Mid-Holocene ITCZ migration: impacts on Hadley cell dynamics and terrestrial hydroclimate

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Table S1. List of the nine PMIP4-CMIP6 models

	Model	Realization	Used years	Model reference
1	EC-Earth3-LR	r1i1p1	100	(Wyser et al., 2020)
2	CESM2	r1i1p1	100	(Gettelman et al., 2019)
3	IPSL-CM6A-LR	r1i1p1	100	(Boucher et al., 2020)
4	ACCESS-ESM1-5	r1i1p1	100	(Ziehn et al., 2020)
5	AWI-ESM-1-1-LR	r1i1p1	100	(Sidorenko et al., 2015)
6	GISS-E2-1-G	r1i1p1	100	(Kelley et al., 2020)
7	MPI-ESM1-2-LR	r1i1p1	100	(Mauritsen et al., 2019)
8	MRI-ESM2-0	r1i1p1	100	(Yukimoto et al., 2019)
9	NorESM2-LM	r1i1p1	100	(Seland et al., 2020)

Defining ITCZ position metrics

We quantify zonal and annual ITCZ locations by applying two different precipitation metrics (Adam et al., 2016; Bian and Räisänen, 2024).

The first metric is the precipitation centroid for ITCZ location, denoted as

$$\phi_{ITCZ} = \frac{\int_{\phi_S}^{\phi_N} \phi[\overline{P}(\phi)\cos\phi]^X \, d\phi}{\int_{\phi_S}^{\phi_N} [\overline{P}(\phi)]^X \cos\phi \, d\phi} \tag{S1}$$

where $[\overline{P}(\phi)]$ is the zonal and time mean precipitation. The boundaries ϕ_S and ϕ_N are defined as $20^\circ S/N$, and the integer power X is 1 (Adam et al., 2016).

The second metric locates the ITCZ location where the total area-weighted precipitation between boundaries ϕ_S and ϕ_N are equally divided (Adam et al., 2016; Bian and Räisänen, 2024):

$$\int_{\phi_S}^{\phi_{ITCZ}} \overline{P}(\phi)\cos\phi d\phi = \int_{\phi_{ITCZ}}^{\phi_N} \overline{P}(\phi)\cos\phi d\phi \tag{S2}$$

where ϕ_S and ϕ_N have the same definition as the first metric.

Table S2. Annual precipitation (unit: mm/year) difference between the MH and PI from the pollen proxy dataset adapted from Herbert and Harrison (2016) and Lowry and McGowan (2024). SE denotes the pooled standard error.

Latitude(°)	Longitude(°)	MAP	SE
-43	145	33.9	±316.12
-43	147	488.81	±400.77
-43	149	340.52	±337.83
-41	145	-192.24	±362.11
-41	147	-134.7	±351.44
-39	141	-1.39	±345.53
-39	143	127.76	±320.8
-39	145	-34.94	±332.51
-39	147	648.35	±589.47
-37	141	344.4	±314.35
-37	143	435.95	±350.25
-37	145	733.33	±310.24
-37	147	347.46	±387.13
-37	149	236.91	±338.02
-37	151	-118.95	±294.92
-35	115	94.1	±405.65
-35	117	360.51	±361.18
-35	119	145.4	±315.22
-35	139	337.95	±409.06
-35	143	-6.69	±294.87
-35	149	218.66	±346.99
-35	151	92.32	±304.07
-33	115	149.26	±354.93
-33	141	350.91	±300.04
-33	151	329.92	±315.23
-31	115	974.56	±323.65
-31	127	366.88	±330.12
-31	139	227.16	±334.44
-31	143	9.63	±295.29
-31	151	529.72	±328.49
-27	153	-100.25	±412.28
-25	153	-35.77	±320.7
-17	127	105.82	±300.74
-17	145	896.86	±476.2
-17	147	-2065.91	±630.63
-15	127	746.57	±357.96
-15	137	298.54	±298.73
-15	145	137.11	±319.76
-13	137	37.03	±334.55
-13	141	-789.8	±330.85
-13	143	8.88	±363.29
-11	143	-22.07	±334.56

Table S3. Alpha index difference between the MH and PI from the pollen proxy dataset adapted from Herbert and Harrison (2016) and Lowry and McGowan (2024). SE denotes the pooled standard error.

Latitude(°)	Longitude(°)	Alpha	SE
-43	145	0	±0.0971
-43	147	0.0265	±0.102
-43	149	0.0152	±0.1098
-41	145	-0.1337	±0.0983
-41	147	-0.1781	±0.1527
-39	141	-0.0532	±0.1302
-39	143	0.0414	±0.1116
-39	145	-0.0495	±0.1451
-39	147	-0.0145	±0.1072
-37	141	0.2339	±0.1195
-37	143	0.0931	±0.14
-37	145	0.2544	±0.1102
-37	147	0.065	±0.129
-37	149	-0.017	±0.1211
-37	151	-0.1508	±0.0984
-35	115	0.1778	±0.1646
-35	117	0.2084	±0.1407
-35	119	0.1549	±0.1452
-35	139	0.2376	±0.1469
-35	143	-0.0034	±0.0971
-35	149	-0.0315	±0.1181
-35	151	0.0283	±0.109
-33	115	0.1347	±0.1438
-33	141	0.5122	±0.1006
-33	151	0.1332	±0.1018
-31	115	0.3877	±0.1244
-31	127	0.3249	±0.1703
-31	139	0.1824	±0.1683
-31	143	0.0089	±0.0987
-31	151	0.2113	±0.1127
-27	153	-0.0817	±0.1585
-25	153	0.0299	±0.1049
-17	127	0.2538	±0.1376
-17	145	0.2457	±0.1148
-17	147	-0.2435	±0.1209
-15	127	0.349	±0.114
-15	137	0.3037	±0.156
-15	145	0.0228	±0.106
-13	137	0.0786	±0.1244
-13	141	0.2548	±0.1142
-13	143	0.0401	±0.117
-11	143	0.0486	±0.1153

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