

# Package ‘NEONiso’

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**Type** Package

**Title** Tools to Calibrate and Work with NEON Atmospheric Isotope Data

**Version** 0.6.4

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**Depends** R (>= 4.0.0)

**Description** Functions for downloading, calibrating, and analyzing atmospheric isotope data bundled into the eddy covariance data products of the National Ecological Observatory Network (NEON) <<https://www.neonscience.org>>. Calibration tools are provided for carbon and water isotope products. Carbon isotope calibration details are found in Fiorella et al. (2021) <[doi:10.1029/2020JG005862](https://doi.org/10.1029/2020JG005862)>, and the readme file at <<https://github.com/lanl/NEONiso>>. Tools for calibrating water isotope products have been added as of 0.6.0, but have known deficiencies and should be considered very experimental currently.

**License** GPL-3

**BugReports** <https://github.com/lanl/NEONiso/issues>

**URL** <https://github.com/lanl/NEONiso>, <https://lanl.github.io/NEONiso/>

**Encoding** UTF-8

**RoxygenNote** 7.2.3

**Imports** dplyr, zoo, httr, lubridate, neonUtilities (>= 2.0.1), magrittr, rhdf5 (>= 2.33.7), R.utils, tidyselect, data.table, rlang, lifecycle, caret, ggplot2, gridExtra

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

**VignetteBuilder** knitr

**Language** en-US

**Config/testthat/edition** 3

**NeedsCompilation** no

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calculate_12CO2	<i>calculate_12CO2</i>
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---

### Description

calculate\_12CO2

### Usage

calculate\_12CO2(total\_co2, delta13C, f = 0.00474)

### Arguments

total_co2	Vector of CO2 mole fractions.
delta13C	Vector of d13C values.
f	Fraction of CO2 that is not 12CO2 or 13CO2. Assumed fixed at 0.00474

### Value

Vector of 12CO2 mole fractions.

### Author(s)

Rich Fiorella <rfiorella@lanl.gov>

### Examples

calculate\_12CO2(total\_co2 = 410, delta13C = -8.5)

calculate\_13CO2      *calculate\_13CO2*

---

**Description**

calculate\_13CO2

**Usage**

```
calculate_13CO2(total_co2, delta13C, f = 0.00474)
```

**Arguments**

total\_co2      Vector of CO2 mole fractions.  
delta13C      Vector of d13C values.  
f              Fraction of CO2 that is not 12CO2 or 13CO2. Assumed fixed at 0.00474

**Value**

Vector of 13CO2 mole fractions.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

**Examples**

```
calculate_13CO2(total_co2 = 410, delta13C = -8.5)
```

---

calibrate\_ambient\_carbon\_Bowling2003  
*calibrate\_ambient\_carbon\_Bowling2003*

---

**Description**

calibrate\_ambient\_carbon\_Bowling2003

**Usage**

```
calibrate_ambient_carbon_Bowling2003(
  amb_data_list,
  caldf,
  site,
  filter_data = TRUE,
  force_to_end = TRUE,
  force_to_beginning = TRUE,
  gap_fill_parameters = FALSE,
  r2_thres = 0.9
)
```

**Arguments**

<code>amb_data_list</code>	List containing an ambient d13C dataset. Will include all variables in 000_0x0_xxm. (character)
<code>caldf</code>	Calibration data frame containing gain and offset values for 12C and 13C isotopologues.
<code>site</code>	Four-letter NEON code corresponding to site being processed.
<code>filter_data</code>	Apply median absolute deviation filter from Brock 86 to remove impulse spikes? Inherited from <code>calibrate_ambient_carbon_Bowling2003()</code>
<code>force_to_end</code>	In given month, calibrate ambient data later than last calibration, using the last calibration? (default true)
<code>force_to_beginning</code>	In given month, calibrate ambient data before than first calibration, using the first calibration? (default true)
<code>gap_fill_parameters</code>	Should function attempt to 'gap-fill' across a bad calibration by carrying the last known good calibration forward? Implementation is fairly primitive currently, as it only carries the last known good calibration that's available forward rather than interpolating, etc. Default FALSE.
<code>r2_thres</code>	Minimum r2 value for calibration to be considered "good" and applied to ambient data.

**Value**

Depends on `write_to_file` argument. If true, returns nothing to environment; but returns calibrated ambient observations to the output file. If false, returns modified version of `amb_data_list` that include calibrated ambient data.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

Function called by `calibrate_carbon_bymonth()` to apply gain and offset parameters to the ambient datasets (000\_0x0\_09m and 000\_0x0\_30m). This function should generally not be used independently, but should be used in coordination with `calibrate_carbon_bymonth()`.

---

```
calibrate_ambient_carbon_linreg
    calibrate_ambient_carbon_linreg
```

---

## Description

calibrate\_ambient\_carbon\_linreg

## Usage

```
calibrate_ambient_carbon_linreg(
  amb_data_list,
  caldf,
  outname,
  site,
  filter_data = TRUE,
  force_to_end = TRUE,
  force_to_beginning = TRUE,
  gap_fill_parameters = FALSE,
  r2_thres = 0.9
)
```

## Arguments

amb_data_list	List containing an ambient d13C dataset. Will include all variables in 000_0x0_xxm. (character)
caldf	Calibration data frame containing gain and offset values for 12C and 13C isotopologues.
outname	Output variable name. Inherited from calibrate_ambient_carbon_linreg
site	Four-letter NEON code corresponding to site being processed.
filter_data	Apply median absolute deviation filter from Brock 86 to remove impulse spikes? Inherited from calibrate_ambient_carbon_linreg
force_to_end	In given month, calibrate ambient data later than last calibration, using the last calibration? (default true)
force_to_beginning	In given month, calibrate ambient data before than first calibration, using the first calibration? (default true)
gap_fill_parameters	Should function attempt to 'gap-fill' across a bad calibration by carrying the last good calibration forward? Implementation is fairly primitive currently, as it only carries the last known good calibration that's available forward rather than interpolating, etc. Default FALSE.
r2_thres	Minimum r2 value for calibration to be considered "good" and applied to ambient data.

**Value**

Nothing to environment; returns calibrated ambient observations to the function orchestrating calibration (calibrate\_carbon). This function is not designed to be called on its own, and is not exported to the namespace.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

Function called by calibrate\_ambient\_carbon\_linreg to apply gain and offset parameters to the ambient datasets (000\_0x0\_09m and 000\_0x0\_30m). This function should generally not be used independently, but should be used with calibrate\_ambient\_carbon\_linreg.

---

calibrate\_ambient\_water\_linreg  
*calibrate\_ambient\_water\_isotopes*

---

**Description**

calibrate\_ambient\_water\_isotopes

**Usage**

```
calibrate_ambient_water_linreg(  
  amb_data_list,  
  caldf,  
  outname,  
  site,  
  file,  
  filter_data,  
  force_to_end,  
  force_to_beginning,  
  r2_thres  
)
```

**Arguments**

amb_data_list	List containing ambient d18O/d2H datasets. Will include all variables in 000_0x0_xxm. (character)
caldf	Calibration data frame containing slope and intercept values for d18O and d2H values.
outname	Output variable name. Inherited from calibrate_ambient_water_linreg
site	Four-letter NEON code corresponding to site being processed.
file	Output file name. Inherited from calibrate_ambient_water_linreg
filter_data	Apply a median filter to output ambient data? inherited.

force_to_end	In given month, calibrate ambient data later than last calibration, using the last calibration? (default true)
force_to_beginning	In given month, calibrate ambient data before than first calibration, using the first calibration? (default true)
r2_thres	Minimum r2 value for calibration to be considered "good" and applied to ambient data.

### Value

Nothing to environment; returns calibrated ambient observations to the output file. This function is not designed to be called on its own.

### Author(s)

Rich Fiorella <rfiorella@lanl.gov>

Function called by `calibrate_ambient_water_linreg` to apply slope and intercept parameters to the ambient datasets (000\_0x0\_09m and 000\_0x0\_30m) to correct to the VSMOW scale. This function should generally not be used independently, but should be used with `calibrate_ambient_water_linreg`. Note that in this version *NO CORRECTION FOR HUMIDITY* is performed. Use with caution.

---

calibrate_carbon	<i>calibrate_carbon</i>
------------------	-------------------------

---

### Description

**[Experimental]** This function drives a workflow that reads in NEON carbon isotope data of atmospheric CO<sub>2</sub>, calibrates it to the VPDB scale, and (optionally) writes the calibrated data to a new HDF5 file. Two different approaches are possible: a) a calibration on <sup>12</sup>CO<sub>2</sub> and <sup>13</sup>CO<sub>2</sub> isotopologues independently, after Bowling et al. 2003 (Agr. For. Met.), or b) a direct calibration of δ<sup>13</sup>C and CO<sub>2</sub> values using linear regression. Most of the time the results generated are extremely similar to each other. Wen et al. 2013 compared several different carbon isotope calibration techniques and found this to be the superior method under most circumstances. We also found this to be the case for NEON data (Fiorella et al. 2021; JGR-Biogeosciences).

### Usage

```
calibrate_carbon(
  inname,
  outname,
  site,
  method = "Bowling_2003",
  calibration_half_width = 0.5,
  force_cal_to_beginning = TRUE,
  force_cal_to_end = TRUE,
  gap_fill_parameters = FALSE,
  filter_ambient = TRUE,
```



```

r2_thres = 0.95,
correct_refData = TRUE,
write_to_file = TRUE,
remove_known_bad_months = TRUE,
plot_regression_data = FALSE,
plot_directory = NULL,
avg = 9,
min_nobs = NA
)

```

## Arguments

iname	Input file(s) that are to be calibrated. If a single file is given, output will be a single file per site per month. If a list of files corresponding to a timeseries at a given site is provided, will calibrate the whole time series.
outname	Name of the output file. (character)
site	Four letter NEON site code for site being processed. (character)
method	Are we using the Bowling et al. 2003 method ("Bowling_2003") or direct linear regression of d13C and CO2 mole fractions ("linreg")?
calibration_half_width	Determines the period (in days) from which reference data are selected (period is 2*calibration_half_width).
force_cal_to_beginning	Extend first calibration to the beginning of the file? (default true)
force_cal_to_end	Extend last calibration to the end of the file? (default true)
gap_fill_parameters	Should function attempt to 'gap-fill' across a bad calibration by carrying the last good calibration forward? Implementation is fairly primitive currently, as it only carries the last known good calibration that's available forward rather than interpolating, etc. Default FALSE.
filter_ambient	Apply the median absolute deviation filter (Brock 86) to remove impulse spikes in output ambient data? (logical; default true)
r2_thres	Minimum r2 threshold of an "acceptable" calibration. Acts to remove calibration periods where a measurement error makes relationship nonlinear. Default = 0.95
correct_refData	NEON has indicated there are a few instances where reported d13C or CO2 reference values are wrong. If set to true, correct known incorrect values. This argument will (hopefully, eventually) go away after NEON has fixed the reference database. Users will be warned prior to removal of this argument.
write_to_file	Write calibrated ambient data to file? (Mostly used for testing)
remove_known_bad_months	There are a few site months with known spectral issues where the isotope ratios are likely unrecoverable. This parameter allows removal of these files, but allows them to remain in archive.

plot_regression_data	Default false; this is useful for diagnostics.
plot_directory	Only used if plot_regression_data is TRUE, but specify where to write out diagnostic plot of regression data.
avg	The averaging interval to extract, in minutes. Default 9, but will change to 6 eventually.
min_nobs	Minimum number of high-frequency observations to define a peak.

### Details

The 'linreg' method simply takes measured and reference d13C and CO2 values and generates a transfer function between them using `lm()`. For the gain-and-offset method, d13C and CO2 values are converted to 12CO2 and 13CO2 mole fractions. Gain and offset parameters are calculated for each isotopologue independently, and are analogous to regression slope and intercepts, but jointly correct for CO2 concentration dependence and place d13C values on the VPDB scale. The gain and offset parameters are defined by:

$$G = (X_{2,ref} - X_{1,ref}) / (X_{2,meas} - X_{1,meas})$$

$$O = X_{2,ref} - GX_{2,meas}$$

Calibrated ambient isotopologues are then given as:

$$X_{cal} = X_{meas}G + O$$

Measurements of reference materials were considered "good" if the following conditions were met:

- Measured CO2 concentrations were within 10 ppm of known "reference" concentrations.
- Variance of the CO2 concentration in standard peak was < 5 ppm.
- Measured d13C value must be within 5 per mil of known "reference" d13C value.

The first two criteria are intended to filter out periods where there is a clear issue with the gas delivery system (i.e., nearly empty gas tank, problem with a valve in the manifold, etc.); the third criterion was adopted after visual inspection of data timeseries revealed that often the first standard measurement following an instrument issue had higher-than-expected error. This criterion clips clearly poor values. Selection of these criteria will become a function argument, and therefore customizable, in a future release.

The behavior of this function will be a bit different depending on what is supplied as `iname`. If a single file is provided, the output will be monthly. However, a list of files corresponding to a site can also be provided, and then a single output file per site will be generated.

### Value

Returns nothing to the environment, but creates a new output HDF5 file containing calibrated carbon isotope values.

### Author(s)

Rich Fiorella <rifiorella@lanl.gov>

## Examples

```
## Not run: fin <- system.file('extdata',
'NEON.D15.ONAQ.DP4.00200.001.nsae.2019-05.basic.20201020T211037Z.packed.h5',
  package = 'NEONiso', mustWork = TRUE)
calibrate_carbon_bymonth(inname = fin, outname = 'out.h5',
  site = 'ONAQ', write_to_file = FALSE)
calibrate_carbon_bymonth(inname = fin, outname = 'out.h5',
  site = 'ONAQ', method = 'linreg', write_to_file = FALSE)
## End(Not run)
```

---

```
calibrate_carbon_bymonth
      calibrate_carbon_bymonth
```

---

## Description

**[Deprecated]** This function drives a workflow that reads in NEON carbon isotope data of atmospheric CO<sub>2</sub>, calibrates it to the VPDB scale, and (optionally) writes the calibrated data to a new HDF5 file. Two different approaches are possible: a) a calibration on <sup>12</sup>CO<sub>2</sub> and <sup>13</sup>CO<sub>2</sub> isotopologues separately, after Bowling et al. 2003 (Agr. For. Met.), or b) a direct calibration of δ<sup>13</sup>C and CO<sub>2</sub> values using linear regression. The vast majority of the time the results generated from either method are extremely similar to each other. Wen et al. 2013 compared several different carbon isotope calibration techniques and found this to be the superior method under most circumstances. We also found this to be the case for NEON data (Fiorella et al. 2021; JGR-Biogeosciences).

## Usage

```
calibrate_carbon_bymonth(
  inname,
  outname,
  site,
  method = "Bowling_2003",
  calibration_half_width = 0.5,
  force_cal_to_beginning = TRUE,
  force_cal_to_end = TRUE,
  gap_fill_parameters = FALSE,
  filter_ambient = TRUE,
  r2_thres = 0.95,
  correct_refData = TRUE,
  write_to_file = TRUE
)
```

## Arguments

inname	Name of the input file. (character)
outname	Name of the output file. (character)

site	Four letter NEON site code for site being processed. (character)
method	Are we using the Bowling et al. 2003 method ("Bowling_2003") or direct linear regression of d13C and CO2 mole fractions ("linreg")?
calibration_half_width	Determines the period (in days) from which reference data are selected (period is 2*calibration_half_width).
force_cal_to_beginning	Extend first calibration to the beginning of the file? (default true)
force_cal_to_end	Extend last calibration to the end of the file? (default true)
gap_fill_parameters	Should function attempt to 'gap-fill' across a bad calibration by carrying the last known good calibration forward? Implementation is fairly primitive currently, as it only carries the last known good calibration that's available forward rather than interpolating, etc. Default FALSE.
filter_ambient	Apply the median absolute deviation filter (Brock 86) to remove impulse spikes in output ambient data? (logical; default true)
r2_thres	Minimum r2 threshold of an "acceptable" calibration. Acts to remove calibration periods where a measurement error makes relationship nonlinear. Default = 0.95
correct_refData	NEON has indicated there are a few instances where reported d13C or CO2 reference values are wrong. If set to true, correct known incorrect values. This argument will (hopefully, eventually) go away after NEON has fixed the reference database. Users will be warned prior to removal of this argument.
write_to_file	Write calibrated ambient data to file? (Mostly used for testing)

## Details

The 'linreg' method simply takes measured and reference d13C and CO2 values and generates a transfer function between them using `lm()`. For the gain-and-offset method, d13C and CO2 values are converted to 12CO2 and 13CO2 mole fractions. Gain and offset parameters are calculated for each isotopologue independently, and are analogous to regression slope and intercepts, but jointly correct for CO2 concentration dependence and place d13C values on the VPDB scale. The gain and offset parameters are defined by:

$$G = (X_{2,ref} - X_{1,ref}) / (X_{2,meas} - X_{1,meas})$$

$$O = X_{2,ref} - GX_{2,meas}$$

Calibrated ambient isotopologues are then given as:

$$X_{cal} = X_{meas}G + O$$

Measurements of reference materials were considered "good" if the following conditions were met:

- Measured CO2 concentrations were within 10 ppm of known "reference" concentrations.
- Variance of the CO2 concentration in standard peak was < 5 ppm.

- Measured d13C value must be within 5 per mil of known "reference" d13C value.

The first two criteria are intended to filter out periods where there is a clear issue with the gas delivery system (i.e., nearly empty gas tank, problem with a valve in the manifold, etc.); the third criterion was adopted after visual inspection of data timeseries revealed that often the first standard measurement following an instrument issue had higher-than-expected error. This criterion clips clearly poor values. Selection of these criteria will become a function argument, and therefore customizable, in a future release.

## Value

Returns nothing to the environment, but creates a new output HDF5 file containing calibrated carbon isotope values.

## Author(s)

Rich Fiorella <rfiorella@lanl.gov>

## Examples

```
## Not run: fin <- system.file('extdata',
'NEON.D15.ONAQ.DP4.00200.001.nsa.e.2019-05.basic.20201020T211037Z.packed.h5',
  package = 'NEONiso', mustWork = TRUE)
calibrate_carbon_bymonth(inname = fin, outname = 'out.h5',
  site = 'ONAQ', write_to_file = FALSE)
calibrate_carbon_bymonth(inname = fin, outname = 'out.h5',
  site = 'ONAQ', method = 'linreg', write_to_file = FALSE)
## End(Not run)
```

---

calibrate\_carbon\_reference\_data  
*calibrate\_carbon\_reference\_data*

---

## Description

calibrate\_carbon\_reference\_data

## Usage

```
calibrate_carbon_reference_data(inname, outname, standard, site, calDf)
```

## Arguments

inname	Input file name.
outname	Output file name.
standard	Which standard are we working on? Must be "Low", "Med", or "High"
site	NEON 4-letter site code.
calDf	Calibration data frame - this is the output from fit_carbon_regression

**Value**

Nothing to the environment.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

calibrate\_standards\_carbon  
*calibrate\_standards\_carbon*

---

**Description**

calibrate\_standards\_carbon

**Usage**

```
calibrate_standards_carbon(
  cal_df,
  ref_df,
  f = 0.00474,
  r2_thres = 0.95,
  correct_bad_refvals = FALSE,
  site,
  refGas
)
```

**Arguments**

cal_df	Data.frame containing calibration parameters
ref_df	Data.frame containing reference gas measurements
f	Fraction of CO <sub>2</sub> isotopologues that are not <sup>12</sup> CO <sub>2</sub> or <sup>13</sup> CO <sub>2</sub> . Inherited from script calling this function.
r2_thres	Threshold for calibration regression to be used to calibrate standards data. Default is 0.95. Calibrated reference gas measurements occurring during calibration periods with r <sup>2</sup> values less than r <sub>2</sub> _thres will be marked NA.
correct_bad_refvals	Should we correct known/suspected incorrect reference values in the NEON HDF5 files? (Default = FALSE).
site	Four letter NEON site code. Only used if correct_bad_refvals = TRUE.
refGas	One of "low", "med", or "high." Only used if correct_bad_refvals = TRUE.

**Value**

A data.frame having the same number of rows of cal\_df, with additional columns added for calibrated CO<sub>2</sub> mole fractions and d13C values.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

calibrate\_standards\_water  
*calibrate\_standards\_water*

---

**Description**

calibrate\_standards\_water

**Usage**

```
calibrate_standards_water(cal_df, ref_df, r2_thres = 0.95)
```

**Arguments**

cal_df	Data.frame containing calibration parameters
ref_df	Data.frame containing reference gas measurements
r2_thres	Threshold for calibration regression to be used to calibrate standards data. Default is 0.95. Calibrated reference gas measurements occurring during calibration periods with r2 values less than r2_thres will be marked NA.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

calibrate\_water      *calibrate\_water*

---

**Description**

**[Experimental]** This function uses NEON validation data to apply drift corrections to measured ambient water isotope ratios. In brief, ambient water isotope ratios are calibrated by generating regressions using reference water measurements bracketing an ambient period. Three reference waters are measured once per day, with several injections per reference water. Due to memory effects, only the last three are used currently to generate calibration equations. Regressions between measured d18O and d2H values and NEON-provisioned known reference values are generated, and used to calibrate the period of ambient measurements between them if the r2 of the regression is greater than a threshold value (by default, this is 0.95). Most of this function deals with selecting the appropriate calibration data and determining calibration quality. This function also contains a wrapper for `calibrate_ambient_water_linreg`, which calibrates the ambient water data using the calibration parameters generated in this function. This function also copies over data in the `qfqm` and `ucrt` hdf5 data groups.

**Usage**

```
calibrate_water(
  inpath,
  outpath,
  site,
  calibration_half_width = 14,
  filter_data = TRUE,
  force_cal_to_beginning = FALSE,
  force_cal_to_end = FALSE,
  r2_thres = 0.95,
  slope_tolerance = 9999
)
```

**Arguments**

inpath	Directory path to input (monthly) NEON HDF5 files.
outpath	Directory path to save output data file. (For now, 1 per site).
site	Four-letter NEON code for site being processed.
calibration_half_width	Determines the range of standard measurements to use in determining the calibration regression dataset. Creates a moving window that is 2*calibration_half_width days wide. Default is set to 14 for a 28 day moving window.
filter_data	Apply median absolute deviation filter from Brock 86 to remove impulse spikes?
force_cal_to_beginning	Extend first calibration to the beginning of the file?
force_cal_to_end	Extend last calibration to the end of the file?
r2_thres	Minimum r2 threshold of an "acceptable" calibration. Acts to remove calibration periods where a measurement error makes relationship nonlinear. Default = 0.95
slope_tolerance	How different from 1 should we allow 'passing' regression slopes to be? Experimental parameter, off by default (e.g., default slope parameter = 9999)

**Details**

*IMPORTANT NOTE* Currently this function does not apply a correction for humidity dependence of Picarro isotopic measurements. This is because the data to implement these corrections is not yet publicly available. Caution is suggested when analyzing data at low humidities, below ~5000 ppm, with likely higher biases at lower humidity values.

Additionally, please note that this function is meant to work on *all* files for a given site at the same time. A more flexible version that can handle all files or monthly files will be added to a future release.

**Value**

nothing to the workspace, but creates a new output file of calibrated water isotope data.



**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

calibrate\_water\_linreg\_bymonth  
*calibrate\_water\_linreg*

---

**Description**

**[Deprecated]** This function uses NEON validation data to apply drift corrections to measured ambient water isotope ratios. In brief, ambient water isotope ratios are calibrated by generating regressions using reference water measurements bracketing an ambient period. Three reference waters are measured once per day, with several injections per reference water. Due to memory effects, only the last three are used currently to generate calibration equations. Regressions between measured d18O and d2H values and NEON-provisioned known reference values are generated, and used to calibrate the period of ambient measurements between them if the r2 of the regression is greater than a threshold value (by default, this is 0.95). Most of this function deals with selecting the appropriate calibration data and determining calibration quality. This function also contains a wrapper for `calibrate_ambient_water_linreg`, which calibrates the ambient water data using the calibration parameters generated in this function. This function also copies over data in the `qfqm` and `ucrt hdf5` data groups.

**Usage**

```
calibrate_water_linreg_bymonth(  
  inname,  
  outname,  
  site,  
  time_diff_between_standards = 1800,  
  filter_data = TRUE,  
  force_cal_to_beginning = TRUE,  
  force_cal_to_end = TRUE,  
  r2_thres = 0.95  
)
```

**Arguments**

<code>inname</code>	Name of the input file.
<code>outname</code>	Name of the output file.
<code>site</code>	Four-letter NEON code for site being processed.
<code>time_diff_between_standards</code>	Time (in seconds) required between consecutive standard measurements.
<code>filter_data</code>	Apply median absolute deviation filter from Brock 86 to remove impulse spikes?
<code>force_cal_to_beginning</code>	Extend first calibration to the beginning of the file?

force_cal_to_end	Extend last calibration to the end of the file?
r2_thres	Minimum r2 threshold of an "acceptable" calibration. Acts to remove calibration periods where a measurement error makes relationship nonlinear. Default = 0.95

### Details

*IMPORTANT NOTE* Currently this function does not apply a correction for humidity dependence of Picarro isotopic measurements. This is because the data to implement these corrections is not yet publicly available. Caution is suggested when analyzing data at low humidities, below ~5000 ppm, with likely higher biases at lower humidity values.

### Value

nothing to the workspace, but creates a new output file of calibrated carbon isotope data.

### Author(s)

Rich Fiorella <rfiorella@lanl.gov>

---

calibrate\_water\_reference\_data  
*calibrate\_water\_reference\_data*

---

### Description

calibrate\_water\_reference\_data

### Usage

calibrate\_water\_reference\_data(outname, standard, site, stdDf, calDf)

### Arguments

outname	Output file name.
standard	Which reference material is being 'calibrated'? (Low, med, or high)
site	NEON 4-letter site code.
stdDf	Data frame of reference material measurements.
calDf	Calibration data frame - this is the output from fit_water_regression

### Value

Nothing to the environment.

---

carbon\_regression\_plots  
*carbon\_regression\_plots*

---

**Description**

carbon\_regression\_plots

**Usage**

```
carbon_regression_plots(caldata, plot_filename, method, mtitle)
```

**Arguments**

caldata	Data frame corresponding to a specific calibration period.
plot_filename	What should the output file name for diagnostic plot be?
method	Which method are we using? Currently works for gain/offset.
mtitle	Fed from above routine - what should the plot title be?

**Value**

Nothing to the environment, but a pdf plot to a file.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

convert\_NEONhdf5\_to\_POSIXct\_time  
*convert\_NEONhdf5\_to\_POSIXct\_time*

---

**Description**

convert\_NEONhdf5\_to\_POSIXct\_time

**Usage**

```
convert_NEONhdf5_to_POSIXct_time(intime)
```

**Arguments**

intime	Vector of datetimes in NEON data files (as string) to convert to POSIXct class
--------	--

**Value**

Vector of datetimes from NEON data file now in POSIXct format.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

**Examples**

```
convert_NEONhdf5_to_POSIXct_time("2019-06-01T12:00:00.000Z")
```

---

```
convert_POSIXct_to_NEONhdf5_time  
    convert_POSIXct_to_NEONhdf5_time
```

---

**Description**

Converts a POSIXct object back to the character format used by NEON in their HDF eddy covariance files. Output format, using strftime syntax, is %Y-%m-%dT%H:%M:%OSZ.

**Usage**

```
convert_POSIXct_to_NEONhdf5_time(intime)
```

**Arguments**

`intime`            POSIXct vector to convert to NEON time format.

**Value**

Returns character version of POSIXct object matching NEON time variable format.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

**Examples**

```
convert_POSIXct_to_NEONhdf5_time(Sys.time())
```

---

copy_qfqm_group	<i>copy_qfqm_group</i>
-----------------	------------------------

---

**Description**

copy\_qfqm\_group

**Usage**

```
copy_qfqm_group(data_list, outname, site, file, species)
```

**Arguments**

data_list	List of groups to retrieve qfqm data from.
outname	Output filename.
site	Four-letter NEON site code.
file	Input filename.
species	CO2 or H2O? Same function used for both CO2 and H2O isotopes.

**Value**

Nothing to the workspace, but copies qfqm group from input file to output file.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

copy_ucrt_group	<i>copy_ucrt_group</i>
-----------------	------------------------

---

**Description**

copy\_ucrt\_group

**Usage**

```
copy_ucrt_group(data_list, outname, site, file, species)
```

**Arguments**

data_list	List of groups to retrieve ucrt data from.
outname	Output file name.
site	NEON 4-letter site code.
file	Input file name.
species	H2O or CO2.

**Value**

Nothing to the workspace, but copies ucrf group from input file to output file.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

```
correct_carbon_ref_cval
    correct_carbon_ref_cval
```

---

**Description**

This ugly function is present out of necessity, and will only exist for as long as it is necessary. It is an internal correction within the NEONiso calibration routines that is required as there are some mismatches between the 'true' isotope reference values and those in the NEON HDF5 files. NEON is working on correcting this, and after it has been corrected, this function has no need to exist and will be immediately deprecated. As a result, this function is fairly messy but there is little incentive to improve it.

**Usage**

```
correct_carbon_ref_cval(
  std_frame,
  site,
  omit_already_corrected = TRUE,
  co2_tol = 5,
  d13c_tol = 0.25
)
```

**Arguments**

std_frame	Standard data frame to perform swap on.
site	NEON four letter site code.
omit_already_corrected	Should we attempt correction, if it's already been corrected in the raw files.
co2_tol	Tolerance to use to select co2 values that need to be replaced, in ppm. Default = 5 ppm.
d13c_tol	Tolerance to use to select d13C values that need to be replaced, in ppm. Default = 0.25 per mil.

**Details**

Current sites and time periods affected:

**Value**

A data.frame, based on std\_frame, where NEON-supplied reference values have been corrected if a mismatch has previously been identified.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

correct\_carbon\_ref\_output  
*Correct carbon ref output*

---

**Description**

Correct carbon ref output

**Usage**

```
correct_carbon_ref_output(  
  std_list,  
  site,  
  omit_already_corrected = TRUE,  
  co2_tol = 5,  
  d13c_tol = 0.25,  
  refGas  
)
```

**Arguments**

std_list	List containing reference/validation gas measurements.
site	Four-letter NEON site code.
omit_already_corrected	Skip correction if the reference gas values have already been corrected in the files (default TRUE) If you have older versions of the files, you may want to set this to FALSE.
co2_tol	Tolerance used to identify a mismatch in CO2 values. Will correct measured CO2 values within +/- co2_tol within time period identified as having incorrect reference values.
d13c_tol	Tolerance used to identify a mismatch in d13C values. Will correct measured d13C values within +/- d13c_tol within time period identified as having incorrect reference values.
refGas	Which reference gas is being corrected? Expects "co2High", "co2Med", or "co2Low"

**Value**

A version of `std_list` with corrected reference values.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

delta\_to\_R

*delta\_to\_R*

---

**Description**

delta\_to\_R

**Usage**

```
delta_to_R(delta_values, element)
```

**Arguments**

delta\_values    A vector of isotope ratios in delta notation.

element        Which element to return R values - carbon, oxygen, or hydrogen.

**Value**

Vector of isotope ratios (R values).

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

**Examples**

```
delta_to_R(delta_values = 0, element = 'oxygen') # 2005.2e-6 for VSMOW.
```



---

```
estimate_calibration_error  
  estimate_calibration_error
```

---

**Description**

estimate\_calibration\_error

**Usage**

```
estimate_calibration_error(formula, data)
```

**Arguments**

formula	Formula to pass to caret::train to perform cross validation.
data	Data frame to perform cross-validation on.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

```
extract_carbon_calibration_data  
  extract_carbon_calibration_data.R
```

---

**Description**

extract\_carbon\_calibration\_data.R

**Usage**

```
extract_carbon_calibration_data(data_list)
```

**Arguments**

data_list	List containing data, from the /*/dp01/data/ group in NEON HDF5 file.
-----------	---

**Value**

Returns data frame of required variables.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

```
extract_water_calibration_data
    extract_water_calibration_data
```

---

## Description

extract\_water\_calibration\_data

## Usage

```
extract_water_calibration_data(  
  data_list,  
  ucrt_list = NULL,  
  standard,  
  ucrt_source = "data",  
  method = "by_site"  
)
```

## Arguments

data_list	List containing data, from the <code>*/dp01/data/</code> group in NEON HDF5 file.
ucrt_list	List containing uncertainty data, from the <code>*/dp01/ucrt/</code> group in NEON HDF5 file. (only works if paired with <code>ucrt_source = 'ucrt'</code> and <code>method = 'by_month'</code> )
standard	String indicating whether to grab data from the high, medium, or low standard.
ucrt_source	Where from HDF5 file should variance be extracted from? (Only "data" works now..."ucrt" will throw an error.)
method	Are we calling this function from the <code>calibrate_water_linreg</code> function (use "by_month") or the <code>calibrate_water_linreg_bysite</code> function (use "by_site")

## Value

Returns data frame of required variables.

## Author(s)

Rich Fiorella <rfiorella@lanl.gov>

---

filter\_median\_brock86 *filter\_median\_Brock86*

---

**Description**

Median absolute deviation filter of Brock 1986.

**Usage**

```
filter_median_brock86(data, width = 7, threshold = 5)
```

**Arguments**

data	Vector to filter.
width	Width of filter, in rows.
threshold	Only filter values that are <code>abs(threshold)</code> away from median

**Value**

Returns filtered vector.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

fit\_carbon\_regression *fit\_carbon\_regression*

---

**Description**

fit\_carbon\_regression

**Usage**

```
fit_carbon_regression(  
  ref_data,  
  method,  
  calibration_half_width,  
  plot_regression_data = FALSE,  
  plot_dir = "/dev/null",  
  site,  
  min_nobs = NA  
)
```

**Arguments**

ref_data	Reference data.frame from which to estimate calibration parameters.
method	Are we using the Bowling et al. 2003 method ("Bowling_2003") or direct linear regression of d13C and CO2 mole fractions ("linreg")?
calibration_half_width	Determines the period (in days) from which reference data are selected (period is 2*calibration_half_width).
plot_regression_data	True or false - should we plot the data used in the regression? Useful for debugging.
plot_dir	If plot_regression_data is true, where should the plots be saved?
site	Needed for regression plots.
min_nobs	Minimum number of high-frequency observations to define a peak.

**Value**

Returns a data.frame of calibration parameters. If method == "Bowling\_2003", then data.frame includes gain and offset parameters for 12CO2 and 13CO2, and r<sup>2</sup> values for each regression. If method == "linreg", then data.frame includes slope, intercept, and r<sup>2</sup> values for d13C and CO2 values.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

fit\_water\_regression    *fit\_water\_regression*

---

**Description**

fit\_water\_regression

**Usage**

```
fit_water_regression(stds, calibration_half_width, slope_tolerance, r2_thres)
```

**Arguments**

stds	Reference data.frame from which to estimate calibration parameters.
calibration_half_width	Determines the period (in days) from which reference data are selected (period is 2*calibration_half_width).
slope_tolerance	Allows for filtering of slopes that deviate from 1 by slope_tolerance.
r2_thres	What is the minimum r2 value permitted in a 'useful' calibration relationship.

**Value**

Returns a data.frame of calibration parameters. Output data.frame includes slope, intercept, and  $r^2$  values for d13C and CO2 values.

---

get_Rstd	<i>get_Rstd</i>
----------	-----------------

---

**Description**

get\_Rstd

**Usage**

```
get_Rstd(element)
```

**Arguments**

element            Which element to return standard ratio - carbon, oxygen, or hydrogen.

**Value**

Heavy-to-light isotope ratio of most common stable isotope standard. VSMOW for water, VPDB for carbon.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

**Examples**

```
get_Rstd("carbon") # returns 0.0111797  
get_Rstd("oxygen") # returns 2005.20e-6
```

---

ingest_data	<i>ingest_data</i>
-------------	--------------------

---

**Description**

ingest\_data

**Usage**

```
ingest_data(inname, analyte, name_fix = TRUE, avg)
```

**Arguments**

<code>iname</code>	A file (or list of files) to extract data from for calibration.
<code>analyte</code>	Carbon (Co2) or water (H2o)?
<code>name_fix</code>	Fix to data frame required for next-generation calibration functions, but breaks old 'by_month()' functions. This parameter provides a necessary work around until these functions are removed.
<code>avg</code>	The averaging interval to extract, in minutes.

**Value**

List of data frames, taken from files specified in `iname`

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

loocv

*loocv*

---

**Description**

loocv

**Usage**

loocv(mod)

**Arguments**

<code>mod</code>	Fitted model to estimate leave-one-out CV on.
------------------	---

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

helper function for the leave-one-out cross variance

---

```
manage_local_EC_archive
    manage_local_EC_archive
```

---

### Description

Utility function to help retrieve new EC data and/or prune duplicates, as NEON provisions new data or re-provisions data for an existing site and month.

### Usage

```
manage_local_EC_archive(
    file_dir,
    get = TRUE,
    unzip_files = TRUE,
    trim = FALSE,
    dry_run = TRUE,
    sites = "all",
    release = "RELEASE-2023"
)
```

### Arguments

file_dir	Specify the root directory where the local EC store is kept.
get	Pull down data from NEON API that does not exist locally?
unzip_files	NEON gzips the hdf5 files, should we unzip any gzipped files within file_dir? (Searches recursively)
trim	Search through local holdings, and remove older file where there are duplicates?
dry_run	List files identified as duplicates, but do not actually delete them? Default true to prevent unintended data loss.
sites	Which sites to retrieve data from? Default will be all sites with available data, but can specify a single site or a vector here.
release	Download data corresponding to a specific release? Defaults to "RELEASE-2023." To download all data, including provisional data, set to NULL.

### Value

Returns nothing to the environment, but will download new NEON HDF5 files for selected sites (if get = TRUE), unzip them in the local file directory (if unzip\_files = TRUE), and identify and remove suspected duplicate files (if trim = TRUE and dry\_run = FALSE).

### Author(s)

Rich Fiorella <rfiorella@lanl.gov>

restructure\_ambient\_data  
*restructure\_ambient\_data*

---

**Description**

restructure\_ambient\_data

**Usage**

```
restructure_ambient_data(inpath, analyte)
```

**Arguments**

inpath	Folder containing data to stack.
analyte	Carbon (Co2) or water (H2o)?

**Value**

List of data extracted from files listed in inpath.

---

restructure\_ambient\_data2  
*restructure\_ambient\_data2*

---

**Description**

restructure\_ambient\_data2

**Usage**

```
restructure_ambient_data2(inpath, analyte)
```

**Arguments**

inpath	Folder containing data to stack.
analyte	Carbon (Co2) or water (H2o)?

**Value**

List of data extracted from files listed in inpath.



---

restructure\_carbon\_variables  
*restructure\_carbon\_variables*

---

**Description**

restructure\_carbon\_variables

**Usage**

```
restructure_carbon_variables(dataframe, varname, mode, group)
```

**Arguments**

dataframe	Input data.frame, from neonUtilities::stackEddy
varname	Which variable are we applying this function to? There's a list of ~10 common ones to write to the hdf5 file.
mode	Are we fixing a reference data frame or an ambient data frame?
group	Data, ucrt, or qfqm?

**Value**

data.frame formatted for output to hdf5 file.

---

restructure\_water\_variables  
*restructure\_water\_variables*

---

**Description**

restructure\_water\_variables

**Usage**

```
restructure_water_variables(dataframe, varname, mode)
```

**Arguments**

dataframe	Input data.frame, from neonUtilities::stackEddy
varname	Which variable are we applying this function to? There's a list of ~10 common ones to write to the hdf5 file.
mode	Are we fixing a reference data frame or an ambient data frame?

**Value**

data.frame formatted for output to hdf5 file.

---

R_to_delta	<i>R_to_delta</i>
------------	-------------------

---

**Description**

R\_to\_delta

**Usage**

R\_to\_delta(R\_values, element)

**Arguments**

R_values	A vector of isotope ratios (e.g., R values).
element	Which element to return delta values - carbon, oxygen, or hydrogen.

**Value**

Vector of isotope ratios in delta notation.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

**Examples**

```
R_to_delta(R_values = 2005.20e-6, element = 'oxygen') # returns 0.
```

---

select_daily_reference_data	<i>select_daily_reference_data</i>
-----------------------------	------------------------------------

---

**Description**

select\_daily\_reference\_data

**Usage**

select\_daily\_reference\_data(standard\_df, analyte, min\_nobs = NA)

**Arguments**

standard_df	Input reference data.frame.
analyte	Are we calibrating CO2 and H2O? (Use argument 'co2' or 'h2o', or else function will throw error)
min_nobs	Minimum number of high-frequency observations to define a peak. If not supplied, defaults are 200 for analyte = 'co2' or 30 for analyte = 'h2o'

**Value**

Smaller data.frame where only the reference data selected to use in the calibration routines is returned. Assumes that we are calibrating on a daily basis, and not on a longer time scale. Data are selected based on two criteria: cannot be missing, and must be at least a certain number of high-frequency observations in order to qualify as a valid measurement. For the water system, this function also keeps only the last three injections for each reference water per day.

---

setup_output_file	<i>setup_output_file</i>
-------------------	--------------------------

---

**Description**

Creates a skeleton hdf5 file for the calibrated data.

**Usage**

```
setup_output_file(inname, outname, site, analyte)
```

**Arguments**

inname	Input file name.
outname	Output file name.
site	NEON 4-letter site code.
analyte	Carbon ('Co2') or water ('H2o') system?

**Value**

Nothing to the environment, but creates a new data file with the most basic output HDF5 structure consistent with NEON's data files.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

```
swap_standard_isotoperatios  
    swap_standard_isotoperatios
```

---

**Description**

There are a few suspected instances where the water isotope ratios for oxygen and hydrogen have been flipped in the reference data. This function corrects them until they are corrected in the NEON database using a d-excess filter.

**Usage**

```
swap_standard_isotoperatios(std_frame, dxs_thres = 500)
```

**Arguments**

std_frame	Standard data frame to perform swap on.
dxs_thres	d-excess threshold to indicate when to swap.

**Value**

A data.frame based on `std_frame`, where d18O and d2H values have been swapped from NEON input files if determined to have a reference value mismatch. Mismatch is determined based on the d-excess of the standard ( $= d2H - 8*d18O$ ), using a value of 500 by default.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

```
terrestrial_core_sites  
    terrestrial_core_sites
```

---

**Description**

```
terrestrial_core_sites
```

**Usage**

```
terrestrial_core_sites()
```

**Value**

A vector listing NEON core terrestrial sites.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

**Examples**

```
terrestrial_core_sites()
```

---

```
terrestrial_relocatable_sites  
      terrestrial_relocatable_sites
```

---

**Description**

terrestrial\_relocatable\_sites

**Usage**

```
terrestrial_relocatable_sites()
```

**Value**

A vector listing NEON core terrestrial sites.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

**Examples**

```
terrestrial_relocatable_sites()
```

---

```
validate_analyte      validate_analyte
```

---

**Description**

validate\_analyte

**Usage**

```
validate_analyte(analyte)
```

**Arguments**

analyte            Co2 or H2o?

**Value**

Standardized string for the water ('H2o') or carbon ('Co2') systems to make sure strings are standardized across package functions.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

validate\_output\_file    *validate\_output\_file*

---

**Description**

validate\_output\_file

**Usage**

```
validate_output_file(inname, outname, site, analyte)
```

**Arguments**

inname	Input file name.
outname	Output file name.
site	NEON 4-letter site code.
analyte	Carbon ('Co2') or water ('H2o') system?

**Value**

Nothing to environment, simply checks to make sure expected groups are in output.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

water\_isotope\_sites    *water\_isotope\_sites*

---

**Description**

water\_isotope\_sites

**Usage**

```
water_isotope_sites()
```

**Value**

A vector listing NEON sites measuring water vapor isotope ratios.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

**Examples**

```
water_isotope_sites()
```

---

write\_carbon\_ambient\_data  
                          *write\_carbon\_ambient\_data*

---

**Description**

Write out ambient observations from the NEON EC towers where the isotope data (either H2O or CO2) have been calibrated using this package.

**Usage**

```
write_carbon_ambient_data(outname, site, amb_data_list)
```

**Arguments**

outname	Output file name.
site	NEON 4-letter site code.
amb_data_list	Calibrated list of ambient data - this is the output from one of the calibrate_ambient_carbon* functions.

**Value**

Nothing to the environment, but writes data in amb\_data\_list to file.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

write\_carbon\_calibration\_data  
*write\_carbon\_calibration\_data*

---

**Description**

write\_carbon\_calibration\_data

**Usage**

write\_carbon\_calibration\_data(outname, site, calDf, method)

**Arguments**

outname	Output file name.
site	NEON 4-letter site code.
calDf	Calibration data frame - this is the output from fit_carbon_regression
method	Was the Bowling et al. 2003 or the linear regression method used in fit_carbon_regression?

**Value**

Nothing to the environment, but writes out the calibration parameters (e.g., gain and offset or regression slopes and intercepts) to the output hdf5 file.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

write\_carbon\_reference\_data  
*write\_carbon\_reference\_data*

---

**Description**

write\_carbon\_reference\_data

**Usage**

write\_carbon\_reference\_data(inname, outname, site, calDf)



**Arguments**

inname	Input file name.
outname	Output file name.
site	NEON 4-letter site code.
calDf	Calibration data frame - this is the output from fit_carbon_regression

**Value**

Nothing to the environment, but writes calibrated reference data to hdf5 file.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

write_qfqm	<i>write_qfqm</i>
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---

**Description**

Write NEON's qfqm data for an isotope species to output file. Wraps copy\_qfqm\_group.

**Usage**

```
write_qfqm(inname, outname, site, analyte)
```

**Arguments**

inname	Input file name.
outname	Output file name.
site	NEON 4-letter site code.
analyte	Carbon ('Co2') or water ('H2o') system?

**Value**

Nothing to the environment, but writes qfqm data to file.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

write_ucrt	<i>write_ucrt</i>
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---

**Description**

Write NEON's ucrt data for an isotope species to output file. Wraps copy\_ucrt\_group.

**Usage**

```
write_ucrt(inname, outname, site, analyte)
```

**Arguments**

inname	Input file name.
outname	Output file name.
site	NEON 4-letter site code.
analyte	Carbon ('Co2') or water ('H2o') system?

**Value**

Nothing to the environment, but writes ucrt data to file.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

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write_water_calibration_data	<i>write_water_calibration_data</i>
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**Description**

write\_water\_calibration\_data

**Usage**

```
write_water_calibration_data(outname, site, calDf)
```

**Arguments**

outname	Output file name.
site	NEON 4-letter site code.
calDf	Calibration data frame - this is the output from fit_water_regression

**Value**

Nothing to the environment, but writes out the calibration parameters (e.g., regression slopes and intercepts) to the output hdf5 file.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

---

write\_water\_reference\_data  
*write\_water\_reference\_data*

---

**Description**

write\_water\_reference\_data

**Usage**

```
write_water_reference_data(inname, outname, site, lowDf, medDf, highDf, calDf)
```

**Arguments**

inname	Input file name.
outname	Output file name.
site	NEON 4-letter site code.
lowDf	Dataframe corresponding to the "low" reference water.
medDf	Data frame corresponding to the "med" reference water.
highDf	Data frame corresponding to the "high" reference water.
calDf	Calibration data frame - this is the output from fit_water_regression

**Value**

Nothing to the environment, but writes calibrated reference data to hdf5 file.

**Author(s)**

Rich Fiorella <rfiorella@lanl.gov>

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