Measuring, Understanding, and Predicting Western Water

Dr. Dan Feldman,
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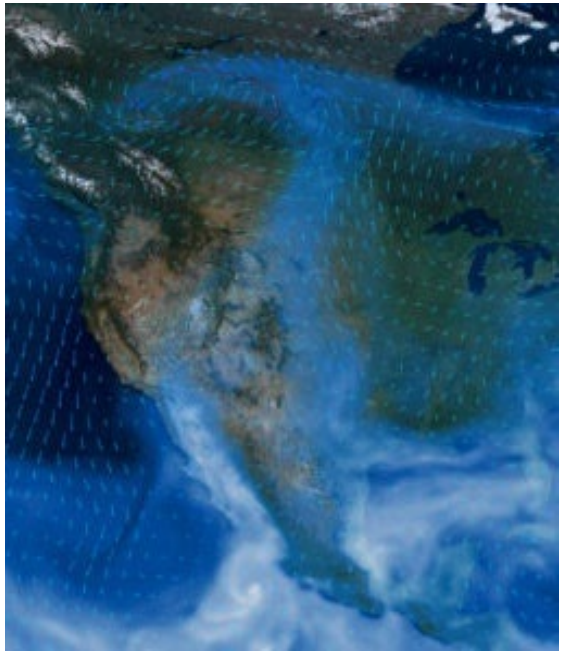
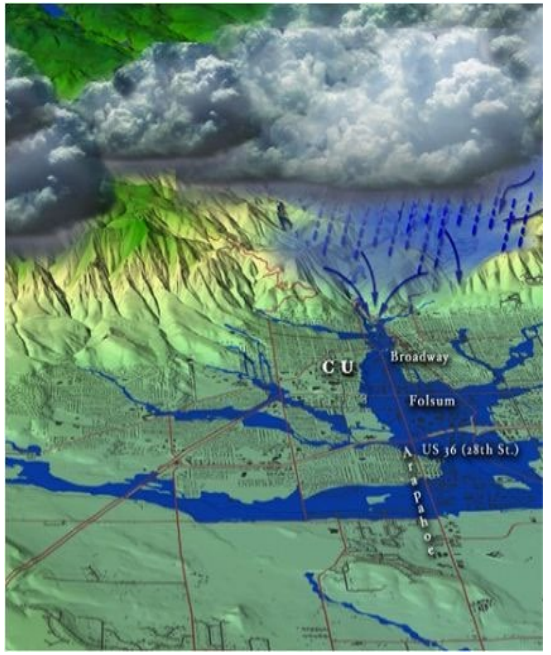
drfeldman@lbl.gov and https://sail.lbl.gov
With contributions from many, many others





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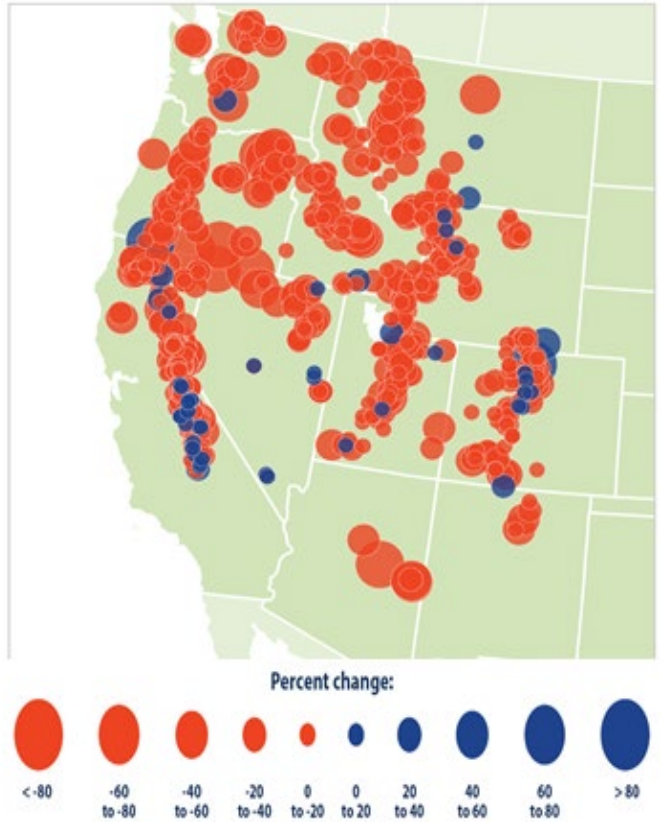
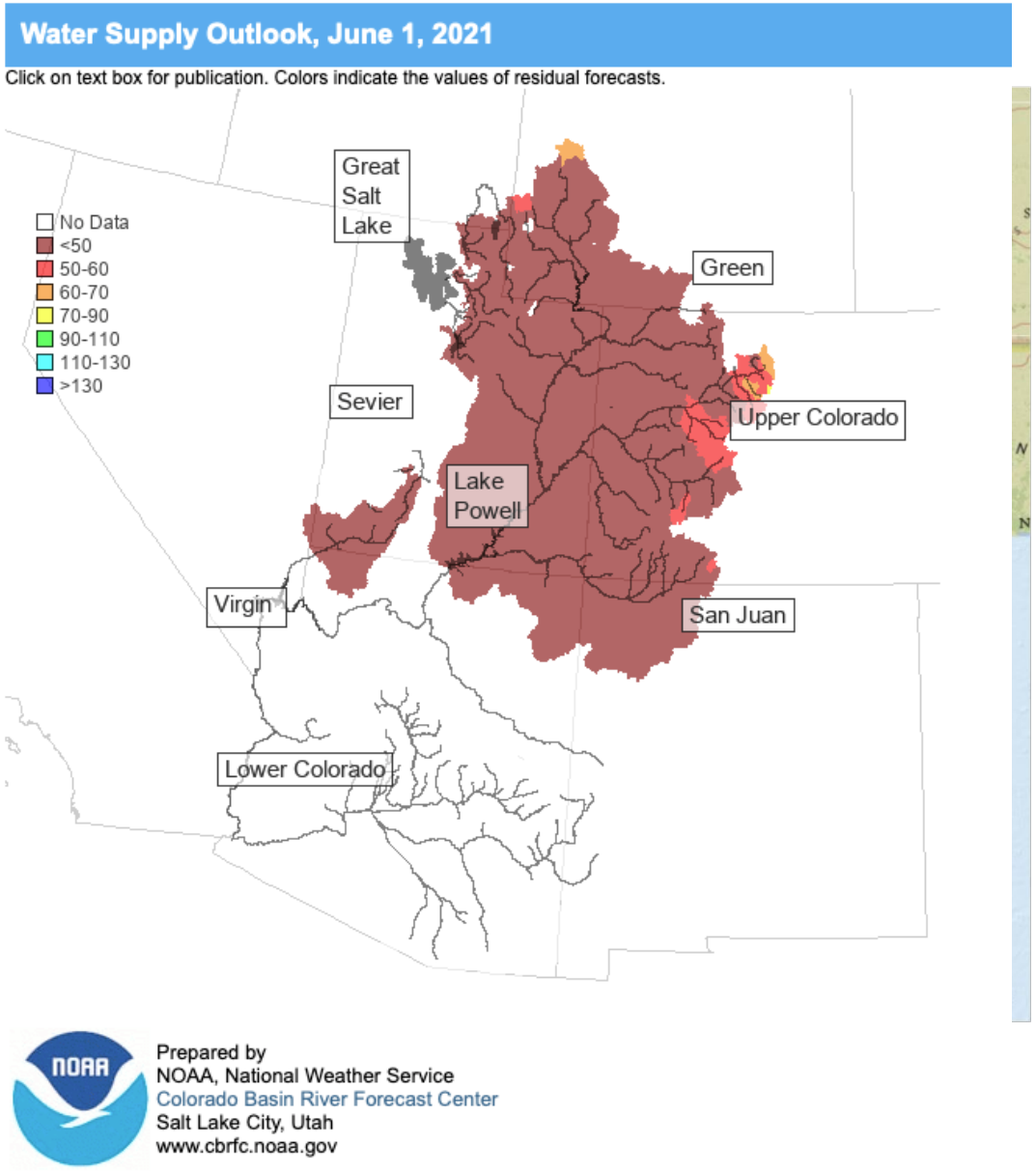
The Colorado River Watershed is Changing

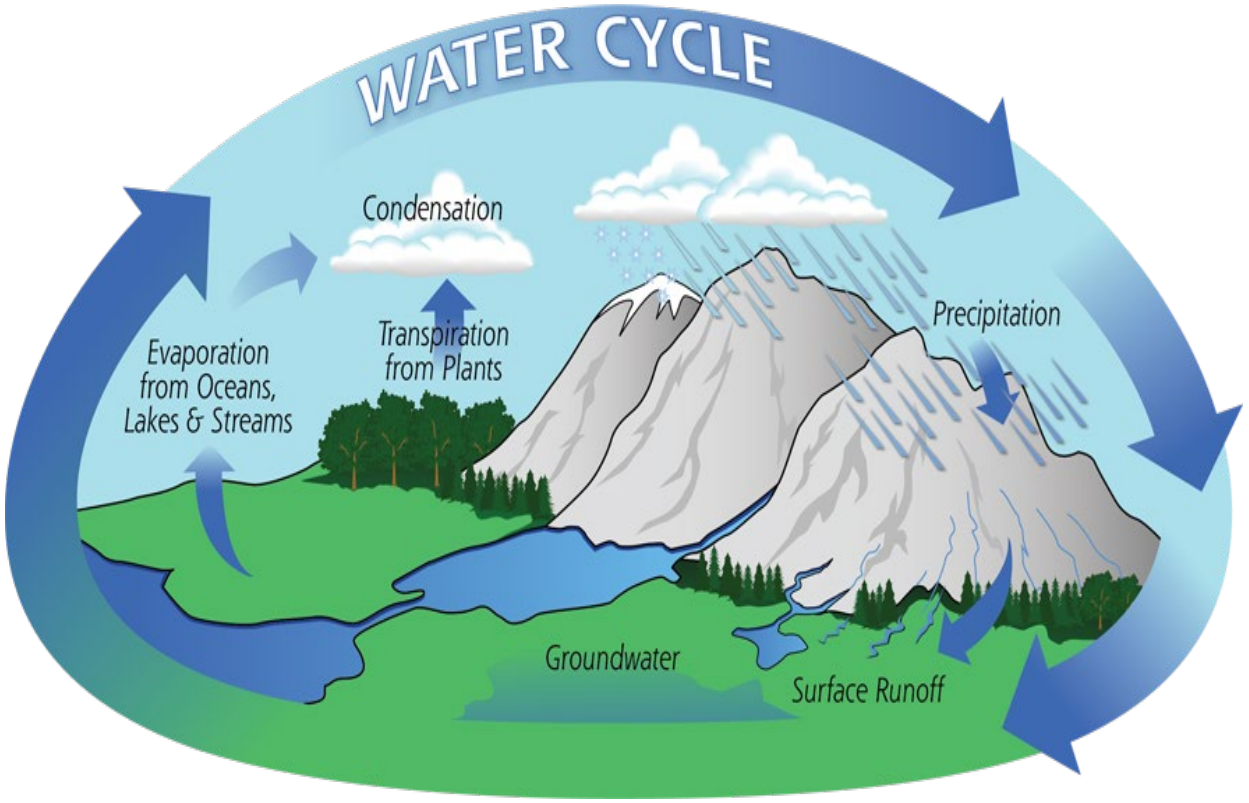
1955-2016 trends in April Snowpack



Mote and Sharp, 2016



Where did the water go?!?!



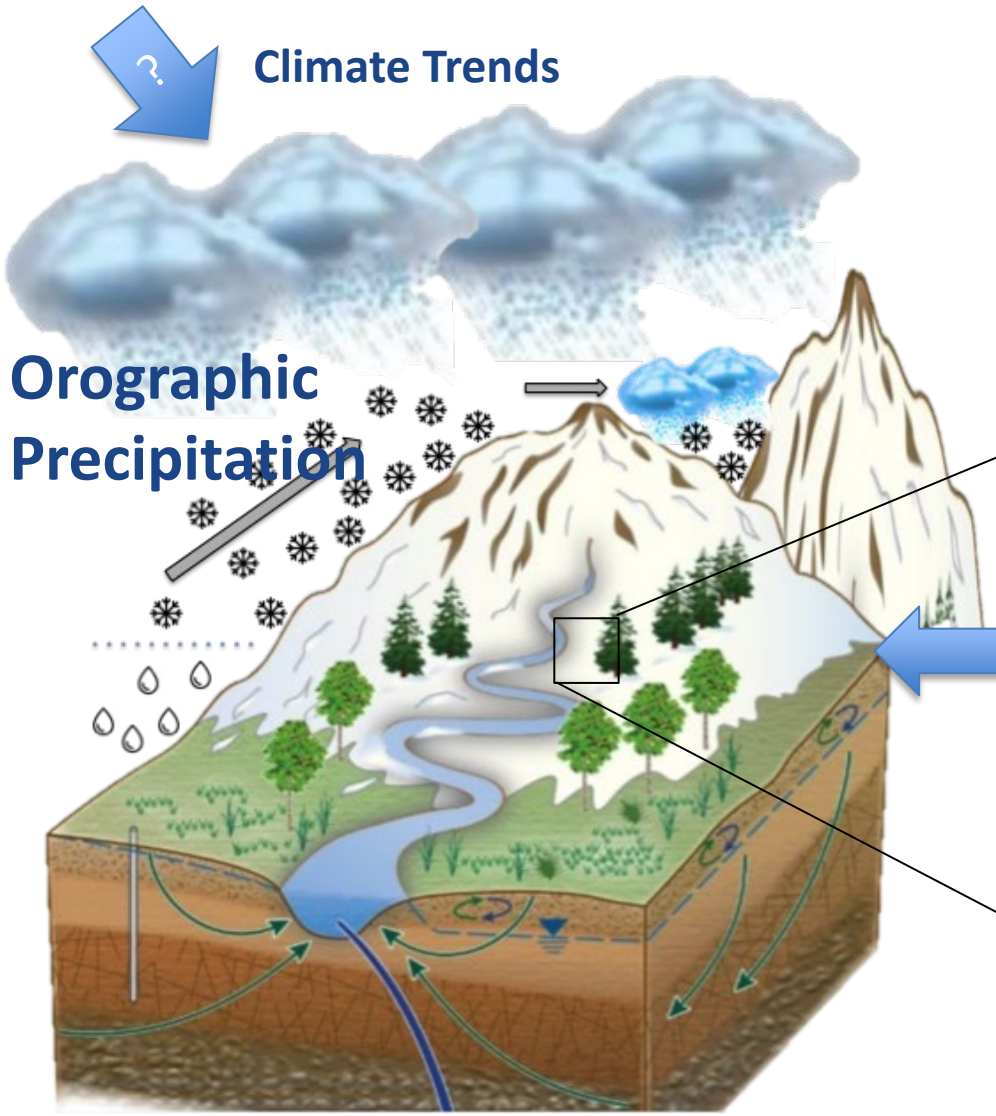
Potential Explanations:

1. Low precip after winter
2. Precip overestimated
3. Dry soils
4. Large ET losses
5. Snow sublimation

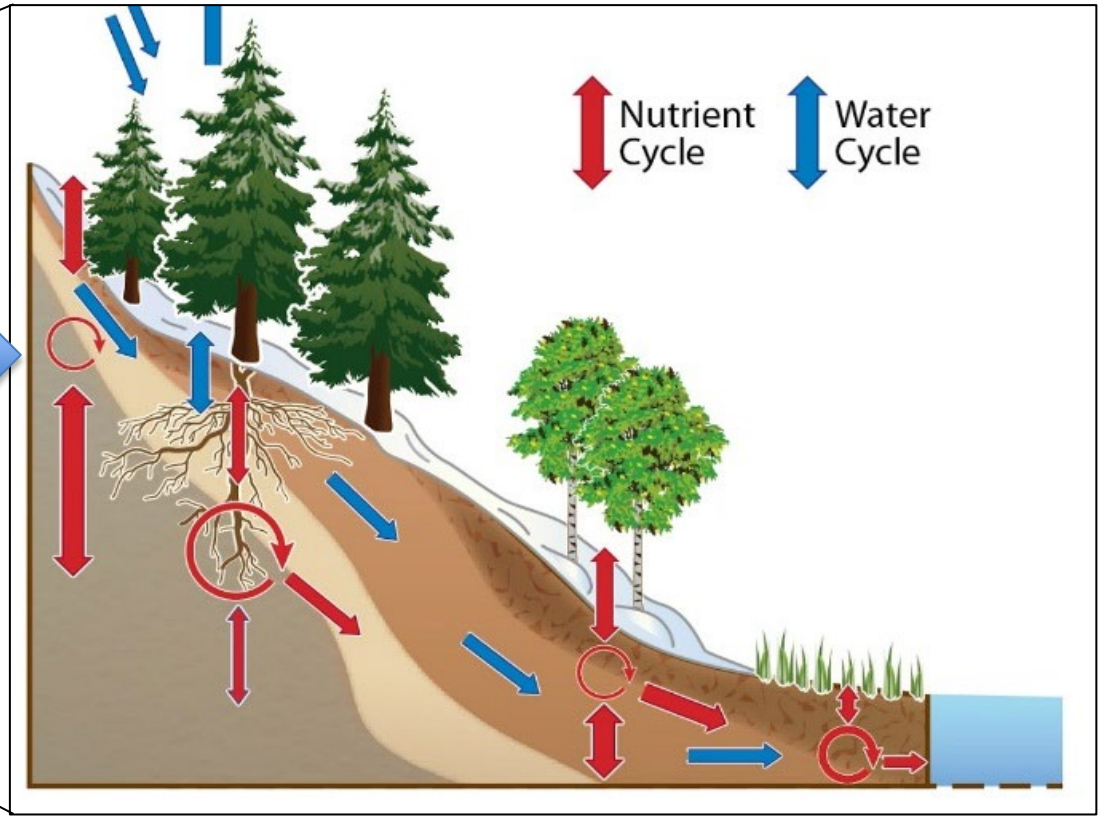
$$P = ET + R + I + \triangle S$$

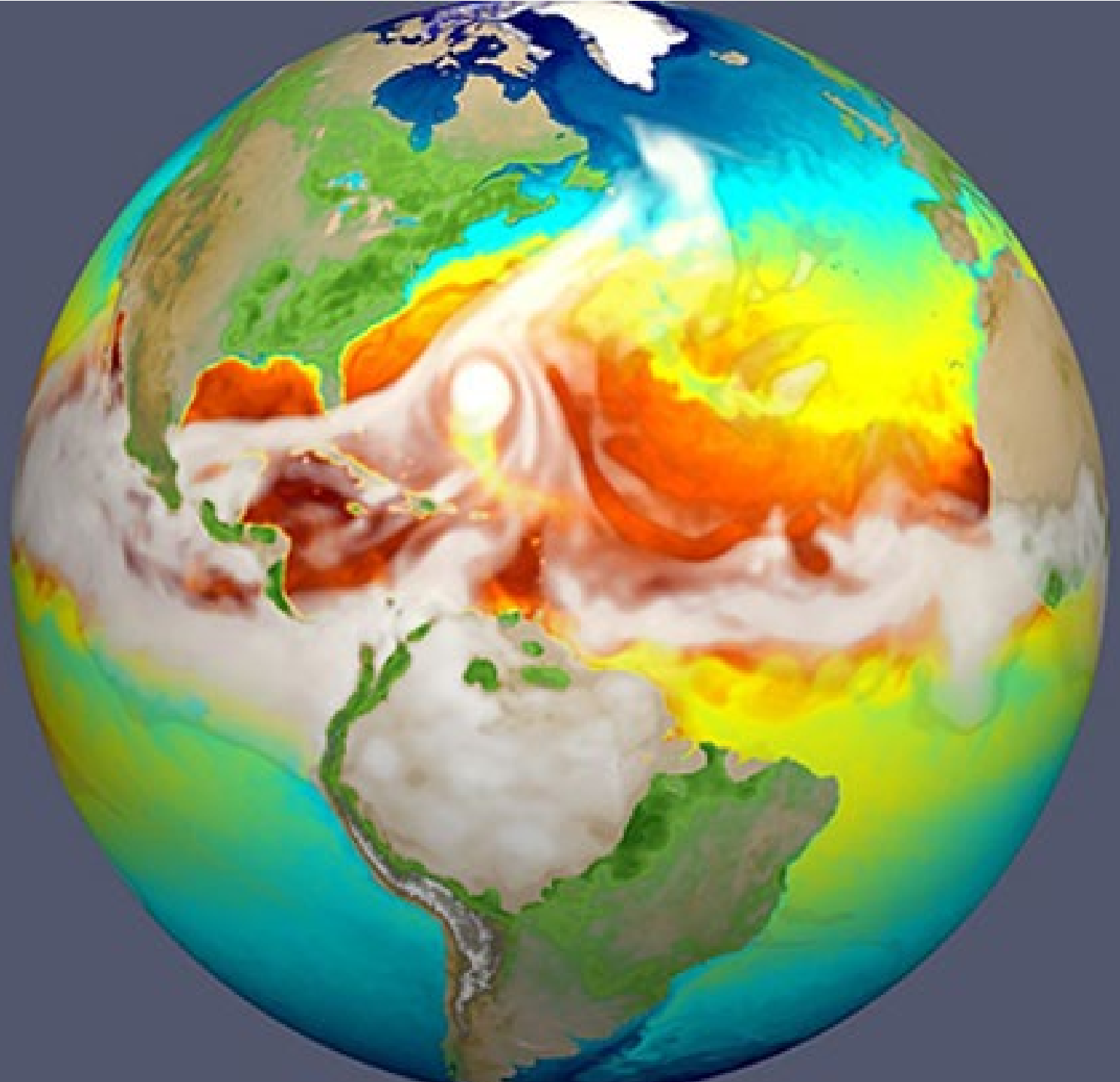
Precipitation | Evapotranspiration (Sublimation) | Runoff | Infiltration | Storage

Predicting where the water will go is complex

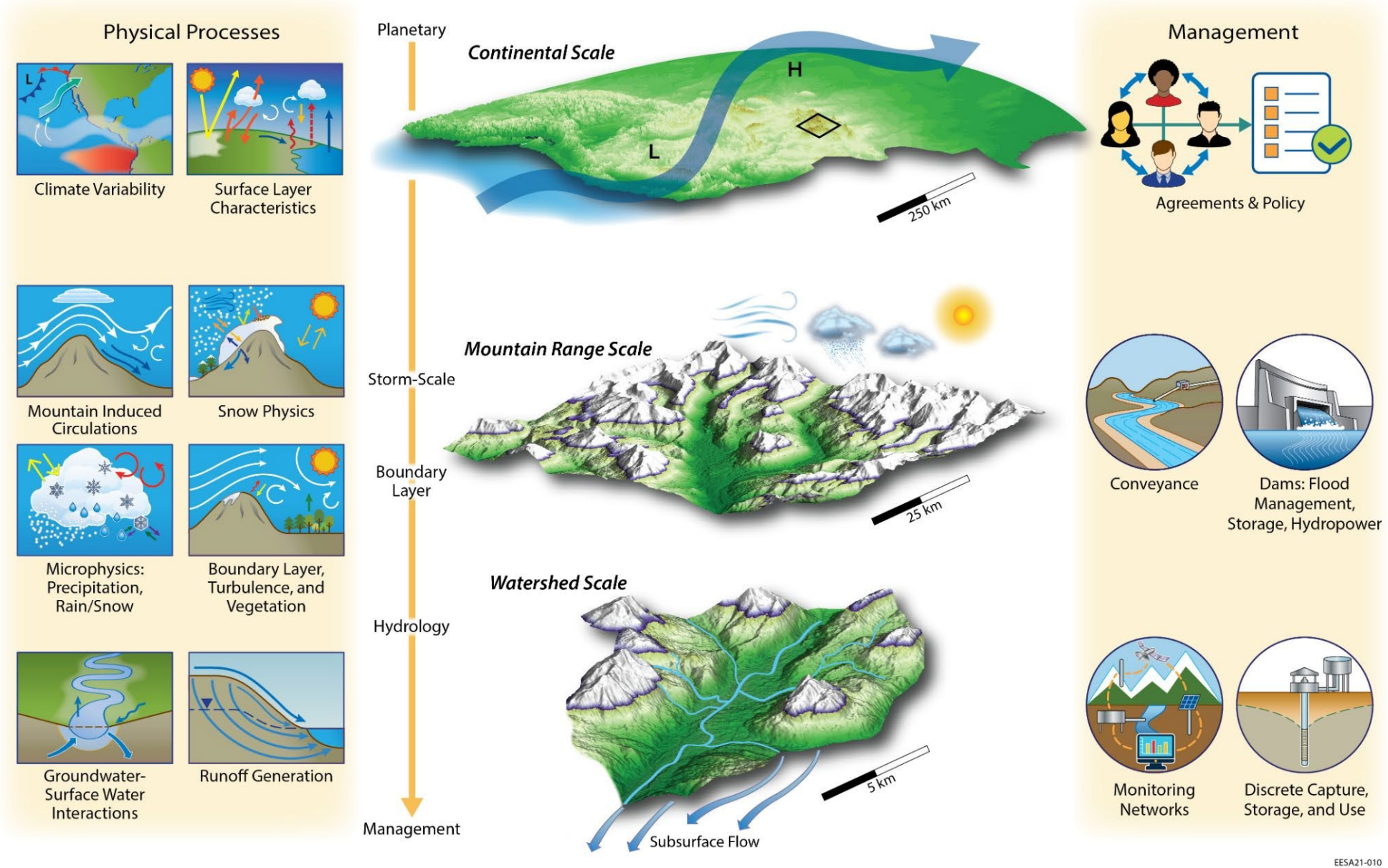


Land Through Subsurface Processes





How do we narrow that range?



Woodburn et al, 2021

Observational Gaps Lead to Understanding and Prediction Gaps

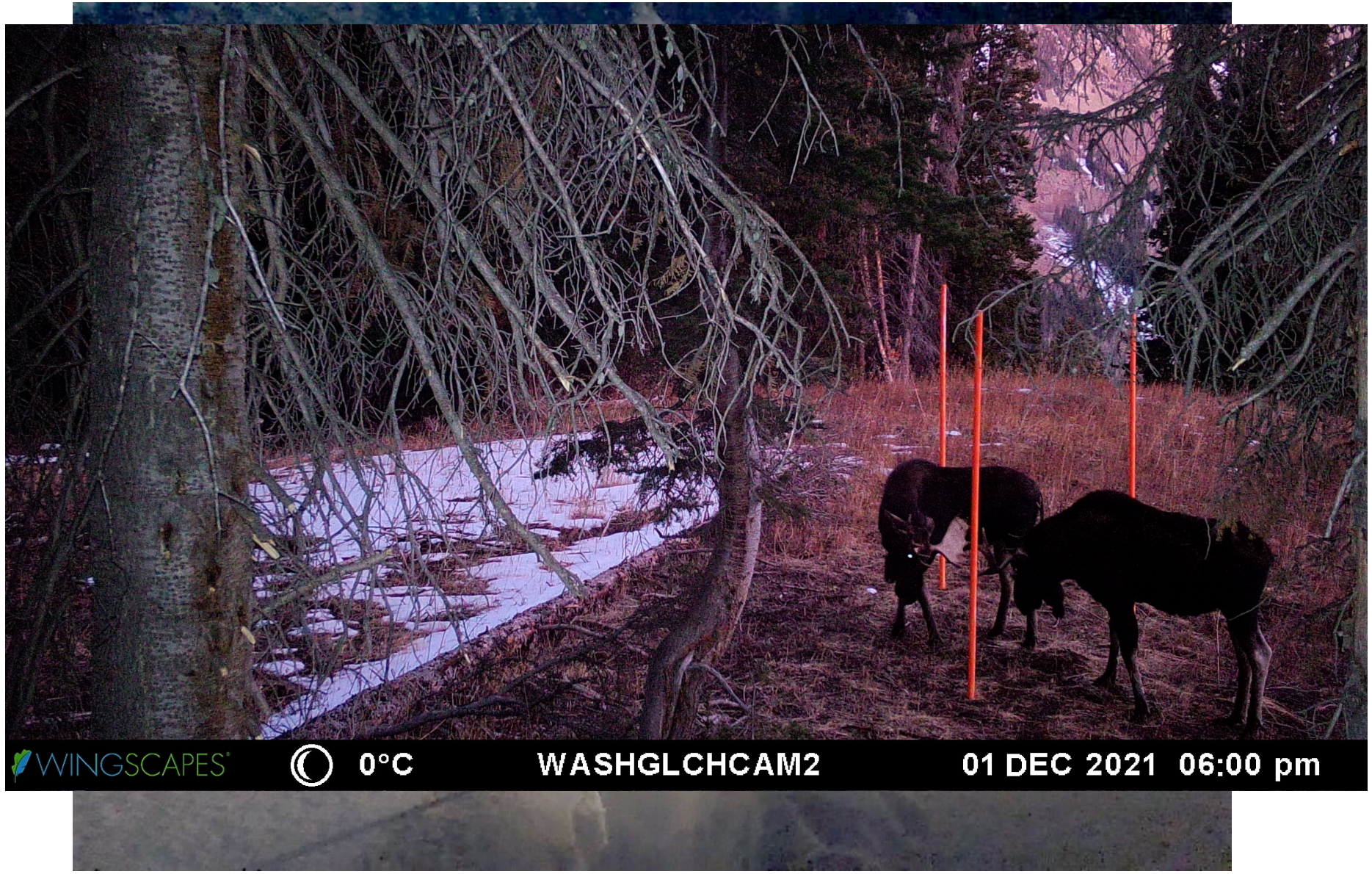


Photo Credit: Ryan Carr (2021)

SAIL: Surface Atmosphere Integrated Field Laboratory

~$20M Infrastructure Investment by DOE ARM near Crested Butte, Colorado. Started 9/21.

Deploying dozens of instruments. Partnering closely with NOAA to improve weather forecasts

SAIL in the News!

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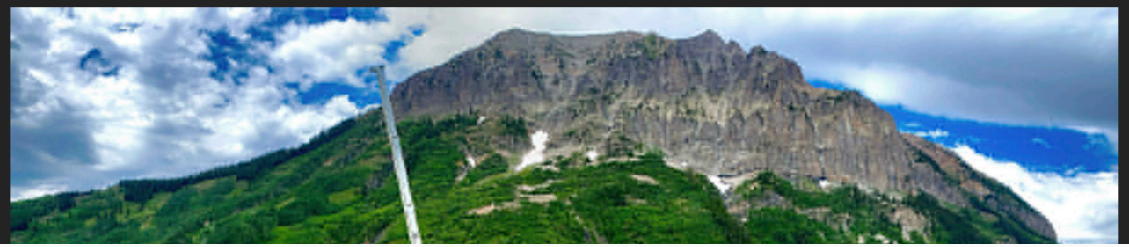
NEWS | EARTH

High in the Colorado Rockies, scientists launch search for causes of western water woes

New study of snow, ice, and rain aims to improve Colorado River flow forecasts

24 AUG 2021 · 5:00 PM · BY ERIK STOKSTAD



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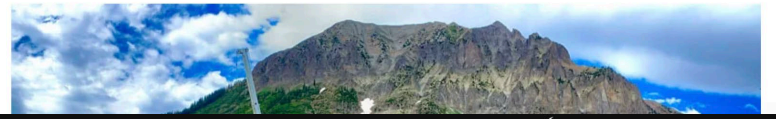
Collaboration in the Rockies Aims to Model Mountain Watersheds Worldwide

As Earth's climate changes at an unprecedented rate, the Surface Atmosphere Integrated Field Laboratory is studying precipitation on an unprecedented scale.

By Saima Sidik 21 September 2021



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Atmospheric research seeks to inform water policy

Tom Oates

At a time of critical concern about climate change and federally declared water shortages, a Surface Atmosphere Integrated Field Laboratory (SAIL) site began operations on September 1, close to the headwaters of the Colorado River, near Crested Butte, Colorado. Called the first-ever "bedrock-to-atmosphere" observation system, the SAIL project's primary objective is to monitor and predict rain, snowfall, and water availability in the Col-

precipitation occurs to eventual flows of water", says Ken Williams, SAIL co-investigator and LBNL's water resources program lead (Crested Butte, CO). "When should we release water from a dam? How much should we release and how much should we hold? We believe the data we gather will be very useful for those policy-making decisions."

"The threats are multidimensional; it's not just temperature", says Alejandro Flores, an eco-hydrologist with SAIL and associate professor at Boise State University (Boise, ID). For example, "dark aerosols influence how quickly snow melts and are linked back to human activity.

Also, "plants
mountain hillslo
moves from the
sky to ground. Th
of the climate
instrumentation
our ability to un
the pumps, whic
Steltzer, co-princ
LBNL's US DO
SFA and professc
(Durango, CO).

"As scientist
resources policie
place where wate
I think they will

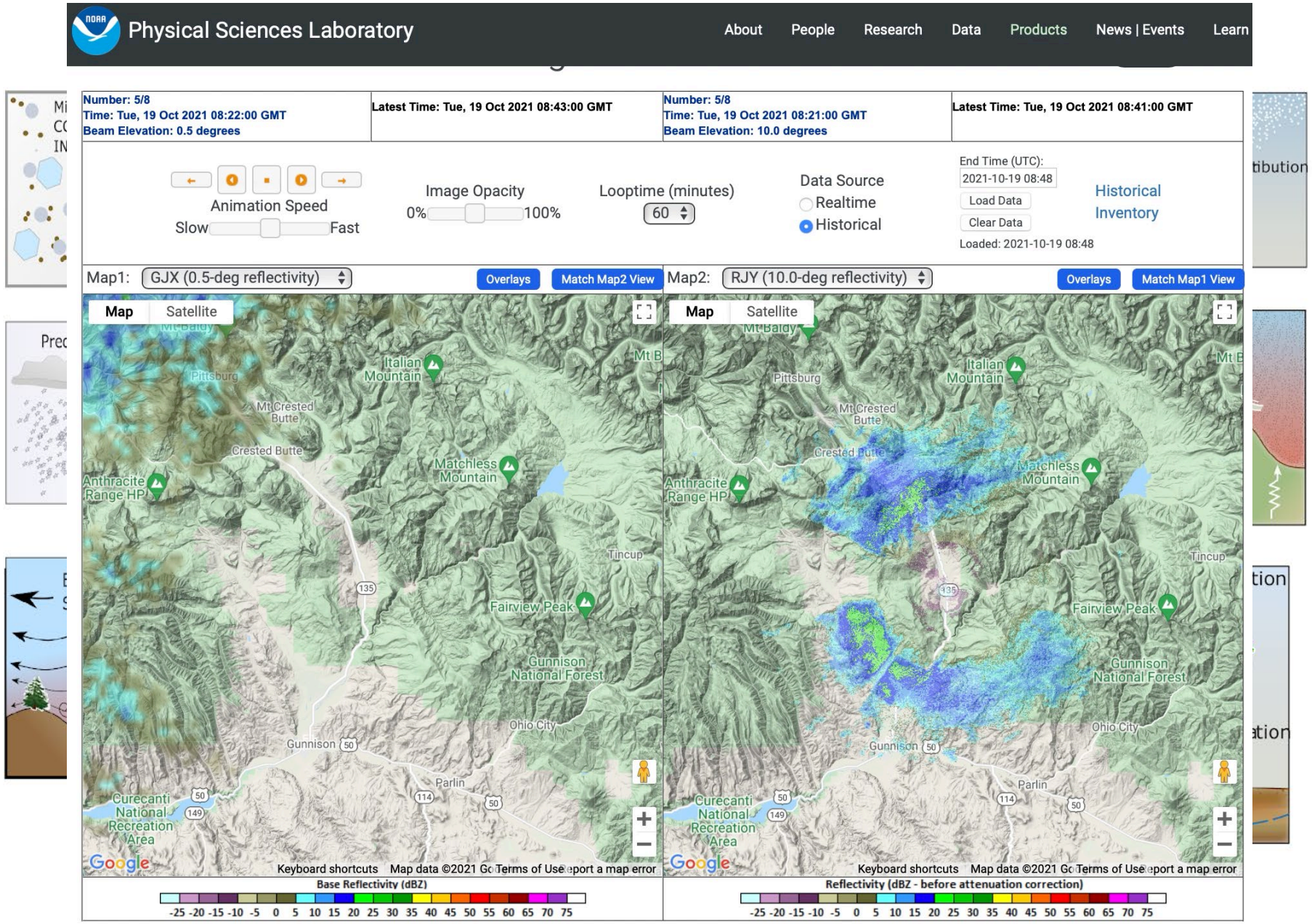
The Washington Post
Democracy Dies in Darkness

He spent almost 50 years alone at 10,000 feet. His hobby helped shape climate research in the Rockies.

An amateur scientist began logging snowfall to keep busy. Along the way, he became an unwitting chronicler of climate change in a region known as the water tower for the drying American West.

By Karin Brulliard

November 27, 2021 at 7:00 a.m. EST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Beam Elevation: 0.5 degrees
Latest Time: Tue, 19 Oct 2021 08:43:00 GMT
Number: 5/8
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Beam Elevation: 10.0 degrees
Latest Time: Tue, 19 Oct 2021 08:41:00 GMT
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Slow
Fast
Image Opacity
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100%
Looptime (minutes)
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Data Source
Realtime
Historical
End Time (UTC):
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Load Data
Clear Data
Loaded: 2021-10-19 08:48
Historical Inventory
Map1:
GJX (0.5-deg reflectivity)
Overlays
Match Map2 View
Map2:
RJY (10.0-deg reflectivity)
Overlays
Match Map1 View
Map
Satellite
Mt Baldy
Italian Mountain
Pittsburg
Mt Crested Butte
Crested Butte
Anthracite Range HP
Matchless Mountain
Tincup
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Base Reflectivity (dBZ)
-25 -20 -15 -10 -5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75
Reflectivity (dBZ - before attenuation correction)
-25 -20 -15 -10 -5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

EESA20-047

Vision

Unite advanced models, observation and data systems to meet the challenge of regional climate prediction and provide actionable information for resource managers

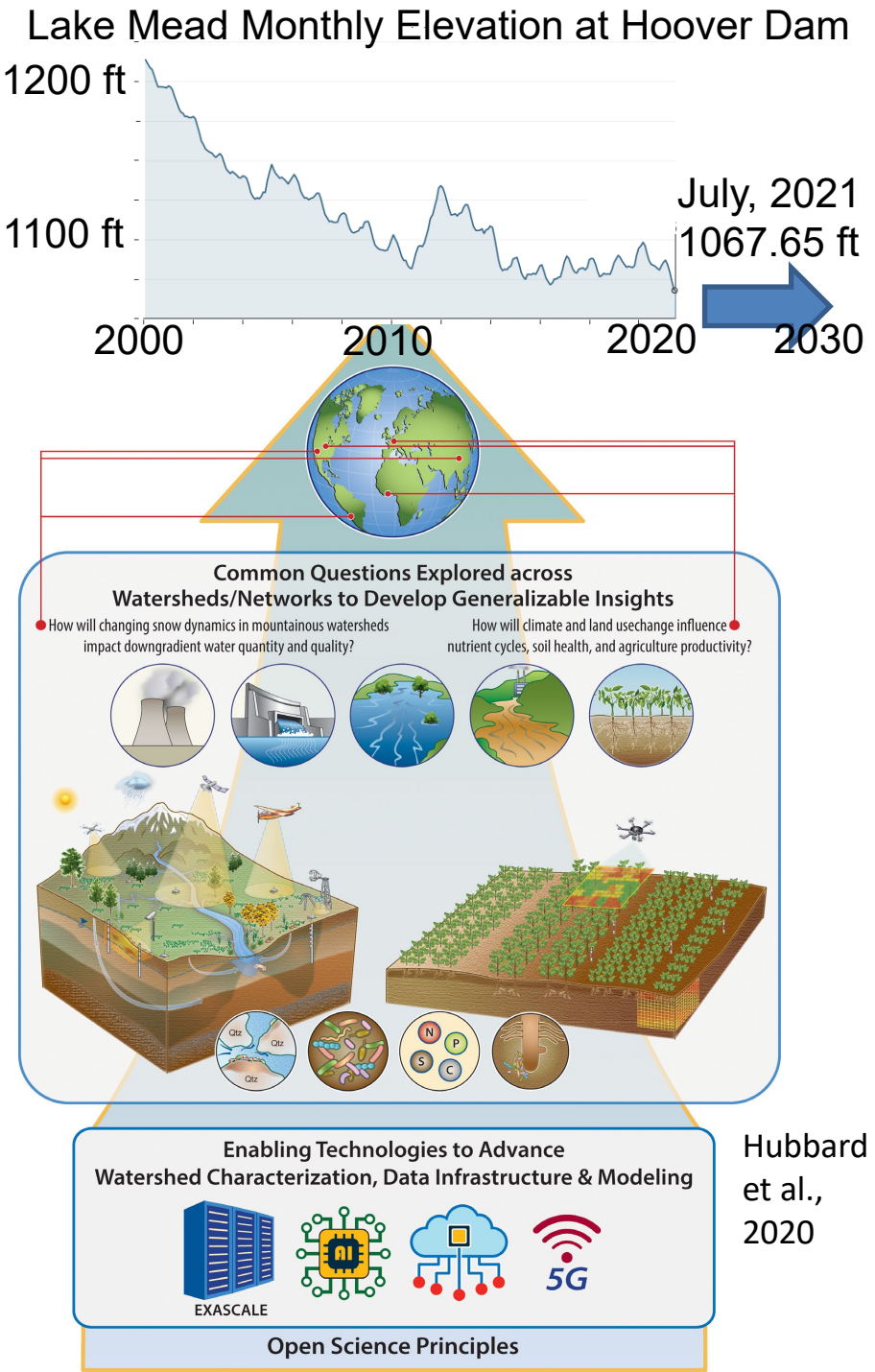
Opportunity

Emerging Technologies allow us to advance and transform Prediction

Convergence of Projects and Extreme Collaborations provide Opportunity for Sum>Parts

Let's follow up!

drfeldman@lbl.gov



Hubbard et al., 2020