Impacts of snowpack accumulation and summer weather on alpine glacier hydrology

Caroline Aubry-Wake, Dhiraj Pradhananga , John W. Pomeroy

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CENTRE FOR HYDROLOGY

GWF

UNIVERSITY OF SASKATCHEWAN

Canadian Rockies: Variable weather and extremes over the last 5 years

Summer 2013

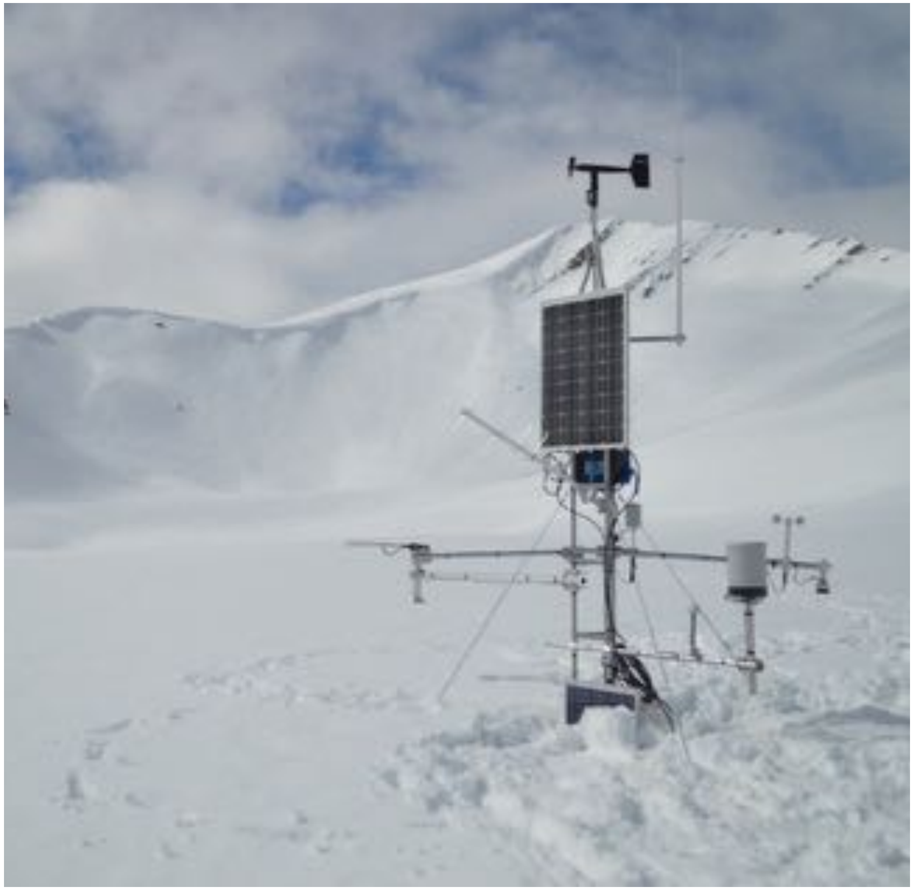
Summer 2017

Winter 2015

Spring 2017

How does glacier runoff reacts to inter-annual variability?

For winter accumulation



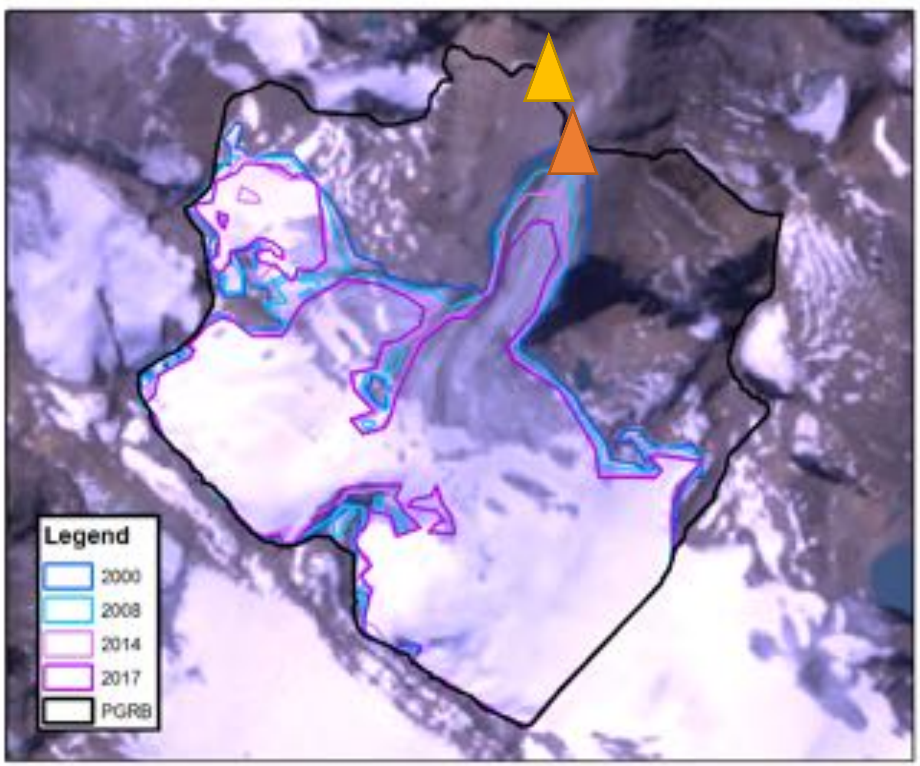
For summer weather

Relevance

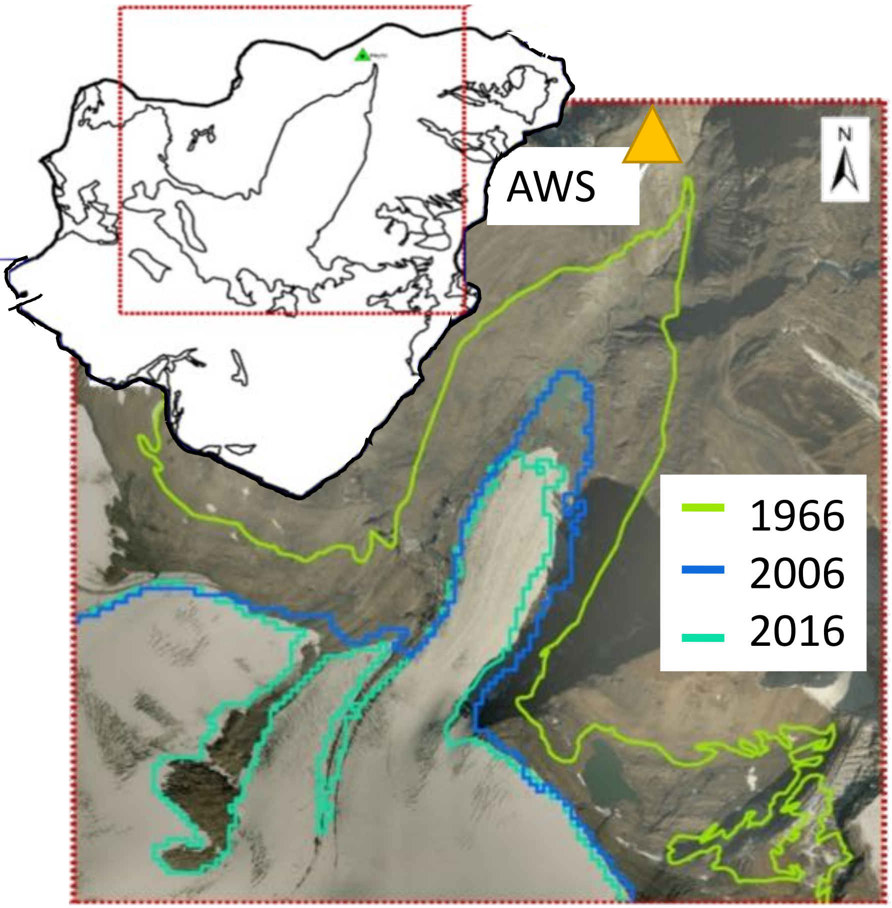
- Glacier melt is an important contributor to late summer streamflow
- Increasing weather extremes in a changing climate
- Investigating current inter-annual variability can help understanding future water resources

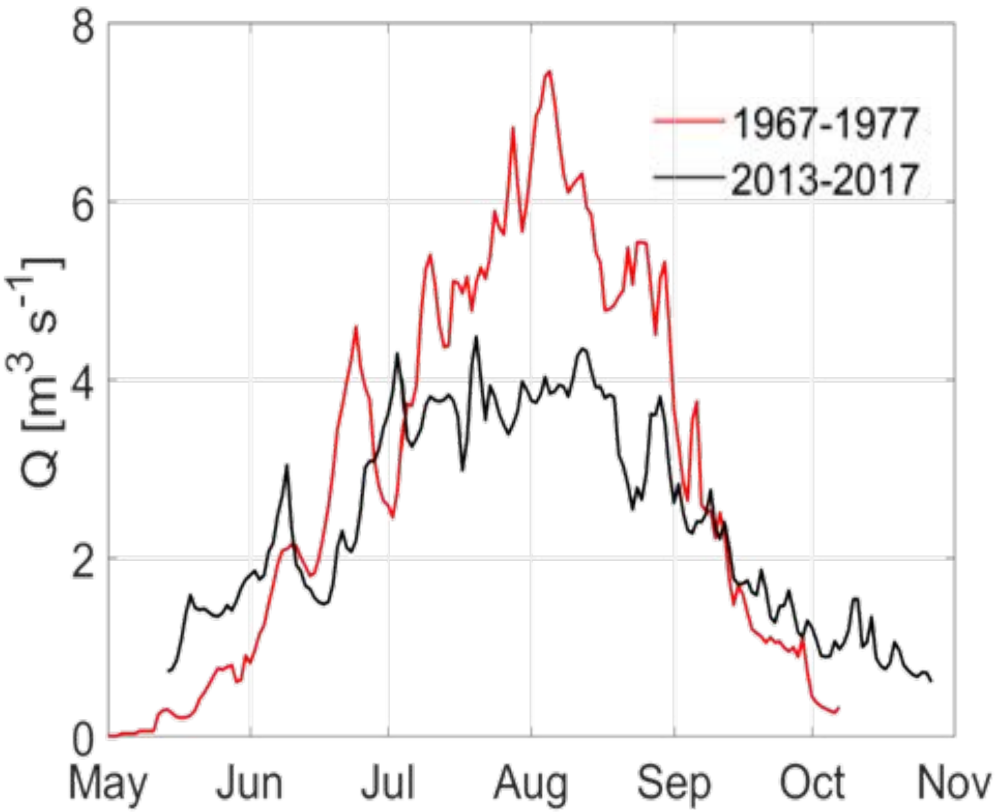
Peyto Glacier

- 2100 - 3190 m a.s.l.
- Weather station with T, RH, U, radiation budget
- Streamflow at outlet



Historical Retreat and Runoff



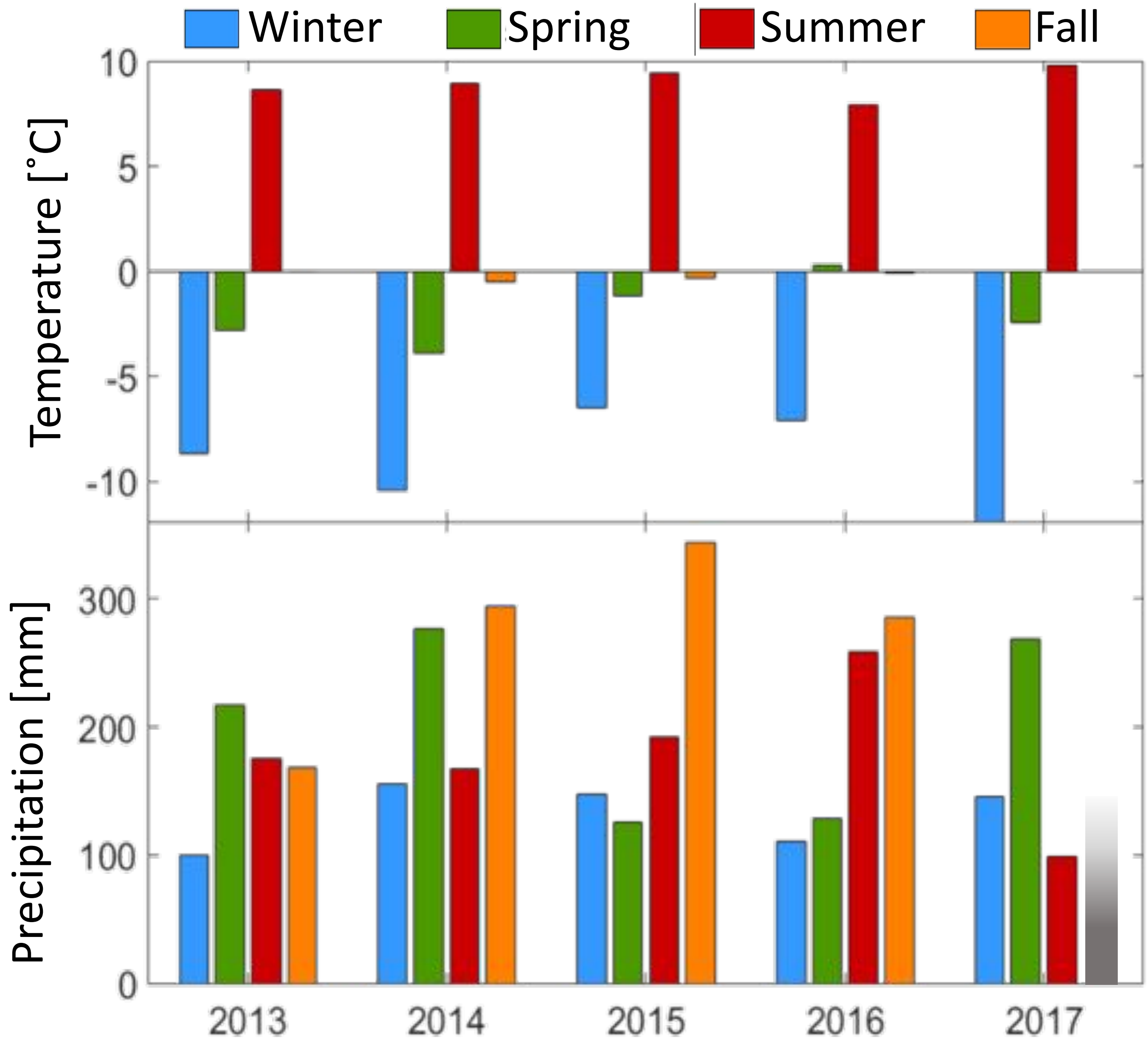


1966: 14.4 km^2

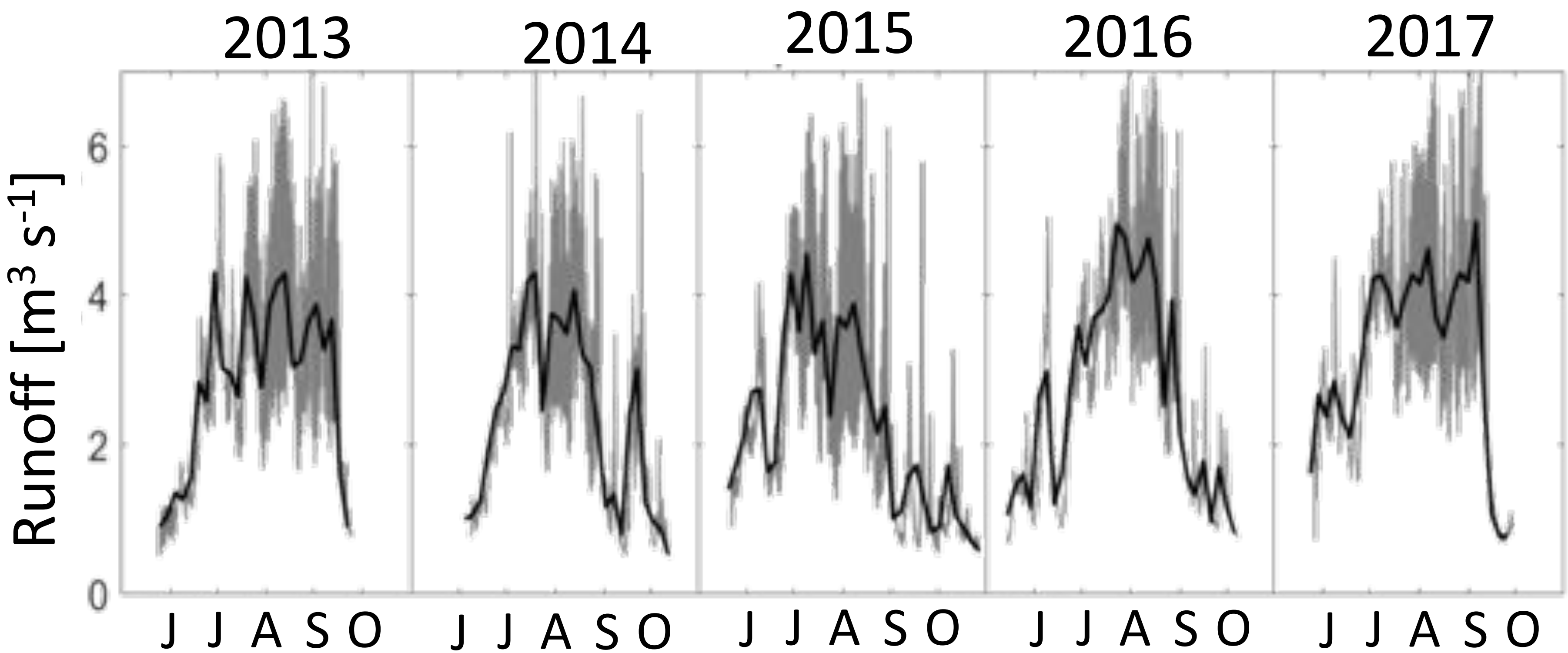
2016: 9.9 km^2

Temperature and precipitation, 2013-2017

- High spring precipitation balance low winter snowpack
- Fall precipitation close to 0˚C
- Limited comparison



How variable is the Peyto runoff ?

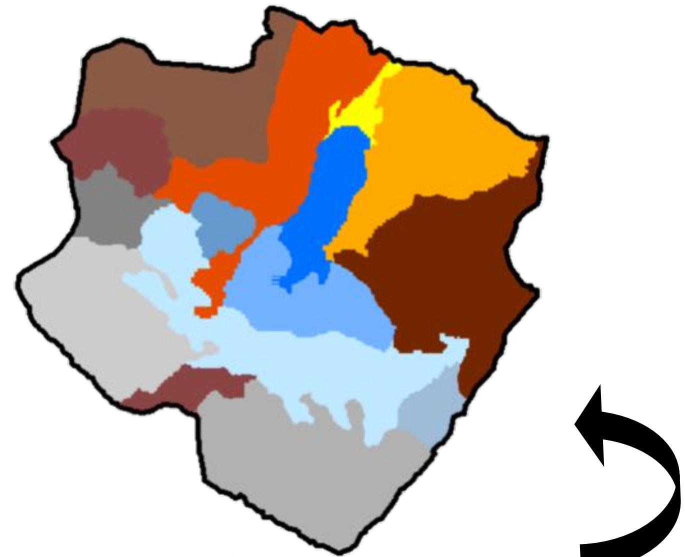


Total Runoff (10^7 m^3)	**3.0**	**2.7**	**3.1**	**3.4**	**3.5**
Mass balance (mm w.e.)	-910	-1630	-1538	-1844	-1410

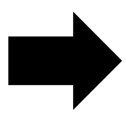
Cold Region Hydrological Modelling Platform (CRHM)

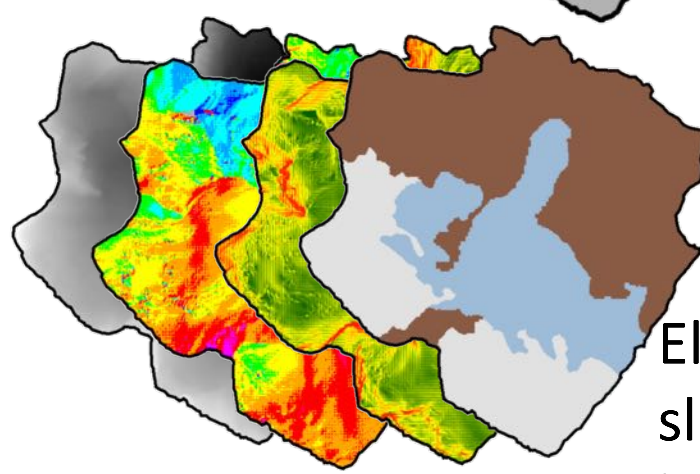
- Cold region processes
- Process-based, modular, flexible
- Includes avalanches, blowing snow, glacier and snowmelt
- Input data: Weather station
- Run 2013-2017

Hydrological Response Unit



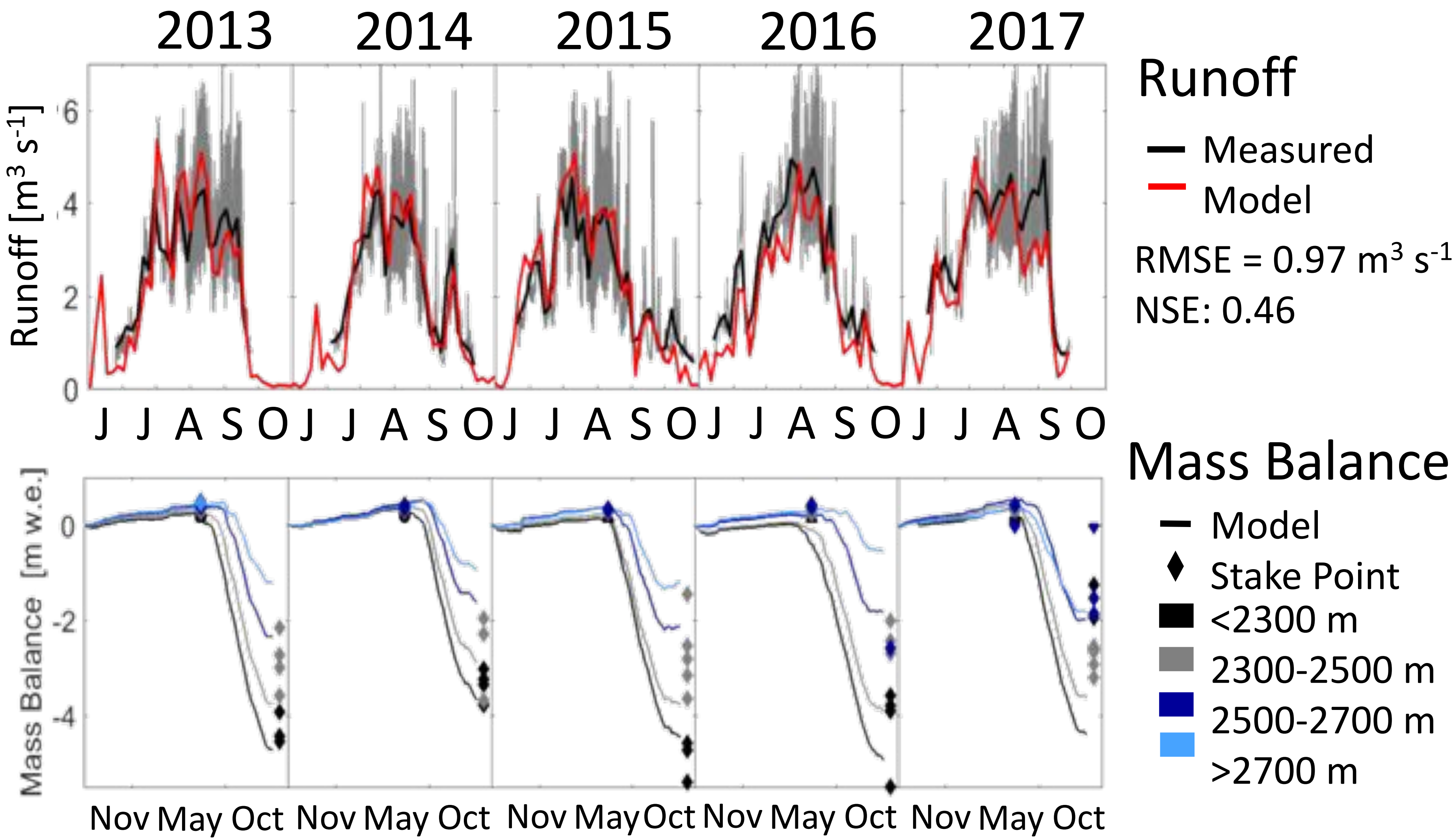
Basin



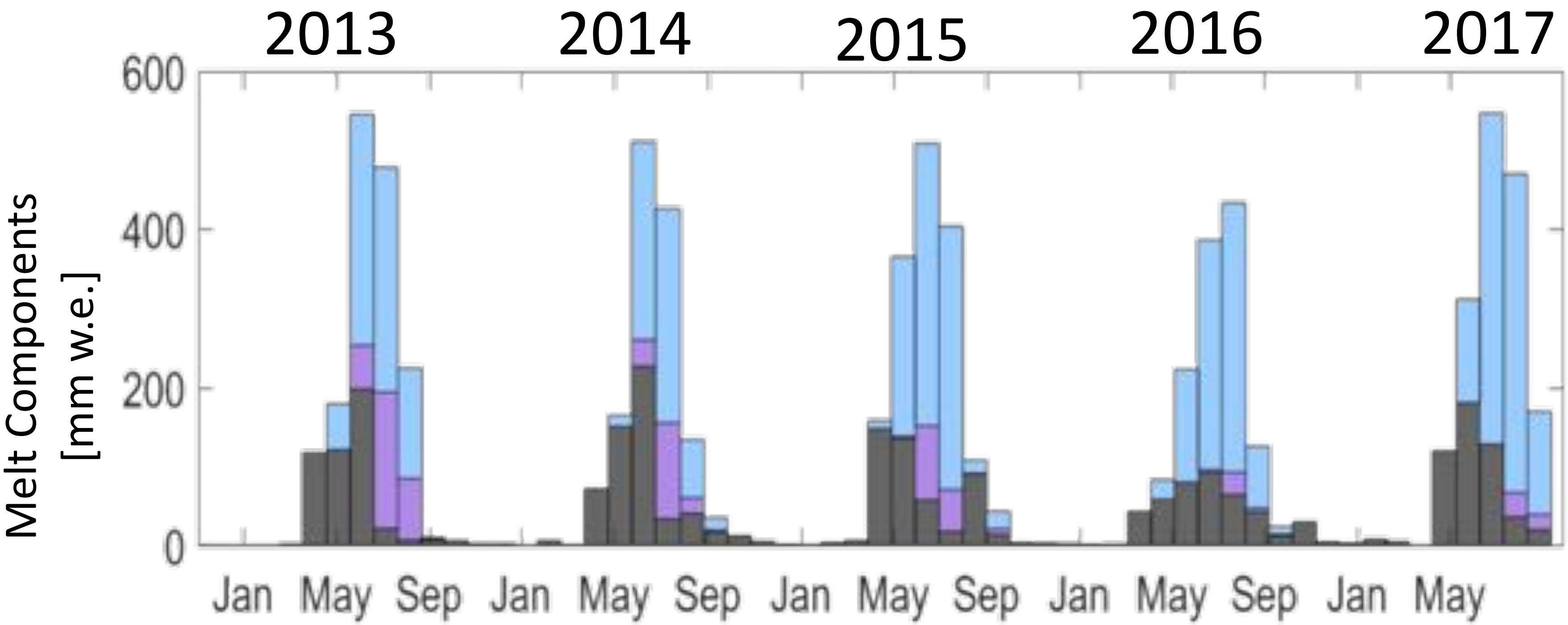


Elevation, slope, aspect, land cover

Model validation

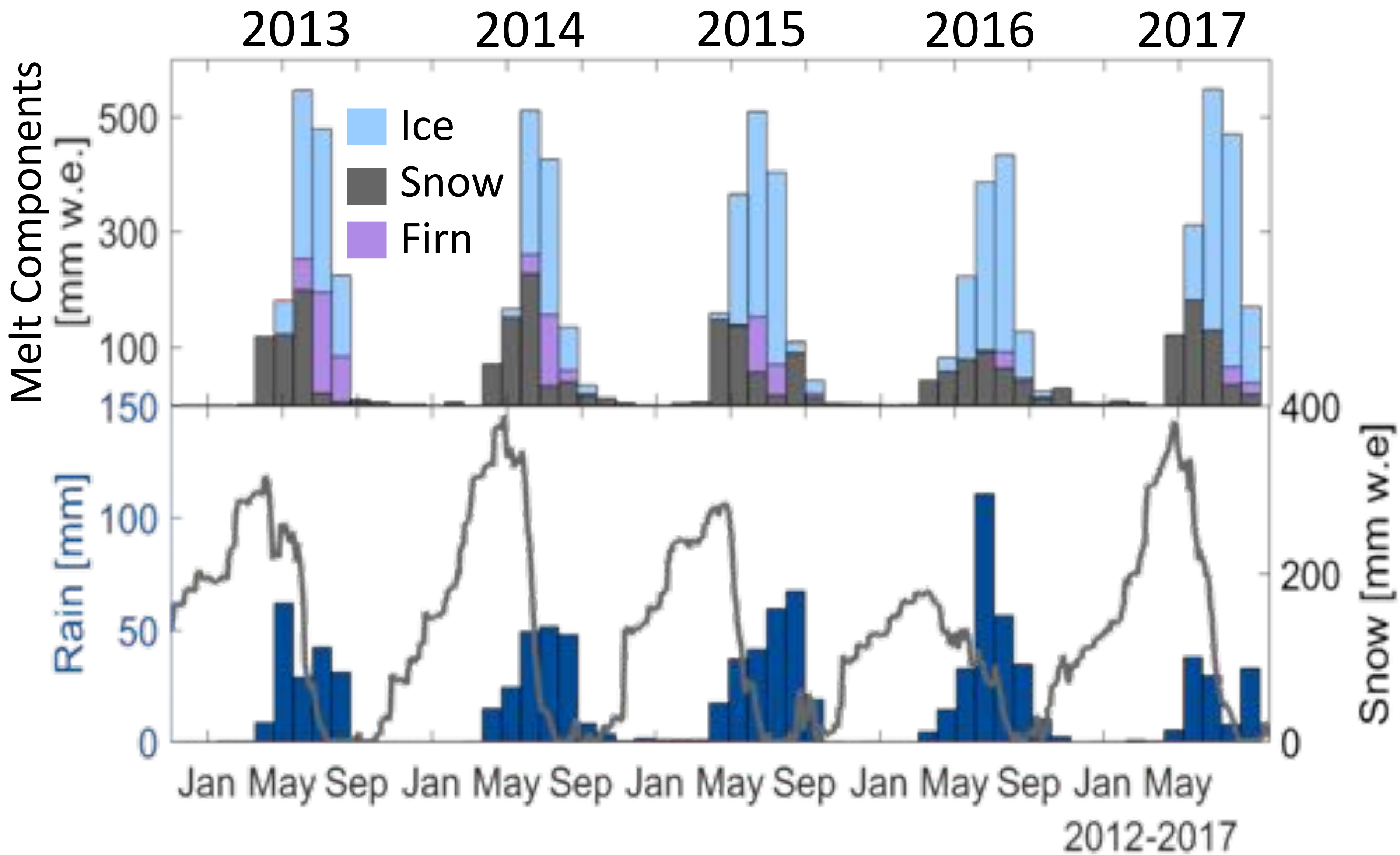


Melt components

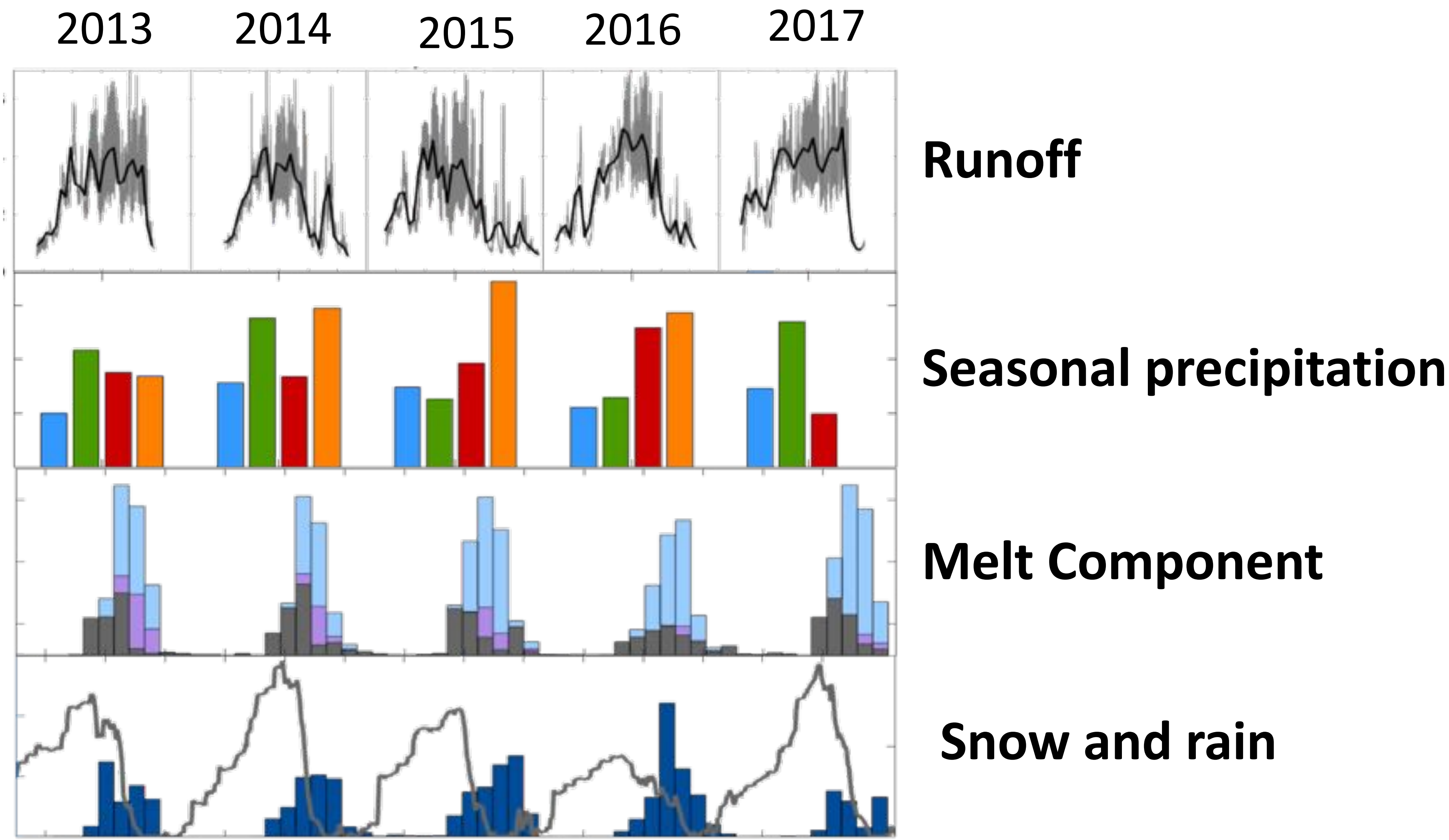


Total (m w.e.)	1.56	1.32	1.60	1.34	1.69
Ice	50%	46%	60%	67%	65%
Snow	31%	41%	31%	30%	32%
Firn	19%	13%	9%	3%	3%

Melt components, snow and rain



What generates streamflow?



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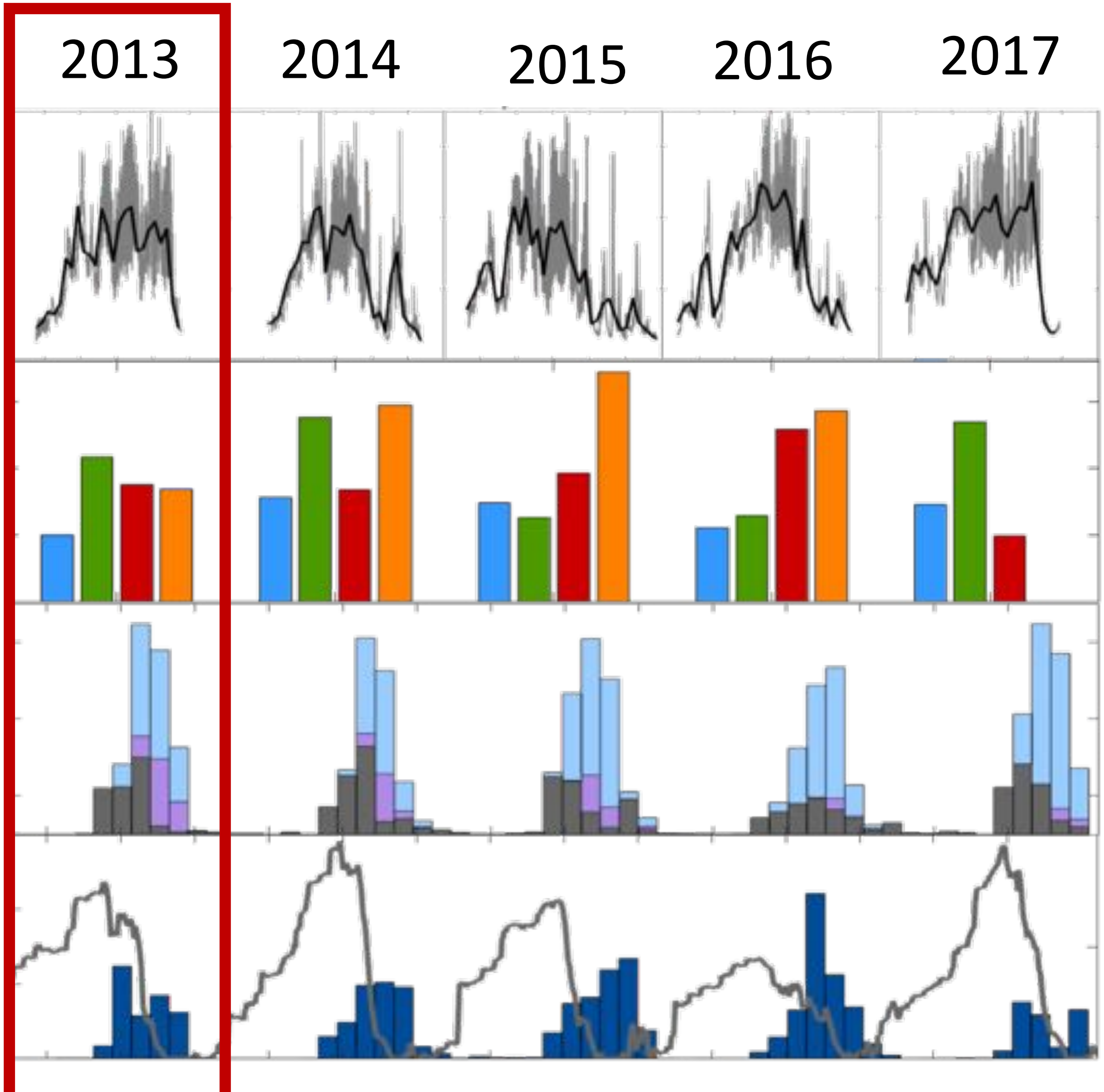

2013: Firn melt

2014: Nearly equal ice and snow

2015: Fall precipitation

2016: High rain and melt

2017: High snowmelt

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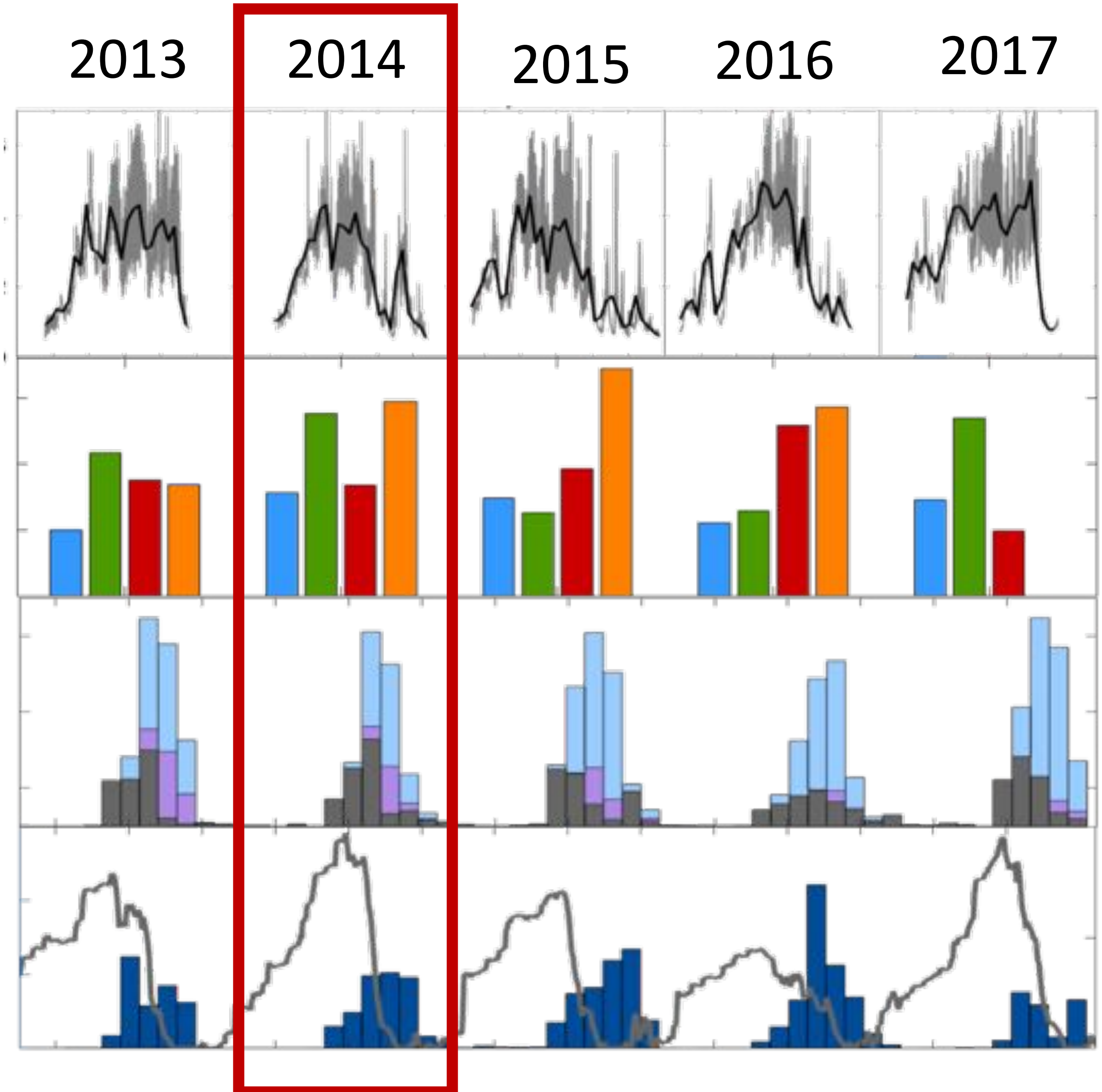

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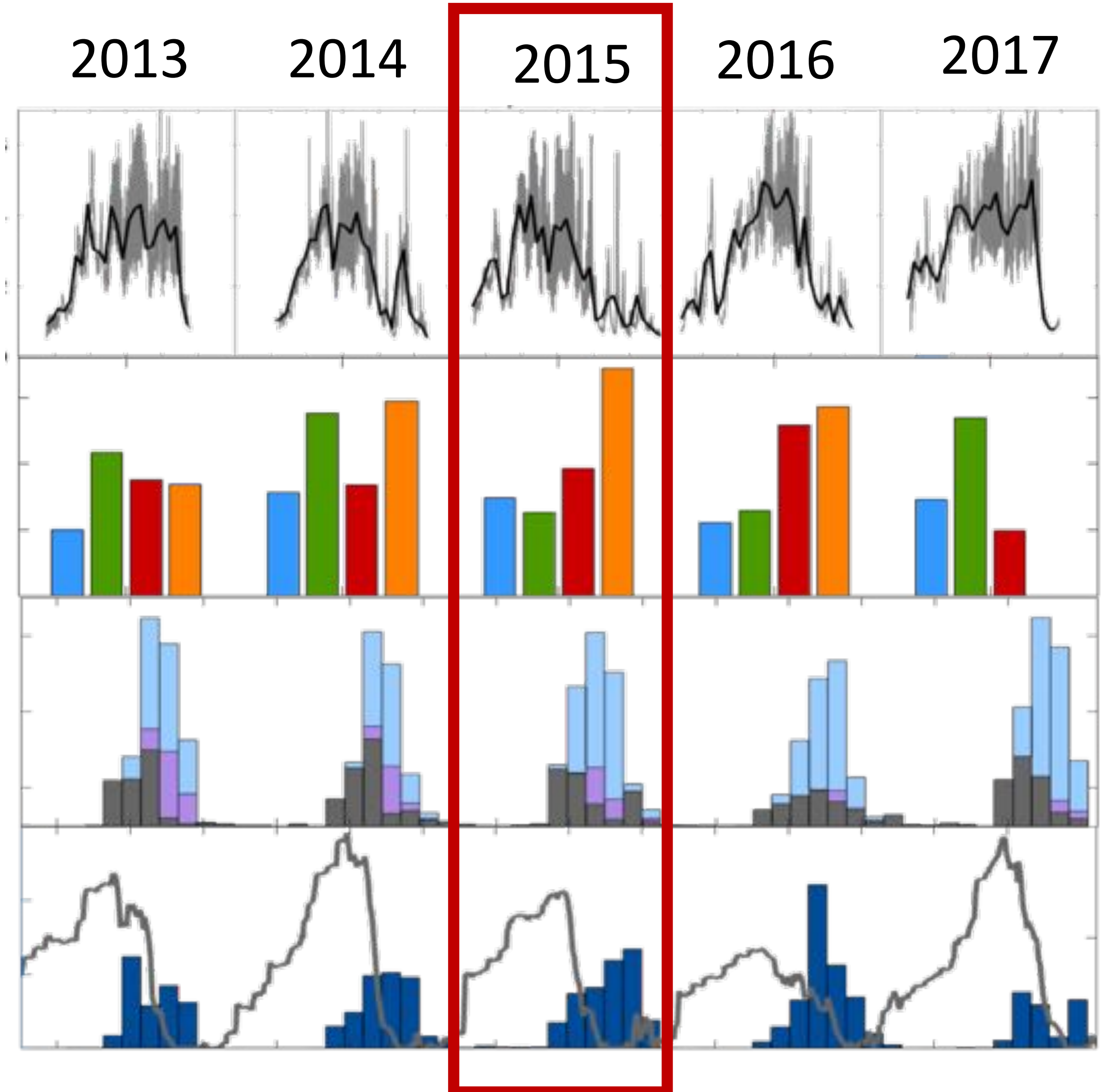

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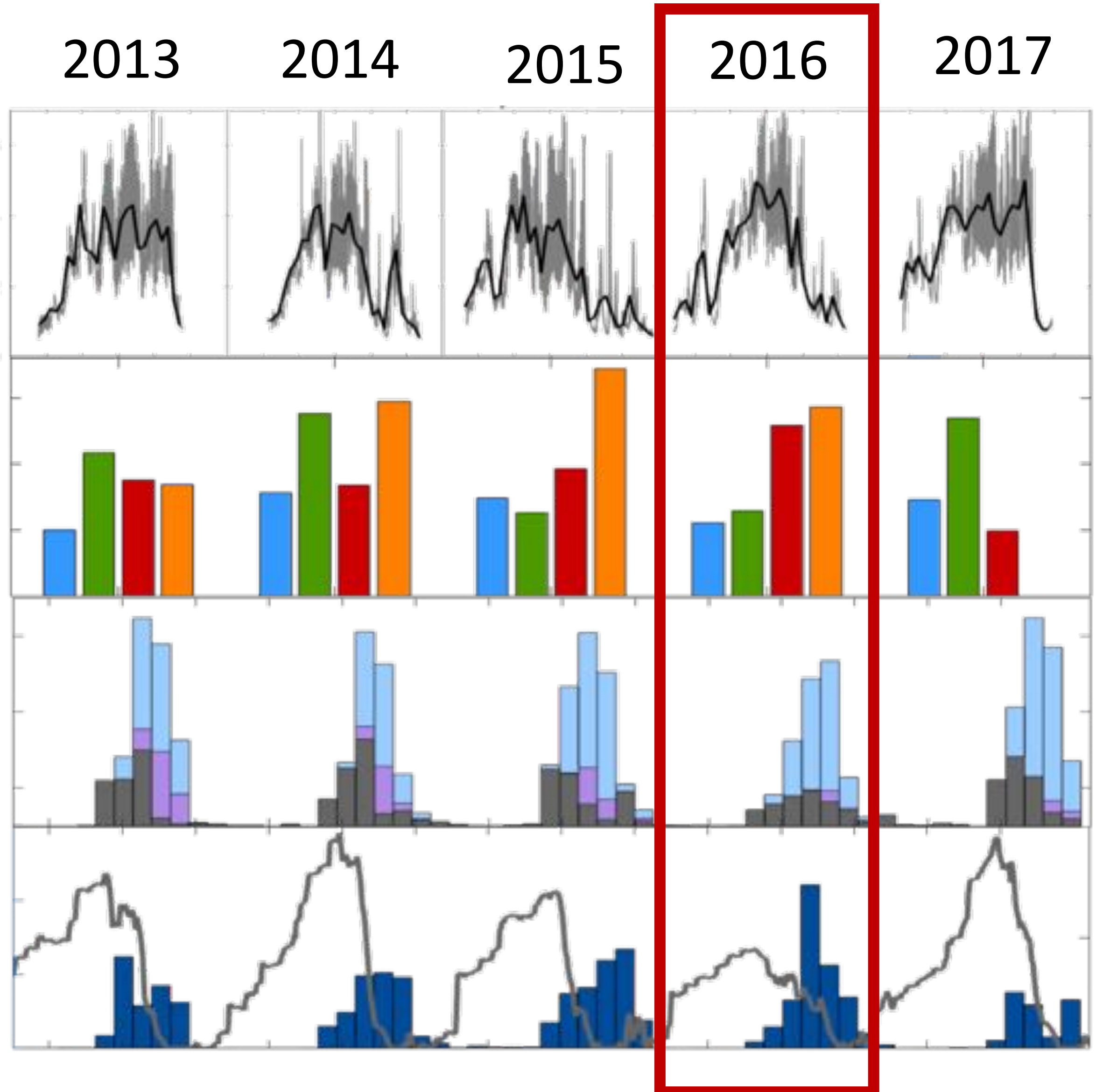

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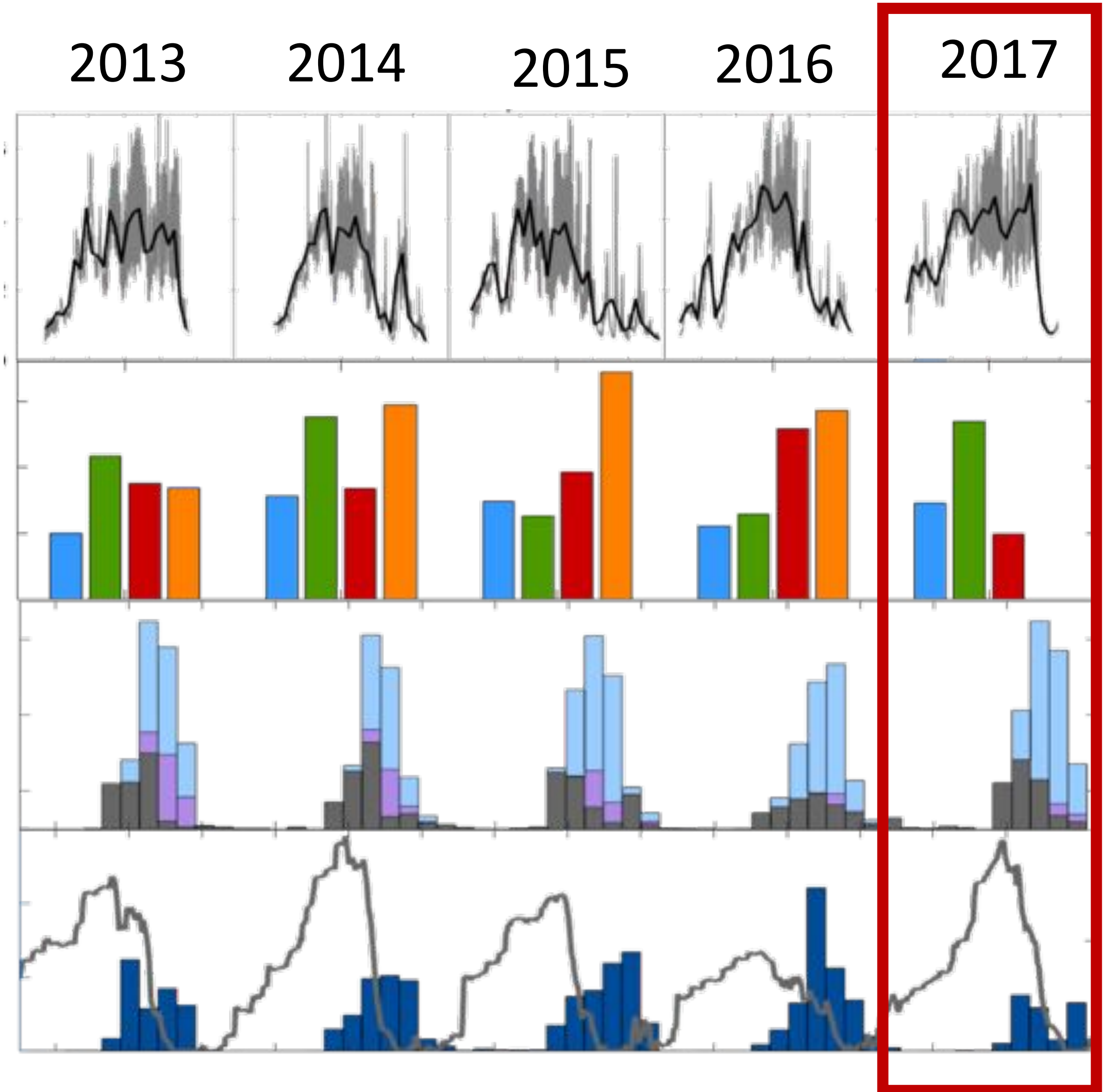

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Summary

- Combining fieldwork and modeling provides further insights on the sources and variability of glacier runoff
- At Peyto, glacier melt still buffers streamflow, even though total runoff is less than historical
- Runoff composition varies considerably depending on seasonal conditions
- Years of low snow can be buffered by high summer rain, and vice-versa

Thank you,

Questions?