

Plume Dynamics of Three Prescribed Fires in Western States

Stephen Drake, PhD, University of Nevada, Reno



Project Participants

- Stephen Drake (PI) – Research Scientist at UNR with background in measuring atmospheric fluxes in forests and snowy environments
- Neil Lareau – Assistant Professor at UNR measuring plume dynamics of wildfires using remote sensing techniques
- Tyler Salas – graduate student in Neil Lareau Lab that participated in the Sycan Marsh Preserve deployments

Examining 3 Prescribed Burns

Sagehen Experimental Forest:
April 29, 2021

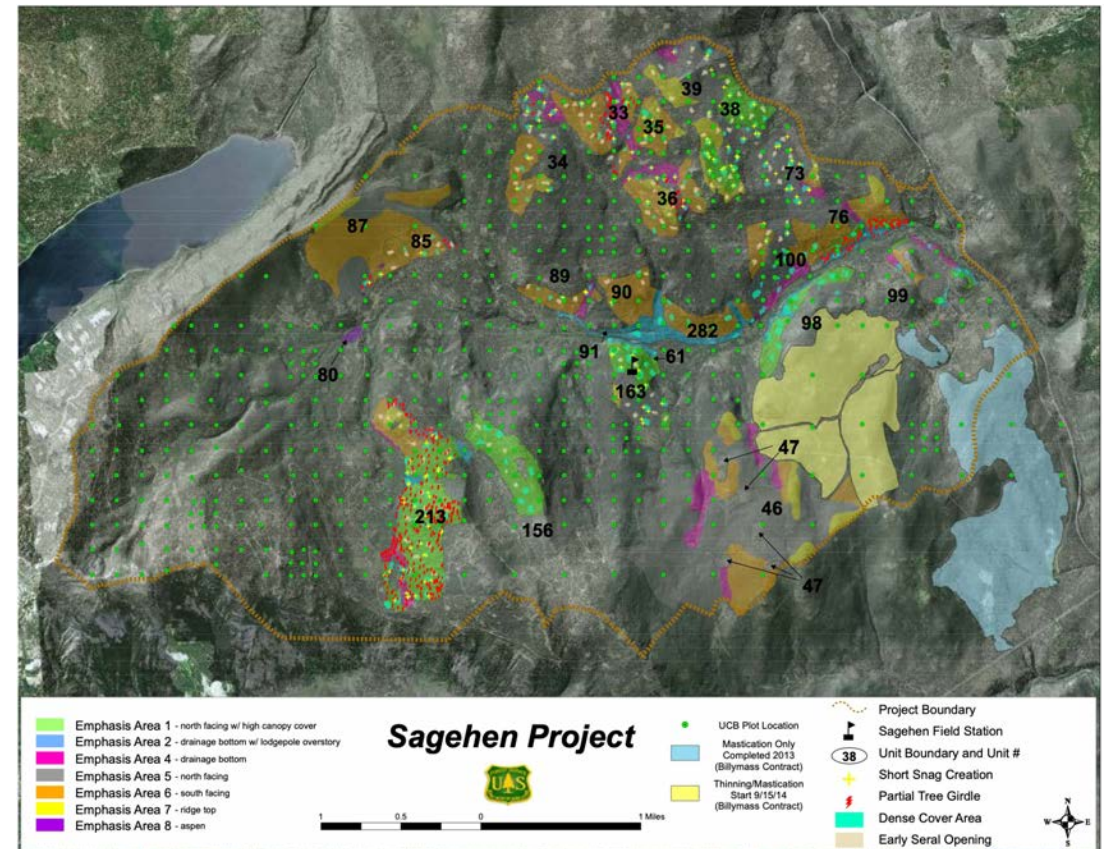
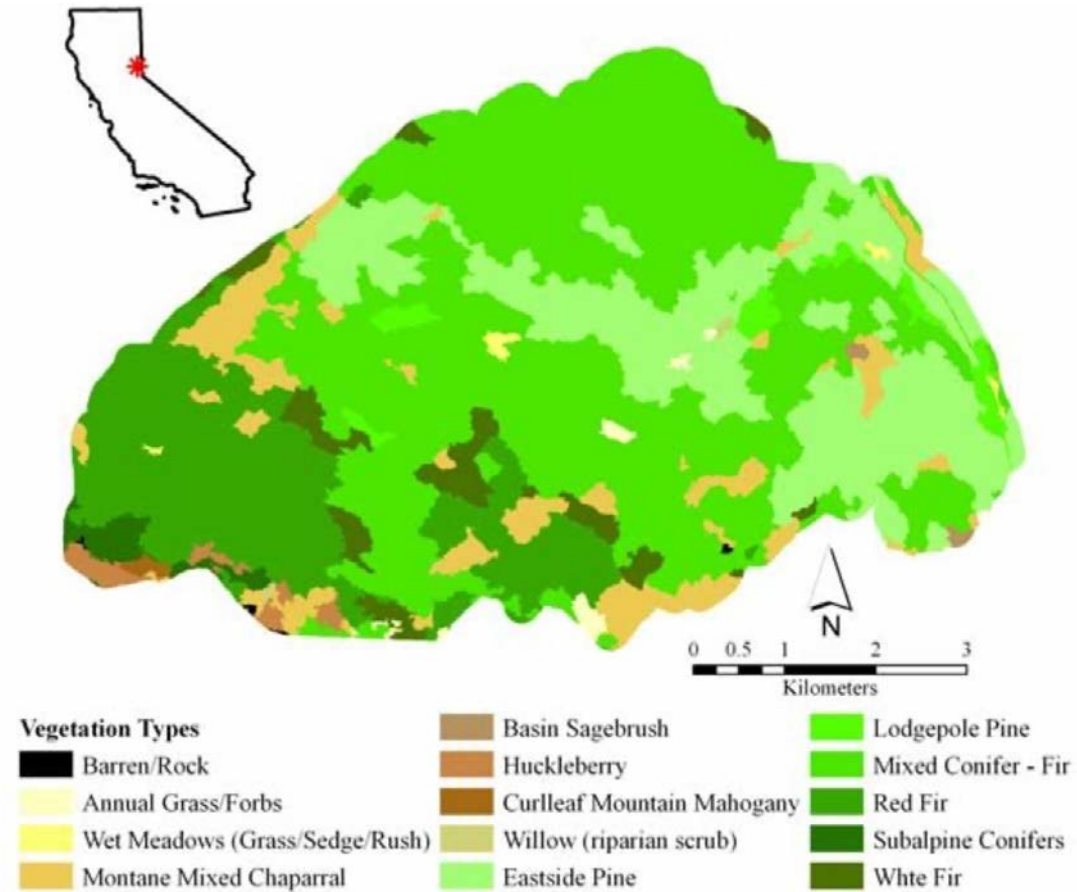
Sycan Marsh Preserve:
October 25, 2022
October 26, 2022*



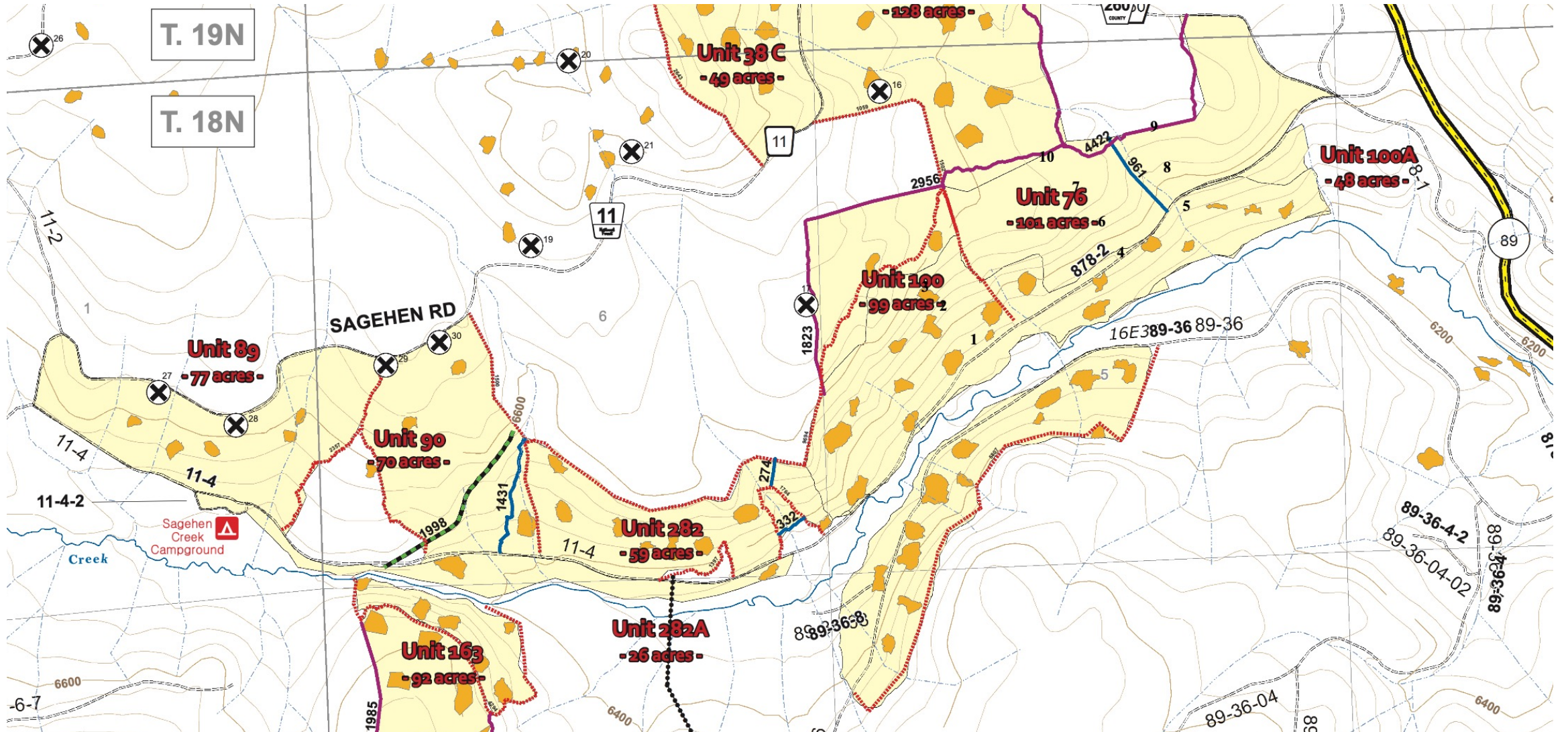
Sagehen Underburn

April 29, 2021

Sagehen Vegetation Type



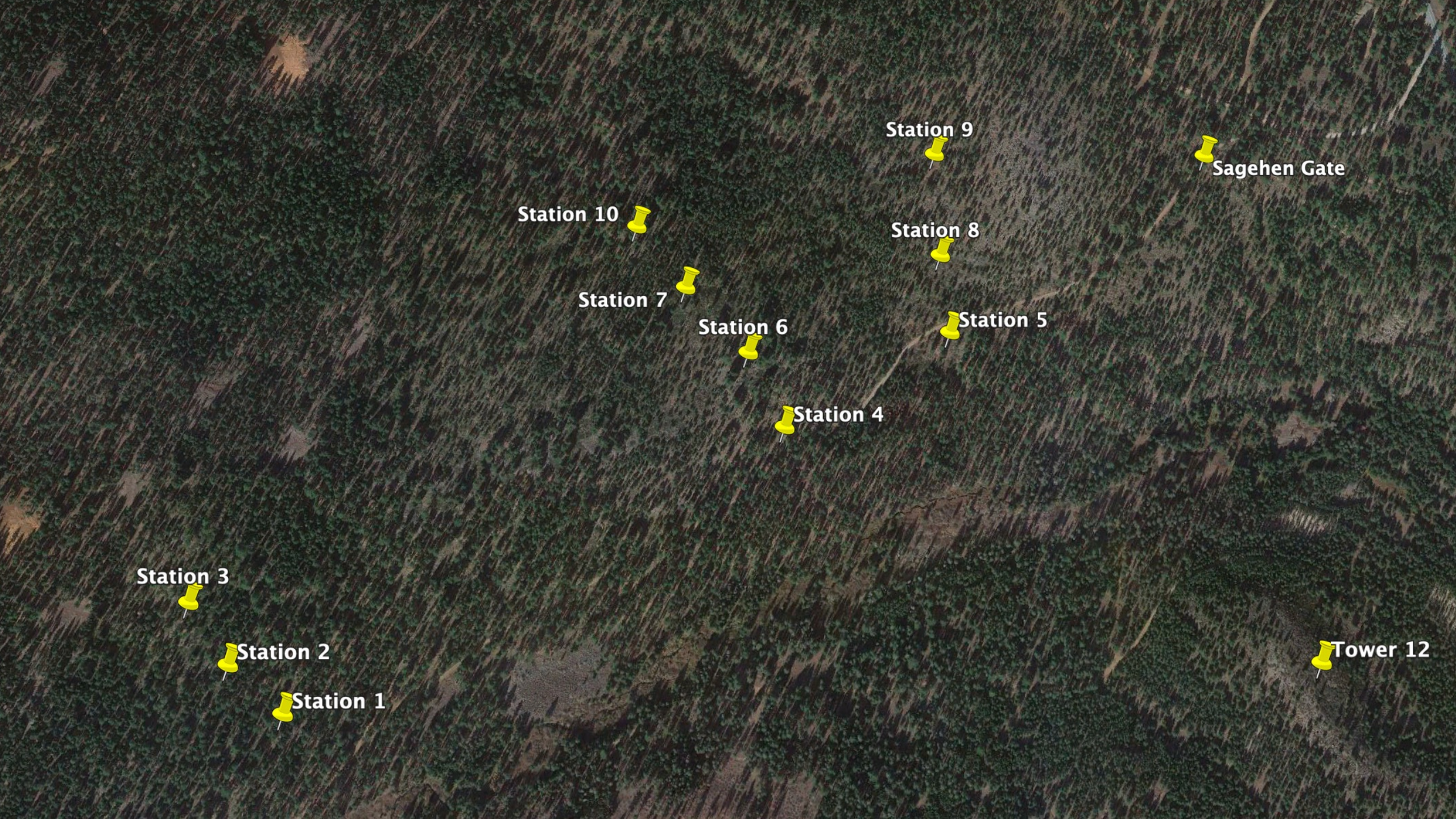
Treatment goal: Units 76, 100



Pile burns of medium/heavy fuels

- Lower extent of Unit 100
- Preparation for underburn
- November 30, 2020





Station 3

Station 2

Station 1

Station 10

Station 7

Station 6

Station 4

Station 9

Station 8

Station 5

Sagehen Gate

Tower 12

Subcanopy Stations




Station 9 – high frequency



Station 8 – low frequency


April 29, 2021





UAS

East Zone
Tahoe National Forest
Prescribed Fire Organizer
Updated 10/2019



TAHOE

Project:	Sagehen Hills Unit #		
Burn Unit:	76		
Size:	100		
Complexity:	Moderate		
Funding Code:	NFHF		
Burn Lat/Long:	39° 26.565' x 120° 13.555'		
Legal Location:	T19N R16E S32		
Burn Boss:	Brian Pimentel (T)		
Date:			

Burn Prescription Parameters			
Element	hot	cold	spot wx forecast/predicted
Temp	75	55	75-77
RH%			48
Wind Speed (MFWS)	8	6.2	5-9
Wind Direction			South
10hr TL fuel stick	5	13	7
Probability of Ignition (PIG)	71	20	
Predicted Fire Behavior	max	min	
Rate of spread (ROS) ch/hr	12.9	1.3	
Flame length (FL) feet	5.2	1.7	

Contingency			
Contingency Level Determination will be completed prior to starting burn using Appendix F of the Rx Burn Plan. This section is for quick reference.			
Fire Prescription Level	1 2		
Contingency Level	1 2		
Required Resources (#)	Engines 2	Crew	WT 2
Patrols			
Resources Identified/Assigned **note if resource is onsite			
1 - Type 3 Contract engine			
1 - Type 2 15 person crew			
2 - Type 3 Forest Service engines E-271 E-361			

1

Area Forecast Discussion

Issued by NWS Reno, NV

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FXUS65 KREV 291016
AFDREV

[Area Forecast Discussion](#)

National Weather Service Reno NV
316 AM PDT Thu Apr 29 2021

.SYNOPSIS...

The drying and warming trend continues into Friday, with many lower valleys reaching into the 80s each afternoon. Temperatures cool but remain above average Saturday through the middle of next week. Increased afternoon and evening breezes are expected Friday into the weekend. Precipitation chances look meager through the first few days of May.

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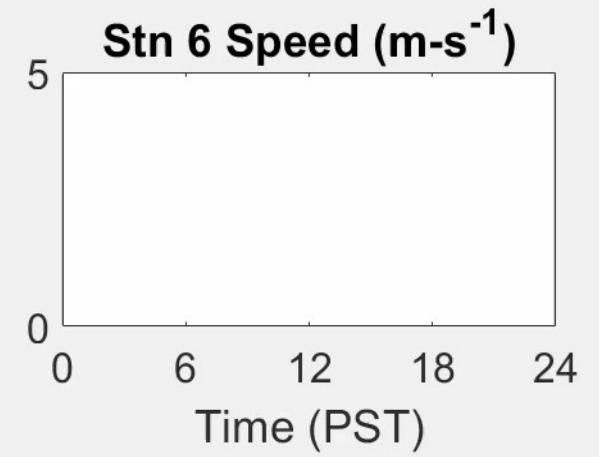
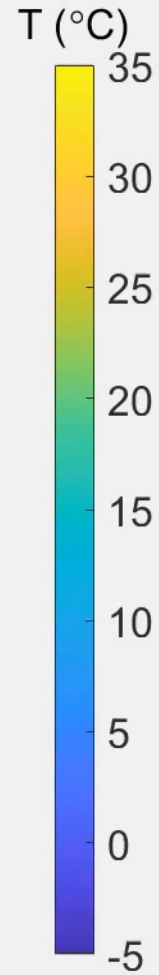
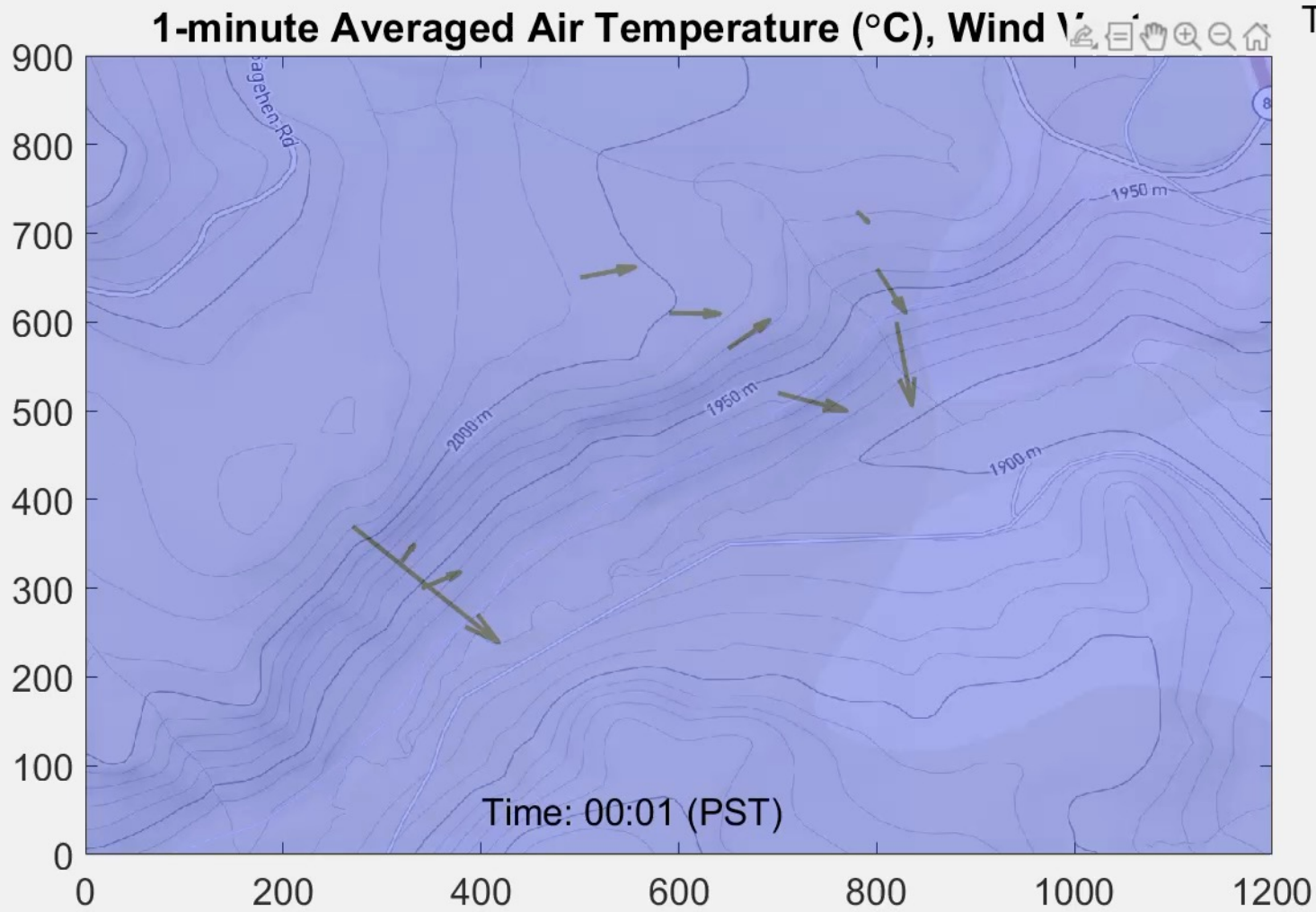
.SHORT TERM...

A strong area of high pressure continues to build over the region into Friday, before drifting east and weakening this weekend as a [trough](#) of low pressure passes by to our north and east. High pressure looks to rebuild into the region by early-to-mid next week.

The main message continues to be the increasing temperatures as the 500-[hPa ridge](#) axis begins to come overhead today. Mid-afternoon to early evening temperatures today and Friday will push into the 80s for the lower valleys of western Nevada and 70s for Sierra valleys. Winds today will remain light with modest afternoon breezes, while afternoon breezes will pick up Friday (25-30 mph) as southwesterly [flow](#) increases with the [ridge](#) axis moving east over the Great [Basin](#). Today, we will have a better shot at tying/breaking the maximum temperature at Reno-Tahoe International Airport of 86 degrees with NBM guidance having a 50% chance of this occurring. For Friday, [cirrus](#) coverage increases, which will lower our chances to 9% of breaking or tying a relatively stout record of 89 degrees. These rather warm afternoon temperatures will help to melt snow, which will increase flows on streams and rivers in and away from the Sierra. Stay mindful and be careful near these waters as they are running cold this time of year.

As the [ridge](#) slides east Saturday, a weak cold [front](#) will move through cooling temperatures and increasing afternoon gusts into the 30-35 mph range, with some amplified winds in prone areas along the Sierra [Front](#) (gusts up to 40 mph). Winds Saturday will be from the west-northwest and will veer from the north Sunday. Although it will

April 29, 2021





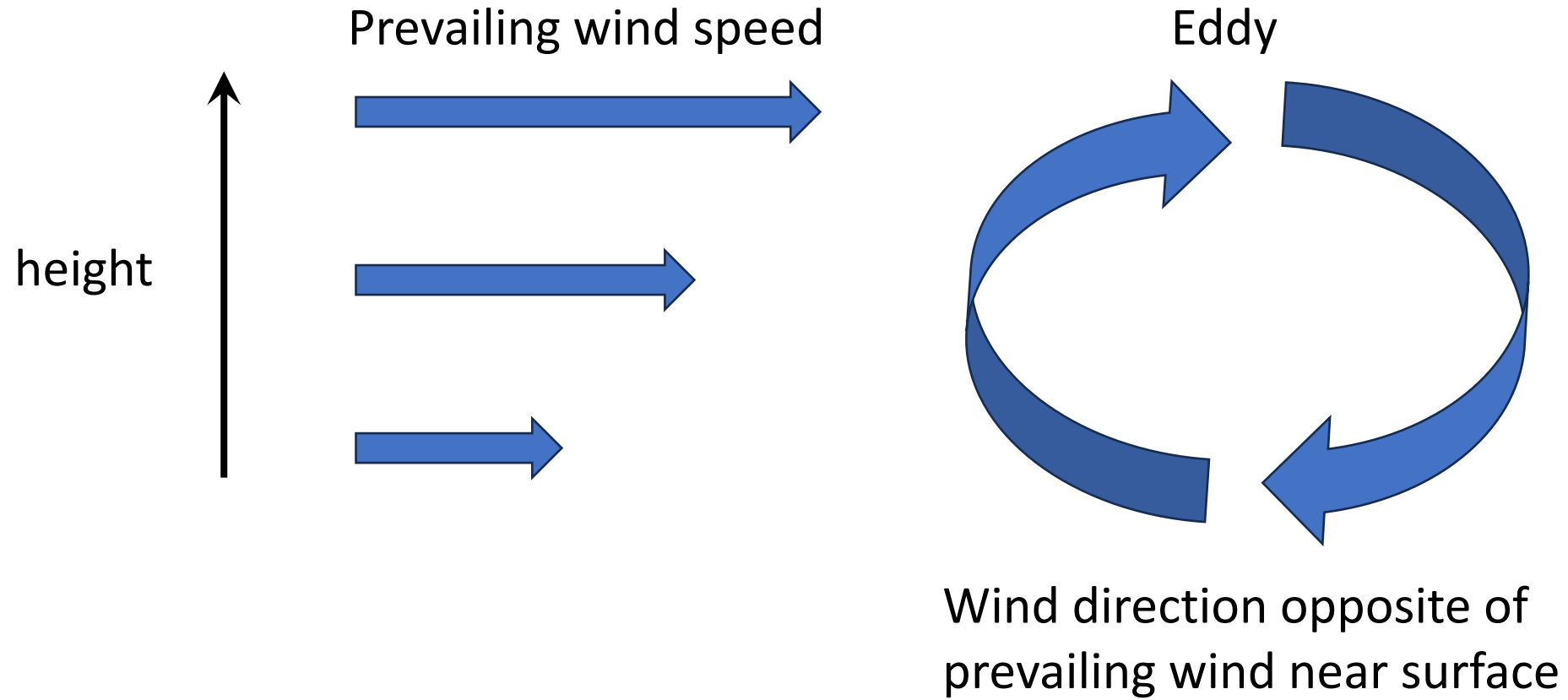
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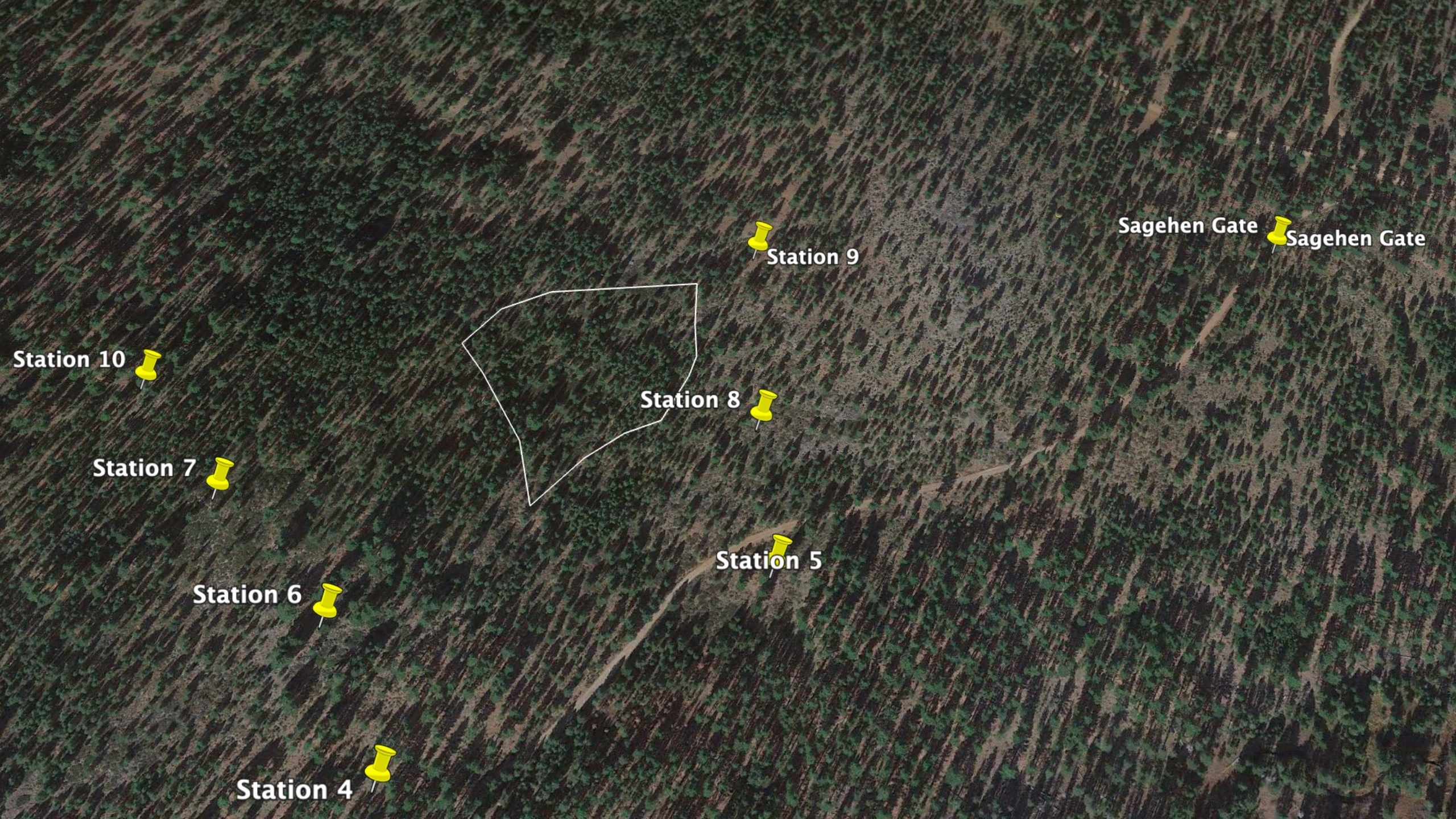


39 °C / 102 °F

04/29/2021 14:00:45

Idealized Eddy





Station 9

Sagehen Gate Sagehen Gate



Station 8

Station 10

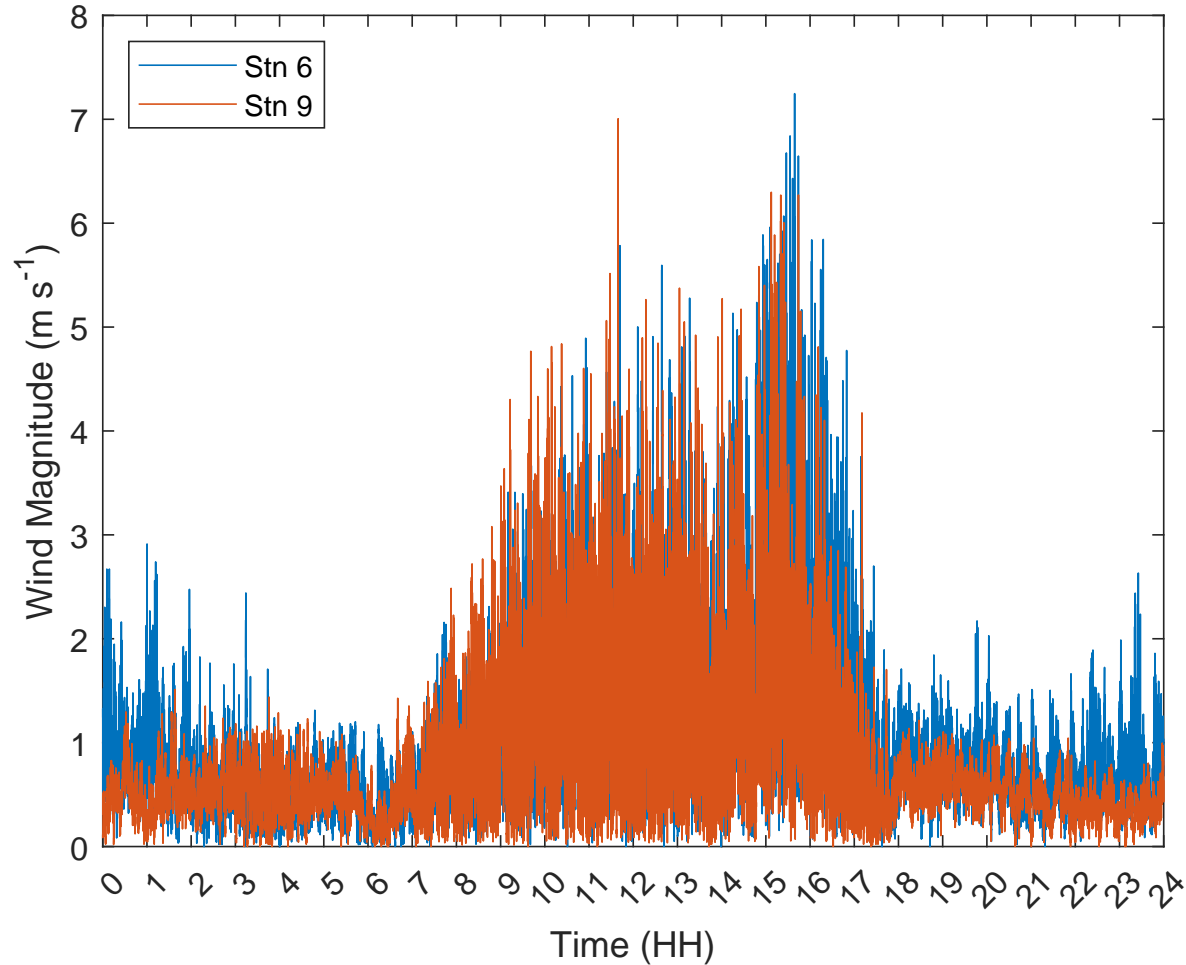
Station 7

Station 5

Station 6

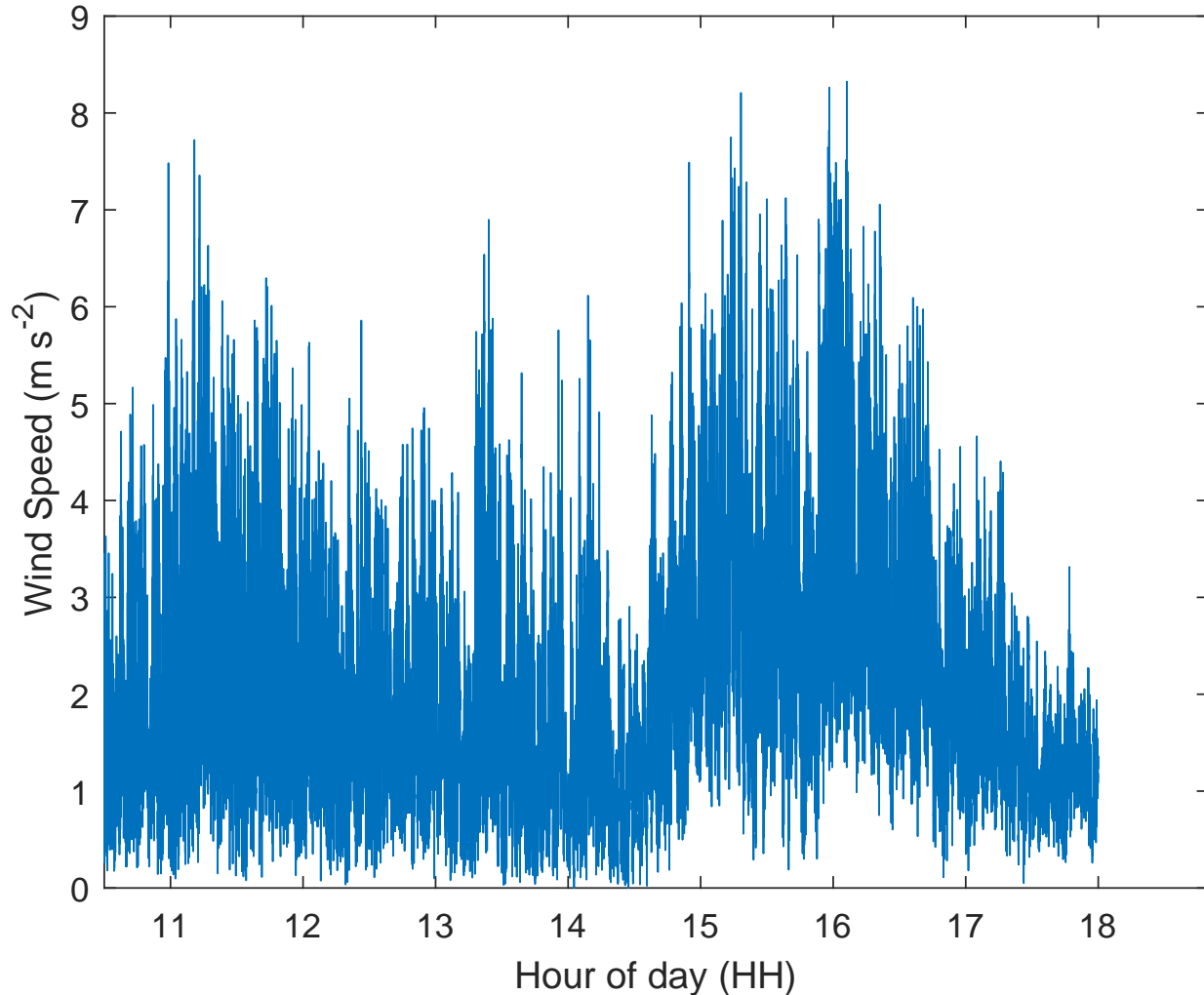
Station 4

Wind Magnitude (3D wind speed)



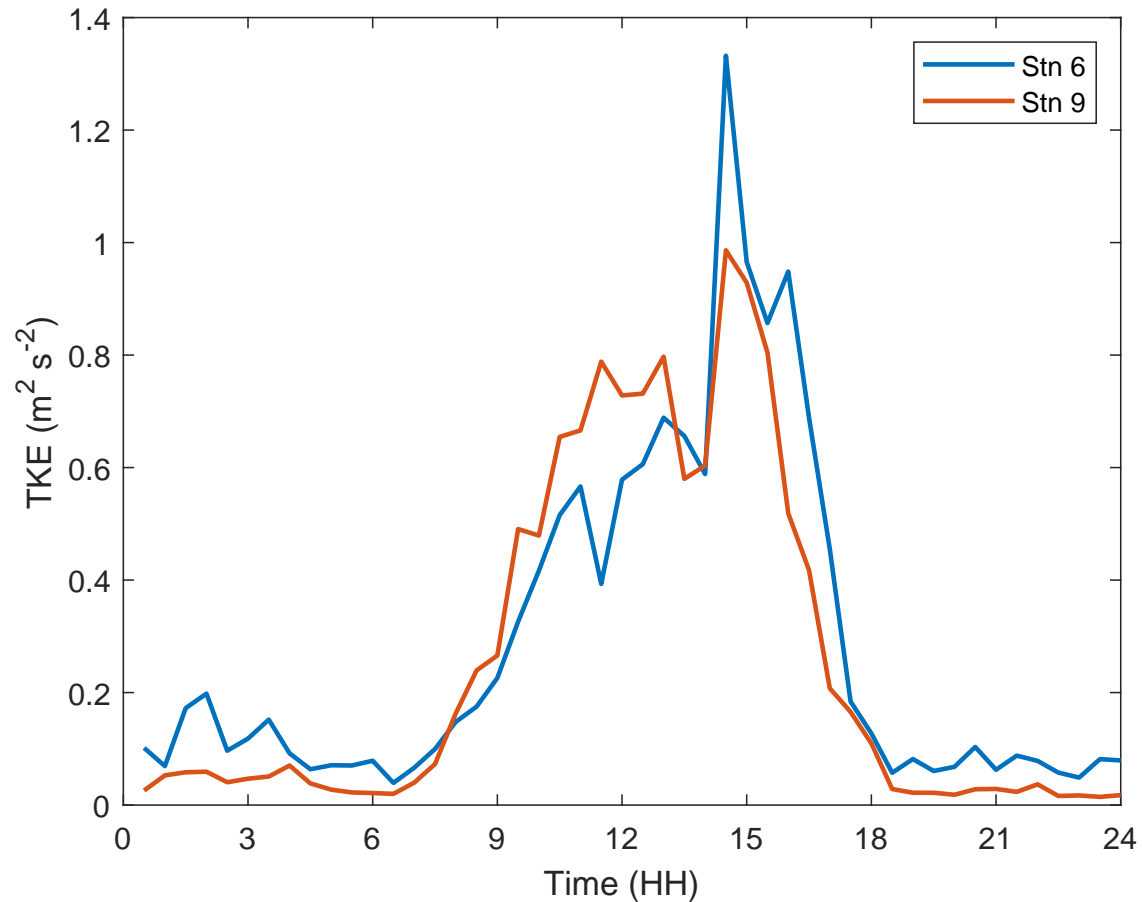
- 10 Hz wind magnitude
- Wind speed increases due to daytime heating
- Afternoon spike in wind speed (between 2:30-4:30PM)

Wind Magnitude (Tower 12)



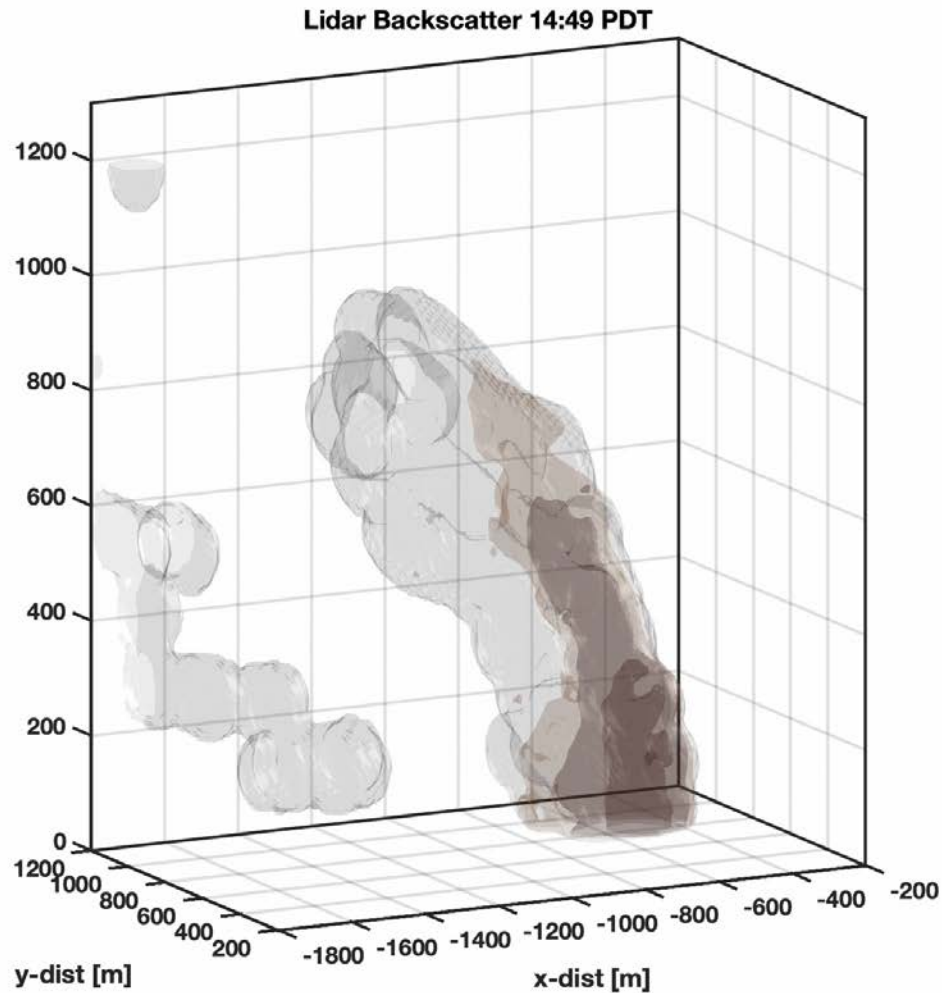
- 10 Hz wind magnitude
- Background wind speed increase in the afternoon
- Afternoon spike in wind speed (between 2:30-4:30PM)

Turbulence Kinetic Energy (TKE)



- TKE is noisy so use 15-minute time average
- Large spike in TKE starting at 2:45 PM at both stations
- Corresponds to timing of wind shift in earlier video

Lidar Measurement of Plume Load



- Lidar backscatter image levels are in \log_{10} intervals
- With height, particulate concentration is quasi-linear in a log scale
- Smaller high-concentration footprint \rightarrow volume average of particulate concentration decreases faster with height

April 29, 2021 5:43 PM

- Fire crowning due to ladder fuels
- Treatment is stopped
- Fire is suppressed



May 1, 2021
(2 days later)



May 1, 2021
(2 days later)



1 year later



April 7, 2022

(1 year later)

vs September 27, 2023

(2 years later)



April 7, 2022

(1 year later)



vs September 27, 2023

(2 years later)



September 27, 2023



Burned

Unburned

Outreach: Truckee Community Center Exhibit



Exhibit: <https://www.forestandfire.org/about-the-exhibition>

PBS: <https://watch.pbsreno.org/video/local-feature-episode-716-lziz1s/>

FOREST \rightleftharpoons FIRE

Forests are a dynamic force on Earth. On a planetary level they help regulate temperature and climate. On a local level, they protect and support watersheds and biodiversity. Both levels are critical to human well-being. The fire-adapted forests of the Sierra Nevada are no exception but as the megafires that decimate millions of trees yearly tell us, our forest is in trouble.

13,000 years ago, as the last Ice Age receded from the Sierra Nevada, forests grew and humans appeared. Humans are a dynamic force as well, fire workers. Observing the abundance that sprang up in the path of fires set by lightning strike, indigenous people learned to care for the forest with small fires. The Sierra Nevada old-growth forest was shaped by fire and human influence.

Unlike indigenous people, most people do not understand the cooperative nature of the forest ecology or see themselves as kin to forest species, treating them accordingly. Only recently, through science, is it understood that ignoring indigenous knowledge, removing large trees and fire suppression made the entire forest biome vulnerable to catastrophic fire, accelerating a rapidly warming climate.

Fortunately, humans and the forest are both dynamic forces. We are both capable of responding to threat, but only humans can respond quickly. Scientific research informs us how best to bring 25 million acres of Sierra Nevada forest back into equilibrium (\rightleftharpoons) with fire but it is through cultural change, in how we understand and relate to the forest, that will bring long-lasting well-being to forest and people alike.

—Michael and Heather Llewellyn

Los bosques son una fuerza dinámica en la Tierra. A nivel planetario, ayudan a regular la temperatura y el clima. A nivel local, protegen y apoyan las cuencas hidrográficas y la biodiversidad. Ambos niveles son fundamentales para el bienestar humano. Los bosques adaptados al fuego de Sierra Nevada no son una excepción. Pero, como demuestran los megaincendios que diezman millones de árboles cada año, nuestros bosques tienen problemas.

Hace trece mil años, cuando la última Edad de Hielo terminaba en Sierra Nevada, crecieron los bosques y llegaron los humanos. Los humanos son una fuerza dinámica por derecho propio. Observando la abundancia de recursos que surgía al paso de los incendios provocados por los rayos, los pueblos indígenas aprendieron a cuidar el bosque con pequeños fuegos. El bosque antiguo de Sierra Nevada fue moldeado por la intervención humana.

A diferencia de los nativos, la mayoría de la gente no entiende la naturaleza cooperativa de la ecología forestal ni se ve a sí misma como pariente de las especies forestales. Sólo recientemente los científicos han empezado a conocer los peligros de ignorar los conocimientos ecológicos tradicionales y los riesgos de eliminar los árboles grandes y suprimir los incendios, lo que hace que todo el bioma forestal sea vulnerable a una conflagración catastrófica y a un calentamiento global acelerado.

Afortunadamente, tanto los humanos como los bosques son fuerzas dinámicas. Ambos somos capaces de responder a las amenazas, pero sólo los humanos pueden responder rápidamente. La investigación científica revela cuál es la mejor manera de devolver el equilibrio (\rightleftharpoons) con el fuego a los 25 millones de acres de bosque de Sierra Nevada. Pero también es necesario un cambio cultural en nuestra relación con el bosque para conseguir un bienestar duradero tanto para el bosque como para las personas.

Presented to the people of the Tahoe-Truckee region of California, this project is a partnership between Nevada County Arts Council, Truckee-Donner Recreation and Park District, and University of California, Berkeley - Sagehen Creek Field Station, with Educational and Environmental Outreach by Sierra Watershed Education Partnerships. FOREST = FIRE was created by Michael and Heather Llewellyn



Sycan Marsh Preserve

October 25 – 28, 2022

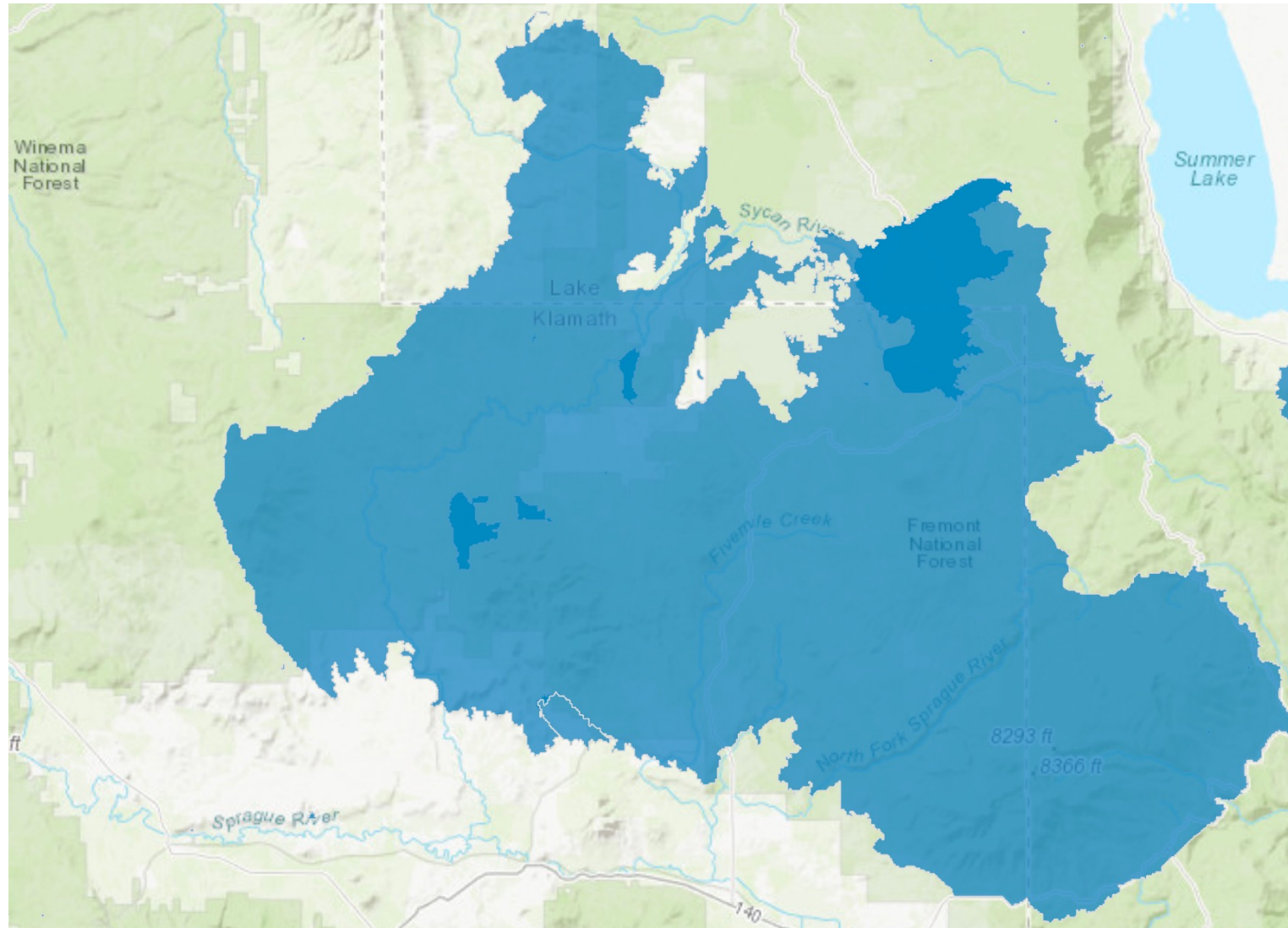


Sycan Marsh Actors

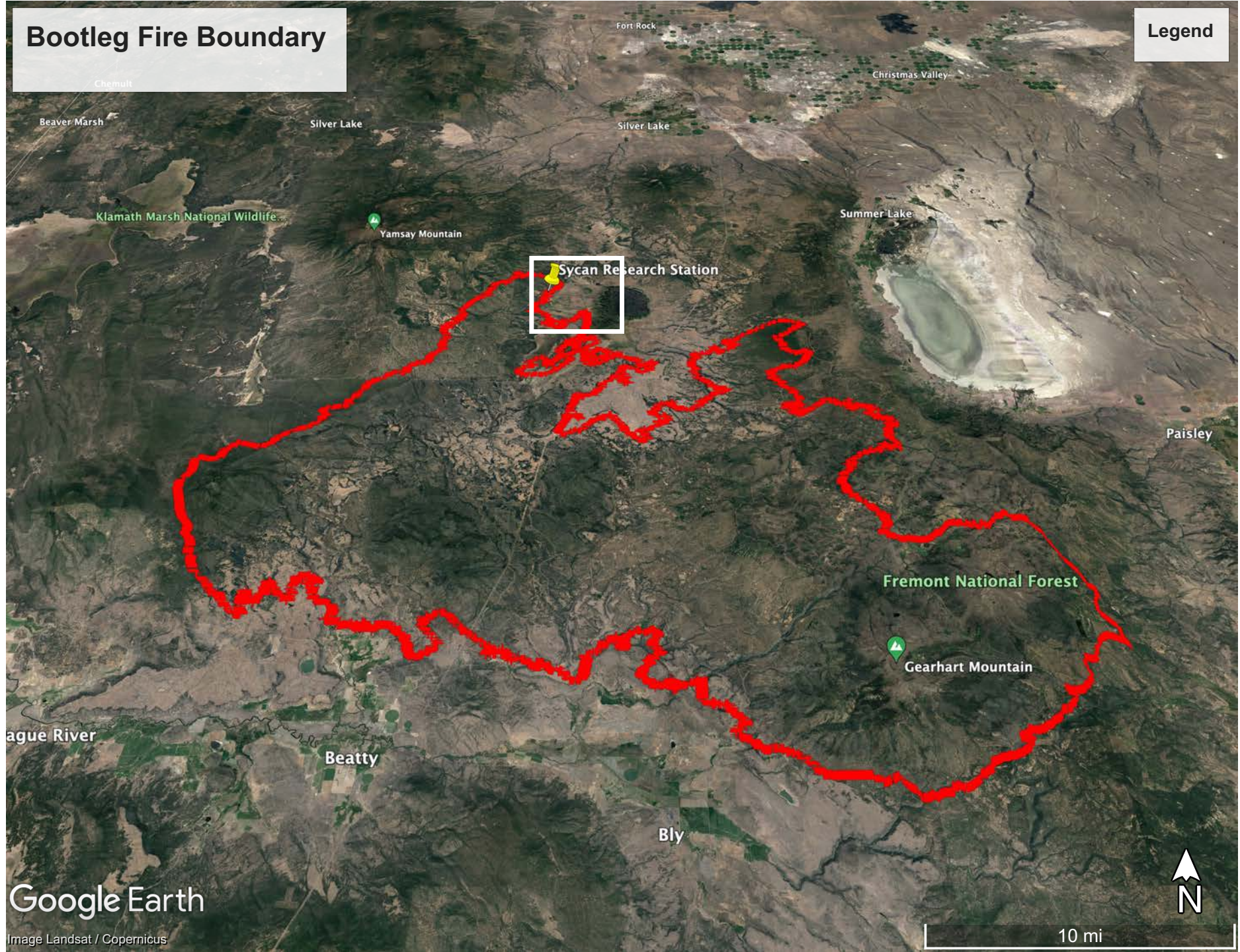
- Katie Sauerbrey – Burn Boss (TNC)
- Russ Parsons – Fire Sciences Laboratory, Missoula
- Andy Hudak – Rocky Mountain Research Station, Moscow
- Adam Watts – Desert Research Institute, Reno



Bootleg Fire, July-August 2021, 647 mi²



Bootleg Fire Boundary



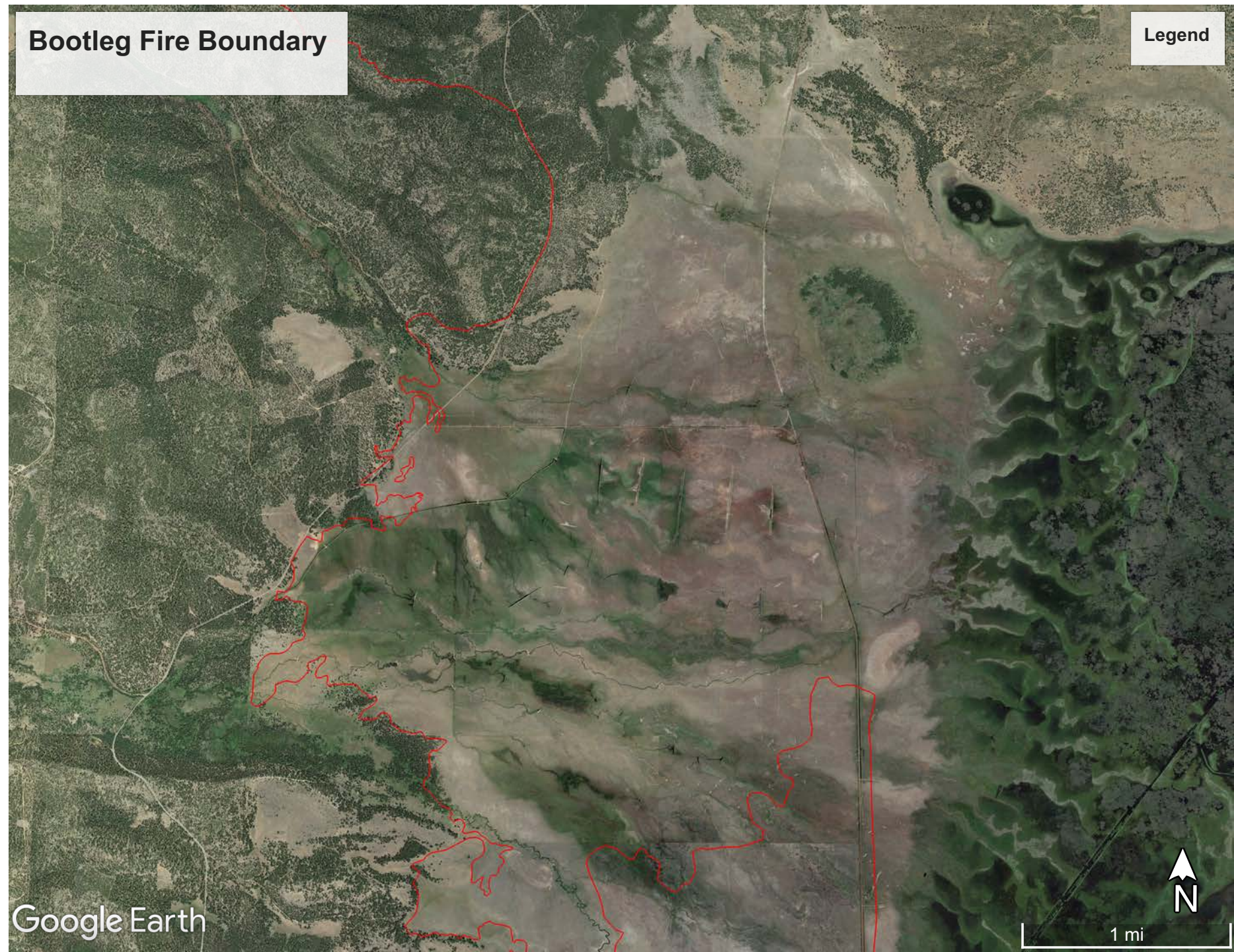
Source:
Interagency Fire Center

<https://data-nifc.opendata.arcgis.com/datasets/nifc::wfigs-interagency-fire-perimeters/explore?location=42.648393%2C-121.093482%2C10.63>

Bootleg Fire Boundary

Legend

Bootleg Fire Video:
<https://www.youtube.com/watch?v=uhVt1pPFMgl>



Google Earth

1 mi

BICO East 2D Treatments





Lidar

- Halo Photonics Streamline Scanning Lidar



An arrest in Oregon worries those who want to prescribe more fire on the land

Every year, land managers intentionally set millions of acres on fire across the United States. Last month, one of those prescribed fires in Eastern Oregon's Grant County had the rare distinction of making news headlines.

On Oct. 19, Grant County Sheriff Todd McKinley [arrested Ricky Snodgrass](#), the leader of a U.S. Forest Service crew conducting a prescribed burn in the Malheur National Forest.

The sheriff charged Snodgrass with reckless burning after the fire crept onto about 20 acres of private land beyond the national forest boundary.

The incident was a [potential flash point](#) in a long-simmering conflict between rural Western sheriffs and the federal government. At the same time, some prescribed fire advocates worry the arrest could be another setback in efforts to use more fire in forest management.

"The sheriff felt like he was protecting the community and restoring justice, and I think it's just the opposite," said Timothy Ingalsbee, a fire ecologist and director of [Firefighters United for Safety, Ethics and Ecology](#), or FUSEE. "One of the intentions of that prescribed fire was to make the community safer in the event of a future wildfire."

<https://www.opb.org/article/2022/11/20/burn-boss-arrest-oregon-prescribed-fire/>



Grant County Sheriff arrests US Forest Service employee after prescribed burn jumps to private property

The leader of a U.S. Forest Service crew conducting a prescribed burn in the Malheur National Forest was arrested Wednesday on charges of reckless burning, according to the Grant County Sheriff's Office.

Oct. 20, 2022

Pre-burn meeting at Nature Conservancy Conference Room (Jim Castles Applied Research Station)

- Met each morning to discuss conditions, fire treatment plan for the day
- Coordinate crews



October 25 Treatment



1:19 PM



2:07 PM

Localized heavy fuels burn



October 26, 2022 4:18 PM



October 26, 2022 5:18 PM

Post-burn landscape

- Heavier fuels carried fire
- Fine fuels then dried and burned





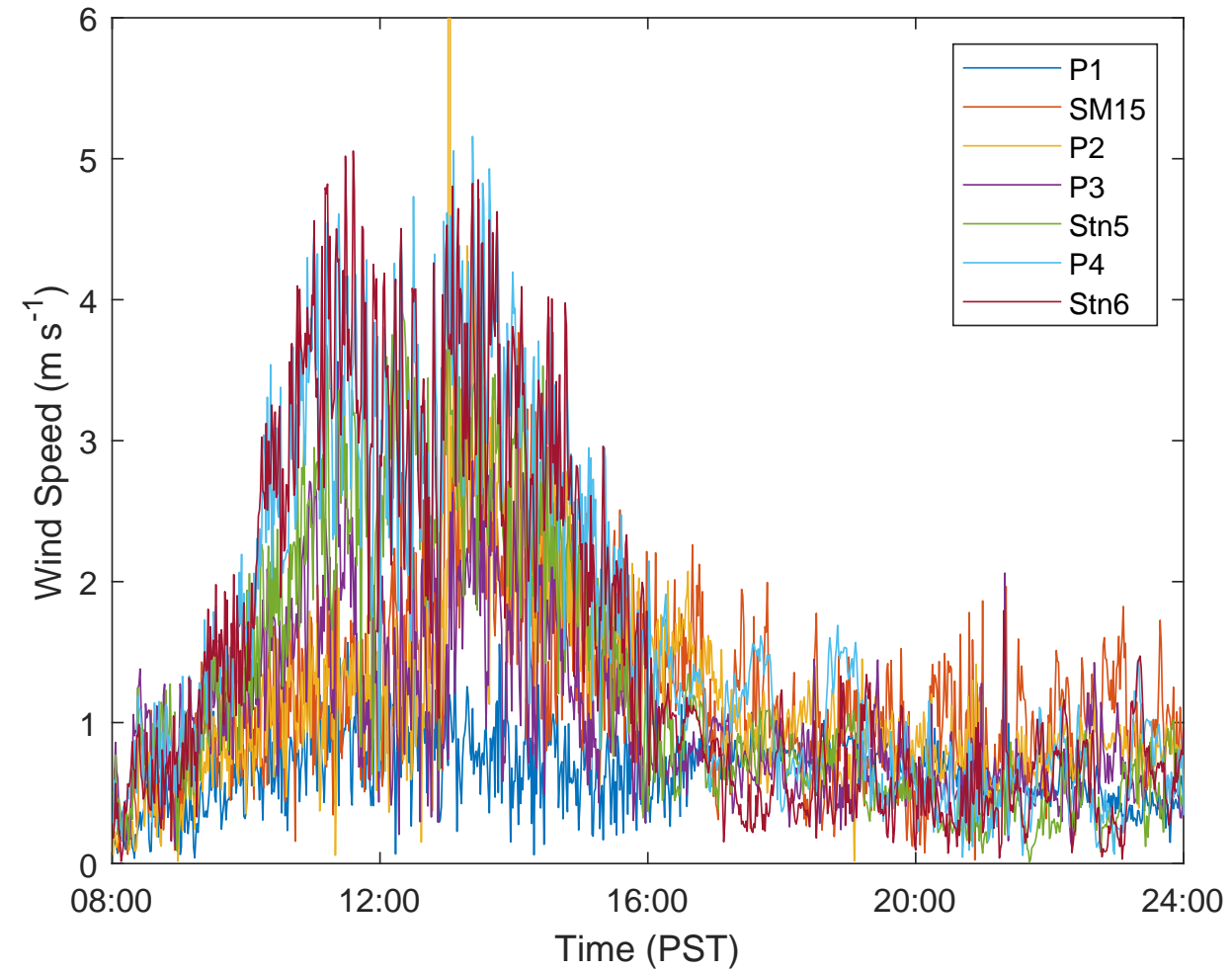
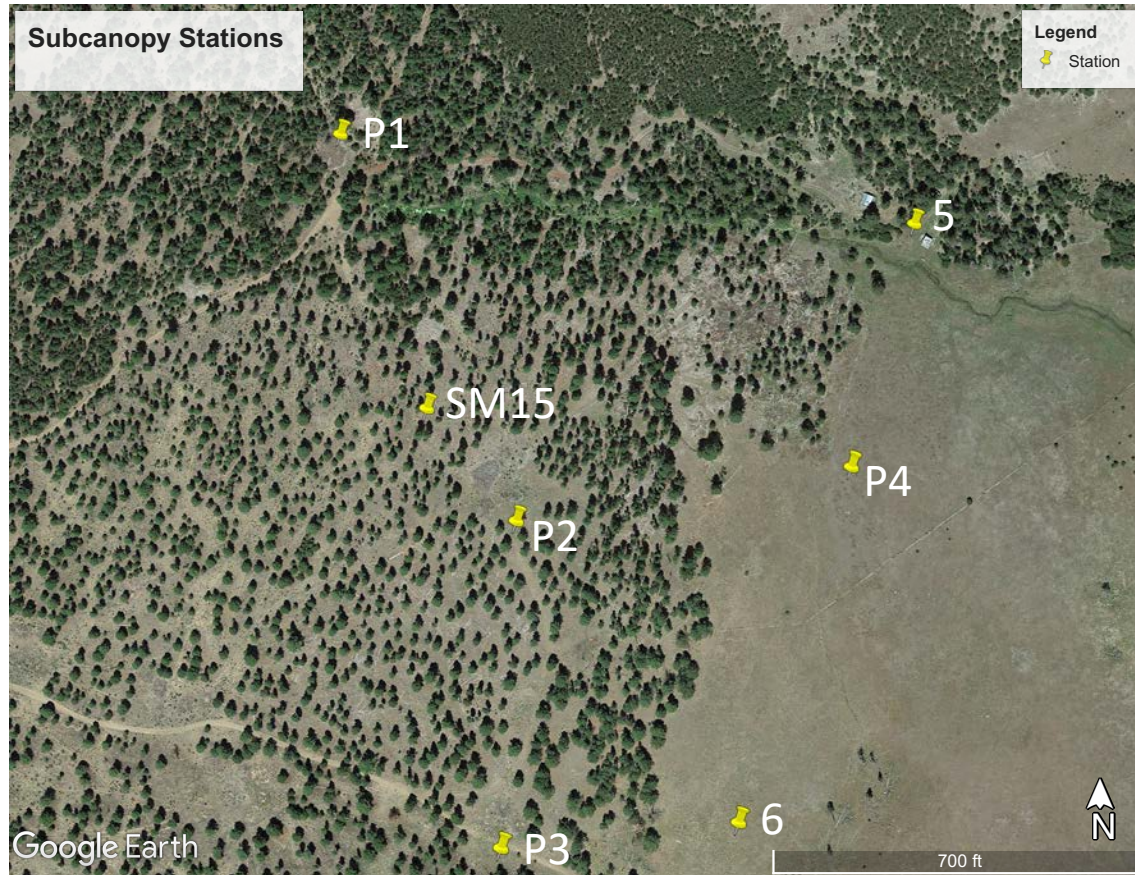
Meldase

(12 °C / 53 °F 10/27/2022 11:00:11

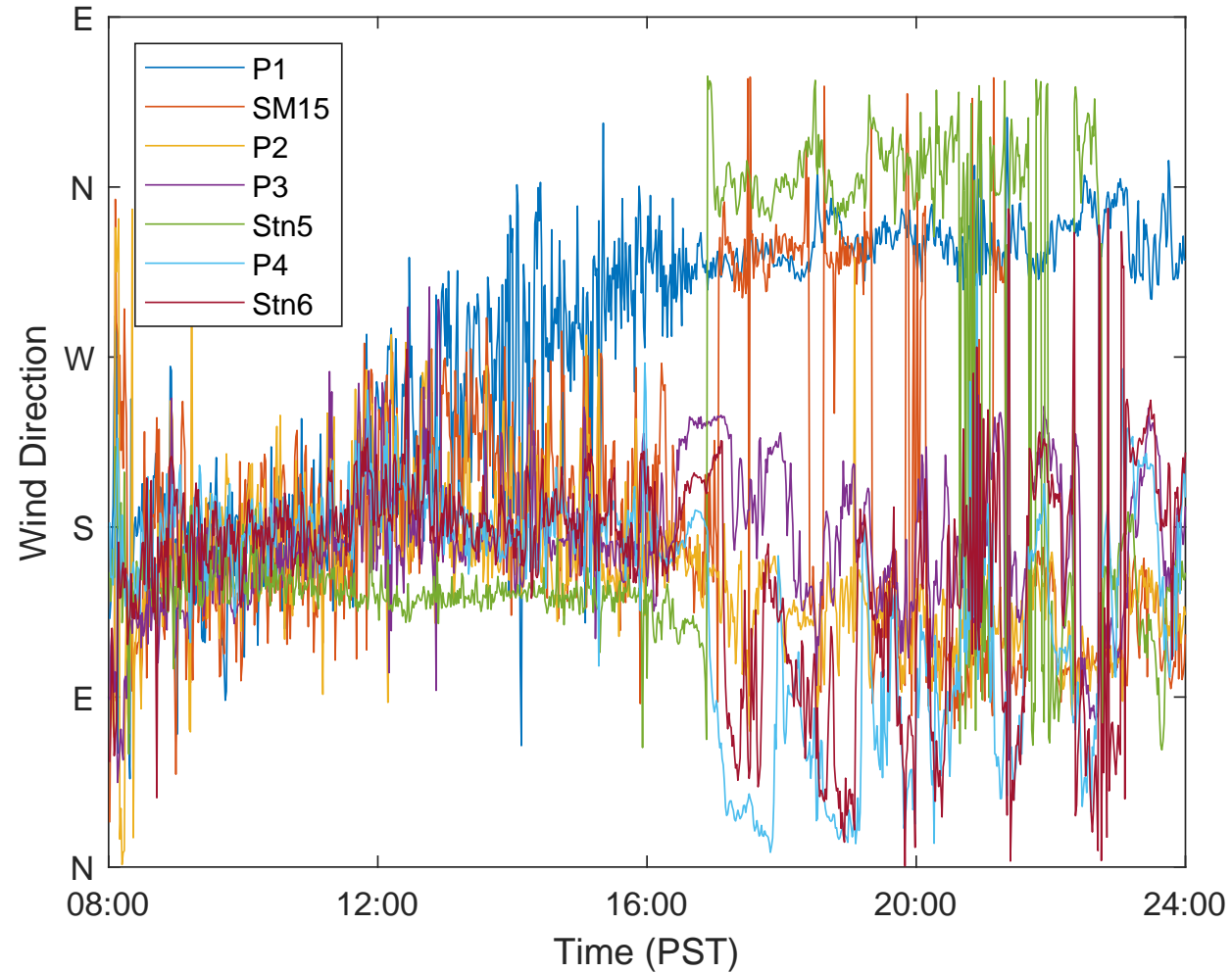
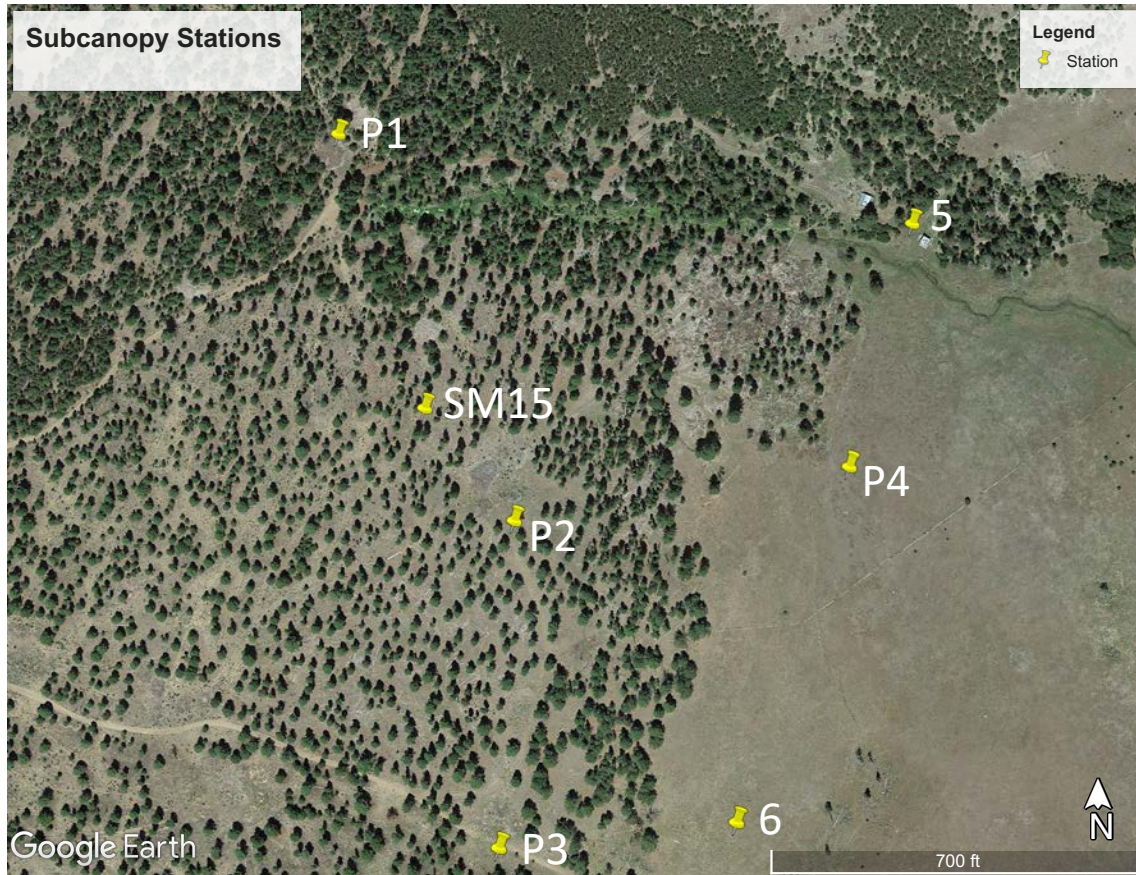
Unit 2A burn, October 27



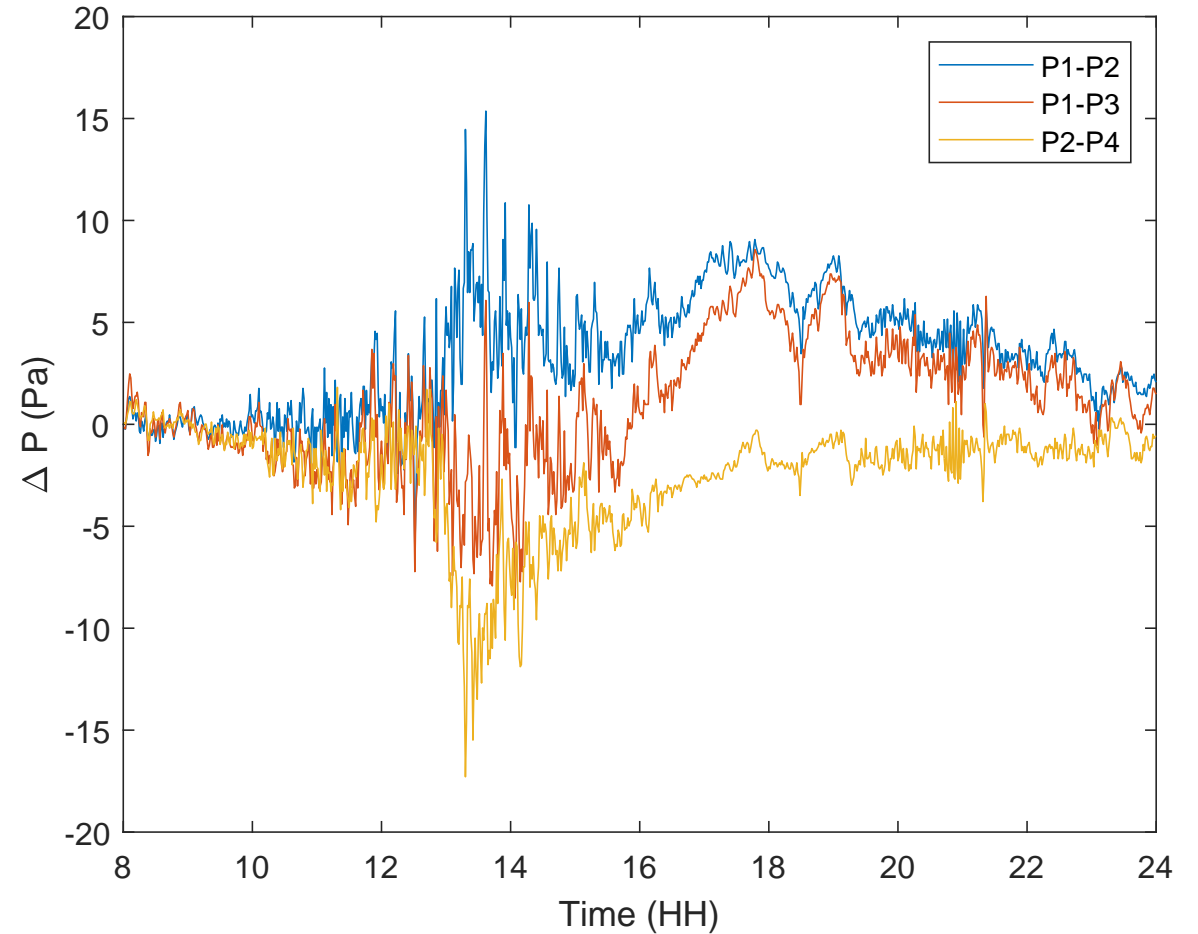
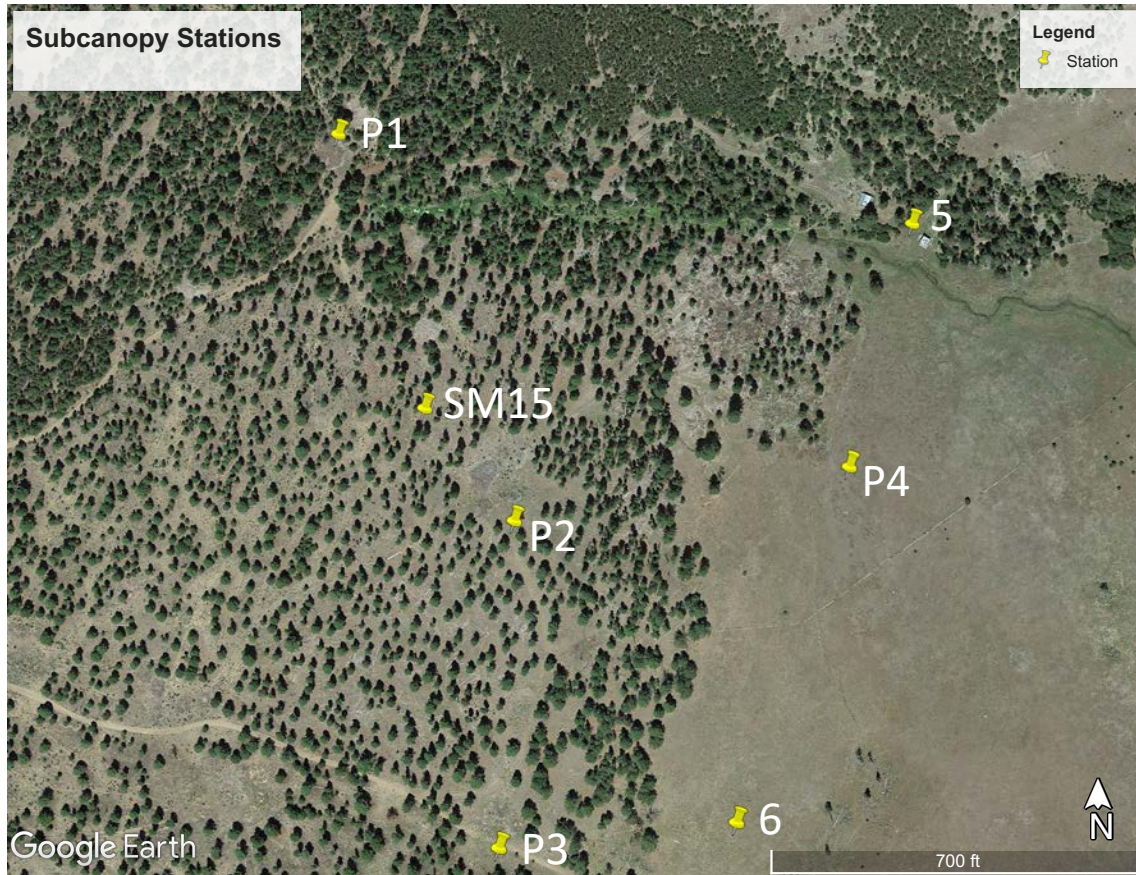
Wind Speed

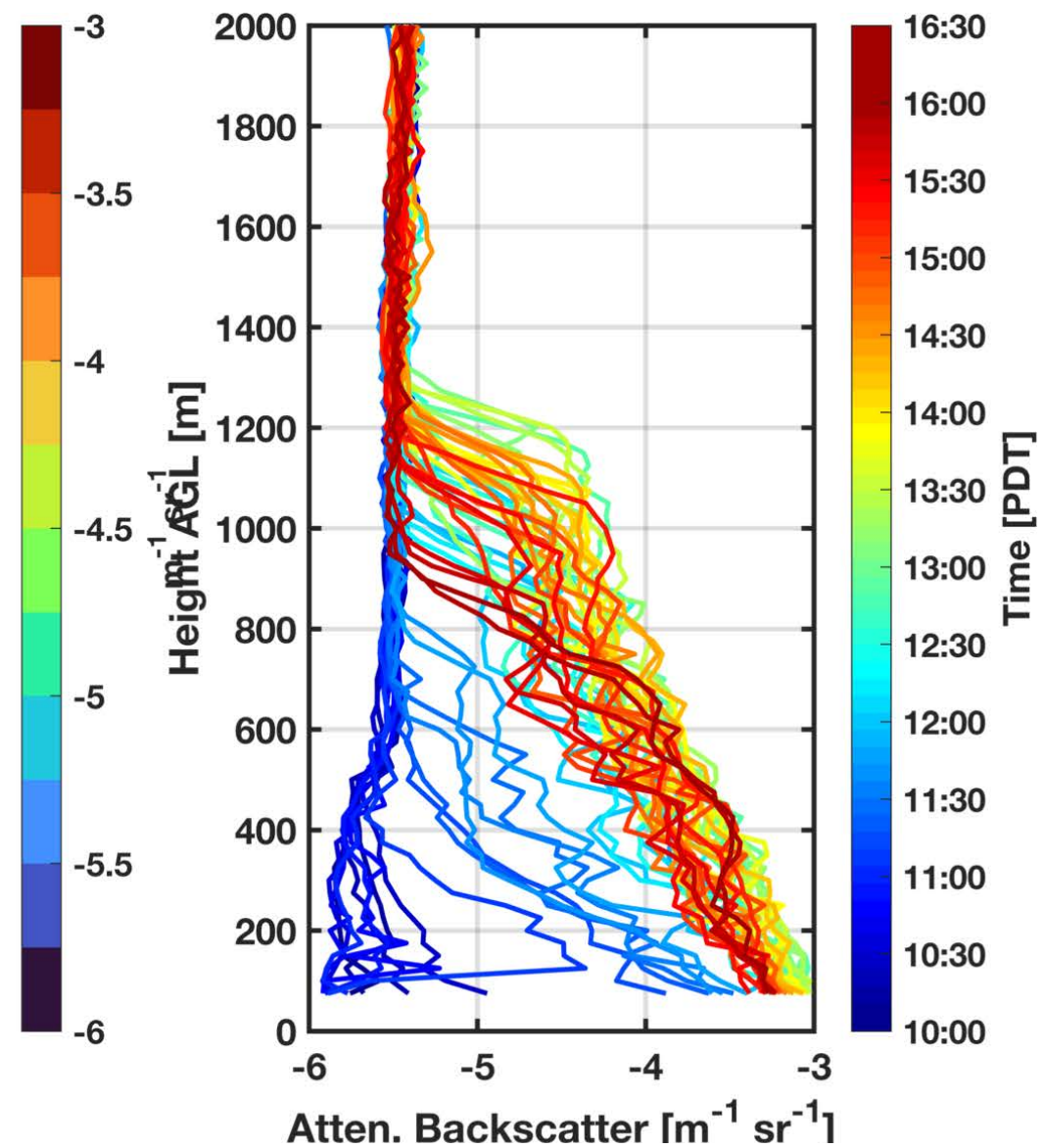
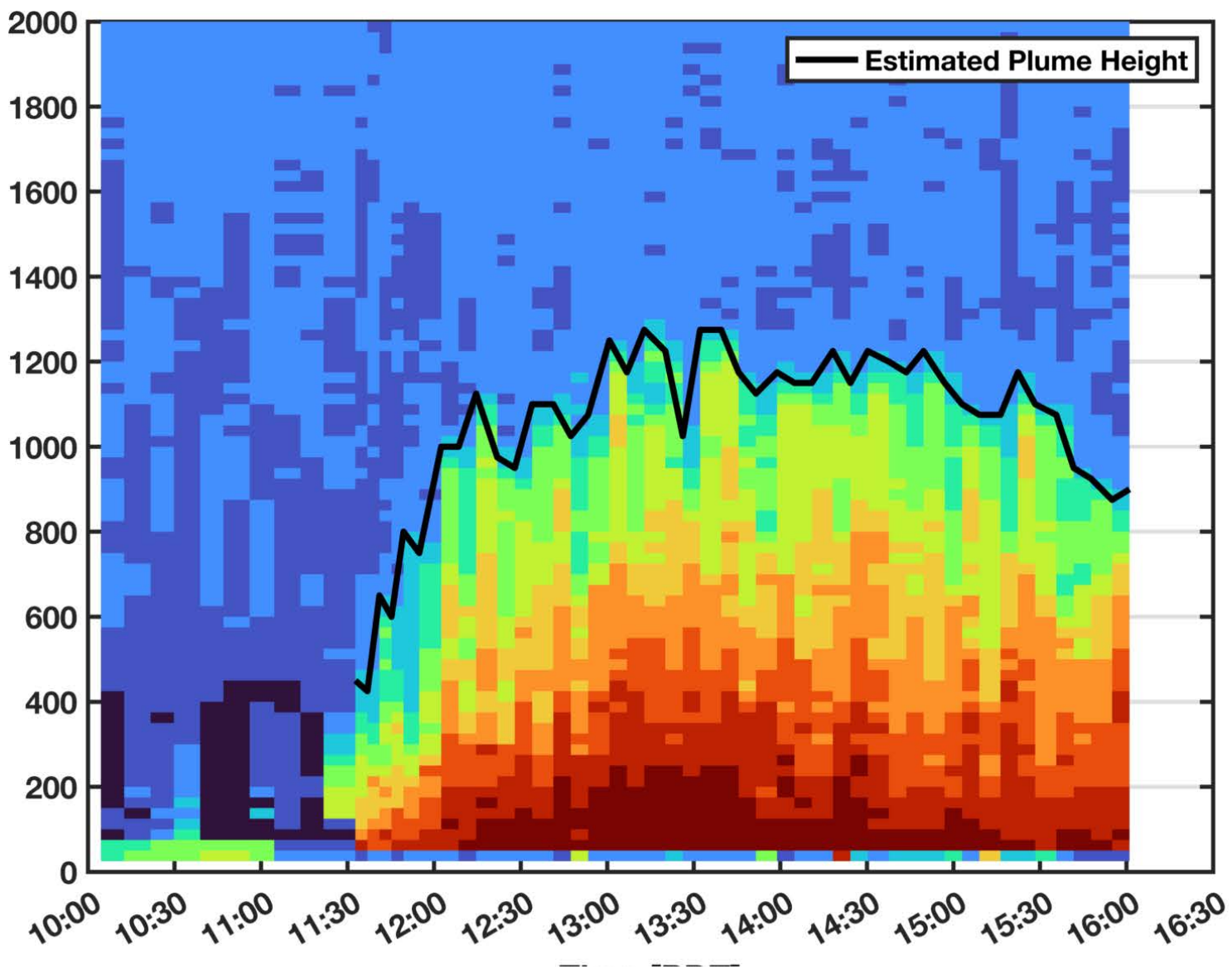


Wind Direction

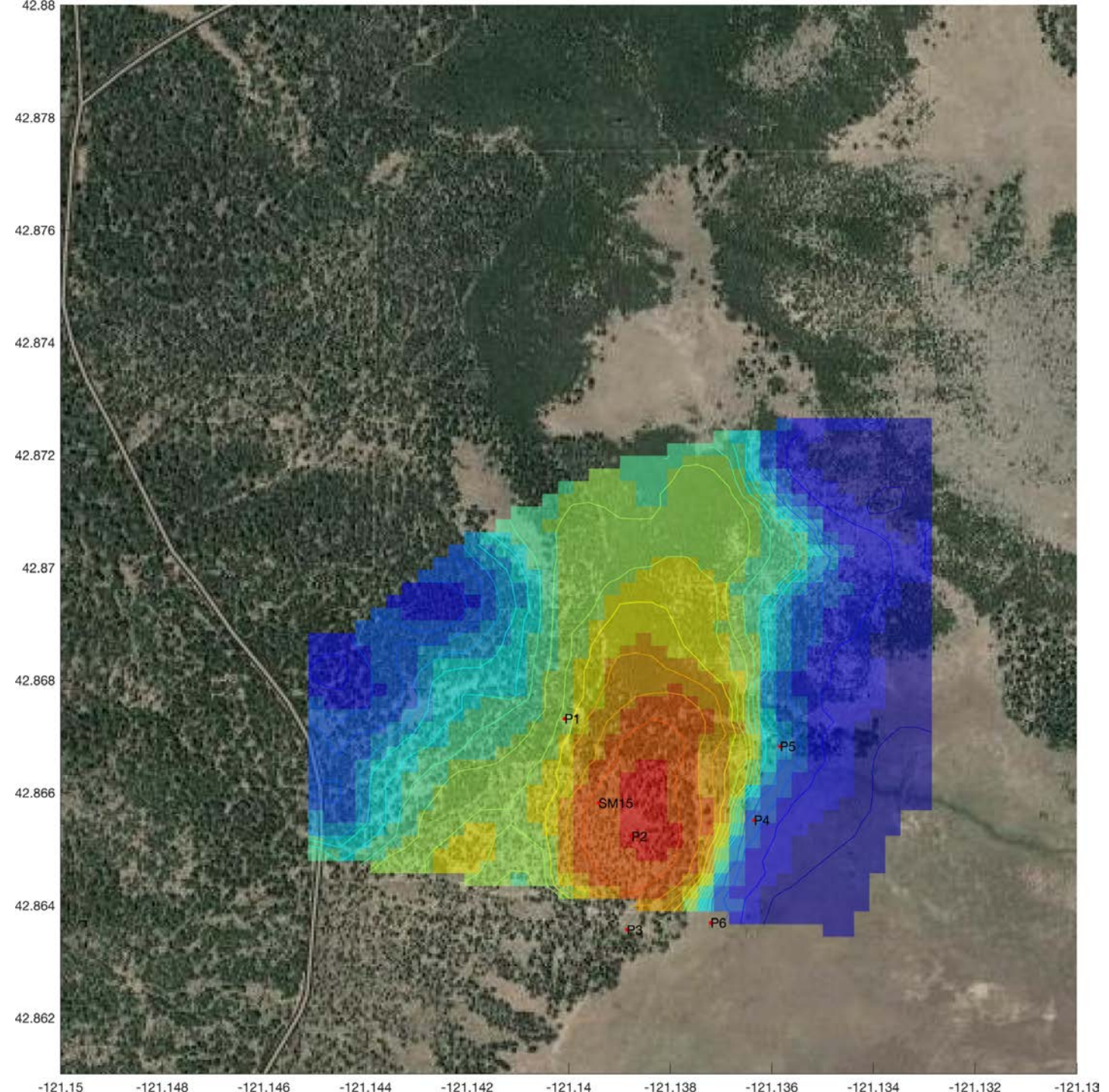


Pressure Difference

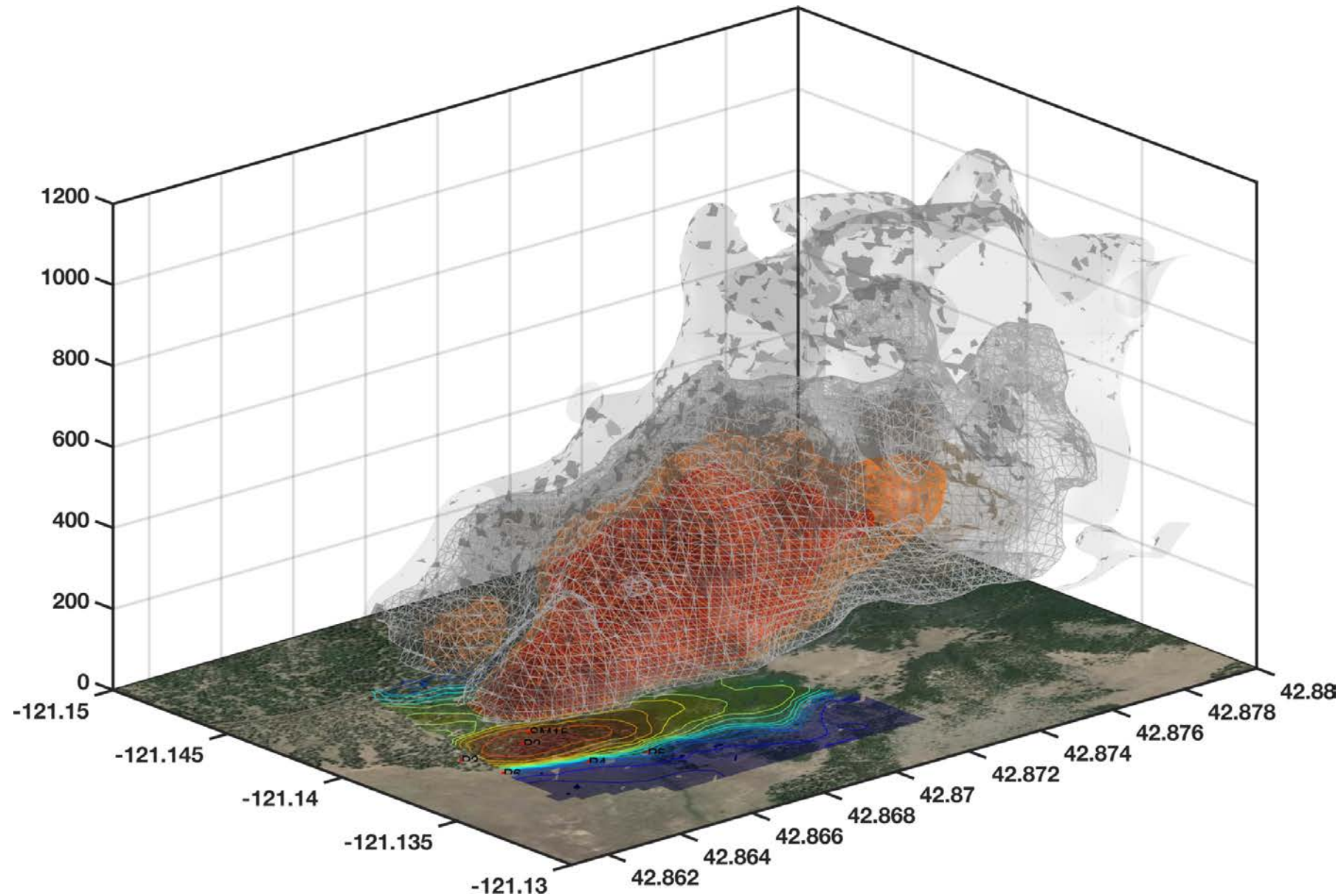




- Can georeference lidar data
- Georeferenced perspective affords the ability to co-locate other remotely sensed data such as IR measurements from drone platforms



- When the plume is not vertically aligned it may be more accurate to use the distance along the plume centerline rather than height
- This is a topic of active research





Comparing Sagehen and Sycan 2A Plumes

- Similarities

- Convective initial conditions
- Upright plume with minimal near-field fumigation
- Quasi-linear distribution of particulates in \log_{10} space -> exponential decay

- Differences

- Sagehen was an underburn whereas 2A was more aggressive
- Burn 2A consumed more biomass, quicker
- Burn 2A produces a much taller plume
- Burn 2A produces more large ash that visibly deposited not far from the burn area
- In burn 2A Heavy fuels were purposefully ignited

Next Steps

- Further quantify plume dynamics as a function of meteorological conditions
- Assimilate other's findings (Sycan burns)
- Search for similarity relationships and thus pertain to a larger set of prescribed fires