River Flow and Inundation in African Rivers

Simon Dadson[1], with Neil MacKellar[2], Piotr Wolski[2] and Mark New[2]

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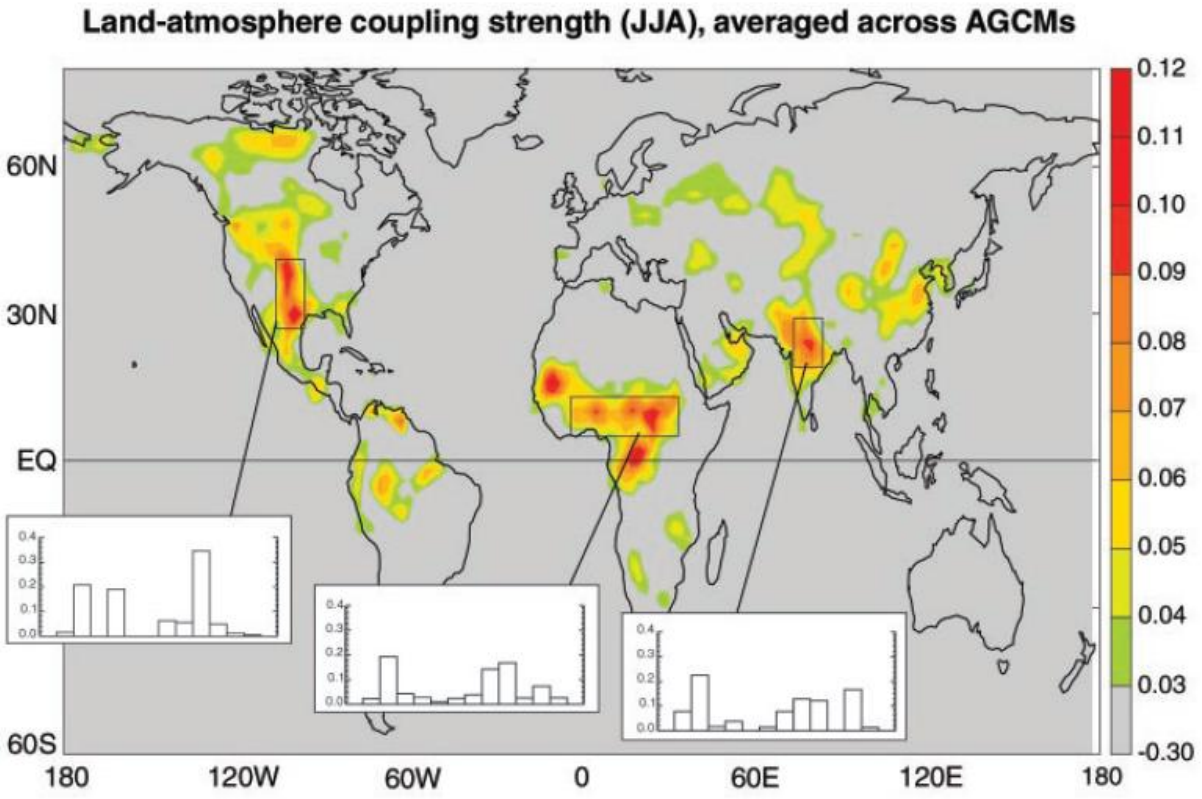
Land-surface in the Earth system



- Feedbacks strongest in transition zones between wet and dry climates.
- Evaporation is sensitive to soil moisture *and* can trigger moist convection.
- Need to know state of soil moisture in order to provide accurate forecasts.

Koster *et al.*, 2004. *Science* 305:1138-1140

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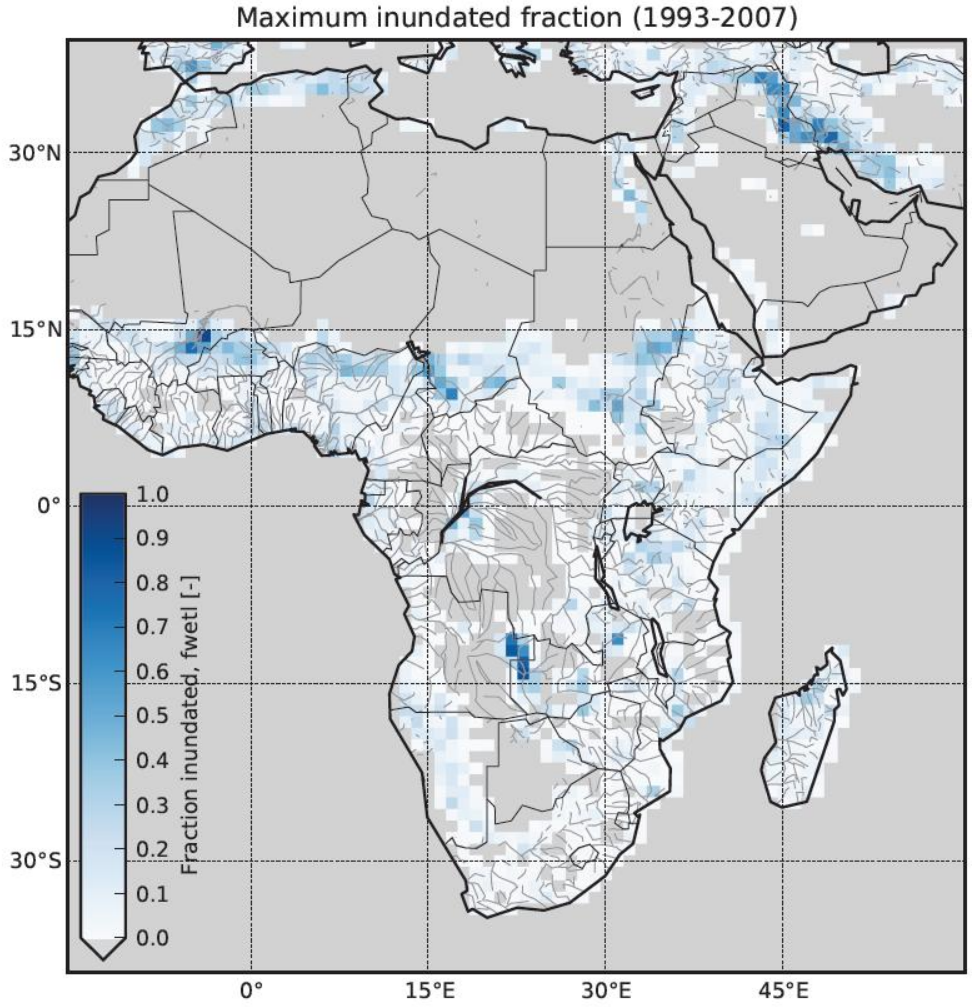
EO data reveal African flooding



Data: Prigent *et al.*, 2007 *J. Geophys. Res.*, 112, D12107, doi:10.1029/2006JD007847

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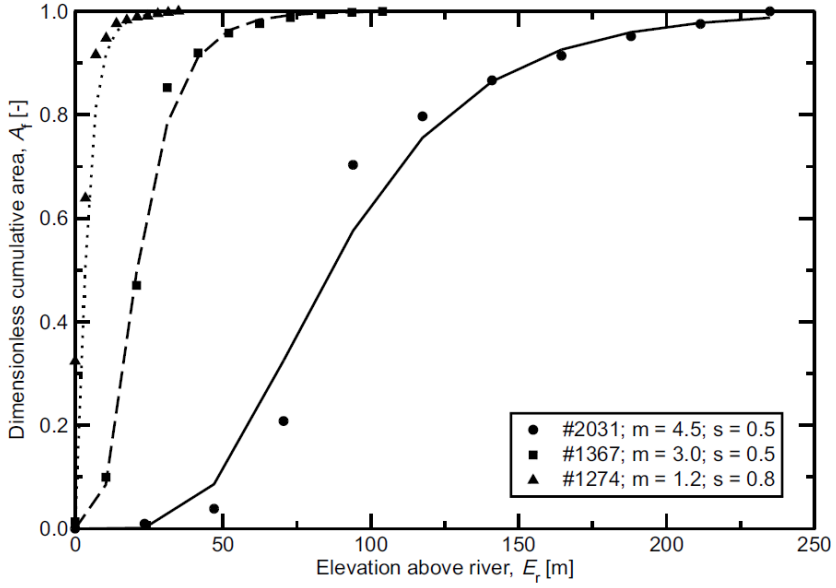
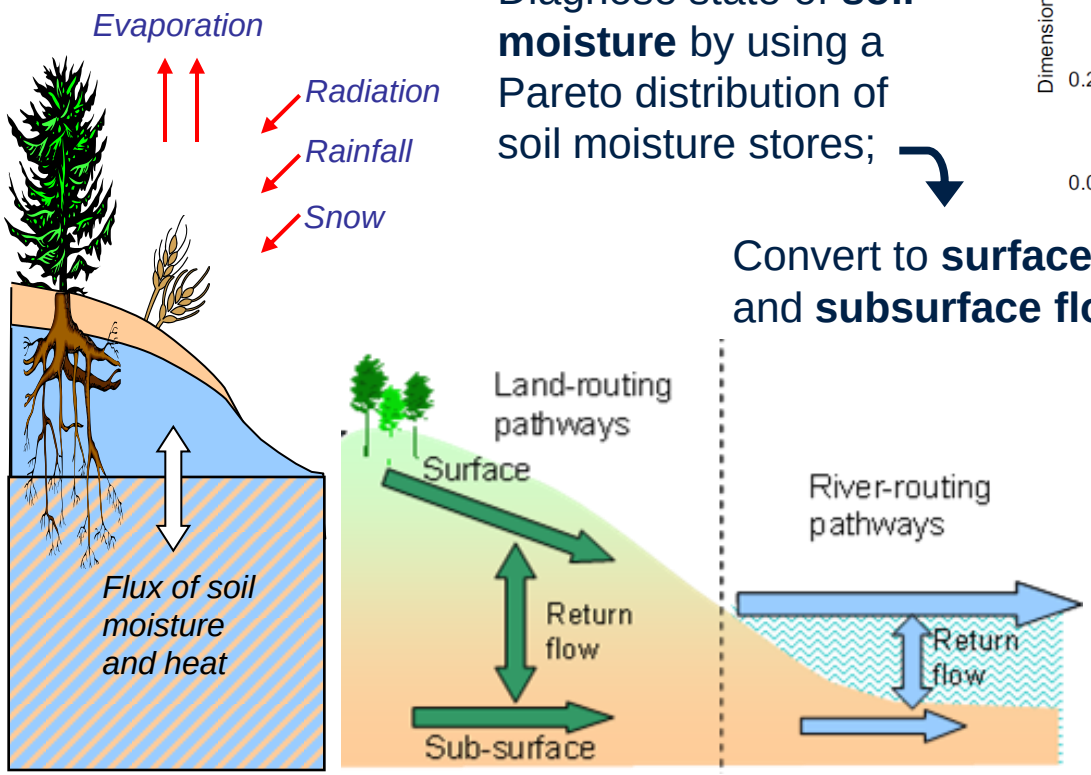
Flow routing and inundation in JULES

Joint UK-Land Environment Simulator (JULES) takes **temperature**, **wind speed**, **humidity**, **LW** & **SW radiation** and **precipitation** from RCM;

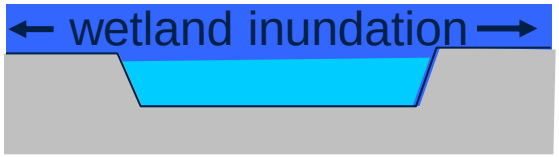
Diagnose state of **soil moisture** by using a Pareto distribution of soil moisture stores;





Convert to **surface** and **subsurface flow.**

Inundated wetland area calculated using sub-grid elevation data



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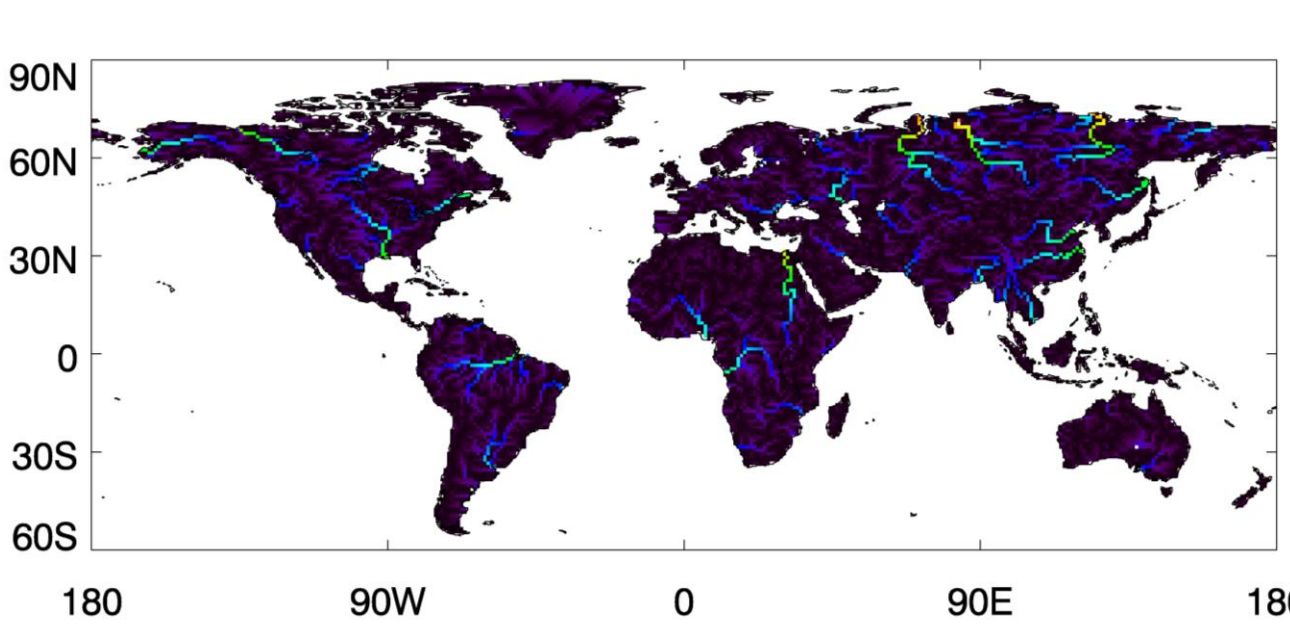
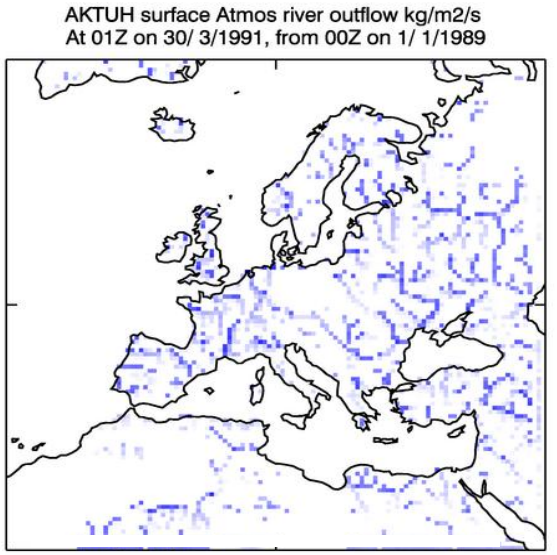
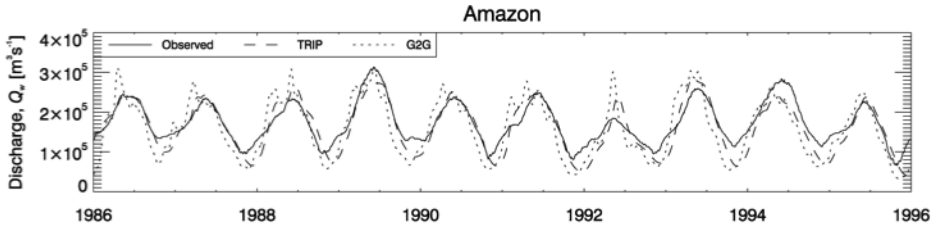
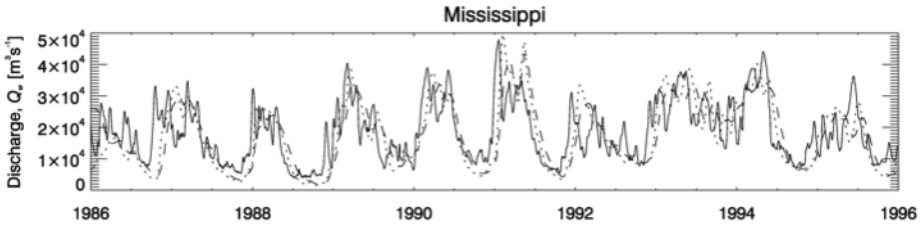
Dadson *et al.*, 2010, *J. Geophys. Res.*, 115: D23114

Coupled river model in UM & MONSooN









Dadson, S. J. *et al.*, 2011, *J. Hydrology.* 10.1016/j.jhydrol.2011.10.002

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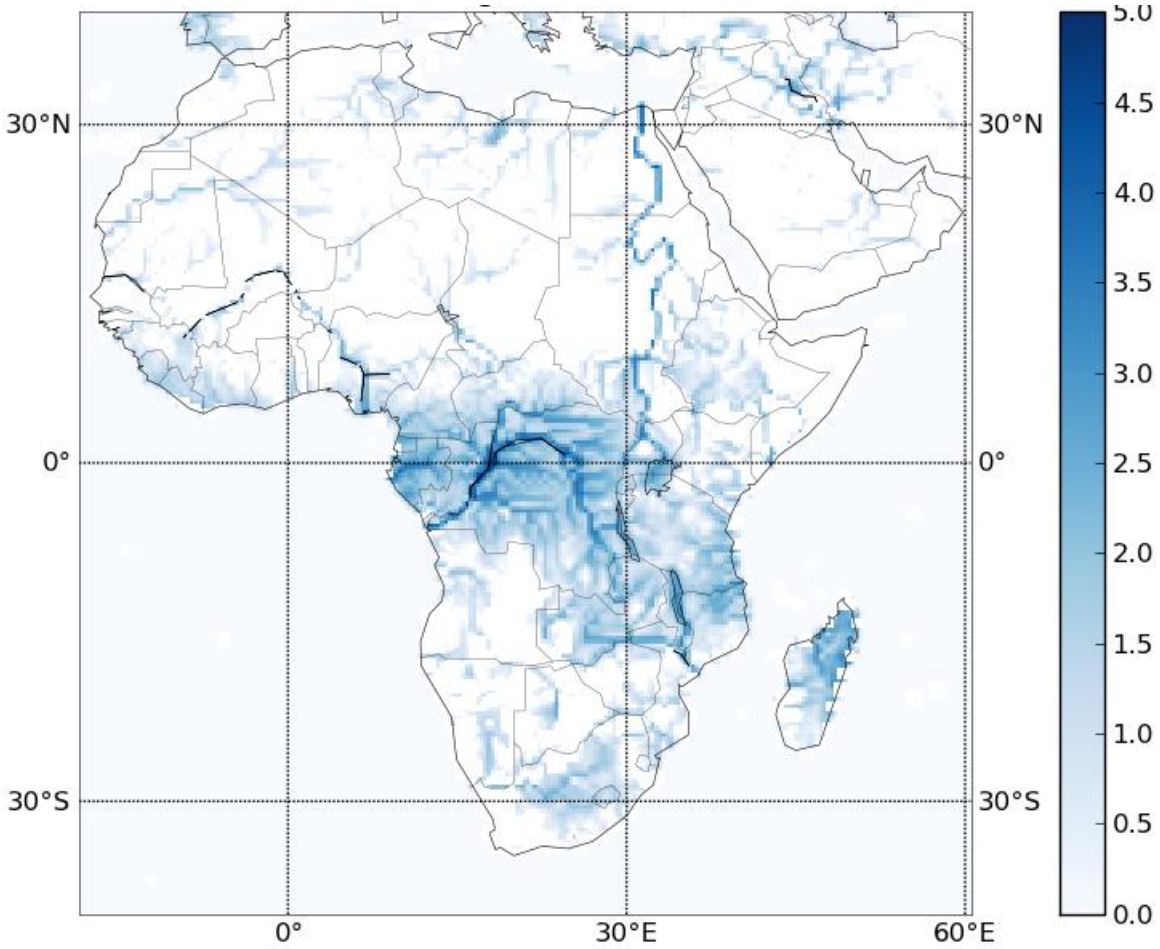
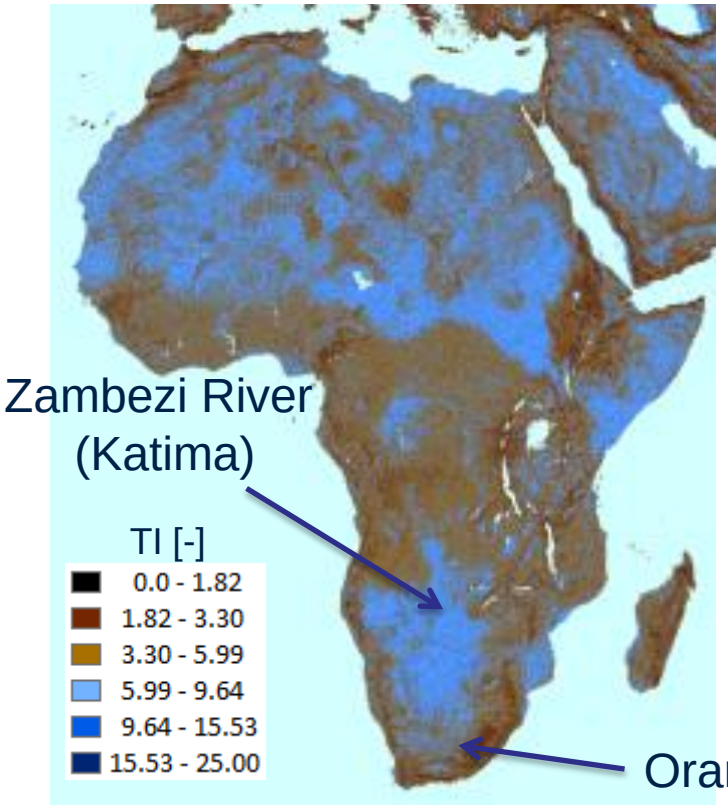
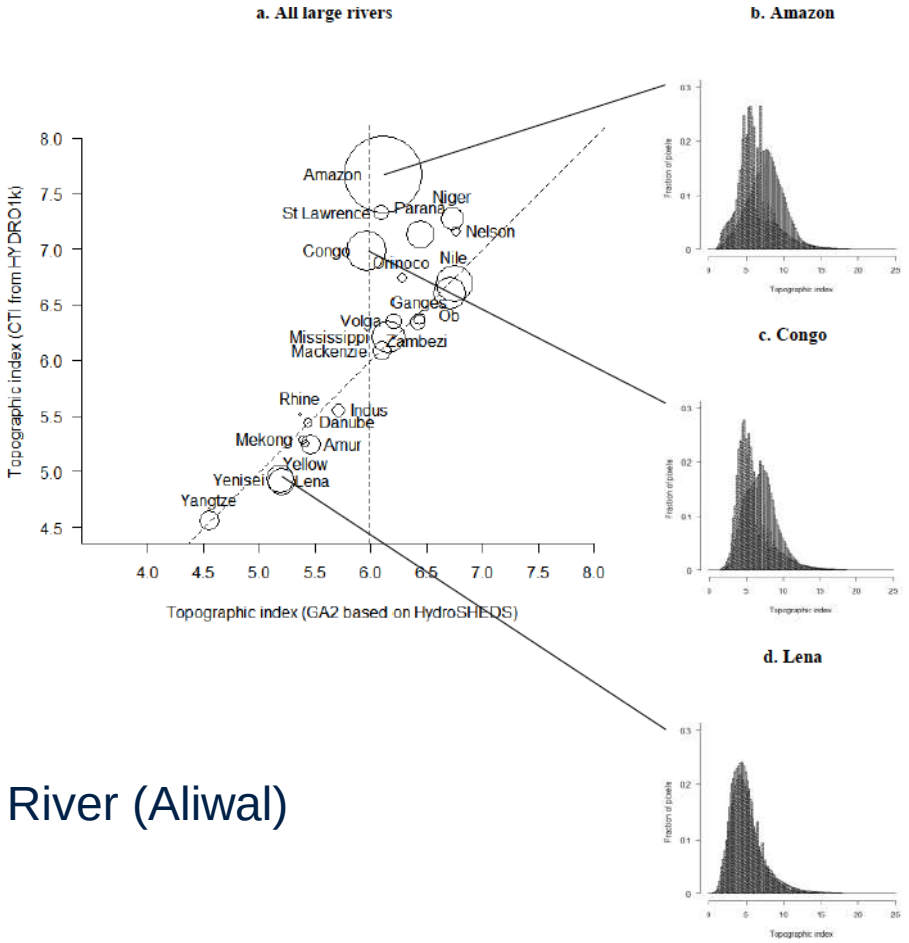
Recent inclusion in JULES vn4.2



New Topographic Index dataset





Marthews, T. R., Dadson, S. J., Lehner, B., Abele, S. and Gedney, N. *Hydrol. Earth Syst. Sci.*, in press

(see www.hydrol-earth-syst-sci-discuss.net/11/6139/2014/)

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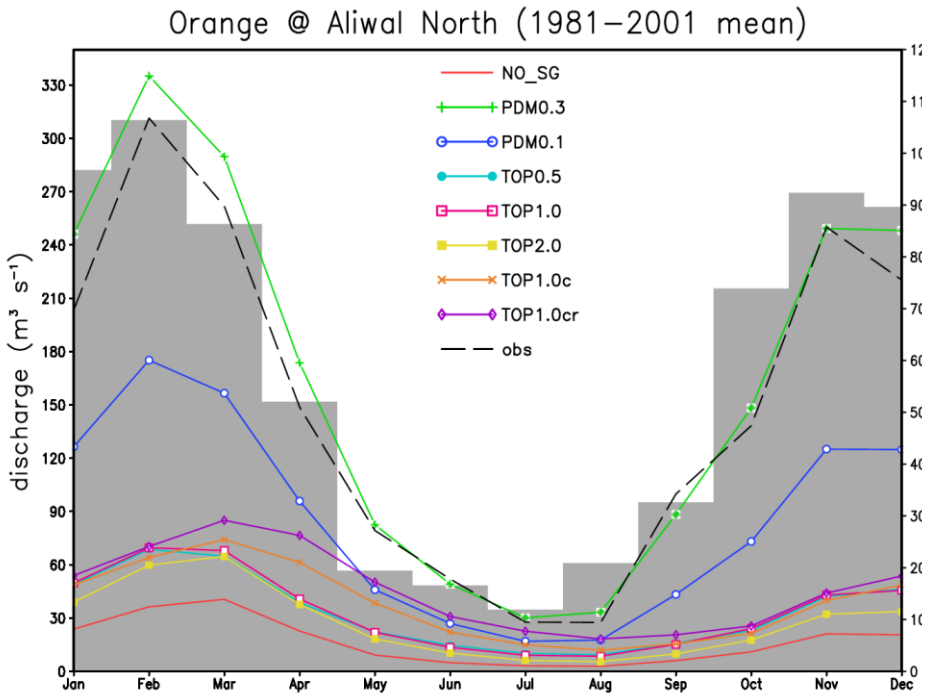
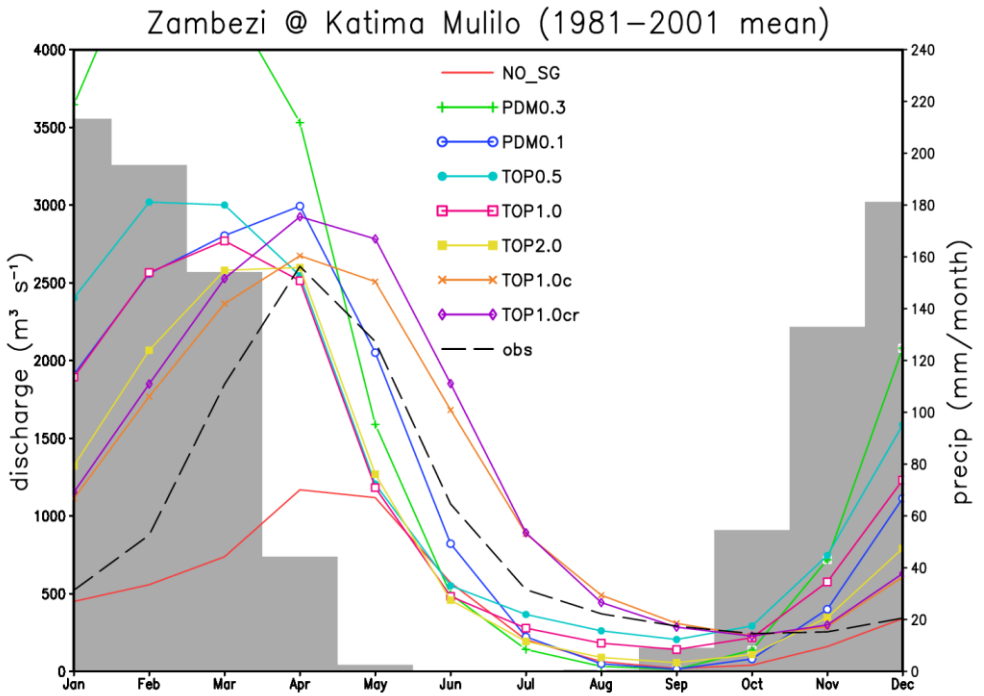
Results





- Catchment-specific optimal model configuration
- PDM runoff production well-suited to steep terrain and clay soils in Orange;
- TOPMODEL captures slow sub-surface response of deep porous soils in Zambezi

Mackellar, N., Dadson, S., New, M., and Wolski, P. Evaluation of the JULES land surface model in simulating catchment hydrology in southern Africa. In review.

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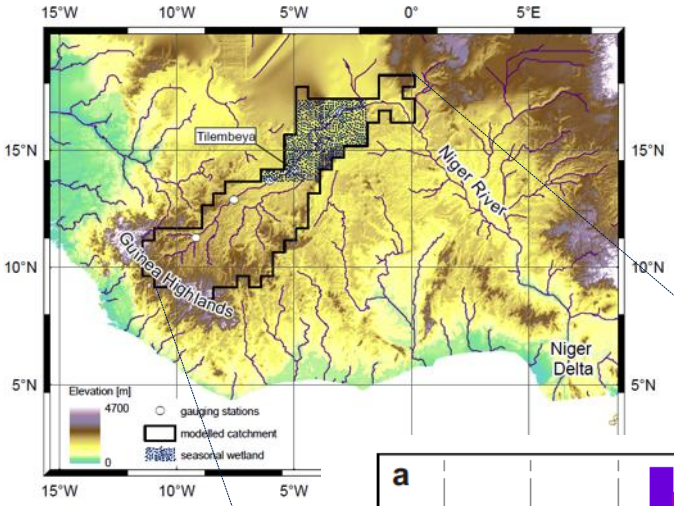
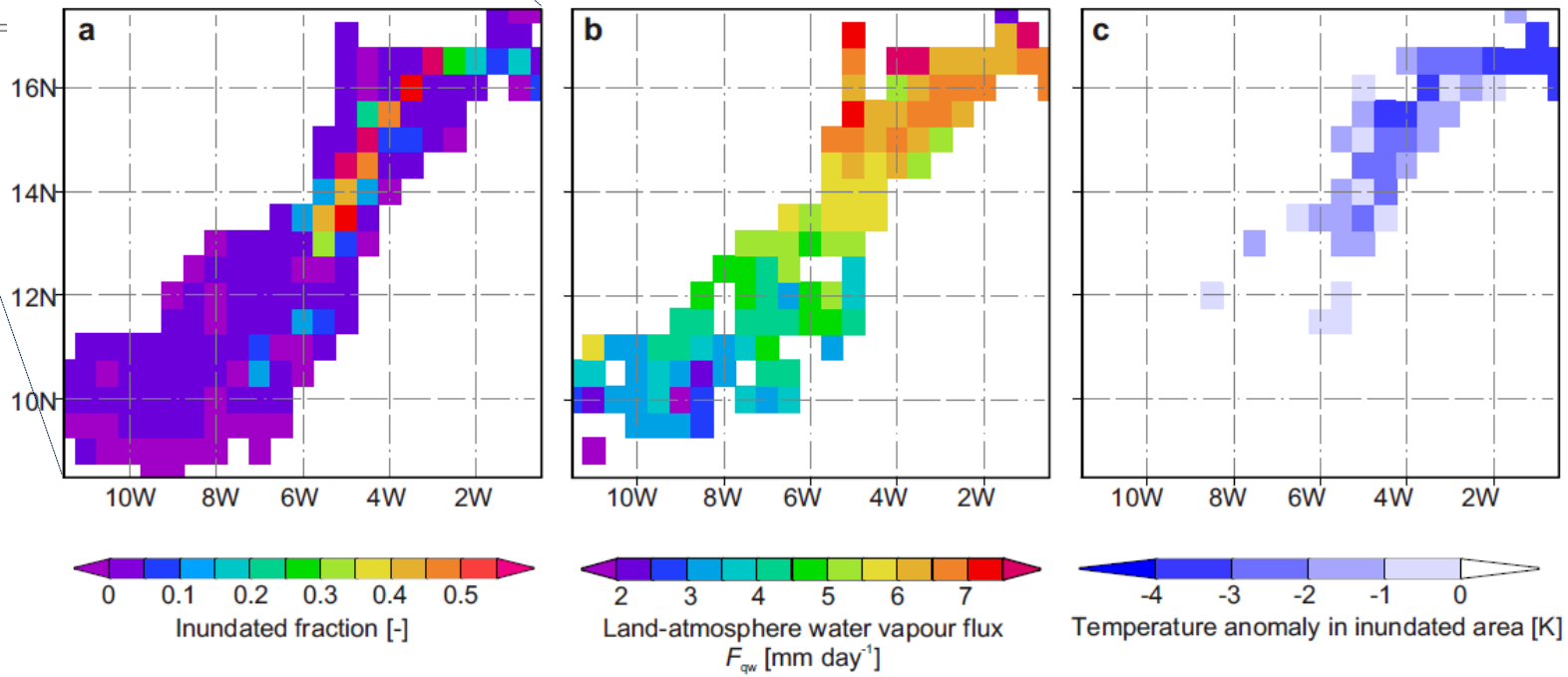
Land-atmosphere feedbacks in W. Africa



- **Niger Inland Delta, Mali**
- **Inundation drives water vapour flux and temperature anomaly;**
- **Seasonal flooding provides up to 50% of water vapour to atmosphere.**



Dadson *et al.*, 2010, *J. Geophys. Res.*, 115: D23114

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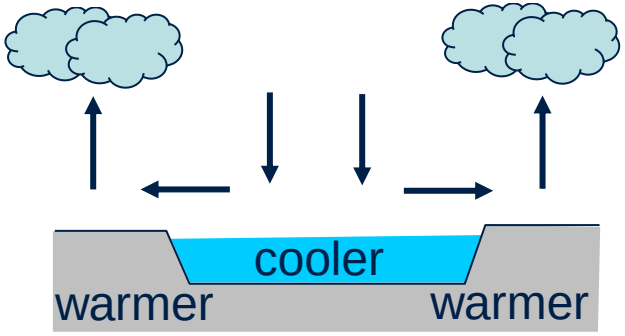
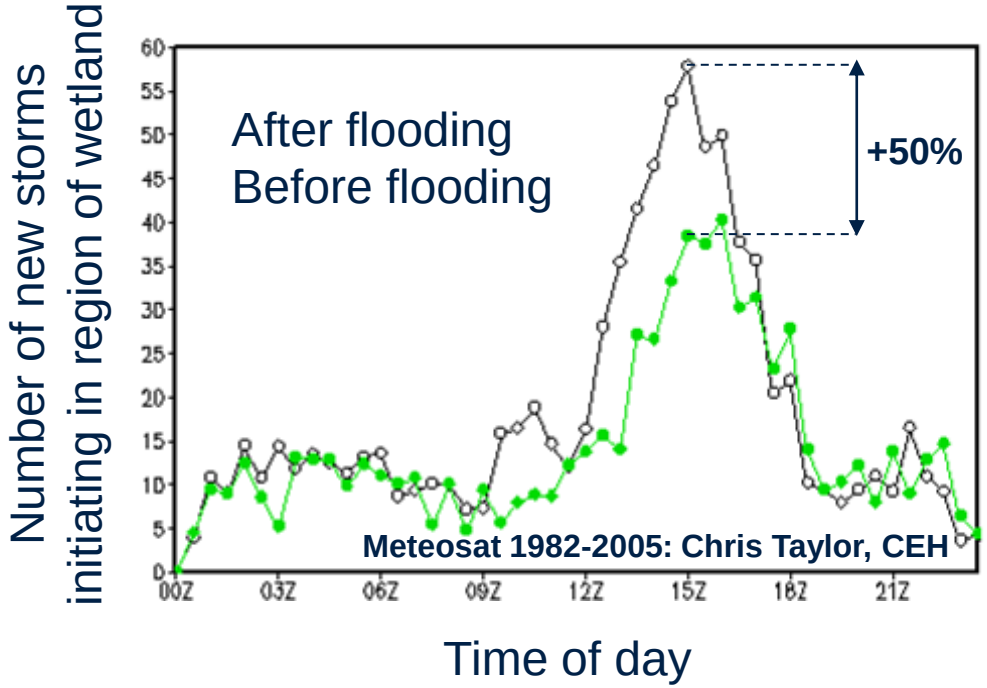
Land-atmosphere interaction





- **Development of a "wetland breeze";**
- **50% more daytime storms during floods**
- **How does spatial configuration of inundation affect land-atmosphere interaction?**

Dadson *et al.*, 2010, *J. Geophys. Res.*, 115: D23114
Taylor, (2010), *Geophys. Res. Lett.*, 37, L041652

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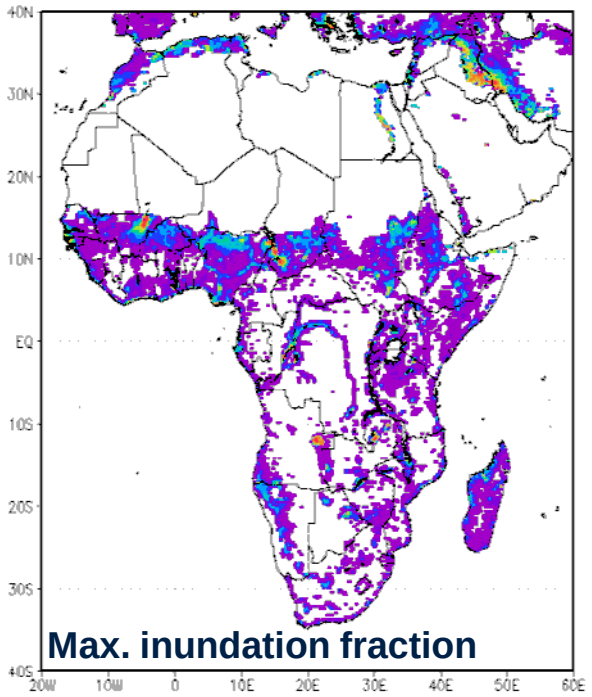
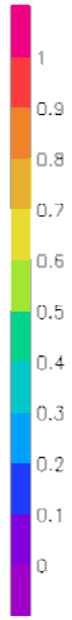
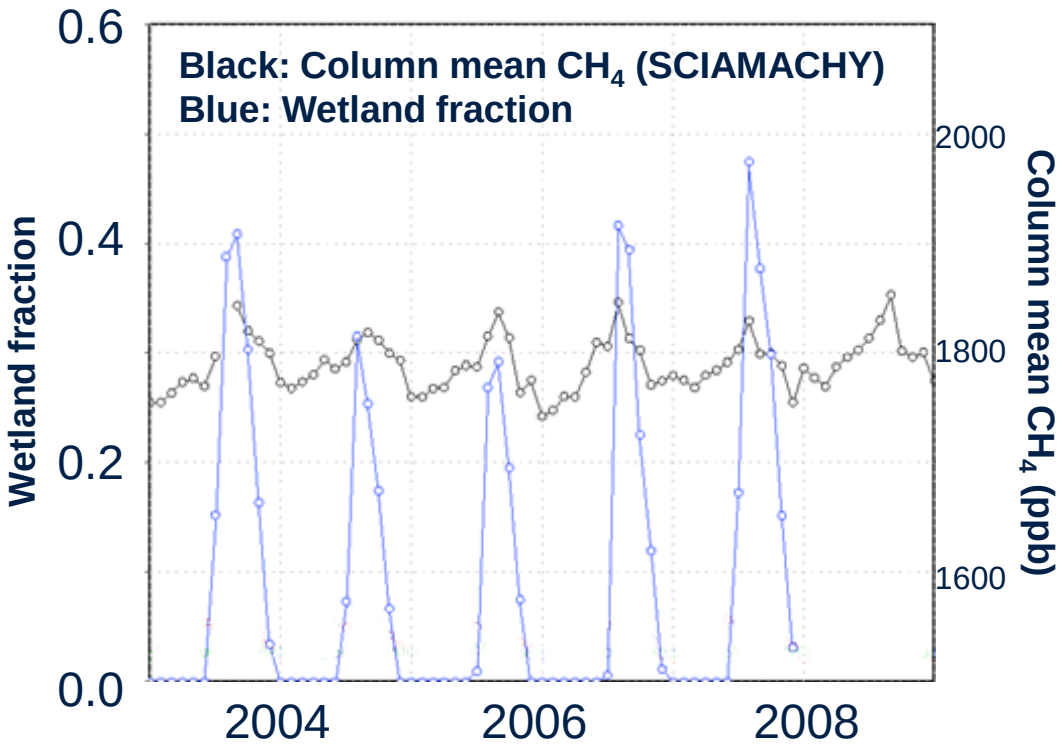
Links between the water and carbon cycles







- Methane (CH_4) is the second most important greenhouse gas after CO_2.
- Wetlands are largest natural source of CH_4, via anoxic degradation of organics.
- CH_4 fluxes from wetlands are poorly quantified (105-278 Tg yr^{-1}, 75% tropical).

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Summary

- High resolution topographic datasets for large-scale river models
- Improves river flow predictions in S. African rivers
- Provides capability to diagnose future changes in water and carbon cycle

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