The January 12, 2010 Haiti Earthquake

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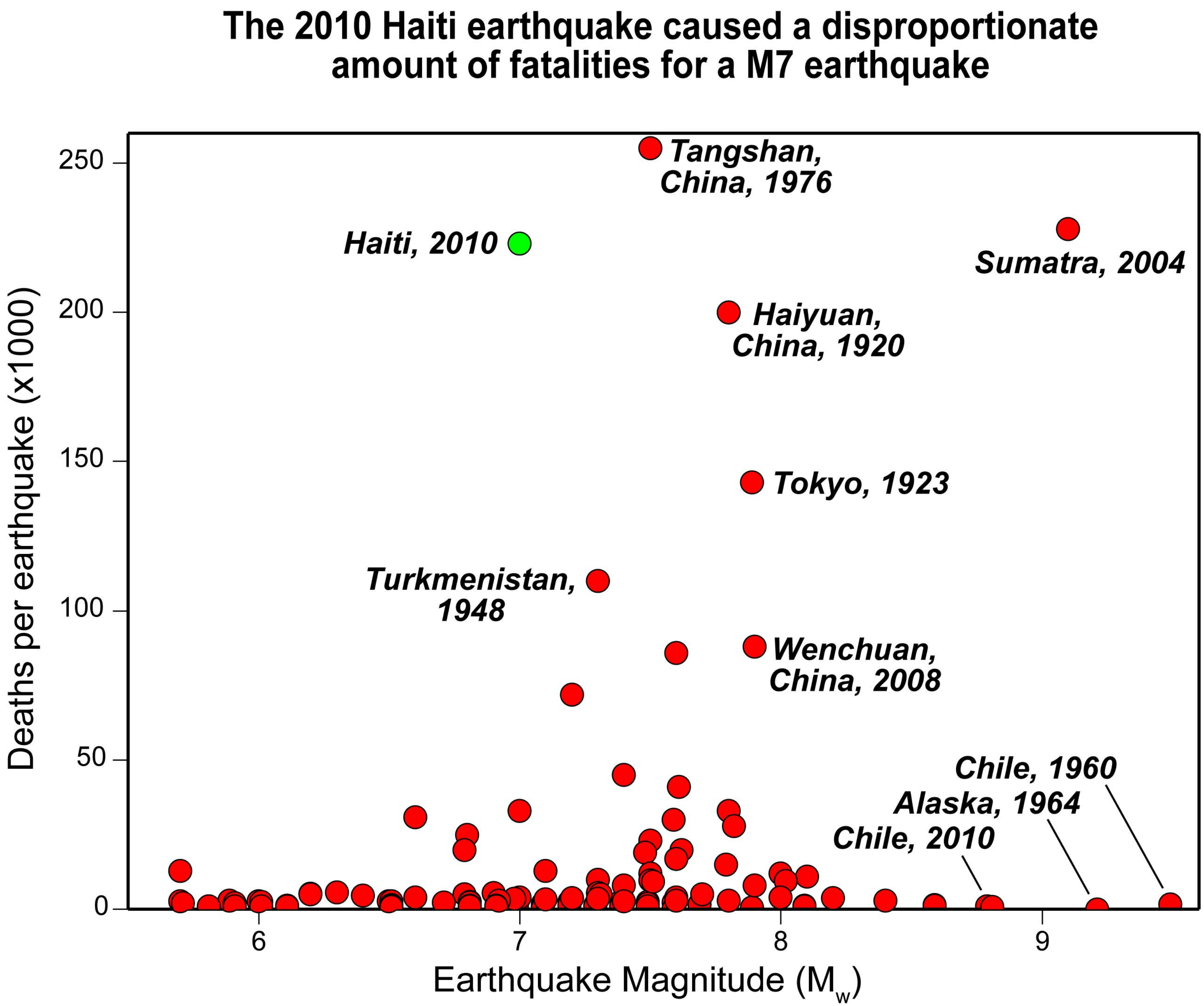

The 2010 Haiti earthquake caused a disproportionate amount of fatalities for a M7 earthquake
Tangshan, China, 1976
Haiti, 2010
Sumatra, 2004
Haiyuan, China, 1920
Tokyo, 1923
Turkmenistan, 1948
Wenchuan, China, 2008
Chile, 1960
Alaska, 1964
Chile, 2010
Deaths per earthquake (x1000)
250
200
150
100
50
0
6
7
8
9
Earthquake Magnitude (M_w)

250,000 residences and 30,000 commercial buildings were severely damaged

An estimated 8 billion dollars of damage – 120% of Haiti's GDP

500 schools were destroyed

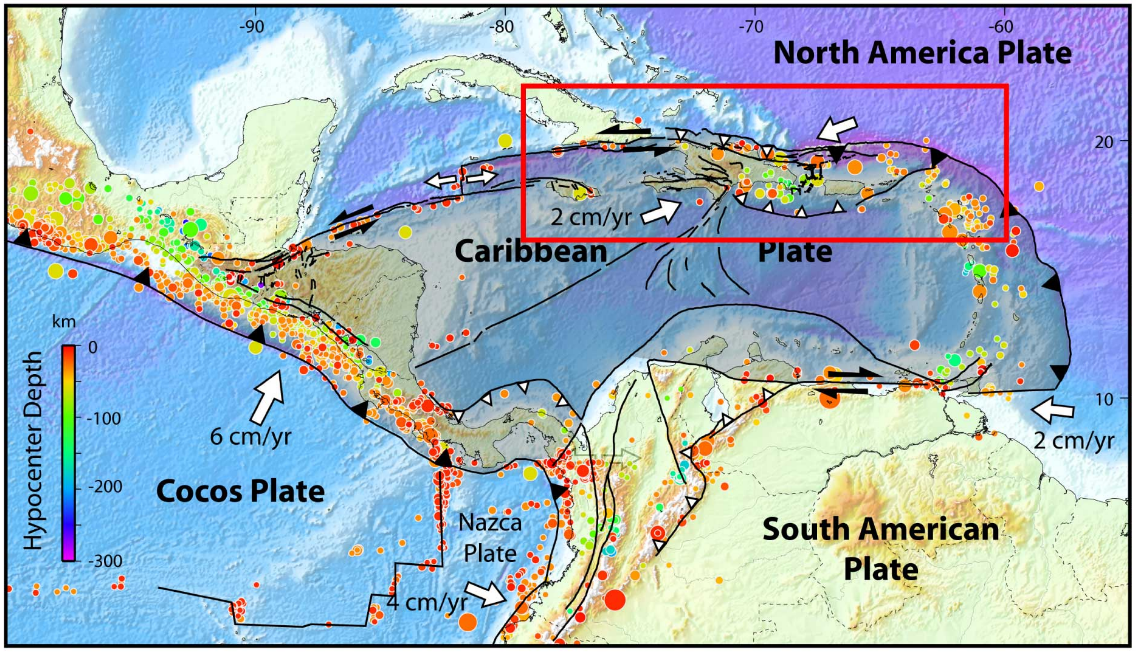
100 churches were destroyed

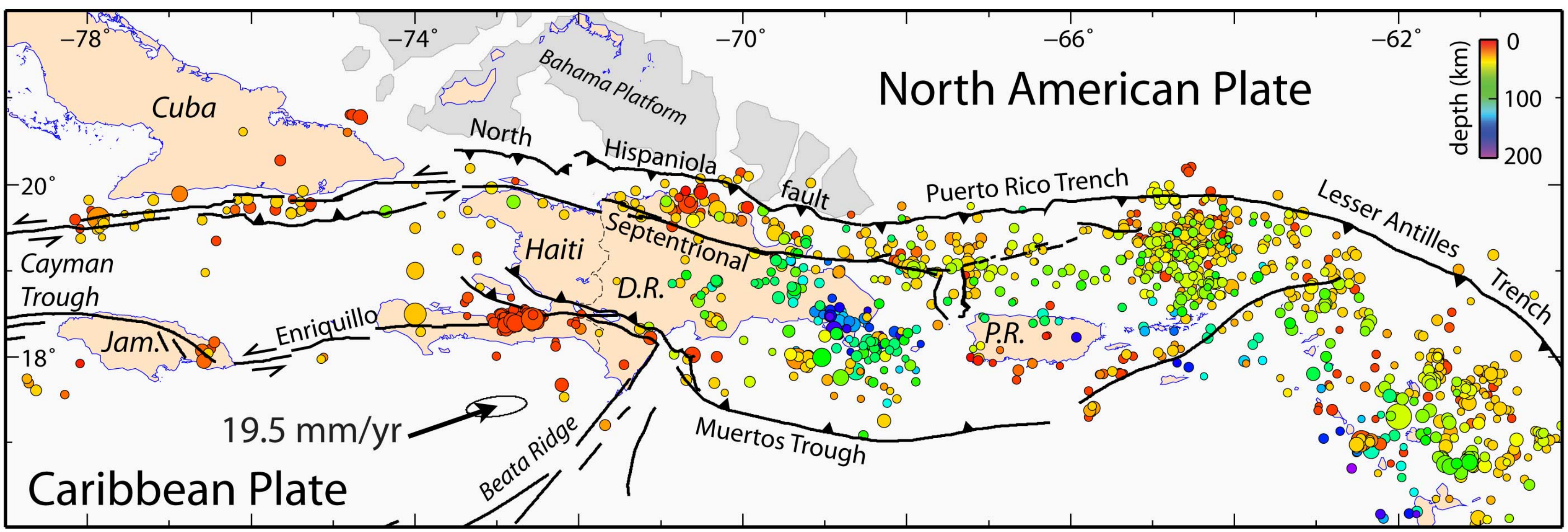

Virtually every government
building was destroyed

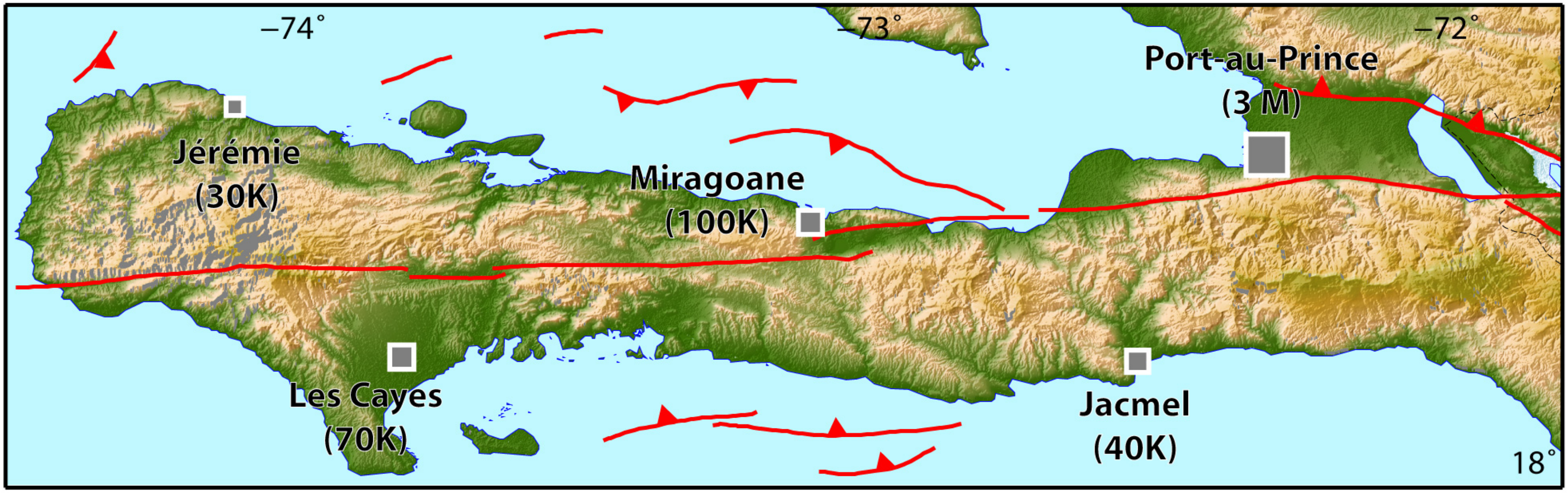

Concrete buildings collapsed on the hillside
Tin shacks undamaged on the valley floor

1.5 million homeless

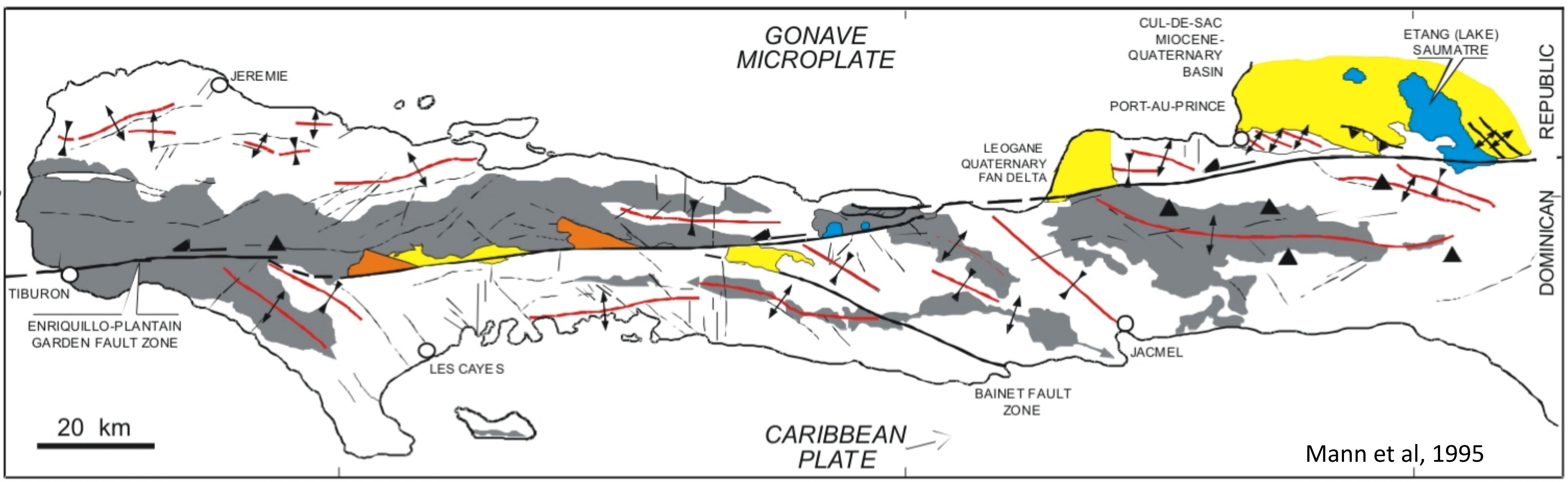
The northern Caribbean plate is a broadly deforming boundary where highly oblique convergence is partitioned into thrust and strike-slip fault zones.





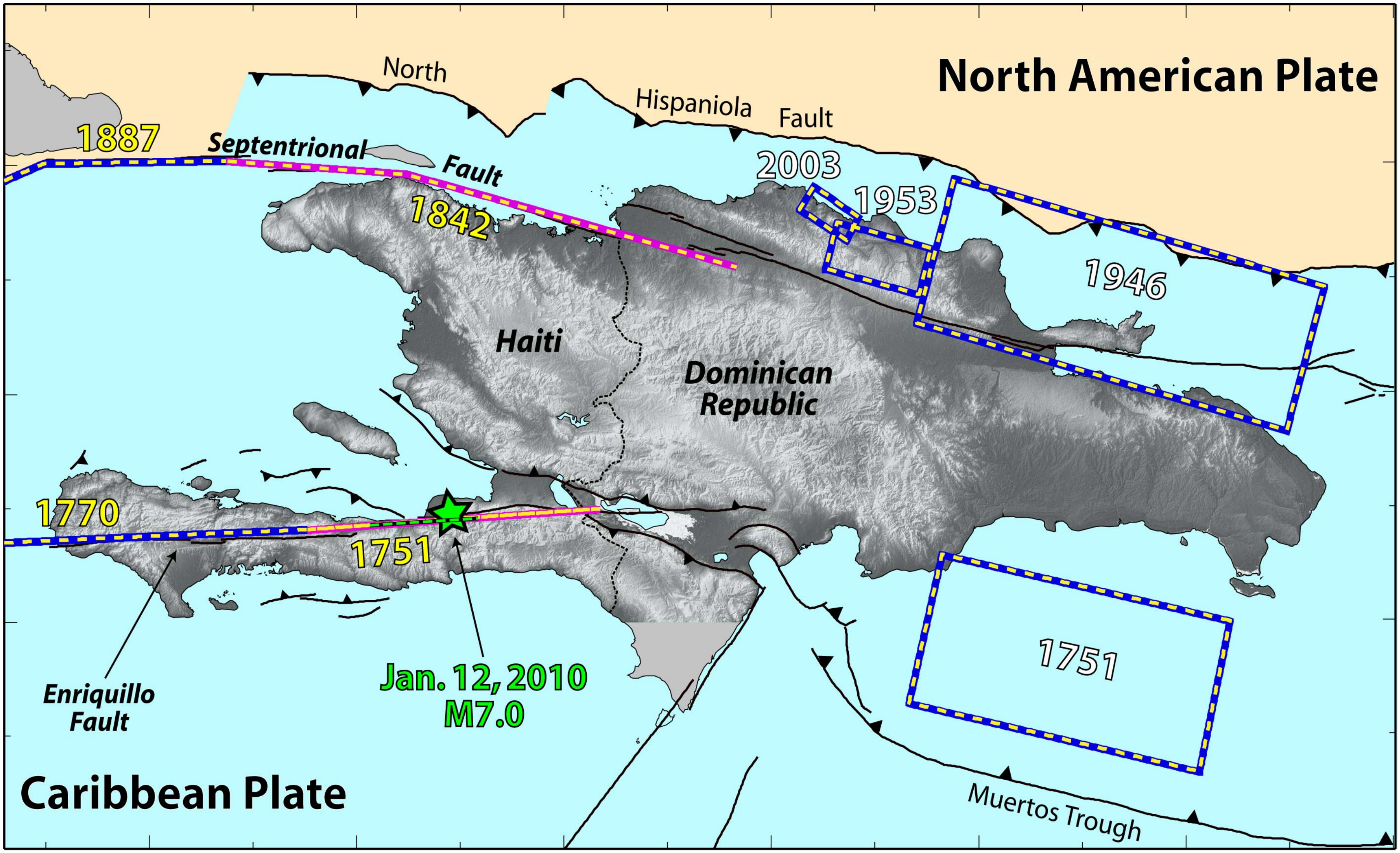


−74˚
−73˚
−72˚
Port-au-Prince
(3 M)
Jérémie
(30K)
Miragoane
(100K)
Les Cayes
(70K)
Jacmel
(40K)
18˚



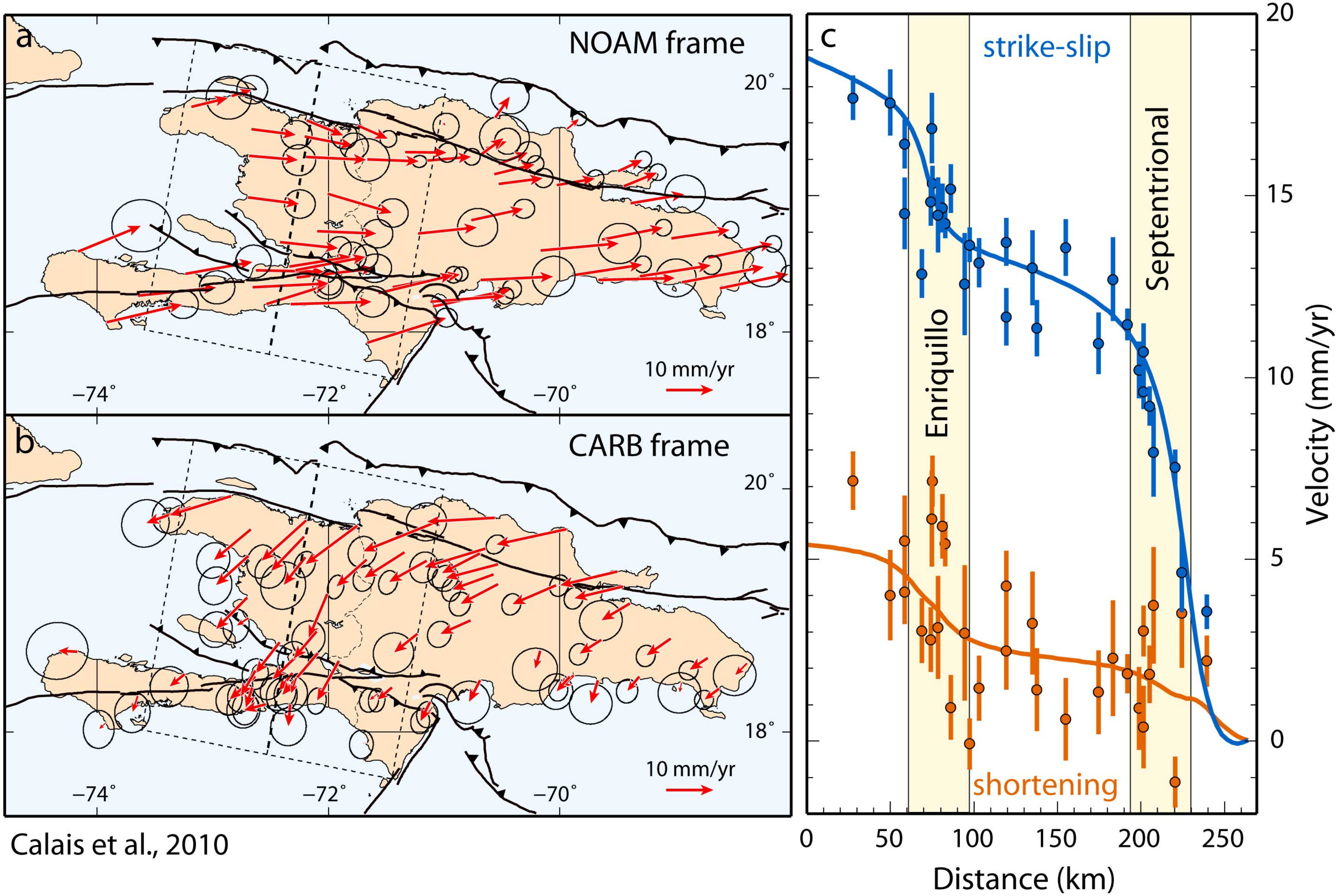
GONAVE
MICROPLATE
CUL-DE-SAC
MIOCENE-
QUATERNARY
BASIN
ETANG (LAKE)
SAUMATRE
PORT-AU-PRINCE
JEREMIE
LEOGANE
QUATERNARY
FAN DELTA
DOMINICAN
REPUBLIC
TIBURON
ENRIQUILLO-PLANTAIN
GARDEN FAULT ZONE
LES CAYES
JACMEL
BAINET FAULT
ZONE
CARIBBEAN
PLATE
20 km
Mann et al, 1995

Haiti has a long history of large earthquakes, though none in the past century until 2010



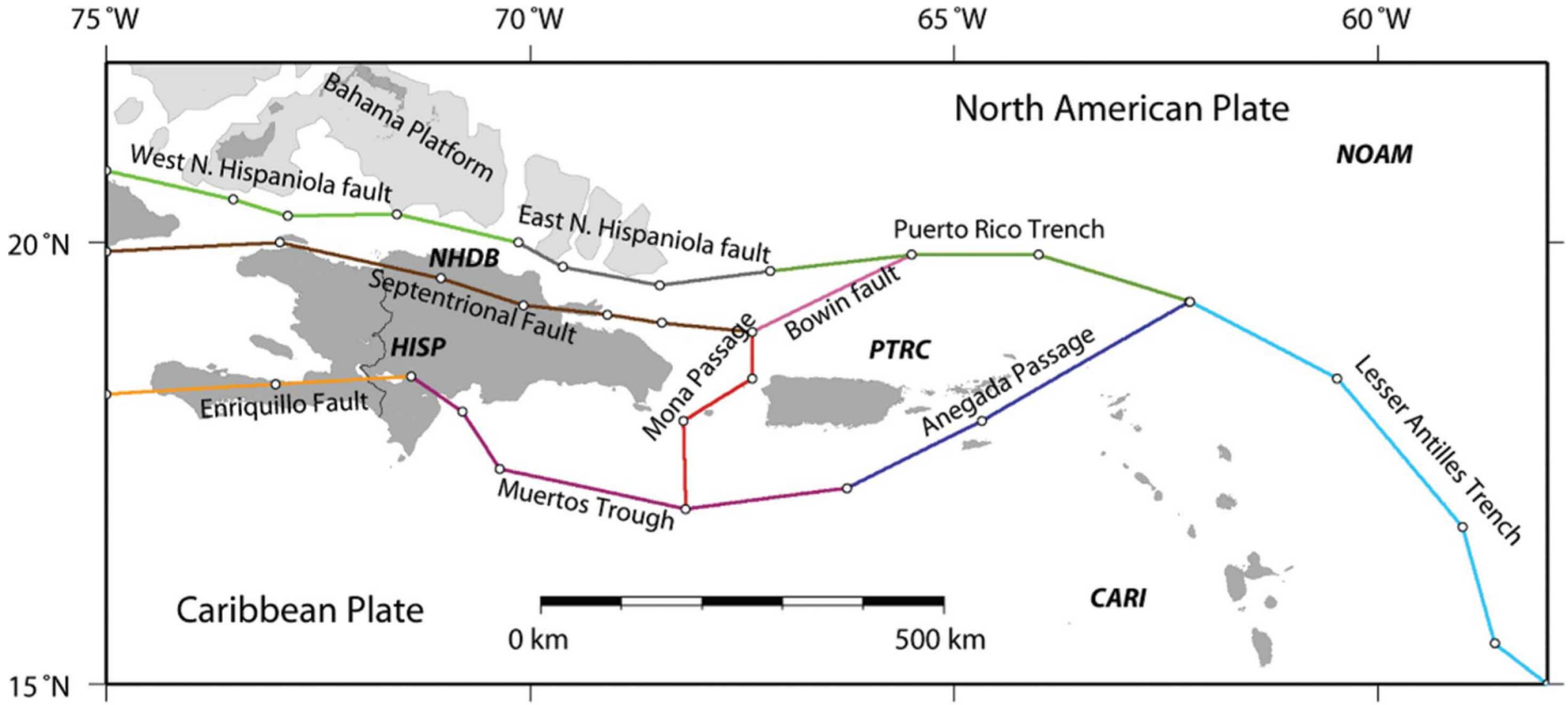
Ali et al., 2008

GPS Observed Secular Velocity Structure



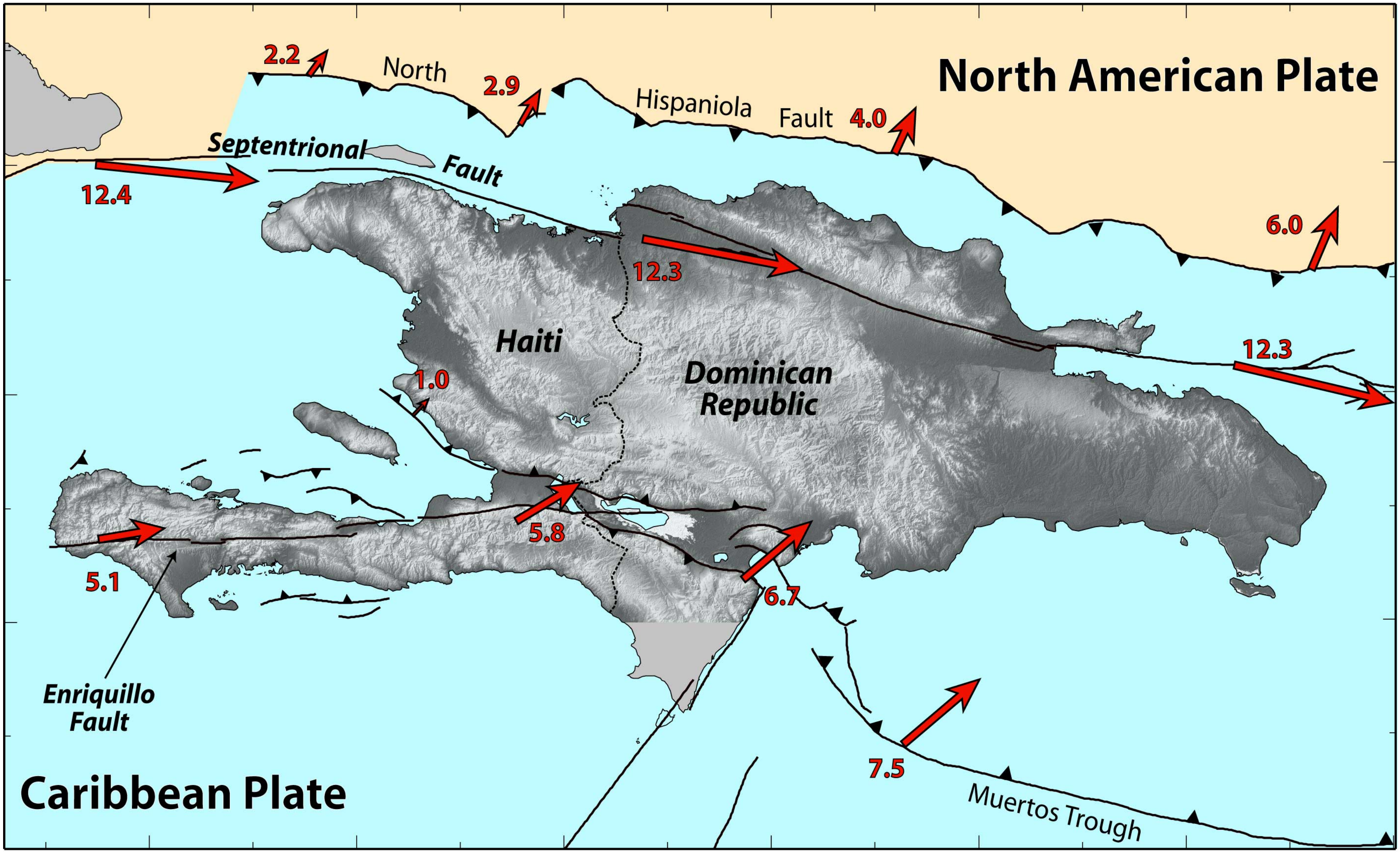
Calais et al., 2010

A block model was used to invert GPS and earthquake slip vector data to infer long-term slip rates on the active faults



Manaker et al., 2008

This allows us to define long-term slip rates on the major faults



Manaker et al., 2008

Long Term Slip Rates (mm/yr)

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2008

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Interseismic Plate coupling and strain partitioning in the Northeastern Caribbean

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GJI Seismology

SUMMARY

The northeastern Caribbean provides a natural laboratory to investigate strain partitioning, its causes and its consequences on the stress regime and tectonic evolution of a subduction plate boundary. Here, we use GPS and earthquake slip vector data to produce a present-day kinematic model that accounts for secular block rotation and elastic strain accumulation, with variable interplate coupling, on active faults. We confirm that the oblique convergence between Caribbean and North America in Hispaniola is partitioned between plate boundary parallel motion on the Septentrional and Enriquillo faults in the overriding plate and plate-boundary normal motion at the plate interface on the Northern Hispaniola Fault. To the east, the Caribbean/North America plate motion is accommodated by oblique slip on the faults bounding the Puerto Rico block to the north (Puerto Rico subduction) and to the south (Muertos thrust), with no evidence for partitioning. The spatial correlation between interplate coupling, strain partitioning and the subduction of buoyant oceanic asperities suggests that the latter enhance the transfer of interplate shear stresses to the overriding plate, facilitating strike-slip faulting in the overriding plate. The model slip rate deficit, together with the dates of large historical earthquakes, indicates the potential for a large (M_w7.5 or greater) earthquake on the Septentrional fault in the Dominican Republic. Similarly, the Enriquillo fault in Haiti is currently capable of a M_w7.2 earthquake if the entire elastic strain accumulated since the last major earthquake was released in a single event today. The model results show that the Puerto Rico/Lesser Antilles subduction thrust is only partially coupled, meaning that the plate interface is accumulating elastic strain at rates slower than the total plate motion. This does not preclude the existence of isolated locked patches accumulating elastic strain to be released in future earthquakes, but whose location and geometry are not resolvable with the present data distribution. Slip deficit on faults from this study are used in a companion paper to calculate interseismic stress loading and, together with stress changes due to historical earthquakes, derive the recent stress evolution in the NE Caribbean.

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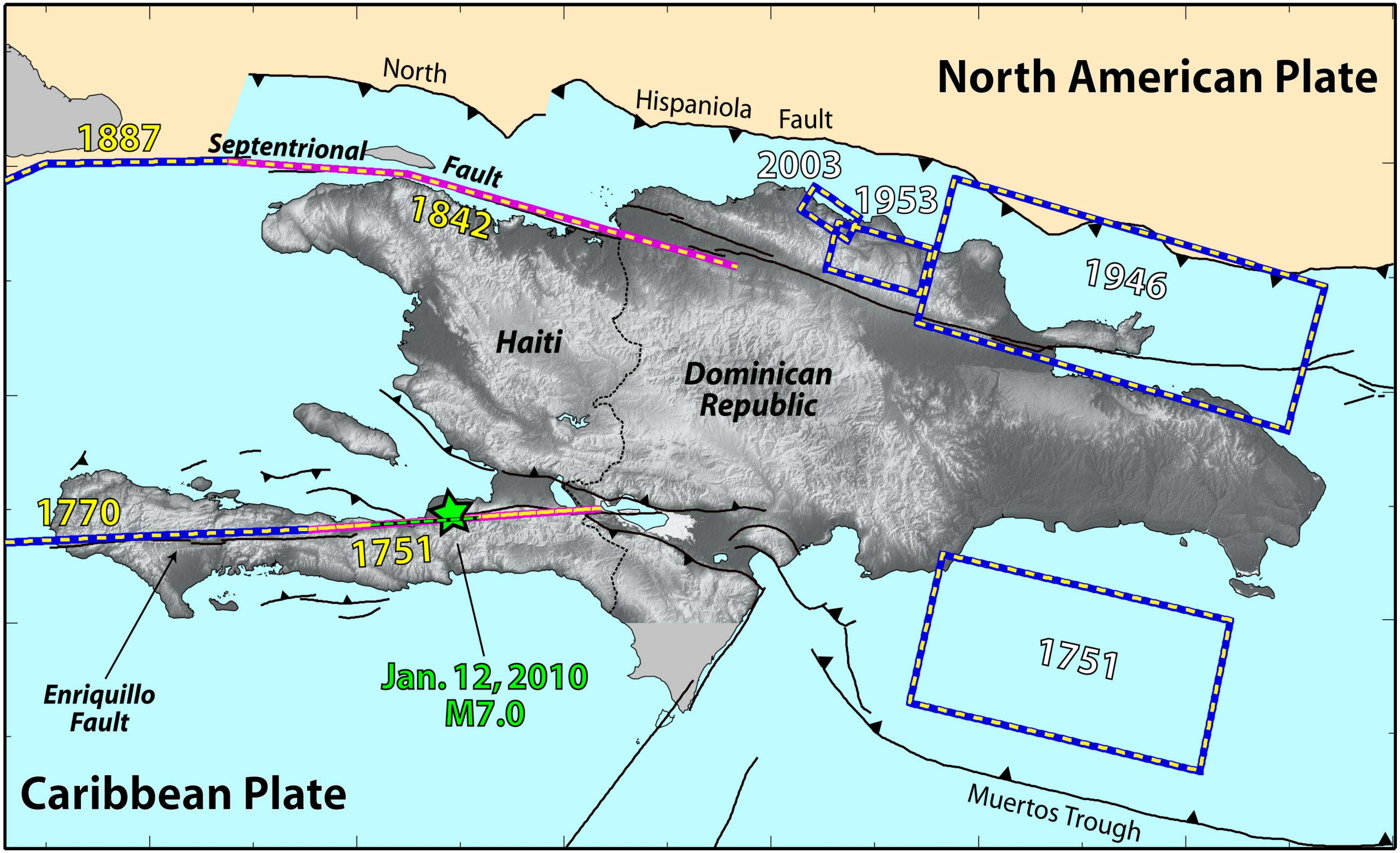
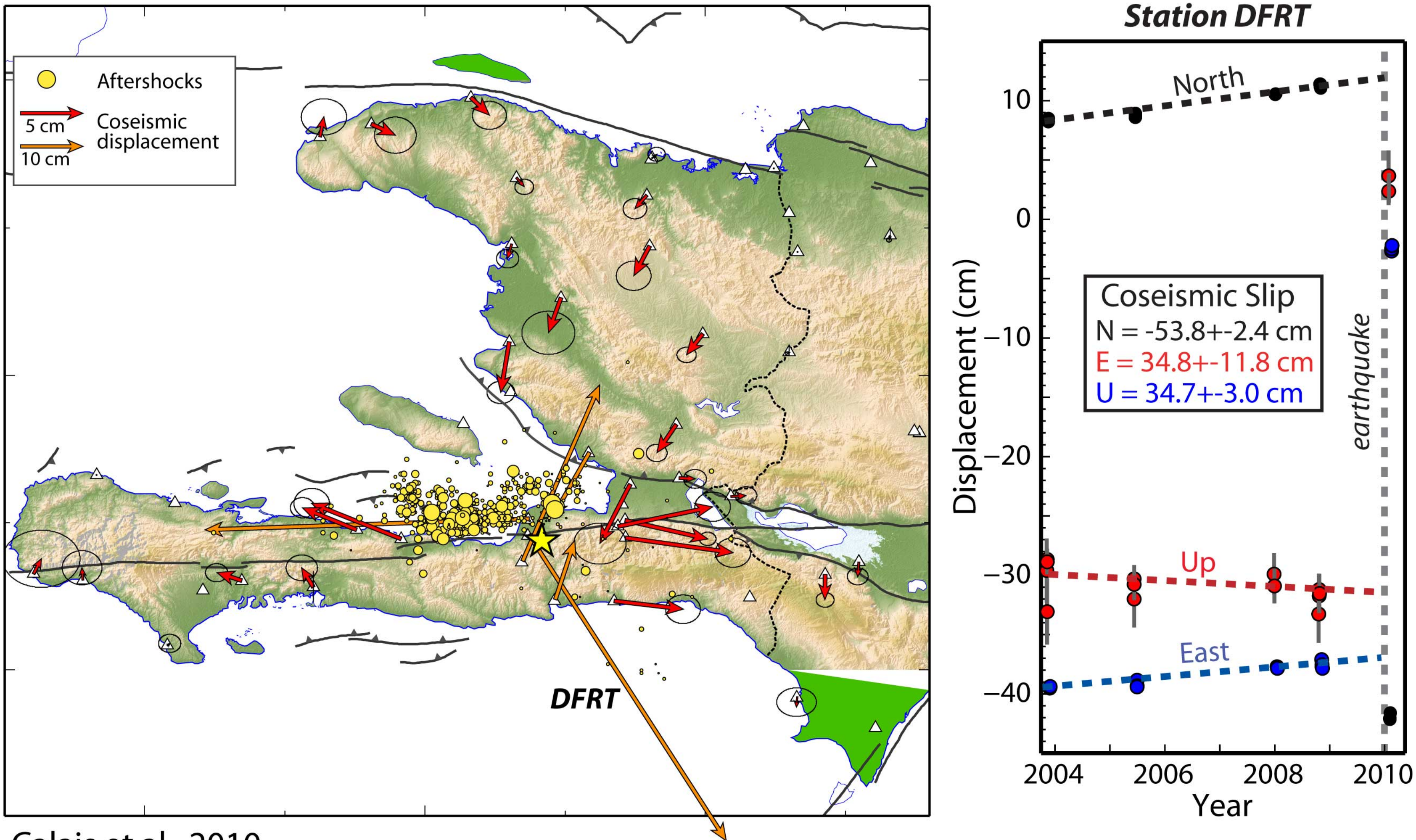
The 2010 earthquake occurred where forecast, though only broke a portion of the inferred 1751 rupture surface

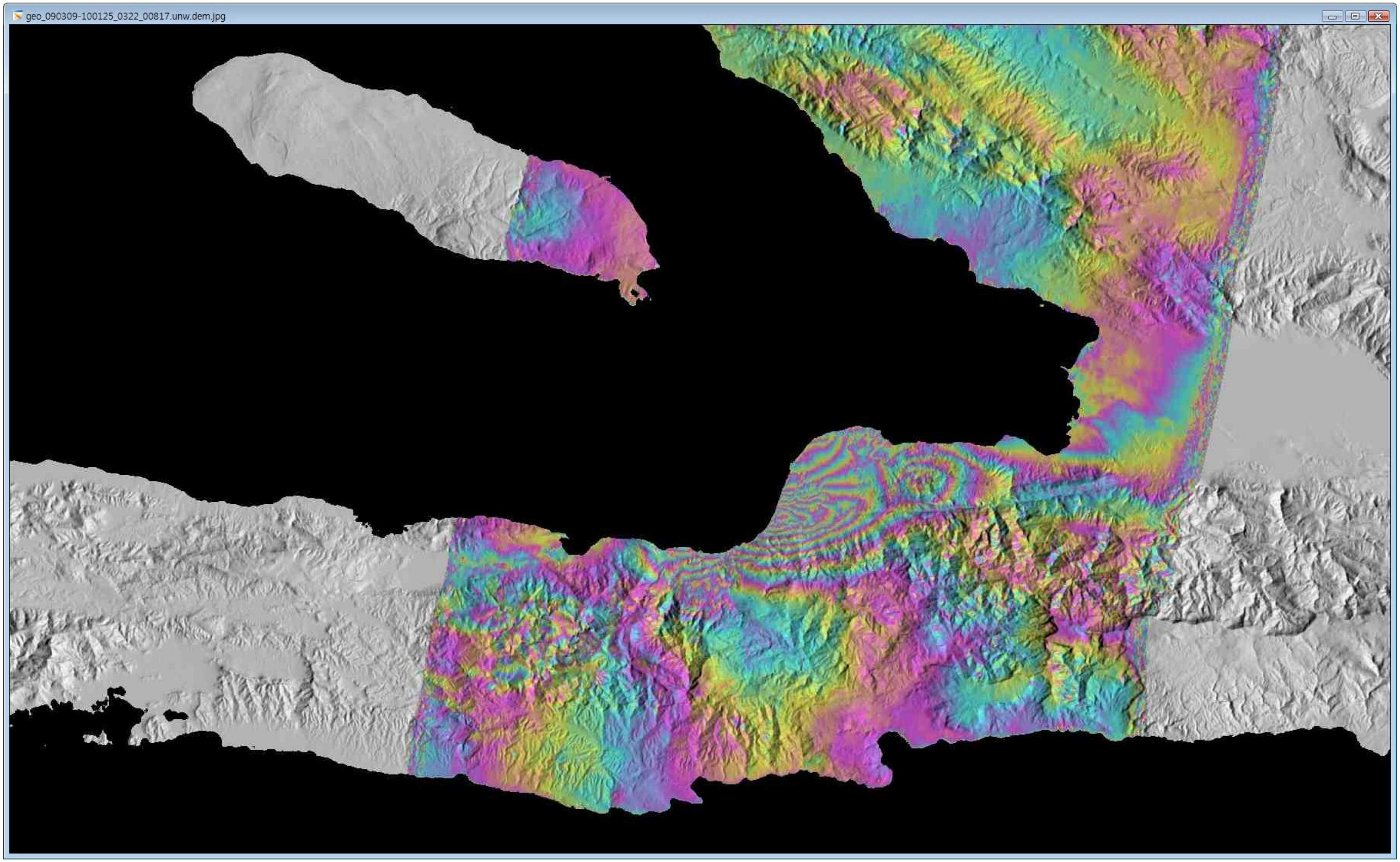


GPS Measured Coseismic Displacements

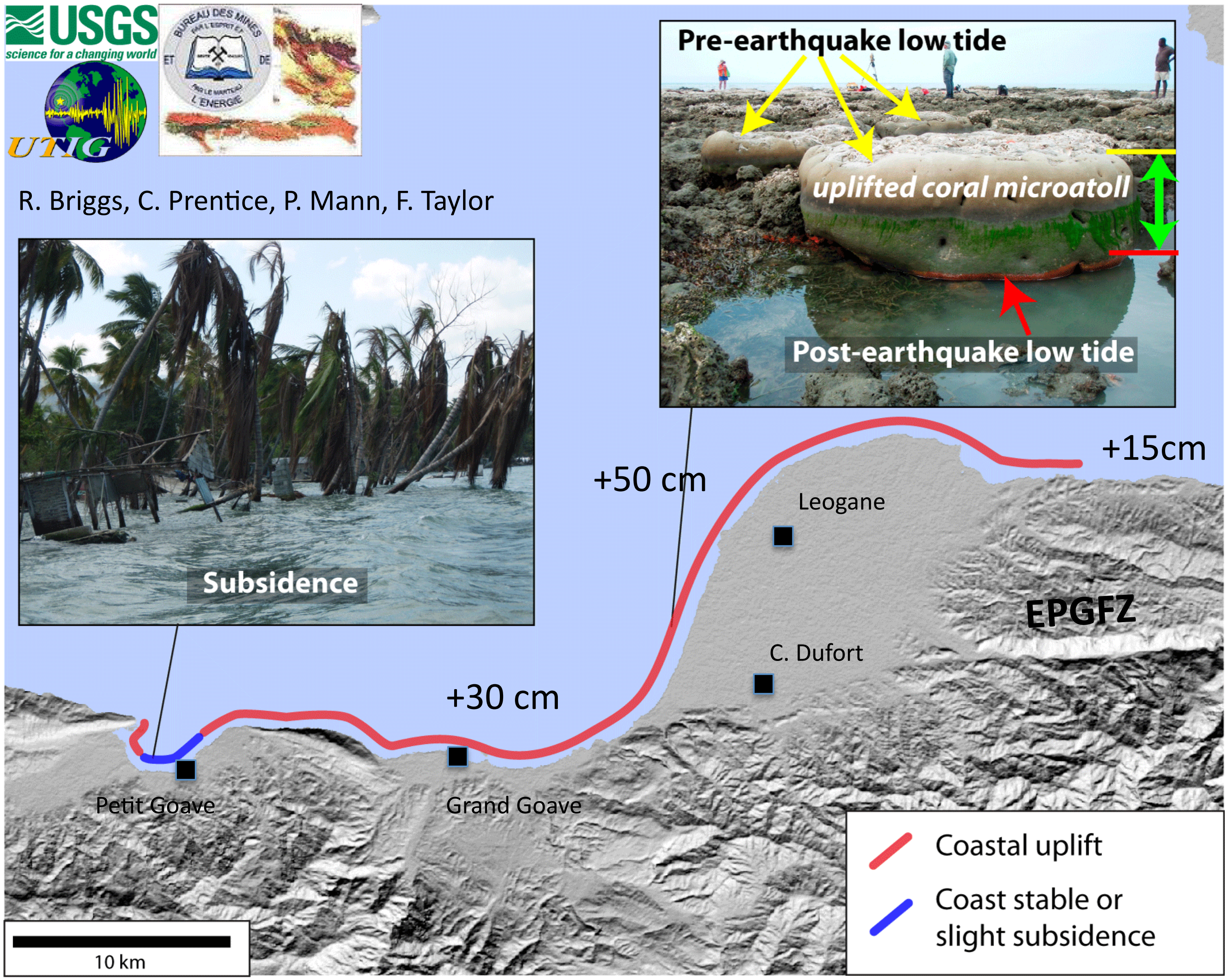


Calais et al., 2010

ALOS interferogram (University of Miami)



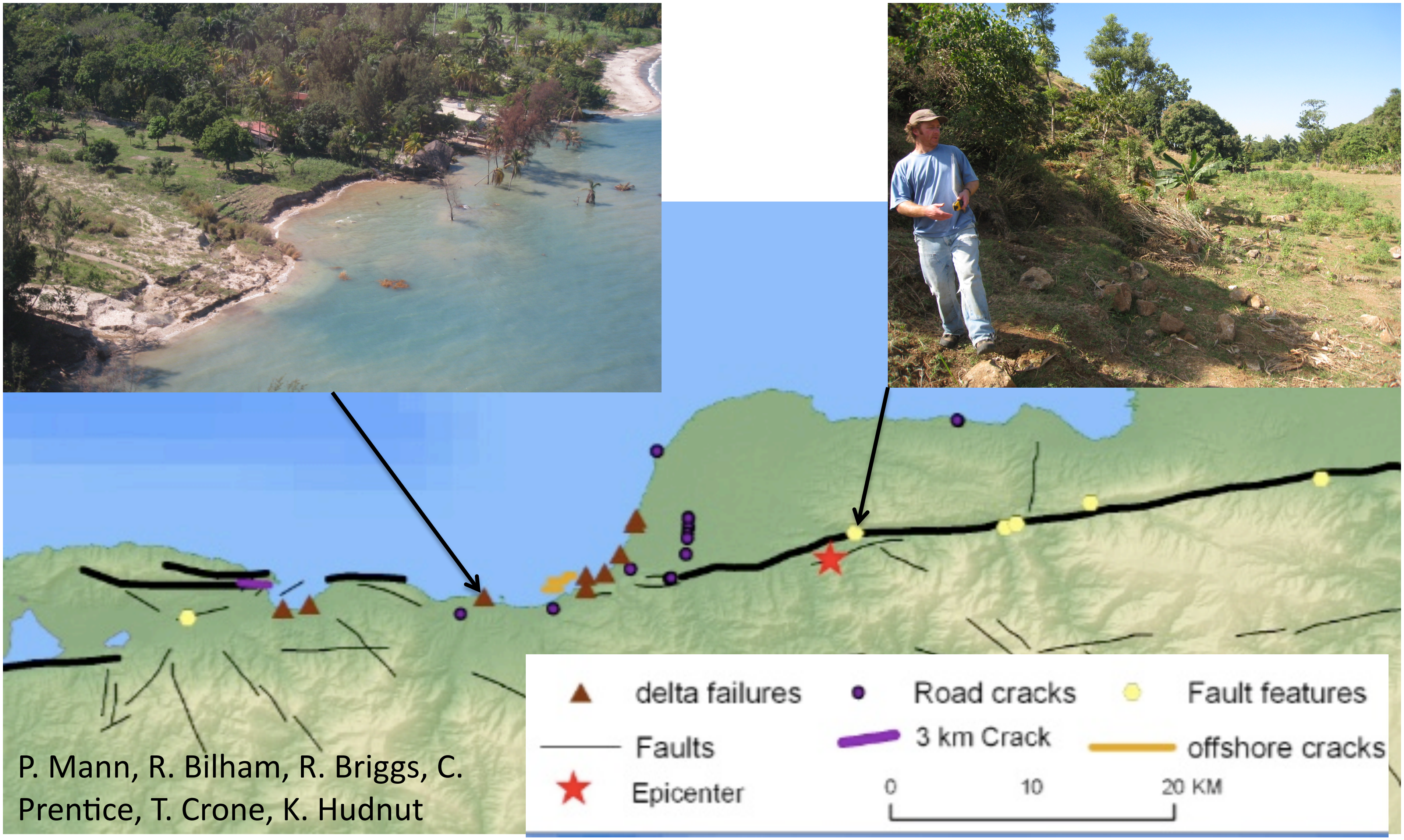
Coastal observations show primarily uplift



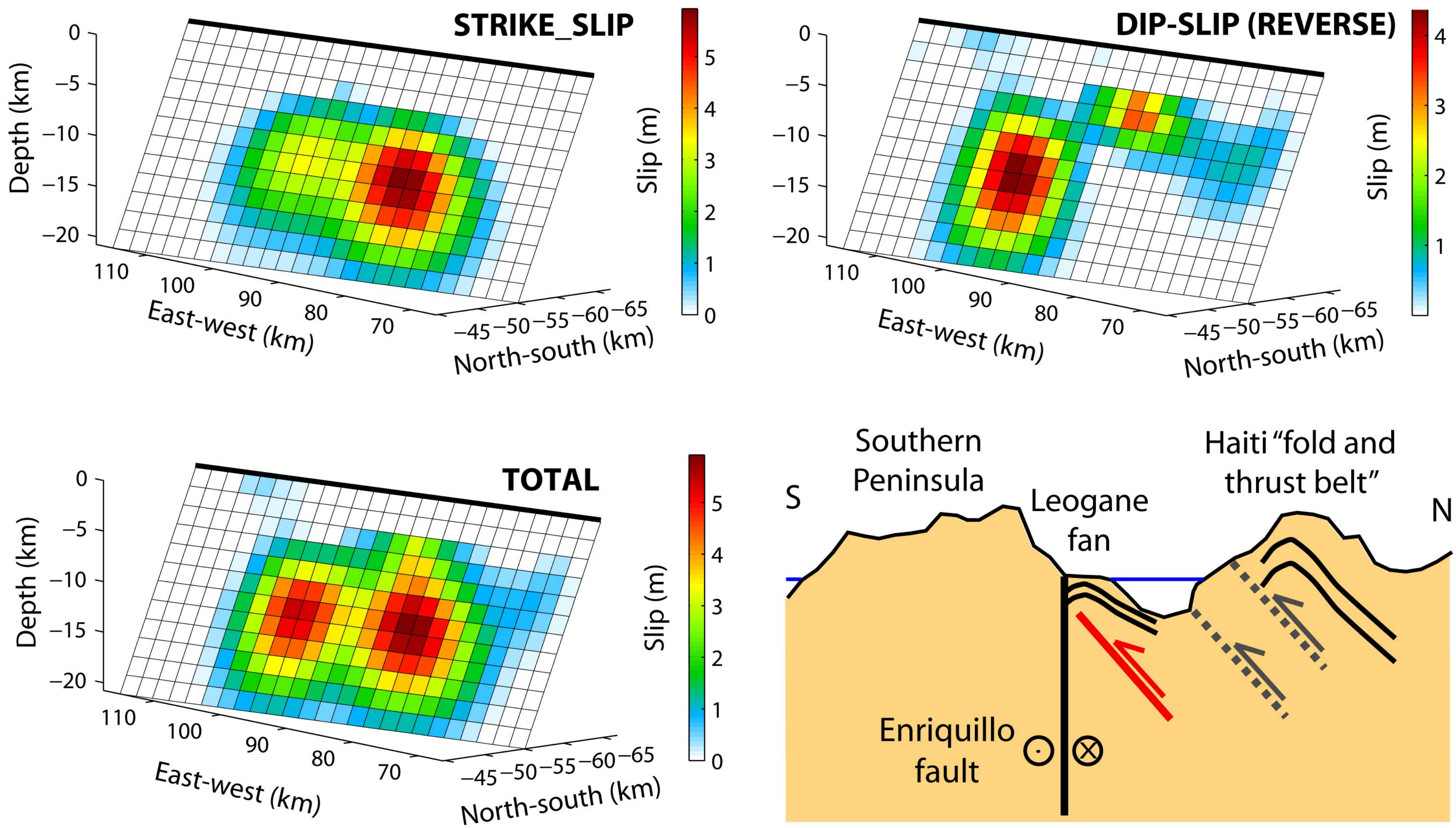
No Surface rupture!

Delta failure

Non-rupture…

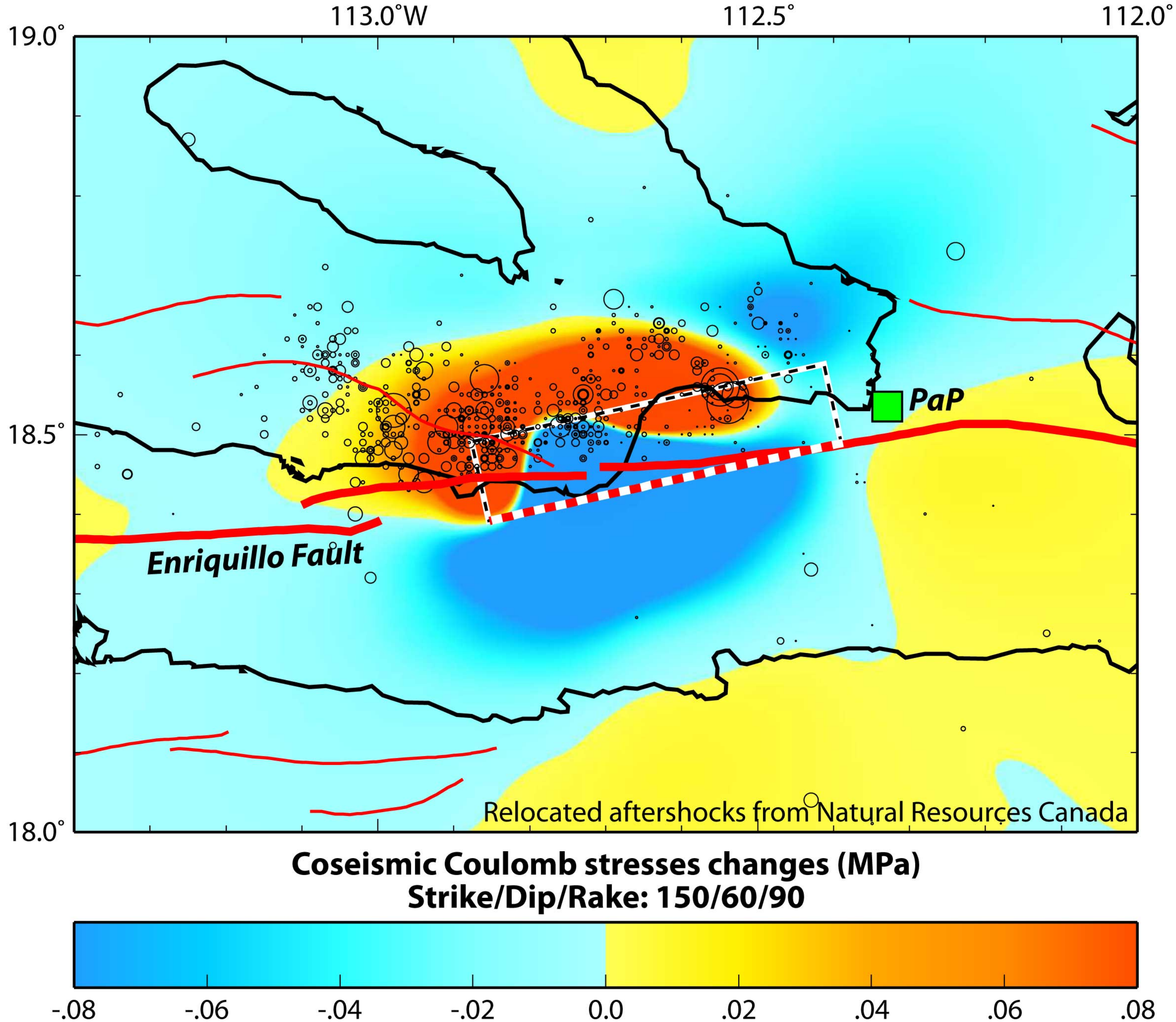


Coseismic slip distibution inferred from inversion of GPS and InSAR data:
Not the Enriquillo Fault!



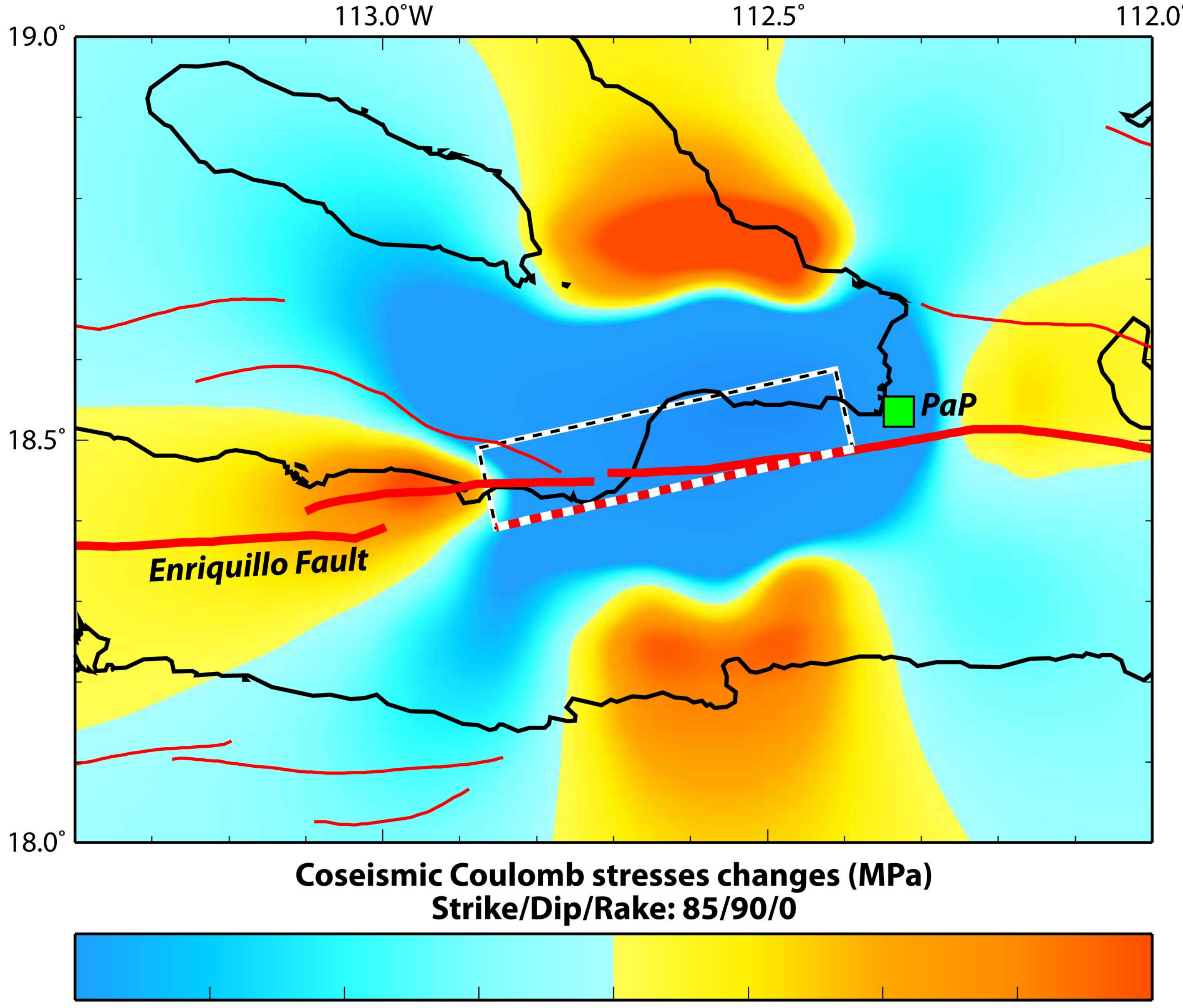
Calais et al., 2010

Aftershocks are well explained by Coulomb stress changes



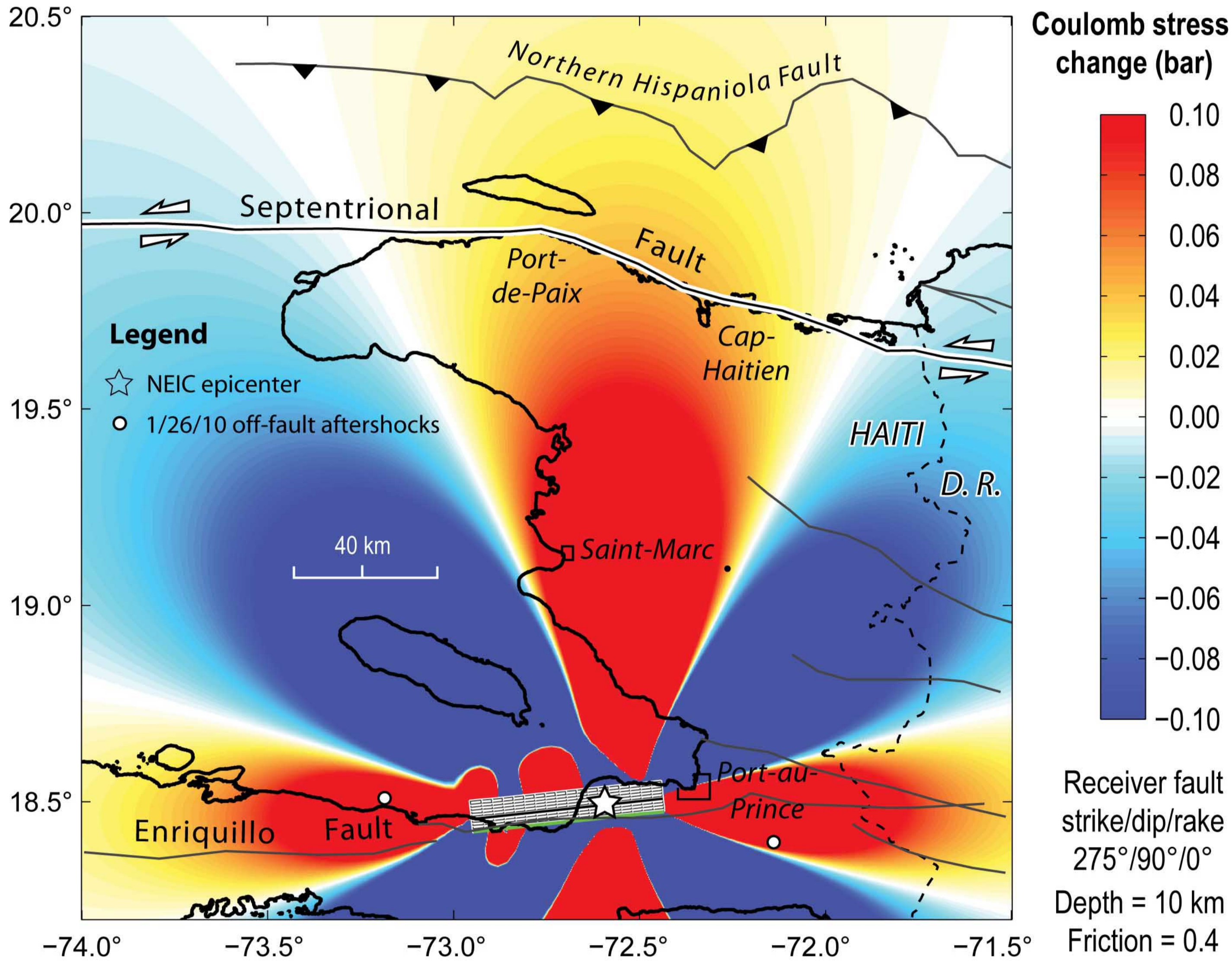
Calais et al., 2010

Coulomb stress on the Enriquillo Fault in the Port-au-Prince region has been reduced



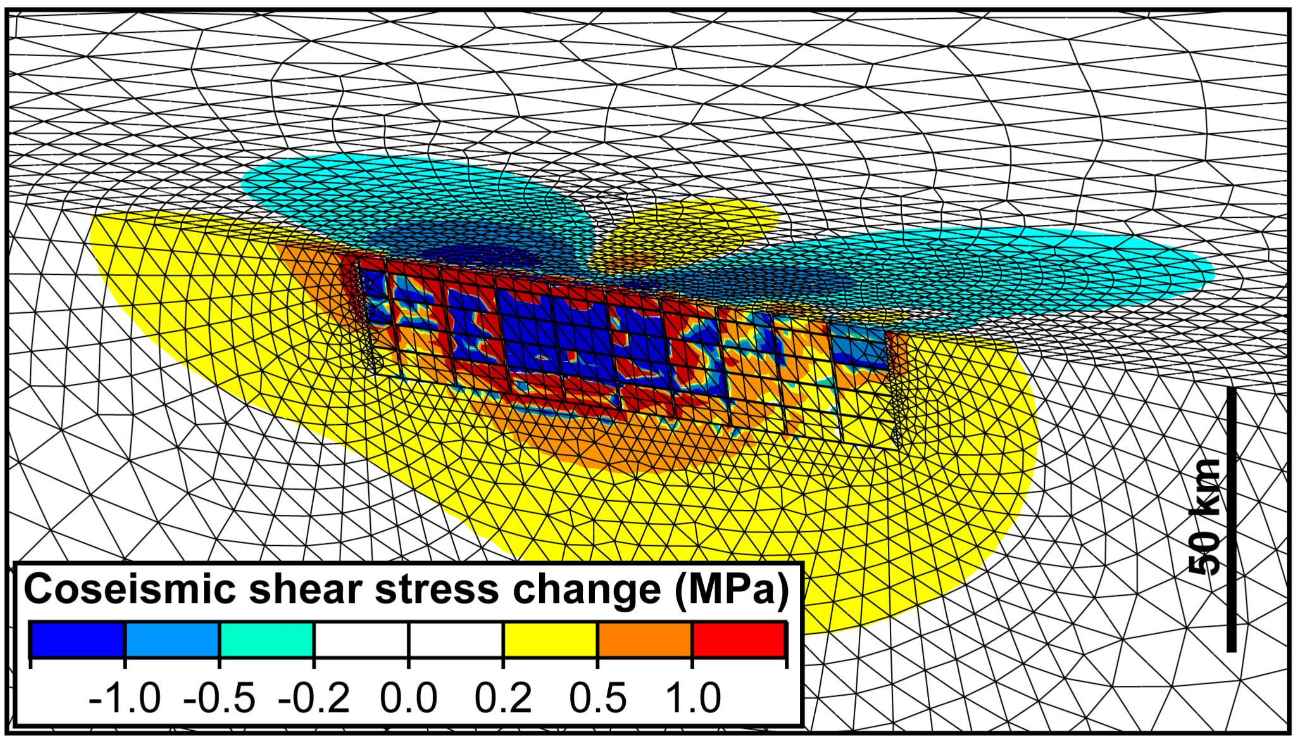
Calais et al., 2010

USGS coseismic Coulomb stress changes

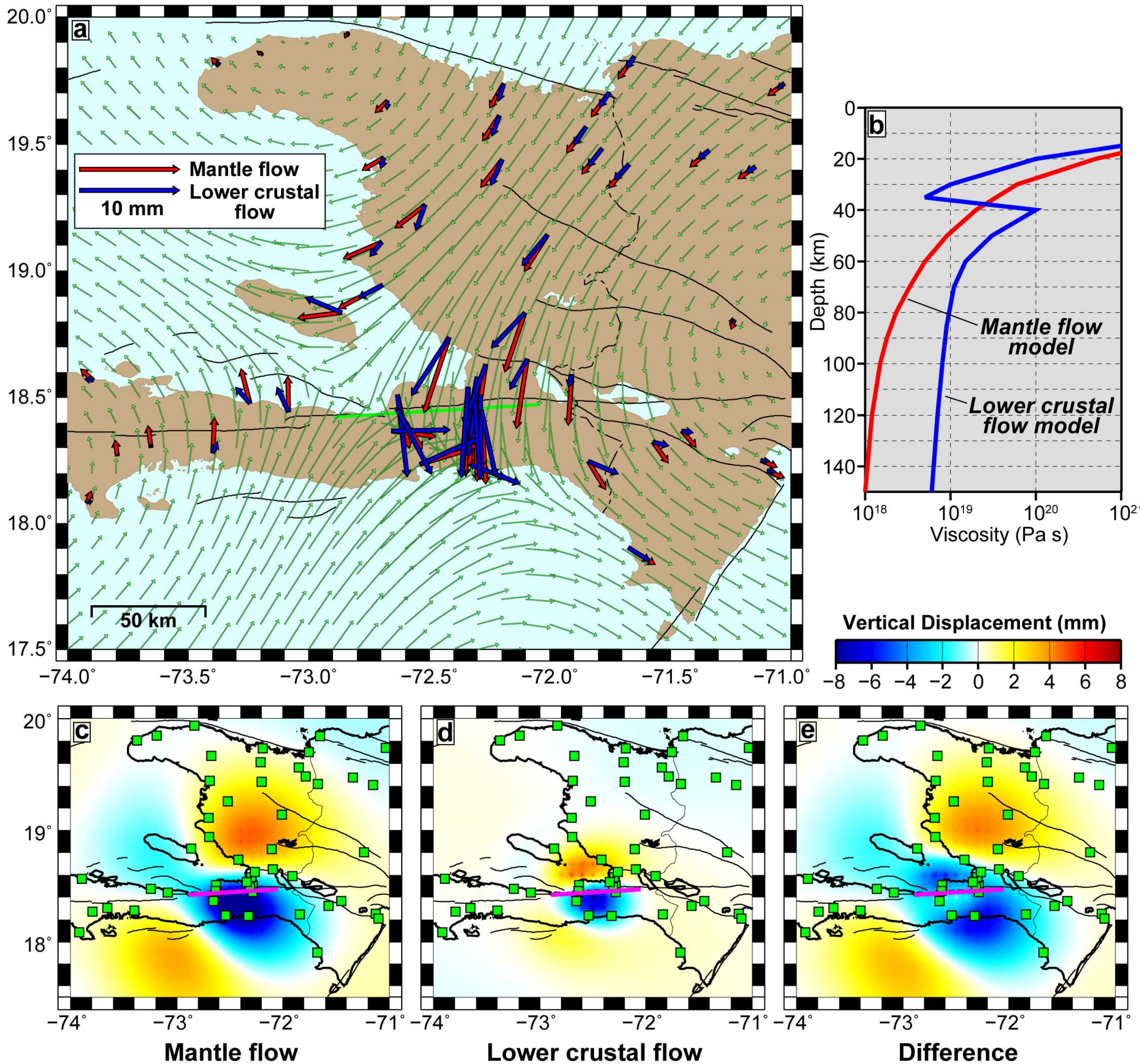


Lin et al., 2010, pubs.usgs.gov/of/2010/1019/of2010-1019/

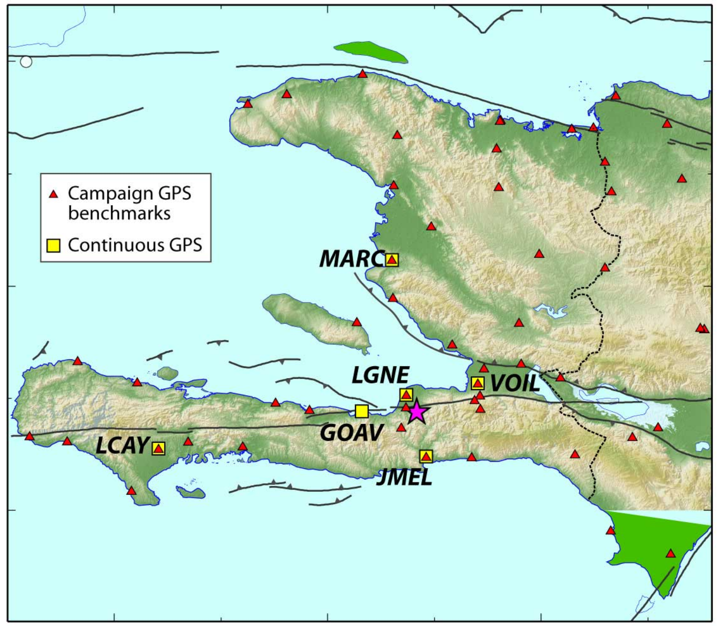
Preliminary Finite Element model of coseismic stress changes

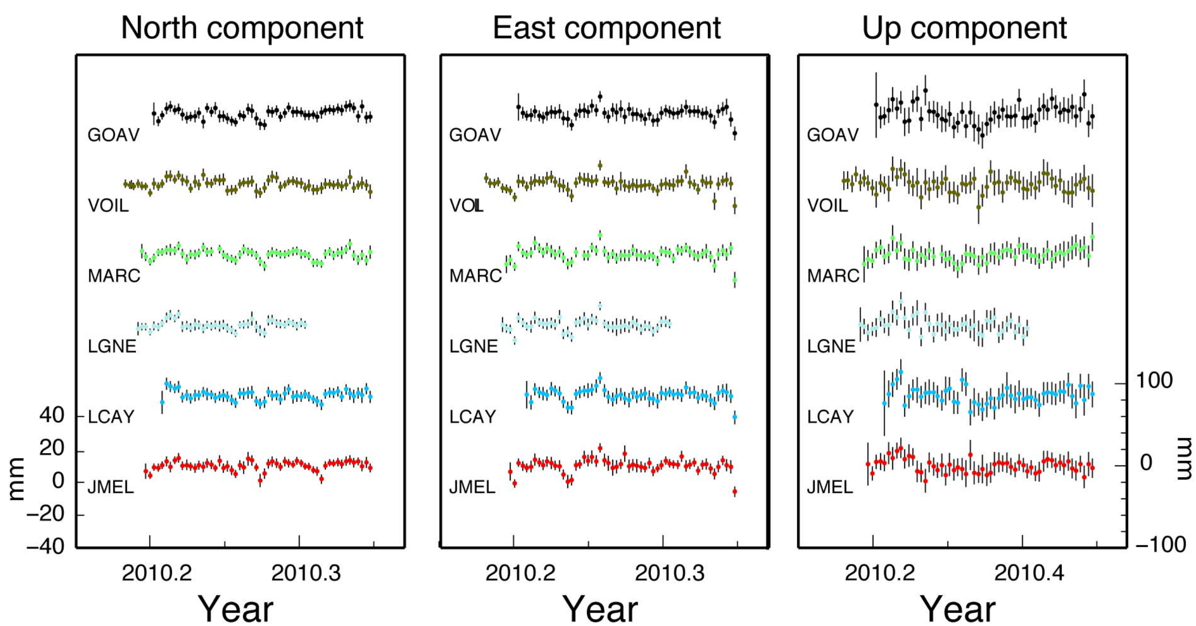


Predicted postseismic displacements after 3 years

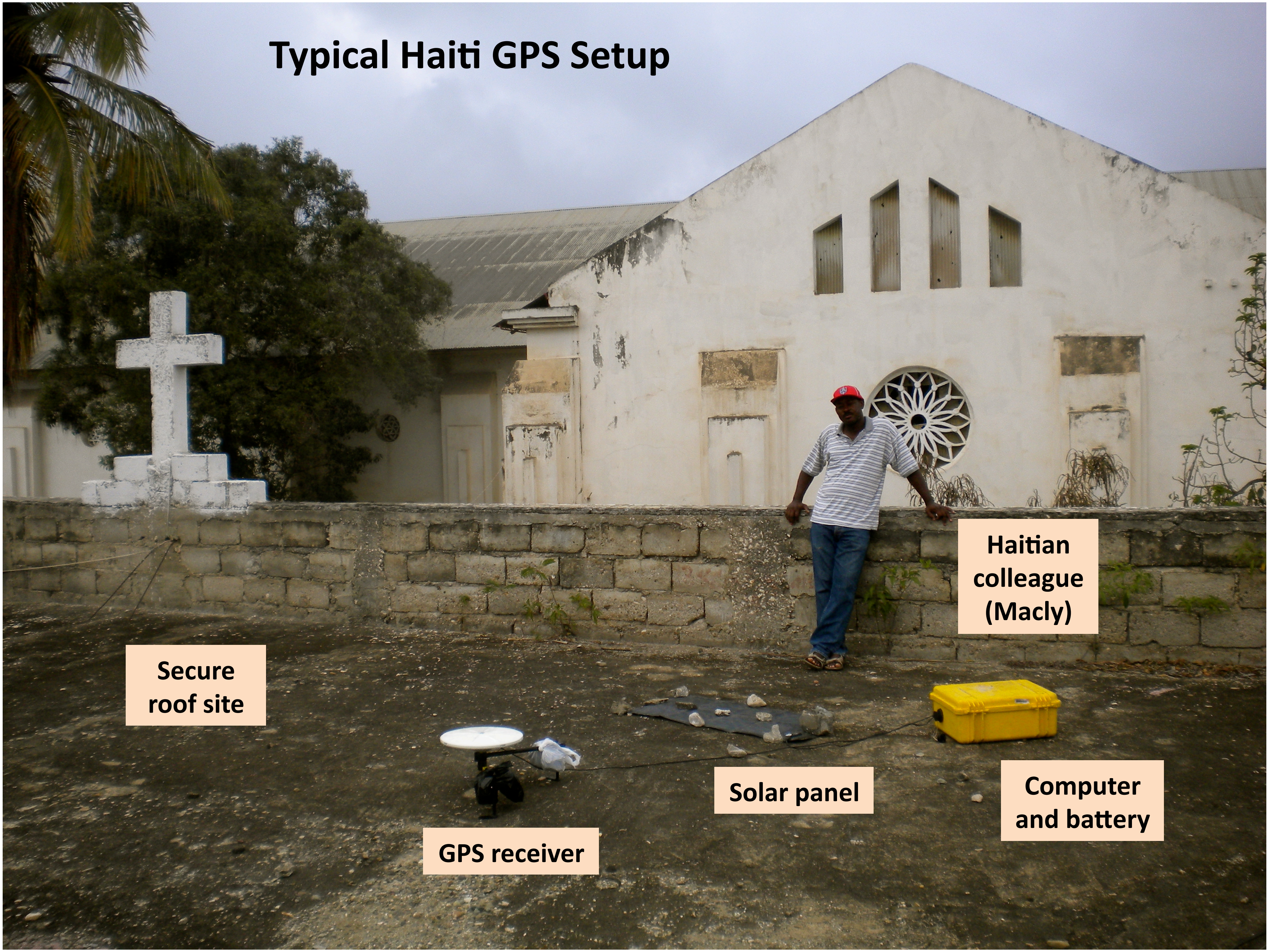


First several months of continuous GPS data (too early for a postseismic transient to be readily visible)





February's GPS Campaign


Typical Haiti GPS Setup
Haitian colleague (Macly)
Secure roof site
Solar panel
Computer and battery
GPS receiver

Tent city in Port-au-Prince


LAROSE
MALOUK
SHOOGAR
PHANTOMS NEW CD

BONNE FÊTE MÔLE ST NICOLAS
MATRACO SA
ANNEE 2009
02629