Supplement 1: Age models of cores LD1 and F80

Age determination for core LD1

Table S1. Sediment ^{210}Pb measurements and calculation of ^{210}Pb-based age model for site LD1. The observed ^{210}Pb activities were corrected for the salt in the porewater which precipitated during the drying process ('salt corr.'). Salt contents were estimated for each slice from the water content and bottom water salinity.

Sample mid-depth (cm)	Observed ^{210}Pb activity (mBq g^{-1})	SE for Observed ^{210}Pb activity (%)	Salt content of dry sample Wt%	Observed ^{210}Pb activity (mBq g^{-1}, salt corr.)	Background (mean of ^{214}Pb and ^{214}Bi)	Excess ^{210}Pb activity (mBq g^{-1}, salt corr.)	Cumulative excess ^{210}Pb activity (mBq g^{-2}, salt corr.)	Year (CRS model)	Mass accumulation rate (g cm^{-2} yr^{-1}, CRS model)
0.25	764	4.4	26.73	1195.2	178.4	1016.8	1265.95	2011.5	0.0385
0.75	722	4.8	25.77	784.3	296.5	487.9	1250.97	2011.1	0.0524
1.25	441	6.5	20.60	600.8	310.5	290.3	1243.43	2010.9	0.0694
1.75	611	5.3	16.97	632.5	292.7	339.9	1237.49	2010.8	0.0797
2.5	279	7.8	14.88	665.7	428.5	237.2	1228.76	2010.5	0.1023
3.5	333	7	16.10	793.1	527.3	265.8	1214.62	2010.2	0.1111
4.5	641	5.2	20.27	618.9	403.7	215.2	1200.11	2009.8	0.1187
5.5	578	5.3	21.33	826.7	405.2	421.6	1191.13	2009.5	0.1129
6.5	535	5.6	18.60	743.6	391.1	352.5	1174.59	2009.1	0.1113
7.5	3728	2.2	16.06	673.7	360.0	313.7	1158.29	2008.6	0.1117
8.5	1366	3.5	14.51	736.7	329.7	407.0	1141.13	2008.2	0.1073
9.5	1539	3.2	12.32	806.8	397.5	409.3	1116.19	2007.5	0.1031
11	1228	3.7	11.36	606.3	363.6	242.8	1086.28	2006.6	0.1096
13	1603	3.1	12.31	870.2	275.6	594.6	1047.67	2005.4	0.0917
15	2420	2.5	12.49	819.6	387.8	431.9	960.70	2002.6	0.0868
17	784	4.5	6.31	664.4	430.2	234.3	898.47	2000.5	0.0920
19	872	4.2	6.40	743.9	286.9	457.0	832.34	1998.0	0.0807
21	616	5	6.28	726.2	300.8	425.4	704.90	1992.7	0.0725
23	886	4.2	6.52	777.0	436.4	340.6	584.30	1986.7	0.0682
25	699	4.6	6.48	841.1	496.4	344.6	490.93	1981.1	0.0630
27	569	5.6	4.89	452.9	184.9	268.0	395.96	1974.2	0.0586
29	347	7.5	5.00	376.0	157.6	218.4	300.92	1965.4	0.0550
32	337	8.1	4.18	258.3	139.7	118.7	225.04	1956.0	0.0526
36	189	11	7.34	192.5	99.1	93.4	128.84	1938.1	0.0498

The sediment from LD1 was measured using a Canberra BeGe gamma ray spectrometer at Utrecht University. For the age determination a constant rate of supply model (Appleby and Oldfield, 1983) was implemented using a background estimated from the mean counts of ^{214}Pb and ^{214}Bi. The observed variations in $^{210}Pb_{xs}$ from an exponential decay profile (Figure S1) are likely caused by variable sedimentation rates, related to non-constant vertical and lateral sediment fluxes and high rates of authigenic mineral formation. There is no evidence for strong resuspension at the site itself, however, given the laminated nature of the sediment.

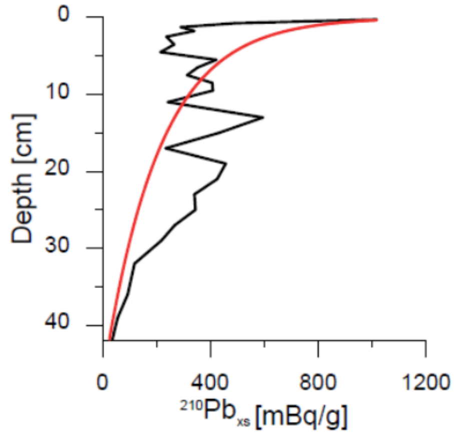

Figure S1. $^{210}Pb_{xs}$ (black) and exponential decay profile (red).

Age determination for core F80

In 2013 an additional sediment core was taken from site F80 during a cruise with RV Aranda. Mini sub-cores were embedded in Spurr´s epoxy resin as described in section 2.4 of the main article, and LA-ICP-MS line scanning was performed on the blocks. The resulting high-resolution Mo/Al and Mn/Al profiles were used to construct an age model based on the bottom-water oxygen conditions at this site (Figure S2). The onset of prolonged anoxic conditions at 1979 was tied to the major increase in Mo/Al, while the oxygenating inflow event of 1993 was tied to the most recent major peak in Mn/Al. Between these markers, oscillations in Mo/Al were considered representative of annual pulses of organic matter accumulation (and intensified reducing conditions) and tied to consecutive years accordingly. (Figure S2).

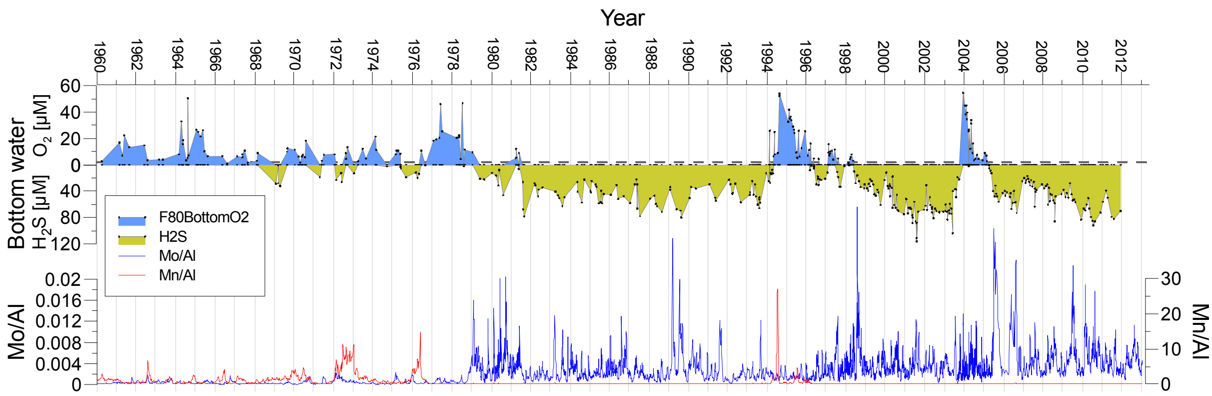

Figure S2. Records of bottom water oxygen at a water depth below 185 m (Baltic Sea Environmental Database at Stockholm University; http://nest.su.se/bed/ACKNOWLE.shtml) and corresponding LA-ICP-MS sediment Mn/Al (red) and Mo/Al-ratios (blue) for 1960-2013 for site F80.

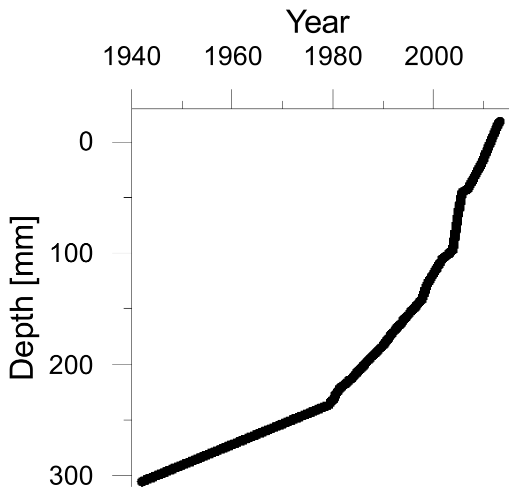

Figure S3. Age model retrieved using the annual cycle in Mo burial.

The age-depth model yielded by the combined Mo/Al and Mn/Al tie-point dating method is shown in Figure S3, and demonstrates a clear increase in sedimentation rates towards the sediment surface. The raw LA-ICP-MS Mo/Al data were subsequently binned to a series of mean values of equivalent resolution to the multicore taken from F80 in 2009, to allow the 2009 discrete sample record (Figure 4 of the main article) to the age model to be expressed on the same age scale.