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Precipitation in the mountains of Central Asia: isotopic composition and source regions

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Table S1: Descriptive statistics of stable isotope ratios and *d-excess*. N is number of samples; SD is standard deviation.

Catchment	Ulken Almaty (UA)					Chon Kyzyl Suu (CKS)					Ala Archa (AA)					Chirchik (CHK)				
Temporal Resolusion/Type	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
Oxygen, ‰																				
January	8	-22.5	5.9	-33.6	-12.1	7	-11.7	4.6	-17.3	-4.9	7	-13.1	5.4	-20.2	-5.8	24	-16.4	6.6	-32.4	-5.5
February	21	-15.7	6.7	-25.5	-3.3	9	-16.4	6.6	-23.8	-1.7	16	-12.6	4.8	-22.1	-6.6	53	-10.1	5.1	-23.8	-0.1
March	25	-12.7	4.2	-20.7	-7.2	9	-11.1	1.7	-13.8	-8.8	16	-11.0	5.2	-21.5	-1.7	44	-7.2	4.6	-16.0	3.8
April	20	-13.8	5.4	-24.6	-4.2	18	-12.0	5.1	-20.4	-3.4	9	-9.5	5.7	-14.9	1.9	35	-7.4	5.5	-17.8	3.3
May	37	-9.0	3.4	-13.2	-0.1	33	-9.5	3.5	-15.8	-2.5	12	-5.2	2.0	-9.4	-2.1	33	-2.7	3.6	-9.0	4.3
June	47	-5.0	3.6	-11.0	1.4	30	-5.4	4.1	-12.8	6.0	5	-5.0	2.3	-8.0	-2.4	17	0.2	4.2	-13.0	4.3
July	45	-4.1	4.0	-12.3	6.1	31	-3.1	2.7	-7.7	5.5	8	-2.0	3.1	-7.2	2.4	15	-1.6	2.9	-5.9	2.8
August	49	-5.6	4.4	-16.4	1.1	24	-5.3	3.1	-11.6	0.7	15	-0.4	5.2	-10.6	8.6	11	-4.0	4.2	-12.9	-0.2
September	34	-8.0	5.1	-23.6	3.8	14	-6.3	3.9	-12.1	2.8	6	-3.4	5.3	-8.8	3.2	4	-4.9	3.6	-10.0	-1.8
October	30	-12.7	4.1	-19.7	-6.5	5	-8.4	4.9	-13.8	-2.3	7	-12.1	4.3	-19.7	-7.6	4	-5.5	3.5	-10.5	-2.9
November	14	-16.4	6.0	-27.4	-5.8	2	-19.2	1.6	-20.4	-18.1	7	-12.6	4.8	-21.1	-6.1	14	-18.8	6.6	-30.8	-11.7
December	8	-19.3	6.3	-28.5	-12.5	1	-15.4	-	-15.4	-15.4	7	-15.0	4.9	-21.7	-9.3	18	-14.1	5.0	-20.9	-6.0
DJF	37	-17.9	6.9	-33.6	-3.3	17	-14.4	5.9	-23.8	-1.7	30	-13.3	4.9	-22.1	-5.8	95	-12.5	6.1	-32.4	-0.1
MAM	82	-11.3	4.7	-24.6	-0.1	60	-10.5	4.0	-20.4	-2.5	37	-8.7	5.1	-21.5	1.9	112	-6.0	5.0	-17.8	4.3
JJA	141	-4.9	4.1	-16.4	6.1	85	-4.6	3.5	-12.8	6.0	28	-1.7	4.5	-10.6	8.6	43	-1.5	4.0	-13.0	4.3
SON	78	-11.3	5.8	-27.4	3.8	21	-8.0	5.4	-20.4	2.8	20	-9.7	6.2	-21.1	3.2	22	-13.8	8.7	-30.8	-1.8
Annual	338	-9.4	6.6	-33.6	6.1	183	-7.8	5.3	-23.8	6.0	115	-8.4	6.6	-22.1	8.6	272	-8.2	7.1	-32.4	4.3
Mixed	45	-8.5	3.6	-16.4	-0.1	14	-11.5	3.3	-15.5	-1.7	17	-10.5	1.6	-13.8	-8.0	44	-10.1	3.9	-20.0	-2.8
Rain	173	-5.4	4.1	-14.8	6.1	137	-5.7	3.8	-15.8	6.0	66	-4.2	4.6	-12.9	8.6	152	-4.0	4.7	-16.5	4.3
Snow	120	-15.4	5.7	-33.6	-3.3	32	-15.0	4.4	-23.8	-4.9	32	-15.7	4.2	-22.1	-5.8	76	-15.4	6.0	-32.4	-4.7
Hydrogen, ‰																				
January	8	-168.9	49.7	-258.8	-78.8	7	-87.3	29.5	-138.6	-58.2	7	-86.5	46.9	-140.9	-30.8	24	-123.2	55.5	-247.9	-43.5
February	21	-119.1	51.1	-203.7	-47.0	9	-125.3	45.4	-186.5	-39.8	16	-82.9	40.5	-166.4	-32.8	53	-68.5	44.7	-188.0	11.8
March	25	-87.3	32.7	-148.5	-48.9	9	-83.0	15.1	-101.3	-57.8	16	-72.0	40.5	-159.9	-13.1	44	-42.8	35.2	-117.9	24.1
April	20	-97.6	45.7	-187.6	-10.0	18	-87.9	40.8	-156.9	-3.9	9	-61.1	43.8	-103.8	27.3	35	-47.4	44.3	-128.6	29.7
May	37	-56.3	26.5	-92.7	3.4	33	-61.1	30.8	-115.1	6.8	12	-28.3	17.7	-57.0	-1.8	33	-15.5	27.5	-63.5	29.4
June	47	-29.6	22.8	-70.9	9.4	30	-32.5	26.3	-85.3	17.1	5	-34.7	14.5	-48.0	-14.0	17	-0.1	28.1	-89.2	36.5
July	45	-23.9	24.6	-76.3	38.2	31	-10.2	17.6	-45.8	19.6	8	-16.4	27.7	-62.8	25.8	15	-16.6	20.5	-50.9	21.3
August	49	-31.8	30.6	-112.3	6.9	24	-22.8	23.2	-71.3	18.9	15	2.7	28.9	-63.2	45.2	11	-18.3	29.3	-82.0	10.2
September	34	-48.1	37.9	-176.8	26.6	14	-27.9	26.5	-68.7	30.0	6	-12.6	32.7	-53.2	24.9	4	-32.0	29.8	-68.6	-4.4
October	30	-87.3	30.6	-142.3	-47.9	5	-55.2	29.6	-93.3	-24.5	7	-73.4	42.0	-141.8	-25.4	4	-23.3	28.5	-64.0	-0.5
November	14	-114.9	44.9	-187.8	-43.4	2	-140.0	6.5	-144.7	-135.4	7	-76.0	40.1	-151.9	-42.3	14	-134.9	55.3	-237.1	-78.3
December	8	-140.3	53.9	-214.8	-86.9	1	-102.6	-	-102.6	-102.6	7	-90.3	40.5	-153.9	-44.8	18	-97.3	40.3	-151.2	-20.5
DJF	37	-134.5	53.9	-258.8	-47.0	17	-108.3	41.4	-186.5	-39.8	30	-85.5	40.6	-166.4	-30.8	95	-87.8	52	-247.9	11.8
MAM	82	-75.8	38.1	-187.6	3.4	60	-72.4	34.4	-156.9	6.8	37	-55.2	39.8	-159.9	27.4	112	-36.2	38.5	-128.6	29.7
JJA	141	-28.6	26.3	-112.3	38.2	85	-21.6	24.2	-85.3	19.6	28	-9.4	29.6	-63.2	45.2	43	-10.5	26.8	-89.22	36.5
SON	78	-75.2	44.5	-187.8	26.6	21	-45.1	42.1	-144.7	30.0	20	-56.1	46.9	-151.9	24.9	22	-95.9	70.2	-237.1	-0.5
Annual	338	-62.4	50.3	-258.8	38.2	183	-49.0	43.2	-186.5	30.0	115	-52.1	47.3	-166.4	45.2	272	-55	54.9	-247.9	36.5
Mixed	45	-52.6	26.4	-112.3	5.5	14	-88.0	17.8	-114.1	-39.8	17	-61.4	13.5	-94.4	-44.8	44	-62.8	34.5	-152.8	-0.97
Rain	173	-31.4	26.6	-104.1	38.2	137	-30.6	28.4	-115.1	30.0	66	-22.8	29.9	-83.0	45.2	152	-24.3	34.4	-119.9	36.5
Snow	120	-110.8	45.7	-258.8	-10.5	32	-110.6	34.0	-186.5	-58.2	32	-107.5	34.9	-166.4	-30.8	76	-112	50.7	-247.9	-15.3
d-excess, ‰																				
January	8	10.8	7.9	-4.9	18.1	7	6.5	16.4	-19.3	22.4	7	18.2	7.1	9.5	29.0	24	8.1	13.7	-25.4	35.3
February	21	6.4	10.9	-22.2	17.1	9	5.6	13.3	-26.1	15.7	16	18.0	4.8	9.0	25.9	53	12.6	10.3	-18.2	34.1
March	25	14.0	6.7	-3.7	23.1	9	6.2	5.4	-3.2	12.4	16	15.8	7.1	-1.6	25.3	44	14.9	8.7	-6.7	33.2
April	20	12.5	7.8	-11.0	26.5	18	7.9	9.2	-19.1	23.3	9	14.9	3.7	7.5	20.0	35	11.8	6.0	-1.8	24.5
May	37	15.8	6.7	-8.3	24.4	33	14.5	4.8	4.5	27.1	12	13.5	5.5	6.8	23.7	33	6.5	9.3	-12.2	21.2

June	47	10.5	9.9	-14.5	23.0	30	10.7	9.9	-31.0	21.1	5	5.1	7.6	-2.2	17.4	17	-1.7	9.2	-15.7	14.9
July	45	8.8	11.5	-26.5	23.1	31	14.9	9.7	-26.3	27.1	8	-0.1	8.7	-14.9	11.8	15	-3.5	9.1	-25.2	10.0
August	49	13.1	7.5	-5.1	24.1	24	19.8	6.5	-0.2	29.1	15	6.2	17.6	-23.8	46.4	11	13.4	8.4	-4.1	23.8
September	34	15.8	8.1	-4.0	29.1	14	22.4	5.4	7.5	28.3	6	14.3	14.4	-0.9	40.4	4	6.8	10.3	-5.5	18.4
October	30	14.1	8.0	-5.0	29.3	5	11.6	11.5	-5.9	22.4	7	23.5	11.2	13.1	41.1	4	20.6	1.5	19.8	22.8
November	14	16.5	9.9	3.1	31.1	2	13.8	6.2	9.4	18.2	7	24.8	17.4	6.2	54.2	14	15.5	5.4	8.7	26.3
December	8	14.2	6.1	6.2	25.9	1	20.9	*	20.9	20.9	7	29.5	13.6	11.1	45.7	18	15.8	5.5	6.4	30.1
DJF	37	9.0	9.8	-22.2	25.9	17	6.9	14.3	-26.1	22.4	30	20.7	9.2	9.0	45.7	95	12.1	10.8	-25.4	35.3
MAM	82	14.5	7.0	-11.0	26.5	60	11.3	7.4	-19.1	27.1	37	14.8	5.9	-1.6	25.3	112	11.4	8.8	-12.2	33.2
JJA	141	10.9	9.8	-26.5	24.1	85	14.8	9.6	-31.0	29.1	28	4.2	14.0	-23.8	46.4	43	1.5	11.2	-25.2	23.8
SON	78	15.2	8.3	-5.0	31.1	21	19.0	8.5	-5.9	28.3	20	21.2	14.5	-0.9	54.2	22	14.9	7.2	-5.5	26.3
Annual	338	12.5	9.1	-26.5	31.1	183	13.4	9.8	-31.0	29.1	115	14.9	12.6	-23.8	54.2	272	10.4	10.6	-25.4	35.3
Mixed	45	15.2	7.2	-8.3	25.4	14	3.7	10.7	-26.1	18.4	17	22.8	10.7	13.1	54.2	44	17.6	7.8	1.8	35.3
Rain	173	11.9	9.9	-26.5	29.3	137	15.3	9.1	-31.0	29.1	66	11.2	13.5	-23.8	46.4	152	7.8	10.1	-25.2	29.6
Snow	120	12.5	8.5	-22.2	31.1	32	9.7	8.9	-19.3	22.4	32	18.4	8.0	7.1	45.7	76	11.3	10.9	-25.4	31.3

Table S2: Stepwise regression equations for the meteorological seasons linking $\delta^{18}O$, δD, and *d-excess* with latitude, longitude, and elevation. Predictors, statistically significant at 95% confidence level, are highlighted in bold and p-values are shown for every predictor in the order they are listed in the equations.

Season	$\delta^{18}O$	δD	*d-excess*
DJF	$\delta^{18}O_{DJF}$ = –15.8 – 0.04Lat + 0.15Lon – **0.005E** (0.97; 0.56; <0.01)	δD_{DJF} = –223 + 1.94Lat + 1.57Lon – **0.04E** (0.81; 0.47; <0.01)	*d-excess*$_{DJF}$ = – 96.5 + 2.26Lat + 0.34Lon – **0.007E** (0.24; 0.50; 0.02)
MAM	$\delta^{18}O_{MAM}$ = 51.8 – 0.84Lat – 0.29Lon – 0.002E (0.19; 0.09; 0.05)	δD_{MAM} = 427 – 5.84Lat – **2.94Lon** – 0.009E (0.25; 0.03; 0.18)	*d-excess*$_{MAM}$ = 12.8 + 0.89Lat – **0.61Lon** – **0.002E** (0.40; 0.03; <0.01)
JJA	$\delta^{18}O_{JJA}$ = 30.3 – 0.66Lat – 0.01Lon **– 0.002E** (0.24; 0.95; 0.02)	δD_{JJA} = 302 – **7.89Lat** + 0.49Lon – 0.01E (0.03; 0.71; 0.08)	*d-excess*$_{JJA}$ = 58.9 – 2.59Lat + 0.59Lon + **0.001E** (0.08; 0.26; <0.01)
SON	$\delta^{18}O_{SON}$ = –29.9 – 2.02Lat + **1.51Lon** – **0.004E** (0.06; <0.01; <0.01)	δD_{SON} = –306 – **16.97Lat** + **13.9Lon** – **0.04E** (0.04; <0.01; 0.03)	*d-excess*$_{SON}$ = –66.4 – 0.83Lat + **1.80Lon** – **0.01E** (0.59; 0.02; 0.03)

Table S3: Mean isotopic ratios for the warm (δ_w; May – October) and cold (δ_c; November – April) periods for all event-based samples.

Period	Oxygen, ‰				Hydrogen, ‰			
	UA	CKS	AA	CHK	UA	CKS	AA	CHK
May –October	-6.9	-6.0	-4.1	-2.3	-42.8	-33.0	-22.5	-14.1
November –April	-15.5	-13.0	-12.1	-10.8	-111.6	-96.7	-77.4	-73.2
δ_w–δ_c	8.6	7.0	8.0	8.5	68.8	63.7	54.9	59.1

Table S4: Regression between $\delta^{18}O$ and δD and air temperature for each sampling site. Coefficients of determination are statistically significant at 95% confidence level at all sites except CHK3 (Tashkent).

Sampling site	$\delta^{18}O$		δD	
	Equation	R^2	Equation	R^2
Bolshoe Almatinskoe Lake (BAL)	$\delta^{18}O_{Annual} = 0.69t - 10.45$	0.59	$\delta D_{Annual} = 5.33t - 70.76$	0.60
Lesnoy Cordon	$\delta^{18}O_{Annual} = 0.67t - 11.72$	0.46	$\delta D_{Annual} = 5.50t - 81.25$	0.49
Baityk	$\delta^{18}O_{Annual} = 0.60t - 11.35$	0.66	$\delta D_{Annual} = 4.10t - 72.33$	0.59
Tashkent	$\delta^{18}O_{Annual} = 0.32t - 9.06$	0.27	$\delta D_{Annual} = 2.46t - 61.53$	0.27
Pskem	$\delta^{18}O_{Annual} = 0.55t - 9.85$	0.54	$\delta D_{Annual} = 3.79t - 63.08$	0.47
Oygaing	$\delta^{18}O_{Annual} = 0.74t - 10.09$	0.64	$\delta D_{Annual} = 5.50t - 81.25$	0.56

Table S5: Summary of the OLSR calculations. SE is standard error.

Region / catchment	Slope	SE	Intersept	SE	R^2	n
CA (all samples)	7.56	0.05	8.65	0.54	0.96	909
CA (DJF)	8.10	0.13	13.78	2.06	0.95	179
CA (MAM)	7.75	0.09	10.52	0.88	0.97	291
CA (JJA)	6.17	0.12	2.66	0.70	0.90	297
CA (SON)	7.72	0.12	13.50	1.53	0.97	142
CA (rain)	6.64	0.09	4.74	0.58	0.91	529
CA (mixed)	7.73	0.25	13.21	2.57	0.89	120
CA (snow)	7.95	0.11	11.77	1.74	0.96	260
UA (all samples)	7.56	0.07	8.41	0.82	0.97	338
UA (DJF)	7.69	0.23	3.52	4.49	0.97	37
UA (MAM)	8.04	0.17	14.89	2.04	0.97	82
UA (JJA)	6.27	0.14	2.36	0.91	0.93	141
UA (SON)	7.50	0.15	9.55	1.95	0.97	78
UA (rain)	6.29	0.13	2.63	0.88	0.93	173
UA (mixed)	7.16	0.28	8.09	2.55	0.94	45
UA (snow)	7.83	0.13	9.88	2.22	0.97	120
CKS (all samples)	7.87	0.14	12.42	1.29	0.95	183
CKS (DJF)	6.68	0.52	-12.14	8.04	0.91	17
CKS (MAM)	8.41	0.24	15.57	2.63	0.96	60
CKS (JJA)	6.54	0.26	8.16	1.46	0.89	85
CKS (SON)	7.60	0.35	15.79	3.33	0.96	21
CKS (rain)	7.09	0.19	10.02	1.30	0.91	137
CKS (mixed)	5.21	0.50	-28.33	5.90	0.89	14
CKS (snow)	7.46	0.35	1.58	5.54	0.93	32
AA (all samples)	7.01	0.15	6.62	1.64	0.95	115
AA (DJF)	8.05	0.35	21.36	5.01	0.95	30
AA (MAM)	7.69	0.19	12.13	1.89	0.98	37
AA (JJA)	6.09	0.48	0.96	2.29	0.85	28
AA (SON)	7.25	0.53	14.00	5.99	0.91	20
AA (rain)	6.08	0.28	3.00	1.72	0.88	66
AA (mixed)	5.74	1.65	-1.05	17.56	0.41	17
AA (snow)	8.08	0.35	19.65	5.63	0.95	32
CHK (all samples)	7.66	0.09	7.65	0.99	0.96	272
CHK (DJF)	8.38	0.18	16.74	2.51	0.96	95
CHK (MAM)	7.45	0.16	8.17	1.23	0.95	112
CHK (JJA)	6.15	0.35	-2.00	1.60	0.90	43
CHK (SON)	8.05	0.19	15.53	3.01	0.99	22
CHK (rain)	7.09	0.16	4.11	1.02	0.93	145
CHK (mixed)	8.60	0.29	23.68	3.15	0.95	52
CHK (snow)	8.22	0.20	14.67	3.35	0.96	75

Table S6: Slopes, intercepts, and standard deviations derived from different regression methods applied to the monthly-averaged and event-based data sets. Results of t-test comparing each regression method and OLSR are shown. N is a number of samples. The metrics are as follows: slope of regression line (a), standard deviation of the slope (sa), intercept of regression line (b), standard deviation of the intercept (sb), average value of the sum of the squared errors of three methods, either OLSR, RMA and MA or three precipitation-weighted regressions, root mean Sum of Squared Errors (RMSSE). The proximity of the RMSSE values to 1.0 is an indicator of the suitability of a regression method for the analysed data set.

Monthly	N	a	sa	b	sb	RMSSE	t-value	p-value
OLSR	137	7.5778	0.1182	9.7101	1.2355	1.0074		
RMA	137	7.7012	0.1173	10.7859	1.2279	1.0026	0.7378	0.46
MA	137	7.8224	0.1206	11.8433	1.2607	1.0057	1.4549	0.15
PWLSR	137	7.7358	0.1165	12.1886	1.0953	1.0012	0.9331	0.35
PWRMA	137	7.8533	0.1171	13.1535	1.1005	1.0049	1.6181	0.11
PWMA	137	7.9689	0.1182	14.1021	1.111	1.0152	2.2763	0.03
Event-based	N	a	sa	b	sb	RMSSE	t-value	
OLSR	869	7.5606	0.0509	8.8169	0.5436	1.0079		
RMA	869	7.7075	0.0508	10.0619	0.544	1.0031	2.0376	0.04
MA	869	7.8524	0.0518	11.2895	0.5538	1.0078	4.0184	<0.01
PWLSR	869	7.8576	0.0508	14.2822	0.5326	1	3.9999	<0.01
PWRMA	869	7.9987	0.051	15.5161	0.5349	1.0123	5.8342	<0.01
PWMA	869	8.1379	0.0517	16.7339	0.5419	1.0313	7.5758	<0.01

Table S7: Slopes, intercepts, and standard errors derived from different regressions methods applied to the event-based samples in each catchment. All metrics are as in Table S6.

Ulken Almaty (UA)	N	a	sa	b	sb	RMSSE	t-value	p-value
OLSR	332	7.5437	0.0721	8.3315	0.8212	1.0061		
RMA	332	7.6564	0.0718	9.3836	0.8197	1.0024	1.1042	0.27
MA	332	7.767	0.0731	10.4159	0.833	1.006	2.1758	0.03
PWLSR	332	7.8049	0.0748	12.6969	0.8637	1	2.5067	0.01
PWRMA	332	7.9221	0.075	13.8732	0.8669	1.0144	3.591	<0.01
PWMA	332	8.0374	0.0758	15.0299	0.8762	1.0348	4.6175	<0.01
Chon Kyzyl Suu (CKS)	N	a	sa	b	sb	RMSSE	t-value	
OLSR	149	7.9449	0.1457	14.2324	1.2822	1.0099		
RMA	149	8.139	0.1447	15.6373	1.276	1.0039	0.939	0.35
MA	149	8.332	0.1492	17.0342	1.3126	1.0098	1.8561	0.07
PWLSR	149	8.4272	0.1154	20.8734	1.0011	1	2.2304	0.03
PWRMA	149	8.5426	0.1158	21.7223	1.0045	1.0101	2.7389	0.01
PWMA	149	8.6565	0.117	22.5598	1.0145	1.0231	3.2258	<0.01
Ala Archa (AA)	N	a	sa	b	sb	RMSSE	t-value	
OLSR	115	7.0141	0.1545	6.6244	1.641	1.0109		
RMA	115	7.2037	0.1531	8.2119	1.6308	1.0043	0.8652	0.39
MA	115	7.3912	0.1585	9.7814	1.6837	1.0108	1.704	0.09
PWLSR	115	7.117	0.1559	9.4696	1.8109	1.0028	0.4668	0.47
PWRMA	115	7.3073	0.1569	11.3159	1.8228	1.0074	1.3178	0.19
PWMA	115	7.4956	0.1599	13.1428	1.8576	1.0243	2.1311	0.04
Chirchik (CHK)	N	a	sa	b	sb	RMSSE	t-value	
OLSR	272	7.6396	0.0885	7.4144	0.954	1.0073		
RMA	272	7.7767	0.0881	8.5341	0.9523	1.0029	1.0933	0.28
MA	272	7.9117	0.09	9.6371	0.9706	1.0072	2.1562	0.03
PWLSR	272	7.7797	0.0869	11.3965	0.9194	1.0013	1.0966	0.27
PWRMA	272	7.9097	0.0873	12.4983	0.9232	1.0056	2.0997	0.04
PWMA	272	8.0376	0.0883	13.5835	0.9342	1.0166	3.064	<0.01

Table S8: Slopes, intercepts, and standard errors derived from different regressions methods applied to the event-based precipitation in different seasons. All metrics are as in Table S6.

Event-based DJF	N	a	sa	b	sb	rmSSEav	t-value	p-value
OLSR	168	8.1417	0.1354	14.6149	2.073	1.0092		
RMA	168	8.3266	0.1346	17.1842	2.0626	1.0036	0.9626	0.34
MA	168	8.5104	0.1384	19.738	2.1187	1.0091	1.9036	0.06
PWLSR	168	8.0465	0.1349	15.2372	1.992	1.018	0.4931	0.62
PWRMA	168	8.2321	0.1357	17.7164	2.0034	1.0048	0.4685	0.64
PWMA	168	8.4165	0.1379	20.1798	2.0367	1.0031	1.4176	0.16
Event-based MAM	N	a	sa	b	sb	rmSSEav	t-value	
OLSR	273	7.7301	0.0867	10.7352	0.8727	1.0069		
RMA	273	7.8607	0.0863	11.855	0.8705	1.0027	1.0629	0.29
MA	273	7.9892	0.0881	12.9578	0.887	1.0068	2.0968	0.04
PWLSR	273	8.0178	0.0826	14.5088	0.8818	1	2.3071	0.02
PWRMA	273	8.1324	0.0829	15.5757	0.8849	1.0127	3.1927	<0.01
PWMA	273	8.2451	0.0838	16.6258	0.894	1.0304	4.0353	<0.01
Event-based JJA	N	a	sa	b	sb	rmSSEav	t-value	
OLSR	290	6.2077	0.1185	2.8686	0.6886	1.0205		
RMA	290	6.5255	0.1181	4.1605	0.6906	1.0079	1.8841	0.06
MA	290	6.8446	0.1243	5.4575	0.7223	1.0202	3.7075	<0.01
PWLSR	290	6.8188	0.135	9.7689	0.843	1	3.3468	<0.01
PWRMA	290	7.1934	0.1368	11.7214	0.8542	1.0444	5.1796	<0.01
PWMA	290	7.5739	0.1422	13.705	0.8876	1.1069	6.8131	<0.01
Event-based SON	N	a	sa	b	sb	rmSSEav	t-value	
OLSR	138	7.7143	0.1222	13.2973	1.5572	1.0069		
RMA	138	7.8448	0.1213	14.7225	1.5476	1.0027	0.7534	0.45
MA	138	7.9732	0.1242	16.1258	1.5826	1.0068	1.4862	0.14
PWLSR	138	8.0415	0.1261	19.119	1.7186	1	1.8438	0.07
PWRMA	138	8.1749	0.1266	20.7757	1.7256	1.0194	2.5579	0.01
PWMA	138	8.3065	0.1281	22.4107	1.7463	1.0453	3.2302	<0.01

Table S9: Slopes, intercepts, and standard errors derived from different regressions methods applied to different types of precipitation. All metrics are as in Table S6.

Rain	N	a	sa	b	sb	rmSSEav	t-value	p-value
OLSR	514	6.6615	0.0889	4.9455	0.5849	1.0179		
RMA	514	6.9574	0.0887	6.4088	0.5865	1.0069	2.341	0.02
MA	514	7.2541	0.0927	7.8765	0.6099	1.0176	4.6148	<0.01
PWLSR	514	7.3314	0.0935	11.6977	0.6652	1	5.0051	<0.01
PWRMA	514	7.6294	0.0944	13.4627	0.6718	1.0365	7.006	<0.01
PWMA	514	7.9292	0.0972	15.2385	0.6914	1.0856	8.8251	<0.01
Mixed	N	a	Sa	b	sb	rmSSEav	t-value	
OLSR	113	7.6191	0.2487	12.7937	2.5384	1.0233		
RMA	113	8.057	0.2465	16.9766	2.5202	1.009	1.2366	0.22
MA	113	8.5065	0.2626	21.2692	2.6801	1.0231	2.4537	0.02
PWLSR	113	7.9792	0.2094	16.1732	2.1009	1.006	1.0192	0.31
PWRMA	113	8.2785	0.2113	18.9864	2.1201	1.0091	1.8458	0.07
PWMA	113	8.5802	0.217	21.8225	2.1775	1.0243	2.645	<0.01
Snow	N	a	Sa	b	sb	rmSSEav	t-value	
OLSR	241	7.995	0.1086	12.7211	1.7801	1.0089		
RMA	241	8.1708	0.1081	15.4332	1.7738	1.0035	1.1415	0.25

MA	241	8.3452	0.1109	18.1239	1.8181	1.0088	2.256	0.02
PWLSR	241	7.9762	0.1174	14.1555	1.9575	1.0085	0.1214	0.90
PWRMA	241	8.1817	0.1181	17.4222	1.9699	1.0036	1.2004	0.23
PWMA	241	8.3862	0.1203	20.6755	2.0065	1.0128	2.4886	0.01

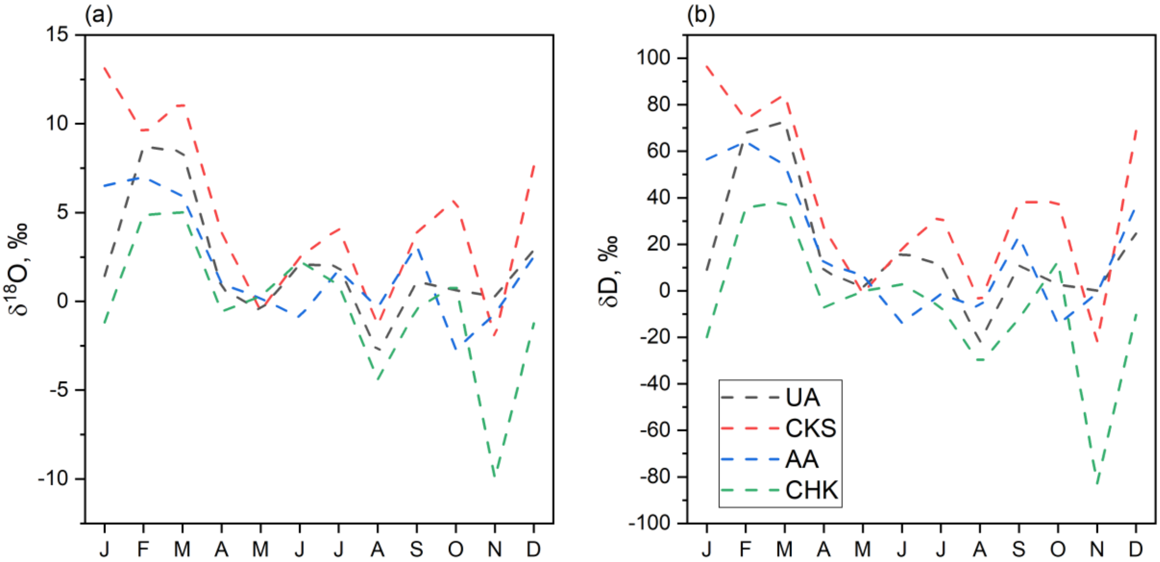

Figure S1: Differences between data obtained in this study and the data from the Waterisotopes Database for (a) $\delta^{18}O$; (b) δD.

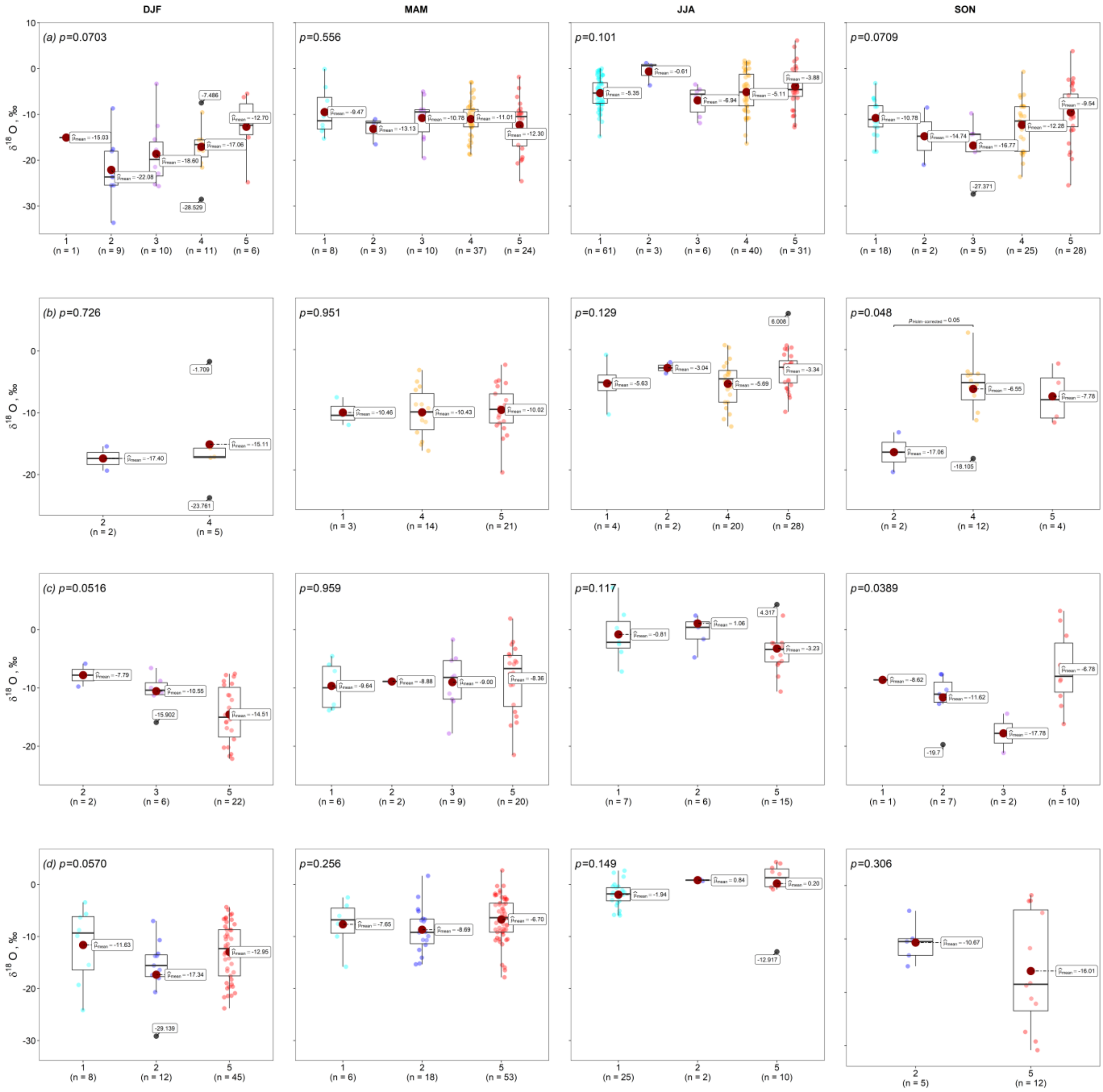

Figure S2: Values of $\delta^{18}O$ for each original cluster for each site and season: (a) UA1; (b) CKS2; (c) AA1; (d) CHK1.

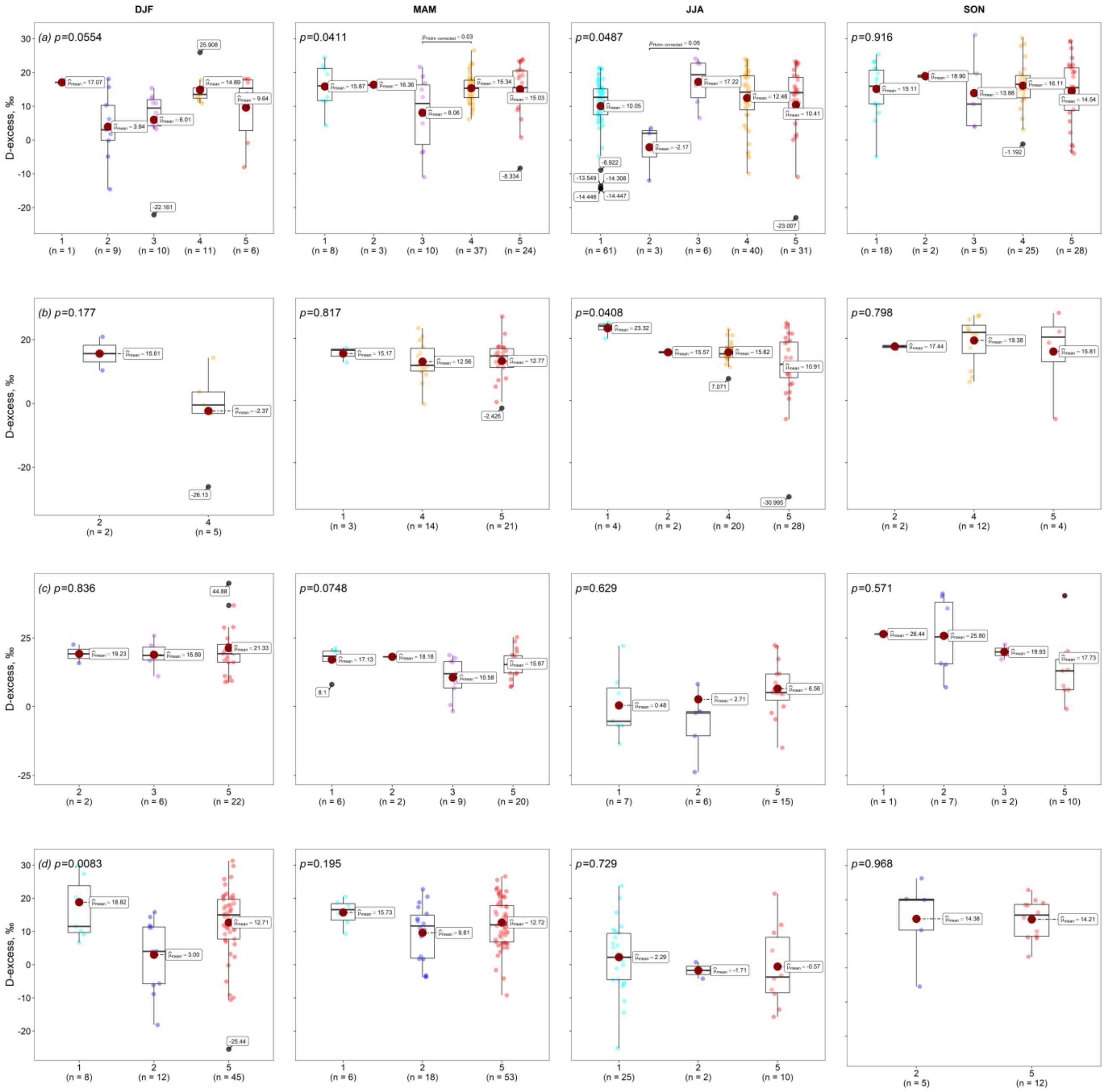

Figure S3: Values of *d-excess* for each original cluster for each site and season: (a) UA1; (b) CKS2; (c) AA1; (d) CHK1.