**Supplementary figures and data descriptions**

**Supplementary Figure 1:** sedimentary facies interpretation of high-resolution seismically mapped surfaces S4-6 (see Fig. 2 for stratigraphical position) in relation to the wells. Approximate ages of the mapped surfaces are 2.8 Ma (S4), 2.44 Ma (S5) and 2.34 Ma (S6).

**Supplementary Figure 2**: Main pollen types in the spliced record of A15-3 (blue) and A15-4 (red) expressed as percentages of the total pollen. Dashed lines between AP % and T/M ratio indicate the observed lags of 3-8 kyr between (terrestrial) cooling and sea level decreases.

**Supplementary Figure 3:**

Age-depth model of the spliced A15-3 and A15-4 sections based on a smoothing spline interpolation (optimised range set to 1.65) of tie age points in Table S1 taken from Kuhlmann et al. (2006ab). The tie points where updated to recent range calibrations where necessary.

**Supplementary Figure 4:**

Well tie correlation points between A15-3 and A15-4 are based on the Gamma Ray correlation displayed in Fig. 2. The high R2 of the linear relation between the well tie points confirms that the proxy records from both wells can by spliced confidently into a single record.

**Supplementary Figure 5:**

The terrestrial to marine palynomorph (T/M) ratio with in- and exclusion of bisaccate pollen show minimal offset, indicating a low influence of differential transport processes.

**Supplementary Figure 6:**

Ternary diagram based on the brGDGT analyses showing values close but not identical to the soil calibration. Samples with higher BIT (>0.5) show a greater correspondence to the soil calibration, which indicates some contribution of in-situ produced (aquatic) brGDGTs.

**Supplementary Table S1**

Chronostratigraphical control points taken from Kuhlmann et al. (2006ab). The tie points where updated to recent range calibrations where necessary. Minimum and maximum ages represent the range of ages from literature. Plotted ages represent the midpoints of these values. Miocene ages are not shown in Fig. S3 due to a hiatus at ~1240 mbsl separating the Miocene and Pliocene deposits (Kuhlmann et al., 2006ab).

**Supplementary Table S2**

Palynological abundance data of A15-3 and A15-4 by taxon and composite indices as displayed in Fig. 3. Percent data are based on a separate marine and terrestrial total.

**Supplementary Table S3**

Borehole Gamma Ray data (A15-3) and geochemical data of A15-3 and A15-4 (O and C stable isotope ratios, TOC, Alkane ratios, brGDGTs).

**References**

Kuhlmann, G., Langereis, C.G., Munsterman, D., van Leeuwen, R.-J., Verreussel, R., Meulenkamp, J., Wong, T.E., 2006a. Chronostratigraphy of Late Neogene sediments in the southern North Sea Basin and paleoenvironmental interpretations. Palaeogeography, Palaeoclimatology, Palaeoecology 239: 426–455. https://doi.org/10.1016/j.palaeo.2006.02.004.

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