Quantitative Hg Content Migration Process II. Yang Dongfang Migration Model Application

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Abstract: Based on the investigation data of Jiaozhou Bay in May, August and October, 1992, the migration process of Hg content that came from atmospheric subsidence in Jiaozhou Bay was studied. In August, the central point 2016 in the east of Jiaozhou Bay was taken as the source of atmospheric subsidence, with the Hg content of 0.050 μg/L. According to the absolutely and relatively horizontal loss rate model of matter content, the results showed the facts: A series of concentric circles with different gradients have been formed with station 2016 as the center. Taking the central station 2016 in the east of Jiaozhou Bay as the source of atmospheric subsidence, the Hg content decreased towards surrounding waters. The absolutely horizontal loss rate value of Hg content was between 0.19-0.63 Yang Dongfang absolute number, and the relatively horizontal loss rate value of Hg content was between 3.80-12.60 Yang Dongfang relative number. The sequence of Hg content from low to high was: the central water area of the bay < the northeast water area of the bay < the southeast water area of the bay < the northwest water area of the bay, and the sequence of Hg content absolutely horizontal (relatively) loss rate value from low to high was: the northwest water area of the bay < the central water area of the bay < the northeast water area of the bay < the southeast water area of the bay. The Hg content showed the starting point value of the source point, the end point value of the water area. And the absolutely (relatively) horizontal loss rate value of the Hg content showed the migration process value of the water area from the starting point to the end point. This revealed that the starting point, end point and process value of Hg content showed the migration process of Hg content in water. According to the Yang Dongfang horizontal loss rate model of substance content, the migration and change process of Hg content decreasing along the gradients to surrounding waters could be calculated and quantified.

1. Introduction
The mercury (Hg) content discharged by human to the atmosphere, under the effect of the atmospheric settlement, entered the ocean. The Hg content from atmospheric settlement was relatively high, but the time of atmospheric settlement was relatively short. The Hg content took the offshore source point as the center, forming a high Hg content area, which would diffuse to the surrounding areas and decrease [1-14]. So, the migration and change process of Hg content decreasing along the gradients to the around areas in Jiaozhou Bay can be quantitatively studied to determine the source and pollution degree of Hg in Jiaozhou Bay.
2. Investigation Waters and Methods

2.1 Jiaozhou Bay Environments

Jiaozhou Bay is a typical semi closed Bay with 120°04′ - 120°23′E, 35°58′ - 36°18′N, between Tuan island and Xuejia island, covering an area of about 446km², with an average water depth of about 7m. Around Jiaozhou bay, Dagu River, Yang River and Haibo River, Licun River and Loushan River, the horological characteristics of which can alter in different seasons [15, 16].

2.2 Materials and Methods

The North Sea Monitoring Center of the State Oceanic Administration showed the survey data on Hg in Jiaozhou Bay in May, August and October 1992. At 13 stations in Jiaozhou Bay taken were water samples: 52, 53, 54, 55 56, 57, 58, 59, 60, 61, 2104, 2105 and 2106 stations (Figure 1). The samples were taken in May, August and October, 1992 respectively. The Hg content in Jiaozhou Bay water body had been got with the national standard method being included in the Specification for Marine Monitoring (1991) [17].

3. Results and Discussions

3.1 Horizontal Content Change of the Same Source

In August, the central station 2016 in the east of Jiaozhou Bay was taken as the source of atmospheric subsidence, with the Hg content of 0.050 μg/L. A series of concentric circles with different gradients have been formed with station 2016 as the center. The Hg content decreased from 0.050 μg/L in the center to 0.021 μg/L in the center of the Bay, 0.037 μg/L in the northwest, 0.031 μg/L in the northeast and 0.033 μg/L in the southeast of the Bay (Figure 2).

According to the absolutely horizontal loss rate model of matter content, it was calculated (Table 1). In August, in the east of Jiaozhou Bay, from the central water area in the east to the central water area in the Bay, the absolutely loss rate value of Hg content in surface was 0.40 Yang Dongfang absolute number. In the northwest water area of the Bay, the absolutely horizontal loss ratio of Hg content in the surface was 0.19 Yang Dongfang absolute number. In the northeast water area of the bay, the absolutely horizontal loss rate of Hg content in the surface was 0.45 Yang Dongfang absolute number. In the southeast water area of the Bay, the absolutely horizontal loss rate of Hg content in the surface was 0.63 Yang Dongfang absolute number. Therefore, taking the eastern central station 2016 of Jiaozhou Bay as the source of atmospheric subsidence, the Hg content decreased to surrounding
waters, and the absolutely horizontal loss rate of the Hg content was 0.19-0.63 Yang Dongfang absolute number.

![Fig.2 Hg content distribution at the surface in Jiaozhou Bay in August(μg/L)](image)

According to the relatively horizontal loss rate model of matter content, it was calculated (Table 1). In August, in the east of Jiaozhou Bay, from the central water area in the east to the central water area of the Bay, the relatively horizontal loss rate of Hg content in the surface was 8.00 Yang Dongfang relative number. To the northwest waters of the Bay, the relatively horizontal loss rate of Hg content in the surface was 3.80 Yang Dongfang relative number. To the Northeast waters of the Bay, the relatively horizontal loss rate of Hg content in the surface was 9.00 Yang Dongfang relative number. In the southeast of the Bay, the relatively horizontal loss rate of Hg content in the surface was 12.60 Yang Dongfang relative number. Therefore, taking the eastern central station 2016 of Jiaozhou Bay as the source of atmospheric subsidence, the Hg content decreased towards the surrounding waters, and the relatively horizontal loss rate of the Hg content was 3.80-12.60 Yang Dongfang relative number.

| Time                  | August  | August  | August  | August  |
|-----------------------|---------|---------|---------|---------|
| In the eastern central waters | From 2016 to 55 | From 2016 to 57 | From 2016 to 2015 | From 2016 to 59 |
| Distance to all directions | 7075.05 | 6803.93 | 4154.61 | 2686.07 |
| Variation range of Hg content | 0.021-0.050 | 0.037-0.050 | 0.031-0.050 | 0.033-0.050 |
| Absolutely horizontal loss rate value of Hg content | 0.40 | 0.19 | 0.45 | 0.63 |
| Relatively horizontal loss rate value of Hg content | 8.00 | 3.80 | 9.00 | 12.60 |
| Calculation value characteristics of Hg content | Same time, same source, different distances |

3.2 Calculated value characteristics of the same source

With the same time, the same starting point and different ending point, the Hg content at the starting point was the same, and the absolute loss per unit distance is different. In August, in the east of Jiaozhou Bay, the Hg content decreased from 0.050 μg/L in the central water area of the east to 0.021 μg/L in the central water area of the Bay, 0.037 μg/L in the northwest water area of the Bay, 0.031 μg/L in the northeast water area of the Bay and 0.033 μg/L in the southeast water area of the bay.
Therefore, the sequence of decreasing Hg content from low to high was: the central water area < the northeast water area < the southeast water area < the northwest water area. According to the model of the absolutely horizontal loss rate of the matter content, the order of the absolutely horizontal loss rate of the Hg content from low to high was: the water area in the northwest of the Bay < the water area in the center of the Bay < the water area in the northeast of the Bay < the water area in the southeast of the bay. According to the model of relatively horizontal loss rate of matter content, the order of the value of relatively horizontal loss rate of Hg content was: the northwest water area < the central water area < the northeast water area < the southeast water area of the bay.

The order of the absolutely horizontal loss rate of Hg content and the relatively horizontal loss rate of Hg content is the same. This order is inconsistent with the order of Hg content decreasing from 0.050 μg/L of high content in the center to the surrounding waters along the gradients. This showed that the loss value of Hg content in the process of migration was different from the value at the end. Therefore, a series of concentric circles with different gradients are formed with the Eastern Center of Jiaozhou Bay as the source of atmospheric subsidence. The order of Hg content from low to high was not consistent with the order of absolutely and relatively horizontal loss rate value of Hg content from low to high. This revealed that the terminal value and process value of Hg content show different characteristics of Hg content migration in waters.

3.3 Quantitative migration process

According to the absolutely and relatively horizontal loss rate model of matter content, the absolutely and relatively horizontal loss rate value of matter content was determined, which showed the migration process value of matter content through waters. Therefore, the author put forward the quantitative change of matter content in the whole migration process: from the starting point of water area to the end point of water area, as well as the migration process through the water area. In this way, the whole migration process of Hg content can be displayed quantitatively.

A series of concentric circles with different gradients were formed with the Eastern Center of Jiaozhou Bay as the source point of atmospheric subsidence. Then, the Hg content decreased from 0.021 μg/L to 0.050 μg/L in the central water area, northwest water area, northeast water area and southeast water area of the bay. According to the Yang Dongfang’s horizontal loss rate model of substance content, the calculation results showed that the change range of the absolutely horizontal loss rate value of Hg content was 0.19-0.63 ydfr, and the change range of the relatively horizontal loss rate value of Hg content was 3.80-12.60 ydfr. In this way, the Hg content showed the value from the same point of atmospheric deposition to the end point of this water area, and the absolutely and relatively horizontal loss rate value of Hg content showed the process value from the same point of atmospheric deposition to this water area. Therefore, according to the Yang Dongfang’s horizontal loss rate model of matter content, we can calculate and quantify the migration and change process of Hg content decreasing along the gradients to surrounding waters.

4. Conclusions

In August, the central station 2016 in the east of Jiaozhou Bay was taken as the source of atmospheric subsidence, with the Hg content of 0.050 μg/L. A series of concentric circles with different gradients have been formed with 2016 station as the center. The Hg content decreased from 0.050 μg/L in the center to 0.021 μg/L in the center of the Bay, 0.037 μg/L in the northwest, 0.031 μg/L in the northeast and 0.033 μg/L in the southeast of the bay.

According to the absolutely and relatively horizontal loss rate model of matter content, the results showed the facts: A series of concentric circles with different gradients were formed with the Eastern Center of Jiaozhou Bay as the source of atmospheric subsidence 0.050. Then, it decreased along the gradients, to the central water area, northwest water area, northeast water area and southeast water area of the bay. The sequence of Hg content from low to high was: the central water area < northeast water area < southeast water area < northwest water area of the Bay. The sequence absolutely(relatively) loss rate value of Hg content from low to high was: the northwest water area < northeast water area <
southeast water area of the bay. The Hg content showed the starting point value of the source point to the end point value of the water area, and the absolutely horizontal loss rate value of the Hg content showed the migration process value of the water area from the starting point to the end point. This revealed that the values at starting point, end point and process of Hg content showed the migration process of Hg content in water.

According to the Yang Dongfang's horizontal loss rate model of substance content, the migration and change process of Hg content decreasing along the gradients to surrounding waters can be calculated and quantified. Through the Yang Dong's horizontal loss rate model of matter content, the absolutely and relatively horizontal loss rate value of matter content can be calculated. Then, by using the Yang Dong's horizontal loss rate model of matter content, the absolute (relatively) horizontal loss rate value of matter content and the water from the source point, the matter content of the water area could be calculated.

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