EGU2018-11050
Session CL0.00

A 14 KA RECORD OF LITHOGENIC GRAIN SIZE, UPWELLING AND BIOLOGICAL PRODUCTION IN THE NE-PACIFIC

TERRESTRIAL AND OCEANIC PROCESSES LINKED TO TELECONNECTIONS AT MILLENNIAL-SCALE

Elsa Arellano-Torres[1], C. Álvarez-Covelli[2], M. S. Lozano-García[3]
(1) Facultad de Ciencias, UNAM, Mexico City, Mexico
(2) Universidad El Bosque, Bogotá, Colombia
(3) Instituto de Geología, UNAM, Mexico City, Mexico

OUTLINE

Introduction
- Study Area – NE Pacific Ocean
- Research Goal

Materials and Methods
- Composite Core GC41/PC14
- Chronology – radiocarbon based age model
- Grain Size, Geochemistry, & Time Series analyses

Results & Discussion
- Terrestrial inputs, siliceous & carbonate plankton communities reconstructions
- Common frequencies, ENSO-like and PDO-hydrological variability
- Climate forcings over the last 14 ka

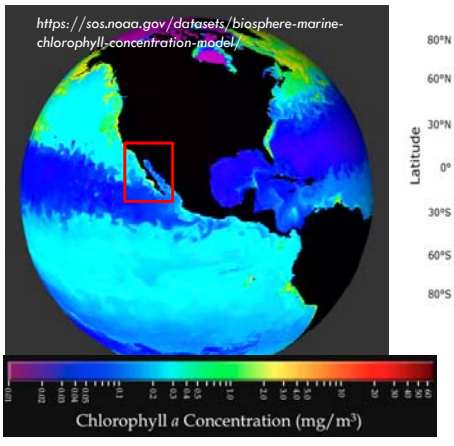
Conclusions

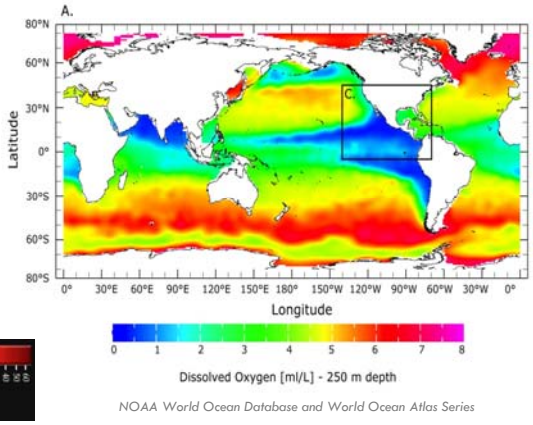
INTRODUCTION

- Rapid climate changes and variability during the Holocene. What are the main forcing mechanisms and periodicities?
- Ocean controls of climate change through C-export and sequestration.
- Variations between siliceous vs carbonate organisms.
- NE Pacific Ocean is a high sensitive region to climatic and ecological regimes.
- Influenced by high and low latitudes processes.
- Ideal to determine connections between ocean - atmosphere - land.

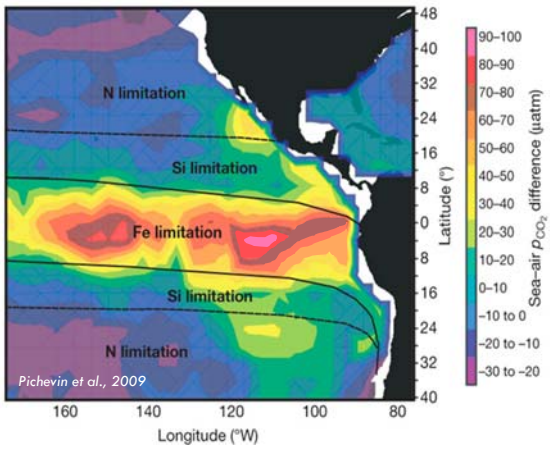
STUDY AREA NE PACIFIC

- Wind driven coastal upwelling
- High biological productivity
- Extensive oxygen minimum zone
- Subsurface denitrification





NOAA World Ocean Database and World Ocean Atlas Series



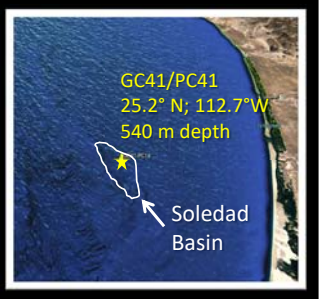
Oceanic areas with nutrient limitation for primary producers → diatoms & coccolithophores as regulators of the C-cycle and CO_2 sequestration at suborbital scale.

Dry and semi-arid climate on land → contribution of terrigenous material and micro-nutrients (Fe) to the ocean.

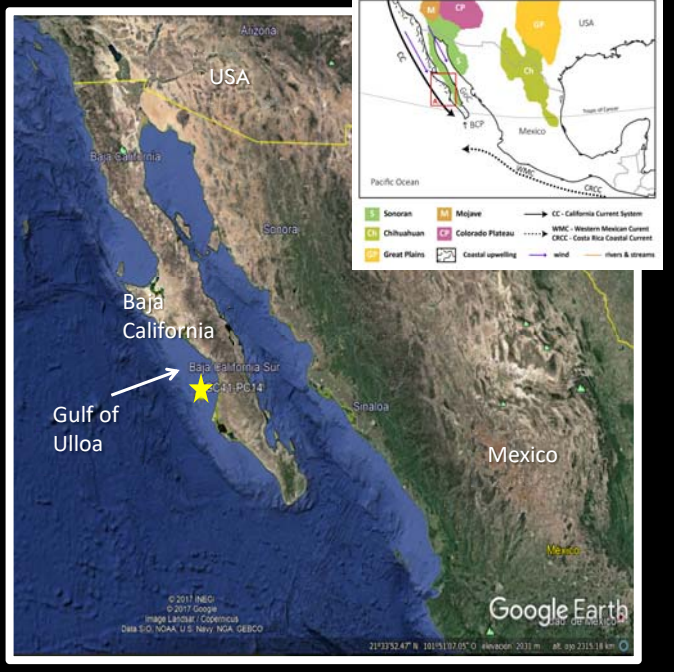
GOAL

- To conduct a multi-proxy study off the Baja California margin (NW Mexico).
- To determine patterns of variations in the accumulation and deposit of silicate (e.g. diatoms) and carbonate (e.g. coccolithophores) organisms, and their relationship to nutrient limitation and terrigenous contributions from land (i.e., wind and/or river).
- To investigate the interconnections between the ocean and climate on land over the deglaciation and the Holocene at millennial to sub-millennial scales.

MARINE SEDIMENT CORE COMPOSITE MV99-GC41/PC14



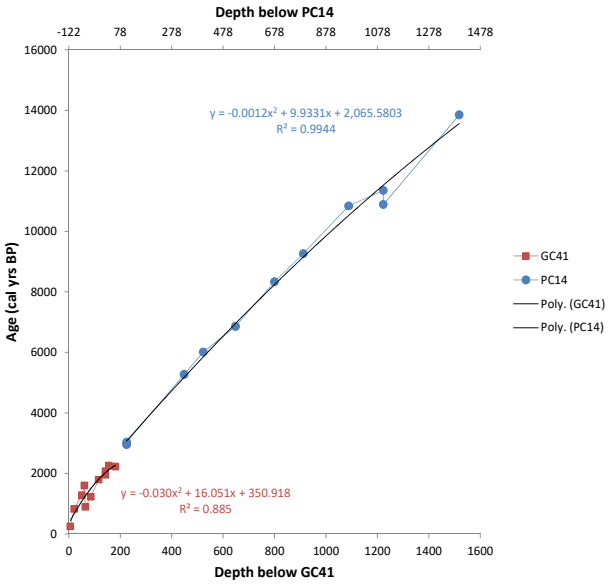
Van Geen, A., & Scientific Party. (2001), Lamont-Doherty Observatory Technical Report LDEO. Lamont Doherty Core Repository.



AGE MODEL

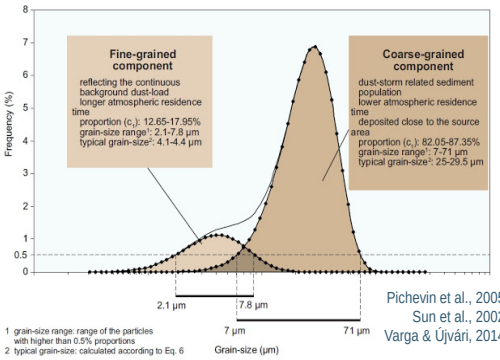
Published by:

Van Geen et al., 2003 Paleoceanography
Marchitto et al., 2010 Science

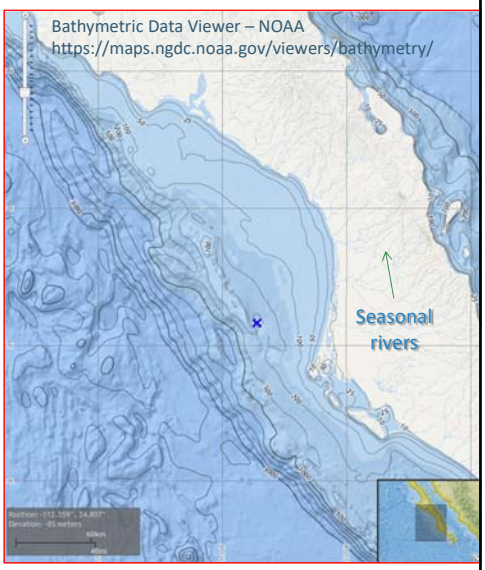


GRAIN SIZE ANALYSIS

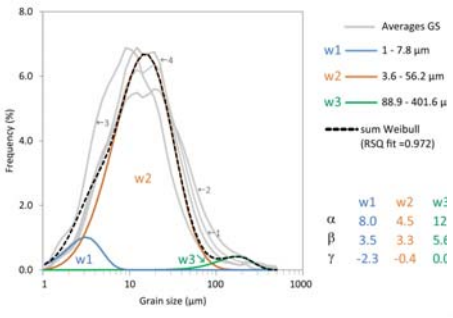
1. Elimination of biogenic components → $CaCO_3$, organic matter, biogenic opal.
2. Laser Particle Counter Analysette 22. Range 1 – 500 mm → Udden-Wentworth grain size classification
3. Polymodal sediment → Weibull distribution model.

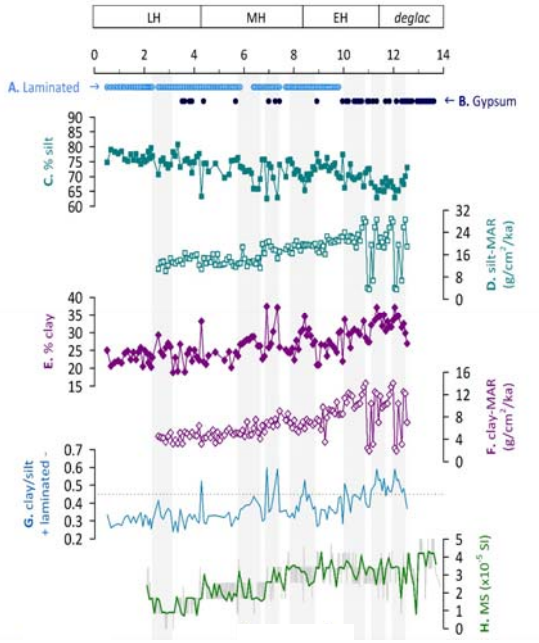


Pichevin et al., 2005
Sun et al., 2002
Varga & Újvári, 2014



GRAIN SIZE TERRIGENOUS COMPONENTS

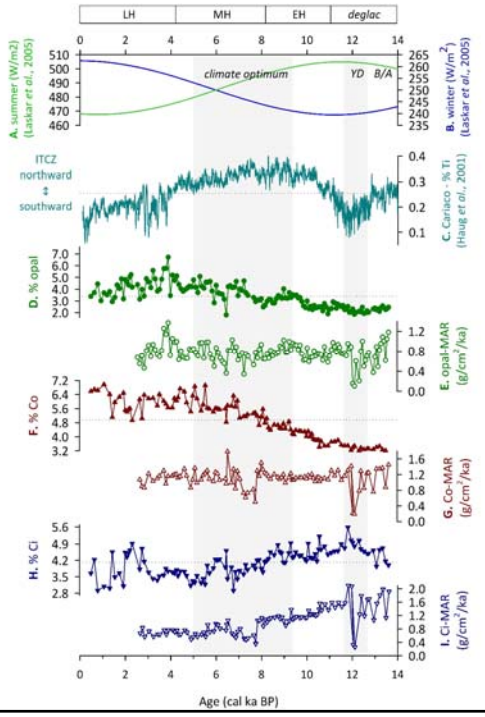




GEOCHEMISTRY
BIOGENIC COMPONENTS

Mortlock and Froelich (1989) → opal content by molybdate blue spectrophotometry on alkaline extracts.

Equipment Flash 2000 using NC Solis analysis → Total Carbon & Total Inorganic Carbon.

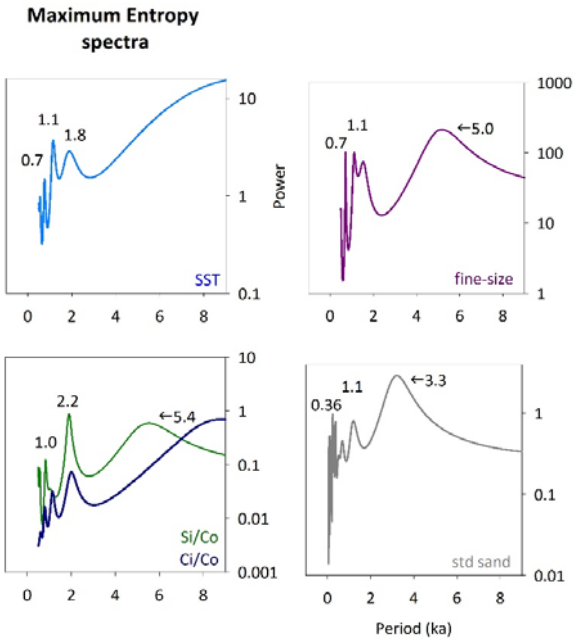


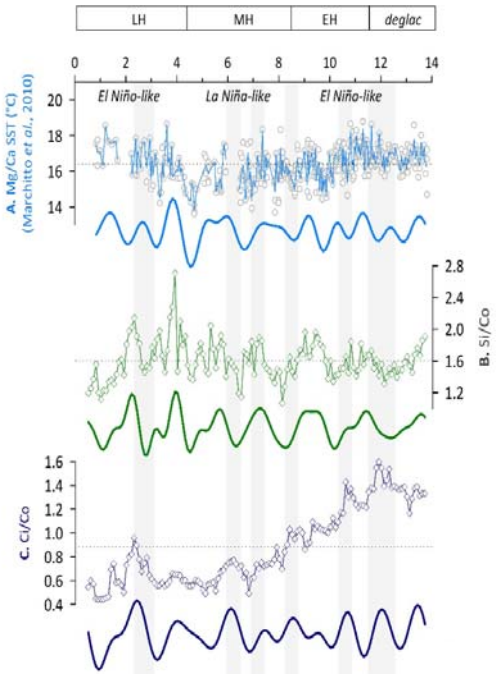
TIME SERIES ANALYSES

Software *Analyseries* - (Paillard et al., 1996) to perform Spectra Analyses

Maximum Entropy Method (MEM)

F test using Multitaper Method (MTM). Frequencies > 0.90 confidence level, output $1x10^{-4}$ – $5x10^{-3}$ cycles/ka.





Redfield ratios

Si:Co ocean average > 1

Si:Co moderate C-export < 1

Si:Co high C-export < 10 (S Ocean)

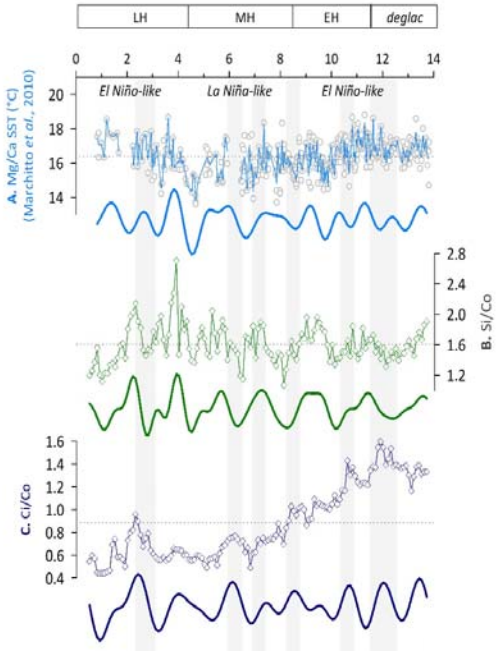
Si:Co G. of California ~ 4

Si:Co California Current System (CCS) ~ 0.5 – 3.0

Ci:Co Pacific average ~ 0.27 - 0.33

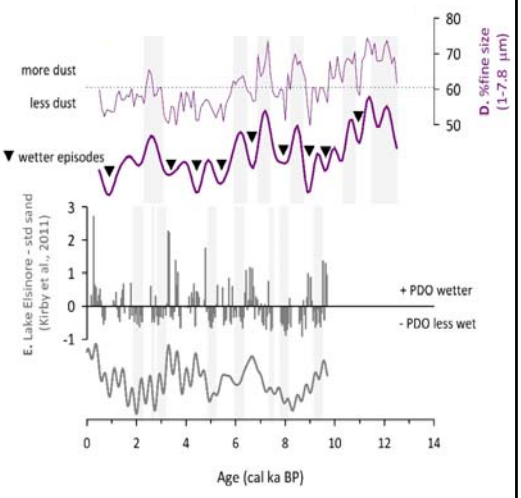
Ci:Co equatorial Pacific upweling ~ 1.5

Ci:Co G. of California and CCS ~ 0.5 – 1.0



Literature reviews from SW USA and NW Mexico (e.g. Antinao et al., 2016; Barron et al., 2012; Kirby et al., 2011)

→ Episodes of alternated dryness & effective moisture periods evidenced by high stand lake-levels and alluvial systems



CONCLUSIONS

During the Holocene, we found time periodicities between silicate and carbonate records at ~1.1 to 2 ka/cycle, indicating variations between high/low productivity and C-export.

The reconstructed phytoplankton - hydrographic relationships can be used to evaluate past changes in upper-ocean conditions driven by long-term teleconnections, like ENSO.

In the NE Pacific, not only upwelling, but also nutrient advection and turbulence driven by continental climate play an important role for the biological productivity and phytoplankton ecological succession.

Variations determined by our terrigenous proxy reveal periodicities < 0.7 ka/cycle that coincide to the PDO-like proxy record → explained by a latitudinal extent of the PDO-fingerprint (?) although further efforts to understand these effects are required.

AKNOWLEDGEMENTS

- Nichole Anest (Curator), Lamont-Doherty Core Repository - LDEO, Columbia University
- Project Funding PAPIIT-IA105517, UNAM
- PAPIIT Scholarship for C. Alvarez-Covelli