20th-century interseismic deformation in the Lesser Antilles subduction zone from coral microatolls

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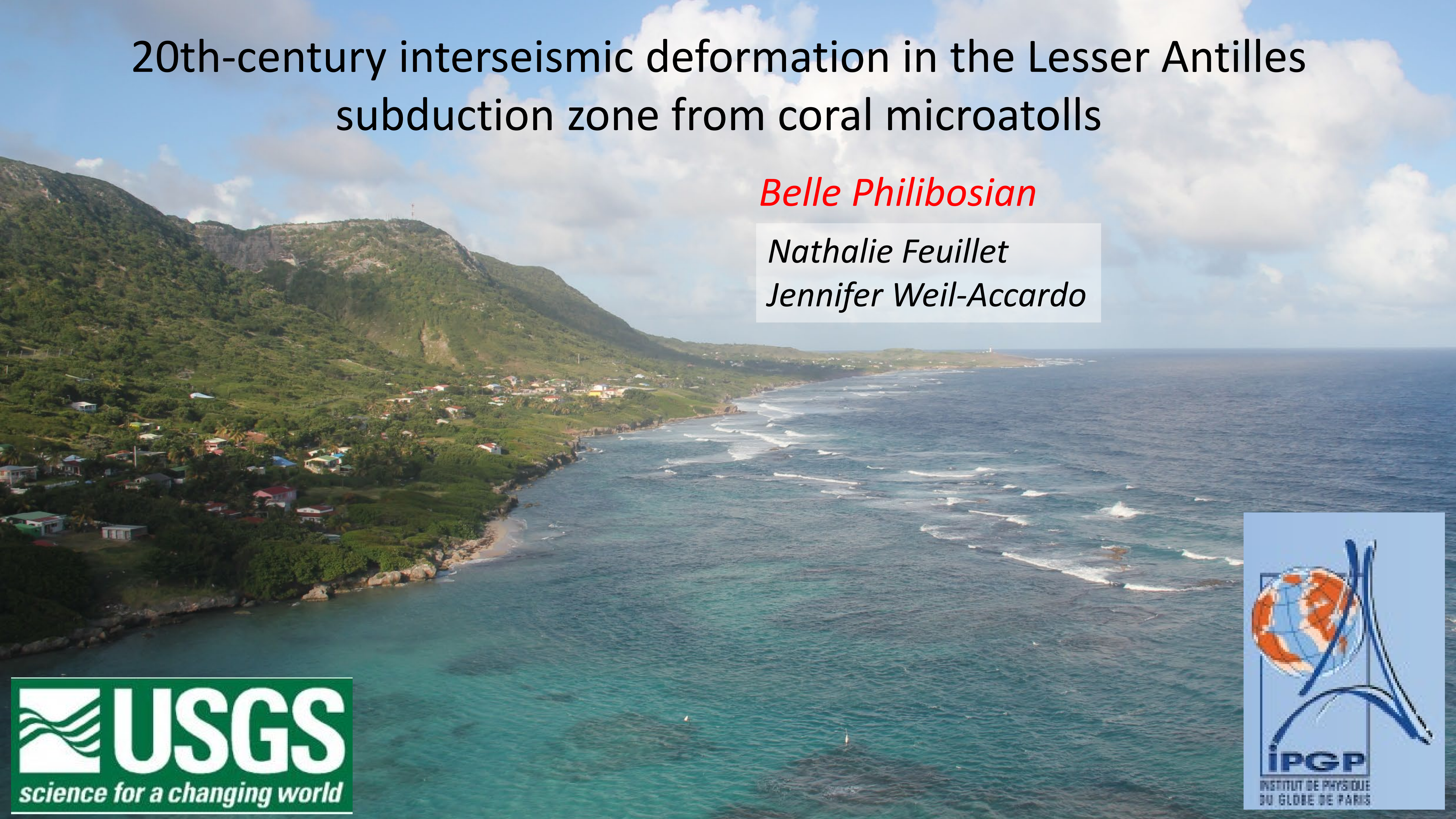

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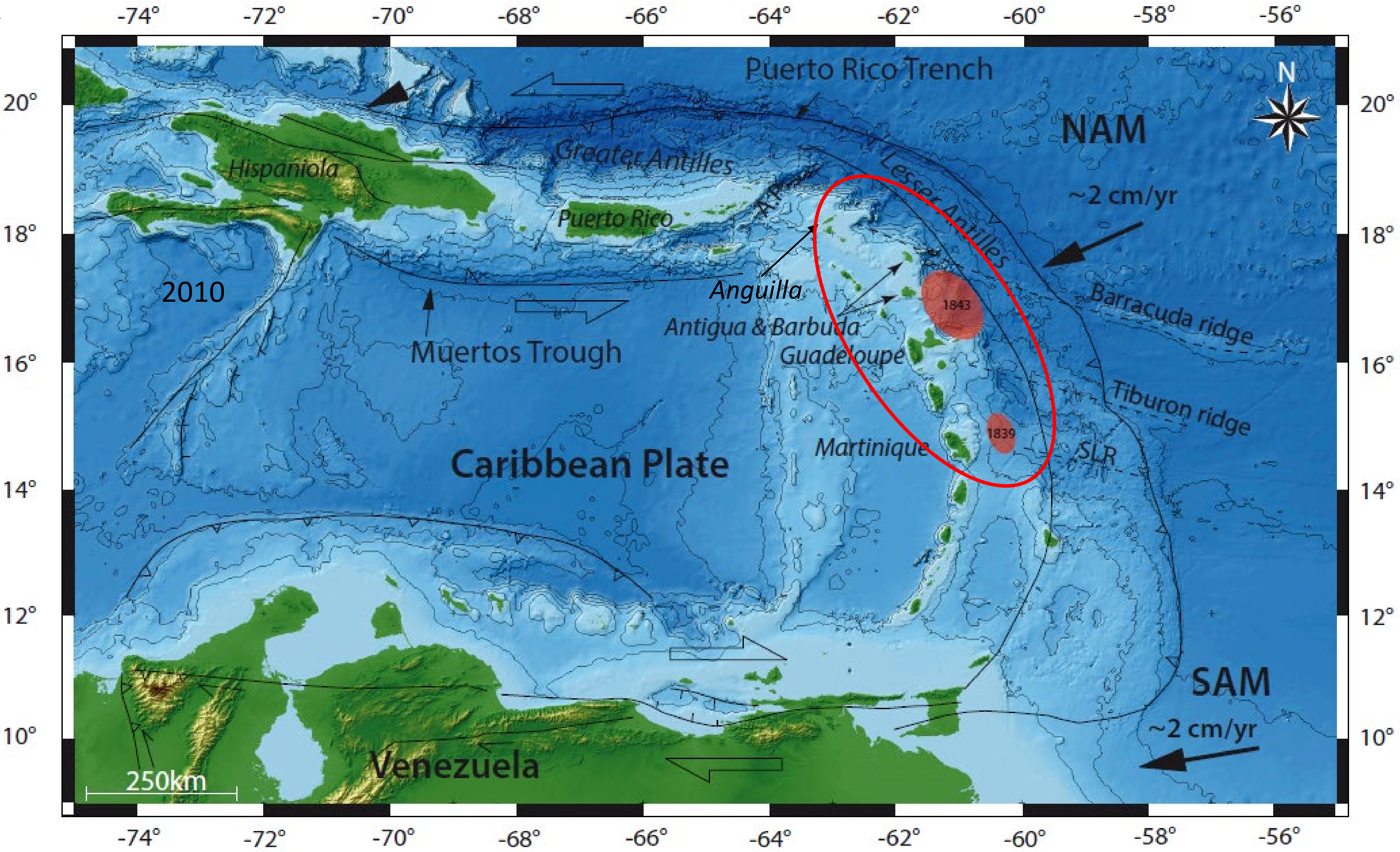
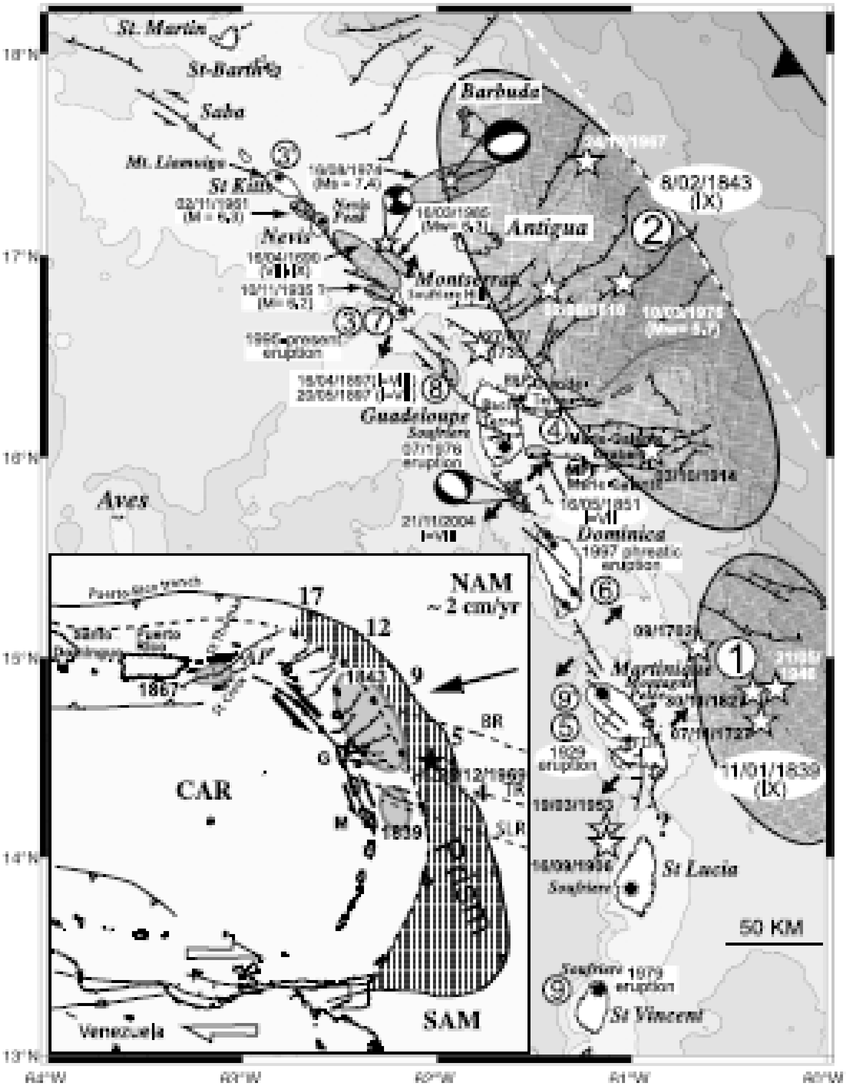
Regional Overview



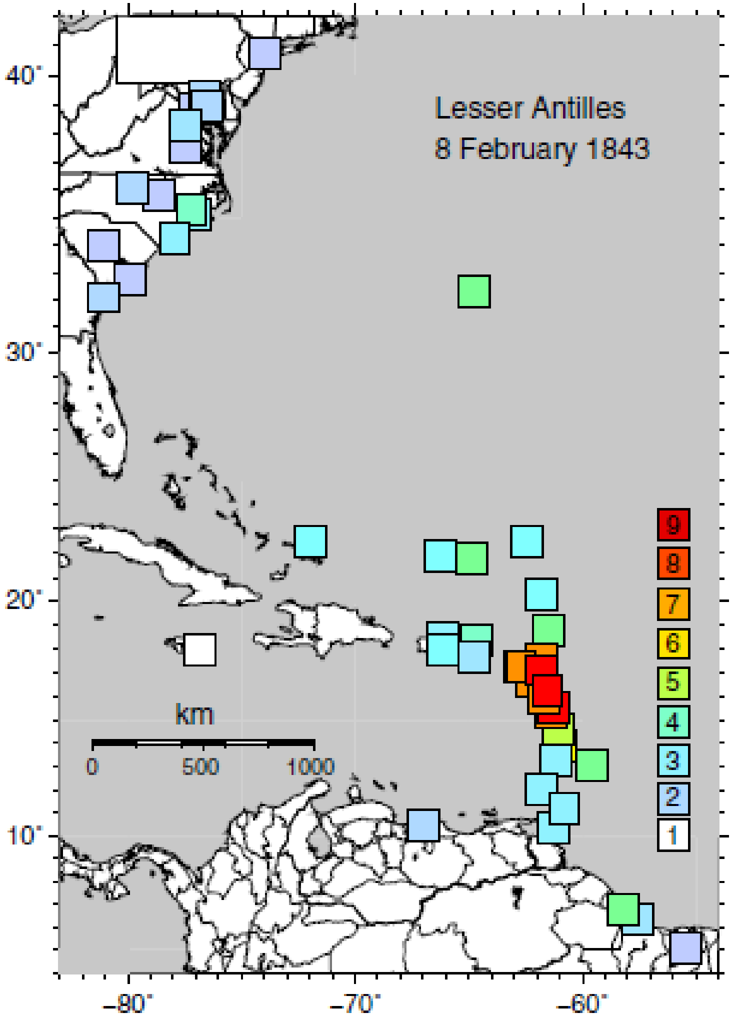
Motivation

- No large subduction earthquakes in the instrumental era
- Lesser Antilles historical record includes some likely megathrust ruptures but is too short to fully characterize the fault behavior.
- Instrumental records that could record strain accumulation (GNSS) are sparse and cover only a small fraction of the likely seismic cycle period.
- Our goal: Use coral microatolls to obtain longer-term deformation and records of past events.

1843 Guadeloupe Earthquake (M_w ~8.5)

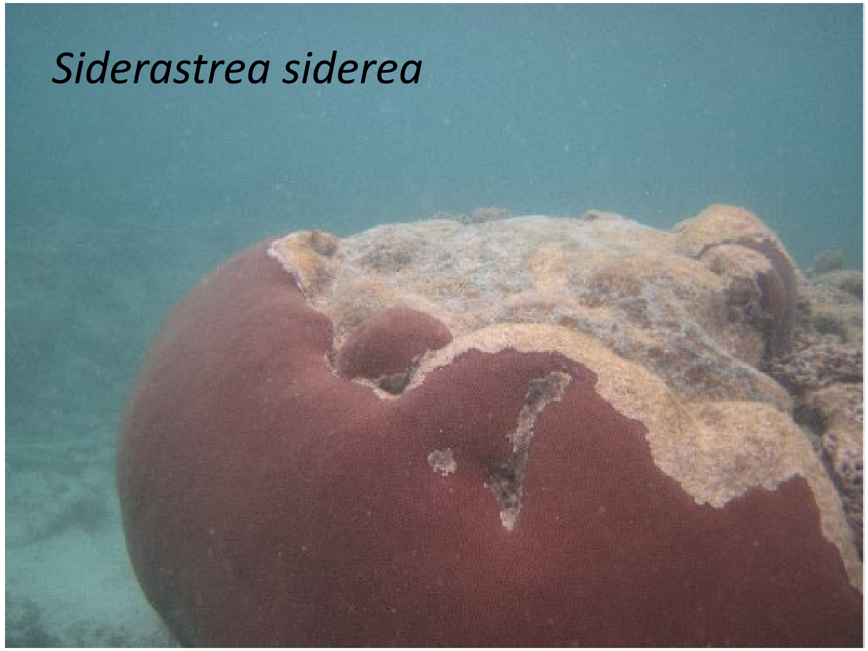


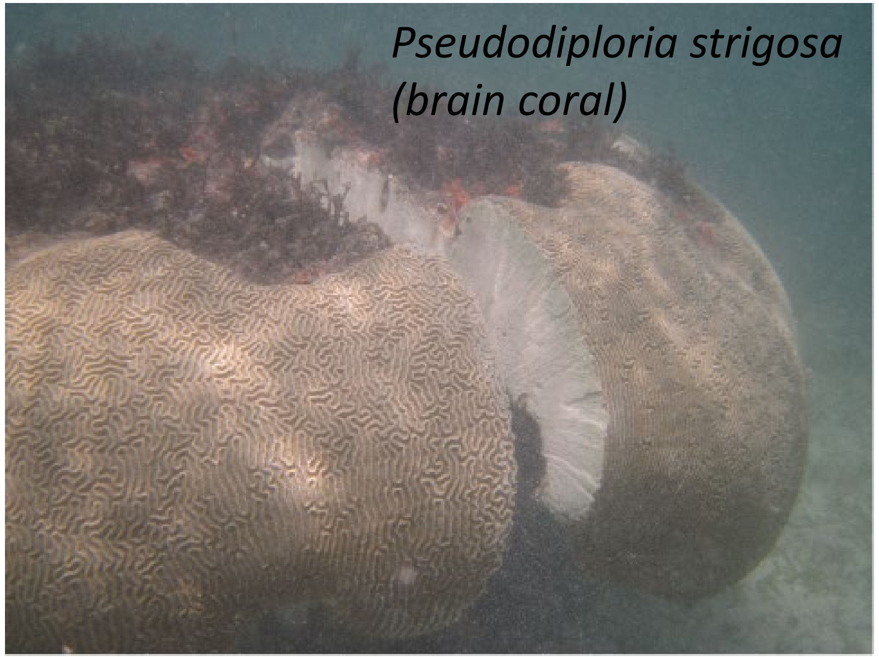
(Feuillet et al. 2011)



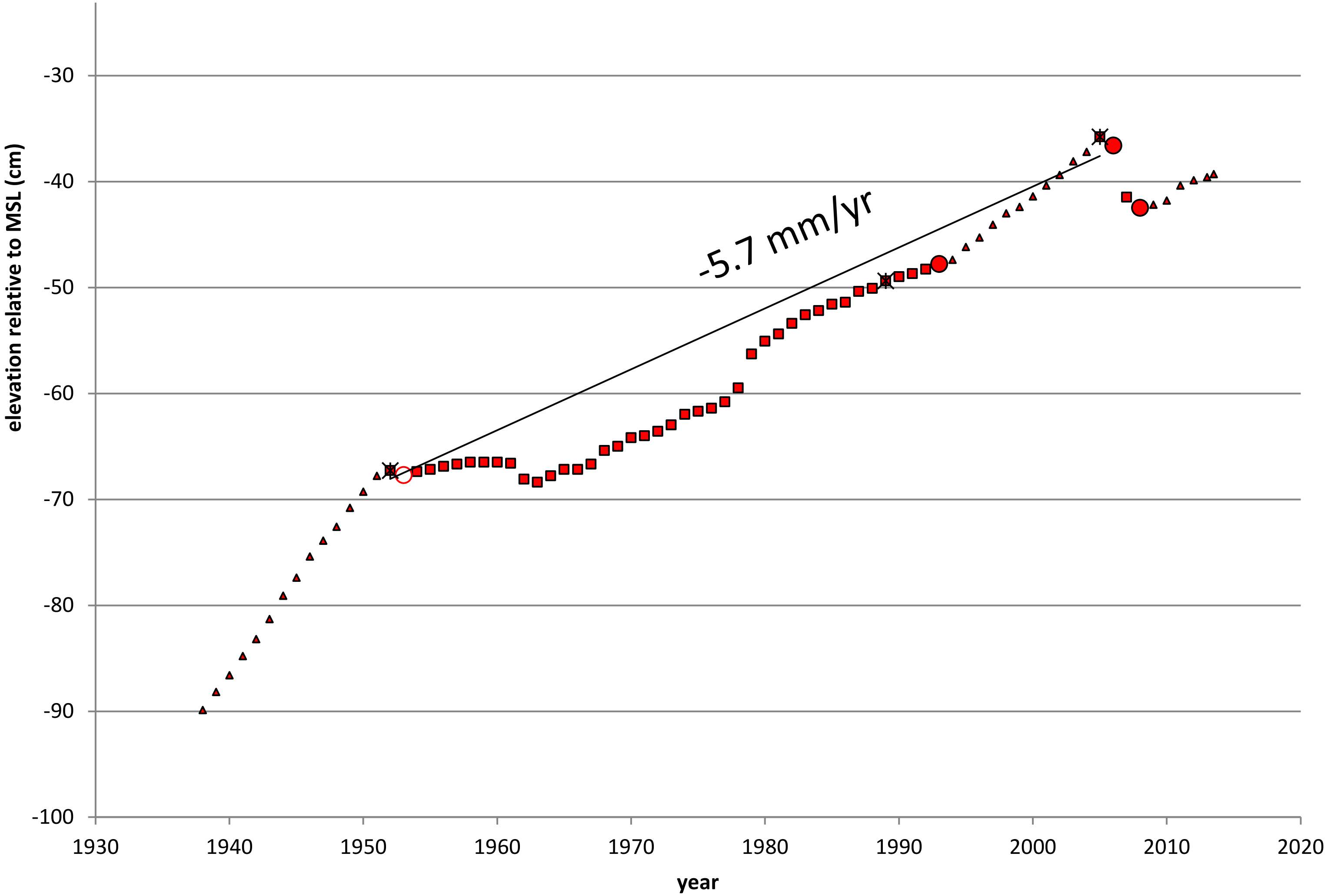
(Hough 2013)

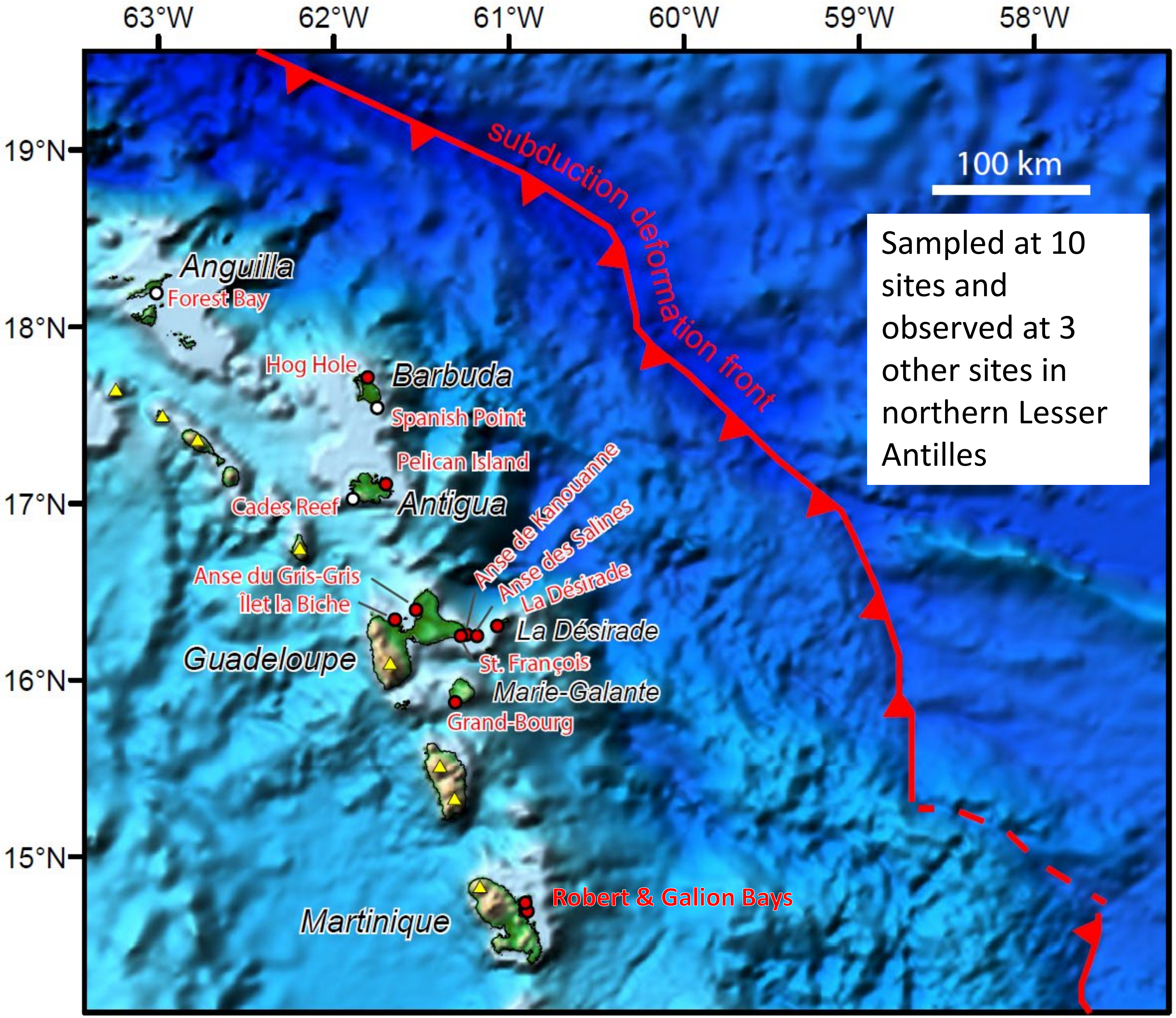
Caribbean Hemispherical (Microatoll-Forming) Corals





Mapping Growth History and Relating to Relative Sea Level

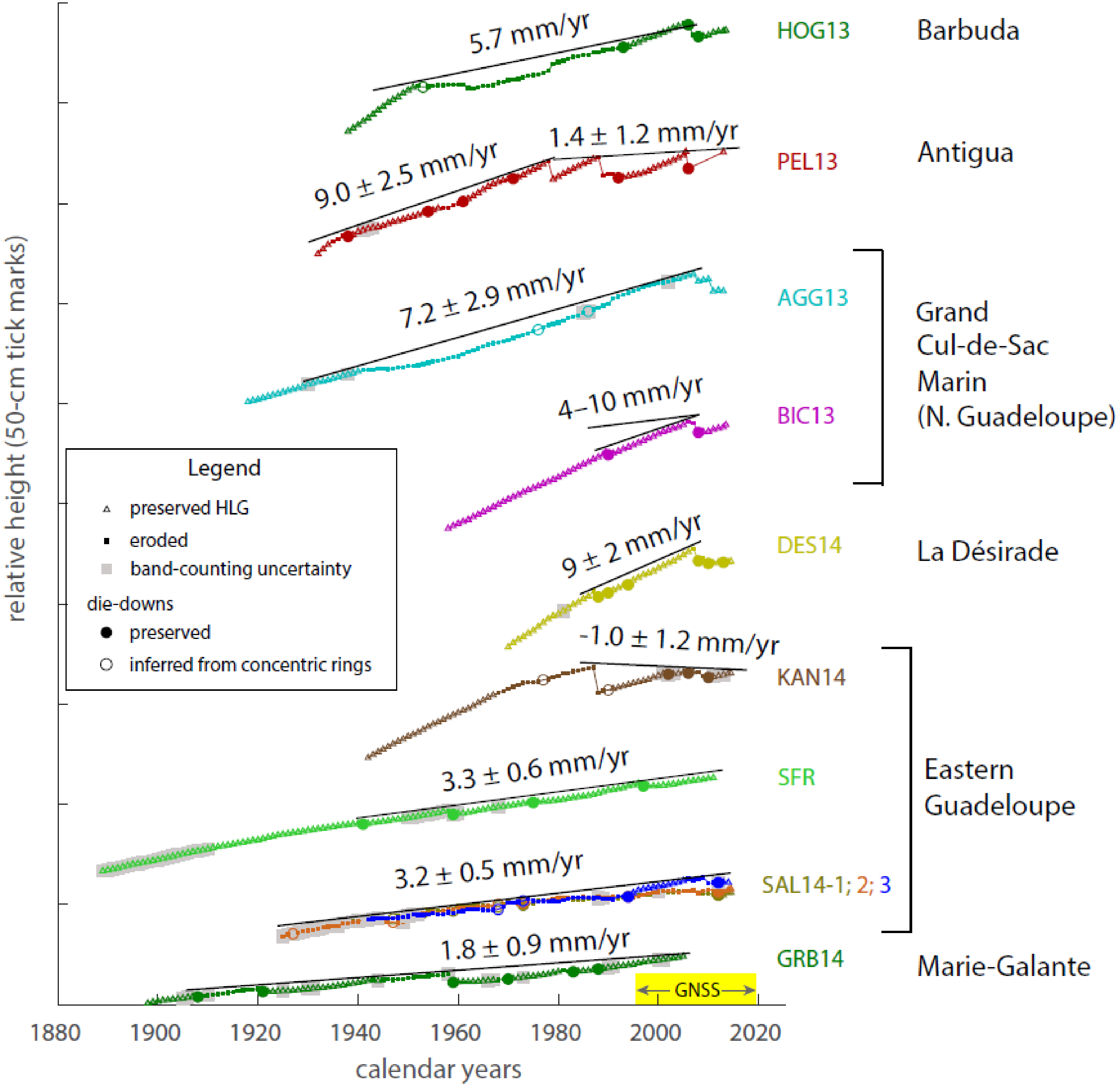




63°W
62°W
61°W
60°W
59°W
58°W
19°N
18°N
17°N
16°N
15°N
100 km
subduction deformation front
Sampled at 10 sites and observed at 3 other sites in northern Lesser Antilles
Anguilla
Forest Bay
Hog Hole
Barbuda
Spanish Point
Pelican Island
Cades Reef
Antigua
Anse de Kanouanne
Anse des Salines
La Désirade
Anse du Gris-Gris
Îlet la Biche
La Désirade
Guadeloupe
St. François
Marie-Galante
Grand-Bourg
Robert & Galion Bays
Martinique

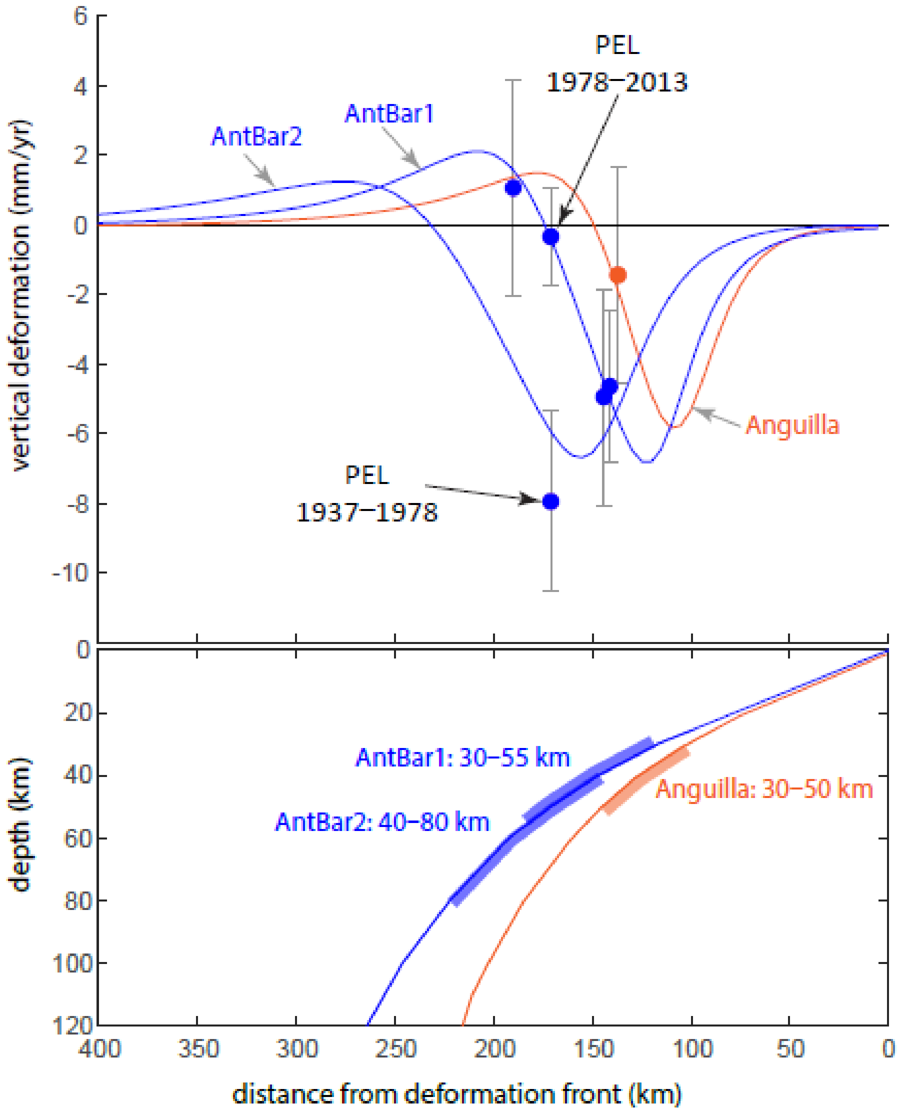
Gradual Submergence

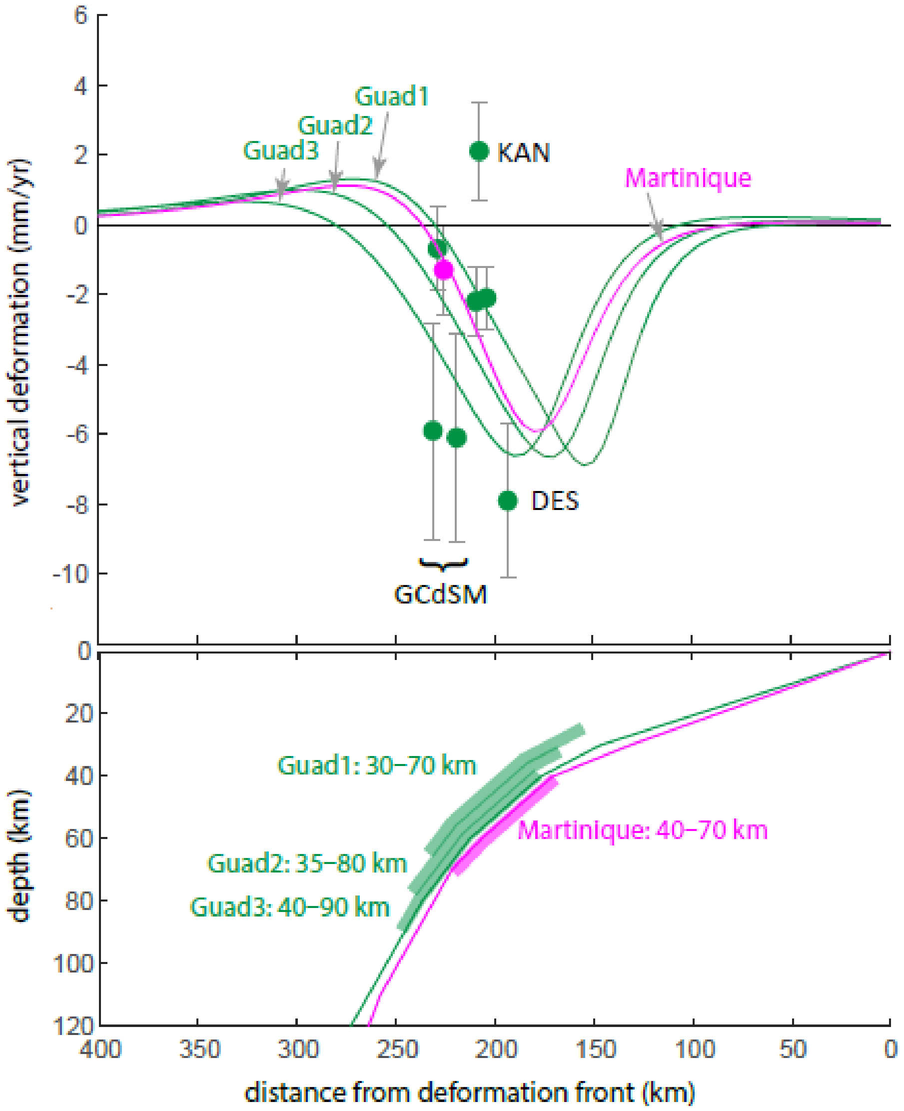
- Only one coral possibly shows effects of 19th-century earthquake; others are too young
- Rates span 1 cm/yr of range
- Only one site displays emergence
- We correct our data for sea-level change to obtain the true rate of land-level change.
- Sea-level change would affect all sites in this region roughly equally; relative motion between sites must be due to land-level change (e.g. tectonic).



We attempt to reproduce the observed vertical deformation rates with simple elastic backslip models of interseismic plate interface coupling.

- Most data fit by locked patches between 30 and 70 km depth
- Uplift at KAN site cannot be fit simultaneously with neighboring sites
- Sites with very fast subsidence rates cannot be fit well
- Sites which cannot be fit well may have local effects or non-representative coral records





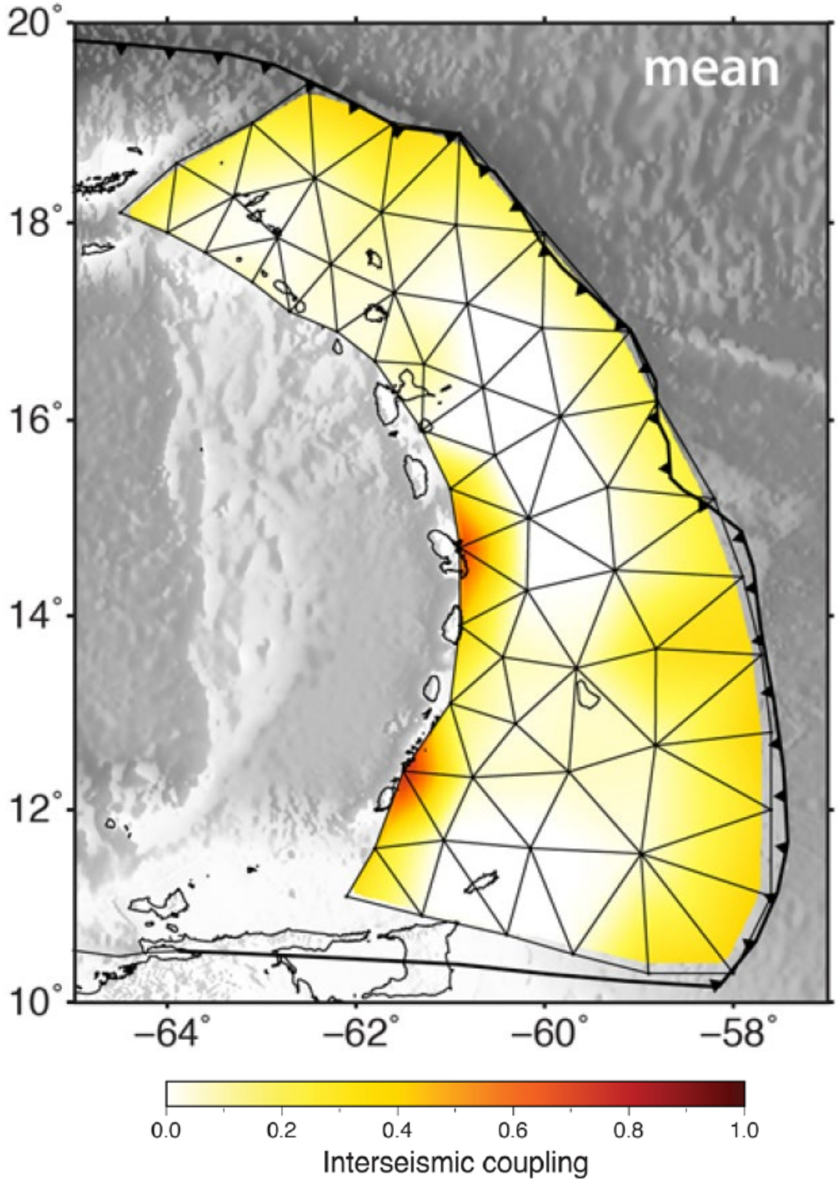
Comparison With GNSS

Recent models of horizontal GNSS data suggest little to no coupling on most of the plate interface.

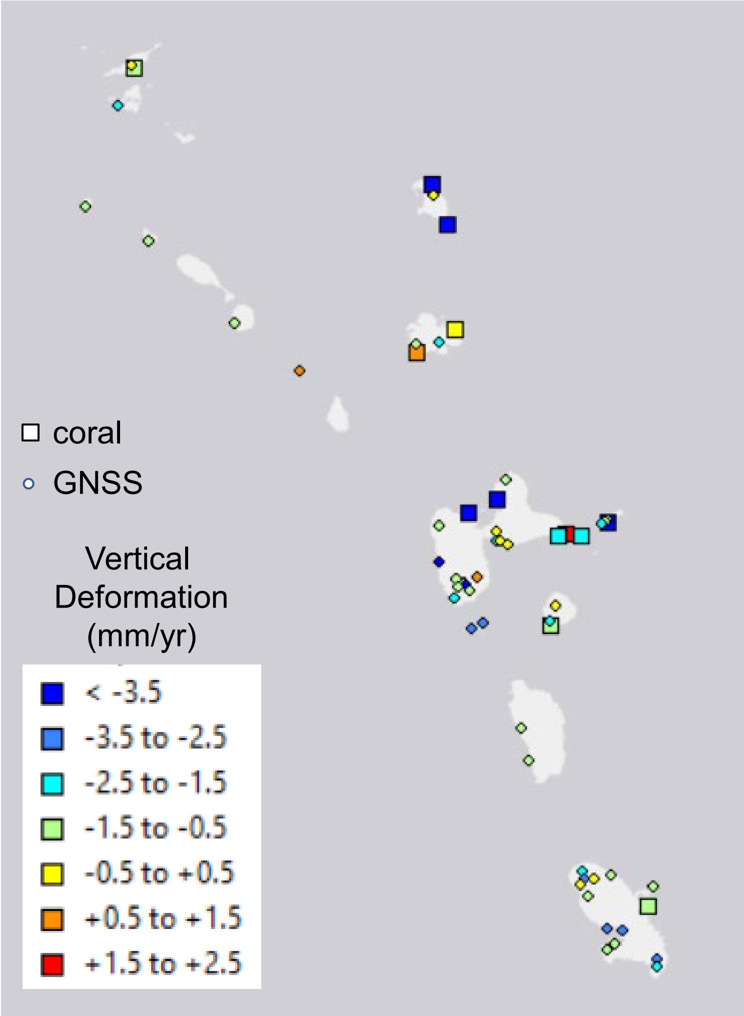
Vertical GNSS data show highly variable deformation with no clear spatial pattern, but average 1–2 mm/yr of subsidence. Agreement with coral-based deformation rates varies.

Why are the GNSS results different from coral results?

- GNSS covers only 20 years; coupling distribution may change over time
- Sparsity of GNSS stations in Caribbean may not constrain horizontal plate motion well
- Likely influence from factors other than interface coupling



van Rijsingen et al., 2020



Comparison of coral data with GNSS data from *van Rijsingen et al., 2022*

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20^{th}-century strain accumulation on the Lesser Antilles megathrust based on coral microatolls

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See also:

Weil-Accardo et al., 2016
Two hundred thirty years of relative sea level changes due to climate and megathrust tectonics recorded in coral microatolls of Martinique (French West Indies)
J. Geophys. Res., Solid Earth, 121 (4) (2016), pp. 2873-2903, 10.1002/2015JB012406

Thank You