Geophysical Research Abstracts
Vol. 19, EGU2017-1713, 2017
EGU General Assembly 2017

Holocene climate variability and oceanographic changes off western South Africa

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South Africa is located at a critical transition zone between subtropical and warm-temperate climate zones influenced by the Indian and Atlantic oceans. Presently, the seasonal changes of atmospheric and oceanic systems induce a pronounced rainfall seasonality comprised of two different rainfall zones over South Africa. How did this seasonality develop during the Holocene?

To obtain a better understanding of how South African climates have evolved during the Holocene, we conduct a comprehensive spatial-temporal approach including pollen and dinoflagellate cyst records from marine sediment samples retrieved from the Namaqualand mudbelt, a Holocene terrigenous mud deposit on the shelf of western South Africa. The representation of different vegetation communities in western South Africa is assessed through pollen analysis of surface sediments. This approach allows for climate reconstructions of the summer rainfall zone (SRZ) using Group 1 (Poaceae, Cyperaceae, *Phragmites*-type and *Typha*) and winter rainfall zone (WRZ) using Group 2 (Restionaceae, Ericaceae, *Anthospermum*, *Stoebe/Elytropappus*-type, *Cliffortia*, *Passerina*, *Artemisia*-type and *Pentzia*-type) from a single marine archive. The fossil pollen data from gravity core GeoB8331-4 indicate contrasting climate patterns in the SRZ and WRZ especially during the early and middle Holocene. The rainfall amount in the SRZ is dominated by insolation forcing, while in the WRZ it is mainly attributed to the latitudinal position of the southern westerlies. Dinoflagellate cyst data show significantly different oceanographic conditions associated with climate changes on land. High percentages of autotrophic taxa like *Operculodinium centrocarpum* and *Spiniferites* spp. indicate warm and stratified conditions during the early Holocene, suggesting reduced upwelling. In contrast, the middle Holocene is characterized by a strong increase in heterotrophic taxa in particular *Lejeunecysta paratenella* and *Echinidinium* spp., indicating cool and nutrient-rich waters with active upwelling. Thus, sea surface temperatures are dominated by upwelling dynamics influenced by the latitudinal position of the southern westerlies rather than warm waters via the Agulhas leakage. The paleo-productivity changes during the late Holocene are controlled by the freshwater influx of the Orange River indicated by abundant fluvial-related taxa such as *Brigantedinium* spp., *Protoperidinium americanum* and *Lejeunecysta oliva*. This corroborates the increase of Poaceae/Asteraceae ratio suggesting increased summer rainfall in the SRZ. Therefore, the terrestrial (pollen) and marine (dinoflagellate cyst) records generated from the same sediment sequence enable a clear understanding of the mechanisms driving variability in the Holocene of South Africa and provide significant insight into the land-ocean linkages.