Метод анализа глубины верхнего перемешанного слоя RBF нервной сетью

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Аннотация: *глубина верхнего перемешанного слоя имеет большое значение при анализе вертикальной структуры температуры морской воды и в ее моделировании.*

В статье с помощью данных SST и ветров в акватории, проведенного по регулярной сетке станций, дан результат исследования глубины верхнего перемешанного слоя RBF нервной сетью.

Следовательно, можно использовать RBF нервную сеть в анализе глубины верхнего перемешанного слоя, которая является важным параметром в моделировании вертикальной структуры температуры морской воды.

Abstract: *the depth of homogeneous layer is of an important signification in modeling and analyzing vertical structure of water temperature.*

This paper deals with the result of studying to analyze the depth of homogeneous layer with RBF neural network by using the data of SST and wind in the zone of water where the regular section observed data of water temperature is not observed.

Thus, we can use the model of RBF neural network to analyze the depth of homogeneous layer-the important parameter for modeling vertical structure of water temperature.

Ключевые слова: *глубина верхнего перемешанного слоя, вертикальная структура температуры морской воды, RBF нервная сеть.*

Keywords: *depth of homogeneous layer; vertical structure of water temperature; RBF neural network.*

Vertical structure of water temperature is of a great significance in analyzing of fishing ground and using of submarine acoustic tools and navigation instruments.

The parametric model which is considering about characters of vertical distribution of water temperature in model for analyzing the vertical structure of water temperature is widelused [2].

Here one of the most important parameters is the depth of homogeneous layer.

We studied for estimating of the depth of homogeneous layer by RBF neural network.

RBF neural network consist of input, neutral and output layer, every layer has respectively N, M, L of neural cells.

In RBF neural network, input layer signal is sent to neutral layer after non-liner conversion by basis function, in neutral layer output signal is sent by liner conversion.

Here, basis function is very important, typically is Gauss function [1].

$$G(\| x - w_j \|) = \exp(-\frac{\| x - w_j \|^2}{\sigma^2}) = \exp\left(-\frac{\sum (x_i - w_{ji})^2}{\sigma^2}\right)$$

Here, x :input vector, w_j :joint weight vector, σ : parameter of Gauss function type.

Now for user, in Matlab RBF neural network easily can be used as standard type.

Using RBF neural network which is super in approximate capacity, fractionation capacity and study velocity etc, we made up analysis model of the depth of homogeneous layer from the data of water temperature and wind on the sea surface.

In the input and output parameter, analysis data of three-dimensional water temperature and wind in every month during several years what is observed in 30years, standard layer, 10 n-mile interval at Korean east sea, also section data of sea water temperature during from 10^{th} to 16^{th} , August,1989 in same area.

The input parameter of neural network was used as surface temperature, horizontal temperature gradient, wind velocity, latitude and longitude, and the output parameter as the depth of homogeneous layer.

Surface temperature, wind velocity, latitude and longitude are all prepared from basic data.

Temperature gradient was calculated by 10n·mile in unit from basic data.

Here estimating the depth of homogeneous layer from the basic data is very important, in this paper, we decide the depth which their temperature gradient is over 0.05℃/m from sea surface as the up limit of leap layer by considering vertical structure property of water temperature.

Data of Input parameter from three-dimensional water temperature and wind in every month during several years and 1500~2000 data of the depth of homogeneous layer is used in study of RBF neural network.

100~150 data of unused in this study can use as investigate data.

From average data of several years, analyzed results of the depth of homogeneous layer in every month by using RBF neural network as follow table № 1, 2.

Table 1. Analyzed results and error of the depth of homogeneous layer in January

Latitude	longitude	Surface temperature (℃)	Temperature gradient (℃/1 unit)	Wind velocity (m/s)	depth of homogeneous layer		error (m)
					Observed value(m)	Calculated value(m)	
36.67	132.17	12.1	0.1	6.4	88.0	90.9	2.9
36.67	134.00	12.4	0.2	6.5	105.0	102.6	-2.4
37.00	133.17	12.2	0.2	6.4	106.0	107.7	1.7
37.00	135.00	12.5	0.3	6.6	101.0	101.4	0.5
38.00	130.00	11.4	0.5	6.6	78.0	73.8	-4.2
38.00	131.83	12.0	0.4	6.5	83.0	84.2	1.2
38.17	137.00	11.7	0.1	6.5	118.0	118.9	0.9
38.33	129.33	8.1	0.8	6.6	53.0	52.0	-1.0
39.00	128.50	5.6	0.4	6.5	68.0	67.4	-0.6
39.00	132.17	7.1	0.5	6.5	55.0	55.7	0.7
40.17	129.00	4.7	0.3	6.4	47.0	47.5	0.5
37.00	135.00	12.5	0.3	6.6	101.0	101.4	0.5

37.50	**129.50**	**11.6**	**0.5**	**6.6**	**58.0**	**53.2**	**-4.8**
38.50	**132.17**	**9.6**	**1.0**	**6.5**	**70.0**	**74.8**	**4.8**
38.83	**134.33**	**10.8**	**0.7**	**6.5**	**114.0**	**115.1**	**1.1**

Table 2. Analyzed results and error of the depth of homogeneous layer in august

latitude	**longitude**	**Surface temperature (℃)**	**Temperature gradient (℃/1 unit)**	**Wind velocity (m/s)**	**depth of homogeneous layer**		**error (m)**
					Observed value(m)	**Calculated value(m)**	
51.33	**141.33**	**14.2**	**0.4**	**4.4**	**25.0**	**26.2**	**1.2**
51.00	**141.67**	**13.3**	**0.3**	**4.5**	**24.0**	**24.3**	**0.3**
50.83	**141.17**	**14.3**	**0.4**	**4.6**	**24.0**	**24.5**	**0.5**
35.50	**130.50**	**26.4**	**0.1**	**5.0**	**13.0**	**13.5**	**0.5**
35.50	**132.33**	**26.3**	**0.1**	**5.1**	**3.0**	**0.9**	**-2.1**
36.83	**135.50**	**26.4**	**0.1**	**4.9**	**4.0**	**2.3**	**-1.7**
37.00	**132.17**	**25.8**	**0.0**	**5.1**	**6.0**	**6.6**	**0.7**
37.83	**133.33**	**26.4**	**0.1**	**5.0**	**4.0**	**1.3**	**-2.7**
37.83	**137.00**	**26.4**	**0.2**	**4.9**	**6.0**	**4.7**	**-1.3**
38.00	**133.17**	**26.3**	**0.2**	**5.0**	**4.0**	**3.3**	**-0.7**
38.83	**138.83**	**26.3**	**0.1**	**4.9**	**6.0**	**2.6**	**-3.4**
39.00	**129.17**	**21.1**	**0.0**	**4.9**	**2.0**	**1.7**	**-0.3**
39.00	**131.00**	**21.5**	**0.5**	**5.0**	**3.0**	**3.1**	**0.1**
44.17	**140.50**	**20.6**	**0.1**	**4.8**	**10.0**	**8.3**	**-1.7**
44.33	**140.83**	**20.5**	**0.2**	**4.7**	**12.0**	**13.6**	**1.6**

In order to make sure the reality the section observed data of water temperature in August, 1989 year was used as investigating data.

The results of calculating the depth of homogeneous layer as follows table 3.

Table 3. Analyzed results and error of the depth of homogeneous layer in august, 1989

latitude	**longitude**	**Surface temperature (℃)**	**Temperature gradient (℃/1 unit)**	**Wind velocity (m/s)**	**depth of homogeneous layer**		**error (m)**
					Observed value(m)	**Calculated value(m)**	
38.52	**129.10**	**23.0**	**0.9**	**7.0**	**2.0**	**2.2**	**0.2**
38.52	**130.00**	**24.4**	**0.3**	**5.0**	**5.0**	**4.8**	**-0.2**
39.00	**130.10**	**24.2**	**0.6**	**8.0**	**5.0**	**1.5**	**-3.5**
39.00	**129.40**	**23.4**	**0.4**	**3.0**	**2.0**	**1.4**	**-0.6**
39.22	**129.40**	**24.6**	**0.7**	**6.0**	**2.0**	**2.2**	**0.2**
39.22	**129.50**	**24.6**	**0.4**	**3.0**	**3.0**	**2.3**	**-0.7**
37.30	**129.30**	**23.0**	**0.6**	**5.0**	**2.0**	**2.4**	**0.4**
39.37	**129.30**	**23.7**	**0.5**	**4.0**	**2.0**	**2.1**	**0.1**
39.37	**129.20**	**23.2**	**0.2**	**3.0**	**2.0**	**4.9**	**2.9**
39.30	**129.50**	**24.2**	**1.0**	**7.0**	**2.0**	**2.7**	**0.7**
39.22	**129.50**	**24.6**	**0.4**	**3.0**	**3.0**	**2.3**	**-0.7**
39.22	**129.40**	**24.6**	**0.7**	**6.0**	**2.0**	**2.2**	**0.2**
35.14	**130.22**	**25.0**	**0.3**	**8.0**	**18.0**	**15.8**	**-2.2**
35.03	**131.01**	**25.6**	**0.2**	**10.0**	**20.0**	**14.7**	**-5.3**
34.36	**130.23**	**25.9**	**0.1**	**11.0**	**19.0**	**13.7**	**-5.3**

By analyzing the depth of homogeneous layer in every month by the method of RBF neural network, mean absolute error is less than 2meters and maximum error is about 6meters.

Conclusion

When the field of water temperature and wind on sea surface is known, the depth of homogeneous layer can be easily analyzed by the method of RBF neural network.

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