

Global tipping points in forest wildfires

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2020/12/10

The Amazon in Brazil is on fire - how bad is it?

By The Visual and Data Journalism Team
BBC News

🕒 30 August 2019



Amazon fires



Amazon fires: Are they worse this year than before?

By Jack Goodman and Christopher Giles
BBC Reality Check and Visual Journalism

🕒 28 August



Reality Check



Preserving the Amazon rainforest is of global importance in the fight against climate change, but it is under threat from forest fires, mostly started to clear land for agriculture.

Yes, Australia has always had bushfires: but 2019 is like nothing we've seen before

Record low rainfall has contributed to a continent-scale emergency that has burned through more than 5m hectares and alarmed scientists, doctors and firefighters



▲ Scientists say the lack of moisture in the landscape is a key reason this year's bushfire have been so severe and the climate crisis is behind the lengthening of the fire season. Photograph: David Gray/Getty Images

As the area burned across Australia this fire season pushes beyond five

The Australian Fires

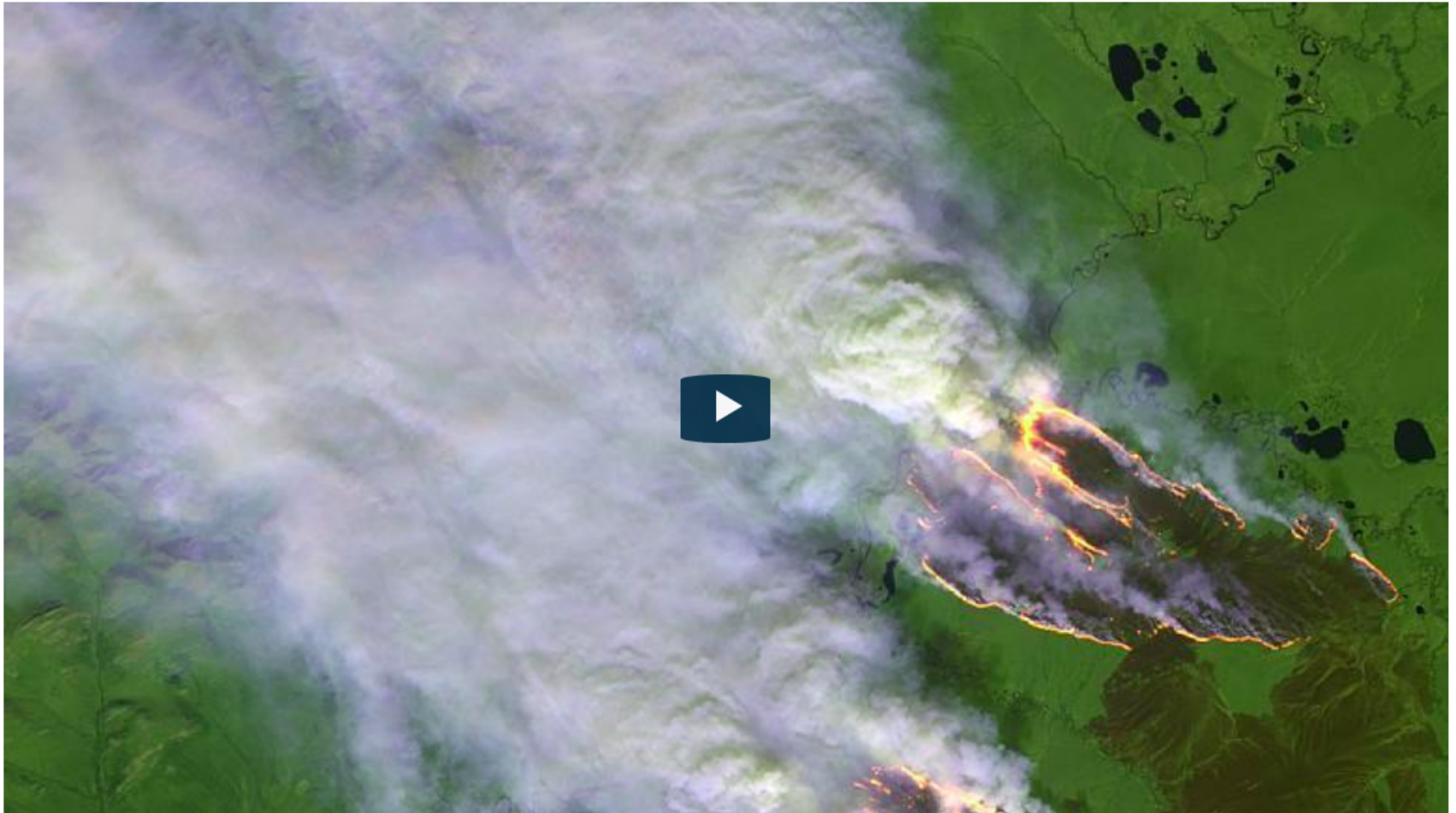


A man in Lake Conjola tried to defend a property on New Year's Eve as fire consumed the house next door. Matthew Abbott for The New York Times

'Low chance' Siberia wildfires will be brought under control: Greenpeace fire expert

COMMENTS

By [Rachael Kennedy](#) & Sandrine Amiel and agencies • last updated: 11/08/2019



Copernicus monitoring of Arctic fires in the Sakha Republic, 4 August 2019 - Copyright Copernicus via Twitter



Why forest fires in Siberia, Russia threaten us all

Wildfires in Siberia have been releasing record amounts of greenhouse gases, scientists say, contributing to global warming. The fires, fuelled by abnormally high temperatures, have been burning as far north as the Arctic Circle.

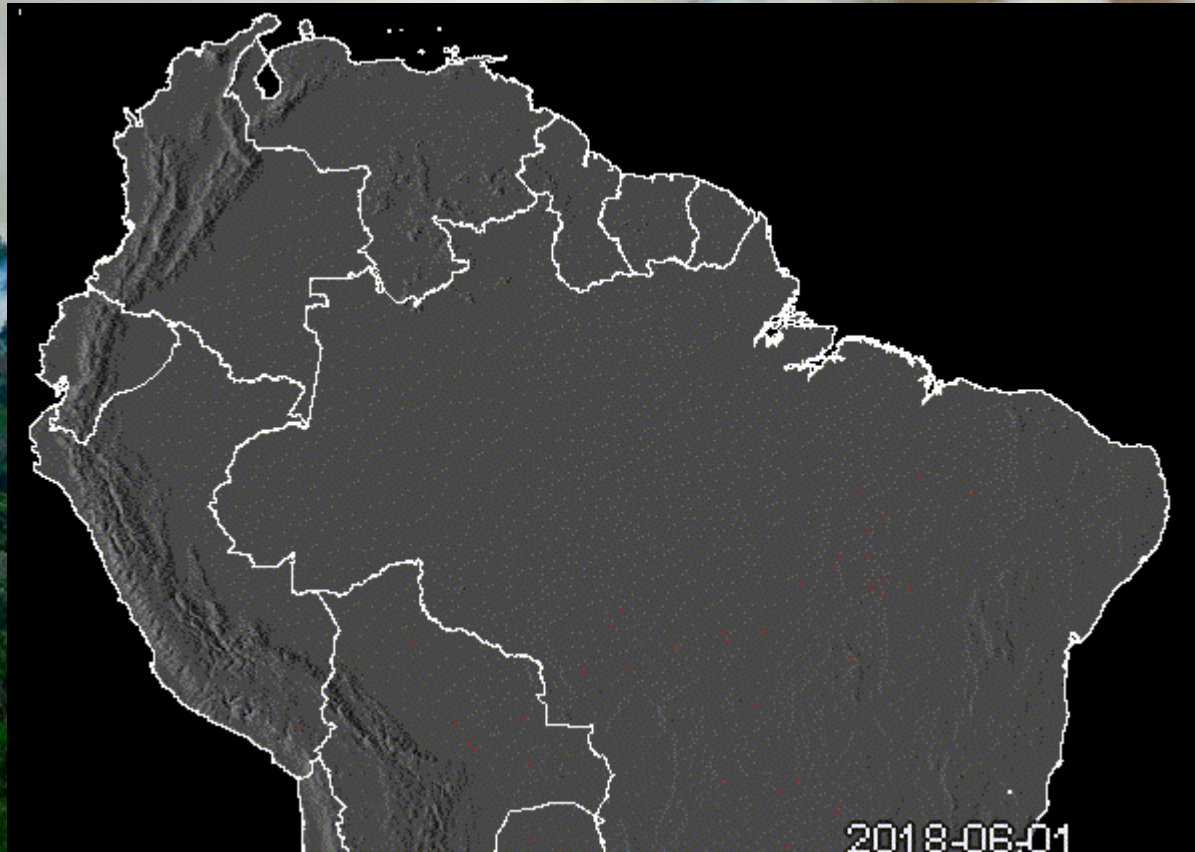
BBC Moscow correspondent Steve Rosenberg travelled to the remote Yakutia region, in northeastern Russia, to gauge the effects of climate change, both on local communities and on the planet.

Producer: Will Vernon

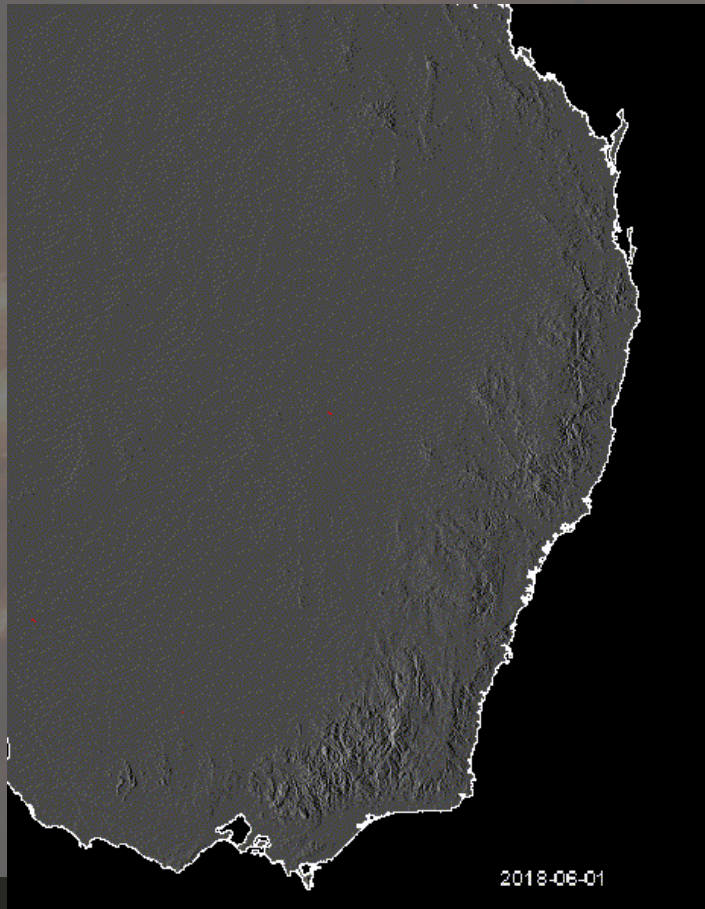
Camera and editing: Matthew Goddard

🕒 17 September | [BBC News](#) | [Science & Environment](#)

Fires Everywhere



Fires Everywhere - Australia



Fires Everywhere - East Siberia

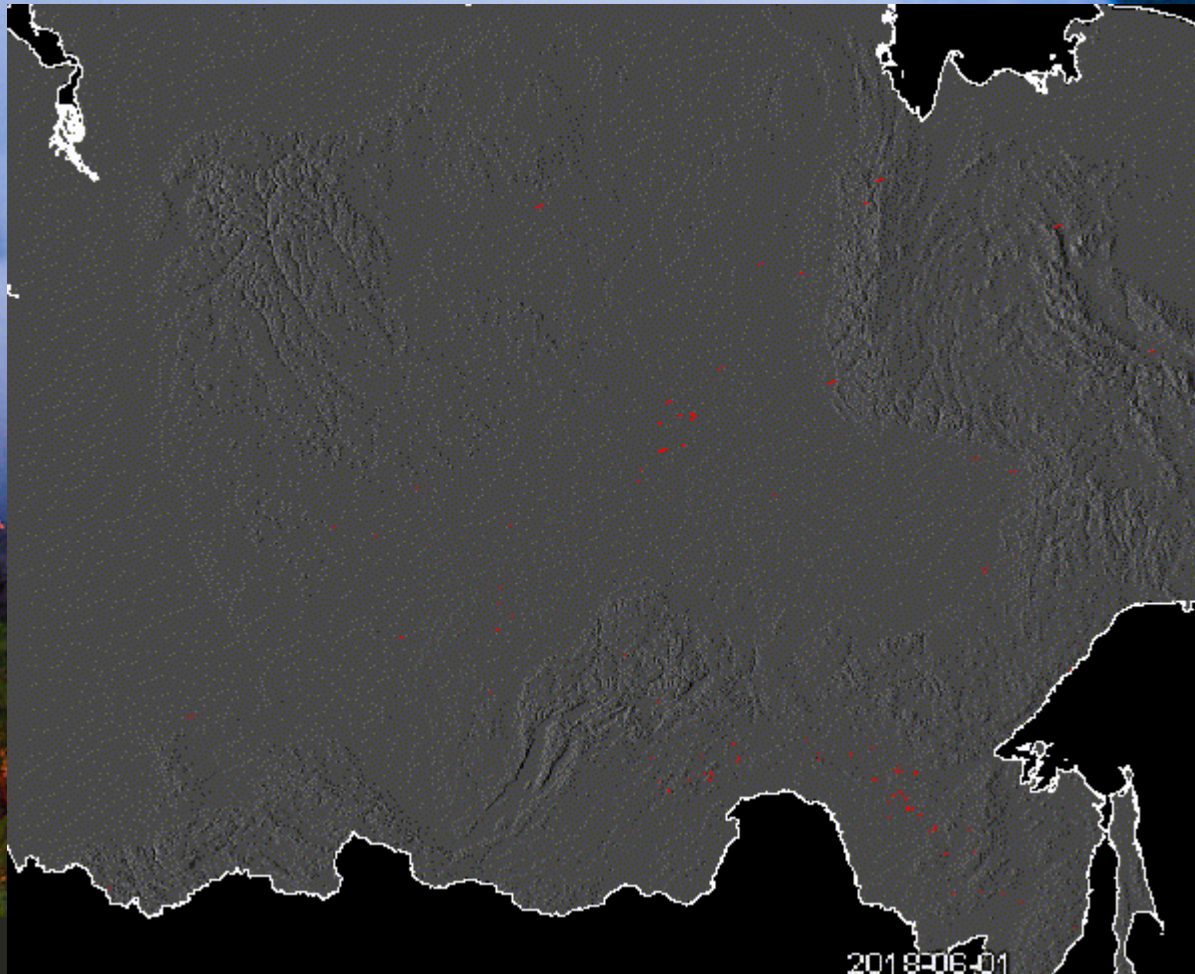
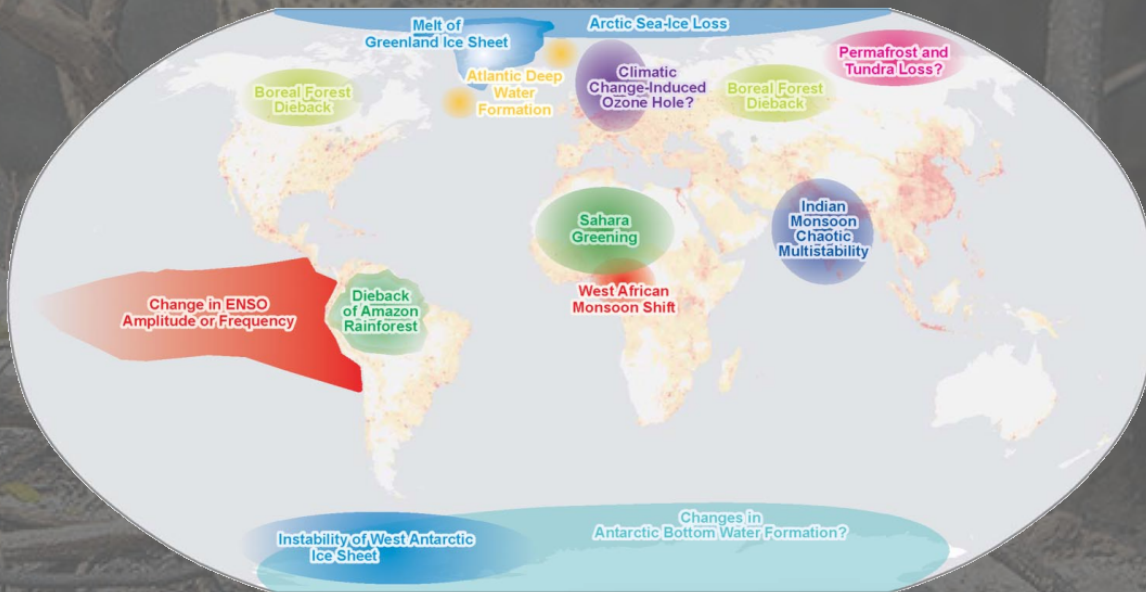




Foto: Firefighters and volunteers in the Pantanal, Brazil, have been fighting to rescue jaguars from extreme fires. Crédito: Andre Penner/AP/Shutterstock.

Earth tipping elements

- **tipping element** describe subsystems of the Earth system that are at least subcontinental in scale and can be switched into a qualitatively different state by small perturbations.
- **The tipping point** is the corresponding critical point at which the future state of the system is qualitatively altered.



Lenton et. al 2008 10.1073/pnas.0705414105



Foto: Firefighters and volunteers in the Pantanal, Brazil, have been fighting to rescue jaguars from extreme fires. Crédito: Andre Penner/AP/Shutterstock.

Critical points Questions

Are these events critical points?

Are they happening at the same time?

Are there global factors that influence them?

Are there different dynamics or mechanisms?

Fingerprints of critical points

Power law Fire distribution

High number of patches

Fire sizes spawning a wide range

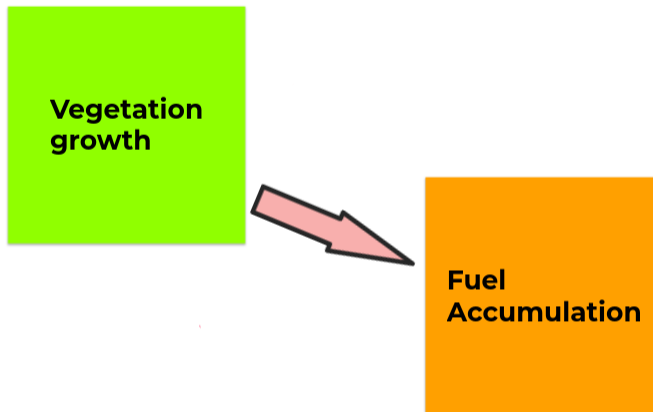
There is a qualitatively different state of the system

Fire dynamics



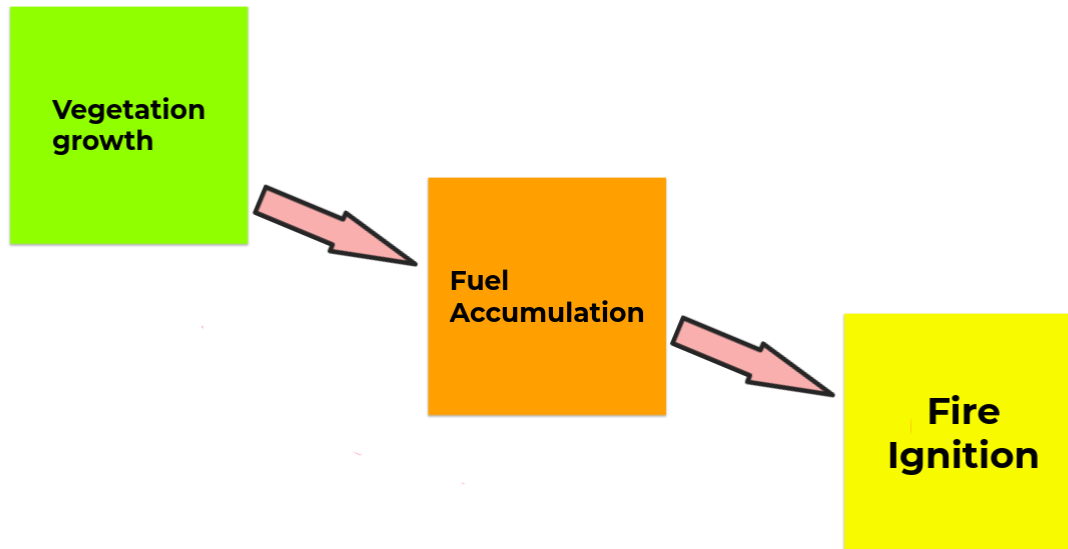
**Vegetation
growth**

Fire dynamics



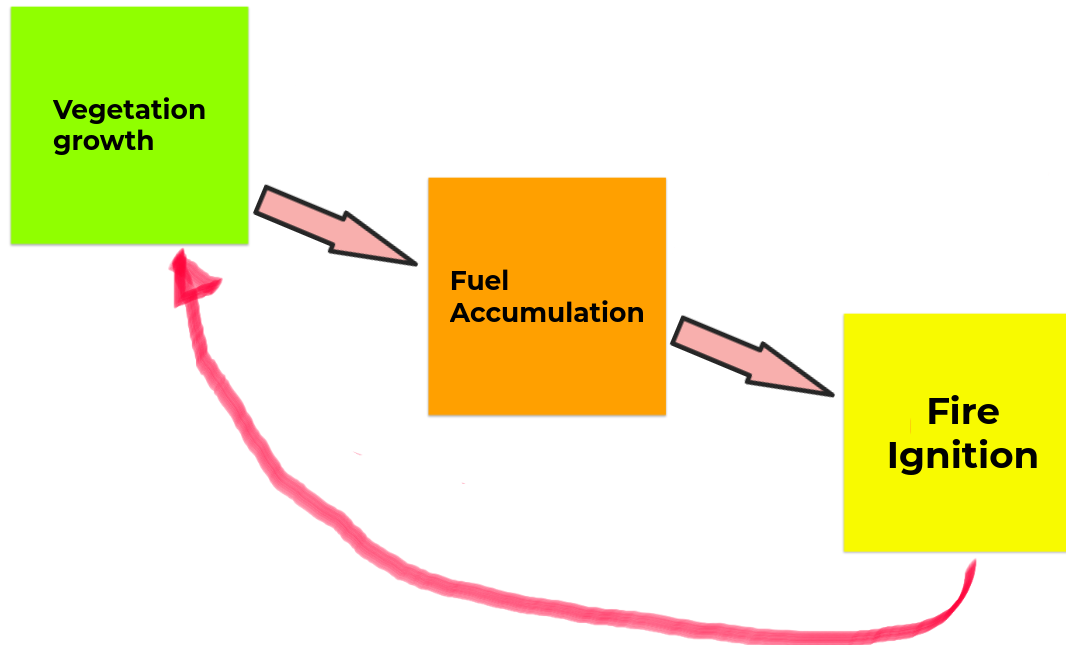
- Vegetation growth builds biomass that dries

Fire dynamics



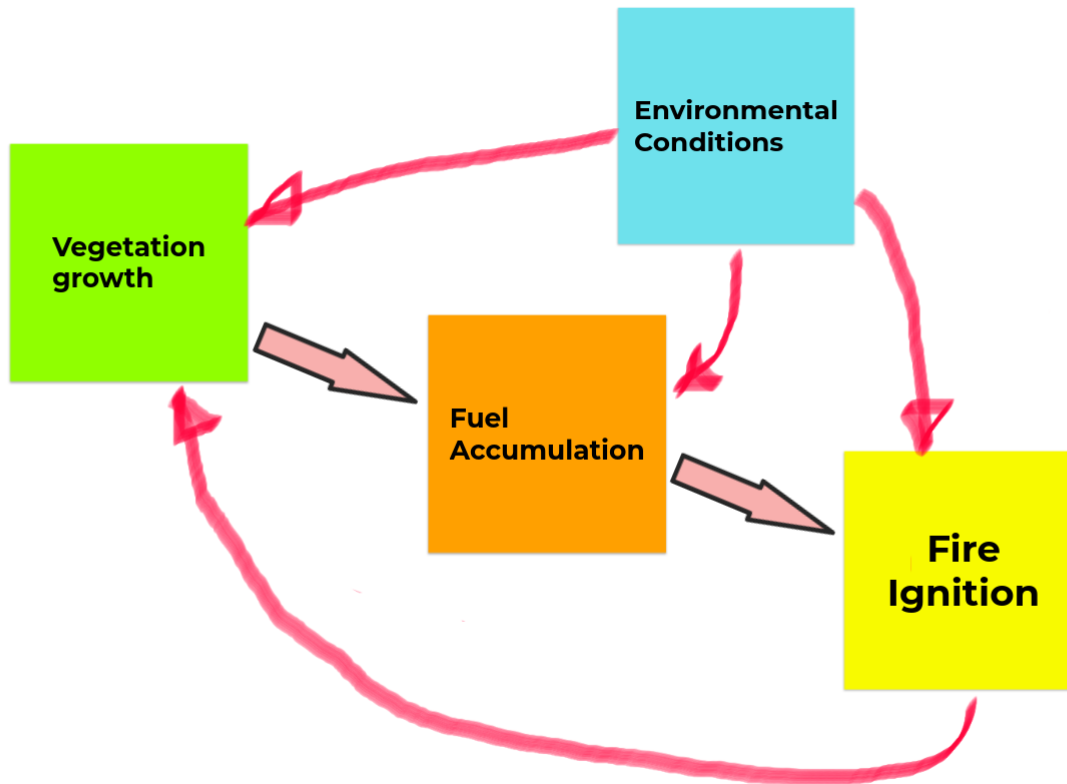
- By natural or antropogenic causes

Fire dynamics



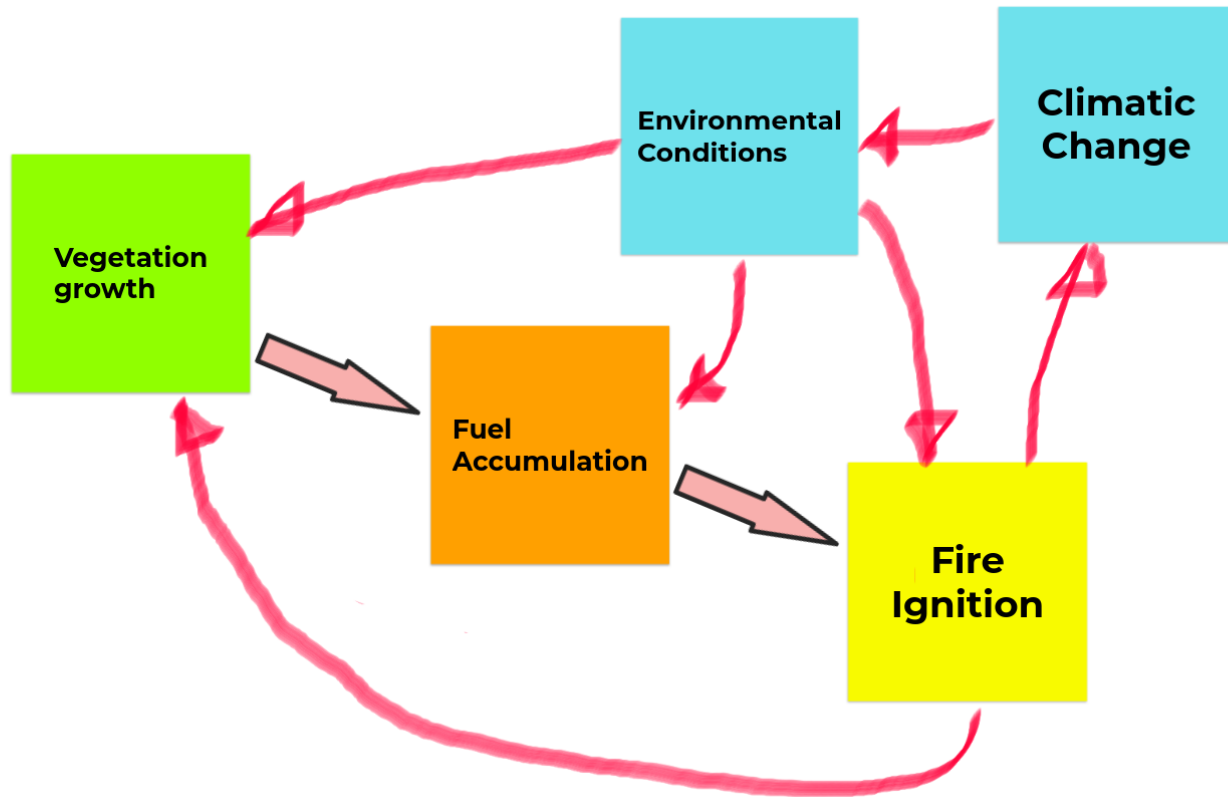
- Generates open spaces or vegetation could be dependent

Fire dynamics

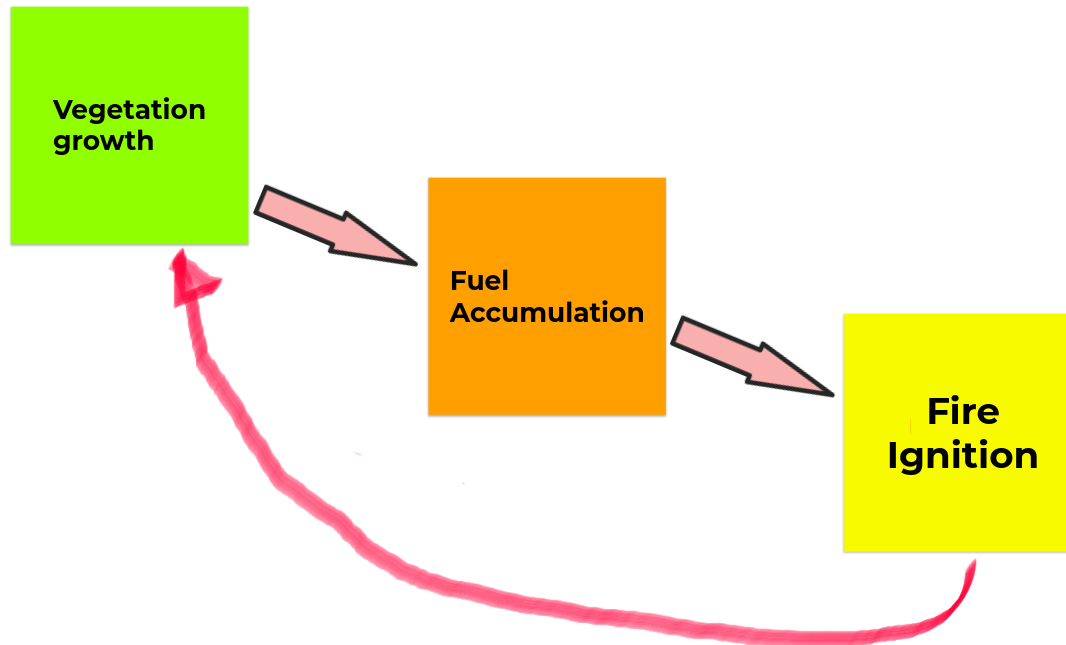


- Dry conditions, temperature, soil water

Fire dynamics



Fire dynamics



A Simple Forest Fire model

Local scale around 100 *Km* of side (Australia region has 1500 x 300 *Km*)

Initially fixed the potential sites where forest can grow (randomly)

Random growth of forest inside its area

A Simple Forest Fire model

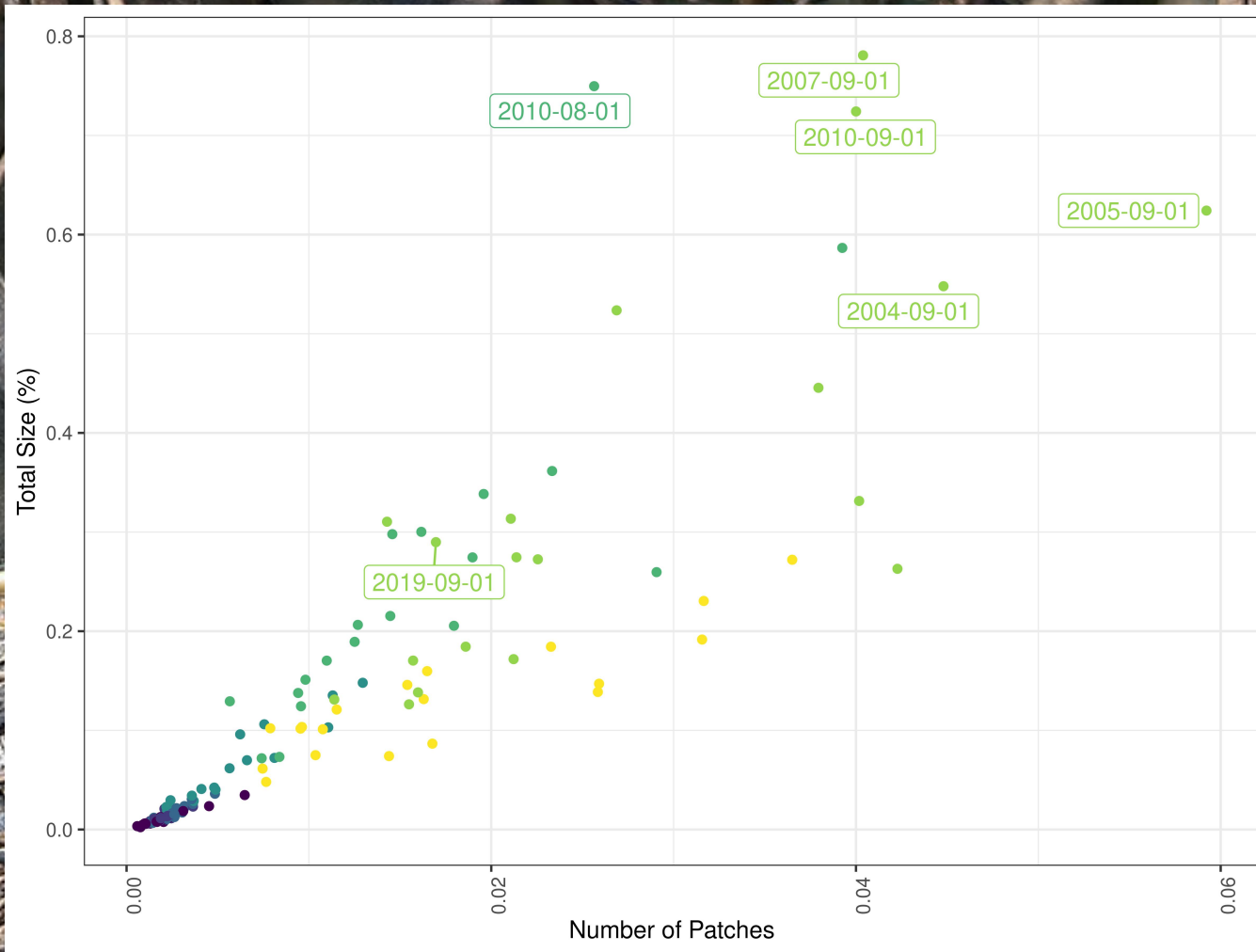
A Simple Forest Fire model

A Simple Forest Fire model

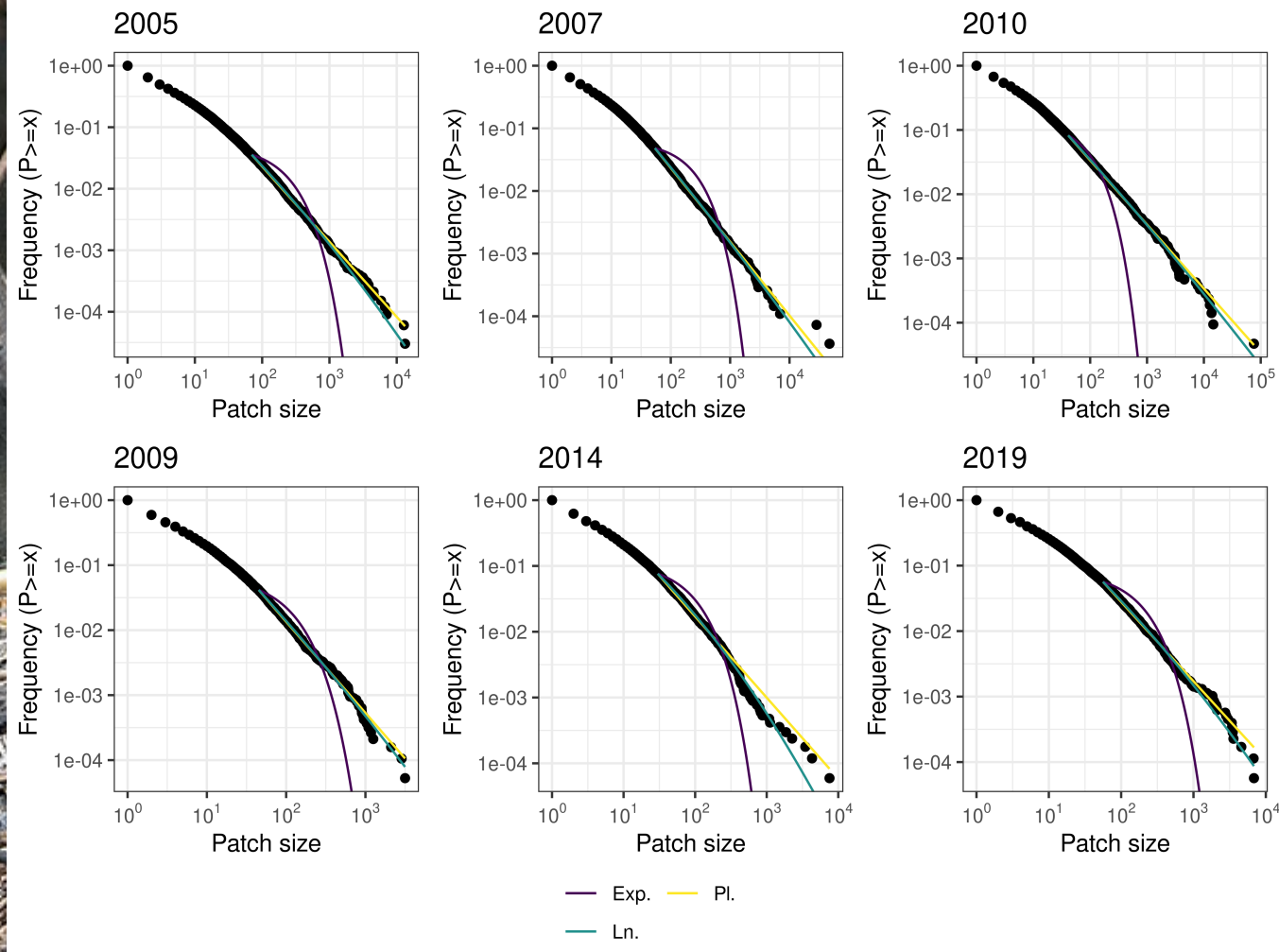
A Simple Forest Fire model



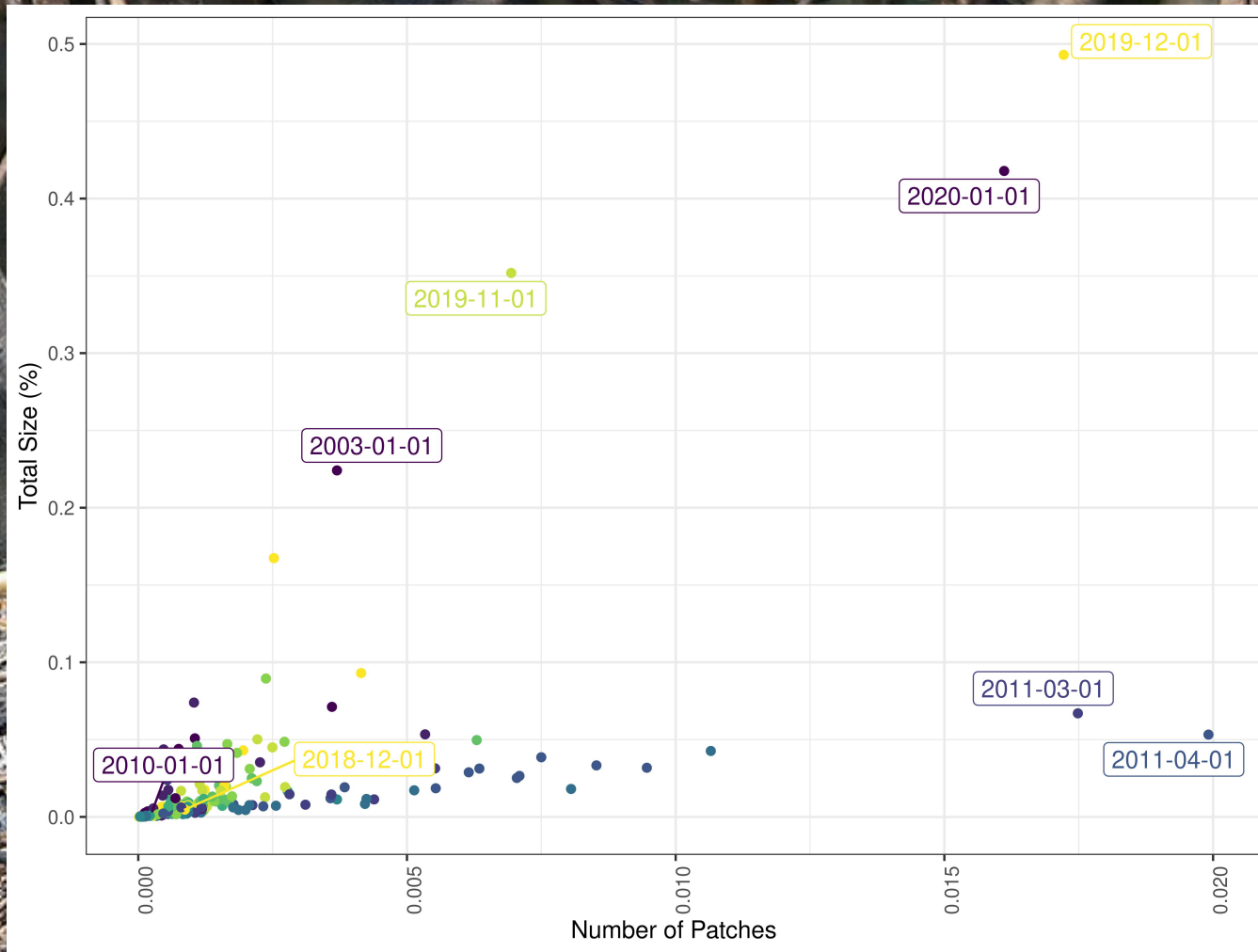
Comparing Fire distributions -Amazon



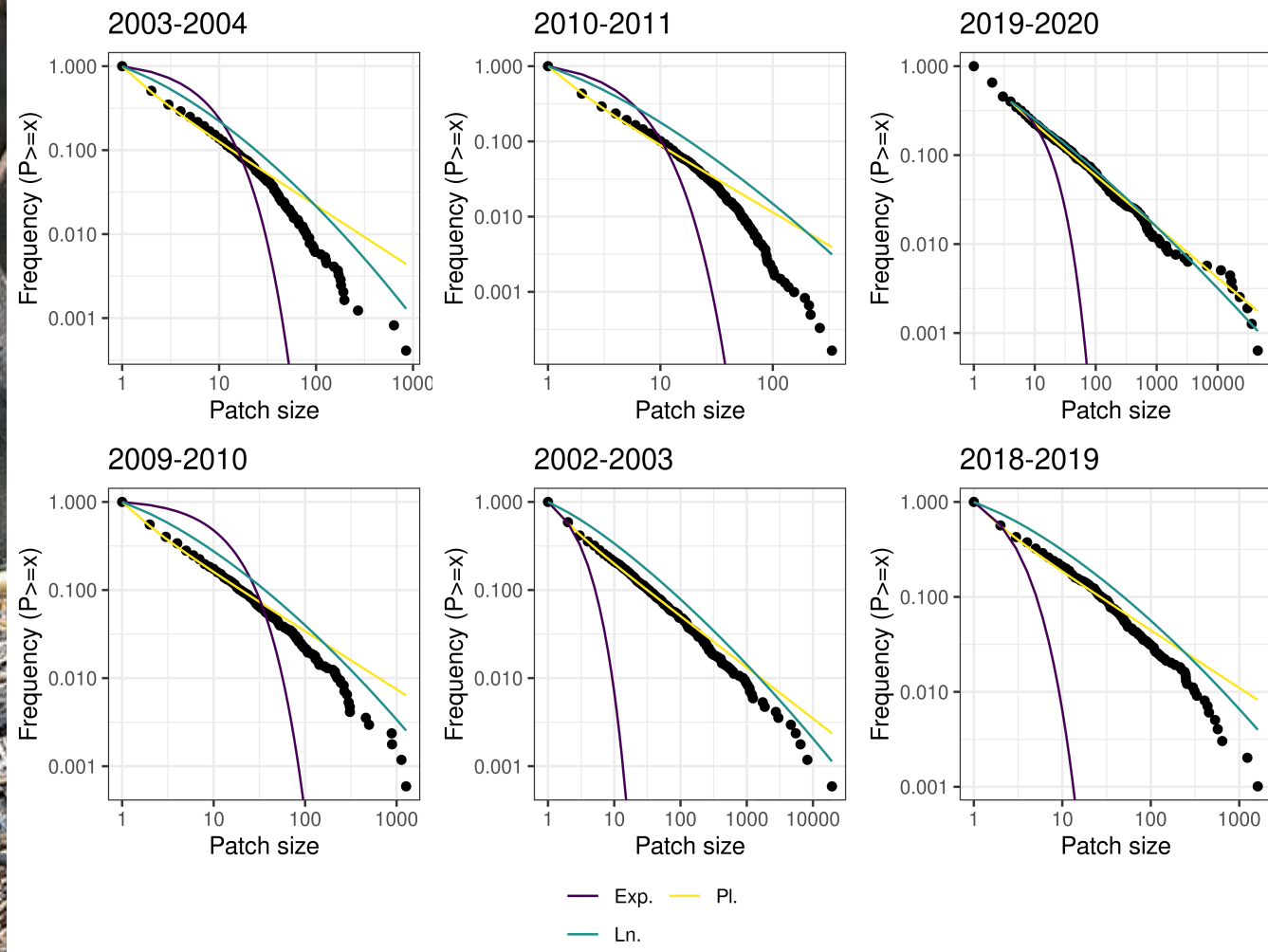
Comparing Fire distributions - Amazon



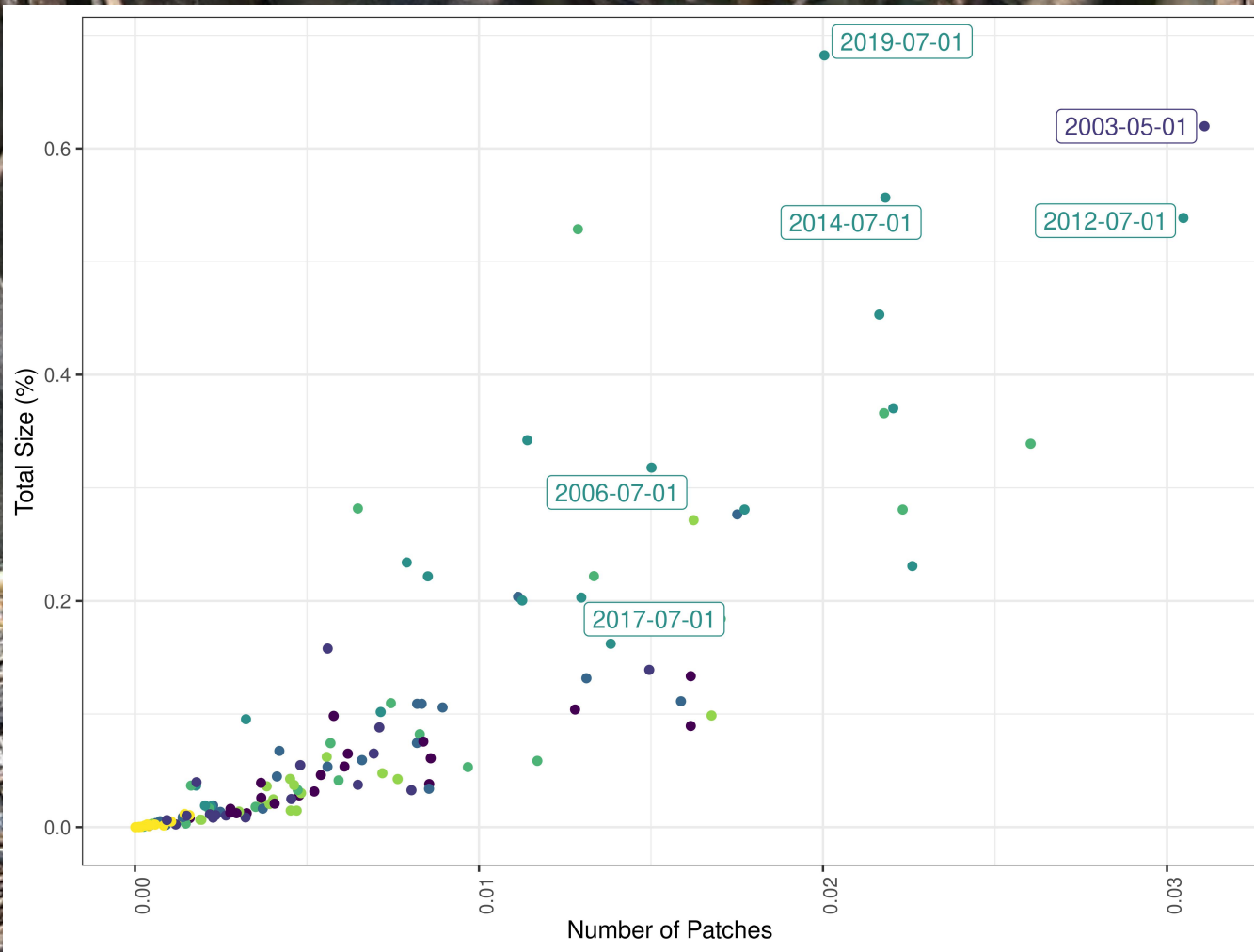
Comparing Fire distributions -Australia



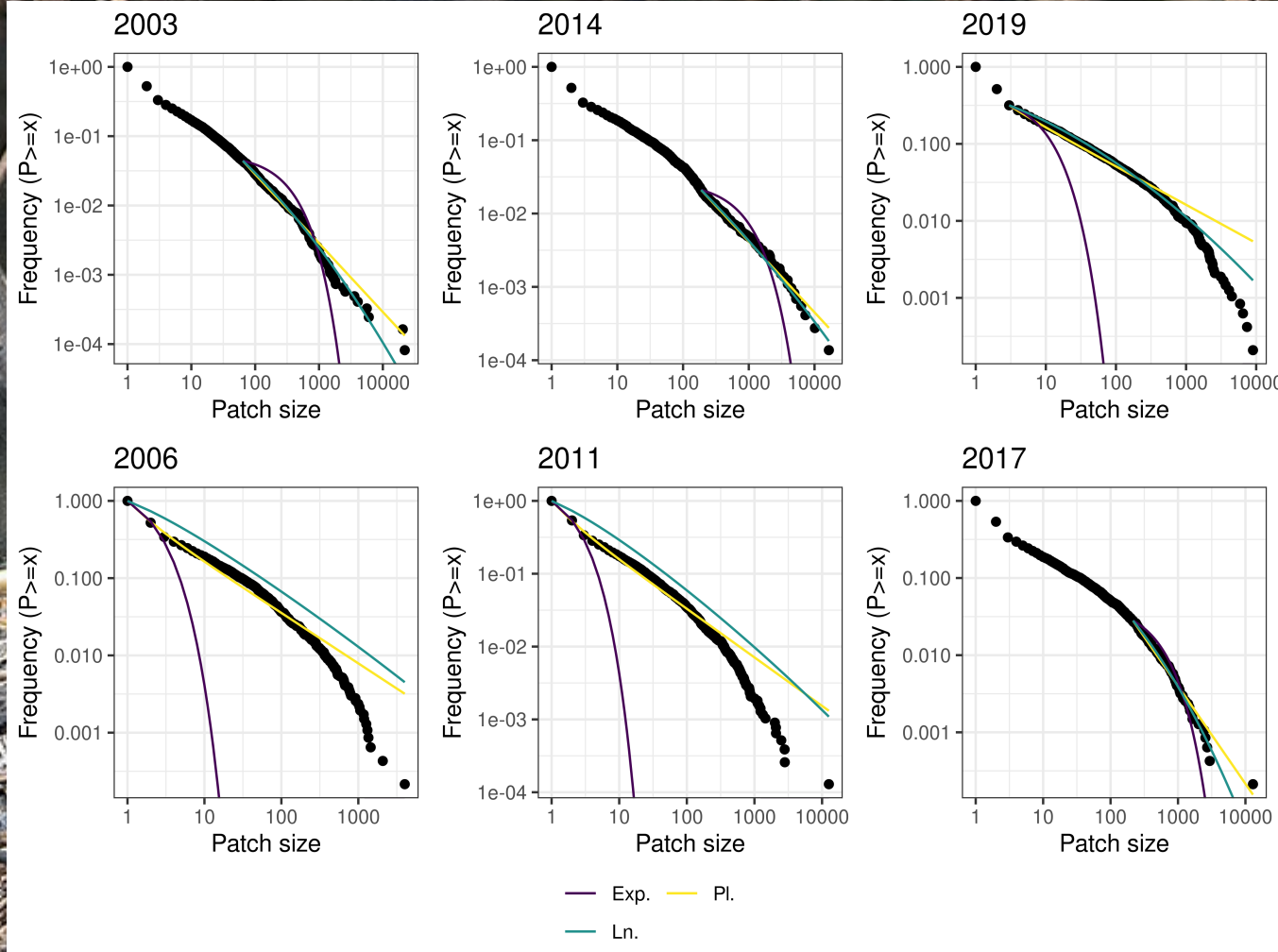
Comparing Fire distributions - Australia



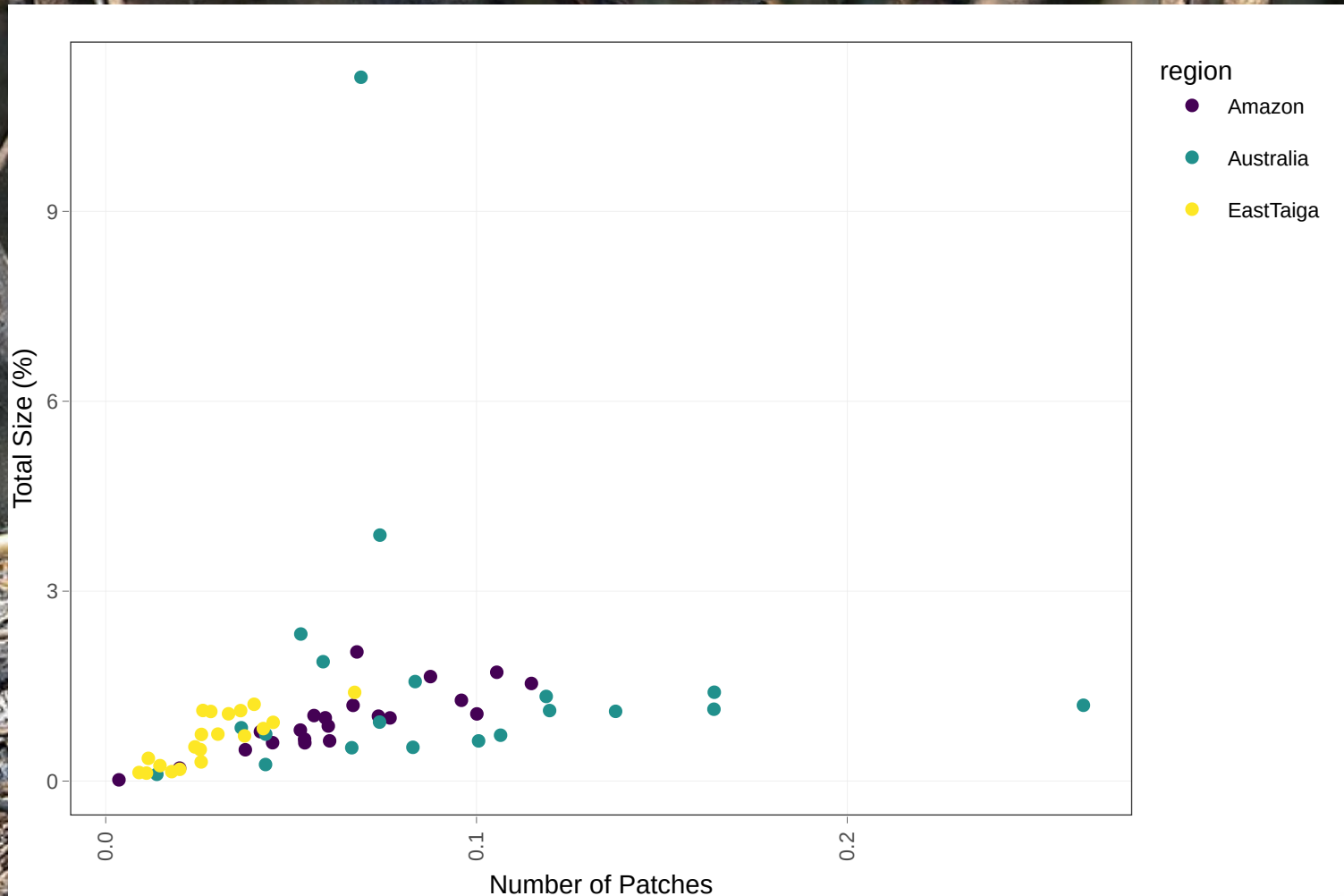
Comparing Fire distributions - Siberia



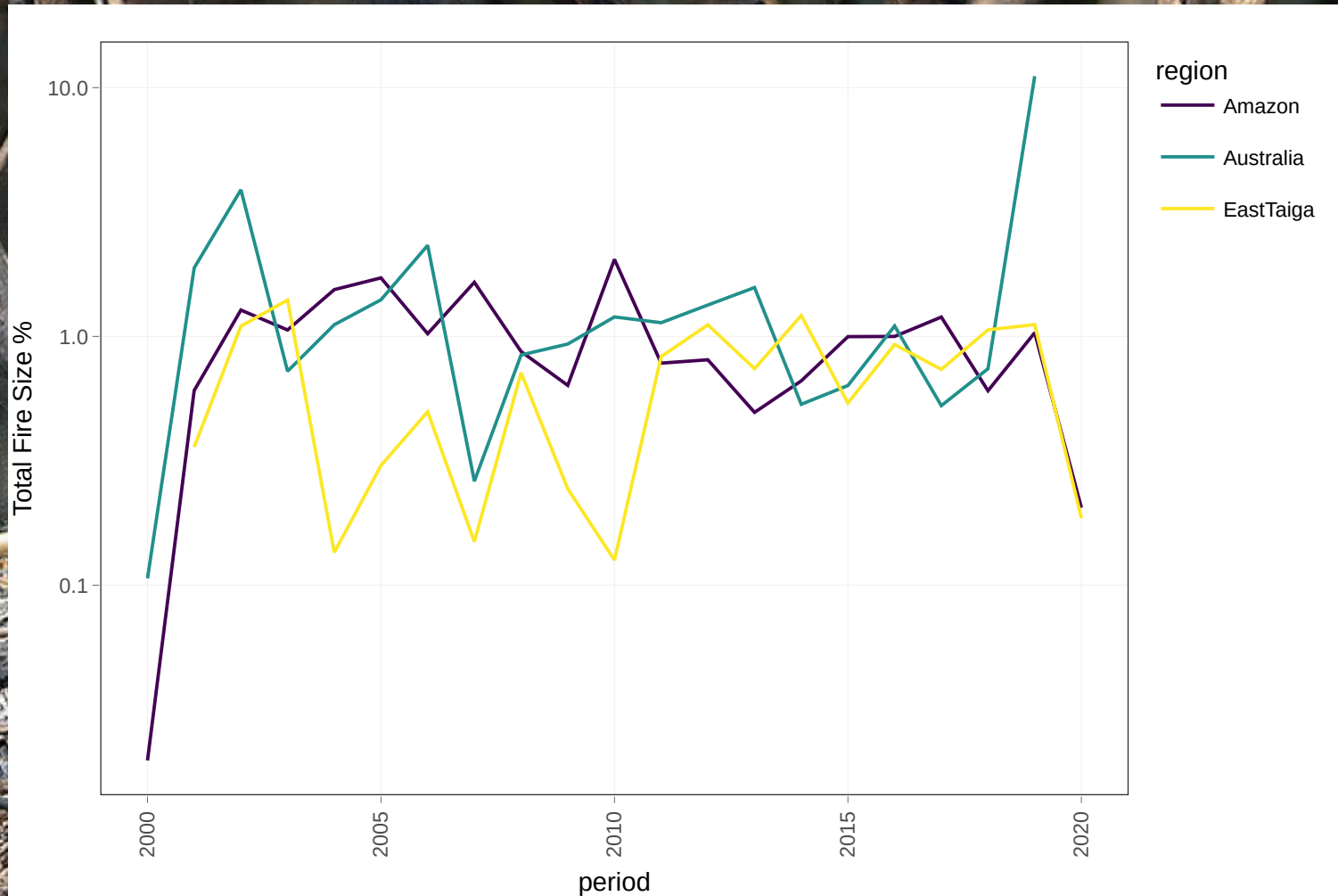
Comparing Fire distributions - Siberia



Comparing Fire distributions



Comparing Fire distributions



Are these events critical points? ✓

- Probably only Australia 2019-2020 seems to be related to a regime change

Are they happening at the same time? ✗

- Big fire events seems to be uncorrelated

Are there global factors that influence them? 🤔

- ENSO Oscillations (El Niño) - Dry conditions - Amazonia
- Artic Oscilation - Changes in growth season - Siberia
- Australia an attribution study is currently under way

Are these forests adapted to fire?



Foto: Bomberos y voluntarios en el Pantanal, Brasil, han estado luchando por rescatar jaguares de incendios extremos. Crédito: Andre Penner/ AP/Shutterstock

Are these forests adapted to fire?

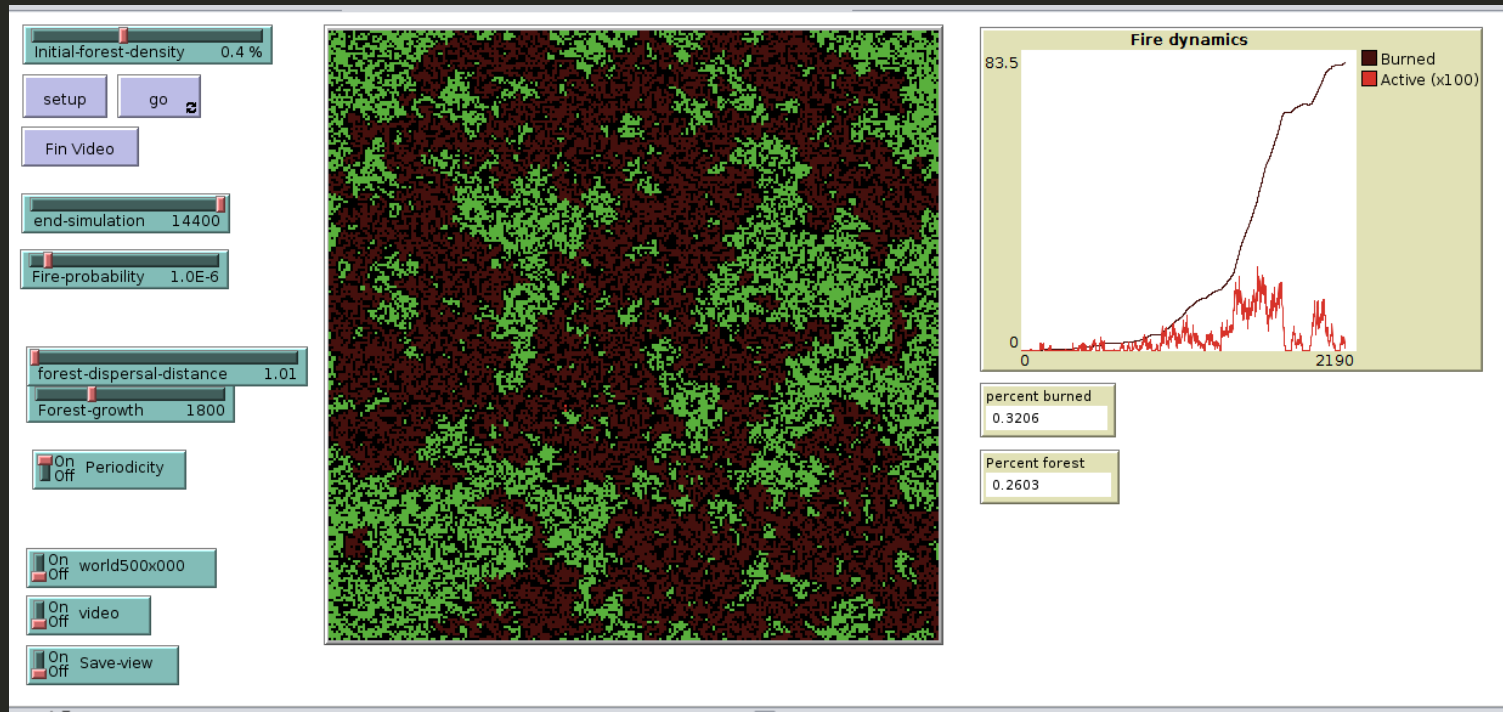
- Fire is an integral part of some ecosystems

Amazonas tropical rainforest ✗

Australia temperate forest ✓

Siberia East Boreal forest ✓

Another Forest Fire model

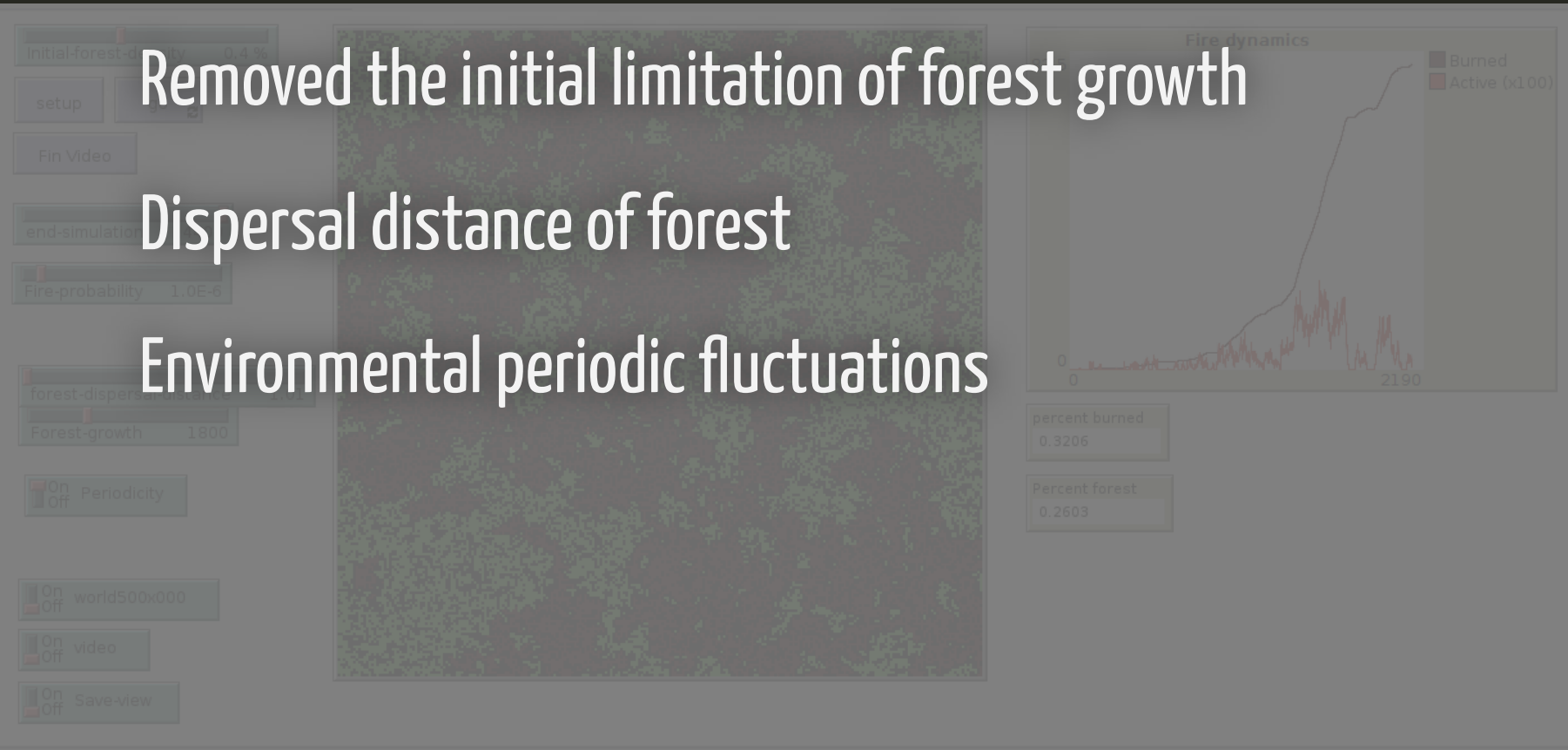


Another Forest Fire model

Removed the initial limitation of forest growth

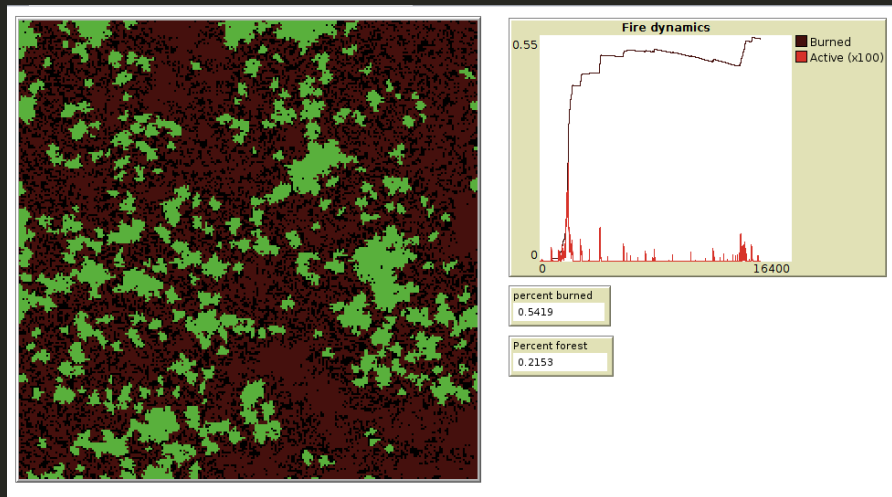
Dispersal distance of forest

Environmental periodic fluctuations



Another Forest Fire model

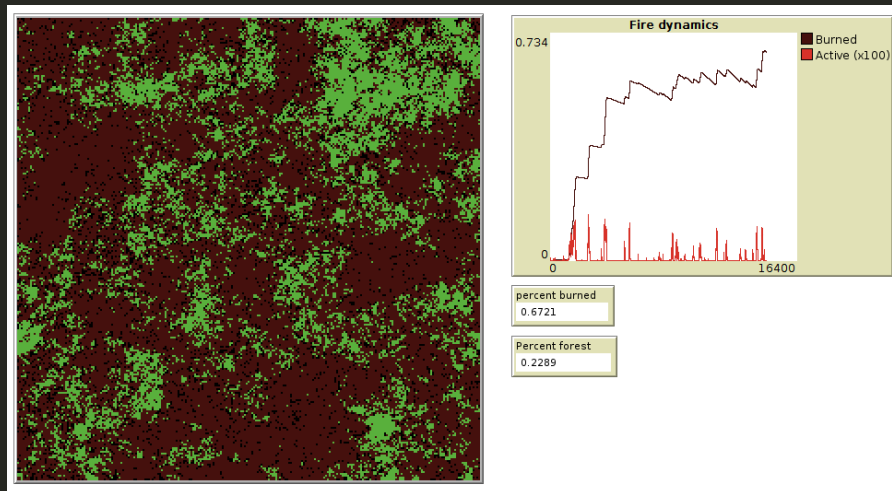
Short dispersal



- When the forest is not adapted to fire, only grows from the border of forest patches

Another Forest Fire model

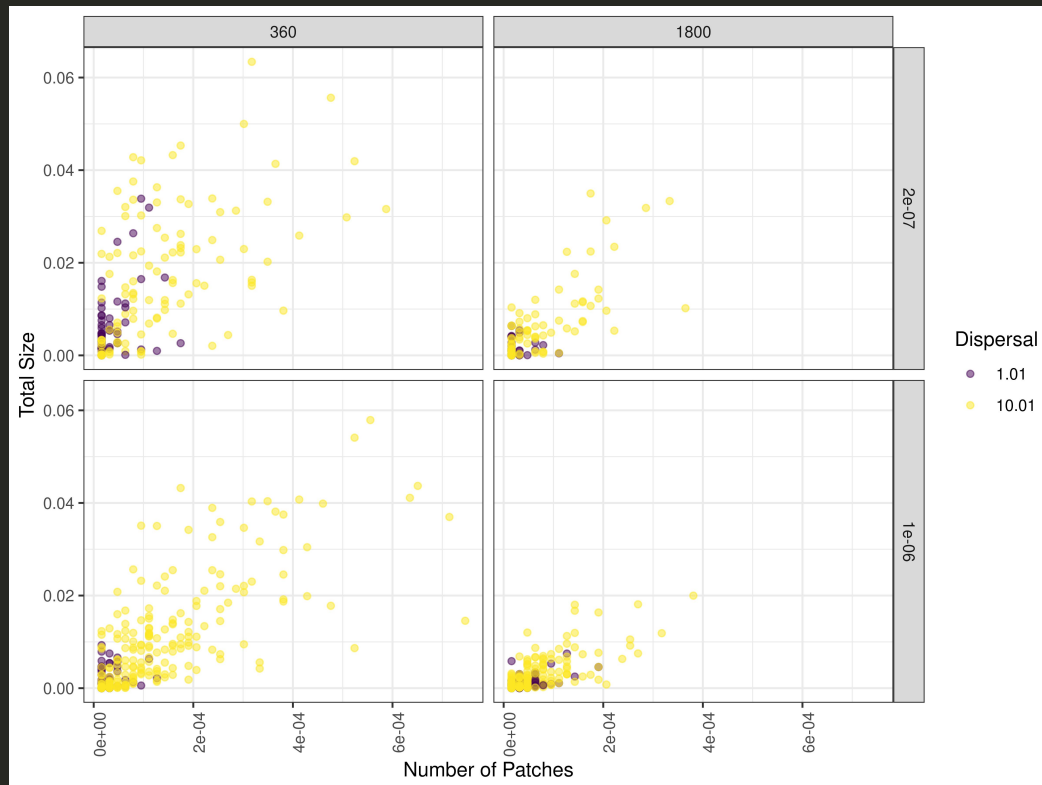
Long dispersal



- When the forest is adapted to fire, can grow inside burned areas

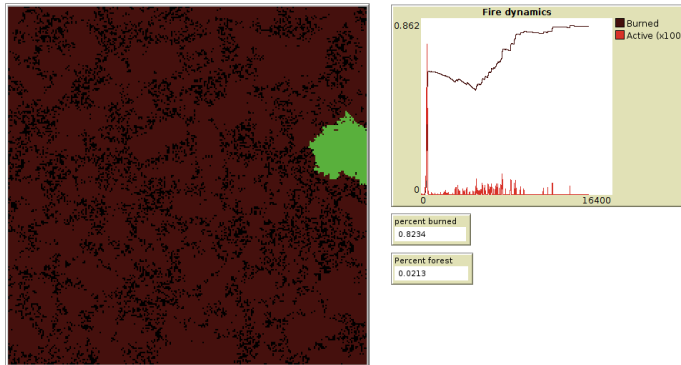
Another Forest Fire model

Dispersal - Growth time - Fire probability

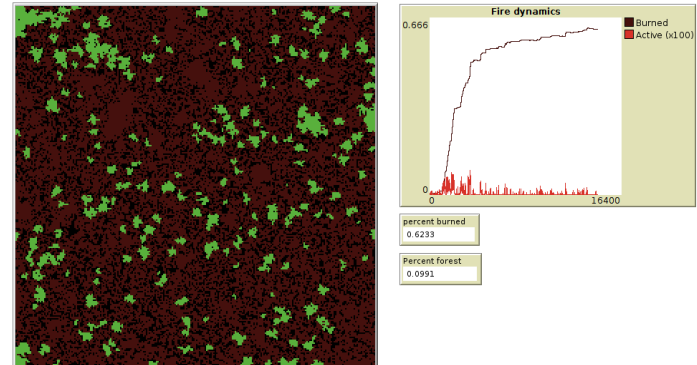


If the forest is NOT adapted to fire

A Higher growth rate is worse



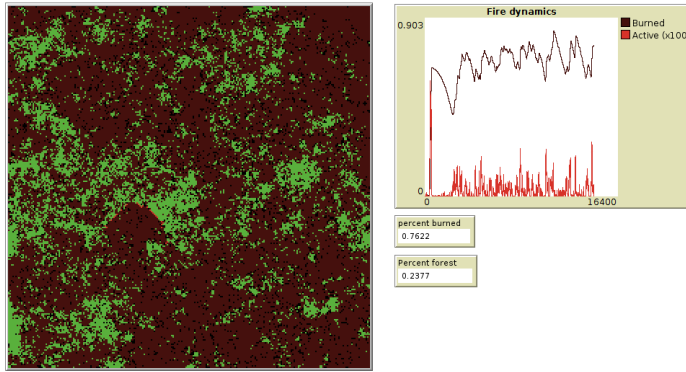
- Forest recover in 1 year



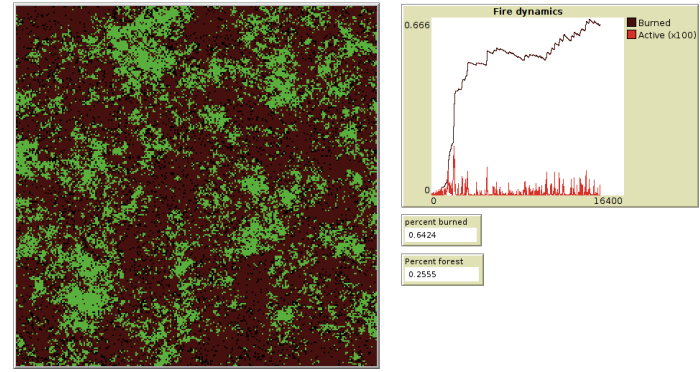
- Forest recover in 5 years

If the forest IS adapted to fire

A Higher growth cause more extreme fire events



- Forest recover in 1 year



- Forest recover in 5 years





Australia is a warning signal about future scenarios under climate change

Primarily due to an increase of fuel density due to dry conditions

More regions should be studied 

Time scales of these transitions could be 100 years

Adaptation mechanisms should be included in the model 

FIN

- You can access a simplified version of the model here

<http://netlogoweb.org/web?>

<https://raw.githubusercontent.com/lisaravia/fireNL/main/DynamicFireWeb.nlogo>

Collaborators

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Laboratory of Interdisciplinary Physics - University of Padua

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