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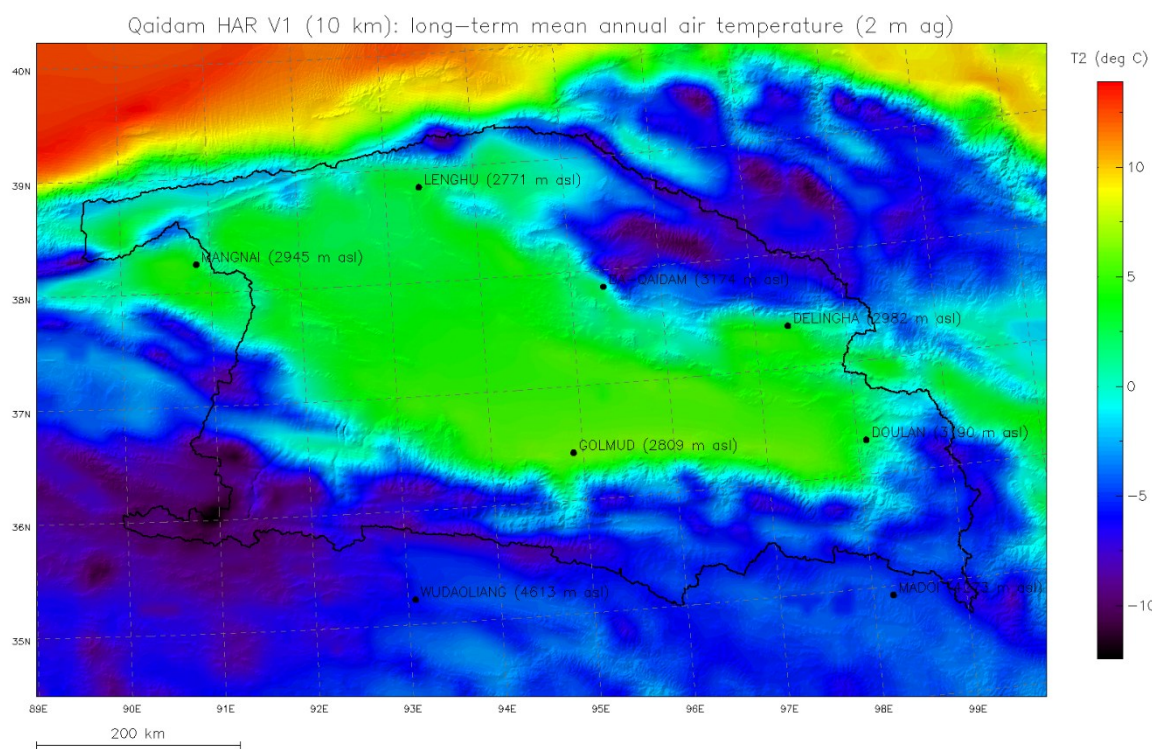
Survival of the Qaidam Mega-Lake System under Mid-Pliocene Climates and its Restoration under Future Climates

Dieter Scherer¹

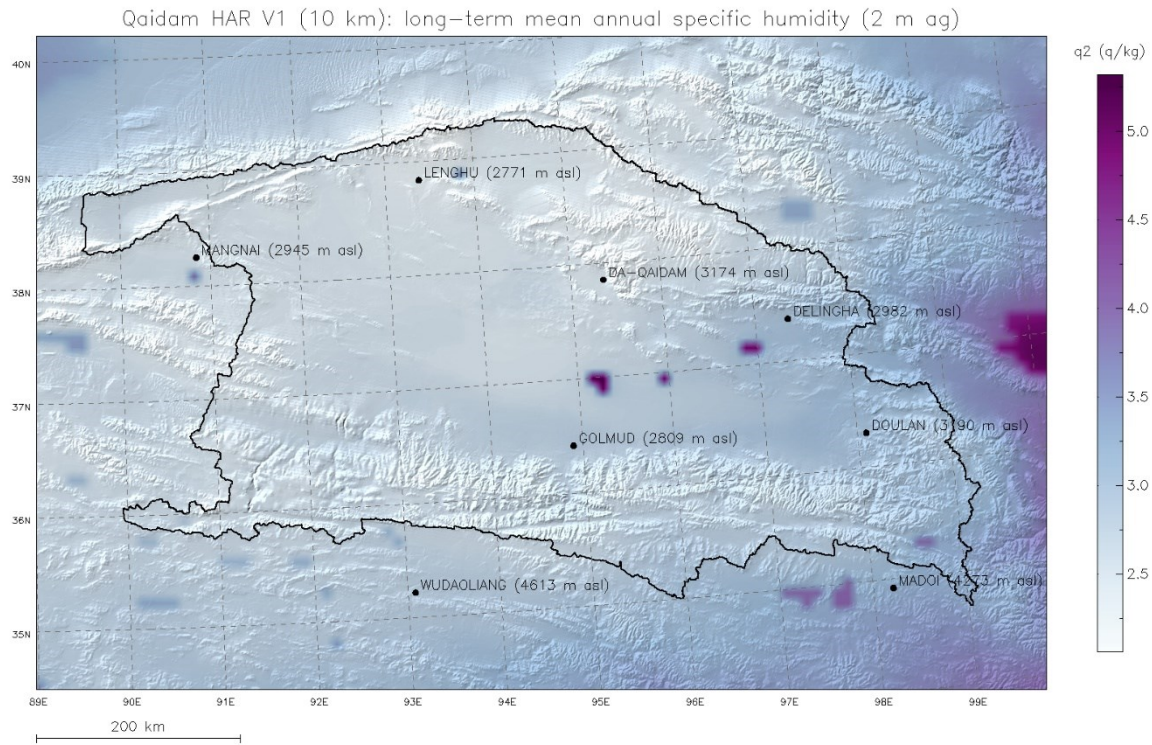
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1 Supplementary Figures



10 **Figure S1: Mean annual air temperature (2 m above ground) derived from the HAR V1 (10 km) data set for the study period of 14 hydrological years (2001-2014) for the Qaidam basin and its surrounding regions. Black line: boundary of the Qaidam basin (Lehner and Grill, 2013). Topographic shading is based on DEM data from the SRTM.**



15 **Figure S2: Mean annual specific humidity (2 m above ground) derived from the HAR V1 (10 km) data set for the study period of 14 hydrological years (2001-2014) for the Qaidam basin and its surrounding regions. Black line: boundary of the Qaidam basin (Lehner and Grill, 2013). Topographic shading is based on DEM data from the SRTM.**

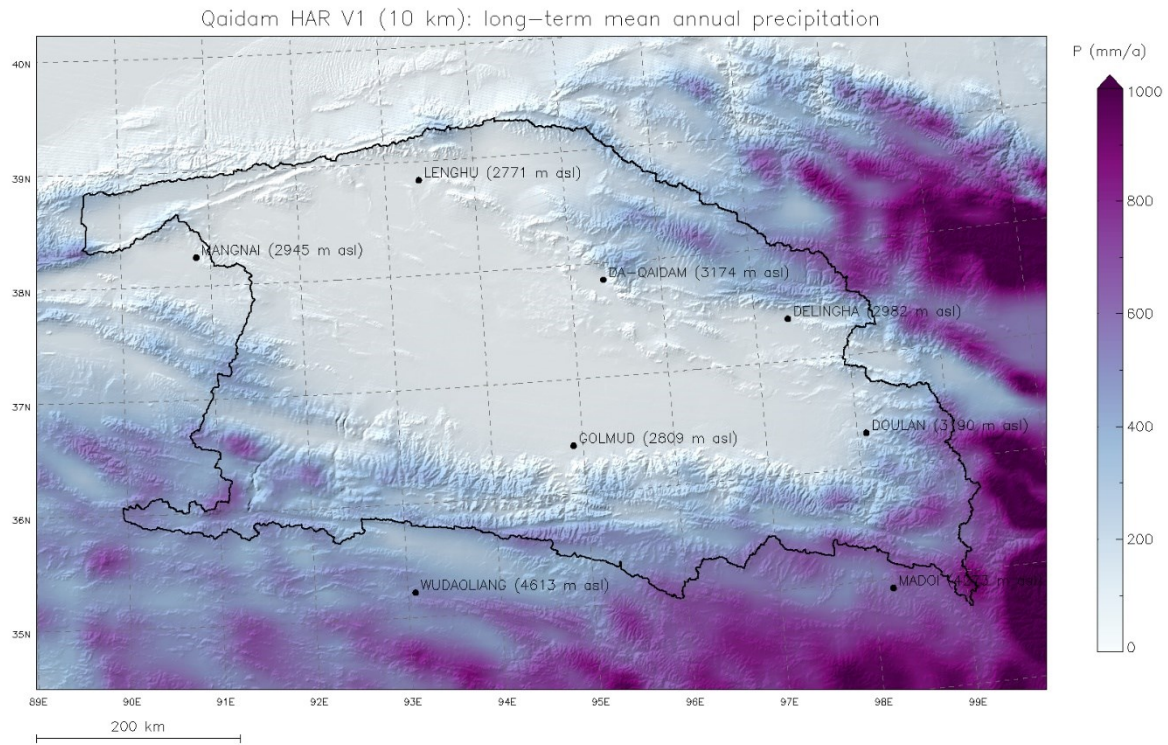
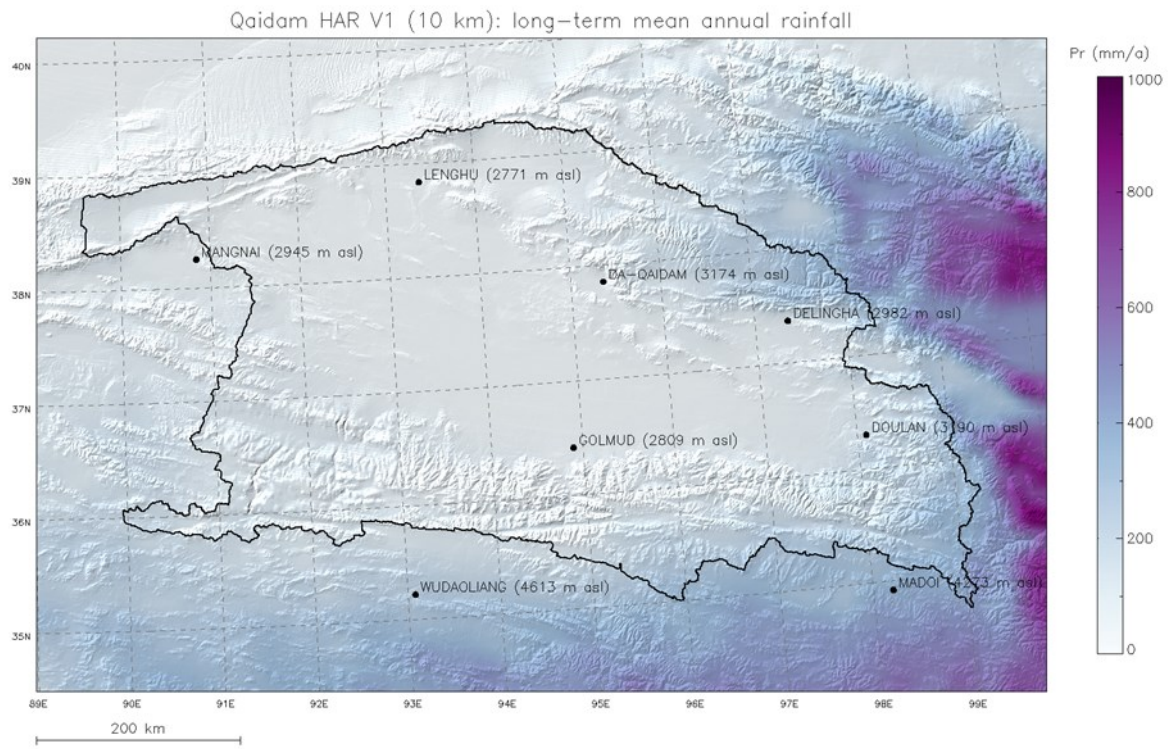
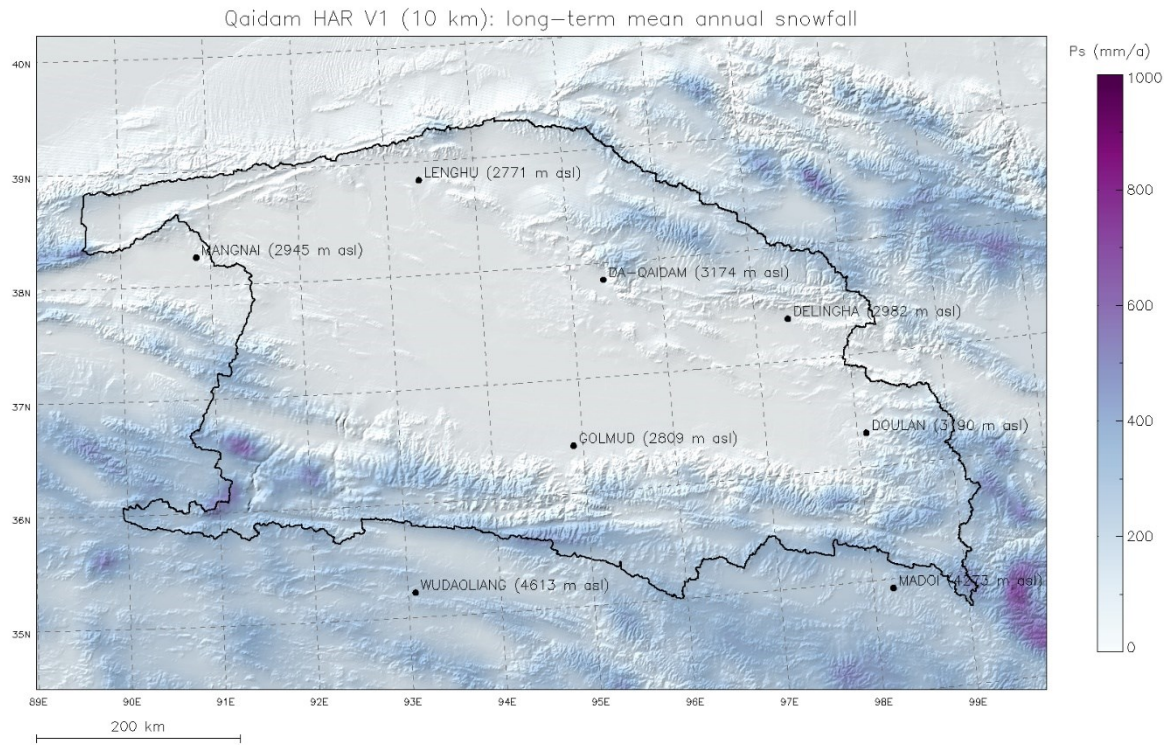


Figure S3: Mean annual precipitation derived from the HAR V1 (10 km) data set for the study period of 14 hydrological years (2001-2014) for the Qaidam basin and its surrounding regions. Black line: boundary of the Qaidam basin (Lehner and Grill, 2013). Topographic shading is based on DEM data from the SRTM.

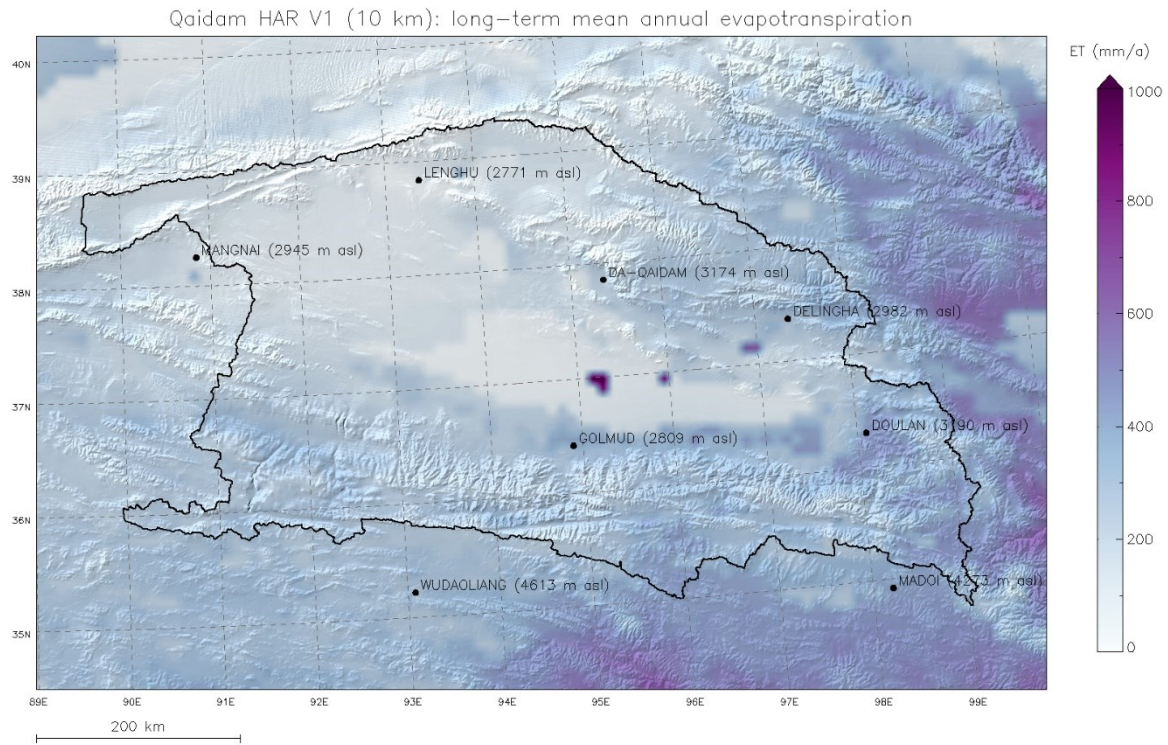


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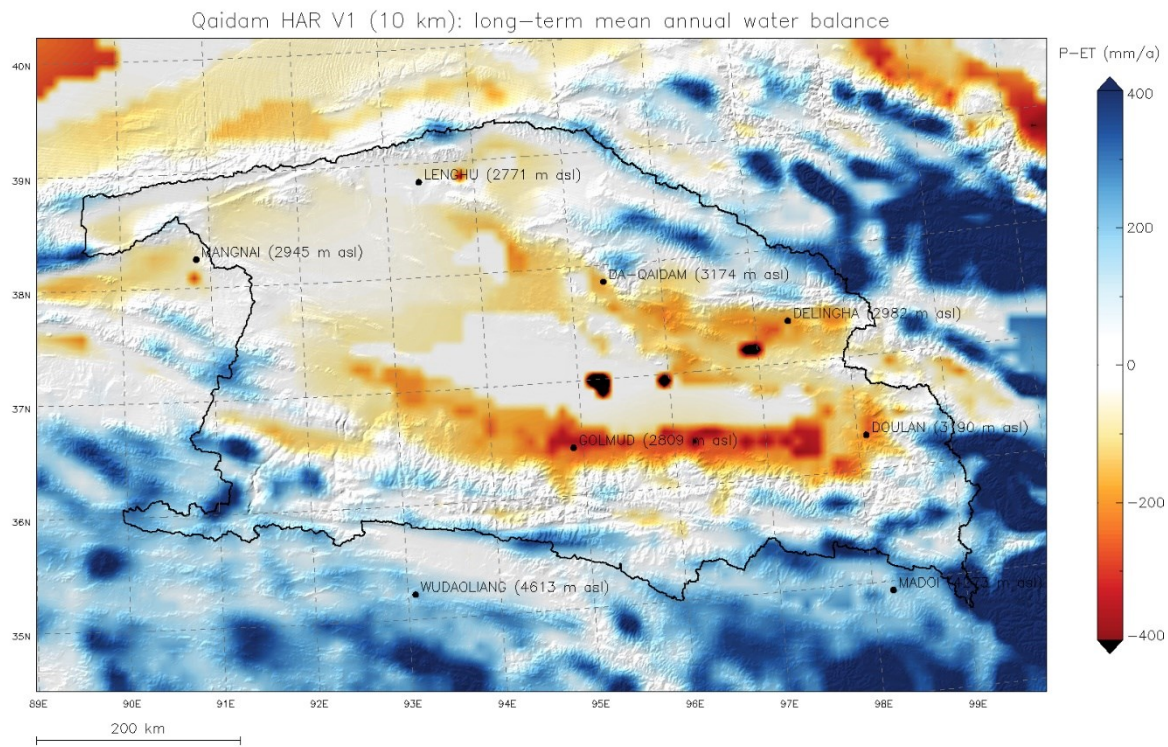
Figure S4: Mean annual rainfall derived from the HAR V1 (10 km) data set for the study period of 14 hydrological years (2001-2014) for the Qaidam basin and its surrounding regions. Black line: boundary of the Qaidam basin (Lehner and Grill, 2013). Topographic shading is based on DEM data from the SRTM.



25 **Figure S5: Mean annual snowfall derived from the HAR V1 (10 km) data set for the study period of 14 hydrological years (2001-2014) for the Qaidam basin and its surrounding regions. Black line: boundary of the Qaidam basin (Lehner and Grill, 2013). Topographic shading is based on DEM data from the SRTM.**



30 **Figure S6: Mean annual actual evapotranspiration derived from the HAR V1 (10 km) data set for the study period of 14 hydrological years (2001-2014) for the Qaidam basin and its surrounding regions. Black line: boundary of the Qaidam basin (Lehner and Grill, 2013). Topographic shading is based on DEM data from the SRTM.**



35 **Figure S7: Mean annual water balance, i.e., precipitation P minus actual evapotranspiration ET , derived from the HAR V1 (10 km) data set for the study period of 14 hydrological years (2001-2014) for the Qaidam basin and its surrounding regions. Black line: boundary of the Qaidam basin (Lehner and Grill, 2013). Topographic shading is based on DEM data from the SRTM.**

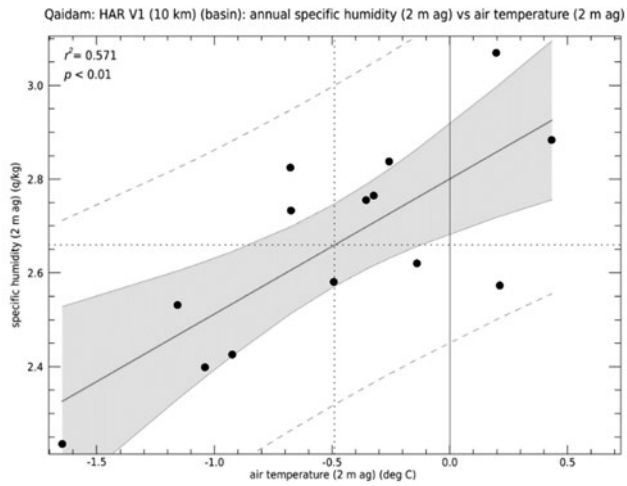


Figure S8: Specific humidity q versus air temperature T in the Qaidam basin during the hydrological years 2001 to 2014. Dotted lines: annual means; solid lines: regression lines; light grey shades: confidence interval; dashed lines: prediction interval.

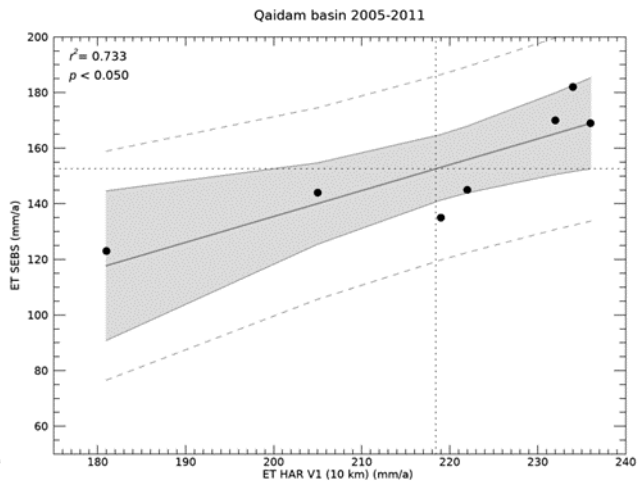
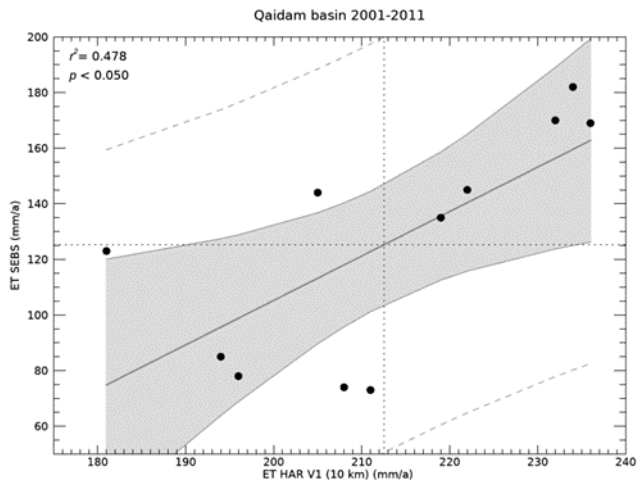
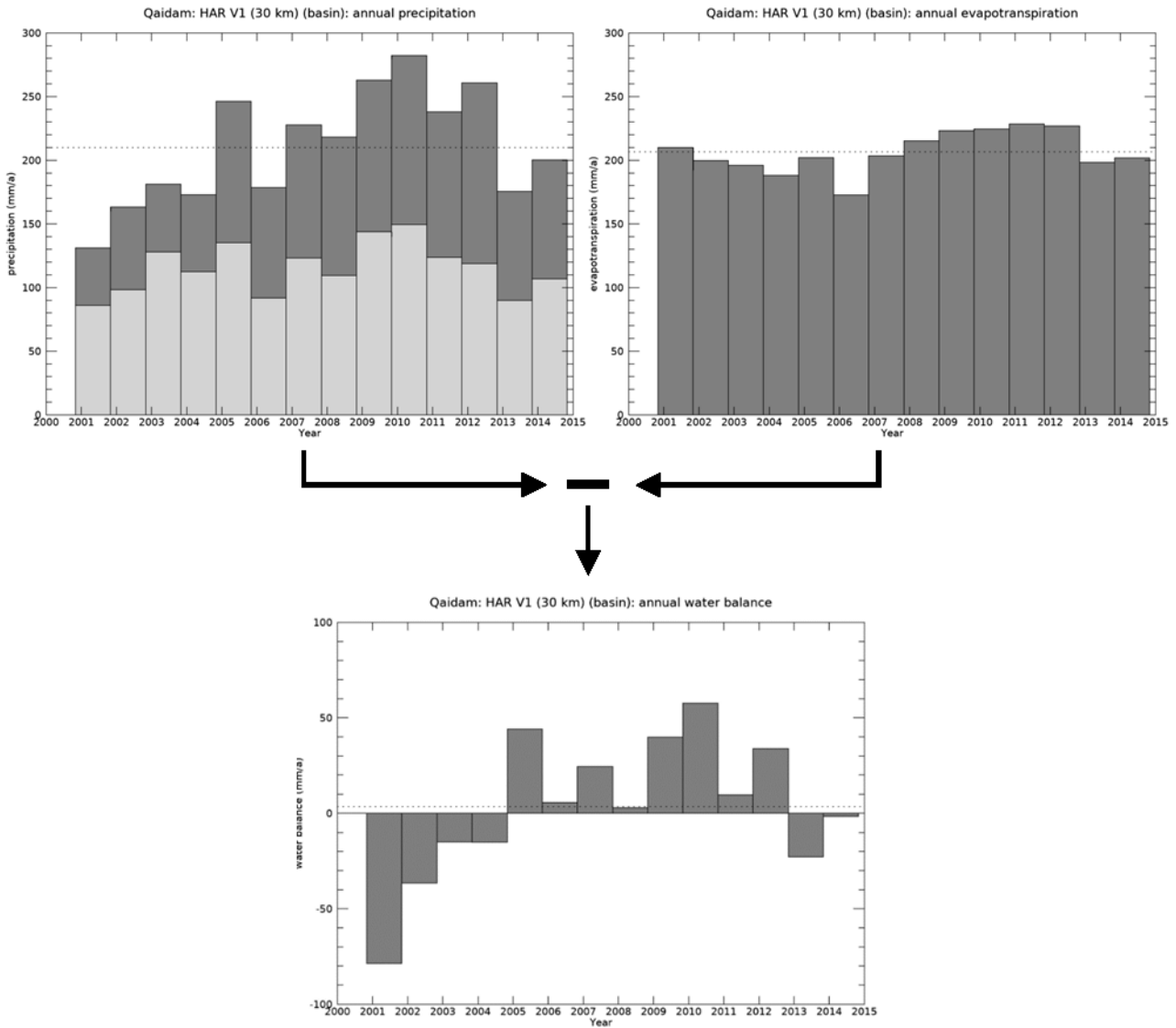
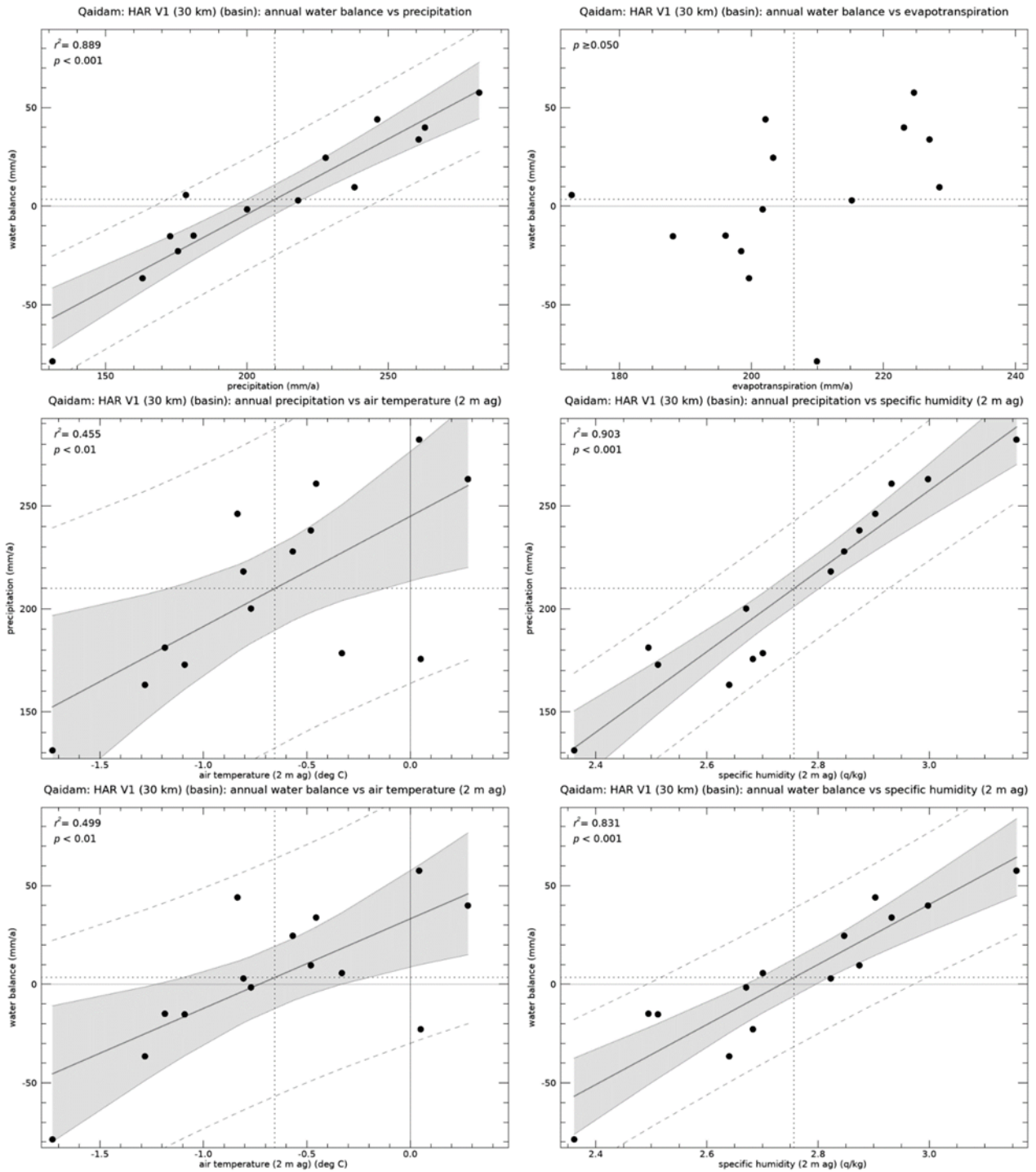


Figure S9: Annual actual evapotranspiration ET determined by the SEBS-based study of Jin et al. (2013) versus ET of the HAR V1 (10 km) data set in the Qaidam basin for the calendar years 2001–2011 (left) and 2005–2011 (right). Dotted lines: annual means; solid lines: regression lines; light grey shades: confidence intervals; dashed lines: prediction intervals.

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45 Figure S10: Annual precipitation P (upper left), actual evapotranspiration ET (upper right), and water balance $\Delta S = P - ET$ (lower) in the Qaidam basin as in Fig. 2 but derived from the 30 km model domain of the HAR V1 data set. Upper left: light grey bars: annual snowfall P_{snow} ; dark grey bars: annual rainfall $P_{rain} = P - P_{snow}$. Dotted lines: mean annual values.



50 **Figure S11:** Water balance $\Delta S = P - ET$ versus precipitation P (upper left) and actual evapotranspiration ET (upper right); P versus air temperature T (middle left) and specific humidity q (middle right); ΔS versus T (lower left) and q (lower right) during the hydrological years 2001 to 2014 as in Figure 4 but derived from the 30 km model domain of the HAR V1 data set. Dotted lines: annual means; solid lines: regression lines; light grey shades: confidence intervals; dashed lines: prediction intervals.

2 Supplementary Tables

55 Table S2: Monthly and annual air temperature T in the Qaidam basin for the 14 hydrological years (2001-2014) covered by the HAR V1 (10 km) data set.

T (deg C)	10	11	12	1	2	3	4	5	6	7	8	9	year
2001	-2.0	-10.3	-14.2	-16.1	-11.5	-7.7	-1.8	3.5	9.4	13.3	10.6	6.5	-1.6
2002	-1.5	-8.3	-14.5	-16.7	-10.8	-6.6	1.0	4.1	9.9	12.4	11.6	5.1	-1.2
2003	-3.1	-9.5	-12.3	-13.2	-10.2	-5.9	0.2	3.9	9.2	11.2	10.6	6.1	-1.0
2004	-1.2	-7.4	-12.7	-14.9	-11.6	-4.3	1.4	4.1	8.4	11.2	10.3	5.3	-0.9
2005	-2.0	-10.6	-11.8	-13.1	-10.4	-4.8	-0.5	5.1	9.6	11.6	10.9	7.3	-0.7
2006	-0.9	-8.7	-13.4	-11.5	-8.5	-6.6	-0.7	5.1	9.7	13.0	12.9	7.7	-0.1
2007	0.8	-7.3	-13.7	-16.2	-10.0	-5.8	0.9	7.0	9.4	11.5	12.0	6.6	-0.4
2008	-0.6	-7.2	-11.7	-14.8	-14.9	-5.4	0.1	7.1	10.0	11.7	9.8	7.2	-0.7
2009	0.3	-7.3	-11.0	-12.8	-8.4	-5.0	2.6	5.3	10.2	12.1	10.7	8.0	0.4
2010	-0.6	-8.2	-12.6	-11.5	-8.9	-5.3	-0.8	5.4	9.8	13.9	12.8	7.7	0.2
2011	-0.2	-8.1	-14.3	-16.5	-8.8	-7.7	0.8	6.4	10.7	12.9	12.8	7.7	-0.3
2012	0.9	-5.6	-12.3	-17.9	-11.9	-6.8	0.1	6.4	10.7	12.7	12.6	7.6	-0.3
2013	-1.0	-9.1	-13.7	-15.2	-9.6	-2.5	1.3	6.3	11.5	12.9	13.8	7.4	0.2
2014	0.8	-10.3	-15.2	-14.1	-11.3	-4.4	-0.1	5.0	10.2	13.4	11.6	7.9	-0.5
mean	-0.7	-8.4	-13.1	-14.6	-10.5	-5.6	0.3	5.3	9.9	12.4	11.6	7.0	-0.5

Table S2: Monthly and annual specific humidity q in the Qaidam basin for the 14 hydrological years (2001-2014) covered by the HAR V1 (10 km) data set.

q (g/kg)	10	11	12	1	2	3	4	5	6	7	8	9	year
2001	1.9	1.2	1.0	0.8	0.9	1.0	1.8	2.3	3.1	4.2	4.7	3.8	2.2
2002	1.7	1.3	1.0	0.9	1.1	1.4	2.2	2.7	4.0	5.5	4.4	4.0	2.5
2003	2.0	1.4	1.3	1.1	1.4	1.7	2.4	2.5	3.5	4.0	4.3	3.1	2.4
2004	1.8	1.6	1.1	1.1	1.3	1.7	1.9	2.7	3.3	4.5	5.0	2.9	2.4
2005	2.0	1.4	1.3	1.1	1.2	1.9	1.9	2.8	4.2	6.2	5.7	4.0	2.8
2006	2.0	1.2	0.8	1.1	1.5	1.1	1.7	2.4	4.3	6.4	5.1	3.5	2.6
2007	2.2	1.5	1.0	0.7	1.2	1.7	2.0	2.5	4.4	5.5	5.9	4.3	2.8
2008	2.7	1.3	1.0	1.0	1.1	1.5	1.8	3.0	4.2	6.1	4.6	4.5	2.7
2009	2.6	1.6	1.2	1.1	1.3	1.5	2.0	2.9	4.1	6.1	4.8	5.3	2.9
2010	2.4	1.4	1.1	1.1	1.4	1.7	2.0	3.1	5.6	7.1	5.1	4.7	3.1
2011	2.6	1.3	0.9	0.7	1.3	1.3	2.0	3.2	4.8	5.4	5.6	4.0	2.8
2012	2.3	1.7	0.9	0.8	1.2	1.5	1.7	3.4	5.0	6.5	6.0	3.1	2.8
2013	1.9	1.1	0.9	0.9	1.2	1.2	1.6	3.2	4.5	5.9	5.2	3.3	2.6
2014	2.0	1.2	0.9	0.8	1.1	1.5	2.0	2.1	4.6	5.4	5.0	4.2	2.6
mean	2.2	1.4	1.0	0.9	1.2	1.5	1.9	2.8	4.3	5.6	5.1	3.9	2.7

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Table S3: Monthly and annual precipitation P in the Qaidam basin for the 14 hydrological years (2001-2014) covered by the HAR V1 (10 km) data set.

P (mm)	10	11	12	1	2	3	4	5	6	7	8	9	year
2001	5	4	6	3	3	3	19	16	17	11	20	15	122
2002	2	1	6	3	3	10	16	25	34	25	12	22	160
2003	5	3	6	4	8	17	28	23	19	21	26	10	171
2004	3	5	5	8	10	11	12	29	24	24	24	8	163
2005	6	4	8	3	7	13	9	27	29	55	39	26	229
2006	5	2	1	3	12	4	16	16	37	39	23	12	170
2007	8	3	2	1	5	14	14	20	59	35	28	33	222
2008	7	2	1	6	6	7	13	24	26	60	25	35	212
2009	13	5	6	6	9	14	11	44	20	57	33	38	256
2010	12	5	4	5	7	21	14	39	77	42	18	26	270
2011	11	1	3	3	6	12	14	35	49	29	35	22	221
2012	7	5	1	3	6	10	10	44	46	60	40	14	246
2013	12	4	4	3	7	2	7	30	24	41	18	23	174
2014	5	3	2	1	5	9	19	14	41	31	27	30	188
mean	7	3	4	4	7	11	15	28	36	38	26	23	200

65 **Table S4: Monthly and annual rainfall P_{rain} in the Qaidam basin for the 14 hydrological years (2001-2014) covered by the HAR V1 (10 km) data set.**

P_{rain} (mm)	10	11	12	1	2	3	4	5	6	7	8	9	year
2001	1	0	0	0	0	1	3	3	7	10	13	8	45
2002	0	0	0	0	0	0	4	8	19	19	9	10	70
2003	0	0	0	0	0	1	7	5	8	12	15	3	52
2004	0	0	0	0	0	1	3	7	14	16	18	3	62
2005	0	0	0	0	1	1	2	8	15	42	28	12	110
2006	0	0	0	0	0	0	5	5	19	36	16	6	87
2007	2	1	0	0	0	1	5	5	31	26	24	16	110
2008	1	0	0	0	0	1	3	10	16	46	15	19	112
2009	3	0	0	0	0	1	3	13	11	44	23	27	126
2010	1	0	0	0	1	1	2	14	54	36	14	17	141
2011	1	0	0	0	1	1	3	10	33	22	30	12	113
2012	2	1	0	0	0	0	2	17	28	51	35	5	142
2013	2	0	0	0	0	1	2	11	18	33	16	9	93
2014	1	0	0	0	0	1	4	4	24	26	20	14	95
mean	1	0	0	0	1	1	4	9	21	30	19	12	97

Table S5: Monthly and annual snowfall P_{snow} in the Qaidam basin for the 14 hydrological years (2001-2014) covered by the HAR V1 (10 km) data set.

P_{snow} (mm)	10	11	12	1	2	3	4	5	6	7	8	9	year
2001	4	4	6	3	3	2	16	13	10	1	7	7	77
2002	2	1	6	3	3	10	12	17	15	6	3	12	90
2003	5	3	6	4	8	16	21	18	11	9	11	7	119
2004	3	5	5	8	10	10	9	22	10	8	6	5	101
2005	6	4	8	3	6	12	7	19	14	13	11	14	119
2006	5	2	1	3	12	4	11	11	18	3	7	6	83
2007	6	2	2	1	5	13	9	15	28	9	4	17	112
2008	6	2	1	6	6	6	10	14	10	14	10	16	100
2009	10	5	6	6	9	13	8	31	9	13	10	11	130
2010	11	5	4	5	6	20	12	25	23	6	4	9	129
2011	10	1	3	3	5	11	11	25	16	7	5	10	108
2012	5	4	1	3	6	10	8	27	18	9	5	9	104
2013	10	4	4	3	7	1	5	19	6	8	2	14	81
2014	4	3	2	1	5	8	15	10	17	5	7	16	93
mean	6	3	4	4	6	10	11	19	15	8	7	11	103

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Table S6: Monthly and annual actual evapotranspiration ET in the Qaidam basin for the 14 hydrological years (2001-2014) covered by the HAR V1 (10 km) data set.

ET (mm)	10	11	12	1	2	3	4	5	6	7	8	9	year
2001	13	7	5	5	8	16	22	30	28	32	31	20	216
2002	10	5	4	4	8	14	18	26	33	34	27	20	204
2003	12	7	5	5	9	17	21	26	25	28	27	18	200
2004	10	6	4	5	8	14	17	25	25	30	32	17	193
2005	10	6	5	6	8	14	20	23	27	34	31	21	208
2006	11	6	4	6	7	10	13	19	27	34	25	17	179
2007	11	7	5	4	8	16	15	20	31	38	32	24	210
2008	17	8	6	5	7	13	18	22	30	35	37	23	222
2009	17	9	6	6	9	16	18	27	29	37	32	26	233
2010	16	10	6	7	9	17	20	23	36	39	30	20	234
2011	18	10	7	6	11	16	18	28	33	34	34	23	238
2012	16	10	5	4	9	17	20	32	32	34	36	21	238
2013	13	8	5	5	9	11	12	29	29	35	30	22	209
2014	14	8	4	6	8	13	24	21	24	34	31	23	212
mean	13	8	5	5	9	15	18	25	29	34	31	21	214

75 Table S7: Monthly and annual water balance $\Delta S = P - ET$ (precipitation P minus actual evapotranspiration ET) in the Qaidam basin for the 14 hydrological years (2001-2014) covered by the HAR V1 (10 km) data set.

<i>P-ET</i> (mm)	10	11	12	1	2	3	4	5	6	7	8	9	year
2001	-8	-3	1	-2	-5	-13	-3	-13	-11	-21	-11	-5	-94
2002	-8	-4	2	-1	-4	-4	-2	-2	2	-9	-15	1	-44
2003	-6	-4	1	-1	-1	0	7	-2	-6	-7	-1	-8	-29
2004	-7	-1	1	3	2	-3	-5	3	-1	-6	-8	-9	-30
2005	-4	-2	3	-3	-2	-1	-11	4	2	21	8	5	21
2006	-6	-4	-2	-2	5	-6	3	-3	10	5	-3	-5	-10
2007	-3	-4	-3	-4	-3	-2	-2	0	29	-2	-4	10	11
2008	-10	-7	-4	1	-1	-7	-5	2	-5	25	-12	12	-10
2009	-5	-4	-1	0	0	-1	-7	17	-9	20	1	12	24
2010	-4	-5	-3	-2	-2	4	-6	16	42	3	-13	6	36
2011	-7	-9	-3	-3	-5	-4	-4	6	16	-5	1	-1	-17
2012	-9	-5	-4	-1	-3	-7	-10	12	14	26	3	-7	8
2013	-1	-4	-2	-2	-2	-9	-5	1	-5	6	-12	1	-35
2014	-9	-6	-3	-4	-3	-4	-5	-6	17	-3	-4	7	-24
mean	-6	-4	-1	-2	-2	-4	-4	2	7	4	-5	1	-14

80 Table S8: Annual actual evapotranspiration ET in the Qaidam basin for the calendar years 2001 to 2011 covered by both the HAR V1 (10 km) data set and the SEBS data as published in Jin et al. (2013).

<i>ET</i> (mm/a)	HAR V1	SEBS	Diff.
2001	211	73	138
2002	208	74	134
2003	196	78	118
2004	194	85	110
2005	205	144	61
2006	181	123	58
2007	219	135	84
2008	222	145	77
2009	232	170	62
2010	236	169	67
2011	234	182	52
2001-2011	213	125	87
2001-2004	202	77	125
2005-2011	218	153	66

Table S9: Mean monthly and annual air temperature T , specific humidity q , precipitation P , rainfall P_{rain} , snowfall P_{snow} , actual evapotranspiration ET , and water balance $\Delta S = P - ET$ in the Qaidam basin as in Table 1 but derived from the 30 km model domain of the HAR V1 data set; sigma: standard deviations of annual values for each quantity during the 14-years study period.

month	10	11	12	1	2	3	4	5	6	7	8	9	year	sigma
T (deg C)	-0.9	-8.6	-13.2	-14.8	-10.6	-5.9	0.1	5.2	9.8	12.3	11.5	6.7	-0.7	0.6
q (g/kg)	2.3	1.4	1.1	1.0	1.3	1.5	2.0	2.9	4.4	5.8	5.3	4.0	2.8	0.2
P (mm)	8	4	4	4	7	11	15	29	39	39	28	23	210	45
P_{rain} (mm)	1	1	0	0	0	1	4	8	22	29	19	11	95	30
P_{snow} (mm)	7	3	4	4	7	10	11	21	17	10	9	12	115	20
ET (mm)	13	8	5	6	9	14	18	24	28	32	29	20	206	16
$P-ET$ (mm)	-5	-4	-1	-2	-1	-4	-3	5	11	7	-2	3	3	36

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