Characterizing Lightning-Initiated Wildfire to Develop New Nowcasting Techniques for Wildfire Identification

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1 - NASA SPoRT
2 - NOAA/SPC/OU-CIMMS
3 - US Forest Service
4 - UAH
5 - NWS HUN/SPoRT
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)

Current Methods

Observed Dry Lightning/Estimated Rain: 27-Jun-17

Also produced is a dry lightning map that shows where lightning has occurred where precipitation was < 0.25 in for the eastern half of the US, and < 0.10 in for the Western US.

Current Methods

• Currently the U.S. Forest Service utilizes flash density, Normalized Difference Vegetation Index (NDVI), and fuel density/type to assess lightning ignition efficiency for the day.
• Based on this efficiency, a lightning density threshold is applied to compute the probability that a wildfire has started.
  - If the Ignition Efficiency is High (orange color), the density required for ignition is 9 flashes km$^{-2}$.
  - If the Ignition Efficiency is Extreme (red), the density required for ignition is 5 flashes km$^{-2}$.
  - These are empirically derived metrics from Latham and Schleitter (1989).

https://www.wfas.net/images/firedanger/ltng_pi.png
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.
  • GLM has the capability to detect continuing current.
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:
  o Combine observed cloud-to-ground (CG) flashes with real-time land surface model output, and
  o Compare data with areas where lightning did not start a wildfire to determine what land surface conditions and lightning characteristics were responsible for causing wildfires.
The First Hurdle: Fire Reporting

- Like severe storm reports, fire reports have their challenges for specific timing and location.
# A Tale of Two Searches

## Fire Radius

<table>
<thead>
<tr>
<th></th>
<th>IC+CG</th>
<th>CG Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of ltng fires</td>
<td>0.83</td>
<td>0.77</td>
</tr>
<tr>
<td>Percent of ltng fires before report date</td>
<td>0.81</td>
<td>0.75</td>
</tr>
</tbody>
</table>

## Fixed Radius

<table>
<thead>
<tr>
<th></th>
<th>10 km</th>
<th>5 km</th>
<th>2 km</th>
<th>1 km</th>
<th>0.5 km</th>
<th>0.25 km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of fires</td>
<td>93%</td>
<td>89%</td>
<td>68%</td>
<td>46%</td>
<td>27%</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td>88%</td>
<td>77%</td>
<td>60%</td>
<td>40%</td>
<td>23%</td>
<td>8%</td>
</tr>
</tbody>
</table>

*Searches for these tables went 14 days back from the start date and 14 days ahead of the start date to find corresponding flashes.*
Based on the literature of the NLDN, the 95-98th percentile distance error is between 5-6 km. 75th percentile distance error is around 1.6 km.

Fixed search radius assigning lightning events not associated with the fire itself.
- Distance to the fire start point is greater than the size of the fire.
### Distribution of Fires in Time – Fire Radius Method

<table>
<thead>
<tr>
<th>Day</th>
<th>IC+CG</th>
<th>CG Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>-14</td>
<td>0.44%</td>
<td>0.33%</td>
</tr>
<tr>
<td>-13</td>
<td>0.44%</td>
<td>0.22%</td>
</tr>
<tr>
<td>-12</td>
<td>0.99%</td>
<td>0.88%</td>
</tr>
<tr>
<td>-11</td>
<td>0.55%</td>
<td>0.55%</td>
</tr>
<tr>
<td>-10</td>
<td>0.44%</td>
<td>0.44%</td>
</tr>
<tr>
<td>-9</td>
<td>0.44%</td>
<td>0.44%</td>
</tr>
<tr>
<td>-8</td>
<td>0.99%</td>
<td>0.66%</td>
</tr>
<tr>
<td>-7</td>
<td>0.55%</td>
<td>0.44%</td>
</tr>
<tr>
<td>-6</td>
<td>0.88%</td>
<td>0.22%</td>
</tr>
<tr>
<td>-5</td>
<td>1.33%</td>
<td>0.88%</td>
</tr>
<tr>
<td>-4</td>
<td>2.76%</td>
<td>2.54%</td>
</tr>
<tr>
<td>-3</td>
<td>3.76%</td>
<td>3.43%</td>
</tr>
<tr>
<td>-2</td>
<td>4.53%</td>
<td>3.87%</td>
</tr>
<tr>
<td>-1</td>
<td>10.83%</td>
<td>10.17%</td>
</tr>
<tr>
<td>0</td>
<td>52.38%</td>
<td>50.17%</td>
</tr>
</tbody>
</table>

**Day Plus 1**

![Graph showing distribution of fires in time](image)

*Source: NASA SPoRT*
The other 7%

- Closest flash is before 14 days.
- Some are misreported – more likely human started.
- Some have the wrong day (e.g., below).

Closest lightning to fire start

![Map and chart showing soil moisture over time.](image-url)
Conclusions

• Somewhere between 83% and 93% 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