

海洋热盐环流能决定人类文明走向吗？

大西洋热盐环流多百年际振荡与人类文明演变史

YANG Haijun (杨海军)^{1,2}, LI Yang (李洋)² and YANG Kunpeng (杨昆鹏)¹

¹Department of Atmospheric and Oceanic Sciences, Fudan University

²LaCOAS and Department of Atmospheric and Oceanic Sciences

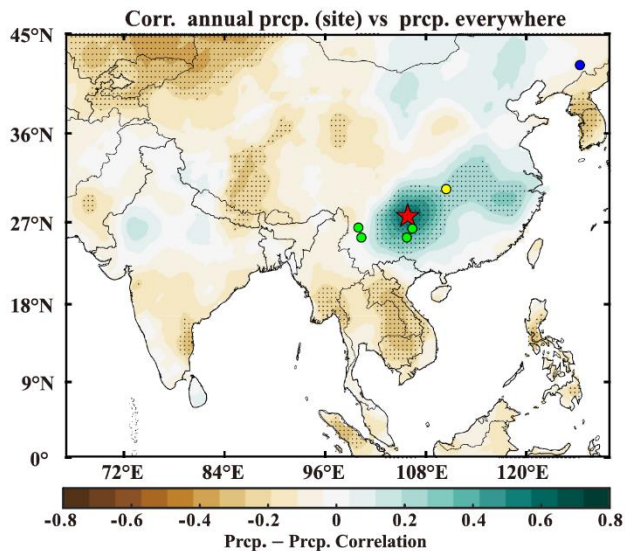
School of Physics, Peking University

Email: yanghj@fudan.edu.cn

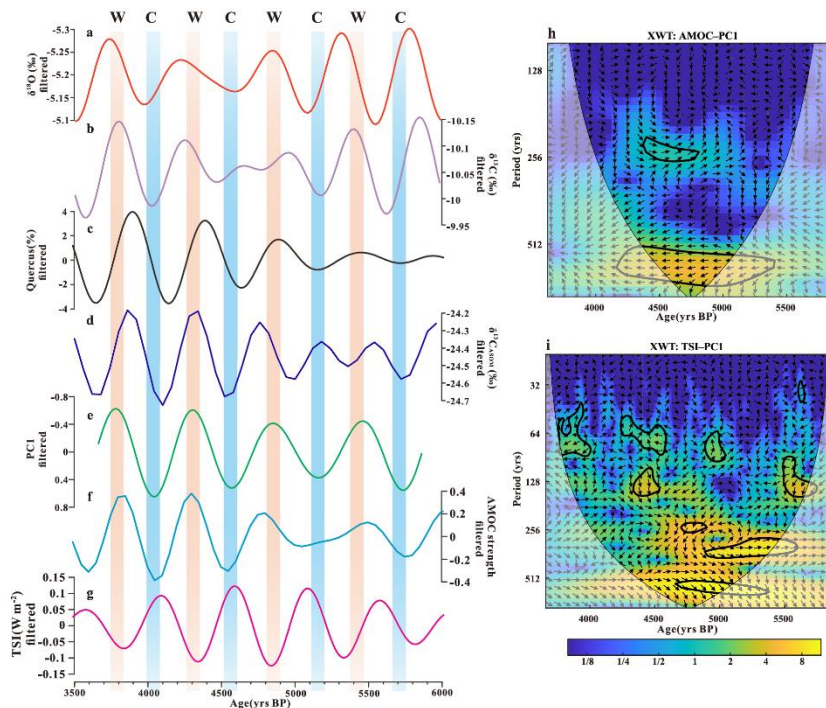


Records in China: 200-300 or 600 (?) Years

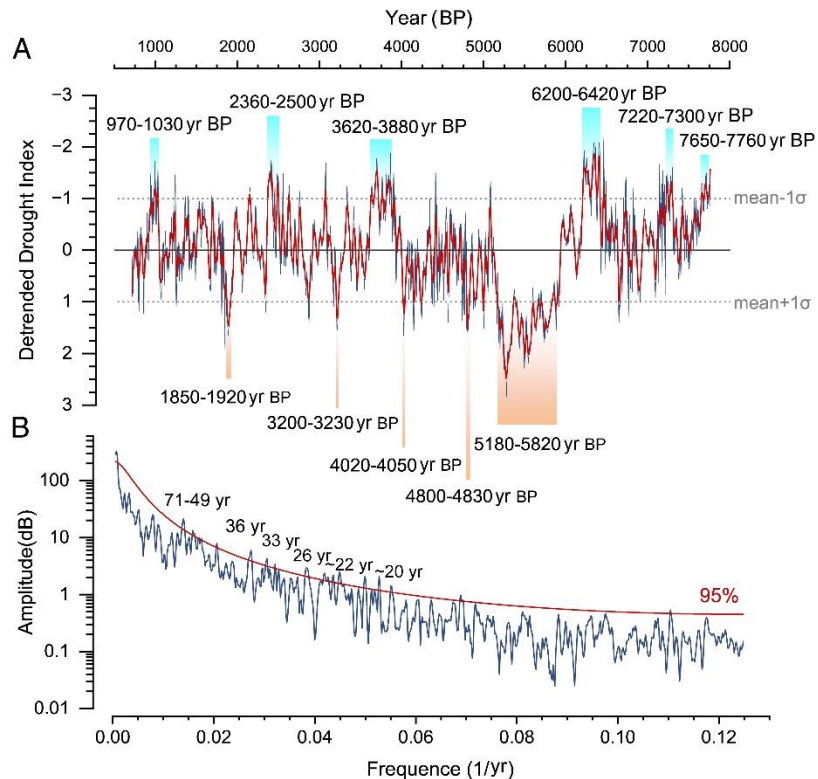
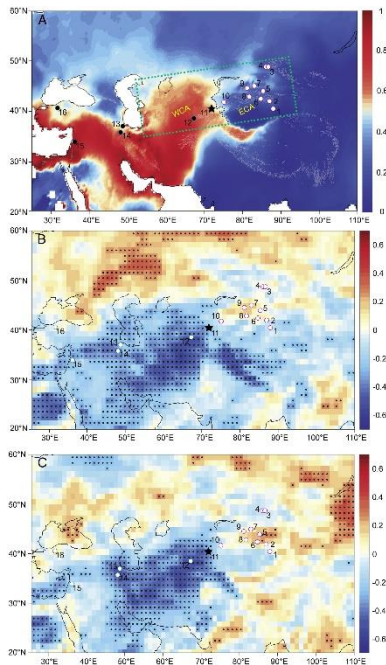
550-Year period during 6000-3500 BP on Yunnan-Guizhou Plateau



Li et al. 550-Year Climate Periodicity in the Yunnan-Guizhou Plateau During the Late Mid-Holocene: Insights and Implications. *GRL*, 2023, 10.1029/2023GL103523.

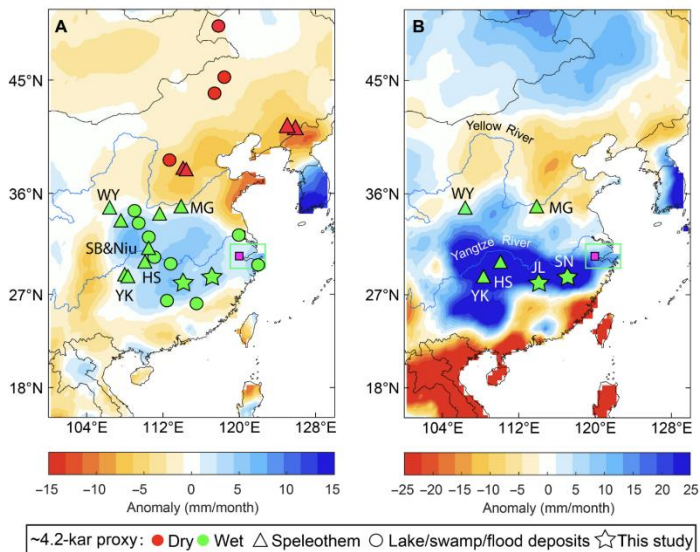


Records in Central Asia since 7800 BP

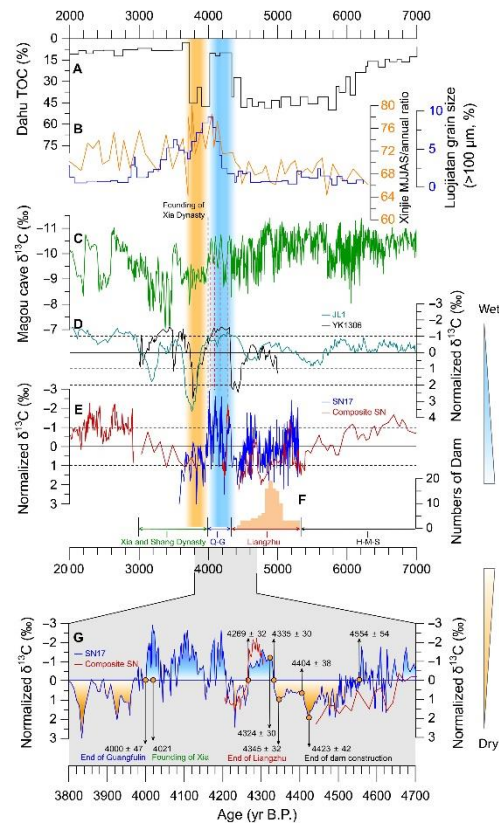


Tan et al., Hydroclimatic changes on multiple timescales since 7800 y BP in the winter precipitation-dominated Central Asia. *PNAS*, 2024,121 (14) e2321645121. <https://doi.org/10.1073/pnas.2321645121>

Records in China: Liangzhu Culture (5300-4300 BP)



Zhang et al. Collapse of the Liangzhu and other Neolithic cultures in the lower Yangtze region in response to climate change. *Sci. Adv.*, 2021, 10.1126/sciadv.abi9275.

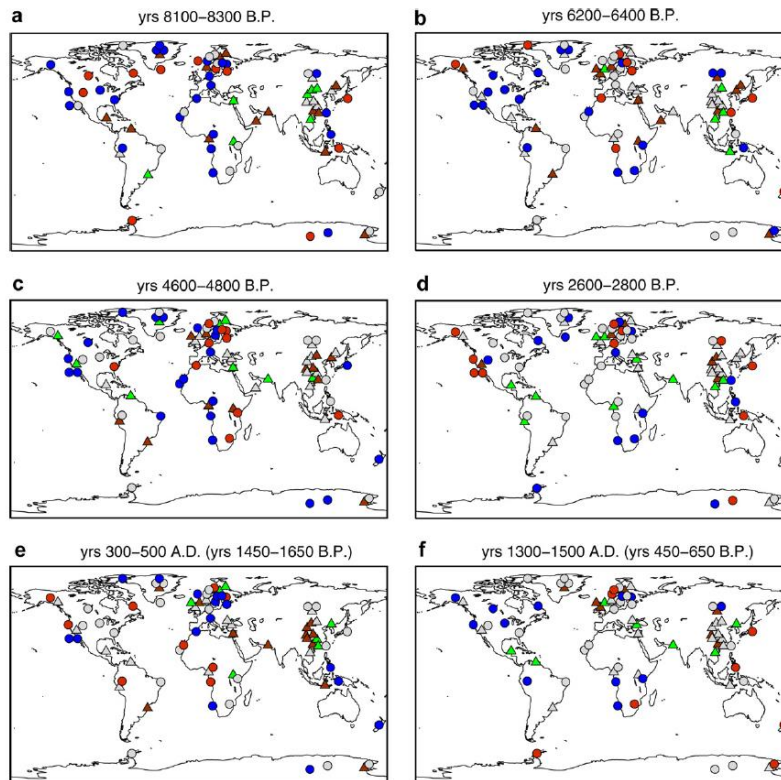
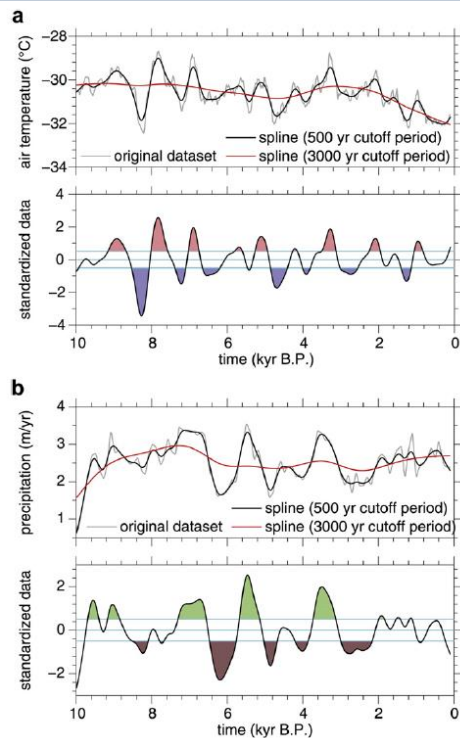


理解中华文明之演变：我们能做什么？

- 建立基础性理论 (Done)
- 地球气候系统模式模拟过去5000年以来的气候演变 (Ongoing)
- 降尺度区域耦合气候模式模拟大中华区域的天气与气候 (Planing)
- 解释过去5000年人类文明之演变：How to make stories?

Reconstructions (Wanner et al. 2011)

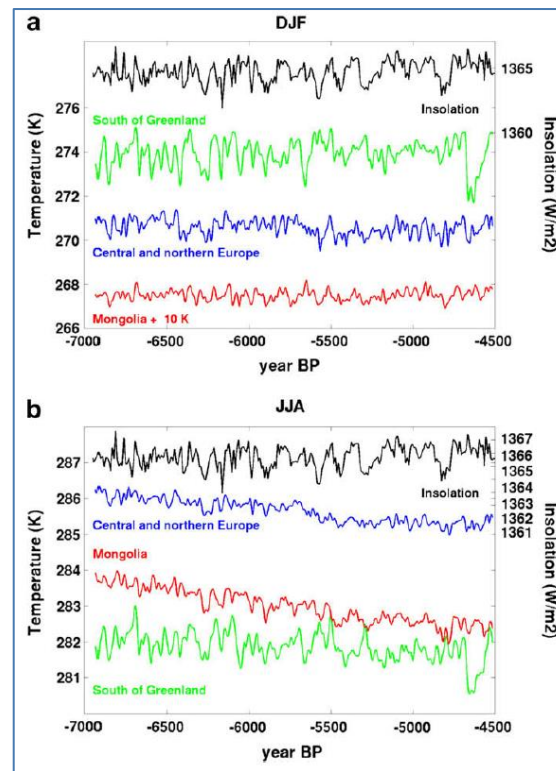
Not so good for model validation



Simulating the Holocene Climate

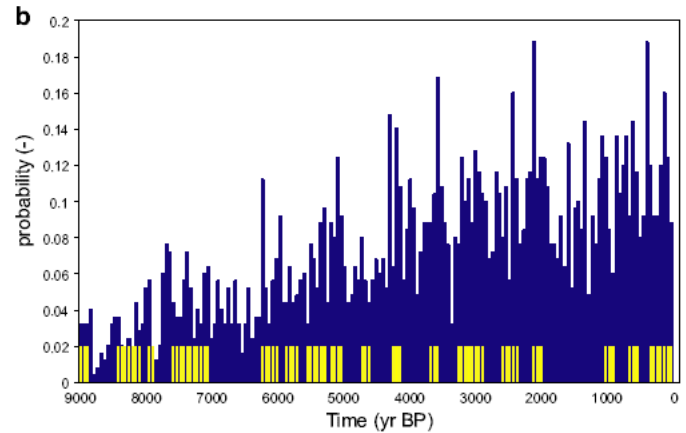
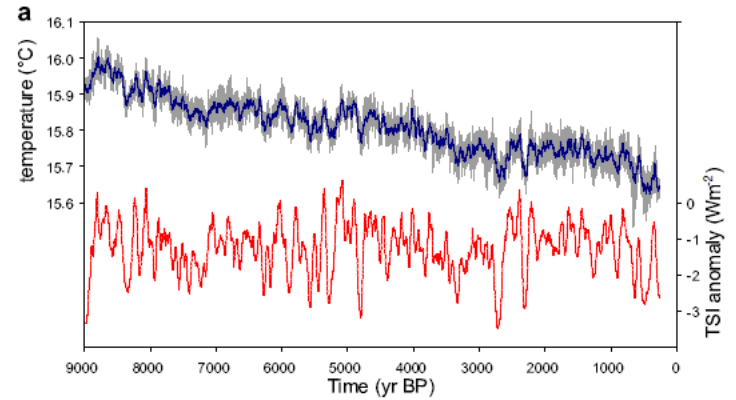
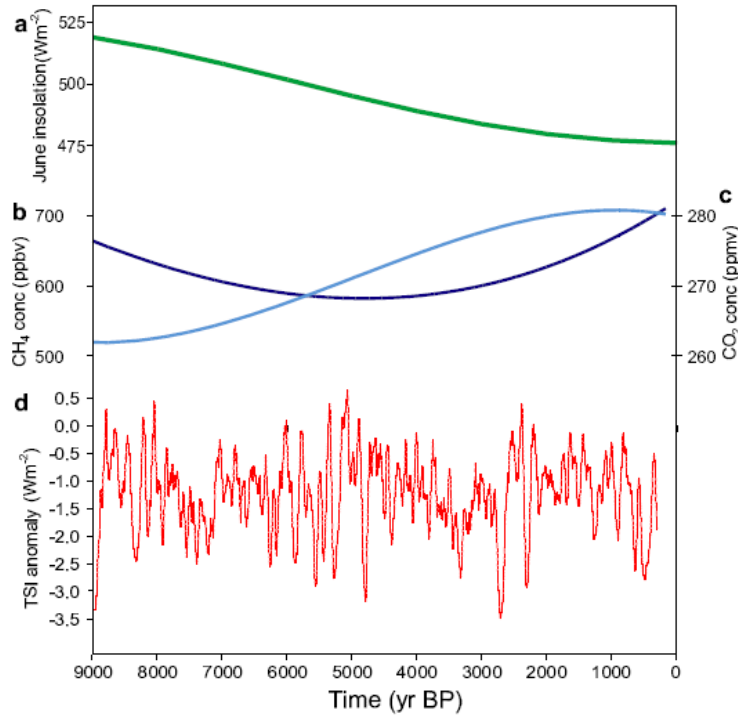
Most focus on the specific time slices (PMIPs; Wagner et al. 2007, 2008), or use acceleration techniques (Lorenz and Lohmann 2004; Timm and Timmermann 2007), or use intermediate complexity models (Weber 2001; Renssen et al. 2006; Bakker et al. 2017), due to the expensive computational costs.

shown in Fig. 15. A more comprehensive analysis can be found in Wagner et al. (2008), where increased spectral power on multi-decadal timescales, in accordance with other studies, was found. Although the simulation is too short to allow a meaningful spectral analysis on multi-centennial to millennial timescales, a qualitative visual inspection of the regional temperatures can give some indication whether cyclicities on these timescales are simulated. Boreal summer and winter temperatures south of Greenland show strong centennial variability, which dominates multi-centennial and longer components. In addition to this centennial variability,



(Wanner et al. 2008)

Transient simulation from 9000 BP by Renssen et al. 2006 using intermediate complexity model.



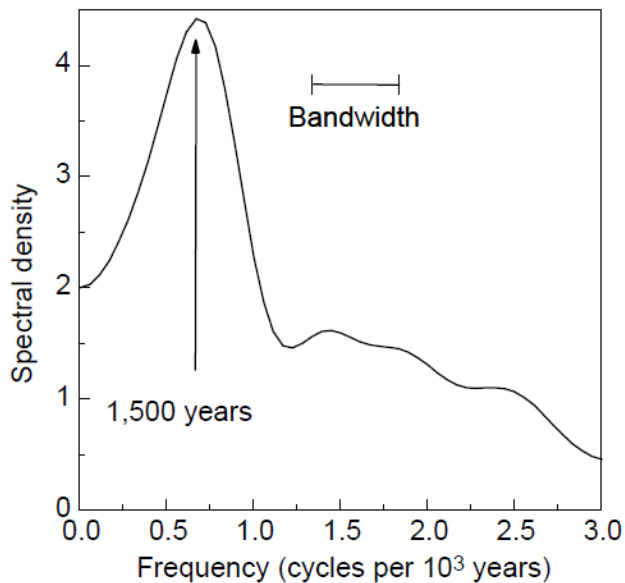
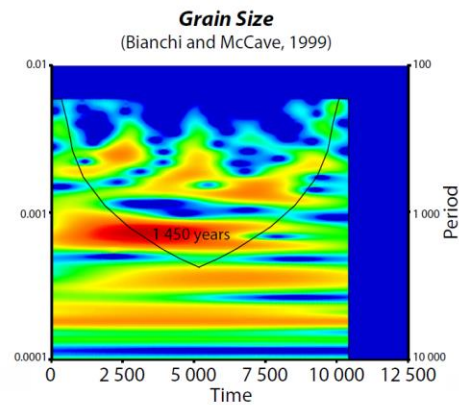
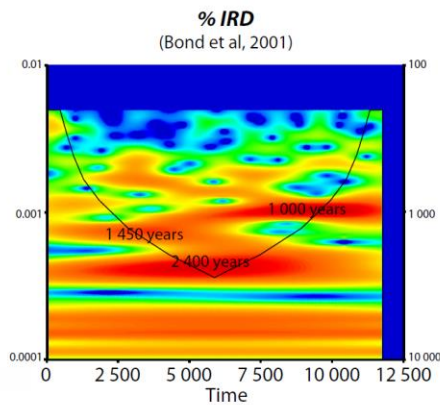
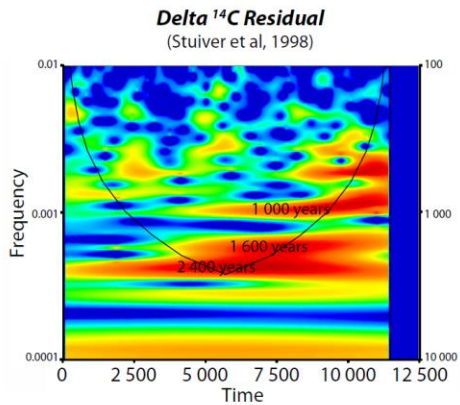


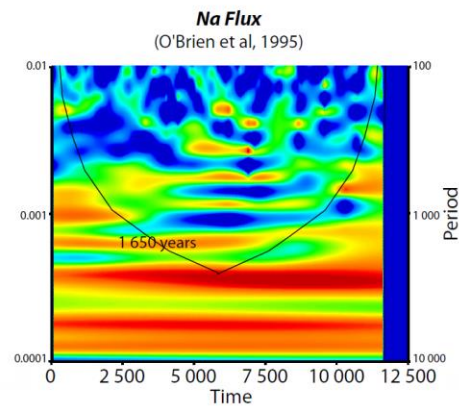
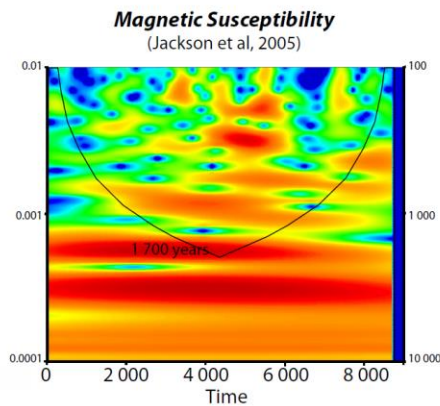
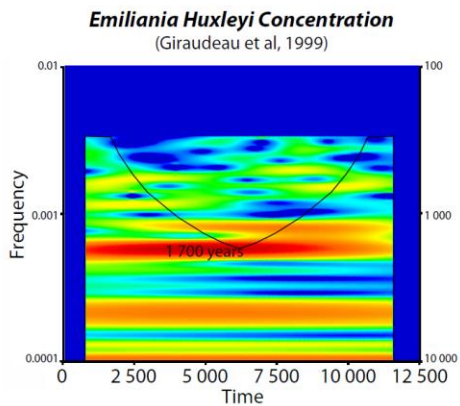
Figure 3 Spectral analysis by the Blackman-Tukey technique³⁴ of the sortable silt mean size record from NEAP-15K using data as shown in Fig. 2b. The 1,500-yr peak accounts for 26% of the total signal in the range above the Nyquist frequency ($1/180\text{ yr}^{-1}$) analysed (including red noise).

So far, no clear 1500-yr periodicity in ice cores, **an oceanic internal oscillation** in “conveyor” strength is more probable a forcing mechanism than solar variation. (Bianchi and McCave, 1999, Nature)

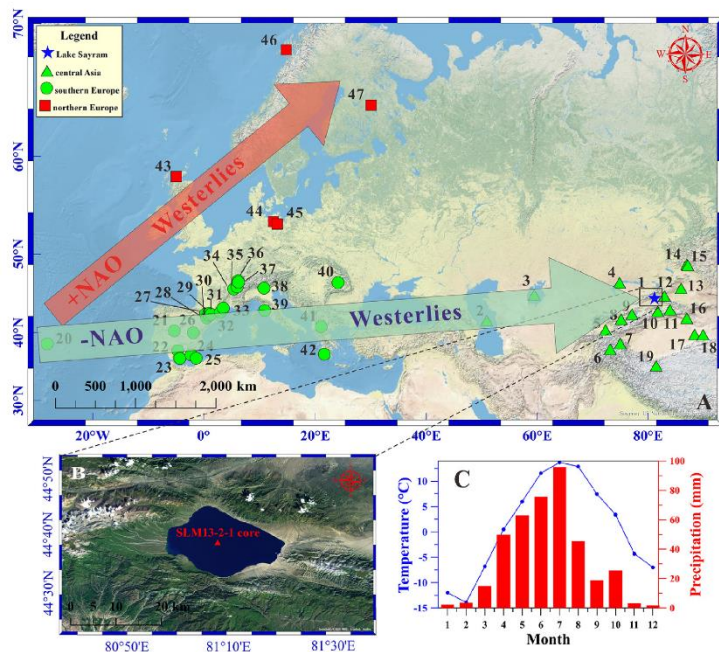
The broad peak centred at 1500-yr has been attributed to **ocean dynamics**. (Thornalley et al, 2009, Nature; Debret et al, 2007, CP)



Debret et al, 2007, CP



Millennial Variability- Bond Cycle: ~1500 (?) Years



Lan et al. (2020)



Contents lists available at ScienceDirect

Quaternary Science Reviews

journal homepage: www.elsevier.com/locate/quascirev



Late Holocene hydroclimatic variation in central Asia and its response to mid-latitude Westerlies and solar irradiance

Jianghu Lan ^{a,b,**}, Jin Zhang ^{c,*}, Peng Cheng ^{a,b}, Xiaolin Ma ^{a,b}, Li Ai ^{a,b}, Sakonvan Chawchai ^d, Kang'en Zhou ^{a,c}, Tianli Wang ^{a,c}, Keke Yu ^f, Enguo Sheng ^g, Shugang Kang ^{a,b}, Jingjie Zang ^a, Dongna Yan ^{a,e}, Yaqin Wang ^a, Liangcheng Tan ^{a,b,h}, Hai Xu ^{c,b}

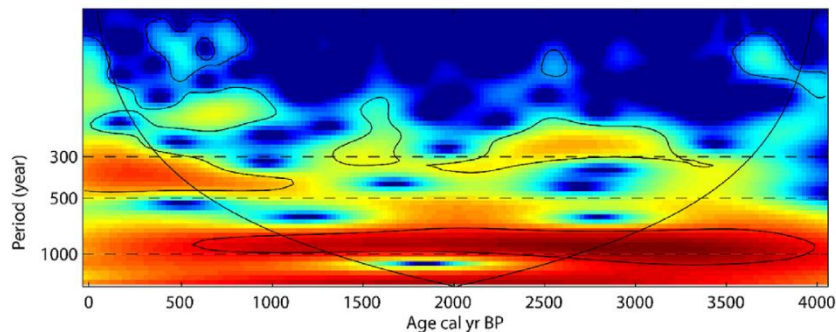
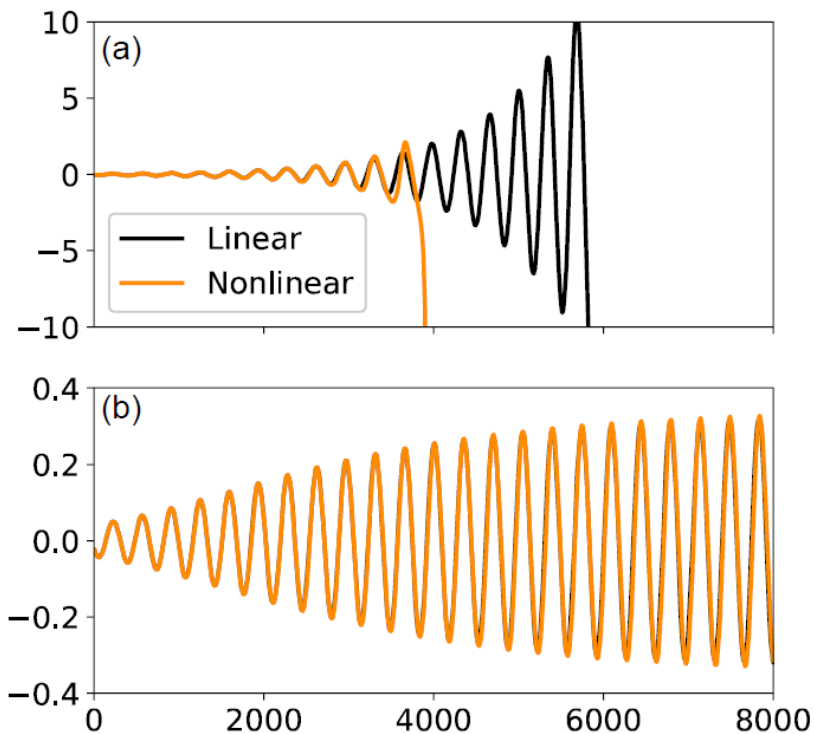


Fig. 7. Evolutionary spectral analysis of hydroclimatic variations recorded by $\delta^{13}\text{C}_{\text{carb}}$ from Lake Sayram over the past 4000 years. Black lines indicate >90% significance levels.

Nonlinear Advection Effect

$$q'(S'_1 - S'_2)$$



Li and Yang (2022)

