Using NASA's Remote Sensing Datasets and Land Information System to Characterize Lightning Initiated Wildfires

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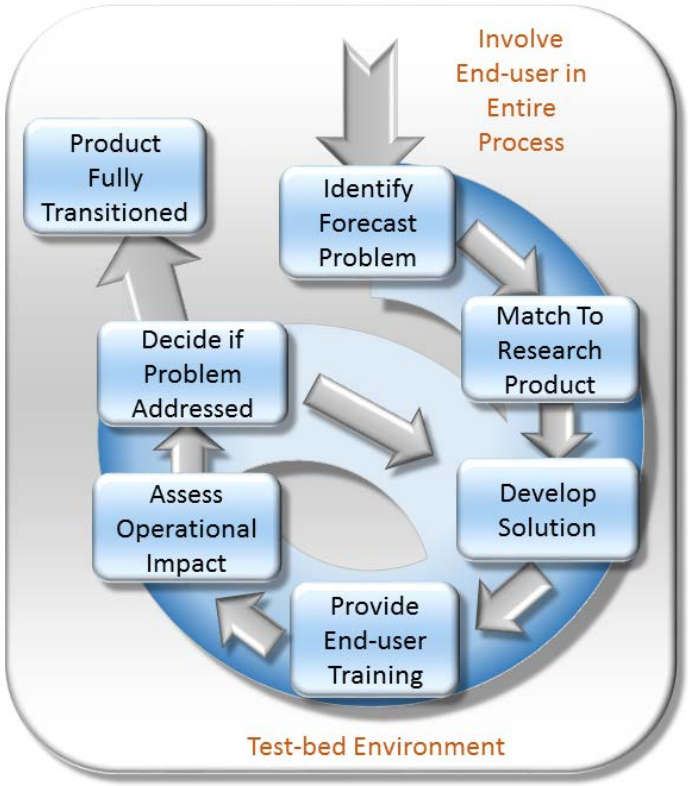
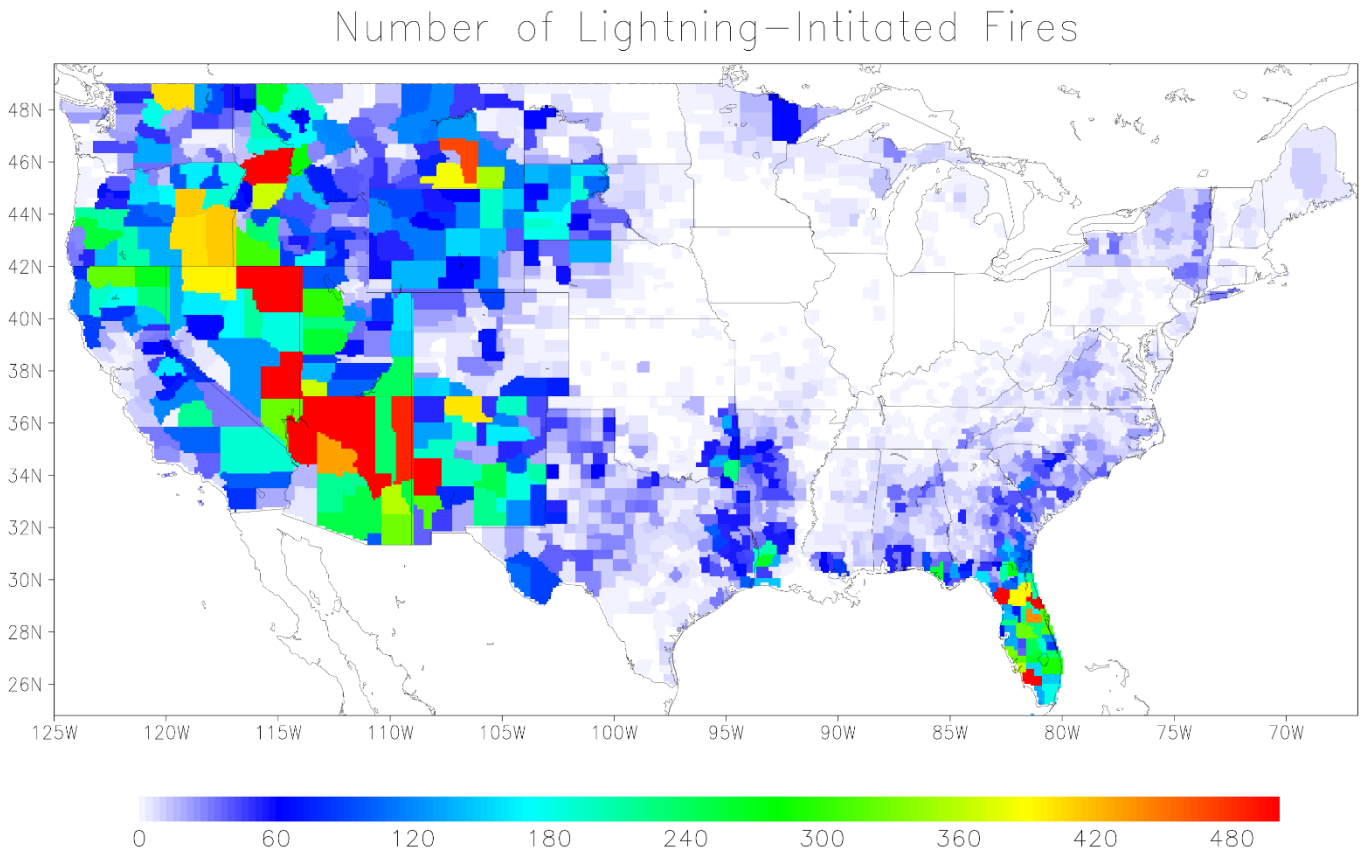
What is SPoRT?

- SPoRT is the Short-Term Prediction and Research Transition.
- Our main purpose is to transition NASA datasets and products to operational end users by identifying an operational challenge and determine how NASA data and products can aid in the decision making process.



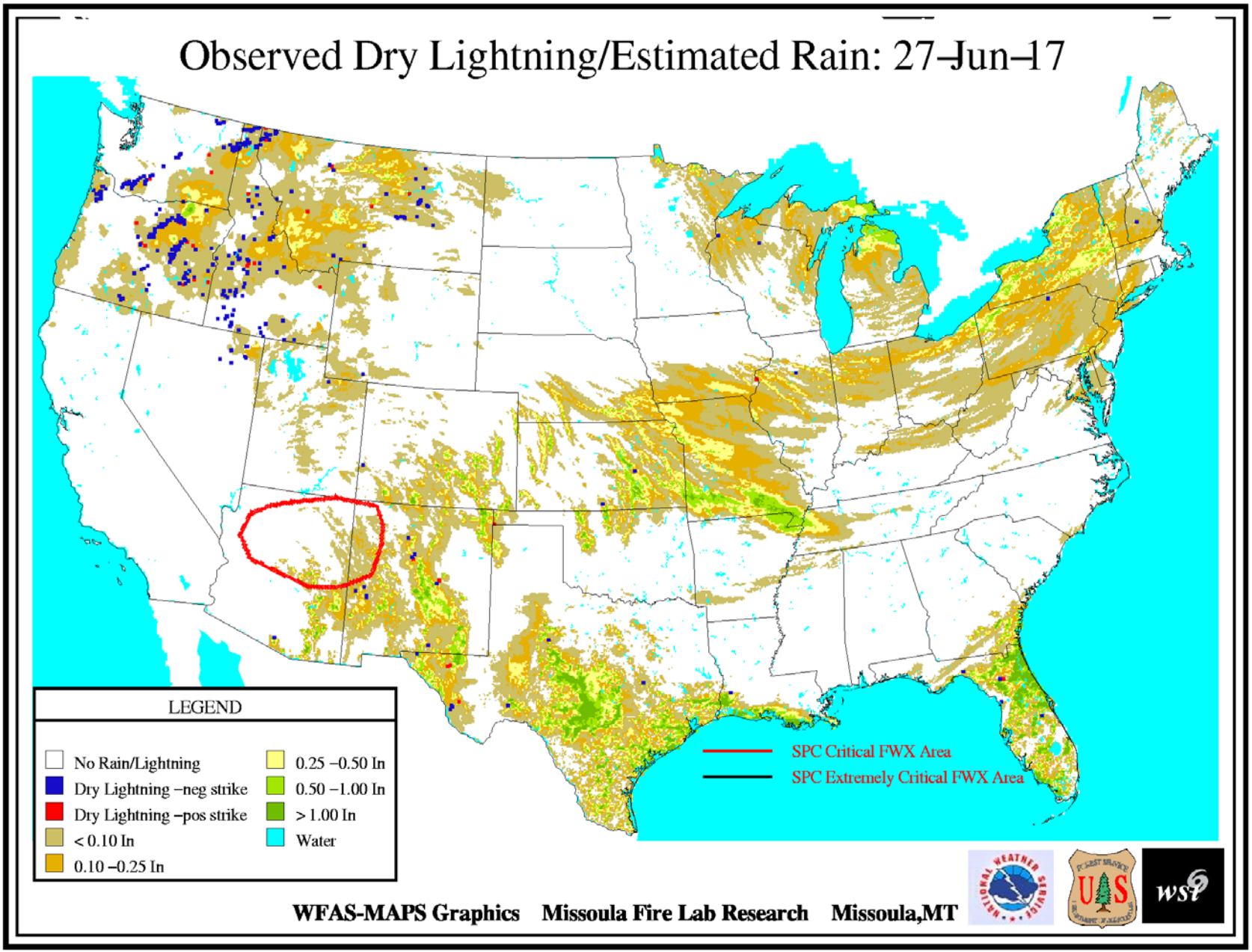
Why Lightning-Initiated Fire?

- While only 16% of the total number of wildfires within the US, lightning initiated fire accounts for 56% of the acreage burned (Balch et al. 2017)



1992-2015 lightning initiated fires by county. Data source, USFS Wildfire Database, Short (2017).

Current Methods



Potential Areas to Improve Real-Time Information for Identification and Decision Making

- Development of a real-time probability for lightning initiated fire.
    - Current procedures are updated 1 day later
- Indication of areas where holdover events are possible.
    - The 1 day map highlighting wildfire potential does not account for holdover events (Sopko et al. 2016).
- GLM, GLM, GLM
    - Continuing current a key parameter in fire ignition from lightning.
    - The Geostationary Lightning Mapper has the capability to detect continuing current, and when combined with ground based lightning networks and land datasets, may indicate higher probability fire start locations.

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Purpose and Goals

- Can we use modeled information of the land surface and characteristics of lightning beyond flash occurrence to increase the identification and prediction of wildfires?

- The goals of this study are to:
  - Combine observed cloud-to-ground (CG) flashes with real-time land surface model output, and
  - Compare data with areas where lightning did not start a wildfire to determine what land surface conditions, rainfall observations, and lightning characteristics were responsible for causing wildfires.

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The First Hurdle: Fire Reporting

- Like severe storm reports, fire reports have their challenges for specific timing and location.

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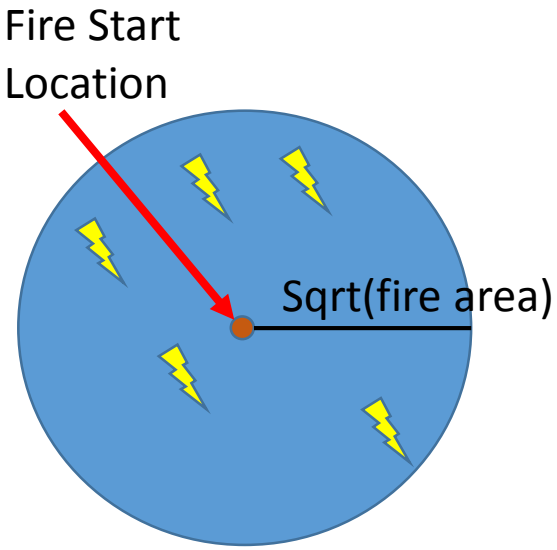
Fire Radius Methodology



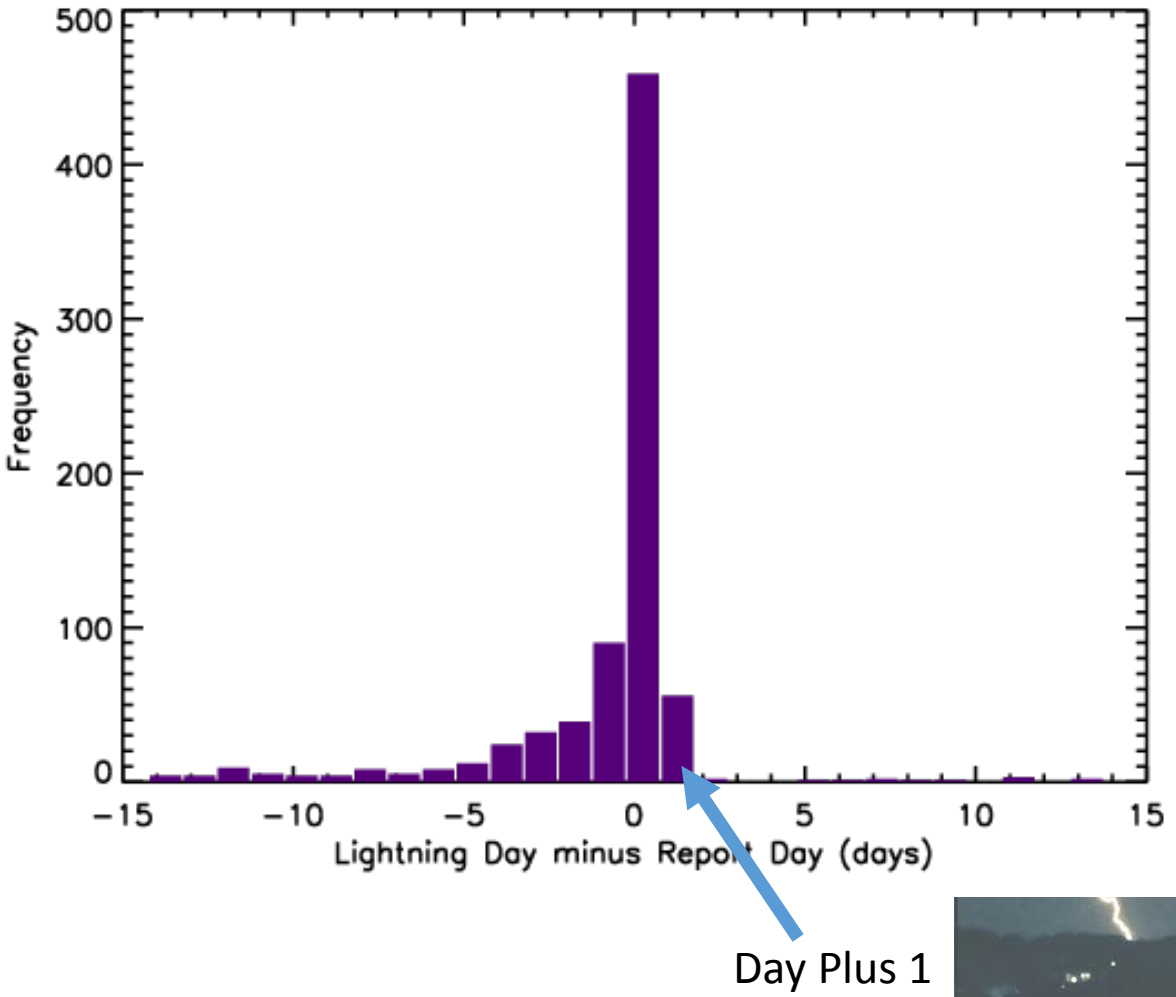
1. Use Fire location and fire size to set spatial boundaries for collecting lightning within the footprint of the fire.
2. Search the National Lightning Detection Network data for 14 days prior to fire report and 3 days after the fire report.
3. Determine distance to fire error for the closest lightning flash to the fire start location.

	total percentages	
	IC+CG	CG Only
Reported lightning fires with lightning occurring within fire boundary	83%	77%
Percent of fires where lightning occurs in boundary prior to reported start date.	81%	75%

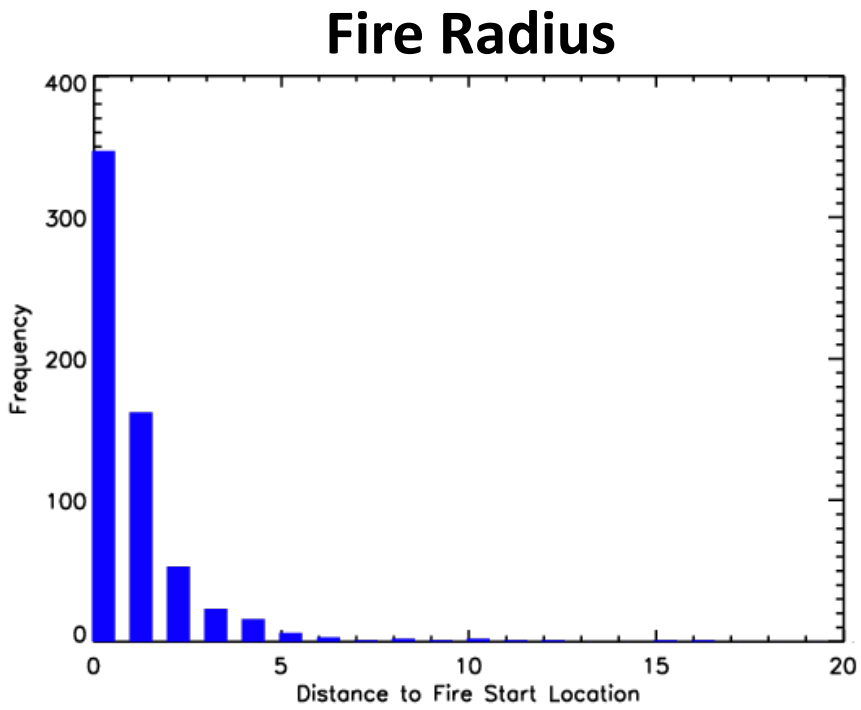
*Searches for these tables went 14 days back from the start date and 3 days ahead of the start date to find corresponding flashes.

Distribution of Fires in Time – Fire Radius Method

	IC+CG	CG Only
-14	0.44%	0.33%
-13	0.44%	0.22%
-12	0.99%	0.88%
-11	0.55%	0.55%
-10	0.44%	0.44%
-9	0.44%	0.44%
-8	0.99%	0.66%
-7	0.55%	0.44%
-6	0.88%	0.22%
-5	1.33%	0.88%
-4	2.76%	2.54%
-3	3.76%	3.43%
-2	4.53%	3.87%
-1	10.83%	10.17%
0	52.38%	50.17%



Fire Start Location Error

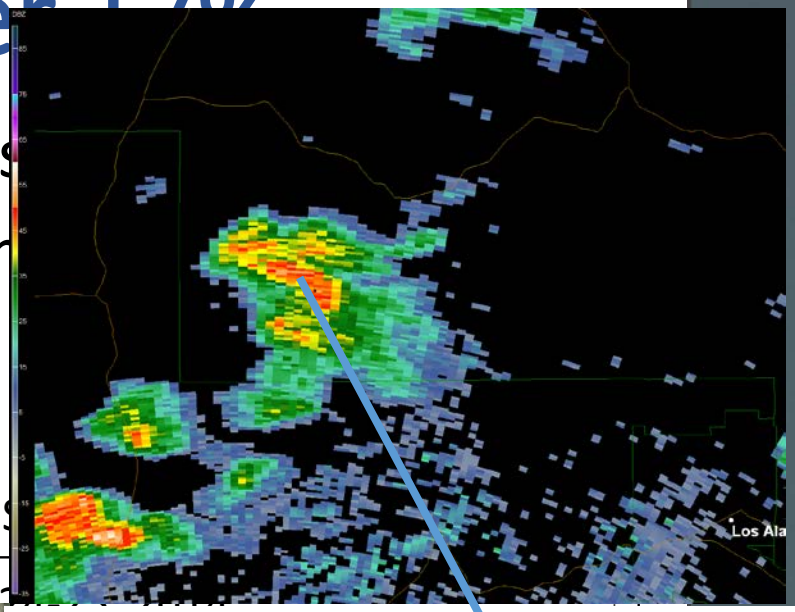


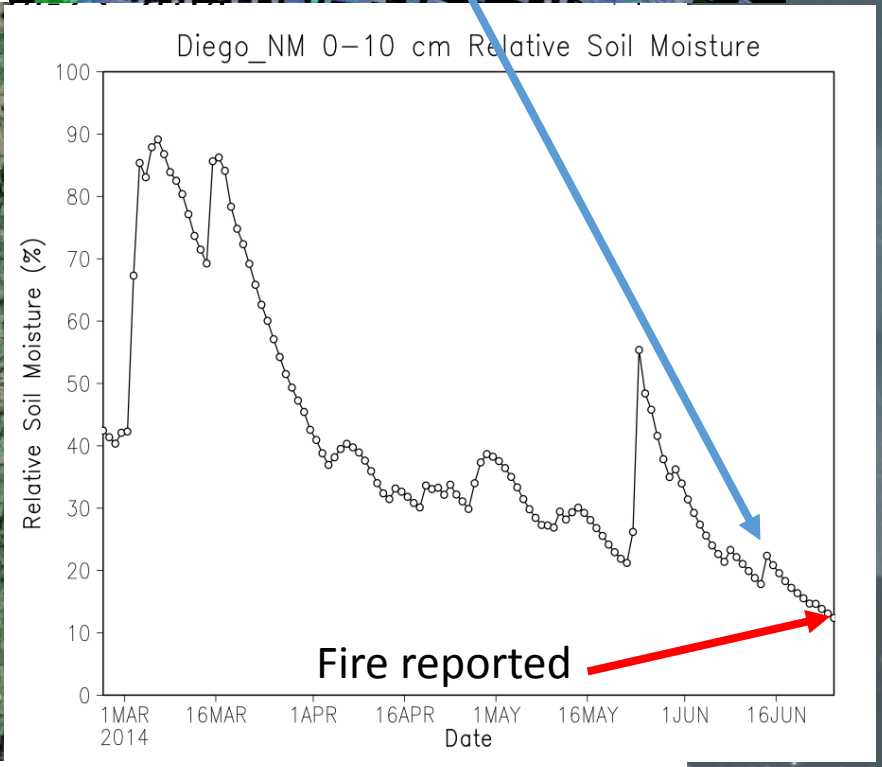
Based on the literature of the NLDN (Biagi et al. 2007), the 95-98thth percentile distance error is between 5-6 km. 75th percentile distance error is around 1.6 km.

The other 17%

- Closest flash is outside of s
- Some are misreported – m started
- Some have the wrong day

Closest lightning to fire start



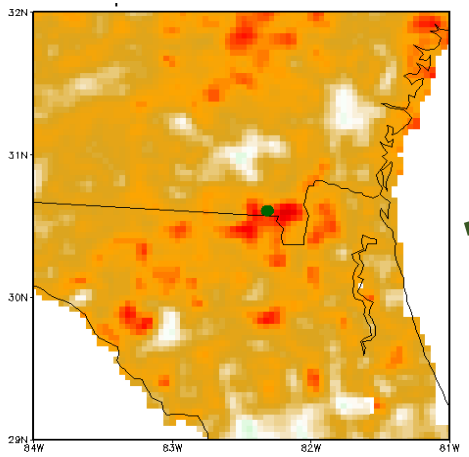


Conclusions

- Approximately 83% of lightning initiated fires can be associated with lightning within a 14 day period near fire start.
  - Sources of missing events:
  - Incorrect day
  - Incorrect cause
  - Missed flash
  - Holdover events that last longer than the 14 day window
- Approximately 52% of events occur on the same day as they are reported.
  - An additional 10% occur the day before
  - 77% of lightning flashes that are best associated with the fire occur within 7 days of the report date.
- The fire start location will be misreported

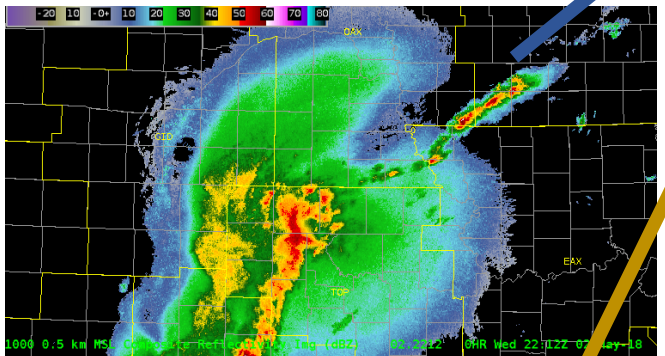
Working Toward A Real-Time Lightning Initiated Fire Product

ESI

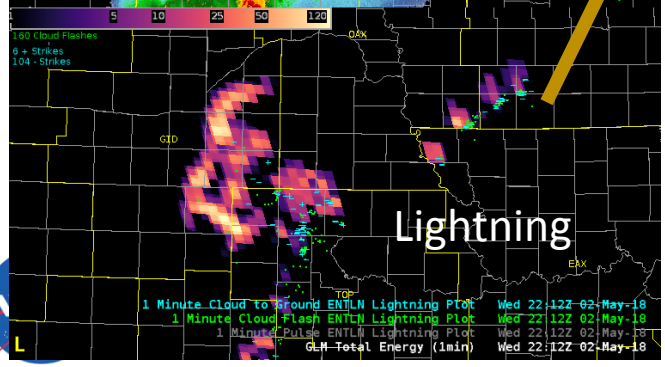


Conceptual Idea of Lightning initiated fire heat map

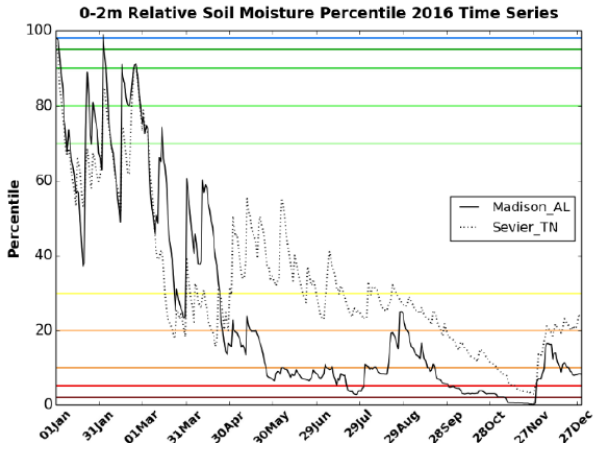
Precipitation

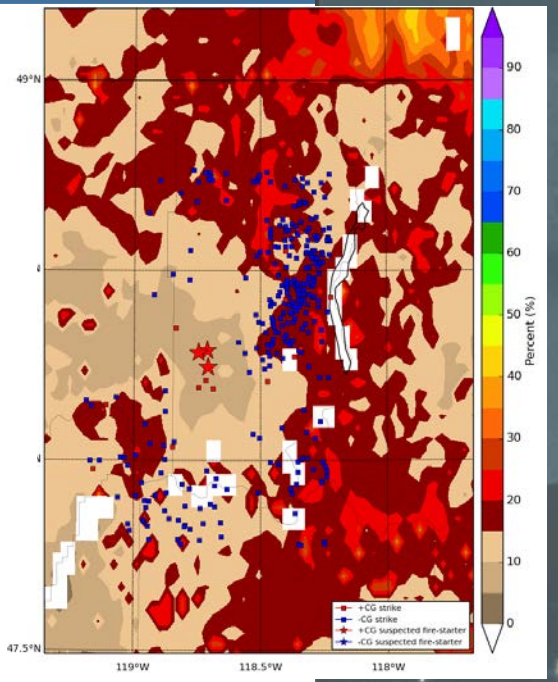


Lightning

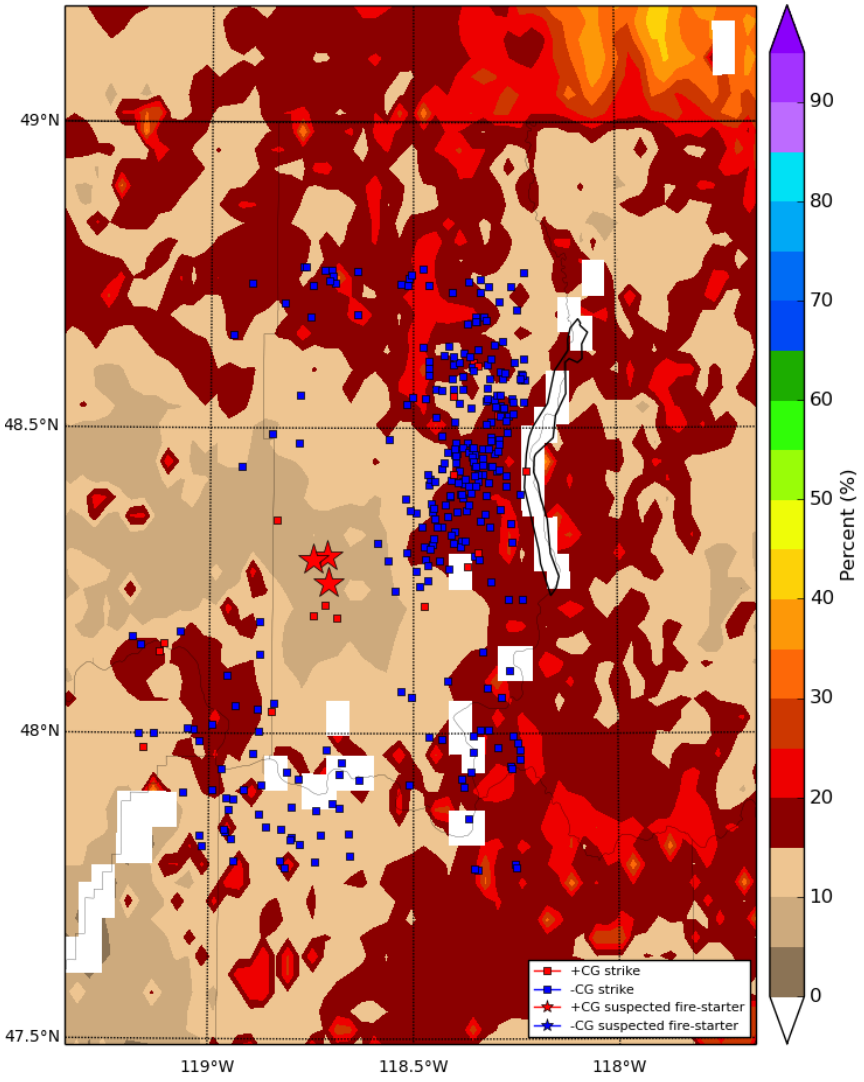


Modeling





Data Sources



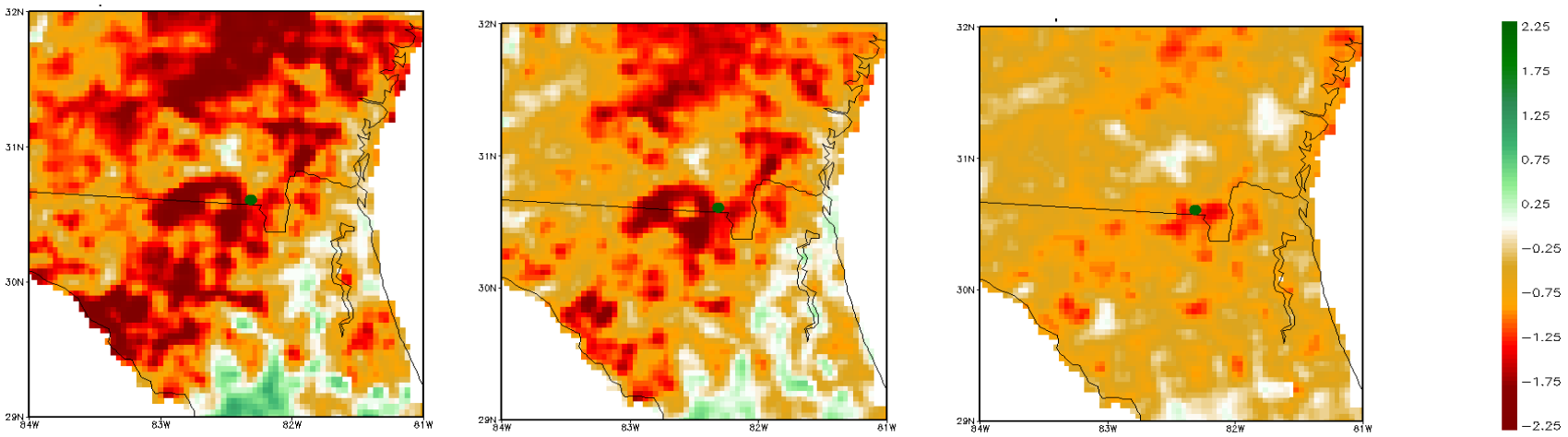
Land Information System (SPoRT-LIS)

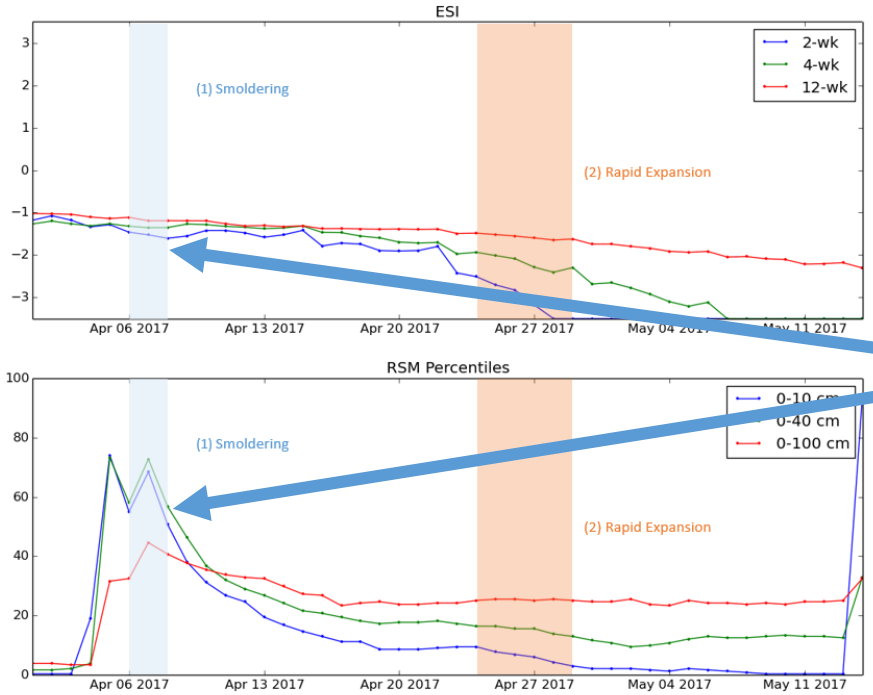
- Observations-driven land surface model forced by NWP model analyses and radar/gauge QPE.
- Daily output from "climatological" simulation spanning 1981 – present; hourly output in real time.
- Python code used to extract data:
  - 0-10 cm volumetric and relative soil moistures
  - Total column relative soil moisture (0-200 cm layer)
  - Green vegetation fraction (GVF)
    - MODIS monthly climatology for historical output
    - NESDIS/VIIRS real-time daily GVF; 2012 – present
- Evaporative Stress Index
- Multi-radar Multi-Sensor Precipitation totals
- Lightning data
  - National Lightning Detection Network and Earth Networks
  - Geostationary Lightning Mapper

Evaporative Stress Index Example – The West Mims Fire (2017).

APR 4

2-wk **4-wk** **12-wk**



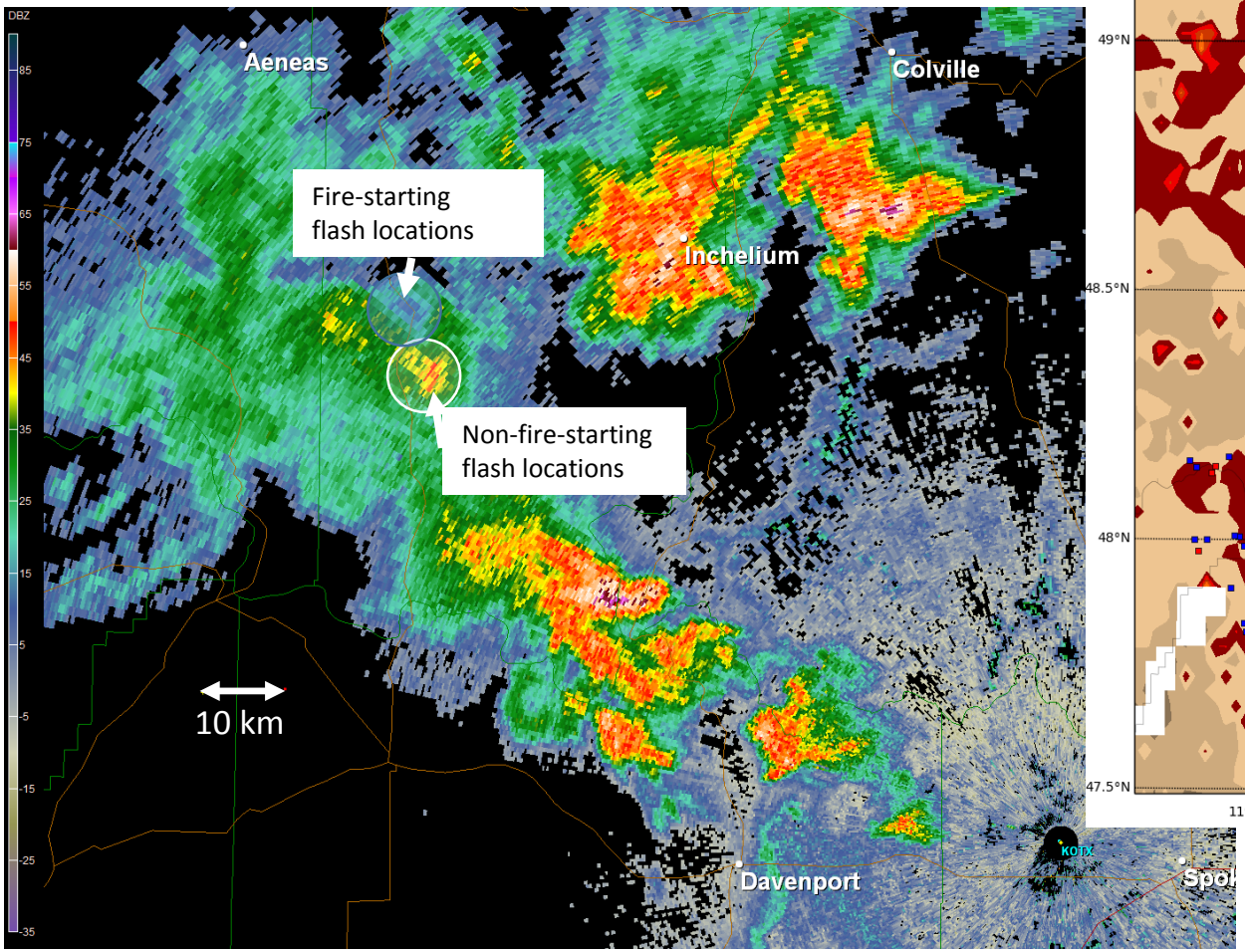


Evaporative Stress Index (ESI) is a satellite derived product to assess vegetation stress.

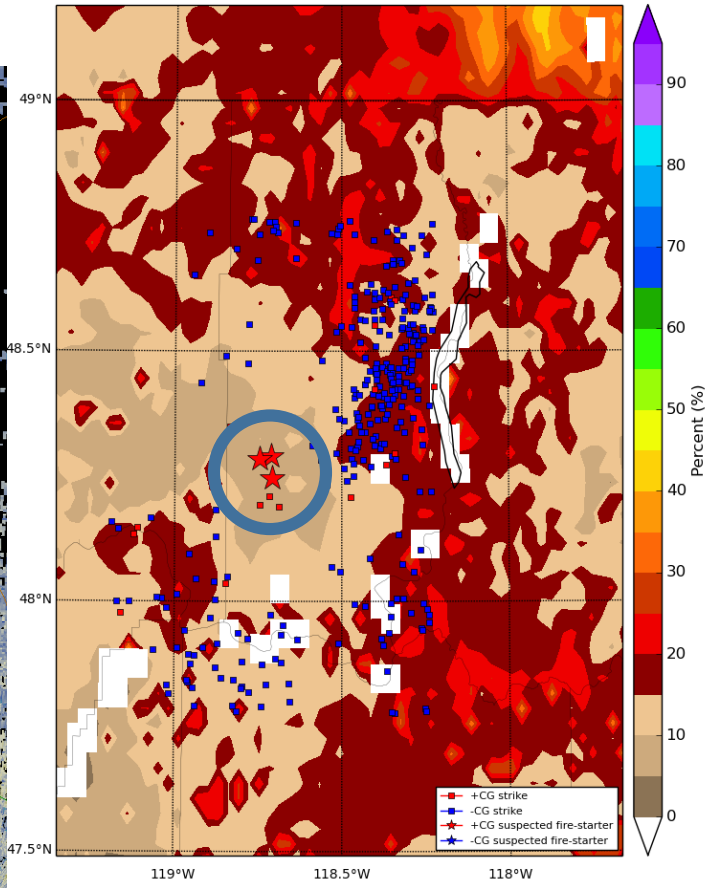
ESI is less responsive to rapid changes in rainfall and soil moisture (left).

ESI captures water conservation in plants prior to their change in color (e.g., an NDVI approach)

The flash location relative to precipitation cores…



KOTX Radar 0015 UTC 3 August 2015



SPoRT LIS 0-10 cm soil moisture valid 00 UTC 3 August 2015

Devil's Elbow Fire Complex, Washington State, August 2015.

Future Direction for Product

- Have a prototype to test in the field by this Summer
  - Working directly with USFS Redding GAAC.
- Refine and make operational by summer 2019.

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