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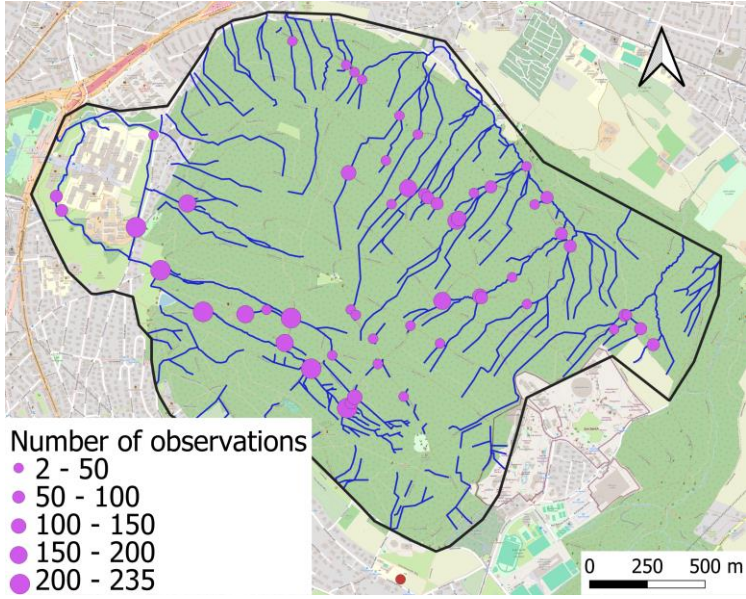
crowd water

PICO
A.3

Combining citizen science data and the hierarchical structuring of temporary streams to reconstruct the patterns of channel wetting and drying

Mirjam Scheller (mirjam.scheller@uzh.ch)
Nicola Durighetto, Ilja van Meerveld, Jan Seibert, Gianluca Botter



Zuriberg, Zurich, Switzerland

Citizen science data	Hierarchical model	Correlation with precipitation	Daily flow states during summer
Days: 402	Days: 402		Days: 791
Observations: 4,360	Observations: 14,695		Observations: 35,569

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Combining citizen science data and the hierarchical structuring of temporary streams to reconstruct the patterns of channel wetting and drying

Mirjam Scheller[1], Nicola Durighetto[2], Ilja van Meerveld[1], Jan Seibert[1], Gianluca Botter[2]

[1] University of Zurich, Department of Geography, Zurich, Switzerland
[2] University of Padua, Department of Civil, Environmental and Architectural Engineering, Padova, Italy

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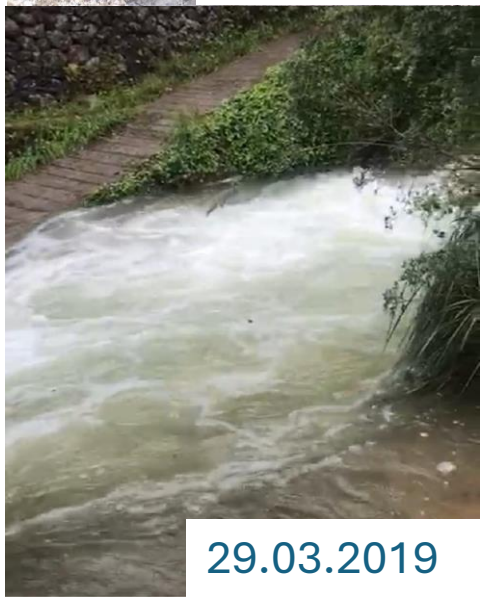
Contact
mirjam.scheller@uzh.ch

Motivation to study temporary streams

- More than half of the global stream network is intermittent (Messager et al. 2021)
- Stream network expansion and contraction affects:
  - Habitats for aquatic species (Steward et al. 2022)
  - Discharge dynamics (Godsey and Kirchner 2014)
  - Travel times (van Meerveld et al. 2019)
  - Population dynamics (Sánchez-Montoya et al. 2016)
  - Sediment and nutrient transport (Fortesa et al. 2021)
- Temporary streams are sensitive to climate change (Sauquet et al. 2021)
- BUT: Lack of data → Citizen Science

Mallorca: Josep Fortesa

21.04.2020



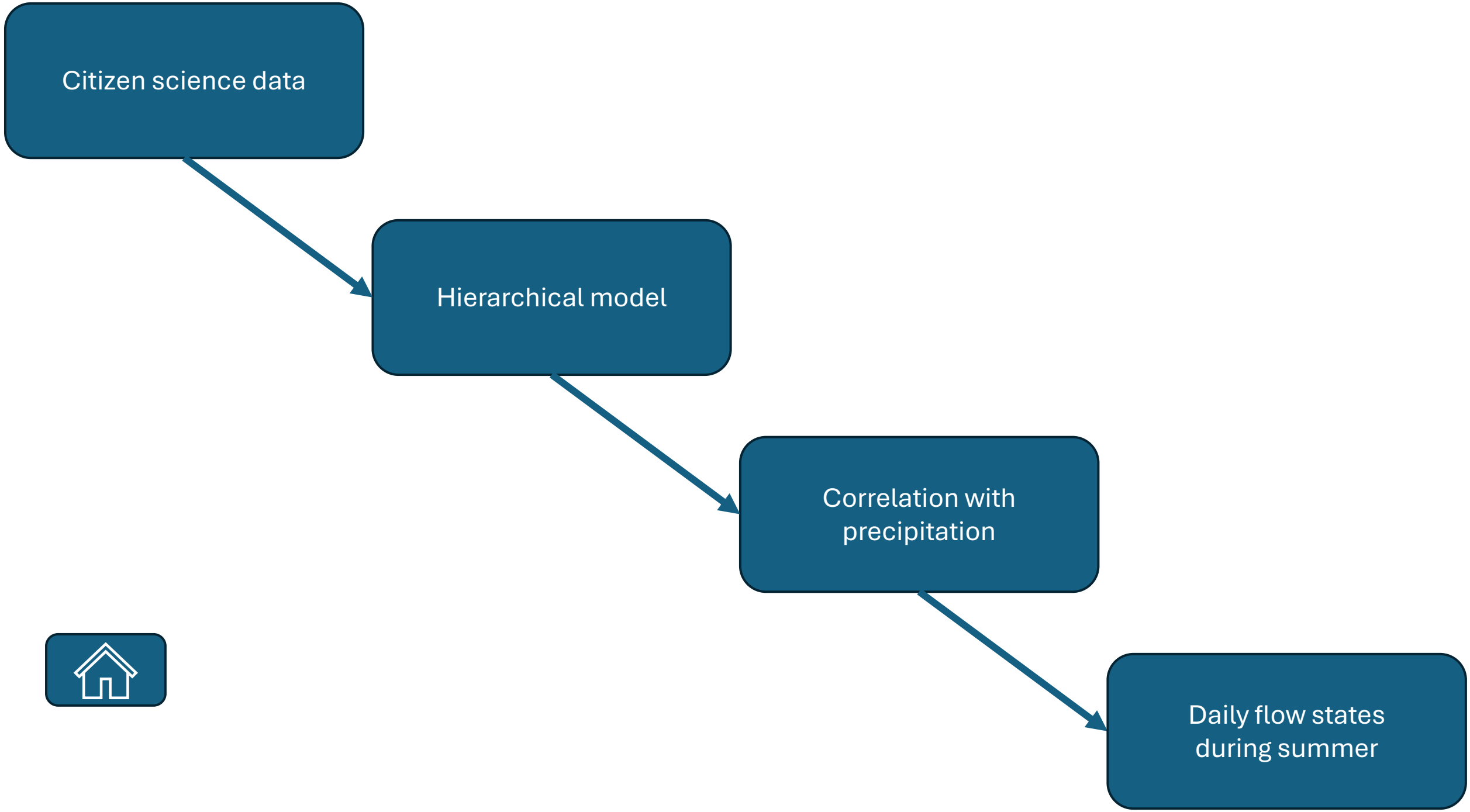
29.03.2019

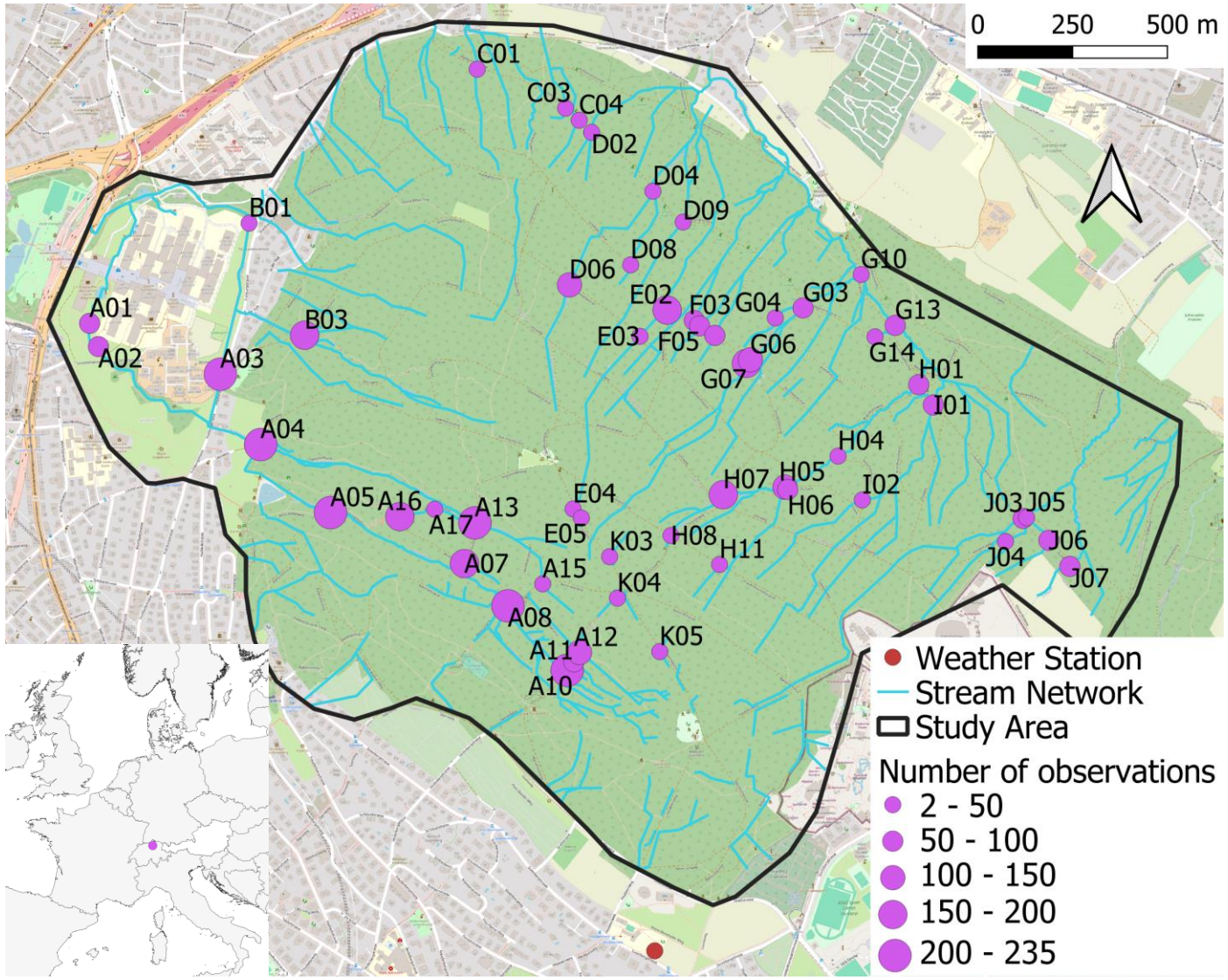
Research Question

Can we use citizen science data to derive the hierarchical structure of stream wetting and drying?

Can we afterwards improve the spatial and temporal resolution of citizen science data?

Shortcut to conclusions (click)

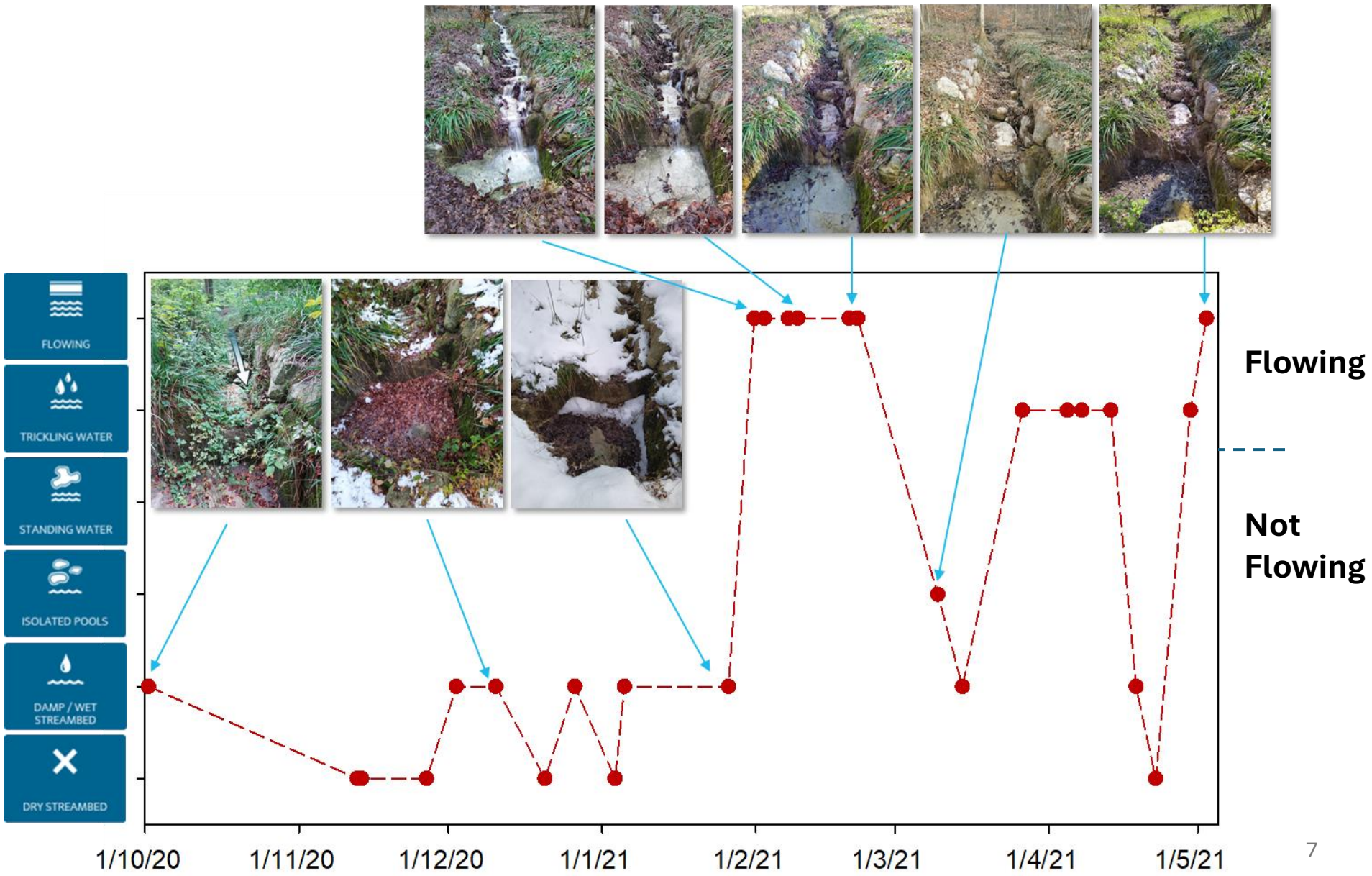

Citizen science data
Hierarchical model
Correlation with precipitation
Daily flow states during summer



Citizen Science observations of temporary streams in the CrowdWater app on Zuriberg, Zurich, Switzerland.

- Since September 2020
- Area of 4 km^2
- 55 sites
- 4,360 flow state observations during 402 days
  - 1- 36 observations per day (median: 10)
  - 2-235 Observations per site (median: 64)

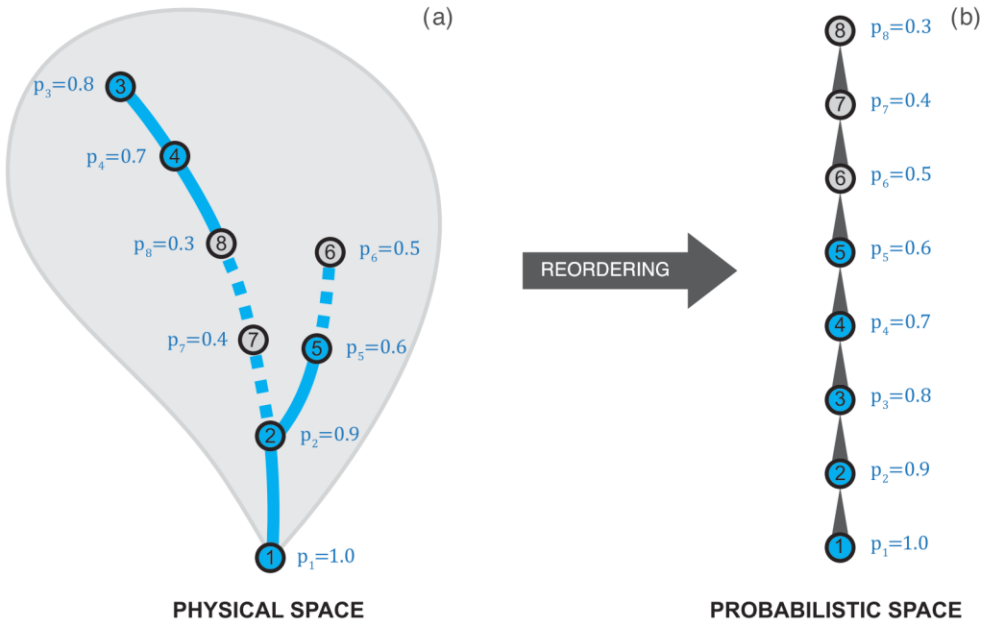
Exemplary time series



Hierarchical structuring of temporary streams

From physical to probabilistic space

→ Reordering by the probability for the stream segment to flow

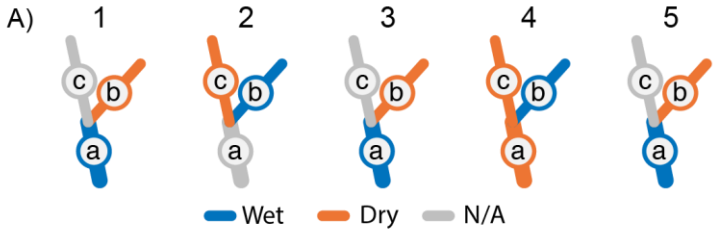


Botter & Durighetto (2020)

Goals:

- Get the hierarchical order without any uncertainties
- Being able to predict flow states

Details: Hierarchical Model



B) **Wet states matrix Xw**

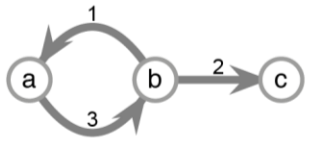
Node	Time 1	2	3	4	5
a	1	0	1	0	1
b	0	1	0	1	0
c	0	0	0	0	0

Dry states matrix Xd

Node	Time 1	2	3	4	5
a	0	0	0	1	0
b	1	0	1	0	1
c	0	1	0	1	0

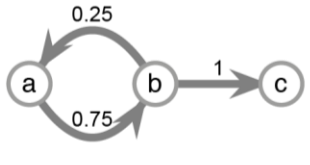
C) **Observation matrix O**

	a	b	c
a	0	3	0
b	1	0	2
c	0	0	0



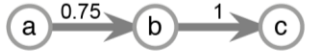
D) **Normalized observation matirx A**

	a	b	c
a	0	0.75	0
b	0.25	0	1
c	0	0	0



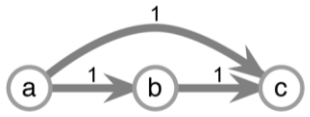
E) **Hierarchy matrix H**

	a	b	c
a	0	0.75	0
b	0	0	1
c	0	0	0



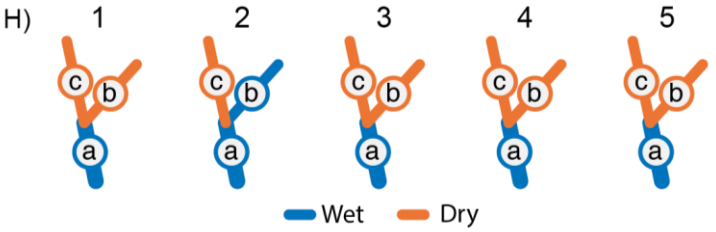
F) **Reachability matrix R**

	a	b	c
a	0	1	1
b	0	0	1
c	0	0	0



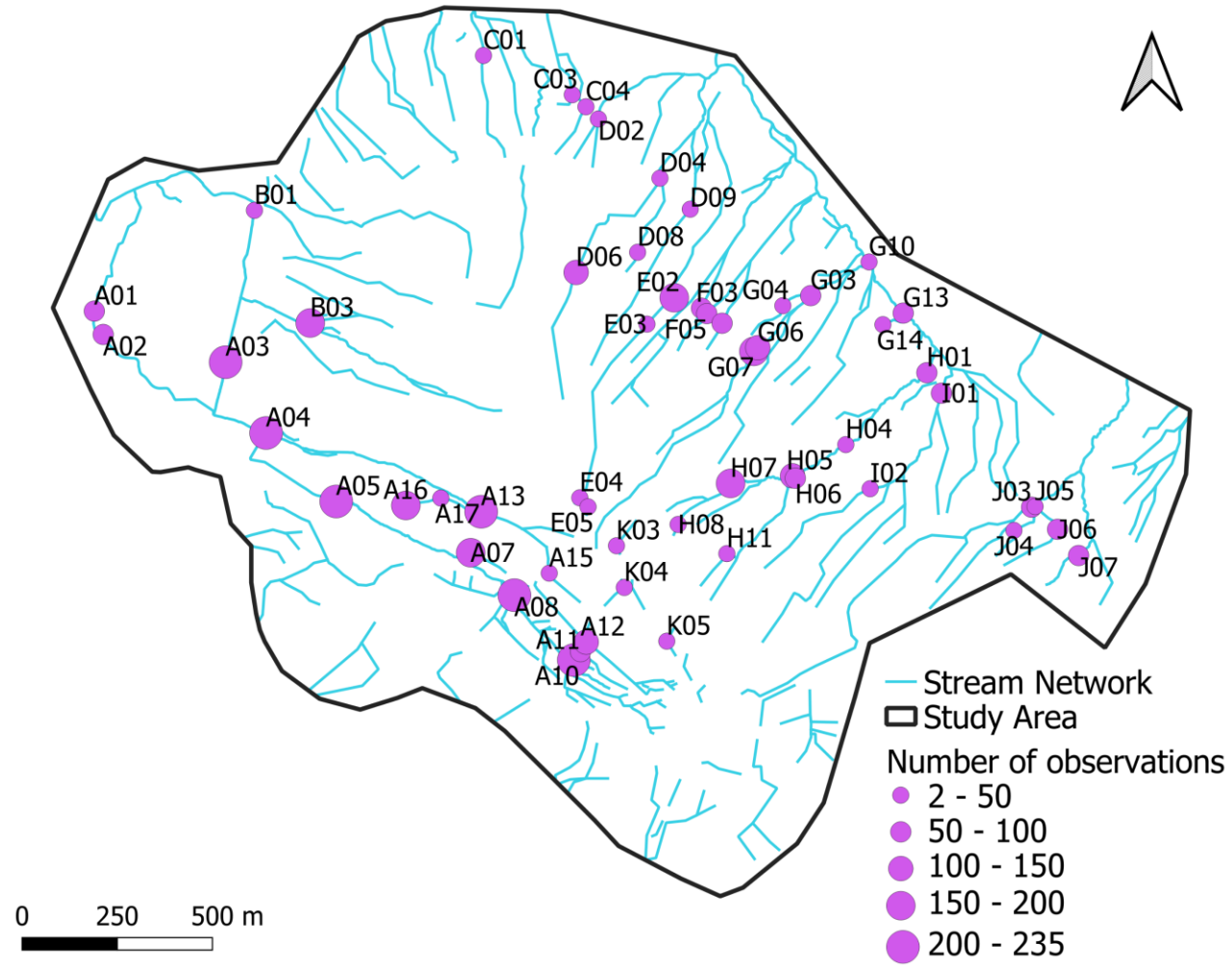
G) **Reconstructed states Y**

Node	Time 1	2	3	4	5
a	0	1	0	1	0
b	0	0	0	-1	0
c	-1	0	-1	-1	-1

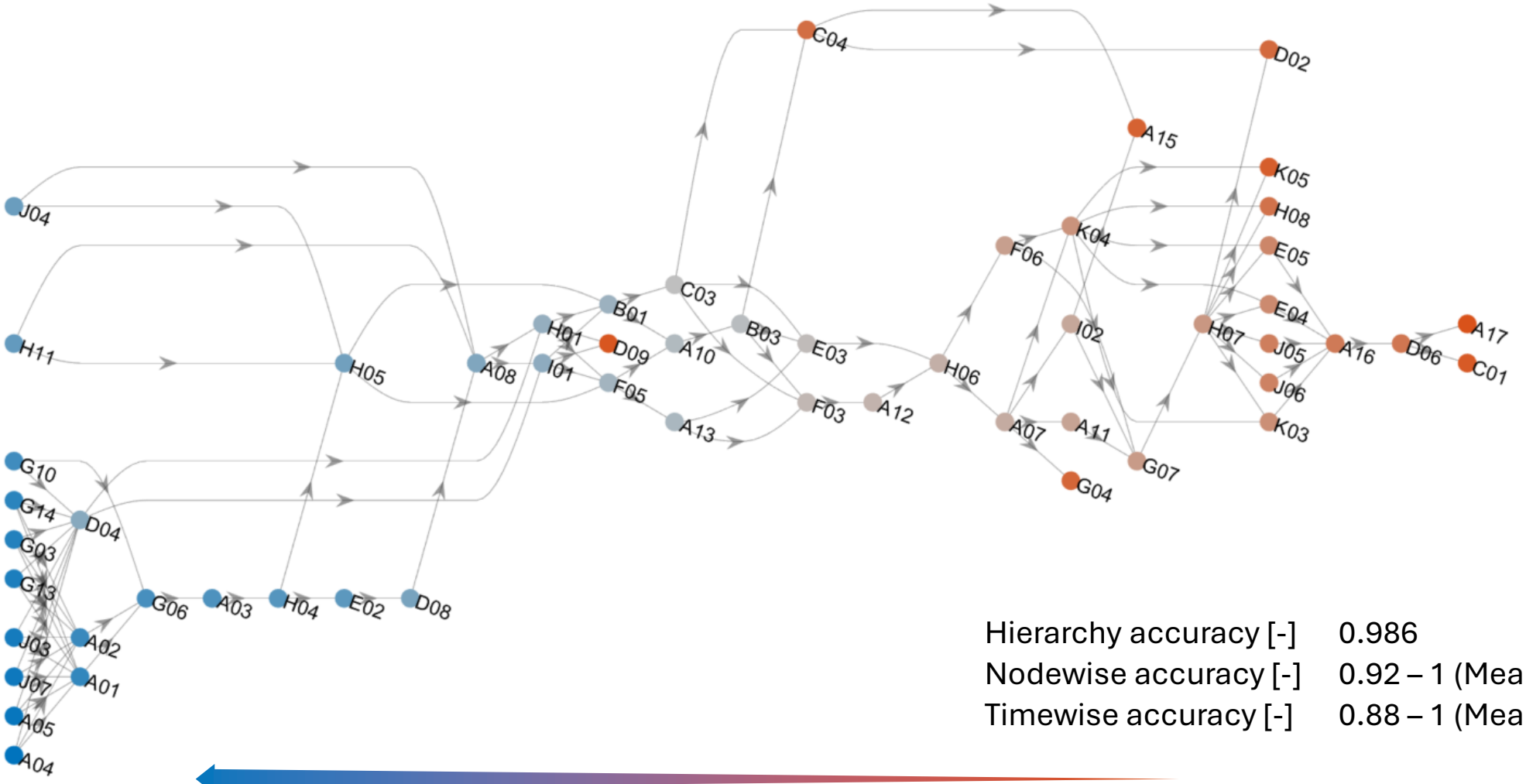


Durighetto et al. (2023)

From **physical** to probabilistic space



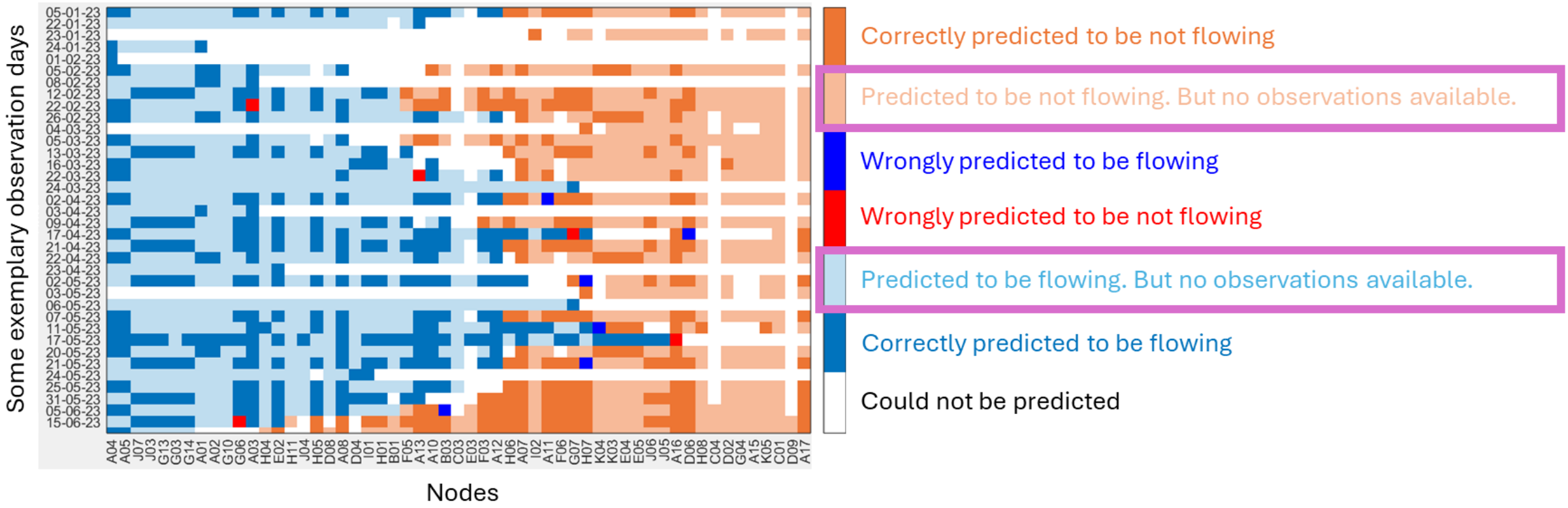
From physical to **probabilistic** space



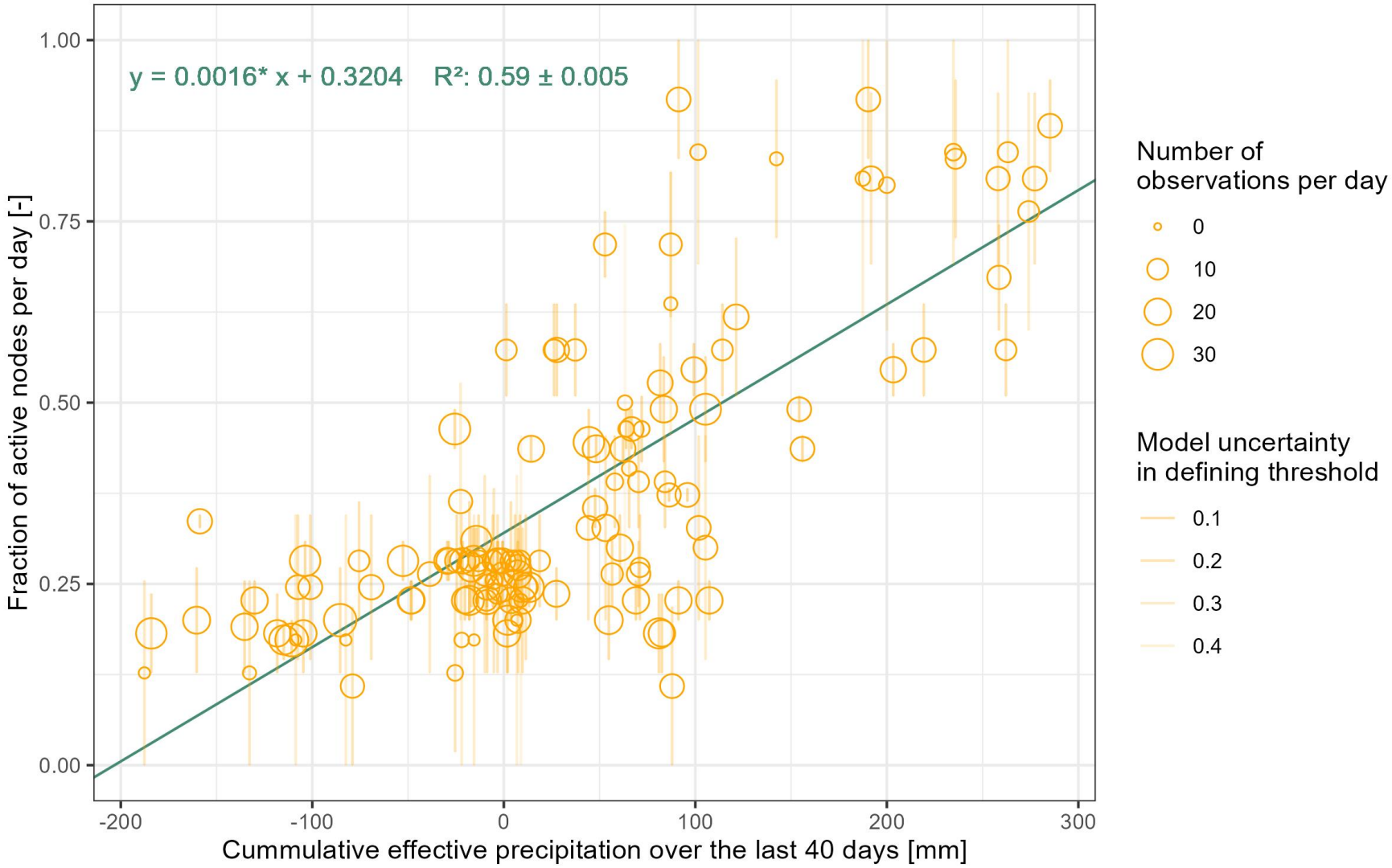
Hierarchy accuracy [-]	0.986
Nodewise accuracy [-]	0.92 – 1 (Mean: 0.99)
Timewise accuracy [-]	0.88 – 1 (Mean: 0.99)

Persistency of flow

New information



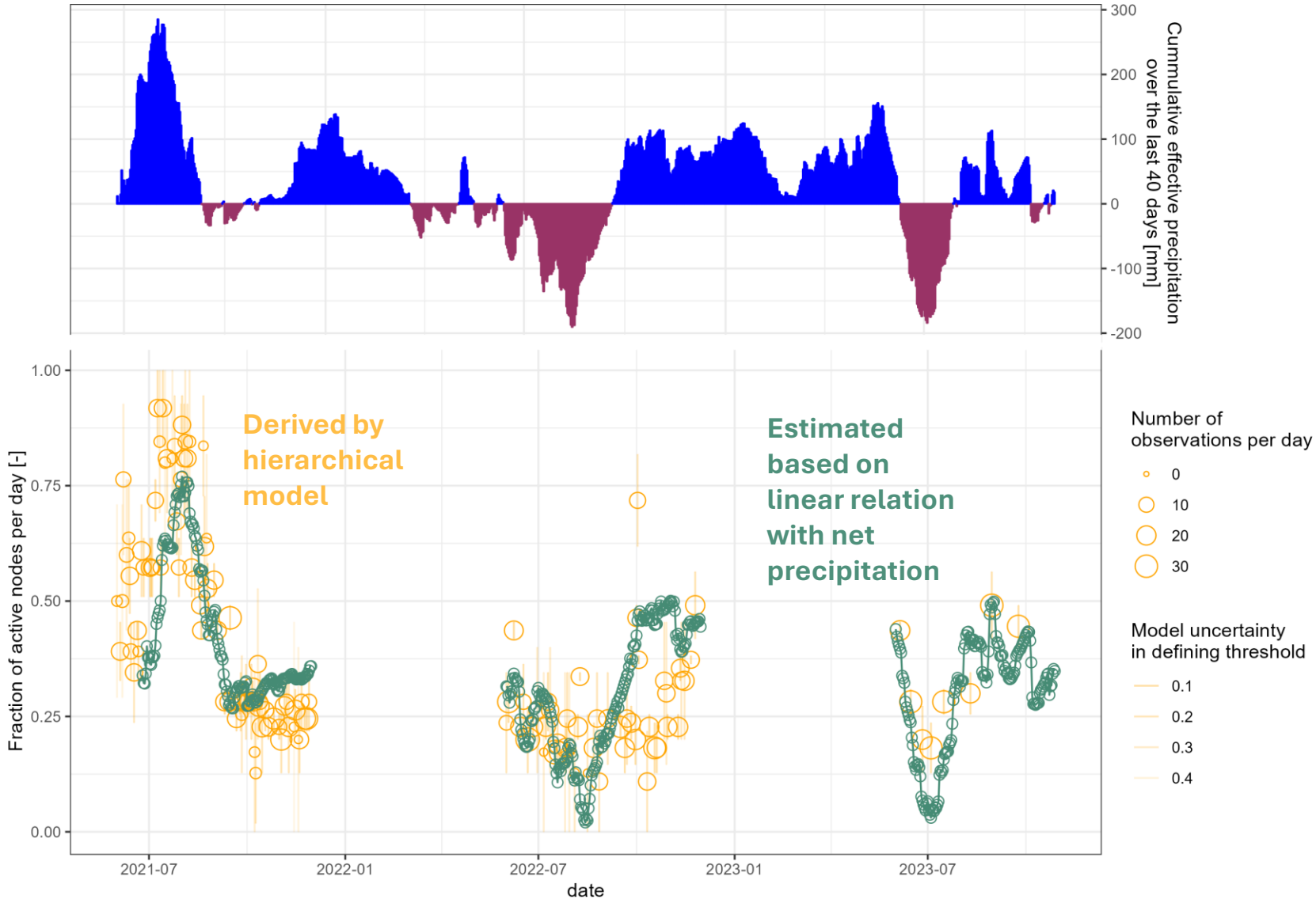
From 4,360 observations to 14,695 predictions



Correlation between the fraction of active nodes (derived by hierarchical model) and effective precipitation over the last 40 days during summer (Jun.-Nov.).

Only days with uncertainty <0.5 were considered.

Work in progress (click): Tests with different kinds of functions and their influence on model performances.



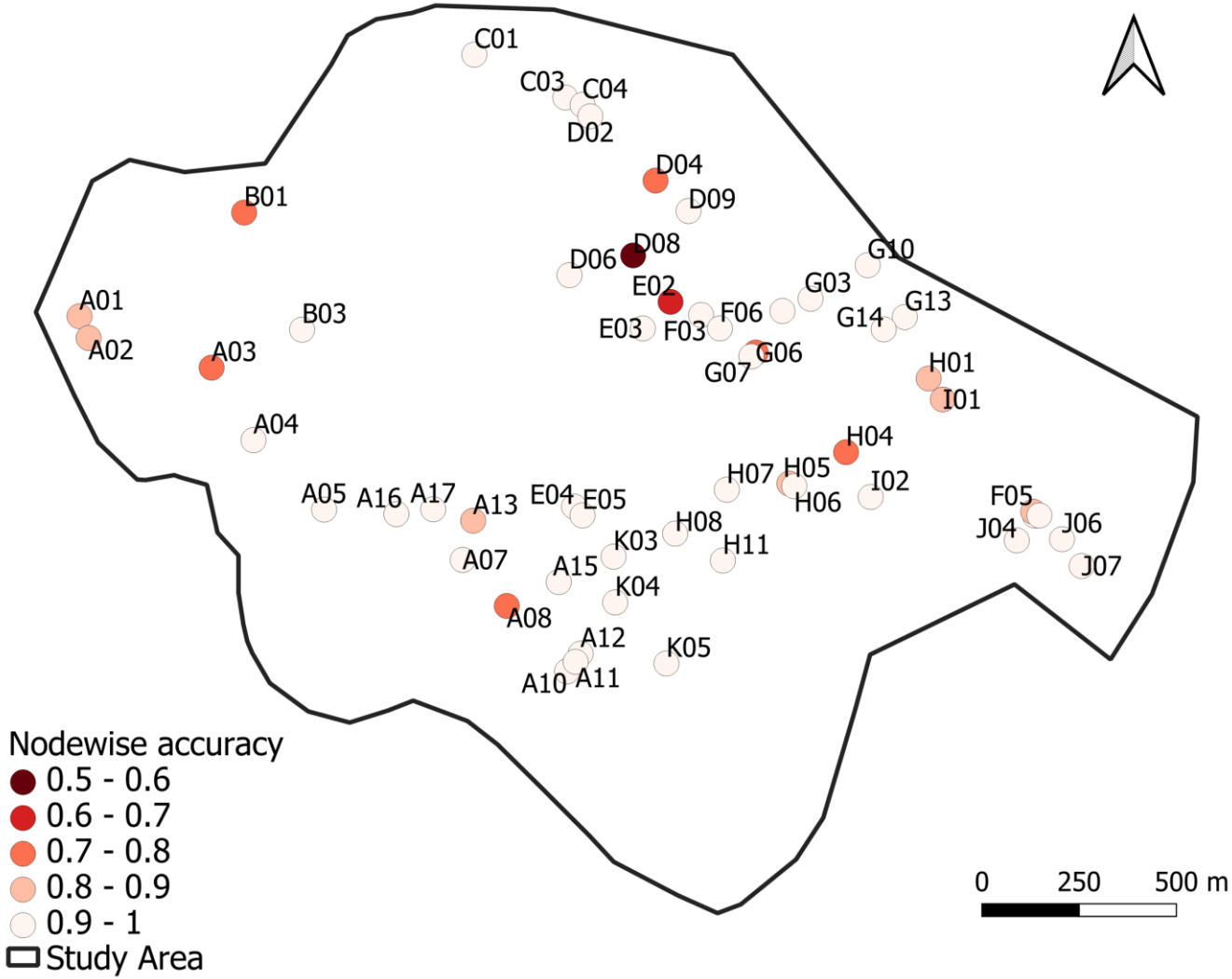
Model accuracy with the thresholds derived by the linear correlation compared to observations: **0.92**

14,695 observations
→ 35,569

402 says with observations :
→ 791

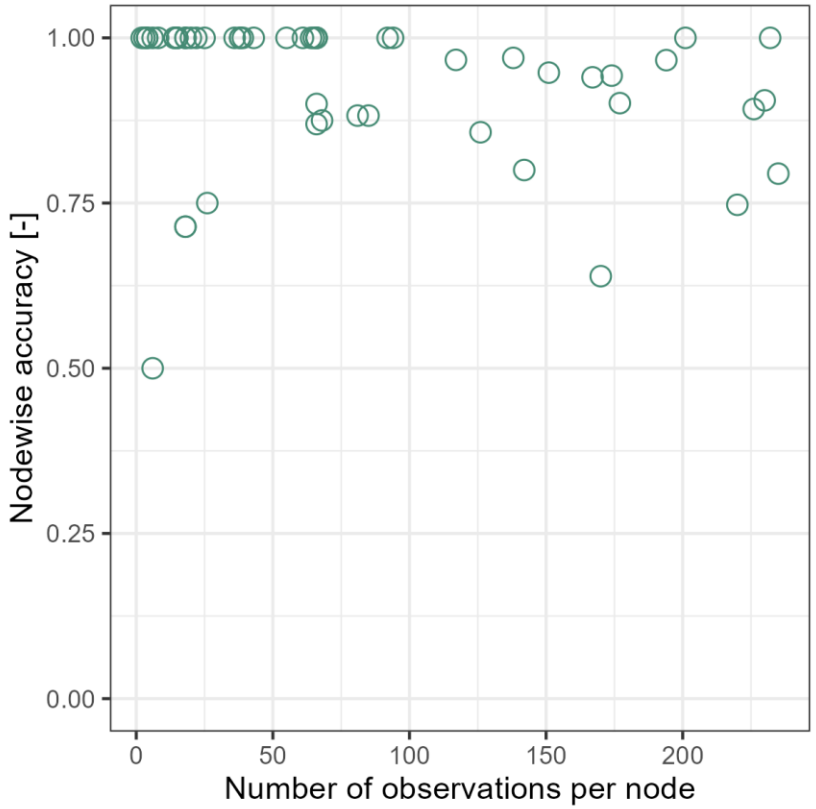
→ Daily timesteps during the summer months

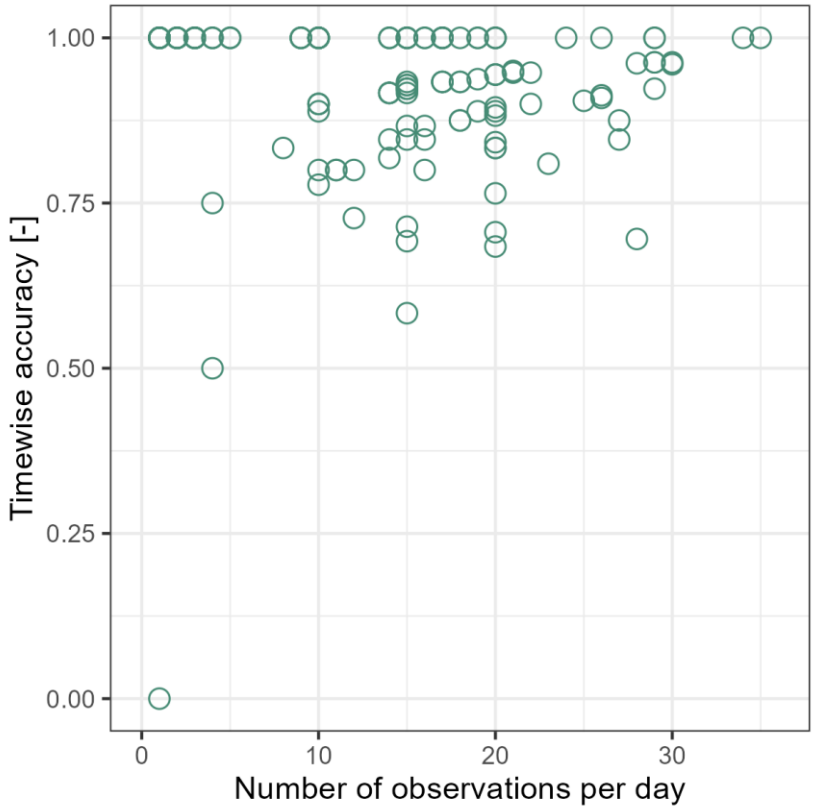
Map of nodewise accuracy of linear model output compared to observations



For a map with all the background info, please click here.

Nodewise and timewise accuracies as a function of linear model output compared to original observations plotted over the number of observations per node or day.





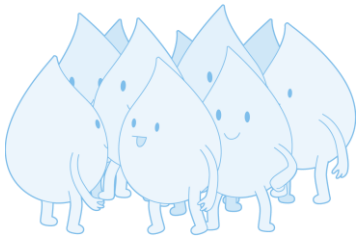
Citizen Science Data

Hierarchical Model

Correlation with Precipitation

Daily flow state values during summer

Feedback to Citizen Scientists



Contact

mirjam.scheller@uzh.ch

Conclusions

Can we use citizen science data to derive the hierarchical structure of stream wetting and drying?

- Yes. Activation of nodes turned out to be hierarchical.
- Limitation of citizen science data:
  Due to the irregular spatial selection of the observation points it is not possible to assign designated stream length to the nodes. Thus, we can't describe the expansion and contraction of the stream network but "only" the fraction of active nodes.

Can we afterwards improve the spatial and temporal resolution of the citizen science data?

- Yes. The number of data points of the flow states increased from 4,360 to 35,569.
- Yes. Accuracies of model results can be used to guide citizen scientists .

Abstract

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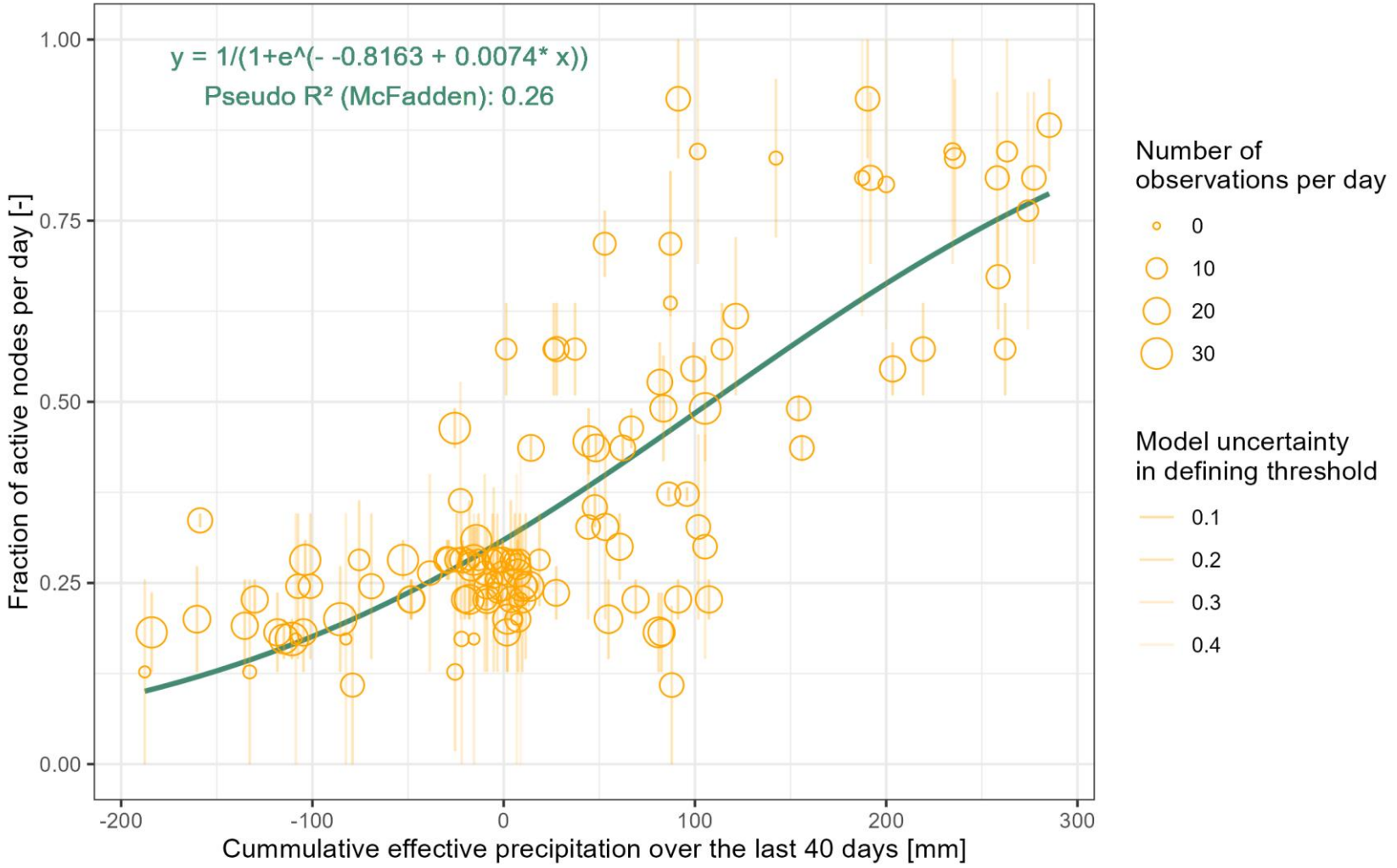
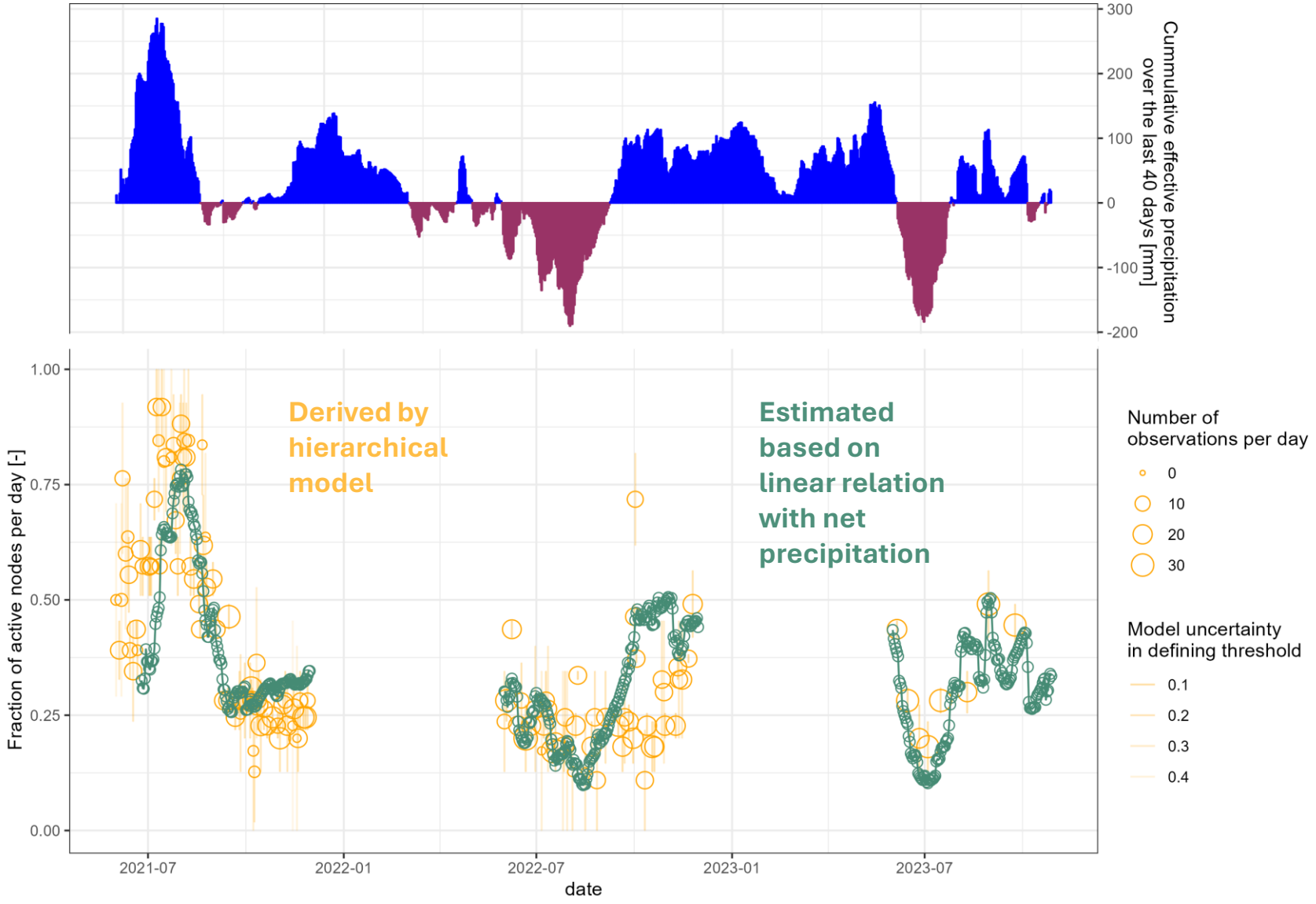
Work in progress – Logistic regression

Jump back to linear correlation



Work in progress – Logistic regression

Jump back to linear correlation



Model accuracy with the thresholds derived by the logistic correlation compared to observations:
0.93