UW-WyCEHG Ecohydrogeophysics (EHG) Course Summer 2013 – Summer 2016

EHG Timeline

2013 – UW & Jackson St. Univ. students participate in Laramie, WY, Late June 2013 – 14 attendees (7 – UW & 7 - JSU), 5 UW Faculty Instructors, 2 UW Staff, Blair-Wallis, and Snowy Range sites.

2014 – UW & Jackson St. Univ. students participate in Jackson, MS, May 2014 - 15 attendees (8 – UW & 7 - JSU), 5 UW Faculty Instructors, 1 JSU Faculty, 3 UW Staff, Collaboration with USACE-Vicksburg at Buck Chute site.

2015 – UW & HBCU students participate in Laramie, WY, May/June 2015, course restricted to 12 – 11 attendees (4 - UW & 7 – HBCU), 1.5 UW Faculty Instructors, 2 Graduate TA's, 1 UW Staff, Blair-Wallis site.

2016 – UW & HBCU students participate in Laramie, WY, Late July 2016, course restricted to 12 – 13 attendees (11 – UW & 2- HBCU), 1 UW Faculty Instructor, 3 Graduate TA's, Blair-Wallis site.

2017 – Not Offered

Wyoming Center for Environmental Hydrology and Geophysics

EHG Goals/Learning Outcomes

- In the beginning (2013 & 2014), the course was exclusively available to UW and Jackson State Univ. (MS) students. Students were exposed to the various methods & tools for studying the sciences of Ecology, Botany, Surface Hydrology, and Geophysics. The four sections of the course were independent and little integration between the disciplines was required of the participants.

- At the end (2015 & 2016), the course was opened up to students from any HBCU in the U.S. Additionally, the course objective was to integrate Ecological, Botanical, Hydrological and Geophysical methods to investigate, image and map the surface and subsurface water distribution/movement as it exists and influences the plant life, root zone and upper soils at a predetermined site.
  - Simply put, students attempt to quantitatively solve the water balance for the site and evaluate those results within the framework of an hypothetical future scenario/condition at that same site (e.g. fire, road construction, pumping well installation, etc.).

Water Balance Equation

A general water balance equation is:

$$P = Q + E + \Delta S$$

where

P is precipitation

Q is runoff

E is evapotranspiration

ΔS is the change in storage (in soil or the bedrock)

The Water Balance Equation used:

$$\Delta S = -ET + Qnet$$

ΔS is change in storage
ET is evapotranspiration
Qnet = Qi-Qo

Earth is a closed system which means it has a continuous water cycle.

EHG Instructors & Participants

Instructors:

2013 – Brad Carr, Brent Ewers, Steve Holbrook, Scott Miller, Dave Williams, Liz Nysson, Jordan Hayes, Brady Flinchum

2014 – Brad Carr, Brent Ewers, Ezat Heydari (JSU), Steve Holbrook, Scott Miller, Dave Williams, Liz Nysson, Suman Chitrakar.

2015 – Brad Carr, Dave Williams, Liz Nysson, Suman Chitrakar, Heather Speckman

2016 – Brad Carr, Daniel Beverly, Suman Chitrakar, Jason Mercer, (Liz Nysson).

Student Attendees:

University of Wyoming – 30
Jackson State University – 17
Howard University - 3
North Carolina A&T - 1
Southern University - 1

Major/Emphasis:

Ecology - 4
Botany - 3
Hydrology - 9
Earth Science - 13
Civil Engineering - 14
Computer Sci – 6
Atmospheric Sci – 1
Petroleum Eng. - 1

Graduate/Undergraduate:

Graduate – 14
Undergraduate - 38

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Field Methods

Geophysics

Objective: Collect and analyze DC Resistivity Data

AGI Super Sting R8/IP/SP Resistivity Meter

-Water table, bedrock depth and structure

-Use pole dipole method

Hydrology

Objective: Figure conductivity, turbidity, and streamflow

HOBO Conductivity Data Logger+Salt Slug

-Two separate sections, 200 grams NaCl each

OTT MF-Pro

-stream discharge for cross section

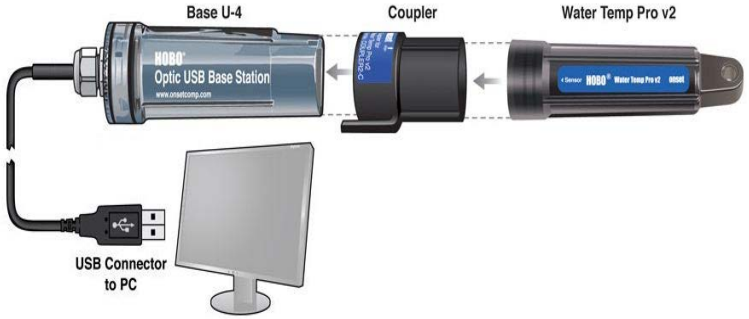


Photo Credit: www.hobodataloggers.com and Dan Beverly

Ecology

Groundwater wells

- Contained pressure transducer

Sapflow Sensors

- Granier-type sapflow sensors

Meteorological Tower

- Eddy Covariance, vertical wind speeds
- Sonic Anemometers: sensible/latent heat flux

Ecology: Water Isotopes

Collect a variety samples to later extract water isotopes in the Stable Isotope Facility

Surface/Ground Water

Tree Xylem

Soil

Ecology: Vegetation

Pressure Bombing

- Tree samples collected and
- Dried for pressure difference

Tree Core Collection (sapwood)

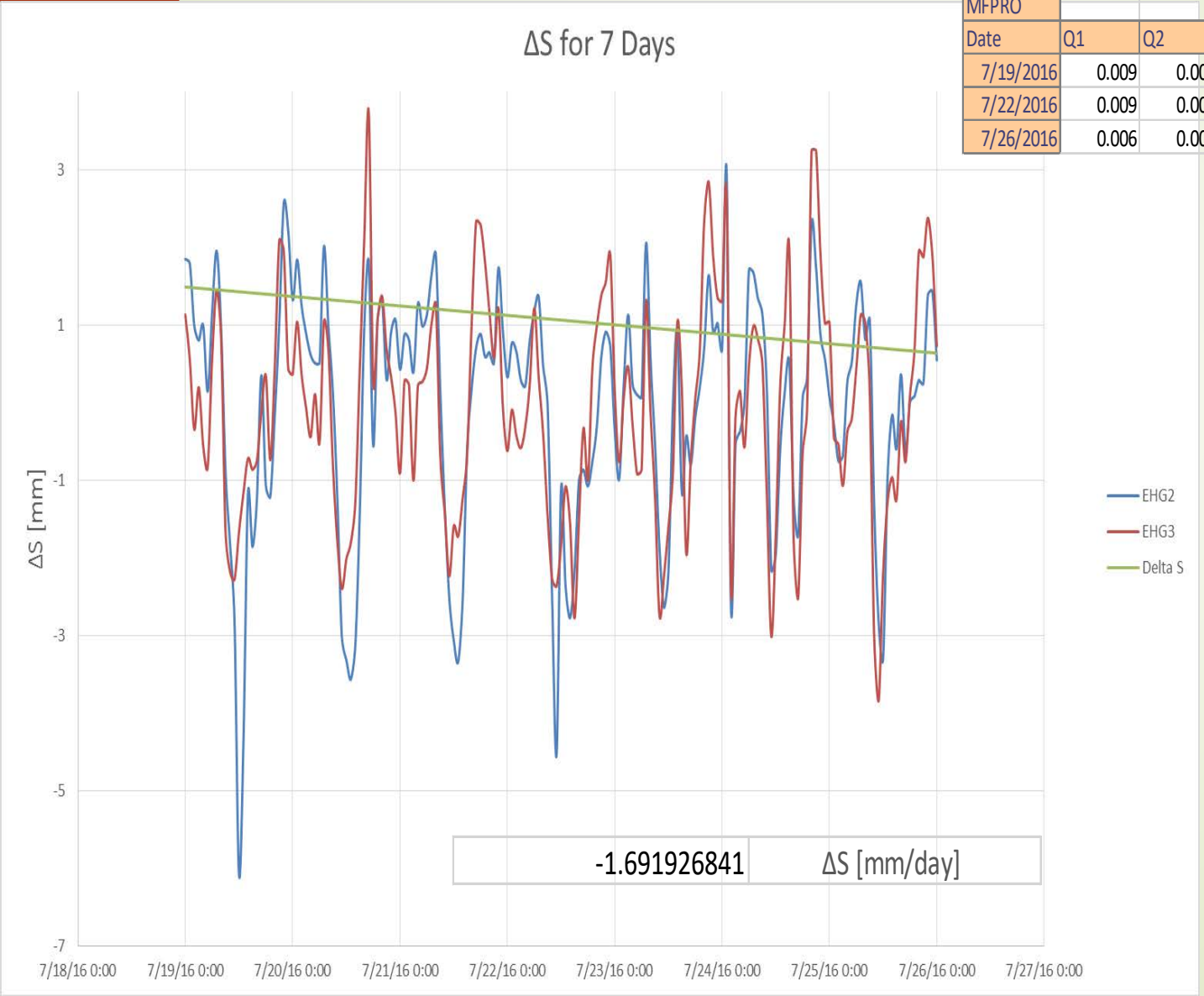
- Aspen cores, pine cores, willow branches

Results

Hydrology

SALT SLUG					
Date	Q1	Q2	Qnet		
7/19/2016	0.007841	0.008883	0.0010419	0.0021	m3/s
7/22/2016	0.007291	0.010694	0.0034031	1.80E+11	mm3/day
7/26/2016	0.004095	0.005888	0.0017926	270.55	mm/day

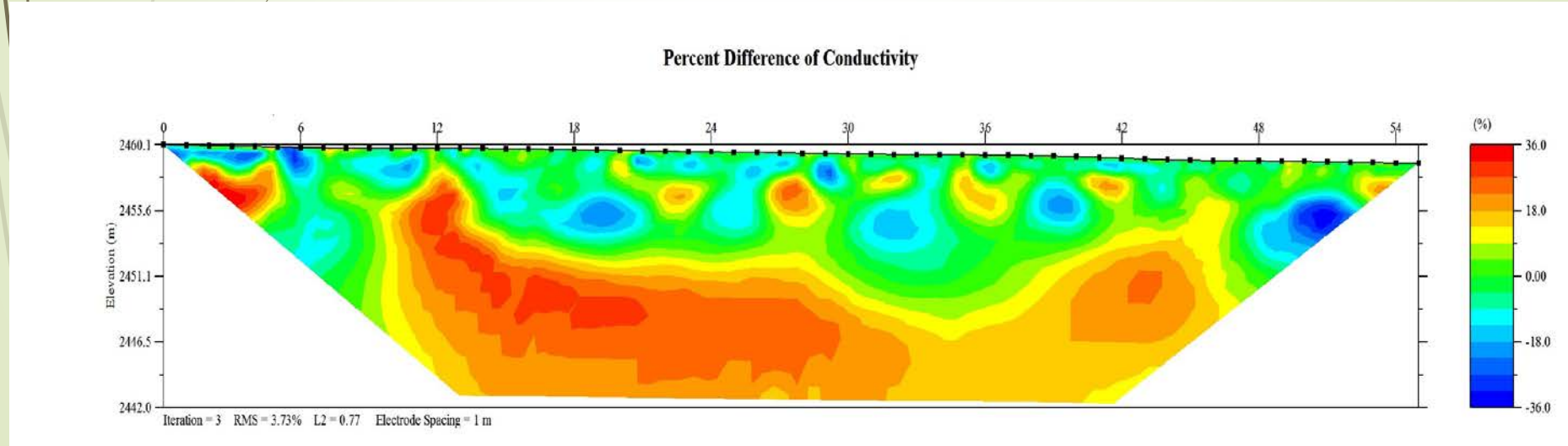
MFPRO					
Date	Q1	Q2	Qnet		
7/19/2016	0.009	0.009	0	-0.0010	m3/s
7/22/2016	0.009	0.007	-0.002	-8.64E+10	mm3/day
7/26/2016	0.006	0.005	-0.001	-130.12	mm/day



- Q_{Net} calculated from Salt Slug and MFPro
- ΔS from Water table depths
- ΔS also calculated from

Geophysics

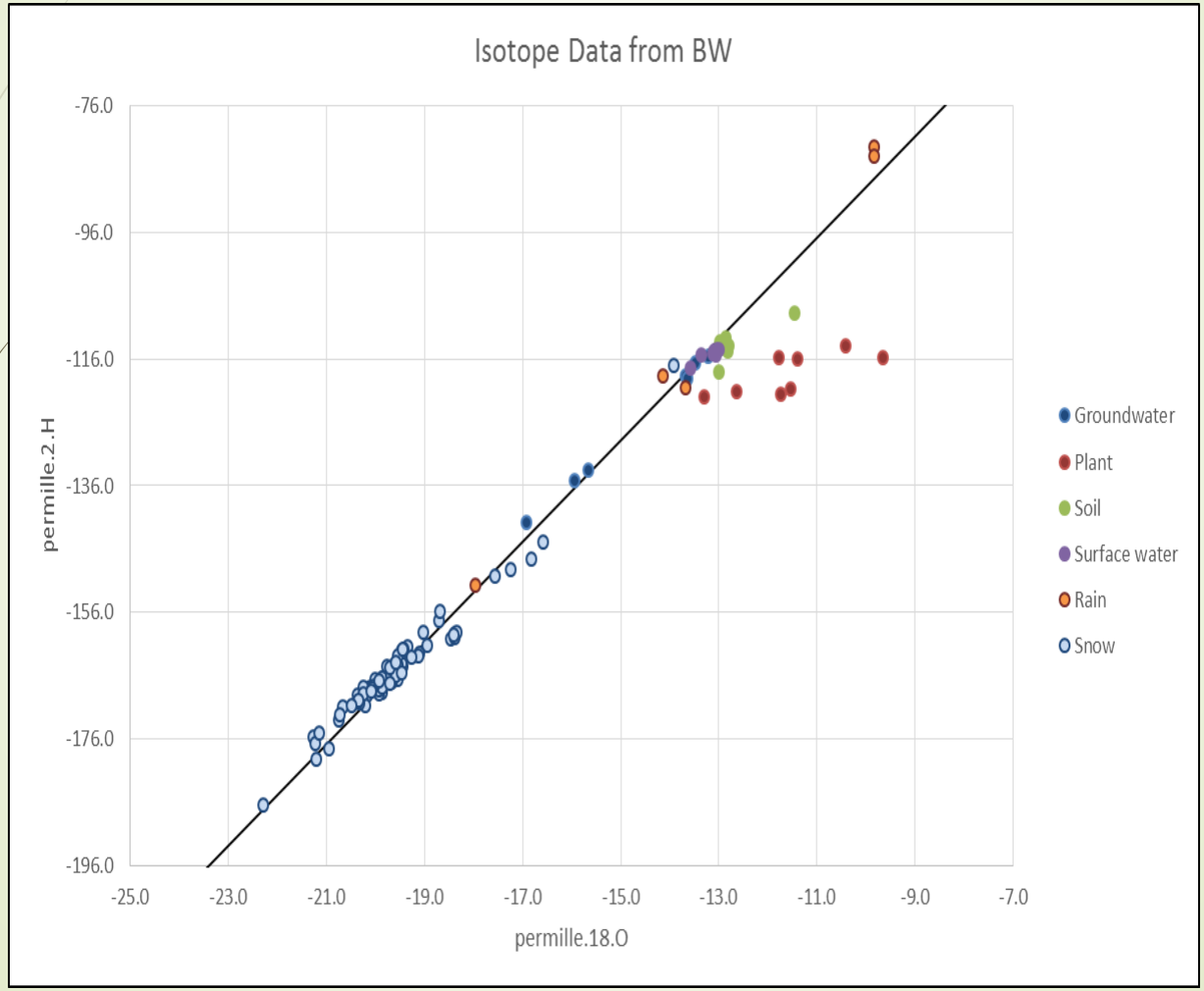
Use resistivity data from multiple days to obtain a difference in resistance and determine percent change in soil water content



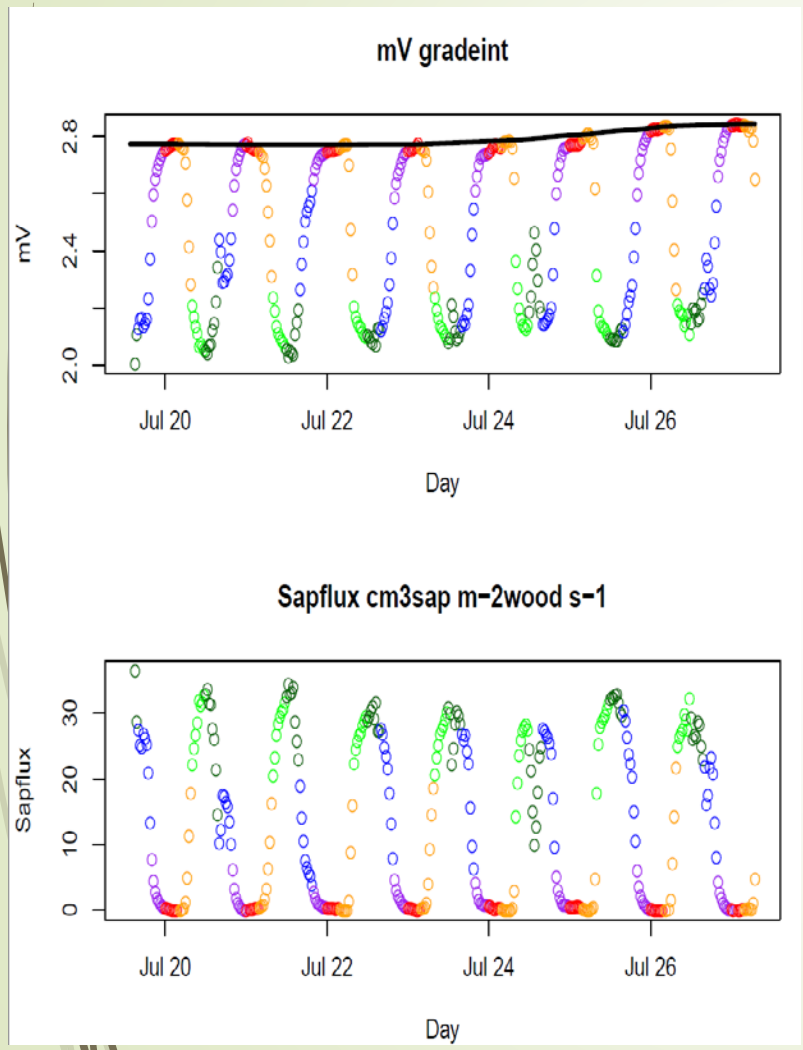
Soil Water Content from Geophysical Data

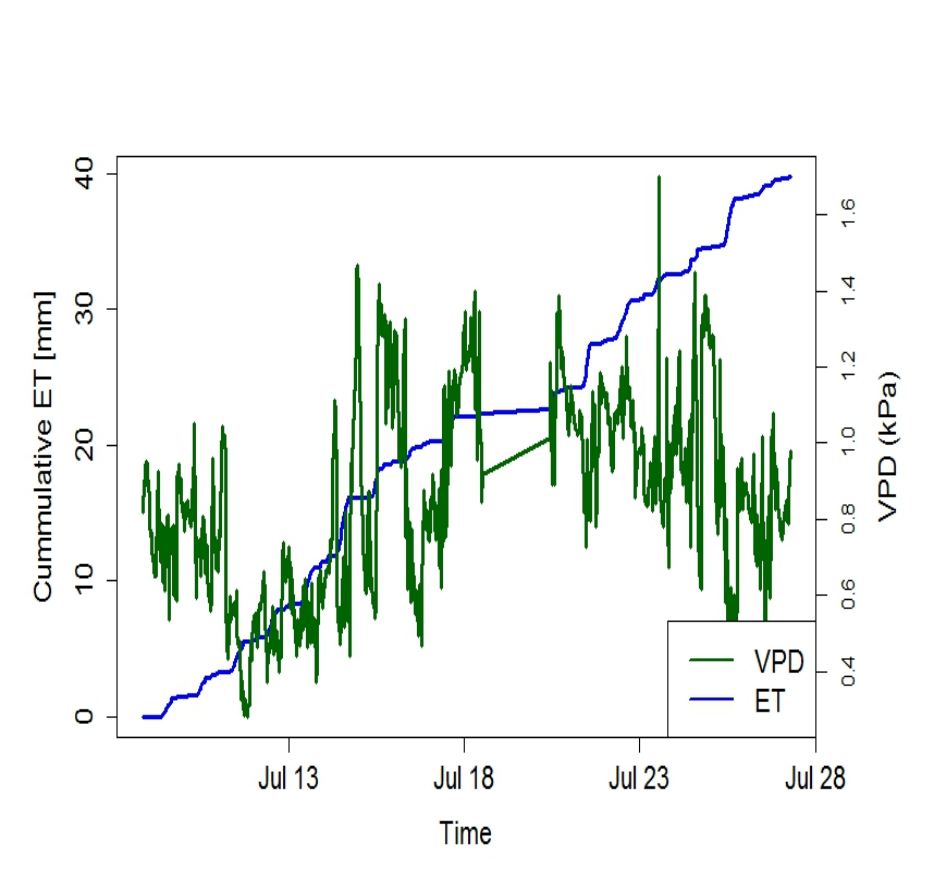
EHGL1A_INF										
	Electrodes					water content at elctrode				
Depth	5	16	27	38	50	5	16	27	38	50
0.5	94.1	245.6	184.9	102	148.8	13.87231	8.12417	9.517912	13.26241	10.7437
1	83.2	80.2	113.9	82.6	106.9	14.85826	15.16573	12.4708	14.91836	12.91985
1.5	116.1	48.1	169.1	107.7	93	12.33844	20.16947	10.00409	12.86623	13.96358
2	220.7	44.8	273.2	151.3	103.8	8.623269	20.98504	7.655665	10.64433	13.13364
2.5	465.6	88.8	353.5	267.1	159.6	5.686588	14.32815	6.630843	7.75269	10.33196
3	1012.8	359.5	395.6	267.1	303.7	3.686496	6.568891	6.22751	7.75269	7.216849
3.5	1258.9	558	506.2	286.7	609.7	3.265328	5.140469	5.427517	7.452471	4.892608
4	1415.4	1816.1	462.3	344.6	907.2	3.05876	2.661741	5.709191	6.725817	3.919986
4.5	1415.4	4137.5	626.7	493.6	907.2	3.05876	1.681607	4.818138	5.504357	3.919986
5	1413	7838.1	1041.4	493.8	1143.5	3.061657	1.177528	3.629683	5.503114	3.445202

Isotope


Isotope Data from BW
-76.0
-96.0
-116.0
-136.0
-156.0
-176.0
-196.0
permille.2.H
-25.0
-23.0
-21.0
-19.0
-17.0
-15.0
-13.0
-11.0
-9.0
-7.0
permille.18.O
Groundwater
Plant
Soil
Surface water
Rain
Snow

Ecology





Tree transpiration= -0.925 mm/day

Tower E_T= -2.541 mm/day

Did we close the water budget equation?

$$P = \Delta S + E_T + Q_{Net}$$

$$0 = -1.48 + (-0.925 + (-2.541)) + (-130.12)$$

$$0 \neq -135.006 \text{ mm/day}$$

$P = 0$ mm/day

$Q_{Net} = -130.12$ mm/day

E_T = Tree transpiration + Tower E_T

Tree transpiration = -0.925 mm/day

Tower E_T = -2.541 mm/day

ΔS = -1.48 mm/day from resistivity data

or

-1.69 mm/day from water table data

Conclusions

- Water Budget Equation was not closed
  - Need more data
  - Expand study site or change area for better Eddy Covariance Tower data with wind direction
- Case Scenario
  - Hypothesis 1: Water storage will increase with less demand from trees/understory, at least in the case of a moderate fire or moderate thinning.
  - Hypothesis 2: ET will actually increase after a moderate severity fire.

ario

e starts due to lightning strike at the bottom of the study area
replacing crown fire burns 50% of the over-story and 75% of the
er that no precipitation occurs within the study area, develop
sed on the scenario.

that could be proposed:
apotranspiration be affected by high intensity fire?
discharge predicted to be affected post-fire?
water storage or ground water increase or decrease post-fire?

Hypotheses

- Hypothesis 1:
  - The reduction in tree canopy and understory coverage from a high severity fire will increase water storage because of less water demand from trees.
- Hypothesis 2:
  - Evapotranspiration will decrease after the fire because of the loss of 50 percent of canopy and 75 percent of understory.

Evapotranspiration after high intensity fire

- Study site is a mixed forest with predominantly Aspen and Willow tree species, which both recover from fires by resprouting.
- After a high intensity fire in a resprouting eucalypt forest, E_T has been observed to reduce up to 41%.
- E_T in a forest burnt at high intensity fire does not recover until around 8-12 years post fire.
- Observed a cumulative decrease in E_T of around 18% over 5 years, 13% over 10

Reference: “Trends in evapotranspiration and streamflow following wildfire in resprouting eucalypt forests”, Nolan et. Al 2015

Discharge after moderate severity fire

- Surviving trees have higher rates of transpiration post fire
- Mod= ↑E_T and ↓Q
- E_T is higher at Mod. sev. site for 0-3 years post fire vs. high sev. Site
- Declines in Q due to increased E_T following moderate severity wildfire were of similar magnitude to Q declines driven by a drought that coincided with a fire.
- Greater reduction in Q is expected when wildfire occurs during prolonged dry periods

Reference: Nolan et. Al 2015

Conclusions

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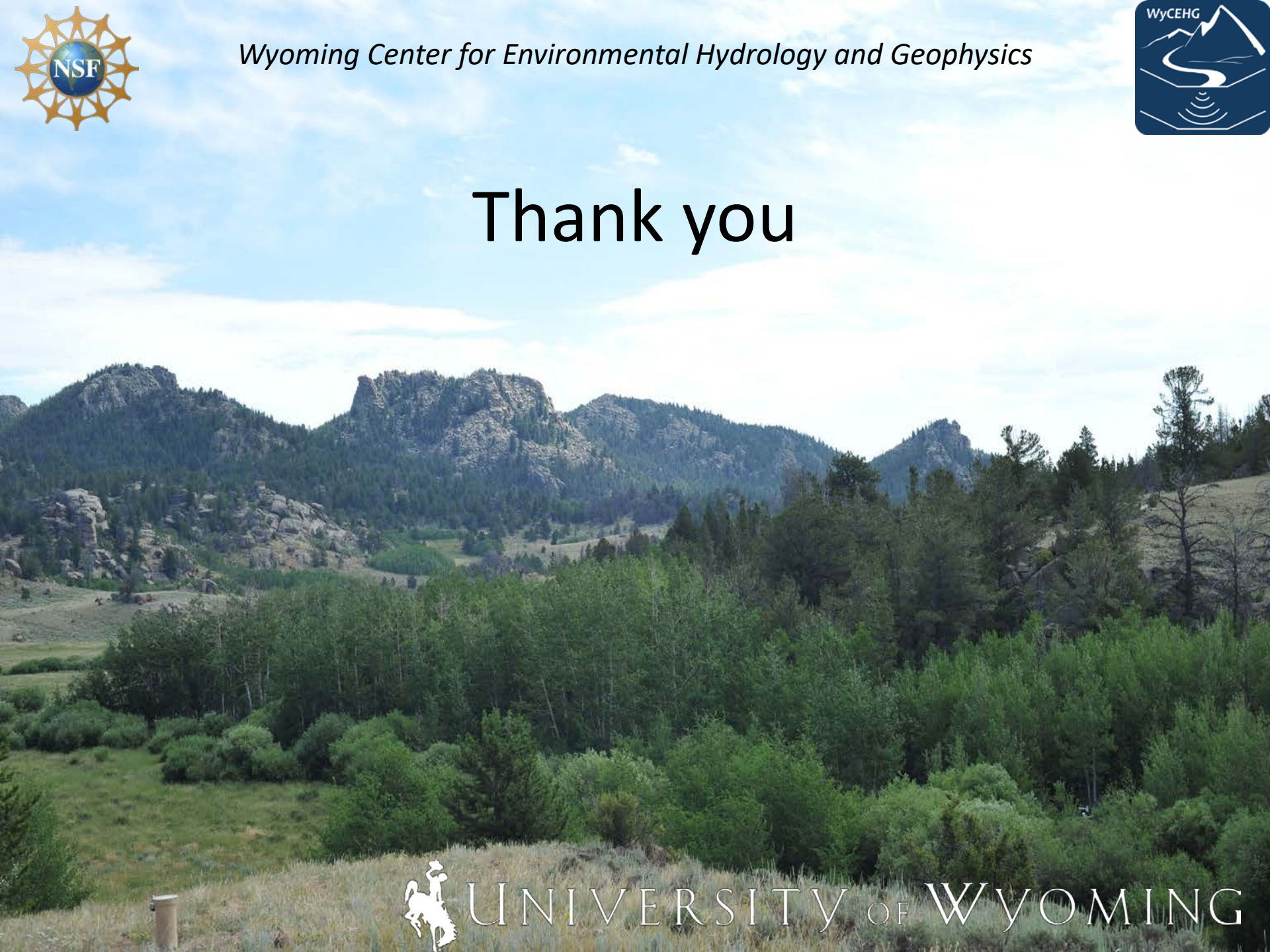
Thank you