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

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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).

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).
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>Percent of Lightning Fires</th>
<th>IC+CG</th>
<th>CG Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of Lightning Fires before report date</td>
<td>0.83</td>
<td>0.77</td>
</tr>
</tbody>
</table>

### Fixed Radius

<table>
<thead>
<tr>
<th>All Flashes</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>Total Percentages</td>
<td>93%</td>
<td>89%</td>
<td>68%</td>
<td>46%</td>
<td>27%</td>
<td>9%</td>
</tr>
<tr>
<td>88%</td>
<td>77%</td>
<td>60%</td>
<td>40%</td>
<td>23%</td>
<td>8%</td>
<td></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>IC+CG</th>
<th>CG Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>-14</td>
<td>0.44%</td>
</tr>
<tr>
<td>-13</td>
<td>0.44%</td>
</tr>
<tr>
<td>-12</td>
<td>0.99%</td>
</tr>
<tr>
<td>-11</td>
<td>0.55%</td>
</tr>
<tr>
<td>-10</td>
<td>0.44%</td>
</tr>
<tr>
<td>-9</td>
<td>0.44%</td>
</tr>
<tr>
<td>-8</td>
<td>0.99%</td>
</tr>
<tr>
<td>-7</td>
<td>0.55%</td>
</tr>
<tr>
<td>-6</td>
<td>0.88%</td>
</tr>
<tr>
<td>-5</td>
<td>1.33%</td>
</tr>
<tr>
<td>-4</td>
<td>2.76%</td>
</tr>
<tr>
<td>-3</td>
<td>3.76%</td>
</tr>
<tr>
<td>-2</td>
<td>4.53%</td>
</tr>
<tr>
<td>-1</td>
<td>10.83%</td>
</tr>
<tr>
<td>0</td>
<td>52.38%</td>
</tr>
</tbody>
</table>

![Graph showing distribution of fires in time with IC+CG and CG Only categories.](image)

**Day Plus 1**
The other 7%

- Closest flash is before 14 day search period.
- Some are misreported – more likely human started.
- Some have the wrong day (e.g., June 13, 2014)

Closest lightning to fire start

Start Date in USFS database

Image from Google Earth
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