Applications of Atmospheric Rivers to Paleohydroclimate Problems in the Great Basin

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DRI Desert Research Institute

Southwest Climate Science Center

Comer Family Foundation

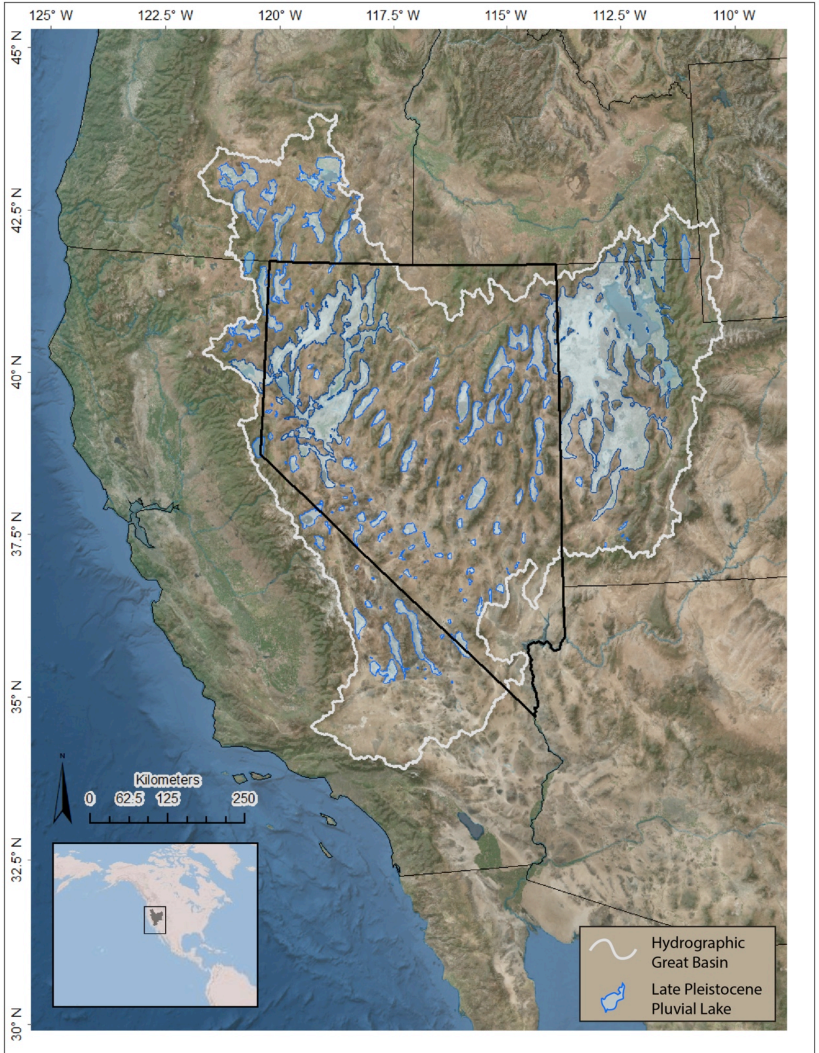
TIDES WHAT'S POSSIBLE

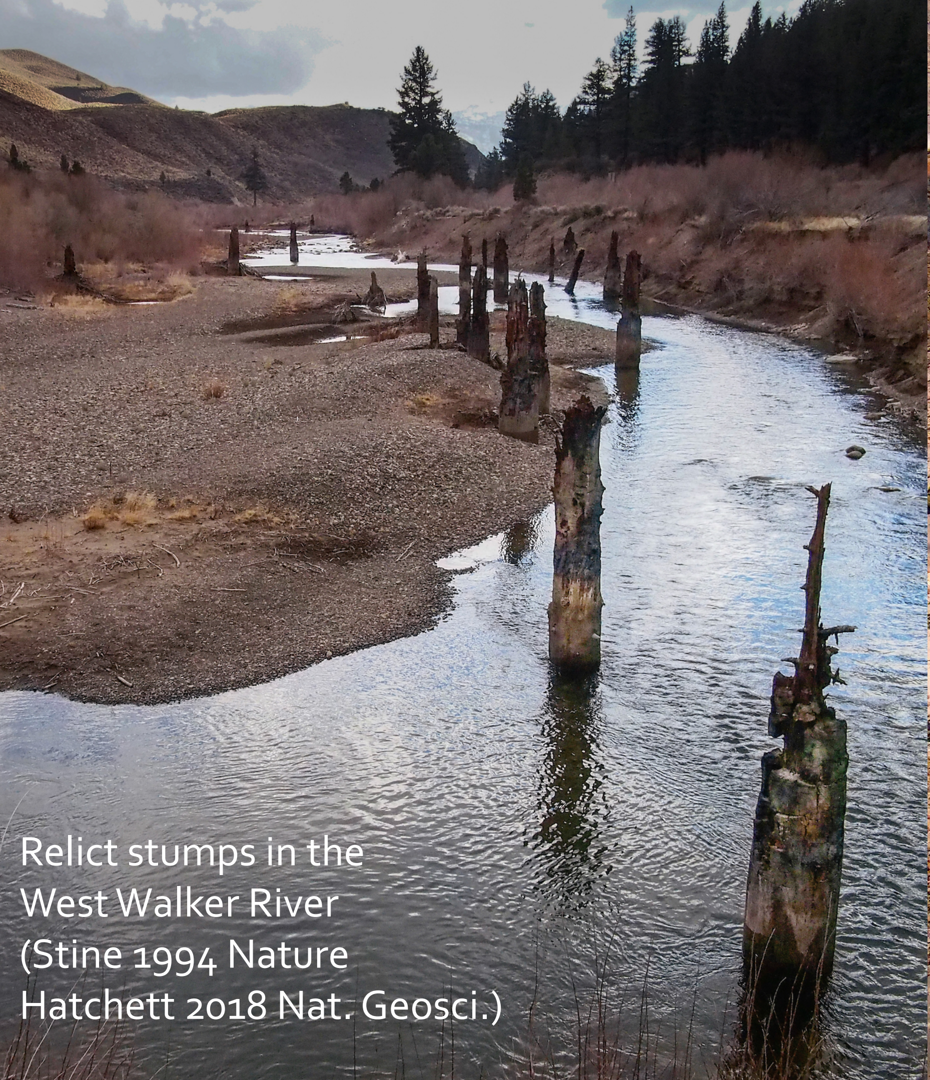
National Fish and Wildlife Foundation

NASA EPSCoR Nevada

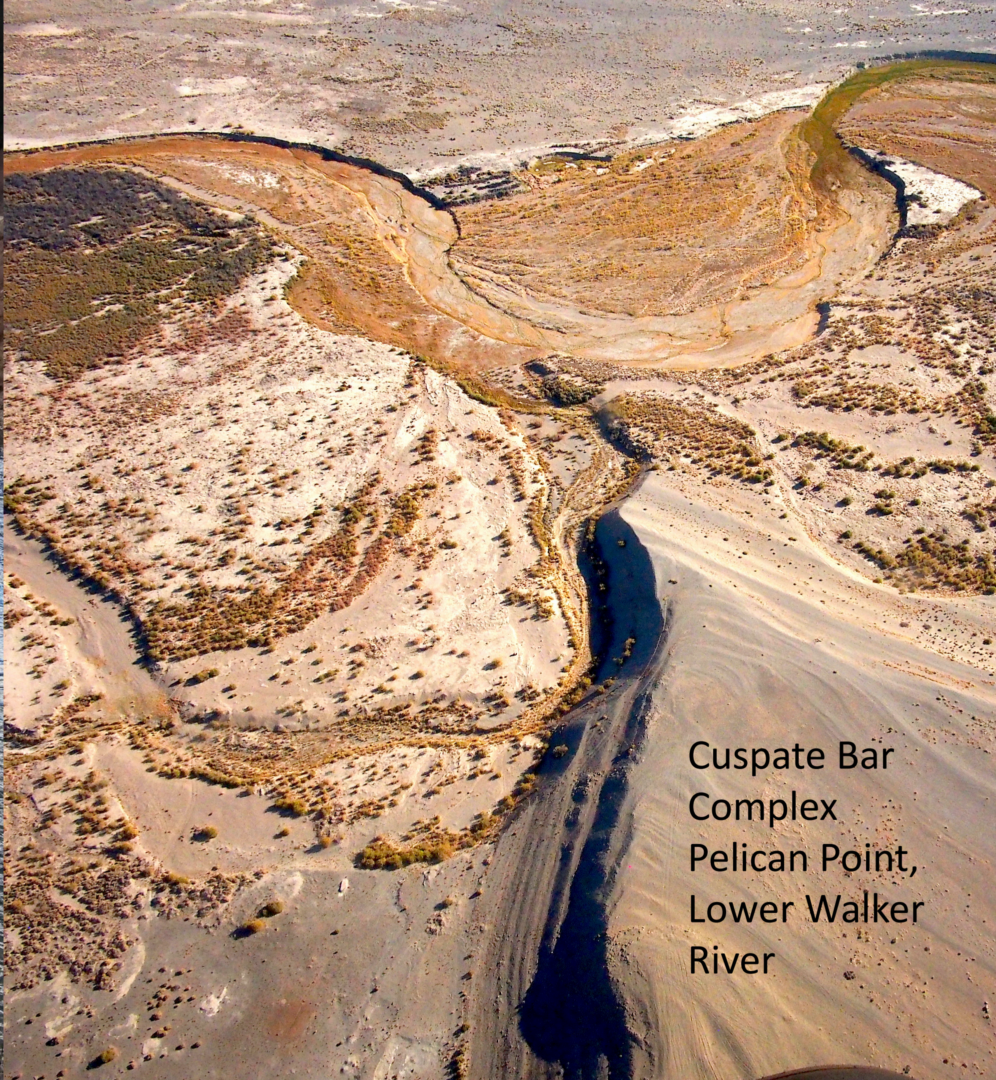
Nevada NASA Space Grant Consortium Since 1991

The Great Basin: Home of the closed basin terminal lake



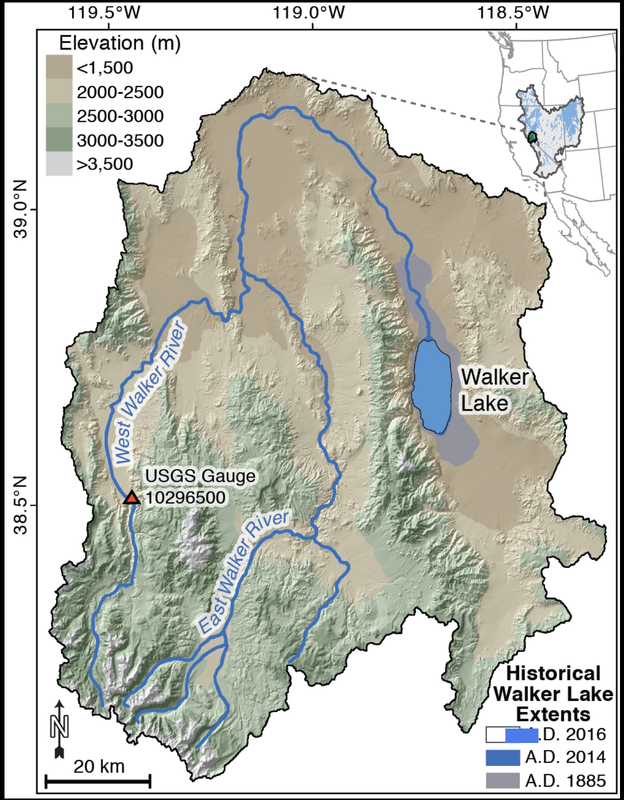


Relict stumps in the West Walker River (Stine 1994 Nature Hatchett 2018 Nat. Geosci.)



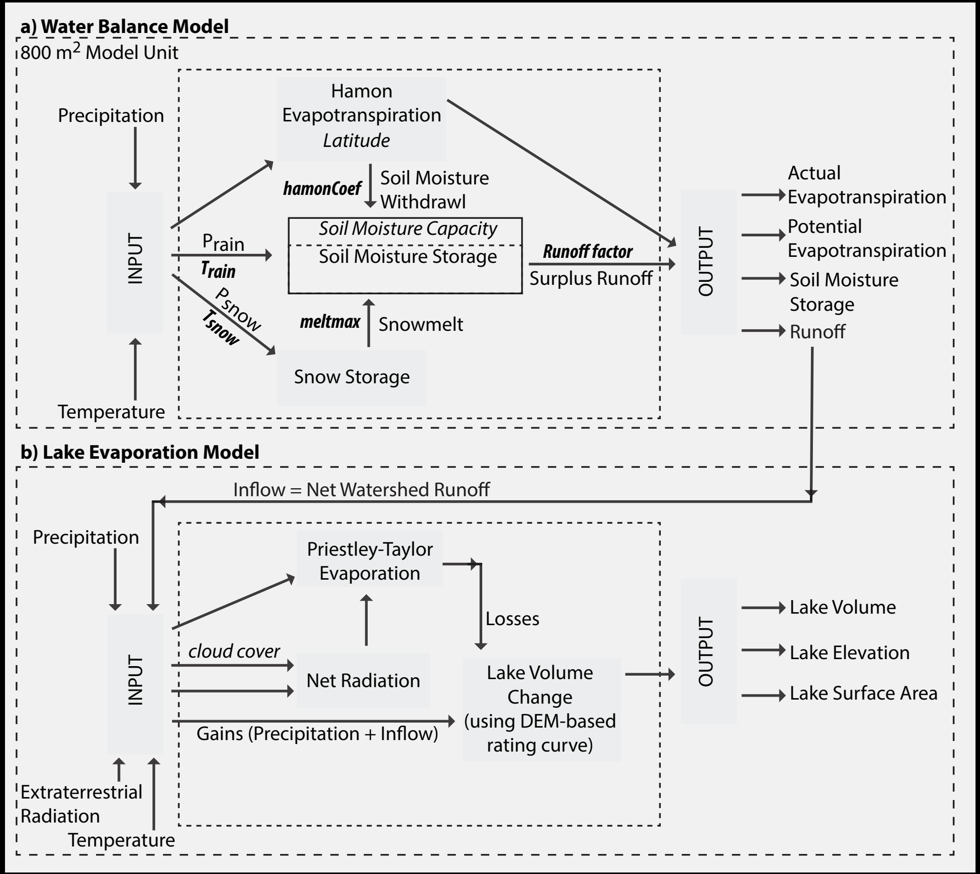
Cuspate Bar Complex Pelican Point, Lower Walker River

Focus: The Walker Lake Basin

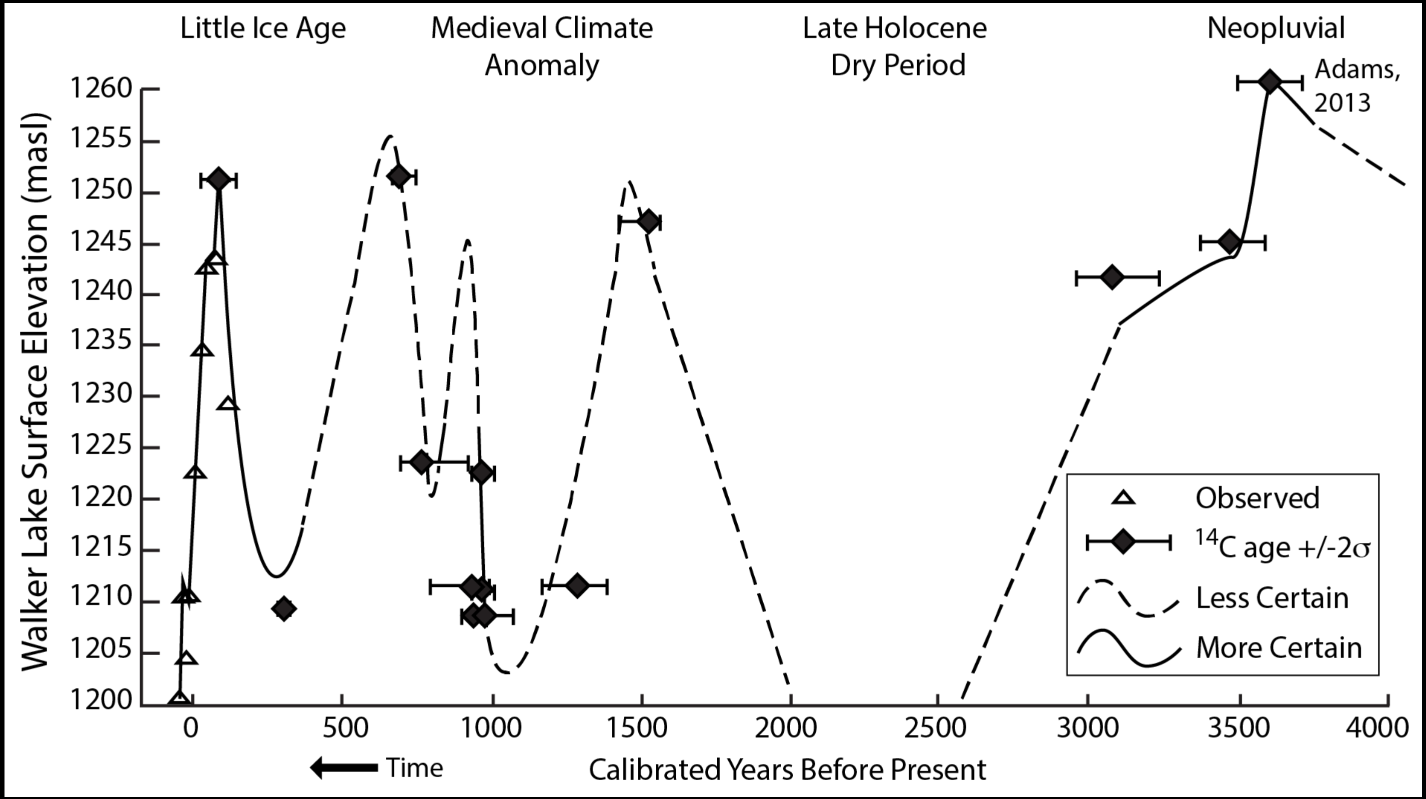


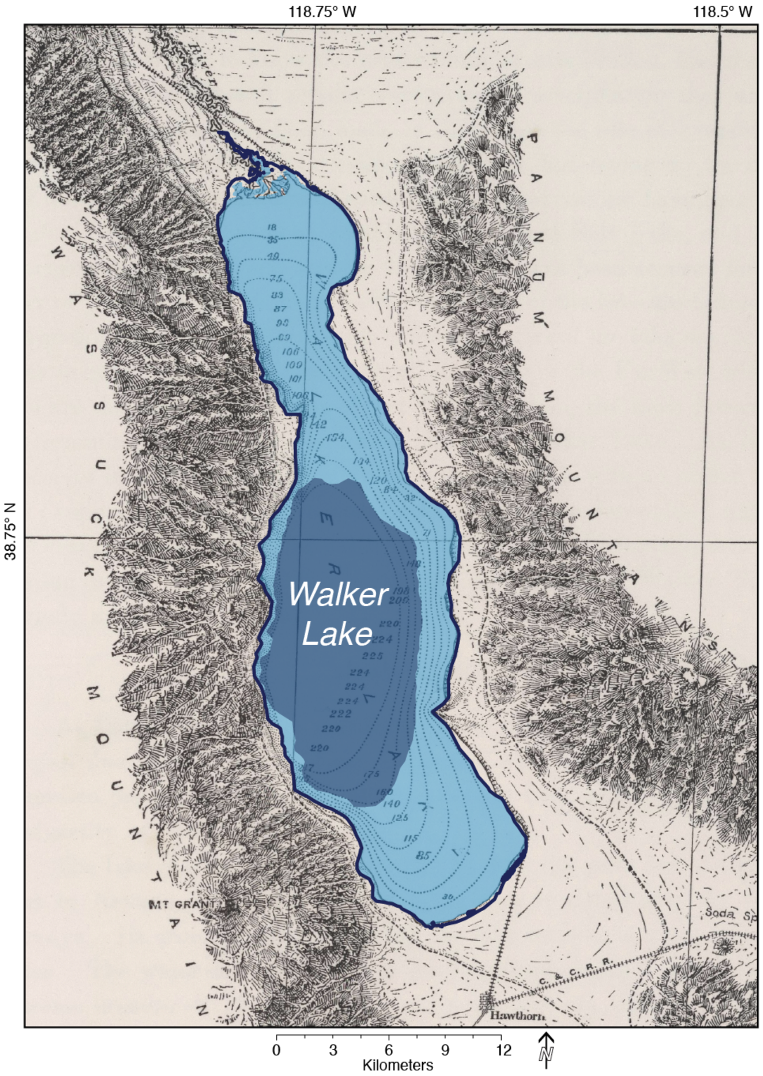
Watershed Water Balance and Lake Evaporation Models

(Hatchett et al. 2015 *Geophys. Res. Lett.*, Barth et al. 2016 *J. Paleolimnol.*)



Walker Lake shoreline reconstruction
(Adams Bull. Amer. Geol. Soc. 2007, 2013)

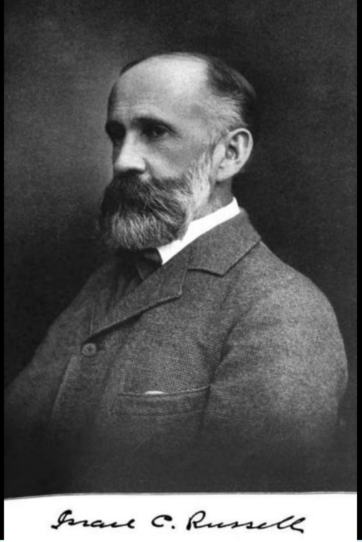




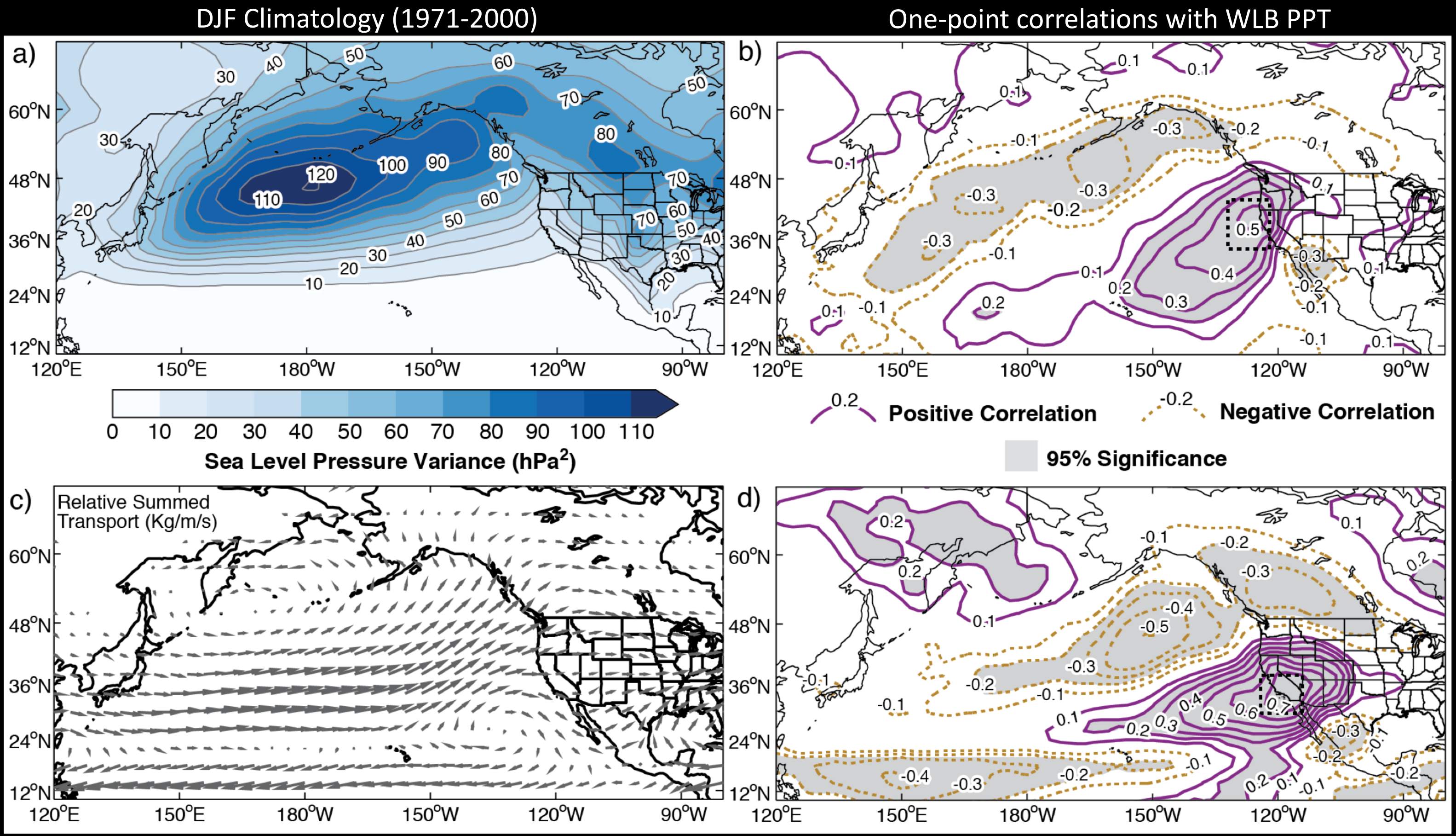
Israel Russell 1882 A.D.
1250 m

Late Holocene ca. 1890 A.D.
1252 m

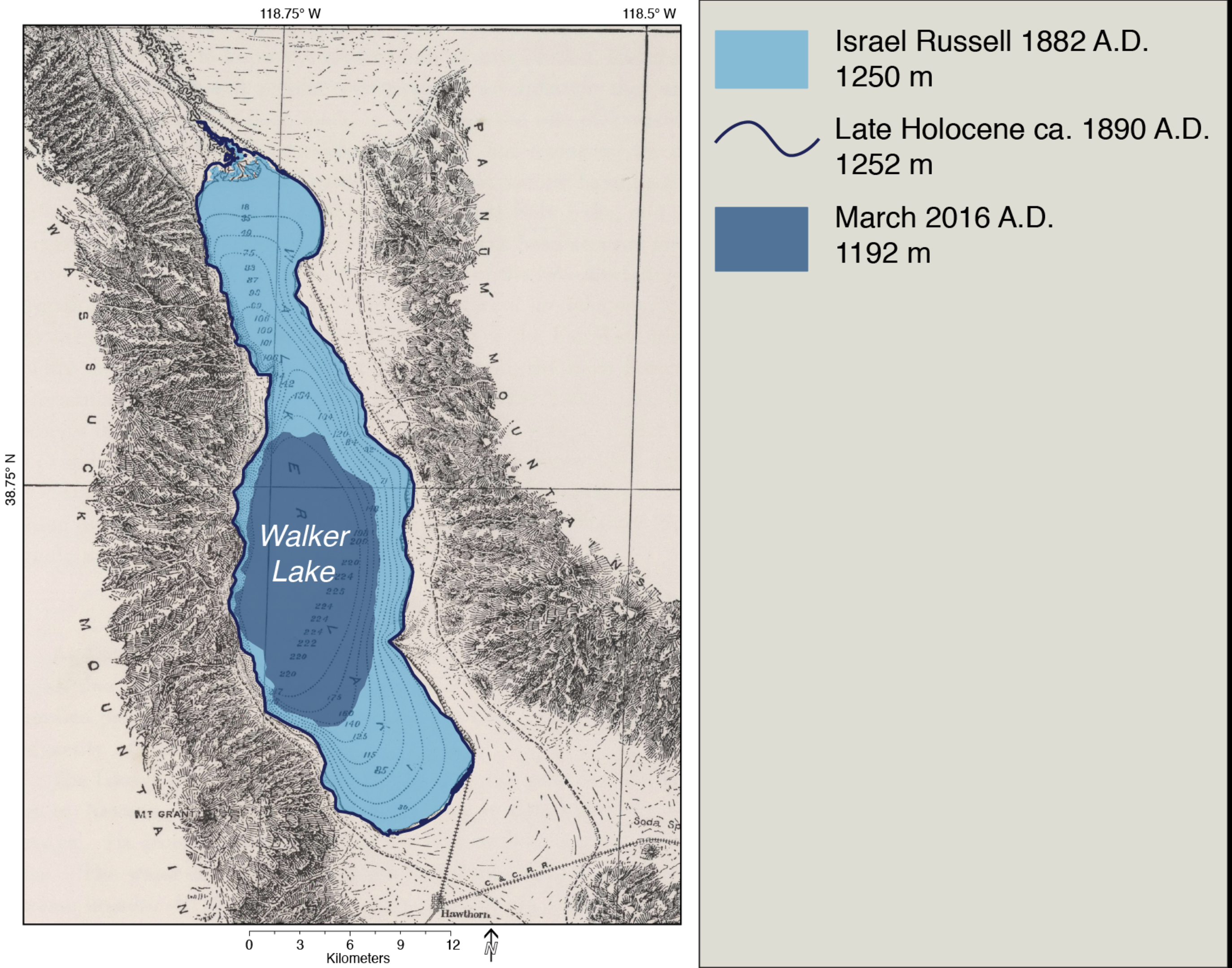
March 2016 A.D.
1192 m



What are terminal lake levels more sensitive to: Winter Storm Track Activity or Moisture Transport?



Hatchett et al. (2018 Geol. Soc. Amer. Sp. Papers)


118.75° W
118.5° W
38.75° N
Walker Lake
MT GRANT
Hawthorn
Soda Sp
0
3
6
9
12
Kilometers
N
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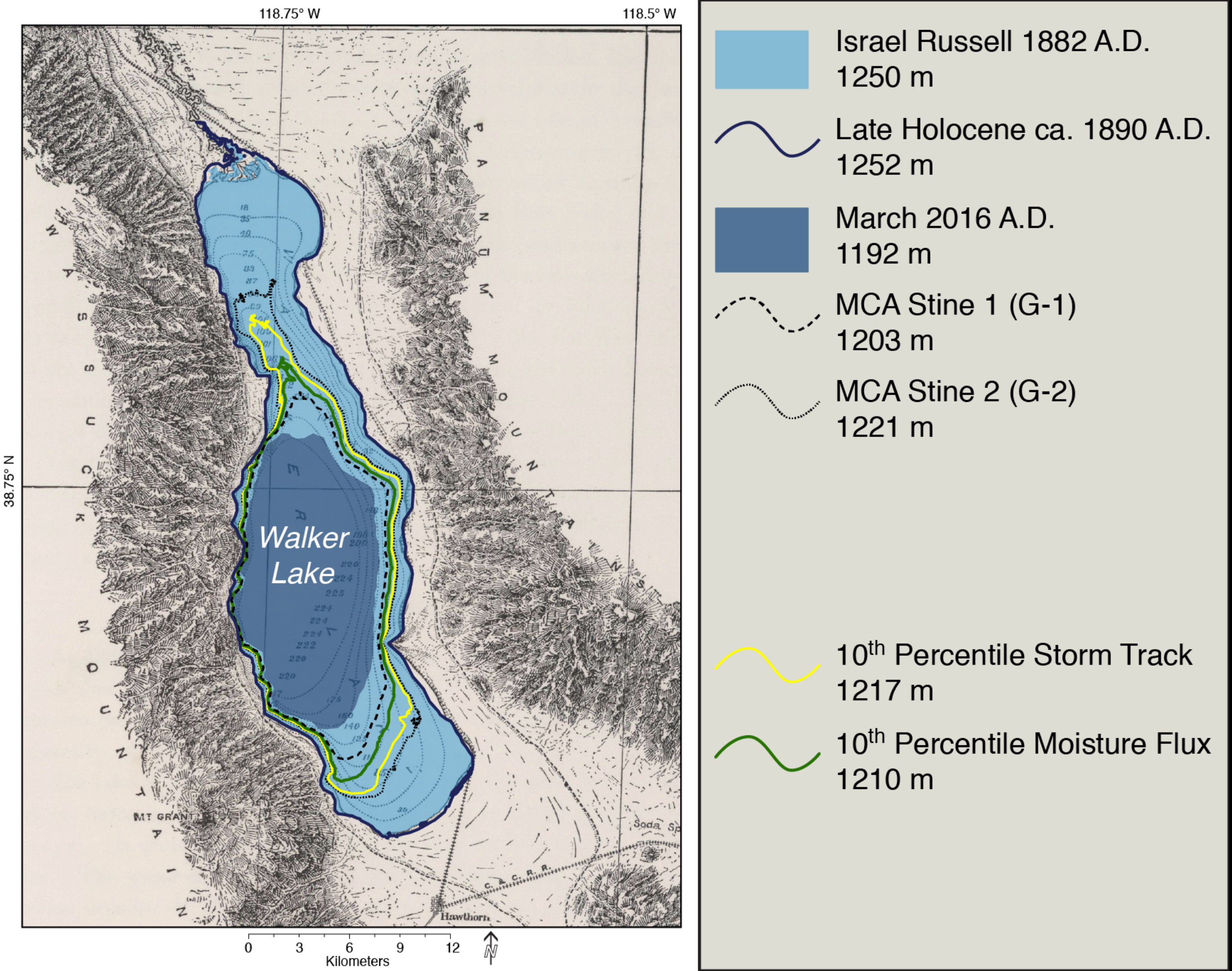

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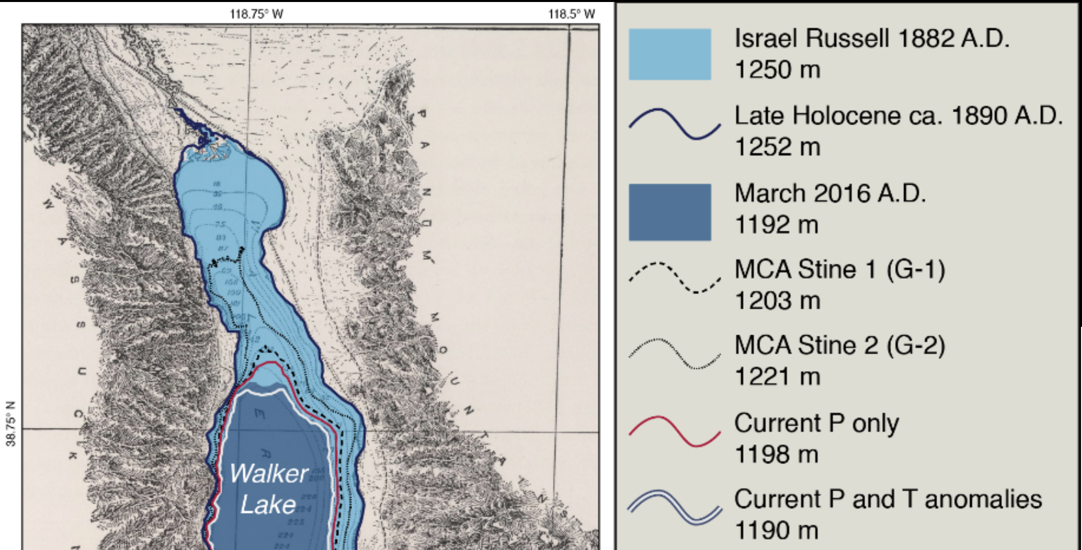
March 2016 A.D.
1192 m
MCA Stine 1 (G-1)
1203 m
MCA Stine 2 (G-2)
1221 m
10th Percentile Storm Track
1217 m
10th Percentile Moisture Flux
1210 m

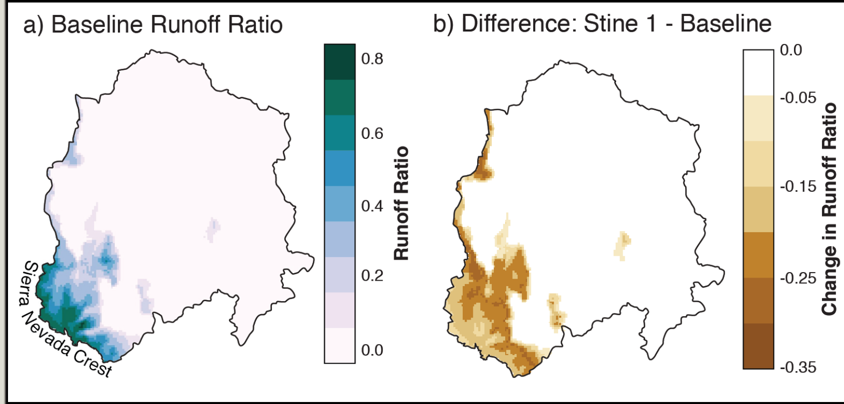
Application to 2012-2016 Drought: On par with magnitude of medieval megadroughts, but not persistence (5 years vs. 140+)



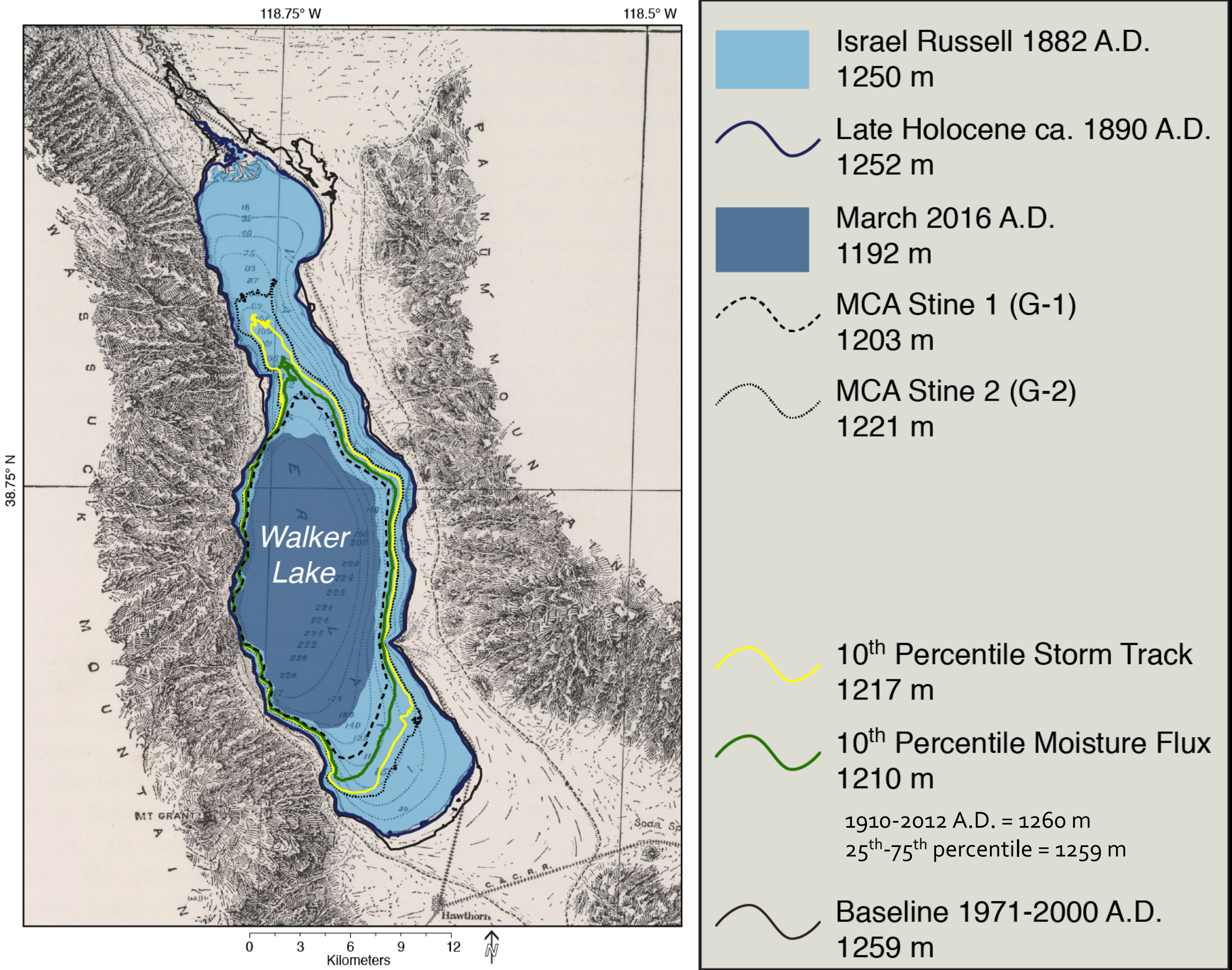
* Other historical droughts have similar precipitation anomalies to recent drought

Land surface process:

53% reduction in contributing area, also explains asymmetric lake response to wet climate



Hatchett et al. (2015) Geophys. Res. Lett.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10th Percentile Storm Track
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10th Percentile Moisture Flux
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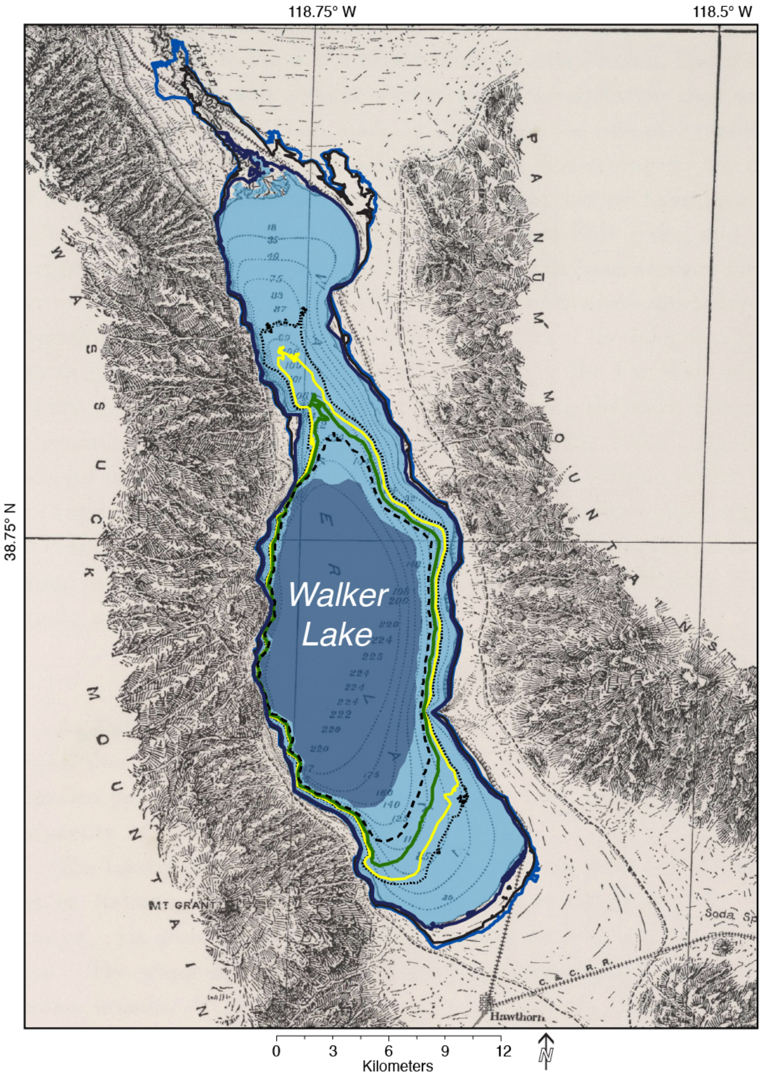
1910-2012 A.D. = 1260 m
25th-75th percentile = 1259 m
Baseline 1971-2000 A.D.
1259 m



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1192 m

MCA Stine 1 (G-1)
1203 m

MCA Stine 2 (G-2)
1221 m

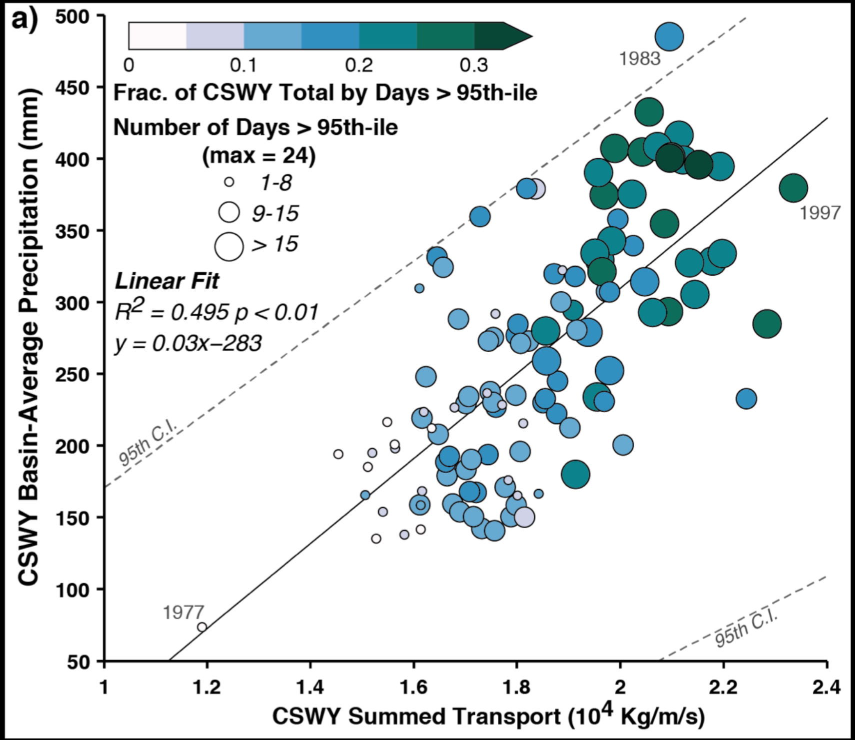
Baseline ≈ 1910-2012 ≈ Neopluvial

Implies 20th century as wet as any
in past 3,700 years

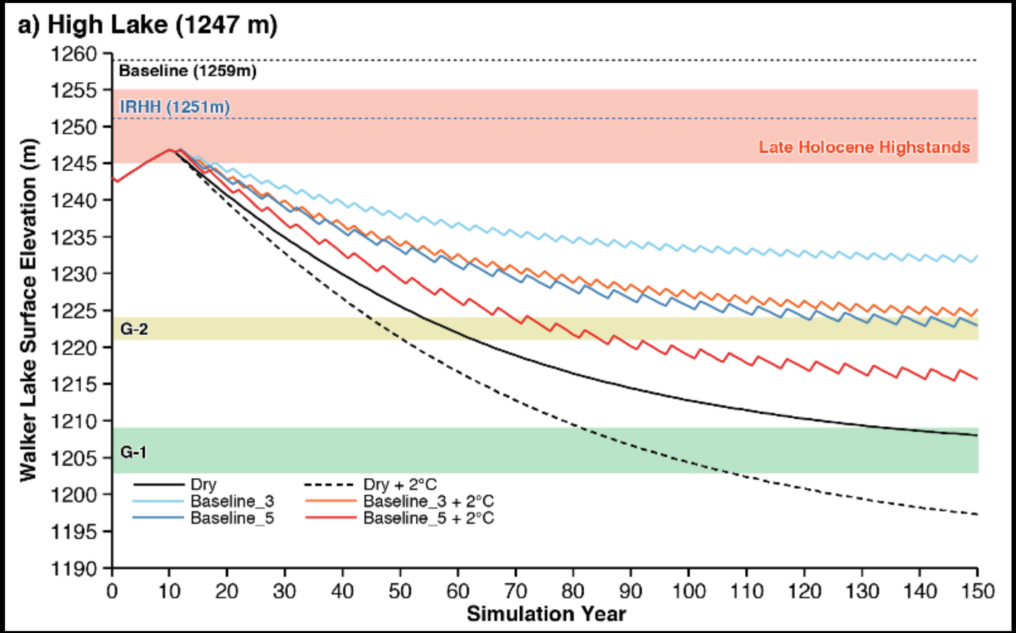
Neopluvial (ca. 3.7ka)
1261 m

Baseline 1971-2000 A.D.
1259 m

Strong transport days (>95th percentile) drive wet/dry years in Walker Lake Basin



…even occasional normal wet years can *maintain* megadrought trajectory (think repeat of 2012-2015+2016)

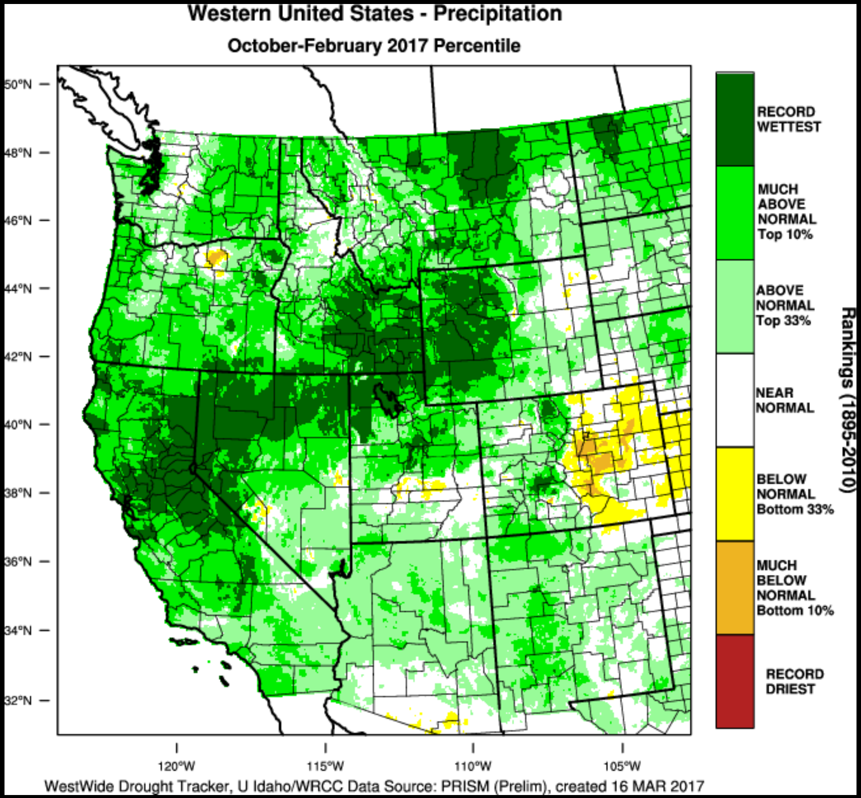


WY1949-2012:
90% of >95th-ile days classified as atmospheric river days by Rutz et al. (2014 Mon Wea. Rev.)

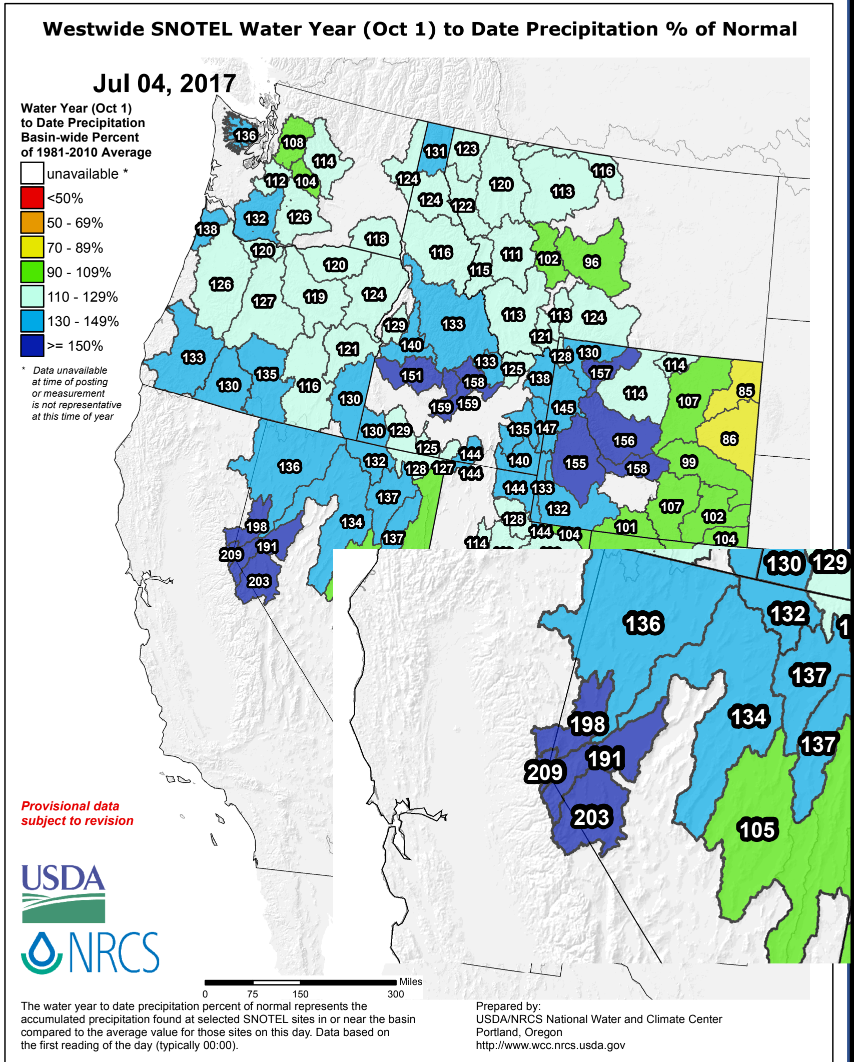
Hatchett et al. (2016 Quat. Sci. Rev.)

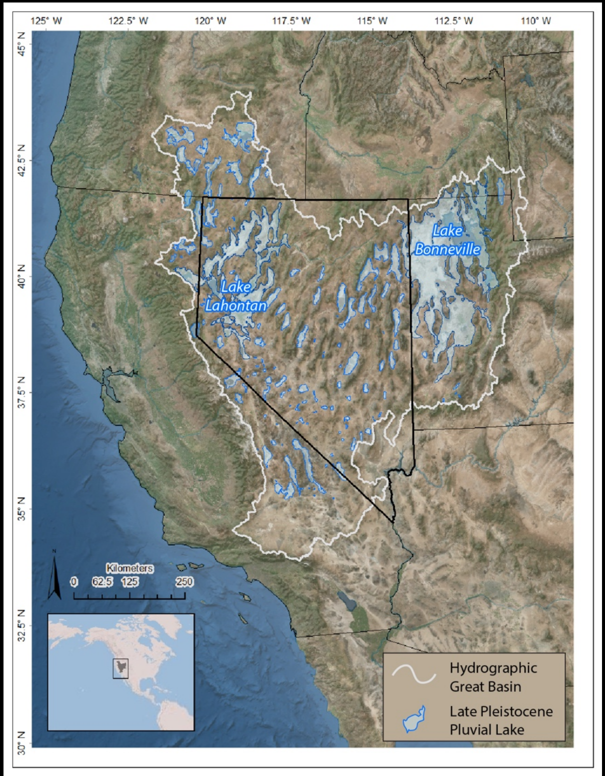
WY2017 as Evidence for N. Sierra Inland Penetration Pathway → Filling of Pluvial Lake Basins

Rutz et al. (2015 *Mon. Wea. Rev.*) regime 2
Swales et al. (2016 Geophys. Res. Lett.) Nodes 5&7



WY2017 PPT on par with Deglacial (16kya) Pluvial Lake highstands





Barth et al. 2016 *Jour. Paleolimnology*

Birkel et al. 2012 *Arct. Antarct. Alp. Res.*

Hudson et al. in review

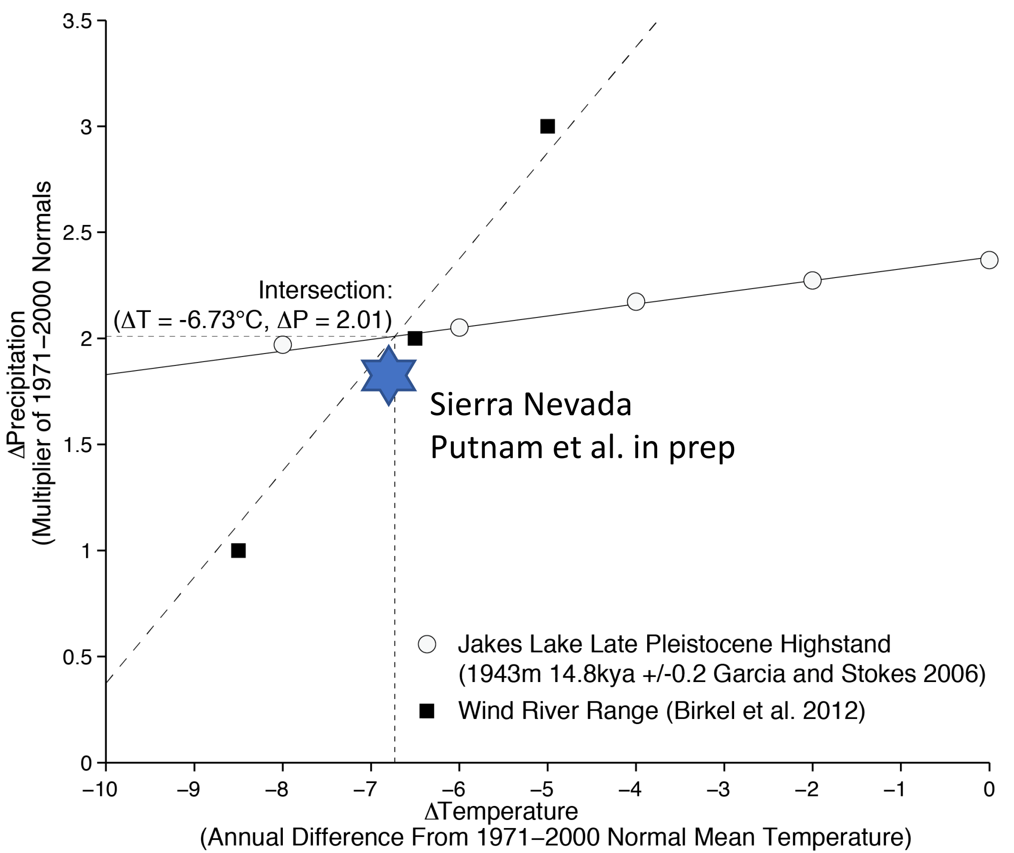
Garner, Hatchett unpublished model runs

WY2017 on par with Deglacial PPT anomalies

Deglacial Climate required 2x normal (e.g., 2016/2017) PPT *(but for 100+ years)*

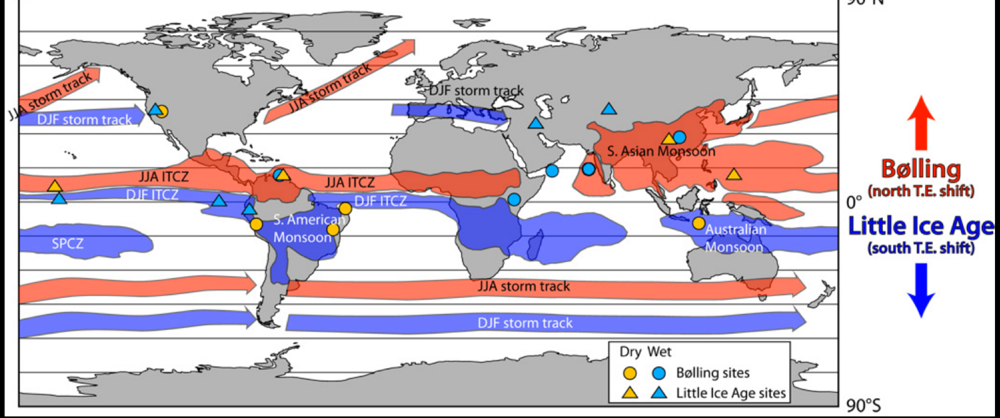
Jakes Lake + Wind River/Sierra Nevada

(Barth et al. 2016 *Jour. Paleolimnol.*
Birkel et al. 2012 *Arctic Alp Antarc Res.*)



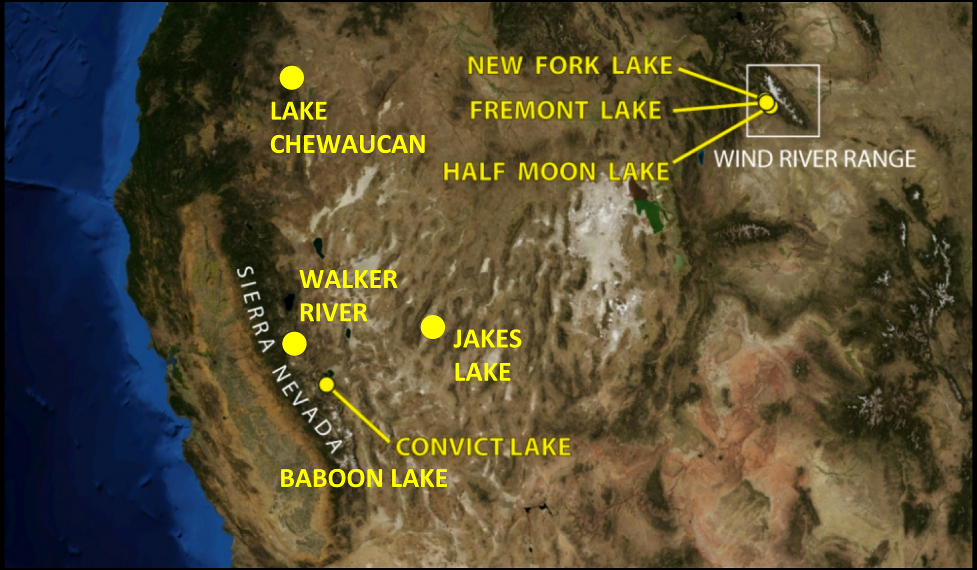
Ongoing Hydroclimate Application:

Response of midlatitude and alpine regions to a warming world



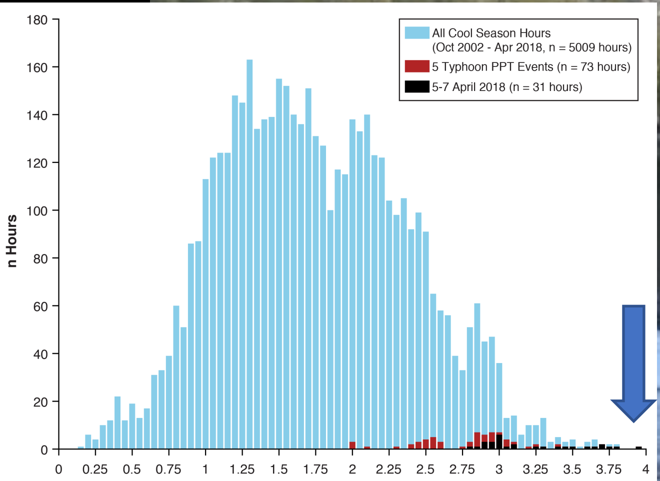
Putnam and Broecker (2017) Sci. Adv. Broecker and Putnam (2013) PNAS

Hatchett (2018) Nature Geosci.

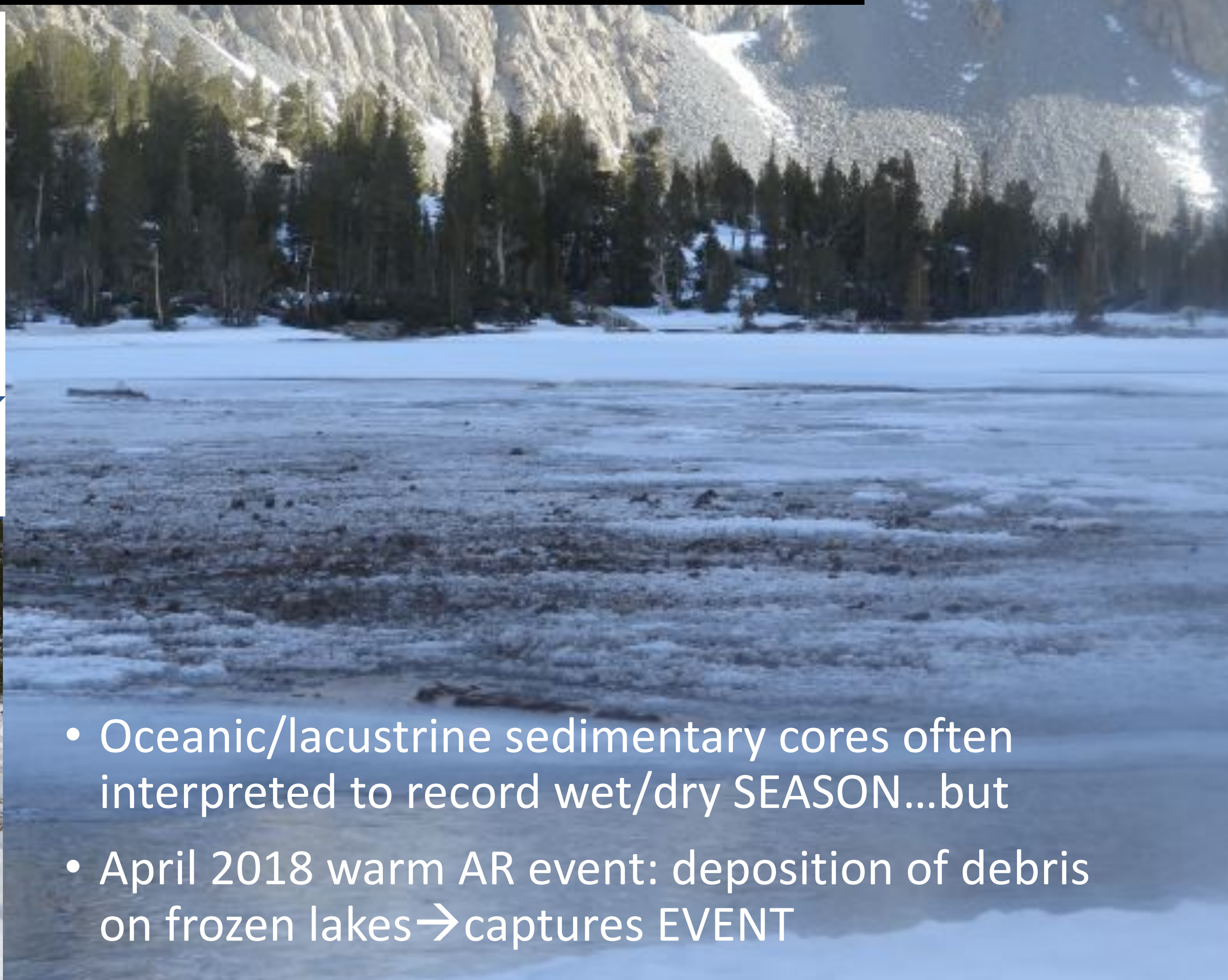


Birkel et al. (2012) Arc. Alp. Ant. Res., Hudson et al. in review

Warm AR events in the alpine: Care with proxy interpretations



Hatchett 2018 Atmos.



- Oceanic/lacustrine sedimentary cores often interpreted to record wet/dry SEASON…but
- April 2018 warm AR event: deposition of debris on frozen lakes→captures EVENT

“The prudent society will plan for its future by examining its past.”

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Gary Comer Science and Education Foundation
Tides Foundation

Concluding Remarks:

1. Hydroclimate variability in the Great Basin strongly coupled to moisture flux and AR landfall (more so than storm track activity)

2. Megadroughts are devoid of ARs but can still have occasional intervening wet years

3. The 2016/2017 winter provides an example of an ‘average’ Deglacial wet season in terms of precipitation (2x normal)

4. A need exists for high resolution (i.e., AR-resolving) paleoclimate simulations to explore controls of past climate shifts

5. Proxy records derived from sediments should be interpreted with care (events vs. seasons)