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Inversion and prediction of ocean resource flow

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ABSTRACT. *Drastic changes in ocean temperatures have severely impacted the economies of fisheries around the world, forcing them to make changes. In order to solve these problems, we firstly conduct spatial uniform sampling of the Scottish sea area, simulate the whole sea area with sample points, and conduct inversion and accurate prediction of SST, salt content and chlorophyll concentration, so as to find the dynamic relationship among the three, reflecting the evolution of Marine resource flow. In order to determine the potential factors of the difference, we constructed a spatial field distribution model, visualized the spatial distribution by kriging interpolation, and found out the geographical direction of the three.*

KEYWORDS: *Inversion, potential factors*

1. Introduction

Oceans make up 71 percent of the earth's surface, and 84 percent of them are more than 2,000 meters deep. As greenhouse gas levels increase, more and more heat enters the earth's system, with about 90 percent going into and stored in the oceans. And so, changes in the temperature of the world's oceans call for urgent solutions. A warming of the world's oceans could destroy the habitats of some sea creatures, leading to more extreme weather events. When ocean temperatures change so much that they threaten the continued survival of populations in the area, they continue to migrate to habitats more suitable for their current and future life and reproductive success. Companies that depend on the stability of Marine life will be severely affected by this geographic shift.

The American lobster industry has faced similar problems. In 1980-90, only 50 percent of the lobsters caught in the United States came from Maine. In the next decade, that figure has risen to 85 percent. But because of the sharp rise in ocean temperatures and the effects of climate change and so on. Lobsters are moving out of their traditional habitats and into cooler northern waters, known as Canadian waters. Because of the migration of this population, the area of American lobster fishing will gradually decrease, and fishermen will bear higher risks.

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Mackerel and herring make an important economic contribution to the Scottish fishing industry. The problems facing Scotland's fishing industry will be more complex than those facing the us lobster industry because of rising ocean temperatures, global warming and Brexit.

2. Fish habitat prediction model

2.1 Fish quality of life indicators

2.1.1 Determination of SST and dissolved salt content

Herring and mackerel are found in much of the north Atlantic basin offshore and on the high seas, and even herring are migrating north and south across the Atlantic. According to Hook, Line and Sinker, sea temperatures and dissolved salt content in the north Atlantic vary greatly with the seasons, depending on the migration and spatial distribution of pelagic fish (such as herring) and migratory fish (such as mackerel).

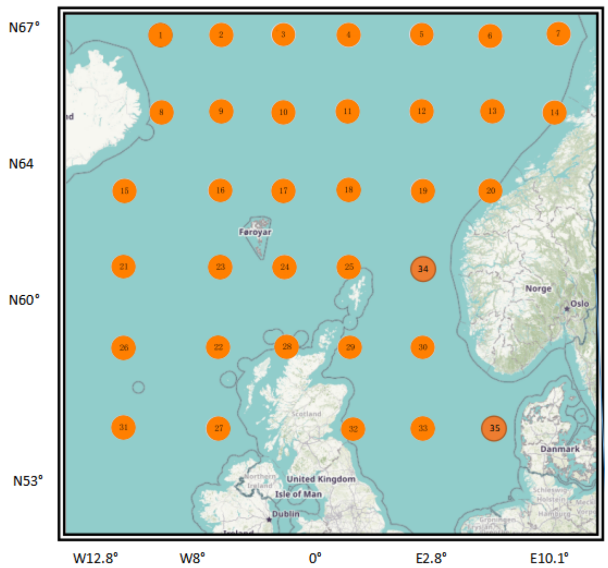

Figure 1

We consider that the radiation energy received by the offshore infrared sensor is a combination of the amount of radiation reflected by the surface and the amount of radiation emitted by the skin layer of the sea surface, which makes the measurement of SST easier. Therefore, based on the *MODIS* SST measurement algorithm proposed by *Kohtaro Hosoda* et al., we propose an inversion algorithm model using multiple groups of sample points.

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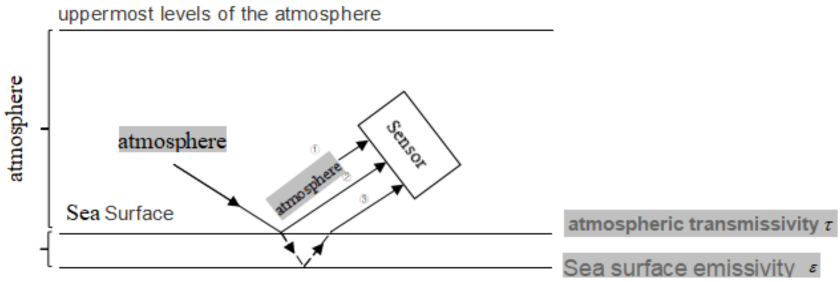

Figure 2

2.1.2 Determination of ocean temperature data -- based on Split Window Algorithm model

We choose two different channels in the MODIS data of thermal radiation data (31 and 32 channels) is used to remove atmospheric influence on measurement, for assuming that water is a bold and than emissivity known, again by using NOAA satellite AVHRR sensor data we can easily get the adjacent two thermal channel (31 and 32 channels) radiation brightness $B_{31}(T)$ and $B_{32}(T)$, a linear combination of the temperature T to eliminate the influence of atmospheric radiation.

$$B_{31}(T) = \tau_{31}\varepsilon_{31}B_{31}(T_s) + (1-\tau_{31})[1+\tau_{31}(1-\varepsilon_{31})]B_{31}(T_a)$$

$$B_{32}(T) = \tau_{32}\varepsilon_{32}B_{32}(T_s) + (1-\tau_{32})[1+\tau_{32}(1-\varepsilon_{32})]B_{32}(T_a)$$

Because we can think of the ocean as a black body, by Planck's black body radiation formula

$$B(T) = \frac{2\hbar c^2}{\lambda^5(e^{\frac{c\hbar}{\lambda KT}-1})}$$

The radiation brightness $B_{31}(T)$ and $B_{32}(T)$ the central wavelength λ of the channel are substituted according to the Planck blackbody radiation formula.

$$\lambda = \sqrt[5]{\frac{2\hbar c^2}{B(T)(e^{\frac{c\hbar}{\lambda KT}-1}})}$$

λ is band center wavelength, because the sea surface temperature is lower and the Planck blackbody law of calculation of temperature dependence is bigger, based on the temperature of 260-300 k (namely - 10-20 ˚ C), choose MODIS, 31 and 32 of thermal infrared band center wavelength, namely 11.03 μm (band31) and 12.02

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μm (band32), calculated from Planck blackbody's law of MODIS thermal infrared band of the corresponding temperature and blackbody radiation diagram 3-1 to 31, 32 band center wavelength of radiation temperature and its value, the relationship between

Figure 3 shows the linear simplified Planck equation corresponding to the central wavelength of MODIS thermal infrared band. The fitting accuracy is good, and the determination coefficient is above 0.99.

Table 1

Table 1 Linear Simplified Planck Equation for the Center Wavelength of the MODIS Thermal Infrared Band

Band	Liner equation	R^2
Band 31	$B_{31}(T) = -64.60363T + 20.37838;$	0.9998
Bang 32	$B_{32} = -68.72575T + 0.473453;$	0.9997

Split window algorithm proposed by *Min* based on the 31st and 32th bands of MODIS data:

$$T_s = A_0 + A_1T_{31} + A_2T_{32}$$

Where, T_a is SST (K), T_{31} and T_{32} are the radiation brightness temperatures at bands 31 and 32 of MODIS data respectively, A_0、A_1、A_2 is the parameters of the split window algorithm, defined as follows:

$$A_0 \quad = [\frac{D_{32}(1 - C_{31} - D_{31}}{D_{32}C_{31} - D_{31}C_{32}})]a_{31} - [\frac{D_{31}(1 - C_{32} - D_{32}}{D_{32}C_{31} - D_{31}C_{32}}]a_{32}$$

$$A_1 = [1 + \frac{D_{31}}{D_{32}C_{31} - D_{31}C_{32}} + [\frac{D_{32}(1 - C_{31} - D_{31}}{D_{32}C_{31} - D_{31}C_{32}}]b_{31}$$

$$A_2 = \frac{D31}{D_{32}C_{31} - D_{31}C_{32}} + [\frac{D_{31}(1 - C_{32} - D_{32}}{D_{32}C_{31} - D_{31}C_{32}}]b_{32}$$

The intermediate parameter in the formula:

$$C_i = \tau_i(\theta)\varepsilon_i, D_i = (1 - \varepsilon_i)[1 + (1 - \varepsilon_{31})\tau_i]$$

Where, i refers to bands 31 and 32 of MODIS, $\tau_i(\theta)$ is the atmospheric transmittance from the Angle of the ith wave.$\varepsilon_i$is the SST emissivity of the ith wave. According to the wave characteristics of MODIS, SST fluctuates within a certain range, a_i, b_i changed with it.

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2.1.3 Dissolved salt content and chlorophyll concentration

Similar to the sea surface temperature inversion model, the extraction of salt content and chlorophyll concentration by SST is still affected by the atmosphere, and the data obtained are ocean surface data. By analyzing the relationship between the light temperature, the relative permittivity of seawater and the ocean surface salinity, the surface salinity can be inversely expressed by the light temperature, namely:

$$S = F^{-1}(T_{bp}, f, \theta, T)$$

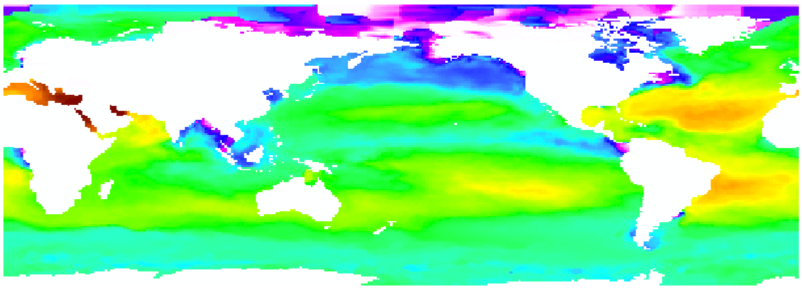

Figure 3

We used comparative experiments to analyze the extraction results of three different inversion models on the chlorophyll concentration of the sea surface, and found that the regression model of the three models was of high precision, followed by the two-band ratio model, and the NDVI exponential model was of low precision.

$$R_2/R_1, (R_2 - R_1)/(R_2 + R_1)$$

is the reflectance of two bands.

We used a second model to extract chlorophyll concentrations from the ocean surface.

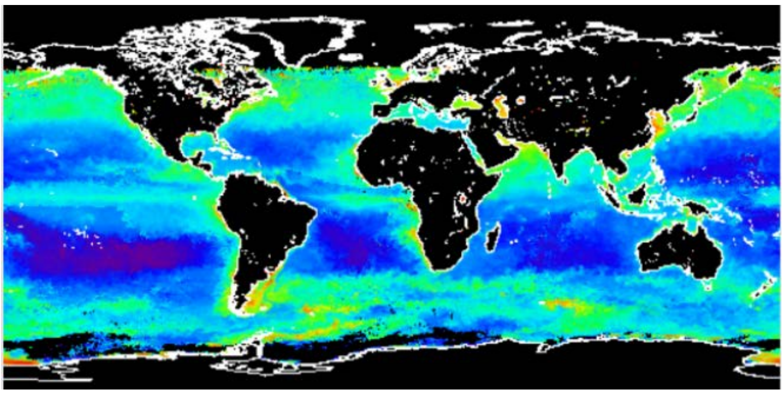

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Figure 4

3. Short note in *Hook Line and Sinker magazine*

He global greenhouse effect is becoming more and more obvious, and the Marine ecological environment is also closely related to the temperature. Therefore, the change of global ocean temperature is a problem we must face squarely. The warming of the ocean will cause a series of impacts, such as habitat destruction of organisms, changes in ocean currents, the occurrence of various rare extreme weather, the rise of sea level and the imbalance of sea water quality, etc. In particular, it will cause a great degree of industrial impact on the fishing industry of coastal countries. When ocean temperatures change so much that they threaten the continued survival of populations in the area, they continue to migrate to habitats more suitable for their current and future life and reproductive success. In this way, many fishing companies will be damaged by a series of fishery chains caused by population transfer.

In 1980-90, only 50 percent of the lobsters caught in the United States came from Maine. In the next decade, that figure has risen to 85 percent. But because of the sharp rise in ocean temperatures and the effects of climate change and so on. Lobsters are moving out of their traditional habitats and into cooler northern waters, known as Canadian waters. Because of the migration of this population, the area of American lobster fishing has been gradually reduced, and fishermen have been forced to bear the high risk of capital chain rupture.

4. Strength and Weakness

This model uses analytic hierarchy process and particle swarm algorithm as tools, with fewer calculation steps. The acquisition of data is relatively simple, and the inherent disadvantage is that the determination of weights is subjective, which will have a certain impact on the results obtained.This model uses the method of joint equations to build the model. The advantage is that its analysis process is simple and easy to understand. It has strong practicability for different schemes, but it requires more data and lacks flexibility.

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