



## Assessing Factors Associated with Apparent Hotspot-Cluster Spread in Upper Northern Thailand Using a Rothermel-Inspired Model

Piyachet Saengchan<sup>1\*</sup>, Kritakan Meejan<sup>1</sup> and Winwan Santipapwiwatana<sup>1</sup>

<sup>1</sup>Princess Chulabhorn Science High School Chiang Rai, 345 Moo 2, Rob Wiang, Mueang Chiang Rai, Chiang Rai 57000, Thailand

\*E-mail: Piyachet.barnaby@gmail.com

### Abstract

Satellite active-fire data provide broad spatial coverage, but hotspot coordinates represent nominal pixel centres rather than directly observed fire fronts. This study evaluated whether daily centroid displacement of VIIRS hotspot clusters ( $R_{obs}$ ) could support assessment of fuel moisture, wind speed, and terrain slope in upper northern Thailand. We processed 221,418 detections from Suomi NPP, NOAA-20, and NOAA-21 collected from 1 February to 1 May 2026. After de-duplication and confidence filtering, 186,675 detections remained. Spatial DBSCAN with a 2-km radius, followed by temporal-gap splitting, produced 155 groups with at least two observed days and 1,016 complete  $R_{obs}$  records. A validity audit found that a single dominant algorithmic group (Group 0) contained 169,861 detections (92.22% of grouped data), spanned all 90 days, and covered almost the entire 332 × 334 km study box, indicating spatial percolation rather than a single fire. Under physically constrained calibration, the moisture, wind, and slope effects approached zero; the reduced model collapsed to an approximately constant prediction ( $R^2 \approx 0$ , RMSE = 2.096 m min<sup>-1</sup>, MAPE = 225.6%). Row-level correlations with  $R_{obs}$  also opposed the expected physical directions. For centroid movements of at least 1 km, the median angular difference from downwind was 85.8° and the Rayleigh  $p$ -value was 0.829. These results do not support using daily hotspot-centroid displacement to calibrate a physical fire-spread model. The main contribution is a reproducible validity assessment showing that spatiotemporal event construction and a validated fire-front target must precede factor ranking or model calibration.

**Keywords:** VIIRS active fire, apparent spread rate, Rothermel model, DBSCAN, validity assessment