

# Biophysical feedbacks enhancing dry and hot conditions

Diego G. Miralles [...]



## Motivation

Intensification

Propagation

Conclusion



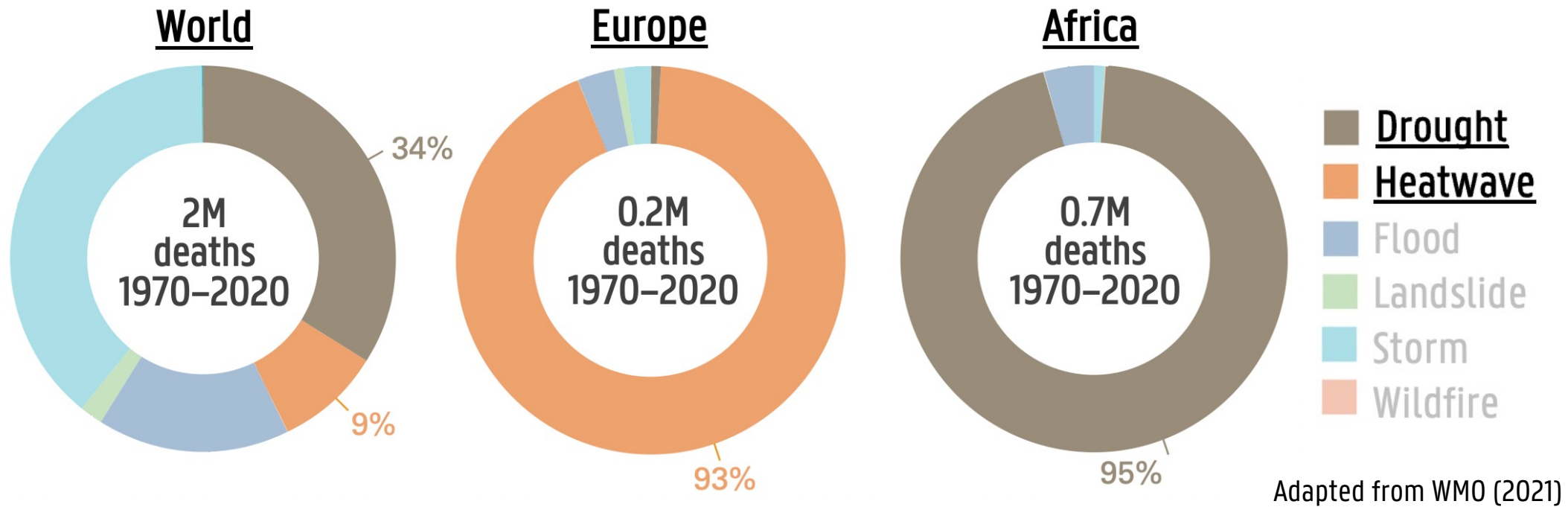


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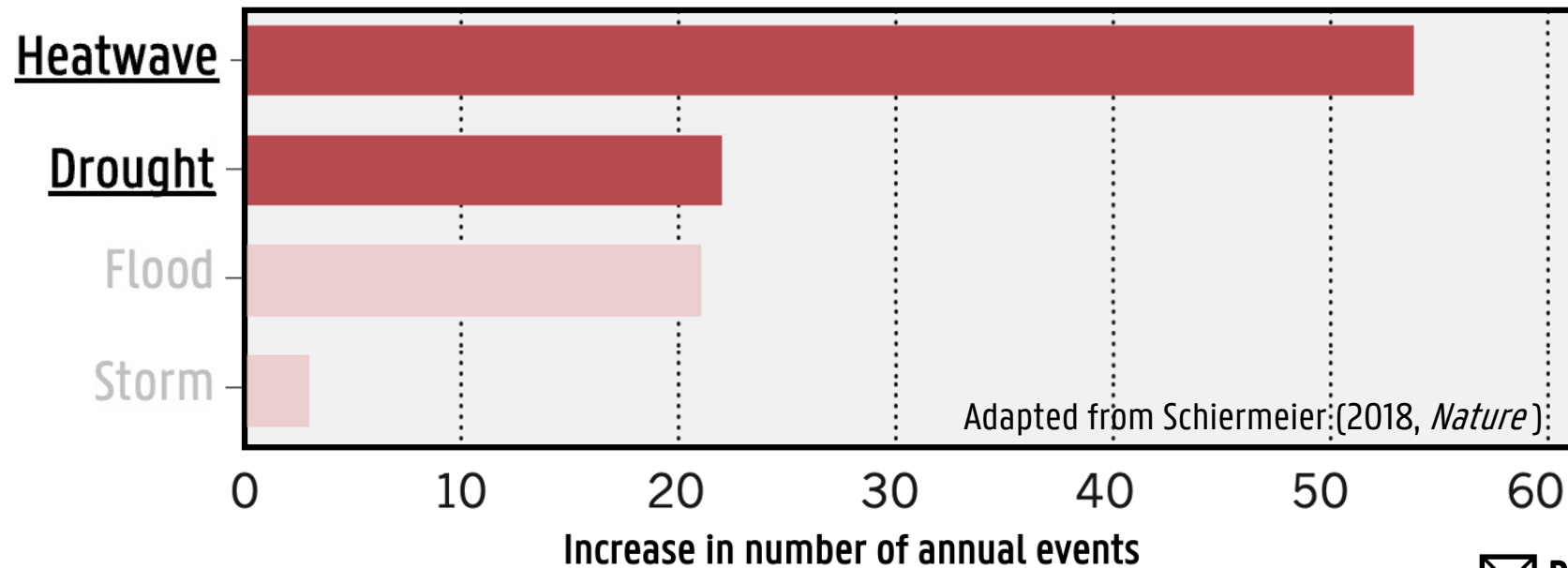
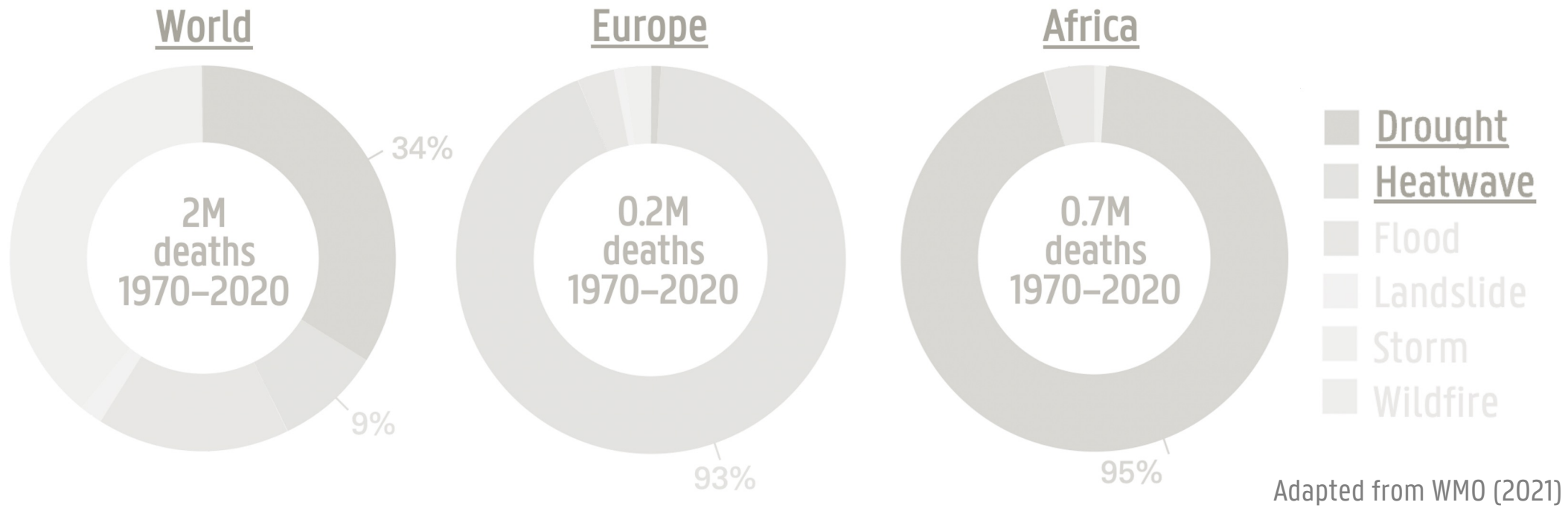


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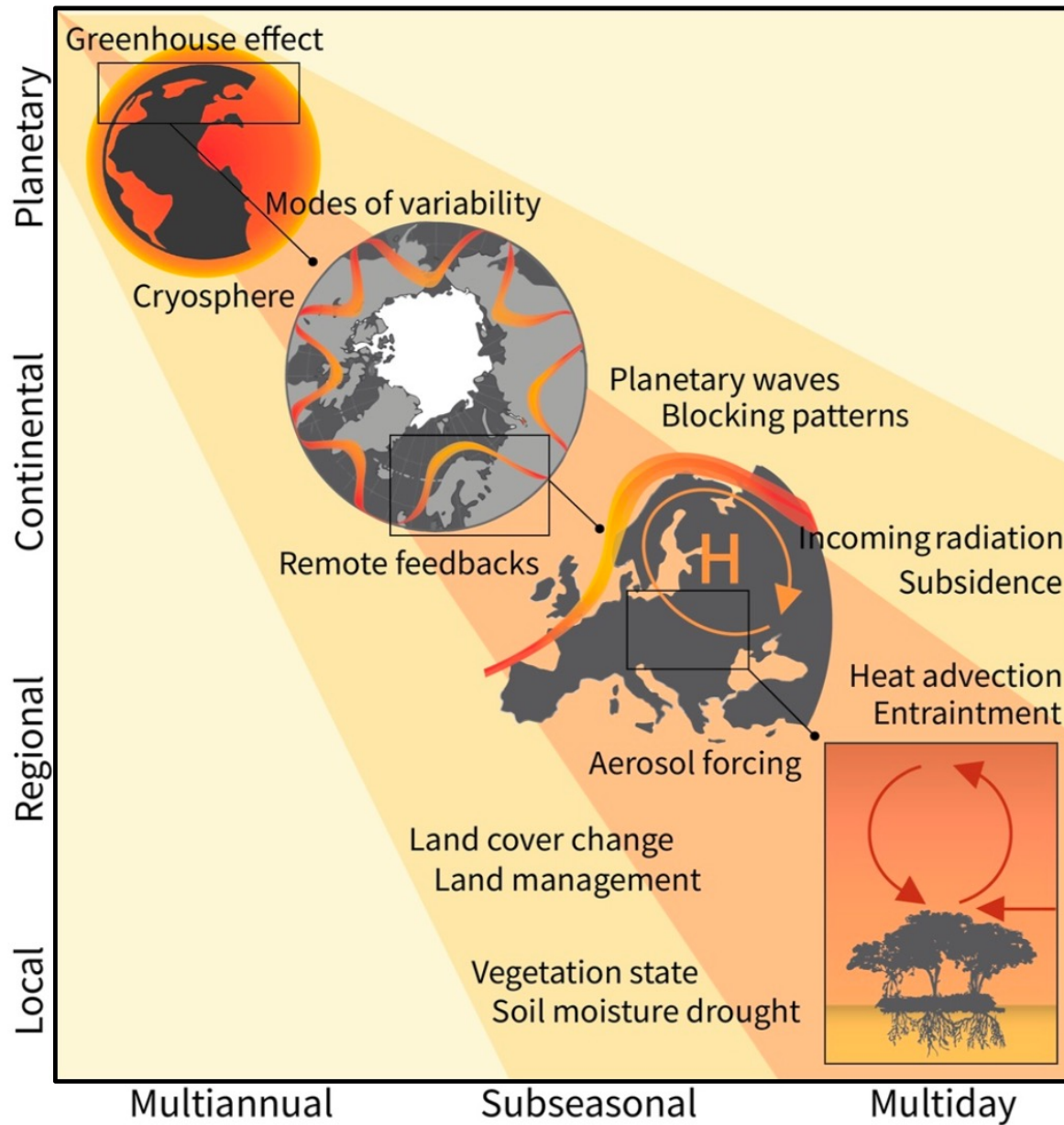


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Barriopedro *et al.* (2023)

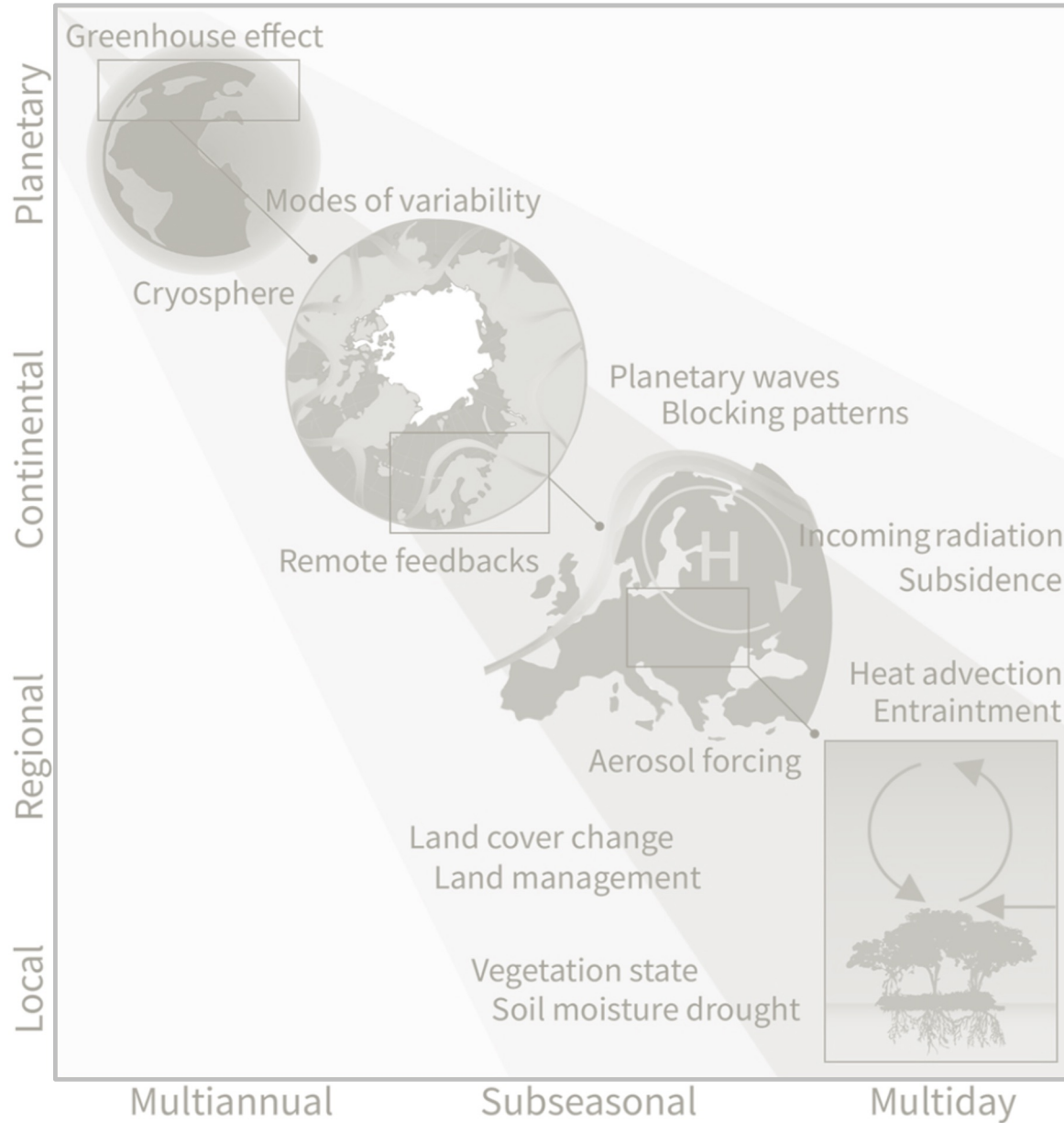


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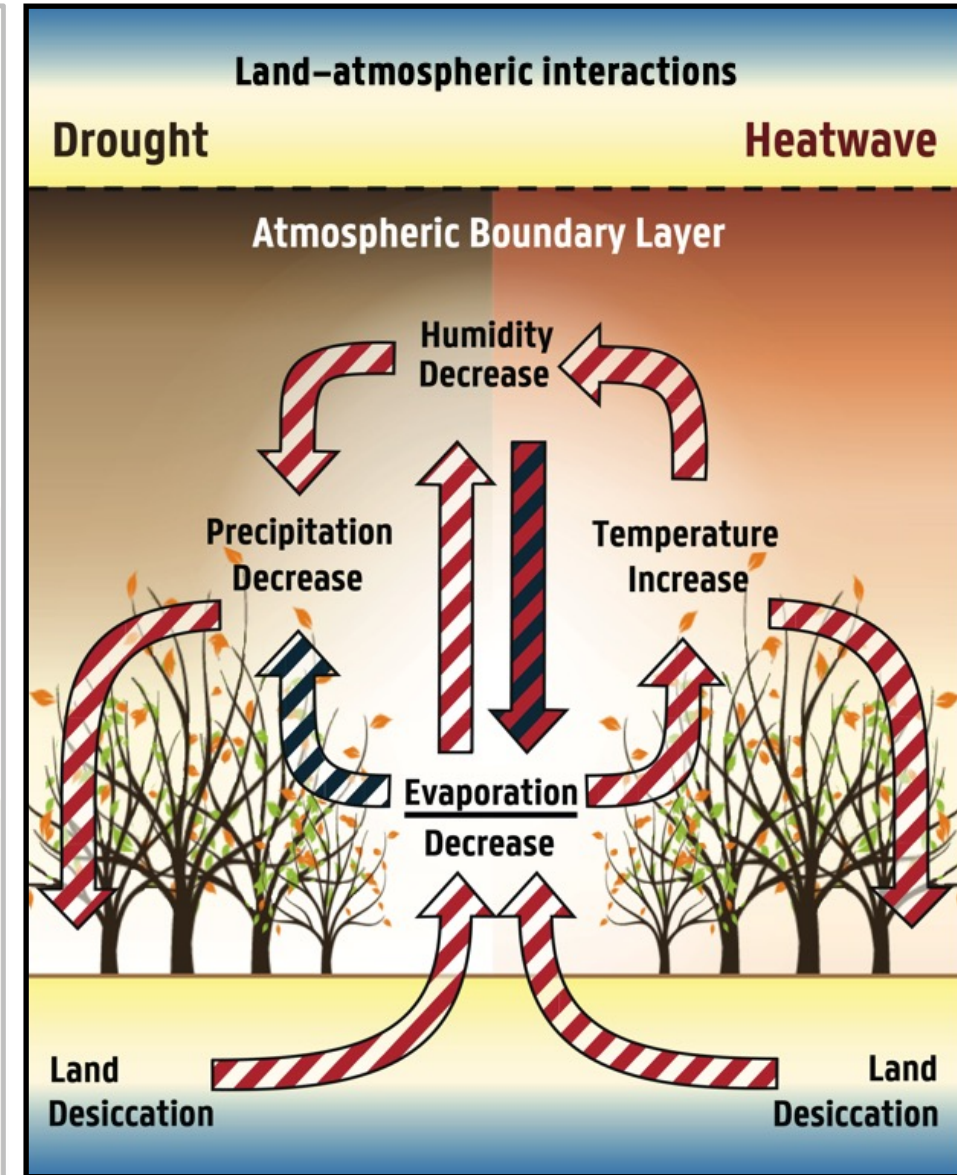
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Barriopedro *et al.* (2023)



Miralles *et al.* (2019)

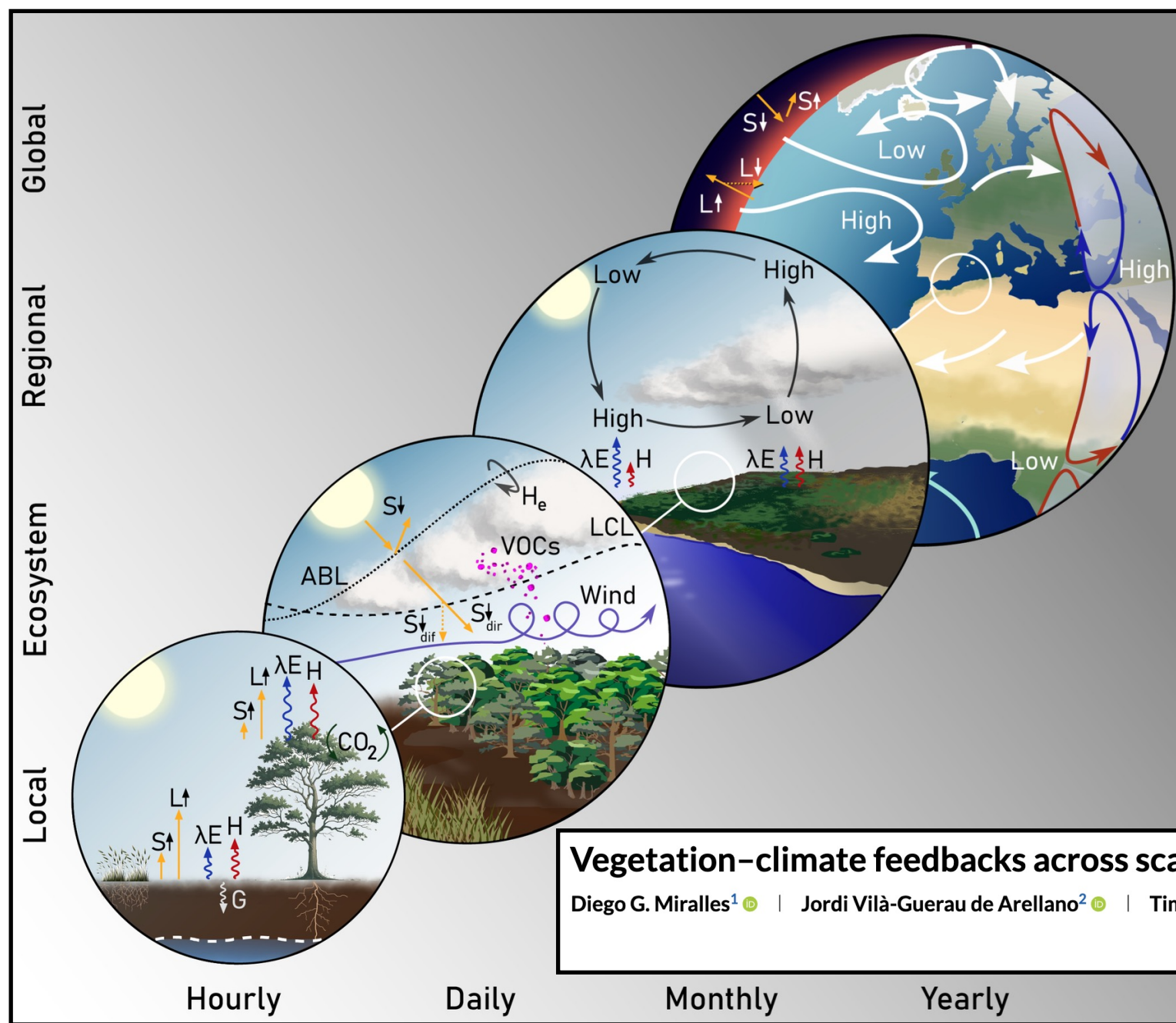


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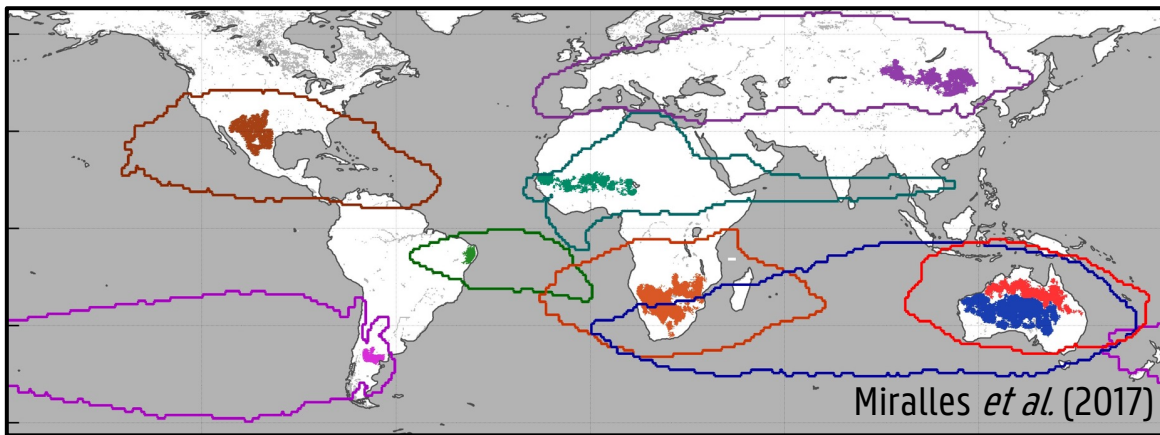
## Vegetation-climate feedbacks across scales

**ANNALS** OF THE NEW YORK ACADEMY OF SCIENCES

Diego G. Miralles<sup>1</sup> | Jordi Vilà-Guerau de Arellano<sup>2</sup> | Tim R. McVicar<sup>3,4</sup> | Miguel D. Mahecha<sup>5,6,7</sup>

doi: 10.1111/nyas.15286 (2025)





- ❖ Land-atmosphere feedbacks can have teleconnected effects
- ❖ Due to influences on heat and moisture advection and circulation

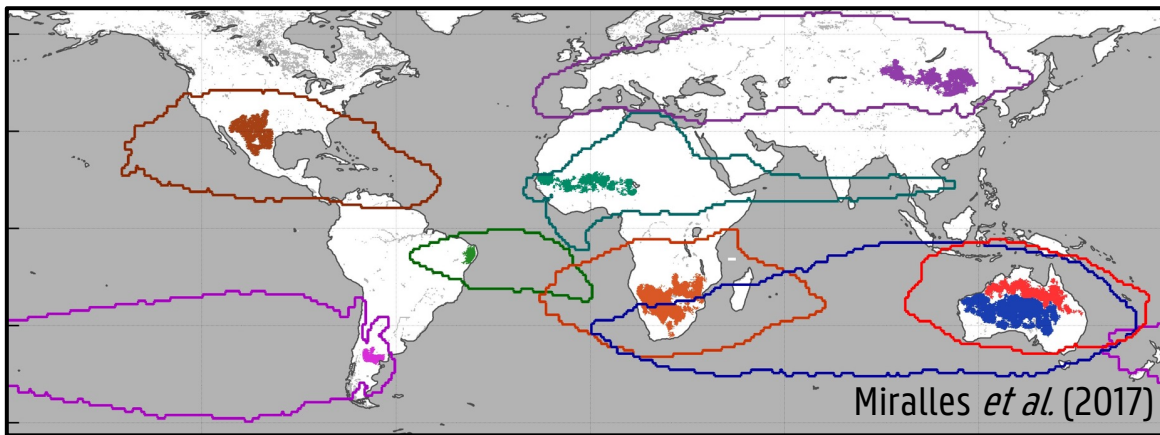
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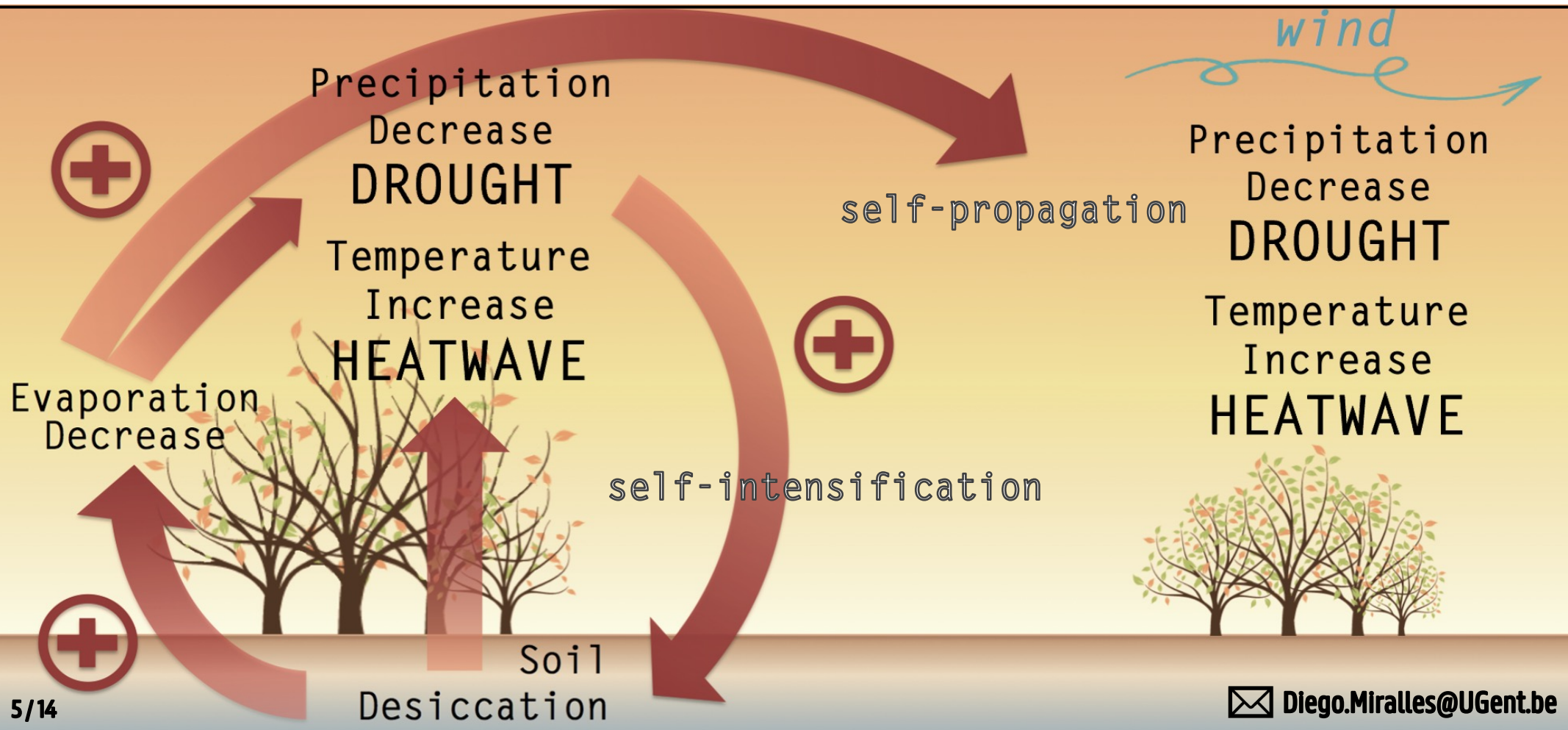
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Understanding land feedbacks crucial...

- ❖ Forecast & projection
- ❖ Better adaptation

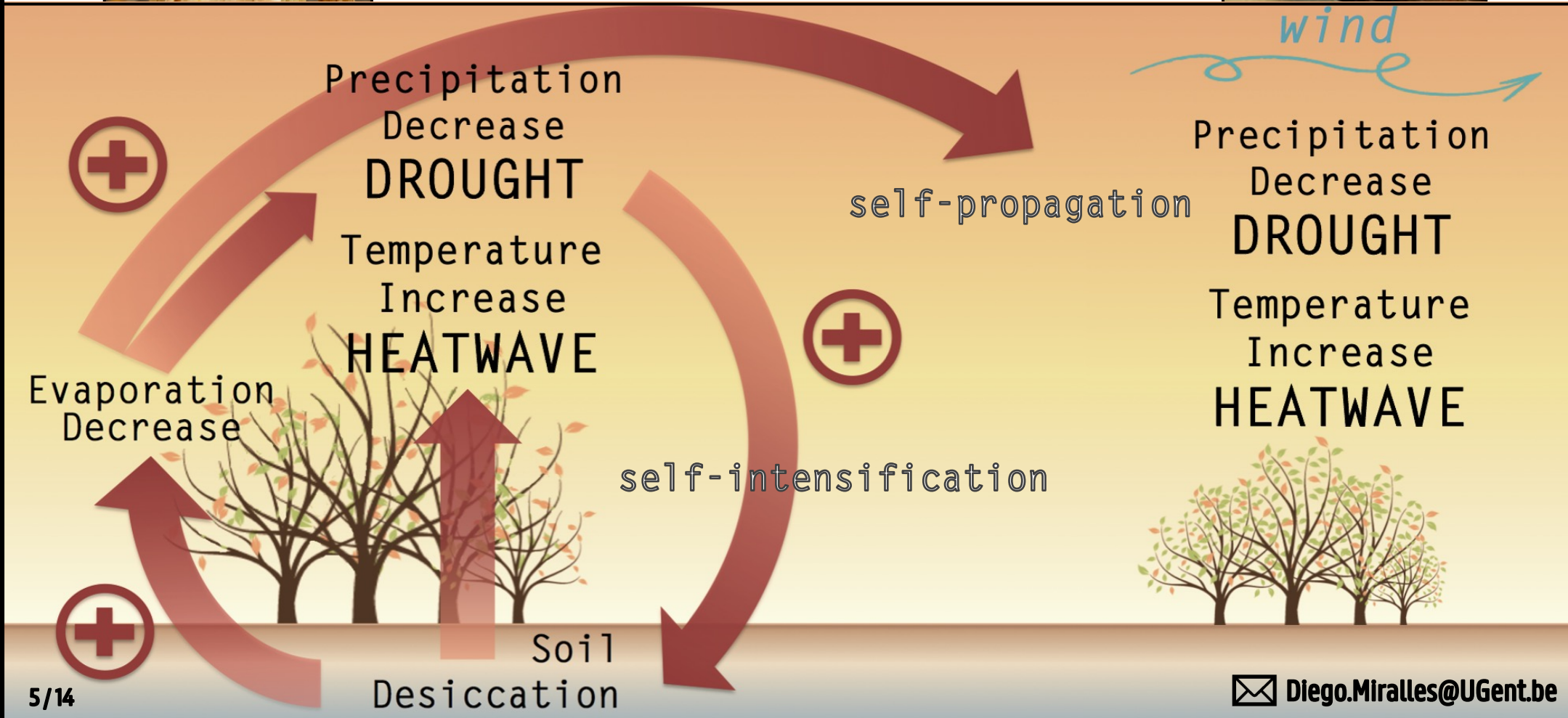


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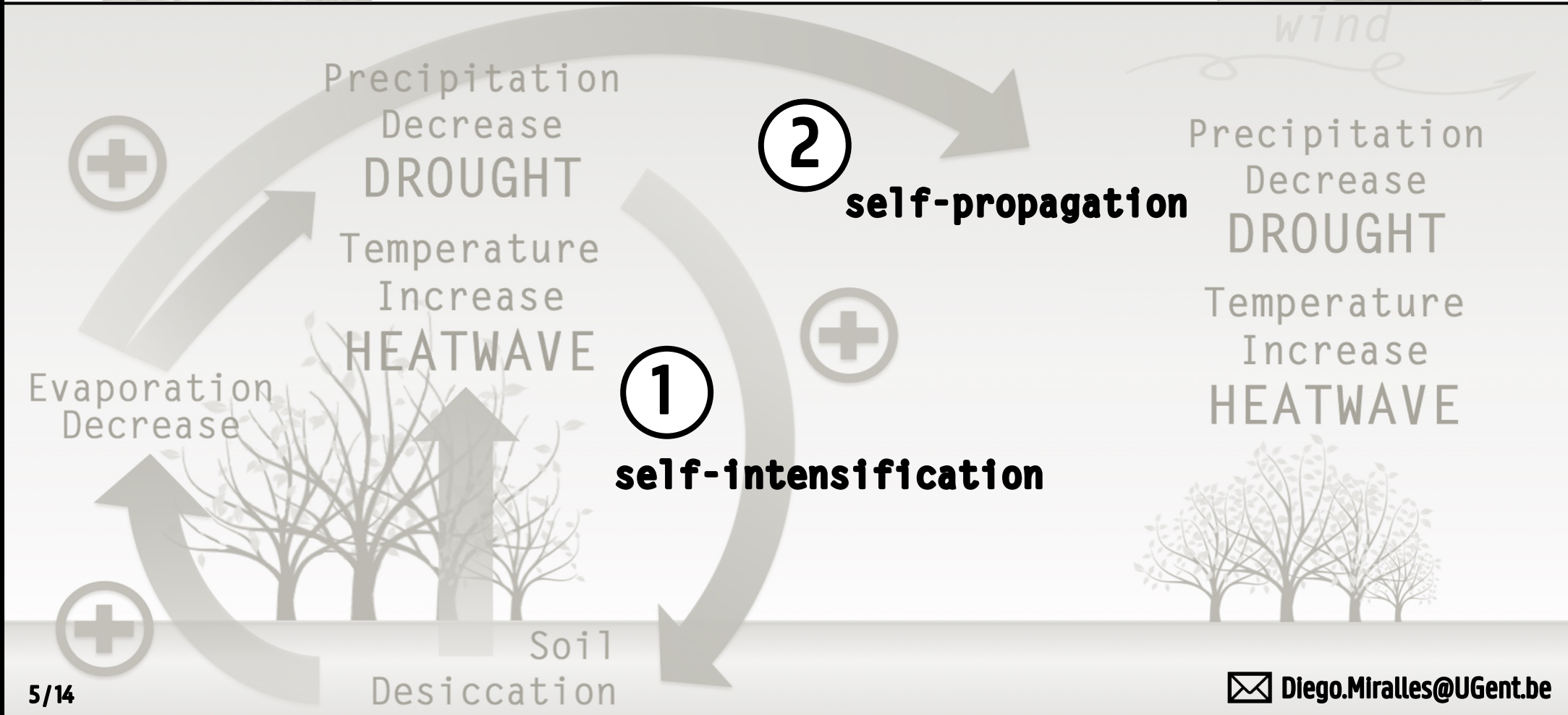


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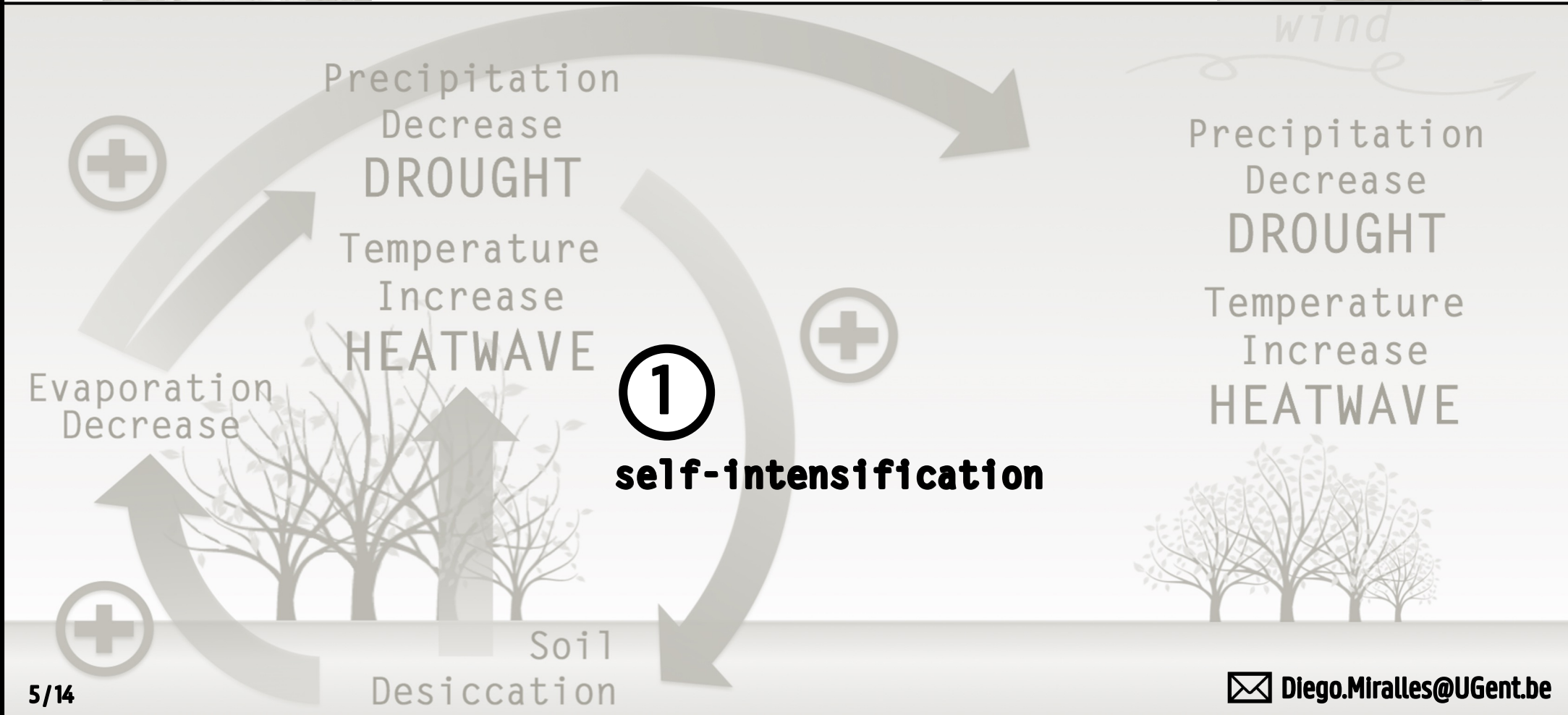


Motivation

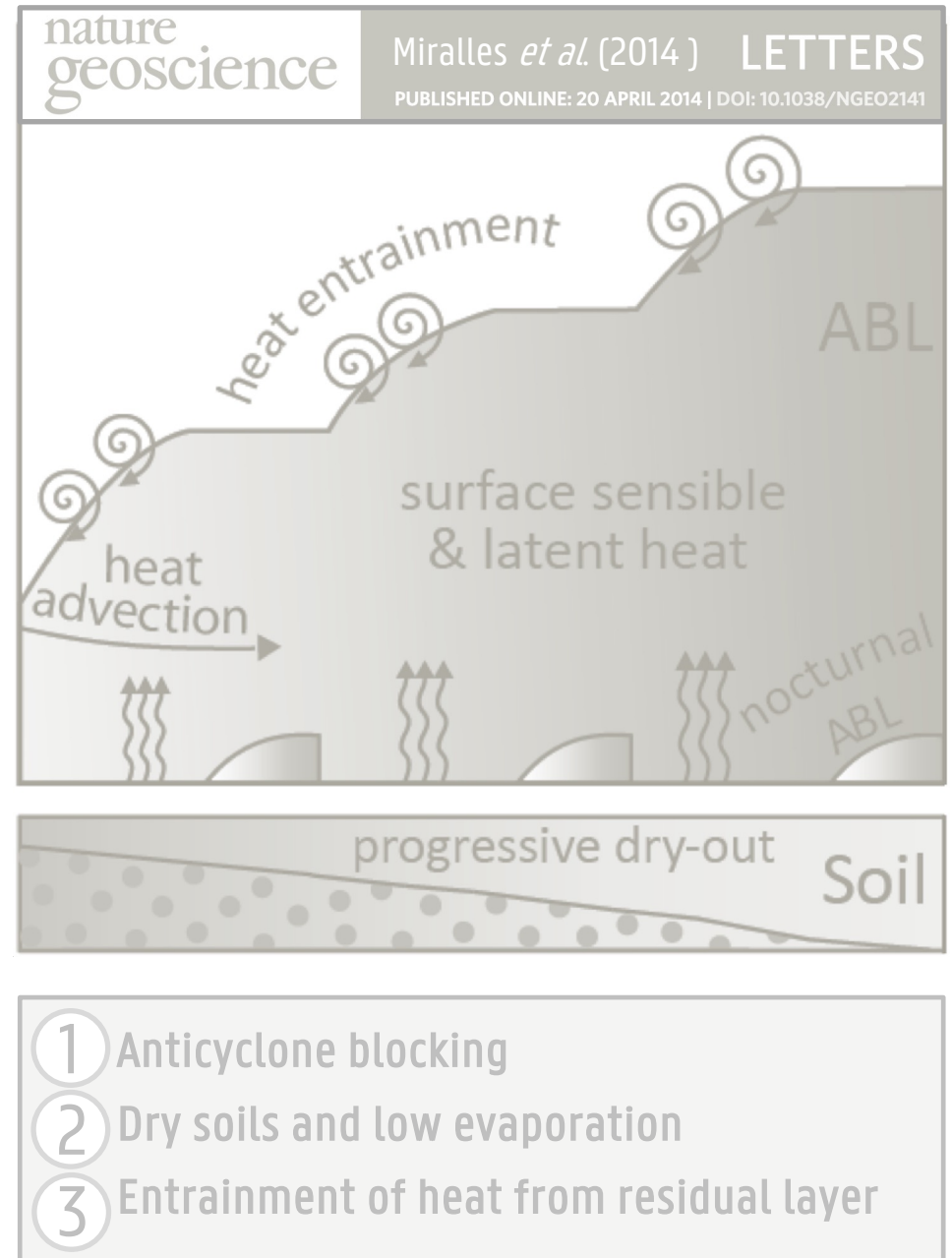
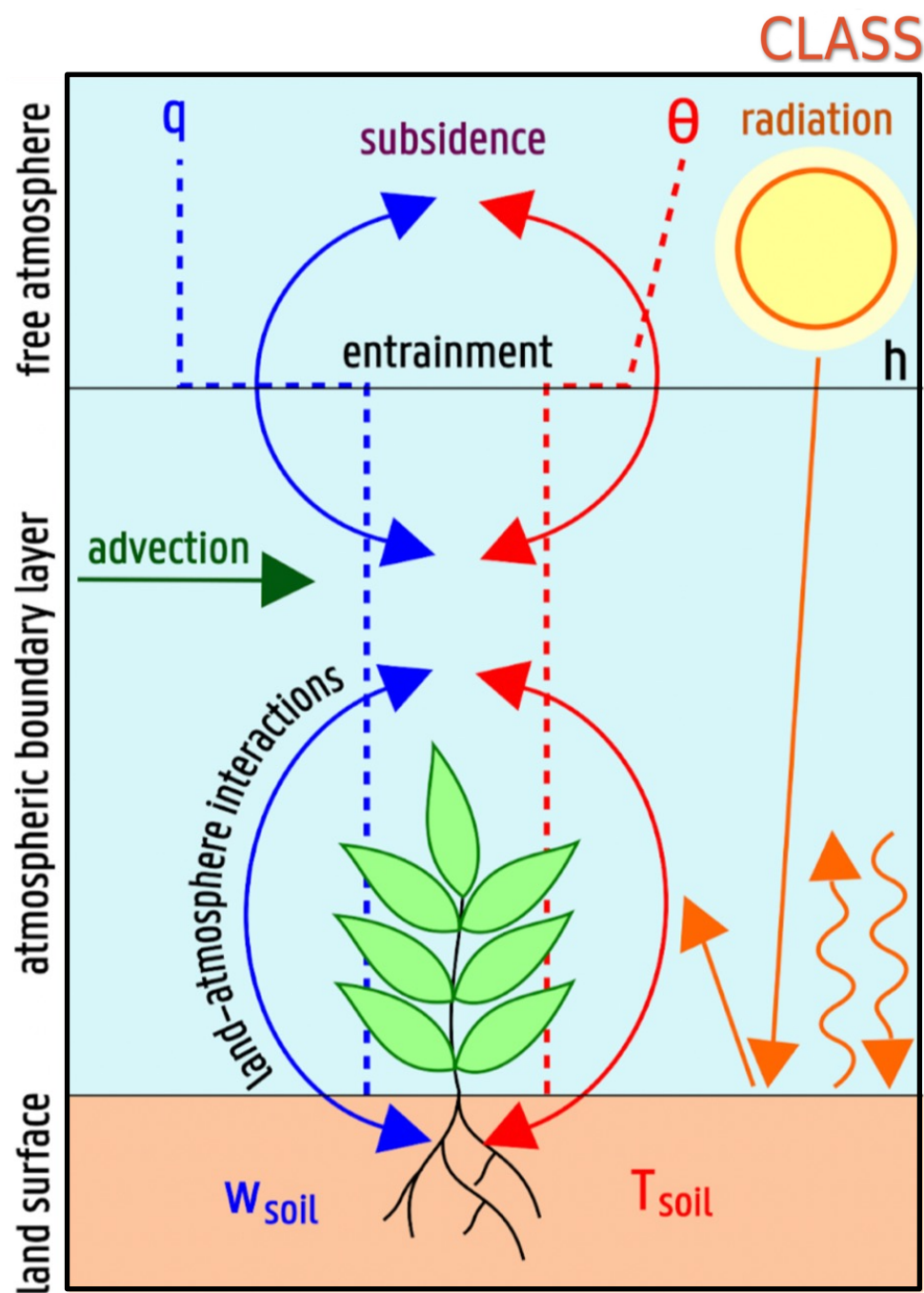
**Intensification**

Propagation

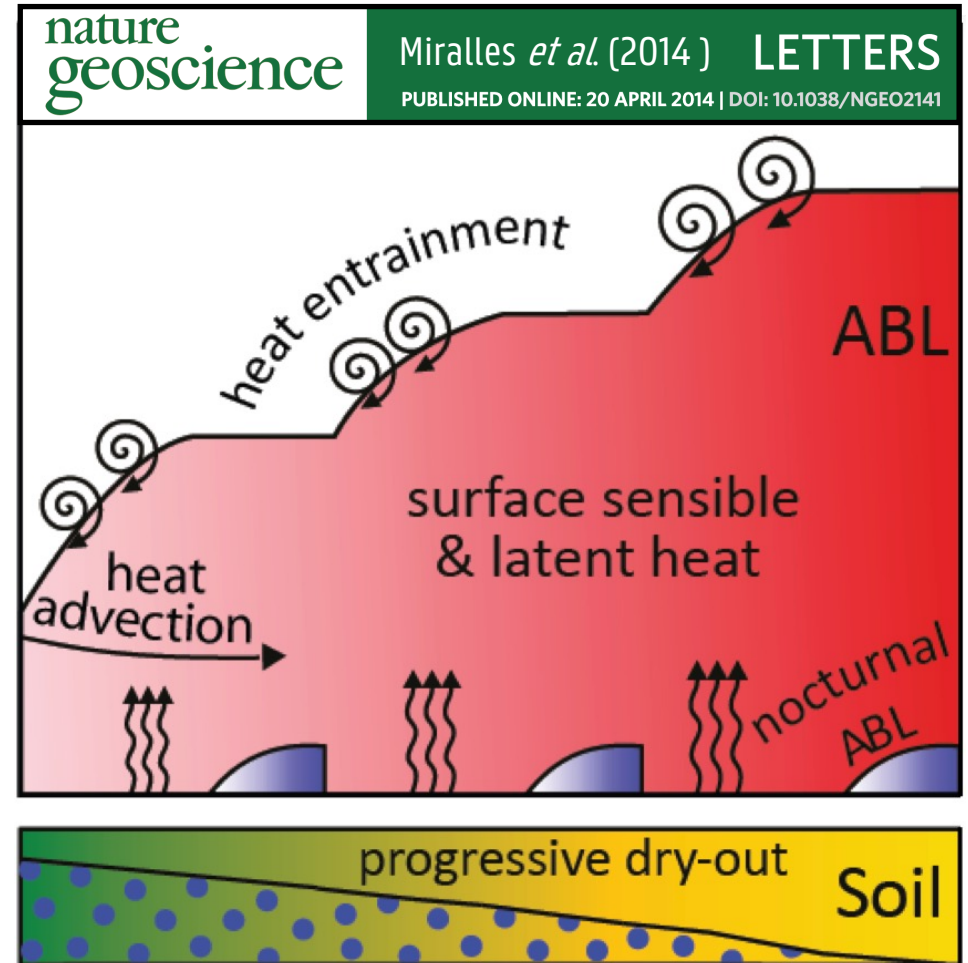
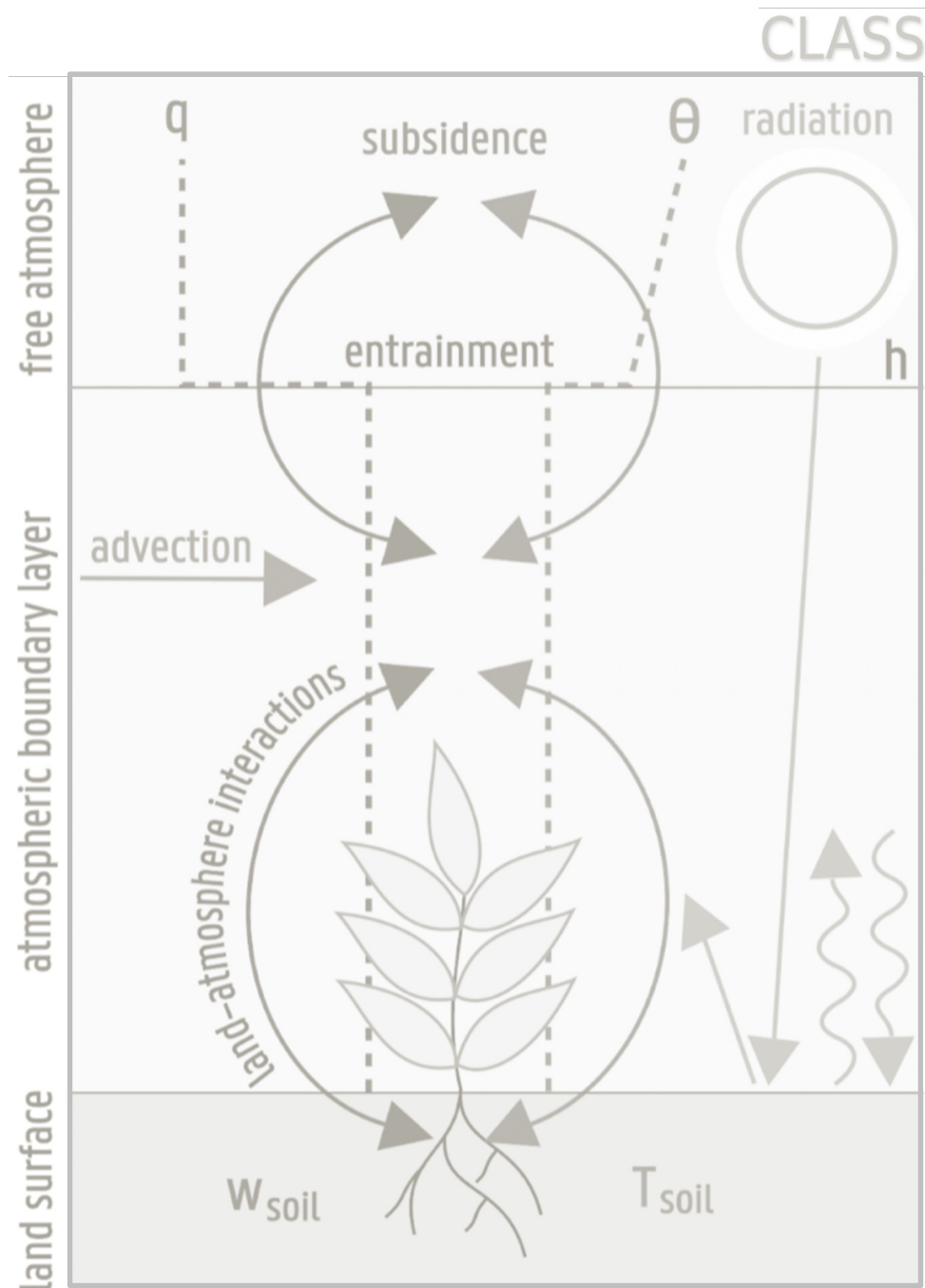
Conclusion











- ① Anticyclone blocking
- ② Dry soils and low evaporation
- ③ Entrainment of heat from residual layer



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## DATA



**Balloon soundings**  
 $>10^6$  quality checked profiles


 **Operational soundings**  
**Research campaigns**





**Ancillary data**  
 satellite, reanalysis and surveys

  **Soil properties**

  **Vegetation features**

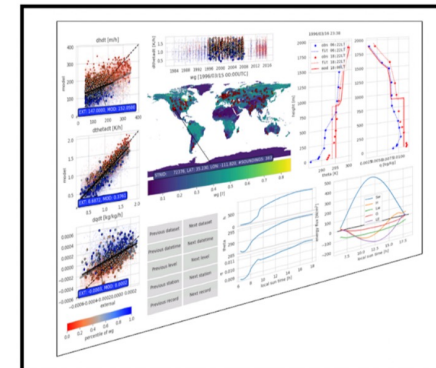
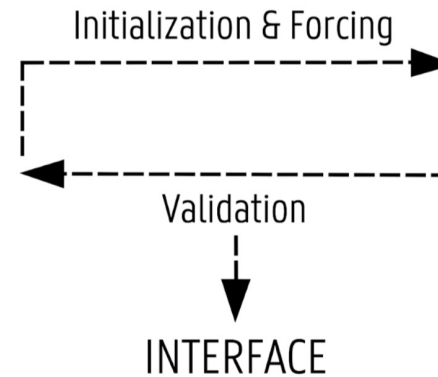
 **Surface heat exchanges**

 **Radiation forcing**

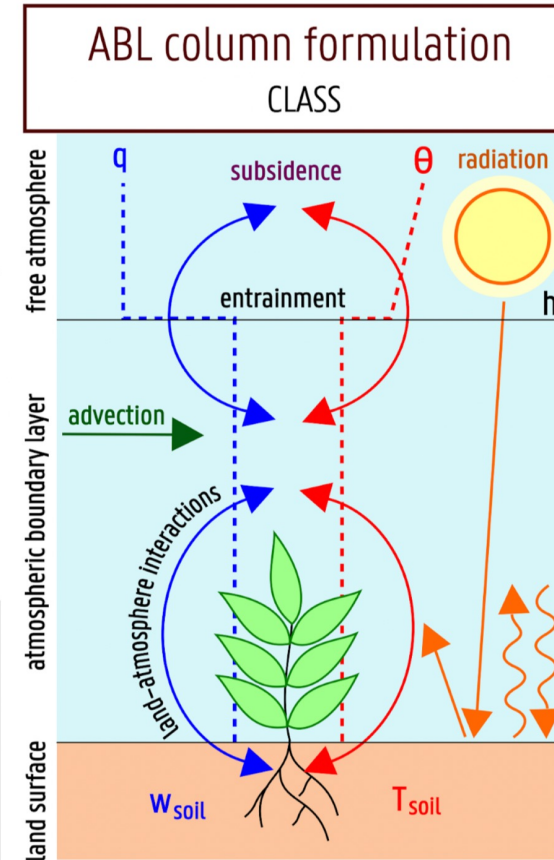
 **Large-scale atmosphere**

## CLASS<sup>4CL</sup>

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



## MODEL





Wouters *et al.* (2019)










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**Balloon soundings**  
 $>10^6$  quality checked profiles

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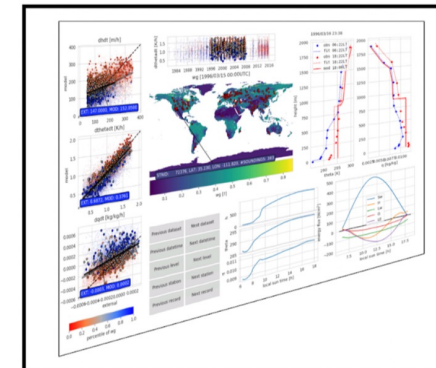
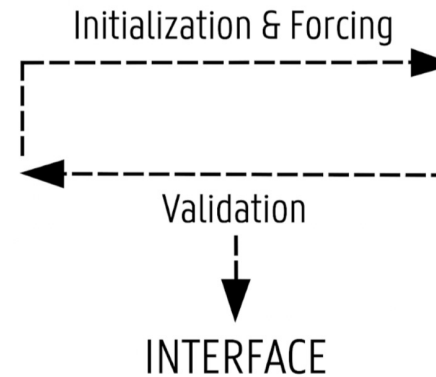


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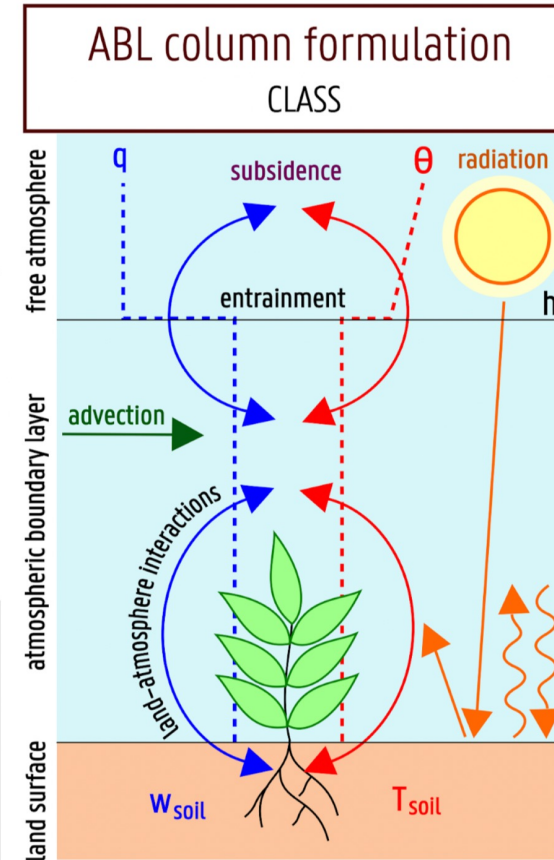
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Wouters *et al.* (2019)



**ARTICLE** **OPEN**

**npj** | Climate and Atmospheric Science

# Soil moisture signature in global weather balloon soundings

Jasper M. C. Denissen <sup>1,2</sup>✉, René Orth <sup>1</sup>, Hendrik Wouters<sup>3,4</sup>, Diego G. Miralles <sup>3</sup>, Chiel C. van Heerwaarden <sup>5</sup>,  
 Jordi Vilà-Guerau de Arellano <sup>5</sup> and Adriaan J. Teuling <sup>2</sup>

(2021)





SCIENCE ADVANCES | RESEARCH ARTICLE

ATMOSPHERIC SCIENCE

Wouters *et al.* (2022)

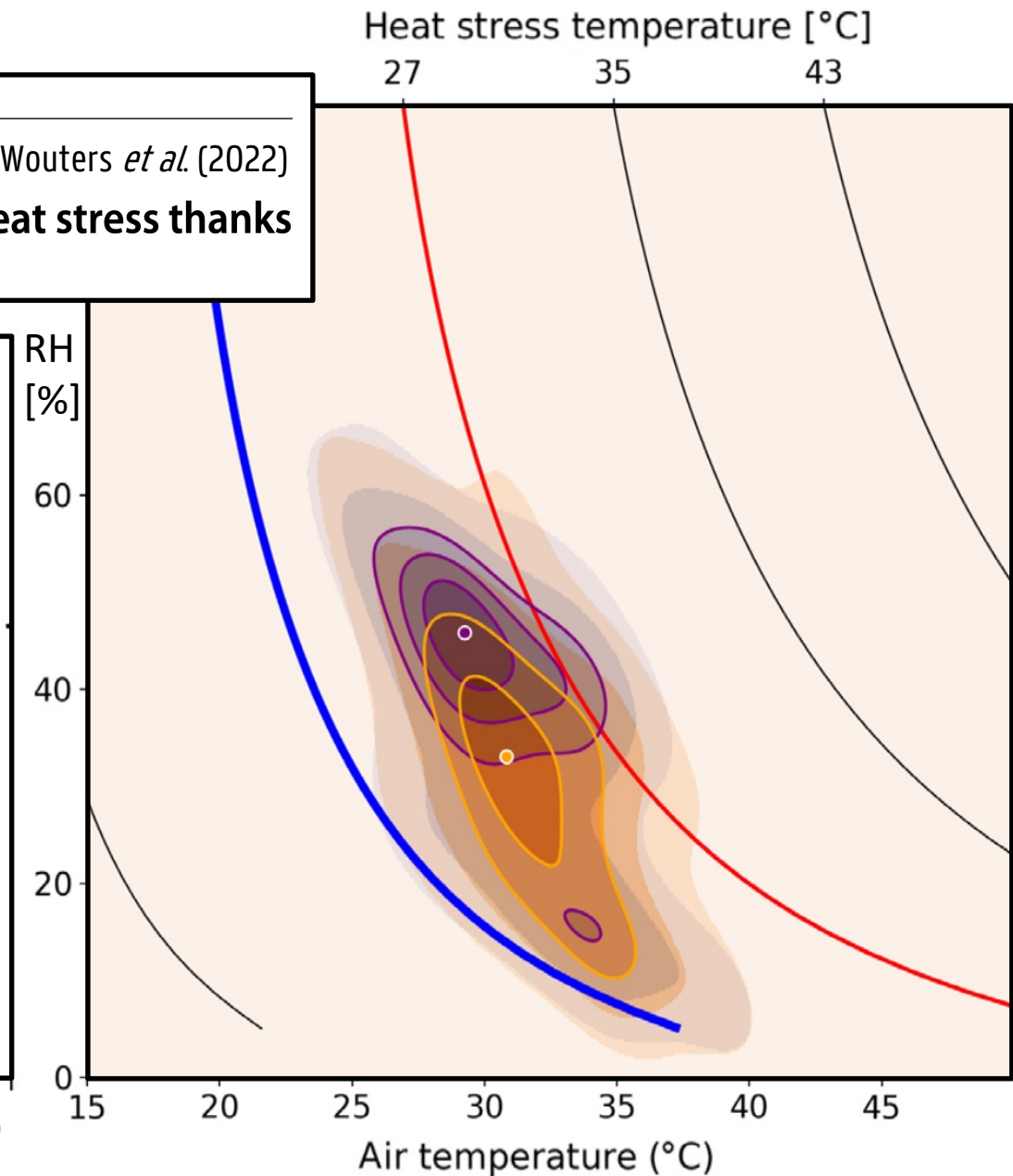
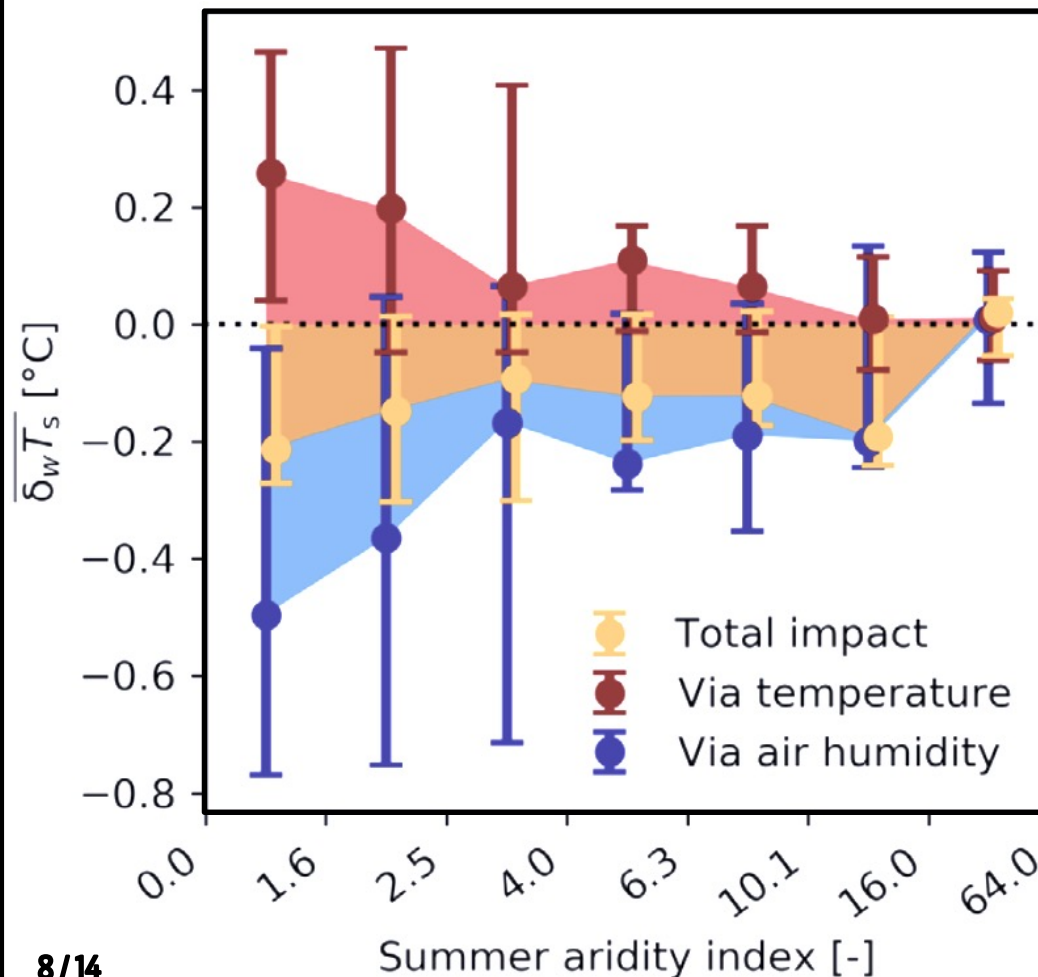
# Soil drought can mitigate deadly heat stress thanks to a reduction of air humidity

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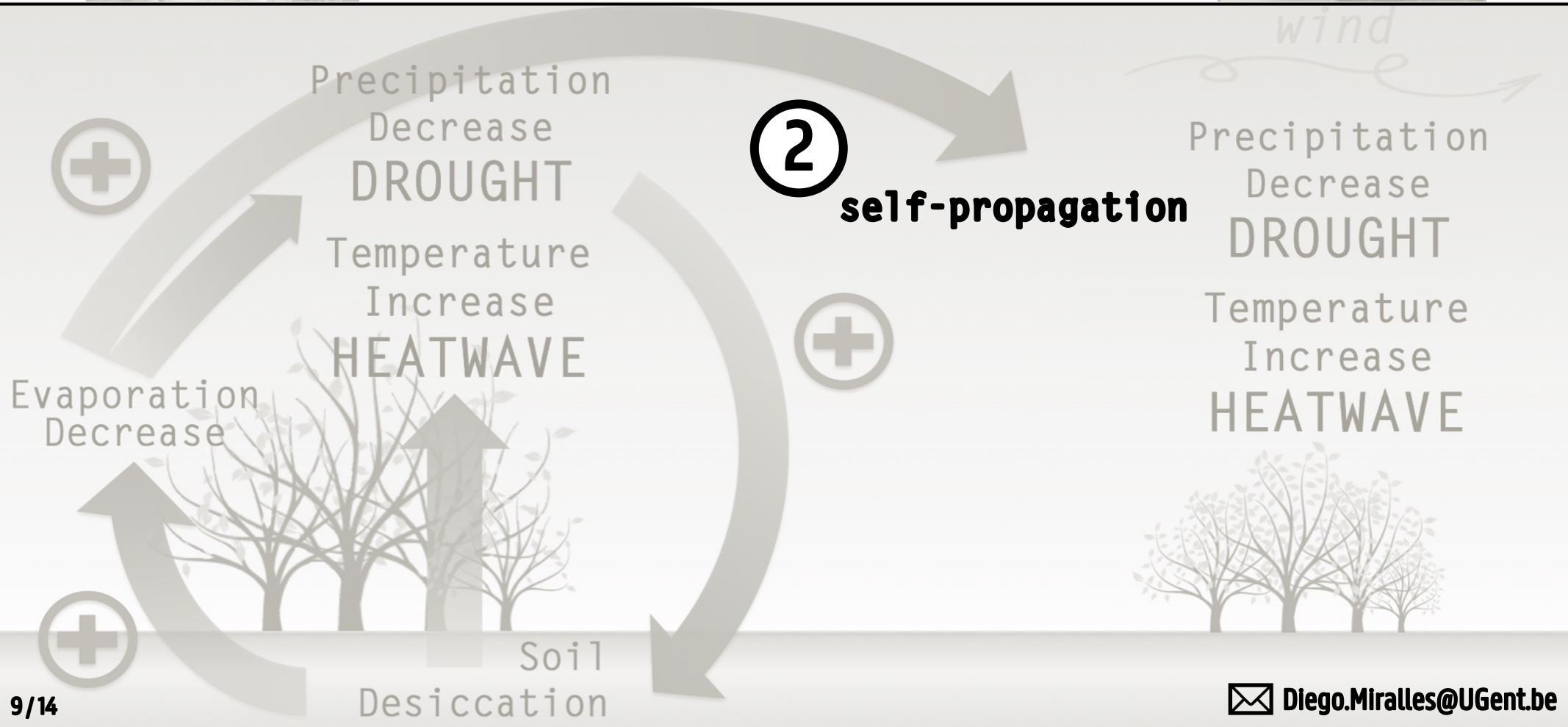
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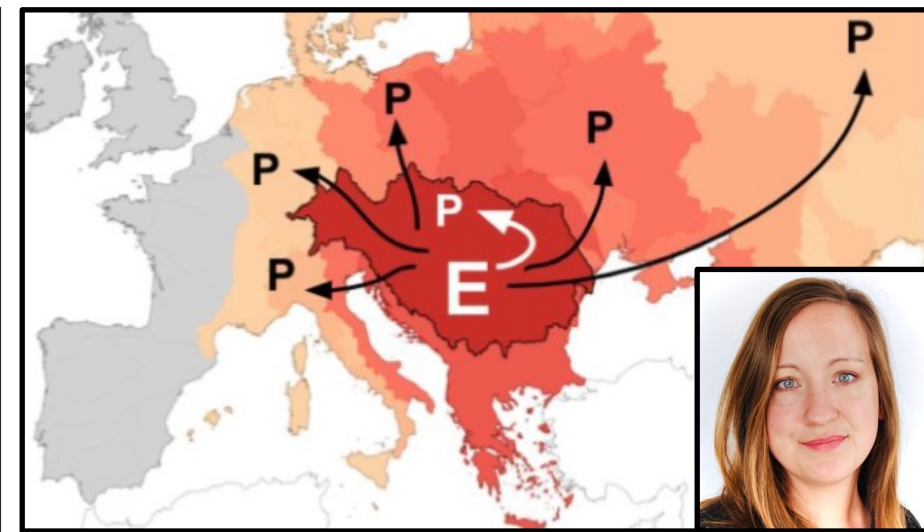
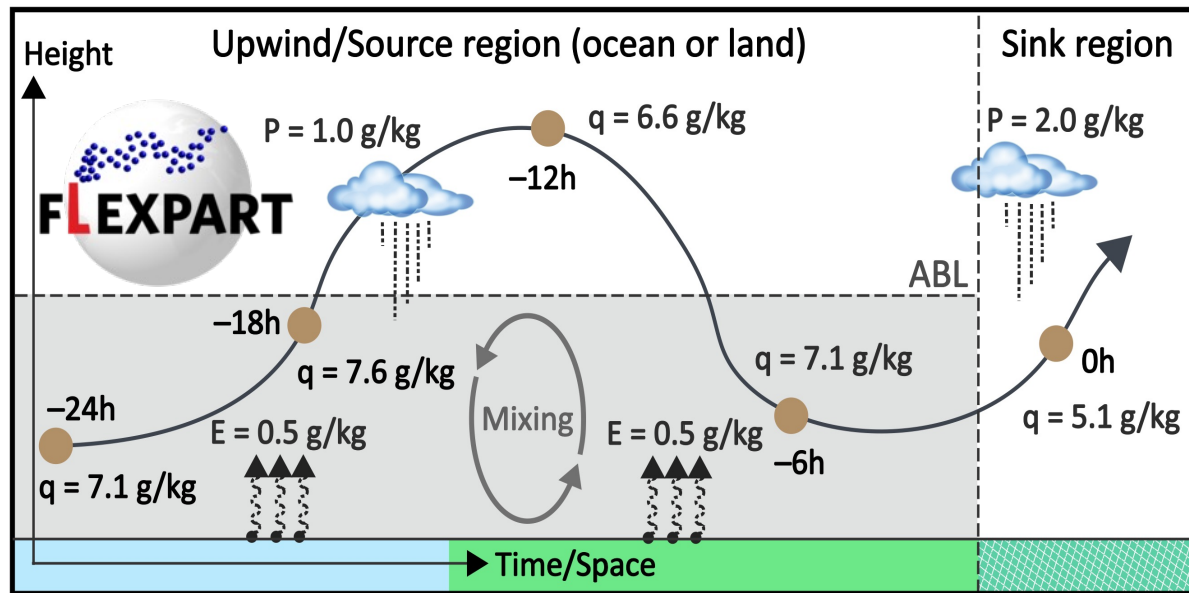


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Keune *et al.* (2022)

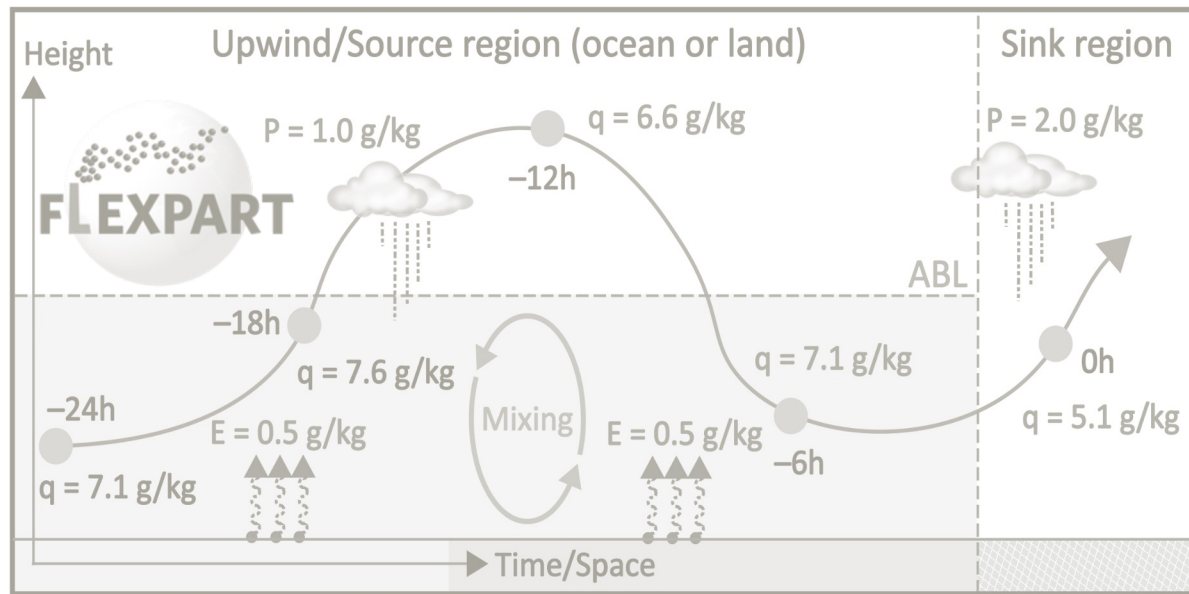
Keune & Miralles (2019)

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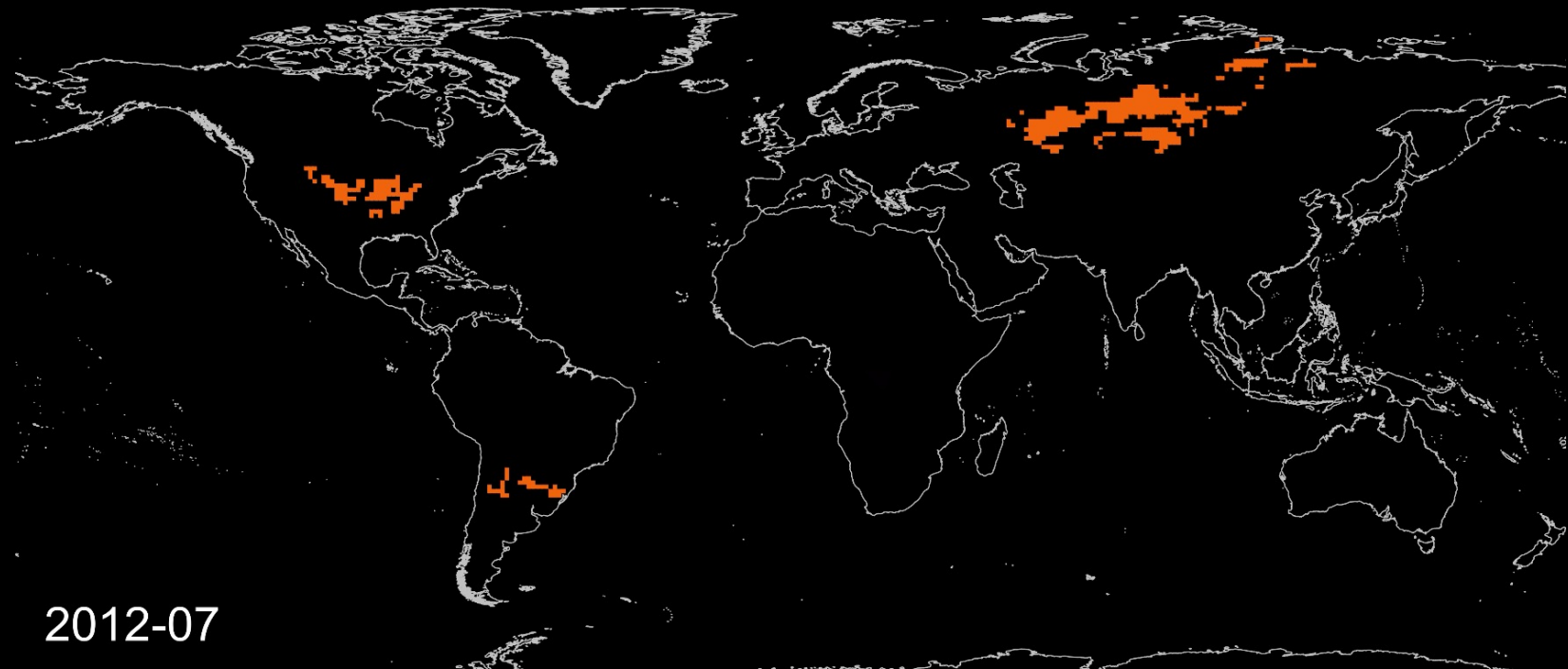
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Keune *et al.* (2022)

Keune & Miralles (2019)







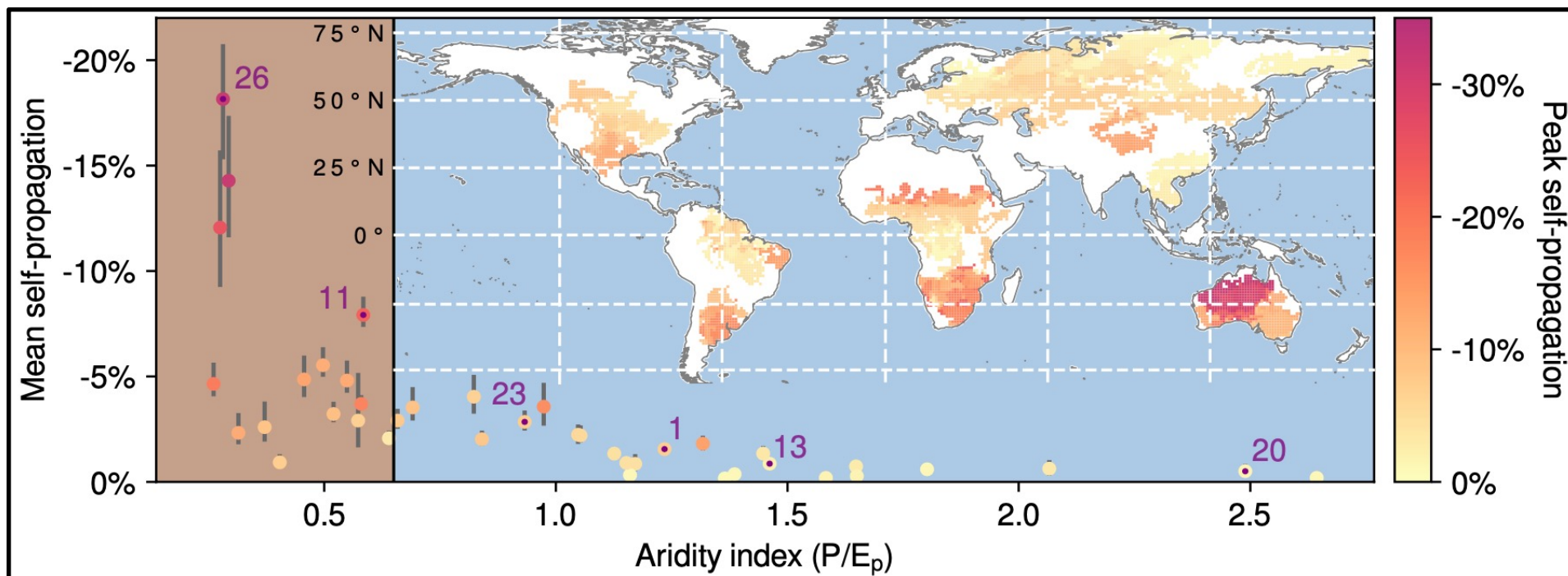
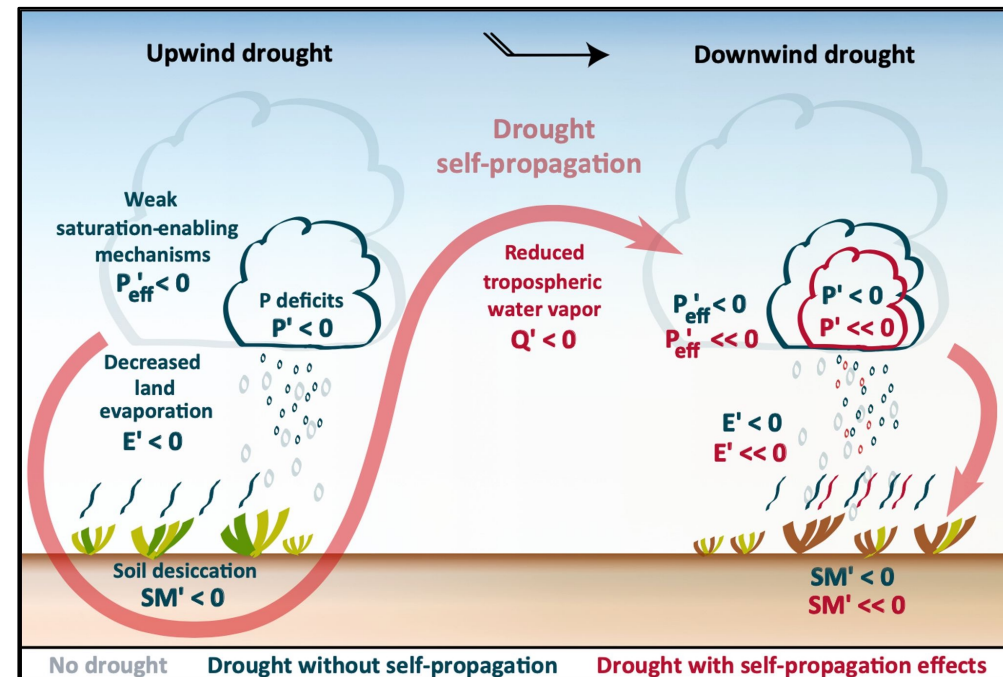
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**nature geoscience** **ARTICLES**  
<https://doi.org/10.1038/s41561-022-00912-7>  
**Drought self-propagation in drylands due to land-atmosphere feedbacks** (2022)  
 Dominik L. Schumacher<sup>1</sup>✉, Jessica Keune<sup>1</sup>, Paul Dirmeyer<sup>2</sup> and Diego G. Miralles<sup>1</sup>

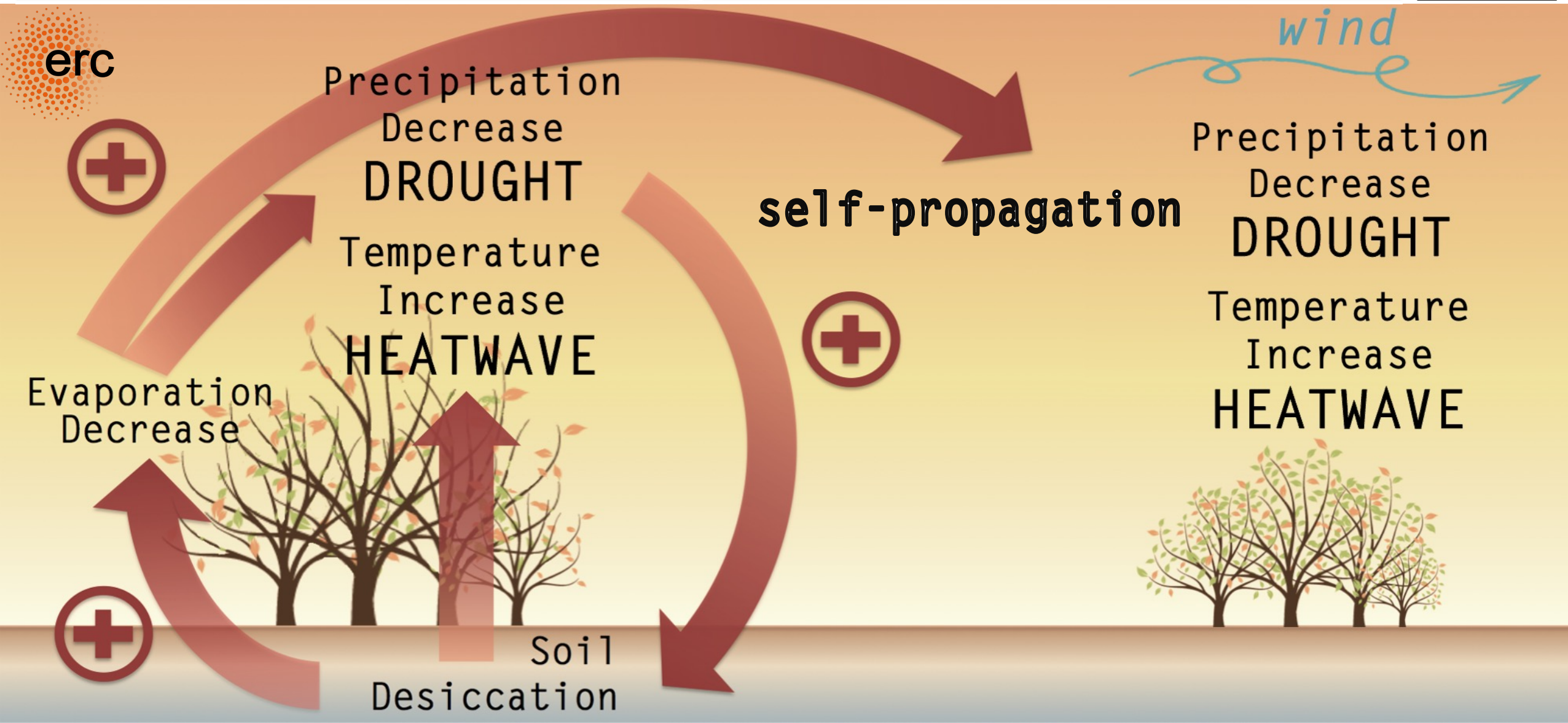


# Drought self-propagation in drylands due to land-atmosphere feedbacks

(2021)

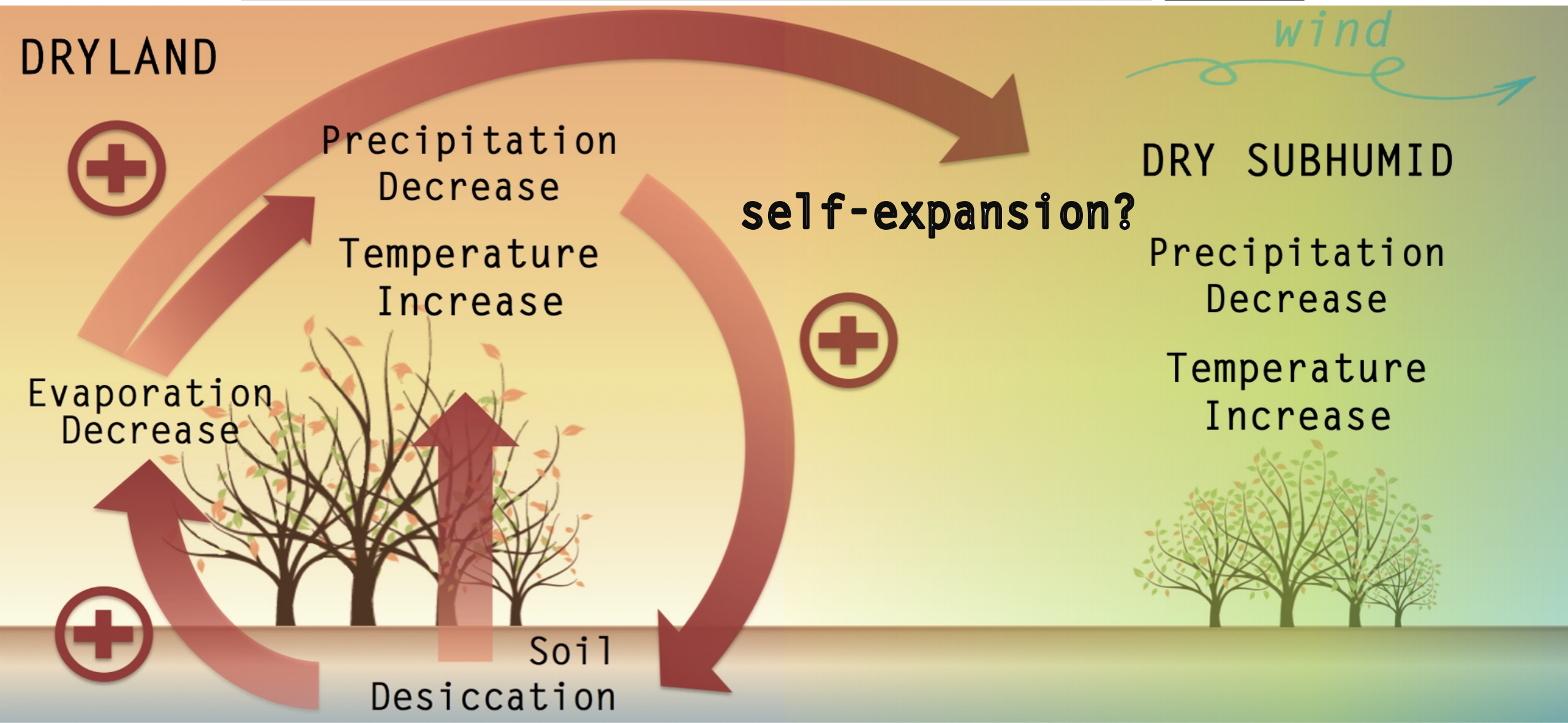
# Amplification of mega-heatwaves through heat torrents fuelled by upwind drought

(2019)





# Dryland self-expansion enabled by land-atmosphere feedbacks



Also at climatological scales

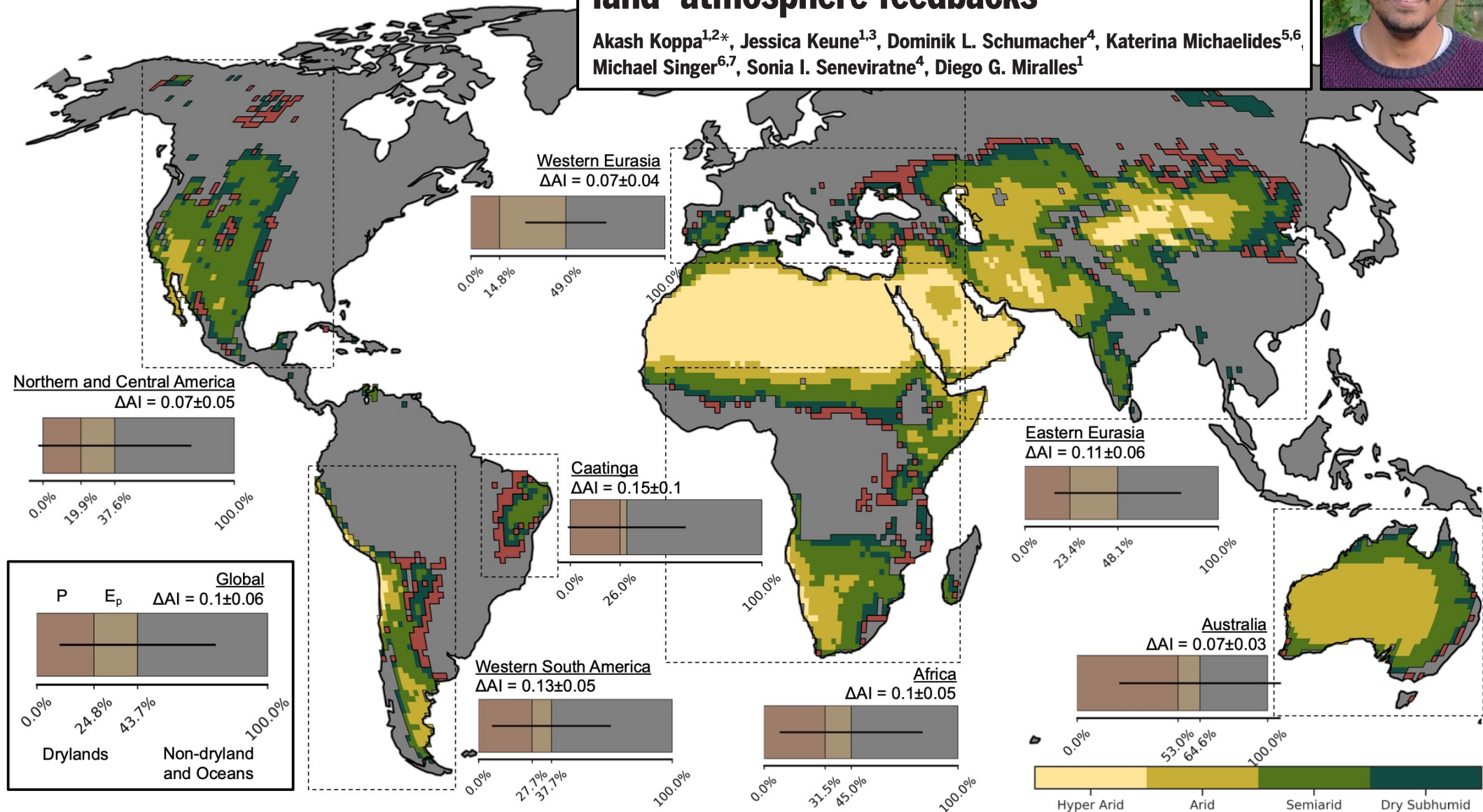
DRYLANDS

SCIENCE

2024

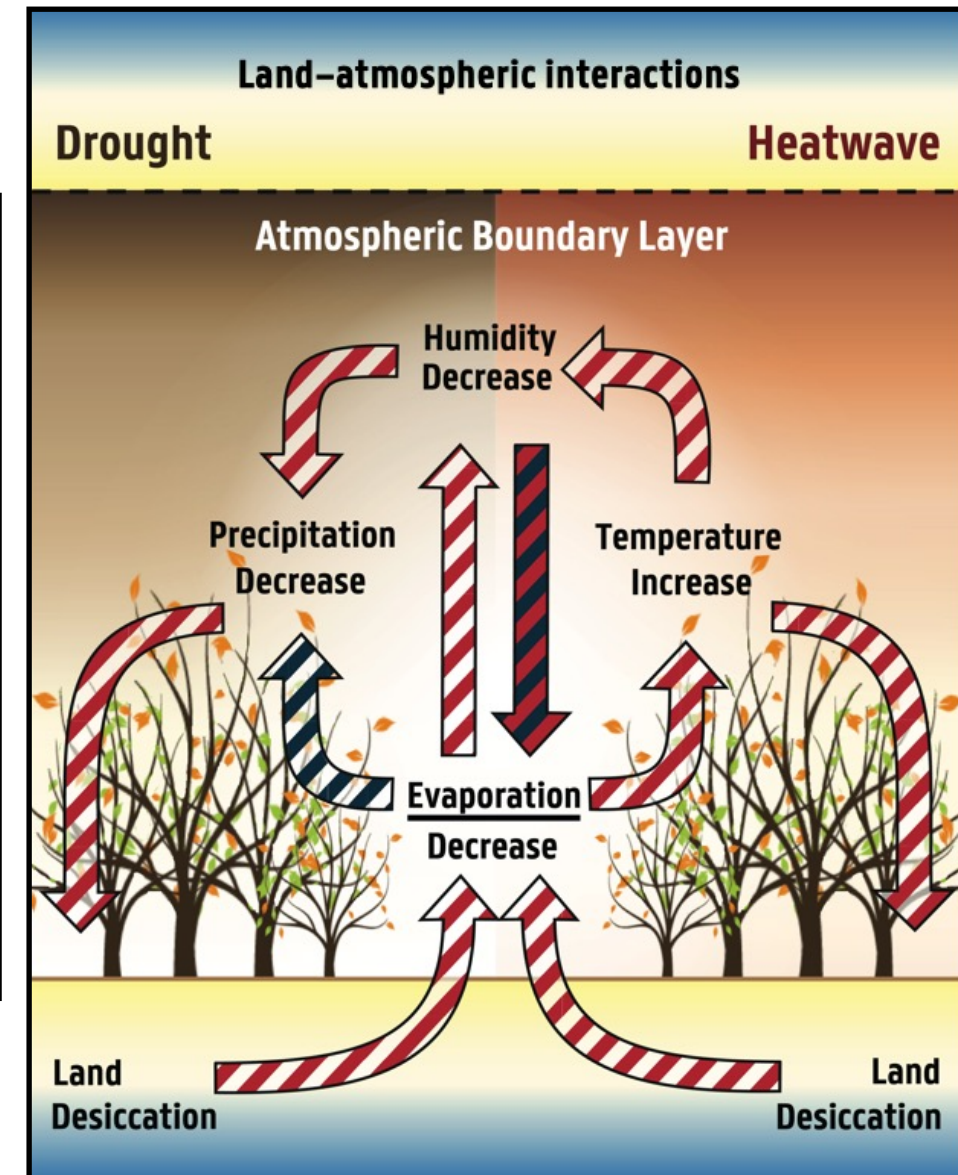
# Dryland self-expansion enabled by land-atmosphere feedbacks

Akash Koppa<sup>1,2\*</sup>, Jessica Keune<sup>1,3</sup>, Dominik L. Schumacher<sup>4</sup>, Katerina Michaelides<sup>5,6</sup>, Michael Singer<sup>6,7</sup>, Sonia I. Seneviratne<sup>4</sup>, Diego G. Miralles<sup>1</sup>



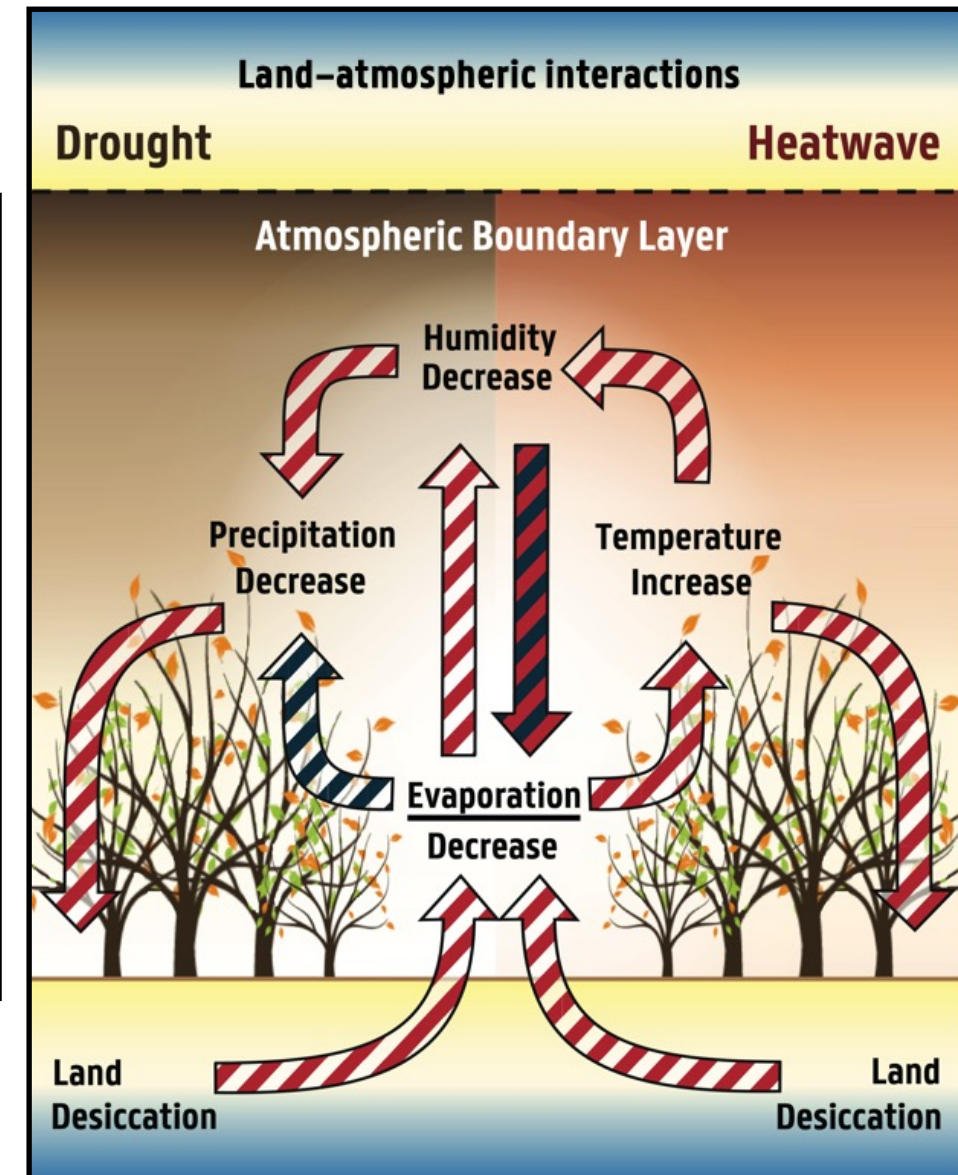


- ① **The land modulates the atmosphere** from meteorological to climatological scales
- ② Droughts and heatwaves self-intensify via land feedbacks
- ③ Dry soils can be beneficial for human heat stress
- ④ Droughts and heatwaves self-propagate mostly in drylands
- ⑤ Drylands self-expand in downwind direction via feedbacks
- ⑥ Potential of land management as mitigation strategy



Miralles *et al.* (2019)

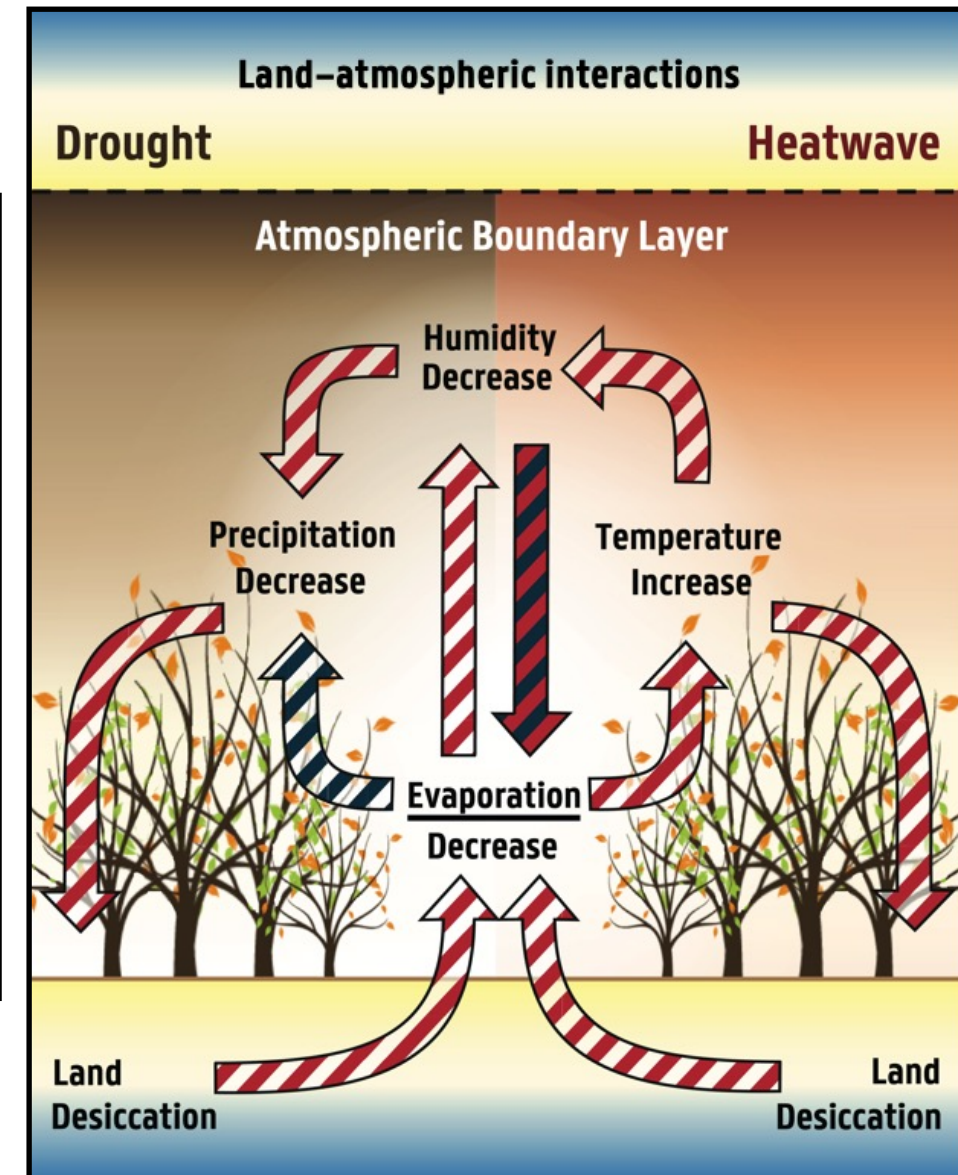
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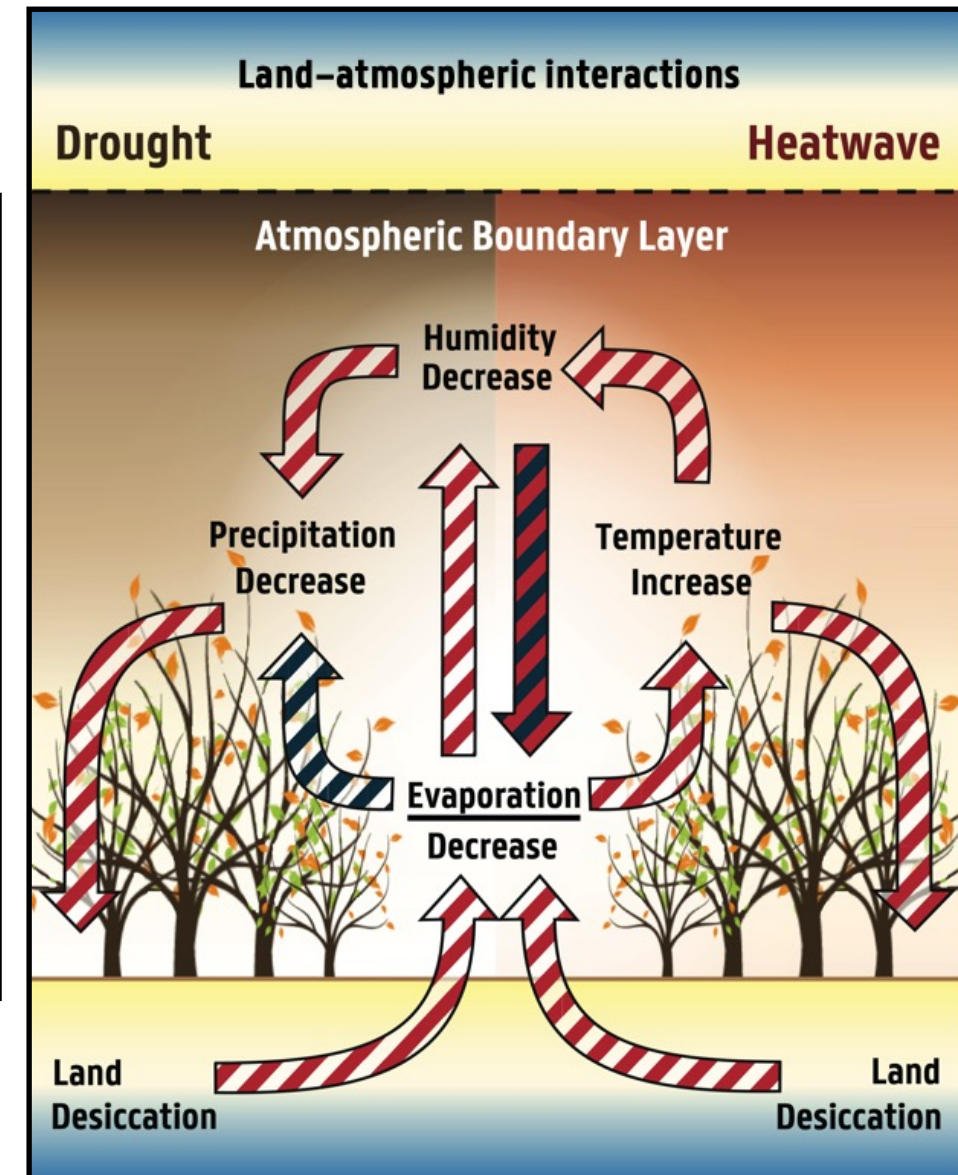


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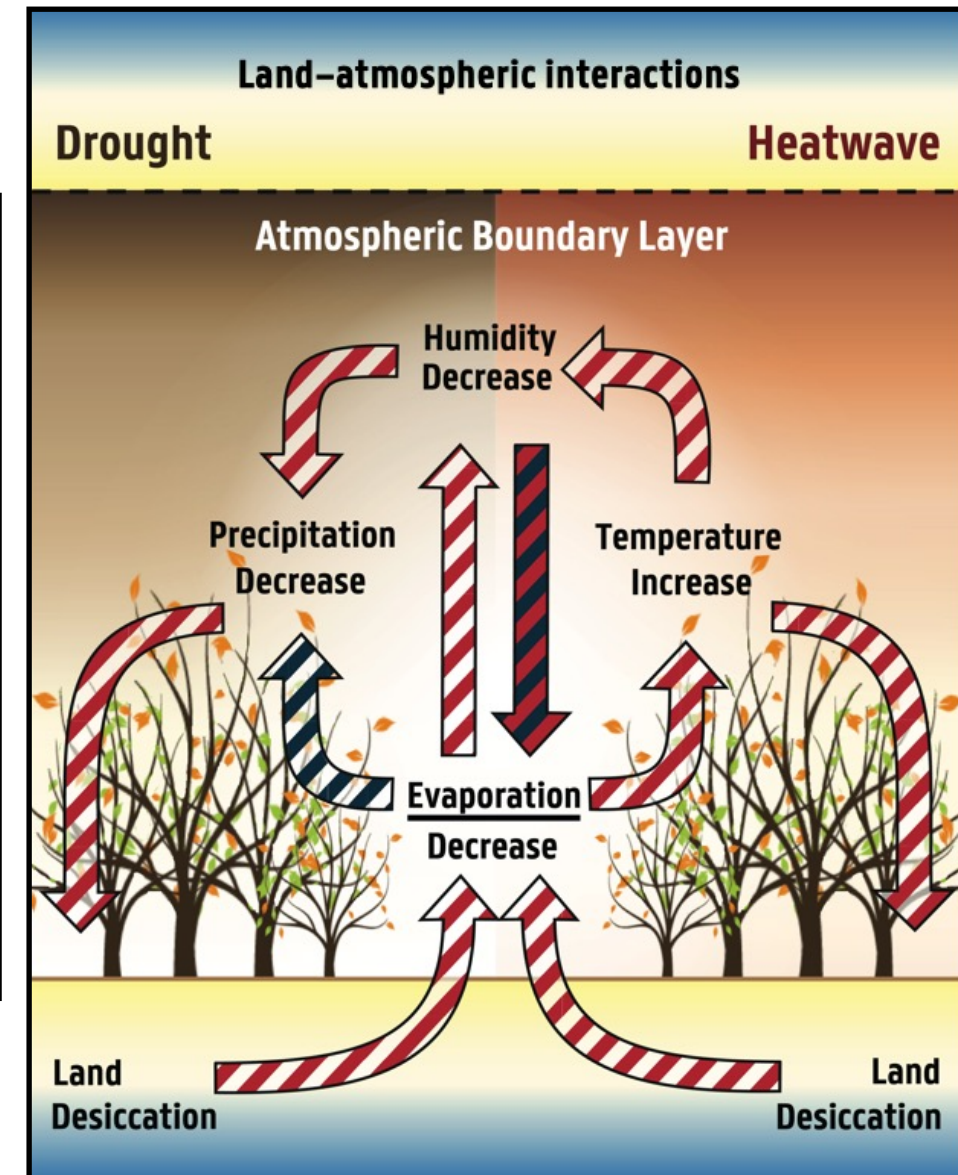
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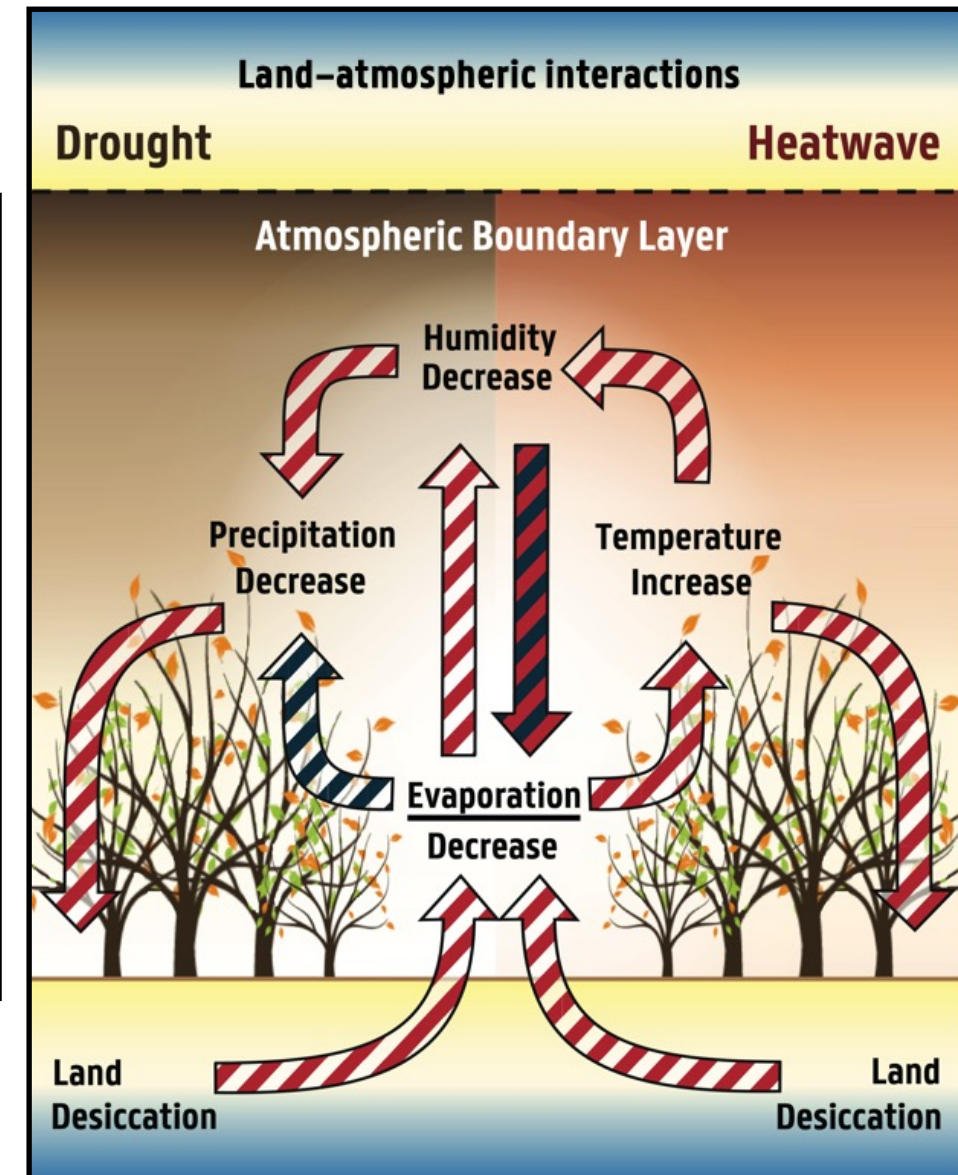


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