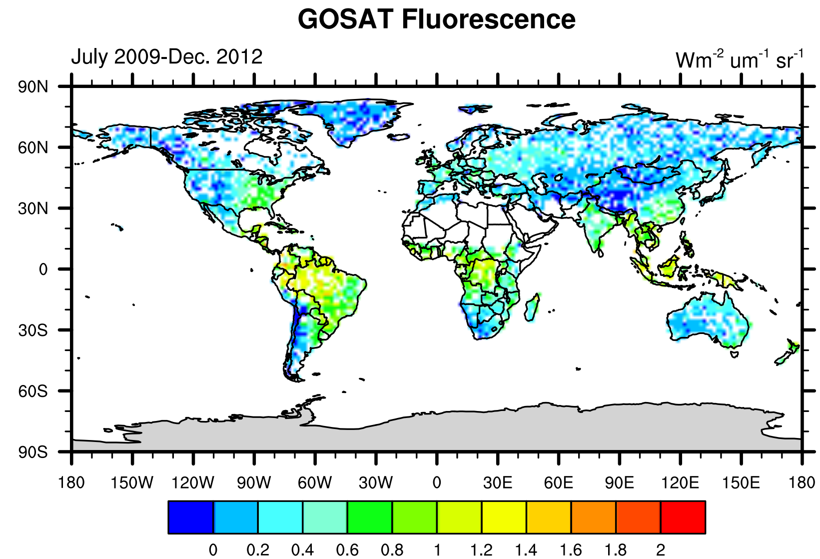
Using solar-induced fluorescence to constrain model GPP

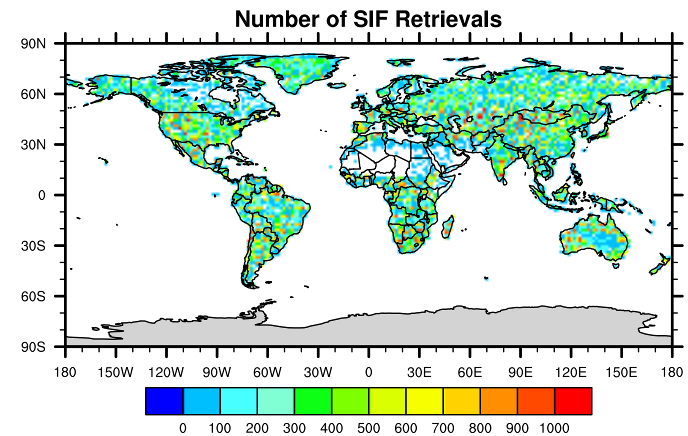
$$GPP = PAR \cdot FPAR \cdot \varepsilon_p$$

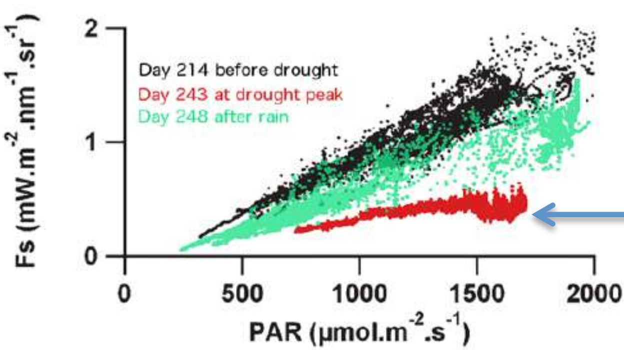
$$SIF = PAR \cdot FPAR \cdot \varepsilon_f$$

$$GPP = SIF \cdot \varepsilon_p / \varepsilon_f$$

- Observed at 757nm and 771 nm
- E_p is a function of temperature and moisture stress. The satellite-retrieved SIF can identify periods of such stress, and show instantaneous response whereas NDVI and LAI are more integrated responses.





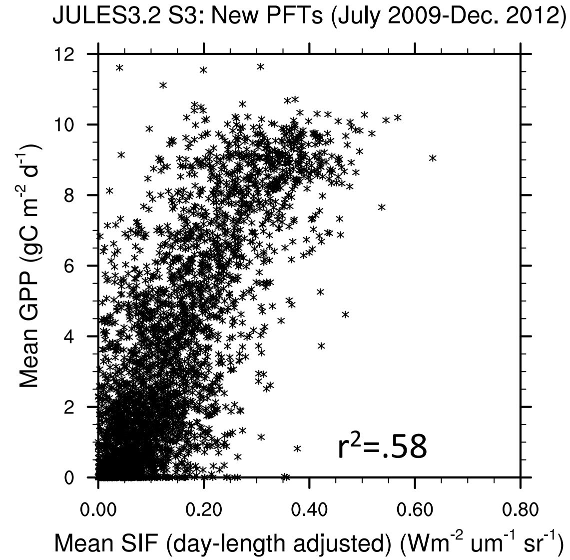


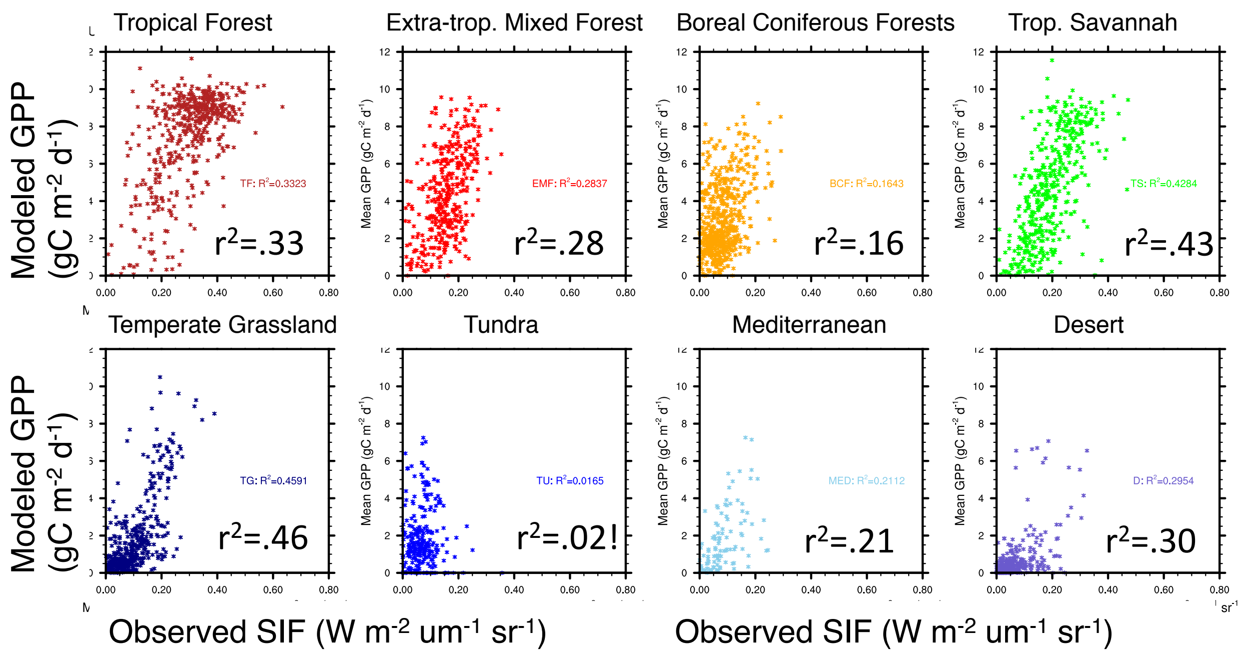
Drought-induced reduction in SIF when no concurrent decline in LAI or NDVI observed.

Daumard et al. 2010; Joiner et al. 2011; Frankenberg et al. 2011; Parazoo et al. 2013; Parazoo et al. 2014.

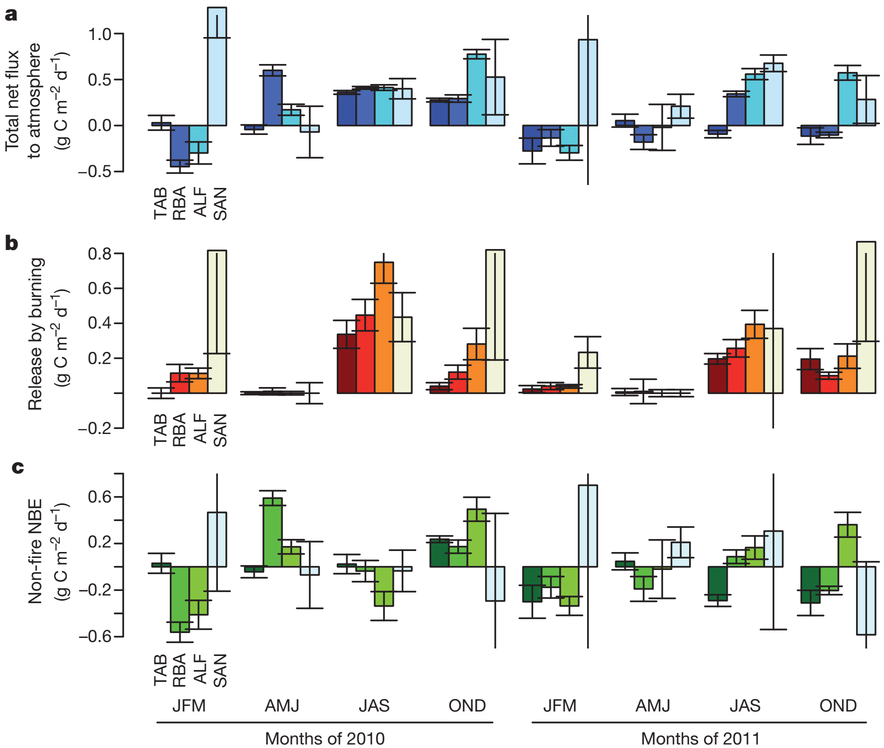
Using solar-induced fluorescence to constrain model GPP

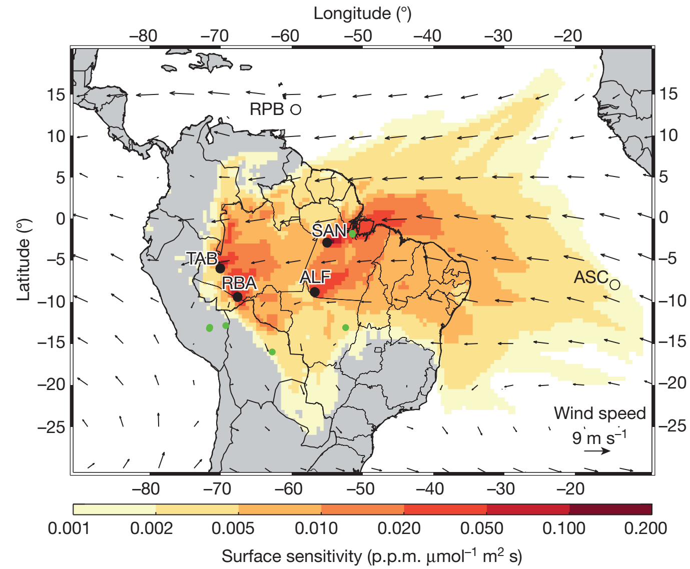
- GPP is highly correlated with SIF (as it should be – both are a function of radiation)
- How do we do on the biome level?
- Okay for temperate and tropical grasslands.
- Boreal forests and Mediterranean shrub not great.
- Tundra is very bad (often too productive)





Application: 2010 Amazon drought





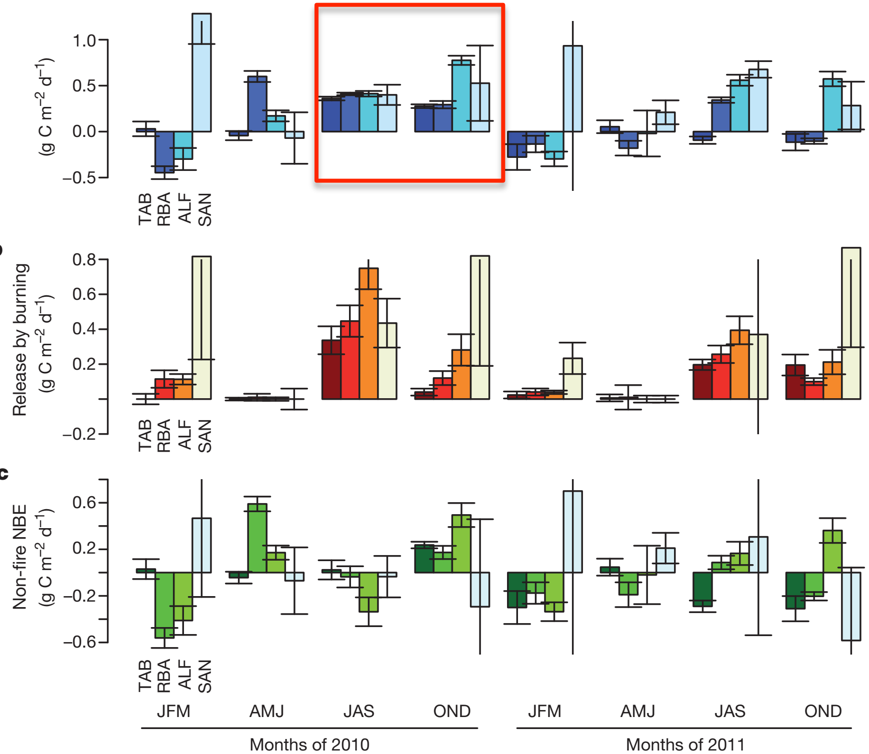
Drought sensitivity of Amazonian carbon balance revealed by atmospheric measurements

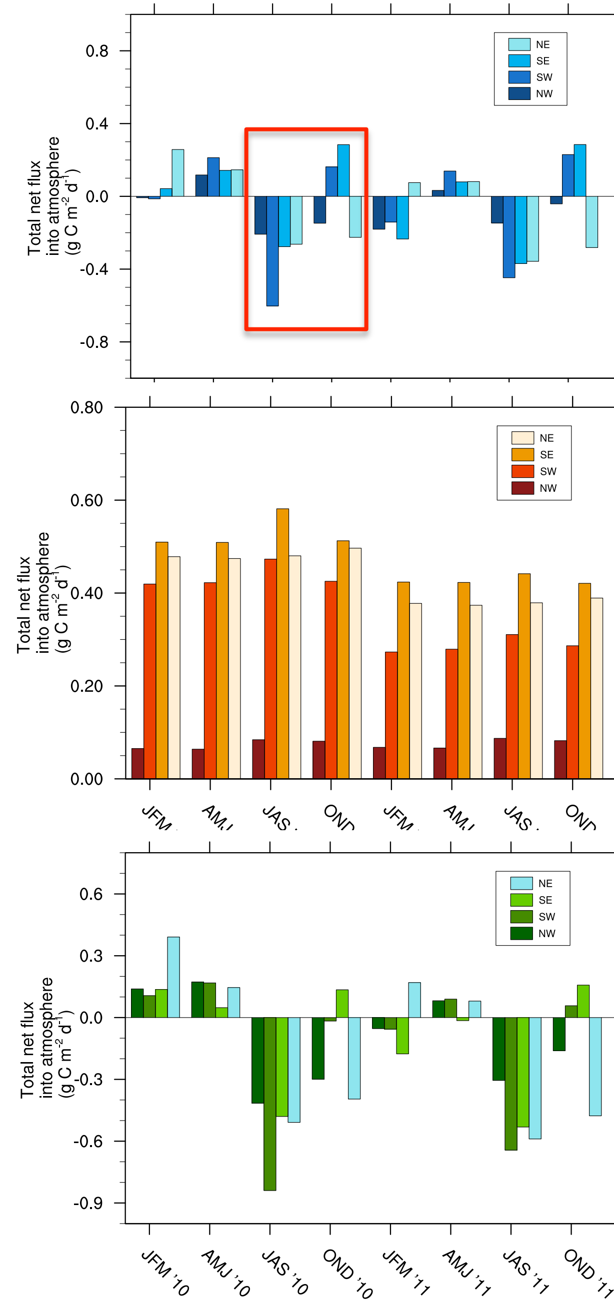
L. V. Gatti[1]*, M. Gloor[2]*, J. B. Miller[3,4]*, C. E. Doughty[5], Y. Malhi[5], L. G. Domingues[1], L. S. Basso[1], A. Martinewski[1], C. S. C. Correia[1], V. F. Borges[1], S. Freitas[6], R. Braz[6], L. O. Anderson[5,7], H. Rocha[8], J. Grace[9], O. L. Phillips[2] & J. Lloyd[10,11]

Total net flux to atmosphere

Release by burning

Non-fire Net Biome Emissions



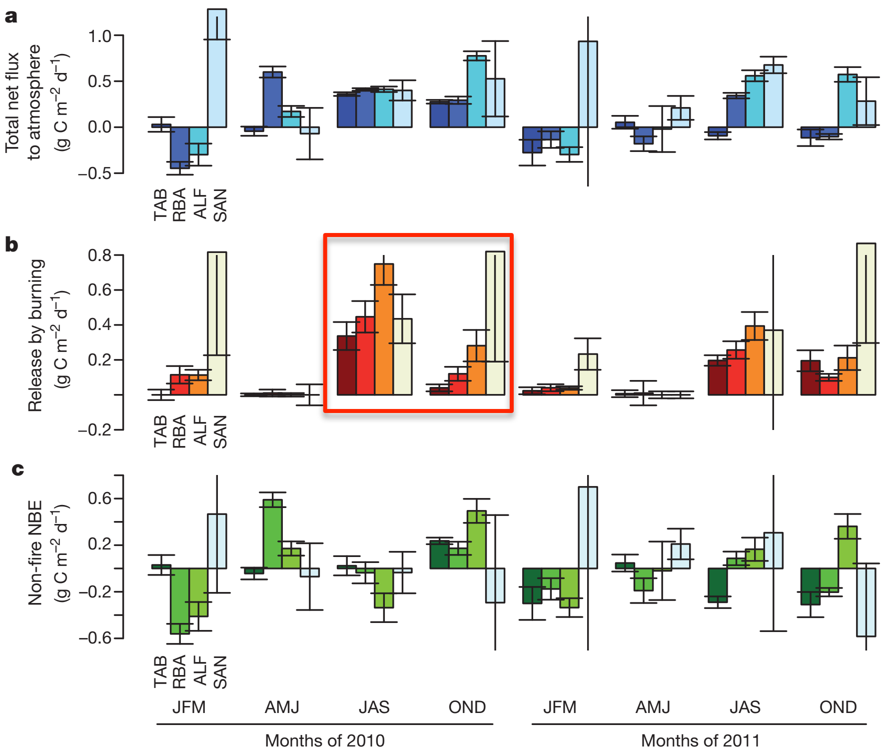


Total net flux to atmosphere

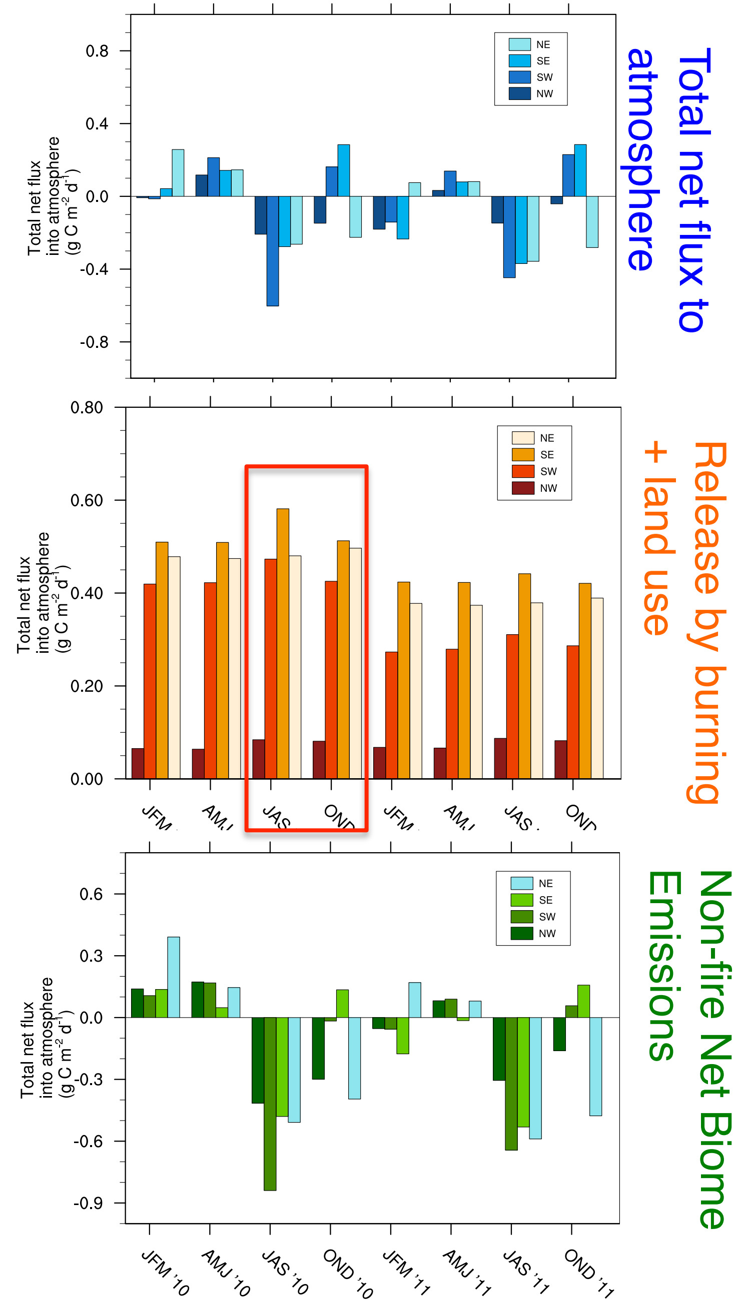
Release by burning + land use

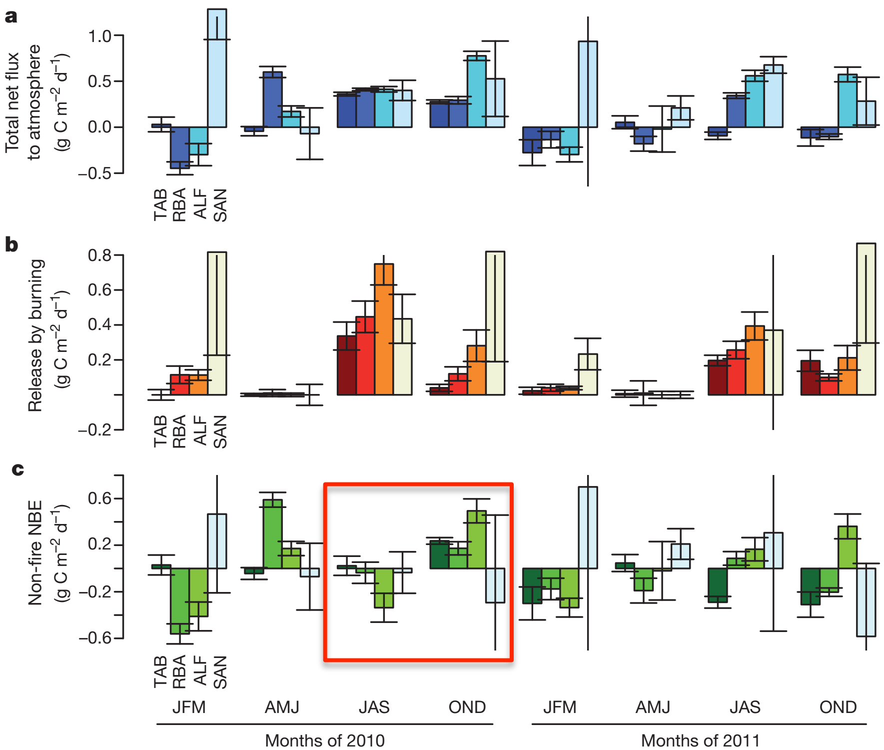
Non-fire Net Biome Emissions

- Observed total flux to atmosphere was positive during JAS-OND 2010.
- TRENDY models incorrectly simulated a C sink in JAS, and incorrect in the NW and NE regions in OND.

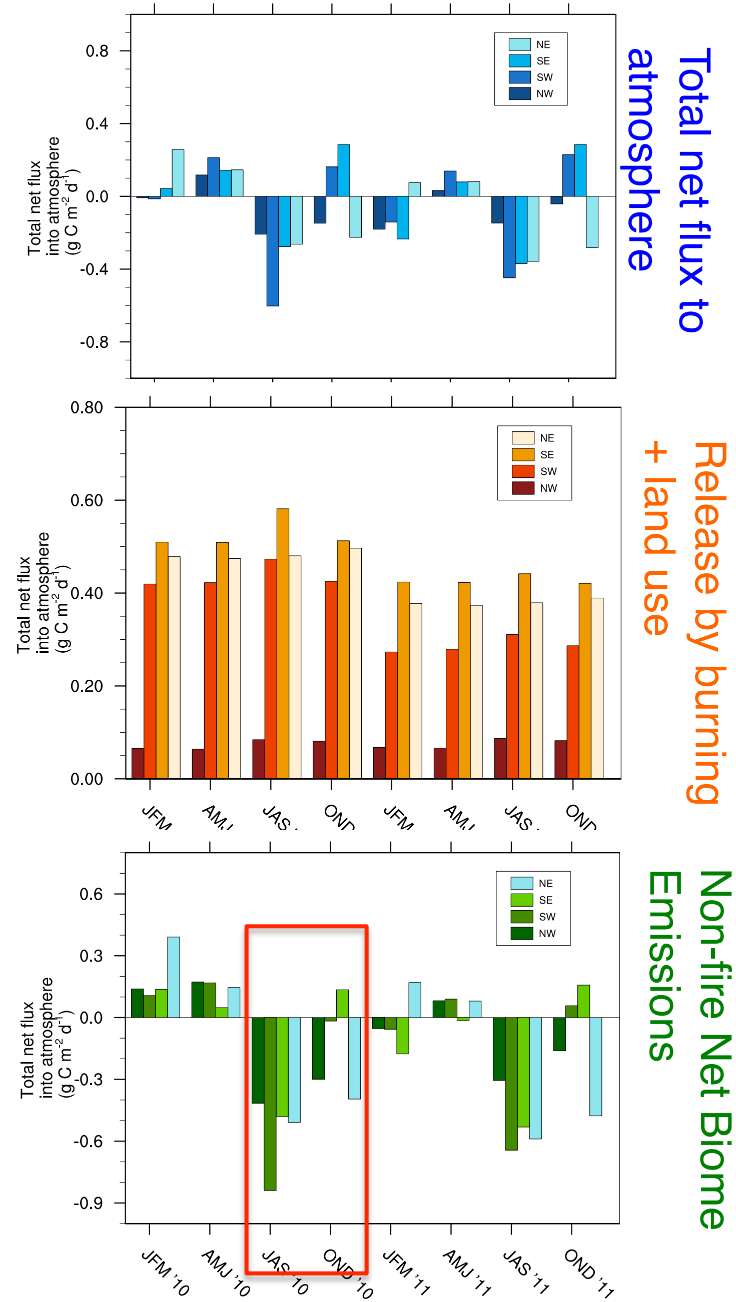


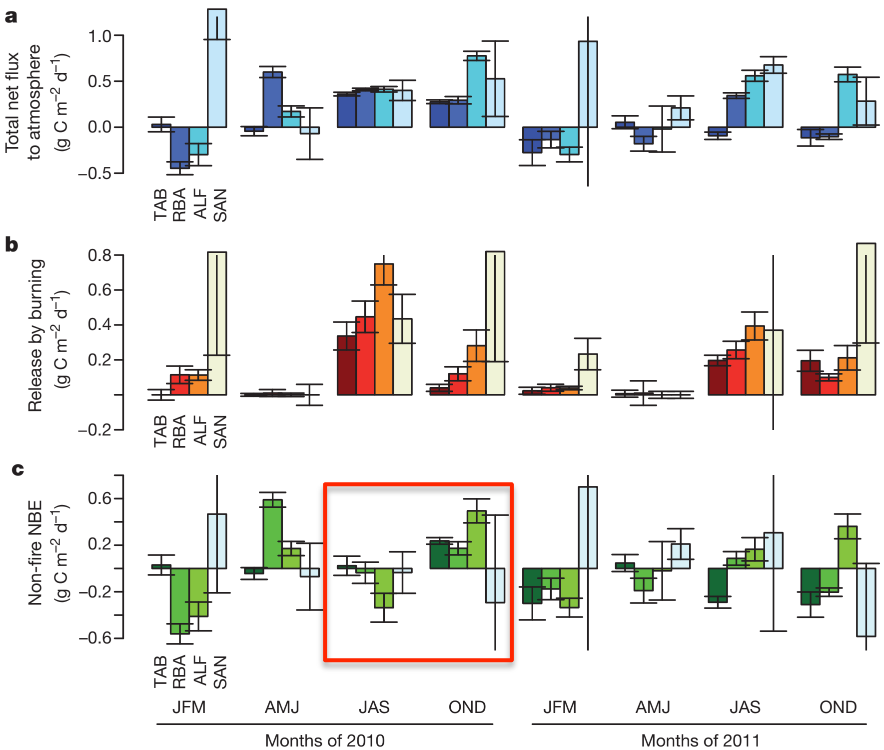
- TRENDY models: fFire+fLuc too weak in NW in JAS 2010.
- The source in OND is due to overly strong fFire+fLuc.

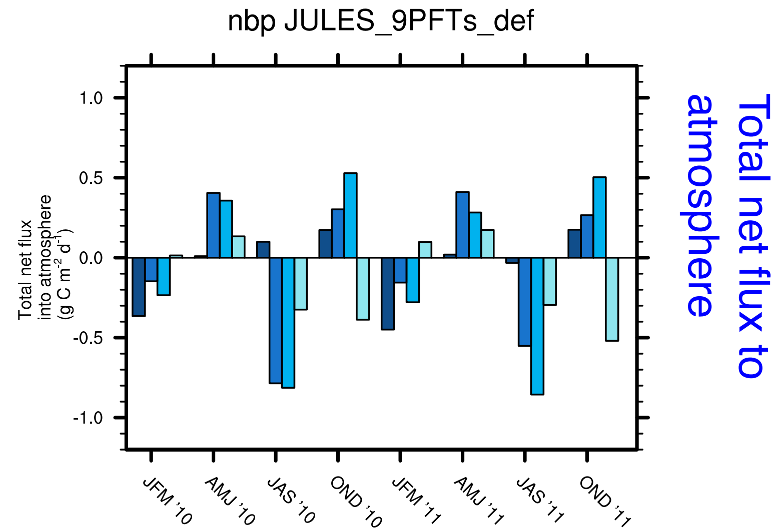


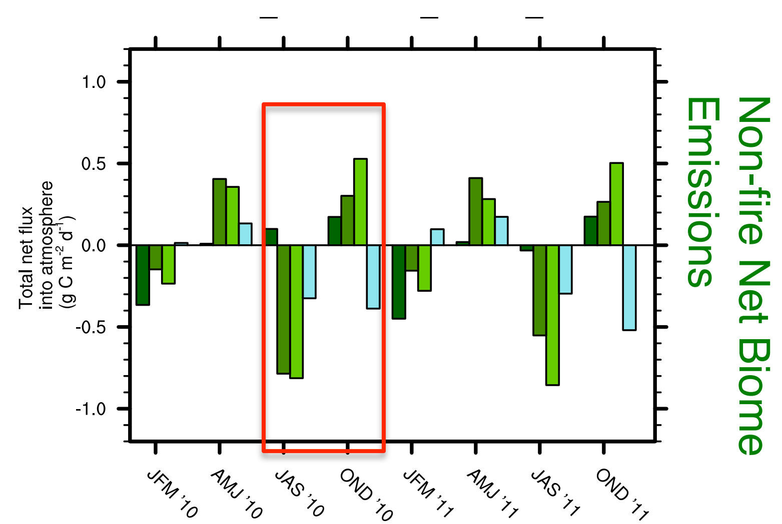


- Natural fluxes were a C sink in JAS, C source in OND except for NE.
- TRENDY models capture the JAS sink but it is too strong.
- Do not capture the OND source in NE and SE.









- How does JULES compare with the other TRENDY models?
- The LUC flux is miniscule and no firs, so NBP = NBP_natural
- Uptake is too strong in JAS (similar to the other models).
- C source in OND better simulated in JULES.

The new PFTs:

- Give JULES the ability to represent more biomes.
- 9 is not a hard-wired number so experiments can be done with more or less.
- More closely match observed physiology.
- Evaluation against multiple datasets enables us to pinpoint regions most in need of further development.
- None of these runs used tuned parameters – so we know we can do better.
- In common with other DGVMs, JULES underestimated the GPP sensitivity to the 2010 Amazon drought, but captured some lag effects on overall biome C flux.

Thank you a.harper@exeter.ac.uk @docAHarper