

# Methods for estimating the peak season in time series data

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# Outline

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# Introduction

- ▶ Better estimations of the fire season in the Amazon forest could foster better town planning 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<sup>+</sup>22].

# Amazonian fire calendar

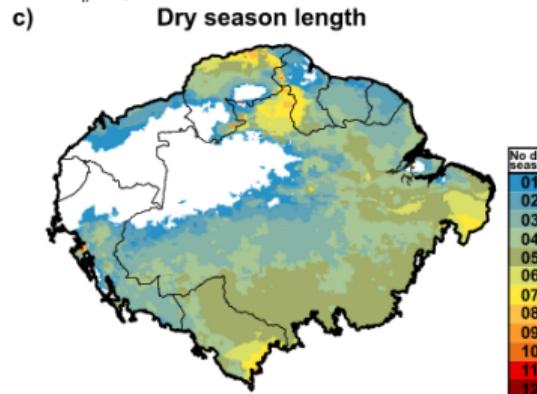
- ▶ Start, end, & length of the dry season in the Amazon.
- ▶ Rain data (CHIRPS 1989-2019) on a 10Km grid.
- ▶ The dry season are the consecutive months with rainfall below 100 mm.
- ▶ Regions are neighborhoods with the same season start & end.
- ▶ Critical fire periods are regions of similar dry season determined by k-means clustering.
- ▶ Their results area available online for [download](#) and [visualization](#).

ENVIRONMENTAL RESEARCH LETTERS

LETTER

Spatio-temporal variation in dry season determines the Amazonian fire calendar

Nathália S Carvalho<sup>1,2,\*</sup>, Liana O Anderson<sup>1,3</sup>, Cássio A Nunes<sup>1</sup>, Ana C M Pessôa<sup>1,2</sup>, Celso H L Silva Junior<sup>1,2,4</sup>, João B C Reis<sup>1,2</sup>, Yosio E Shimabukuro<sup>1,2</sup>, Erika Berenguer<sup>1,2</sup>, Jos Barlow<sup>1,2</sup>, and Luiz E O C Aragão<sup>1,2,4</sup>



Source: [CAN<sup>+21</sup>].

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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](#).



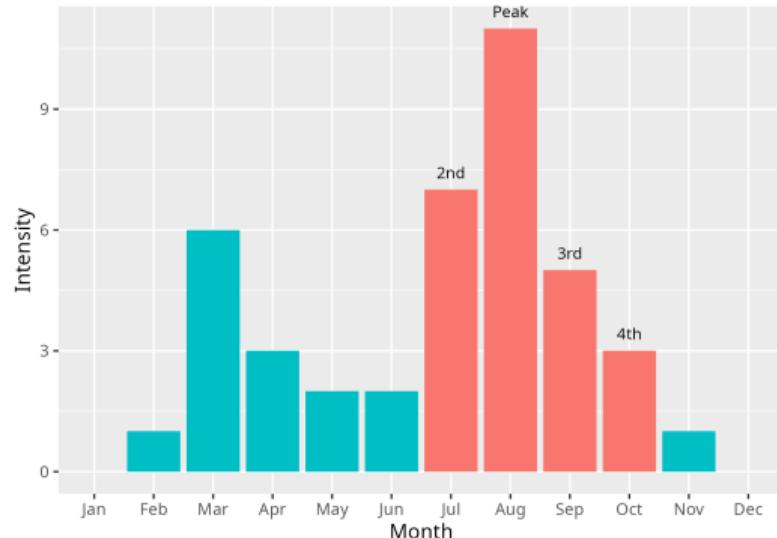
## Data

- ▶ We used 5 years of world fire data from VIIRS NPP (from 2019 to 2023, 10.213.4267 registries).
- ▶ We aggregated these data by month into a grid of  $0.25^\circ$ .



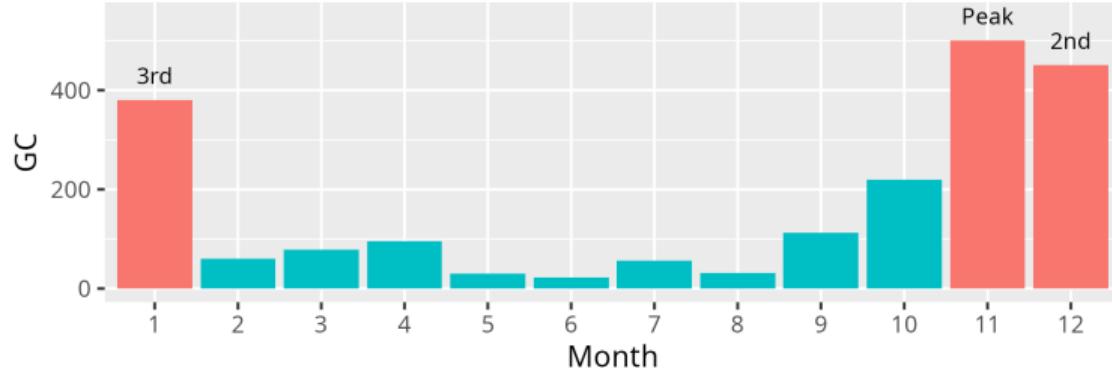
# Peak and threshold

- ▶ 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

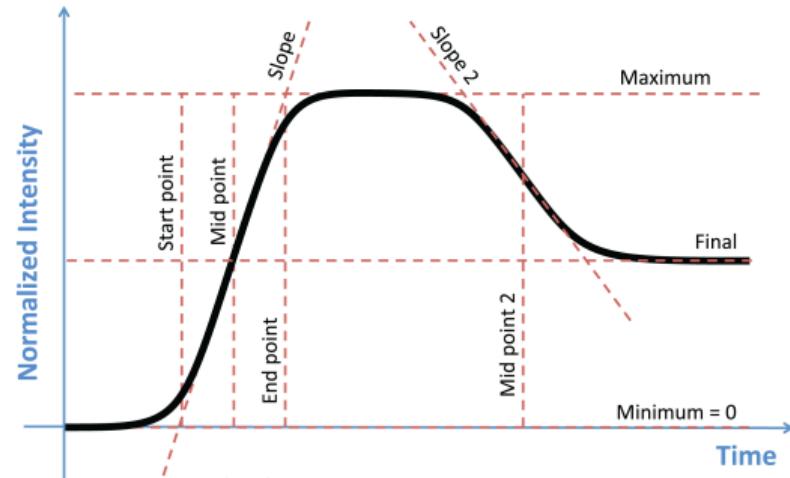
Month	GC
1	380
2	60
3	78
4	96
5	30
6	22
7	56
8	32
9	112
10	220
11	500
12	450



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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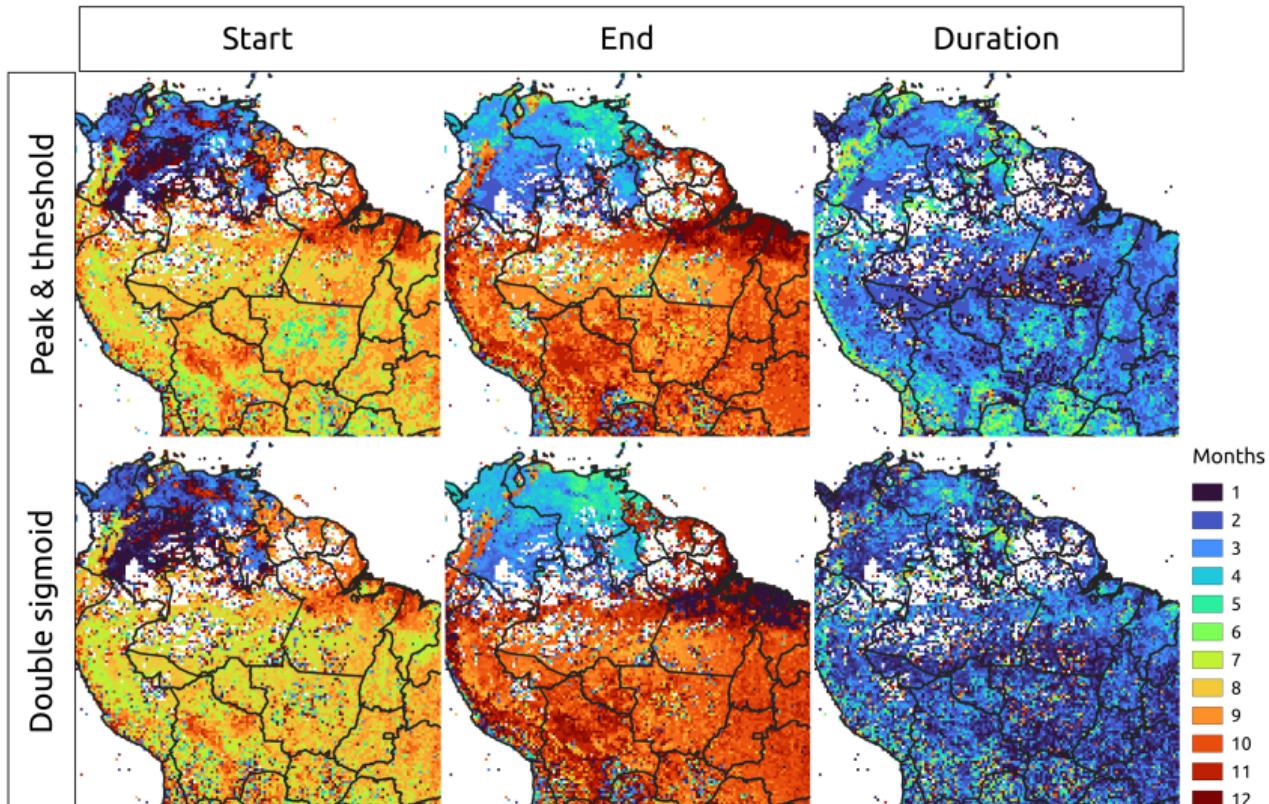
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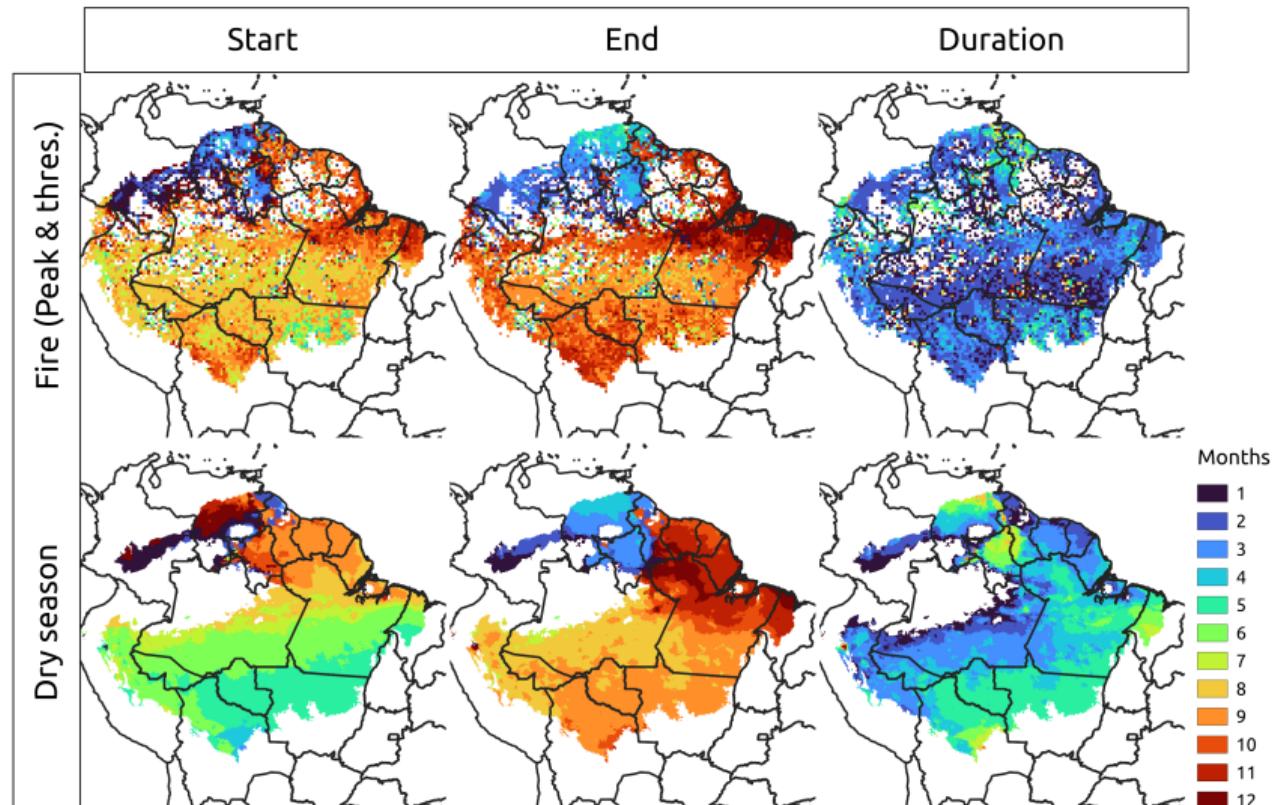
# Results



## Fire & dry seasons

- ▶ Carvalho et al., [CAN<sup>+</sup>21] is actually about establishing the dry season 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<sup>+</sup>21], to validate them.

# Fire & dry seasons



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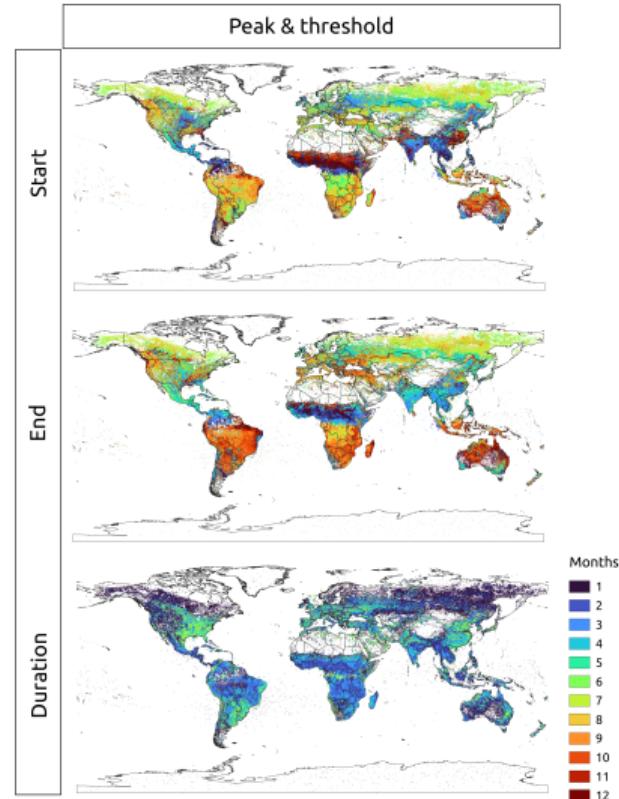
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## Final remarks

- ▶ We ran both methods for the world.
- ▶ Both peak & threshold and double sigmoid methods can be employed to estimate season of Earth Observation phenomena besides fire.
- ▶ Source code available at  
<https://github.com/albhasan/seasonmetrics>.



## References I

-  Nathália S Carvalho, Liana O Anderson, Cássio A Nunes, Ana C M Pessoa, Celso H L Silva Junior, João B C Reis, Yosio E Shimabukuro, Erika Berenguer, Jos Barlow, and Luiz E O C Aragão, *Spatio-temporal variation in dry season determines the Amazonian fire calendar*, Environmental Research Letters **16** (2021), no. 12, 125009.
-  M. Umut Caglar, Ashley I. Teufel, and Claus O. Wilke, *Sicegar: R package for sigmoidal and double-sigmoidal curve fitting*, PeerJ **6** (2018), e4251.
-  Claudio Aparecido De Almeida, Luis Maurano, Dalton M. Valeriano, Gilberto Câmara, Lúbia Vinhas, Marisa Da Motta, Alessandra Rodrigues Gomes, Antonio Miguel Vieira Monteiro, Arlesson Antônio De Almeida Souza, Cassiano Gustavo Messias, Camilo Daleles Rennó, Marcos Adami, Maria Isabel Sobral Escada, Luciana De Souza Soler, and Silvana Amaral, *METODOLOGIA UTILIZADA NOS SISTEMAS PRODES E DETER -2 a EDIÇÃO (ATUALIZADA) INPE São José dos Campos 2022*.

## 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.
-  Edzer Pebesma, *Simple Features for R: Standardized Support for Spatial Vector Data*, The R Journal **10** (2018), no. 1, 439.