# Methods for estimating the peak season in time series data

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# Outline

Introduction

Materials & methods
- Method 1: Peak and threshold
- Method 2: Double sigmoidal

Results

Final remarks

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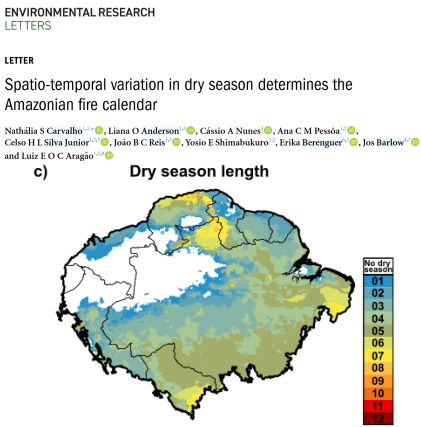
# Introduction

- Better estimations of the fire season in the Amazon forest could foster better town planing and improve responses to excessive fire smoke.
- Previous studies focused on the dry rather than the fire season and its regional patterns.
- Besides, it is common practice to assume a fixed fire season.
- We present pixel-wise estimation of the fire season in the Amazon based on fire spot detected by VIIRS.
- We developed a new method for estimating peak-seasons given intensity data over time.

Deforestation by slash and cut (*Corte e queima*). Source: [DAMV+22].

# Amazon fire calendar

- Stratification of the Amazon basin according to the dry season start and end.
- It uses the mean monthly rainfall (CHIRPS) from 1989 to 2019 over a 10 km grid.
- The dry season is made of the consecutive months with rainfall below 100 mm.
- Regions are neighborhoods of pixels with the same start and end.
- Their results are available online online.




Source: [CAN+21].

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# Software

- R language [IG96].
- R packages *dplyr* and *ggplot2*.
- R packages for vector (*sf* [Peb18]) and raster (*terra* [Hij20]) data.
- R package *sicegar* for double sigmoid regression [CTW18].
- Analysis code available on GitHub.

# Data

- We used fire data from VIIRS NPP.

# Peak and threshold

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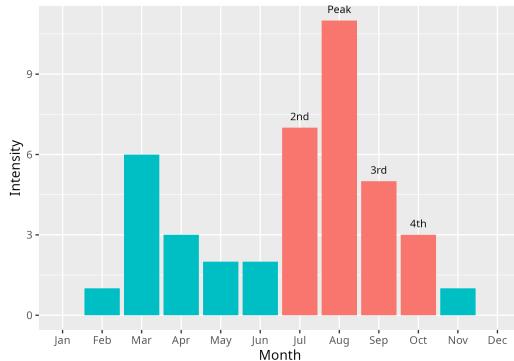
- Originally proposed by Guilherme Mataveli.
- A season is a subset of contiguous months that host the peak and at least 60% of the total intensity (observations) of a phenomenon.



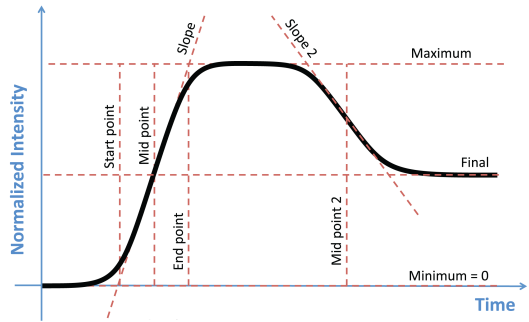
# Peak and threshold example

| Month | GC |
|---|---|
| 1 | 380 |
| 2 | 60 |
| 3 | 78 |
| 4 | 96 |
| 5 | 30 |
| 6 | 22 |
| 7 | 56 |
| 8 | 32 |
| 9 | 112 |
| 10 | 220 |
| 11 | 500 |
| 12 | 450 |

| Iteration | Test Months | Chosen | Season | Cum. Sum |
|---|---|---|---|---|
| 1 | Peak | 11 | 11 | 500 (25%) |
| 2 | 10 or 12 | 12 | 11-12 | 950 (47%) |
| 3 | 10 or 1 | 1 | 11-12-1 | 1330 (65%) |

# Double sigmoidal fitting

- Input data represents intensity measured over time.
- Growth happens in two phases: exponential intensity increase until level off at a maximum level (first sigmoid function); decay to a lower intensity or even zero (second sigmoid).
- The midpoints are assumed as the start and end of the season.




Source: [CTW18].

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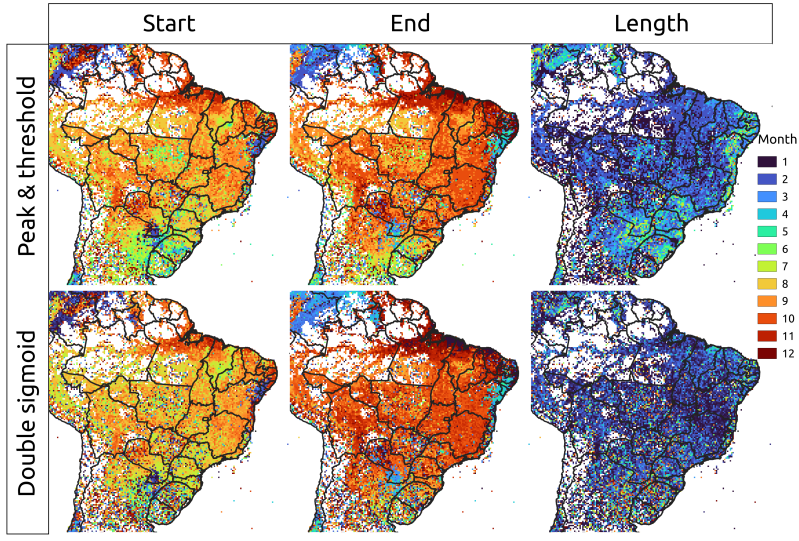
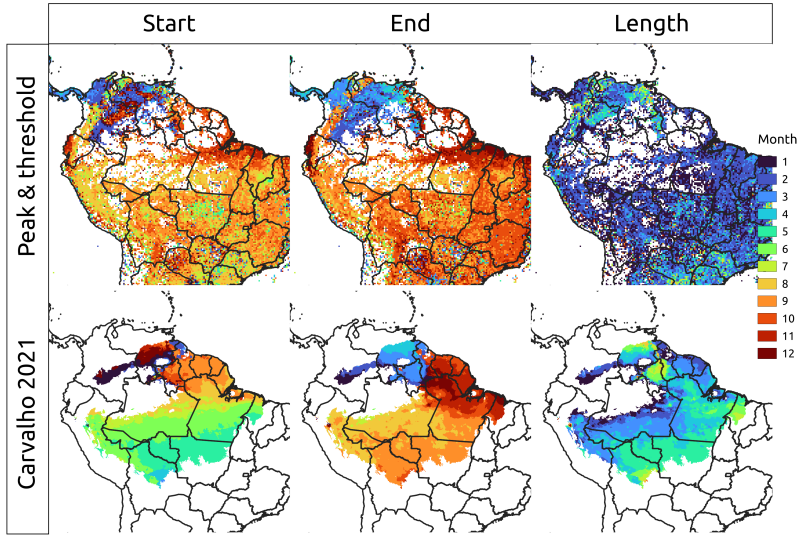

Start
End
Length
Peak & threshold
Double sigmoid
Month
1
2
3
4
5
6
7
8
9
10
11
12

# Result comparison

- Carvalho et al., [CAN+21] is actually about the establishing the dry and rainy seasons rather than the fire season.
- They use the fire spots to validate their results.
- Instead, we're using the fire spots to estimate the fire season and use [CAN+21], to validate them.

# Result comparison



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- Source code available at https://github.com/albhasan/seasonmetrics.

# References I


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- M. Umut Caglar, Ashley I. Teufel, and Claus O. Wilke, *Sicegar: R package for sigmoidal and double-sigmoidal curve fitting*, PeerJ **6** (2018), e4251.
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# References II


- Robert J. Hijmans, *Terra: Spatial Data Analysis*, March 2020, pp. 1.7–83.
- Ross Ihaka and Robert Gentleman, *R: A Language for Data Analysis and Graphics*, Journal of Computational and Graphical Statistics **5** (1996), no. 3, 299.
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