HOCLAT

A web-based Holocene Climate Atlas

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Cover Picture: Delivery of the tithe (Pieter Brueghel, 1564-1638)
(http://alkmene.blog.de/2010/12/30/ach-s-immer-winter-waeren-10277039/)

1. Idea of the HOCLAT Atlas

The present interglacial, the Holocene, has sustained the growth and development of modern society (Wanner et al., 2008). It started about 11,700 years BP with a rapid transition from the cold period called Younger Dryas to a subsequent, generally warmer period that showed relatively small amplitudes in the reconstructed temperature (Alley et al., 1993), but larger ones in tropical precipitation records (Alverson et al., 2003). On the millennial timescale, the climate of the Holocene was strongly influenced by the decreasing (increasing) solar insolation in the Northern (Southern) Hemisphere summer (winter), leading to a southern shift of the Intertropical Convergence Zone (ITCZ) and a weakening of the Northern Hemisphere summer monsoon systems (Braconnot et al., 2007). On the multidecadal to multicentennial timescale, Holocene climate was variable and fluctuated between warm and cold, and humid and arid states (Mayewski et al., 2004). Based on existing high resolution proxy data the Holocene Climate Atlas (HOCLAT) provides an overview on the spatiotemporal variability of these fluctuations.

HOCLAT is based on 46 temperature and 35 humidity/precipitation timeseries (Table 1 and 2), obtained from different proxy archives*. These proxy based reconstructions are associated with different methodological problems. First, a suitable age model has to ensure a satisfactory temporal assignment of the data. Second, the proxy has to allow an accurate estimation of the climate state variable. Third, we have to consider that many timeseries comprise a high amount of regional or local climate variability. Finally, we have to accept that many data sets only represent seasonal climate signals, even when their resolution is multiannual to multidecadal.

We tried to select high quality proxies with a high temporal resolution, and to use a clear and simple statistical procedure (see description in section 2). We did not use any interpolation procedure. Section 3 shows the analysed graphics of all timeseries, and section 4 represents the anomaly maps. A detailed description of the data including the analysis of important Holocene cold events can be found in:

Wanner, H., Solomina, O., Grosjean, M., Ritz, S.P., Jetel, M., 2011. Structure and origin of Holocene cold events. Submitted.

* *We warmly thank our colleagues for providing us the different data sets!*

2. Data and methods

The selection of the temperature and humidity/precipitation timeseries was undertaken based on the available literature. In the case of questionable quality of a data set the decision of whether to accept or reject the data was made after thorough discussion within our team or with the corresponding author. Only records with a clearly defined methodology, an average resolution better than 160 years, and a temporal coverage of at least 70% of the defined Holocene period (10,000 – 0 years BP) were used. The restriction to the last 10,000 years was chosen due to the small data availability prior to this period. Table 1 and 2 show the lists of the temperature and humidity/precipitation proxies, including their characteristic features. More detailed descriptions can be found in the cited references. It must be recognized that some timeseries only represent seasonal temperature or humidity/precipitation values. In this case the assessment of the annual mean value is restricted.

Since the focus of HOCLAT is on centennial-scale changes, high-frequency variability was eliminated by applying a spline-fit according to Enting (1987) with a cut-off frequency of 1/500 yr^{-1}. Low-frequency variability was removed by detrending every data set using a spline-fit with 1/3000 yr^{-1} cut-off frequency. We statistically define a cold period as the time span where temperature proxy values fall below one half of a standard deviation of the Holocene mean value (thus, approximately 30% of the data is within a cold period; see the blue segments in the graphics of section 3.1.). Analogously, warm periods are defined (red segments). Humidity proxy data was processed in the same way in order to detect dry and humid periods (brown and green segments in section 3.2.). Section 4 shows the 100 anomaly maps with the 100 year averages of temperature and humidity/precipitation between 10,000 years BP and the present. In case of a high spatial density some data points had to be slightly shifted.

As mentioned above, Tables 1 and 2 (following 3 pages) list the proxy data represented in sections 3 and 4, together with a short description of the characteristics of the data.

Table 1

	Type of temperature proxy	Record	Region	~Lat (deg)	~Long(deg)	~Re	Reference
1	Pollen (air temp., °C)	Lake sediment core	Sweden	60.83	15.83	108	Antonsson et al. (2006)
2	Chironomidae (July air temp., °C)	Lake sediment core	Sweden	68.37	18.7	79	Larocque and Hall (2004)
3	Pollen (July air temp., °C)	Lake sediment core	Finland	68.68	22.08	68	Seppä and Birks (2001)
4	Pollen (July air temp., °C)	Lake sediment core	Sweden	69.2	21.47	60	Seppä and Birks (2002)
5	Foram. MAT (August SST, °C)	Sea sediment core	Norway	66.97	7.63	72	Risebrobakken et al. (2003)
6	Pollen (Air temp., °C)	Lake sediment core	Finland	61.48	26.07	73	Heikkilä and Seppä (2003)
7	Pollen (Air temp., °C)	Lake sediment core	Sweden	58.55	13.67	98	Seppä et al. (2005)
8	Uk37 (SST, °C)	Sea sediment core	Gulf of Guinea	-5.6	-36.6	138	Schefuss et al. (2005)
9	Uk37 (SST, °C)	Sea sediment core	South China Sea	20.12	117.38	143	Pelejero et al. (1999)
10	Mg/Ca (SST, °C)	Sea sediment core	Southeast Atlantic	-25.5	13	104	Farmer et al. (2005)
11	Pollen (July air temp., °C)	Fossil pollen records	North America	57	-63	99	Viau et al. (2006)
12	Pollen (July air temp., °C)	Fossil pollen records	North America	55	-106	99	Viau et al. (2006)
13	Pollen (July air temp., °C)	Fossil pollen records	North America	43	-95	99	Viau et al. (2006)
14	Pollen (July air temp., °C)	Fossil pollen records	North America	64	-142	99	Viau et al. (2006)
15	Pollen (July air temp., °C)	Fossil pollen records	North America	35	-81	99	Viau et al. (2006)
16	Pollen (July air temp., °C)	Fossil pollen records	North America	37	-115	99	Viau et al. (2006)
17	Uk37 (Air temp., °C)	Sea sediment core	North West Africa	20.75	-18.58	80	Zhao et al. (1995)
18	d18O (Air temp., °C)	Ice core	GISP2, Greenland	72	-38	13	Alley (2000)
19	d18O from ostracods (‰)	Lake sediment core	Germany	47.1	11	35	von Grafenstein (1999)
20	Uk37 (SST, °C)	Sea sediment core	Mediterranean	36.13	-2.62	120	Cacho et al. (2001)
21	Uk37 (SST, °C)	Sea sediment core	North Pacific	41.68	-124.93	129	Barron et al. (2003)
22	Mg/Ca (SST, °C)	Sea sediment core	Equatorial Pacific	6.3	125.83	49	Stott et al. (2007)
23	Mg/Ca (SST, °C)	Sea sediment core	Equatorial Pacific	-5	133.45	49	Stott et al. (2007)
24	Radiolarian (Summer SST, °C)	Sea sediment core	Nordic Sea	63.1	2.6	81	Dolven et al. (2002)
25	Mg/Ca (SST, °C)	Sea sediment core	Gulf of Guinea	2.5	9.38	40	Weldeab et al. (2007)
26	F13 (warm season SST, °C)	Sea sediment core	Subtropical Atlantic	20.75	-18.58	104	deMenocal et al. (2000)
27	d18O (‰)	Speleothem	South Africa	-24.02	29.18	10	Holmgren et al. (2003)
28	dD (Temp. anomaly, °C)	Ice core	Vostok, Antarctica	-78	106	44	Petit et al. (1999)
29	dD (Temp., °C)	Ice core	EPICA Dome C, Antarctica	-75	123	18	Jouzel et al. (2007)
30	d18O (G. Bulloides, ‰)	Sea sediment core	Northeast Pacific	34.27	-120.07	14	Friddell et al. (2003)
31	d18O (N. Pachyderma, ‰)	Sea sediment core	Northeast Pacific	34.27	-120.07	14	Friddell et al. (2003)
32	d18O (‰)	Ice core	GRIP, Greenland	72	-37	4	Johnsen et al. (1997)
33	d18O (‰)	Speleothem	New Zealand	-41.33	172.22	40	Williams et al. (2005)
34	dD (‰)	Ice core	Taylor Dome, Antarctica	-77.8	158.72	30	Steig et al. (1998)
35	Soil bacteria (annual mean air temp., °C)	Lake sediment core	Congo River Basin	-5.58	11.22	136	Weijers et al. (2007)
36	d18O (‰)	Ice core	NGRIP, Greenland	76	-42	20	Vinther et al. (2006)
37	d18O (‰)	Ice core	Huascaran (Peru)	-9	-77.5	99	Thompson et al. (1995)
38	d18O (‰)	Ice core	Kilimanjaro	-3	37	50	Thompson et al. (2002)
39	d18O (‰)	Ice core	Agassiz ice cap	80	-73	25	Fisher and Koerner (1994)
40	Pollen (Coldest month temp., °C)	Lake sediment core	Lake Bajkal	52.78	108.12	130	Tarasov et al. (2009)

41	Pollen (Warmest month temp., °C)	Lake sediment core	Lake Bajkal	52.78	108.12	130	Tarasov et al. (2009)
42	(Summer SST, °C)	Sea sediment core	North Atlantic	60	-37	12	Mayewski et al. (2004)
43	TEX86 (SST, °C)	Sea sediment core	Antarctica	-64.86	-64.2	96	Shevenell et al. (2007)
44	d18O (Temp., °C)	Speleothem	Norway	66.62	13.68	34	Lauritzen et al. (1999)
45	Pollen (Annual mean air temp., °C)	Lake sediment core	Estonia	58.58	26.65	98	Seppä and Poska (2004)
46	Uk37 (SST, °C)	Sea sediment core	North Pacific	36.03	141.78	66	Isono et al. (2009)

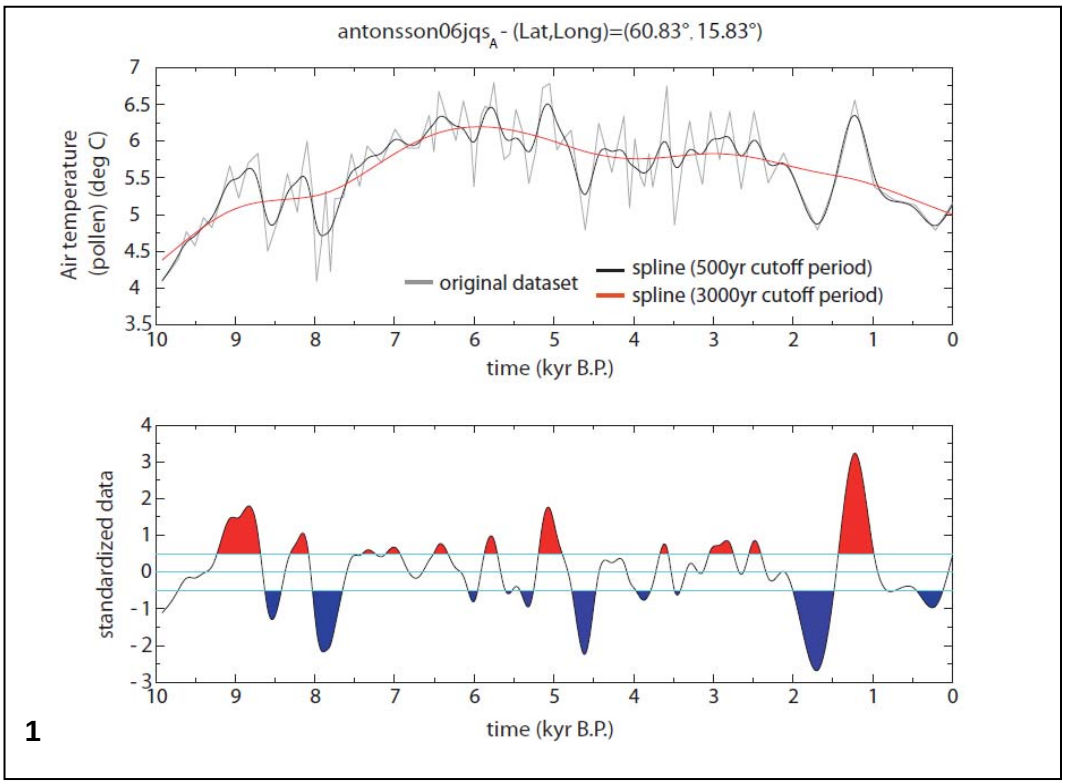
Table 2

	Type of humidity/precipitation proxy	Record	Region	~Lat(deg)	~Long(deg)	~Re	Reference
1	Accumulation rate (m ice/yr)	Ice core	GISP2, Greenland	72	-38	29	Alley (2000)
2	d18O (‰)	Lake sediment core	Canada	60.35	-134.8	22	Anderson et al. (2005)
3	Winter precipitation (% of present winter precipitation)	Lake sediment core	Norway	69.73	19.98	99	Bakke et al. (2005)
4	d18O (‰)	Speleothem	Oman	17.17	54.3	6	Fleitmann et al. (2007)
5	d18O (‰)	Speleothem	Oman	24.62	65.98	16	Staubwasser et al. (2003)
6	d18O (‰)	Speleothem	Dongee Cave, China	25.28	108.83	4	Wang et al. (2005)
7	d18O (‰)	Speleothem	Dongge Cave, China	25.28	108.83	15	Dykoski et al. (2005)
8	Ti (%)	Sea sediment core	Cariaco Basin	10.7	-65.17	6	Haug et al. (2001)
9	Precipitation (cm/yr)	Tree rings	Nevada, USA	37	-117	1	Hughes and Graumlich (1996)
10	Indian Ocean summer monsoon d13C (‰)	Peat bog sediment core	China	32.77	102.5	88	Hong et al. (2005)
11	East Asian summer monsoon d13C (‰)	Peat bog sediment core	Northeast China	42.22	126.52	24	Hong et al. (2005)
12	Plant macrofossil; detrended correspondence analysis (axis 1 scores)	Peat bog sediment core	Scotland	55.83	-3.43	75	Langdon (2003)
13	Humification residuals (absorbance at 540 nm)	Peat bog sediment core	Scotland	55.83	-3.43	75	Langdon (2003)
14	Water table depth (cm)	Peat bog sediment core	Scotland	55.83	-3.43	79	Langdon (2003)
15	Precipitation (mm/yr)	Lake sediment core	Finland	69.2	21.47	60	Seppä and Birks (2002)
16	Relative lake level (Diatom principal component)	Lake sediment core	Lake Victoria	0.08	32.8	39	Stager et al. (2002)
17	Ti (1/s)	Lake sediment core	Lake Huguang Maar, China	22.5	110.28	1	Yancheva et al. (2007)
18	Annual mean precipitation (mm/yr)	Lake sediment core	Lake Bajkal	52.78	108.12	130	Tarasov et al. (2009)
19	Precipitation (mm/yr); dig.	Lake sediment core	Norway	61.75	7	110	Nesje et al. (2001)
20	Accumulation rate (cm ice/yr)	Ice core	Taylor Dome, Antarctica	-77	158	160	Steig et al. (2000)
21	Clay layer frequency (layers/200 yr)	Sea sediment core	Black Sea	41.54	31.17	50	Lamy et al. (2006)
22	Clay layer frequency (layers/200 yr)	Sea sediment core	Black Sea	41.17	31.09	52	Lamy et al. (2006)

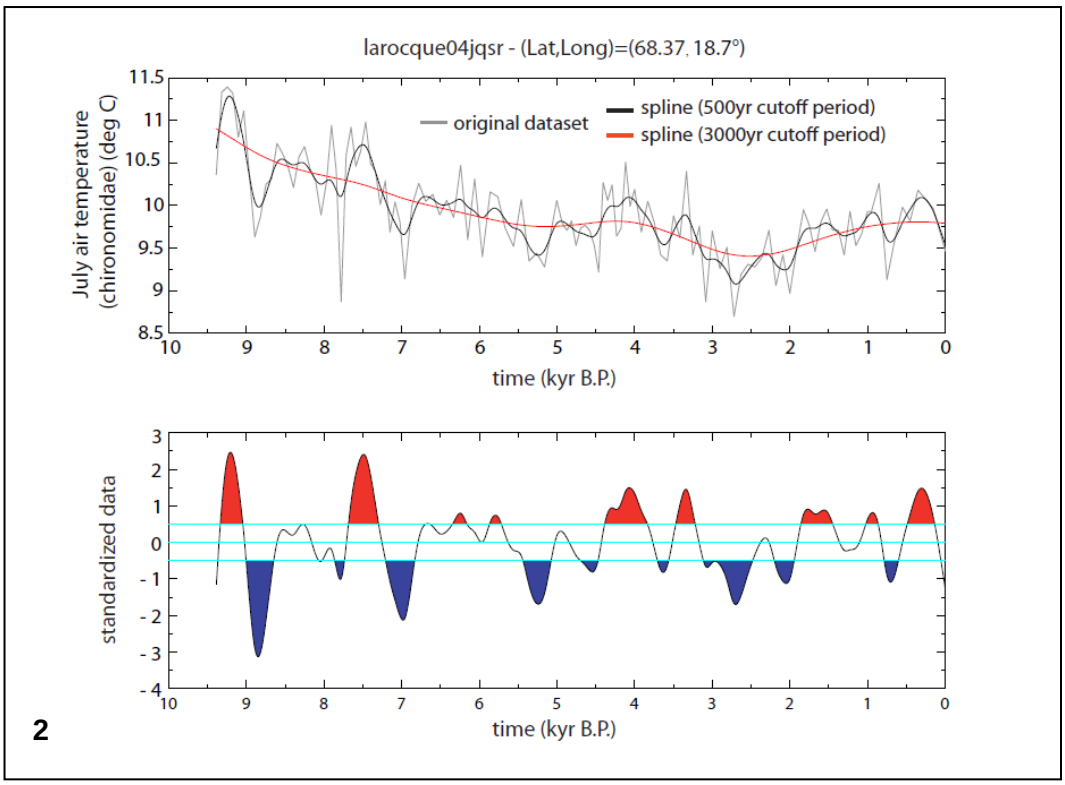
23	CaCO3 (%)	Lake sediment core	Lake Chichancanab, Mexico	19.87	-88.77	22	Hodell et al. (1995)
24	Magnetic IRM ((A/m))	Sea sediment core	Eastern Mediterranean	34.07	32.72	73	Larrasoaña et al. (2003)
25	d18O (‰)	Speleothem	Indonesia	-8.53	120.43	10	Griffiths et al. (2009)
26	d18O (‰)	Speleothem	Brazil	-27.22	-49.15	40	Wang et al. (2006)
27	Moisture index OUT OF d18O calcite and d18O ice (‰); dig.	Lake sediment core and ice core	Peru	-10	-76	143	Seltzer et al. (2000)
28	SSS (psu)	Sea sediment core	Gulf of Guinea	2.5	9.38	40	Weldeab et al. (2007)
29	d18O (‰)	Speleothem	China, Jiuxian Cave	33.57	109.1	10	Cai et al. (2010)
30	Precipitation (mm/yr); dig.	Speleothem	Heshang & Dongge Caves, China	28	110	110	Hu et al. (2008)
31	F-bSiO2 (g/m2 per year); dig.	Lake sediment core	Northeast China	42.28	126.6	63	Schettler et al. (2006)
32	Logarithm of pollen concentration (log(grains/g)); dig.	Lake sediment core	Northcentral, China	39	103.33	61	Chen et al. (2006)
33	Percentage of Picea and Pinus pollen (%); dig.	Lake sediment core	Northcentral, China	39	103.33	61	Chen et al. (2006)
34	d18O (‰)	Speleothem	China, Qixing Cave	26.07	107.25	70	Cai et al. (2001)
35	TOC (%); dig.	Lake sediment core	Mongolia	40.1	108.45	74	Chen et al. (2006)

3. Graphics of time series

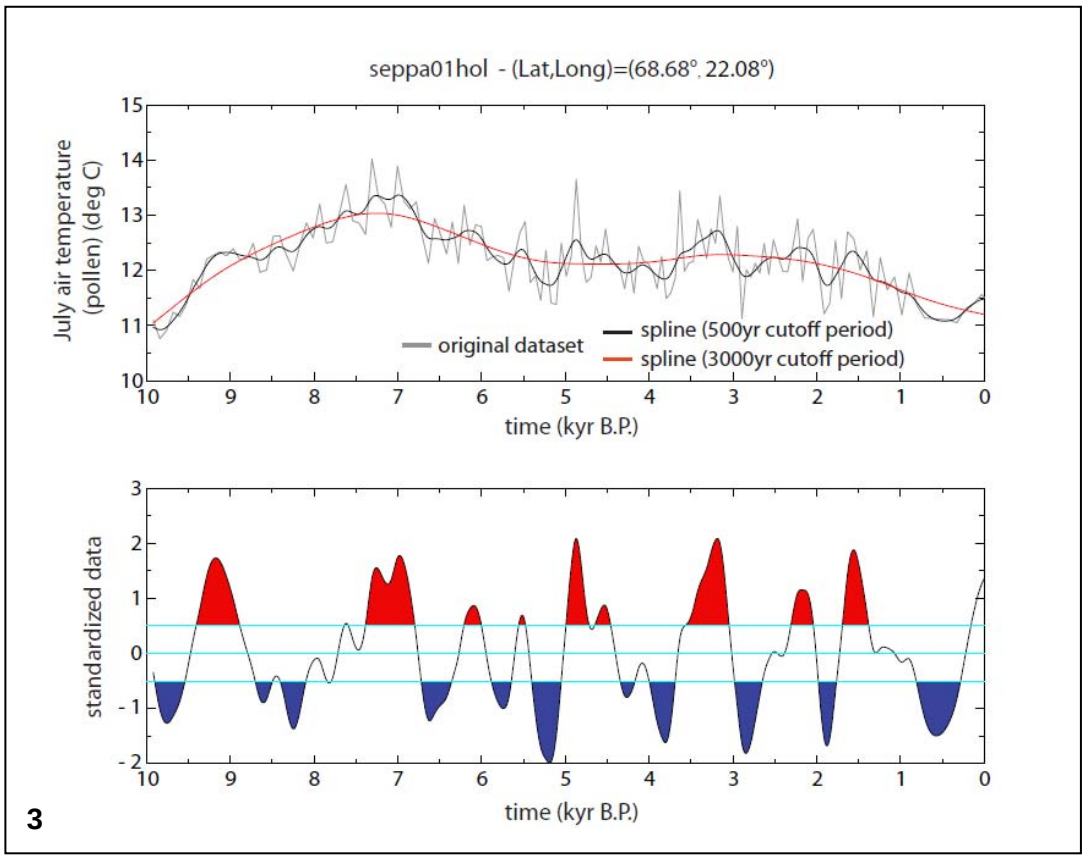
3.1. Temperature



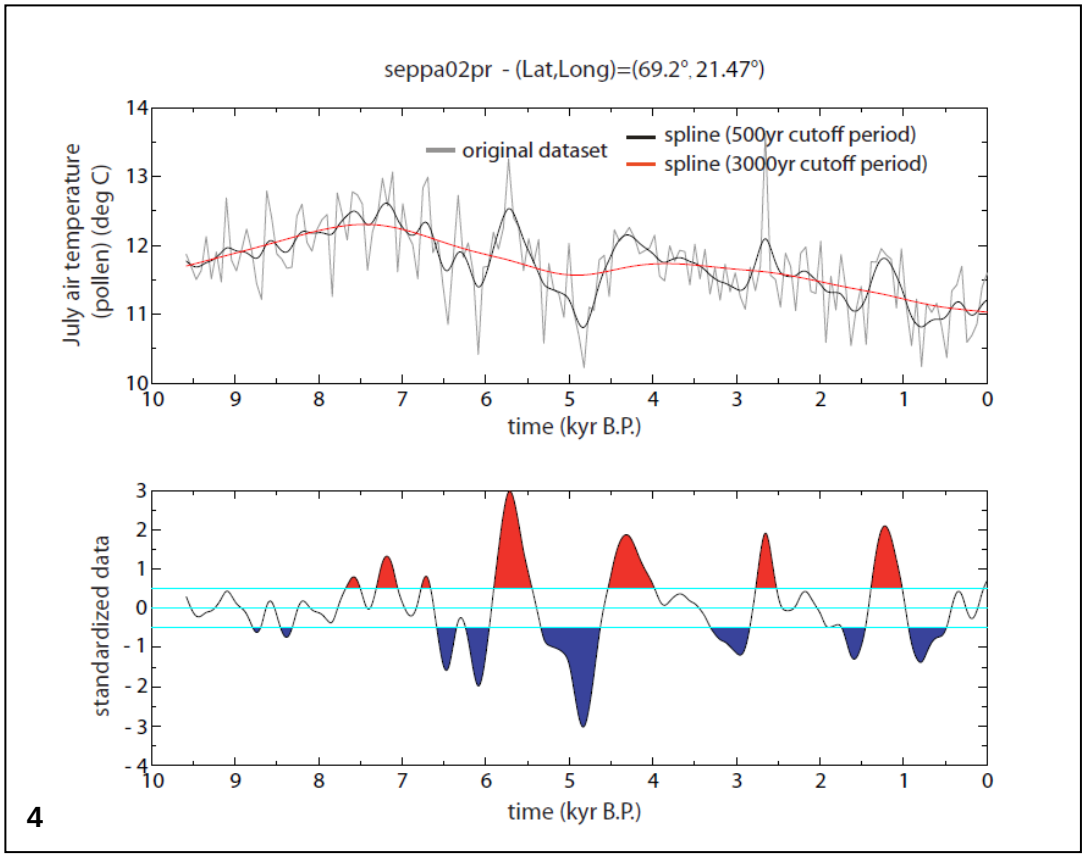
1



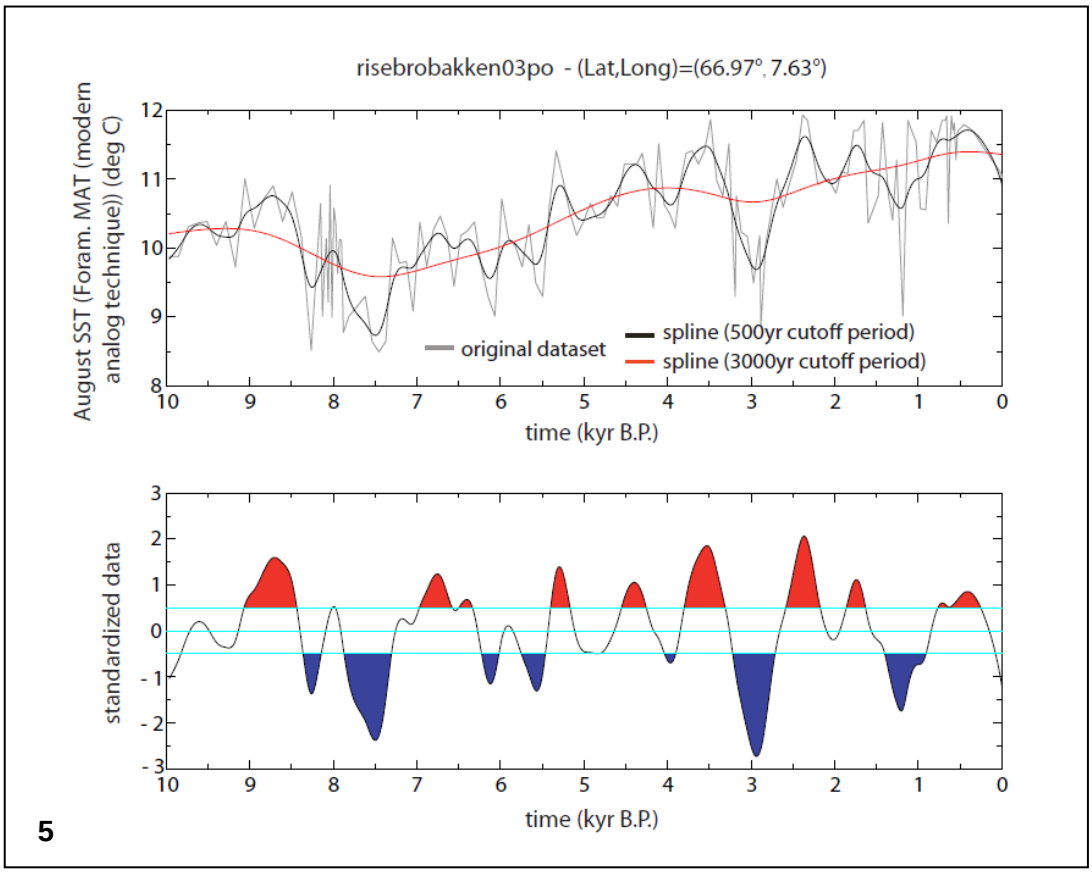
2


seppa01hol - (Lat,Long)=(68.68°, 22.08°)
July air temperature (pollen) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

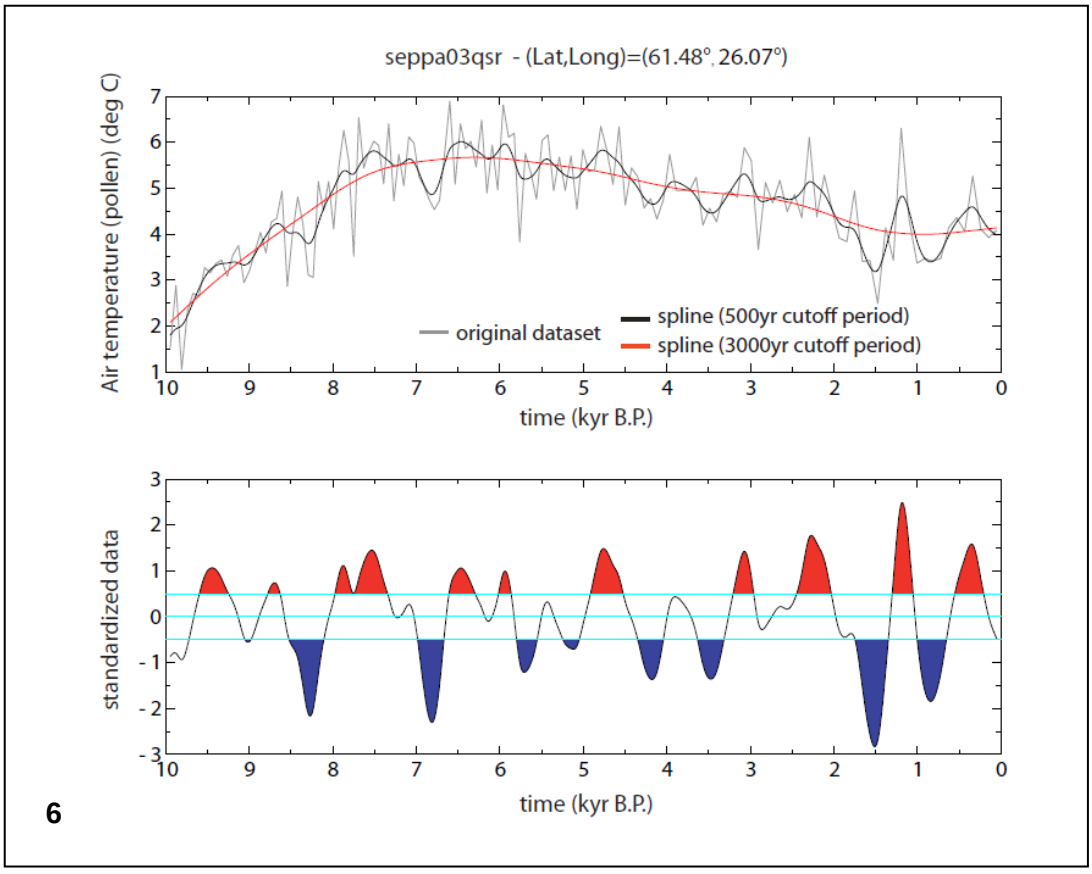
3


seppa02pr - (Lat,Long)=(69.2°, 21.47°)
July air temperature (pollen) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

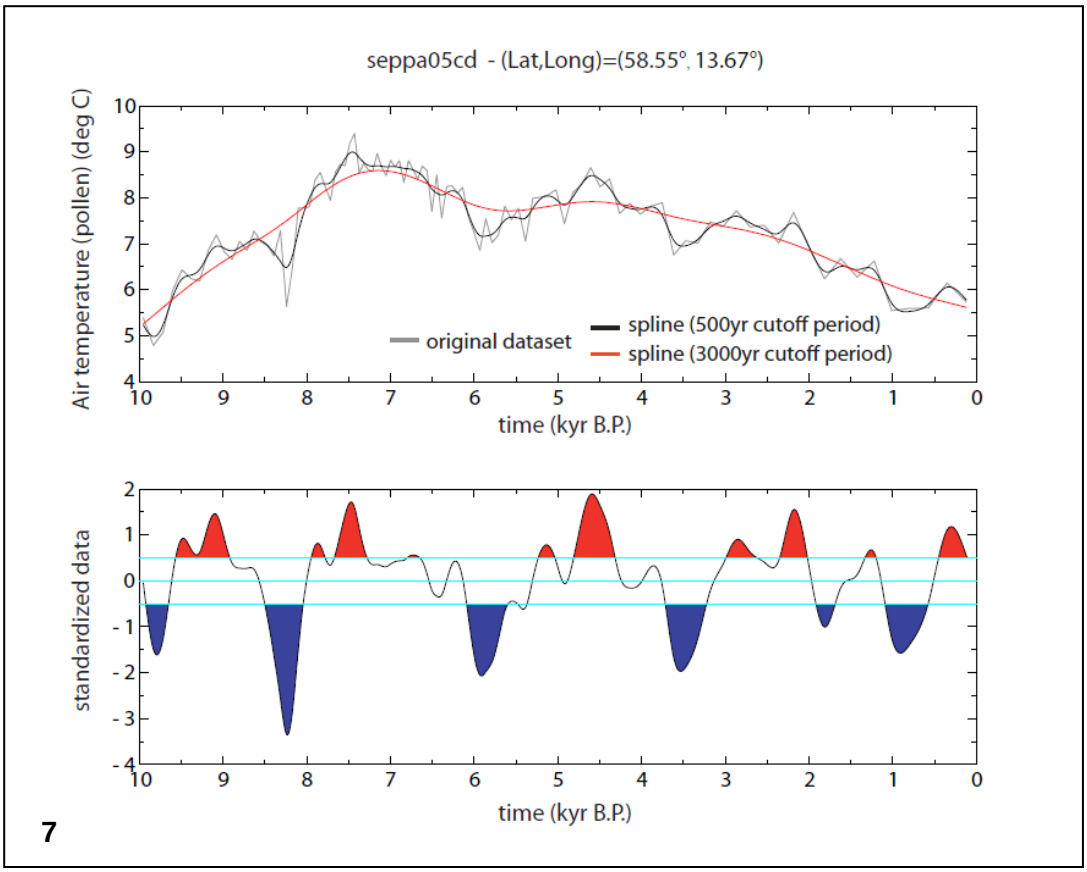
4


risebrobakken03po - (Lat,Long)=(66.97°, 7.63°)
August SST (Foram. MAT (modern analog technique)) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

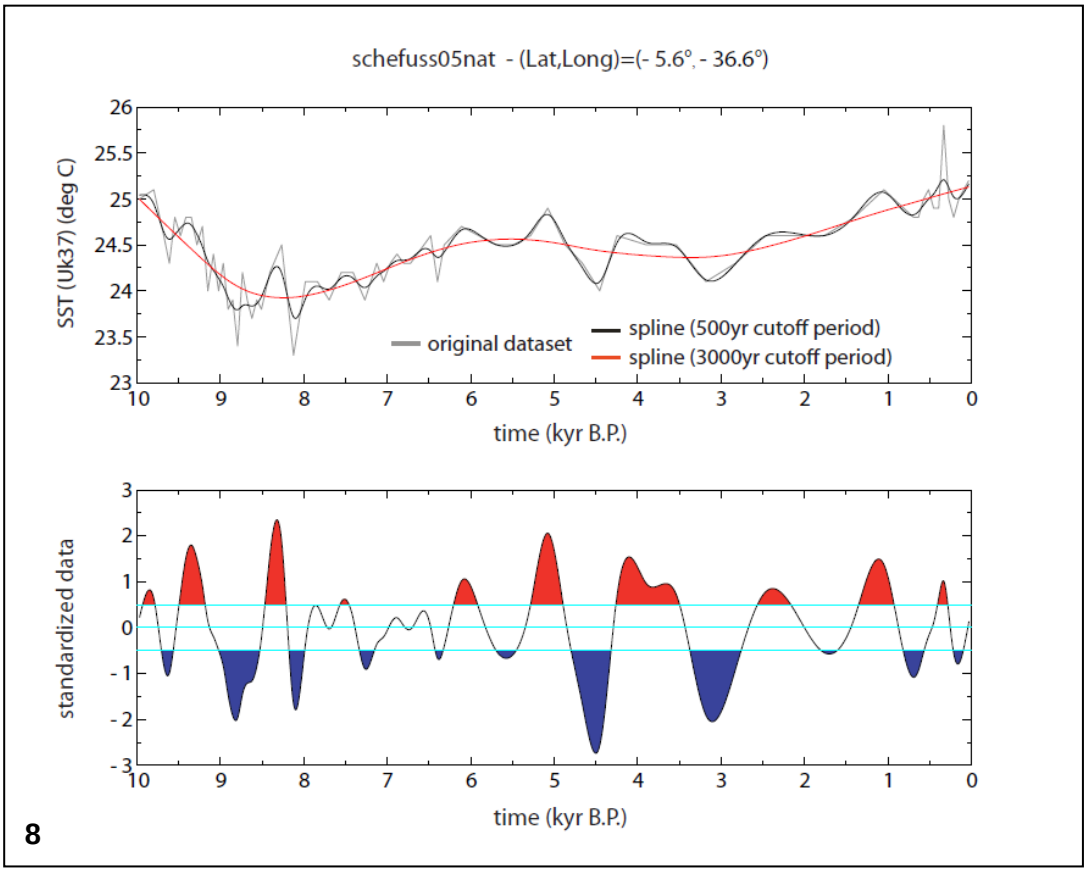
5


seppa03qsr - (Lat,Long)=(61.48°, 26.07°)
Air temperature (pollen) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

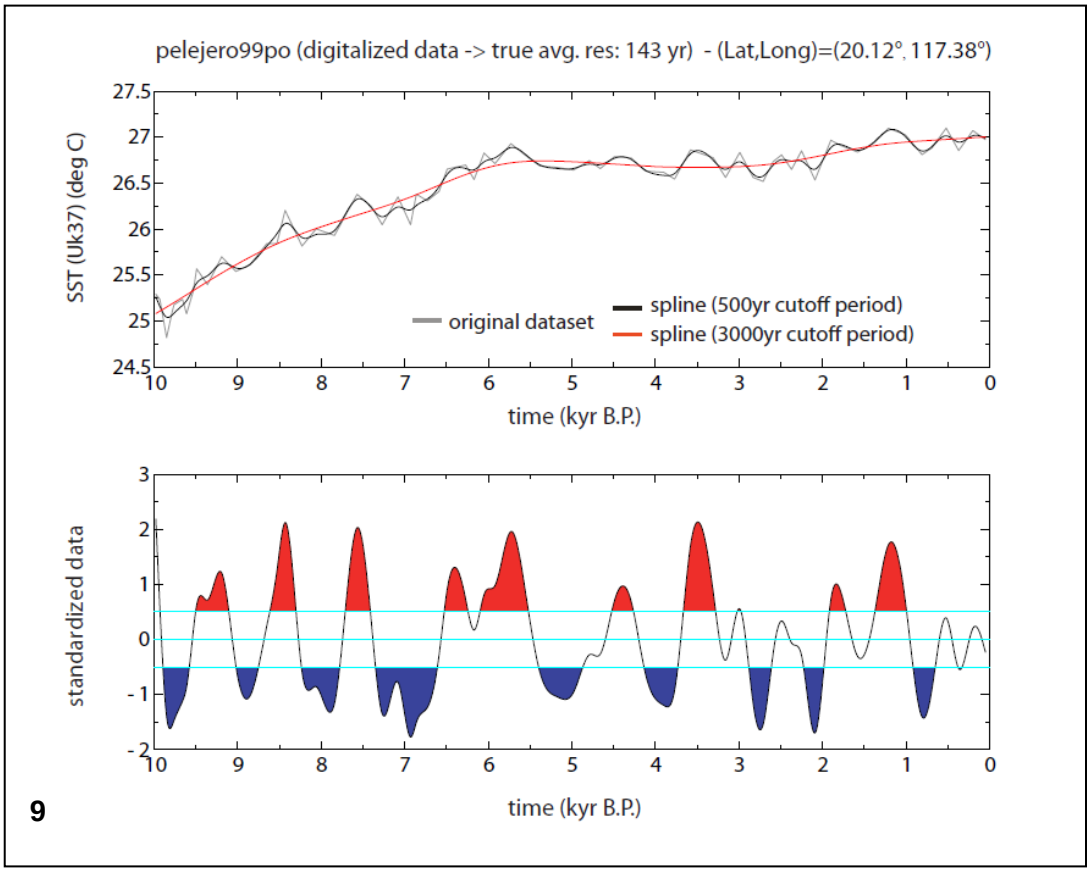
6


seppa05cd - (Lat,Long)=(58.55°, 13.67°)
Air temperature (pollen) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

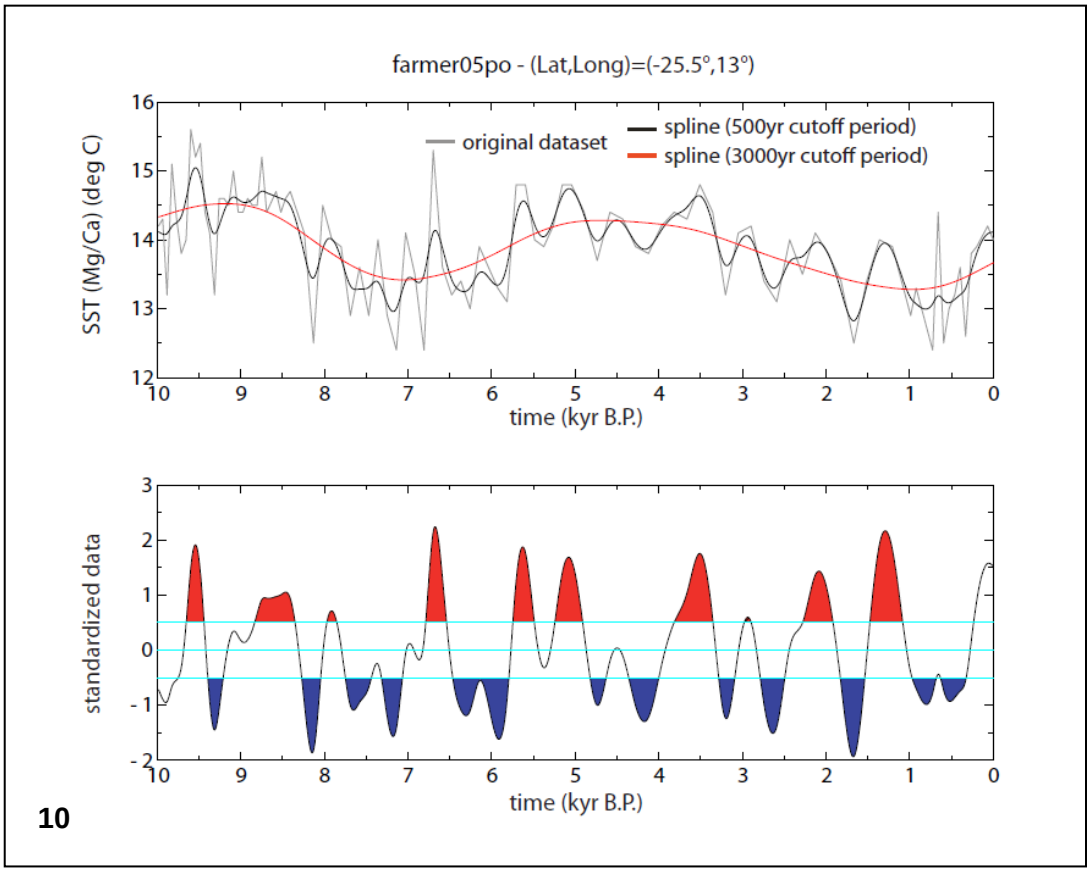
7


schefuss05nat - (Lat,Long)=(- 5.6°, - 36.6°)
SST (Uk37) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

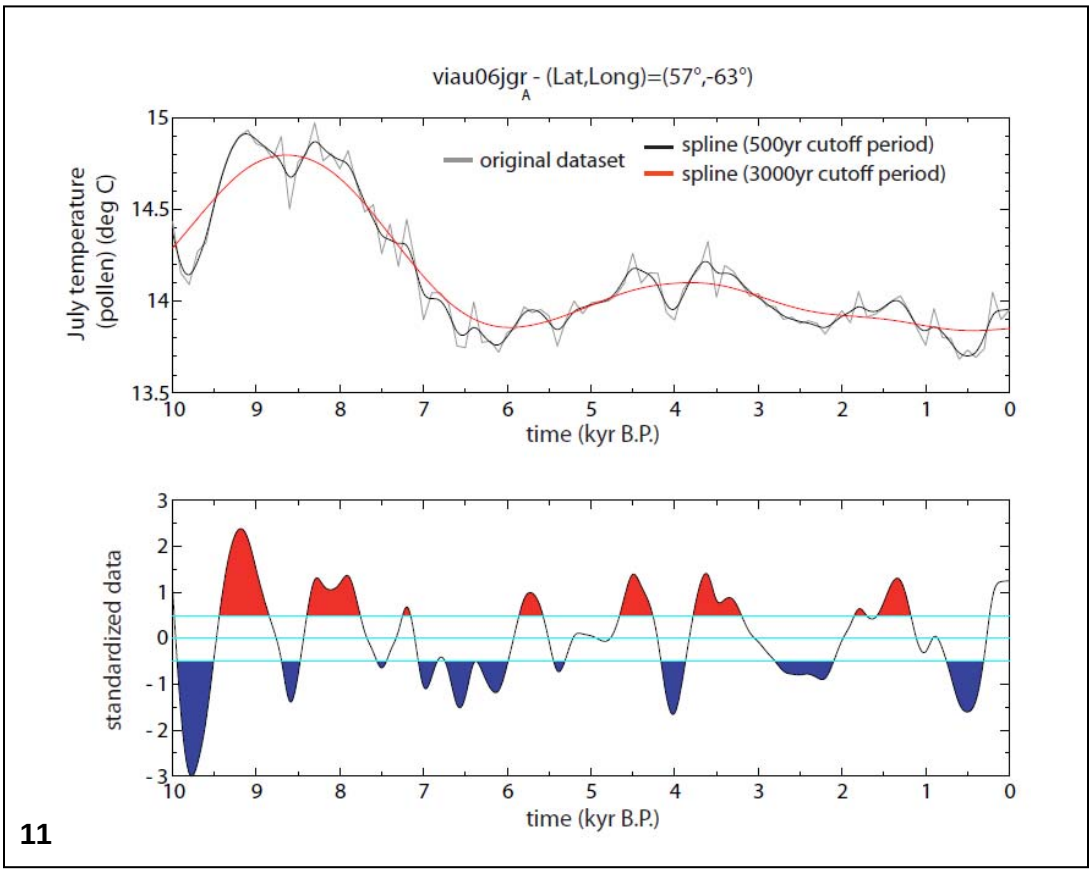
8


pelejero99po (digitalized data -> true avg. res: 143 yr) - (Lat,Long)=(20.12°, 117.38°)
SST (Uk37) (deg C)
27.5
27
26.5
26
25.5
25
24.5
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
3
2
1
0
-1
-2
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

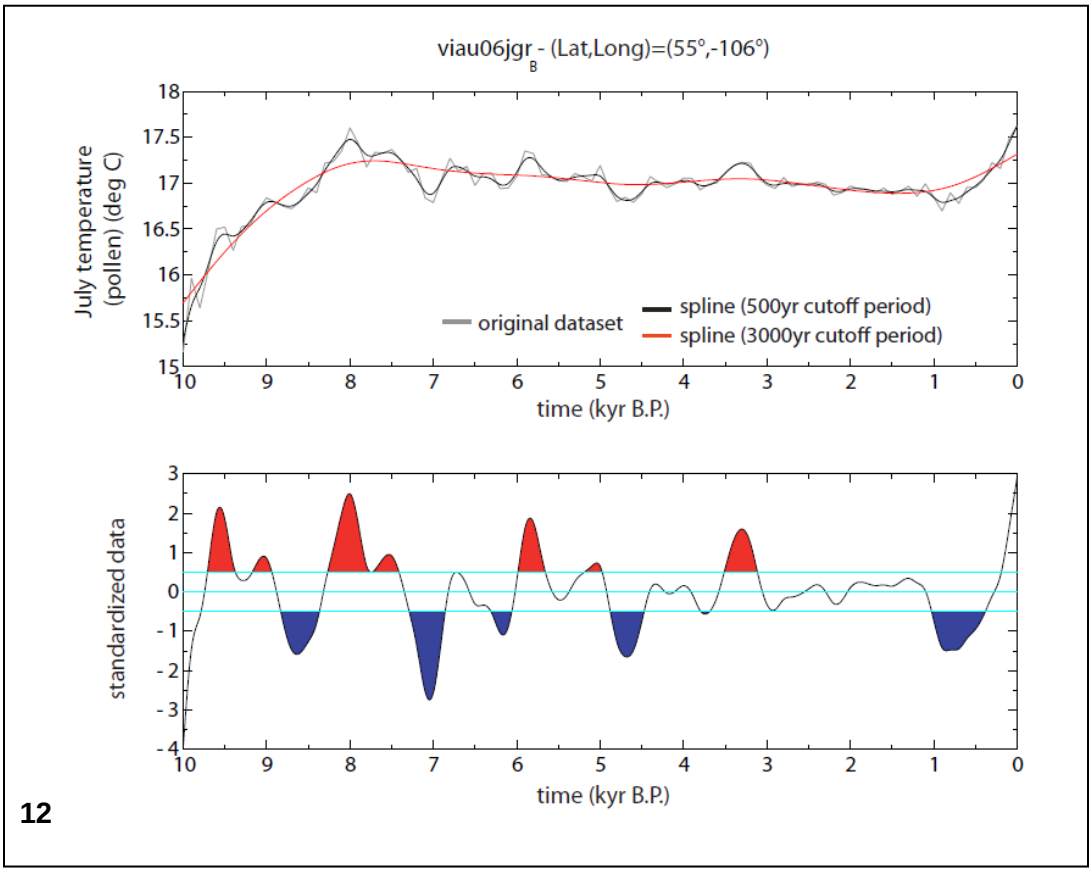
9


farmer05po - (Lat,Long)=(-25.5°,13°)
SST (Mg/Ca) (deg C)
16
15
14
13
12
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
3
2
1
0
-1
-2
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

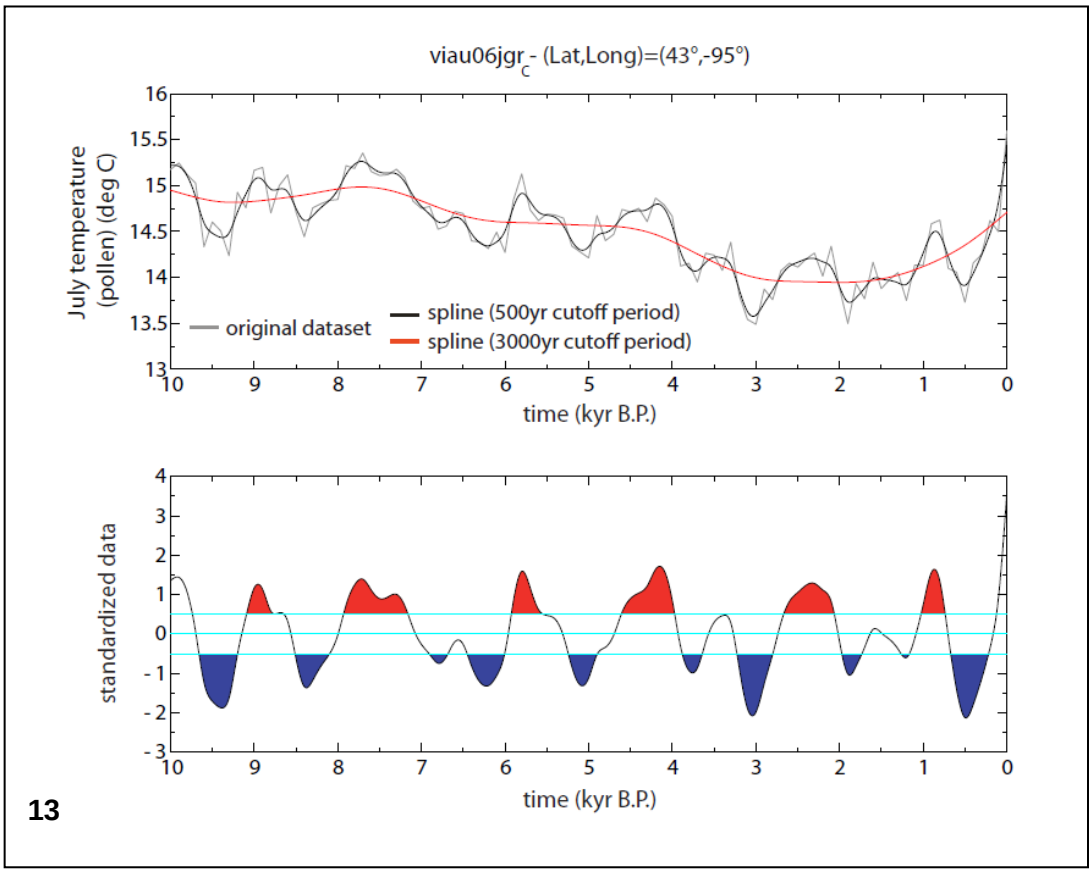
10


viau06jgr_A - (Lat,Long)=(57°,-63°)
July temperature (pollen) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

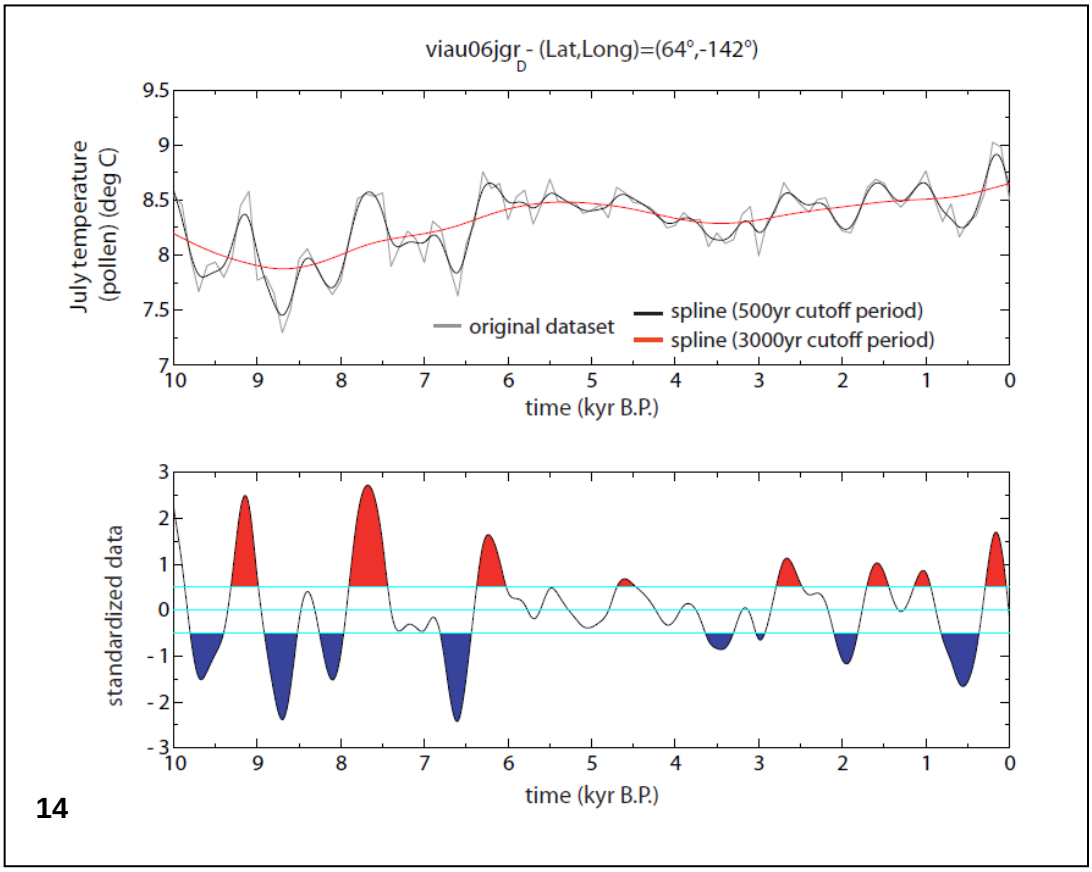
11


viau06jgr_B - (Lat,Long)=(55°,-106°)
July temperature (pollen) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

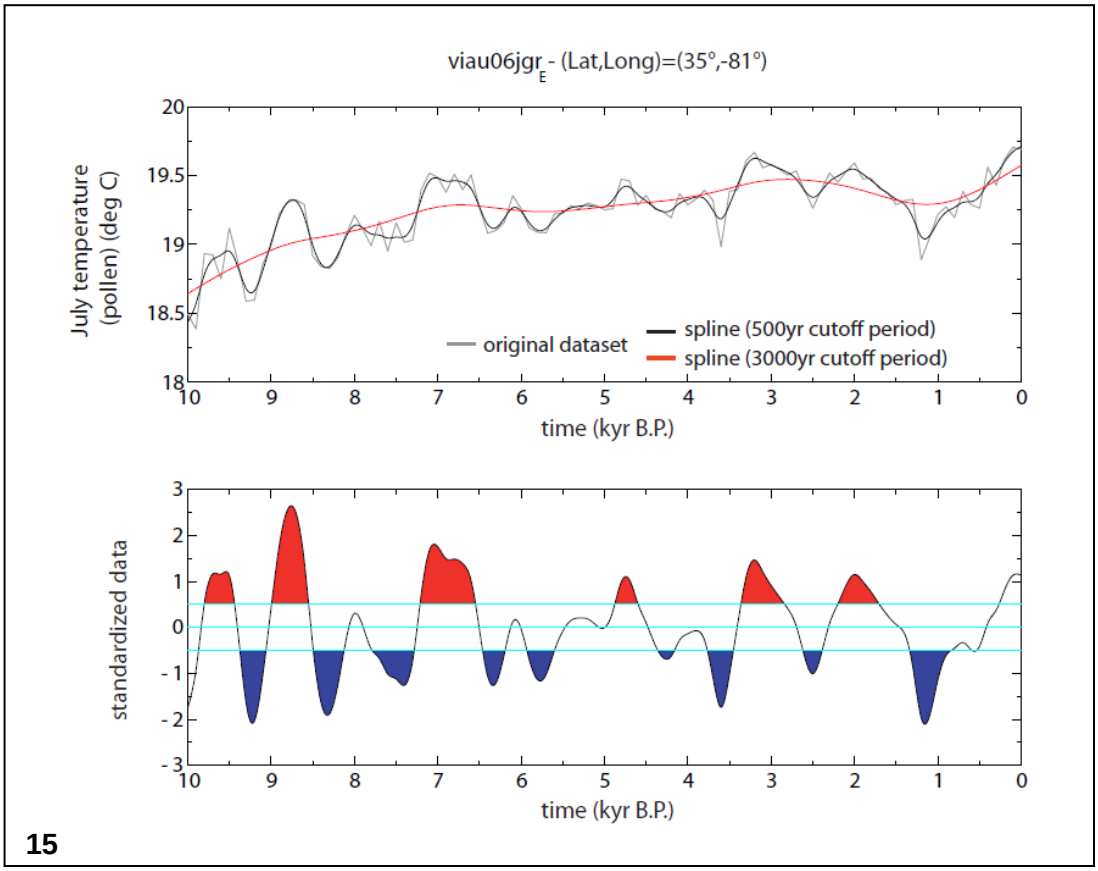
12


viau06jgr_C - (Lat,Long)=(43°,-95°)
July temperature (pollen) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

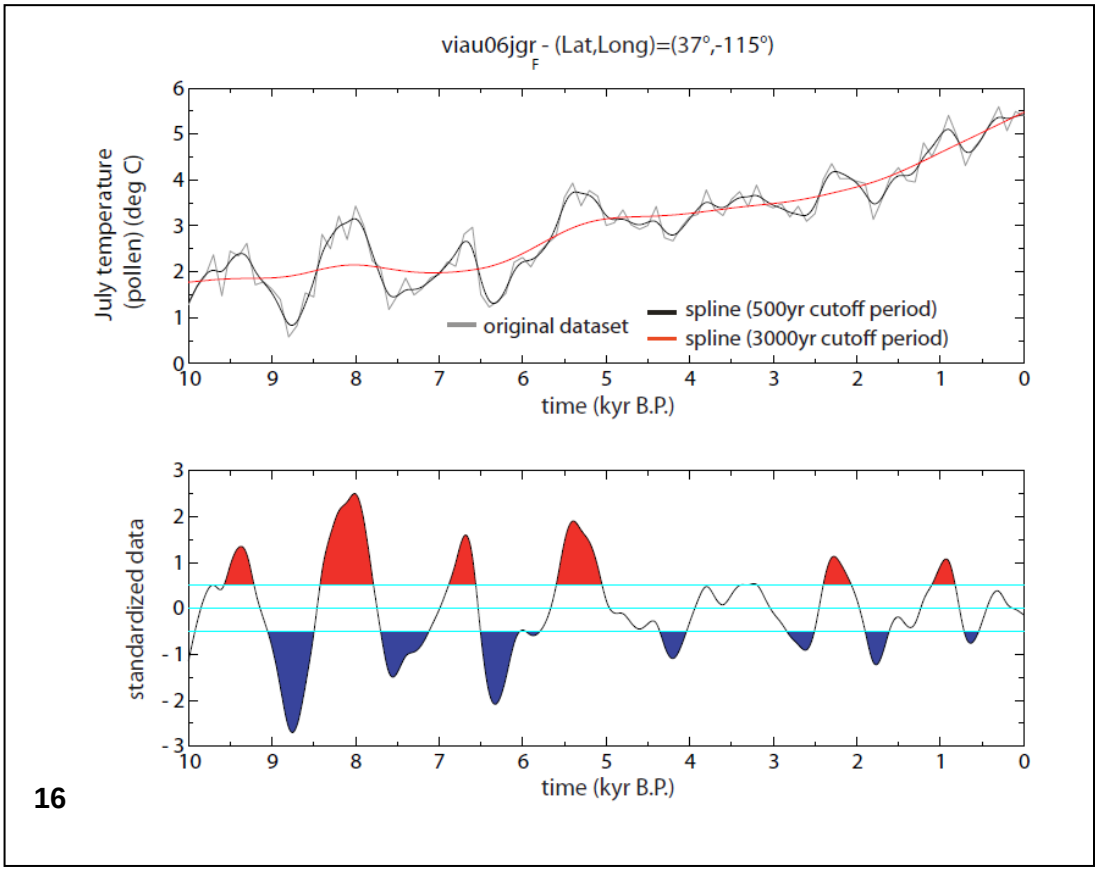
13


viau06jgr_D - (Lat,Long)=(64°,-142°)
July temperature (pollen) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

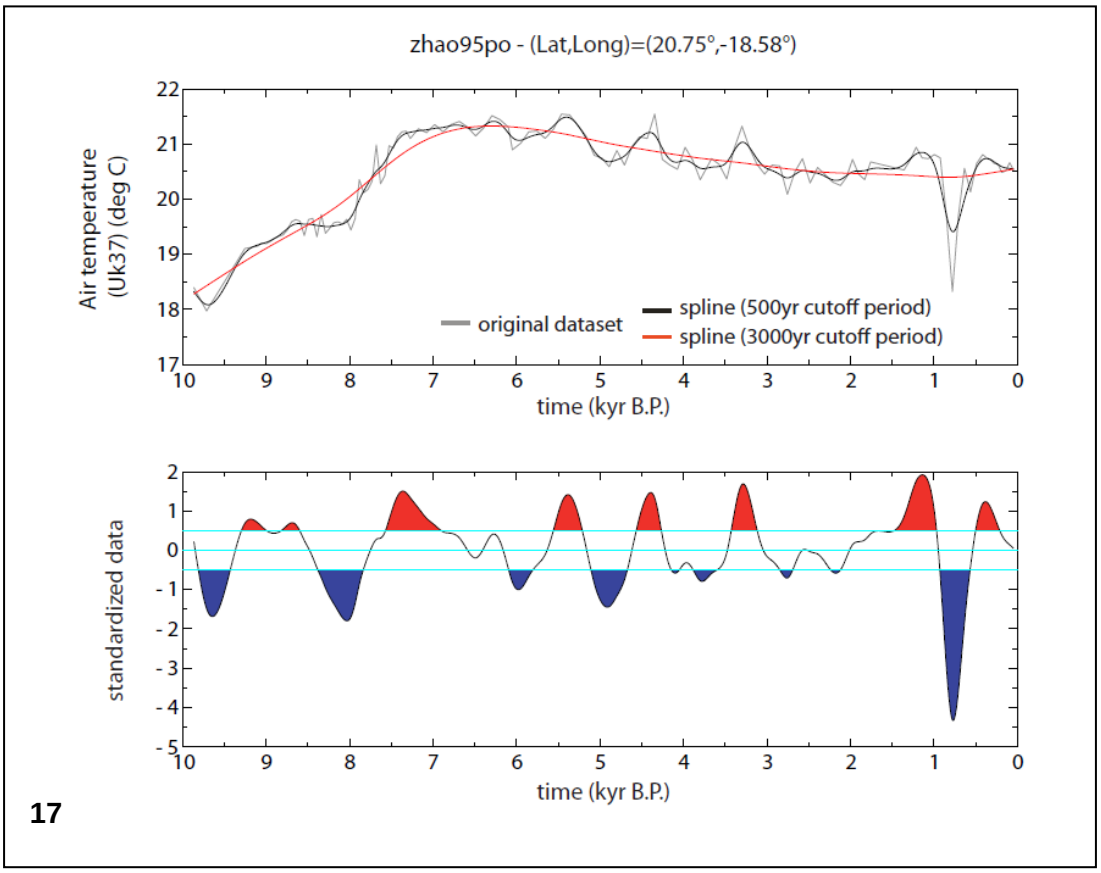
14


viau06jgr_E - (Lat,Long)=(35°,-81°)
July temperature (pollen) (deg C)
20
19.5
19
18.5
18
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
3 2 1 0 -1 -2 -3
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

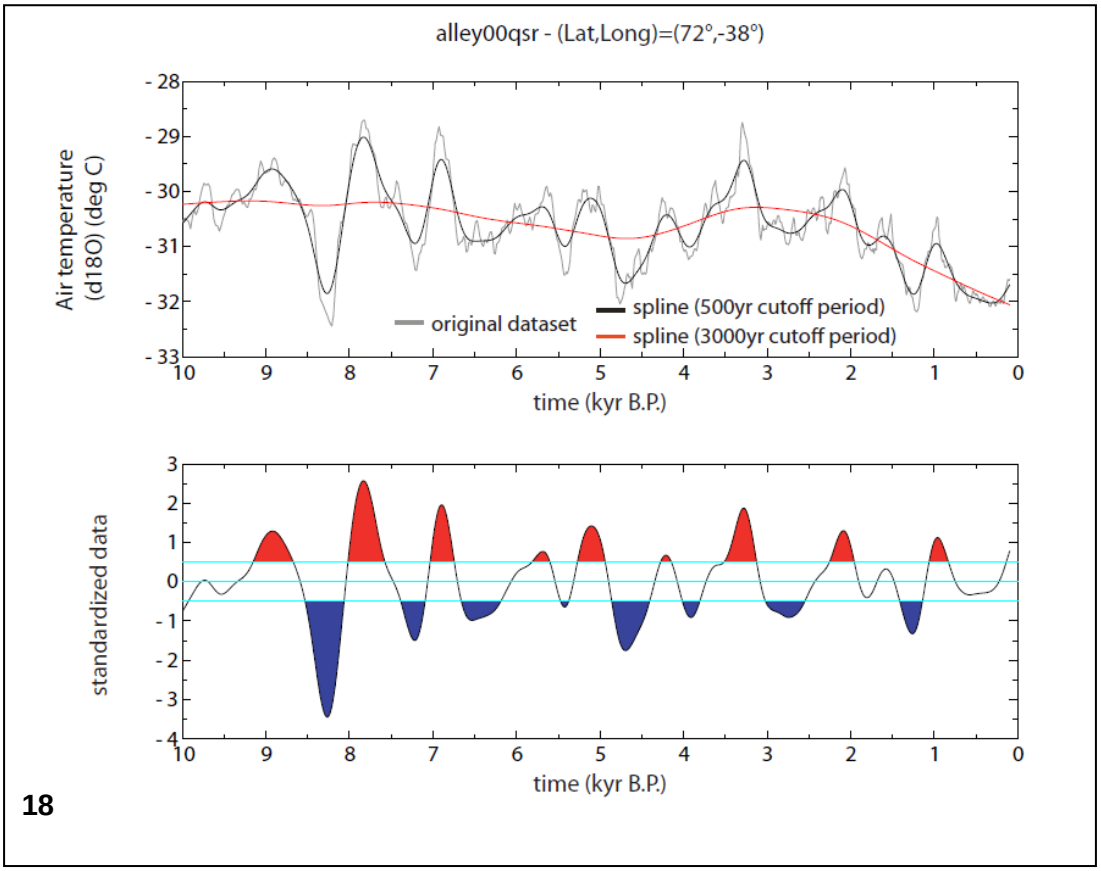
15


viau06jgr_F - (Lat,Long)=(37°,-115°)
July temperature (pollen) (deg C)
6 5 4 3 2 1 0
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
3 2 1 0 -1 -2 -3
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

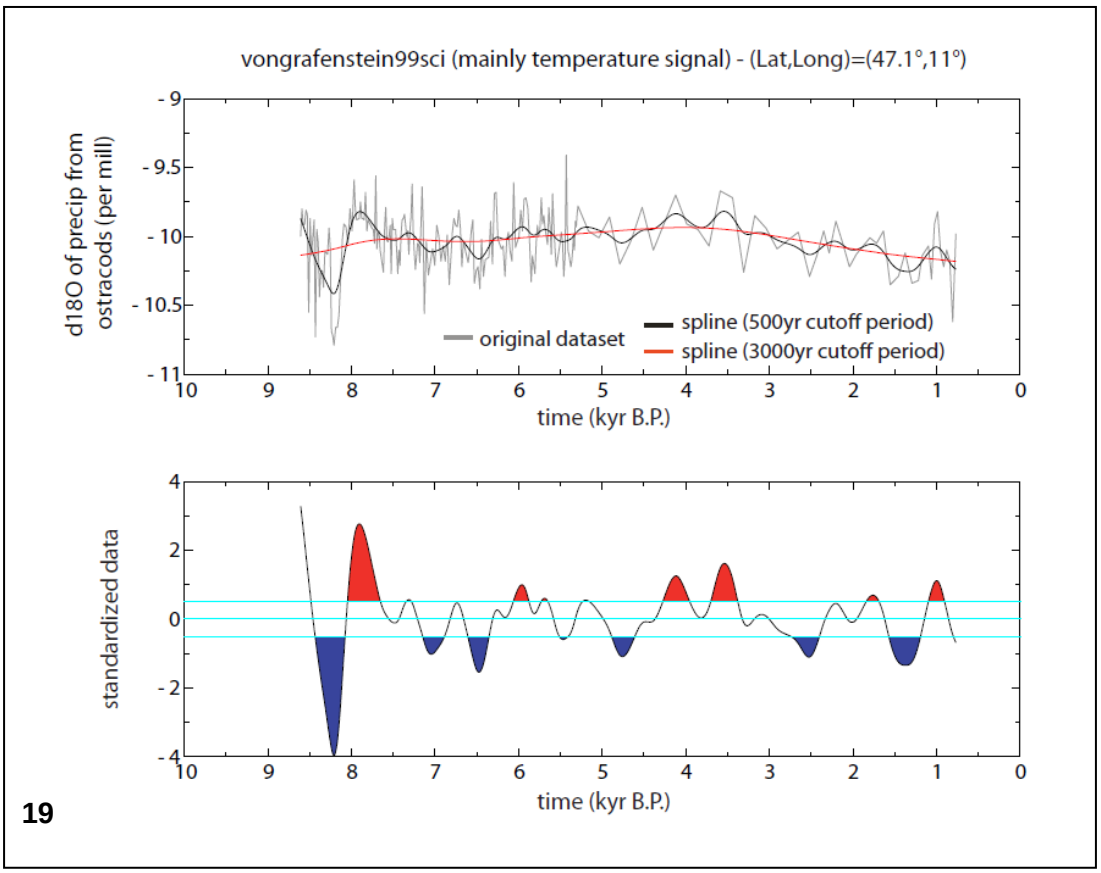
16


zhao95po - (Lat,Long)=(20.75°,-18.58°)
Air temperature (Uk37) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

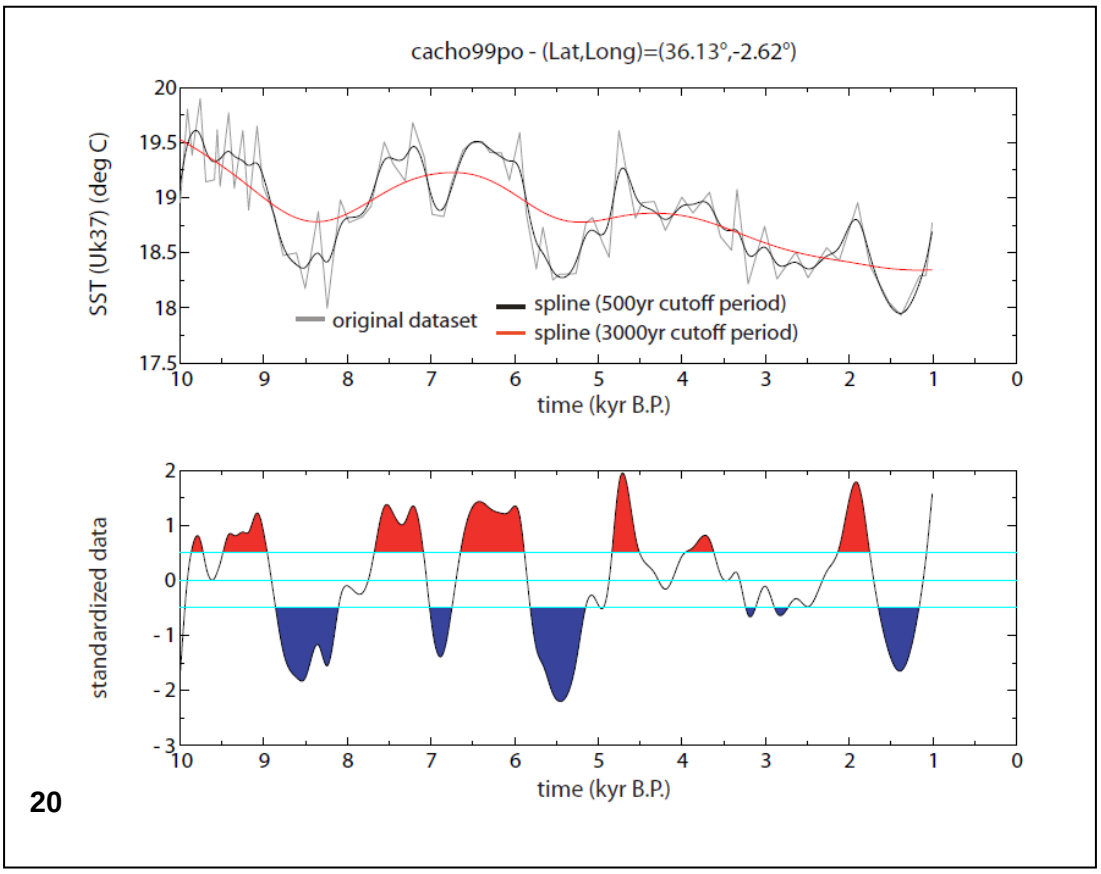
17


alley00qsr - (Lat,Long)=(72°,-38°)
Air temperature (d18O) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

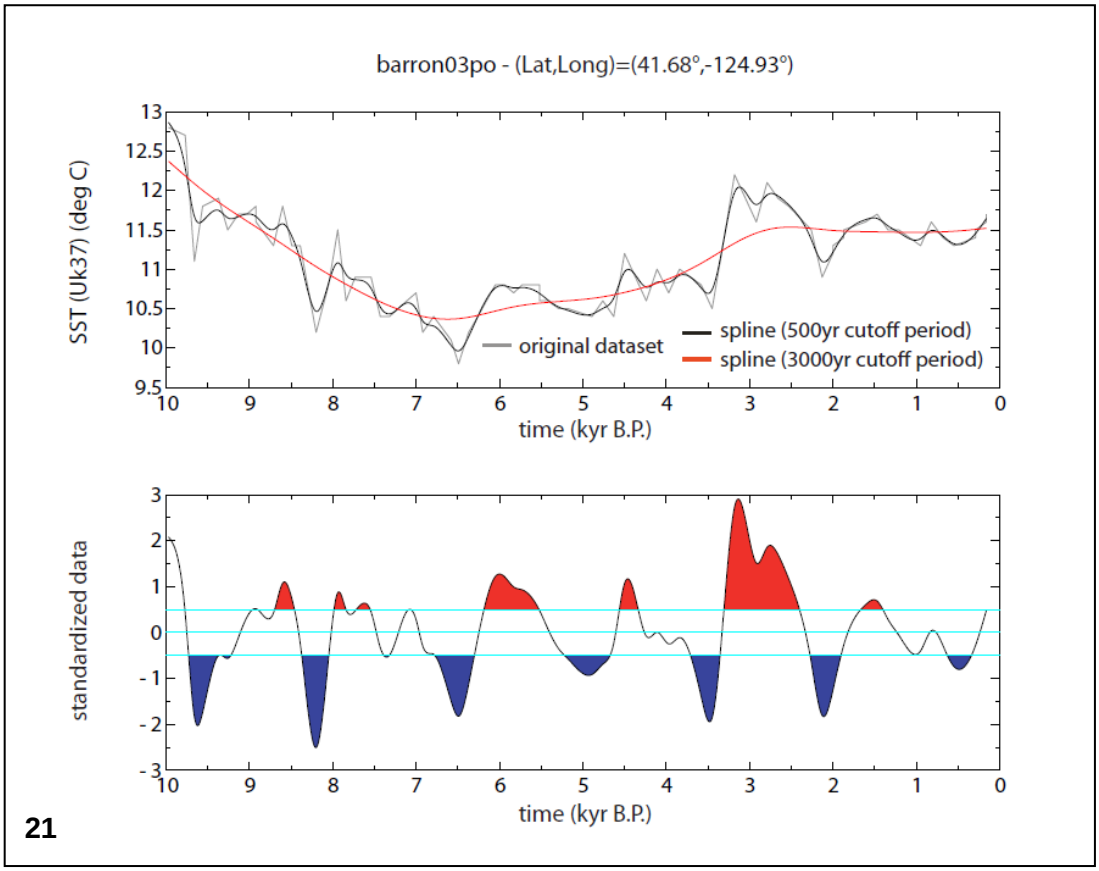
18


vongrafenstein99sci (mainly temperature signal) - (Lat,Long)=(47.1°,11°)
d18O of precip from ostracods (per mill)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

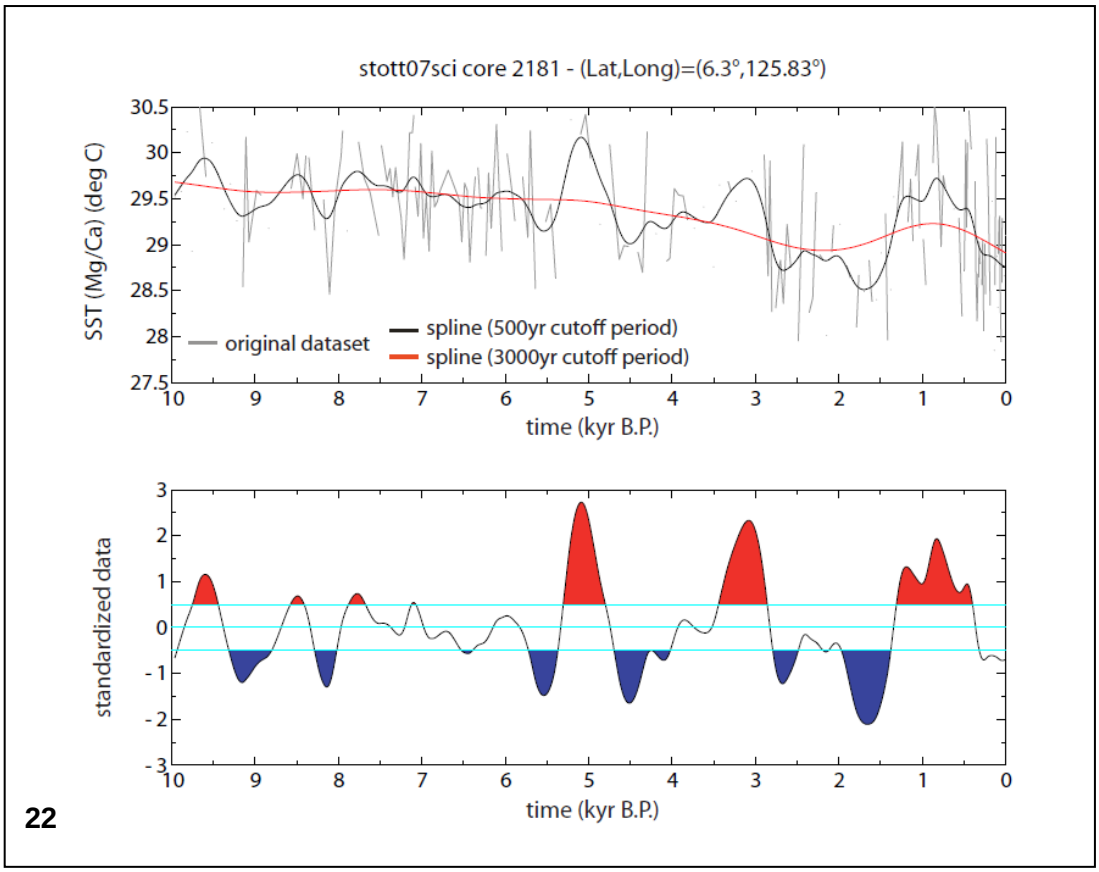
19


cacho99po - (Lat,Long)=(36.13°,-2.62°)
SST (Uk37) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

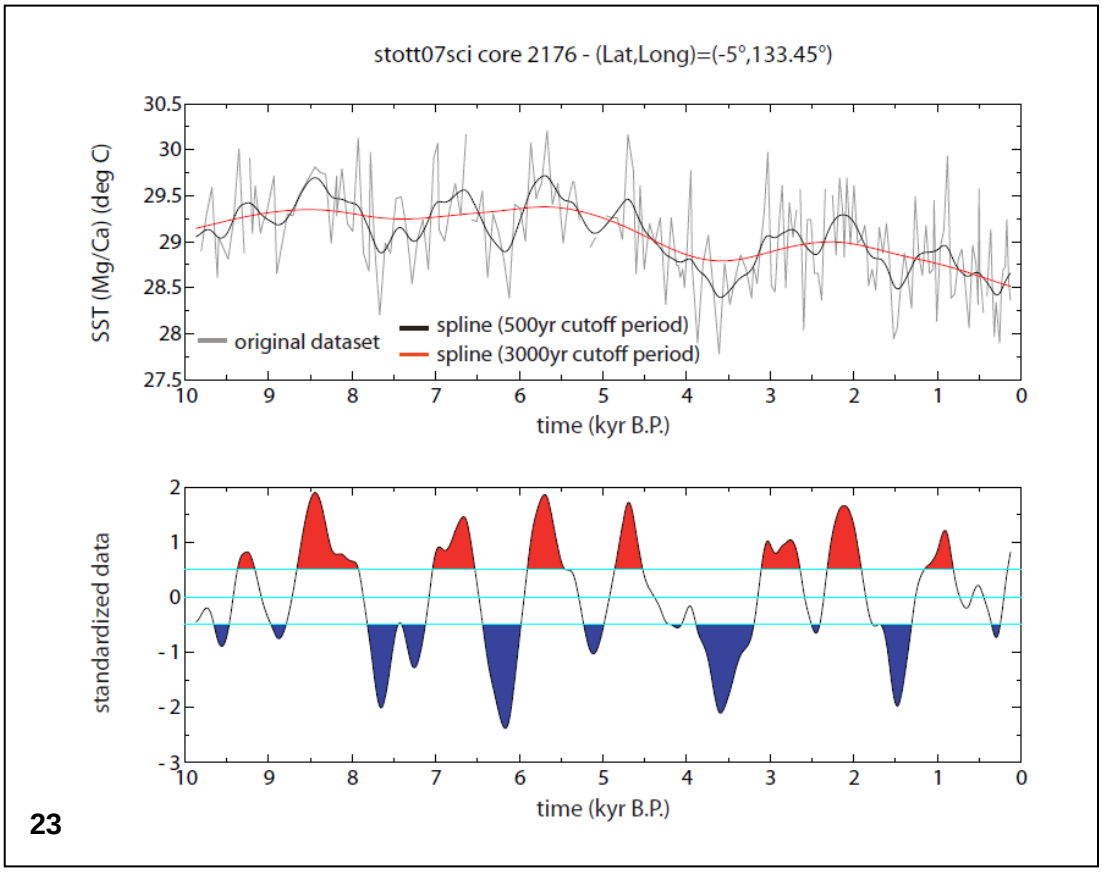
20


barron03po - (Lat,Long)=(41.68°,-124.93°)
SST (Uk37) (deg C)
13
12.5
12
11.5
11
10.5
10
9.5
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
3
2
1
0
-1
-2
-3
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

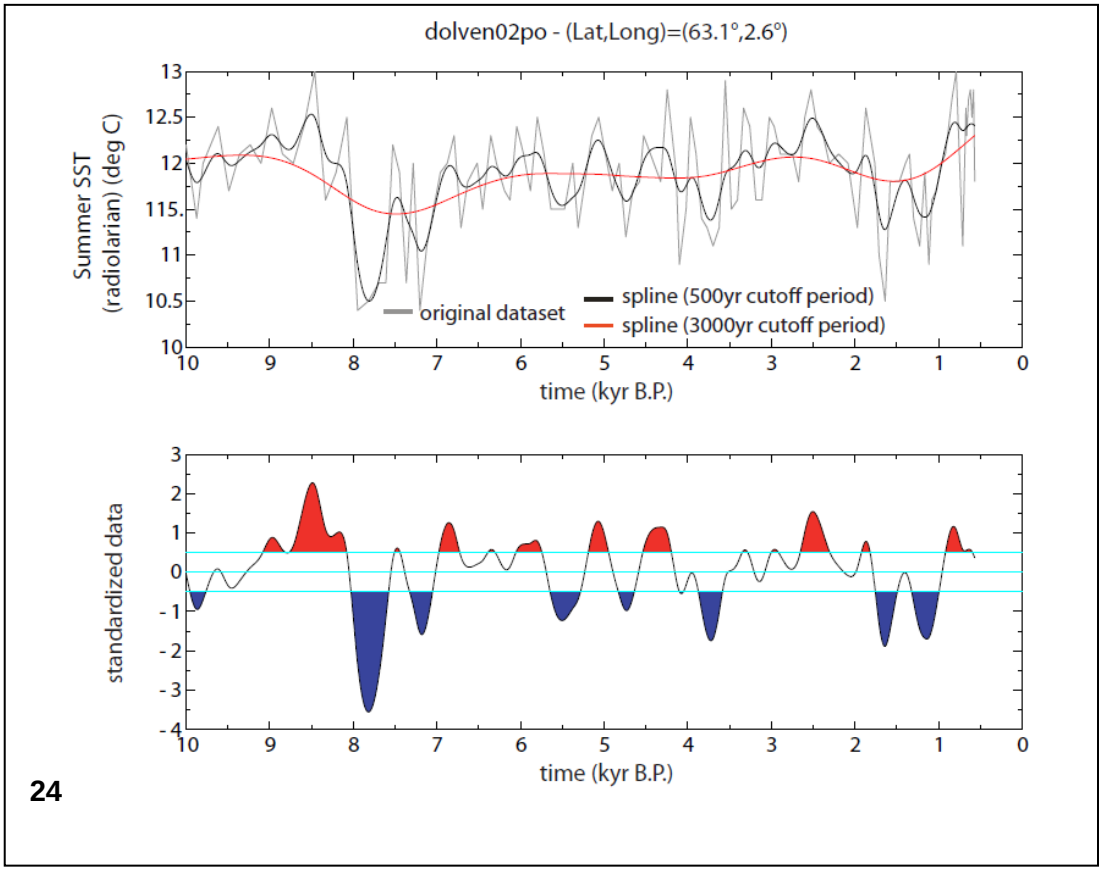
21


stott07sci core 2181 - (Lat,Long)=(6.3°,125.83°)
SST (Mg/Ca) (deg C)
30.5
30
29.5
29
28.5
28
27.5
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
3
2
1
0
-1
-2
-3
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

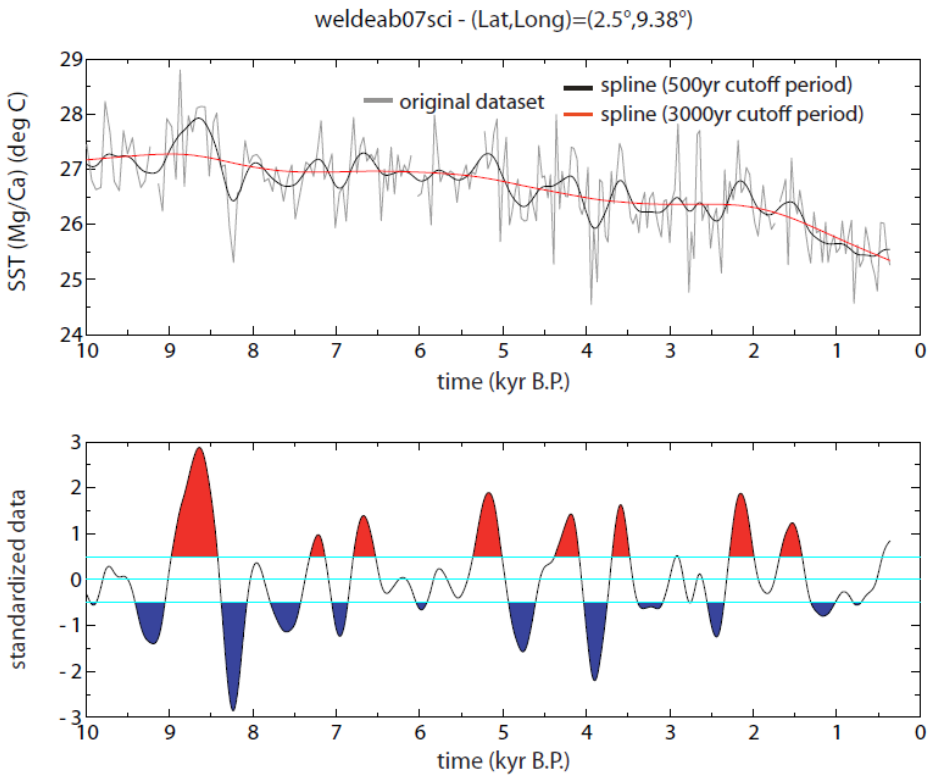
22


stott07sci core 2176 - (Lat,Long)=(-5°,133.45°)
SST (Mg/Ca) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

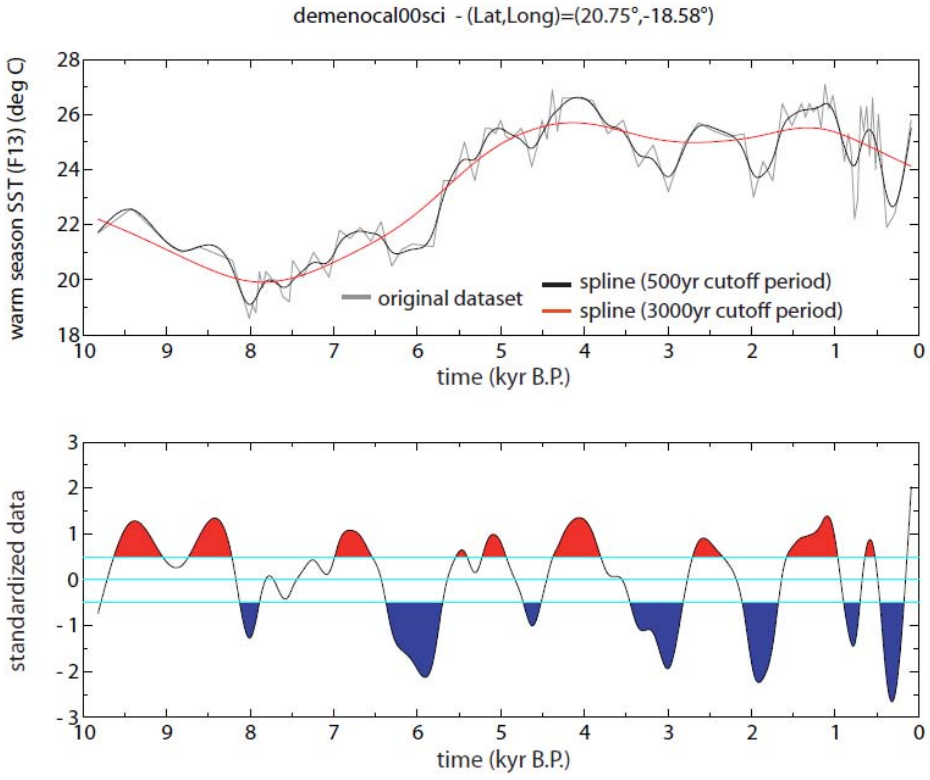
23


dolven02po - (Lat,Long)=(63.1°,2.6°)
Summer SST (radiolarian) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

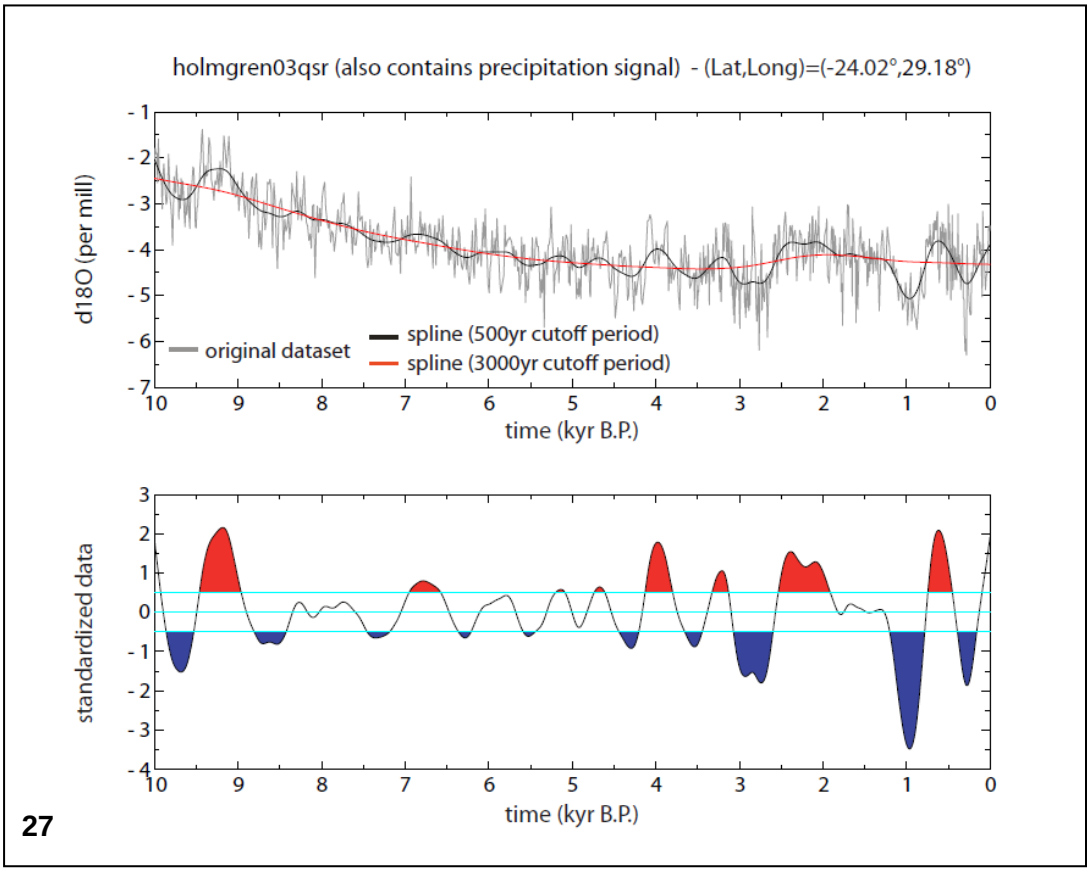
24


weldeab07sci - (Lat,Long)=(2.5°,9.38°)
SST (Mg/Ca) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

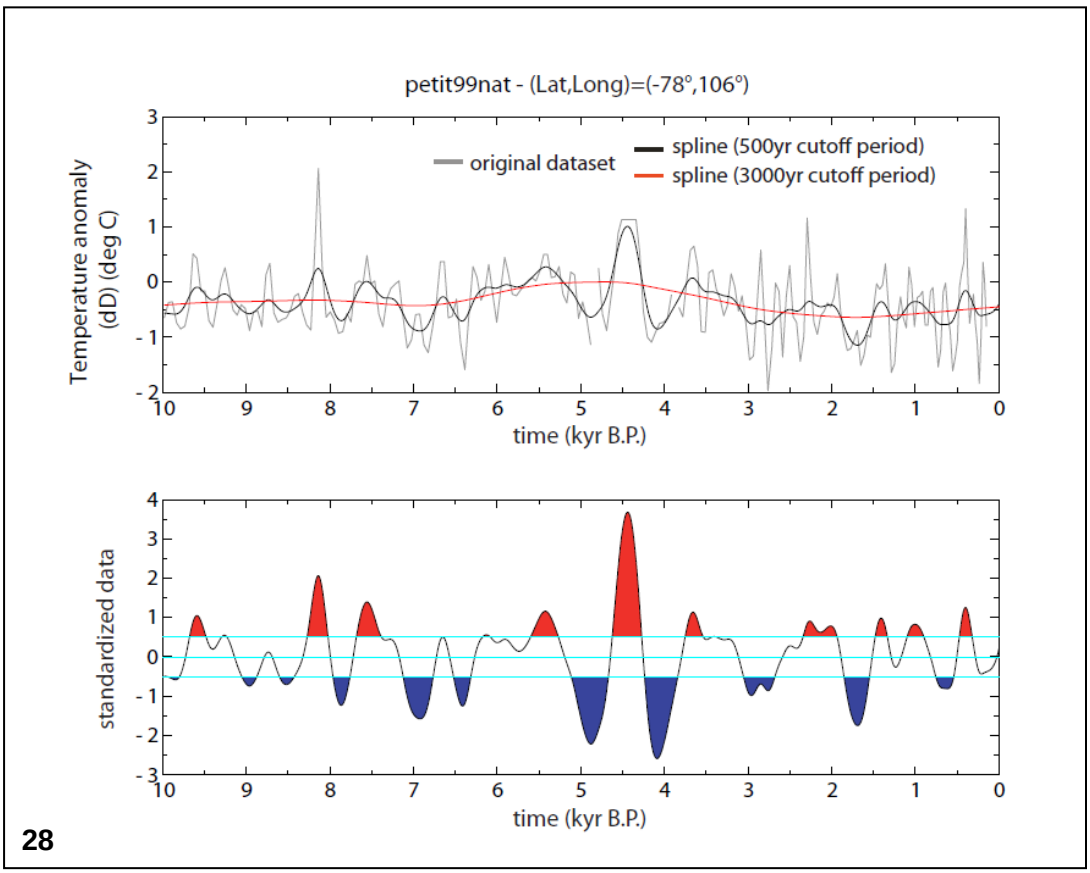
25


demenocal00sci - (Lat,Long)=(20.75°,-18.58°)
warm season SST (F13) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

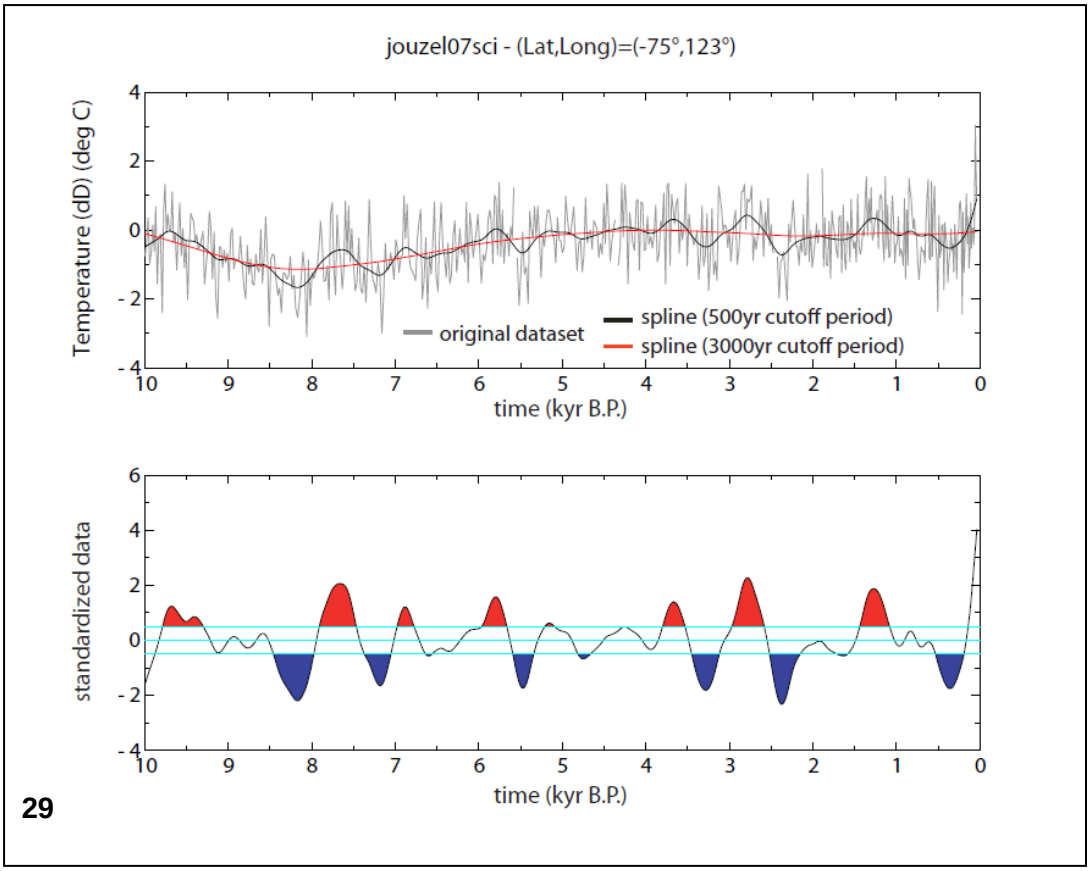
26


holmgren03qsr (also contains precipitation signal) - (Lat,Long)=(-24.02°,29.18°)
d18O (per mill)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

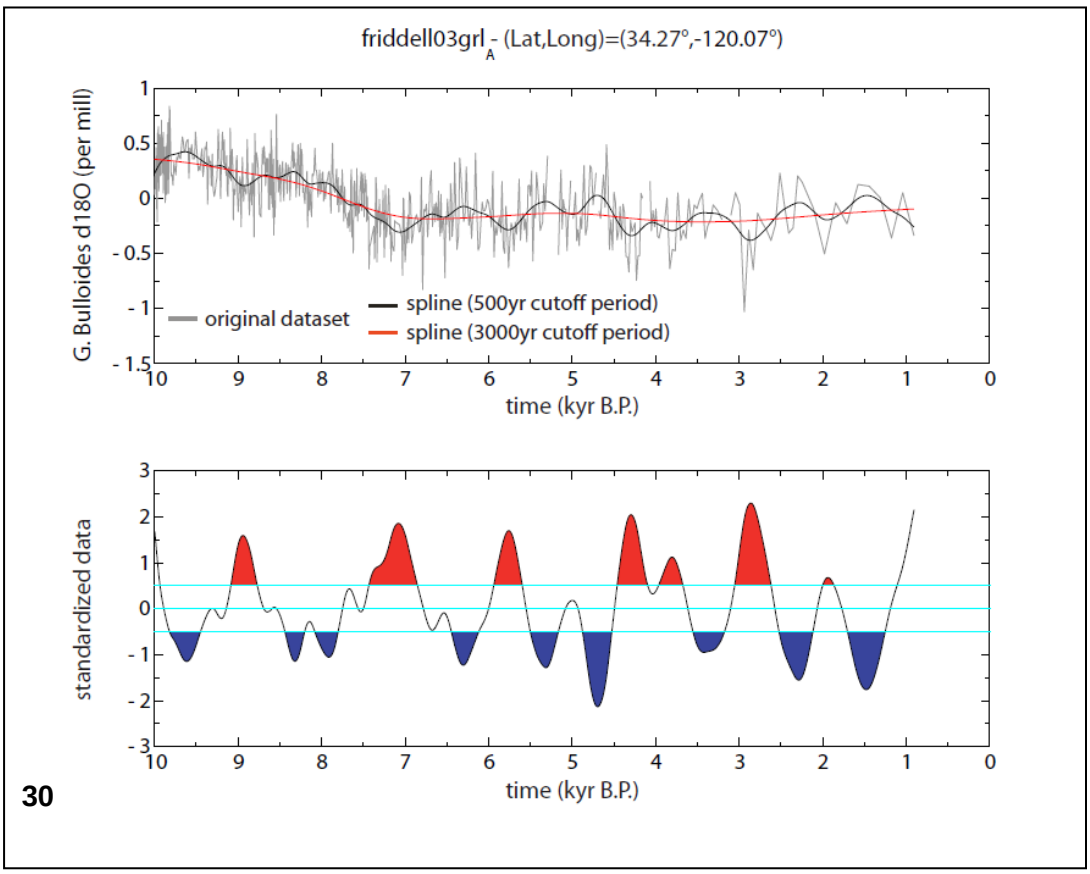
27


petit99nat - (Lat,Long)=(-78°,106°)
Temperature anomaly (dD) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

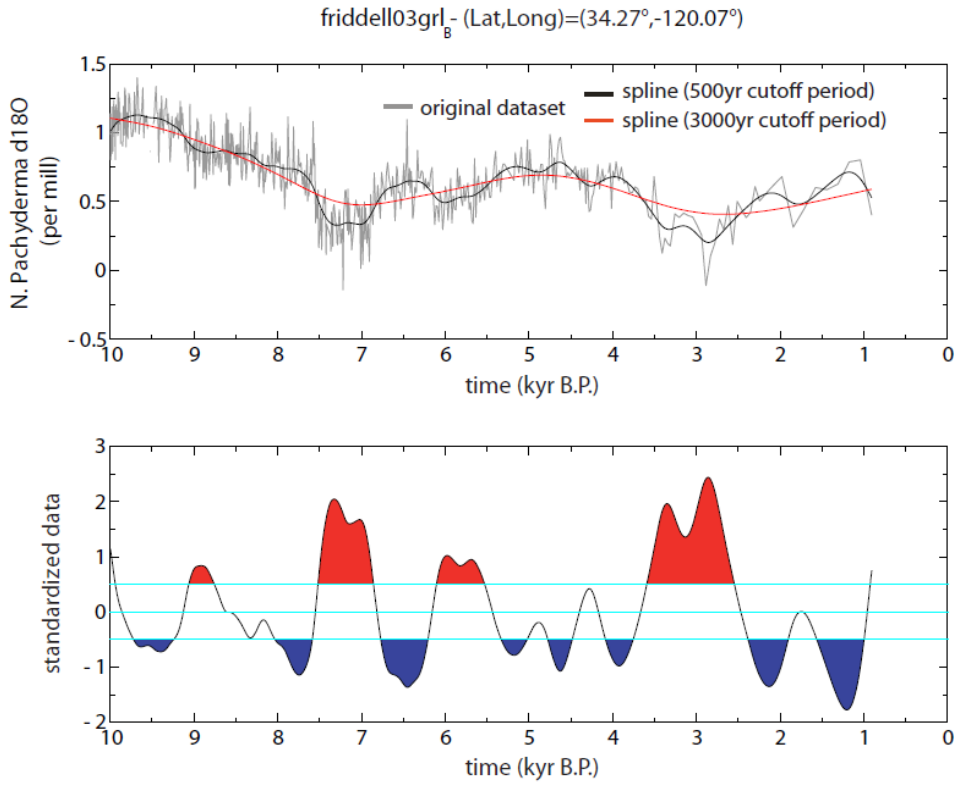
28


jouzel07sci - (Lat,Long)=(-75°,123°)
Temperature (dD) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

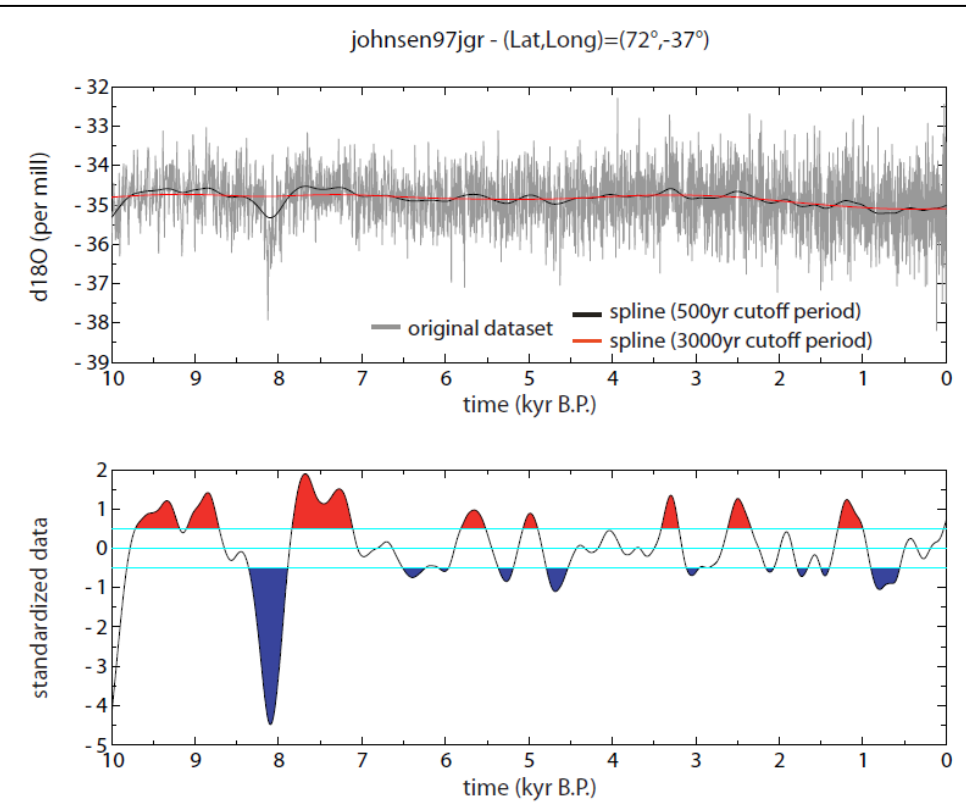
29


friddell03grl_A - (Lat,Long)=(34.27°,-120.07°)
G. Bulloides d18O (per mill)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

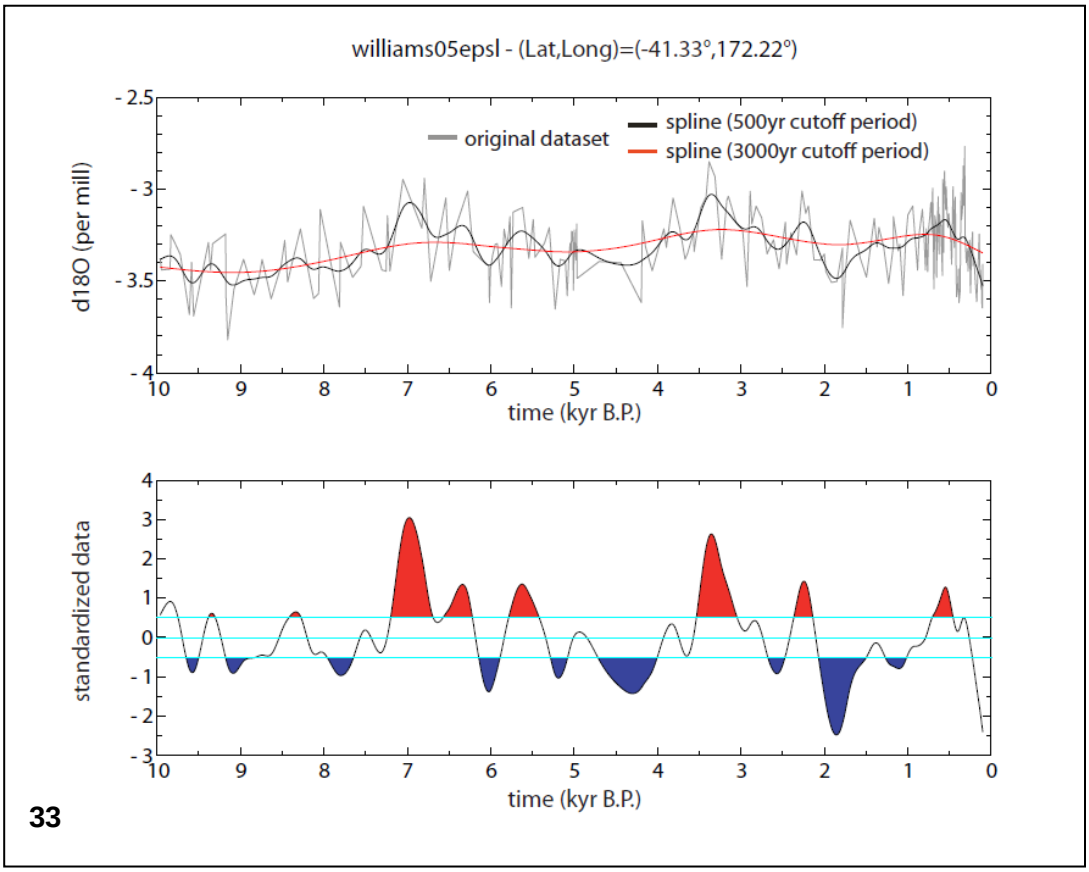
30


friddell03grl_B - (Lat,Long)=(34.27°,-120.07°)
N. Pachyderma d18O (per mill)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

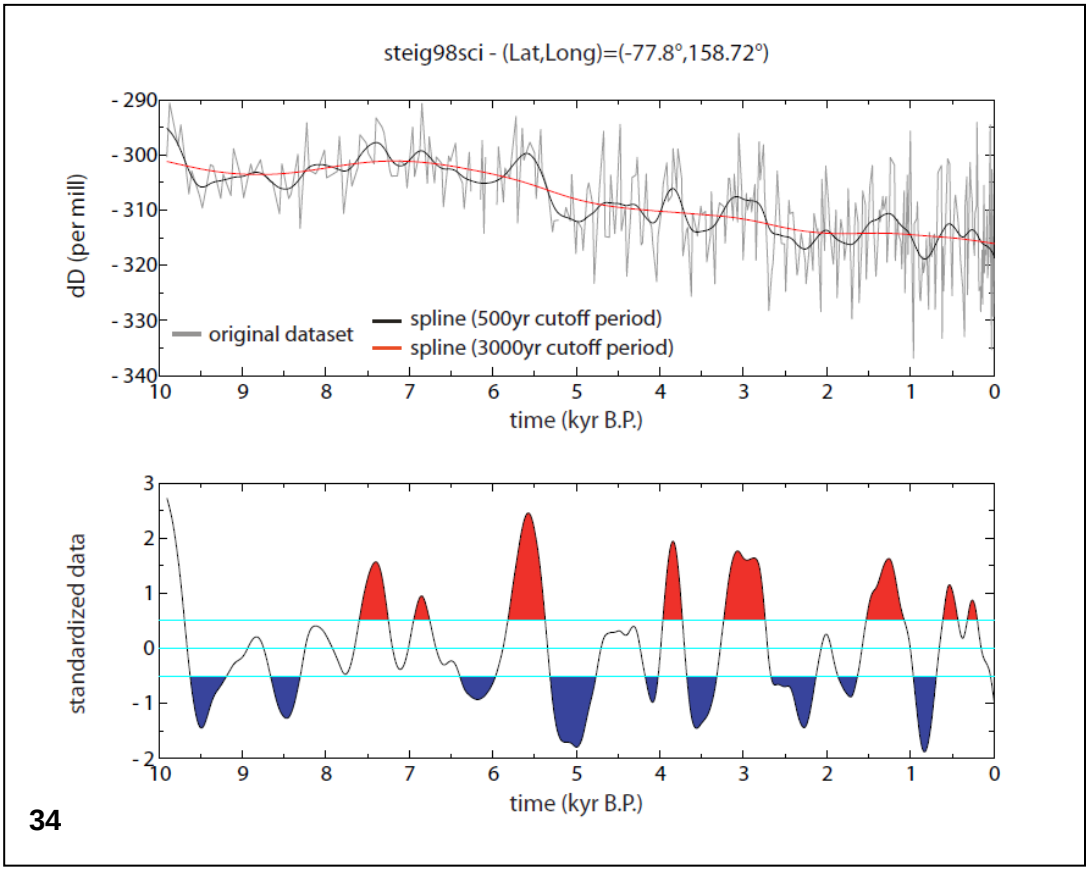
31


johnsen97jgr - (Lat,Long)=(72°,-37°)
d18O (per mill)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

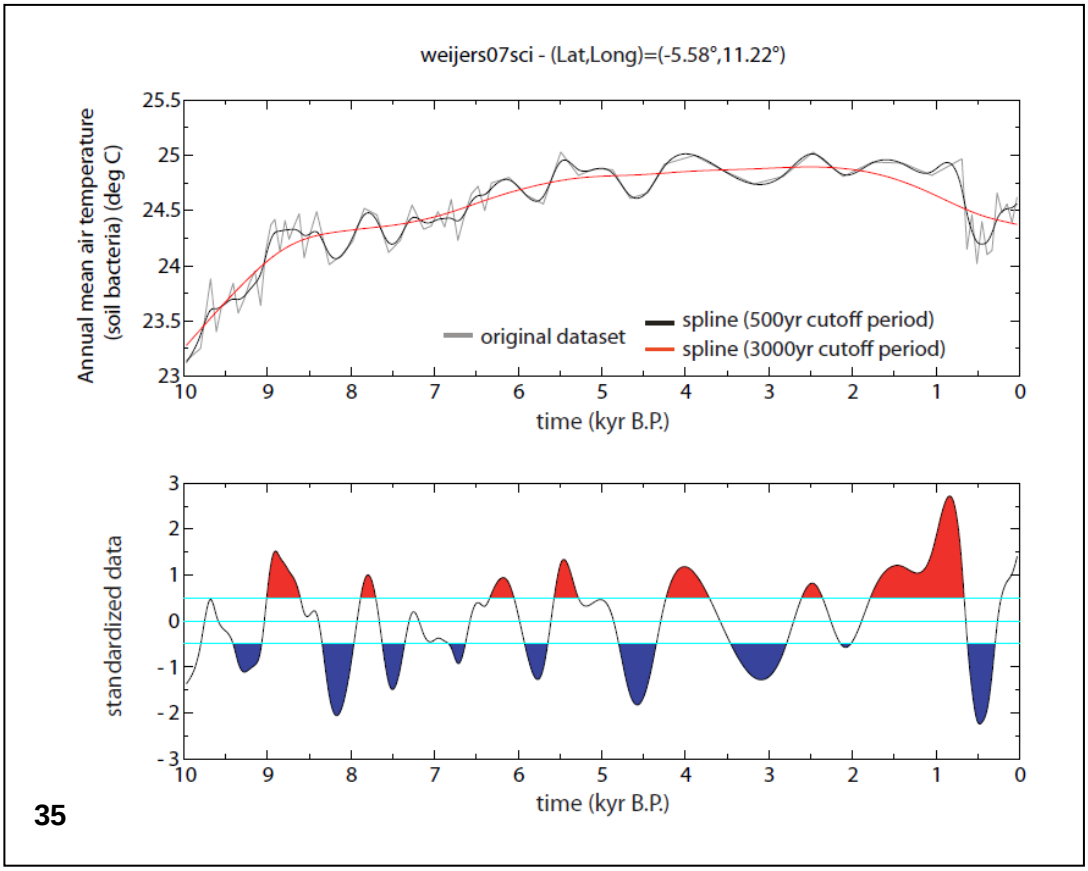
32


williams05epsl - (Lat,Long)=(-41.33°,172.22°)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
d18O (per mill)
time (kyr B.P.)
standardized data
time (kyr B.P.)

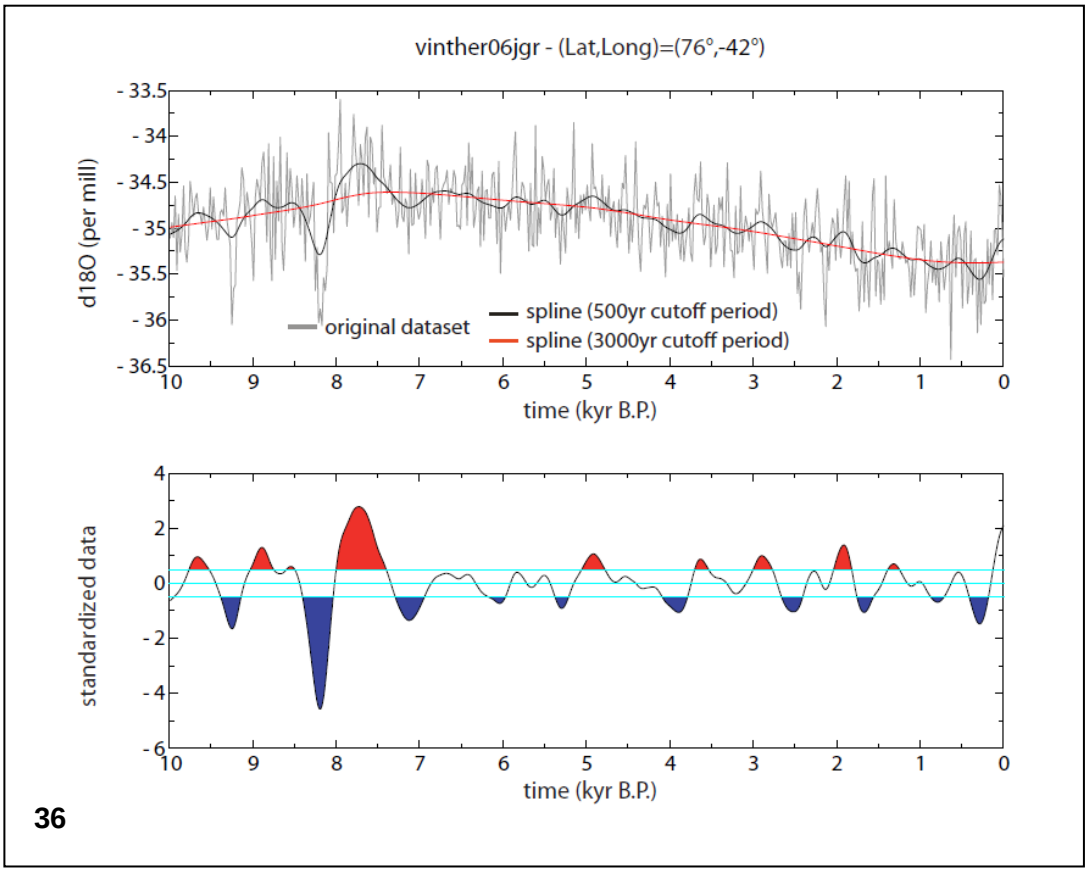
33


steig98sci - (Lat,Long)=(-77.8°,158.72°)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
dD (per mill)
time (kyr B.P.)
standardized data
time (kyr B.P.)

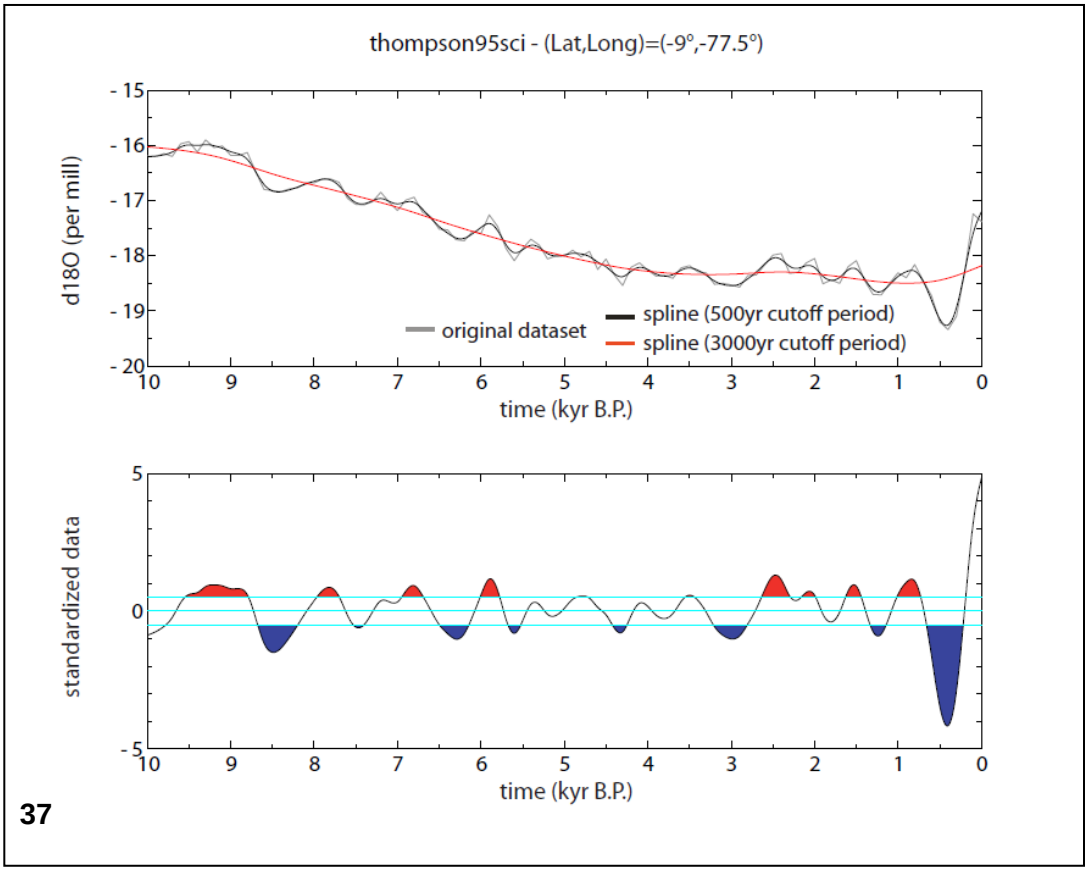
34


weijers07sci - (Lat,Long)=(-5.58°,11.22°)
Annual mean air temperature (soil bacteria) (deg C)
25.5
25
24.5
24
23.5
23
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
3 2 1 0 -1 -2 -3
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

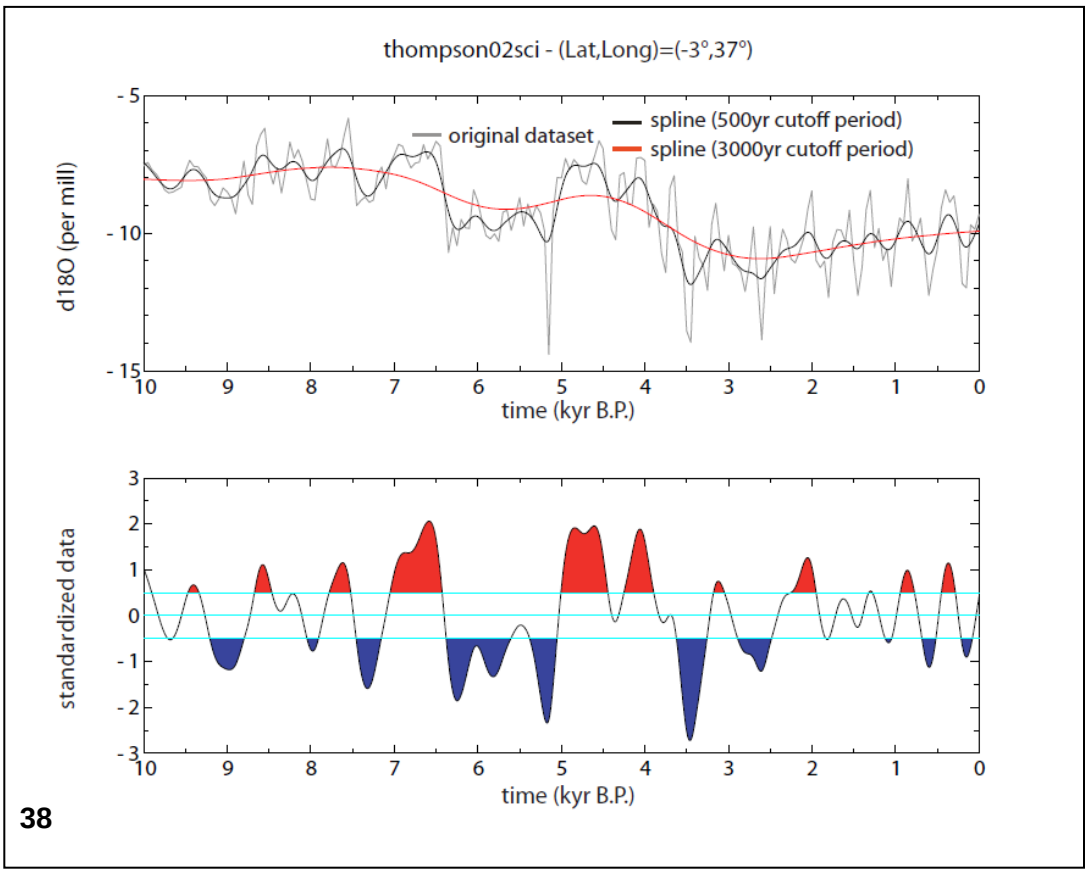
35


vinther06jgr - (Lat,Long)=(76°,-42°)
d18O (per mill)
-33.5
-34
-34.5
-35
-35.5
-36
-36.5
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
4 2 0 -2 -4 -6
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

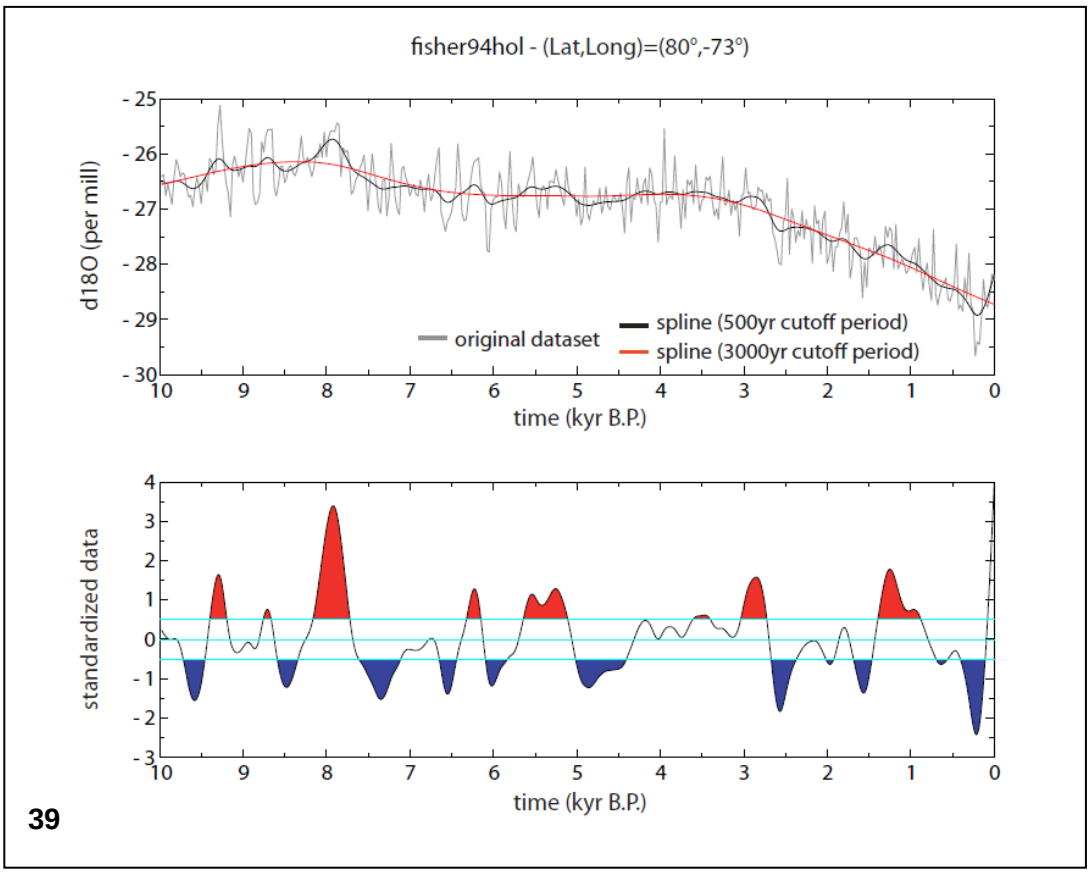
36


thompson95sci - (Lat,Long)=(-9°,-77.5°)
d18O (per mill)
- 15
- 16
- 17
- 18
- 19
- 20
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
5
0
-5
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

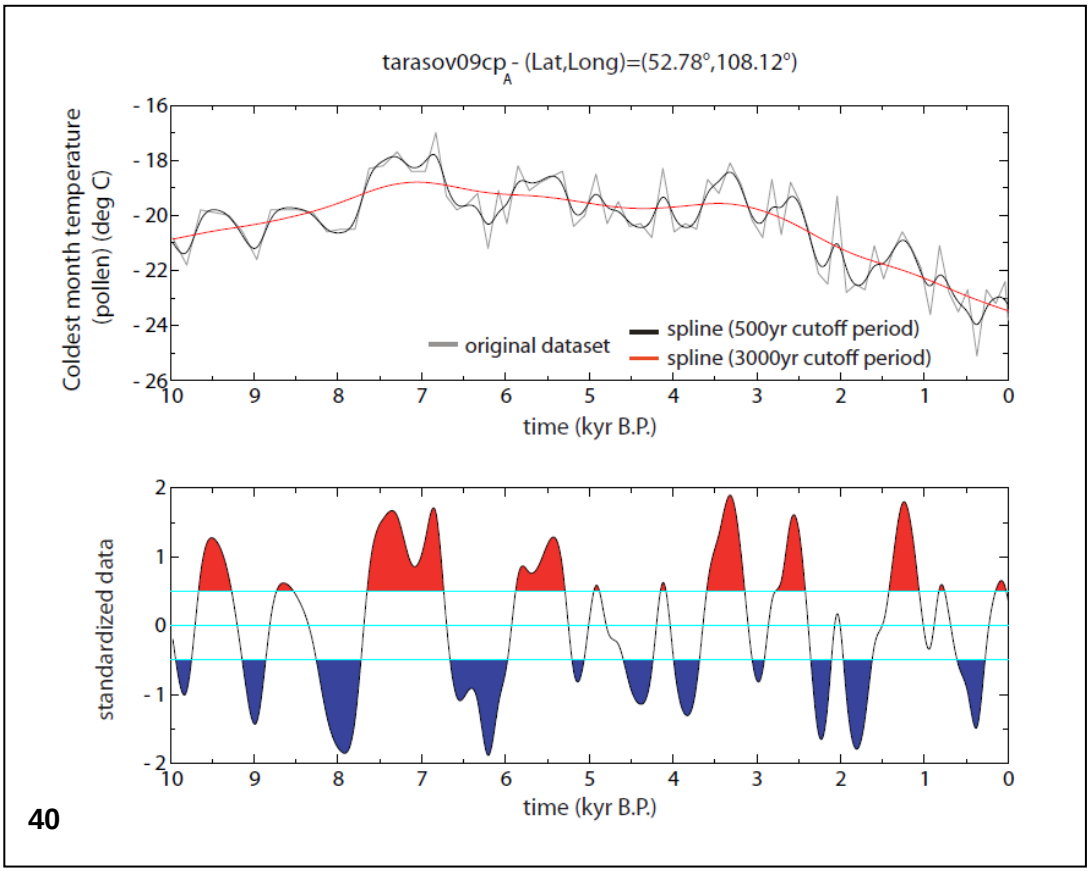
37


thompson02sci - (Lat,Long)=(-3°,37°)
d18O (per mill)
- 5
- 10
- 15
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
3
2
1
0
-1
-2
-3
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

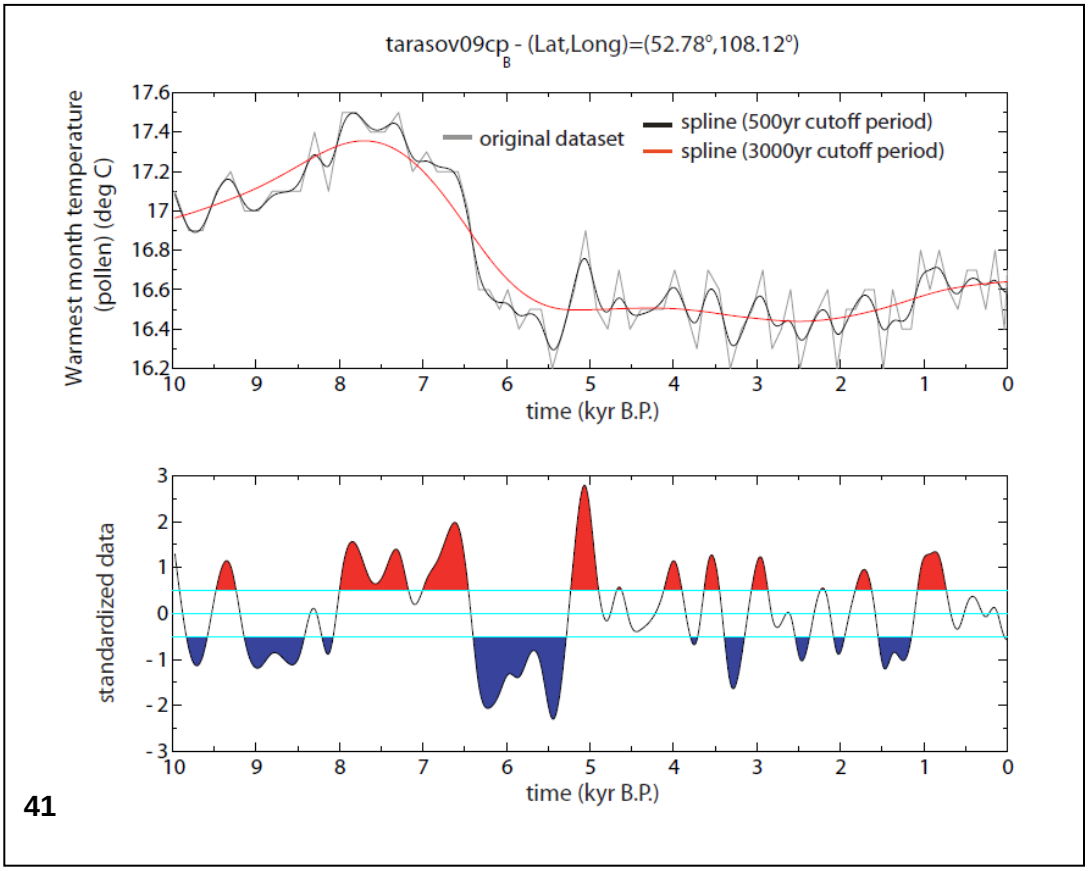
38


fisher94hol - (Lat,Long)=(80°,-73°)
d18O (per mill)
- 25
- 26
- 27
- 28
- 29
- 30
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
4 3 2 1 0 -1 -2 -3
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

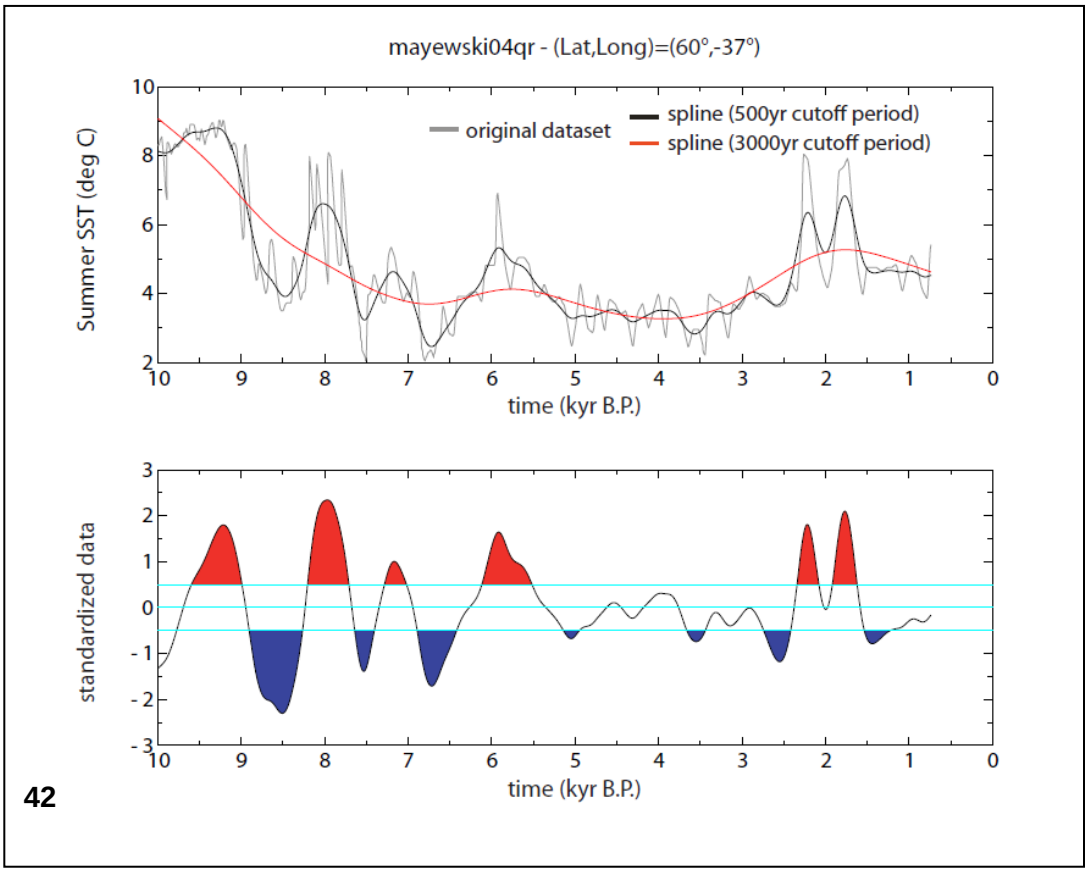
39


tarasov09cp$_A$ - (Lat,Long)=(52.78°,108.12°)
Coldest month temperature (pollen) (deg C)
- 16
- 18
- 20
- 22
- 24
- 26
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
2 1 0 -1 -2
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

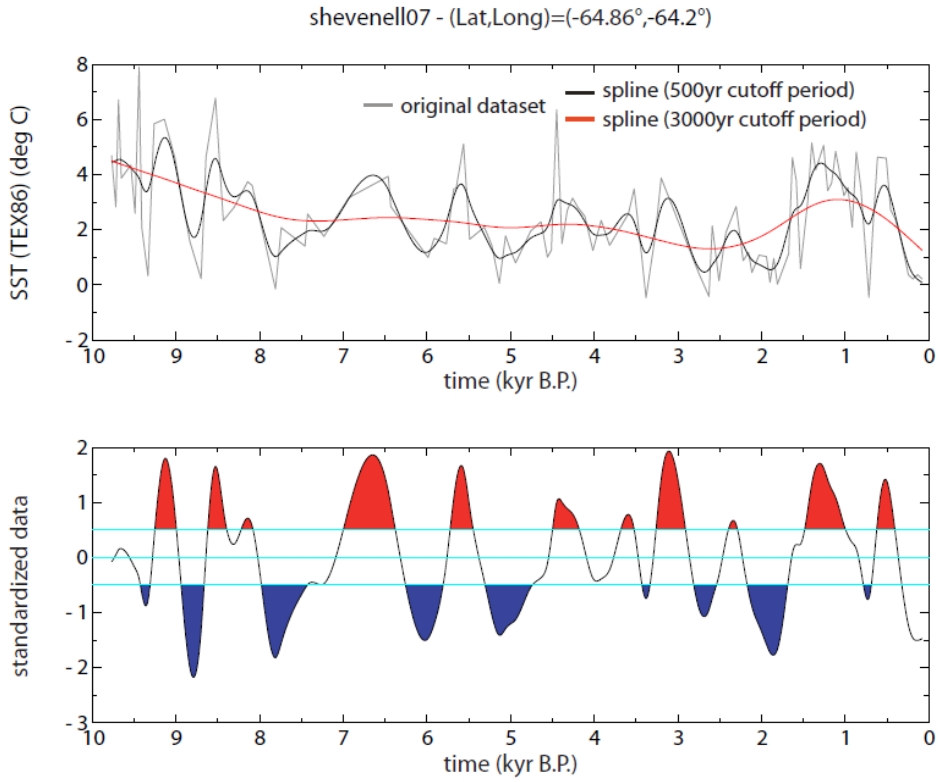
40


tarasov09cp_B - (Lat,Long)=(52.78°,108.12°)
Warmest month temperature (pollen) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

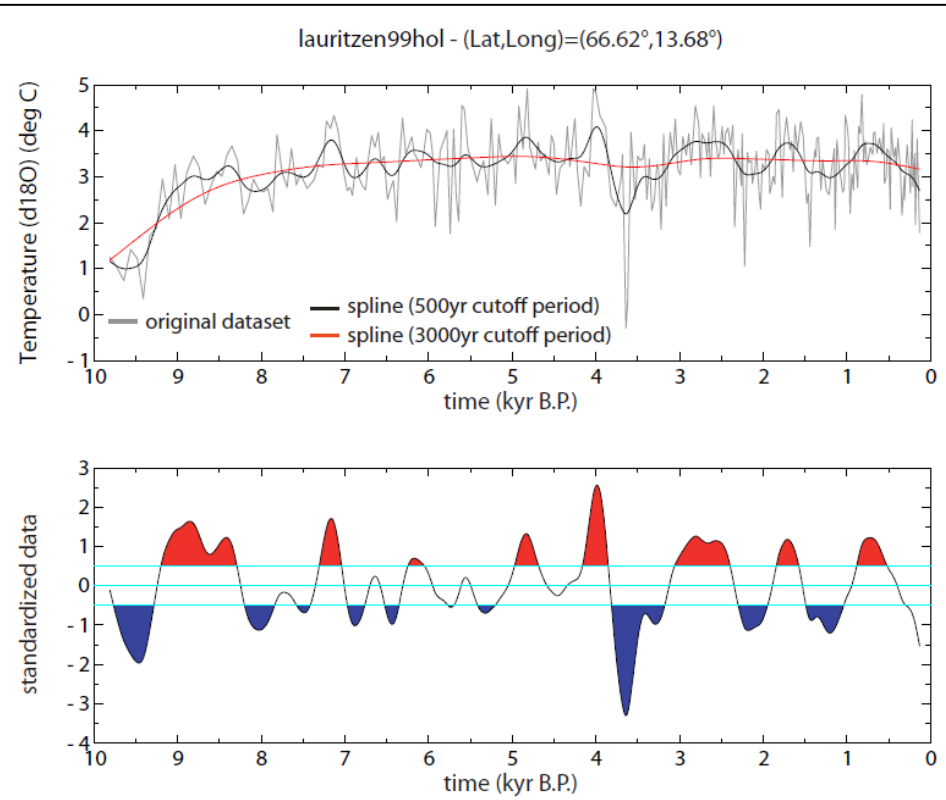
41


mayewski04qr - (Lat,Long)=(60°,-37°)
Summer SST (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

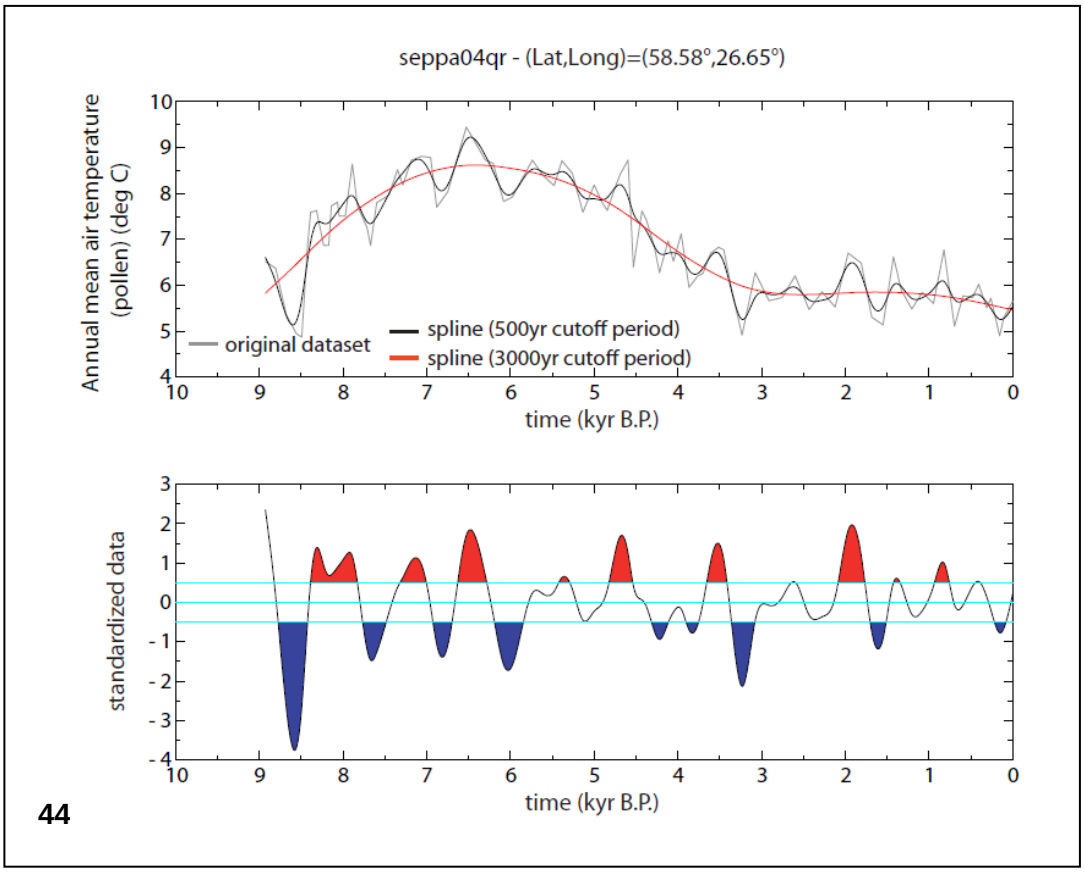
42


shevenell07 - (Lat,Long)=(-64.86°,-64.2°)
SST (TEX86) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

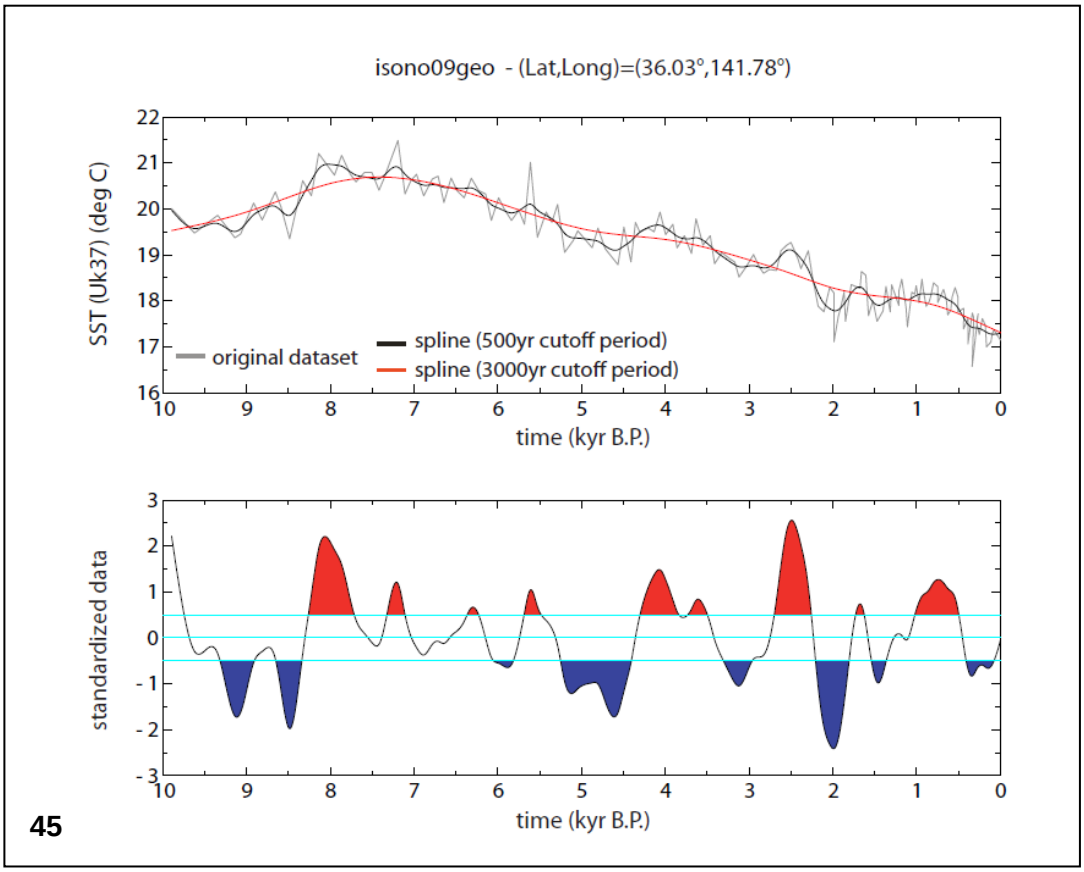
43


lauritzen99hol - (Lat,Long)=(66.62°,13.68°)
Temperature (d18O) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

44

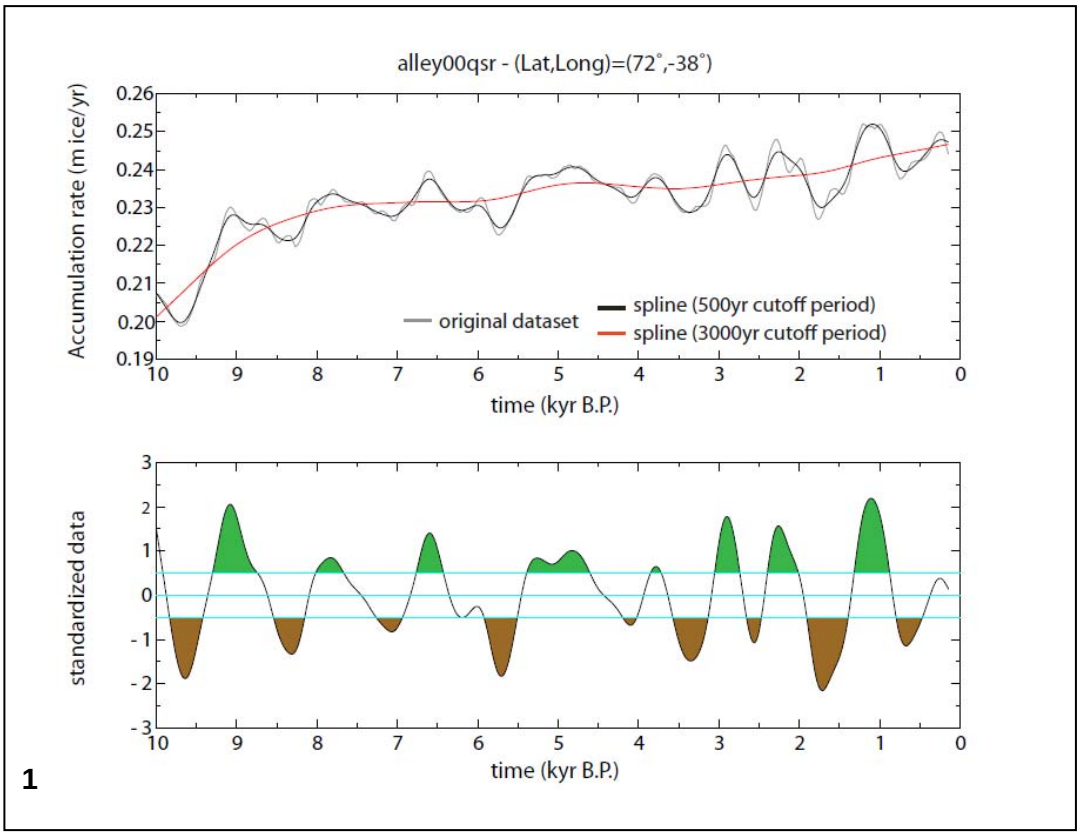

seppa04qr - (Lat,Long)=(58.58°,26.65°)
Annual mean air temperature (pollen) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

44

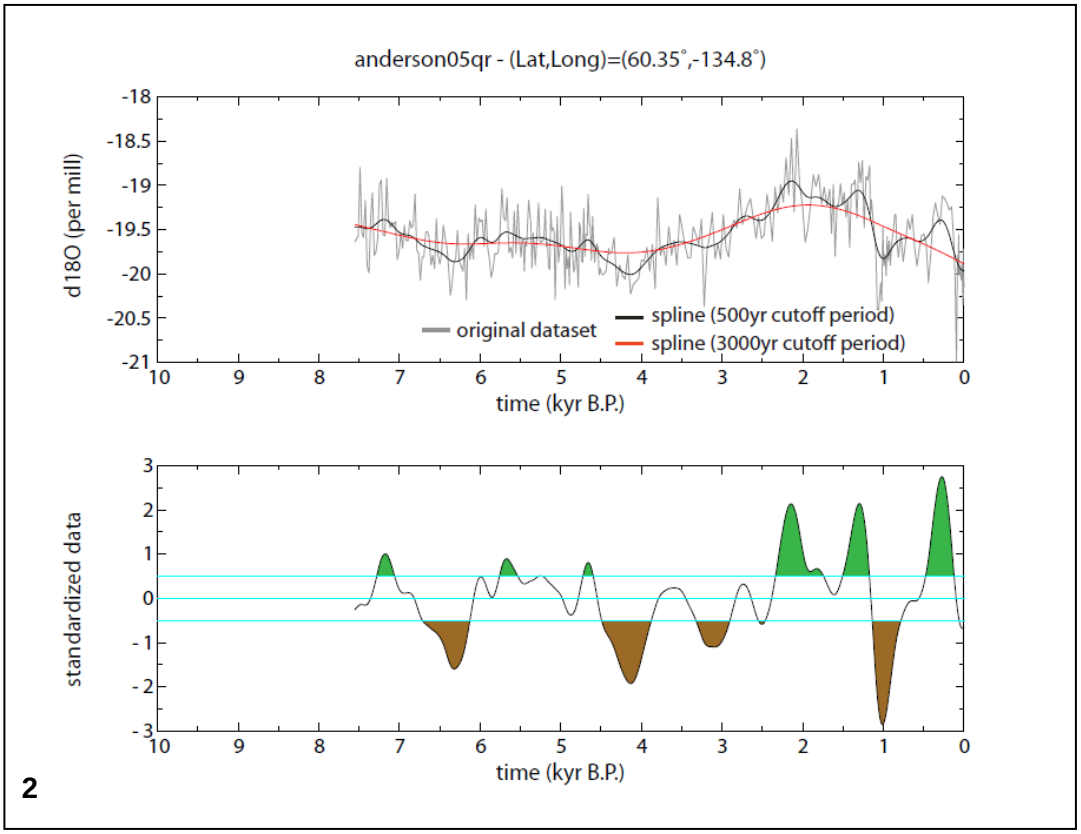

isono09geo - (Lat,Long)=(36.03°,141.78°)
SST (Uk37) (deg C)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

45

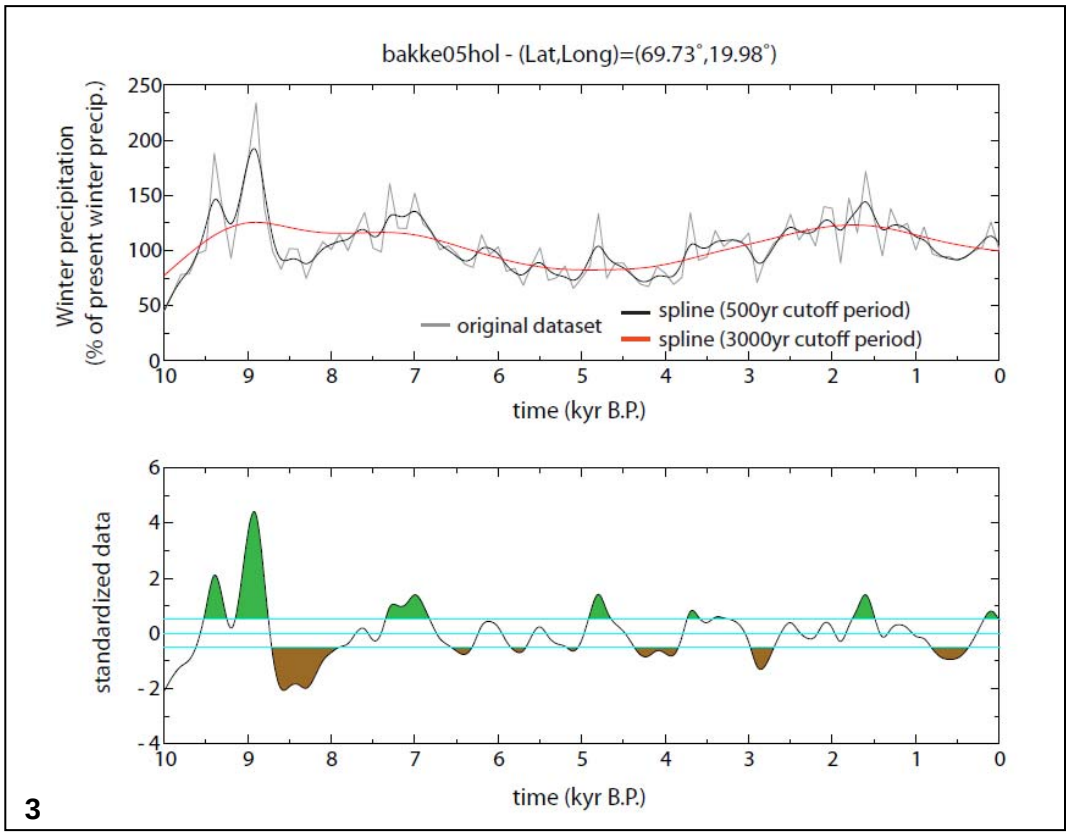
3.2. Humidity/precipitation



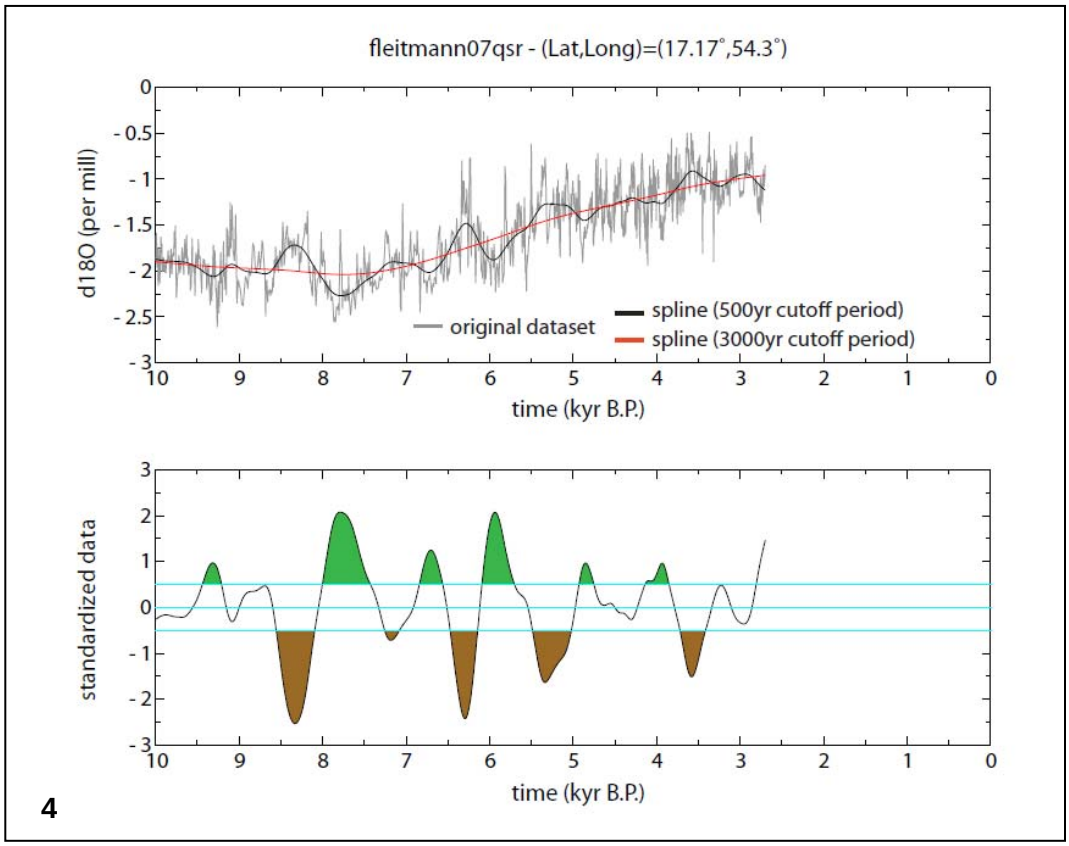
1



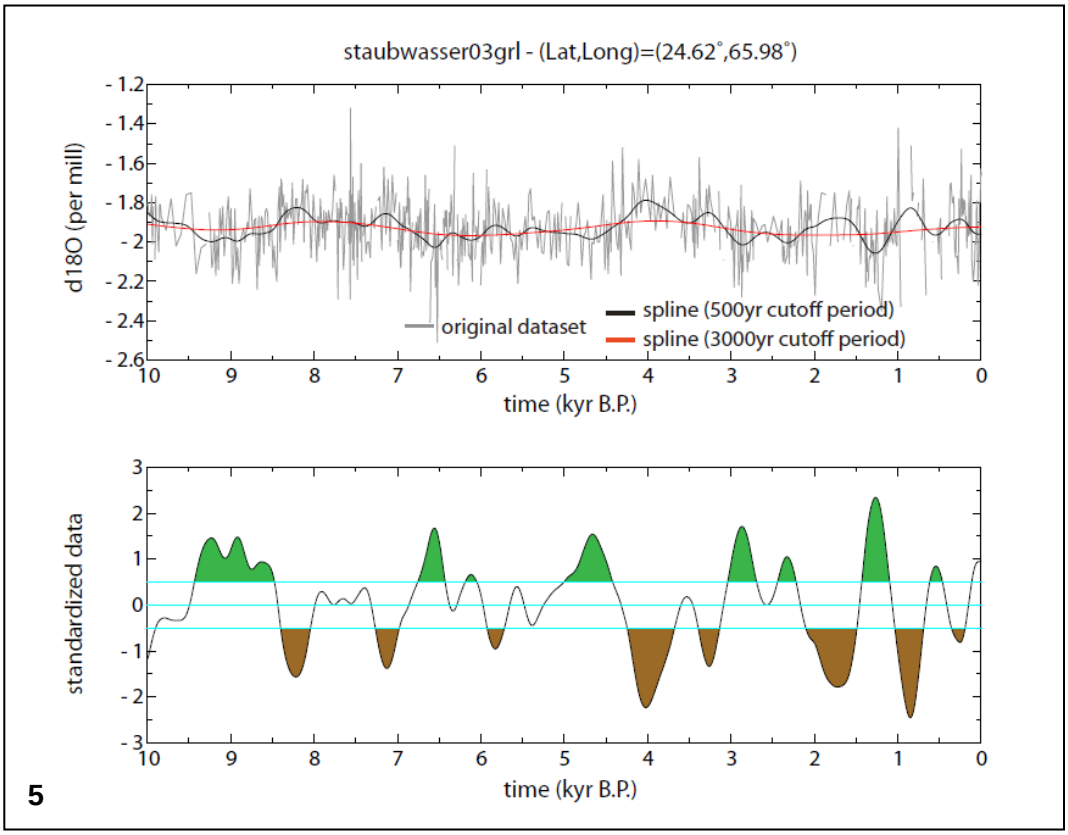
2


bakke05hol - (Lat,Long)=(69.73°,19.98°)
Winter precipitation
(% of present winter precip.)
250
200
150
100
50
0
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
6
4
2
0
-2
-4
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

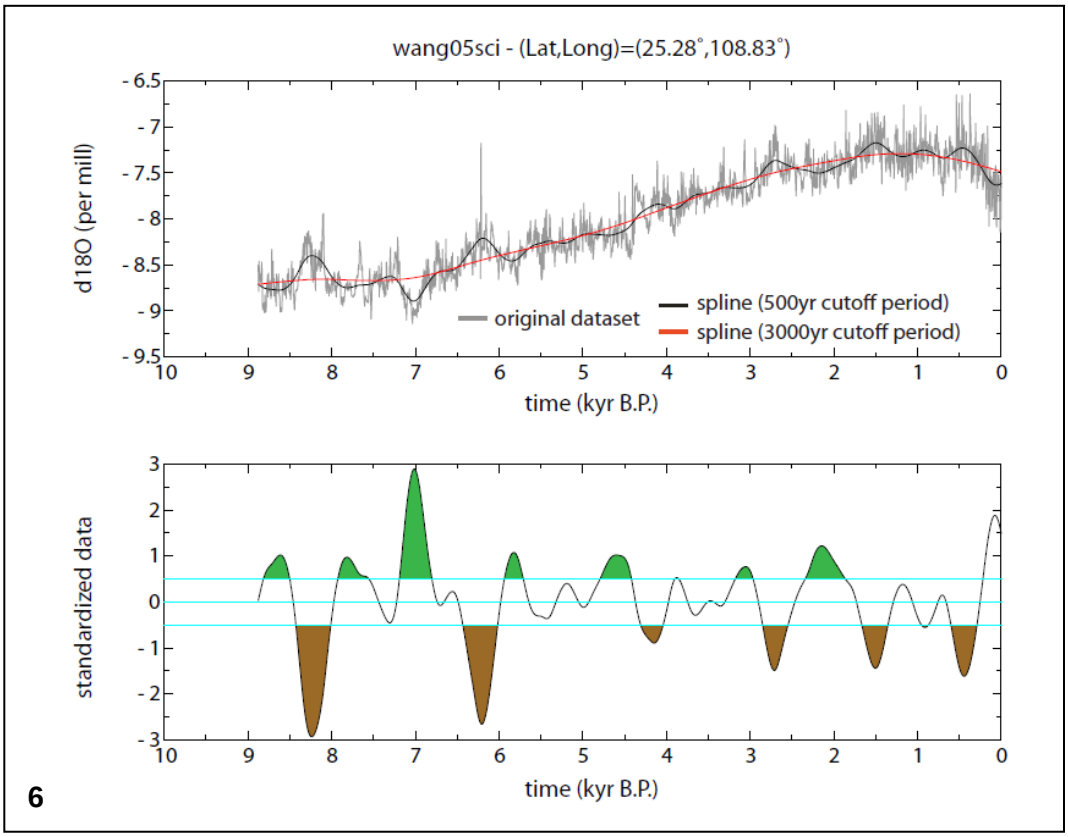
3


fleitmann07qsr - (Lat,Long)=(17.17°,54.3°)
d18O (per mill)
0
-0.5
-1
-1.5
-2
-2.5
-3
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
3
2
1
0
-1
-2
-3
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

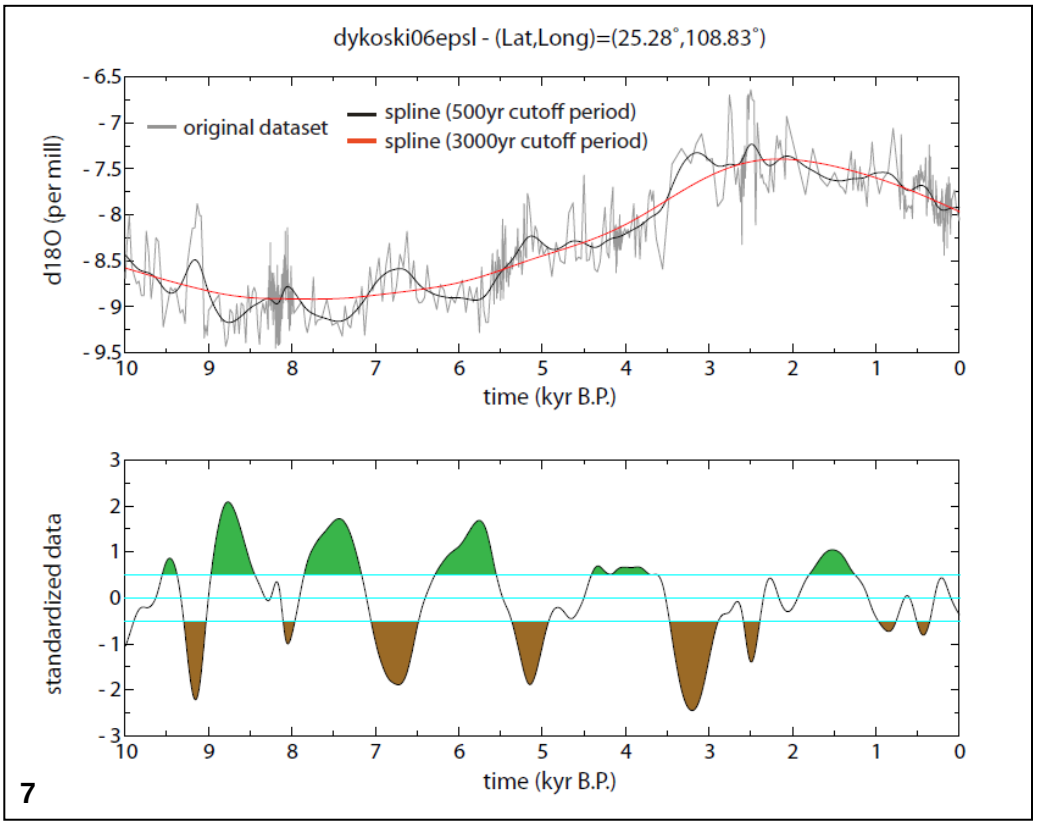
4


staubwasser03grl - (Lat,Long)=(24.62°,65.98°)
d18O (per mill)
- 1.2
- 1.4
- 1.6
- 1.8
- 2
- 2.2
- 2.4
- 2.6
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
3 2 1 0 - 1 - 2 - 3
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

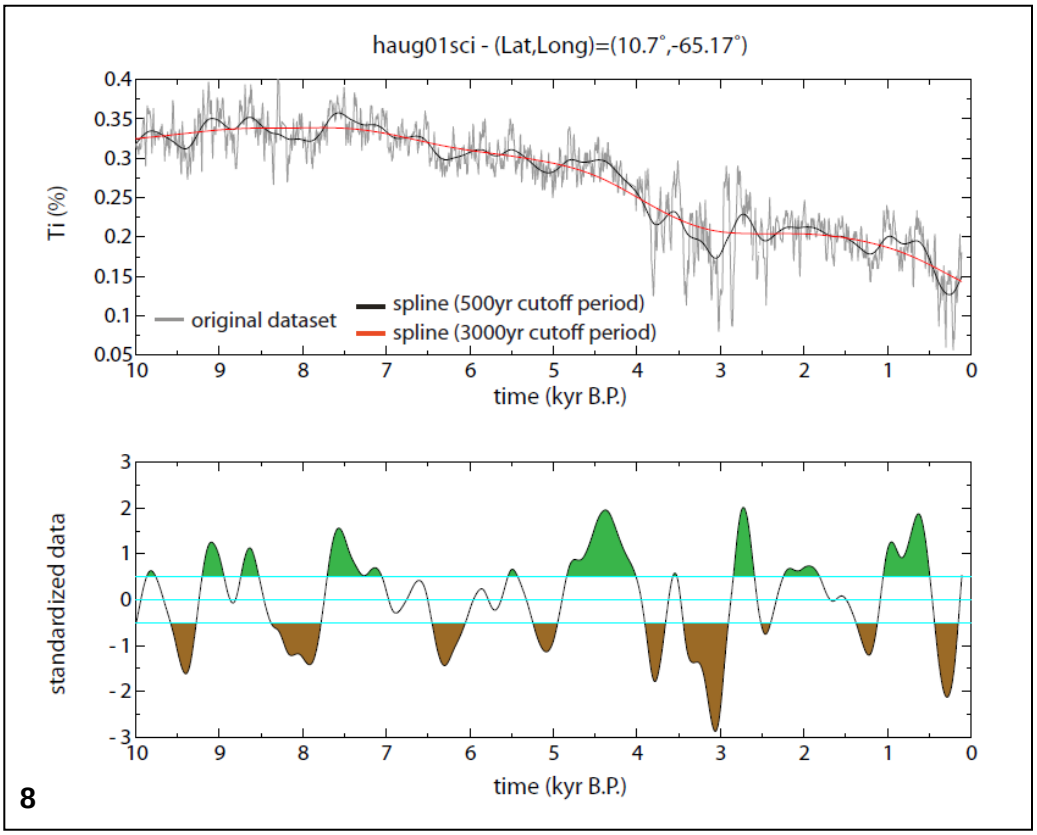
5


wang05sci - (Lat,Long)=(25.28°,108.83°)
d18O (per mill)
- 6.5
- 7
- 7.5
- 8
- 8.5
- 9
- 9.5
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
3 2 1 0 - 1 - 2 - 3
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

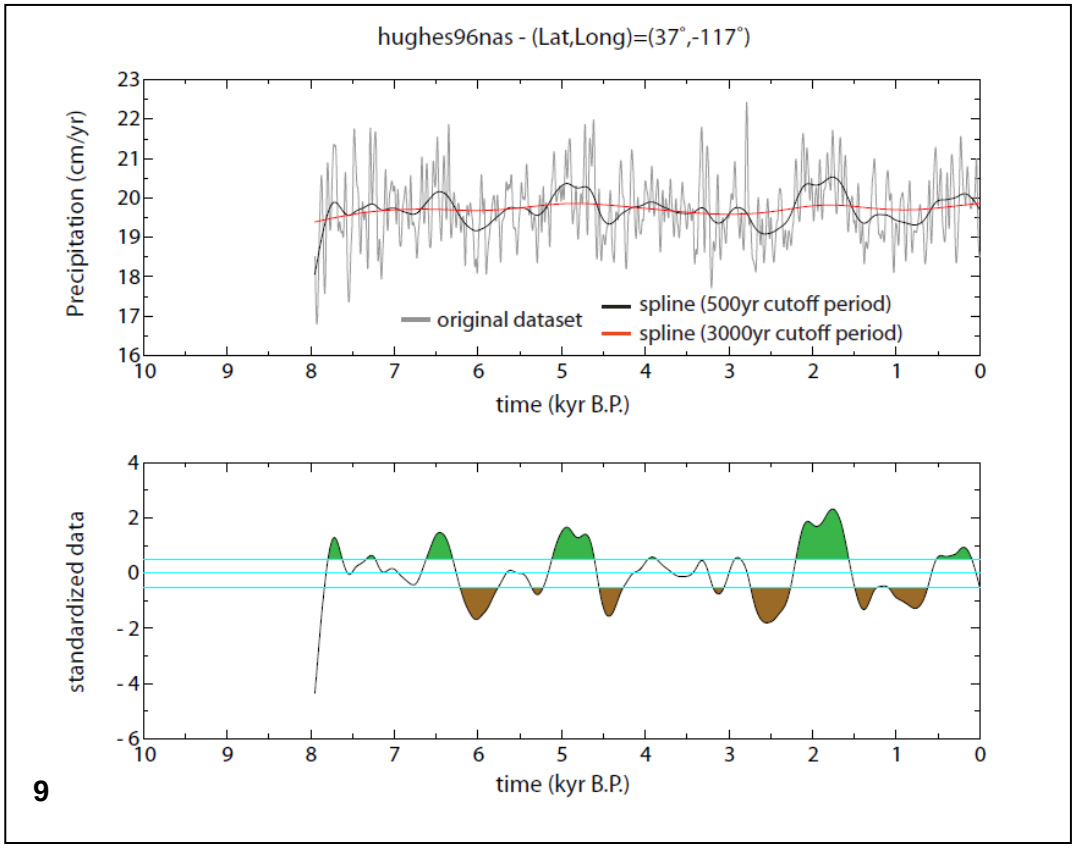
6


dykoski06epsl - (Lat,Long)=(25.28°,108.83°)
d18O (per mill)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

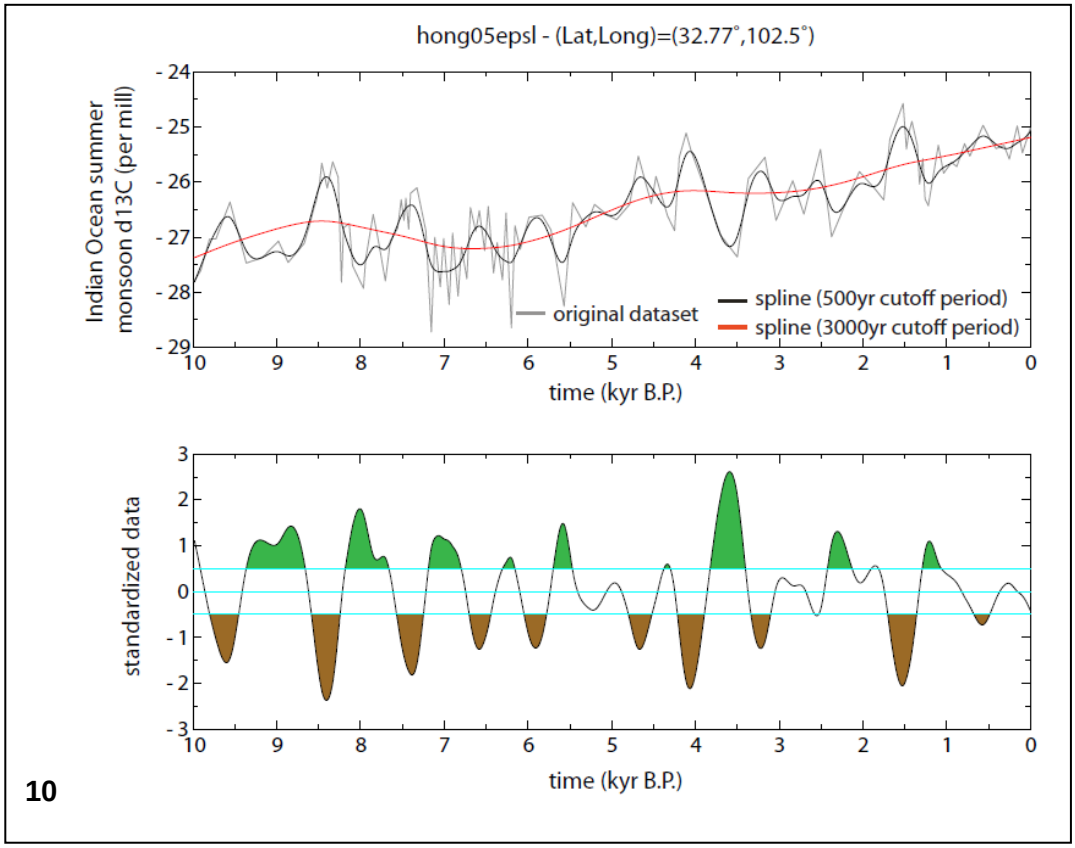
7


haug01sci - (Lat,Long)=(10.7°,-65.17°)
Ti (%)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

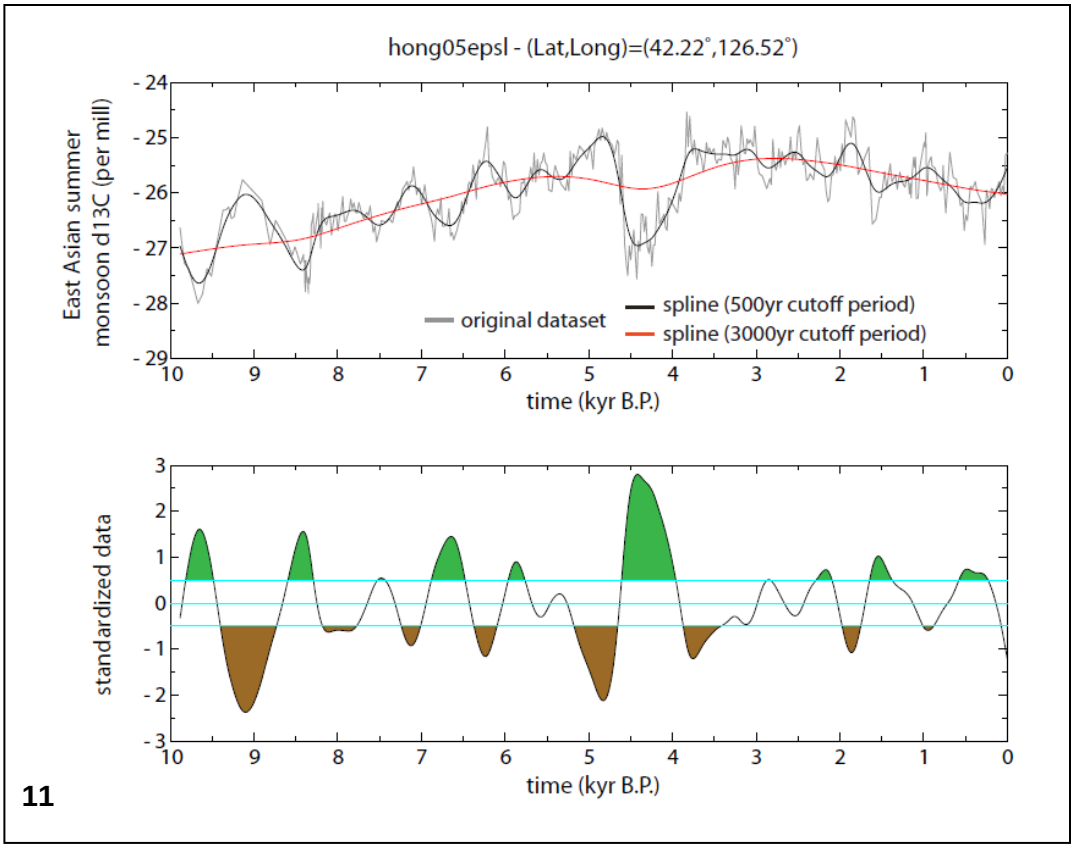
8


hughes96nas - (Lat,Long)=(37°,-117°)
Precipitation (cm/yr)
23
22
21
20
19
18
17
16
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
4
2
0
-2
-4
-6
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

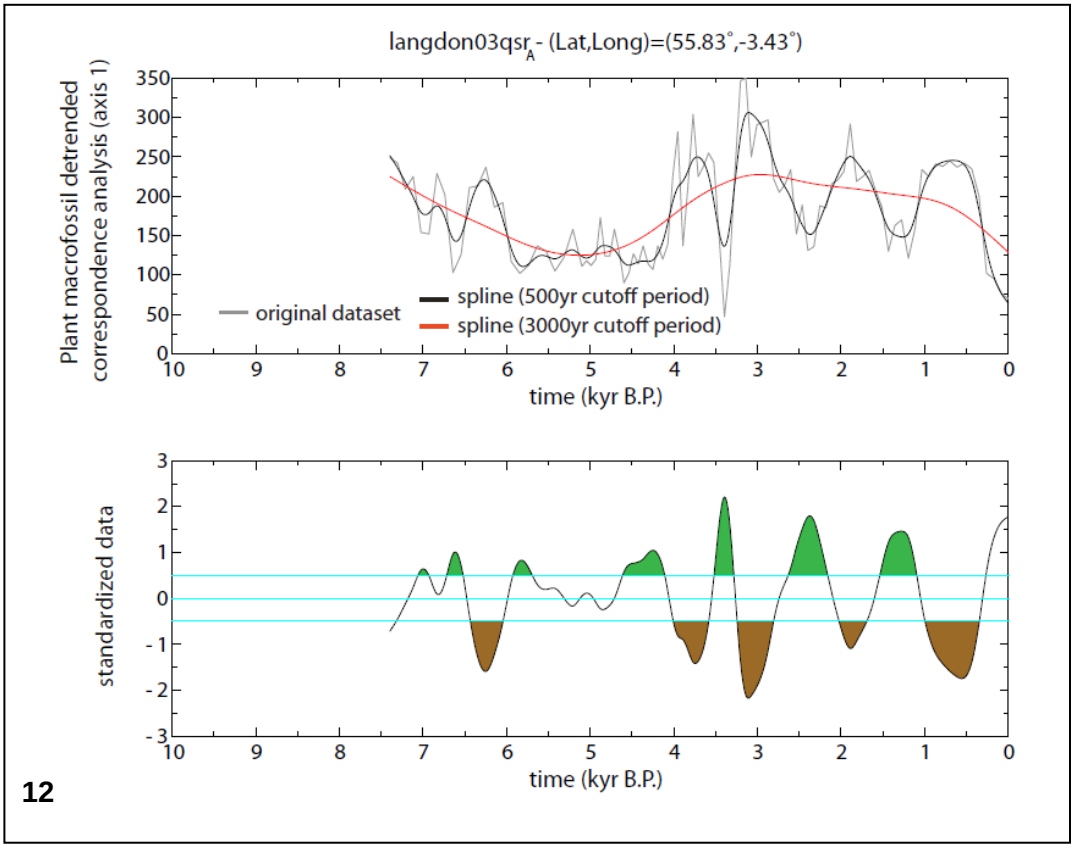
9


hong05epsl - (Lat,Long)=(32.77°,102.5°)
Indian Ocean summer monsoon d13C (per mill)
-24
-25
-26
-27
-28
-29
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
3
2
1
0
-1
-2
-3
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

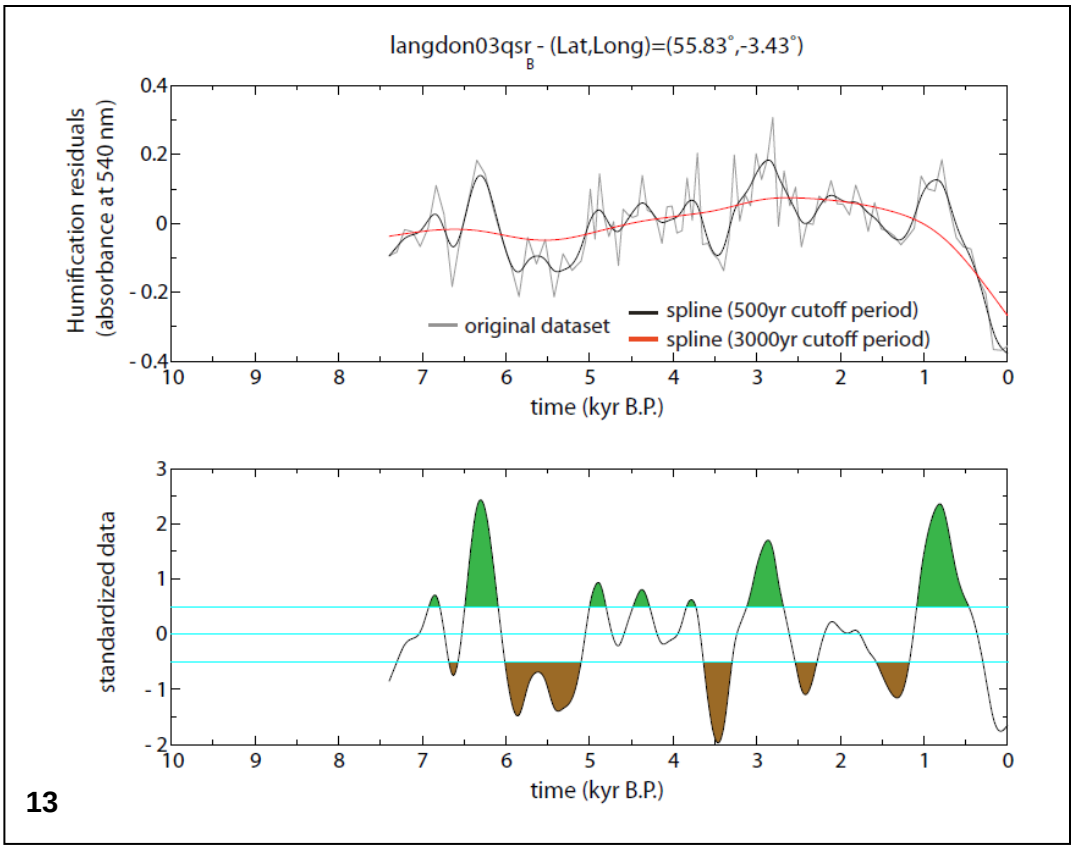
10


hong05epsl - (Lat,Long)=(42.22°,126.52°)
East Asian summer monsoon d13C (per mill)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

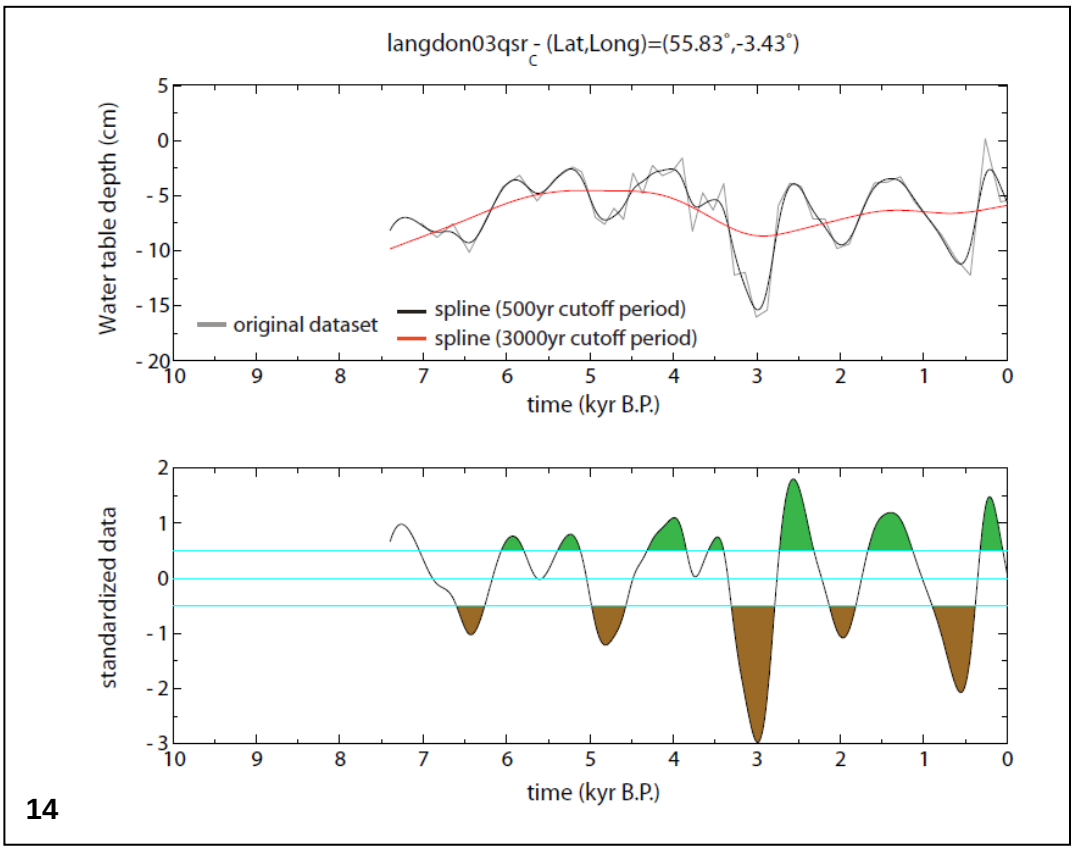
11


langdon03qsr$_A$ - (Lat,Long)=(55.83°,-3.43°)
Plant macrofossil detrended correspondence analysis (axis 1)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

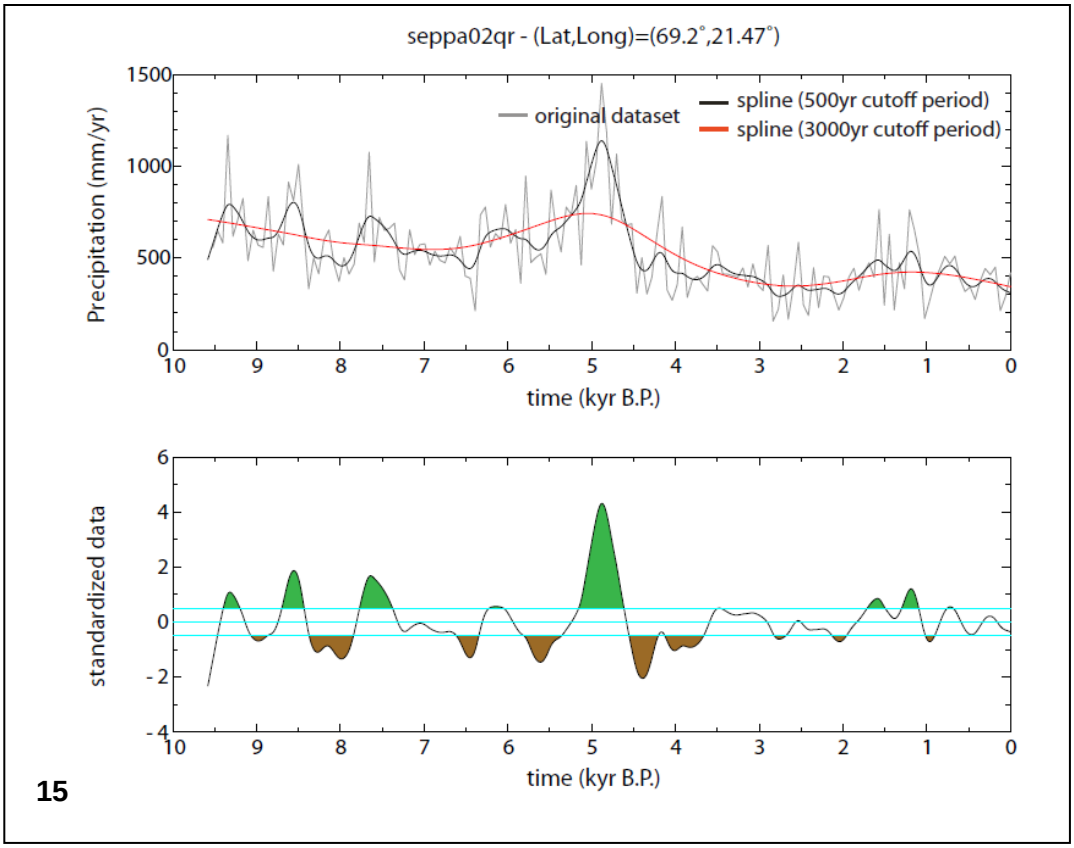
12


langdon03qsr B - (Lat,Long)=(55.83°,-3.43°)
Humification residuals (absorbance at 540 nm)
0.4
0.2
0
- 0.2
- 0.4
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
3 2 1 0 - 1 - 2
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

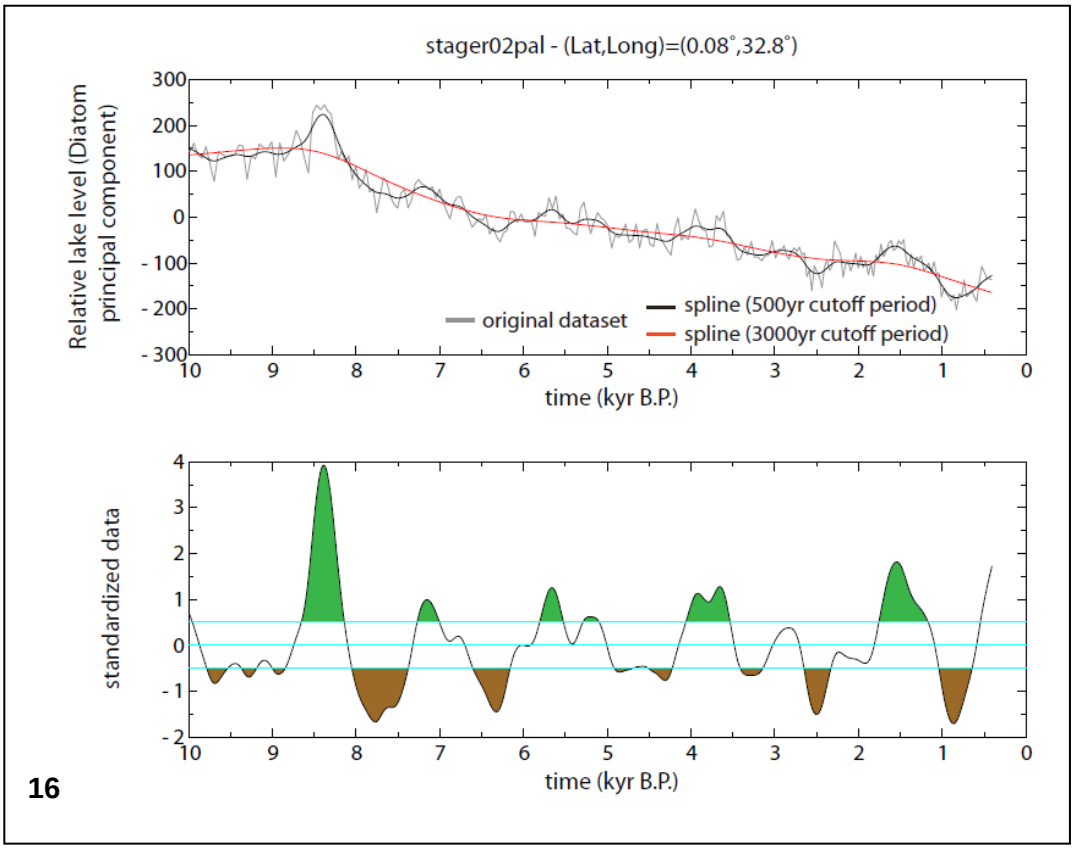
13


langdon03qsr C - (Lat,Long)=(55.83°,-3.43°)
Water table depth (cm)
5 0 - 5 - 10 - 15 - 20
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
2 1 0 - 1 - 2 - 3
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

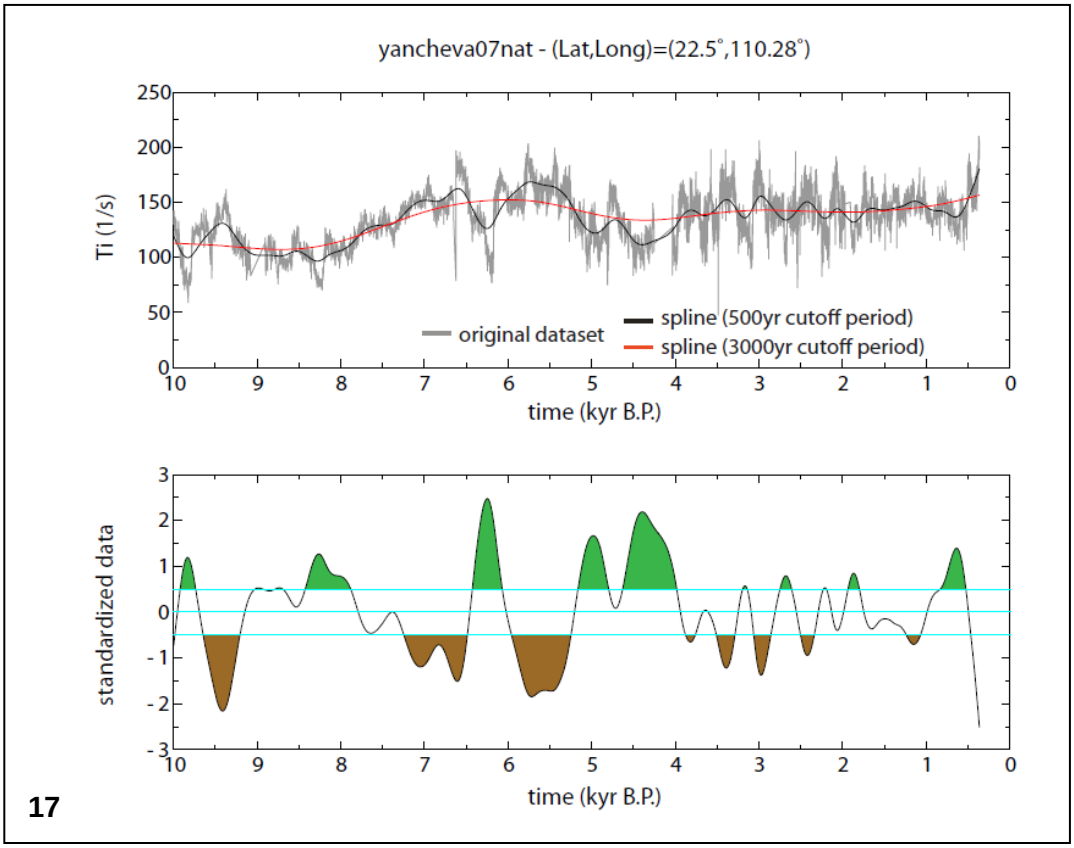
14


seppa02qr - (Lat,Long)=(69.2°,21.47°)
Precipitation (mm/yr)
1500
1000
500
0
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
6
4
2
0
-2
-4
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

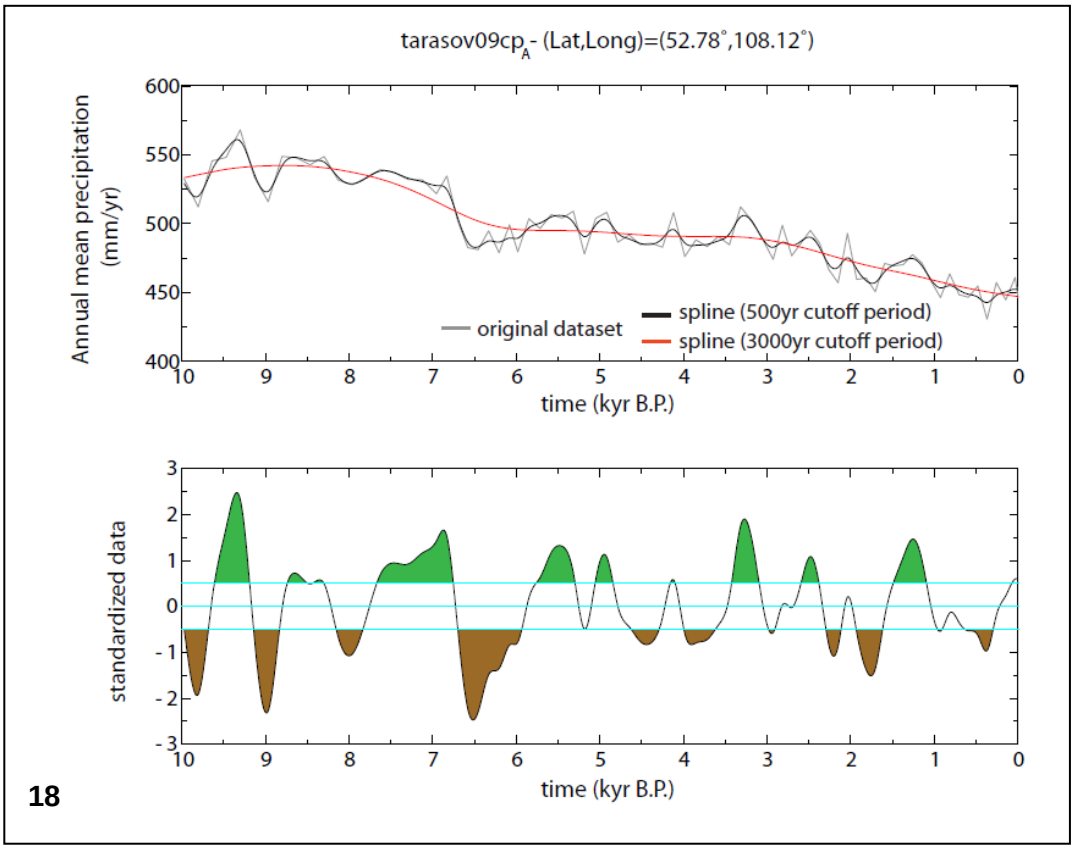
15


stager02pal - (Lat,Long)=(0.08°,32.8°)
Relative lake level (Diatom principal component)
300
200
100
0
-100
-200
-300
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
4
3
2
1
0
-1
-2
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

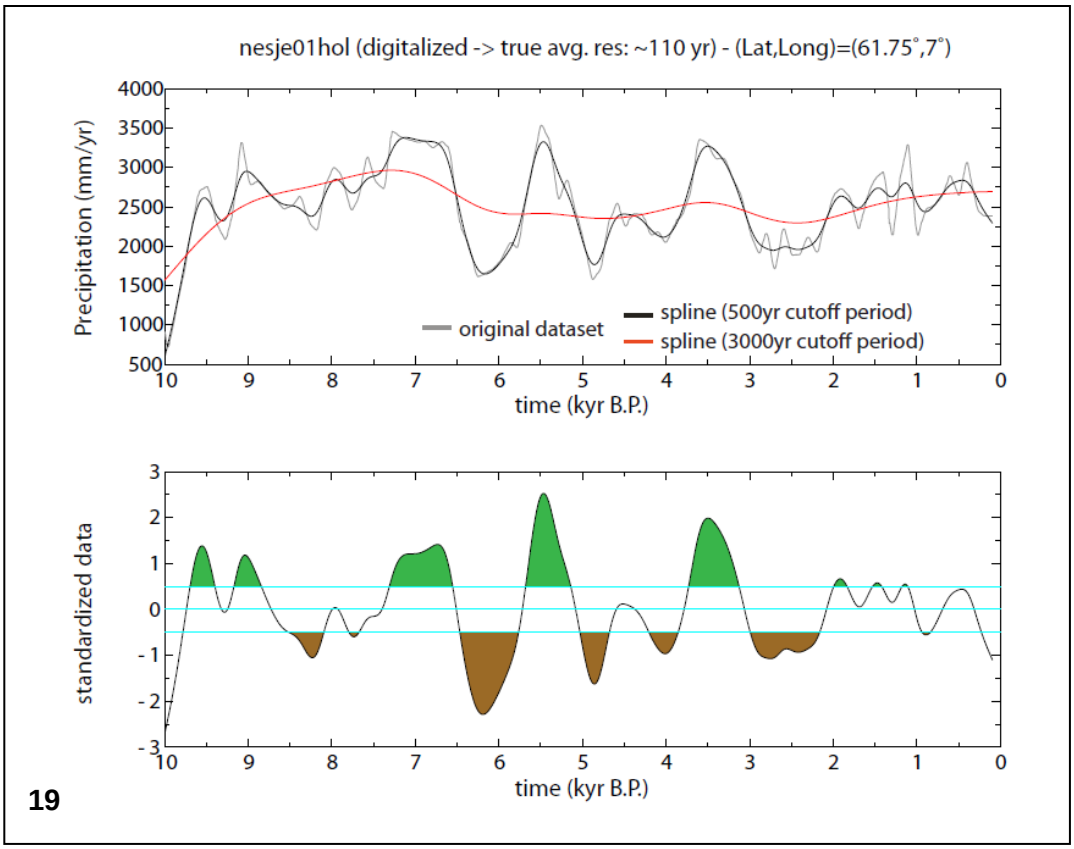
16


yancheva07nat - (Lat,Long)=(22.5°,110.28°)
Ti (1/s)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

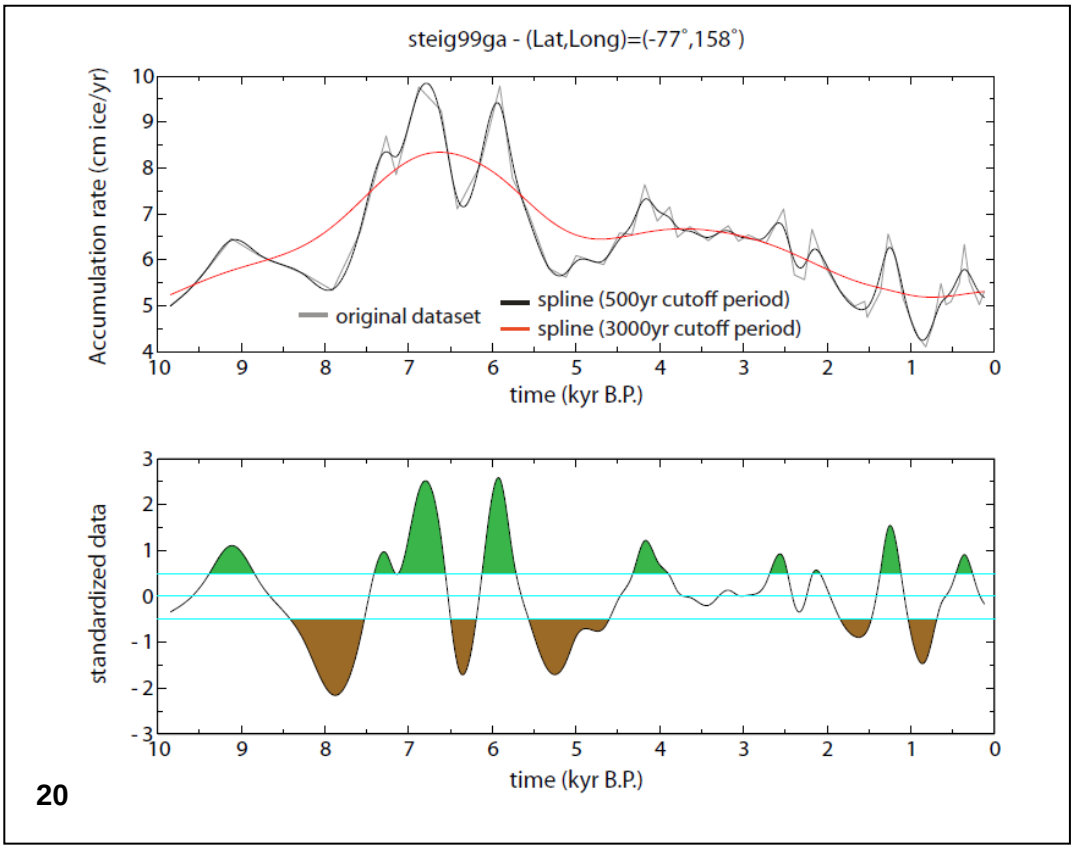
17


tarasov09cp$_A$ - (Lat,Long)=(52.78°,108.12°)
Annual mean precipitation (mm/yr)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

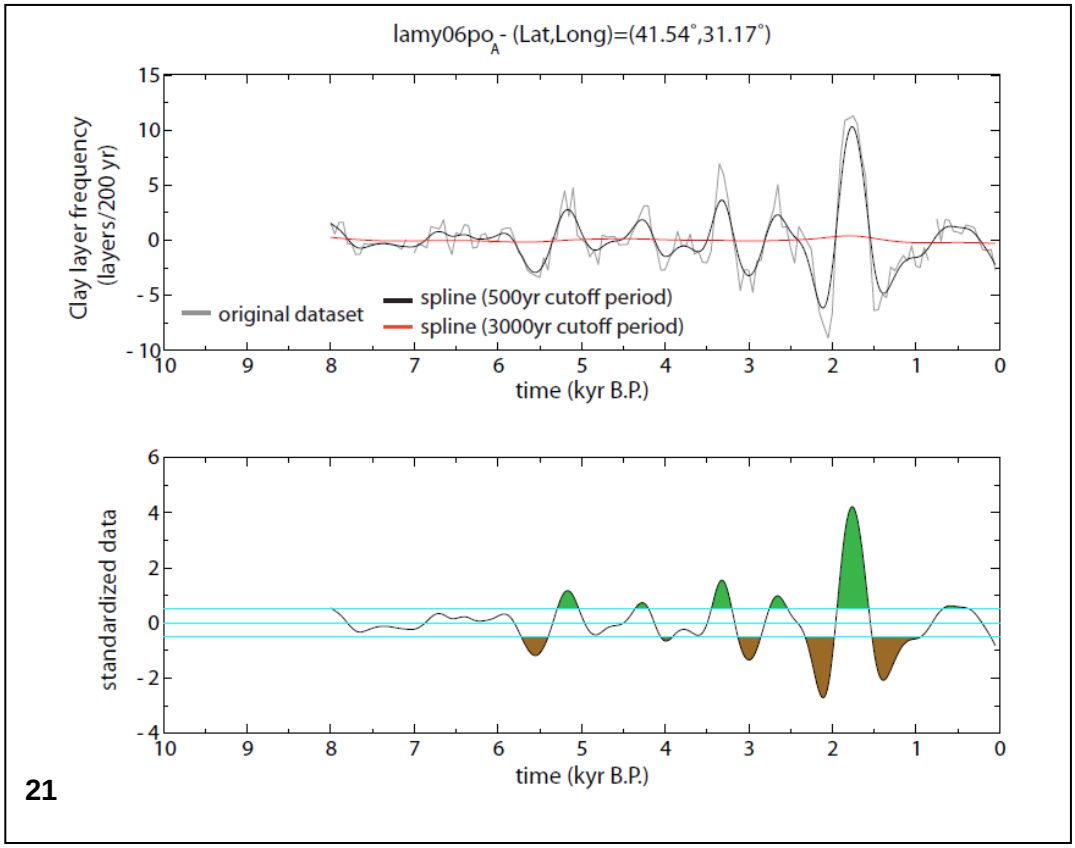
18


nesje01hol (digitalized -> true avg. res: ~110 yr) - (Lat,Long)=(61.75˚,7˚)
Precipitation (mm/yr)
4000
3500
3000
2500
2000
1500
1000
500
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
3
2
1
0
-1
-2
-3
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

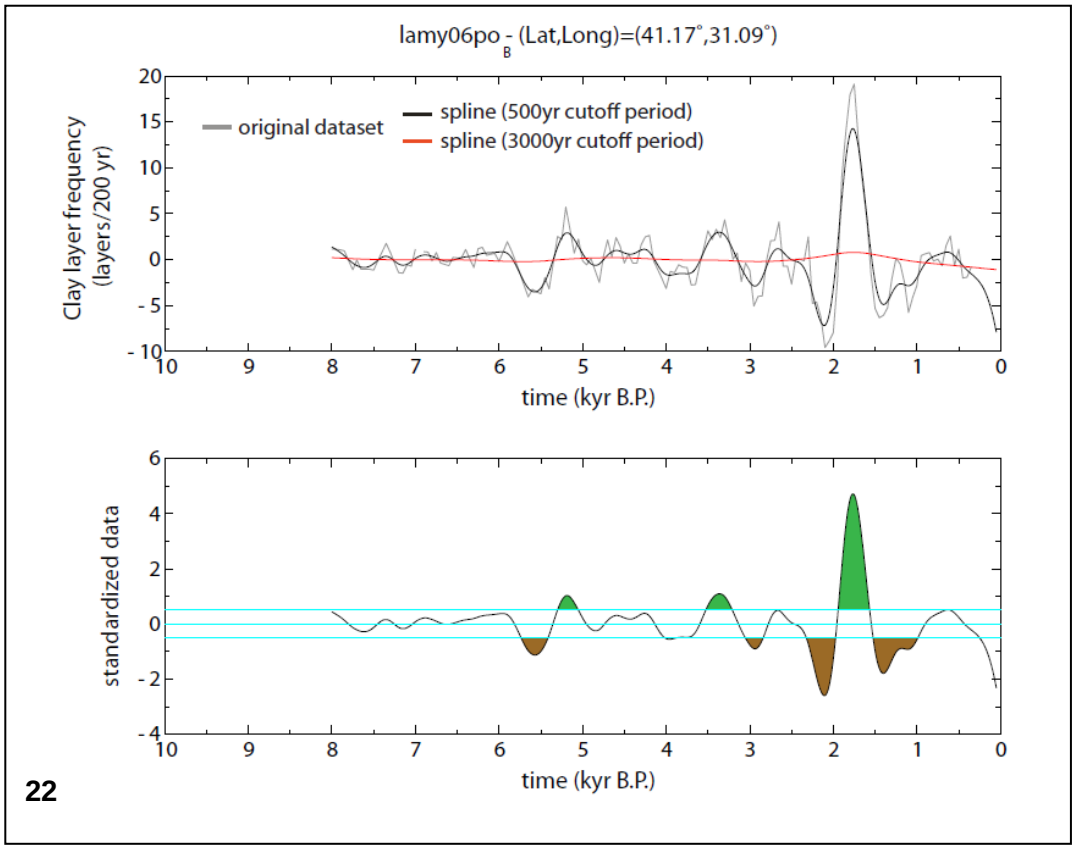
19


steig99ga - (Lat,Long)=(-77˚,158˚)
Accumulation rate (cm ice/yr)
10
9
8
7
6
5
4
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)
standardized data
3
2
1
0
-1
-2
-3
10 9 8 7 6 5 4 3 2 1 0
time (kyr B.P.)

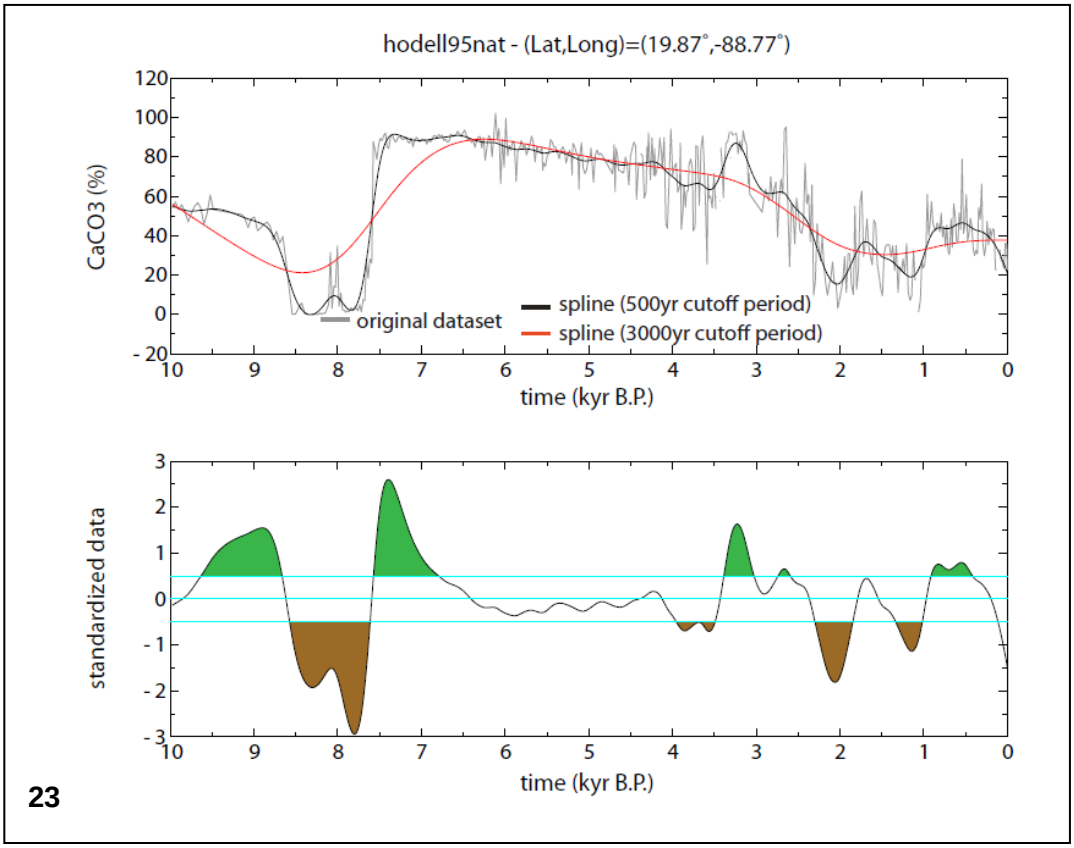
20


lamy06po$_A$ - (Lat,Long)=(41.54°,31.17°)
Clay layer frequency (layers/200 yr)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

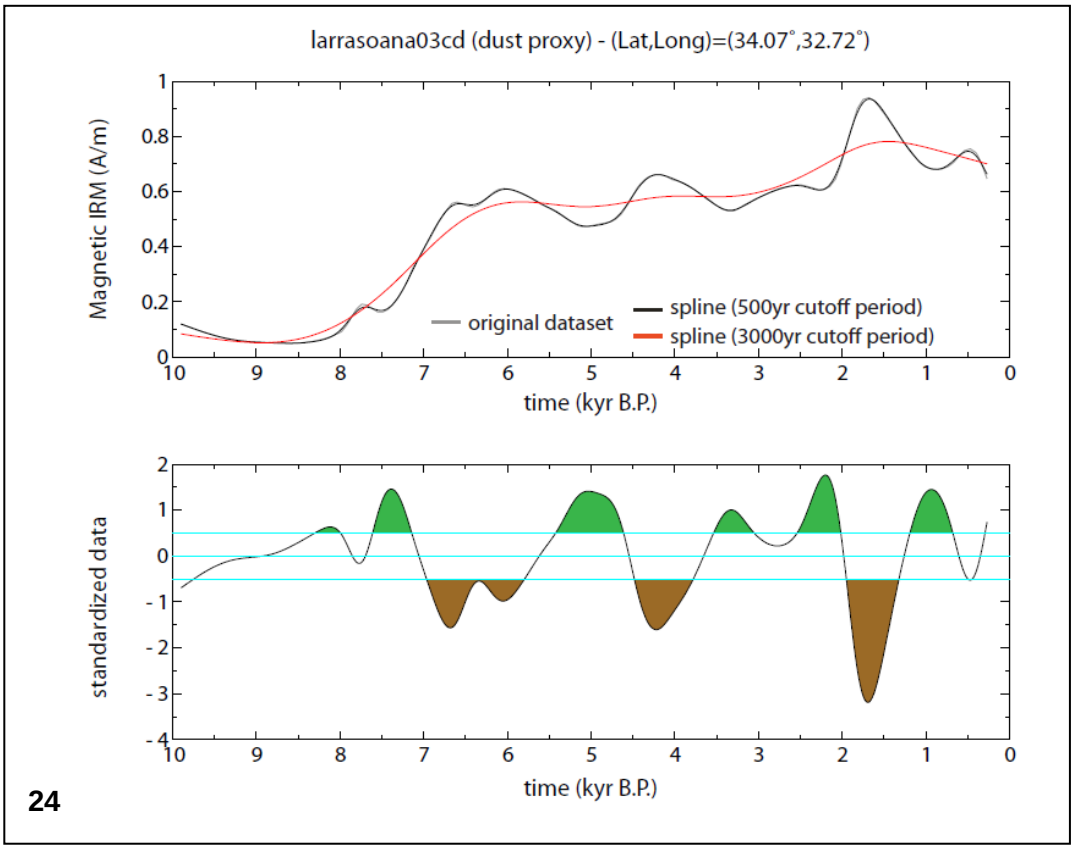
21


lamy06po$_B$ - (Lat,Long)=(41.17°,31.09°)
Clay layer frequency (layers/200 yr)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

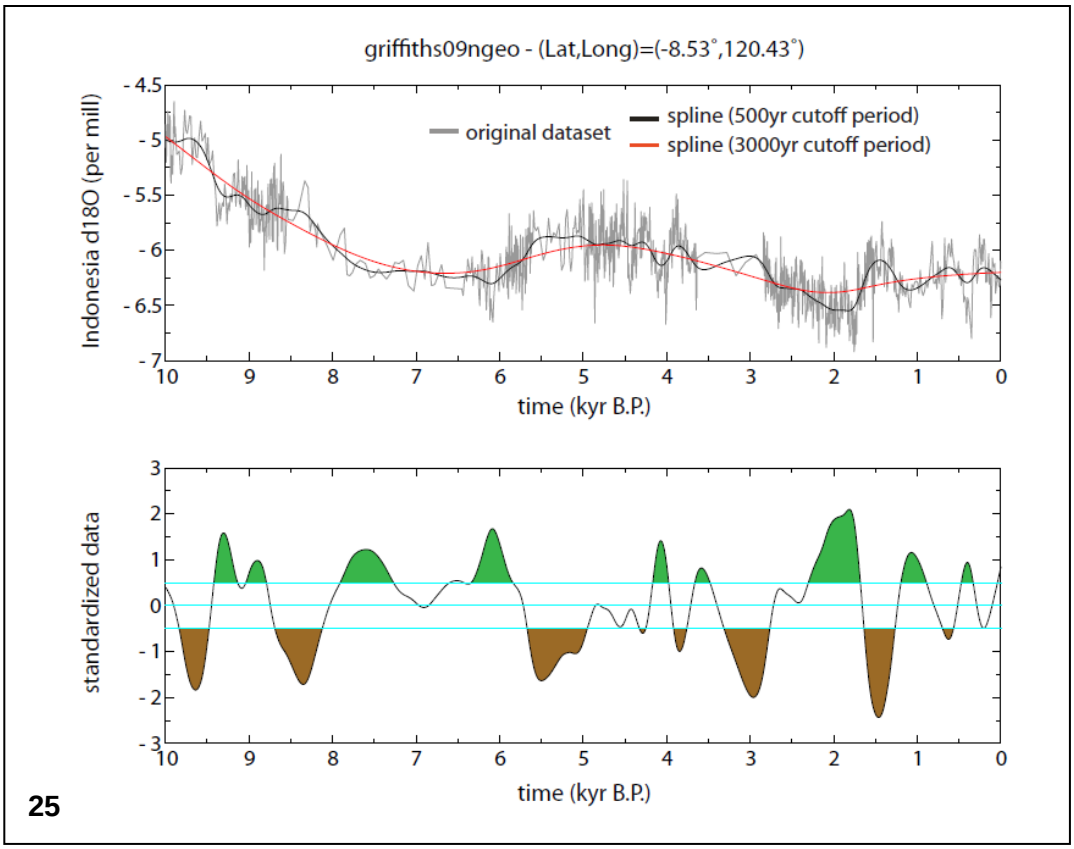
22


hodell95nat - (Lat,Long)=(19.87°,-88.77°)
CaCO3 (%)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

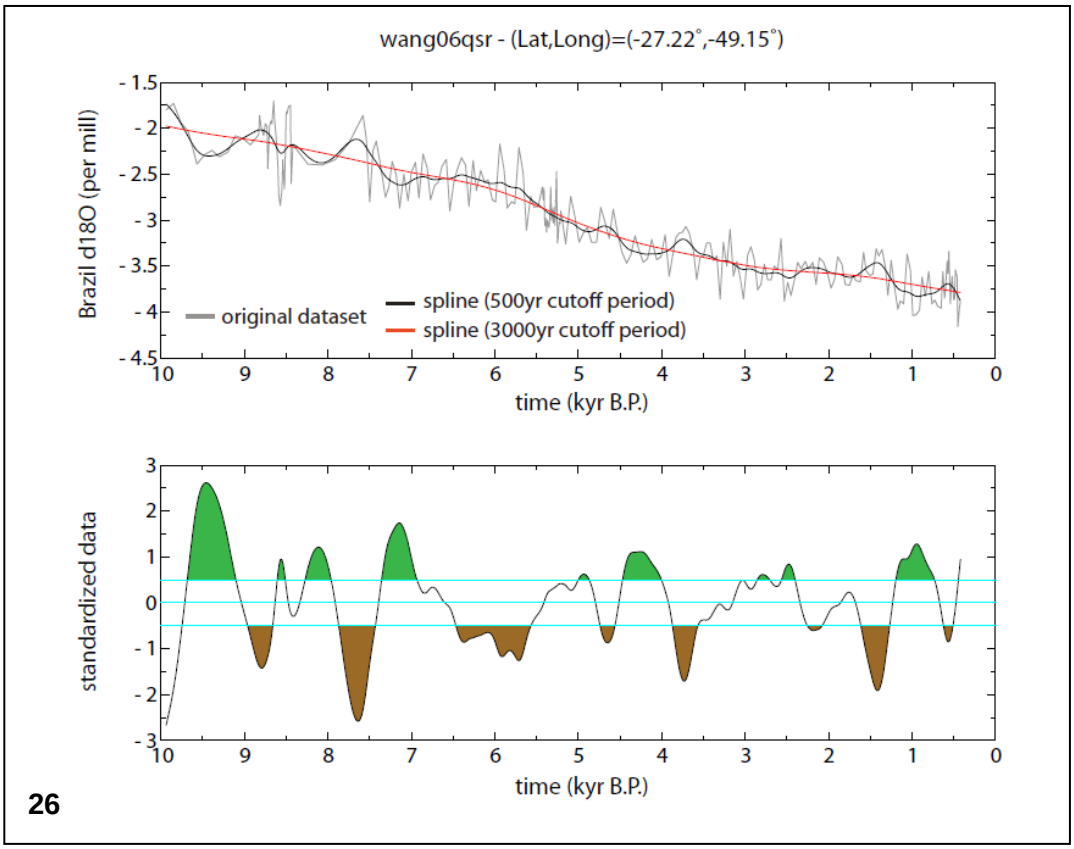
23


larrasoana03cd (dust proxy) - (Lat,Long)=(34.07°,32.72°)
Magnetic IRM (A/m)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

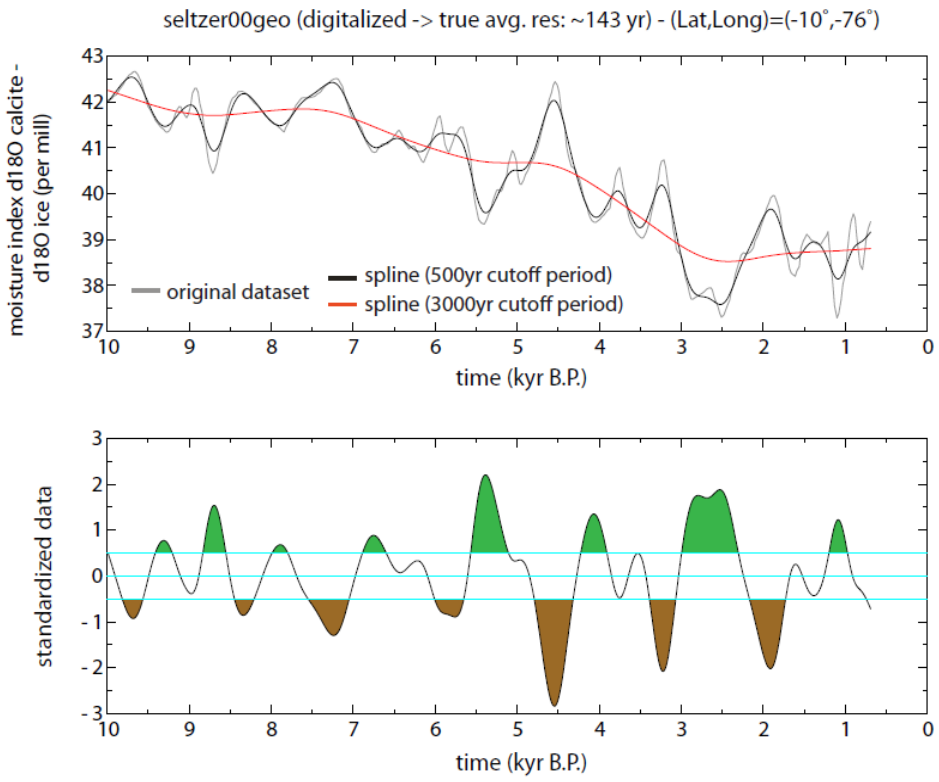
24


griffiths09ngeo - (Lat,Long)=(-8.53˚,120.43˚)
Indonesia d18O (per mill)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

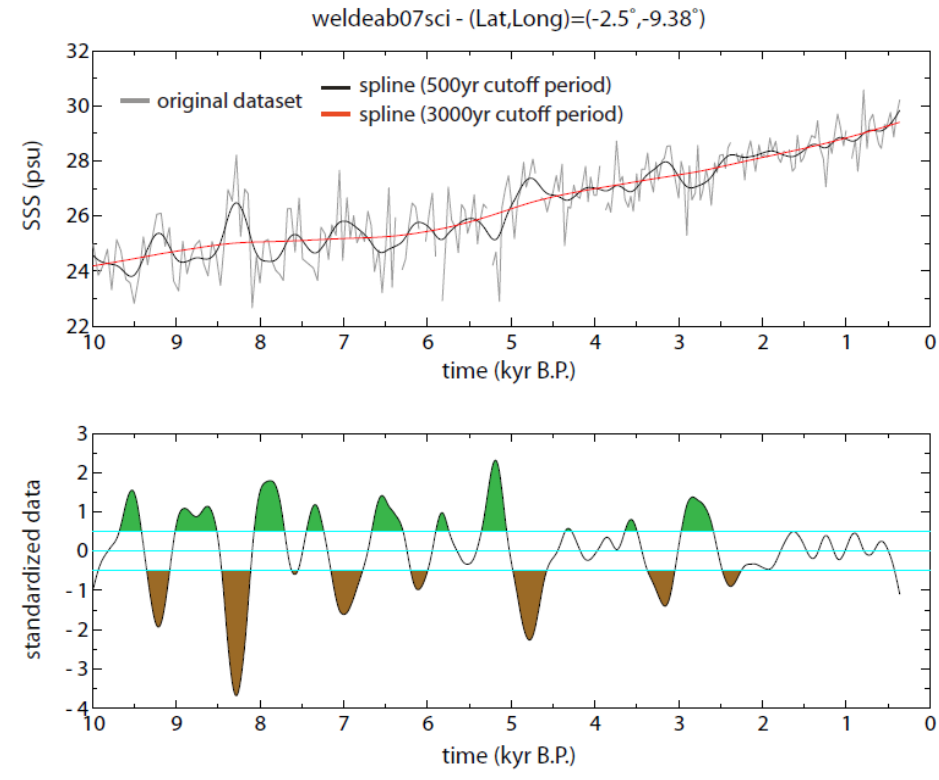
25


wang06qsr - (Lat,Long)=(-27.22˚,-49.15˚)
Brazil d18O (per mill)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

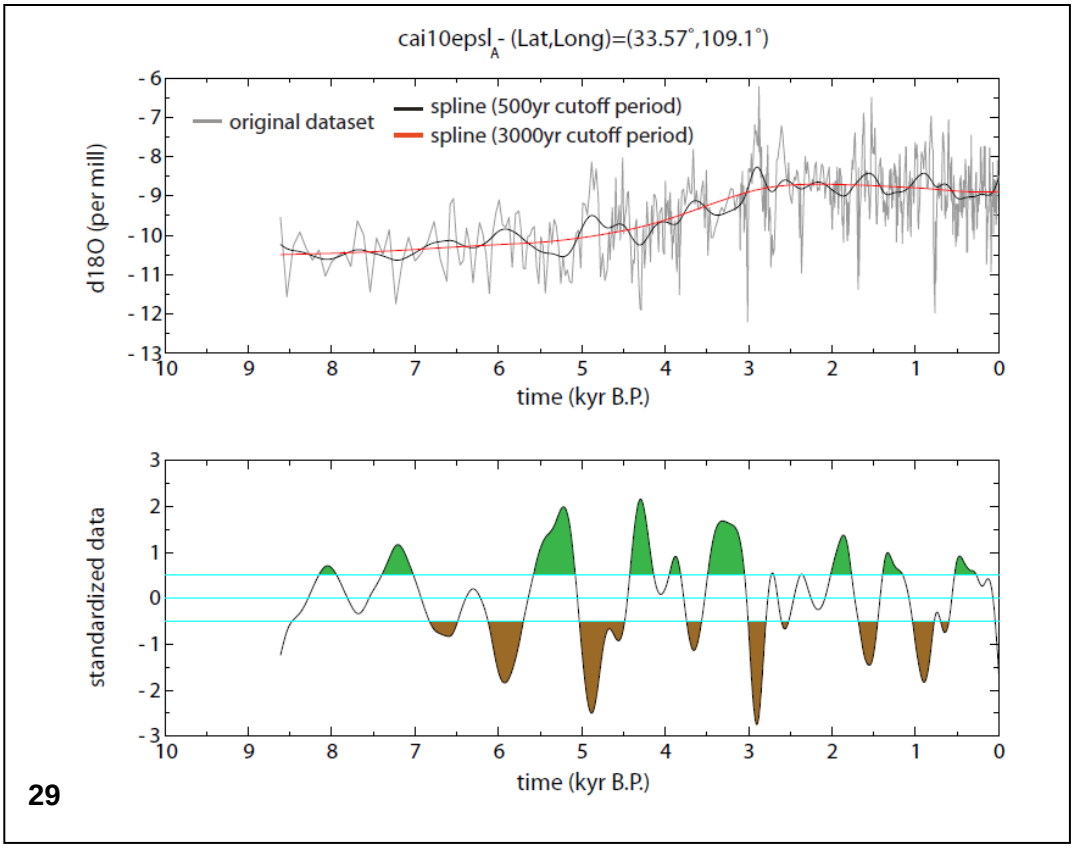
26


seltzer00geo (digitalized -> true avg. res: ~143 yr) - (Lat,Long)=(-10˚,-76˚)
moisture index d18O calcite - d18O ice (per mill)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

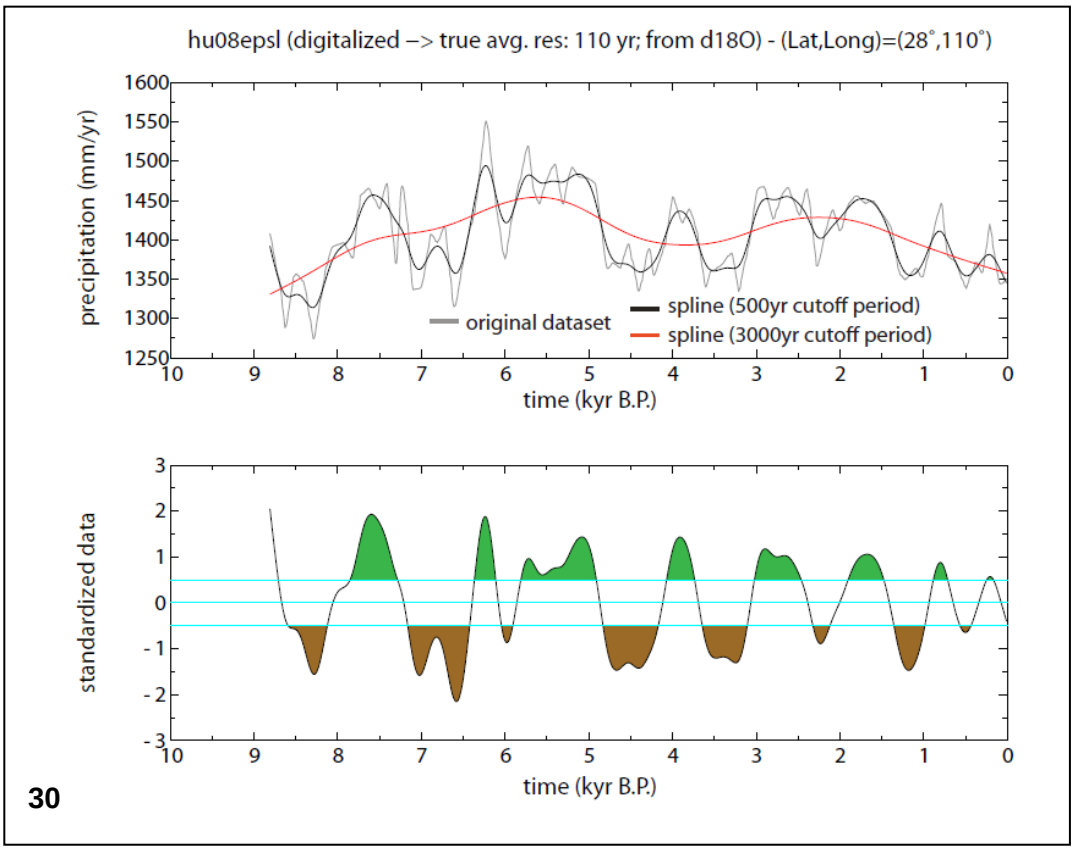
27


weldeab07sci - (Lat,Long)=(-2.5˚,-9.38˚)
SSS (psu)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

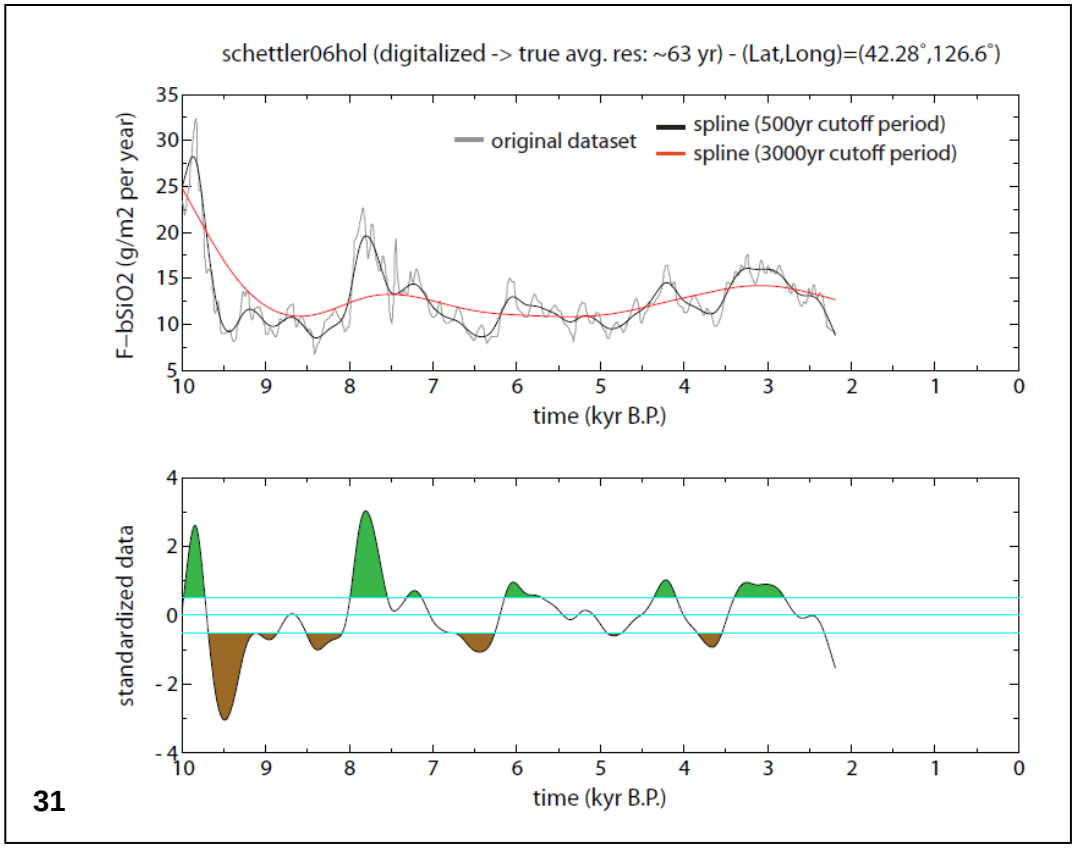
28


cai10epsl_A - (Lat,Long)=(33.57°,109.1°)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
d18O (per mill)
time (kyr B.P.)
standardized data
time (kyr B.P.)

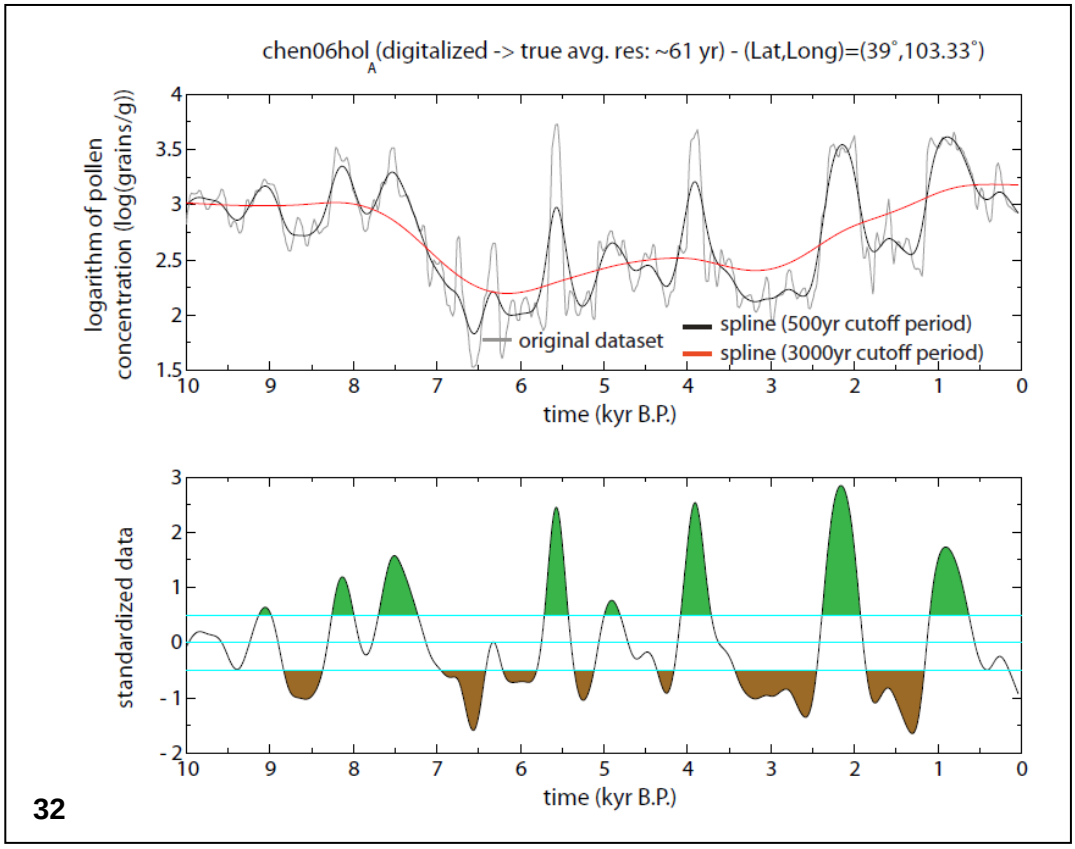
29


hu08epsl (digitalized –> true avg. res: 110 yr; from d18O) - (Lat,Long)=(28°,110°)
precipitation (mm/yr)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

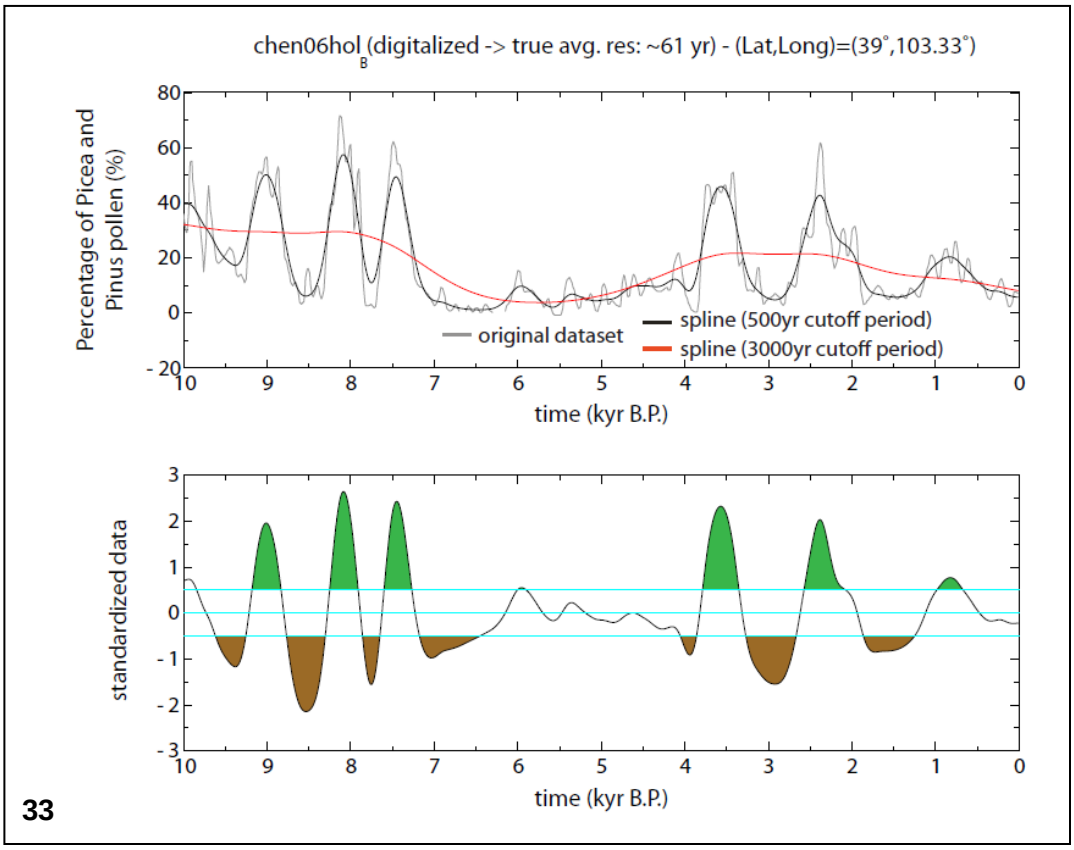
30


schettler06hol (digitalized -> true avg. res: ~63 yr) - (Lat,Long)=(42.28˚,126.6˚)
F–bSiO2 (g/m2 per year)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

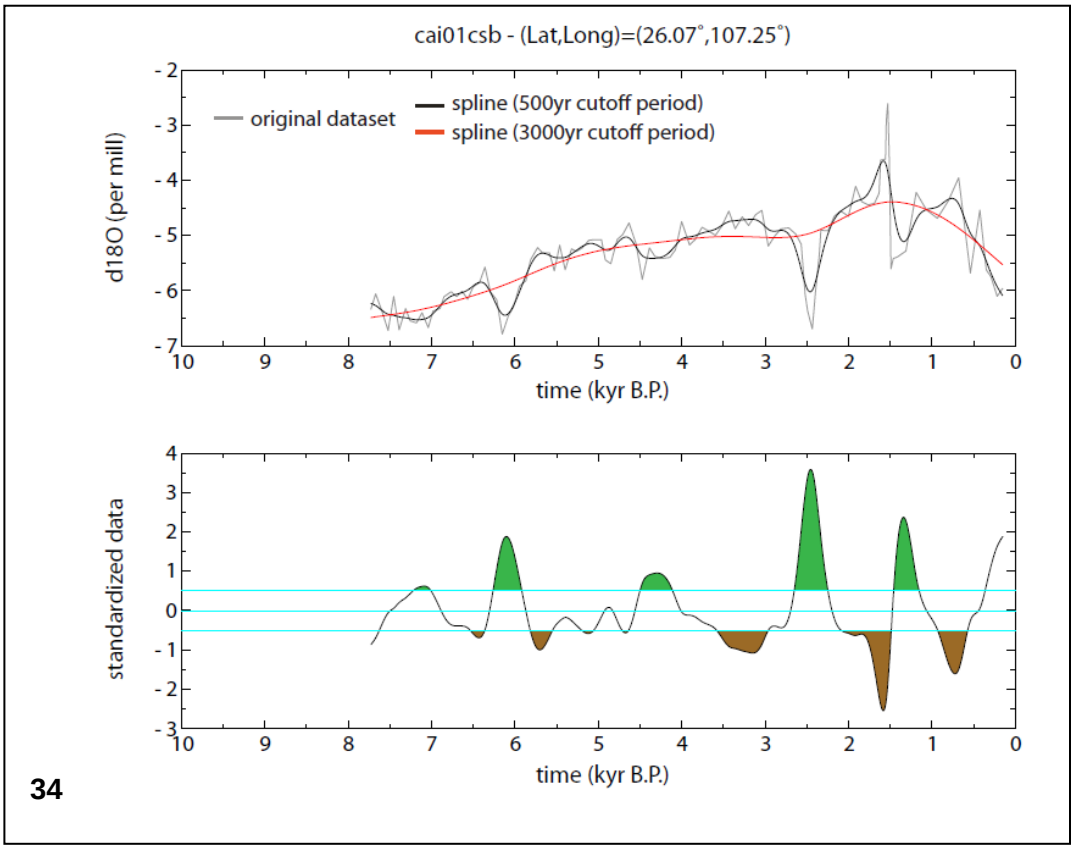
31


chen06hol A (digitalized -> true avg. res: ~61 yr) - (Lat,Long)=(39˚,103.33˚)
logarithm of pollen concentration (log(grains/g))
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

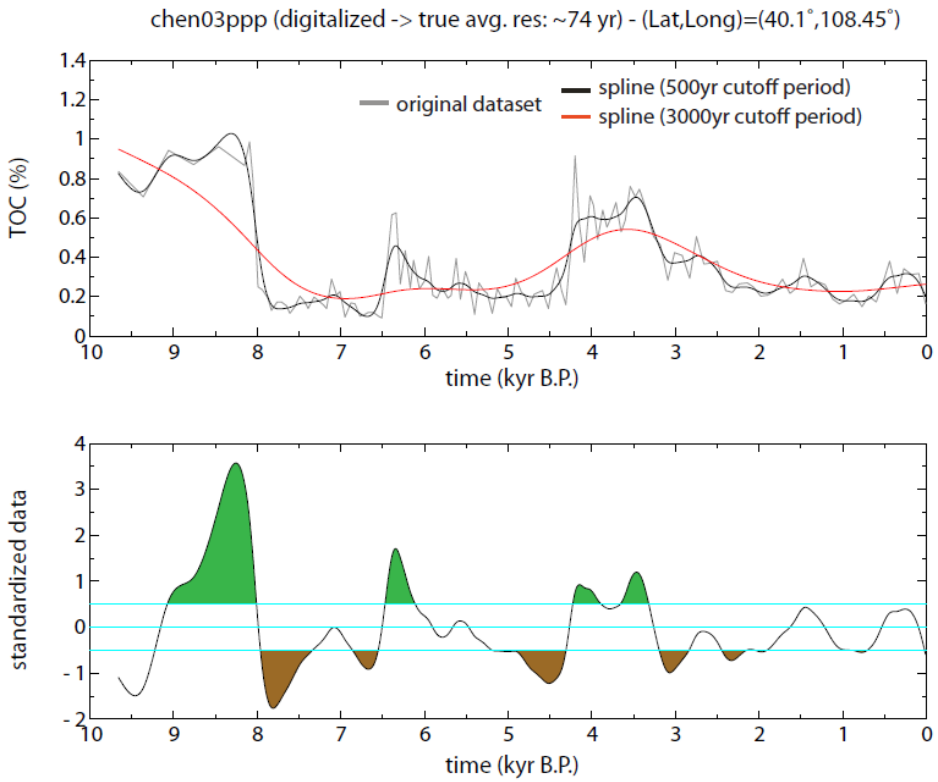
32


chen06hol_B (digitalized -> true avg. res: ~61 yr) - (Lat,Long)=(39°,103.33°)
Percentage of Picea and Pinus pollen (%)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

33

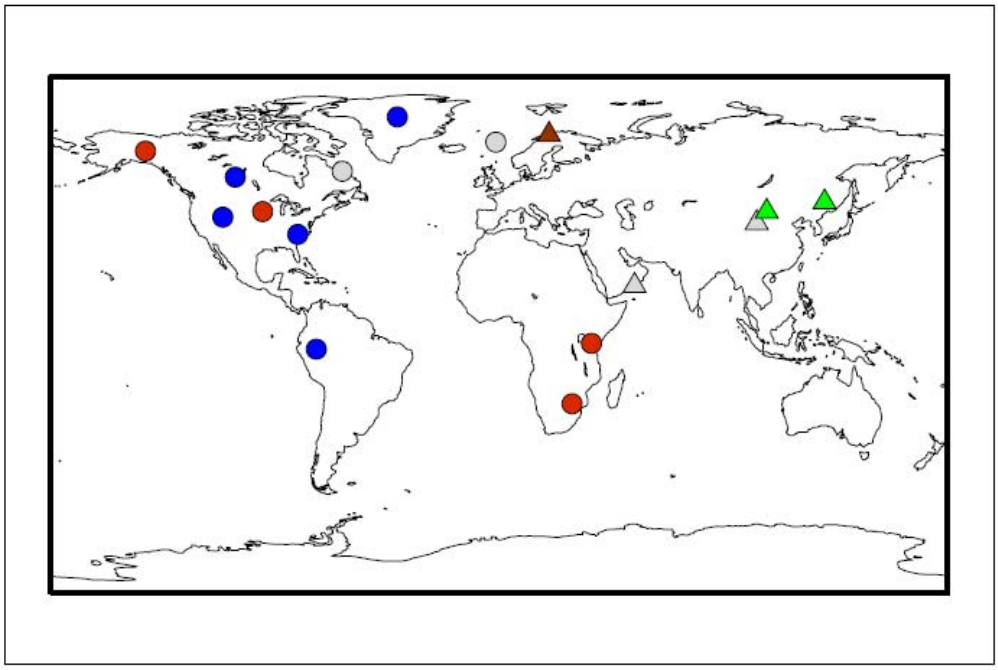

cai01csb - (Lat,Long)=(26.07°,107.25°)
d18O (per mill)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
time (kyr B.P.)
standardized data
time (kyr B.P.)

34

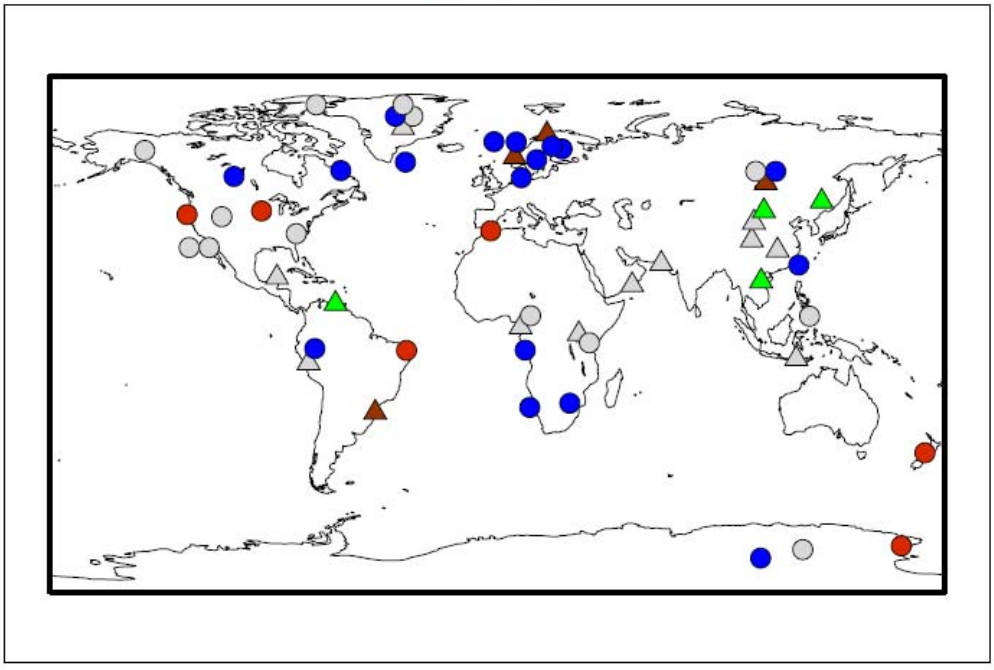

chen03ppp (digitalized -> true avg. res: ~74 yr) - (Lat,Long)=(40.1°,108.45°)
original dataset
spline (500yr cutoff period)
spline (3000yr cutoff period)
TOC (%)
time (kyr B.P.)
standardized data
time (kyr B.P.)

4. Anomaly maps

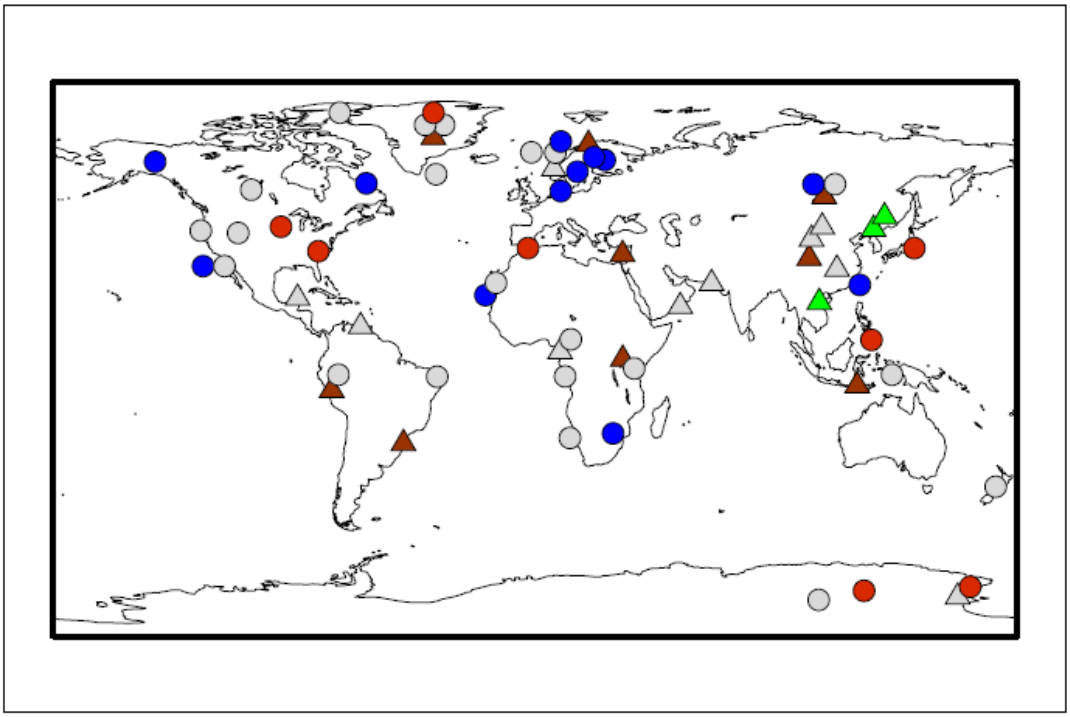
mean of yrs 9900–10000 B.P.



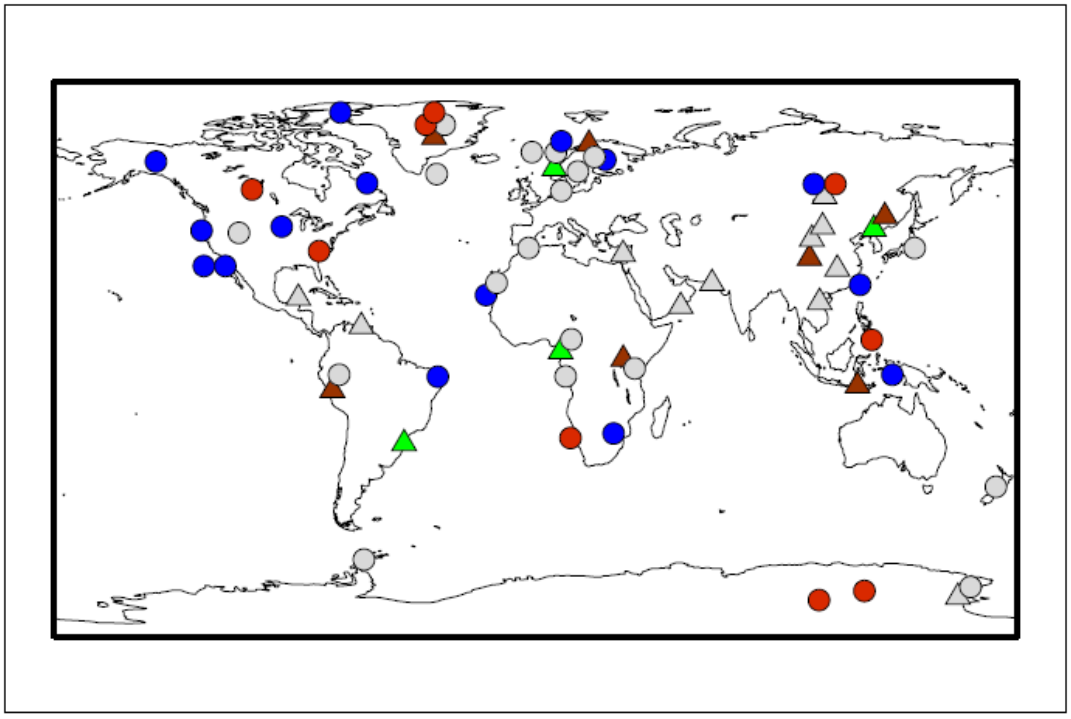
mean of yrs 9800–9900 B.P.



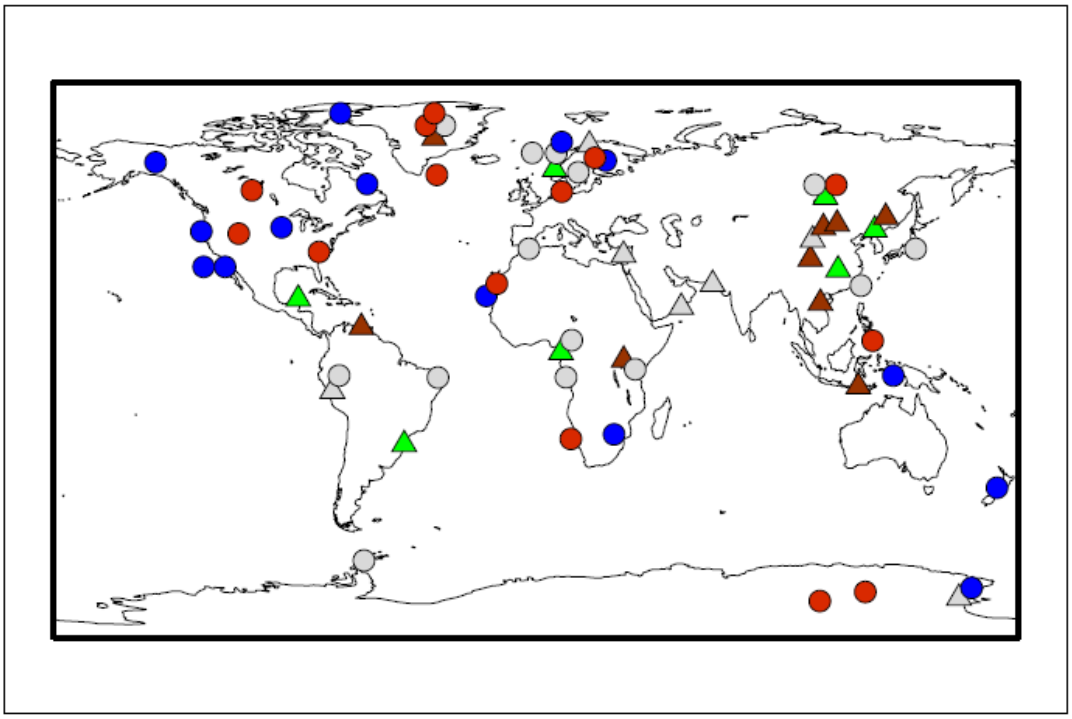
mean of yrs 9700–9800 B.P.



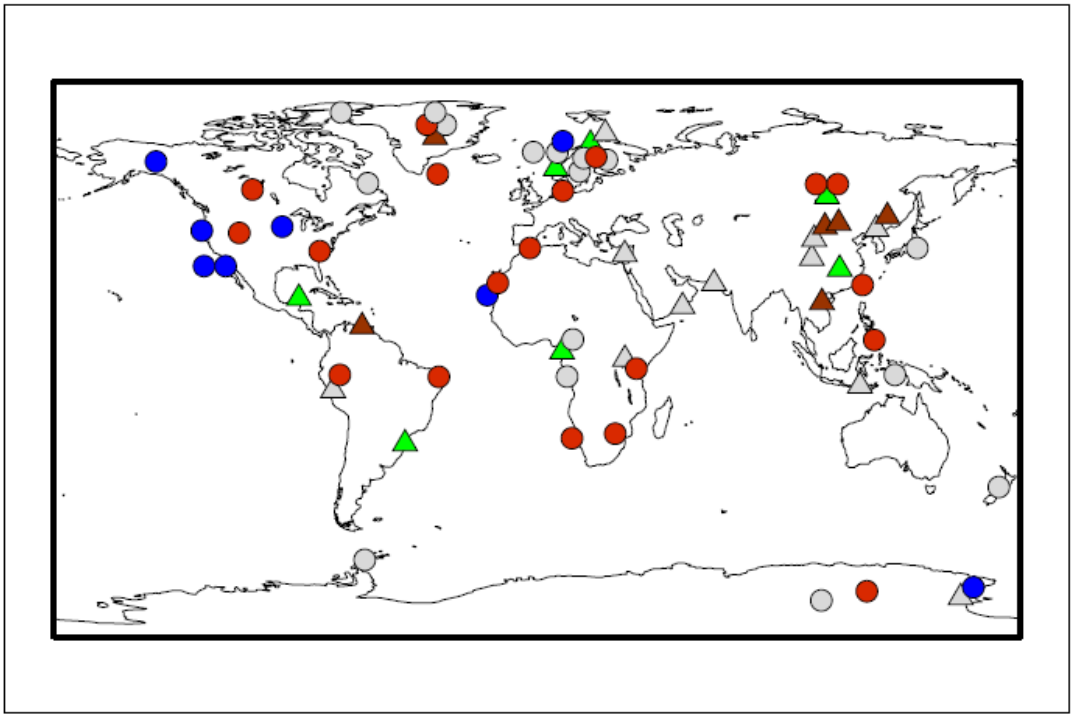
mean of yrs 9600–9700 B.P.



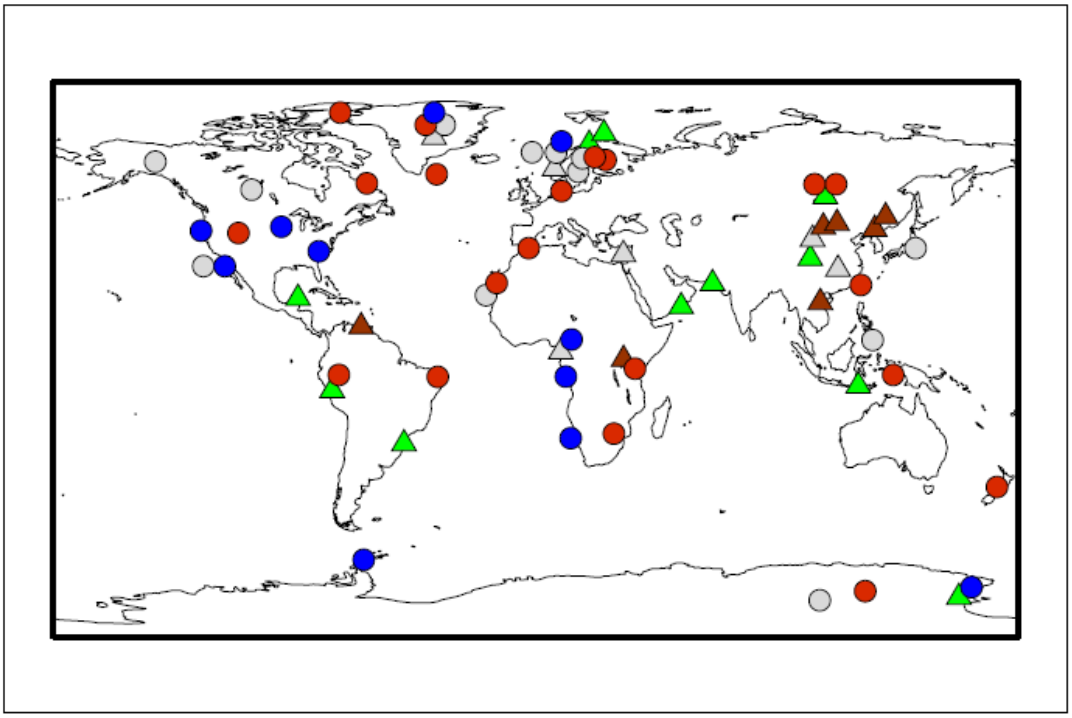
mean of yrs 9500–9600 B.P.



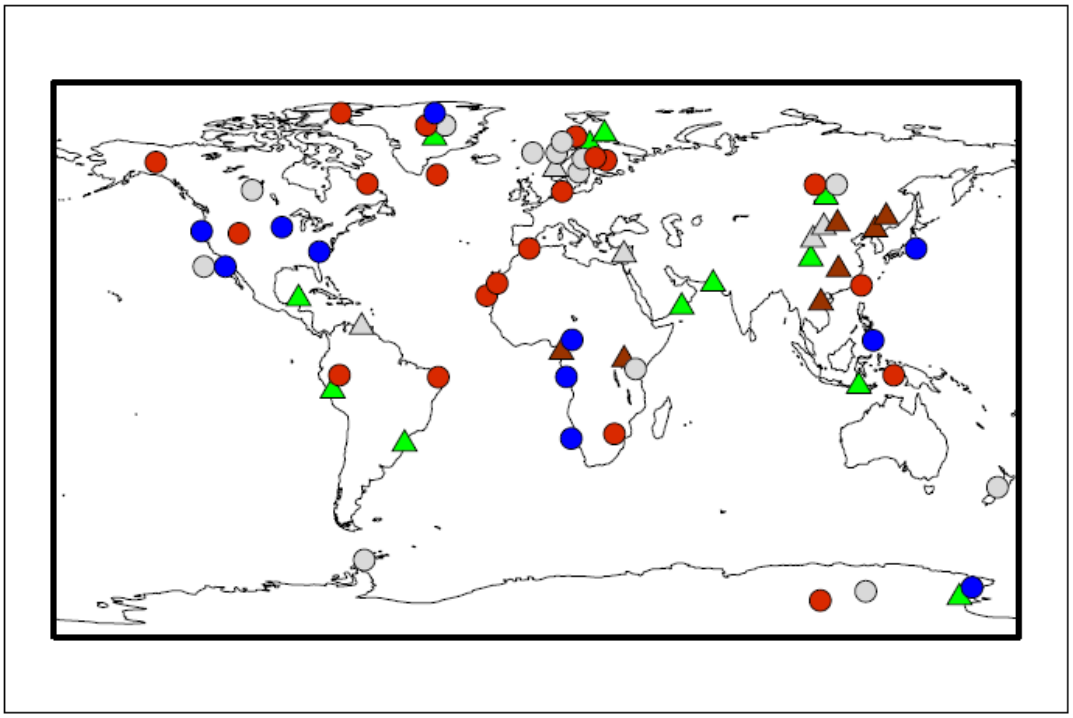
mean of yrs 9400–9500 B.P.



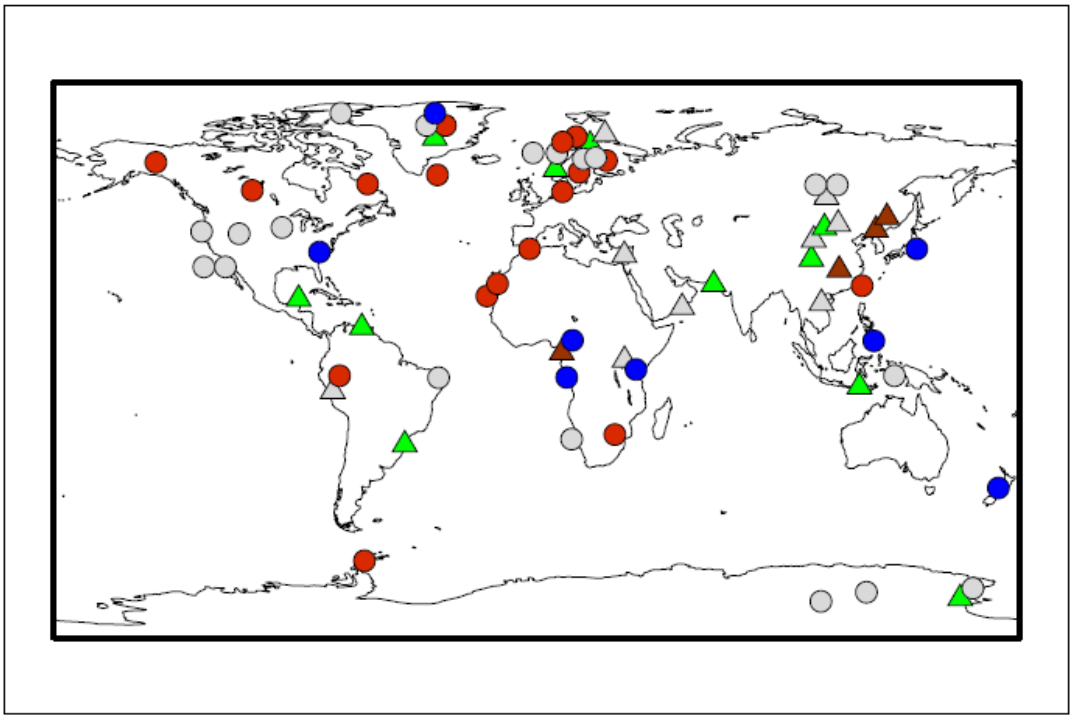
mean of yrs 9300–9400 B.P.



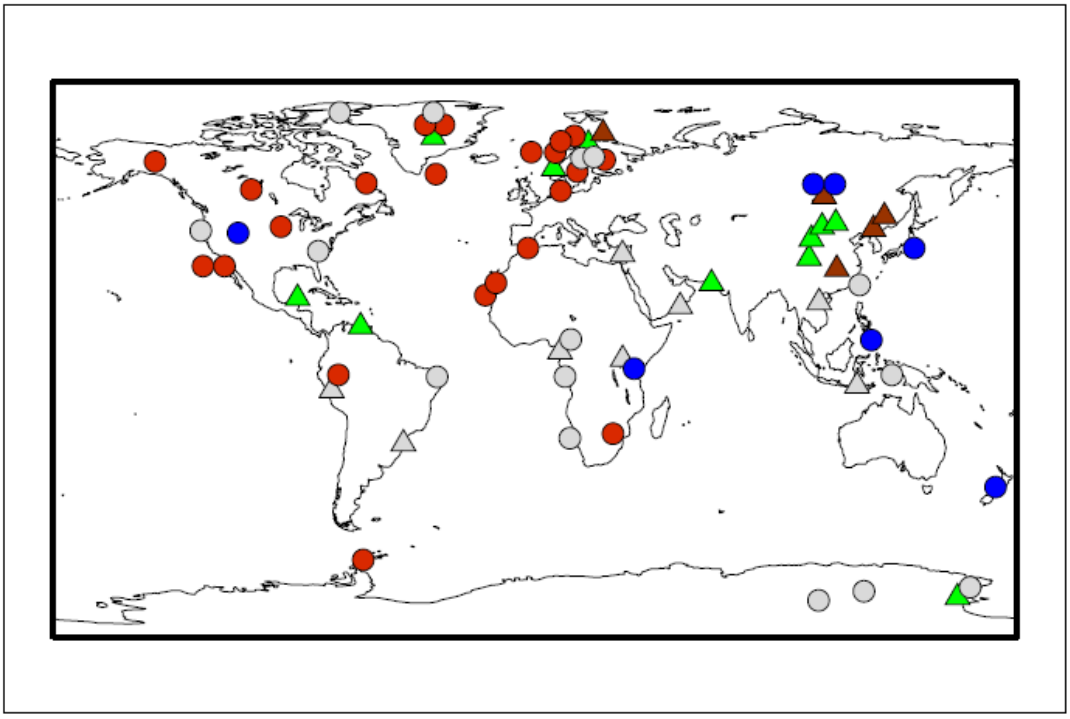
mean of yrs 9200–9300 B.P.



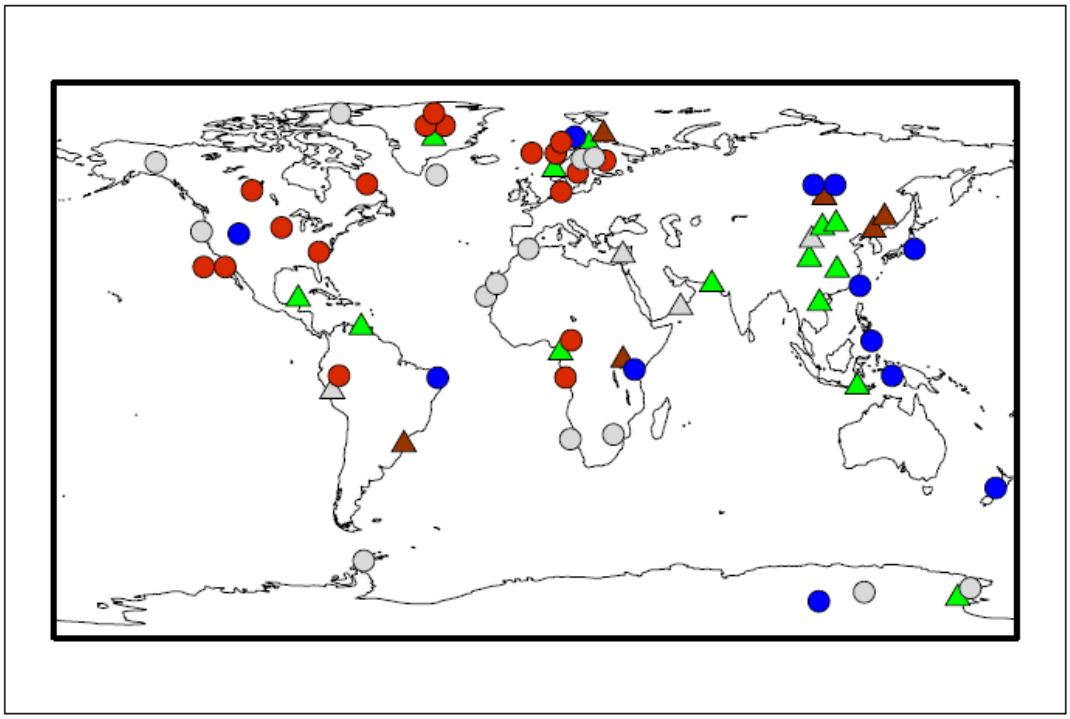
mean of yrs 9100–9200 B.P.



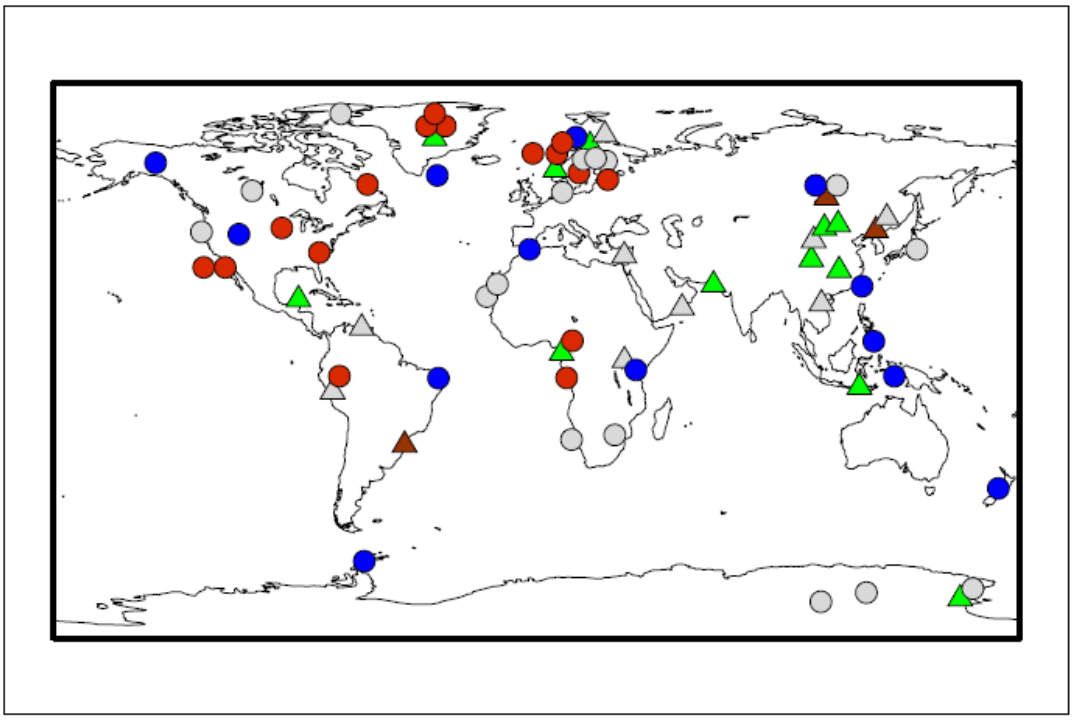
mean of yrs 9000–9100 B.P.



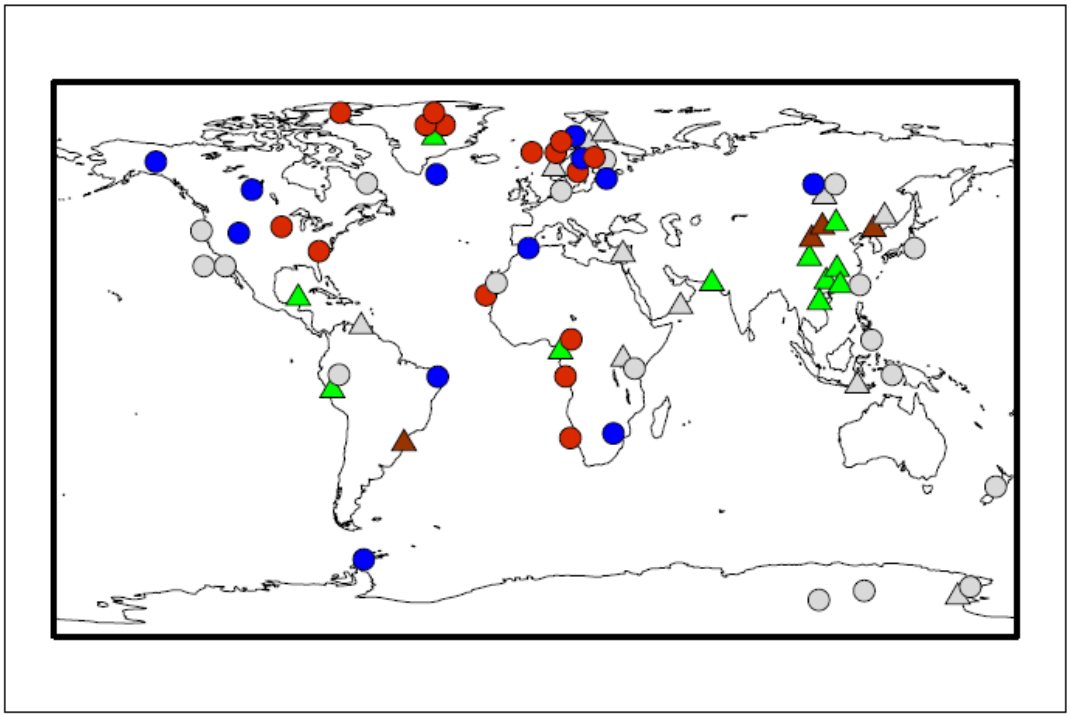
mean of yrs 8900–9000 B.P.



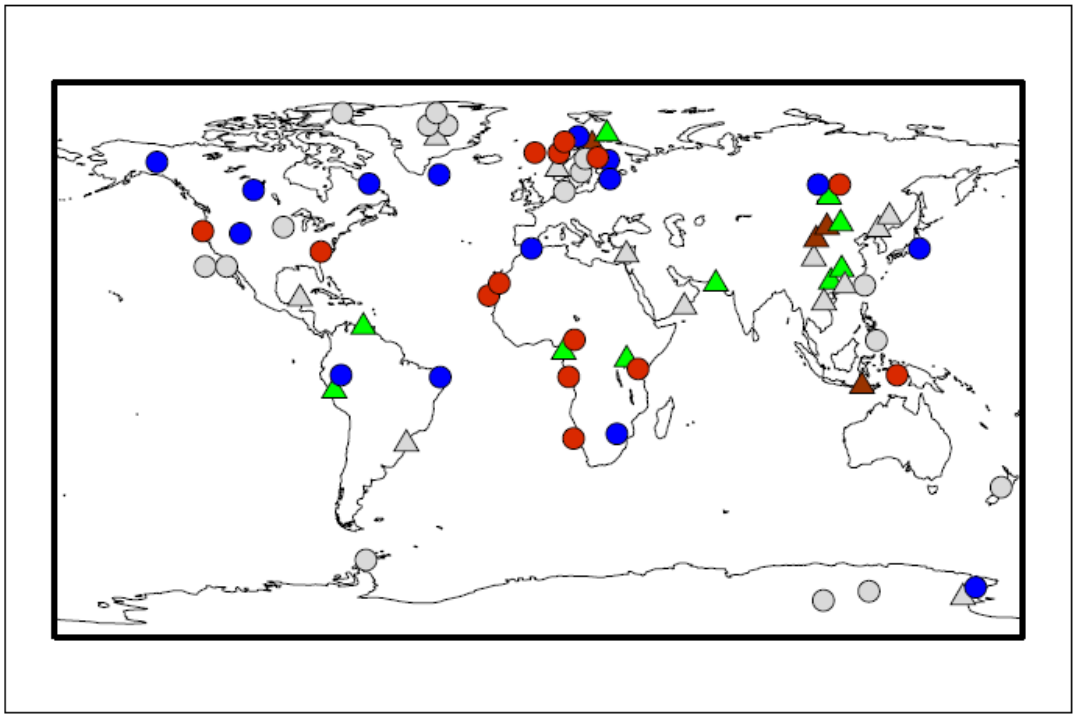
mean of yrs 8800–8900 B.P.



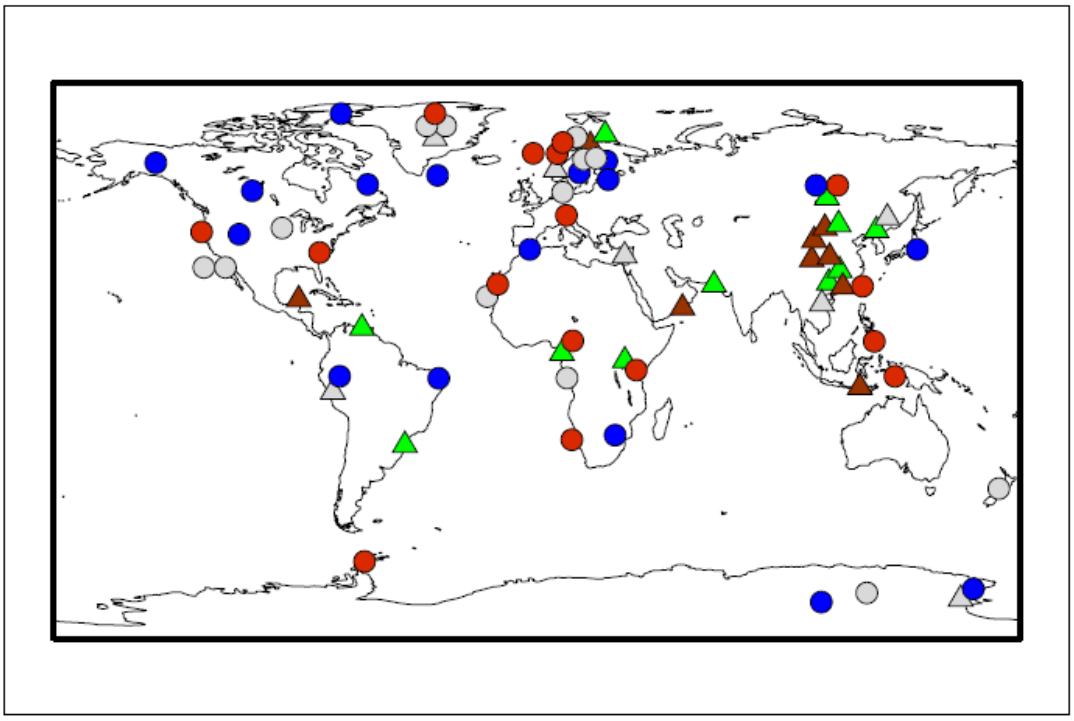
mean of yrs 8700–8800 B.P.



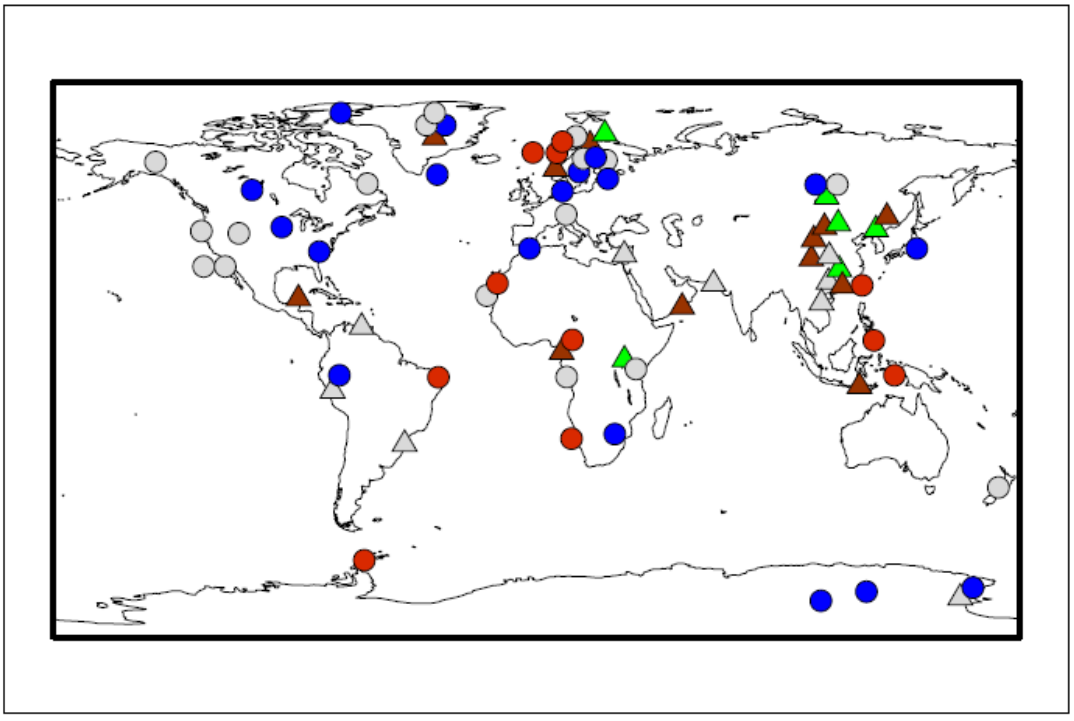
mean of yrs 8600–8700 B.P.



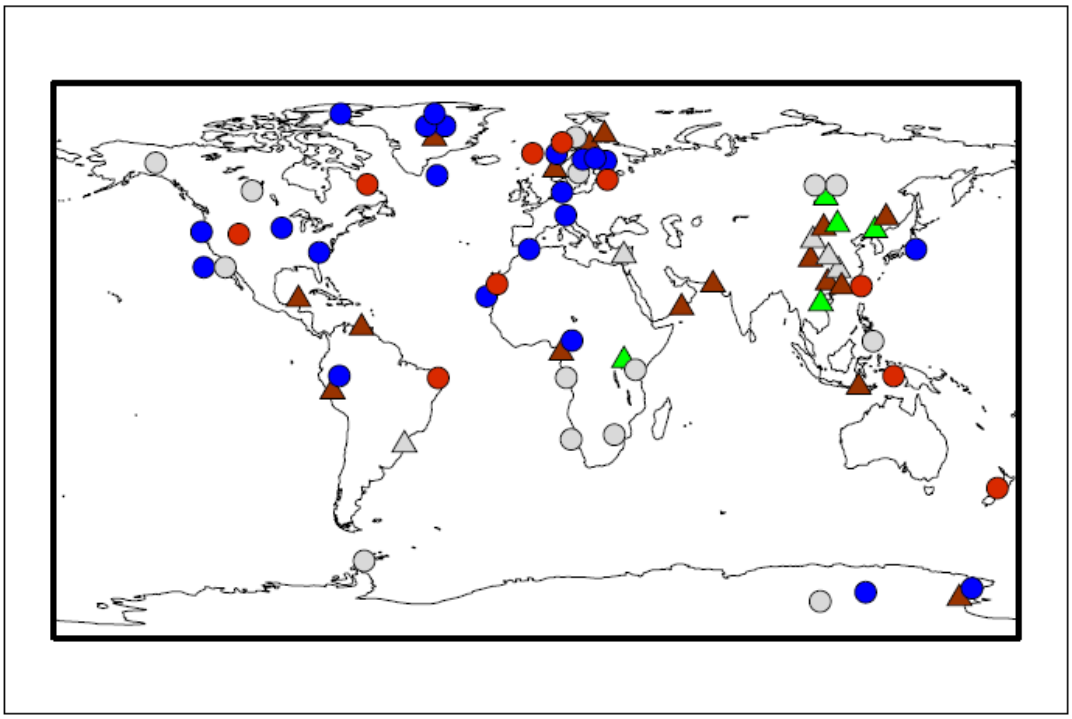
mean of yrs 8500–8600 B.P.



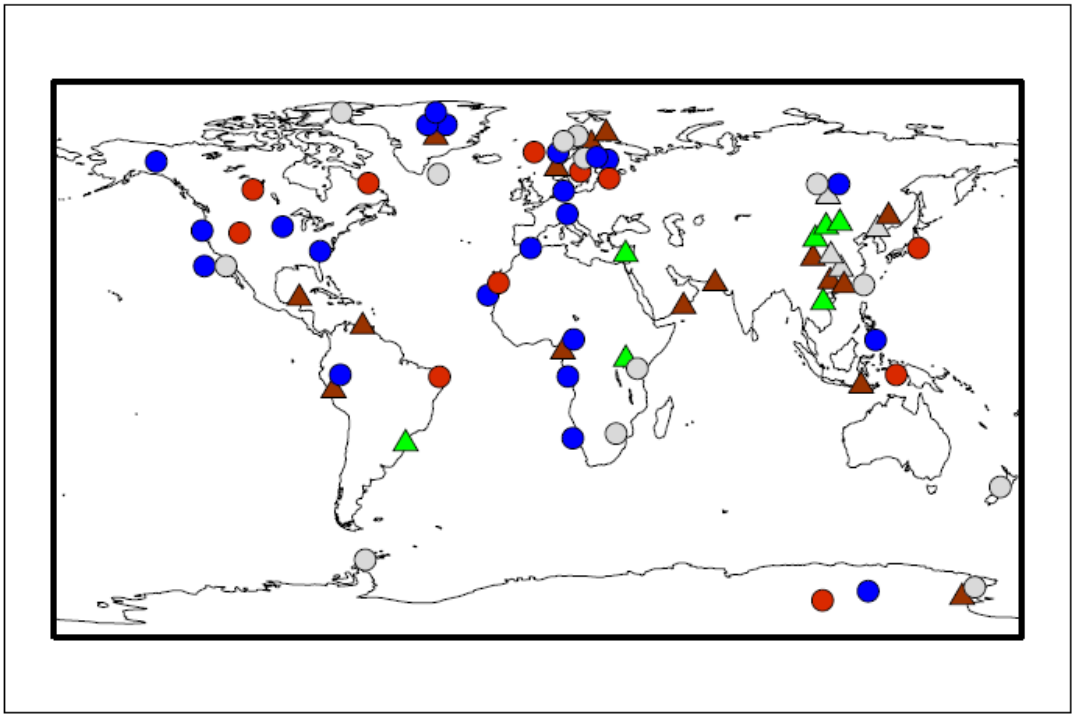
mean of yrs 8400–8500 B.P.



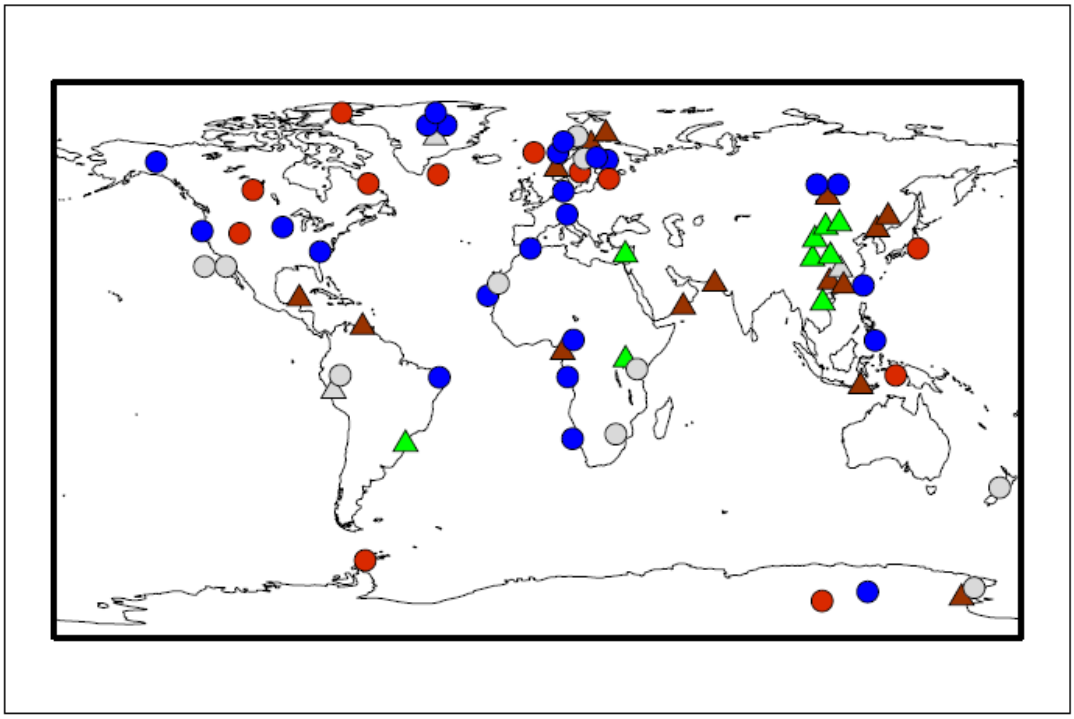
mean of yrs 8300–8400 B.P.



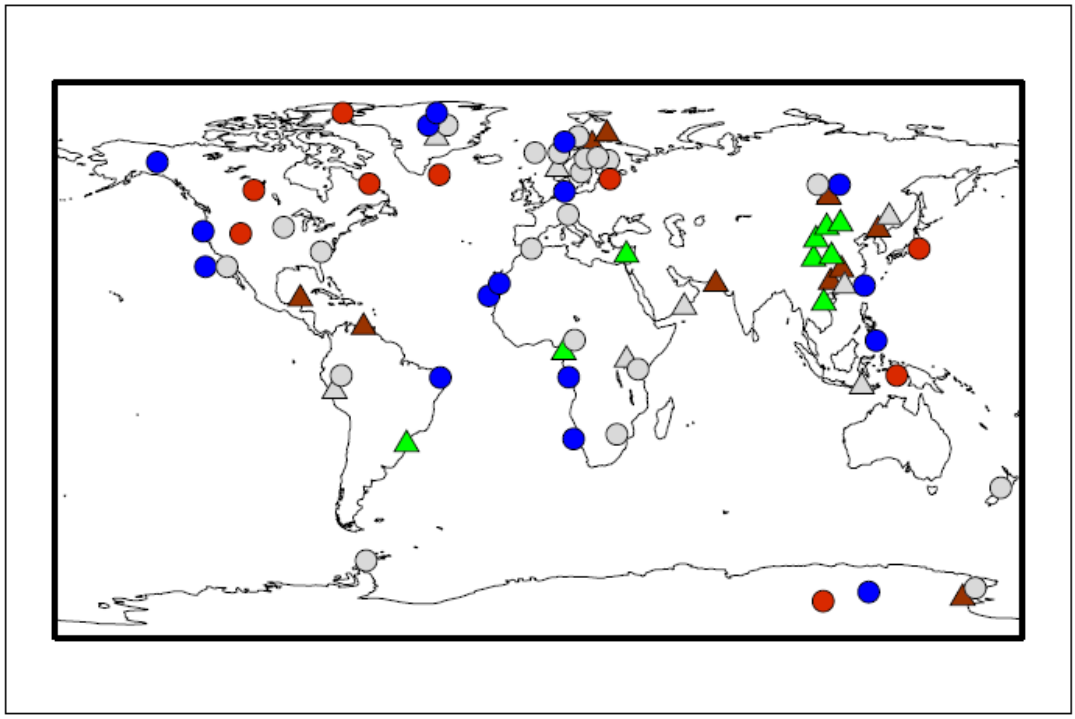
mean of yrs 8200–8300 B.P.



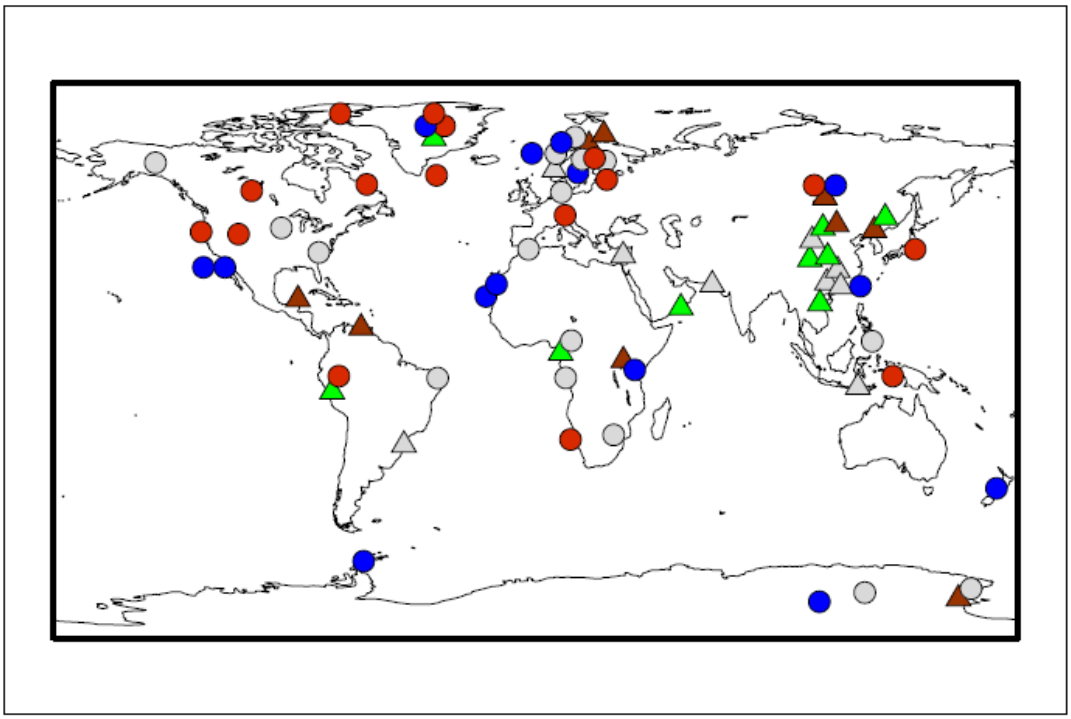
mean of yrs 8100–8200 B.P.



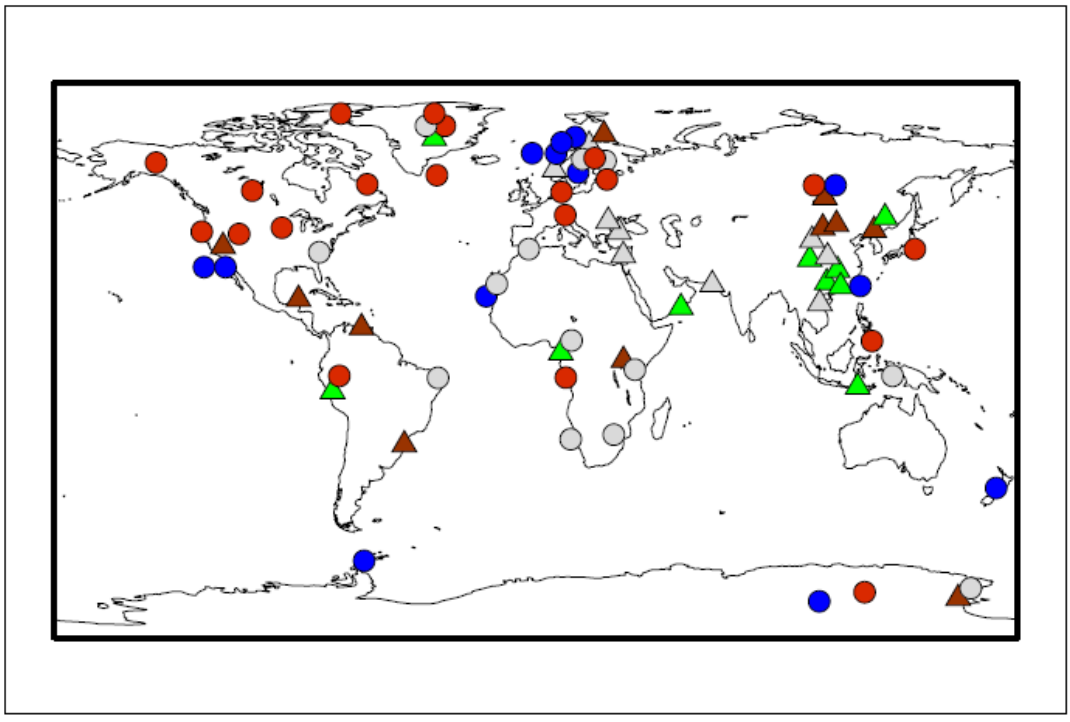
mean of yrs 8000–8100 B.P.



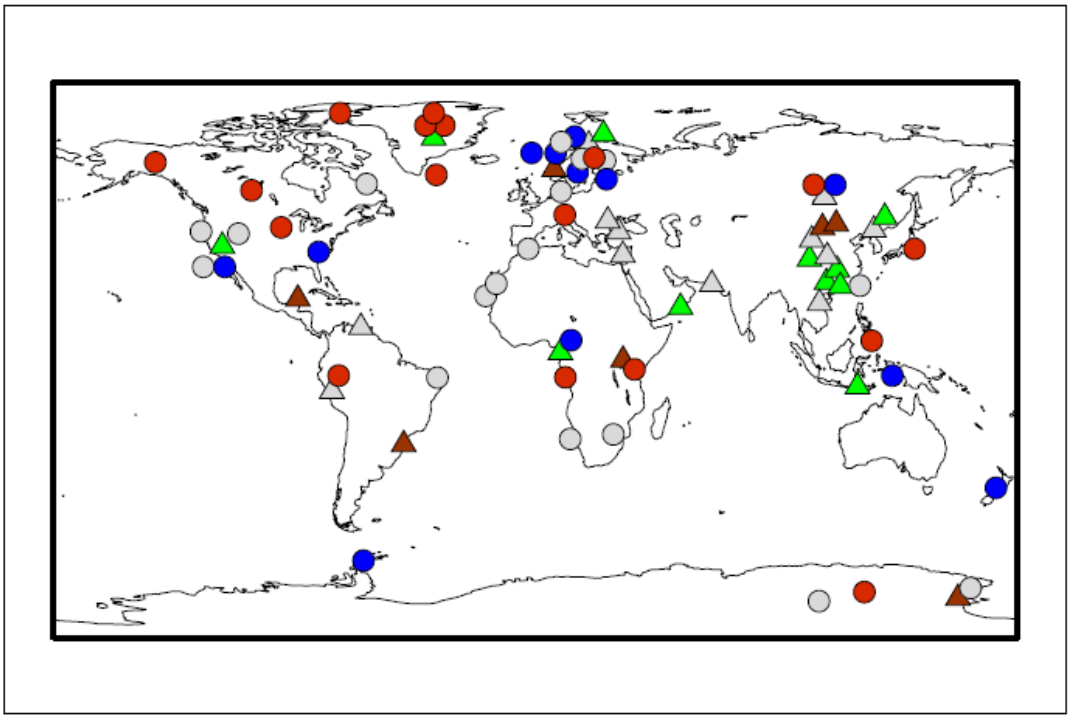
mean of yrs 7900–8000 B.P.



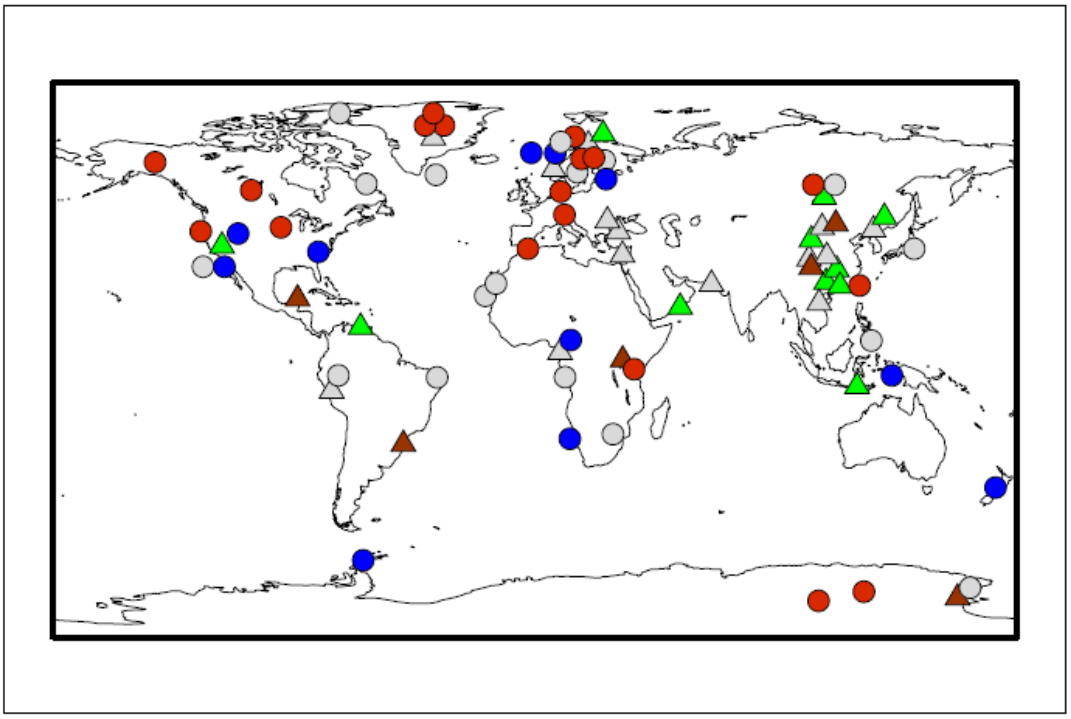
mean of yrs 7800–7900 B.P.



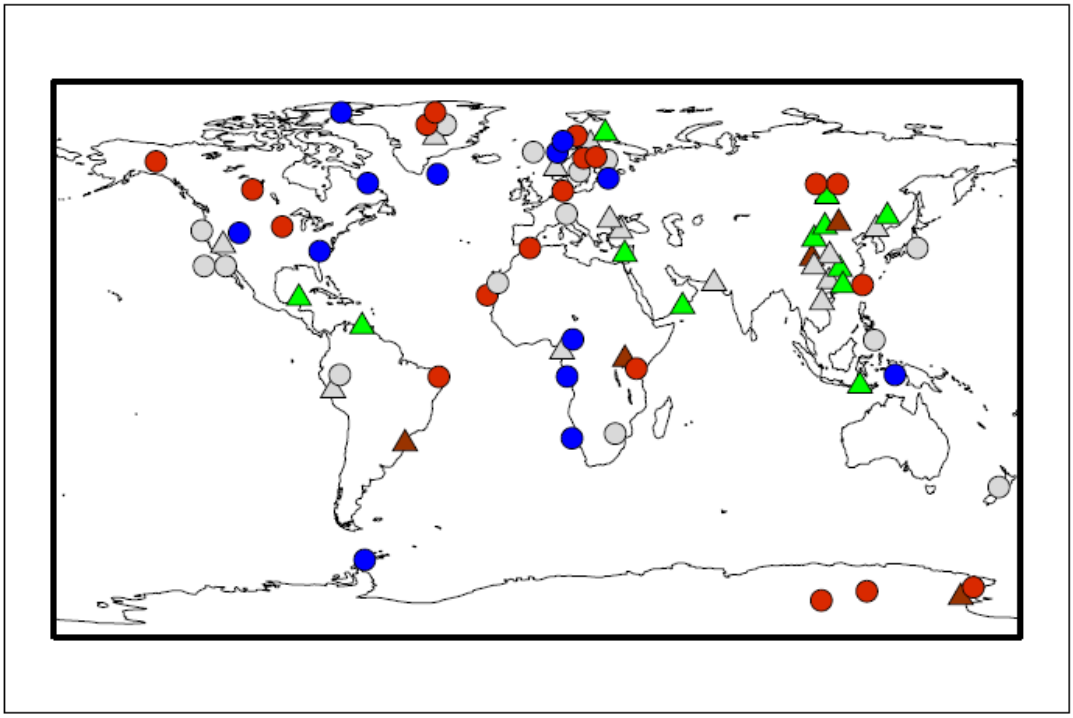
mean of yrs 7700–7800 B.P.



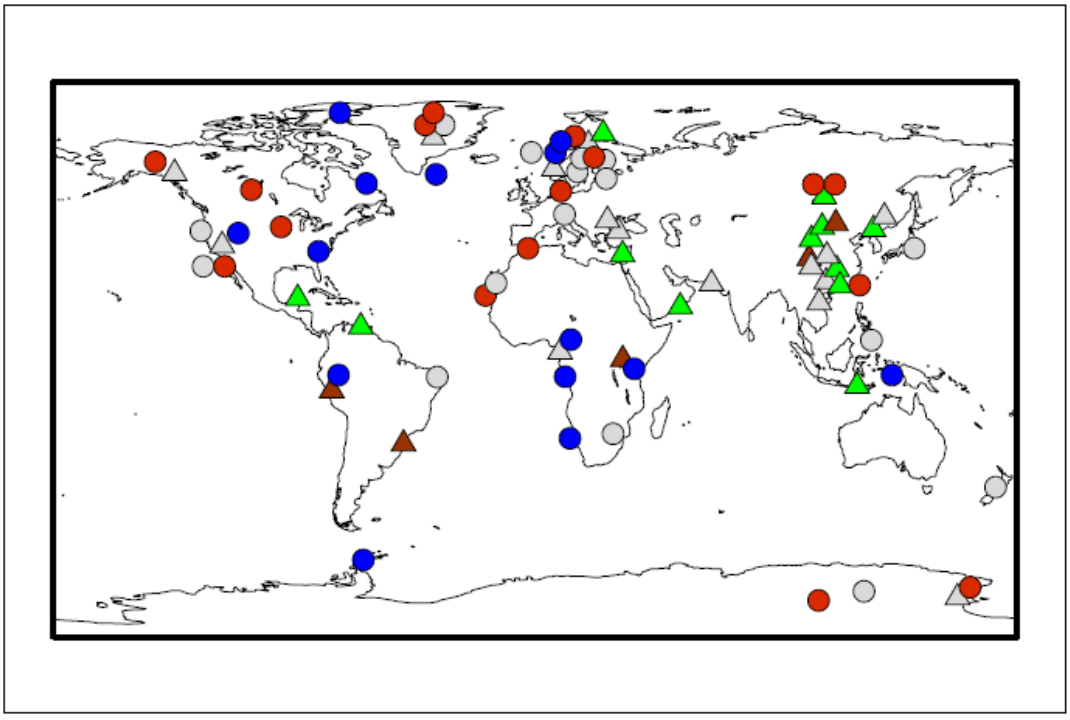
mean of yrs 7600–7700 B.P.



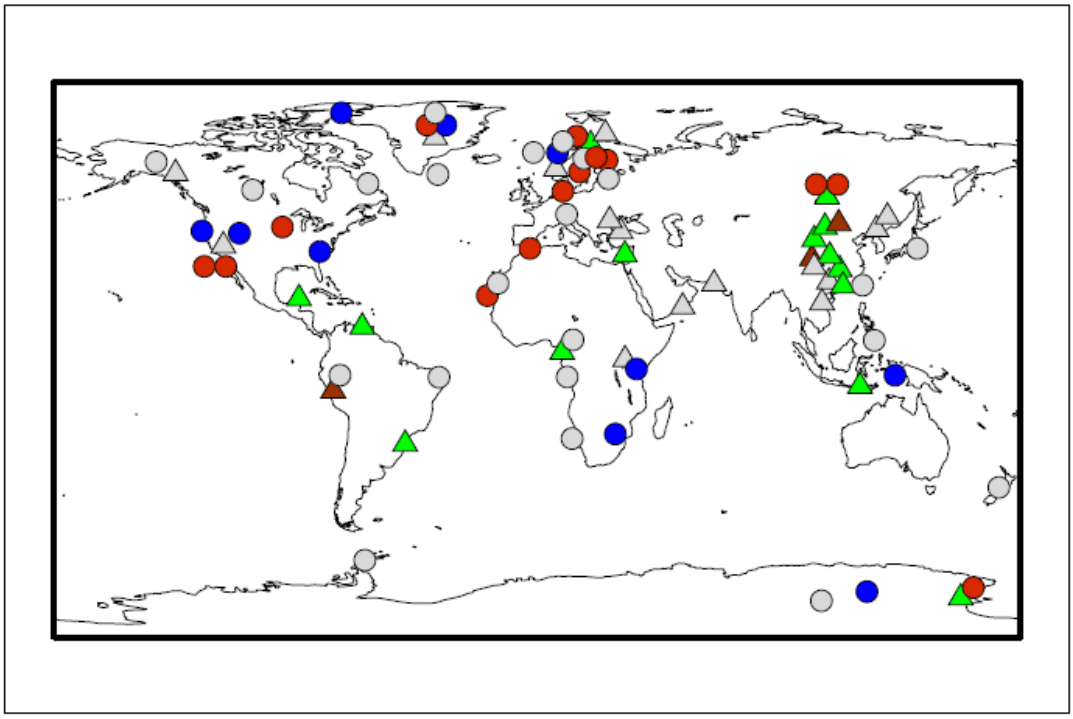
mean of yrs 7500–7600 B.P.



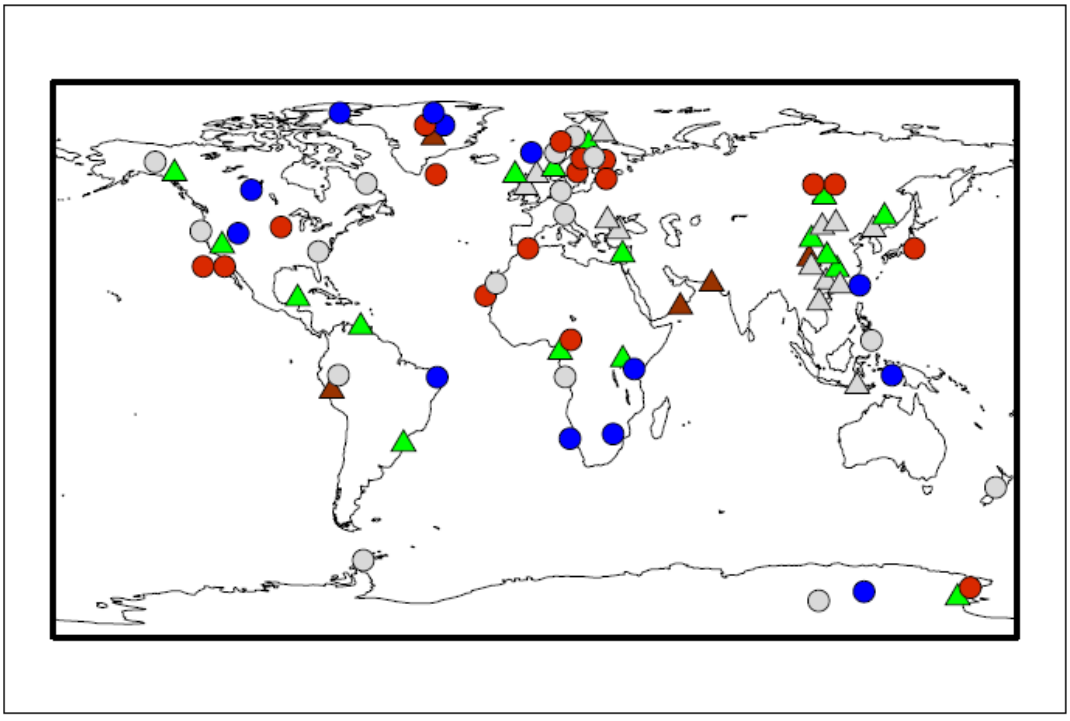
mean of yrs 7400–7500 B.P.



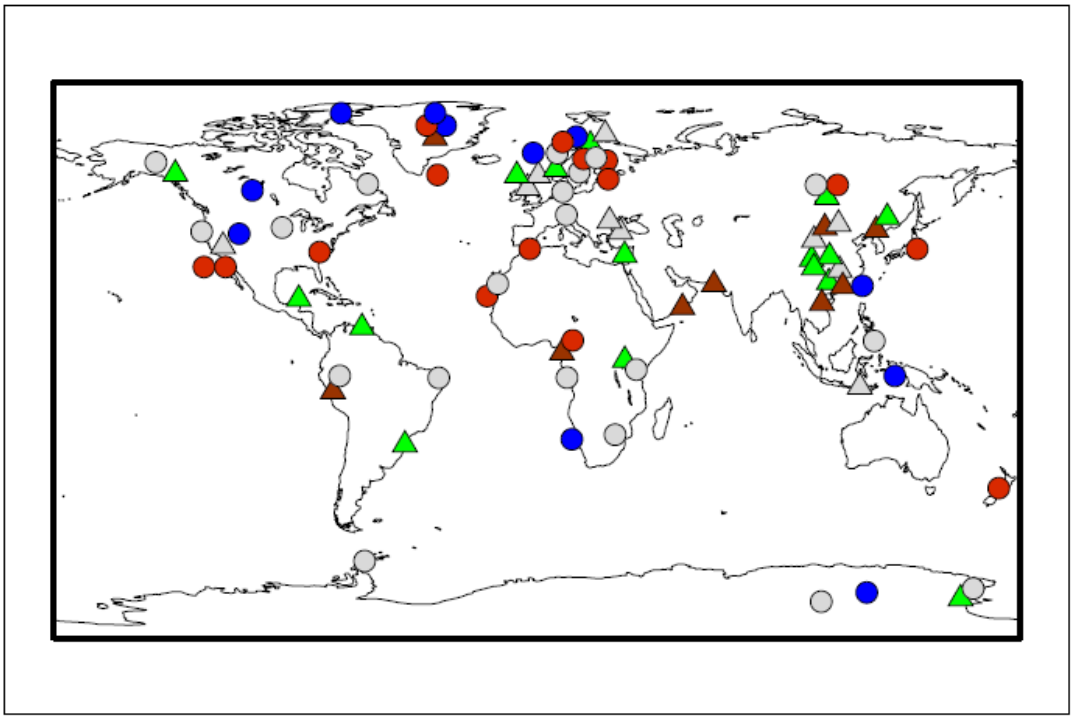
mean of yrs 7300–7400 B.P.



mean of yrs 7200–7300 B.P.



mean of yrs 7100–7200 B.P.



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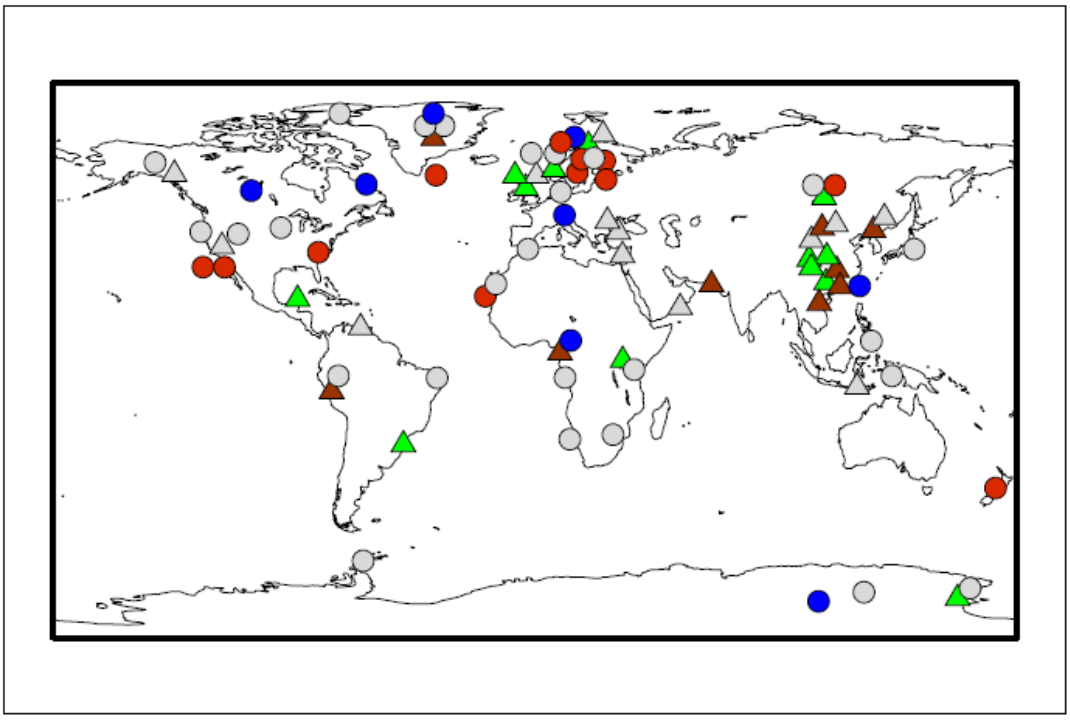
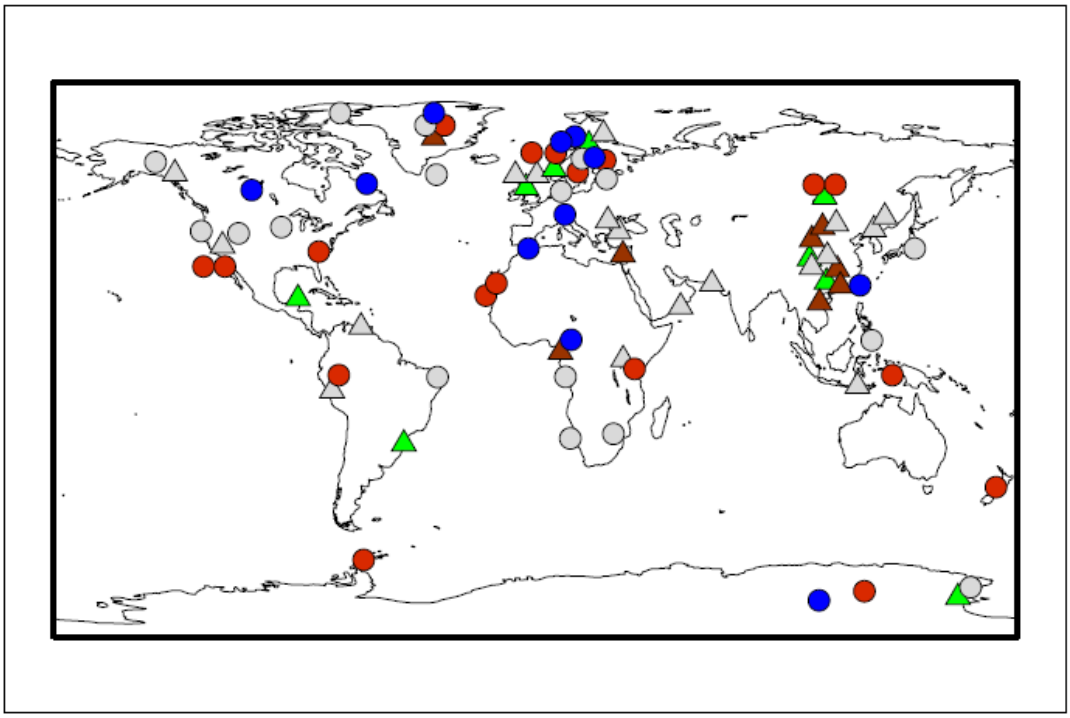
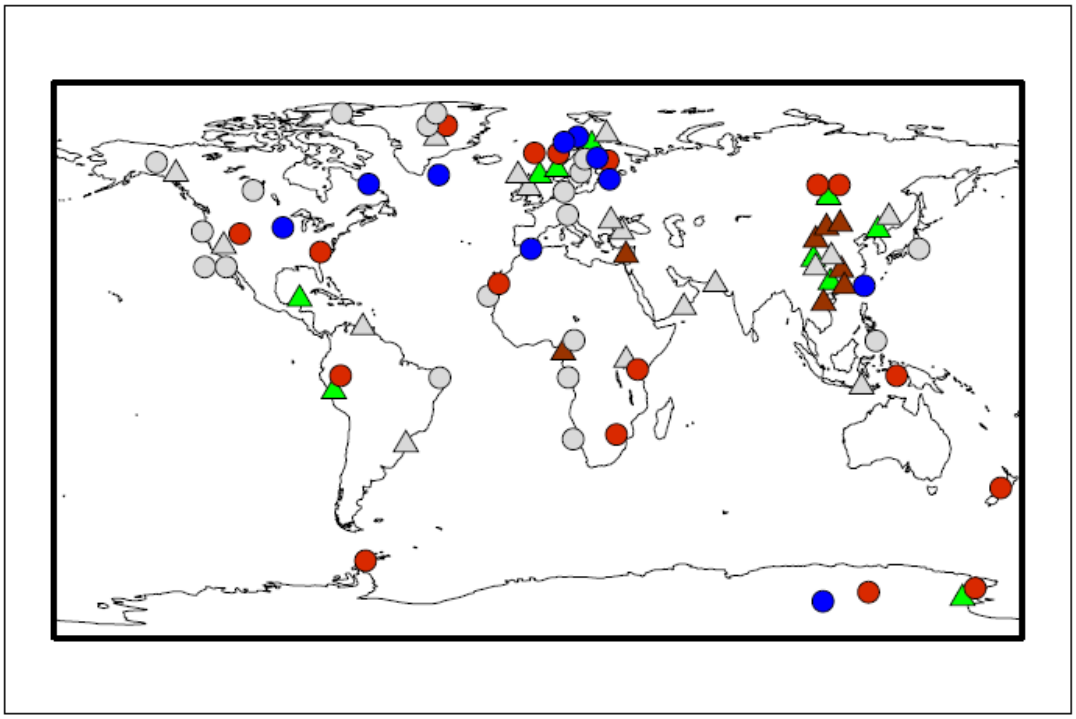


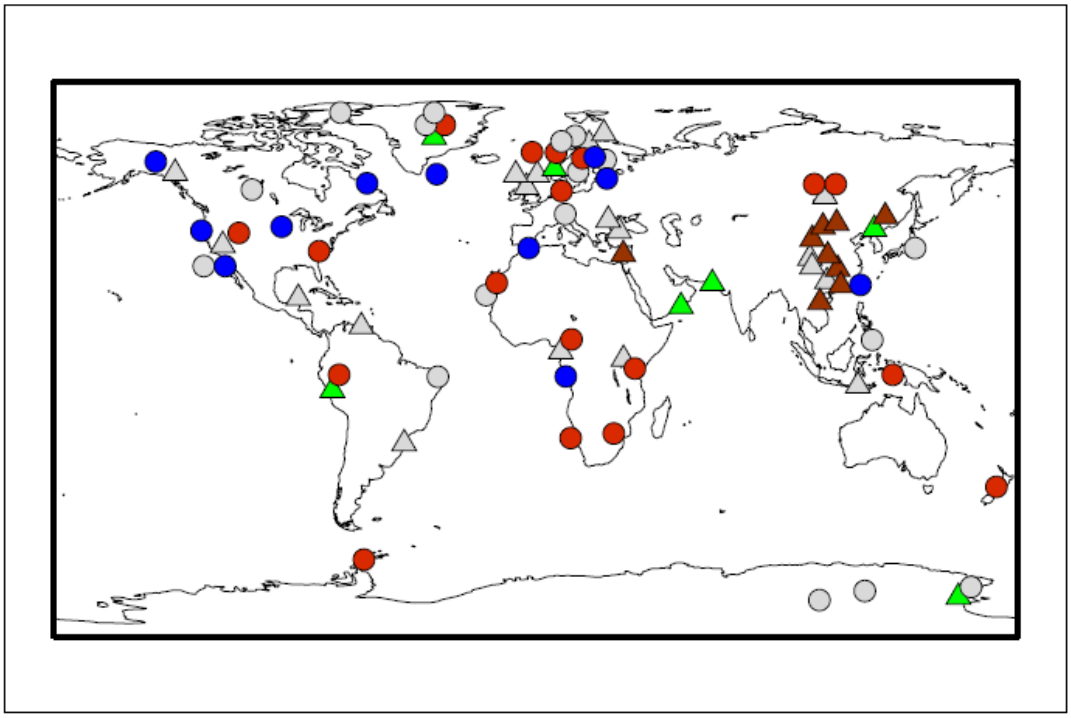
mean of yrs 6900–7000 B.P.



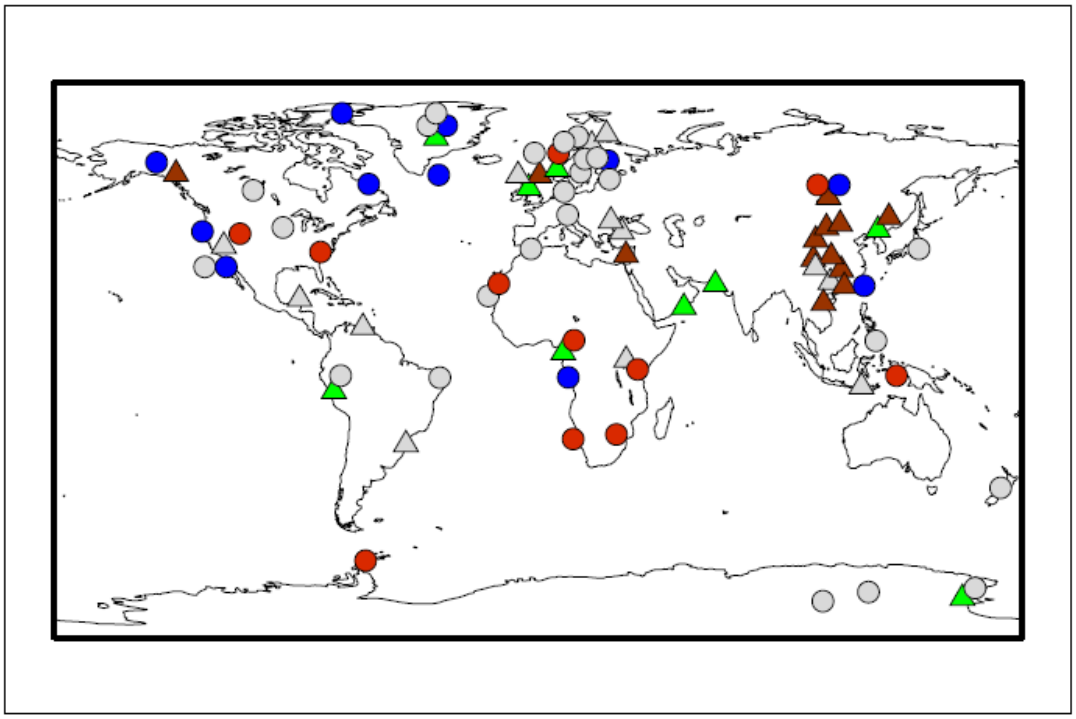
mean of yrs 6800–6900 B.P.



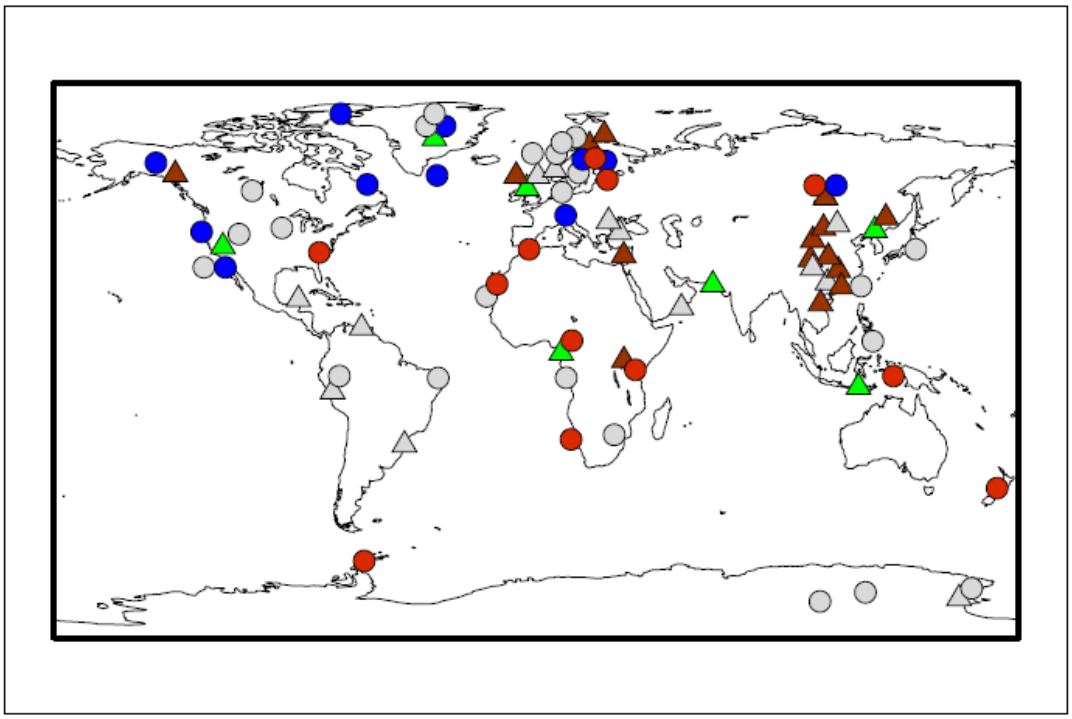
mean of yrs 6700–6800 B.P.



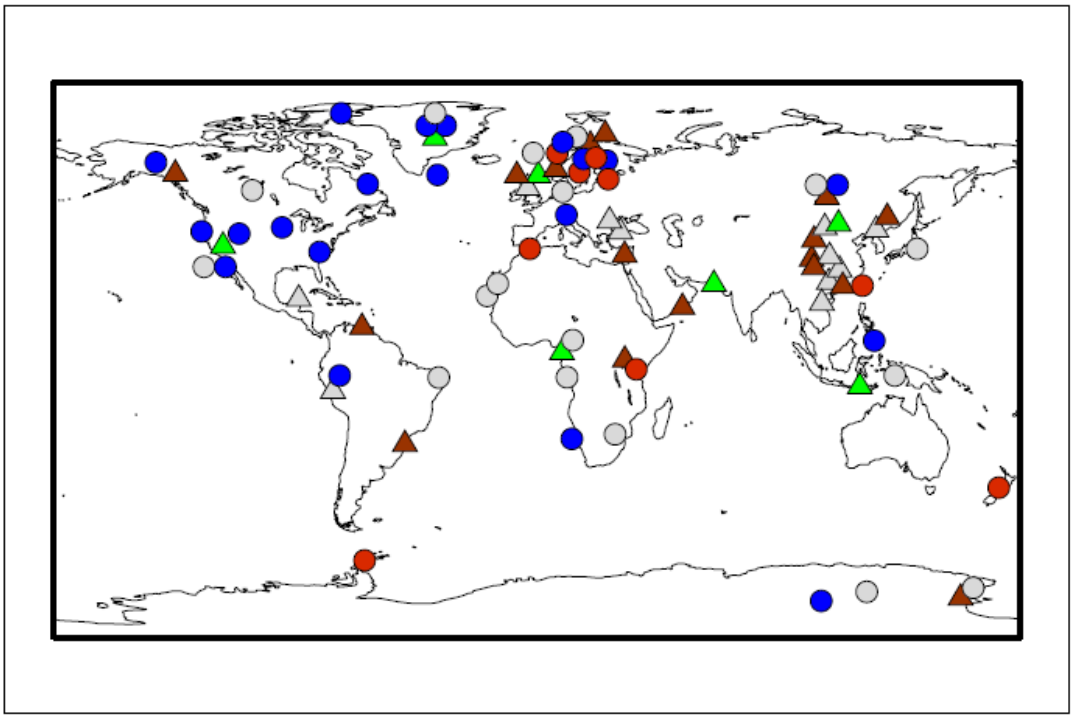
mean of yrs 6600–6700 B.P.



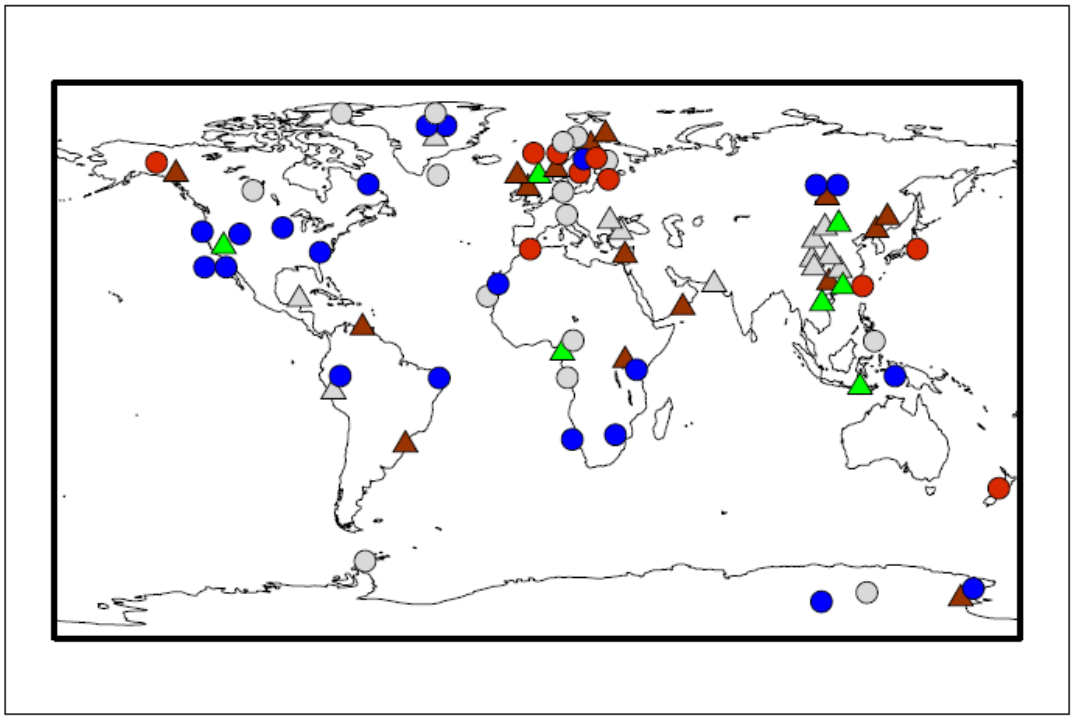
mean of yrs 6500–6600 B.P.



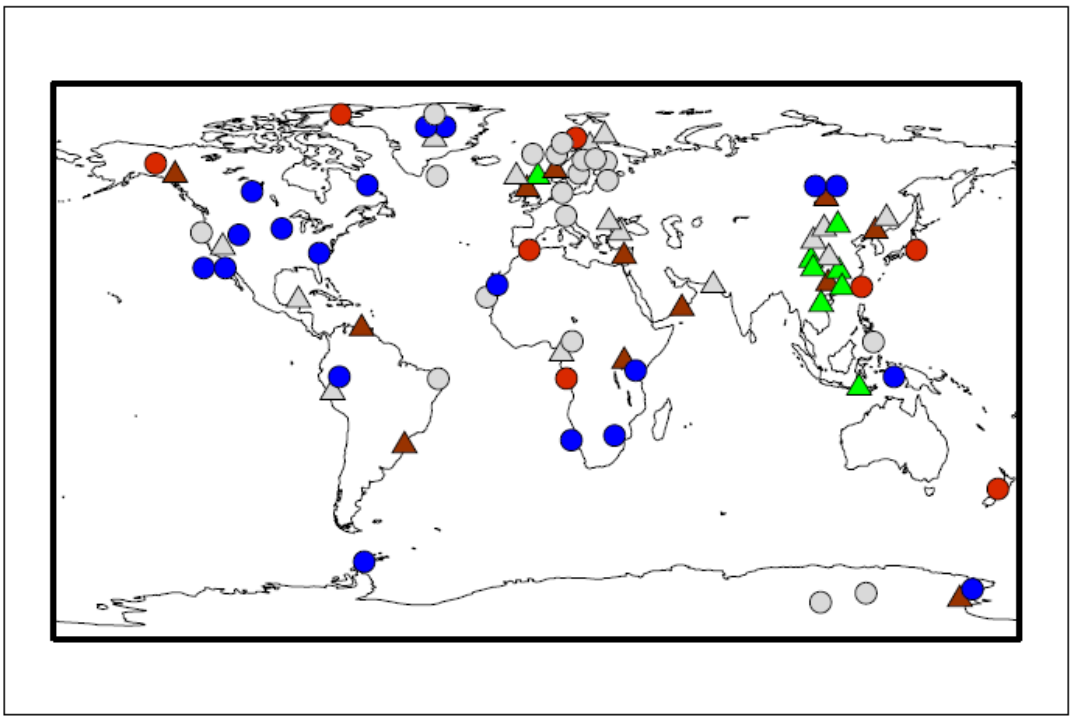
mean of yrs 6400–6500 B.P.



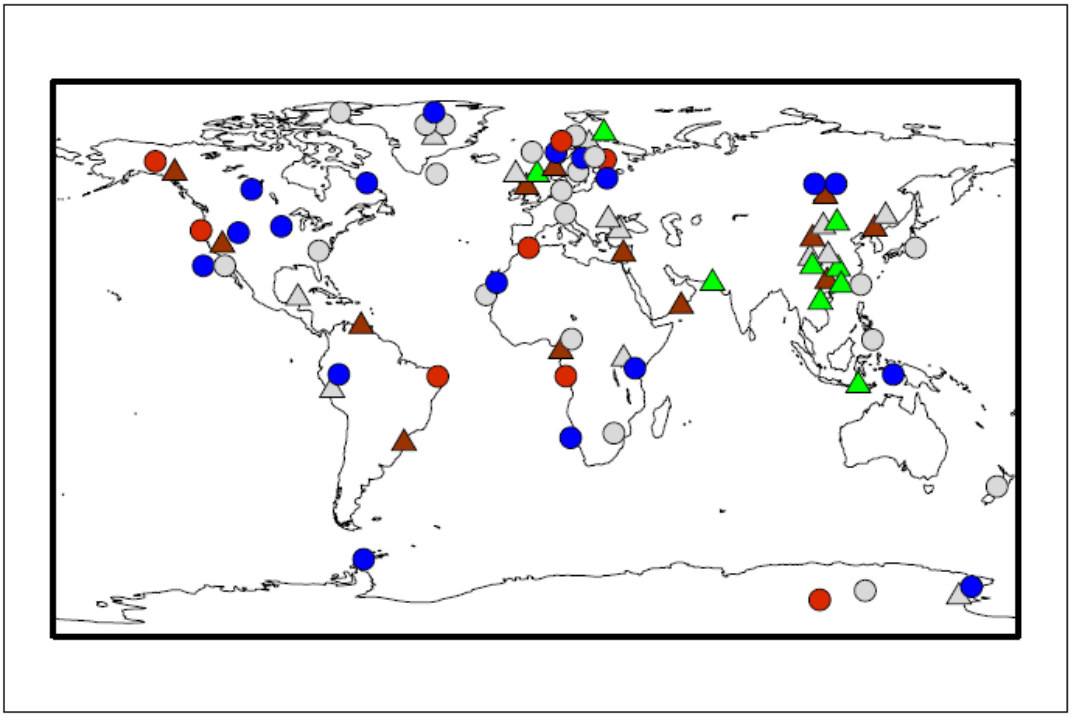
mean of yrs 6300–6400 B.P.



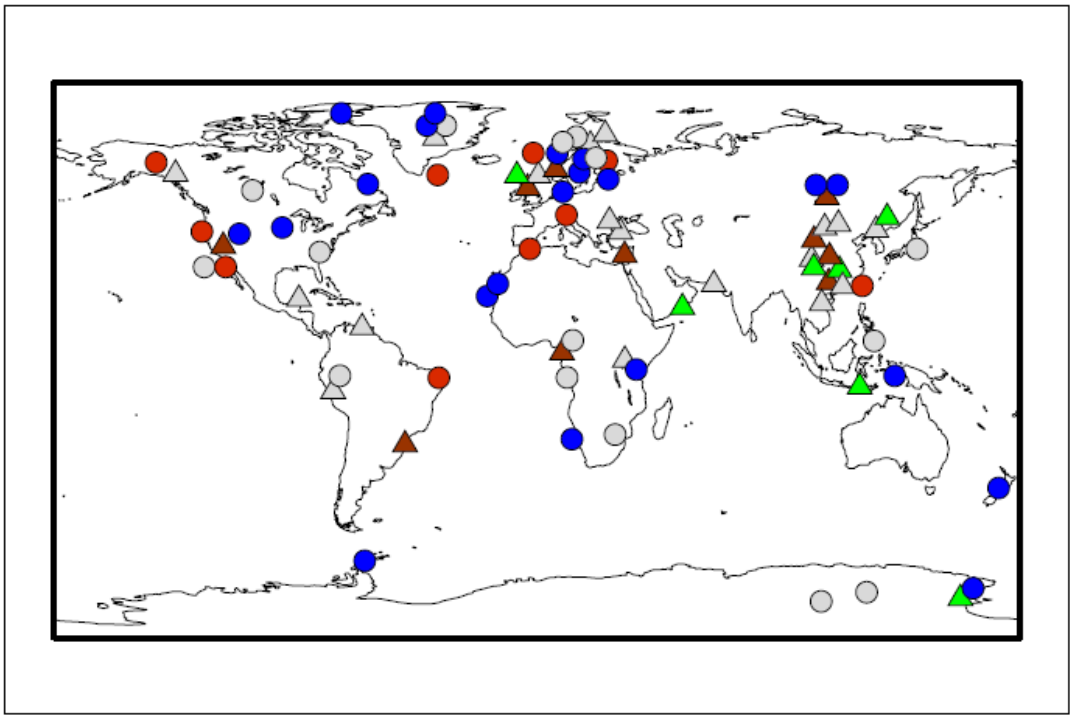
mean of yrs 6200–6300 B.P.



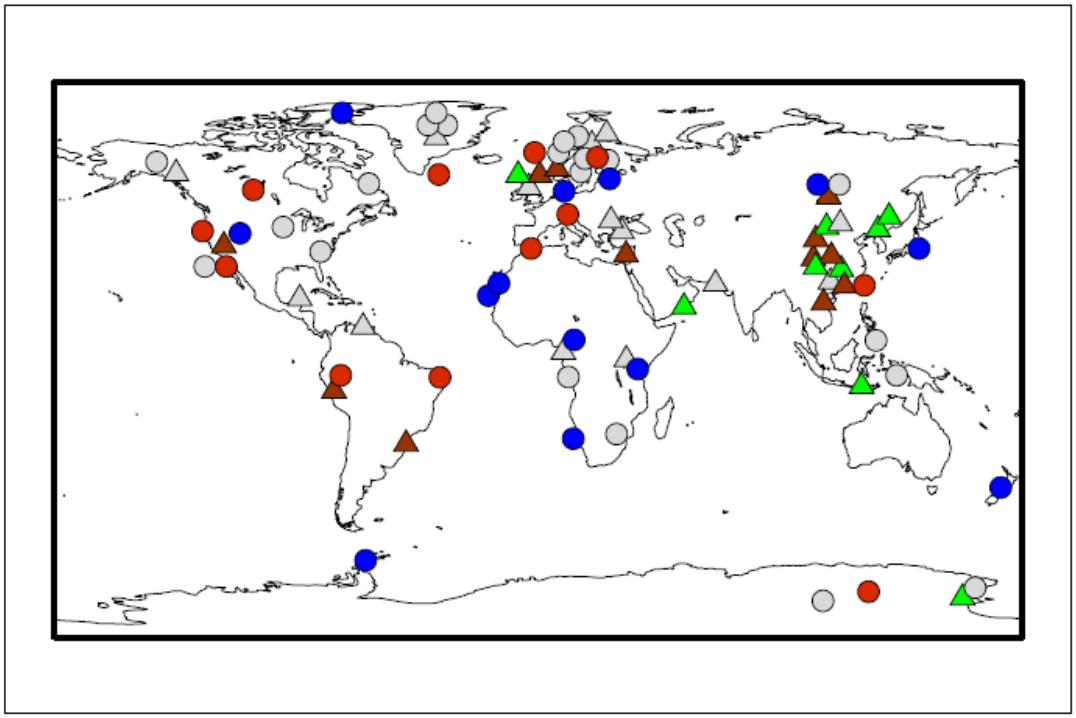
mean of yrs 6100–6200 B.P.



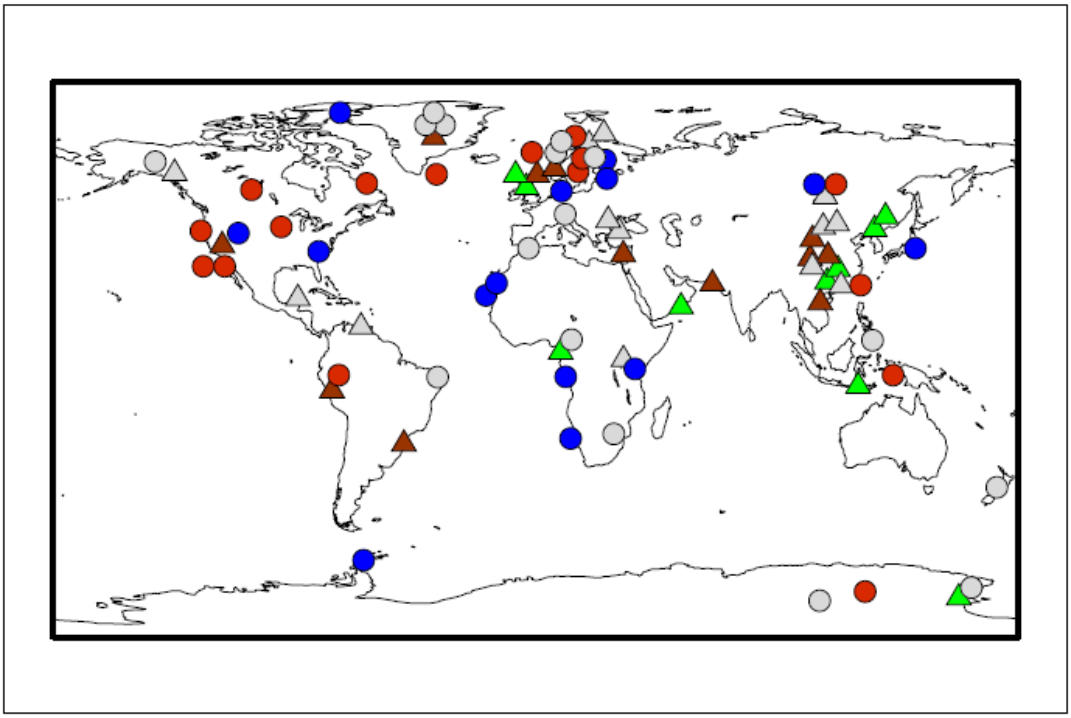
mean of yrs 6000–6100 B.P.



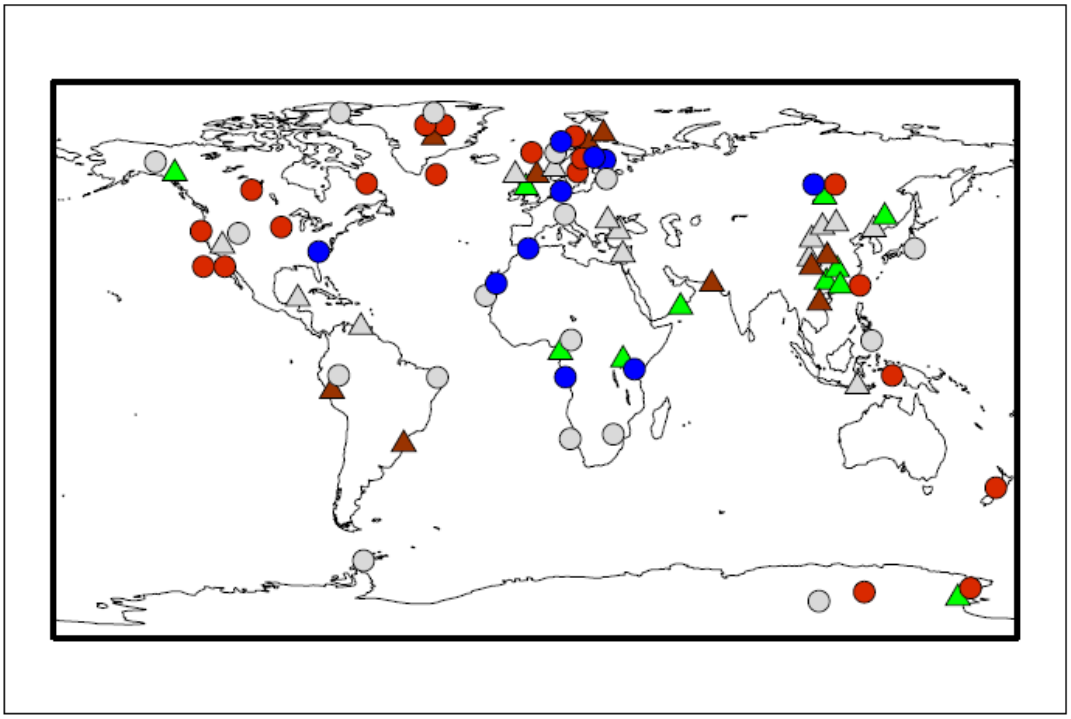
mean of yrs 5900–6000 B.P.



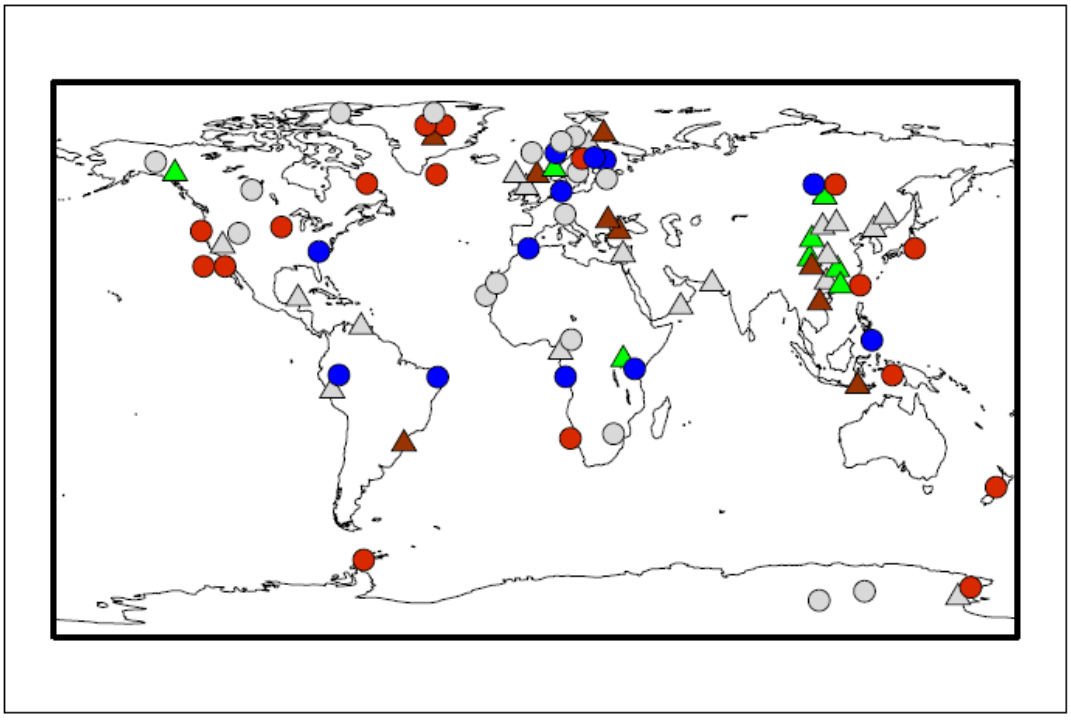
mean of yrs 5800–5900 B.P.



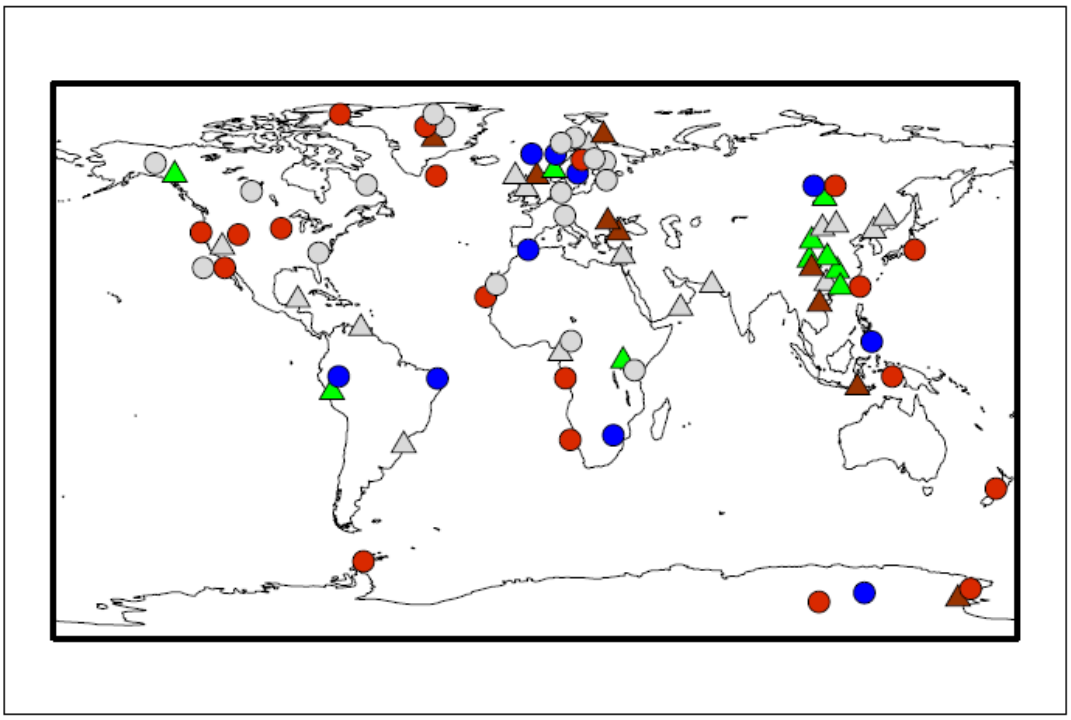
mean of yrs 5700–5800 B.P.



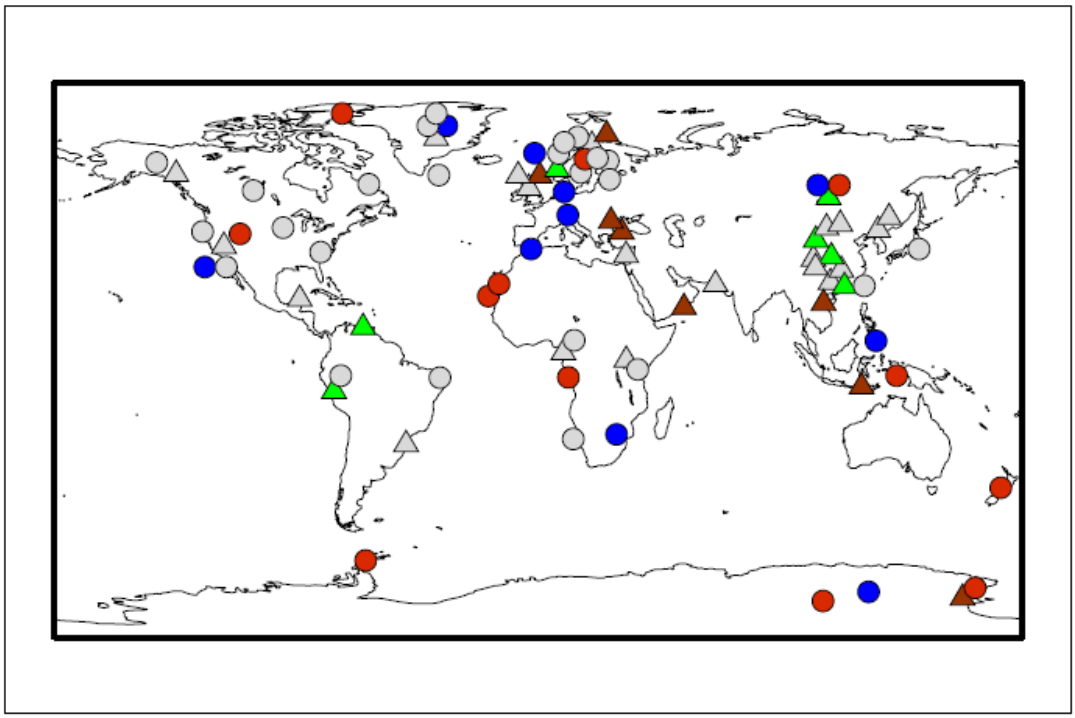
mean of yrs 5600–5700 B.P.



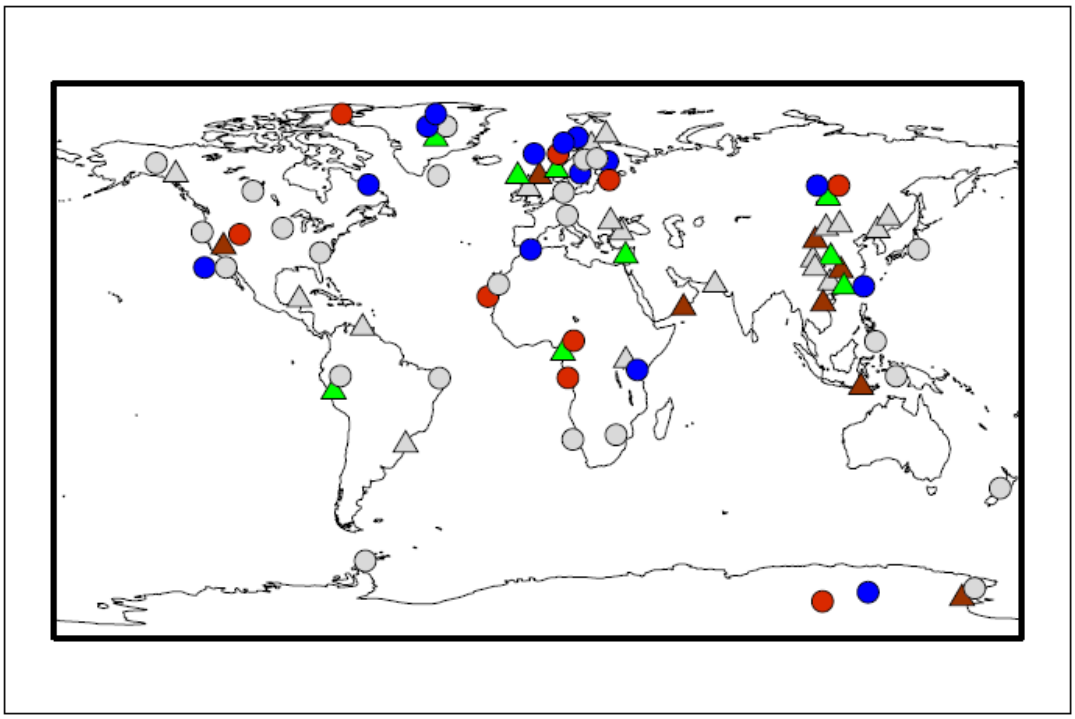
mean of yrs 5500–5600 B.P.



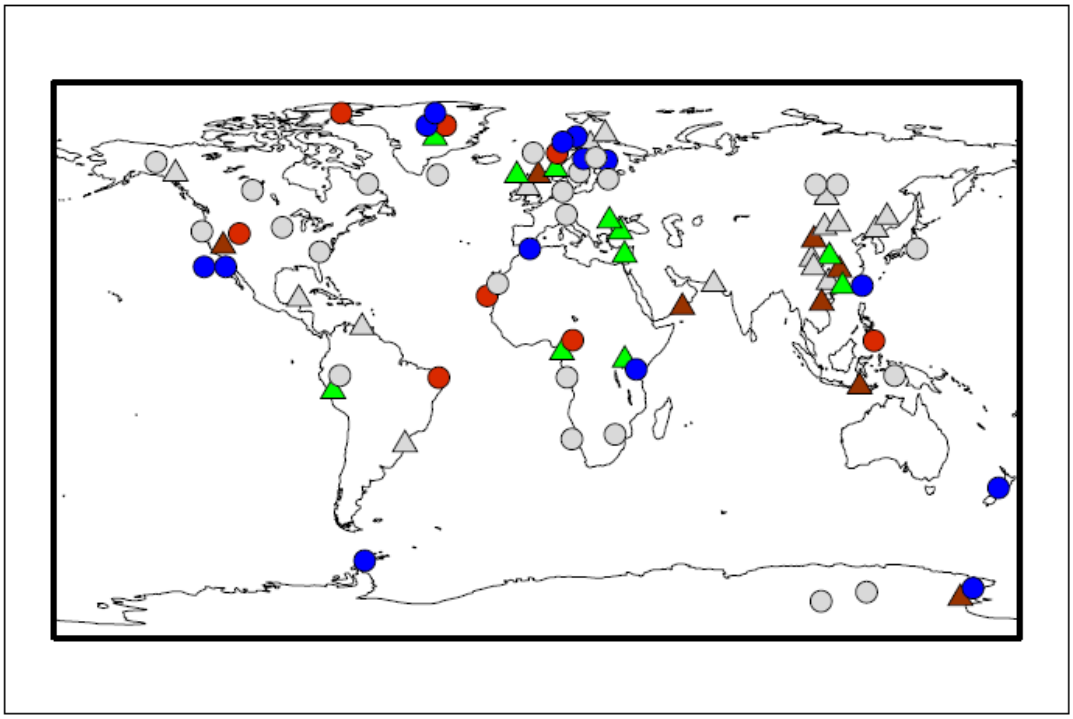
mean of yrs 5400–5500 B.P.



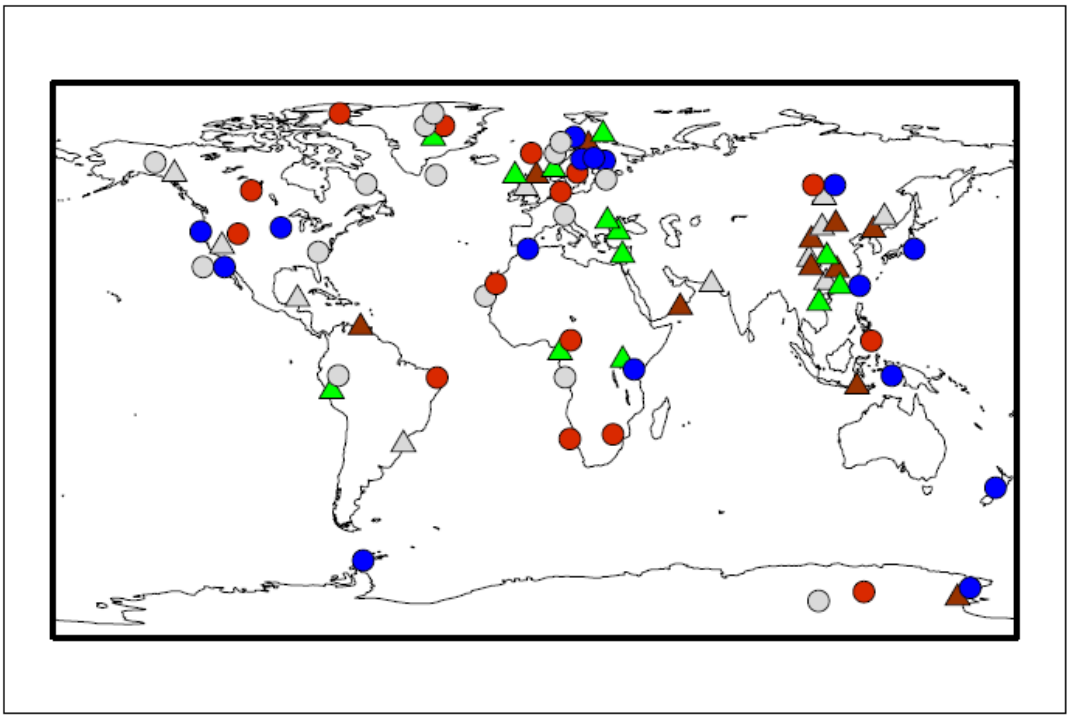
mean of yrs 5300–5400 B.P.



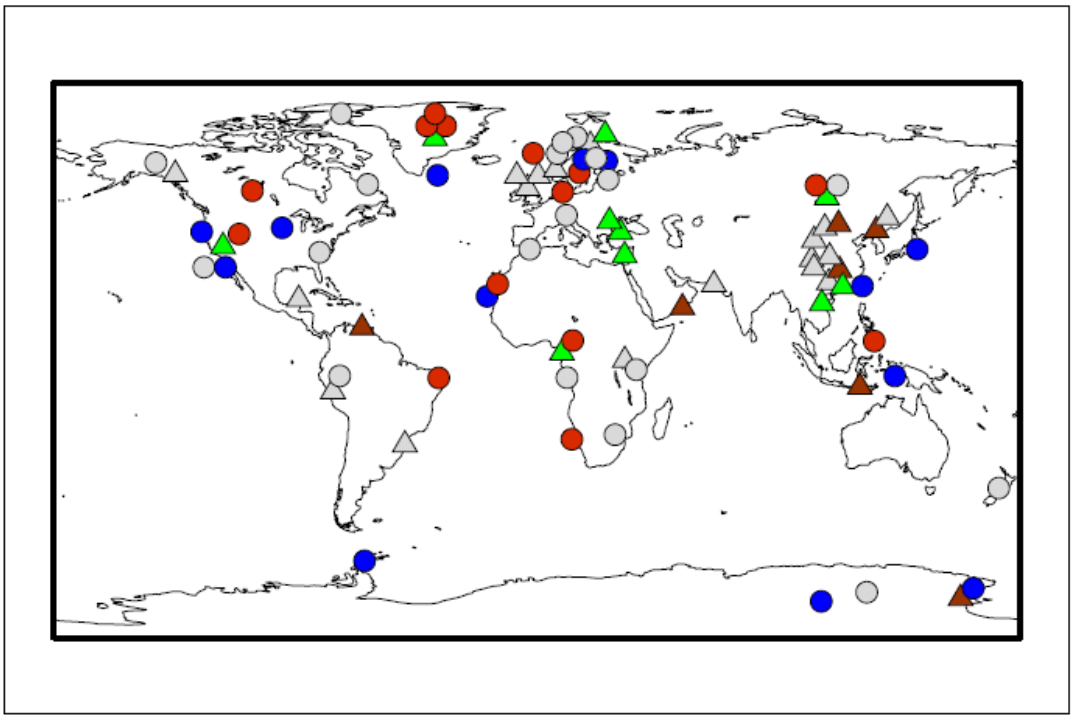
mean of yrs 5200–5300 B.P.



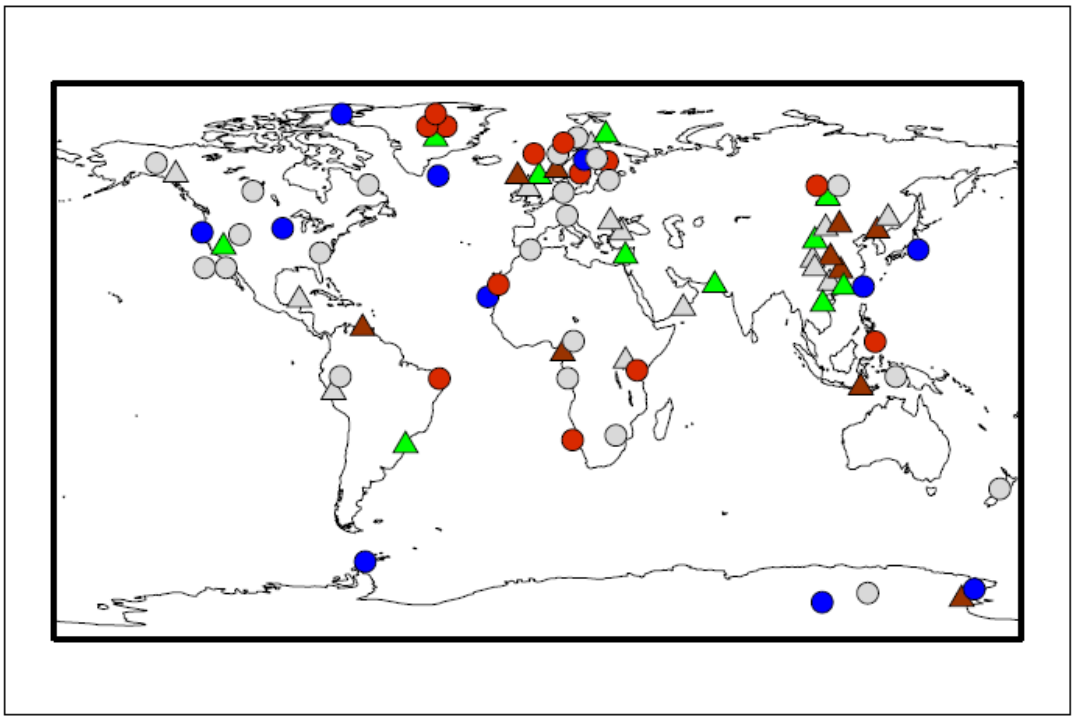
mean of yrs 5100–5200 B.P.



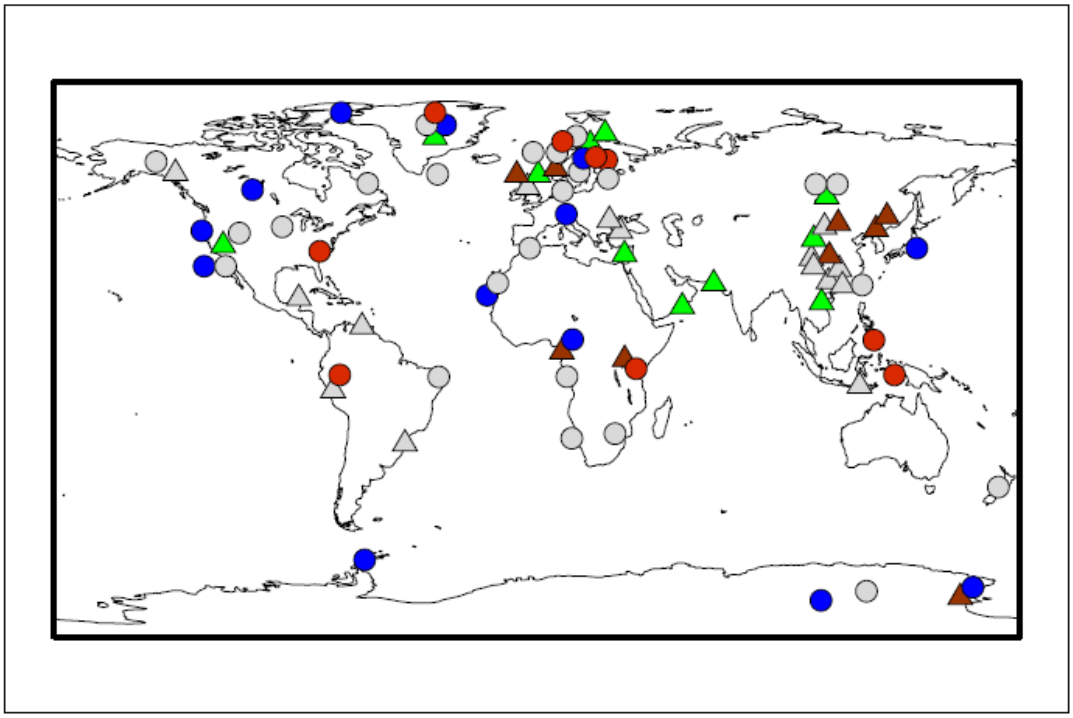
mean of yrs 5000–5100 B.P.



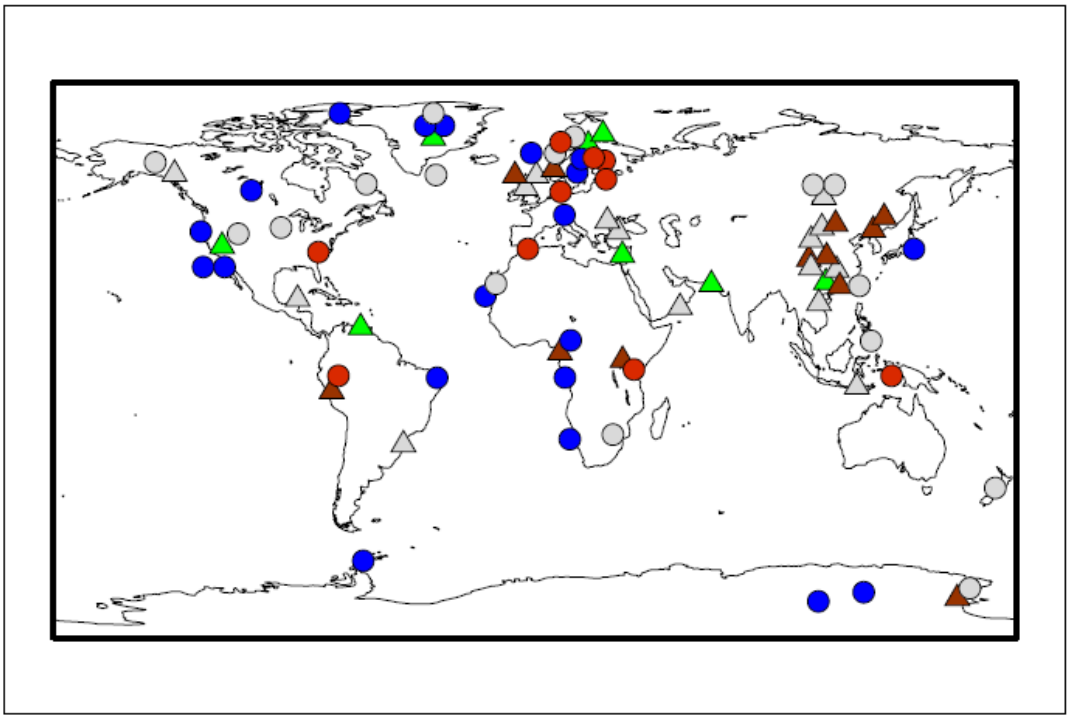
mean of yrs 4900–5000 B.P.



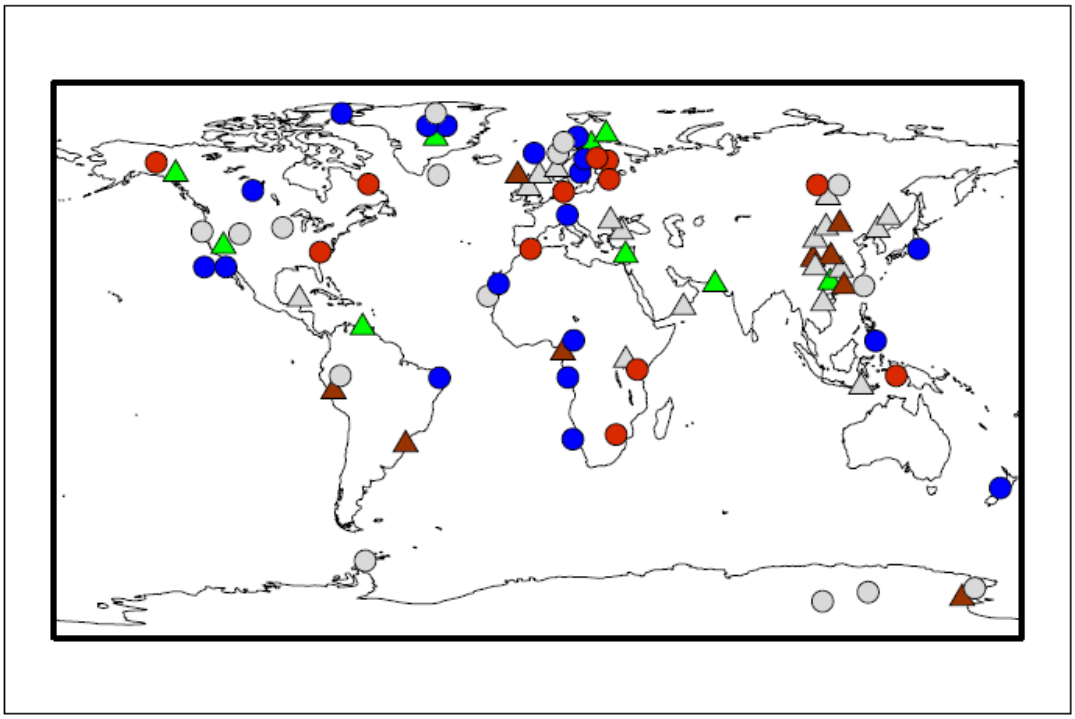
mean of yrs 4800–4900 B.P.



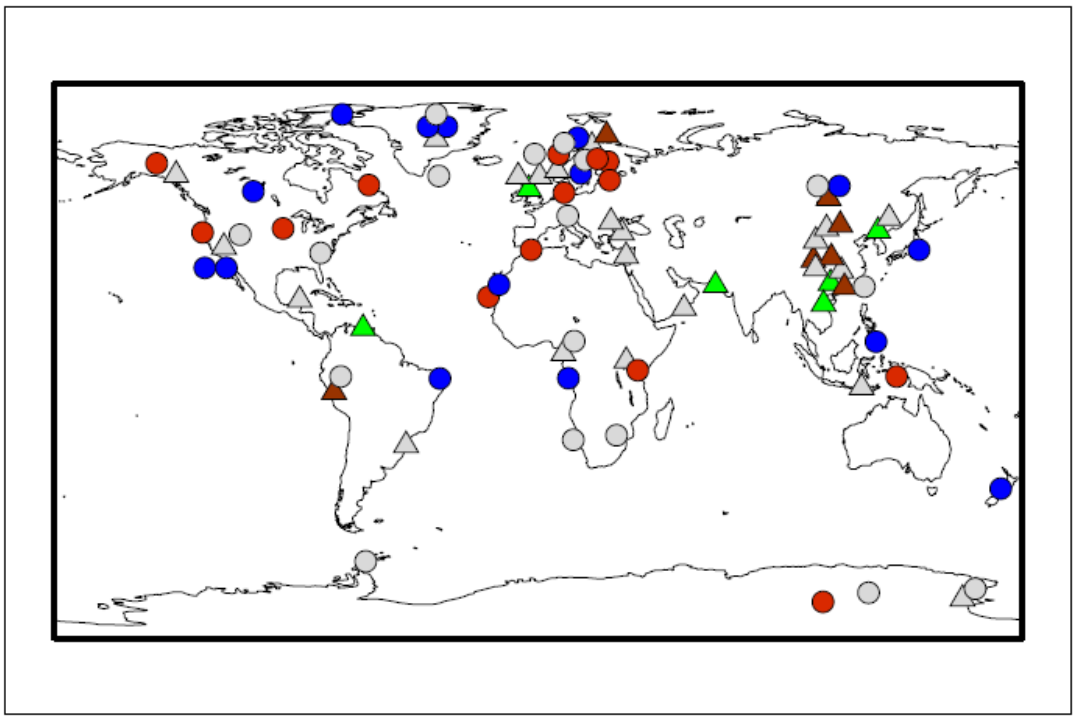
mean of yrs 4700–4800 B.P.



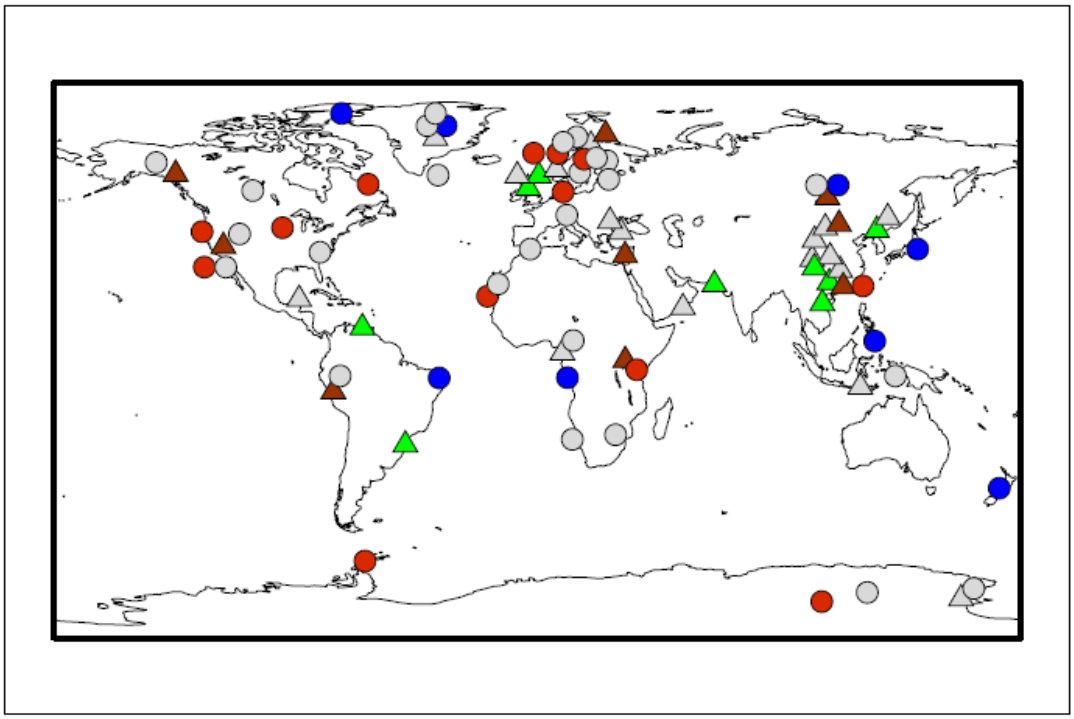
mean of yrs 4600–4700 B.P.



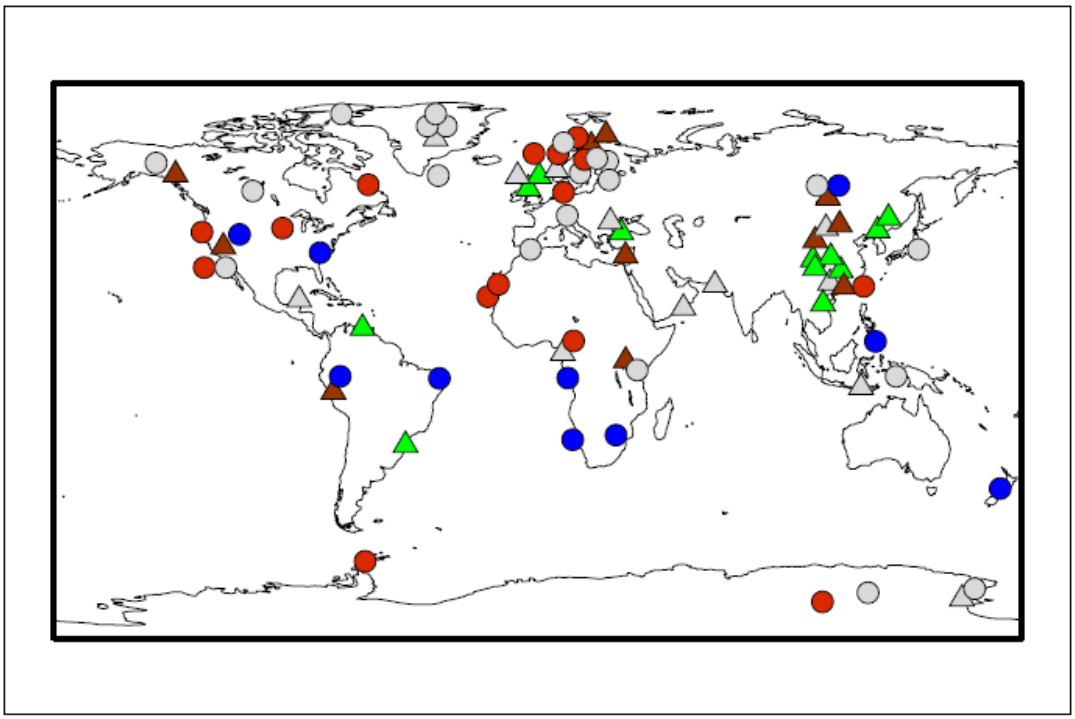
mean of yrs 4500–4600 B.P.



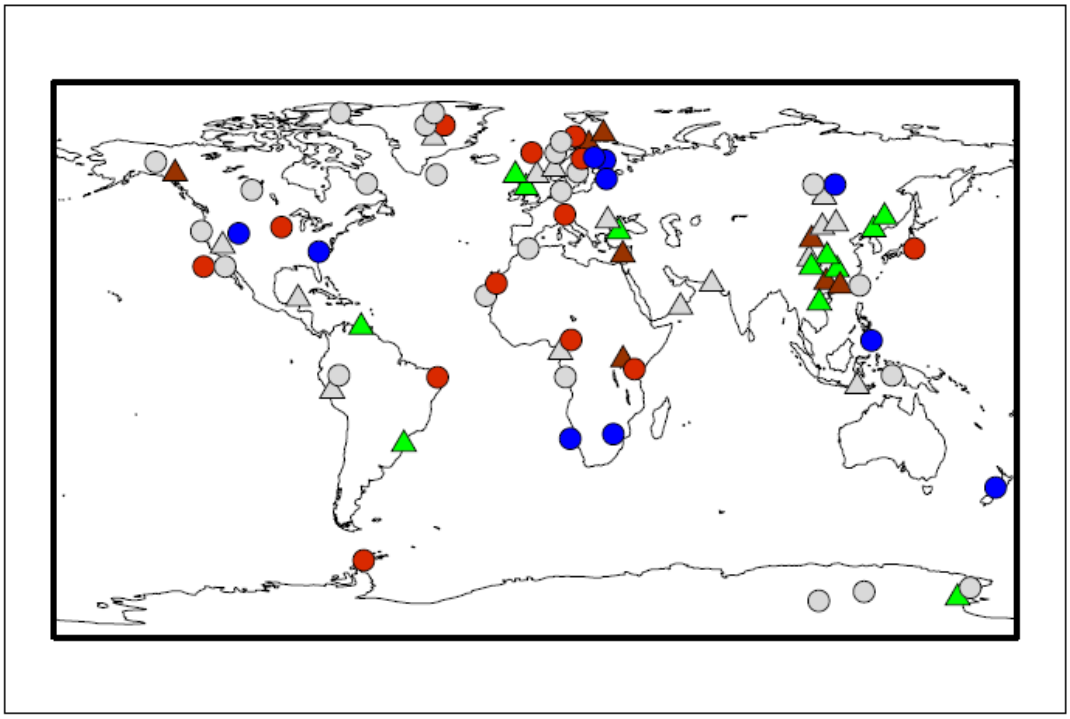
mean of yrs 4400–4500 B.P.



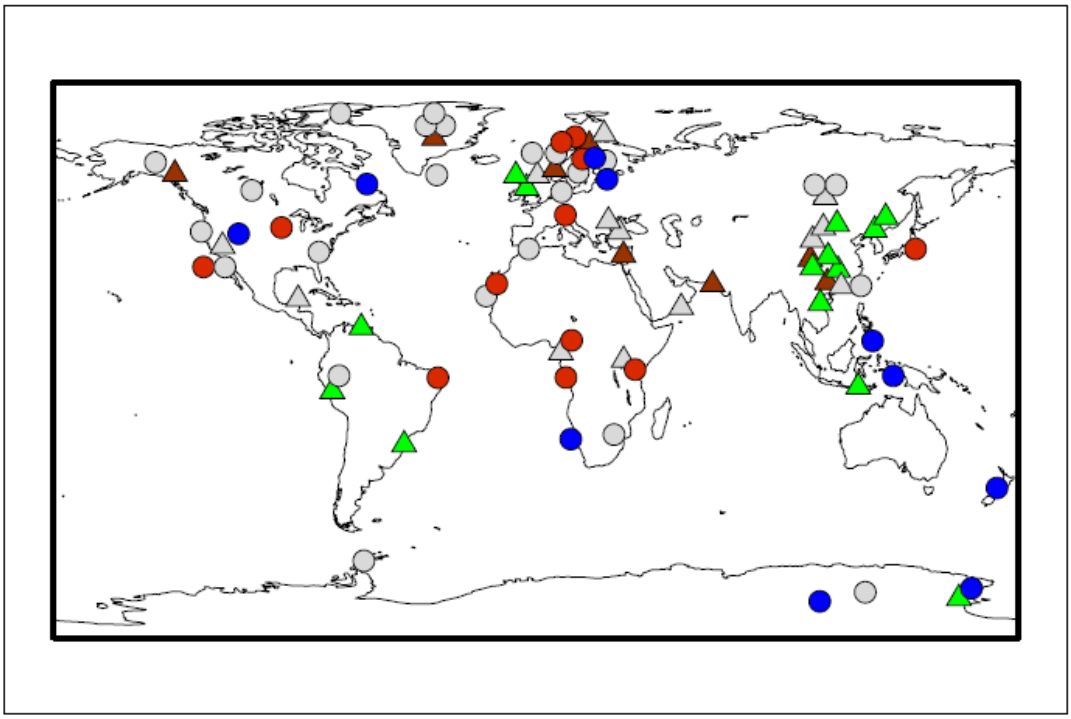
mean of yrs 4300–4400 B.P.



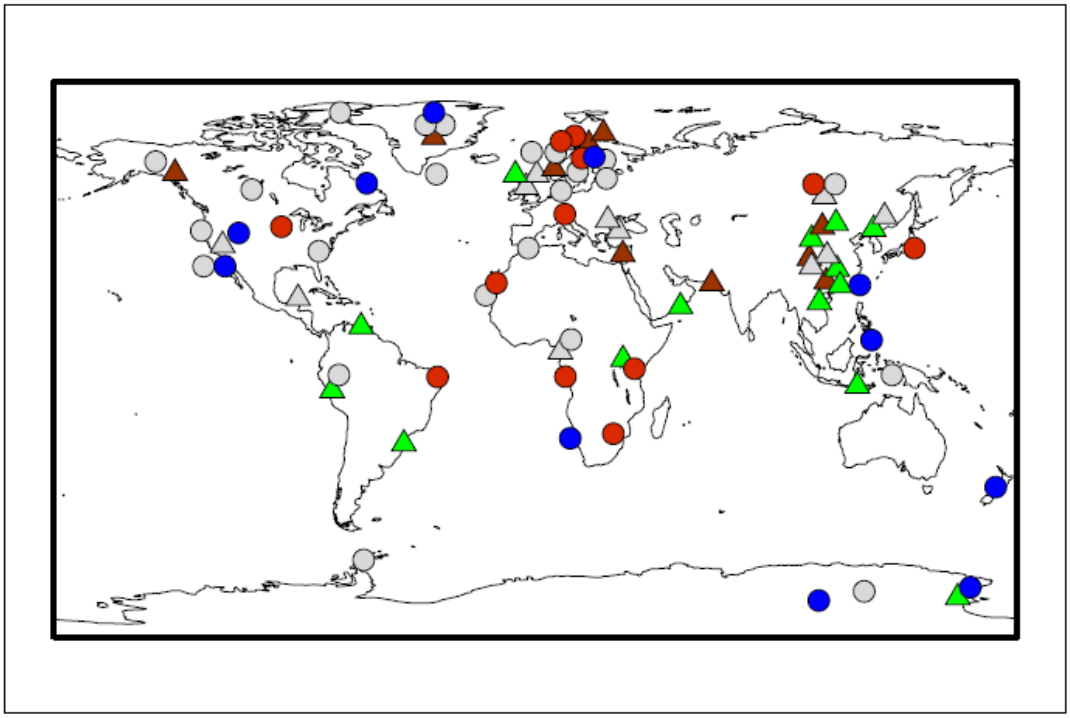
mean of yrs 4200–4300 B.P.



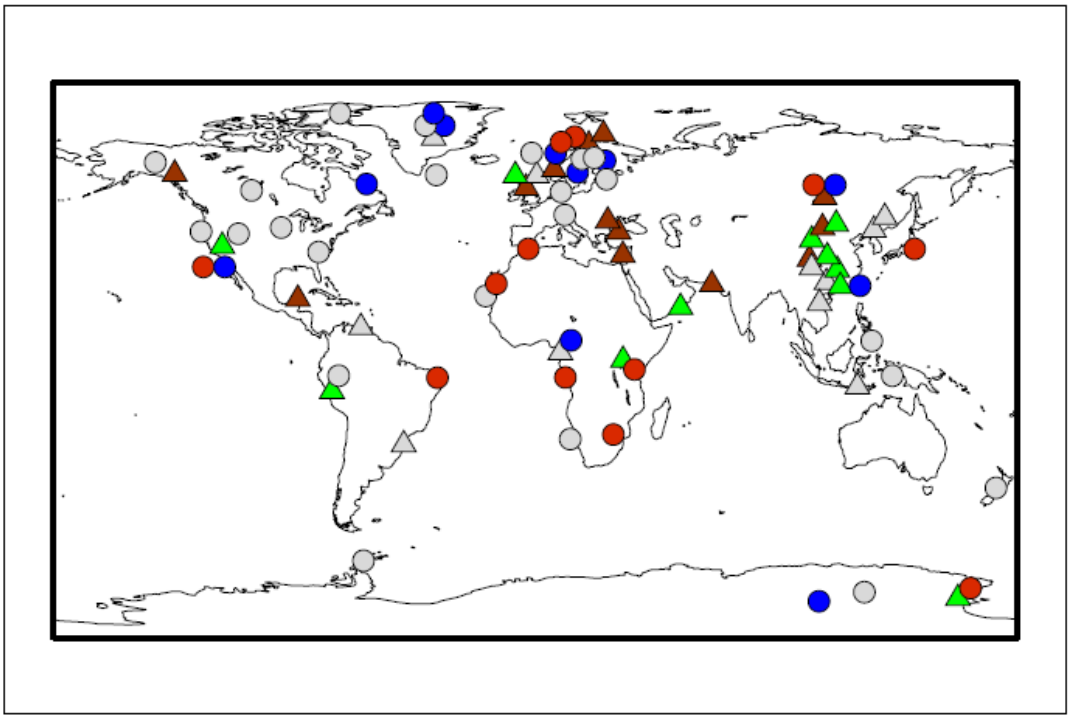
mean of yrs 4100–4200 B.P.



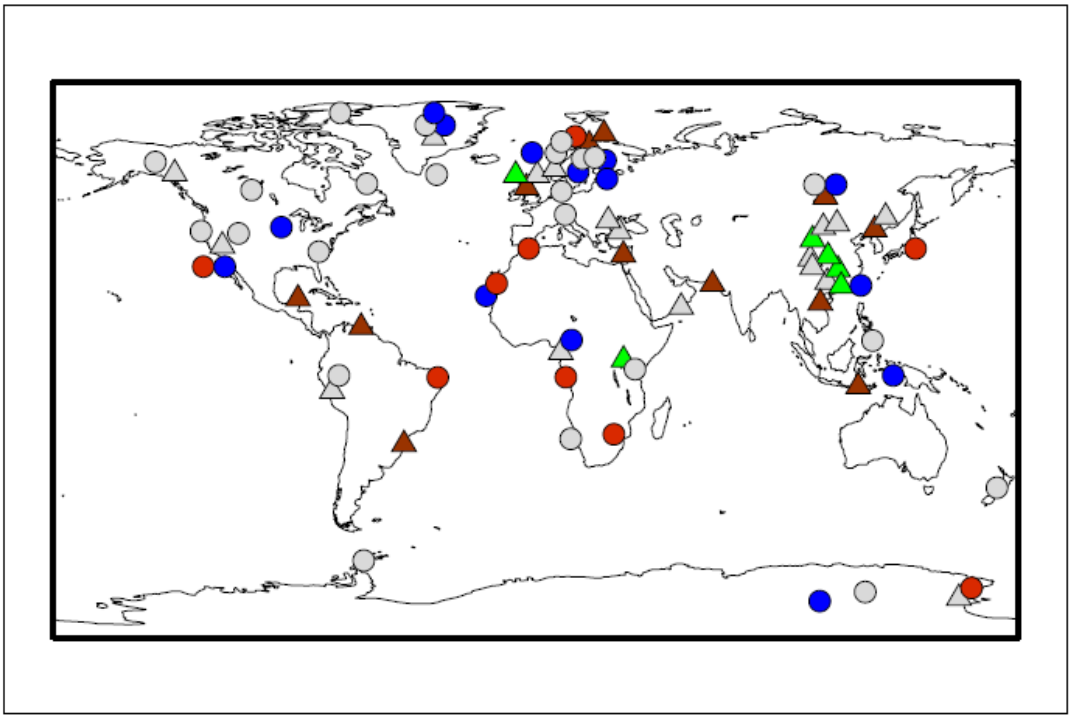
mean of yrs 4000–4100 B.P.



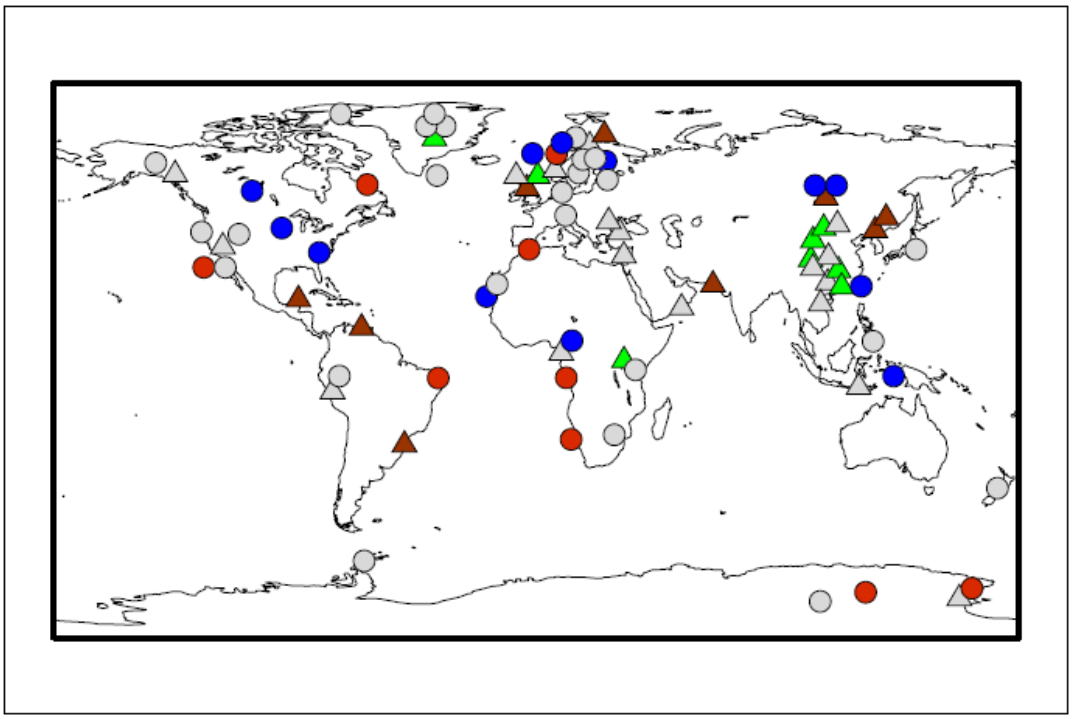
mean of yrs 3900–4000 B.P.



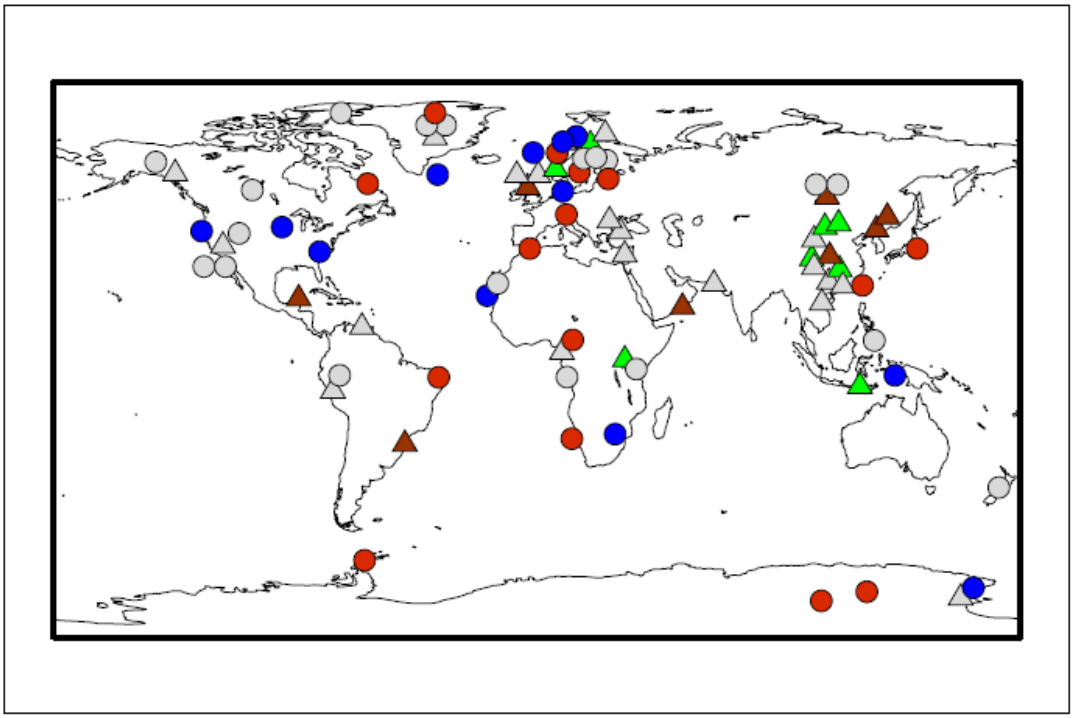
mean of yrs 3800–3900 B.P.



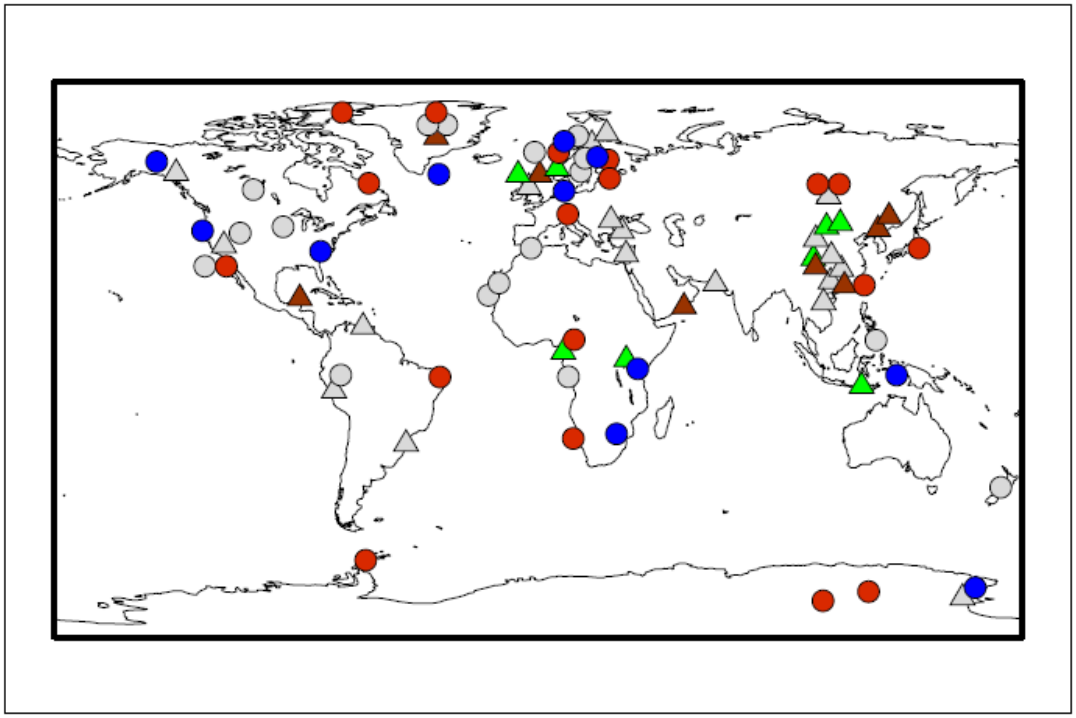
mean of yrs 3700–3800 B.P.



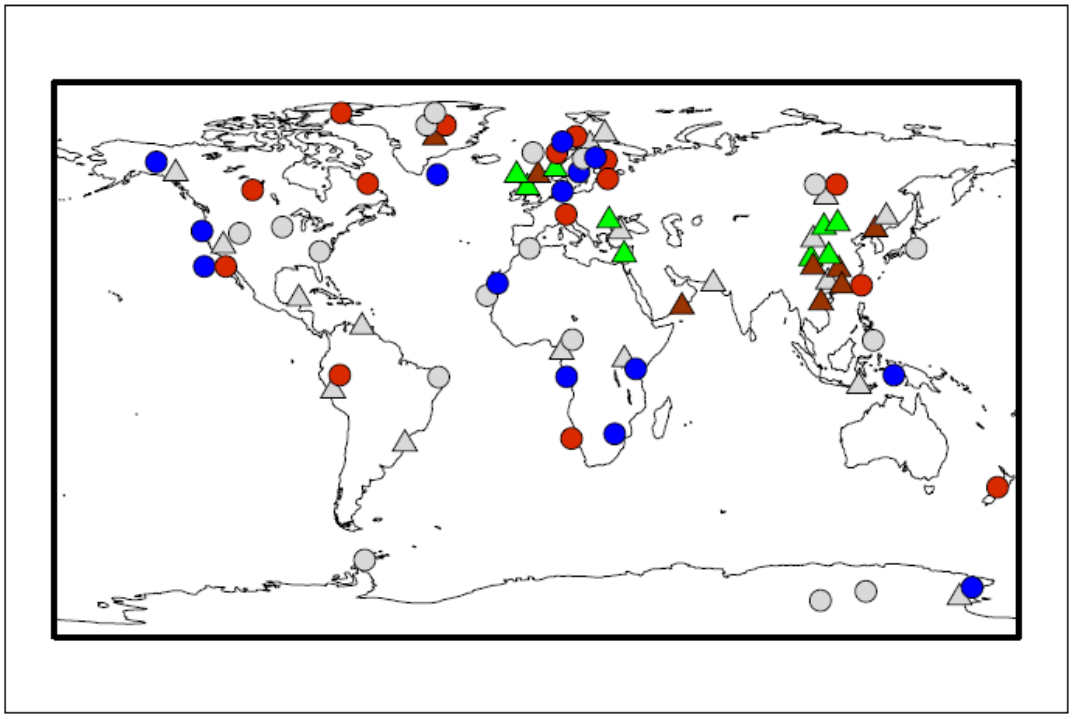
mean of yrs 3600–3700 B.P.



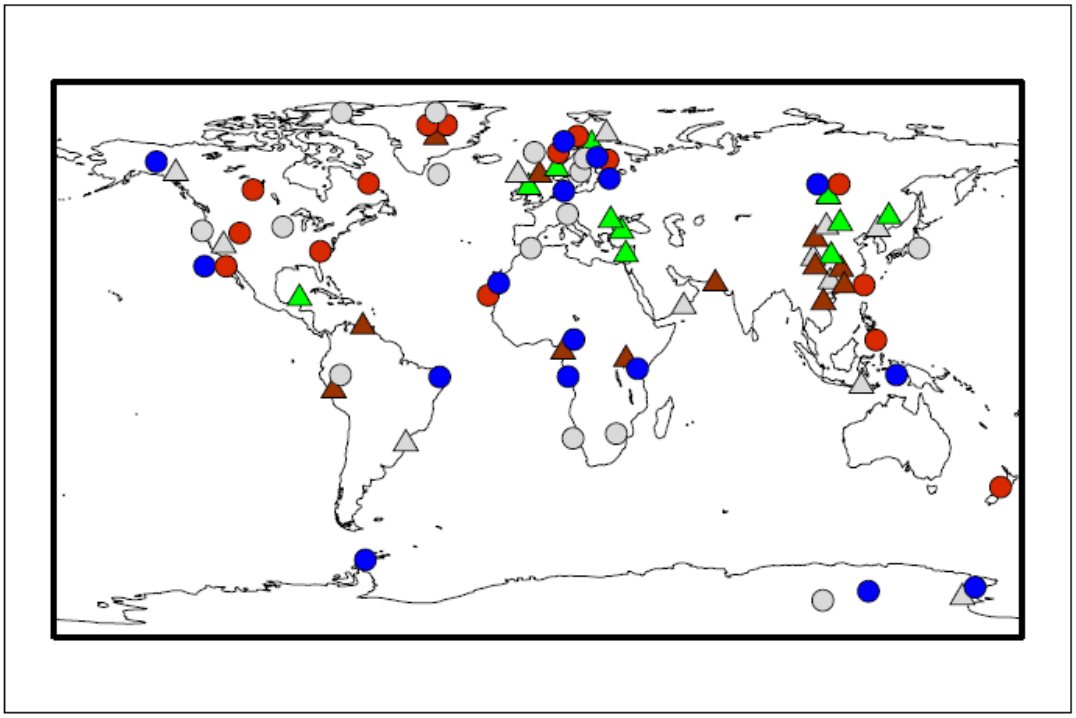
mean of yrs 3500–3600 B.P.



mean of yrs 3400–3500 B.P.



mean of yrs 3300–3400 B.P.



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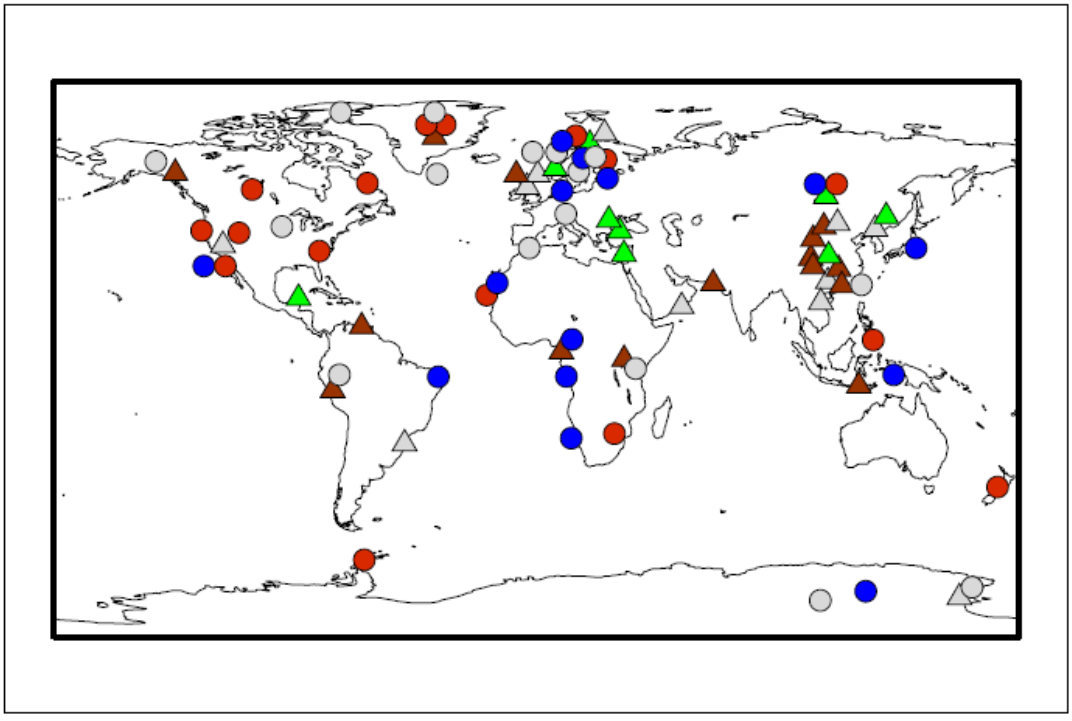

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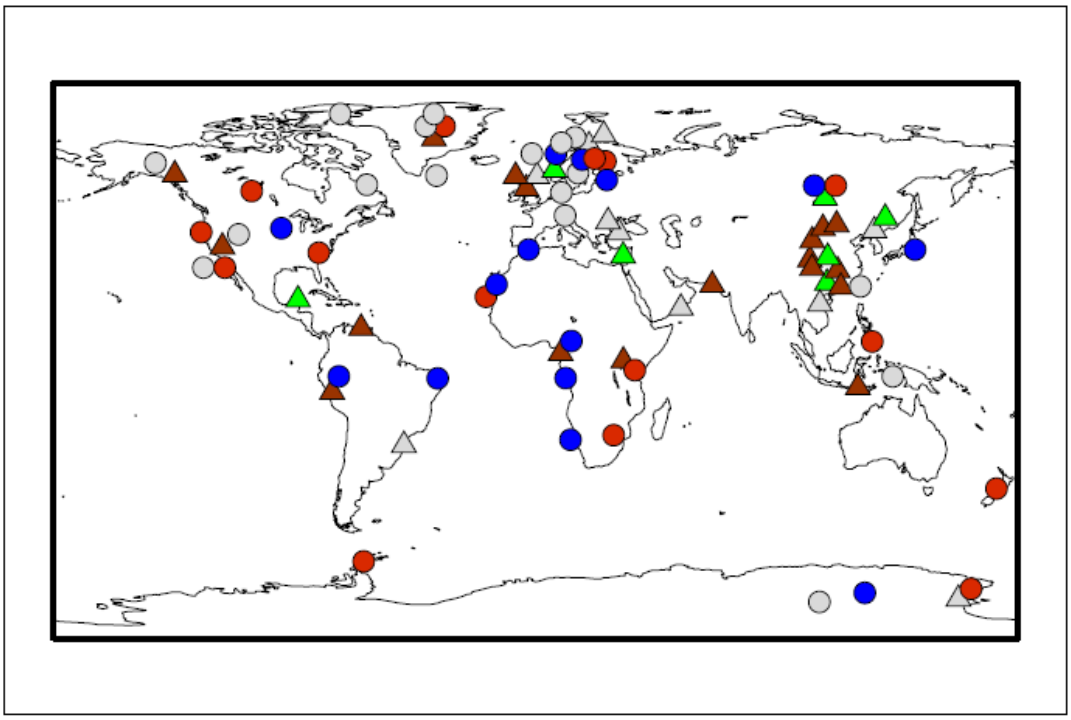

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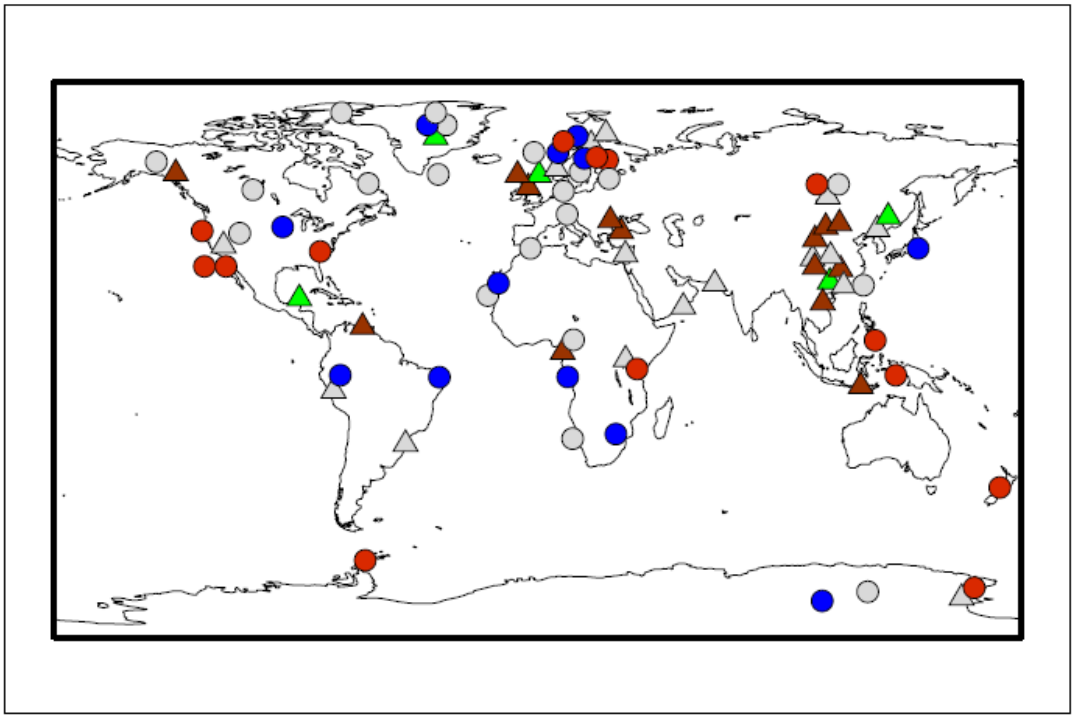

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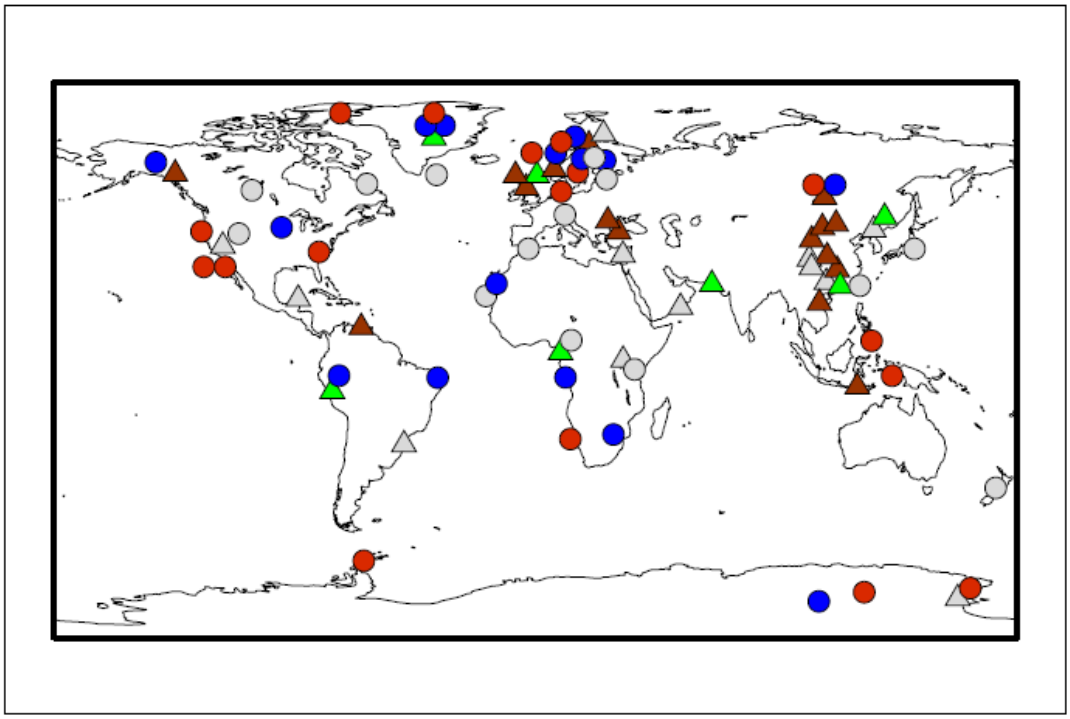

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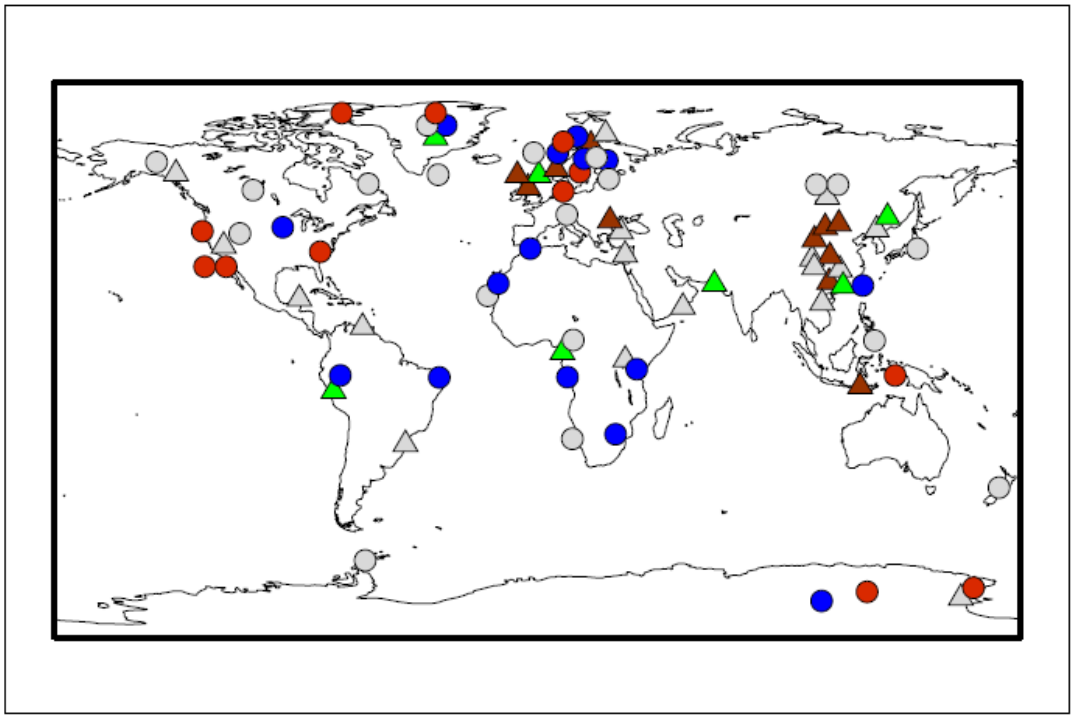

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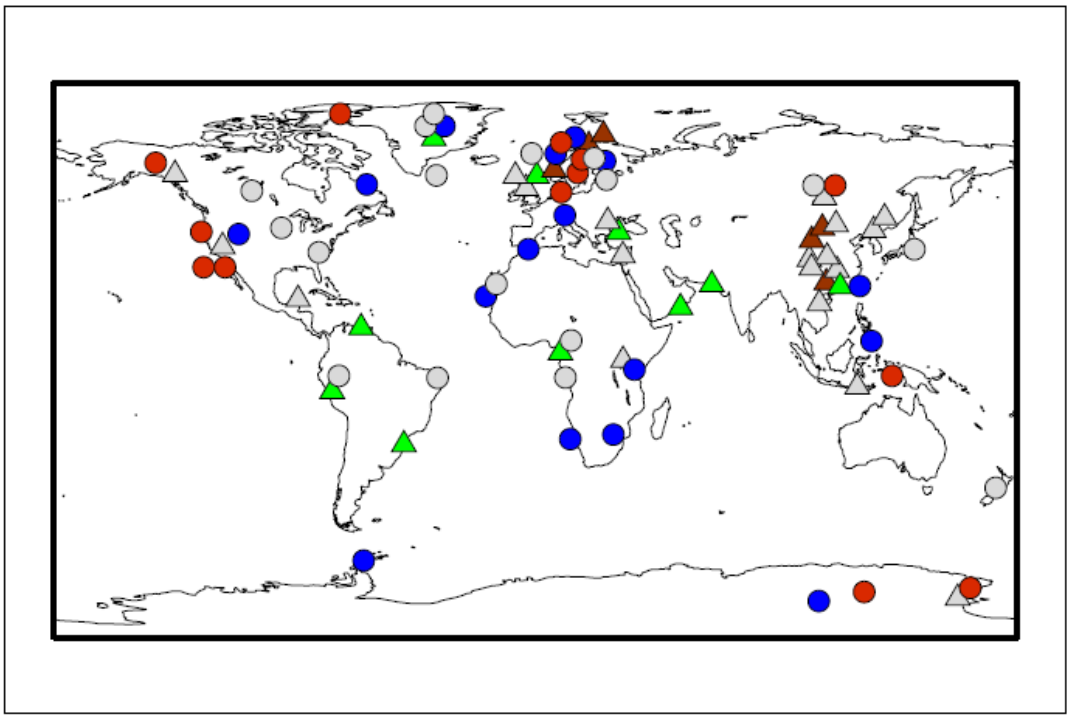

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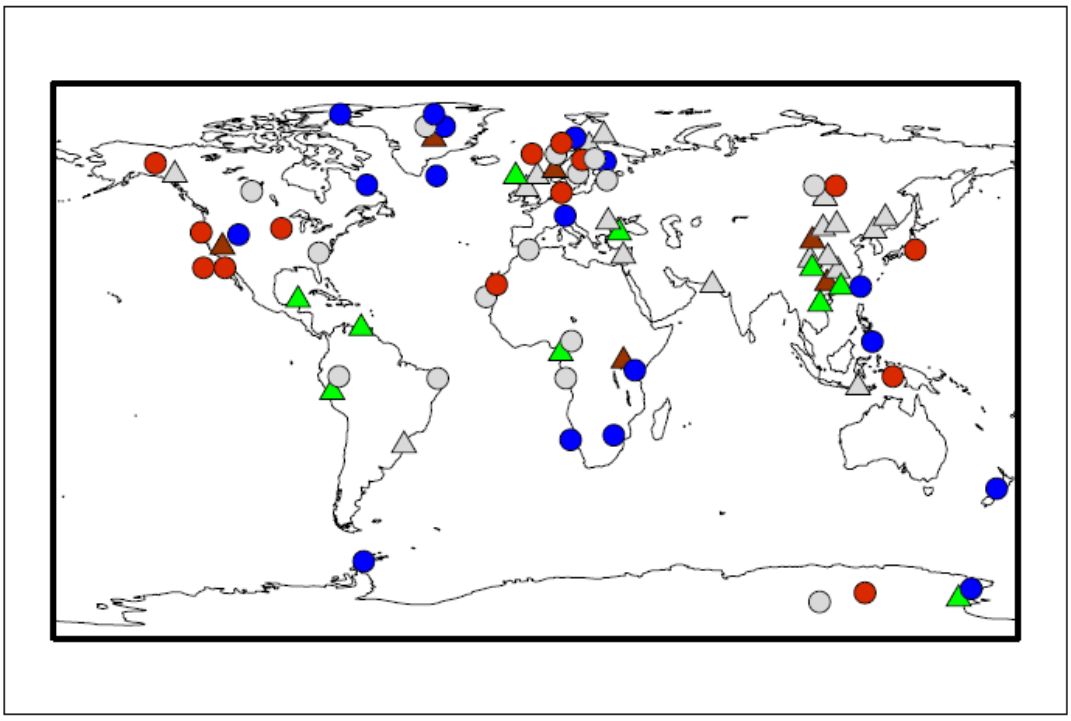

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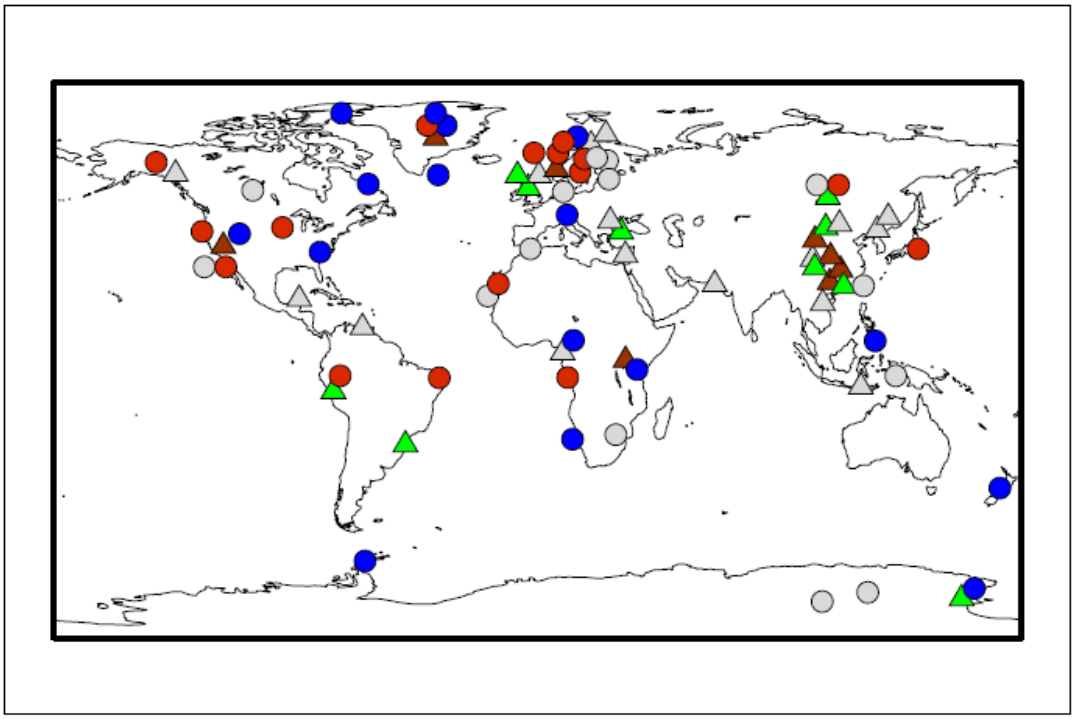

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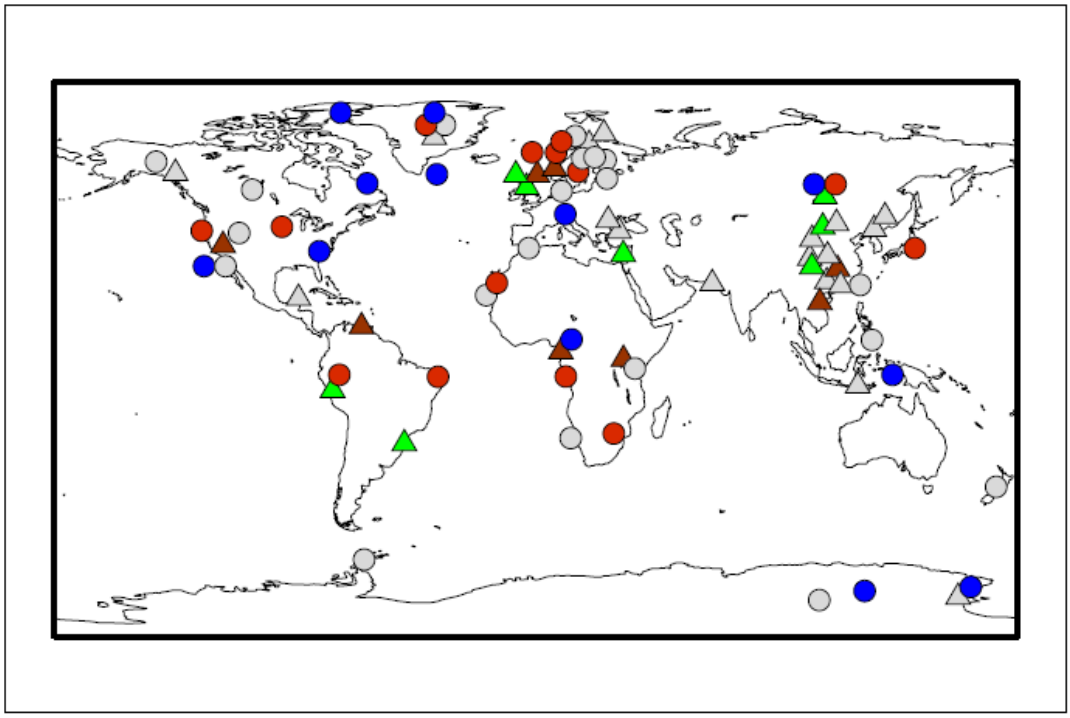

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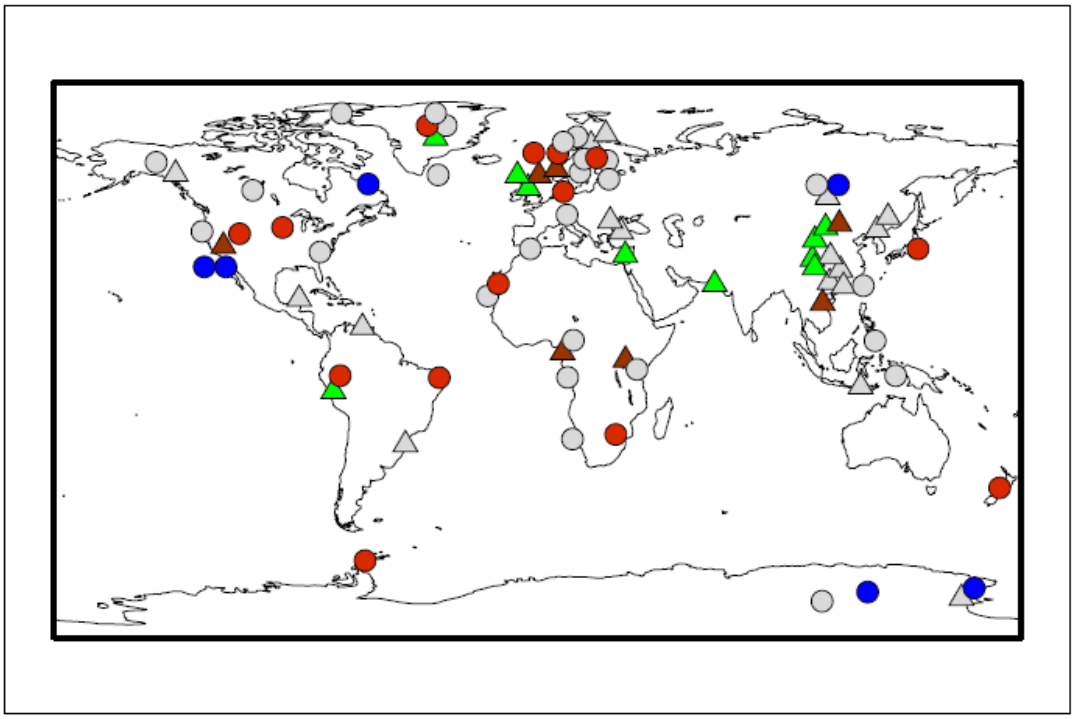

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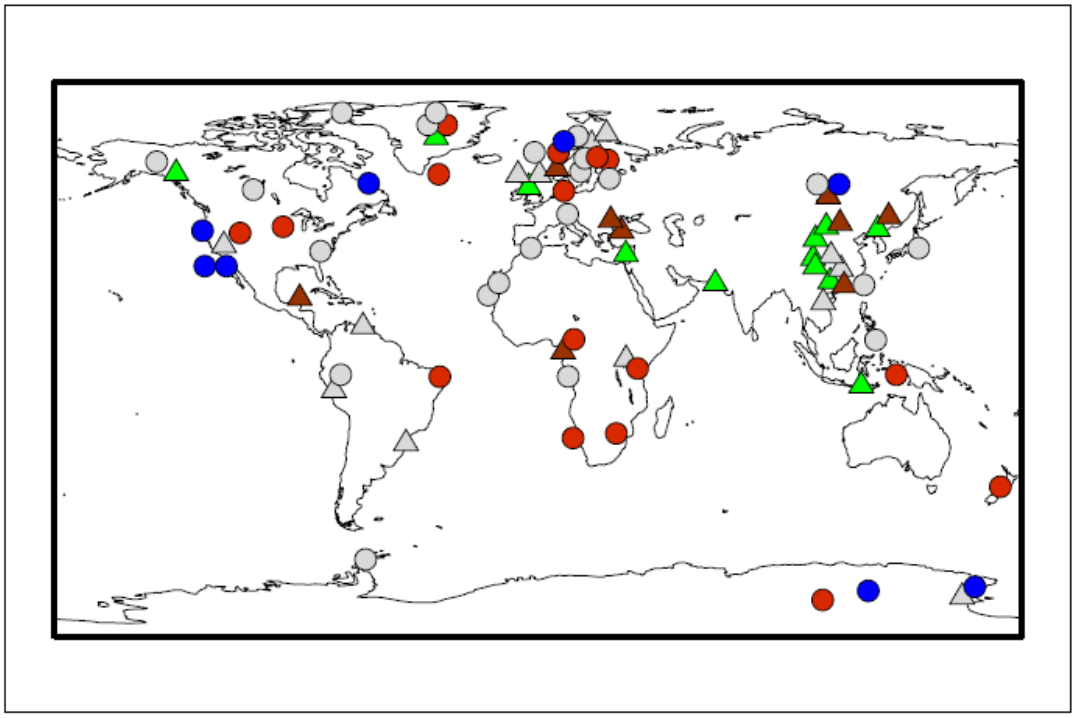

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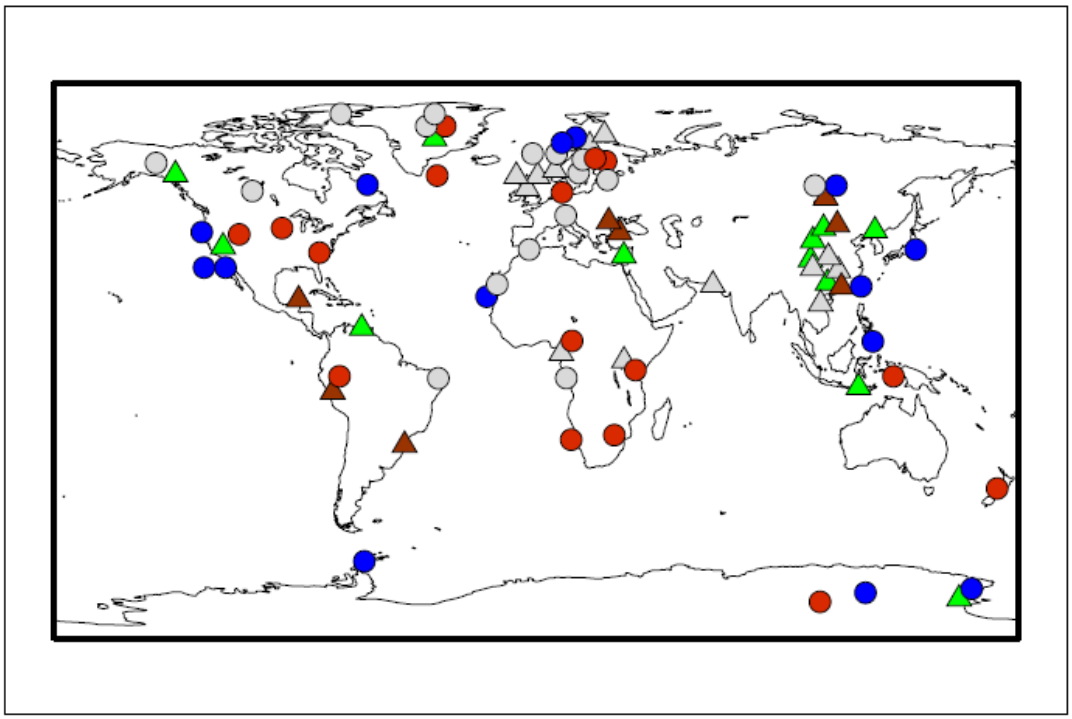

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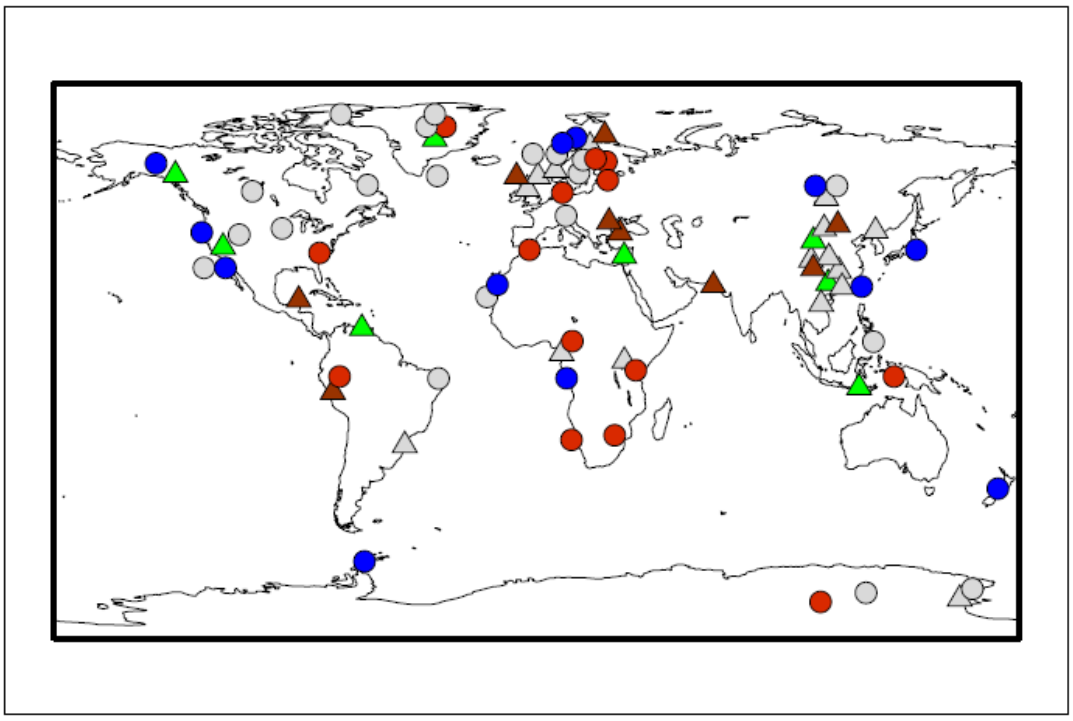

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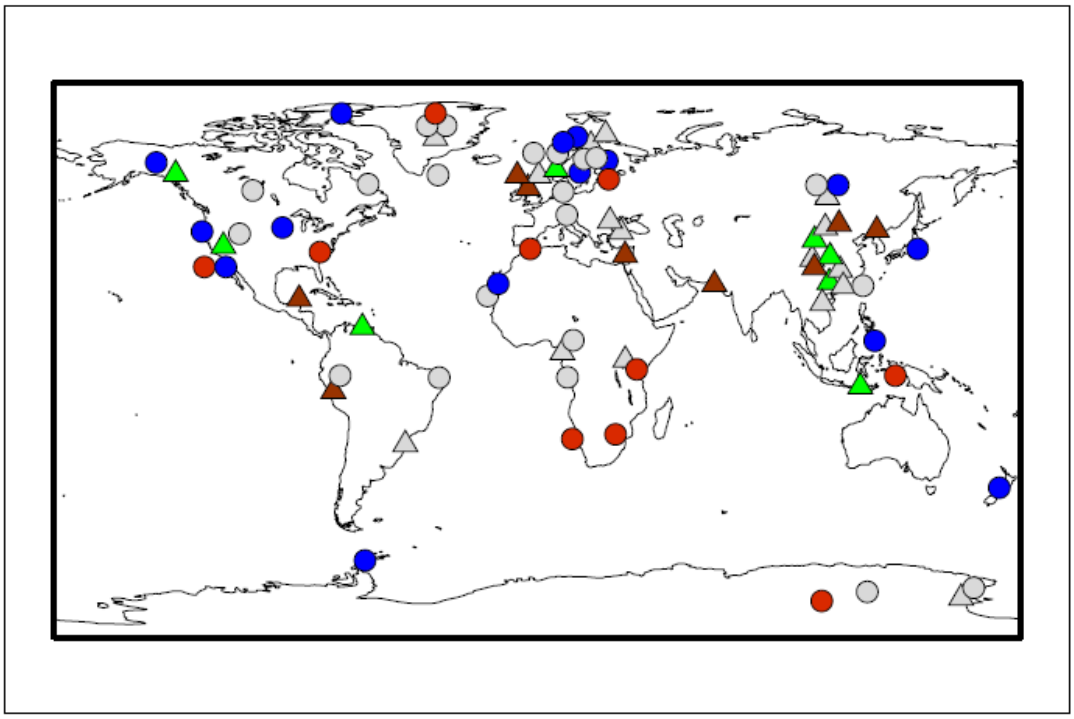

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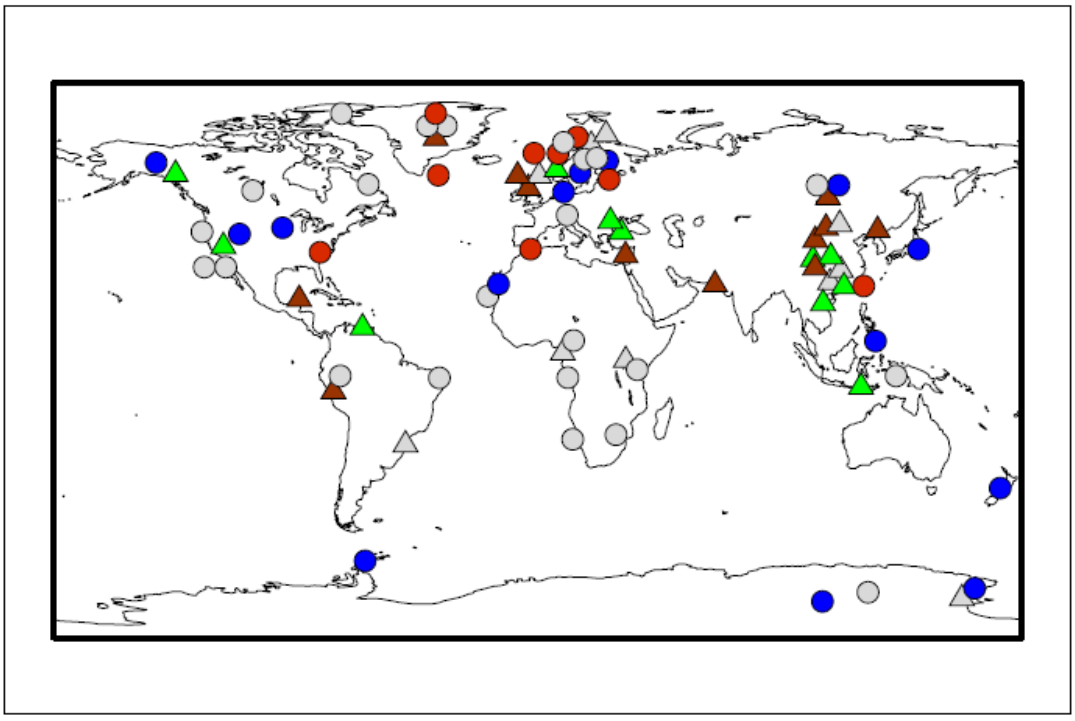

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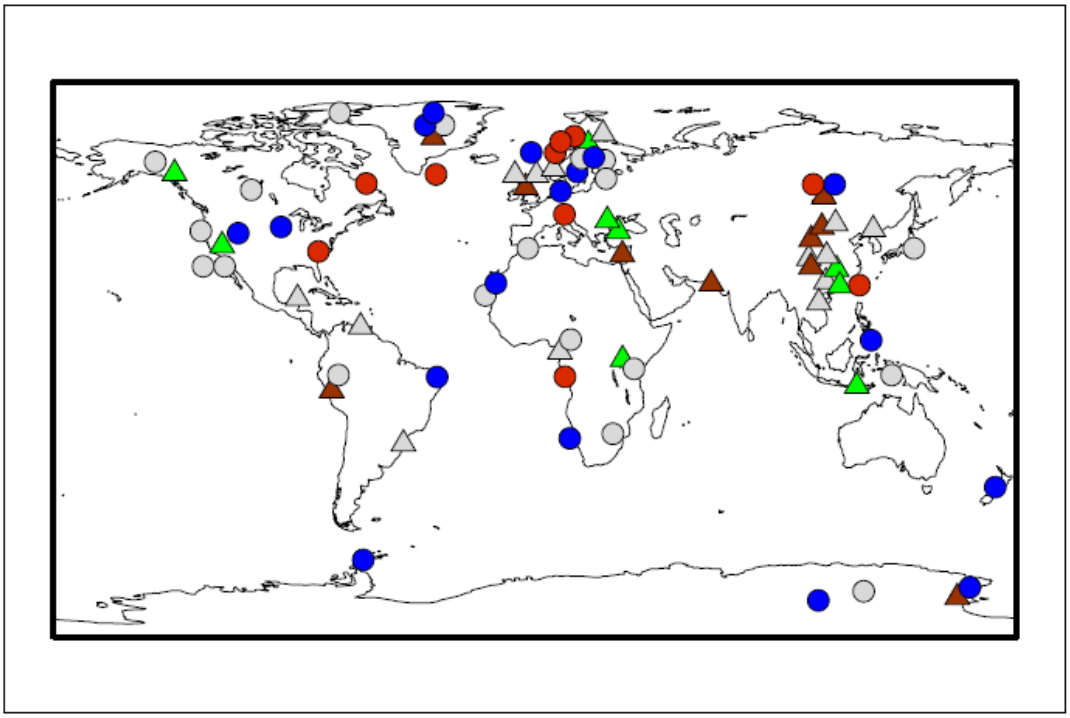

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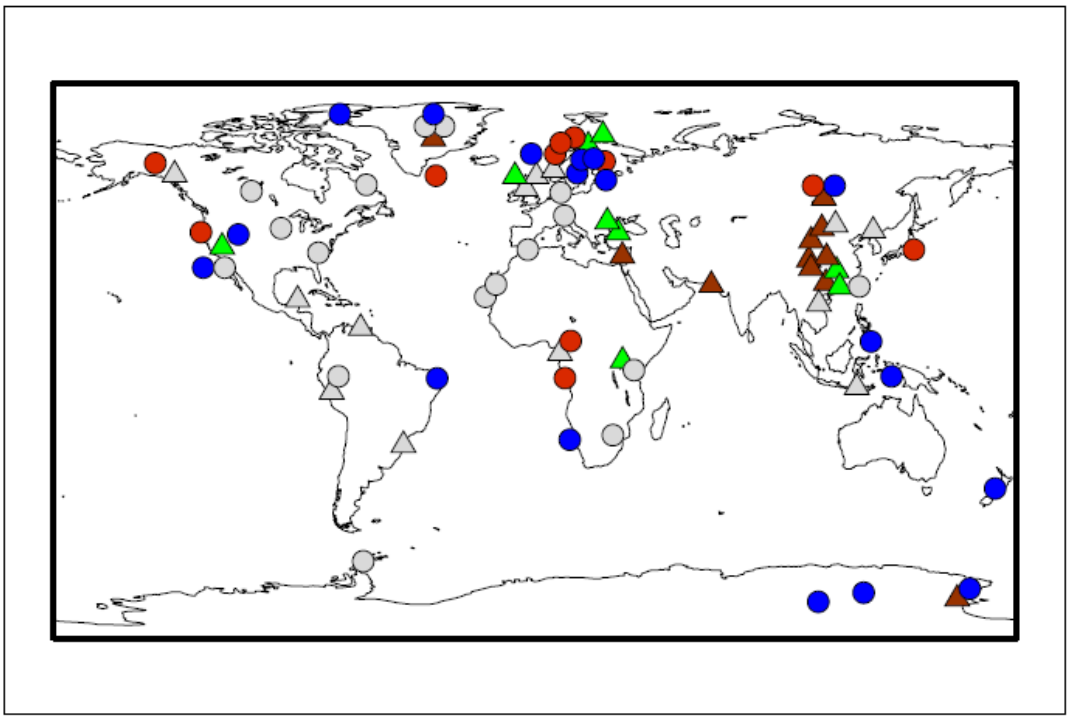

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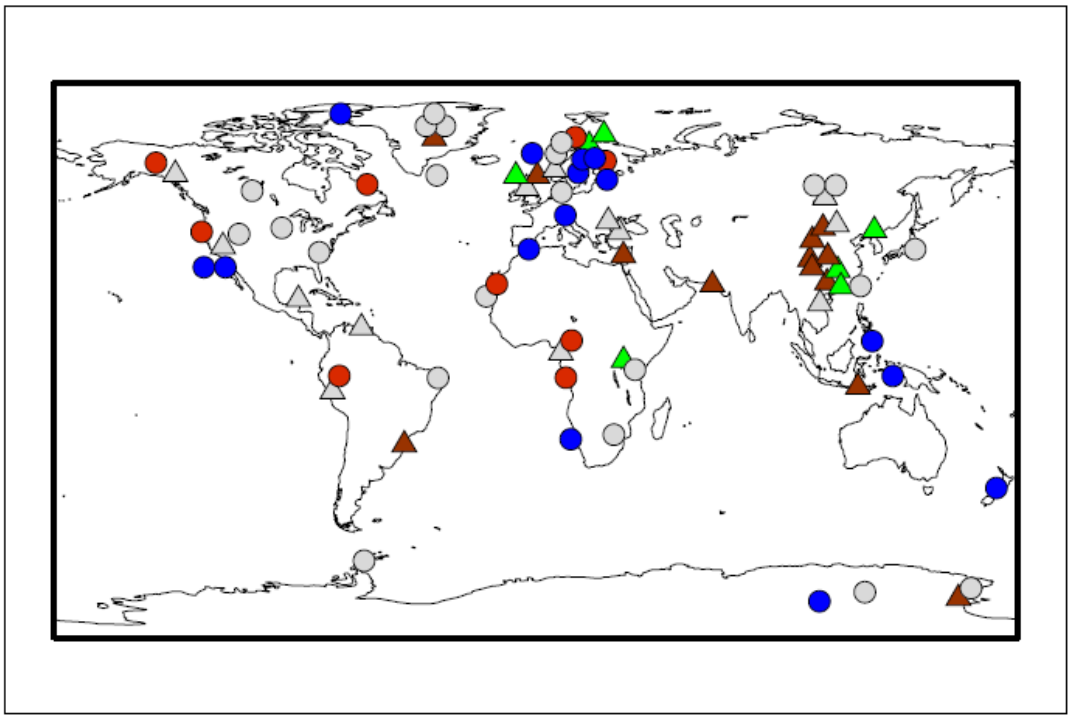

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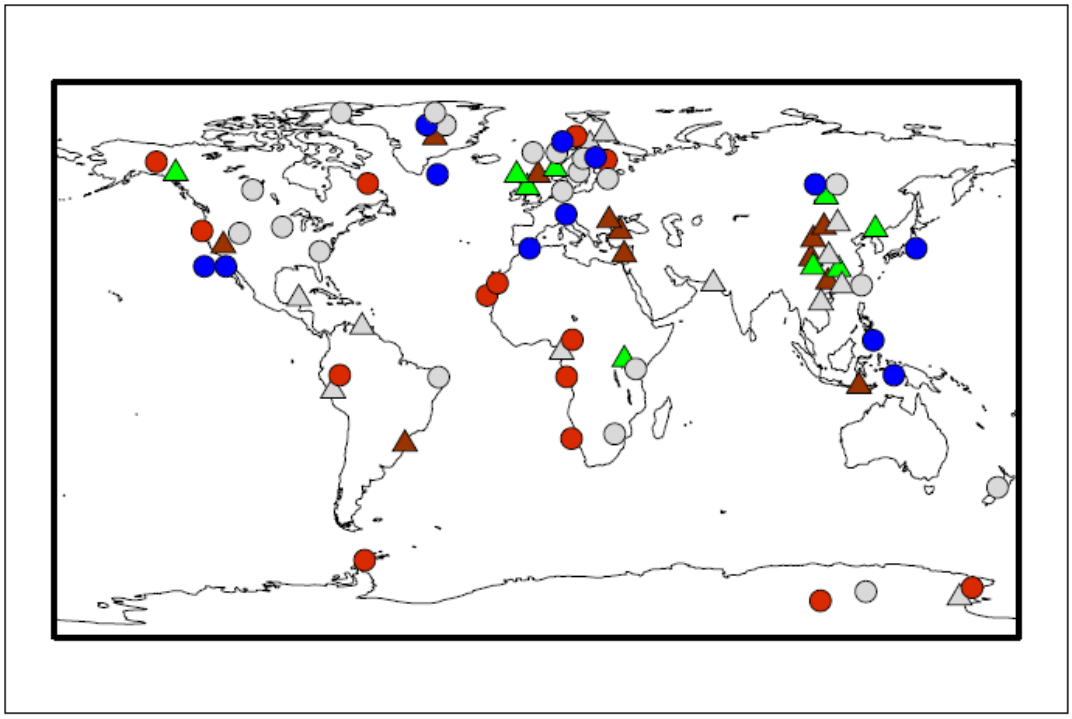

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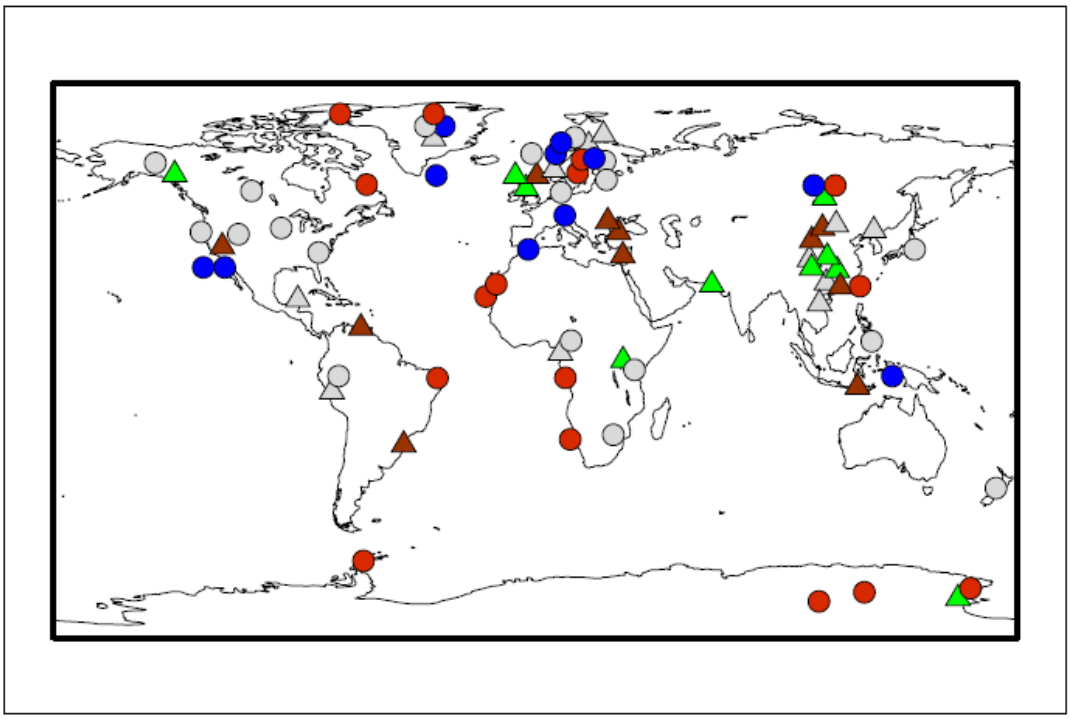

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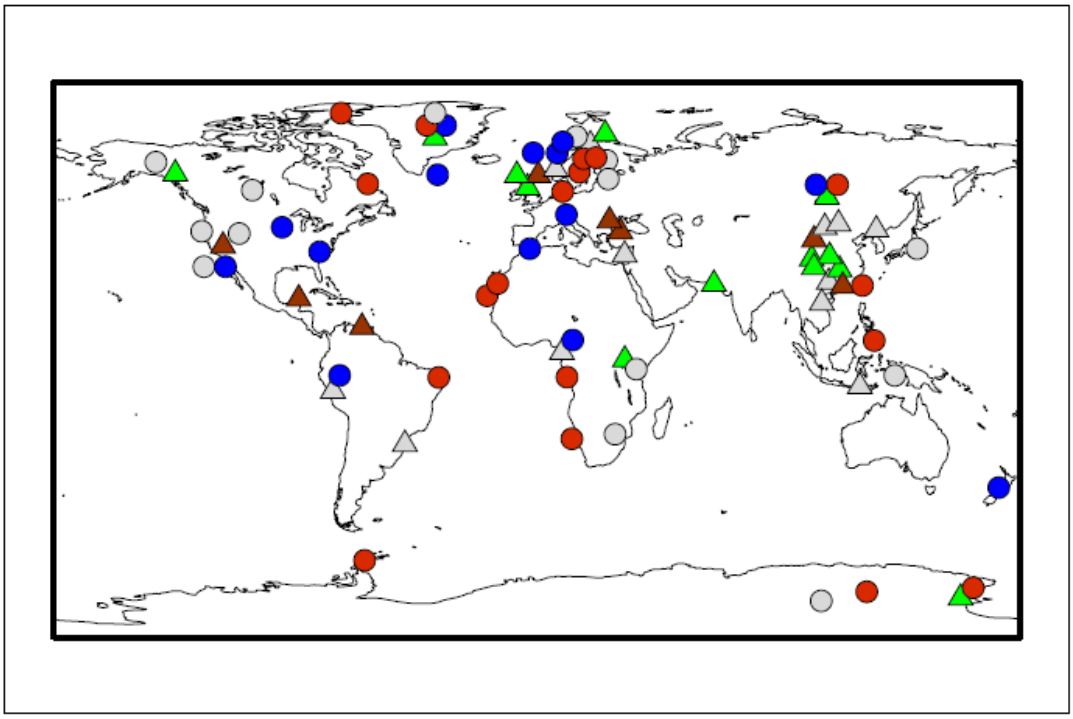

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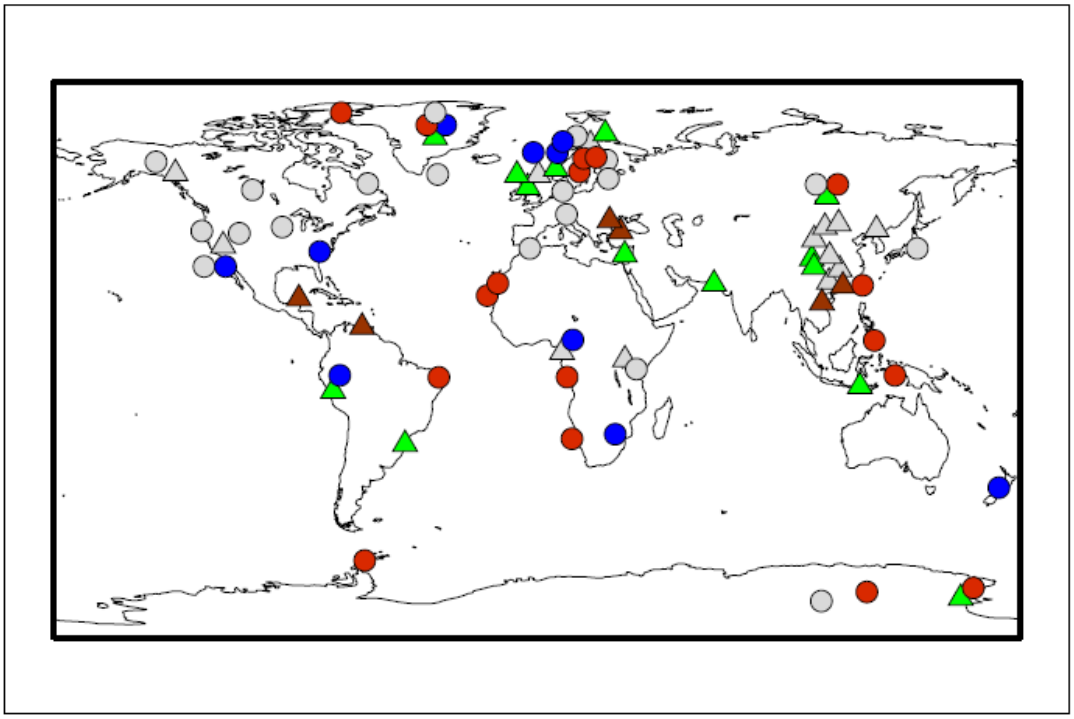

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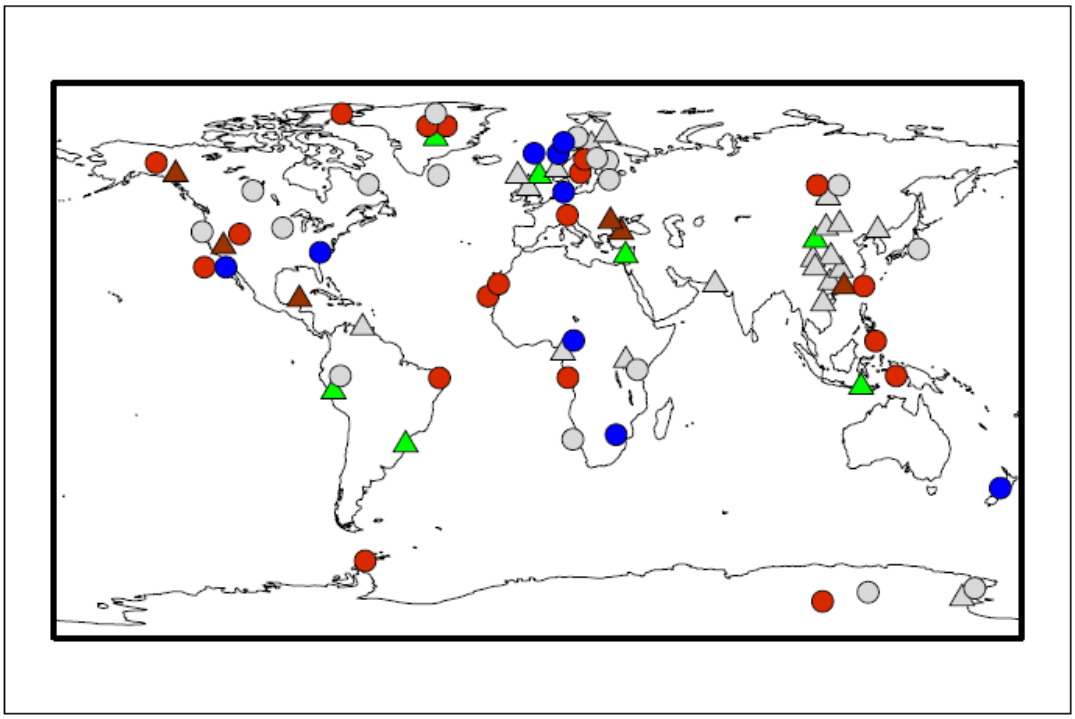

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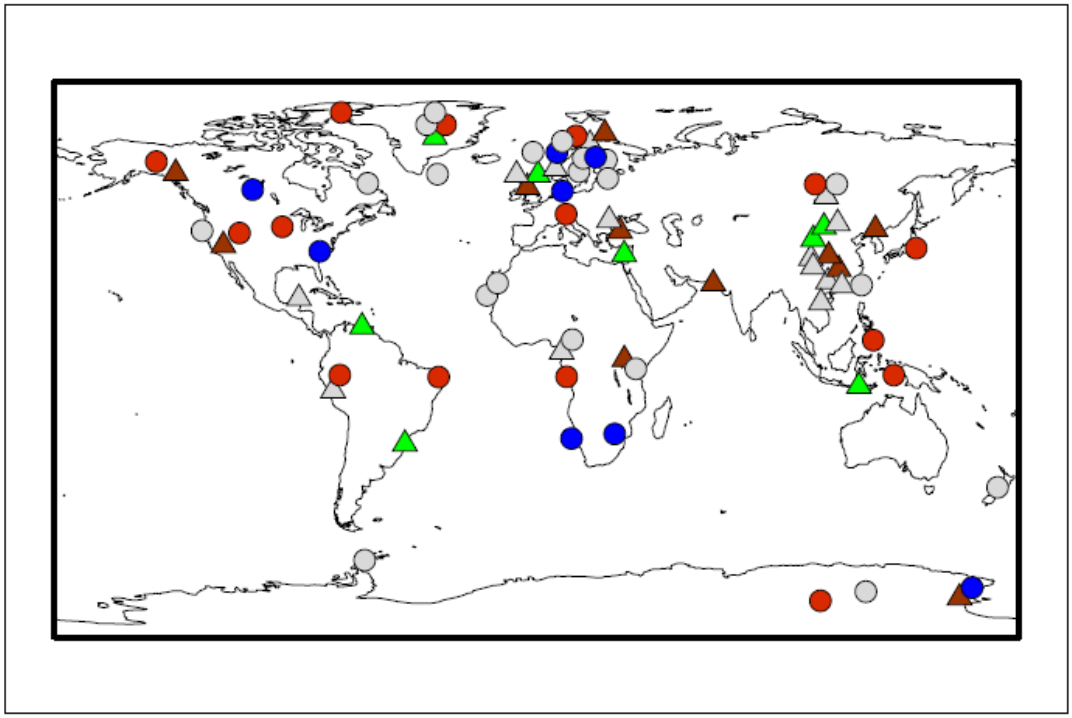

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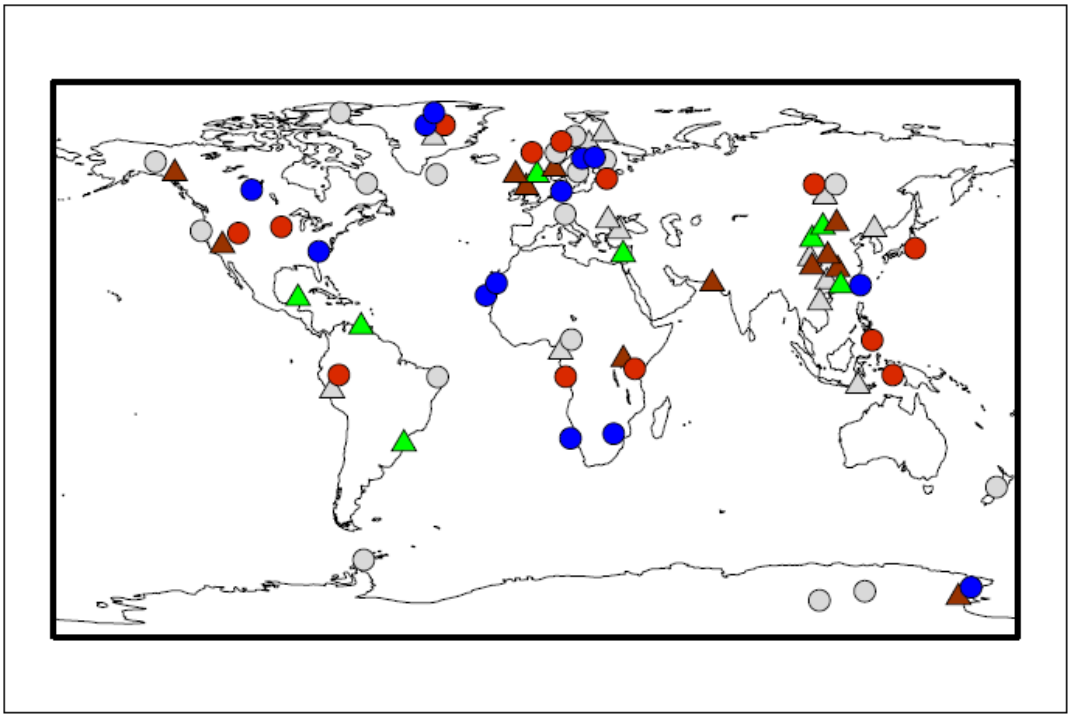

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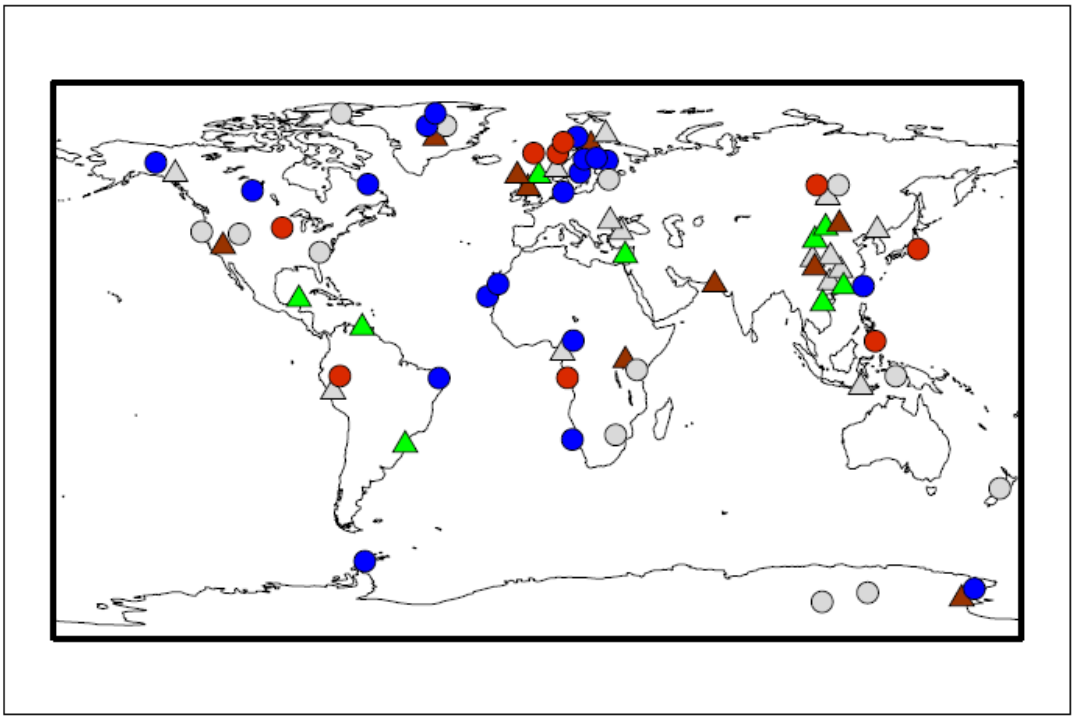

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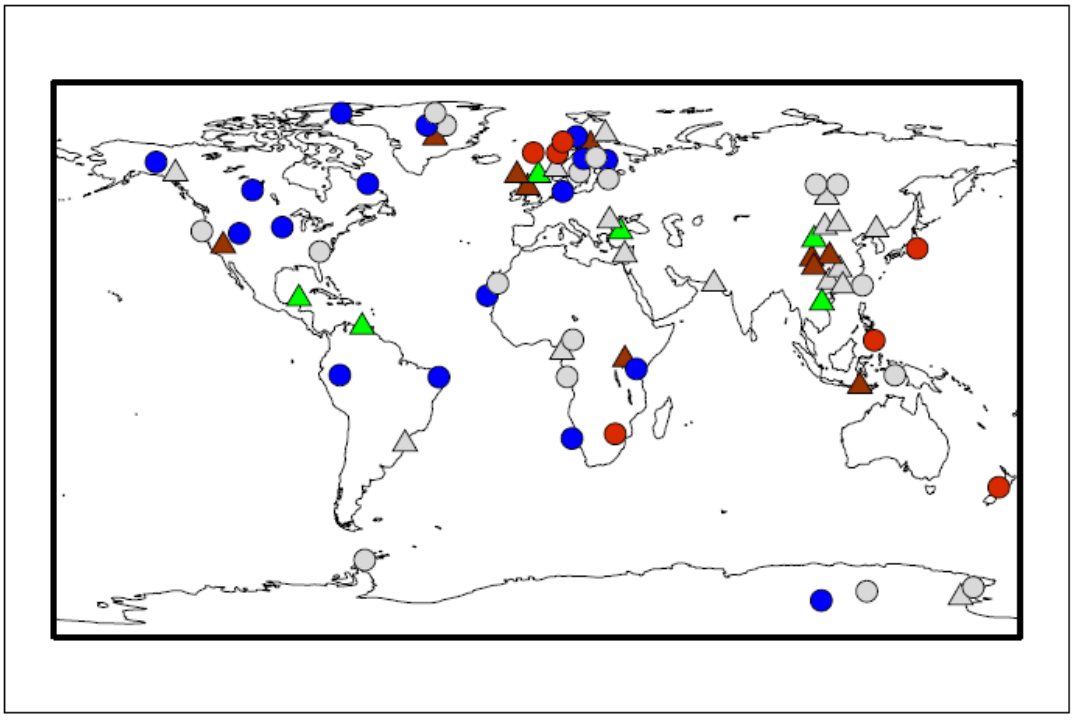

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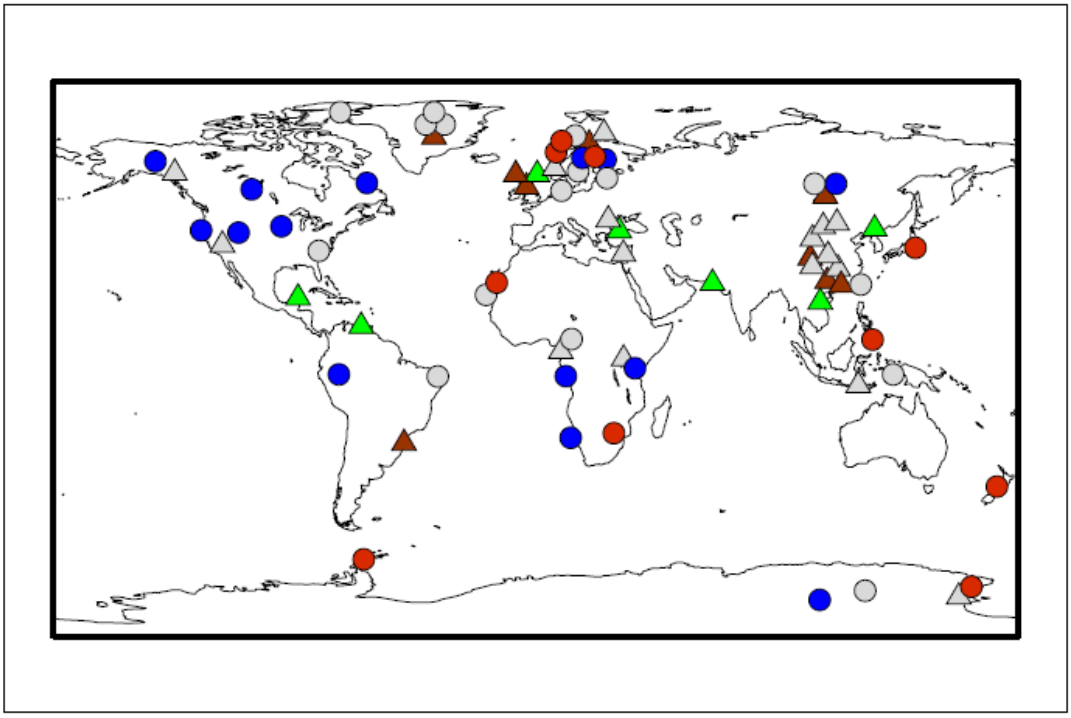

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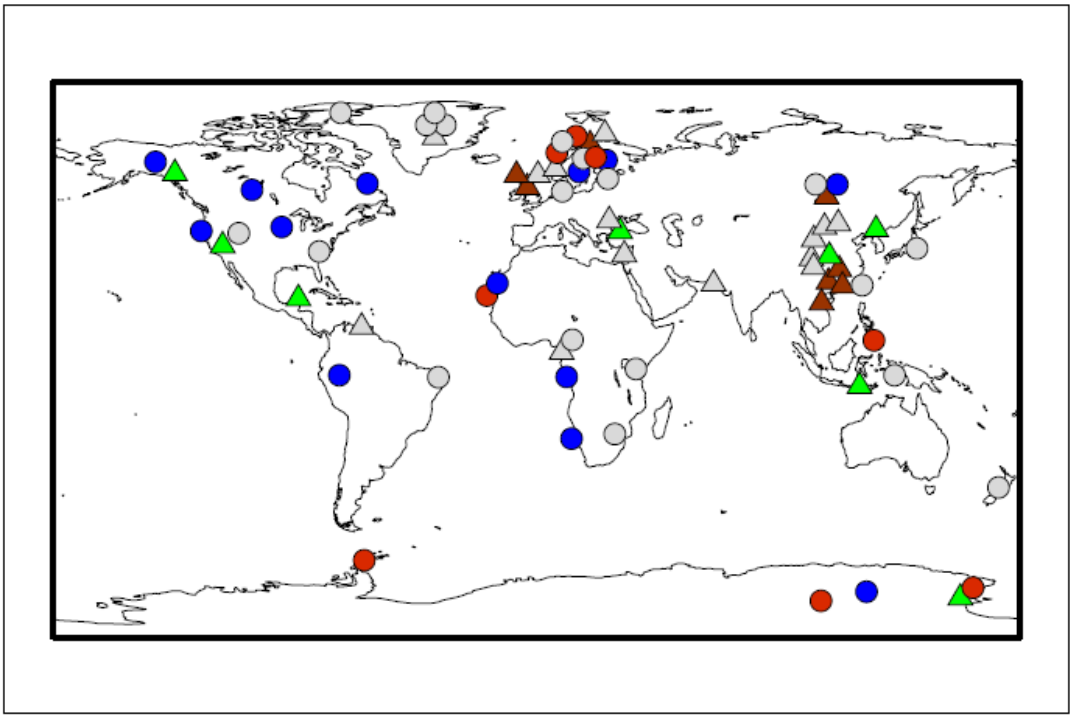

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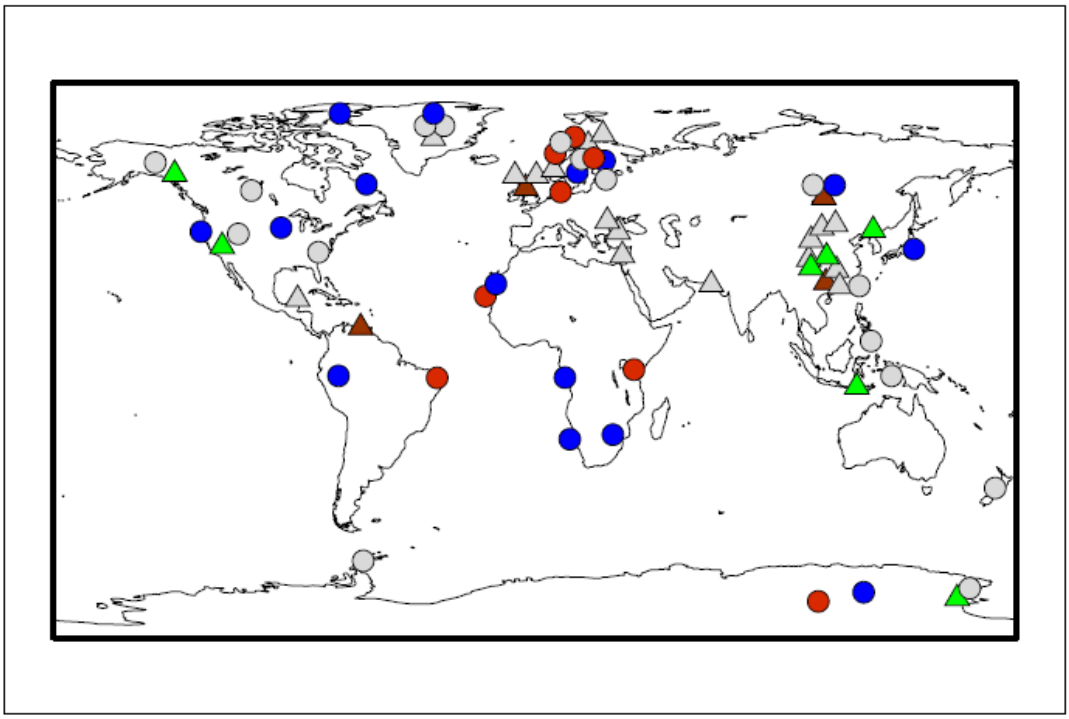

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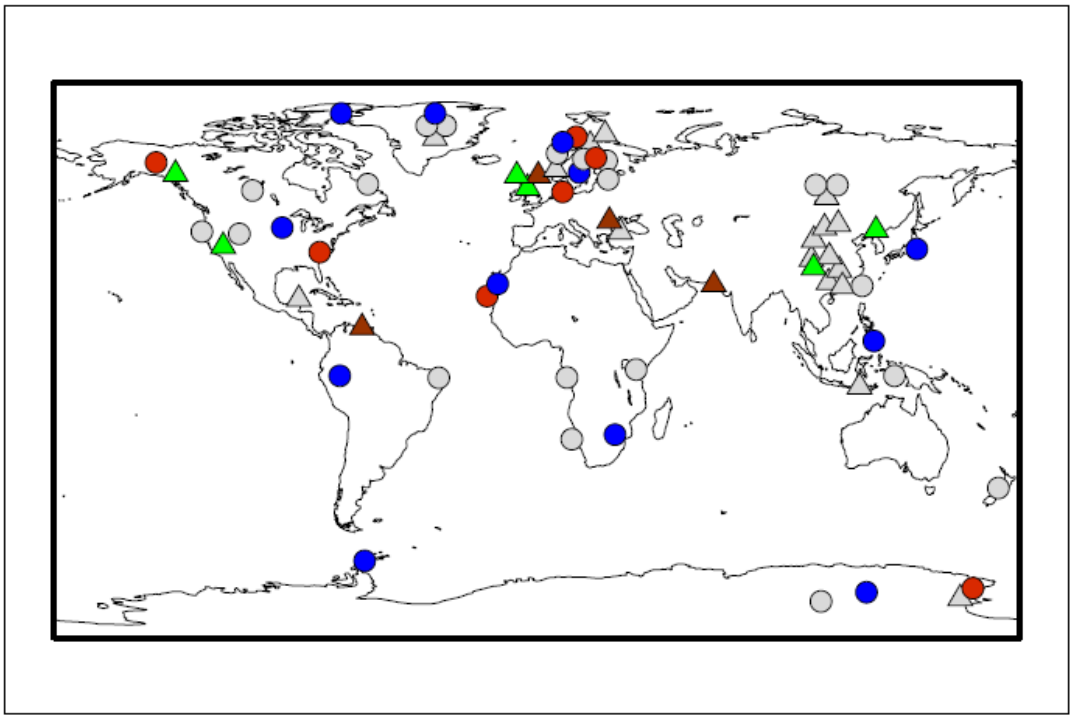

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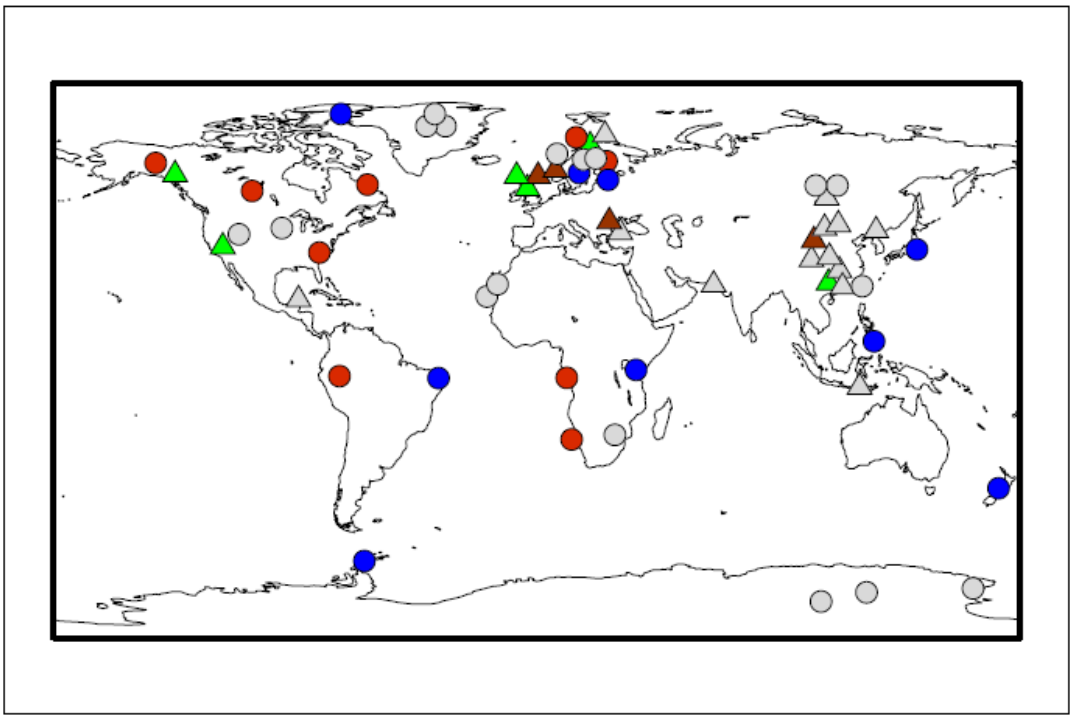
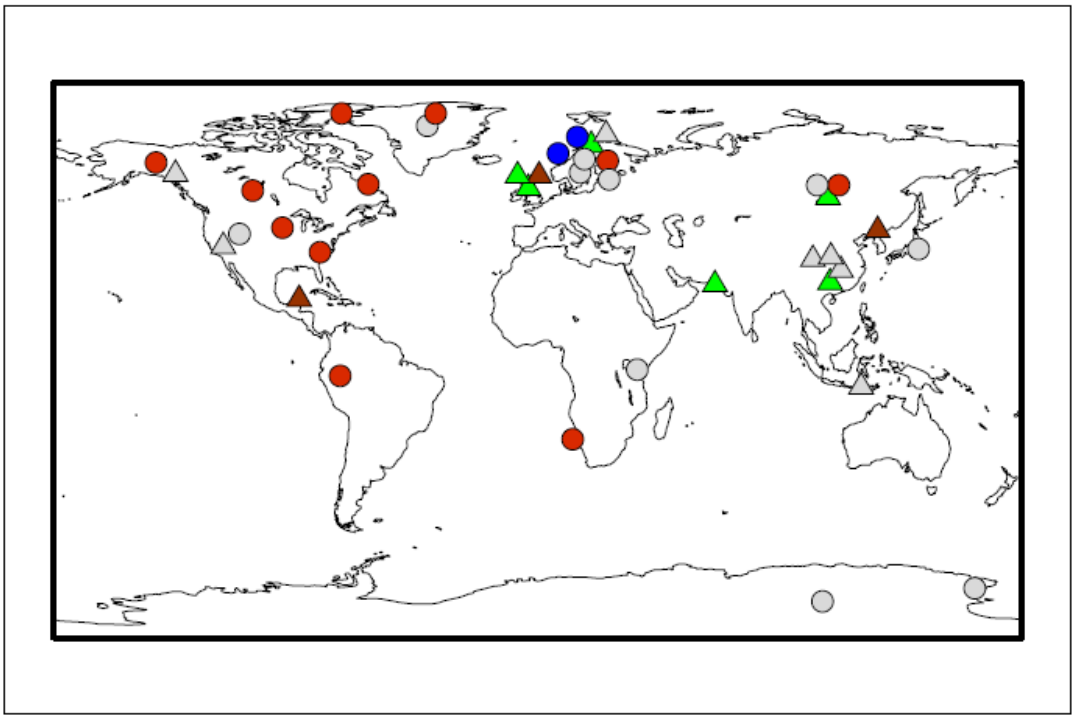


mean of yrs 0–100 B.P. (yrs 1850–1950 A.D.)



Acknowledgement

We thank Lucie Greiner for the excellent graphical support and Louise Newman for proofreading the english text of HOCLAT.

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