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16 | 06 | 2022

Land–atmosphere feedbacks during droughts

Diego G. Miralles

& the DRY–2–DRY team

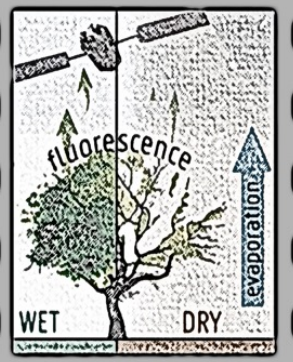
D. Schumacher

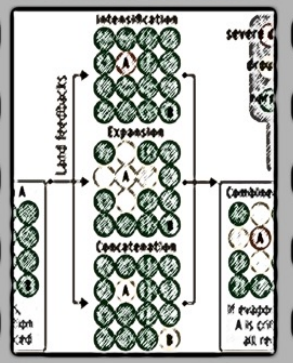
J. Keune

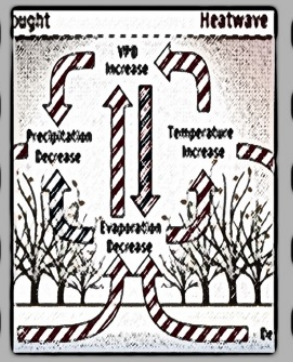
I. Petrova

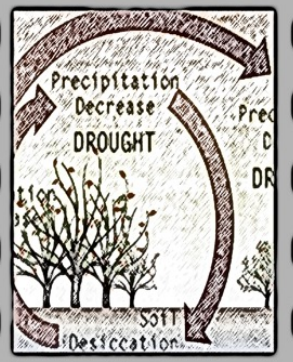
A. Koppa

H. Wouters









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2017

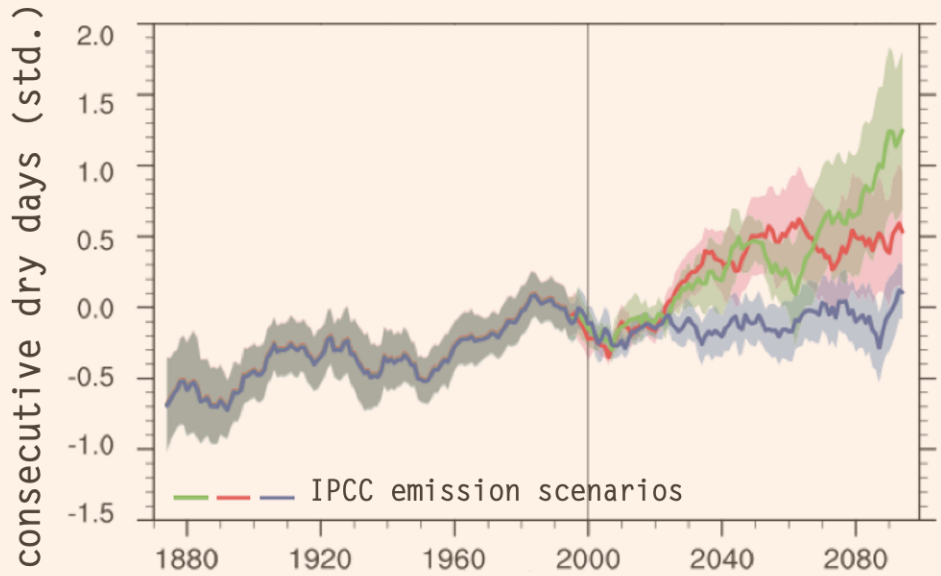
DRY–2–DRY

Do droughts self-propagate and self-intensify?

Diego G. Miralles

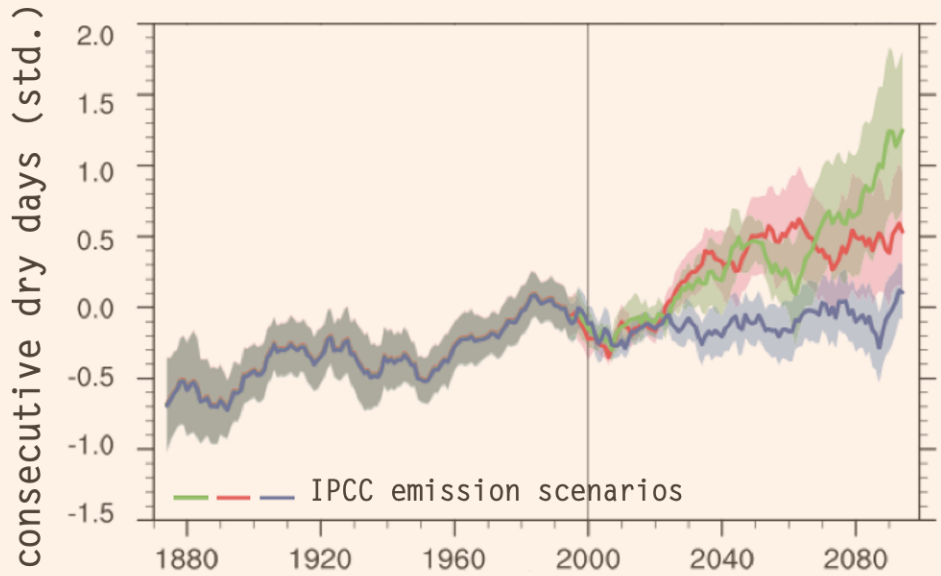
UNIVERSITEIT GENT

the motivation



Drought aggravation
predicted, but high
uncertainty

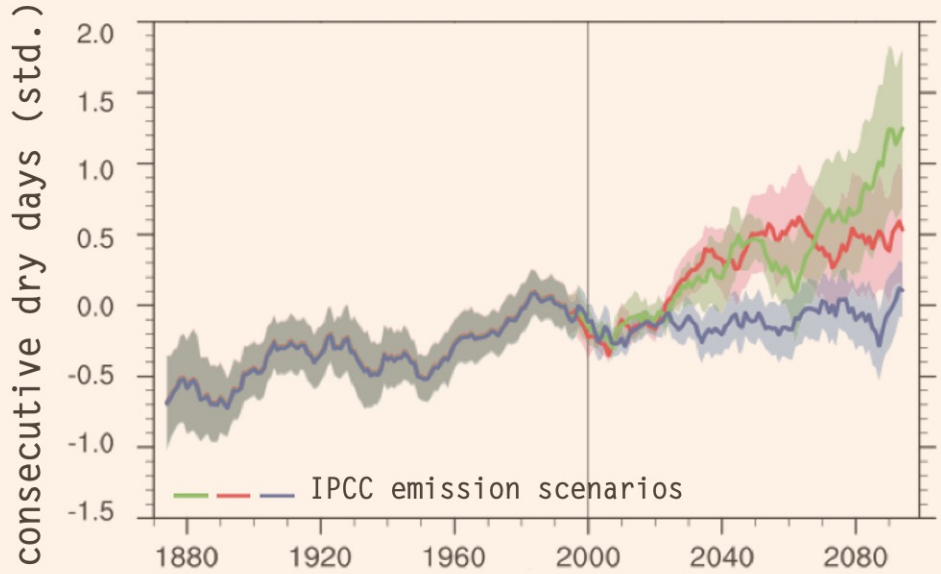
the motivation



Drought aggravation predicted, but high **uncertainty**

Uncertainty due to lack of understanding of **land feedbacks**

the motivation



Drought aggravation predicted, but high **uncertainty**

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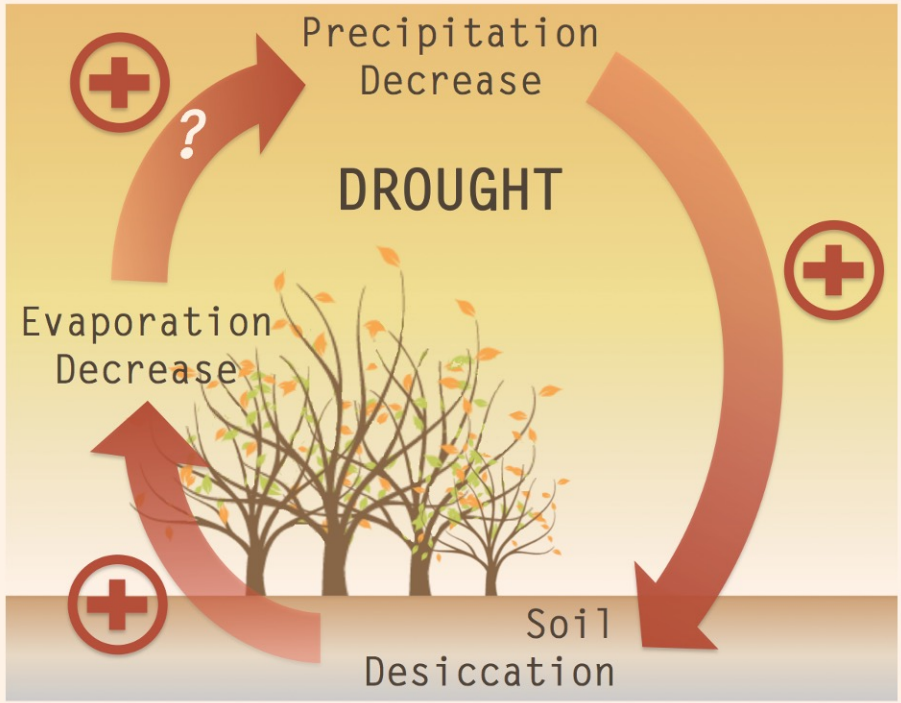


nature geoscience
LETTERS
PUBLISHED ONLINE: 20 APRIL 2014 | DOI: 10.1038/NGEO2141

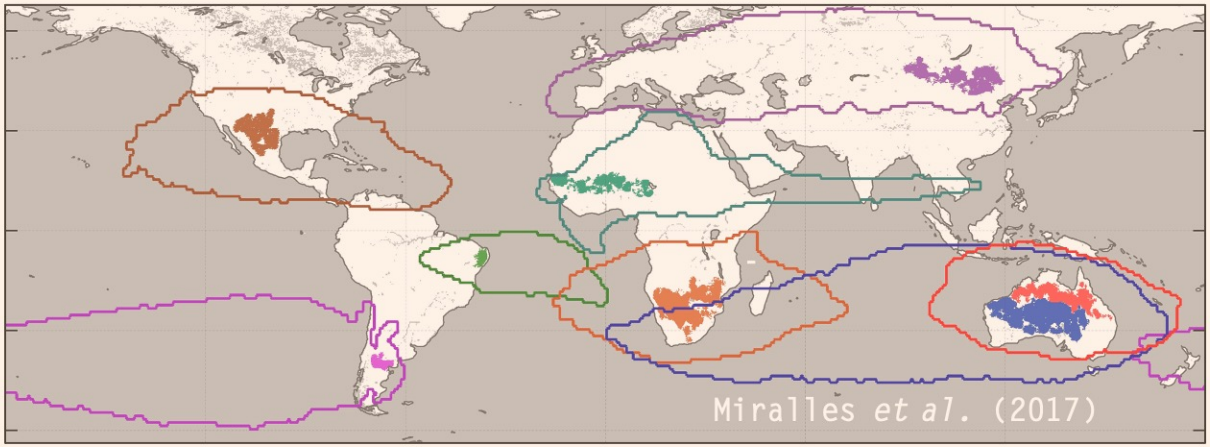
Mega-heatwave temperatures due to combined soil desiccation and atmospheric heat accumulation

Diego G. Miralles[1,2*], A.J. Teuling[3], C.C. van Heerwaarden[4] and J.V.-G.Arellano[5]

nature COMMUNICATIONS
ARTICLE
Received 12 Nov 2014 | Accepted 29 Jan 2015 | Published 5 Mar 2015

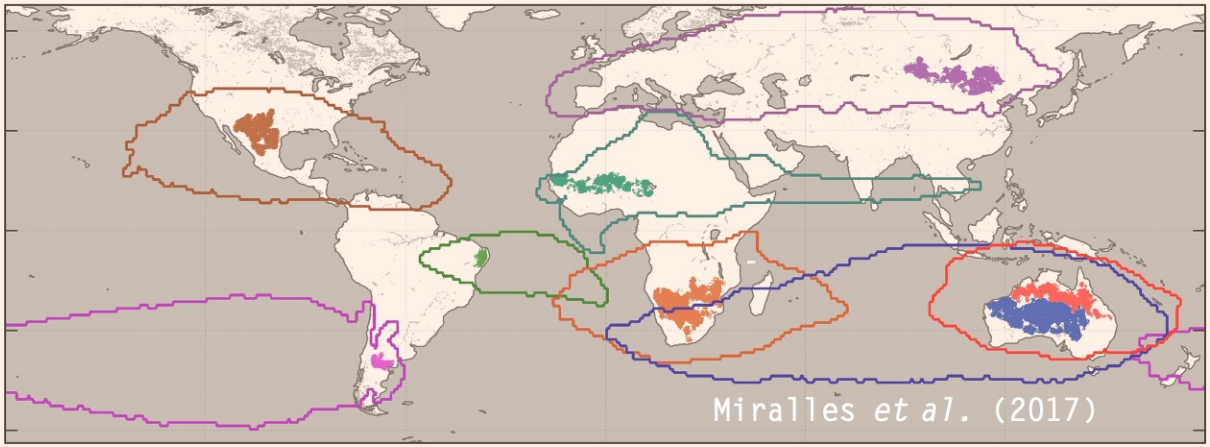
Reconciling spatial and temporal soil moisture effects on afternoon rainfall

B.P. Guillod[1,†], Orlowsky[1], D.G. Miralles[2,3], A.J. Teuling[4] & S.I. Seneviratne[1]



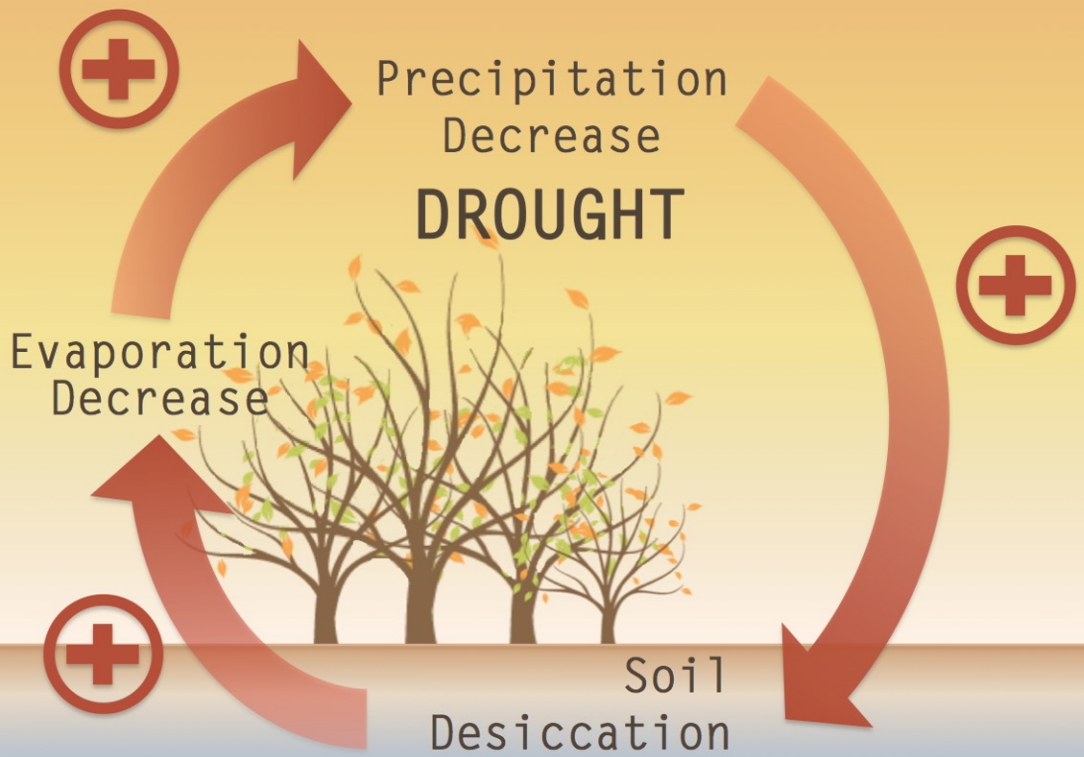
but also
teleconnected effects

the motivation

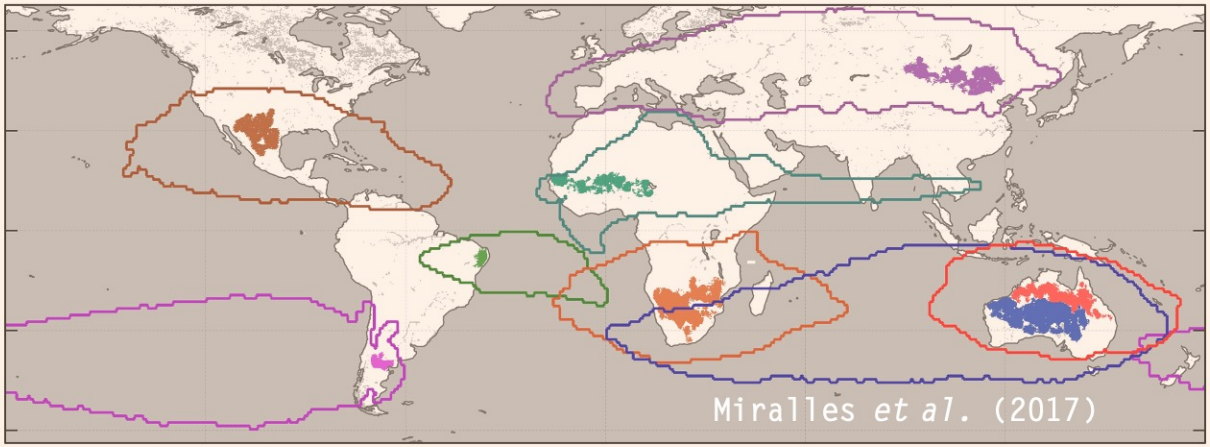


but also **teleconnected effects**

self-intensification



the motivation



but also
teleconnected effects

self-intensification

Precipitation Decrease

DROUGHT

Evaporation Decrease

Soil Desiccation

wind

self-propagation

Precipitation Decrease

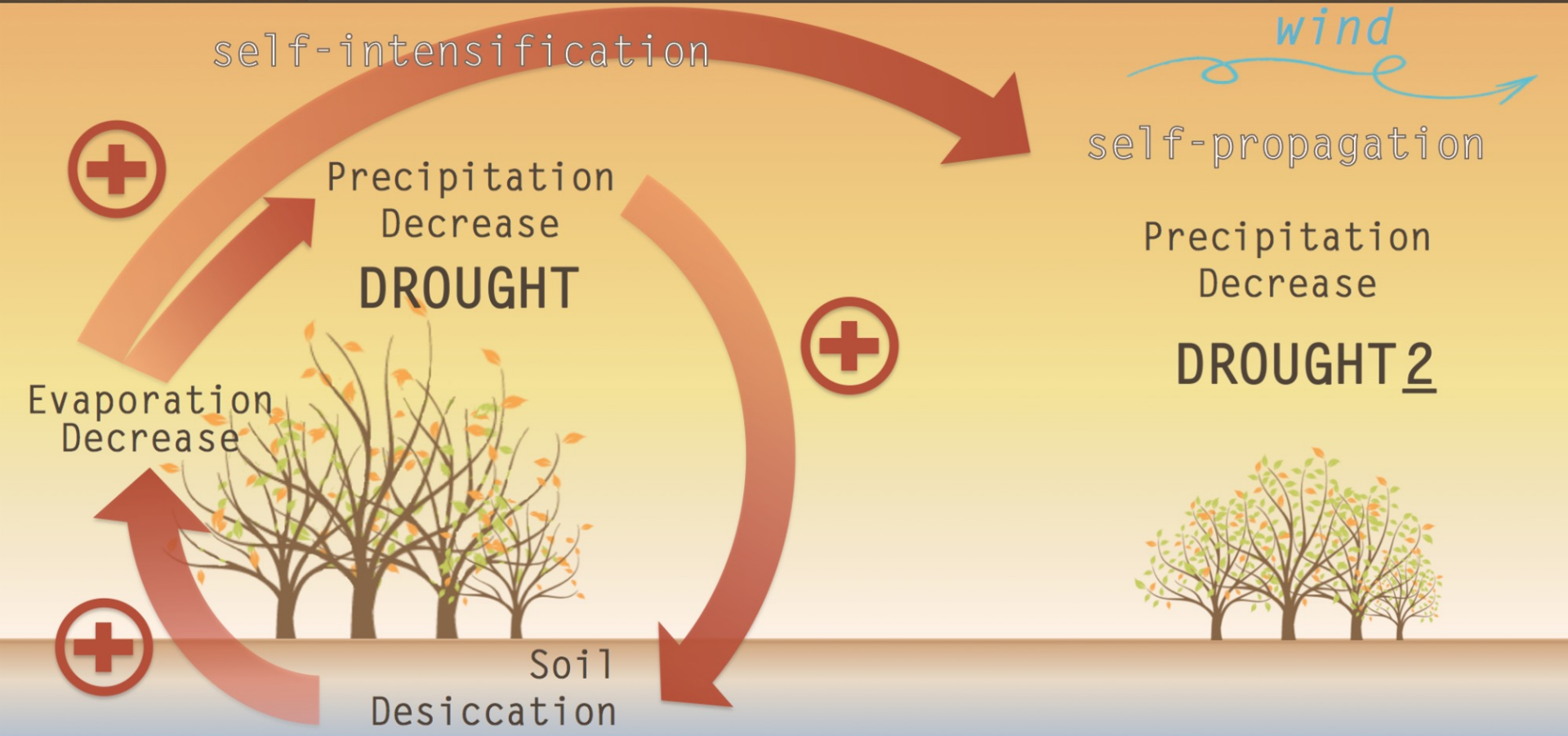
DROUGHT 2

the motivation

Crucial to uncover it **now**

① Timely **forecasting**
② Accurate **projection**
③ Better **adaptation**

...depend on understanding this feedback



the workflow

Objectives

① **To provide evidence of the impact of drought on evaporation (WP1)**

② To quantify the importance of drought self-intensification (WP2)

③ To uncover the existence of drought self-propagation (WP3)

④ To assess the value of land cover management in dampening drought (WP4)

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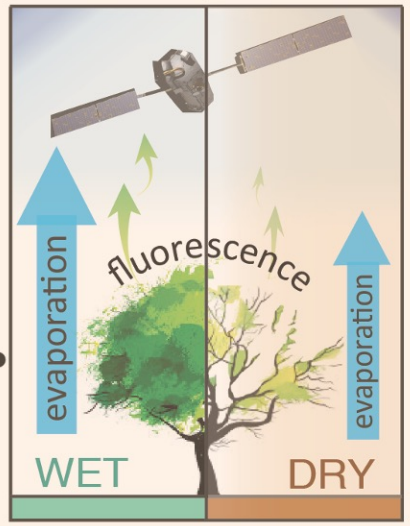
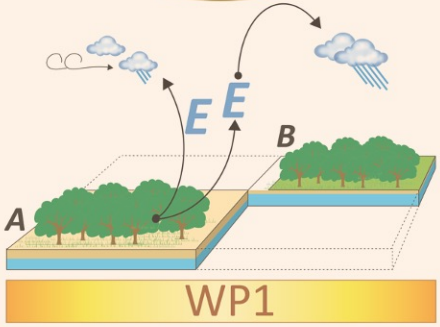
GLEAM
retrieval model

evaporation



Miralles *et al.* (2014a), *Nature Cl. Change*



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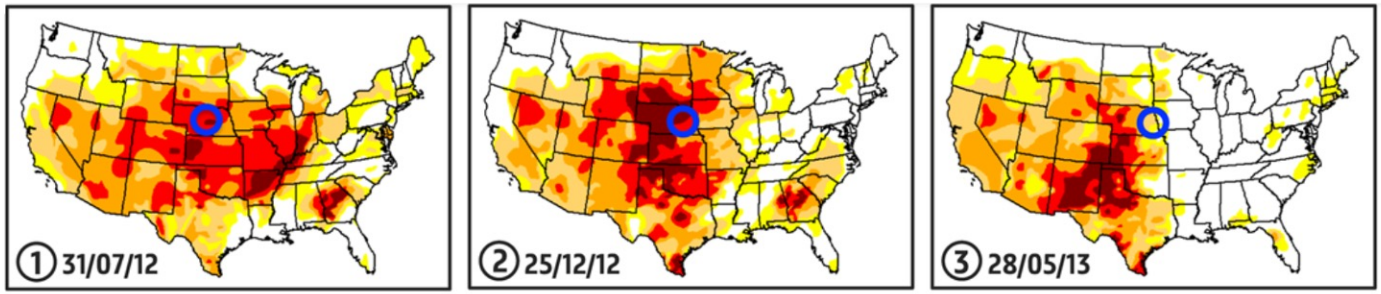
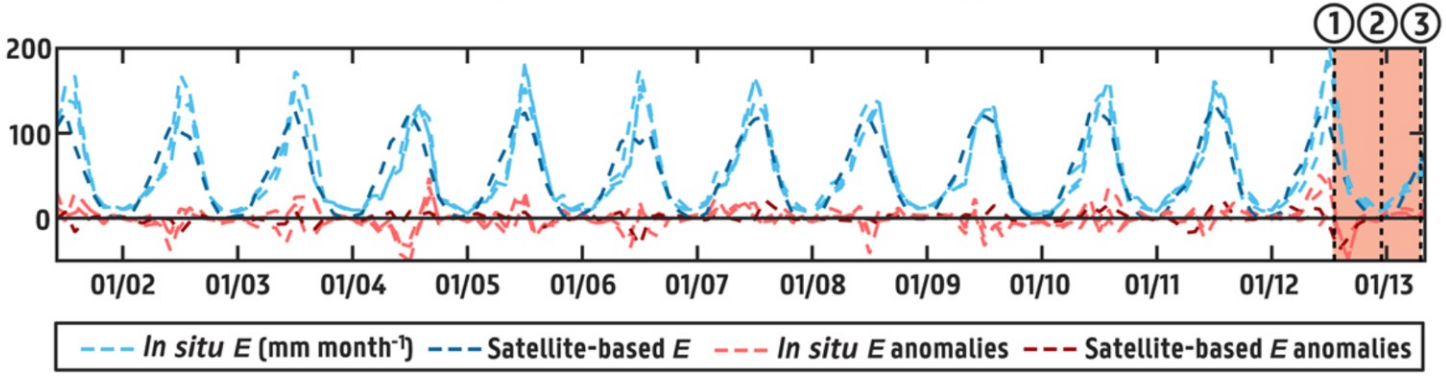
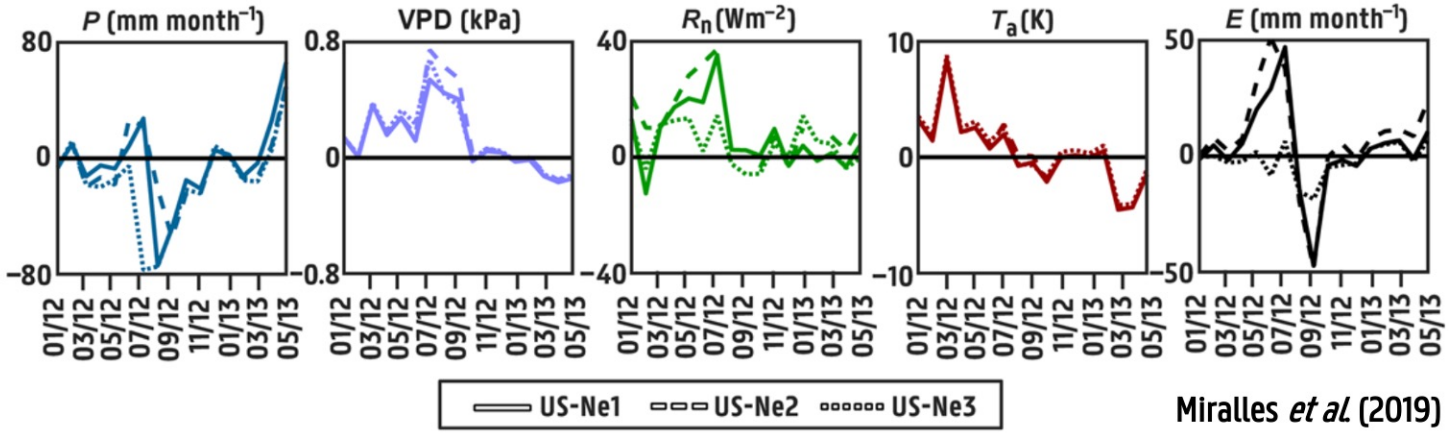




Pioneers Park, 2012 (Nebraska)



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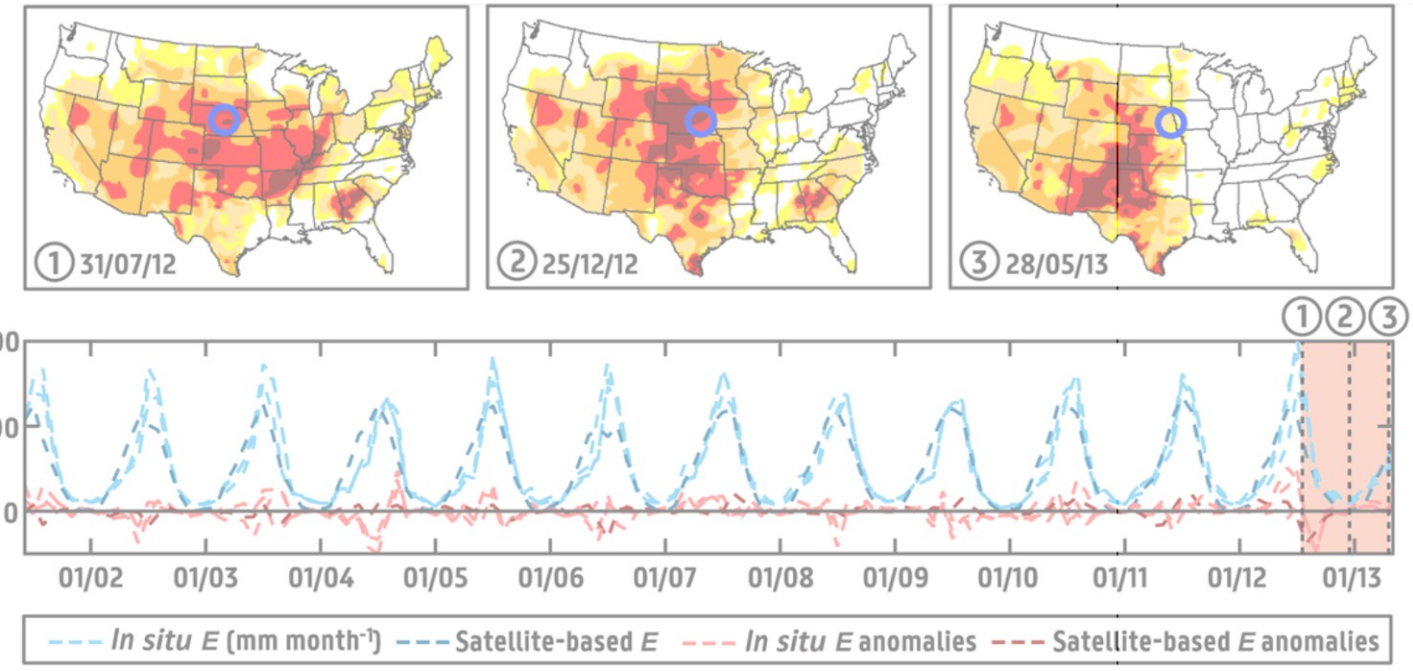

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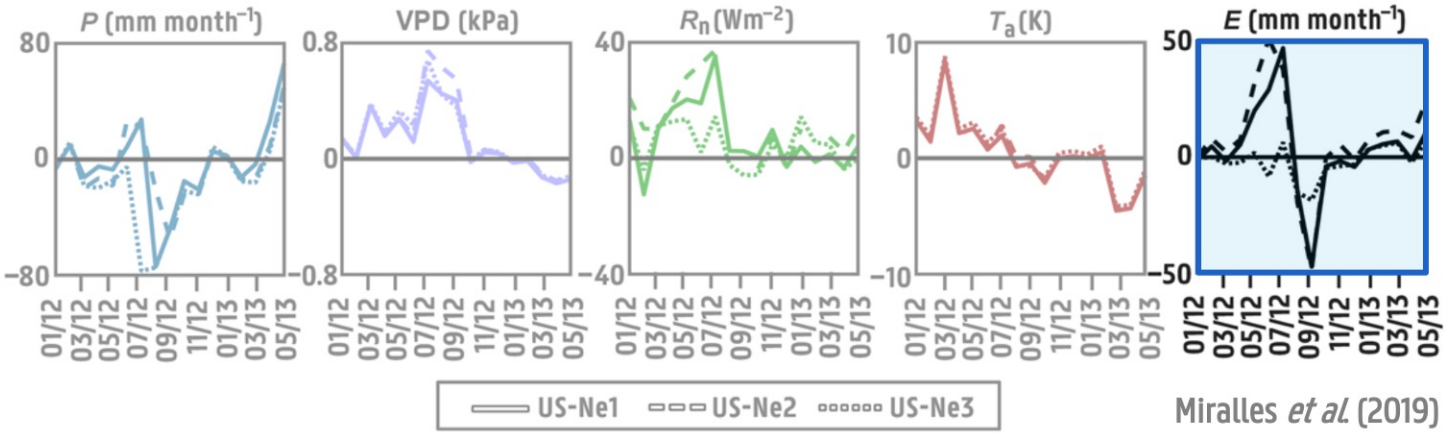

Miralles *et al.* (2019)

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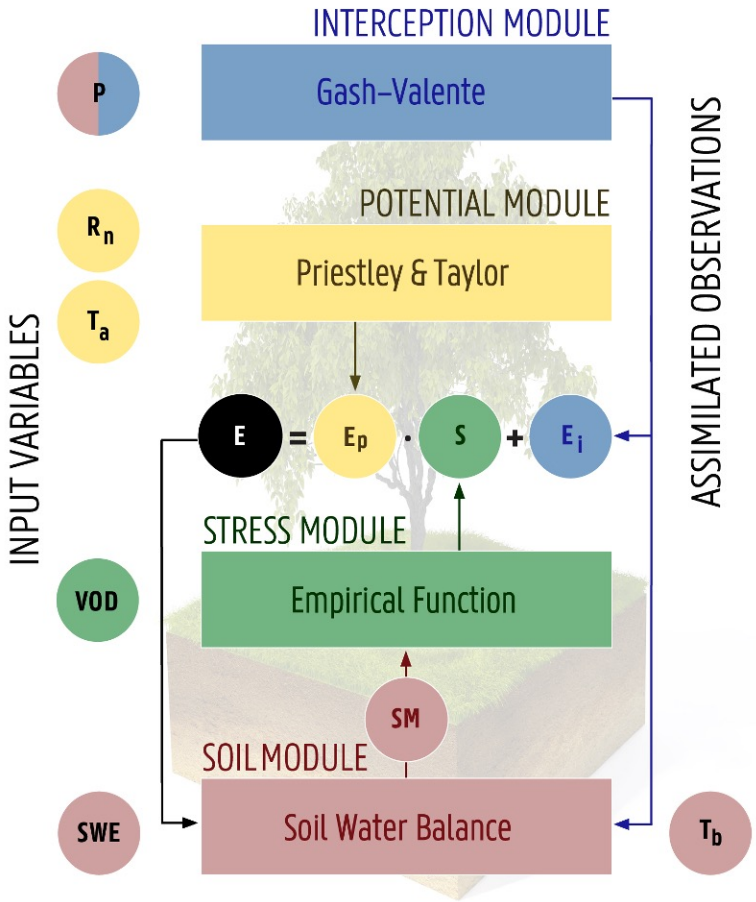

GLEAM v3: satellite-based land evaporation
Martens *et al.* (2017)
Geoscientific Model Development

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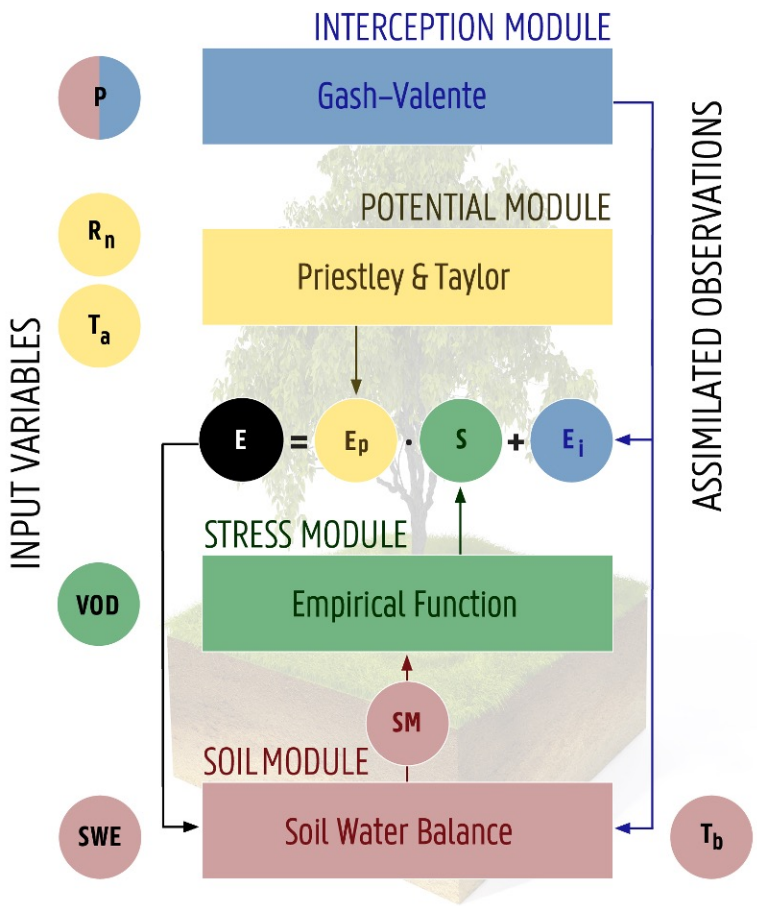

GLEAM v3: satellite-based land evaporation Martens *et al.* (2017) Geoscientific Model Development Open Access EGU

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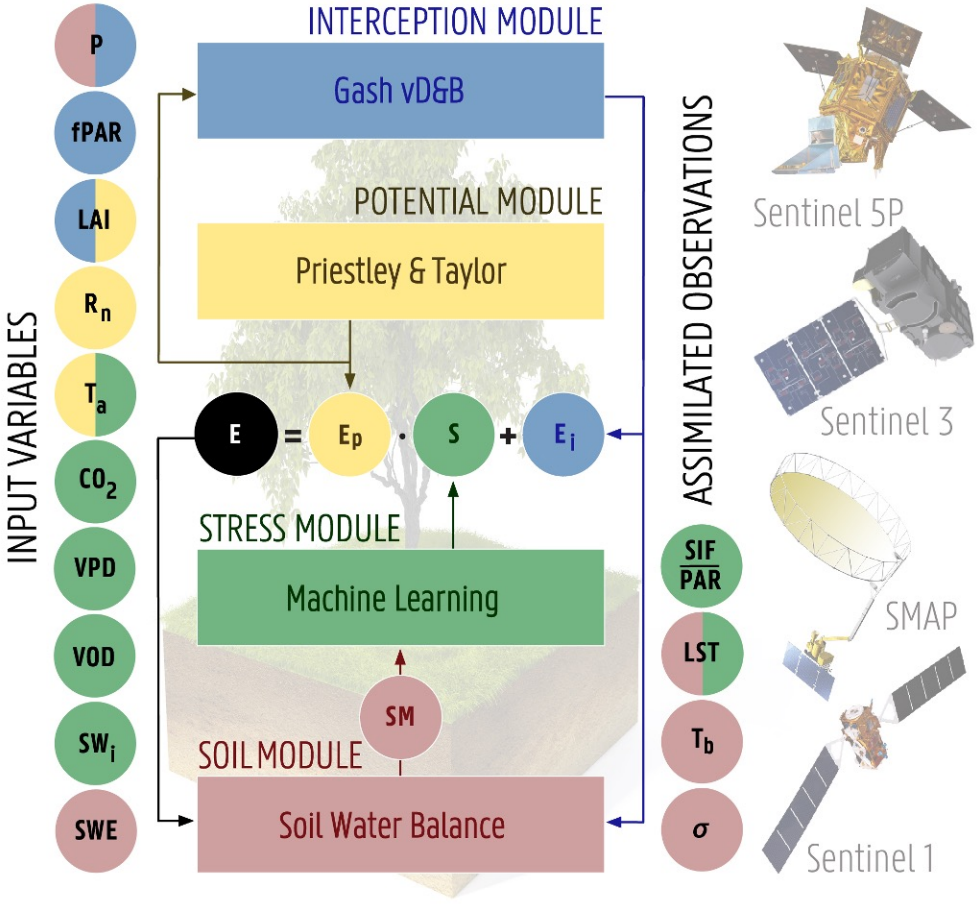

https://doi.org/10.1038/s41467-022-29543-7 OPEN

A deep learning-based hybrid model of global terrestrial evaporation nature COMMUNICATIONS Koppa *et al.* (2022)

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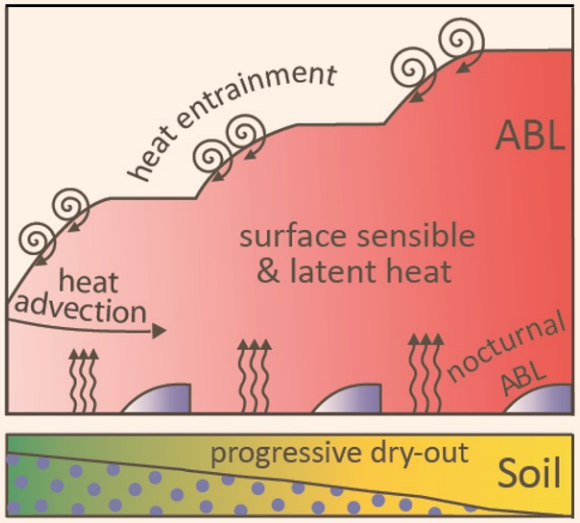
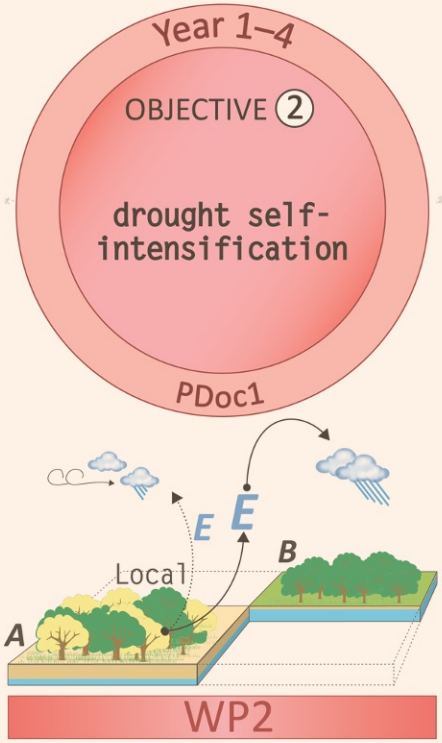


Miralles *et al.* (2014b) *Nat. Geosc.*



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CLASS4GL

Interactive data platform to study the behaviour of the atmospheric boundary layer

DATA

Balloon soundings

>10^6 quality checked profiles

- Operational soundings
- Research campaigns

Ancillary data

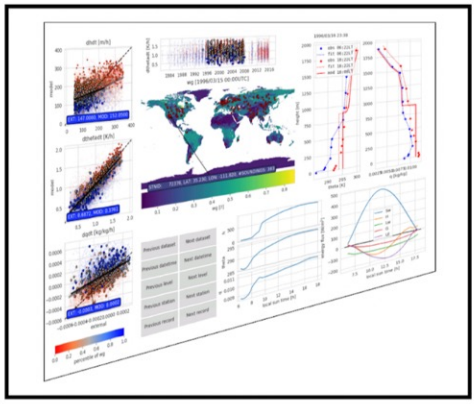
satellite, reanalysis and surveys

- Soil properties
- Vegetation features
- Surface heat exchanges
- Radiation forcing
- Large-scale atmosphere

Initialization & Forcing

Validation

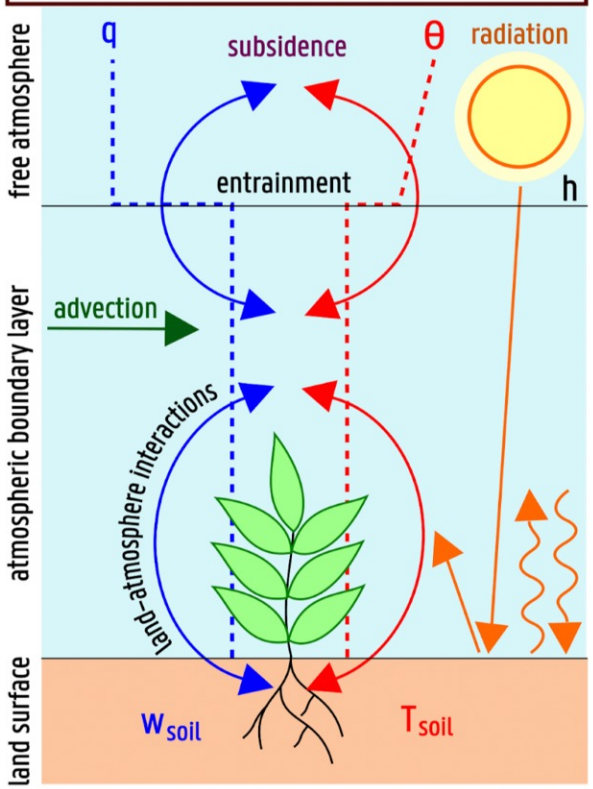
INTERFACE



MODEL

ABL column formulation

CLASS



Wouters *et al.* (2019)

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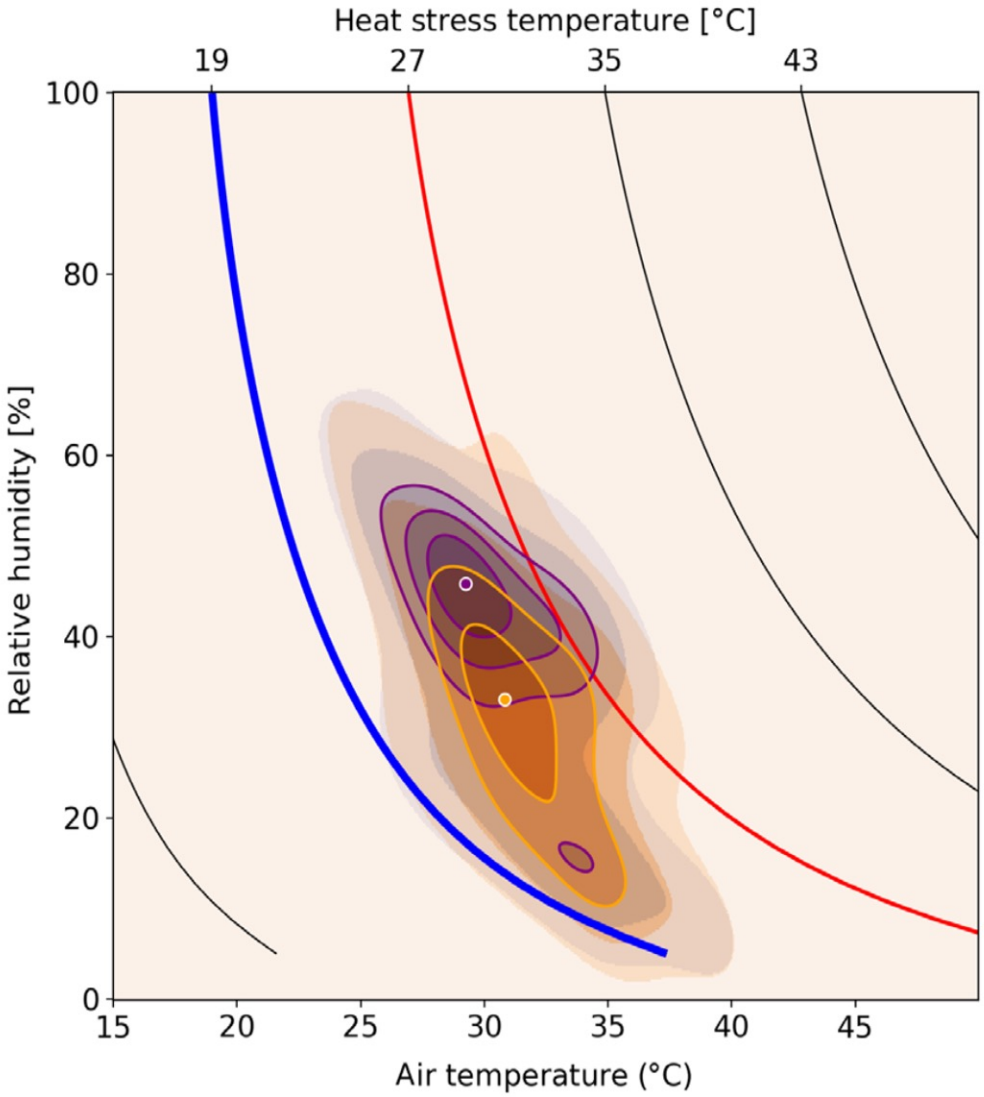

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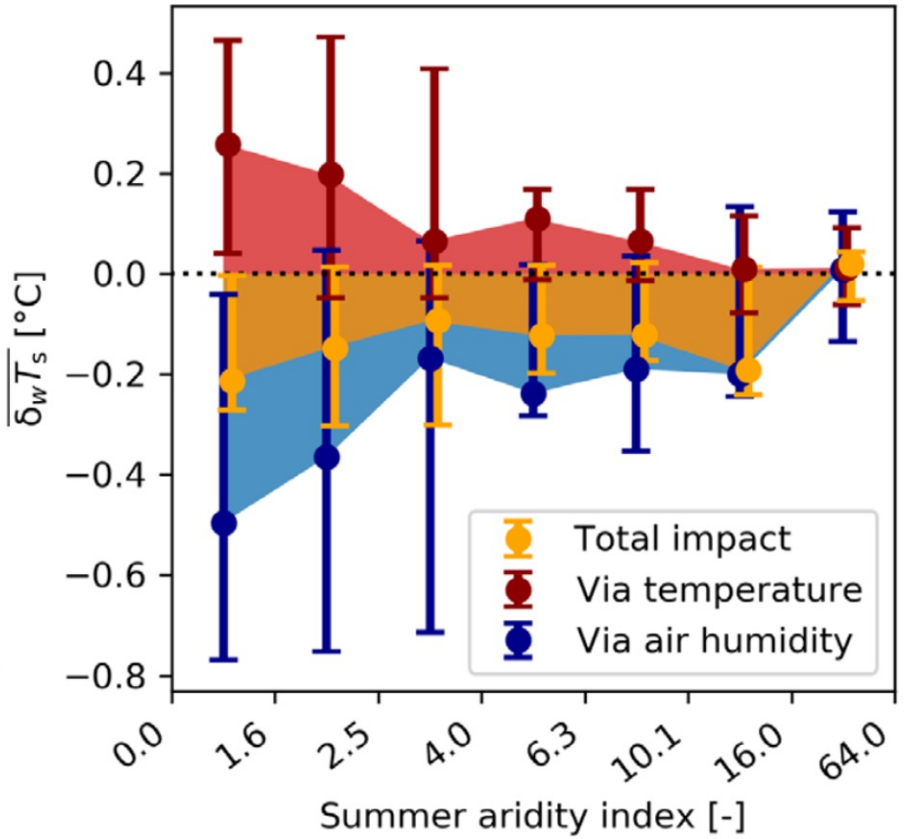
Soil drought can mitigate deadly heat stress thanks to a reduction of air humidity Wouters *et al.* (2022)



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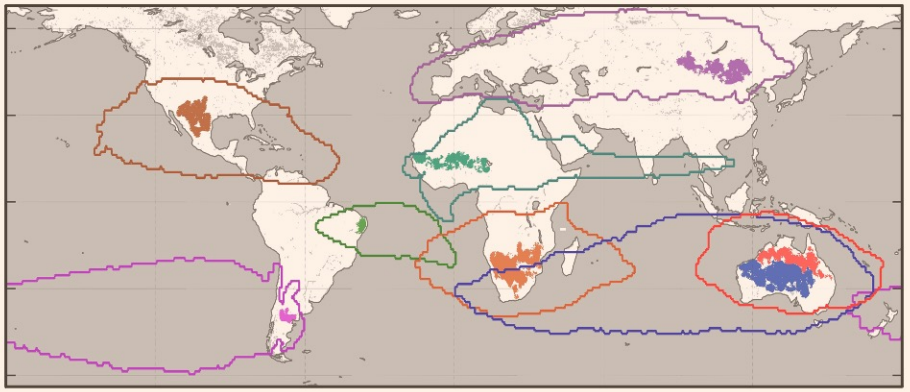

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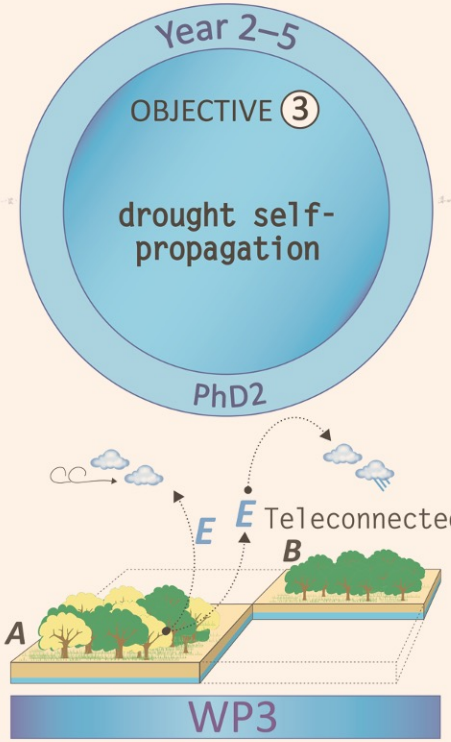

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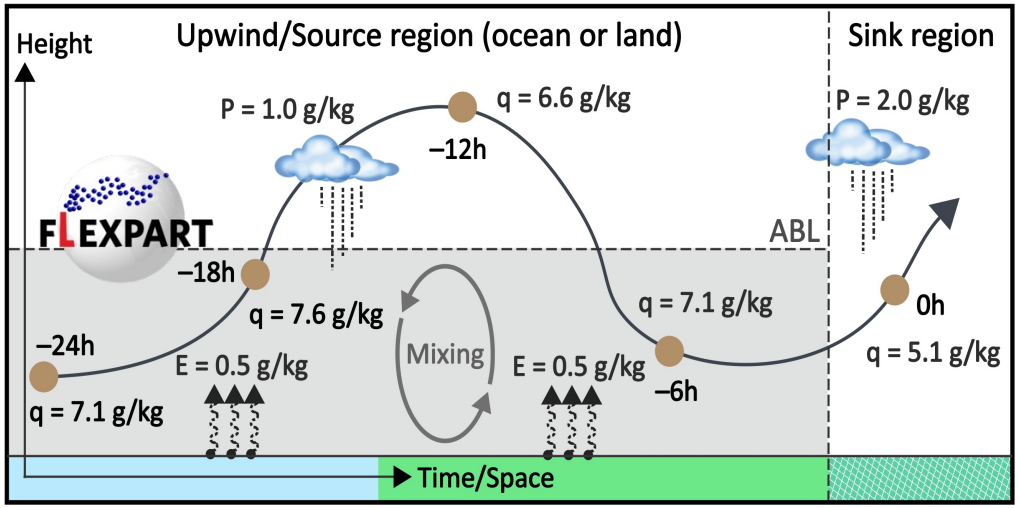

Geosci. Model Dev., 15, 1875–1898, 2022
https://doi.org/10.5194/gmd-15-1875-2022
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Geoscientific Model Development
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EGU

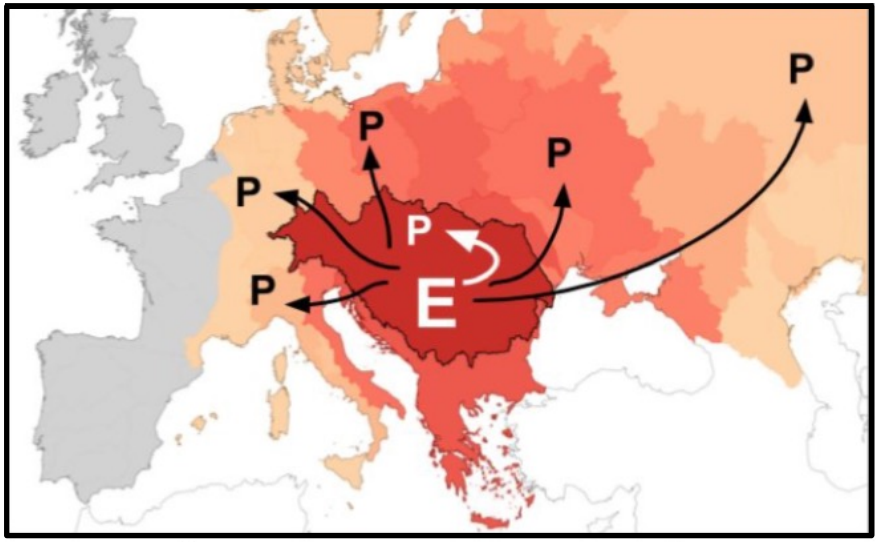
A unified framework to estimate the origins of atmospheric moisture and heat using Lagrangian models

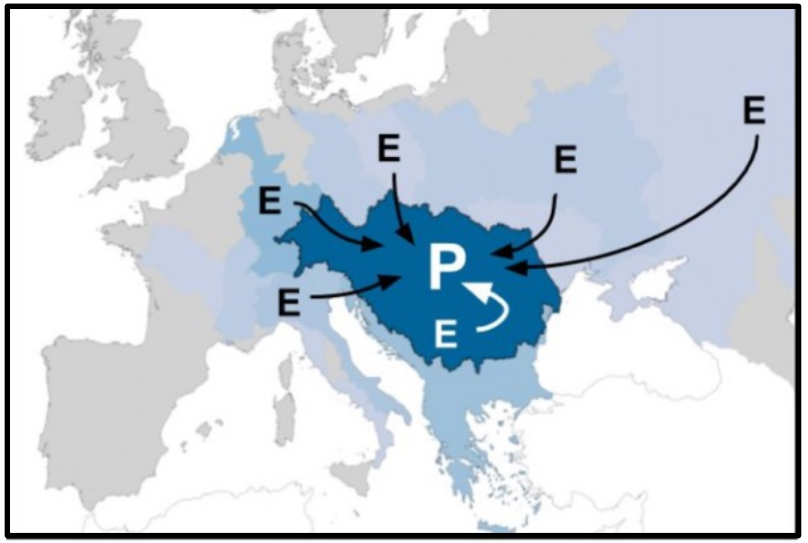
Jessica Keune, Dominik L. Schumacher, and Diego G. Miralles
Hydro-Climate Extremes Lab (H-CEL), Ghent University, Ghent, 9000, Belgium

RESEARCH ARTICLE
10.1029/2019WR025310
AGU100 ADVANCING EARTH AND SPACE SCIENCE
Water Resources Research

A Precipitation Recycling Network to Assess Freshwater Vulnerability: Challenging the Watershed Convention

J. Keune[1] and D. G. Miralles[1]
[1]Laboratory of Hydrology and Water Management, Ghent University, Ghent, Belgium





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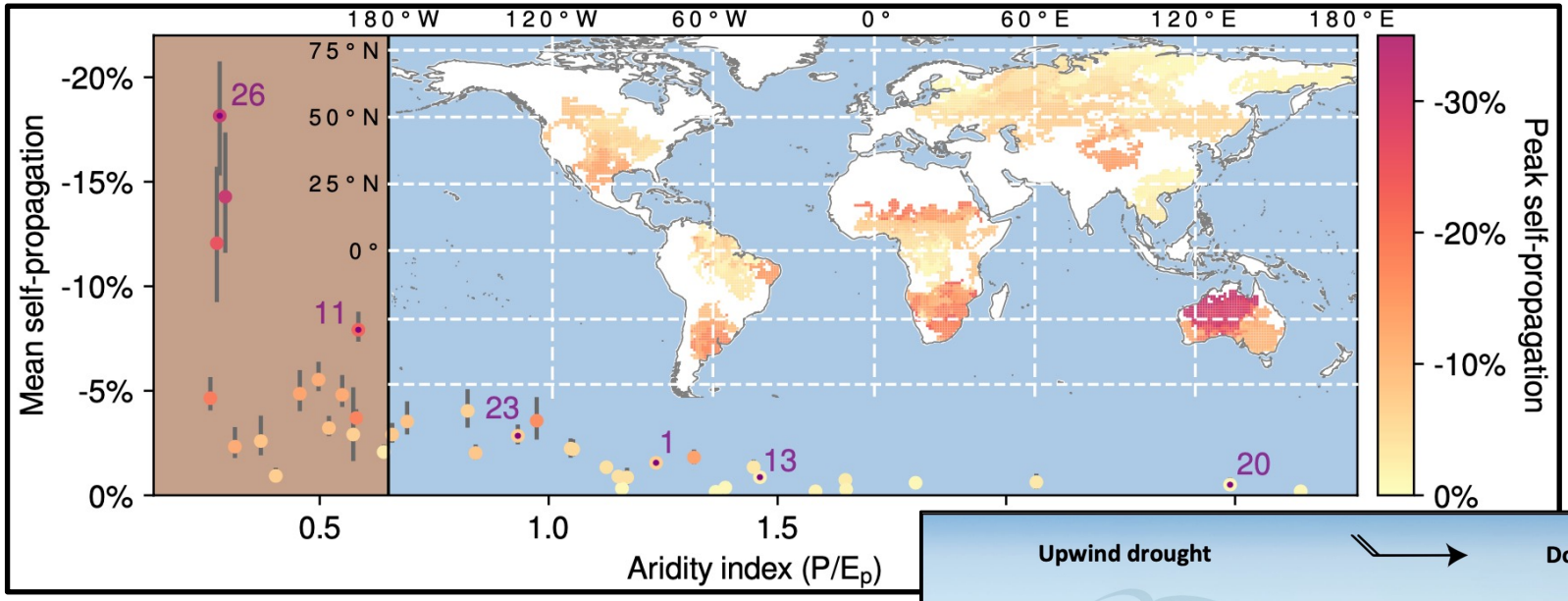

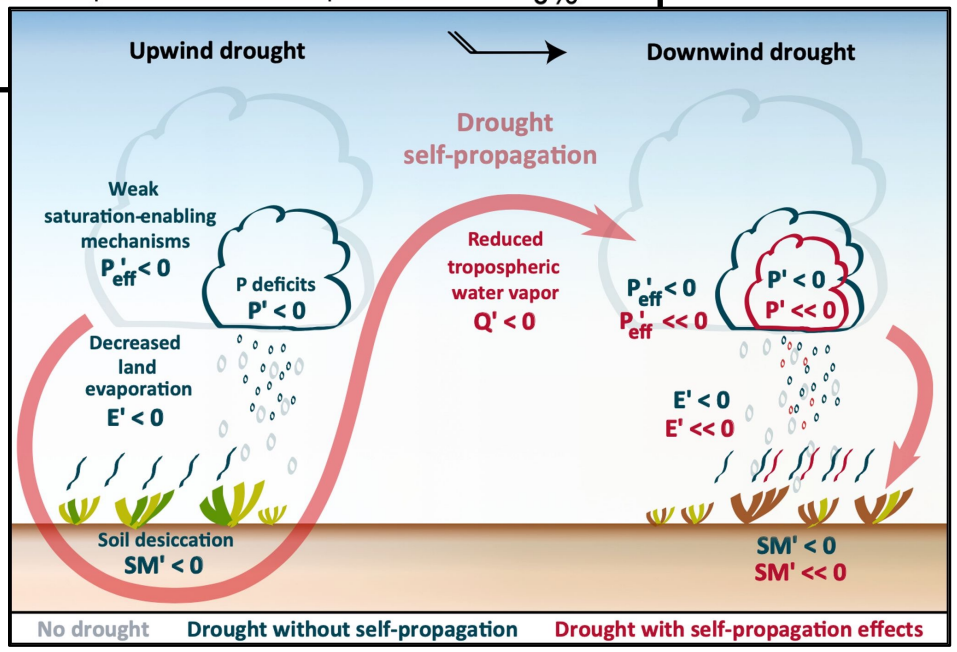

nature geoscience

ARTICLES

https://doi.org/10.1038/s41561-022-00912-7

Drought self-propagation in drylands due to land–atmosphere feedbacks (2022)

Dominik L. Schumacher[1]✉, Jessica Keune[1], Paul Dirmeyer[2] and Diego G. Miralles[1]

✉ Diego.Miralles@UGent.be

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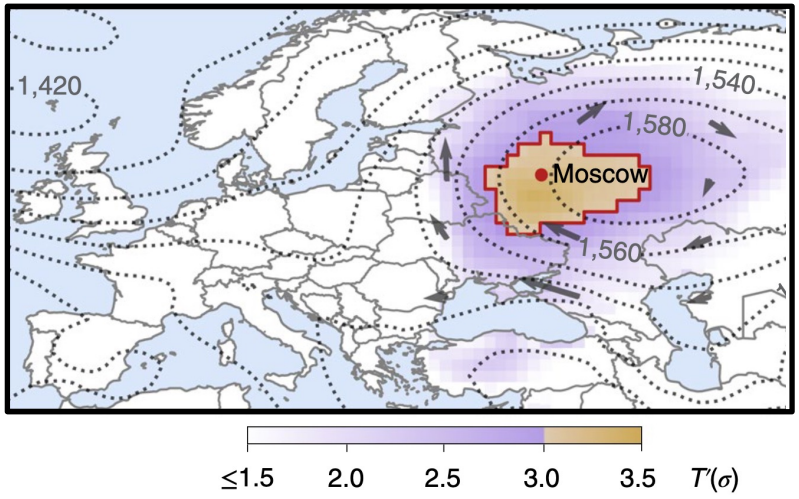

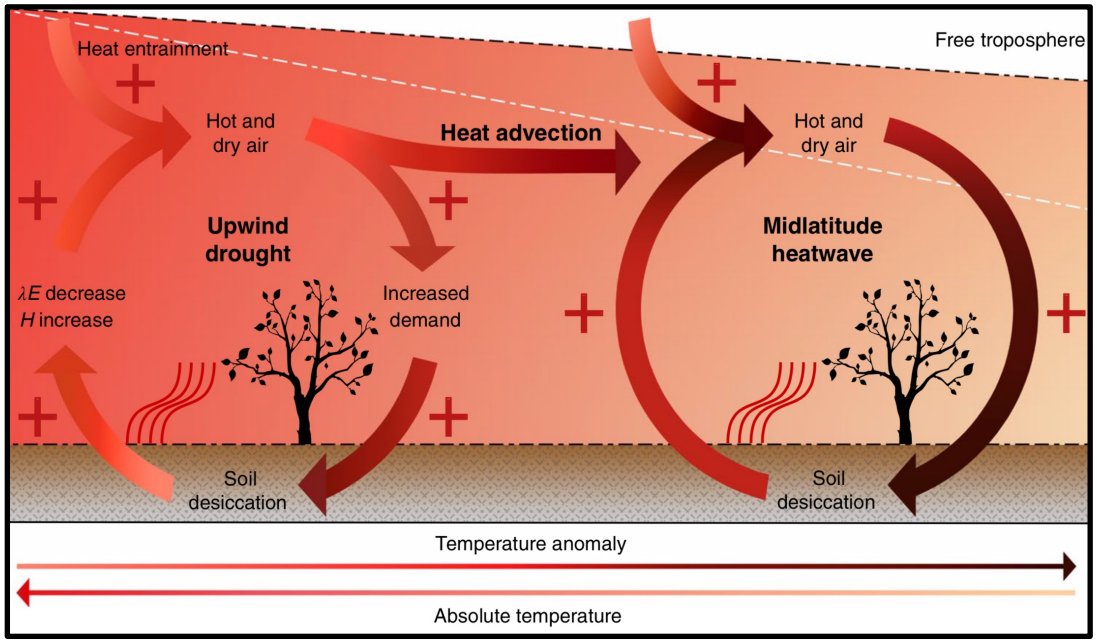

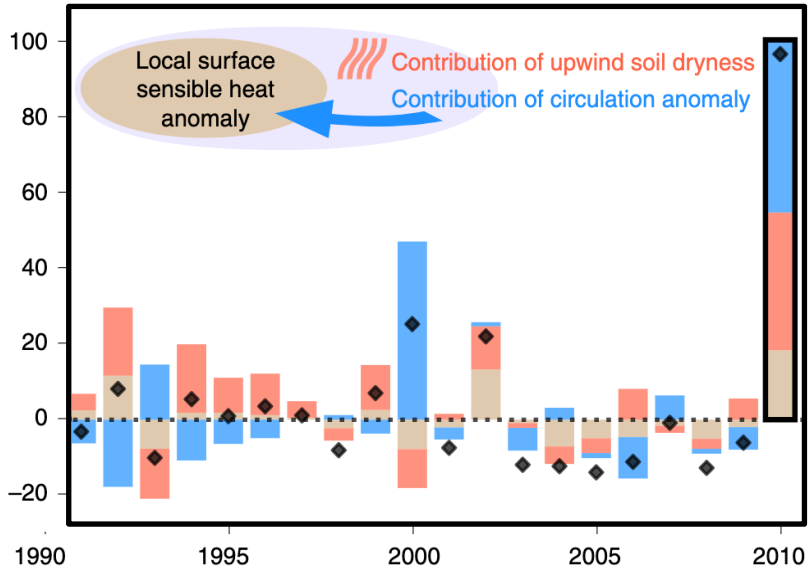

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ARTICLES

https://doi.org/10.1038/s41561-019-0431-6

Amplification of mega-heatwaves through heat torrents fuelled by upwind drought

Dominik L. Schumacher[1*], Jessica Keune[1], Chiel C. van Heerwaarden[2], Jordi Vilà-Guerau de Arellano[2], Adriaan J. Teuling[3] and Diego G. Miralles[1]

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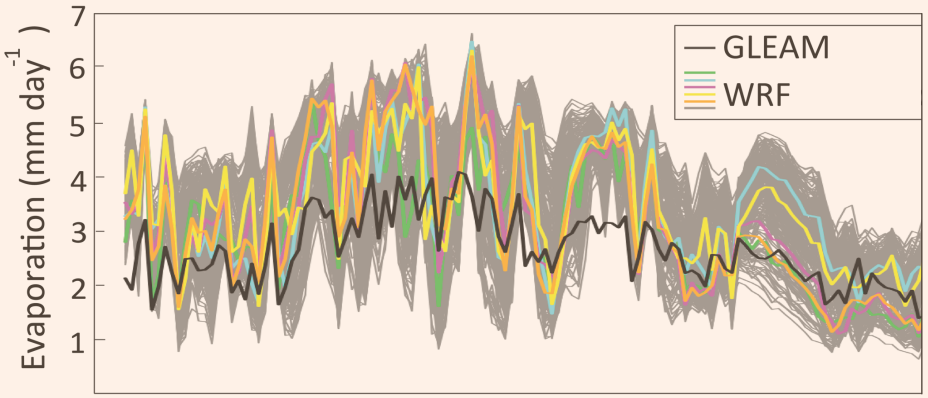
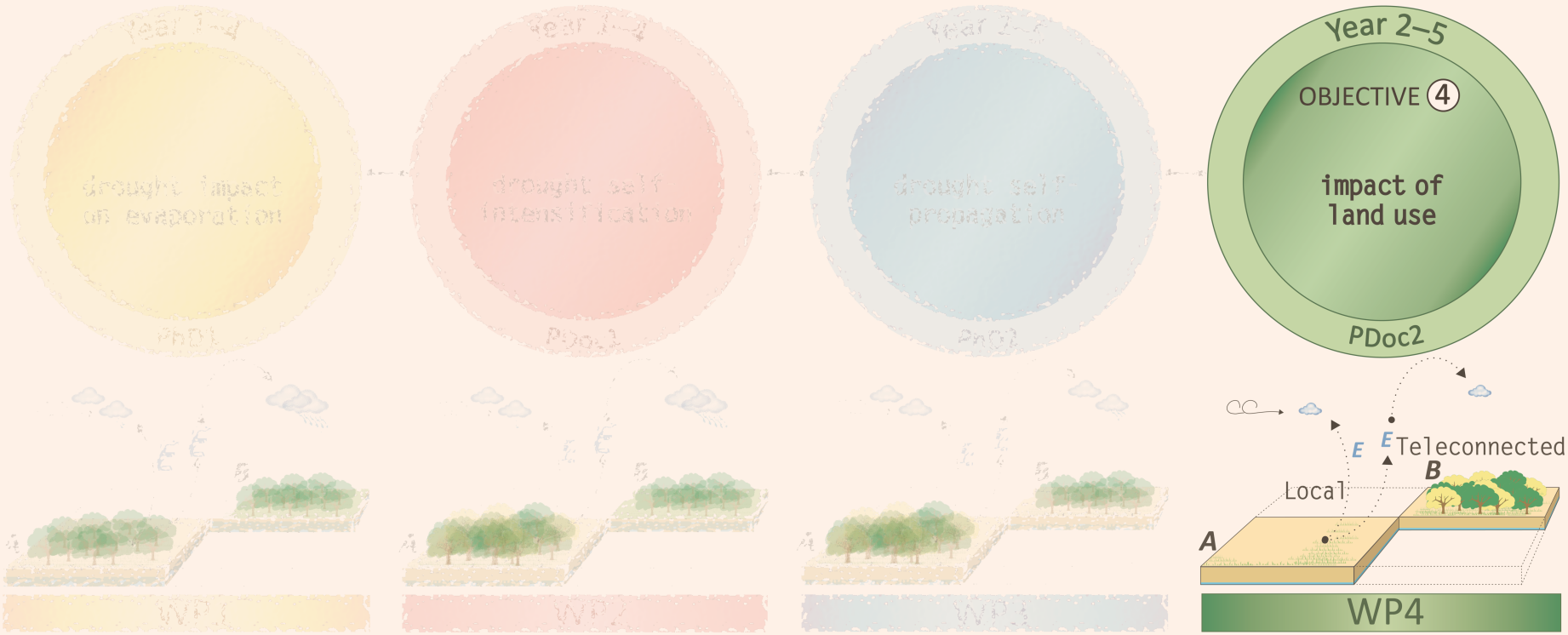


Stegehuis *et al.* (2015)



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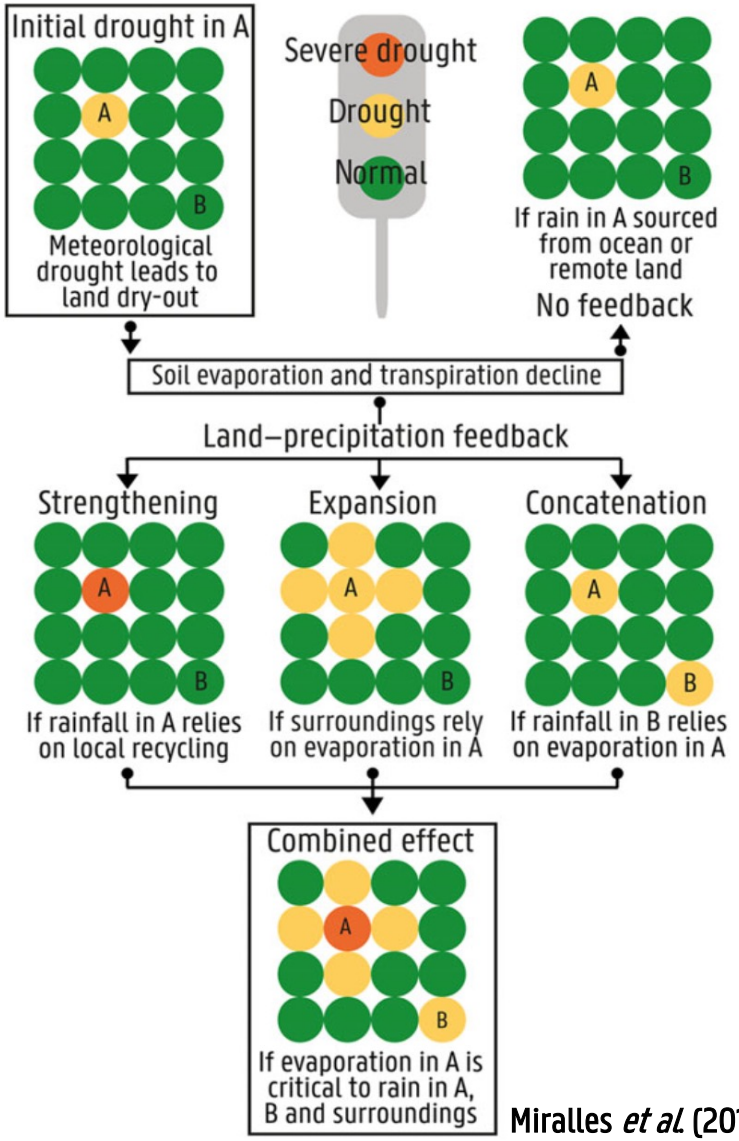
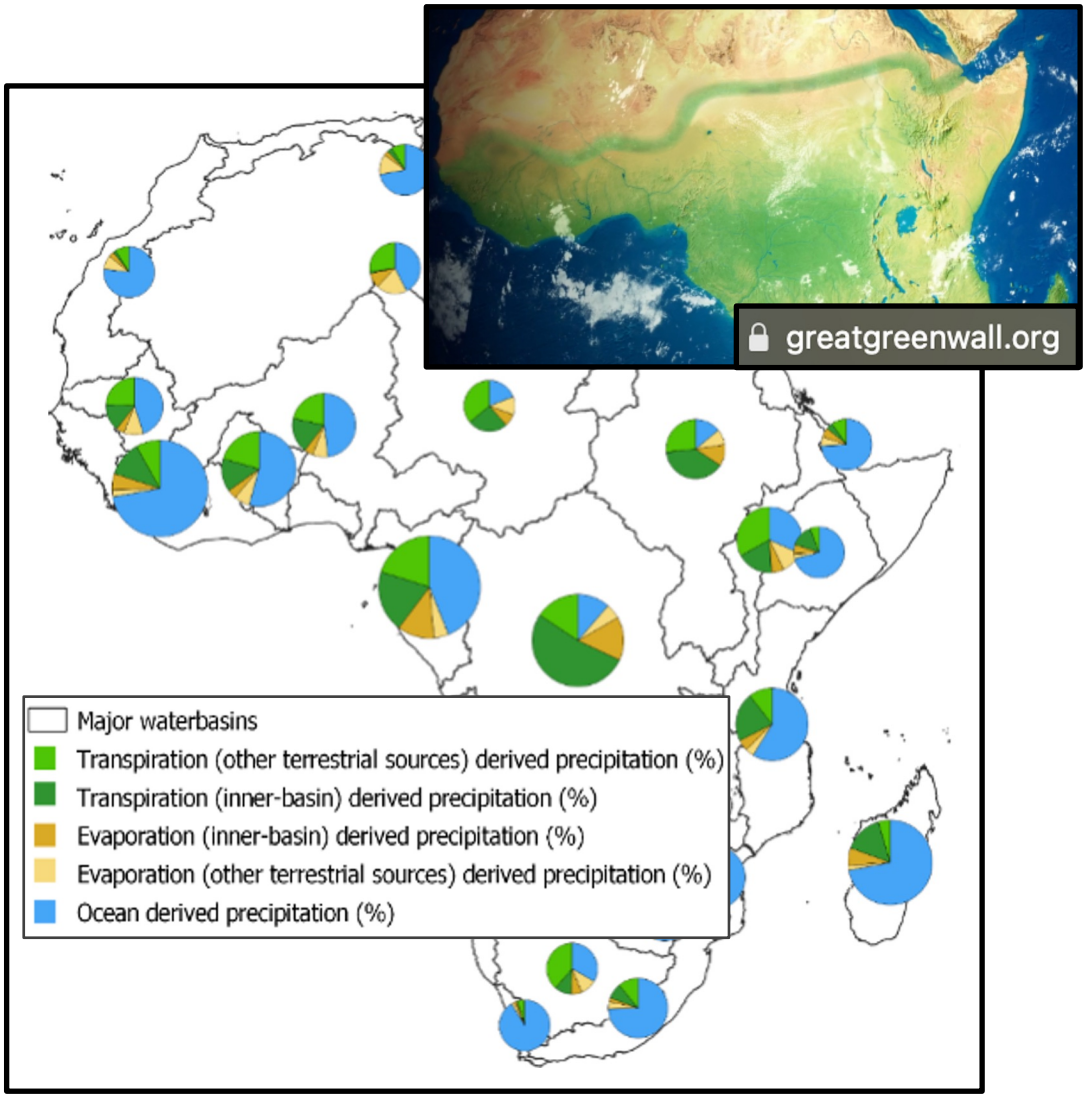


Miralles *et al.* (2019)



Te Wierik *et al.* (*in review*)

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CONCLUSION

1. Droughts and heatwaves trigger an **increase and subsequent decline in evaporation**; very heterogeneous response
2. Potential of **hybrid approaches** to capture that response
3. Soil desiccation can be **beneficial for human heat stress**
4. Need to revise the value of **watersheds in water management**
5. **Drought self-propagation** mainly in drylands and mediated by precipitation efficiency changes
6. **Heatwave self-propagation** at least in Europe
7. Currently exploring **land use adaptation** in feedback hotspots

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- Keune *et al.* (2022) | GMD 15, 1875–1898
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- Te Wierik *et al.* | *in review*
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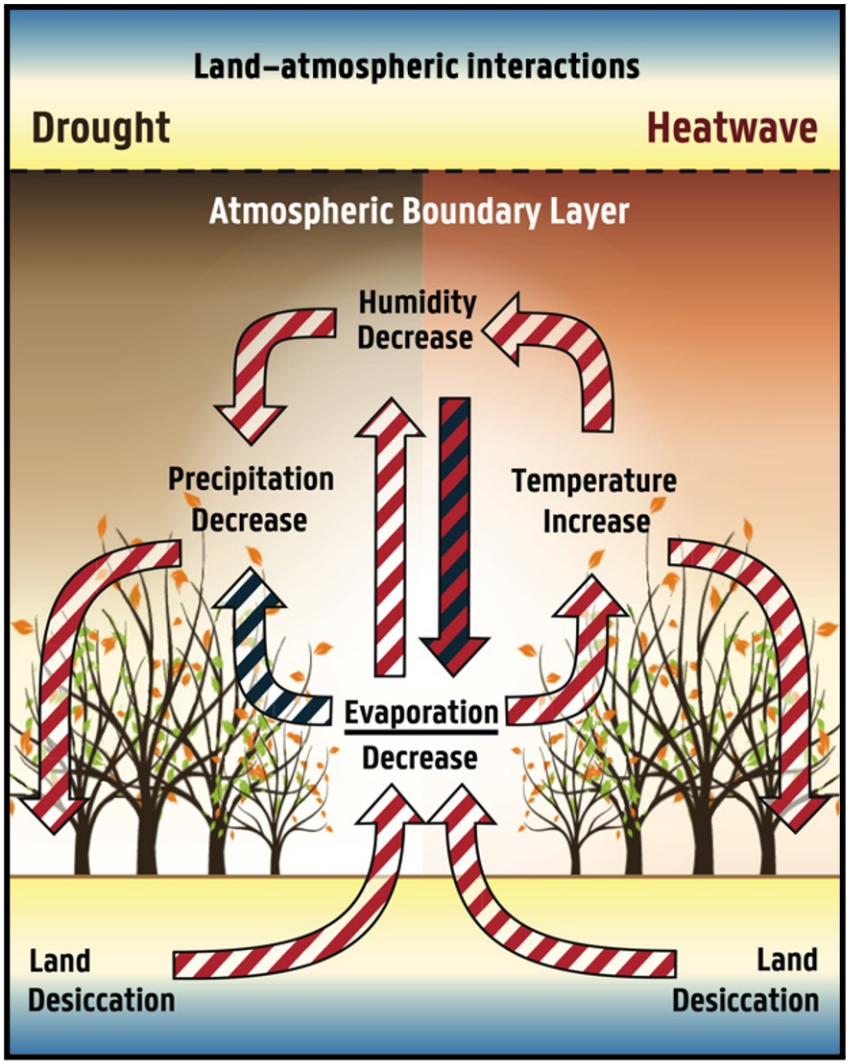

Miralles *et al* (2019)

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