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Multicentennial to millenial scale climate variability in the tropics – a 40,000 year record from the Caribbean Sea obtained from the Galathea 3 Expedition

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The Caribbean region plays a crucial role in climate due to its status as the main source area for the Gulf Stream, its proximity to the Intertropical Convergence Zone (ITCZ) and its central location for Atlantic hurricane passages. A key site is the Anegada-Jungfern Passage in the NE-Caribbean, located between St. Thomas and St. Croix. The passage is a deep gateway for water mass exchange between the North Atlantic and the Caribbean Sea and is characterized by the presence of well stratified water masses, including Subtropical Surface Water, Antarctic Intermediate Water (AAIW), Atlantic Intermediate Water and North Atlantic Deep Water (NADW).

In 2007 a series of marine sediment cores were collected from the Anegada-Jungfern Passage in 2007 during the Galatheas 3 Expedition (Leg 16: 'WINMARGIN' project). The longer cores encompass the period of the last ca. 40,000 years, while shorter cores give the possibility of high-resolution studies of the late Holocene. These and other cores have thus made it possible to track tropical ocean and climate variability and inter-hemispheric heat exchange for the last 40,000 years as well as to study the linkage and heat exchange between the tropical and polar regions. We have reconstructed Late Holocene water mass exchange through the Anegada-Jungfern Passage based on analyses of foraminiferal assemblages; surface water conditions are based on planktonic foraminifera and stable isotopes, while information on intermediate and deep-water flow is based on benthic foraminifera.

Our data show that during the Glacial period, a clear millennial-scale variability in sea-surface temperature and productivity related to Dansgaard-Oeschger oscillations characterised the area, showing that it was subject to significant oceanographic changes linked to these events. Also during the Holocene the region was subject to changes in ocean currents and atmospheric conditions.

During the last 5000 years the benthic fauna suggest a possible 900-year cyclicity in the intermediate water inflow at $\sim$1000 m water depth, i.e. the boundary between AAIW and NADW, indicate an alternating influence of water mass flow dominated by the AAIW from the southern hemisphere and NADW from the northern hemisphere, respectively. These changes were accompanied by variations in sea-surface conditions, and especially during the past 2400 years, multi-centennial shifts between stable and warm surface water conditions and a cooler, more unstable and well-mixed surface water regime occurred. The changes could be related to large scale changes in the atmospheric circulation over the North Atlantic (North Atlantic Oscillation, NAO). During positive NAO, when trade winds are stronger favouring surface-water mixing, the subtropical gyre transports cooler water into the Caribbean Sea. When the NAO is negative and trade winds are weaker, sea surface water conditions are more stable with positive temperature anomalies. Thus it may be concluded that also on longer, glacial time scales periods characterized by strong zonal circulation (NAO+) alternated with periods of more meridional atmospheric circulation (NAO-).