

Not all species will migrate poleward as the climate warms: the case of the seven baobab species in Madagascar.



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Outline

1 Introduction

2 Methods

3 Results

4 Discussion

Introduction



Methods



Results



Discussion



Outline

1 Introduction

2 Methods

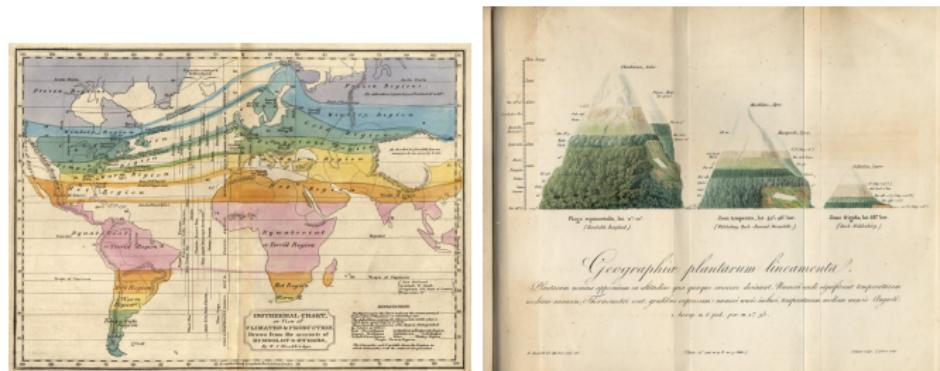
3 Results

4 Discussion

Isotherms

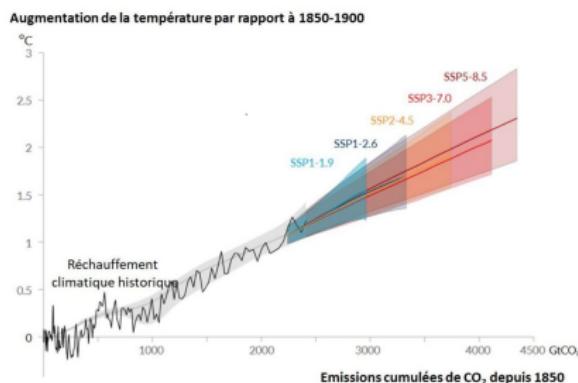
Species should move towards the poles and upslope to track shifting isotherms as climate warms :

- Temperature is an easy to measure climatic variable (Fahrenheit, 1724).
- Temperature is a strong determinant of species biology and distribution.
- Concept of isotherm (Alexander von Humboldt / 1769–1859).



Temperature and CO₂

- Temperature is strongly correlated with CO₂ concentration in the atmosphere.

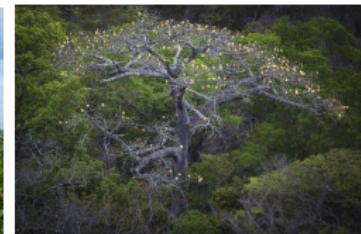


Scientific question

- Species should move poleward and upslope : is it always true ?
- Case of the seven baobab species of Madagascar

Baobabs of Madagascar

- Seven species out of the height baobab species existing on Earth.
- Six are **endemic** to Madagascar.
- Emblematic species (Baobabs' Alley), representative of the biodiversity of Madagascar.
- High endemism (>85%) in almost all taxonomic groups.



Introduction
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Methods
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Results
oooooooo

Discussion
ooooo

Outline

1 Introduction

2 Methods

3 Results

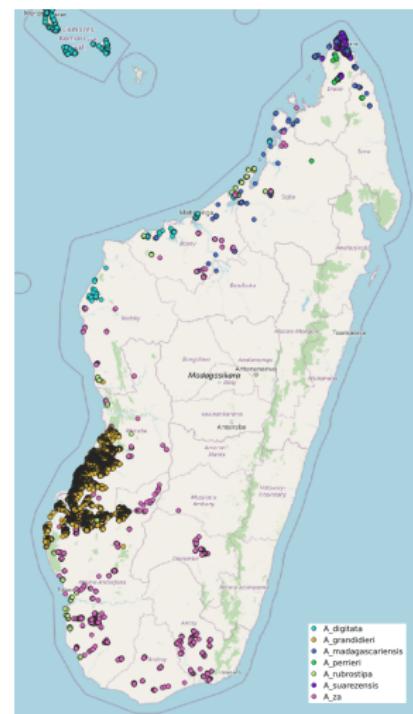
4 Discussion

Species distribution models

- Species distribution models.
- 1. Species climatic niche, 2. Current distribution, 3. Future distribution (2055, 2085).
- **Ensemble modelling** : four statistical algorithms (GLM, GAM, RF, MaxEnt).
- **Ensemble forecasting** : three Global Circulation Models (NorESM1-M, GISS-E2-R, HadGEM2-ES).
- **Two dispersal scenarios** : full dispersal (possible dispersal outside current range), zero dispersal (no dispersal outside current range).
- Presence : the majority of the models predicts a presence.
Uncertainty : number of models predicting a presence.

Occurrence data

- Large occurrence data-base.
- Since 2000, field inventories and photo-interpretation of satellite images.



Climatic data

- Four climatic variables : mean annual temperature ($tmean$, °C), annual precipitation ($precip$, mm/yr), temperature seasonality ($tseas$, °C $sd \times 1000$), climatic water deficit (cwd , mm/yr).
- Two climatic scenarios : RCP 8.5 and RCP 4.5.
- WorldClim data.

Ecological interpretation of SDMs

General use of SDMs in the studies on climate change :

- Correlative models used to derive maps of species range.
- Species vulnerability to climatic change (range contraction or expansion).
- Not much ecological interpretation of the results.

We wanted to push the interpretation further :

- Climatic anomalies in space in the future.
- Variable importance in determining species niche.
- Climate change in current species range.
- Species range shift in latitude and elevation.
- Relationship between temperature and latitude/elevation in Madagascar.

Introduction
ooooo

Methods
ooooo

Results
●ooooooo

Discussion
ooooo

Outline

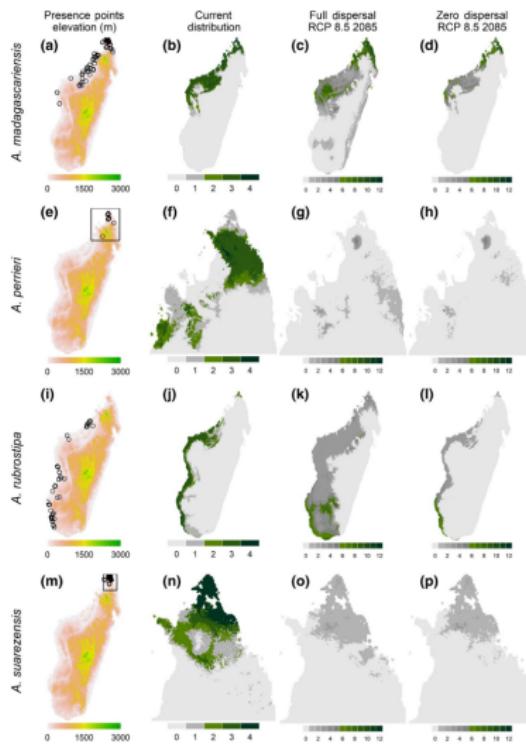
1 Introduction

2 Methods

3 Results

4 Discussion

Range contraction



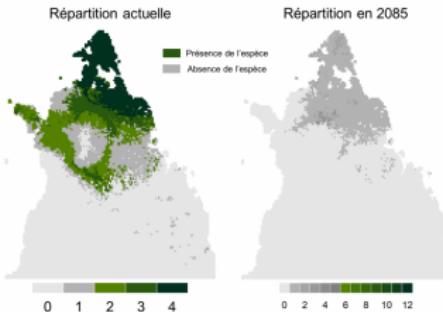
Range contraction

- Four species will experience a strong range contraction (>70%) under RCP 8.5 in 2085.
- Out of these four species, three are threatened by a change in temperature seasonality.

Adansonia suarezensis

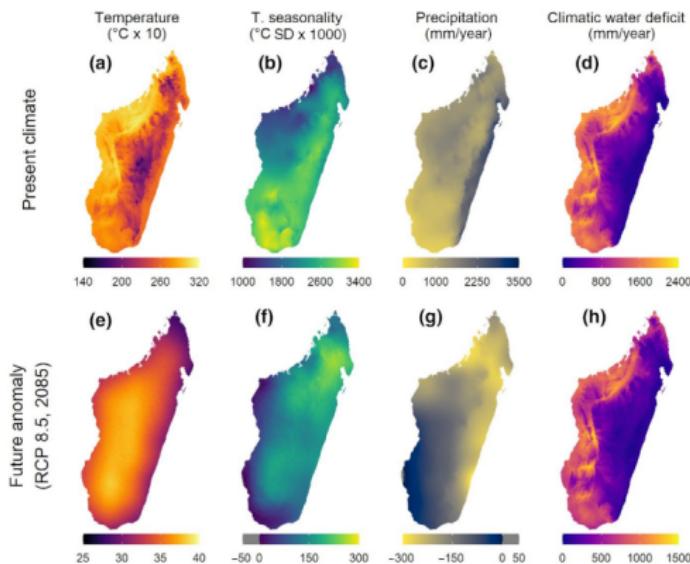


Illustration par Graciela Krekka-Duchaufour



© Tagliaferri M., M. P. Daeritz, J.-M. Léonard, P. Try, C. Correia, J. Lemos, V. Carvalho-Pereira, and G. Veldkamp. 2021. Not all species will migrate poleward as the climate warms: the case of the seven baobab species in Madagascar. *Global Change Biology*. doi: <https://doi.org/10.1111/gcb.15000>

Climatic anomalies

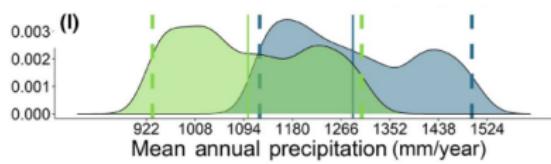
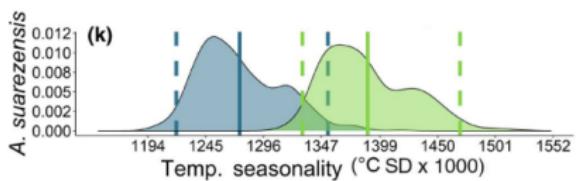


Variable importance

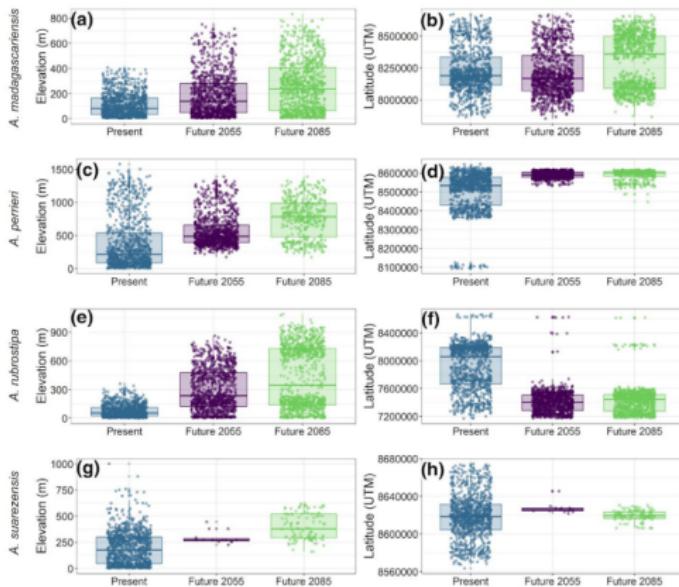
TABLE 2 Relative importance of the four bioclimatic variables in determining species distribution

Species	Mean annual temperature	Temperature seasonality	Precipitation	Climatic water deficit	Most important variables (first and second)
<i>A. digitata</i>	0.364	0.633	0.372	0.552	Tseas/Cwd
<i>A. grandidieri</i>	0.526	0.239	0.550	0.110	Prec/Tmean
<i>A. madagascariensis</i>	0.651	0.824	0.309	0.153	Tseas/Tmean
<i>A. perrieri</i>	0.369	0.954	0.336	0.518	Tseas/Cwd
<i>A. rubrostipa</i>	0.320	0.330	0.360	0.730	Cwd/Prec
<i>A. suarezensis</i>	0.211	0.987	0.620	0.150	Tseas/Prec
<i>A. za</i>	0.471	0.309	0.625	0.168	Prec/Tmean

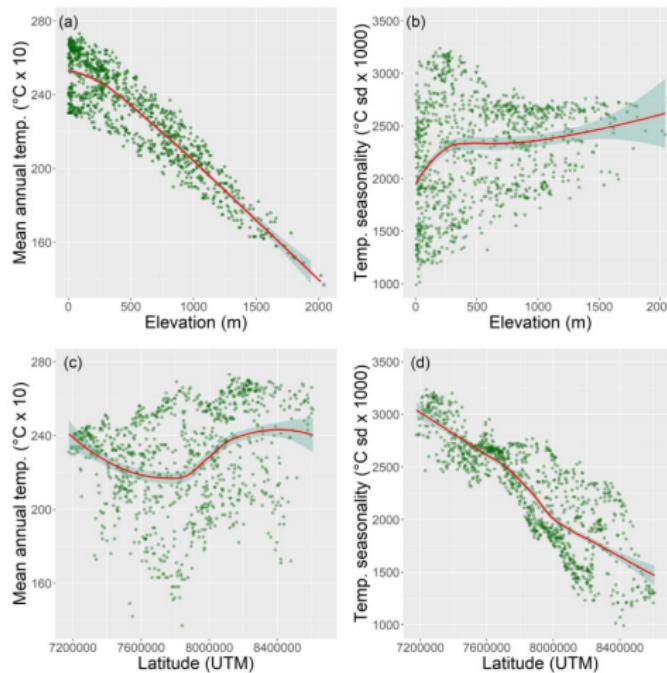
Climate change in current species range



Species range shift in latitude and elevation



Relationship between temperature and latitude/elevation



Introduction
ooooo

Methods
ooooo

Results
oooooooo

Discussion
●ooooo

Outline

1 Introduction

2 Methods

3 Results

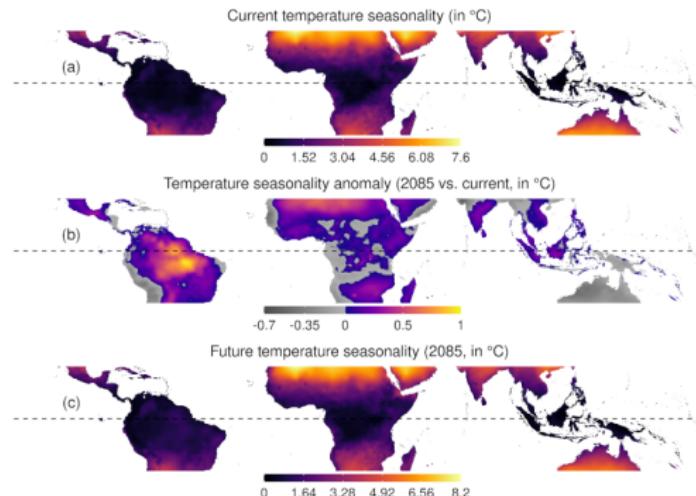
4 Discussion

Species range shift

- Some species might move equatorward to track change in temperature seasonality.
- Range shift direction depends on several things : species climatic niche (variable importance), climatic anomalies in space in the future.
- It is not contradictory to move both equatorward and upslope.

Generalization to the tropics

- General increase of temperature seasonality in the tropics.
- Tropical species usually adapted to low seasonality (cf. tree growth, phenology).



Perspectives

- What does it mean an increase in seasonality under climate change ?
(much warmer rainy season or colder dry season ?)



... Thank you for attention ...
<https://ecology.ghislainv.fr/presentations>



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