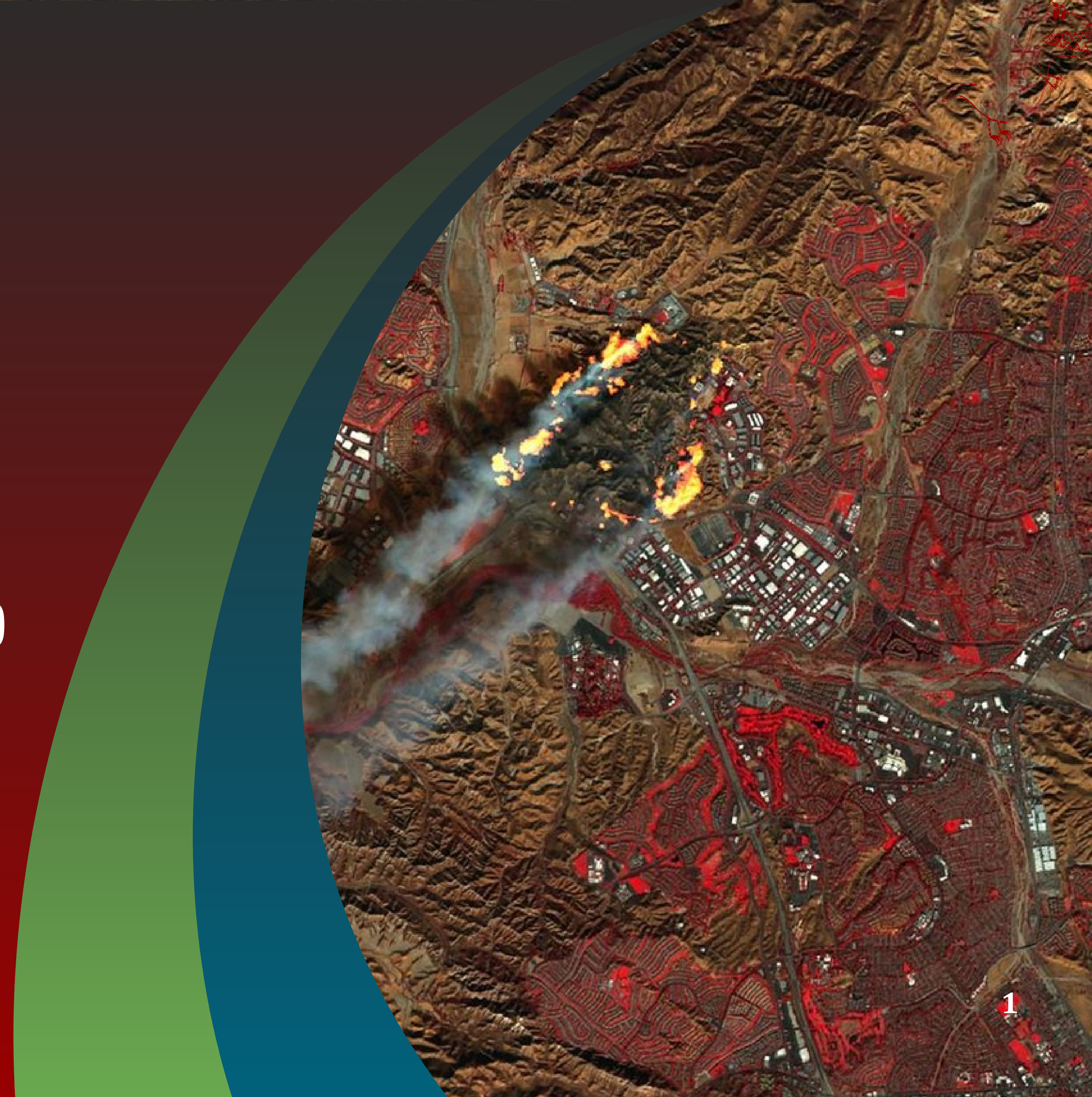# JULES fire community update 2023/24.
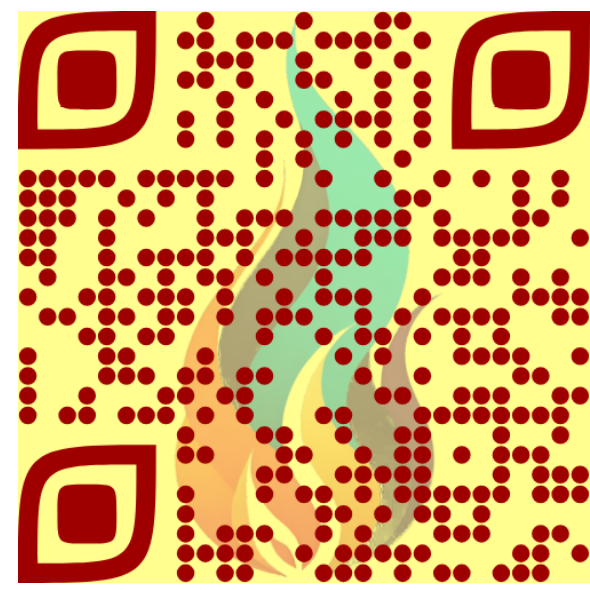
Module coordinators:
Douglas Kelley (doukel@ceh.ac.uk)
Chantelle Burton
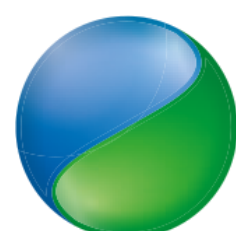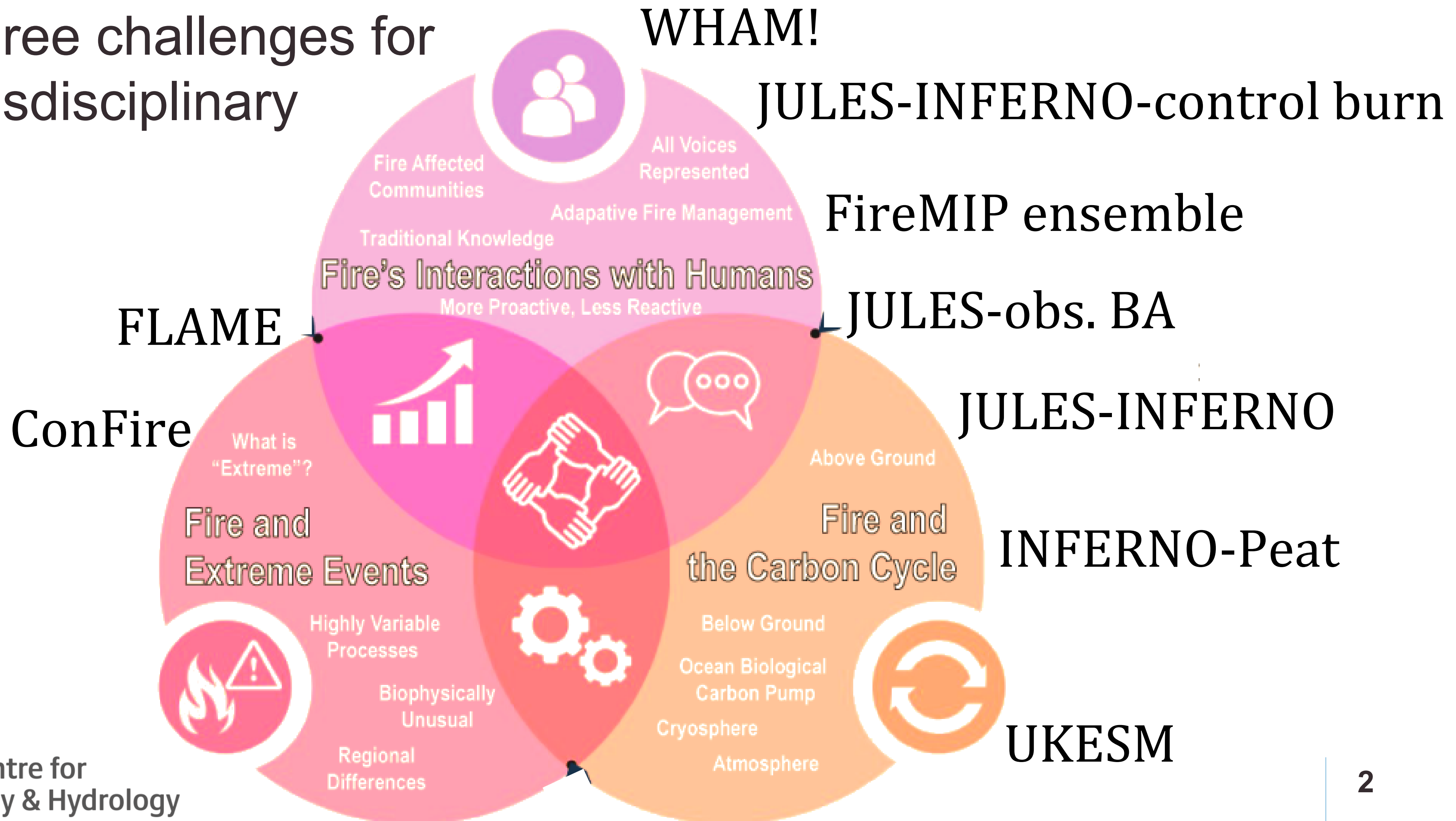
# Igniting Progress

Outcomes from the FLARE workshop and three challenges for the future of transdisciplinary fire science



WHAM!

JULES-INFERNO-control burn

FireMIP ensemble

JULES-obs. BA

JULES-INFERNO

INFERNO-Peat

FLAME

ConFire

UKESM

PROCESS
coupled to JULES

Control burns

INFERNO
Main jules workhorse

ISIMIP
Inter-Sectoral Impact Model
Intercomparison Project

ISIMIP ensemble
attribution

UKESM

State of
Wildfire 20YY

HDI

GLOBAL CARBON BUDGET
2022

ConFire/FLAME
post-process jules for
attribution & projections

INFERNO-Peat

Cour
Pénale
Internationale
International
Criminal
Court

UN environment programme

INFERNO emulator
Fast INFERNO

Prescribed obs

WHAM!
Human agency

EMPIRICAL
Post-process,
Assimilates observation

3

# UK Earth System Model Fire Development

- Integrating the INFERNO models vegetation feedback & emissions (Chantelle, Eddy).

- Atmosphere composition/chemistry coupling (Joao by Amy, Steve T)

- Investigating and prescribing missing peat & agricultural water burning emissions (Amy/Steve T)

- Human ignition and suppression development tied to Human Development Index (Joao)
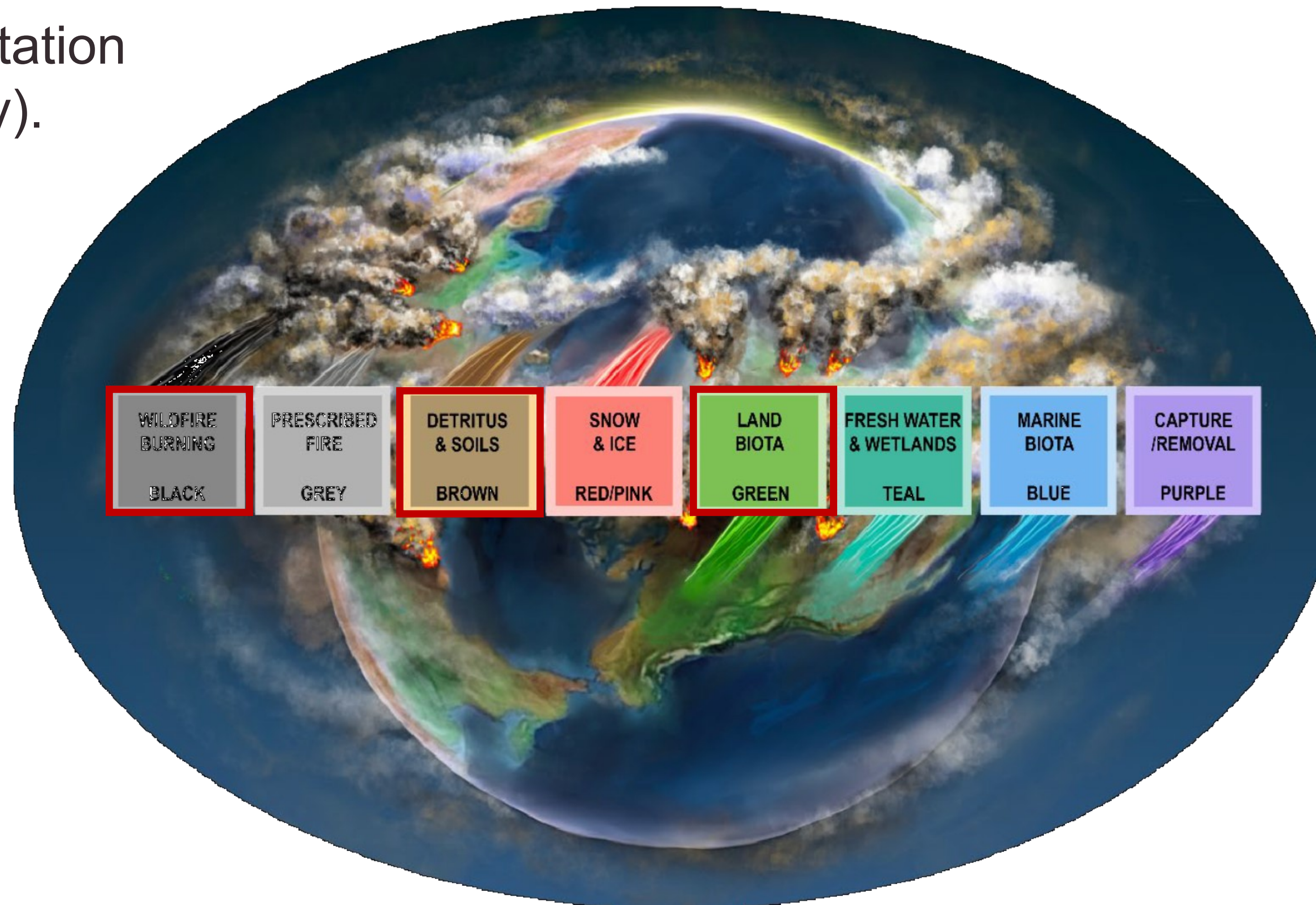
# UK Earth System Model Fire Development

- Technical work is needed to align emitted carbon in JULES with Inferno emissions – shout if you're interested in doing this.

- Assimilating observations to improve INFERNO model parameterisation when in UKESM (DougK/Chantelle/Eddy/Rob)

Application by James Weber:

Preparing UKESM transient runs (~2025-2100) to investigate fire impacts on forestation's climate effect. Includs: atmospheric composition (CO2, BVOCs, O3, methane, aerosols, clouds) & surface albedo to assess net radiative forcing, with potential need for external expertise in other areas.



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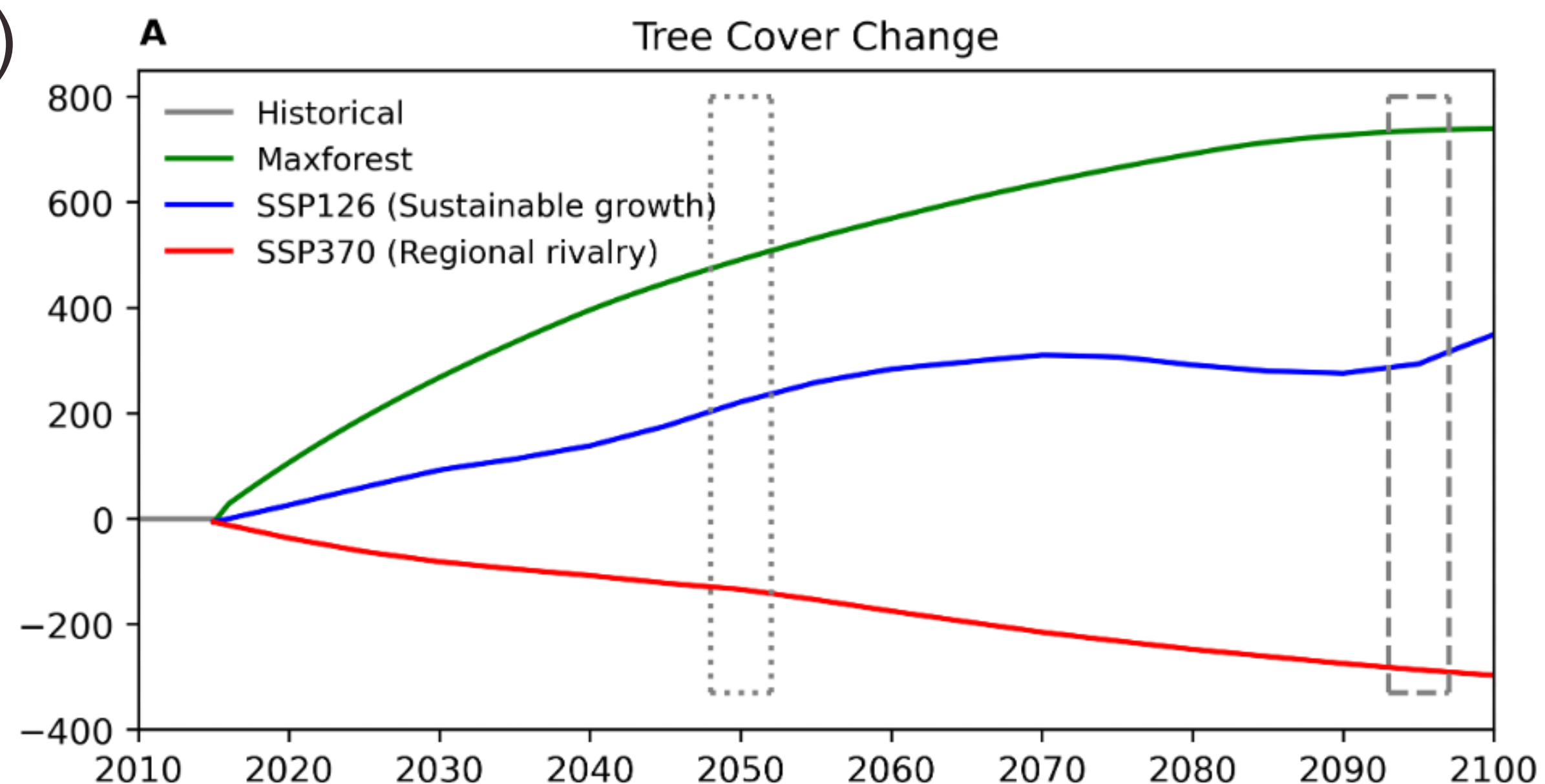
# INFERNO-peat

- Parameterisation of peat fires in the northern high latitudes
- Evaluated for present day (1997-2014) – Blackford et al., 2024 https://doi.org/10.5194/gmd-17-3063-2024
- Able to simulate future trajectories of peat fire change under SSP scenarios
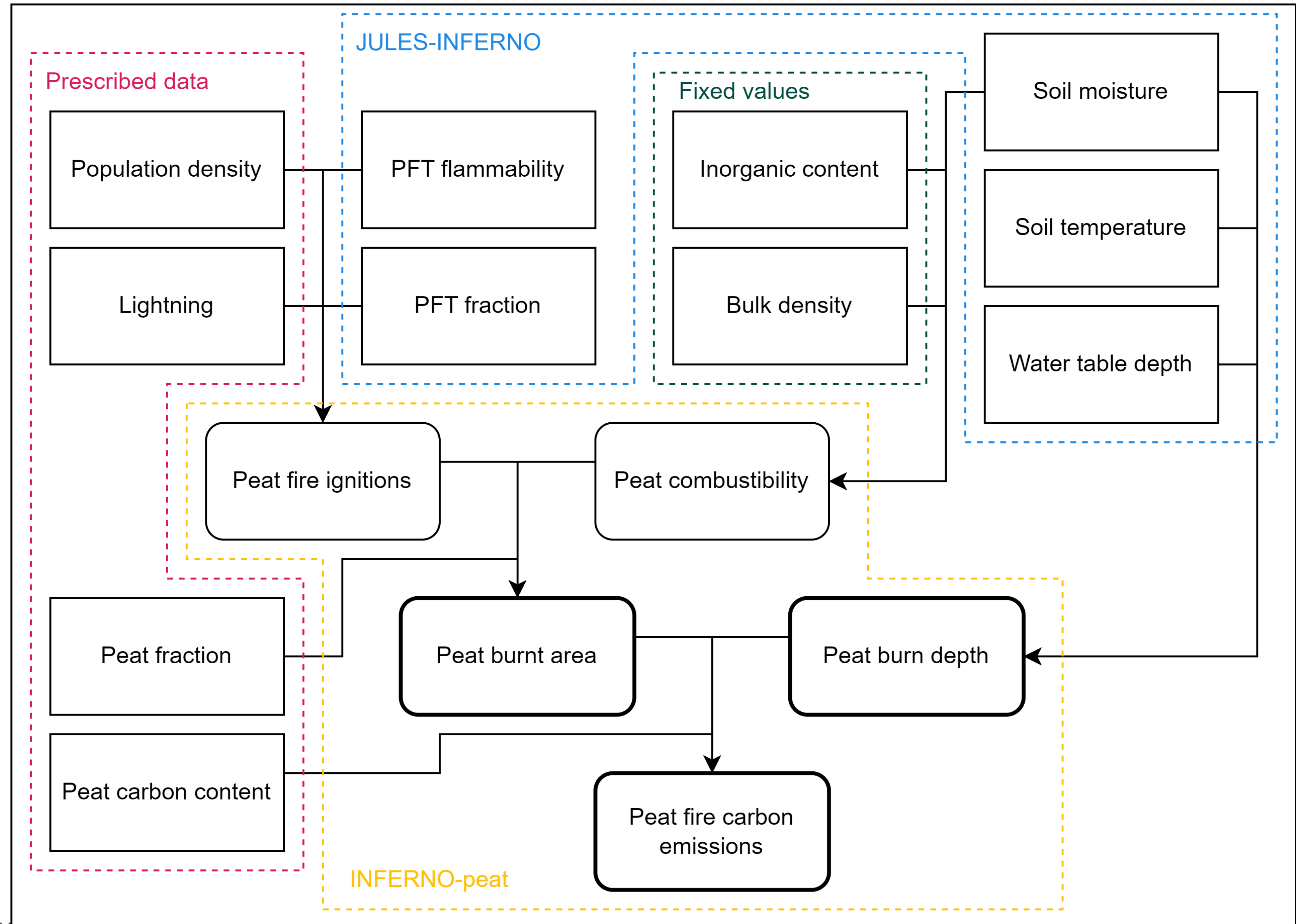
# Modelling future peat burnt area with INFERNO-peat
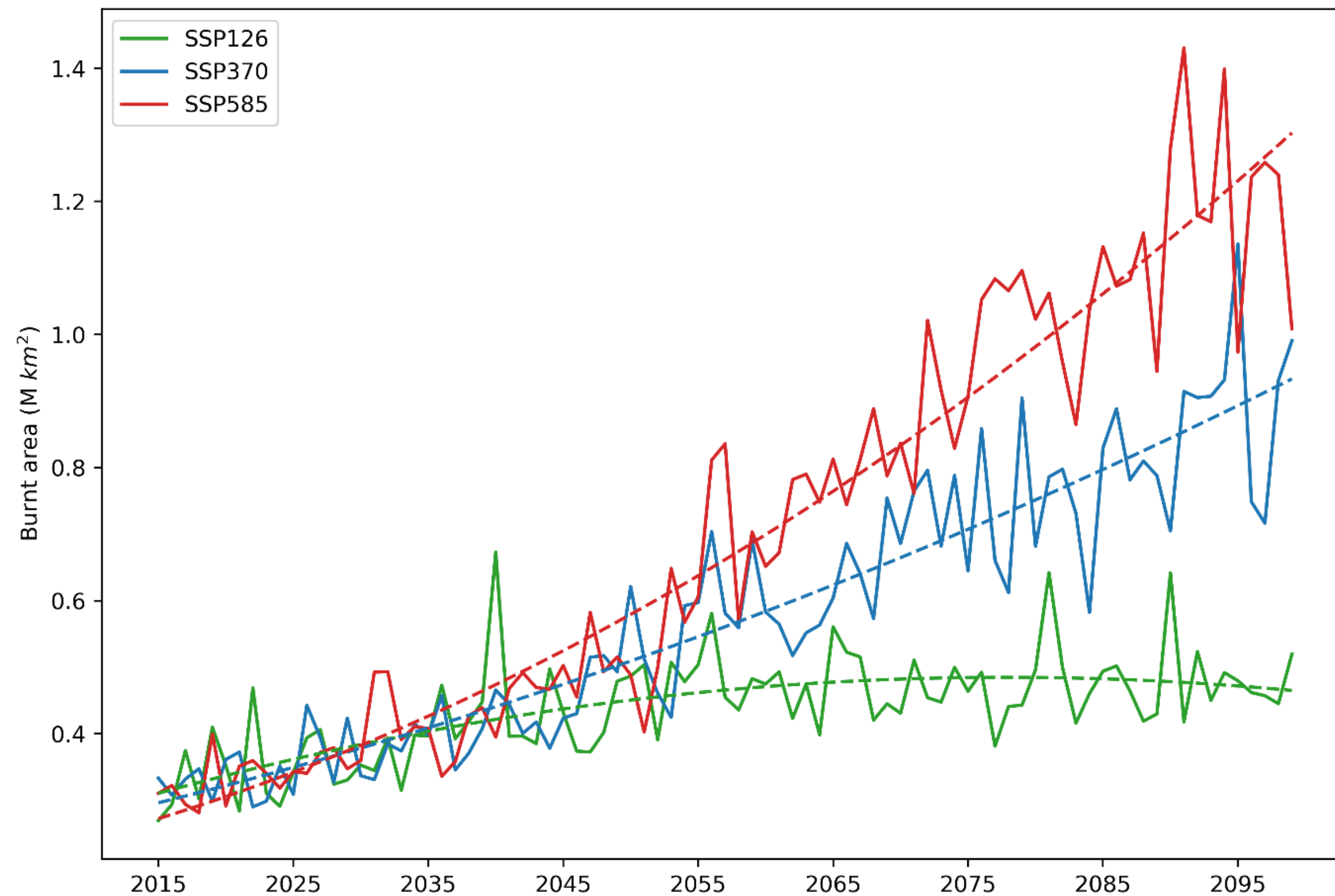


a) SSP126

b) SSP370

c) SSP585

BA fraction change
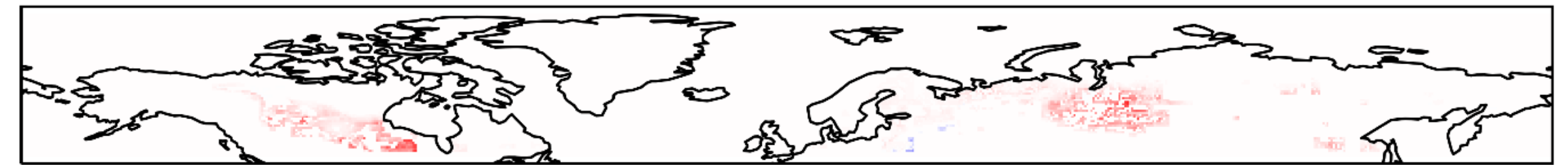
- Peat BA increases under all scenarios
- Largest increase in central Canada and western Siberia
- 270% increase in peat BA by end of century under SSP585

# WHAM!

Published in GMD & WHAM! Offline coupling with INFERNO in review

Completed work on livestock grazing intensity. Shows impacts of livestock farming on burnt area explain ~20-30% of residual between fire model & GFED obs.
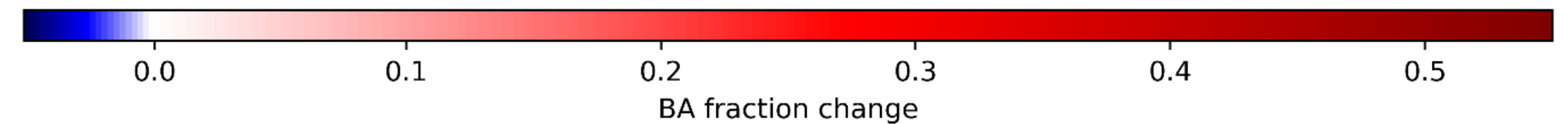
Now working on forest management for fire prevention, particularly for carbon forestry.

...and have started tight coupling, focus of work from Jan 2024.

Perkins, O., Kasoar, M., Voulgarakis, A., Smith, C., Mistry, J. and Millington, J.D., 2024. A global behavioural model of human fire use and management: WHAM! v1. 0. *Geoscientific Model Development*, *17*(9), pp.3993-4016.



https://gmd.copernicus.org/articles/17/3993/2024/

Met Office

UK Centre for Ecology & Hydrology

8
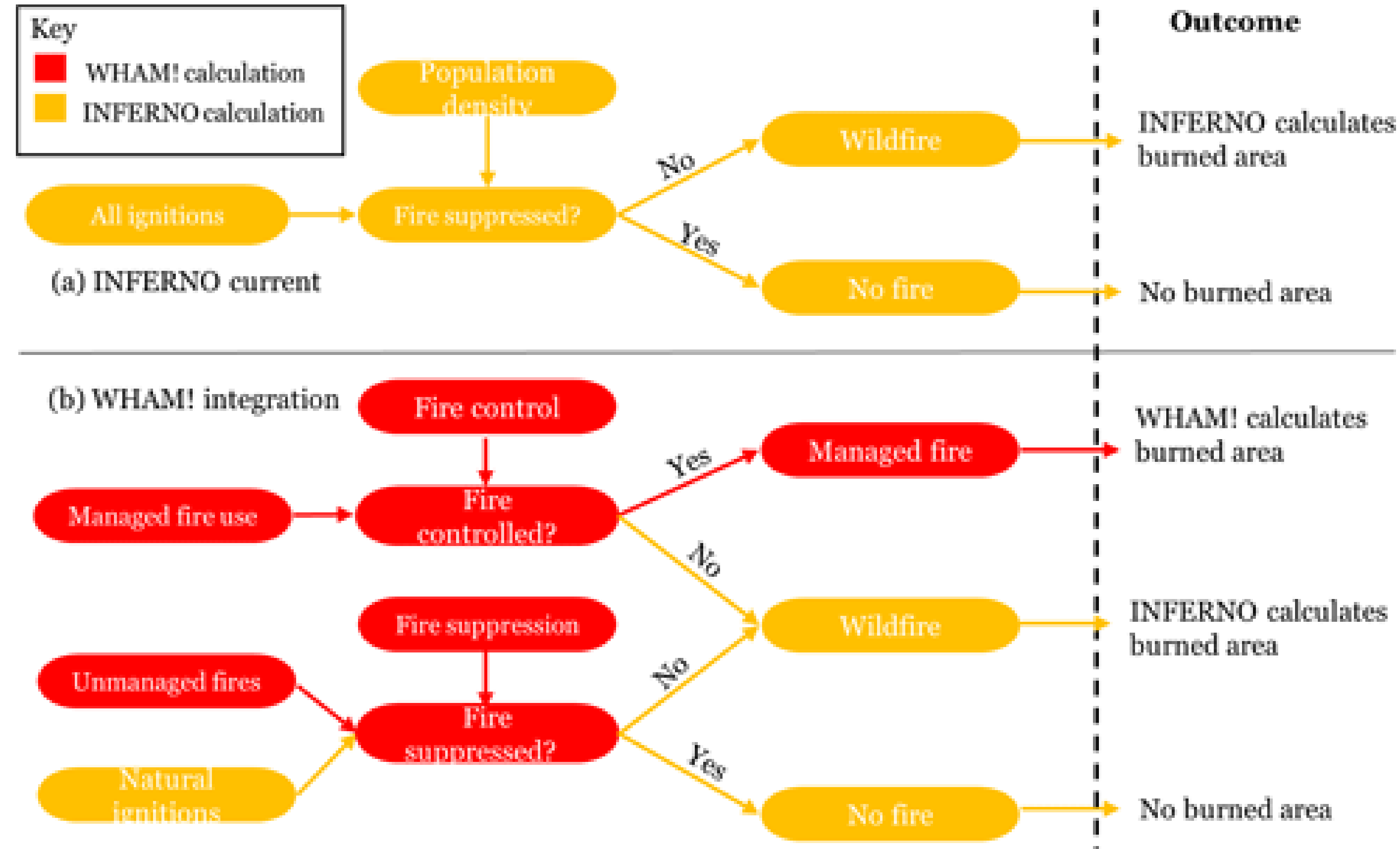
# Other developments

Our Brazil-based Team – see ISIMIP talk

1. FLAME: which will eventually supplement ConFire for direct attribution and uncertainty quantification (Maria LFB, DougK)

2. Intensity of fire extremes (Igor, DougK)

3. Prescribed burning in the Cerredo (Renata V)

This afternoons talks:

1. Prescribing burnt area obs. into JULES:Improving fire disturbance in JULES for the Global Carbon Budget (Mike O S)

2. State of Wildfires report

3. JULES-INFERNO in an ISIMIP ensemble: Global Burned Area Increasingly Explained By Climate Change

4. Towards UKESM2: The Role of Interactive Fire on Atmospheric Composition and Climate (AmyP)

# Publications

Mathison, C., Burke, E., Hartley, A.J., Kelley, D.I., Burton, C., Robertson, E., Gedney, N., Williams, K., Wiltshire, A., Ellis, R.J. and Sellar, A.A., 2023. Description and evaluation of the JULES-ES set-up for ISIMIP2b. *Geoscientific Model Development*, *16*(14), pp.4249-4264.

Blackford, K.R., Kasoar, M., Burton, C., Burke, E., Prentice, I.C. and Voulgarakis, A., 2024. INFERNO-peat v1. 0.0: a representation of northern high-latitude peat fires in the JULES-INFERNO global fire model. *Geoscientific Model Development*, *17*(8), pp.3063-3079.

Cheng, S., Chassagnon, H., Kasoar, M., Guo, Y. and Arcucci, R., 2024. Deep Learning Surrogate Models of JULES-INFERNO for Wildfire Prediction on a Global Scale. *IEEE Transactions on Emerging Topics in Computational Intelligence*.

Teixeira, J.C.M., Burton, C., Kelly, D.I., Folberth, G.A., O'Connor, F.M., Betts, R.A. and Voulgarakis, A., 2023. Representing socio-economic factors in the INFERNO global fire model using the Human Development Index. *Biogeosciences Discussions*, *2023*, pp.1-27.

Perkins, O., Kasoar, M., Voulgarakis, A., Smith, C., Mistry, J. and Millington, J.D., 2024. A global behavioural model of human fire use and management: WHAM! v1. 0. *Geoscientific Model Development*, *17*(9), pp.3993-4016.

da Veiga, R.M., von Randow, C., Burton, C., Kelley, D., Cardoso, M. and Morelli, F., 2024. Understanding the placement of fire emissions from the Brazilian Cerrado biome in the atmospheric carbon budget. *EGUsphere*, *2024*, pp.1-27.

Burton, C., Lampe, S., Kelley, D., Thiery, W., Hantson, S., Christidis, N., Gudmundsson, L., Forrest, M., Burke, E., Chang, J. and Huang, H., 2023. Global burned area increasingly explained by climate change, Nature Climate Change Accepted

Park, C., Takahashi, K., Fujimori, S., Jansakoo, T., Burton, C., Huang, H., Kou-Giesbrecht, S., Reyer, C., Mengel, M., Burke, E. and Li, F., 2023. Attributing human mortality from fire PM2. 5 to climate change, In revirew

Barbosa, M.L.F., Kelley, D.I., Burton, C.A., Ferreira, I.J., da Veiga, R.M., Bradley, A., Molin, P.G. and Anderson, L.O., 2024. FLAME 1.0: a novel approach for modelling burned area in the Brazilian biomes using the Maximum Entropy concept. *EGUsphere*, *2024*, pp.1-47.

Jones, M.W., Kelley, D.I., Burton, C.A., Di Giuseppe, F., Barbosa, M.L.F., Brambleby, E., Hartley, A.J., Lombardi, A., Mataveli, G., McNorton, J.R. and Spuler, F.R., 2024. State of Wildfires 2023–2024. *Earth System Science Data*, *16*(8), pp.3601-3685.

Kelley, D., Gerard, F., Dong, N., Burton, C., Argles, A., Li, G., Whitley, R., Marthews, T., Roberston, E., Weedon, G. and Lasslop, G., 2023. Observational constraints of fire, environmental and anthropogenic on pantropical tree cover, Earth & Environment, accepted

Hamilton, D. S., Kelley, D., Perron, M. M. G., Llort, J., Burton, C., Bergas-Masso, E., Ligouri-Bills, N., Barkley, A., Buchholz, R., Diez, S., Dintwe, K., Forkel, M., Hall, J., Hantson, S., Hayman, G., Hebden, S., Jones, M. W., Kulkarni, C., Nowell, B., ... Volker, C. (2024). Igniting Progress: Outcomes from the FLARE workshop and three challenges for the future of transdisciplinary fire science. Zenodo. https://doi.org/10.5281/zenodo.12634068

Pellegrini, A.F., Reich, P.B., Hobbie, S.E., Coetsee, C., Wigley, B., February, E., Georgiou, K., Terrer, C., Brookshire, E.N.J., Ahlström, A. and Nieradzik, L., 2023. Soil carbon storage capacity of drylands under altered fire regimes. *Nature Climate Change*, *13*(10), pp.1089-1094.

Hantson, S., Hamilton, D.S. and Burton, C., 2024. Changing fire regimes: Ecosystem impacts in a shifting climate. *One Earth*, *7*(6), pp.942-945.

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Did we miss anyone? Anything you want to see? doukel@ceh.ac.uk

## **Wanna be a fire module lead**

- We would like a third module lead from next year onwards

- Things we would like to do more of:
  - Fire module meet up
  - Chasing people to put fire developments into JULES
  - Ticket and code change support
  - Bringing data science into JULES-INFERNO.

Interested? email: Emma Robinson (emrobi@ceh.ac.uk)

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