Anonymous Referee #1

The authors have obtained a solid data set with great potential to enhance our understanding of arctic carbon dynamics. Thus, I recommend reconsidering the article after major changes have been made.

We would like to thank anonymous Referee #1 for the constructive comments and suggestions.

My biggest issue is the presentation of the data. Figures 2 and 3 (especially 3a!) may be the most careless figures I have ever seen, and I am not even color blind. Further, there are 21 figures and 3 maps in this manuscript, this is a crazy overload! I like that the authors keep their color coding throughout the manuscript, but it would be very helpful if: a) the same colors would be used in the overview of figure 1; b) the N-S legend would actually match the locations on figure 1) – there it looks like the order is N-S: 14R09 – R1 – 14S03 – C07 – LV77-4; c) they come up with names like Alaska core, or Chukchi Sea core, or Chukotka core – something that one can remember and not just a code that even does not match the overview figure. d) Indicate uncertainties – not just in their figures but in the entire manuscript.

We simplified figure 3 by separating northern cores (14R09, R1 & C07) from the southern ones (14S03 & LV77-4). We made separate figures for Paq, CPI and %Sphagnum of the five cores and moved them to supplementary material (Figure S1). Figure 1 is also modified as suggested by using the same color coding of the different cores. The N-S captions match their locations in figure 1 and in the "material and methods" section as C07 (72.54ºN, 165.33ºW) is located north to 14S03 (72.23ºN, 157.05ºW). We added grids on the map to make it more visible to the reader. We also modified figures 4 and 5 (see following answers). All modified figures are shown below.

My second big issue is the way that conclusions are drawn. With the amount of computing power and the easy access to scripts/data pipelines, I am struggling to call "here it goes up, here down", still scientific. Especially if the data are not presented in an easy-to-digest way (like mentioned above). For example, they have 2 isotopes and define 3 endmembers, this is perfect for an endmember model like a Markov chain Monte Carlo. Or to use a principle component analysis with all their proxies (FYI: Paq abbreviation is not defined at all). Another suggestion would be to plot your TERR index over precipitation vs the time of your age model to determine what environmental parameters are related to the proxy change. They start to do this in the second part of the manuscript (content and discussion of figures 4 and 5). However, to bin the 5 core sites which lay in completely different locations – several hundreds of km apart (~800km NS and EW!!!) – and are influenced by different river systems and oceanic currents, seam hardly appropriate when comparing it with sea ice cover.

The core of the discussion is based on correlations calculated between time-series. Marine and terrestrial proxies were used to link dynamical/climate processes. In the revised manuscript, we compare individual proxy time-series to climatic/dynamical parameters (temperature, precipitation, river discharge and sea ice concentration). Each instrumental/paleo record was averaged to match the temporal resolution of each proxy record (TERR-alkanes, $ACL_{27\text{-}31}$ and Paq) and calculate correlation (Pearson's r). The results of these calculations are given in Table 1. They show that southern cores (LV77-4 and 14S03) generally show stronger and significant correlation with climatic parameters than northern ones (C07, 14R09 & R1). They also indicate that western coastal core LV77-4 is more significantly linked to river discharges than 14S03, owing to its location in the path of Siberian Coastal Current (SCC) receiving inputs of large Siberian rivers (the main one being the Lena River). Terrestrial inputs at 14S03 core site seem to be mainly controlled by air temperature and sea ice with minor influence of river discharge, mainly from the more distant Yukon River.

I was excited to read the manuscript, based on your abstract, and I believe it can be a good paper, as they have set the foundation for it. But the current state looks more like a draft to me. Their conclusions are important, but I cannot follow how they got there in the way that the manuscript is structured and presented. However, I think they have all needed to make it a howlsome manuscript, and getting it into a different format should allow them to publish it. I do not attach a supplement file, as I think the entire manuscript needs to be reworked, and as they usually would have to reply to every comment, this would make things just more tedious for them and for me.

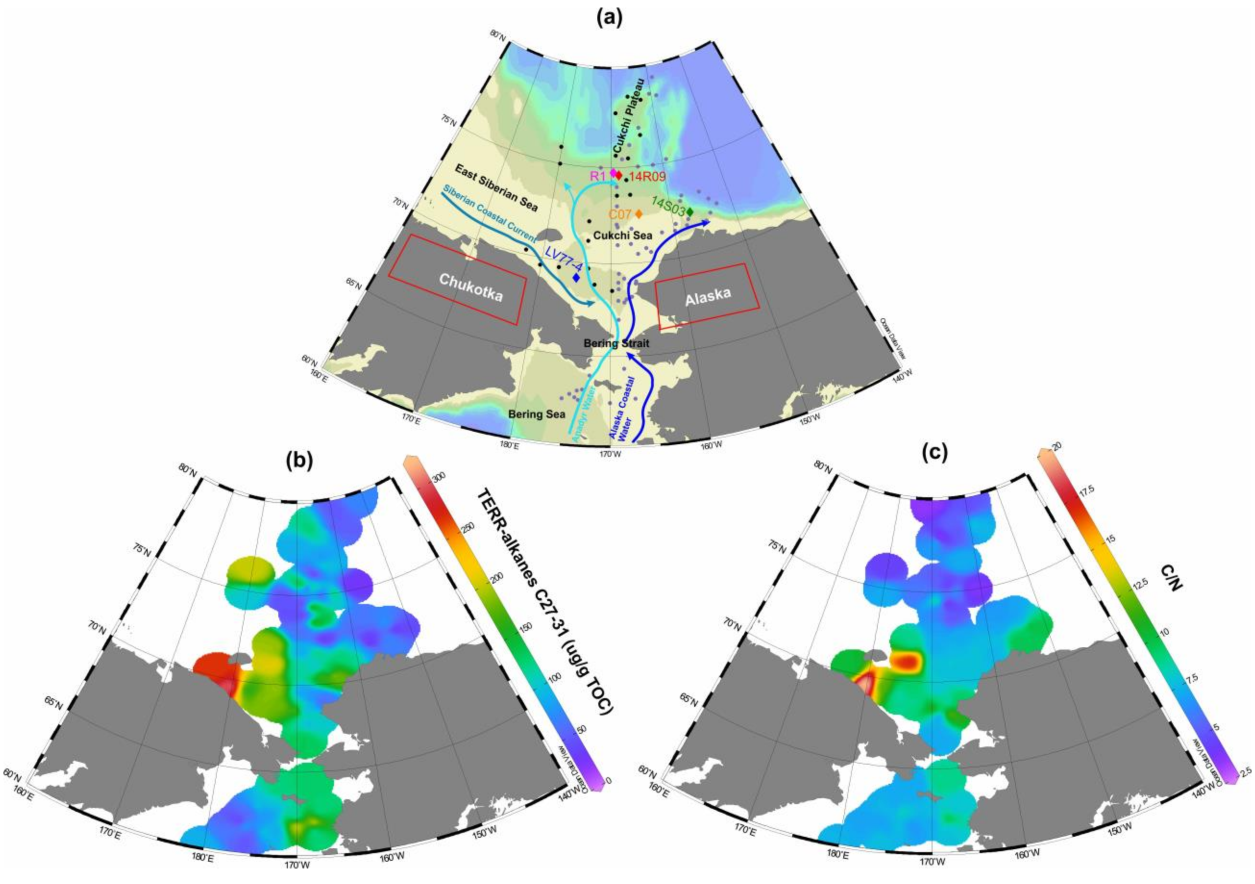

Figure 1: Map showing the location of the five cores (colored diamonds), the new 19 surface sediments (black dots) and those used for comparison (grey dots) (Bai et al., 2024). Main ocean currents, geographical locations mentioned in the text and main seas of the western Arctic Ocean are also shown. Two red rectangles represent the grid points

from which instrumental data of air temperature and precipitation have been extracted (discussed in detail in section 4.3). (b) and (c) combine TERR-alkanes and C/N data from all surface sediments.

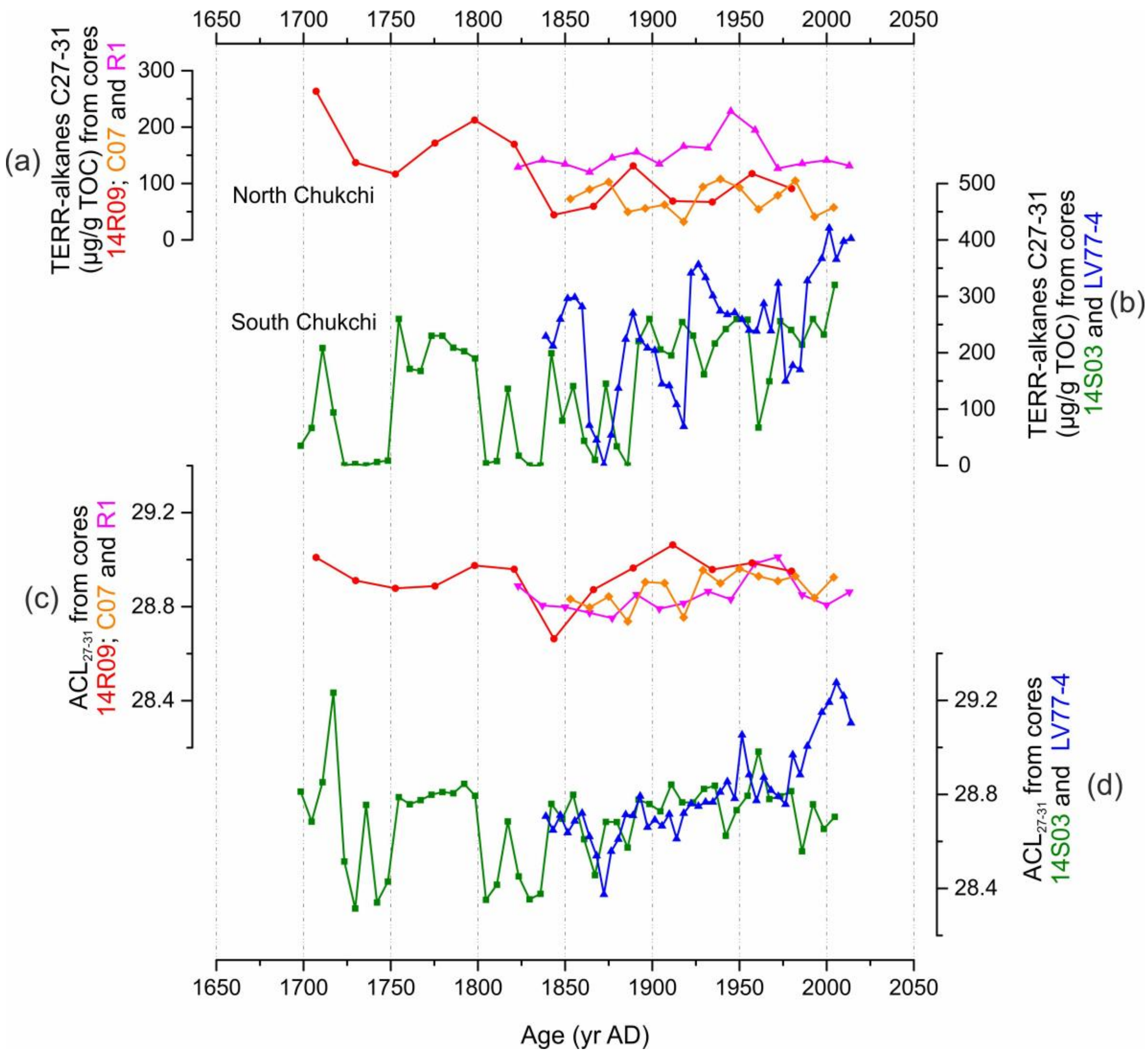

Figure 3: Downcore records of (a) TERR-alkanes C27-C31 (in µg/g TOC) from cores 14R09 (in red), C07 (in orange) and R1 (in magenta) and (b) from cores 14S03 (in green) and LV77-4 (in blue). (c) and (d) same for (a) and (b) but for ACL_{27-31} of TERR-alkanes. The same color coding of the cores is used for all sub-figures.

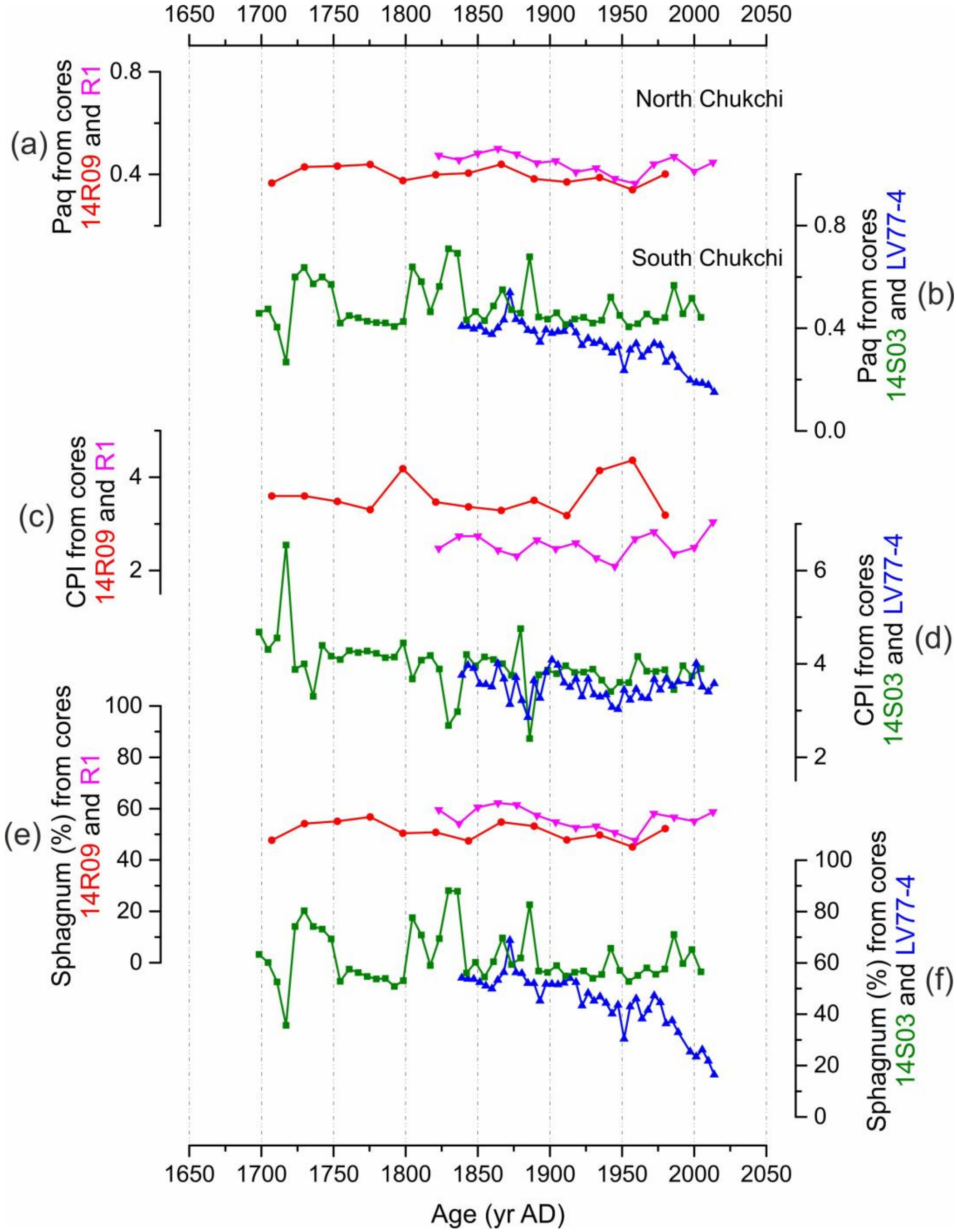

Figure S2: Downcore records of (a) P_{aq} ratio from northern Chukchi Sea (cores R1 and 14R09, in magenta and red, respectively) and (b) from southern Chukchi Sea (cores 14S03 and LV77-4, in green and blue, respectively). For (c) and (d) and (e) and (f) it is the same as (a) and (b) but for CPI_{alk} and Sphagnum (%), respectively. The same color coding of the cores is used for all sub-figures.

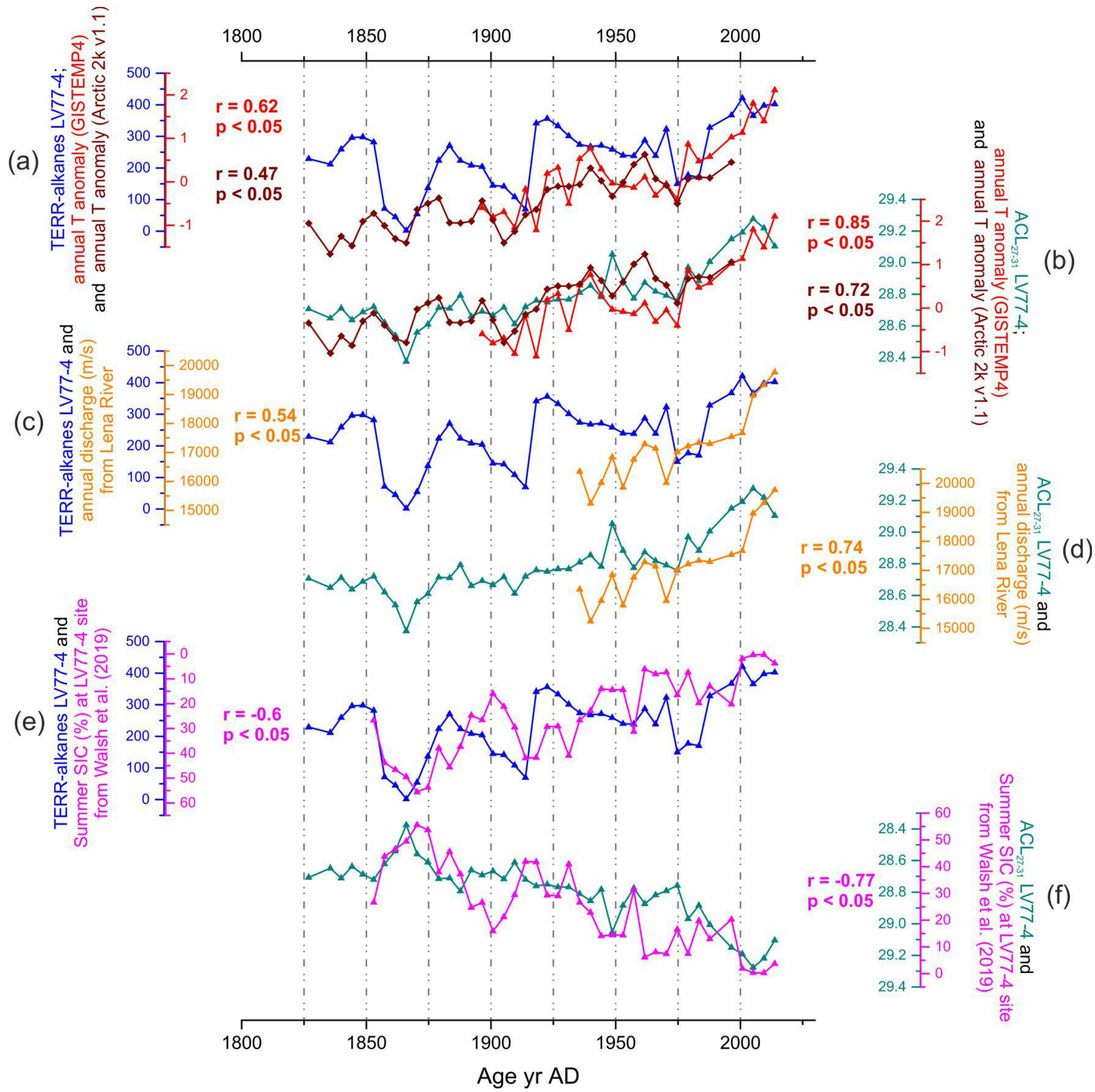

Figure 4: (a) Comparison of the TERR-alkanes C27-C31 concentration (in µg/g TOC) obtained from core LV77-4 with average air temperature anomalies (°C) over Alaska and Chukotka (shown in red; https://data.giss.nasa.gov/gistemp/) and Arctic air temperature anomaly (°C) from PAGES 2k consortium (2013; shown in dark red). (b) Same as (a) but for ACL_{27-31}. (c) Comparison of the TERR-alkanes C27-C31 concentration (in µg/g TOC) obtained from core LV77-4 with mean annual discharge (m/s) from Lena River (https://arcticgreatrivers.org/discharge/). (d) Same as (c) but for ACL_{27-31}. (e) Comparison of the TERR-alkanes C27-C31 concentration (in µg/g TOC) obtained from core LV77-4 with historical and satellite summer sea ice

concentration (%) at the same core site from Walsh et al. (2019). (f) Same as (e) but for ACL_{27-31}. Pearson's r for each comparison is also provided.

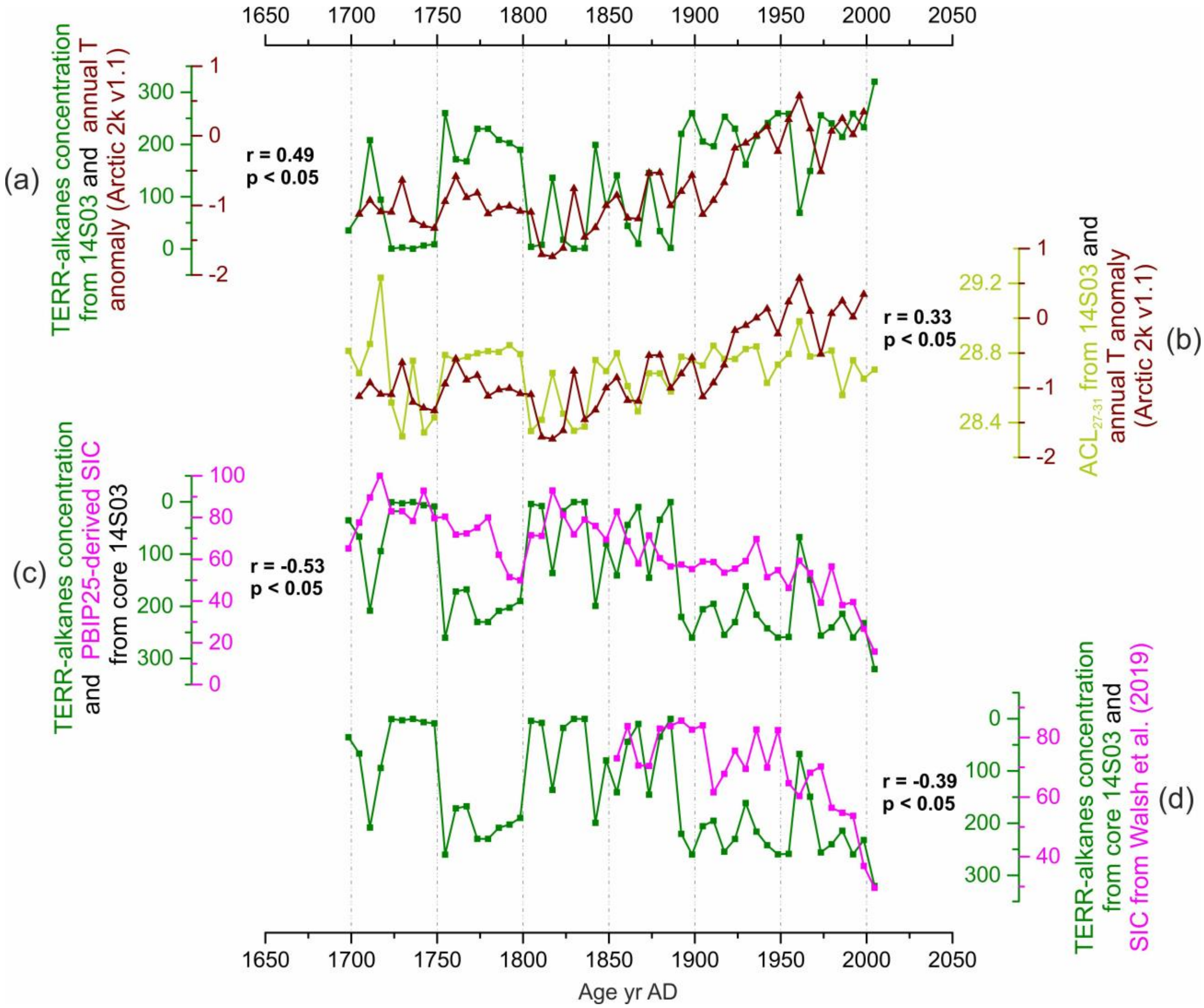

Figure 5: (a) Comparison of the TERR-alkanes C27-C31 concentration (in µg/g TOC) obtained from core 14S03 (in green) with Arctic annual air temperature anomaly (°C) from PAGES 2k consortium (2013; shown in red). (b) Same as (a) but for ACL_{27-31}. (c) Comparison of the TERR-alkanes C27-C31 concentration (in µg/g TOC; inversed Y axis) obtained from core 14S03 (in green) with P_BIP_{25}-derived sea ice concentration reconstructed from the same core using the calibration of Jalali et al. (2024). (d) Same as (c) but for comparison with historical and satellite sea ice concentration from Walsh et al. (2019) at 14S03 core site. Pearson's r for each comparison is also provided.

Tables 1: Table showing correlation coefficient (Pearson's r) calculated between TERR-alkanes, ACL_{27-31} and P_{aq} from each core and climatic parameters (temperature, precipitation, river discharge and sea ice concentration). Correlation is considered significant at $p \leq 0.05$ (shown in bold). Instrumental surface air temperature are from GISTEMP4 (https://data.giss.nasa.gov/gistemp/) while Arctic paleo-temperature are from PAGES 2k consortium (2013). Average annual precipitation data from Alaska and Chukotka are from Global Precipitation Climatology Centre (GPCC; https://psl.noaa.gov/data/gridded/data.gpcc.html). Data of annual discharge from the four rivers (Lena, Kolyma, Yukon and Mackenzie) are from ArcticGR (https://arcticgreatrivers.org/discharge/). Historical and satellite data of summer (JAS) sea ice concentration (SIC) at each core site are from Walsh et al. (2019) while paleo-records of SIC from each core are calculated from $PBIP_{25}$ index using the calibration of Jalali et al. (2024).

	LV77-4			14S03			C007			R01			14R09		
	TERR-alkanes	ACL_{27-31}	P_{aq}	TERR-alkanes	ACL_{27-31}	P_{aq}	TERR-alkanes	ACL_{27-31}	P_{aq}	TERR-alkanes	ACL_{27-31}	P_{aq}	TERR-alkanes	ACL_{27-31}	P_{aq}
Instrumental T averaged over Alaska & Chukotka	**0.62**	**0.85**	**-0.86**	0.3	-0.34	0.4	0.09	0.09	-	-0.22	-0.09	0.15	-	-	-
Paleo T from the pan Arctic region	**0.47**	**0.72**	**-0.76**	**0.49**	**0.33**	-0.25	0.17	**0.57**	-	0.49	0.4	**-0.69**	-0.35	0.28	-0.39
Annual precipitation averaged over Alaska & Chukotka	**0.57**	**0.38**	**-0.45**	0.03	0.01	0.04	-0.44	-0.18	-	0.09	0.35	-0.29	-	-	-
Annual discharge of Lena River	**0.54**	**0.74**	**-0.83**	0.01	0.23	-0.19	**-0.81**	-0.33	-	-0.68	-0.23	0.5	-	-	-
Average annual discharge from Lena, Kolyma, Yukon and Mackenzie rivers	0.23	-0.01	0	-0.22	0.32	-0.4	0.11	0.37	-	-0.29	-0.08	0.25	-	-	-
Historical and satellite SIC (%)	**-0.6**	**-0.77**	**0.79**	**-0.39**	-0.02	0.05	0.2	0.49	-	-0.08	0.09	0.29	-0.13	-0.75	0.76
P_BIP_{25}-derived SIC (%)	-0.21	**-0.5**	**0.47**	**-0.53**	-0.11	0.11	0.23	-0.18	-	-0.08	0.12	0.09	**-0.82**	-0.34	0.18