湖泊环境遥感团队 LAKE REMOTE SENSING GROUP
中国科学院南京地理与湖泊研究所
湖泊环境遥感，一个蓬勃发展的学科，一片散发芬香的土地

Remote Sensing of Cyanobacterial Blooms: from Monitoring to Forecast

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Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences

- A worldwide phenomenon: algae blooms
- Blooming distribution in China
- Spatial-temporal distribution of cyanobacteria blooms in Lake Taihu and Lake Chaohu
- Formation process of cyanobacteria bloom
- PC retrieval in surface waters
- Phytoplankton biomass estimation
- Cyanobacterial bloom forecast

Remote Sensing of Cyanobacterial Blooms: from Monitoring to Forecast

The cyanobacterial blooms exist waters worldwide (lake, reservoir, river, coastal waters in Asia, Europe, Africa, America, ……)

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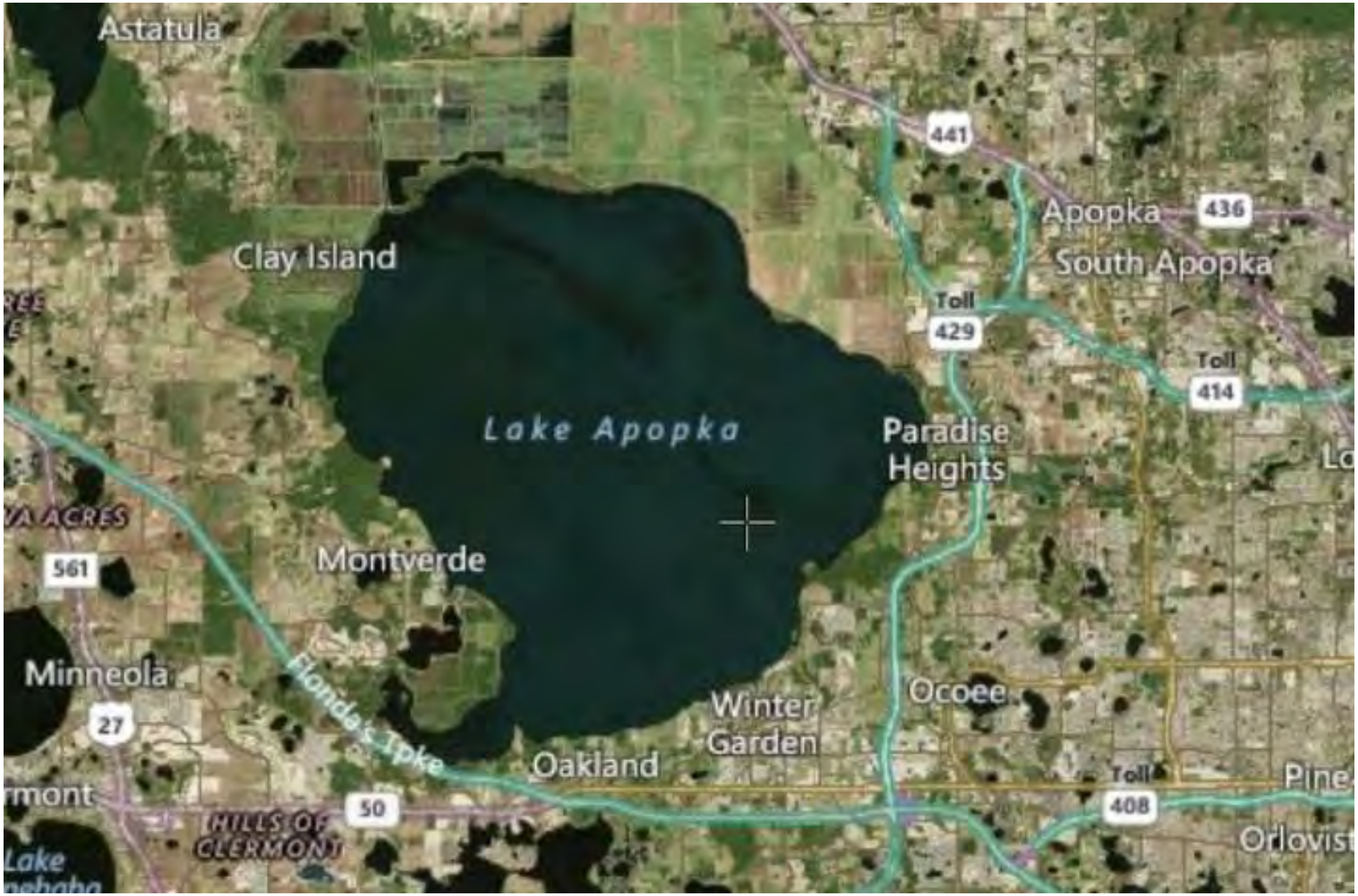
Remote Sensing of Cyanobacterial Blooms: from Monitoring to Forecast



It is the third largest lake in the U.S. state of Florida, 124 km^2, blooms happened in 1940s-1950s

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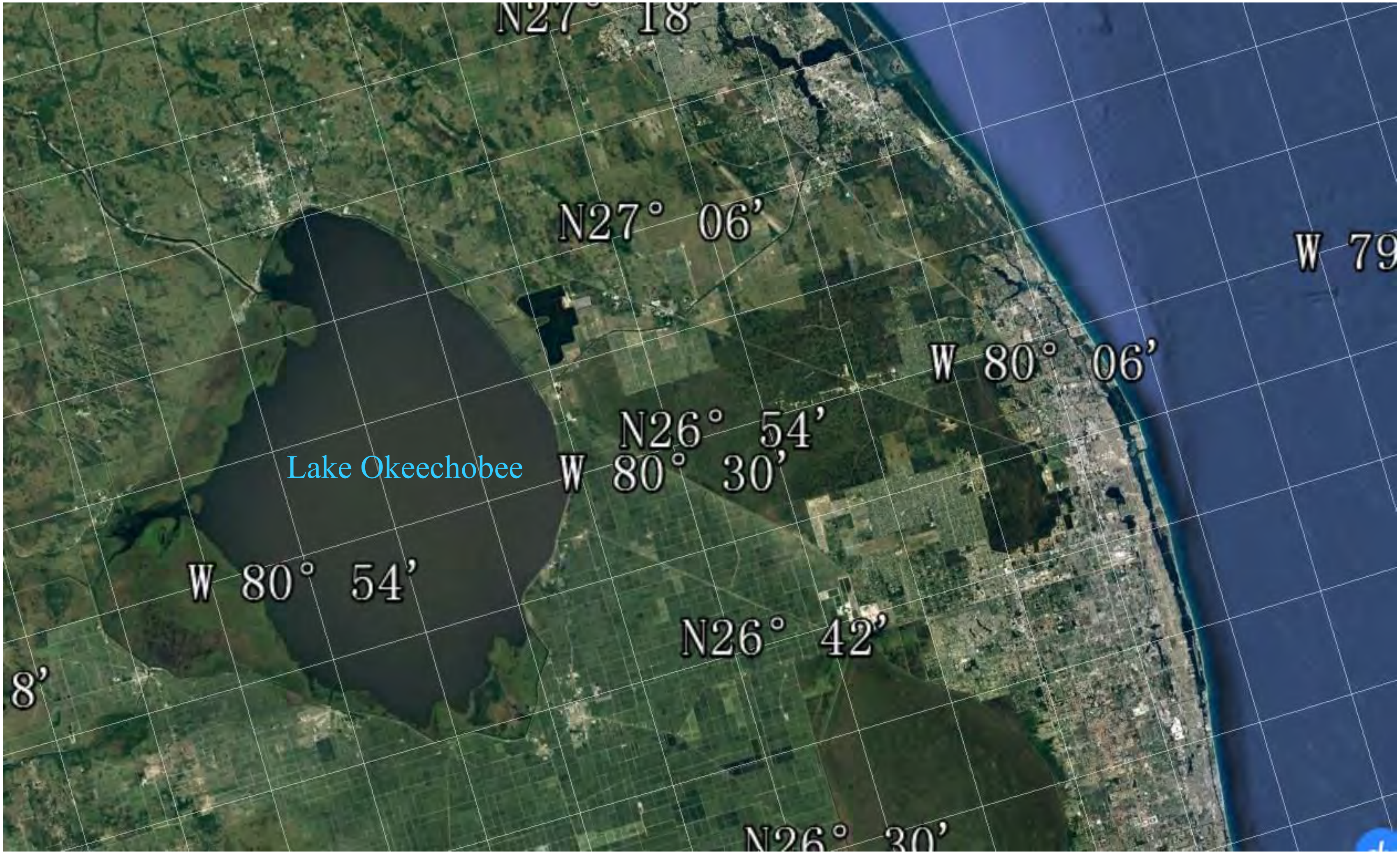
a reservoir in King George, Virginia, United States, with an area of about 4.5 km^2

Remote Sensing of Cyanobacterial Blooms: from Monitoring to Forecast



It is the largest lake in the southeastern United State, with a surface area of about 1900 km^2, blooms happened since 1980s

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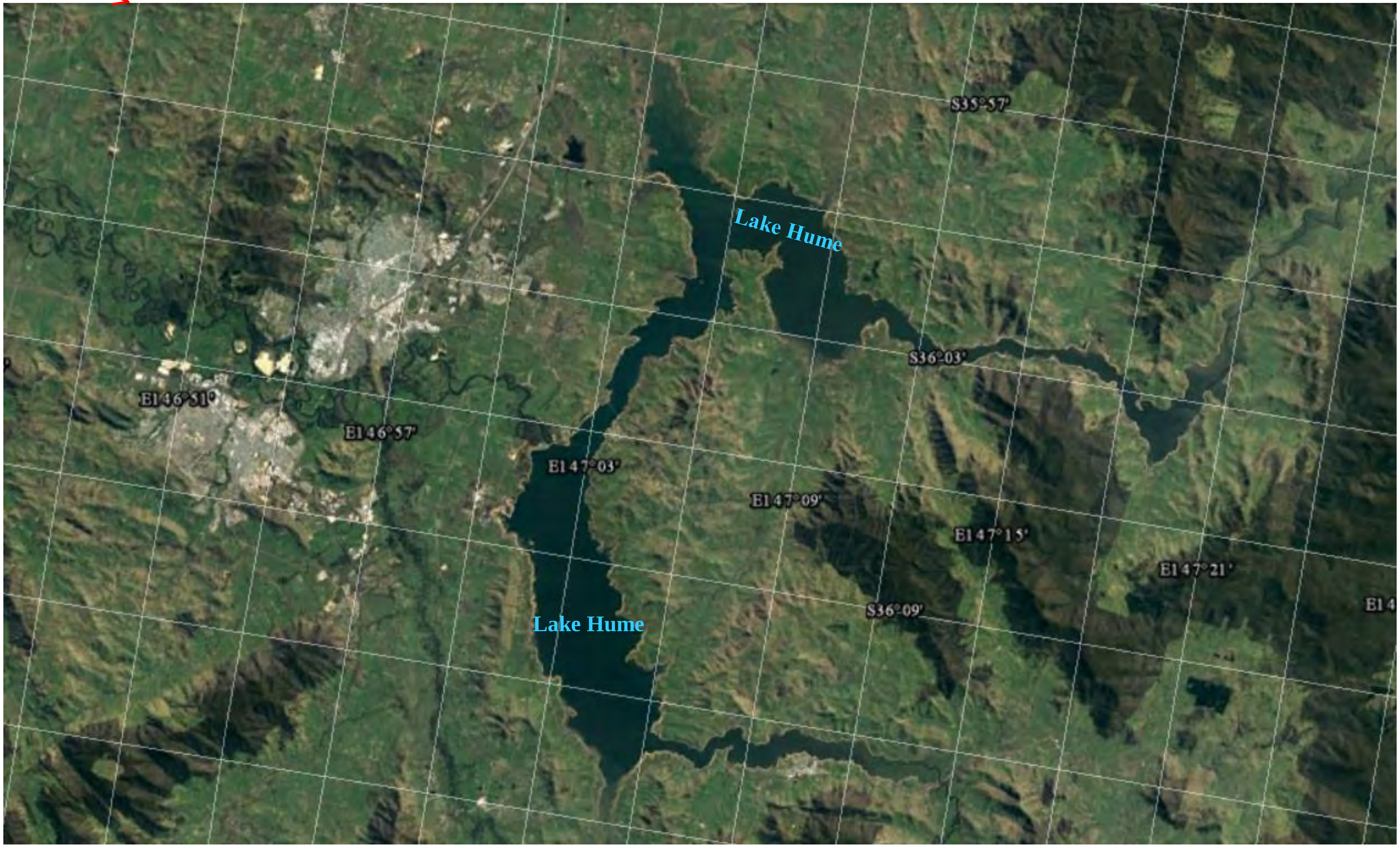
It is situated in Germany, Switzerland and Austria near the Alps, third largest in central Europe, area of 538km^2, max. depth of 252m, blooms happened in 1950s-1970s

Remote Sensing of Cyanobacterial Blooms: from Monitoring to Forecast



It is an artificial lake in Australia , 202.5 km^2, mesotrophic, blooms happened since 1960s

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The cyanobacterial blooms exist waters worldwide (lake, reservoir, river, coastal waters in Asia, Europe, Africa, America, ……)

It is the second-largest lake in Japan, an area of 220 km^2

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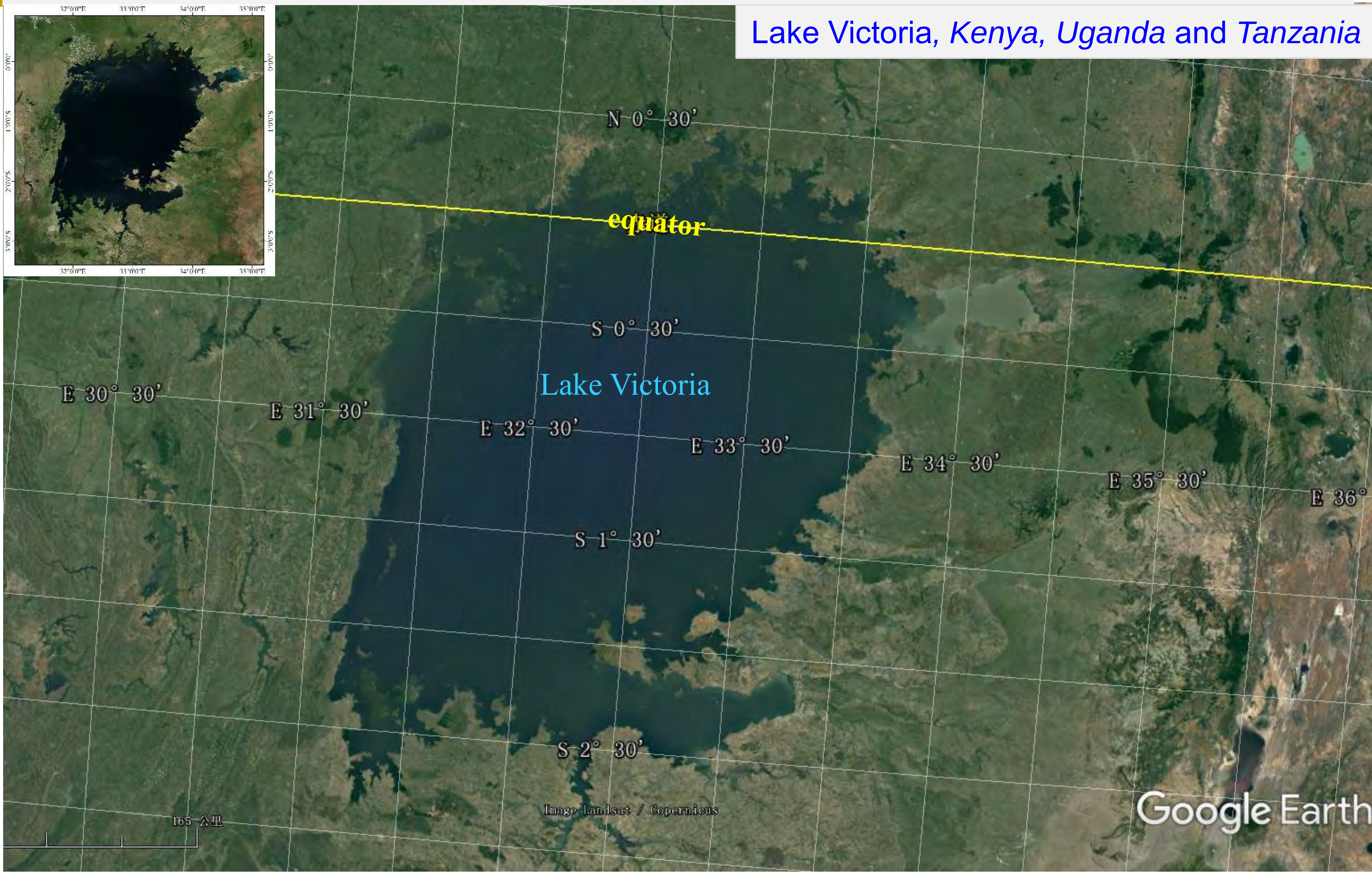
The cyanobacterial blooms exist waters worldwide (lake, reservoir, river, coastal waters in Asia, Europe, Africa, America, ……)

Lake Victoria, *Kenya, Uganda* and *Tanzania*



It is the largest in Africa and the second largest freshwater lake in the world, an area of 69000 km^2

So the lake blooms is a worldwide phenomenon,
from the developed to the developing, to the undeveloped economic countries,
from America, to Europe, Australia, Asia, and to Africa.

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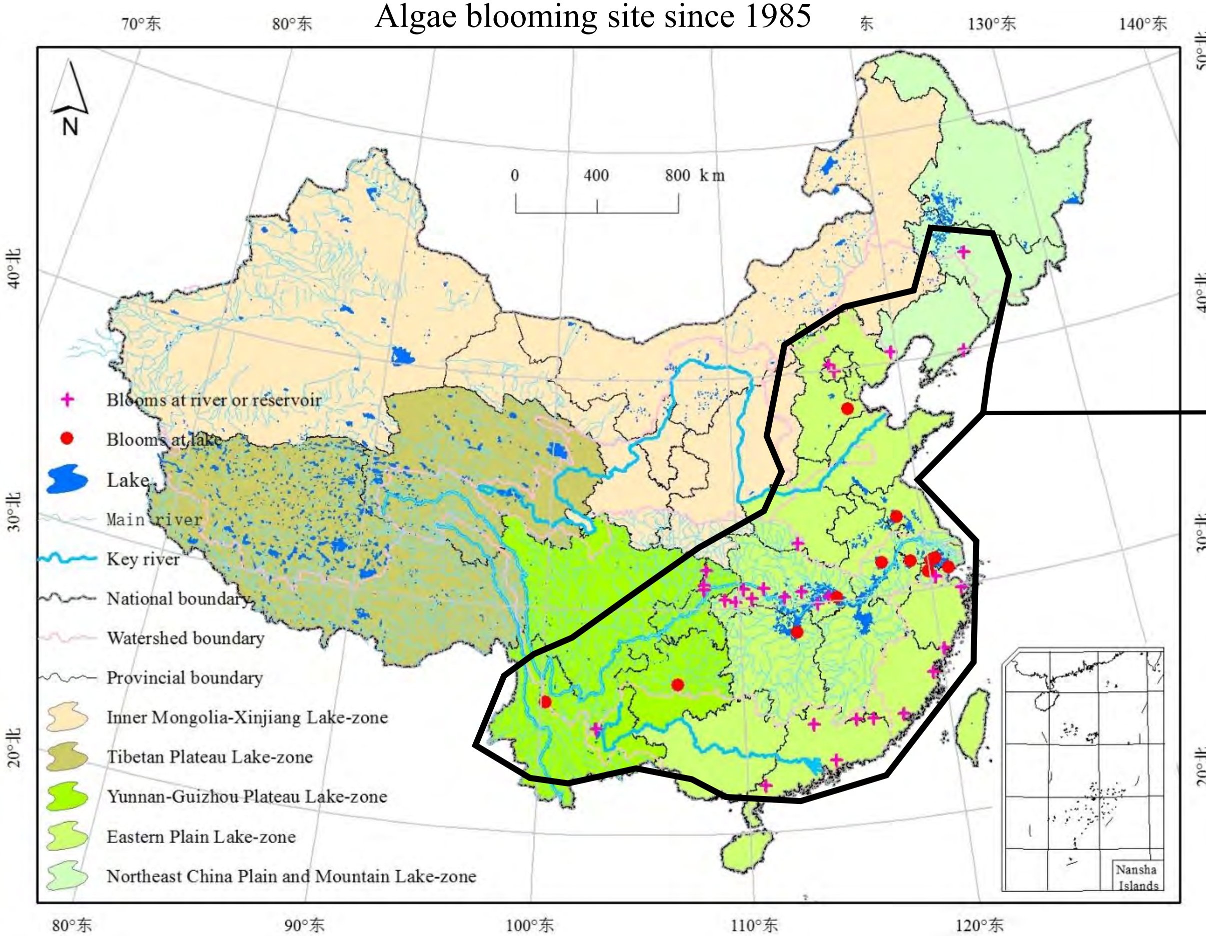
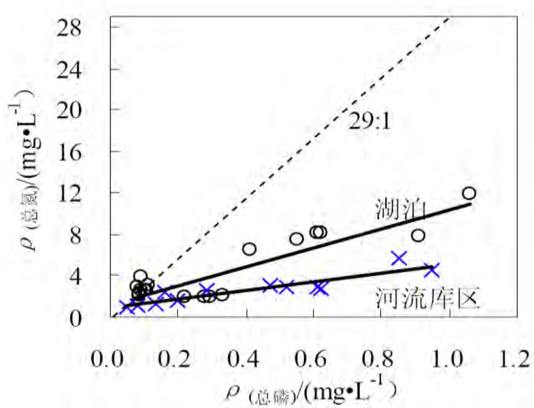
Algae blooming site since 1985



Eastern China
Southern China



The relationship (P<0.001) between nitrogen and phosphorus during algal bloom events

- **Five blooming dominance algae:** Cyanophyta (Microcystis, Anabaena, Oscillatoria, Aphanizomenon) , Euglenophyta (Euglena), Chlorophyta (Chlorella), Bacillaeiophyta (Cyclotella), Pyrrophyta (Peridinium)
- **Blooming main occurrence month:** Mar.-Sep.

Chen N., Zhang Y., Li Y. An integrated analysis of dynamic characteristics of harmful algal bloom in fresh water in China. Ecology and Environmental Sciences. 2010, 19(8): 1994-1998 (In Chinese)
Ma R., Yang G., Duan H., Jiang J., Wang S., Feng X., Li A., Kong F., Xue B., Wu J., Li S.. China's lakes at present: number, area and spatial distribution. *SCIENCE CHINA Earth Sciences (Science in China Series D)*. 2011, 54(2): 283-289

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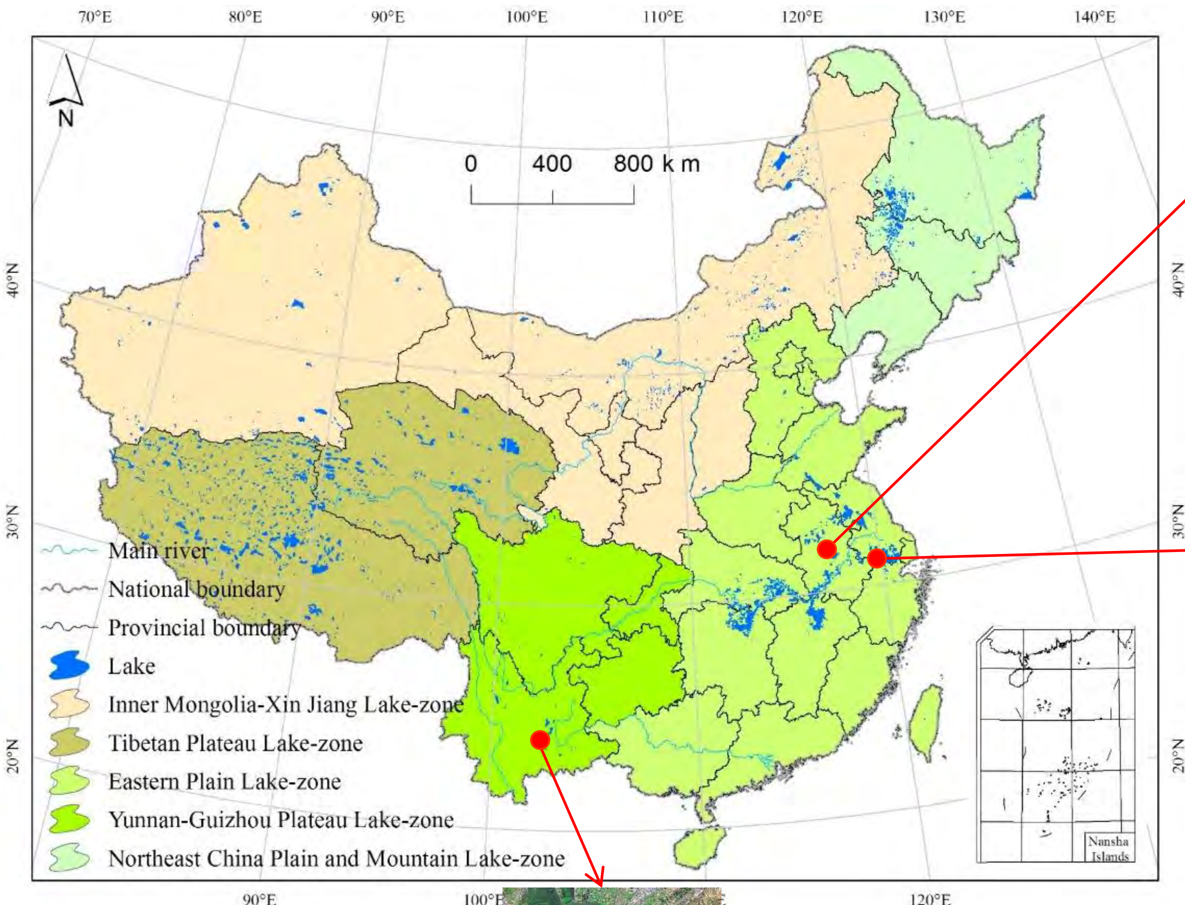
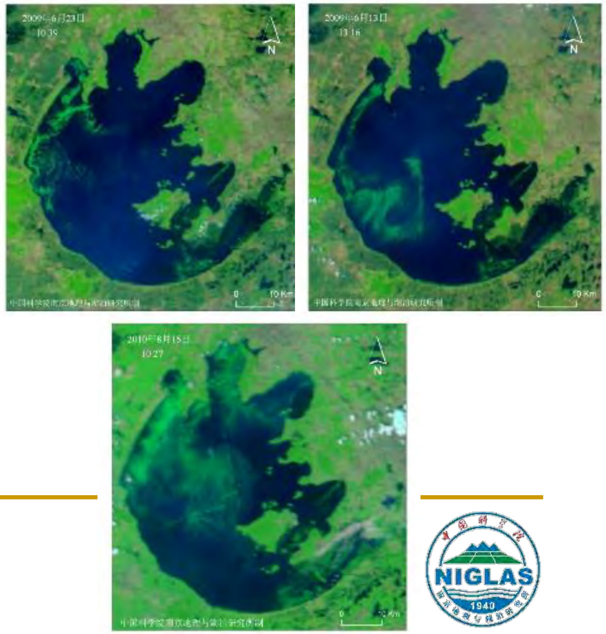
Three representative typical eutrophic lakes



Lake Chaohu

Lake Taihu



Lake Dianchi

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Algal blooms frequency distribution in pixel

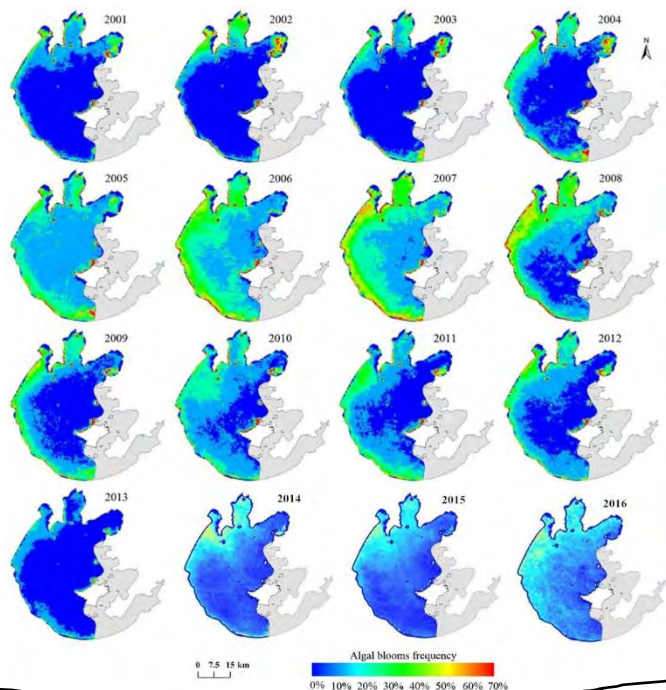
$F_{i,j} = C_{i,j}/TC_j$

$F_{i,j}$ is the relative frequency of bloom occurrence in the i[st] pixel during time j

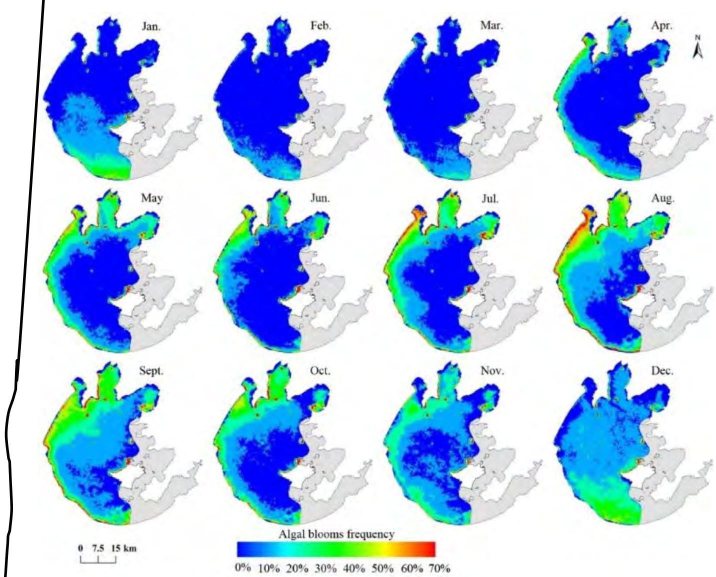
$C_{i,j}$ is the count of bloom occurrence in the same pixel\

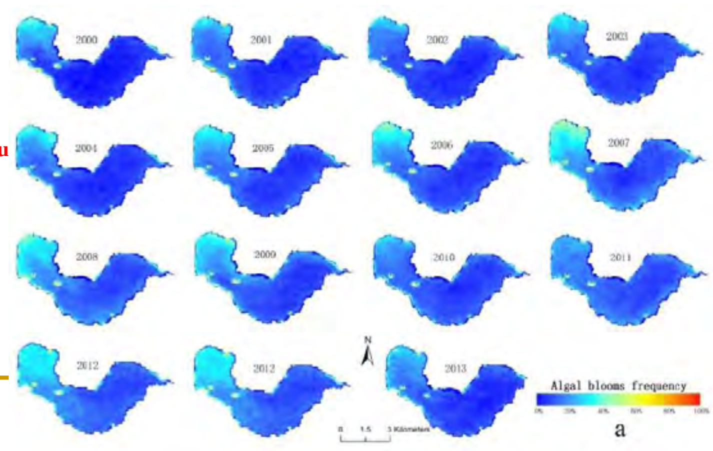
TC_j is the total count of MODIS images

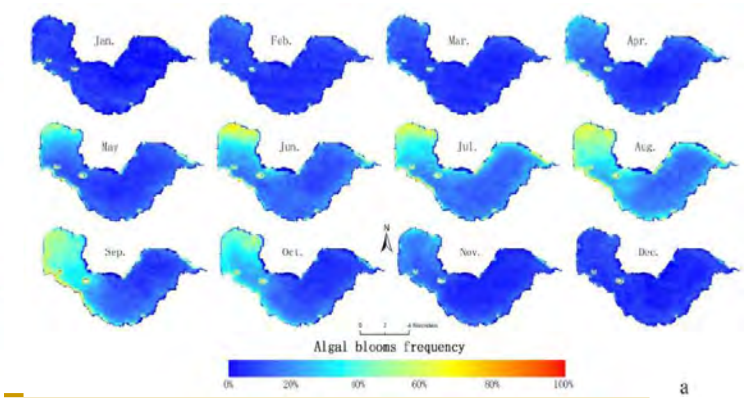
in each year of 2001-2016



in each month of Jan.-Dec.







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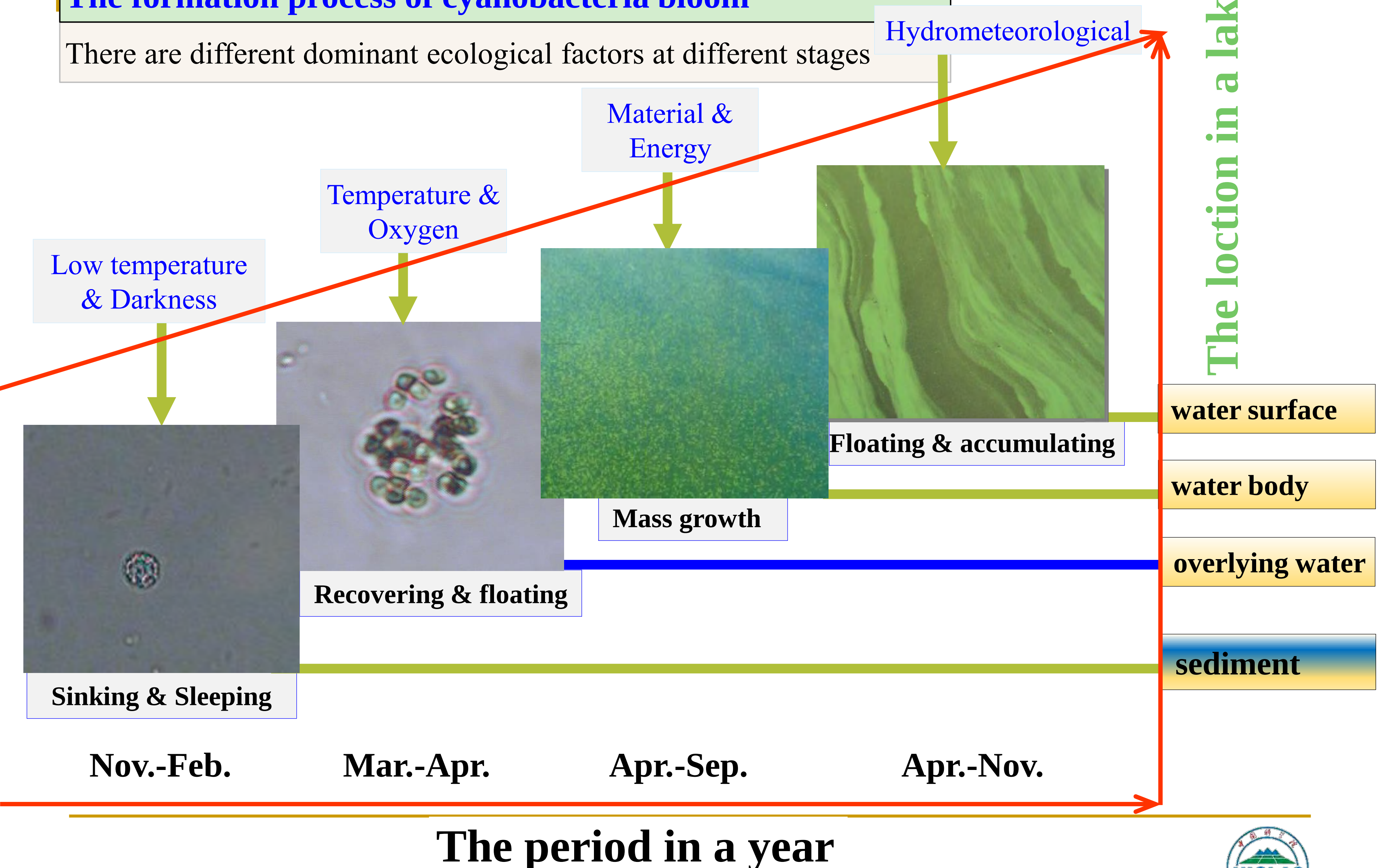
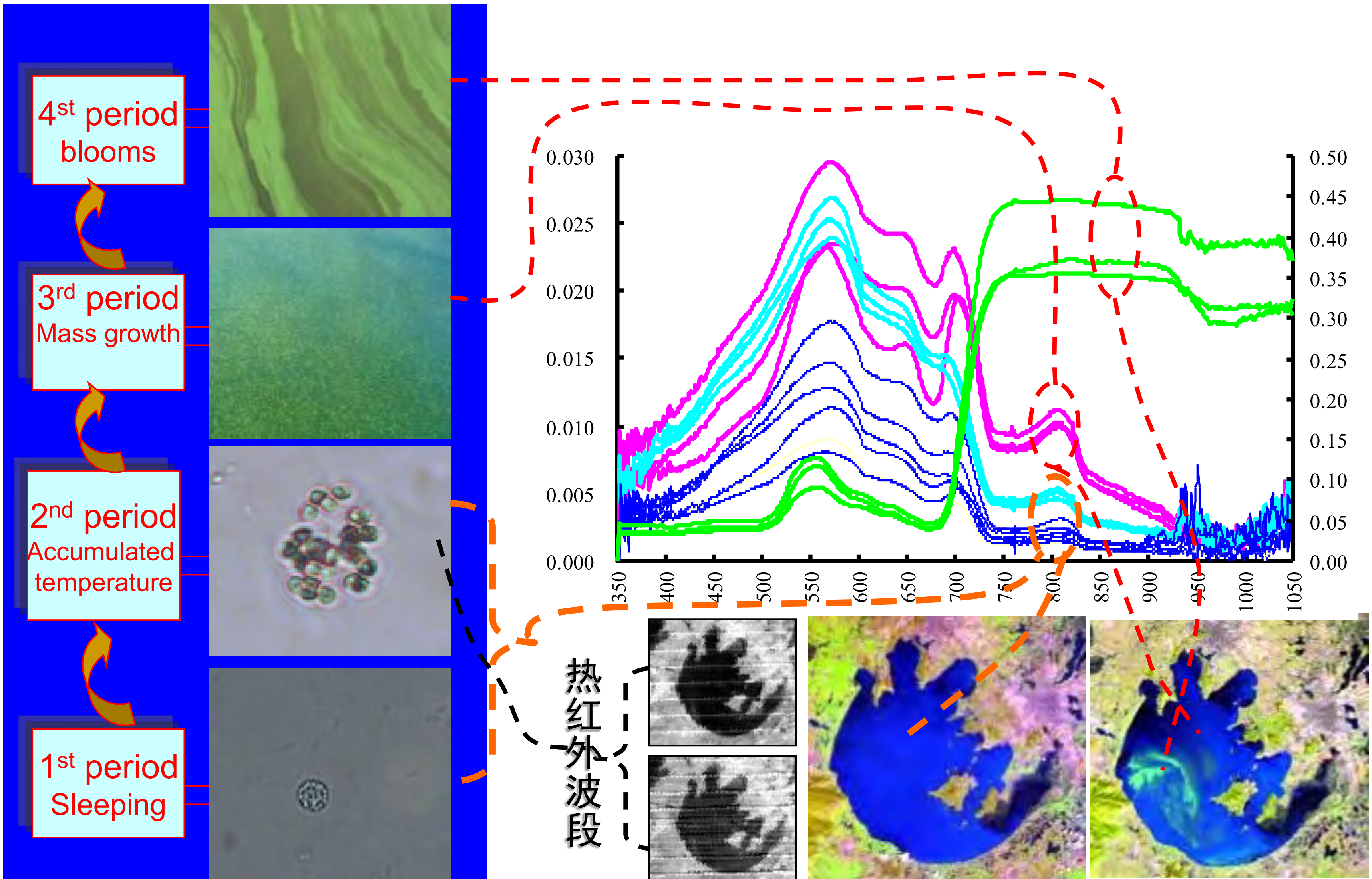
The formation process of cyanobacteria bloom

There are different dominant ecological factors at different stages

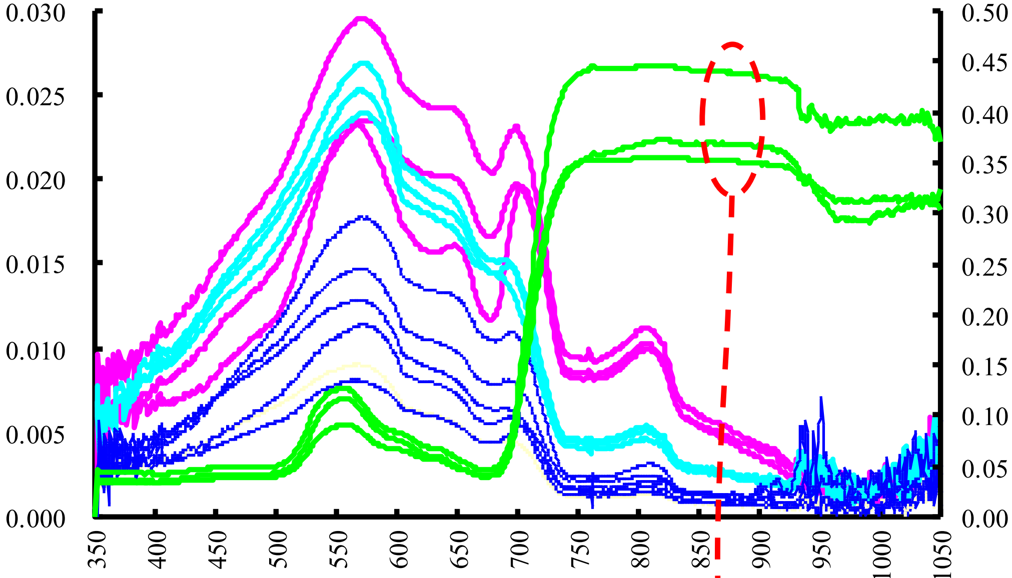


Kong F., Gao G. Hypothesis on cyanobacteria bloom-forming mechanism in large shallow eutrophic lakes. Acta Ecolo. Sinca. 2005, 25: 589–595

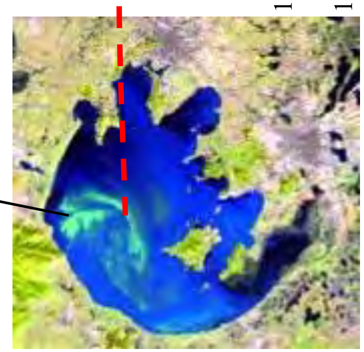
Remote Sensing of Cyanobacterial Blooms: from Monitoring to Forecast



Remote Sensing of Cyanobacterial Blooms: from Monitoring to Forecast



4st period blooms



Almost all optical sensors:

- NOAA AVHRR
- Nimbus-7 CZCS
- Seastar SeaWiFS
- Terra ASTER
- Aqua/Terra MODIS
- NPP VIIRS
- Envisat MERIS
- Landsat MSS/TM/ETM/OLI
- IRS-P6 LISS-3/-4/ AWIFS
- EO-1 Hyperion&ALI
- Sentinel OLCI
- Beijing-1 CCD
- Huanjing-1 CCD
- Gaofen-(1-4) CCD
- …

Remote Sensing of Cyanobacterial Blooms: from Monitoring to Forecast

4th period growing

Single band threshold

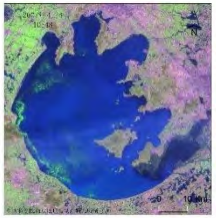
NDVI

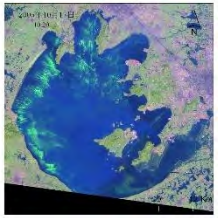
EVI

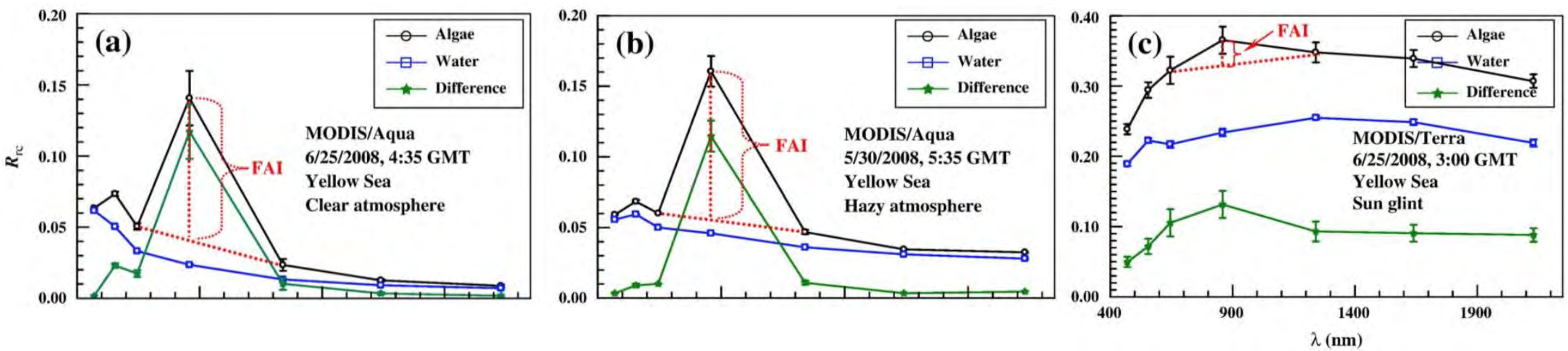
FAI: the difference between Rayleigh-corrected reflectance in the NIR and a baseline formed by the red and SWIR bands

$$R'_{rc,NIR} = R_{rc,RED} + (R_{rc,SWIR} - R_{rc,RED}) \times (\lambda_{NIR} - \lambda_{RED})/(\lambda_{SWIR} - \lambda_{RED})$$

$$\text{FAI} = R_{rc,NIR} - R'_{rc,NIR}$$





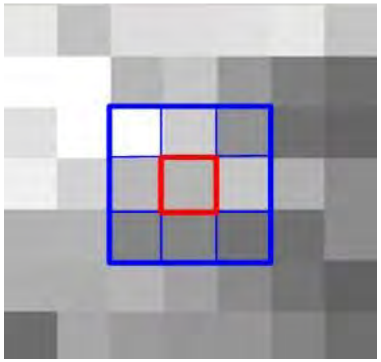


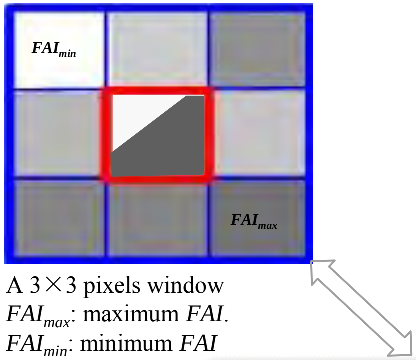
Hu. A novel ocean color index to detect floating algae in the global oceans. Remote Sensing of Environment, 2009, 113: 2118-2129

Remote Sensing of Cyanobacterial Blooms: from Monitoring ...

4th period growing

To decompose algal bloom coverage to sub-pixel level in order to improve the area precision of algal blooming by a novel algorithm **APA (Algae Pixel-growing Algorithm)**





A 3×3 pixels window
FAI_{max}: maximum *FAI*.
FAI_{min}: minimum *FAI*

FAI

0	0	0	0	0	0	0
0	0.027	0.018	0.023	0.027	0.027	0
0	0.032	0.027	0.032	0.032	0.027	0
0	0.036	0.036	0.041	0.036	0.023	0
0	0.041	0.045	0.041	0.032	0.027	0
0	0.045	0.054	0.036	0.036	0.027	0
0	0	0	0	0	0	0

α_{pixel}: Algal bloom partial coverage at sub-pixel scales

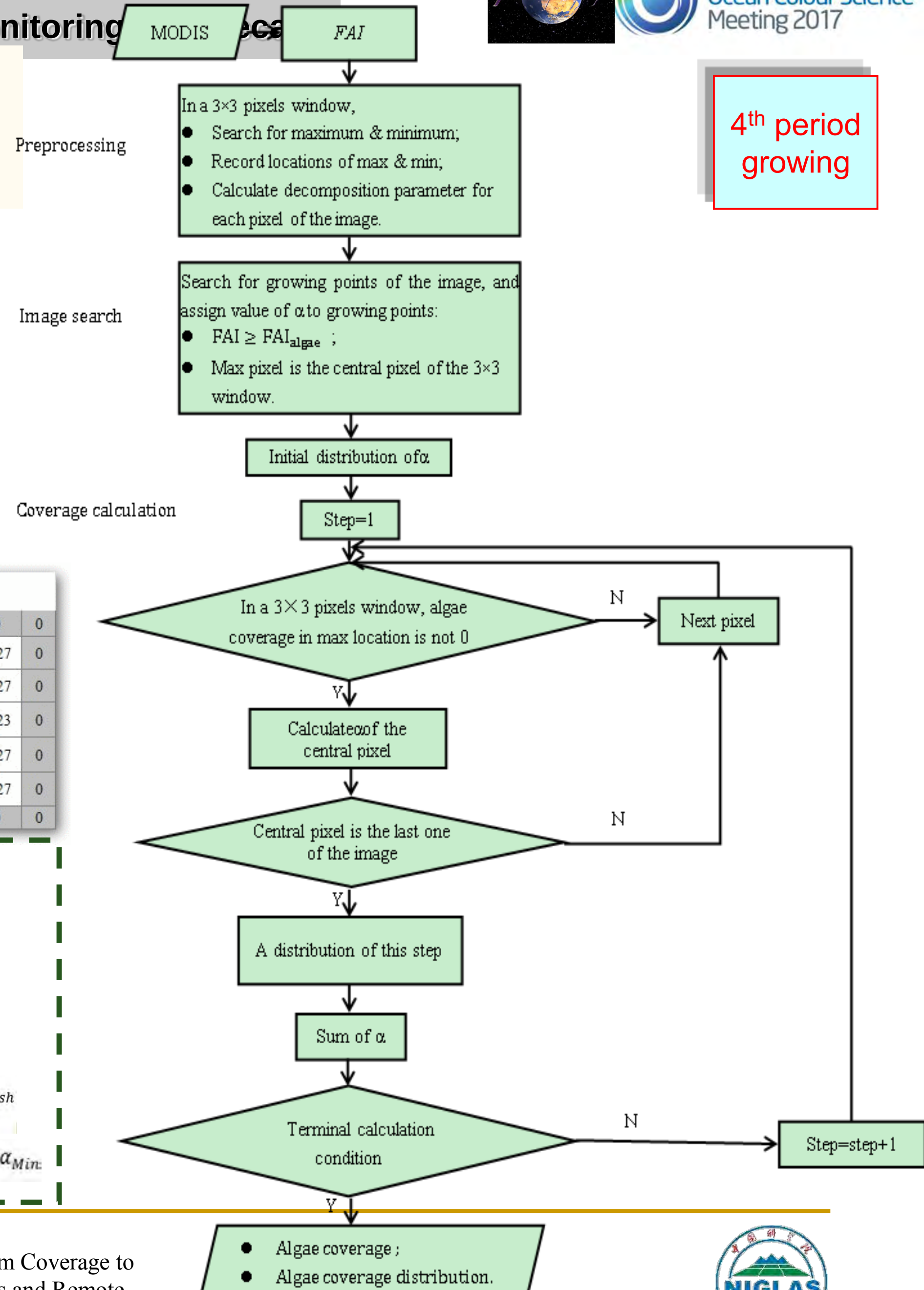
For growing points:

$$\alpha_{pixel} = \begin{cases} 1 & FAI \geq FAI_{algae} \\ \dfrac{FAI_{pixel} - FAI_{non-algae}}{FAI_{algae} - FAI_{non-algae}} & FAI_{algae} > FAI_{pixel} > FAI_{non-algae} \\ 0 & FAI < FAI_{non-algae} \end{cases}$$

$$FAI_{center} = \gamma \cdot FAI_{max} + (1-\gamma) \cdot FAI_{min}$$

$$FAI = \alpha \cdot FAI_{algae}{}^{thresh} + (1-\alpha) \cdot FAI_{water}{}^{thresh} = (FAI_{algae}{}^{thresh} - FAI_{water}{}^{thresh}) \cdot \alpha + FAI_{water}{}^{thresh}$$

$$FAI_{center} = (FAI_{algae}{}^{thresh} - FAI_{water}{}^{thresh}) \cdot \alpha_{center} + FAI_{water}{}^{thresh} \qquad \alpha_{center} = \gamma \cdot \alpha_{Max} + (1-\gamma) \cdot \alpha_{Min}$$

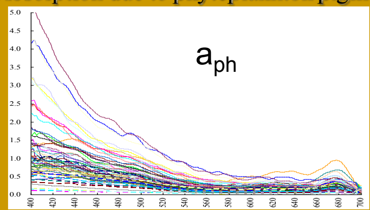


Zhang Y., Ma R., Duan H., Steven A. L., Xu J., Ma M. A Novel Algorithm to Estimate Algal Bloom Coverage to Subpixel Resolution in Lake Taihu. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 2014, 7: 3060-3068

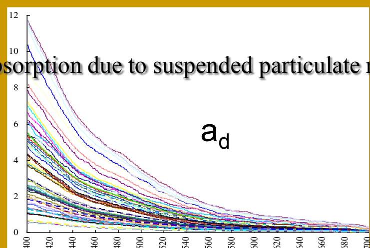
Remote Sensing of Cyanobacterial Blooms: from Monitoring to Forecast

A retrieval model for phytoplankton pigment concentration, respectively, including phycocyanin and chlorophyll-a

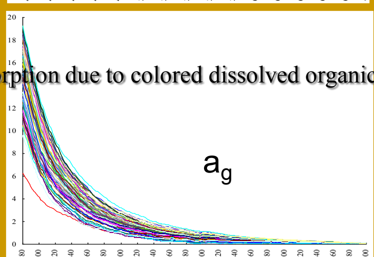
Absorption due to phytoplankton pigment



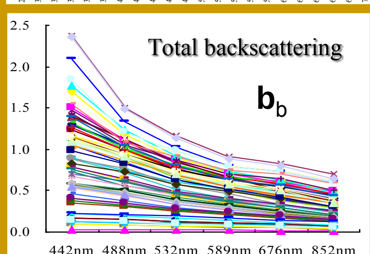
Absorption due to suspended particulate matter



Absorption due to colored dissolved organic matter



Total backscattering

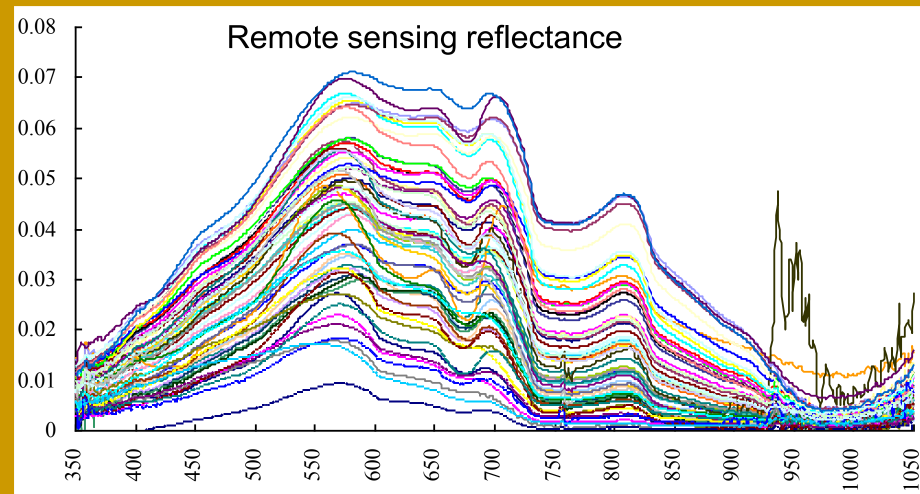


2nd & 3rd period growing

$$a = a_d + a_{ph} + a_g + a_w$$

$$R_{rs}^{w} \approx (0.070 + 0.155u^{0.752})u$$

$$u \equiv b_b / (a + b_b)$$



Remote Sensing of Cyanobacterial Blooms: from Monitoring to Forecast

2nd & 3rd period growing

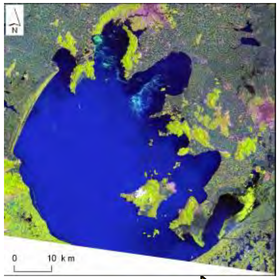
To develop a quantitative inversion model for chlorophyll-a and phycocyanin

$$R_{rs} = f'\frac{b_b}{a + b_b}$$

$$-a_w(\lambda_i)\frac{R(\lambda_i)}{f'(\lambda_i)} + b_{bw}(\lambda_i)\left(1 - \frac{R(\lambda_i)}{f'(\lambda_i)}\right) = \sum\left[a_i^*(\lambda_i)\frac{R(\lambda_i)}{f(\lambda_i)} - b_{bi}^*(\lambda_i)\left(1 - \frac{R(\lambda_i)}{f(\lambda_i)}\right)\right]c_i$$

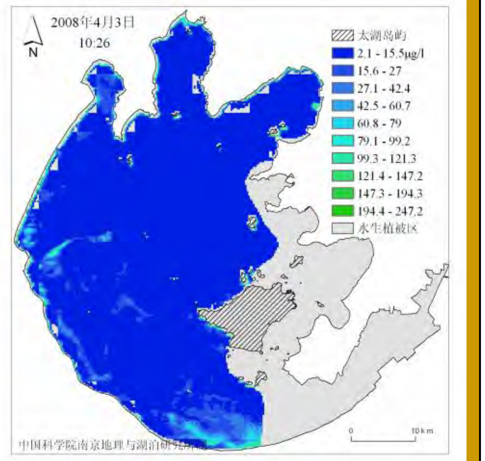
$$\begin{bmatrix} b_{bw}(\lambda_1)\left(1-\frac{R(\lambda_1)}{f'(\lambda_1)}\right) - a_w(\lambda_1)\frac{R(\lambda_1)}{f'(\lambda_1)} \\ b_{bw}(\lambda_2)\left(1-\frac{R(\lambda_2)}{f'(\lambda_2)}\right) - a_w(\lambda_2)\frac{R(\lambda_2)}{f'(\lambda_2)} \\ \cdots\cdots \\ b_{bw}(\lambda_n)\left(1-\frac{R(\lambda_n)}{f'(\lambda_n)}\right) - a_w(\lambda_n)\frac{R(\lambda_n)}{f'(\lambda_n)} \end{bmatrix} =$$

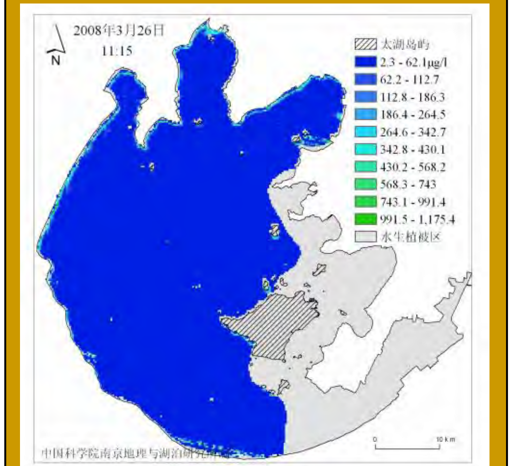
$$\begin{bmatrix} \frac{R(\lambda_1)}{f'(\lambda_1)}a_d^*(\lambda_1) & \frac{R(\lambda_1)}{f'(\lambda_1)}a_g^*(\lambda_1) & \frac{R(\lambda_1)}{f'(\lambda_1)}a_{ph}^*(\lambda_1) & \left(\frac{R(\lambda_1)}{f'(\lambda_1)}-1\right)b_{bp}^*(\lambda_1) \\ \frac{R(\lambda_2)}{f'(\lambda_2)}a_d^*(\lambda_2) & \frac{R(\lambda_2)}{f'(\lambda_2)}a_g^*(\lambda_2) & \frac{R(\lambda_2)}{f'(\lambda_2)}a_{ph}^*(\lambda_2) & \left(\frac{R(\lambda_2)}{f'(\lambda_2)}-1\right)b_{bp}^*(\lambda_2) \\ \cdots\cdots & & & \\ \frac{R(\lambda_n)}{f'(\lambda_n)}a_d^*(\lambda_2) & \frac{R(\lambda_n)}{f'(\lambda_n)}a_g^*(\lambda_2) & \frac{R(\lambda_n)}{f'(\lambda_n)}a_{ph}^*(\lambda_2) & \left(\frac{R(\lambda_n)}{f'(\lambda_n)}-1\right)b_{bp}^*(\lambda_n) \end{bmatrix} \begin{bmatrix} c_d \\ c_g \\ c_{ph} \\ c_p \end{bmatrix}$$



$$Y = AX$$

$$\hat{x} = (A^T A)^{-1} A^T y$$





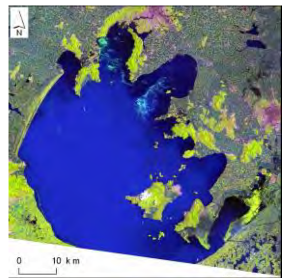
Remote Sensing of Cyanobacterial Blooms: from Monitoring to Forecast

MODIS B1, B2, B31 and B32 → A quantitative inversion model for lake water surface temperature → Accumulated temperature

1st period
Sinking & sleeping

- MODIS B1, B2 → Vegetation index NDVI → Surface emissivity ε_{31} and ε_{32} → Atmospheric transmittance τ_{31} and τ_{32} → Atmospheric water vapor content → MODIS B2, B19
- MODIS B31, B32 → Thermal radiation intensity I_{31}, and I_{32} → Brightness temperature T_{31}, and T_{32} → Split Window Algorithm (with surface emissivity and atmospheric transmittance) → Surface temperature → Geometric correction, cutting, executive line overlay, Graded coloring → Surface temperature result in the study area

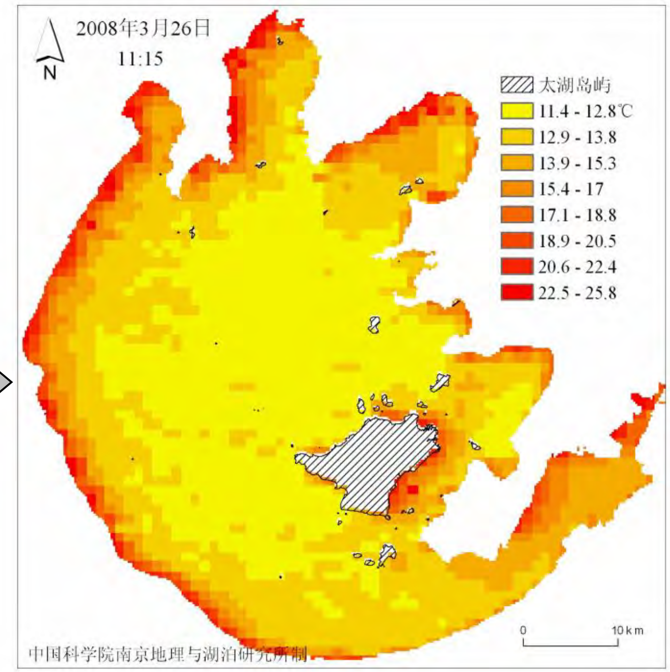
$$T_s = A_0 + A_1 T_{31} - A_2 T_{32}$$



$$T_i = \frac{C_2}{\lambda_i \ln(1 + \frac{C_1}{\lambda_i^5 I_i})}$$

$$w = \left(\frac{\alpha - \ln(\frac{\rho_{19}}{\rho_2})}{\beta} \right)^2$$

$$p_v = \frac{NDVI - NDVI_s}{NDVI_v - NDVI_s} \qquad NDVI = \frac{B_2 - B_1}{B_2 + B_1}$$



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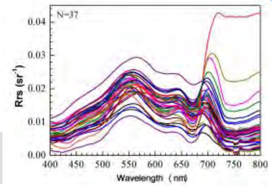
A novel phycocyanin index (PCI) for MERIS



PC has a local absorption peak at ~620 nm.

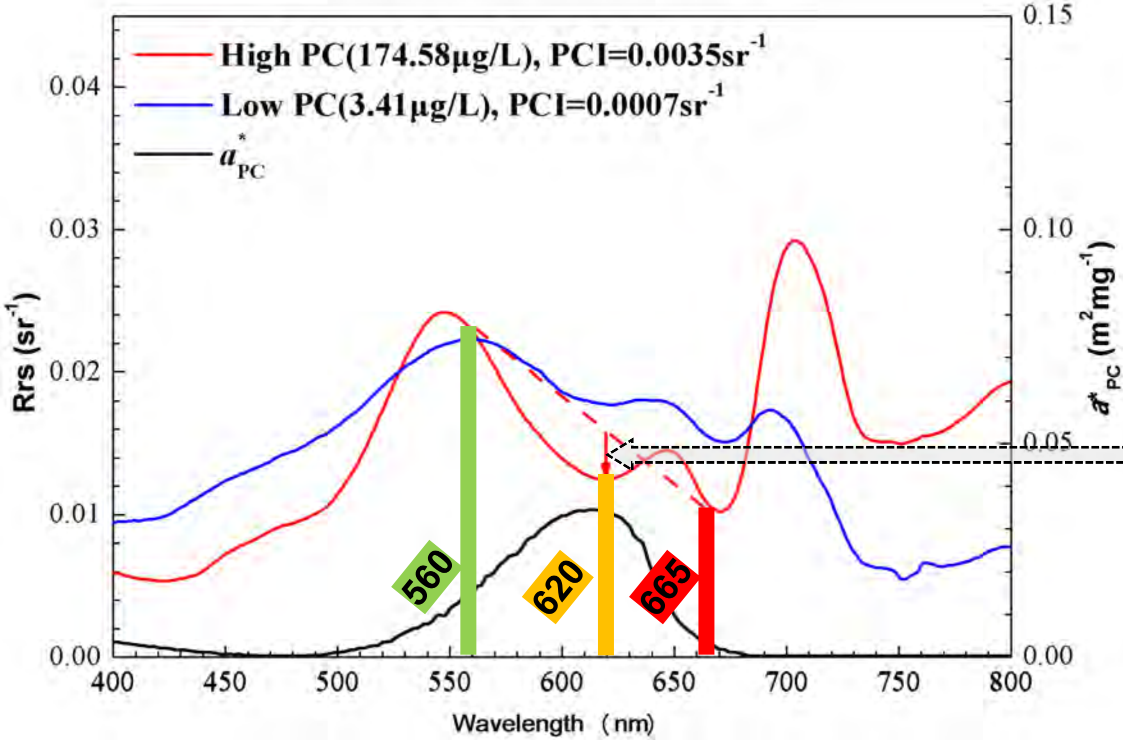
PCI is defined as remote-sensing reflectance (R_{rs}, sr^{-1}) at 620 nm normalized against a baseline formed linearly between $R_{rs}(560)$ and $R_{rs}(665)$.

Lake Taihu

PCI is a monotonic functional relationship with PC concentration

$$PCI = R'_{rs}(620) - R_{rs}(620)$$

$$R'_{rs}(620) = R_{rs}(560) + \frac{620-560}{665-560} \times \left(R_{rs}(665) - R_{rs}(560)\right)$$



$$PCI = R'_{rs}(620) - R_{rs}(620)$$

band 5 (centered at 560nm)
band 6 (centered at 620nm)
band 7 (centered at 665nm)

Qi L., Hu C., Duan H., Cannizzaro J., Ma R. A novel MERIS algorithm to derive cyanobacterial phycocyanin pigment concentrations in a eutrophic lake: Theoretical basis and practical considerations. Remote Sensing of Environment, 2014,9:298-317

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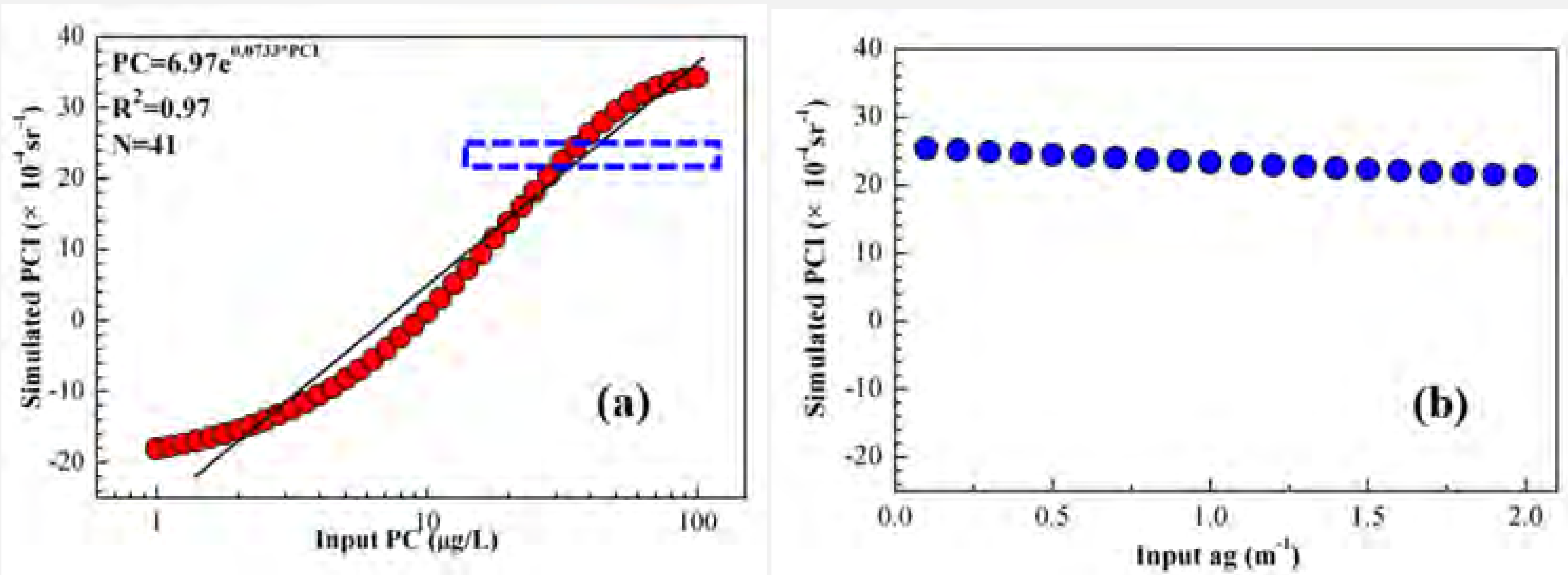
To change PC: 1-100 μg/L, how about PCI ?

In-water and atmospheric simulations



It is sensitive to PC, but insensitive to CDOM or atmospheric perturbations, thus can be applied to satellite data

Qi L., Hu C., Duan H., Cannizzaro J., Ma R. A novel MERIS algorithm to derive cyanobacterial phycocyanin pigment concentrations in a eutrophic lake: Theoretical basis and practical considerations. Remote Sensing of Environment, 2014,9:298-317

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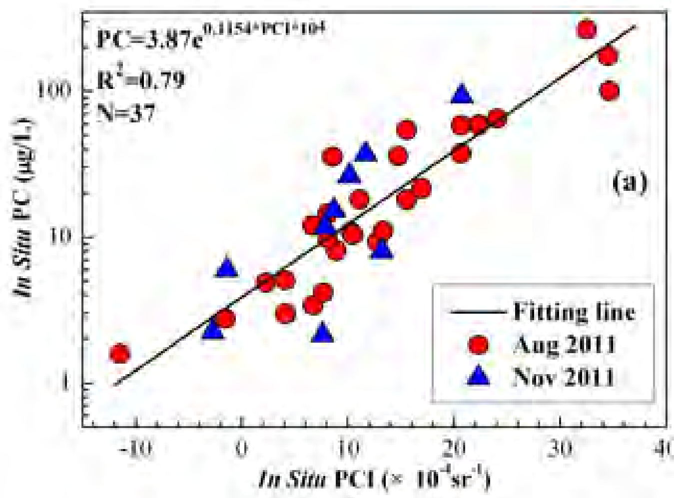
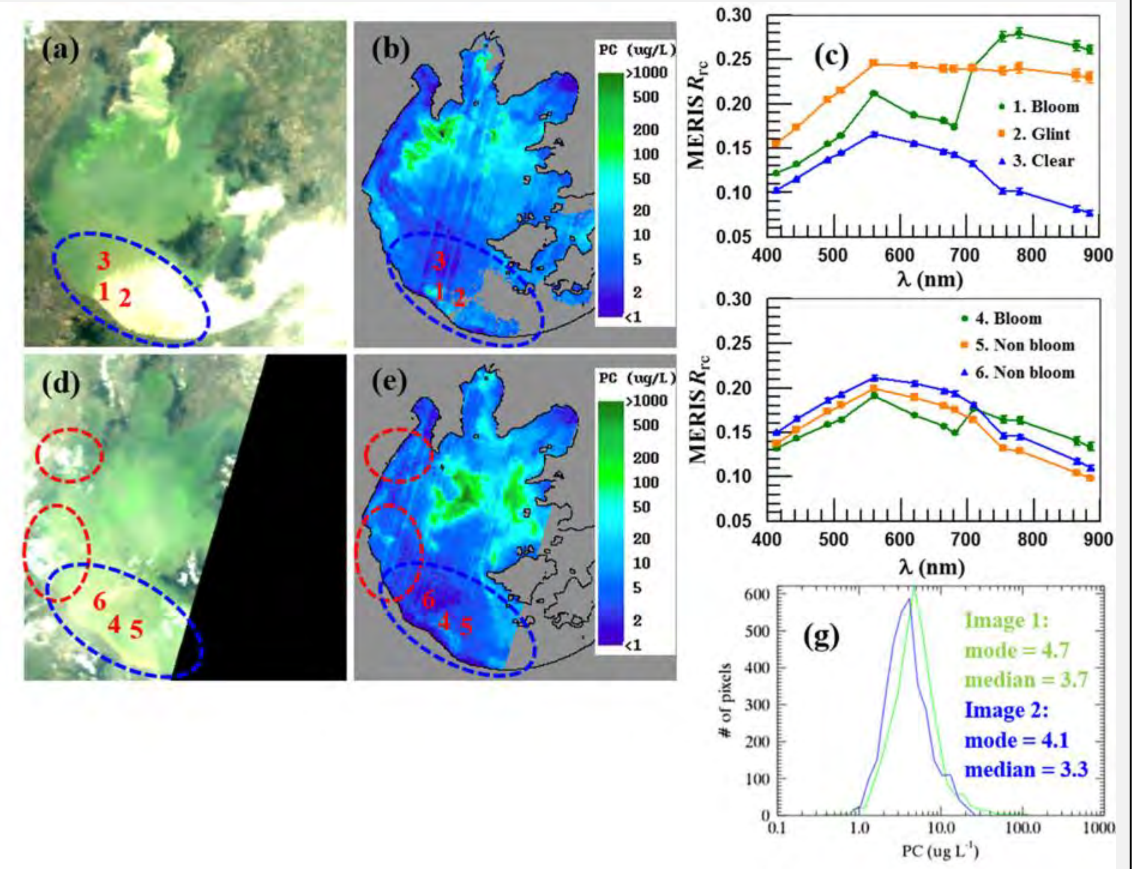
PCI Algorithm development and evaluation

Relationship between in situ PC and PCI



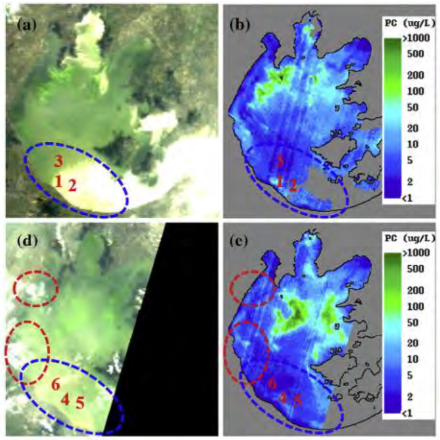


PCI is nearly immune to sun glint, thick aerosols, thin clouds, CDOM, and turbidity.

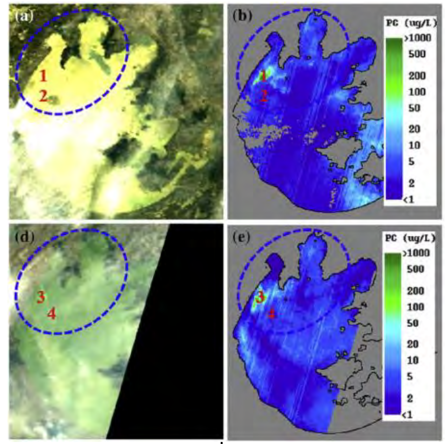
Remote Sensing of Cyanobacterial Blooms: from Monitoring to Forecast

Advantages

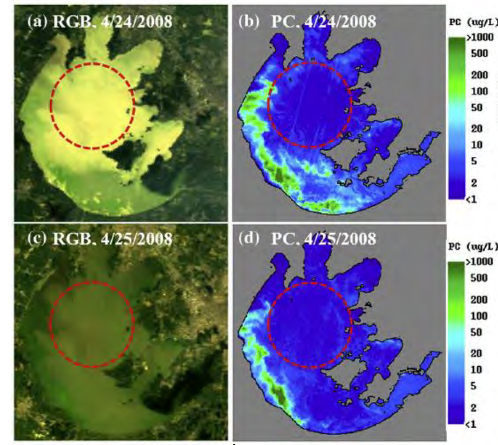
(1) PCI is insensitive to perturbations due to sun glint, thick aerosols, and thin clouds.



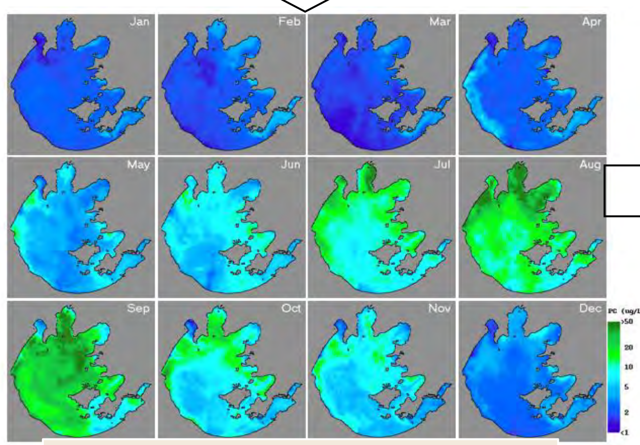
(2) PCI is insensitive to perturbations due to sun glint, thick aerosols, and thin clouds.



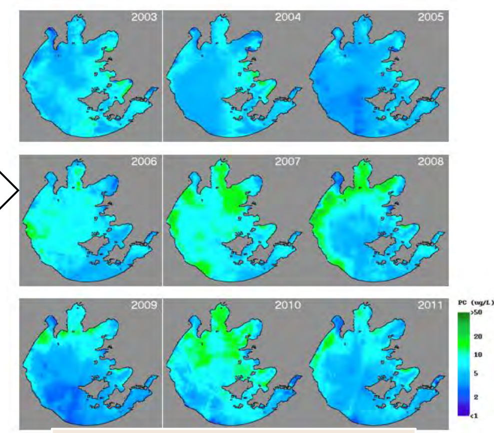
(3) PCI is insensitive to turbidity changes induced by sediment re-suspension



The valid satellite data rate is increased from <1% to 50%



Climatology monthly mean PC distributions



Annual mean PC distributions

Remote Sensing of Cyanobacterial Blooms: from Monitoring to Forecast

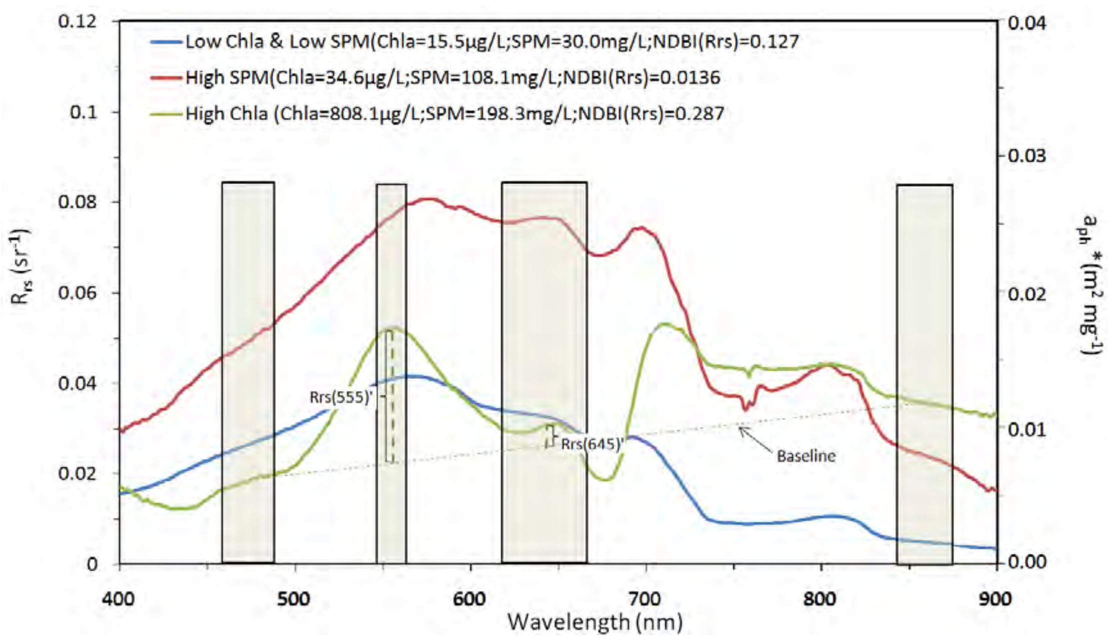
BNDBI (Baseline Normalized Difference Bloom Index) by MODIS band 1 and band 4

$$BNDBI = (R'_{rs}(555) - R'_{rs}(645))/(R'_{rs}(555) + R'_{rs}(645))$$

$$R'_{rs}(555) = R_{rs}(555) - \left[R_{rs}(469) \times \frac{(859-555)}{(859-469)} + R_{rs}(859) \times \frac{(555-469)}{(859-469)}\right]$$

$$R'_{rs}(645) = R_{rs}(645) - \left[R_{rs}(469) \times \frac{(859-645)}{(859-469)} + R_{rs}(859) \times \frac{(645-469)}{(859-469)}\right]$$

$$\text{Chla} = 982.3 \times BNDBI^4 + 71.86 \times BNDBI^3 + 562.4 \times BNDBI^2 + 79.05 \times BNDBI + 6.6$$



Advantages: (1) to reduce the effect of atmosphere; (2) to reduce the effect of turbid water

Zhang Y., Ma R., Duan H., Loiselle S., Zhang M., Xu J. A novel MODIS algorithm to estimate chlorophyll a concentration in eutrophic turbid lakes. Ecological Indicators. 2016, 69: 138-151

- A worldwide phenomenon: algae blooms
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Remote Sensing of Cyanobacterial Blooms: from Monitoring to Forecast

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- Obviously, cyanobacterial blooms are heterogeneous in horizontal and the coverage area can be estimated;
- However, how is it in vertical and how many is the biomass?

It is necessary for forecast warning to acquire the spatial information both in horizontal and in vertical

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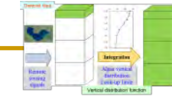

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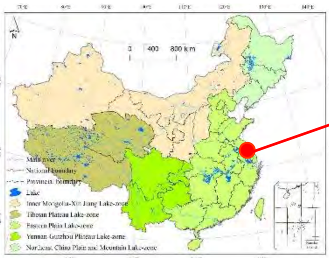
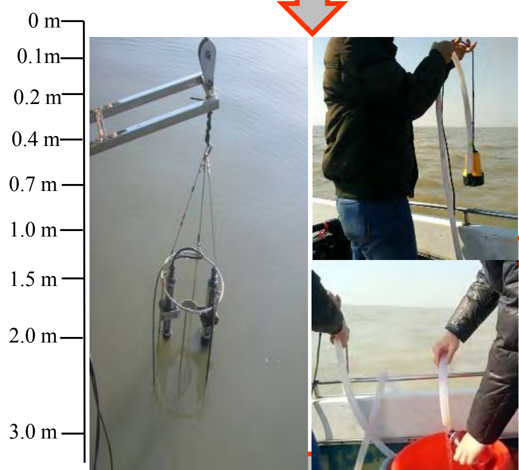
Remote Sensing of Cyanobacterial Blooms: from Monitoring to Forecast

To determine the vertical distribution type by the field



Lake Chaohu

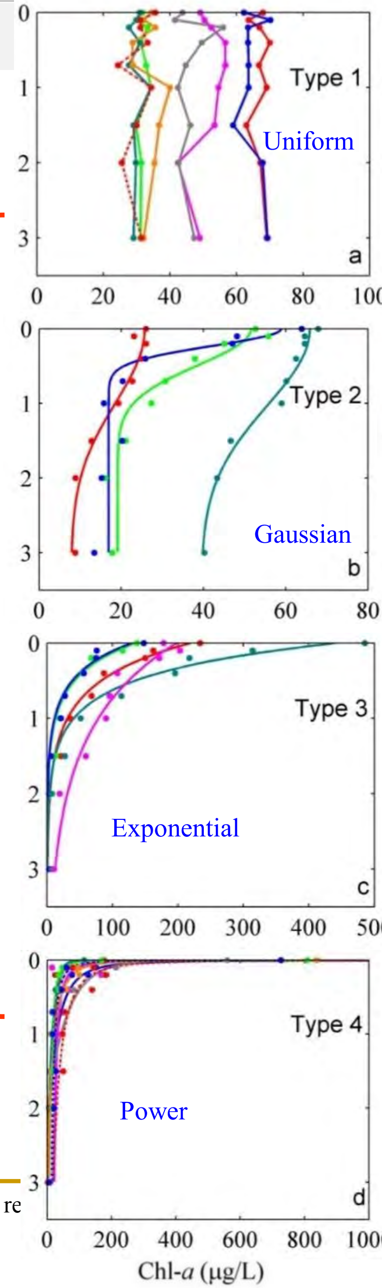
Sampling in vertiacl
Underwater light field by TriOS



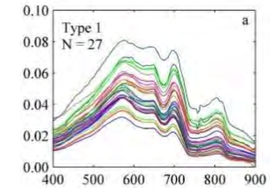
E$_u$: Upwelling irradiance
E$_d$: Downwelling irradiance
L$_u$: Upwelling radiance
Chl, SPM, DOC, POC, PC, a, bb, Kd

	water surface value					CV of vertical profile				
	N	mean	SD	min	max	N	mean(%)	SD(%)	min(%)	max(%)
Chla	74	352.68	922.32	26.00	6988.29	74	67.13	67.79	3.59	238.94
SPIM	41	31.33	17.47	10.00	88.00	41	27.99	13.50	7.61	64.33
DOC	64	27.27	23.21	3.23	126.32	9	13.94	9.26	6.39	33.52

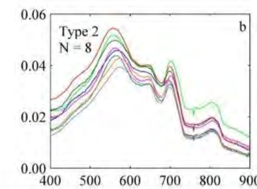
CV=SD/mean×100%



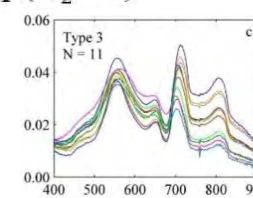
$$f_1(z) = C$$



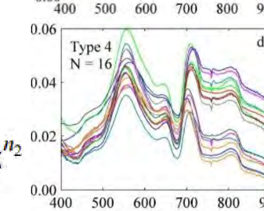
$$f_2(z) = C_0 + \frac{h}{\sigma\sqrt{2\pi}} \exp[-\frac{1}{2}(\frac{z}{\sigma})^2]$$



$$f_3(z) = m_1 \times \exp(m_2 \times z)$$



$$f_4(z) = n_1 \times z^{n_2}$$



Type	parameters	min	max	mean	SD
type 2	C_0	7.76	39.81	22.42	10.85
	σ	0.02	0.41	0.20	0.15
	h	1.48	75.59	34.08	26.94
type 3	m_1	129.4	613.30	280.98	146.54
	m_2	-9.67	-0.64	-3.15	2.79
type 4	n_1	12.46	80.63	29.01	19.82
	n_2	-1.10	-0.28	-0.71	0.26

Kun Xue, Yuchao Zhang, Hongtao Duan, Ronghua Ma, S ... ang. A re ... i
eutrophic lake Remote Sensing. 2015, 7, 14403-14427.

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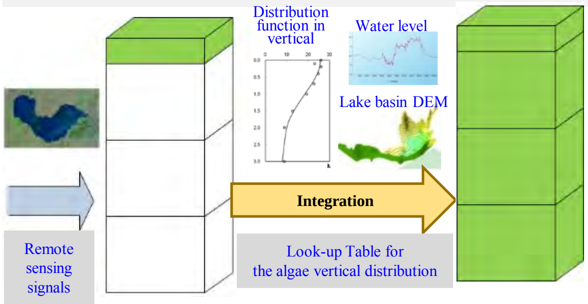
Remote Sensing of Cyanobacterial Blooms: from Monitoring to Forecast

To estimate the total biomass in Lake Chaohu by MODIS imageries



Jing Li, Yuchao Zhang, Ronghua Ma, Hongtao Duan, Loiselle Steven Aurthor, Kun Xue, Qichun Liang. Satellite-Based Estimation of Column-Integrated Algal Biomass in Nonalgae Bloom Conditions: A Case Study of Lake Chaohu, China IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 2017, 2: 450-462

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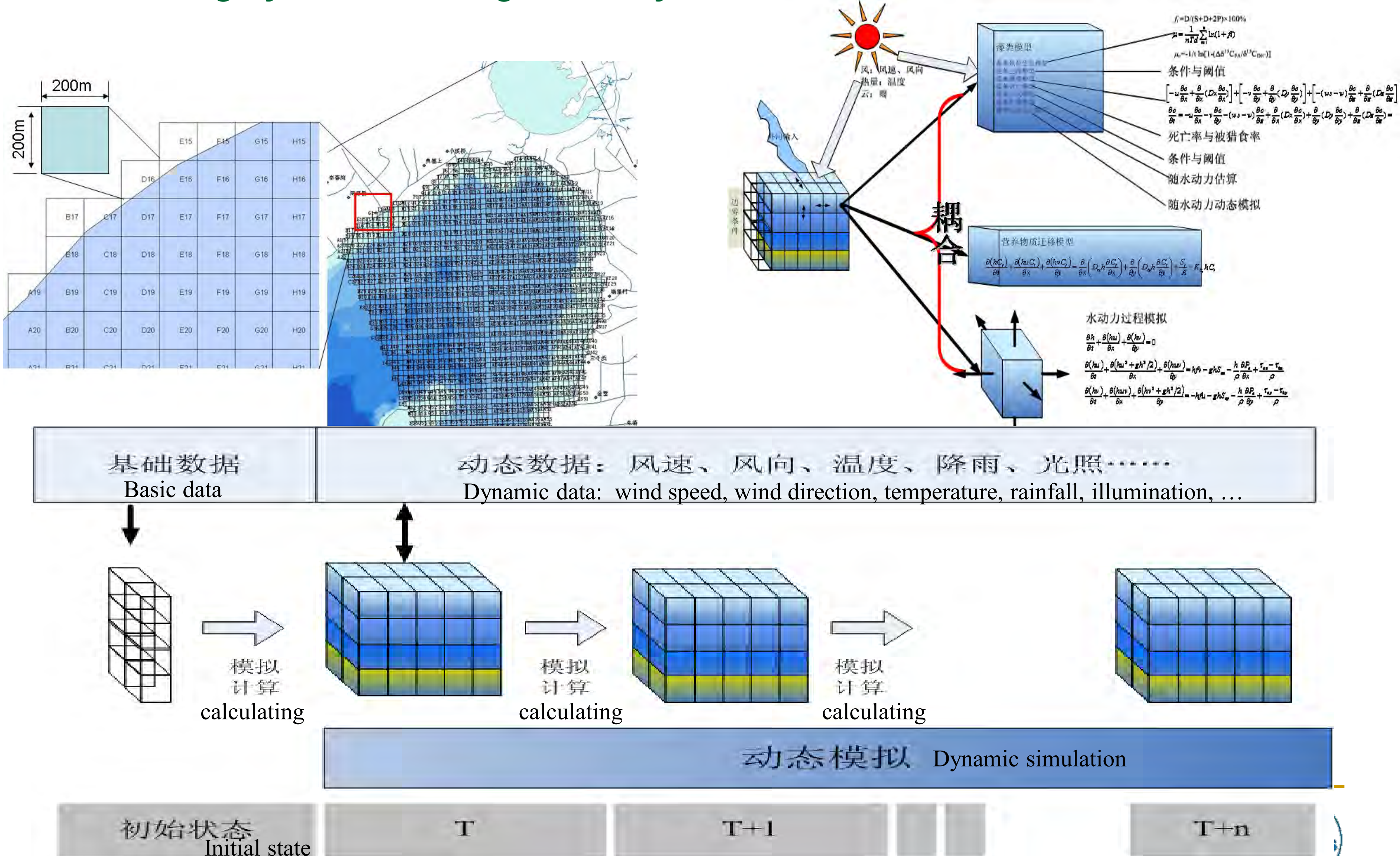
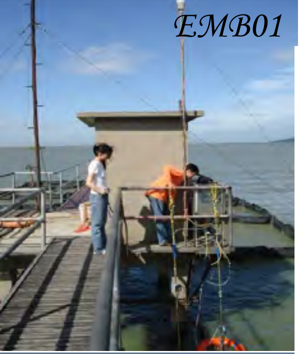
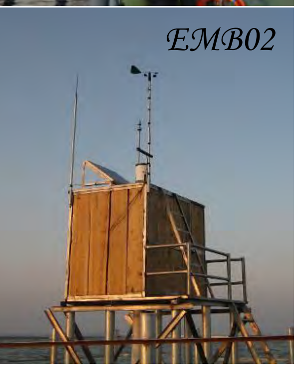
- A worldwide phenomenon: algae blooms
- Blooming distribution in China
- Spatial-temporal distribution of cyanobacteria blooms in Lake Taihu and Lake Chaohu
- Formation process of cyanobacteria bloom
- CHL&PC retrieval in surface waters
- Phytoplankton biomass estimation
- Cyanobacterial bloom forecast

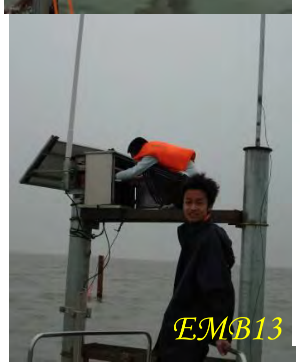
To develop a cyanobacteria bloom prediction model including cyanobacteria growth, hydrodynamic and nutrient distribution

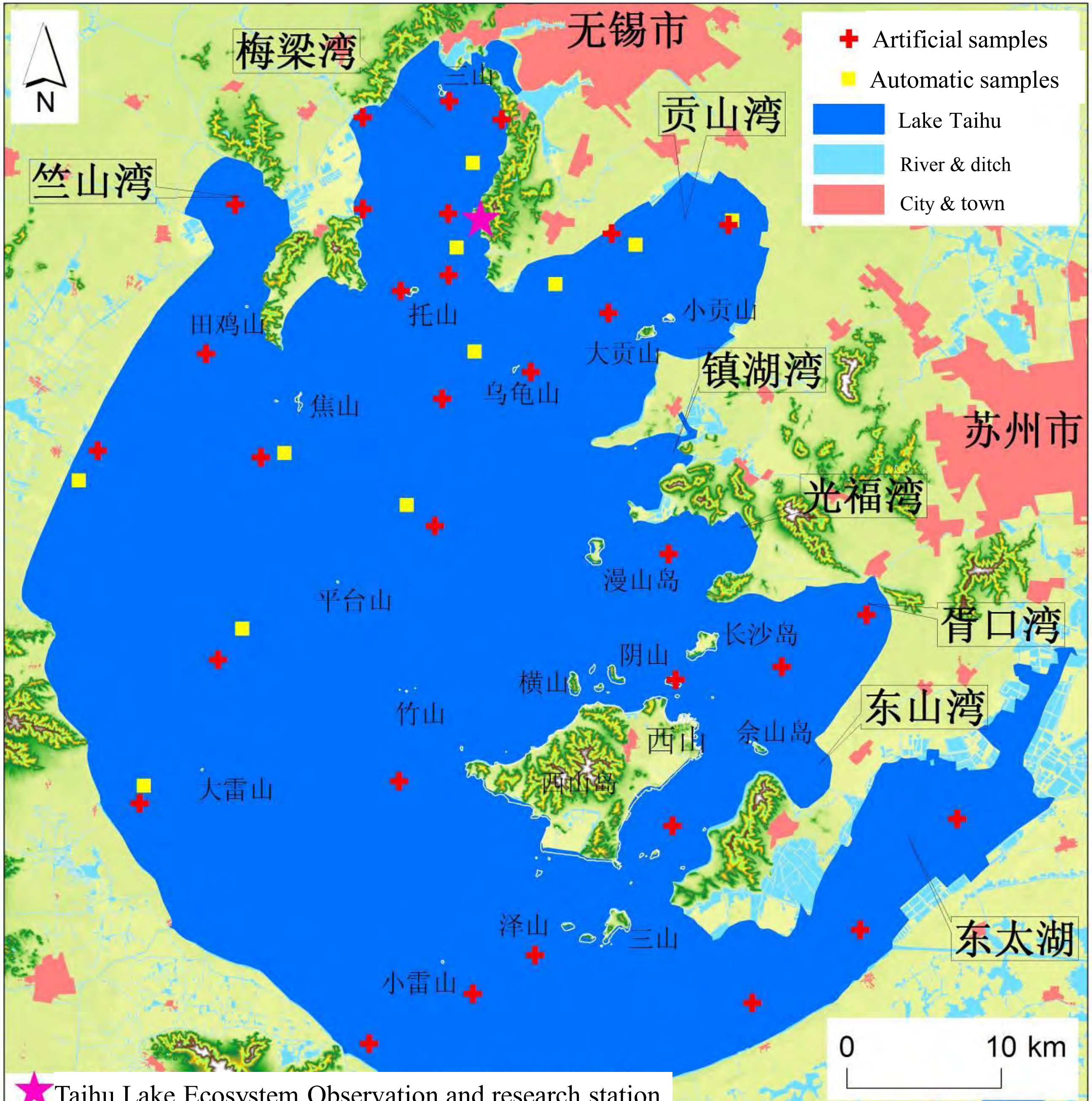


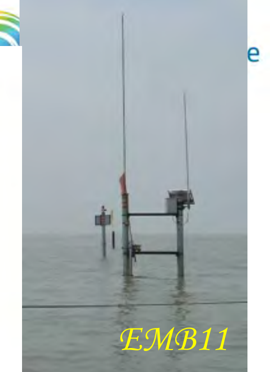
Observation data: automatic and artificial in Lake Taihu



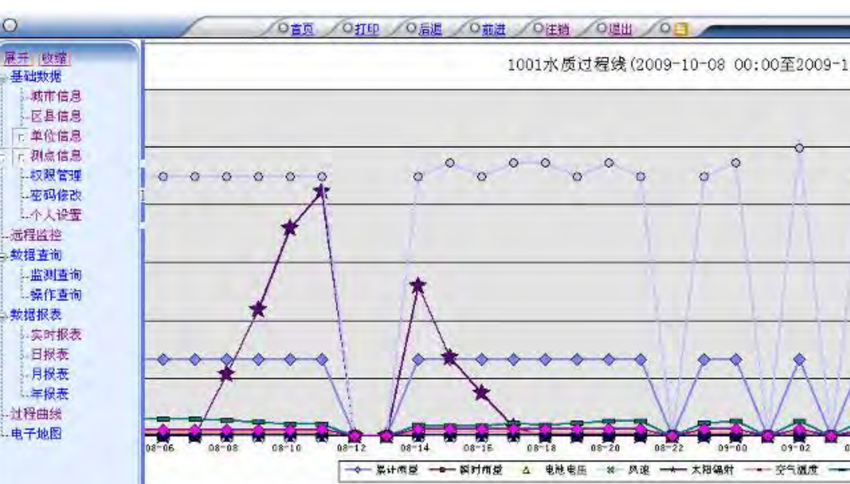








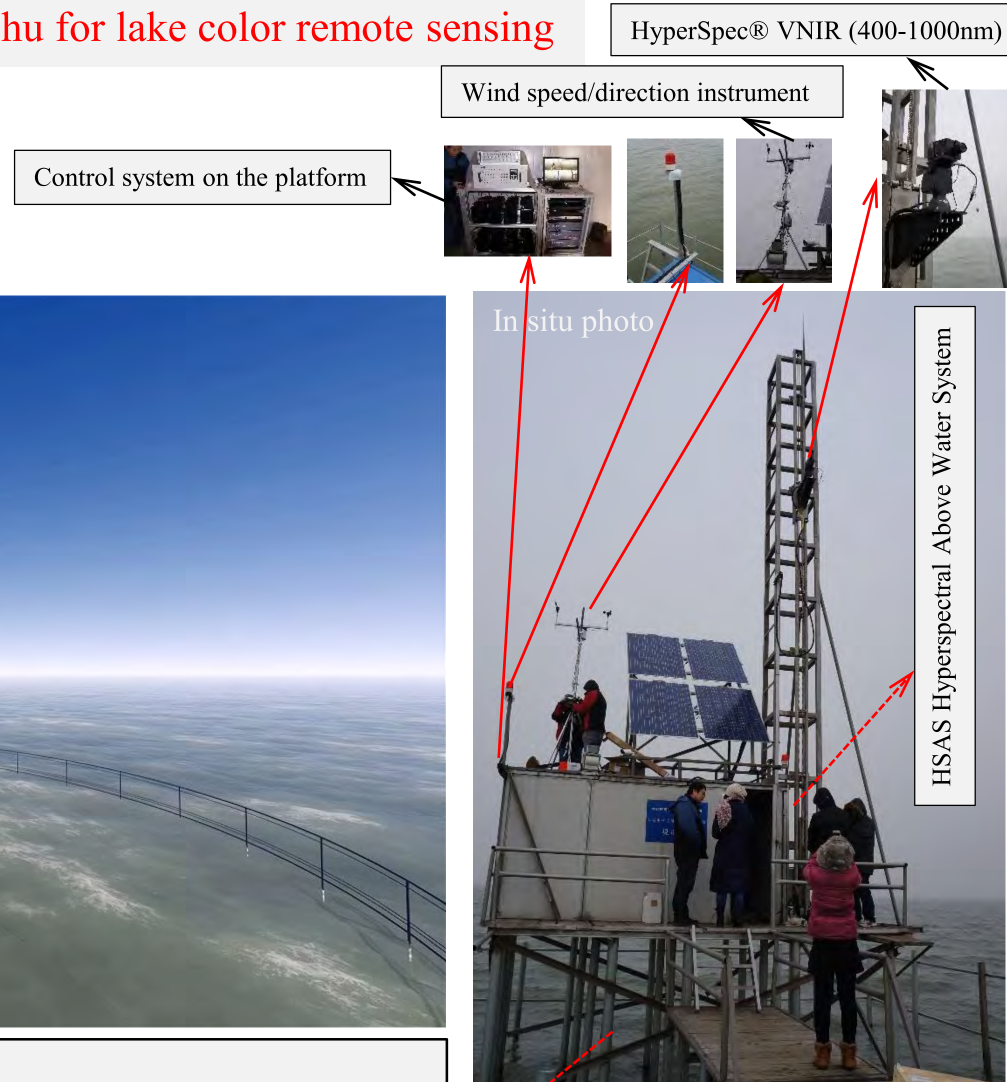
A water quality automatic monitoring system for Lake Taihu



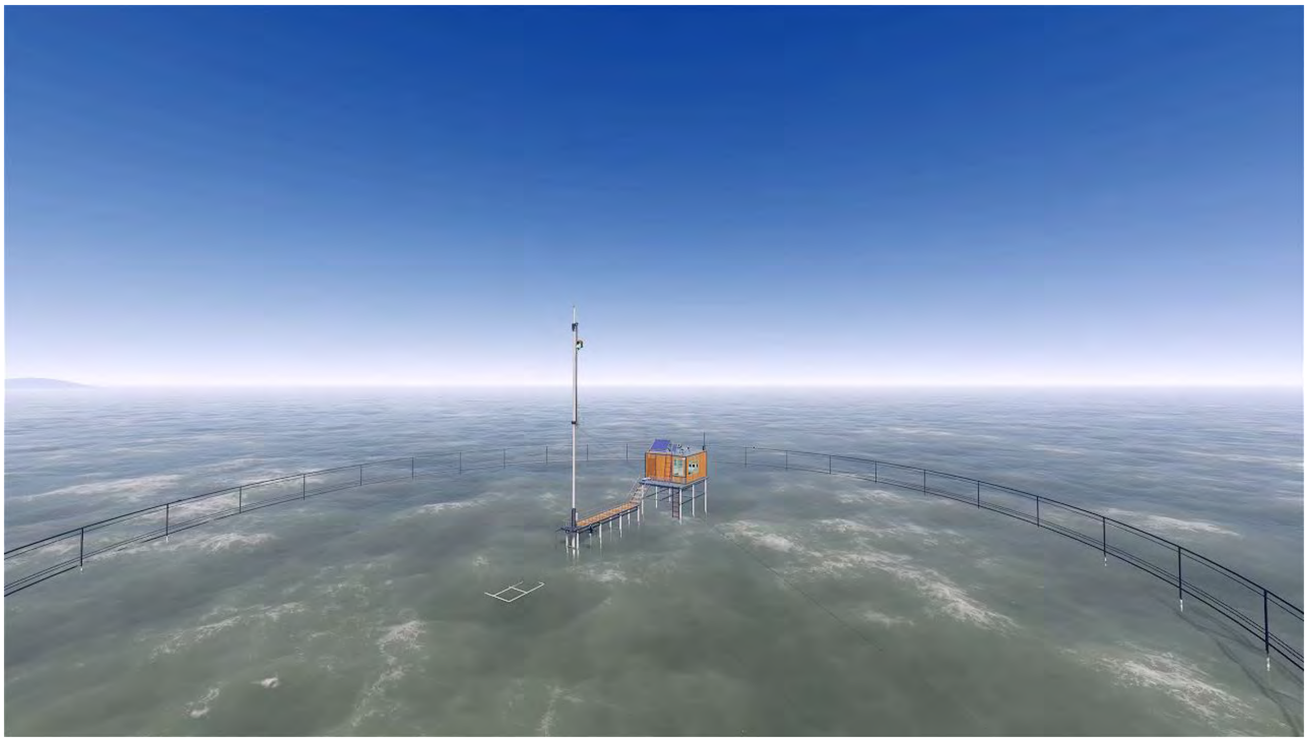
测点信息列表

序号	单位名称	测点号牌	在线状态	设备状态	累计雨量	瞬时雨量	电池电压	风速	风向	大气压	太阳辐射	空气温度	湿度	蓝绿藻	PH	叶绿素	溶解氧	浊度	深度	氨氮	硝酸盐	水体温度	电导率	盐度	远程操作	监测曲线
1	中科院南京湖泊研究所	1001	✓	✓	264.75	0.00	13	0.0	0.3	73.84	746.5	10.4	53.4	849	9.20	2.42	4.59	1986.00	0.85	0.00	38.73	21.24	0.38	0.19		
2	中科院南京湖泊研究所	1002	✓	✓	2.50	0.00	14	10.7	60.5	77.94	825.6	20.1	61.0	0	8.36	非数字	6.20	非数字	3.35	1.02	0.68	23.30	0.50	0.25		

FTP (Field Test Platform) in Lake Taihu for lake color remote sensing



Simulation field



- HeadWall HyperSpec® VNIR (400-1000nm)
- Flow velocity and direction instrument
- On-line water quality monitoring system/Cyclops-7 Submersible Sensors (chl-a, turbidity, water temperature, DO, conductivity, blue-green algae, etc.)
- RAMSES Underwater Hyperspectral (RAMSES-ARC/ACC-UV/VIS)
- HS-6P
- AC-S absorption attenuation meter

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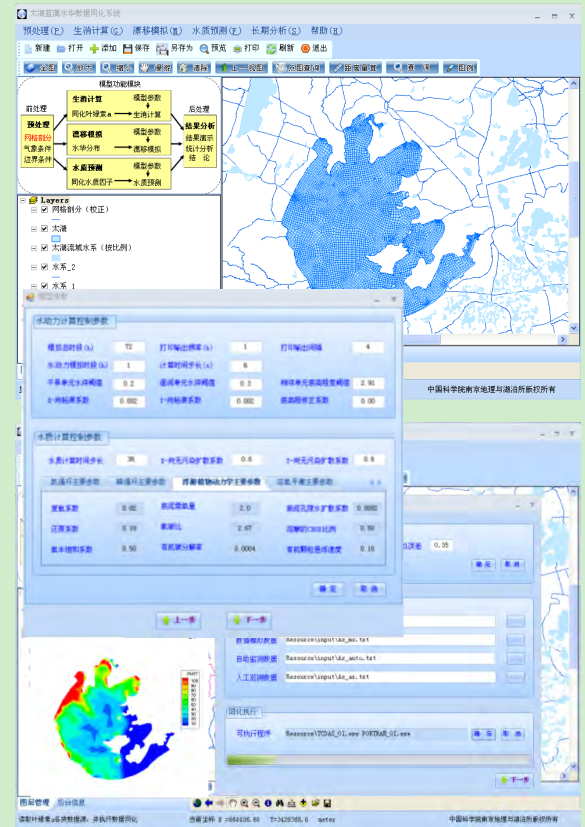
A lake cyanobacterial blooms monitoring software/system by MODIS

the MODIS satellite broadcasting and relay system

the lake cyanobacterial blooms MODIS monitoring system



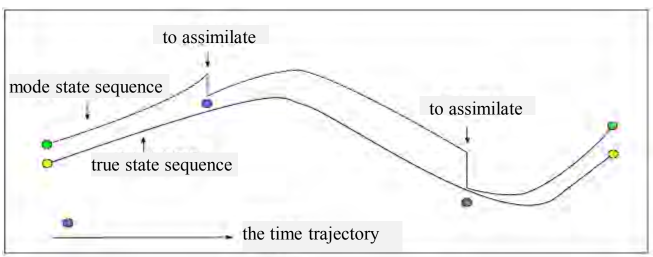
the data assimilation system for cyanobacterial blooms forecast in Lake Taihu

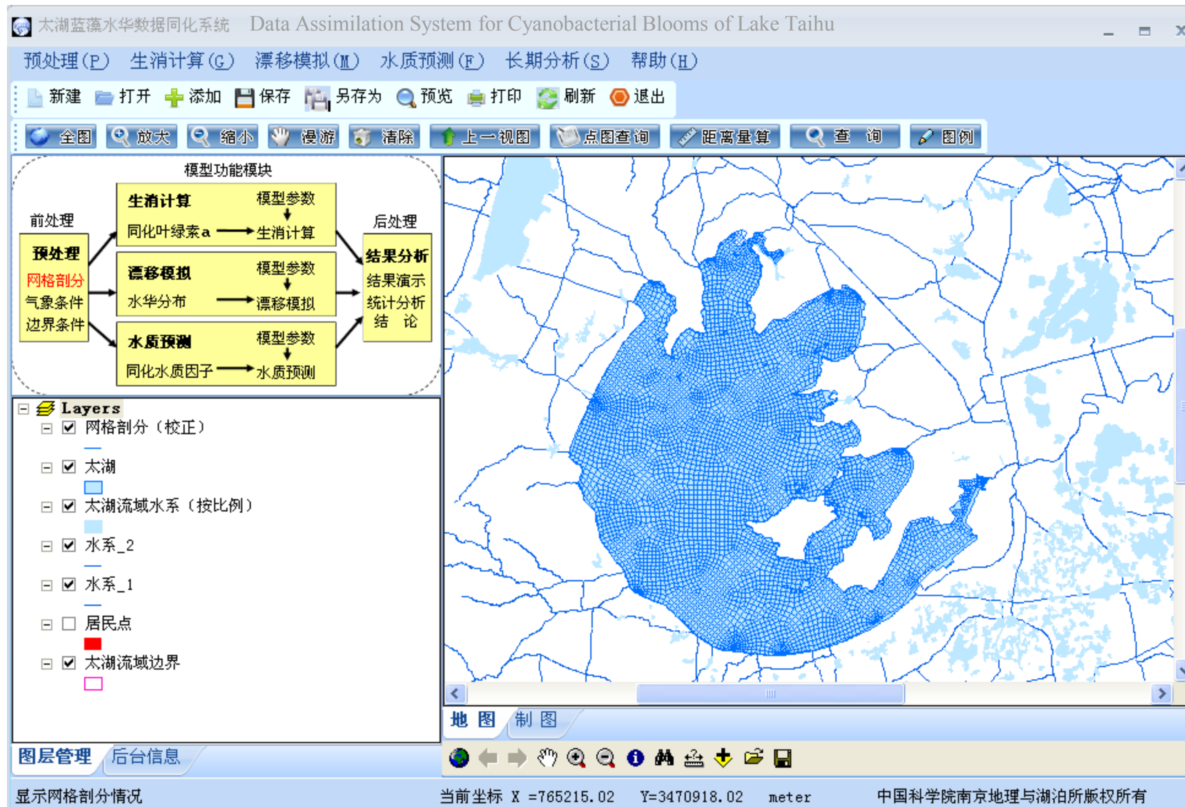
Data Assimilation in Ecological Processes of Cyanobacterial Bloom in Taihu Lake

To couple the hydrodynamic model

with remote sensing inversion data, automatic and artificial monitoring data

to implement multi-source data assimilation of cyanobacterial blooms





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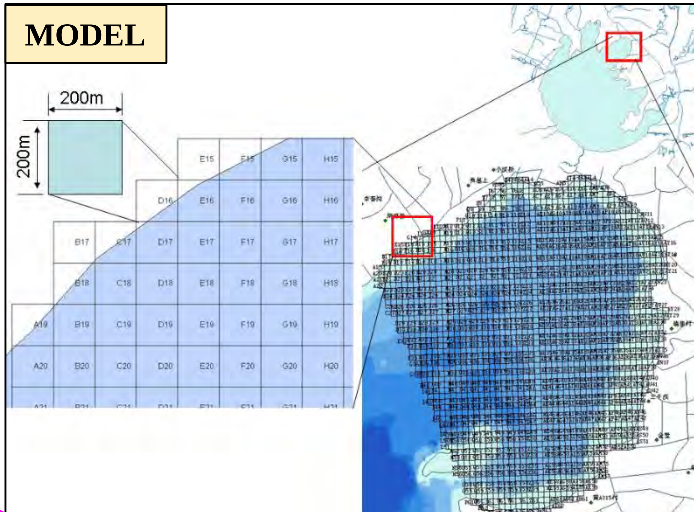
Remote Sensing of Cyanobacterial Blooms: from Monitoring to Forecast

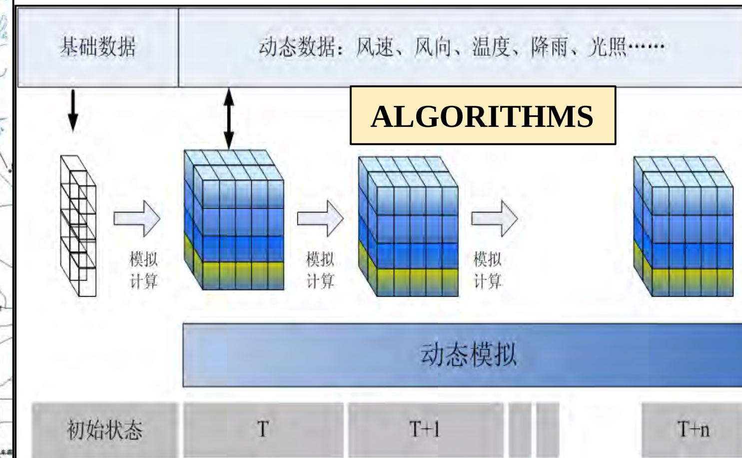
A model/software integrating cyanobacteria growing, water dynamic, and nutrient distribution model

DATA

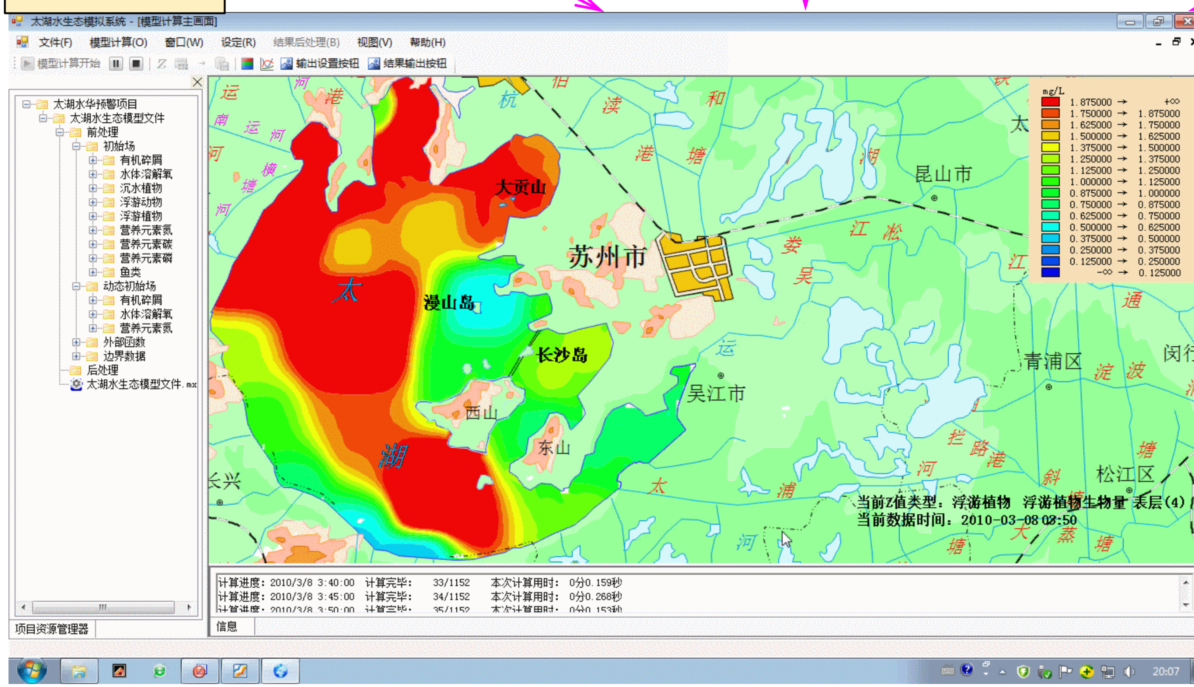
MODEL



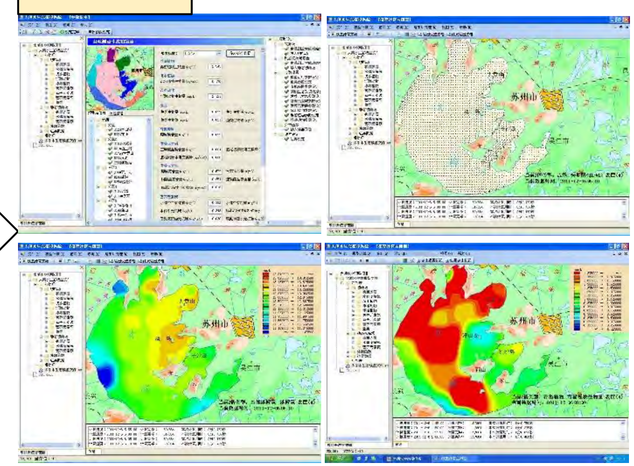
ALGORITHMS



SOFTWARE



OUTPUT



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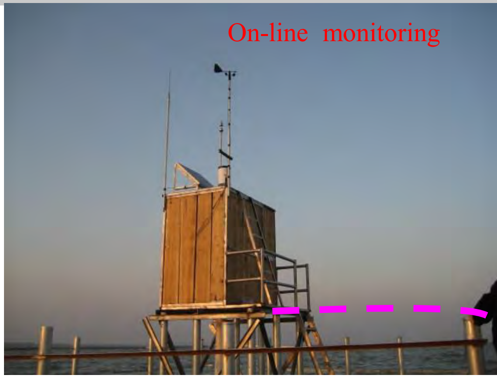
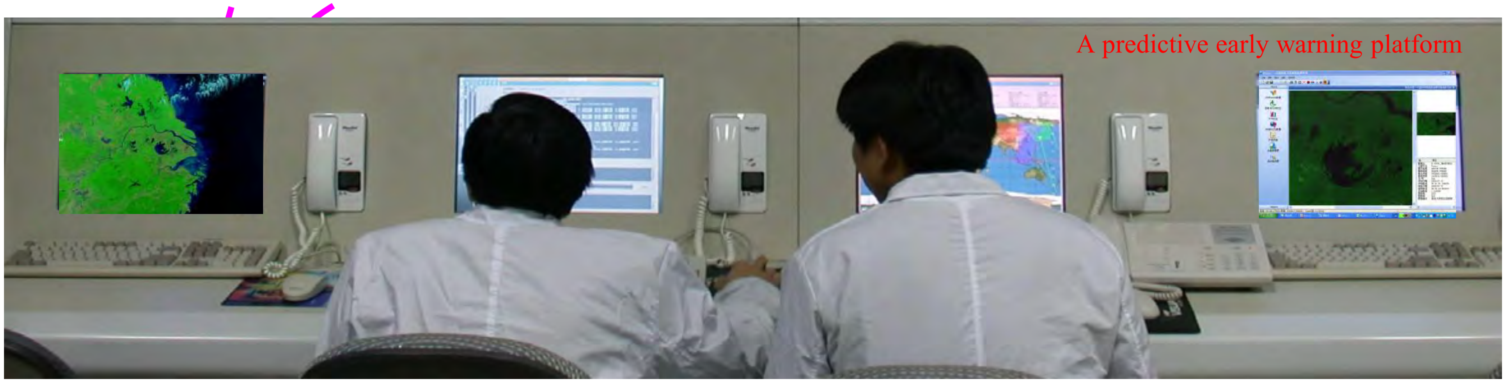
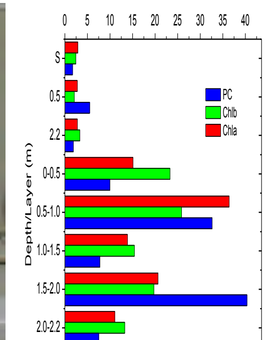
Remote Sensing of Cyanobacterial Blooms: from Monitoring to Forecast

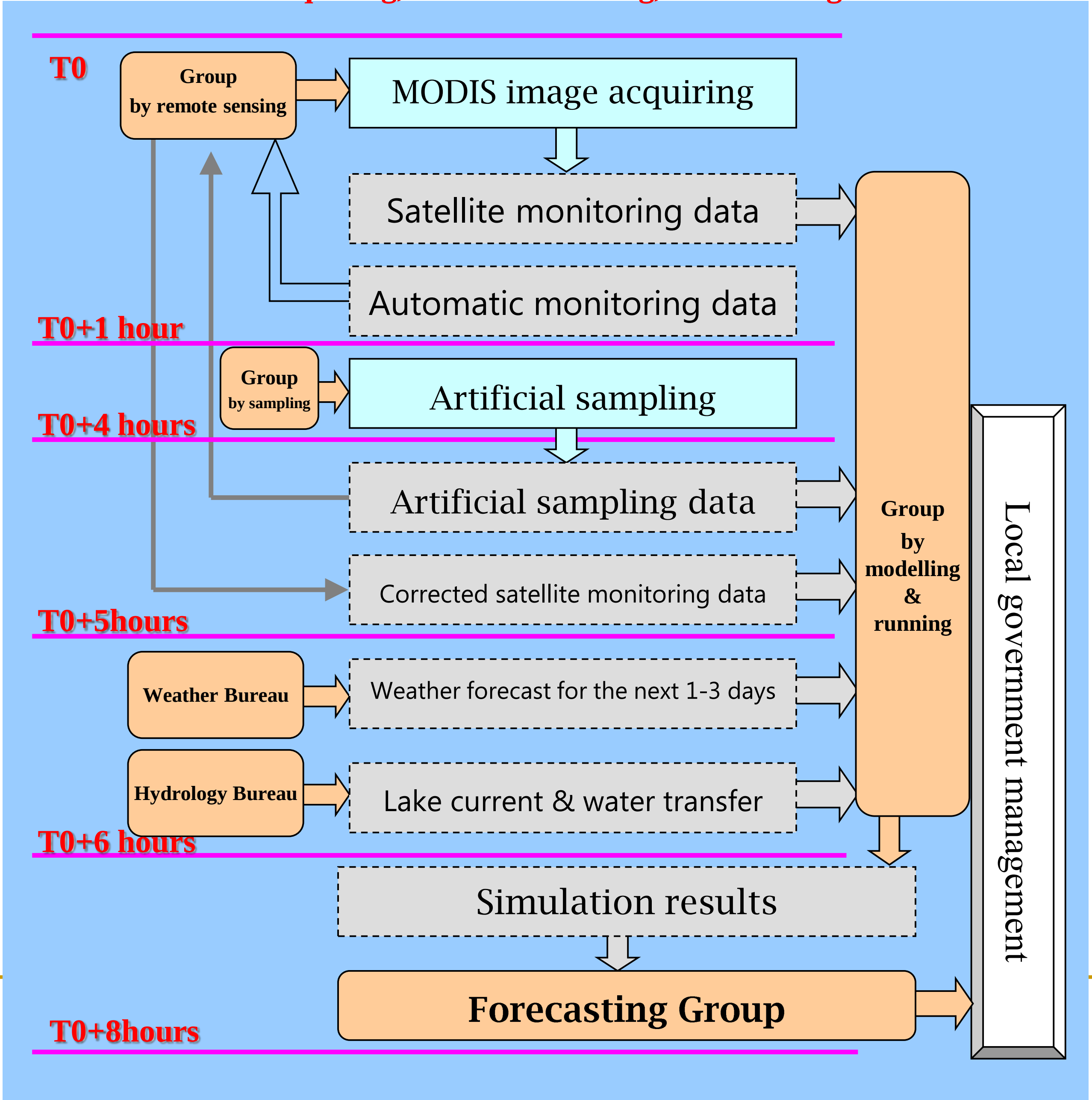






Remote Sensing of Cyanobacterial Blooms: from Monitoring to Forecast

Only eight hours from MODIS data acquiring, model forecasting, to the local government informing



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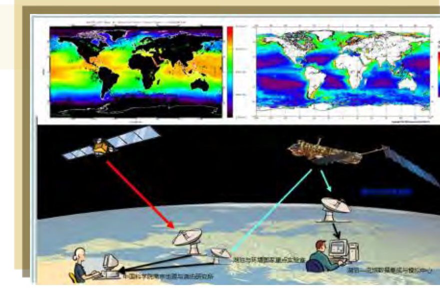
Remote Sensing of Cyanobacterial Blooms: from Monitoring to Forecast

Lake Taihu cyanobacteria blooming/forcast report for local government every three days



太湖蓝藻卫星遥感监测报告

总第 918 期

中国科学院南京地理与湖泊研究所　2016 年 06 月 13 日

2016 年 06 月 13 日 11 时 00 分的 MODIS 卫星影像显示……面出现蓝藻水华，通过 APA 算法计算，高低强度蓝藻华……424.4km²，涉及面积 616.12km²（详情见表 1 和表 2）。太……华 MODIS 卫星遥感反演结果分别见图 1-图 5。

受陆地地表影响，沿岸水体叶绿素和藻蓝素的反演结果……参考。太湖温度分布较为均一，沿岸温度略高于湖中心温度……

表 1 太湖水体卫星遥感反演结果

	平均叶绿素 (μg/l)	平均藻蓝素 (μg/l)	平均表层水温 (℃)	绝对面积 (km2)
11 时 00 分	27.2	88.9	28.3	424.4

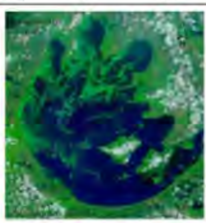


图 1 太湖 MODIS 卫星影像

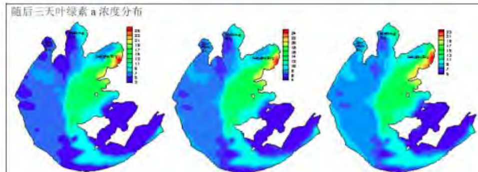
图 2 太湖分区图

太湖蓝藻及湖泛监测预警半周报

太湖蓝藻及湖泛监测预警工作小组　2015-10-12

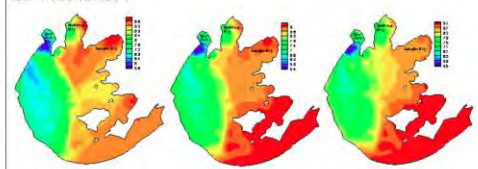
中国科学院南京地理与湖泊研究所太湖蓝藻及湖泛监测预警半周报

随后三天叶绿素 a 浓度分布



10 月 13 日　10 月 14 日　10 月 15 日

随后三天溶解氧浓度分布



10 月 13 日　10 月 14 日　10 月 15 日

区域	发生水华概率	出现异味水体概率
太湖沙塘段	40%	20%
沙塘符渎段	60%	30%
符渎陈东段	60%	30%
陈东八房段	40%	20%
吴塘于子段	60%	10%
漏洞新开段	60%	10%
梅梁湾	60%	10%

监测人：江苏省水文局　数据整理人：李未　预报人：秦伯强、李未、张运林、朱广伟

Lake Taihu cyanobacteria blooming forecast report for local government and public

To forecast the cyanobacteria blooming **occurrence site, probability/area and spatial distribution**


Thank you