Our model of woodcock flight altitudes included both potential flight locations and known ground locations, with each class of data informing a different aspect of the model. Known ground locations were assumed to always have a true altitude of 0m, making their recorded altitudes solely attributable to measurement error by the GPS units and can the recorded altitude for a given bird *i* can be modelled as follow:

|  |  |  |
| --- | --- | --- |
|  |  | Eq. 1 |

where is the mean average error observed across all birds and is the standard error associated with the error. As such, the ground locations can be used to inform directly the error term associated with the measurement error in our model for the birds in flights. The benefit of using the data to address issues related to measurement error, and the importance of addressing this issue are reviewed in Poessel et al 2018 and Péron et al. 2020.

For birds that are potentially in flight there are two possible outcomes. They can be in flight in which case = , or recorded in flight with altitude , in which case = + . This can be modelled as follows:

|  |  |  |
| --- | --- | --- |
|  |  | Eq. 2 |
|  |  | Eq. 3 |

Where for each bird i that is identified in flight (i.e., Ground =0) is drawn from a common Gamma distribution with the shape and a rate . The mean altitude observed for birds in flight () can be derived by dividing the shape by the rate parameter (i.e., ) and the standard deviation of the distribution can be derived by . The status of the birds, whether it is in flight or in the air, is evaluated by the model. We have used a latent discrete parameterization in the model since the programming language we used (i.e., Stan) does not support sampling discrete parameters. we provided an informed prior of p = 0.33*,* which we based on pre-existing knowledge of the ratio of stopovers to migratory flights during a typical woodcock migration (Fish et al. 2024). Measurement bias in the data, , was given an uninformative normal prior with mean 0 and standard deviation 1, while the standard deviation of the measurement error, , was given a half-normal prior with standard deviation 1. We gave and semi-informative priors to restrict their possible values to those that might sensibly describe a distribution scaled between 0 and 1 (McElreath 2018). After simulating possible distributions, we chose to give a half-normal prior with standard derivation 5 and a half-normal prior with standard derivation 10.