HSR1 Python library

## Introduction

This manual describes a Python library for analysing datasets from the HSR1 radiometer, and displaying a summary of the data collected. This comes in two parts:

1. For early instruments, the text-based data files are loaded and stored into a database in the same format used by later instruments.
2. For datasets in the database format, the library can then quickly plot summary charts showing the complete dataset, or show data in more detail in daily plots. These give an overview of the health and accuracy of the readings, including the GPS and other internal sensors.

Version

This manual describes version 0.4.8 of the python library

## Authors

Albie Gray, John Wood

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# Installation

## pip

This library can be installed from the pip repository using the command:

pip install hsr1

And updated to the latest version using this command:

pip install --upgrade hsr1

## conda

conda distribution is not currently supported

# Timezones

## HSR1 Timezone settings

Reading times are recorded by the instrument using the Windows time setting. It is recommended to set this to UTC, though other timezones are acceptable. It is best to avoid any daylight saving, which can change the timezone part way through a dataset.

The HSR1 timezone is read from the deployment.ini file, which must be created by the user on early HSR1s. This also contains other metadata about the data series and datalogging settings. There is an example of this file in the deployment metadata section at the end of this manual.

## Database timezone settings

Reading times are stored in the database in local time as a timezone aware timestamp. If there are multiple dataseries in a database with different timezones (for example during daylight saving time) it will work the same way, with each measurement being in the local time when it was measured, according to the user supplied timezone.

When loading from the database, all timezones will be loaded into Python as a timezone aware pandas timestamp, which is mostly interchangeable with a python datetime.datetime. The timezone used on loading is passed in the db.load() command, and may be different from the timezone used in recording the dataset. In general, UTC is used for all astronomical calculations, and the local timezone is used in presenting the data where a local time is appropriate, e.g. in separating data into daily chunks.

# Angles

Internally, all angles are stored as radians and all functions that take an angle take it in radians. When loading data from the database, angle columns will be in radians. All graphs are in degrees

# Flags

Included in the graphing section of the library is the capability to detect implausible data points and overlay them in a different colour. This means that potentially misleading datapoints are easy to spot and can’t be confused with real data. Currently the only graphs that display flagged data are the graphs in the [integral summary](#_plot_integral), with the parameter flag=True, and daily line plots when plotting integral data, again with the parameter flag=True. In future versions of this library, it will be possible to automatically filter out the flagged readings. You can, however, calculate the flags manually using this code:

From hsr1.plots import flagData

flags = flagData.flag(data, ignore\_nights=True)

The flags dataframe can then be used to filter the data returned from the database

# Examples

## Storing .txt files to the database

1. Set the locations of the data filepath, the Deployment.ini file, and the database to create or update.
2. Create a DBDriver object with the location of the database (if it doesn’t exist, it will create a new one).
3. Read the data from the .txt files, and the Deployment.ini file.
4. Store the data to the database. During this process, the solar position information (solar azimuth & zenith, atmospheric path length) will be calculated and stored to the database.

import hsr1

data\_filepath = “txt\_datasets/2024\_data/”

deployment\_metadata\_filepath = “txt\_datasets/metadata/2024\_metadata”

database\_loacation = “databases/2024\_data.db”

db = hsr1.DBDriver(database\_location)

data = hsr1.read\_txt.read(data\_filepath, deployment\_metadata\_filepath)

db.store(data)

## Loading data from the database

1. Make a DBDriver object.
2. Use db.load(), passing in a list of all the columns you want, start time, end time and any sql conditions.

import hsr1

database\_location = “databases/2024\_data.db”

db = hsr1.DBDriver(database\_location)

data = db.load([“pc\_time\_end\_measurement”, “global\_integral”],

condition=”sza < 1.57”)

This example will load the time and the global irradiance for all records where the sun is above the horizon.

## Making graphs from a database

1. Make a graph object, passing in a DBDriver or the name of a database.
2. Use the methods of the graph object to plot the graphs you want.
3. Some graphs are more generic, and you can pass in the parameters you want to plot, these are detailed in the [reference](#_vmgxekh30cy4) section.

import hsr1

database\_location = “databases/2024\_data.db”

graph = hsr1.Graph(database\_location)

graph.plot\_integral()

graph.plot\_gps()

graph.plot\_dips\_summary()

graph.plot\_accessory()

graph.plot\_daily\_line([“global\_integral”, “diffuse\_integral”])

graph.plot\_daily\_hist([“rh”, “pressure”])

## Making a custom graph

This is an example of how to make a line graph of the atmospheric optical depth at 5 different wavelengths. This covers loading from the database, unpacking spectral data, and using the existing graphs.

# import hsr1, and also numpy and pandas which are used for data processing

import numpy as np

import pandas as pd

import hsr1

# creates DBDriver object for the database where the data to be plotted is stored

database\_location = "C:/Users/albie/work/Albiegray/databases/test\_ts.db"

db = hsr1.DBDriver(database\_location)

# loads all the columns required for this plot. pc\_time\_end\_measurement is used for plotting,

# and all the other columns are used to calculate the aod

requirements = ["pc\_time\_end\_measurement", "global\_spectrum",

"diffuse\_spectrum", "sza", "sed"]

data = db.db\_load.load(["pc\_time\_end\_measurement", "global\_spectrum", "diffuse\_spectrum", "sza", "sed"])

# spectral data is returned as a column in this dataframe, where each reading is a numpy array

# containing 801 values, which represents the intensities at wavelengths 300 to 1100

# only the aod\_microtops will be plotted

aod\_type = "aod\_microtops"

# calculates the aod\_values that will be used for the plot.

# this calculates aod at all wavelengths, but the desired wavelengths will be selected later

aod\_data = hsr1.utils.HsrFunc.calc\_aod\_from\_df(data)

# these are the wavelengths that will be plotted

wavelengths = np.array([380, 440, 500, 675, 870, 1020])

# filters for just the aod type that is being used, and converts the series of arrays into a 2d array

aod = np.stack(aod\_data[aod\_type].values)

# filters the wavelengths to only include the selected wavelengths.

# -300 because the wavelengths are from 300-1100, so the first in the array is 300nm

aod = aod[:, wavelengths-300]

# convert the array back into a dataframe, and add the time column

limited\_df = pd.DataFrame(aod, columns=wavelengths.astype(str))

limited\_df["pc\_time\_end\_measurement"] = aod\_data["pc\_time\_end\_measurement"]

# calculates which readings have a clear sky and which are cloudy. uses the "wood" method by default

# calculate\_clearsky\_filter returns an array of 1s and 0s which can be used to filter an array or dataframe

clearsky\_filter = hsr1.utils.HsrFunc.calculate\_clearsky\_filter(data)

# filter the aod and time values using the clearsky filter

# this will cause gaps in the index where values were skipped,

# reset\_index returns it to a normal increasing index

limited\_df = limited\_df.loc[clearsky\_filter, :].reset\_index(drop=True)

# creates a graph object

graph = hsr1.Graph(db)

# plots the graph

# sets rows=3, days\_in\_row=7 to put fewer days on each page, which shows each day

# in more detail than putting a whole month on a page

graph.plot\_daily\_line(dataframe=limited\_df,

columns=wavelengths.astype(str),

rows=3, days\_in\_row=7,

title\_prefix=aod\_type+"\n")

# Reference

## DBDriver

hsr1.DBDriver(db\_name, db\_type=”sqlite”)

Generic class for database operations.

**DBDriver** contains a [Load](#_Load) and a [Store](#_Store) object, and exposes common methods in those objects to the user for easy access.

Parameters:

* db\_name(str): name of the db. if the db doesn't exist, it will be created when data is stored to it.
* db\_type(str): type of database used. Currently only sqlite is supported.

Attributes:

* db\_name(str) the name of the database
* db\_store(hsr1.db.Store): a [Store](#_Store) object connected to this database
* db\_load(hsr1.db.Load): a [Load](#_Load) object connected to this database
* last\_timestamp(str): the last timestamp in the database
* first\_timestamp(str): the first timestamp in the database

Methods:

* [add\_precalculated\_values](#_vvid2t22jo0t)
* [make\_gpx](#_gq0lwbjx4hb0)
* [store](#_c69tb191rh6v)
* [load](#_emxwt18ki414)
* [load\_table\_names](#_i8vsoc8huwq)
* [load\_accessory](#_hut31jaeyq9r)
* [load\_metadata](#_yecgx8fks4h)

### add\_precalculated\_values

db\_driver.add\_precalculated\_values()

calculates some commonly used values and stores them to the database. These include solar azimuth & zenith angles, solar irradiance at Top of Atmosphere, and atmospheric path length.

Parameters:

* method(str): which library to use.

"ephem": basic calculation

"sg2\_static": really fast for a static instrument

"sg2\_mobile": slow, not recommended, but works for a mobile dataset.

"sg2": detects whether the dataset is mobile and uses the appropriate method.

None(default): uses "sg2\_static" if static, and “ephem” if the dataset is mobile.

Returns:

* None, just updates the database with a new table.

Note: currently drops all precalculated values and calculates new ones, so if this is taking a long time when adding to a large database, try storing to a smaller database, precalculating only the new values, then merging into the main database.

### make\_gpx

db\_driver.make\_gpx(filename)

make and save an .xml file, containing the latitude & longitude values and timestamp.

The file can be used with google my maps or another gpx viewer.

Parameters:

* filename(str): the file location that the .gpx file will be saved to

Returns:

* None

### store

db\_driver.store(dfs, precalculate=True)

Exposes the [store](#_Store_2) method of [hsr1.db.Store](#_Store)

### load

db\_driver.load(columns=[], start\_time=None, end\_time=None, condition=””,

raise\_on\_missing=True, sort=True, deserialise=True,

timezone=”+00:00”)

Exposes the [load](#_load_2) method of [hsr1.db.Load](#_Load)

### load\_table\_names

db\_driver.load\_table\_names()

Exposes the [load\_table\_names](#_load_table_names_1) method of [hsr1.db.Load](#_Load)

### load\_accessory

db\_driver.load\_accessory(columns=[], start\_time=None, end\_time=None,

condition=””, raise\_on\_missing=True, sort=True,

deserialise=True, timezone=”+00:00”)

Exposes the [load\_accessory](#_load_accessory_1) method of [hsr1.db.Load](#_Load)

### load\_metadata

db\_driver.load\_metadata(columns=[], condition=””, raise\_on\_missing=True)

Exposes the [load\_metadata](#_load_metadata_1) method of [hsr1.db.Load](#_Load)

## Store

hsr1.db.SqliteDBStore(driver)

Handles all the storing operations in the database.

SqliteDBStore is the only store class that has been implemented, but other future databases will also follow this structure.

Note: it is not recommended to create your own instance of this class, instead use the attribute db\_store of a [DBDriver](#_DBDriver) object instead.

Parameters:

* driver([hsr1.graph.DBDriver](#_DBDriver)): driver object for the database that data will be stored to

Attributes:

* driver([hsr1.graph.DBDriver](#_DBDriver)): driver object for the database that data will be stored to

Methods:

* [store](#_Store_2)
* [combine\_database](#_combine_database)
* [combine\_database\_folder](#_combine_database_folder)
* [drop\_table](#_drop_table)

### store

store.store(dfs, precalculate=True)

stores data to the database

This function should usually only be used straight after reading data from a dataset of .zip files, and you can pass the output of that straight into the dfs parameter of this function.

Parameters:

* dfs(tuple(pandas.dataframe)): tuple of 3 or 4 dataframes each containing data for a different table of the database.
  + The order is: spectral\_data, system\_data, deployment\_metadata, accessory\_data (if included)
* precalculate(bool): if True, calculates some commonly used values and stores them to a separate table in the database. These are required for some graphs, so it is recommended to keep this as True.

### combine\_database

store.combine\_database(new\_db\_name)

combines another database into the current database.

Parameters:

* new\_db\_name(str): file path to the database that will be merged into the current one.

The current database is the one connected to the [DBDriver](#_DBDriver) that you are accessing store from. This function will append all the data in the new database onto the current database.

### combine\_database\_folder

store.combine\_database\_folder(folder, delete=False)

Combines a folder of databases into the current database.

Parameters:

* folder(str): the folder containing several databases to merge into the current database.
* delete(bool): if True, deletes the contents of the the folder after they are combined

Calls combine\_database on each database in the folder.

### drop\_table

store.drop\_table(table\_name)

drops a given table from the database.

parameters:

* table\_name: the name of the table to be dropped.

## Load

hsr1.db.SqliteDBLoad(db\_name)

Handles all the loading from the database.

SqliteDBLoad is the only Load class that has been implemented, but other future database implementations will also follow this structure.

Note: it is not recommended to create your own instance of this class, instead use the attribute db\_load of a DBDriver object instead.

Parameters:

* db\_name(str): the name of the db that data is being loaded from

Attributes:

* db\_name(str): the name of the db that data is being loaded from
* exists(bool): whether the database exists already or not

Methods:

* [load](#_load_2)
* [load\_metadata](#_load_metadata_1)
* [load\_accessory](#_load_accessory_1)
* [load\_table\_names](#_load_table_names_1)
* [load\_sql](#_load_sql)

### load

load.load(columns=[], table=None, start\_time=None, end\_time=None,

condition=””, raise\_on\_missing=True, sort=True,

deserialise=True, timezone=”+00:00”)

Loads requested columns from the database.

Parameters:

* columns(list(str)): default []. list of database columns that you want data from. If [] then all columns in spectral\_data, system\_data, and precalculated\_values will be returned. See the note about loading accessory\_data and data from other tables. List of all the database tables and columns can be found [here](#DatabaseReferenceTitle).
* table(str): the table you are loading data from. “spectral\_data”, “system\_data”, “precalculated\_values”, “deployment\_metadata” and if your database has it, “accessory\_data”. Use this if the columns you want are in multiple tables and you want to specify which one you want.
* start\_time(str): string representing a timestamp. Format is YYYY-MM-DD HH:MM:SS in the device’s local time that is stored in the database, not in the timezone that is passed in the timezone parameter. Timestamps are stored as strings in the database, so there is a simple string comparison. You don't need to provide a full timestamp, it will return all timestamps after your query and is inclusive.
* end\_time(str): see above.
* condition(str): for more complex queries. A string that will be appended to the SQL query. “ WHERE “ is automatically appended so no need to include that. For even more control, use [load\_sql](#_wwbhnu5cgpk4)
  + E.g.: “sza < 1.57” will select all values where sza is less than 1.57.
* raise\_on\_missing(bool): default True. If one or more columns couldn’t be found in the database, the program will raise an error. Set this to False to skip missing columns
* sort(bool): default True. Sorts the result by the database’s local reading time. This doesn't take long on most databases, but if you have a large database that you know is sorted, or doesn't need to be sorted, setting this to false can speed up query times.
* deserialise(bool): default True. Automatically deserialise the spectral data back into numpy arrays.
* timezone(str): default “+00:00”. The time zone that all the data will be converted into when loaded. This ensures all data is in the same time zone when it is loaded from the database

Returns:

* result(pandas.dataframe): one dataframe with all requested database columns as columns.

Note: because some tables have different reading frequencies (deployment\_metadata will only have a handful of readings, one for each data series, accessory\_data has readings at the sampling frequency, and all the other tables have readings at the storage (averaging) frequency) you can't load columns from multiple tables in the same request, if they have different measurement periods. To get around this, do separate calls to load for each table type.

Note: spectral data columns, e.g. global\_spectrum is also returned as a single column in the output dataframe, each reading is a numpy array of 801 floats representing the values at wavelengths 300-1100. To convert from the column of arrays in to one dataframe with 801 columns, run this code snippet:

new\_df = pd.DataFrame(np.stack(total\_dataframe[spectral\_column].values),

columns=np.arange(300, 1101, 1))

Note: if table is not specified and a requested column is in multiple tables, this method will try and guess which one you want. The priorities are below:

1. All columns are in the same table type (if you request pc\_time\_end\_measurement and some accessory\_data columns, it will return the time in the accessory\_data table), to avoid a crash.
2. The table priorities when there is no other way to distinguish between tables:
   1. spectral\_data
   2. system\_data and precalculated\_values (same priority as there are no shared columns that aren't in spectral\_data)
   3. accessory\_data and deployment\_metadata (same priority as there are no shared columns that aren't in spectral\_data)

### load\_metadata

load.load\_metadata(columns=[], condition=””, raise\_on\_missing=True)

Loads the requested data from the deployment\_metadata table.

Parameters:

* columns(list(str)): default []. List of database columns that you want data from. If [] then all columns will be returned.
* condition(str): for more complex queries. A string that will be appended to the SQL query. “ WHERE “ is automatically appended so no need to include that.
  + E.g.: “sza < 1.57” will select all values where sza is less than 1.57.
* raise\_on\_missing(bool): default True. If one or more columns couldn’t be found in the database, the program will raise an error. Set this to False to skip missing columns.

The same as calling [load](#_load_2)() with table=”deployment\_metadata”, but this method only has the parameters that have an effect on the deployment\_metadata table

### load\_accessory

load.load\_accessory(columns=[], start\_time=None, end\_time=None,

raise\_on\_missing=True, sort=True, timezone=”+00:00”)

Loads the requested data from the accessory\_data table.

The same as passing [load](#_load_2)() with table=”accessory\_data”. Same parameters as load() but without table, as that is always “accessory\_data”, and deserialise, as there is no serialised data in this table.

Parameters:

* columns(list(str)): default []. list of database columns that you want data from. If [] then all columns will be returned
* start\_time(str): string representing a timestamp. Format is YYYY-MM-DD HH:MM:SS in local time. Timestamps are stored as strings in the database, so there is a simple string comparison. You don't need to provide a full timestamp, it will return all timestamps after your query and is inclusive.
* end\_time(str): see above.
* condition(str): for more complex queries. A string that will be appended to the SQL query. “ WHERE “ is automatically appended so no need to include that.
  + E.g.: “sza < 1.57” will select all values where sza is less than 1.57.
* raise\_on\_missing(bool): default True. If one or more columns couldn’t be found in the database, the program will raise an error. Set this to False to skip missing columns.
* sort(bool): default True. Sorts the result by the database’s local reading time. This doesn't take long on most databases, but if you have a large database that you know is sorted, or doesn't need to be sorted, setting this to false can speed up query times.
* timezone(str): default “+00:00”. The time zone that all the data will be converted into when loaded. This ensures all data is in the same time zone when it is loaded from the database.

### load\_table\_names

load.load\_table\_names()

return a dictionary of all the table names and their corresponding column names.

Format: {“table\_1”: [“column\_1”, “column\_2”, “column\_3”], “table\_2”:[“column\_1”, …], ...}

Parameters:

* None

Returns:

* Dictionary containing table and column names.

### load\_sql

load.load\_sql(sql)

Runs a custom SQL query on the database, and returns the result as a dataframe

Parameters:

* sql(str): the query to run.

Returns:

* A dataframe containing the requested data. If the query doesn't return any data, returns None.

## Graph

hsr1.Graph(data=None, driver=None, dataframe=None,

deployment\_metadata=None, accessory\_data=None,

output\_location=None, diffuse\_name=”DIF”, timezone=”+00:00”,

dpi=100

\*\*kwargs)

A class for graphing HSR1 data.

Parameters:

* data(hsr1.DBDriver, pandas.dataframe, str): to be used as a positional argument, as either a DBDriver or a dataframe containing all the data(these can also be passed as keyword arguments), or a string of the database name. if this is a DataFrame, it should contain all the data you want to plot in the spectral\_data, system\_data, and precalculated\_values table of the database
* driver(hsr1.DBDriver): to pass a DBDriver object as a keyword argument.
* dataframe(pandas.dataframe: to pass a dataframe of data as a keyword argument. The data in this dataframe should be from the spectral\_data, system\_data, and precalculated\_values tables in the database, data from the other tables can be passed below.
* deployment\_metadata(pandas.dataframe): to pass a dataframe of deployment metadata as a keyword argument.
* accessory\_data(pandas.dataframe): to pass a dataframe of accessory\_data as a keyword argument.
* output\_location(str): String filepath to a folder where all the graphs generated will be stored.
* diffuse\_name(str): what to call the diffuse on graph labels. Default=”DIF”
* timezone(str): the timezone to add to the time in the dataset.
* dpi(int): the dots per inch of the figure, measure of resolution, increase this if the graphs are blurry, decrease this if it is taking too long to generate.
* Also supports passing keyword arguments into [load](#_7mwxritdxu2m) when loading data from a database.

Attributes

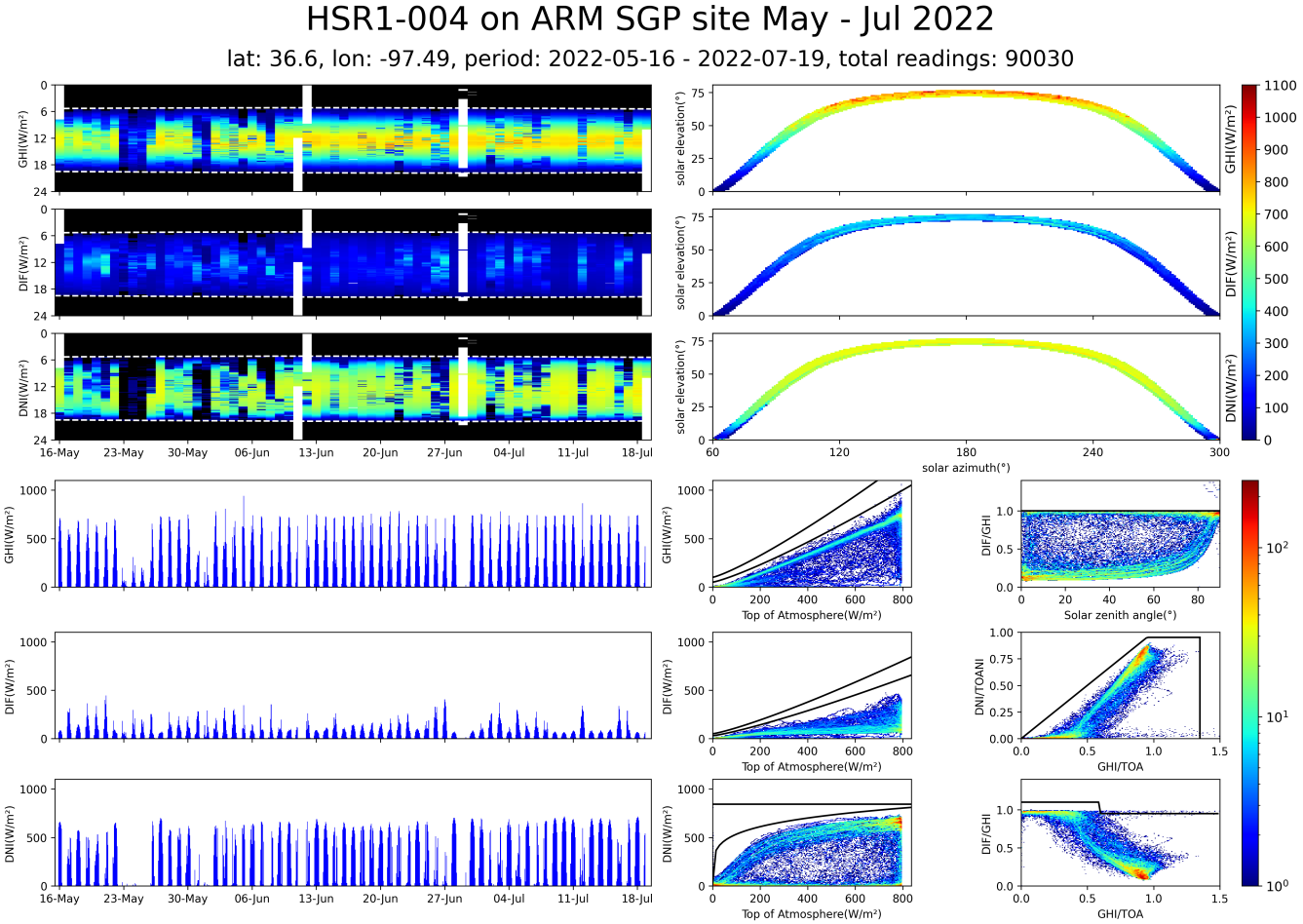
* All the above parameters
* Timedelta(pandas.timedelta): the time difference between local time and UTC.

Methods:

* [plot\_integral](#_plot_integral)
* [plot\_gps](#_plot_gps)
* [plot\_dips\_summary](#_plot_dips_summary)
* [plot\_accessory](#_plot_accessory)
* [plot\_daily\_line](#_plot_daily_line)
* [plot\_daily\_hists](#_plot_daily_hists)
* [biggest\_dips](#_biggest_peaks)
* [daily\_biggest\_dips](#_daily_biggest_dips)
* [plot\_time\_day](#_plot_time_day)

### plot\_integral

graph.plot\_integral(flag=False, title=””, max\_integral=None)



time/day plots(top left):

Each column represents one day of data, red=brightest, blue=darkest, white=missing data. Dotted white lines represent sunrise and sunset.

elevation/azimuth plots(top right):

Plots the solar elevation against the azimuth, with the colour representing the intensity, same scale as time/day plots. Shows the path of the sun throughout the dataset. Can be used to get a sense of where in the day the sun is brightest, and can also be used to find obstructions to the instrument

Integral plots(bottom left):

Simple plots of the global, diffuse and direct normal intensity over time. On a smaller dataset, you can get a good overview of each day, whereas on a full dataset you can see how the intensity varies over time. These show the broadband values integrated over the range 400nm – 1000nm.

accuracy/plausibility checks(bottom right):

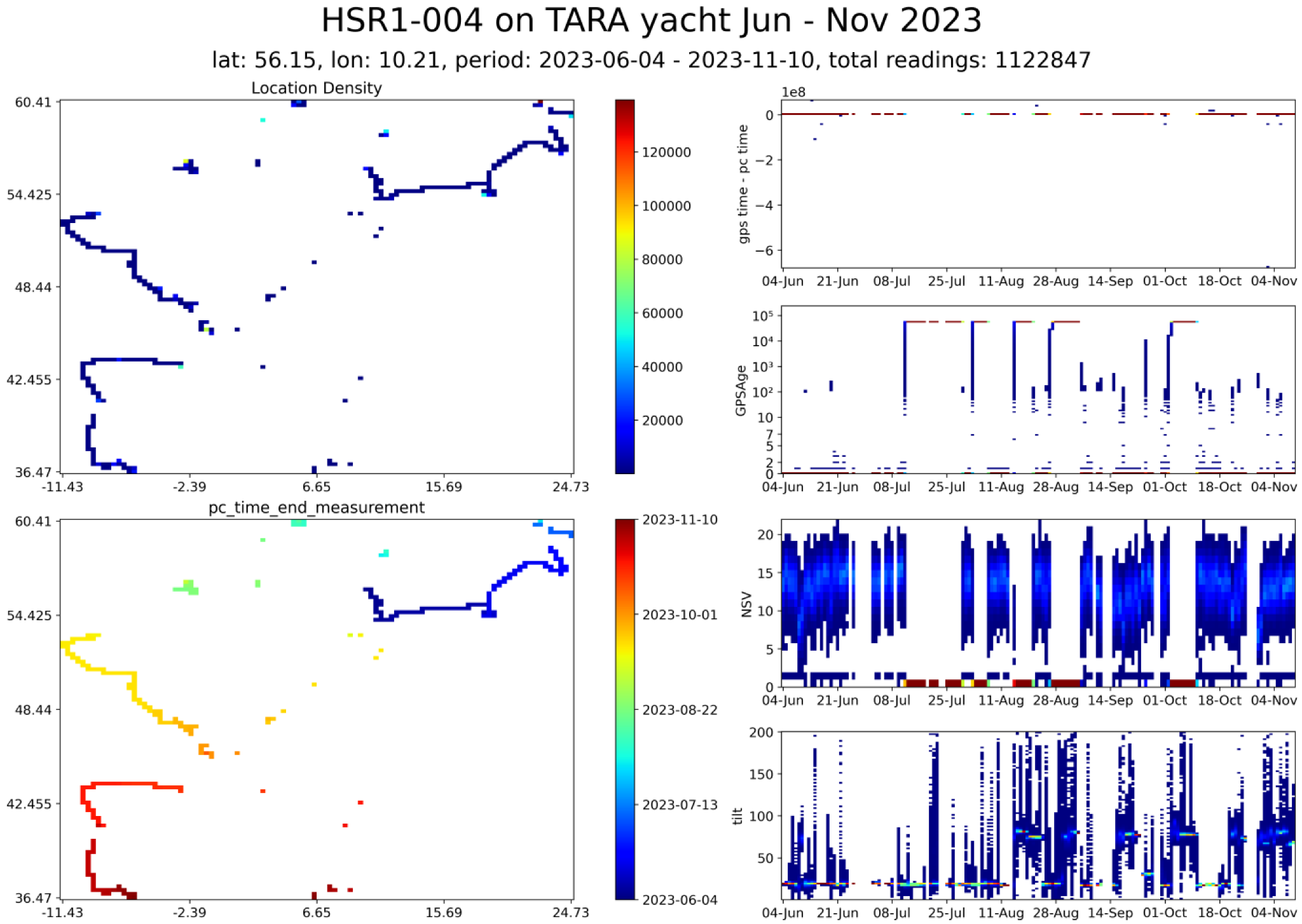
A series of plots that help check the accuracy of the data. The black lines are the BSRN’s Physically possible limits, and the extremely rare limits. When the flag parameter is True (False by default), all data over the Physically possible line will be plotted as pink on all the other graphs in the summary. When flag is False, only the values over the limit for each individual graph will be plotted in pink. Details of what each graph is plotting is on the axes. Colour represents density. NB – the BSRN limit values are reduced to the extraterrestrial spectrum integrated over 400nm – 1000nm to match the HSR1 outputs.

Parameters:

* flag(bool) default False: overlays the implausible data (from the accuracy/plausibility checks) on top of the regular data in pink.
* title(str) default “”: the title to display at the top of the plot. It left blank, it will be filled with the title field of the deployment\_metadata table.
* max\_integral(float) default None: the maximum intensity reading. Sets the colour scale and axis ylimits. Automatically set to the largest value in ghi, dhi or dni, but if you want to compare multiple datasets with the same axes and colour scales, pass the same max\_integral here.

### plot\_gps

graph.plot\_gps()



Plots a summary of the gps and related data. On a mobile dataset, shows where the instrument has been over the dataset. On a static dataset, shows the variation of the gps

Gps and frequency plot (top left)

Plots the latitude and longitude, with the colour representing the number of readings at that location

Gps and datetime plot (bottom left):

Plots the latitude and longitude, with the colour representing the time of the most recent reading at that location

Gps time error (top right):

Plots gps time-pc time on a modified logarithmic scale. It is logarithmic above and below 0, and -10 to +10 are linear.

GPSAge (middle top right):

Plots the time (s) since the last valid gps reading. This shows when the gps is not reading correctly.

NSV (middle bottom right):

Plots the number of satellites in view. Low values mean inaccurate gps.

Note: it is common to see NSV values up to 20, which may seem incorrect, as there are only 24 GPS satellites (which means you can only ever see a maximum of 12 at once), but these higher values are because satellites from other constellations are visible, e.g: GLONASS

Tilt (bottom right):

The output of the integrated tilt sensor, calculated as the square root of roll^2 + pitch^2

When the database has a simple GPS file rather than accessory\_data, there are different plots, rather than just empty space:

baro\_temp (middle top right):

The temperature reading inside the instrument from the barometer, replaces GPSAge graph

Pressure (middle bottom right):

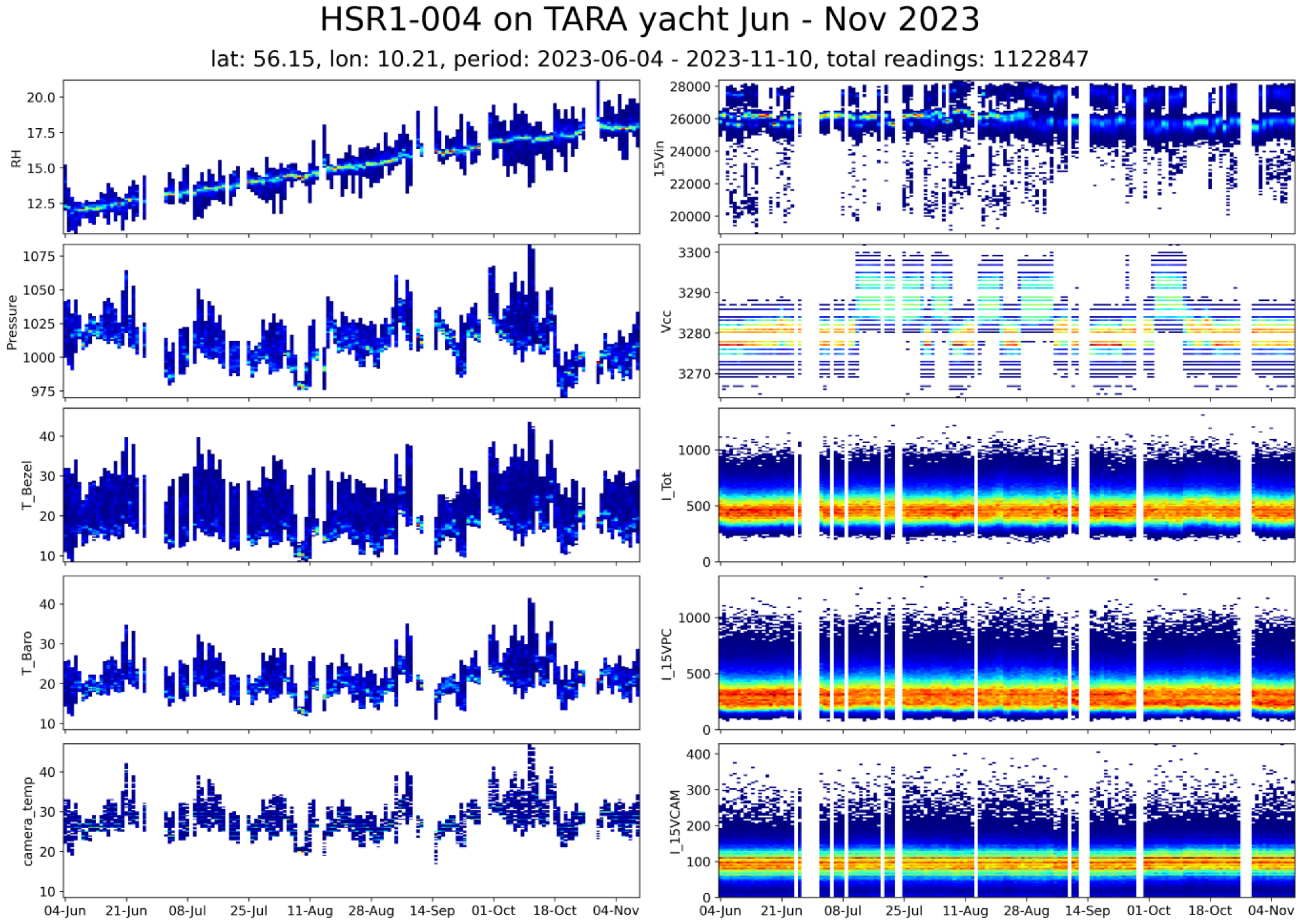
The pressure reading inside the instrument, replaces NSV graph

Relative humidity (bottom right):

The relative humidity inside the instrument, replaces tilt graph

### plot\_accessory

graph.plot\_accessory()



Plots a summary of the data in the accessory\_data table. Will raise an exception if the database does not have an accessory\_data table.

The plots:

Relative humidity inside the enclosure

Pressure inside the enclosure

Temperature at the bezel

Temperature as measured by the barometer

Camera temperature

15Vin – the power supply to the instrument

VCC – the internal CPU supply rail

Total current into the instrument

Current used by the pc

Current used by the camera

### plot\_dips\_summary

graph.plot\_dips\_summary()

A screen shot of a computer

Description automatically generated

Plots the wavelength of the 15 most prominent absorption dips at each reading as a frequency histogram. This can give a picture of how accurate the wavelength calibration is over the whole dataset. The correct locations of some prominent dips are plotted on the y-axis and with a grey line on the graph as a reference

Params:

* n(int) default 15: number of dips to choose from each reading.
  + Dips are chosen by most prominent first.
  + A small n value may miss out some dips, and a large one will be noisy.
* cutoff\_angle(float) default 80: Degrees. Only include solar zenith angles less than this value. Used for only including daylight data.
* cutoff\_wavelength(float) default 1000: only include wavelengths less than this value. Used to avoid noisy readings at the top of the spectrum.
* reference\_lines(list) default shown above: list of wavelengths where dips should appear, will be superimposed onto the graph as a reference.
* reference\_labels(list) default shown above: labels for the reference lines. Must be the same length as reference\_lines, pass “” if you don't want to label a value.

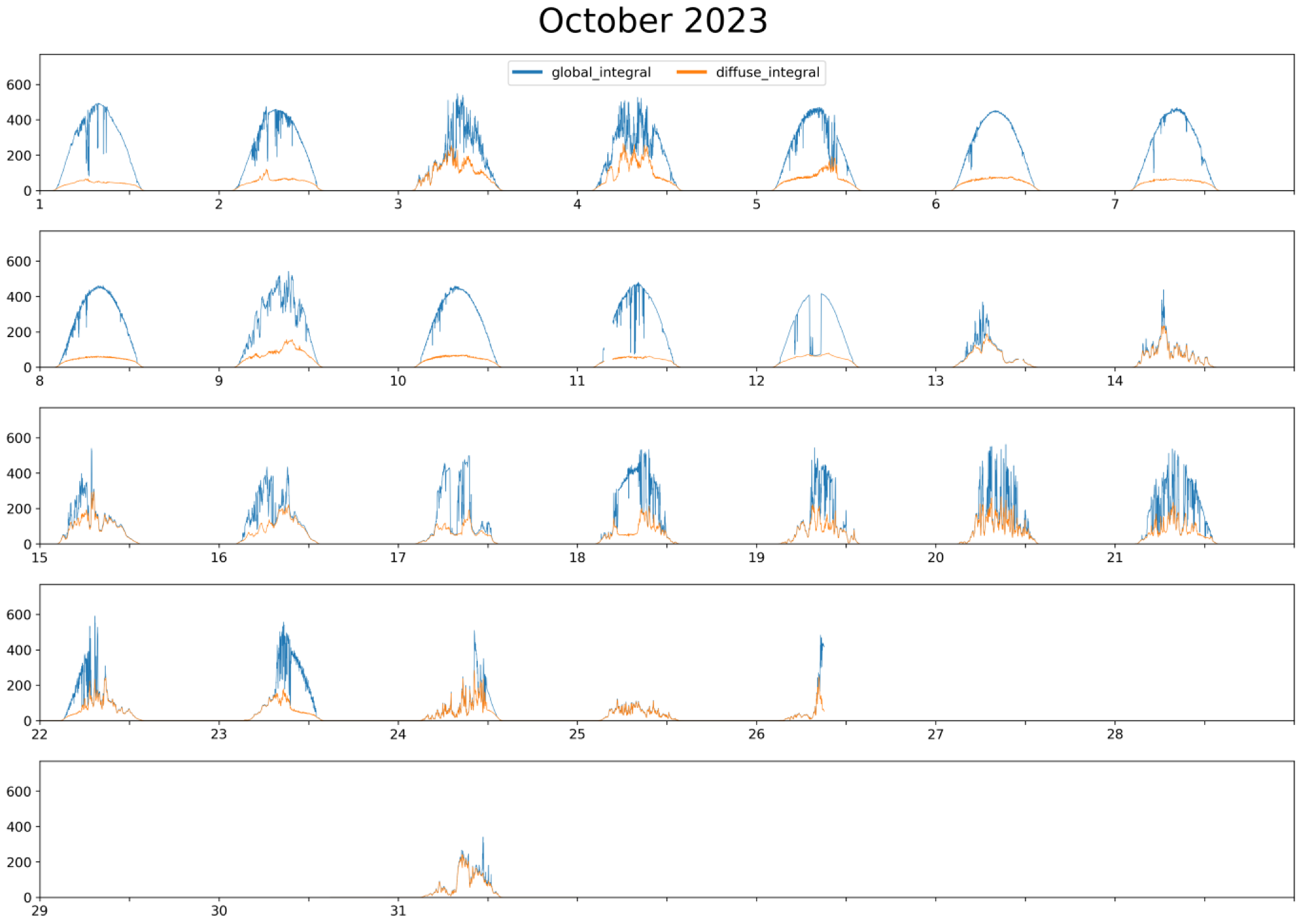
### plot\_daily\_line

graph.plot\_daily\_line(columns, period=”monthly”, rows=None,

days\_in\_row=None, flag=False, ignore\_zero=False,

title\_prefix=””, \*\*kwargs)

plots a line graph of each requested column



Plots a line graph of some data columns, spread over multiple pages if necessary. You can control how the days are spread over the pages using the period, rows, and days\_in\_row parameters.

Note: even if you pass a period value, if you also pass a rows and a days\_in\_row values, they will take precedence and may not show the whole period.

There are some presets with titles and columns already selected:

* daily\_integrals() The global, diffuse, and direct normal
* daily\_temps() All the internal temperatures measured

Parameters:

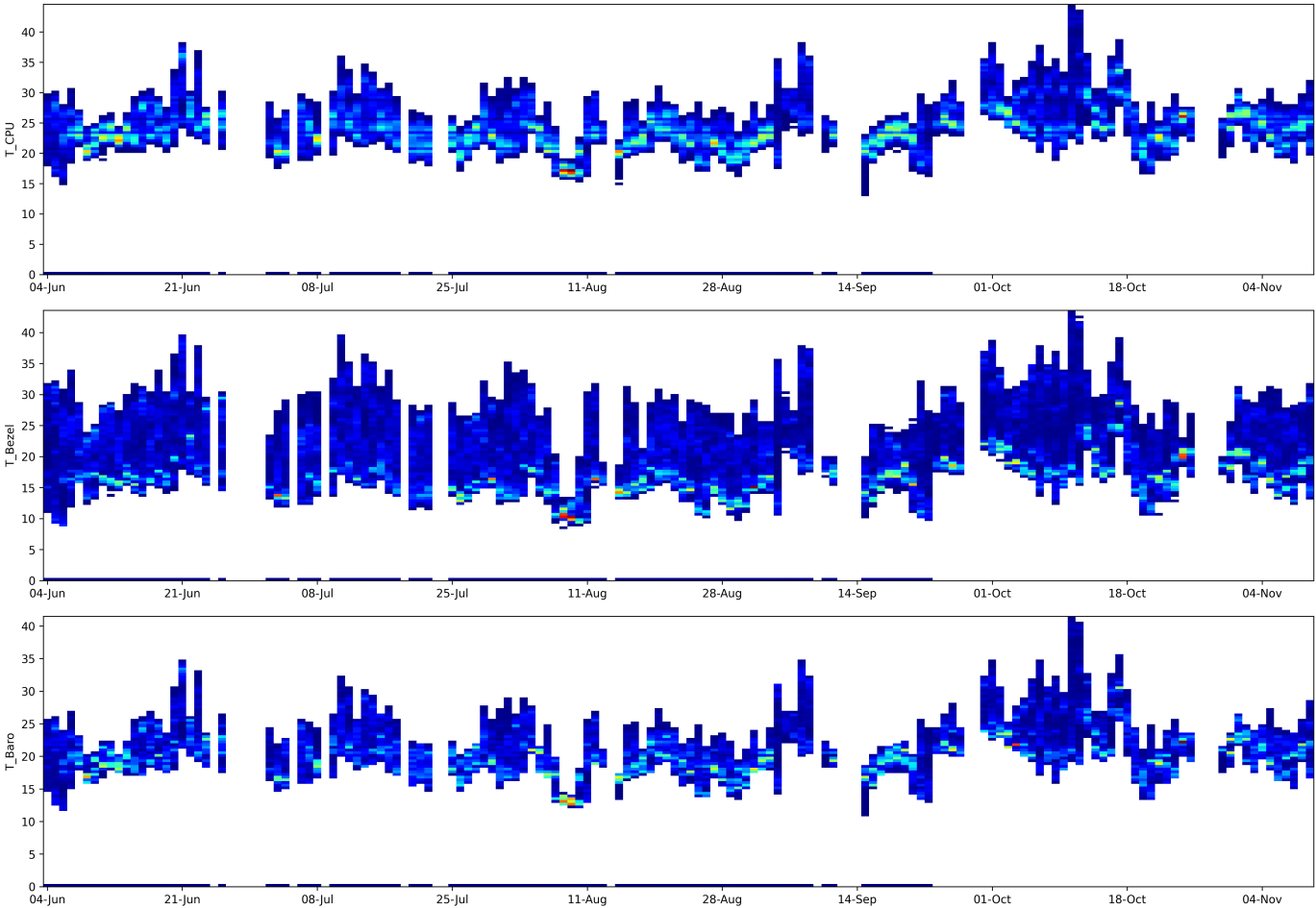
* Columns(list of strings): the names of the columns you want to plot.
* Period(int): how many days to plot per page, options: "weekly", "monthly", int
* rows(int): number of rows per page
* days\_in\_row(int): number of days per row
* flag(bool): whether or not to superimpose flagged data onto the graphs
* ignore\_zero(bool): whether or not to plot zeros
* title\_prefix(str): string that will display before the title

Note: you can’t currently plot data from the accessory\_data table, at the same time as from any other tables, as they may have different frequencies

### plot\_daily\_hists

plots a 2d histogram representing one column of data.

graph.plot\_daily\_hist(columns, title=””, \*\*kwargs)



Plots a 2d histogram that covers the whole dataset. Each column shows the frequency of every value over one day, and over a whole dataset you can see the trend of the data, and also the outliers. Colour represents frequency, blue is infrequent, red is very frequent.

You can pass a list of column names and multiple plots will be displayed.

Like the daily plots, there are a few presets with columns and titles already set:

* pht\_hists() pressure, humidity and temperature
* voltage\_hists() all the internally measured voltages
* current\_hists() all the internally measured currents

parameters:

* columns(list(str)): list of column headers that will be plotted OR string of one column name.
* title(str): the title of the plot

You can also pass keyword arguments to [load](#_load_2), which will control what data is being plotted.

You can also pass keyword arguments to the underlying DailyHists function:

* ignore\_zero(bool): filters out all the zero values.
* weight(bool): weights each column of the histogram based on how many readings are in that day, means shorter days have the same impact as longer days
* bins(int): number of bins to have on the y-axis.
* zero\_axes(bool): if True, starts the y-axis from 0, rather than the lowest data value.
* ylims(int, int): can manually set the ylims.
* show\_xticks(bool): whether or not to show labels on the x-axis, useful when plotting multiple at once with the same scale.
* ybuffer(bool): if True, adds a 10% buffer to the top of the graph.
* limited\_bins(bool): if True, sets the number of bins to the number of unique readings.
* log(bool): if True, uses a log scale in the positive and negative direction.

When using a log scale(log=True), there a few parameters you can pass as keyword arguments that control how the scaling works

* linthresh, base, linscale: explained in matplotlib’s documentation [here](https://matplotlib.org/stable/api/_as_gen/matplotlib.colors.SymLogNorm.html).

These parameters control the spacing of the yticks on the log scale, and the defaults won't work for all ranges of values.

* lin\_ticks: how many ticks on the y axis to show for the linear portion, depends on how large the graph is.
* log\_ticks\_skipped: the gap between each log tick, default 0, used if the graph is small and the log ticks are overlaid on top of themselves.

### biggest\_dips

plots the wavelength of the most common peaks.

graph.biggest\_dips(n=15, cutoff\_angle=numpy.radians(80), cutoff\_wavelength=1000, date\_format=”%y-%m-%d %H:%M”, title=None)

A screen shot of a graph

Description automatically generated

The size of each point represents the width of the dip, the colour of each point represents the prominence.

Params:

* n(int): the number of peaks that will be selected per measurement.
* cutoff\_angle(float)(degrees): the maximum zenith angle included, used for excluding nighttime.
* cutoff\_wavelength(float): the maximum wavelength included.
* date\_format(str): the format to display the date on the x axis as. Uses [datetime.strftime](https://docs.python.org/3/library/datetime.html).
* Title(str): the title of the plot.

### daily\_biggest\_dips

makes daily plots of the location of the most prominent dips throughout each day.

graph.daily\_biggest\_dips(n=15, cutoff\_angle=80, cutoff\_wavelength=1000,

date\_format=”%H:%M”)

A screen shot of a computer

Description automatically generated

The size of each point represents the width of the dip, the colour of each point represents the prominence.

Params:

* n(int): the number of peaks that will be selected per measurement.
* cutoff\_angle(float)(degrees): the maximum zenith angle included, used for excluding nighttime.
* cutoff\_wavelength(float): the maximum wavelength included.
* date\_format(str): default “%M:%H” the format to display the date on the x axis as. Uses [datetime.strftime](https://docs.python.org/3/library/datetime.html).

### plot\_time­\_day

plots a variable’s change over each day in the dataset.

graph.plot\_time\_day(column, stack\_resolution=”max”)

A colorful image of a sound wave

Description automatically generated with medium confidence

Parameters:

* column(str): the name of the column that will be plotted.
* stack\_resolution(str): (“max”, “mean”, or “min”). When there are more readings in a day than pixels, how should all the readings be combined into one pixel.

### Spectrum day plot

plots each spectrum over a day on a colour intensity plot

graph.plot\_spectrum\_day(normalisation=None)

A screenshot of a graph

Description automatically generated

parameters:

* normalisation: How to normalise the data. Default None
  + None: no normalisation
  + toa\_integral: divided by the top of atmosphere integral
  + pvlib: normalises against a spectrum generated by pvlib

x axis is hour of day

y axis is wavelength

colour is intensity

also plots a line graph of the global and diffuse integral, to get an idea of what the cloud coverage was like at each point in the day.

### AOD day plot

graph.plot\_aod\_day(clearsky\_filter=”wood”, clearsky\_filter\_kwargs={})

Plots the Aerosol Optical Depth across the spectrum, one page per day

A screenshot of a computer screen

Description automatically generated

* parameters:
  + clearsky\_filter: which clearsky filtering method to use. currently only "wood" is implemented. if None, no filtering is applied
  + clearsky\_filter\_kwargs: keyword arguments to pass to the clearsky\_filter method, these will vary depending on which filtering method is used. The keyword arguments for each method are listed below.

x axis is hour of day

y axis is wavelength

colour is the optical depth at that wavelength and time

summary of clearsky filtering options:

“wood” – currently the only implemented method, keeps all readings where the aod at 500nm is less than 2, and is within 0.05 of all readings within 4 minutes.

Parameters(to be passed into clearsky\_filter\_kwargs):

* reading\_index: the wavelength that is used for the clearsky calculations. if on a full 300-1100nm spectra, make sure to subtract 300 from the wavelength you want to use
* absolute\_filter: any readings higher than this will be filtered out
* relative\_filter: any readings that are more than this value more or less than any other within the time window will be filtered out
* relative\_time\_period: the time period over which the relative filtering is done. this is the total time period that the filtering is done by, so if you want 5 mins either side, pass 10min. format is a string that will be passed to pd.Timedelta. documentation: https://pandas.pydata.org/docs/reference/api/pandas.Timedelta.html

also plots a line graph of the global integral, diffuse integral, and total optical depth at 500nmx500 to get an idea of what the cloud coverage was like at each point in the day.

total\_od is the total optical depth, with no corrections

aod\_microtops is the aerosol optical depth, with the Rayleigh scattering removed

aod\_wood\_2017 is the same as the above value but with an empirical correction as detailed in: [Wood, J., Smyth, T. J., and Estellés, V.: Autonomous marine hyperspectral radiometers for determining solar irradiances and aerosol optical properties, Atmos. Meas. Tech., 10, 1723–1737, https://doi.org/10.5194/amt-10-1723-2017, 2017.](https://amt.copernicus.org/articles/10/1723/2017/)

### Daily AOD line plot at specific wavelengths

Plots several line graphs of the AOD sampled at certain passed wavelengths, defaults to the wavelengths measured by Cimel spectrometers: [380, 440, 500, 675, 870, 1020]

graph.plot\_aod\_cimel(aod\_type=”aod\_microtops”, wavelengths=None,

period=21, rows=3, days\_in\_row=7,

upper\_limit=2, lower\_limit=0,

clearsky\_filter=”wood”, clearsky\_filter\_kwargs={})

A white screen with black text

Description automatically generated

Parameters:

* aod\_type: one of: total\_od, aod\_microtops, aod\_wood\_2017. which aod calculation to use.
* period(int or string): how many days to plot per page, options: "weekly", "monthly", int.
* rows: number of rows per page
* days\_in\_row: number of days per row
* upper\_limit: the max value to display
* lower\_limit: the minimum value to display
* clearsky\_filter: which clearsky filter algorithm to use
* clearsky\_filter\_kwargs: keyword arguments to pass to clearsky\_filter

summary of clearsky filtering options:

“wood” – currently the only implemented method, keeps all readings where the aod at 500nm is less than 2, and is within 0.05 of all readings within 4 minutes.

Parameters(to be passed into clearsky\_filter\_kwargs):

* reading\_index: the wavelength that is used for the clearsky calculations. if on a full 300-1100nm spectra, make sure to subtract 300 from the wavelength you want to use
* absolute\_filter: any readings higher than this will be filtered out
* relative\_filter: any readings that are more than this value more or less than any other within the time window will be filtered out
* relative\_time\_period: the time period over which the relative filtering is done. this is the total time period that the filtering is done by, so if you want 5 mins either side, pass 10min. format is a string that will be passed to pd.Timedelta. documentation: https://pandas.pydata.org/docs/reference/api/pandas.Timedelta.html

## read\_txt

the read\_txt module is used to read the .txt files that are outputted by older hsr1 modules and convert it into a format that can be stored in the database. there are three functions you might use, read(), which reads the most commonly used data, and the global and diffuse spectra. read\_raw\_txt() reads each channel’s spectral readings. read\_raw\_pixels() reads each channel’s raw pixel data, before it is converted into spectral data

functions:

* read
* read\_raw\_txt
* read\_raw\_pixels

### read

read(hsr\_path="", start\_date="2000-01-01", end\_date="2100-01-01", deployment\_metadata\_filepath=None)

reads all the commonly used data from the .txt files. only loads the global and diffuse spectrum

* params:
  + hsr\_path: the filepath to the data that will be read. this folder should contain one .zip file for each day, named YYYY-MM-DD.zip
  + start\_date: the first date that is read from the folder of zip files, inclusive. should be in the format YYYY-MM-DD
  + start\_date: the last date that is read from the folder of zip files, inclusive. should be in the format YYYY-MM-DD
  + deployment\_metadata\_filepath: the filepath to the deployment metadata .ini file that will be read.
* returns:
  + tuple of dataframes that can be stored to the database using DBDriver.store(). one dataframe per table in the database

### read\_raw\_txt

read\_raw\_txt(hsr\_path="", start\_date="2000-01-01",

end\_date="2100-01-01", deployment\_metadata\_filepath=None)

reads each channel of spectral data from the .txt files

* params:
  + hsr\_path: the filepath to the data that will be read. This folder should contain one .zip file for each day, named YYYY-MM-DD.zip
  + start\_date: the first date that is read from the folder of zip files, inclusive. Should be in the format YYYY-MM-DD
  + start\_date: the last date that is read from the folder of zip files, inclusive. Should be in the format YYYY-MM-DD
  + deployment\_metadata\_filepath: the filepath to the deployment metadata .ini file that will be read
* returns a tuple of dataframes that can be used with rawDBDriver.store to make a raw dataset

### read\_raw\_pixels

reads the raw pixel data for each channel in the .txt files

* params:
  + file\_path: the filepath to the data that will be read. This folder should contain one .zip file for each day, named YYYY-MM-DD.zip
  + skiprows: the nuber of rows at the top of each file to skip when reading

# Database reference

Data from an HSR1 is stored across several tables in a sqlite database.

## spectral\_data

this is where the sunlight data is stored. This has the global and diffuse integral and spectral data.

Columns:

* pc\_time\_end\_measurement(string): the timestamp of the reading. In local time with a timezone. This time is the time at the end of the period where the readings were averaged and stored. For example, if readings are taken every 10 seconds and averaged every minute, the readings at 12:00:10, 12:00:20, 12:00:30, 12:00:40, 12:00:50, and 12:01:00 would all be stored under the timestamp 12:01:00.
* sample\_id(string): a UUID that is unique to this measurement. The same sample ID is used for the measurement’s system\_data, precalculated\_values and the accessory\_data that was generated at the same timestamp.
* dataseries\_id(string): a UUID that is unique to each dataseries. A Dataseries is a run of data collection that has all the same settings. If a run of data is stored incrementally to the database, each section is stored as a separate dataseries. Each dataseries id is shared between all the tables of the database.
* global\_spectrum(bytes): the global spectral output of the instrument. The data is compressed to save storage space and time, but when loading from the database it is automatically decompressed into a numpy array of floats for each measurement. The data is encoded from a 1d numpy array using numpy’s [array.tobytes() function](https://numpy.org/doc/stable/reference/generated/numpy.ndarray.tobytes.html).
* diffuse\_spectrum(bytes): the diffuse spectral output of the instrument. The data is compressed to save storage space and time, but when loading from the database it is automatically decompressed into a numpy array of floats for each measurement. The data is decoded using numpy’s [array.frombuffer()](https://numpy.org/doc/stable/reference/generated/numpy.frombuffer.html#numpy.frombuffer) function
* global\_integral(float): global solar intensity. The integrated value of the measured spectrum over 400nm – 1000nm.
* diffuse\_integral(float): diffuse solar intensity. The integrated value of the measured spectrum over 400nm – 1000nm.
* global\_molar(float): global molar intensity. The integrated value of the measured spectrum over 400nm – 700nm with a quantum weighting.
* diffuse\_molar(float): The integrated value of the measured spectrum over 400nm – 700nm with a quantum weighting.
* camera\_temp(float): the temperature measured in the camera. A few degrees higher than ambient.

## system\_data

data from the internal GPS module. If the instrument has accessory\_data, columns from accessory\_data are just renamed and averaged from that.

Averaging specifics:

Each reading in spectral\_data has a corresponding reading in system\_data. All readings in accessory\_data are averaged to the next reading in spectral\_data. In cases where there has been a dropout of spectral\_data, the first system\_data reading once back is deleted, as if the accessory\_data file is still running, then all the data that was taken while there was no spectral\_data readings would all be averaged in to one measurement, which would be misleading.

Columns:

* pc\_time\_end\_measurement(string): the timestamp of the reading. In local time with a timezone. This time is the time at the end of the period where the readings were averaged and stored. For example, if readings are taken every 10 seconds and averaged every minute, the readings at 12:00:10, 12:00:20, 12:00:30, 12:00:40, 12:00:50, and 12:01:00 would all be stored under the timestamp 12:01:00.
* gps\_time(string): the time as measured by the GPS module in UTC. The difference between this and the pc time can be useful for finding when the GPS is inaccurate.
* gps\_status(string): the status of the GPS. A=Valid, V=Invalid.
* gps\_latitude(float): the latitude in degrees.
* gps\_longitude(float): the longitude in degrees.
* gps\_altitude(float): the height above sea level, in meters
* pressure(float): the pressure in hPa.
* baro\_temp(float): the temperature measured by the barometer in Celsius.
* rh(float): the relative humidity. Measured as the percentage of water in the air, where condensation starts at 100% rh.
* rh\_temp(float): the temperature measured by the rh sensor in Celsius.
* dataseries\_id(string): a UUID that is unique to each dataseries. A Dataseries is a run of data collection that has all the same settings. If a run of data is stored incrementally to the database, each section is stored as a separate dataseries. Each dataseries id is shared between all the tables of the database.
* sample\_id(string): a UUID that is unique to this measurement. The same sample ID is used for the measurement’s system\_data, precalculated\_values and the accessory\_data that was generated at the same timestamp.

## precalculated\_values

a few columns of values that are commonly used in calculations. Having these values in the database means they’re only calculated once, saving processing time when using the data.

Columns:

* pc\_time\_end\_measurement(string): the timestamp of the reading. In local time with a timezone. This time is the time at the end of the period where the readings were averaged and stored. For example, if readings are taken every 10 seconds and averaged every minute, the readings at 12:00:10, 12:00:20, 12:00:30, 12:00:40, 12:00:50, and 12:01:00 would all be stored under the timestamp 12:01:00.
* sza(float): the solar zenith angle, in radians. This is the angle between the sun and the zenith (the point in the sky directly upwards).
* azimuth(float): the solar azimuth angle, in radians. This is the horizontal angle between the sun and true north.
* toa\_hi(float): w/m^2. the horizontal solar intensity at the top of the atmosphere. To calculate the direct normal intensity, multiply this by cos(sza).
* Sed(float): the distance between the sun and the earth in AU. This is caused by the earth’s orbit being elliptical, not circular.
* Airmass(float): the optical path length. Expressed as a ratio to the minimum path length (vertically upwards).
* sample\_id(string): a UUID that is unique to this measurement. The same sample ID is used for the measurement’s system\_data, precalculated\_values and the accessory\_data that was generated at the same timestamp.
* dataseries\_id(string): a UUID that is unique to each dataseries. A Dataseries is a run of data collection that has all the same settings. If a run of data is stored incrementally to the database, each section is stored as a separate dataseries. Each dataseries id is shared between all the tables of the database.

## deployment\_metadata

all the metadata stored in the deployment metadata .ini file. Contains data about the deployment and also the specific dataseries. Each row corresponds to one dataseries, and a new row is added each time data is appended to the database.

Columns:

* aux\_average\_period(int): the time period over which the GPS readings are averaged. This is the period of all the measurements in the system\_data table. If the device measures accessory\_data, the period will be the same as the spectral measurements.
* aux\_sampling\_period(int): the time period over which readings are taken. Readings are then averaged according to aux\_average\_period. If the device measures accessory\_data, that will be recorded with the same period as the spectrometer
* calibration\_comment(string): comment to describe where and how the calibration was made.
* calibration\_time(string): timestamp when the instrument was calibrated.
* camera\_calibration\_file(string): name of the calibration file containing the camera’s calibration.
* camera\_id(string): the camera’s id (serial number).
* data\_structure\_id(string): the version of the database
* dataseries\_id(string): a UUID that is unique to each dataseries. A dataseries is a run of data collection that has all the same settings. If a run of data is stored incrementally to the database, each section is stored as a separate dataseries. Each dataseries id is shared between all the tables of the database.
* default\_elevation(float): the elevation value to use when the GPS is inactive.
* default\_latitude(float): the latitude value to use when the GPS is inactive.
* default\_longitude(float): the longitude value to use when the GPS is inactive.
* deployment\_description(string): a short description of the current deployment.
* deployment\_id(string): a UUID that is shared across all the dataseries in the deployment. New data will automatically share existing deployment\_ids if they have the same values in all of the columns.
* gain(float): the gain setting for the spectrometer.
* hdr(float): True if the spectrometer is measuring in high dynamic range mode.
* integration\_time(float): the integration time (ms) for the spectrometer.
* license(string): the name of the license that the data is held under.
* license\_reference(string): web link to the above license.
* location\_name(string): the name of the location where this dataseries is measured from.
* mobile(int): is the dataseries mobile or not 0=static, 1=mobile.
* operator\_contact(string): contact details for the operator of this instrument
* owner\_contact(string): contact details for the owner of this instrument.
* platform\_id(string): reference to platform or campaign metadata if known.
* processing\_level(int): 0 - raw detector values; 1 - calibrated detector output e.g. my Raw files; 2 - recalibrated, or derived data e.g. Global & Diffuse; 3 - further interpreted or adjusted
* sensor\_id(string): the id (label serial nimber) of this instrument.
* sensor\_type(string): the type of this instrument.
* software\_id(string): the version of the software currently running on the instrument.
* spectrometer\_average\_period(float): the time period over which the spectrometer readings are averaged.
* spectrometer\_burst\_number(float): number of consecutive readings in each sample.
* spectrometer\_calibration\_file(string): name of the file containing the spectrometer calibration.
* spectrometer\_sampling\_period(float): the period between each spectrometer reading.
* start\_time(string): timestamp of the start of the dataseries.
* timezone(string): the local timezone at the time of recording in the form “+/-hh:mm”. timestamps are stored as local time with this timestamp, so if you want to account for daylight-saving time, you should start a new dataseries when the clocks change with the new timezone.
* wavelengths(string): the start, stop, and step of the measured wavelengths.

# accessory\_data

this table contains the contents of the accessory\_data.txt file. It is more detailed than GPS.txt, but only exists on more modern instruments.

* pc\_time\_end\_measurement(string): the timestamp of the reading. In local time with a timezone. This time is the time at the end of the period where the readings were taken. For example, if readings are taken every 10 seconds, the readings at 12:00:10, 12:00:20, 12:00:30, 12:00:40, 12:00:50, and 12:01:00 would all be stored under the timestamp 12:01:00.
* Clock\_error(float): difference between the control PCB CPU clock and GPS time.
* Latitude(float): the Latitude measured by the GPS
* Longitude(float): the Longitude measured by the GPS
* Altitude(float): the Altitude measured by the GPS
* GPSAge(float): time since last valid GPS reading, in seconds
* NSV(float): Number of satellites in view, across all constellations
* GPSSpare(float): Not in use
* \_15Vin(float): Input voltage
* \_3VCAP(float): Voltage at storage capacitor for internal PCB processor
* HTRIn(float): Voltage at heater power input
* Vcc(float): Control PCB processor supply rail
* VSpare(float): Not in use
* I\_Tot(float): Total input current (mA)
* I\_15VPC(float): PC current (mA) (high voltage supply)
* I\_15VCAM(float): Cameral current (mA)
* I\_5VPC(float): PC current – 5V supply
* ISpare(float): Not in use
* T\_CPU(float): Temperature measured at the CPU, in Celsius.
* T\_Bezel(float): Temperature measured at the bezel (optical head) in °C
* T\_RH(float): Temperature measured by the relative humidity sensor, in Celsius.
* T\_Baro(float): Temperature measured by the barometer, in Celsius.
* RH(float): the relative humidity. Measured as the percentage of water in the air, where condensation starts at 100% rh.
* Pressure(float): the pressure in hPa.
* IMU\_Output\_Type(float): Type number for inertial output values
* Yaw(float): the Yaw, in degrees.
* Roll(float): the Roll, in degrees.
* Pitch(float): the Pitch, in degrees.
* Q\_W(float): values representing the orientation in quaternions.
* Q\_X(float): values representing the orientation in quaternions.
* Q\_Y(float): values representing the orientation in quaternions.
* Q\_Z(float): values representing the orientation in quaternions.
* Acc\_X(float): Acceleration in the X direction
* Acc\_Y(float): Acceleration in the Y direction
* Acc\_Z(float): Acceleration in the Z direction
* IMU1(float): Not in use
* IMU2(float): Not in use
* Control\_flags(float): Copy of the internal control flags
* Control\_flags2(float): Copy of the internal control flags
* StatusFlags(float): Copy of internal status flags
* Heater(float): Heater control PWM value
* MsgCount(float): Count of number of Modbus messages received correctly
* RdgCount(float): Count of number of readings incorporated in this reading value
* Watchdog(float): Count of watchdog – PC is reset if this gets to zero
* gps\_time(string): a timestamp containing the time as measured by the GPS unit. When it is working correctly, it should be the same as pc\_time\_end\_measurement
* cpu\_time(string): a timestamp containing the time measured by the CPU
* dataseries\_id(string): a UUID that is unique to each dataseries. A Dataseries is a run of data collection that has all the same settings. If a run of data is stored incrementally to the database, each section is stored as a separate dataseries. Each dataseries id is shared between all the tables of the database.

## Deployment.ini file

This file provides deployment metadata for the conversion of text files to the database. It is stored as a text file, and can have any valid name.

The example below shows a typical file format. This should be edited to match your specific dataset, and is used by the db.store() function.

[deployment]

# Information relating to the overall campaign

content = deployment\_metadata

data\_structure\_id = 1.0

deployment\_id =

deployment\_description = HSR1-005 at Winster 2024

sensor\_type = HSR1 prototype v2 general reference

sensor\_id = HSR1-005

camera\_id = 700007631242

owner\_contact = john@peakdesign.co.uk

operator\_contact = John Wood

license = CC BY-NC 4.0

license\_reference = https://creativecommons.org/licenses/by-nc/4.0

[dataseries]

# information relating to this particular logging series

processing\_level = 2

# timezone of PC clock

timezone = 00:00

# set these values for a stationary setup, or if the GPS is not fitted

default\_latitude = 53.14

default\_longitude = -1.63

default\_elevation = 240

#This information is taken from the logging software or datafiles

software\_id = 1.0.0.11

calibration\_time = 2024-02-01

calibration\_comment = Calibration against HSR1-001 & HSR1-003 at Winster

camera\_calibration\_file = 'Baumer 700007631242 CameraCalibration 20ms 4seq 2024-02-01.txt'

spectrometer\_calibration\_file = 'Baumer 700007631242 SpectrometerCalibration 2024-02-02 C.tx'

start\_time = ''

integration\_time = 5

gain = 2

hdr = 1

spectrometer\_sampling\_period = 10

spectrometer\_average\_period = 60

spectrometer\_burst\_number = 1

wavelengths = 300, 1100, 1

aux\_sampling\_period = 10

aux\_average\_period = 60

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