Supporting Information

Syphard et al. 10.1073/pnas.1713885114

SI Text

Data Sources. We stratified our analyses of fire-climate relationships using geographical boundaries that delineate relatively homogenous climatic regions across the United States, created by NEON (www.neonscience.org/field-sites/spatiotemporal-design).

The federal fire data included historical records from the BLM, NPS, and USFS. These data are available from Wildland Fire Management Information (https://www.nifc.gov/) for Department of Interior agencies (NPS and BLM) and from the National Wildfire Coordinating Group (fam.nwcg.gov/fam-web/weatherfirecd/state_data.htm) for all USFS fires. The national interagency FPA FOD (47) is available at https://www.fs.usda.gov/rds/archive/Product/RDS-2013-0009.4/ as a point-based Geographic Information System (GIS) layer that also delineates fire origins.

The explanatory variables used to associate with the variation in strength of fire-climate relationships came from a variety of sources. We evaluated two climate variables, mean annual precipitation and mean annual temperature range, using PRISM climate normals (www.prism.oregonstate.edu/normals/) from 1971 to 2000. To calculate temperature range, we subtracted mean annual minimum temperature from mean annual maximum temperature using PRISM data. We also summarized two topographic variables, slope and elevation, using 30-m data downloaded from LANDFIRE (https://landfire.cr.usgs.gov/topographic.php).

To determine whether the importance of climate varied according to resources, or fuel, we evaluated the mean forest biomass (mg/ha) within regions (https://data.fs.usda.gov/geodata/rastergateway/biomass/conus_forest_biomass.php) as well as the proportion of non-Wildland Urban Interface (WUI) vegetated land (silvis.forest.wisc.edu/maps/wui/2010/download). We summed the annual proportion area burned across each period of record to determine if the strength of fire-climate relationships varied according to the overall amount of fire in the region.

To investigate the role of human presence in mediating fire-climate relationships, we calculated the mean Euclidean distance to major roads (https://www.arcgis.com/home/item.html?id=871852b13b53426dabdf875f80c04261) and the distance to medium- or high-density development (selected from the attributes of the WUI map described above). We used these proximity variables because there is generally little development that occurs within the boundaries of federally owned lands.

Fire Data Assembly. We assembled the federal data from individual fire reports, available from years 1972–2010, although some BLM records started in later years, up to 1980. Fire reports vary in form and detail from bureau to bureau, so we assembled commonly input information for all agencies. The coordinate locations represent the point of fire origin, with the area burned for each fire provided in the attribute tables. Therefore, we summed annual area burned within the jurisdictional area of the federal agencies within NEON domains, then divided it by the total area of each region to ensure that the calculation of fire activity was comparable. This resulted in annual values of proportion of area burned for 37 distinct study areas. We calculated jurisdictional area via a spatial overlay of federal land boundaries within boundaries the NEON domains. Because the fires were provided as point locations, it is possible that large fires could span one of the division boundaries. However, we assigned all attributed area burned to the geographical region in which the points were located.

As with the federal data, the FPA FOD data list fire size and year as digital attributes. For analysis of these FPA FOD fires, which encompassed multiple public and private land ownerships, we calculated the proportion of area burned as the annual area burned divided by the entire area within the NEON domain, resulting in 17 study areas. This was the dependent variable in the statistical models of fire-climate relationships.

Additional Modeling Details. For hierarchical partitioning analysis, we considered all seasonal temperature and precipitation variables, including prior-year precipitation, for all of the 37 study regions. To meet linear regression assumptions of normal distribution, we log-transformed the response, then specified the model family to be "gaussian" with R^2 as our goodness-of-fit measure.

For the multiple regression analysis, we systematically applied the same approach for all regions. We used the package MuMIn in R (49, 50) to generate multiple-regression models using all possible combinations of the predictor variables and to rank models using Akaike information criterion (sample size corrected). We also calculated the variance inflation factor to check for multicollinearity (51).

Although we present significant results as $P \leq 0.05$, if a Bonferroni correction were applied to the P values to account for multiple comparisons, the significant P value would be lowered to 0.005.

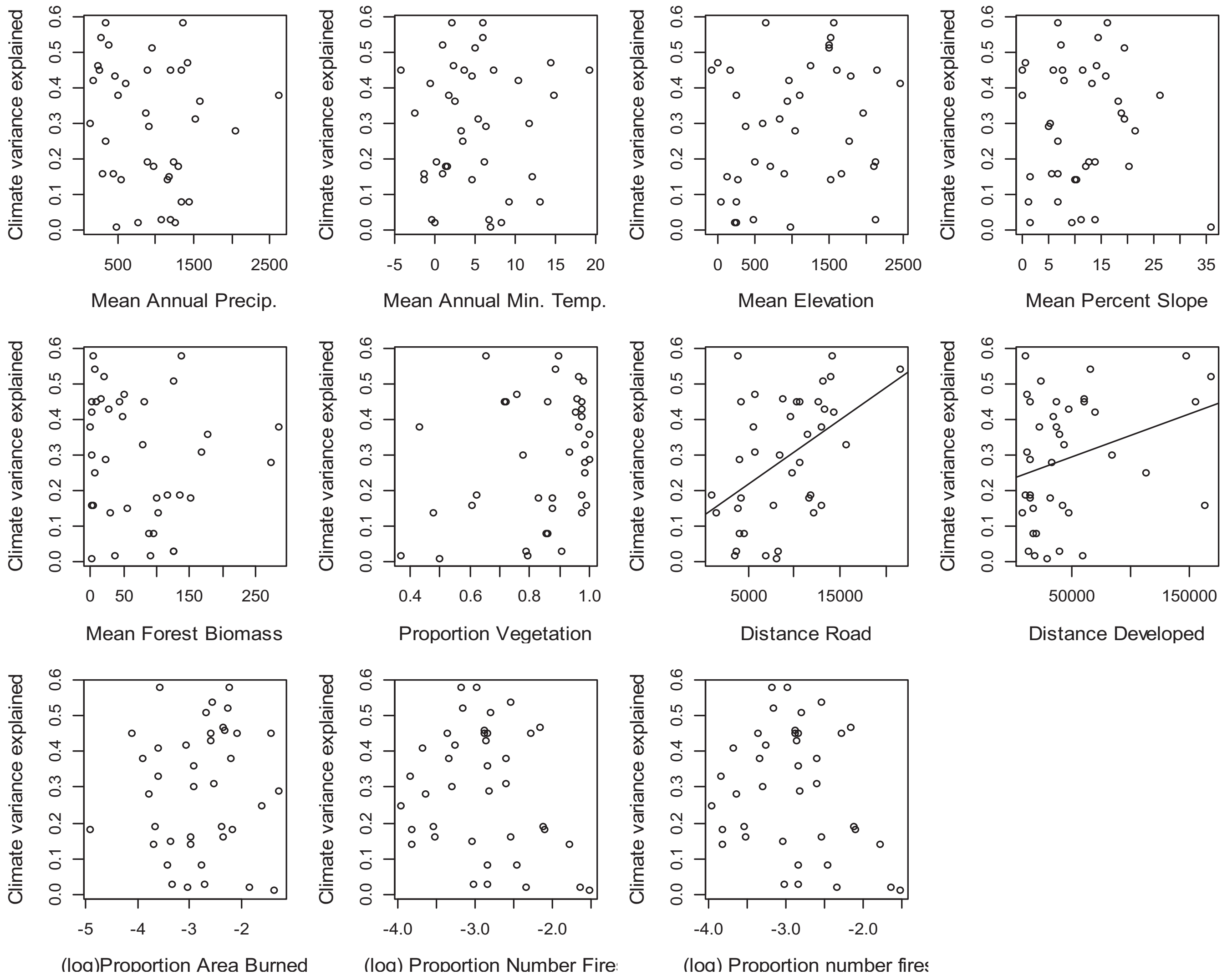

Fig. S1. Relationship of variance explained (by climate on fire activity) with biophysical and human characteristics of federal lands in 37 different regions. Trend lines only shown for significant relationships. Min., minimum; Precip., precipitation.

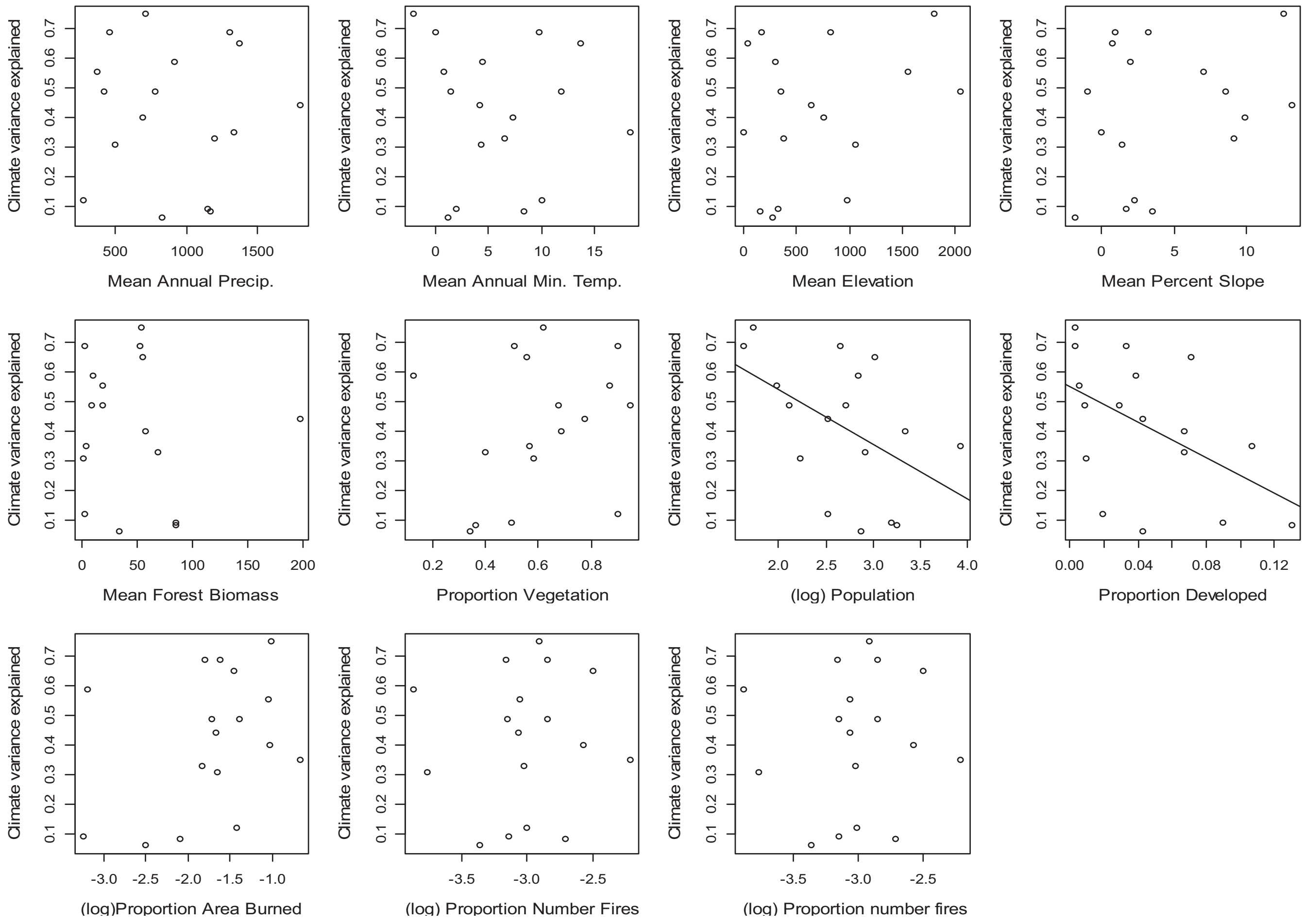

Fig. S2. Relationship of variance explained (by climate on fire activity) with biophysical and human characteristics of 17 NEON regions. Trend lines only shown for significant relationships. Min., minimum; Precip., precipitation.

Table S1. Best-performing multiple-regression model of annual fire activity and seasonal climate variables within NEON domains of three federal agencies

NEON domain	Best model	AIC	Adjusted R^2	Max VIF
NPS				
Appalachian	(neg)Aut_ppt − Spr_ppt − Win_ppt	157.66	0.31	1.35
Atlantic Neotropical	(neg) Spr_ppt + Sum_tmx + Win_tmx	123.09	0.45	1
Central Plains	(neg)Spr_tmx	185.25	0.01	NA
Desert Southwest	Prior_ppt − Spr_tmx + Sum_tmx	173.79	0.42	2
Great Basin	(neg) Aut_ppt	152.95	0.03	NA
Great Lakes	(neg)Prior_ppt	101.95	0.02	NA
Mid-Atlantic	(neg)Prior_ppt + Spr_tmx − Win_ppt	159.22	0.19	1.1
Northeast	(neg)Sum_ppt	117.13	0.14	NA
Northern Rockies	Aut_tmx + Spr_tmx − Sum_ppt	182.69	0.45	1.1
Northern Plains	(neg)Spr_ppt − Win_ppt	129.16	0.16	1
Ozarks	Win_tmx	153	0.02	NA
Pacific Northwest	Aut_ppt + Sum_tmx + Win_tmx	162.86	0.38	1.9
Pacific Southwest	Aut_tmx	102.98	0.18	NA
Prairie Peninsula	(neg)Aut_ppt + Spr_tmx	246.29	0.29	1.02
Southeast	(neg)Aut_tmx − Spr_ppt − Spr_tmx − Sum_ppt − Sum_tmx	293.68	0.47	1.6
Southern Plains	Aut_ppt − Prior_ppt − Spr_ppt − Sum_tmx − Win_tmx	381.25	0.38	2.01
Southern Rockies	(neg)Prior_ppt _ Spr_tmx + Sum_tmx	136.132	0.54	1.6
USFS				
Appalachian	(neg)Aut_ppt − Spr_ppt +Spr_tmx-Win_ppt	91.48	0.58	1.4
Desert Southwest	Aut_tmx − Spr_ppt − Spr_tmx − Sum_ppt + Win_tmx	171.77	0.43	2.7
Great Basin	Sum_tmx	135.65	0.19	NA
Mid-Atlantic	(neg)Spr_ppt	136.36	0.03	NA
Northeast	(neg)Aut_ppt + Sum_ppt + Sum_tmx	131.56	0.18	1.54
Northern Rockies	(neg) Prior_ppt + Spr_tmx − Sum_ppt	203.81	0.33	1.02
Northern Plains	(neg)Aut_ppt − Sum_ppt	151.28	0.14	1
Ozarks	(neg)Aut_ppt	149.18	0.08	NA
Pacific Northwest	Sum_tmx	163.01	0.28	NA
Pacific Southwest	(neg)Spr_ppt − Sum_ppt + Sum_tmx	134.68	0.51	1.19
Prairie Peninsula	(neg)Aut_ppt + Spr_tmx	206.1	0.45	1.23
Southeast	Win_tmx	103.83	0.08	NA
Southern Plains	Prior_ppt + Win_tmx	156.6	0.15	1.18
Southern Rockies	(neg)Prior_ppt − Spr_ppt + Sum_tmx	192.45	0.41	1.14
BLM				
Central Plains	Prior_ppt + Spr_tmx	402.22	0.25	1.005
Desert Southwest	Prior_ppt + Win_ppt + Sum_tmx	95.17	0.3	1.08
Great Basin	Prior_ppt + Aut_ppt + Sum_tmx	84.35	0.52	1.17
Northern Rockies	(neg)Prior_ppt + Spr_ppt + Spr_tmx + Sum_tmx + Win_tmx	159.67	0.58	2.23
Northern Plains	Sum_tmx	122.51	0.16	NA
Pacific Northwest	Aut_tmx + Sum_tmx	125.52	0.36	1.12
Pacific Southwest	Aut_tmx + Prior_ppt + Sum_tmx + win_tmx	96.78	0.46	1.89
Southern Rockies	Spr_tmx + Win_ppt + Win_tmx	94.83	0.45	1.13

AIC, Akaike information criterion; Aut, autumn; Max VIF, maximum variance inflation; NA, not applicable; ppt, mean precipitation; Spr, spring; Sum, summer; tmx, mean maximum temperature; Win, winter.

Table S2. Best-performing multiple-regression model of annual fire activity and seasonal climate variables within NEON domains using the FPA FOD

NEON domain	Best model	AIC	Adjusted R^2	Max VIF
Appalachian	Spr_tmx − Aut_ppt	63.15	0.33	1.03
Atlantic Neotropical	Aut_tmx + Sum_tmx	54.07	0.35	1.16
Central Plains	Sum_tmx + Aut_tmx	62.86	0.31	4.35
Desert Southwest	Win_tmx − Win_ppt	47.4	0.12	2.06
Great Basin	(neg) Sum_ppt + win_tmax	48.05	0.54	1.07
Great Lakes	(neg) Spr_ppt − win_ppt	48.47	0.06	1.05
Mid-Atlantic	Sum_tmx − Spr_ppt	34.25	0.08	1.1
Northeast	(neg) Spr_ppt	52.46	0.09	NA
Northern Rockies	Win_tmx − Sum_ppt	51.76	0.75	1.39
Northern Plains	Sum_tmx − sum_ppt + Win_tmx	41.45	0.69	1.96
Ozarks	Sum_tmx − Spr_ppt − Win_ppt	14.6	0.69	1.02
Pacific Northwest	(neg)Spr_ppt − Spr_tmx	64.72	0.44	1.33
Pacific Southwest	Sum_tmx − Spr_ppt − Aut_ppt	42.88	0.4	1.36
Prairie Peninsula	Spr_tmx − Aut_tmx	33.85	0.59	1.49
Southeast	Aut_tmx − Spr_ppt − Sum_ppt	18.1	0.65	1.01
Southern Plains	Spr_tmx − Aut_ppt	60.81	0.49	1.08
Southern Rockies	(neg) Spr_ppt − Sum_ppt + Win_tmx	43.19	0.49	1.12

AIC, Akaike information criterion; Aut, autumn; Max VIF, maximum variance inflation; ppt, mean precipitation; Spr, spring; Sum, summer; tmx, mean maximum temperature; Win, winter.