

Impact des changements globaux & locaux sur les propriétés de calcification des coraux massifs tropicaux

Eric Douville (LSCE)

Eric.Douville@lsce.ipsl.fr



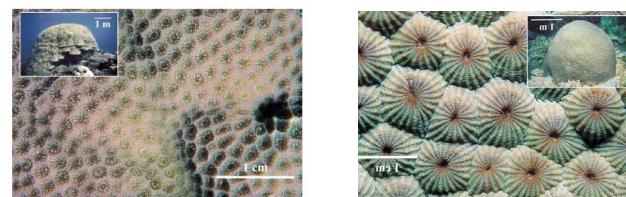
Marine geochemistry

Isotopic & elemental geochemistry

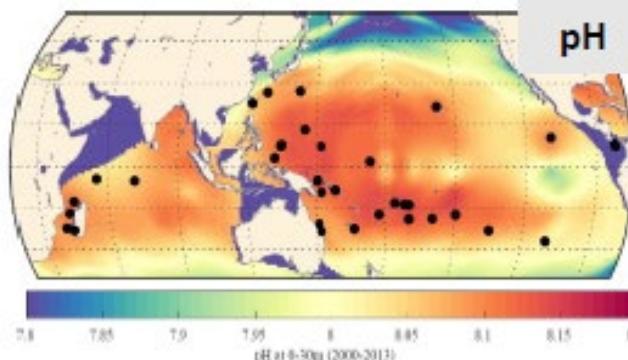
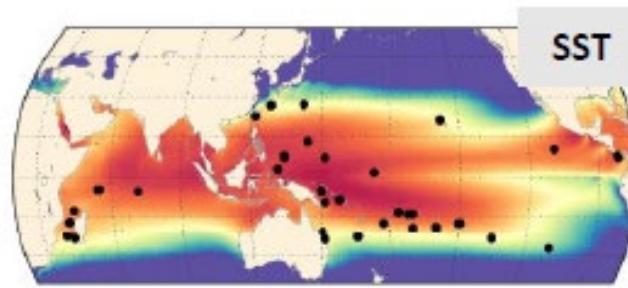
¹⁴C & U-Th Geochronology

Coral physiology & biology

Modelling



**Massive Corals
(Porites – Diploastrea)**



Impact studies

Ocean Acidification

Global Warming

**Local pollution
(metals, nutrients, etc.)**

Bio-erosion

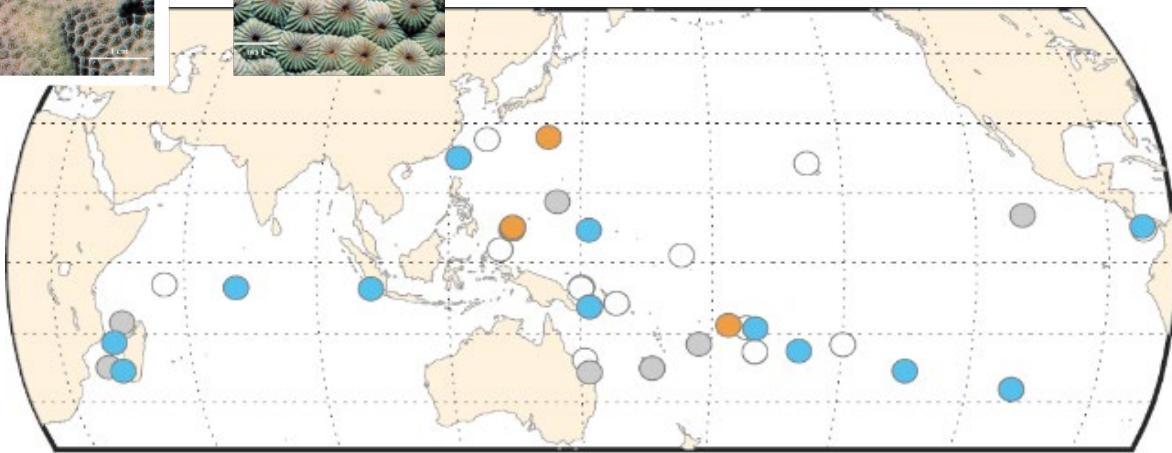
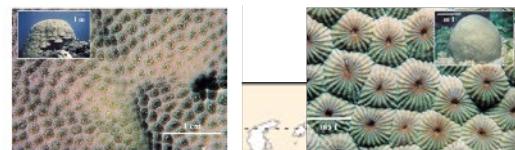
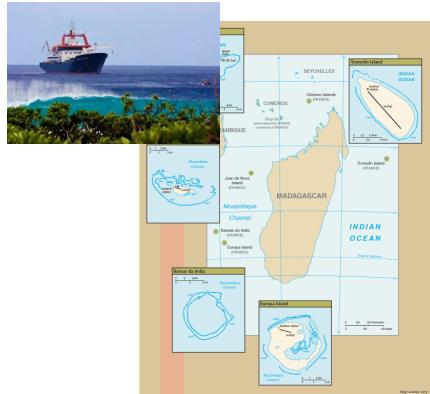
Coral resilience

Pacific Ocean

		Date of sampling	Latitude	Longitude	Genus /species	Sampling depth (m)	Modern linear extension (mm.yr ⁻¹)	Total length (cm) & potential number of years or recovering period	Geochemical data already acquired by the consortium or collaborators
451	Anakena, Isla de Pascua (Chile)	03/09/2016	S 27°04'	W 109°19'	Porites	13.8	11.4	73	64
652	Tekava, Gambier (French Polynesia)	23/09/2016	S 23°09'	W 134°50'	Porites	8.8	9.6	72	76
851c3	Aitutaki, Cook (New Zealand)	14/11/2016	S 18°50'	W 159°48'	Porites	14.1	10.4	69	66
Tau-1	TaOu, American Samoa	Nov. 2011	S 14°	W 170°	Porites	16.5		601	1520-2011
1452c9	Pisinun, Chuuk (Micronesia)	22/01/2017	N 07°08'	E 151°53'	Porites	8	10.9	88	81
2352	Losuia, Tabungora Island (P. New Guinea)	06/11/2017	S 9°21'	E 152°02'	Porites	14	9.9	90.0	91
2853	Green Island (Taiwan)	24/03/2018	N 22°39'	E 121°29'	Porites	3	8.1	109	135
3251	Secas islands (Panama)	25/08/2018	N 7°57'	W 82°03'	Porites	3	11.8	115	97
2352c18	Losuia, Tabungora Island (P. New Guinea)	06/11/2017	S 9°21'	E 152°02'	Diploastrea	12.9	4.1	82	201
2853	Green Island (SE) Taiwan	23/03/2018	N 22°39'	E 121°29'	Diploastrea	13	6.3	39	61


TARA-PACIFIC
S. Planes, D. Allemand


*TEs (Trace Element ratios like Li/Mg, B/Ca, etc.) (1) Tangri et al., 2018; (2) Linsley et al. (2019)

CLIM-EPARSES (TAAF)
A. Tribollet


Island – 23 (Yanaba Island) Papua New Guinea



tara
EXPEDITIONS
FOUNDATION



tara
PACIFIC
2016 - 2018

Porites lobata: 92 cm (~ 80 years)



Diploastrea: 86,5 cm (150 years)

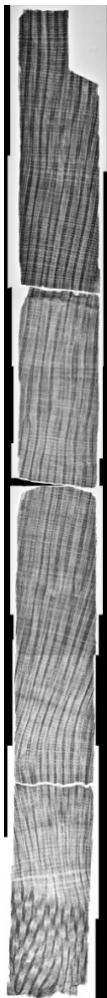


Global changes

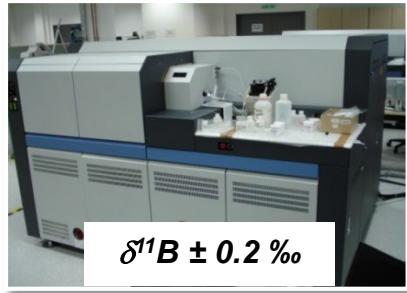
Lophelia pertusa



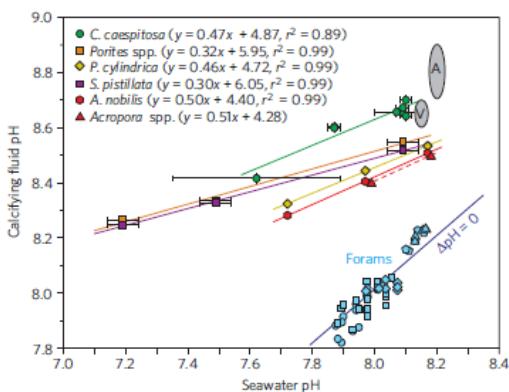
Diploastrea heliopora



pH: Boron isotopes ($\delta^{11}\text{B}$)

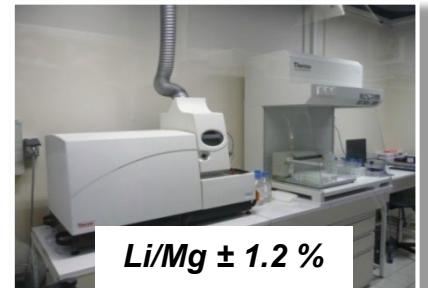


MC-ICPMS Neptune ^{Plus}

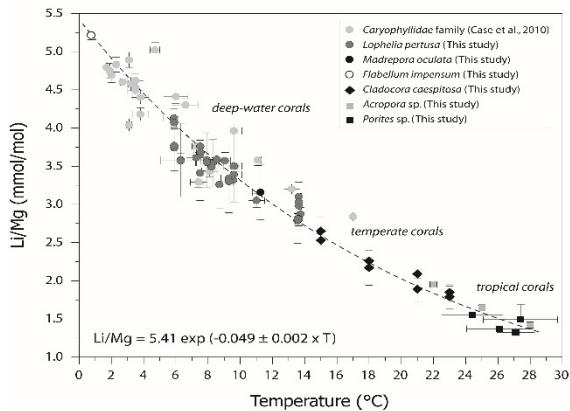


Trotter et al. (2011)
McCulloch et al. (2012)

SST: Trace elements (Li/Mg)

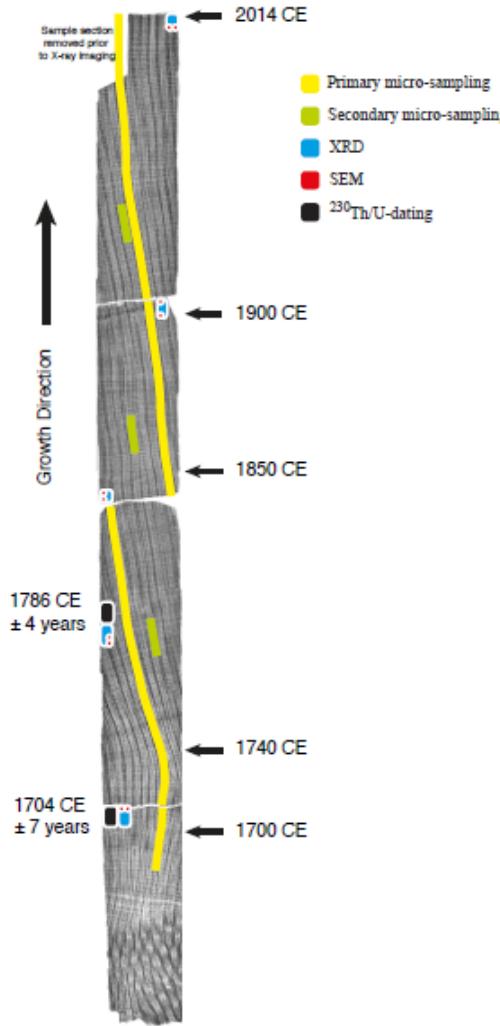


ICP-MS Xseries^{II} & iCAP TQ
Li/Mg, Sr/Ca, B/Ca, U/Ca



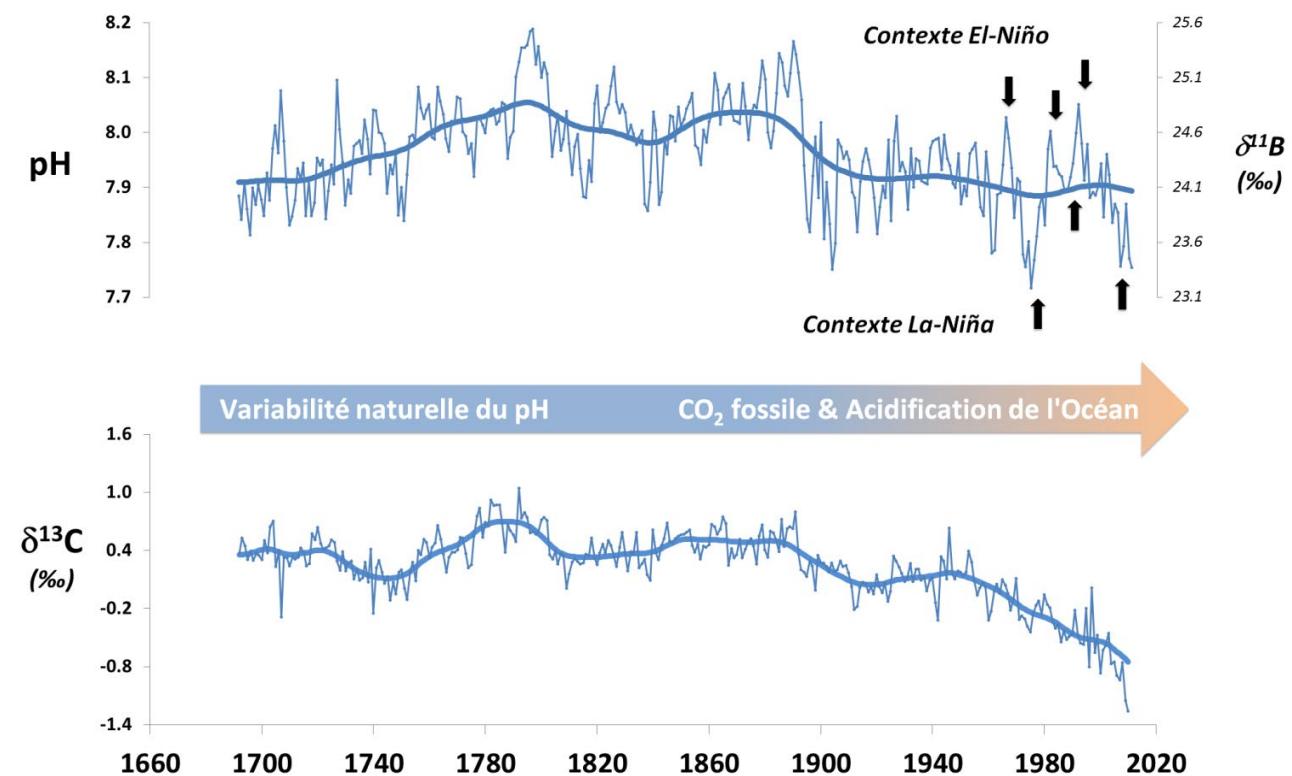
Montagna et al. (2014, GCA)
Cuny-Guirriec et al. (2019, Chem. Geol.)
Canesi et al. (2024, Chem. Geol.)

D. heliopora X-radiograph positive



Surface ocean pH variations since 1689 CE and recent ocean acidification in the tropical South Pacific

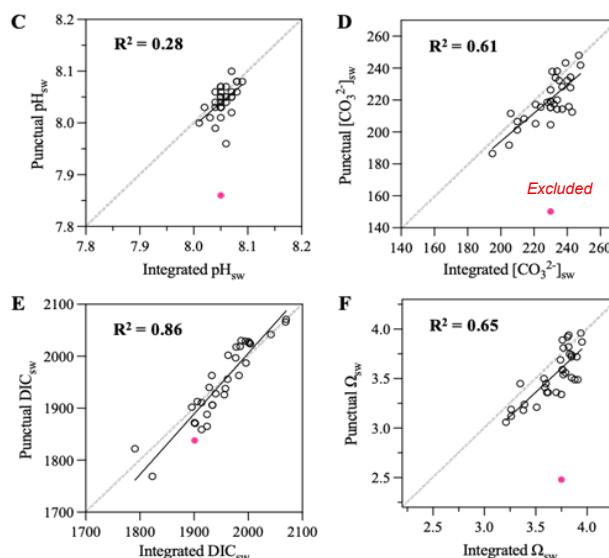
Henry C. Wu^{1,2,3}, Delphine Dissard¹, Eric Douville¹, Dominique Blamart¹, Louise Bordier², Aline Tribollet¹, Florence Le Correc¹, Edwige Pons-Branchu¹, Arnaud Dapoigny² & Claire E. Lazareth¹



Differences in carbonate chemistry up-regulation of long-lived reef-building corals

Environmental data

TARA one-time sampling (TA-TC, SNAPOCO₂)
vs
6-yr integr. SST & carb. chem. (databases)



Geochemical data

Boron geochemistry
in skeletal core-TOPs
(2010-2016)

$\delta^{11}\text{B}$ B/Ca



pH_{cf} $\text{CO}_3^{2-}_{\text{cf}}$
And all carbonate chemistry
parameters of calcifying fluid

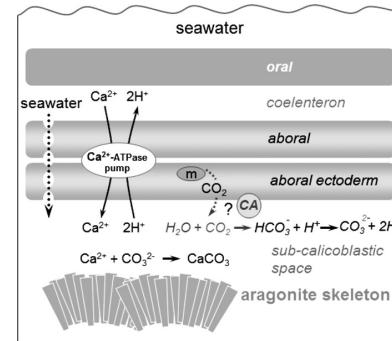
scientific reports

Canesi et al. (2023)

Differences in carbonate chemistry up-regulation of long-lived reef-building corals

Main objective : study coral biocalcification processes from a geochemical point of view

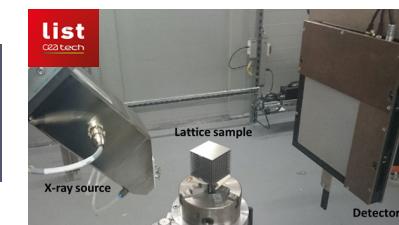
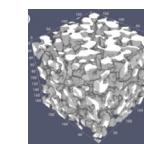
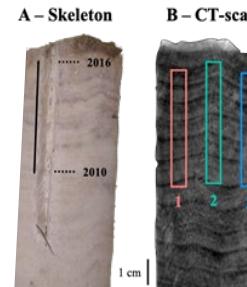
→ Today we can reconstruct carbonate chemistry in the internal calcifying fluid of corals (boron proxy)



3D Tomography
(CT-Scan & μ-CT)

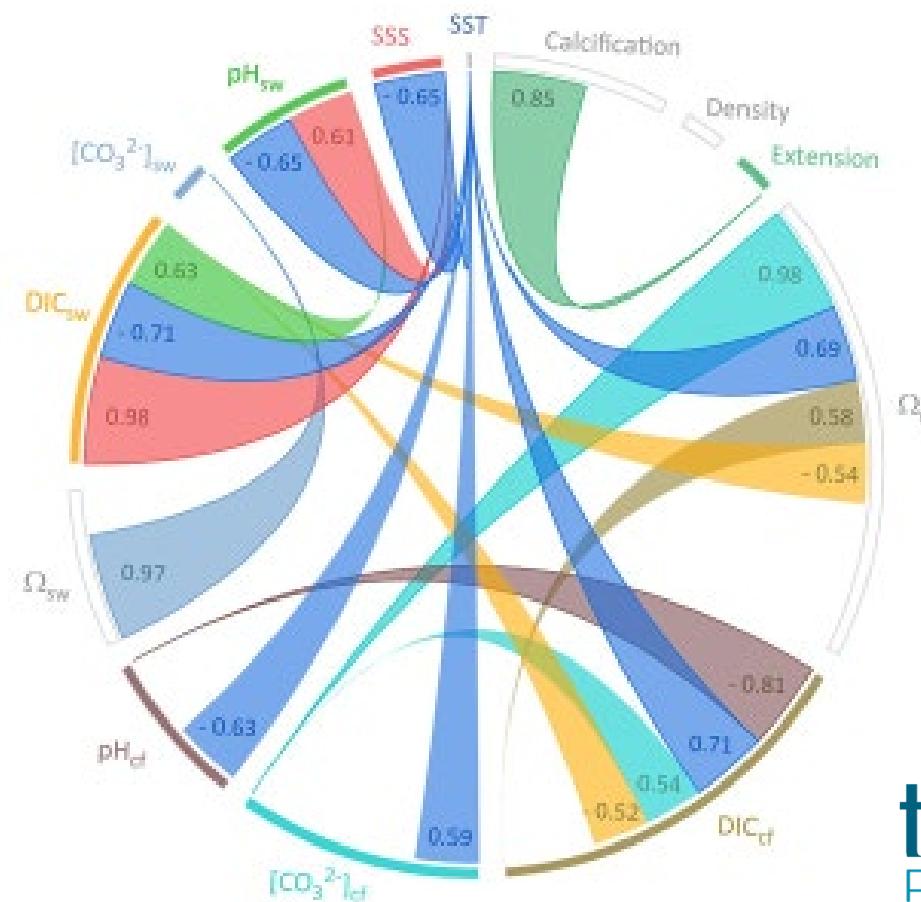
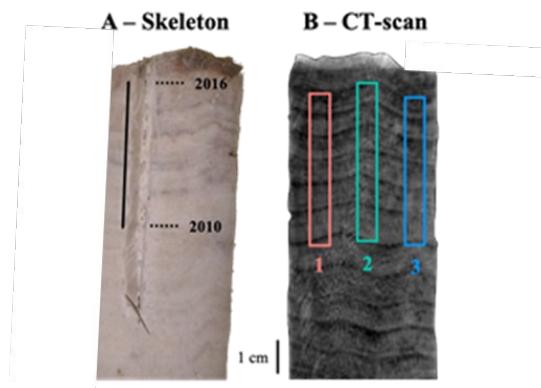
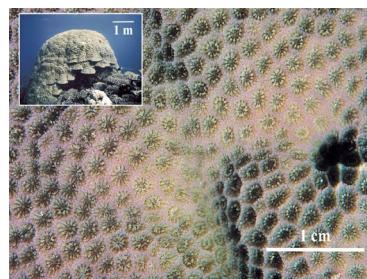
Calcification & growth parameters (l.ext./density)

Skeletal core-TOP sections
(2010-2016)



Differences in carbonate chemistry up-regulation of long-lived reef-building corals

Porites (n=39)

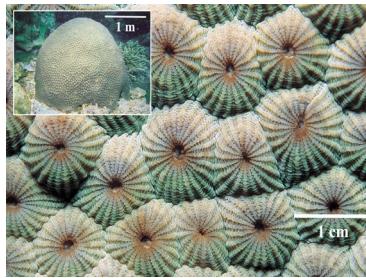


tara
PACIFIC

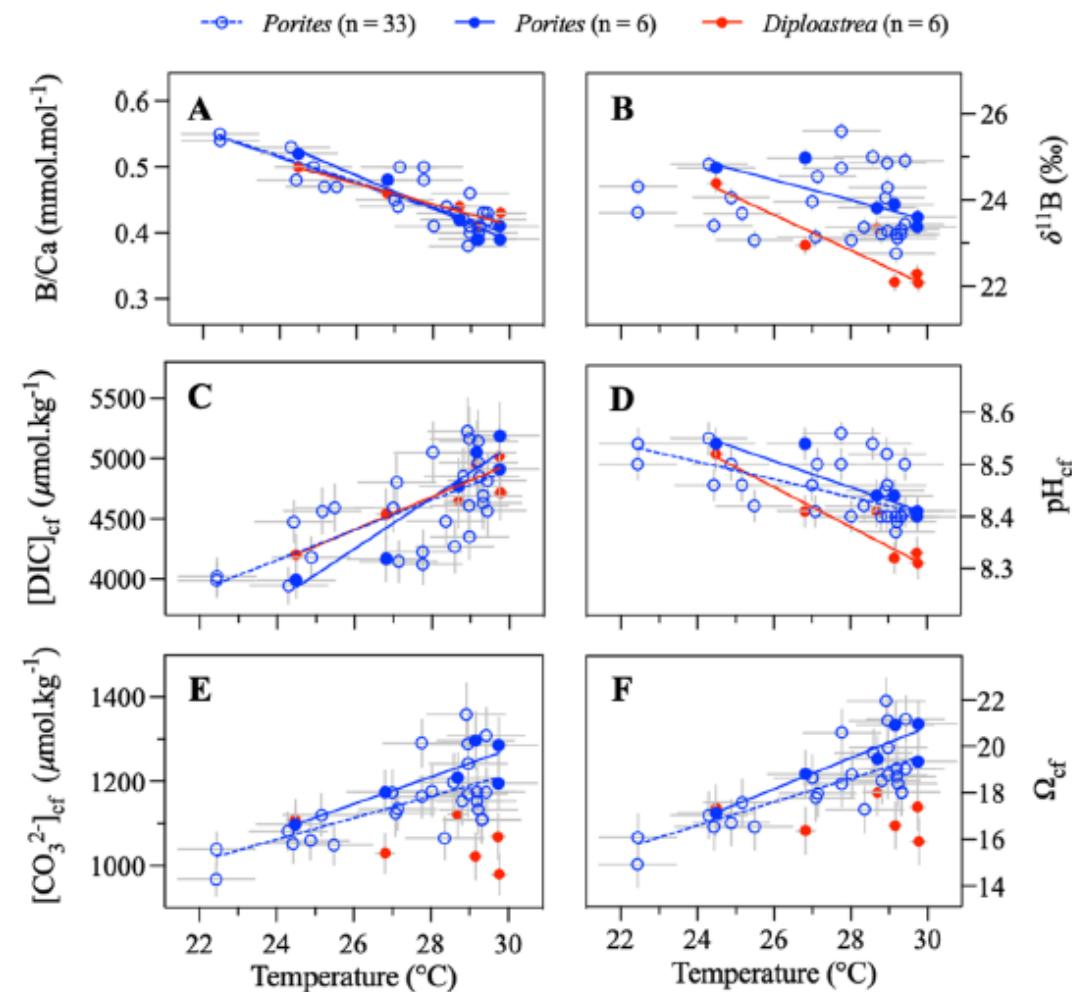
Porites (n=39)



Diploastrea (n=6)

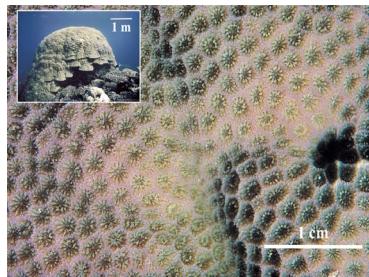


Differences in carbonate chemistry up-regulation of long-lived reef-building corals

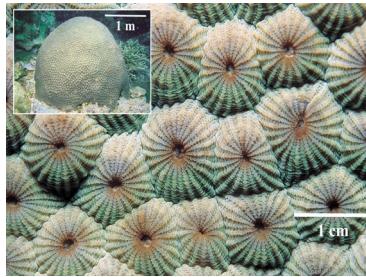


Canesi et al. (2023)

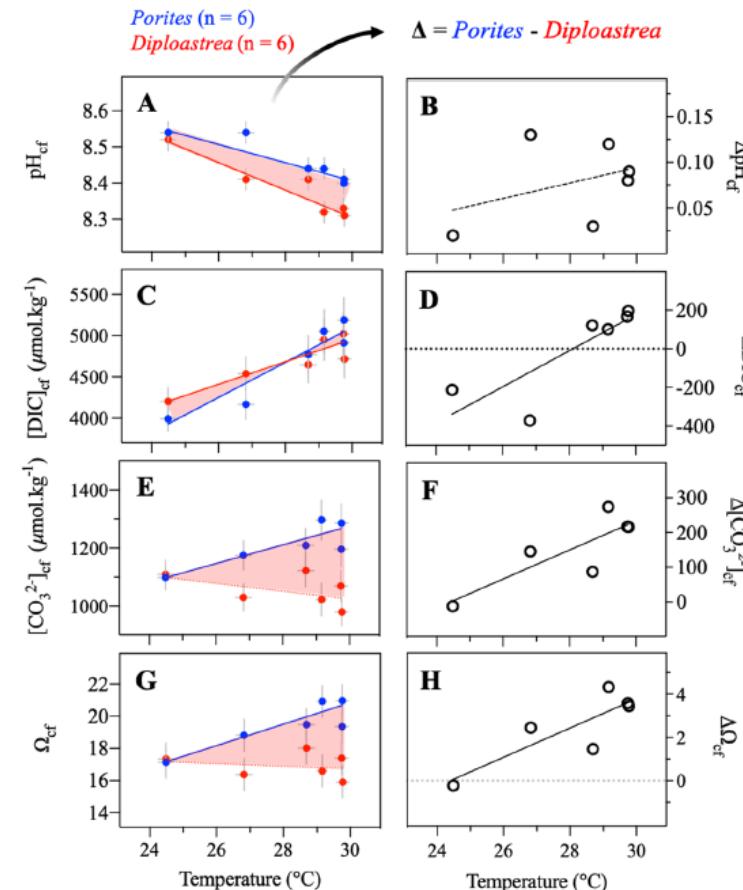
Porites (n=39)



Diploastrea (n=6)



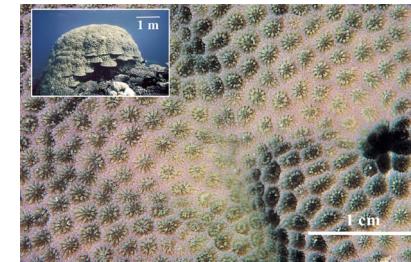
Differences in carbonate chemistry up-regulation of long-lived reef-building corals



Temperature effects on coral calcification

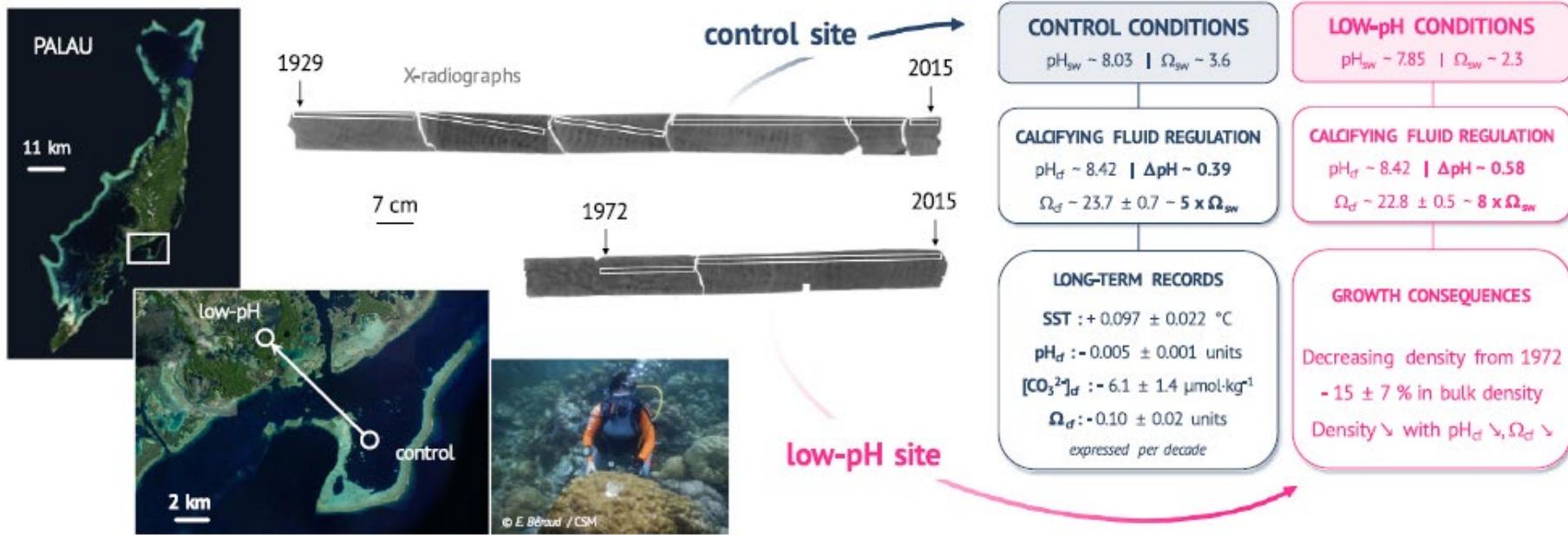


Canesi et al. (2024)



Porites (n=2)

CORAL CORE COLLECTION OF MASSIVE PORITES CORALS OF PALAU EXPOSED TO NATURAL LONG-TERM:



Impact of OA (pH) on Porites calcification



Bio-erosion,
Pollutants (heavy metals / nutrients),
But also micro-plastics,
Org. molecules, etc.

IndoPacific coral cores



Coral cultures



COR-Resilience: Investigating tropical CORal Resilience to global/local changes over the last centuries: biogeochemical observations and modelling

Consortium



Laboratoire des Sciences du Climat et de l'Environnement (CEA)

E. Douville



Laboratoire Océanographique de Villefranche sur mer (SU)

F. Lombard



Centre Scientifique de Monaco (CSM)

S. Reynaud



Laboratoire d'Océanographie et du Climat: Expérimentations et Approches Numériques (IRD)

M. Khodri



Environnements & Paléo-environnements Océaniques et Continentaux (CNRS)

E. Dassié



Geochemistry (Bore)
Geochronology
Coral cores (past)
Paleo-reconstruction (2-5 centuries)

Expertises

Modern Oceanography
Modern environmental parameters
Marine Cartography & Time-series

Coral sclerochronology
Physiology/ecophysiology
Cultures in aquarium (SST / pollutants)

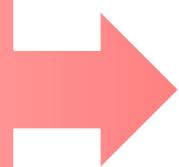
Bio-erosion (micro-borers, SEM)
Pollutants (ICPMS)
Archives quality (XRD)
Modelling

Geochemistry
Stable isotopes
Pollutants (metals)

COR-Resilience: *Investigating tropical CORal Resilience to global/local changes over the last centuries: biogeochemical observations and modelling*

- a full basin-wide observations of modern and past SST, pH, heavy metal and micro-bioerosion variability
- a full Indo-Pacific basin “data – model” comparison of SST and carbonate chemistry changes over the last 2-5 centuries
- a full comprehensive evaluation of multi-parametric-environmental effects on coral calcification for two different massive reef-building species

- SST
- pH and carbonate chemistry (Ω)
- Light/Rainfall
- Pollution (metals /eutropification)
- Bio-erosion



Evaluate their impact on the calcification of corals

Predict their future resilience and acclimatization

5 WPs ► Coordination, modern environments, past, calcification processes & modelling