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 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.
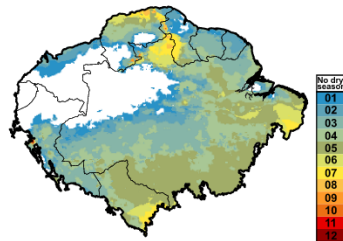
- Their results are available online online.

Nathália S Carvalho[1,2], Liana O Anderson[1,2], Cássio A Nunes[1], Ana C M Pessôa[1,3],
Celso H L Silva Junior[1,2,3], João B C Reis[1,2], Yosio E Shimabukuro[3], Erika Berenguer[4,5], Jos Barlow[5],
and Luiz E O C Aragão[1,3]
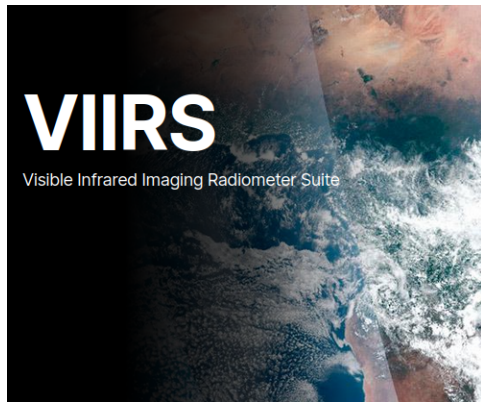
c) **Dry season length**

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].
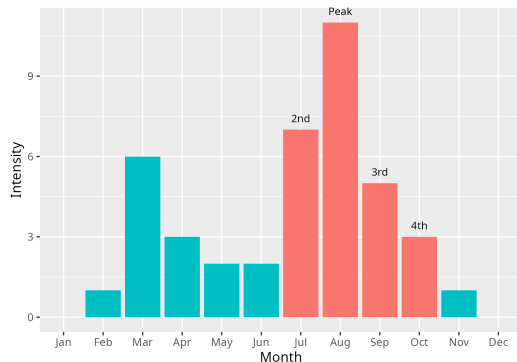- Analysis code available on GitHub.
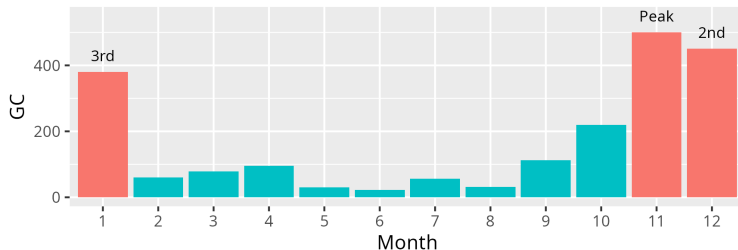
Data

- We used fire data from VIIRS NPP.

Peak and threshold

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▶ 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.
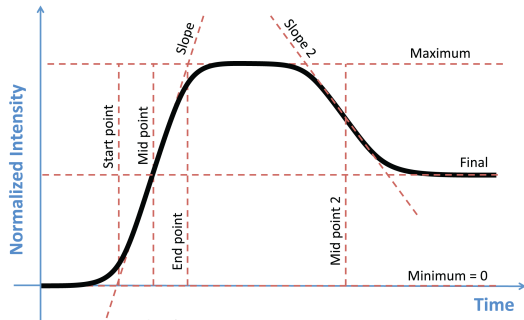
Peak and threshold example

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.
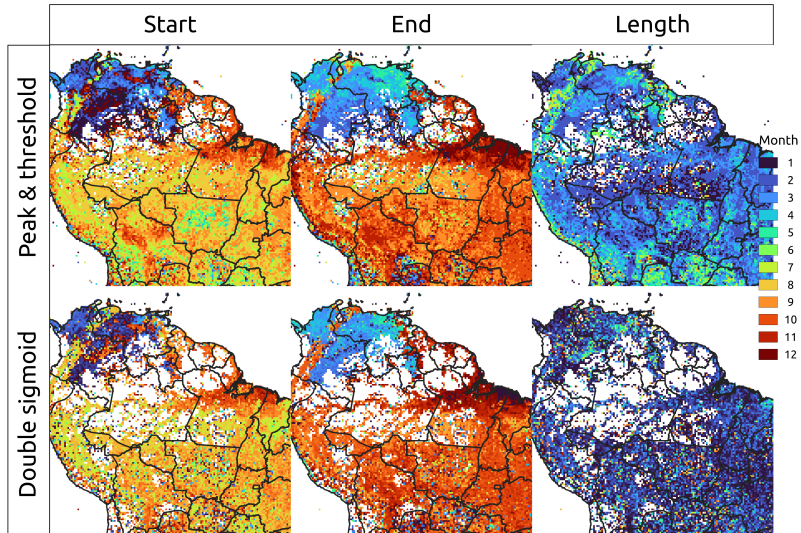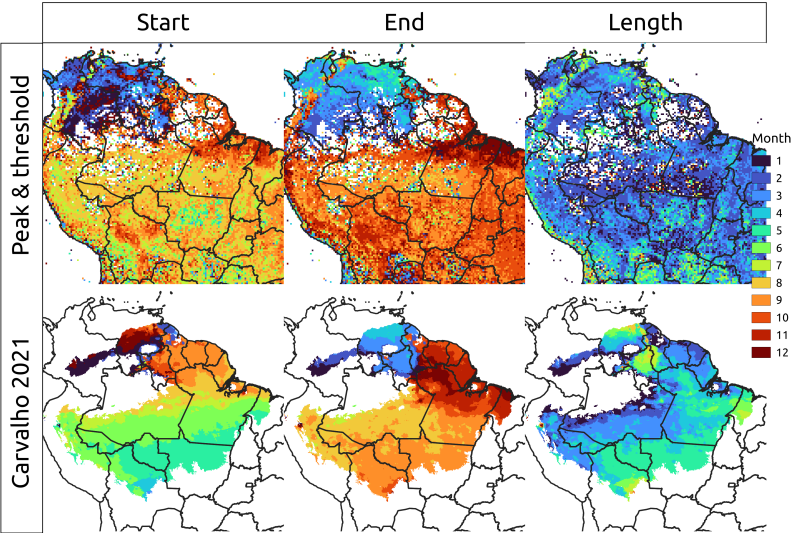

Source: [CTW18].

Outline

Results

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

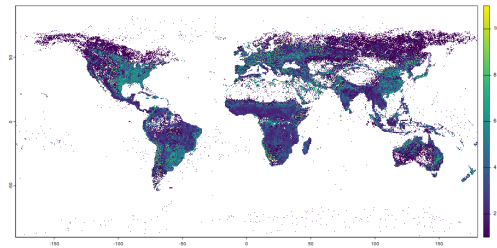# Outline

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.

Length of the fire season using Peak & Threshold.

📄 Nathália S Carvalho, Liana O Anderson, Cássio A Nunes, Ana C M Pessôa, 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.