Impacts of renewable energies on biodiversity

Chiro-Eolhab : Impacts of wind turbines on habitat use by bats across time and lanscape

Fabien VERNIEST[1], Kévin BARRÉ[1], Christian KERBIRIOU[1], Isabelle LE VIOL[1] & Camille LEROUX[1,2]

1. CESCO
2. Auddicé biodiversité


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*injury caused by a change in pressure

Context

- A twofold problem:
  - Mortality due to collisions (and barotrauma*), which can affect population dynamics → increased risks due to attraction effects
  - Loss of habitat use → caused by avoidance/disturbance effects

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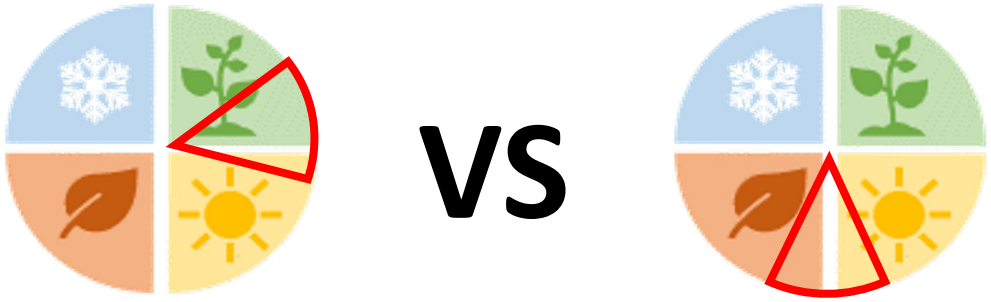
- A twofold problem:
  - Mortality due to collisions (and barotrauma*), which can affect population dynamics → increased risks due to attraction effects
  - Loss of habitat use → caused by avoidance/disturbance effects
- Behaviours that may be influenced by the following factors:
  - Temporal [1]
  - Spatial [2]
  - Characteristics and operation of wind turbines [3]

[1] McKay *et al*. (2024). *Wildlife Biology, 59*(10)
[2] Leroux *et al.* (2022). *Journal of Applied Ecology*, *59*(8)
[3] Ellerbrok *et al*. (2024). *Global Ecology and Conservation*, *49*

Initial question and objectives

Generalisation of bats' response to wind turbines through:

- ❑ Seasons?



- ❑ Years?

Year **n** VS Year **n+10**

- ❑ Landscape contexts?

- ❑ Species?

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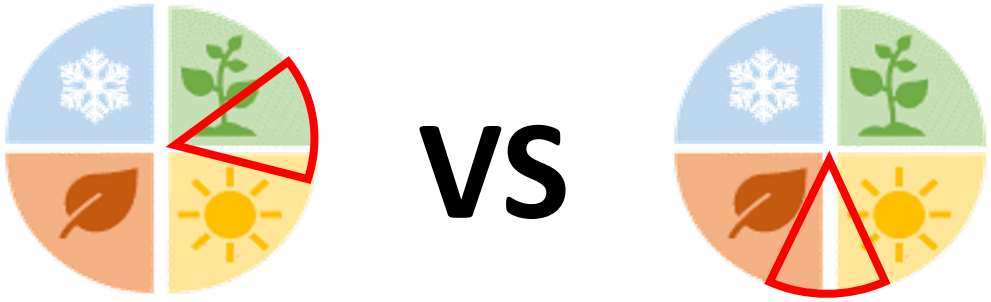


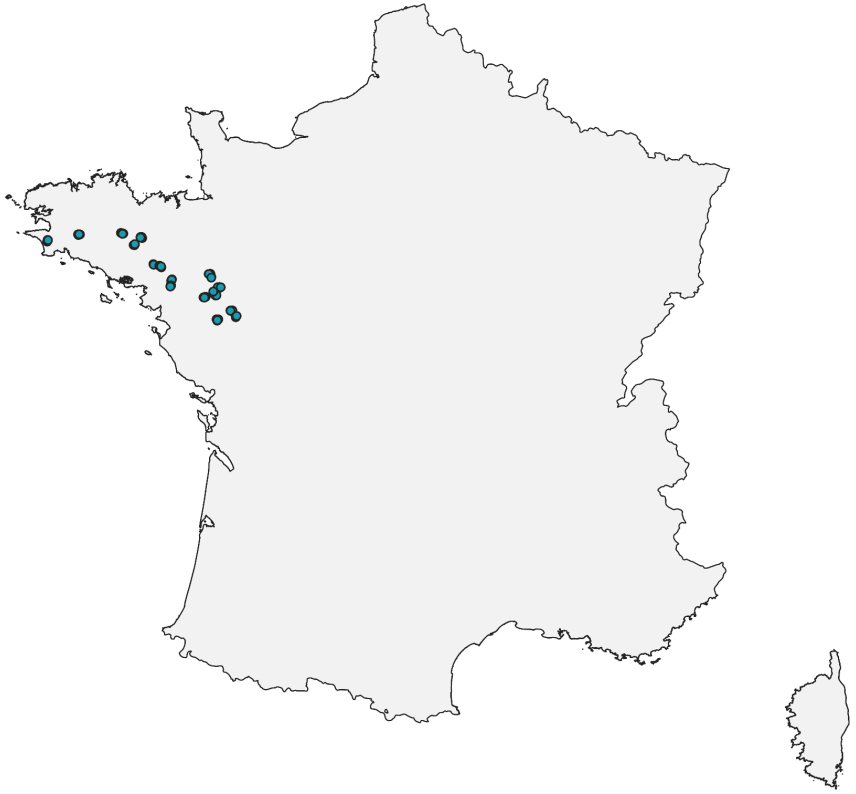
- ❑ Years?

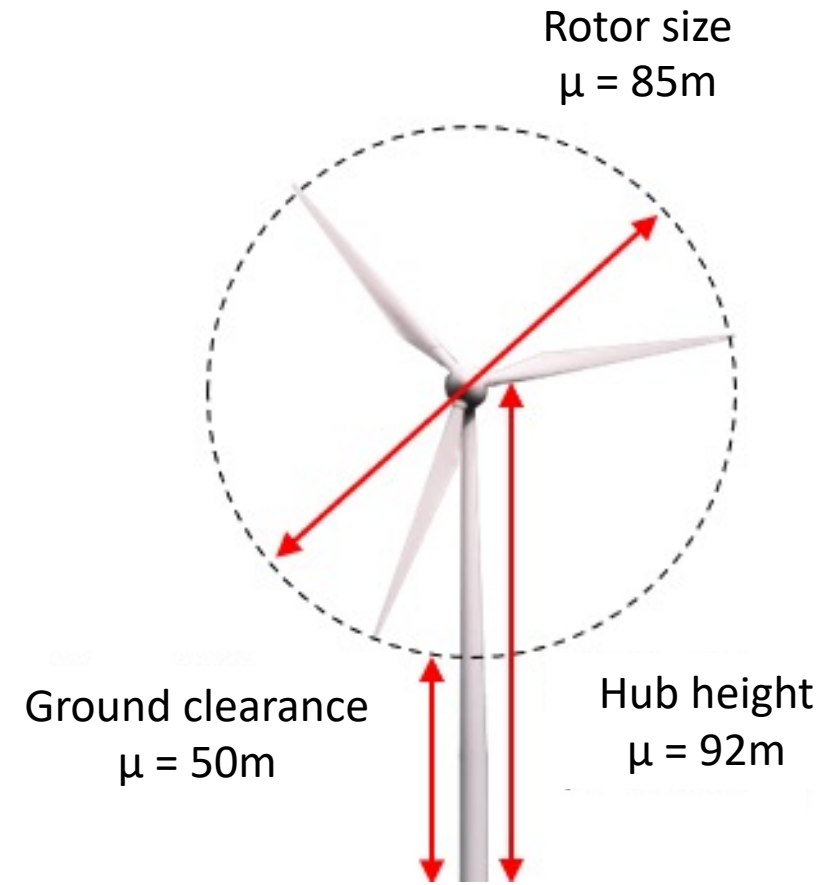
- ❑ Landscape contexts?

- ❑ Species?

Methods

- ❑ Ultrasonic recorders at hedgerows
- ❑ **116 sites** and 18 wind farms
- ❑ Sites sampled both during June and September

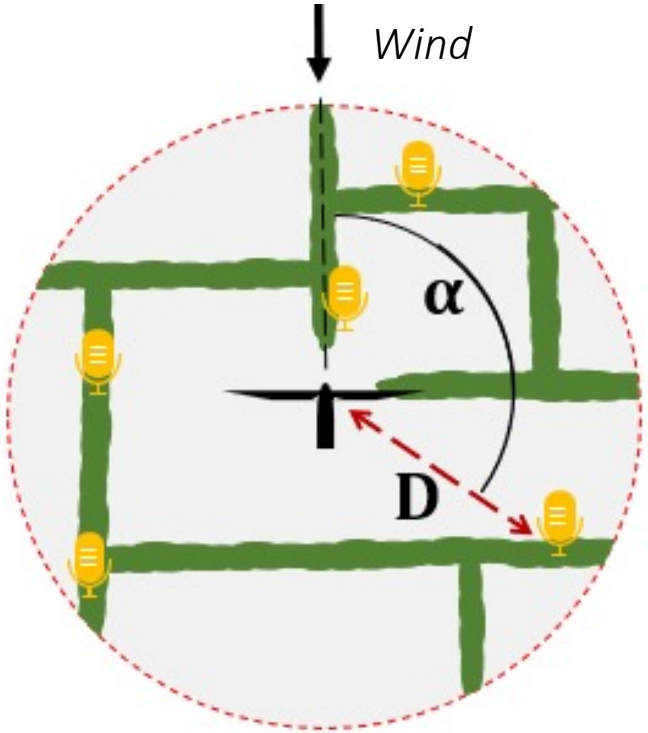




Distribution of common pipistrelle (*Pipistrellus pipistrellus*) activity is altered by airflow disruption generated by wind turbines

Methods

- Gradient of:
  - **Distance** to the nearest wind turbine (25 – 1500m)
  - **Wind exposition**



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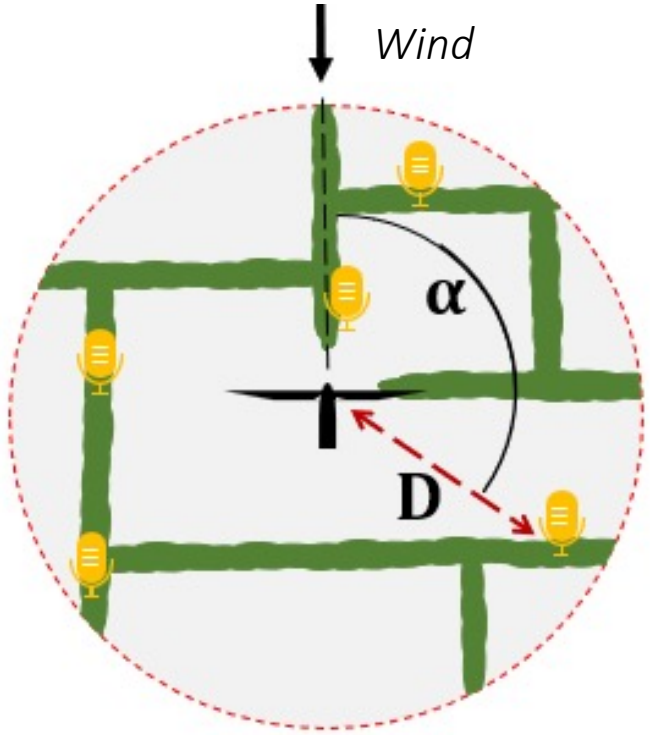

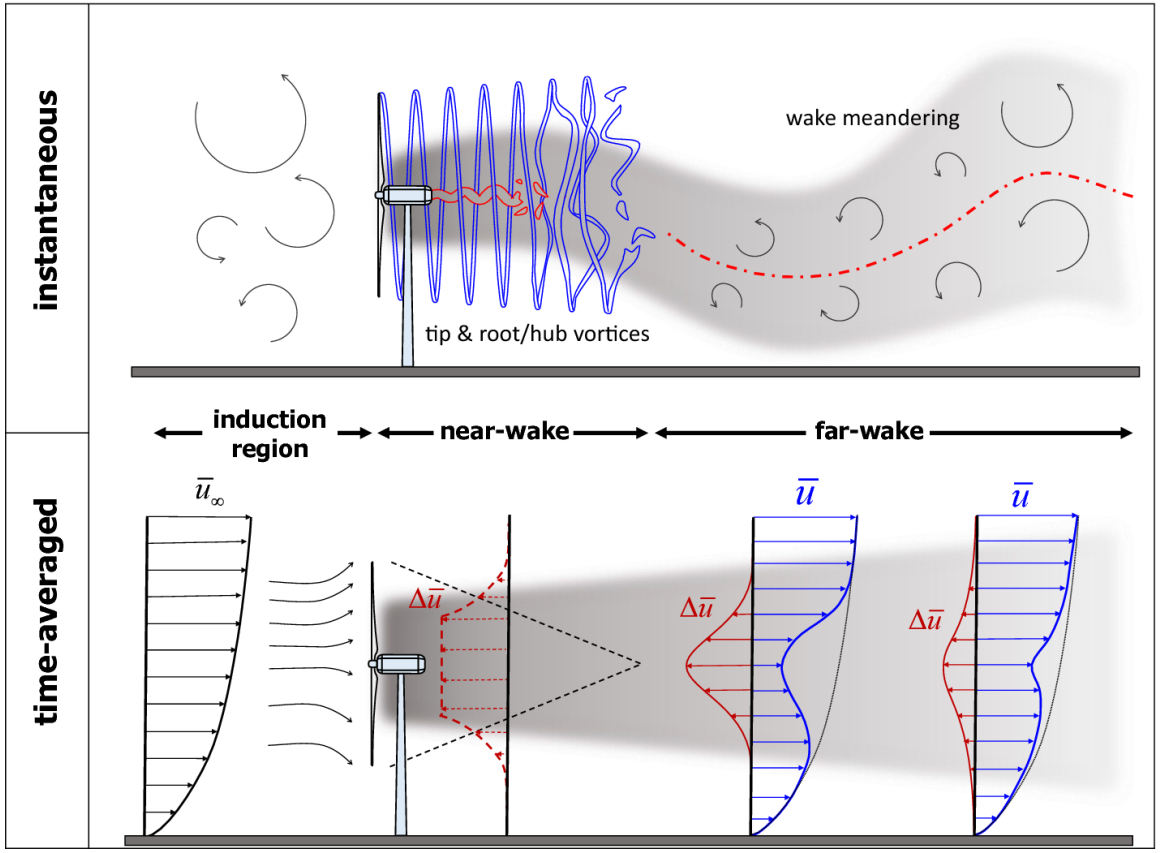

Porté-Agel, F., Bastankhah, M. & Shamsoddin, S. Wind-Turbine and Wind-Farm Flows: A Review. Boundary-Layer Meteorol 174, 1–59 (2020). https://doi.org/10.1007/s10546-019-00473-0

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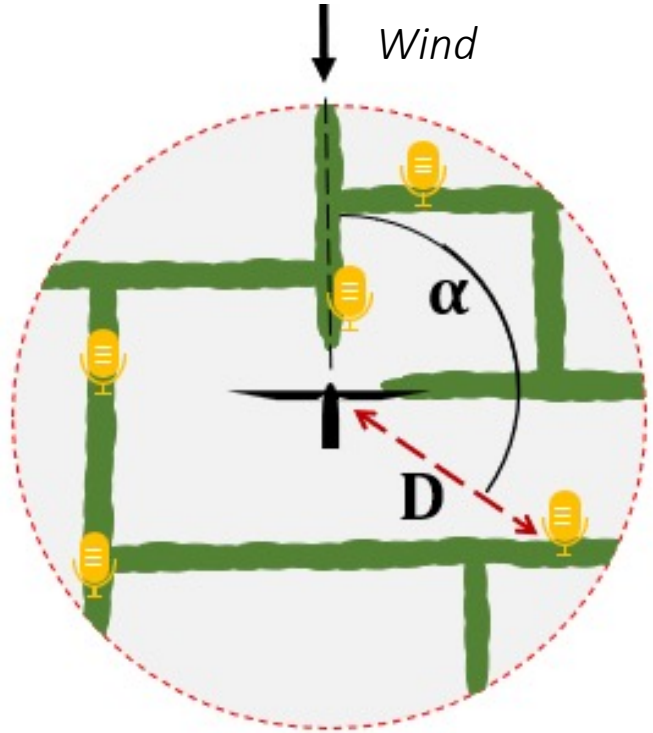
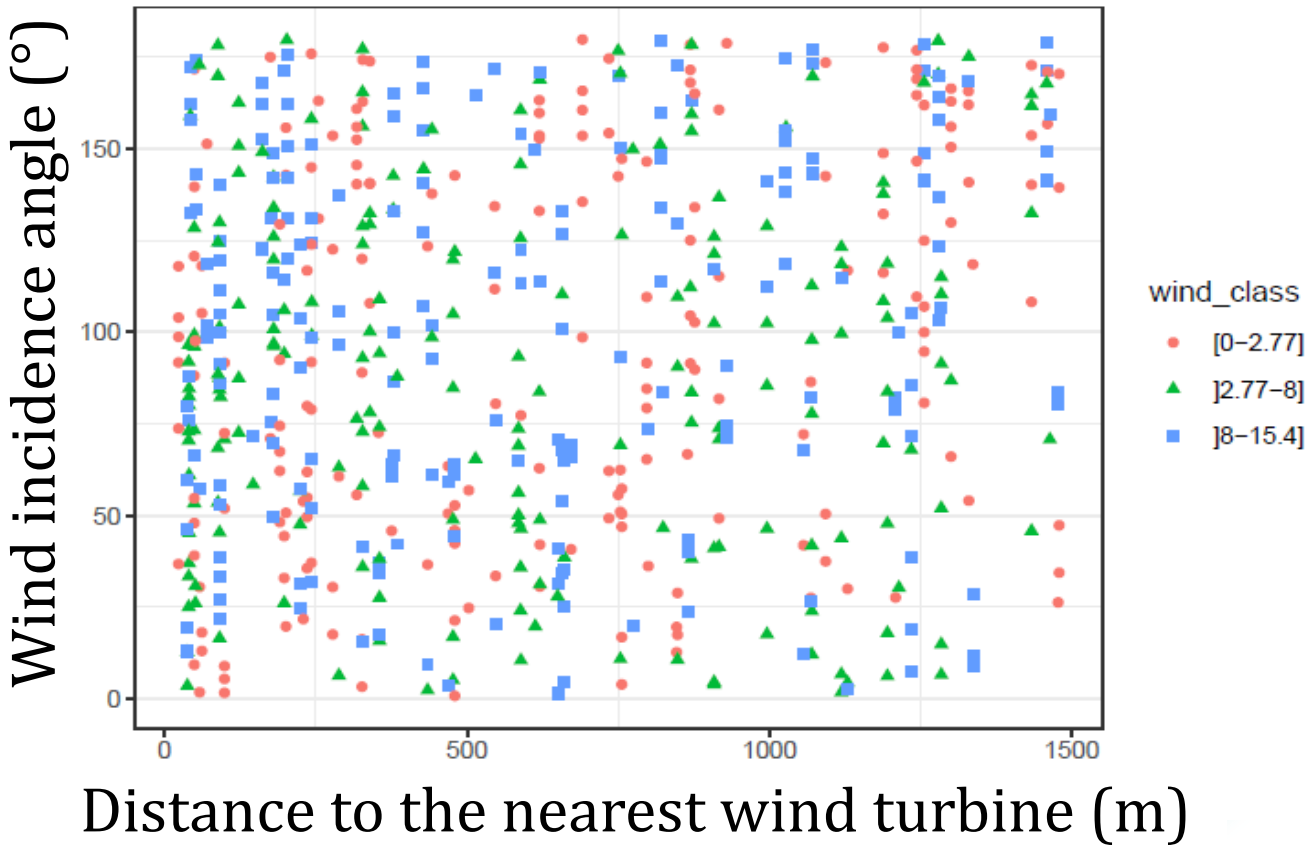
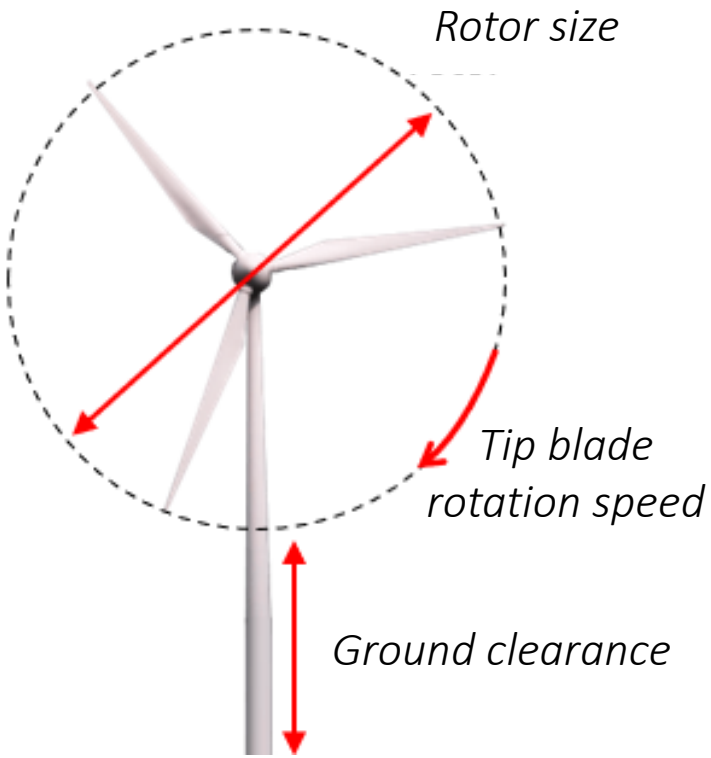




Methods

Operation and characteristics of the wind turbine



Weather conditions

: Average temperature

$V^{m.s^{-1}}$: Average wind speed

α : Wind incidence angle

Landscape variables

- Around the sites (50m → 10km):
  - *Habitat superficie*
  - *Length of landscape features (e.g. hedgerows, roads)*
- Distance to landscape features (e.g. forests, urban areas)

Methods

Full model

interactions

Bat activity ~ *Wind incidence angle* (α)
+ *Distance to nearest wind turbine* (D)
+ *Blade tip rotation speed* ($V^{m.s^{-1}}$)
+ *Ground clearance* (G) + *Rotor diameter* ($Ø$)
+ *Distance to nearest water* (D) + *Hedgerow length* (L)
+ *Average temperature* ( ) + *Average wind speed* ($V^{m.s^{-1}}$)
+ *Average precipitation* + (1|*site*) + (1|*night*)

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→ 1 model per season and taxa

5. Main results

Pipistrellus pipistrellus

Nyctalus spp.

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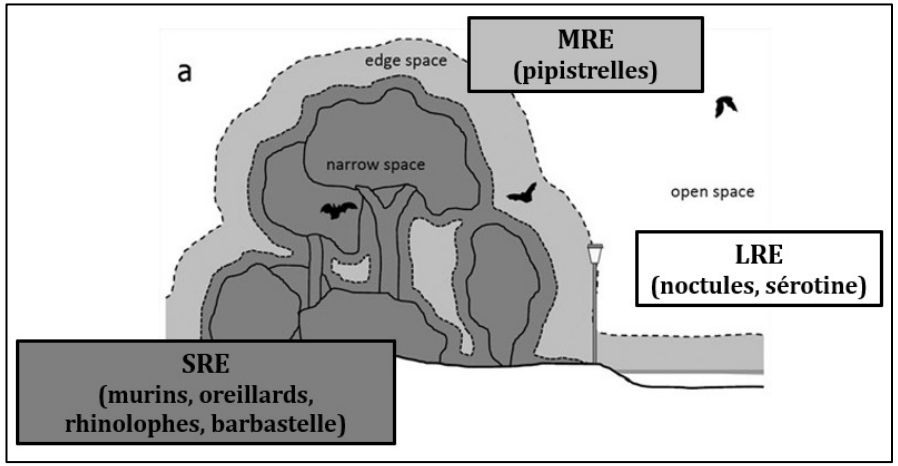
MRE = Mid-range echolocators

Nyctalus spp.
LRE = Long-range echolocators



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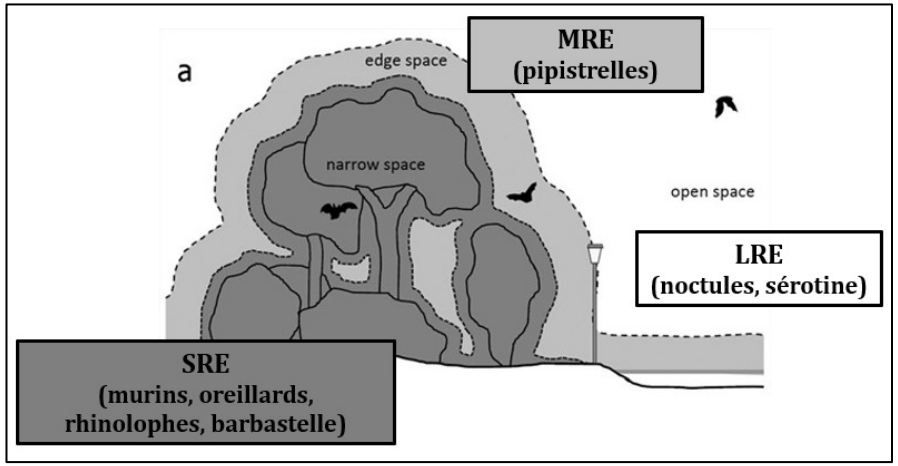

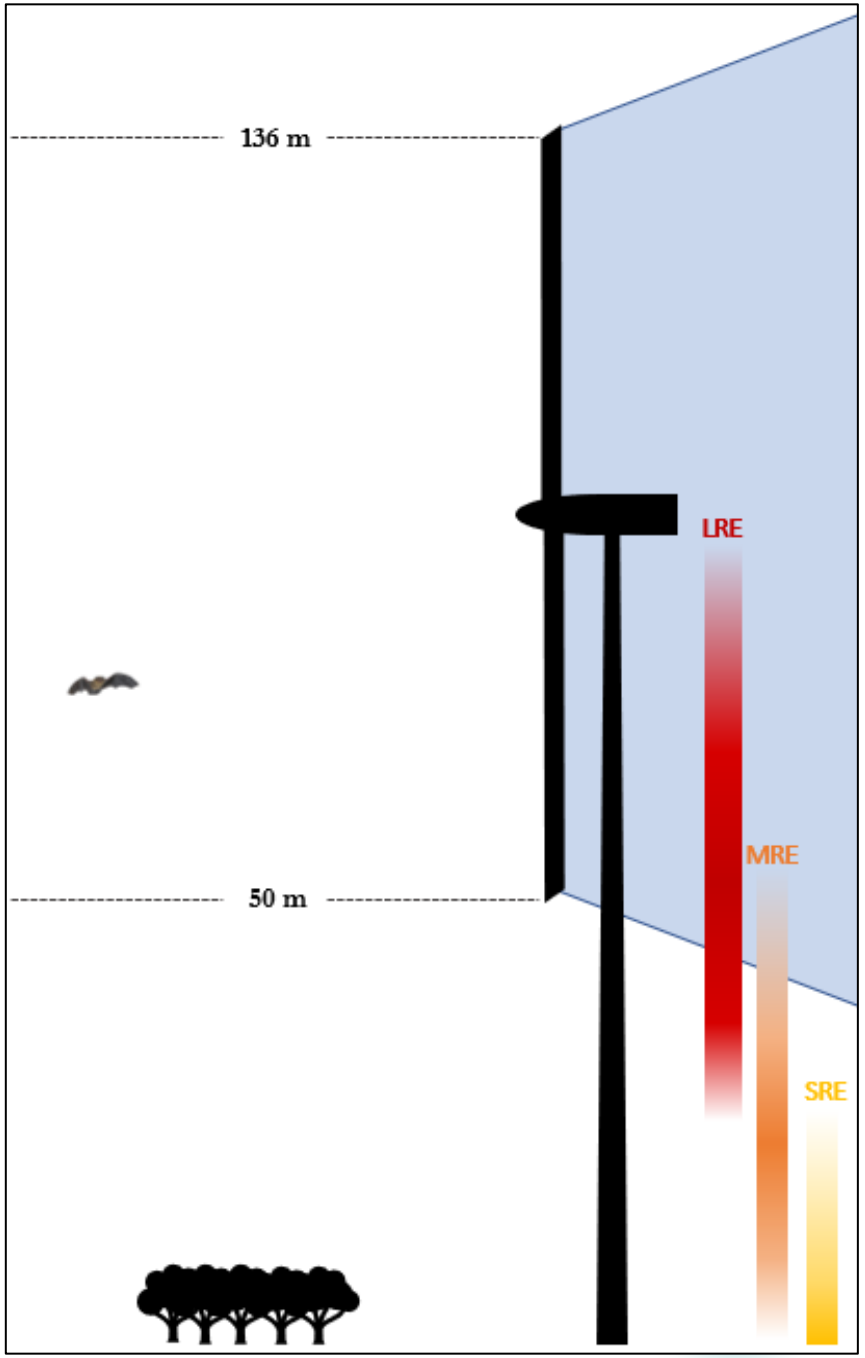

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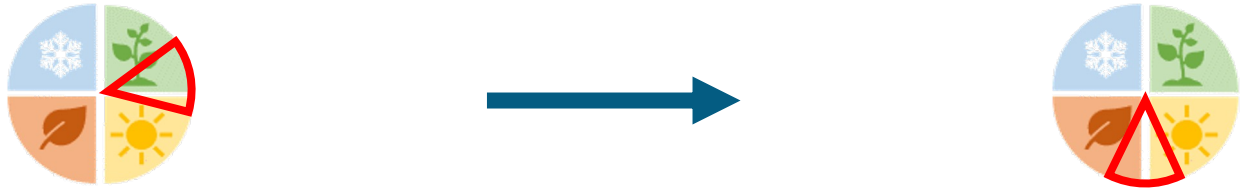

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- Rotor size: ▬
- Wind incidence angle and its interaction with rotation speed: ▬

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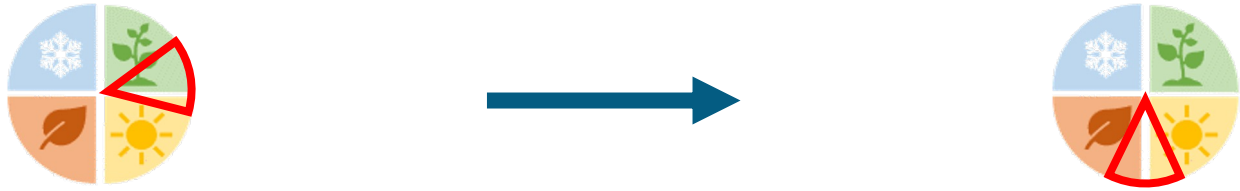

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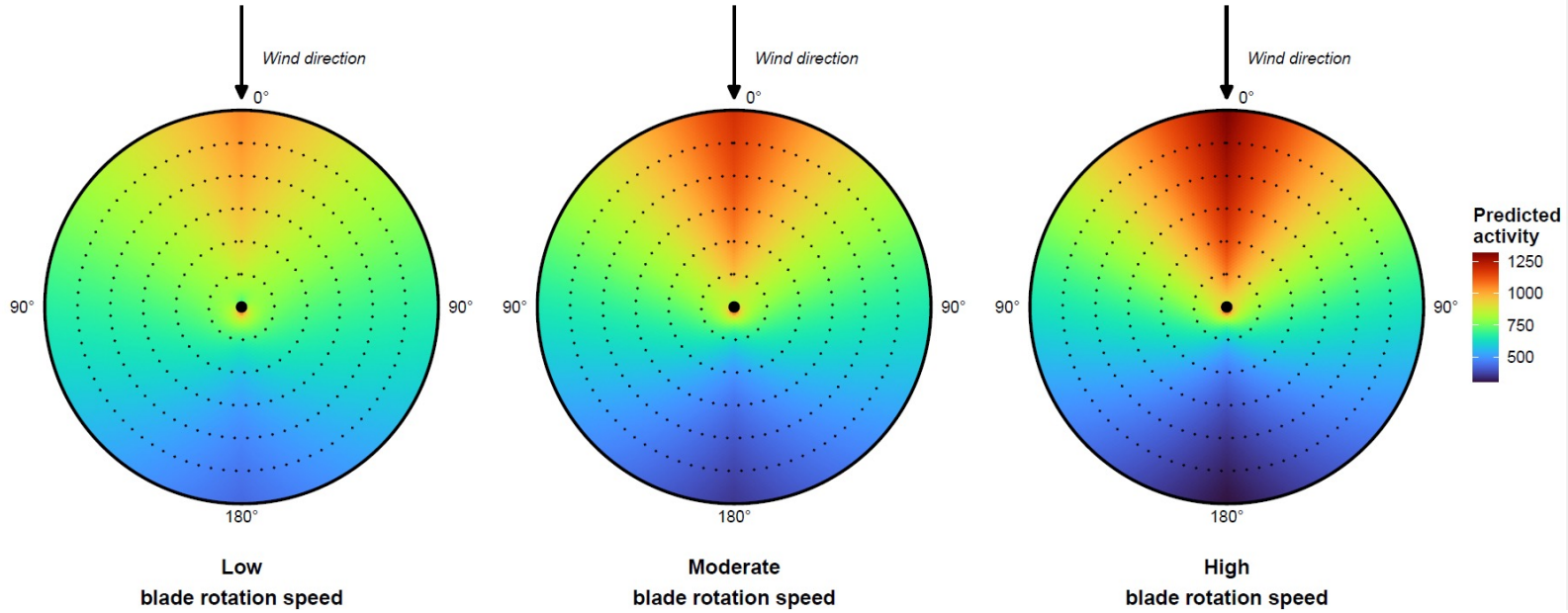

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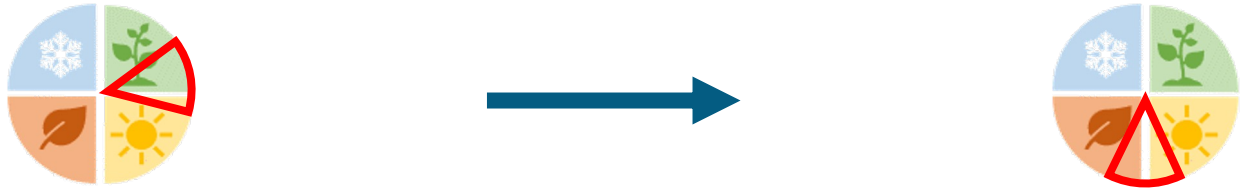

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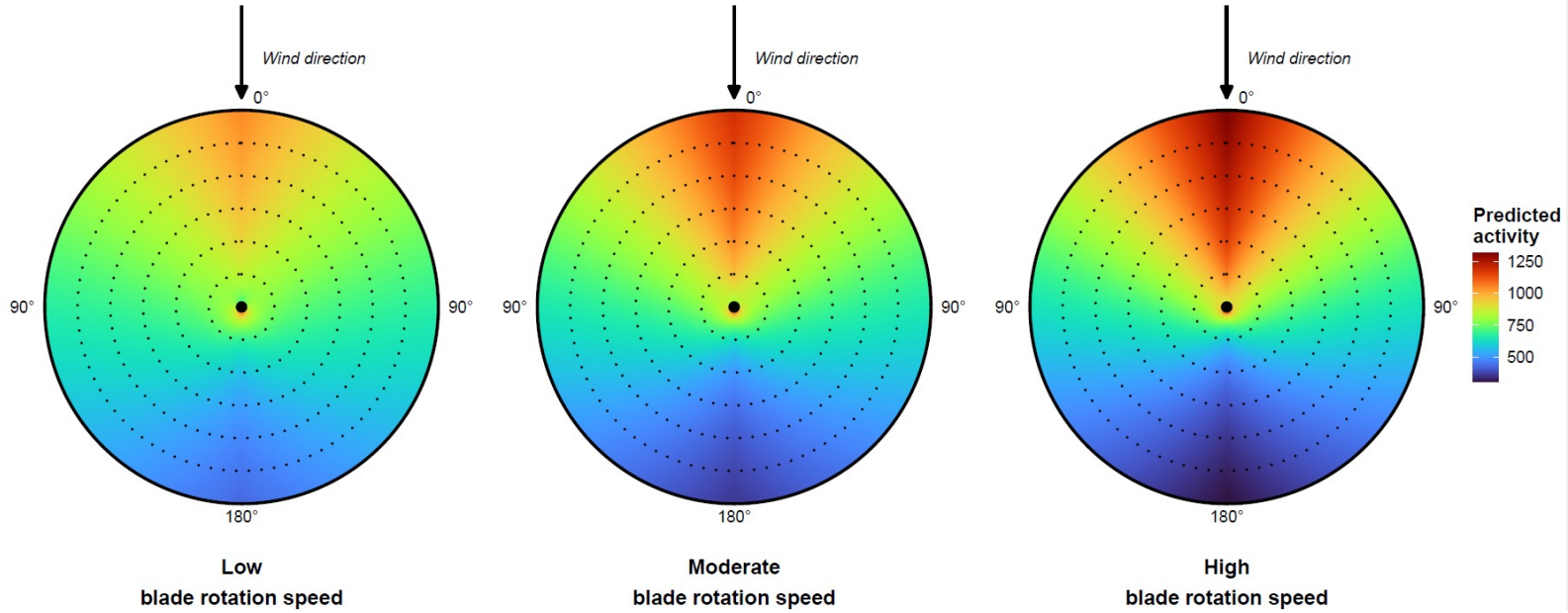

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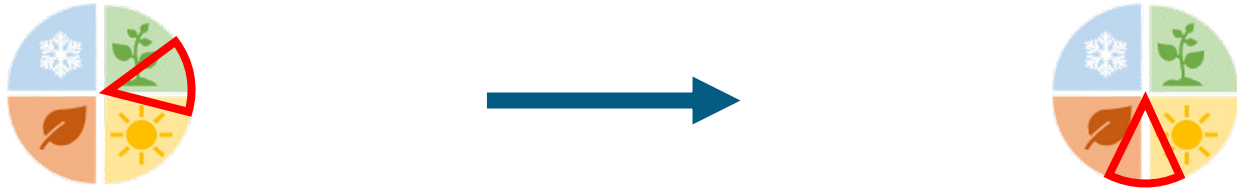

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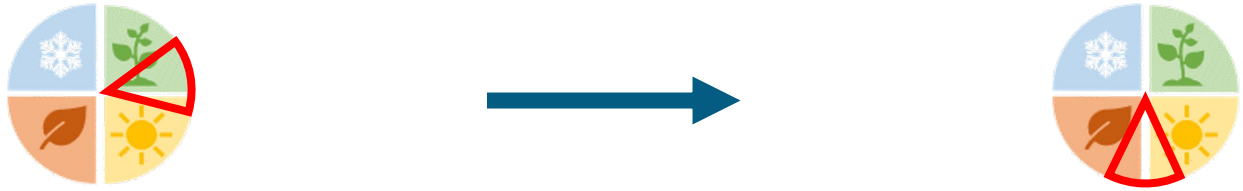

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- Depending on the species: differences in wind turbine variables affecting bat activity
- Depending on the season: the effects of wind turbines are generally more significant in late spring spring, whilst weather effects are more significant in late summer

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Recommendations:

- Keeping wind turbines away from suitable habitats
- Positionning wind turbines so as to minimise the exposure of suitable habitats to wake effects

7. Limits and perspectives

Limits:

- Biological measures at ground height (1.70m)
- Highly simplified wake effect

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Perspectives:

1. Re-analysis of this data using a more detailed wake modelling approach and a more in-depth analysis of the effects in relation to the landscape context:

   => BatWake (IFPEN, MNHN, Auddicé biodiversité)

2. New field season to carry out acoustic measurements at rotor height

   => Ongoing study of activity at hub height (thermal camera + acoustic monitoring)

3. Considering seasonal patterns in bats' behaviour towards wind turbines when developing curtailment algorithms?

   => AlgoChiro, EOLBAT

mirova research center

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MESSAGES CLÉS

1. Stronger impact of wind turbines in late spring –weather becoming more of a limiting factor in late summer?

2. Negative effect related to wind turbine rotation

3. Further research is needed related to bat interaction with wake effect

4. Need to take into account loss of habitat use in environmental impact assessments

Thank you for your attention!

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