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Continuous monitoring and modelling of cyanobacteria dynamics in urban lakes

Application to Lake Enghien, France and Lake Pampulha, Brazil

Talita Silva, Brigitte Vinçon-Leite, Bruno Lemaire, Bruno Tassin,
Martin Seidl, Nilo Nascimento



OUTLINE

- Cyanobacteria monitoring
- Proliphyc project
 - Measurement buoy
- Lake Enghien
 - Monitoring
 - Modelling
- Lake Pampulha
 - Monitoring methodology
 - Integrated modelling approach
 - Expected results
- Conclusions

LIMITS OF THE USUAL MONITORING

○ Cyanobacteria monitoring

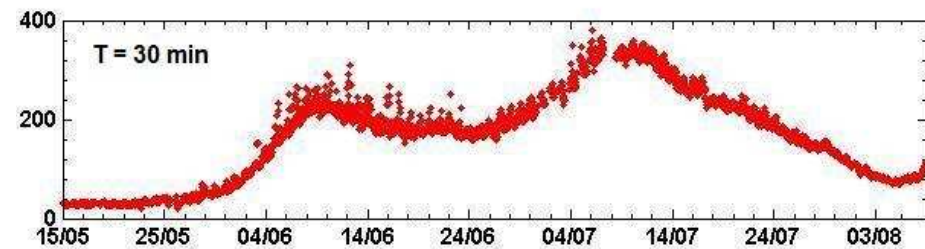
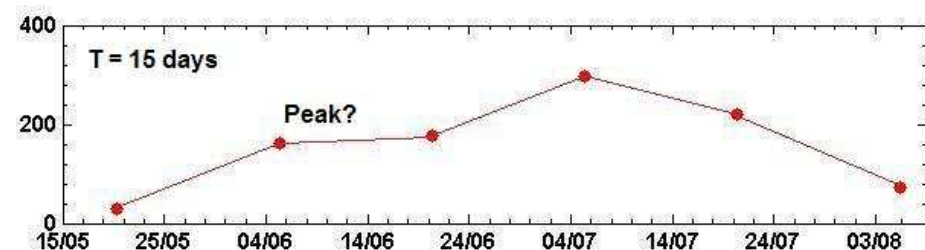
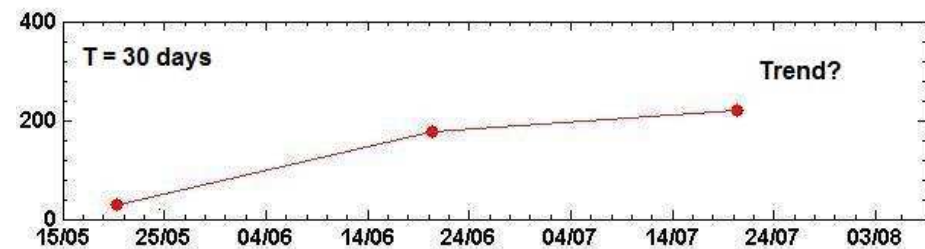
- How it is usually done



- How we propose to do it



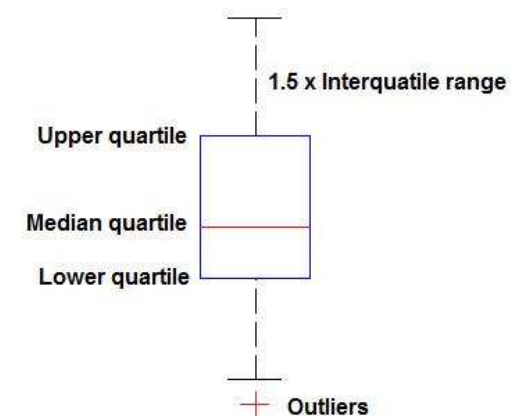
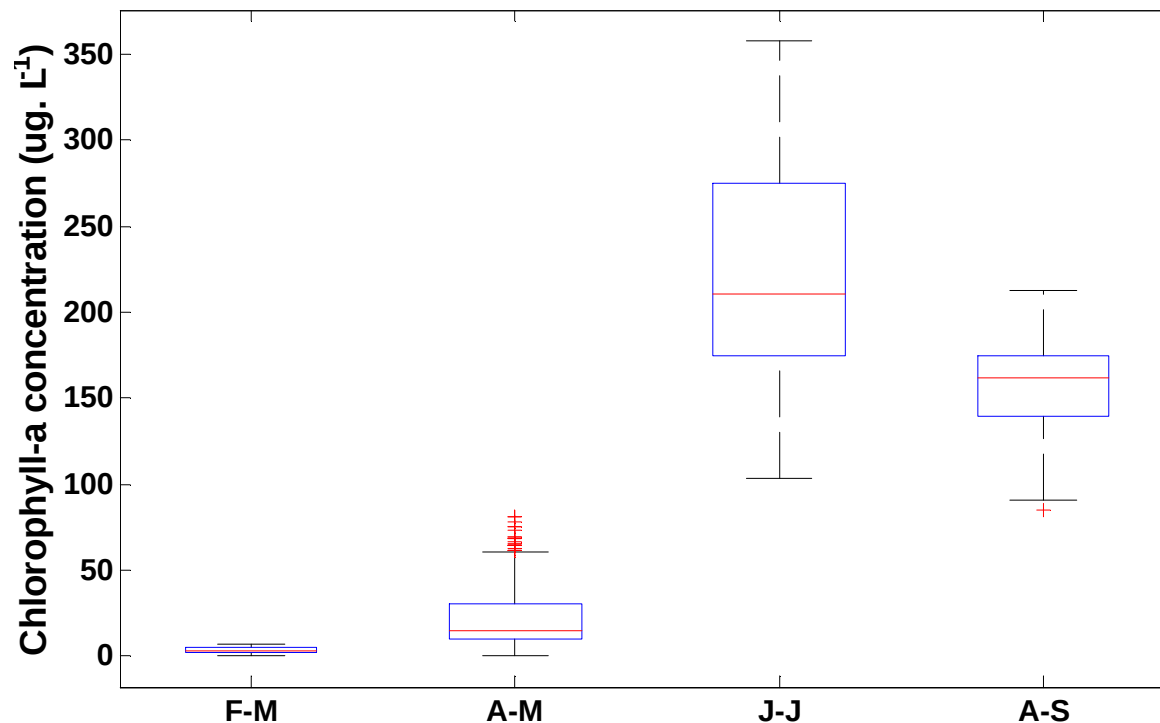
Cyanobacteria – Chlorophyll-a concentration ($\mu\text{g. L}^{-1}$)



BENEFITS OF HIGH-FREQUENCY MONITORING

French protocol (European WFD)

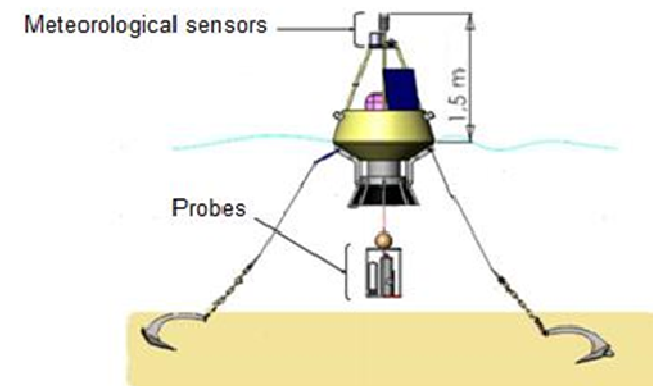
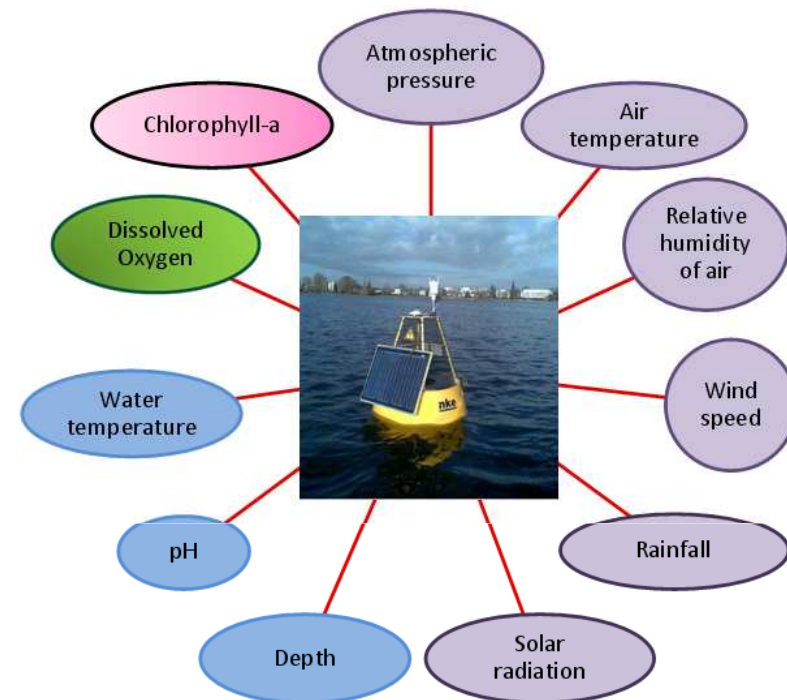
- 4 sampling campaigns/year
 - Including 3 during the summer
- 3 weeks = minimum interval between the campaigns





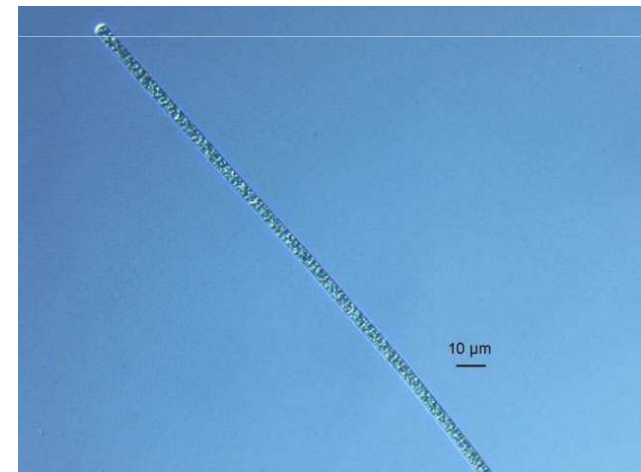
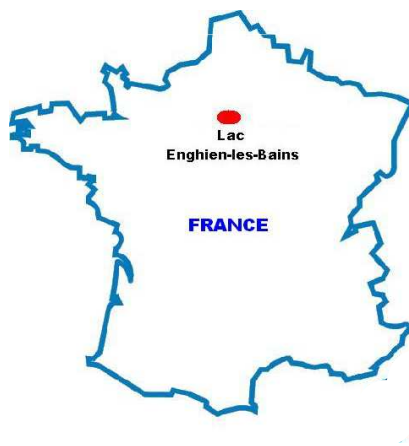
PROLIPHYC PROJECT

- A measuring buoy
 - High-frequency data (15-30 min)
 - Data teletransmission (daily)
- Warning system
 - Based on the weather forecast and buoy measurements
 - Short-term predictive modelling (1 week)



LAKE ENGHIEEN-LES-BAINS

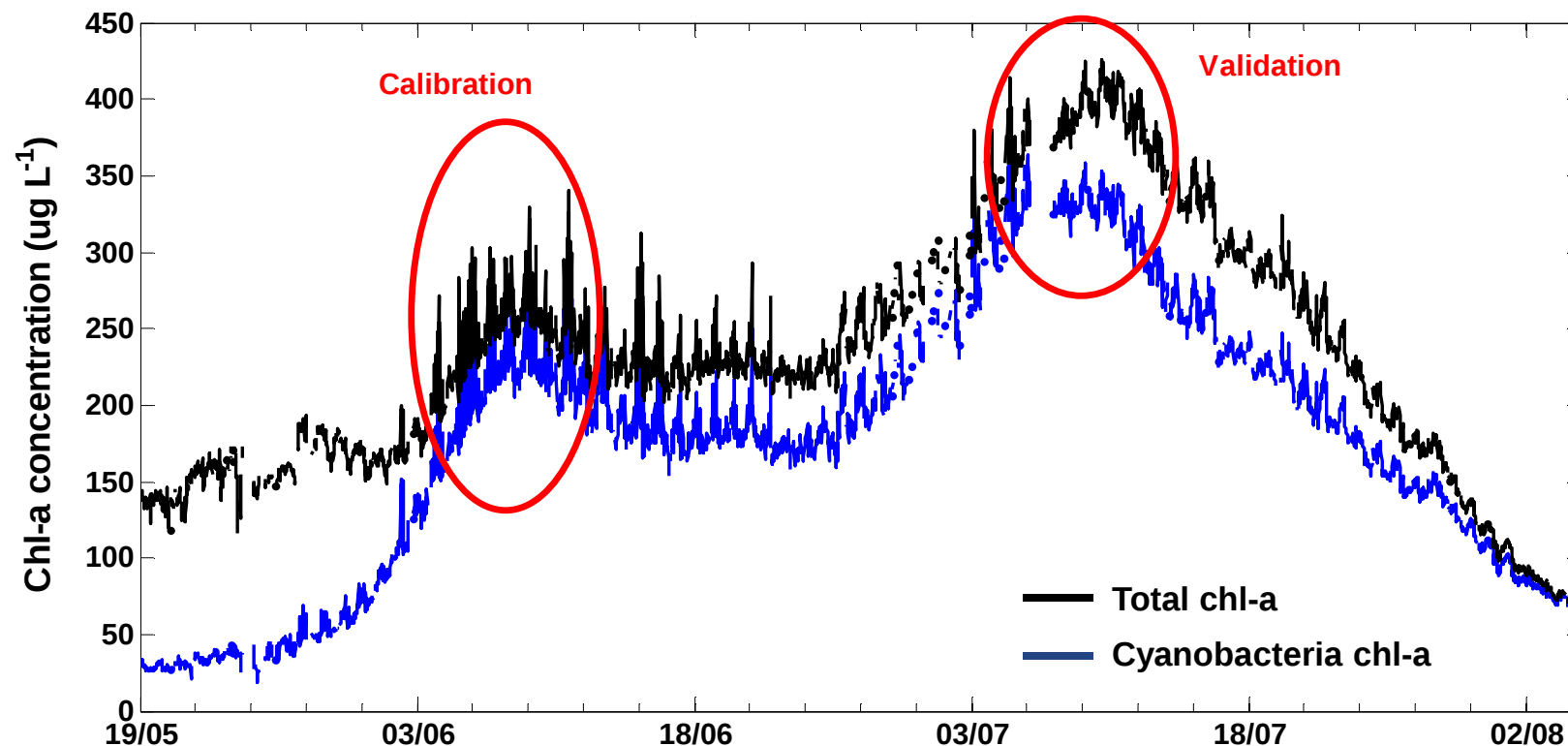
- 41 ha, mean depth = 1.5 m
- Rainwater storing, sport, landscape
- Inappropriate wastewater discharges
- *Planktothrix agardhii* blooms



(Escoffier 2008)

MODELLING

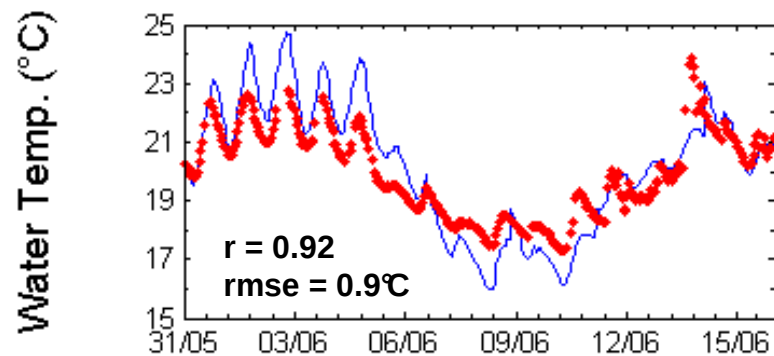
- DYRESM-CAEDYM model (Centre for Water Research, University of Western Australia)
- 1 phytoplankton group: cyanobacterium *Planktothrix agardhii*
- Model calibration and validation



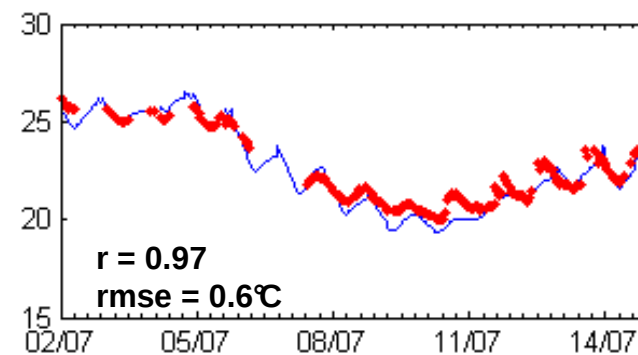
DYCD RESULTS

- Model results show good agreement with measurements
- High frequency data → thorough assesment of results
 - Gal *et al.* (2009); Burger *et al.* (2008); Hornung (2002)
 - Medium-term simulations, hourly time step

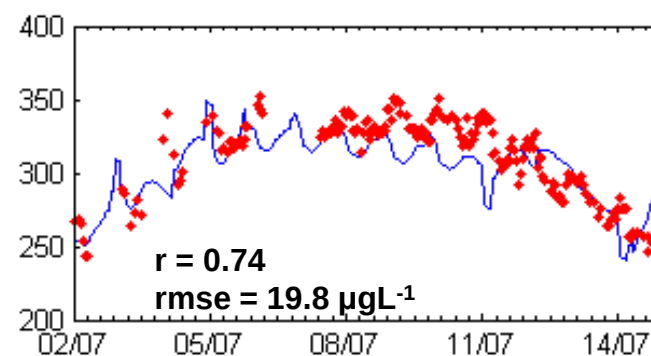
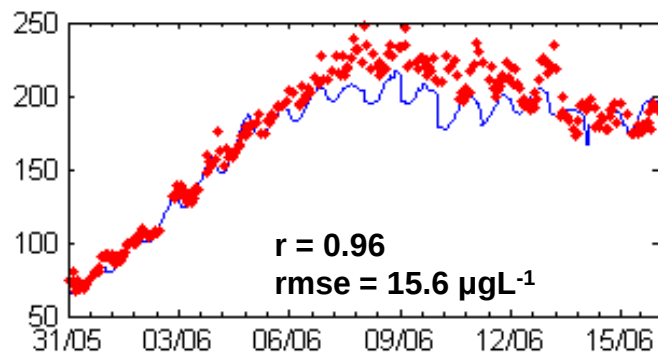
Calibration period 1-16 June 2009



Validation period 2-16 July 2009



Cyanobacteria
chl-a ($\mu g L^{-1}$)



Depth : 0.75 m

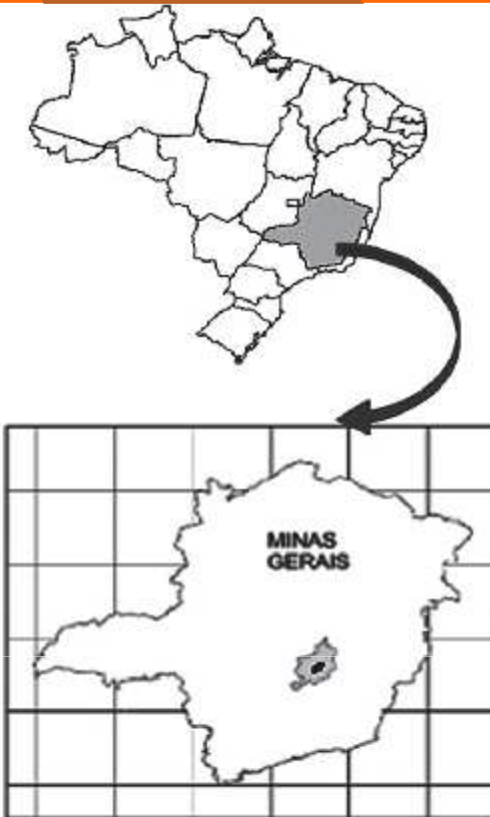
LAKE PAMPULHA

- Belo Horizonte, Minas Gerais, Brazil
- 197 ha, 10 hm³, 5,0 m (mean depth)
- Former drinking water source

Urbanization + no sanitation
infrastructure + no erosion control

lake silting and storage capacity
reduction

- Cyanobacteria blooms and macrophyte growth
- Touristic spot
 - Fishing, sailing, landscape



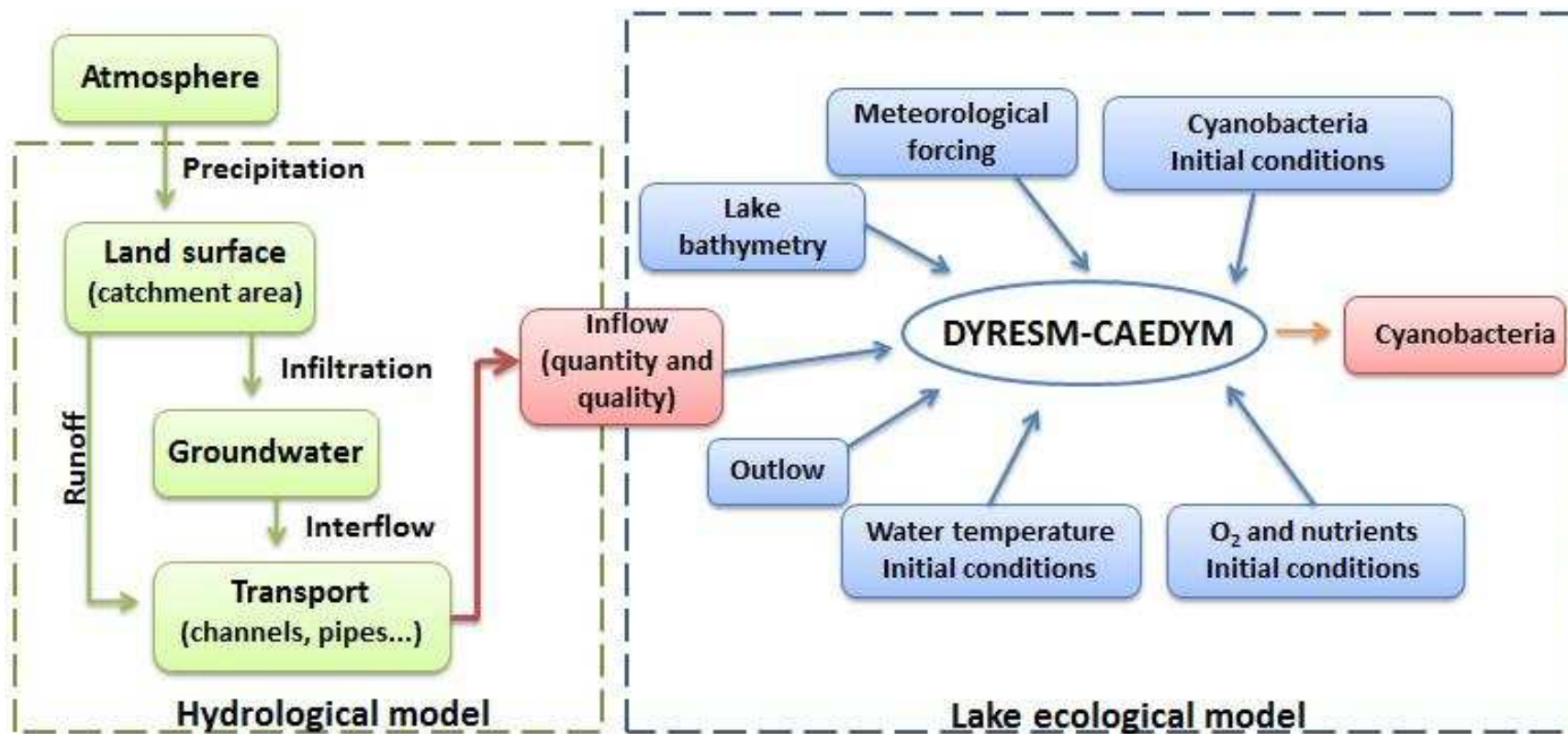
WATERSHED AND LAKE MONITORING

- High frequency data*
 - Two main tributaries and lake outlet :
 - Rain gauges
 - Flow rate
 - Temperature, conductivity and turbidity
 - Automatic samplers: nutrients and dissolved oxygen
 - Measurement buoy :
 - Temperature, conductivity, pH, O₂ and chl-a
 - Meteorological forcing : INMET



INTEGRATED APPROACH

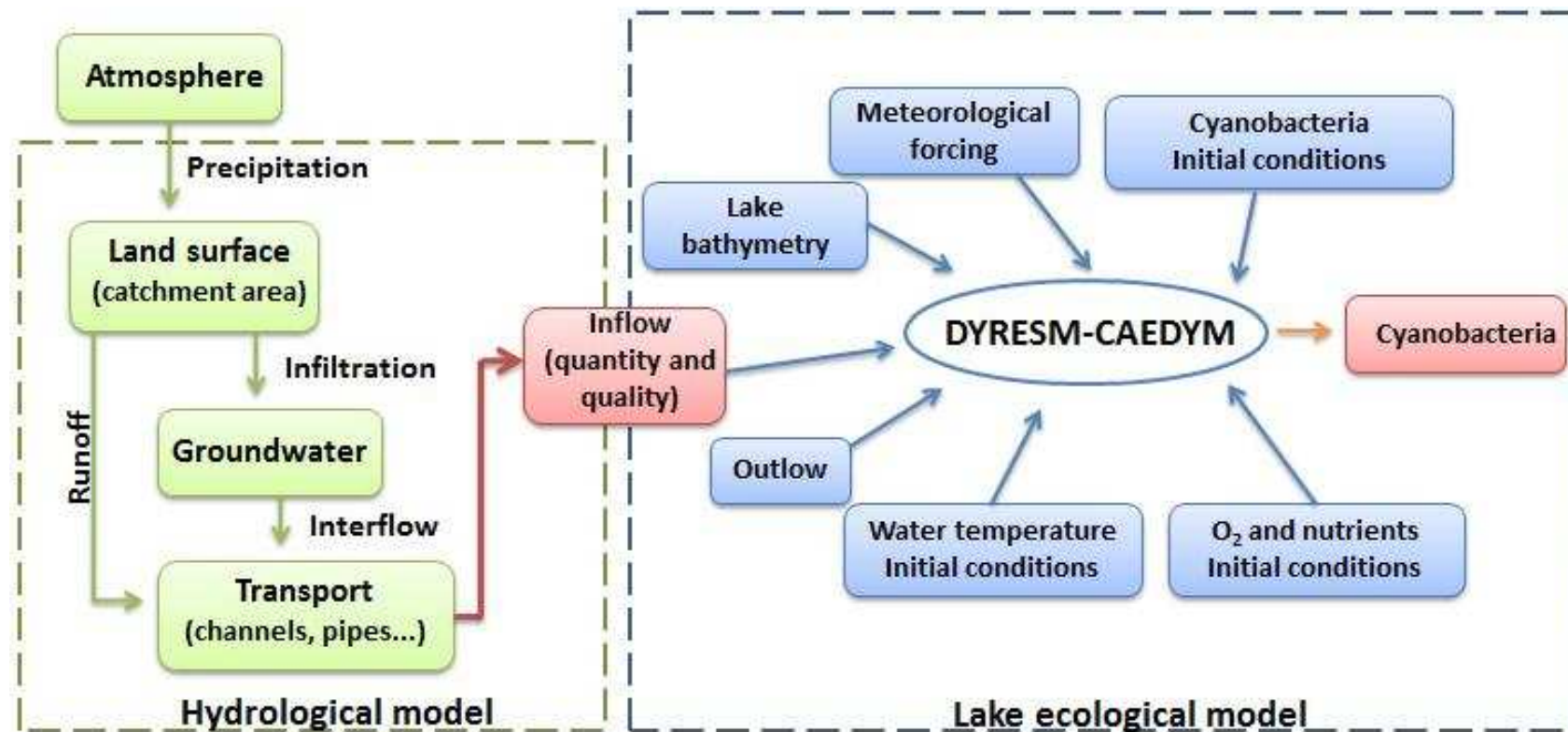
- Watershed hydrological model + Lake ecological model



Why a modelling approach?

INTEGRATED APPROACH

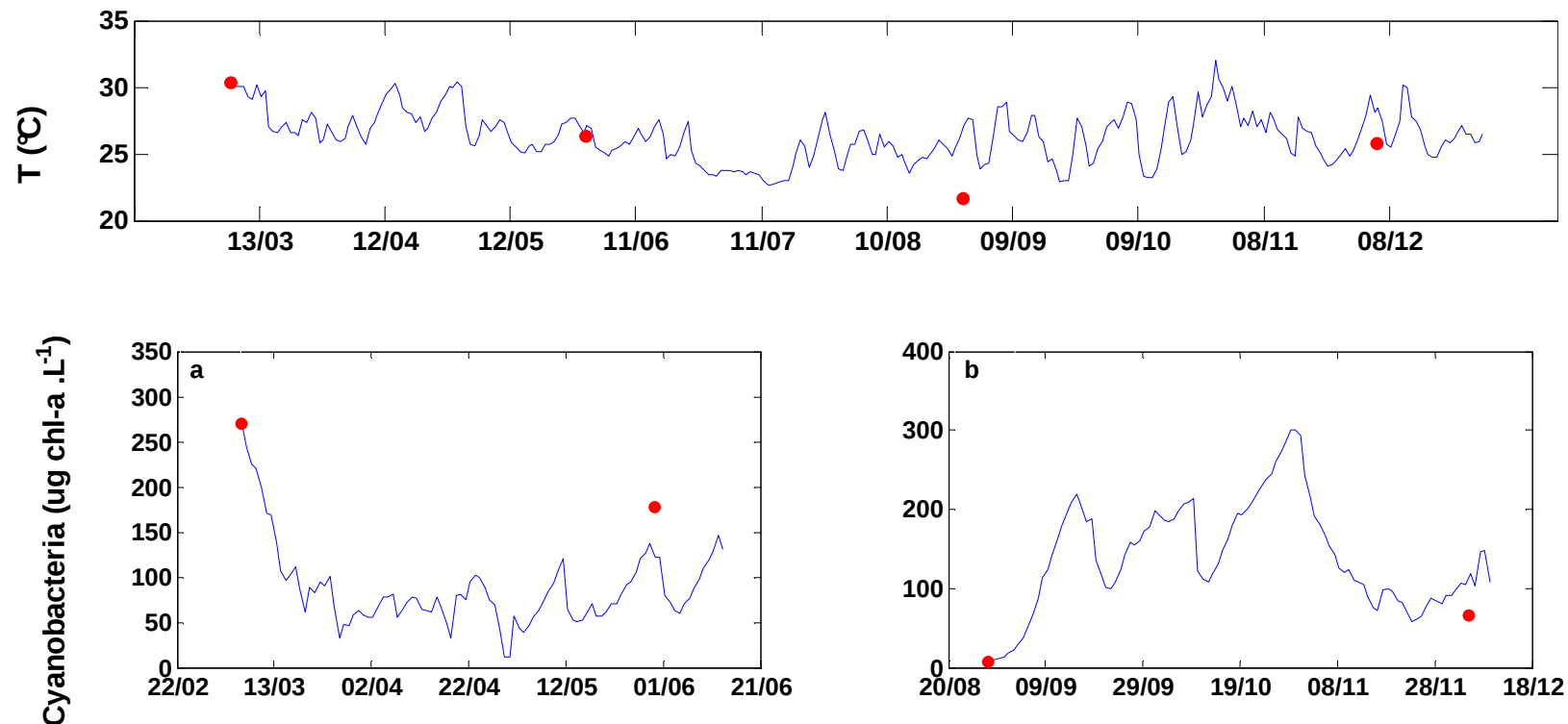
- Watershed hydrologic model + Lake ecological model



Lake response x Different scenarios of watershed evolution:
Land-use changes, impervious area expanding...

LAKE ECOLOGICAL MODEL

- Belo Horizonte municipality data
- Cyanobacteria species:
 - *Nostocaceae*, *Microcystis wesenbergii*, *Sphaerocavum* sp.
- Cyanobacteria modelling: on-going



CONCLUSIONS

○ Lake Enghien

- Warning system
- High frequency lake monitoring
- Cyanobacteria dynamics modelling
- Few data about the catchment

○ Lake Pampulha

- Management tool
- High frequency watershed monitoring *in progress*
- High frequency lake monitoring *from September/2011*
- Cyanobacteria dynamics modelling *preliminary results*
- Watershed modelling and scenarios

NEWS BULLETIN: AN OCCURENCE OF CYANOBACTERIA (BLUE-GREEN ALGAE)
HAS BEEN DETECTED IN CHAMCOOK LAKE



THANK YOU FOR YOUR ATTENTION!