Post-wildfire summer greening depends on the previous winter’s snowpack

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Wildfire is a key aspect of forests
Over 80% of forest fires in the western U.S. burned within the seasonal snow zone

Gleason et al. 2013
Burned woody debris decreases snow albedo and causes snow to melt weeks earlier than in adjacent unburned areas.

Albedo decay for forests and burned forests

Gleason et al. 2013
Gleason & Nolin 2016
How does snow affect forest health and forest (re)growth?

- Relationship between snow and summer greening (Trujillo et al. 2013)
- Relationship between snow and wildfire (Westerling et al. 2006)

**Question:** Does snow affect summer greening (vegetation regrowth) in the post-fire environment?
New Snow Metrics

In the absence of reliable estimates of western US SWE we have derived several new snow metrics based on daily snow cover from the Moderate Resolution Imaging Spectroradiometer (MODIS):

– Snow Cover Frequency
– Snow Disappearance Date
– Snow Cover Duration
Snow Cover Frequency (SCF)

\[
SCF = \frac{\text{# of snow observations}}{\text{# of valid observations}}
\]

- Uses remote sensing observations from NASA’s Moderate Resolution Imaging Spectroradiometer (MODIS)
- Daily observations of snow cover (MOD10A1) at 500-m spatial resolution
- Cloud correction is applied
- Computed in Google Earth Engine
Snow Cover Frequency  February 2011 and February 2015
New website-based implementation called SnowCloud

- Watershed and HUC-level selection (or user-supplied ROI)
- Elevation range (m)
- Date range (min 30 days, max. 1 year)
How do you predict streamflow in the absence of field data? This challenge is particularly vexing in snowy mountain regions. Critical data are often absent and prediction efforts are hampered by lack of timely snow data. Predicting low flows is particularly important where water resources are limited.

Remote sensing, cloud computing, and interactive web-based mapping tools offer a new paradigm for delivering key streamflow data to water resource managers.
Three fires:

Pot Peak (2006)  
Thorn Creek (2006)  
Grays Creek (2007)

Variables:

- Max summer EVI (greenness)
- SCF
- Soil type
- Land cover type
Grays Creek Fire – clayey/skeletal soil

Pre-fire year
Soil Type: clayey/skeletal

Pre-fire average $\Delta$EVI vs. $\Delta$SCF relationship is not significant

Post-fire year 1
Soil Type: clayey/skeletal

Year 1 post-fire $\Delta$SCF explains 41% of variance in $\Delta$EVI

Burn severity index
Grays Creek Fire – clayey skeletal soil

Post-fire year 2
Soil Type: clayey/skeletal

Post-fire year 3
Soil Type: clayey/skeletal

Year 2 post-fire $\Delta$EVI vs. $\Delta$SCF relationship is not significant

Year 3 post-fire $\Delta$EVI vs. $\Delta$SCF relationship is not significant
Pot Creek Fire – ashy/pumiceous soil

Year 1 post-fire $\Delta$SCF explains **69%** of variance in $\Delta$EVI

Year 2 post-fire $\Delta$EVI vs. $\Delta$SCF relationship is not significant
Pot Creek Fire – coarse/skeletal soil

Year 1 post-fire $\Delta$EVI vs. $\Delta$SCF relationship is not significant

Year 2 post-fire $\Delta$EVI vs. $\Delta$SCF relationship is not significant
Thorn Creek Fire – clayey/skeletal soil

Pre-fire year
Soil Type: clayey/skeletal

Change in EVI vs. ∆SCF relationship is not significant

Post-fire year 1
Soil Type: clayey/skeletal

Year 1 post-fire ∆SCF explains 27% of variance in ∆EVI
Thorn Creek Fire – clayey/skeletal soil

Year 2 post-fire ΔSCF explains 13% of variance in ΔEVI

Year 3 post-fire ΔEVI vs. ΔSCF relationship is not significant
Thorn Creek Fire – vegetation types

Pre-fire

Post-fire year 1

Soil Type: clayey/skeletal

Pre-fire

Post-fire year 1

Change in EVI

Change in SCF

Change in EVI

Change in SCF
Thorn Creek Fire – vegetation types

Post-fire year 2
Soil Type: clayey/skeletal

Post-fire year 3
Soil Type: clayey/skeletal

Change in EVI

Change in SCF

Dry-Mesic Montane Mixed Conifer Forest
Mesic Montane Mixed Conifer For
Ponderosa Pine Woodland and Savanna
Subalpine Dry-Mesic Spruce-Fir Forest and Woodland

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Summary

• Snow matters in the post-fire environment
• Preliminary results suggest that antecedent snowcover affects post-fire summer greening but need to examine many more fires, more variables
• Simple snow metrics can be very helpful in the absence of SWE
Next Steps

Identify key physiographic variables (in addition to snow)
Test snow disappearance date (SDD)
Make new snow metrics publicly available via website
Examine in the context of potential future SnowEx sites