What made Winter 2018 unique?

- Tail-heavy winter
- Highest snowfall intensity ever (?) at the Snow Lab: 55 cm/3 hours = 18.3 cm/hr; $\text{avep} = 0.046 \text{ kg/m}^3$, February 26
- Interval board density measurement of 358 kg/m$^3$ after rain-on-snow March 22. $\text{HN24} = 6.5 \text{ cm}$, $\text{HN24W} = 2.3 \text{ cm}$
- Strong differential melting Dec – Feb across our study site
- Significant basal ice by mid-February
November 2017

Total precip since October 1 = 447 mm (194% of average for November 30).

163 mm (6.42") of precip as snowfall
258 mm (10.16") of precip as rain

UC Berkeley
Central Sierra Snow Laboratory
Donner Summit, California
Hourglass Chute
Skier-triggered wind+storm slab
November 16, 2017
Height of snowpack
$H_{S_{\text{max}}} = 2.32 \text{ m}, \text{ March 17, 76}\% \text{ of average}$

Snow water equivalent
$\text{SWE}_{\text{max}} = 67.4 \text{ cm}, \text{ March 24, 72}\% \text{ of average}$

24 hour snowfall
$\sum H_{N24} \text{ (through May 5)} = 6.79 \text{ m}, 68\% \text{ of average}$
Snowiest day 64.0 cm, March 16
Donner Summit Snowfall and Snowpack, Winters 1879-2018

Data Sources:
1879-1945 Southern Pacific Railroad
1946-2018 Central Sierra Snow Laboratory

Snowfall average = 10.3 m, 33.9 ft
Max depth average = 3.5 m, 11.6 ft

Total snowfall
Maximum snowpack depth
Water Year 2018
Total precipitation = 1541 mm (98% of average)
Total snowfall = 679 cm (68% of average)
Max SWE = 67.4 cm (March 26, 72% of average)
average snowpack density

(kg/m³)

2017-2018

Nov 1 Dec 1 Jan 1 Feb 1 Mar 1 Apr 1
The 2017/2018 Sierra Nevada Snow Drought

California Snowpack Anomaly Jan 15, 2018

Fallen Leaf (1900 m / 6220 ft)

Central Sierra Snow Lab (2089 m / 6850 ft)

-300 -240 -180 -120 -60 0 60 120 180 240 300

Snow Water Equivalent (SWE)

Difference from Jan 15 Average (mm)

- Mean Precipitation (PPT)
- Observed PPT
- Median Snow Water Equivalent (SWE)

Snow Drought: PPT < 100%
Warm Snow Drought: SWE < 100%
Dry Snow Drought: PPT < 100% and SWE < 100%

B. Hatchett / @Dr_Ops
D. McEvoy / @Hydromet_man WRCC/DRI
Northern Sierra Nevada
January 2018
“In the last 10 years, the snowline in the northern Sierra has risen on average 120 ft/year.”

—Ben Hatchett
By early February our modest snowpack was the product of three modest snowfalls.
Blocking high pressure off the California coast broke down on February 18
**Rain-on-(cold)snow events**

<table>
<thead>
<tr>
<th>Date</th>
<th>Rain (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 3-10</td>
<td>149</td>
</tr>
<tr>
<td>March 8-13</td>
<td>32</td>
</tr>
<tr>
<td>March 20-22</td>
<td>123</td>
</tr>
<tr>
<td>April 6-7</td>
<td>76</td>
</tr>
</tbody>
</table>

Snowline started at 6700 ft, then rose to 12,000 ft, then up to 13,400 ft.  

*(B.Hatchett)*
Stage height Upper Castle Creek at 6883’
December 8, 2017 - April 4, 2018
Upper Castle Creek at 6883 feet elevation
Stage height (cm)   April 4 - May 21, 2018
Stage height Lower Castle Creek at 6883'
December 8, 2017 - April 4, 2018

[Graph showing stage height over time with notable peaks on March 13 and March 20, labeled as 'rain-on-snow']
Free water dripping out of bottom of snow core
Meltpan daily outflow
November 21, 2017 - May 4, 2018

**North pan** total outflow = 118.88 cm

**South pan** total outflow = 73.34 cm

Total precip = 107.90 cm

\[
\frac{118.88}{107.90} = 1.10
\]

\[
\frac{73.34}{107.90} = 0.68
\]
fraction WATER YEAR rain
test statistic = 233
p-value = .005
$\alpha = .01$
$R^2 = 0.26$

fraction DEC-MAR rain
test statistic = 248
p-value = .003
$\alpha = .01$
$R^2 = 0.27$
SWE Comparison

- Pressure plate 5 foot
- Pressure plate 9 foot
- Cosmic ray detector
- Hand measured
- Fluid pillow hourly
- Fluid pillow daily

(A. Heggli)
Snow survey for near- and far-field neutron sensor
April 26, 2018

37 transects, 437 samples

HS\text{ave} = 33 \text{ cm}
SWE_{ave} = 14.3 \text{ cm}
Neutron SWE = 15.0 \text{ cm}

HS_{ave} = 56 \text{ cm}
SWE_{ave} = 24.3 \text{ cm}
Neutron SWE = 29.3 \text{ cm}

Master stake HS = 55.5 \text{ cm}
No statistically significant relationship.
Abies magnifica + Letharia vulpina
April 1, 2018
HS ~2.5 m

Abies magnifica + Letharia vulpina
2.5 m / 3.5 m = 0.71
Hard, dense basal ice.
92.6 g/110 cm$^3$ = 0.842 g/cm$^3$  
9 cm(0.842) = 7.58 cm$_{swe}$
Installed 3290 mm capacity Geonor precipitation gauge
June 2018
August 29, 2018

Sommer pressure plate back online.
Set flush with soil surface.

Diurnal flux of ~1 cm SWE
Installed September 2018
all ~4.65 m above ground
Thank you