PALEOPRODUCTIVITY, PALEOTEMPERATURE AND TERRIGENOUS INPUT IN THE MID-PLEISTOCENE SOUTHERN SOUTH ATLANTIC: IMPLICATIONS FROM BIOMARKER RECORDS (ODP-SITE 1089)

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In order to reconstruct changes in paleoproductivity, paleosea-surface temperatures, and terrigenous/marine organic carbon input and their relationship to climate change, specific biomarkers (*n*-alkanes, fatty acids, alkenones, sterols), Rock-Eval pyrolysis data, and stable carbon isotopes of the organic fractions (total C_{org} and biomarkers), as well as accumulation rates of organic carbon were determined in sediment samples from ODP Site 1089 (Atlantic sector of the Southern Ocean; *Gersonde, Hodell et al. 1999*, Fig. 1).

The investigated samples represent the time interval from Marine Oxygen Isotope Stages (MIS) 12 to 5e (i.e., about 450 to 100 ka). Based on the biomarker data, marine organic carbon was significantly enriched during glacial stages. Estimated paleo-productivity, corrected for the amount of refractory ("dead") organic matter as obtained from Rock-Eval pyrolysis (Fig. 2), reaches values of about 50 gC m^{-2} y^{-1} during peak interglacials (e.g., MIS 5e and lowermost MIS 11), which is close to the modern productivity measured in the study area (Fig. 3). During glacial intervals, the productivity was increased reaching values of about 100-150 gC m^{-2} y^{-1}. These glacial/interglacial changes are explained by a northward shift of the high-productivity zone during glacials. During peak-interglacials, alkenone seasurface temperatures were about 6°C warmer than during glacials.

Stable carbon isotopic analyses of the terrigenous *n*-alkanes identified a mixed origin of C_3 and C_4-plants, with a variability in relative proportions constrained to proxies of ocean circulation (Fig. 4).

The biomarker records display a distinct periodic variability which is related to Milankovich and sub-Milankovich climate cycles (Fig. 5). Furthermore, a correlation with the Vostok temperature curve (Petit et al. 1999) and the SPECMAP climate record (Imbrie et al. 1984) is obvious.

The same type of work is in progress for ODP Site 1093, located further to the south.

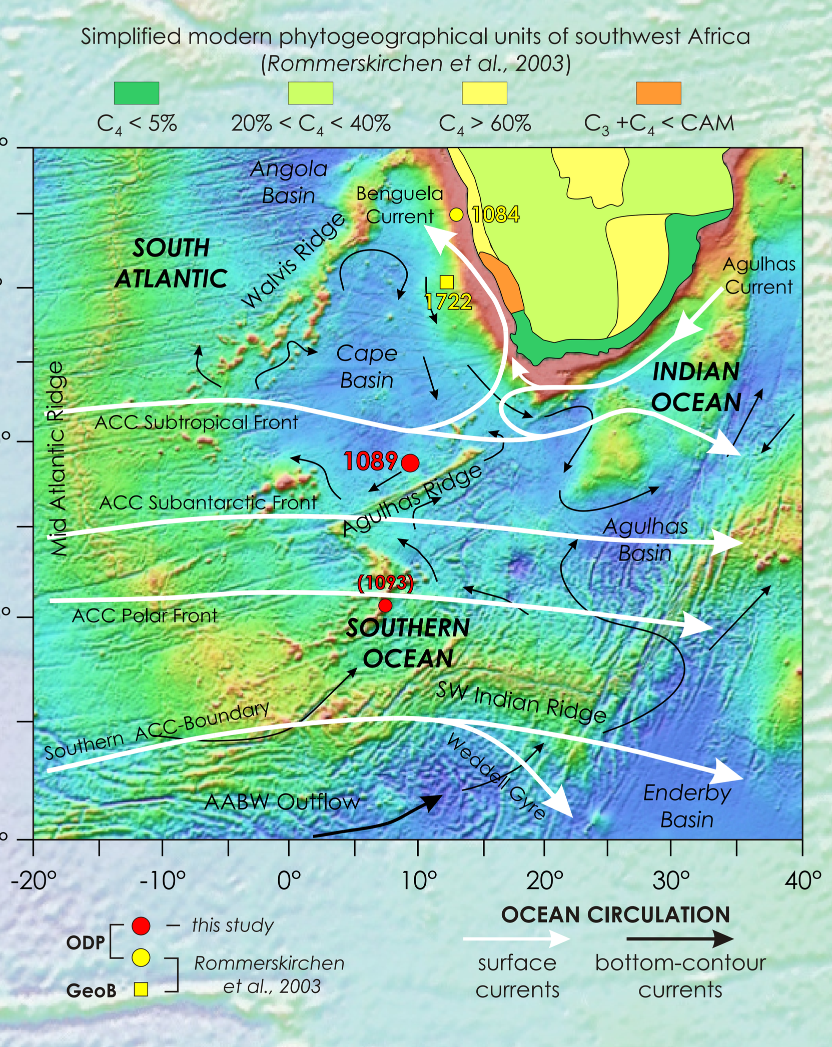

Fig. 1: Study area showing the position of ODP Site 1089 and cited core locations in the southeastern South Atlantic. Arrows indicate independent surface and bottom ocean circulation pattern (adapted from *Kuhn & Diekmann, 2002*). Coloured regions of south Africa indicate simplified distribution of terrestrial plant-types. Background image shows satellite derived gravity field (*Smith & Sandwell, 1997*).

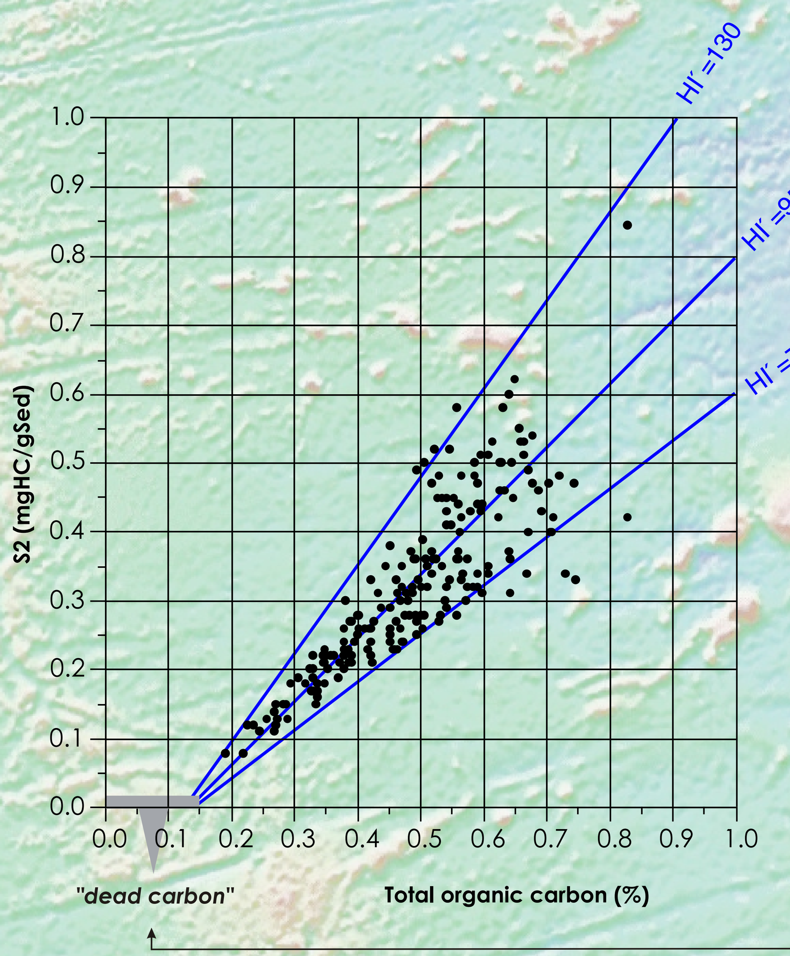

Fig. 2: Correlation of total organic carbon (*Kuhn & Diekmann, 2002*) and S2-values from Rock-Eval pyrolysis (R = 0.844, n = 198). The intercept of the regression line (not shown) determines an amount of ca. 0.13% "dead" (i.e. refractory) organic carbon. HI: hydrogen index (S2x100/TOC), calculated after subtraction of "dead carbon".

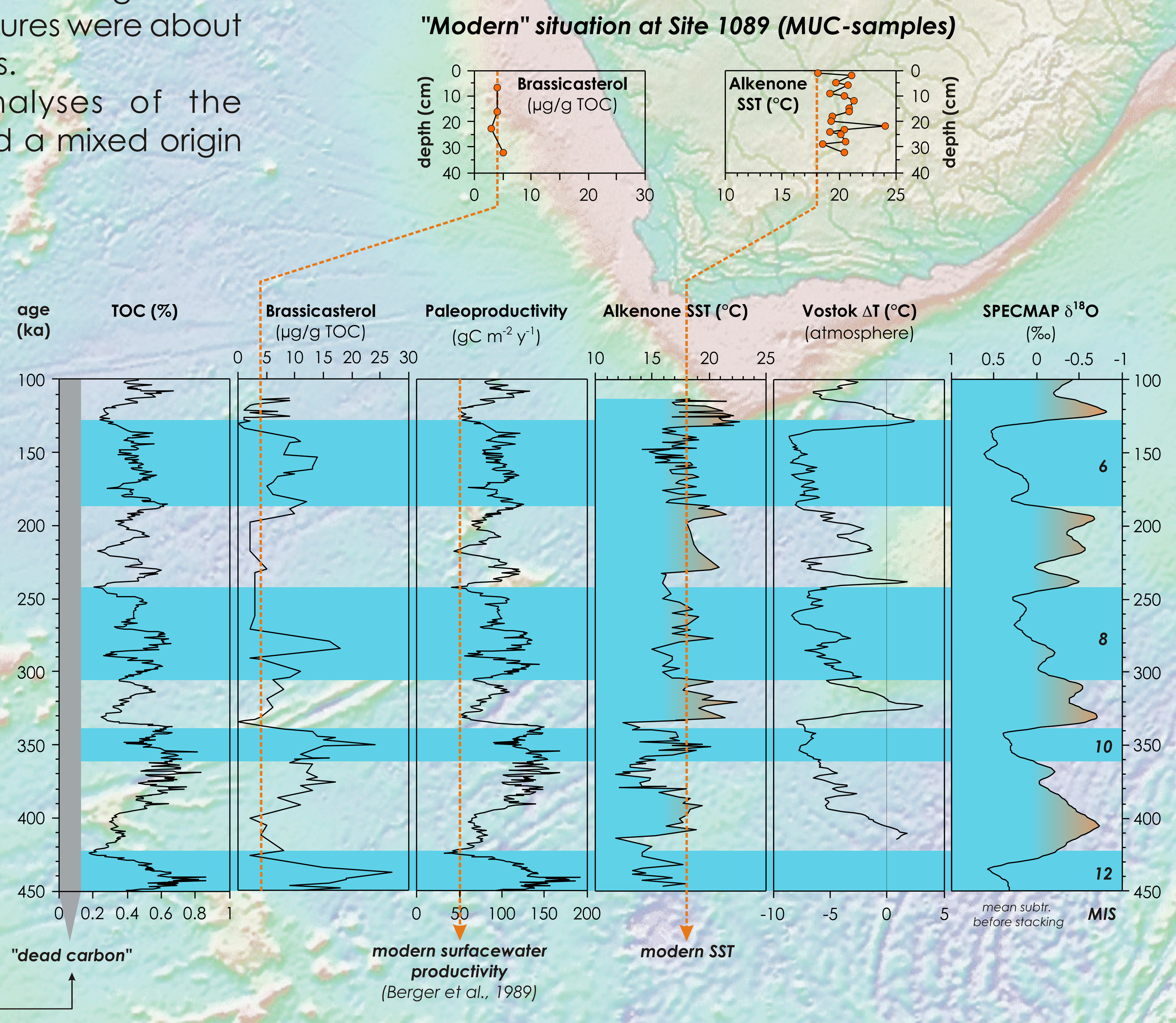

Fig. 3: Total organic carbon (*Kuhn & Diekmann, 2002*), amount of brassicasterol (a diatom-derived organic compound), estimated paleoproductivity (according to the formula of *Stein, 1986*), and alkenone-derived sea-surface temperature (SST) for the time interval 100 to 450ka at ODP Site 1089. The records are correlated with the Vostok atmospheric temperature difference (ΔT, *Petit et al., 1999*) and the benthic $\delta^{18}O$ SPECMAP stack (*Imbrie et al., 1984*). "Modern" values (top of the figure) derive from MUC-samples taken at the location of Site 1089.

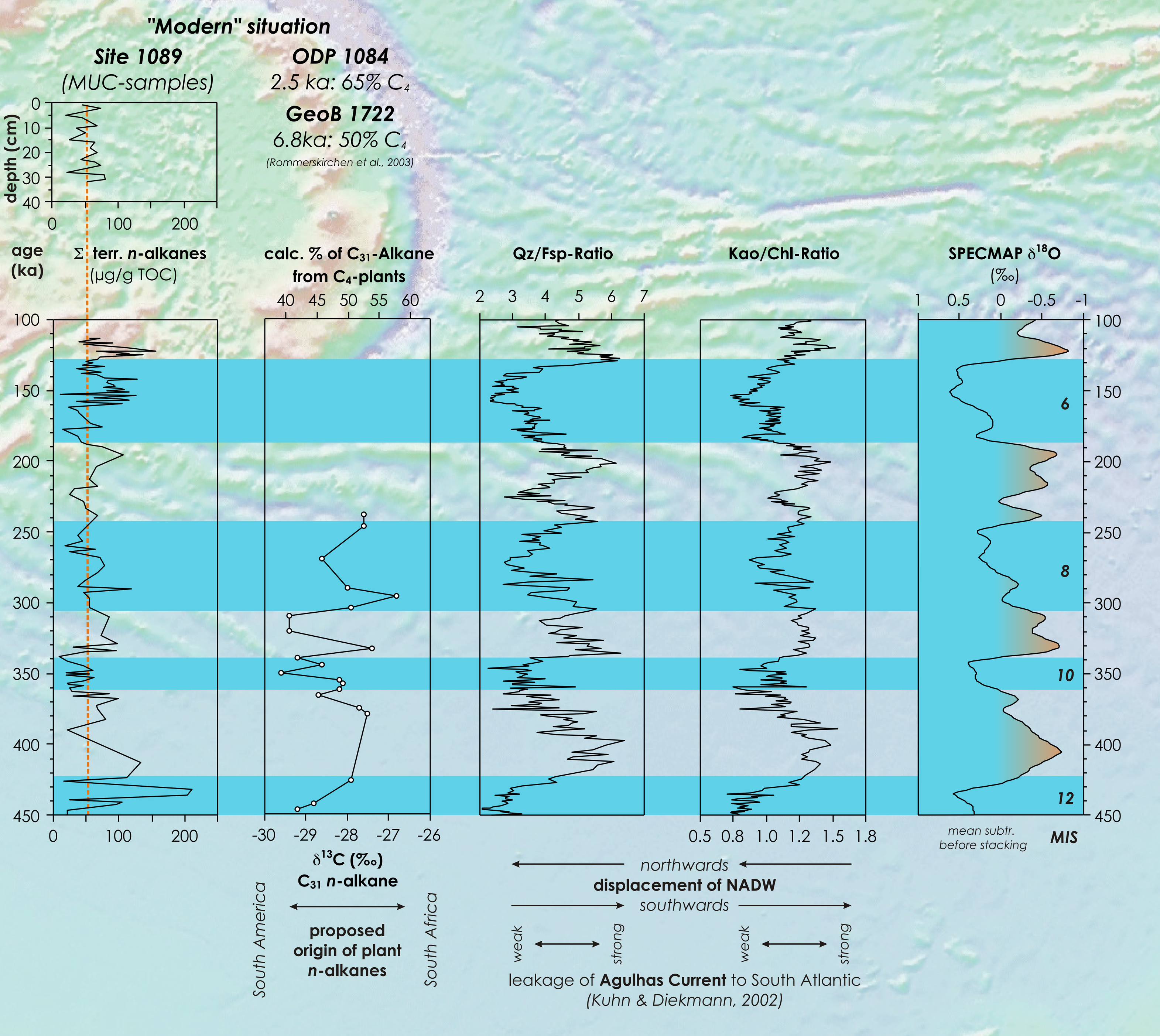

Fig. 4: Amount of landplant-derived *n*-alkanes (Σ C_{27},C_{29},C_{31}), carbon isotopic composition of *n*-C_{31} alkane, and %-contribution of C_4-plants from binary mixing-calculations assuming literature-derived C_3 (-35.5‰) and C_4 (-20.4‰) *n*-alkane endmembers (*Collister et al., 1994; Chikaraishi & Naraoka, 2003*). The proportions of C_4-derived *n*-alkanes correlates with proxies for the variability of ocean circulation (*Kuhn & Diekmann, 2002*), suggesting an origin from different continents for the terrigenous *n*-alkanes and thus obscuring the *n*-alkane record in terms of absolute amounts.

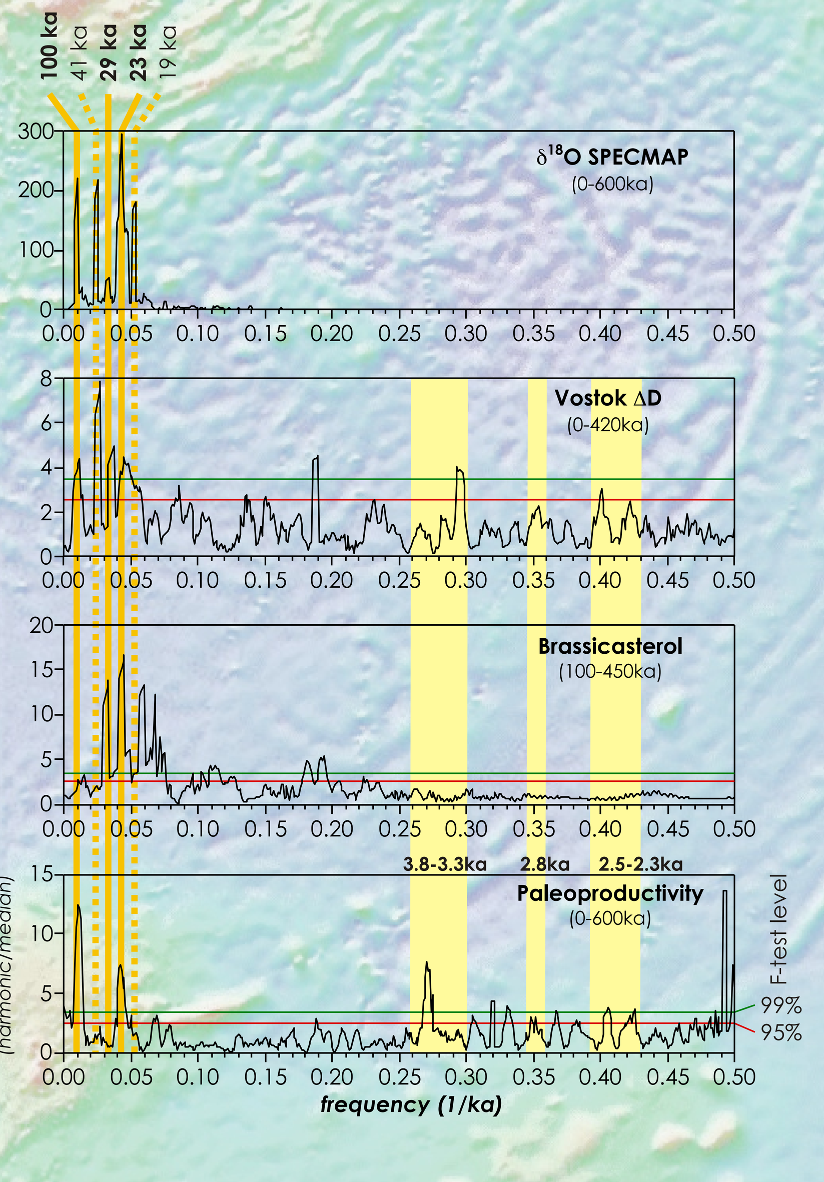

Fig. 5: Spectral analysis (MTM-SSA-toolkit, *Ghil et al., 2002*) of organic carbon records in Site 1089, compared to SPECMAP and Vostok ΔD. The analysed time window (100-450ka) of the brassicasterol record shows relevant peaks for cycles connected to the precession (23ka), also present in the extended time range (0-600ka) of the paleoproductivity data. For these data, a prominent spectral peak occurs also with the eccentricity cycle (100ka), but is less obvious in the shorter brassicasterol record. In addition, a 29ka cycle is present in the brassicasterol spectrum. The paleoproductivity data also show relevant spectral peaks at higher frequencies, partly correlating with the Vostok record.

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