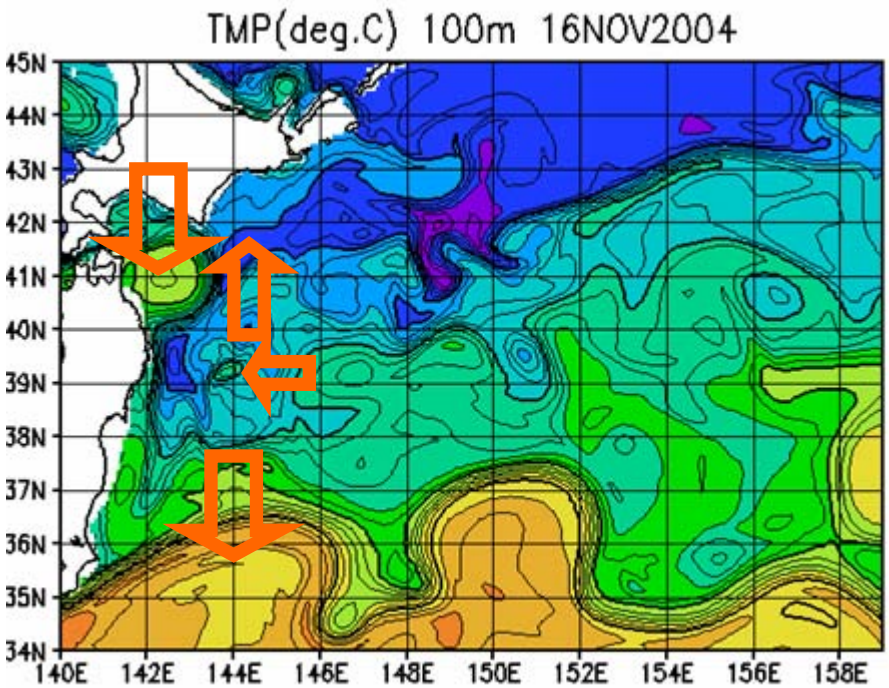
Water mass structure in the Kuroshio-Oyashio mixed water region reproduced by JCOPE2

Yasumasa Miyazawa, Takashi Kagimoto (JAMSTEC), Kosei Komatsu (FRA)

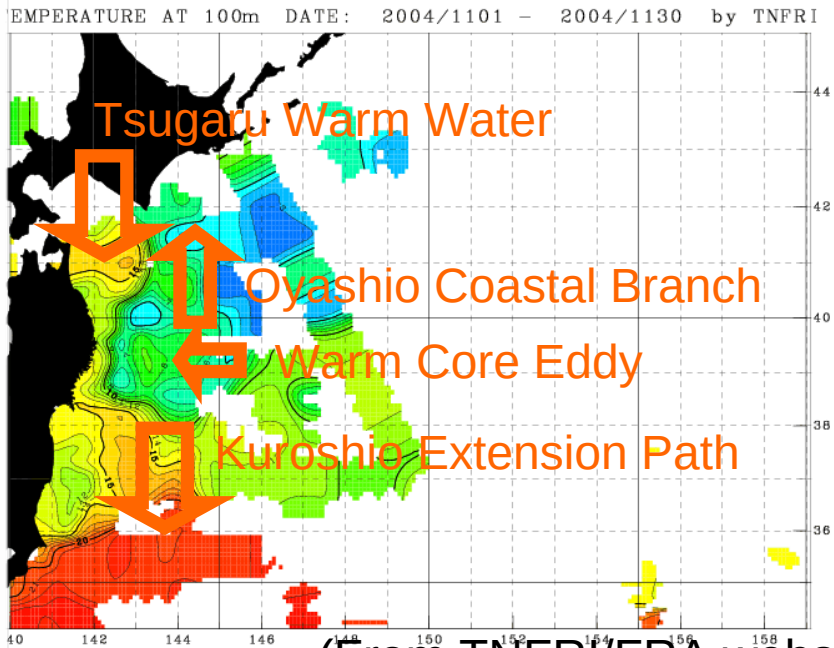
JAMSTEC
Japan Agency for Marine-Earth Science and Technology

Incorporated Administrative Agency
Fisheries Research Agency

JCOPE2 + Fishery Community Data



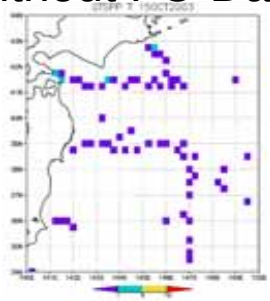
Fishery Community Data
(Optimum Interpolation)



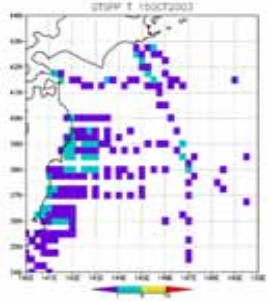
(From TNFRI/FRA website)

Sensitivity of Fishery Community Data

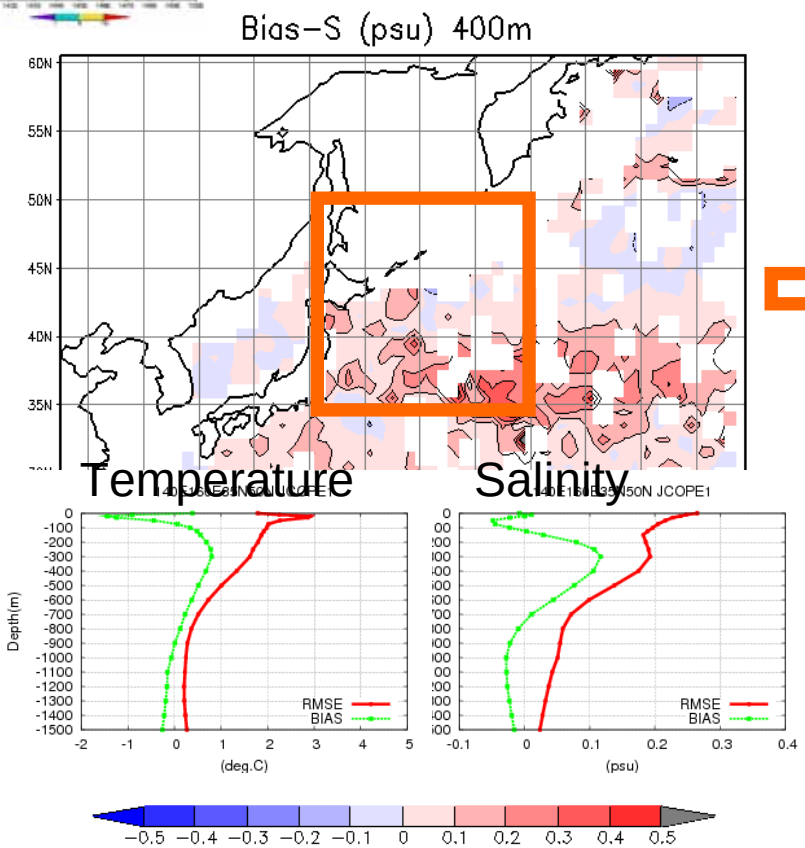
Without FC-Data



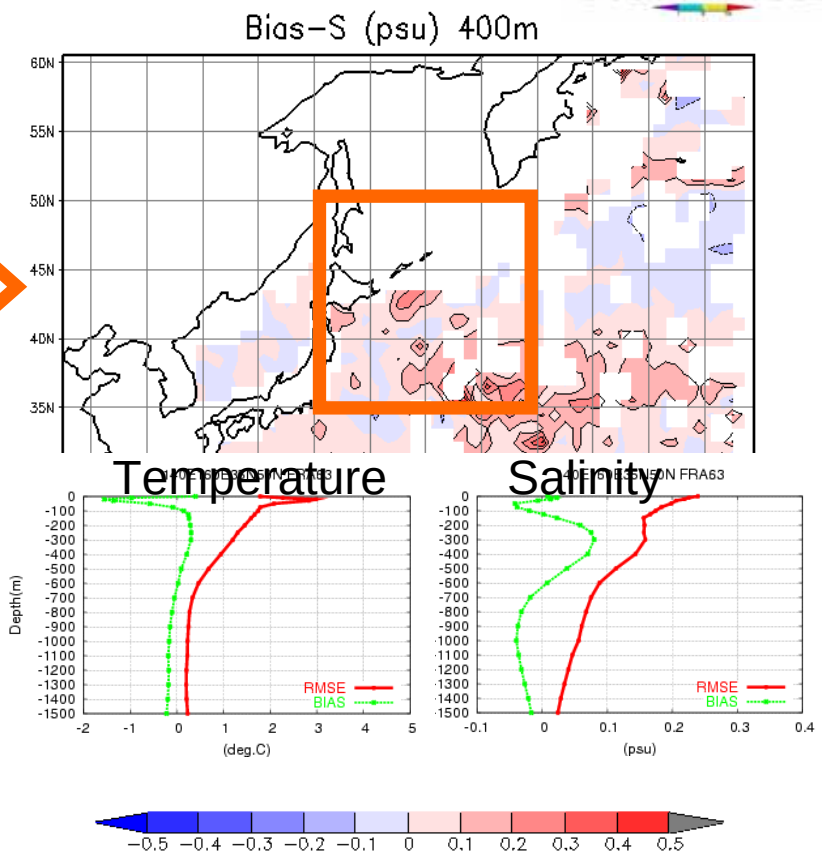
With FC-Data



Low salinity (Low temperature) Bias in upper layer
High salinity (High temperature) Bias in middle layer



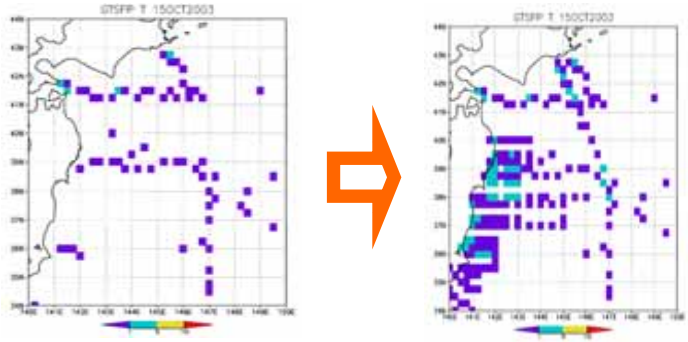
JCOPE1



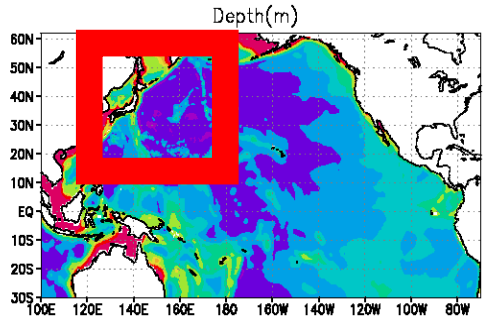
JCOPE1 + FC-Data (FRA63)

JCOPE1→JCOPE2

Sea Surface Height Anomaly
Sea Surface Temperature
In-situ Temperature/Salinity Profiles



Assimilation of Fishery Community Data



POM based OGCM
1/12 deg., 45levels

Improved Advection-Viscosity/Diffusion Schemes
(Central Difference Advection
→Flux Corrected Transport Advection)
(Harmonic → Biharmonic Viscosity/Diffusion)

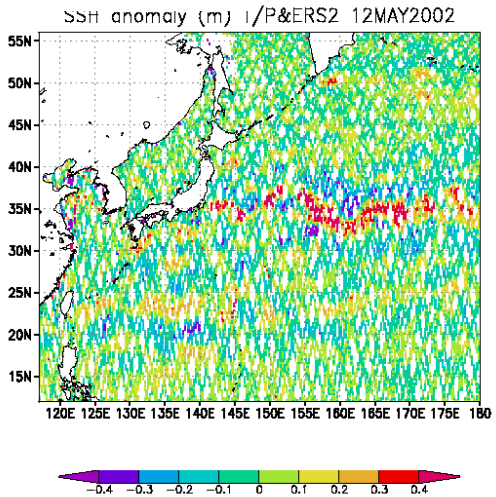
Assimilation Data
(JCOPE2 + FC Data)

3DVAR + Observation Statistics

Data Assimilation

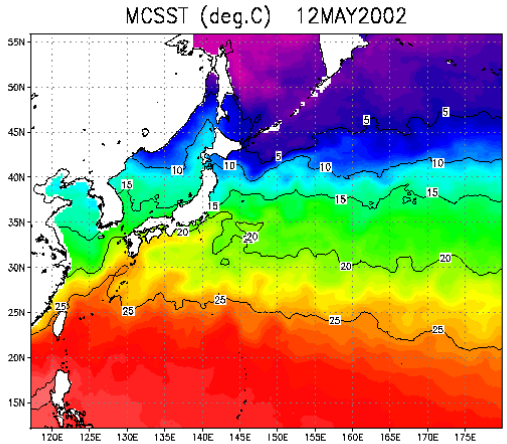
Jason-1 ENVISAT GFO From JPL/CCAR

SSHA



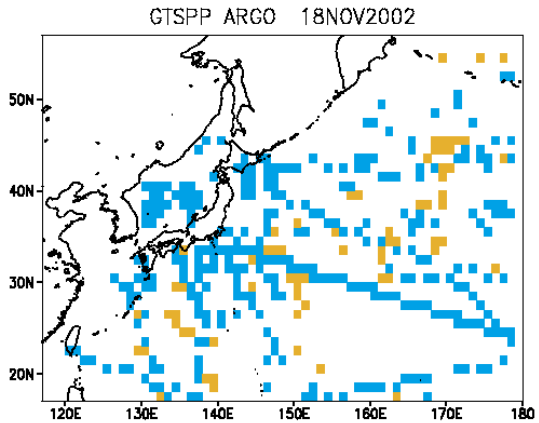
NAVOCEANO MCSST from JPL

SST



Profile data from GTSPP

T/S Profiles



JCOPE1:

Multivariate Optimum Interpolation + Model Statistics

JCOPE2:

3-Dimensional Variational assimilation + Observation Statistics

Which is better for assimilation of Fishery Community Data?

3D Variational Assimilation

Minimize a cost function:

$$(X - X^f)^T B^{-1}(X - X^f)$$
$$+(y_T^o - H_T X)^T R_T^{-1}(y_T^o - H_T X) + (y_S^o - H_S X)^T R_S^{-1}(y_S^o - H_S X)$$
$$+(y_\eta^o - H_\eta(X))^T R_\eta^{-1}(y_\eta^o - H_\eta(X))$$
$$+(y_{T_s}^o - H_{T_s} X)^T R_{T_s}^{-1}(y_{T_s}^o - H_{T_s} X)$$

X State variables: Temperature and salinity, 0m→1500m, 24 levels

X^f First guess: Model forecast + GDEM Climatology

y_T^o, y_S^o Temperature/salinity profile data

y_η^o Sea surface height anomaly data

$y_{T_s}^o$ Sea surface temperature data

$$X = X^f + \sum_{i=1}^{12} \alpha_i C_i X_{EOF_i}$$

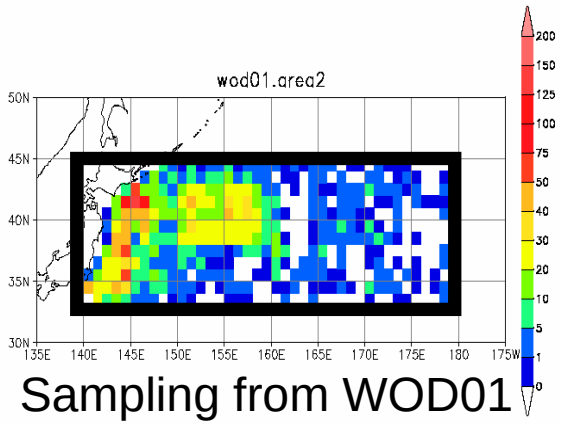
Control variables are amplitudes of T-S coupling EOF modes (Fujii and Kamachi 2003; Usui et al., 2006)

B

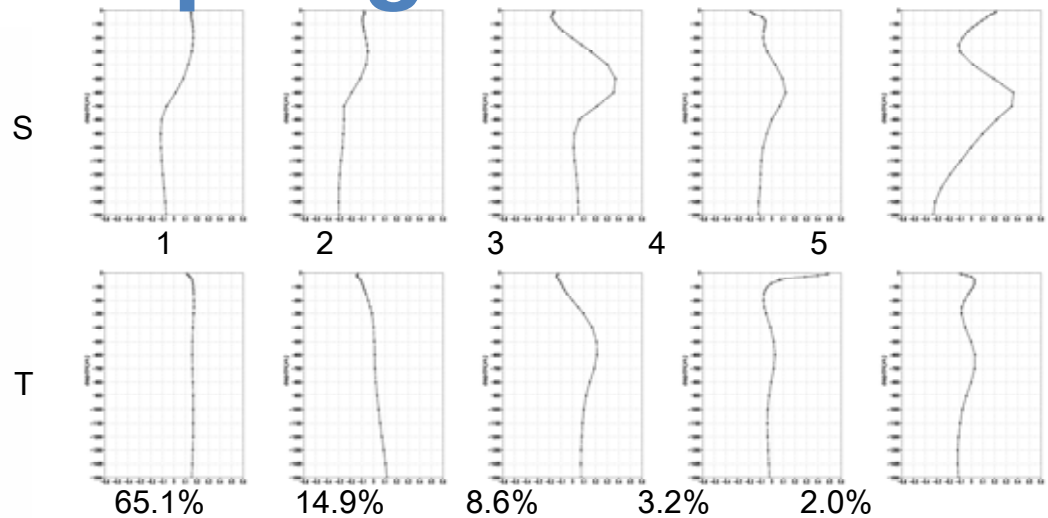
Background error covariance matrix with horizontal scale of 50km in mixed water region

Observation Statistics -T-S coupling EOF modes-

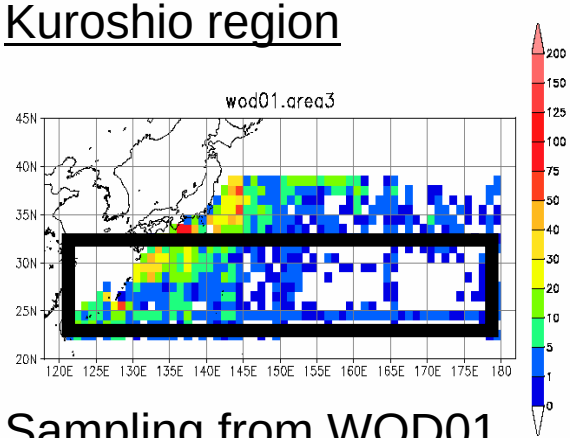
Oyashio region



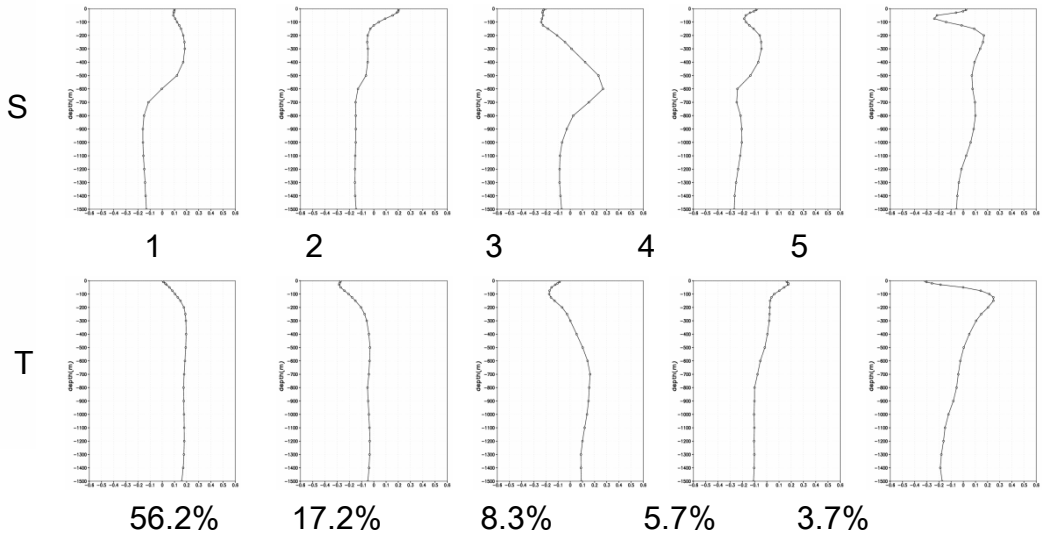
Sampling from WOD01



Kuroshio region

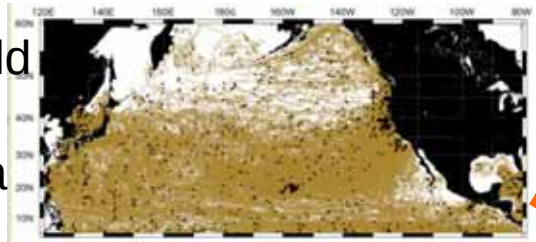


Sampling from WOD01

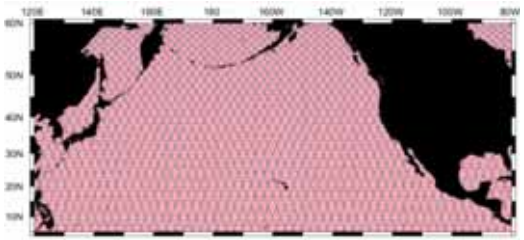


Regional Metrics –Kuroshio/Kuroshio Extension path-

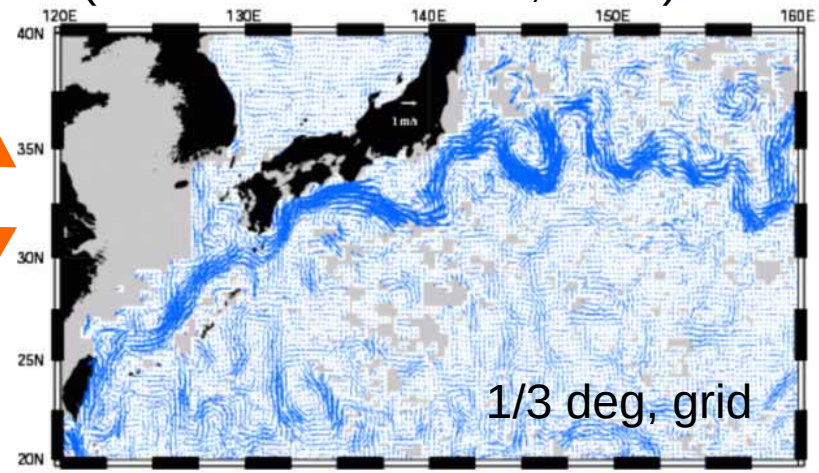
Mean velocity field calculated from drifting Buys data

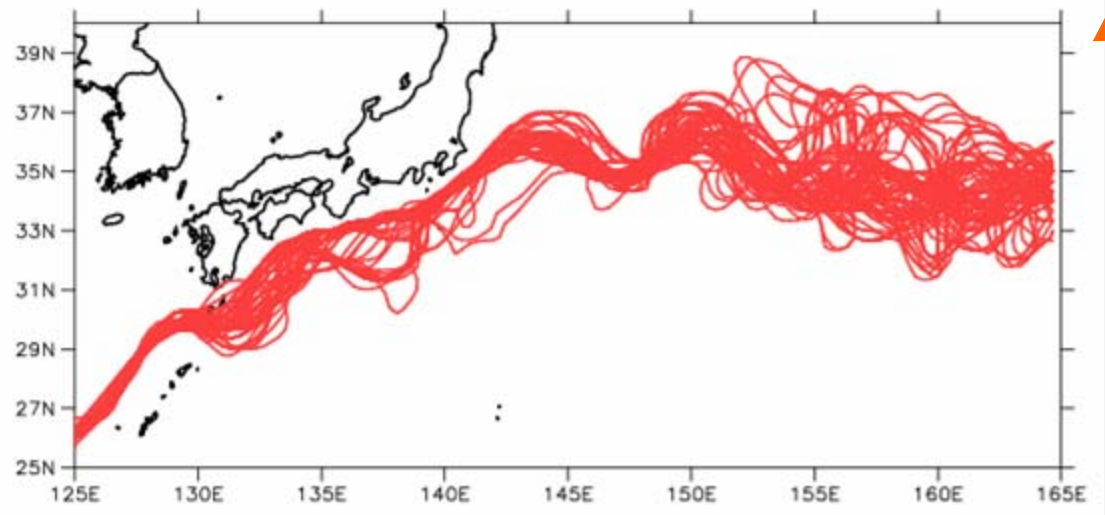


Geostrophic velocity anomaly calculated from SSHA



Snapshot of surface velocity data (Uchida and Imawaki, 2003)

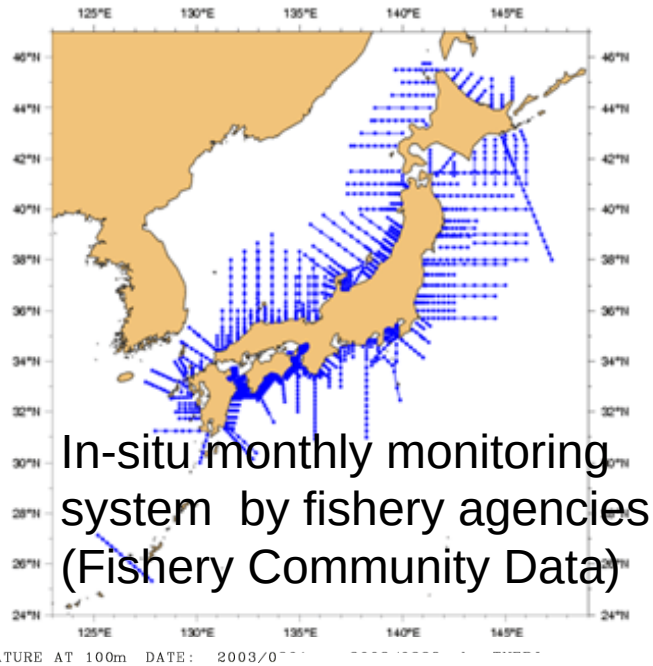




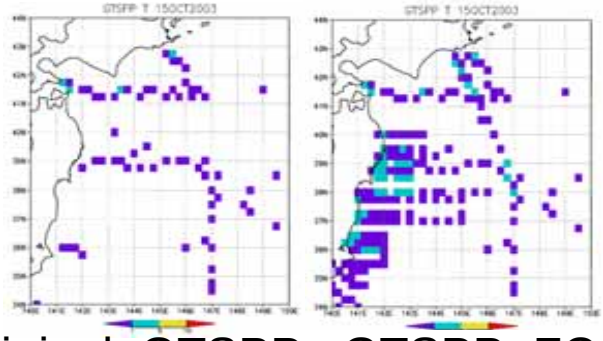
Kuroshio-Kuroshio Extension path estimated from surface geostrophic velocity data

weekly data
2003.02-2005.02

Regional Metrics
-Dense in-situ data-

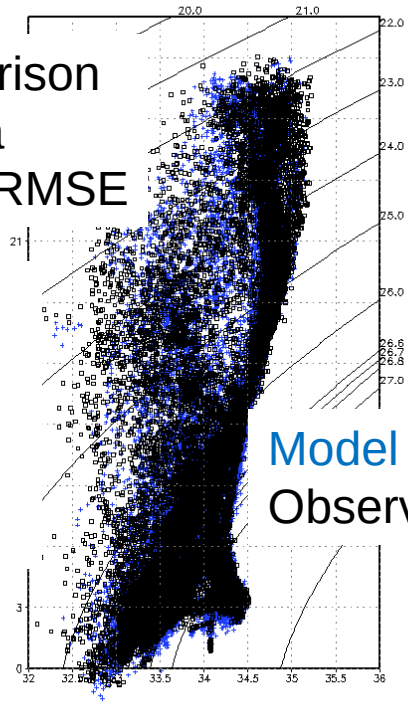


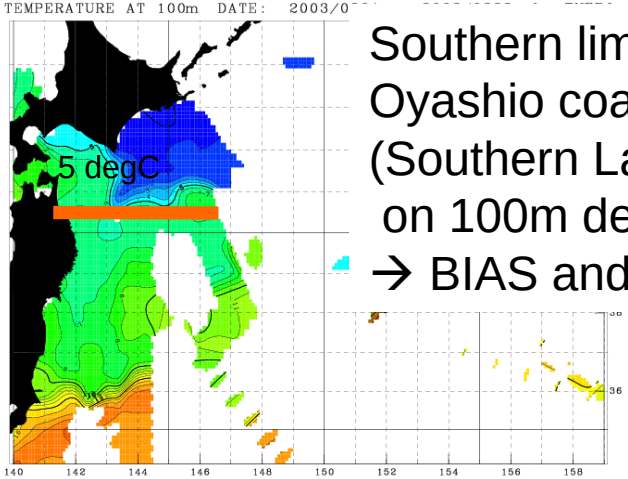
In-situ monthly monitoring system by fishery agencies (Fishery Community Data)



Original GTSPP GTSPP+FC data

Direct comparison of profile data
→ BIAS and RMSE





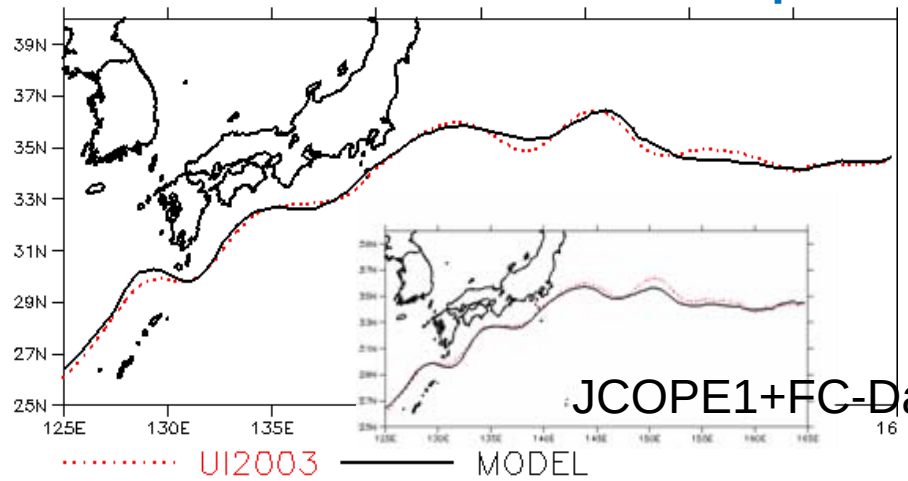
Southern limit of Oyashio coastal branch (Southern Latitude of 5 degC isotherms on 100m depth)
→ BIAS and RMSE

JAMSTEC
JAPAN AGENCY FOR MARINE-EARTH SCIENCE AND TECHNOLOGY

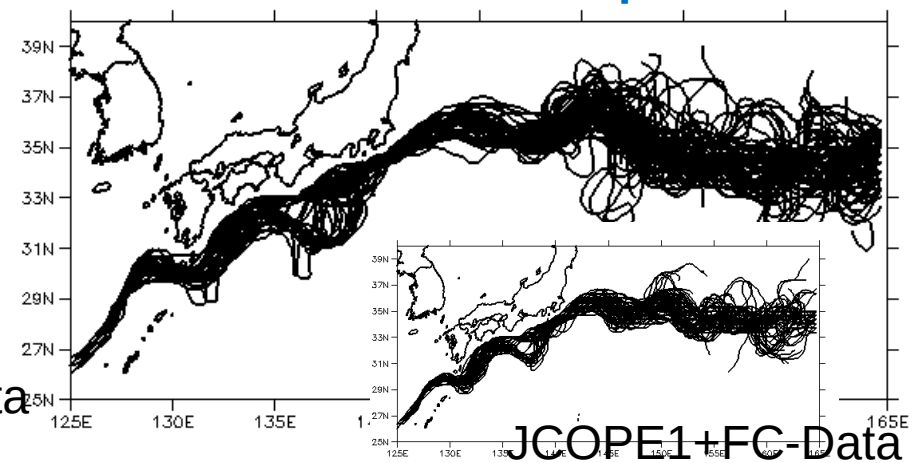
Incorporated Administrative Agency
Fisheries Research Agency

Kuroshio-Kuroshio Extension Path 2003.02-2005.02

JCOPE2+FC-Data <mean path>

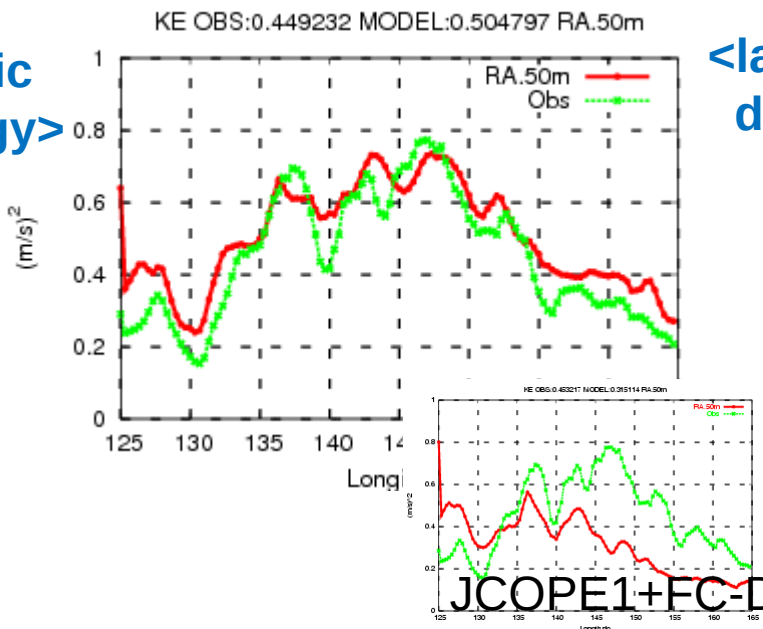


JCOPE2+FC-Data <path series>



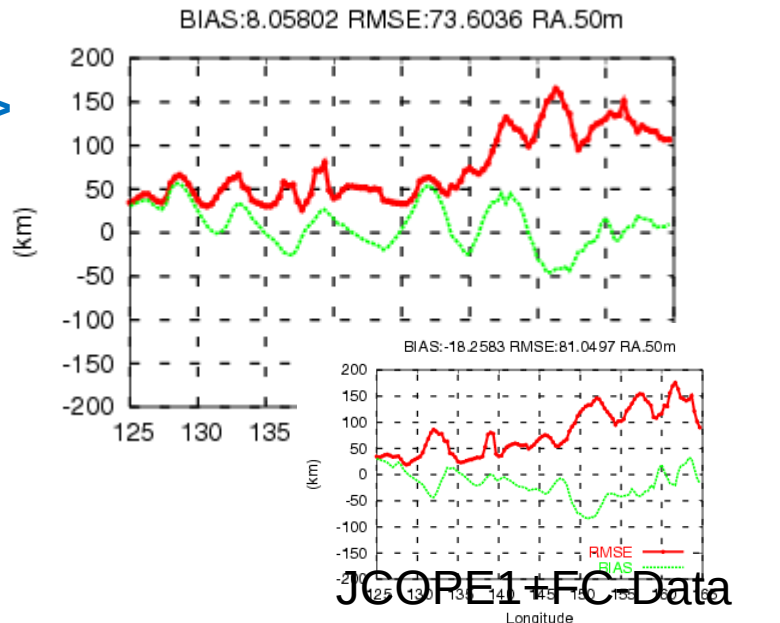
JCOPE2+FC-Data

<kinetic energy>



JCOPE2+FC-Data

<latitudinal deviation>

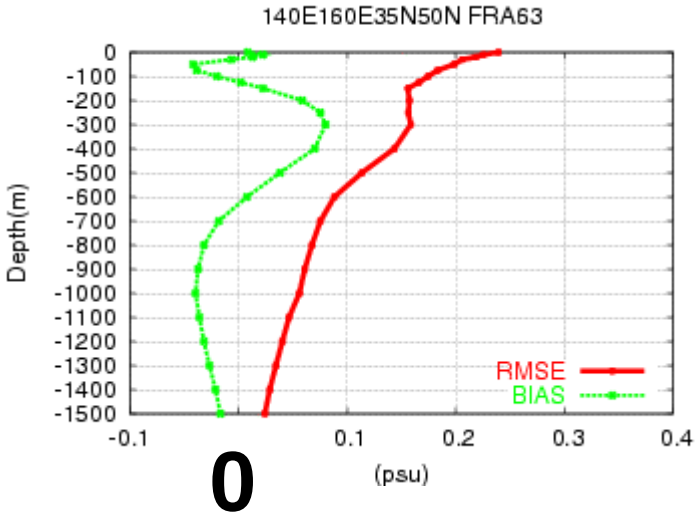


Validation of TS Profiles 2003.02-2005.02

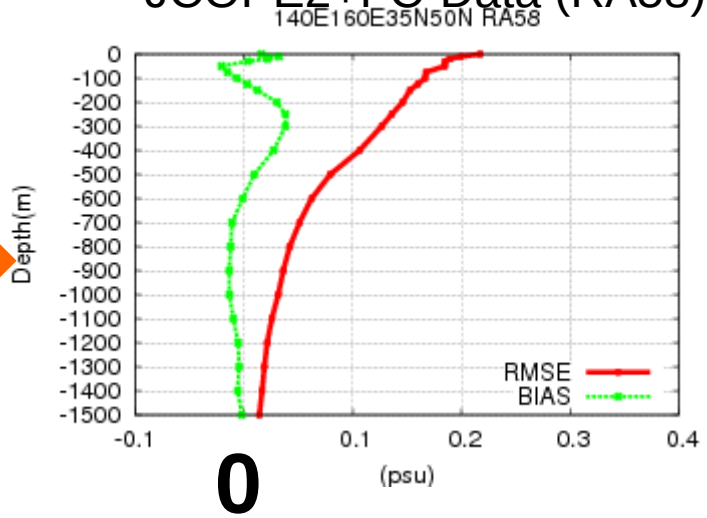
JCOPE1+FC-Data (FRA63)

JCOPE2+FC-Data (RA58)

S

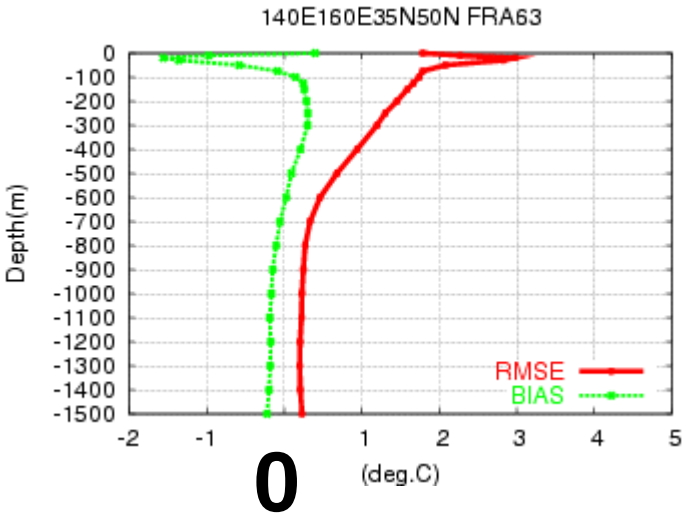


0

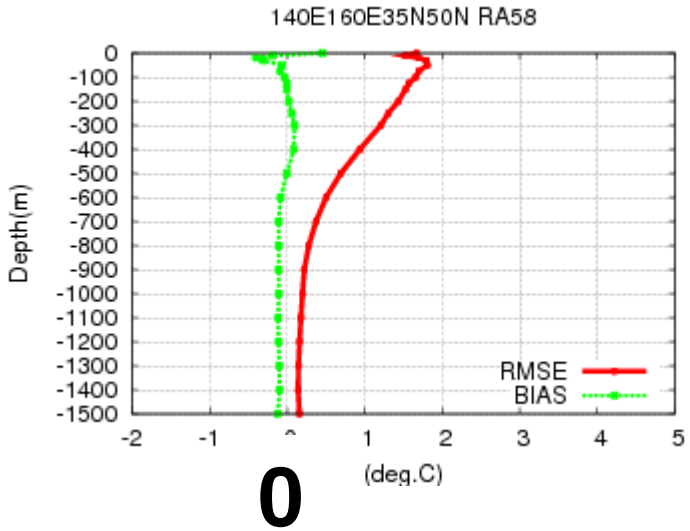


0

T



0



0

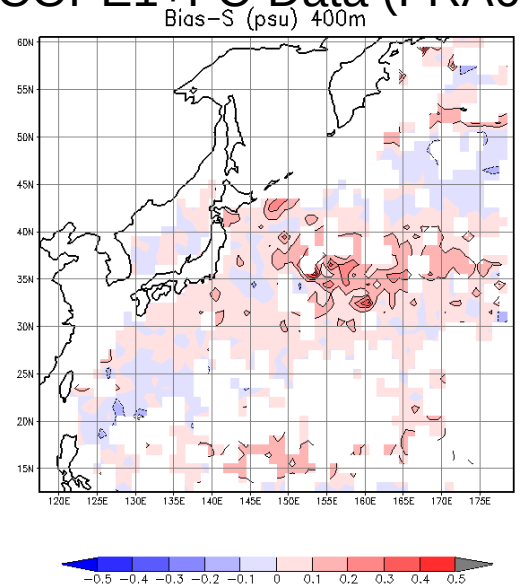
TS Biases at 400m Depth

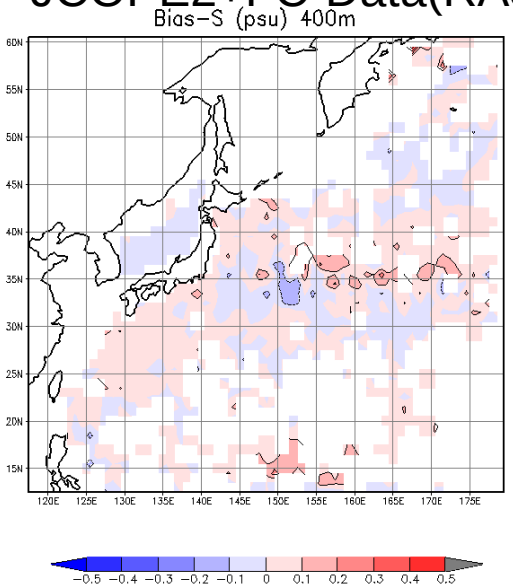
2003.02-2005.02

JCOPE1+FC-Data (FRA63)

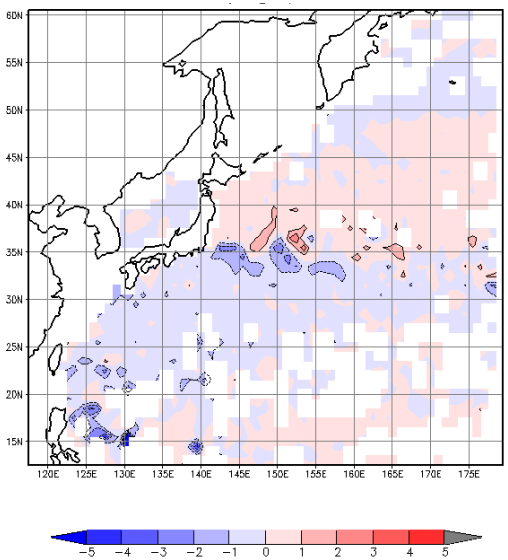
JCOPE2+FC-Data(RA58)

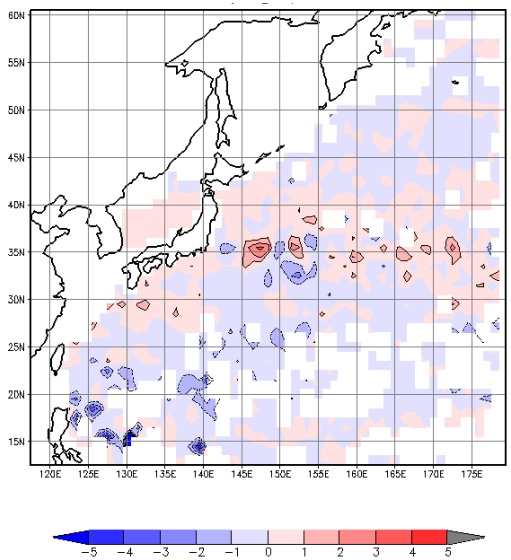
S





T



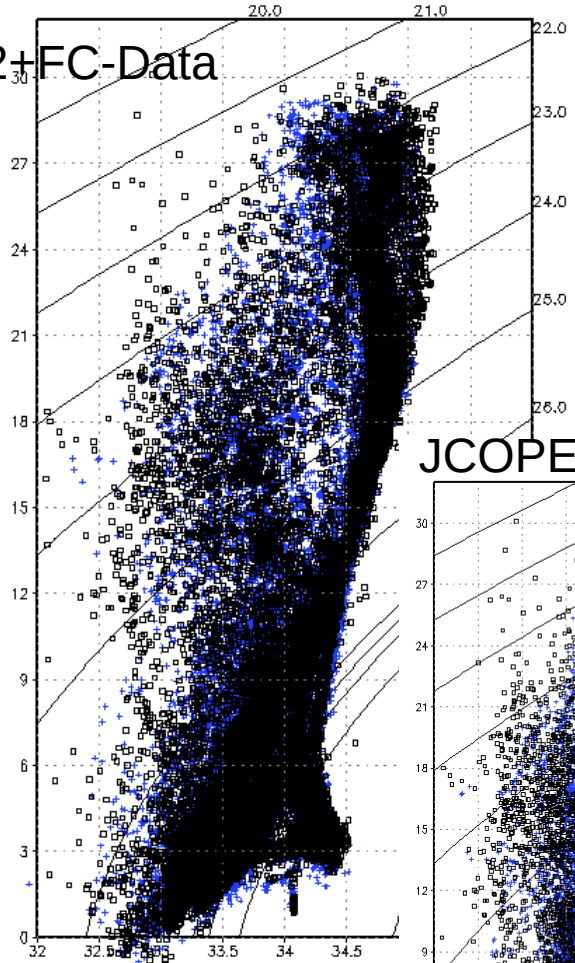


TS Diagram

2003.02-2005.02

140-150E 35-45N

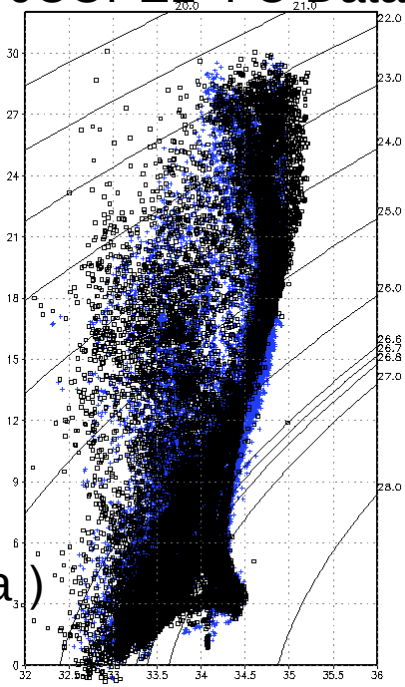
JCOPE2+FC-Data



Obs.

Model

JCOPE1+FC-Data

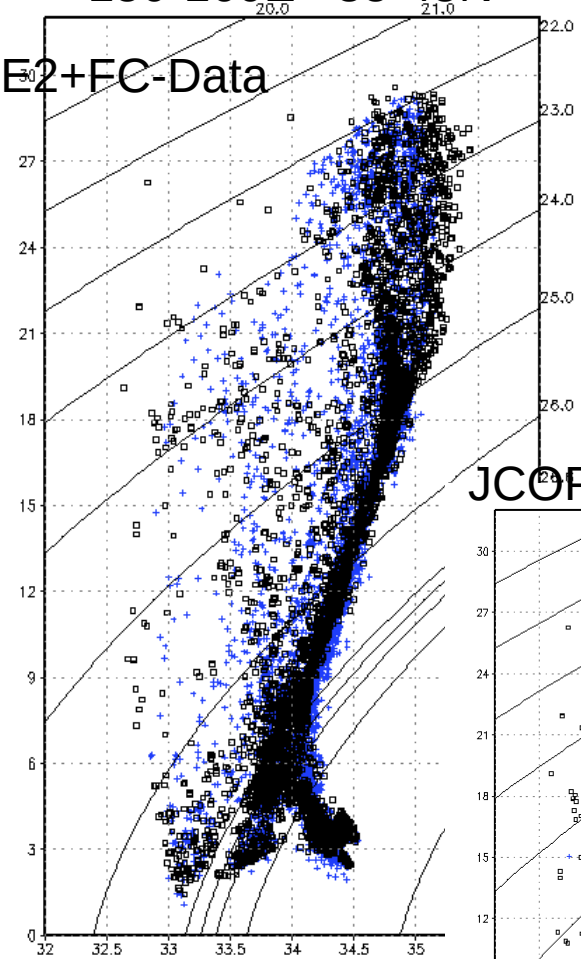


Coastal region

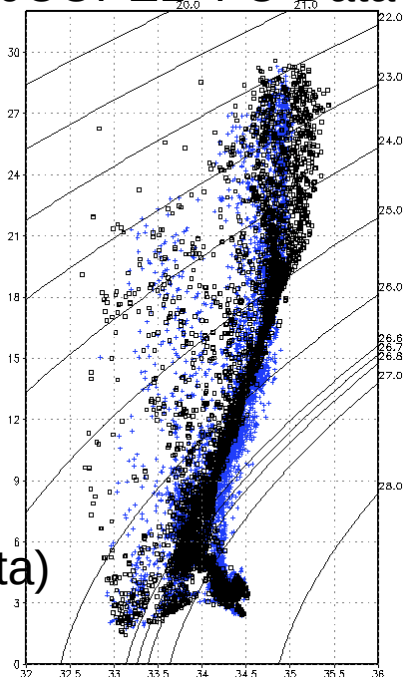
(+ many FC-Data)

150-160E 35-45N

JCOPE2+FC-Data



JCOPE1+FC-Data

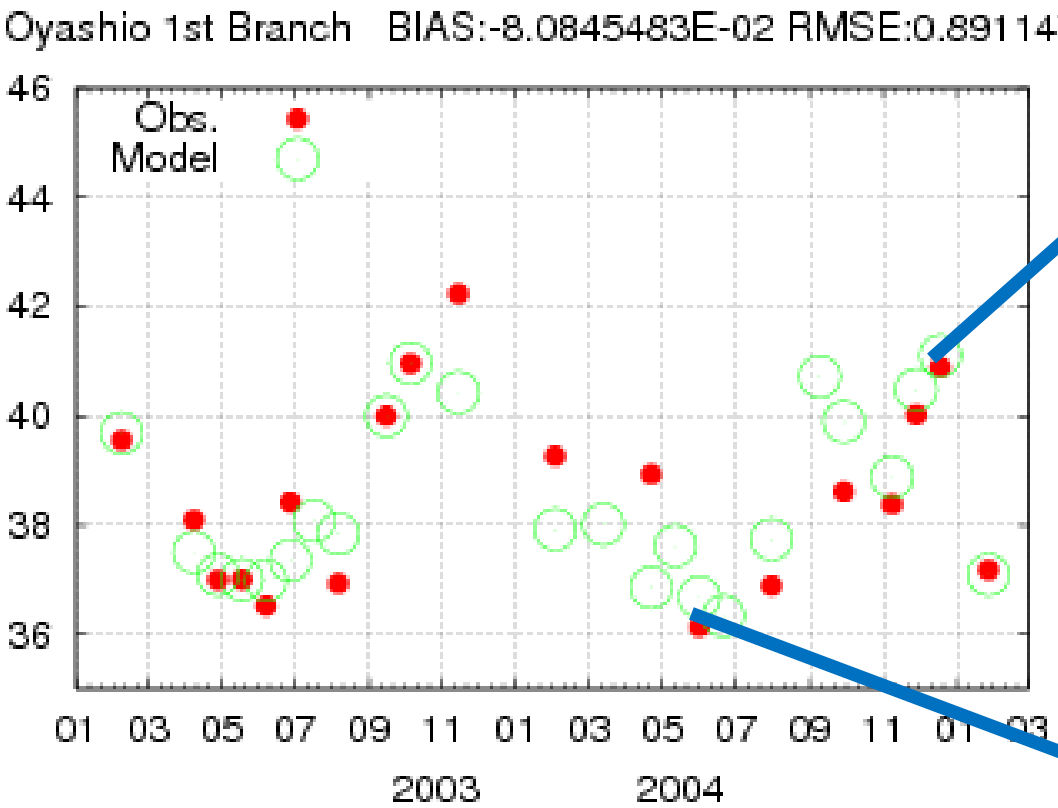


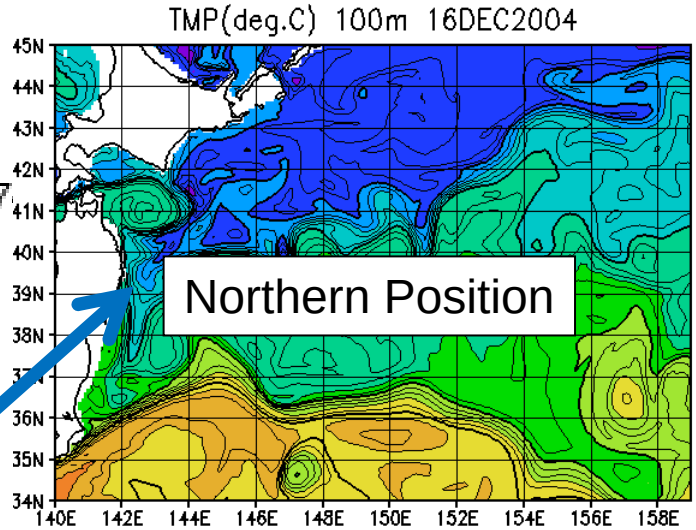
Open ocean region

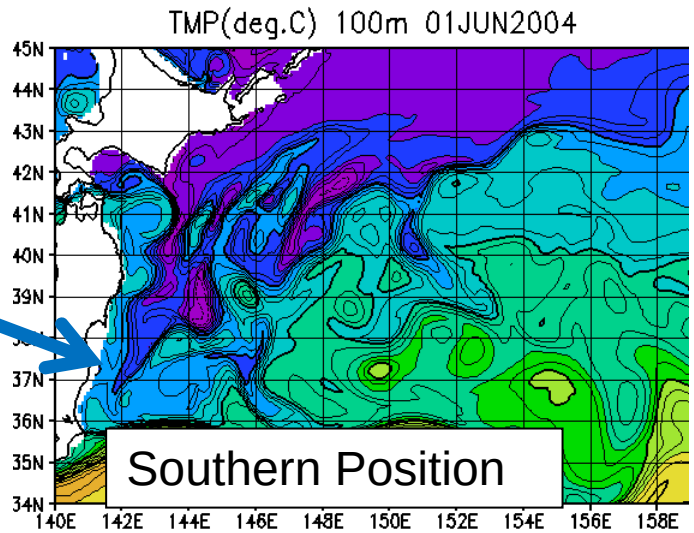
(+ a few FC-Data)

Oyashio Coastal Branch

JCOPE2+FC-Data



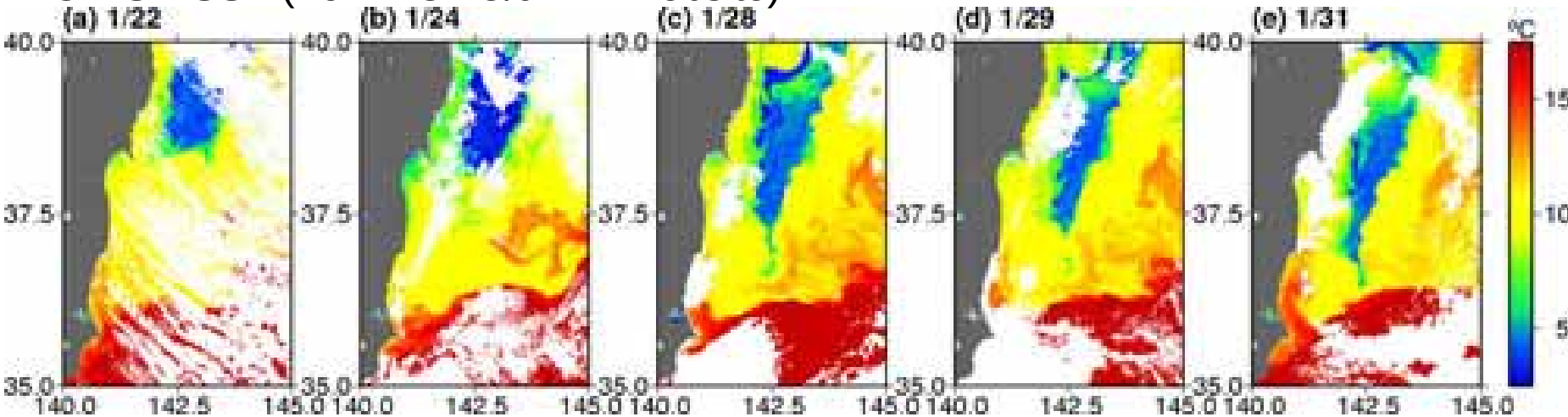




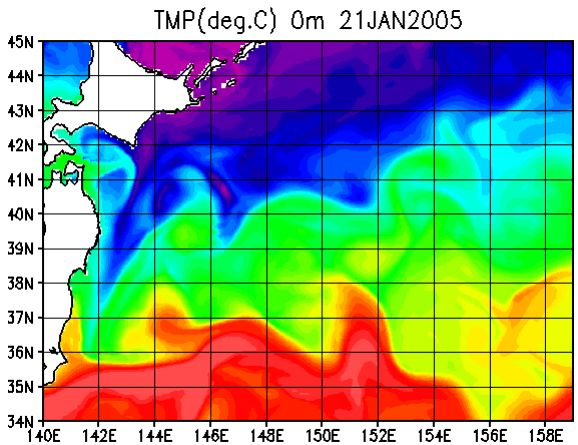
JCOPE1+FC-Data: BIAS=0.15, RMSE=1.21

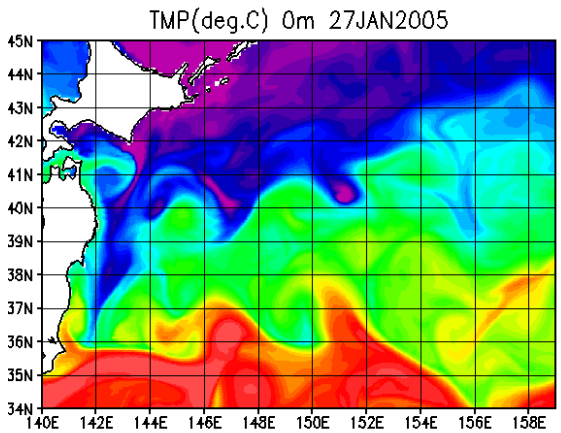
Southward Intrusion of Oyashio Coastal Branch

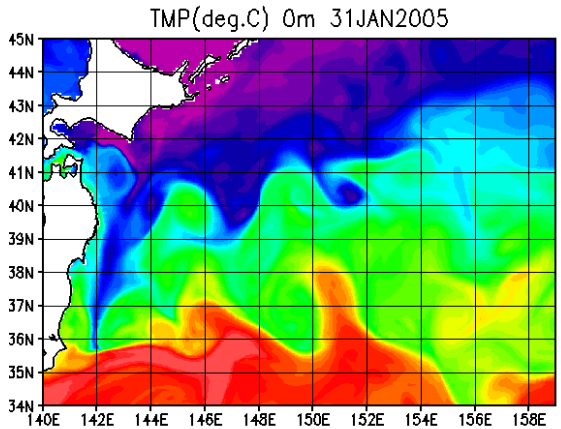
MODIS SST (from EORC/JAXA website)



JCOPE2+FC-Data SST

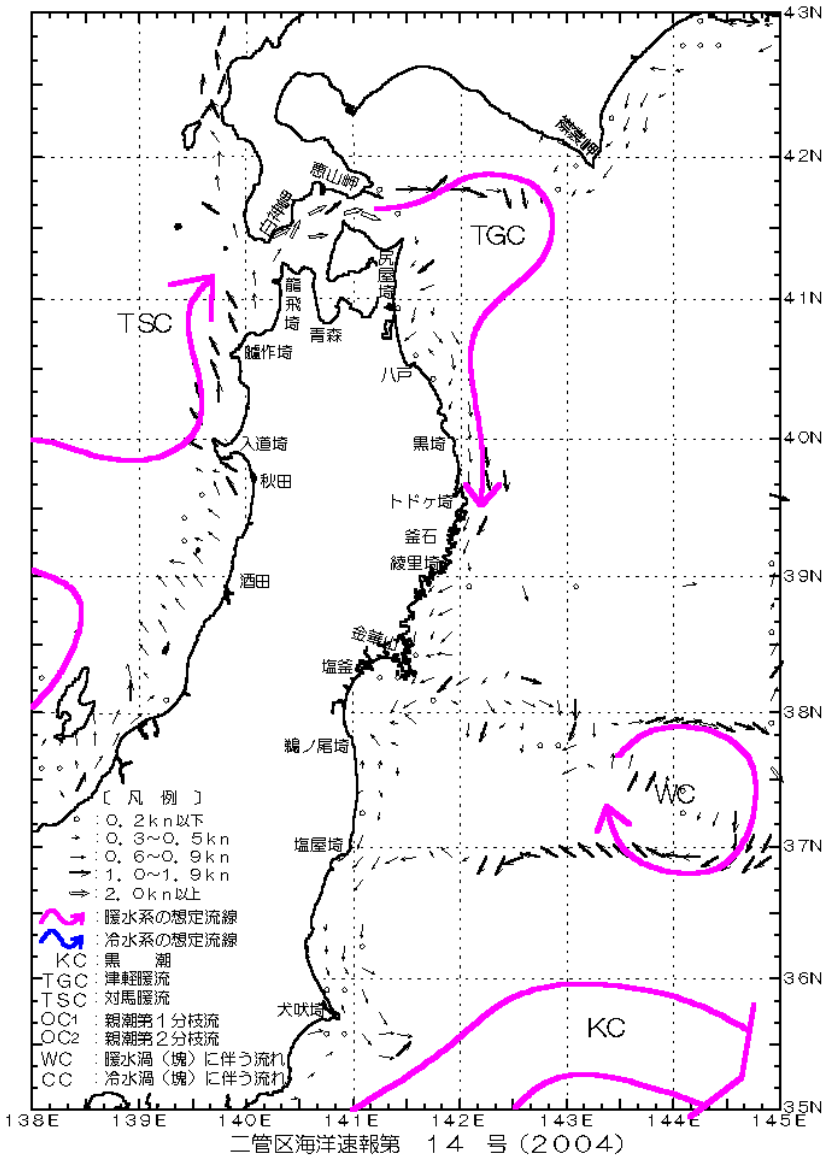






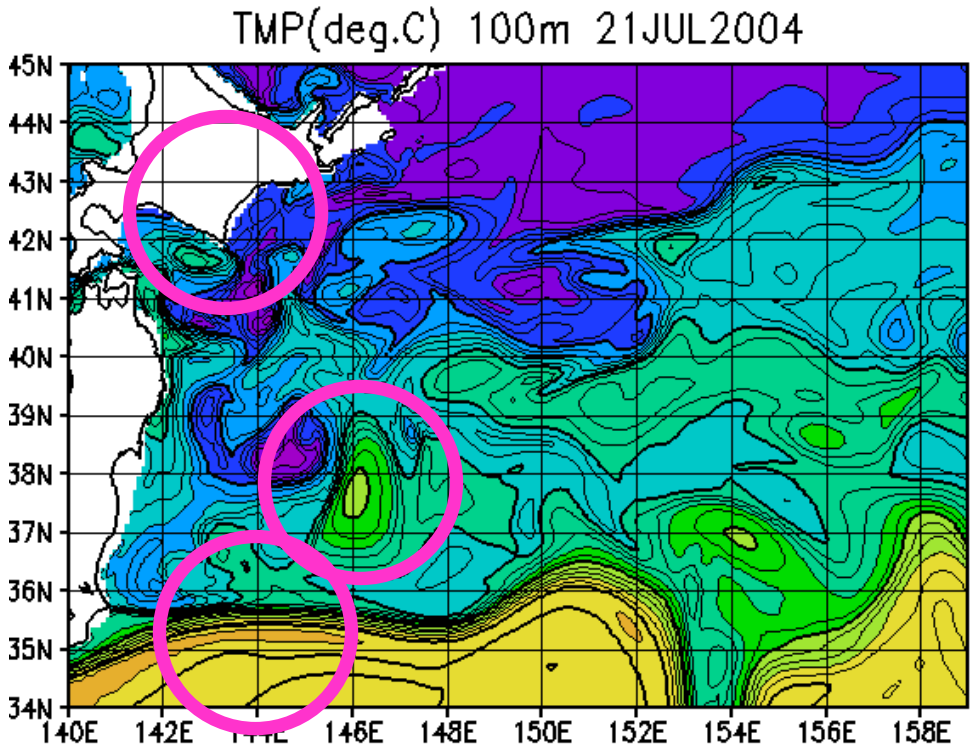
Meso-scale events

Observation Report by Japan Coast Guard

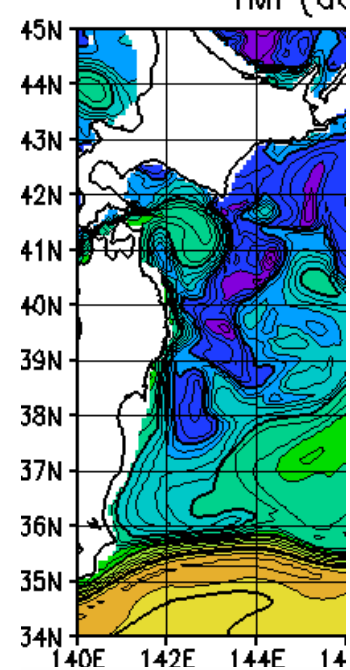


二管区海洋速報第 14 号（2004）

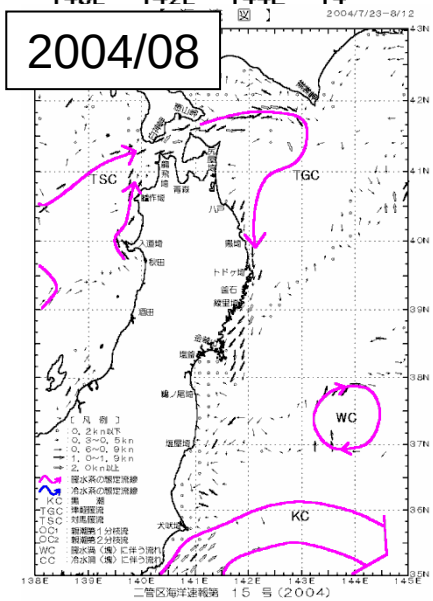
JCOPE2+FC-Data

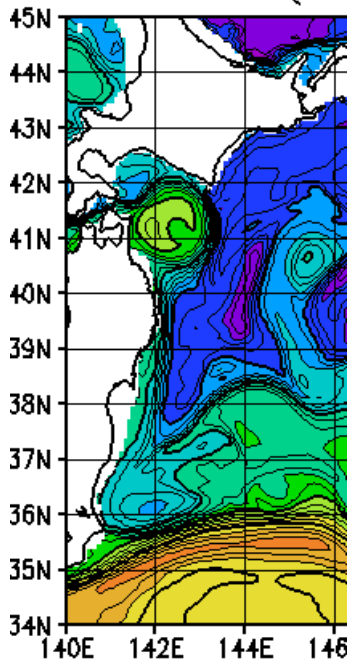


Time evolution 2004/08-2004/10

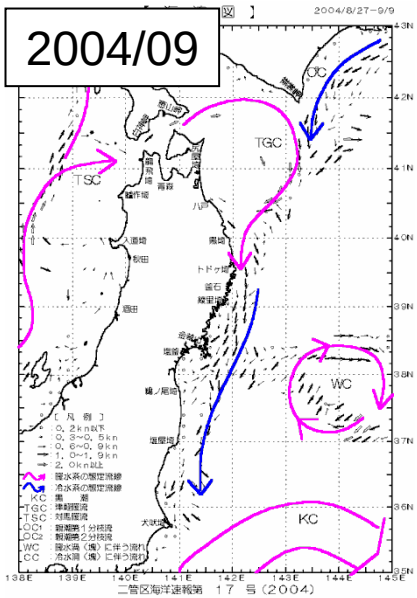


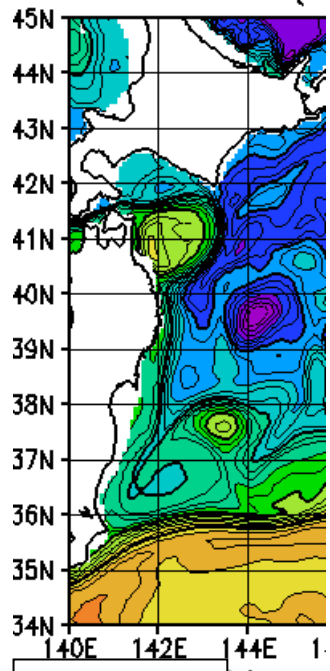
2004/08



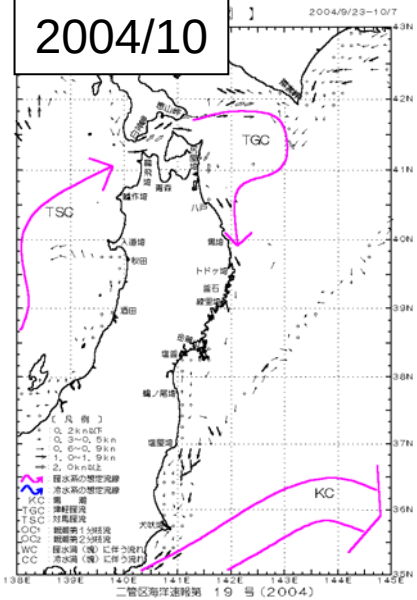


2004/09

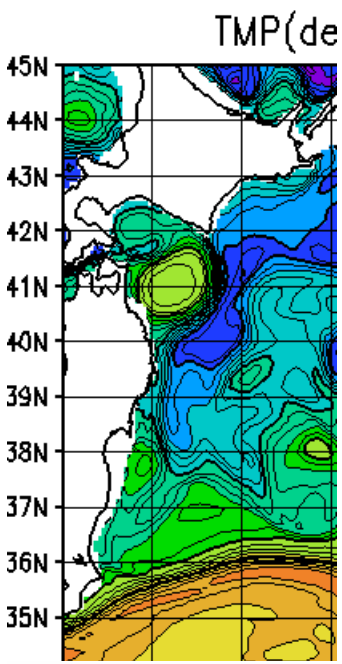


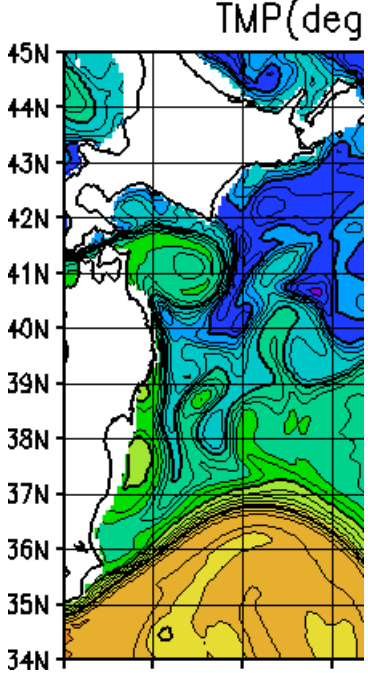


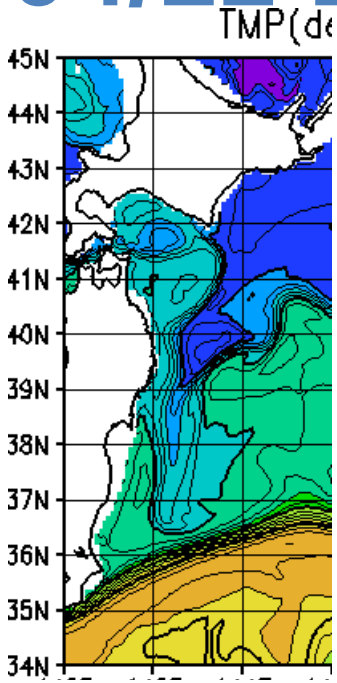
2004/10

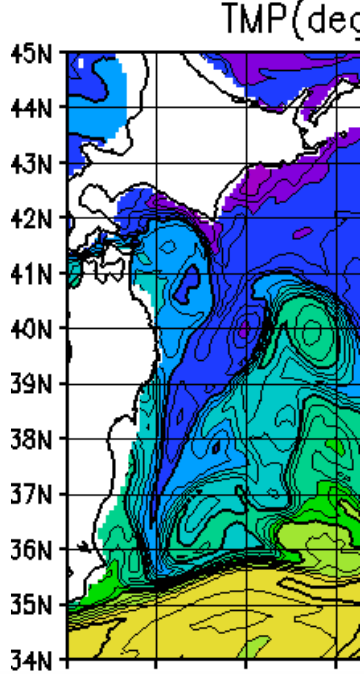


Time evolution 2004/11-2005/02

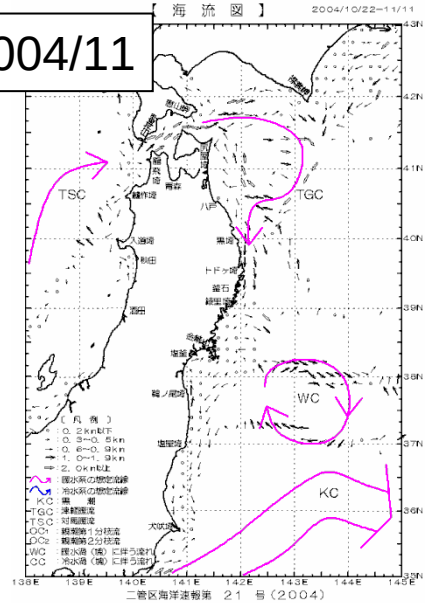




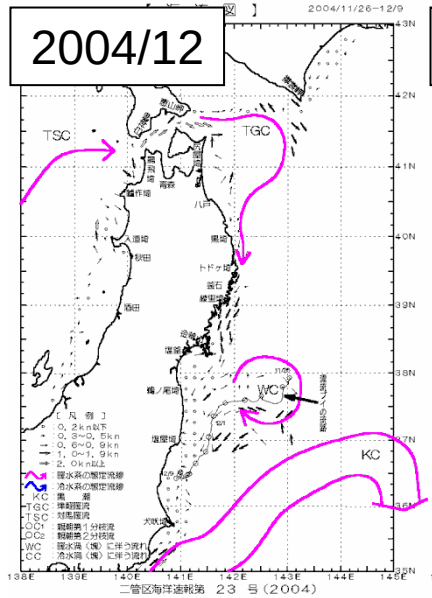




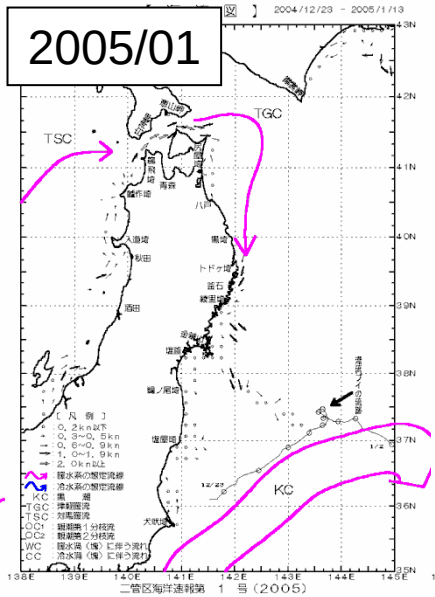
2004/11



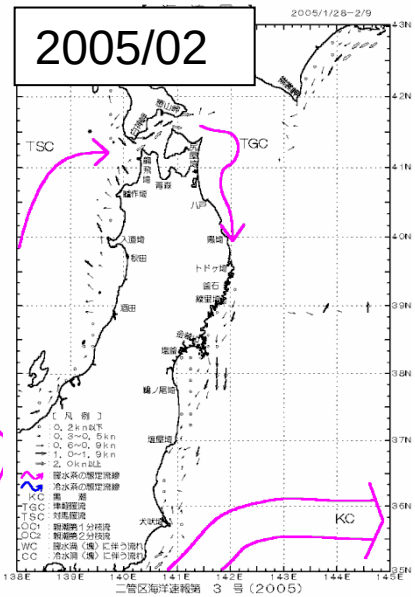
2004/12



2005/01

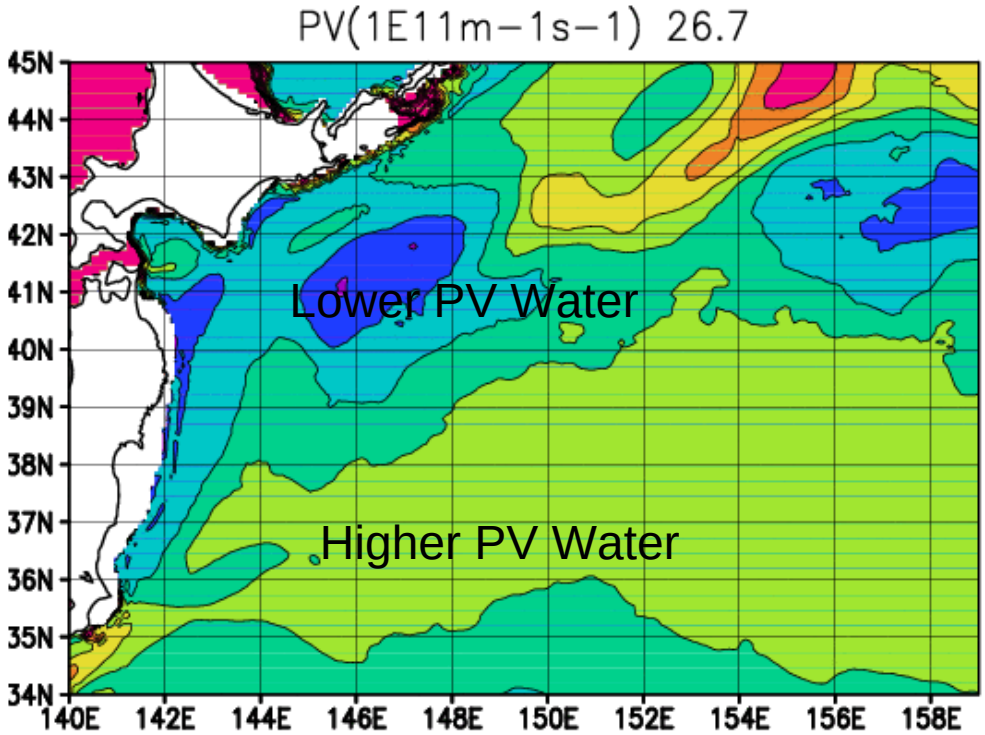


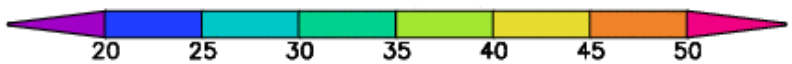
2005/02



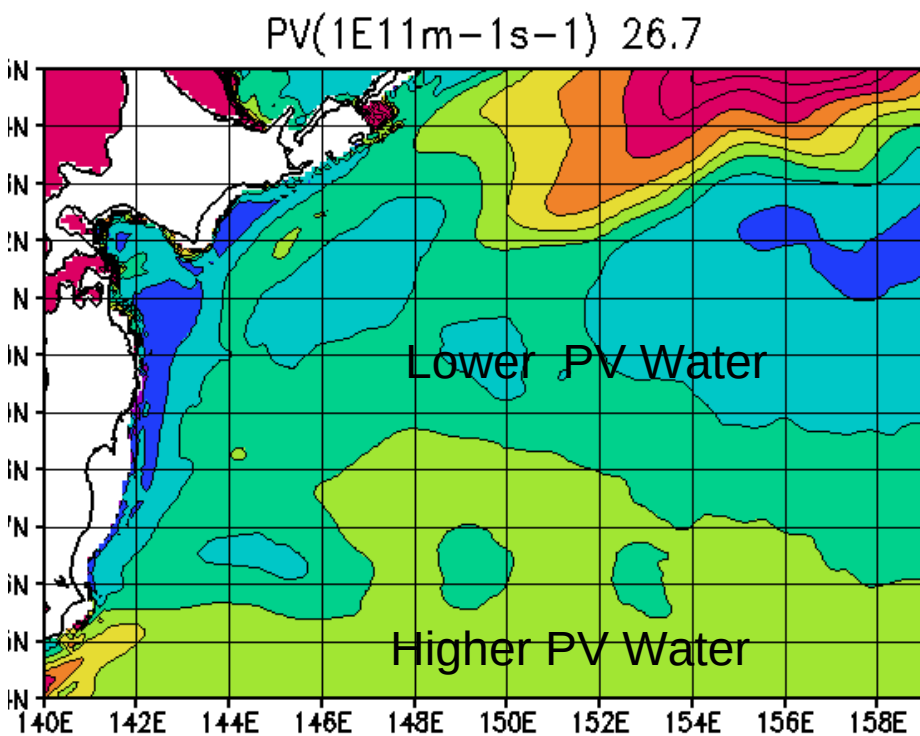
NPIW

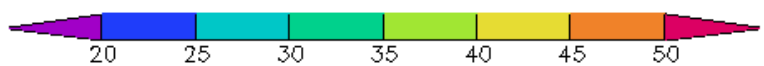
JCOPE1 + FC-Data (FRA63)





JCOPE2 + FC-Data(RA58)





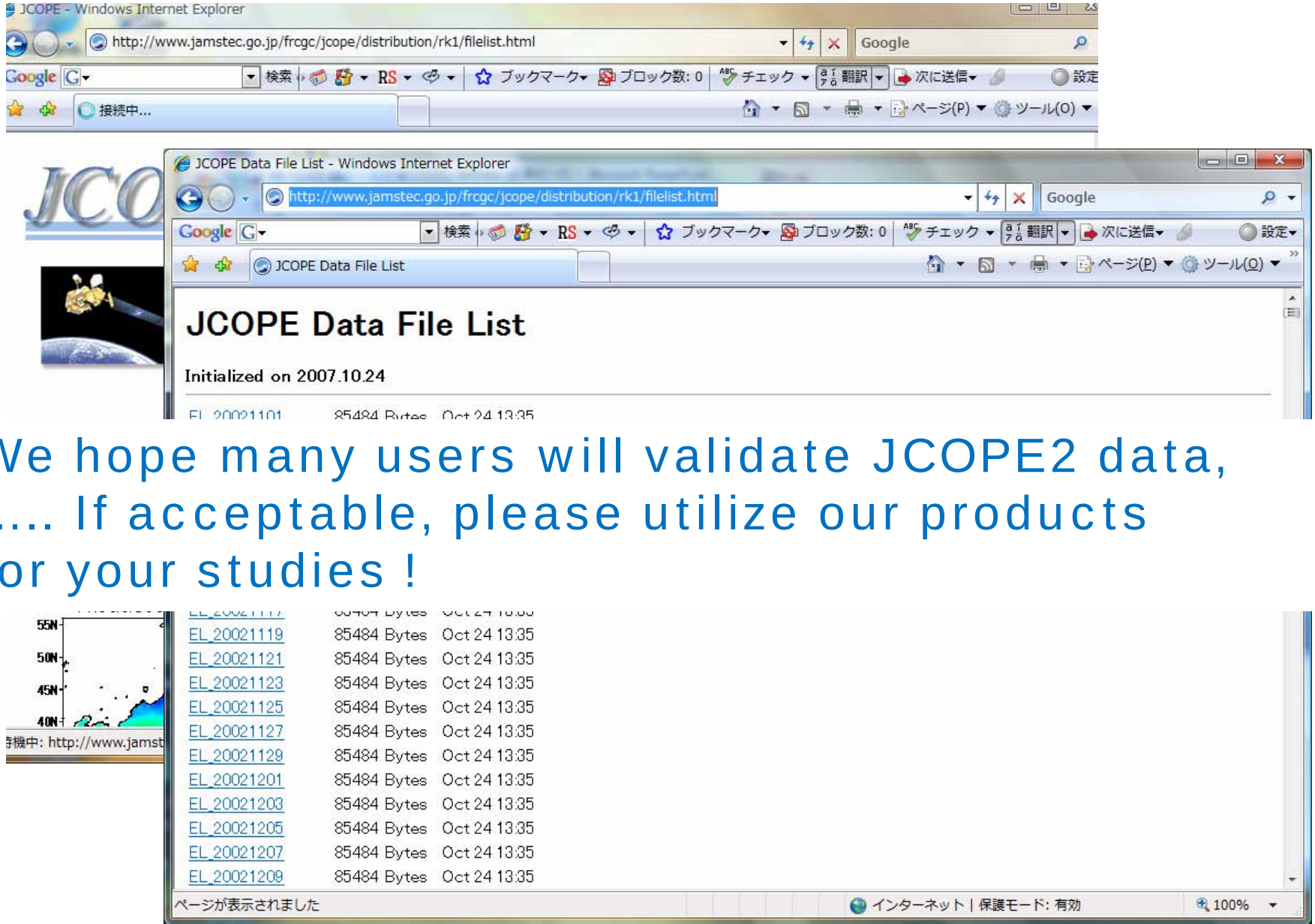
Summary

- A data assimilation method fully utilizing observation statistics (3DVAR with T/S coupling EOF modes) assimilates Fishery Community Data with lower BIAS/RMSE than an older version method utilizing model statistics (JCOPE1).
- The JCOPE2 reanalysis represents some features of meso-scale events in Kuroshio/Oyashio mixed water region, (2003-2004), thereby reproducing water mass property consistent with an observational view.

- We are now creating new JCOPE2 reanalysis data with longer term,1992-2007 (without Fishery data for 1st version due to data preparation problem)
- The new JCOPE2 data will be freely distributed for use in science research and will be downloaded from the JCOPE website: http://www.jamstec.go.jp/frcgc/jcope/ (2008-)

- Off course, the 'endless' improvement for reduction of the model biases must be conducted.

On-line Distribution



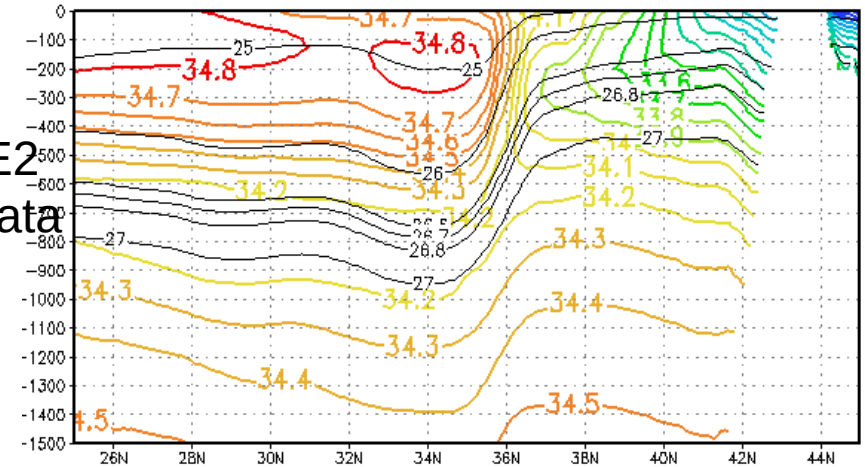
We hope many users will validate JCOPE2 data, ... If acceptable, please utilize our products for your studies !

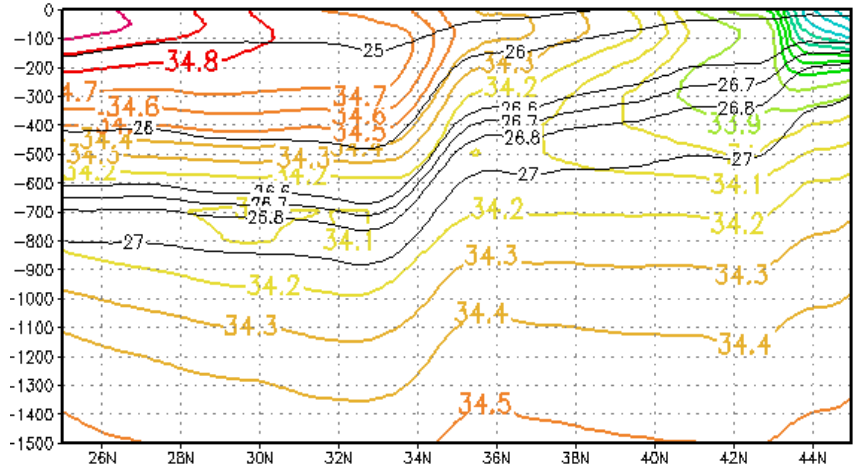
Climatological view of water mass property 2003.02-2005.02

144E

155E

JCOPE2 +FC-Data





WOA Climatology