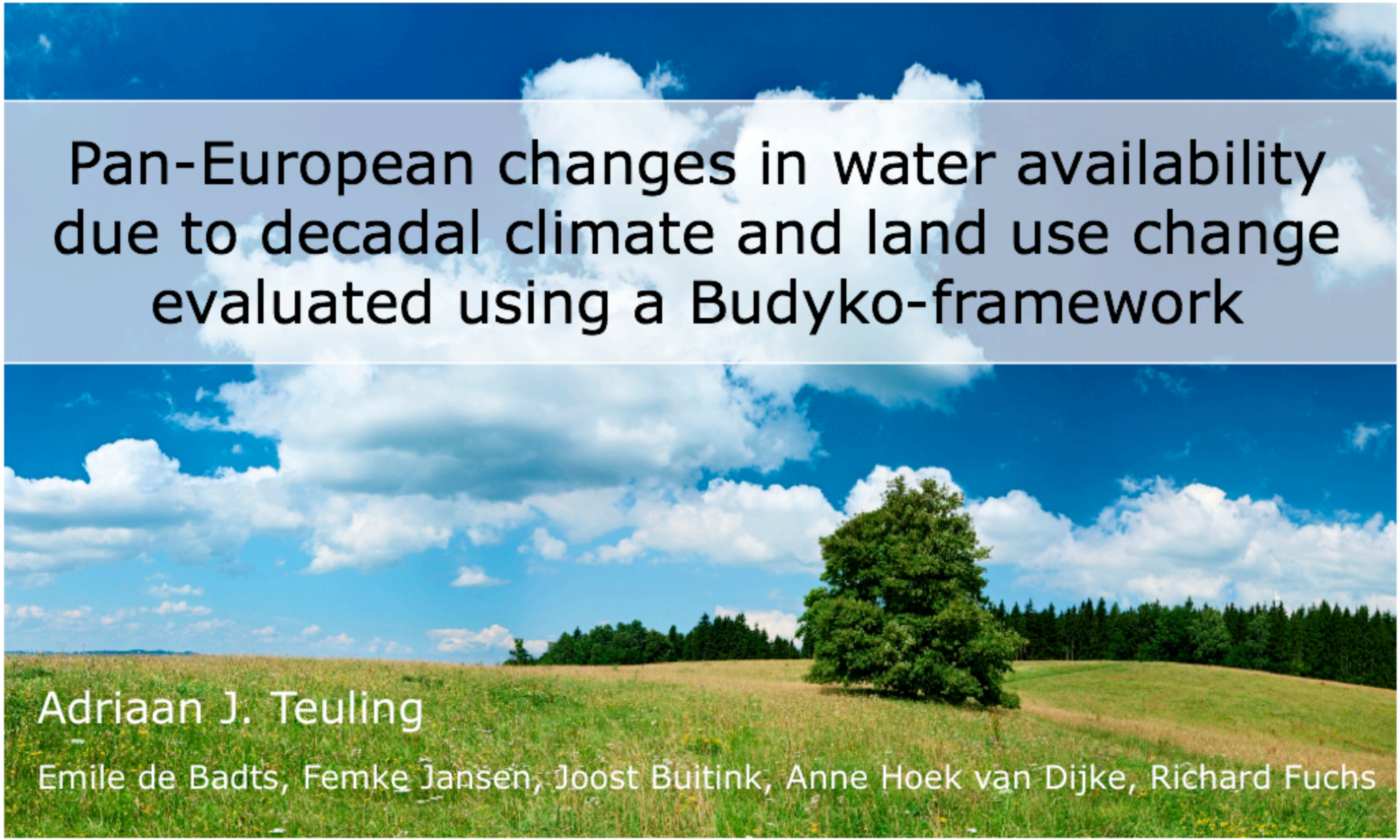
Pan-European changes in water availability due to decadal climate and land use change evaluated using a Budyko-framework



Adriaan J. Teuling

Emile de Badts, Femke Jansen, Joost Buitink, Anne Hoek van Dijke, Richard Fuchs

100years

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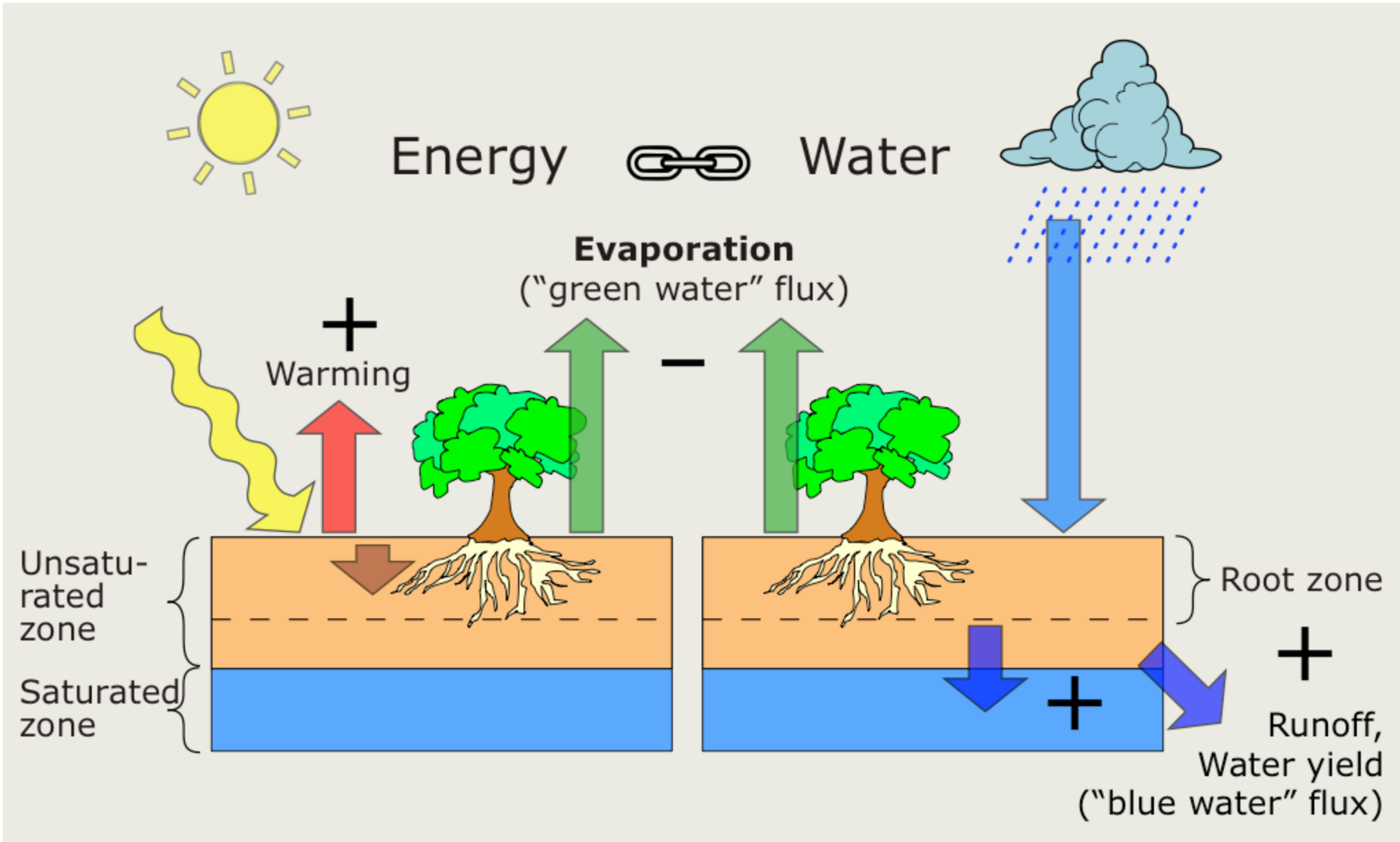
Evaporation, climate, and the hydrological cycle



Modified after Seneviratne et al. (2010), *Earth-Sci. Rev.*, **99**

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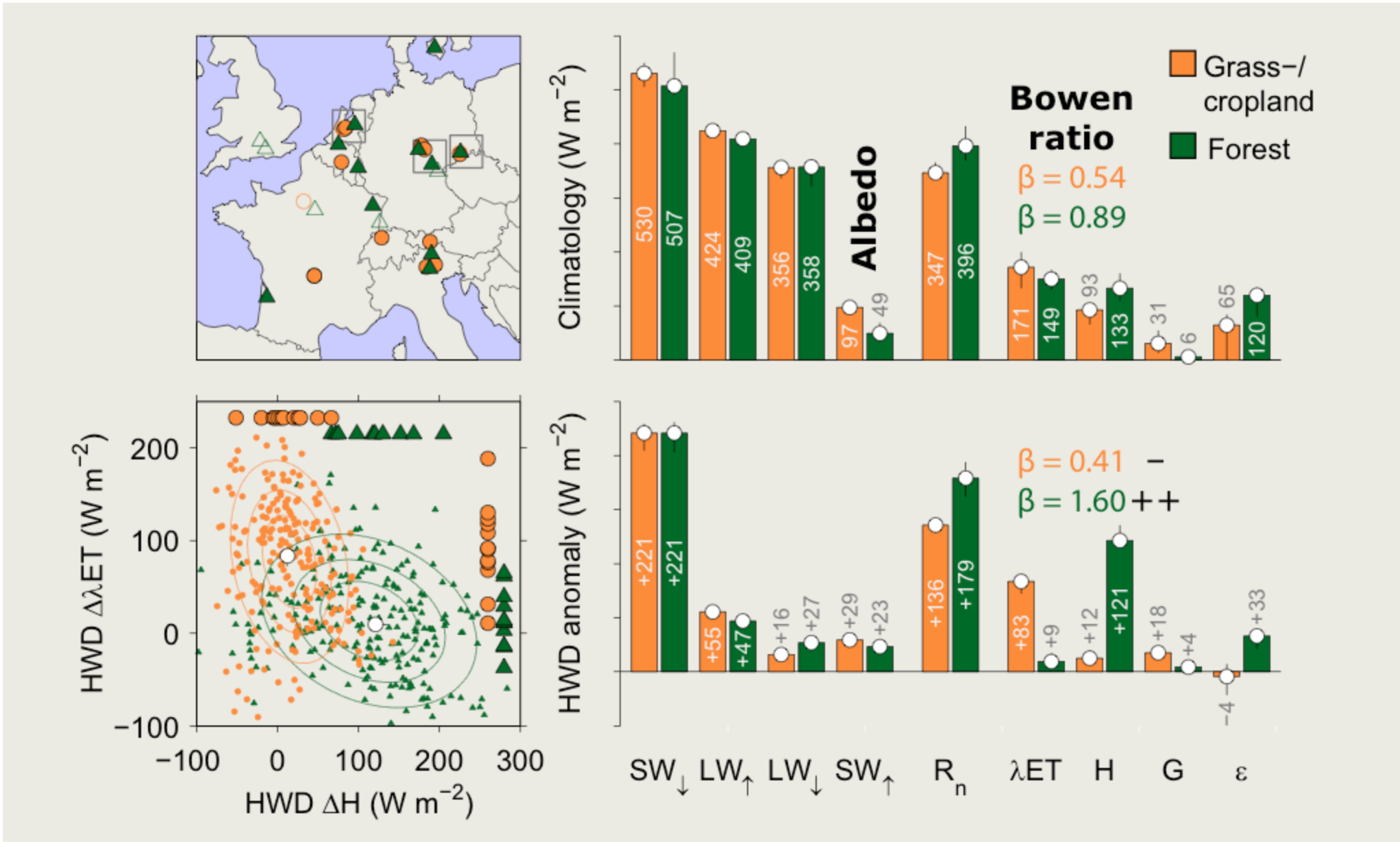
Warming role of forests during heatwaves



Teuling et al. (2010), *Nature Geosci.* **3**
van Heerwaarden & Teuling (2014), *Biogeosci.* **11**

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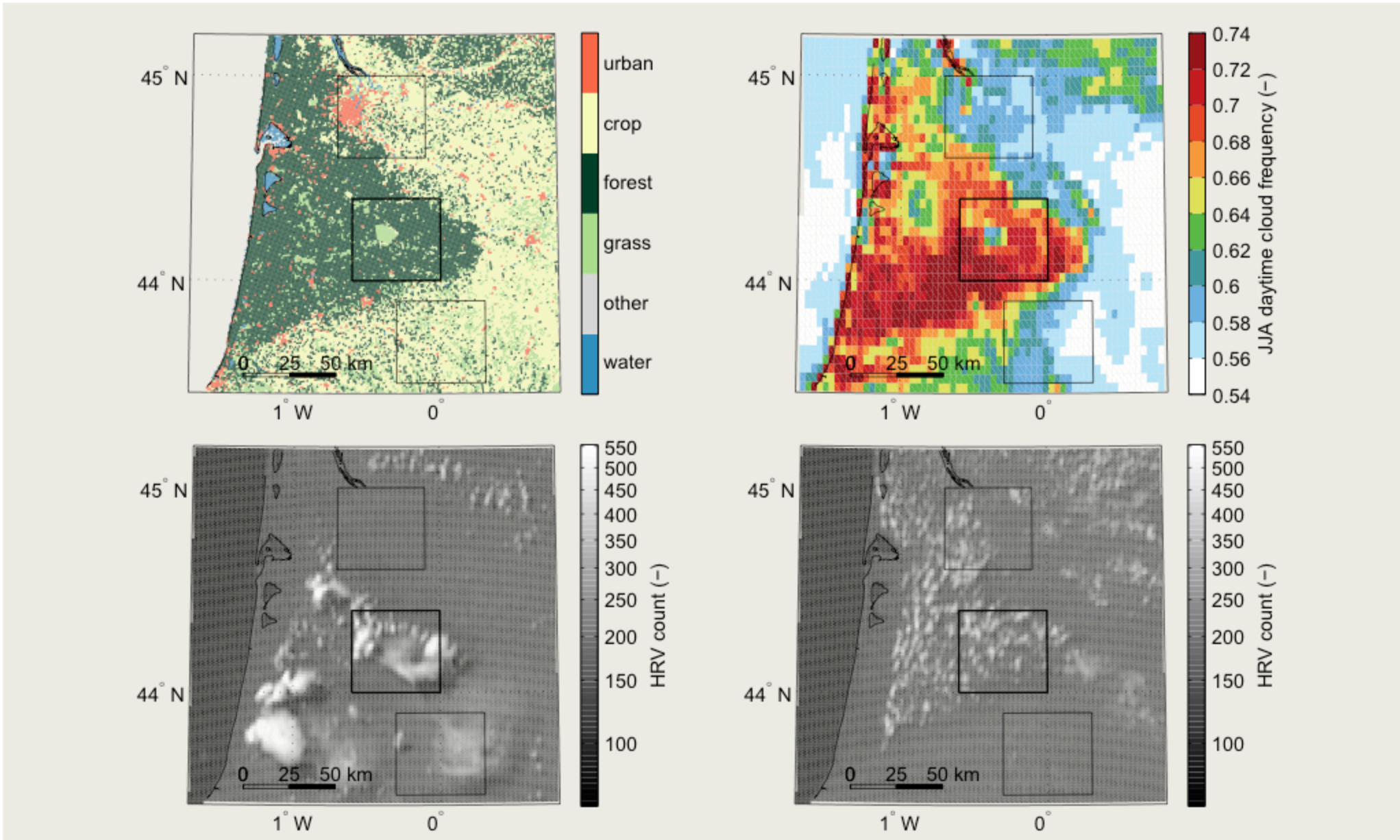
Cloud cover enhancement over forest



Teuling et al. (2017), *Nature Commun.* **8**

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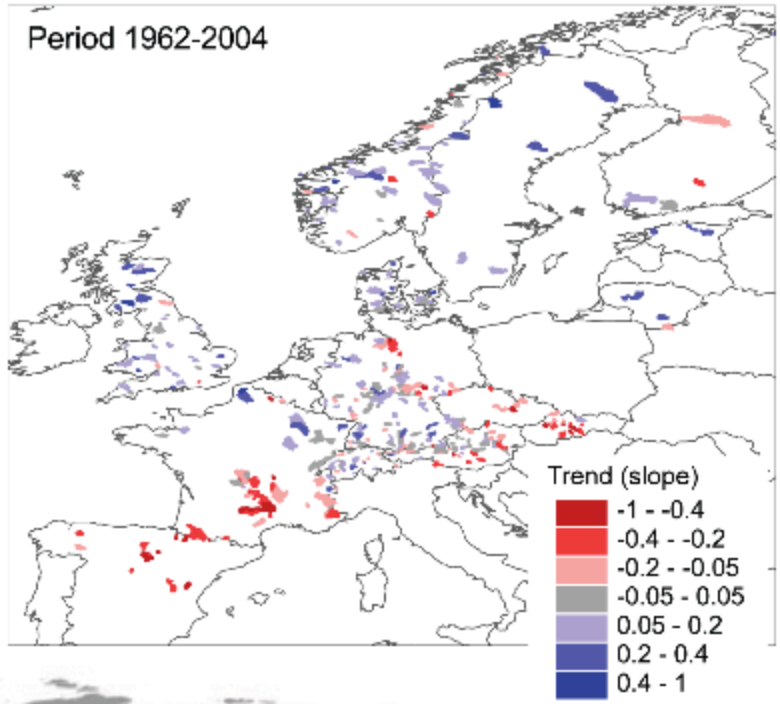
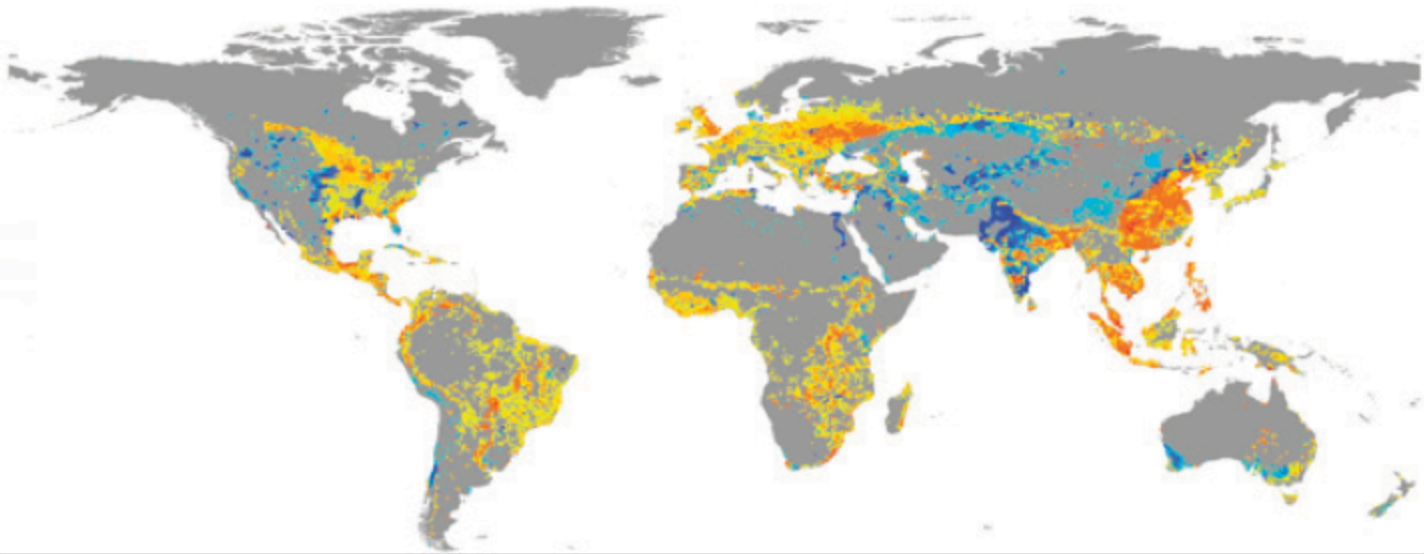
Changes in land cover & blue water fluxes

Spatially coherent changes in observed annual streamflow across Europe



Current anthropogenic land-cover change reduces annual TET by approximately 3,500 $km^3\ yr^{-1}$ (5%)



Stahl et al. (2010), *Hydrol. Earth Syst. Sci.* **14**
Sterling et al. (2012), *Nature Climate Change* **3**

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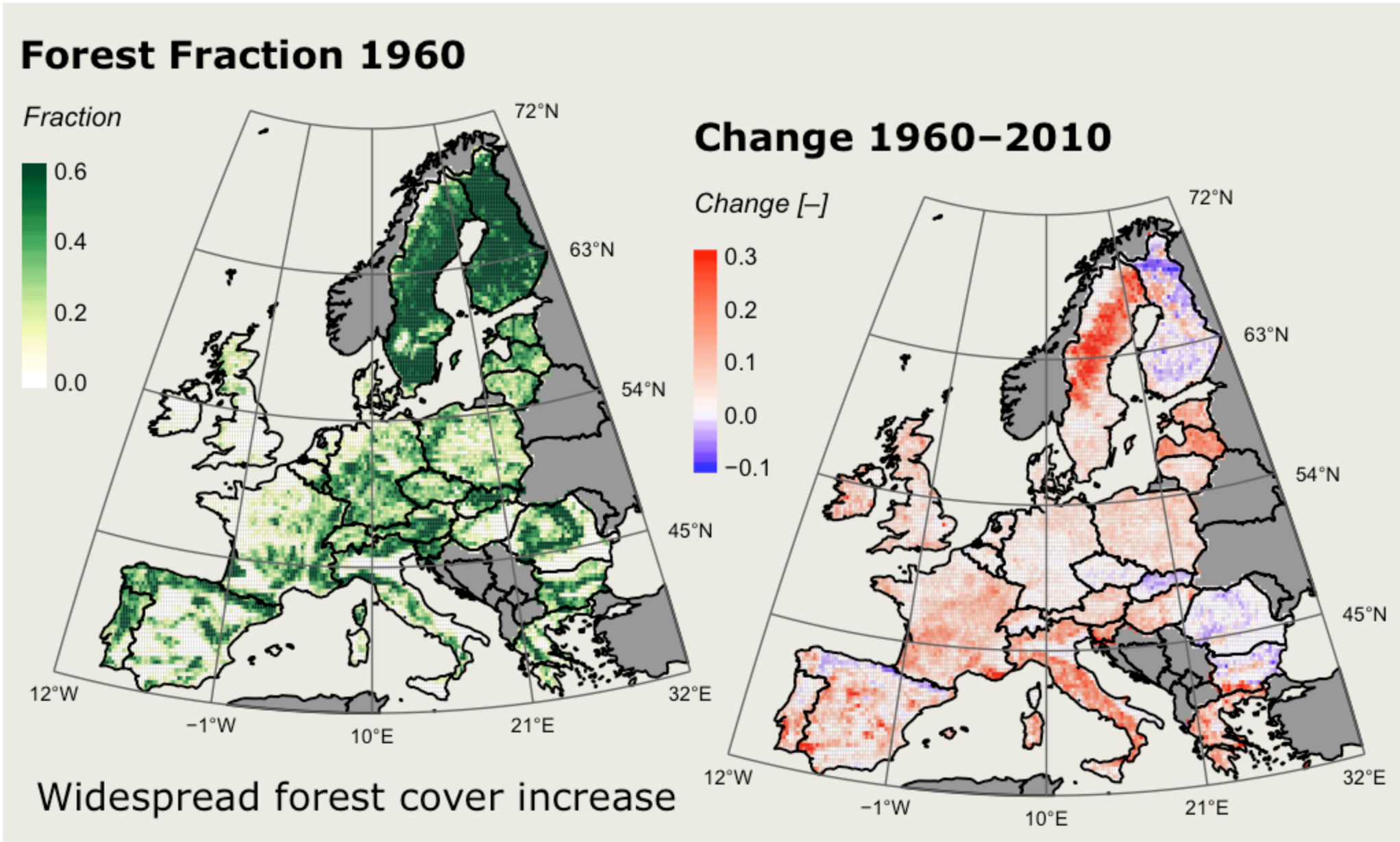
Land cover: re-/afforestation



data: Fuchs et al. (2015), *Glob. Ch. Biol.* **21**

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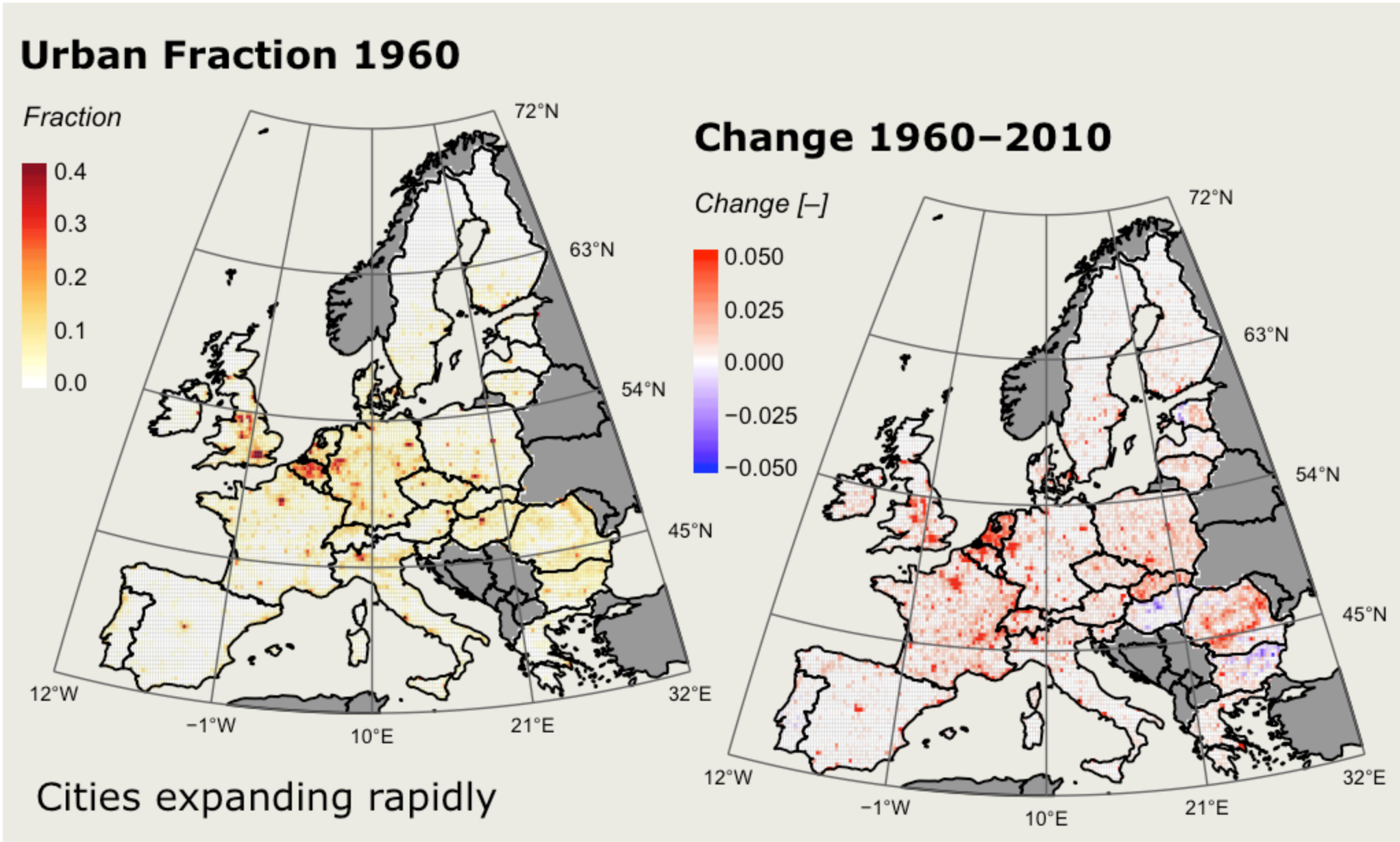
Land cover: urbanisation



Cities expanding rapidly

data: Fuchs et al. (2015), *Glob. Ch. Biol.* **21**

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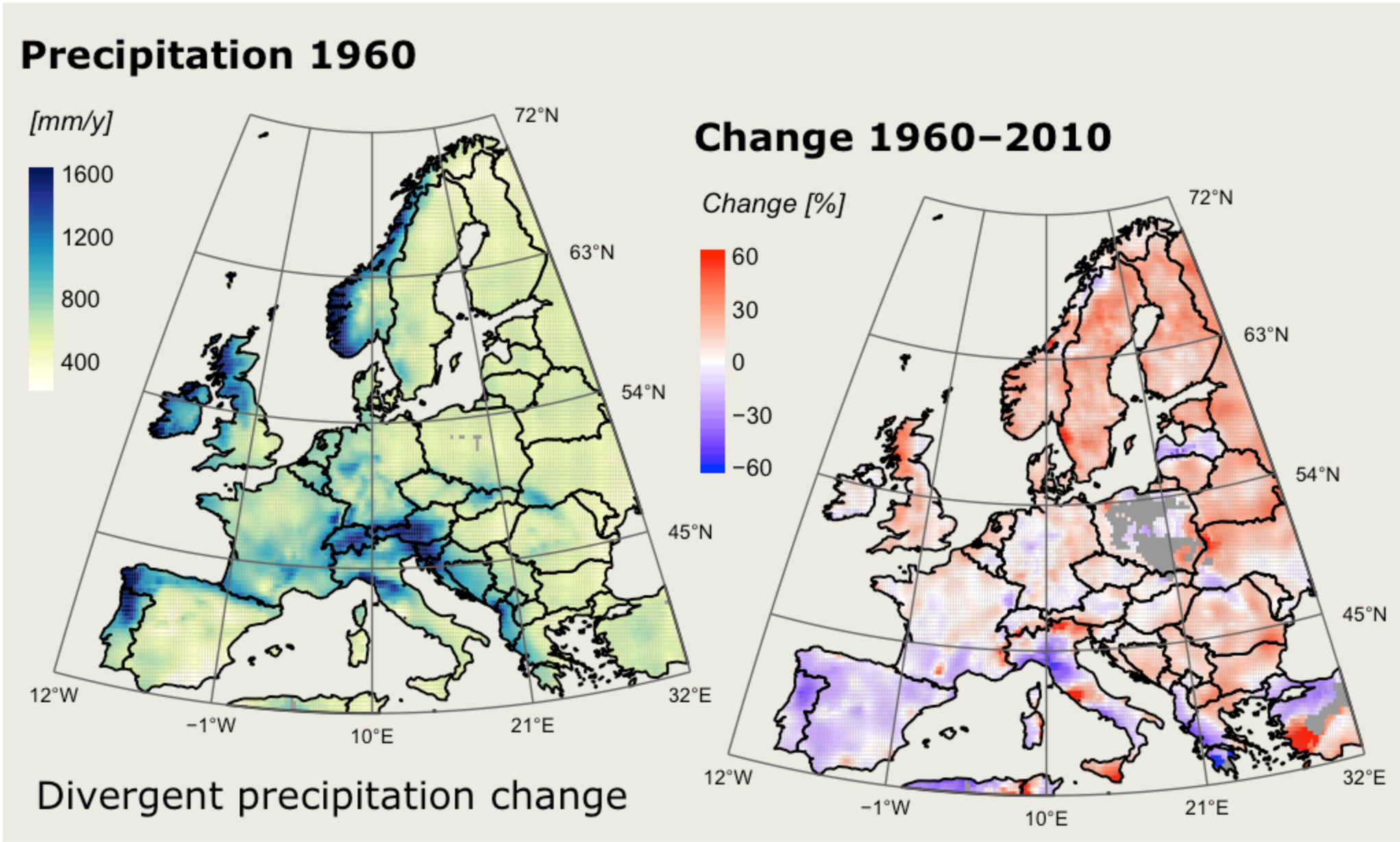
Climate: precipitation change



data: ecad.eu

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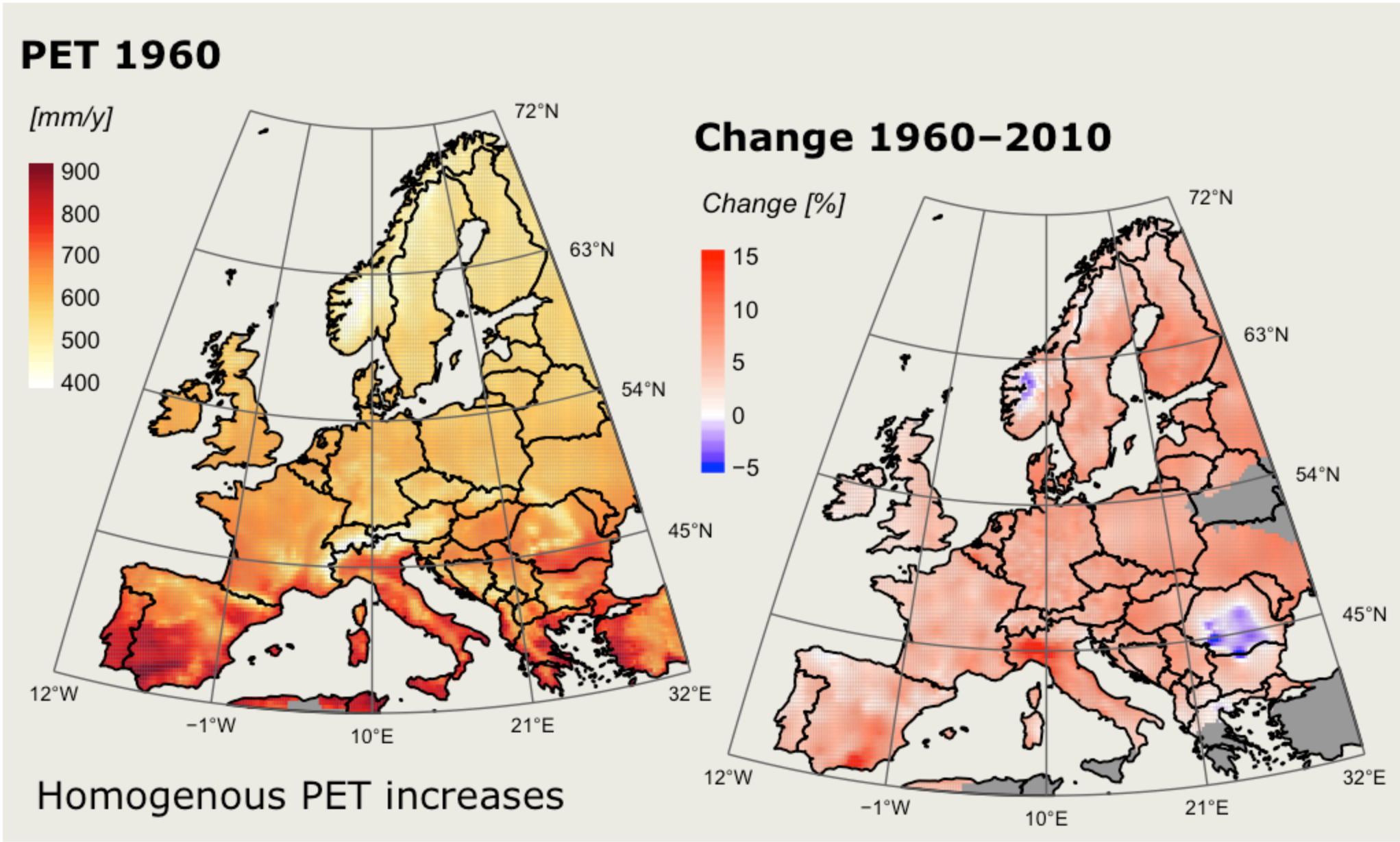
Climate: potential evaporation change



data: ecad.eu

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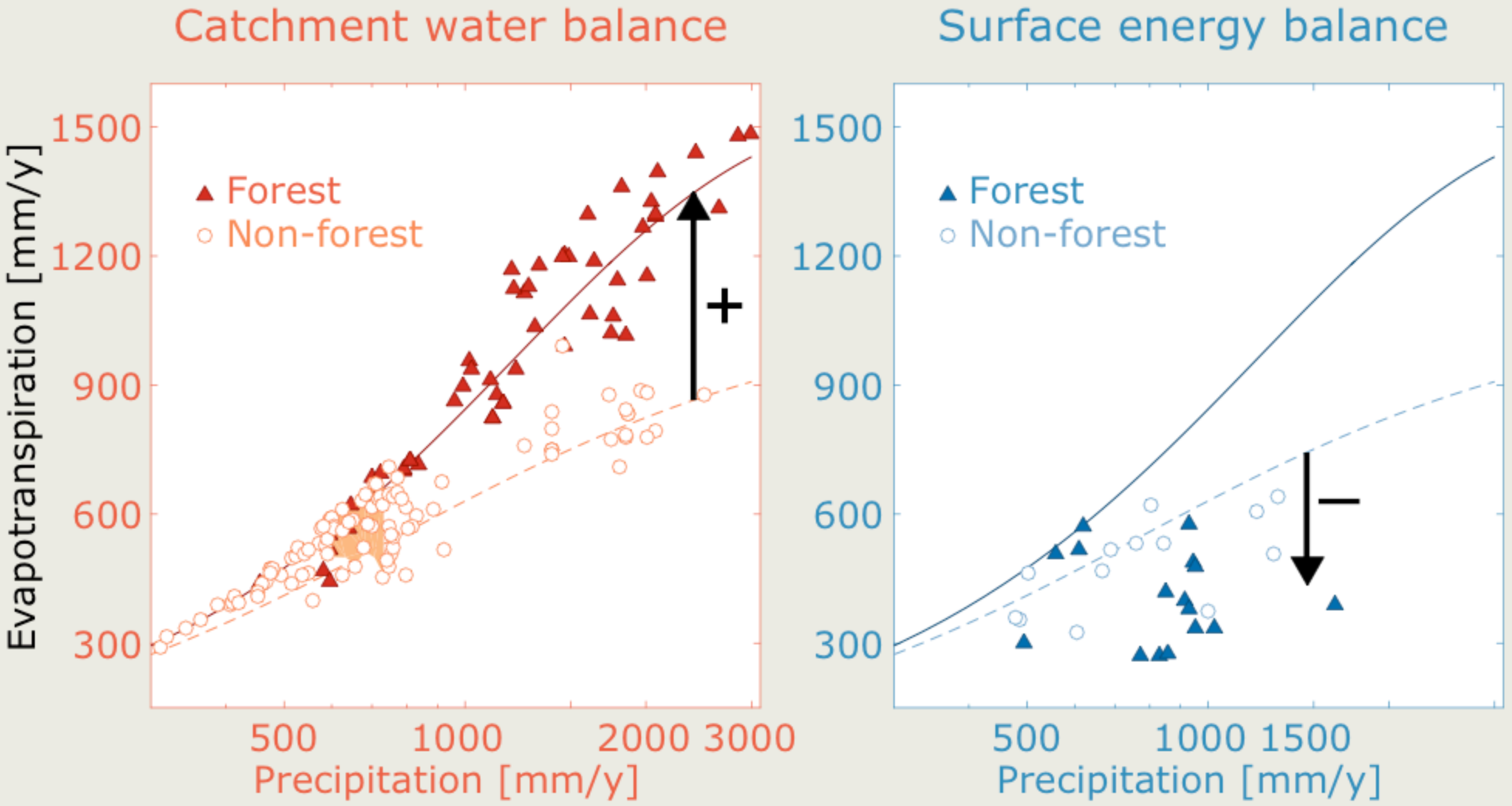
A forest evapotranspiration paradox?



Paradox: Sign of ET difference depends on method!

Zhang et al. (2001), *Water Resour. Res.* **37**
Williams et al. (2012), *Water Resour. Res.* **48**
Teuling (2018), *Vadose Zone J.* **17**

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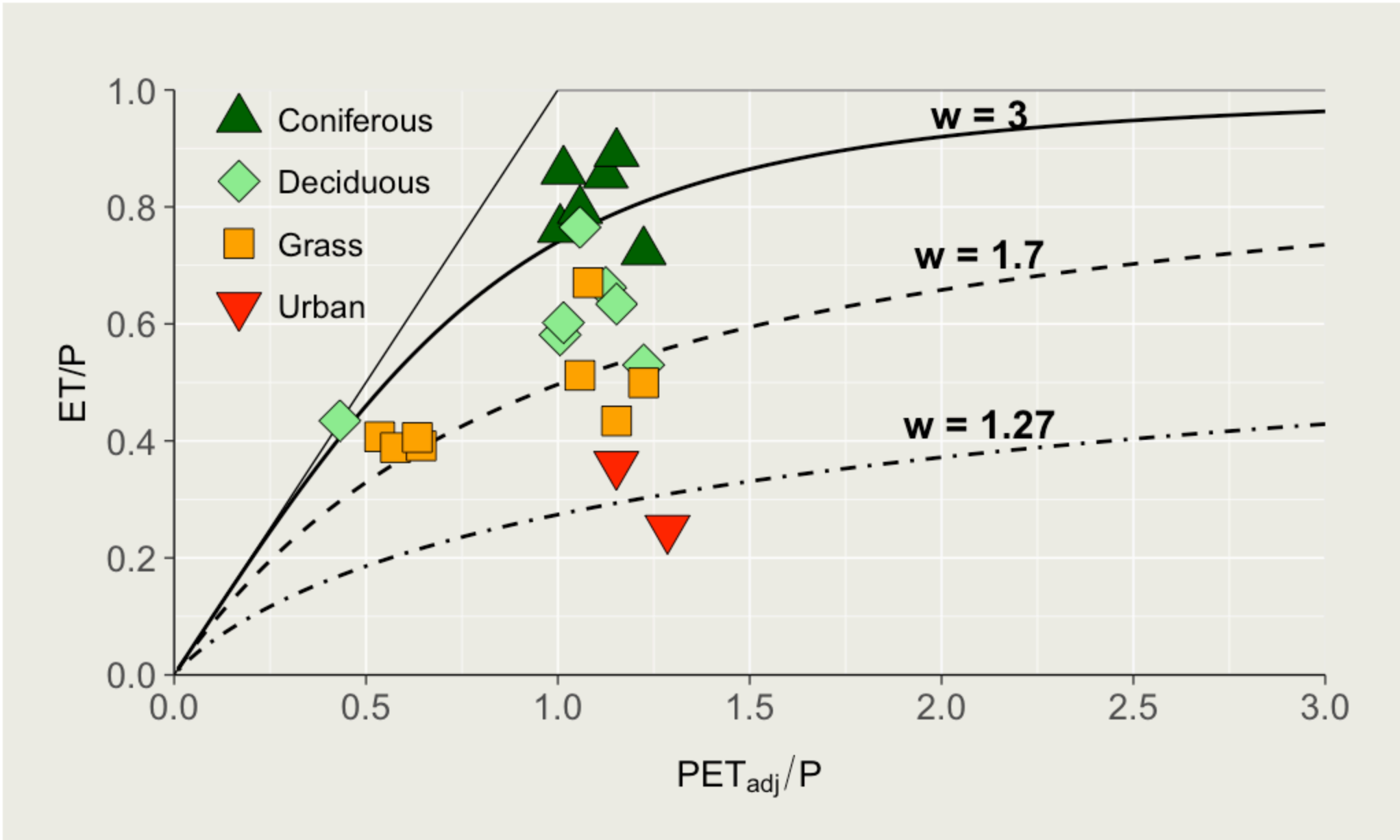
Budyko parameters from lysimeter data



Calder (1976), *J. Hydrol.* **30**
Jacobs et al. (2015), *Build. Environm.* **83**
Teuling (2018), *Vadose Zone J.* **17**

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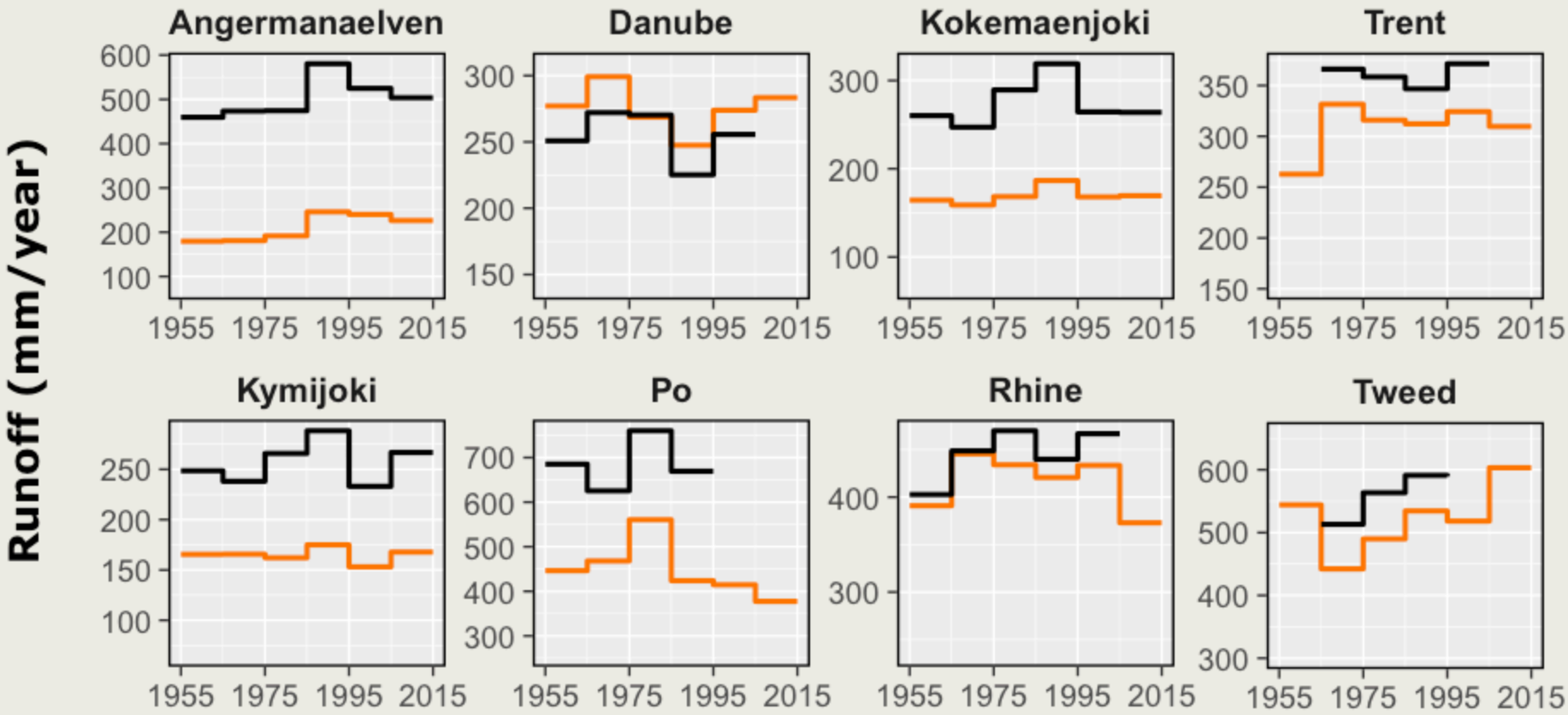
Validation against runoff observations



Decadal average blue water fluxes generally showed a good relation with runoff observations for large river basins across Europe

de Badts (2018), *MSc thesis WUR*

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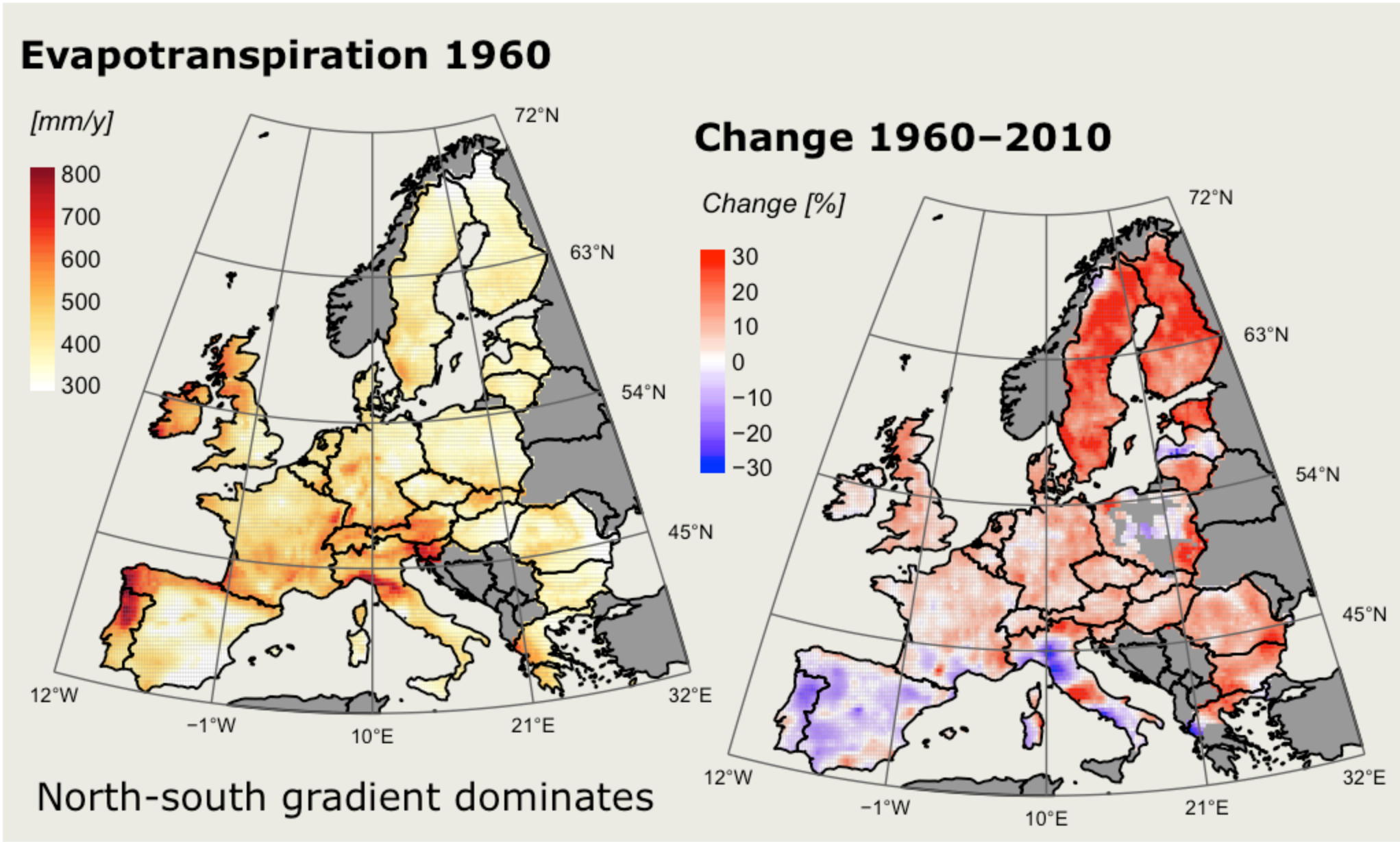
Gradient in green water flux changes



de Badts (2018), *MSc thesis*

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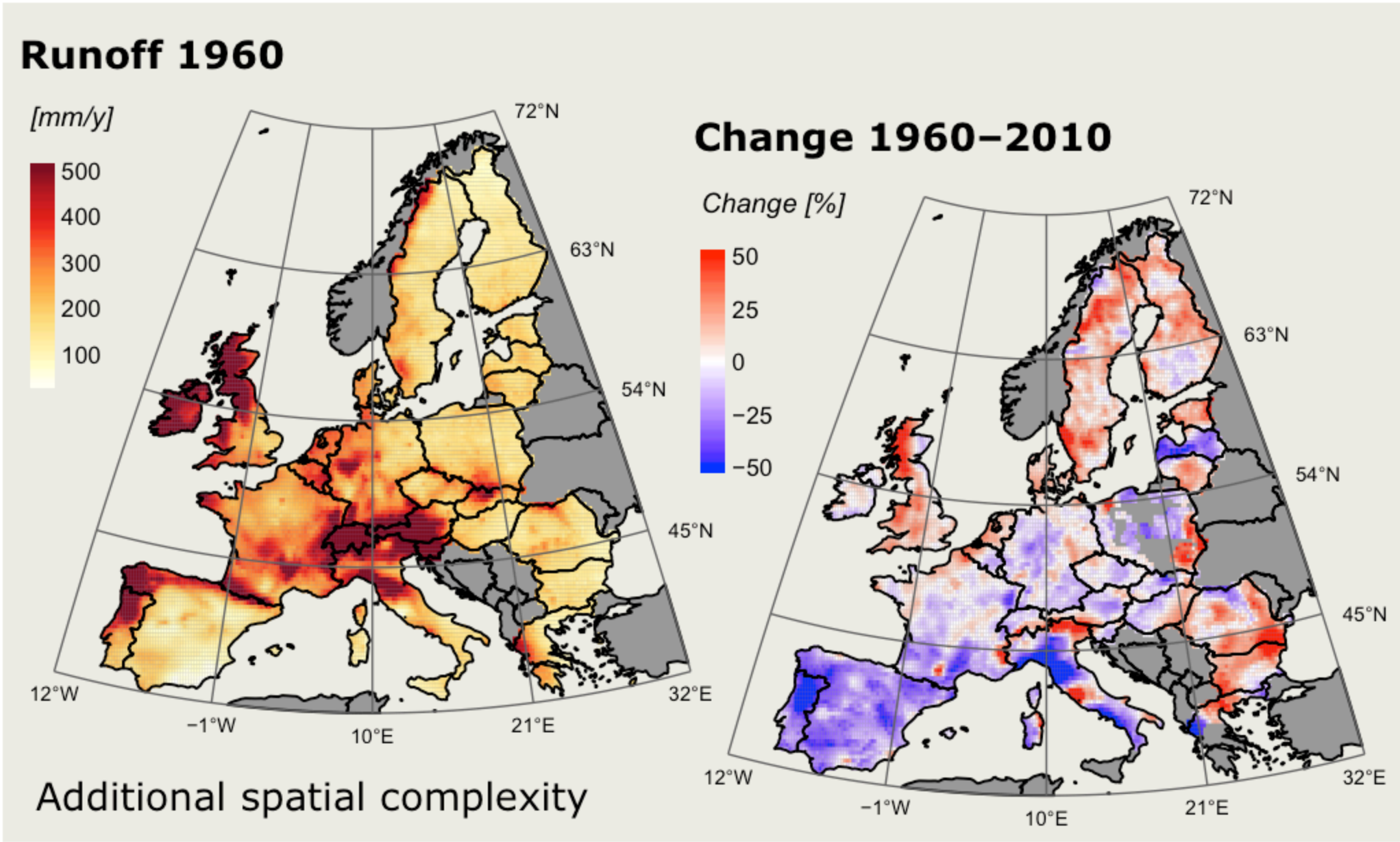
More complex pattern in blue water fluxes



Additional spatial complexity

de Badts (2018), *MSc thesis*

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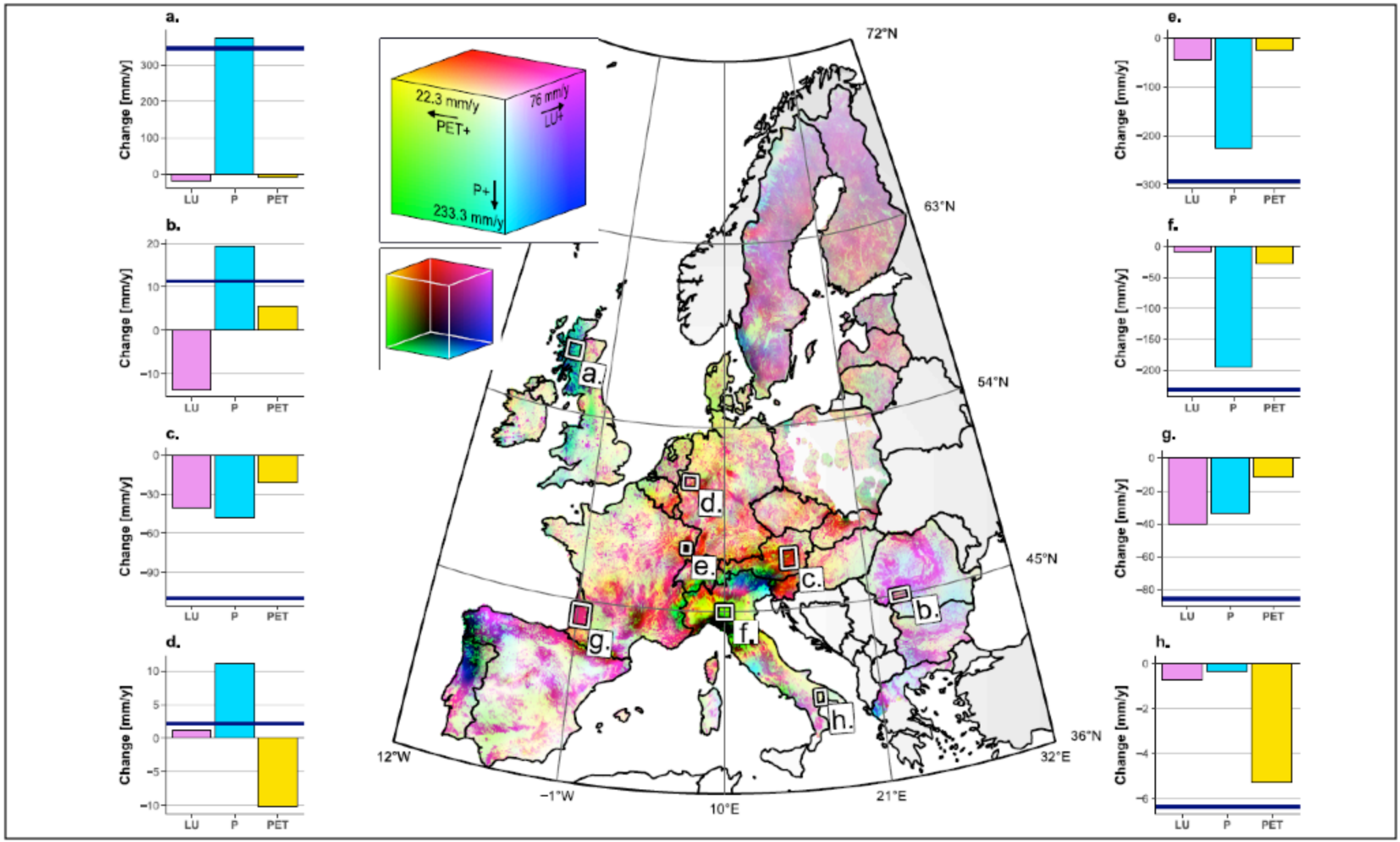
What drives changes in blue water fluxes?



de Badts (2018), *MSc thesis WUR*
Pijl et al. (2018), *Anthropocene* **22**

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Positive vs. negative contributions

	Factor	*Positive* (km^3y^{-1})	*Negative* (km^3y^{-1})	*Net* (km^3y^{-1})
ET	Land-use	68.7	−7.4	61.3
	Precipitation	97.2	−52.2	45.0
	PET	33.7	−0.2	33.5
Runoff	Land-use	7.4	−68.7	−61.3
	Precipitation	160.0	−80.4	79.6
	PET	0.2	−33.7	−33.5

de Badts (2018), *MSc thesis WUR*

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Conclusions

- Climate change exceeds land cover impact on blue water fluxes
- Strong climate gradient, land cover impact more consistent
- Parsimonious modeling approach consistent with observations