An application of a deeper type underwater glider to observe temperature, salinity, DO and chl-a distribution and its connection to an operational ocean forecasting model.

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Collaborators

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SEA corporation

Underwater glider

Introduced as a future ocean observing equipment in a science fiction written by Prof. H. M. Stommel.

“The Slocum Mission” in Oceanography(1989)

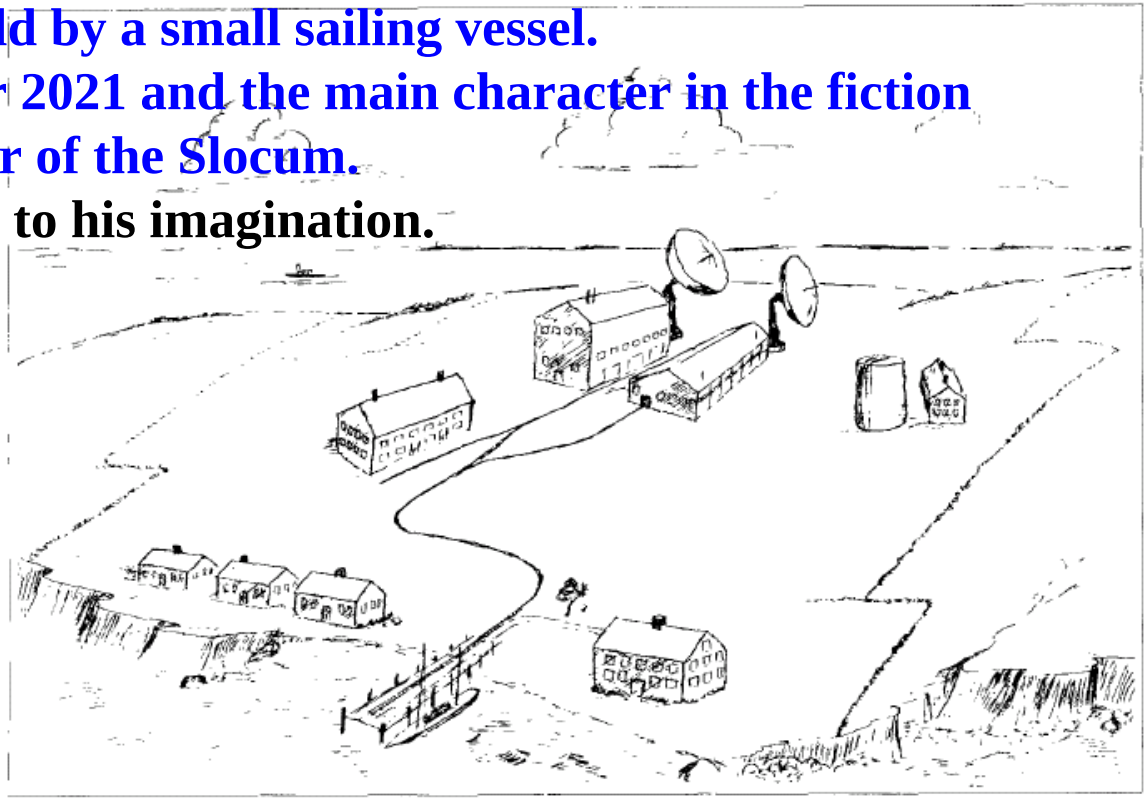
Slocum uses thermal engine and the lifetime is designed to 5 years.

They migrate vertically through the ocean by changing ballast, and steer horizontally by gliding.

The Slocum float is named after Joshua Slocum, the Yankee skipper who first went around the world by a small sailing vessel.

This is fiction assumed for 2021 and the main character in the fiction works in the control center of the Slocum.

However, we are very close to his imagination.



Stommel (1989)

Underwater glider in the real world

They migrate vertically by changing ballast, and convert the vertical motion to horizontal movement by gliding on inclined wings.
At surface, they send data through satellite communications.

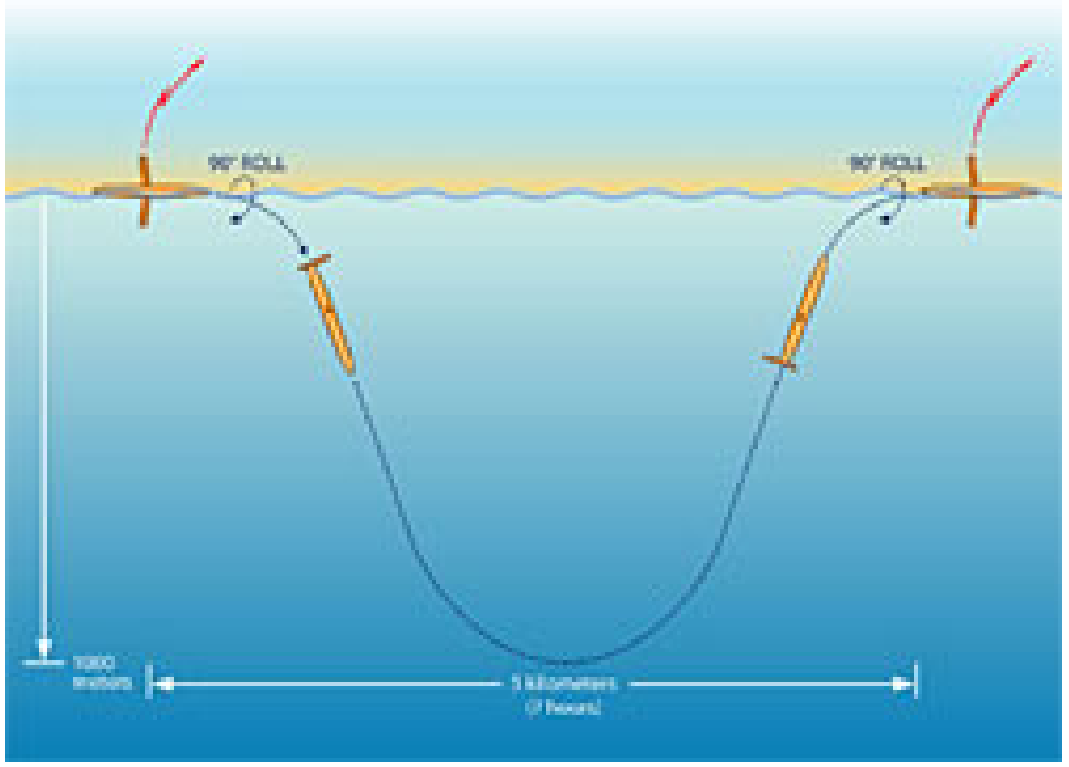
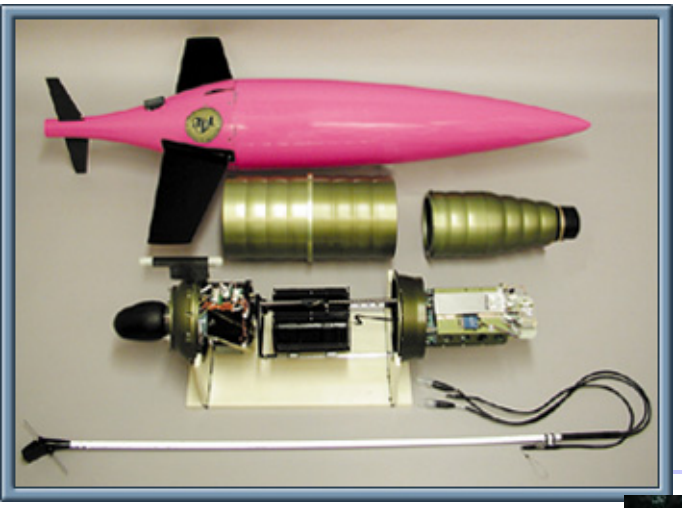


Illustration by Jayne Doucette (WHOI)

Underwater gliders used in the world

Seaglider (Univ. Washington)



Spray glider (Scripps Institution of Oceanography)

Slocum glider (Webb)

Slocum glider

Equipments can be installed are

CTD, DO, Chl-a, echo sounder(bathymetry)

ADCP, scatter meter, FRRF, nutrient sensors scanning sonar, video camera, etc.

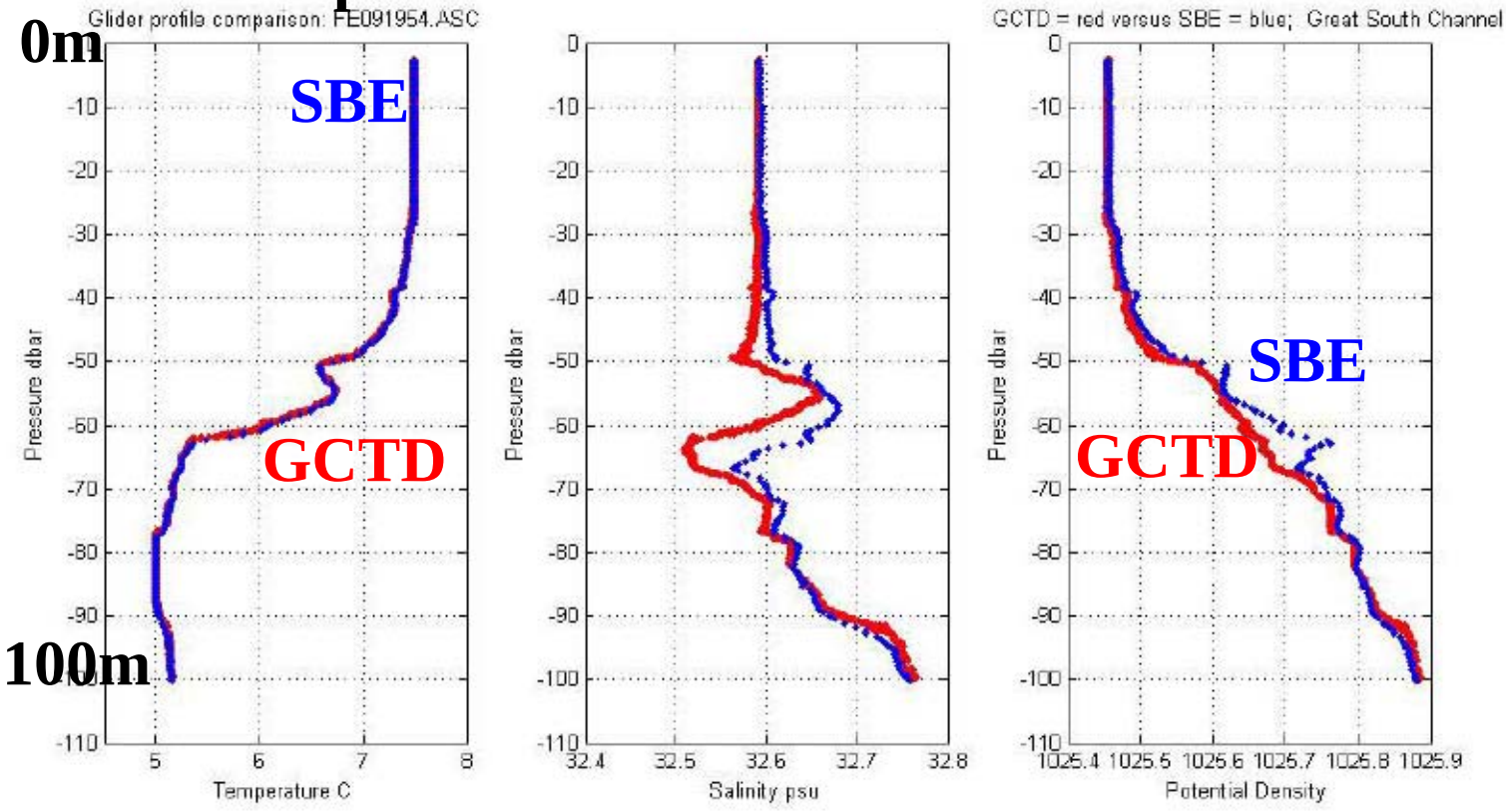
	Slocum (shallow)	Slocum (deep)
Max depth	200 db	1000 db
Max speed	40 cm/s	50 cm/s
Volume change	450 cc	504 cc
Batteries	Alkaline	Lithium
Duration	20 days	90 days
Range	500 km	1500km

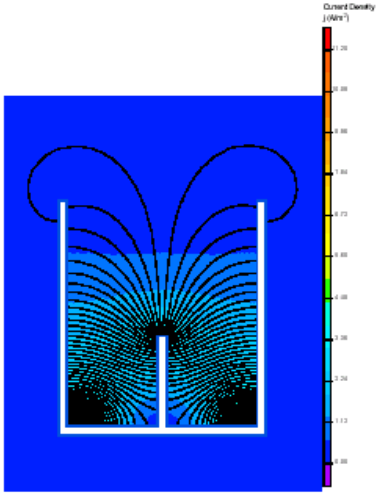
CTD

GCTD (Schmitt & Petitt, 2006)

- **designed for gliders and AUVs**
- **four-electrode conductivity cell**
- **first response**

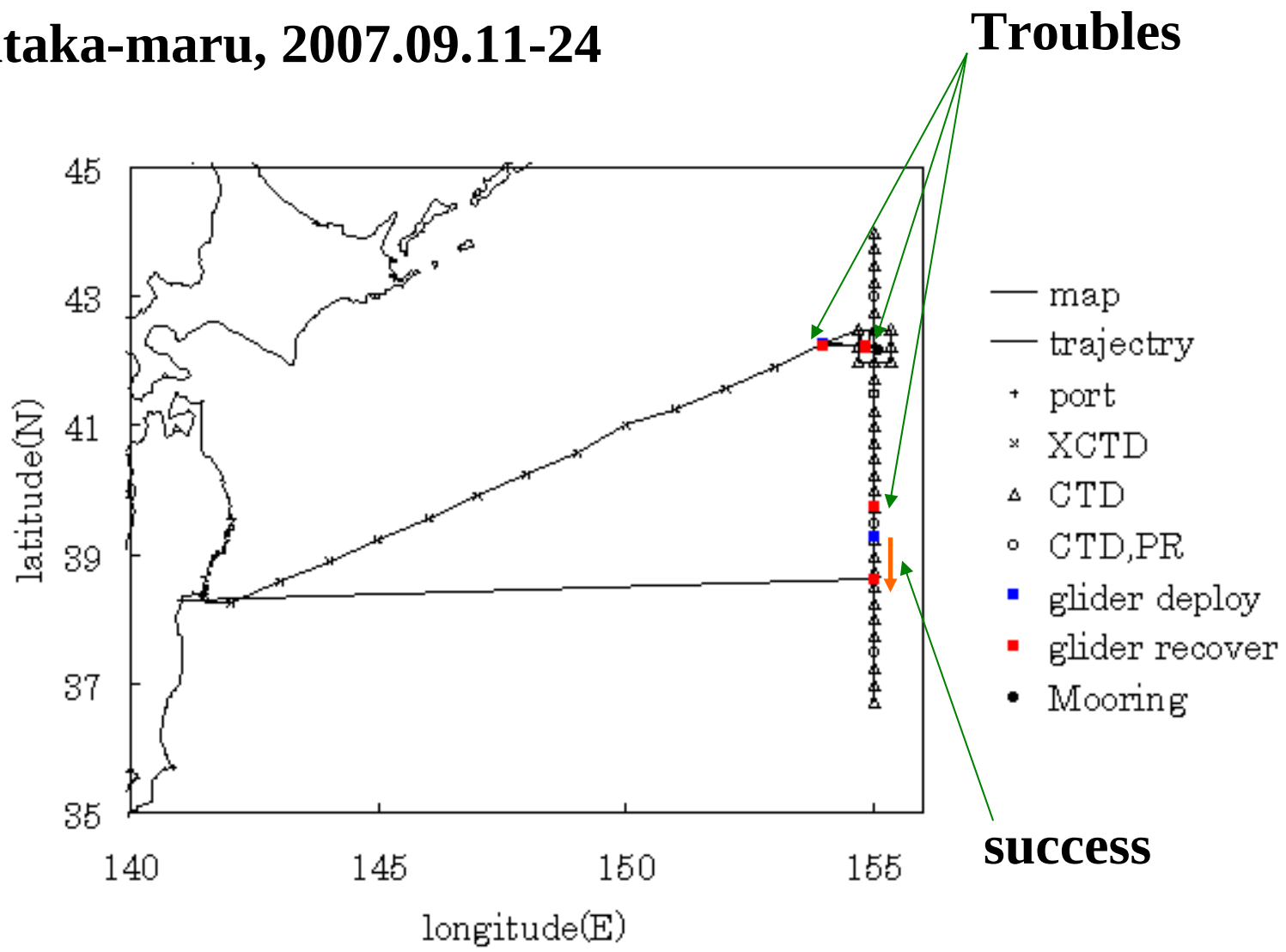
Temp. **Sal.** **Dens.**



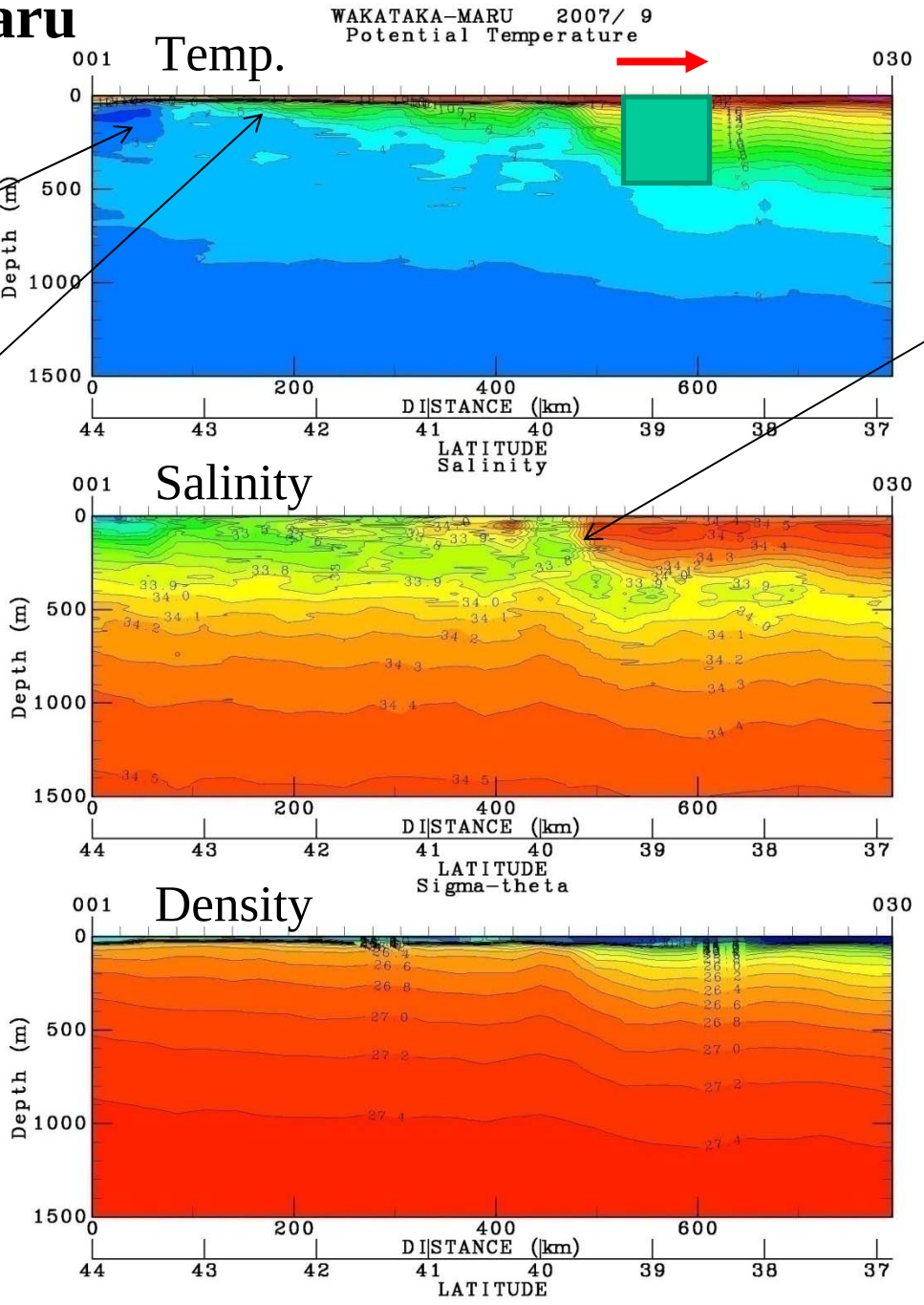


First trial at open ocean

Wakataka-maru, 2007.09.11-24



Wakataka-maru
2007.09.11-24
155E



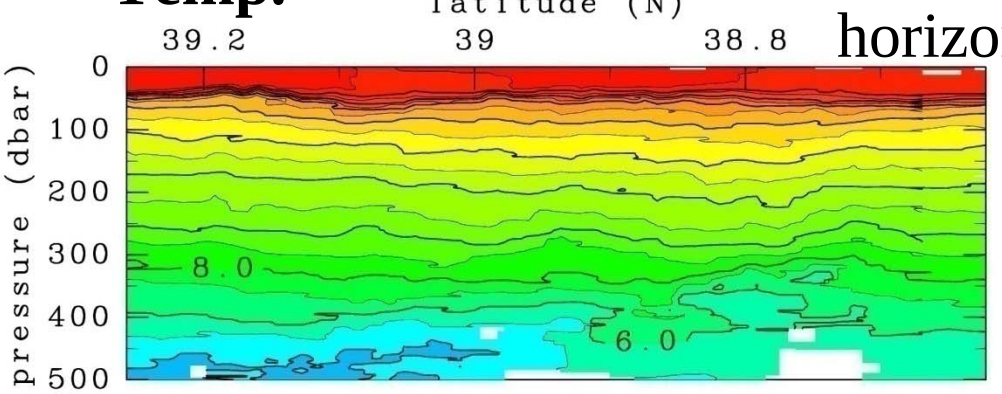
Western Subarctic Gyre Water

Subarctic Front

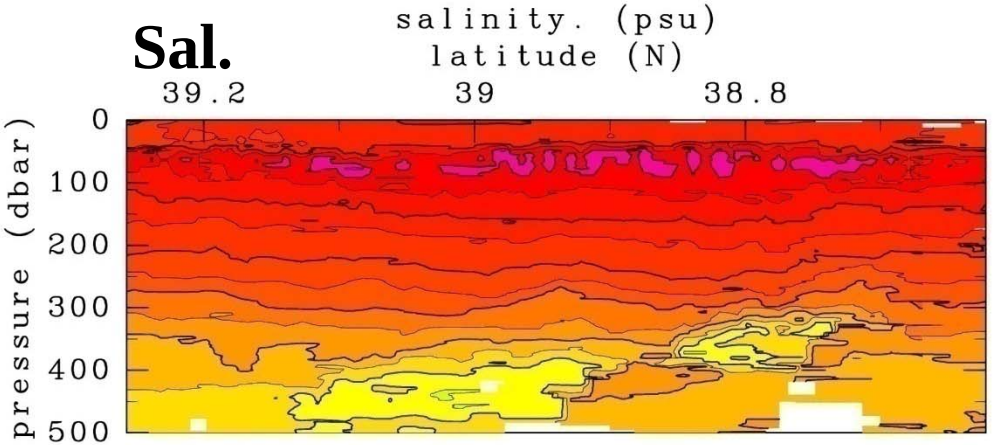
Subarctic Boundary

Glider captured finer structure in horizontal scale.

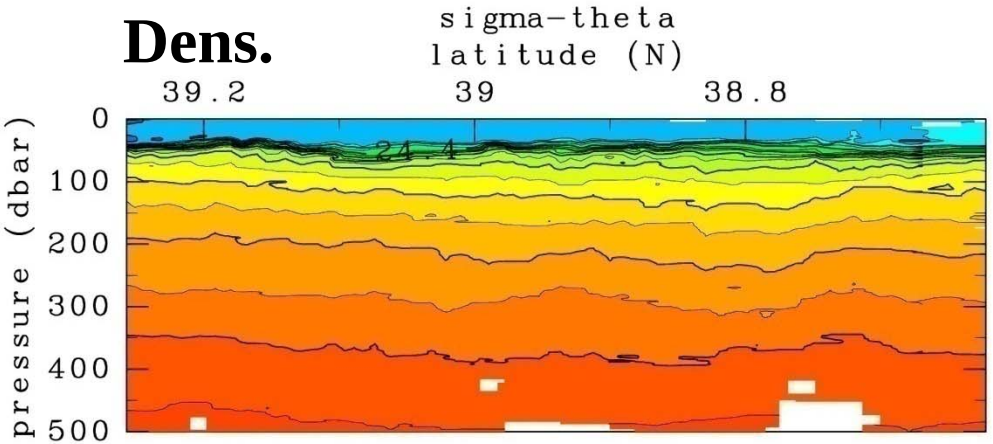
Temp.



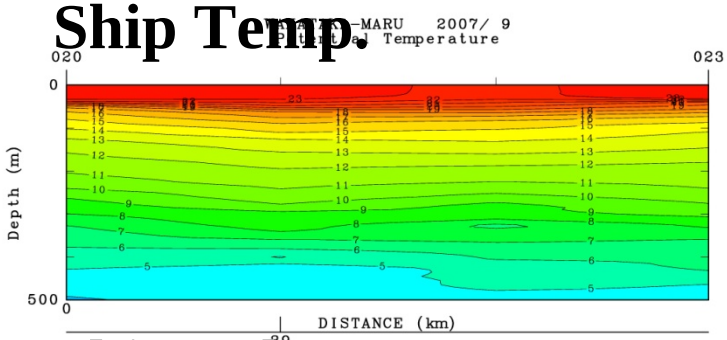
Sal.



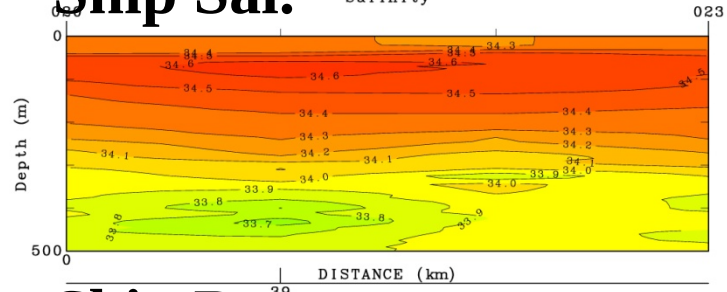
Dens.



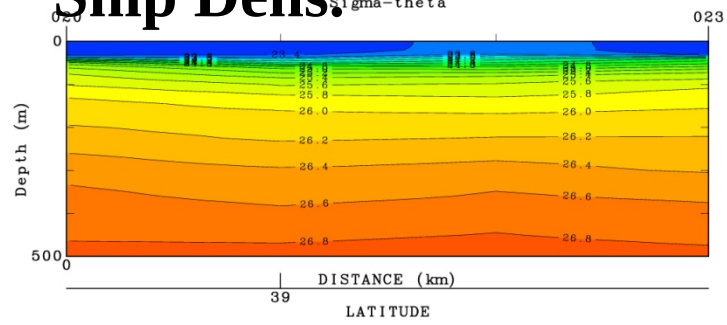
Ship Temp.

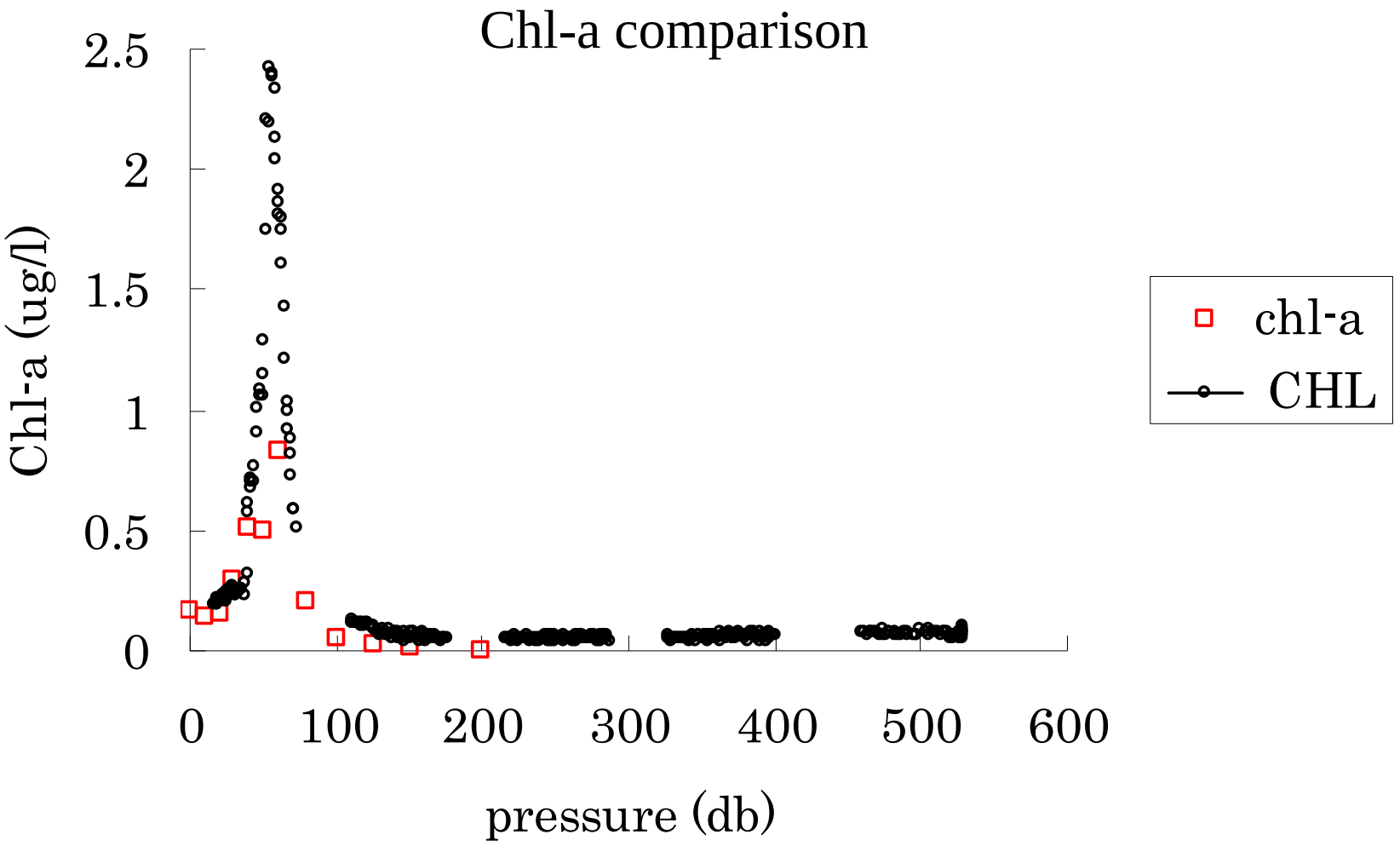


Ship Sal.



Ship Dens.

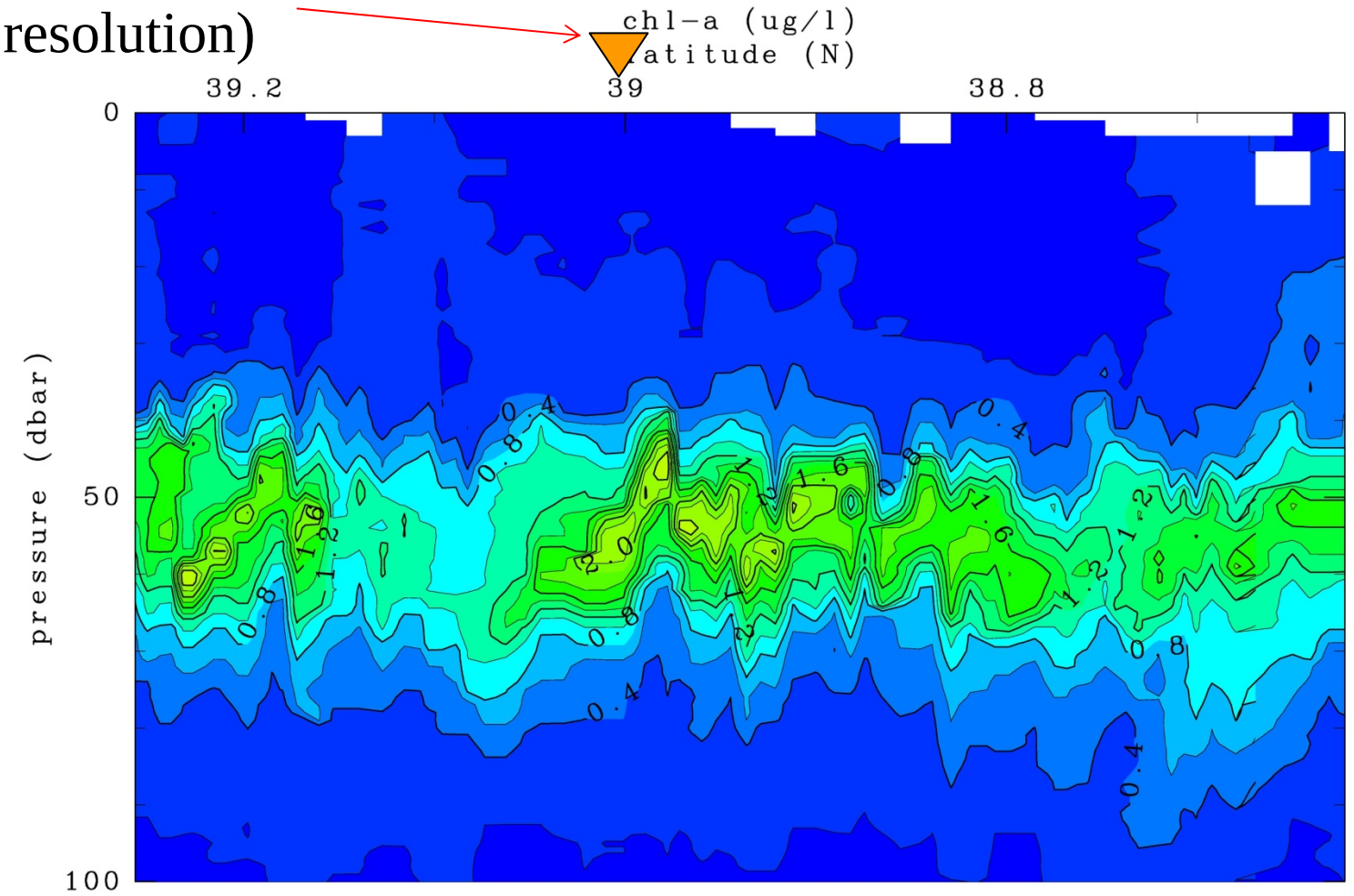




Vertical resolution of in situ water samples are limited to O(10 m). Glider is able to observe fine vertical structure.

Glider Chl-a

Ship observation
(30’ resolution)



Glider captured fine scale structure not only in vertical but also in horizontal direction.

Test of underwater glider

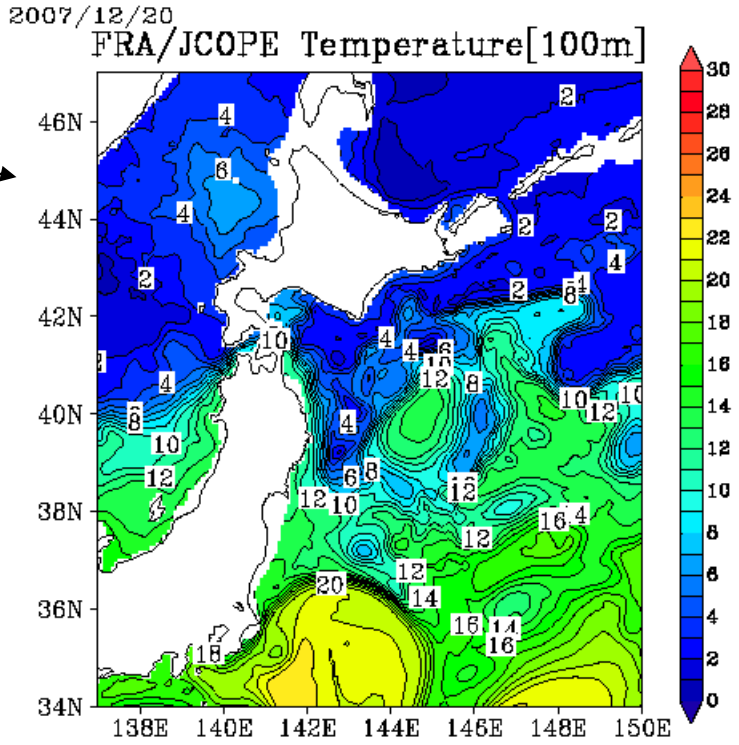
- **Deeper type glider equipped with GCTD, chl-a, DO sensors are on testing in the Northwestern Pacific**
  - **Handling skills were improved.**
  - **Lithium battery was developed in Japan.**
  - **Change outer frame material to aluminum from glass-fiber.**

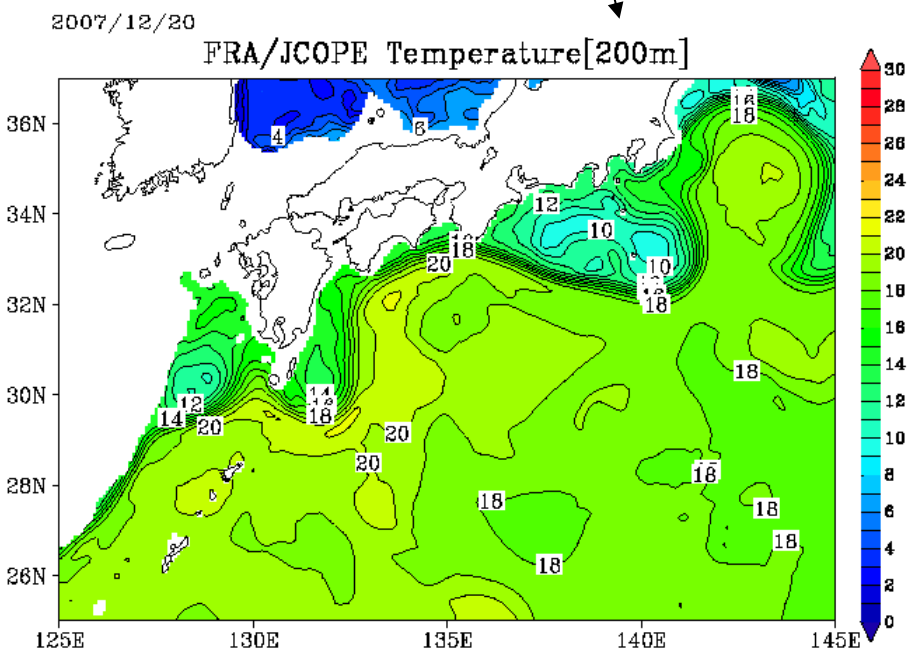
Future perspective

- **Process studies, such as mode water formations.**
- **Linkage to an ocean data assimilation and prediction system, such as FRA-JCOPE.**

FRA-JCOPE Web

http://ben.nrifs.affrc.go.jp/web_IIsys/index.html

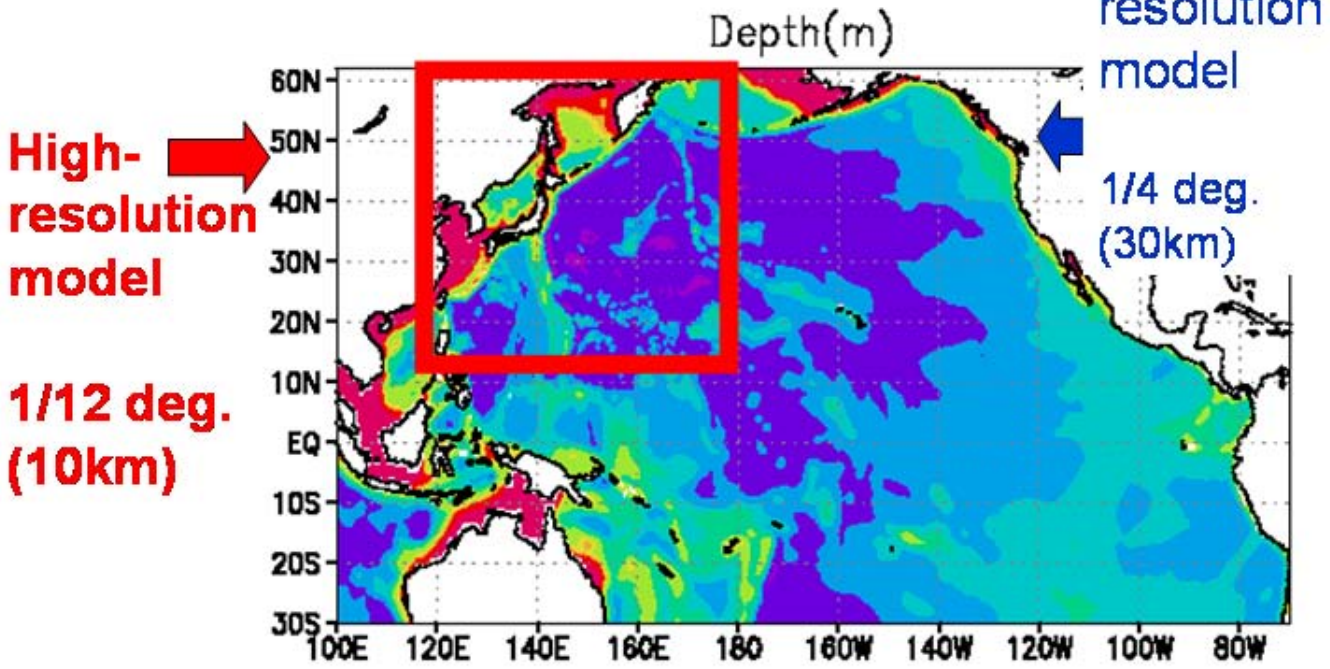




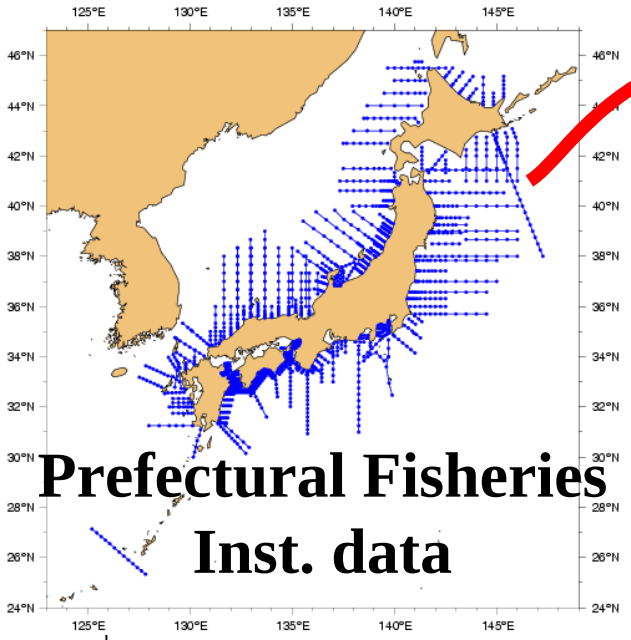
FRA-JCOPE started operational prediction since Apr. 2007

FRA-JCOPE system

Based on JCOPE system developed by JAMSTEC
(Miyazawa et al., 2004 & 2005).
Princeton Ocean Model (POM/POMgcs)
Modified sigma-coordinate (s-coordinate)
1/12 deg & 45 layer + 1/4 deg & 21 layer
one-way nesting method (Guo et al., 2003)



courtesy of Dr. Miyazawa



Prefectural Fisheries Inst. data

GTS

FRA-JCOPE

Satellite SST, SSHA

Hydrographic data GTSPP

OI

Optical Interpolation

Grid data

MOI

Multivariate Optical Interpolation

Analysis data

IAU

Incremental Analysis Update

Reanalysis data

Reanalysis data

prediction

Forecast

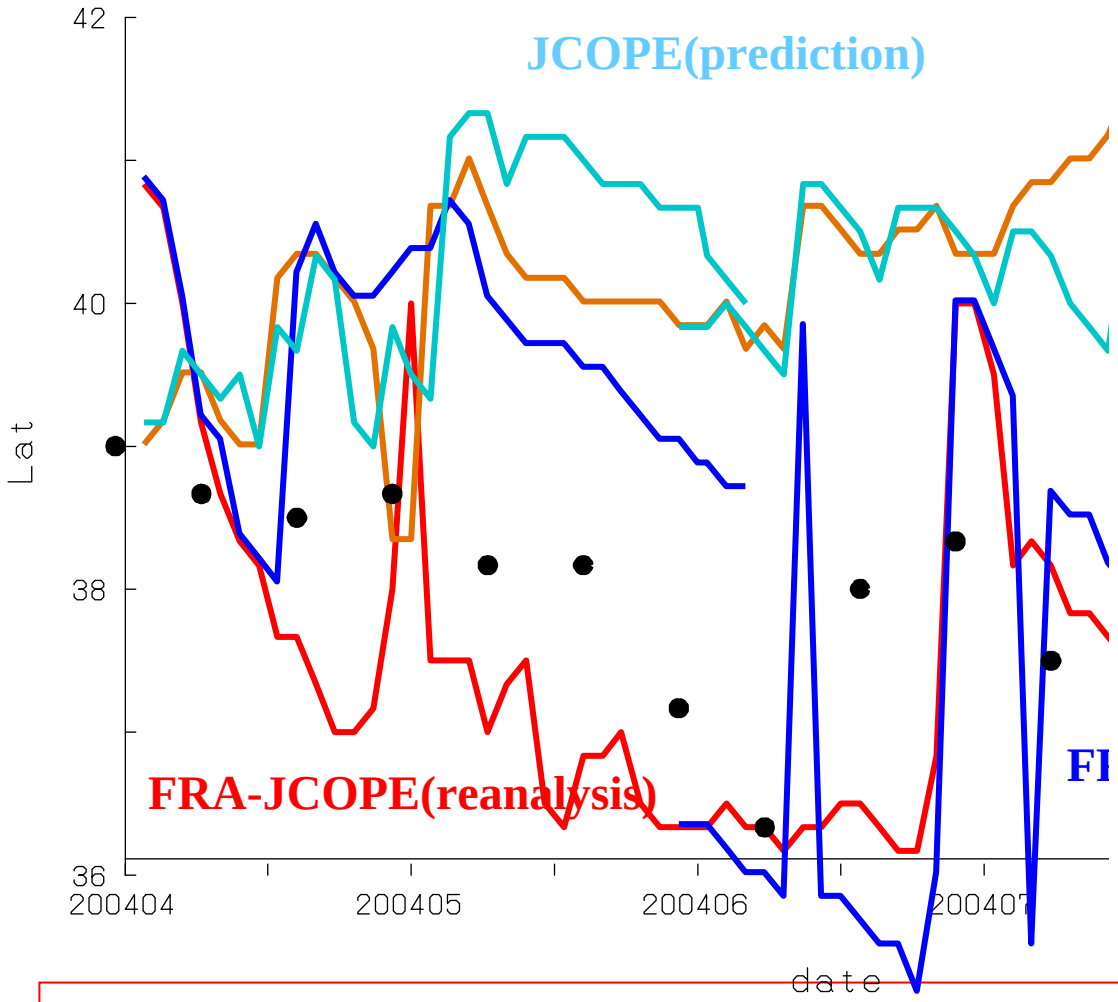
Forecast

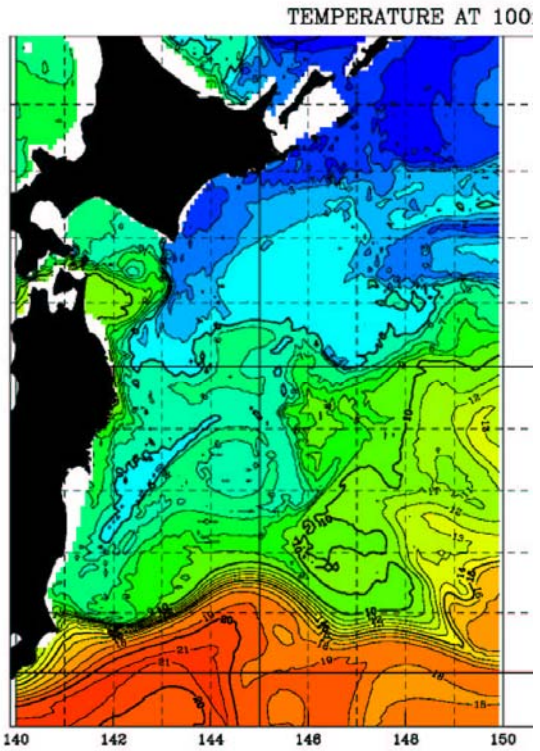
time

one week

http://www.jamstec.go.jp/frcgc/jcope/index.html

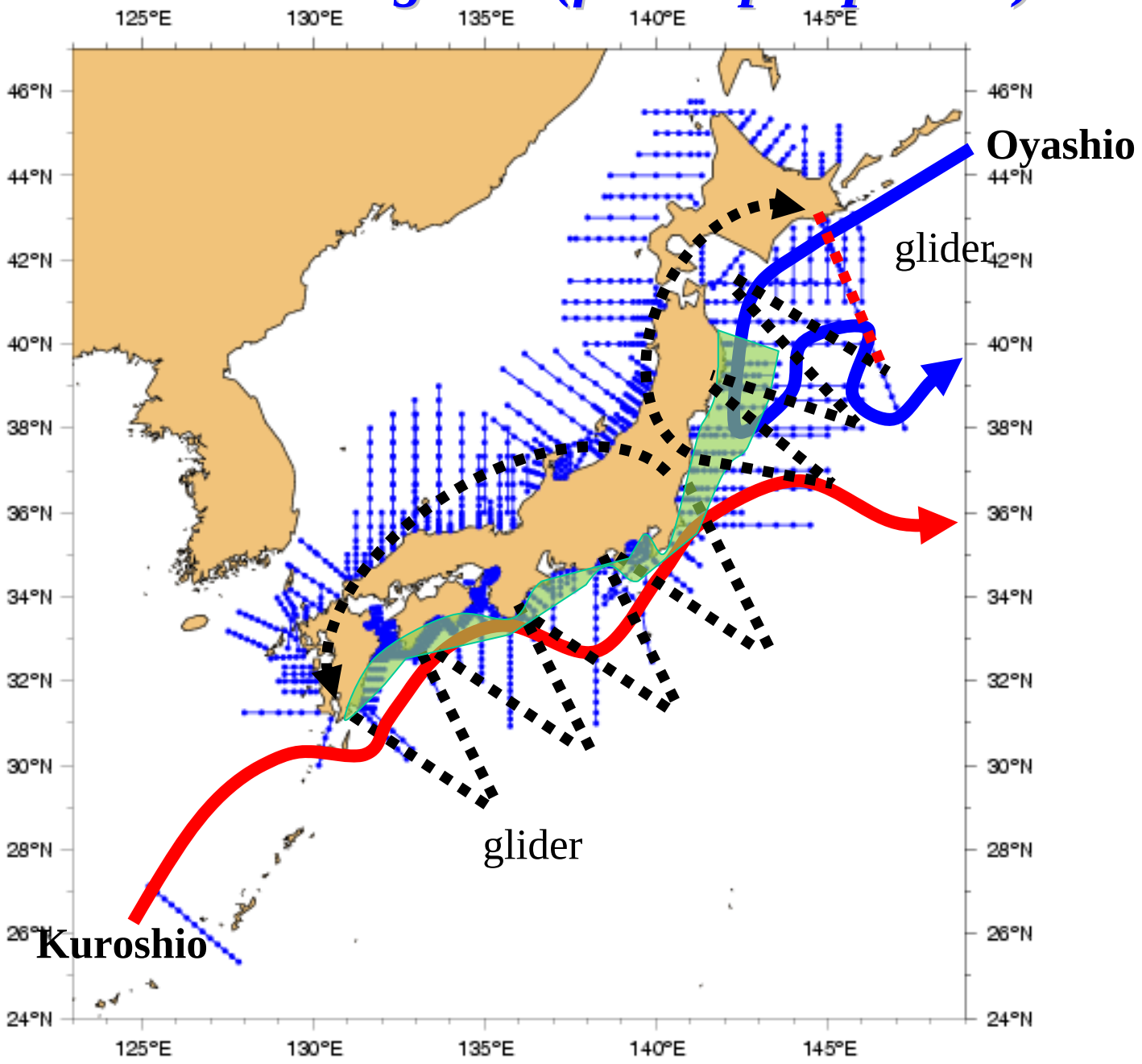
Southern latitude of Oyashio 1st Branch





Reanalysis and predictions were much improved by adding the data (Kakehi et al., 2007, Ito et al., 2006).
To improve more, assimilation seems to be improved by adding data.

FRA-JCOPE with glider (future perspective)



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There is a potential not only physical prediction is improved by gliders, but linkage for LTL model analysis since glider can measure chl-a.