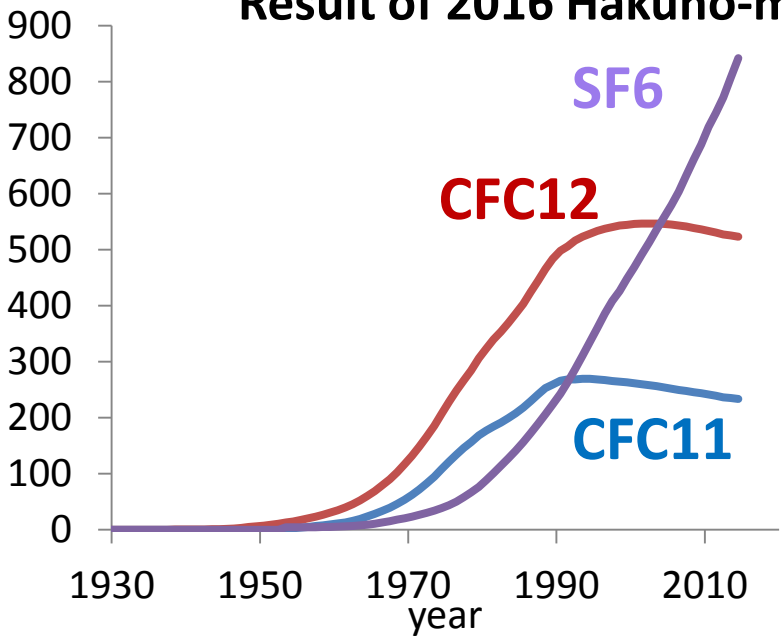
Ito et al. (in prep.)

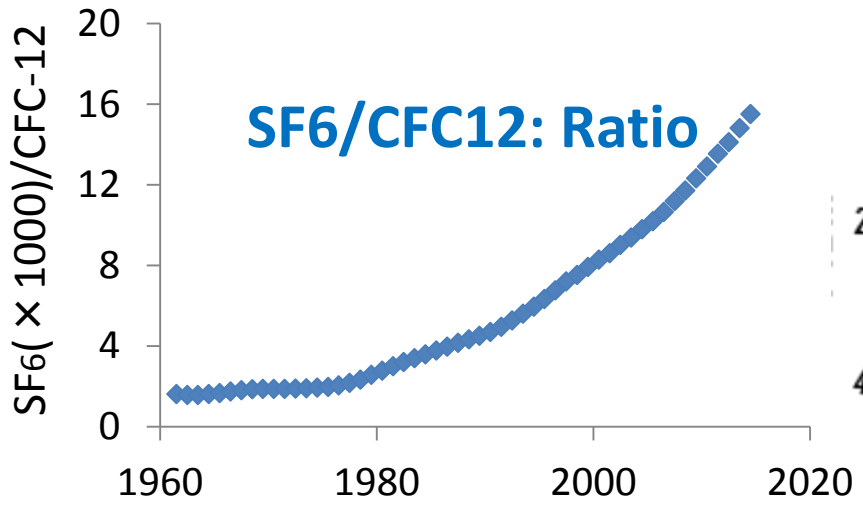
Estimation of water mass age by CFC & SF_6 off Cape Darnley (AABW formation site)



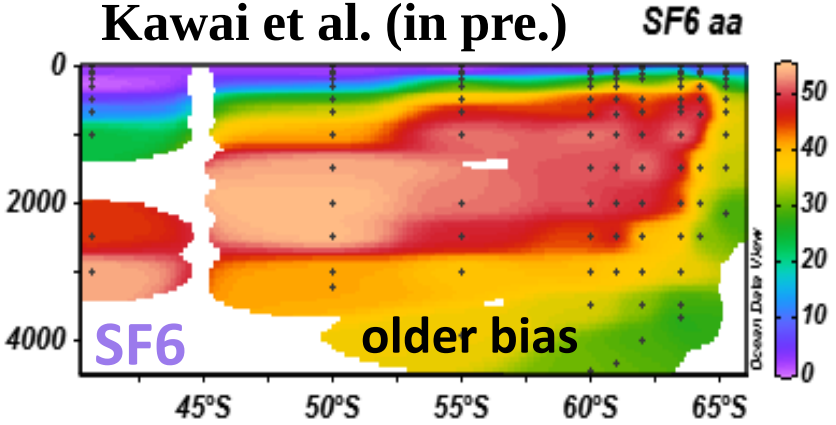
More extensive observations (CFC, SF6, mooring array) are planned in Jan-Feb 2019. Using Hakuho-maru

Result of 2016 Hakuho-maru

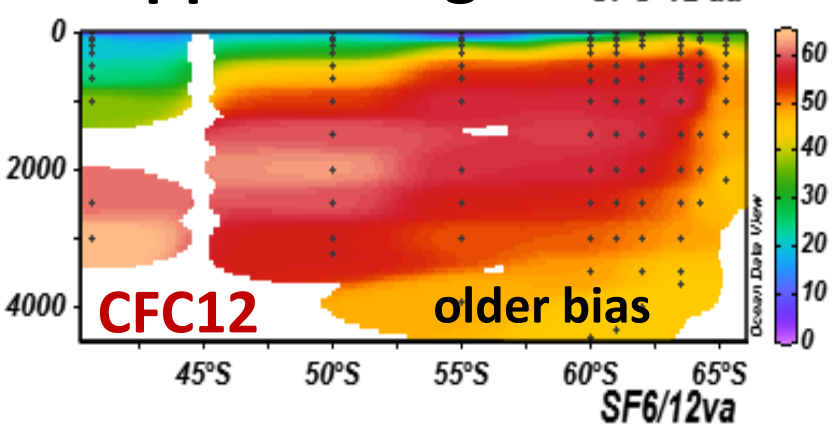


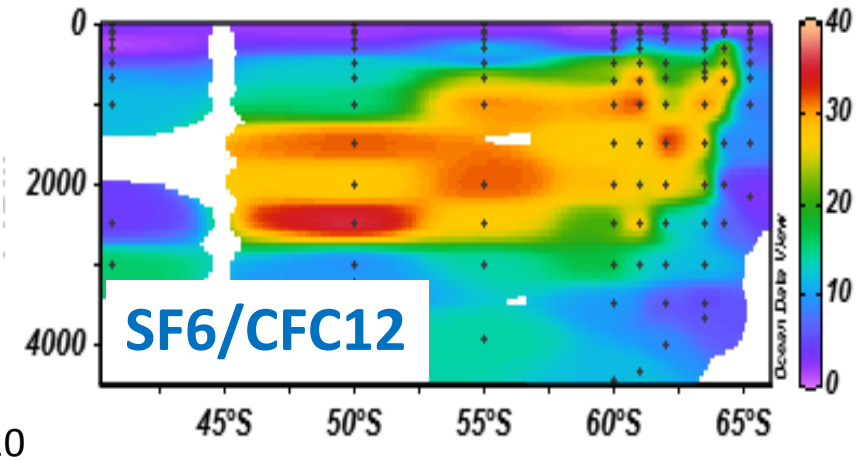


Kawai et al. (in pre.)



apparent age

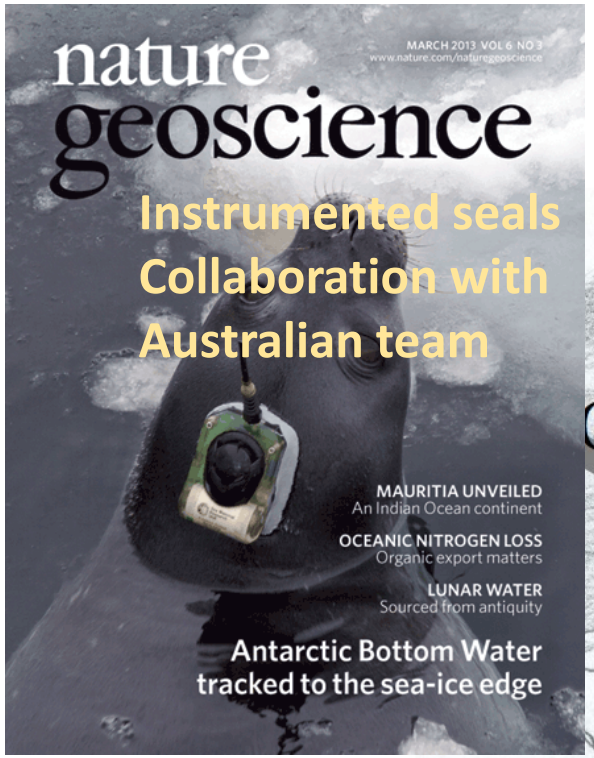


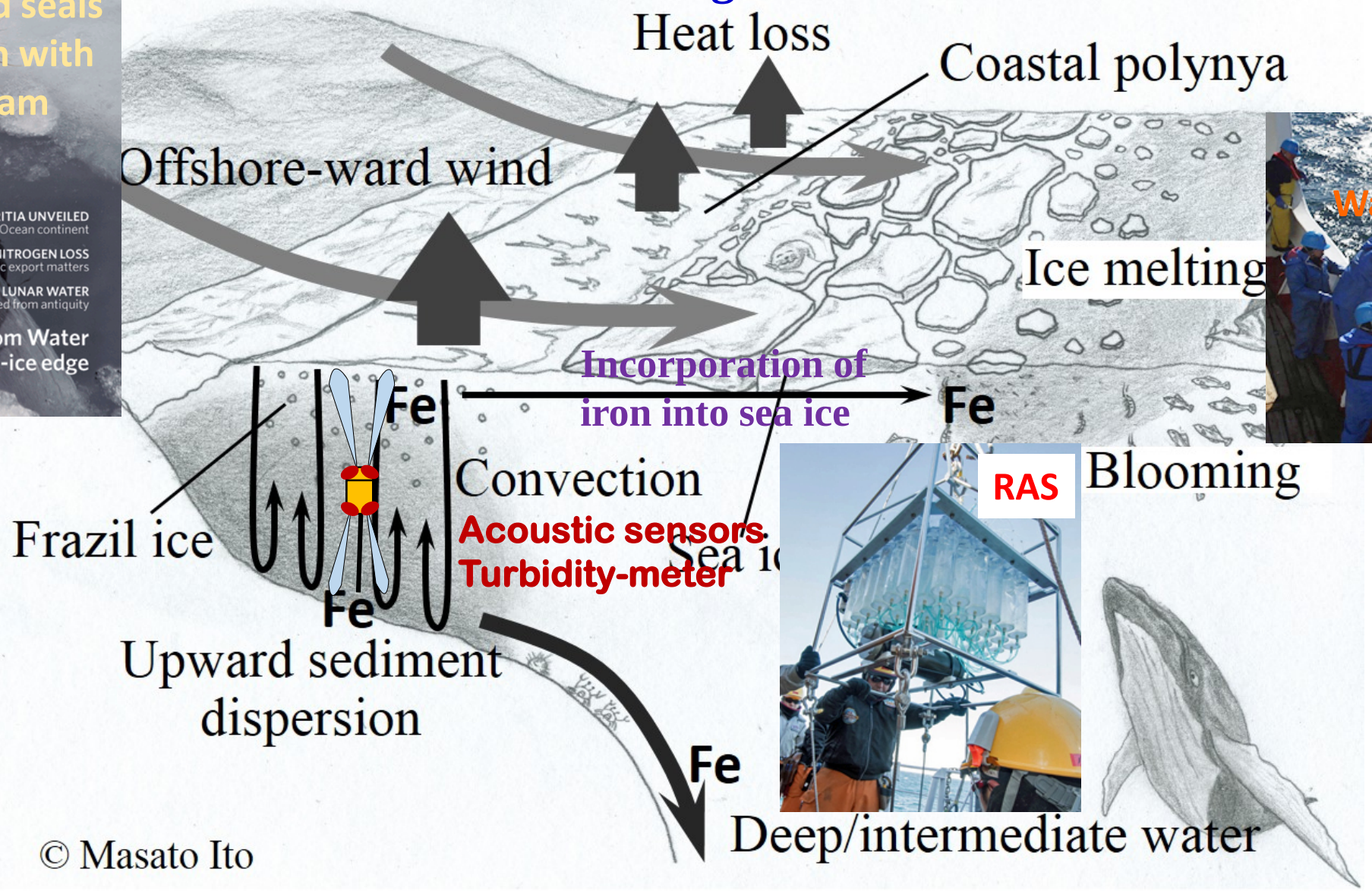


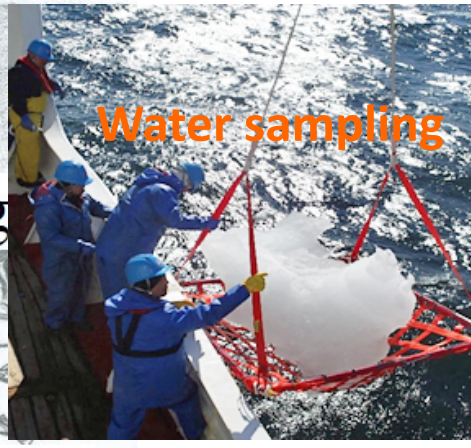
Direct observations of a coastal polynya: Cape Darnley Polynya

High ice production process: frazil ice formation

Circulation of iron through dense water & sea ice



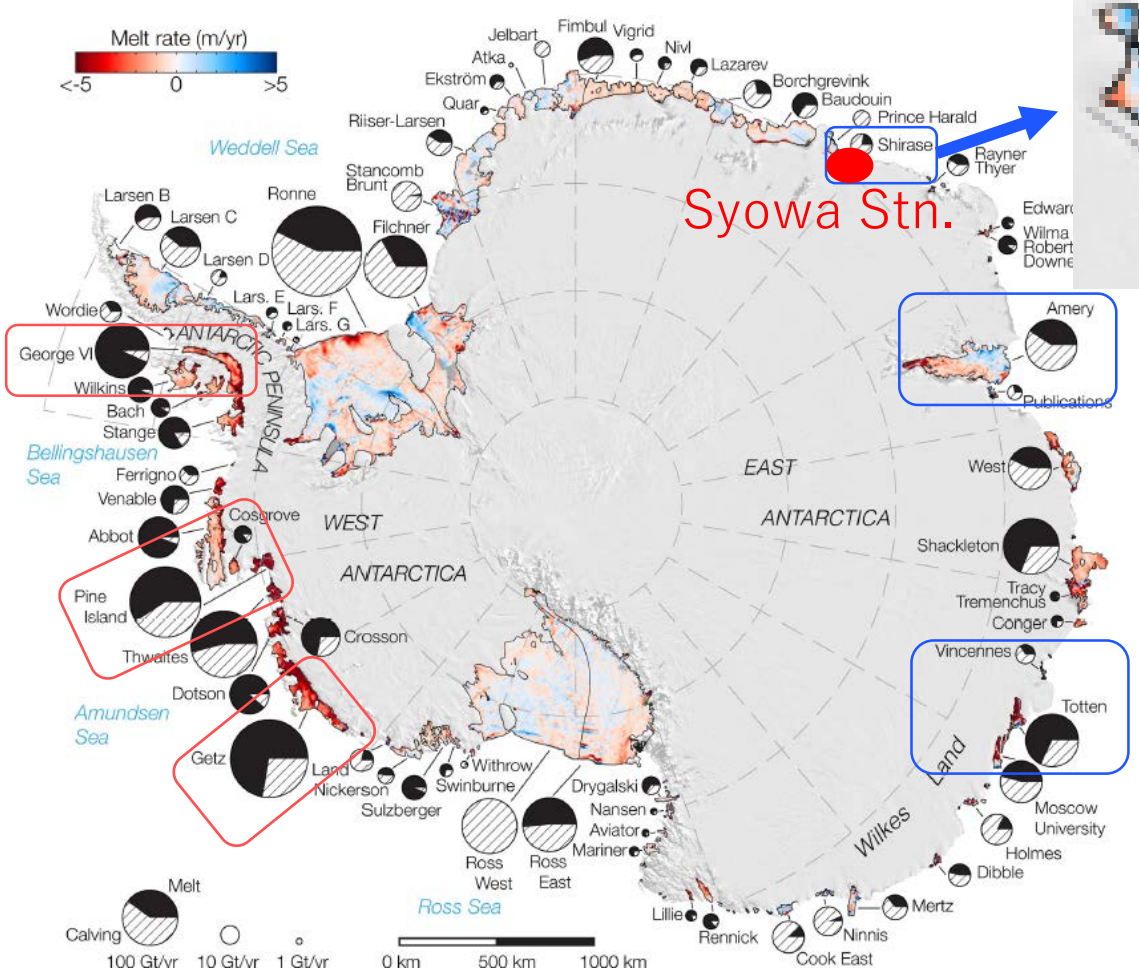


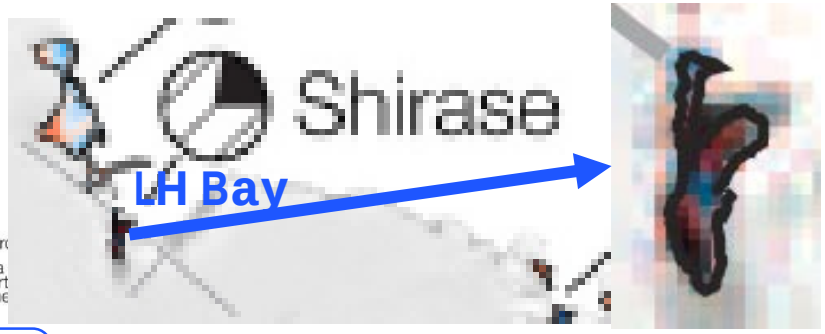


Blooming

Basal Melt of Shirase Glacier Tongue

south of Lutzow-Holm Bay (LH Bay), East Antarctica





smaller area with relatively high basal melt rate!

WEST Antarctica

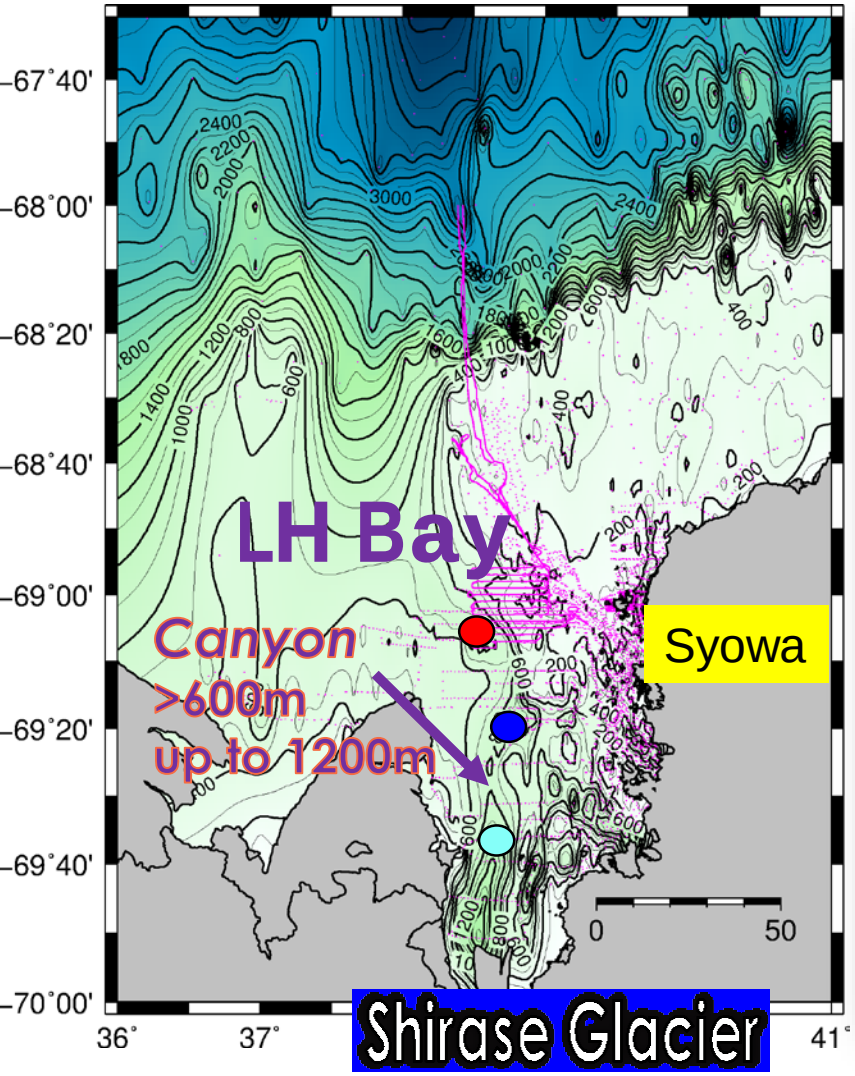
EAST Antarctica

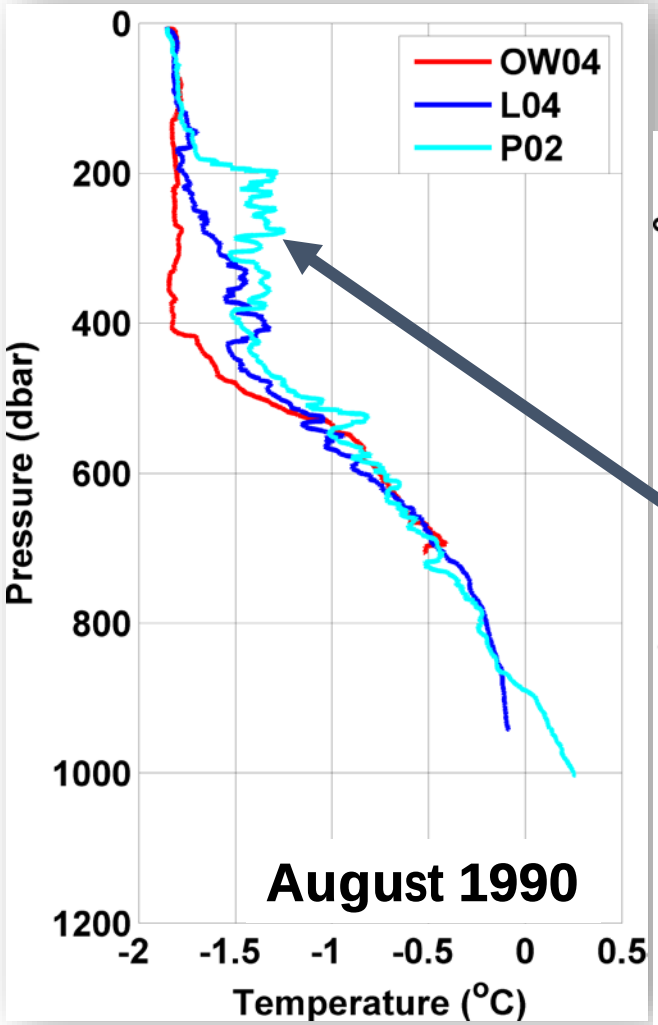
	Area (km^2)	Basal malt (m/yr)
George VI	23,434	3.8±0.7
Pine Island	6,249	16.2±1
Getz	34,018	4.3±0.4
Shirase	821	7.0±2
Amery	60,654	0.6±0.4
Vincennes	935	5.3±2
Totten	6,032	10.5±0.7

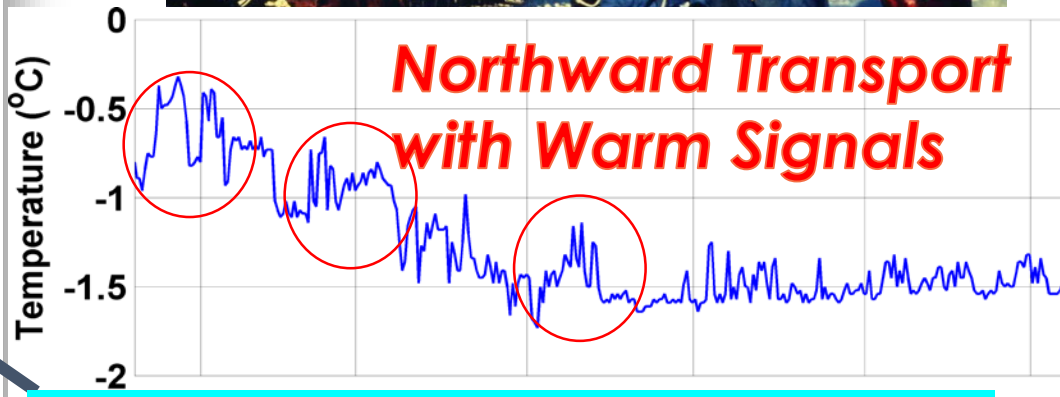
Basal melt rates of Antarctic ice shelves [*Rignot et al.*, 2013]

Hydrographic observations in LH Bay have been extremely limited!!

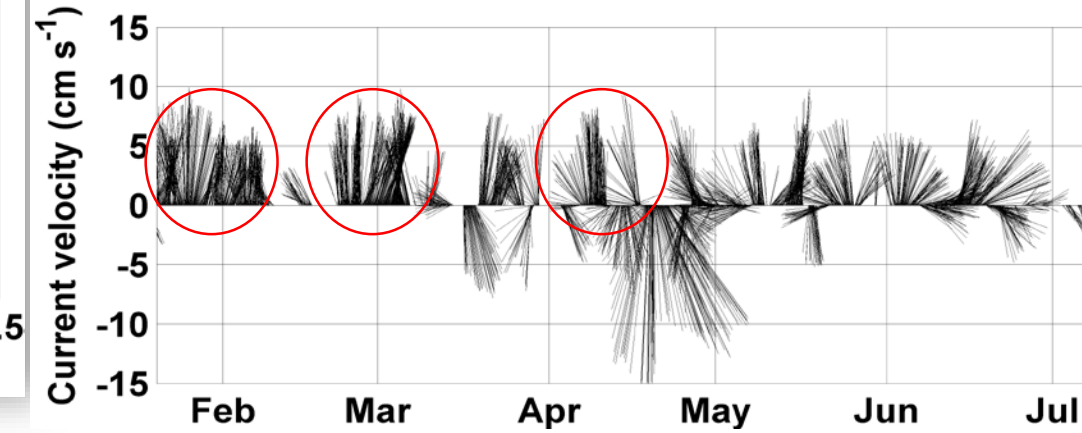
Only winter observations under landfast ice during1990-92 (JARE-31;32)



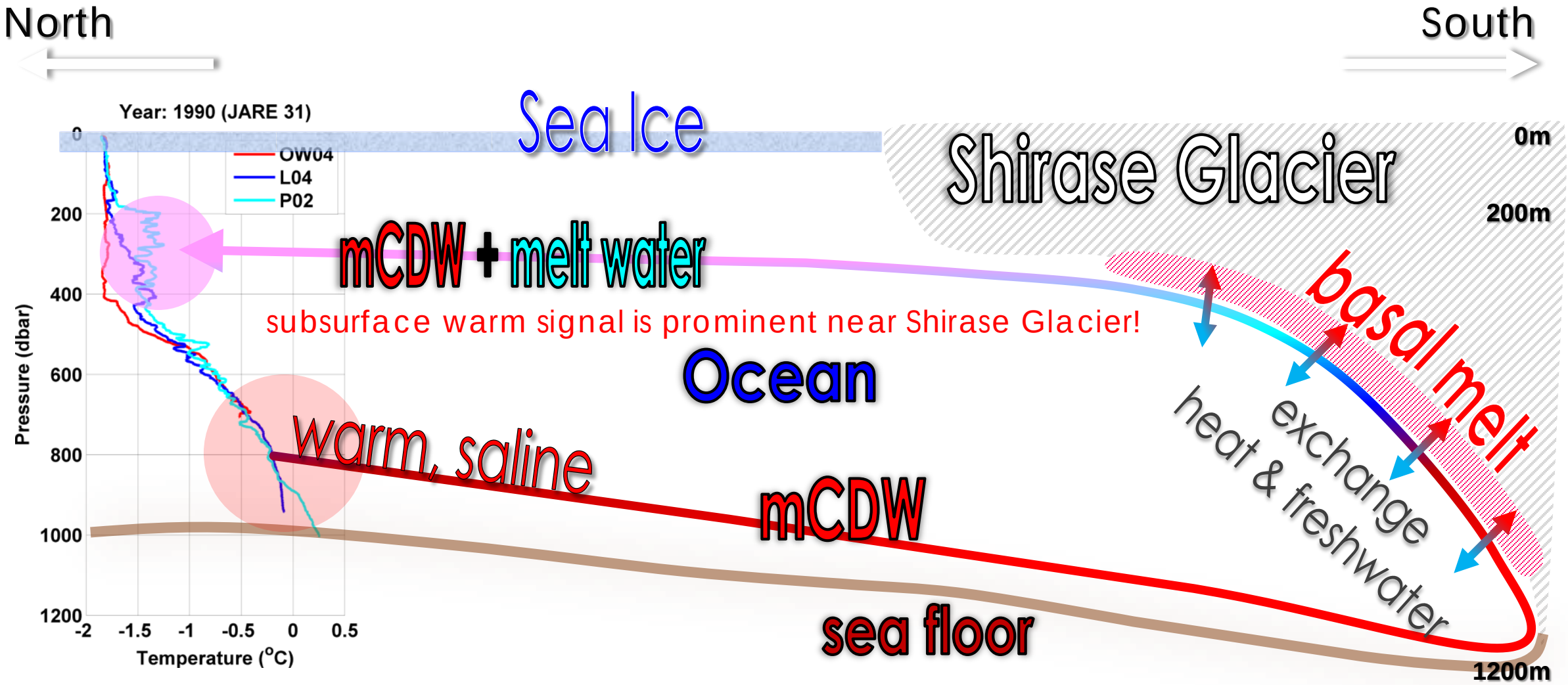




Temp. & velocity at 300m dep (P02)



Proposed 3-dimenstional circulation, associated with Shirase Glacier-Ocean interaction



Typical profile (OW04)

Profile influenced by the interaction (P02)

Proposed by Dr. Hirano

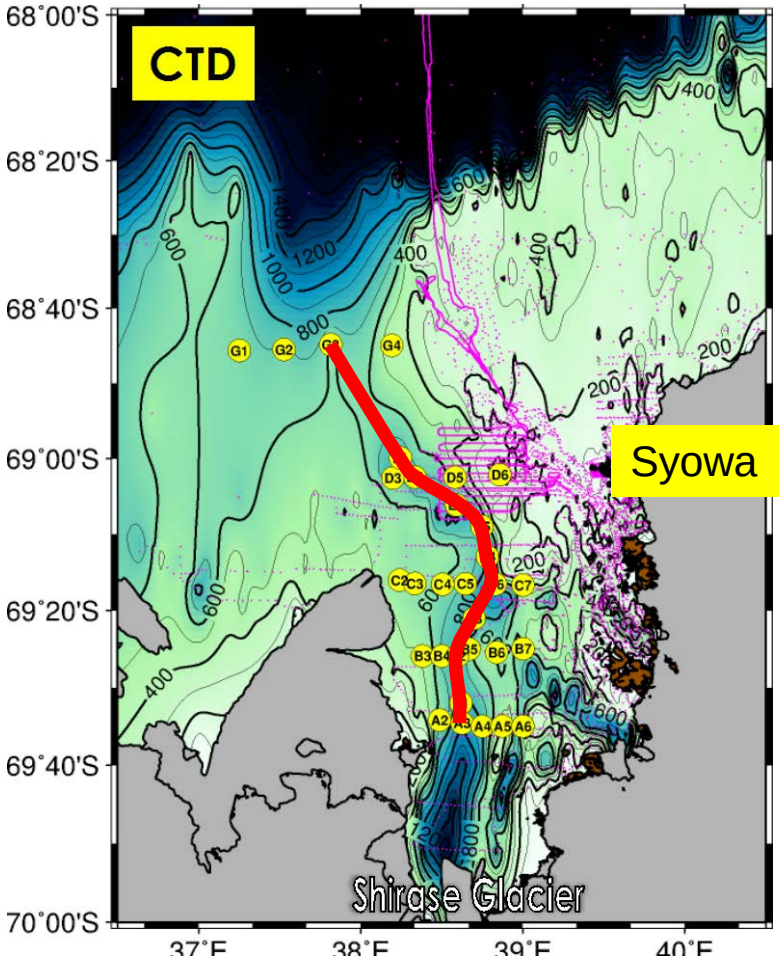
The first bay-scale hydrographic observation (Jan-Feb 2017: JARE58)

Vertical sections 'along' Canyon : *Melt Water Signals??*

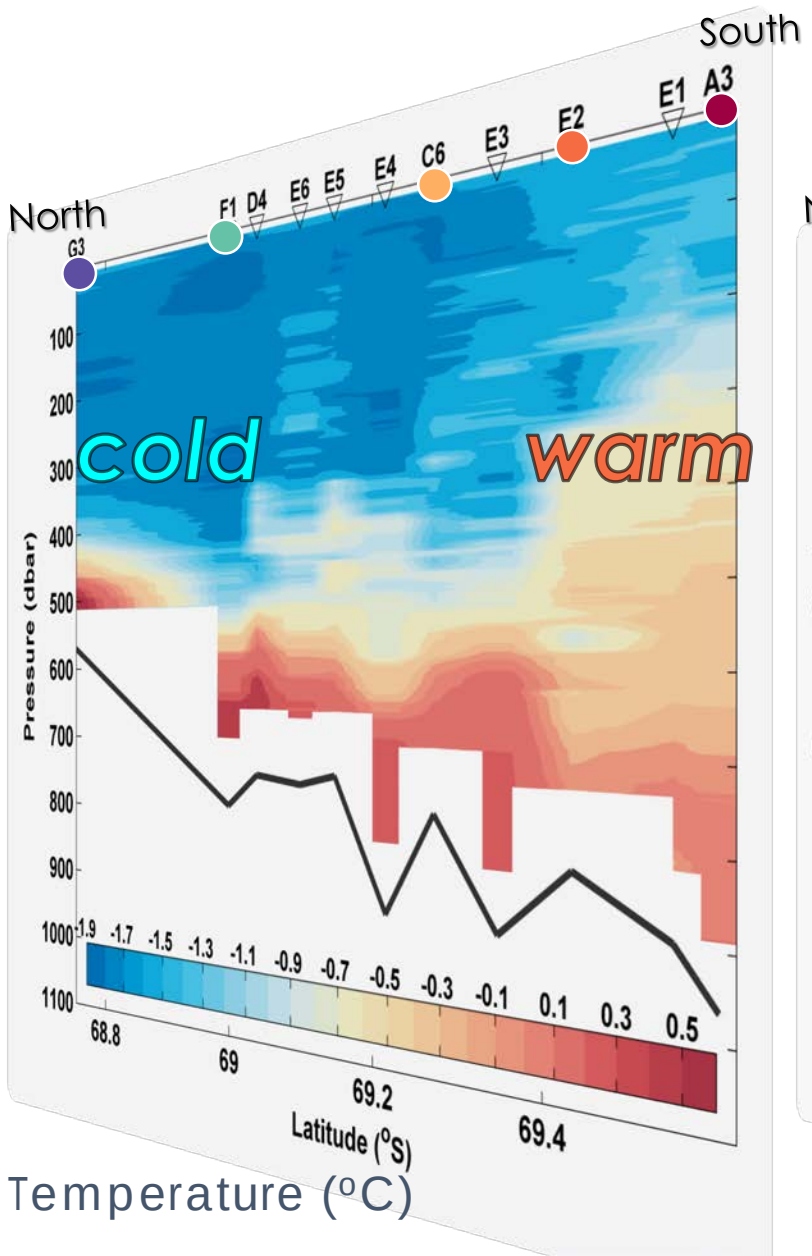
toward SGT (south)...

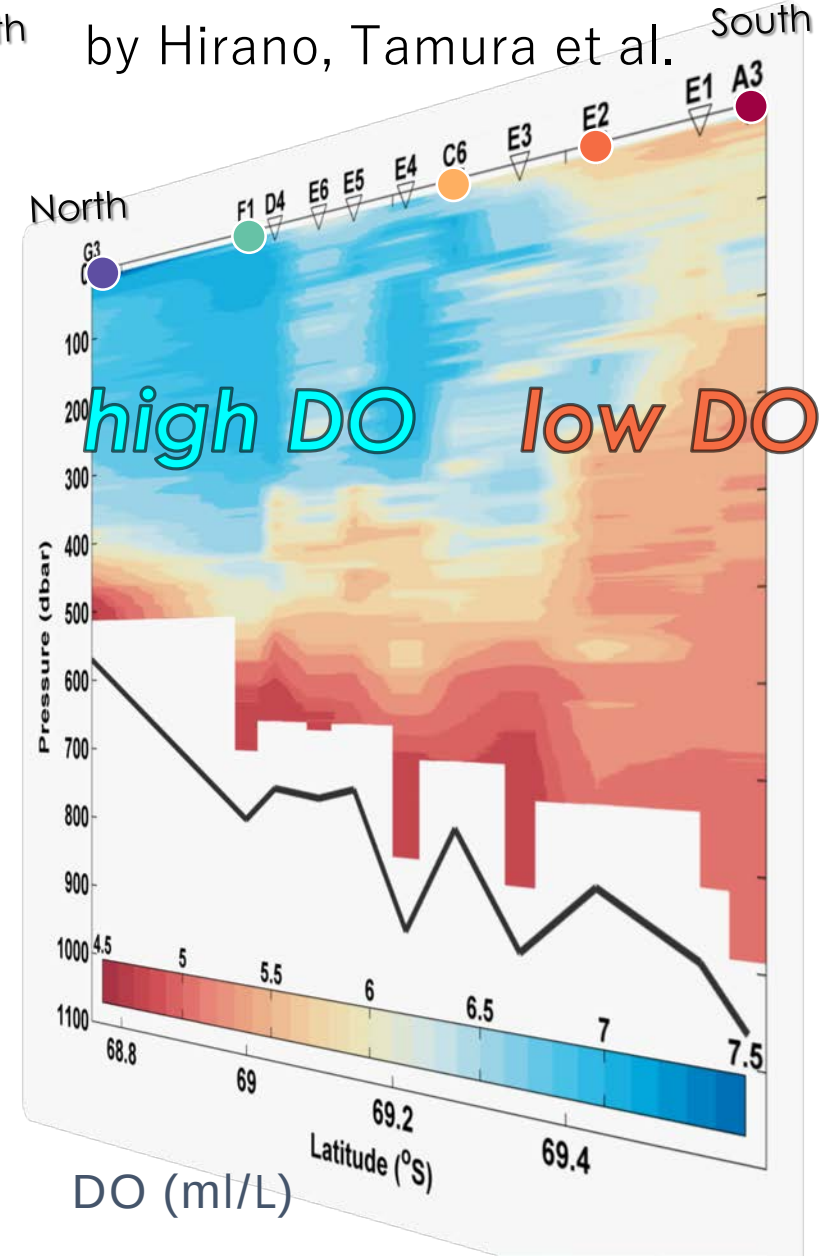
warmer and lower DO

at subsurface (WW layer)



by Hirano, Tamura et al.



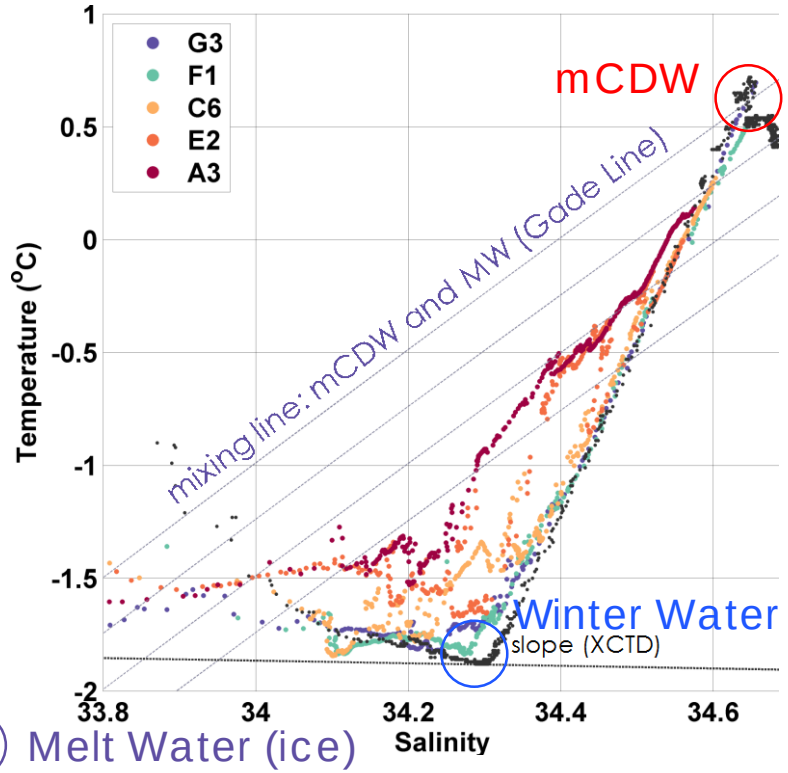


Melt Water Fraction from *T-S*, *DO-T*, *DO-S* pairs

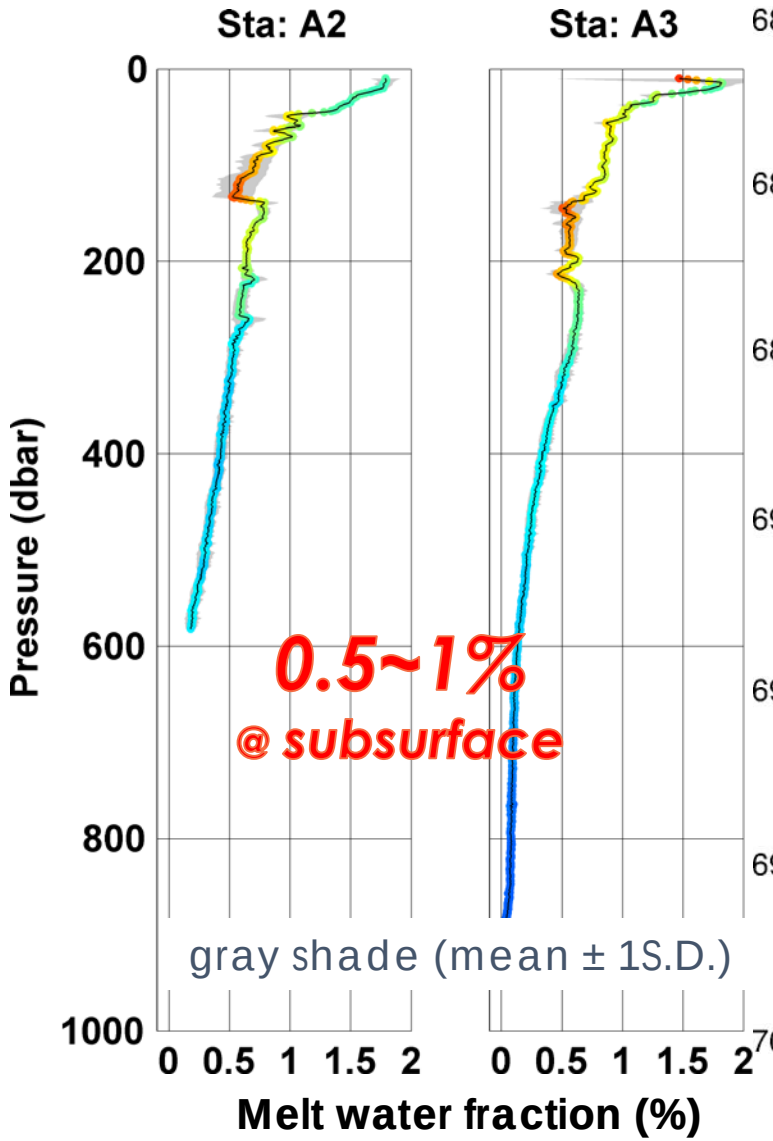
by Hirano, Tamura et al.

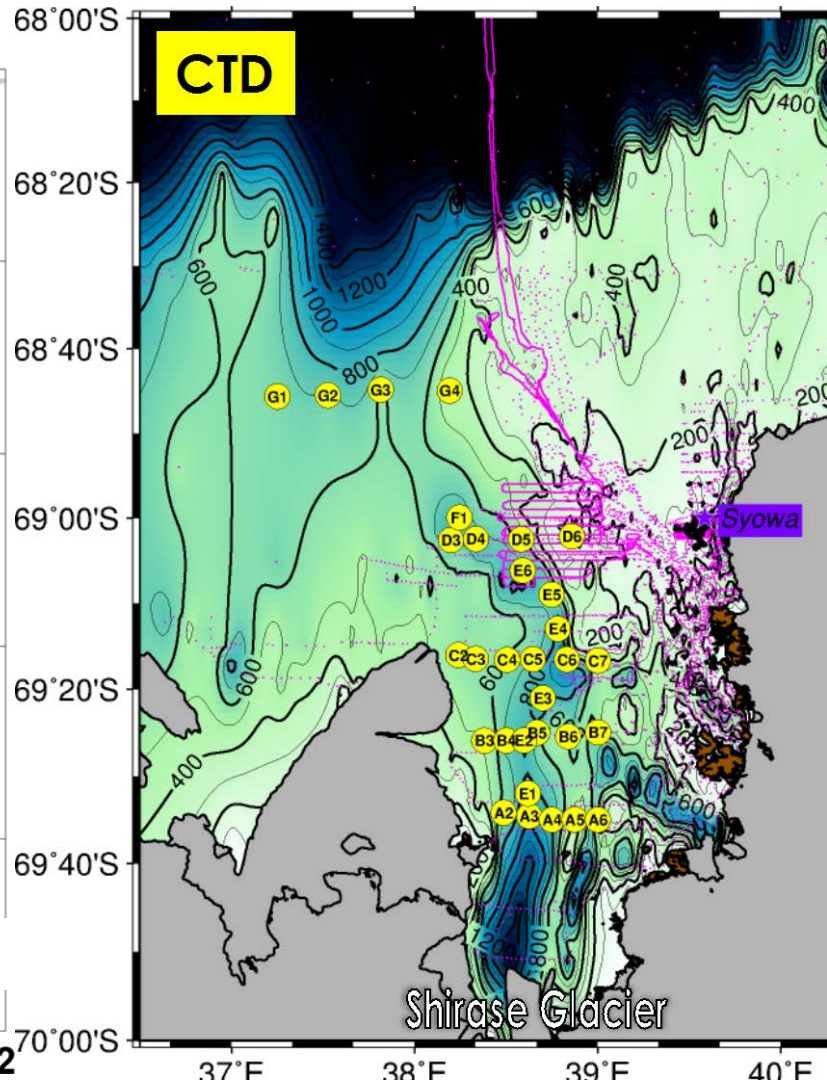
3-end members

mCDW (*T* ~ 0.7°C, *S* ~ 34.65, *DO* ~ 4.5ml/L)
WW (*T* ~ 1.8°C, *S* ~ 34.30, *DO* ~ 7ml/L)
MW (*T* ~ -90°C, *S* ~ 0, *DO* ~ 28.5ml/L)



canyon west center

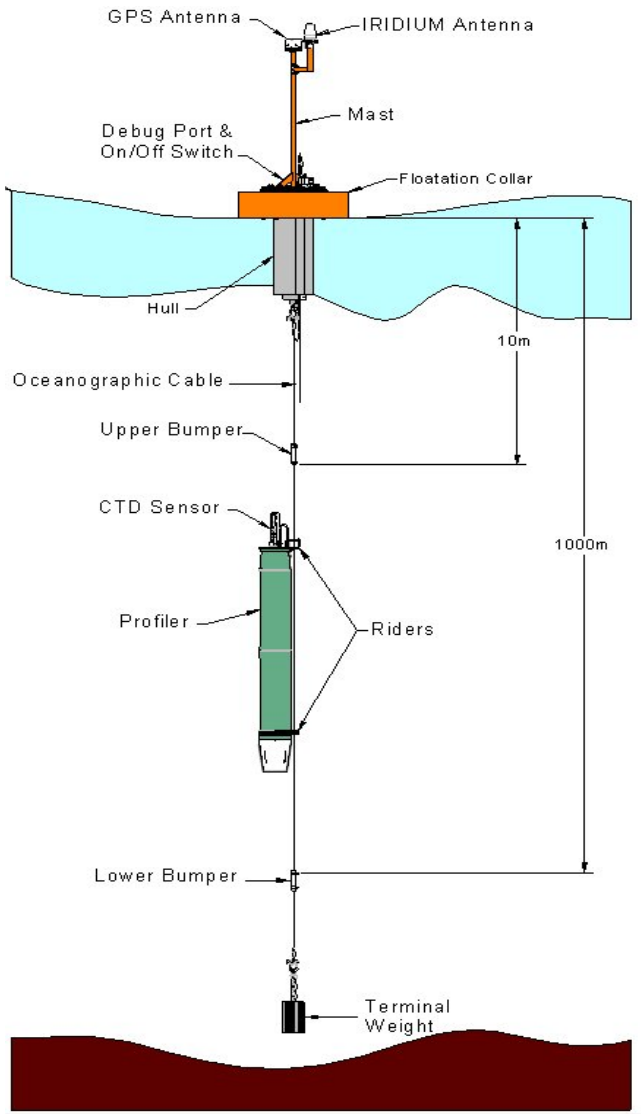


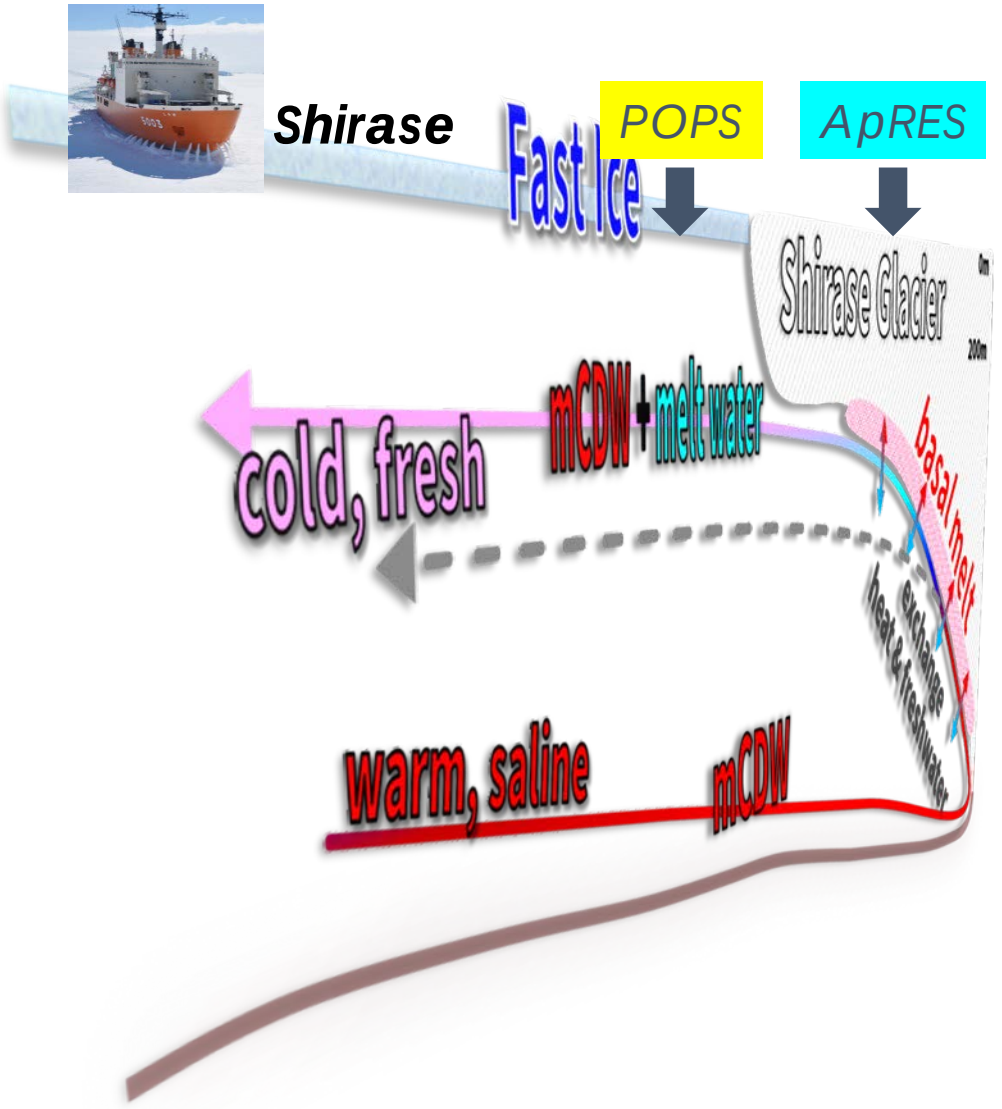


Near Future Observations (JARE59 in 2017/18)

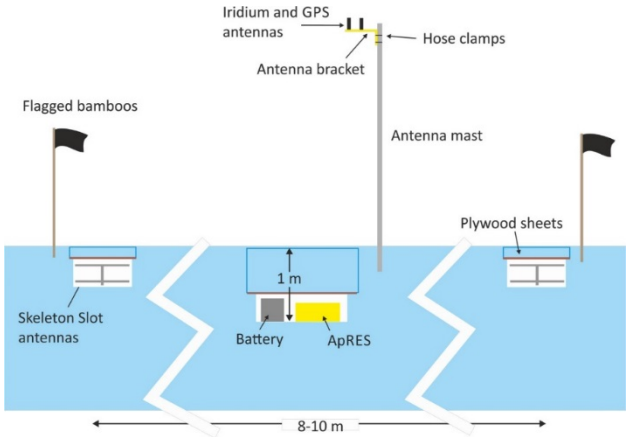
*Toward understanding a **"seasonality"** of SGT-ocean interaction*

Polar Ocean Profiling System





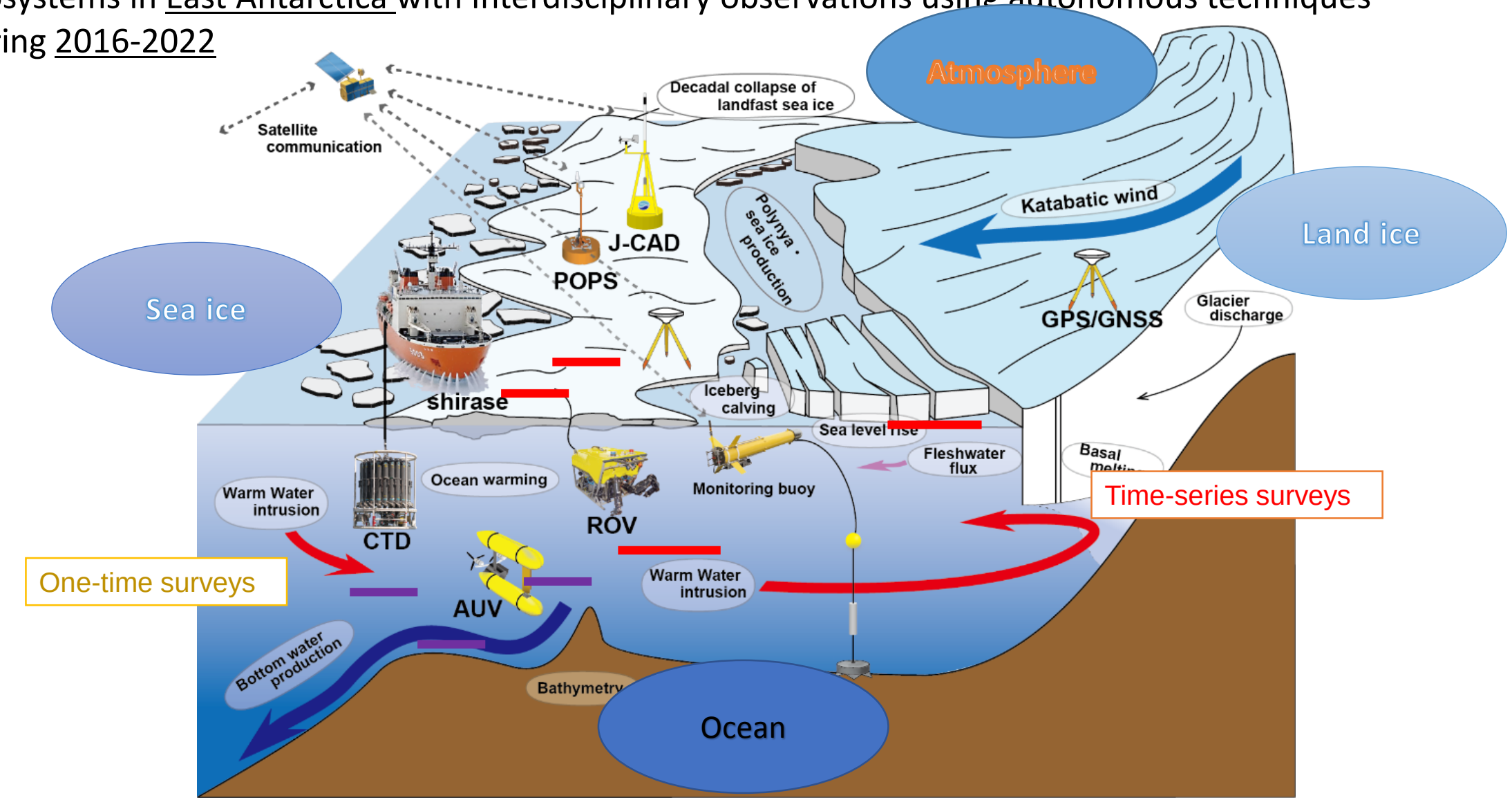
ApRES (Ice radar)

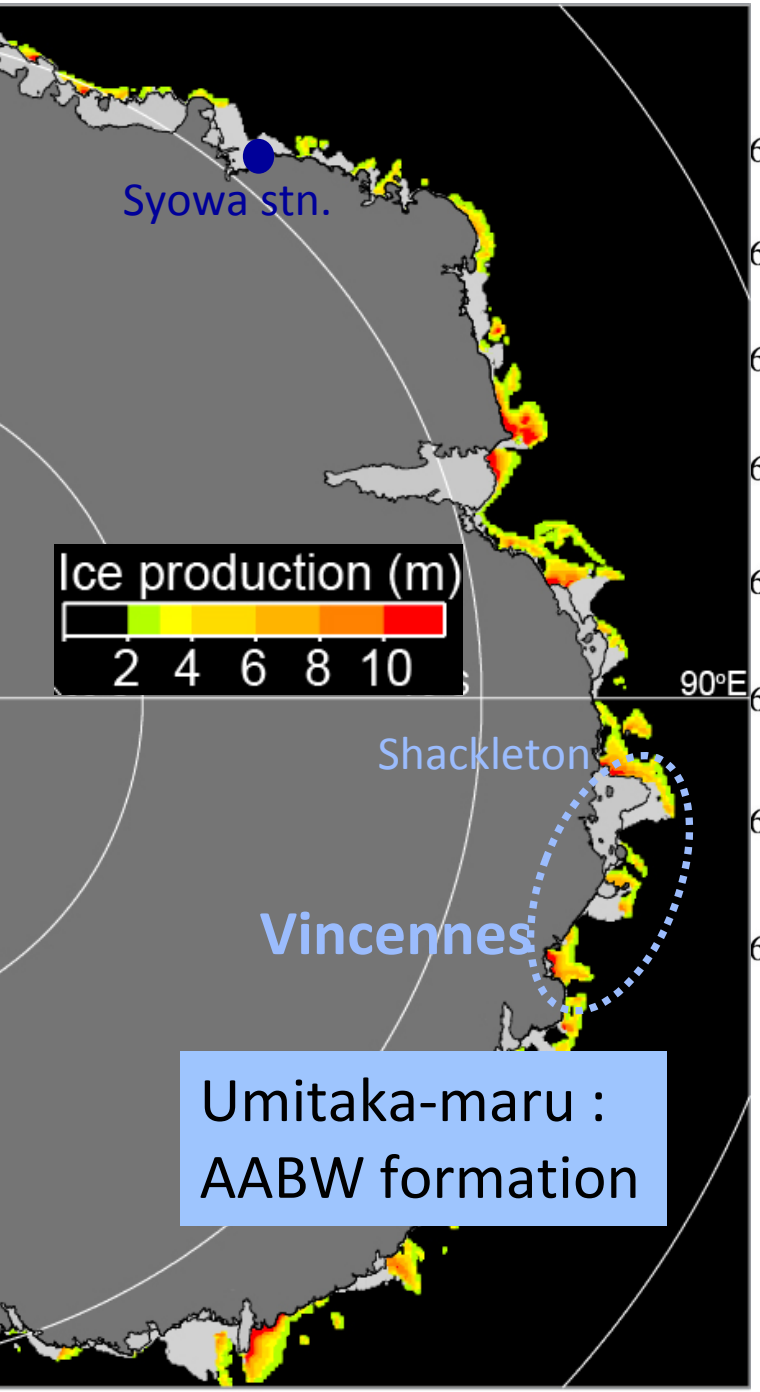


CTD-LADCP observation

Research of Ocean-ice BOundary InTeraction and Change around Antarctica (ROBOTICA) ,led by Drs. Aoki & Tamura

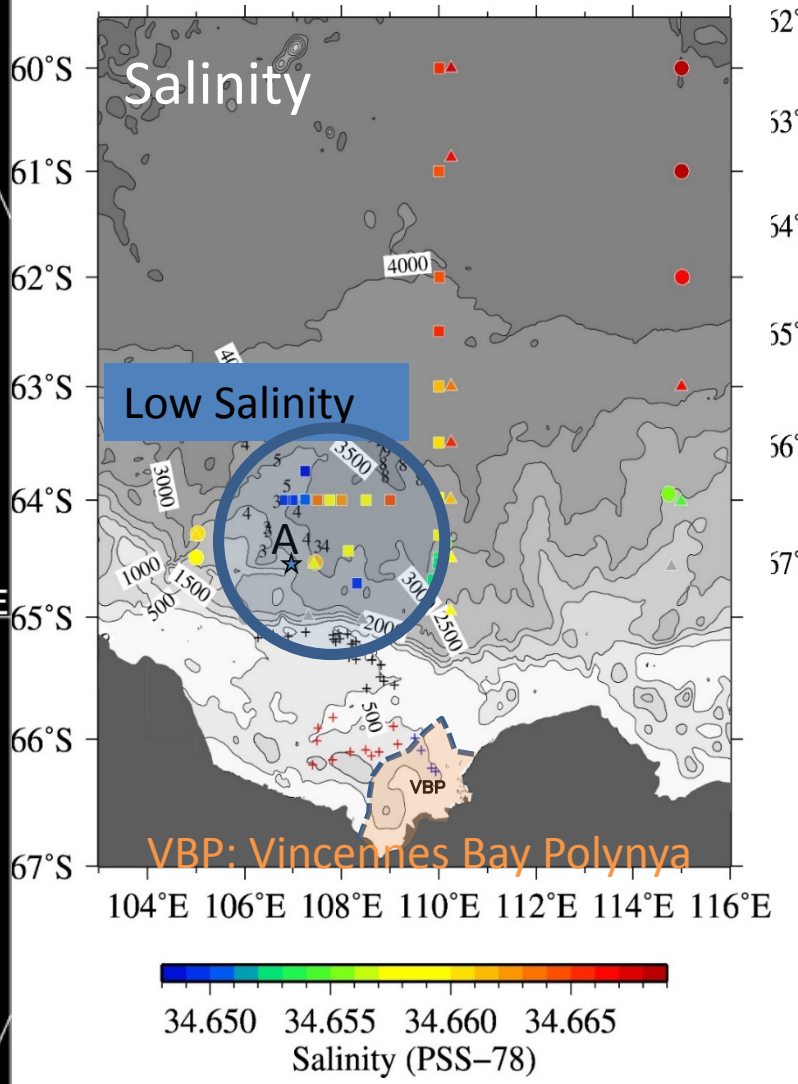
Based on mobility of *Shirase,* revealing Interactions and decadal-longer variabilities of Climate subsystems in East Antarctica with Interdisciplinary observations using autonomous techniques during 2016-2022





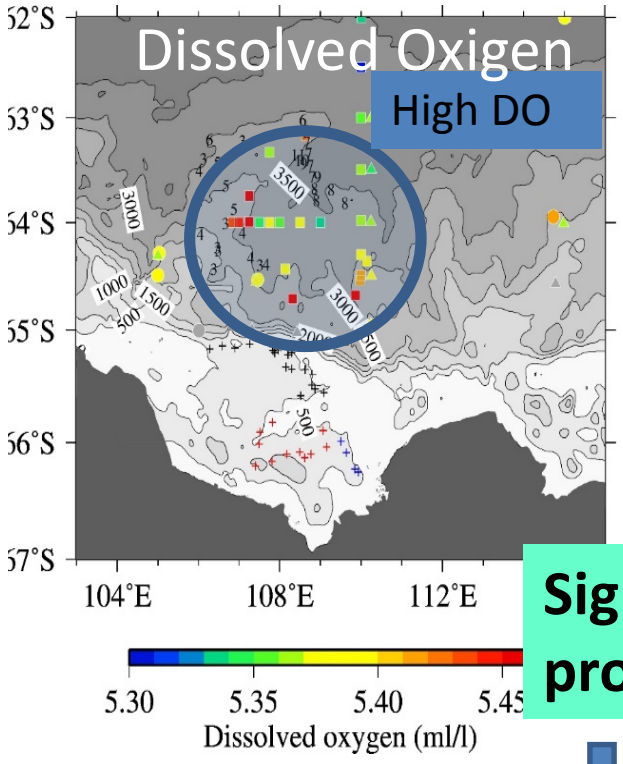
Umitaka-maru : AABW formation

CTD observation: 2011－2013



Distribution of salinity and DO at density range of bottom water

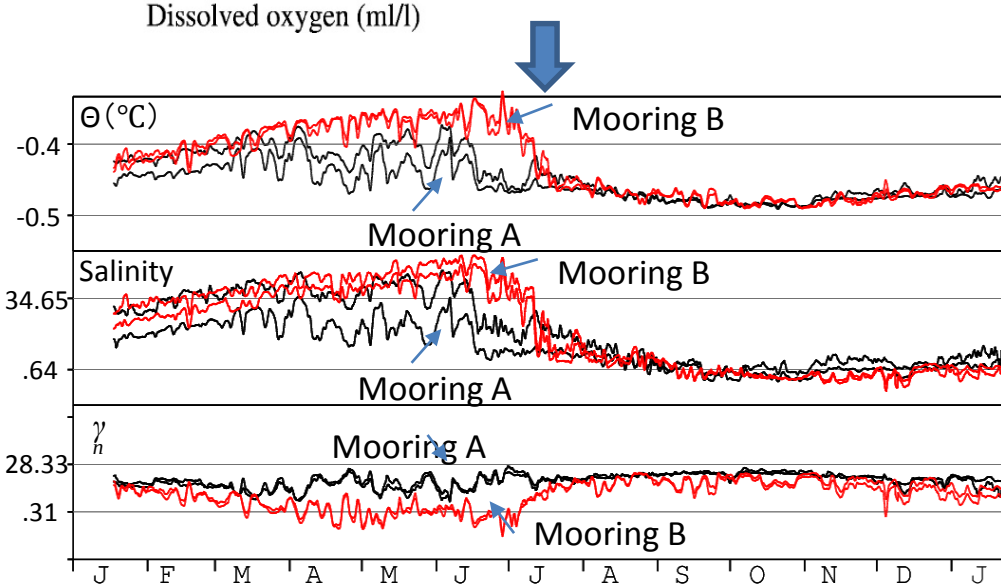
Kitade et al. (2014) GRL



Fresh and High DO water was observed near the bottom off VBP.

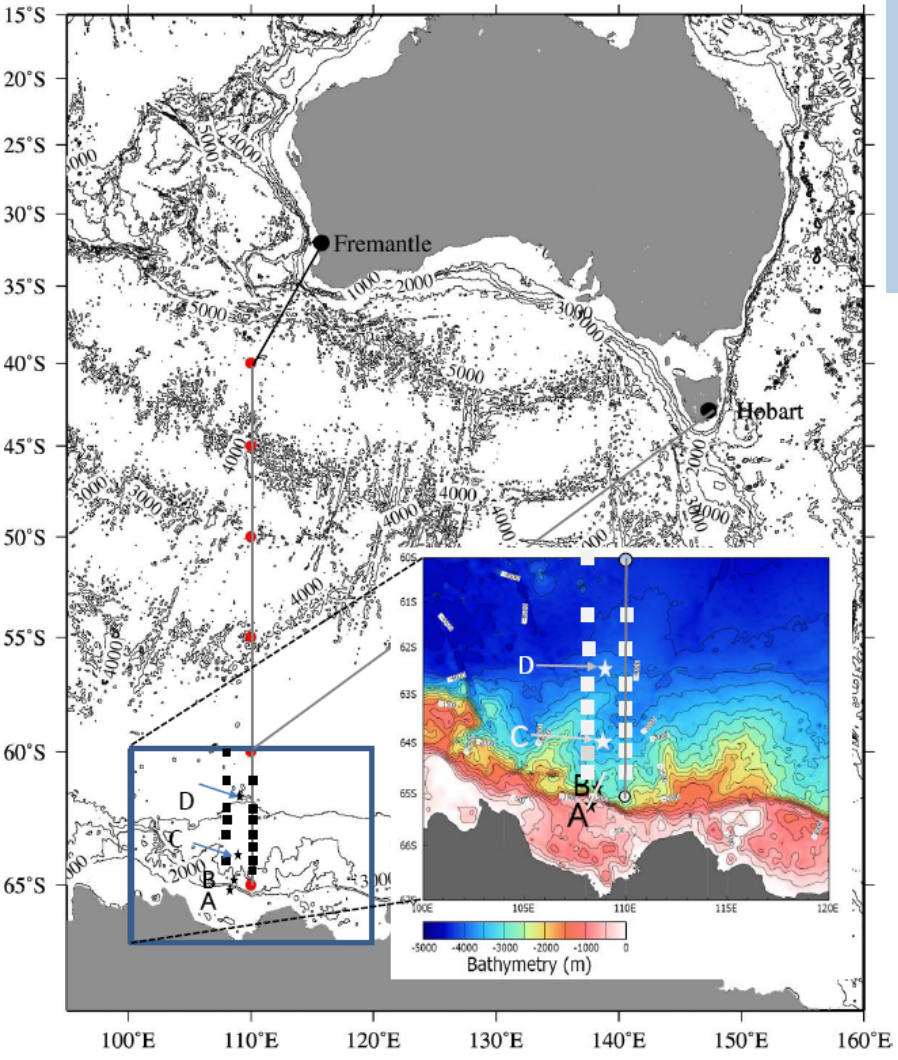
<u>From mooring data</u>
Cold and fresh water appeared suddenly in winter.

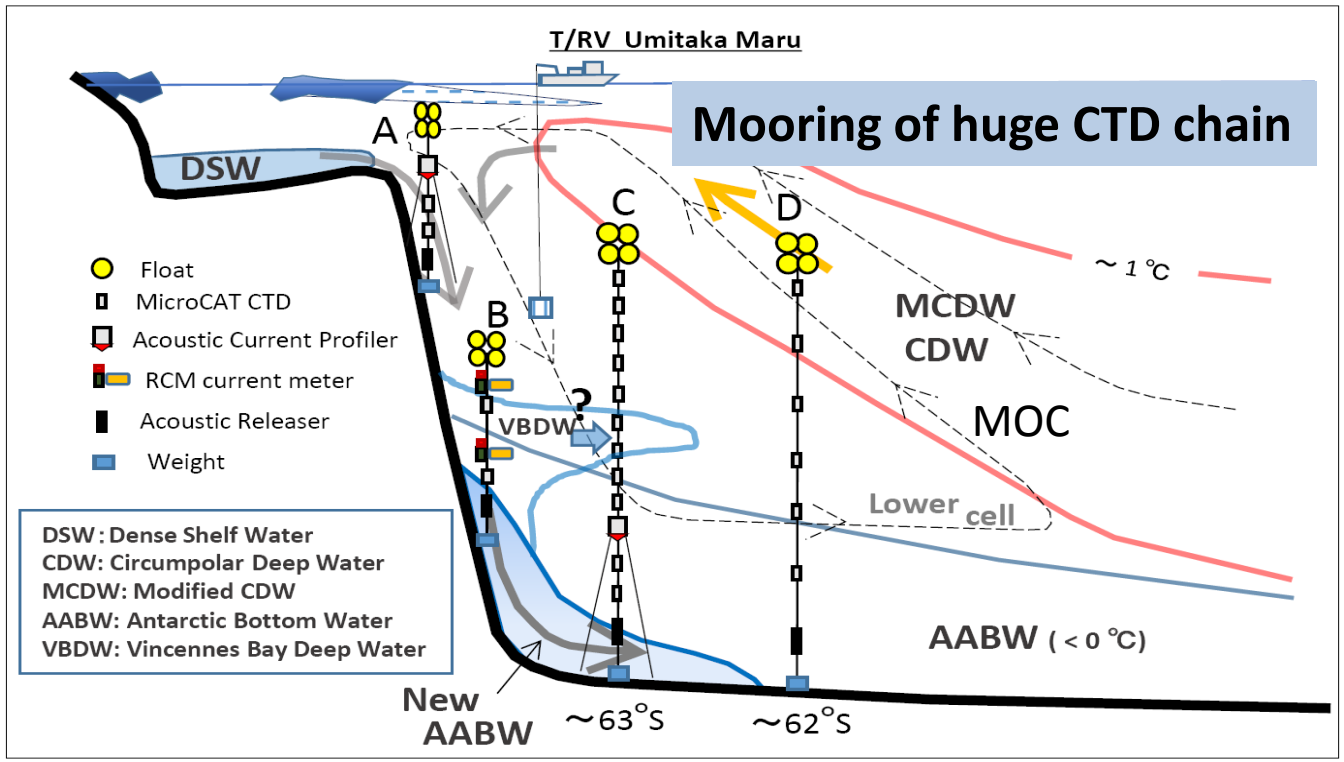
Signals of AABW production off VBP



Research cruises using Umitaka-maru during 2016-22 (every year), led by Dr. Kitade

Observation of Meridional Overturning Circulation including AABW production: Vincennes & Shackleton area

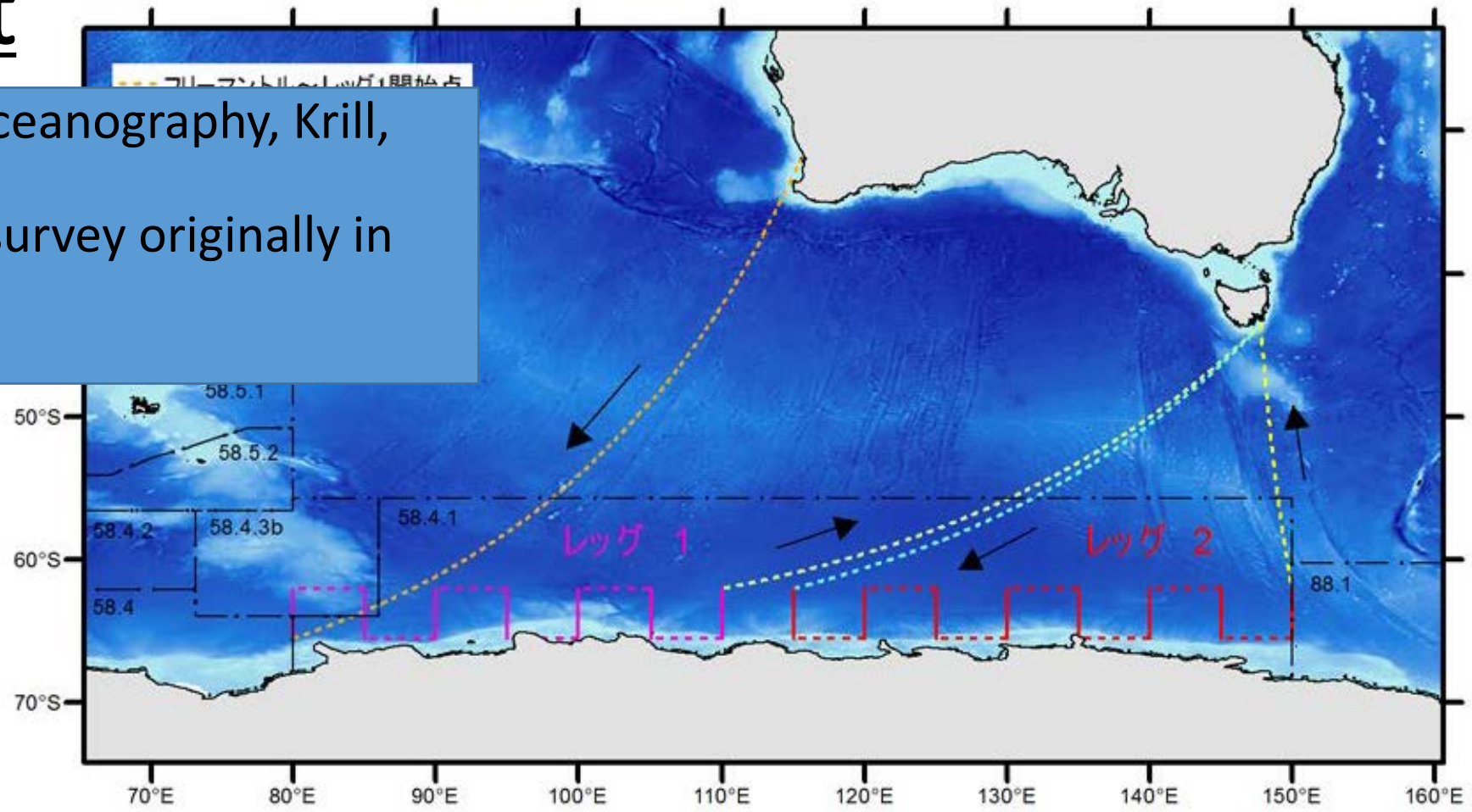




BROKE Revisit

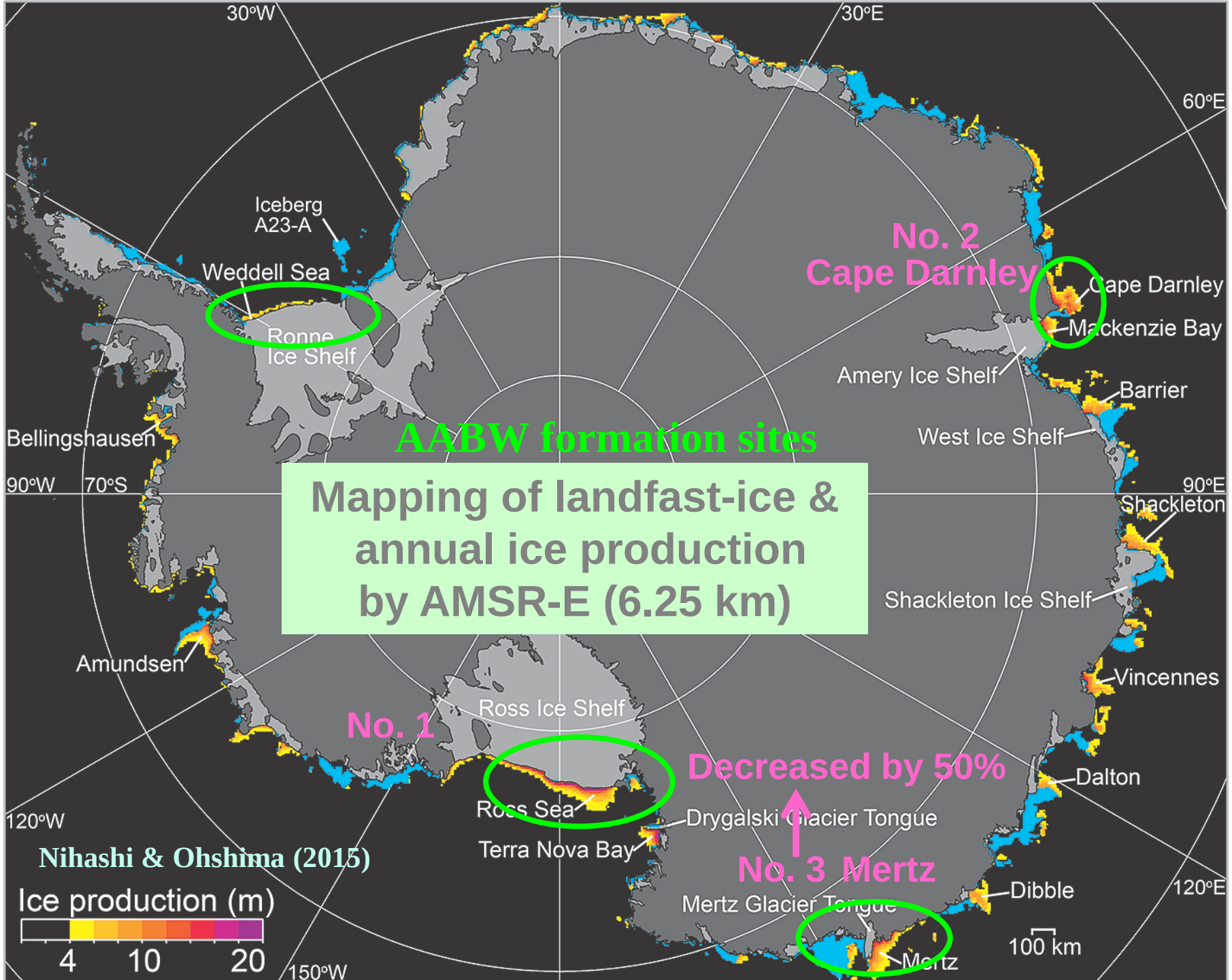
2018/19

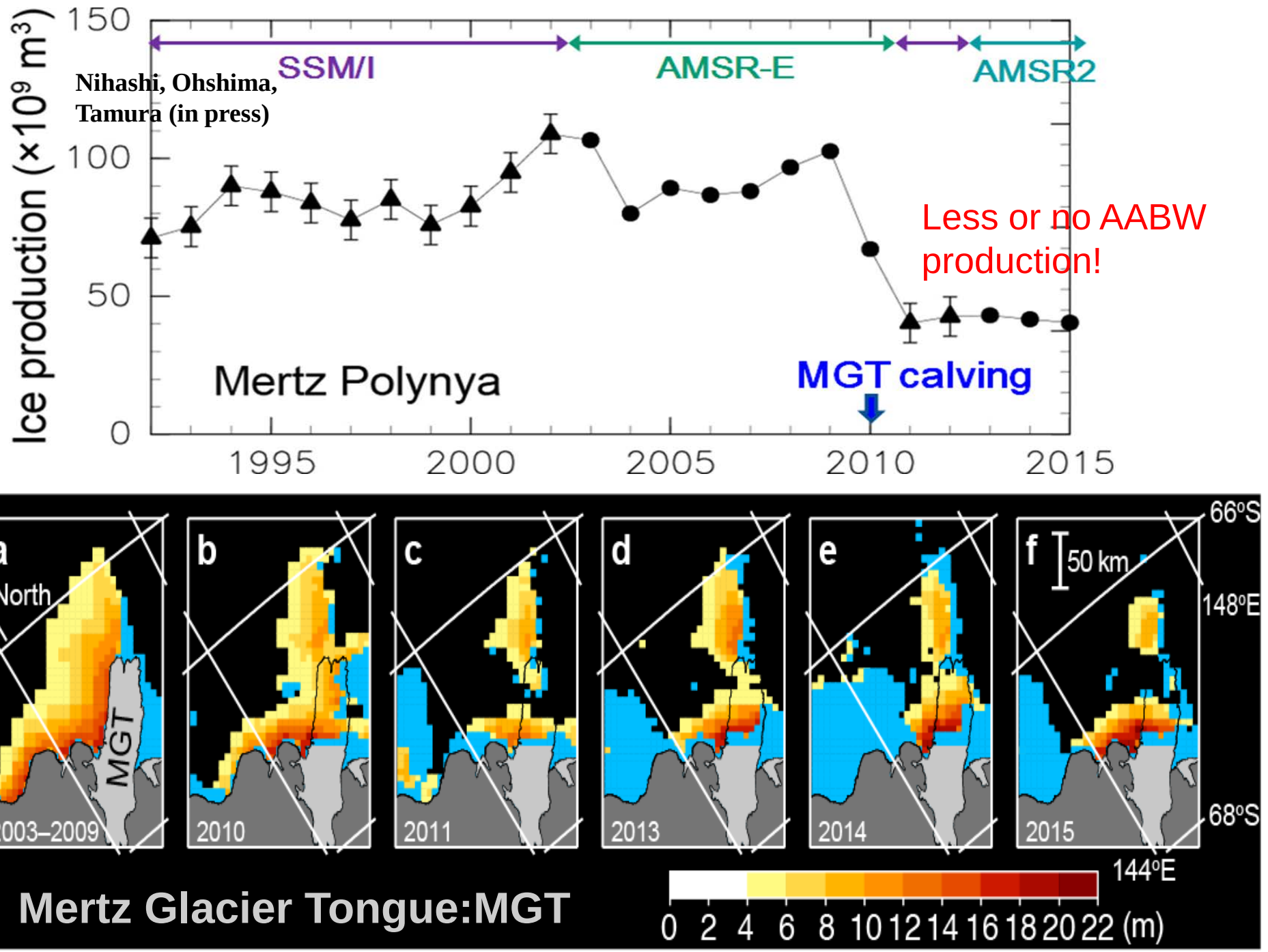
- Baseline Research on Oceanography, Krill, and the Environment
- Ecosystem and physics survey originally in 1996



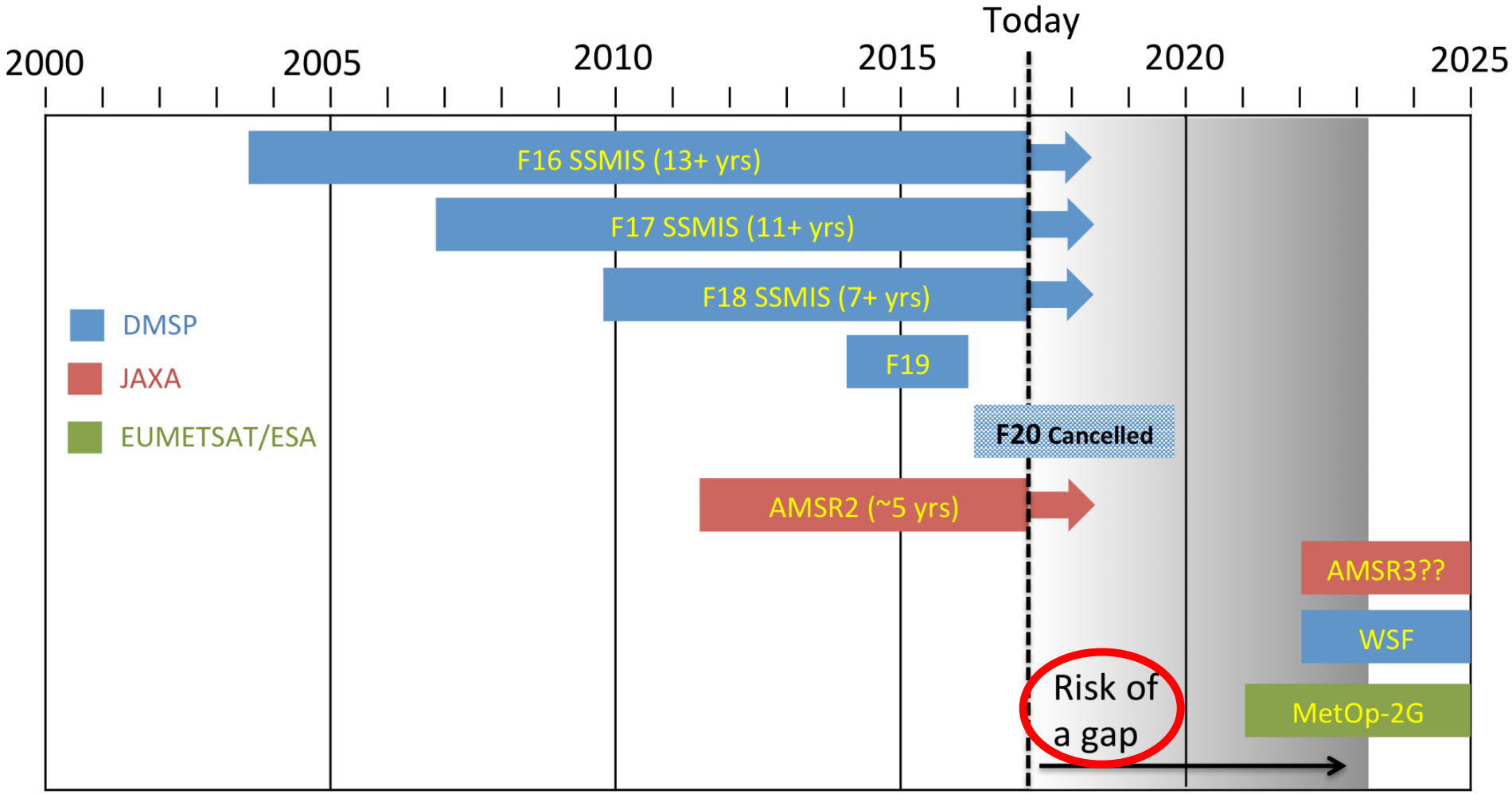
- Leg 1
  - 2018/17-19/1/14
- Leg 2
  - 2019/1/27-2/27

- Kaiyo maru cruise led by National Research Institute of Far Sea Fisheries
- More than 120 CTDs (offshore/nearshore)


30°W
30°E
60°E
90°W
70°S
90°E
120°W
120°E
150°W
Iceberg
A23-A
Weddell Sea
Ronne
Ice Shelf
Bellingshausen
Amundsen
No. 2
Cape Darnley
Cape Darnley
Mackenzie Bay
Amery Ice Shelf
Barrier
West Ice Shelf
Shackleton
Shackleton Ice Shelf
Vincennes
Dalton
Dibble
AABW formation sites
Mapping of landfast-ice &
annual ice production
by AMSR-E (6.25 km)
No. 1
Ross Ice Shelf
Ross Sea
Terra Nova Bay
Drygalski Glacier Tongue
Decreased by 50%
No. 3 Mertz
Mertz Glacier Tongue
Mertz
100 km
Nihashi & Ohshima (2015)
Ice production (m)
4
10
20


Ice production (×10⁹ m³)
150
100
50
0
SSM/I
AMSR-E
AMSR2
Nihashi, Ohshima, Tamura (in press)
Mertz Polynya
MGT calving
Less or no AABW production!
1995
2000
2005
2010
2015
a
North
MGT
2003–2009
b
2010
c
2011
d
2013
e
2014
f
50 km
2015
66°S
148°E
68°S
144°E
Mertz Glacier Tongue:MGT
0 2 4 6 8 10 12 14 16 18 20 22 (m)

Current and future polar orbiting passive microwave sensors



WSF = U.S. Dept. of Defense Weather Satellite Follow-on (proposed)
AMSR3 = Advanced Microwave Scanning Radiometer 3 (proposed)
MetOp-2G = European Meteorological Operational satellite, 2nd generation

provided by Dr. Meier (NASA GSFC)

AMSR2 is currently the only PM sensor operating within its nominal mission lifetime