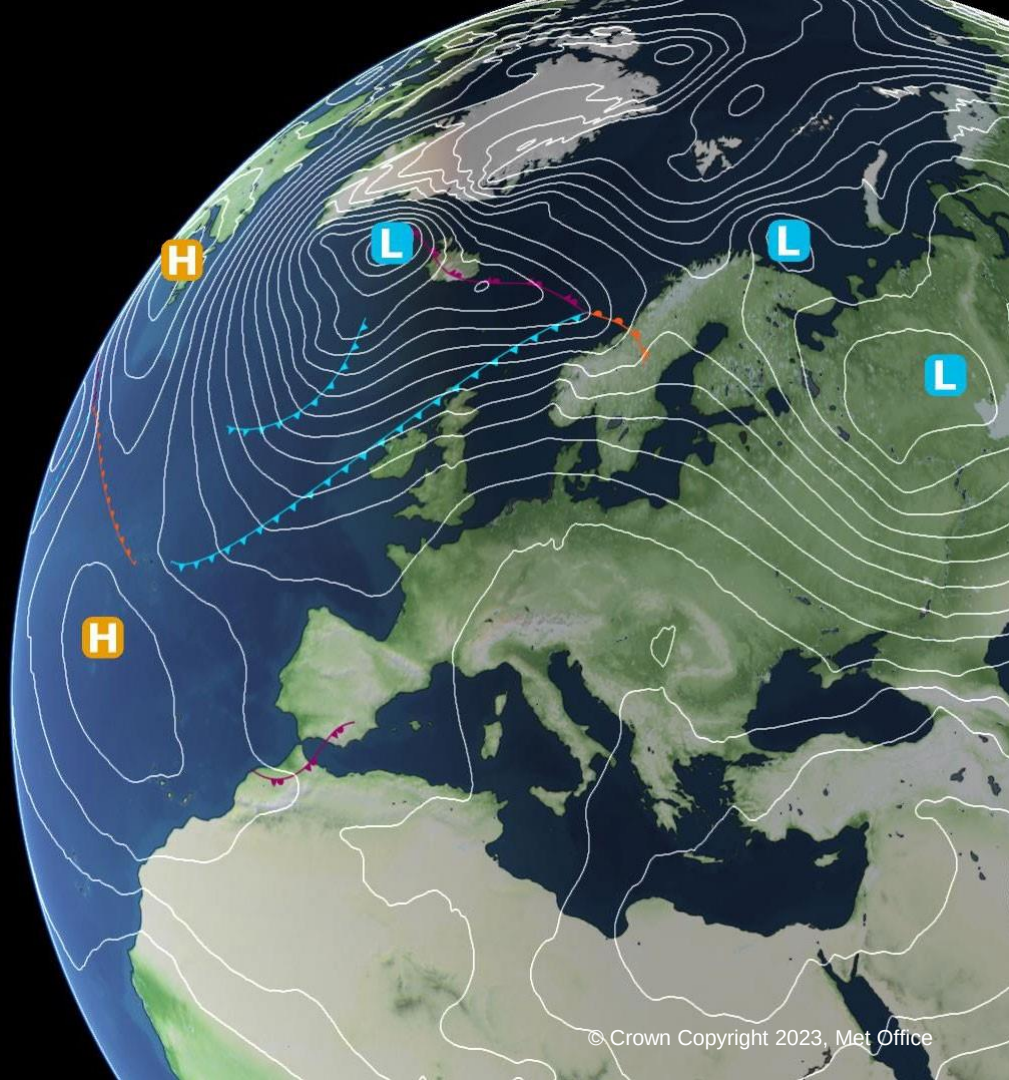
JULES as an impacts model

Andy Hartley, Eleanor Burke, Camilla Mathison, Doug Kelley, Chantelle Burton, Eddy Robertson, Nic Gedney, Jess Stacey, Emma Robinson, Anna Bradley, Ron Kahana, and many others

JULES Annual Meeting, 15th September



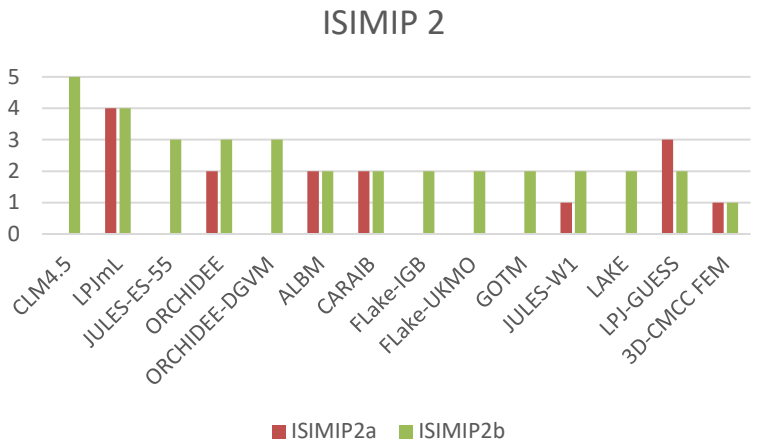
ISIMIP: Inter-Sectoral Impacts Model Inter-comparison Project

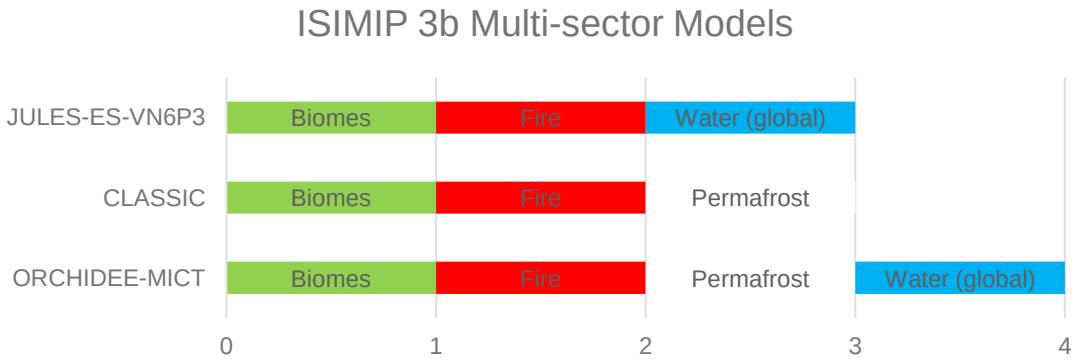
"ISIMIP provides a framework for consistently projecting the impacts of climate change across affected sectors and spatial scales"

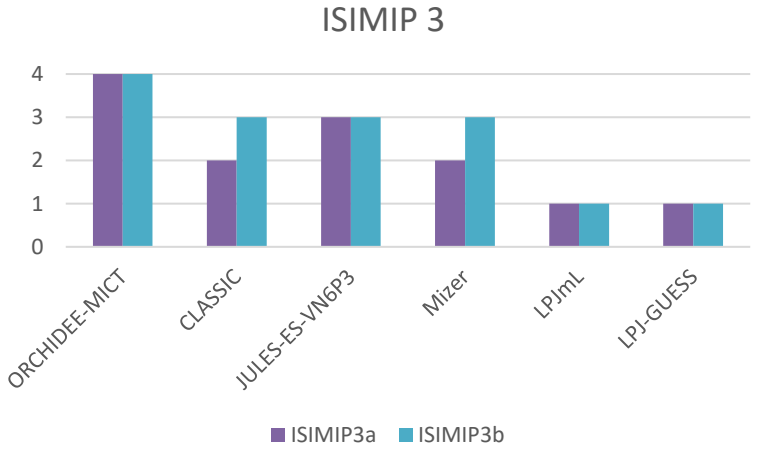
- **Aim**: use JULES to quantify the impacts of climate on multiple sectors (Biomes, Hydrology, Fire & Agriculture), understand uncertainties and look at interactions between different sectors.
- **JULES Setup**: 0.5° resolution, daily timestep (disaggregated), bias corrected driving data for pre-industrial, historical, SSP1-26, SSP3-70, and SSP5-85
- **Includes:** TRIFFID, TRIFFID-Crop, Nitrogen limitation, River routing, Land-use change, and fire

Multi-sector

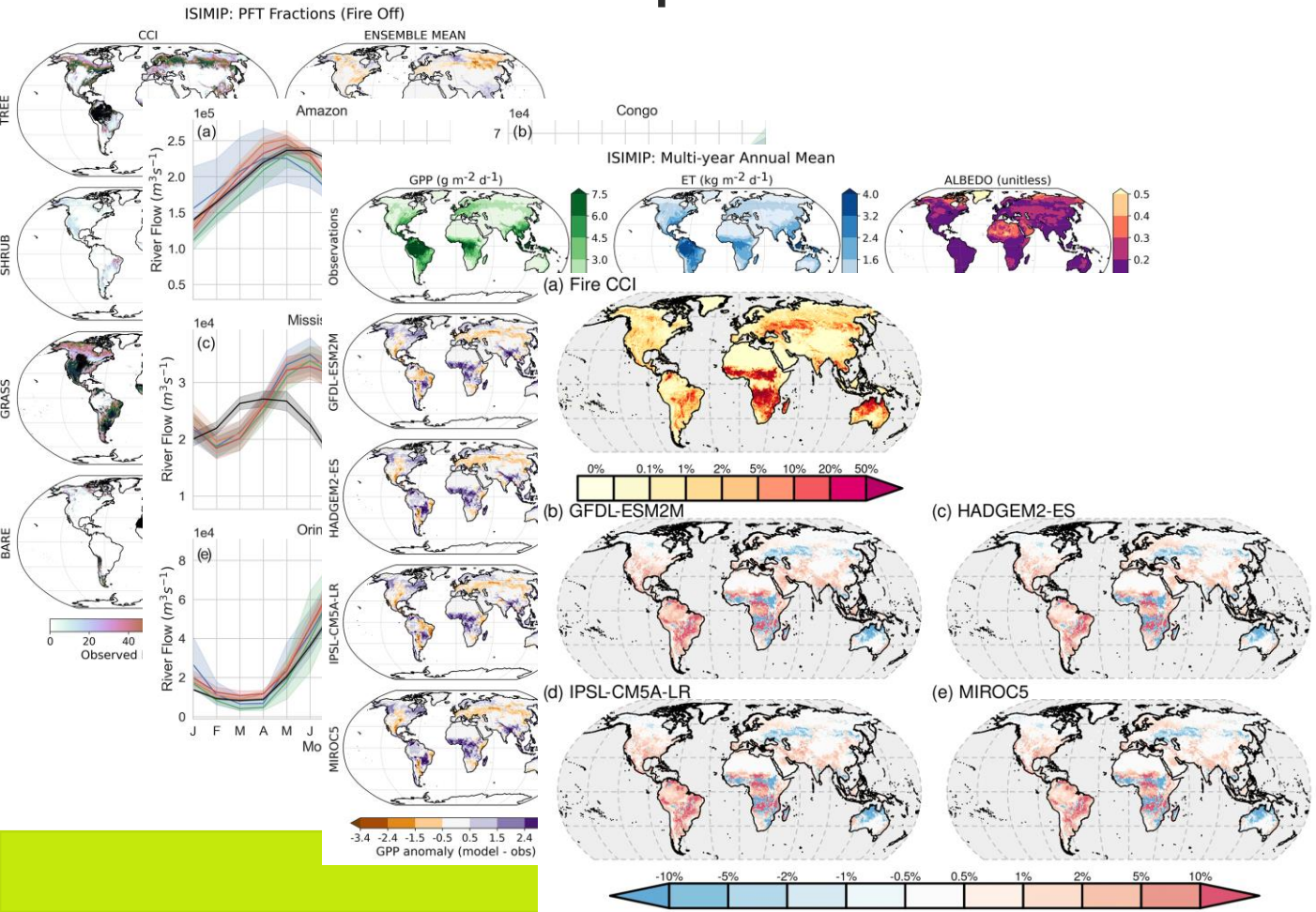
- Contributions to Water (global), Biomes, Fire and Permafrost
- In addition, we could contribute towards Agriculture, Regional Forest and Peat







Description & Evaluation Paper



Evaluation of PFT vegetation distribution, river flow, surface fluxes (GPP, ET and albedo) and fire

Mathison, C., et al. (2023).

Description and evaluation of the JULES-ES set-up for ISIMIP2b.

Geoscientific Model Development, 16(14), 4249–4264. https://doi.org/10.5194/GMD-16-4249-2023

Interactions between ES processes is key for robustly understanding impacts

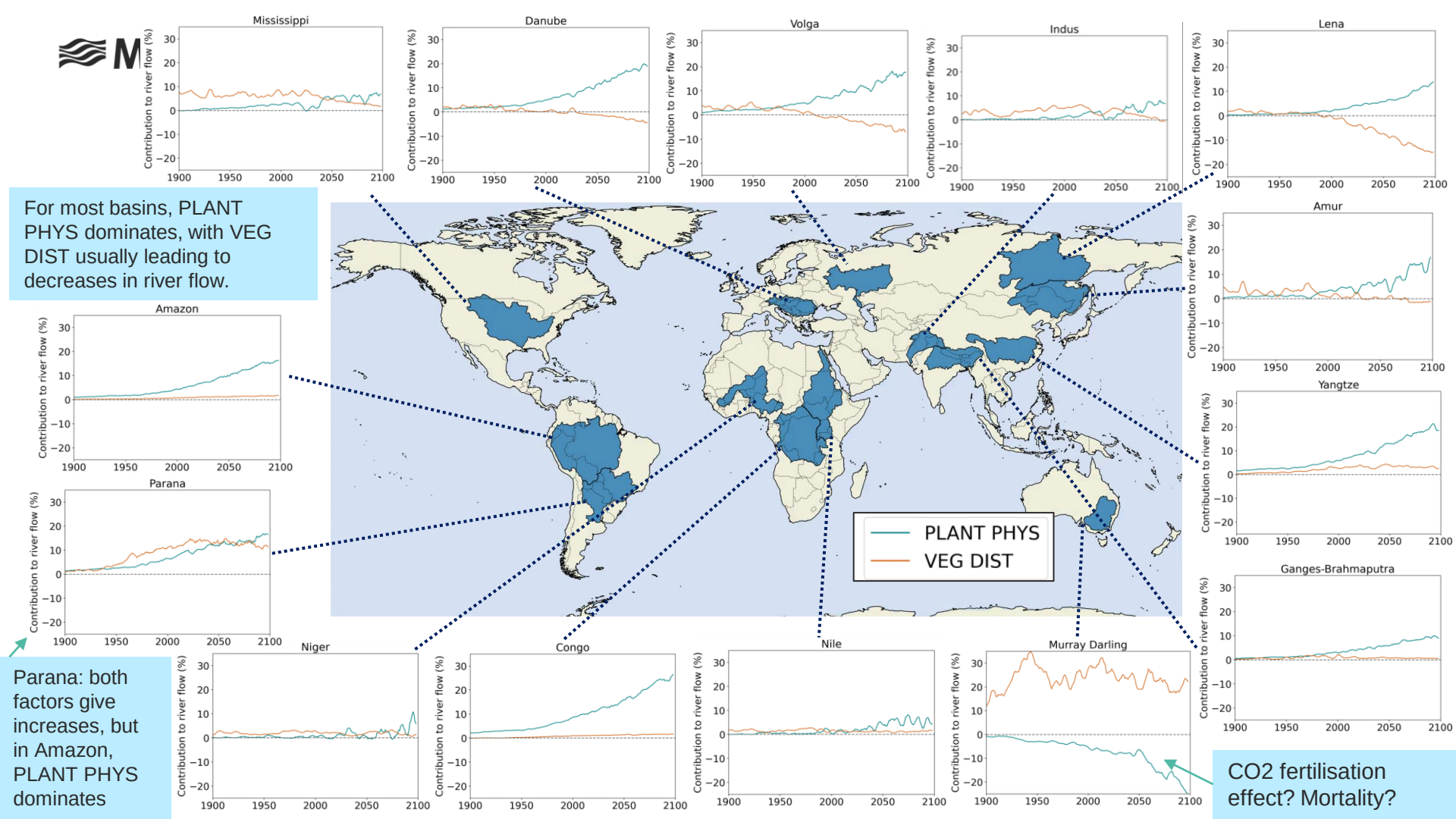
Water Stress, Jess Stacey

CO_2 -> GPP -> LAI -> PFT % -> Plant physiological forcing -> Hydrology

Fire modelling & attribution to climate change, Chantelle Burton & Doug Kelley

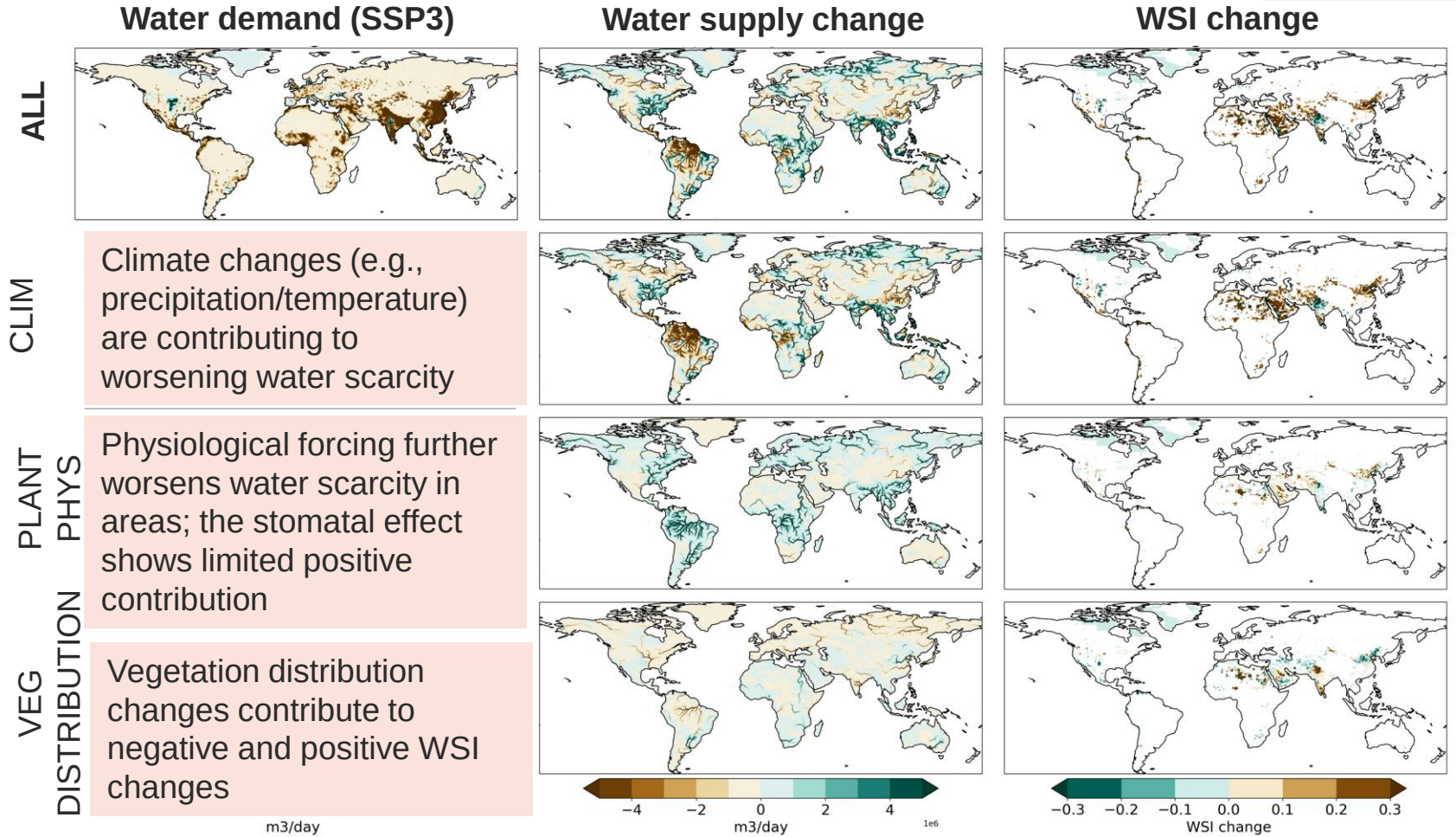
CO_2 -> GPP -> Fire -> PFT % -> Carbon cycle feedback

Land-based mitigation, Emma Robinson


Mississippi
Danube
Volga
Indus
Lena
Amur
Yangtze
Ganges-Brahmaputra
Murray Darling
Nile
Congo
Niger
Parana
Amazon
Contribution to river flow (%)
PLANT PHYS
VEG DIST
For most basins, PLANT PHYS dominates, with VEG DIST usually leading to decreases in river flow.
Parana: both factors give increases, but in Amazon, PLANT PHYS dominates
CO2 fertilisation effect? Mortality?

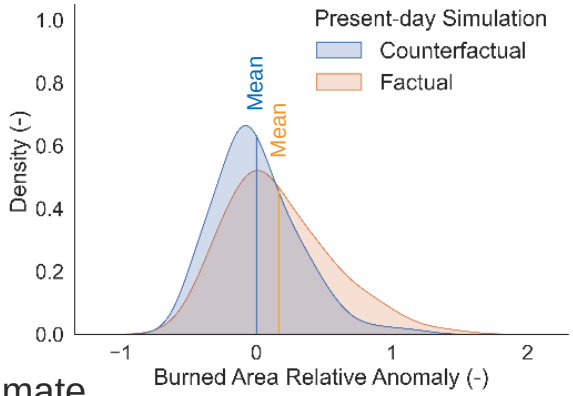
How is each factor contributing to the change in water scarcity (2010 -> 2050)?

Non water-scarce areas (WSI < 0.05) masked out



Global Burned Area Increasingly Explained By Climate Change

- Shift in mean
- Relative Anomaly
- Factual vs Counterfactual
- 2003-2019



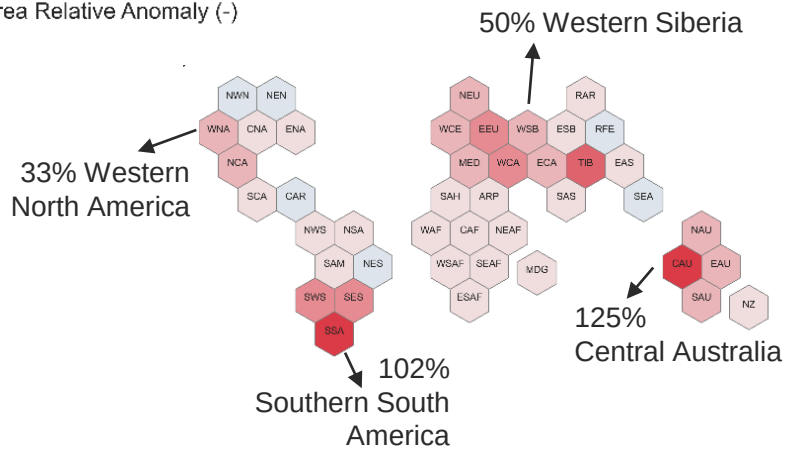
ISIMIP 3a: Attribution

Chantelle Burton & Seppe Lampe

D. I. Kelley, W. Thiery, S. Hantson, N. Christidis, L. Gudmundsson, M. Forrest, E. Burke, J. Chang, H. Huang, A. Ito, S. Kou-Giesbrecht, W. Li, L. Nieradzik, F. Li, Y. Chen, J. Randerson, G. Lasslop, C. P. O. Reyer, M. Mengel

In review with Nature Climate Change

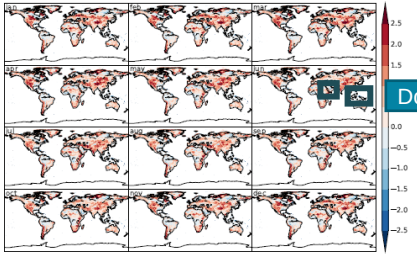
- **16% more burned area globally** due to climate change
- Highest regional increases in **CAU 125%**
- **Direct Human Forcing** (population & land-use change) **has damped the effect of climate change** on burned area
- The **effects on climate change have increased** over time 1900-2020



JULES for NetZero+

Bias-corrected ensemble of climate projections

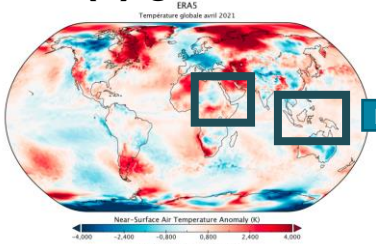
ISIMIP
Inter-Sectoral Impact Model Intercomparison Project



Downscale

ERA5(T) global reanalysis

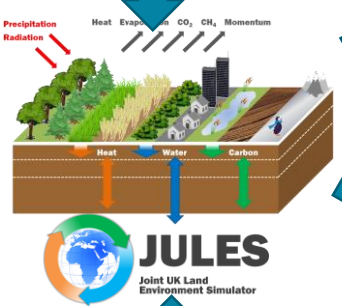
ECMWF



Downscale

ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

JULES-ES configuration



JULES
Joint UK Land Environment Simulator

Regional ancillaries

Ensemble of climate and land surface projections to 2100 for adaptation and mitigation

Near real time climate and land surface state for attribution

Met Office

UK Centre for Ecology & Hydrology

Emma Robinson, Matt Wiggins, Doug Clark, Becky Oliver, Toby Marthews, Sonja Folwell, and others

Future development plans & ideas

Improving processes that under-pin impacts

- Plant stress under drought, and recovery from drought
- Hydrological processes

Improving / adding impacts

- Over-bank inundation
- Permafrost
- Cropland irrigation
- Dams
- Improved crops

Understanding JULES outputs for use in impacts services

- Response to extremes
- Provide alternatives to indices
- Co-produce use cases

Future science & technical challenges

- Analysis of ISIMIP2b & 3b data
- How to derive benefit from JULES output for weather and climate applications?
- Rapid assessment using emulators?
- Regional simulations
- Improve the suite setup
  - E.g. daily to sub-daily timestep, uncertainty in driving data (TRENDY), matching offline with UKESM (online) setups

Join the JULES-ISIMIP community!

For more information please contact

https://metoffice.sharepoint.com/sites/MetOfficeJULES-ISIMIPExt

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