South American fires and their impacts on ecosystems increase with continued emissions

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& thanks to Karina Williams

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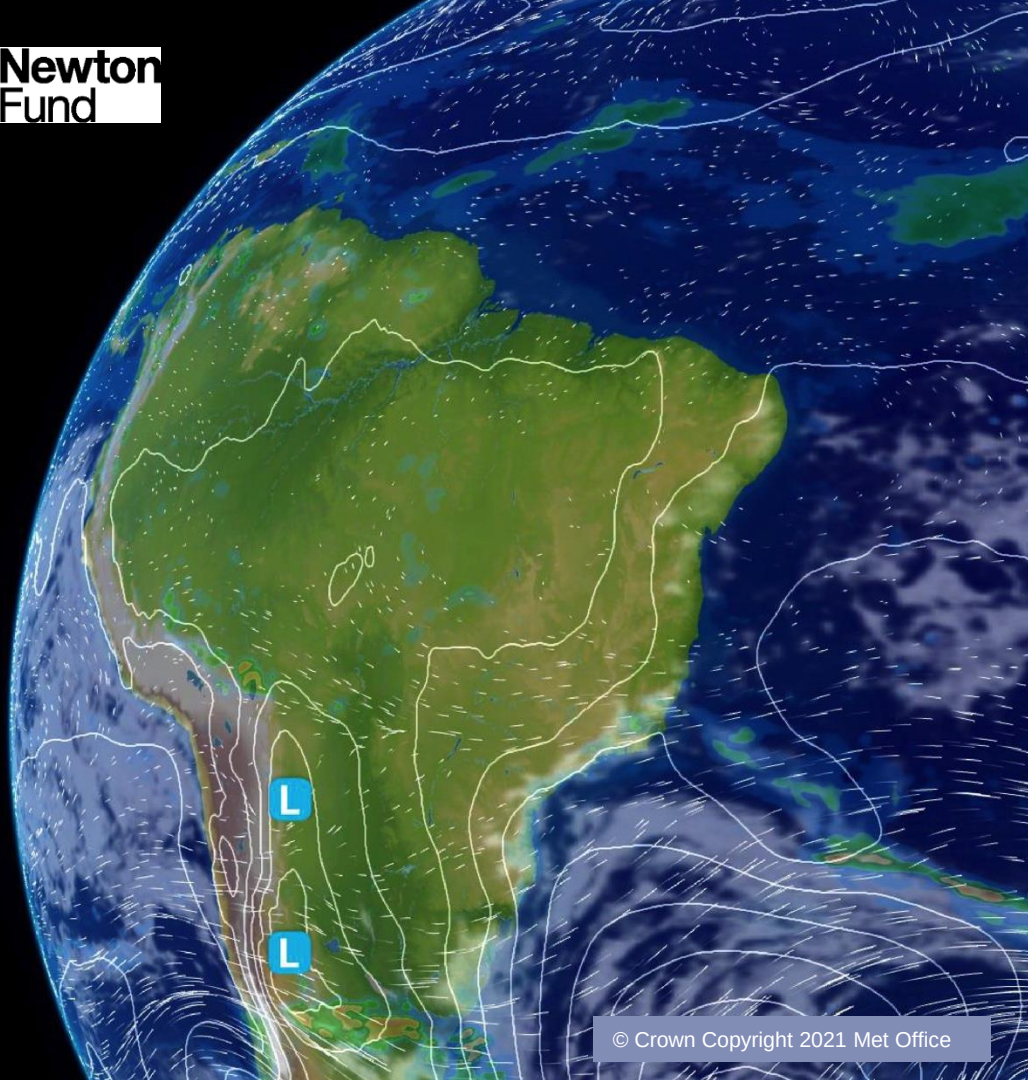

Context

- We are already seeing shifts in fire regimes in South America (e.g. Jolly et al 2015*)
- But confidence in future projections of fire is low, based on complexity of interactions and feedbacks, and large variation across models (IPCC AR5)
- Disagreement in future projections of rainfall over South America as well
- UKESM1 does not include fire-vegetation interactions within the carbon cycle
- We assess the impact of fire on carbon storage for future global warming levels (GWLs) using UKESM1 climate forcing in JULES
- How much fire-induced carbon loss will there be over South America at different global warming levels in the future?

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Methods

- We use the JULES land surface model driven with UKESM1 climate
- We use spatially and temporally varying climate and land-use from CMIP6:

  Historical period = 1860-2014,

  Future period = 2015-2100 for SSP126, SSP370 and SSP585

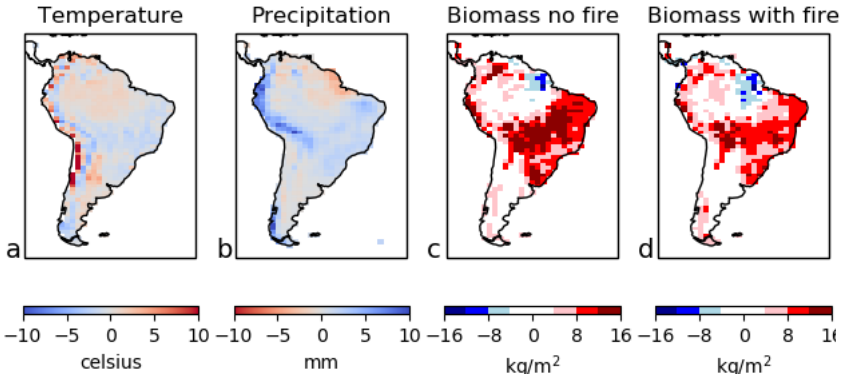
With thanks to Richard Ellis and Alistair Sellar for the UKESM runs

- We calculate change from present day to 4 GWLs: 1.5˚C, 2.0˚C, 3.0˚C, 4.0˚C
- We use dynamic vegetation from TRIFFID, coupled with the fire model INFERNO, where:

  Burnt area = ignitions x flammability x avg BA

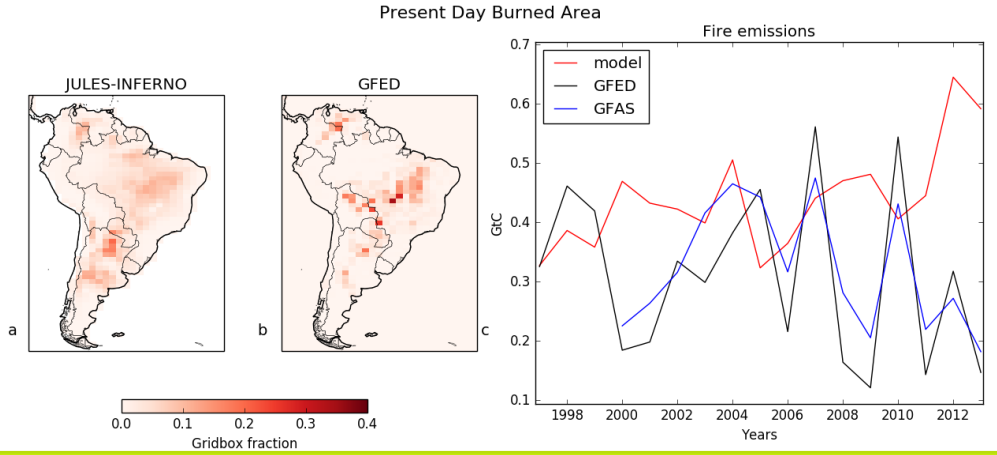
  BA (population & lightning) (Fuel, soil moisture, precip, temp, humidity)

Validation

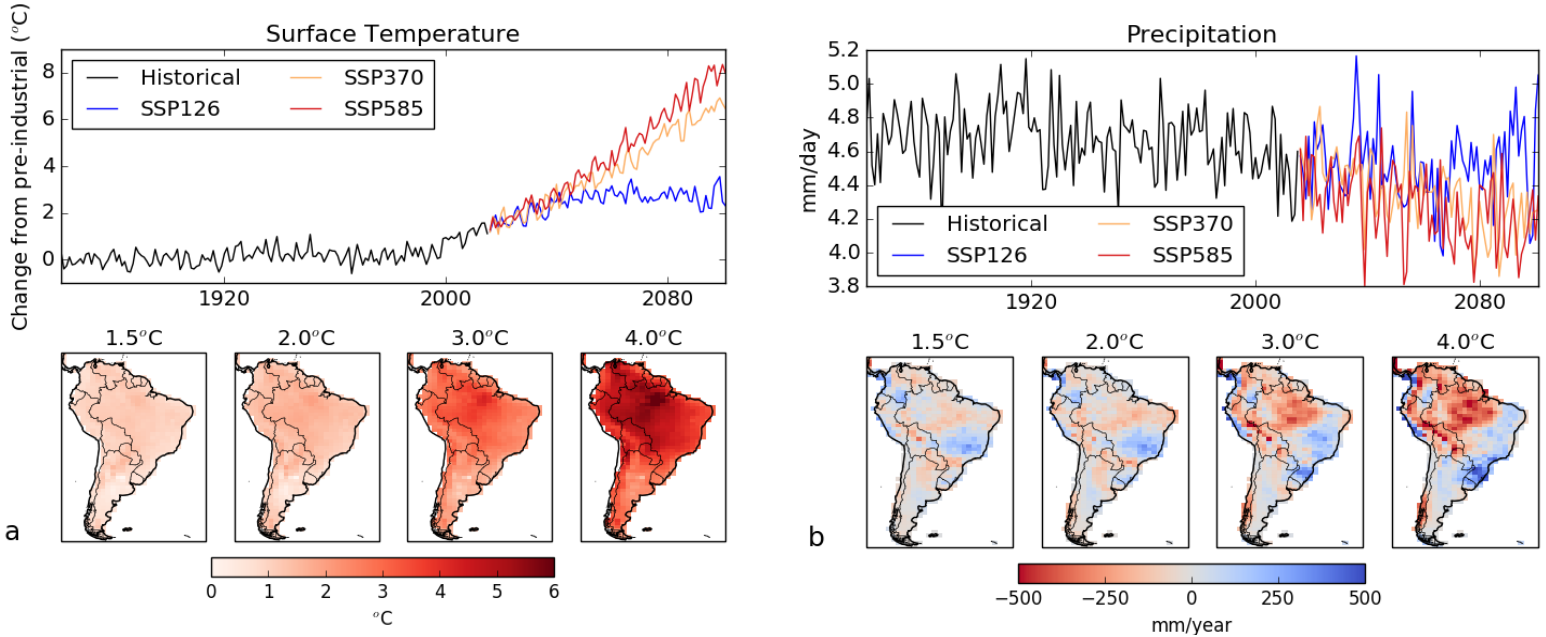


Present day modelled bias (against observations) in temperature (CRU, 1980-2013), precipitation (CMAP, 1980-2013), and biomass (Global Carbon, 1996-2005) with and without fire

Maps of burned area fraction at present day (1997-2013) modelled by JULES-INFERNO (a) and from GFED4.1s observations (b). Time series of present day (1997-2013) carbon emissions from fire as modelled by JULES-INFERNO (red), and from GFED4.1s observations (black) and GFAS observations (blue, 2000-2013) (c)

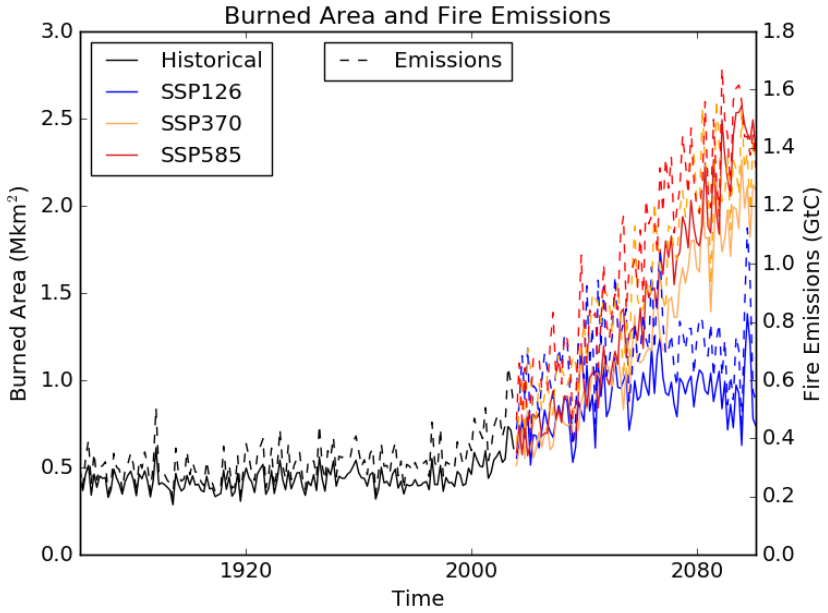


Results

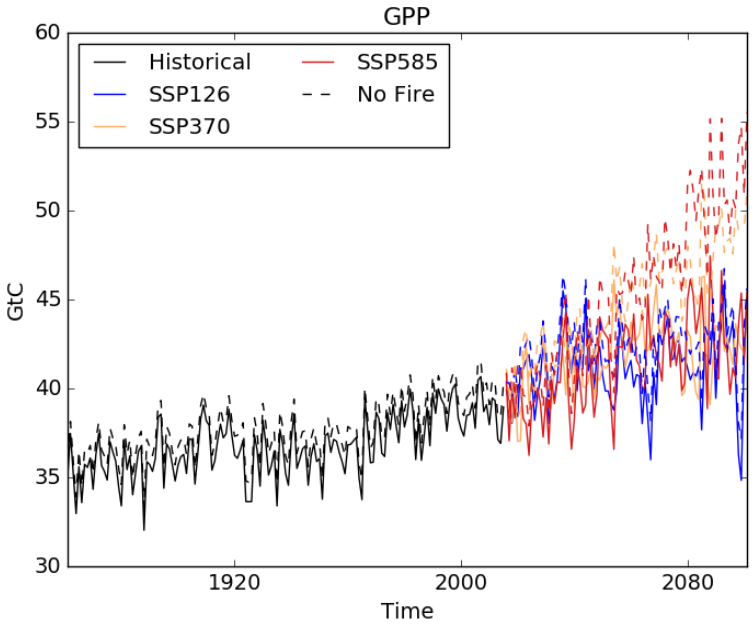


Top row: Modelled time series of (a) mean temperature (degrees Celsius above pre-industrial 1860-1900) and (b) precipitation (mm/day) over South America. Bottom row: maps of change in (a) mean temperature (degrees Celsius) and (b) precipitation (mm/year) above present day at four GWLs for SSP370

Results



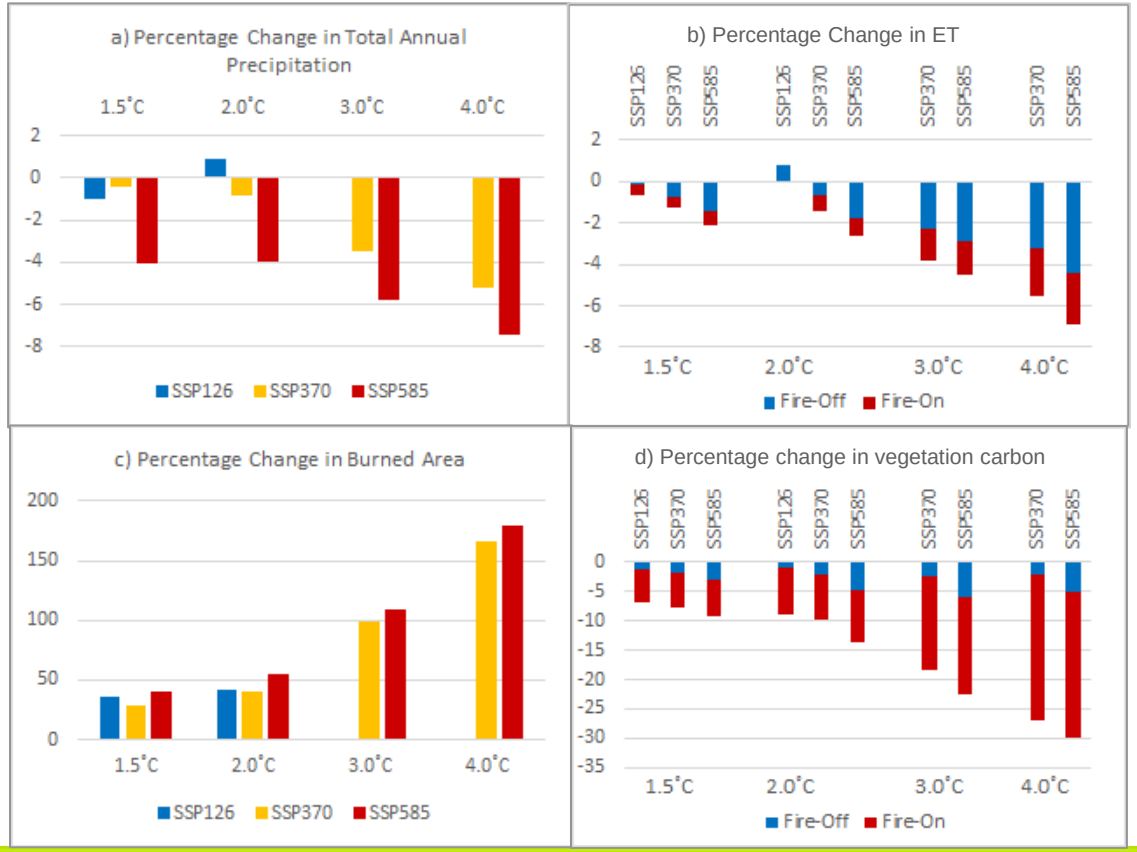
Time series of burned area (Mkm^2, solid line) and fire emissions (GtC, dashed line) for South America



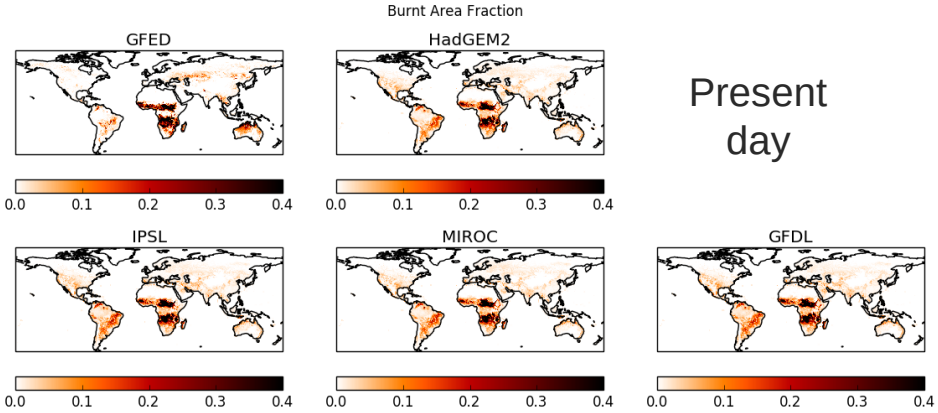
Timeseries of GPP (GtC) with fire (solid lines) and without fire (dashed lines)

Conclusions

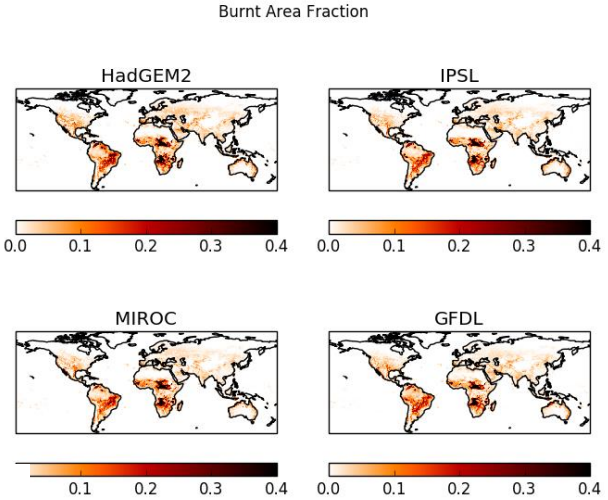
- Using UKESM1 climate projections, burned area increases in high warming, high emissions scenarios
- Fire-vegetation feedbacks could lead to loss of tree cover, vegetation carbon and productivity
- These fire-vegetation feedbacks are not currently represented in UKESM1, and could have large impacts on future projections of the carbon cycle



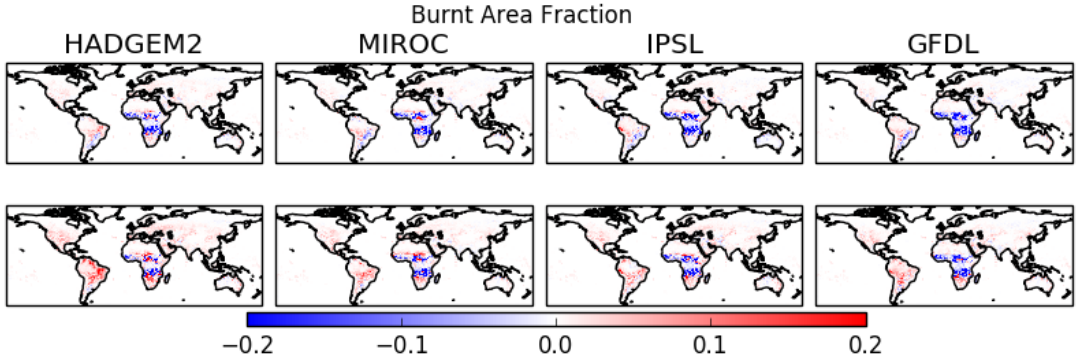
New ISIMIP runs



Present day



RCP6.0 2090s



Change from PD

Thanks to Camilla Mathison & Eleanor Burke

Met Office
Hadley Centre

Questions?