HOLOCENE 6000-YR CLIMATE CYCLES IN TEMPERATE AND SUB-TROPICAL SST RECORDS – A COSMIC RAY CONNECTION?

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INTRODUCTION

Temperature cycles with periods > 2000 yr, including peaks of order 6000 yr, has been reported in 14C proxy records in sediments for Fennoscandia (Olsen et al, 2005) and in glacier geochemistry for the Greenland ice-sheet (Mayewski et al, 1997, 2004). Similar spectral peaks are also seen in 14C and 10Be isotopes in Greenland GRIP ice-cores (Xapsos, 2009); these cycles have been attributed to solar sunspot activity (Solanki et al, 2004). Complicating the question of existence of global millennial cycles, a comparison of d18O data in ice cores for Greenland (NGRIP) and Antarctica (EDML) has shown that for events prior to the Last Glacial Maximum (LGM), variations on the scale of 2-6kyr are markedly stronger in northern hemisphere records, associated with ice dynamics and Dansgaard–Oeschger (D-O) and Heinrich events (EPICA, 2006).

In this study we use temperature proxies for sea-surface temperatures obtained from 3 deep-sea drill cores. These records were first compared in Asten (2018). We now compare these with the d18O record from EDML (Antarctica) ice-cores, and cosmic ray flux (based on EDML and GRIP Antarctica and Arctic ice cores, 10Be and 14C from McCracken et al, 2013) in order to find occurrence of a ~6000 year period.

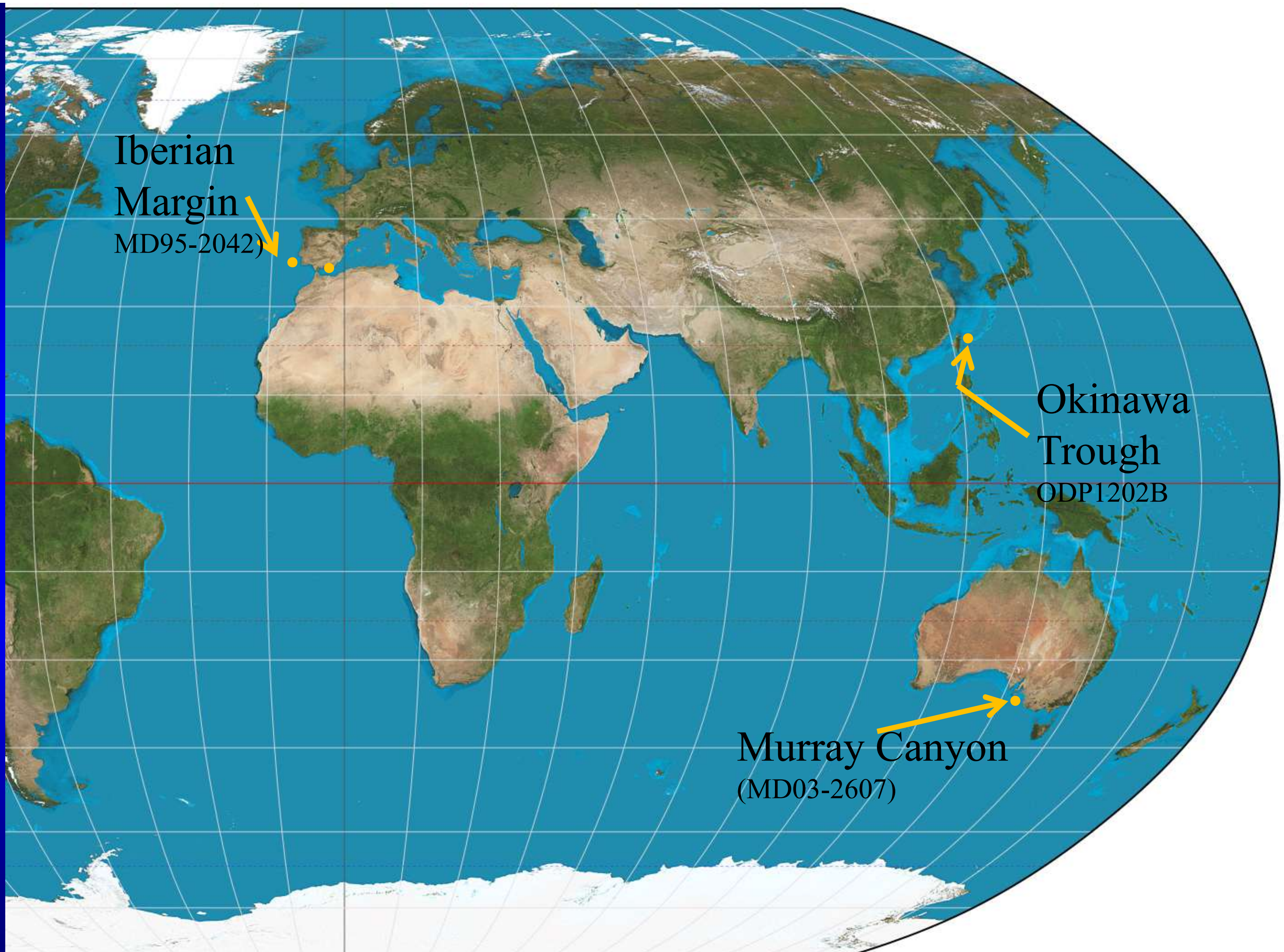
We restrict data to time 0-20000 BP in order to avoid the strong Dansgaard–Oeschger (D-O) signatures in data affected by North Atlantic glacial variations pre the Last Glacial Maximum*.

Each core uses the UK’37 temperature proxy:
the relative abundance of long-chain unsaturated ketones, as found in algae which reside in the near-surface ocean
- a proxy for sea-surface temperature.

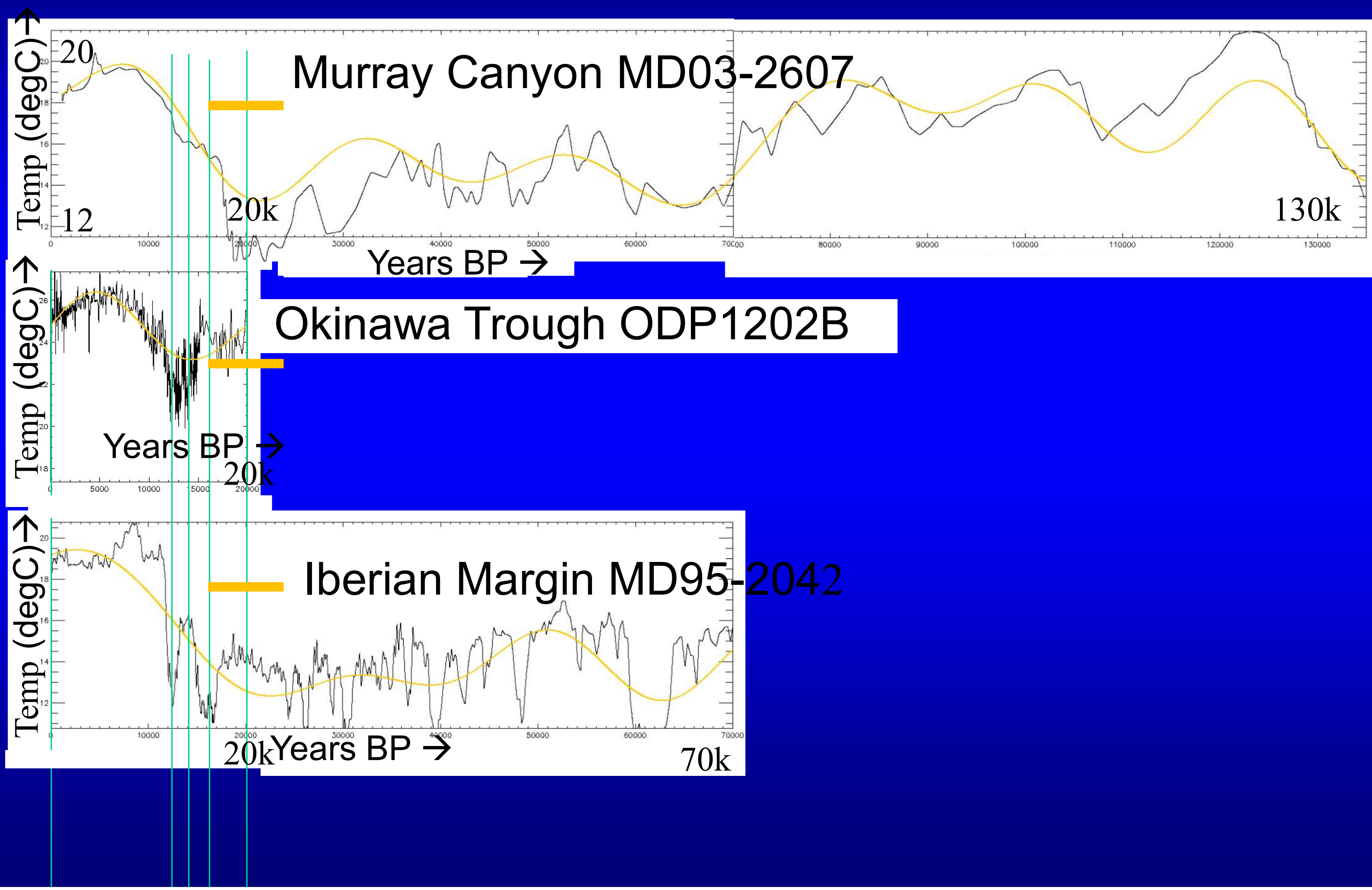
* The 0-20ka interval does include one event D-O1 at age 14500 yr BP

Source holes, depths and sedimentation rates, for UK37 temperature proxies used in this study

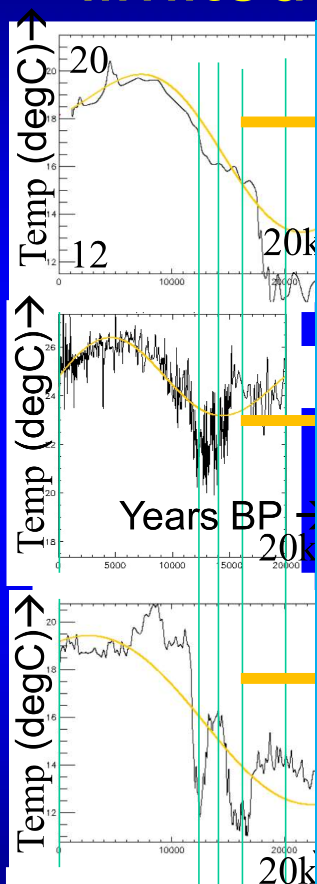
Hole	Location	AGE	Depth	No. Of	Ave Rate of	Ref
				Samples	Sedimentation	
		ka	m		cm/kyr	
MD03-2607	Murray Canyon	134	15	172	11	Santos et al 2013
	Southern Ocean					
	SE Australia					
ODP 1202B	Okinawa trough	20	84	439	420	Ruan et al 2015
	W Pacific					
MD95-2042	Iberian Margin	70	31.4	401	45	Darfeuil et al 2016
	offshore					


Iberian
Margin
MD95-2042)
Okinawa
Trough
ODP1202B
Murray Canyon
(MD03-2607)

Source holes – temperature proxies as time series



Source holes – temperature proxies limited to 0 – 20ka BP for this study



Murray Canyon MD03-2607

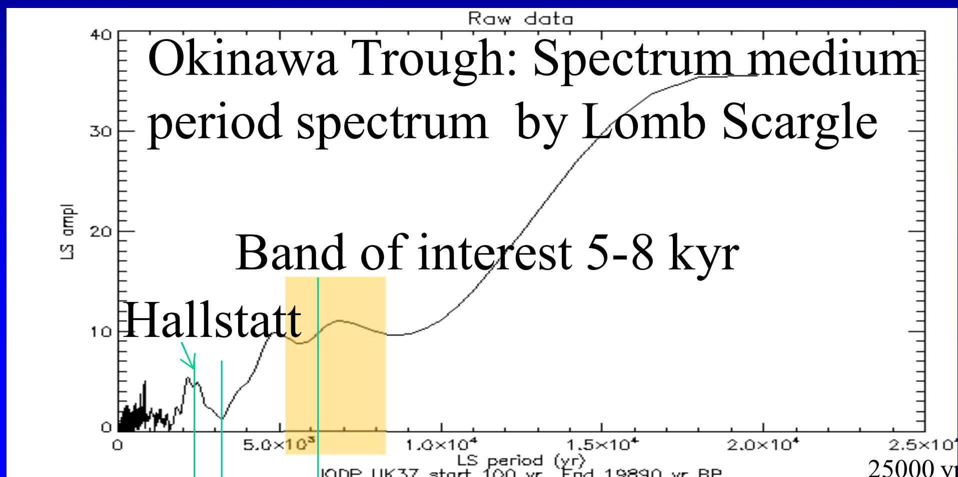
Okinawa Trough ODP1202B

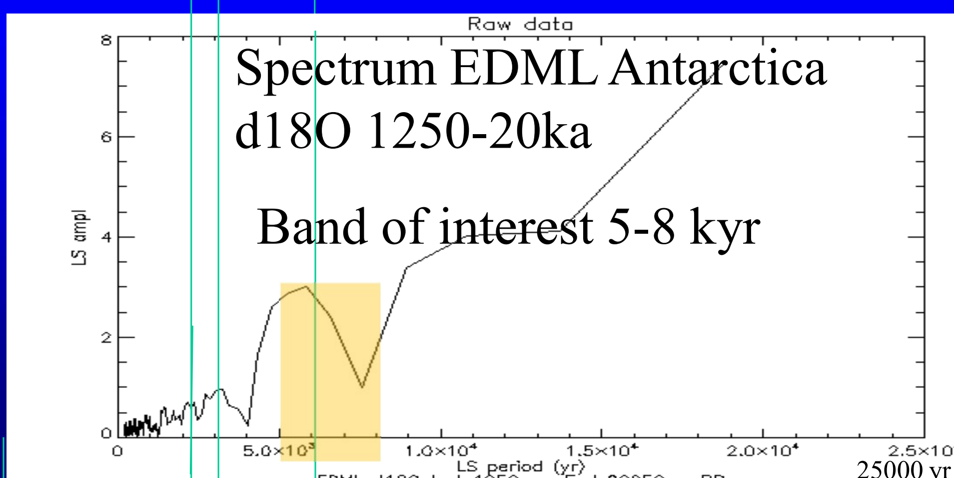
Iberian Margin MD95-2042

USE OF LOMB-SCARGLE SPECTRAL ANALYSIS

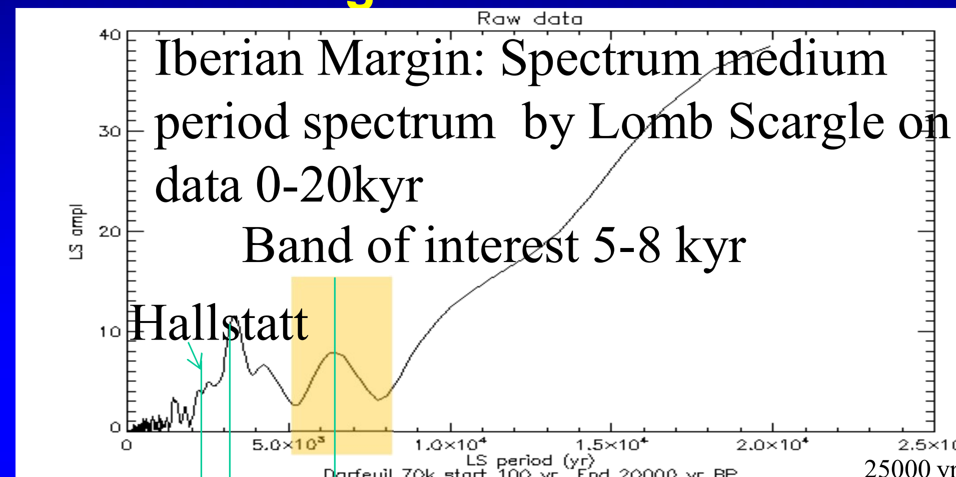
The Lomb Scargle approach estimates a frequency spectrum, based on a least squares fit of sinusoids to data samples, which do not need to be equally spaced in time. The LS method has the particular advantage of avoiding an assumption of cyclic replication of the data series (implicit in the FFT approach). It appears to provide higher resolution of the period spectrum than the FFT. It also appears less sensitive to dominant low-frequency peaks, or trends in the data, which are known to produce strong leakages to other frequencies when using FFT methods.

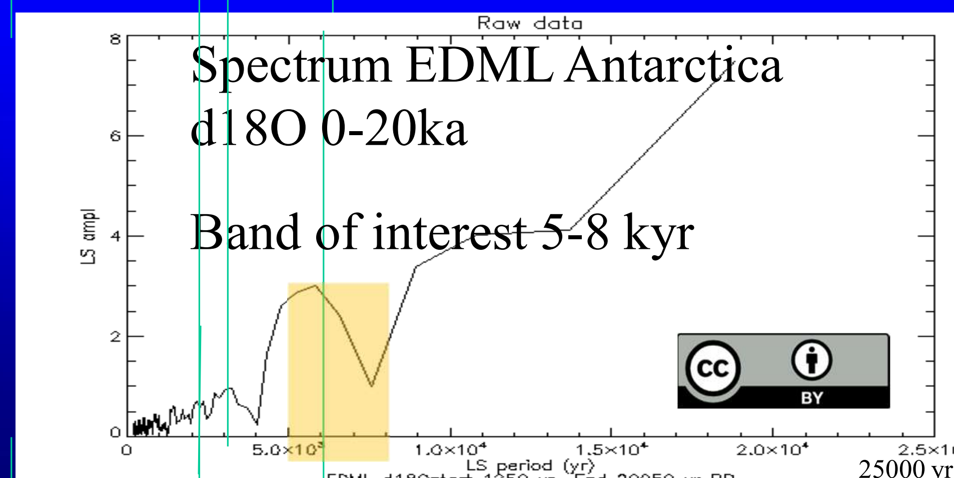
Compare spectra of Okinawa Trough with spectrum of 1250-20ka segment of EDML d18O



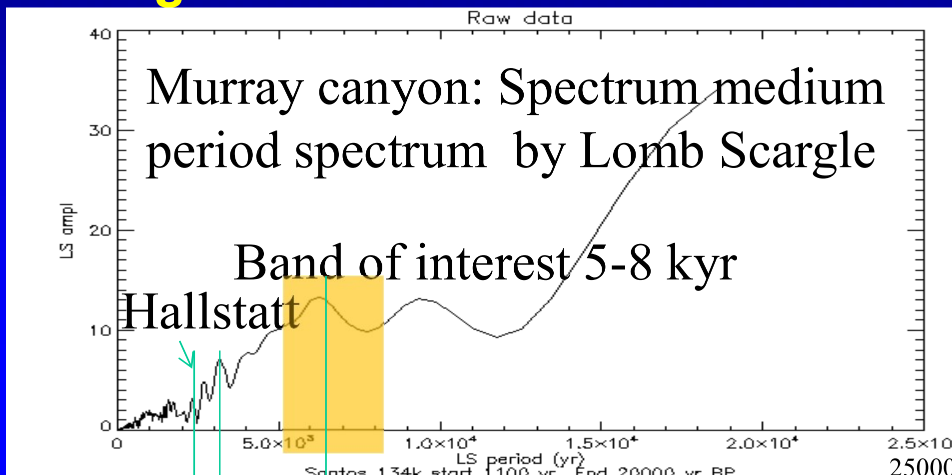


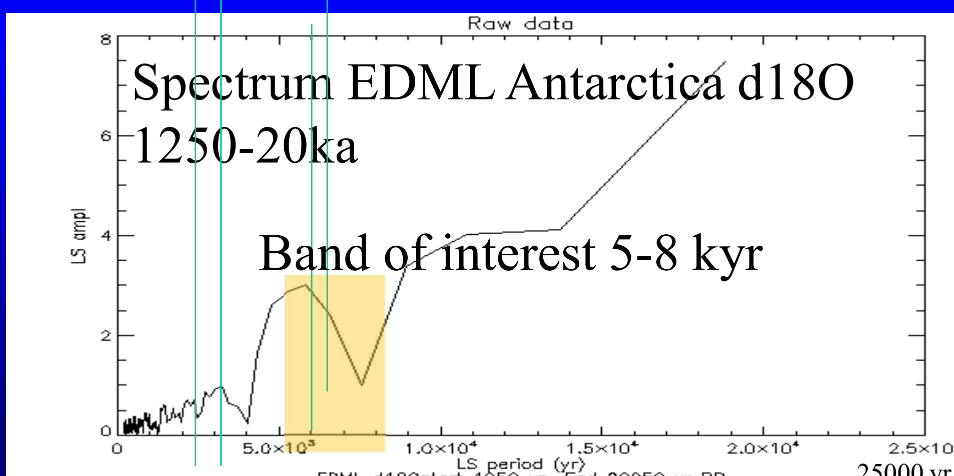
Compare spectra of Iberian Margin segment 0-20ka with spectrum of 1250-20ka segment of EDML d18O



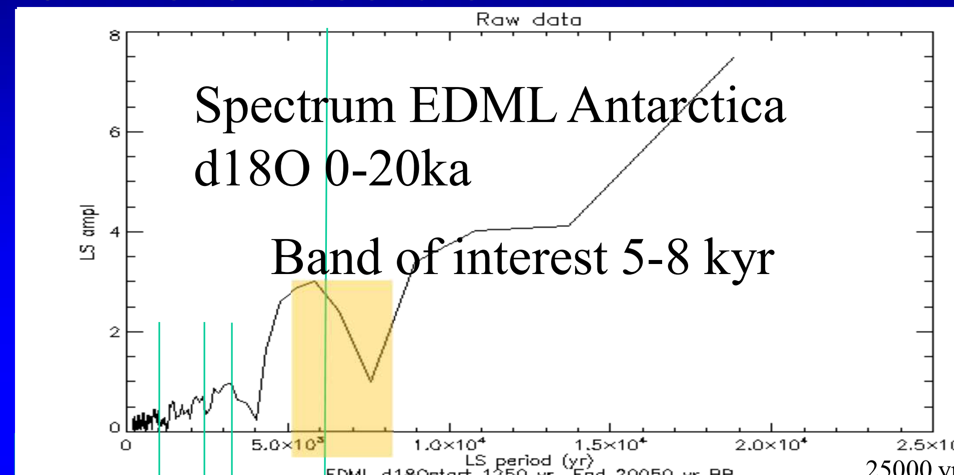


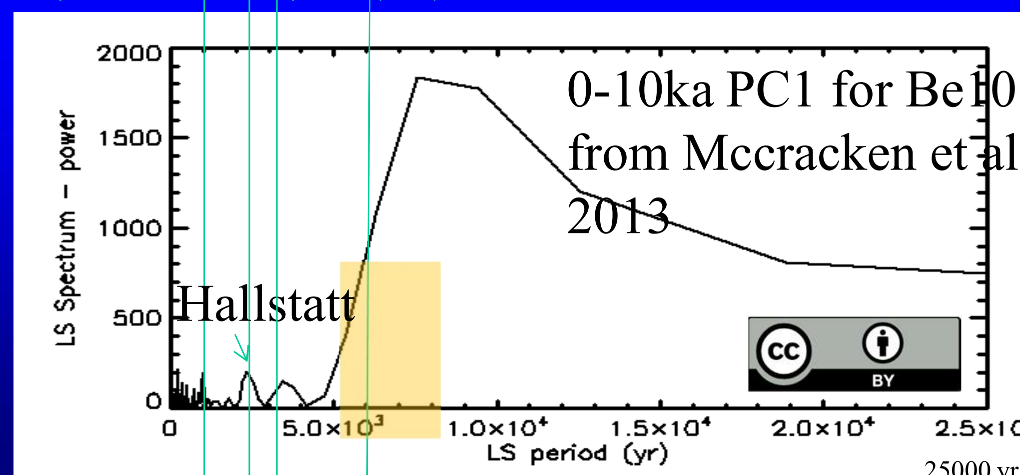
Compare spectra of Murray Canyon segment 0-20kyr with spectrum of 0-20ka segment of EDML d18O





Compare spectra of0-20ka segment of EDML d18O with spectrum of PC1 of 0-10k Be10 record of McCracken et al 2013





CONCLUSIONS - ~6500 yr CYCLES

All 3 ocean sediment proxy temperature records 0-20ka show medium/strong spectral peak at ~6500 yr period.
Ditto EDML Antarctica d18O.
Ditto indication from the 10ka record of cosmic ray flux from 2013 (needs confirmation with a longer data set)
Suggests linkage between ~6500 yr global temperature cycles and cosmic rays. [Unlike the Milankovich periods 23ka-120ka.]

[Full data lengths - not included here - Murray Canyon & Iberian Margin sediment temperature proxies (UK'37) and EDML d18O 140k data lengths show very clear Milankovich periods 23k 41k and 100k year → consistent with solar insolation as driver of temp variation]

CONCLUSIONS – SHORTER PERIODS

2 of 3 Sediment proxy temperature records 0-20ka also show
- strong/medium **peak ~3200 yr** for temperature,
- ditto d18O
- ditto 2013 10Be data set

Okinawa trough proxy temperature records shows strong
Hallstatt **2300 yr peak**
- ditto 2013 10Be record
[NOT on d18O]

Iberian Margin and Murray Canyon proxy temperature records show
strong/medium Bond **1500 yr peak**
[NOT on d18O or 2013 10Be]

Okinawa trough proxy temperature records shows strong
Eddy **900-1200 yr** peaks
- ditto 2013 10Be record
- ditto 900-1200 yr peaks d18O

THE BURNING QUESTION?

Evidence for a ~6500 yr cycle in global temperature is strong
- possibly also in cosmic ray flux

Scafetta (2020) studied a range of periods created by planetary motion combinations – shows periods as long as the Bond cycle (1500 yr) and Hallstatt cycle (2300 yr), but none longer such as 3500 yr or 6500 yr cycles observed in this study

Could a ~6500 yr cycle be

a subharmonic of the Bond cycle? (4*1500 yr)

but the Bond cycle is not present in two of our deep ocean sediment examples where the 6500 yr cycle is present

a harmonic of a Milankovich period?, eg precession period 23000/3 years?

but not a clear multiple

& Milankovich periods relate to solar insolation variations not cosmic ray flux variations

a modulation from interaction of a pair of short periods?

high amplitudes makes this less likely

[ends]

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