Wildfire probability mapping based on regional soil moisture models

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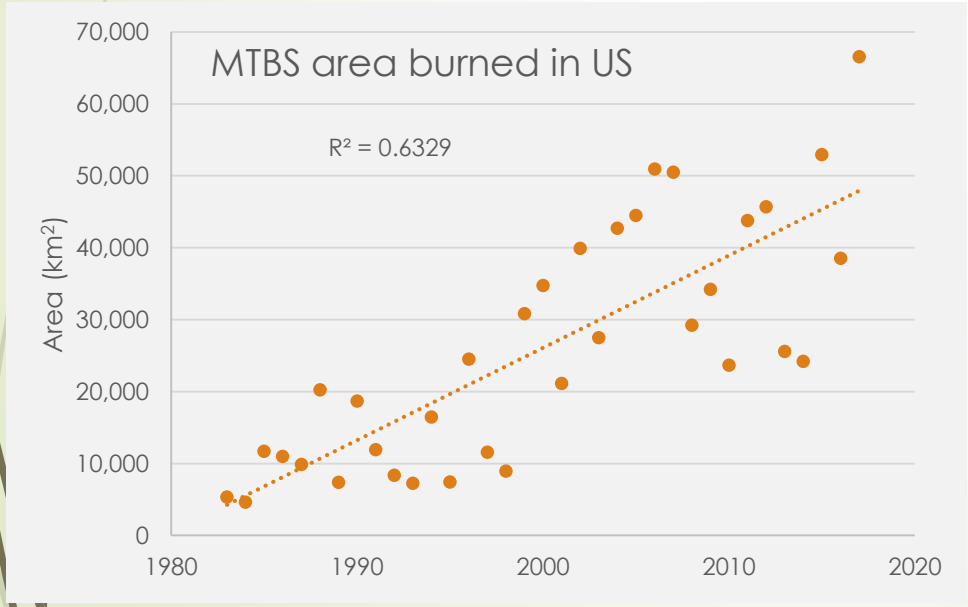
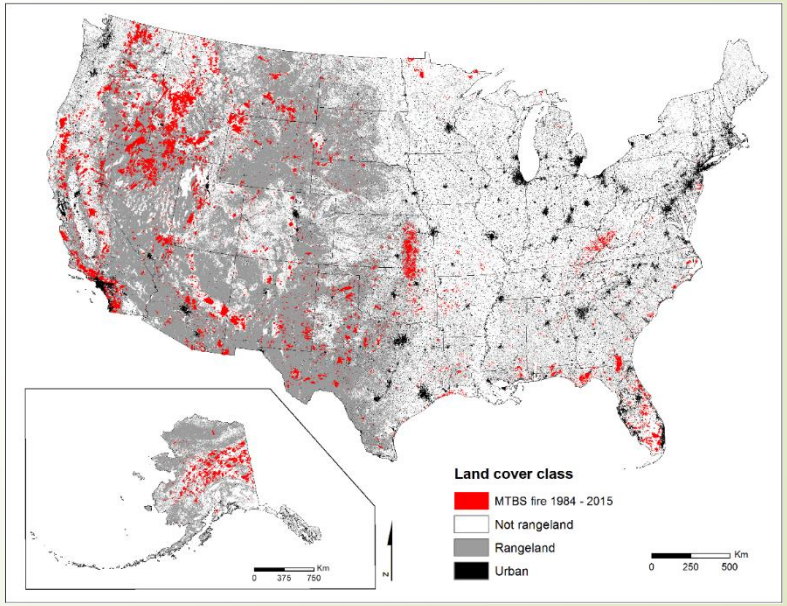
Introduction

- Wildfire affects an estimated 148.8 Mkm^2 globally each year
- Average of 38,452 km^2 in the US over the last 10 years





Levi and Bestelmeyer 2018; van der Werf et al. 2017

Fire

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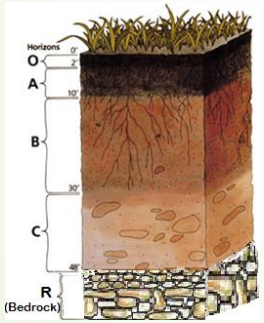
Soil

What happened to the soil?

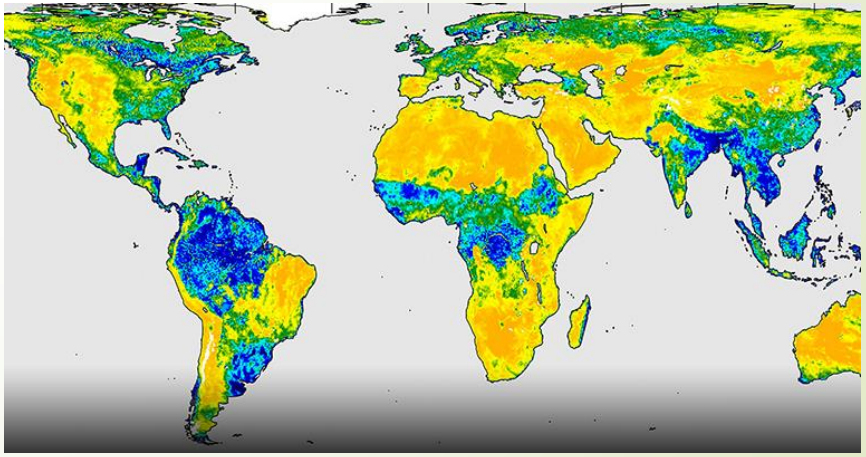
http://kuow.org/post/california-fire-plus-drought-plus-rain-add-mud
http://whrc.org/black-spruce-the-fire-king/

Fire likelihood

Climate Fuel Ignition Topography



- SMAP soil moisture – 3 day composite Aug. 25-27, 2015



Littell et al. 2009, Krawchuk and Moritz 2011, Abatzoglou and Kolden 2013, Yang et al. 2015, https://smap.jpl.nasa.gov/news/1247/nasa-soil-moisture-radar-ends-operations-mission-science-continues/

Rationale

- Recent work has shown that soil moisture strongly influences wildfire activity during much of the year
  - controls on plant productivity and live fuel moisture
- Soil moisture has been shown to be a better predictor of the occurrence of large growing-season wildfires than the commonly used Keetch-Byram drought index,
  - potential benefits of incorporating soil moisture information in wildfire danger assessments
- Still, soil moisture is not currently used operationally for wildfire prediction because data are often unavailable at the appropriate scales of space and time.

(Krueger et al., 2015, 2016, and 2017; Jensen et al. 2018)

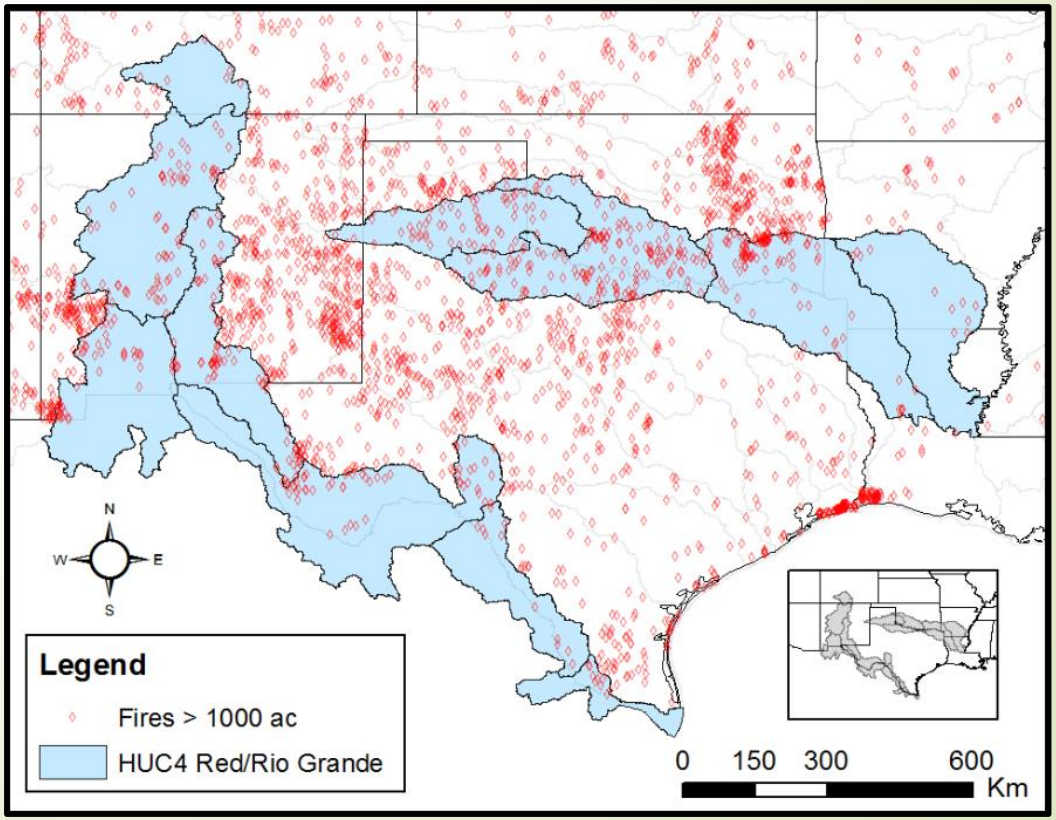
Objectives

Develop and disseminate wildfire danger assessments for the south central (SC) region that are rooted in spatially and temporally dense estimates of soil moisture.

1) Develop effective soil moisture models for SC river basins using digital soil maps, gridded climate data, and satellite vegetation indices;
2) Quantify the relationships between modeled soil moisture and wildfire probability; and
3) Develop and distribute soil moisture and wildfire probability maps for the Red River (RR) and Rio Grande (RG) basins.

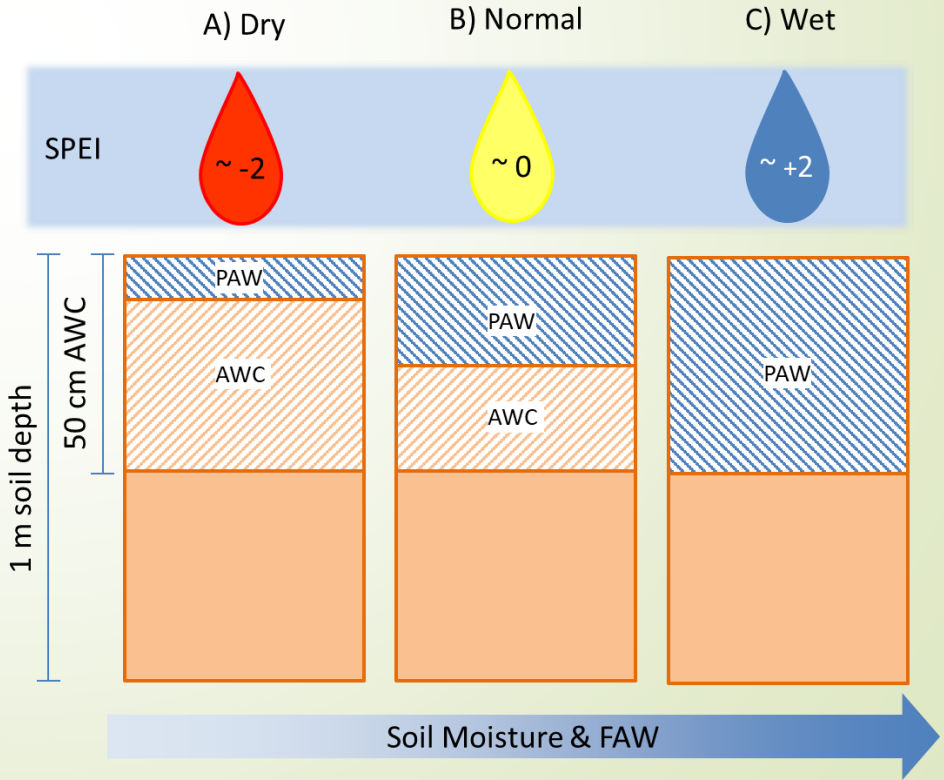
Focus area

- Rio Grande River Basin (87,794 mi^2)
- Red River Basin (124,591 mi^2)
- Southwestern and South Central US



Hypothesis

- *In situ* measured soil moisture can be used to train simple, spatially and temporally dense, soil moisture models, and that these models can improve spatiotemporal wildfire prediction in the SC region.
- Next step toward our long-term goal of using soil moisture data to refine and improve wildfire danger assessments across the US.

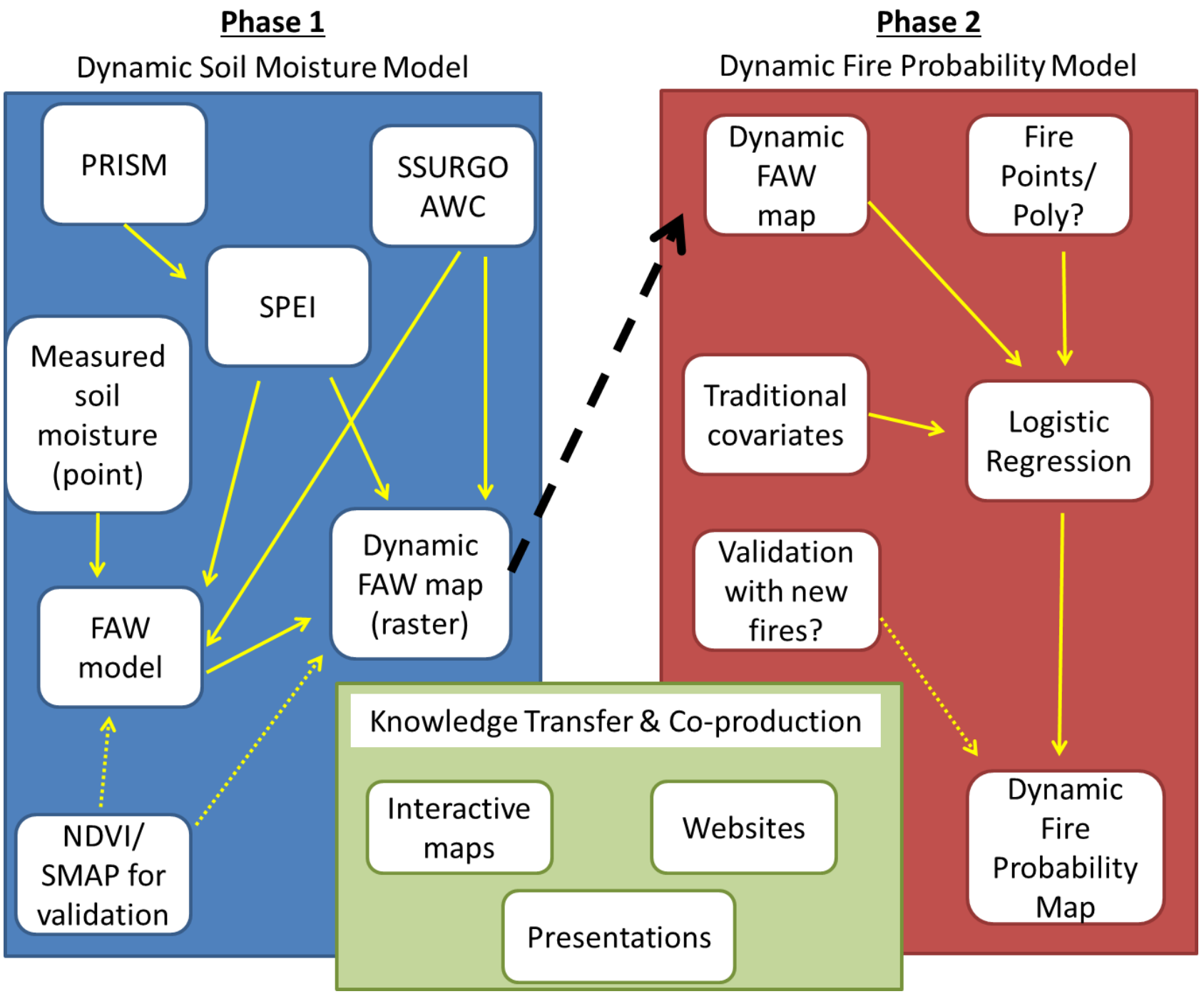


Methods – Phase 1
Soil Moisture

- Develop models to estimate spatial and temporal dynamics of fraction of available water capacity (FAW), a soil moisture based drought index known to influence the size and probability of wildfires in the SC region
- FAW is the ratio of plant available water (PAW) to available water capacity (AWC), where PAW is the volumetric water content that is available to plants at a given time (dynamic) and AWC is the maximum plant available water that a soil can hold (static)

Methods – Phase 2
Fire probability modeling

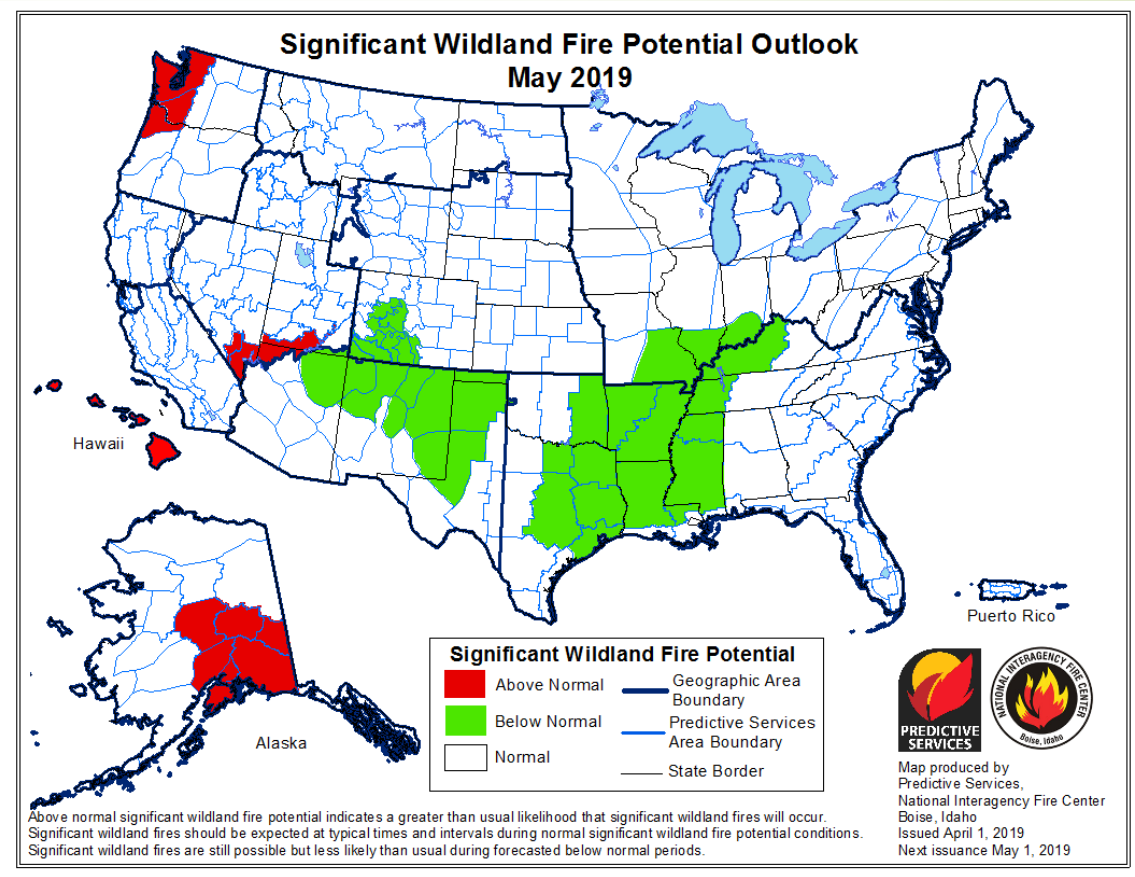
- Develop watershed-scale wildfire probability models for relatively detailed temporal scales (e.g., monthly, seasonal) using observed weather and modeled FAW (2000-2016).
- Predictor variables including modeled FAW (phase 1) MODIS-based estimates of LFM and traditional covariates such as ignition (lightning, distance to road/urban), fuel load (RS/vegetation maps), and weather.
- Fire probability models will be considered acceptable if models are statistically significant (e.g., p-value < 0.05) and representative of spatial fire distribution.


Phase 1
Dynamic Soil Moisture Model
Phase 2
Dynamic Fire Probability Model
PRISM
SSURGO AWC
SPEI
Measured soil moisture (point)
FAW model
Dynamic FAW map (raster)
NDVI/ SMAP for validation
Dynamic FAW map
Fire Points/ Poly?
Traditional covariates
Logistic Regression
Validation with new fires?
Dynamic Fire Probability Map
Knowledge Transfer & Co-production
Interactive maps
Websites
Presentations

Anticipated specifications of soil moisture and wildfire models

- 250 m spatial resolution
- Upper 40 cm of soil profile (root zone of fine fuels)
- Daily estimates of FAW (ideally)
- Watershed-scale fire probability models (logistic regression, machine learning, etc.)
  - Seasonal, monthly, weekly(??)
  - Testing/development with data from 2000-2016

How can we improve existing tools?



Implications

- Develop and evaluate decision-making tools and techniques to assist resource managers
- Communicate or increase capacity for utilizing climate information
- Resulting soil moisture and wildfire probability maps can inform decisions by resource managers, and our soil moisture model will improve climate data production by leveraging existing environmental data to produce an improved climate product
- Dissemination of soil moisture data and wildfire probability products through the web will facilitate their use by stakeholders
- More precisely quantify the impacts of drought (i.e., soil moisture) on wildfire across several ecosystems in the SC region

Thank you!

- We look forward to group discussions!