Unprecedented coring performance with the upgraded Research Vessel *Marion Dufresne*

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The MD203 ACCLIMATE expedition was the first coring cruise onboard the Research Vessel *Marion Dufresne* since her midlife refit in 2015 (Rousseau et al. 2016). Taking place in March 2016 in the South Atlantic Roaring Forties and Howling Fifties, this cruise provided a full-scale exercise to test, in rough sea conditions, the latest generation of sediment coring equipment.

To illustrate the unprecedented quality of long sediment sequences taken with the improved giant CALYPSO piston corer, we compared two deep-water cores collected ~13 km apart on the South African margin (Fig. 1): (1) core MD02-2587 taken in 2002 with the former coring facilities and (2) core MD16-3510 recovered with the new coring facilities.

The similarity of downcore sediment reflectance changes measured on board confirmed that both cores record the same climatic and environmental events (Fig. 1A-C). However, the 2002 core is stretched by up to 30% compared to the 2016 core, meaning that, for a similar core length, the 2016 core goes further back in time. Also, the 2002 core exhibited signs of coring deformation marked by bent dark layers, which, in contrast, are straight in the 2016 core (Fig. 1B). The absence of sediment stretching and deformation in the 2016 core thus highlighted the unprecedented quality of this ~45-meter-long core taken at ~4400 m of water-depth with a recovery rate higher than 94%!

Sediment stretching and deformation were known features of giant piston cores taken with the former R/V *Marion Dufresne* coring facilities (Skinner and McCave 2003). They were due to the elastic rebound of the cable, which, after the sudden release of the corer weight, caused the upward acceleration of the piston and hence over-sampling of the sediment.

Three major modifications of the R/V *Marion Dufresne* coring facilities, in addition to the modernized winch and gantry, led to the outstanding quality of sediment cores recovered during the ACCLIMATE cruise. First, the use of a specially designed DYNEEMA synthetic cable, with a controlled minimum elasticity, strongly limited the elastic rebound of the coring system. Second, the systematic use of the CINEMA software (Bourillet et al. 2007; Woerther et al. 2012), which specifically simulates the elastic rebound prior to coring operations, to optimize the corer settings according to the site's specificities (e.g. water-depth, corer configuration), further contributed to minimize sediment disturbances during coring. Finally, the implementation of pressure and acceleration sensors on the core head and the triggering system, and the injection of this data in the CINEMA software, allowed for a detailed monitoring of coring kinematics, in particular of the piston behavior. This approach led to a thorough understanding of the coring procedure and gave detailed information on the degree of preservation of the recovered sediment sequence.

The upgraded R/V *Marion Dufresne* is the sole research vessel able to collect up to 75-meter-long continuous sequences of undisturbed sediments at water depths as deep as 4500 m. The improved sediment coring facilities now yield cores of outstanding quality, which will provide indispensable high-resolution records to unravel past ocean and climate dynamics.

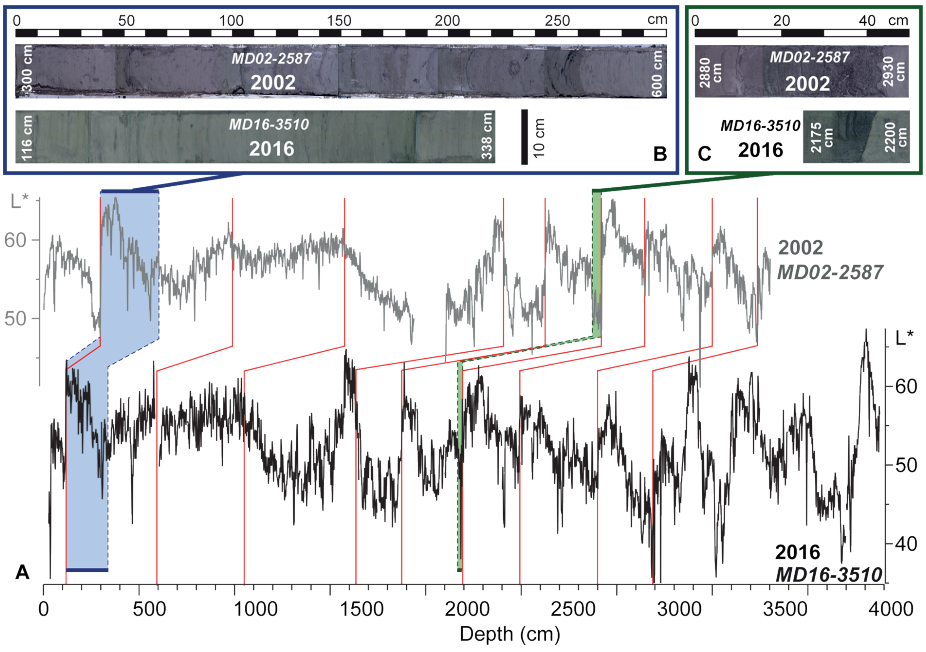

Figure 1: Comparison of cores MD02-2587 (35°17.7'S, 29°22.2'E, 4468 m) and MD16-3510 (35°21.38'S, 29°14.78'E, 4435 m) collected in 2002 and 2016, respectively, at the same South African margin site. **(A)** Downcore reflectance (L*) changes in both cores on their respective depth-scales. Red lines highlight conspicuous color changes synchronous in both cores. The 2002 core is stretched compared to the 2016 core. **(B)** Core photographs of the same time period (blue area) covered by 300 and 222 cm of sediments in the 2002 and 2016 cores, respectively. Dark layers are straight in the 2016 core, while bent in the 2012 core. **(C)** Core photographs of the same turbiditic event (green area). The characteristic downward coarsening of turbiditic sediments is stretched in the 2002 core. These features illustrate the absence of sediment stretching and deformation in the 2016 core, in opposition to the 2002 core.

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LINKS

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