The Range and Standards of Yang Dongfang Temporal Water Temperature Variation Angle II. Model Application

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Abstract: According to the investigation materials about water bodies of Jiaozhou Bay in May, August and October 1979, this paper studied the changing process of water temperature in the surface and bottom waters. Based on the definition and model of Yang Dongfang temporal water temperature variation angle, the results indicated that in the water bodies of inside, around and outside of bay mouth, Viewing the waters inside of bay mouth, around the bay mouth and outside of bay mouth as one water body, the length of variation range of Yang Dongfang temporal water temperature variation angle is 2.98° when heating the surface of this water body, and 0.14° when heating the bottom. The length of variation range of this angle is 6.87° when cooling the surface and 7.28° when cooling the bottom, which displays the changing process of water temperature under the heating or cooling condition.

1. Introduction
Along with the rise of air temperature in spring, the quantity of heat heated by the sun is delivered to the seabed through water bodies. Similarly, along with the decline of air temperature in autumn, the quantity of cold cooled by the wind is delivered to the seabed through water bodies. Therefore, it is important to study the transmission process of heat in water bodies [1-10]. Based on the investigation materials about water temperature in Jiaozhou Bay in May, August and October 1979 and the definition and model of Yang Dongfang temporal water temperature variation angle, this paper exhibited the spatial and temporal changes of the source and transmission quantity of heat and cold energy in water bodies, which provided a scientific basis for the research on vertical and horizontal transmission process in water bodies.

2. Investigation water fields, materials and methods

2.1 Natural environment in Jiaozhou Bay
Jiaozhou Bay is located in the south of Shandong Peninsula, ranging in 120°04’-120°23’E, 35°58’-36°18’N, bounded by Tuan Island and Xuejiao Island, and connecting to the Yellow Sea. With the area of 446km\textsuperscript{2} and average depth of 7m, it is a typical semi-enclosed bay. There are more than 10 rivers flow to the sea, of which the Dagu River, the Yang River, and some rivers in the urban of Qingdao such as Haipo River, Licun River and Loushan River, are the rivers with large runoff and sediment concentration. These rivers are ephemeral streams with obviously seasonal hydrological
2.2 Materials and methods
The investigation materials about the water temperature in the water bodies of Jiaozhou Bay in May, August and October of 1979 applied in this study are offered by the North China Sea Environmental Monitoring Center of State Oceanic Administration. In May, August and October, setting three stations to take water samples from the surface and bottom respectively: H34, H35, H36 (as shown in figure 1). Based on the water depth to take samples:
- Taking from surface and bottom layer, where the depth > 10m;
- Taking from surface layer only, where the depth < 10m.
This investigation method conforms to the national standards, and is recorded in The Specification for Marine Monitoring (1991) [13].

3. Results and Discussions
In May and August, it appears that the surface waters inside of the bay mouth transfer water heat to the marine waters around bay mouth of Jiaozhou Bay and that the waters outside of the bay mouth transfer water heat to the marine waters around bay mouth in October. Along with the changes of time, it is easily to quantify the rise or drop degree of water temperature on the basis of Yang Dongfang temporal water temperature variation angle proposed by the author, no matter the water temperature is rising or declining.

3.1 The rise and drop of water temperature in the waters inside of bay mouth
From May to August, water temperature in the surface rises and Yang Dongfang temporal water temperature angle is 78.69°. When $60^\circ < \alpha_{AB} < 90^\circ$, the angle is Yang Dongfang fast rise angle. At this time, the water temperature in the surface rises rapidly with the change of time. It indicates that the quantity of heat increases fast from May to August as the sun can heat the surface water directly.

From August to October, water temperature in the surface declines and Yang Dongfang temporal water temperature angle is $-77.28^\circ$. When $-90^\circ < \alpha_{AB} < -60^\circ$, the angle is Yang Dongfang fast drop angle. At this time, the water temperature in the surface drops rapidly with the change of time. It indicates that the quantity of heat decreases fast from May to August under the cooling of wind.
From May to August, water temperature in the bottom rises and Yang Dongfang temporal water temperature angle is 75.61°. When 60°<α<90°, the angle is Yang Dongfang fast rise angle. At this time, the water temperature in the bottom rises rapidly with the change of time. It indicates that the quantity of heat rises fast from May to August under the heating of sun.

From August to October, water temperature in the bottom declines and Yang Dongfang temporal water temperature angle is -71.27°. When -90°<α<-60°, the angle is Yang Dongfang fast drop angle. At this time, the water temperature in the bottom drops rapidly with the change of time. It indicates that the quantity of heat decreases fast from August to October under the cooling of wind.

3.2 The rise and drop of water temperature in the waters around bay mouth
From May to August, water temperature in the surface rises and Yang Dongfang temporal water temperature angle is 78.84°. When 60°<α<90°, the angle is Yang Dongfang fast rise angle. At this time, the water temperature in the surface rises rapidly with the change of time. It indicates that the quantity of heat increases fast from May to August under the heating of sun.

From August to October, water temperature in the surface declines and Yang Dongfang temporal water temperature angle is -77.22°. When -90°<α<-60°, the angle is Yang Dongfang fast drop angle. At this time, the water temperature in the surface drops rapidly with the change of time. It indicates that the quantity of heat decreases fast from May to August under the cooling of wind.

From May to August, water temperature in the bottom rises and Yang Dongfang temporal water temperature angle is 75.61°. When 60°<α<90°, the angle is Yang Dongfang fast rise angle. At this time, the water temperature in the bottom rises rapidly with the change of time. It indicates that the quantity of heat rises fast from May to August under the cooling of wind.

From August to October, water temperature in the bottom declines and Yang Dongfang temporal water temperature angle is -68.66°. When -90°<α<-60°, the angle is Yang Dongfang fast drop angle. At this time, the water temperature in the bottom drops rapidly with the change of time. It indicates that the quantity of heat decreases fast from August to October under the cooling of wind.

3.3 The rise and drop of water temperature in the waters outside of bay mouth
From May to August, water temperature in the surface rises and Yang Dongfang temporal water temperature angle is 75.86°. When 60°<α<90°, the angle is Yang Dongfang fast rise angle. At this time, the water temperature in the surface rises rapidly with the change of time. It indicates that the quantity of heat increases fast from May to August under the heating of sun.

From August to October, water temperature in the surface declines and Yang Dongfang temporal water temperature angle is -70.41°. When -90°<α<-60°, the angle is Yang Dongfang fast drop angle. At this time, the water temperature in the surface drops rapidly with the change of time. It indicates that the quantity of heat decreases fast from May to August under the cooling of wind.

From May to August, water temperature in the bottom rises and Yang Dongfang temporal water temperature angle is 75.47°. When 60°<α<90°, the angle is Yang Dongfang fast rise angle. At this time, the water temperature in the bottom rises rapidly with the change of time. It indicates that the quantity of heat rises fast from May to August under the cooling of wind.

From August to October, water temperature in the bottom declines and Yang Dongfang temporal water temperature angle is -63.99°. When -90°<α<-60°, the angle is Yang Dongfang fast drop angle. At this time, the water temperature in the bottom drops rapidly with the change of time. It indicates that the quantity of heat decreases fast from August to October under the cooling of wind.

3.4 The rise of water temperature from May to August
From May to August, the water temperature in the surface waters inside, around and outside of bay mouth rises and the corresponding Yang Dongfang temporal water temperature variation ranges in 75.86-78.84°, which belongs to Yang Dongfang fast rise angle. In this period, the water temperature in the surface rises fast over time. Meanwhile, the water temperature in the bottom also rises rapidly, and the Yang Dongfang temporal water temperature variation angle ranges within 75.47-75.61°, which is a
Yang Dongfang temporal water temperature variation angle too. The water temperature in the bottom rises fast as the time changes.

The range of Yang Dongfang temporal water temperature variation angle in the surface layer is greater than the range in the bottom, which indicates that the water temperature rises much faster in the surface than in the bottom. The range interval of the water temperature variation angle in the surface is 2.98° while 0.14° in the bottom, which indicates that the rising degree of water temperature in the surface layer is greater than it in the bottom layer. That is, the differences of rising degree of water temperature in the surface waters inside, around and outside of bay mouth is greater than it in the bottom waters. It reveals that the rising degree of water temperature is different in the surface waters when the sun heat different water areas at the same time. However, when the heat is delivered to the bottom waters through the water bodies, the water temperature rising degree is consistent in the bottom.

3.5 The drop of water temperature from August to October
From August to October, the water temperature in the surface waters inside, around and outside of bay mouth drops and the corresponding Yang Dongfang temporal water temperature variation ranges in -70.41° to -77.28°, which belongs to Yang Dongfang fast drop angle. In this period, the water temperature in the surface drops fast over time. Meanwhile, the water temperature in the bottom also drops rapidly, and the Yang Dongfang temporal water temperature variation angle ranges within -63.99° to -71.27°, which is a Yang Dongfang temporal water temperature variation angle too. The water temperature in the bottom drops fast as the time changes.

The range of Yang Dongfang temporal water temperature variation angle in the surface layer is greater than the range in the bottom, which indicates that the water temperature drops much faster in the surface than in the bottom. The range interval of the water temperature variation angle in the surface is 6.87° while 7.28° in the bottom, which indicates that the drop degree of water temperature in the surface layer is smaller than it in the bottom layer. That is, the differences of drop degree of water temperature in the surface waters inside, around and outside of bay mouth is smaller than it in the bottom waters. It reveals that the drop degree of water temperature is different in the surface waters when the wind cools different water areas at the same time. However, when the cold energy is delivered to the bottom waters through the water bodies, the changing degree of water temperature is much great in the bottom.

3.6 Water temperature variation process in water bodies
When heating or cooling the surface of water bodies, water temperature will rise or decline. Through the effect of vertical water bodies, the eddy turbulence in the vertical direction will result in the heat exchange between surface and bottom waters, which will lead to the rise or decline of the water temperature in the bottom.

When heating the surface of a water body, the variation interval of Yang Dongfang temporal water temperature variation angle is 2.98° in the surface layer, while it is 0.14° in the bottom. It shows that the changing degree of the rising of water temperature in the surface is greater than it in the bottom. In the surface, the sun heats various water bodies at the same time while the rising degree of water temperature is relatively small. In the bottom, heat is delivered to the bottom through water bodies so the rising degree of water temperature is much smaller than it in the surface.

When cooling the surface of a water body, the variation interval of Yang Dongfang temporal water temperature variation angle is 6.87° in the surface layer, while it is 7.28° in the bottom. It shows that the drop degree of water temperature in the surface is smaller than it in the bottom. In the surface, the wind cools various water bodies at the same time where the drop degree of water temperature is relatively large. In the bottom, the cooling energy is delivered to the bottom through water bodies where the drop of water temperature is much greater than it in the surface.
4. Conclusion
Taking time as x-axis, and the water temperature as y-axis, getting the calculation results based on the definition and model of Yang Dongfang temporal water temperature variation angle as follows:

Viewing the water bodies inside of bay mouth, around the bay mouth and outside of bay mouth as a whole, when heating the water, the range interval of the Yang Dongfang temporal water temperature variation angle in the surface is 2.98° while 0.14° in the bottom. When cooling the water, the range interval of the Yang Dongfang temporal water temperature variation angle in the surface is 6.87° while 7.28° in the bottom, which displays the changing process of water temperature in water bodies.

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