Ecosystem metabolism and chlorophyll dynamics in a tropical maar lake, Mexico.

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Conclusions

• Metabolic balance was driven by allochtones inputs in 2013 cycle and by autochtonous matter during 2014.

• The dynamics of photoautotrophic community depend on nutrient pulses, where a specific group tend to a full development when one of the nutrients is limited.

• Deep chlorophyll maximum concentration was linked to the capacity of cyanobacterial bloom to arrest nutrients.

Introduction

• The occurrence of algal blooms as a result of high nutrient concentration implies increased primary production and the generation of a considerable amount of organic matter (Sellner *et al*., 2003).

• Light penetration, among another factors, induces the chlorophyll profile to down trend from the surface (Hamilton *et al*., 2010). This is also known as deep chlorophyll maximum (DCM) (Cullen, 1982).

• The biomass generated from these processes represents a significant amount of carbon sequestered in aquatic systems thereby buried in sediments.

• The catchment basin of maar lakes improves the transport of allochtonous matter. Beyond the long term salinization and rise of alkalinity, closed basins are more likely to reflect the effects of organic matter inputs (Alcocer *et al*., 2005; Alcocer *et al*., 2014). Even though these inputs support high respiration rates, volcanic lakes are known as highly productive systems (Melack, 2009)

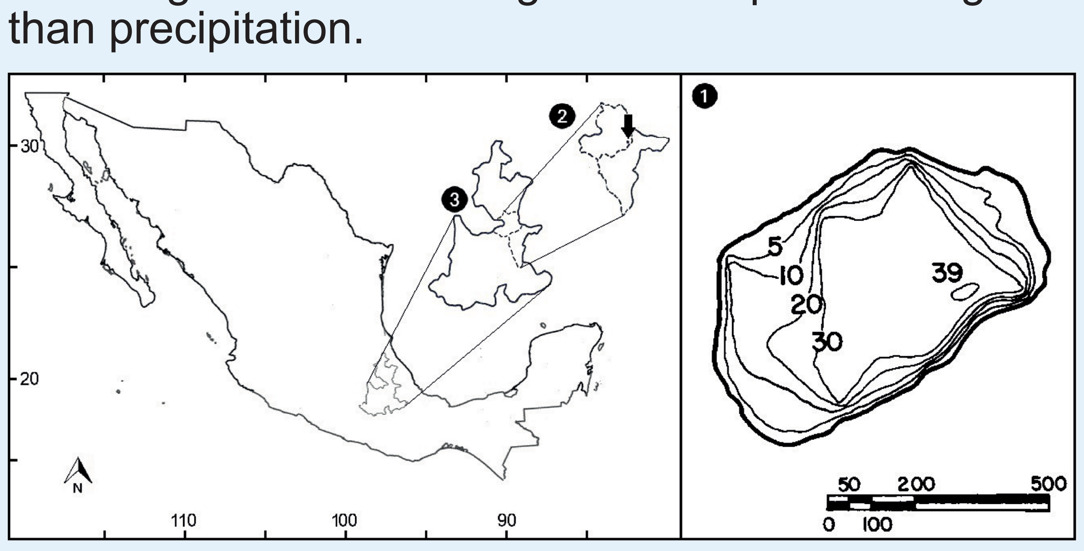
Aims

• This reasearch evaluates the effect of an annual cyanobacterial bloom upon deep chlorophyll maximum formation and net ecosystem productivity mirrored as changes in gross primary productivity (GPP) and respiration (R) rates.

Method

• Study area
◦ Lake Atexcac is located in a crater with steep slopes, mailny composed by volcanic material. The lake has a maximum depth of 39 m and fill a surface of 0.31 Km^2.

◦ The region is under a regime of evaporation higher than precipitation.



Location and bathymetry of Lake Atexcac. The lake (1) is located on the Oriental basin (2) in Puebla state (3), Mexico.

• Sampling

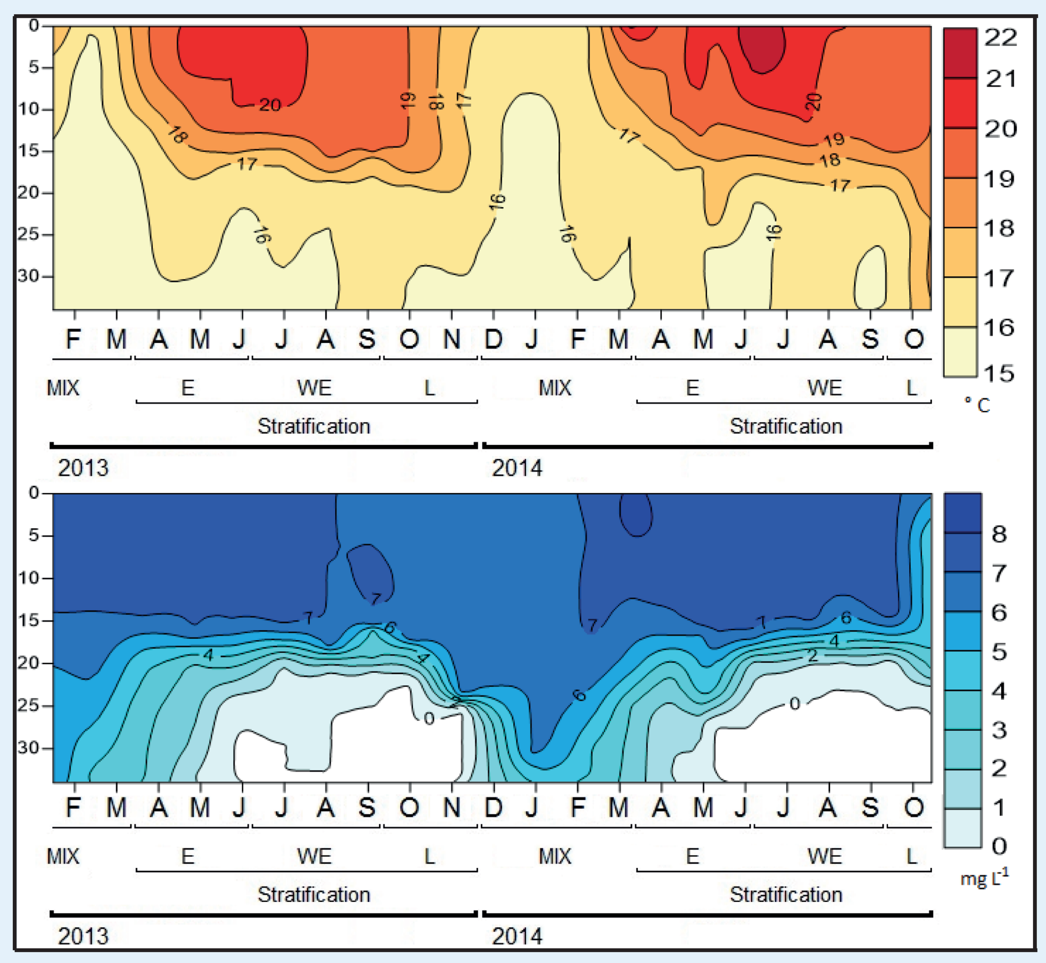
◦ Samples were taken monthly from February 2013 to October 2014 at the deepest limnetic zone with a Wildco 2.5 L Van-Dorn bottle.

◦ Primary productivity was evaluated based on the changes of dissolved oxygen using the light-dark bottle incubation method (Gaarder and Gran, 1927).

◦ Chlorophyll a content was determined by *in vitro* fluorescence (Arar and Collins, 1997) using a digital field fluorometer (Turner Designs 10-AU, USA).

Results

• The lake had mixing period during the hemispheric winter and remain stratified for eight months.



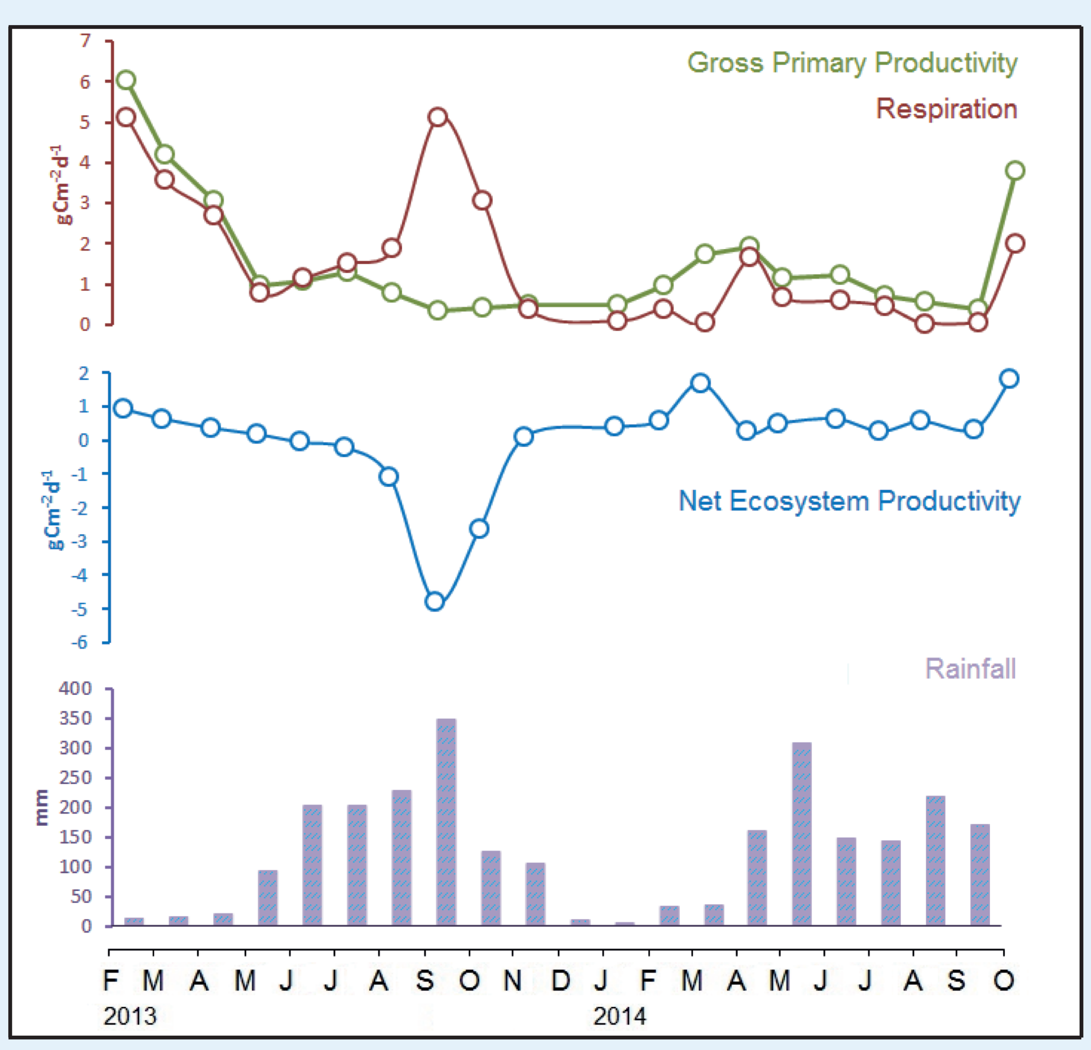
Depth-time diagram of isotherms (up) and isopleths of dissolved oxygen (down) in lake Atexcac.

• The lake metabolism showed high inter-annual variation mainly due to enhanced R rates during 2013 stratification.

◦ These extreme R rates were statistically correlated with rainfall.

◦ Maximum GPP was recorded during cyanobatcerial bloom in both years.

◦The lake behaved as heterotrophic during 2013 and as autotrophic the next year.

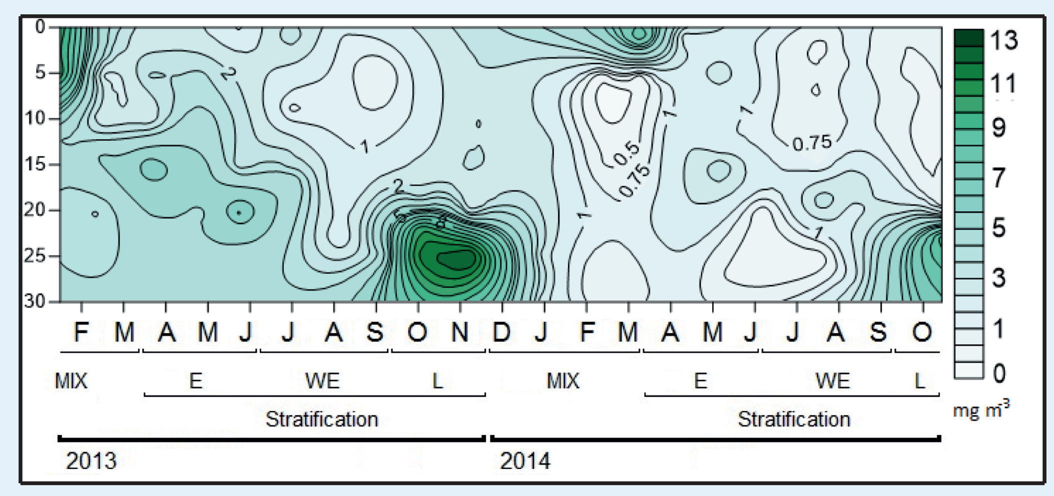


Temporal variation of gross primary productivity and respiration (upper panel) from February 2013 to October 2014. Temporal variation of net ecosystem productivity (NEP) in the same period of time (middle panel). Temporal variation of rainfall (monthly average) in the period of study (lower panel).

• Chlorophyll a was higher in surface layer during cyanobacterial bloom in both years.

◦ After the bloom the chlorophyll profile was skewed from surface and a DCM was established.

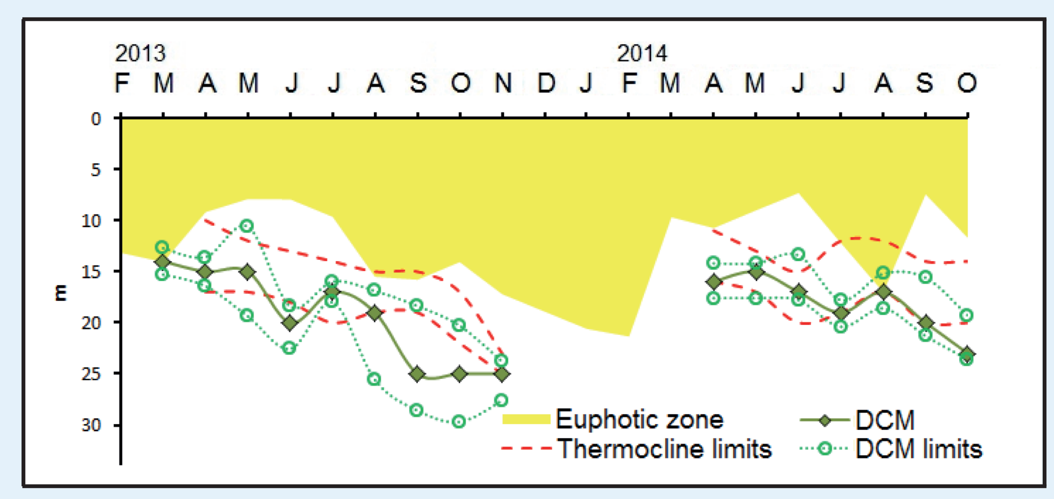
◦ In addition, chlorophyll concentration during 2013 cycle were twice times higher than that recorded in 2014 whole cycle.



Depth-time diagram of isoplets of chlorophyll a in Lake Atexcac.

◦ The DCM deepened and its maximum concentration increased as stratification became more pronounced.

◦ Thermal stratification is clearly involved in DCM stablishment process.



Temporal variation of deep chlorophyll maximum thickness and thermocline thickness. Variation of euphotic zone is also shown.

• Inter-annual variation was also reflected as different trophic level of the lake for two consecutive years.

◦ The intensity of the cyanobacterial bloom affects the main parameters to determine trophic state as GPP, chlorophyll concentration and inorganic nutrients

Integrated GPP and trophic state for different systems with similar thermal behaviour, location and chemical composition than lake Atexcac

	GPP		Trophic status
	g C m^{-2} day^{-1}		
	Average	Range	
Monomictic lake			
Lake Biwa	0,8	0.21-1.48	Mesotrophic
Lake Kinneret	1,8	01-0.35	Eutrophic
Tropical lake			
Lake Atexcac 2013	1,87	0.34-6.04	Eutrophic
Lake Atexcac 2014	1,29	0.39-1.91	Mesotrophic
Lake Alchichica	5,5	1.78-9.22	Eutrophic
Tropical reservoir			
Valle de Bravo	2,2	1.7-2.9	Eutrophic

*Oxygen measurements converted into carbon using a photosynthetic quotient of 1

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