Table S1: Comparison of PaleoClim (Brown et al. 2018) layers to our inferred layers via a jackknife approach at 0.021 Mya (Last Glacial Maximum), 0.787 Mya (MIS19 in the mid-Pleistocene), and 3.3 Mya (Pliocene Glacial Event M2). Bioclimatic variables include mean annual temperature (bio1), temperature seasonality (bio4), annual precipitation (bio12), precipitation of wettest month (bio13), precipitation of driest month (bio14), and precipitation seasonality (bio15). The pearson correlation coefficient (r) and mean difference between the PaleoClim layer and the inferred layer is indicated.

	time (Mya)	r	mean difference
bio1	0.021	0.744	-115.27
bio4	0.021	0.443	3134.30
bio12	0.021	0.543	95.73
bio13	0.021	0.538	18.52
bio14	0.021	0.500	1.99
bio15	0.021	0.693	23.57
bio1	0.787	0.839	105.62
bio4	0.787	0.677	2817.45
bio12	0.787	0.713	260.64
bio13	0.787	0.715	50.58
bio14	0.787	0.665	4.73
bio15	0.787	0.596	11.13
bio1	3.3	0.921	16.99
bio4	3.3	0.769	1355.72
bio12	3.3	0.794	50.15
bio13	3.3	0.814	10.40
bio14	3.3	0.732	-0.05
bio15	3.3	0.792	9.21

Table S2: Comparison of Oscillayers (Gamisch 2019) to layers generated with PaleoGenerate at overlapping time points. Bioclimatic variables include mean annual temperature (bio1), temperature seasonality (bio4), annual precipitation (bio12), precipitation of wettest month (bio13), precipitation of driest month (bio14), and precipitation seasonality (bio15). The pearson correlation coefficient (r) and mean difference between the Oscillayers layer and the inferred layer is indicated.

	time (Mya)	r	mean difference
bio1	0.2	0.890	-23.36
bio1	0.26	0.814	23.91
bio1	0.4	0.926	-40.93
bio1	0.46	0.806	13.59
bio1	0.53	0.825	51.82
bio1	0.66	0.801	21.42
bio1	0.73	0.823	30.3
bio1	0.79	0.820	89.07
bio1	0.86	0.892	-10.57
bio1	0.92	0.829	64.29
bio1	1.06	0.871	-37.13
bio1	1.12	0.822	79.26
bio1	1.32	0.87	-22.16
bio1	1.39	0.886	-35.54
bio1	1.52	0.849	-51.35
bio1	1.78	0.90	-0.82
bio1	1.85	0.867	-37.11
bio1	1.91	0.883	-1.45
bio1	2.05	0.877	-19.43
bio1	2.18	0.888	-12.47
bio1	2.24	0.909	7.95
bio1	2.38	0.888	-25.14
bio1	2.44	0.896	1.4
bio1	2.64	0.949	14.02
bio1	2.77	0.949	9.66

bio1	2.84	0.935	-19.14
bio1	2.9	0.932	-14.93
bio1	3.04	0.956	-2.32
bio1	3.1	0.954	12.71
bio1	3.3	0.896	57.96
bio12	0.2	0.686	69.02
bio12	0.26	0.602	184.78
bio12	0.4	0.760	38.37
bio12	0.46	0.591	179.84
bio12	0.53	0.626	204.46
bio12	0.66	0.586	194.61
bio12	0.73	0.616	183.21
bio12	0.79	0.635	246.62
bio12	0.86	0.680	91.78
bio12	0.92	0.636	213.71
bio12	1.06	0.658	62.5
bio12	1.12	0.634	234.68
bio12	1.32	0.648	91.45
bio12	1.39	0.689	49.97
bio12	1.52	0.626	58.8
bio12	1.78	0.685	103.59
bio12	1.85	0.651	66.83
bio12	1.91	0.659	117.22
bio12	2.05	0.658	89.99
bio12	2.18	0.674	91.61
bio12	2.24	0.699	107.33
bio12	2.38	0.681	68.32
bio12	2.44	0.608	108.56
bio12	2.64	0.809	96.30
bio12	2.77	0.806	92.51
bio12	2.84	0.771	65.3
bio12	2.9	0.762	75.29
bio12	3.04	0.821	69.41
bio12	3.1	0.822	88.51
bio12	3.3	0.772	161.11
bio13	0.2	0.677	1.19
bio13	0.26	0.592	30.11
bio13	0.4	0.742	-6.9
bio13	0.46	0.581	29.91
bio13	0.53	0.619	31.7

bio13	0.66	0.576	31.82
bio13	0.73	0.606	29.49
bio13	0.79	0.636	36.32
bio13	0.86	0.682	4.26
bio13	0.92	0.630	32.43
bio13	1.06	0.644	1.18
bio13	1.12	0.632	34.94
bio13	1.32	0.643	5.23
bio13	1.39	0.673	-1.25
bio13	1.52	0.609	1.72
bio13	1.78	0.693	5.58
bio13	1.85	0.639	1.97
bio13	1.91	0.665	8.18
bio13	2.05	0.654	4.71
bio13	2.18	0.674	4.41
bio13	2.24	0.709	5.52
bio13	2.38	0.673	1.21
bio13	2.44	0.687	6.33
bio13	2.64	0.816	-0.9
bio13	2.77	0.811	-1.22
bio13	2.84	0.766	-3.77
bio13	2.9	0.757	-2.34
bio13	3.04	0.827	-4.29
bio13	3.1	0.827	-2.1
bio13	3.3	0.780	7.29
bio14	0.2	0.683	6.79
bio14	0.26	0.612	6.22
bio14	0.4	0.712	7.65
bio14	0.46	0.598	5.79
bio14	0.53	0.632	7.64
bio14	0.66	0.594	6.46
bio14	0.73	0.625	6.31
bio14	0.79	0.615	9.86
bio14	0.86	0.679	7.81
bio14	0.92	0.639	8.15
bio14	1.06	0.656	6.17
bio14	1.12	0.624	9.24
bio14	1.32	0.651	7.37
bio14	1.39	0.682	5.92
bio14	1.52	0.617	5.54

bio14	1.78	0.682	8.48
bio14	1.85	0.649	6.27
bio14	1.91	0.661	8.78
bio14	2.05	0.66	7.46
bio14	2.18	0.675	7.75
bio14	2.24	0.693	8.77
bio14	2.38	0.679	6.72
bio14	2.44	0.679	8.69
bio14	2.64	0.722	10.98
bio14	2.77	0.723	10.73
bio14	2.84	0.713	9.1
bio14	2.9	0.707	9.35
bio14	3.04	0.735	9.7
bio14	3.1	0.731	10.72
bio14	3.3	0.683	14.07
bio15	0.2	0.682	-2.73
bio15	0.26	0.588	5.66
bio15	0.4	0.730	-10.39
bio15	0.46	0.578	6.87
bio15	0.53	0.604	2.99
bio15	0.66	0.580	6.88
bio15	0.73	0.596	4.58
bio15	0.79	0.593	0.66
bio15	0.86	0.674	-2.79
bio15	0.92	0.608	1.82
bio15	1.06	0.666	-1.03
bio15	1.12	0.599	1.22
bio15	1.32	0.66	-0.82
bio15	1.39	0.684	-2.43
bio15	1.52	0.641	1.05
bio15	1.78	0.672	-3.34
bio15	1.85	0.661	-0.61
bio15	1.91	0.659	-1.89
bio15	2.05	0.665	-1.43
bio15	2.18	0.673	-2.47
bio15	2.24	0.678	-4.47
bio15	2.38	0.68	-2.5
bio15	2.44	0.671	-3.21
bio15	2.64	0.739	-14.33
bio15	2.77	0.736	-13.92

bio15	2.84	0.731	-11.52
bio15	2.9	0.723	-11.29
bio15	3.04	0.749	-13.89
bio15	3.1	0.746	-14.73
bio15	3.3	0.711	-15.36
bio4	0.2	0.732	-96.52
bio4	0.26	0.634	2155.64
bio4	0.4	0.801	-1090.66
bio4	0.46	0.613	2346.6
bio4	0.53	0.668	1767.27
bio4	0.66	0.606	2382.8
bio4	0.73	0.655	1975.63
bio4	0.79	0.658	1503.3
bio4	0.86	0.722	-69.7
bio4	0.92	0.679	1595.66
bio4	1.06	0.698	163.58
bio4	1.12	0.665	1560.99
bio4	1.32	0.684	251.57
bio4	1.39	0.732	-74.4
bio4	1.52	0.649	497.74
bio4	1.78	0.724	-134.09
bio4	1.85	0.687	239.35
bio4	1.91	0.694	123.35
bio4	2.05	0.698	147.7
bio4	2.18	0.717	-18.17
bio4	2.24	0.742	-310.65
bio4	2.38	0.728	-61.06
bio4	2.44	0.721	-106.86
bio4	2.64	0.816	-1598.74
bio4	2.77	0.813	-1537.68
bio4	2.84	0.804	-1224.20
bio4	2.9	0.794	-1176.20
bio4	3.04	0.834	-1581.52
bio4	3.1	0.827	-1675.12
bio4	3.3	0.751	-1687.16