Supplementary Material: Incorporating observed fire severity in refined emissions estimates for boreal and temperate forest fires in the carbon budget model CBM-CFS3 v1.2

2025-12-29

S1 - Mean pool size by Reconciliation Unit

Table S1: Carbon pool size (Mg C/ha) for canopy fuels by Reconciliation Unit for 2023. RU are sorted in decreasing size of Softwood Merchantable, the largest average surface pool. Columns are in decreasing mean pool size.

Ecozone	Jurisdiction	RU	Softwood Merchantable	Softwood Other	Hardwood Merchantable	Softwood Stem Snag	Hardwood Other	Softwood Foliage	Hardwood Stem Snag	Softwood Branch Snag	Hardwood Branch Snag	Hardwood Foliage
PM	British Columbia	41	75.7	33.9	3.1	10.1	1.2	9.3	0.4	2.3	0.1	0.1
TP	Yukon Territory	44	33.3	13.0	27.5	5.7	12.1	3.5	4.7	0.8	0.7	1.1
PM	Yukon Territory	47	30.3	17.1	4.1	5.8	2.9	4.7	1.3	1.4	0.3	0.2
HP	Ontario	18	29.8	9.4	3.9	4.8	1.6	4.0	1.0	0.7	0.1	0.3
BC	Yukon Territory	46	26.7	15.7	3.9	6.0	2.5	3.9	1.1	1.7	0.3	0.2
MC	Alberta	36	25.8	19.2	3.1	3.4	2.5	3.8	0.4	1.6	0.2	0.2
BC	British Columbia	40	24.5	22.7	2.8	4.9	2.1	4.6	0.4	2.5	0.2	0.2
MC	British Columbia	42	23.7	13.7	2.8	7.2	1.1	3.6	0.5	1.9	0.1	0.1
BC	Northwest Territories	54	21.1	17.0	1.3	8.4	1.0	3.6	0.7	1.4	0.1	0.1
TC	Yukon Territory	45	20.7	12.2	4.4	6.9	4.1	3.4	2.2	1.4	0.4	0.3
BSW	Ontario	16	20.3	7.7	1.2	4.5	0.5	3.2	0.4	0.8	0.1	0.1
BSE	Newfoundland	1	20.1	16.2	2.7	2.3	2.9	9.3	0.4	1.1	0.2	0.8
TC	Northwest Territories	53	18.6	11.1	0.4	3.8	0.2	2.5	0.1	0.9	0.0	0.0
BSE	Labrador	4	17.8	14.8	0.5	6.2	0.5	8.8	0.2	1.3	0.0	0.1
BP	Alberta	34	16.5	15.1	5.2	3.0	4.8	3.4	1.8	1.6	0.6	0.2
TSE	Labrador	3	16.3	13.4	0.1	9.1	0.2	7.1	0.1	1.2	0.0	0.0
BSE	Quebec	15	15.8	6.9	8.8	2.9	4.4	1.9	1.1	0.6	0.3	0.6
AM	Quebec	11	15.7	7.4	11.0	2.1	5.7	1.3	1.2	0.6	0.4	0.6
AM	Prince Edward Island	6	14.4	6.4	12.6	1.4	7.3	2.7	1.3	0.4	0.4	1.3
BSW	Manitoba	22	14.0	4.9	4.2	4.4	1.4	1.8	1.2	0.6	0.2	0.3
BSE	Ontario	19	13.5	4.9	11.7	1.8	4.9	2.0	1.7	0.3	0.3	0.9
TP	Alberta	31	12.3	11.4	2.5	4.0	2.5	1.9	2.9	1.3	0.4	0.1
AM	New Brunswick	7	12.1	7.6	9.6	1.3	7.6	2.2	1.0	0.5	0.5	0.8
TP	British Columbia	38	11.8	14.9	12.4	1.9	6.8	2.0	2.1	1.0	0.5	0.5
BP	Northwest Territories	52	10.8	20.2	2.1	2.5	7.2	1.8	0.5	2.2	0.8	0.4
BP	Saskatchewan	28	9.2	3.3	10.8	2.9	2.7	1.3	2.6	0.3	0.3	0.4
TP	Northwest Territories	50	9.0	6.3	2.9	2.6	3.4	1.1	0.9	0.5	0.3	0.2
BSW	Saskatchewan	27	8.9	2.9	1.8	5.1	0.6	1.1	1.1	0.5	0.1	0.1
AM	Nova Scotia	5	8.8	2.9	17.6	1.1	7.4	1.0	1.9	0.2	0.4	1.2
BP	Manitoba	23	8.1	3.4	12.0	2.2	4.2	1.4	3.3	0.4	0.4	1.5
BP	British Columbia	39	7.3	8.7	19.7	2.1	9.2	1.8	2.9	1.0	0.8	0.7
TSW	Alberta	32	6.5	11.5	2.2	3.0	5.0	2.6	1.5	1.3	0.5	0.2
TSW	Northwest Territories	51	4.6	10.5	0.7	2.1	1.3	1.7	0.4	1.7	0.1	0.1
BSW	Alberta	33	1.1	6.2	1.2	1.0	7.0	1.5	1.4	1.2	1.6	0.3

Table S2: Carbon pool (Mg C/ha) for sub-canopy fuels by Reconciliation Unit for 2023. RU are sorted in decreasing size of Aboveground Slow DOM, the largest average surface pool. Columns are in decreasing mean pool size.

Ecozone	Jurisdiction	RU	Aboveground Slow DOM	Medium DOM	Aboveground Fast DOM	Aboveground Very Fast DOM	Softwood Coarse Roots	Hardwood Coarse Roots	Belowground Fast DOM	Belowground Very Fast DOM	Softwood Fine Roots	Hardwood Fine Roots
PM	British Columbia	41	58.3	19.1	16.1	8.7	24.1	0.8	3.0	1.4	2.3	0.1
PM	Yukon Territory	47	46.1	32.2	22.8	25.5	10.1	3.5	3.6	4.1	1.4	0.5
TP	Yukon Territory	44	46.0	22.3	14.7	15.4	9.9	9.5	3.2	2.5	1.1	1.0
BSE	Newfoundland	1	44.2	5.9	9.3	10.2	8.7	2.7	1.5	1.3	1.4	0.4
TC	Yukon Territory	45	42.0	29.2	19.9	14.7	7.0	3.5	3.5	2.9	1.0	0.6
BSE	Labrador	4	41.5	13.0	11.2	11.4	7.7	0.2	1.6	1.7	1.5	0.0
BP	Manitoba	23	39.5	12.7	5.4	12.0	2.3	5.1	1.4	1.5	0.5	1.0
AM	New Brunswick	7	38.8	7.0	9.8	6.9	4.1	5.4	1.8	1.1	0.7	0.9
BP	Northwest Territories	52	38.5	7.4	20.8	9.9	6.2	3.8	2.2	2.3	1.1	0.7
BP	Alberta	34	37.8	10.4	14.8	6.6	6.7	3.2	2.4	1.6	1.0	0.6
BC	British Columbia	40	37.6	9.6	18.0	9.8	10.0	1.0	2.2	2.1	1.5	0.2
MC	Alberta	36	35.6	12.2	15.7	7.7	9.4	2.6	2.4	1.8	1.4	0.4
AM	Prince Edward Island	6	35.4	6.1	5.8	7.4	4.4	5.0	1.1	1.0	0.8	0.9
BC	Yukon Territory	46	34.8	21.2	16.1	11.8	9.0	2.9	2.8	2.6	1.3	0.4
AM	Quebec	11	33.8	9.0	8.7	7.1	4.6	5.0	1.8	1.3	0.8	0.9
BSE	Quebec	15	32.0	10.7	8.1	8.4	4.6	4.1	1.7	1.5	0.9	0.7
AM	Nova Scotia	5	31.4	6.0	4.9	6.1	2.2	6.3	1.1	0.9	0.6	1.2
TSE	Labrador	3	30.7	15.2	10.3	8.0	6.7	0.1	1.9	1.8	1.5	0.0
BP	British Columbia	39	29.3	10.1	10.9	7.8	3.3	5.9	1.6	1.4	0.7	0.8
MC	British Columbia	42	27.8	12.9	11.5	5.3	7.9	0.8	2.3	1.2	1.2	0.1
BSE	Ontario	19	27.3	8.1	5.7	7.9	3.8	5.0	1.2	1.3	0.7	0.9
HP	Ontario	18	26.3	14.6	6.5	7.8	8.2	2.5	1.4	1.8	1.4	0.5
TP	British Columbia	38	25.7	7.6	10.1	7.8	5.4	3.9	1.4	1.6	1.0	0.5
TP	Alberta	31	24.2	21.9	11.2	5.4	4.8	1.9	2.6	1.7	0.9	0.5
BC	Northwest Territories	54	23.7	31.7	15.8	10.3	7.8	1.6	2.4	2.7	1.5	0.3
TSW	Alberta	32	22.2	19.2	12.7	6.3	3.8	3.0	2.4	1.8	0.8	0.7
BP	Saskatchewan	28	21.4	13.3	5.0	6.0	2.5	4.1	1.5	1.4	0.6	0.8
BSW	Ontario	16	20.0	10.7	6.0	5.2	5.7	0.5	1.3	1.3	1.3	0.1
BSW	Manitoba	22	17.2	14.8	4.7	6.1	3.7	2.3	1.3	1.6	0.9	0.5
TP	Northwest Territories	50	13.9	13.1	6.9	8.1	2.9	2.7	1.5	2.4	0.8	0.7
TC	Northwest Territories	53	11.3	24.1	9.4	10.0	5.7	0.5	1.4	3.0	1.5	0.1
BSW	Alberta	33	11.0	11.5	11.6	5.0	1.6	3.3	2.2	1.4	0.4	1.0
BSW	Saskatchewan	27	10.9	13.0	3.7	4.2	2.2	1.2	1.4	1.2	0.6	0.3
TSW	Northwest Territories	51	10.4	11.9	10.1	5.8	3.0	1.2	1.9	2.1	0.7	0.3

S2 - Annual variability in observed Buildup Index during wildfire spread, and impact on modelled ecozone-level forest floor emissions
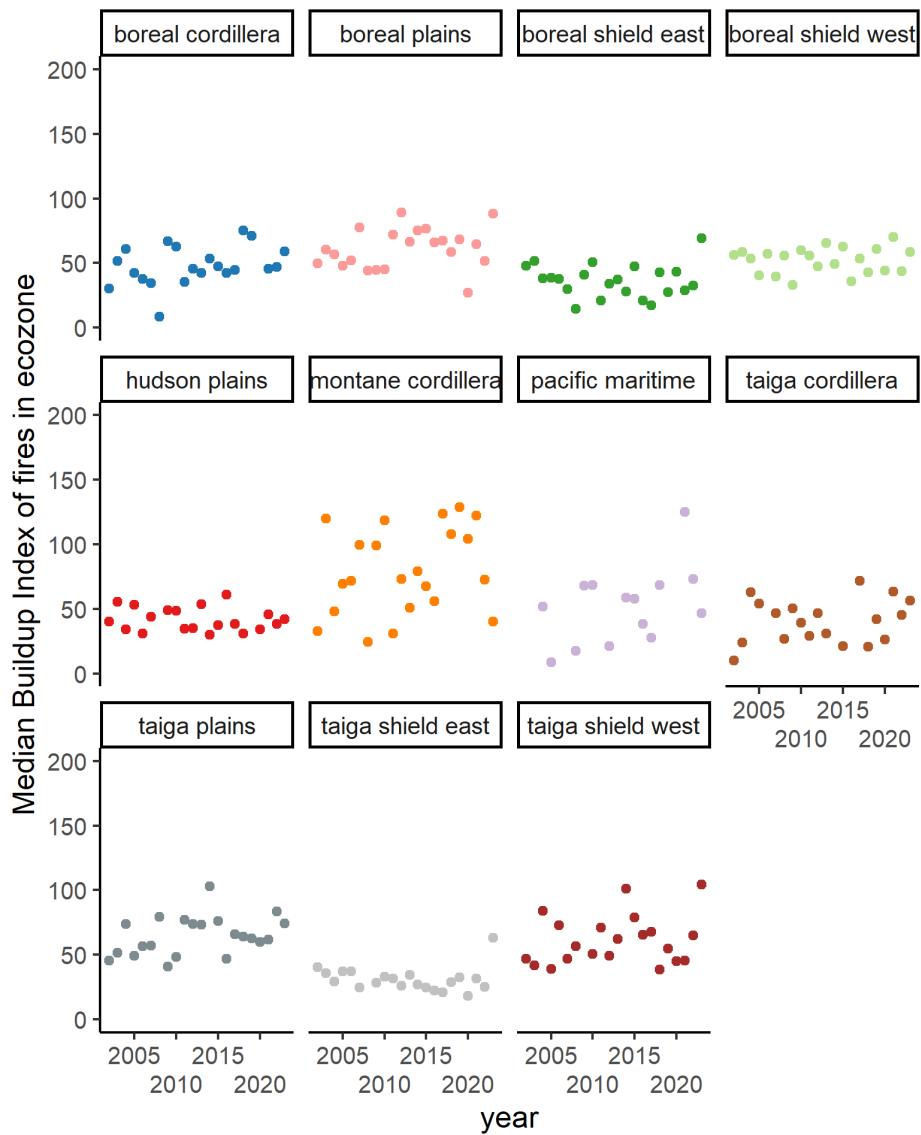
Figure S1: Annual variability in area-weighted median BUI of active fire spread days by ecozone.
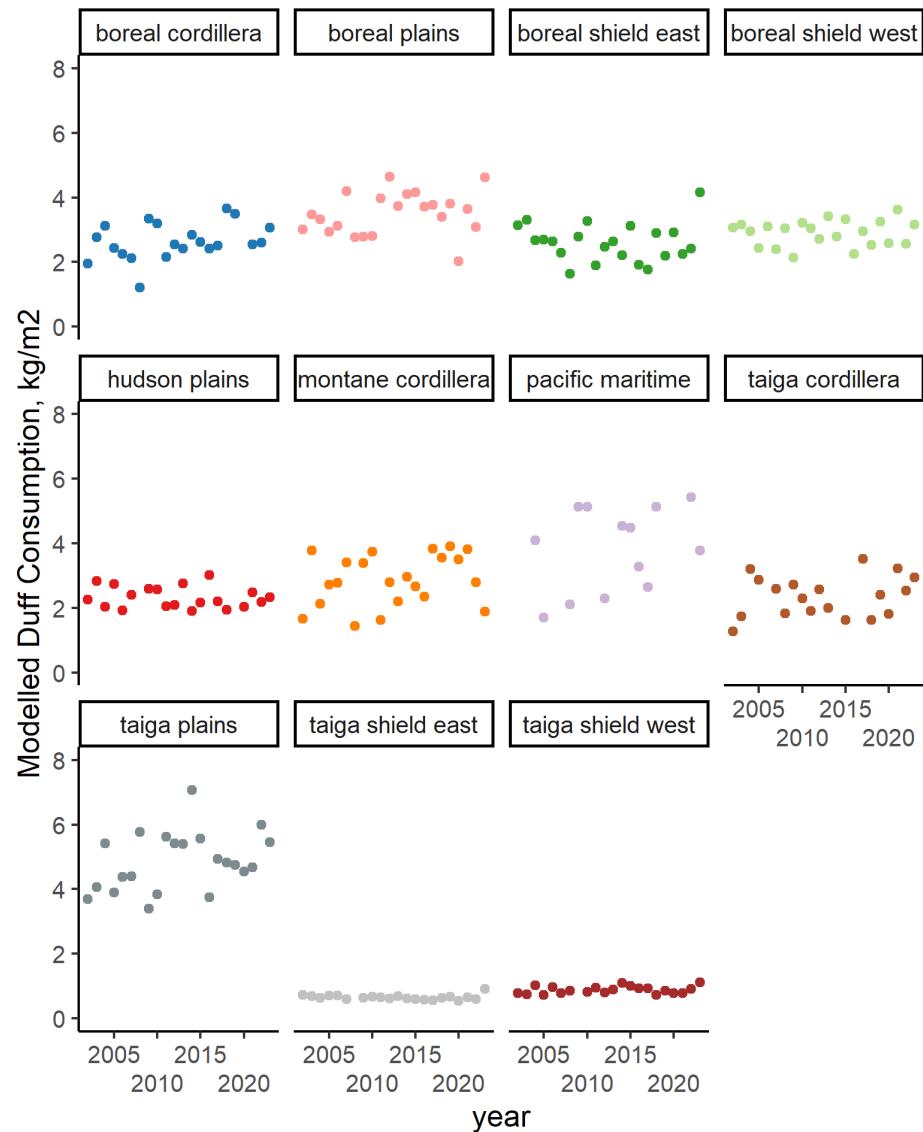
Figure S2: Annual variability in forest floor median consumption values by ecozone.
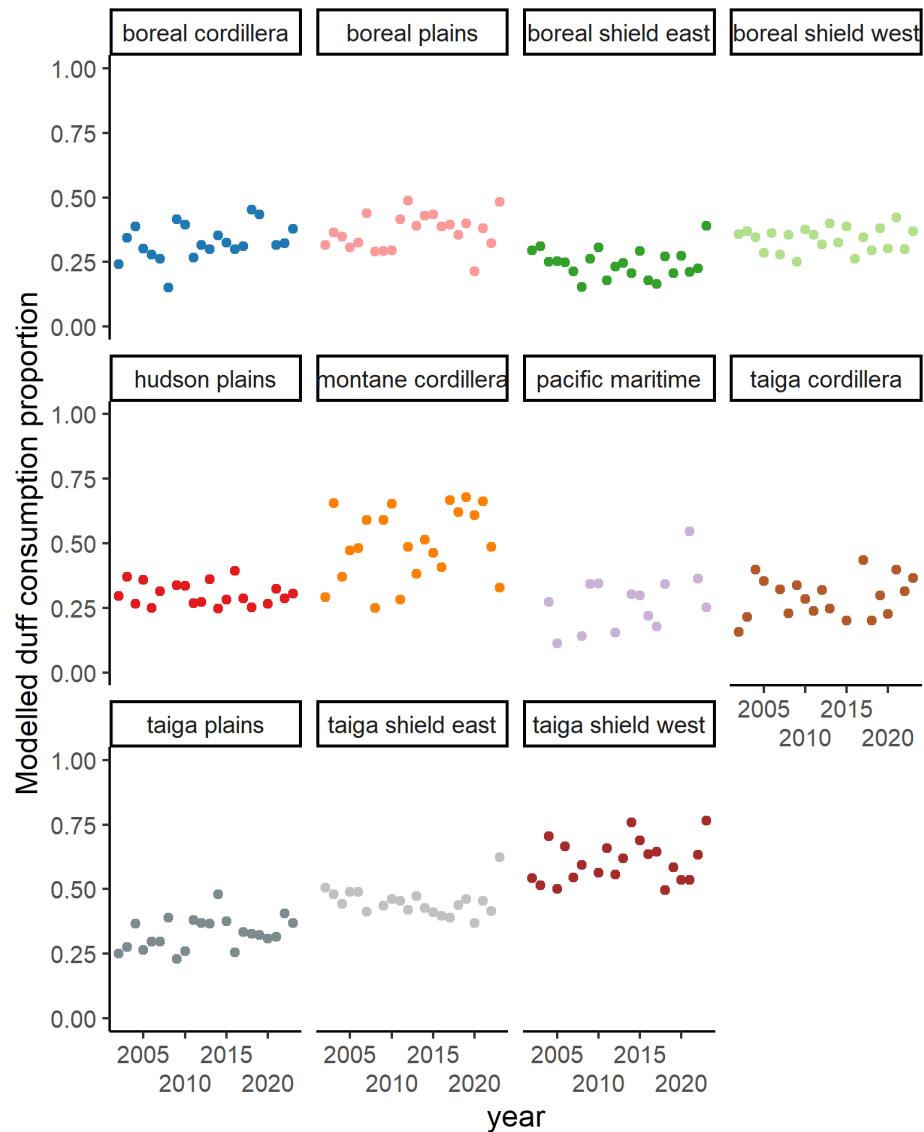
Figure S3: Annual variability in forest floor proportional consumption by ecozone.

S3 - Representative photos

Figure S4: Partial area-wise burning of thin litter and duff layer in a boreal pine-aspen mixedwood stand following surface fire, one year after fire. Note low consumption of woody debris and snags.

Figure S5: Continuous crown fire in a forested boreal peatland dominated by black spruce. 90% of the forest floor experienced approximately 10 cm of burning except small patches of Sphagnum moss that appear as unburned light coloured features. Note low consumption of downed woody debris embedded in unburned peat in bottom right corner

Figure S6: Example of high rates of relative duff consumption in a low pre-fire duff (AGSlow) loading. Note the low rates of woody debris and stump consumption in this jack pine-dominated stand.

Figure S7: Preferrential mortality of understory trees in a low-severity surface fire, one year after the fire. Larger diameter trees in the background remain alive with near-zero Crown Fraction Burned, while smaller diameter trees, many of which are <5 m in height visible in the foreground, were killed by the fire but with no canopy fuel consumption even of smaller trees.

Figure S8: Patchy crown fuel consumption in a high severity fire, one year after the fire. While the majority of canopy fuels were consumed in this photo, local landscape features such as this depression allowed for small patches of trees to be killed by a surface fire, but the canopy remained unconsumed. These red needles remain on the tree for 1-2 years and afterwards are an input into the litter layer.

Figure S9: Example of consumption of broadleaf foliage during high severity fire in mixedwood fuels, taken one week after the fire. Note the lack of foliage in the aspen trees (white coloured stems in background) in a mixedwood with Engelmann spruce and subalpine fir.