

How Weather Conditions Affect Wildfires: Caldor Fire Case Study

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Abstract

Due to an increasing frequency in droughts and heatwaves in areas such as western North America, wildfires have become an increasingly common occurrence. Given their ability to destroy local ecosystems and worsen air quality, it's important to know how a wildfire will develop in the near future and where it will spread to next. GOES-17 satellite imagery can help to identify trends in how the weather variables of temperature, humidity, and wind speed and direction affect the spread of wildfires, allowing firefighters to combat fires more effectively in the future. To do this, I analyzed the 2021 Caldor Fire in Northern California on two different days as a case study. I used band 7 of GOES-17 to observe the effect of temperature on August 17, 2021, and I used GOES-17 GeoColor imagery from August 25 to measure the effects of wind on wildfire and smoke development.

Research Question

How do temperature, humidity, and wind affect wildfires, and how can this knowledge be used to fight wildfires more effectively?

GOES Data (Caldor Fire, California)

August 25, 2021

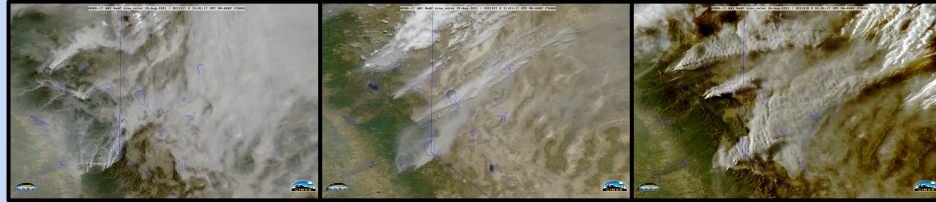
Smoke increases during the day, with a south-westerly wind causing a smoke plume extending northeast
GOES-17 GeoColor
Bands 1, 2, & 3: Blue(0.47 μ m), Red(0.64 μ m), Near-IR(0.86 μ m)

Also combines band 2 of Himawari-8 AHI: green(0.51 μ m)

15:00 UTC
(8am)

21:00 UTC
(2pm)

2:00 UTC
(7pm)

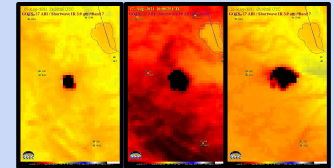


Smoke increases and thickens throughout the day as wind speeds increase. The fire also spreads in the direction of the wind, as shown by the development of new smoke plumes northeast of the fire's location of origin..

August 17, 2021

Shows diurnal temperature fluctuation
GOES-17 Band 7: Shortwave IR (3.9 μ m)

12:00 UTC (5am local time) 20:00 UTC (1pm) 3:00 UTC (8pm)



- Fire grows throughout the day due to higher temperatures and lower humidity
- Starts to lose heat in the evening due to greater temperature gradient between fire and surface

Conclusions

- Wildfire strength and size follow a diurnal pattern, strengthening during the day due to hotter and drier conditions and stronger winds, and weakening during the night
 - Firefighters should fight fires primarily in the early morning before sunrise when burning is the slowest and weakest
- Wildfires and smoke spread in the direction of the wind
 - Firefighters should fight fires in the direction of the wind

References

- CIMSS Satellite Blog: <https://cimss.ssec.wisc.edu/satellite-blog/>
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The Rising Cost of Wildfire Protection: <https://headwaterseconomics.org/wildfire/homes-risk/fire-cost-background/>
Climate Change Indicators: Wildfires: <https://www.epa.gov/climate-indicators/climate-change-indicators-wildfires>
Caldor Fire(Wikipedia): https://en.wikipedia.org/wiki/Caldor_Fire