Three-dimensional analyses of salinity and temperature in the Pacific using a variational method with vertical coupled temperature-salinity EOF modes

- Salinity impacts in the Equatorial and North Pacific Assimilation Systems -

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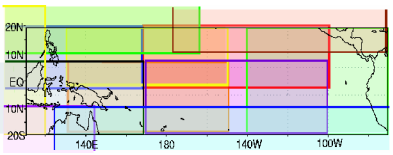
Abstract

Data assimilation systems analyzing salinity (S) as well as temperature (T) has been developed in the Meteorological Research Institute (MRI), and is examined in the equatorial and western-north Pacific. The systems (MOVE: Mri Ocean Variational Estimation) use Three Dimensional Variational (3D-VAR) method with vertical coupled T-S Empirical Orthogonal Function (EOF) mode decomposition with area partition (CTSA: Coupled T-S Assimilation). Sea Surface Height (SSH) of TOPEX/ POSEIDON (T/P) altimetry, in-situ (ship and ARGO float) T and S data are used for assimilation. We report here preliminary results about impacts of salinity data to state variables (T, velocity and salinity itself). The coupled T-S assimilation is compared with conventional halfway assimilation (CHA: T-assimilation and S-climatology). The comparison shows the power of the CTSA and the importance of salinity data.

Equatorial Pacific in Global System



Method (3DVAR)

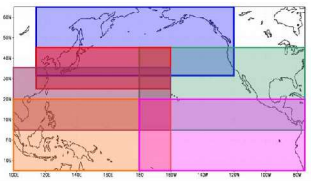
$$J = \frac{1}{2}\mathbf{x}^T\mathbf{B}^{-1}\mathbf{x} + \frac{1}{2}(h(\mathbf{x}) - \mathbf{x}_o)^T\mathbf{R}^{-1}(h(\mathbf{x}) - \mathbf{x}_o) + J_c$$

$\mathbf{x}$: Increments $\mathbf{x}_o$: Observations h : Observation function

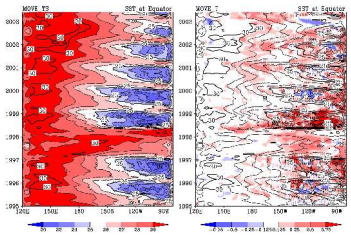
$\mathbf{B}$: First-Guess error covariance matrix J_c : Other constraints

$\mathbf{R}$: Observation error covariance matrix

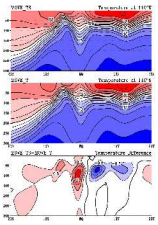
North Pacific System



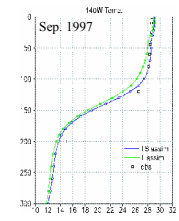
Impact to Temperature



Time-longitude variation of SST (Left: CTSA) and CHA (Right, and difference CTSA-CHA)

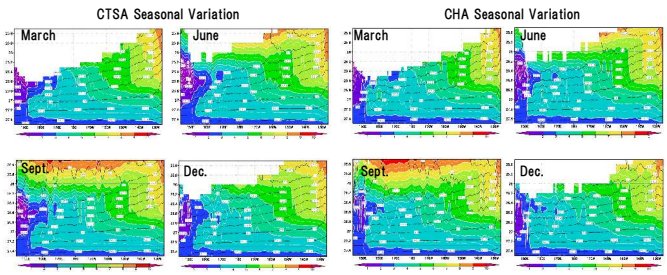


Depth-latitude sections of T (℃, contour)



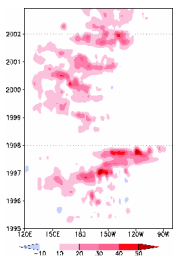
Comparison of CTSA (TS assim) and CHA (T assim) with observation

Impact to Temperature

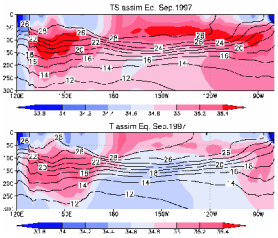


Density-Longitude section of T(color) and S(contour) along 47N in each season

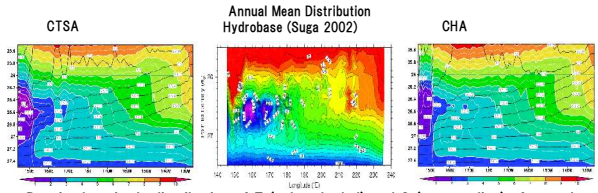
Impact to Salinity



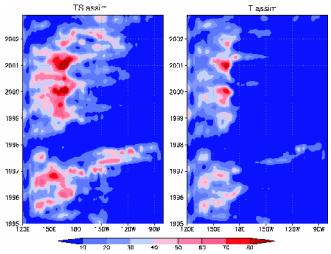
Time-longitude variation of difference (CTSA-CHA) in the Isothermal Layer Depth (ILD: SST-0.5C)



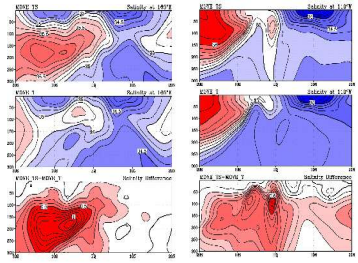
Temperature and salinity distribution of CTSA (top) CHA (bottom) in the zonal section



Density-Longitude distribution of T (color shaded) and S (contour line) of annual mean values along 47N in CTSA, Hydrobase (Obs. Climatology) and CHA

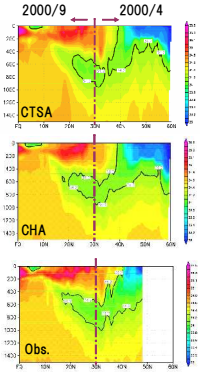


Time-longitude variation of barrier layer thickness in CTSA (Left) and CHA (Right)

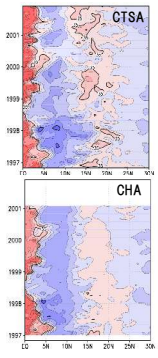


Comparison of Salinity Field of CTSA (upper), CHA (middle) and the difference (bottom: CTSA-CHA) in 165E (Left column) and 110W (Right column)

Impact to Salinity

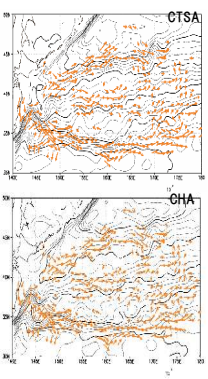


Comparison of Salinity field (NPIW: salinity min.) of CTSA, CHA, and Ship Observation in April and September, 2000



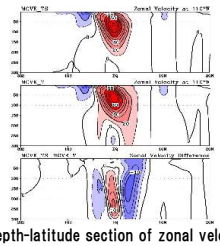
Comparison of variation of salinity field in time-latitude domain (NPTW variability) of CTSA (upper) and CHA (lower) along 137E, 150m depth

Impact to Velocity

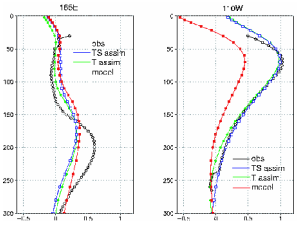


Comparison of flow fields (acceleration potential on 26.7 sigma theta surface) of CTSA (upper) and CHA (lower) with velocity field derived from ARGO floats (see Iwao et al., 2003).

Impact to Velocity



Depth-latitude section of zonal velocity in CTSA (upper), CHA(middle) and the difference (CTSA-CHA)



Comparisons of velocity field of observation (obs), CTSA (TS assim), CHA (T assim), and model simulation (model) in the western (Left: 160E) and eastern (Right: 110W) Pacific.