DYNAMIC BROWNIAN BRIDGE MOVEMENT MODELS FOR SPATIAL ECOLOGY

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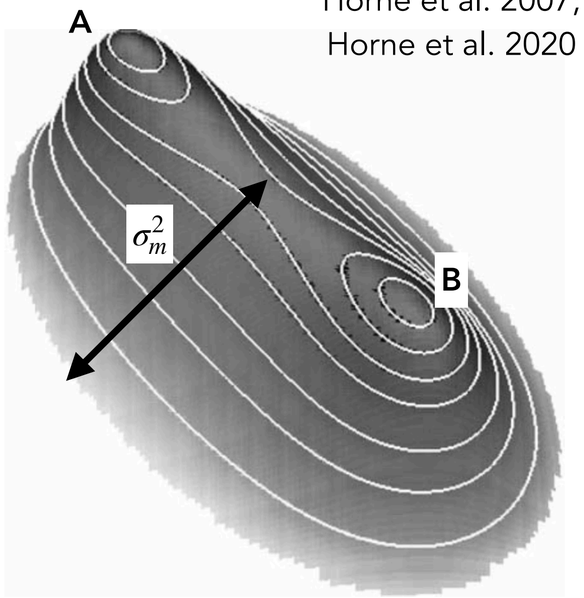
What <u>are</u> Brownian bridge movement models (BBMM)?

- **Horne et al. (2007)**: "The BBMM is based on the properties of a conditional random walk between successive pairs of locations, dependent on the time between locations, the distance between locations, and the Brownian motion variance that is related to the animal's mobility "
- **Also Horne et al. (2007)**: "A Brownian bridge is a continuous-time stochastic model of movement in which the probability of being in an area is conditioned on starting and ending locations, the elapsed time between those points, and the mobility or speed of movement."
- **Kranstauber et al. (2012)**: "The recent introduction of the Brownian bridge movement model (BBMM) improves on the traditional UD statistics by incorporating the temporal structure of tracking data and explicitly modelling the movement path … by incorporating both the order of locations and the amount of time between them. "

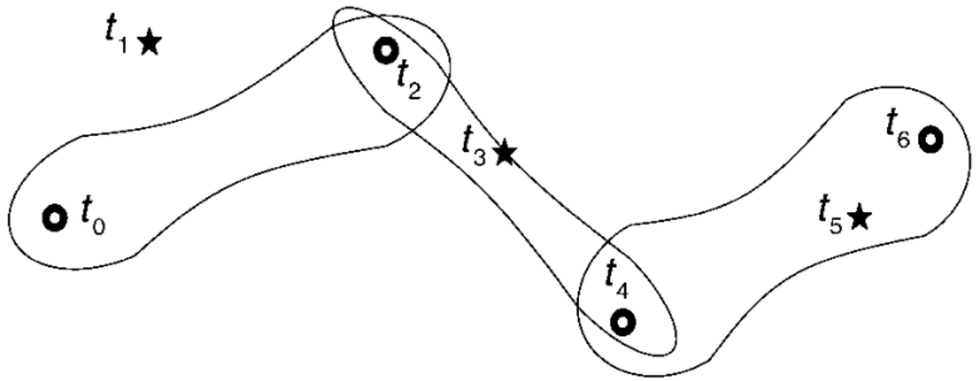
Horne et al. 2007;
Horne et al. 2020



σ_m^2 = Brownian motion variance

Potential issues with BBMMs

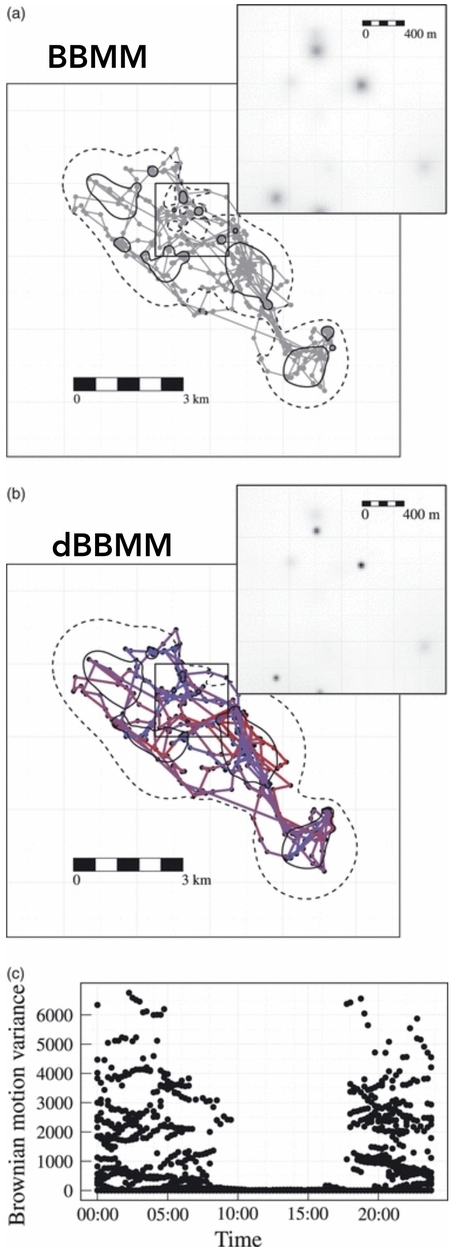
- No directional persistence in underlying model (Horne et al. 2020)
  - Only connects 2 points via a diffusive Brownian motion process
- Assumes homogeneous movement behavior pattern across full duration of tracks (Kranstauber et al. 2012)
  - May not capture dynamic process of behavioral shifts, resulting in imprecision of the estimated UD



Horne et al. 2007

dynamic BBMMs (dBBMM)

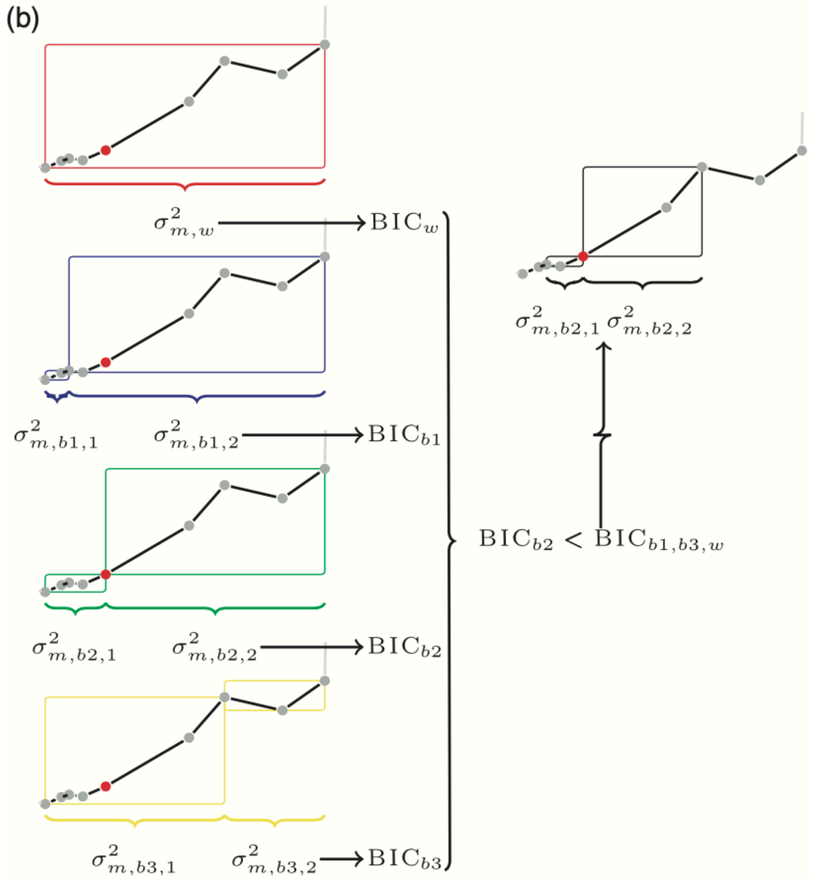
- Proposed as extension to estimate Brownian motion variance (σ_m^2) for different behavioral segments of tracks (Kranstauber et al. 2012)
- Performs modified behavioral change point analysis (BCPA) to estimate these behavioral shifts
- Expected to improve estimates of occurrence distributions of animal movement



Kranstauber et al. 2012

User-defined parameters of a dBBMM

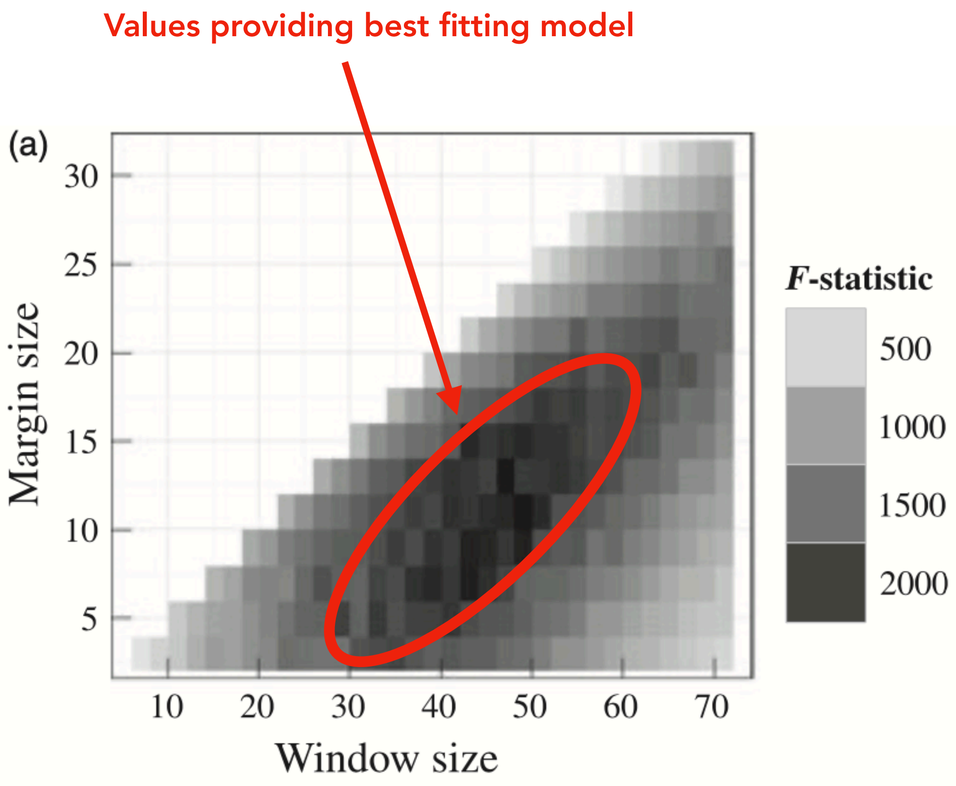
- Telemetry error for each observation
  - Can be single value or different value per observation
- Sliding window size (w)
  - Must be > $2m$
- Margin size (m)
  - Must be minimum of 3
  - On either end of w



Kranstauber et al. 2012

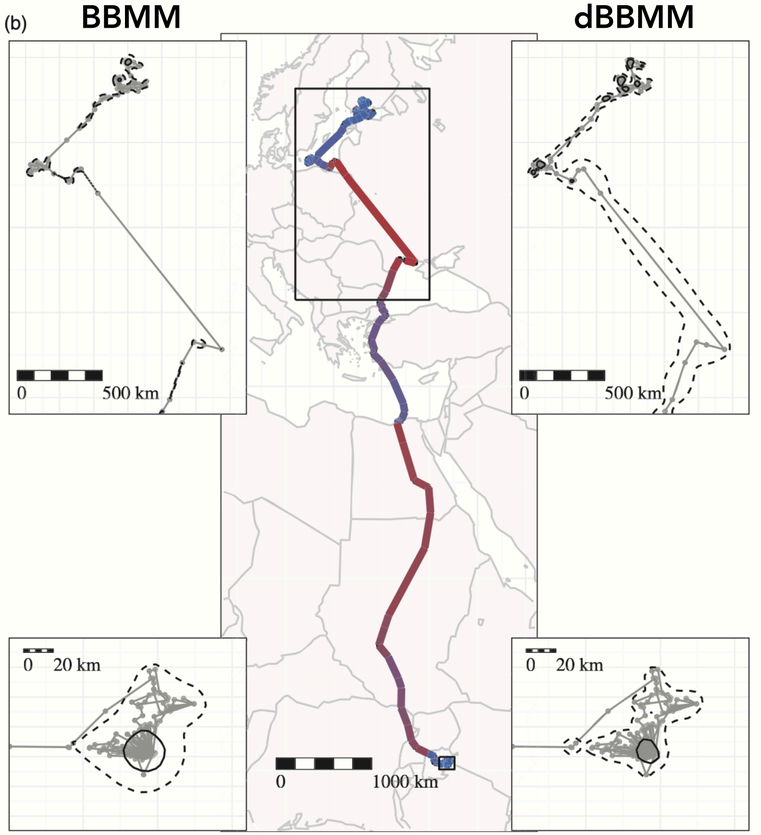
How to select w and m

- Increasing w increases the reliability of σ_m^2
  - At cost of missing rapid changes
- Increasing m increases likelihood of identifying relatively weak breakpoints
  - At cost of potentially not detecting breakpoints due to limited observations in w
- Choices for w and m should be determined by the time interval over which biologically relevant behavioral changes are expected to occur
- These values will vary depending on the time interval of the telemetry dataset (acoustic or satellite)

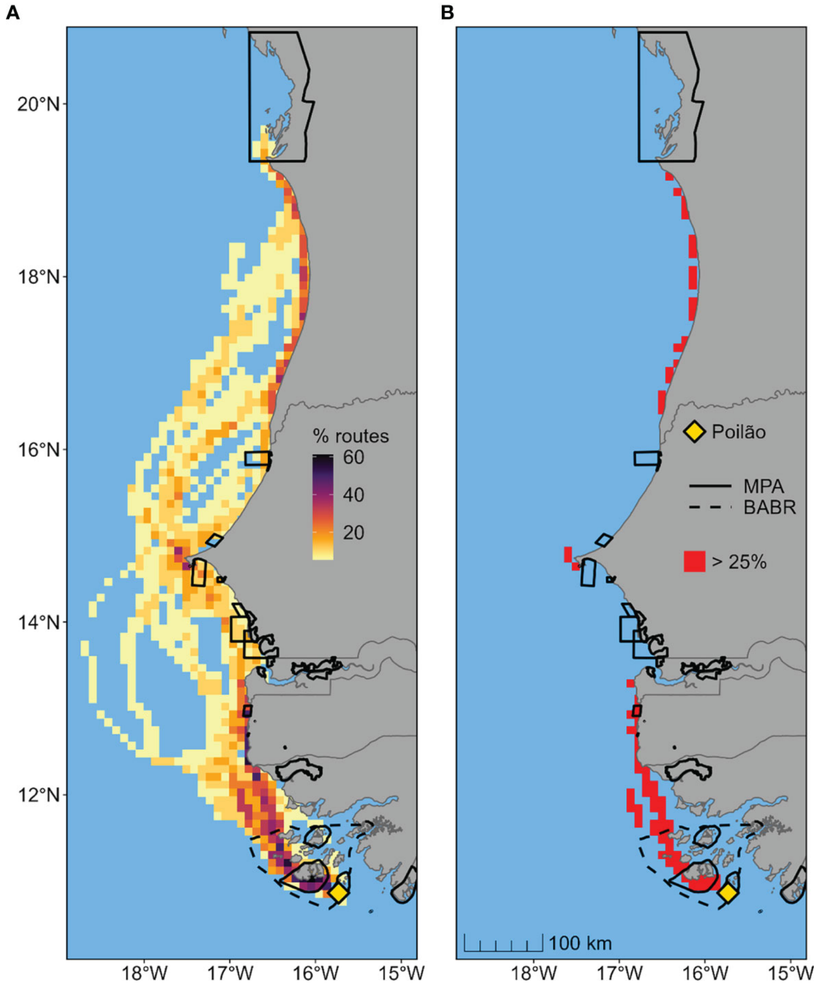


Kranstauber et al. 2012

Motivating examples

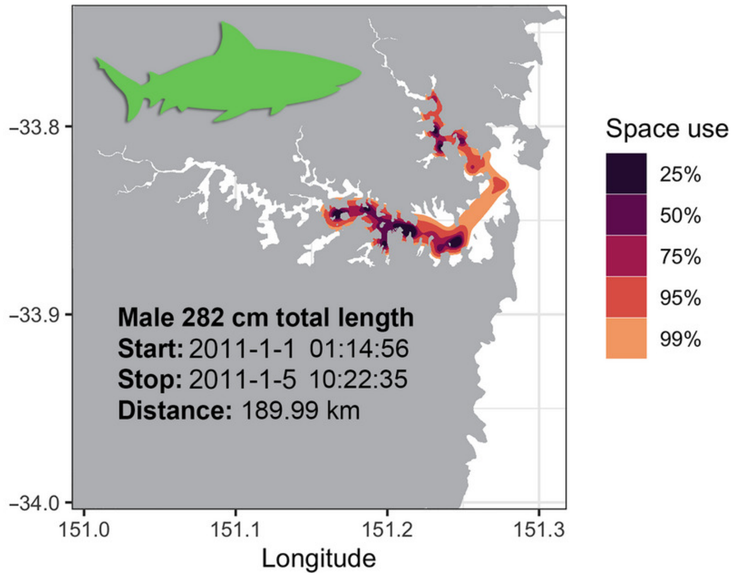


Kranstauber et al. 2012



Patrício et al. 2022

Niella et al. 2020



Let’s calculate dBBMMs!

References

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