The 2020 M_w 6.7 and 5.8 earthquakes on the Doldrums transform system, equatorial Atlantic: slip on a slow oceanic transform

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The equatorial Atlantic region is characterized by several major transform faults and slow-spreading Mid-Atlantic Ridges (MAR), which are some of the longest on Earth. Besides, the equatorial Atlantic presents at least two of the few multi-fault transform systems of the Atlantic Ocean, in which they are formed by a set of transform fault segments and intra-transform ridges (ITR). One of them is the Doldrums transform system (DTS), formed by a long 630 km offset composed by five transform segments (Doldrums, Vernadsky, double 7.4ºN and Bogdanov) and four ITRs. The MAR presents spreading rates of 25-27 mm/year over the Doldrums transform system. The Vernadsky segment offsets by ~145 km and it is formed by a transform valley with a width of 10-12 km, and depths ranging from 4700 to 4900 m. There are two local structural highs over the adjacent northern wall of the transform valley, one of them is an Oceanic Core Complex (OCC) located in 7.78ºN latitude. This OCC presents a surface of approximately 20 km-long and 8-km wide which was exhumed by a detachment fault. Similarly, the Bogdanov transform segment of the DTS have an offset length of ~75 km and transform valley with ~12 km wide, and has an OCC with a detachment fault of ~25 km length located over the southern valley wall of the east ridge-transform intersection. Using data of regional distance broad-band stations (1,200-2,400 km), we examined the strong Mw 6.7 strong earthquake that occurred in 2020/9/6 over the transform valley of the Vernadsky segment, as also the Mw 5.8 (2020/9/17) occurred 11 days after with epicenter a little further north of the strongest event. We used seismic stations belonging to the Incorporated Research Institutions for Seismology and the Brazilian Seismographic Network. The data was analyzed for epicenter location through the HYPO71 plugin of the SeiscomP package, using a CRUST1.0 velocity profile. Also, we analyzed the focal depths from surface waveform modeling using the ISOLA package for the Mw 6.7 and 5.8 events, as also other two historic events located in the west area of the Vernadsky transform valley and occurred in 2004/01/16 with Mw 6.2 and 5.8 (2018/10/07). The results presented a cluster of more than 120 aftershocks with magnitude mb >3.7 that occurred in the first three days after the mainshock Mw 6.7. Part of the aftershock epicenters is situated over the south area of the 7.78ºN OCC, in the same area of the Mw 5.7 aftershock. The waveform modeling fitted the best solution with a centroid hypocenter of 10 km in 2020 Mw 6.7 event, a depth of 14 km in 2020 Mw 5.8, 10 km in 2004 Mw 6.2, and for last a hypocenter of 9 km for the Mw 5.8 2018. In general, we believe that the 2020 Mw 6.7 earthquake in east transform was a case of large stress discharge originated by seismic cycle, similarly to the behavior in pair of event sequence 2004 Mw 6.2 and 2018 Mw 5.8 in the west part of the transform valley. Differently, we suspect that the 2020 Mw 5.8 aftershock with a deeper hypocenter may have occurred from the stress released by the detachment fault existent in the surface of the 7.78ºN OCC. More deep events can be identified close of other detachment faults as the OCC located in ridge-transform intersections of the Bogdanov transform segment, or the OCC situated in the 13.2ºN MAR reported by recent articles.

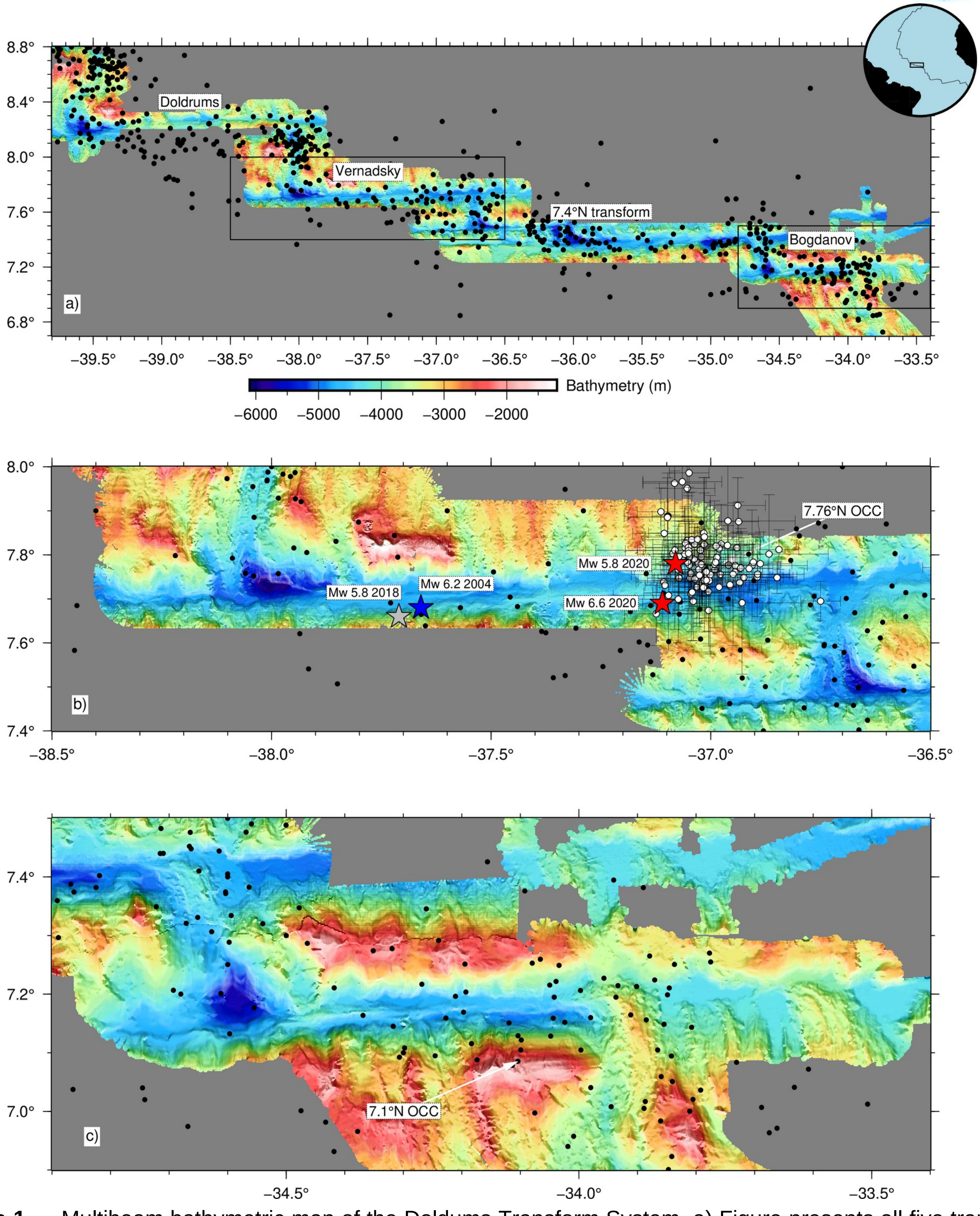

Figure 1 — Multibeam bathymetric map of the Doldums Transform System. a) Figure presents all five transform segments situated over the complete multi-fault system. The black color circles presents the complete epicenters of the ISC (<=2015 year) and IRIS (>2015 year) global networks catalogue. b) Map of the Vernadsky transform segment. The blue, gray, and red triangles presents the four 2004, 2018 and dual 2020 GCMT strong earthquakes applied in waveform modeling for the focal depth estimations. White circles shows the aftershocks occurred after of the Mw 6.7 2020 earthquake and recorded by the NE Brazil/Cape Verde and African seismic stations. c) Bogdanov transform is presented in map.

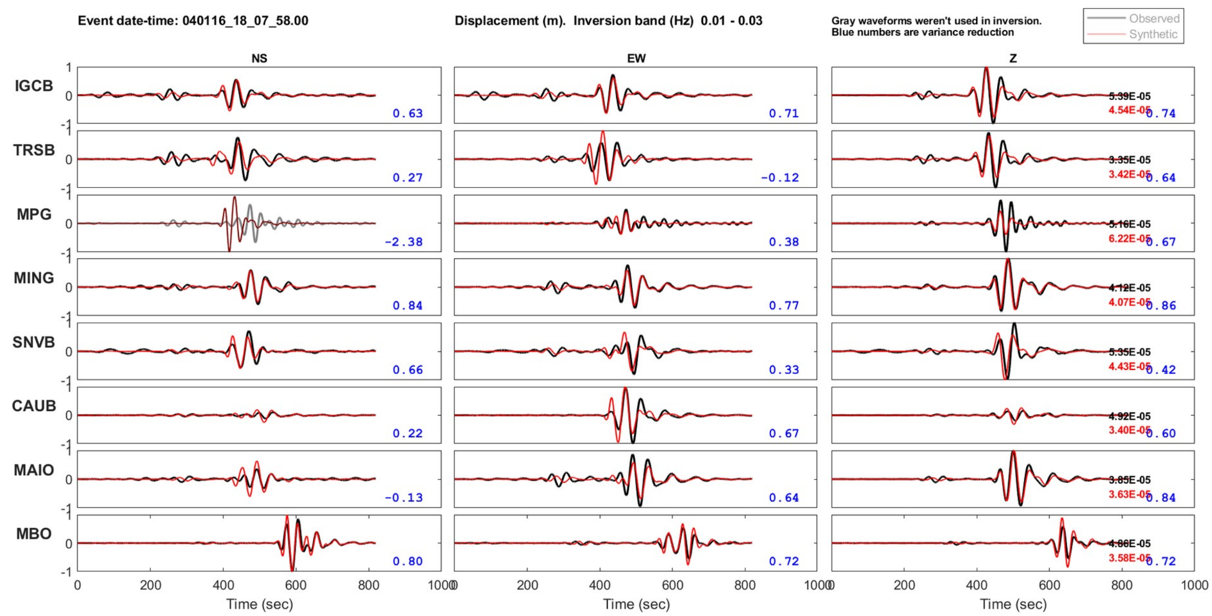

Figure 2 — Waveforms (black) and their models (red) obtained with the best-fitting source position in the 2004/1/16 Mw 6.2 earthquake. The model has a 10-km depth, variace reduction 0.64, centroid time +2.4, and fixed GCMT mechanism. Data plotted in gray were not used in the inversion due to bug in component.

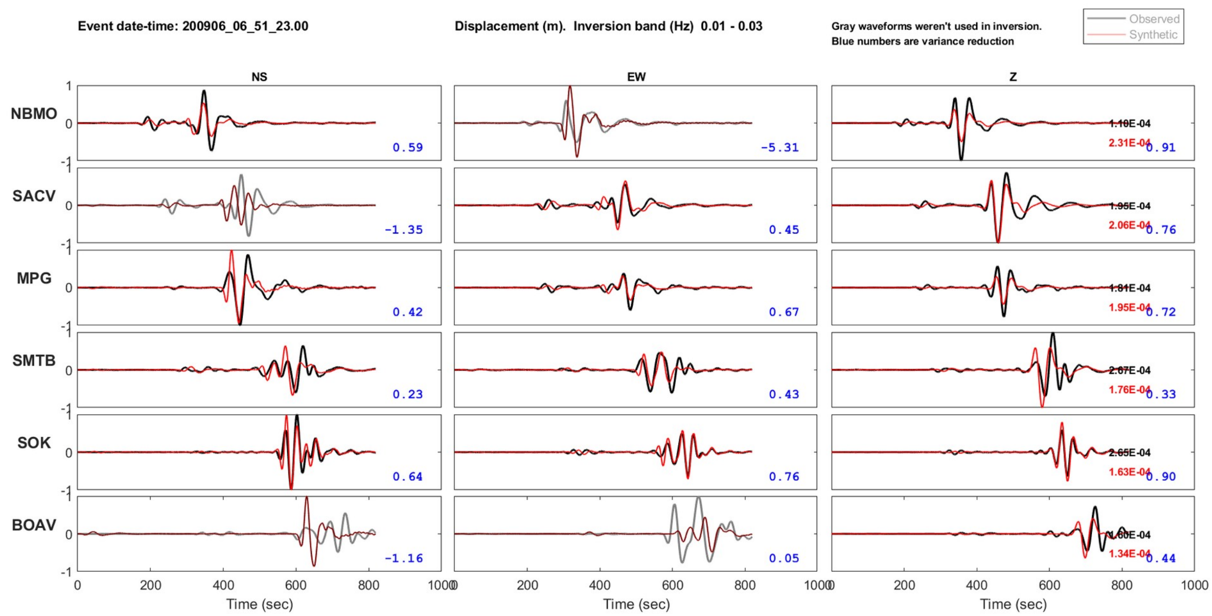

Figure 3 — Waveforms (black) and their models (red) obtained with the best-fitting source position in the 2020/9/6 Mw 6.7 earthquake. The model has a 10-km depth, variace reduction 0.58, centroid time +1.1, and fixed GCMT mechanism. Data plotted in gray were not used in the inversion due to bug or noise in component.