Roles of in-situ profile data obtained by Japanese fishery research agencies in quality of the eddy-resolving ocean reanalysis data: FRA-JCOPE2

Yasumasa Miyazawa, RuoChao Zhang, Sergey M. Varlamov (JAMSTEC)
Takashi Setou, Daisuke Ambe, Tomowo Watanabe (FRA)

As an application of the real-time ocean forecast activities around Japan, we have recently produced the reanalysis data (JCOPE2 reanalysis data) with horizontal high resolution of 1/12 deg. to describe the oceanic variability associated with the Kuroshio-Kuroshio Extension, the Oyashio, and the mesoscale eddies in the western North Pacific.

Collaboration between JAMSTEC and FRA allowed to include additional in-situ T/S profiles for data assimilation, which were not included in the previous version.

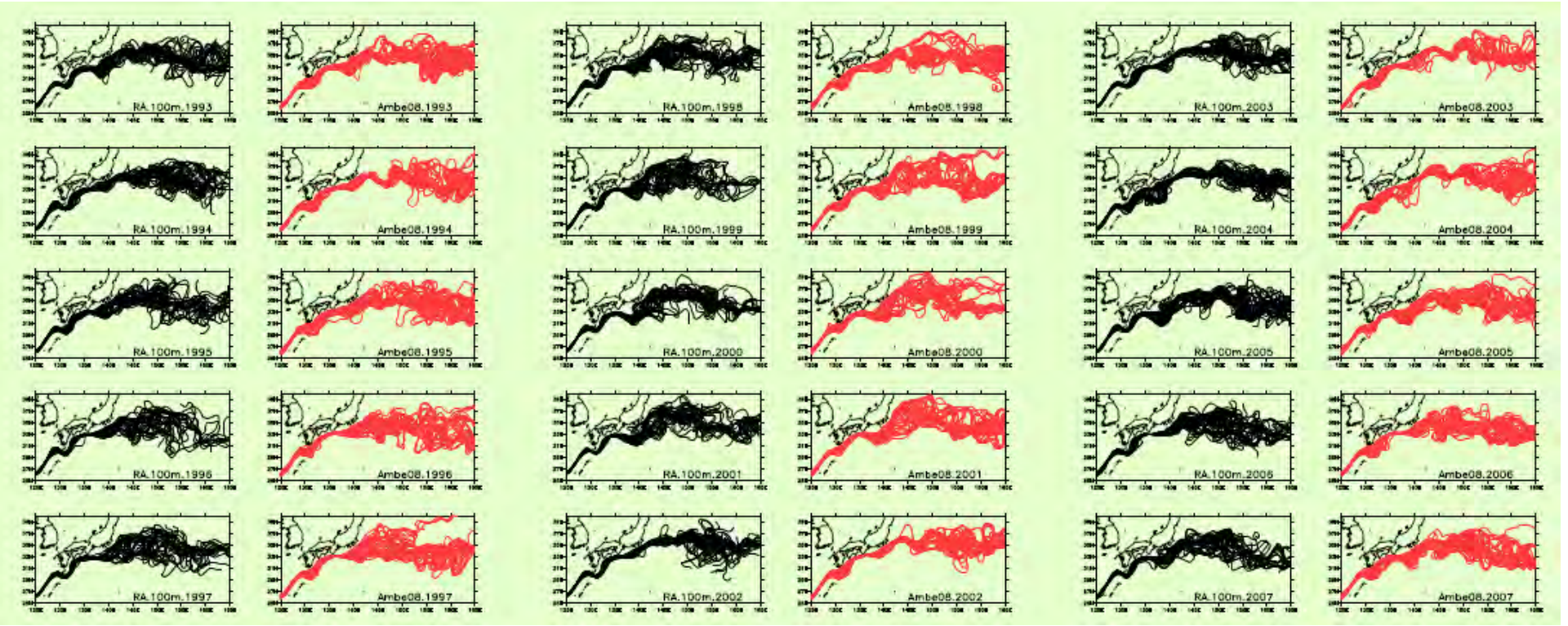
We thus produced a second version of the reanalysis data (FRA-JCOPE2 reanalysis data) for the period from 1993 to 2009 assimilating in-situ T/S profiles provided from Japanese fishery research agencies in addition to the profiles archived in the GTSPP.

Impacts of additional in-situ data on the quality of the reanalysis reveal how in-situ observation network contributes to reproduction of the oceanic conditions.

15-year ocean reanalysis 1993-2007

(Miyazawa et al., 2009, JO)

Black : Reanalysis, Red: Observed

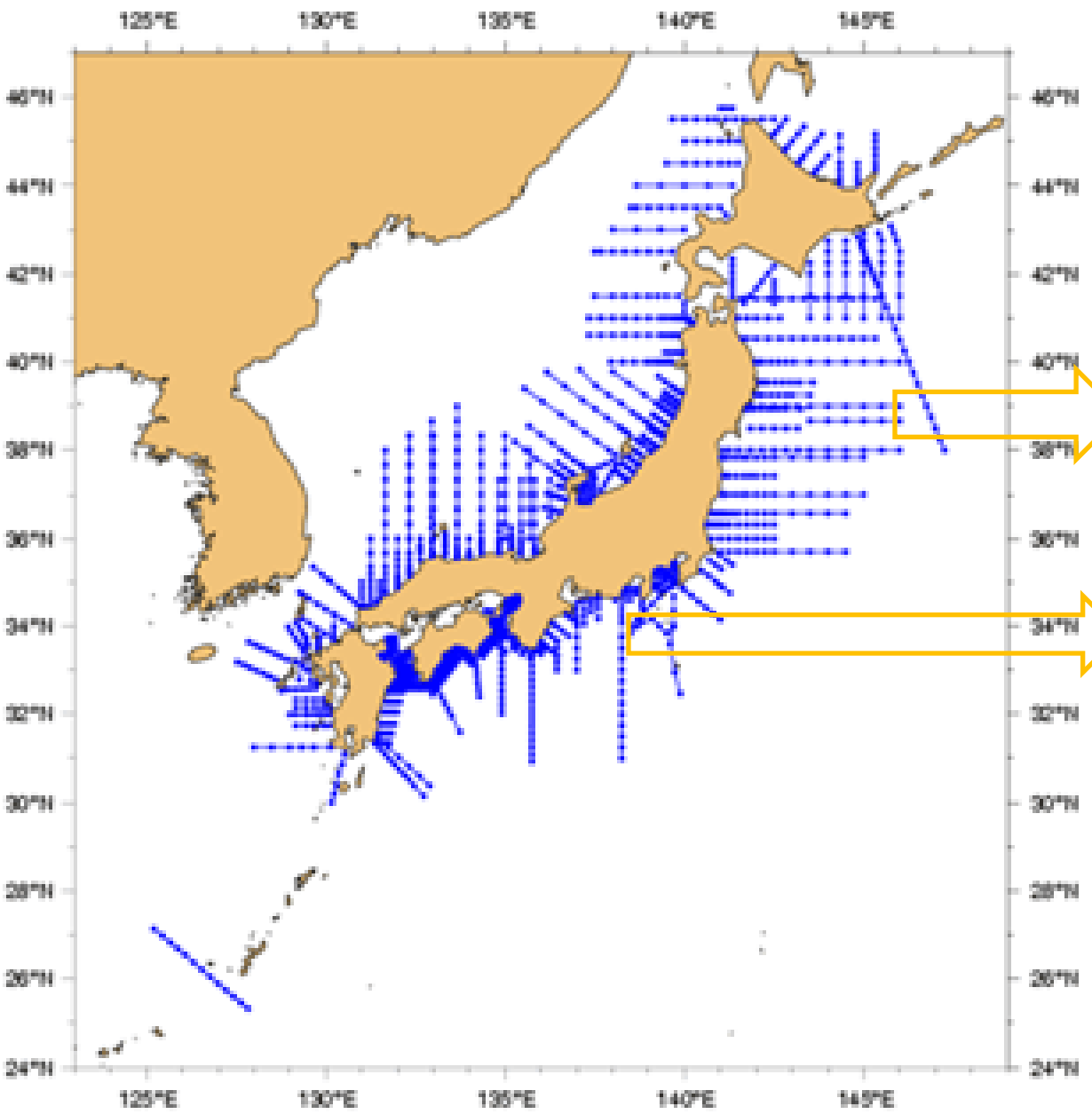


We have established ocean forecasting methods allowing reproduction of realistic oceanic conditions.

By assimilating the available data including the altimetry data obtained continuously past 15 years, we have created the long-term reanalysis data.

Our reanalysis successfully reproduced the regime shift. Also the large meandering and no-large meandering states of the Kuroshio south of Japan are well represented by the reanalysis.

FRA-DATA distribution



Collaboration between FRA and JAMSTEC allowed to include the in-situ data Obtained by the Japanese Fishery research agencies.

Kuroshio-Oyashio mixed water region
→Offshore coverage

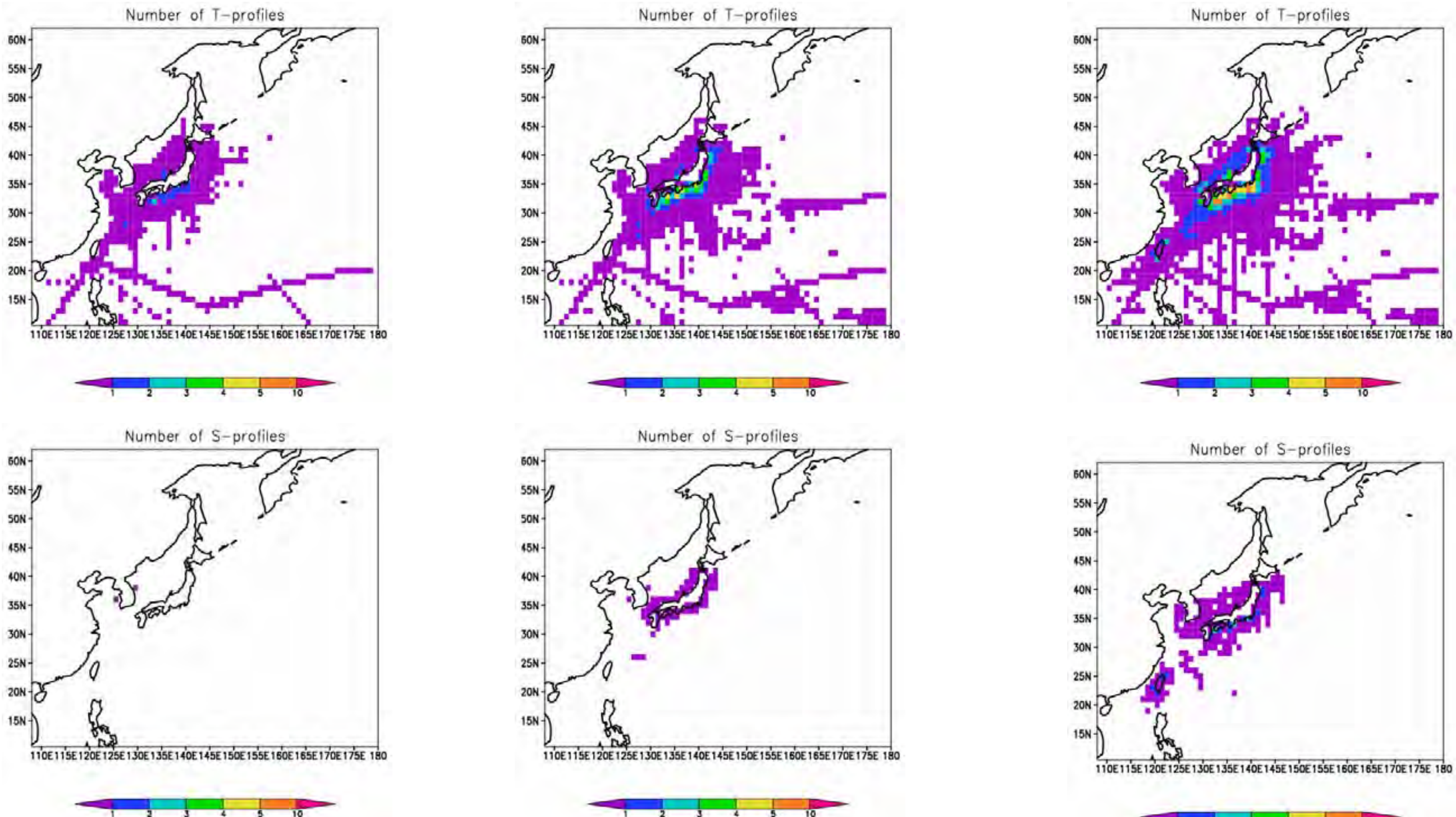
South of Japan
→Nearshore coverage

FRA-JAMSTEC Cooperative study

Impacts of in-situ T/S data obtained by Japanese Fishery Research Agencies on the quality of Reanalysis/Forecast using ocean forecast systems

Temp.

Sali.



GTSPP | GTSPP+FRA | GTSPP+FRA+WOD

Density of in-situ observation (monthly mean number of in-situ observation report within 1 deg, grid from 1993 to 1999)

JCOPE2 data assimilation system

3-dimensional variational data assimilation

Minimization of the cost function using the conjugate gradient method

$$J(y) = \frac{1}{2}\sum_{l}\sum_{m} y_{l,m}^{T} B_{l,m}^{-1} y_{l,m} + \frac{1}{2}\sum_{i}\left[H_i x(y) - x_i^O\right]^T R_i^{-1}\left[H_i x(y) - x_i^O\right] + \frac{1}{2\sigma_h^2}\sum_{j}\left[\mathcal{H}_j(x(y)) - h_j^O\right]^2$$

Estimates gridded temperature and salinity with ¼ degree. , 24 levels from 0-1500m by changing the amplitudes of T-S coupling EOF modes (Fujii and Kamachi 2003)

$$x(y) = x_f + S\sum_{l} w_l U_l \Lambda_l y_l,$$

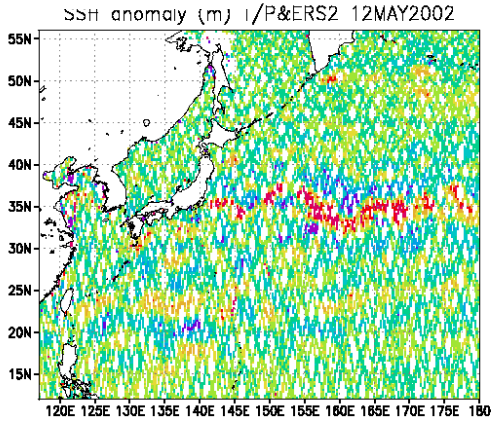
Sea surface dynamic height anomaly is compared with sea surface height anomaly obtained by satellite altimetry

$$\mathcal{H}(x) = -\frac{1}{\rho_s}\int_0^{z_m} \rho'(x,p)dz$$

Data Assimilation

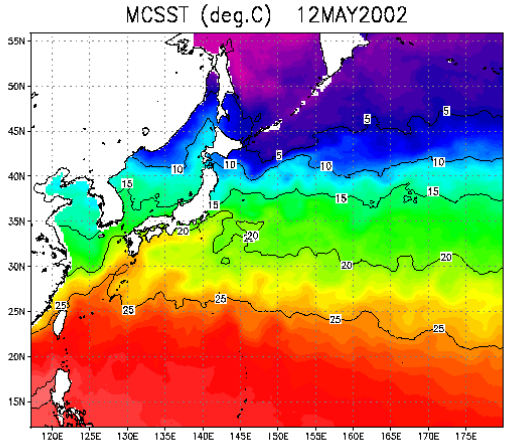
Jason-1,2 ENVISAT GFO
From US-GODAE/CCAR

SSHA



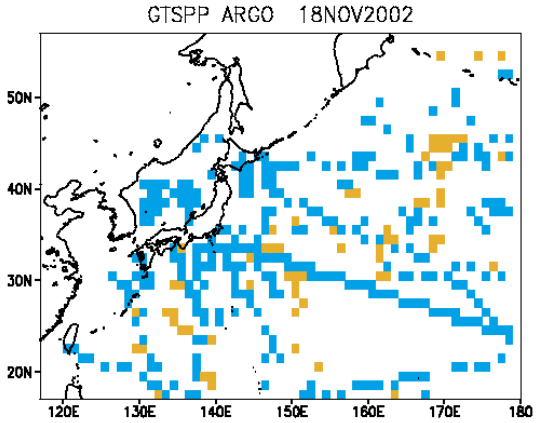
NAVOCEANO MCSST
from JPL

SST



Profile data from
GTSPP

T/S Profiles



JCOPE1 (FRA-JCOPE):
Multivariate Optimum Interpolation + Model Statistics
JCOPE2 (FRA-JCOPE2):
3-Dimensional Variational assimilation + Observation Statistics

Updated version of data assimilation is quite skilful because of using observation statistics instead of model statistics. Model statistics inevitably introduces model biases into the data assimilation process.

Reanalysis 1993-present

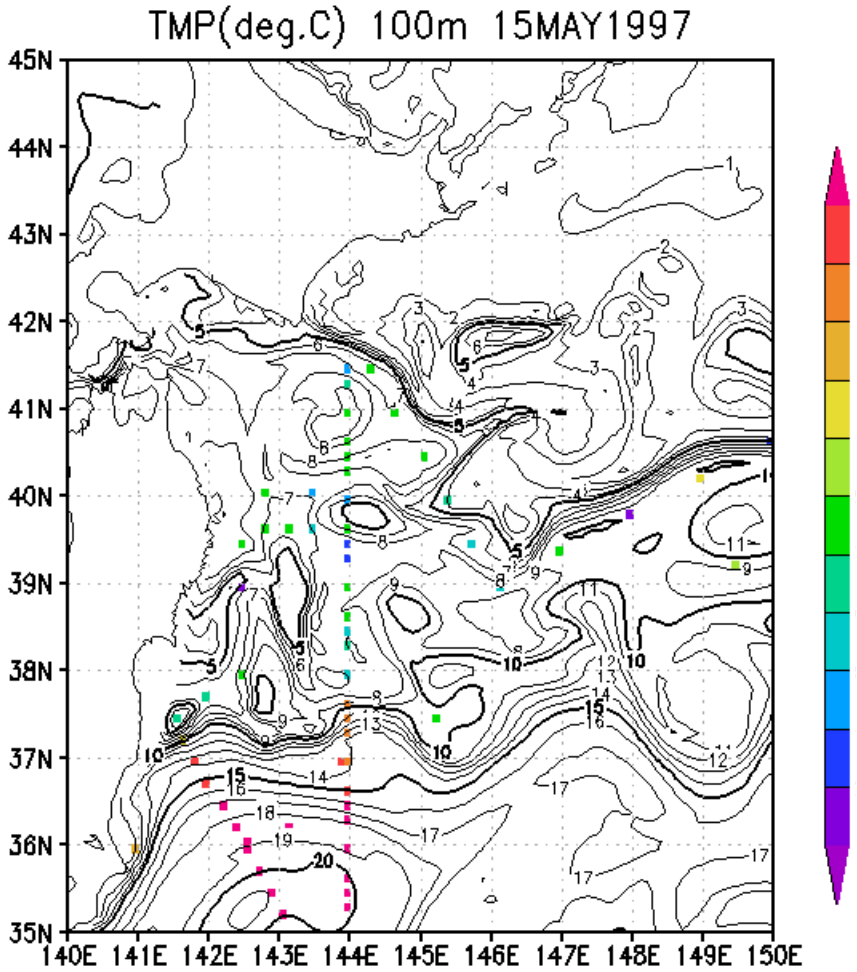
The model is based on the Princeton Ocean Model (POM)
The spatial range is 10.5-62N and 108-180E

Data type	Used data
Atmospheric data for calculation of momentum/heat fluxes	**NCEP/NCAR Reanalysis data**
Sea surface salinity flux	**WOA2005 monthly mean salinity data , used for relaxation of salinity at surface**
Satellite altimetry	**TOPEX/POSEIDON, ERS-1,2, GFO→ JASON-1, Envisat**
Satellite sea surface temperature	**NOAA MCSST→ NAVOCEANO MCSST**
In-situ temperature/salinity data	**GTSPP or GTSPP+FRA+WOD**

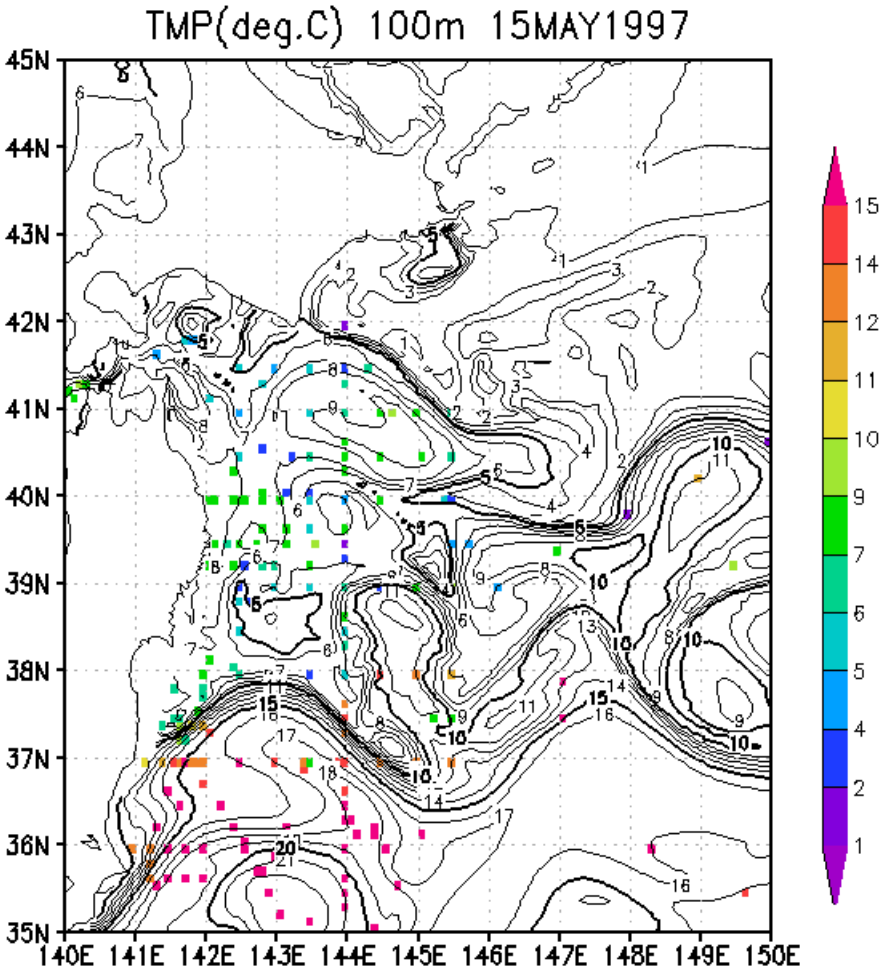
We have conducted two sensitivity experiments with and without the assimilation of the additional in-situ T/S profiles to investigate impacts of the Additional fishery data.

MAY 1997

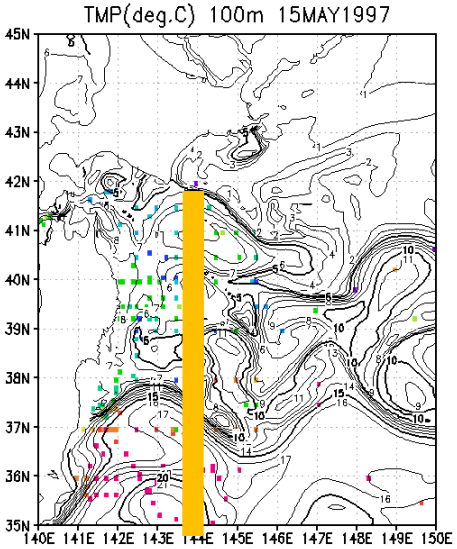
GTSPP



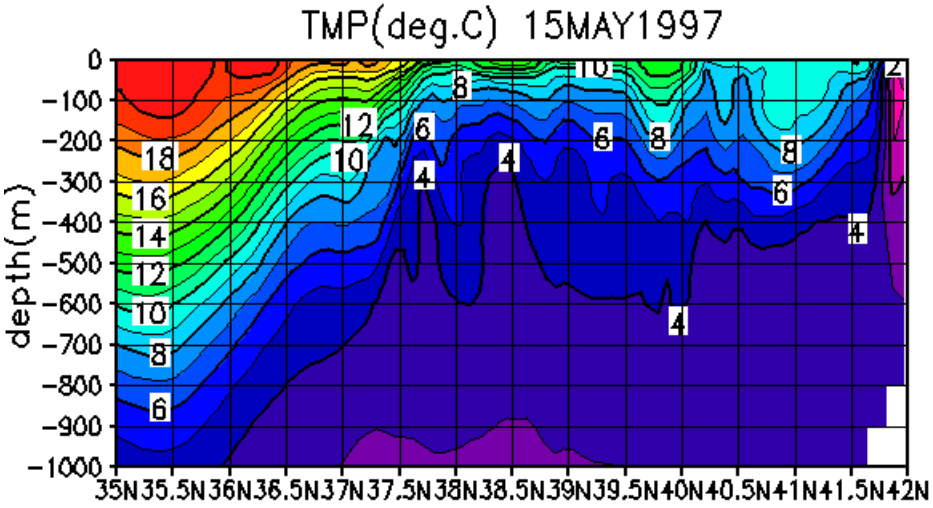
GTSPP+FRA+WOD



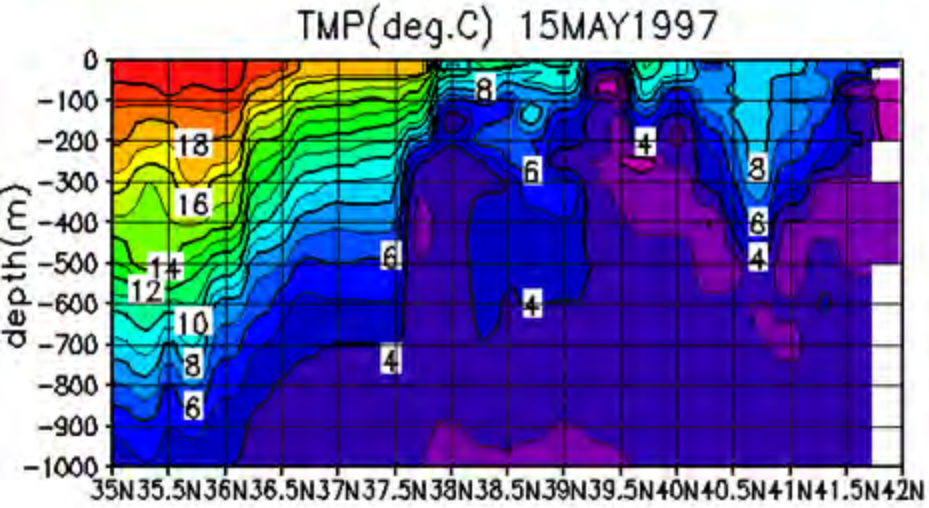
144E line: MAY 1997



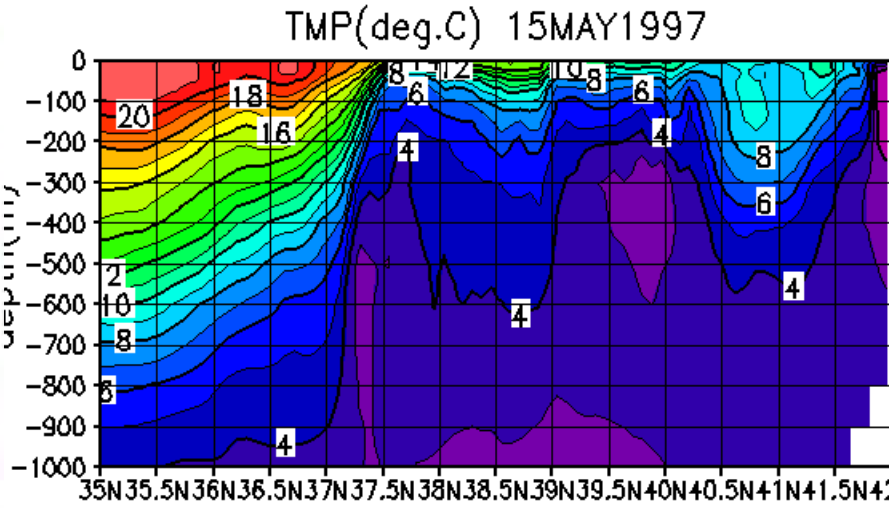
GTSPP



In-situ observation



GTSPP+FRA+WOD

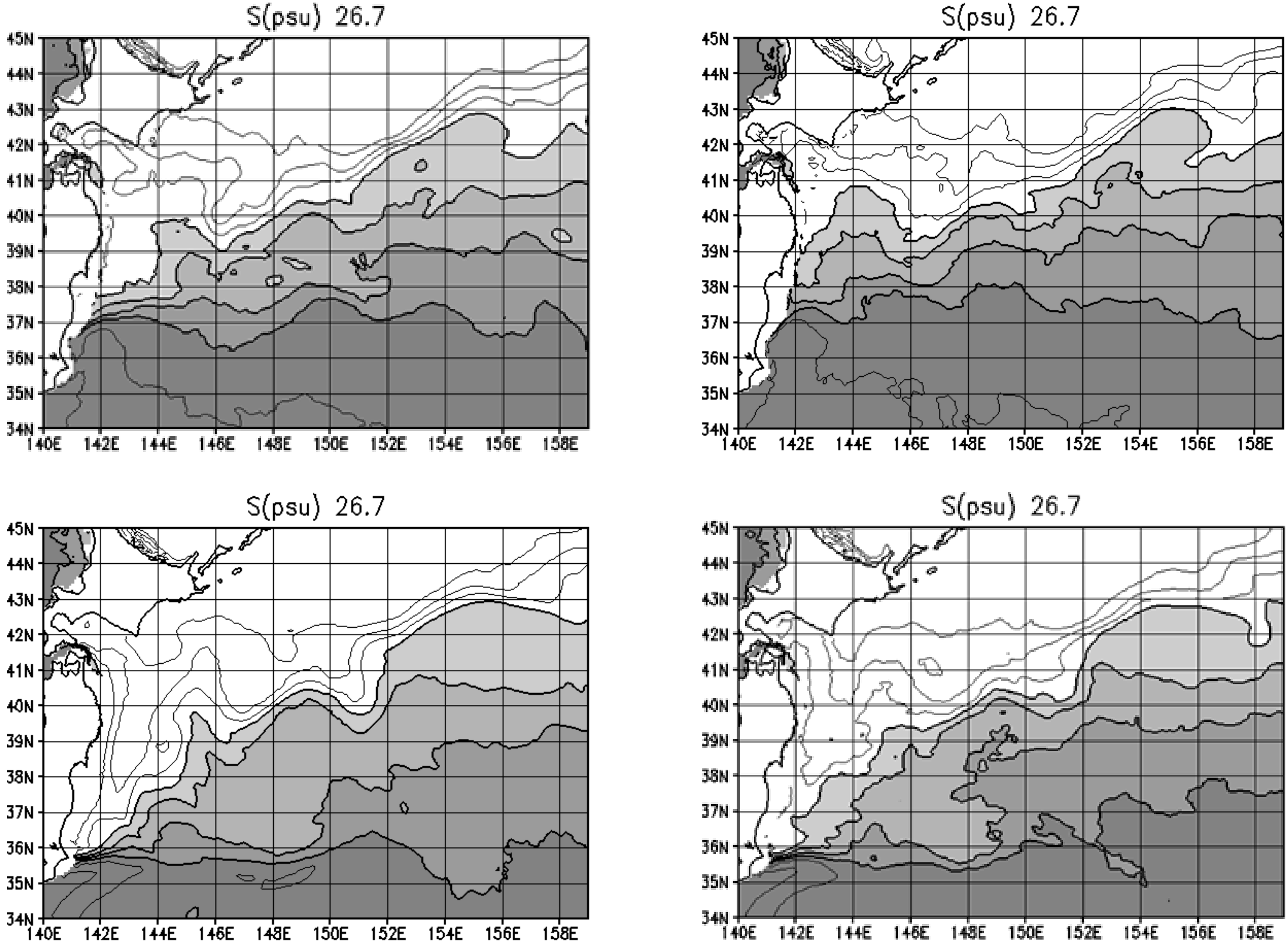


Inter-annual variation of NPIW

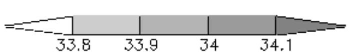
GTSPP | **GTSPP+FRA+WOD**

1999 Weak Oyashio Water

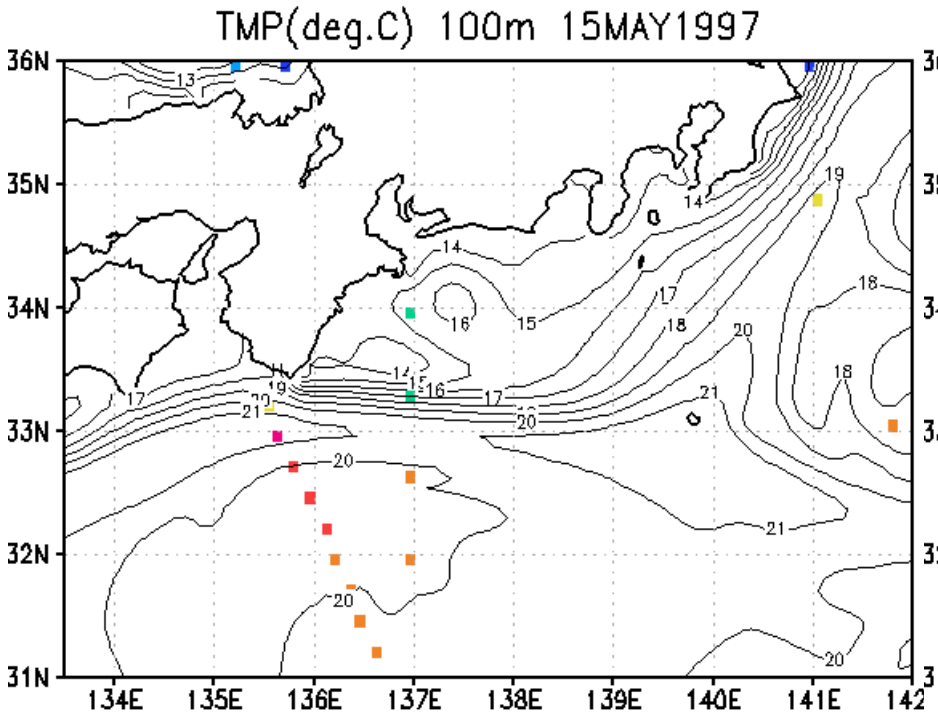
2004 Strong Oyashio Water



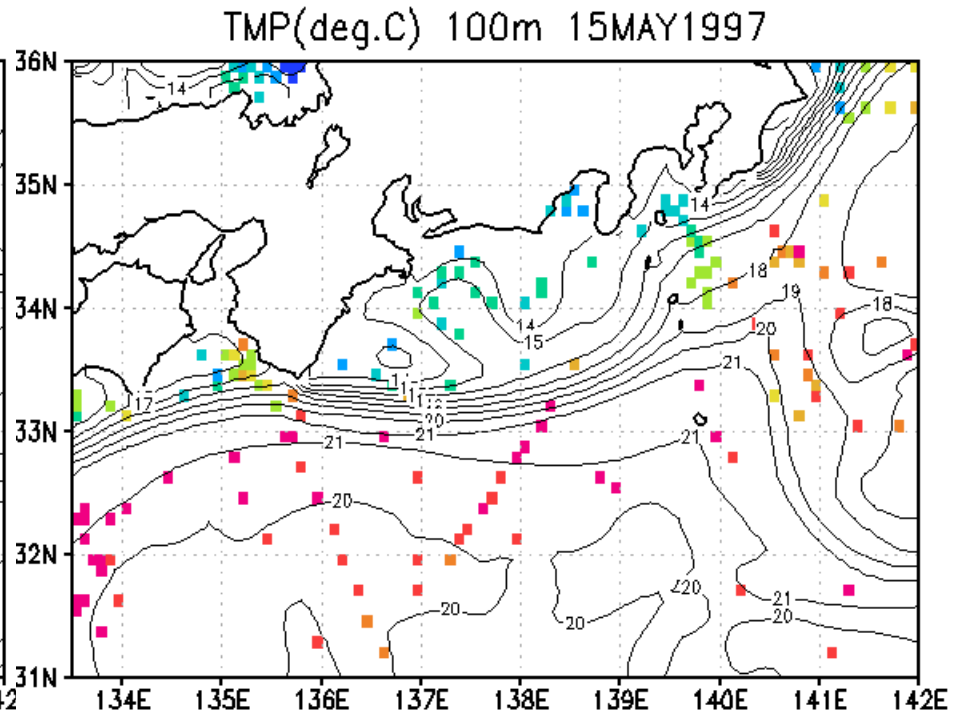
We have reproduced more evident interannual variation of NPIW.



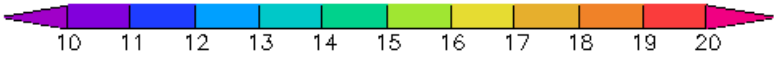
South of Japan: Kuroshio region
Impacts of nearshore data?



GTSPP

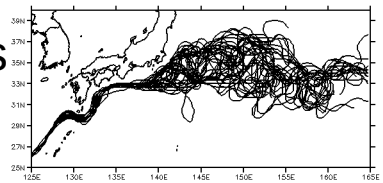


GTSPP+FRA+WOD

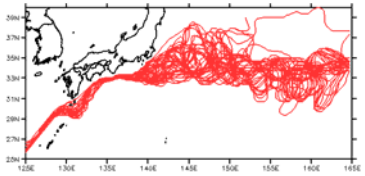


Skill for Kuroshio-Kuroshio Extension path latitude

Reanalysis 1997

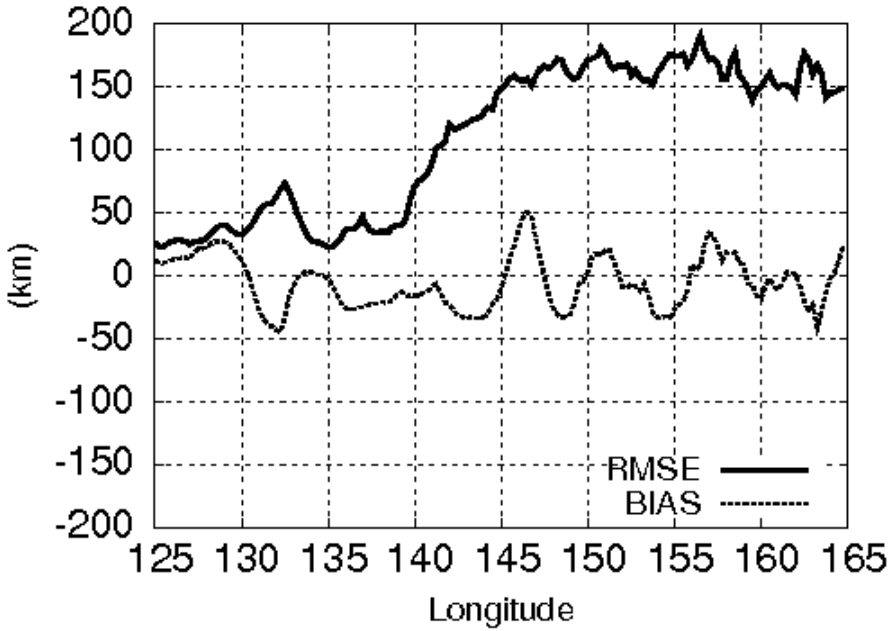


Observation 1997

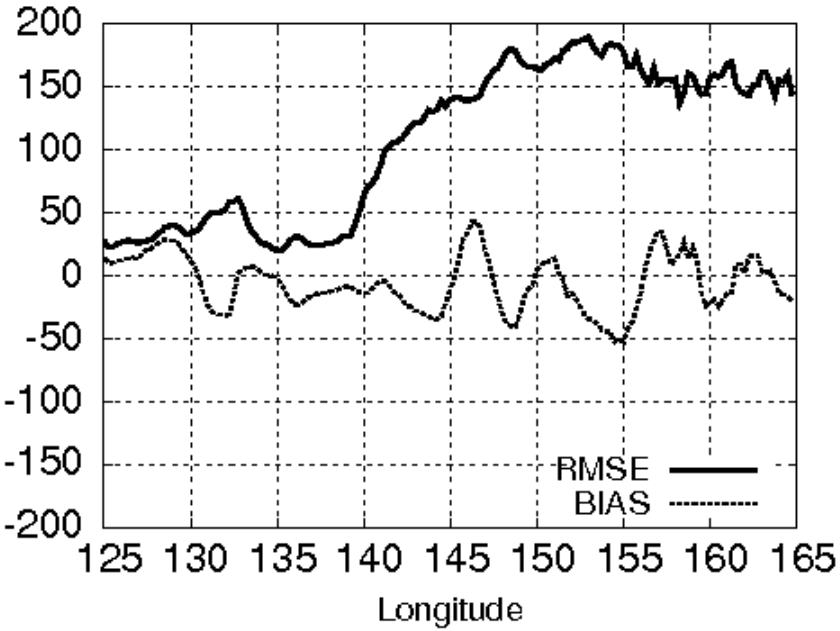


← Ambe et al., 2009

Comparison of the reproduced path latitude with observed path latitude



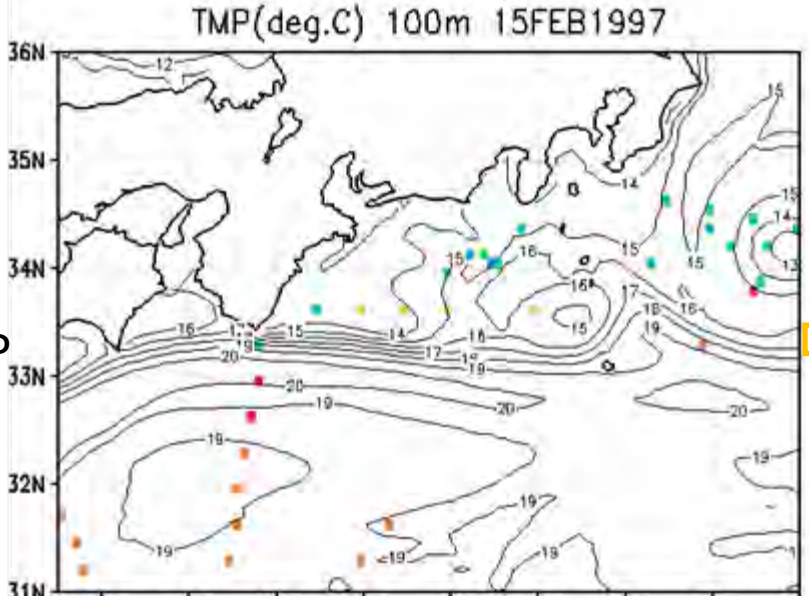
GTSPP

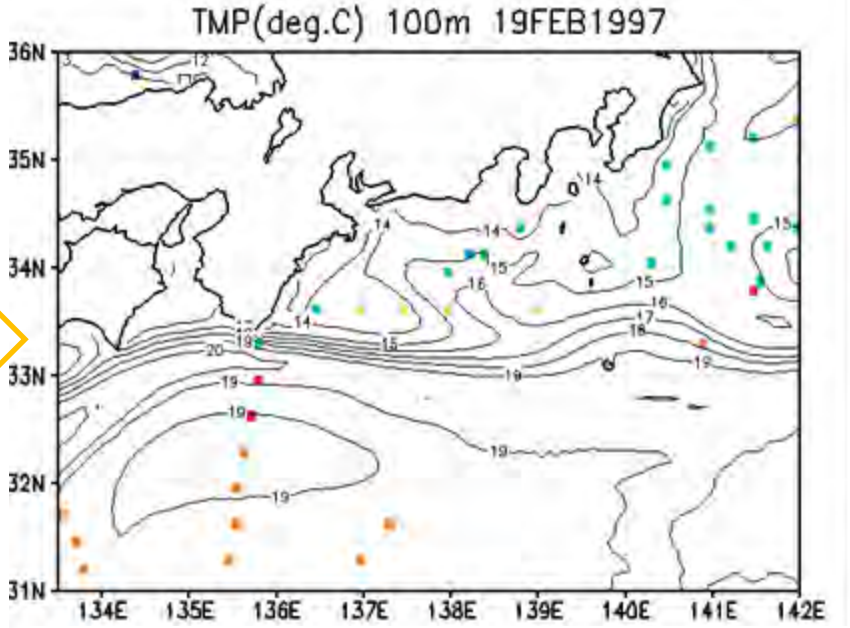


GTSPP+FRA+WOD

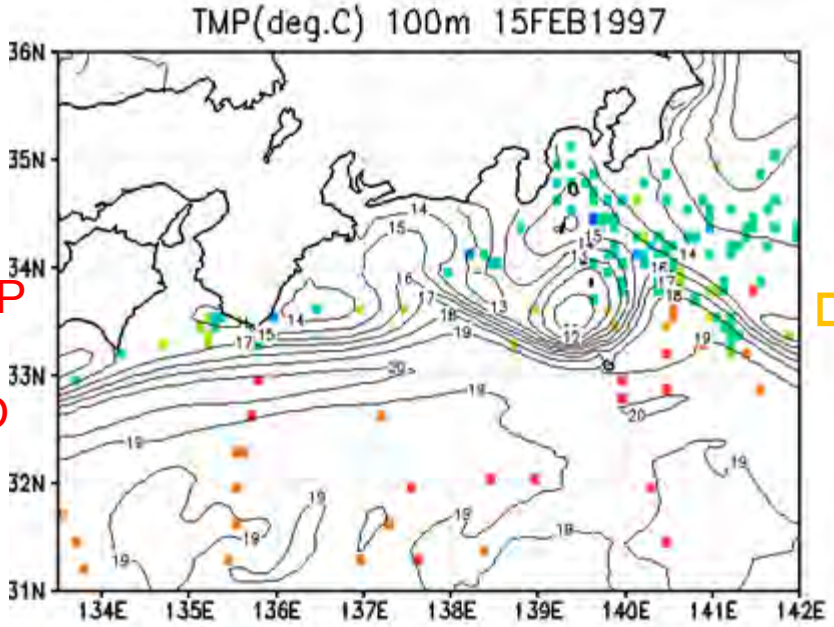
Impacts of near shore data

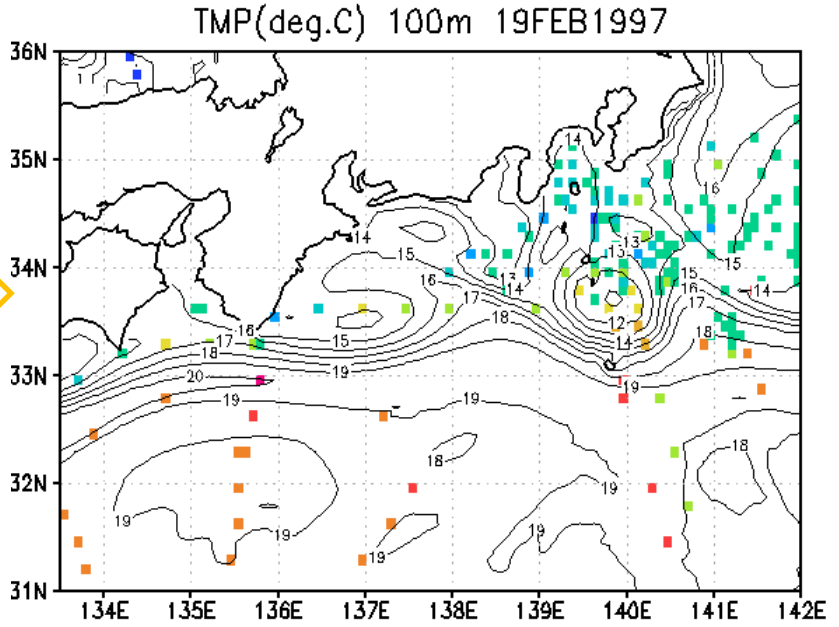
GTSPP



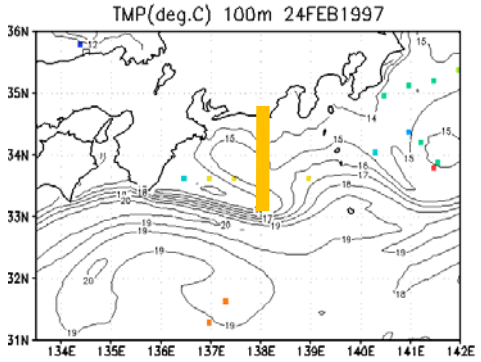


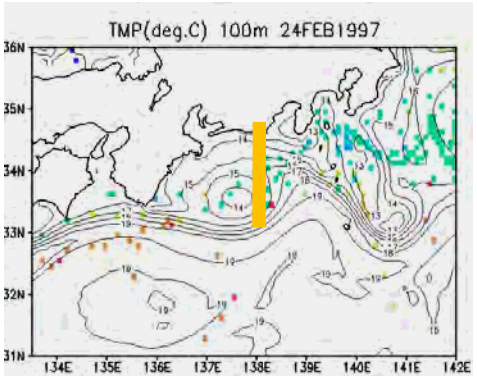
GTSPP
+FRA
+WOD



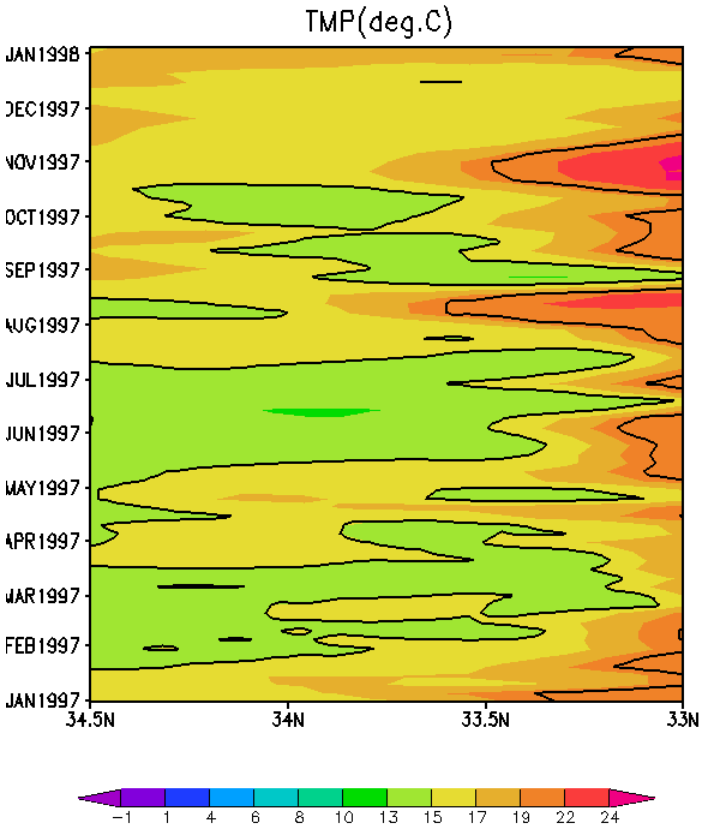


Impacts of nearshore data

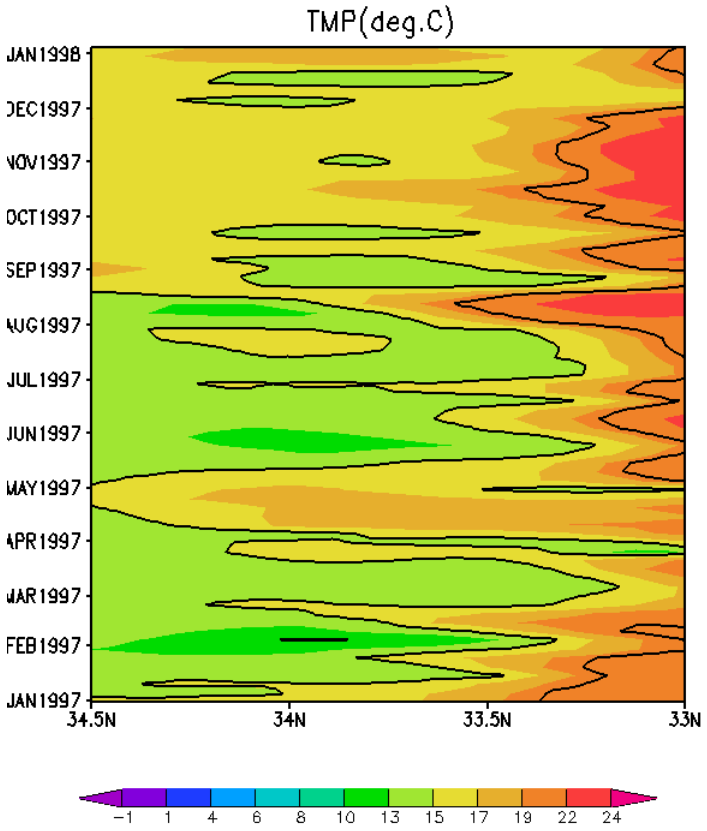




GTSPP

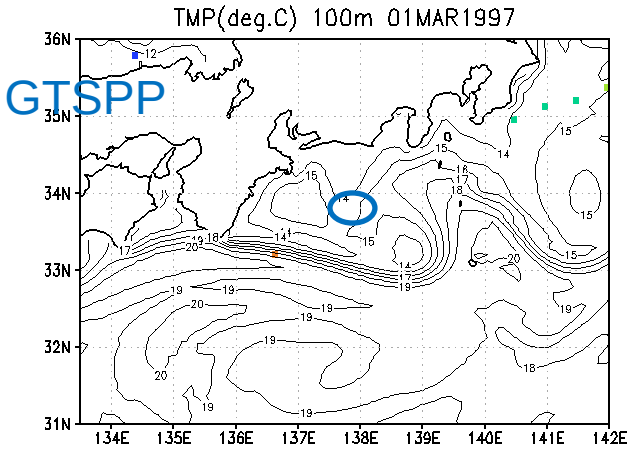


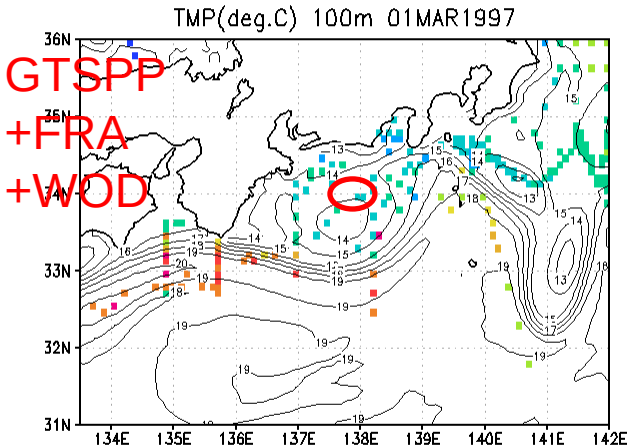
GTSPP+FRA+WOD

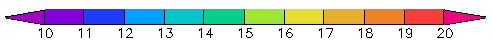


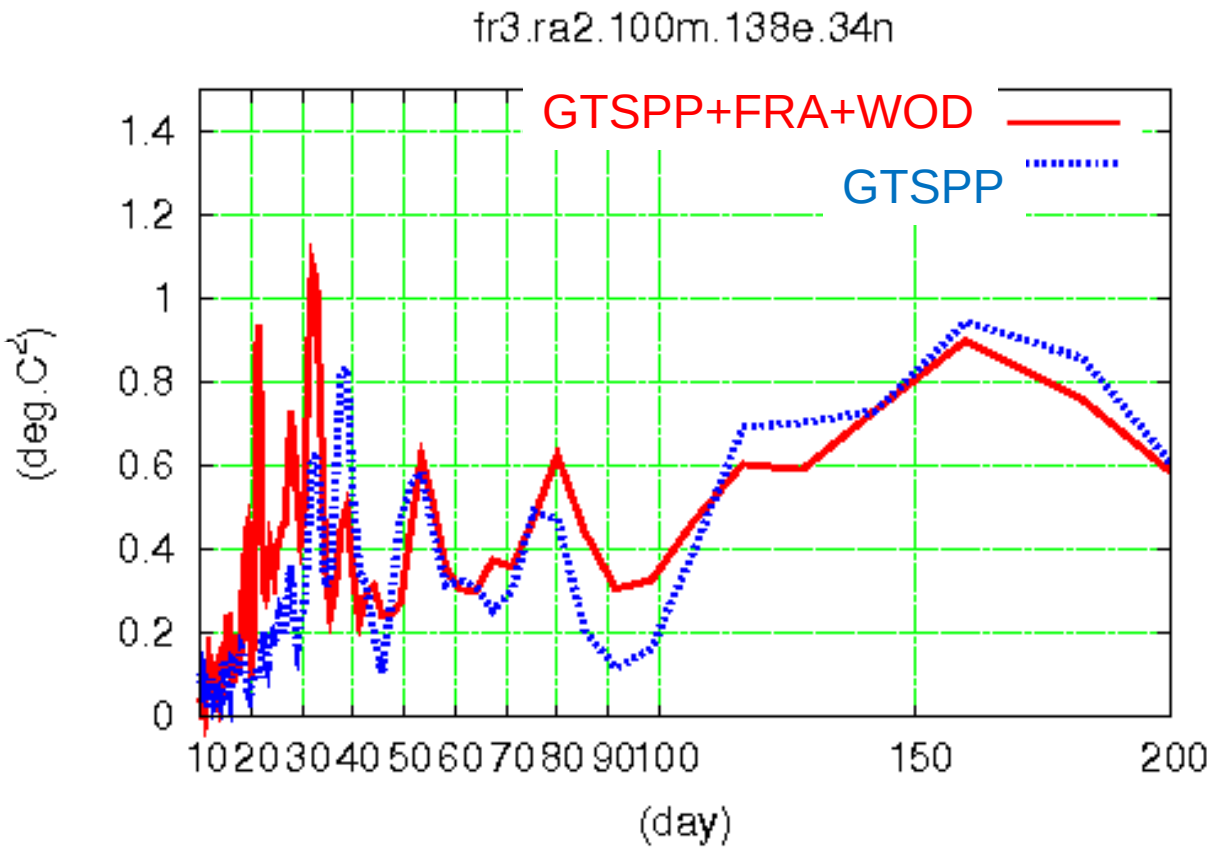
Impacts of nearshore data

Power spectrum of temperature at 100m, 138E, 34N (from 1993.01 to 1999.12)









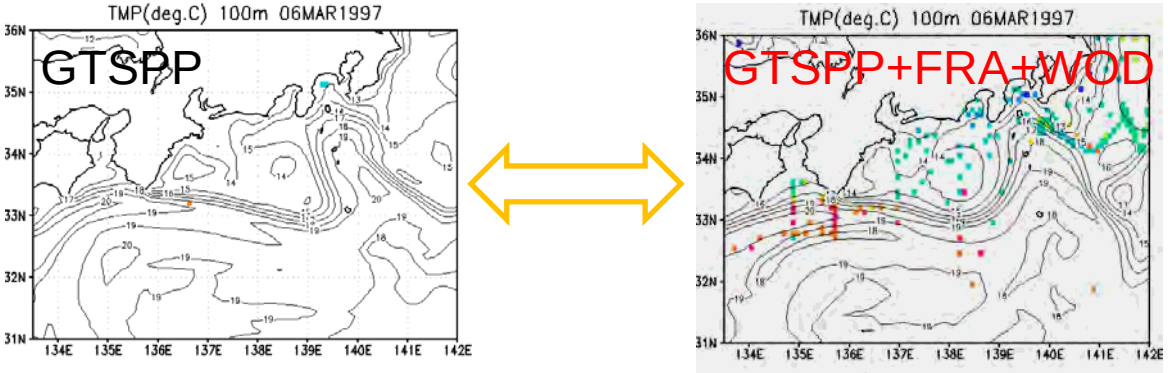
Summary

To investigate impacts of in-situ temperature/salinity data around the Japan Coasts, we have examined the sensitivity of in-situ T/S data, with emphasis on possible roles of the observation network maintained by Japanese fishery agencies.

In the Kuroshio-Oyashio mixed water region, comparatively offshore coverage of the fishery data is effective to present more clear features such as meso-scale eddies, Kuroshio extension meandering, and Oyashio intrusion.

South of Japan, the coverage of the fishery data is limited to nearshore region. Then inclusion of the fishery data do not much affect the presentation of the Kuroshio path and the offshore eddies.

However, inclusion of the fishery enhances front variability with time scale shorter than 1-month. It is effective to present more active water exchange/material transport between nearshore and offshore region.

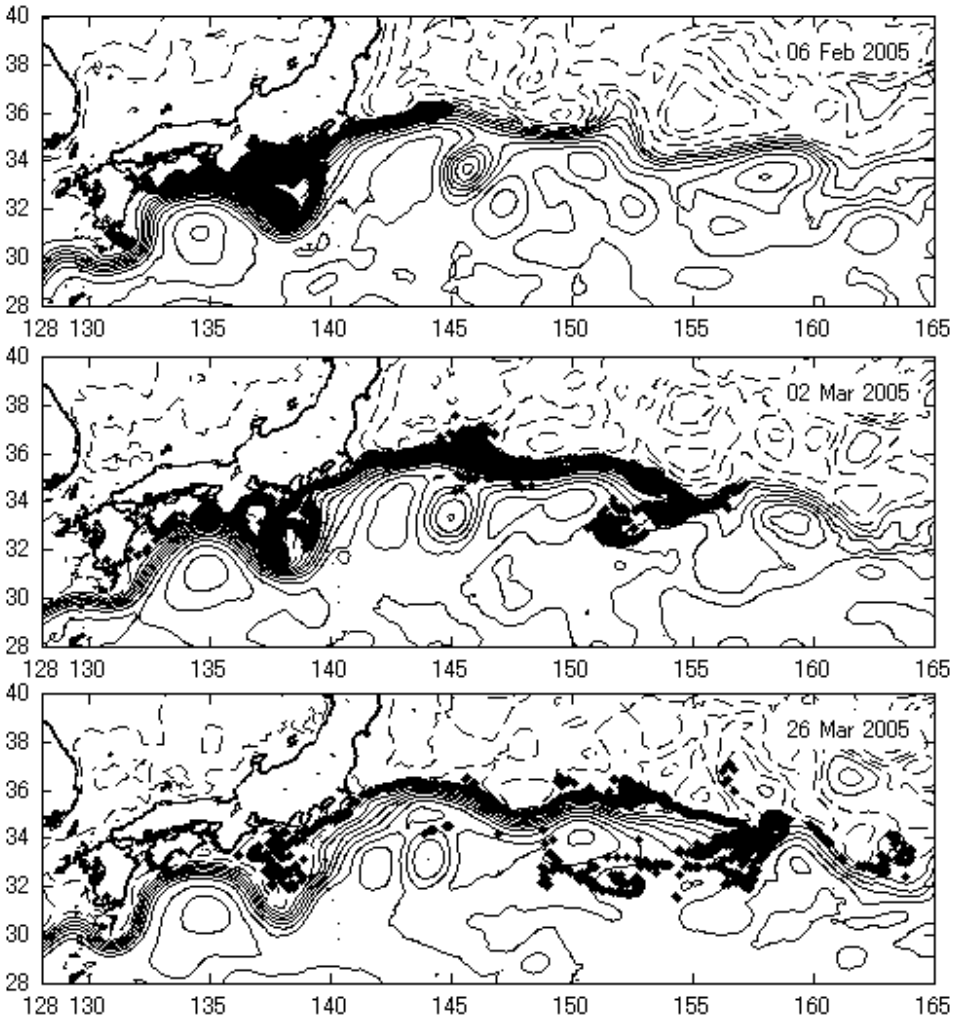


Possible impacts of nearshore data on larval dispersal

Enhanced front variability that was reproduced by inclusion of the fishery data may impact the skill of of the larval dispersal simulation using the reanalysis velocities.

For example, egg grounds of some fishes are limited in the nearshore region. The front variability affects
the early stage of the larval dispersal.

FRA-JCOPE2 data contribute to the investigation of variability in the fishery resources around Japan.



Particle tracking of the sardine larvae
using the JCOPE data (Kiyomatsu et al., PICES2009)

FRA-JCOPE2 data distribution (planned)

Our data is being freely distributed to non-commercial users !
http://www.jamstec.go.jp/frcgc/jcope/htdocs/distribution/