Snow droughts and their impacts on downstream rivers

Atelier Neige
Grenoble, 13.11.2026

Corentin Chartier-Rescan

Different perspectives on snow



Israel Perkins Warren

Different perspectives on snow



Israel Perkins Warren



SRF/SLF

Different perspectives on snow



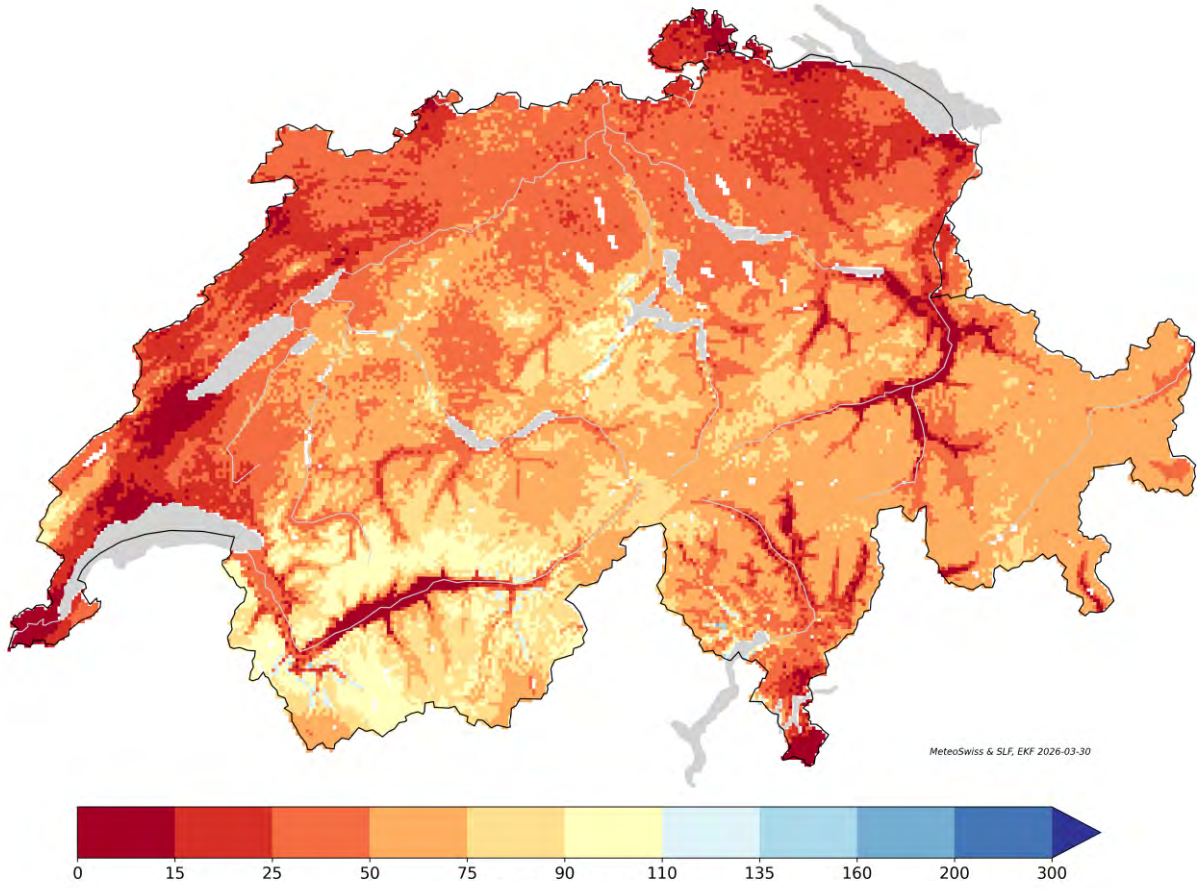
Israel Perkins Warren



SRF/SLF



Winter 2026 was characterized by a low snow cover



March 2026 snow height anomaly [%]

SLF and MeteoSwiss, 2026

In the past, this led to severe consequences

Western US (2026)



Miranda Green/RJ Sangosti

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Italy (2022)



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Afghanistan (2018)



FAO

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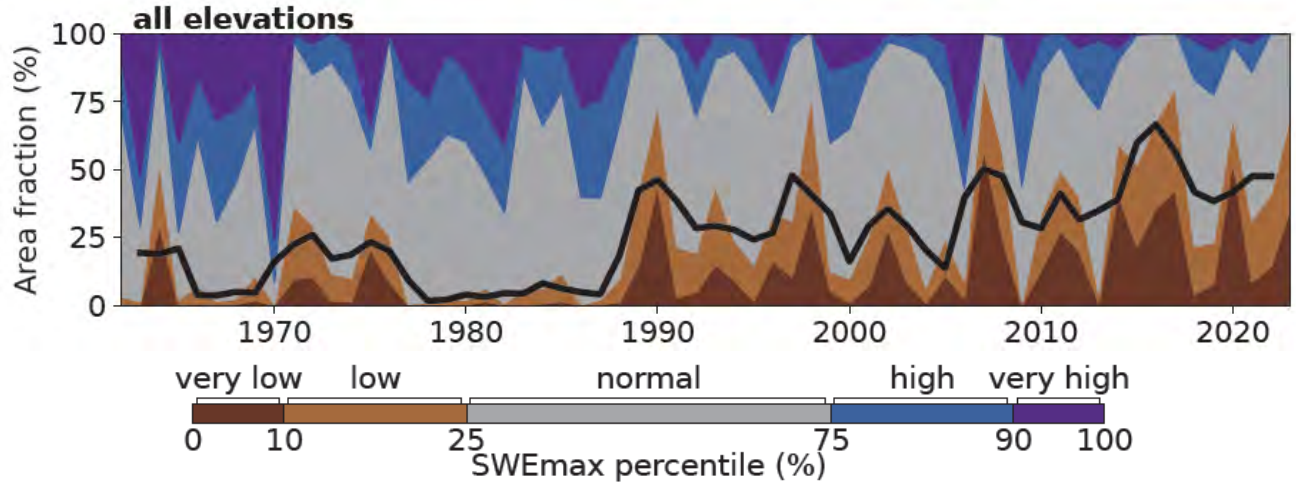
«*May Kabul be without gold rather than snow.*»

Afghan proverb

A generalized decrease in snow over the Alps



Wood et al., under review

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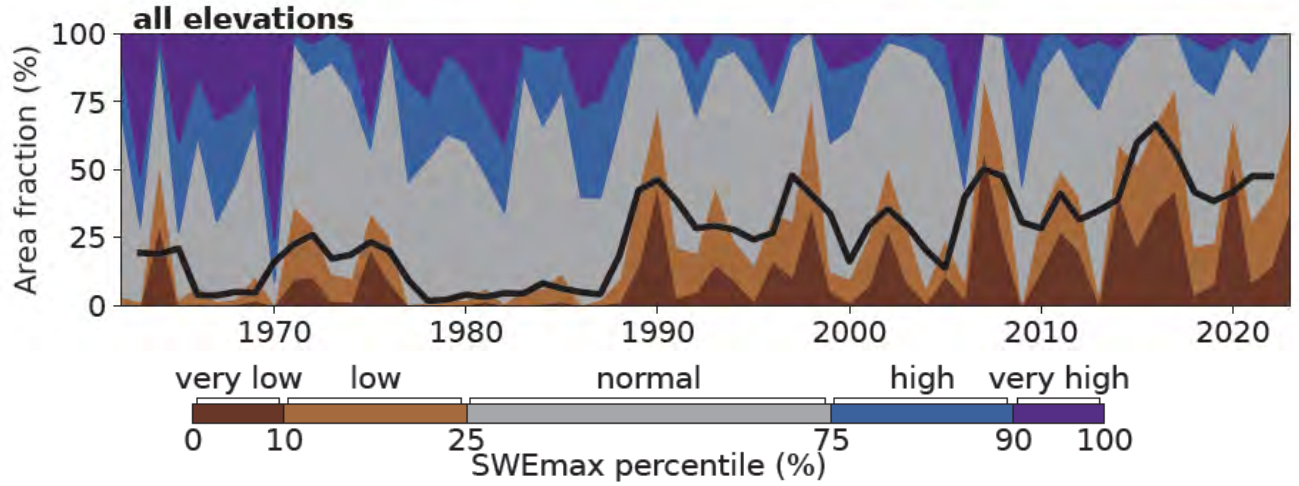

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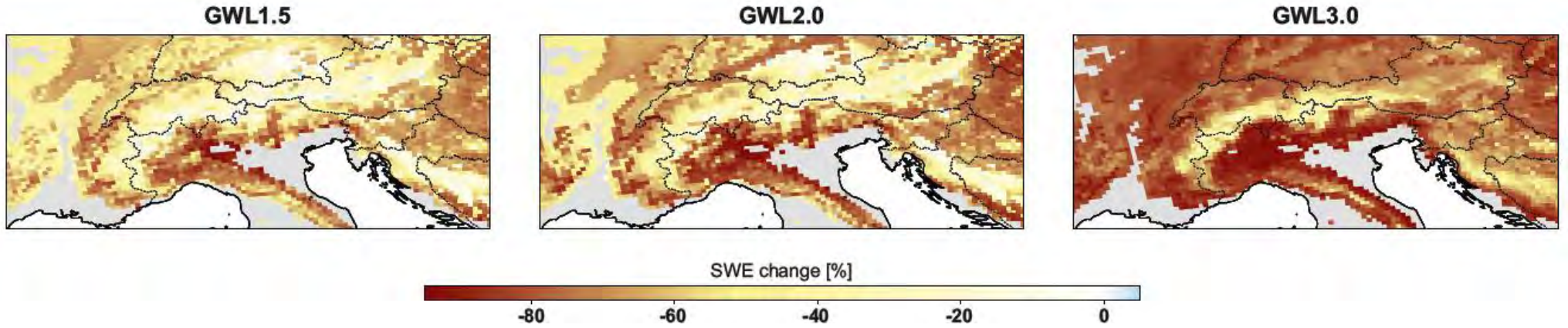

Climate scenarios for Switzerland, 2025

How to characterize the lack of snow?

Snow Water Equivalent (SWE): amount of water obtained by instantly melting $1\,m^2$ of the snow cover

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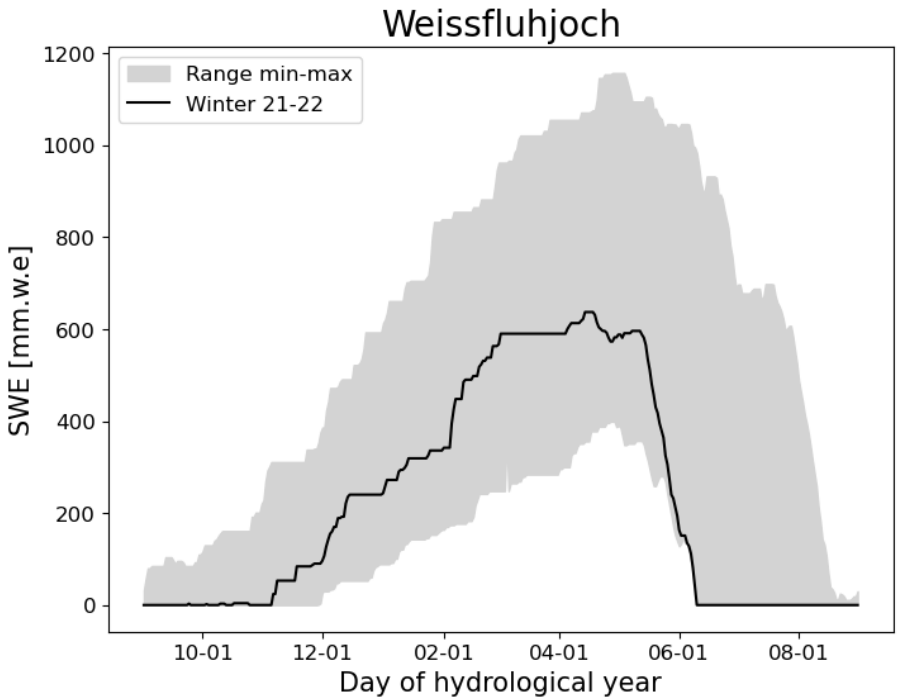

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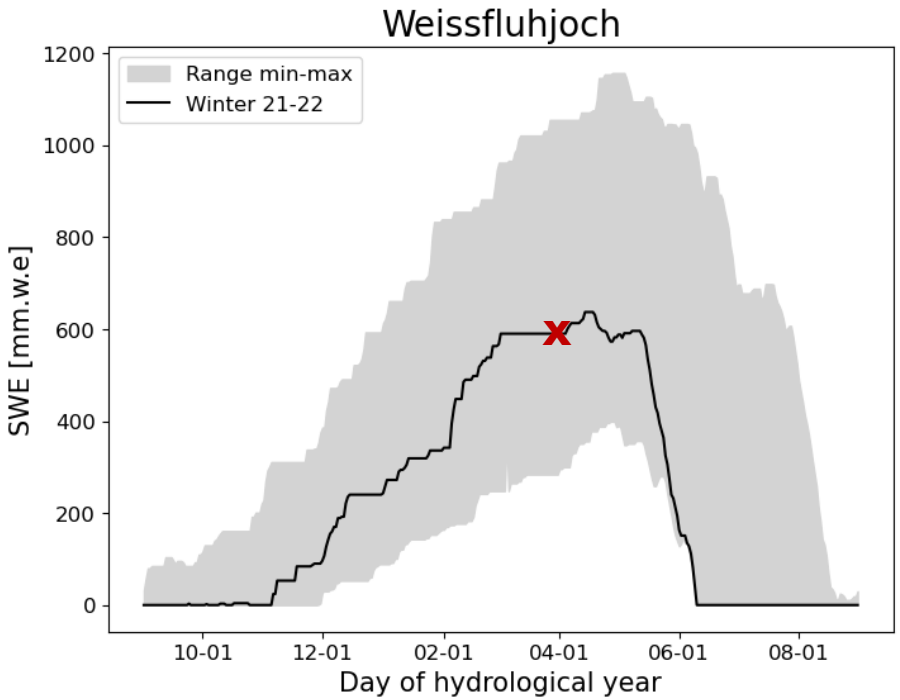

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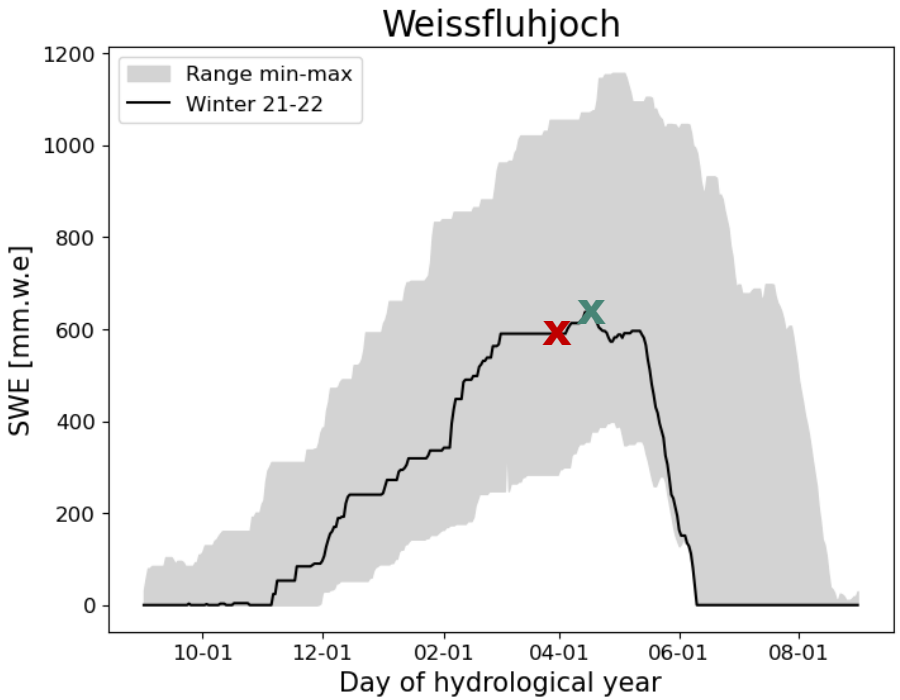

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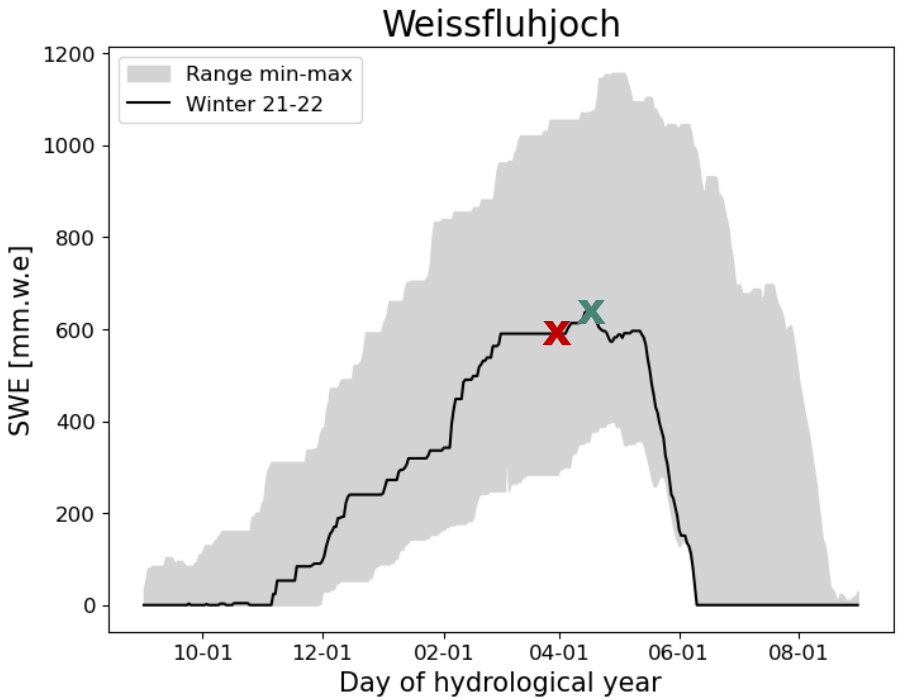

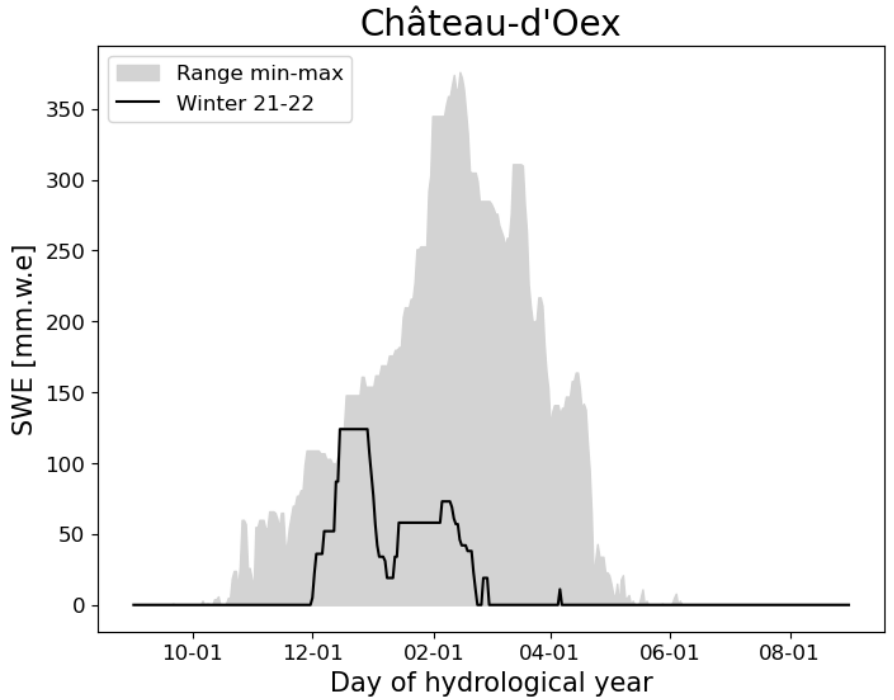

Using an event-based definition, i.e. «snow droughts»

«Defining snow drought based upon single points in time (i.e., 1 April) may result in misleading evaluations of snow droughts», *in Hatchett and McEvoy (2018)*

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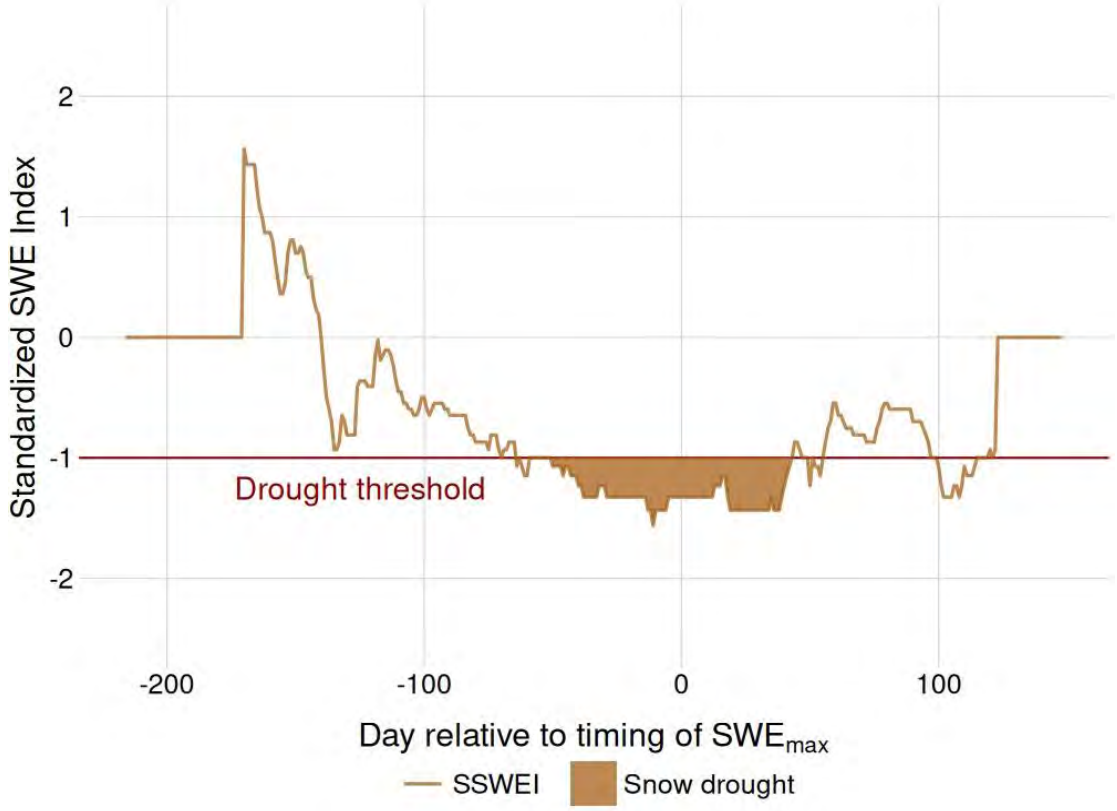
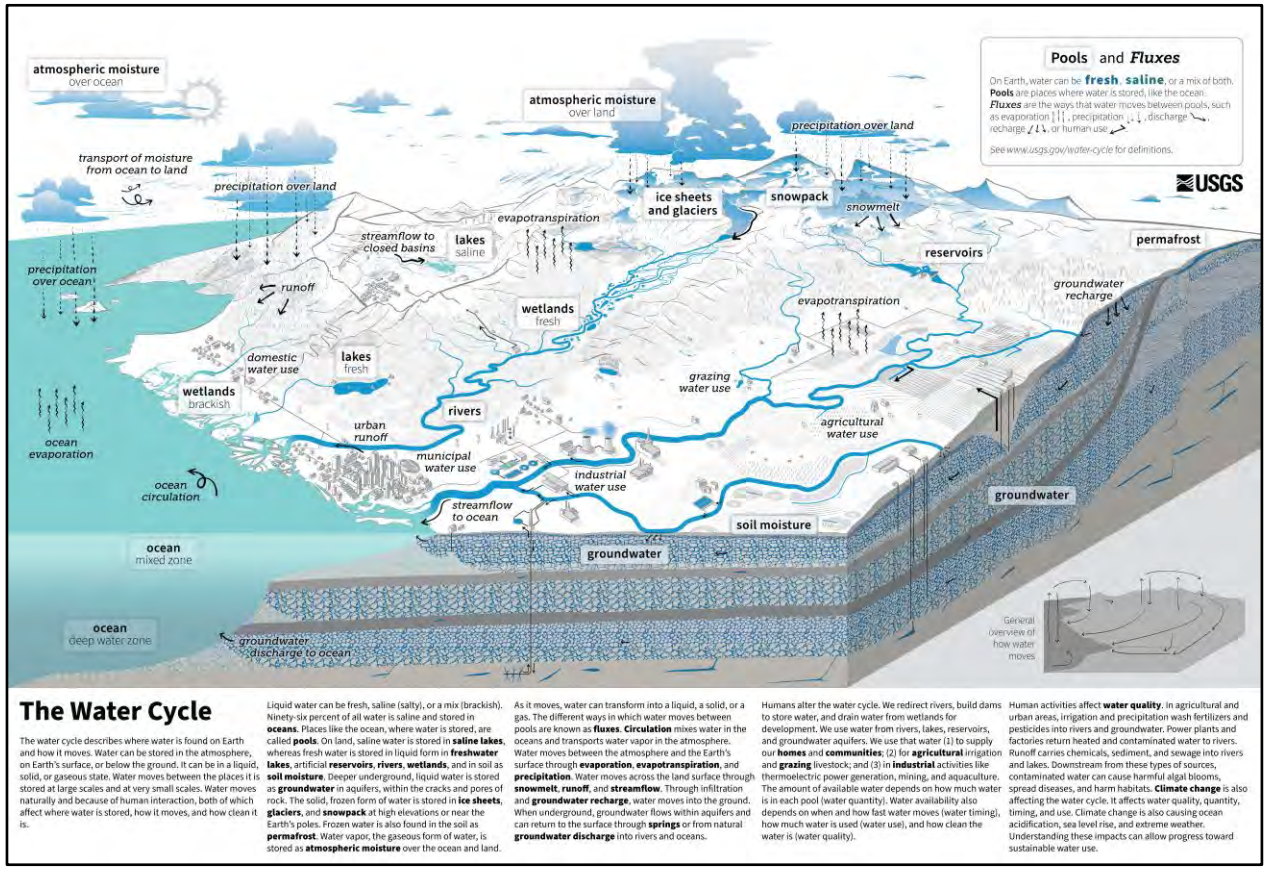


Consequences of snow droughts on hydrological droughts





Drought propagation downstream the water cycle



USGS

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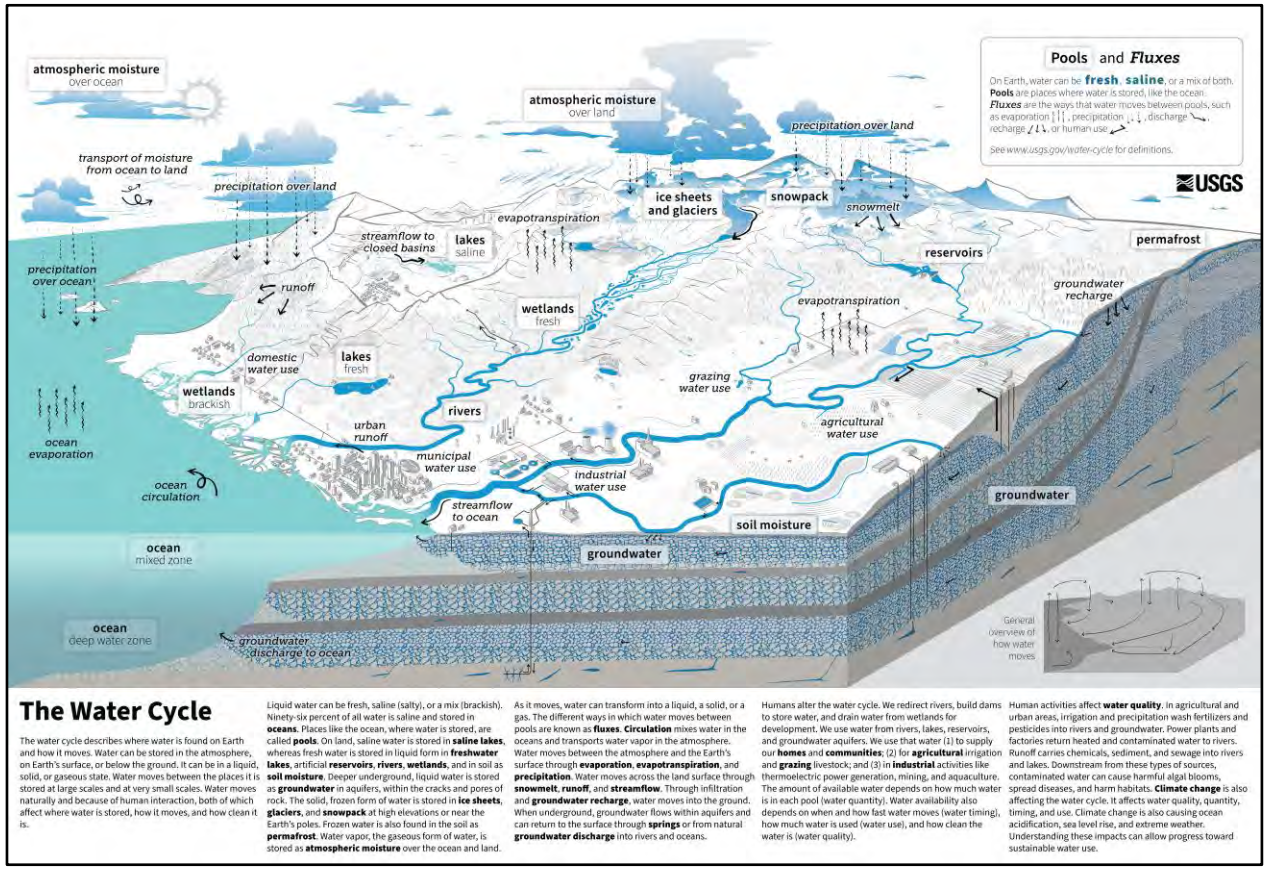

USGS

Drought Spatial Extent and Dependence Increase During Drought Propagation From the Atmosphere to the Hydrosphere

Manuela I. Brunner[1,2,3] and Corentin Chartier-Rescan[1,2,3]

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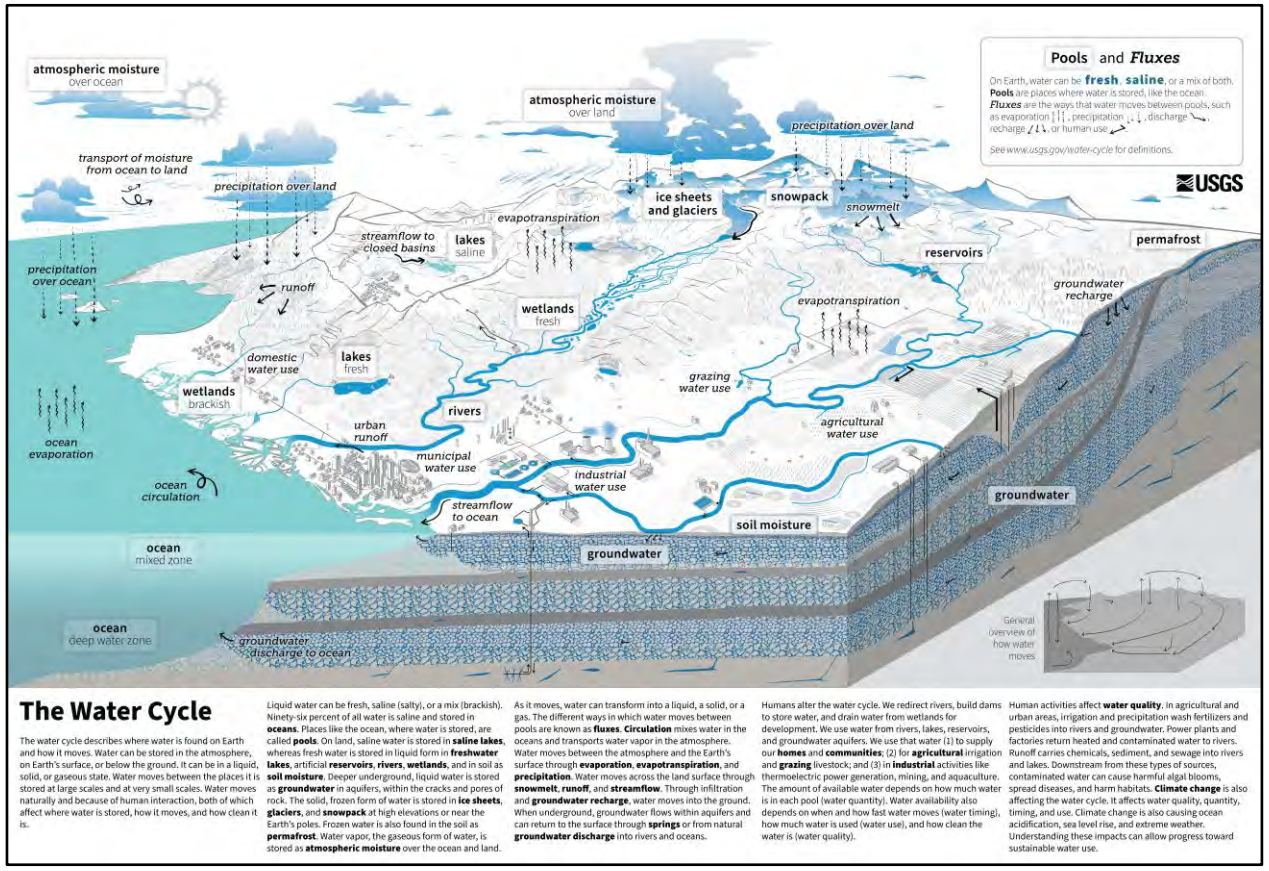

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But what about the role of snow drought ?

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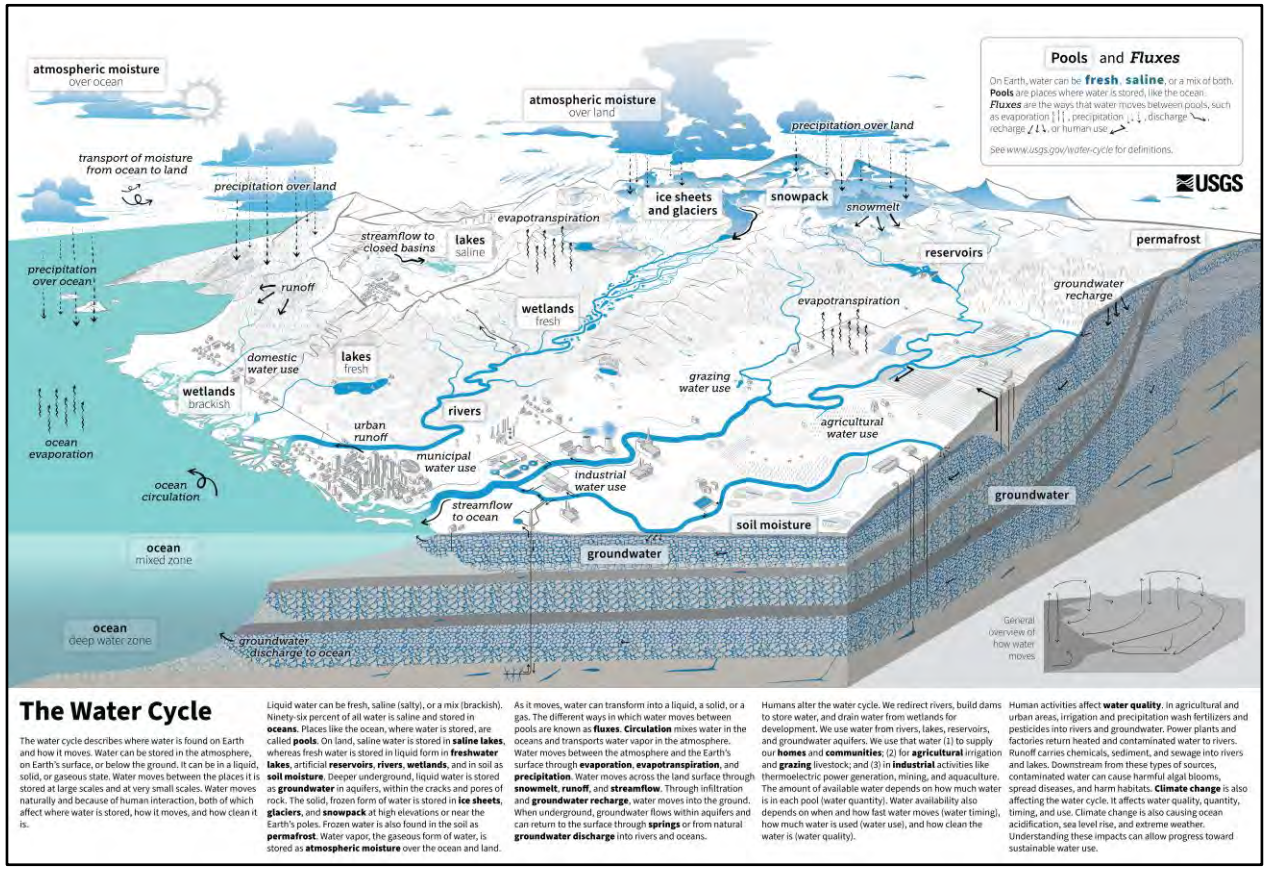

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But what about the role of snow drought ?

ENVIRONMENTAL RESEARCH
LETTERS

LETTER

Snow drought propagation and its impacts on streamflow drought in the Alps

Corentin Chartier-Rescan[1,2,3,*], Raul R Wood[1,2,3] and Manuela I Brunner[1,2,3]

Identification of snow & hydrological droughts

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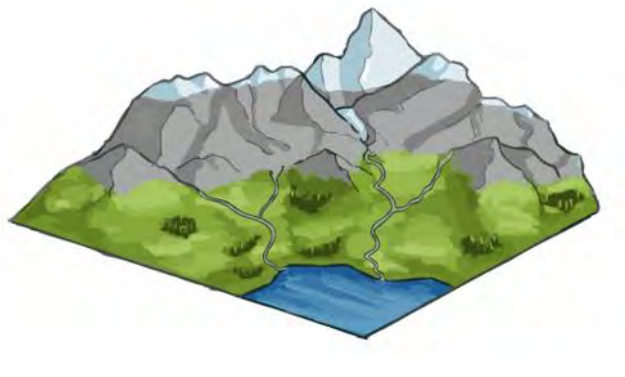
Identification of snow & hydrological droughts



Normal

Identification of snow & hydrological droughts





Normal **Drought**

Identification of snow & hydrological droughts





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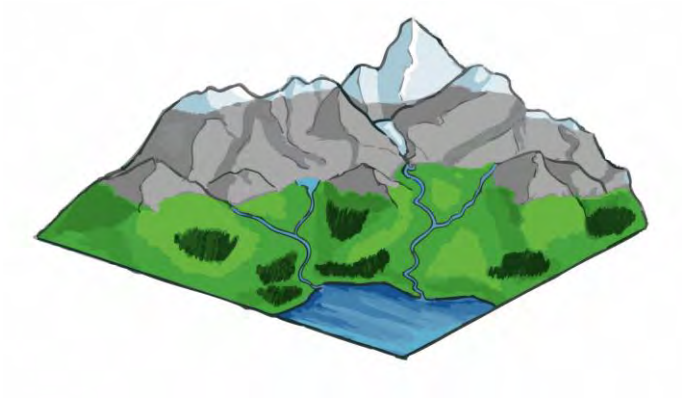

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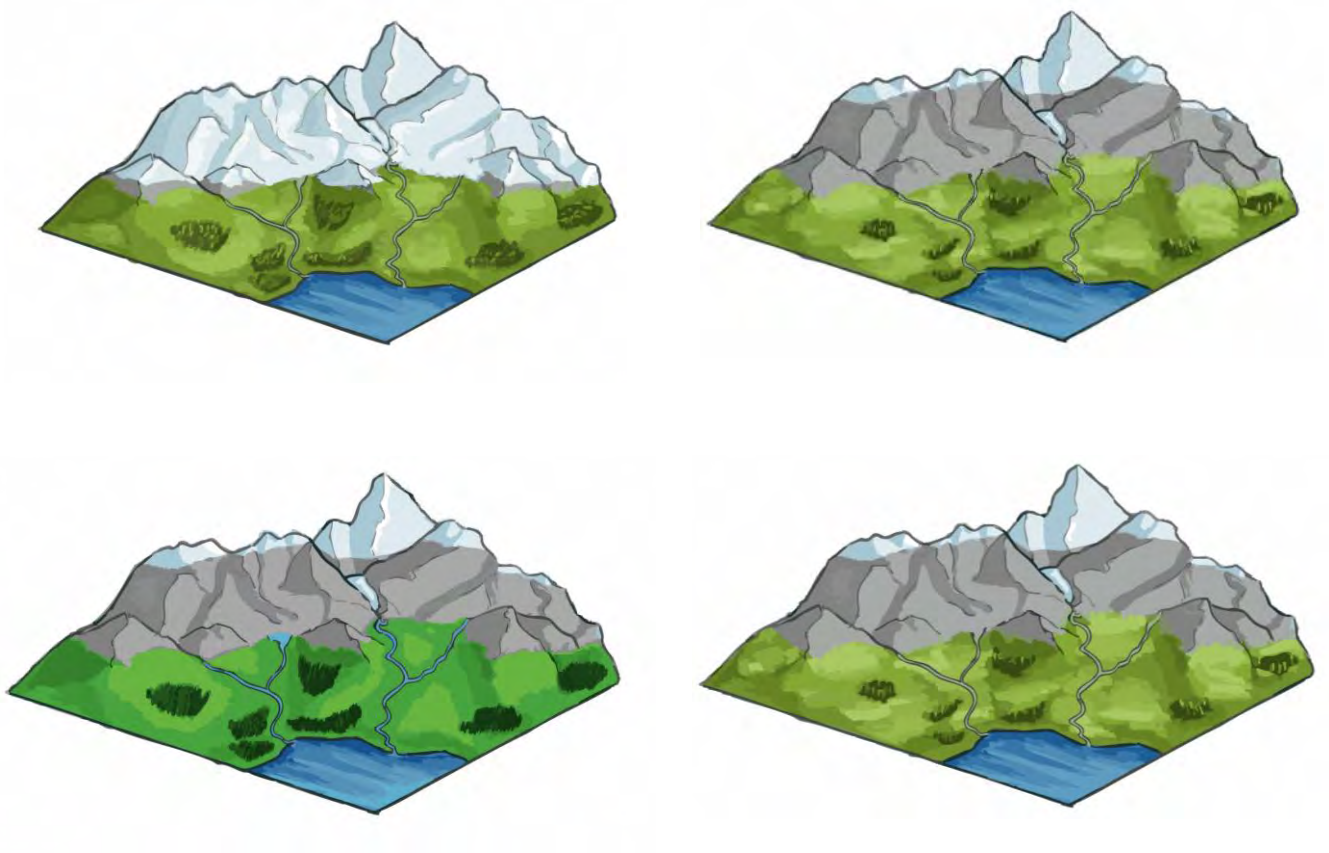

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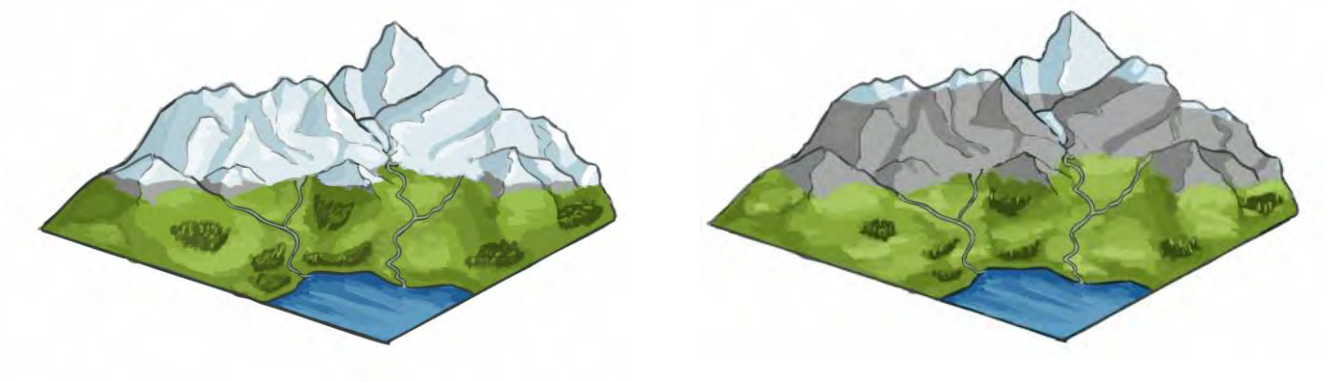

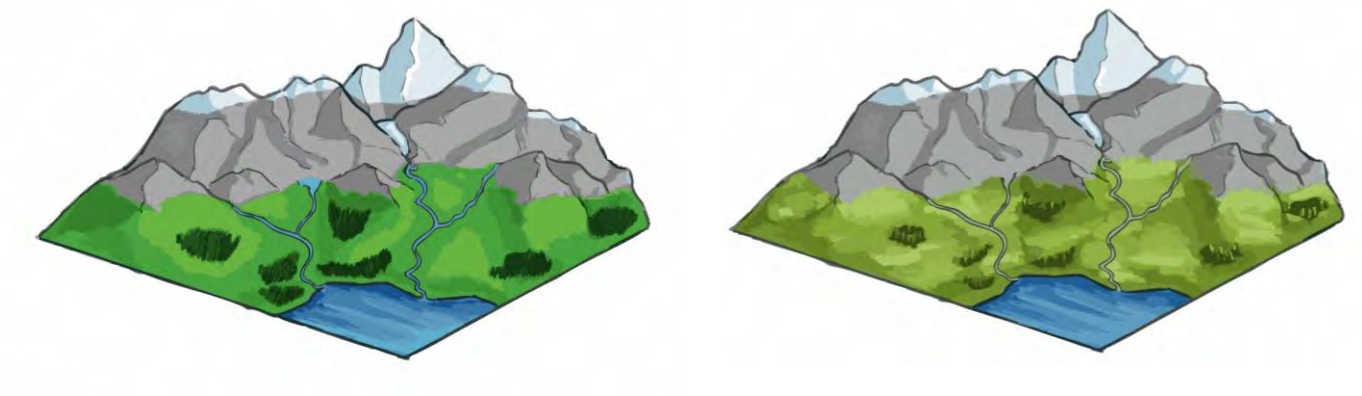

Dynamic

Normal **Drought**

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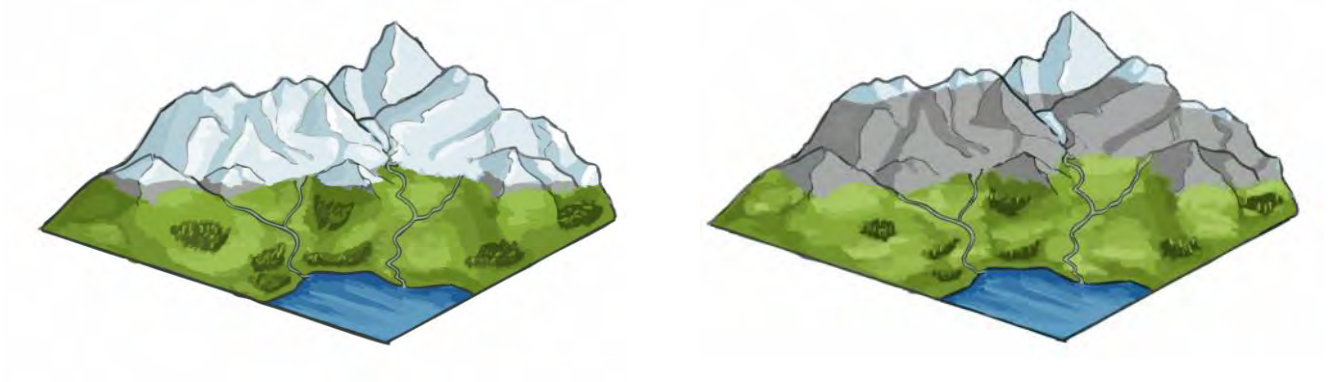
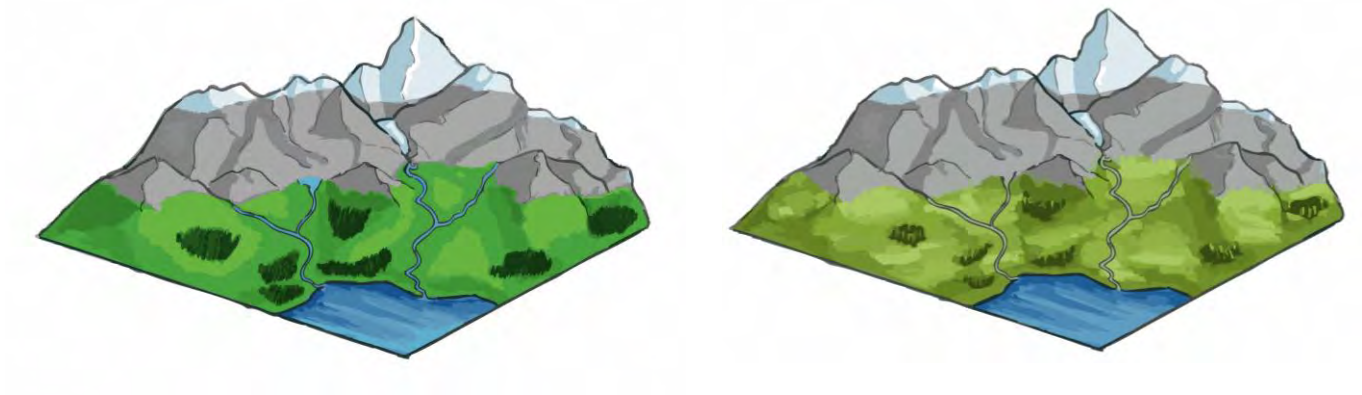




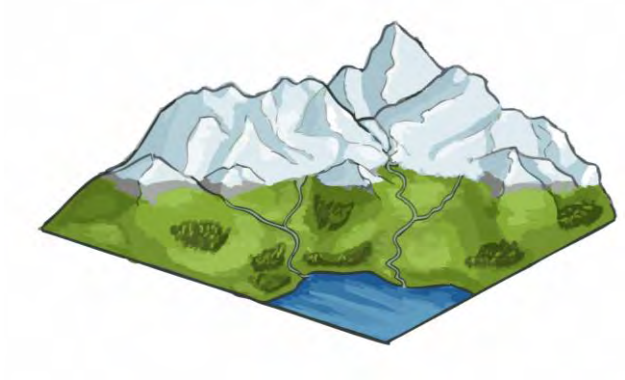
Dynamic

Local

Normal **Drought**

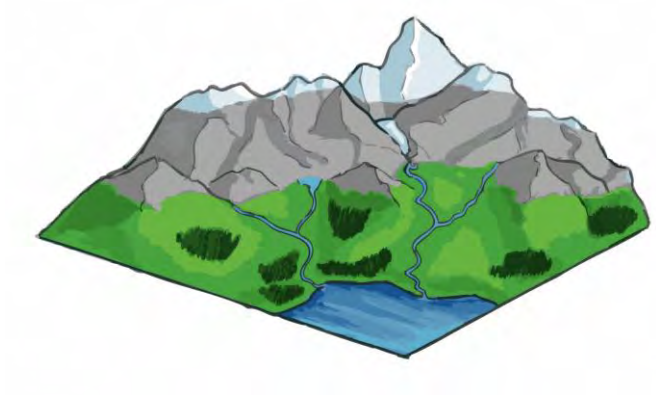
Identification of snow & hydrological droughts













Normal

Drought

Dynamic

Local

Based on co-occurrence

18% of snow droughts propagated to hydrological droughts

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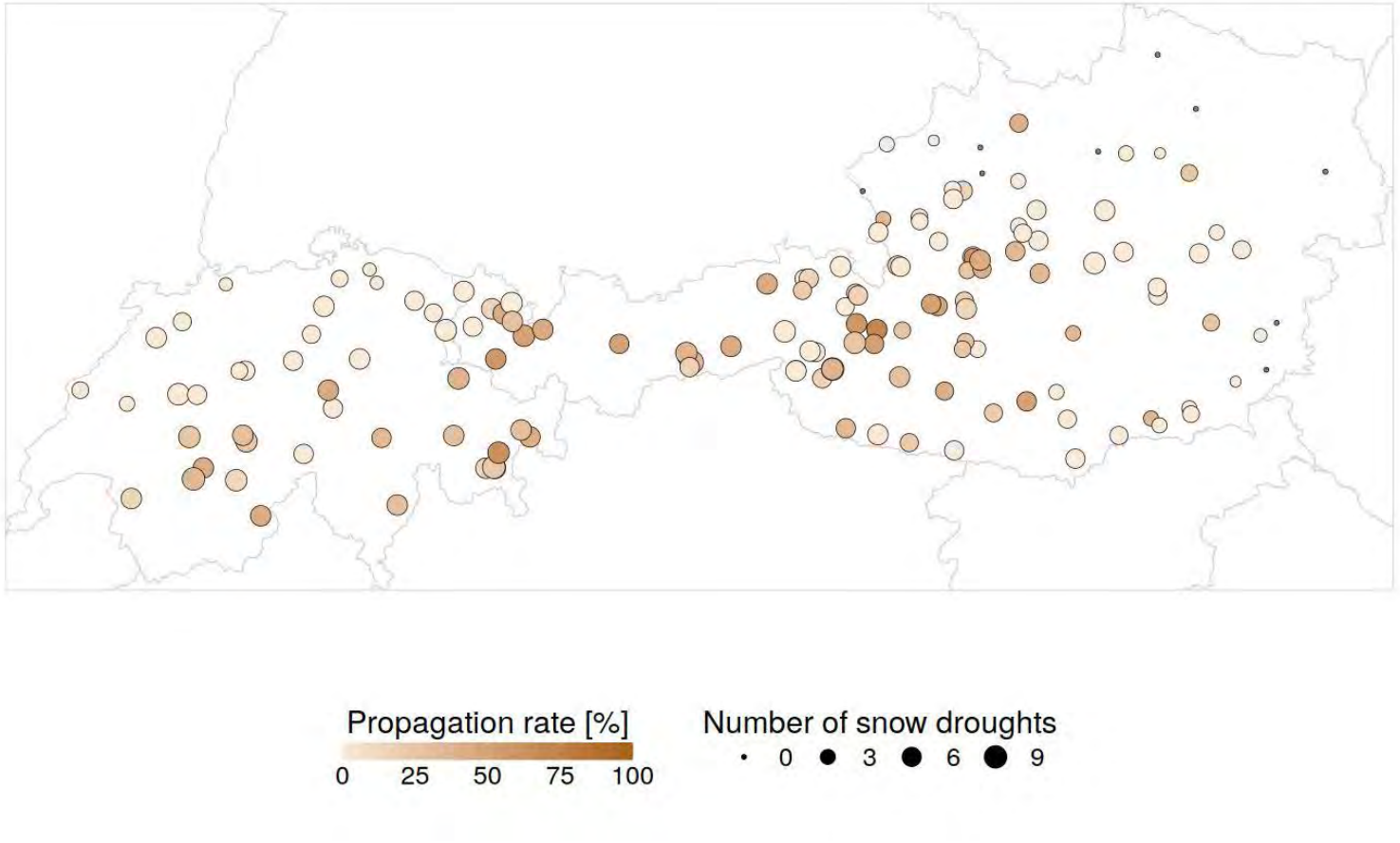

Chartier-Rescan et al., 2025

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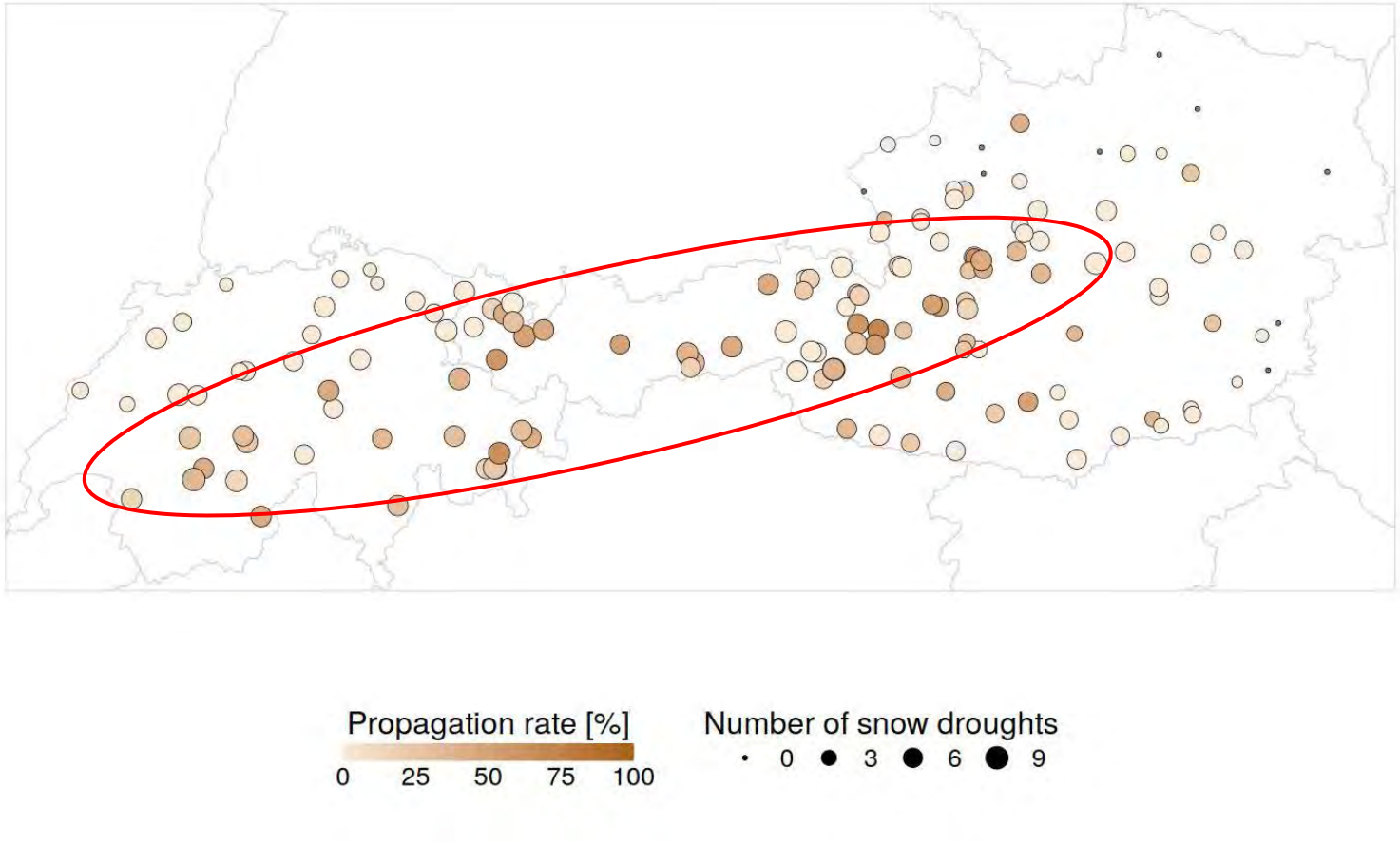

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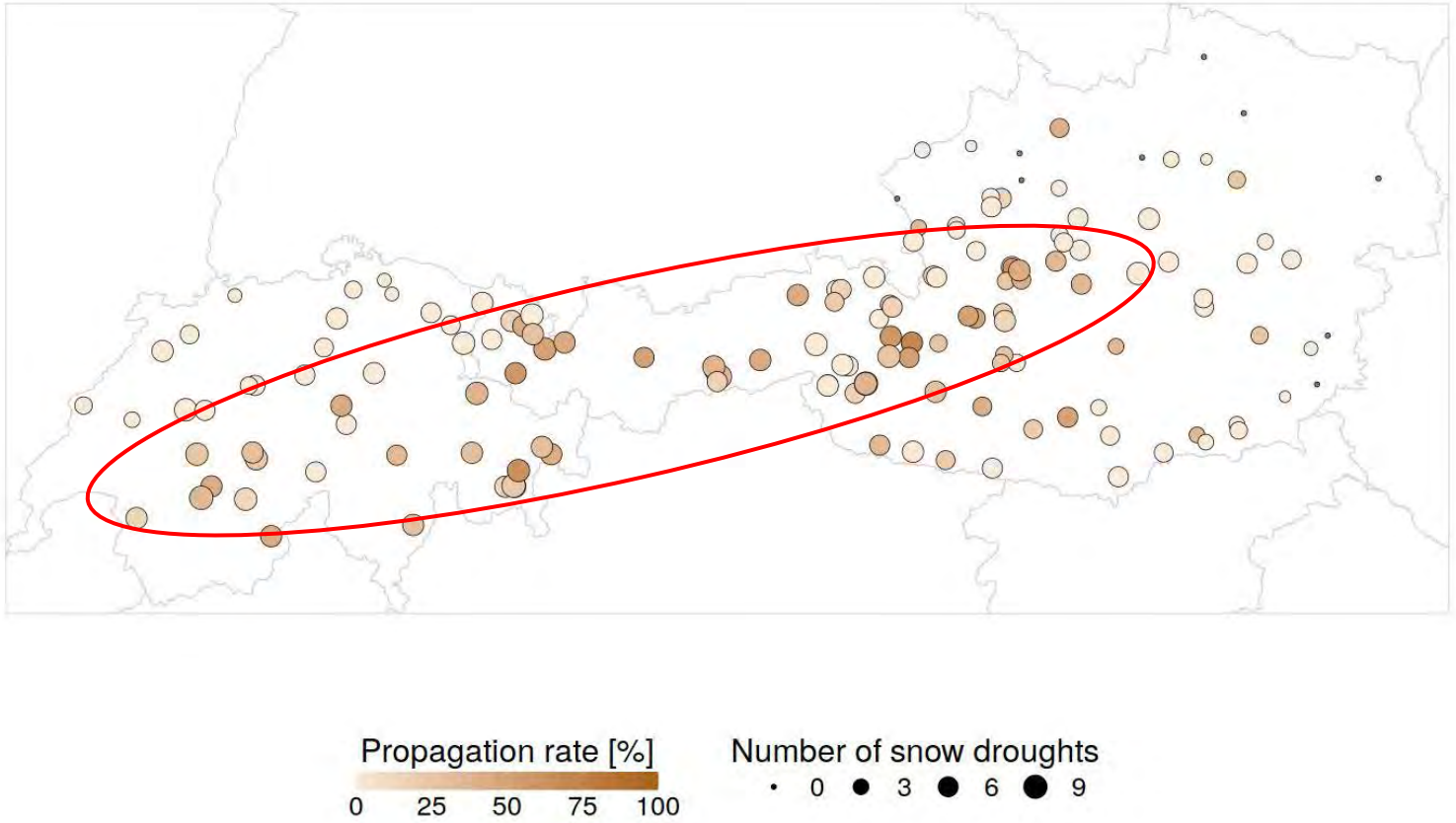

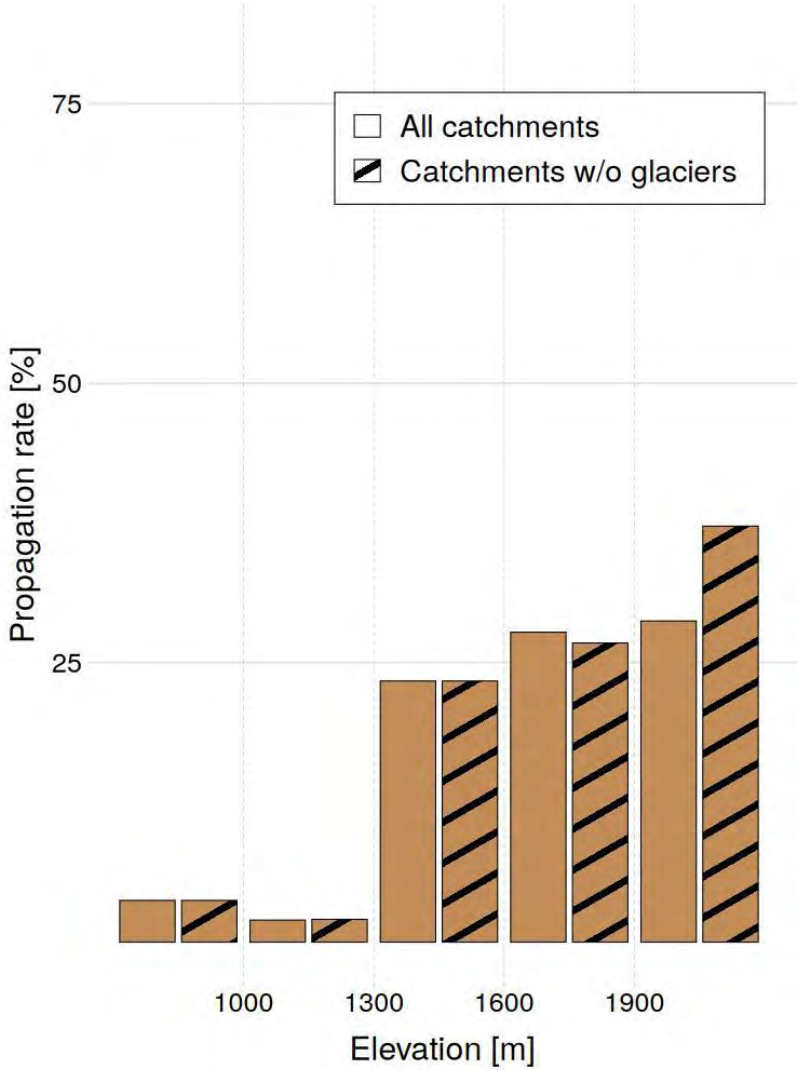

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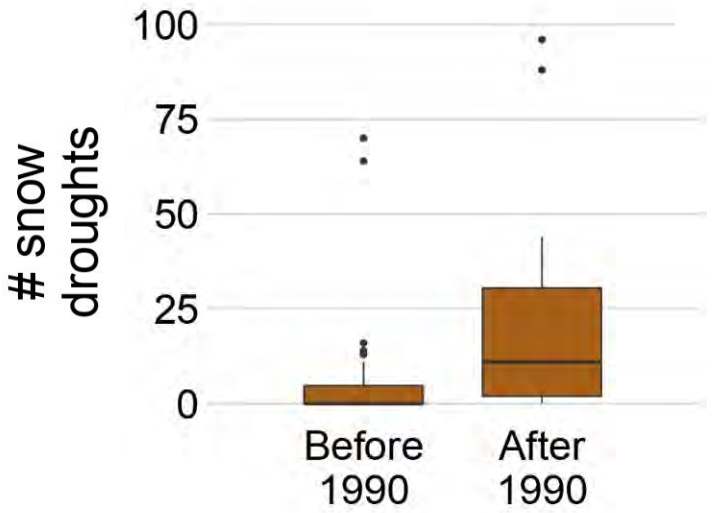
More streamflow droughts are generated by snow droughts



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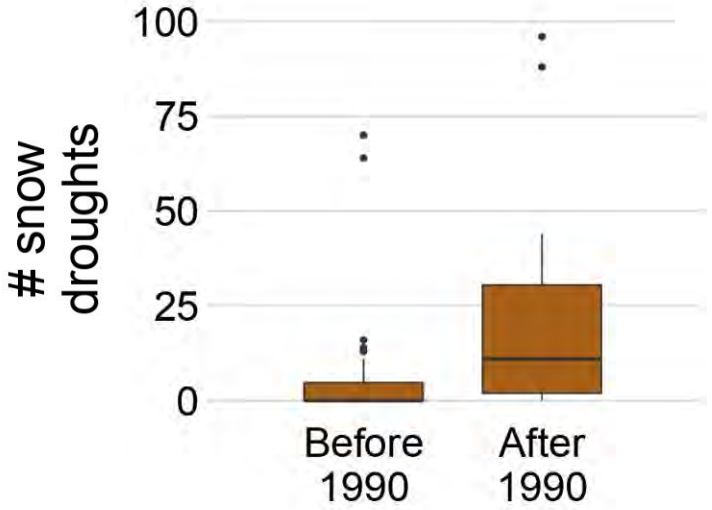

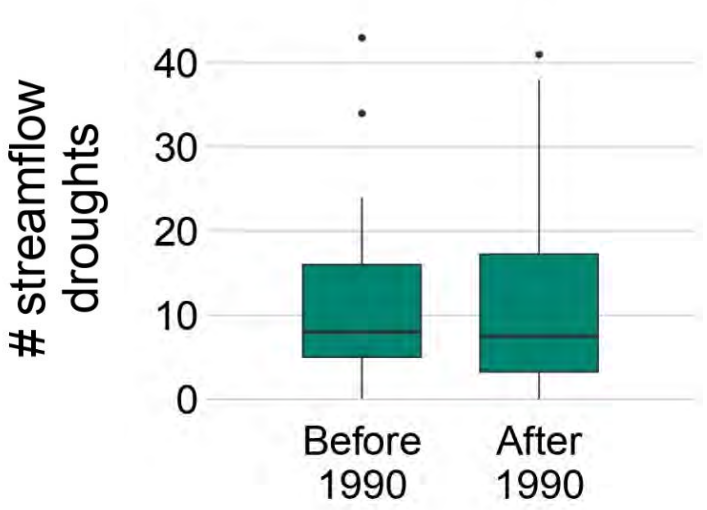

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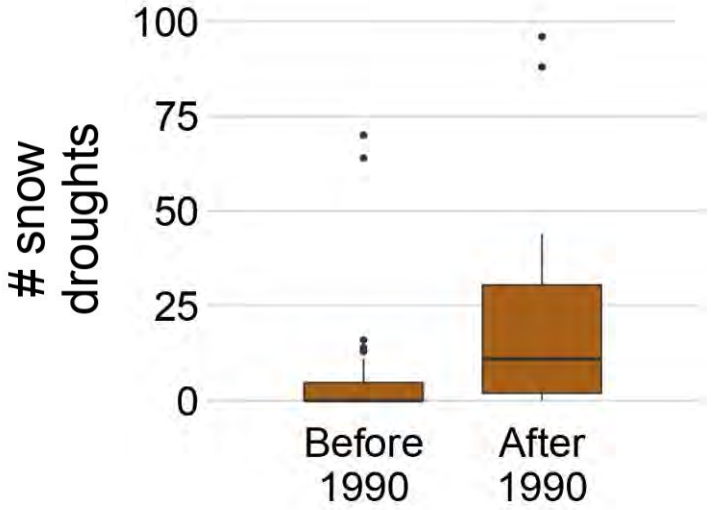

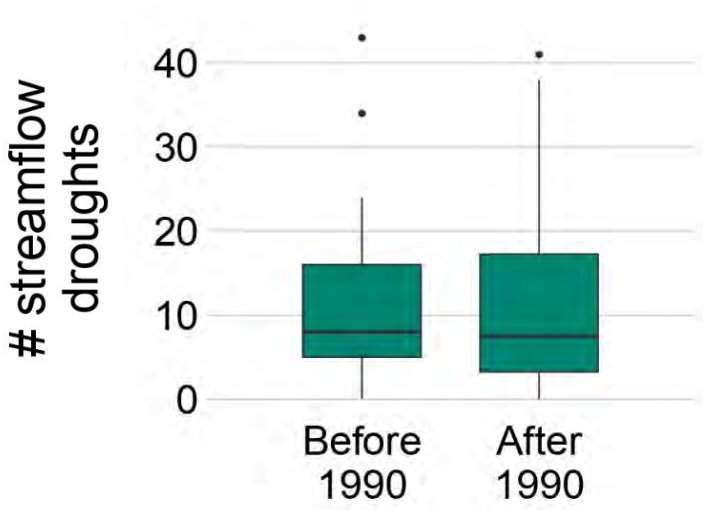

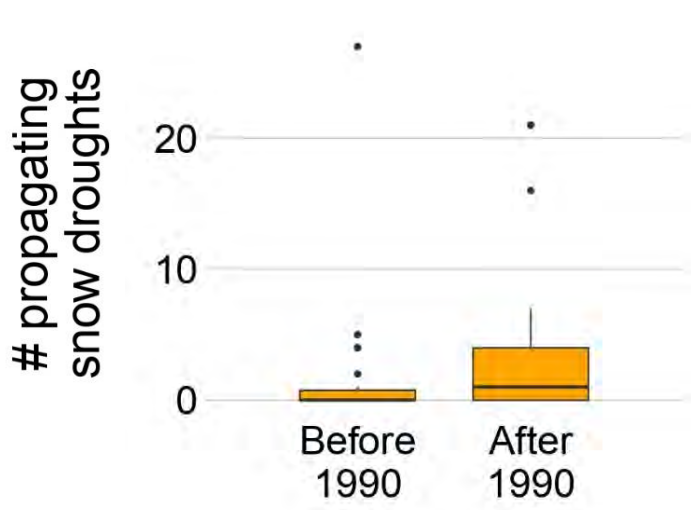

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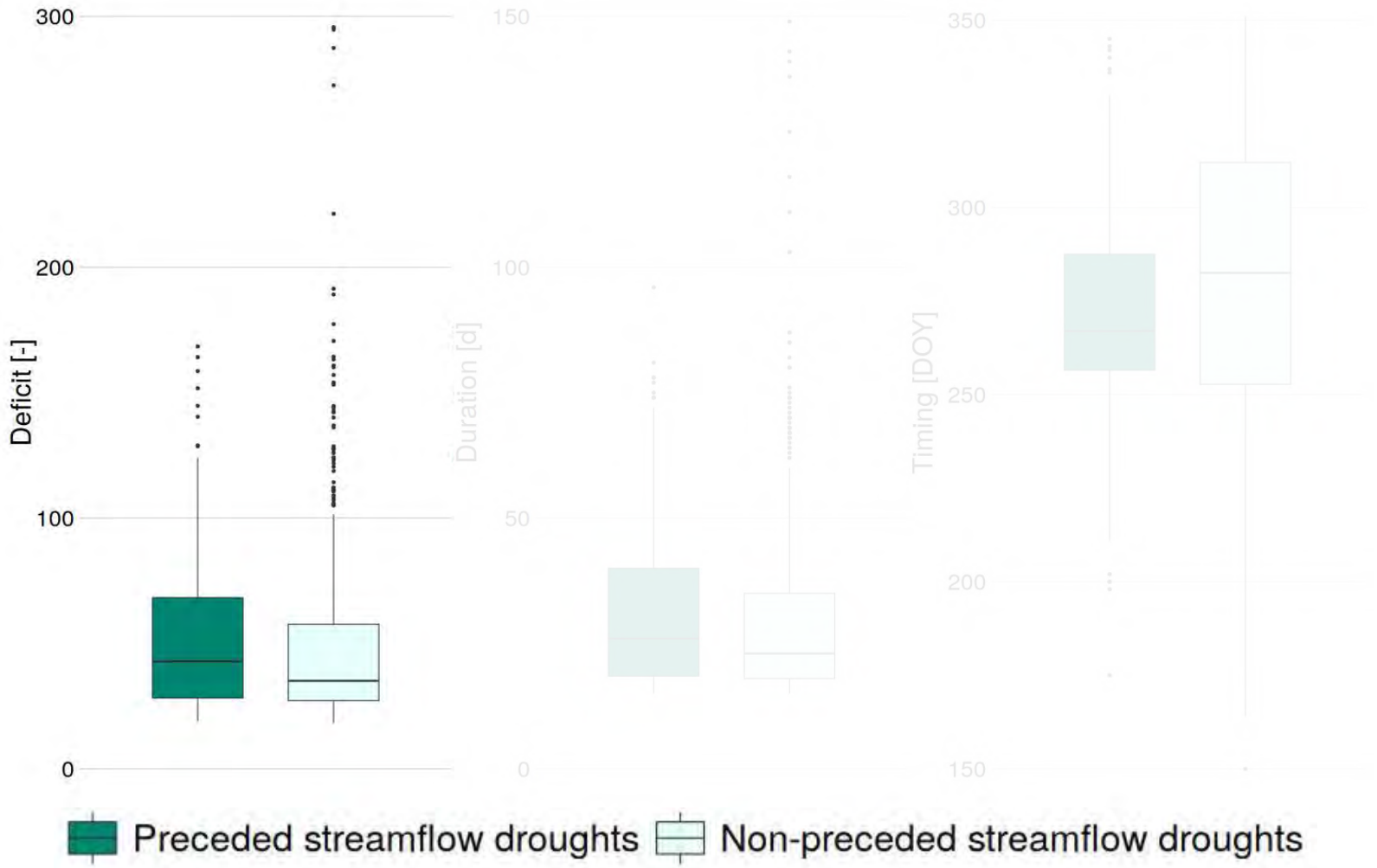

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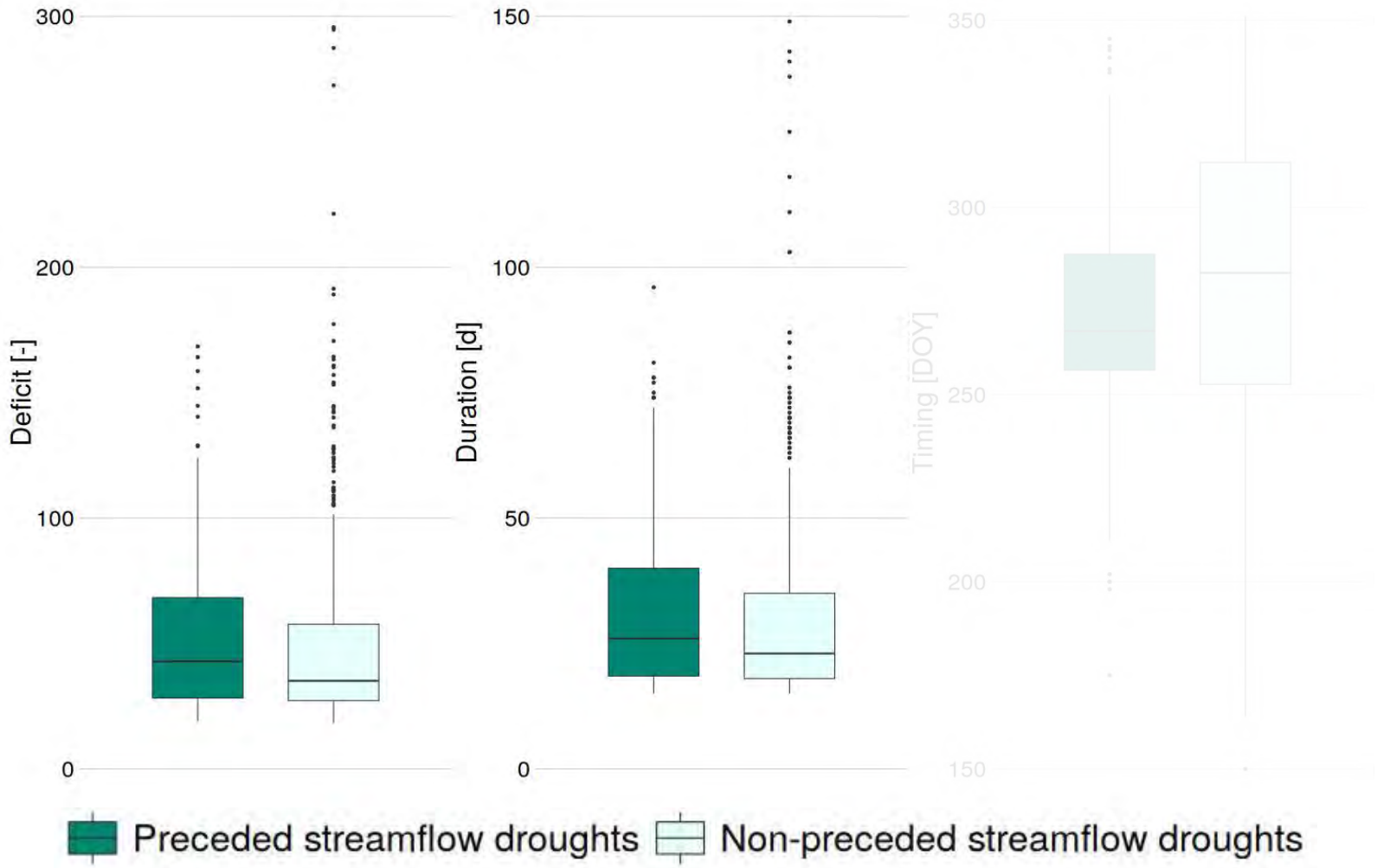

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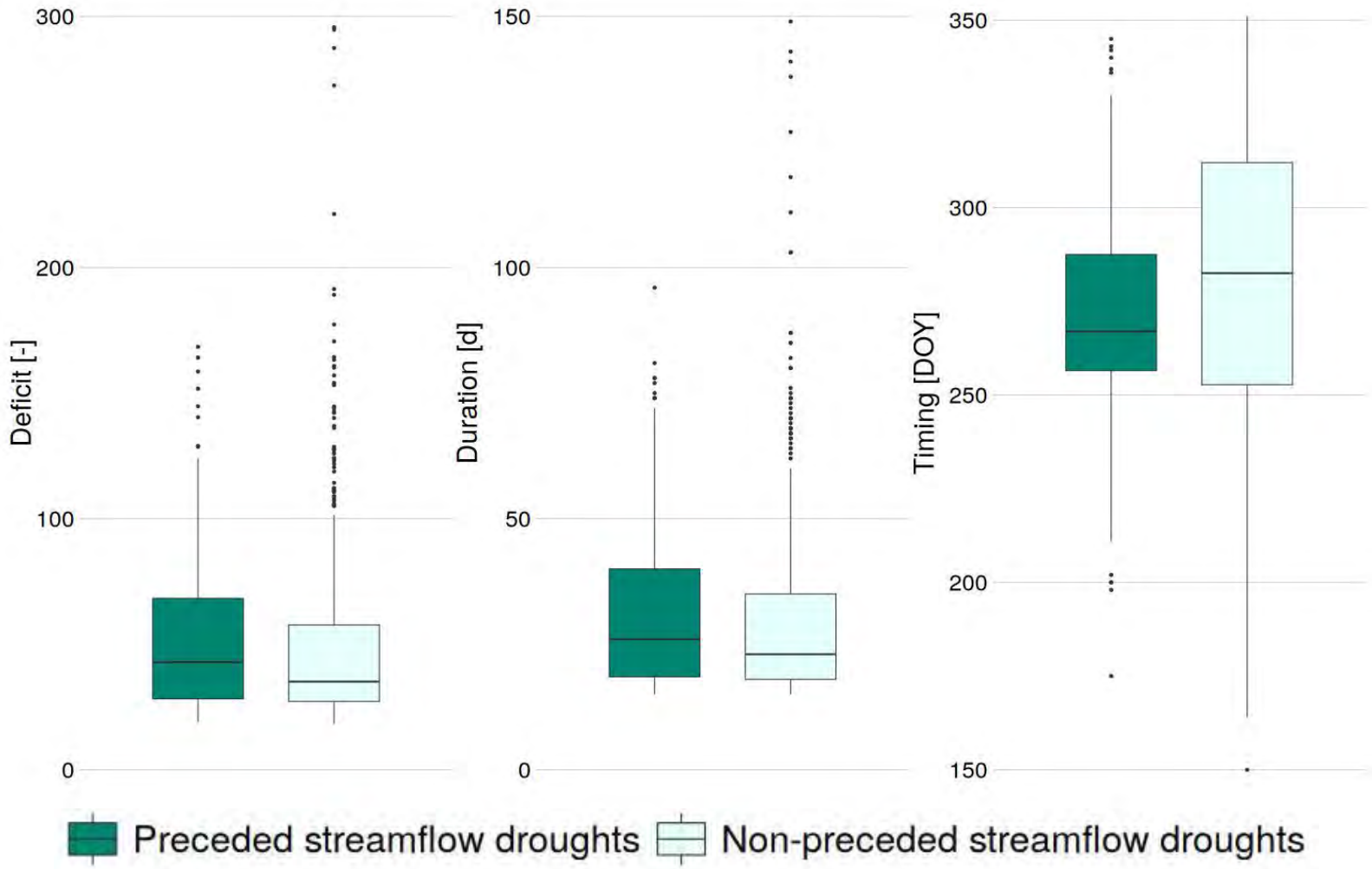

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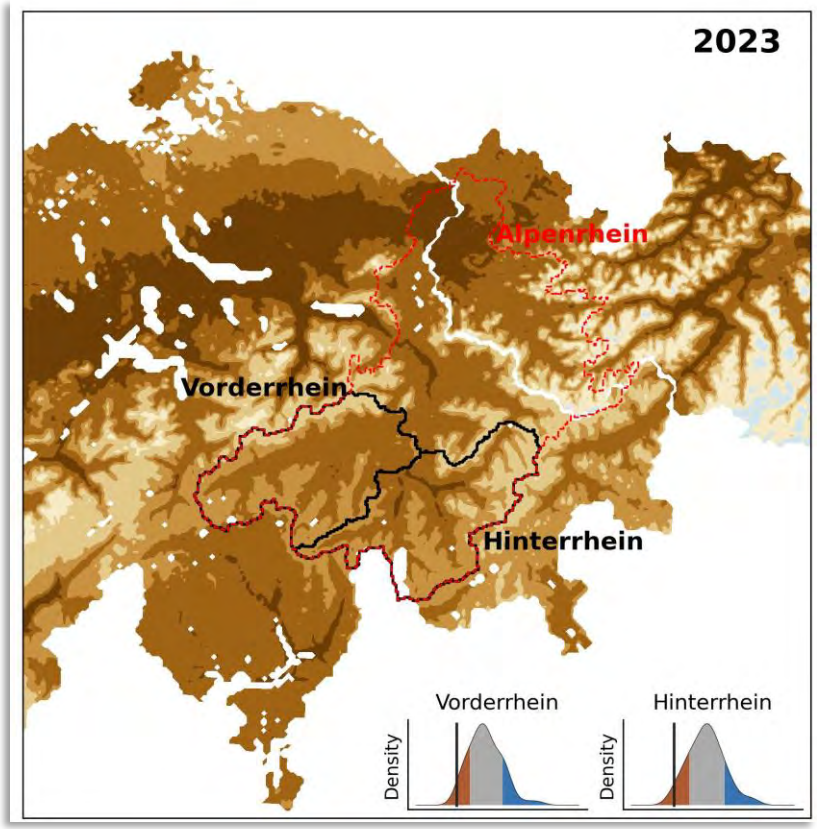

Wood et al, under review

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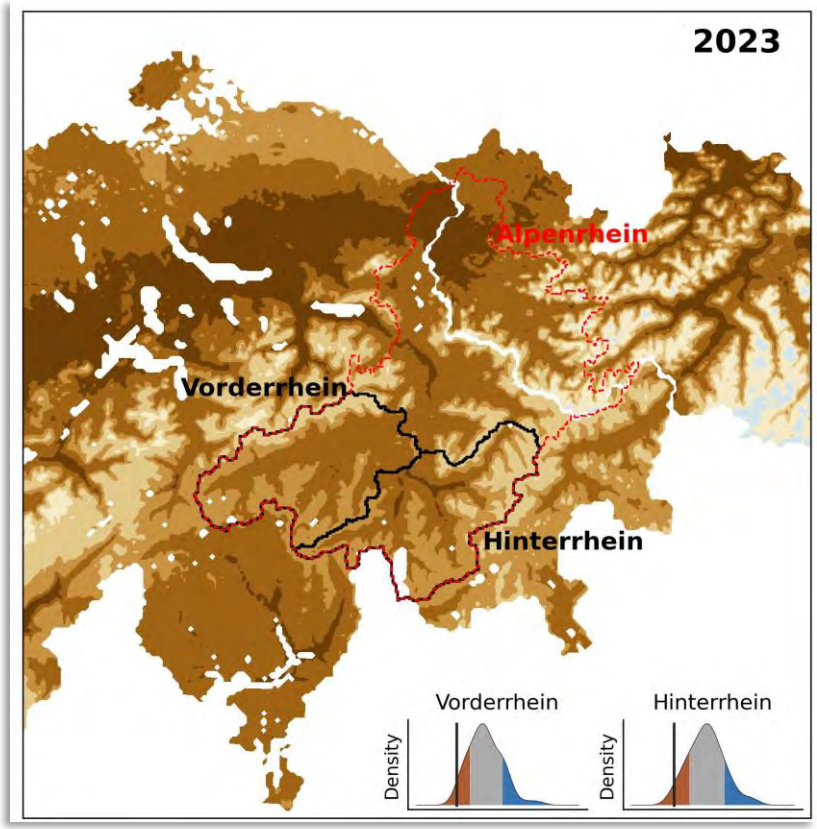

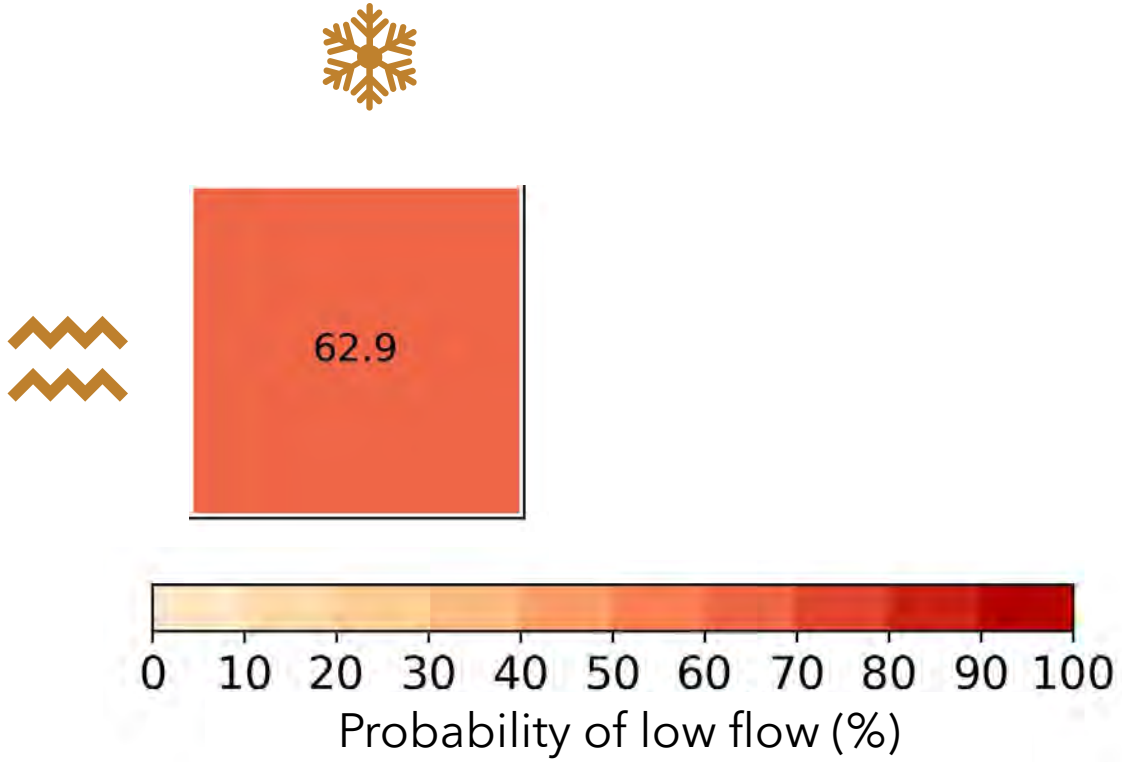

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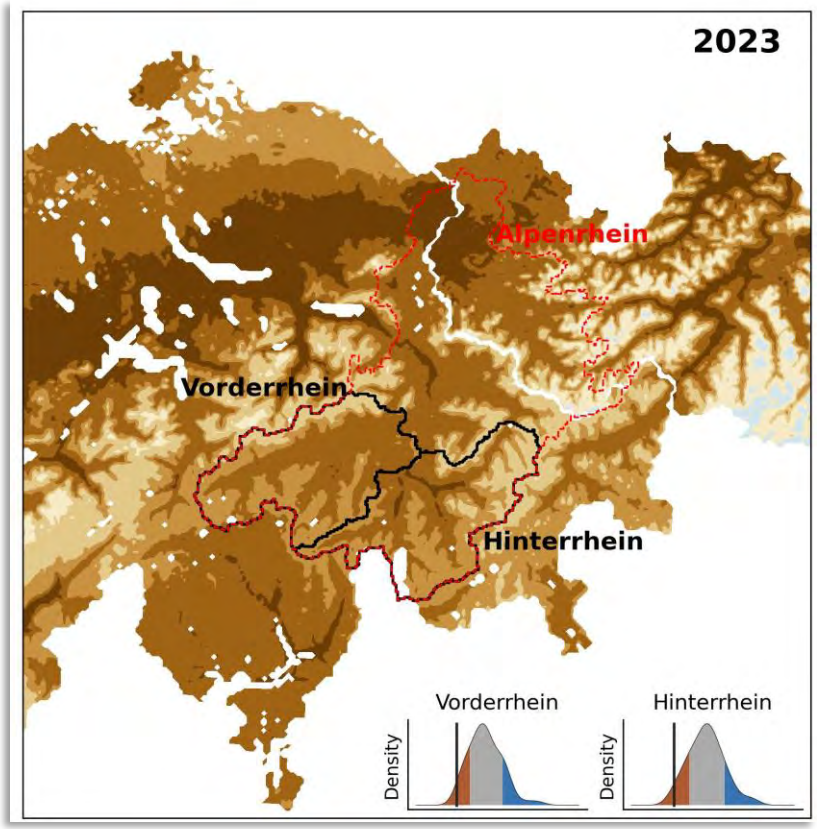
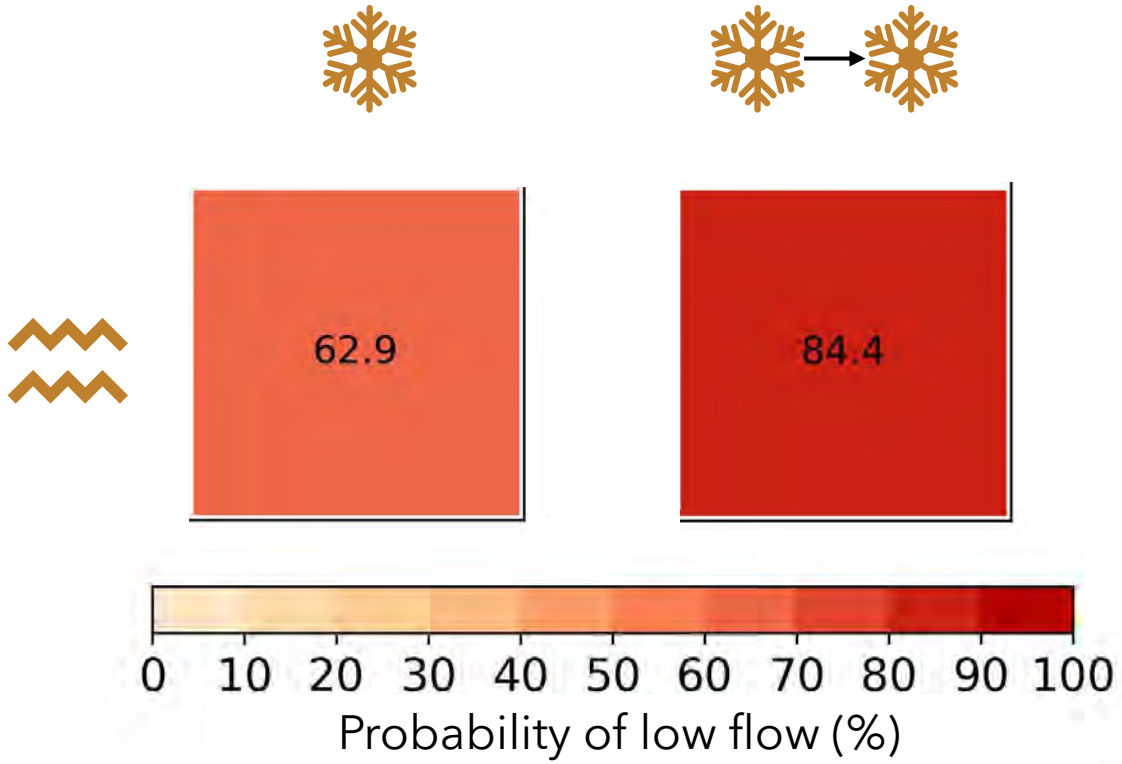




Wood et al, under review

Consequences of snow droughts on hydrological droughts



Snow droughts reduce downstream discharge in spring/summer



Consequences of snow droughts on hydrological droughts





- Snow droughts reduce downstream discharge in spring/summer
- Higher impacts in non-glacierized headwater catchments

Consequences of snow droughts on hydrological droughts



- Snow droughts reduce downstream discharge in spring/summer
- Higher impacts in non-glacierized headwater catchments
- Streamflow droughts following snow droughts are more severe



Consequences of snow droughts on river temperature





Snow as a cooling factor for the river

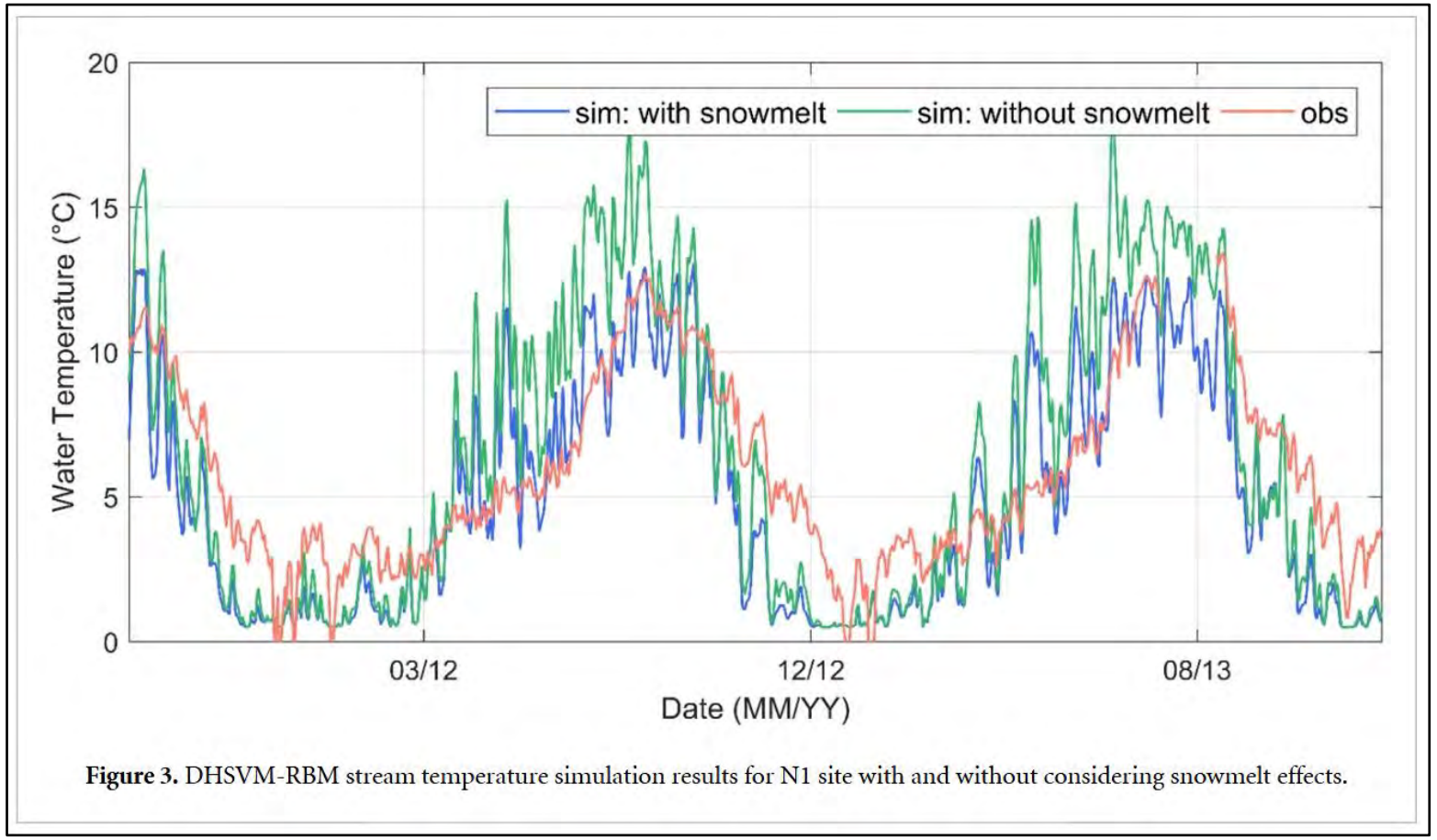
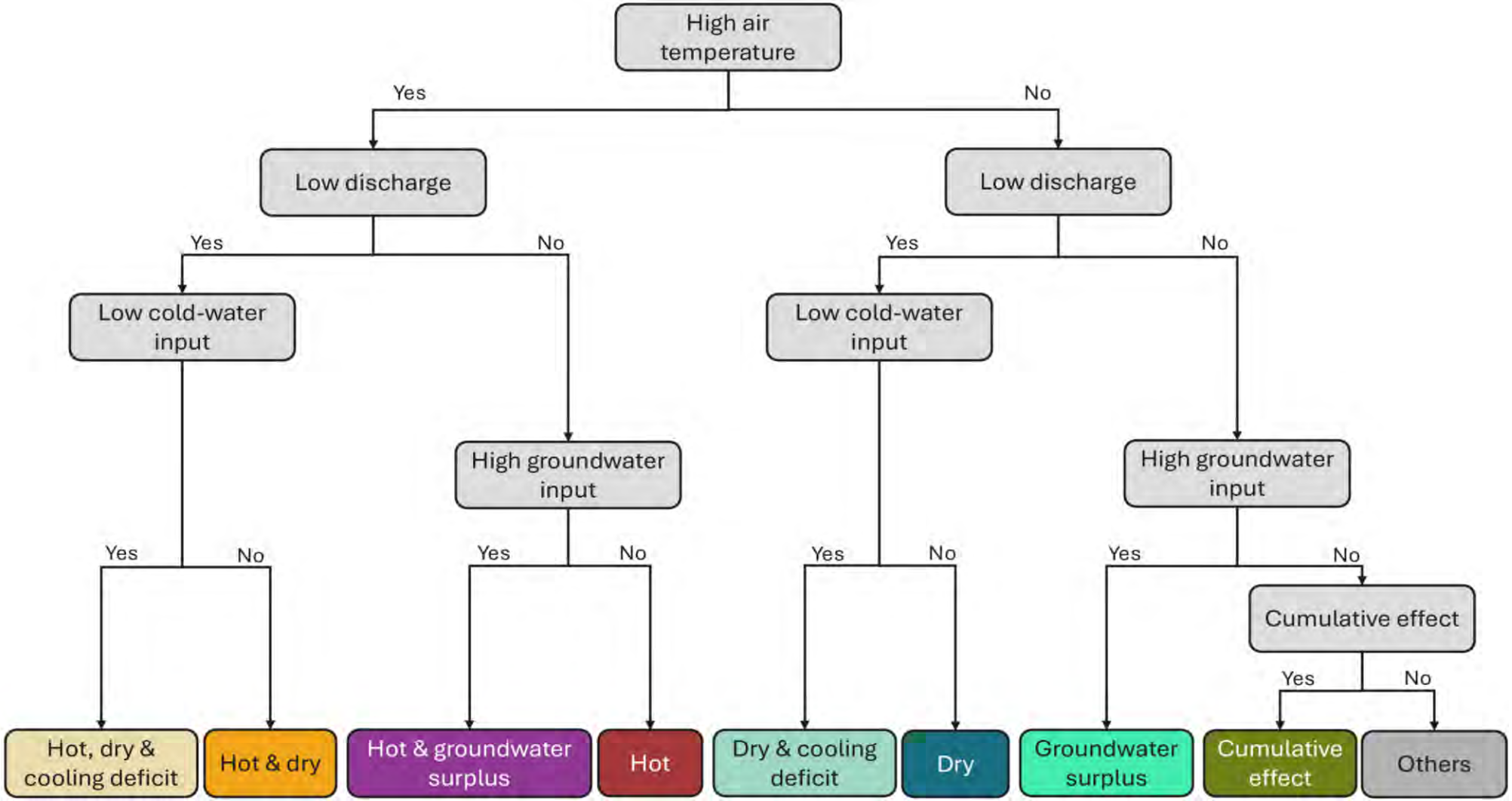


Figure 3. DHSVM-RBM stream temperature simulation results for N1 site with and without considering snowmelt effects.

Yan et al., 2021

A typology to test snow influence on riverine heatwaves



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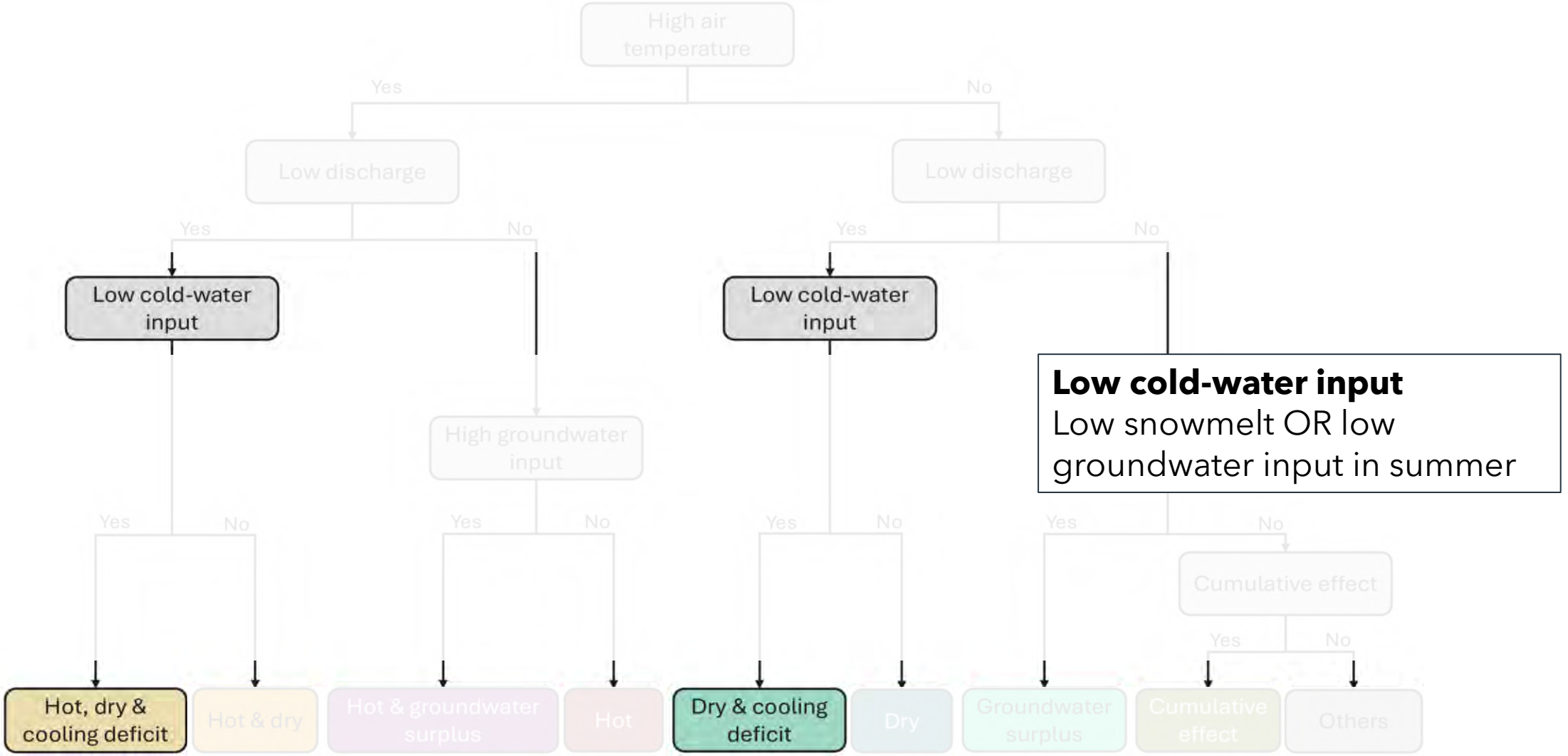
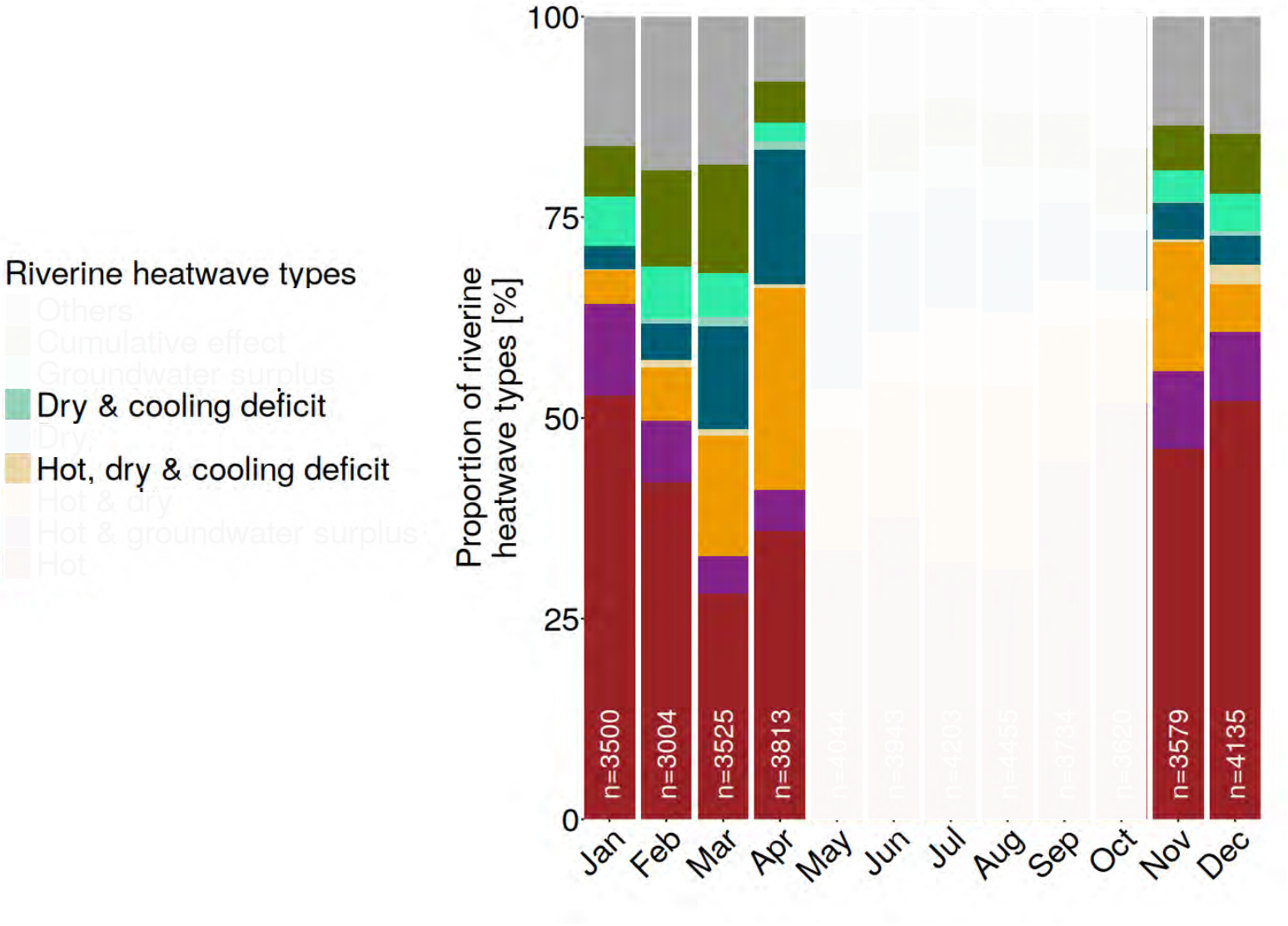


Low cold-water input
Low snowmelt OR low groundwater input in summer

Chartier-Rescan et al., under review

Snow is not among the key factors for riverine heatwaves…



Chartier-Rescan et al., under review

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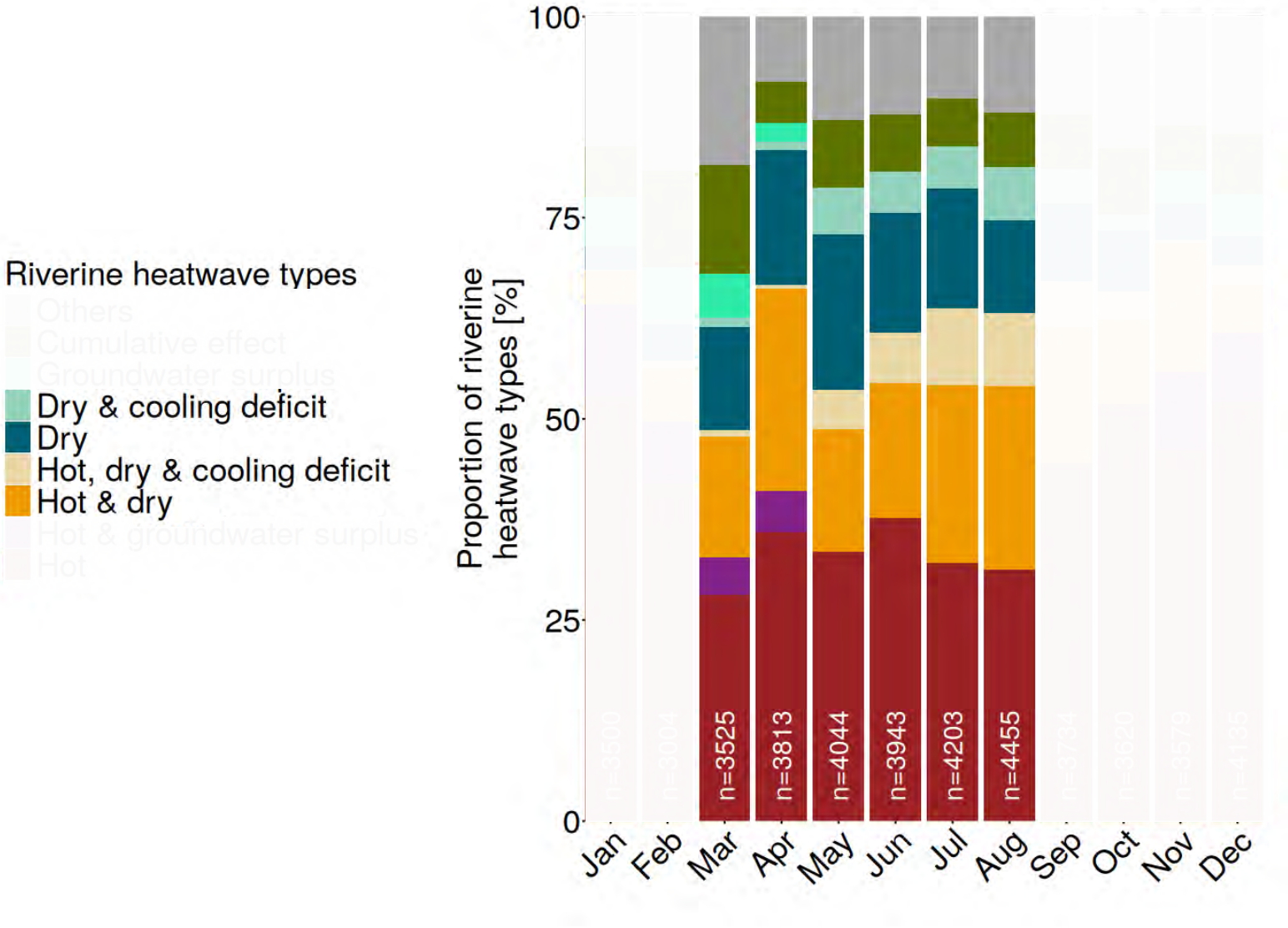

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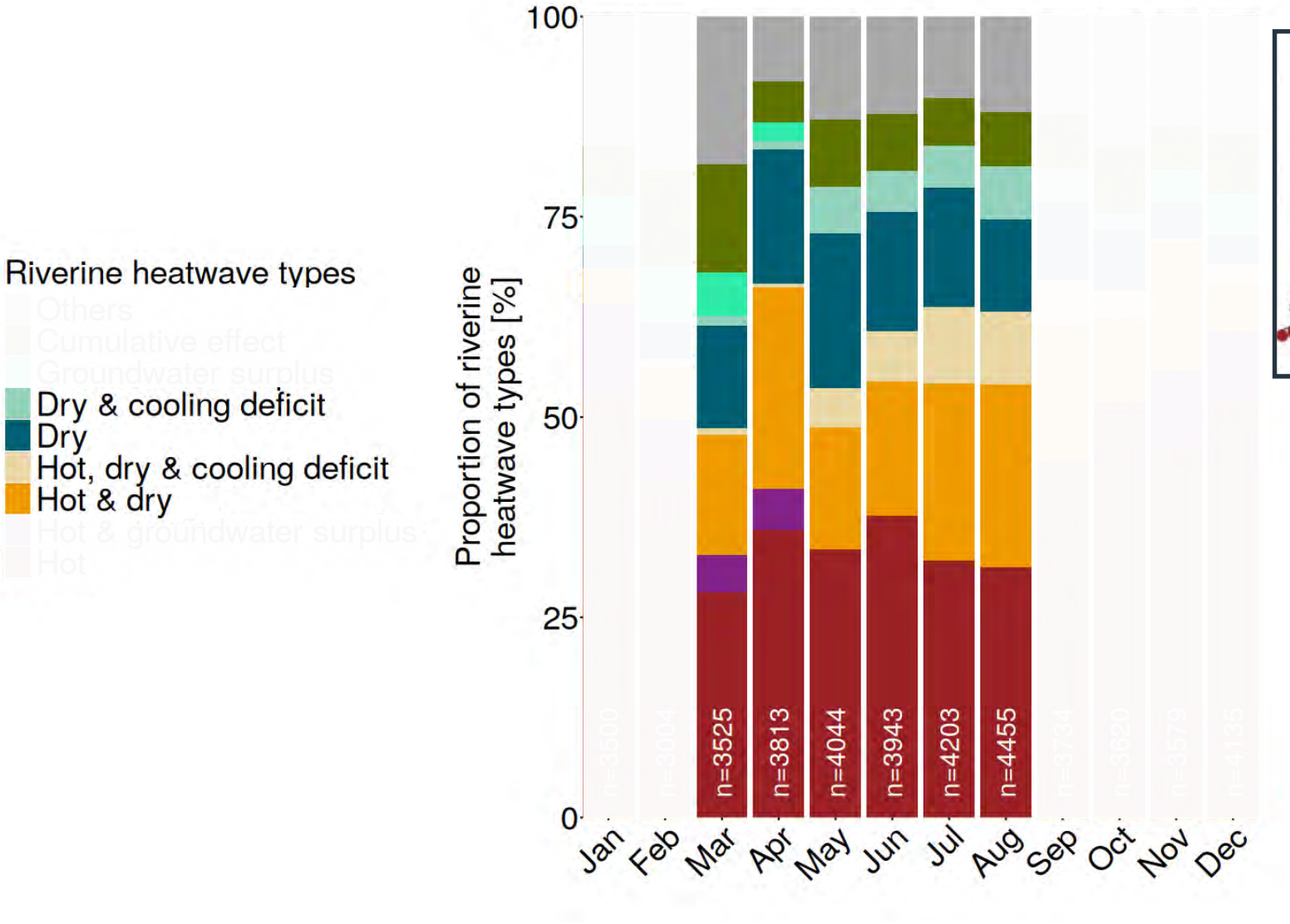
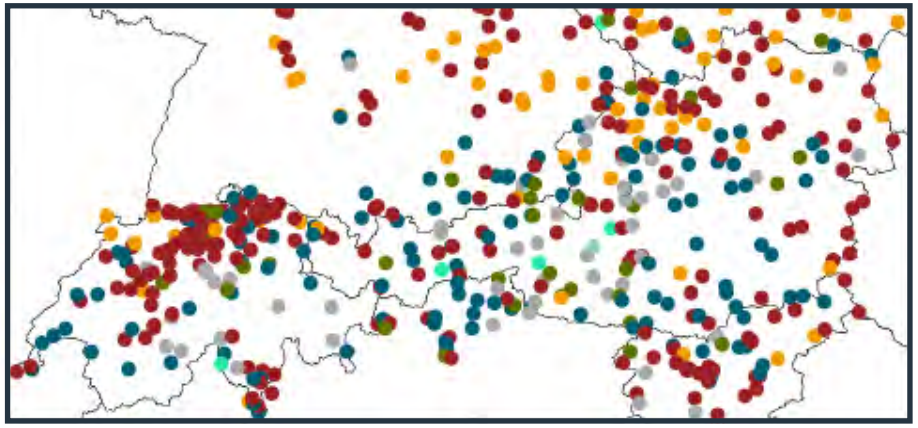
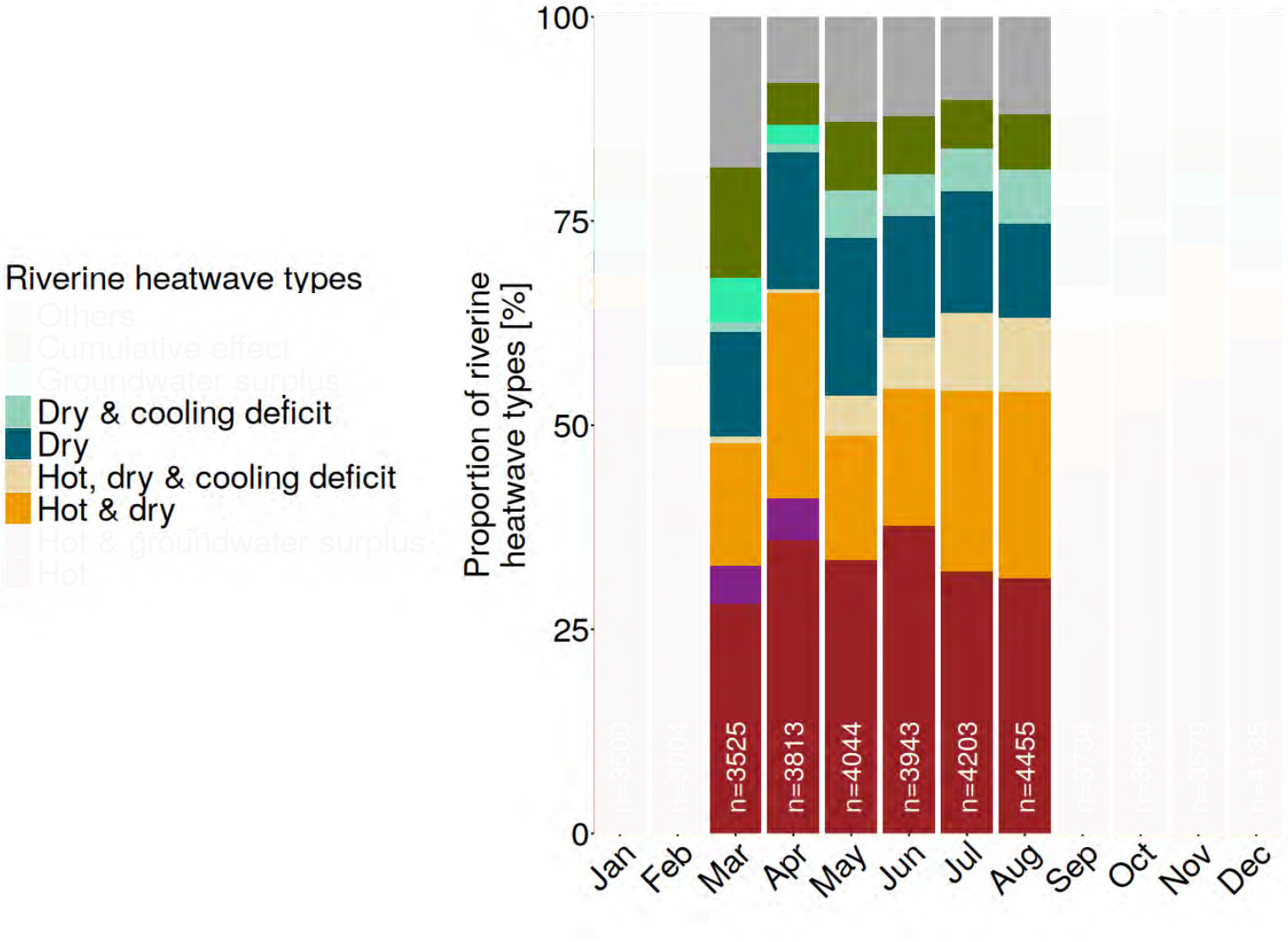


Spring (MAM)

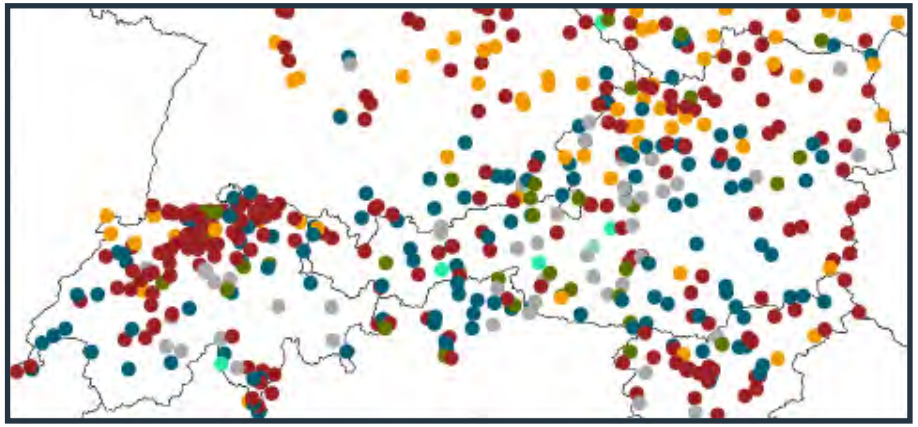


Chartier-Rescan et al., under review

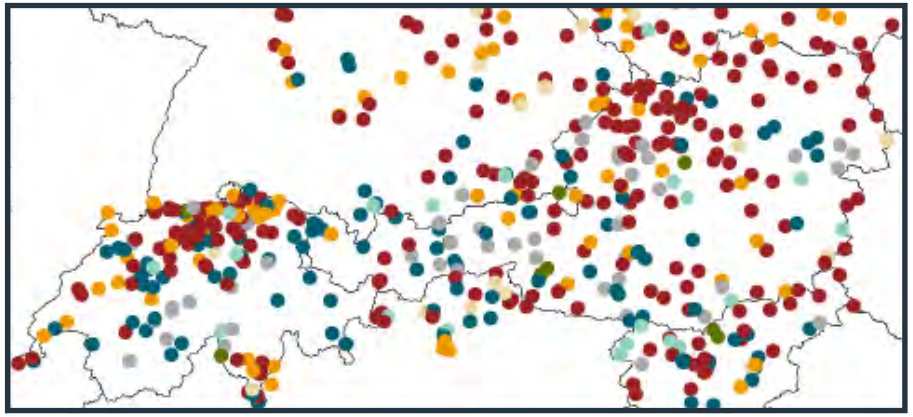
… but matters as a precursor of low flow conditions



Spring (MAM)



Summer (JJA)



Chartier-Rescan et al., under review

Consequences of snow droughts on river temperature



Snow doesn’t directly impact the onset of riverine heatwaves



Consequences of snow droughts on river temperature



- Snow doesn’t directly impact the onset of riverine heatwaves
- But it influences low flows, and in turn riverine heatwaves



Consequences of snow droughts on river temperature



- Snow doesn’t directly impact the onset of riverine heatwaves
- But it influences low flows, and in turn riverine heatwaves





Take-home messages

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Take-home messages



Snow droughts decrease availability of water in spring/summer

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Take-home messages

- Snow droughts decrease availability of water in spring/summer
- Snow droughts impact water quality through discharge

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Take-home messages

- Snow droughts decrease availability of water in spring/summer
- Snow droughts impact water quality through discharge
- The severe consequences are expected to worsen in the future

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Take-home messages

- Snow droughts decrease availability of water in spring/summer
- Snow droughts impact water quality through discharge
- The severe consequences are expected to worsen in the future



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