The Value of Water Stable Isotope Data for Improving Process Understanding in a Central Asian High Mountain Basin

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October 16, 2024

INARCH Workshop

Research Projects (2012-2018)

The CAWa Project Partners

Regional Research Network "Water in Central Asia" (CAWa)

CAWa - Tools Supporting Water Management in Central Asia

CAIAG

Центрально-Азиатский Институт прикладных Исследований Земли (ЦАИИЗ)
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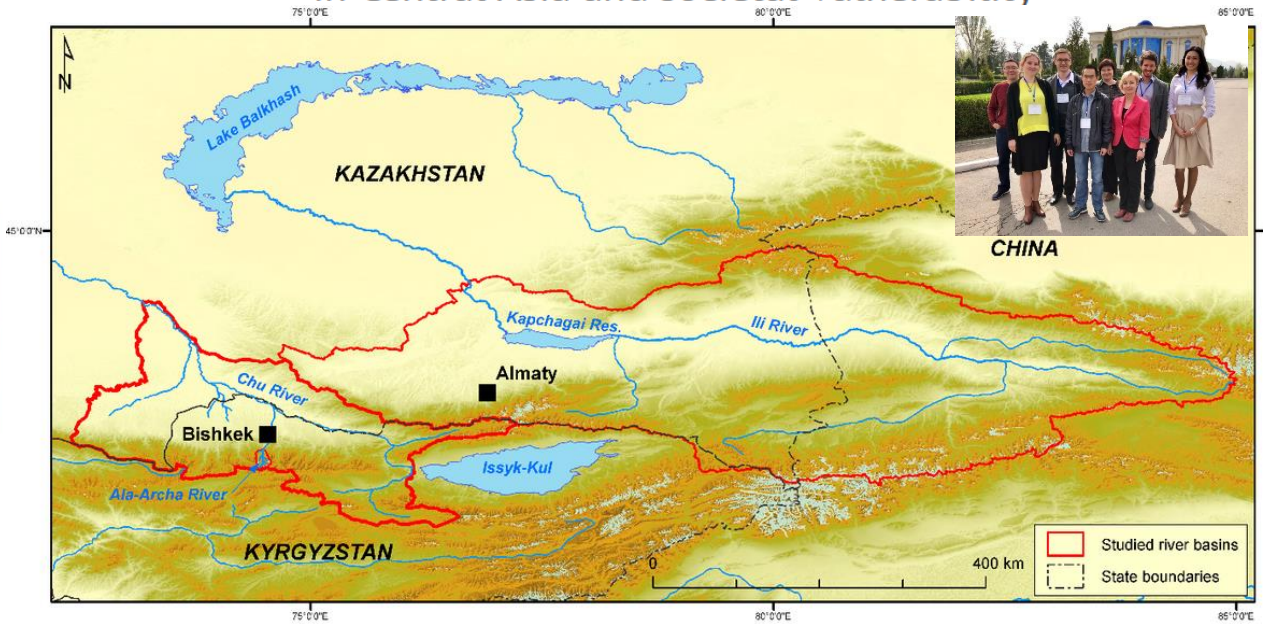
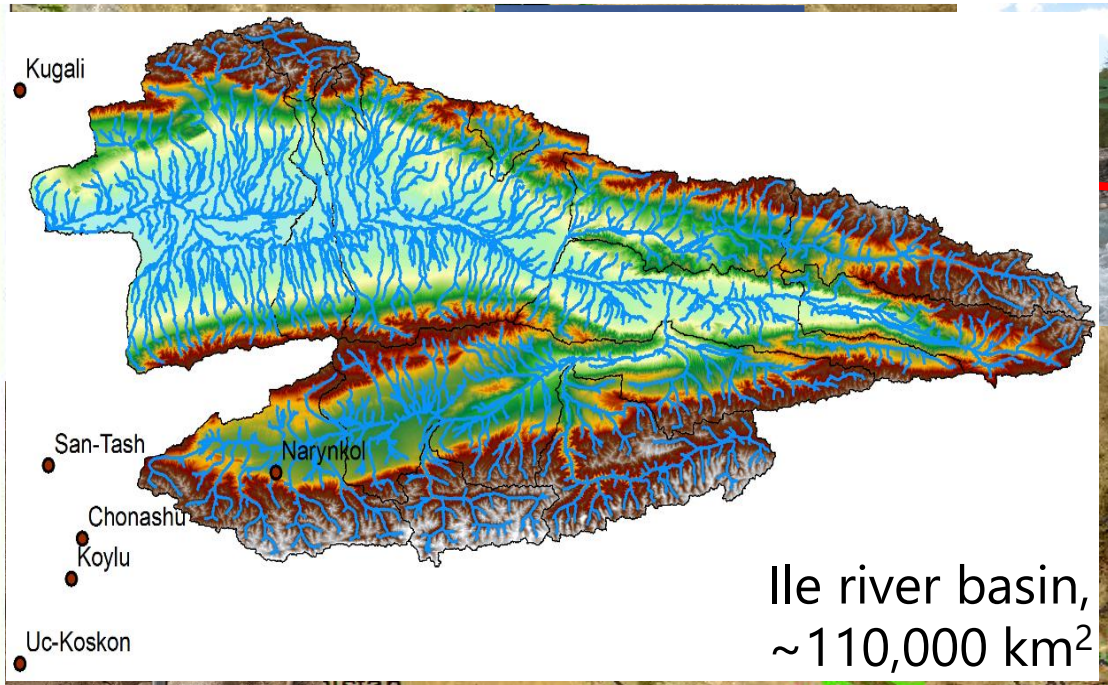
You are here: Главная ▸ Projects ▸ Changes in Glacier and Snow-melt runoff components in Central Asia and societal Vulnerability

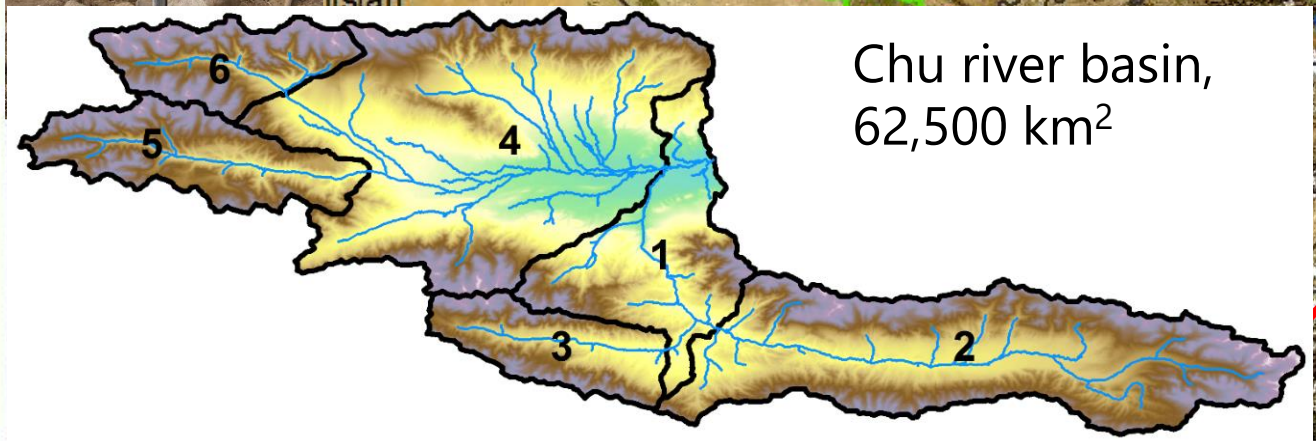
Changes in Glacier and Snow-melt runoff components in Central Asia and societal Vulnerability



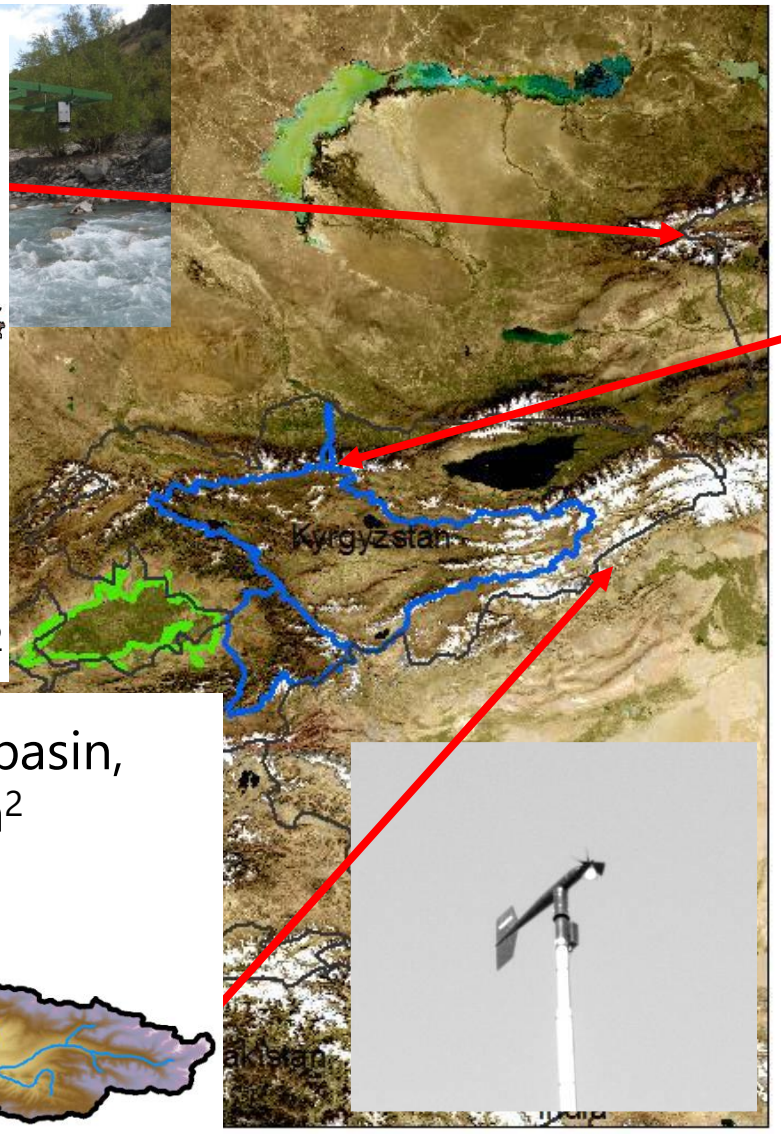
Study Basins



Ile river basin,
~110,000 km^2



Chu river basin,
62,500 km^2



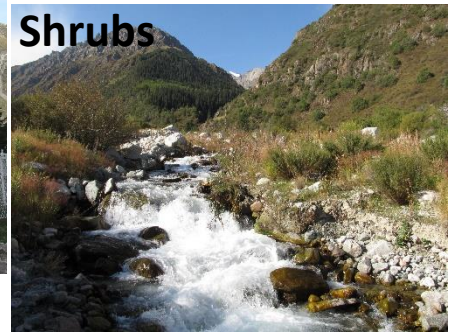
Ala-Archa basin,
233 km^2
Glacier=17%
Ele.:1560-4864 m

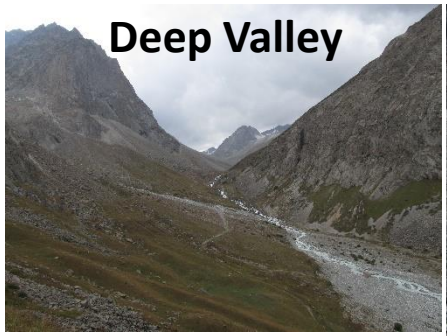
Climate & Land Cover

TABLE 1. Average Yearly Precipitation (Pr) and Standard Deviation (σ), (Z) Average Altitude of Stations Located in Altitudinal Range.

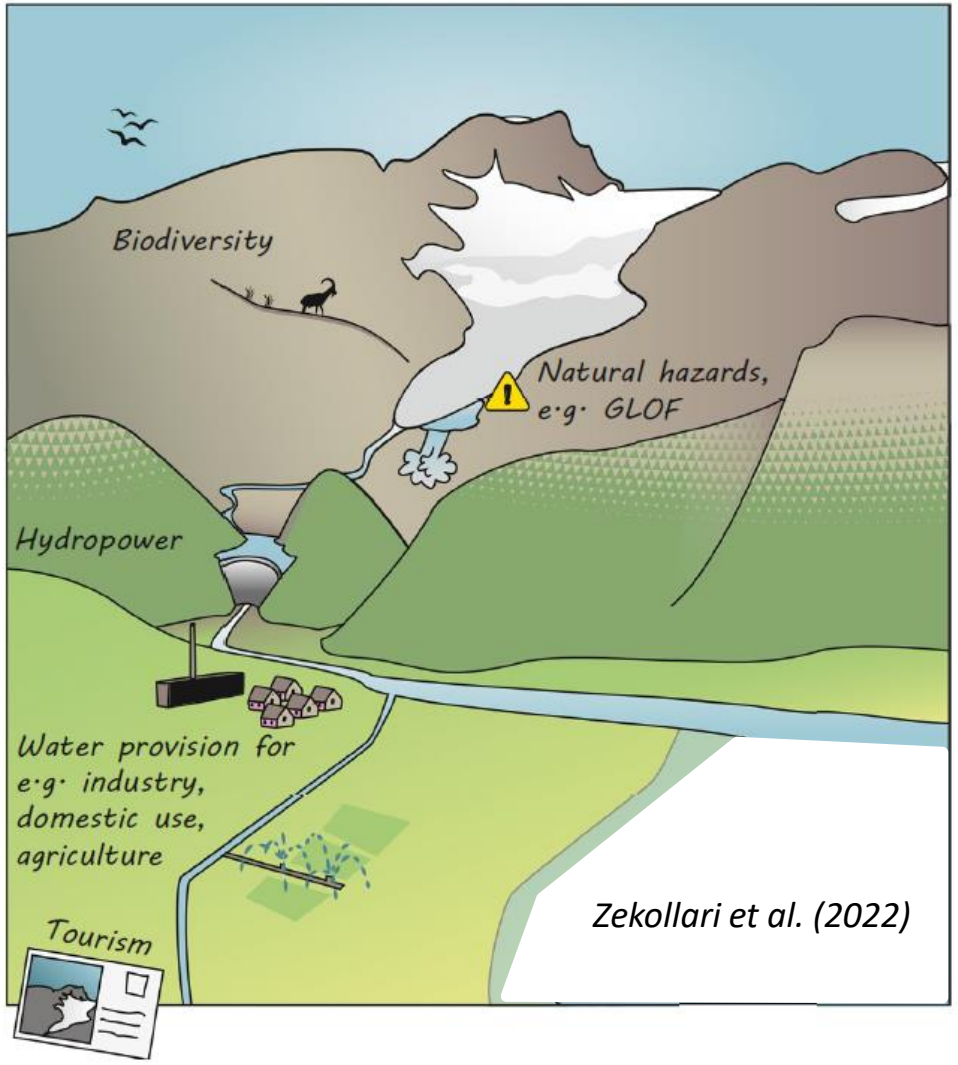
Aizen et al (1995)

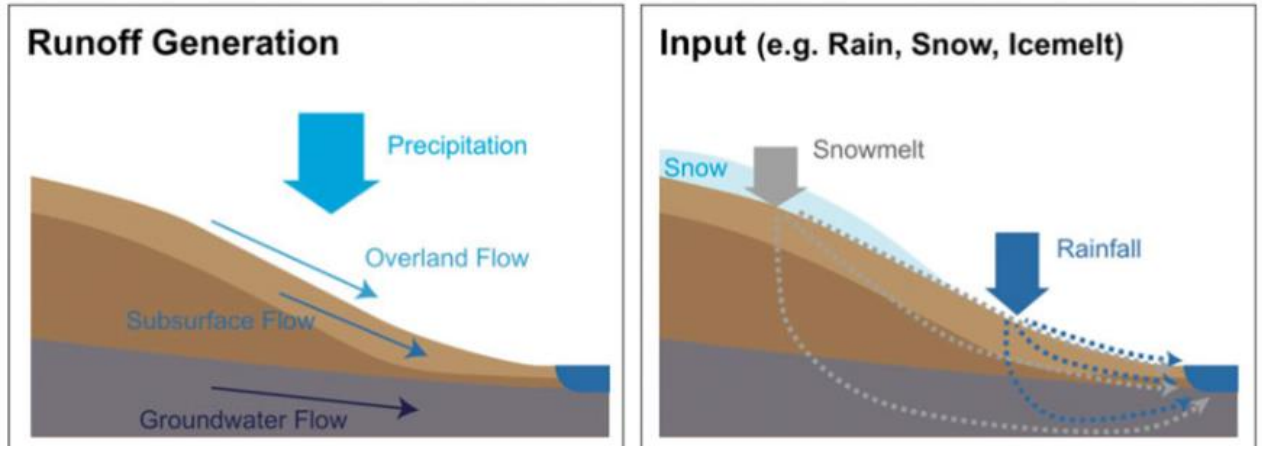
Altitudinal Range (m)	West Tien Shan Z (m)	West Tien Shan Pr (mm)	West Tien Shan σ (mm)	North Tien Shan Z (m)	North Tien Shan Pr (mm)	North Tien Shan σ (mm)	Central Tien Shan Z (m)	Central Tien Shan Pr (mm)	Central Tien Shan σ (mm)
500-1000	879	403	101	769	368	98			
1001-1500	1203	505	216	1294	424	141	1277	276	35
1501-2000	1751	559	217	1736	422	184	1806	271	53
2001-2500	2252	593	197	2170	512	216	2279	304	60
2501-3000	2820	595	208	2679	589	174	2798	272	67
3001-3500	3230	617	109	3304	727	100	3226	427	101
> 3500							3776	444	161



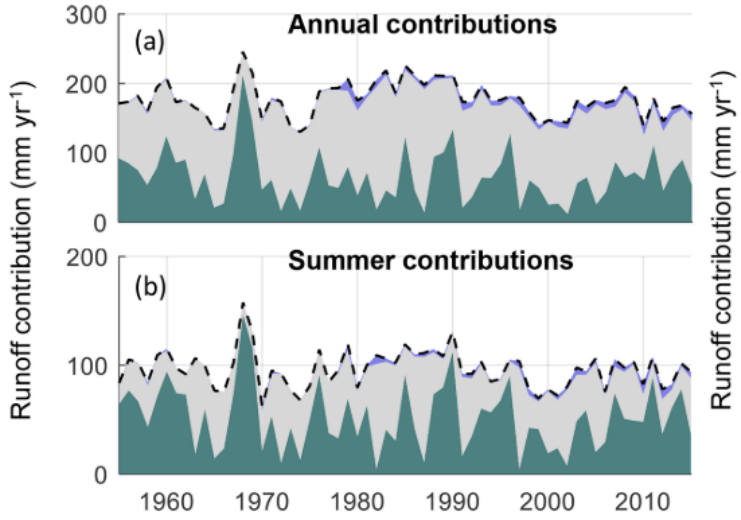


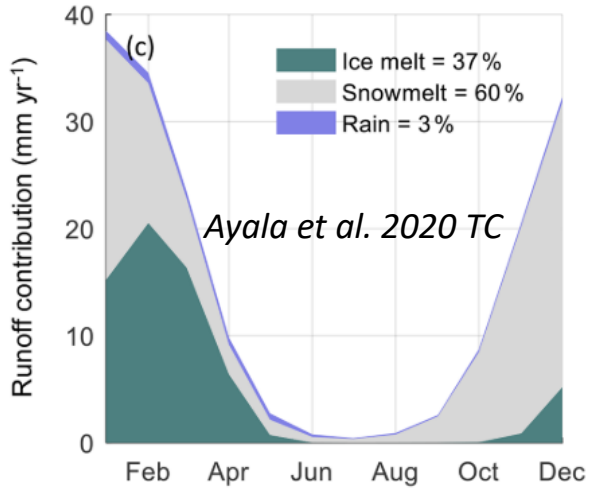
Complex Hydrological Processes in Study Area





Weiler et al. 2018





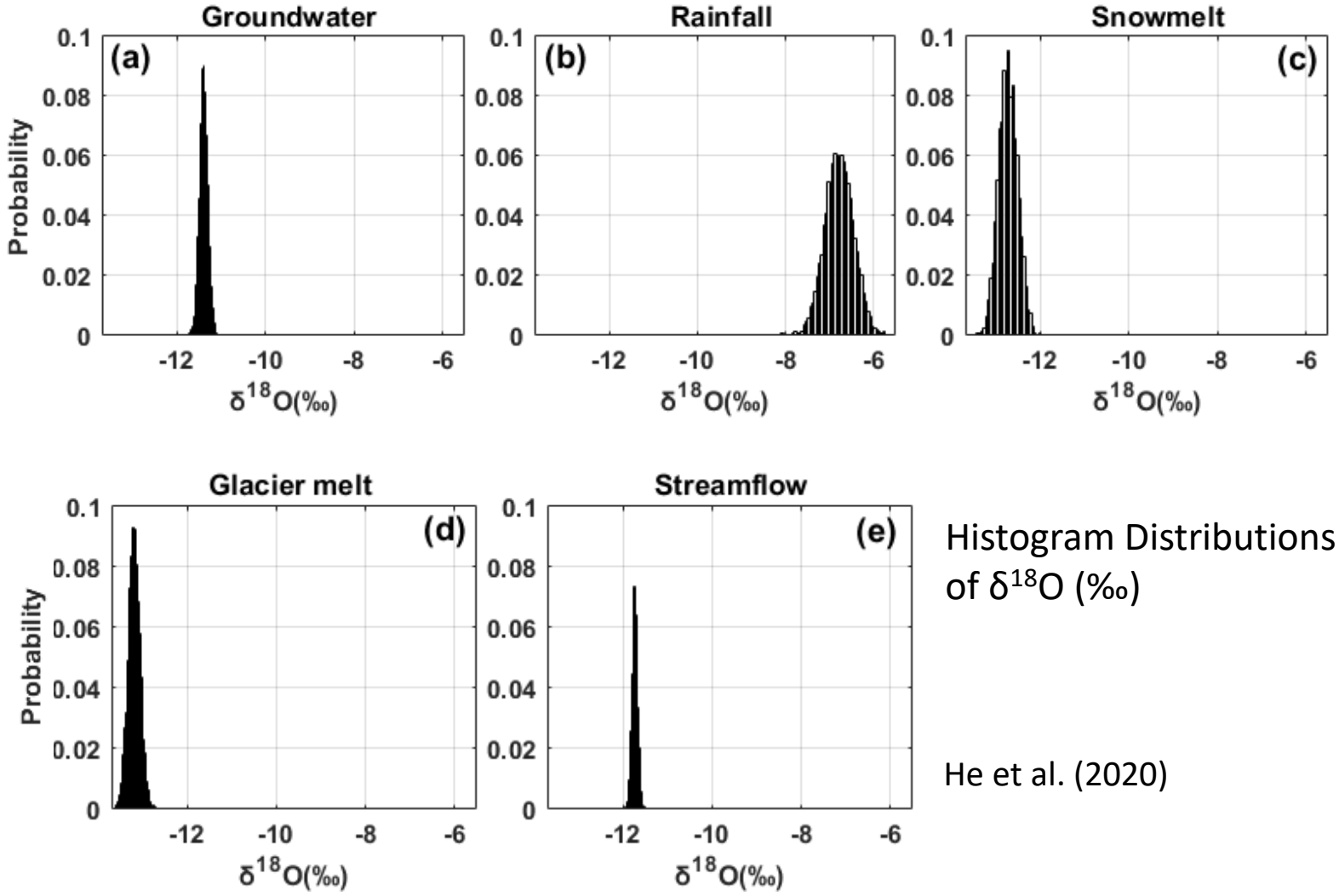
Ayala et al. 2020 TC

Challenges in Processes Understanding

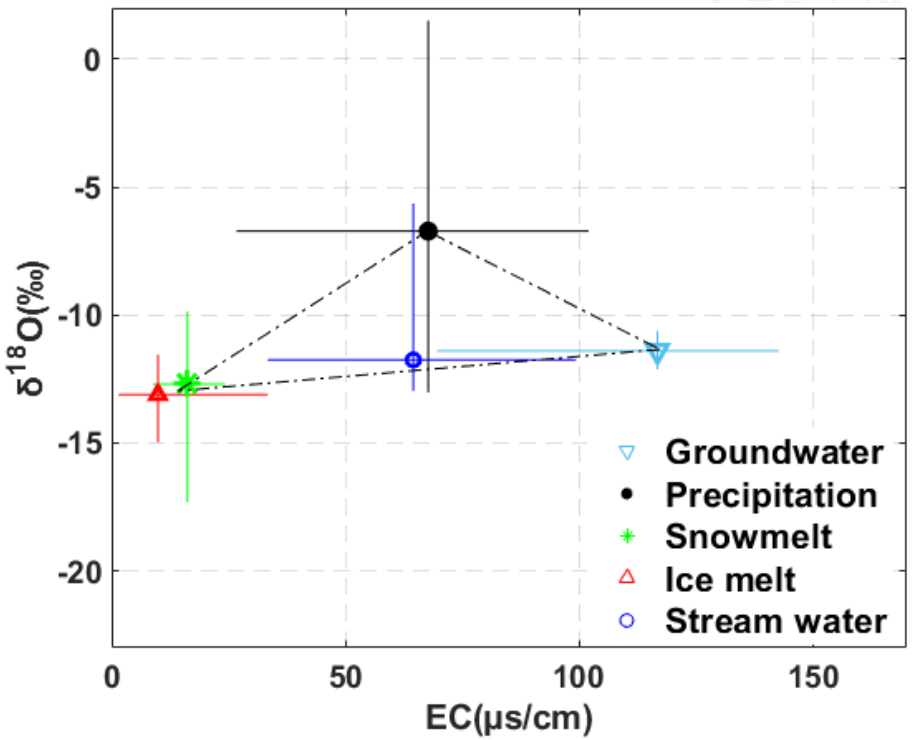
- Strongly Varying Contributions of Runoff Components
- Insufficient Understanding of the Interactions between Surface and Sub-surface Water

Water Sampling for Isotope Data Analysis

End-members Identifed by Tracer Data

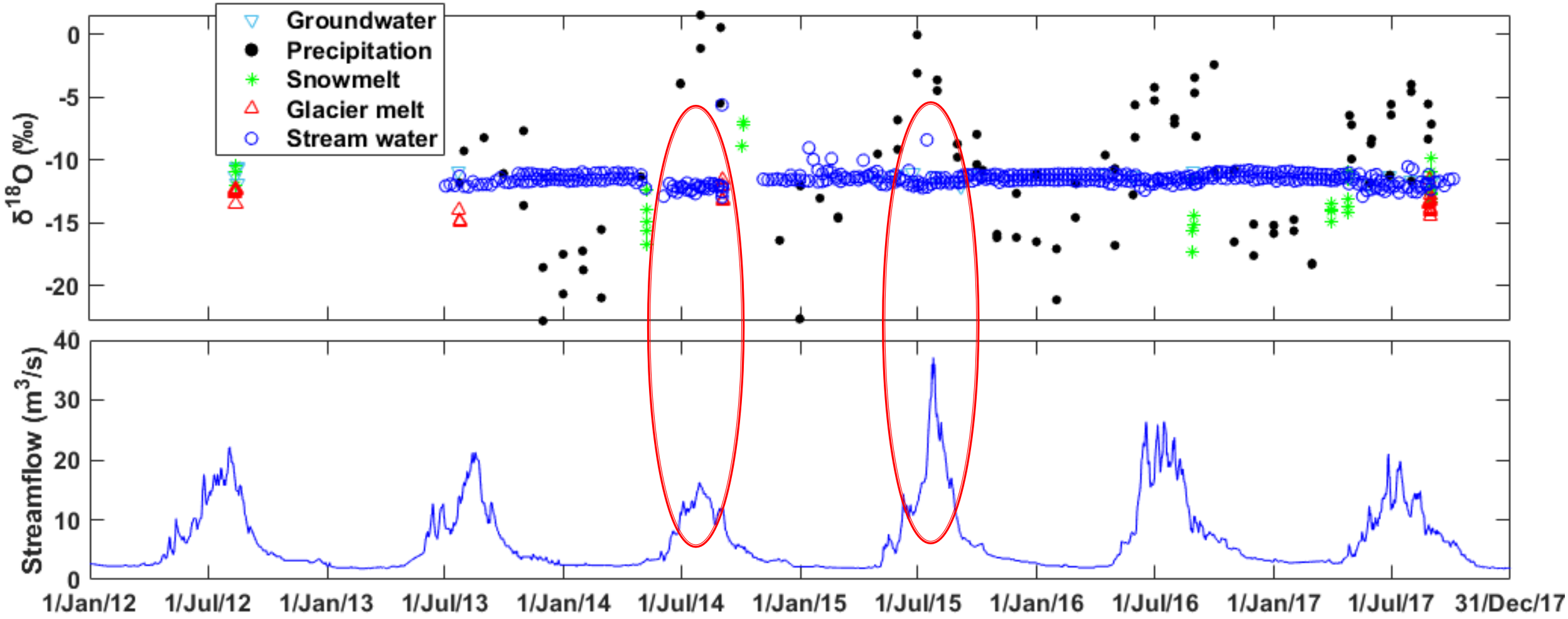


Histogram Distributions of $\delta^{18}O$ (‰)

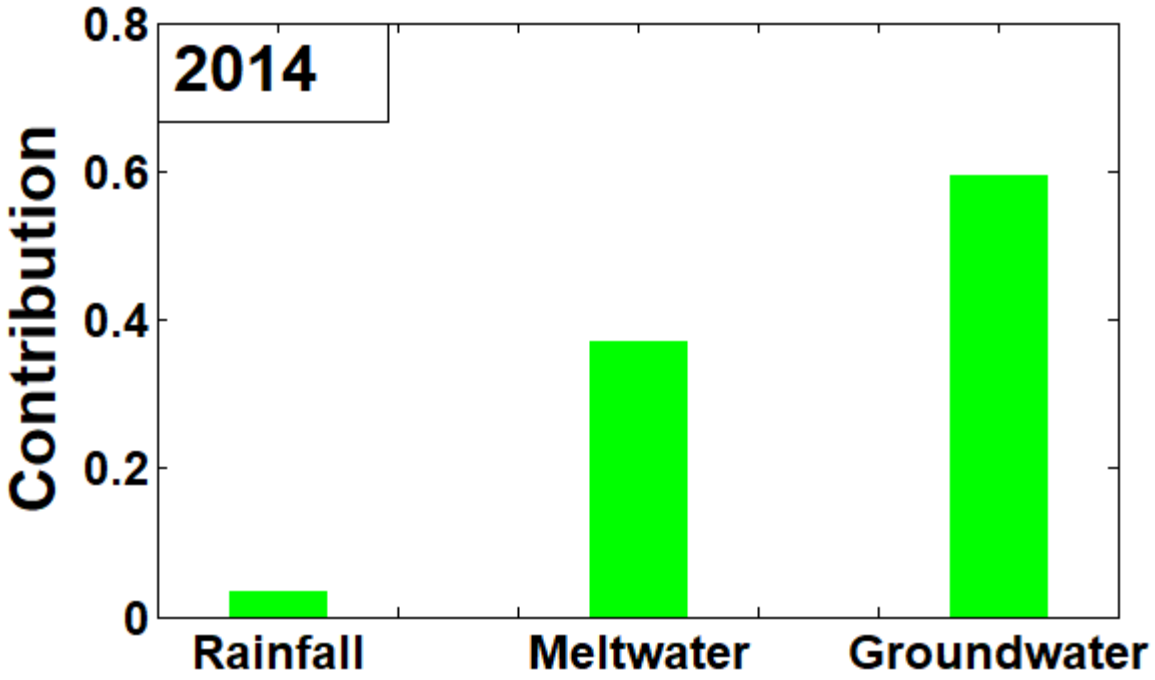


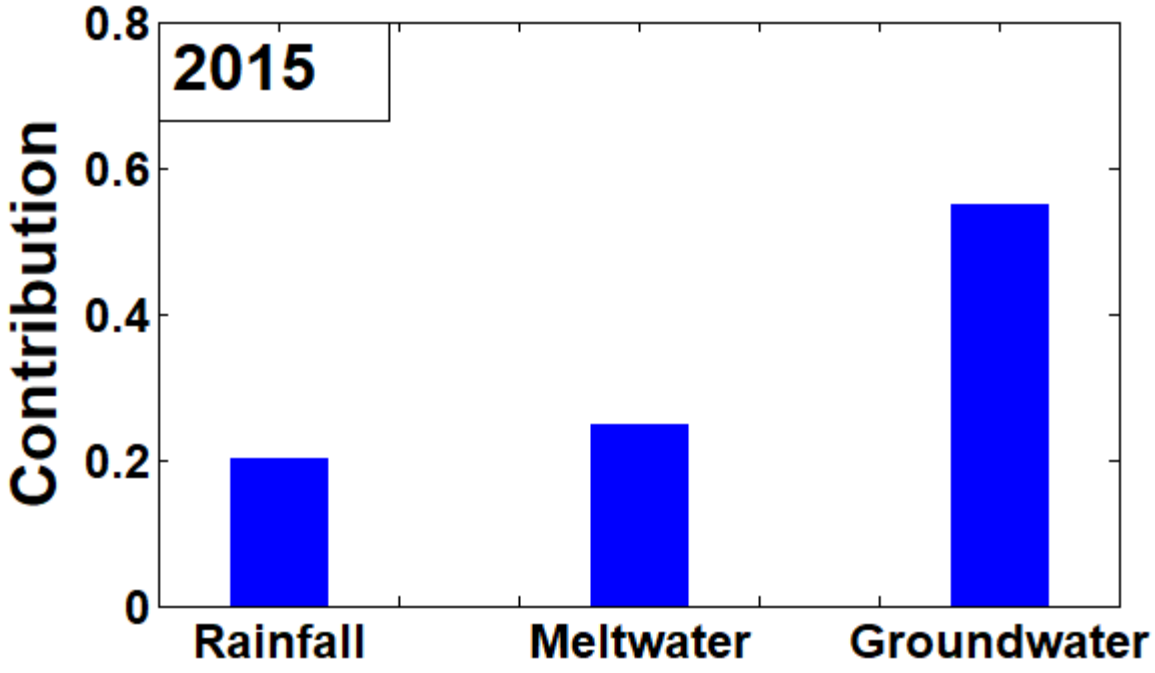
He et al. (2020)

Time Series of Measured δ18O



Interannual Variations in Contributions





Challenges in Process Understanding

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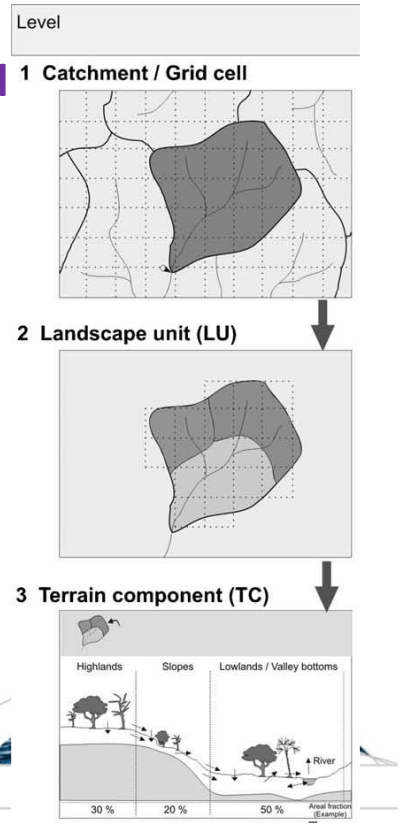
WASA Hydrological Model for Semi-Arid Regions

Water Availability in Semi-Arid Environments (WASA) Hydrological model

Processes coded in WASA:

- Snow melt
- Glacier melt and glacier dynamics
- Infiltration
- Soil water movement
- Evapotranspiration
- Runoff generation
- Runoff routing in river network
- Retention in reservoirs



AGU PUBLICATIONS

Water Resources Research

RESEARCH ARTICLE
10.1002/2017WR021966

The Value of Hydrograph Partitioning Curves for Calibrating Hydrological Models in Glacierized Basins

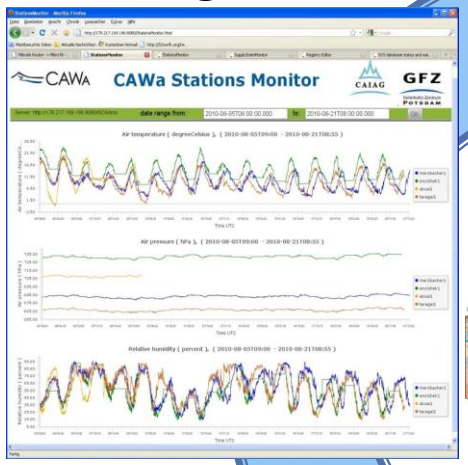
Zhihua He[1], Sergiy Vorogushyn[1], Katy Unger-Shayesteh[1], Abror Gafurov[1], Olga Kalashnikova[3], Elvira Omorova[4], and Bruno Merz[1,2]

Key Points:
- The HPC-based method (1) delivers model-internal consistency

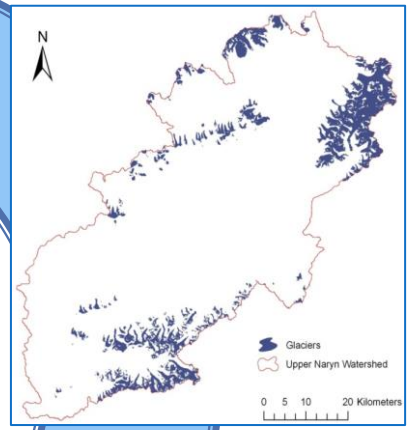
Guentner (2002); He et al. (2018)

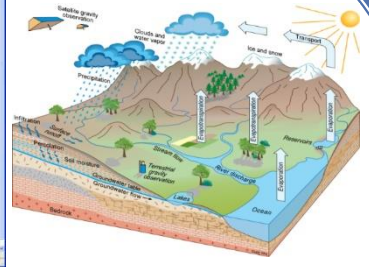
Model Calibration

Discharge records

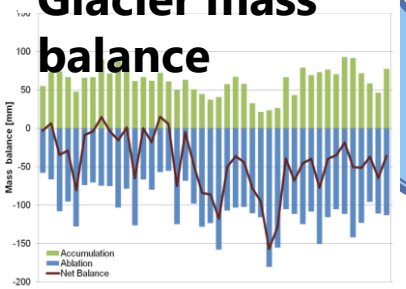


Glacier area dynamics



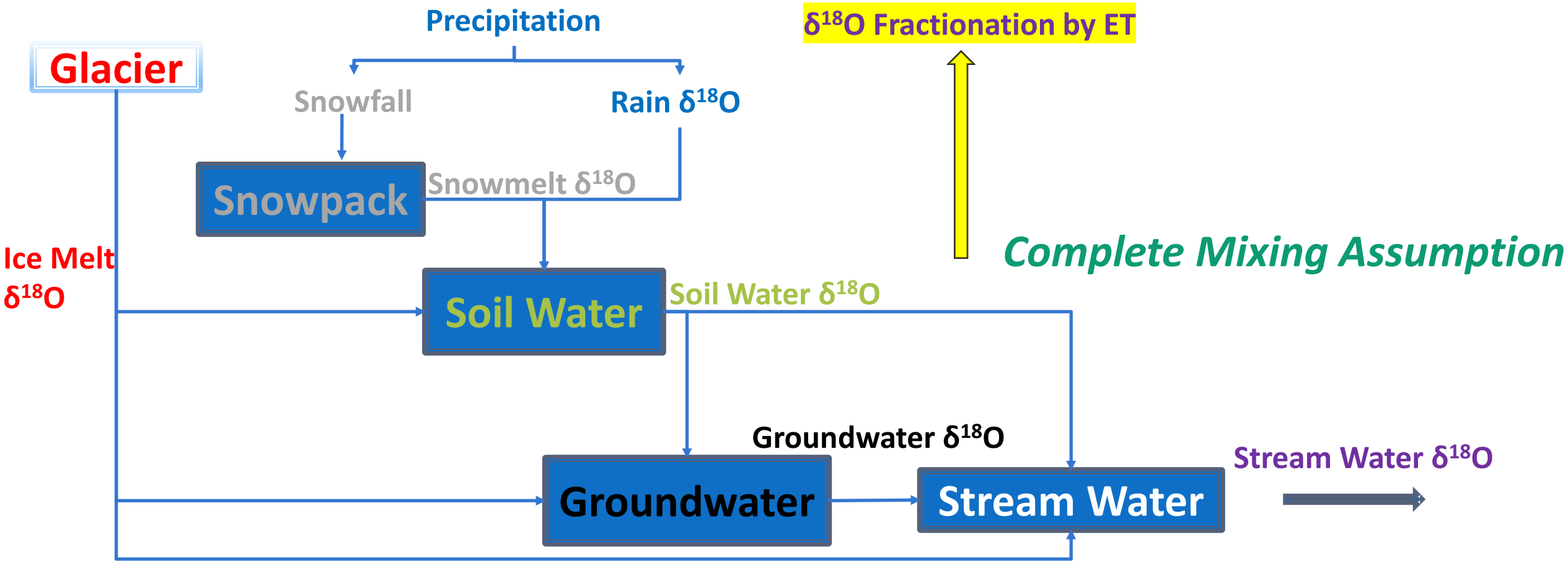


Glacier mass balance



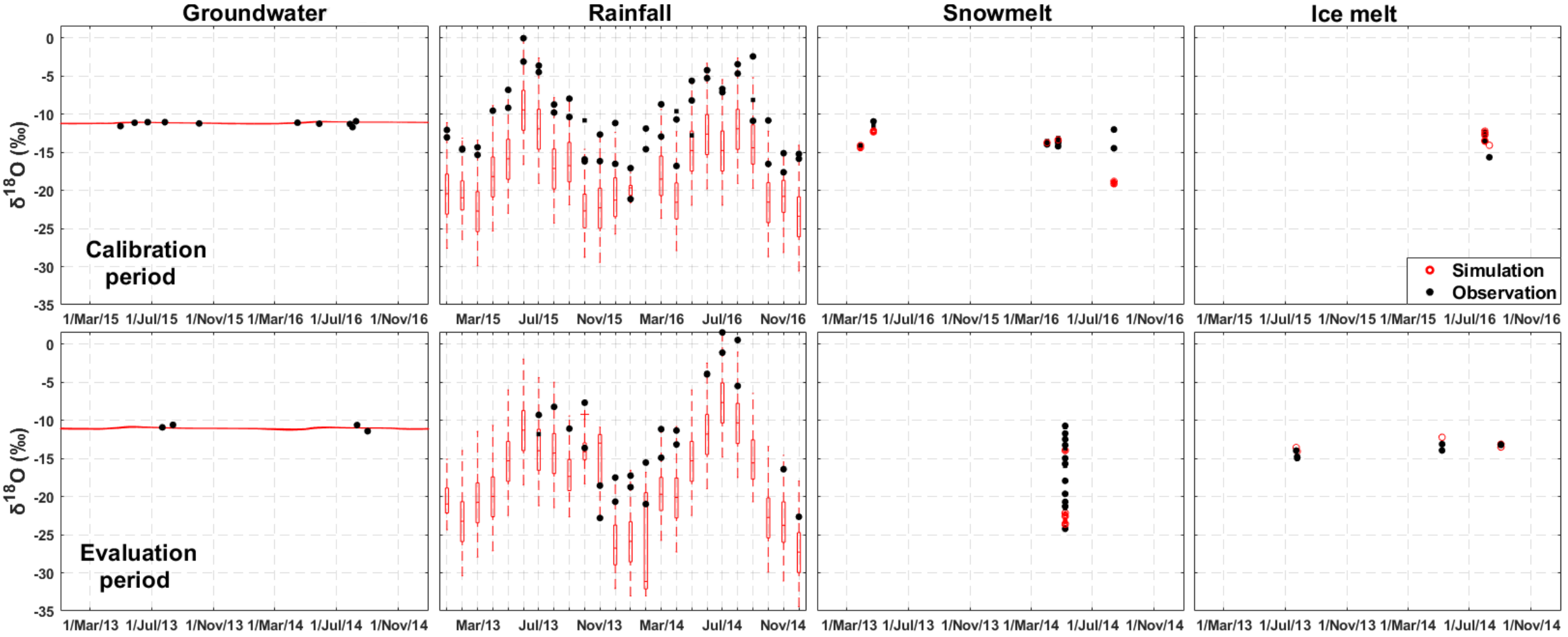
Snow cover patterns from satellite imagery

Isotope-aided WASA Model

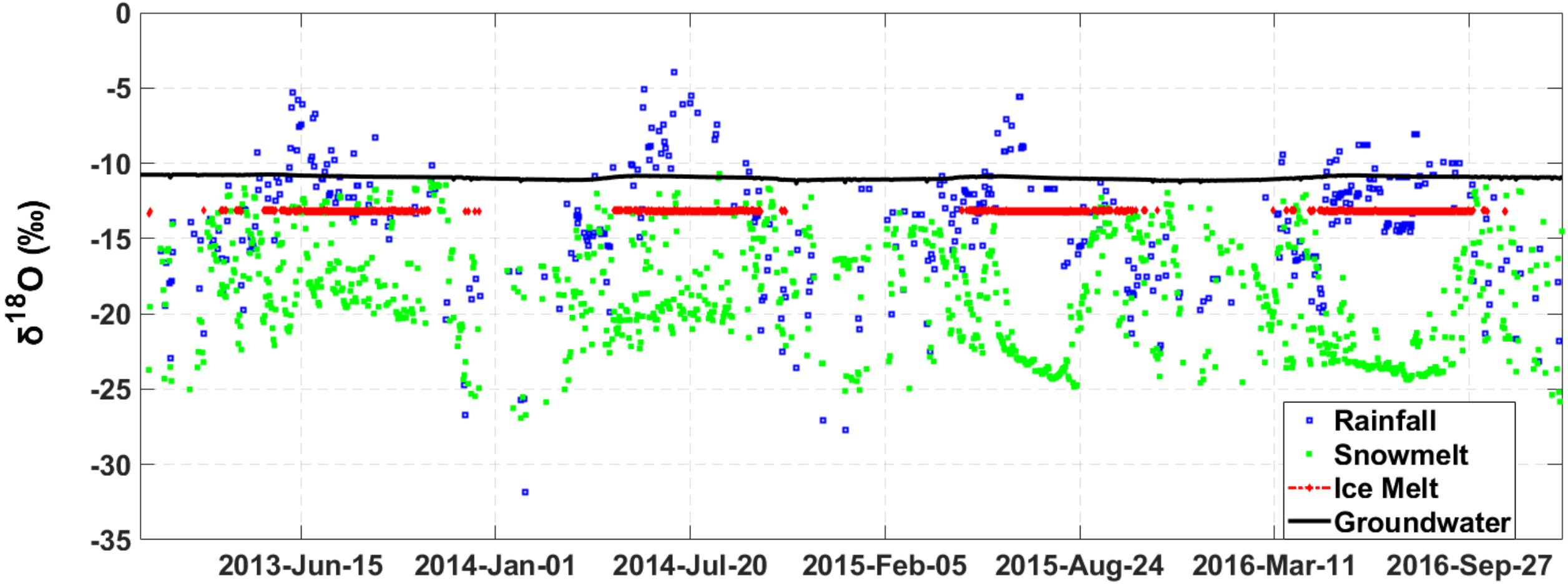


Isotope-aided WASA hydrological model (He et al. 2019)

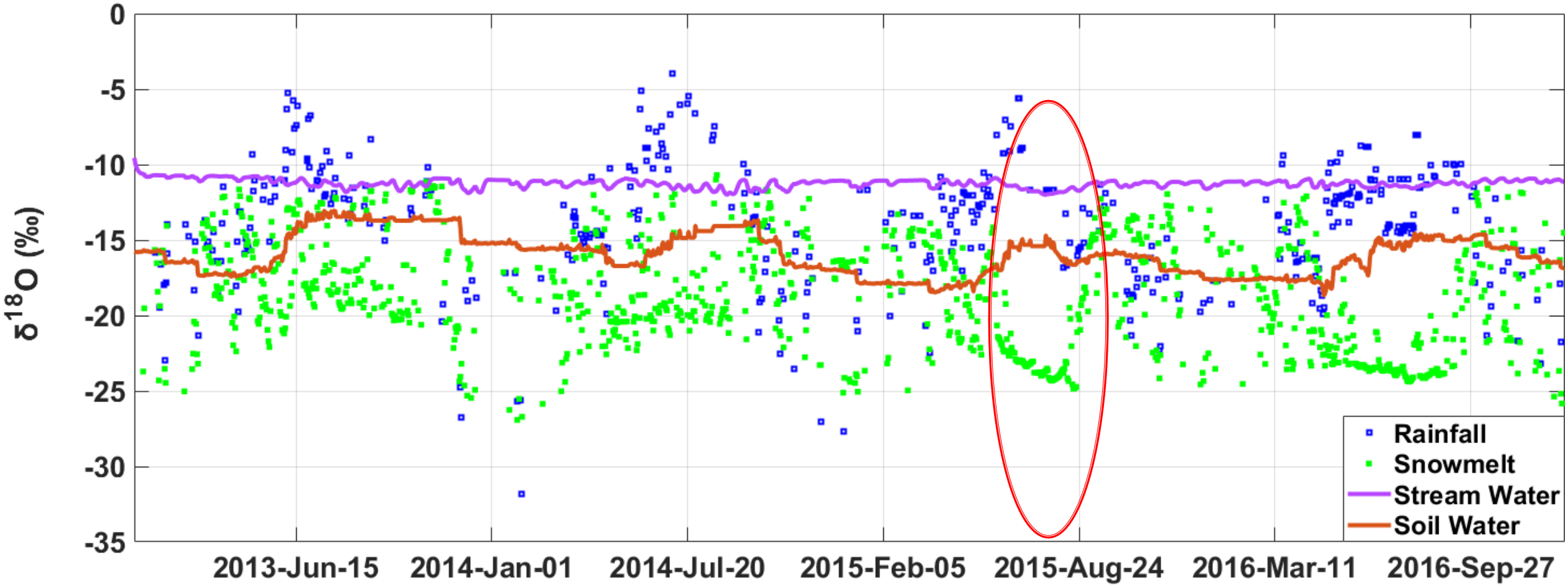
Isotope-aided Model Performance



Limited Impact of Surface Water on Groundwater



Small Impact of Soil Water on Stream Water



Wrap Up…

- An isotope-aided hydrological model indicated the dominance of groundwater and surface runoff in streamflow within the study basin.

- Limitations: Soil water isotope data were not measured for model evaluation; there is likely an underestimation of the contribution of meltwater to groundwater, as subglacial flow was not considered; Impacts of residence time and permafrost

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Thank you for your attention!

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