THE DENSITY CURRENT PATTERNS IN SOUTH-CHINA SEA

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Abstract: *The monthly averaged temperature and salinity fields are treated by the geostrophic calculation formula to obtain the density current patterns in the South-china sea for all months of the year. The current patterns are compared to show the annual changes of the water circulation. Obtained values of water transport through the oceanographic sections across the Bashi and Formos entrances may be served as the data for the boundary conditions for the circulation models of this sea and other calculations and applications as well.*

The first information on the current fields in South-china sea and adjacent waters was presented in [1, 4]. In these reports the current maps of the South-china sea were drawn up based on the observed data that were usually rarely available at the moment they were built. Besides, there exist the current maps only for the surface of the sea. The current patterns of the South-china sea obtained with the application of numerical hydro-dynamical models have the more detail on the structure of circulation of the sea. But the fact that in realization of the numerical models one usually used the proposed boundary conditions because of the lack of the detailed current observations at the open boundaries of the computed domain makes these current maps of restricted accuracy and reliability.

Recently, the number of observed records on physical parameters of the water such as temperature, salinity for the regions of the South-china sea was growing up very fast and the different techniques for the data analysis were applied to obtain the detailed interpolation fields of these parameters for the whole sea [2, 3]. This report presents the results of the geostrophic calculation with the objectively analyzed fields of temperature and salinity of the South-china sea.

Suppose one have two oceanographic stations A and B on the isobars P_1 and P_2 (figure 1). Under the affecting of any external motive the water density on the vertical line AD may become less than that on the vertical line BC. And there will be appear a horizontal gradient of the pressure in direction from A to B and the water particles tend to move in the same direction. However, the Coriolis force will deflect the movement to the right so that the pressure gradient of the direction from A to B will balanced to the Coriolis force affecting in the inverse direction. This will happen when the current direction is perpendicular to the plane of the section from inside towards us.

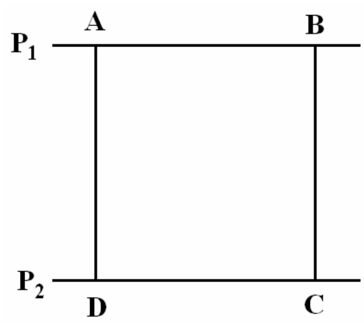


Figure 1. Oceanographic stations scheme

In this stable movement the work of the pressure force and that of Coriolis force on the exclusive line $ABCD$ are equal to each other

$$\oint_{ABCD} \alpha dP = -\oint_{ABCD} 2\omega V \sin\phi dL \,, \qquad (1)$$

where $\omega -$ the Earth rotation speed; $\phi -$ the latitude; $dL -$ the element of the curve $ABCD$; $\alpha -$ the specific volume of the sea water.

From the figure 1 we have

$$\oint_{ABCD} \alpha dP = \alpha_A(P_2 - P_1) - \alpha_B(P_2 - P_1) = D_A - D_B \,, \qquad (2)$$

where $D_A, D_B -$ the dynamical depth of the station A and B respectively, and

$$\oint_{ABCD} 2\omega V \sin\phi dL = 2\omega L \sin(V_1 - V_2) \,, \qquad (3)$$

where $V_1, V_2 -$ the average current velocities on the isobar lines P_1 and P_2 respectively; $L -$ the distance between stations A and B (the integrals along the fragments BC and DA are compensate).

Substitution (2) and (3) into (1) gives the geostrophic formula of the dynamical method for calculation of stable density current

$$V_1 - V_2 = \frac{D_A - D_B}{2\omega L \sin\phi} \,. \qquad (4)$$

The dynamical depth D at the oceanographic station is computed after the specific volume of the sea water due to the formula

$$D = \int_P^{P_0} \alpha dP = \sum_P^{P_0} \alpha \Delta P = \sum_P^{P_0} V_{PST} \cdot 10^{-3} \Delta P + \sum_P^{P_0} 0{,}9 \Delta P \,,$$

where $V_{PTS} -$ the conventional specific volume of the sea water at the temperature T, salinity S and pressure P. When this dynamical depth D is used in formula (4) one can cancel the last constant term and the formula for computing D becomes simple

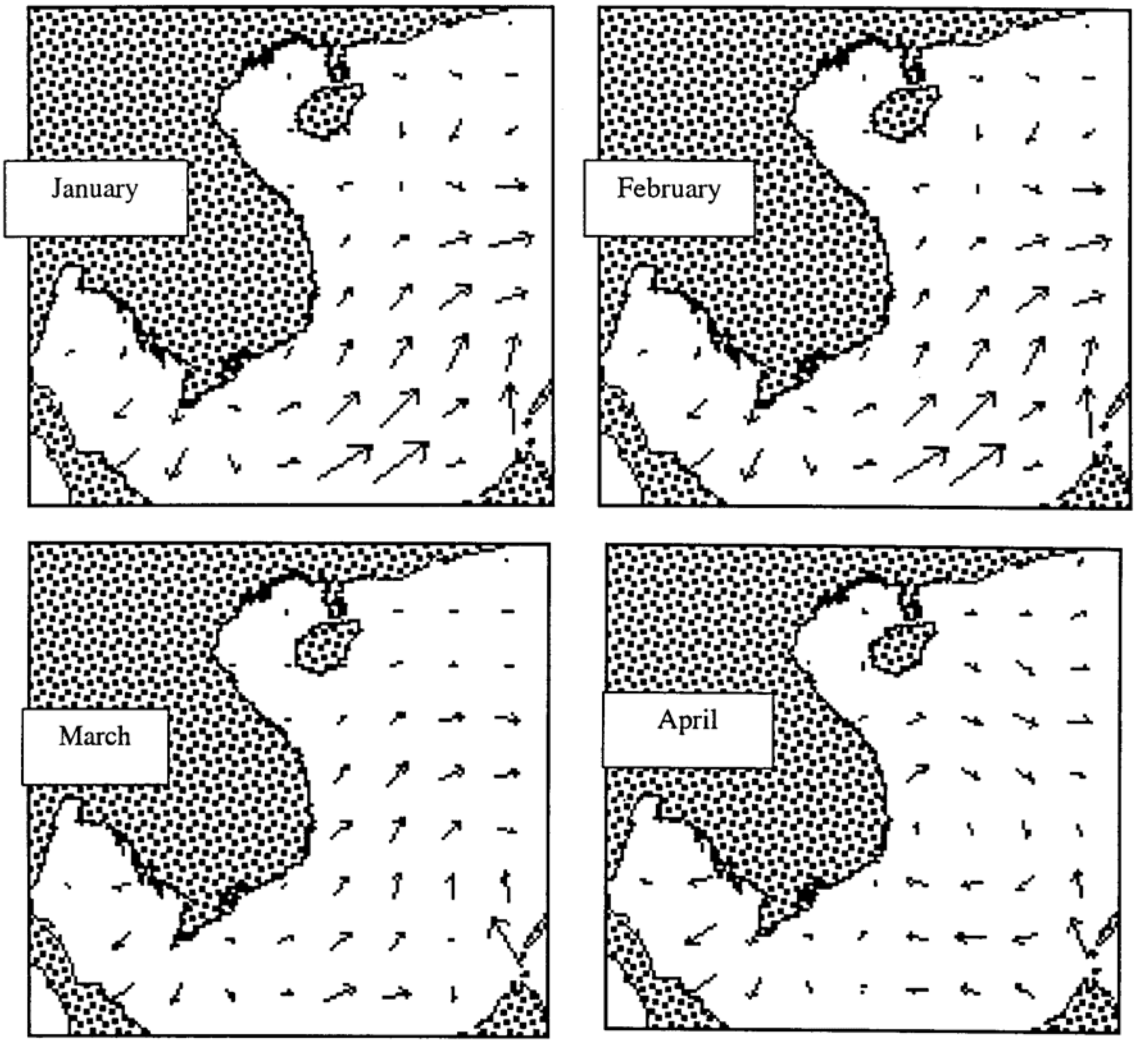
$$D = \sum_P^{P_0} V_{PTS} \cdot 10^{-3} \Delta P \,. \qquad (5)$$

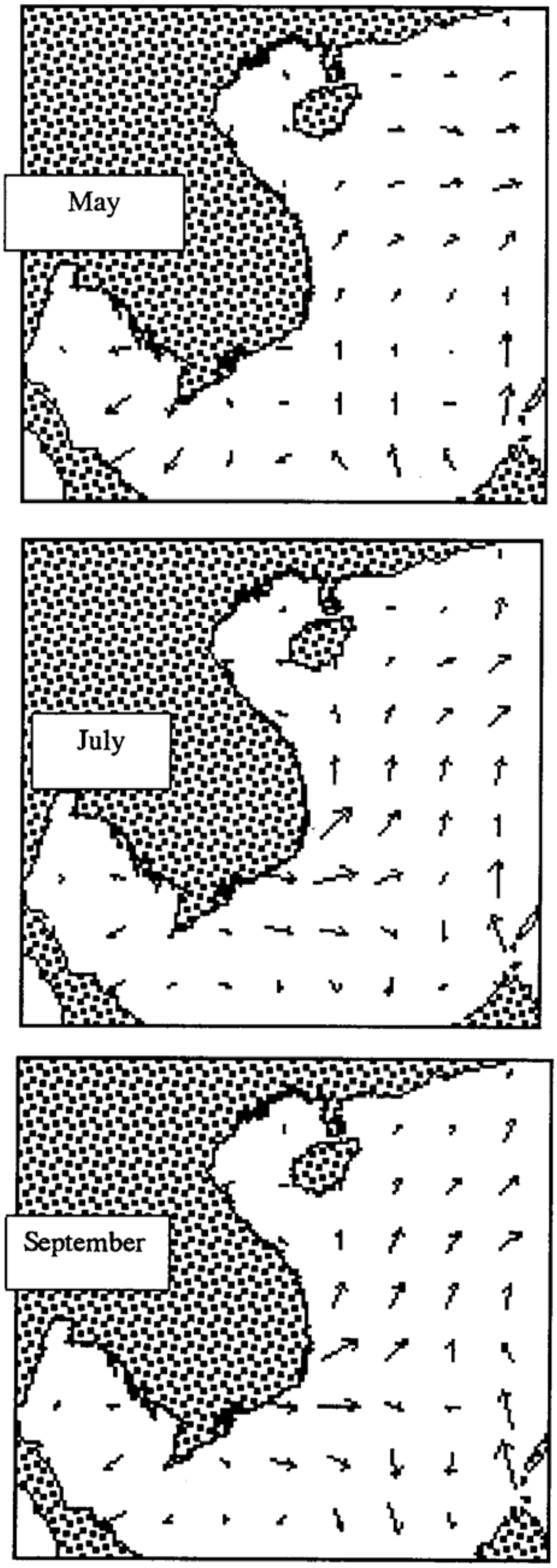
The formula (4) and (5) serve as the main expressions for the treatment of the specific volume field to evaluate the density current field in the sea.

With this purpose we have collected the objectively analyzed data on the monthly averaged temperature and salinity for 17 levels from the surface up to the horizon 1000 m for the whole South-china sea for all months of the year. The specific volume of the sea water was determined due to the Bjerknes expression. The dynamical heights (relatively to the sea bottom) were computed at grid points of the meshes of size 1° longitude and latitude. After that we have evaluated the eastward compound of current velocity at the meridian sides of each mesh and the northward compound – at the parallel sides. The resulting vector of the density current was assigned to the center of the meshes in the sea.

In the practical scheme of calculation the zero velocity (the zero dynamical plane) of the meshes in shallow water was accepted at the sea bed and for all other squares in deep region the velocity at level 1000 m was accepted to be zero.

Thus, we have created 12 monthly averaged density current maps for the year. Figure 2 presents the average density current fields for the surface of the South-china sea for months from January to December respectively.

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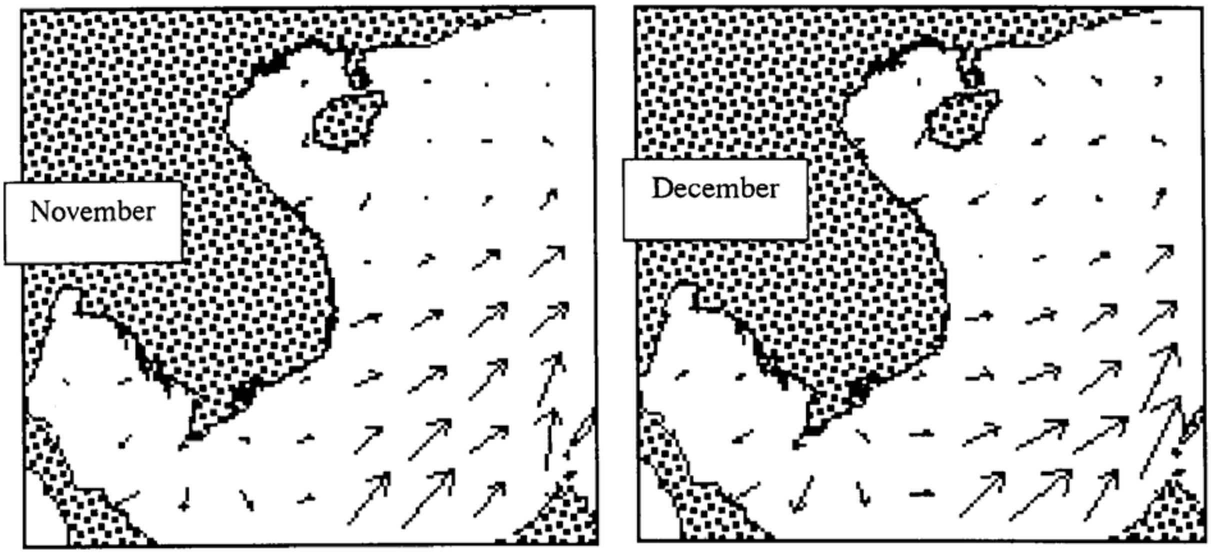

Figure 2. South-china sea density current patterns

The structure of the circulation in northeast entrances (table 1) appears to be complicated. The water from Pacific ocean enters the South-china sea mainly through the Bashi entrance and it exits the sea through the Taiwan strait. The discharge of water through this narrow entrance is small in relation to the Bashi strait.

Table 1. Discharge through Bashi entrance $18^\circ 30' N - 21^\circ 30' N, 121^\circ E$

Month	Bashi entrance (million m^3/s)			Taiwan strait (thousand m^3/s)		
	$19^\circ - 20^\circ$	$20^\circ - 21^\circ$	$21^\circ - 22^\circ$	$117^\circ - 118^\circ$	$118^\circ - 119^\circ$	$119^\circ - 120^\circ$
January	-5.6	-3.2	-3.3	-0.9	-26.1	6.9
March	-4.5	-2.3	-2.6	2.7	-16.6	1616.6
May	-3.8	-2.3	-3.1	6.1	10.7	13.4
July	-3.9	-2.3	-2.5	2.0	5.3	34.9
September	-3.2	-1.3	-1.7	-4.6	9.7	21.8
November	-3.0	-1.5	-2.2	2.0	4.7	9.0

This work is a result of the theme 7.8.11 "The system of currents in the west of South-china sea and its impact on the natural conditions of Vietnam coastal" (Basic Research Program, The Earth Sciences 1999).

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CÁC SƠ ĐỒ DÒNG CHẢY MẬT ĐỘ ỔN ĐỊNH Ở BIỂN ĐÔNG

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