

EARTH LAB

A Slice of Earth Systems Data & Analytics



Dr. Jennifer K. Balch, Director & Assistant Professor

Geography, Applied Mathematics, Cooperative Institute for Research in
Environmental Sciences, Ecology & Evolutionary Biology,
Environmental Studies, Geological Sciences, Institute of
Behavioral Science, National Snow and Ice Data Center,
and Research Computing



University of Colorado **Boulder**
Grand Challenge

CU Boulder's Grand Challenge

Our world is facing significant issues with a changing environment, increasing populations and limited resources. The intersection of people, resources and our planet is where CU-Boulder can use its expertise in space-based observation and exploration to address our world's most pressing problems.

OUR SPACE. OUR FUTURE.

Reinventing Discovery through Technological Innovation

[Our Space. Our Future.](#)

**Earth Lab is the next national
synthesis center for Earth Systems
Science.**

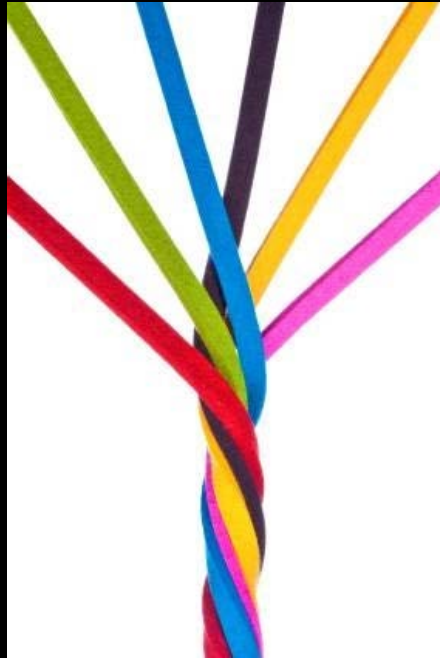
MISSION STATEMENT

To harmonize Earth observations from aerospace platforms and other sources to address scientific challenges in understanding the pace and pattern of global change to help society better manage and adapt.



SCIENCE:

Understand the
Pace and Pattern
of Global Change



ANALYTICS HUB: Deal with the Data Deluge



EDUCATION: Create the Next Generation of Earth Analysts

Earth Lab's Analytics Hub:

Brian Johnson, Max Joseph, Tim Dunn



- Foundational capability in tools and expertise to examine Earth observations and related information through data integration and analytics
- Creating tight collaborations between scientists and experts in data analytics, computing, and visualization
- Accelerating discovery by creating new tools and helping researchers scale
- Commitment to open, reproducible science



**Data
Analytics Research**



**Remote Sensing
& Data Science**

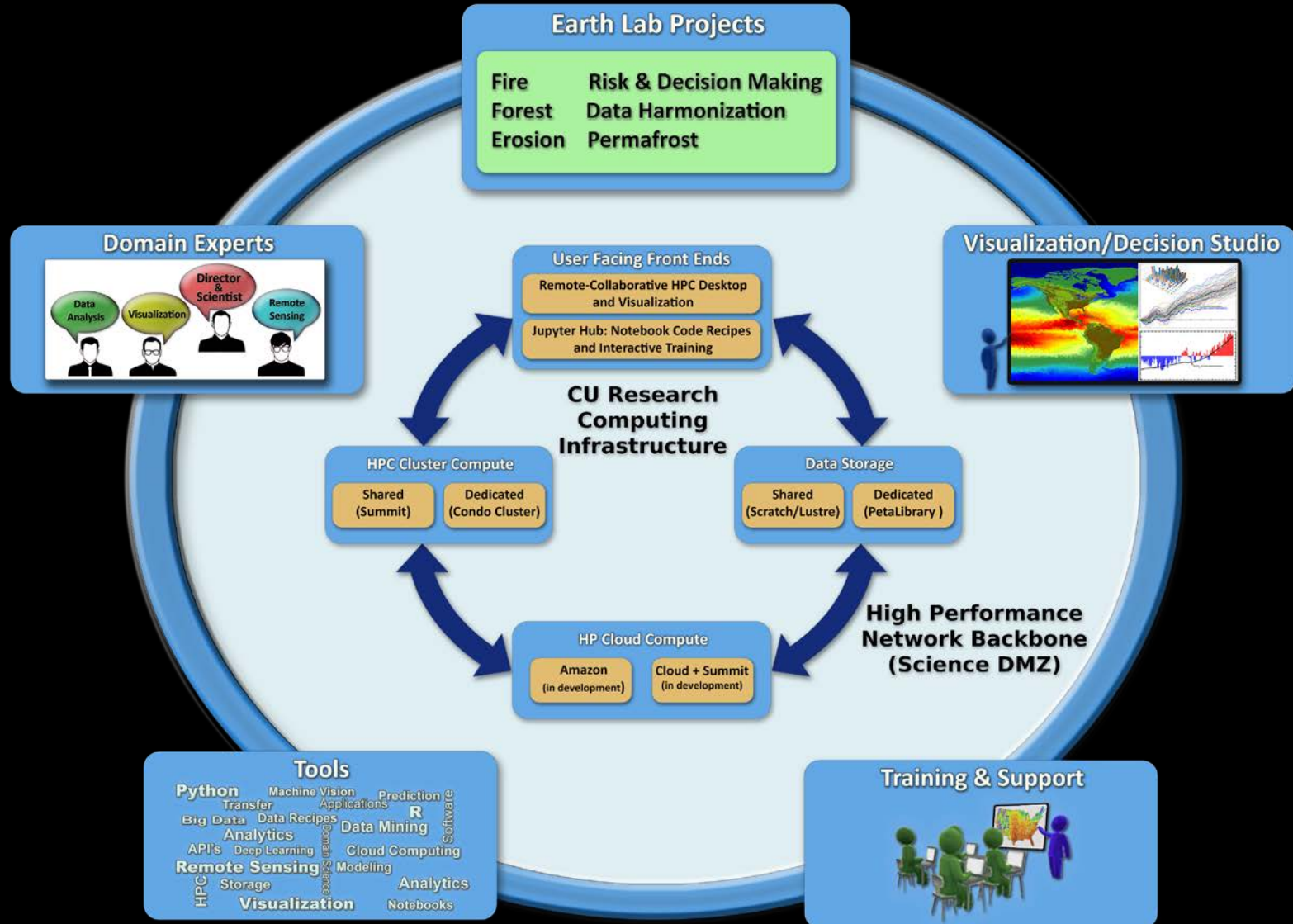


**Computing &
Visualization**

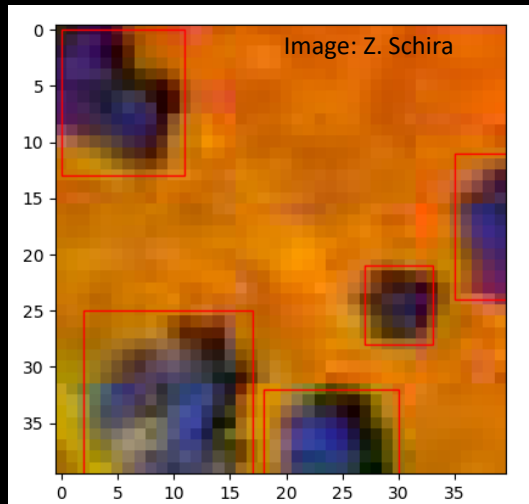


**Technical Training
& Support**

Infrastructure



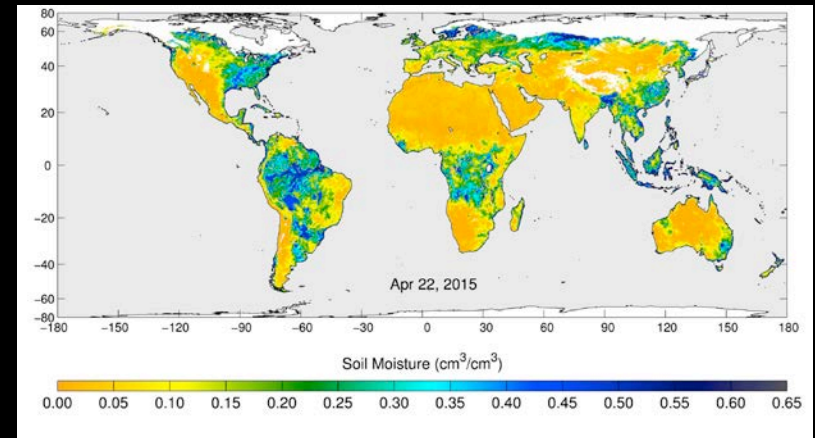
Earth Data Analytics



Convolutional Neural Networks



Cloud Compute Solutions



SMAPR

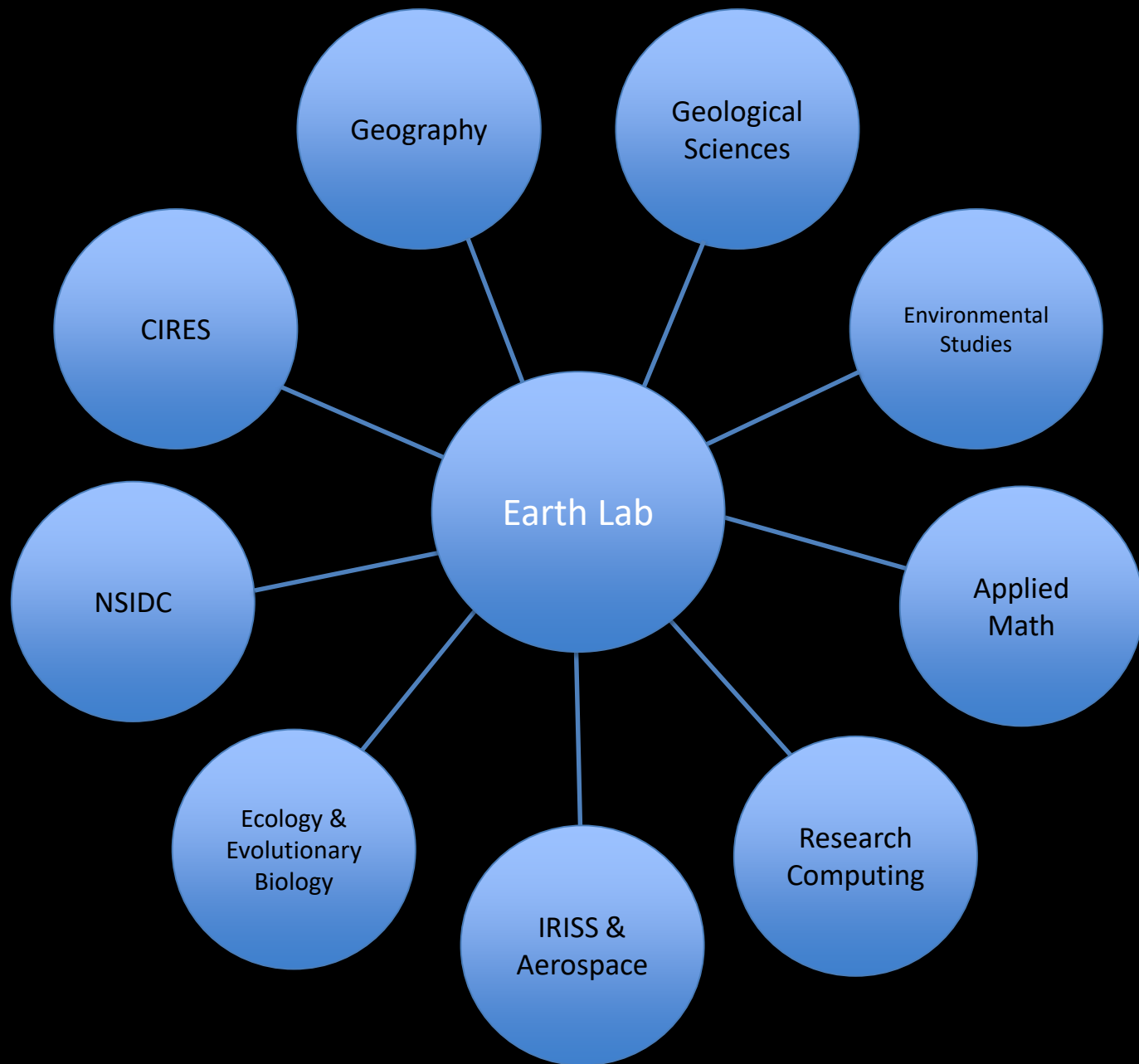


DigitalGlobe Partnership

Where are the Sweet Spots?
Data-Rich Opportunities at the
intersection between
Climate &
Human Health

Science Projects: integrate Aerospace data with other data sources to...

- Understand how fire is changing in the U.S. over the past two decades. (**Project Fire**)
- Improve risk management and decision-making in land use and hazards mitigation. (**Project Risk**)
- Determine the sensitivity of permafrost to a warming Arctic. (**Project Permafrost**)
- Identify how rapid and slow landscape evolution impacts our lives. (**Project Erosion**)
- Determine what is driving Colorado forest dieback. (**Project Forest**)
- Examine how data at varying resolutions represents Earth System phenomena. (**Project Data Harmonization**)
- Predict slow and abrupt change, or surprises, across multiple systems. (**Project Extremes**)



Drought Risk

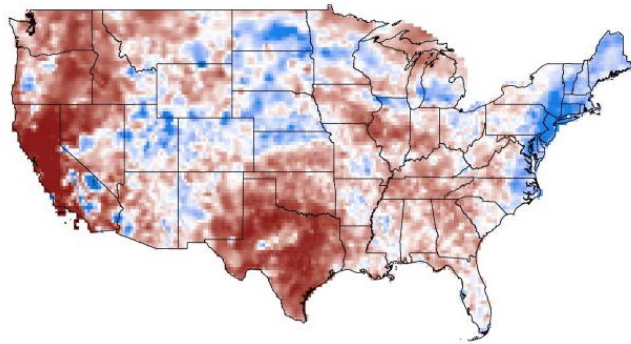
How droughts affect ranching insurance



Bill Travis, Trisha Shrum, Travis Williams, Max Roland
GEOGRAPHY, WESTERN WATER, CIRES

Comparing & combining measures of drought risk

CPC Gridded Precip Jul-Aug 2011

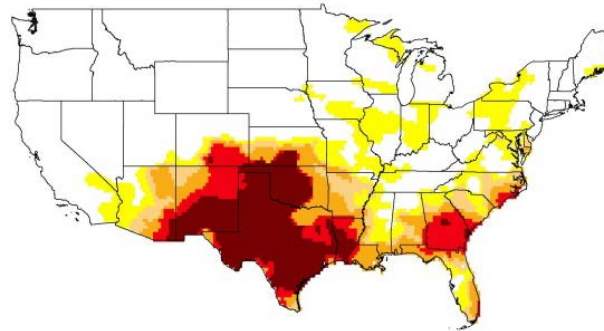


Percent of
Long Term Mean

0 100 200 300

**NOAA/CPC's Gridded
Precipitation**

US Drought Monitor Jul-Aug 2011

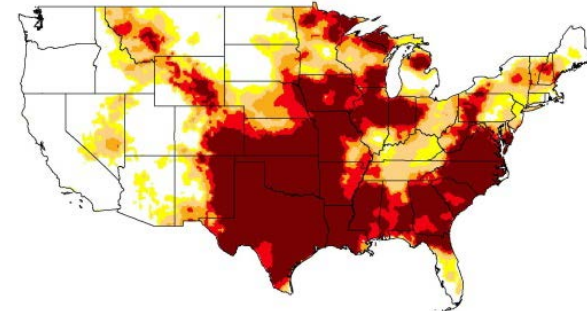


Median Drought
Condition

none	D1-D4	D3-D4
D0-D4	D2-D3	D4

**U.S. Drought
Monitor's
Drought intensity
levels**

Evaporative Drought Demand Index Conditions
Jul-Aug 2011



Eddi Drought Condition

none	ED1	ED3
ED0	ED2	ED4

**NOAA/ESRL's
Evaporative Demand
Drought Index
(EDDI)**

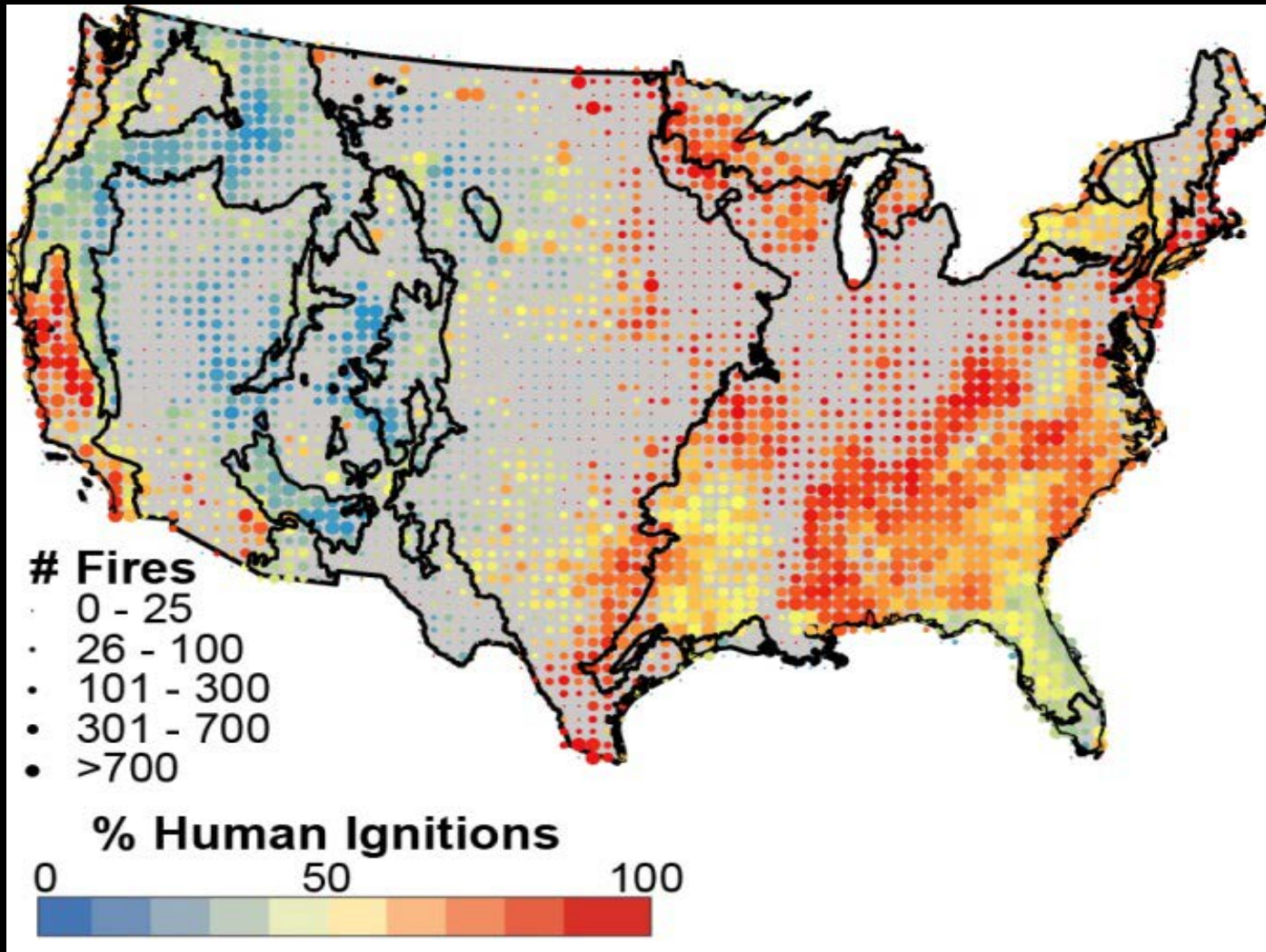
Fire

How people and climate are changing fires
across the U.S.

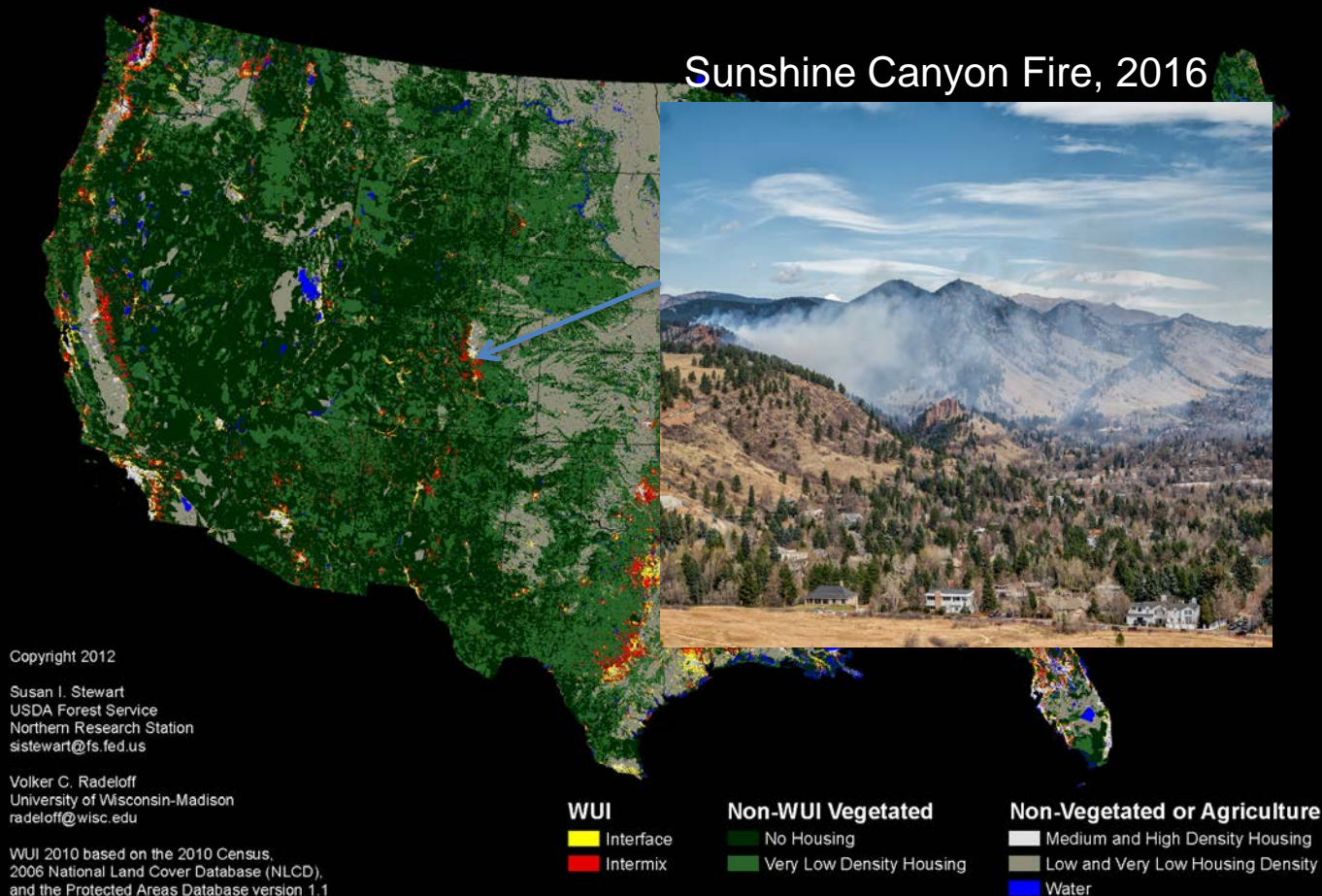


Jennifer Balch, Chelsea Nagy, Nate
Mietkiewicz, Lise St. Denis, Adam
Mahood, Sepideh Dadashi, Mollie
Buckland
GEOGRAPHY

The role of people in U.S. wildfires



Cost of wildfires where people live



96% of all fires started in the WUI are human-caused



Social Impacts of Hazards through Twitter

- Filtering strategy (St. Denis, 2015)
- Automated classification of 50+ high-impact mega-fires
- Segmentation of conversation
- Generalizability to other crisis events

Blue Cut fire in Southern California has been sending out smothering smoke



RETWEETS
2

LIKES
2



BLUE CUT FIRE, 2016: 78,000 tweets; 1500 related to smoke and air quality

Forests

What is driving Colorado forest dieback?



Carol Wessman, Megan Cattau, Brian
Argrow, Eric Frew, Amy DeCastro, Young-
young Shen
IRISS, ENVIRONMENTAL STUDIES,
ECOLOGY, CIRES, AEROSPACE



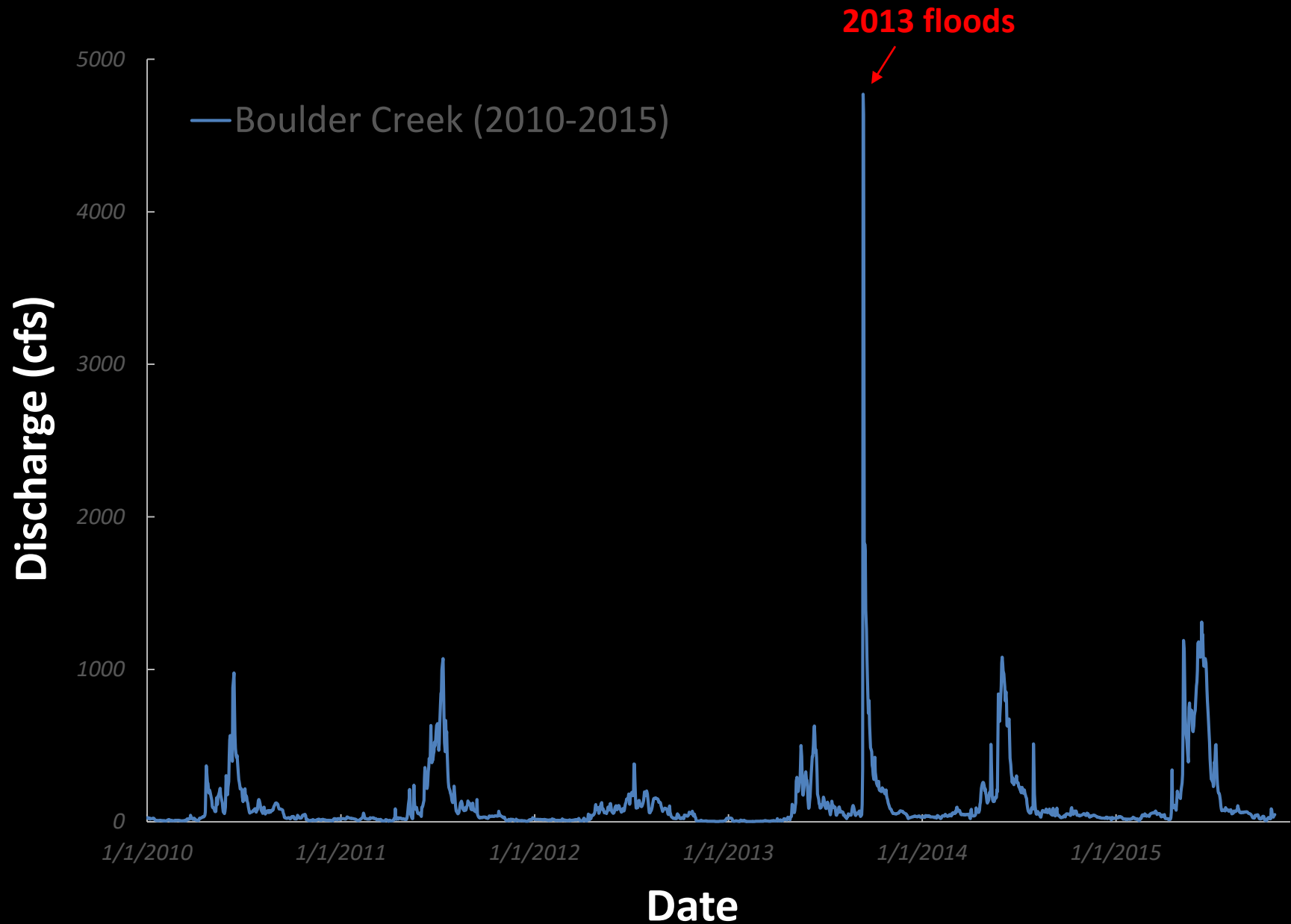
Erosion

Understanding how extreme rainfall drives
landslides

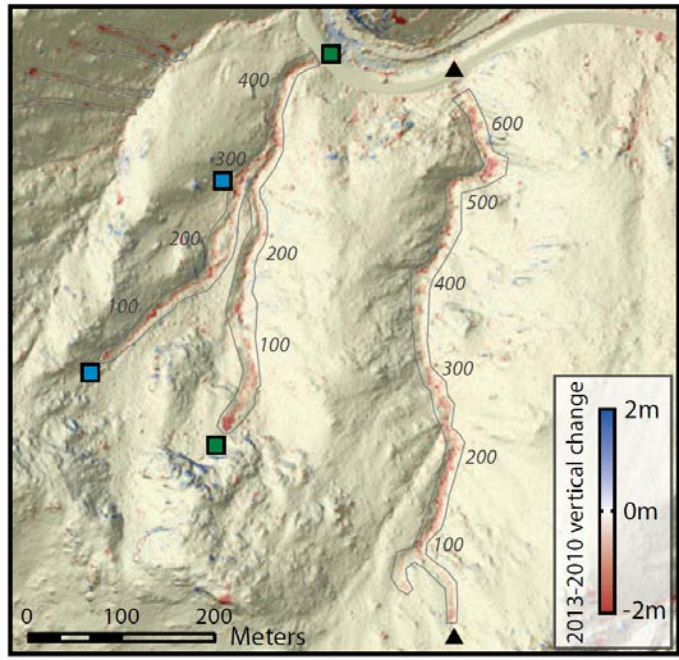


Bob Anderson, Greg Tucker, Suzanne Anderson, Matt Rossi
GEOLOGICAL SCIENCES, GEOGRAPHY, CIRES

Extreme hydro-climatic events (2013 event)



Geomorphic impacts (2013 event)



Exhumation by debris flows in the 2013 Colorado Front Range storm

Scott W. Anderson^{1*}, Suzanne P. Anderson^{1†}, and Robert S. Anderson²

¹Department of Geography, and Institute of Arctic and Alpine Research (INSTAAR), University of Colorado, Boulder, Colorado 80309, USA

²Department of Geological Sciences, and Institute of Arctic and Alpine Research (INSTAAR), University of Colorado, Boulder, Colorado 80309, USA

Triggered > 100 landslides on the hillslopes exhuming 100's to 1000's of years of soil production

Also triggered devastating river flooding, river erosion, and deposition impacting mountain and Plains communities

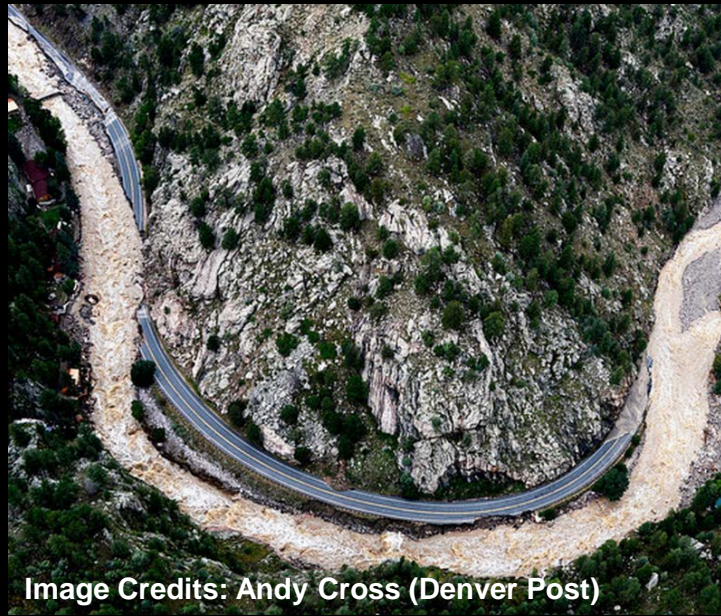
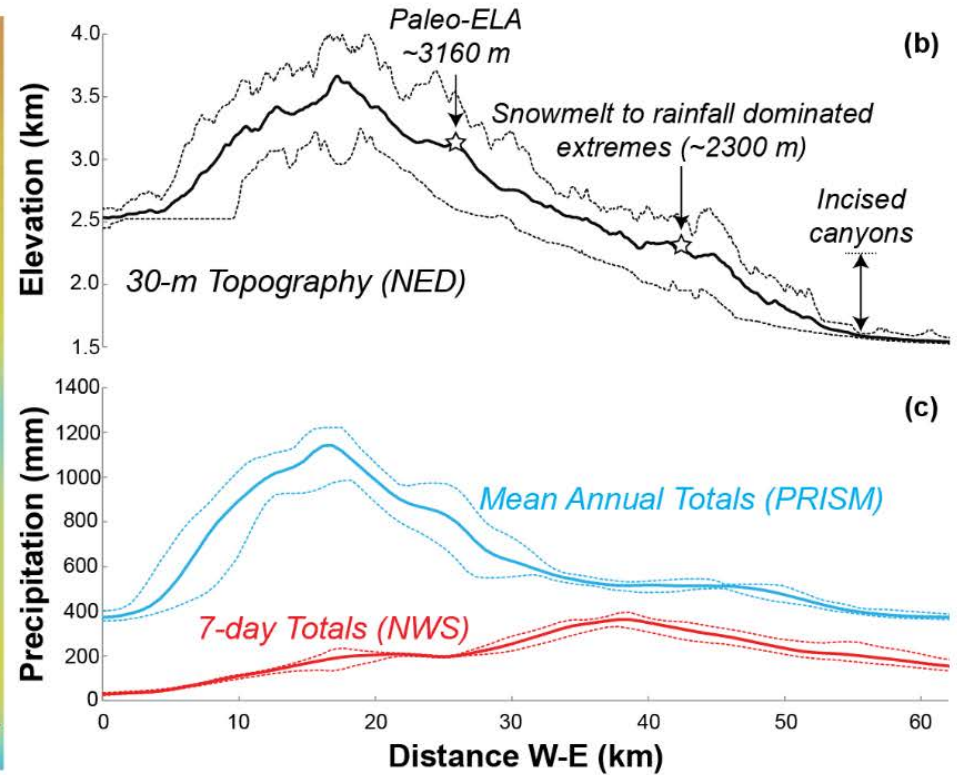
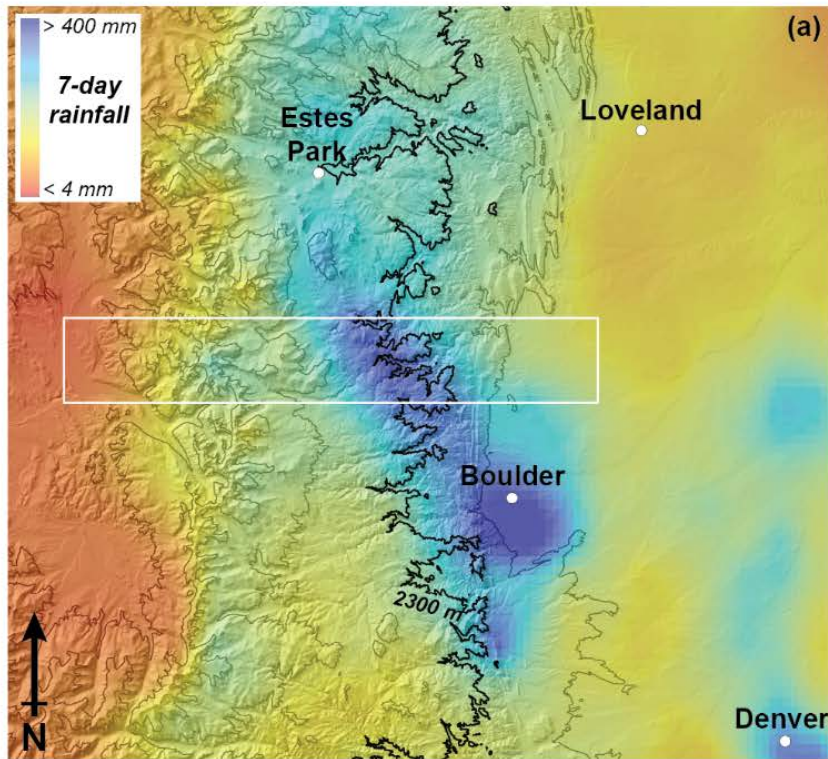


Image Credits: Andy Cross (Denver Post)

St. Vrain River, CO



Snowmelt to rainfall generated extremes

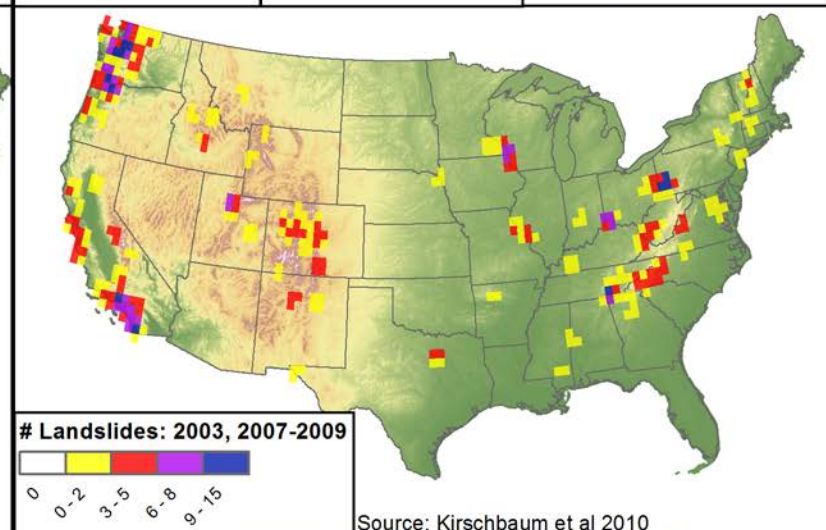
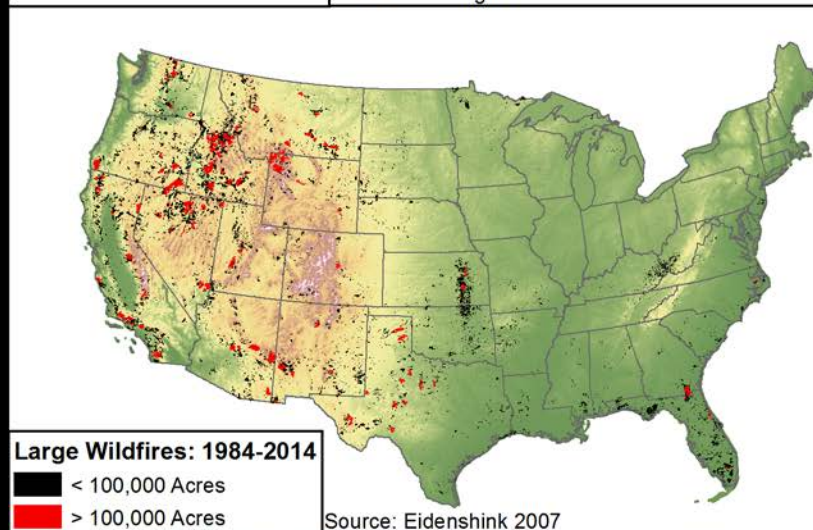
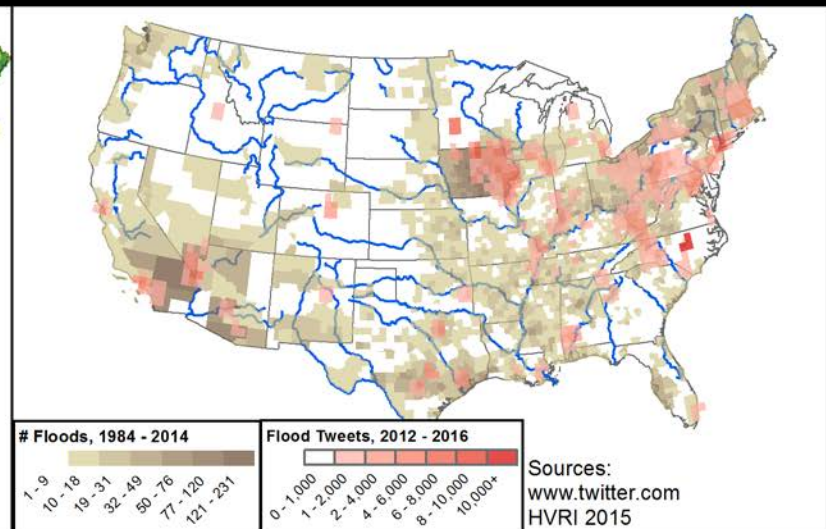
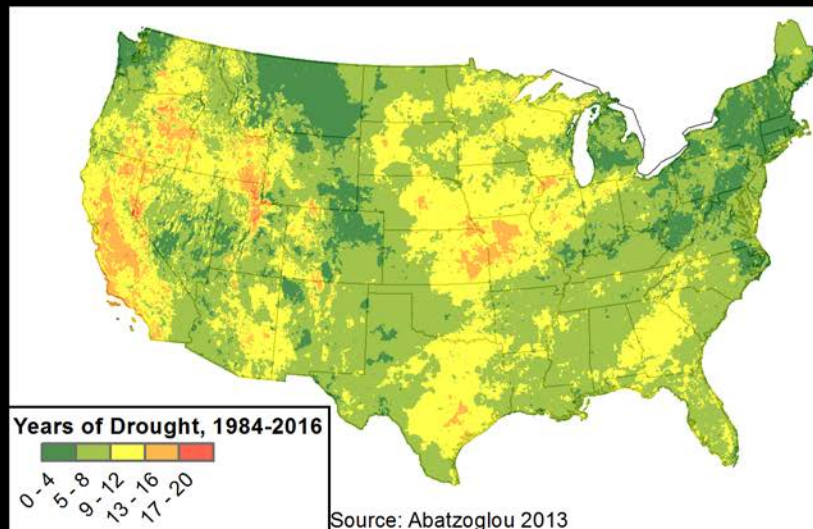


Coupled Extremes

Understanding & predicting how droughts,
fires, floods, and landslides interact

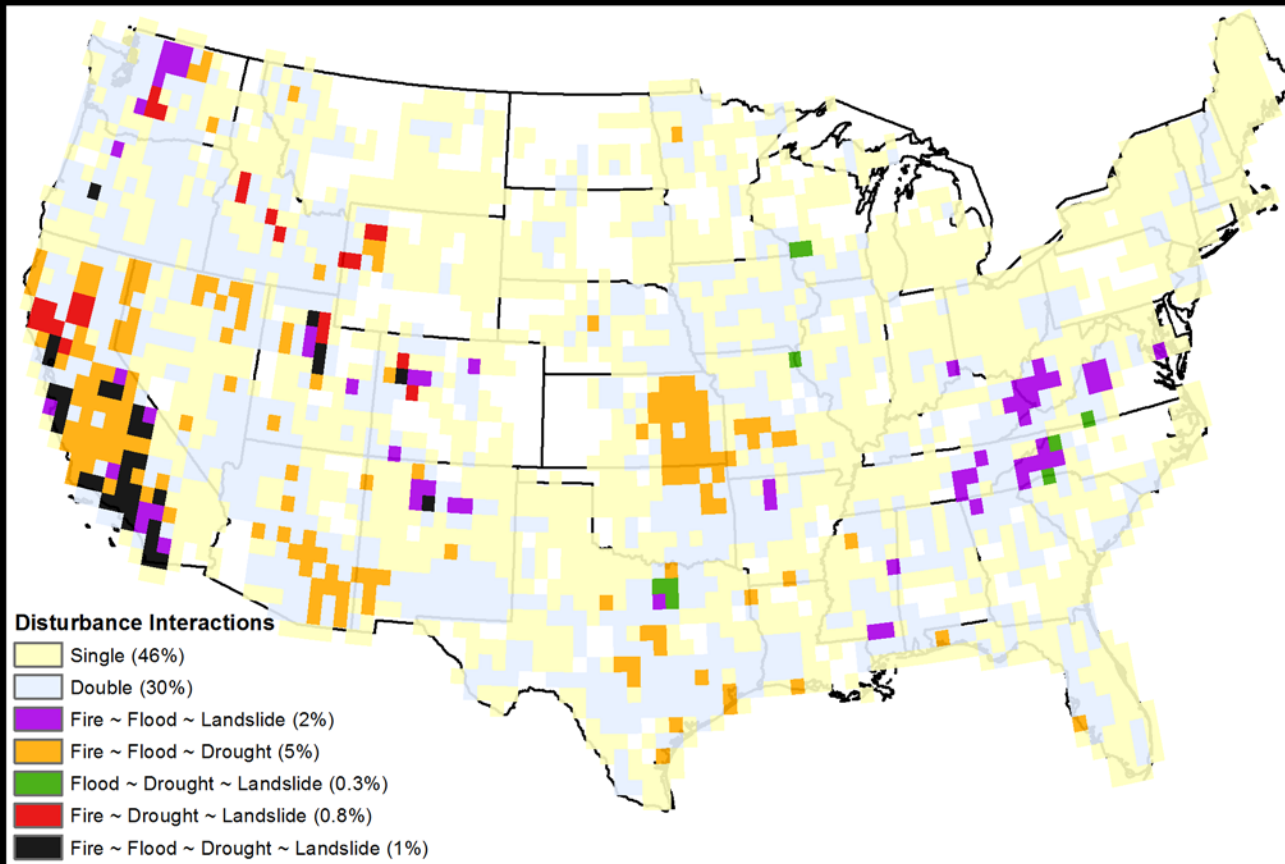


Jennifer Balch, Bill Travis, Ben Livneh, Greg Tucker,
and Earth Lab Team, Postdocs, & Grads
GEOGRAPHY, GEOLOGICAL SCIENCES, CIRES,
ENVIRONMENTAL ENGINEERING



Balch et al. in prep.

Three or more disturbance types co-occur in
9.1% of the U.S.



Balch et al. in prep.

[illegible]



EARTH LAB

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www.colorado.edu/earthlab

Thank you.

Earth data analytics

- Machine learning and Computer vision techniques in Earth science research
- Convolutional Neural Networks for image segment & classification
- Integrating socioeconomic, social media and unstructured data with geospatial data and imagery
- Building reproducible, extensible data workflows in the cloud
- Research in language agnostic tools for data access and manipulation
- DigitalGlobe's GBDX platform for processing its high resolution imagery for use in scientific research

- Remote sensing
- Computing and visualization
- Geospatial and temporal statistics
- Machine learning algorithms
- Open source software programming

- High resolution commercial imagery
- NASA & NOAA Satellite products
- Airborne Hyperspectral & LiDAR
- Social media & textual information
- Model data & geospatial products

From data to decisions

