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SUPPLEMENTARY INFORMATION

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Lightning as a major driver of recent large fire years in North American boreal forests

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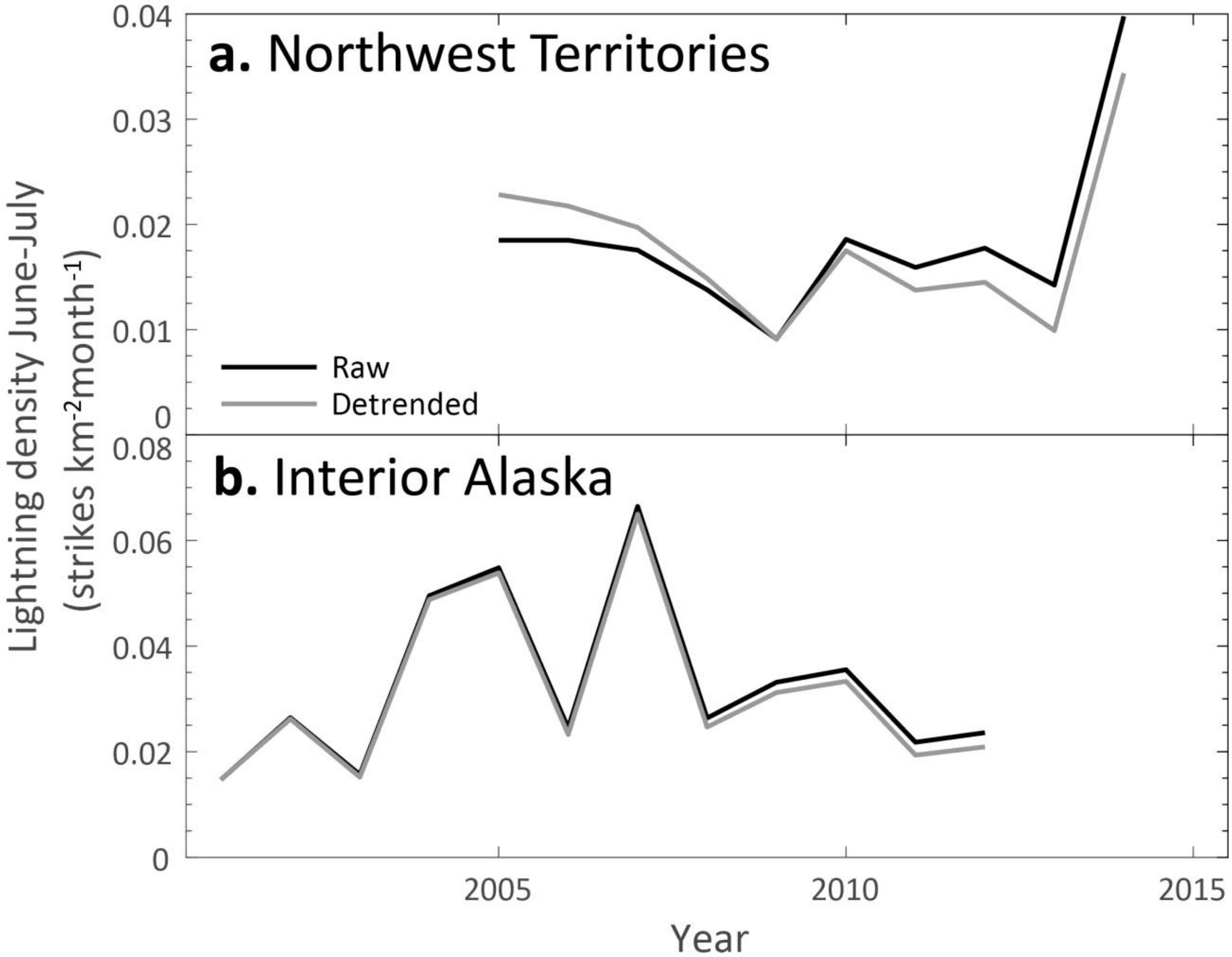
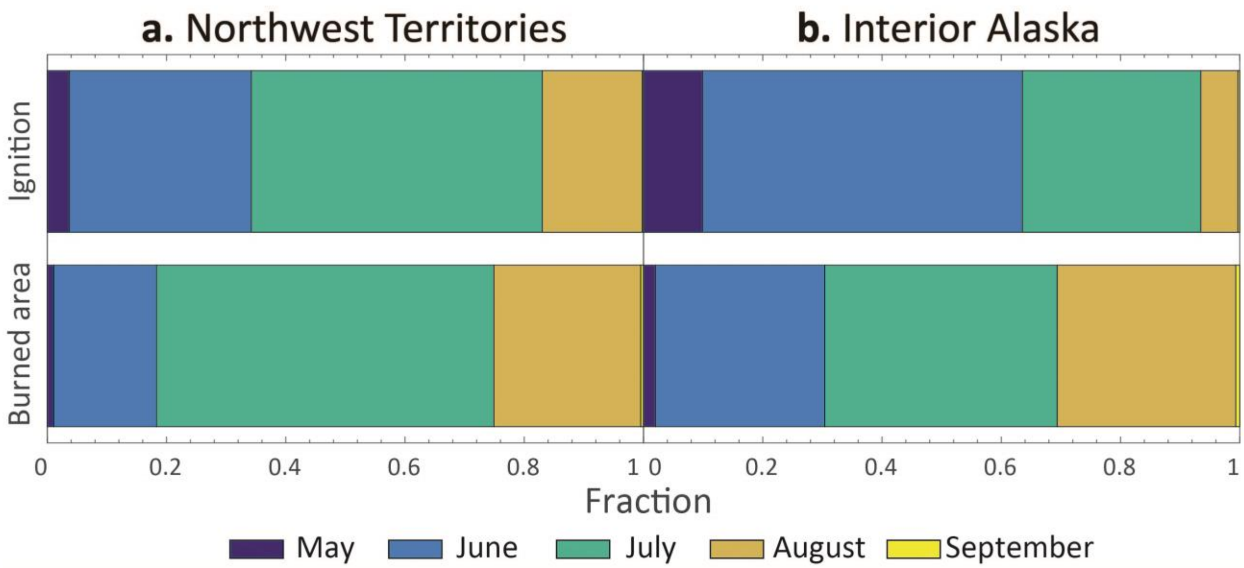
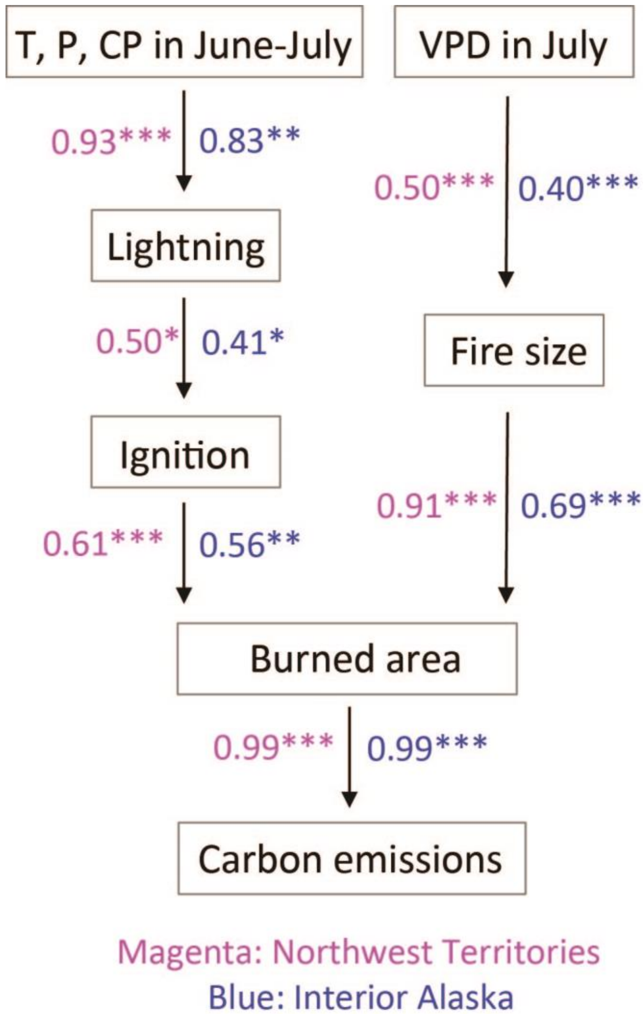
Supplementary figures



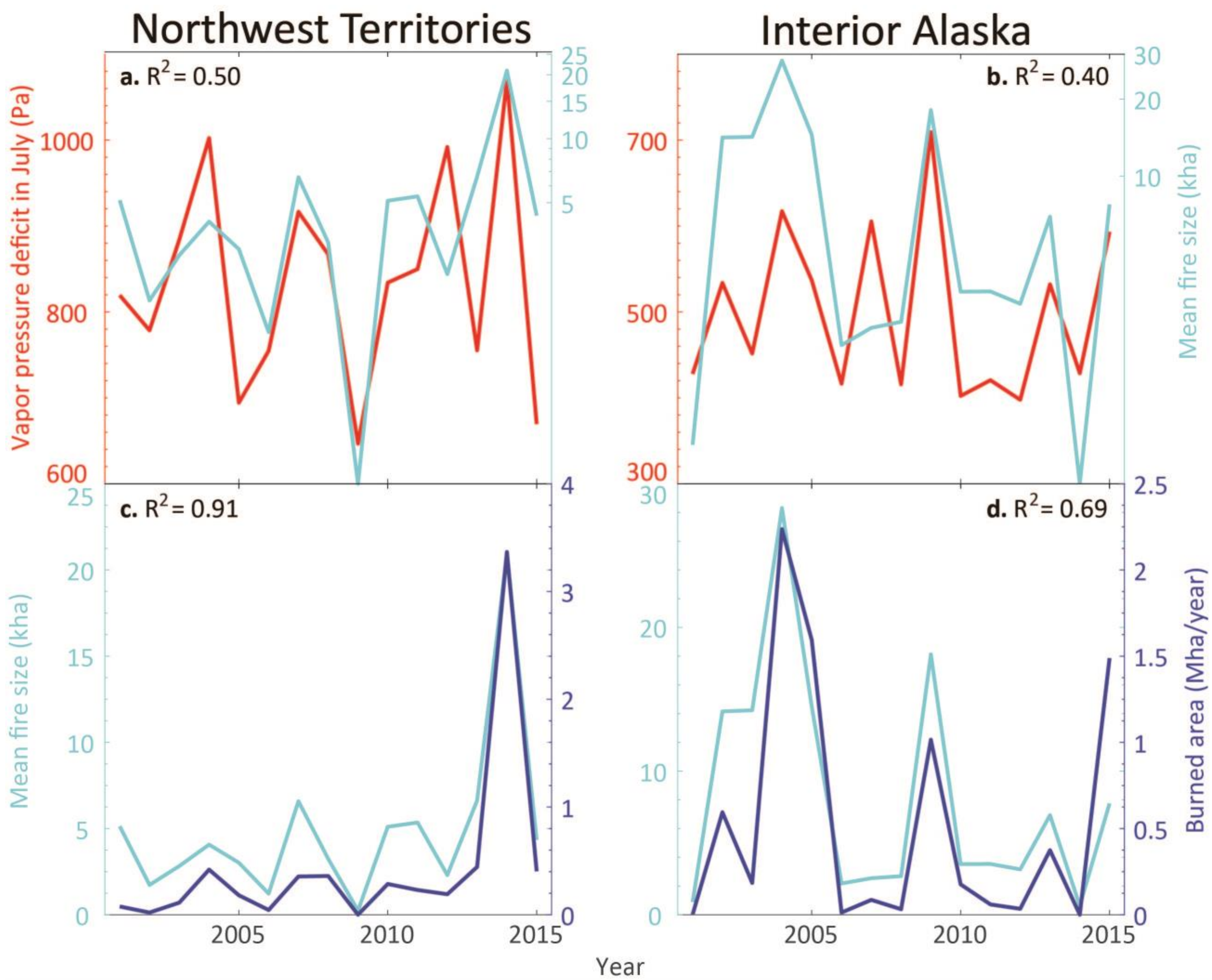
Supplementary Figure 1. Raw (observed) and detrended lightning density for (a) the Northwest Territories and (b) Interior Alaska.



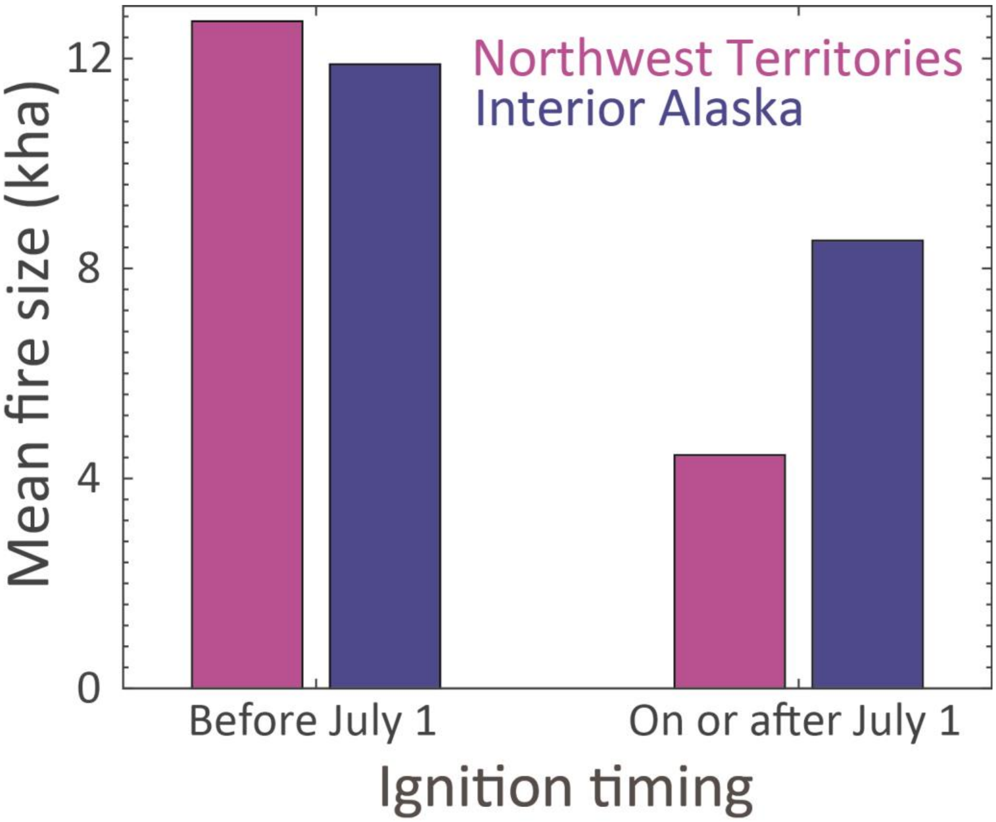
Supplementary Figure 2. **Fraction of ignition and burned area per month in (a) the Northwest Territories and (b) Interior Alaska between 2001 and 2015.** Only ignitions and burned area from lightning ignitions were considered.



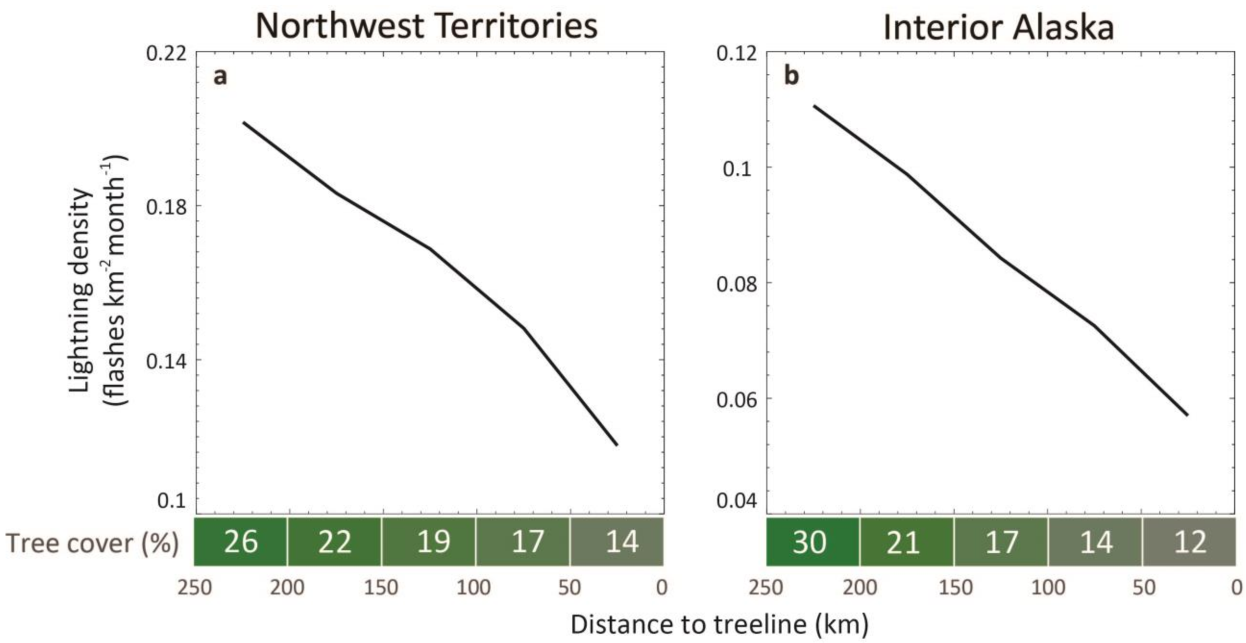
Supplementary Figure 3. **Key statistical relationships found for the cascade from meteorology to carbon emissions for the Northwest Territories and Interior Alaska between 2001 and 2015.** The numbers displayed represent R^2 values (*** denotes significant relationships at a level of $p < 0.001$, ** at a level of $p < 0.01$, and * at a level of $p < 0.05$). (T: temperature, P: precipitation, CP: convective precipitation, VPD: vapor pressure deficit).



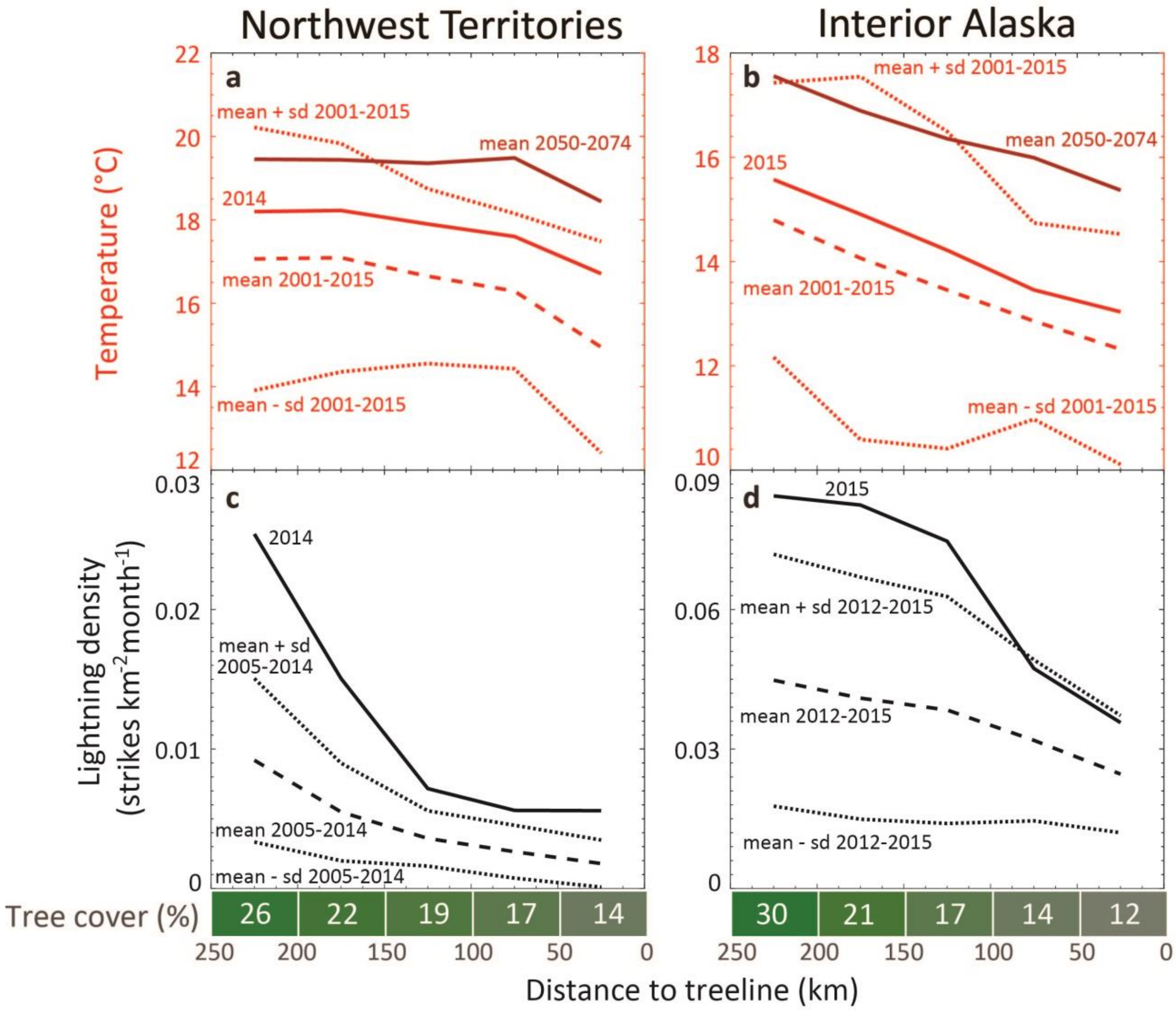
Supplementary Figure 4. Interannual relationships from 2001 to 2015 between (a, b) July vapor pressure deficit and mean fire size, and (c, d) mean fire size and burned area in the Northwest Territories and Interior Alaska. Only lightning fires were considered.



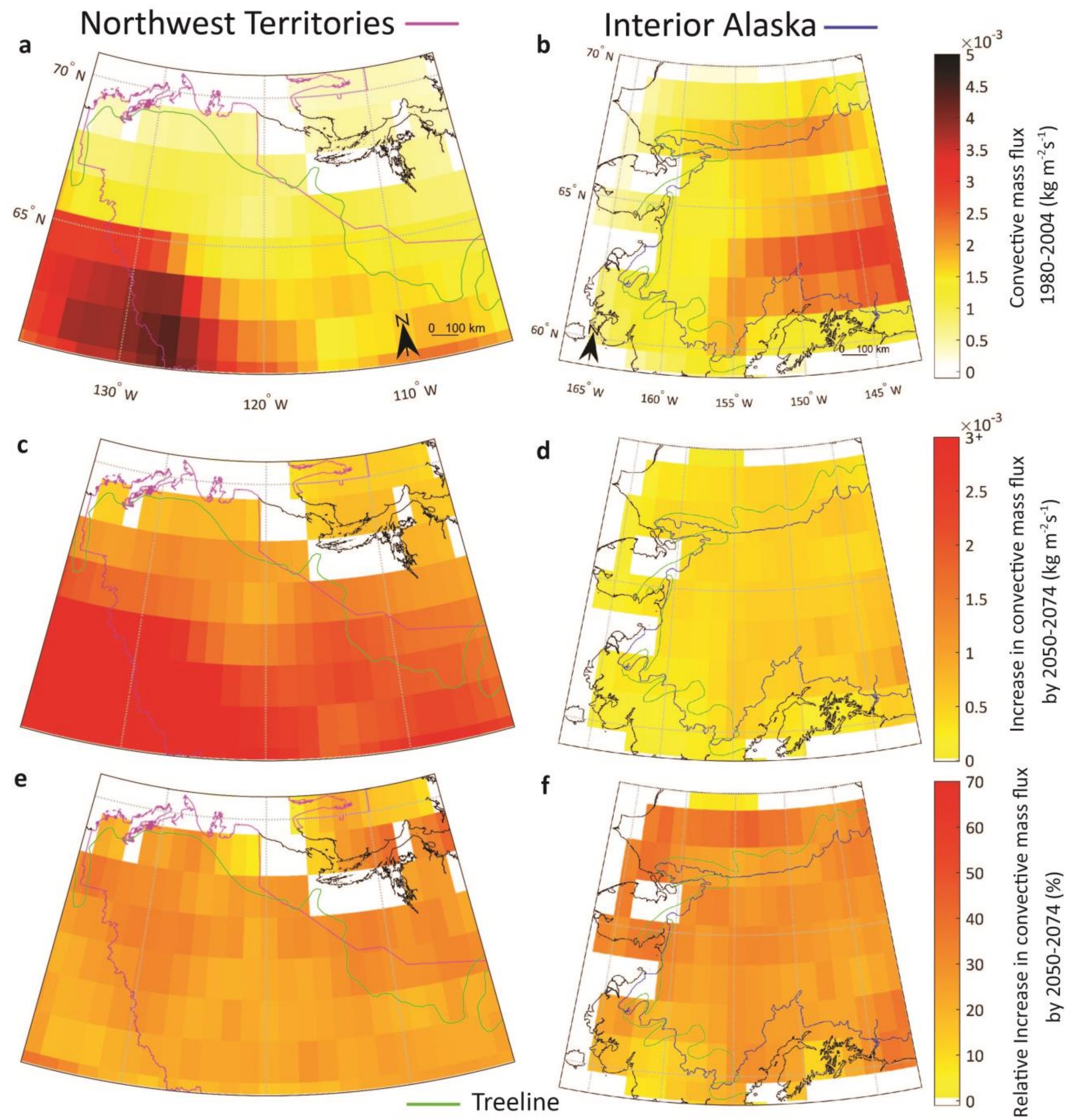
Supplementary Figure 5. **Mean fire size in the Northwest Territories and Interior Alaska between 2001 and 2015 as a function of ignition timing.** Only lightning fires were considered.



Supplementary Figure 6. **Decreases in lightning in June-July in the treeline ecotone for (a) the Northwest Territories, and (b) Interior Alaska.** Intra-cloud and cloud-to-ground lightning flash climatology was derived for June between 1995 and 1999 from the spaceborne Optical Transient Detector.



Supplementary Figure 7. The extreme fire years in the Northwest Territories and Interior Alaska were characterized by above-average (a, b) temperature and (c, d) lightning along the treeline ecotone. Future temperature is also predicted to increase. (sd: standard deviation)



Supplementary Figure 8. **Convective mass flux, a strong lightning predictor[30], in June-July in 1980-2004, and absolute and relative increase in convective mass flux by 2050-2074 for (a, c, e) the Northwest Territories, and (b, d, f) Interior Alaska.**

Supplementary table

Supplementary Table 1. Adjusted R² values (R_{adj}^2) and corrected Akaike information criterion (AICc) of multiple linear regression models (with constant) for modeling interannual variability in lightning in the Northwest Territories (2005-2014) and Interior Alaska (2001-2012). (** denotes significant regression models at a level of $p < 0.01$, and * at a level of $p < 0.05$). (CAPE: convective available potential energy, T: temperature, P: precipitation, CP: convective precipitation)

Predictor variables	Northwest Territories		Interior Alaska	
	R_{adj}^2	AICc	R_{adj}^2	AICc
CAPE	-0.13	-53.22	0.5*	-53.50
T	-0.07	-53.69	0.51*	-55.69
P	0.41*	-59.71	-0.10	-46.03
CP	-0.05	-53.95	0.21	-49.99
$CAPE \times P$	0.17	-56.27	0.34*	-52.16
$CAPE \times CP$	-0.11	-55.09	0.52**	-55.96
$CAPE \times T$	0.13	-48.89	0.50**	-55.40
$T \times P$	0.47*	-60.73	0.04	-47.72
$T \times CP$	-0.10	-53.42	0.49**	-55.20
$P \times CP$	0.04	-47.65	0	-47.17
CAPE, P	0.33	-56.44	0.47*	-53.27
CAPE, CP	0.09	-50.82	0.47*	-53.36
CAPE, T	0.10	-53.51	0.52*	-54.49
T, P	0.37	-61.10	0.50*	-54.04
T, CP	-0.02	-52.22	0.65**	-58.35
P, CP	0.65*	-62.98	0.71**	-60.68
CAPE, T, P	0.43	-54.62	0.46*	-50.86
CAPE, T, CP	0.08	-49.80	0.62*	-55.05
CAPE, P, CP	0.78**	-64.19	0.71**	-58.32
T, P, CP	0.90**	-72.22	0.76**	-60.73
CAPE, T, P, CP	0.91**	-66.30	0.74*	-55.91