LEVERHULME

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Statistical models as a tool to explore the relative importance of climate and CO_2 in driving large-scale changes in wildfire regimes

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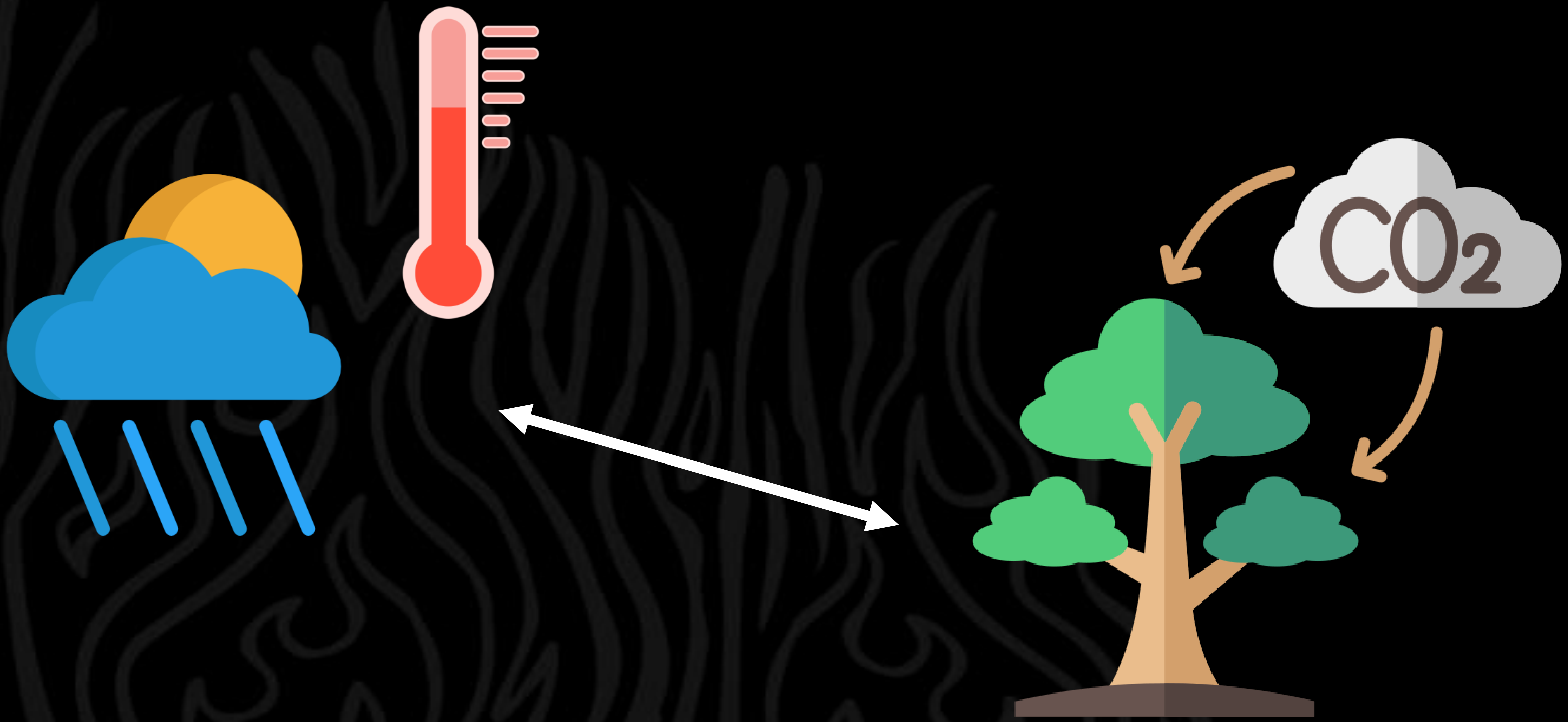
LEVERHULME TRUST

Atmospheric controls of wildfires



Statistical modelling approach

Explicitly account for **physiological effect of CO_2** on vegetation

Observe **relative importance** of different predictors

Apply to **counter-factual** experiments to explore **sensitivity**

Step 1: Modern statistical model building

Satellite observations

16 predictors

Vegetation load and type

Landscape fragmentation

Climate

Ignitions

→

3 generalized linear models

GFEDv4 (Randerson et al 2018)
MCD14ML (Giglio et al 2006)
Globfire (Artés et al., 2019)
GFA (Andela et al., 2019)

→

Burnt Area (BA)

Fire Size (FS)

Fire intensity (FI)

Step 2: experimental set-up

CO_2 only

Baseline climate

Scenario CO_2

Climate only

Scenario climate

Baseline CO_2

Sensitivity

Baseline

Baseline climate

Baseline CO_2

Scenario

Scenario climate

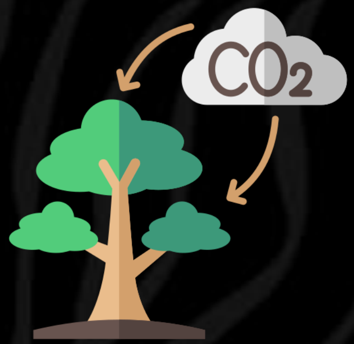
Scenario CO_2

Step 3: Out-of-sample experiments

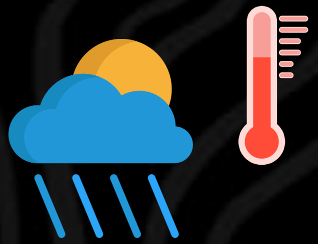
The past

Last Glacial Maximum

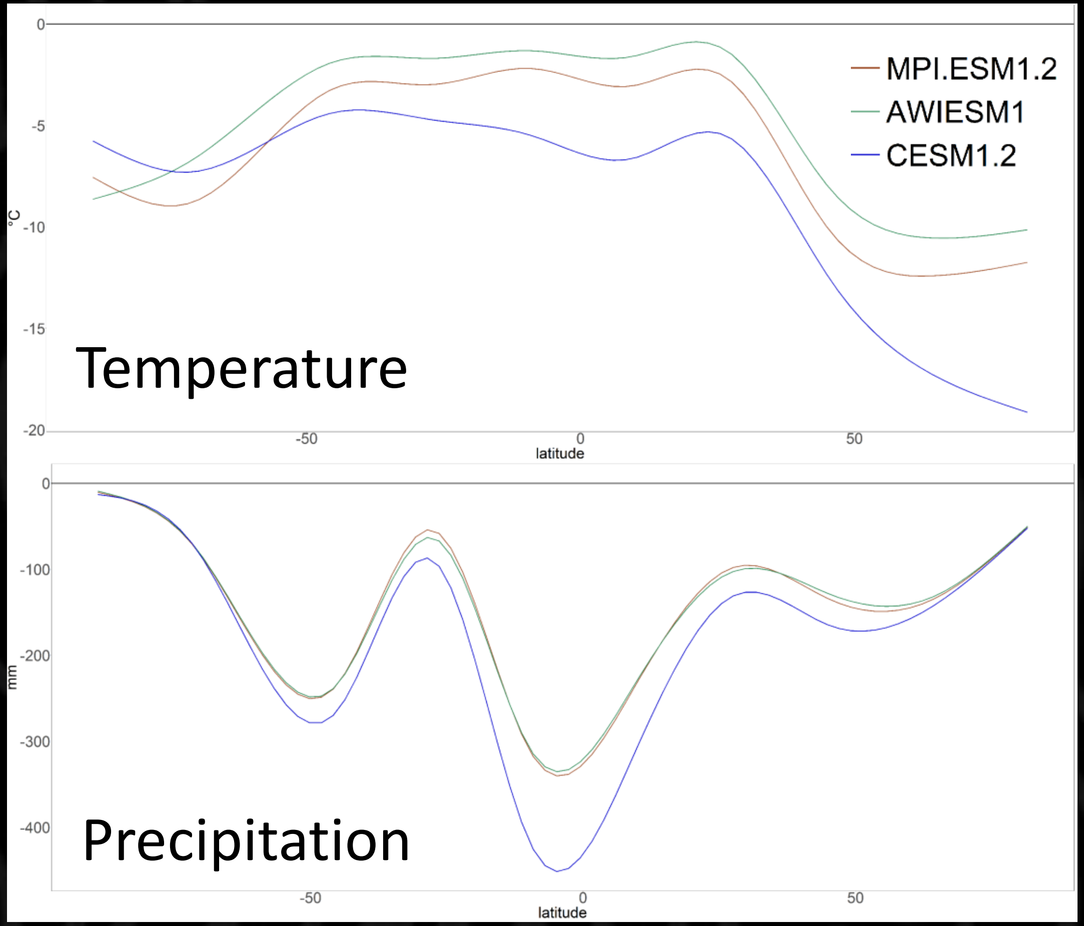
~ 21, 000 years ago



~ 185 ppm



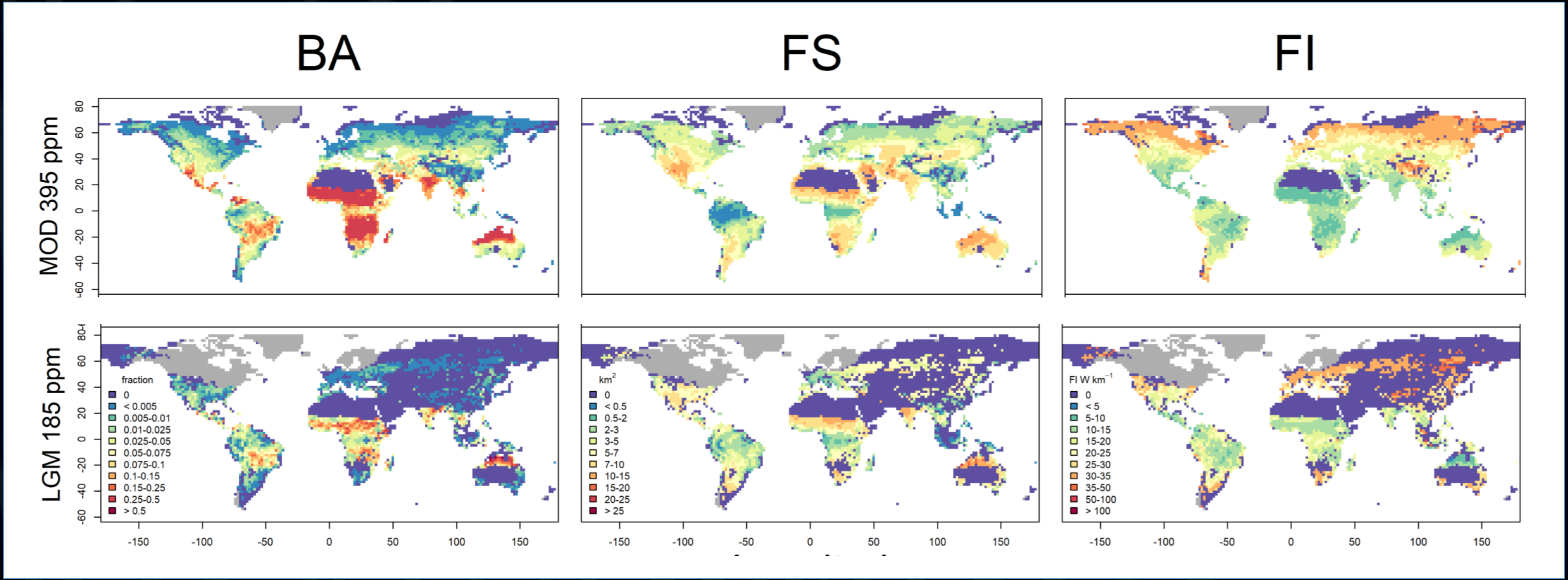
Colder and drier



↓ vegetation productivity & forest cover

↓ biomass burning globally

Modern and LGM wildfire regimes

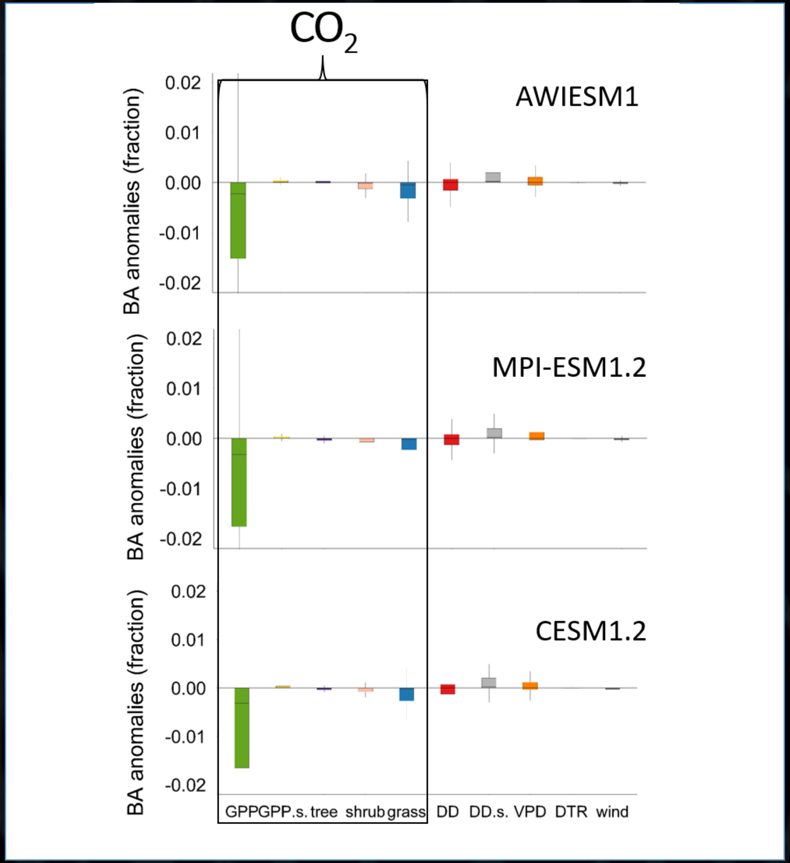


CO_2 vs climate controls at the LGM

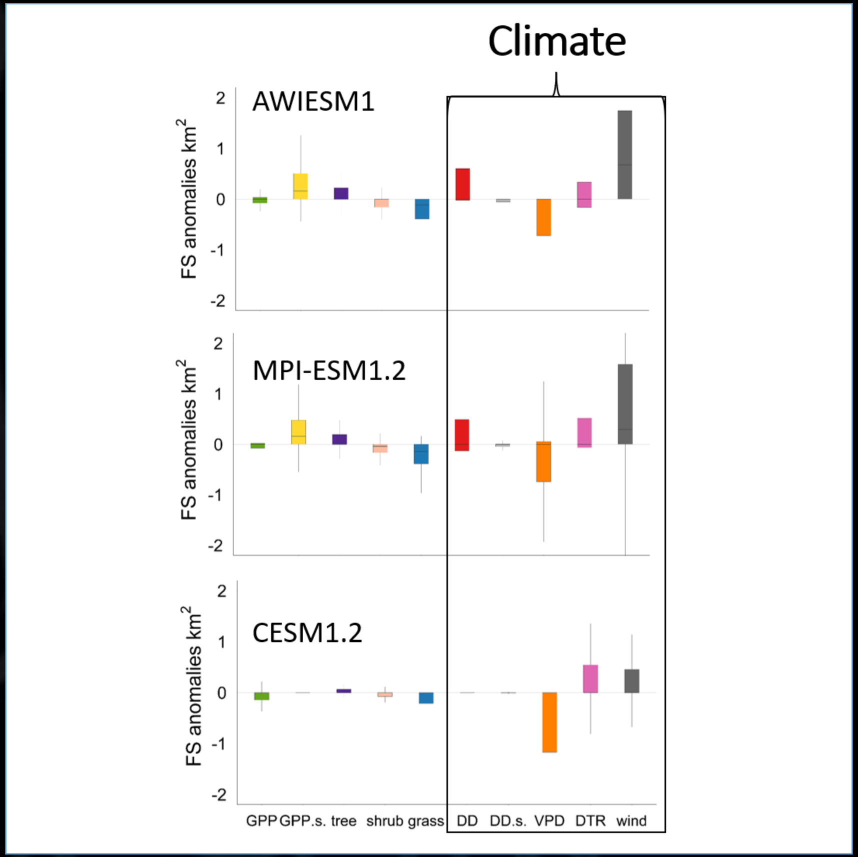
Figure 2. Boxplots showing relative importance of key predictor (GPP: gross primary production, grass: grass cover, VPD: vapour pressure deficit, wind: wind speed) in driving the anomaly between the MOD 395 ppm and LGM 190 ppm experiment

Sensitivity analysis

CO_2 sensitivity

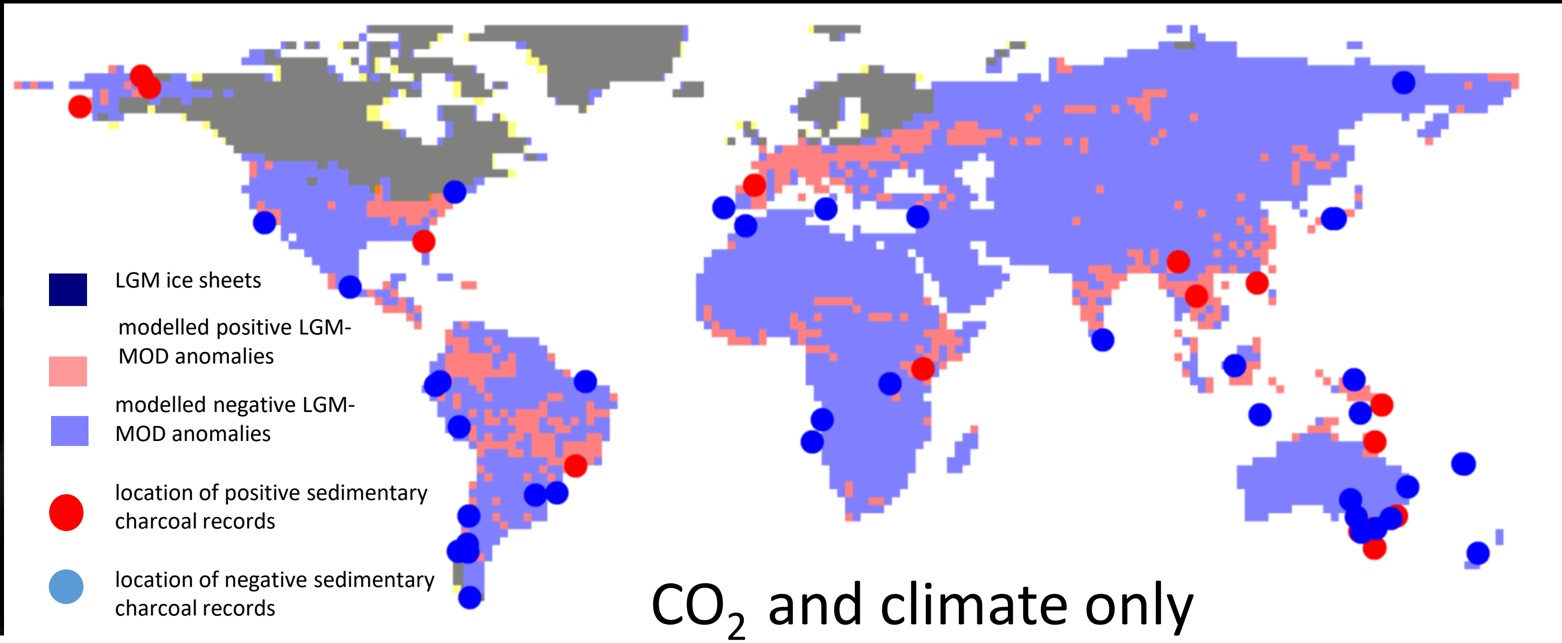


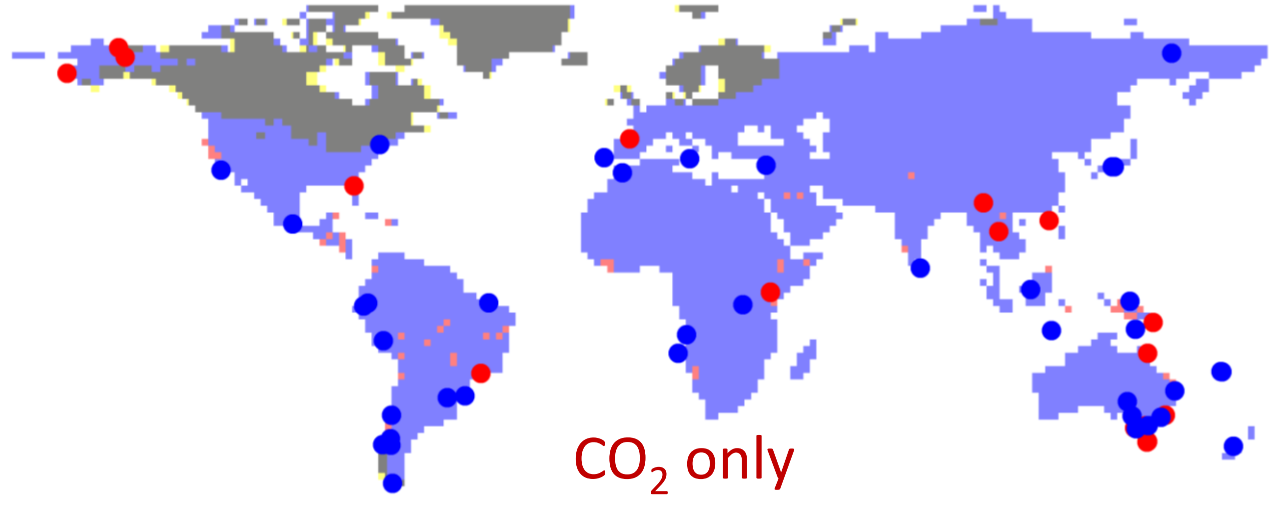
Climate sensitivity

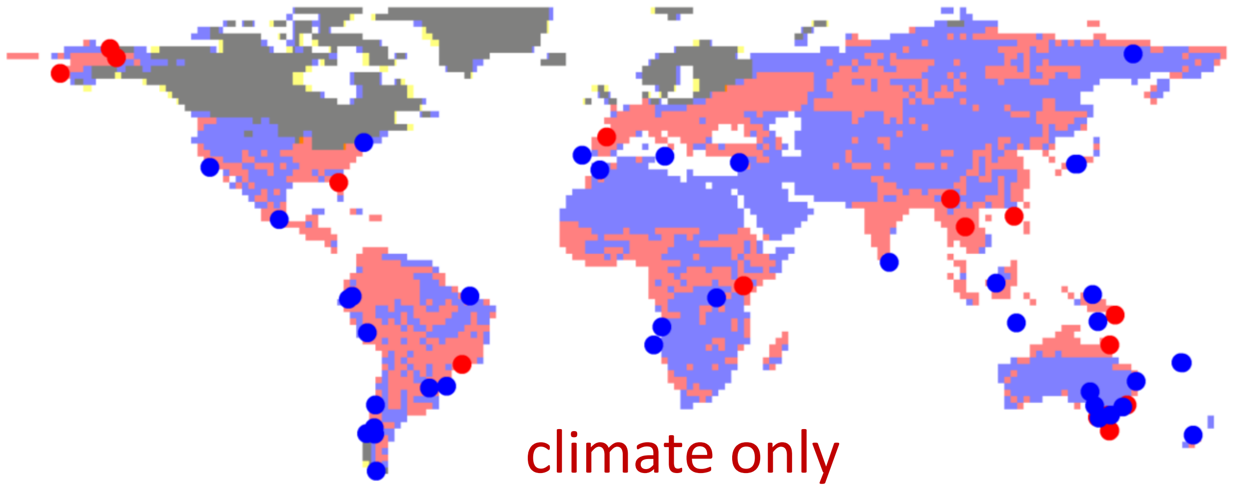


Comparison with sedimentary charcoal records

BA LGM-MOD anomalies





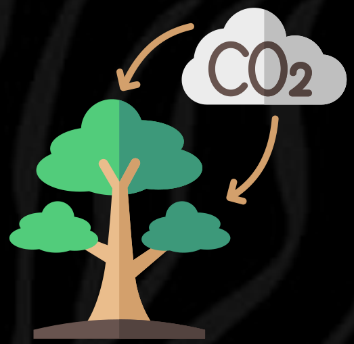


Step 3: Out-of-sample experiments

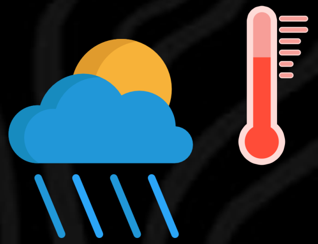
The future

Future conditions

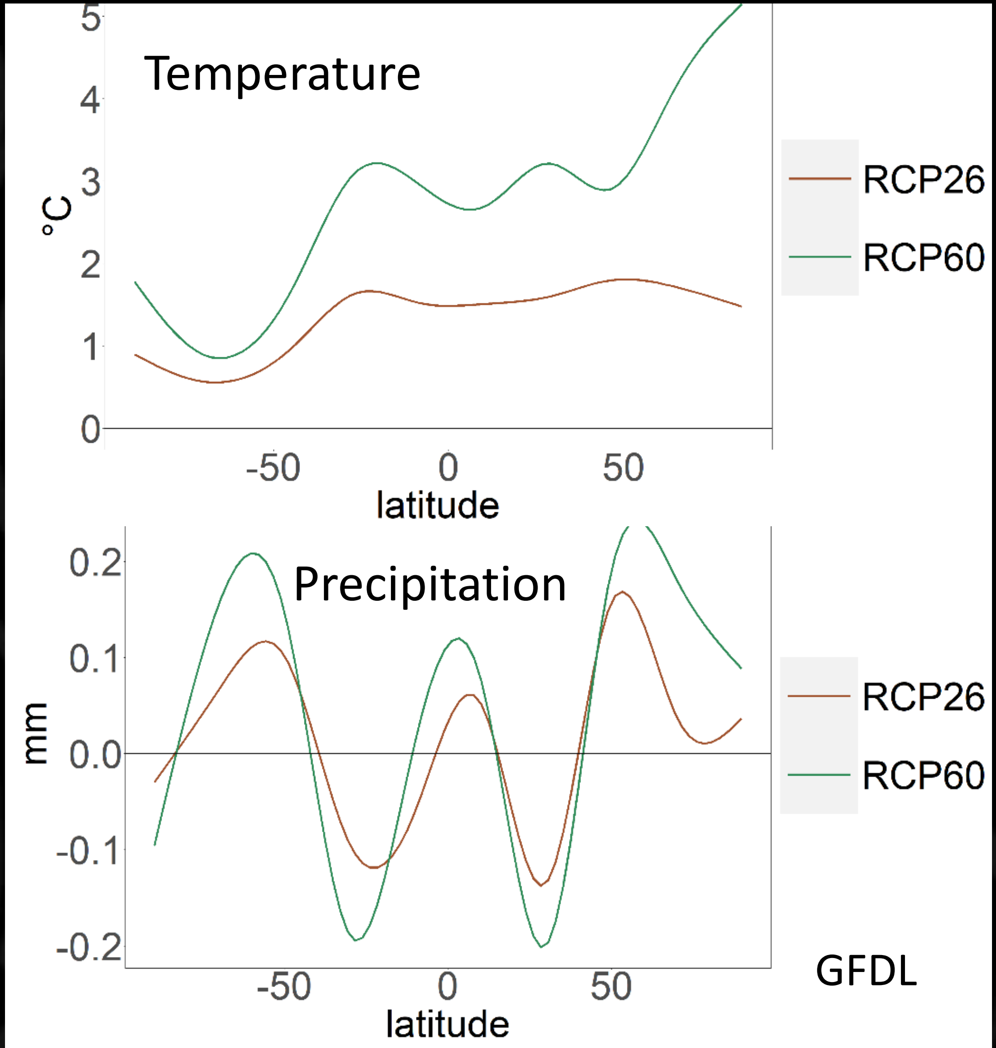
2100 RCP 2.6 & RCP 6.0, SPP2



~ 420-650 ppm

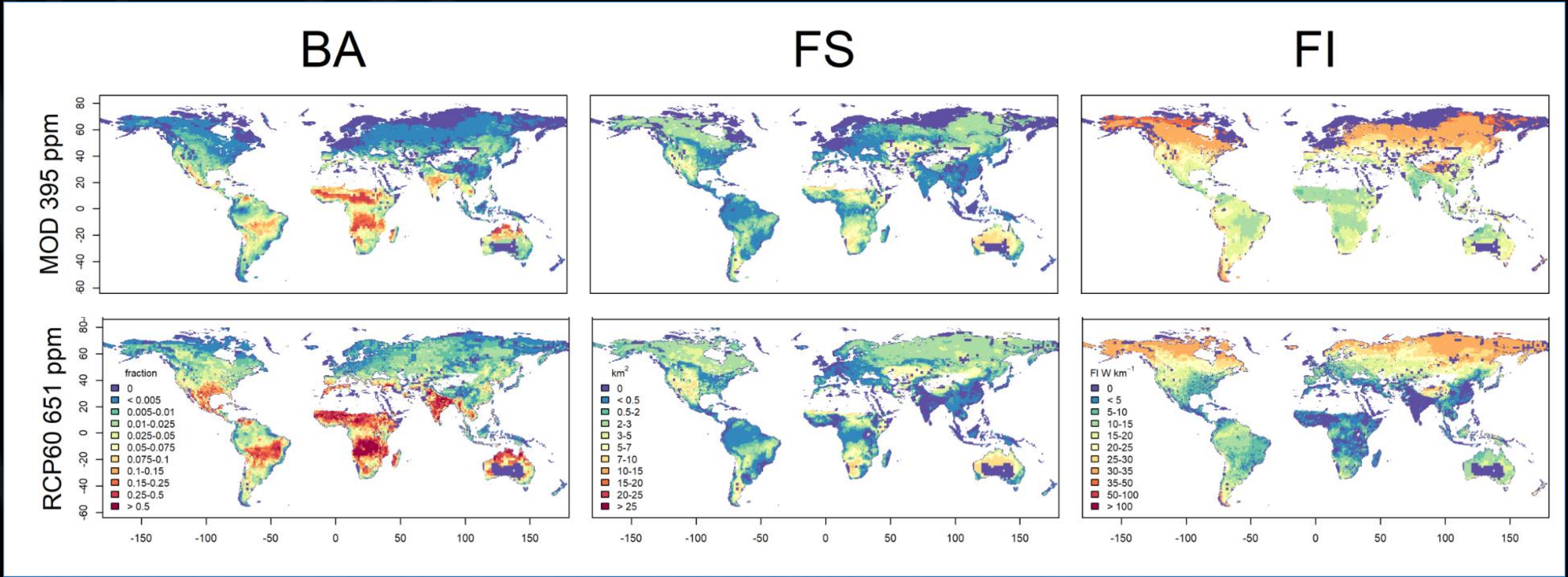


Hotter

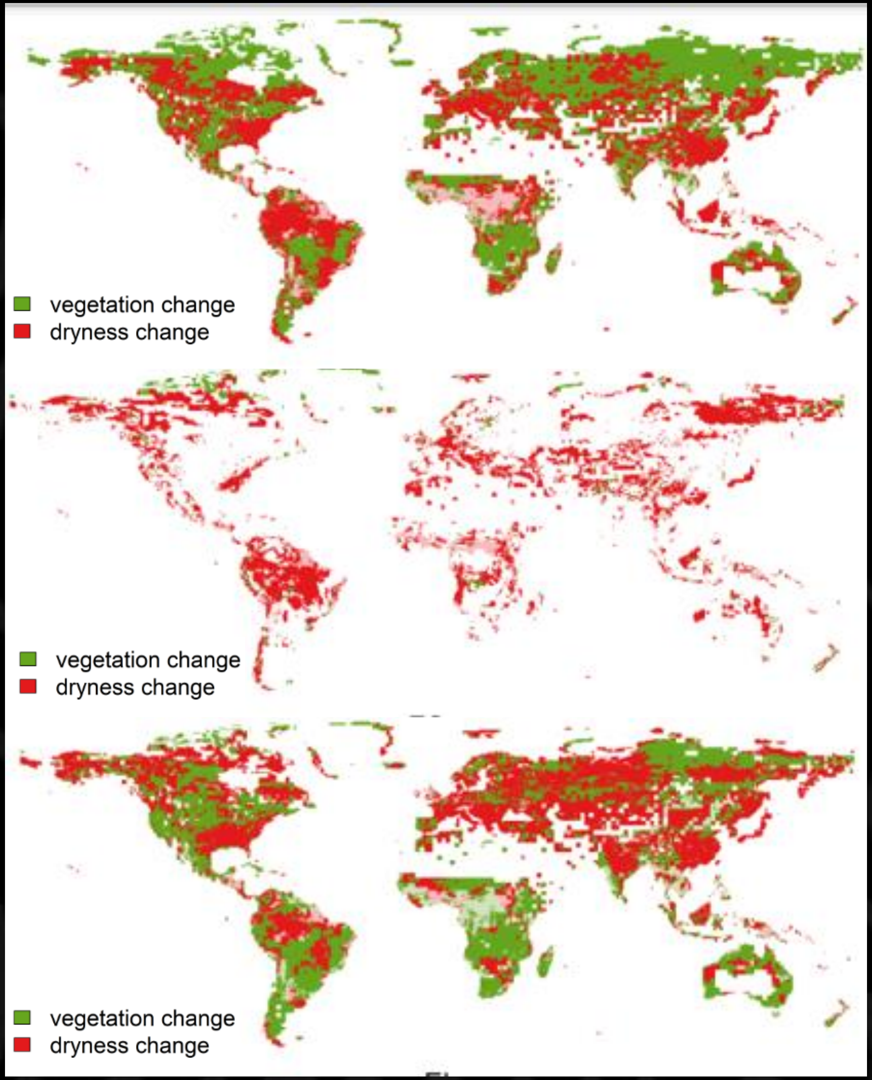


A lot of uncertainty

Modern and RCP6.0 wildfire regimes



CO_2 vs climate controls under RCP 6.0



Similar sensitivity to LGM

Human sensitivity?

Conclusions

Useful for global fire model development

1. GLM analysis as **benchmarking** tool
2. Different fire properties → different **responses**
3. Quantification of **CO_2 effect** → essential for accurate modelling