Supplementary notes

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Late Miocene "washhouse" climate in Europe

1. Stratigraphic-chronological framework

Locality	Biozone	Age (Ma)	Correlation method	Facies	References
Polgardi 2	MN13	5.75+/-0.4	4	5	6
Polgardi 4	MN13	6.45+/-0.35	4	5	6
Tardosbanya 3	MN12	7.25+/-0.45	4	5	4
Csakvar	MN11	8.2+/-0.6	4	5	4, 12
Dorn-Dürkheim	MN11	8.3+/-0.5	4	2	5
Prottes	MN11	8.3+/-0.5	4	2	8
Kohfidisch	MN11	8.75+/-0.2	3	5	2
Suchomasty	MN10	9.0+/-0.2	3	5	3
Varnitza	MN10	9.6+/-0.25	1, 2, 3	1	17
Kalfa	MN10	9.7+/-0.2	1, 2, 3	1	17, 19
Buzhor 1	MN10	9.7+/-0.2	1, 2, 3	1	16, 17, 19
Lapushna	MN9	9.8+/-0.2	1, 2, 3	1	17
Maikop	MN9	9.8+/-0.2	4	3	
Götzendorf	MN9	9.86+/-0.08	1	2	2, 8
Rudabanja	MN9	10.1+/-0.2	3	4	14
Richardhof-Golfplatz	MN9	10.2+/-0.1	1	3	8
Tataros	MN9	10.25+/-0.25	4	3	13
Vösendorf	MN9	10.35+/-0.1	1	1	2, 8
Hammerschmiede 3	MN9	11.1+/-0.1	4	3	1
Hammerschmiede 2	MN9	11.14+/-0.1	4	3	1
Hammerschmiede 1	MN9	11.18+/-0.1	4	3	1
Gritsev	MN9	11.2+/-0.3	1, 2	1, 5	7, 8, 18, 19
Petersbuch 14	MN9	11.3+/-0.5	4	5	1
Petersbuch 48	MN8/9	11.5+/-0.5	4	5	1
Felsötarkany 1+3/2	MN8/9	11.6+/-0.5	2	3	7, 9
Petersbuch 18	MN8	12.0+/-0.5	4	5	1
Tasad	MN8	12.4+/-0.1	2	1	7, 10, 15
Kleineisenbach	MN8	13.0+/-0.25	1	3	1
Anwil	MN8	13.27+/-0.1	1	3	11

Supplementary Table 1: Central- and Eastern European localities, biozones, ages and correlation methods, depositional and environmental facies, and references. Ages are calibrated to the timescale of Gradstein et al. 2004. Correlation codes: 1 – correlation to local magnetostratigraphically dated section or intrabasinal magnetostratigraphy, 2 – correlation to intrabasinal sequence- and bio-stratigraphy, 3 – interpolation of biostratigraphic tie points to both intra- and extrabasinal magnetostratigraphy, 4 – biostratigraphic correlation to extrabasinal magnetostratigraphy. Facies codes: 1 – near shore, 2 – fluvial, 3 – lacustrine, 4 – swamp, 5 – karst. Reference codes: see reference list

Reference (Table 1)

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2. Reconstructing palaeo-precipitation

cf. Pleurodeles sp.	Salamandridae indet.	aff. Chelotriton/cf. Ch. paradoxus	Triturus (vulgaris) sp.	Rana (ridibunda) sp.	Discoglossus sp.	cf. Hyla sp.	Pelodytes sp.	Bufo cf. bufo	Bufo aff. calamita	Bufo sp.	Pelobates sp.	Blanus sp.	Amphisbaenidae indet.	cf. Anguis sp.	Lacerta sp.	Lacerta sp. 1	Lacerta sp. 2	Ophisaurus sp.	Anguidae indet.	Scincidae indet.	Scincomorpha indet. 1	Scincomorpha indet. 2	Varanus sp.	Emydidae indet.	Locality	Age (Ma)	A MAP (mm)	B Present-day MAP (mm)	C δ MAP (mm)	D Relative to recent
				x						x	x			x	x				x	x					Peralejos E	5,360	338	350	-12	-0,0348
				x		x				x	x			x	x				x	x				x	Ld Casares 2	5,460	626	350	276	0,7895
		x		x											x				x						Ld Casares 3	5,790	508	350	158	0,4507
		x		x											x			x							Ld Casares 4	5,840	508	350	158	0,4507
	x		x	x	x					x	x				x			x					x	x	Arquillo 1	6,230	726	350	376	1,0752
	x			x							x				x			x		x				x	Villastar	6,280	650	350	300	0,8558
	x			x							x				x										B.d.Valdecebro 4/5	6,480	563	350	213	0,6079
x				x							x				x										Valdecebro 3	6,560	928	350	578	1,6519
				x							x				x										Masada del Valle 7	6,930	449	350	99	0,2816
				x							x	x			x				x						B.d.Valdecebro 3	6,940	299	350	-51	-0,1459
				x							x		x		x	x			x						La Gloria 6	7,060	243	350	-107	-0,3052
				x									x		x	x		x		x				x	Valdecebro 5	7,070	515	350	165	0,4716
				x				x	x			x				x	x	x		x				x	Concud	7,090	602	350	252	0,7195
				x				x	x			x			x				x	x				x	Concud 3	7,100	682	350	332	0,9472
				x			x	x	x			x			x			x		x	x	x		x	Los Mansuetos	7,110	571	350	221	0,6329
				x			x			x		x			x			x		x					Aljezar B	7,120	441	350	91	0,2594
				x			x			x		x			x			x		x					Toril	7,130	441	350	91	0,2594
				x			x			x		x			x				x	x					Villalba Baja 2B	7,140	441	350	91	0,2594
				x			x			x		x			x				x	x					El Regajo 4	7,150	441	350	91	0,2594
				x			x			x		x			x				x	x					El Regajo 3	7,160	441	350	91	0,2594
				x			x			x		x			x			x							Masada del Valle 5	7,170	520	350	170	0,4863
				x			x			x		x			x			x							Cubla	7,180	520	350	170	0,4863
				x			x			x		x			x			x							Tortajada C	7,260	520	350	170	0,4863
				x			x			x		x			x			x							Concud B	7,300	520	350	170	0,4863

Supplementary Table 2A: Localities, ages, and data-matrix of amphibian and reptilian taxa from the Messinian of the Calatayud-Teruel Basin. A – estimated palaeo-precipitation, B – present-day precipitation in the basin, C – precipitation difference to present day value, D – relative precipitation to present-day value.

Salamandrina nov. sp.	Salamandridae indet.	Triturus (vulgaris) sp.	aff. Chelotriton/cf. Ch. paradoxus	Rana (ridibunda) sp.	Latonia sp.	Pelodytes sp.	Bufo sp.	Pelobates sp.	Anura indet.	Blanus sp.	Amphisbaenidae indet.	Lacerta sp.	Lacerta sp. 1	Lacerta sp. 2	Lacertidae indet.	Ophisaurus sp.	Anguidae indet.	Scincidae indet.	Scincomorpha indet. 1	Diplocynodon sp.	Emydidae indet.	Locality	Age (Ma)	A MAP (mm)	B Present-day MAP (mm)	C δ MAP (mm)	D Relative to recent
				x		x	x			x		x				x						Masada Ruea 4	7,500	520	350	170	0,4863
				x		x	x					x				x						Masada Ruea 3	7,540	587	350	237	0,6780
				x		x	x					x										Masada del Valle 2	7,600	743	350	393	1,1230
							x		x			x										Tortajada B	7,700	689	350	339	0,9682
	x			x			x						x	x			x					Vivero de Pinos	8,000	532	350	182	0,5200
	x			x			x			x			x	x		x		x				Los Aguanaces 3	8,130	418	350	68	0,1932
	x			x			x			x		x	x	x		x		x	x			Los Aguanaces	8,170	327	350	-23	-0,0658
				x			x			x		x				x						Los Aguanaces 1	8,170	443	350	93	0,2661
				x						x		x				x						La Gloria 10	8,220	328	350	-22	-0,0642
x				x						x		x					x					Puente Minero 3	8,390	724	350	374	1,0691
x				x													x					Masada Ruea 2	8,440	1157	350	807	2,3067
x	x			x																		Peralejos D	8,850	1754	350	1404	4,0109
x				x																		La Gloria 11	8,970	1754	350	1404	4,0109
x				x			x				x	x					x					Los Aguanaces 5B	9,010	754	350	404	1,1555
x				x						x			x	x		x		x				La Roma 2	9,340	507	350	157	0,4489
x				x							x		x	x		x						La Roma 1	9,410	598	350	248	0,7073
		x		x								x					x					Puente Minero 10	9,490	508	350	158	0,4507
		x		x								x					x					Puente Minero 2	9,600	508	350	158	0,4507
		x		x				x				x					x					Masia d.l. Roma 11	9,610	443	350	93	0,2661
		x		x								x					x					Puente Minero 8B	9,660	508	350	158	0,4507
		x		x								x					x					Puente Minero 8A	9,670	508	350	158	0,4507
		x		x								x				x						Masia d.l. Roma 9	9,720	508	350	158	0,4507
		x		x											x		x					Masia d.l. Roma 7	9,740	508	350	158	0,4507
		x		x								x					x					Masia d.l. Roma 4C	9,850	508	350	158	0,4507
		x		x								x					x			x		Masia d.l. Roma 4B	9,870	880	350	530	1,5129
		x		x							x	x					x					Masia d.l. Roma 3	9,920	443	350	93	0,2661
		x	x	x								x					x					Cascante 4	10,170	587	350	237	0,6780
				x	x			x				x					x				x	Casa Altas	10,700	764	350	414	1,1820
									x			x					x					Nombrevilla 1	10,760	278	350	-72	-0,2054

Supplementary Table 2B: Localities, ages, and data-matrix of amphibian and reptilian taxa from the Tortonian of the Calatayud-Teruel Basin. For abbreviations see Supplementary Table 2A.

Triturus (marmoratus) sp.	Triturus (vulgaris) sp.	Pleurodeles nov. sp.	Salamandra sp.	Rana sp.	Pelobates sp.	Latonia sp.	Bufo viridis	Anura indet.	Blanus sp. 1	Blanus sp. 2	Blanus sp. 3 LP5L	Blanus sp. 4 COL_C	Amphisbaenidae indet.	Lacerta sp. 1	Lacerta sp. 2	Lacerta sp. 3	Lacerta sp. 4	cf. Edlartetia sp.	Lacertidae indet.	Scincidae sp. 1	Scincidae sp. 2	Scincidae indet.	Mabuja sp.	Gekkonidae indet.	Varanidae indet	Ophisaurus sp.	Anguidae indet.	Emydidae indet.	Locality	Age (Ma)	A MAP (mm)	B Present-day MAP (mm)	C δ MAP (mm)	D Relative to recent
															x						x					x			Nombrevilla 2	11,690	-36	350	-386	-1,1018
					x										x						x					x			Solera	12,010	19	350	-331	-0,9445
				x											x	x					x					x			Toril 1	12,110	211	350	-139	-0,3976
									x					x	x	x		x		x	x					x		x	Toril 2	12,120	256	350	-94	-0,2693
x								x	x	x				x	x	x	x			x	x		x			x		x	Toril 3A	12,130	373	350	23	0,0647
x								x	x	x				x	x	x				x	x		x		x	x		x	Toril 3B	12,140	373	350	23	0,0647
									x	x				x	x	x				x	x		x			x			Paje 2	12,200	13	350	-337	-0,9620
									x	x				x	x	x				x	x					x			Paje 1	12,340	19	350	-331	-0,9445
					x	x			x					x	x	x				x	x					x			Las Planas 5H	12,570	118	350	-232	-0,6632
													x		x	x					x					x			Alcocer 2	12,700	8	350	-342	-0,9760
													x						x			x				x			Las Planas 5K	13,080	19	350	-331	-0,9445
					x						x								x	x				x		x			Las Planas 5L	13,160	38	350	-312	-0,8920
					x		x						x	x	x					x	x					x			Borjas	13,250	19	350	-331	-0,9445
	x				x								x		x	x				x	x					x			Valalto 1B	13,350	137	350	-213	-0,6083
	x	x			x							x			x	x				x	x		x			x			Valalto 1A	13,400	343	350	-7	-0,0207
			x		x							x			x	x				x	x					x			Las Planas 5C	13,550	137	350	-213	-0,6083
					x							x			x	x				x	x					x			Las Planas 5B	13,560	27	350	-323	-0,9220

Supplementary Table 2C: Localities, ages, and data-matrix of amphibian and reptilian taxa from the Serravallian of the Calatayud-Teruel Basin. For abbreviations see Supplementary Table 2A.

Albanerpeton inexpectatum	*Mioproteus caucasicus*	*Mioproteus* aff. *wezei*	*Parahynobius kordosi*	cf. *Parahynobius* sp.	*Andrias scheuchzeri*	*Andrias* sp.	aff. *Palaeoproteus* sp.	Batrachosauroidae indet.	Scapherpetodon nov. sp.	*Salamandra* cf. *sansaniensis*	*Chelotriton paradoxus*	*Chelotriton* sp. 1	*Chelotriton* sp. 2	Salamandridae indet.	*Triturus roehrsi*	*Triturus vulgaris*	*Triturus cristatus*	*Triturus* aff. *montadoni*	*Triturus* cf. *marmoratus*	*Triturus* sp. 1	*Triturus* sp. 2	**Locality**	**Age (Ma)**	**MAP (mm)**
																						Polgardi 2	5.75+/-0.4	354
			x																			Polgardi 4	6.45+/-0.35	440
				x																		Tardosbanya 3	7.25+/-0.45	381
																						Csakvar	8.2+/-0.6	587
																						Dorn-Dürkheim	8.3+/-0.5	1079
																						Prottes	8.3+/-0.5	873
	x										x					x	x					Kohfidisch	8.75+/-0.2	611
										x								x				Suchomasty	9.0+/-0.2	915
																						Varnitza	9.6+/-0.25	278
																						Kalfa	9.7+/-0.2	200
																						Buzhor 1	9.7+/-0.2	1378
																						Lapushna	9.8+/-0.2	1401
	x																		x			Maikop	9.8+/-0.2	1480
	x				x							x								x		Götzendorf	9.86+/-0.08	1303
	x											x	x	x						x	x	Rudabanja	10.1+/-0.2	1057
x	x																			x		Richardhof-Golfplatz	10.2+/-0.1	810
																						Tataros	10.25+/-0.25	1766
					x																	Vösendorf	10.35+/-0.1	918
		x					x	x	x		x				x			x				Hammerschmiede 3	11.10+/-0.1	1196
		x					x				x				x							Hammerschmiede 2	11.14+/-0.1	1008
		x				x	x				x				x							Hammerschmiede 1	11.18+/-0.1	974
	x										x											Gritsev	11.2+/-0.3	550
																						Petersbuch 14	11.3+/-0.5	352
																						Petersbuch 48	11.5+/-0.5	197
															x							Felsötarkany 1+3/2	11.6+/-0.5	372
																						Petersbuch 18	12.0+/-0.5	278
																						Tasad	12.4+/-0.1	1
																x						Kleineisenbach	13.0+/-0.25	511
	x																					Anwil	13.27+/-0.1	894
2	6	6	3	3	6	6	6	6	6	3	3	3	3	6	3	3	3	3	4	3	3			

Supplementary Table 3A: Localities, ages, estimated palaeo-precipitation values, and data-matrix of tailed amphibians from the Serravallian to Messinian of the Paratethys area.

Latonia gigantea	*Latonia ragei*	*Latonia* sp.	*Bombina* cf. *bombina*	*Bombina* cf. *variegata*	*Bombina* sp.	cf. *Discoglossus*	Discoglossidae indet.	*Palaeobatrachus* sp.	cf. *Palaeobatrachus* sp.	*Pelodytes* sp.	*Hyla* cf. *arborea*	*Hyla* sp.	*Bufo bufo*	*Bufo* (cf.) *viridis*	*Bufo* sp. (aff. *viridis* -group)	*Bufo* sp. indet.	*Rana* (*ridibunda*) sp.	*Rana* sp.	*Eopelobates* sp.	*Pelobates* cf. *cultripes*	*Pelobates* cf. *syriacus*	*Pelobates* cf. *decheni*	*Pelobates fuscus*	*Pelobates* sp.	Pelobatidae	**Locality**	**Age (Ma)**	**MAP (mm)**
x														x			x									Polgardi 2	5.75+/-0.4	354
x												x		x			x						x			Polgardi 4	6.45+/-0.35	440
x														x			x						x			Tardosbanya 3	7.25+/-0.45	381
													x					x								Csakvar	8.2+/-0.6	587
																										Dorn-Dürkheim	8.3+/-0.5	1079
																										Prottes	8.3+/-0.5	873
x	x		x									x	x				x			x						Kohfidisch	8.75+/-0.2	611
x				x									x						x							Suchomasty	9.0+/-0.2	915
																										Varnitza	9.6+/-0.25	278
																										Kalfa	9.7+/-0.2	200
																x		x								Buzhor 1	9.7+/-0.2	1378
																										Lapushna	9.8+/-0.2	1401
							x										x									Maikop	9.8+/-0.2	1480
x								x									x									Götzendorf	9.86+/-0.08	1303
x					x	x	x	x	x	x		x					x								x	Rudabanja	10.1+/-0.2	1057
x											x							x						x		Richardhof-Golfplatz	10.2+/-0.1	810
																										Tataros	10.25+/-0.25	1766
							x									x										Vösendorf	10.35+/-0.1	918
x								x							x		x		x							Hammerschmiede 3	11.10+/-0.1	1196
x																	x									Hammerschmiede 2	11.14+/-0.1	1008
x												x					x									Hammerschmiede 1	11.18+/-0.1	974
x								x								x	x					x		x		Gritsev	11.2+/-0.3	550
x																								x		Petersbuch 14	11.3+/-0.5	352
x																					x					Petersbuch 48	11.5+/-0.5	197
x												x													x	Felsötarkany 1+3/2	11.6+/-0.5	372
		x																								Petersbuch 18	12.0+/-0.5	278
																										Tasad	12.4+/-0.1	1
		x						x									x		x							Kleineisenbach	13.0+/-0.25	511
x																								x		Anwil	13.27+/-0.1	894
3	3	3	3	3	3	3	3	6	6	3	3	3	3	1	3	3	4	4	3	2	2	2	2	2	2			

Supplementary Table 3B: Localities, ages, estimated palaeo-precipitation values, and data-matrix of frogs from the Serravallian to Messinian of the Paratethys area.

Lazarussuchus sp.	*Diplocynodon* sp.	*Emys orbicularis*	*Mauremys gaudryi*	*Sakya* sp.	*Sarmatemys lungui*	Emydidae indet.	*Trionyx* sp.	*Rafetus khosatzkii*	*Chelydropsis murchisoni*	*Chelydropsis* sp.	*Clemmydopsis* sp.	*Clemmydopsis sopronensis*	*Geoemyda* sp.	*Melanochelys* sp.	"*Mlynarskiella*" *storchi*	*Testudo* cf. *kalksburgensis*	*Testudo* cf. *promarginata*	*Testudo* sp.	*Protestudo csakvarensis*	*Protestudo moldavica*	*Protestudo* sp.	*Cheirogaster* sp.	**Locality**	**Age (Ma)**	**MAP (mm)**
														x					x				Polgardi 2	5.75+/-0.4	354
																			x				Polgardi 4	6.45+/-0.35	440
																		x					Tardosbanya 3	7.25+/-0.45	381
													x						x				Csakvar	8.2+/-0.6	587
							x								x			x					Dorn-Dürkheim	8.3+/-0.5	1079
							x										x	x				x	Prottes	8.3+/-0.5	873
			x																x				Kohfidisch	8.75+/-0.2	611
						x					x							x					Suchomasty	9.0+/-0.2	915
														x						x			Varnitza	9.6+/-0.25	278
														x					x				Kalfa	9.7+/-0.2	200
				x	x		x		x					x					x				Buzhor 1	9.7+/-0.2	1378
							x			x				x				x					Lapushna	9.8+/-0.2	1401
						x		x															Maikop	9.8+/-0.2	1480
							x			x								x					Götzendorf	9.86+/-0.08	1303
							x						x			x							Rudabanja	10.1+/-0.2	1057
							x																Richardhof-Golfplatz	10.2+/-0.1	810
		x					x			x								x					Tataros	10.25+/-0.25	1766
							x					x						x					Vösendorf	10.35+/-0.1	918
x										x	x							x					Hammerschmiede 3	11.10+/-0.1	1196
x										x	x							x					Hammerschmiede 2	11.14+/-0.1	1008
							x			x	x							x					Hammerschmiede 1	11.18+/-0.1	974
														x							x		Gritsev	11.2+/-0.3	550
																							Petersbuch 14	11.3+/-0.5	352
																							Petersbuch 48	11.5+/-0.5	197
																							Felsötarkany 1+3/2	11.6+/-0.5	372
																							Petersbuch 18	12.0+/-0.5	278
																							Tasad	12.4+/-0.1	1
						x																	Kleineisenbach	13.0+/-0.25	511
	x						x																Anwil	13.27+/-0.1	894
6	6	6	6	6	6	6	6	6	6	6	6	6	3	3	3	1	1	1	1	1	1	4			

Supplementary Table 3C: Localities, ages, estimated palaeo-precipitation values, and data-matrix of choristoders, crocodiles and turtles from the Serravallian to Messinian of the Paratethys area.

Typhlops grivensis	cf. *Typhlops* sp.	Scolecophidia indet.	*Bransateryx* sp.	*Albaneryx volynicus*	cf. *Albaneryx* sp.	*Blanus* sp.	Amphisbaenidae indet.	Agamidae indet.	Gekkonidae indet.	*Edlartetia sansaniensis*	*Lacerta viridis*	*Lacerta* sp.	*Lacerta* sp. 2	*Miolacerta* sp.	*Lacertidae indet.*	*Chalcides* sp.	Scincidaeindet.	Scincomorphaindet.	*Varanus hoffmanni*	Varanidae indet.	Anguidae indet.	*Pseudopus pannonicus*	*Pseudopus* sp.	*Anguis fragilis*	*Ophisaurus fejfari*	*Ophisaurus* cf. *spinari*	*Ophisaurus* sp.	aff. *Ophisaurus* sp.	**Locality**	**Age (Ma)**	**MAP (mm)**
												x										x					x		Polgardi 2	5.75+/-0.4	354
												x										x							Polgardi 4	6.45+/-0.35	440
												x										x							Tardosbanya 3	7.25+/-0.45	381
																		x											Csakvar	8.2+/-0.6	587
																													Dorn-Dürkheim	8.3+/-0.5	1079
																													Prottes	8.3+/-0.5	873
x									x	x	x	x					x		x			x		x					Kohfidisch	8.75+/-0.2	611
																		x					x						Suchomasty	9.0+/-0.2	915
																			x										Varnitza	9.6+/-0.25	278
																			x			x							Kalfa	9.7+/-0.2	200
																						x							Buzhor 1	9.7+/-0.2	1378
																													Lapushna	9.8+/-0.2	1401
												x																	Maikop	9.8+/-0.2	1480
												x										x							Götzendorf	9.86+/-0.08	1303
	x											x																x	Rudabanja	10.1+/-0.2	1057
												x					x					x							Richardhof-Golfplatz	10.2+/-0.1	810
																													Tataros	10.25+/-0.25	1766
												x															x		Vösendorf	10.35+/-0.1	918
												x					x					x					x		Hammerschmiede 3	11.10+/-0.1	1196
												x					x					x					x		Hammerschmiede 2	11.14+/-0.1	1008
							x					x	x			x						x					x		Hammerschmiede 1	11.18+/-0.1	974
		x	x	x			x	x	x						x		x				x								Gritsev	11.2+/-0.3	550
																											x		Petersbuch 14	11.3+/-0.5	352
												x											x				x		Petersbuch 48	11.5+/-0.5	197
		x										x											x			x			Felsötarkany 1+3/2	11.6+/-0.5	372
																			x				x						Petersbuch 18	12.0+/-0.5	278
		x						x				x	x										x				x		Tasad	12.4+/-0.1	1
					x	x			x	x		x	x	x		x				x			x		x				Kleineisenbach	13.0+/-0.25	511
												x		x									x				x		Anwil	13.27+/-0.1	894
2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1			

Supplementary Table 3D: Localities, ages, estimated palaeo-precipitation values, and data-matrix of squamates from the Serravallian to Messinian of the Paratethys area.

Locality	Age (Ma)	MAP (mm)	Present-day MAP (mm)	Reference station	δ MAP (mm)	Relative to recent	reference
Polgardi 2	5.75+/-0.4	354	619	Balaton	-265	-0,4286	4, 22, 30, 32
Polgardi 4	6.45+/-0.35	440	619	Balaton	-179	-0,2900	30, 31, 32, 33
Tardosbanya 3	7.25+/-0.45	381	630	Budapest	-249	-0,3949	33, 34, 38
Csakvar	8.2+/-0.6	587	630	Budapest	-43	-0,0678	17, 20
Dorn-Dürkheim	8.3+/-0.5	1079	577	Worms/Oppenheim	502	0,8698	25
Prottes	8.3+/-0.5	873	660	Wien	213	0,3228	2
Kohfidisch	8.75+/-0.2	611	660	Burgenland	-49	-0,0741	28, 29
Suchomasty	9.0+/-0.2	915	508	Prag	274	0,5388	1, 14
Varnitza	9.6+/-0.25	278	471	Kishinev	-193	-0,4096	7, 8
Kalfa	9.7+/-0.2	200	471	Kishinev	-271	-0,5761	5, 6, 7, 16
Buzhor 1	9.7+/-0.2	1378	471	Kishinev	907	1,9260	5, 6, 24
Lapushna	9.8+/-0.2	1401	471	Kishinev	930	1,9741	5
Maikop	9.8+/-0.2	1480	772	Maikop	708	0,9177	6, , 9, 10
Götzendorf	9.86+/-0.08	1303	660	Wien	643	0,9747	1, 2, 11, 19
Rudabanja	10.1+/-0.2	1057	630	Budapest	427	0,6777	3, 23, 26
Richardhof-Golfplatz	10.2+/-0.1	810	660	Wien	150	0,2271	11
Tataros	10.25+/-0.25	1766	613	Oradea	1153	1,8810	18, 20
Vösendorf	10.35+/-0.1	918	660	Wien	258	0,3907	21
Hammerschmiede 3	11.10+/-0.1	1196	1241	Kaufbeuren	-45	-0,0361	1
Hammerschmiede 2	11.14+/-0.1	1008	1241	Kaufbeuren	-233	-0,1880	1
Hammerschmiede 1	11.18+/-0.1	974	1241	Kaufbeuren	-267	-0,2153	1
Gritsev	11.2+/-0.3	550	615	Kiev	-65	-0,1060	6, 15, 23, 27, 36, 37
Petersbuch 14	11.3+/-0.5	352	665	Weißenburg	-313	-0,4714	1
Petersbuch 48	11.5+/-0.5	197	665	Weißenburg	-468	-0,7043	1
Felsötarkany 1+3/2	11.6+/-0.5	372	582	Eger	-210	-0,3602	13, 35
Petersbuch 18	12.0+/-0.5	278	665	Weißenburg	-387	-0,5818	1
Tasad	12.4+/-0.1	1	613	Oradea	-612	-0,9983	12
Kleineisenbach	13.0+/-0.25	511	850	Hallbergmoos	-339	-0,3983	1, 3
Anwil	13.27+/-0.1	894	800	Basel Binningen	94	0,1177	3

Supplementary Table 3E: Paratethys area: Localities, ages, estimated palaeo-precipitation values, present-day precipitation near the localities and their reference climate station, precipitation difference to present day values, relative precipitation to present-day values, and references for the faunal content.

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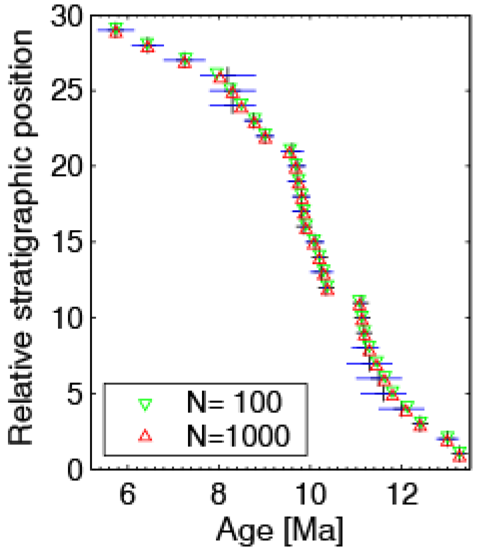
3. Treatment of Age Uncertainties

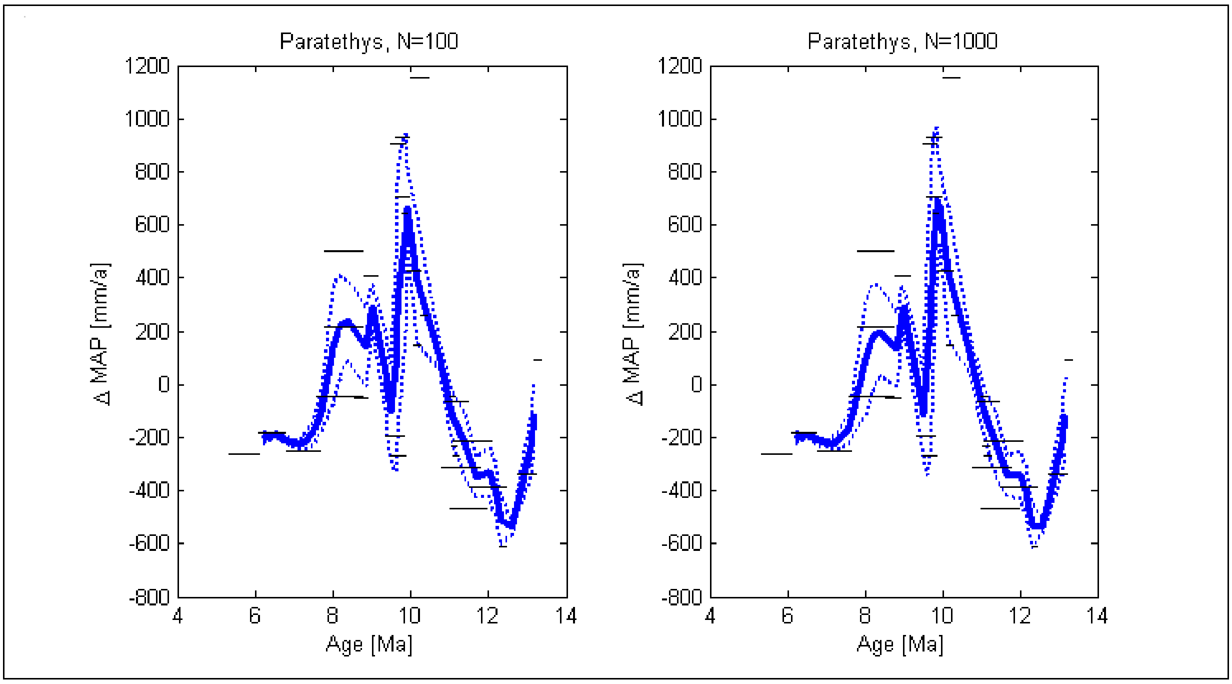
In order to combine or to correlate the rainfall data from both sectors, we first have to treat the age uncertainties of the data points from the C+E sector (Paratethys) before we can fit a hypersurface to them, which can then easily interpolated at the points specified by the good age model for the data from the South-Western sector (Spain).

We use a stochastic approach to treat the age uncertainties of the data from the C+E sector. We generate a large number N of age models consistent with the given error bars and stratigraphic relationships between adjacent samples. The probability for an "event" A to occur at any point a (=the probability that sample A has age a) within the age uncertainty interval $[A^{low}, A^{upp}]$ is given by $prob(a)=1/(A^{upp}-A^{low})$ if there is no overlap between $[A^{low}, A^{upp}]$ and the age uncertainty interval $[B^{low}, B^{upp}]$ for the stratigraphically adjacent event B. If, however, the age uncertainty intervals overlap and the age b of B happens to lie in that part of the interval $[B^{low}, B^{upp}]$ which overlaps with $[A^{low}, A^{upp}]$, then the uncertainty interval for event A becomes smaller. In other words, the generation of age a here depends on the generated age b. The conditional probability for event A to occur at a when B has already occurred at b then is given by $prob(a|b)=1/[A^{upp}-\max(b,A^{low})]$. To avoid a bias towards younger ages (which would inevitably be the case if we were to generate b always prior to a), we randomly alternate between the "b generated prior to a" case and the complementary case that a is generated before b, for which $prob(b|a)= 1/[\min(a,B^{upp})- B^{low}]$. Figure S1 shows the statistical averages over N=100 and N=1000 random age models. Where there is no overlap between adjacent age intervals, each mean age is of the same age as the respective mid point of the given age interval (Fig. S1). Where there is strong overlap, the correlation effects lead to progressively younger (older) mean ages in the upper (lower) parts of a coeval age cluster. The averaged ages for N=100 do not differ markedly from those obtained for N=1000 (Fig. 1), which demonstrates the statistical robustness of the approach. We used N=1000 for the following graphs.

The next step is to regrid the precipitation data for each of the N individual age models at the dates t_j $(j=1...L)$ specified by the well-constrained age model for the W-sector, which will allow for a direct combination of the two records. From the regridded data sets $MAP_k(t_j)$ $(k=1...N)$ we determine the ensemble mean $\langle MAP\rangle(t_j)$ as well as the standard deviation $\sigma_{MAP}(t_j)$. The result of the procedure is shown in Fig. S2, where we plotted the precipitation ratio MAP_t/MAP_0 ($\times$ 100%) relative to present day values (subscript 0). It can be seen that the error bars in the abscissa (age model) have been transformed into error bars in the ordinate (precipitation). After this transformation, the data from the C+E sector can be combined with those of the W-sector to compute the weighed European precipitation curve (Fig 4 in the paper) and the total runoff from both areas (see Section 2.3 and Fig. 5A in the paper).



Supplementary Figure 1: Average datums from N=100 (green down triangles) and N=1000 (red up triangles) random age models for the C+E sector, each of which is consistent with the given age uncertainty intervals (horizontal bars) and preserves the stratigraphic relationship. The plus signs (black) represent the centres of the uncertainty intervals.



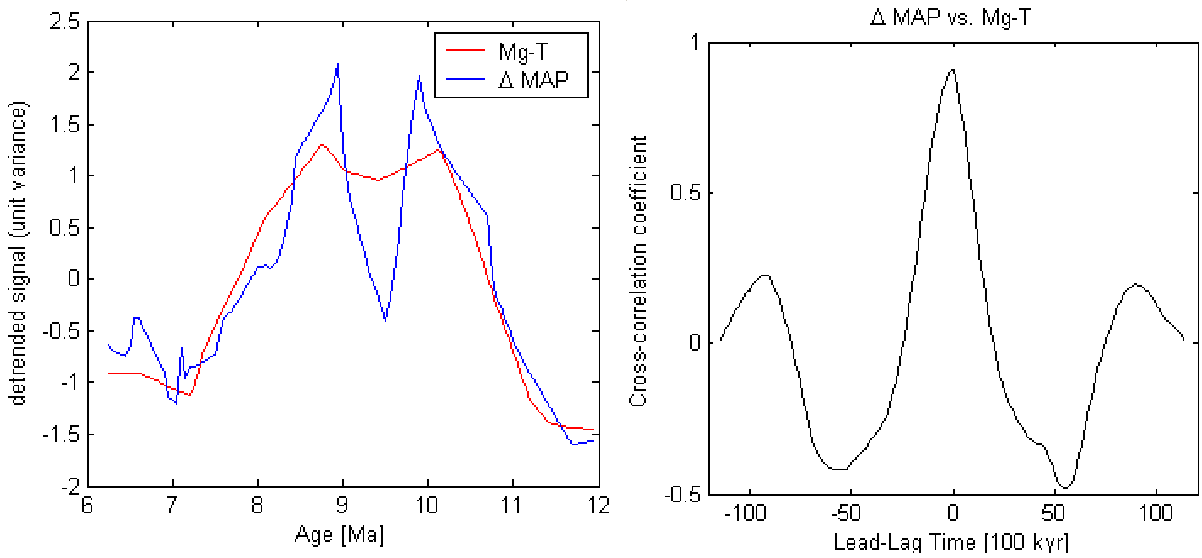
Supplementary Figure 2: Ensemble means and ±1σ confidence intervals of the mean annual precipitation (relative to recent, in mm), obtained from average over N=100 (left) and N=1000 (right) random age models for the C+E sector. The two estimates of the precipitation-age curves are nearly identical. Horizontal black bars represent the raw data with age uncertainties.

4. Catchment area of European rivers

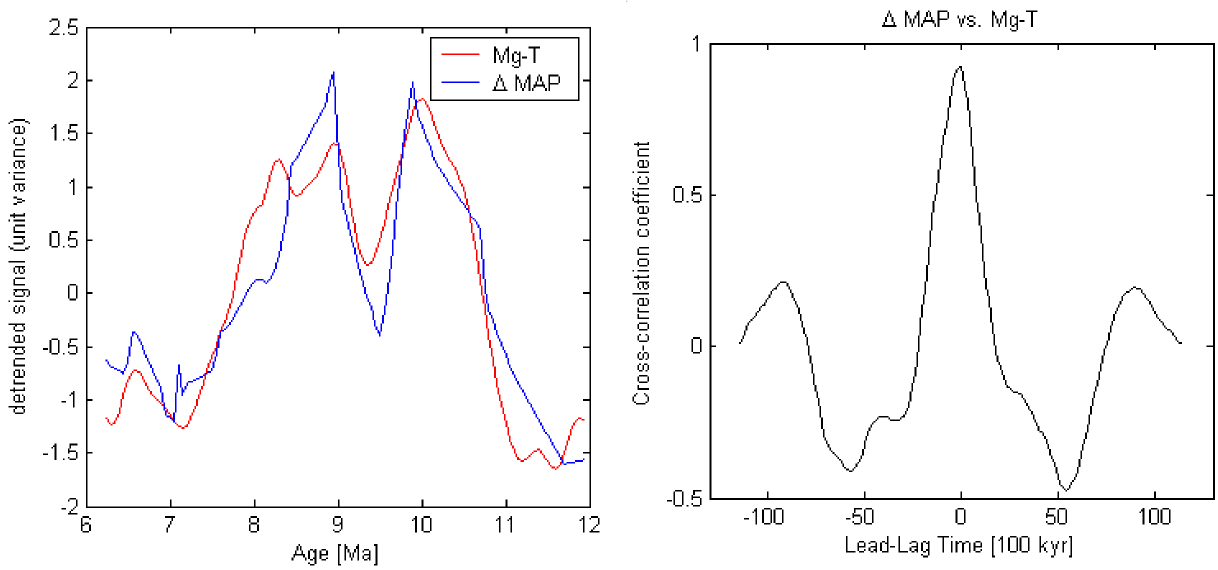
river	sector	catchment area (km²)	
Rhine	W-sector	185.000	
Elbe	W-sector	148.000	
Oder	W-sector	118.800	
Vistula	W-sector	194.000	
Seine	W-sector	78.650	
Garonne	W-sector	57.000	
Loire	W-sector	120.000	
Guadiana	W-sector	66.800	
Guadalquivir	W-sector	57.500	
Duero	W-sector	97.290	
Tagus	W-sector	88.700	
Ebro	W-sector	86.000	
Rhone	W-sector	98.000	
Po	C+E-sector	74.000	
Danube	C+E-sector	817.000	
Don	C+E-sector	422.000	
Dnjepr	C+E-sector	503.000	
Volga	C+E-sector	1.380.000	
		4.591.740	total Europe
		1.395.740	total W-sector
		3.196.000	total C+E-sector
		30	% W-sector
		70	% E+C-sector

Supplementary Table 4: The 18 largest European rivers from the western and central +eastern European sectors, their catchment area (source: www.grid.unep.ch), and the relative proportion of the catchment area in both sectors.

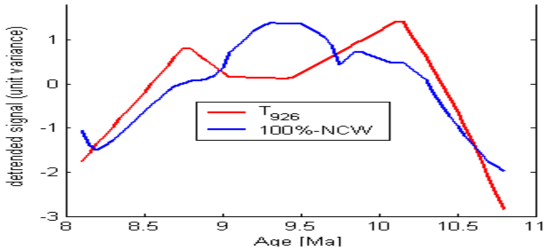
5. Correlation analysis of time series

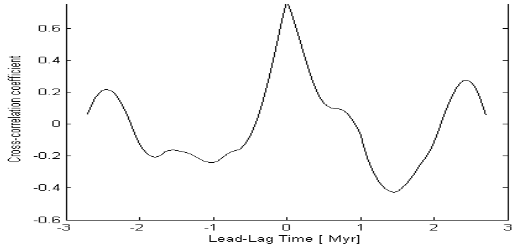


Supplementary Figure 3a: Correlation analysis between ABWT curve (red, from Lear et al., 2003, Fig. 6, filtered composite from three benthic species, *O. umbonatus*, *C. mundulus, C. wuellerstorfi*) and weighted mean-annual precipiation (relative to recent values, in mm; blue) for both sectors. **Left** Both time series are detrended and normalized by their standard deviation to make the variations comparable. The notch in ABWT at ~9.5 Ma corresponds to a temperature decrease of less than 0.5 °C. **Right**: Lead-lag analysis. The maximum correlation coefficient (0.91, with a 95% confidence interval of [0.87,0.94]) is obtained for zero lag, suggesting a zero-phase shift between the two time series. Phase shifts smaller than the temporal resolution (~100 kyr) can of course not be resolved.



Supplementary Figure 3b: As above in Fig. 3a, but now with the ABWT derived from *O. umbonatus* and *C. mundulus* only (as used in Fig. 4 in paper), since there are no *C. wuellerstorfi* Mg-data for the age range between 8 and 9 Ma)**.** The datasets for both species were regridded (50 kyr steps) and smoothed with a five-point running average. The local minimum in ABWT at ~9.4 Ma corresponds to a temperature decrease of 1 °C. The maximum correlation coefficient (0.92, with a 95% confidence interval of [0.89,0.95]) is obtained for zero lag





Supplementary Figure 4. Correlation Analysis: Atlantic Bottom water temperature at ODP Site 926 (Lear et al., 2003) vs 100%-NCW% (Poore et al., 2006). Left: Raw records, offset-detrended and normalized such that standard variation of each record is unity. Right: Lead-lag analysis, the maximum correlation between the two records is obtained as 0.774 (0.64-0.88) for a lag time of 0 Myr.

The correlation analysis shows that the large scale variations in ABWT at Site 926 can be explained by variations in NCW flow such that Site 926 is increasingly bathed by (warmer) Southern Sourced Water (SSW) masses as the (cool) NCW flow is reduced. Between 10 Ma and 9.2 Ma, however, the two records are rather anticorrelated. Since the influence of NCW was low then, it is more likely that the decrease in ABWT reflects lower SSW temperatures.