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Supplement of

Understanding and simulating cropland and non-cropland burning in Europe using the BASE (Burnt Area Simulator for Europe) model

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S1: Land cover type groupings

Main land cover type	Subgroup	Component classes
Croplands	Herbaceous croplands	10 Cropland, rainfed 11 Cropland, rainfed - Herbaceous cover 20 Cropland, irrigated or post-flooding
	Woody croplands	11 Cropland, rainfed - Tree or shrub cover
	Mosaic croplands	3- Mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous cover) (<50%) 40- Mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%) / cropland (<50%)
Non-cropland	Grasslands	130 Grassland
	Shrublands	120 Shrubland 121 Shrubland - Evergreen shrubland 122 Shrubland - Deciduous shrubland
	Woodlands	50 Tree cover, broadleaved, evergreen, closed to open (>15%) 60 Tree cover, broadleaved, deciduous, closed to open (>15%) 61 Tree cover, broadleaved, deciduous, closed (>40%) 62 Tree cover, broadleaved, deciduous, open (15-40%) 70 Tree cover, needleleaved, evergreen, closed to open (>15%) 71 Tree cover, needleleaved, evergreen, closed (>40%) 72 Tree cover, needleleaved, evergreen, open (15-40%) 80 Tree cover, needleleaved, deciduous, closed to open (>15%) 81 Tree cover, needleleaved, deciduous, closed (>40%) 82 Tree cover, needleleaved, deciduous, closed (>40%) 90 Tree cover, mixed leaf type (broadleaved and needleleaved)
	Natural mosaics	100 Mosaic tree and shrub (>50%) / herbaceous cover (<50%) 110 Mosaic herbaceous cover (>50%) / tree and shrub (<50%)
	Sparse vegetation	150 Sparse vegetation (tree, shrub, herbaceous cover) (<15%) 151 Sparse tree (<15%) 152 Sparse shrub (<15%) 153 Sparse herbaceous cover (<15%)

Table S1. Land cover type groupings applied to the ESA LandcoverCCI data.

S2: Additional land cover and fire occurrence per land cover plots

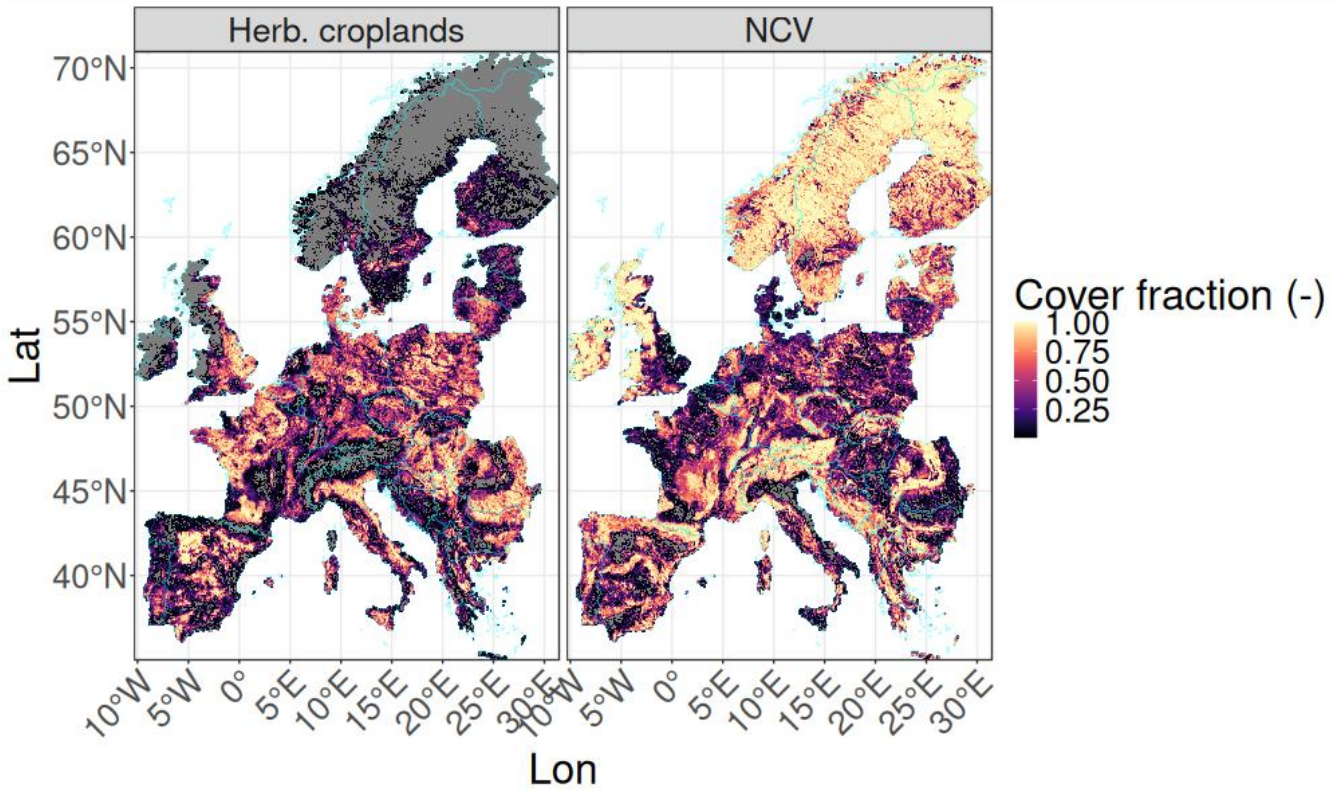

Figure S1. Distribution of NCV and cropland land cover from ESA LandcoverCCI across the European study domain (average 2001-2020)

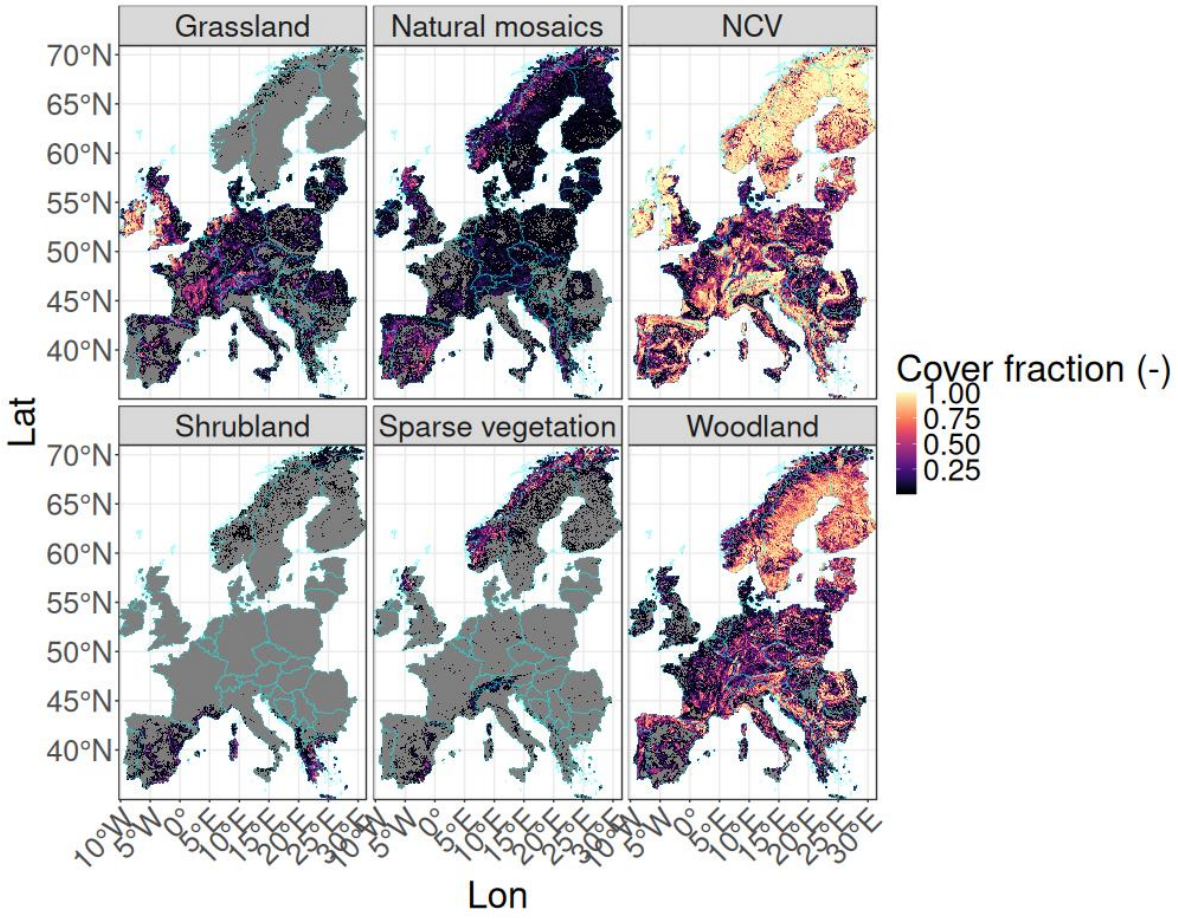

Figure S2. Distribution of NCV land cover subtypes ESA LandcoverCCI across the European study domain (average 2001-2020)

Figure S3. Burnt fraction from ESA FireCCI51 in NCV land cover subtypes across the European study domain (average 2001-2020)

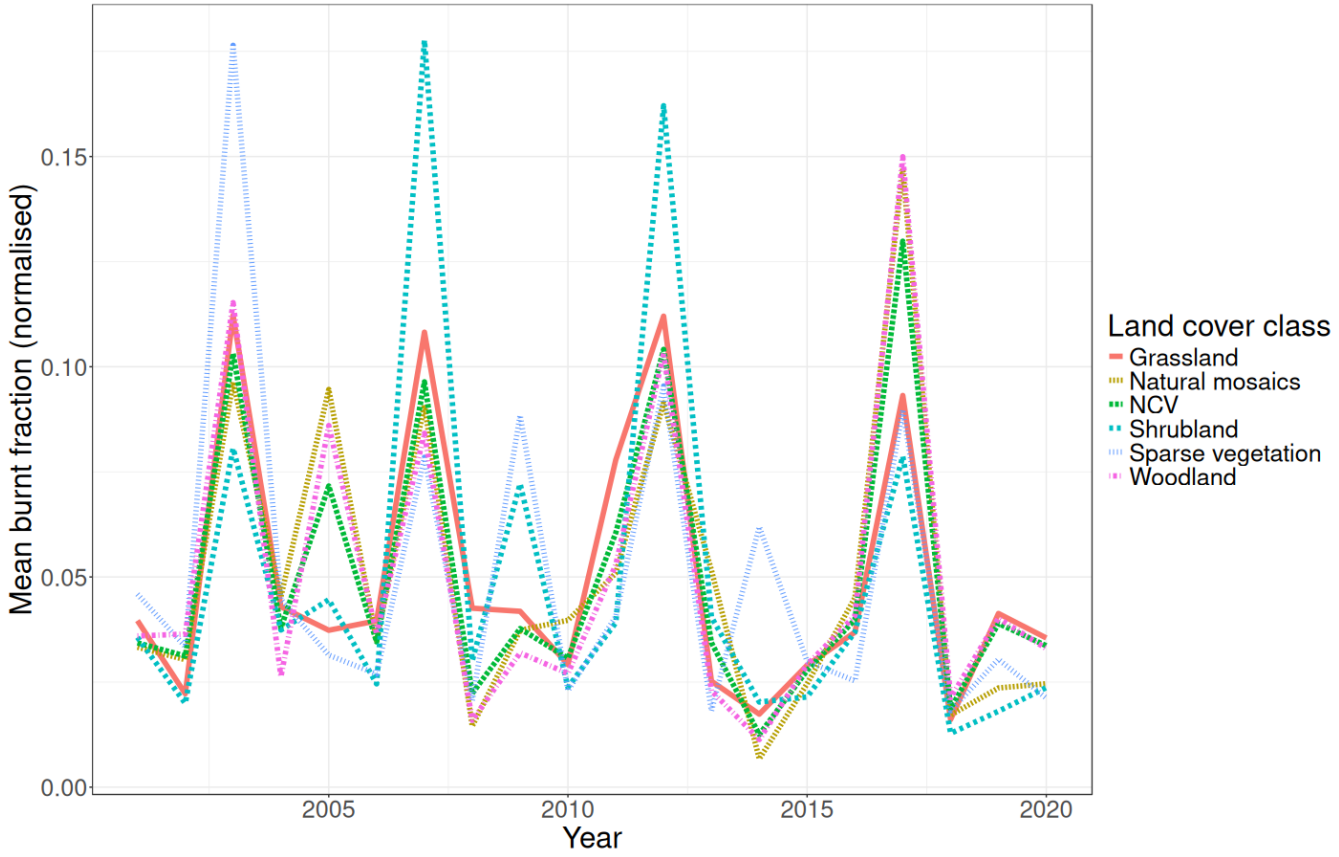

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Figure S4. Mean burnt fraction from ESA FireCCI51 in NCV land cover subtypes across the European study domain.

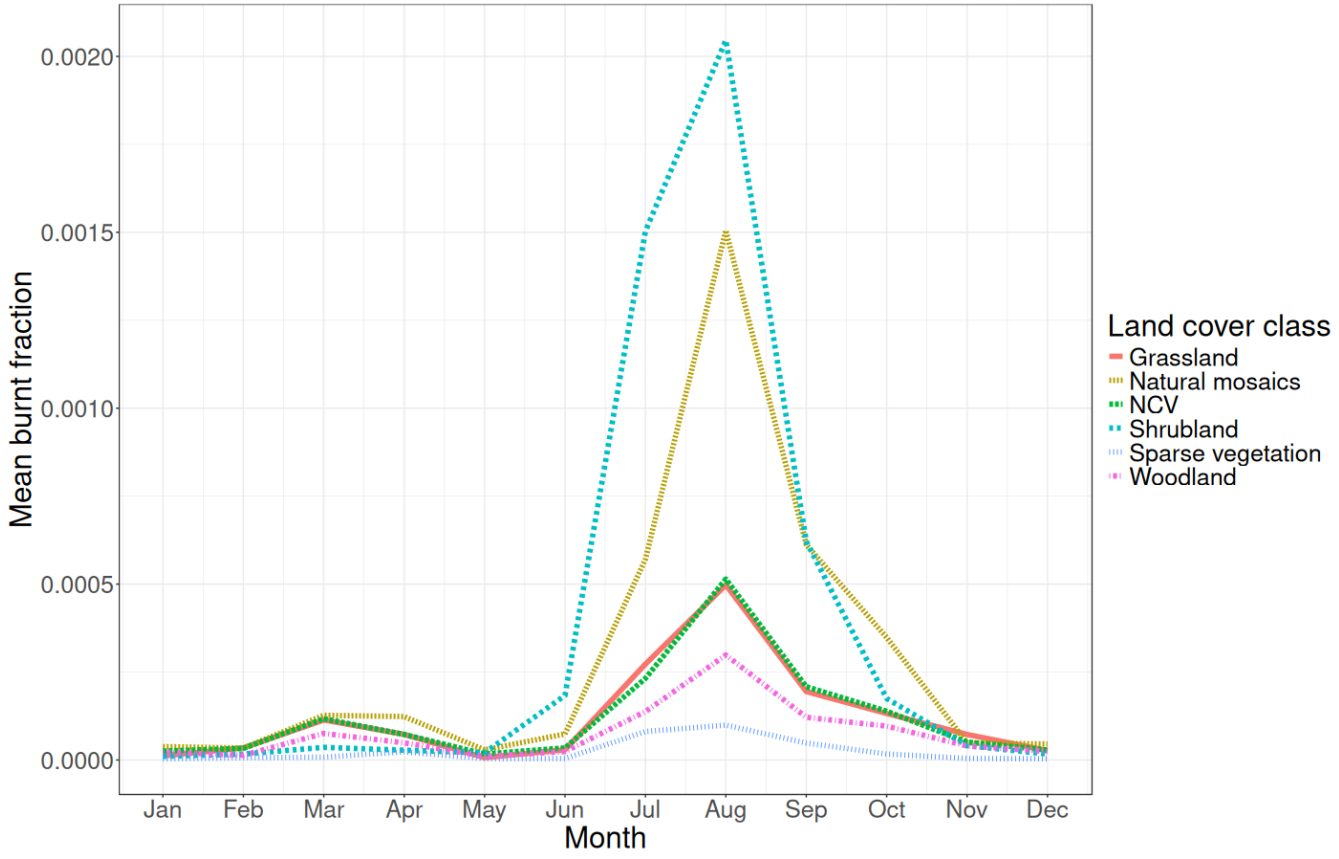

Figure S5. Seasonal cycle of mean burnt fraction from ESA FireCCI51 in NCV land cover subtypes across the European study domain (average 2001-2020).

S3: Predictor correlations

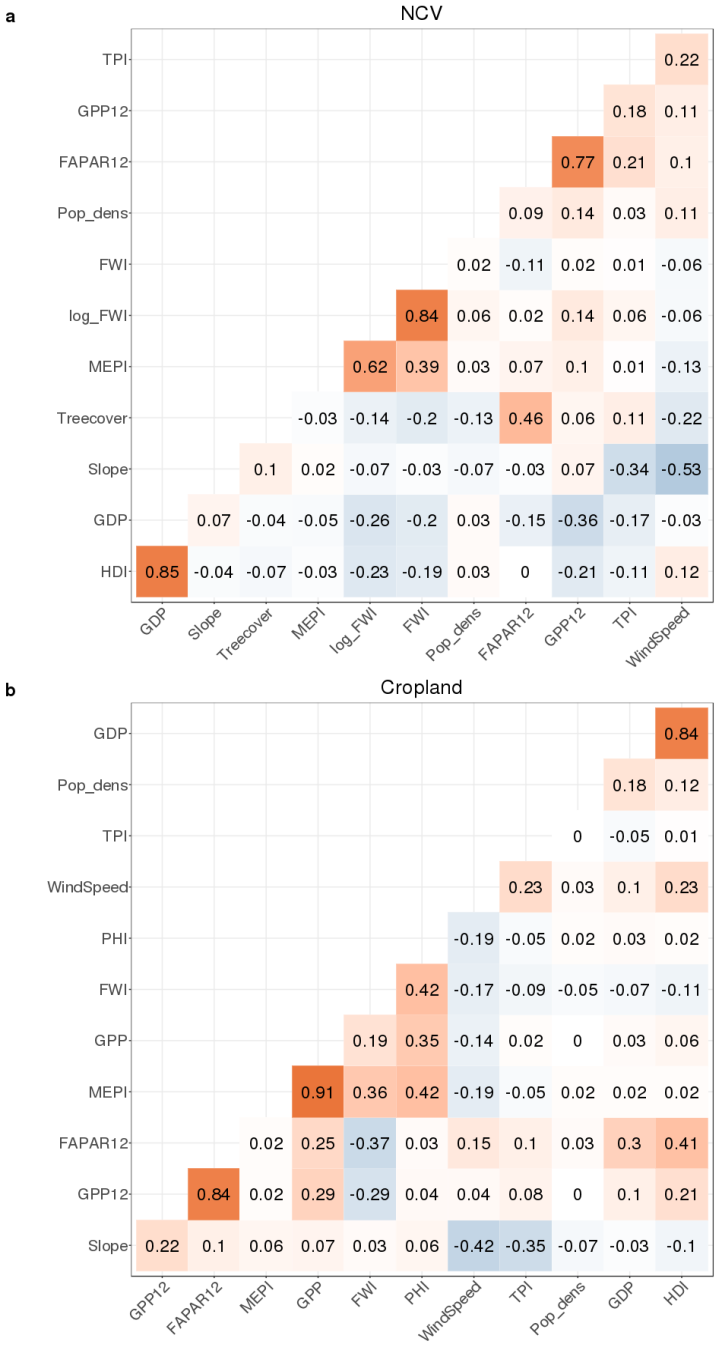

Figure S6. Pearson's correlation of the predictors used in NCV and cropland BASE (final model and alternative model formulations).

S4: Regression model parameters for the final BASE models

Term	Value	Std error	t-statistic	p-value
(Intercept)	-1.33000	0.274000	-4.86	1.15e-06
FAPAR12	6.07000	0.254000	23.90	0.00e+00
Slope	0.08890	0.003300	26.90	0.00e+00
TPI	0.48200	0.053600	8.98	0.00e+00
Pop_dens	0.02940	0.002680	11.00	0.00e+00
HDI	-16.40000	0.331000	-49.40	0.00e+00
Treecover	0.06990	0.005670	12.30	0.00e+00
Treecover^2	-0.00187	0.000103	-18.20	0.00e+00
MEPI	-6.76000	0.252000	-26.80	0.00e+00
log_FWI	1.87000	0.032000	58.50	0.00e+00
MEPI:log_FWI	0.95300	0.081100	11.70	0.00e+00

Table S2. Estimated coefficients, standard errors, t-values and p-values for the final NCV model. P-values below 10^{-16} are reported as zero.

Term	Value	Std error	t-statistic	p-value
(Intercept)	-7.91e+00	1.53e-01	-51.7	0
Pop_dens	-3.26e-02	2.07e-03	-15.8	0
GDP	-2.67e-02	3.04e-04	-87.9	0
Slope	-5.28e-02	3.34e-03	-15.8	0
PHI	3.70e+00	5.79e-02	63.9	0
WindSpeed	-1.71e-01	4.86e-03	-35.2	0
FWI	2.21e-01	2.46e-03	89.7	0
FWI^2	-2.93e-03	4.88e-05	-59.9	0
GPP12	9.54e-03	2.50e-04	38.2	0
GPP12^2	-4.58e-06	1.14e-07	-40.3	0
MEPI	-1.15e+01	1.96e-01	-58.9	0
MEPI^2	7.20e+00	1.84e-01	39.2	0

Table S3. Estimated coefficients, standard errors, t-values and p-values for the final cropland model. P-values below 10^{-16} are reported as zero.

45 **S5: Partial residual plots for the final BASE models**

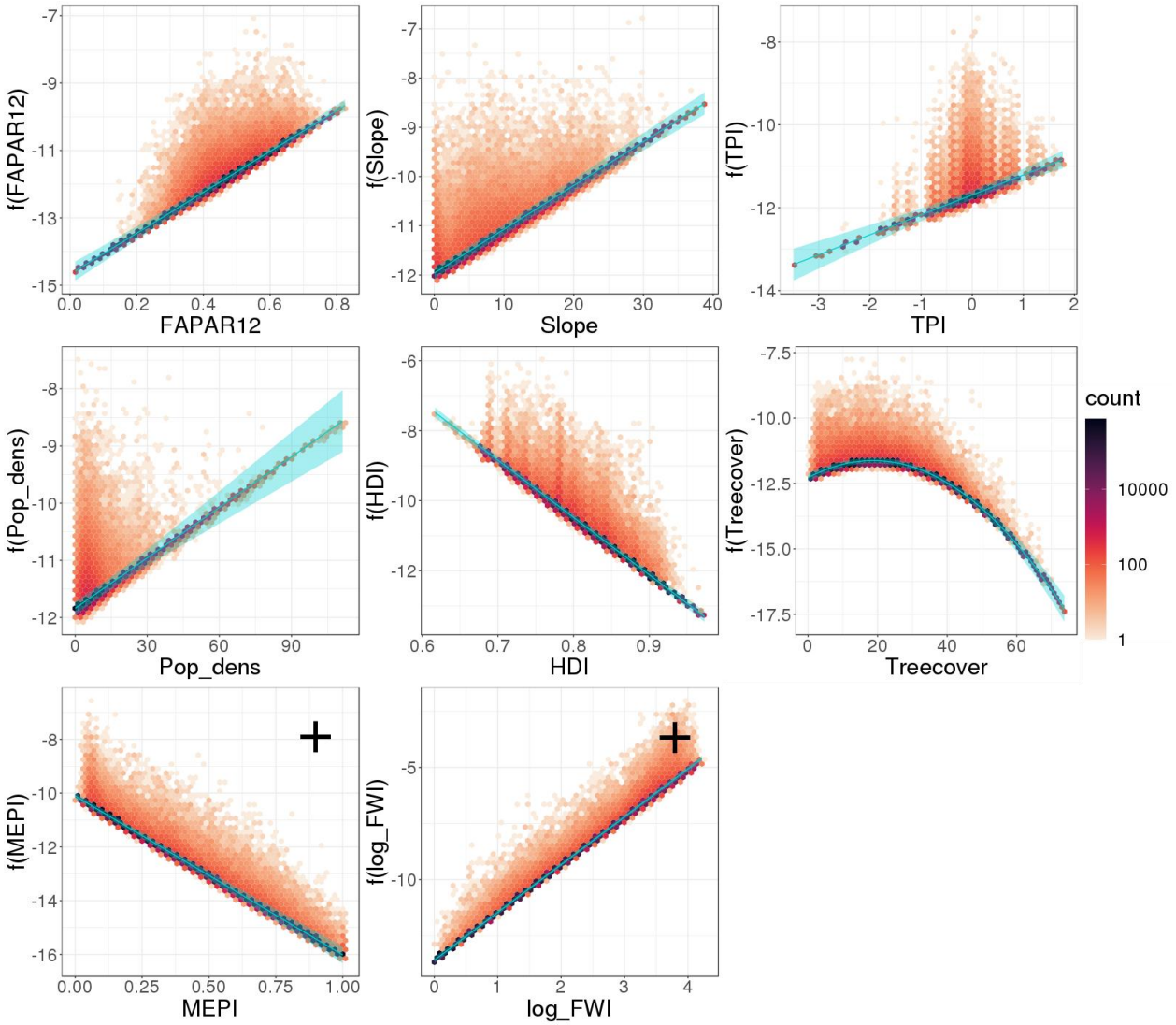

Figure S7. Plots of the partial residuals (orange to purple heatmap, note the logarithmic scale) and partial responses (cyan lines) for BASE NCV on the link scale. The black "+" symbols indicate the variables are involved in an interaction term the effect of which is not included here (see Appendix F).

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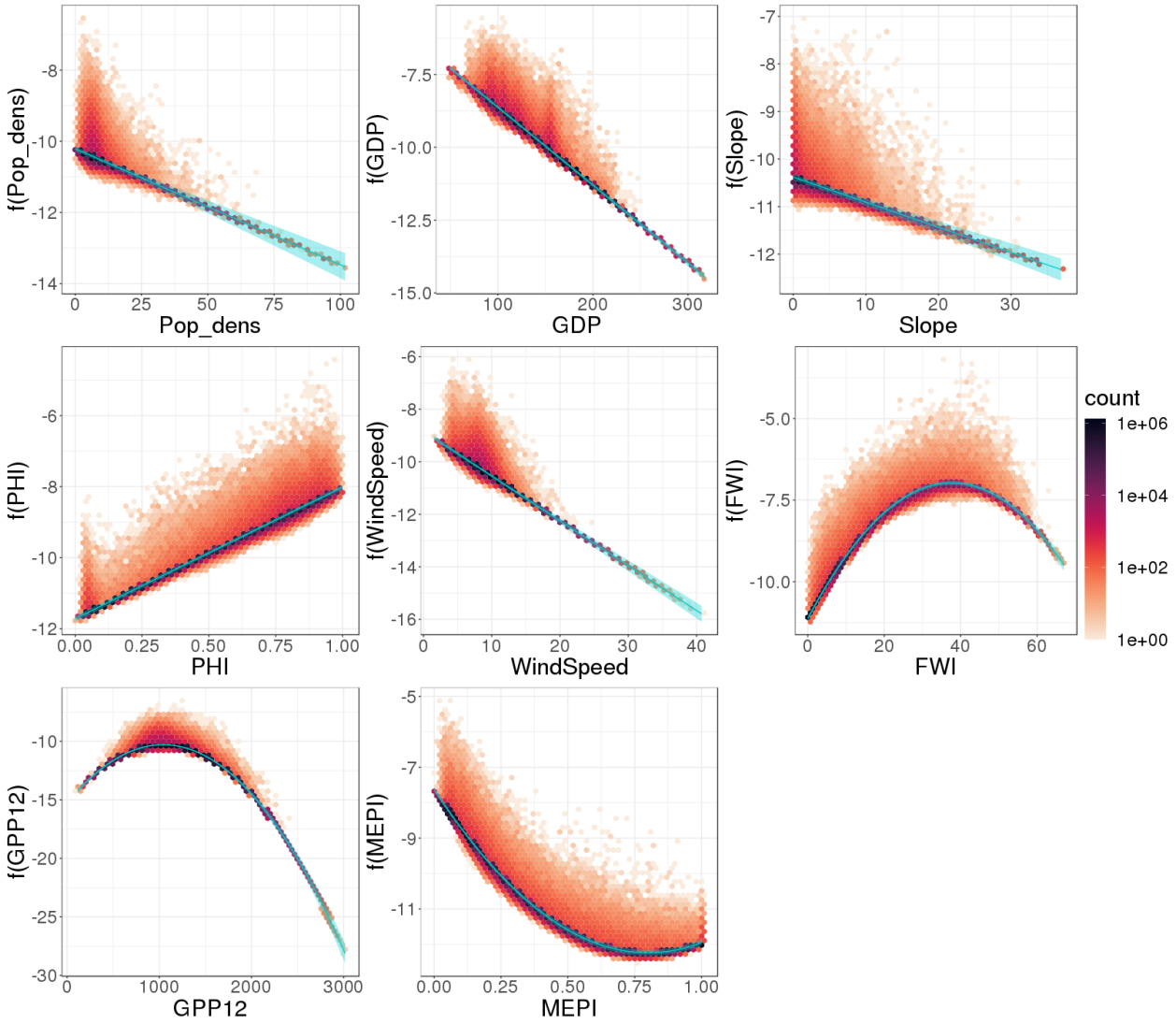

Figure S8. Plots of the partial residuals (orange to purple heatmap, note the logarithmic scale) and partial responses (cyan lines) for BASE cropland on the link scale.

S6: Interaction terms

When developing BASE we tested various interaction terms, however only one was retained in the final BASE configuration: the interaction between MEPI and log_FWI in the NCV model. Including this term improved the IAV NME by 1%, and had only had a very small impact on the other metrics (Table 2). It also improved the timing of the March and August peaks (Fig F1).

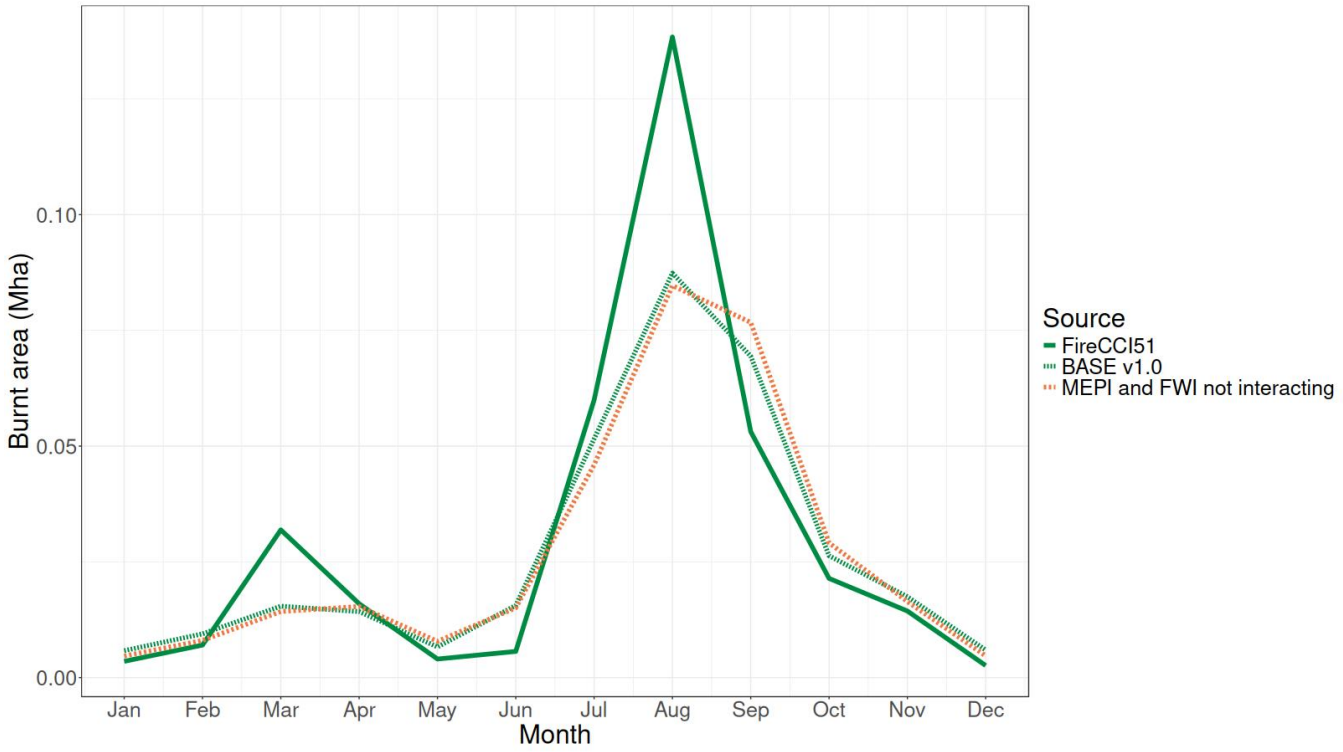

Figure S9: Comparison of seasonal cycle of NCV burning in the final BASE configuration and the sensitivity model with the interaction between FWI and MEPI omitted.

Visualisation of interaction terms requires special consideration as their effects cannot be included in typical 1D predictor response or partial regression plot. We took the approach of isolating the effect of the interaction terms, $\beta_{1,2}.x_1.x_2$, on the response scale and plotting that in two dimensions i.e. (x_1,x_2) space. Similarly to the 1D plots, we kept the other predictors at their median values. In order to isolate an interaction term we first calculated the full model prediction on a 2D plane of x_1 and x_2 (analogous to a 1D response plot). We then calculated the response without the interaction term. Technically speaking, this was done by first, on the link scale, subtracting the $\beta_{1,2}.x_1.x_2$ interaction term from the full prediction. Note that this

prediction still includes the linear terms $\beta_1.x_1$ and $\beta_2.x_2$, so the interaction term $\beta_{1,2}.x_1.x_2$ is the only term that is removed. This was then converted to the response scale and subtracted from the full response, and then this difference was plotted to quantify the effect of the interaction term.

The contribution of this interaction term between MEPI and log_FWI as visualised by this method is shown in Fig 7. This indicates that the interaction increases the predicted burnt fraction at high log_FWI and low to intermediate MEPI.

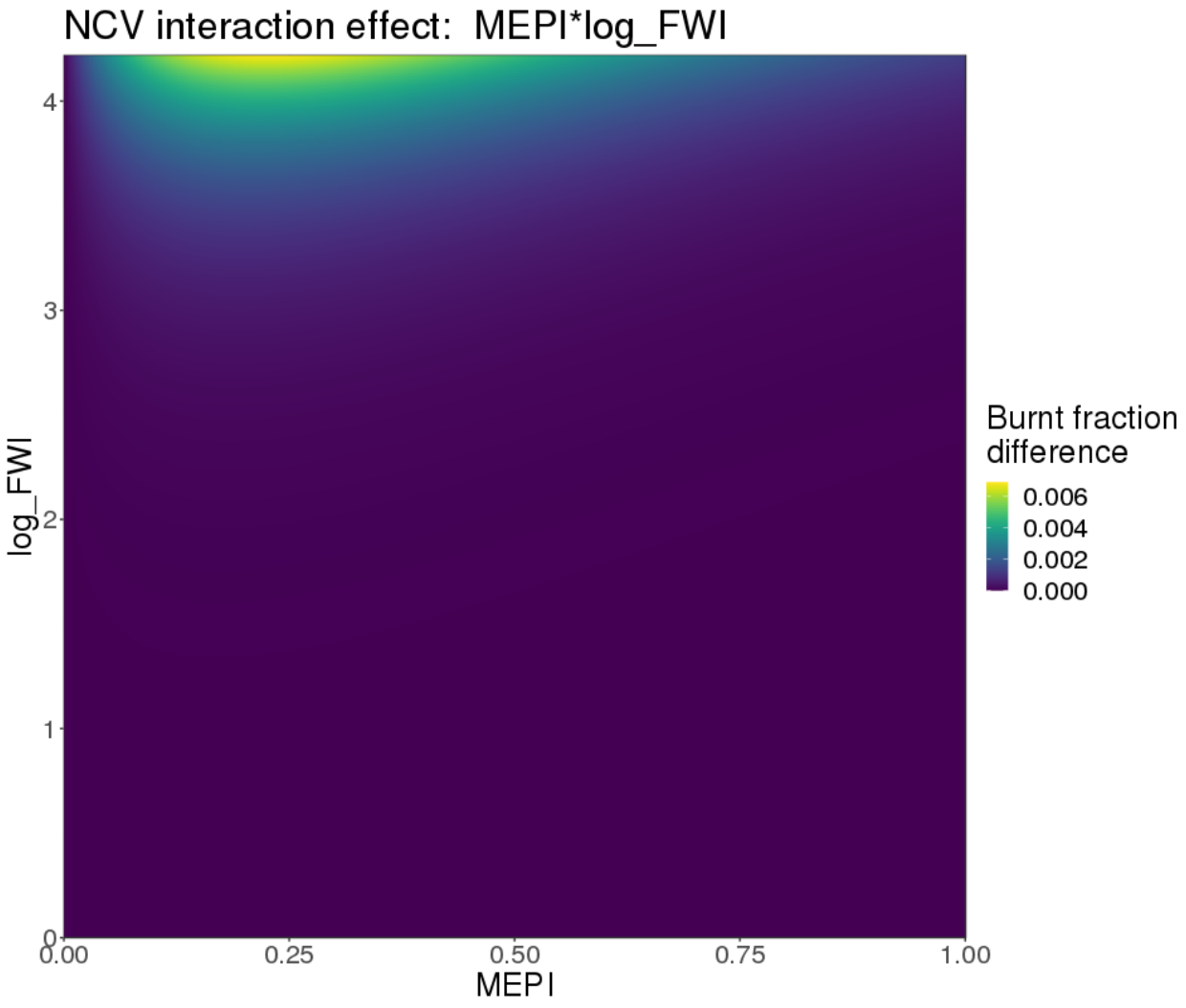

Figure S10. Contribution of the MPEI x log_FWI interaction term on the response scale.

It should be noted that although the interaction term must be monotonic in both dimensions on the link scale by its construction, the difference on the response scale will not necessarily be. This is because the inverse link function is not necessarily linear. In this case the inverse link function is the logistic function which is not linear and in fact plateaus towards an asymptote. This means that in some areas of the (x_1,x_2) space, the response is already very high without the interaction term (i.e. on the plateau on the logistic function), and so adding the interaction term has very little effect on the response *even though the interaction term might be at its largest values on the link scale*. In other words, we don't necessarily expect the *interaction term on the link scale* and the *effect of the interaction term on the response scale* to have the same shape.

S7: Spatiotemporal plots for selected sensitivity models

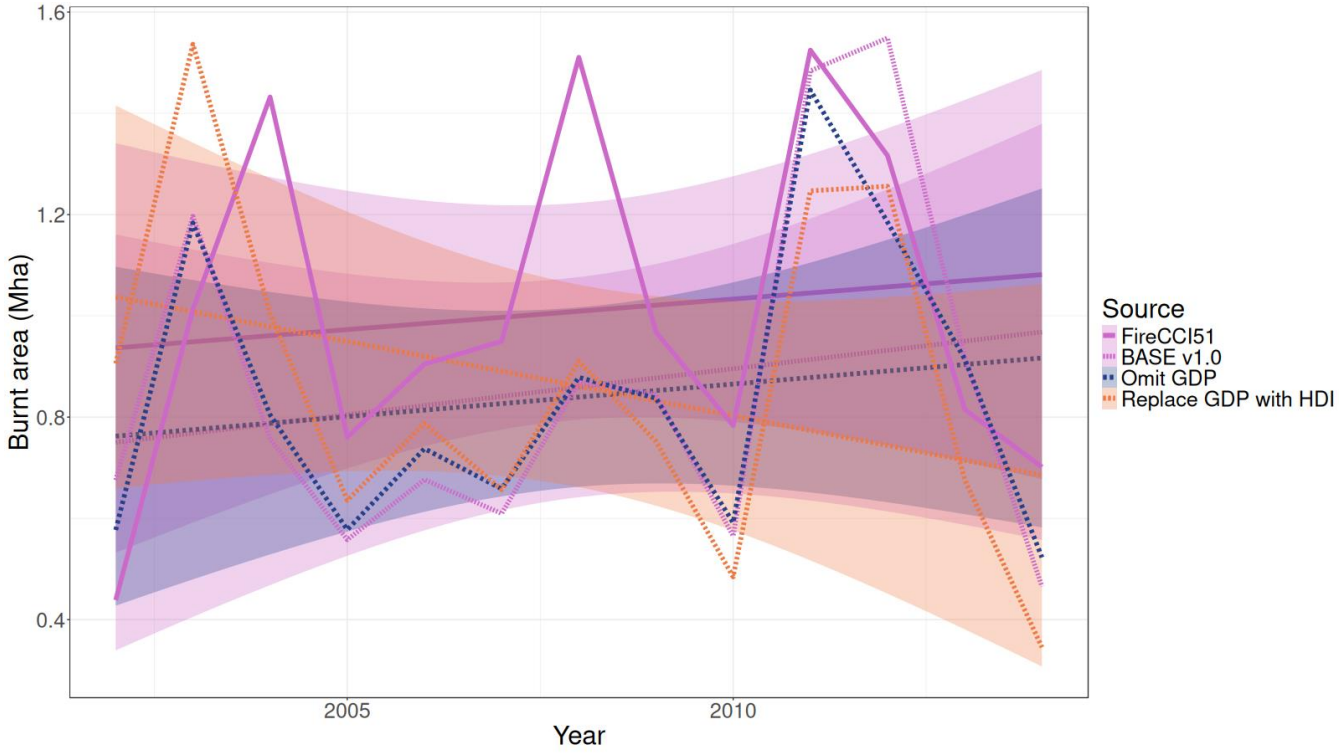

Figure S11: Comparison of IAV of cropland burning in the final BASE configuration and sensitivity models with changed socioeconomic predictors. The trend (calculated with linear regression) is plotted as a straight line with the 95% confidence interval shown as coloured shading.

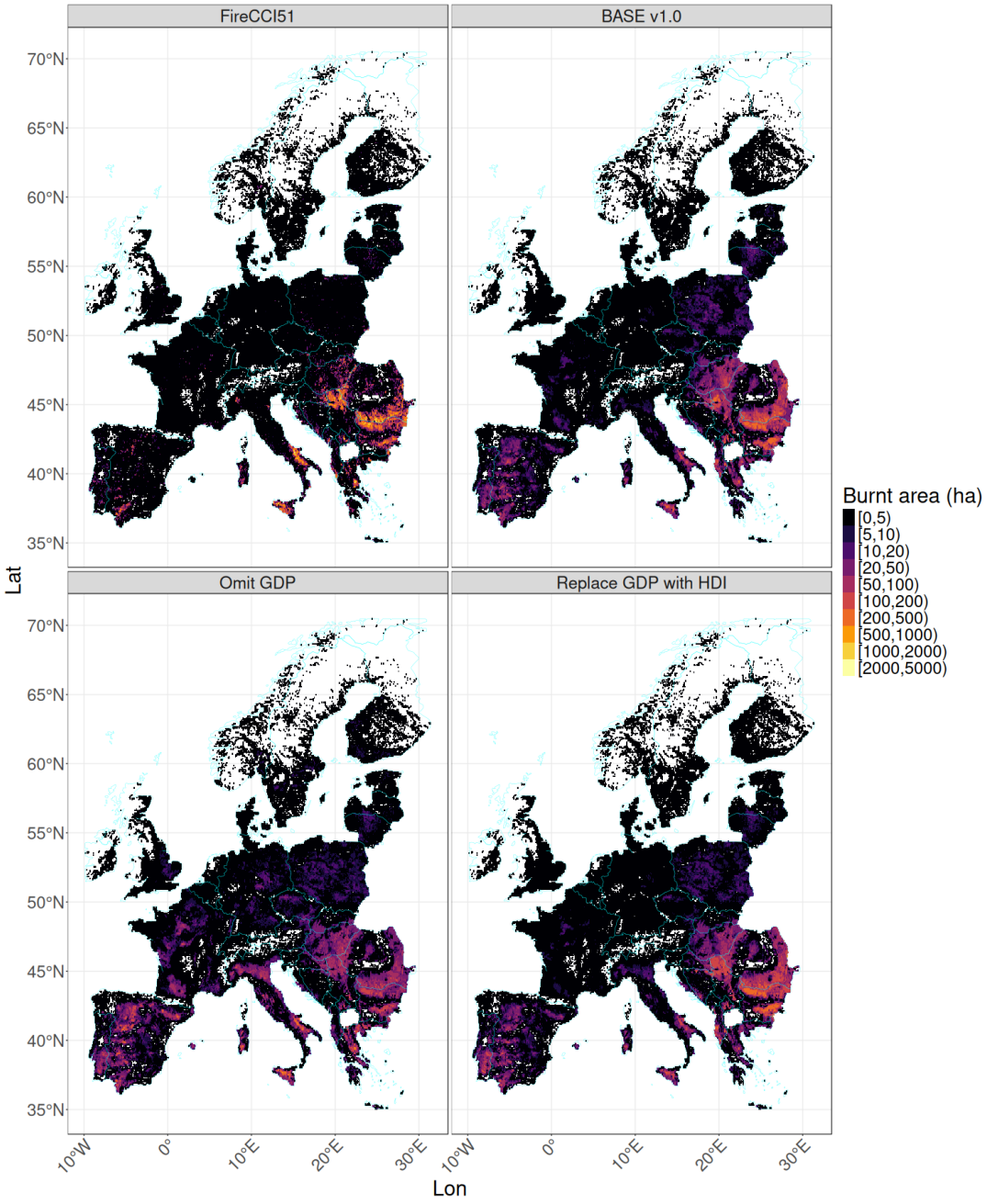

Figure S12: Comparison of spatial patterns of cropland burning in the final BASE configuration and the sensitivity models with changed socioeconomic predictors.

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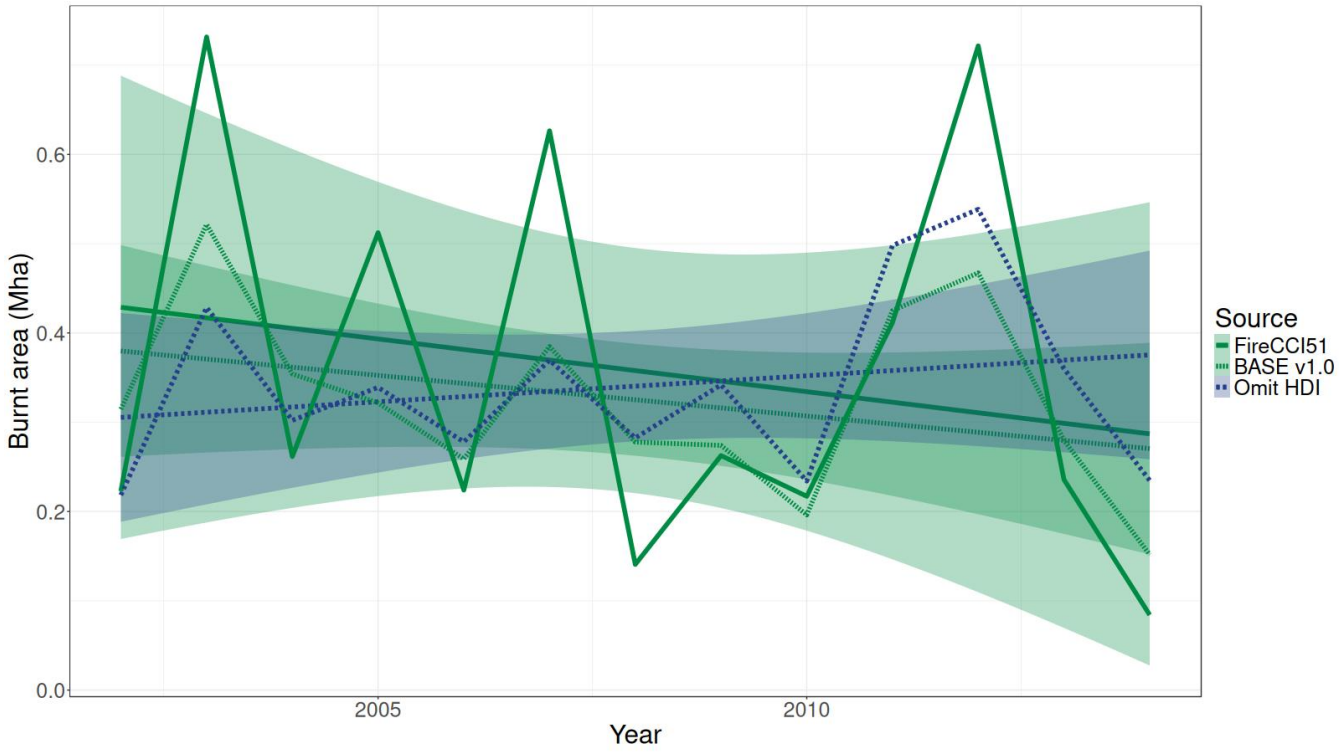

Figure S13: Comparison of IAV of NCV burning in the final BASE configuration and the sensitivity model with HDI omitted. The trend (calculated with linear regression) is plotted as a straight line with the 95% confidence interval shown as coloured shading.