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

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JCOPE2 + Fishery Community Data (Optimum Interpolation)

Tsugaru Warm Water
Oyashio Coastal Branch
Warm Core Eddy
Kuroshio Extension Path

(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 → JCOPE2

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

Assimilation of Fishery Community Data

POM based OGCM
1/12 deg., 45 levels

Assimilation Data (JCOPE2 + FC Data)

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

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:

\[(X - X^f)^T B^{-1} (X - X^f)\]

\[+ (y_T^o - H_T X)^T R_T^{-1} (y_T^o - H_T X) + (y_S^o - H_S X)^T R_S^{-1} (y_S^o - H_S X)\]

\[+ (y_\eta^o - H_\eta(X))^T R_\eta^{-1} (y_\eta^o - H_\eta(X))\]

\[+ (y_{Ts}^o - H_{Ts} X)^T R_{Ts}^{-1} (y_{Ts}^o - H_{Ts} X)\]

\[X\quad \text{State variables: Temperature and salinity, 0m→1500m, 24 levels}\]

\[X^f\quad \text{First guess: Model forecast + GDEM Climatology}\]

\[y_T^o, y_S^o\quad \text{Temperature/salinity profile data}\]

\[y_\eta^o\quad \text{Sea surface height anomaly data}\]

\[y_{Ts}^o\quad \text{Sea surface temperature data}\]

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

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

\[B\quad \text{Background error covariance matrix with horizontal scale of 50km in mixed water region}\]
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)

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

BIAS and RMSE

Direct comparison of profile data
→ BIAS and RMSE

Original GTSSP  GTSSP+FC data

Model Observation
Kuroshio-Kuroshio Extension Path
2003.02-2005.02

JCOPE2+FC-Data <mean path> JCOPE2+FC-Data <path series>

JCOPE2+FC-Data

KE OBS: 0.449232 MODEL: 0.504797 RA.50m

RA.50m Obs

BIAS: 8.05802 RMSE: 73.6036 RA.50m

<kinetic energy>

<latitudinal deviation>
Validation of TS Profiles
2003.02-2005.02

JCOPE1+FC-Data (FRA63)

JCOPE2+FC-Data (RA58)
TS Biases at 400m Depth
2003.02-2005.02
TS Diagram
2003.02-2005.02

140-150E  35-45N
JCOPE2+FC-Data
Obs.

150-160E  35-45N
JCOPE2+FC-Data
Model

JCOPE1+FC-Data

Coastal region
(+ many FC-Data)

Open ocean region
(+ a few FC-Data)
Oyashio Coastal Branch

JCOPE2+FC-Data

Oyashio 1st Branch

BIAS=-8.0845483E-02
RMSE=0.891147

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
TMP(deg.C) 0m 21JAN2005
TMP(deg.C) 0m 27JAN2005
TMP(deg.C) 0m 31JAN2005
Meso-scale events

Observation Report by Japan Coast Guard

JCOPE2+FC-Data

TMP(deg.C) 100m 21JUL2004
Time evolution 2004/08-2004/10
Time evolution 2004/11-2005/02
Averaged view of salinity on 26.7 Iso-sigma surface
From 2003.02-2005.02
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-)
- Of course, the ‘endless’ improvement for reduction of the model biases must be conducted.
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

[Graph showing climatological data for 144E]

155E

[Graph showing climatological data for 155E]

JCOPE2 + FC-Data

WOA Climatology