

# Package: mpmm (via r-universe)

October 11, 2026

**Type** Package

**Title** (Animal) Movement Persistence Mixed-Effects Models

**Version** 0.2-3

**Date** 2025-12-11

**Author** Ian Jonsen [aut, cre], Marie Auger-Méthé [aut, ctb]

**Description** Fit covariates as linear mixed-effects to latent, time-varying movement persistence (autocorrelation).

**Depends** R (>= 3.5.0)

**Imports** TMB (>= 1.7.19), glmmTMB (>= 1.0.0), Matrix (>= 1.2-12), dplyr (>= 1.0.0), tibble (>= 3.0.0), ggplot2, methods, wesanderson, tidyr, reformulas

**License** AGPL-3

**Encoding** UTF-8

**LazyData** true

**LinkingTo** RcppEigen, TMB

**RoxygenNote** 7.3.3

**Suggests** testthat (>= 3.0.0)

**Config/testthat/edition** 3

**Config/testthat/parallel** true

**Config/pak/sysreqs** cmake make libicu-dev

**Repository** <https://ianjonsen.r-universe.dev>

**Date/Publication** 2025-12-11 15:27:45 UTC

**RemoteUrl** <https://github.com/ianjonsen/mpmm>

**RemoteRef** HEAD

**RemoteSha** 1d5712d23814ac89ec3fffb4e9aa4a73fe91cf50

Contents

|                           |           |
|---------------------------|-----------|
| mpmm-package . . . . .    | 2         |
| anova.mpmm . . . . .      | 3         |
| ellie.ice . . . . .       | 3         |
| ellie.ice.short . . . . . | 3         |
| inner_control . . . . .   | 4         |
| logLik.mpmm . . . . .     | 4         |
| mpmm . . . . .            | 5         |
| mpmm_control . . . . .    | 6         |
| plot.mpmm . . . . .       | 8         |
| residuals.mpmm . . . . .  | 8         |
| summary.mpmm . . . . .    | 9         |
| <b>Index</b>              | <b>10</b> |

---

|              |             |
|--------------|-------------|
| mpmm-package | <b>mpmm</b> |
|--------------|-------------|

---

Description

fit movement persistence mixed-effects models to animal location data

Author(s)

Ian Jonsen

References

Jonsen ID, McMahon CR, Patterson TA, et al. (2019) Movement responses to environment: fast inference of variation among southern elephant seals with a mixed effects model. Ecology. 100(1):e02566  
<https://doi.org/10.1002/ecy.2566>

See Also

mpmm

---

|             |                     |
|-------------|---------------------|
| anova.mppmm | <i>anova tables</i> |
|-------------|---------------------|

---

**Description**

perform likelihood ratio tests on 2 or more mppmm fit objects

**Usage**

```
## S3 method for class 'mppmm'
anova(object, ...)
```

**Arguments**

|        |                              |
|--------|------------------------------|
| object | an mppmm fit object          |
| ...    | additional mppmm fit objects |

---

|           |                                                                                                                     |
|-----------|---------------------------------------------------------------------------------------------------------------------|
| ellie.ice | <i>foieGras-filtered Southern elephant seal Argos satellite data with environmental covariates (11 individuals)</i> |
|-----------|---------------------------------------------------------------------------------------------------------------------|

---

**Description**

Example elephant seal Argos tracking data with environmental covariates. Data were sourced from the Integrated Marine Observing System (IMOS) - IMOS is supported by the Australian Government through the National Collaborative Research Infrastructure Strategy and the Super Science Initiative.

**Format**

.RData

---

|                 |                                                                                                                    |
|-----------------|--------------------------------------------------------------------------------------------------------------------|
| ellie.ice.short | <i>foieGras-filtered Southern elephant seal Argos satellite data with environmental covariates (4 individuals)</i> |
|-----------------|--------------------------------------------------------------------------------------------------------------------|

---

**Description**

Example elephant seal Argos tracking data with environmental covariates. Data were sourced from the Integrated Marine Observing System (IMOS) - IMOS is supported by the Australian Government through the National Collaborative Research Infrastructure Strategy and the Super Science Initiative.

**Format**

.RData

---

|               |                                 |
|---------------|---------------------------------|
| inner_control | <i>Control Values for mpmmm</i> |
|---------------|---------------------------------|

---

### Description

inner\_control allows specification of control parameters for the inner optimization used by mpmmm

### Usage

```
inner_control(...)
```

### Arguments

... control parameters for the inner optimizer

### Details

See [MakeADFun](#) and [newton](#) for details and available options. Adapted from S. Wotherspoon <https://github.com/SWotherspoon/RWalc/blob/master/R/RWalc.R>

### Value

Returns a list with components:

|         |                                                |
|---------|------------------------------------------------|
| control | list of control parameters for inner optimizer |
|---------|------------------------------------------------|

### See Also

[MakeADFun](#), [newton](#)

### Examples

```
fit <- mpmmm(~ ice + (ice | id),
data = ellie.ice.short,
inner.control = inner_control(tol = 1e-03))
```

---

|              |                               |
|--------------|-------------------------------|
| logLik.mpmmm | <i>Extract log-likelihood</i> |
|--------------|-------------------------------|

---

### Description

extract log-likelihood from an mpmmm fit object

### Usage

```
## S3 method for class 'mpmmm'
logLik(object, ...)
```

**Arguments**

|        |                                    |
|--------|------------------------------------|
| object | an mpmm model fit object           |
| ...    | additional arguments to be ignored |

---

mpmm

---

*Move Persistence Mixed-Effects Model*


---

**Description**

Fit a move persistence random walk via TMB to a pre-filtered/regularized animal track and estimate gamma as a linear function of covariates

**Usage**

```
mpmm(
  formula = NA,
  data = NULL,
  map = NULL,
  control = mpmm_control(),
  inner.control = inner_control()
)
```

**Arguments**

|               |                                                                                                                     |
|---------------|---------------------------------------------------------------------------------------------------------------------|
| formula       | a right-hand-side regression formula (no response variable)                                                         |
| data          | a data frame of observations (see details)                                                                          |
| map           | a named list of parameters as factors that are to be fixed during estimation, e.g.,<br>list(rho = factor(NA))       |
| control       | a list of control parameters for the outer optimization (see <a href="#">mpmm_control</a> )                         |
| inner.control | a list of control parameters for the inner optimization (see <a href="#">MakeADFun</a> and <a href="#">newton</a> ) |

**Details**

The input track is given as a dataframe where each row is an observed location and columns

- 'id' individual animal identifier,
- 'date' observation time (POSIXct,GMT),
- 'lon' observed longitude,
- 'lat' observed latitude,
- 'tid' identifier for tracks if there are more than one track per individual (optional),
- '...' named covariates appended to track

**Value**

a list with components

|        |                                      |
|--------|--------------------------------------|
| states | a dataframe of estimated states      |
| fitted | a dataframe of fitted locations      |
| par    | model parameter summary              |
| data   | input dataframe                      |
| tmb    | the tmb object                       |
| opt    | the object returned by the optimizer |

**Examples**

```
data(ellie.ice.short)
fit <- mpmm(~ ice + (1 | id), data = ellie.ice.short)
summary(fit)
```

---

|              |                                 |
|--------------|---------------------------------|
| mpmm_control | <i>Control Values for mpmm.</i> |
|--------------|---------------------------------|

---

**Description**

mpmm\_control selects the numerical minimizer, method, associated control parameters, parameter bounds, and likelihood estimation (REML or ML) used by mpmm.

**Usage**

```
mpmm_control(
  optim = c("nlminb", "optim"),
  method = c("BFGS", "L-BFGS-B"),
  lower = NULL,
  upper = NULL,
  REML = FALSE,
  profile = FALSE,
  verbose = 2,
  ...
)
```

**Arguments**

|        |                                                                                                                                                  |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| optim  | the numerical optimizer used in the fit                                                                                                          |
| method | optimization method to be used - one of "BFGS" or "L-BFGS-B" for bounded optimization (default lower and upper bounds are used if not specified) |
| lower  | a list of named parameter lower bounds, if NULL then built in defaults are used when method = "L-BFGS-B", otherwise ignored                      |

|         |                                                                                                                             |
|---------|-----------------------------------------------------------------------------------------------------------------------------|
| upper   | a list of named parameter upper bounds, if NULL then built in defaults are used when method = "L-BFGS-B", otherwise ignored |
| REML    | logical; whether to use REML (TRUE) or maximum likelihood                                                                   |
| profile | logical; option to improve speed and convergence by using REML parameter estimates as initial values for ML optimization    |
| verbose | integer; report progress during minimization: 0 = silent; 1 = optimizer trace; 2 = parameter trace (default))               |
| ...     | control parameters for the chosen optimizer                                                                                 |

### Details

The optimizer used to minimize the objective function is selected by the `optim` argument. Additional control parameters specific to the chosen optimizer are specified via the `dots` argument. See [nlminb](#) and [optim](#) for available options. Adapted from S. Wotherspoon <https://github.com/SWotherspoon/RWalc/blob/master/R/RWalc.R>

### Value

Returns a list with components

|         |                                                                      |
|---------|----------------------------------------------------------------------|
| optim   | the name of the numerical optimizer as a string, "nlminb" or "optim" |
| method  | optimization method to be used                                       |
| lower   | named list of lower parameter bounds                                 |
| upper   | named list of upper parameter bounds                                 |
| REML    | whether REML is to be used in place of ML                            |
| profile | whether to enhance convergence robustness                            |
| verbose | level of tracing information to be reported                          |
| control | list of control parameters for the optimizer                         |

### See Also

[nlminb](#), [optim](#).

### Examples

```
fit <- mpmm(~ ice + (ice | id),
data = ellie.ice.short,
control = mpmm_control(
  optim = "nlminb",
  REML = FALSE,
  eval.max = 2000)
)
```

---

plot.mpmmm

*plot*


---

### Description

Visualise fixed and random covariate relationships from an mpmmm fit object

### Usage

```
## S3 method for class 'mpmmm'
plot(x, label = FALSE, lwd = c(0.25, 0.75), ...)
```

### Arguments

|       |                                                                   |
|-------|-------------------------------------------------------------------|
| x     | an mpmmm fit object                                               |
| label | add id labels to random effects                                   |
| lwd   | a vector of regression line widths (random effect, fixed effects) |
| ...   | additional arguments to be ignored                                |

---

residuals.mpmmm

*residuals*


---

### Description

Extract one-step-ahead residuals

### Usage

```
## S3 method for class 'mpmmm'
residuals(
  object,
  method = "oneStepGaussianOffMode",
  trace = FALSE,
  parallel = TRUE,
  ncores = detectCores() - 1,
  ...
)
```

### Arguments

|          |                                                                      |
|----------|----------------------------------------------------------------------|
| object   | an mpmmm fit object                                                  |
| method   | character naming the method to calculate one-step-ahead residuals    |
| trace    | logical; print progress to console                                   |
| parallel | logical; compute in parallel                                         |
| ncores   | integer; number of cores to use (default = total cores detected - 1) |
| ...      | additional arguments to be ignored                                   |

**Details**

Wrapper function for modified `oneStepPredict` that calculates one-step-ahead residuals, which are residuals that account for temporal correlation in latent states. The modification allows easier parallel computation.

**Value**

a list with components

`res` a tibble with one-step-ahead residuals for longitude and latitude

**References**

Thygesen, U. H., C. M. Albertsen, C. W. Berg, K. Kristensen, and A. Neilsen. 2017. Validation of ecological state space models using the Laplace approximation. *Environmental and Ecological Statistics* 24:317–339.

**Examples**

```
## Not run:
data(ellie.ice)
fit <- mpm(~ ice + (1 | id), data = ellie.ice)
summary(fit)
residuals(fit)

## End(Not run)
```

---

summary.mpm

*object summaries*


---

**Description**

return a summary of an mpm fit object

**Usage**

```
## S3 method for class 'mpm'
summary(object, ...)
```

**Arguments**

`object` an mpm fit object  
`...` additional arguments to be ignored

# Index

- \* **data**
  - ellie.ice, [3](#)
  - ellie.ice.short, [3](#)
- \* **mpmm**
  - mpmm-package, [2](#)
- anova.mpmm, [3](#)
- ellie.ice, [3](#)
- ellie.ice.short, [3](#)
- inner\_control, [4](#)
- logLik.mpmm, [4](#)
- MakeADFun, [4](#), [5](#)
- mpmm, [5](#)
- mpmm-package, [2](#)
- mpmm\_control, [5](#), [6](#)
- newton, [4](#), [5](#)
- nlminb, [7](#)
- oneStepPredict, [9](#)
- optim, [7](#)
- plot.mpmm, [8](#)
- residuals.mpmm, [8](#)
- summary.mpmm, [9](#)