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Determination of the chlorophyll «a» concentration in Lake Baikal using remote sensing methods

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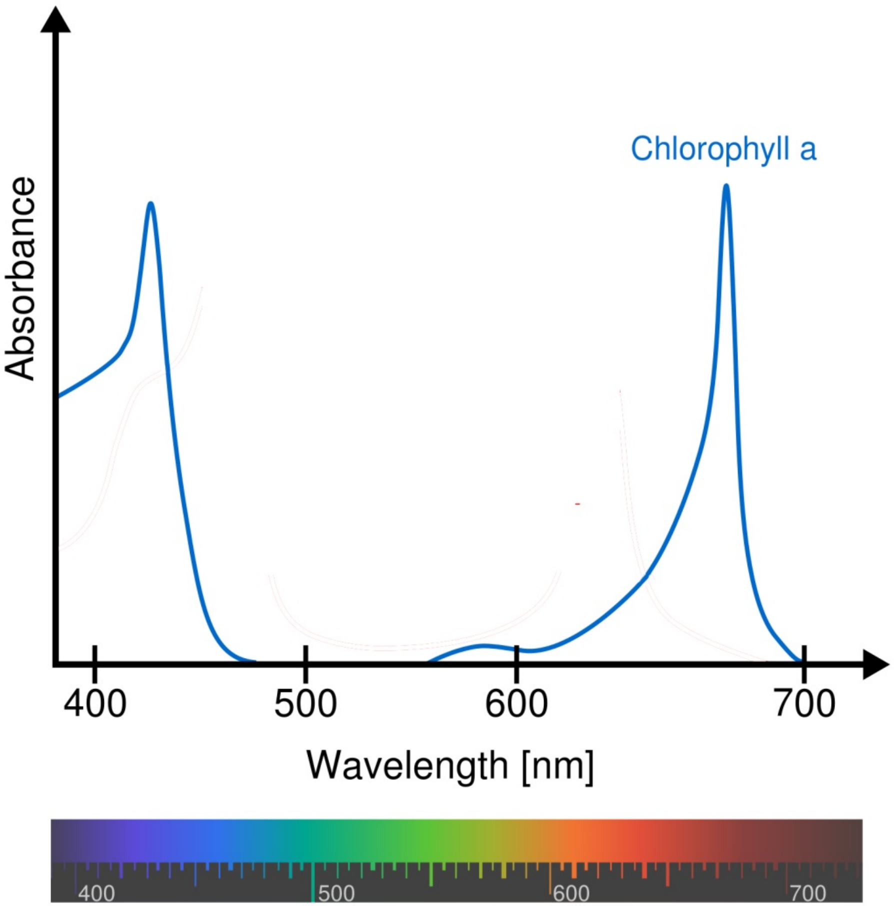
Chlorophyll “a” is the main pigment of green plants, including all groups of algae. This parameter is a key indicator of phytoplankton biomass. To estimate the chlorophyll “a” we chose an approach based on using of the spectral characteristics of the reflection in the blue and green spectral ranges.

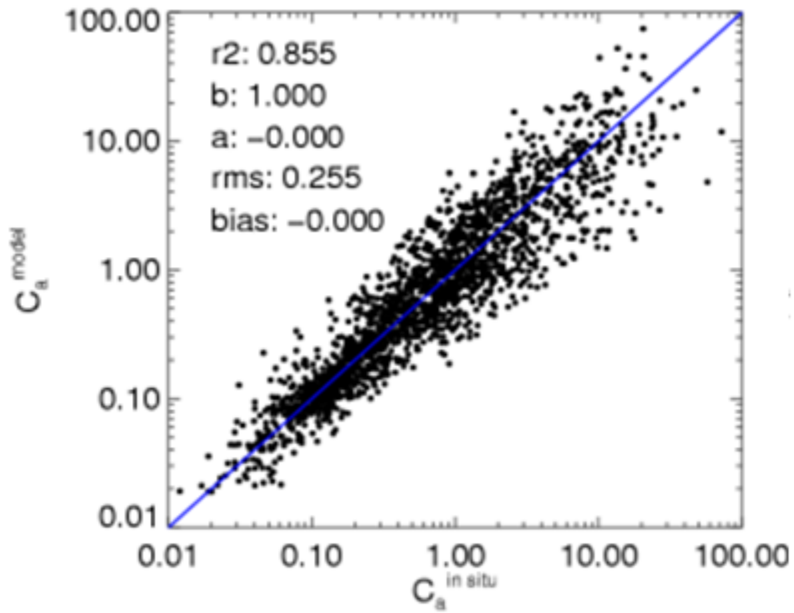
In some papers (Heim et al., 2005; Sayers, 2015) it was shown that remote sensing data have a high correlation with ground measurements of the chlorophyll “a” concentration (R^2 = 0.7-0.72).



The Ocean Color Chlorophyll (OC) v6.

This algorithm returns the near-surface concentration of chlorophyll-a (chlor_a) in mg/m^{-3}, calculated using an empirical relationship derived from in situ measurements of chlor_a and blue-to-green band ratios of in situ Remote sensing reflectance (RRS). Implementation is contingent on the availability three or more sensor bands spanning the 440-570 nm spectral regime.

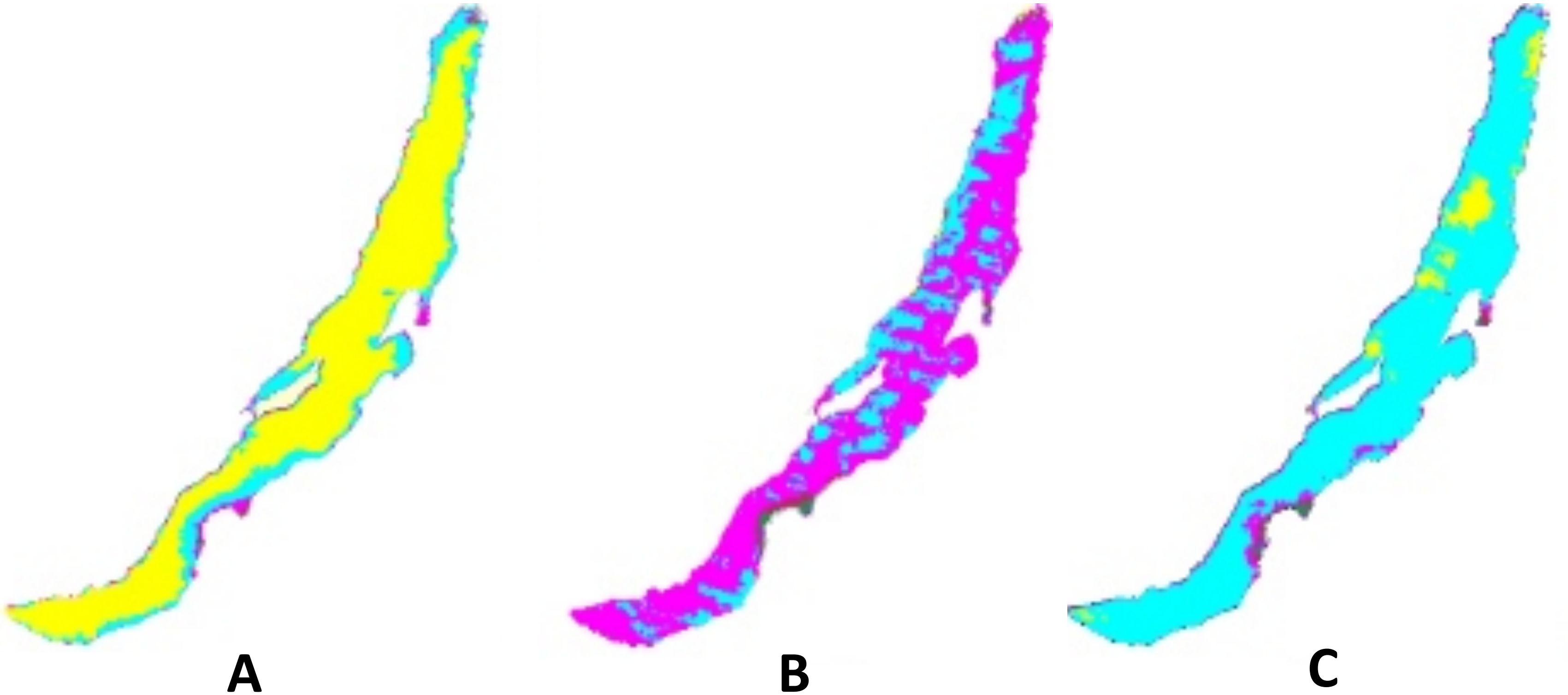
The algorithm is a fourth-order polynomial relationship between a ratio of RRS and chlor_a.



OC3MR: 0.2424,–2.7423, 1.8017, 0.0015,–1.2280

$$log10(chlor_{\downarrow}a) = a_0 + \sum_{i=1}^{4} a_i log10\left(\frac{RRS(\lambda_{blue})}{RRS(\lambda_{green})}\right)^i$$

Distribution of chlorophyll “a” in surface waters of the lake Baikal



1.5000 to 2.0000 [Yellow]
2.0000 to 2.5000 [Cyan]
2.5000 to 3.0000 [Magenta]
3.0000 to 3.5000 [Maroon]
3.5000 to 4.0000 [Sea Green]
4.0000 to 4.5000 [Purple]
4.5000 to 5.0000 [Coral]

A – 07.2011
B – 08.2012
C – 09.2010


b26
b27
b24
b30
b28
b29
b17
b16
b13
b5
b1
b12
b6
b9
b2
b20
b19
b21
Иркутск
Ангарск
Улан-Удэ
Байкальск
Селенгинск
Гусиноозёрск
Онохой
Петровск-Забайкальский
Усть-Ордынский
Шелехов
о. Ольхон
оз. Байкал
залив Малое Море
Иркутское вдхр.
Р-258
А-340

Point	June 13, 2010		August 23, 2010		September 28,2010		Place
	chl_a, mg/m^3	T, °	chl_a, mg/m^3	T, °	chl_a, mg/m^3	T, °	
1	3	15.13	4	7.43	4	8.65	Proval bay
2	2.5	14.32	4	16.00	3	8.52	
3	2	7.96	2.5	11.92	2	9.61	Near delta area
4	2.5	7.59	2.5	11.67	2.5	9.05	
5	2.5	5.86	2.5	10.43	2.5	8.86	
6	3	8.68	3	11.52	2	8.86	
7	3	10.28	2.5	12.47	3	9.02	
8	3	11.32	3	12.89	2.5	9.80	
9	2	4.67	2	10.16	2	9.66	Transect in “open” lake
10	2	2.58	2	9.64	2	9.39	
11	2	2.65	2.5	10.00	2	9.58	
12	2	2.20	2.5	10.38	1.5	9.13	
13	2	2.63	2	10.29	1.5	9.52	
14	2	2.72	2	10.51	1.5	9.54	
15	2	3.21	2	10.75	1.5	8.82	
16	4.5	15.71	4	15.16	4	9.64	Sor Cherkalovo bay
17	4.5	11.26	3	12.78	2.5	9,75	
18	3	15.58	4	15.18	4	9.39	
19	3.5	18.19	5	16,45	3.5	9,95	
20	3.5	15.03	4	14.60	4	9.52	
21	3	3.88	4	16.05	3.5	10.51	Chivyrkuisky bay
22	2.5	4.65	3	15.70	3.5	10,21	
23	2.5	1.70	2.5	14.65	3.5	10.41	
24	2.5	1.74	2	14.35	4	9.38	
25	2	3.34	2	13.33	2.5	10.81	Barguzinsky bay
26	15	2.75	2	12.87	15	11.49	
27	2	2.60	2	13.76	15	10.16	

Conclusions

- It has been determined that the bays the Proval, the Sor Cherkalovo and the Chivyrkuisky are areas with high concentration of chlorophyll “a”. The concentration of chlorophyll “a” on the surface of Lake Baikal is maximized in the end of July.

- In the first period of the algae growing there is a correlation between the average temperature and the concentration of chlorophyll “a” (R^2 = 0.5). In the end of August the dependence is weaker (R^2 = 0.26). In the end of September temperature fields are aligned, the surface temperature generally falls, the chlorophyll concentration slightly falls, and the correlation disappears.


Thank you for your attention!