Supplements

S1. MTM Power Spectra of γ (GRS) and χ (MS)

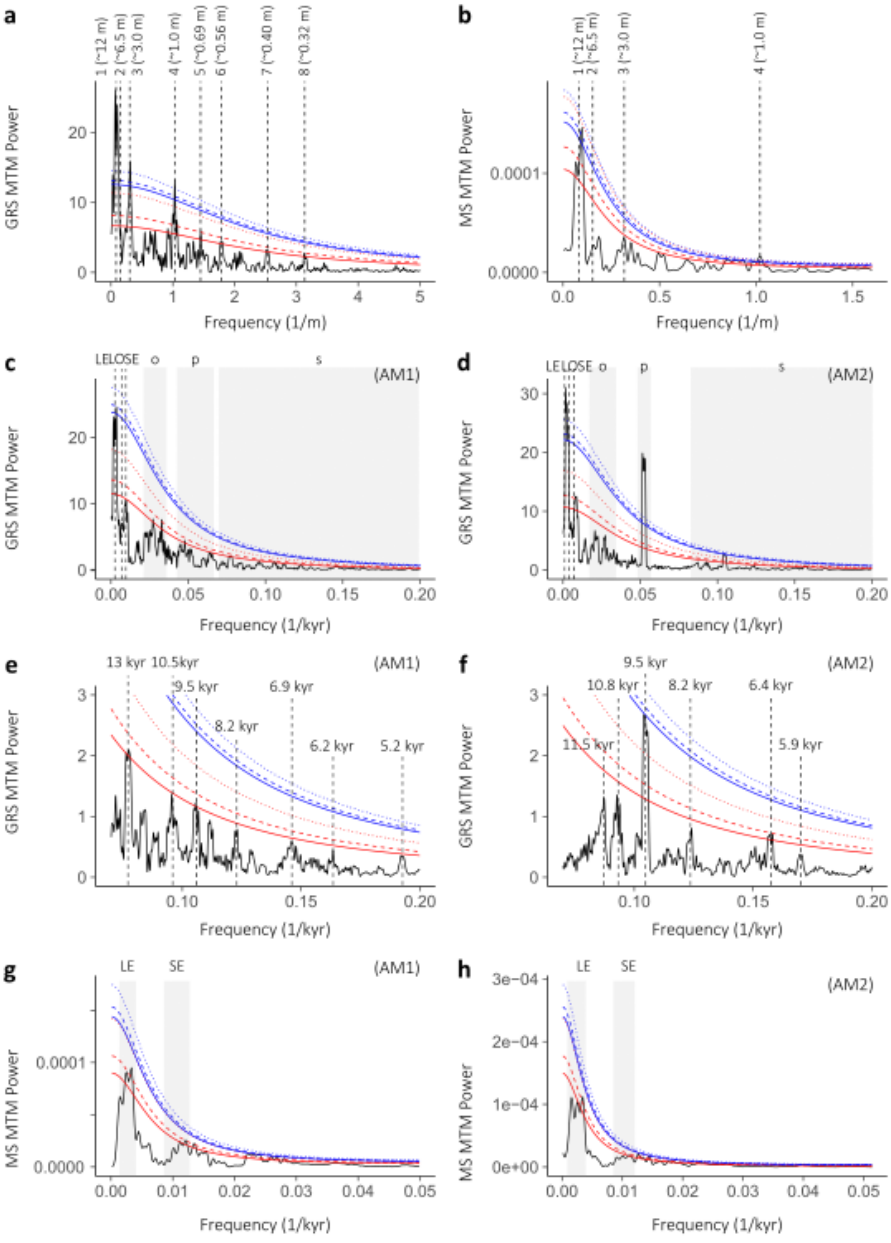


Fig. S1. MTM power spectra of γ and χ. a) MTM spectrum of γ with key components and corresponding periods numbered 1-8, b) MTM spectrum of χ with key components and corresponding periods numbered 1-4, c) MTM spectrum of γ tuned according to AM1, d) MTM of γ tuned according to AM2, e) zoom-in of panel c, f) zoom-in of panel d, g) MTM spectrum of tuned χ according to AM1, h) MTM spectrum of tuned χ according to AM2. Classical significance testing at 90, 95 and 99 % confidence levels using an autoregressive model of order 1 (AR(1)) is included for each spectrum (red full, dashed and dotted red lines, respectively), including Bonferroni corrections (blue). Gray boxes indicate spectral bands of 405-kyr long eccentricity (LE), 173-kyr long obliquity (LO), 100-kyr short eccentricity (LE), obliquity (o), precession (p) as well as sub-Milankovitch cyclicity (s).

S2. Average Sedimentation Rate Estimation using TimeOpt

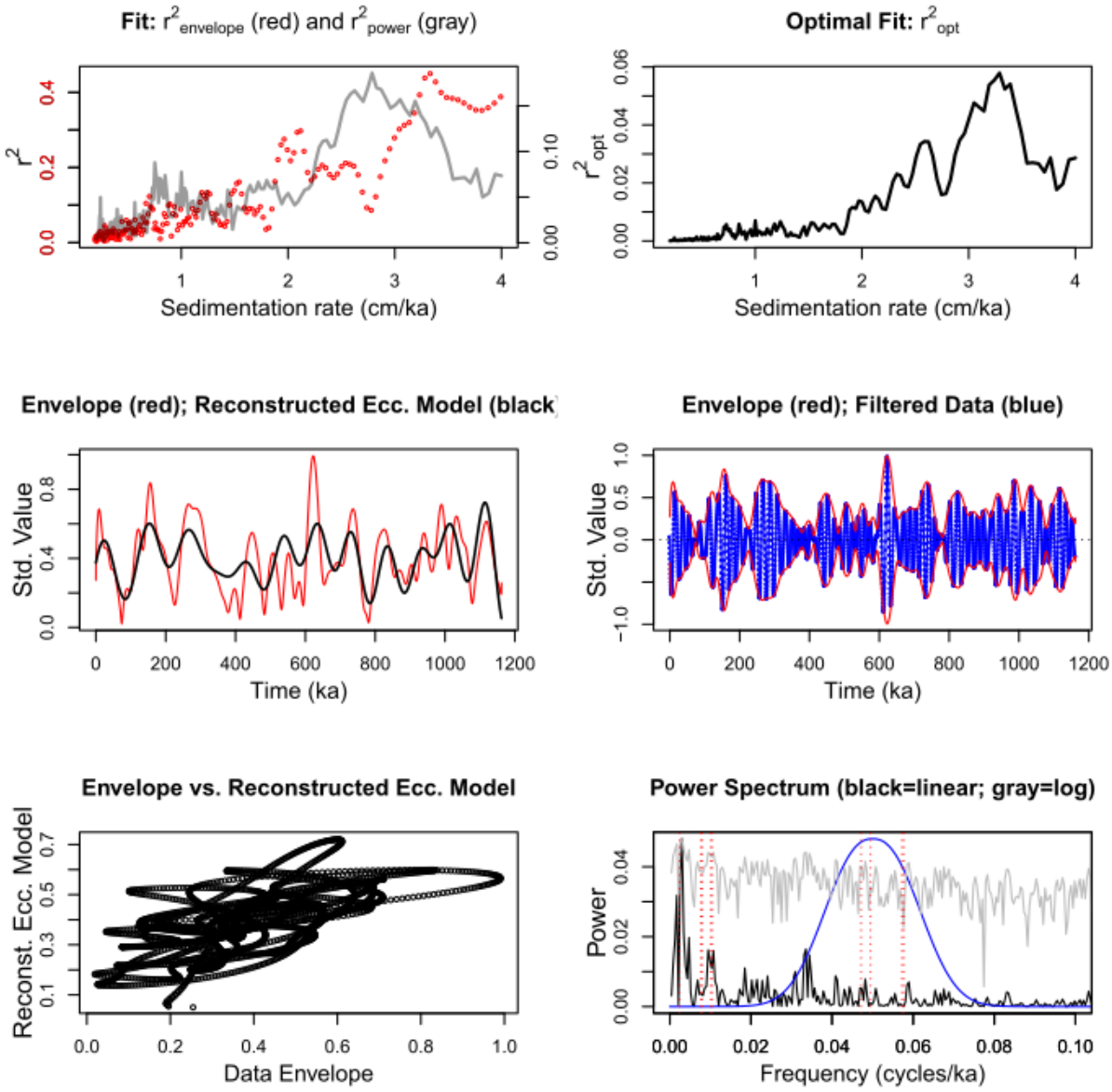
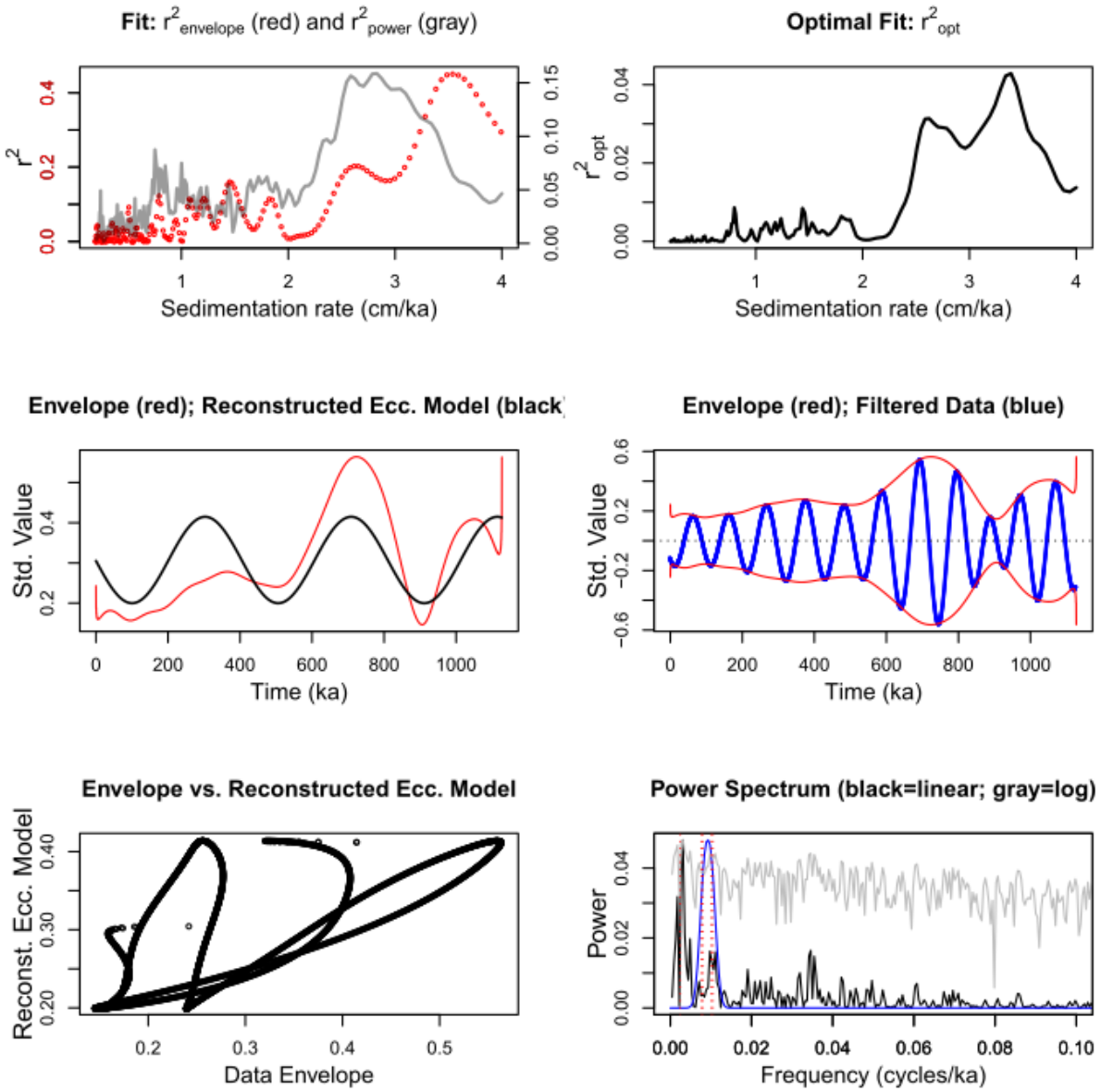


Fig. S2. TimeOpt evaluation of GRS γ, precession modulation by eccentricity. Maximum spectral power r² at an average sedimentation rate of 2.79 cm/kyr, maximum envelope r² at an average sedimentation rate of 3.34 cm/kyr, r^2_{opt} at an average sedimentation rate of 3.29 cm/kyr. Sedimentation rates tested range from 0.2 to 4.0 cm/kyr.



18

19 **Fig. S3. TimeOpt evaluation of GRS γ, short eccentricity modulation by long eccentricity.** Maximum spectral

20 power r² at an average sedimentation rate of 2.83 cm/kyr, maximum envelope r² at an average sedimentation rate

21 of 3.55 cm/kyr, r^2_{opt} at an average sedimentation rate of 3.39 cm/kyr. Sedimentation rates tested range from 0.2 to

22 4.0 cm/kyr.

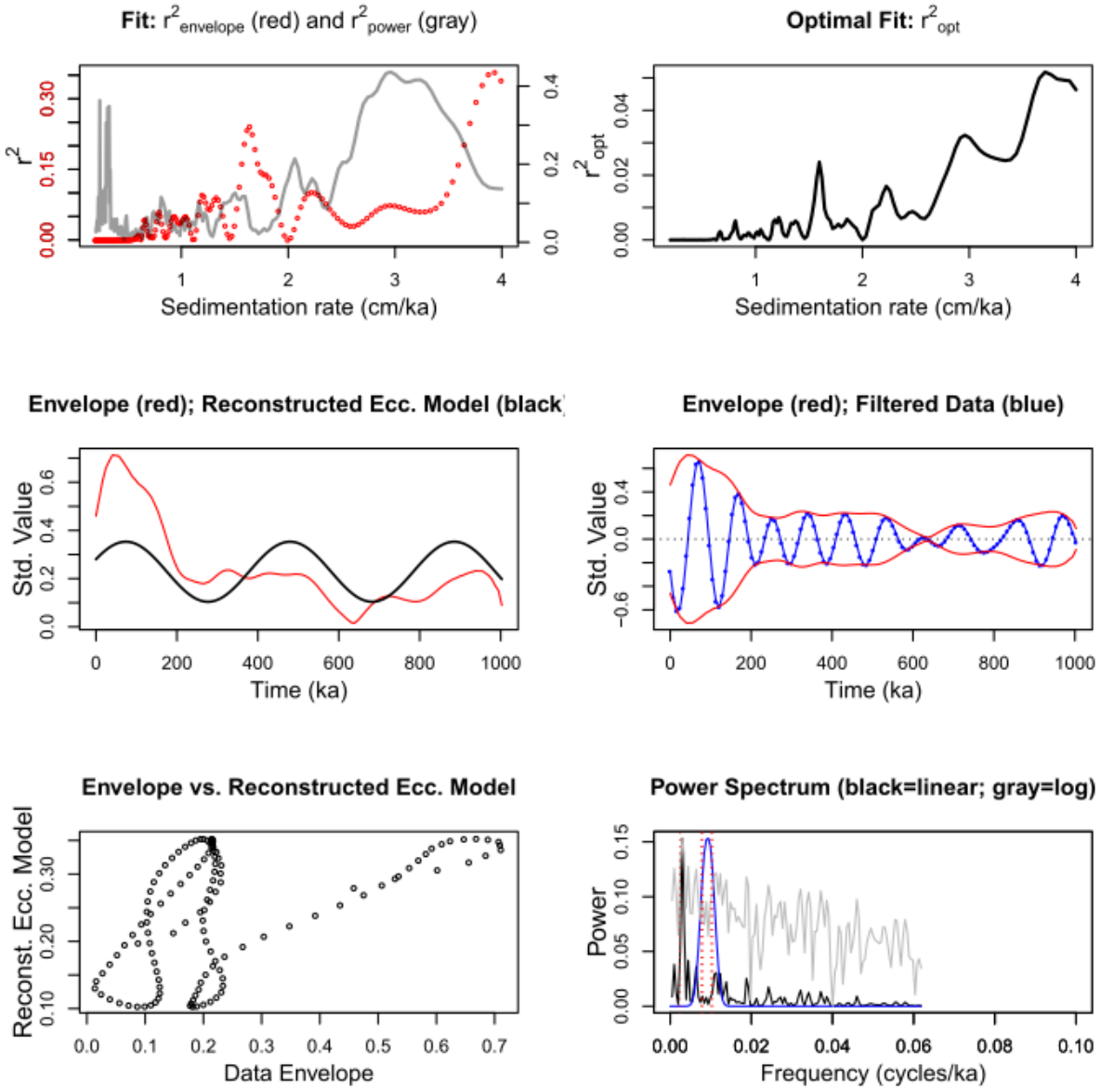


Fig. S4. TimeOpt evaluation of MS χ, short eccentricity modulation by long eccentricity. Maximum spectral power r² at an average sedimentation rate of 2.96 cm/kyr, maximum envelope r² at an average sedimentation rate of 3.94 cm/kyr, r^2_{opt} at an average sedimentation rate of 3.71 cm/kyr. Sedimentation rates tested range from 0.2 to 4.0 cm/kyr.

S3. Cyclostratigraphic Age Model of the Sherburne Formation – Comparison

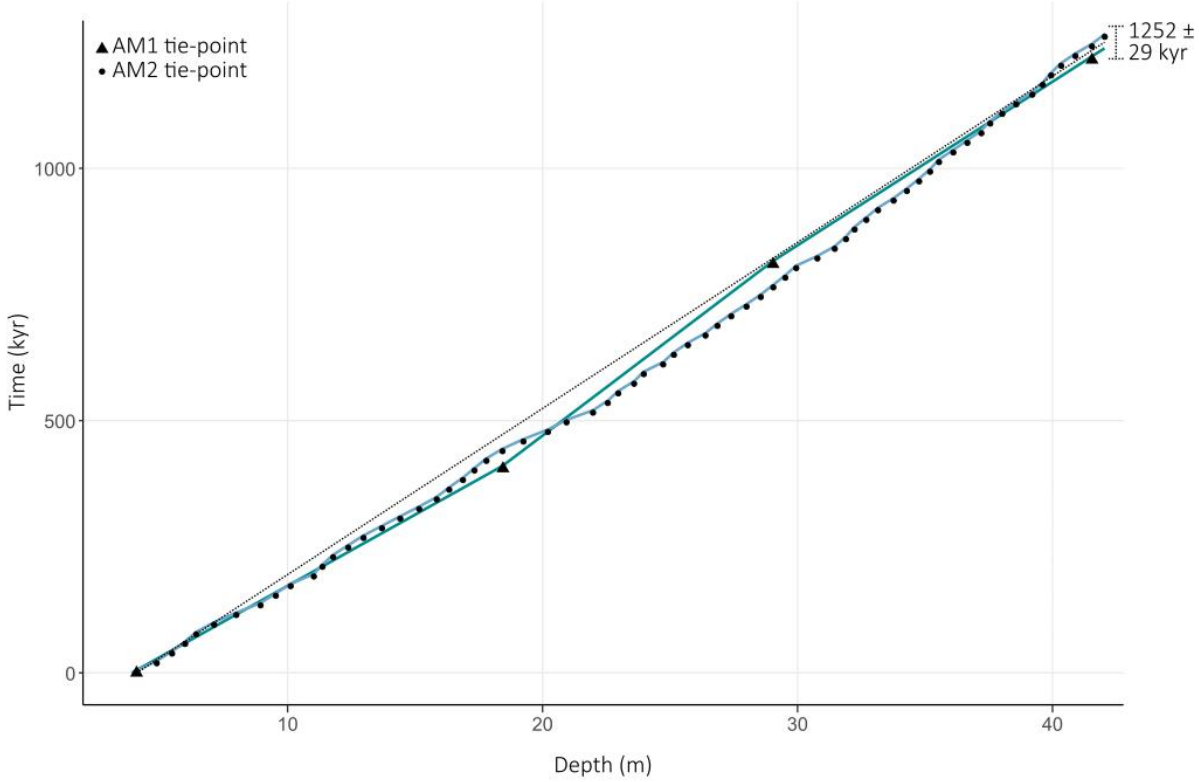


Fig. S5. Sherburne Formation sedimentation rate curves. AM1 (cyan; 405-kyr LE) depth-time tie-points indicated by black triangles, AM2 (blue; precession) depth-time tie-points indicated by black dots. Dotted line represents the average sedimentation rate according to an average estimated duration of 1252 ± 29 kyr.

S4. Testing short-eccentricity harmonics

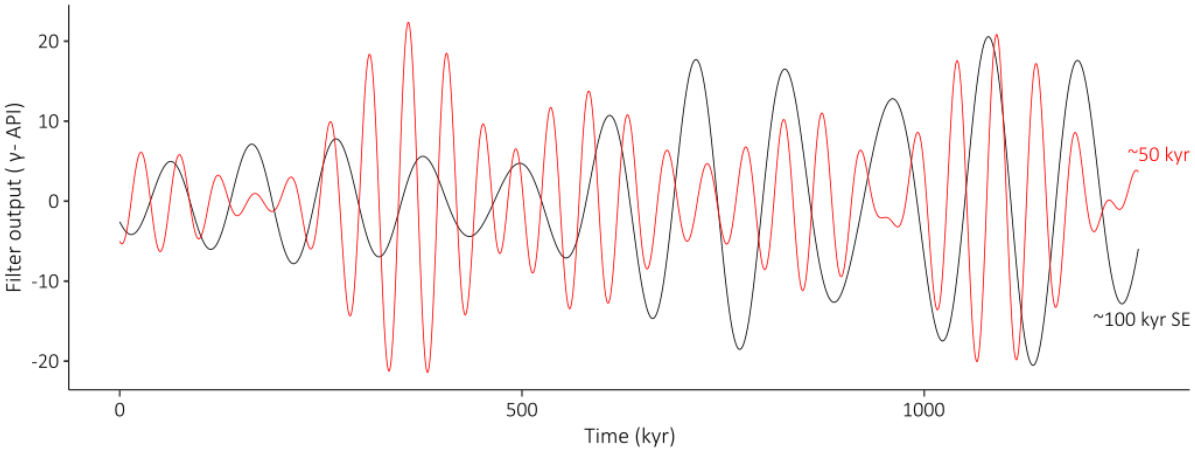


Fig. S6. Extracted short eccentricity and ~50-kyr band. 100~kyr short eccentricity (SE; black) and ~50-kyr band (red). The lack of stable phase and amplitude relationships indicates this ~50-kyr band is most probably not a harmonic of short eccentricity.

S5. Precession-obliquity combination tones

Table S1. Precession-obliquity combination tones. Upper-right quadrant represents sum tones, lower-left quadrant difference tones.

Period (kyr)	34.3	21.2	20.2	17.47	17.34
34.3		13.1	12.7	11.6	11.5
21.2	**55.5**		10.3	9.6	9.5
20.2	**49.1**	428.2		9.4	9.3
17.47	35.6	99.3	129.3		8.7
17.34	35.1	95.2	122.5	2330.2	

S6. MTM and EPSA of Tuned γ (GRS)

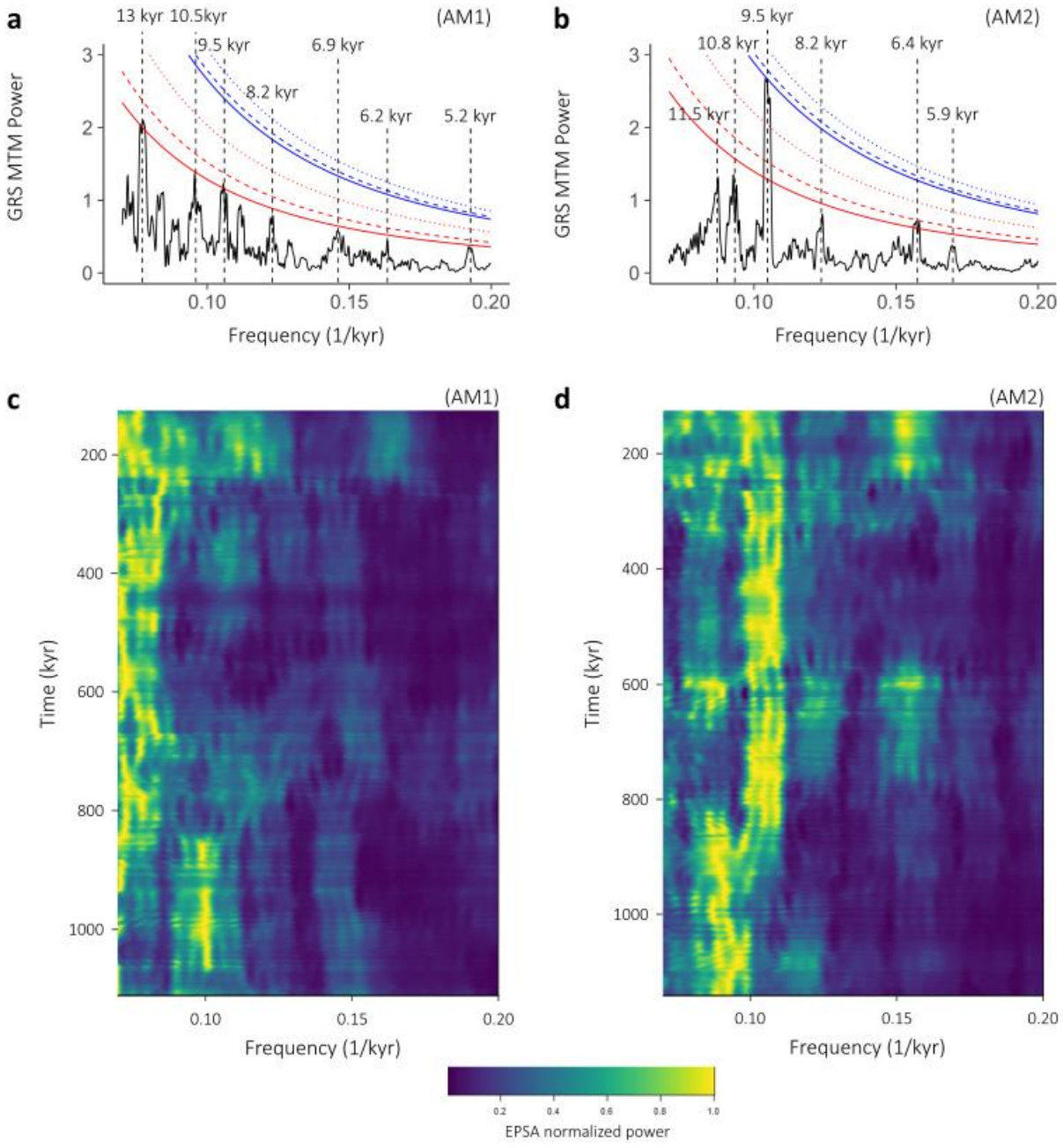


Fig. S7. Spectral analysis of Sherburne Formation sub-Milankovitch cyclicity. a) and b) MTM power spectrum of tuned γ according to AM1 and AM2, respectively, including classical significance testing at 90, 95 and 99 % confidence levels using an autoregressive model of order 1 (AR(1); red full, dashed and dotted red lines, respectively) and Bonferroni corrections (blue), c) and d) evolutive power spectrum analysis (EPSA) normalized power of tuned γ according to AM1 and AM2, respectively