# Biodiversity Exposure FOREcasts (BEFORE): Anticipating Ecological Vulnerability to Global Change

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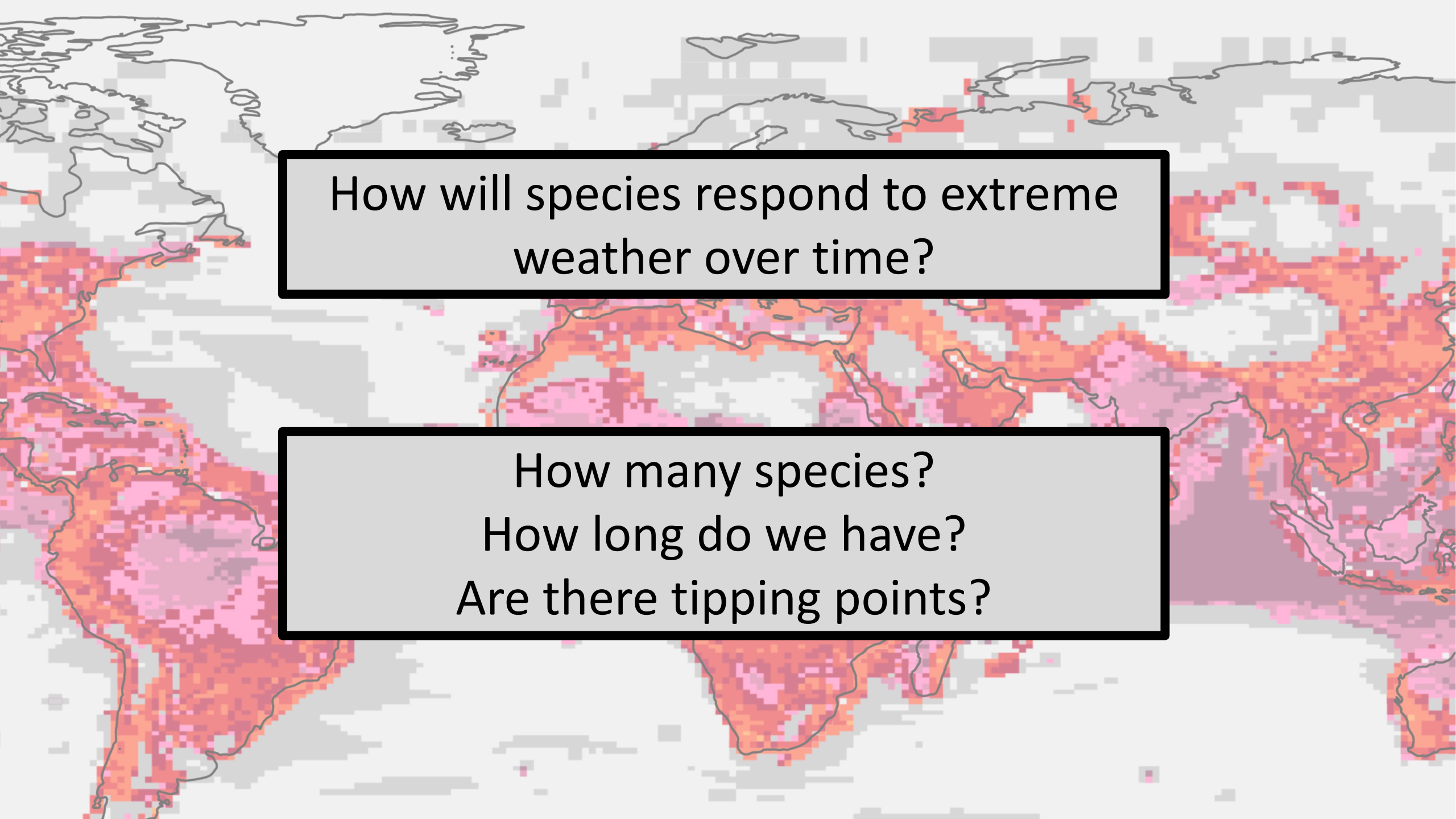
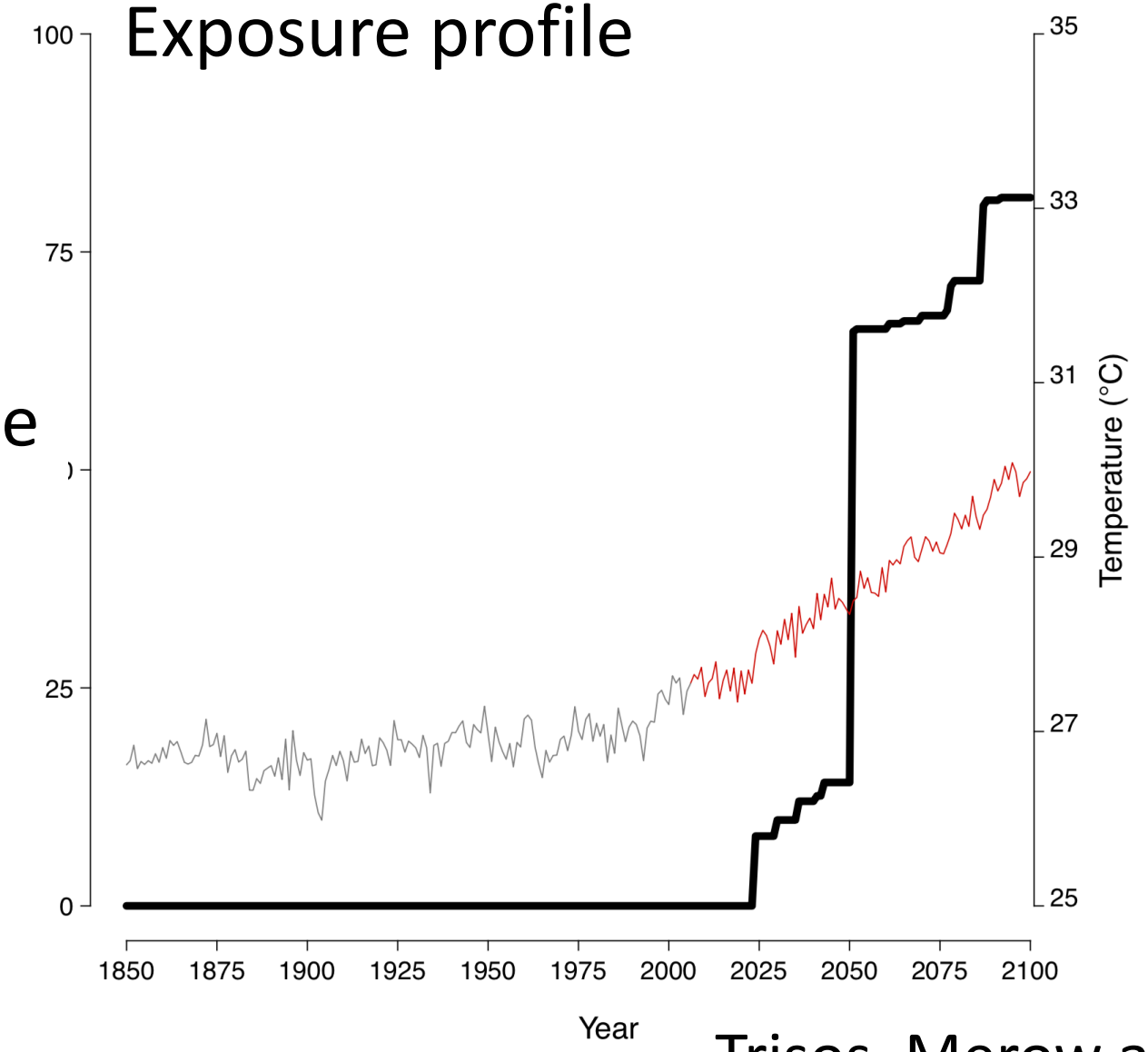

How will species respond to extreme weather over time?
How many species?
How long do we have?
Are there tipping points?

# Exposure profile

% of species in assemblage exposed



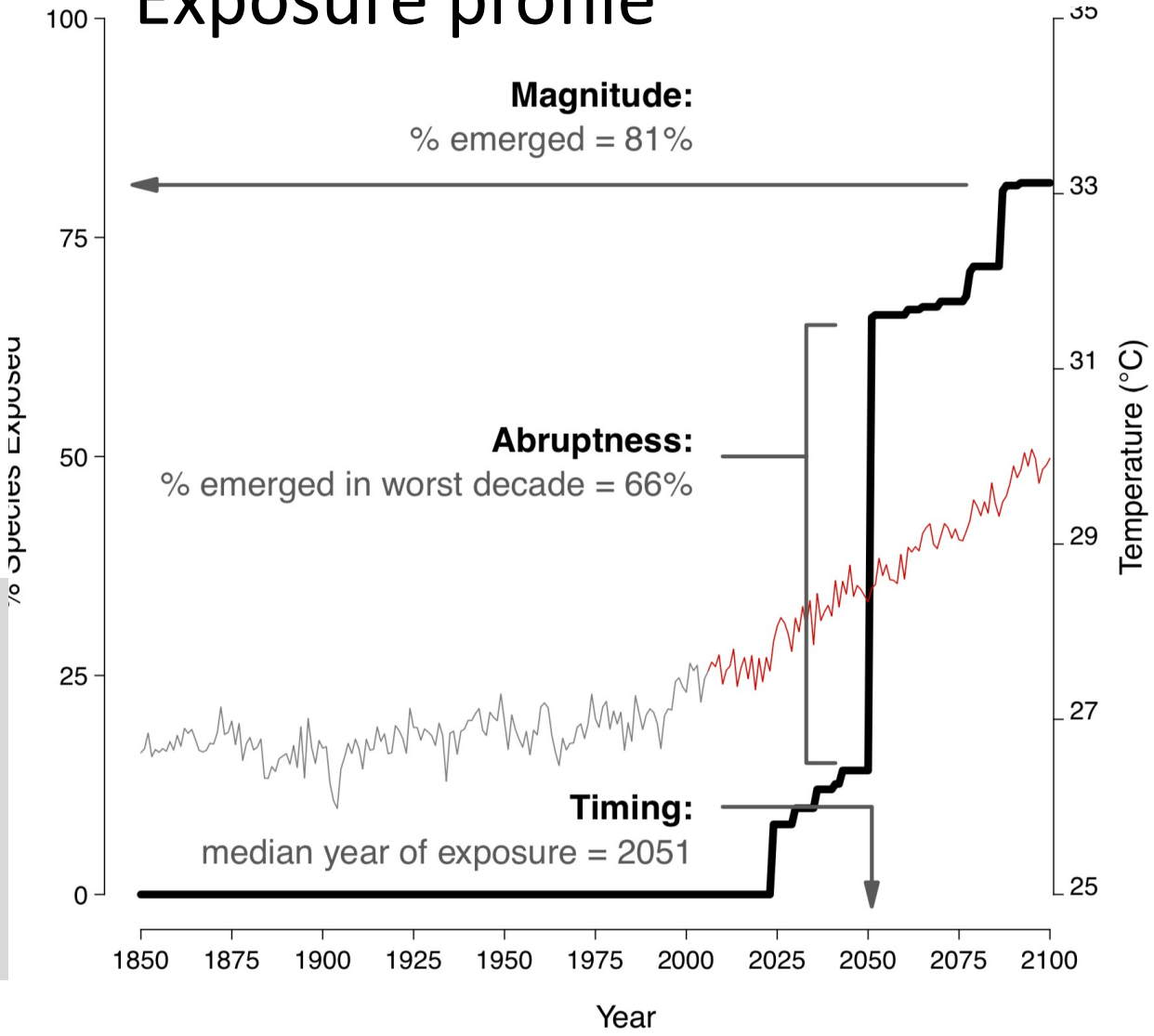

Trisos, Merow and Pigot, *Nature, 2020*

# Exposure profile

% of species in assemblage exposed

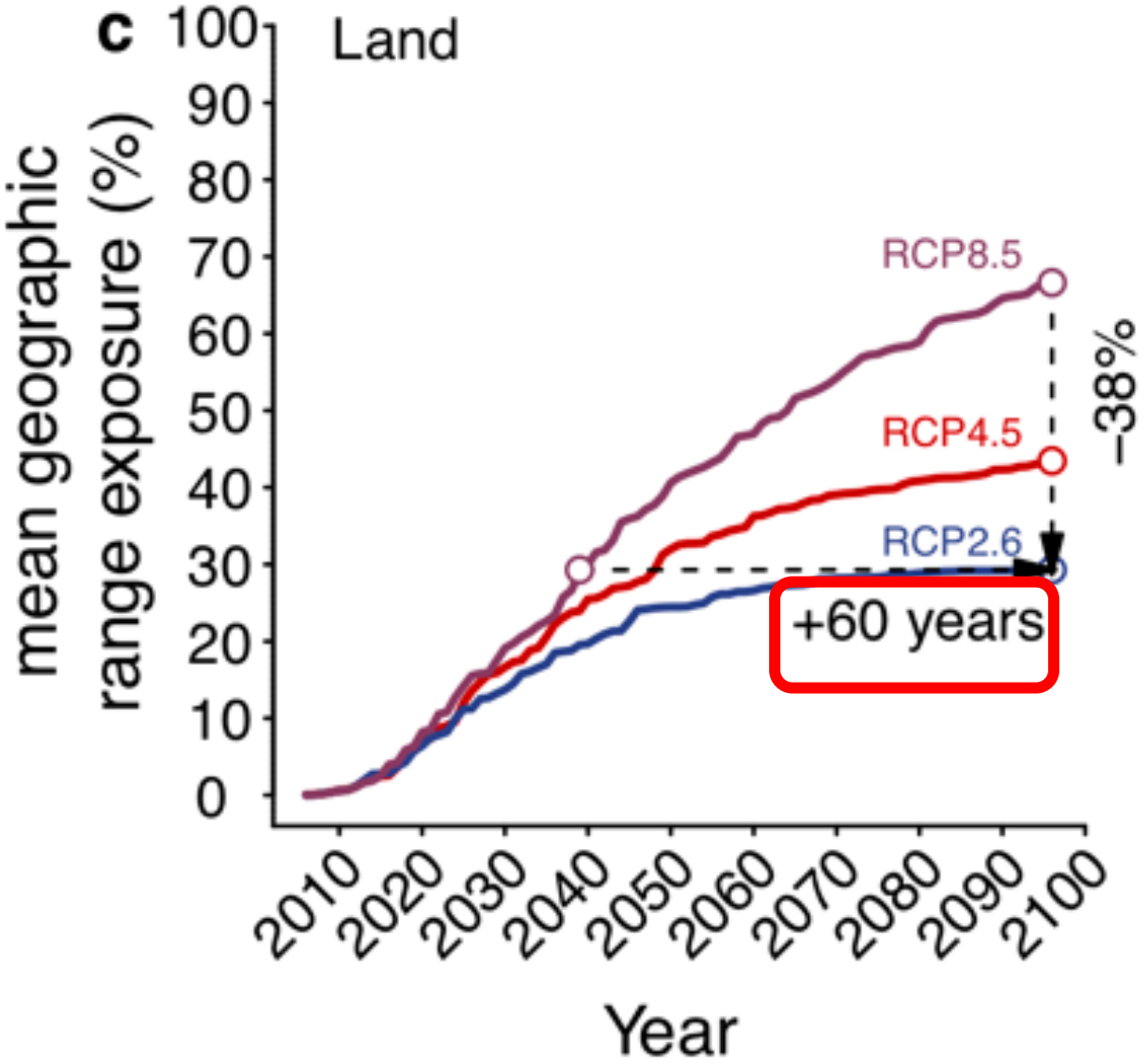
OR

% of a single species range exposed

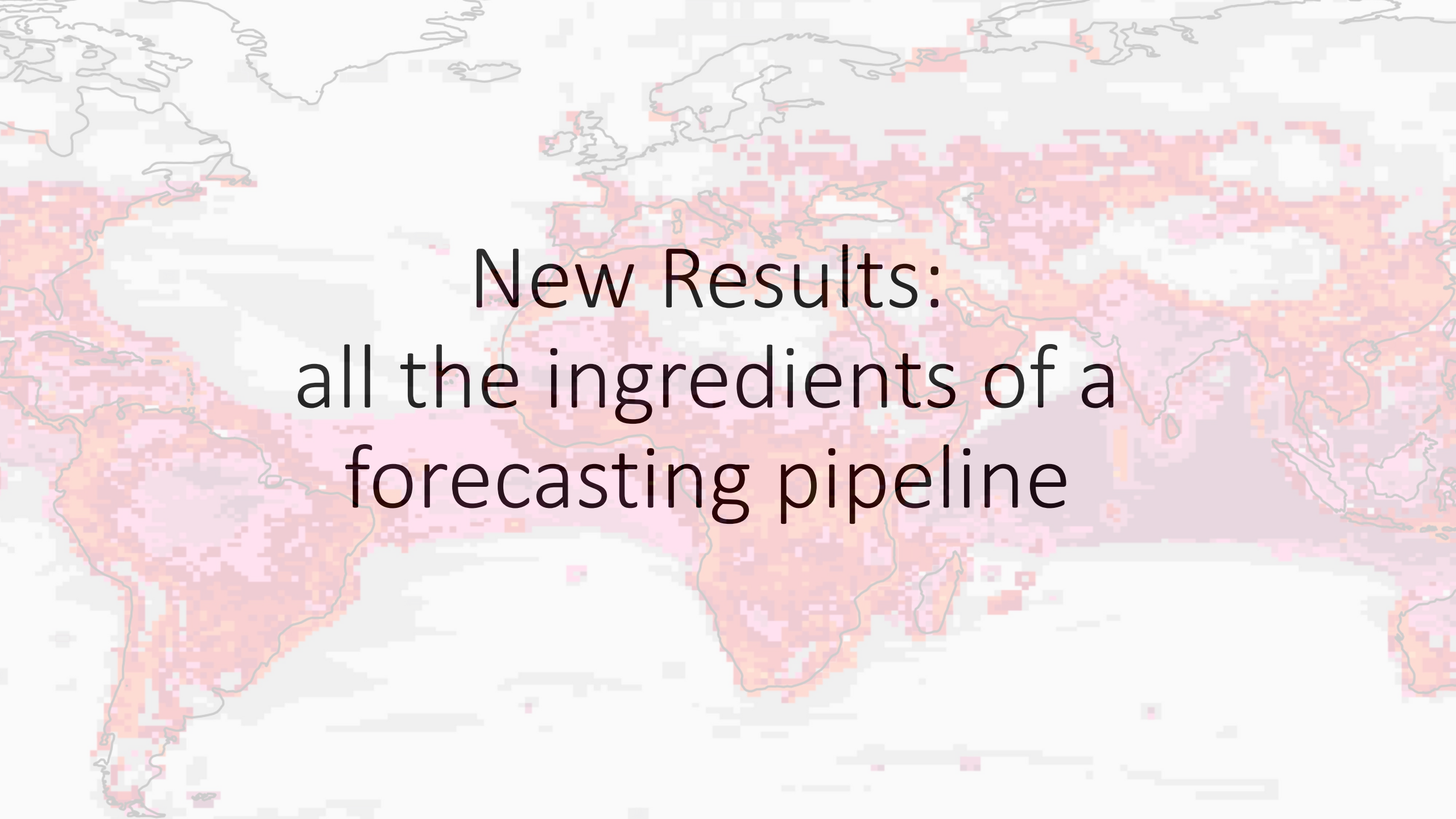



Trisos, Merow and Pigot, *Nature, 2020*

# Background: How long do we have?




Trisos, Merow and Pigot, *Nature, 2020*



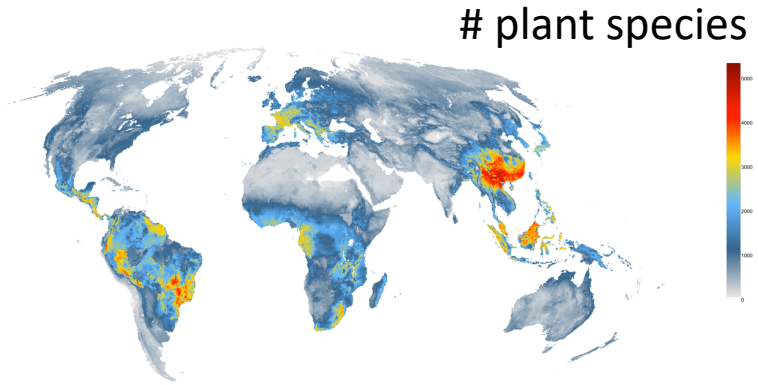
# New Results: all the ingredients of a forecasting pipeline

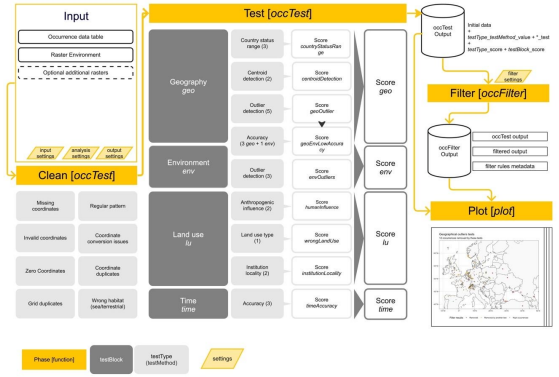
# Inputs

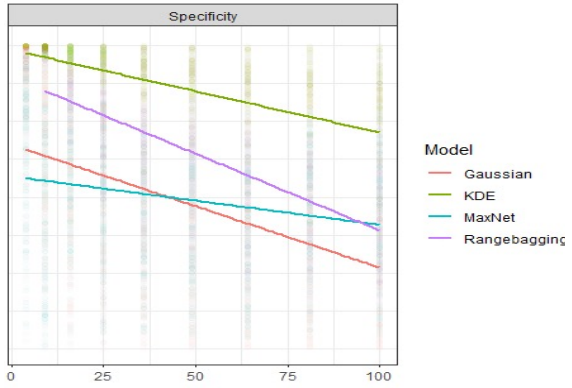
1. Data:
   Global Plant Species Richness
   (~300k species)

2. Data Cleaning:
   R package occTest

3. New Modeling Algorithms:
   R Package pbsdm



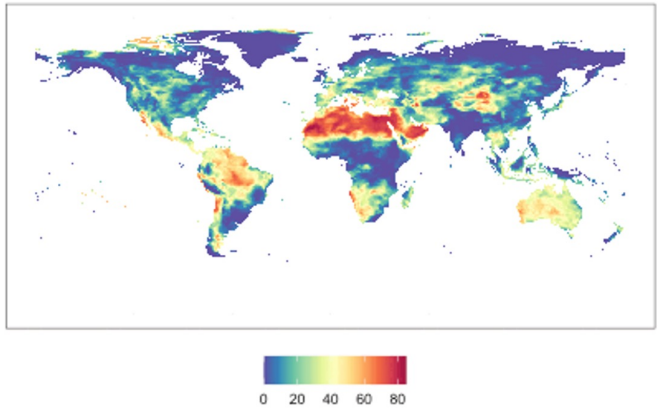

Pep Serra-Diaz

Brian Maitner

# Inputs

4. New Environmental Layers: Droughts
   Severity, Intensity, Duration, Frequency

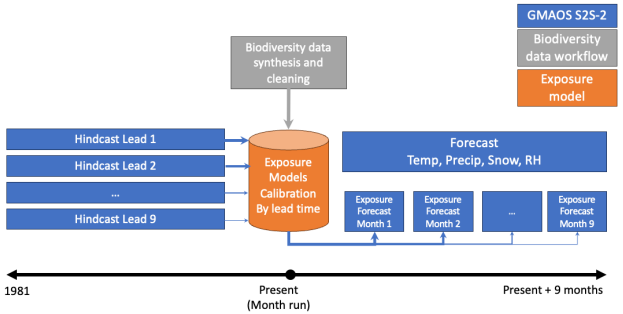
# Extreme Doughts through 2100




Pep Serra-Diaz

Thymios Nikolopoulous
Diogo Araujo

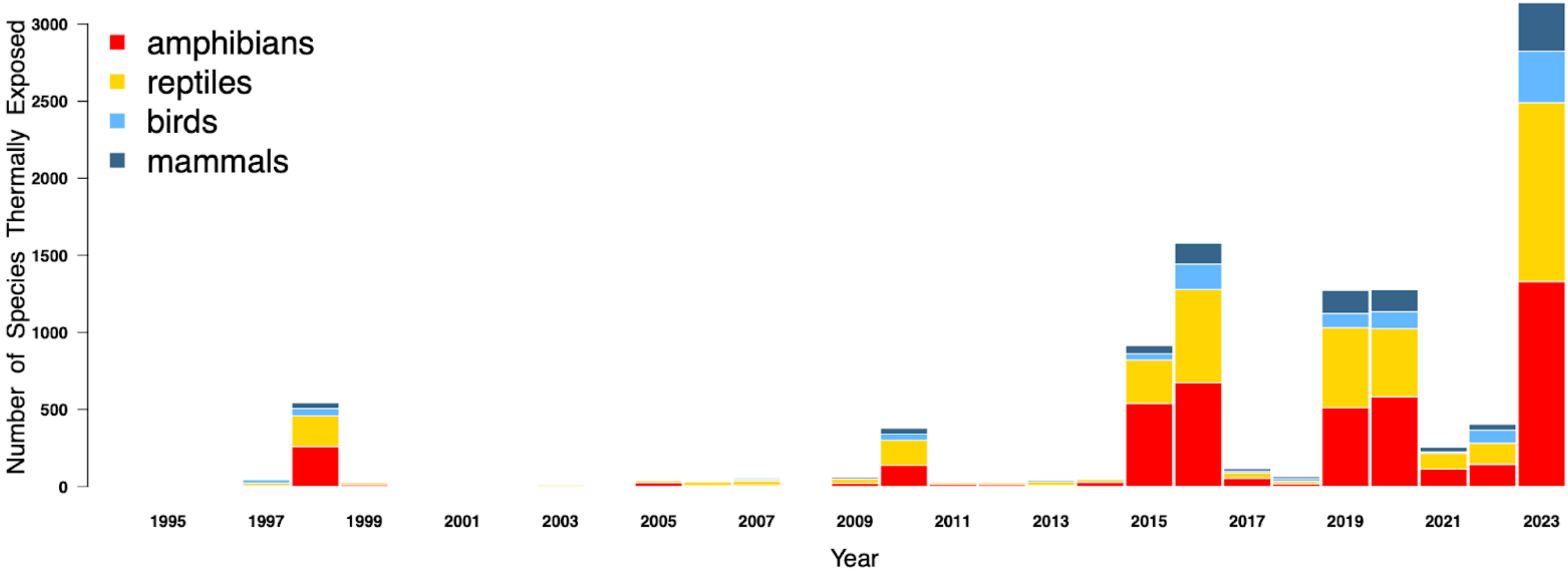
5. New Environmental Layers: S2S
Seasonal to subseasonal
(9 Month) forecasts




Pep Serra-Diaz

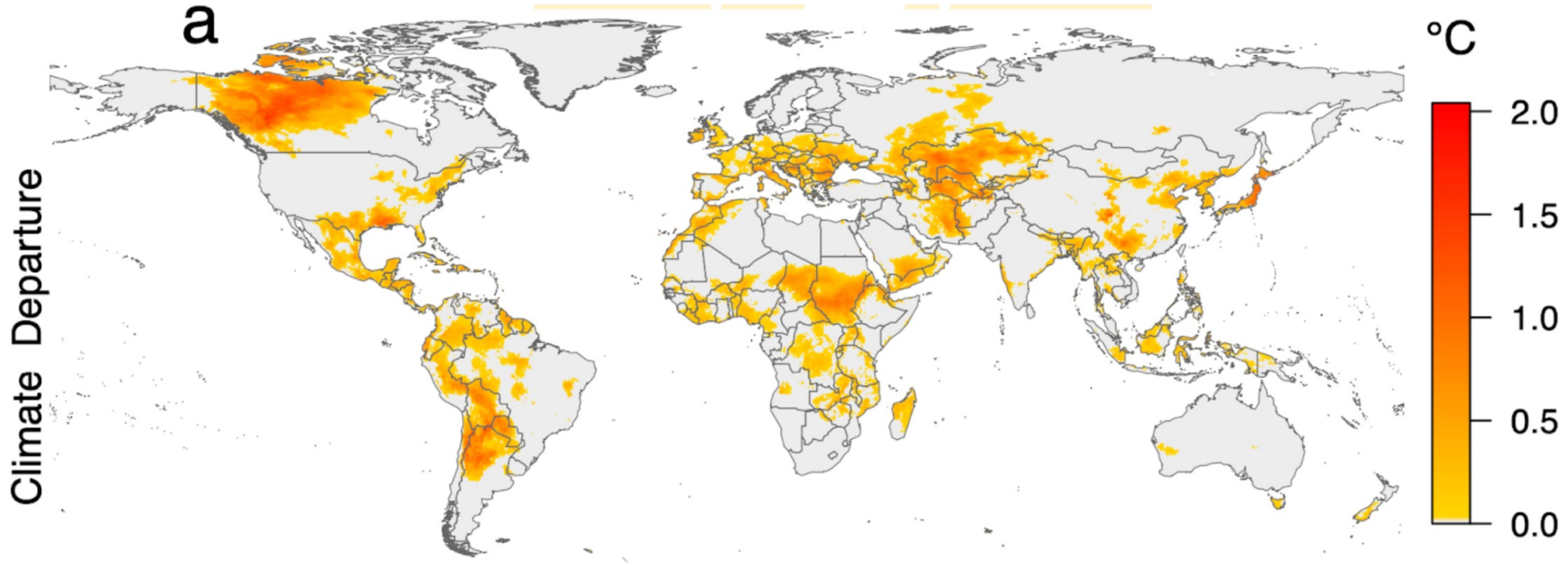
Lauren Andrews
NASA GMAO S2S

# Results: 2023 Exposure



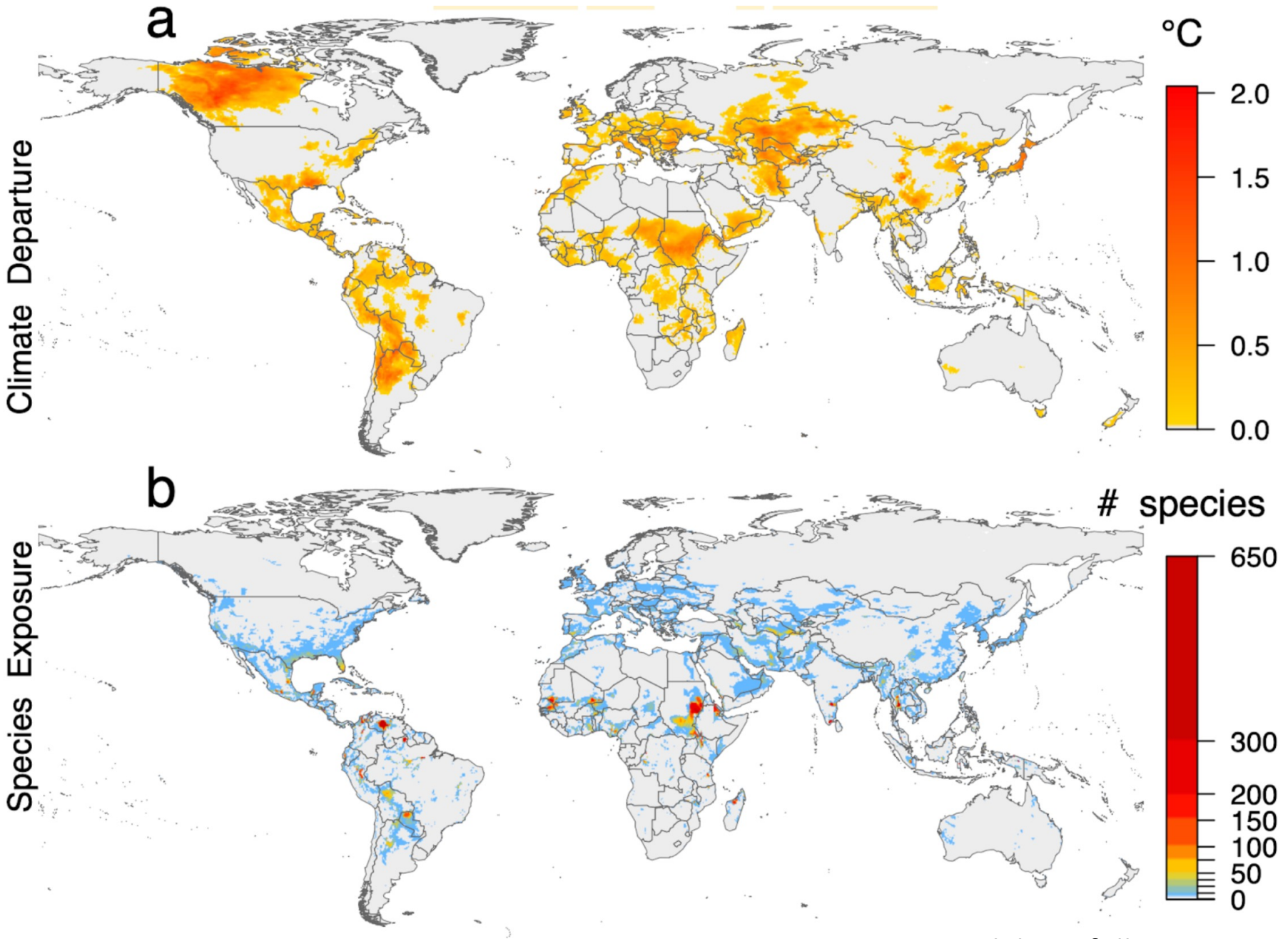

Merow et al, hopefully very soon

# Results: 2023 Exposure



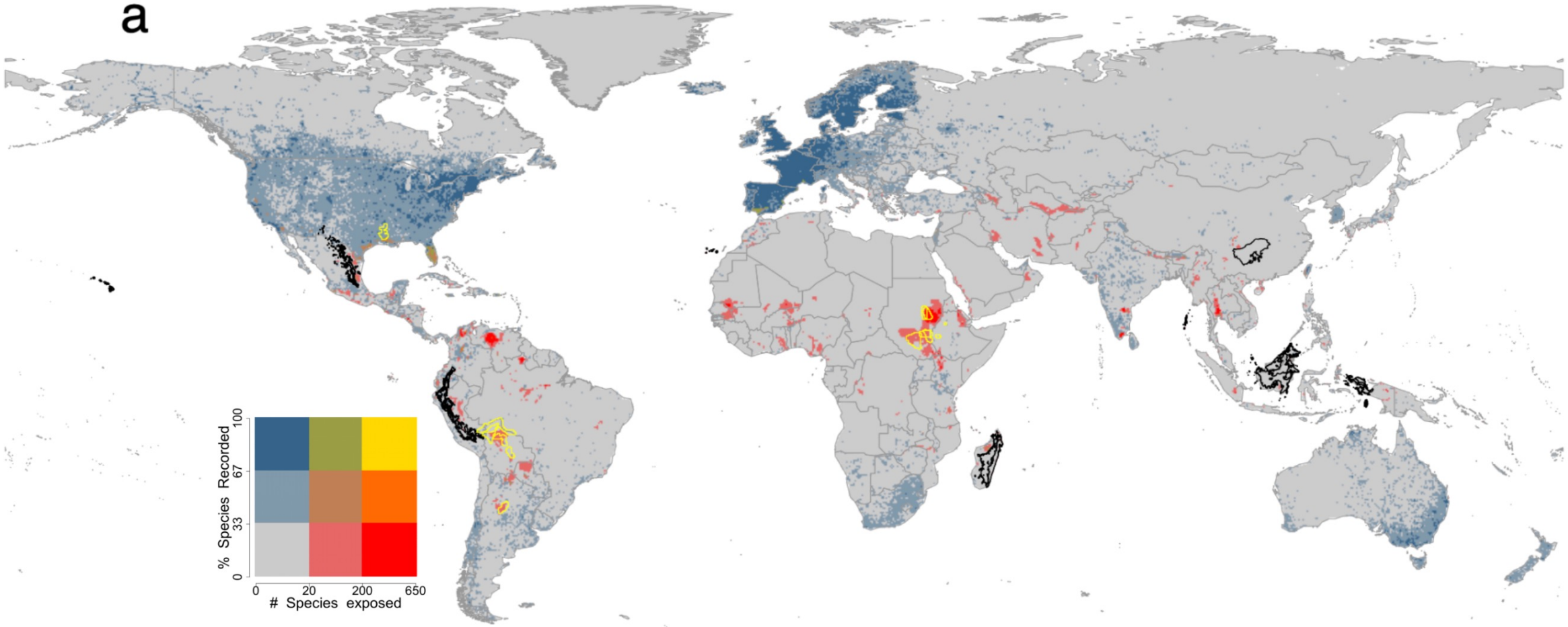

Merow et al, hopefully very soon

# Results: 2023 Exposure



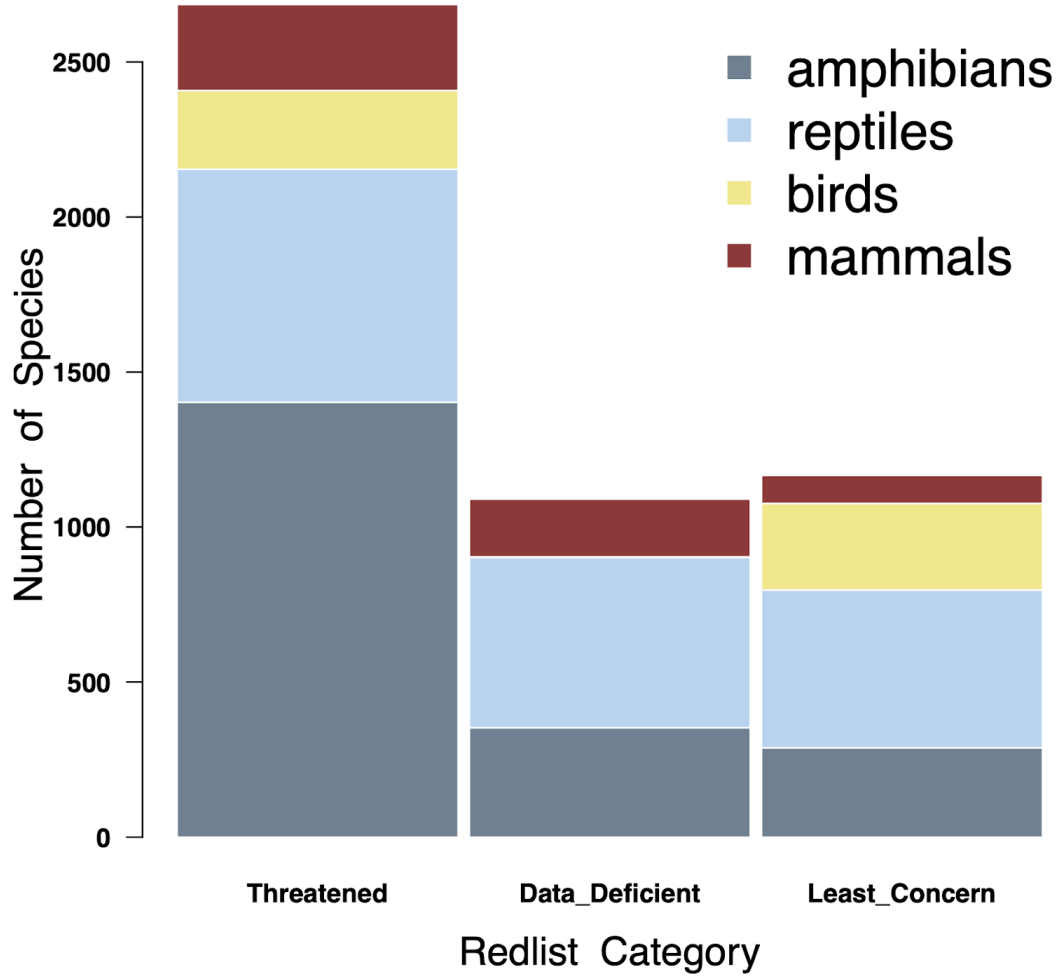

Merow et al, hopefully very soon

# Results: 2023 Exposure x “Monitoring




Merow et al, hopefully very soon

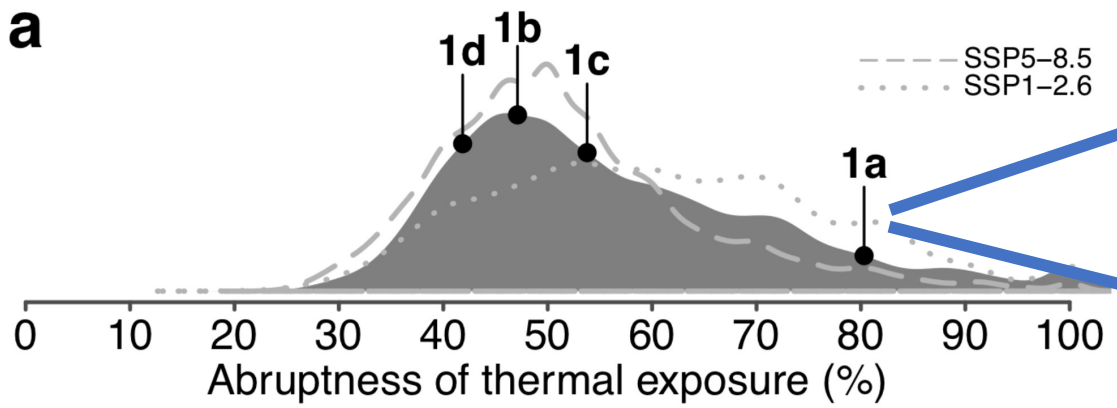
# Results: 2023 Exposure

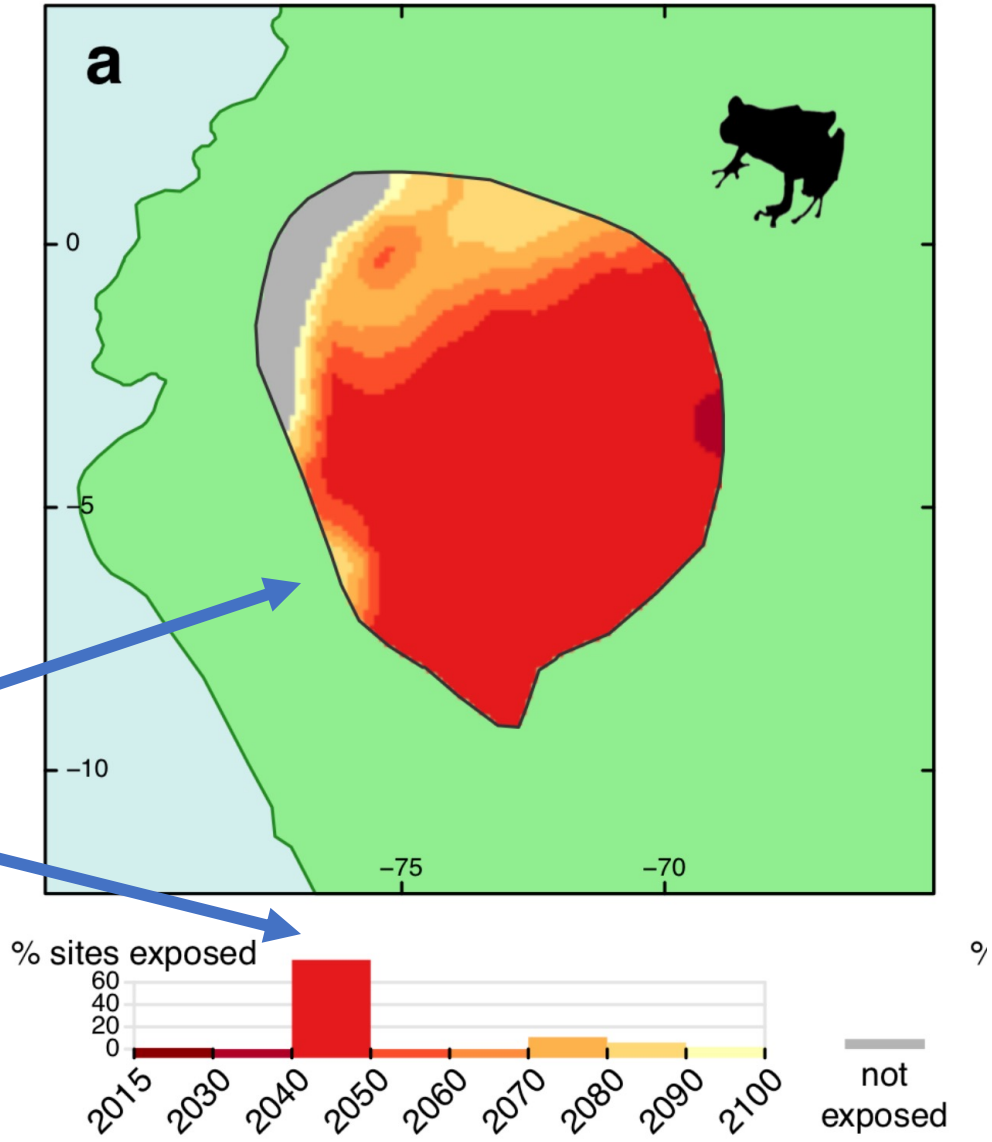



Merow et al, hopefully very soon

# Results: **Timing** of exposure across species ranges

Distribution of abruptness across 30,000 species assessed by IUCN

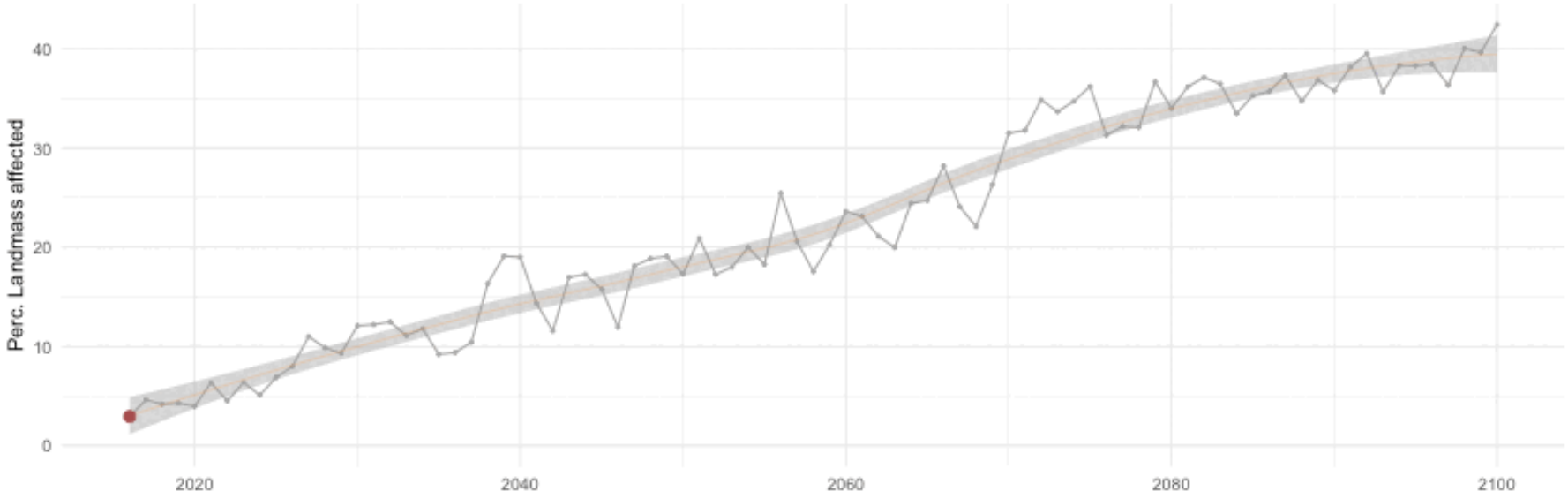



Pigot, Merow, Wilson, Trisos, NEE, 2023

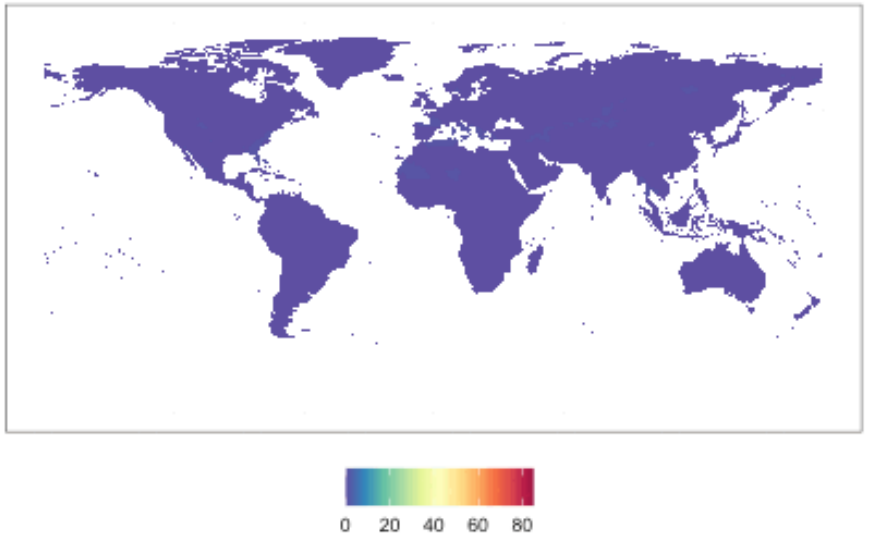
# Results: Plant Drought Exposure

Pep Serra-Diaz



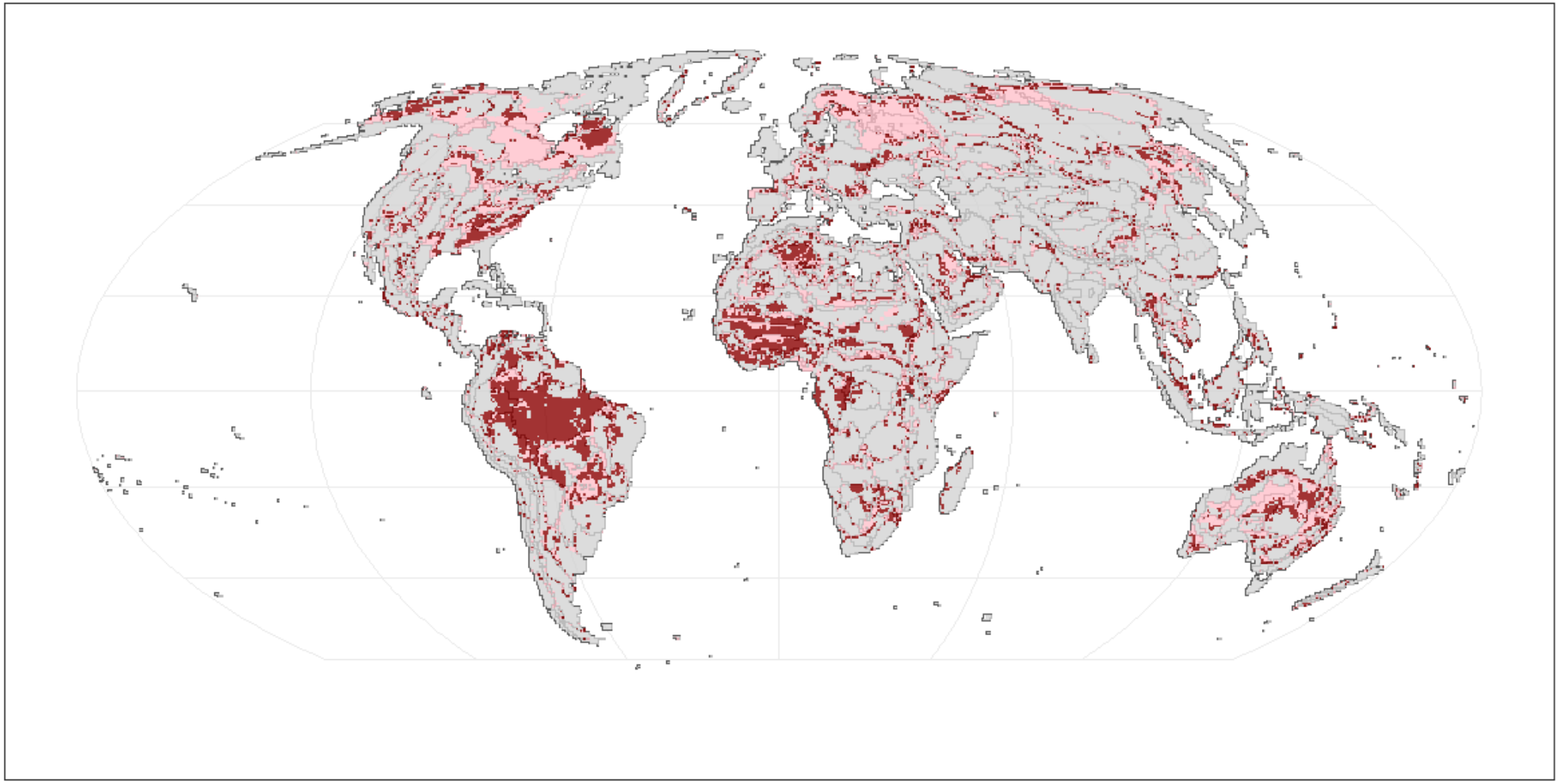

Drought severity

Cummulative departure events




BIEN

# Results: Ecoregion shifts



Brian Maitner

# Results:The global plant threat assessment

Evaluating future increases to extinction risk under multiple threats

Drought

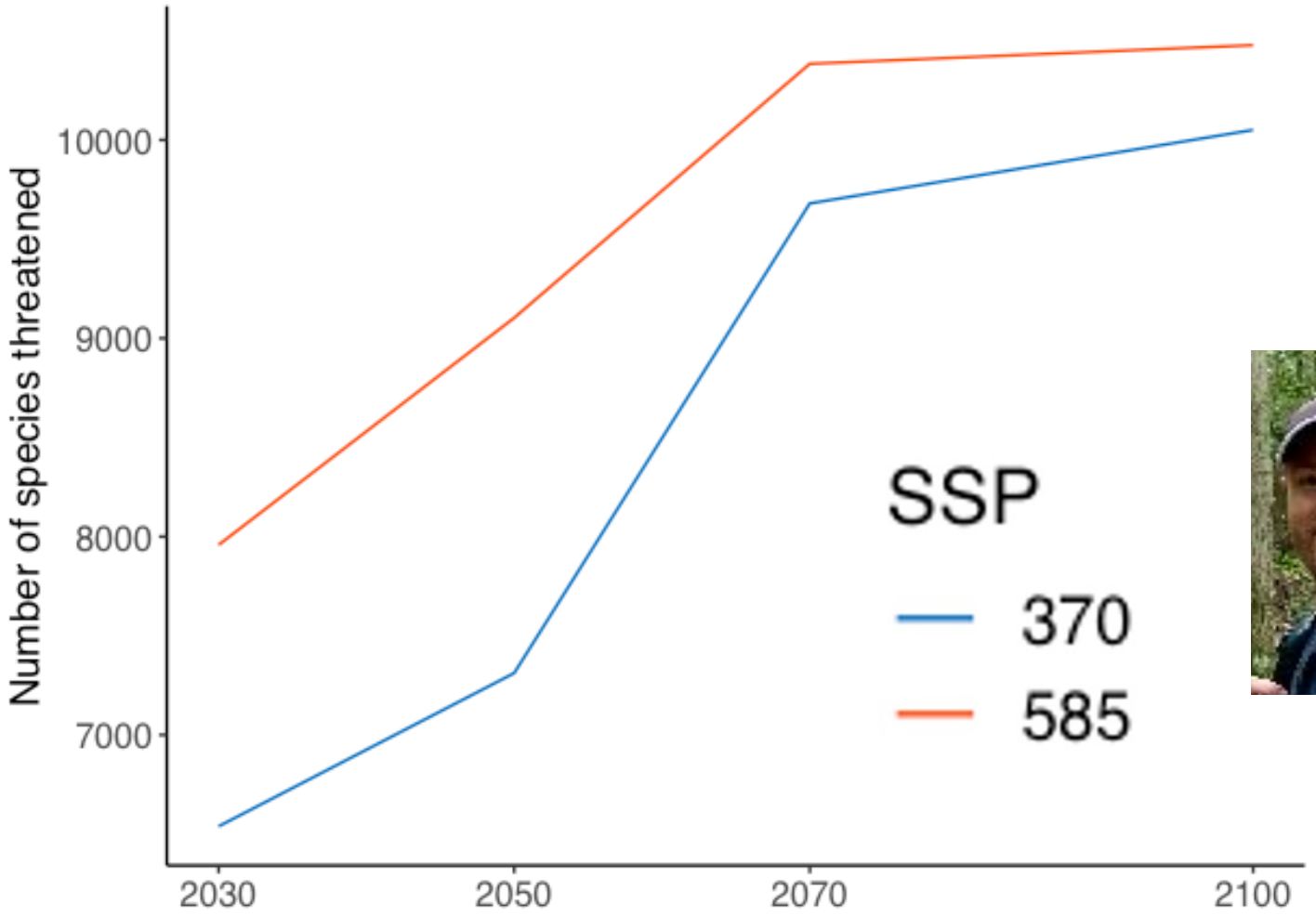
Fire

Deforestation

Climate change

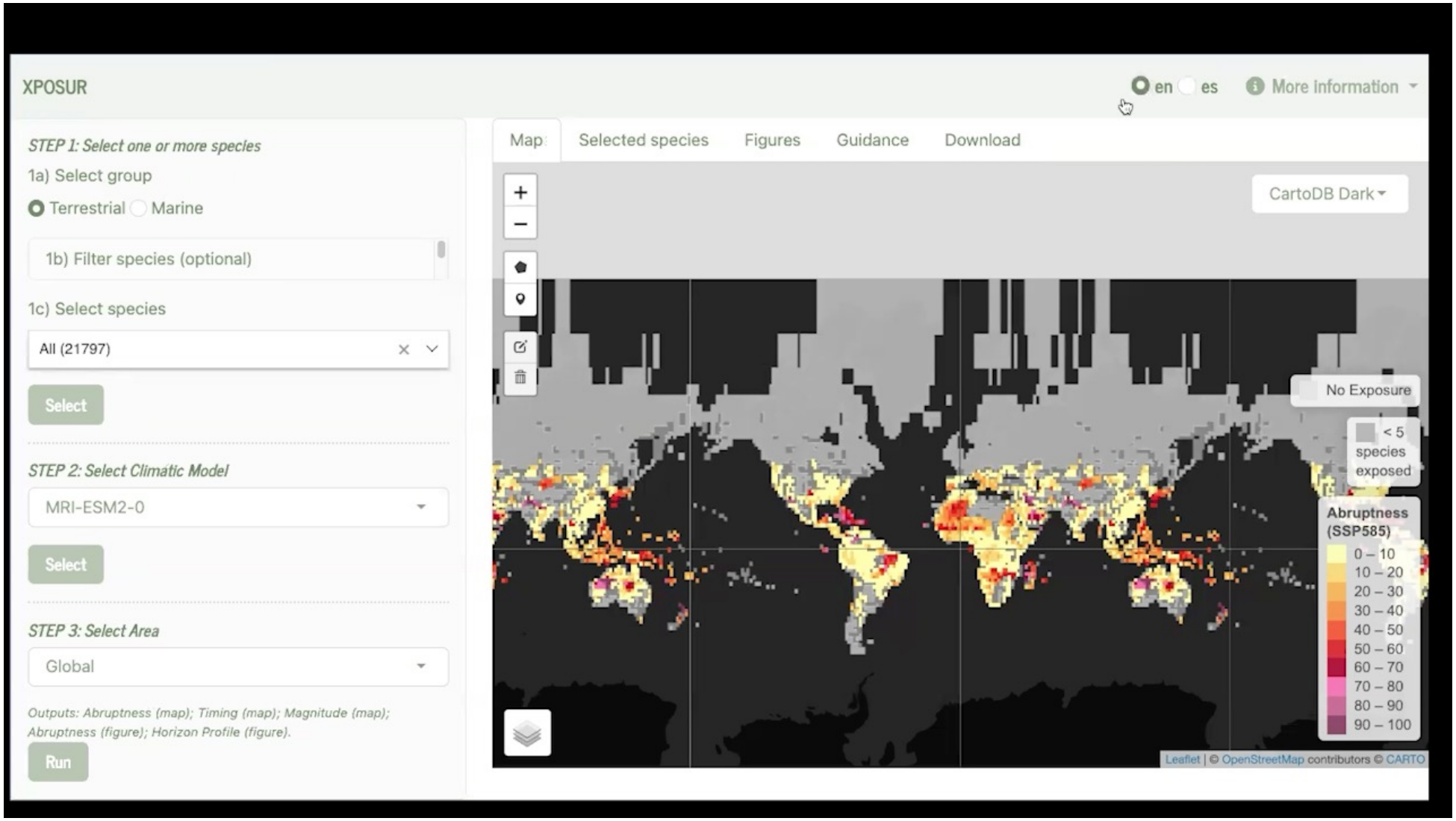
Urban expansion

Agricultural expansion




Ben Carlson

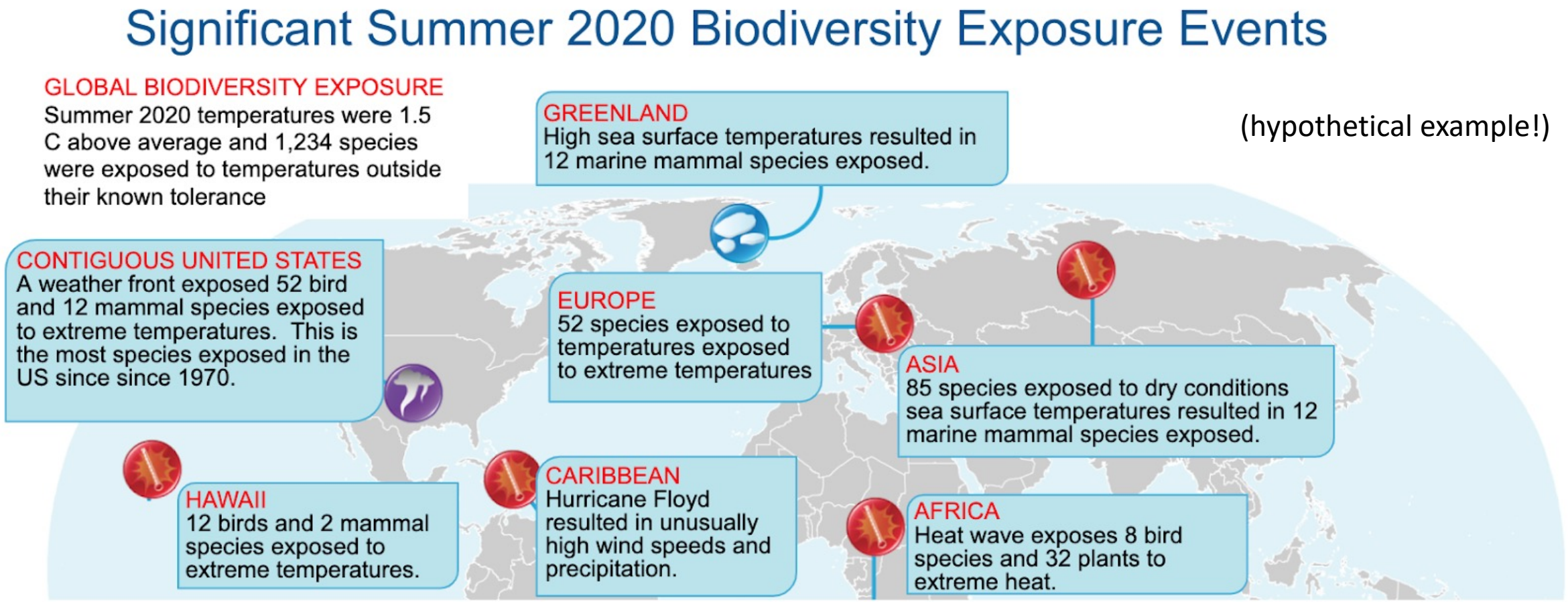
# Results: Web App Serving Data Products




R package: fastRanger

Gonzalo Pinilla-Buitrago

# Soon: Monitoring Exposure Events

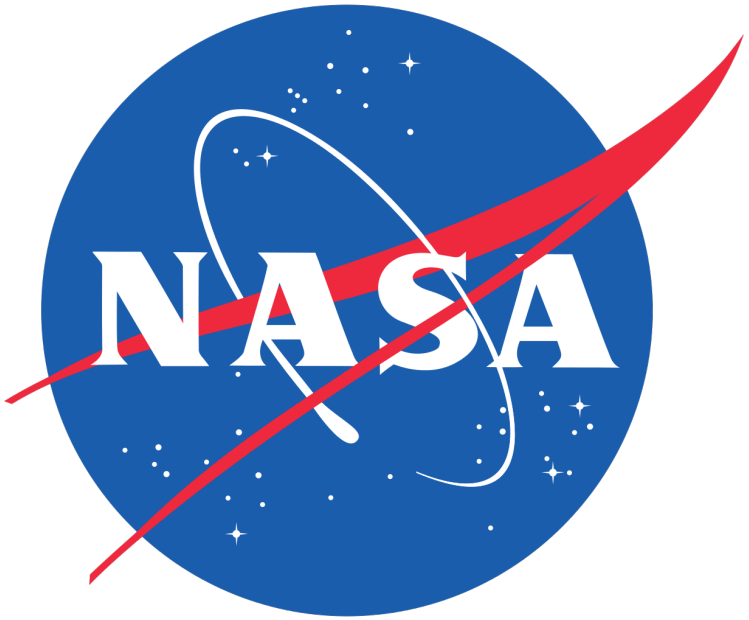



(hypothetical example!)

# Thanks!

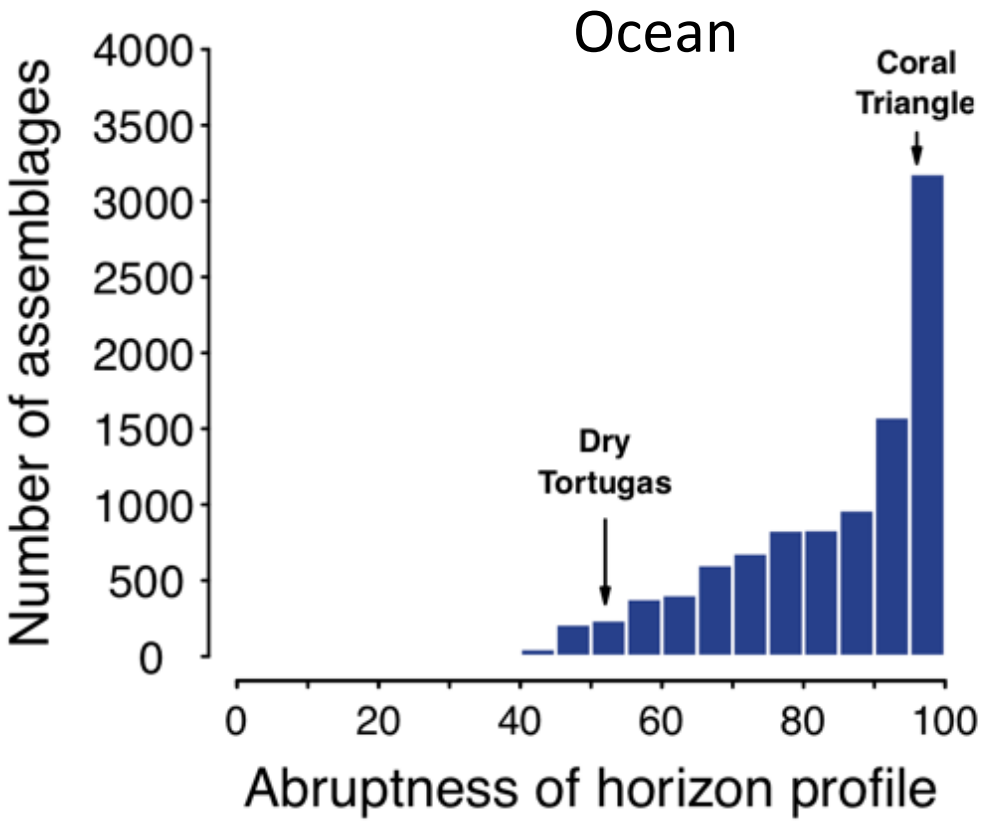
**Pep Serra-Diaz**
**Gonzalo Pinilla-Buitrago**
**Ben Carlson**
**Brian Maitner**
**Mark Urban**
**Brian Enquist**
**Brad Boyle**
**Xiao Feng**
**Patrick Roerdantz**
**The BIEN Working Group**
**Manos Anagnostou**
**Thymios Niklolopolous**
**Diogo Araujo**
**Adam Wilson**
**Chris Trisos**
**Alex Pigot**

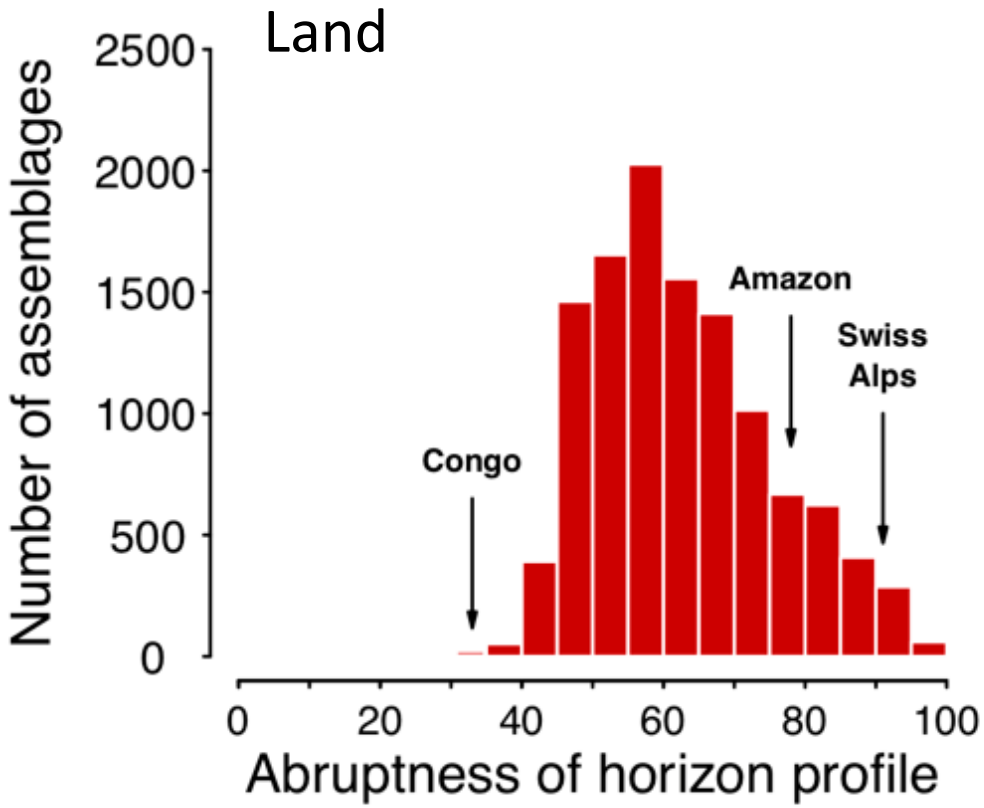
**Questions?**



# BONUS SLIDES

# Background: Abruptness is the rule!



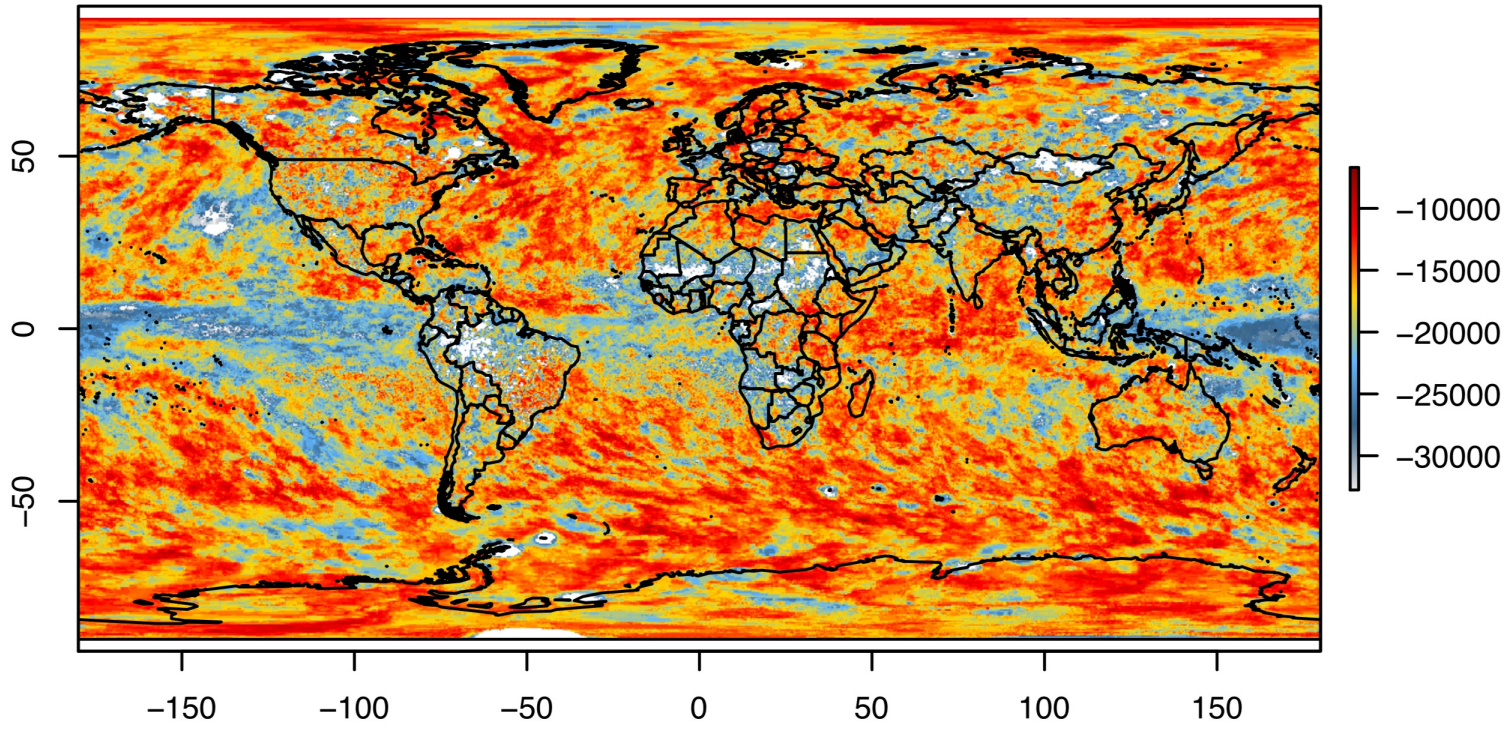

Trisos, Merow and Pigot, *Nature, 2020*

# New Environmental Layers

## Global drought intensity, frequency, duration and severity

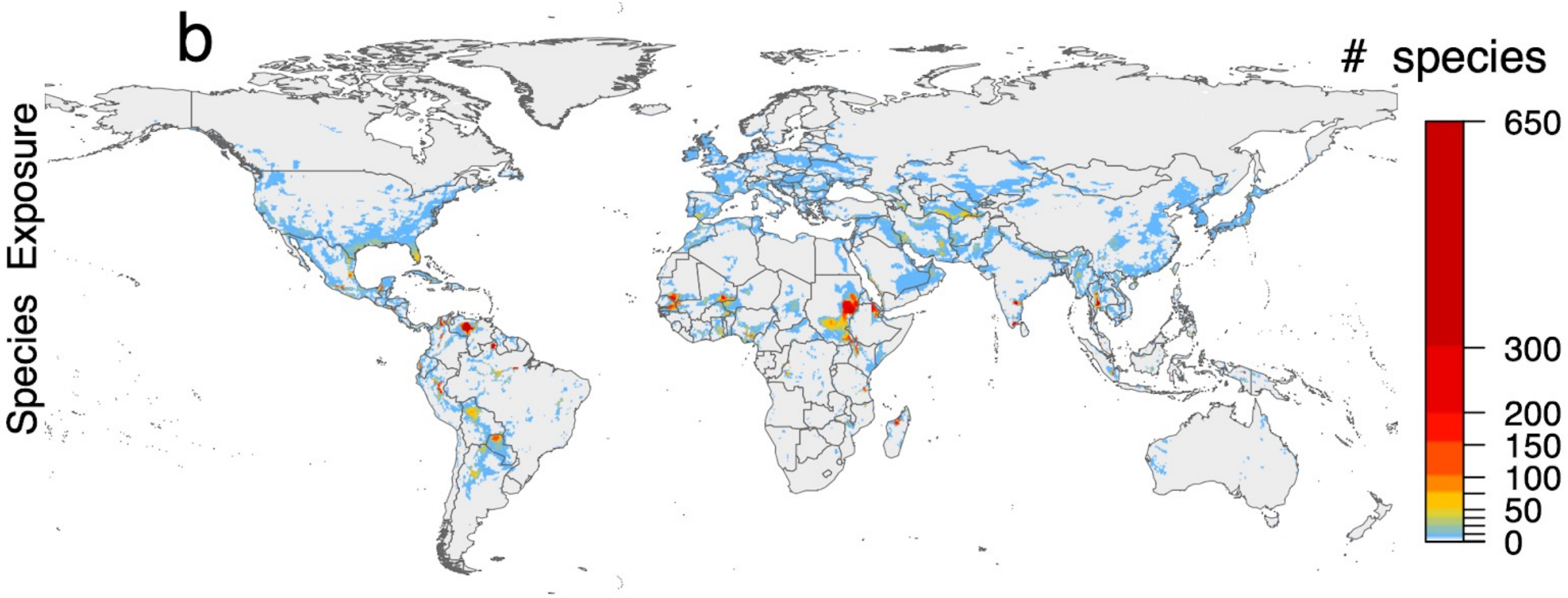
(NASA NEXGDDP CMIP6)

Average 12 Month Severity 1979-2016




Nikolopoulos, Araujo, and Merow, *In Prep*

# Results: 2023 Exposure



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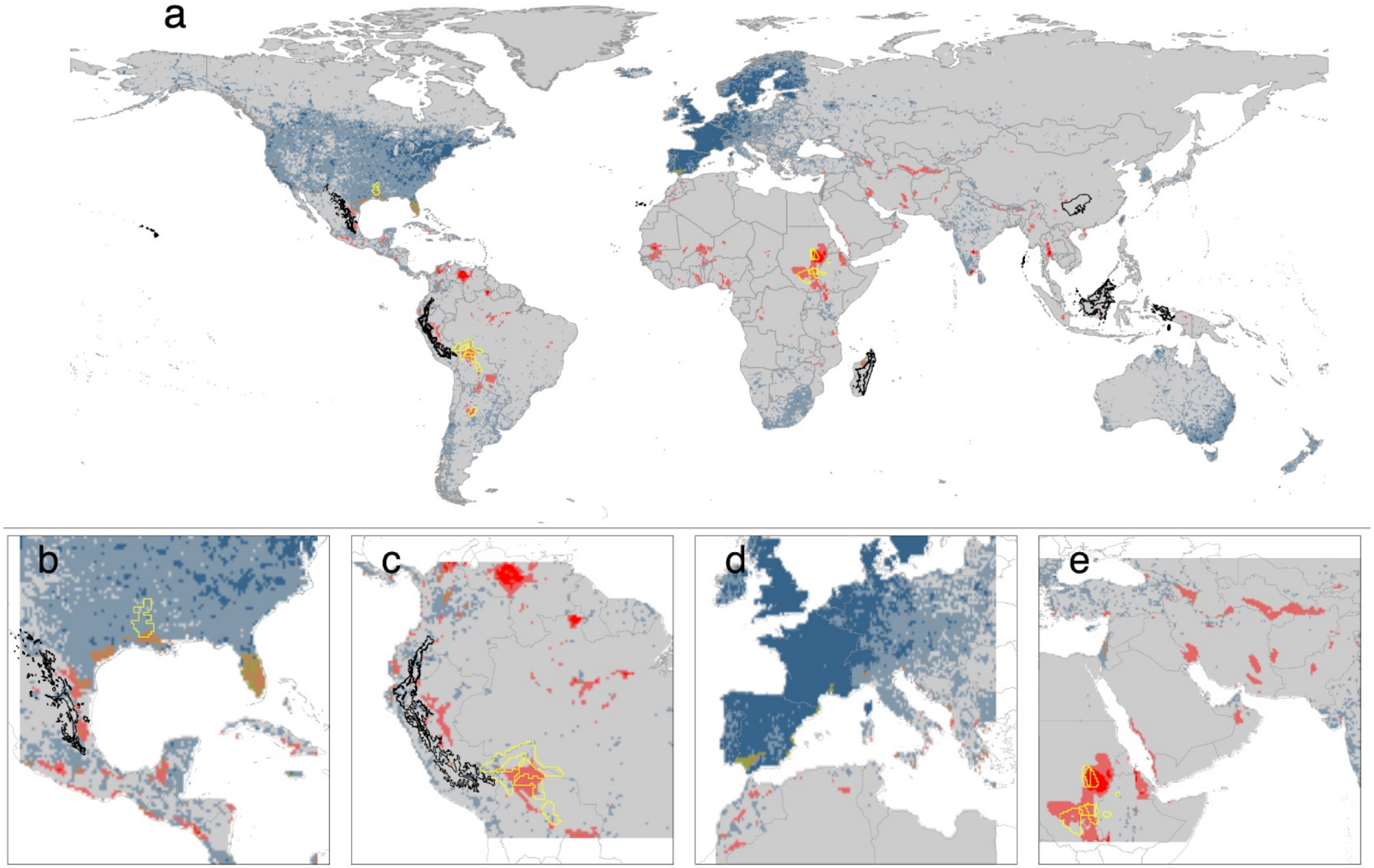
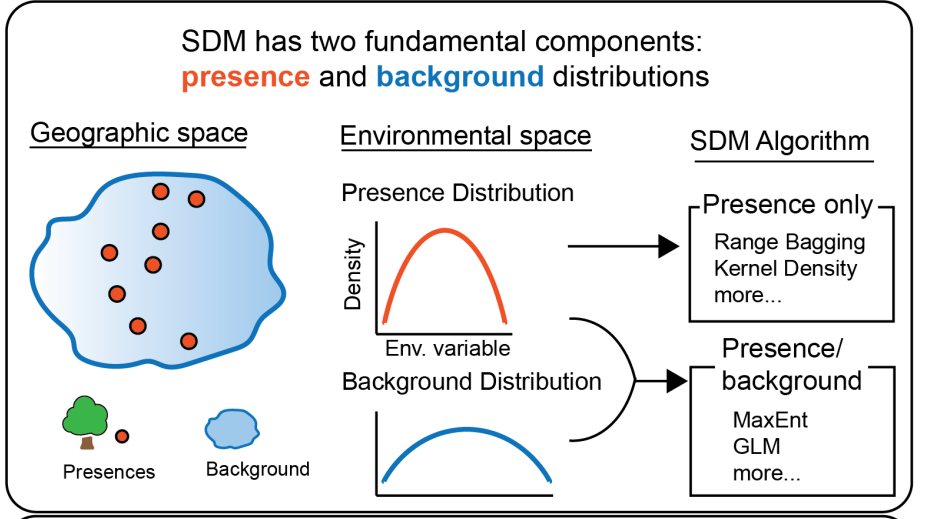
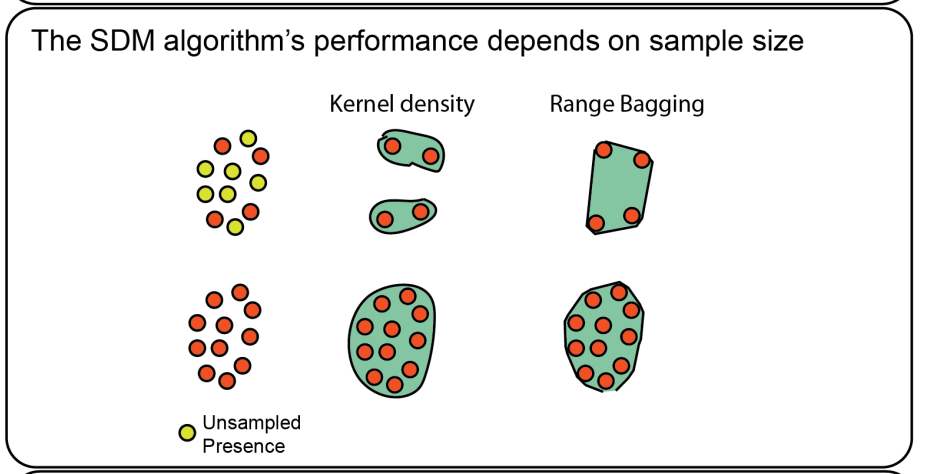
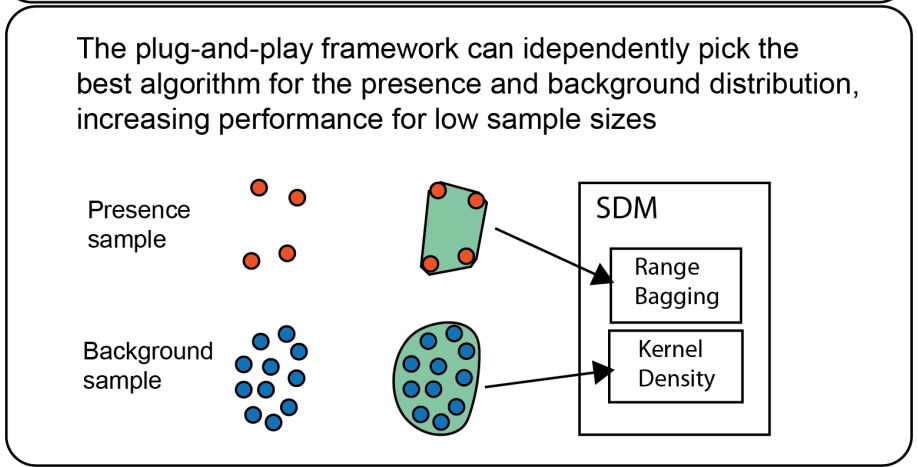


# Results:
# New Modeling Algorithms

## Brian Maitner(s)



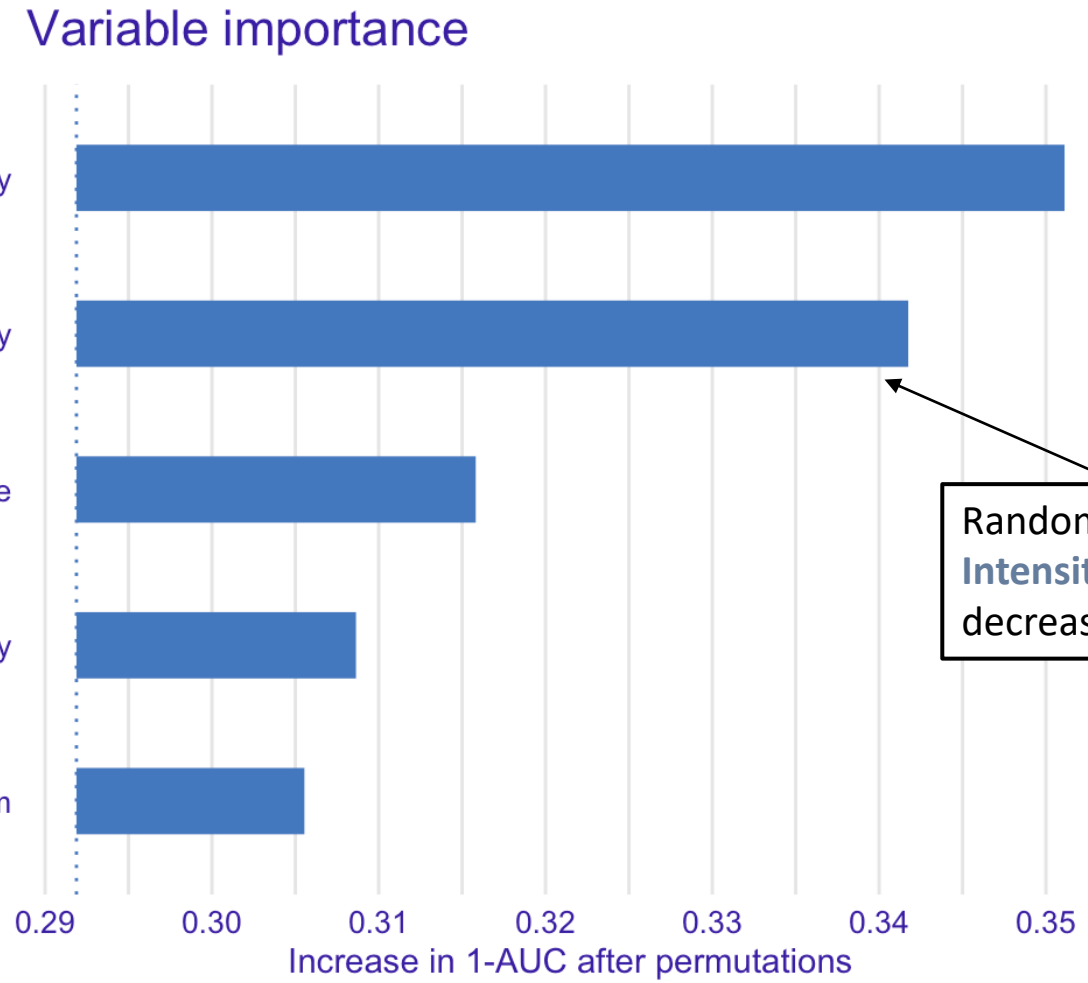
# The global plant threat assessment

Drought threat

Drought exposure max intensity

Drought exposure rate

Drought exposure mean intensity

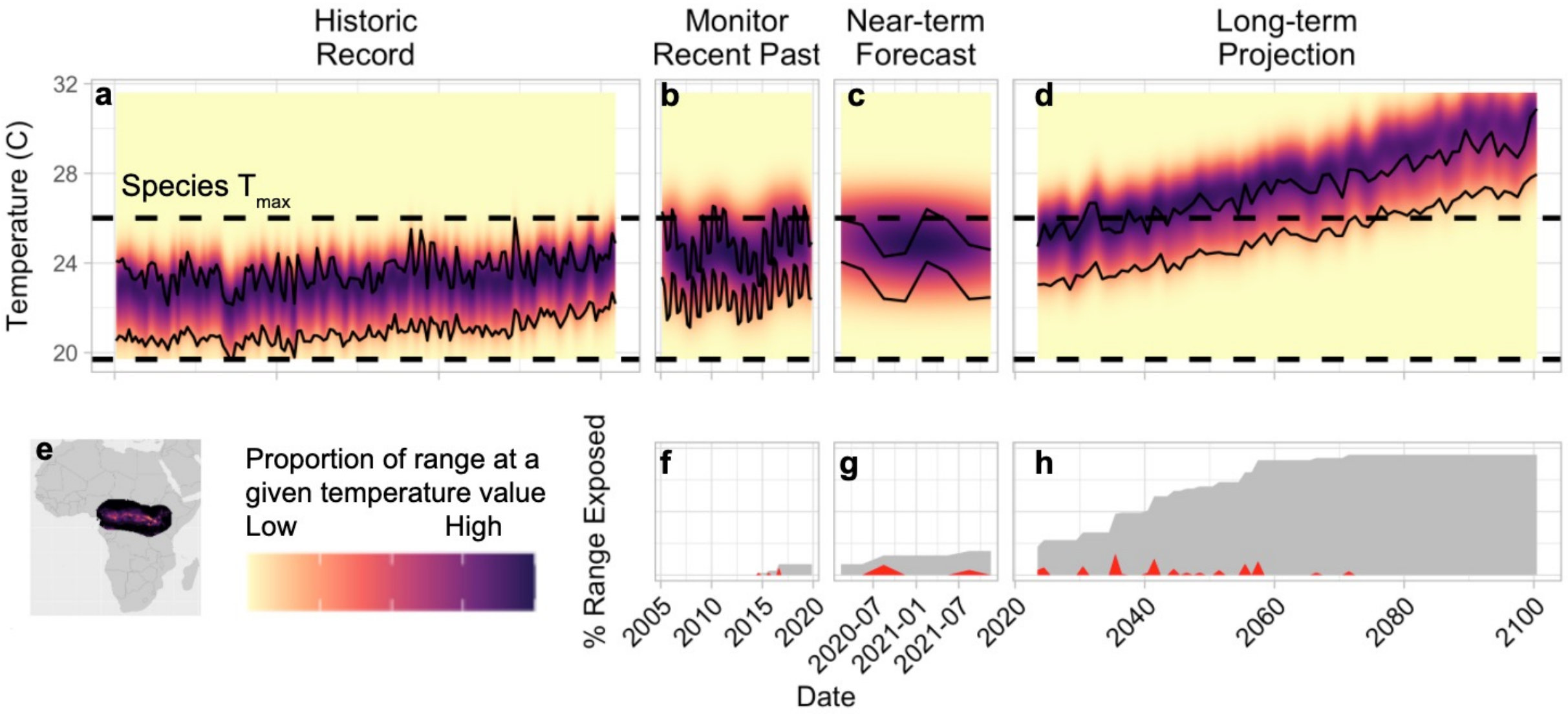



Randomizing **Drought Max Intensity** caused AUC to decrease by 0.34

Goal: Include other threats to understand relative importance to extinction risk

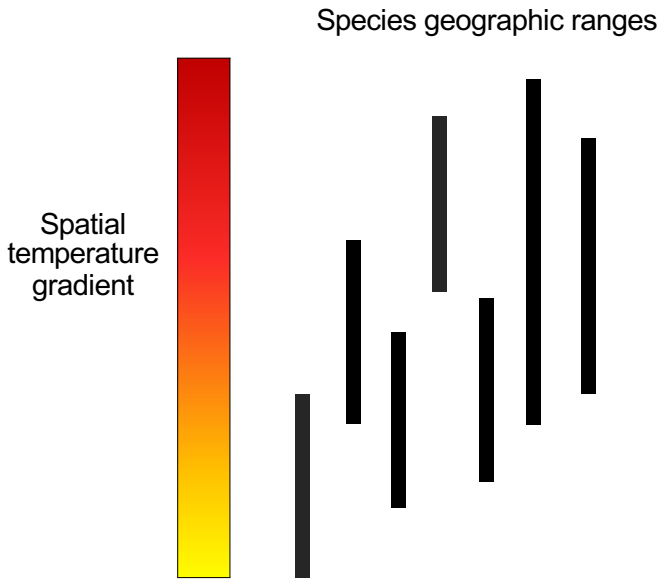
Ben Carlson

# Exposure of locations across species' ranges



# Assessing species' exposure to novel climate

The climate horizon profile



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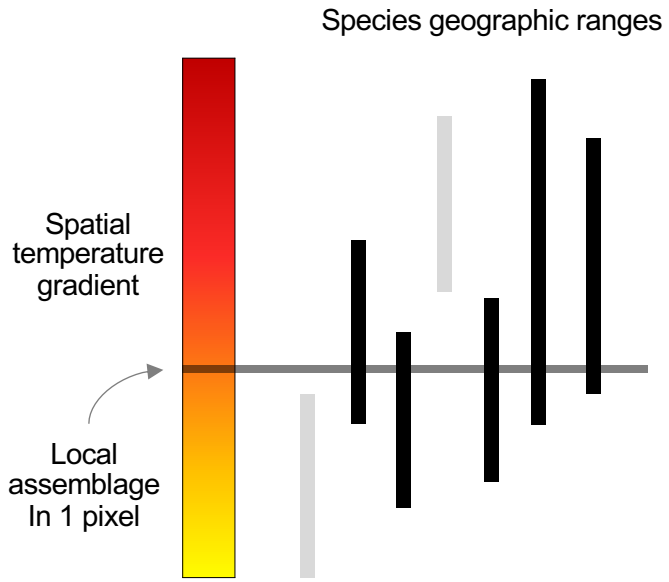

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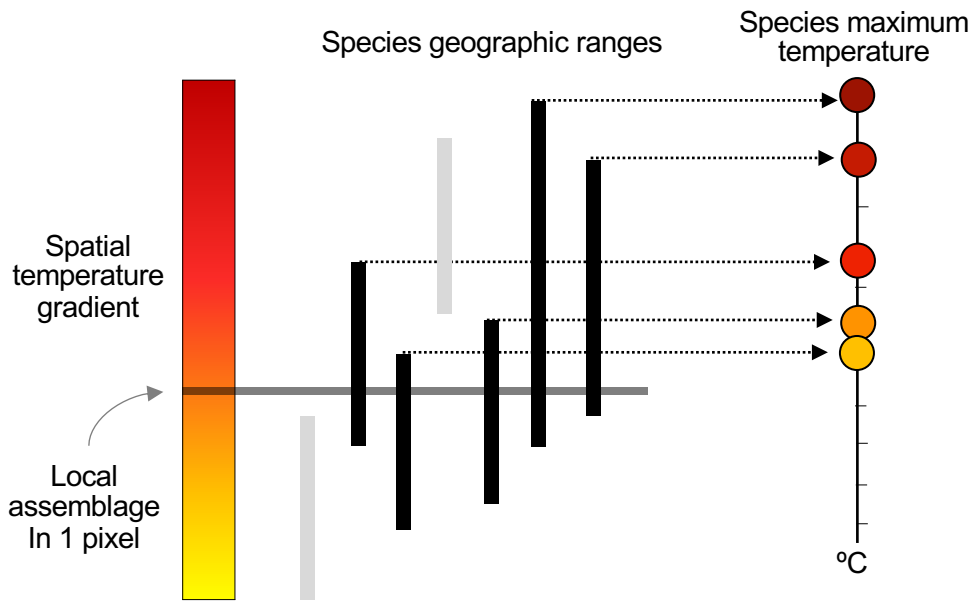

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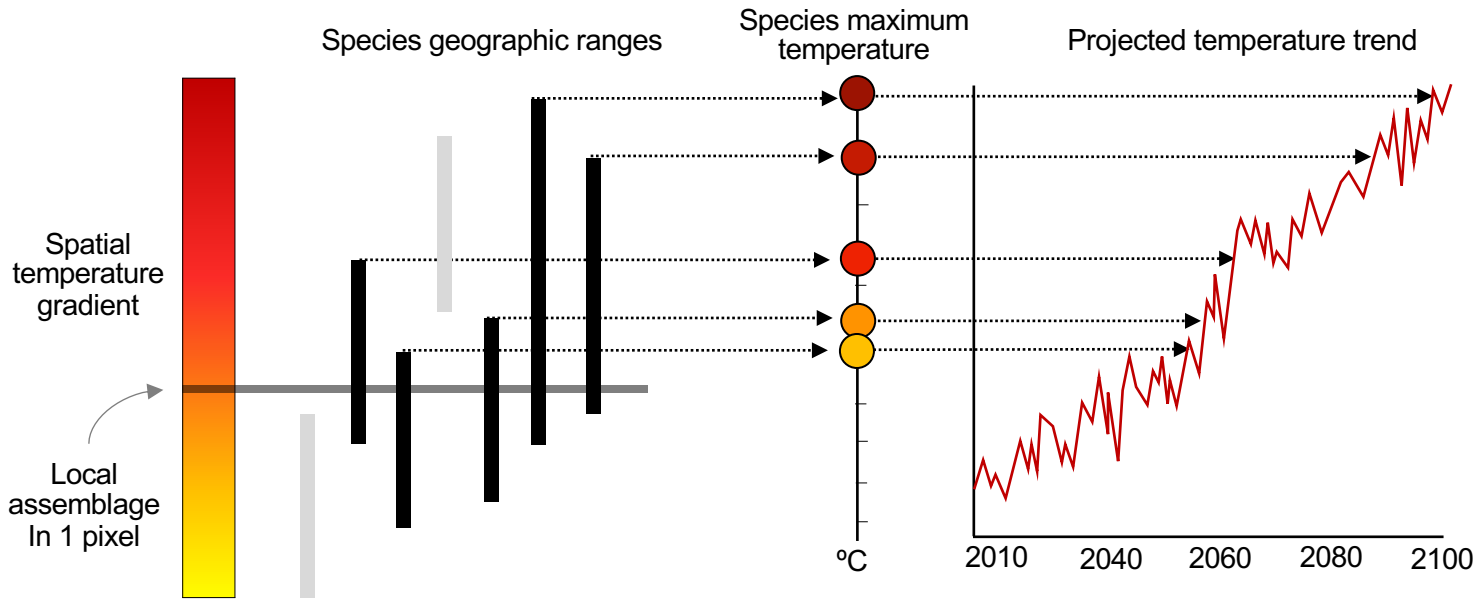

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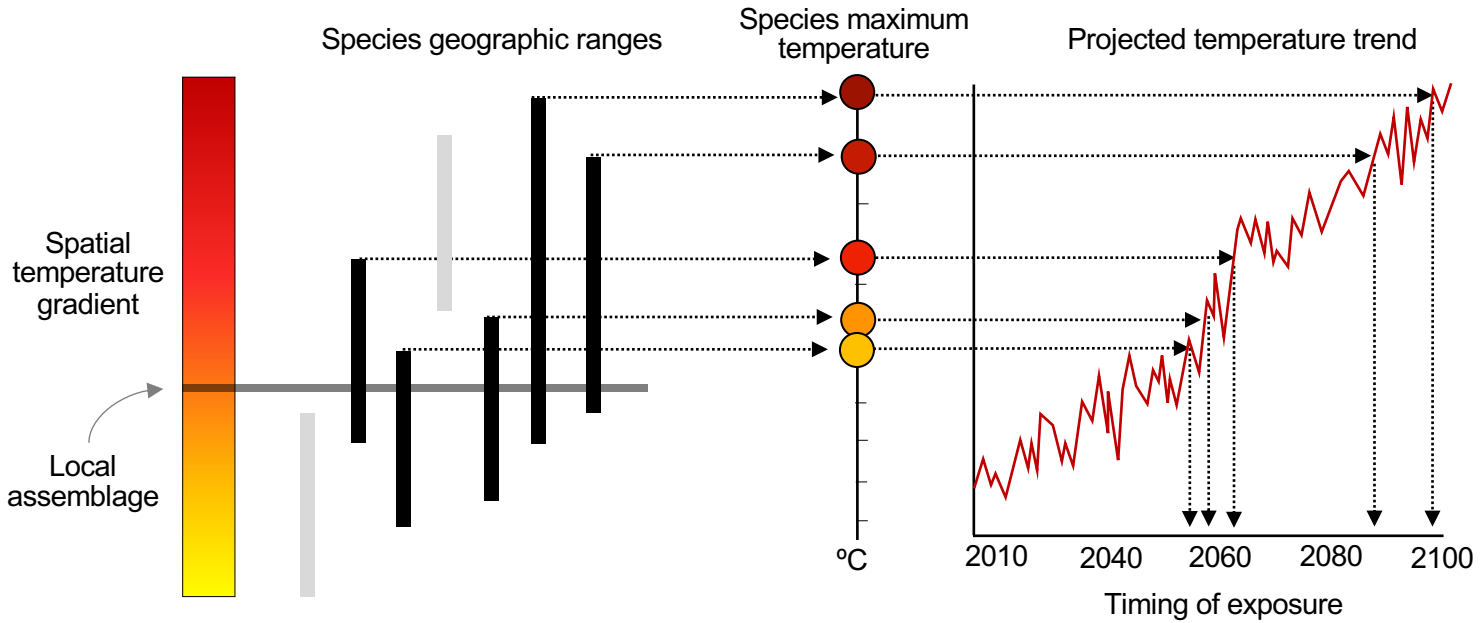

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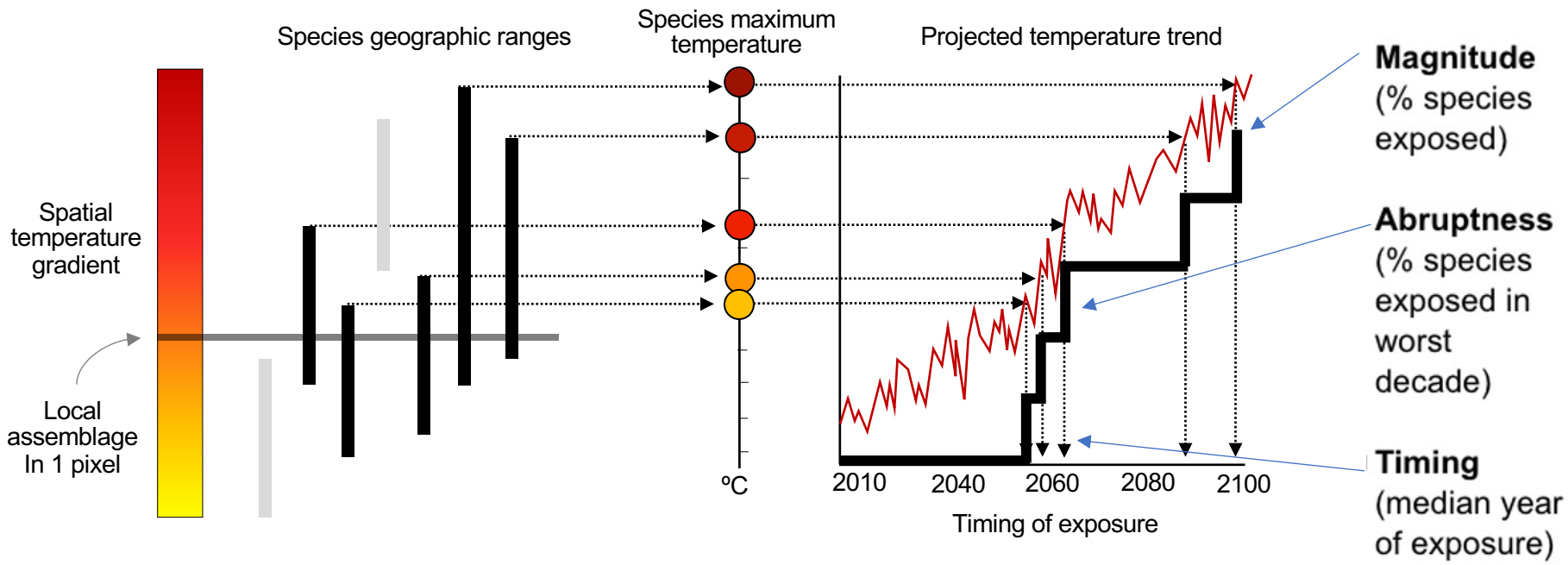
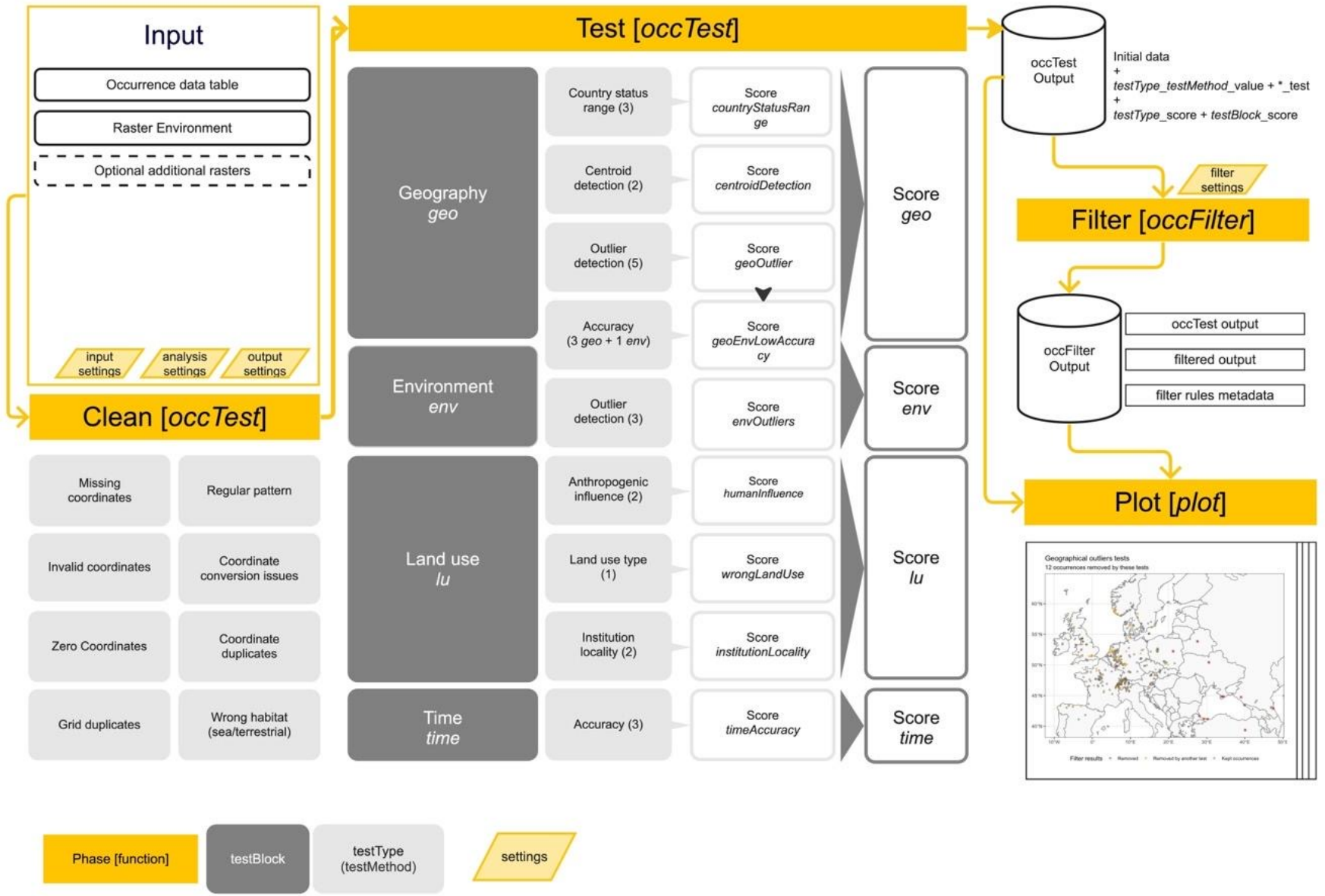



Trisos, Merow and Pigot, *Nature, 2020*

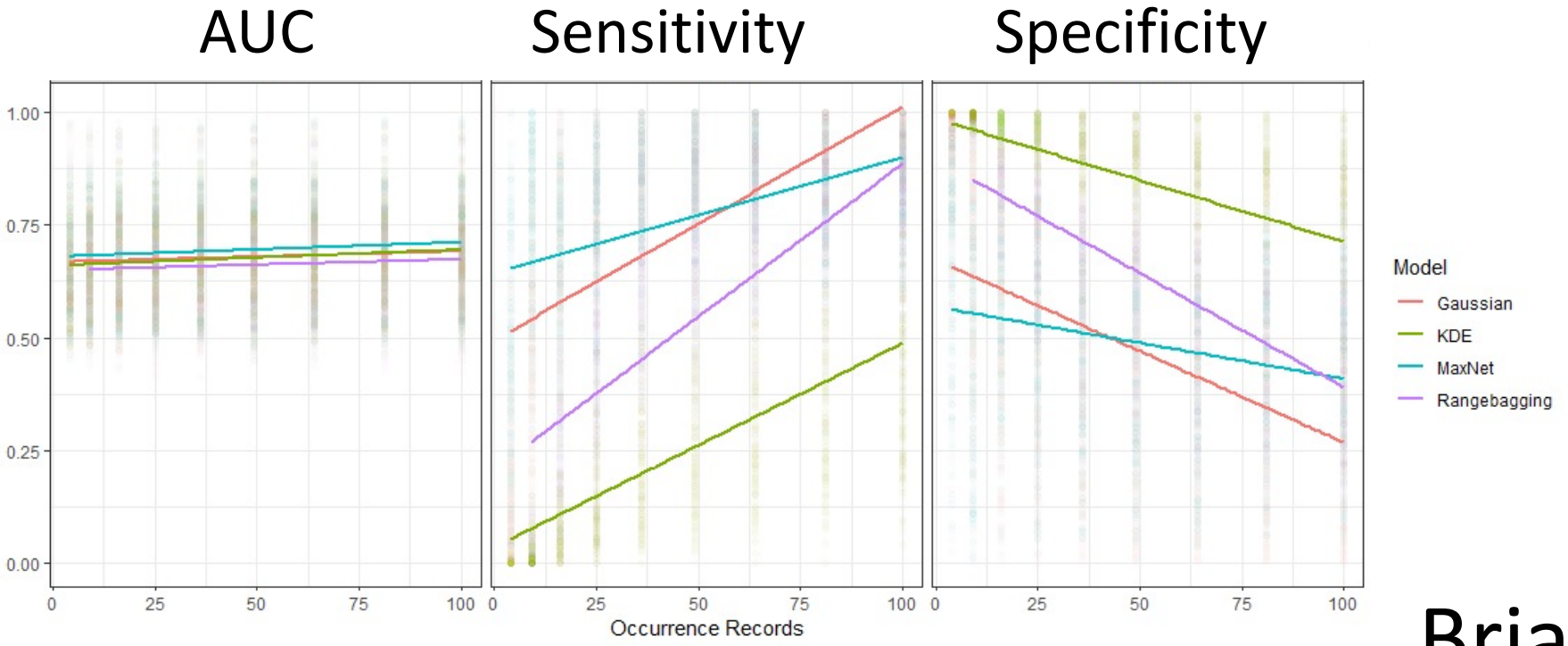
# Results: Data Cleaning

## R package: occTest

Pep Serra-Diaz



# Results: New Modeling Algorithms



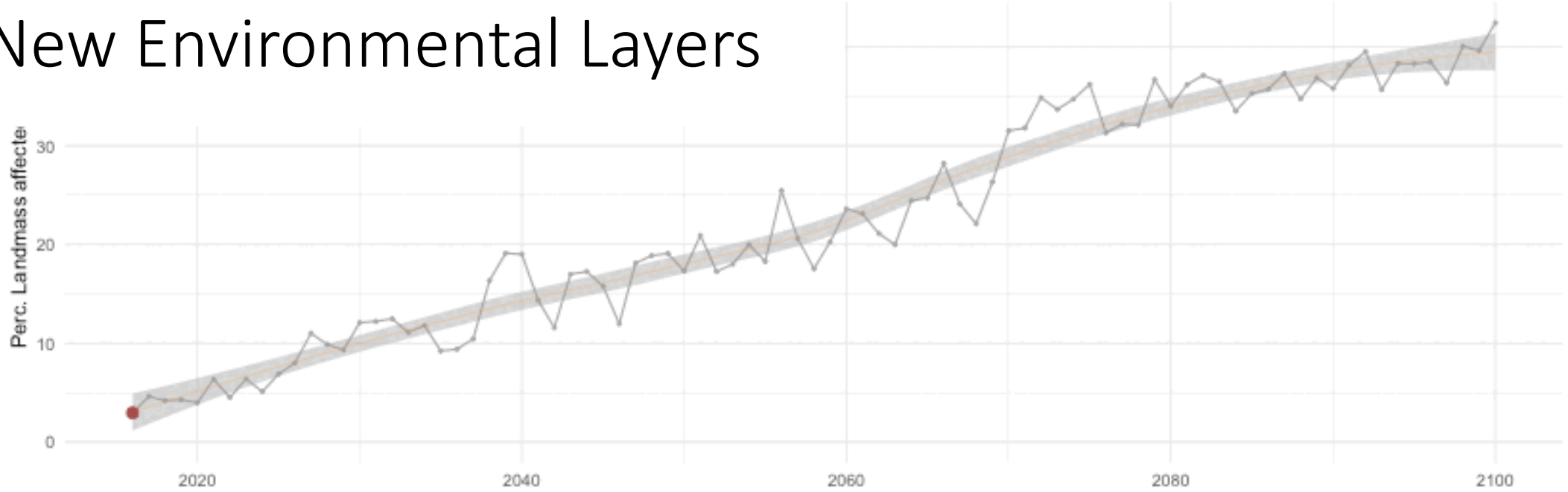

R package: pbSDM

Important for **capturing uncertainty** with small sample sizes,
**i.e. most species**

## Brian Maitner(s)

# Results: New Environmental Layers

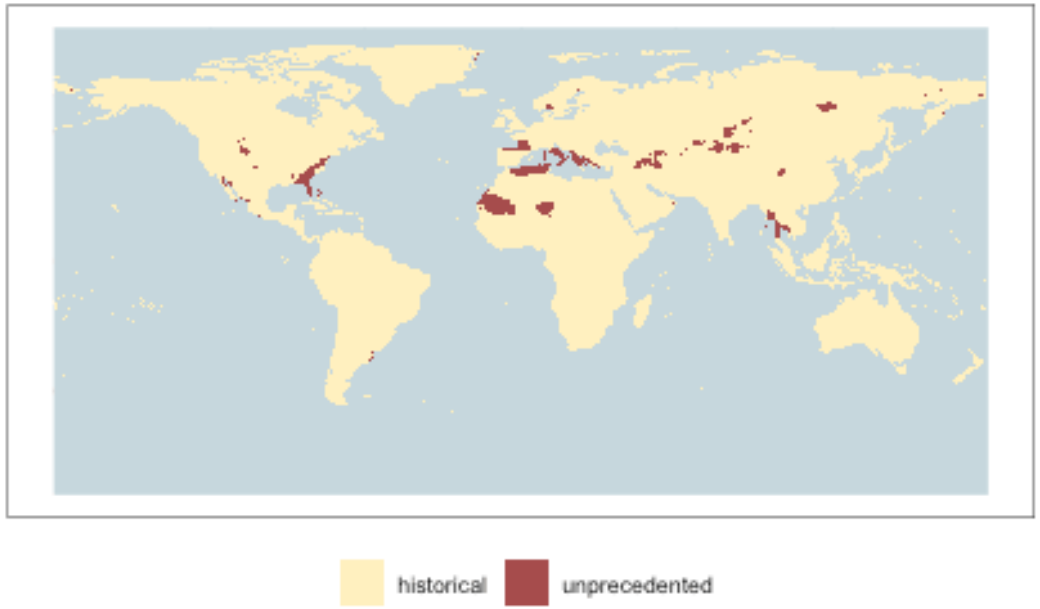
E.g.,
12 month drought Severity

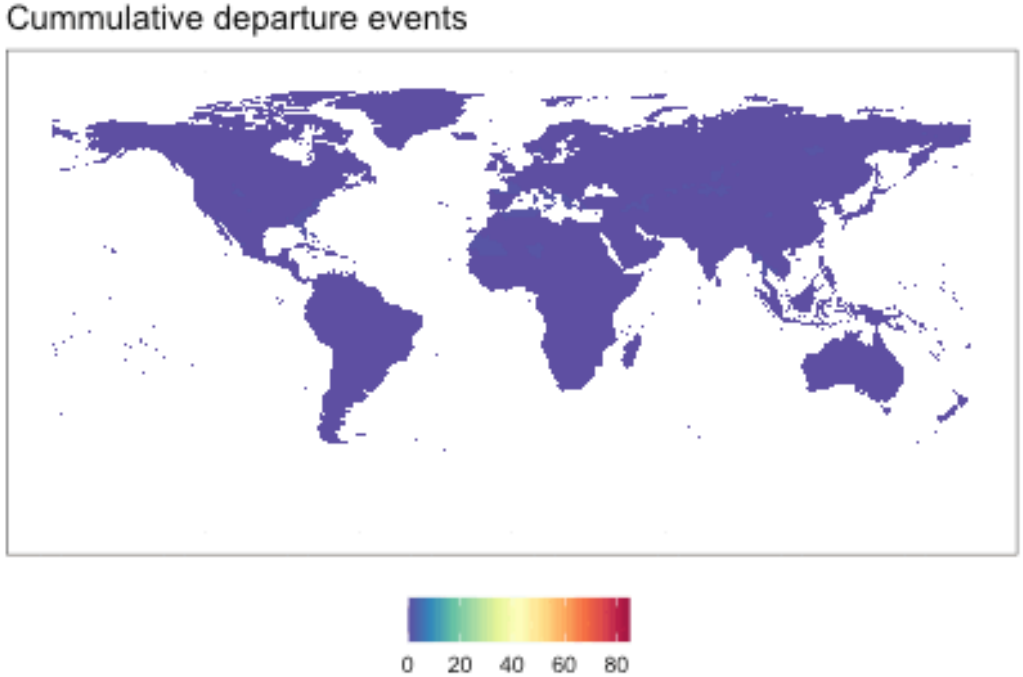


Pep Serra-Diaz

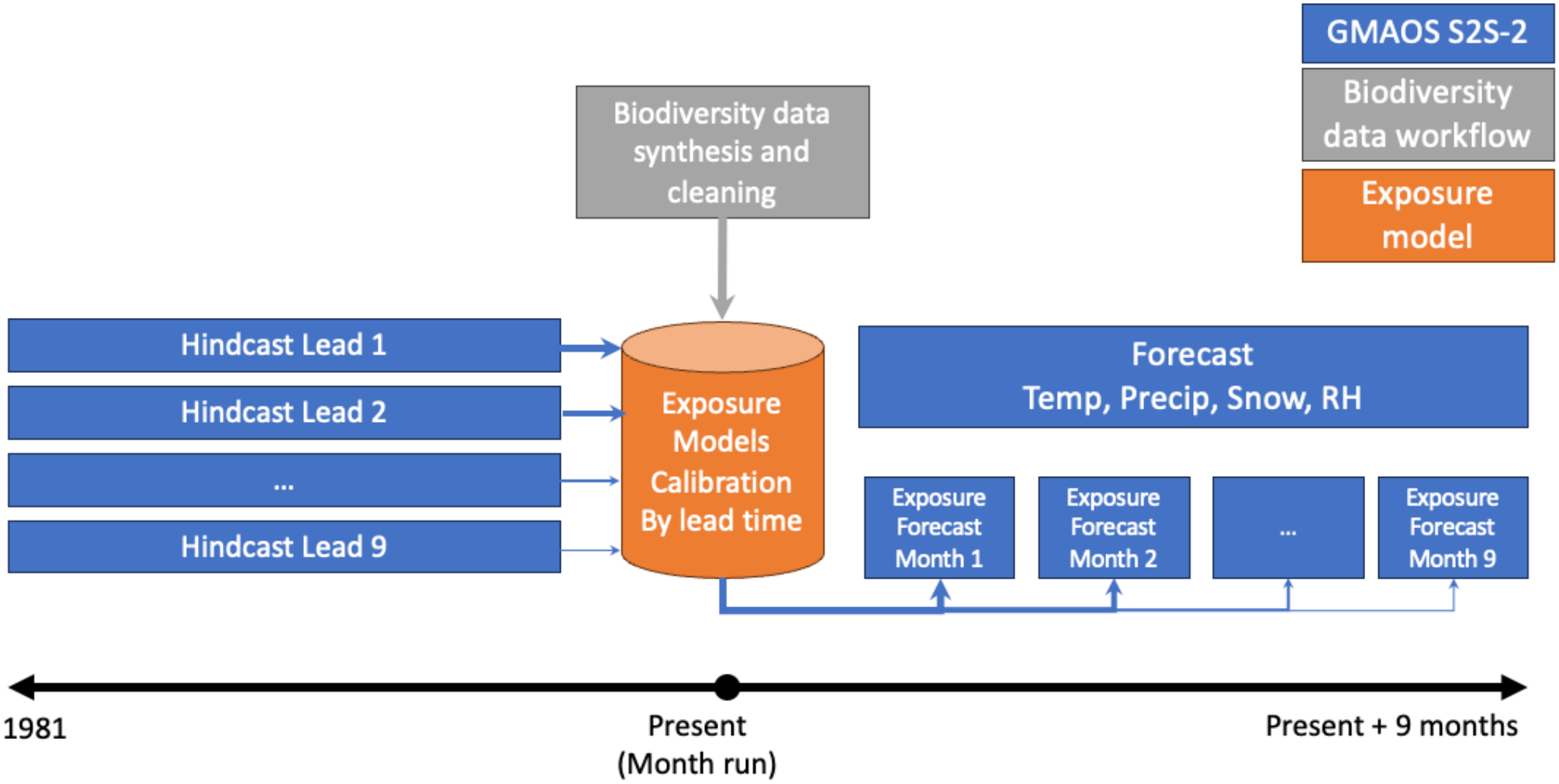
Thymios Nikolopoulous

Diogo Araujo



# Results: S2S forecasts



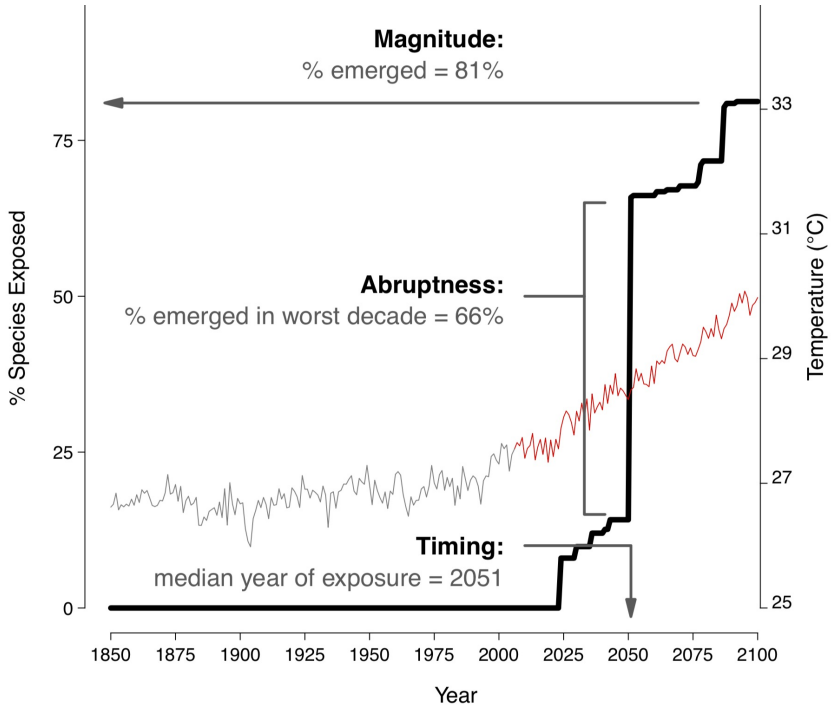
Pep Serra-Diaz

Lauren Andrews

Global Modeling and Assimilation Office
Subseasonal to Seasonal group

# Results: Customizable Data Products

- R package: fastRanger
- **Custom Biodiversity summary statistics in a few seconds**
  - And clade, region,
    etc in 1-3s




Gonzalo Pinilla-Buitrago

# A global monitoring network for all biodiversity at the species level

Inputs:

1. species occurrence data
2. weather/climate data
3. tunable algorithms

Outputs:

4. timing
5. and severity of exposure to extreme events
6. accessible, customizable, useful