

Spatial and temporal variability of temperature and salinity in the global ocean from Argo float data

*Shigeki Hosoda¹, Kanako Sato¹

1. Japan Marine-Earth Science and Technology

Statistical analysis for spatial and temporal variability of oceanic temperature and salinity, especially focusing on decorrelation length and signal/noise ratio, is carried out using long-term accumulated Argo float data.

It has been passed 16 years since International Argo program started. The number of active Argo float exceeded 3000 in late 2007, which is the first target in the Argo program, and then the number of accumulated profile data got to 1,000,000 in 2011. As the global Argo observation array is producing real-time oceanic data each horizontally 3x3 degrees every 10 days, we are able to have a huge amount of temperature and salinity data from sea surface to 2000 dbar in the global ocean. The long-term huge Argo data enable us get statistical information of spatial and temporal variability accurately.

Previously such kind of statistical information were estimated for mainly temperature field using expendable BathyThermograph (XBT) data (e.g., White, 1995; Meyer et al., 1982). However, sampling area of XBT data is temporally and spatially biased because of limited observational or voluntary ship courses. Recently statistical analyses were carried out using a huge amount of Argo float data to investigate statistical structure of longer term spatial variability on oceanic fields of not only temperature but also salinity. For example, Resnyanskii et al. (2010) showed spatial covariance and signal/noise ratio for separated temperature and salinity fields into 12 areas using Argo data for 2005-2007, and discussed the characteristics of statistical structures depending on areas, temperature/salinity and depth qualitatively. However, they directly analyzed only spatial covariance, indirectly guessed temporal one by global average current velocity.

Using 16-year Argo float data, here we show 4-D statistical structures of accurate decorrelation length and signal/noise ratio, referring the analytical method of Resnyanskii et al. (2010).

Used Argo profiling data are delayed mode quality controlled temperature and salinity in Jan. 2001 - Dec. 2016 obtained from the Argo Global Data Assembly Centers (GDACs) and the Advanced Quality Controlled data (AQC), which is well quality controlled dataset for real-time QC Argo data. Anomalies are calculated from monthly climatology of World Ocean Atlas 2013 (WOA2013: Locarnini et al., 2013; Zweng et al., 2013) to remove seasonal variability. Here we separate the global ocean into 25 areas, which is finer than in the previous study. After sorting all profiling data for each areas, the profiling data are interpolated on 23 levels from 10 to 2000 dbar (Akima, 1970). Then covariance of anomalies are calculated for temperature and salinity fields, sorting into 20km bins of zonal and meridional distances between observations from 0 - 3000km, respectively. Temporal covariance is also calculated from sorted profiling data into 5-day bins from Jan. 2001 to Dec. 2016, referring spatial covariance estimated above. Based on these temporal and spatial covariance maps, we then estimate decorrelation lengths for time, horizontal and vertical directions every areas.

The temporal and spatial covariance exponentially decrease with distances in all area, which are qualitatively similar to the previous study except for temporal covariance that is the first time to analyze in this study. However, some differences of spatial structures on decorrelation length and signal/noise ratio in the previous study are detected in the spatial covariance of temperature and salinity, especially in the difference between temperature and salinity, surface and deeper layers. These results are obtained because of sorting finer area separation into 25 areas and using long-term Argo float data.

The basic statistical information in this study is estimated based only on the purely observational data

from the global Argo array. Therefore, this information is expected to be useful for not only applications for objective analyses and optimal interpolation mapping but also improvement and validation of data assimilation and numerical simulation models.

Keywords: Decorrelation length of oceanic variability, Argo, Global ocean

Long-term change of the halocline in the global ocean

*小田 正人¹、上野 洋路²、安井 桂¹

*Oda Masato¹, Ueno Hiromichi², Yasui Katsura¹

1. 北海道大学大学院環境科学院、2. 北海道大学大学院水産科学研究院

1. Graduate School of Environmental Science, Hokkaido University, 2. Faculty of Fisheries Sciences Graduate School of Fisheries Sciences, Hokkaido University

Distribution and long-term change of the halocline in the upper layers of the world ocean were investigated via analysis of World Ocean Database 2013 (WOD13) using a simple definition of the halocline. The halocline was observed in the tropics, equatorward subtropical regions, and subpolar regions, but was absent from central subtropical regions. A strong halocline tended to occur in areas where the sea surface salinity (SSS) was low. Long-term change of the halocline was also observed in the world ocean: halocline was strengthened by more than 20% in the last thirty years in the global average. The change was relatively strong in the tropics, equatorward subtropical regions, and subpolar regions and was closely related with long-term change of SSS: the lower the SSS was, the stronger the halocline became. The correlation coefficient between the horizontal distributions of the halocline strength change and SSS change was -0.55 in the area of 60°S-60°N.

キーワード：塩分躍層、長期変動、塩分、全球海洋、World Ocean Database

Keywords: halocline, long-term change, salinity, global ocean, World Ocean Database

Steric sea level variability from the ocean reanalyses intercomparison project in the East Asian marginal seas

*You-Soon Chang¹, Min-Ji Kang¹

1. Kongju National University

Ocean Reanalyses Intercomparison Project (ORA-IP) is successfully coordinated, but most analyses using this product have been limited to the global scale assessments. In this study, regional assessment on steric height variability has been performed focusing on the East Asian marginal seas. Results show that reanalysis ensemble derived from 15-different assimilation systems depicts higher correlation with satellite observations (altimetry-gravimetry) than objective analysis ensemble. Additional results about the long-term variability for the thermosteric and halosteric components of each product will be presented.

Keywords: Ocean Reanalyses Intercomparison Project (ORA-IP), steric height, East Asian marginal seas

Diagnosing formation of the severe drought in SWC during 2009-2010

*Lin Feng¹

1. The First Institute of Oceanography, State Oceanic Administration, China

An extraordinary severe drought hit Southwest China (SWC) from late 2009 to early 2010 and caused enormous losses. The local long-lasting rainfall deficiency which started several months before and the warmer surface air temperature during this period were considered to be the direct meteorological reasons for this disaster. Station observations covering SWC show that there was an almost unbroken rainfall shortage period from May 2009 to March 2010, including two remarkable spells in 2009, May-Jun-July (MJJ) and the boreal autumn (SON). During the first spell, local anomalous descent in the mid-to-low troposphere plays a dominate role to suppress the convection even the water vapor is enough. Diagnosing the vertical motion equation indicates that the local descent is primarily maintained by the anomalous cold temperature advection processes. Both the advection of mean temperature by anomalous wind and the advection of anomalous temperature by mean wind contribute are important. In SON 2009, a quite different situation is proposed that the less than normal northeastward low-level water vapor transport anomaly instead of the descent motions anomaly lead to the rainfall shortage in SWC. Advanced diagnoses illustrate that the low-level water vapor convergence over SWC is significantly less as the transport reduces and the mean water vapor converged by anomalous wind is mainly responsible for this anomaly. Ultimately, the regional circulation anomaly over SWC is controlled by the concurrent El Niño event, which is distinctive and generates an anomalous cyclone centered over the northwest tropical Pacific Ocean.

Keywords: Rainfall , Southwest China, The tropical Pacific

衛星高度計を用いた黒潮/黒潮続流流路の同定方法

Identification of the Kuroshio and its extension paths from satellite altimetric measurements.

*平野 雄也¹、植原 量行¹

*Yuya Hirano¹, Kazuyuki Uehara¹

1. 東海大学大学院海洋学研究科海洋学専攻

1. Tokai University

本州南岸を流れる黒潮には、2つの流路パターンがある。紀伊半島南岸沖で北緯 32 度以南を流れるような大蛇行する流れ（大蛇行流路）と、大蛇行しない流れである。さらに、大蛇行しない流れは、非大蛇行接岸流路と非大蛇行離岸流路に分類される。黒潮の特徴に関しては、川辺 (2003) によって詳細にまとめられている。また、房総半島東方を流れる黒潮続流に関しては、Qiu and Chen(2005) などに記載されている。黒潮続流では常に蛇行が起きており、その変動も激しく、黒潮続流の流路を決定することは容易ではない。ただし、その種の蛇行が一箇所に留ることはほとんどなく、数ヶ月程度の規模しか持たないことが多いが、本州南方の黒潮蛇行は一旦発生すると、ほぼ同じところに数年程度持続するという特徴を持つ。この長期安定性（定常性）が黒潮蛇行を非常に特異なものにしている（西田, 増田, 尹, 1983）。

このように、黒潮と黒潮続流について、それぞれ多くのことがわかってきているが、それらをひと括りにして考えているものはそう多くはない。そこで、今回は流路の変化や特徴を同時に捉えることで、黒潮と黒潮続流について更に理解を深めることを目的とする。黒潮/黒潮続流の流路について研究するためには、まず、黒潮がどこをどのように流れているかという情報が必ず必要となる。今回、黒潮/黒潮続流の流軸の同定を行うにあたり、AVISO の絶対力学海面高度のデータを用いた。時間解像度は 1 日毎、空間解像度は 0.25×0.25 度である。ただし、黒潮続流では中規模渦の影響がとても大きいため、その影響を取り除く必要がある。そこで、本研究では、1 日毎の海面高度データを 3 ヶ月移動平均している。また、海面高度を用いて流軸を同定する方法は、最初にある海面高度（全期間同一の海面高度）を流軸と定義した上で行うことが多い。しかし、海面高度には夏は熱膨張で海面が高くなるという季節変化がある。そのため、ステリック成分を除かなくてはならない。そこで、任意に定めた範囲において、経度方向に対して 0.25 度ごと地衡流の最大値となる座標を求め、その地点の海面高度の平均をその日の流軸と定義した。ここで用いる地衡流は 1 日毎の海面高度から算出した後、3 ヶ月移動平均したものである。これから得られた結果については、シンポジウム当日に発表することにする。

キーワード：黒潮、黒潮続流

Keywords: The Kuroshio, The Kuroshio Extension

三陸沿岸における内部潮汐について

Internal tides along the Sanriku Coast, Japan

*仁科 慧¹、田中 潔¹、柳本 大吾¹、西垣 肇²

*Kei Nishina¹, Kiyoshi Tanaka¹, Daigo Yanagimoto¹, Hajime Nishigaki²

1. 東京大学、2. 大分大学

1. Tokyo University, 2. Oita University

Hydrographic observations made in several bays (e.g. Otsuchi bay, Toni bay) on the Sanriku Coast, Japan, detected that baroclinic circulations extending over the bays intermittently occur (e.g. Okazaki, 1990, 1994; Tanaka et al. 2016). Previous studies suggest that the main source of this baroclinic circulation is the internal tides (Okazaki, 1990, 1994; Otobe et al., 1996, 2009; Ito et al., 1998), however, detailed mechanisms are not clear. In the present study, we perform numerical experiments with a two-dimensional (x-z) nonhydrostatic model (Akitomo et al. 1995) in order to investigate the internal tides along the Sanriku Coast focused on the amplification process of the baroclinic circulation over the bays. Experimental results (Figure 1) indicate that the internal waves enhance the baroclinic circulations over the bays. This internal waves are generated at the shelf break and propagate to the bay mouth.

キーワード：内部潮汐、三陸、陸棚外縁、非静水圧モデル

Keywords: internal tide, Sanriku, shelf-break, nonhydrostatic model

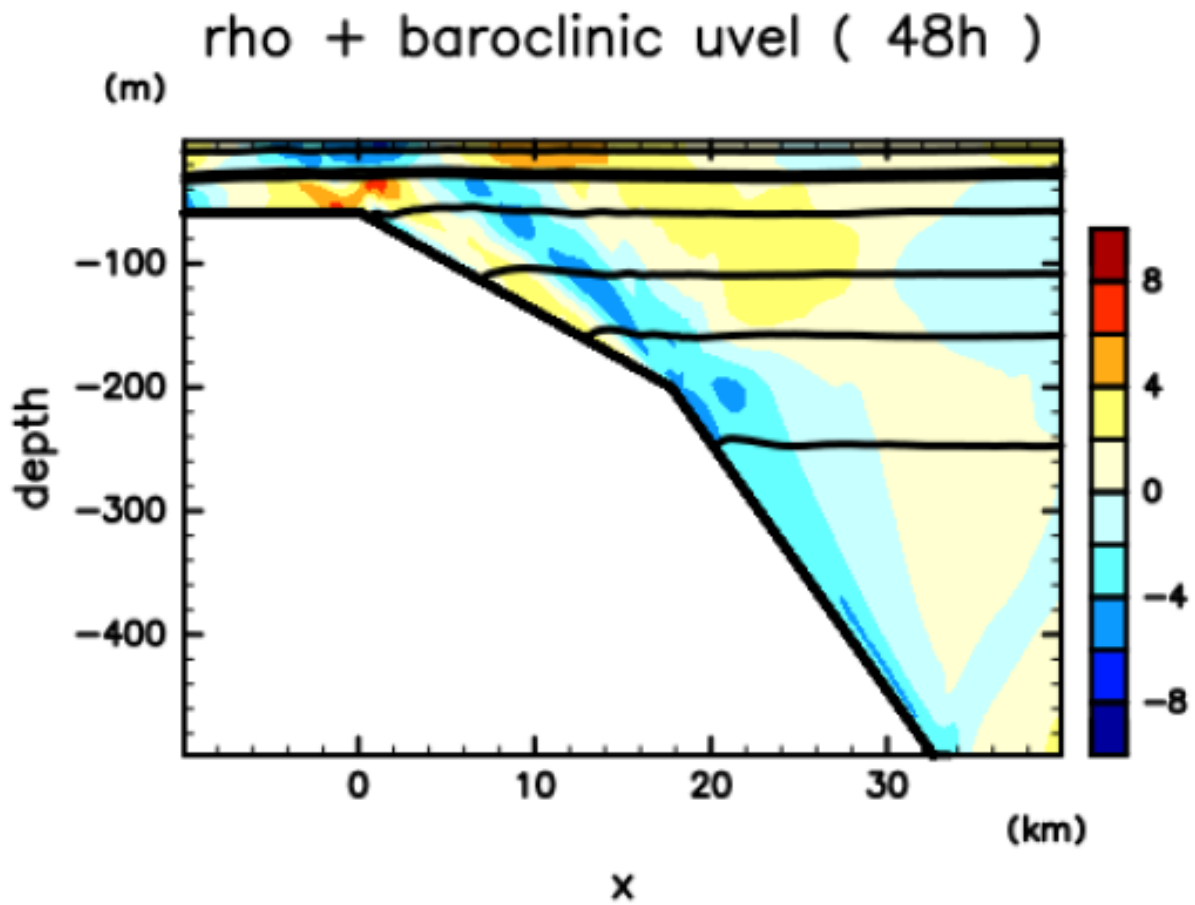


Figure 1. Experimental results of baroclinic cross-shore velocity (color tone, cm/s) and potential density (contour, contour interval 0.5 kg m⁻³)