



Green Corridors: Stochastic Resonance Between Climate Variability and Hominin Migration

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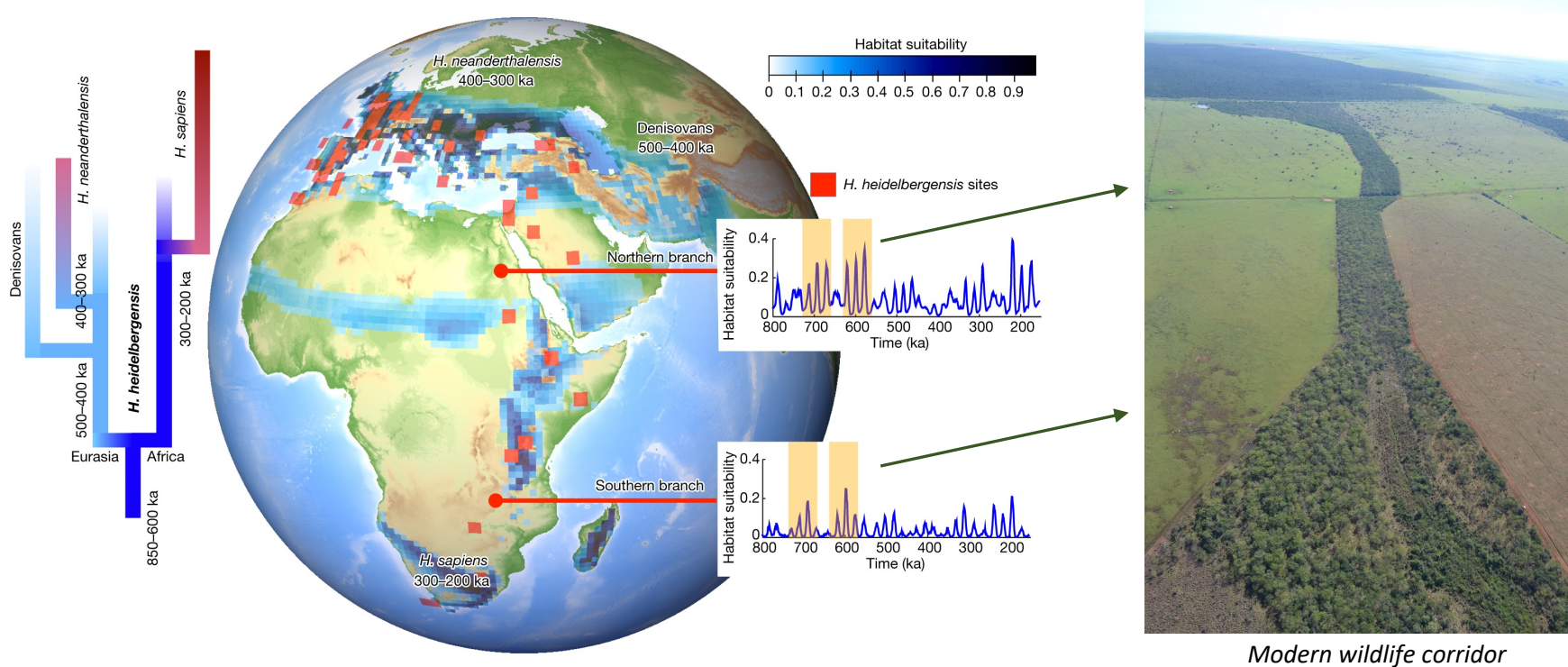


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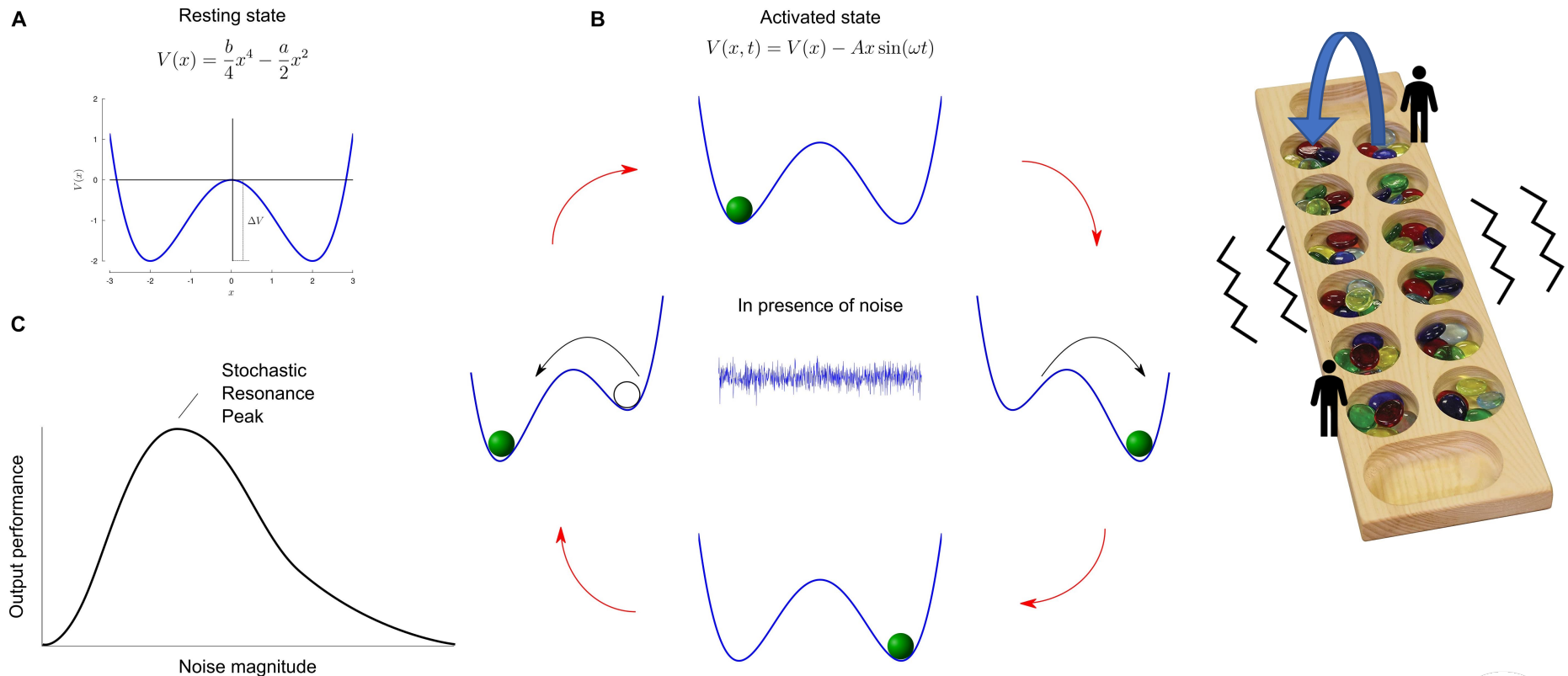
Background: Green Corridors and Hominin Dispersals



- *Homo erectus*, *Homo heidelbergensis*, and *Homo sapiens* all dispersed out of Africa throughout the Pleistocene, further dispersing into various parts of Eurasia
- Climate variability may have periodically opened green corridors through barrier regions

Background: Stochastic Resonance

- **Stochastic resonance (SR)** is a phenomenon which occurs when the **optimal amount of noise is added to a system** such that the signal to noise ratio (SNR) is maximized.
- SR originally used as an explanation for periodic ice ages by Roberto Benzi et al 1989



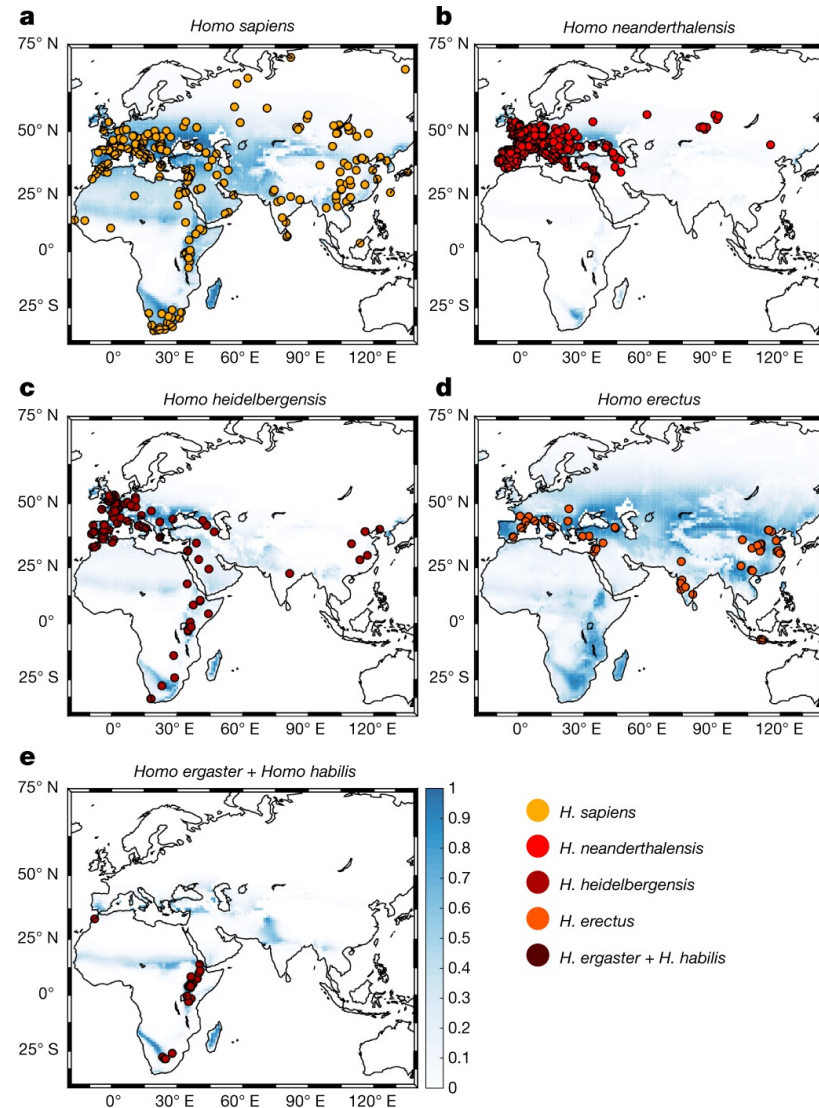
Method: Defining Climate Envelope for Hominin Species

Steps

- Begin with **fossil locations and dates**
- Lookup relevant climate conditions **Temp, Precip, Pmin, NPP** in 2Ma CESM simulation
- Calculate **Mahalanobis Distance** (Climate Envelope)
- Project back to climate simulation

Result

Time-varying map of **habitat suitability** for hominin species



Methods: Agent Based Model Driven by Habitat Suitability

Agents make decisions based on two factors:

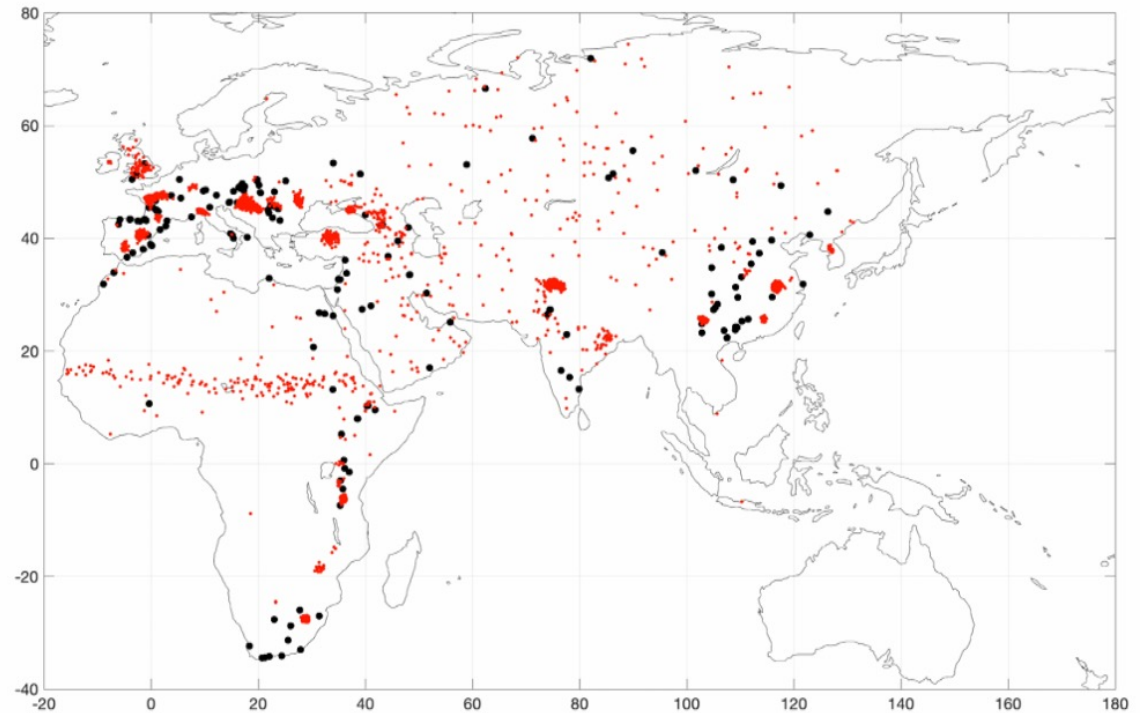
Gradient of Habitat

- “Drifting” towards habitable areas
- Influenced by Climate, Biome, NPP

Randomness

- Gamma Distribution
- varying shape/scale parameter

Fixed Drift, Low Randomness



Sapiens Simulation: Tracers in Red, Fossil Locations in Black

Fixed Drift, Low Randomness = Stuck in Habitat potential wells



Methods: Agent Based Model Driven by Habitat Suitability

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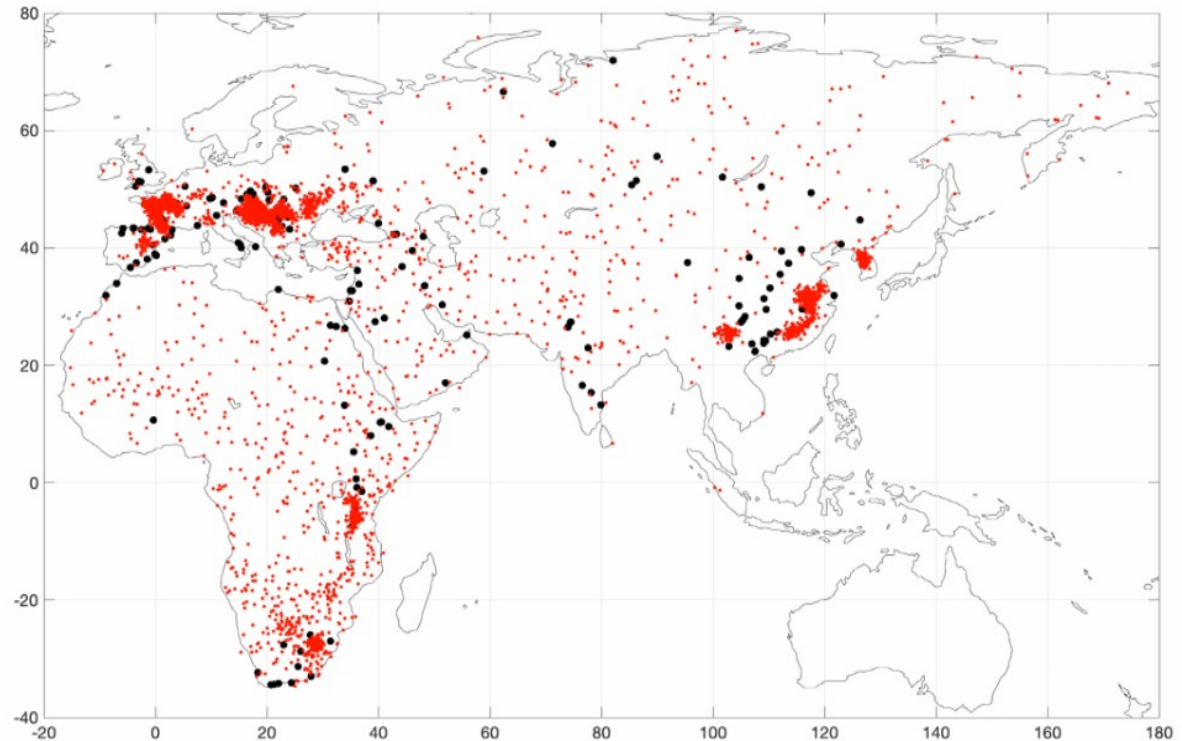
Gradient of Habitat

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Fixed Drift, High Randomness

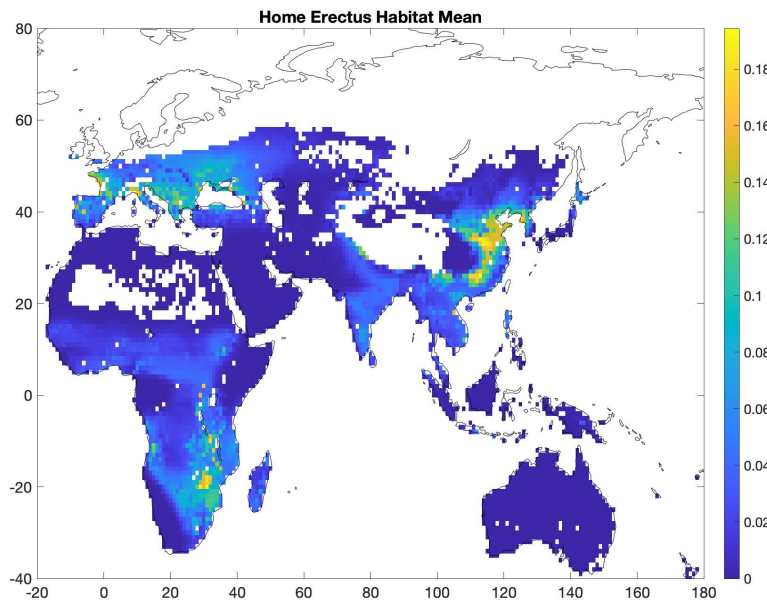


Sapiens Simulation: Tracers in Red, Fossil Locations in Black

Fixed Drift, High Randomness = Easily Freed from potential well

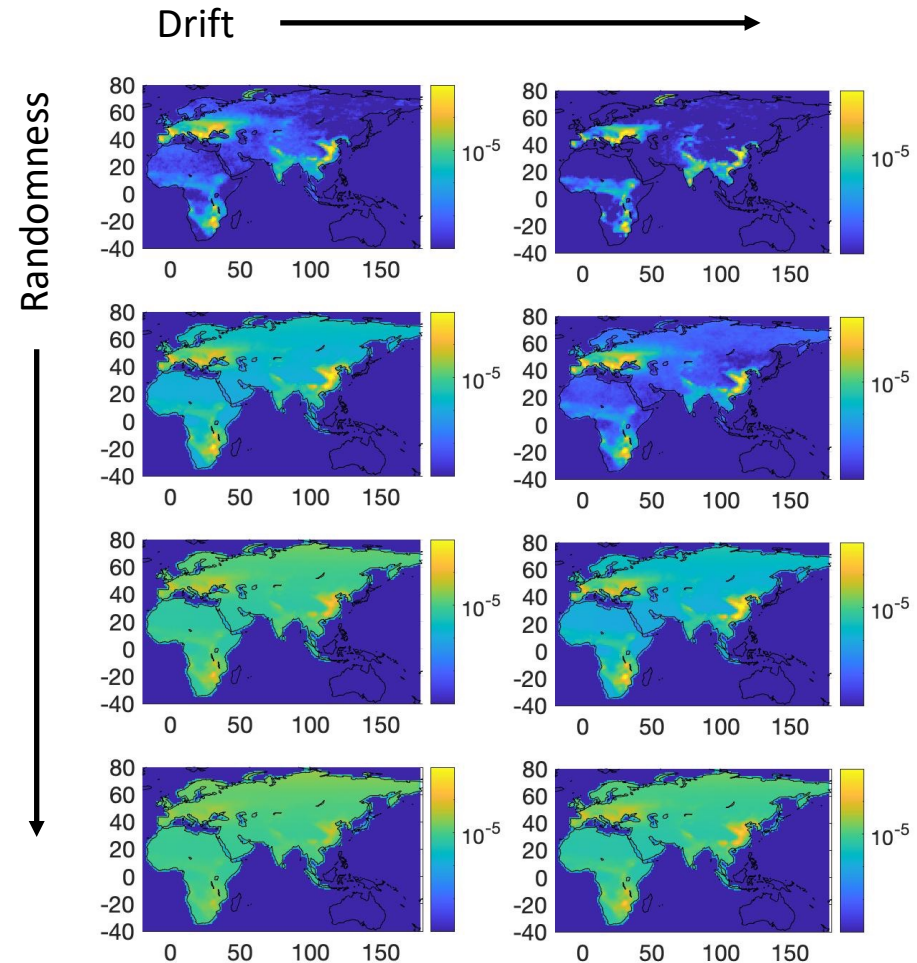


Results *Homo Erectus*: Habitat Vs. Population Density



Population density (output) roughly tracks habitat suitability (input) for varying levels of drift and stochasticity

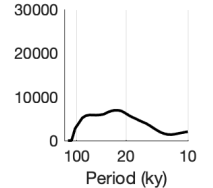
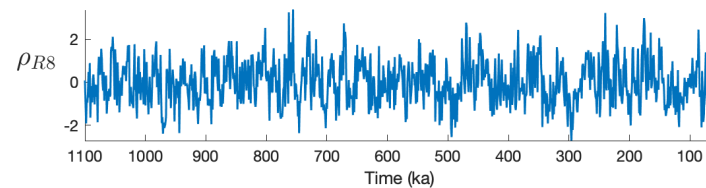
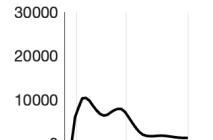
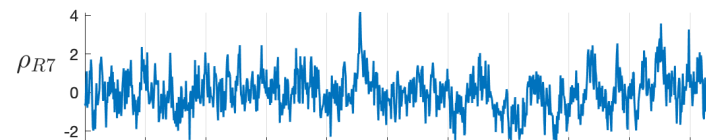
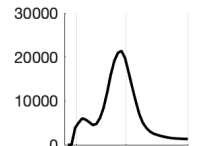
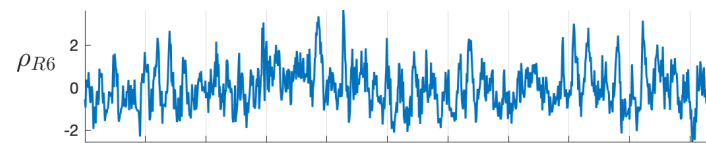
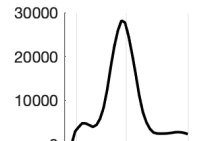
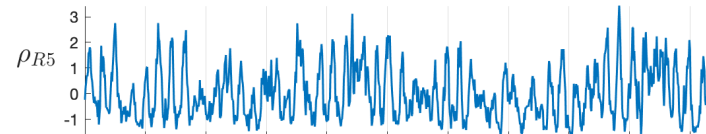
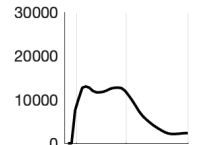
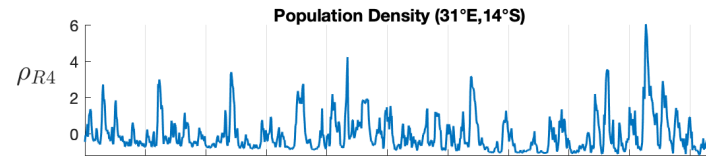
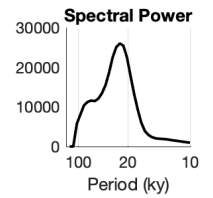
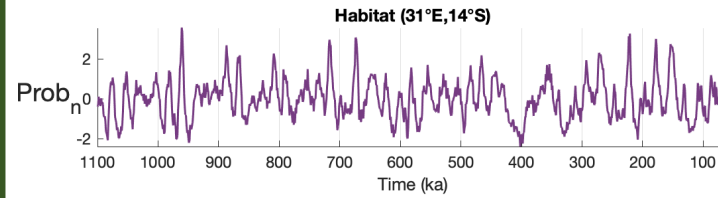
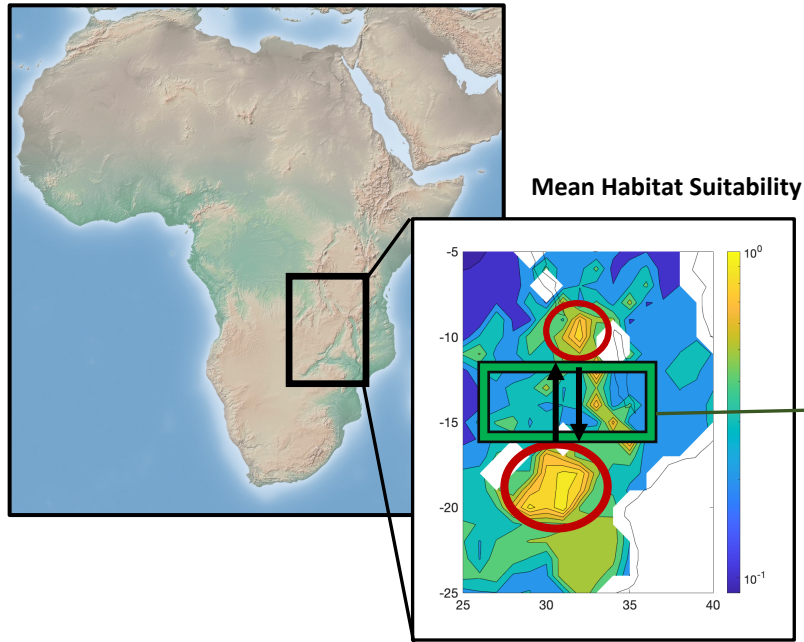
But what about the spaces in between the habitable areas (green corridor)?



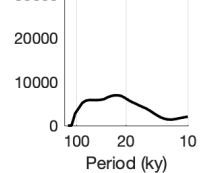
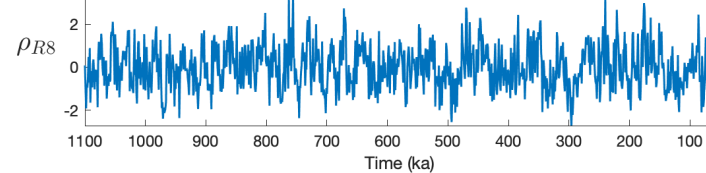
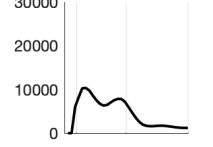
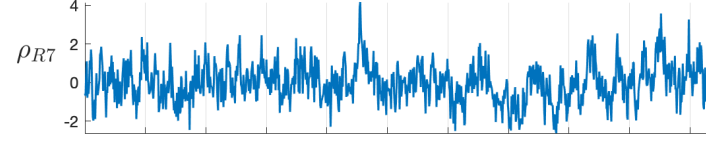
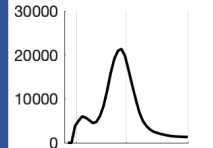
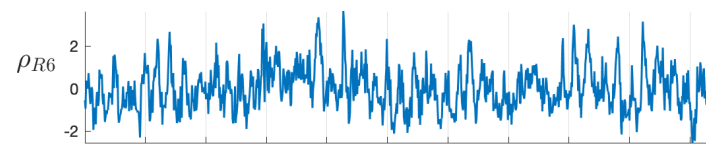
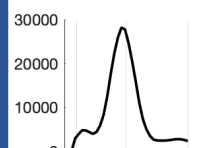
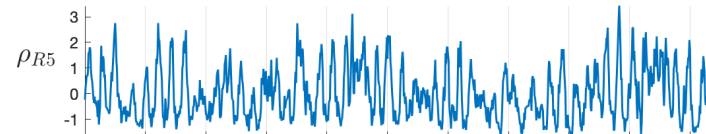
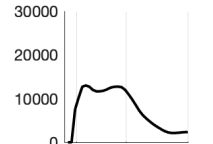
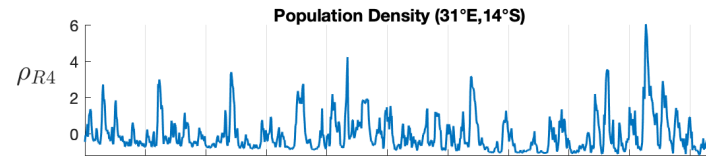
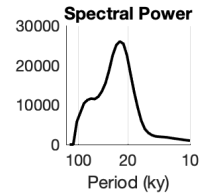
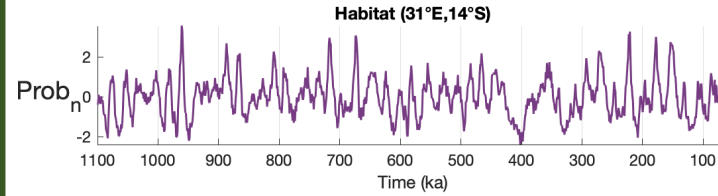
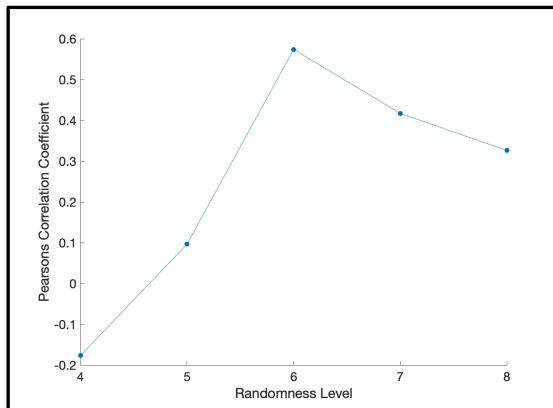
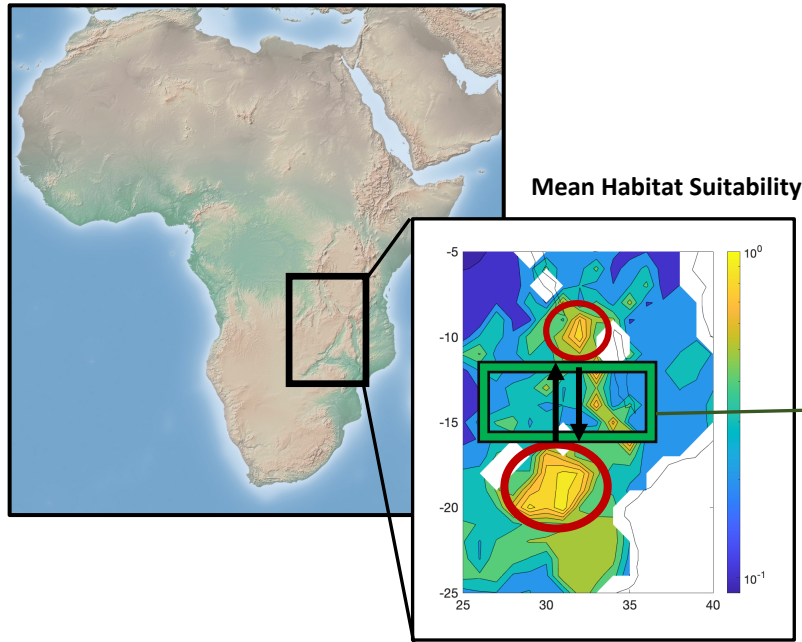
Population Density Tracers/km²
Logscale from 10⁻⁸ to 10⁻³



Results Habitat Vs. Population Density in Green Corridor



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Habitat in Green Corridor is best utilized with optimum stochasticity



Summary

- **Green corridors** are an important concept for understanding **inter-regional connectivity** and **wide scale dispersal**.
- Results from our climate-driven agent-based model suggest that **green corridor utilization** can be understood in terms of **stochastic resonance between orbital-scale climate change and stochastic migration**.

