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The Impact of Landscape Restoration on Precipitation

Ronny Meier[1], Jonas Schwaab[1], Edouard L. Davin[1], and Sonia I. Seneviratne[1]

[1] Institute for Atmospheric and Climate Science, ETH Zurich, Zurich, Switzerland
Correspondence to: ronny.meier@env.ethz.ch

HS7.6
Precipitation small scale variability, hydrometeorologic extremes, and land-use feedbacks in the atmospheric water cycle, and beyond

Motivation

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More precipitation if air mass overpassed more vegetation in Tropics

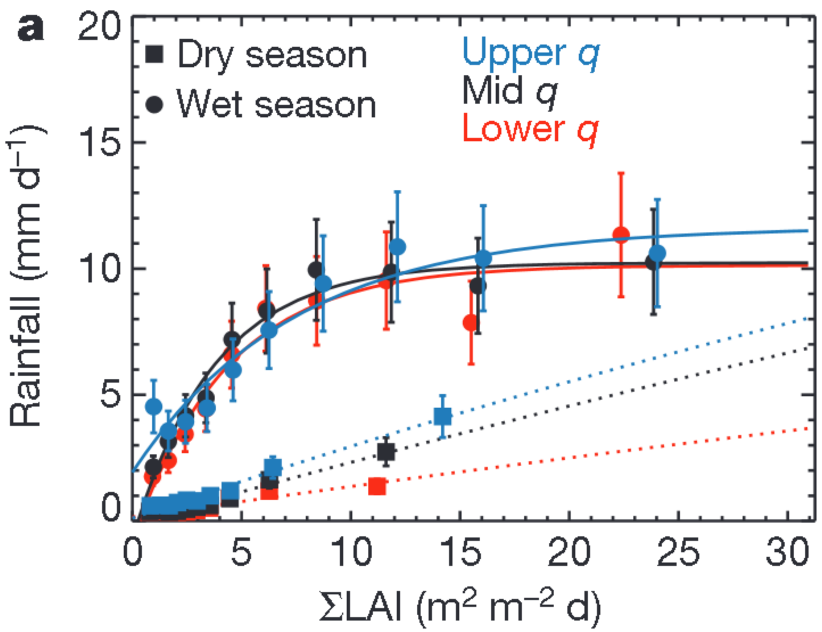

Figure 1: *Relationships between daily precipitation and cumulative exposure of 10-d back-trajectories to vegetation LAI (PLAI) for 2001–2007 for air masses arriving in Minas Gerais, Brazil (10–20uS, 40–50uW) (from Spracklen et al., 2012*[1]*).*

High potential for landscape restoration in Europe

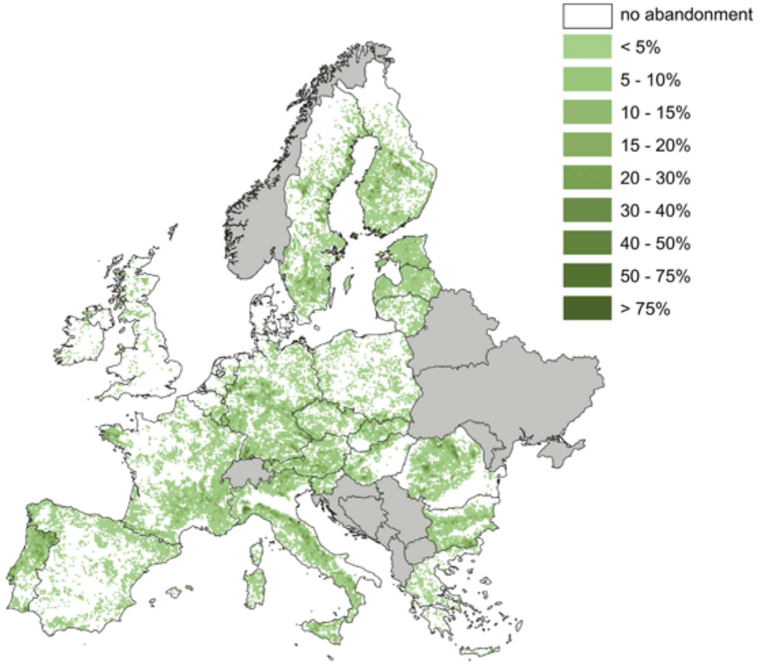

Figure 2: *Fraction of land projected to be rewilded after abandonment of agricultural land until 2030 (from Navarro et al., 2015*[2]*).*

Methods

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- Identify suitable site pairs in GSDR[3,4] rain gauge data set, which differ in 20 % agricultural land and natural vegetation each
- Fit generalized additive models to monthly MSWEP v2.2[5] precipitation climatology from 1986 to 2015

Predictors:

- Topography
- CORINE land cover[6]
- Indexes based on ERA5[7] wind trajectories (including upwind land cover fractions)
- ERA5-Land 2 m temperature[7]

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Local Effect of Landscape Restoration

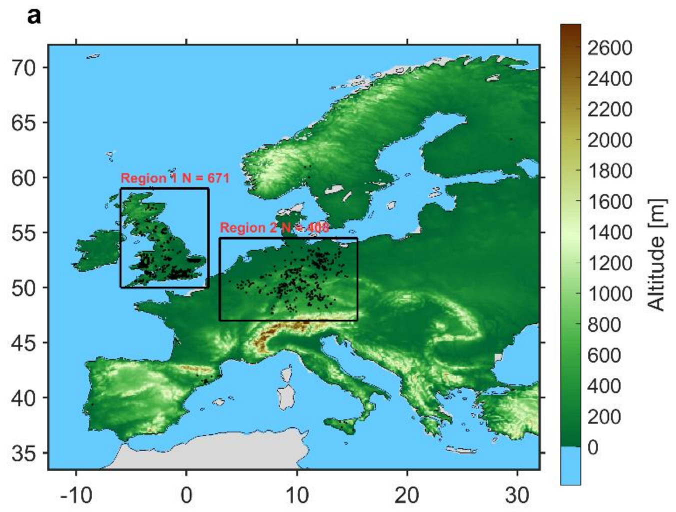
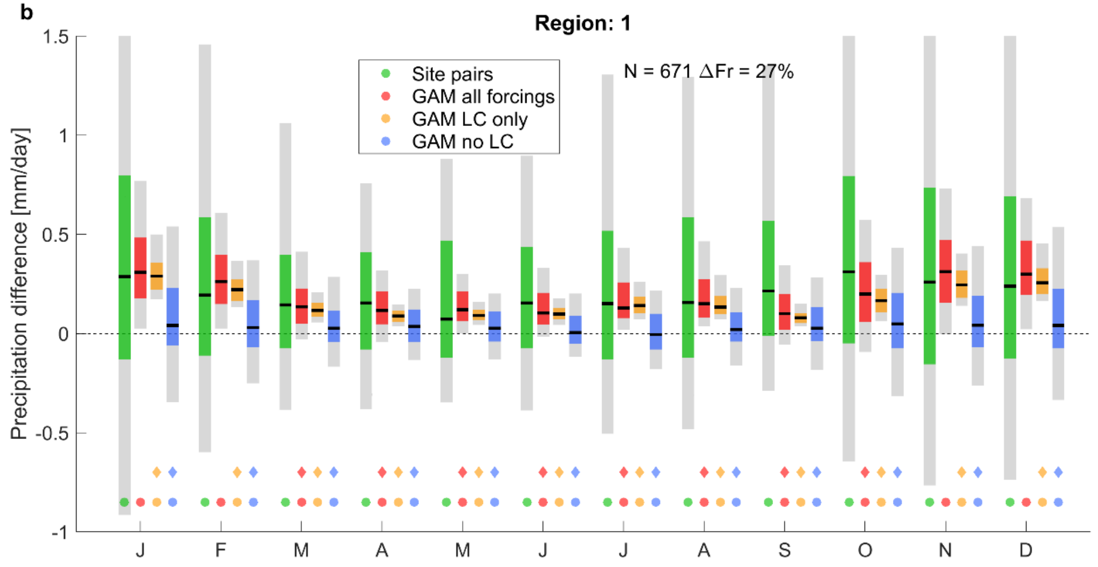
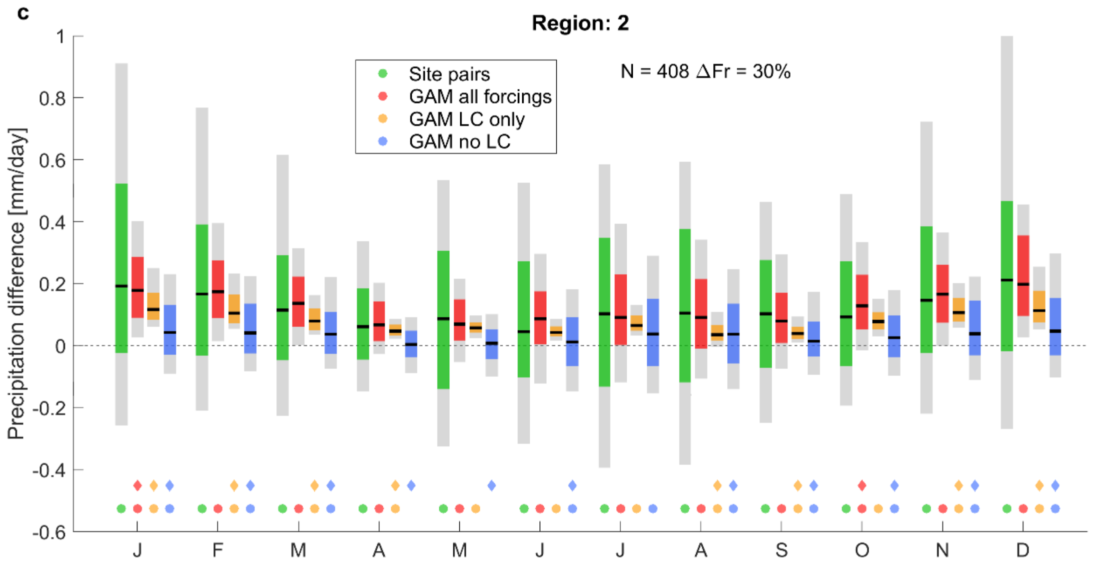


Figure 3: Local precipitation difference between natural vegetation and agricultural land at site pairs. *Panel a shows the location of the site pairs in GSDR and the topography over Europe. Below, the median (black line), interquartile range (colored shading), and range between 10 % and 90 % percentile (grey shading) of the precipitation difference between pairs in the GSDR rain gauge data set (green), the GAM prediction using all the forcings at the individual stations (red), GAM prediction using only the agricultural and natural vegetation land cover fractions at the individual stations but sharing the same conditions for the other variables (orange) , and prediction of GAM which was fitted without land cover information (blue) over the British isles (b) and Central Europe (c). Colored circles indicate samples which are significantly different from zero in a t-test and diamonds GAM prediction samples which are significantly different from the sample of the site pairs in a Welch's t-test both at 5 % confidence level.*





Local Effect of Landscape Restoration

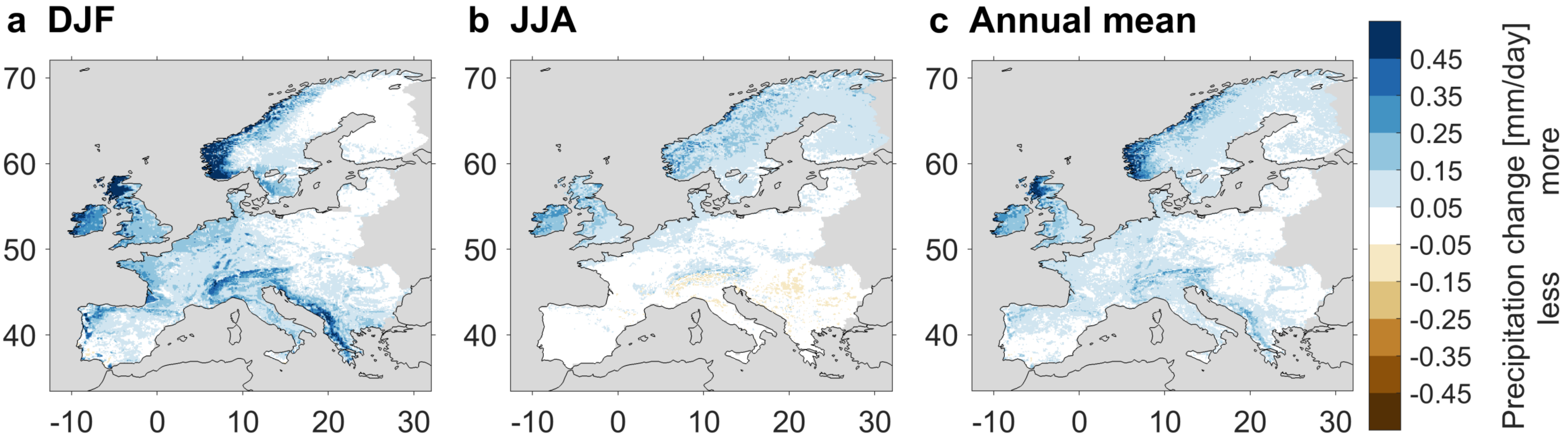


***Figure 4: Local precipitation change due to uniform restoration of 20 % of the land surface.** Local change in precipitation associated with a conversion of 20 % agricultural land to natural vegetation during boreal winter (a), boreal summer (b), and annual mean (c) according to generalized additive models.*

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Remote Effect of Landscape Restoration

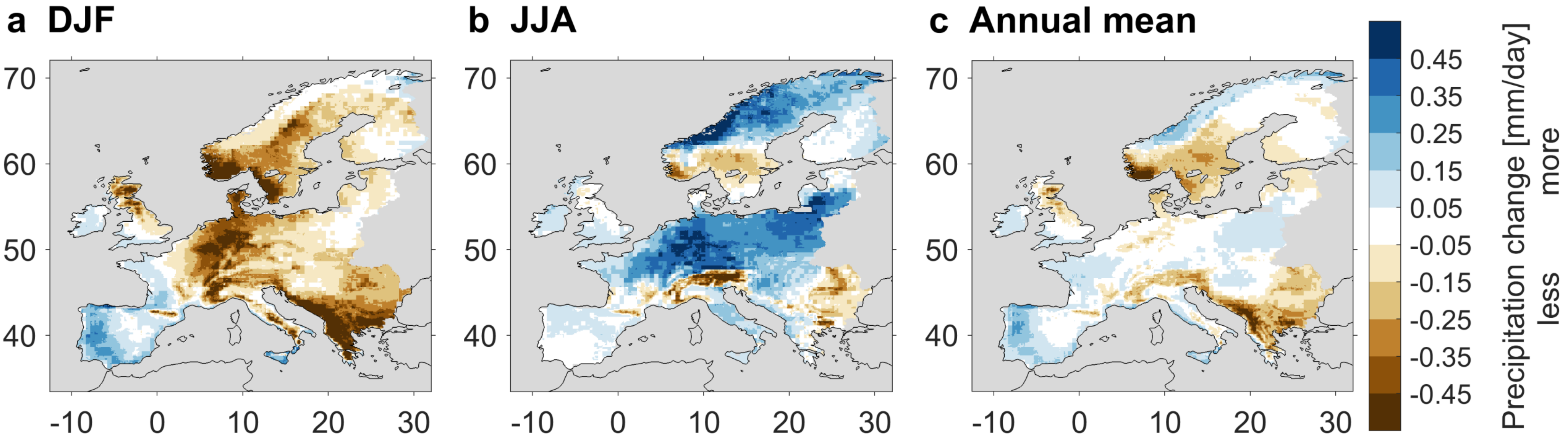

Figure 5: Remote precipitation change due to uniform restoration of 20 % of the land surface. *Remote change in precipitation associated with a conversion of 20 % agricultural land to natural vegetation during boreal winter (a), boreal summer (b), and annual mean (c) according to generalized additive models.*

References

[1] Spracklen, D., Arnold, S. & Taylor, C. Observations of increased tropical rainfall preceded by air passage over forests. Nature 489, 282285, DOI: 10.1038/nature11390 (2012).

[2] Navarro, L. M. & Pereira, H. M. Rewilding Abandoned Landscapes in Europe, 3–23 (Springer International Publishing, Cham, 2015).

[3] Contains data of the following Institutes: Service Puplic de Wallonia, Finnish Meteorological Institute, Météo-France, Deutscher Wetterdienst, Met Éireann, Meteo Trentino, Agrometeorologico Siciliano, Autonome Provinz Bozen–Südtirol, Norwegean Meteorological Institute, Sistema Nacional de Informação de Recursos Hídricos, Instituto Português do Mar e da Atmosfera, Servei Meteorologic de Catalunya, Meteo Schweiz, UK Met Office (Met Office (2006): MIDAS UK Hourly Rainfall Data. NCAS British Atmospheric Data Centre, May 5th 2020. https://catalogue.ceda.ac.uk/uuid/bbd6916225e7475514e17fdbf11141c1), Environment Agency UK, The Scottish Environment Protection Agency (Contains public sector information licensed under the Open Government Licence v3.0), and Natural Resources Wales (Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved).

[4] Lewis, E. et al. GSDR: A global sub-daily rainfall dataset. J. Clim. 32, 4715–4729, DOI: 10.1175/JCLI-D-18-0143.1 (2019). https://doi.org/10.1175/JCLI-D-18-0143.1.

[5] Beck, H. E. et al. MSWEP v2 global 3-hourly 0.1 precipitation: Methodology and quantitative assessment. B. Am. Meteorol. Soc. 100, 473–500, DOI: 10.1175/BAMS-D-17-0138.1 (2019). https://doi.org/10.1175/BAMS-D-17-0138.1.

[6] Kosztra, B., Büttner, G., Hazeu, G. & Arnold, S. Updated clc illustrated nomenclature guidelines. (2019).

[7] Copernicus Climate Change Service (C3S). C3s era5-land reanalysis (2019).

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