An interactive and integrative course for the collection and management of time-space data

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BACKGROUND

Many master programs in hydrology or environmental science separate the collection, processing and visualization of data into different courses. We argue that by doing so we tend to loose the link between:

- The actual measurement,
- The compiling of the observed data sets from different sources including error analysis, and
- The processing and analysis of data

This can be problematic as errors and uncertainties e.g. caused by different measurement methods or spatial/temporal averaging, might appear only during final analysis. Hence, only an integrative approach of collecting, compiling, processing and analyzing a time series from point measurement to a comprehensive report or publication within one course can illustrate these dependencies.

OBJECTIVES

- (A) Enable our students to set up a high quality measuring network on their own
- (B) Foster the collaborative development of analysis tools to answer the question: *is Freiburg is a heat island in winter?*
- (C) Gain insights on spatio-temporal variations of this multi-source sensor network

CONCLUSION

- (A) the students were able to produce consistent, meaningful data beyond annual boundaries.
- (B) many maps were produced and found outside stations to be colder.
- (C) 5 reveals consistent results, comparing the 2016 and 2017 generation

GitHub Stats of this Course

visit the Github repo:

10 collaborators	27 pull requests with
3 group discussions	196 commits including
16 forks	~ 15, 000 lines of code

WEEK ONE → WEEK TWO → WEEK THREE

Figure 1: *The onset HOBO sensor and some examples of the application.*

Figure 2: *The temperature time series individually produced by the students.*

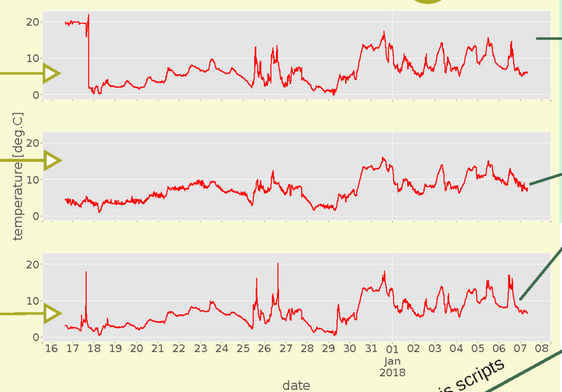
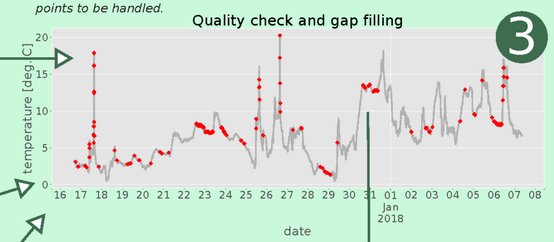


Figure 3: *Quality checked time series. The red dots identify questionable data points to be handled.*



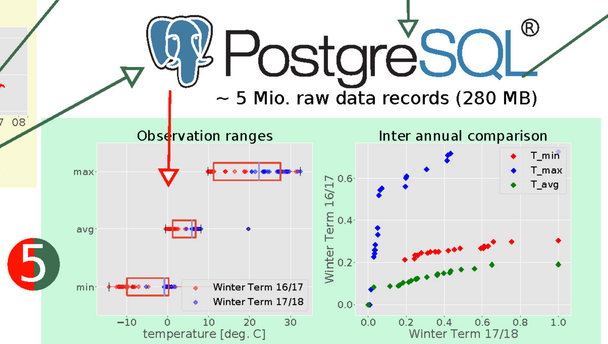


Figure 5: *Right: boxplots of the overall temperature indices ranges. Left: scatter plot relating the two years' indices on a relative scale.*

repository for analysis scripts and DB management scripts

GitHub®

- collaborative creation of a common toolbox for validating and correcting the temperature timeseries.
- review request for specific exercises from the supervisors
- forks and pull requests for sharing code

moodle®

- assignment and exercise submission
- supply with:
  - data
  - lectures
  - exercises
  - supplementary material

Students ↔ Supervisors

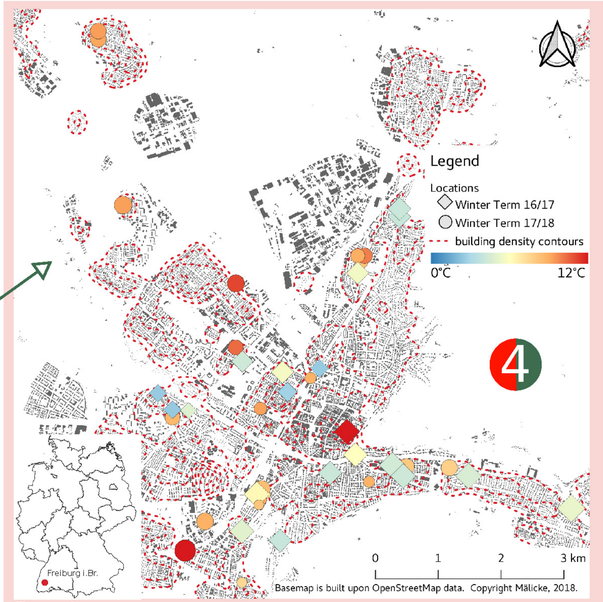


Figure 4: *Average temperature for the three weeks recorded in 2017 (circle symbols) and 2016 (diamond symbols). The time series variance is indicated by the symbol sizes. The dashed contour lines are isopycnics resulting from a kernel density estimate for building entities.*

WHAT WAS DONE?

Every student got a HOBO sensor and placed it at her/his domicile. The HOBO is a pendant temperature and light level sensor with an integrated data logging unit. 1

- The students collected consistent 3-week time series (16.12.2017 - 07.01.2018). 2
- They filled a field protocol for generating meta data and influences like radiation, wind or heat loss by close buildings should be minimized during installation.
- The students did quality checks on their time series and compiled them into a common PostgreSQL database. 3
- Calculating temperature indices in RStduio and the creation of maps using QGIS was conveyed. 4
- Most students found the common data set to be very heterogeneous on temporal and spatial scales; the stations to show dropping average temperatures with declining building densities and the maximum temperature to show the highest variability. 5

EVALUATION BY THE STUDENTS

PROs

- Collaborative tools were teached
- Data flow from the field to the map exercised
- Linked influences during sampling to observed pattern in the data product

Improvements

- Workflow based lecture was new to the students and needs broader deployment in other lectures
- Many new tools and enviormnments were involved ==> workload is quite high

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