Multi-scale water balance analysis of a thawing boreal peatland complex near the southern permafrost limit in western Canada

Alexandre Lhosmot[1*], Gabriel Hould Gosselin[1,2*], Manuel Helbig[1,3], Julien Fouché[1,4], Youngryel Ryu[5], Matteo Detto[6], Ryan Connon[7], William Quinton[8], Tim Moore[9] and Oliver Sonnentag[1, 10]

[1]Département de géographie, Université de Montréal, Montréal, QC, Canada
[2]Department of Geography and Environmental Sciences, Northumbria University, Newcastle upon Tyne, UK
[3]Department of Physics & Atmospheric Science, Dalhousie University, Halifax, NS, Canada
[4]LISAH, Université de Montpellier, INRAE, IRD, Institut Agro, AgroParisTech, Montpellier, France
[5]Department of Landscape Architecture and Rural Systems Engineering, Seoul National University, Seoul, South Korea
[6]Department of Ecology and Evolutionary Biology, Princeton University, Princeton, NJ, USA
[7]Environment and Climate Change, Government of the Northwest Territories, Yellowknife, NT, Canada
[8]Cold Regions Research Centre, Wilfrid Laurier University, Waterloo, ON, Canada
[9]Department of Geography, McGill University, Montréal, QC, Canada
[11]Department of Geography and Environmental Studies, Wilfrid Laurier University, Waterloo, ON, Canada

[*]These authors share the co-first authorship.

Correspondence to: Alexandre Lhosmot (alexandrelhosmot@gmail.com) and Oliver Sonnentag (oliver.sonnentag@umontreal.ca)

1. Supplementary figures

Figure S1. One of the two flume box systems installed at the West sub-basin (the western outlet).

Figure S2. One of the two flume box systems installed at the South sub-basin (the southern one).

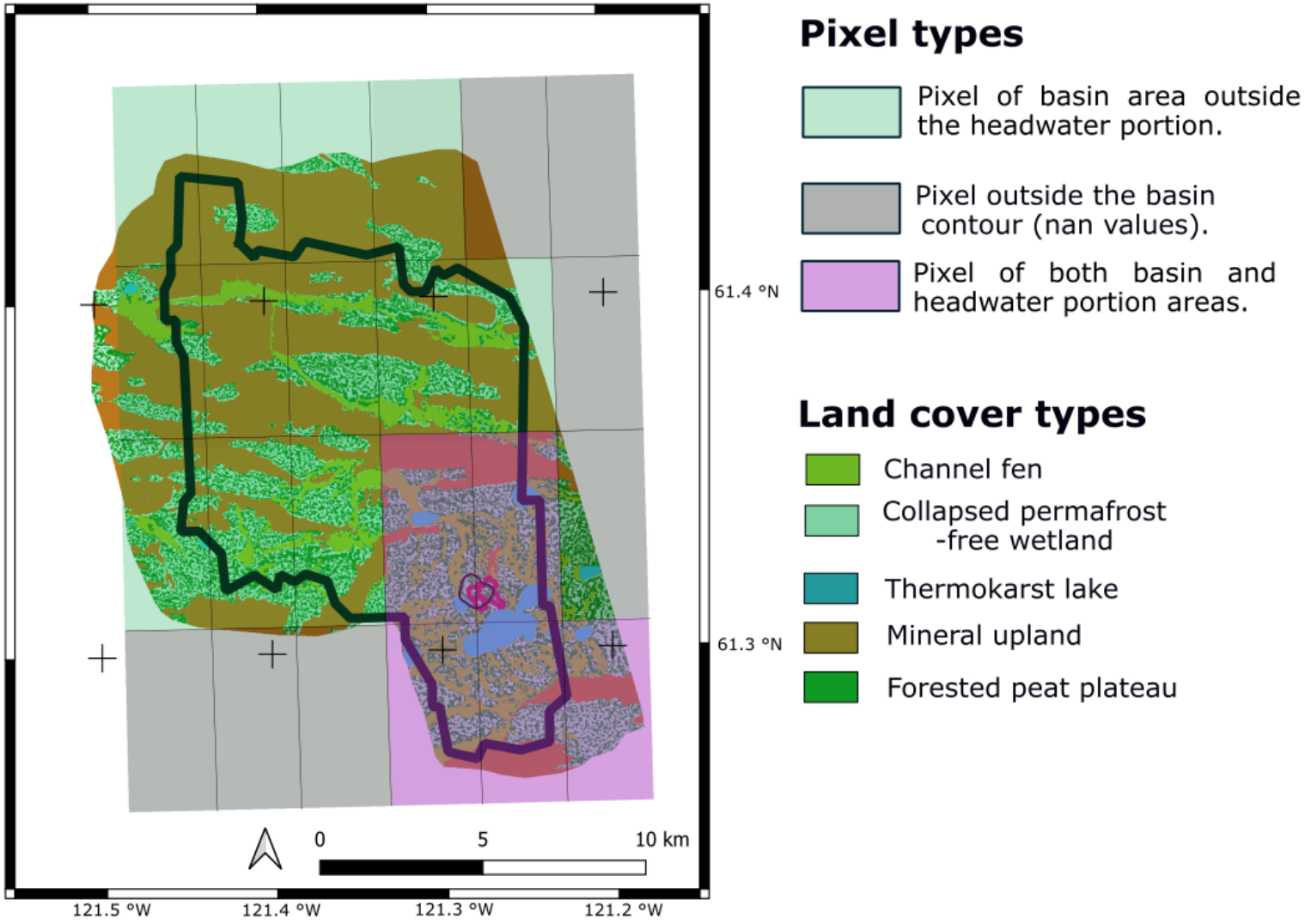

Figure S3: Location and description of the pixels (0.05 degrees of resolution) used for estimating ET with the Breathing Earth System Simulator (BESS) model (Jiang et al., 2016). The landscape map is produced by Chasmer et al. (2014). The black contour corresponds to the basin boundaries derived-from the SRTM DEM (130 km²).

Figure S4: One flume box in August 2024 (post-fire picture).

2. Supplementary Table

Table S1: Annual (hydrological year: October-September) water flux components (mm year^{-1}) over the period 1996-2022: snow water equivalent (SWE), rainfall (R), precipitation (P), evapotranspiration (ET) from the Breathing Earth System Simulator (BESS) at the basin and basin's headwater portion scales (ET_{BESS_BASIN} and ET_{BESS_HEAD}), runoff ($QBASIN_{\_130}$ and $QBASIN_{\_202}$), water storage change calculated from the other water flux components (ΔS_{BASIN_130} and ΔS_{BASIN_202}) and runoff ratio ($Runoff\ ratio_{\_130}$ and $Runoff\ ratio_{\_202}$). The indices "130" and "202" indicate the surface of the basin in square kilometers.

Hydrological year	SWE	R	P	ET_{BESS_BASIN}	ET_{BESS_HEAD}	Q_{BASIN_130}	Q_{BASIN_202}	ΔS_{BASIN_130}	ΔS_{BASIN_202}	$Runoff\ ratio_{\_130}$	$Runoff\ ratio_{\_202}$
1995-10 / 1996-09	107	305	412	–	–	46	30	105	122	0.1	0.1
1996-10 / 1997-09	91	304	395	–	–	103	67	31	68	0.3	0.2
1997-10 / 1998-09	95	306	401	–	–	115	74	24	65	0.3	0.2
1998-10 / 1999-09	126	283	409	–	–	123	79	25	69	0.3	0.2
1999-10 / 2000-09	135	297	431	–	–	163	105	8	66	0.4	0.2
2000-10 / 2001-09	107	324	431	–	–	188	121	-18	49	0.4	0.3
2001-10 / 2002-09	181	233	413	262	256	231	149	-79	3	0.6	0.4
2002-10 / 2003-09	119	285	404	253	249	159	103	-8	48	0.4	0.3
2003-10 / 2004-09	96	151	246	267	257	110	71	-131	-92	0.4	0.3
2004-10 / 2005-09	139	215	354	272	270	160	103	-78	-21	0.5	0.3
2005-10 / 2006-09	128	211	339	268	267	241	155	-170	-84	0.7	0.5
2006-10 / 2007-09	116	234	349	270	269	191	123	-112	-44	0.5	0.4
2007-10 / 2008-09	132	199	331	269	266	155	100	-94	-38	0.5	0.3
2008-10 / 2009-09	140	311	450	286	281	305	196	-140	-32	0.7	0.4
2009-10 / 2010-09	82	301	384	285	282	270	174	-172	-76	0.7	0.5
2010-10 / 2011-09	133	277	410	311	305	227	146	-128	-47	0.6	0.4
2011-10 / 2012-09	81	253	334	280	277	210	135	-156	-81	0.6	0.4
2012-10 / 2013-09	106	153	259	269	263	71	45	-81	-56	0.3	0.2
2013-10 / 2014-09	81	134	215	272	269	26	17	-83	-73	0.1	0.1
2014-10 / 2015-09	118	274	392	254	252	135	87	2	51	0.3	0.2
2015-10 / 2016-09	126	175	301	258	255	108	70	-65	-27	0.4	0.2
2016-10 / 2017-09	84	196	280	233	233	91	58	-43	-11	0.3	0.2

2017-10 / 2018-09	90	179	269	223	222	75	48	-29	-2	0.3	0.2
2018-10 / 2019-09	84	246	330	240	237	63	41	27	50	0.2	0.1
2019-10 / 2020-09	96	321	416	236	230	317	204	-137	-24	0.8	0.5
2020-10 / 2021-09	101	298	399	230	229	151	97	18	72	0.4	0.2
2021-10 / 2022-09	127	111	238	239	242	145	93	-147	-95	0.6	0.4