

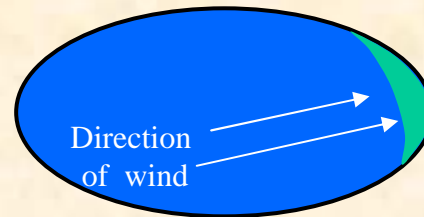


**USE OF A SUBMERSIBLE SPECTROFLUOROMETER
IN CYANOBACTERIAL MONITORING PROGRAMS:
The example of lake Bourget**

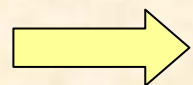
**National Institute of Agronomic Research
Thonon, France**

Spatial distribution of cyanobacteria difficult to evaluate...

- Horizontal distribution mainly linked to physical parameters (wind, current, gyre...)



- Vertical distribution linked to physical parameters but also to ecological strategies of cyanobacteria (dispersed or stratified...)



Good estimation of the distribution and of the biomass of cyanobacteria requires an extensive sampling which is time consuming

We need new tools for monitoring program of cyanobacteria

→ test of the BBE FluoroProbe

The BBE FluoroProbe...a submersible spectrofluorometer

control by computer and
dedicated software

50 m suspension and
connection cable



built-in battery, electronics,
memory...

dark PVC screen

LED and detectors window

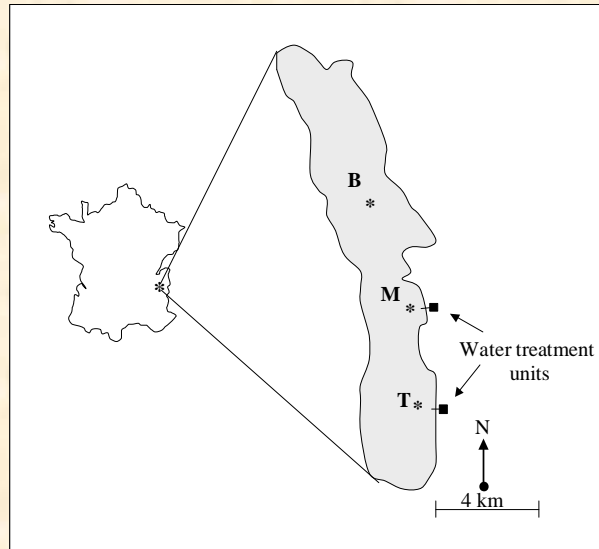
pressure sensor



- ☛ Sequential excitation of water sample using five LEDs at wavelengths of 450, 525, 570, 590 and 610 nm,
- ☛ Recording at 680 nm: PSII chl *a* fluorescence using bandpass filter and photomultiplier
- ☛ Calculation of relative contributions of each spectral group according to fingerprint definitions

...sell by *BBE-Moldaenke (FRG)*

The probe has been essentially tested in lake Bourget



- Water used for human consumption and for recreational activities
- Toxic bloom of *Planktothrix rubescens* since six years
- Low biomass of other phytoplanktonic species ($< 5 \mu\text{g}$ chlorophyll *a*)



Calibration of the probe for *P. rubescens*

Calibration in the lake of Bourget

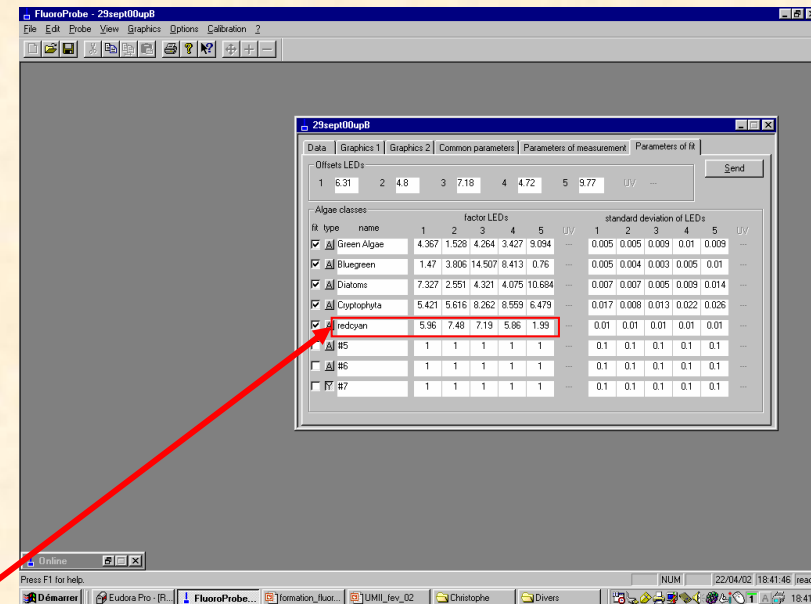
- at a moment where *P. rubescens* represents 100 % of the total biomass
- raw fluorescence data for each LED
- chl *a* estimation by spectrophotometric measurement in laboratory

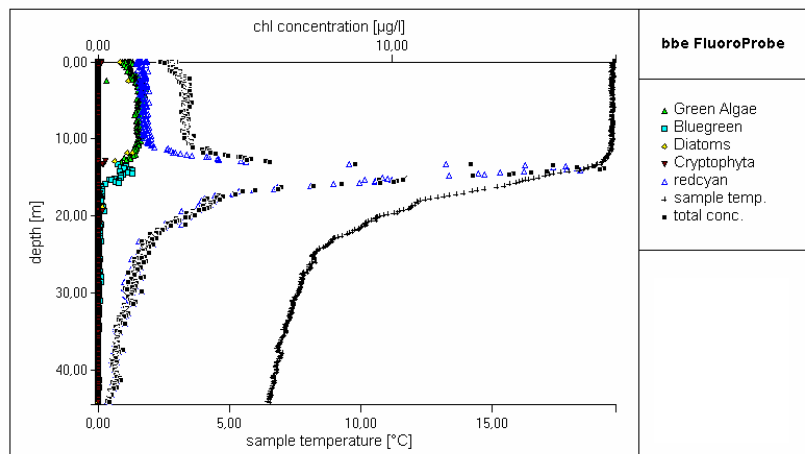
date	time	depth m	temperature °C	LED 1 digits	LED 2 digits	LED 3 digits	LED 4 digits	LED 5 digits
29.09.2000	10:09:25	0.04	19.64	20.42	19.5	22.27	17.12	21.98
29.09.2000	10:09:26	0.05	19.67	20.46	19.65	22.13	17.97	22.9
29.09.2000	10:09:28	0.02	19.6	19.85	19.75	20.84	14.75	23.56
29.09.2000	10:09:29	0.03	19.6	19.86	19.42	20.56	17.66	21.23
29.09.2000	10:09:30	0.05	19.58	20.23	18.54	21.22	15.44	24.06
29.09.2000	10:09:32	0.07	19.63	20.76	19.14	21.22	18.17	22.75
29.09.2000	10:09:33	0.11	19.62	18.05	20.76	20.35	17.03	22.93
29.09.2000	10:09:35	0.07	19.59	20.12	19.42	19.26	15.79	24.1
29.09.2000	10:09:36	0.03	19.62	19.74	20.3	21.2	15.85	22.74
29.09.2000	10:09:37	0.01	19.61	20.01	17.69	19.4	14.93	20.89
29.09.2000	10:09:39	0.01	19.59	19.16	18.19	17.64	15.97	23.17
29.09.2000	10:09:41	0.01	19.59	19.82	17.95	19.92	15.46	21.26
29.09.2000	10:09:42	0.07	19.6	19.39	18.23	20.76	16.19	23.59
29.09.2000	10:09:43	0.15	19.6	17.75	17.09	20.94	16.26	21.74

Mean raw fluorescence for LED2: 19.12 units
 chl *a* concentration: 2.556 $\mu\text{g/L}$
 → relative fluo. at 525 nm : 7.48 / μg chl *a*

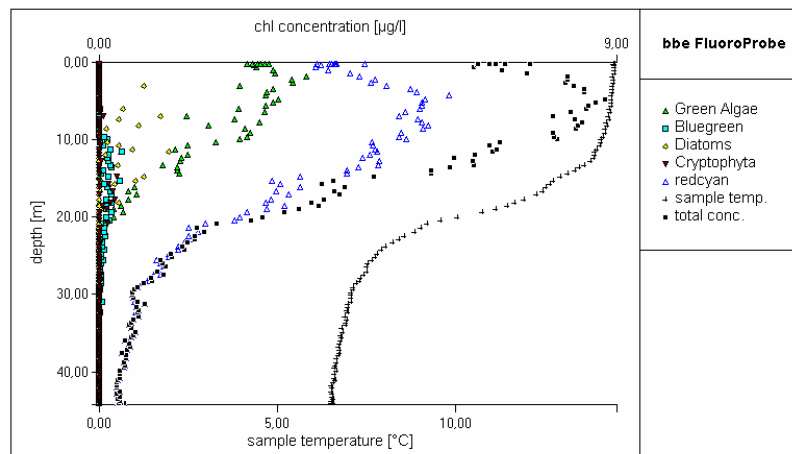
Same work for each LED

Specific fingerprint for *P. rubescens*

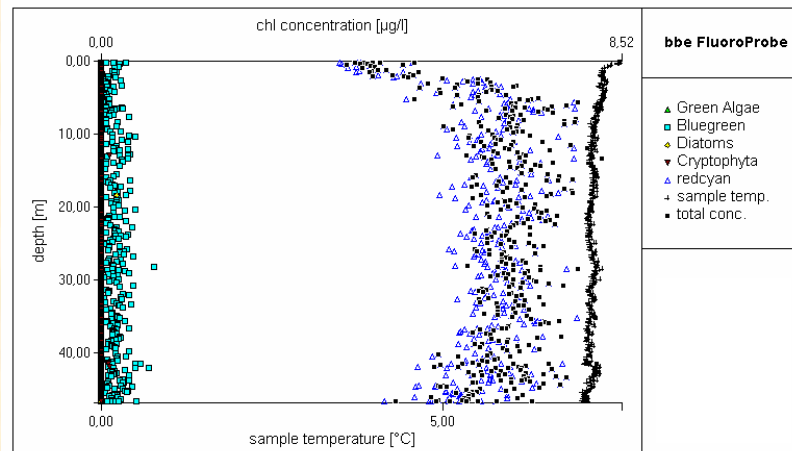




Summer



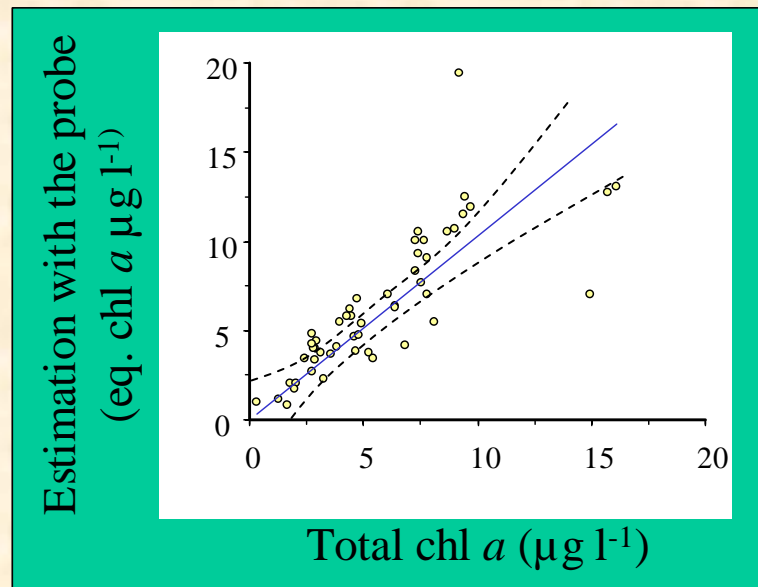
Autumn



Winter

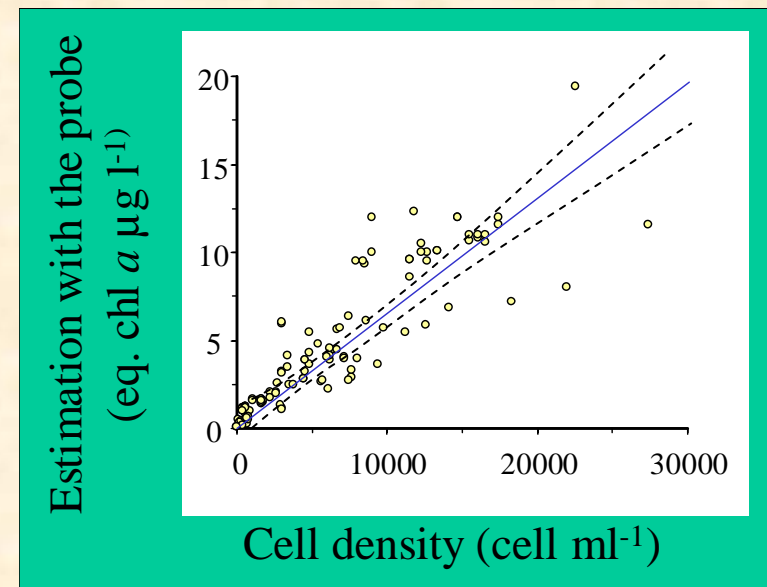
Typical vertical distributions
obtained in the lake Bourget
using the FluoroProbe

Correlation between biomass estimations using the probe and spectrophotometric evaluation of the chl *a*



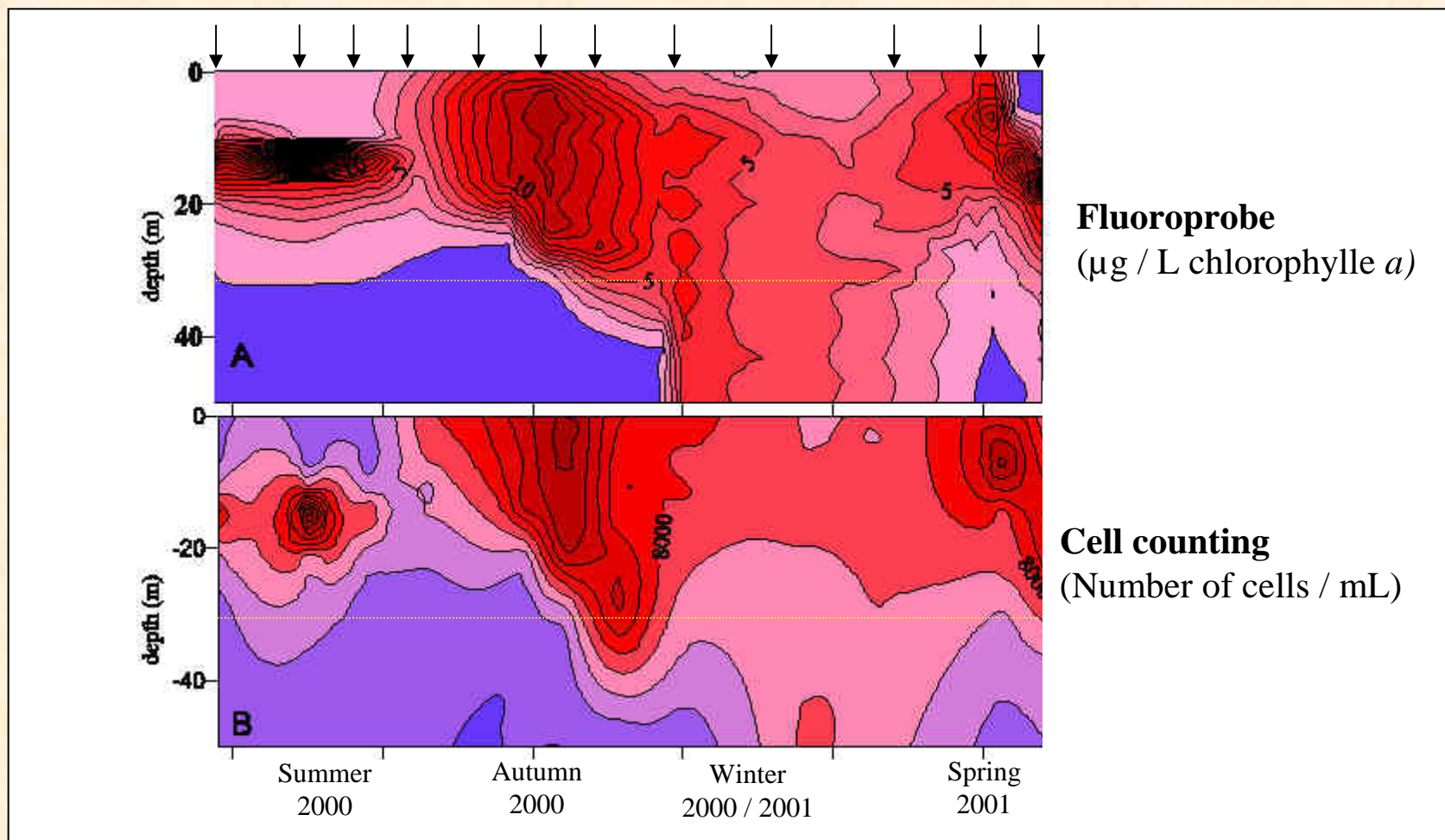
$$y = 1.03 x, r = 0.78, n = 55, \\ P < 0.01$$

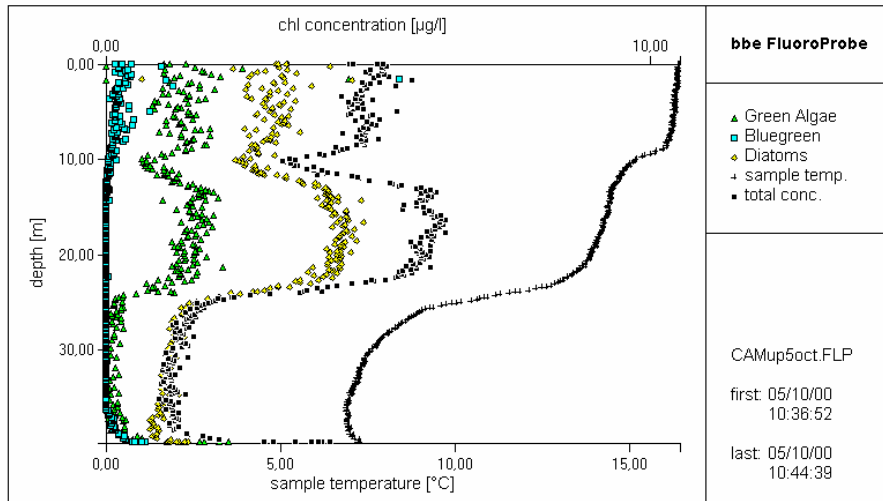
Correlation between biomass estimations using the probe and microscopic cell counts



$$y = 6.54 \cdot 10^{-4} x, r = 0.90, n = 110, \\ P < 0.01$$

Spatio-temporal distribution of *Planktothrix rubescens* in lake Bourget

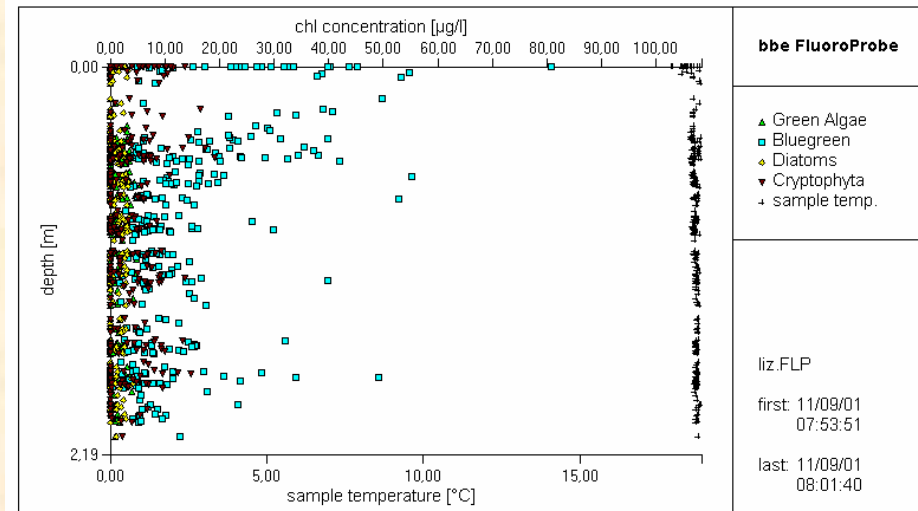




Survey of *Microcystis aeruginosa* in a storage reservoir



Bloom of *Microcystis aeruginosa* in a shallow pond



Applications of the probe :

- Implementation of a monitoring and a management plan for the survey of cyanobacteria in the lake Bourget for:

1. Drinking water : Decision tree mainly based on the use of the probe

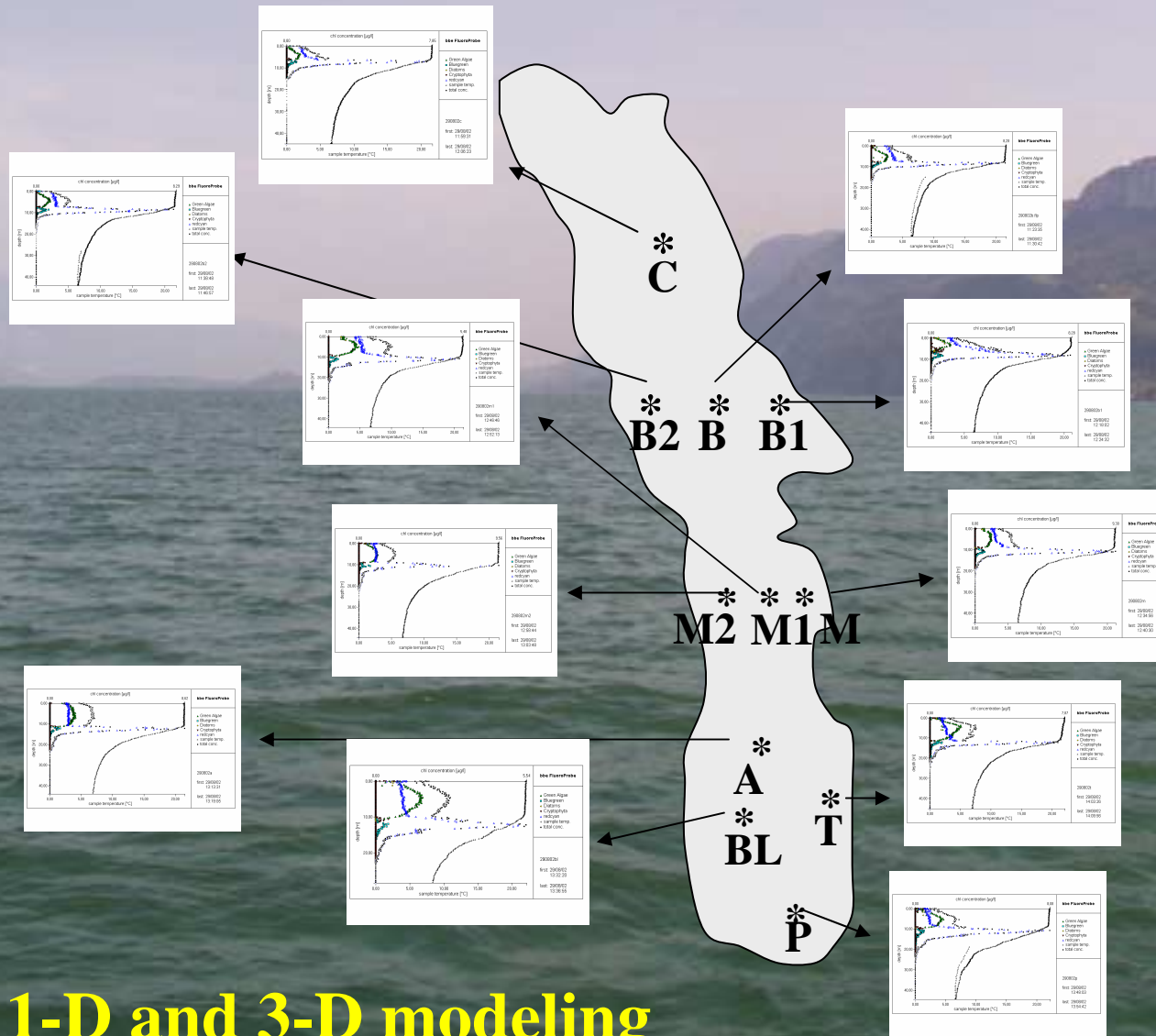
2. Bathing water : Decision tree based on visual survey and on the use of the probe

- Limnological (and oceanic) research

└─> Determination of concentration and spatial distribution of the main algae classes in water

└─> 1-D and 3-D modeling

Population dynamics of cyanobacteria in the lake Bourget



→ 1-D and 3-D modeling

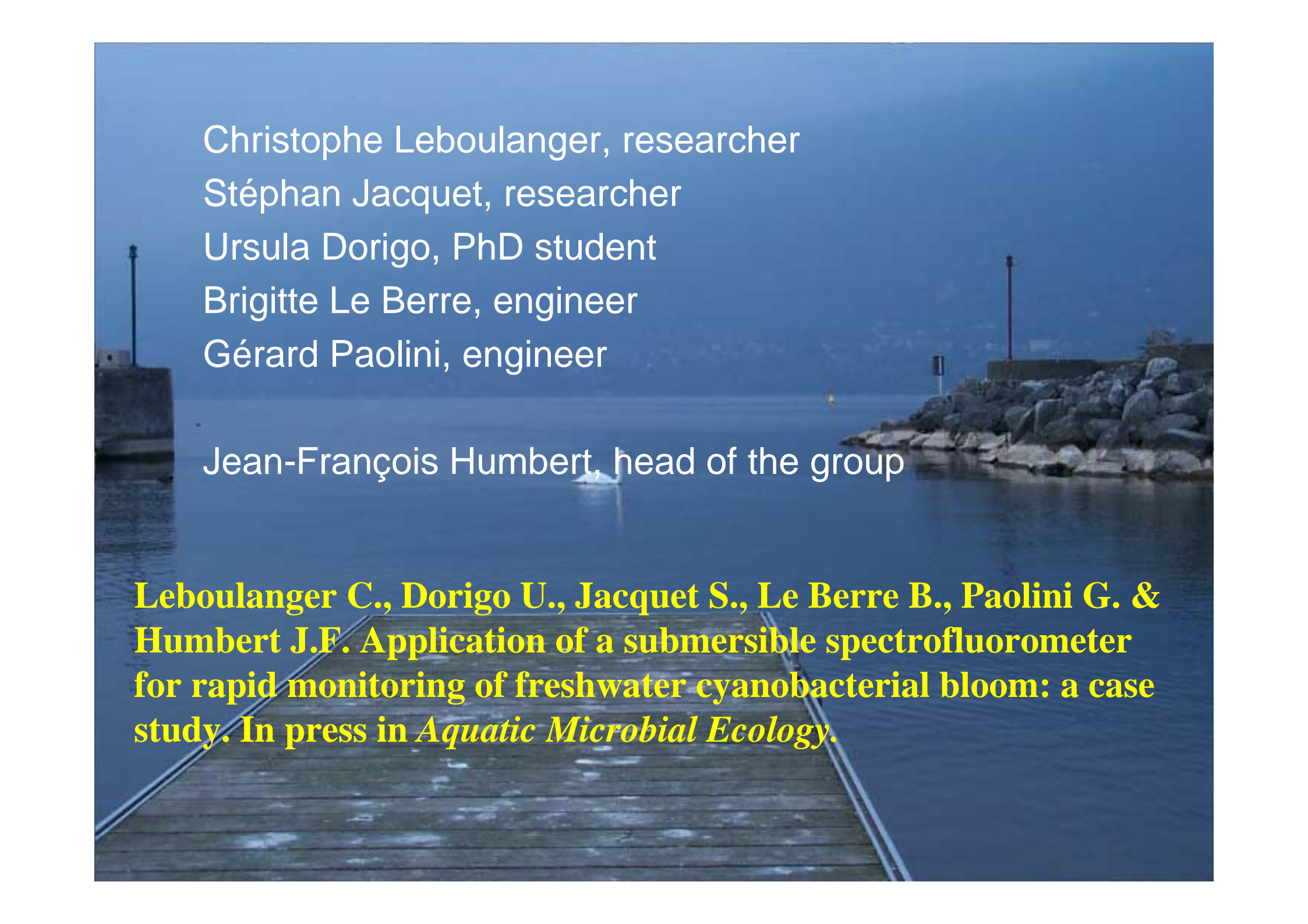
TAKE HOME MESSAGES

Advantages of the probe:

- Fast and reliable determination of chlorophyll concentration
- Very accurate estimation of the vertical distribution of chlorophyll
- Quantification and vertical distribution of the main algae classes
- Skilled personnel unnecessary.

Limits of the probe:

- Underestimation of biomass in surface due to quenching
- Underestimation of cyanobacteria aggregated in colony or raft
- Knowledge on the studied ecosystem



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Ursula Dorigo, PhD student
Brigitte Le Berre, engineer
Gérard Paolini, engineer

Jean-François Humbert, head of the group

Leboulanger C., Dorigo U., Jacquet S., Le Berre B., Paolini G. & Humbert J.F. Application of a submersible spectrofluorometer for rapid monitoring of freshwater cyanobacterial bloom: a case study. In press in *Aquatic Microbial Ecology*.