

Newsletter

June 2020



Abstract

This newsletter briefly presents new developments since the publication of the last newsletter in March 2019. Hence, it is focused on giving an overview of the blog posts that were published on the project's website during that timespan. We comment on the eHives' sensors and illustrate their position inside the hive. Causes and magnitude of measurement errors are discussed. By following two comprehensible examples we show how the eHives' data can be evaluated without using the website's diagram viewer. The eHives' locations and surroundings are presented to make limitations with respect to the data's comparability transparent. The newsletter is completed by a review of the year 2019 in form of a (simplified) graphical depiction summing up most of the collected data for each eHive.

Dear readers,

as announced in the last newsletter, from now on this format is supposed to serve as a résumé letter only, summing up the articles that were released on the website's blog since the last newsletter was published. Thus, we present you a brief overview of the relevant events, news and articles without explaining them in much detail. Instead, we provide a link to the particular blog post so the interested reader can access the full article.

The eHives' sensors & errors of measurement

In order to correctly interpret the eHives' data, it is essential to know what system is used to capture the data and what errors in measurement arise from that method.

In explaining the position of the sensors that are located inside the hive, special attention is paid on exemplifying the differences between individual eHives. The electrical circuits that are used to evaluate the temperature sensors and the scale are illustrated and explained, as an example see Fig. 1. The tolerances in measurement accuracy of all sensors as well as external sources of error are discussed and, as a conclusion, presented in a summarizing table, cf. Tab. 1.

The eHive's sensors were selected with caution. Thus, the expected measurement errors of most sensors are small in magnitude. However, we strongly recommend keeping the declared tolerances in mind while analysing the captured data to prevent false conclusions resulting from an incorrect over-interpretation due to wrong accurateness.

Full article:

- Website: <https://beebit.de/en/blog/20190920/>
- PDF: https://beebit.de/download/blog20190920/sensors_and_errors.pdf

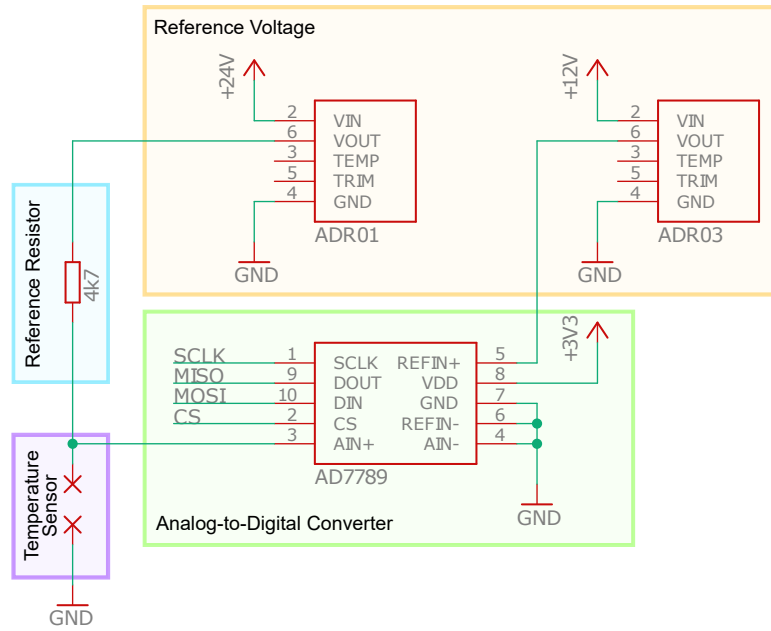


Fig. 1: Electrical circuit for evaluation of the temperature sensors.

Tab. 1: Errors of measurement of the eHive's sensors. For detail see link to full article.

Sensor	Error	Unit	Annotations
Inside temperature	0.2	°C	
Inside humidity	2.5	%	below 20 % and above 80 %: increase to 3.5 %
Weight	0.01	kg	higher deviations at changing temperatures
Outside temperature	0.5	°C	
Outside humidity	3	%	above 90 %: increase to 4 %
Rainfall	0.2	mm/h	above 4 mm/h: 5 % of the measured value
Wind speed	3	km/h	above 60 km/h: 5 % of the measured value
Wind direction	7.5	°	relative error
Solar irradiation	90	W/m ²	
Air pressure	1	mbar	
UV index	0.8	UVI	
Complete current	0.1	A	
Charging voltage	0.01	V	
Radiator current	0.1	A	
Microchip temperature	3	°C	relative error, offset ± 45 °C

Analysing data captured by the eHive

Certainly, you have already used the diagram viewer on BeeBIT's website to plot data stored in the database. However, it is also possible to export and download raw data as a csv-file. This allows a deeper analysis as it is explained in the following two examples. The high-level programming language *Python 3* was used in both examples to process the data sets. The corresponding raw data and scripts were made available to allow easier comprehension and reproduction.

Example I: Processing raw data

In this first example, exporting raw data from the diagram viewer is treated in detail. The structure of the downloaded data file is explained. Building on that knowledge, data sets can be read, processed and compared by a script. The handling of incomplete data sets and linked difficulties are discussed.

In contrast to the first half of the article where technical questions are explained and solved, the second half is mainly focused on the treatment of two biological hypotheses. First, we investigate the temperature regulation at two different positions inside the beehive and deduce the location of the breeding combs. By calculating the deviation to the outside temperature, one can observe that during summer the hive is cooled by the colony at daytime and heated during the night. To assert stronger evidence, the 3-day-mean is calculated so irregular events are damped. This feature is not provided by the online diagram viewer.

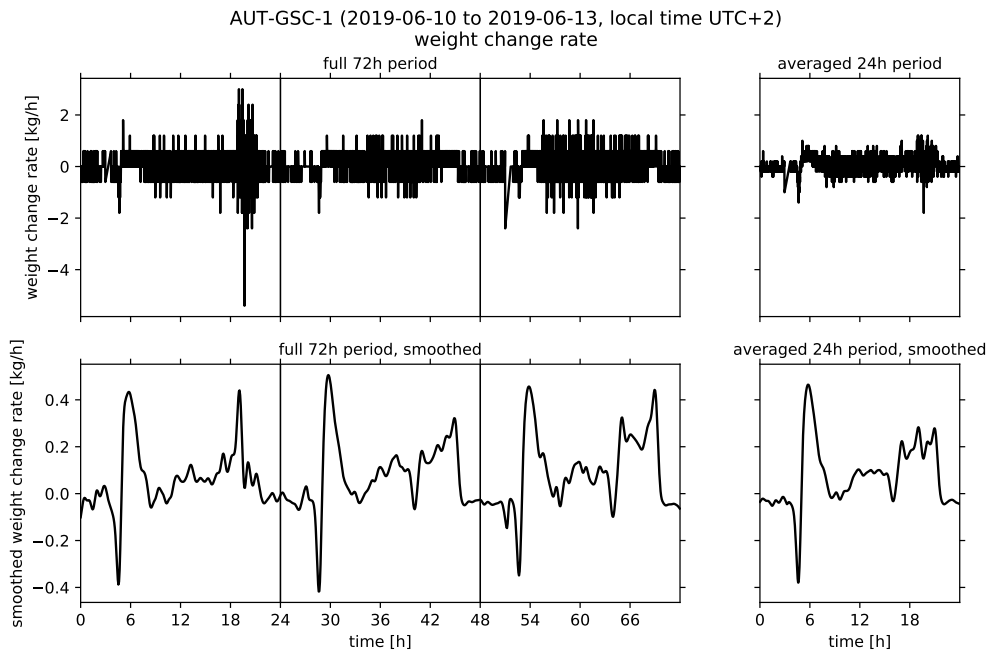


Fig. 2: Weight change rate for the full 72 hours time-frame (left side) and as 3-day-mean (right side). At the top the raw data set, at the bottom the data set after applying the Gauss signal filter. Notice the different scaling of the vertical axis.

The second hypothesis asks how the eHive's weight changes in the course of a day. The time derivative of the hive weight readings is calculated numerically, cf. Fig. 2 (upper half). Because the data set is quite noisy, the Gauss signal filter is applied, cf. Fig. 2 (lower half). The results are interpreted and compared to scientific literature. Such a detailed analysis is not possible by using solely the website's diagram viewer. As we realize, working with raw data can indeed lead to new insights! Of course, the two discussed questions only have exemplary character. One can think

of many more approaches investigated by technically interested students during a (pre-)scientific project. The interpretation of the resulting graphs can be carried out in cooperation with students that are gifted with a stronger biological interest.

Further reading:

- full article (website): <https://bee-bit.de/en/blog/20190720/>
- full article (PDF): https://bee-bit.de/download/blog20190720/export_and_analysis.pdf
- detailed discussion of the Python script (PDF only): https://bee-bit.de/download/blog20190720/export_and_analysis_supportingmaterial.pdf

Example II: In search of correlations

This second example will examine the relation of hive weight and external stimuli (mainly solar irradiation and outside temperature). For this purpose, the relevant data sets will no longer be plotted against time. Instead we plot them against each other, cf. Fig. 3. Although some outliers exist, a correlation between the studied quantities can be observed.

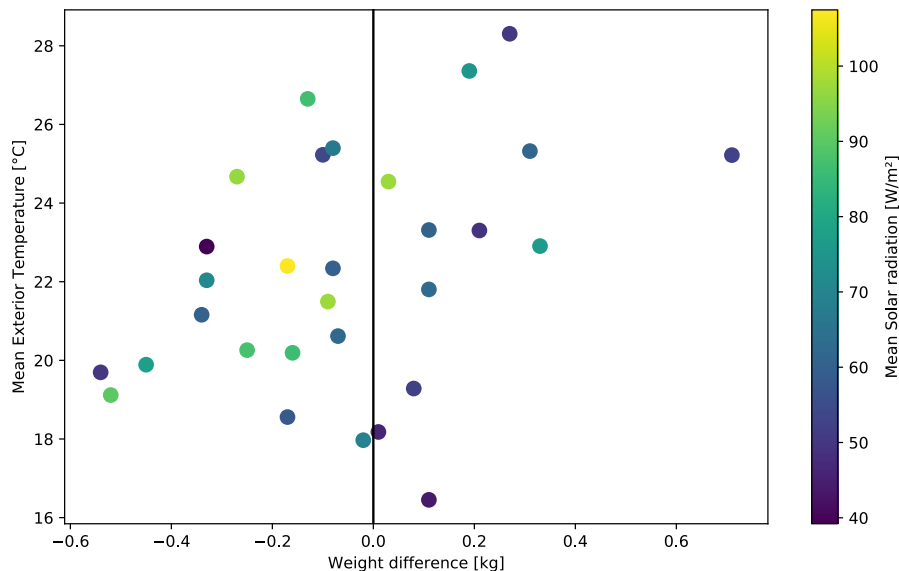


Fig. 3: Relation between outside temperature and weight difference to previous day. The points represent daily mean values. Mean solar irradiation is visualized by an adjacent color scale.

Outliers are discussed separately. Apparently there exist additional environmental conditions that affect the hive's weight. We observe that the increase in weight was notably small at days afflicted with earlier rainfall. Additionally, an effect of changes in air pressure could be assumed. Rainfall that announces itself through low air pressure may increase the nectar gathering activity previous to the actual rain event. Of course, assumptions like these should always be checked with more than one independent data set to reduce the chance of wrongly interpreting a one-time event as a general behaviour. The described analysis is only supposed to be seen as an example that presents interesting biological questions and a possible approach on answering these questions.

Full article:

- Website: <https://beebit.de/en/blog/20190922/>
- PDF: <https://beebit.de/download/blog20190922/analysis2.pdf>

The eHive's locations & surroundings

The eHives are positioned at different locations with a huge variety of surroundings (buildings, trees, etc.). To interpret the captured data, e.g. the weather station's data sets, in a meaningful way, one must consider these local features. Data concerning the activity period, the eHive's version (cf. last newsletter), coordinates and mounting position of the weather station and its wind sensor were compiled in a tabular form for easy comparison. We also listed if a roof exists that protects the eHives from rain and snow. Additionally, the eHives' locations were visualized in a map, cf. Fig. 4. In the full article you can find a time-line where the activity periods are graphically represented.

Full article:

- Website: <https://beebit.de/en/blog/20200315/>

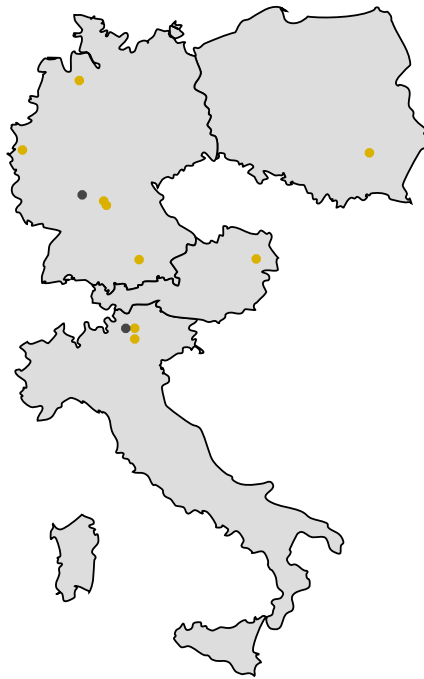


Fig. 4: The eHives' locations. Honey-coloured points mark locations of currently active eHives, dark grey points mark previous locations.

A year in review: 2019 visualized

To celebrate the start into the new year 2020, an infographic for all eHives with sufficient data record was created and made available for download. Said diagram contains most of the data captured by the respective eHive during 2019. Admittedly, the information detail is limited strongly by the compactness in time. However, it is possible to get an overview of the bee colony's activity over the course of the year. As an example, the diagram for eHive AUT-BIE-1 is shown in Fig. 5. For a detailed explanation of the figure please read the full article.

Further reading:

- full article (website): <https://beebit.de/en/blog/20200101/>
- download diagrams for all eHives: https://beebit.de/download/blog20200101/2019_figures.zip

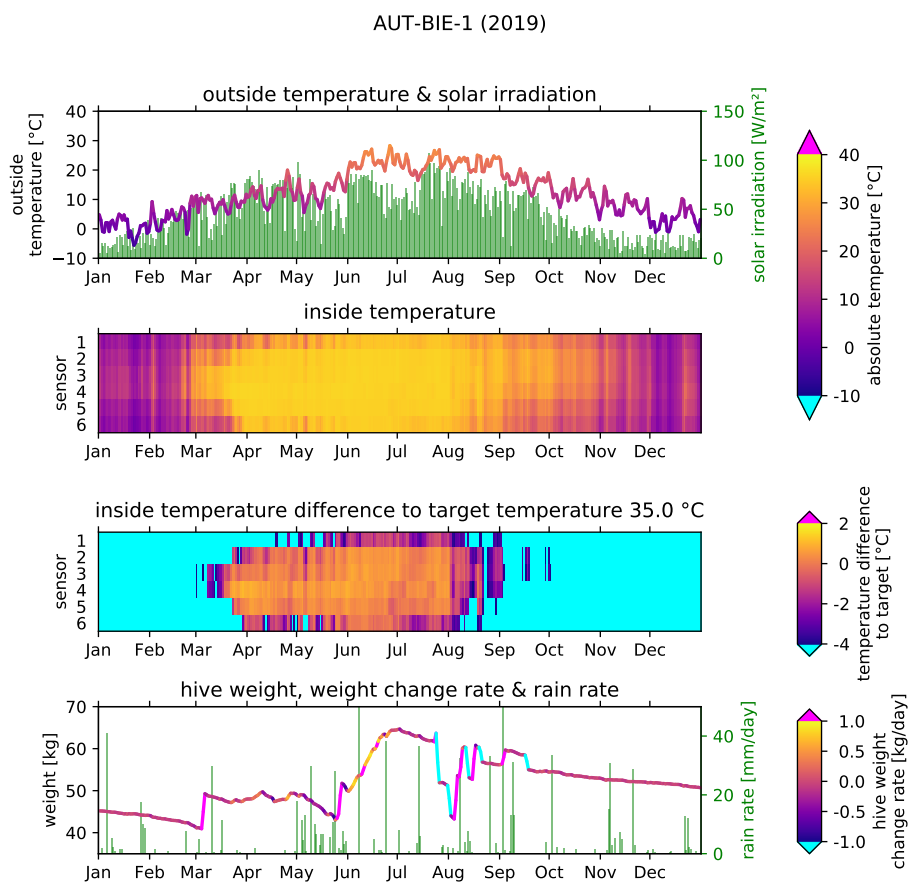


Fig. 5: Full data from 2019 of eHive AUT-BIE-1. For visualization the daily mean of all datasets was computed. For more details see full article.

Closing words

Dear reader, if you have any questions or comments, please feel free to contact us. More information about the project can be found on our website. As we promised in the last newsletter, the website is now optimised for access via mobile devices, too.

In light of recent events, we want to conclude this newsletter by wishing you and your loved ones a light-hearted summertime. Stay healthy!

The BeeBIT Team

Contact

Mail: [beebit\[at\]beebit.de](mailto:beebit[at]beebit.de)
Website: <https://beebit.de/de>

Newsletter

Articles: Jonas Göbel, Jonathan Hofinger,
Christian Weiglein
Editorial: Christian Weiglein