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Subantarctic influence on the mid Miocene initiation of the Benguela upwelling - evidence from ODP Sites 1085 and 1092 planktonic foraminifer assemblages and stable isotopes

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We present middle to late Miocene stable isotope and foraminiferal assemblage data of Ocean Drilling Program (ODP) Sites 1085 from the continental margin off southwest Africa and 1092 from the subantarctic South Atlantic. The studied interval (14-7 Ma) covers the middle Miocene cooling at 14 Ma and the initiation of the Benguela upwelling system at around 11.5 Ma. The middle Miocene Antarctic glaciation, represented by the globally recorded d18O increase events Mi-3 and Mi-4, comes along with a distinct stratification of the upper SE Atlantic water column. However, sustained oceanic upwelling in the Benguela region starts as late as 11.5 Ma, reflected by the development of high productivity foraminifer faunas containingG. bulloides, and by distinctly increasing mixed-layer to thermocline d13C gradients. The first occurrence of N. pachyderma (s) in the Benguela region at 11.5 Ma as well as the deep water cooling at Site 1085 at the same time indicates the growing influence of subantarctic water masses on the Benguela upwelling. This observation is in line with the hypothesis of Sarmiento et al. (2004) that nutrient advection by subantarctic water masses plays an important role for high productivity in the upwelling region of the southeast Atlantic. Two pulses of Indian Ocean-derived foraminifer species Globorotalia menardii at 11.3 and 10.7 Ma may indicate an enhanced spatial variability of the South Atlantic oceanic fronts associated with the establishment of the Benguela upwelling. The assumed leakage of potentially nutrient rich Indian Ocean water via the Agulhas current, that is indicated by the occurence of this species in the southeast Atlantic offers an alternative source for enhanced nutrient content responsible for the initiation of Benguela upwelling. Modeling experiments will help to better constrain

the factors and feedback mechanisms associated with the middle to late Miocene evolution of South Atlantic Ocean circulation and productivity.