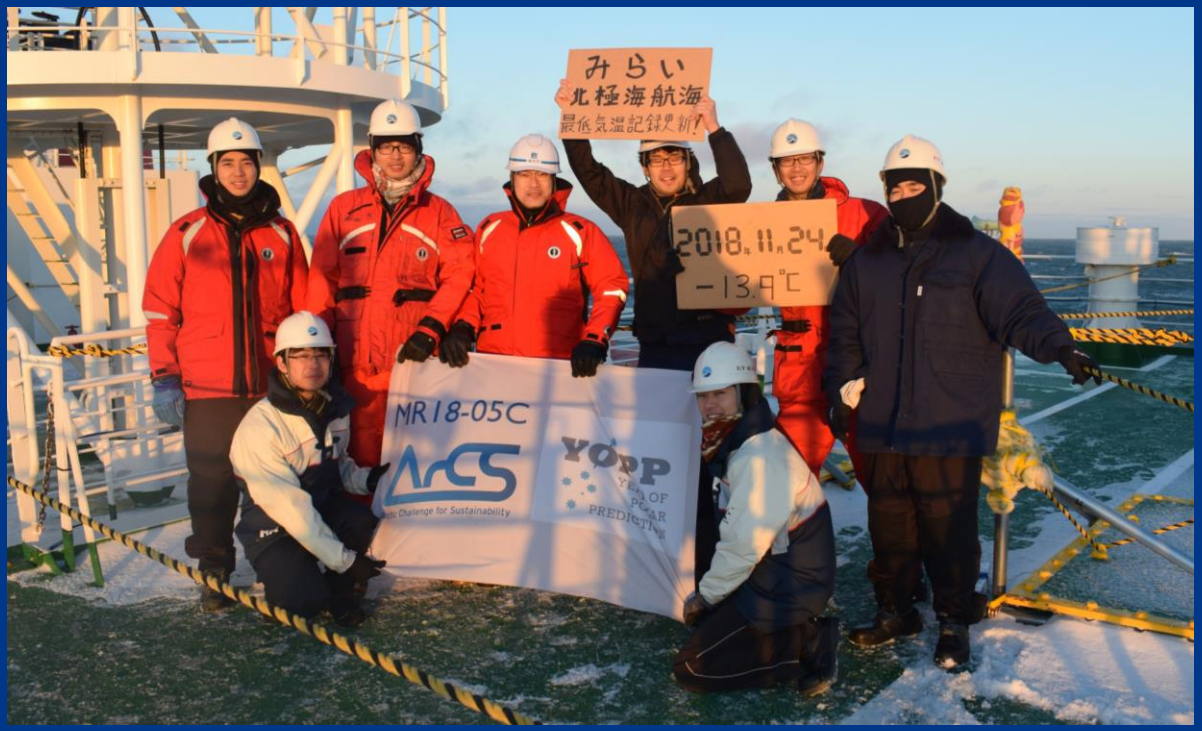
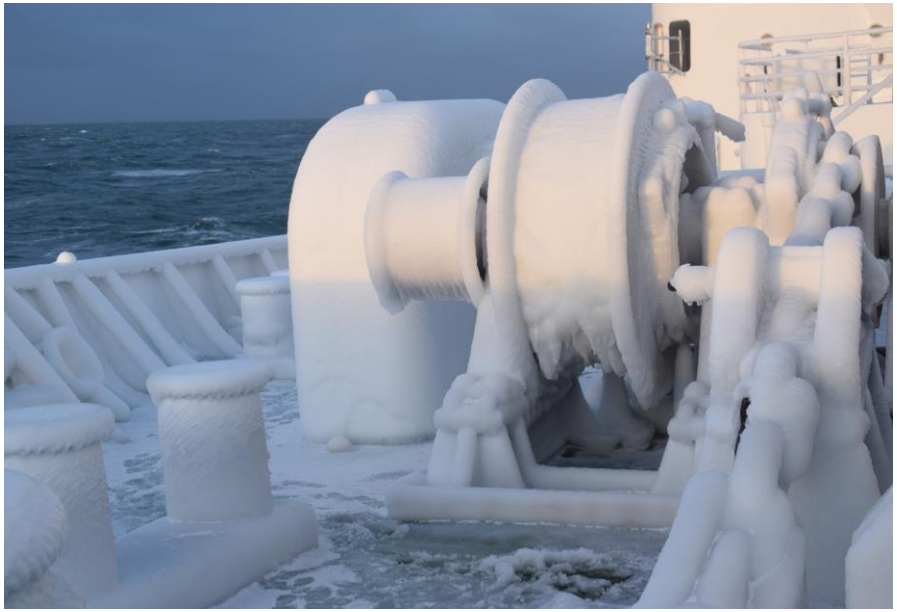
YOPP supports the Japanese Arctic research cruise in 2018

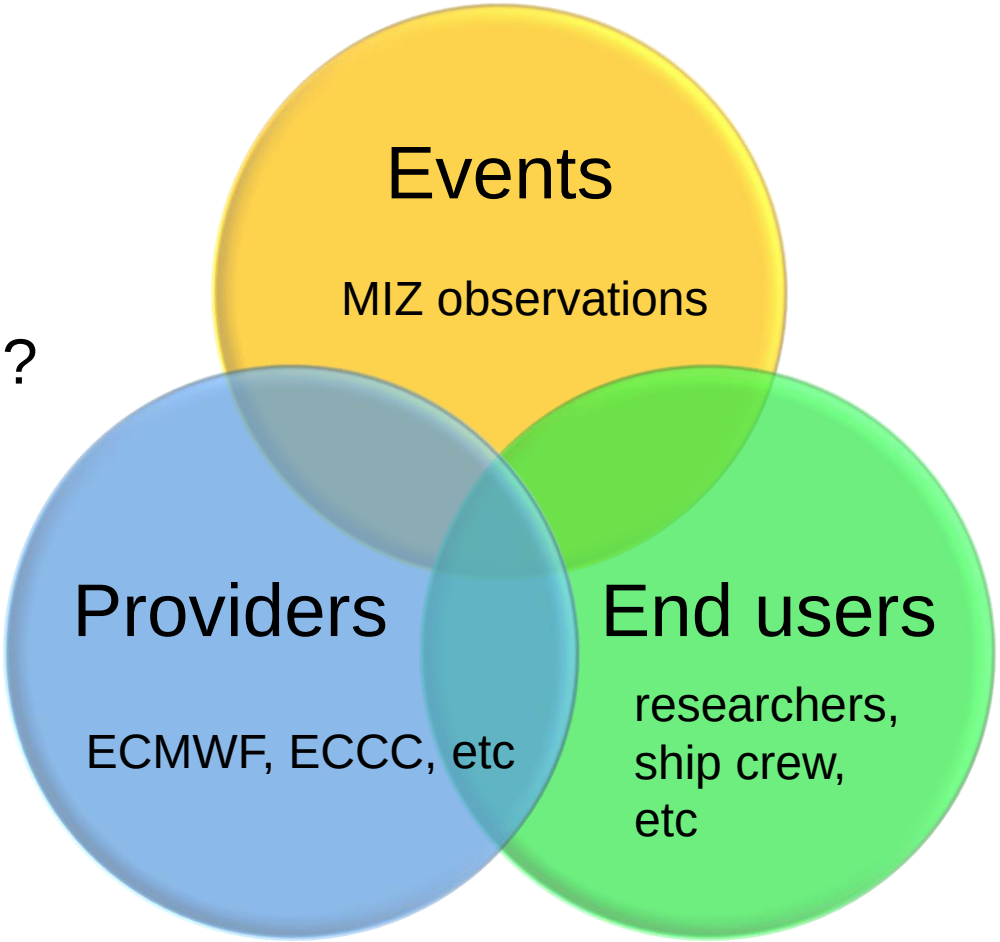
Jun Inoue
(National Institute of Polar Research, Japan）
and
many collaborators from the ArCS project



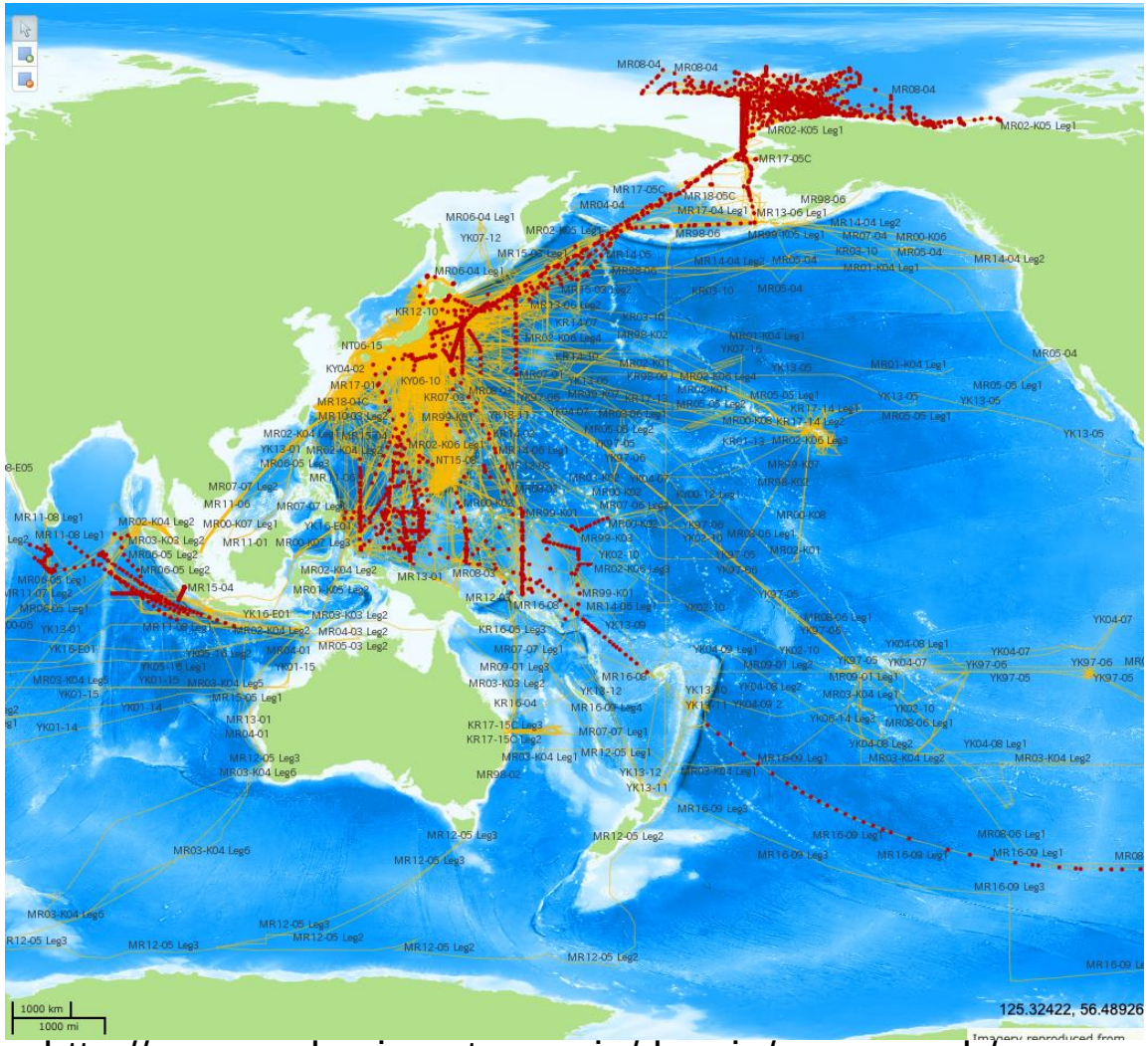
Questions to be covered in this presentation

- How are field campaigns making use of NWP data, for defining cruise planning, choice of period, etc.?
- What NWP-based products are needed to support field campaigns?





RV Mirai (an ice strengthen ship)

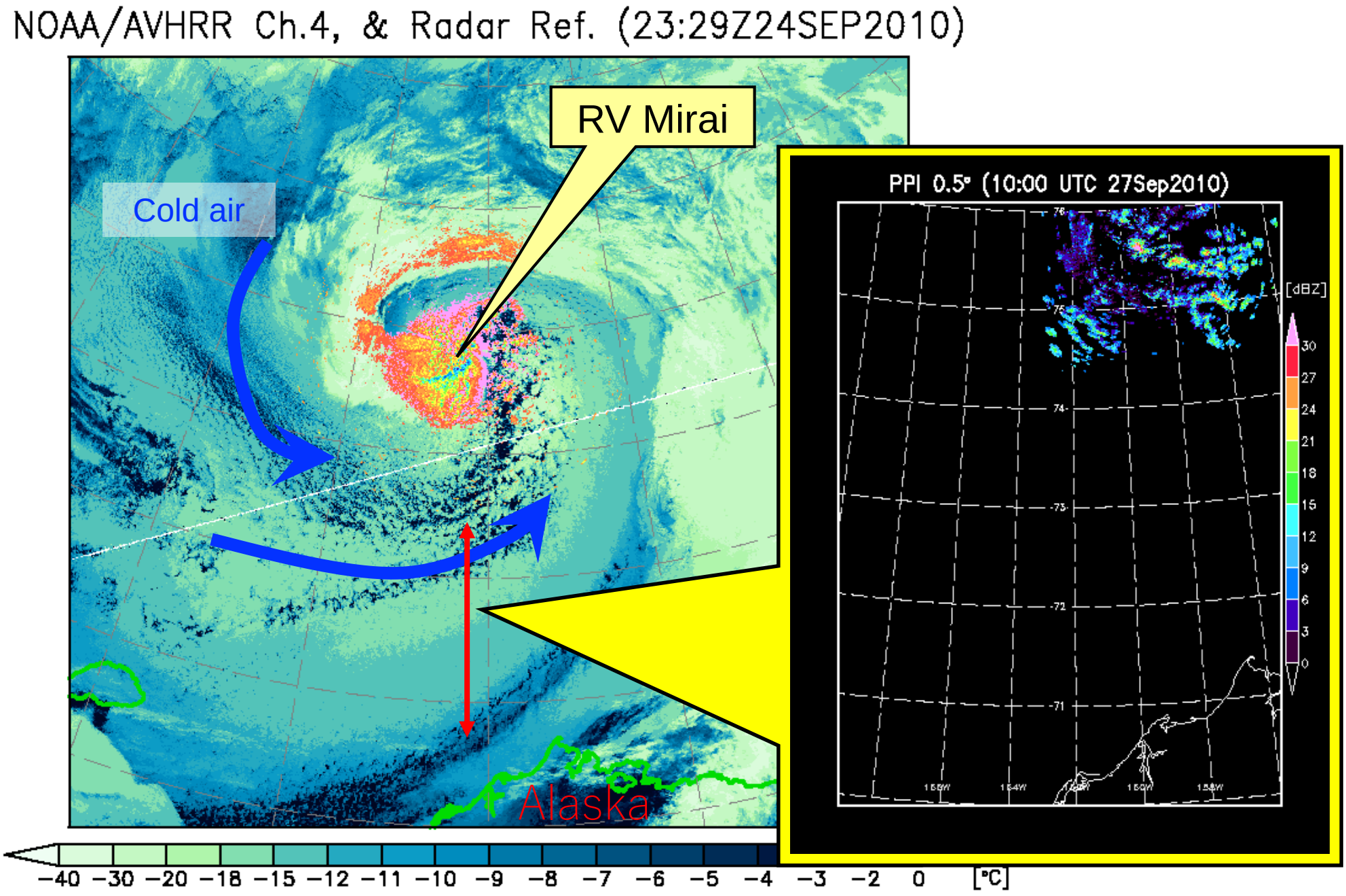


http://www.godac.jamstec.go.jp/darwin/mapsearch/

Principal specifications

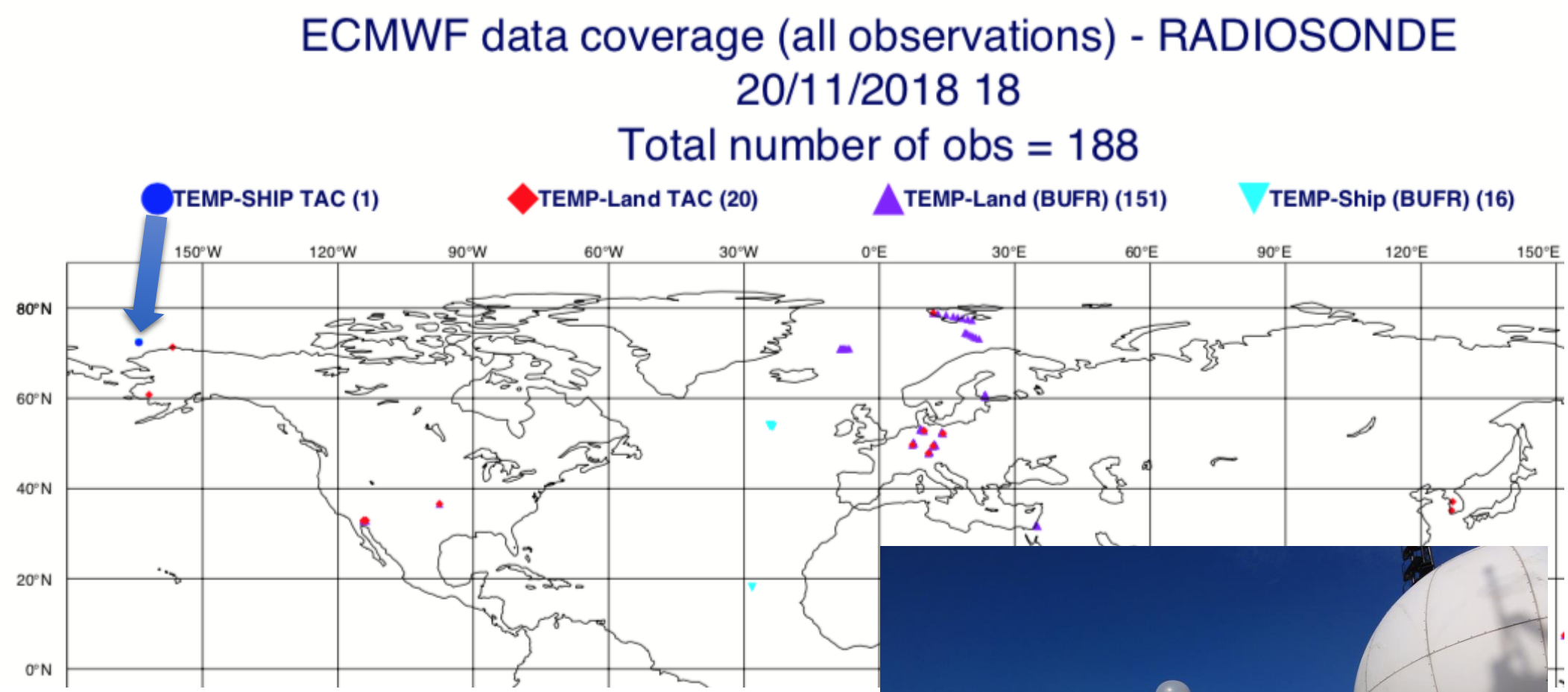
Length	128.5 m
Beam	19.0 m
Depth	10.5 m
Draft	6.9 m
Gross tonnage	8,706 tons
Cruising speed	Approx. 16 knots
Range	Approx. 12,000 nautical miles
Accommodation	80 (34 crew, 46 research personnel)
Main propulsion system	Diesel engines: 1,838kW × 4
	Electric propulsion systems: 700kW × 2
Main propulsion method	Controllable pitch propeller × 2

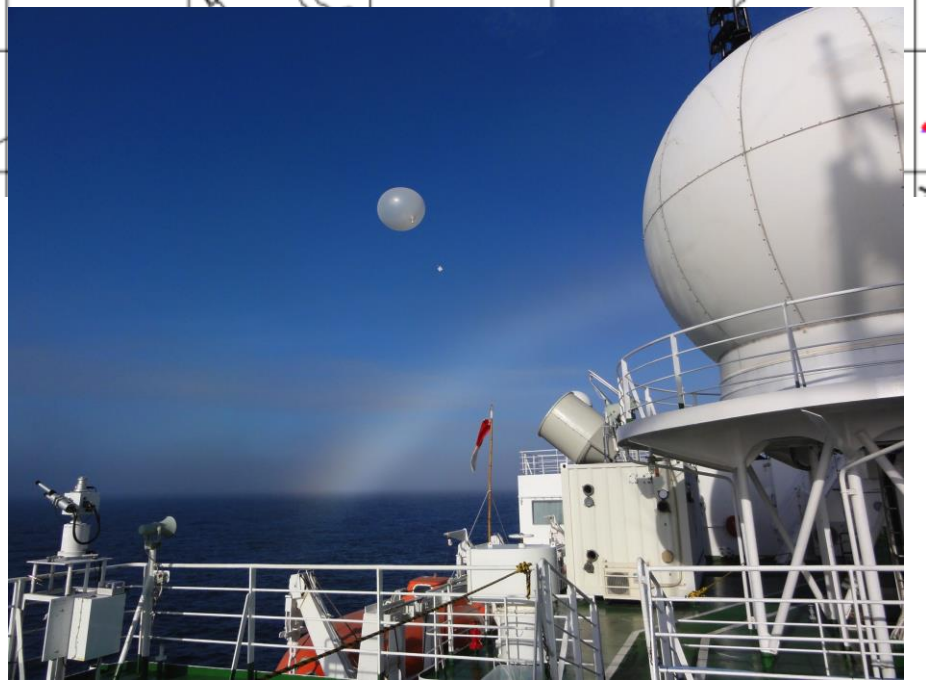
A scanning C-band Doppler radar detects a cyclogenesis



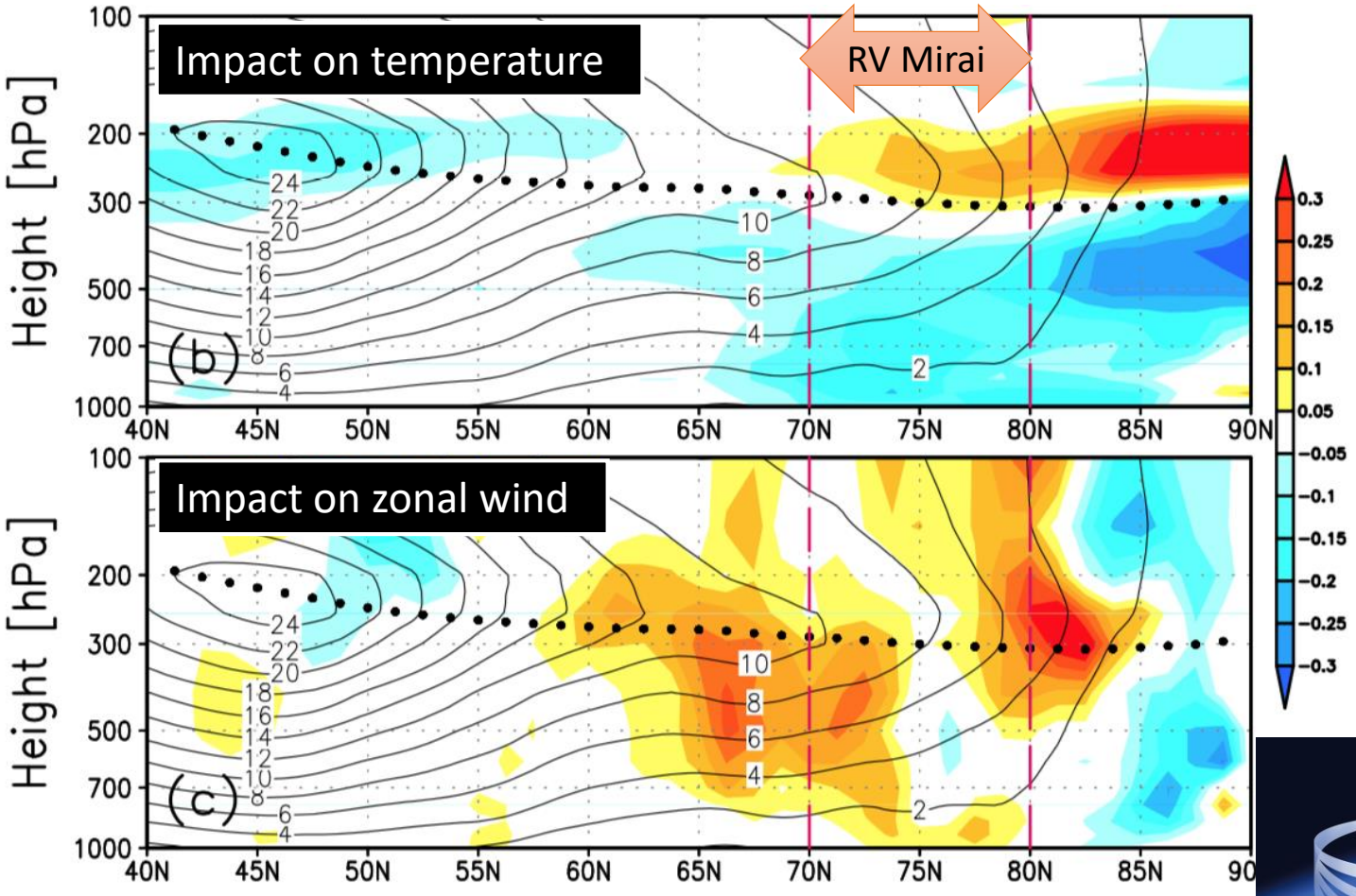
Inoue and Hori (2011 GRL)

Radiosondes from RV Mirai contribute to NWPs

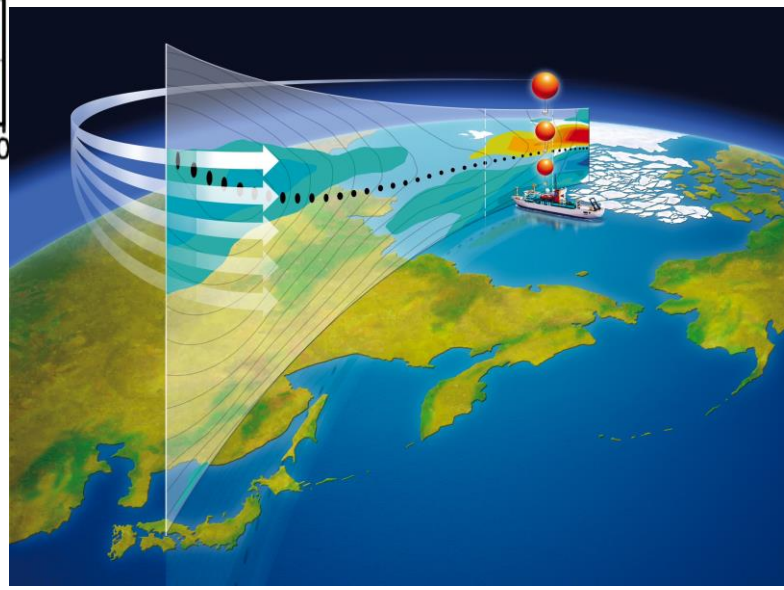




Impacts of the data on the NH atmospheric circulations



Inoue et al. (2013 GRL)



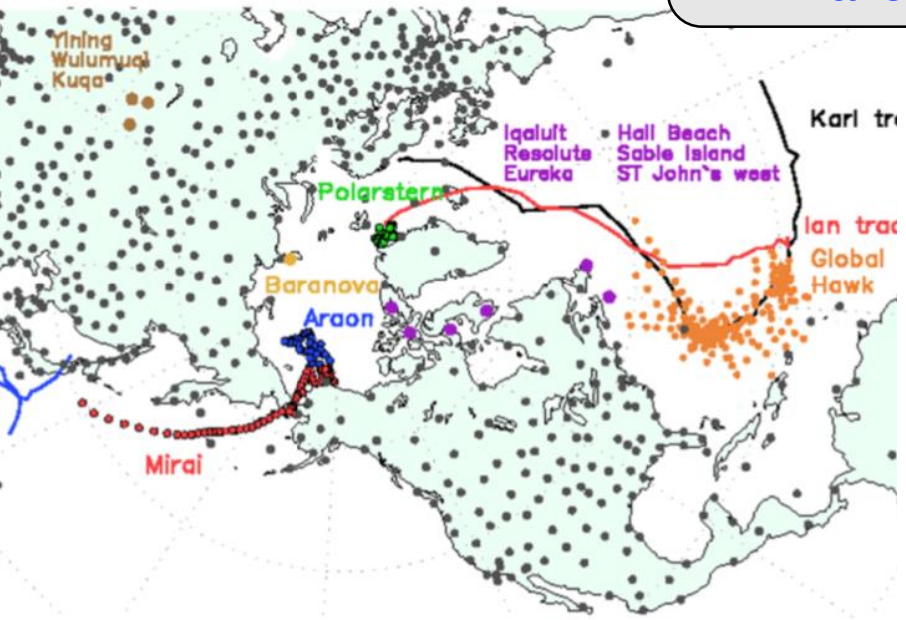
The DA system is presented at the poster session by Akira Yamazaki (JAMSTEC)

Impacts of the Mirai's data on a TC track

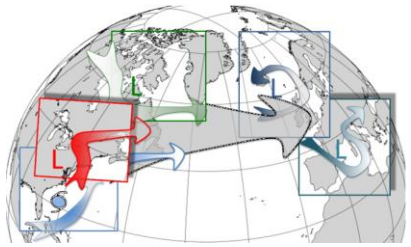
Day 4.5 (initialized from 0000 UTC 24 September 2016)

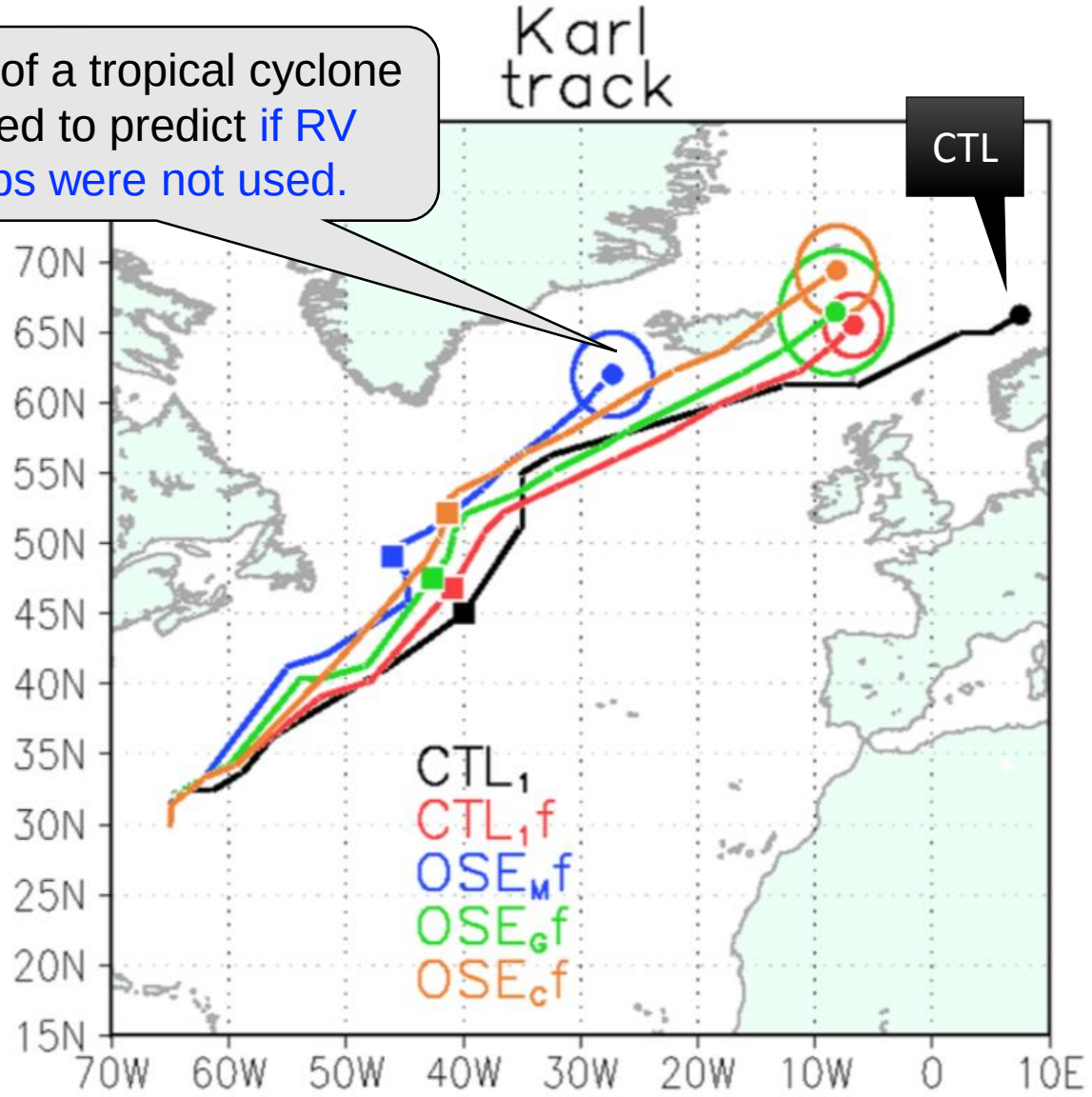
The track of a tropical cyclone was failed to predict if RV Mirai obs were not used.

Radiosonde points



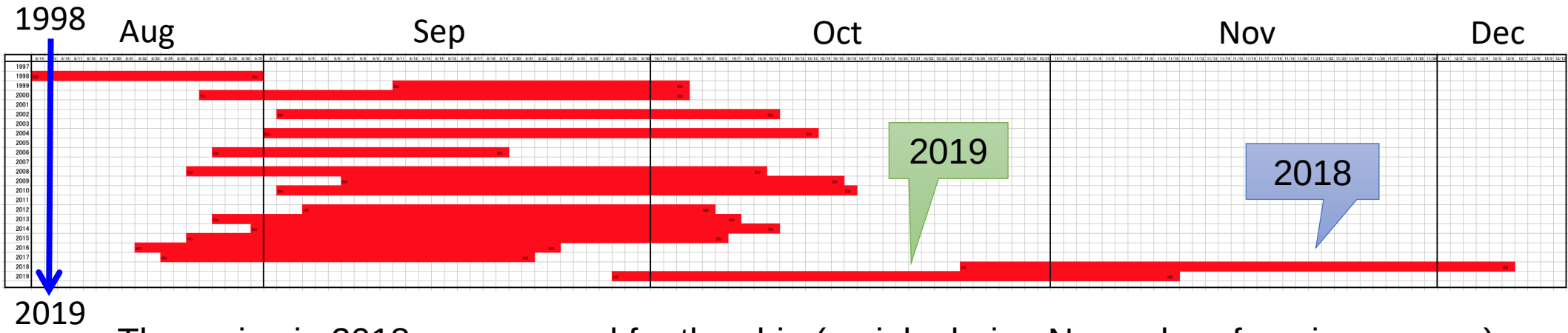
The case of NAWDEX



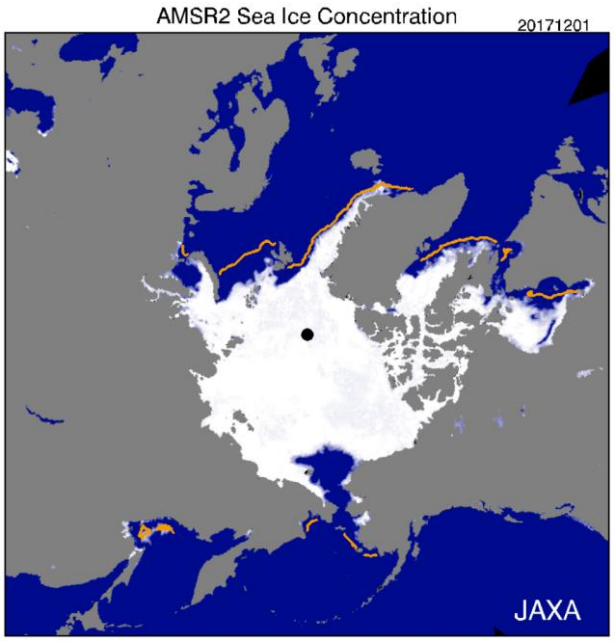


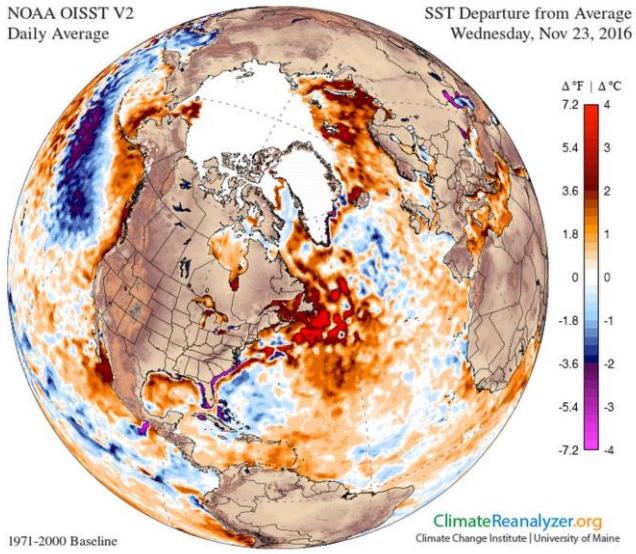
Sato, Inoue et al. (2018 Sci. Rep.)

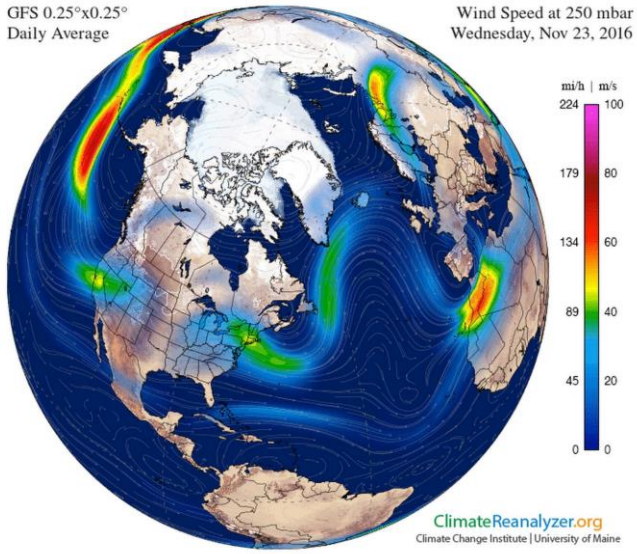
Arctic cruise season for RV Mirai from 1998 to 2019



The cruise in 2018 was unusual for the ship (mainly during November: freezing season).







The winter atmospheric circulations associated with sea-ice anomaly is emerging issues.

Issues for the ice-strengthen ship during freezing season

Sea-ice regulation:

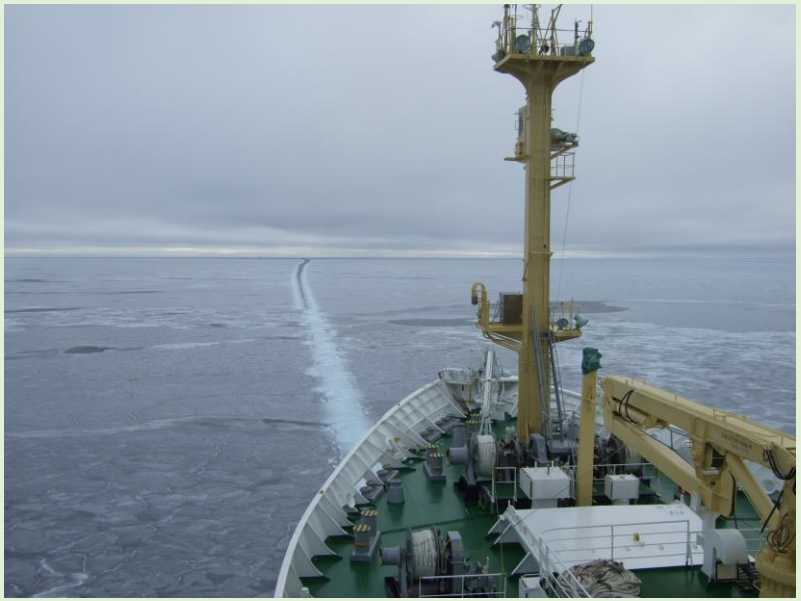
The navigation should be carried out only at the open water* where the ice thickness is less than 0.70m and the concentration is less than 1/10. (*the area where the ice thickness is less than 10cm are defined as Open Water)

Air temperature regulation:

MIRAI shall not proceed into the area where the air temperature below -15C is expected. Such temperature is beyond ice/cold region resistant specification of Mirai.

We need high resolution weather and sea-ice forecasts in real time.

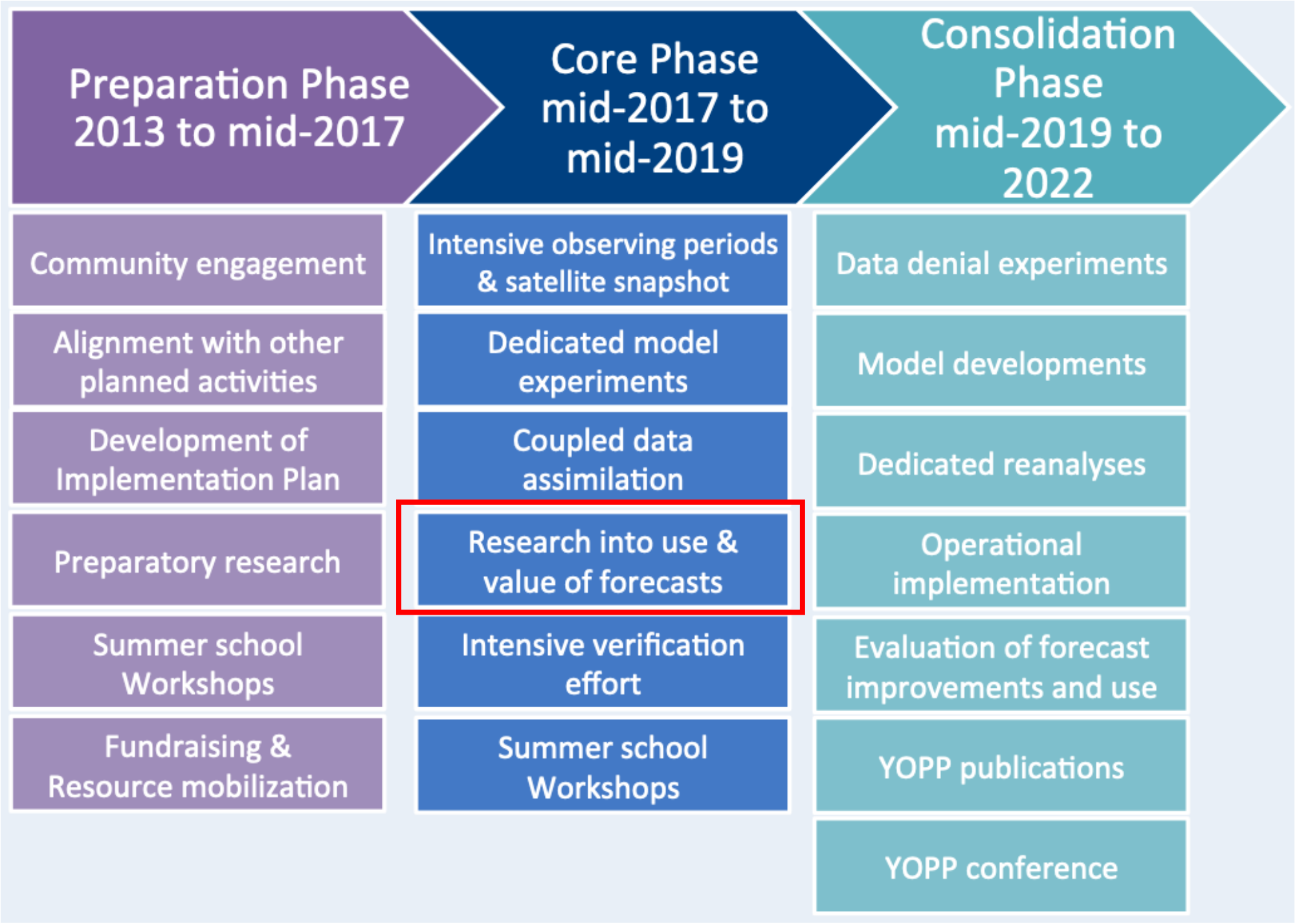
Researchers like sea ice; ship crews dislike it



OK
(sea-ice watch by additional navigation officers can be manageable)

NO GO !
(sea-ice watch by ALL navigation officers disturb the labor management)

PPP-YOPP is on going...



Sources of real time forecast data for RV Mirai

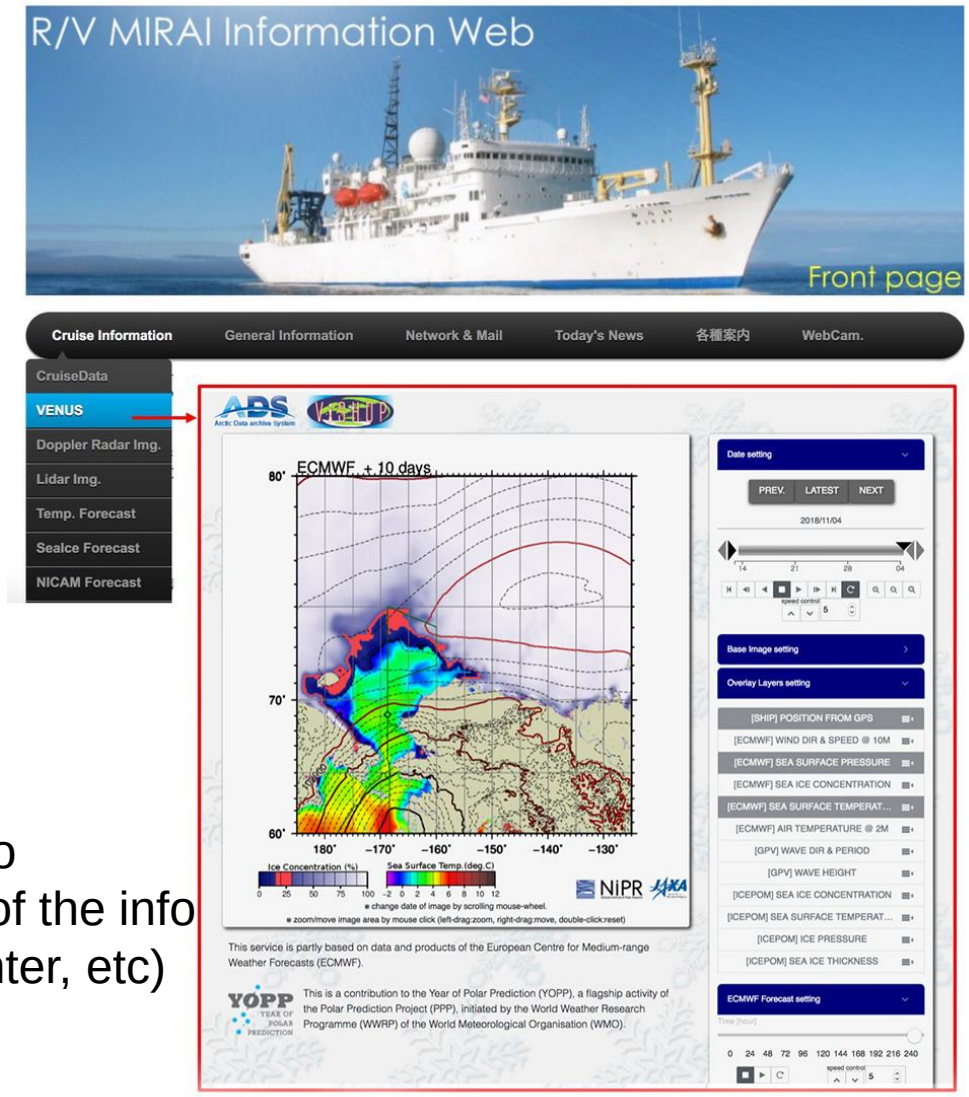
YOPP YEAR OF POLAR PREDICTION

PPP community kindly provided us the real time operational weather and sea-ice forecasts for the RV Mirai Arctic cruise in 2018 (and 2019)

Vessel Navigation Unit support System (VENUS)

Daily observation meeting on RV Mirai

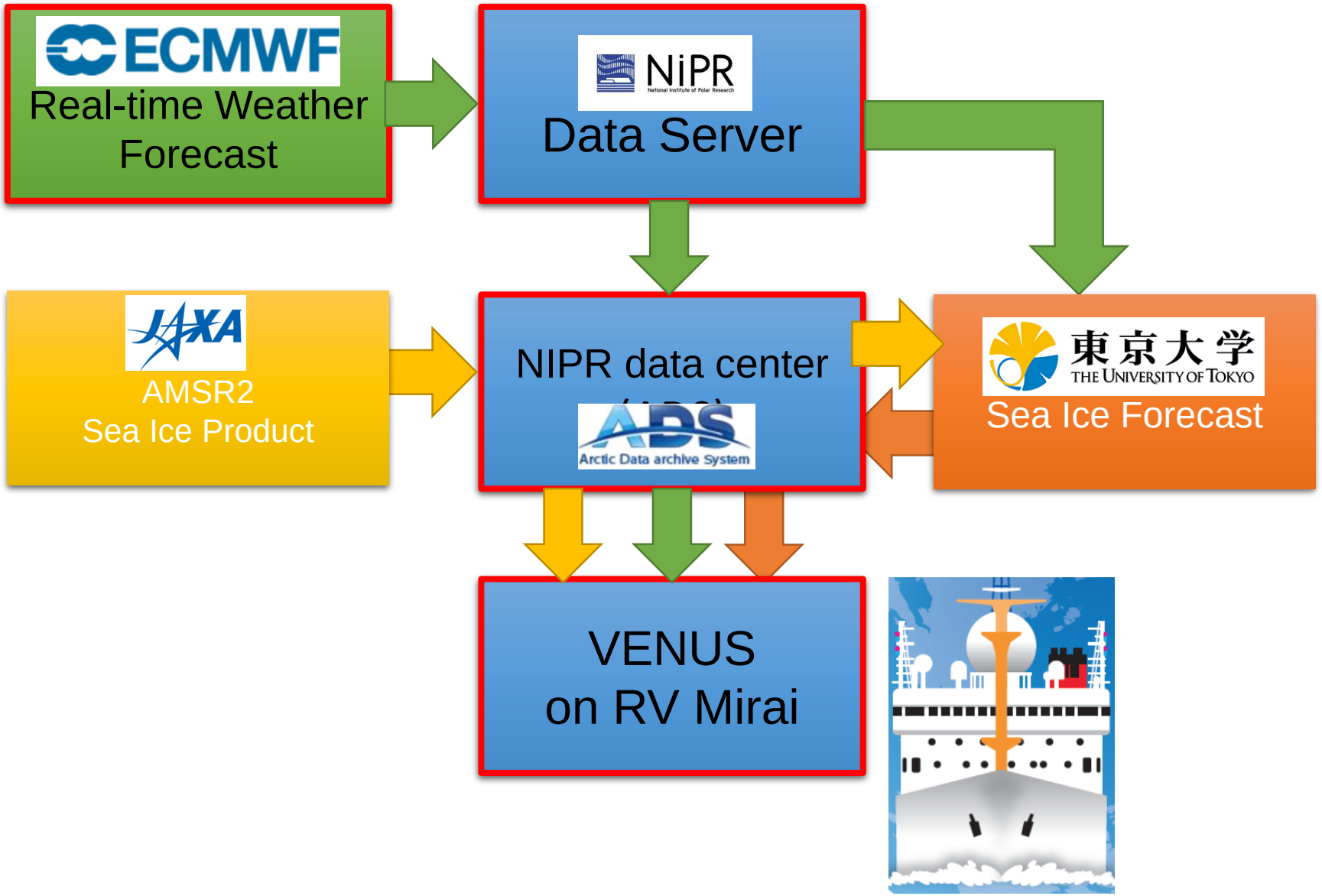
- Demonstrate how to interpret the forecasting info
- Train ship crew for understanding the limitation of the info
  (uncertainty, different performance of each center, etc)
- Apply the system to decision making



Everyone on RV Mirai can access VENUS

https://ads.nipr.ac.jp/venus.mirai/

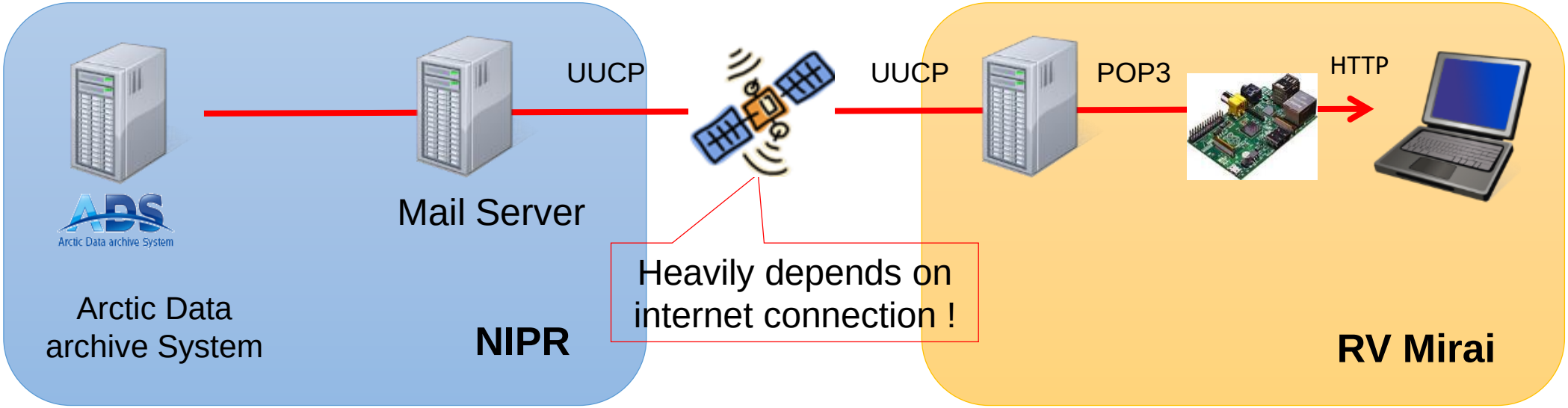
Data flow from ECMWF to RV Mirai



Timeline of data delivery

Time line (UTC)	4	5	6	7	8	9	10	11
ECMWF 00UTC product								

NIPR receives products from ECMWF → NIPR sends the product to the VENUS on RV Mirai → VENUS processes the product and makes plots



We have to prioritize the parameters that researchers really need on the ship.

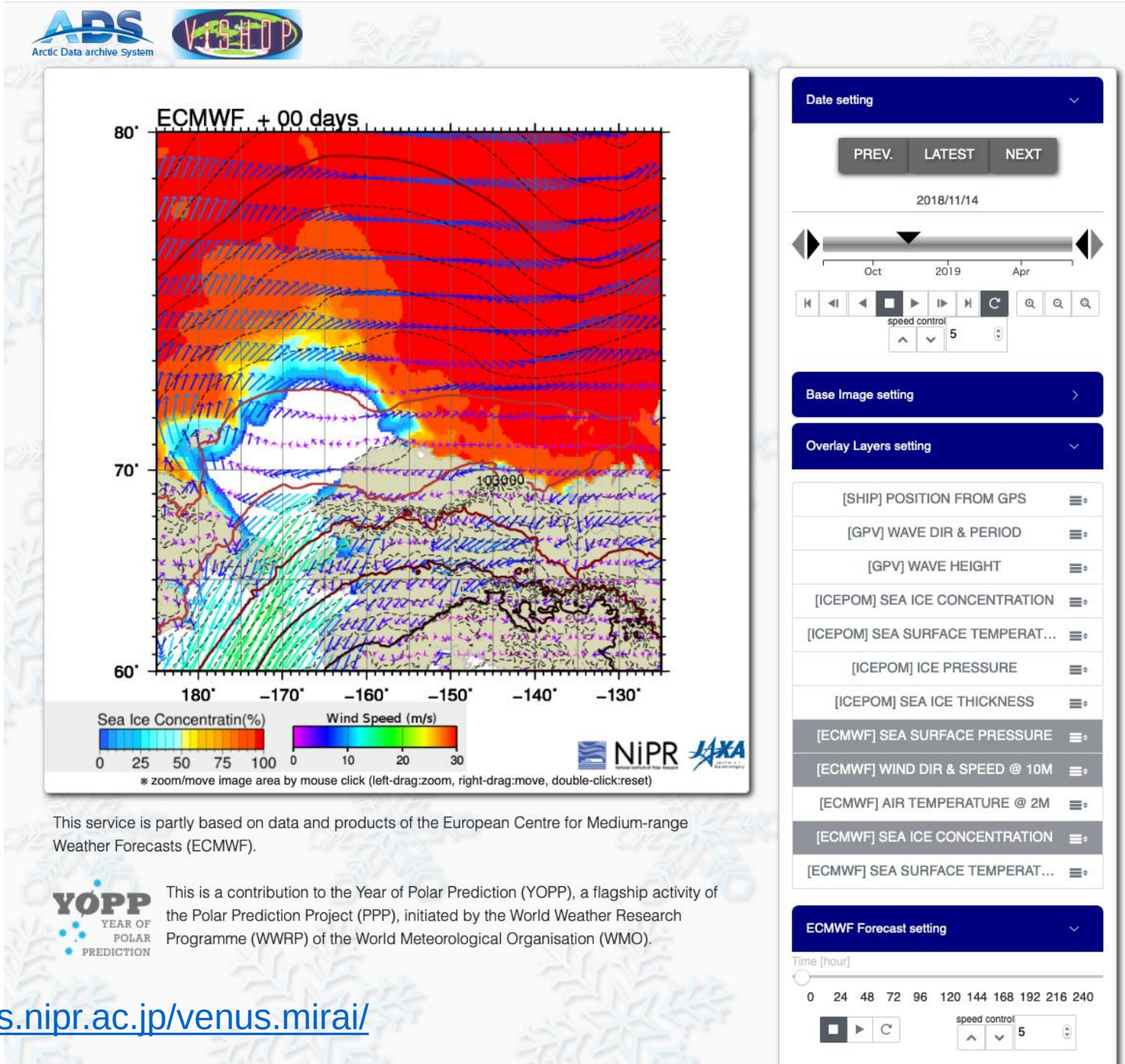
Number of parameters, files, and their file size

Data source from	Parent product	Code	Parameter	Data Type	resolution	number	Total compressed size(Byte)
JAXA	AMSR2	IC0	Sea Ice concentration(%)	Satellite	900x900	1	25,026
	AMSR2	SST	Sea Surface Temperature(℃)			1	99,899
	AMSR2	SIT	Sea Ice Thickness(cm)			1	56,453
JMA	GPV	HTSGW	Wave hight(m)		0.5 degree	4	89,175
	GPV	DIRPW	Wave direction(degree)			4	35,807
	GPV	PERPW	Wave cycle			4	31,065
ECMWF	ECMWF	MSL	Sea Surface Pressure(Pa)	prediction model	0.1 degree	11	5,286,622
	ECMWF	10U	Wind Speed U 10m (m)			11	8,977,694
	ECMWF	10V	Wind Speed V 10m (m)			11	8,974,713
	ECMWF	T2M	Air Temperature 2m (K)			11	7,113,920
	ECMWF	CI	Sea Ice concentration(%)			11	860,666
	ECMWF	SST	Sea Surface Temperature(K)			11	8,278,567
U-Tokyo	IcePOM	CON	Sea Ice concentration(%)		613x684	11	4,710,376
	IcePOM	SST	Sea Surface Temperature(℃)			11	10,175,957
	IcePOM	THI	Sea Ice Thickness(cm)			11	5,039,826
	IcePOM	STR	Ice Pressure(N/m2)			11	5,240,125

Daily Total: 125 files 62MB

(ECMWF products: 40MB)

How does VENUS look like ?



https://ads.nipr.ac.jp/venus.mirai/

Comments from our Canadian ice pilot

During MR 18-05C, daily sea ice analysis and forecasts for navigational recommendations utilizing daily sea ice concentration chart in conjunction with TOPAZ and NOAA sea ice chart forecasts emailed by MPC was augmented by onboard accessed VENUS ECMWF and Canadian sea ice concentration products. The addition of these two products provided more reliable and accurate forecast of sea ice concentration required for navigational purposes.

It is recommended that access to Canadian and ECMWF products be maintained for future ice transit voyages.

Martech Polar

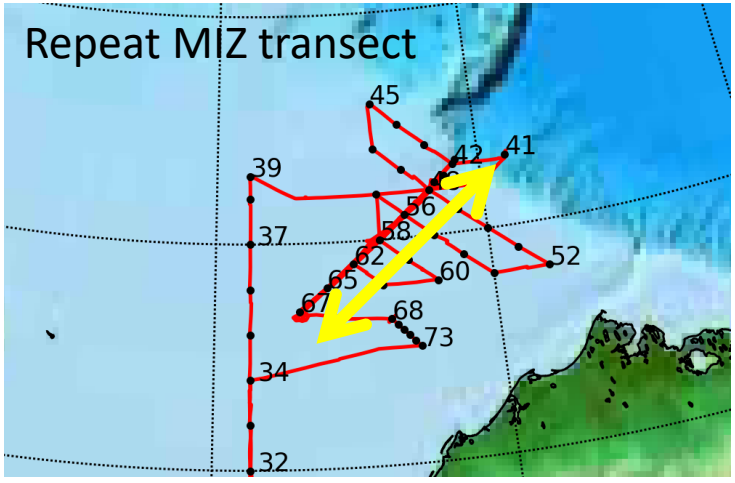
Capt. Duke Snider

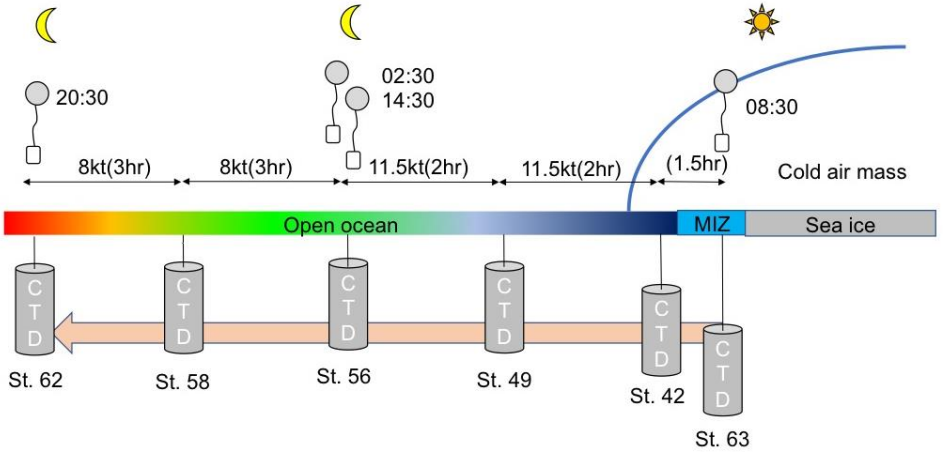
RV Mirai
Voyage MR18 – 05C
Ice Navigation Support

Captain David (Duke) Snider

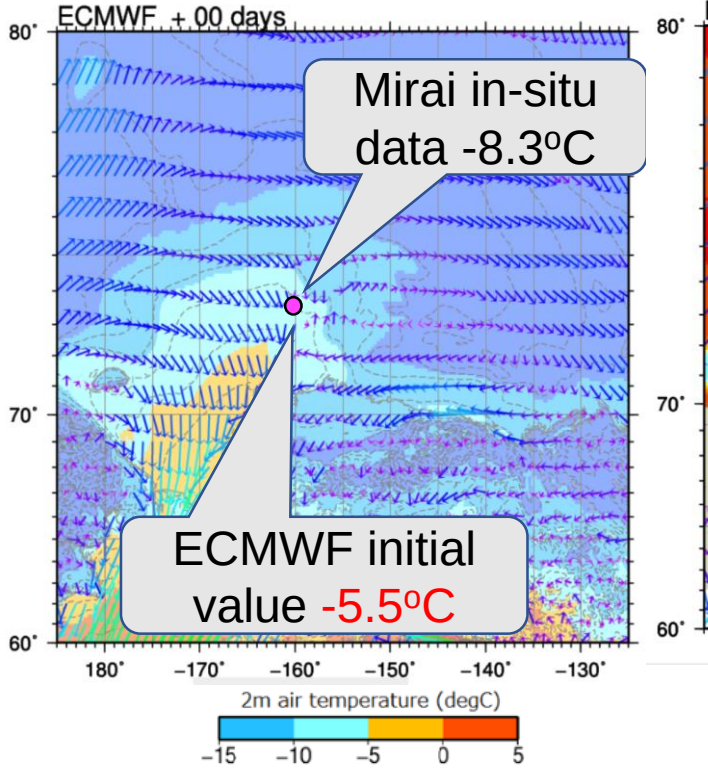
Martech Polar Consulting Limited
04 December 2018

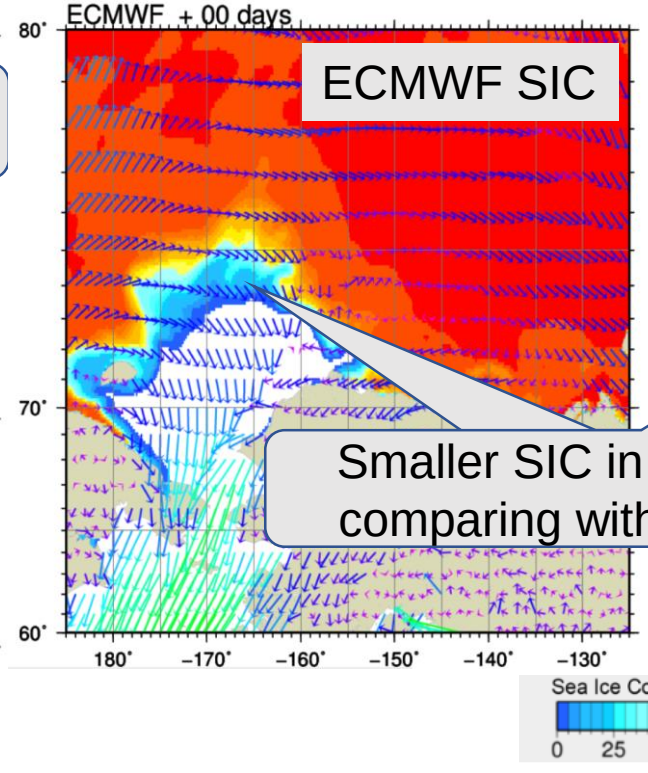
Feedback from end-users to ECMWF (warm bias near MIZ)

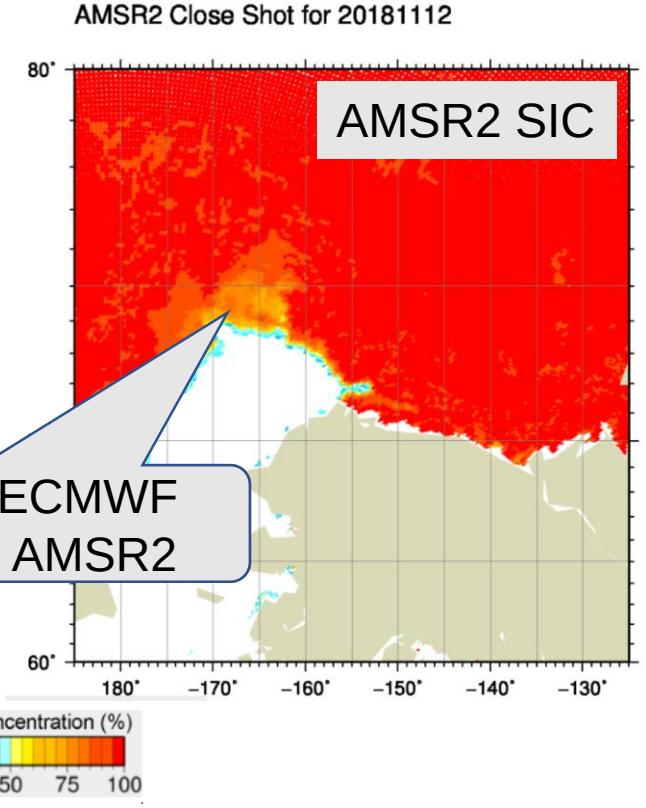




We experienced a warm bias in ECMWF forecasts near the MIZ on 12 Nov.



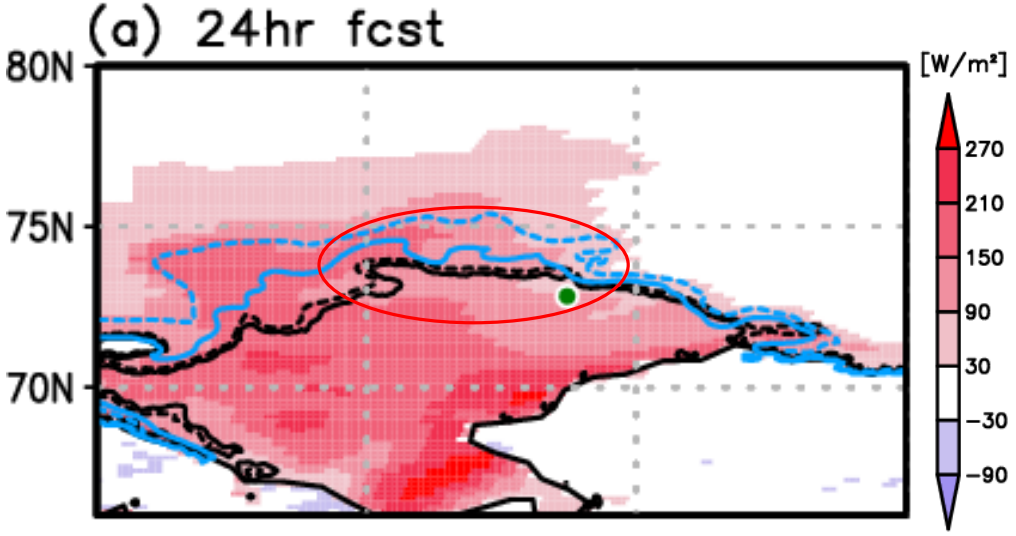




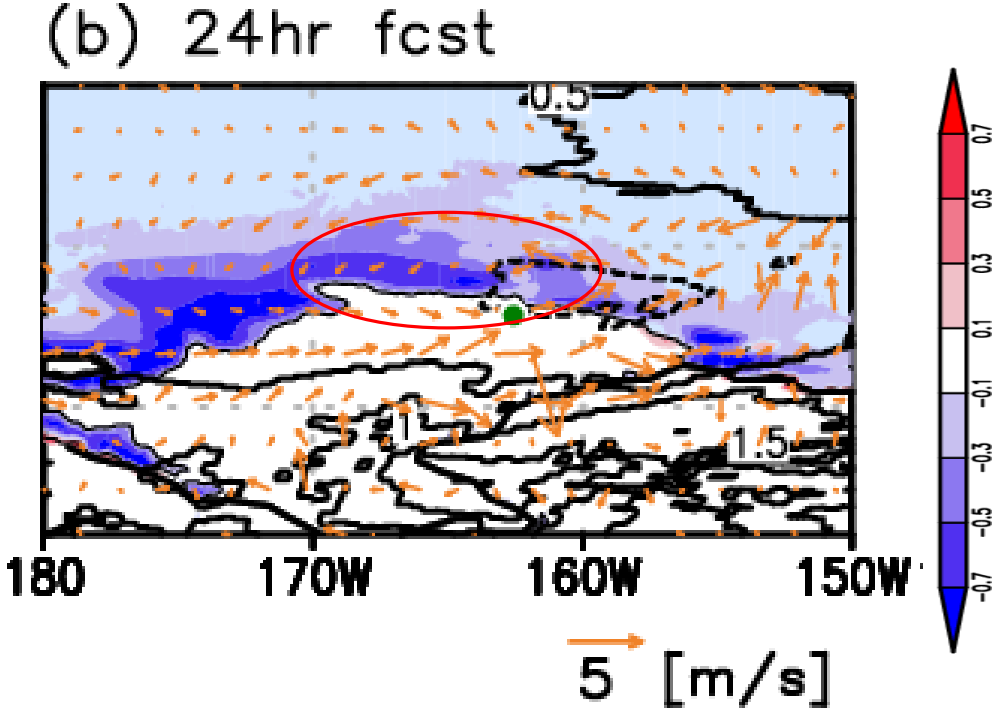
Feedback from end-users to ECMWF (the poster by Akio Yamagami)

Synoptic fields on 12 November (ECMWF deterministic forecast)

Surface turbulent heat flux (ECMWF)

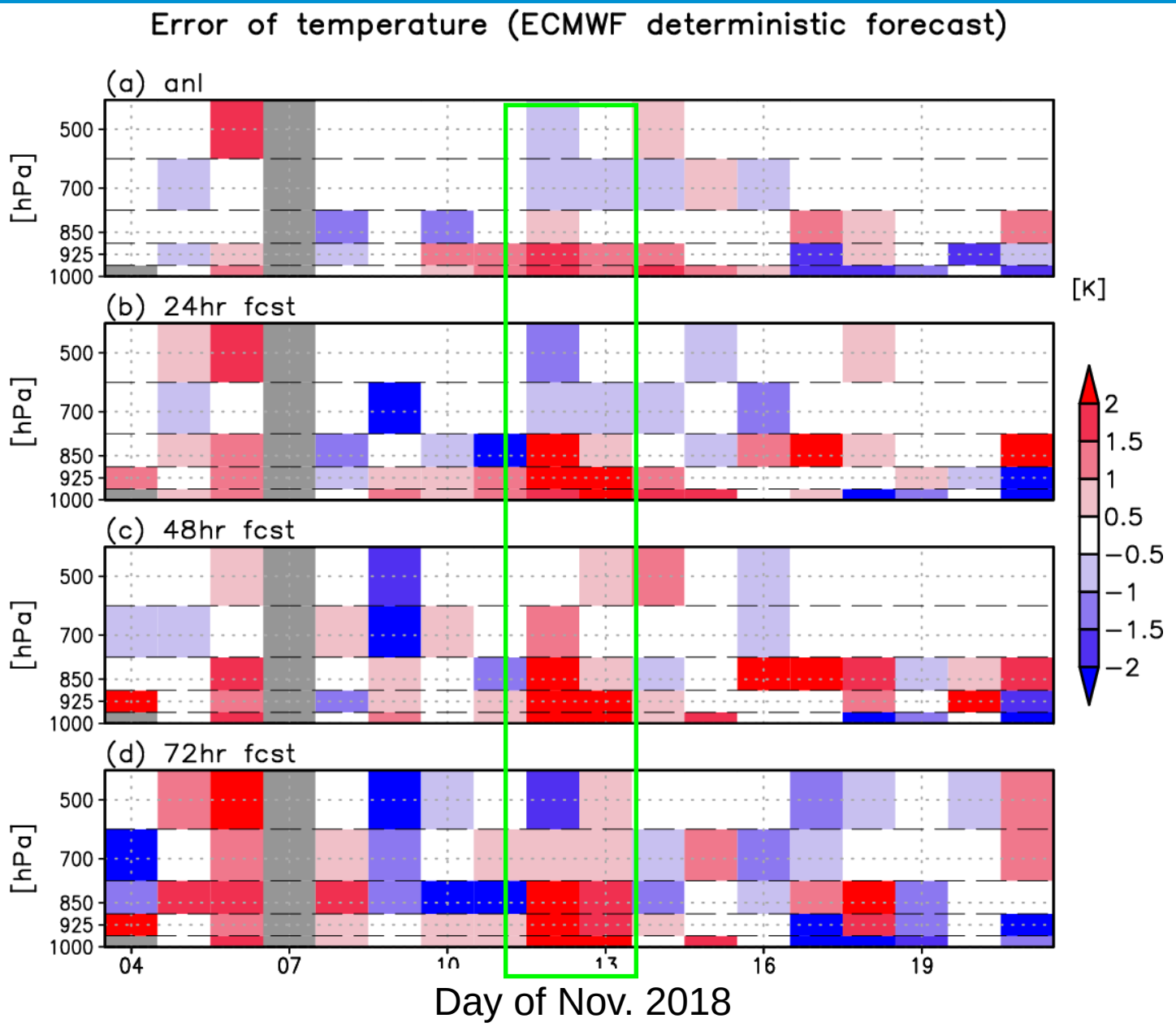


Errors of SIC, PMSL, and winds



- SIC in ECMWF forecast was lower than the observation around the MIZ.
- The negative SLP error and cyclonic circulation of wind error appeared around the MIZ in 24- to 72-hour forecast at 0000 UTC on 12 November.
- The excessive surface heat flux might attribute to the negative SLP error around the MIZ.

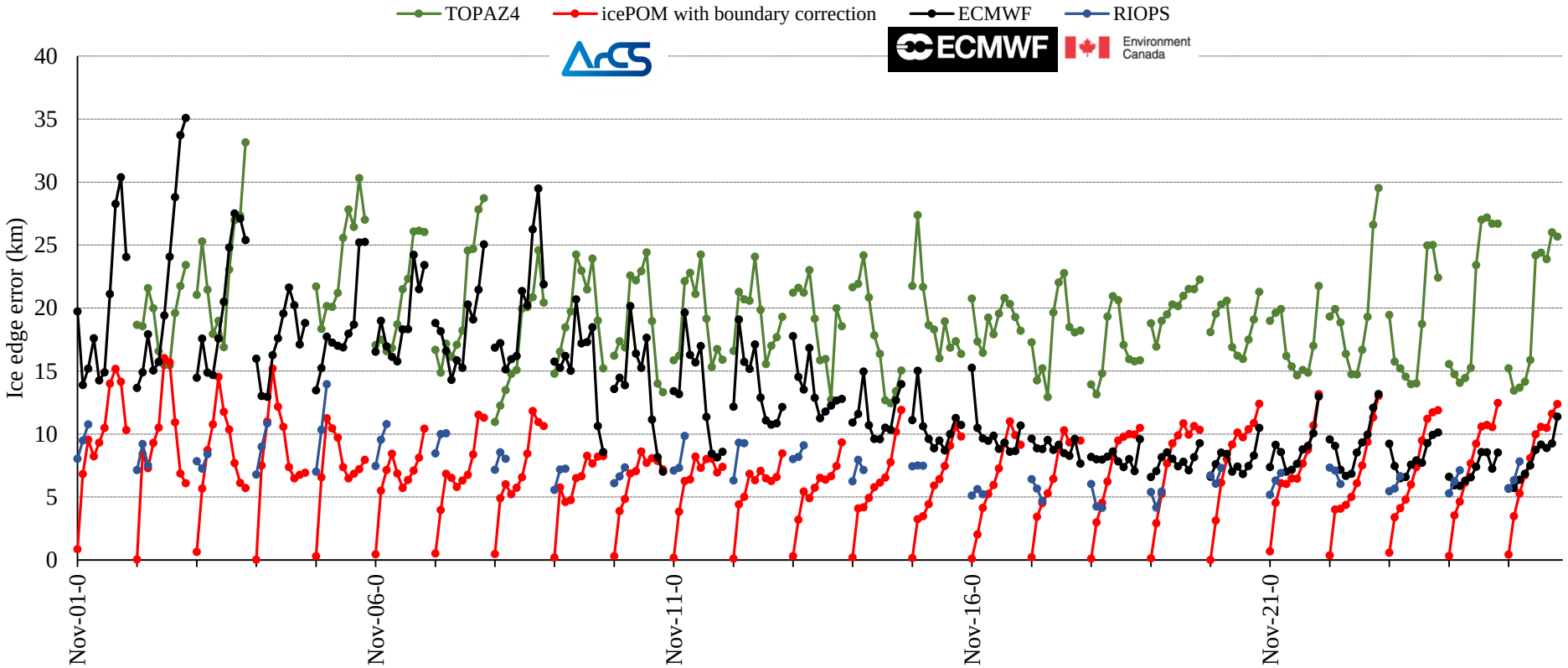
Feedback from end-users to ECMWF (the poster by Akio Yamagami)



- Comparing with radiosondes, the positive error of temperature on 12 November is extended from surface to 850 hPa.

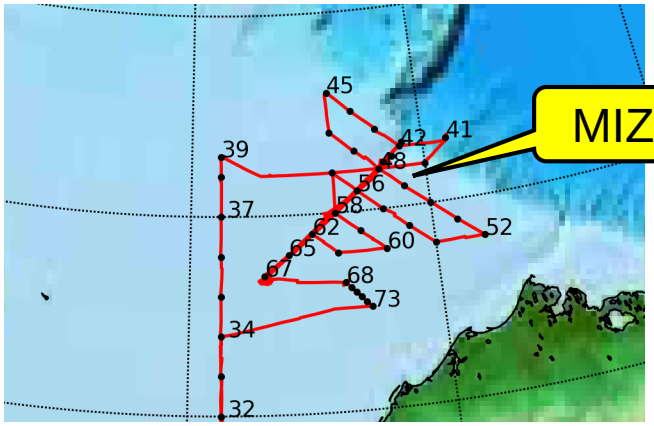
Feedback from end-users to ECMWF & ECCC (the poster by Waruna De Silva) 21

Ice edge (SIC: 15%) error compared with the AMSR2-derived SIC among the models

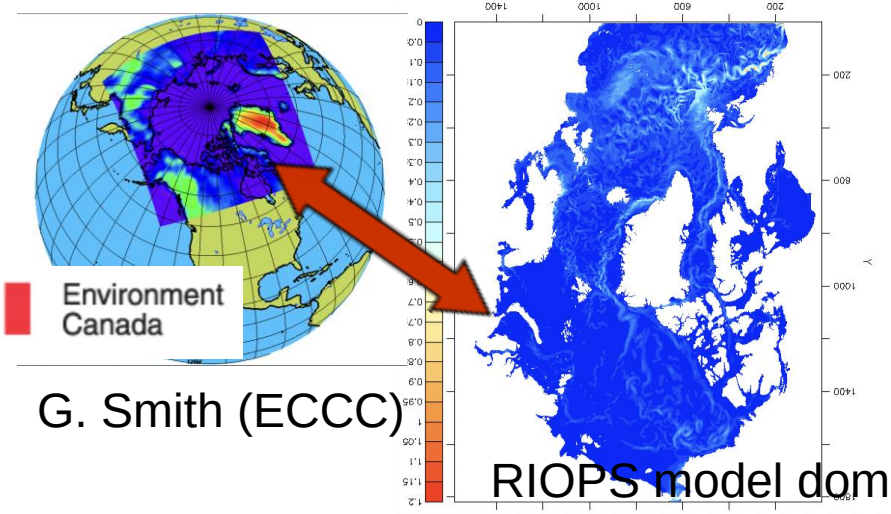


De Silva, Inoue, et al. (Polar Geo., under revision)

Feedback from end-users to ECCC (the poster by Waruna De Silva)



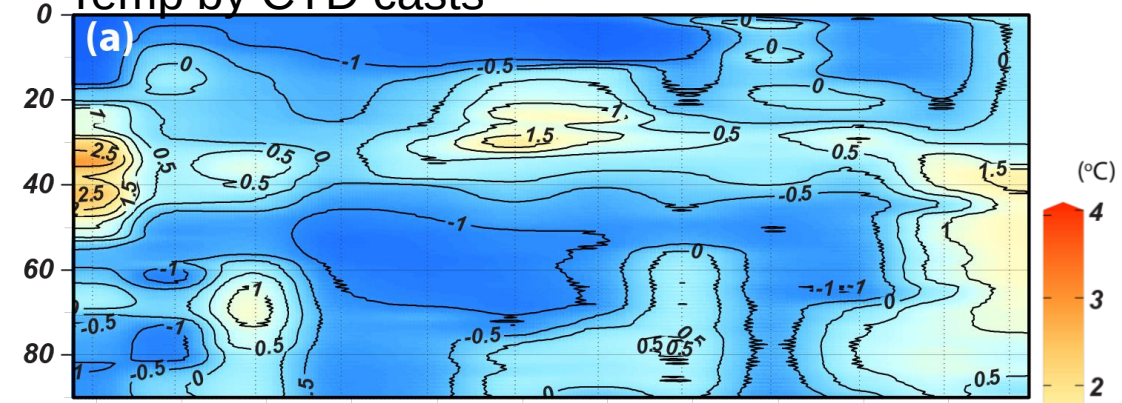
MIZ repeat transect



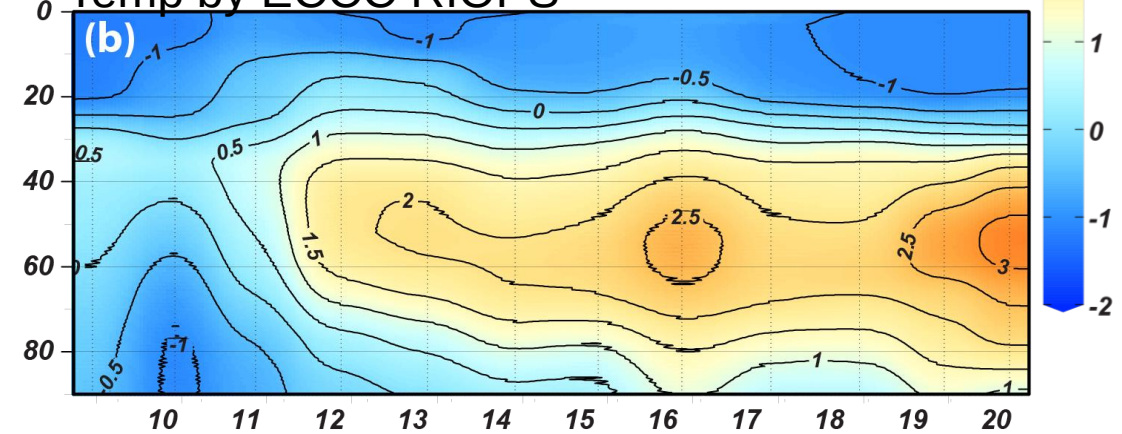
G. Smith (ECCC)

RIOPS model domain

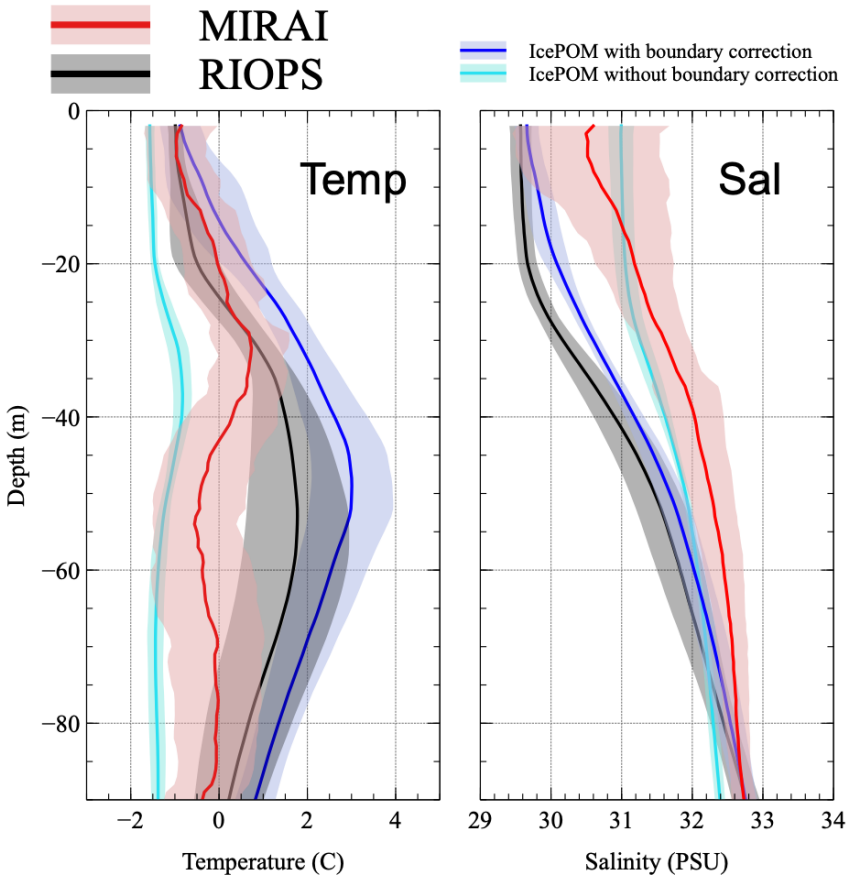
Temp by CTD casts



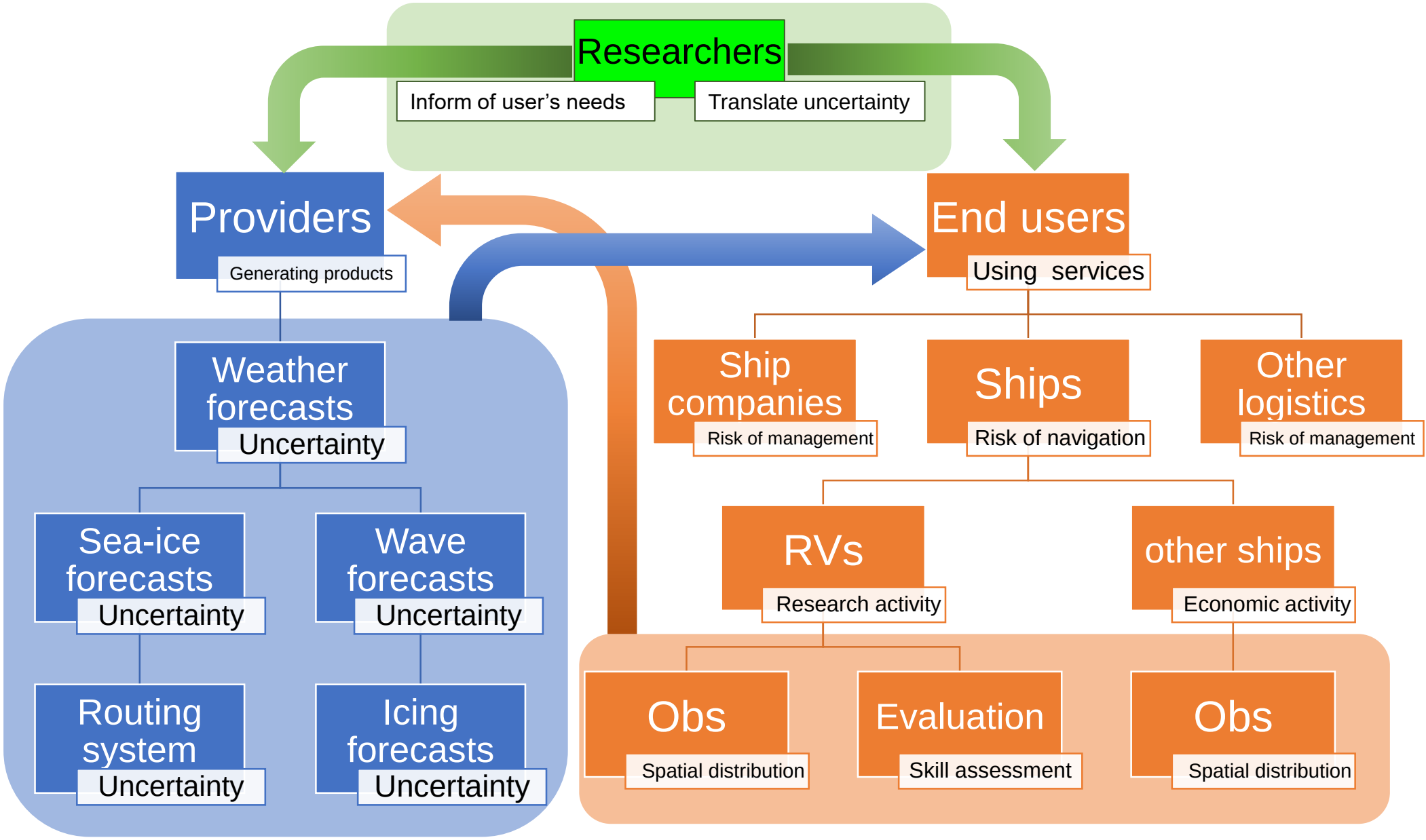
Temp by ECCC RIOPS



November-2018



Lessons learned from the cruise: Consider the ship crew's mind



It is very important to activate the dialogues between providers and end-users.
This workshop provides us such a great opportunity.

Summary

1: How are field campaigns making use of NWP data, for defining cruise planning, choice of period, etc.?

- Sea-ice cover: deciding the northern limit of activity (MIZ)
- Wind speed & wave height: deciding possibility of deck works (e.g. < 17m/s, <4m)
- Wind direction: understand sea-ice drift and source of air mass
- SLP: detecting extreme events
- Air temp: judging the termination of MIZ activity
- Short range: to update daily activities
- Medium range: to estimate of approximate duration of repeat transects & to decide when to escape from the Arctic Ocean through the freezing Bering Strait (to avoid the closure of the strait)

2: What NWP-based products are needed to support field campaigns?

- High resolution surface forecasts (atmosphere, ocean & sea ice) from short to medium ranges
- 3D variables are also useful, but less important comparing with surface parameters (we have to prioritize the parameters because of the limited internet connection)