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Investigating the impact of millennial scale Agulhas Current System variability on global ocean circulation and climate

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Around 4-5 times per year the Atlantic Ocean receives warm, saline waters from the Indo-Pacific Ocean through ring shedding events via the Agulhas Current (AC) around the southern tip of Africa. This transfer of heat and salt into the South Atlantic through the Indo-Atlantic Gateway, the so called 'Agulhas Leakage (AL)', constitutes the 'warm' upper return limb of the global oceans thermohaline circulation. As such AL is believed to have an important role in controlling the variability of the Atlantic meridional overturning circulation (AMOC). For example, recent modelling evidence suggests that AL actively stabilises our present climate, while palaeo-reconstructions highlight its important role as a potential driver for the rapid resumption of global interglacial climate change.

Palaeo-reconstructions focussing on the upstream AC variability itself and its potential connection with the downstream AL, as well as its influence on the AMOC stability, are scarce. Thus the question of what ultimately drives variability of the AL on a range of timescales remains unclear. Here we present high-resolution (centennial-millennial scale) sea surface temperature (SST), salinity (SSS) and thermocline structure records from the "upstream" AC (Natal Valley) over the past 60,000 yrs. Results of surface (Globigerinoides ruber, sensu stricto) and thermocline (Pulleniatina obliquiloculata) planktonic δ18O and Mg/Ca[U+2010]derived temperature records from the main flow path of the AC show modulation which match Antarctic warming events A1, A3, A4, which are more pronounced in the thermocline δ18O record. Mg/Ca derived SSTs suggest temperatures of 20-21°C at the Last Glacial Maximum (LGM), and show a progressive increase during Termination I (TI), which coincides with an increased abundance of subtropical planktonic foraminiferal marker species (Agulhas Leakage fauna, ALF) which indicates a progressive warming due to an increased influence of subtropical waters at the core site.

Sortable silt mean grain sizes together with δ18O and δ13C data measured on the benthic foraminiferal species Cibicidoides wuellerstorfi are used to construct high-resolution records of near-bottom flow vigour and deep water ventilation at the core site (3300 m water depth), which is today influenced by the Agulhas Undercurrent. The results highlight source water change from North Atlantic Deep Waters (NADW) to Antarctic originated Bottom Waters at the core site that can be linked with colder surface temperatures and higher bottom water flow speed during Marine Isotope Stage 2 (MIS 2), at around 26,000 years ago.

A comparison of our "upstream" SST variability with previously published records from the immediate Agulhas Corridor (Martínez Méndez et al, 2010; Cape Basin Record (CBR), Schneider et al., 1999, Peeters et al. 2004), shows that our SST record has a more pronounced temperature variability compared to reconstructions based on the biomarker UK′37 (Peeters et al. 2004), while the early warming trend observed prior to TI (based on Mg/Ca of Globigerinoides bulloides; Martínez Méndez et al. 2010) is not seen in our upstream record.

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