Present-day kinematics and dynamics of the Greater and Lesser Antilles from four decades of GNSS measurements

Eric Calais*[1]

[1]Département de Géosciences – École normale supérieure [ENS] - Paris – France

Résumé

Back in the mid-1980', the northern Caribbean plate boundary, with California, was a testing ground for GPS measurements. The challenges at the time were the topography and tropical climate of the Caribbean, which both affect the precision of GNSS measurements. In such a context, was it possible to measure tectonic motions across its active faults? The answer is yes, and much ground has been covered since the seminal paper by Dixon et al. (1998), based on 7 campaign measurement points, to the current situation where the Greater and Lesser Antilles are now sampled on a continuous basis by more than 200 GNSS stations. Amongst the many results obtained since then, we list a few:
(1) the current kinematics of the Caribbean plate is well-determined, as well as the kinematics of the main micro-plates and blocks that constitute its margins. As a result, the slip rate deficit on most major active faults is known, which is an important contribution to regional earthquake hazard assessment.

(2) the Puerto Rico and Lesser Antilles subductions are uncoupled, and subsiding, over the time interval of the GNSS measurements, consistent with longer-term coral records and offshore evidence for active faulting along the arc. The low coupling may be the result of fluid migration from a pervasively fractured and hydrated subducting oceanic crust, old and formed at a slow spreading ridge.

(3) a significant component of plate-boundary-perpendicular shortening is documented throughout Hispaniola, in a context thought to be purely strike-slip. The GNSS measurements demonstrate that this shortening is localized on a reverse fault system that allows cretaceous Caribbean oceanic crust to the south to overthrust the "Greater Arc of the Caribbean", a rare case of on-going obduction.
(4) the mechanisms of several large earthquakes have been deciphered thanks to a combination of GNSS, InSAR, and seismology (01/12/2010, Mw7.0 Haiti - largest human and economical impact an earthquake ever had on a single country; 01/30/2020, Mw7.8 Cayman - largest earthquake of the instrumental era along the norther Caribbean plate boundary; and 08/14/2021, Mw7.2 Nippes in Haiti - which was understood very early on thanks to citizen seismology).

Mots-Clés: GNSS, Caribbean, kinematics, earthquakes

*Intervenant