# Observations of the Meridional Overturning Circulation Above and Below the Ocean Surface

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A global dataset consisting of three-dimensional monthly varying temperature, salinity, velocity fields from 1990-present has been developed after reconstructing the Global Temperature-Salinity Profile Program (GTSPP) and Argo profile and track data together with the Navy's Master Observational Oceanographic Data Set (MOODS), at spatial resolution equal to or higher than the standard product ($1^{\circ} \times 1^{\circ}$). To improve the temporal and spatial resolution, the Ocean Surface Current Analyses – Real Time (OSCAR) derived from satellite altimeter and scatterometer are also used.

The optimal spectral decomposition (OSD) method (Chu et al., 2003a, b) is used to reconstruct these data. After decomposition, a three-dimensional field is represented by a set of Fourier coefficients. The OSD method has three components: (1) determination of the basis functions, (2) optimal mode truncation, and (3) determination of the Fourier coefficients. Determination of basis functions is to solve the eigen-value problem. The basis functions only depend on the geometry of the ocean basin and the boundary condition. This is to say, the basis functions can be pre-determined before the data analysis. For data without error, the more the modes, the more the accuracy of the processed field. For data with error, this rule of the thumb is no longer true. Inclusion of high-order modes leads to increasing error. The Vapnik variational principal is used to determine the optimal mode truncation. After the mode truncation, optimal field estimation is to solve a set of a linear algebraic equation of the Fourier coefficients. This algebraic equation is usually ill-posed. The rotation method (Chu et al., 2004) is developed to change the matrix of the algebraic equation from ill-posed to well-posed such that a realistic set of the Fourier coefficients are obtained.

With the reconstructed three dimensional ocean fields for the two decades (1990-present), temporal and spatial variability of the meridional overturning circulation (MOC) can be identified. The corresponding overturning streamfunction is calculated. Since rapid changes in the MOC could have implications for regional changes of climate, correlation analysis between our reanalyzed datasets (3D ocean fields) and the surface atmospheric data (such as NCEP reanalyzed wind stress, air-ocean heat and moisture fluxes) will improve understanding of the physical mechanisms behind fluctuations in the MOC. A more flexible and user-driven data processing and distributing system will be discussed, to optimize data use by both the scientific and operational communities.

## References

[1] Chu, P.C., L.M. Ivanov, T.P. Korzhova, T.M. Margolina, and O.M. Melnichenko, 2003: Analysis of sparse and noisy ocean current data using flow decomposition. Part 1: Theory. *J. Atmos. Oceanic Technol*., 20 (4), 478-491.

[2] Chu, P.C., L.M. Ivanov, T.P. Korzhova, T.M. Margolina, and O.M. Melnichenko, 2003: Analysis of sparse and noisy ocean current data using flow decomposition. Part 2: Application to Eulerian and Lagrangian data. *J. Atmos. Oceanic Technol*., 20 (4), 492-512.

[3] Chu, P.C., L.M. Ivanov, and T.M. Margolina, 2004: Rotation method for reconstructing process and fields from imperfect data. *Int. J. Bifur. Chaos*, 14 (8), 2991-2997.