

# Package: dilp (via r-universe)

October 17, 2024

**Title** Reconstruct Paleoclimate and Paleoecology with Leaf Physiognomy

**Version** 1.1.0

**Description** Use leaf physiognomic methods to reconstruct mean annual temperature (MAT), mean annual precipitation (MAP), and leaf dry mass per area (Ma), along with other useful quantitative leaf traits. Methods in this package described in Lowe et al. (in review).

**License** GPL (>= 3)

**URL** <https://github.com/mjbutrim/dilp>, <https://mjbutrim.github.io/dilp/>

**BugReports** <https://github.com/mjbutrim/dilp/issues>

**Depends** R (>= 2.10)

**Imports** dplyr, ggplot2, ggrepel, grDevices, magrittr, rlang, stats, stringr, tidyr, utils, vegan

**Encoding** UTF-8

**LazyData** true

**Roxygen** list(markdown = TRUE)

**RoxygenNote** 7.3.1

**Suggests** knitr, rmarkdown, testthat (>= 3.0.0)

**Config/testthat/edition** 3

**VignetteBuilder** knitr

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

**RemoteUrl** <https://github.com/mjbutrim/dilp>

**RemoteRef** HEAD

**RemoteSha** ef640beef4e551f88bf14889a151ddc41a68ea52

## Contents

calc_lma . . . . .	2
climate_calibration_data . . . . .	4

dilp	5
dilp_cca	7
dilp_errors	9
dilp_outliers	9
dilp_processing	10
lma	11
McAbeeExample	12
physiognomy_calibration_data	13
precip_slr	14
temp_slr	16
view_regressions	17

## Index 18

---

calc_lma	<i>Generate leaf mass per area results</i>
----------	--

---

### Description

calc\_lma() will typically only be called internally by lma(). It provides the flexibility to use custom regression parameters to calculate leaf mass per area (LMA).

### Usage

```
calc_lma(data, params, resolution = "species")
```

### Arguments

data	Must include "petiole metric" or some combination of columns to calculate petiole metric such as "Blade Area", "Petiole Area", and "Petiole Width", or "Leaf Area" and "Petiole Width". If calculating morphospecies-mean LMA, must include "Site" and "Morphotype" columns. If calculating species-mean LMA, only needs to include a "Site" column.
params	A list of regression parameters. Must contain "stat" (= "mean" or = "variance"), "regression_slope", "y_intercept", "unexplained_mean_square", "sample_size_calibration" "mean_log_petiole_metric_calibration", "sum_of_squares_calibration", and "critical_value".

Pre-loaded sets of parameters:

**"royer\_species\_mean\_ma":**

- stat = "mean",
- regression\_slope = 0.382,
- y\_intercept = 3.070,
- unexplained\_mean\_square = 0.032237,
- sample\_size\_calibration = 667,
- mean\_log\_petiole\_metric\_calibration = -3.011,
- sum\_of\_squares\_calibration = 182.1,
- critical\_value = 1.964

```

"royer_site_mean_ma": • stat = "mean",
  • regression_slope = 0.429,
  • y_intercept = 3.214,
  • unexplained_mean_square = 0.005285,
  • sample_size_calibration = 25,
  • mean_log_petiole_metric_calibration = -2.857,
  • sum_of_squares_calibration = 5.331,
  • critical_value = 2.069
"lowe_site_mean_ma": • stat = "mean",
  • regression_slope = 0.345,
  • y_intercept = 2.954,
  • unexplained_mean_square = 0.01212861,
  • sample_size_calibration = 70,
  • mean_log_petiole_metric_calibration = -2.902972,
  • sum_of_squares_calibration = 1.154691,
  • critical_value = 1.995469
"lowe_site_variance_ma": • stat = "variance",
  • regression_slope = 0.302,
  • y_intercept = 5.028,
  • unexplained_mean_square = 0.1713672,
  • sample_size_calibration = 70,
  • mean_log_petiole_metric_calibration = -5.97104,
  • sum_of_squares_calibration = 5.085184,
  • critical_value = 1.995469

```

resolution Either "species" or "site". Informs whether the function should calculate morphospecies-mean LMA values ("species") or site-mean/site-variance LMA values ("site"). If resolution = "site", data must already be in the form of species-mean LMA.

## Value

A table with LMA results

## References

- Royer, D. L., L. Sack, P. Wilf, C. H. Lusk, G. J. Jordan, Ulo Niinemets, I. J. Wright, et al. 2007. Fossil Leaf Economics Quantified: Calibration, Eocene Case Study, and Implications. *Paleobiology* 33: 574–589
- Lowe, A. J., D. L. Royer, D. J. Wiczyński, M. J. Butrim, T. Reichgelt, L. Azevedo-Schmidt, D. J. Peppe, et al. 2024. Global patterns in community-scale leaf mass per area distributions of woody non-monocot angiosperms and their utility in the fossil record. In review.

**Examples**

```
# Calculate morphospecies-mean LMA values with the parameters from Royer et al. (2007)
results <- calc_lma(McAbeeExample,
  params = list(
    stat = "mean",
    regression_slope = 0.382,
    y_intercept = 3.070,
    unexplained_mean_square = 0.032237,
    sample_size_calibration = 667,
    mean_log_petiole_metric_calibration = -3.011,
    sum_of_squares_calibration = 182.1,
    critical_value = 1.964
  ),
  resolution = "species"
)
results

# Calculate site-mean LMA values with the parameters from Lowe et al. (2024) entered from scratch
site_results <- calc_lma(results,
  params = list(
    stat = "mean",
    regression_slope = 0.345,
    y_intercept = 2.954,
    unexplained_mean_square = 0.01212861,
    sample_size_calibration = 70,
    mean_log_petiole_metric_calibration = -2.902972,
    sum_of_squares_calibration = 1.154691,
    critical_value = 1.995469
  ),
  resolution = "site"
)
site_results
```

---

climate\_calibration\_data

*Climate Calibration Data*

---

**Description**

Temperature and precipitation data associated with the modern localities used to calibrate the DiLP model

**Usage**

climate\_calibration\_data

**Format**

climate\_calibration\_data:

A data frame with 92 rows and 3 columns:

**Site** Locality name

**MAT** Mean Annual Temperature (celsius)

**MAP** Mean Annual Precipitation (mm)

**Source**

Peppe et al. 2011

**References**

- Peppe, D.J., Royer, D.L., Cariglino, B., Oliver, S.Y., Newman, S., Leight, E., Enikolopov, G., Fernandez-Burgos, M., Herrera, F., Adams, J.M., Correa, E., Currano, E.D., Erickson, J.M., Hinojosa, L.F., Hoganson, J.W., Iglesias, A., Jaramillo, C.A., Johnson, K.R., Jordan, G.J., Kraft, N.J.B., Lovelock, E.C., Lusk, C.H., Niinemets, Ü., Peñuelas, J., Rapson, G., Wing, S.L. and Wright, I.J. (2011), Sensitivity of leaf size and shape to climate: global patterns and paleoclimatic applications. *New Phytologist*, 190: 724-739. <https://doi.org/10.1111/j.1469-8137.2010.03615.x>

---

dilp

*Generate DiLP results*

---

**Description**

dilp() processes raw leaf physiognomic data, checks for common errors/outliers, and returns the processed data, keys to finding potential errors or outliers, and paleoclimate reconstructions.

**Usage**

```
dilp(specimen_data, params = "PeppeGlobal", subsite_cols = NULL)
```

**Arguments**

specimen\_data A data frame containing specimen level leaf physiognomic data. See Lowe et al. 2024 for more information on how to collect this data. A good reference for how to put together the data: [McAbeeExample](#)

Required columns:

- site
- specimen\_number
- morphotype
- margin
- feret
- blade\_area

- raw\_blade\_perimeter
- internal\_raw\_blade\_perimeter
- length\_of\_cut\_perimeter
- no\_of\_primary\_teeth
- no\_of\_subsidary\_teeth

Recommended columns:

- petiole\_width
- petiole\_area
- blade\_perimeter
- minimum\_feret
- raw\_blade\_area
- internal\_raw\_blade\_area

params

Either a string referring to one of two preloaded parameter sets or a list of custom parameters (same format as the list below).

Preloaded parameter sets are "PeppeGlobal" and "PeppeNH" which are calibrated based on global and northern hemisphere data respectively. Allen et al. (2020) illustrates a situation in which the northern hemisphere parameters may be preferable. The "PeppeNH" parameters only estimate MAT. Use "PeppeGlobal" for all MAP estimates. Defaults to "PeppeGlobal" as follows (Peppe et al. 2011):

- MAT.MLR.M = 0.21,
- MAT.MLR.FDR = 42.296,
- MAT.MLR.TC.IP = -2.609,
- MAT.MLR.constant = -16.004,
- MAT.MLR.error = 4,
- MAT.SLR.M = 0.204,
- MAT.SLR.constant = 4.6,
- MAT.SLR.error = 4.9,
- MAP.MLR.LA = 0.298,
- MAP.MLR.TC.IP = 0.279,
- MAP.MLR.PR = -2.717,
- MAP.MLR.constant = 3.033,
- MAP.MLR.SE = 0.6,
- MAP.SLR.LA = 0.283,
- MAP.SLR.constant = 2.92,
- MAP.SLR.SE = 0.61

subsite\_cols

A vector or list of columns present in `specimen_data` to calculate paleoclimate estimates for. A completely optional parameter - allows different groupings of specimens to be tested, or comparisons of paleoclimate estimates at different levels of grouping. Adds additional estimates to `$results`.

**Value**

A list of tables that includes all pertinent DiLP information:

- `processed_leaf_data`: the full set of cleaned and newly calculated leaf physiognomic data that is necessary for DiLP analysis. See `dilp_processing()` for more information.
- `processed_morphotype_data`: morphospecies-site pair means for all leaf physiognomic data.
- `processed_site_data`: site means for all leaf physiognomic data.
- `errors`: lists any specimens that may be causing common errors in DiLP calculations. See `dilp_errors()` for more information.
- `outliers`: flags outliers in variables used for DiLP analysis that may represent incorrect data. See `dilp_outliers()` for more information.
- `results`: climate reconstructions of MAT and MAP using single and multi-linear regressions.

**References**

- Allen, S. E., Lowe, A. J., Peppe, D. J., & Meyer, H. W. (2020). Paleoclimate and paleoecology of the latest Eocene Florissant flora of central Colorado, USA. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 551, 109678.
- Peppe, D.J., Royer, D.L., Cariglino, B., Oliver, S.Y., Newman, S., Leight, E., Enikolopov, G., Fernandez-Burgos, M., Herrera, F., Adams, J.M., Correa, E., Currano, E.D., Erickson, J.M., Hinojosa, L.F., Hoganson, J.W., Iglesias, A., Jaramillo, C.A., Johnson, K.R., Jordan, G.J., Kraft, N.J.B., Lovelock, E.C., Lusk, C.H., Niinemets, Ü., Peñuelas, J., Rapson, G., Wing, S.L. and Wright, I.J. (2011), Sensitivity of leaf size and shape to climate: global patterns and paleoclimatic applications. *New Phytologist*, 190: 724-739. <https://doi.org/10.1111/j.1469-8137.2010.03615.x>
- Lowe, A.J., Flynn, A.G., Butrim, M.J., Baumgartner, A., Peppe, D.J., and Royer, D.L. (2024), Reconstructing terrestrial paleoclimate and paleoecology with fossil leaves using Digital Leaf Physiognomy and leaf mass per area. *JoVE*.

**Examples**

```
dilp_results <- dilp(McAbeeExample)
dilp_results$processed_leaf_data
dilp_results$processed_morphotype_data
dilp_results$processed_site_data
dilp_results$errors
dilp_results$outliers
dilp_results$results
```

---

`dilp_cca`

*Test if site leaf physiognomy falls within the physiognomic space of the DiLP calibration dataset*

---

## Description

`dilp_cca` plots a canonical correspondence analysis (CCA) ordination of the leaf physiognomic space represented in the calibration dataset of Peppe et al. (2011). The fossil sites being tested are placed along the CCA axes. If a fossil site falls outside of the plotted calibration space, paleoclimate reconstructions for that fossil site should be treated with caution.

## Usage

```
dilp_cca(  
  dilp_table,  
  physiognomy_calibration = physiognomyCalibration,  
  climate_calibration = climateCalibration  
)
```

## Arguments

`dilp_table`        The results of a call to `dilp()`

`physiognomy_calibration`  
                  A physiognomic calibration dataset. Defaults to an internal version of `physiognomy_calibration_data`.

`climate_calibration`  
                  A climate calibration dataset. Defaults to an internal version of `climate_calibration_data`.

## Value

A `ggplot2` plot

## References

- Peppe, D.J., Royer, D.L., Cariglino, B., Oliver, S.Y., Newman, S., Leight, E., Enikolopov, G., Fernandez-Burgos, M., Herrera, F., Adams, J.M., Correa, E., Currano, E.D., Erickson, J.M., Hinojosa, L.F., Hoganson, J.W., Iglesias, A., Jaramillo, C.A., Johnson, K.R., Jordan, G.J., Kraft, N.J.B., Lovelock, E.C., Lusk, C.H., Niinemets, Ü., Peñuelas, J., Rapson, G., Wing, S.L. and Wright, I.J. (2011), Sensitivity of leaf size and shape to climate: global patterns and paleoclimatic applications. *New Phytologist*, 190: 724-739. <https://doi.org/10.1111/j.1469-8137.2010.03615.x>

## Examples

```
results <- dilp(McAbeeExample)  
dilp_cca(results)
```



---

dilp_errors	<i>Check for common errors in DiLP measurements</i>
-------------	---

---

**Description**

dilp\_errors() will typically only be called internally by `dilp()`. However, it can be used on its own to evaluate errors that commonly occur during the data collection and processing steps. A dilp\_errors() call will nearly always follow a `dilp_processing()` call. Returns a data frame.

**Usage**

```
dilp_errors(specimen_data)
```

**Arguments**

specimen\_data Processed specimen level leaf physiognomic data. The structure should match the structure of the output from `dilp_processing()`

**Value**

A 7 by X data frame. Each row shows a common error, and which specimens from the input dataset are tripping it.

**Examples**

```
# Check for errors in the provided McAbeeExample dataset.
dilp_dataset <- dilp_processing(McAbeeExample)
dilp_errors <- dilp_errors(dilp_dataset)
dilp_errors
```

---

dilp_outliers	<i>Identify outlier specimens</i>
---------------	-----------------------------------

---

**Description**

dilp\_outliers() will typically only be called internally by `dilp()`. However, it can be used on its own to locate specimens that may have been misreported or measured incorrectly. dilp\_outliers() returns a data frame listing specimens that have unusually high or low values for the four key parameters used in DiLP analyses. If flagged, it may be worth taking a look at the raw measurements and evaluating if the specimen should be used.

**Usage**

```
dilp_outliers(specimen_data)
```

**Arguments**

`specimen_data` Processed specimen level leaf physiognomic data. The structure should match the structure of the output from `dilp_processing()`

**Value**

A 4 by X data frame. Each row represents one of the DiLP parameters, and the specimens that are outliers for that parameter.

**Examples**

```
# Check for outliers in the provided McAbeeExample dataset. Each
# of these outliers has been manually re-examined and was found acceptable.
dilp_dataset <- dilp_processing(McAbeeExample)
dilp_outliers <- dilp_outliers(dilp_dataset)
dilp_outliers
```

---

<code>dilp_processing</code>	<i>Process raw leaf physiognomic data</i>
------------------------------	---

---

**Description**

`dilp_processing()` will typically only be called internally by `dilp()`. However, it can be used on its own to generate and view a processed DiLP dataset that includes raw and derived physiognomic values useful for DiLP and other physiognomic analyses. Returns a data frame.

**Usage**

```
dilp_processing(specimen_data)
```

**Arguments**

`specimen_data` A data frame containing specimen level leaf physiognomic data. A good reference for how to put together the data: [McAbeeExample](#)

**Value**

A data frame containing cleaned and processed specimen level leaf physiognomic data. New variables calculated are:

- Leaf area
- Feret diameter
- Feret diameter ratio (FDR)
- Raw blade perimeter corrected (Raw blade perimeter - length of cut perimeter)
- Internal raw blade perimeter corrected (Internal raw blade perimeter - length of cut perimeter)
- Total tooth count

- Total tooth count : internal perimeter (TC:IP)
- Perimeter ratio
- Petiole metric
- Aspect ratio
- Shape factor
- Compactness
- Tooth area
- Tooth area : perimeter (TA:P)
- Tooth area: internal perimeter (TA:IP)
- Tooth area : blade area (TA:BA)
- Average primary tooth area (Avg TA)
- Tooth count : blade area (TC:BA)
- Tooth count : perimeter (TC:P)

### Examples

```
dilp_dataset <- dilp_processing(McAbeeExample)
dilp_dataset
```

---

lma

*Generate a suite of leaf mass per area results*

---

### Description

`lma()` takes either raw or processed leaf physiognomic data and returns leaf mass per area (LMA) reconstructions of species-mean, site-mean, and site- variance.

`lma()` calls `calc_lma()` multiple times with different sets of parameters. See `calc_lma()` for more control over LMA reconstructions.

### Usage

```
lma(specimen_data)
```

### Arguments

`specimen_data` A table that must include "Site", "Morphotype", and either "Petiole Metric", or "Blade Area", "Petiole Area", and "Petiole Width".

**Value**

A list of tables containing leaf mass per area reconstructions.

- `species_mean_lma` contains the average LMA for each morphospecies-site pair. Values calculated using the regression from Royer et al. (2007).
- `royer_site_mean_lma` contains the average LMA for each site. Values calculated using the regression from Royer et al. (2007)
- `lowe_site_lma` contains the average LMA for each site. Values calculated using the regression from Lowe et al. (2024)
- `lowe_variance` contains the variance in LMA for each site. Values calculated using the regression from Lowe et al. (2024)

**References**

- Royer, D. L., L. Sack, P. Wilf, C. H. Lusk, G. J. Jordan, Ulo Niinemets, I. J. Wright, et al. 2007. Fossil Leaf Economics Quantified: Calibration, Eocene Case Study, and Implications. *Paleobiology* 33: 574–589
- Lowe, A. J., D. L. Royer, D. J. Wiczyński, M. J. Butrim, T. Reichgelt, L. Azevedo-Schmidt, D. J. Peppe, et al. 2024. Global patterns in community-scale leaf mass per area distributions of woody non-monocot angiosperms and their utility in the fossil record. In review.

**Examples**

```
results <- lma(McAbeeExample)
results
```

---

McAbeeExample

*McAbee Example Data*

---

**Description**

Leaf physiognomic data of specimens collected from the McAbee Fossil Beds in British Columbia, Canada (Lowe et al. 2018).

**Usage**

McAbeeExample

**Format**

McAbeeExample:

A data frame with 192 rows and 18 columns:

**Site** Stratigraphic layer or locality

**Specimen Number** Repository number for individual specimen

**Morphotype** Morphotype the specimen belongs to

- Measurer comments** Additional notes about the specimen or its measurements
- Margin** Whether the margin is toothed (0) or entire (1)
- Petiole Width** The width of the petiole at the basalmost point of insertion into the leaf lamina
- Blade area** The reconstructed area of the leaf lamina, not including the petiole
- Blade perimeter** The length of the perimeter of the leaf lamina, not including the petiole
- Feret** The diameter of a circle with the same area as the leaf lamina, not including the petiole
- Minimum Feret** The longest line that can be drawn between two points on the perimeter of a selection that is perpendicular to Feret length. Approximates blade width.
- Raw blade area** The area of a leaf prepared for tooth measurements that still has its teeth.
- Raw blade perimeter** The perimeter of a leaf prepared for tooth measurements that still has its teeth.
- Internal raw blade area** The area of a leaf prepared for tooth measurements with teeth digitally removed.
- Internal raw blade perimeter** The perimeter of a leaf prepared for tooth measurements with teeth digitally removed.
- Length of cut perimeter** The total length of all segments of leaf removed from the leaf blade while removing damage during preparation of the leaf.
- no. of primary teeth** The number of primary teeth along the undamaged perimeter
- no. of secondary teeth** The number of secondary teeth along the undamaged perimeter

## Source

Lowe et al. 2018

## References

- Lowe, A. J., D. R. Greenwood, C. K. West, J. M. Galloway, M. Sudermann, and T. Reichgelt. 2018. Plant community ecology and climate on an upland volcanic landscape during the Early Eocene Climatic Optimum: McAbee Fossil Beds, British Columbia, Canada. *Palaeogeography, Palaeoclimatology, Palaeoecology* 511: 433–448.

---

physiognomy\_calibration\_data

*Physiognomy Calibration Data*

---

## Description

Leaf physiognomic data taken from the modern localities used to calibrate the DiLP model

## Usage

physiognomy\_calibration\_data

**Format**

physiognomy\_calibration\_data:

A data frame with 92 rows and 12 columns:

**Site** Locality name

**Leaf.area** Average leaf area at site

**FDR** Feret diameter:Feret length. Describes leaf linearity compared to a circle

**Perimeter.ratio** Ratio - Raw blade perimeter:Internal raw blade perimeter

**TC.P** Ratio - Tooth count:Perimeter

**TC.IP** Ratio - Tooth count:Internal perimeter

**Avg.TA** Average area of a primary tooth

**TA.BA** Ratio - Tooth area:Blade area

**TA.P** Ratio - Tooth area:Perimeter

**TA.IP** Ratio - Tooth area:Internal perimeter

**TC.BA** Ratio - Tooth count:Blade area

**Margin** Percentage of untoothed species at the site

**Source**

Peppe et al. 2011

**References**

- Peppe, D.J., Royer, D.L., Cariglino, B., Oliver, S.Y., Newman, S., Leight, E., Enikolopov, G., Fernandez-Burgos, M., Herrera, F., Adams, J.M., Correa, E., Currano, E.D., Erickson, J.M., Hinojosa, L.F., Hoganson, J.W., Iglesias, A., Jaramillo, C.A., Johnson, K.R., Jordan, G.J., Kraft, N.J.B., Lovelock, E.C., Lusk, C.H., Niinemets, Ü., Peñuelas, J., Rapson, G., Wing, S.L. and Wright, I.J. (2011), Sensitivity of leaf size and shape to climate: global patterns and paleoclimatic applications. *New Phytologist*, 190: 724-739. <https://doi.org/10.1111/j.1469-8137.2010.03615.x>

---

```
precip_slr
```

*Estimate precipitation with simple linear regression*

---

**Description**

precip\_slr() will produce estimates of mean annual precipitation and standard error using leaf area analysis.

**Usage**

```
precip_slr(
  data,
  regression = "Peppe2018",
  slope = NULL,
  constant = NULL,
  error = NULL
)
```

**Arguments**

data	A data frame that must include the columns "morphotype", "leaf_area", and "specimen_number". Must be leaf level data.
regression	A string representing one of the following pre-loaded regressions: <ul style="list-style-type: none"> <li>• "Peppe2018" - for global precipitation estimates</li> <li>• "Peppe2011" - The Americas, Japan, and Oceania</li> <li>• "Jacobs2002" - Africa</li> <li>• "Wilf1998" - The Americas and Africa</li> </ul>
slope	Slope, if using a custom regression
constant	Constant, if using a custom regression
error	Standard error, if using a custom regression

**Value**

A table with MAP estimates for each site

**References**

- Peppe, D. J., Baumgartner, A., Flynn, A., & Blonder, B. (2018). Reconstructing paleoclimate and paleoecology using fossil leaves. *Methods in paleoecology: Reconstructing Cenozoic terrestrial environments and ecological communities*, 289-317.
- Peppe, D.J., Royer, D.L., Cariglino, B., Oliver, S.Y., Newman, S., Leight, E., Enikolopov, G., Fernandez-Burgos, M., Herrera, F., Adams, J.M., Correa, E., Currano, E.D., Erickson, J.M., Hinojosa, L.F., Hoganson, J.W., Iglesias, A., Jaramillo, C.A., Johnson, K.R., Jordan, G.J., Kraft, N.J.B., Lovelock, E.C., Lusk, C.H., Niinemets, Ü., Peñuelas, J., Rapson, G., Wing, S.L. and Wright, I.J. (2011), Sensitivity of leaf size and shape to climate: global patterns and paleoclimatic applications. *New Phytologist*, 190: 724-739. <https://doi.org/10.1111/j.1469-8137.2010.03615.x>
- Jacobs, B. F. (2002). Estimation of low-latitude paleoclimates using fossil angiosperm leaves: examples from the Miocene Tugen Hills, Kenya. *Paleobiology*, 28, 399–421.
- Wilf, P. (2008). Fossil angiosperm leaves: paleobotany's difficult children prove themselves. *Paleontological Society Papers*, 14, 319–333.

**Examples**

```
precip_slr(McAbeeExample, regression = "Peppe2011")
```

temp\_slr

*Estimate temperature with simple linear regression***Description**

temp\_slr() will produce estimates of mean annual temperature and standard error using leaf margin analysis.

**Usage**

```
temp_slr(
  data,
  regression = "Peppe2018",
  slope = NULL,
  constant = NULL,
  error = NULL
)
```

**Arguments**

data	A data frame that must include the columns "morphotype" and "margin". Can be leaf or species level data.
regression	A string representing one of the following pre-loaded regressions: <ul style="list-style-type: none"> <li>• "Peppe2018" - for global temperature estimates</li> <li>• "Peppe2011" - The Americas, Japan, and Oceania</li> <li>• "Peppe2011NH" - Peppe 2011 (Northern Hemisphere only)</li> <li>• "Miller2006" - North and Central America</li> <li>• "WingGreenwood" - East Asia - original leaf margin analysis regression</li> <li>• "Wilf1997" - The Americas</li> </ul>
slope	Slope, if using a custom regression
constant	Constant, if using a custom regression
error	Standard error, if using a custom regression

**Value**

A table with MAT estimates for each site

**References**

- Miller, I. M., Brandon, M. T., & Hickey, L. J. (2006). Using leaf margin analysis to estimate mid-Cretaceous (Albian) paleolatitude of the Baja BC block. *Earth and Planetary Science Letters*, 245, 95–114.
- Peppe, D. J., Baumgartner, A., Flynn, A., & Blonder, B. (2018). Reconstructing paleoclimate and paleoecology using fossil leaves. *Methods in paleoecology: Reconstructing Cenozoic terrestrial environments and ecological communities*, 289-317.



- Peppe, D.J., Royer, D.L., Cariglino, B., Oliver, S.Y., Newman, S., Leight, E., Enikolopov, G., Fernandez-Burgos, M., Herrera, F., Adams, J.M., Correa, E., Currano, E.D., Erickson, J.M., Hinojosa, L.F., Hoganson, J.W., Iglesias, A., Jaramillo, C.A., Johnson, K.R., Jordan, G.J., Kraft, N.J.B., Lovelock, E.C., Lusk, C.H., Niinemets, Ü., Peñuelas, J., Rapson, G., Wing, S.L. and Wright, I.J. (2011), Sensitivity of leaf size and shape to climate: global patterns and paleoclimatic applications. *New Phytologist*, 190: 724-739. <https://doi.org/10.1111/j.1469-8137.2010.03615.x>
- Wing, S., & Greenwood, D. R. (1993). Fossils and fossil climate: the case for equable continental interiors in the Eocene. *Philosophical Transactions of the Royal Society of London Series B*, 341, 243–252.
- Wilf, P. (1997). When are leaves good thermometers? A new case for leaf margin analysis. *Paleobiology*, 23, 373–390.

### Examples

```
temp_slr(McAbeeExample, regression = "Peppe2011")
```

---

view_regressions	<i>View preloaded regressions</i>
------------------	-----------------------------------

---

### Description

View preloaded regressions

### Usage

```
view_regressions(type)
```

### Arguments

type                    Must be either "dilp", "lma", "temp", or "precip".

### Value

A data frame containing the parameters for each available regression of the selected type.

### Examples

```
view_regressions("dilp")
```

# Index

## \* datasets

- climate\_calibration\_data, 4
- McAbeeExample, 12
- physiognomy\_calibration\_data, 13

- calc\_lma, 2
- calc\_lma(), 11
- climate\_calibration\_data, 4, 8

- dilp, 5
- dilp(), 8, 9
- dilp\_cca, 7
- dilp\_errors, 9
- dilp\_errors(), 7
- dilp\_outliers, 9
- dilp\_outliers(), 7
- dilp\_processing, 10
- dilp\_processing(), 7, 9, 10

- lma, 11
- lma(), 2

- McAbeeExample, 5, 10, 12

- physiognomy\_calibration\_data, 8, 13
- precip\_slr, 14

- temp\_slr, 16

- view\_regressions, 17