Working with Research Data

Markus Stocker

September 12, 2017

Outline

- Accessing and reusing research data
- Computational environments for data processing
- Curating and storing data, from files to databases
- Research data versioning and backup

Data Access

- It's complicated but it is improving
- Drivers for better access
  - Open Data imperative
  - Credit for publishing data
  - Increase return on investment in scientific research
  - Funders requiring data to be published
- Correspondingly, supporting infrastructures is
  - Increasing in number and quality
  - Adopting principles, guidelines, standards
  - Supporting human and programmatic access

Data Access

- You know how to access *your* data
- More difficult is access to data authored by others
- Presumes others have published their data
- Then you may be able to
  - Find their data
  - Retrieve the data
  - Reuse the data

Find Data

- Useful data can find found in a lot of places
- Online or offline, e.g. printed books (increasingly uncommon)
- In data repositories or as files on a web server
- You could try a Google search
- Or ask your supervisor and fellow students
- The authors of papers you read may cite data and/or sources
- Specialized search, e.g. Registry of Research Data Repositories

re3data.org

REGISTRY OF RESEARCH DATA REPOSITORIES

Search... Search

re3data.org Reaches a Milestone and Begins Offering Badges

re3data.org has reached a milestone of identifying and listing 1,500 research data

Enhancements to creating and updating re3data

We are happy to announce a new feature that enables users to more easily suggest

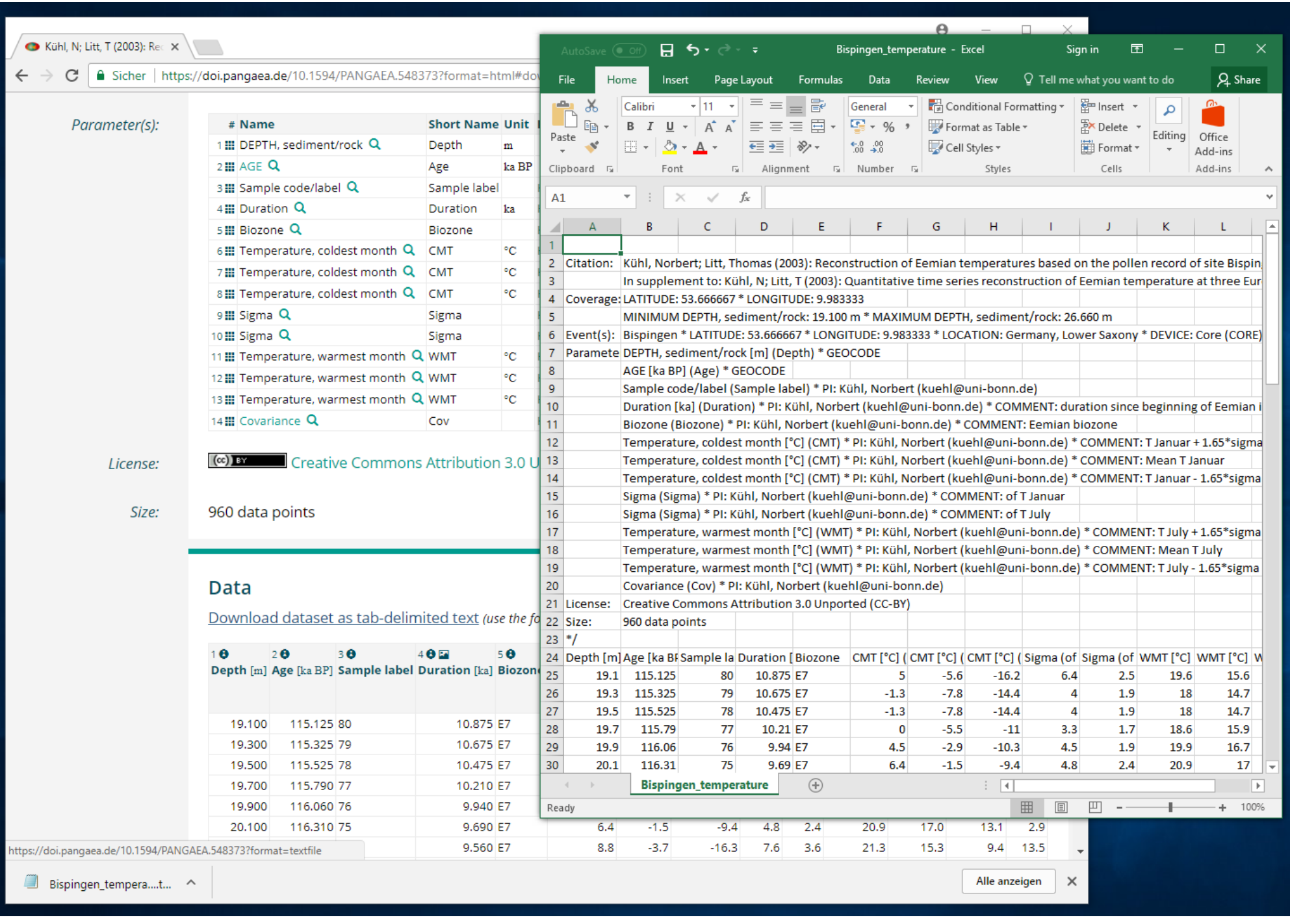
New re3data.org Schema and Search Functionality

We are pleased to announce the publication of version 3.0 of the “Metadata Schema for the Description of Research Data Repositories” (Rücknagel et al., 2015).


Humanities and Social...
Engineering Sciences
Natural Sciences
Life Sciences
Humanities
Social and Behavioural...
Construction Engineering and...
Computer Science, Electrical...
Materials Science and...
Thermal Engineering/Process Engineering
Mechanical and industrial...
Geosciences (including Geography)
Mathematics
Physics
Chemistry
Biology
Medicine
Agriculture, Forestry, Horticulture...
Ancient...
History
Fine...
Linguistics
Literary...
Non-European...
Theology
Philosophy
Education...
Psychology
Social...
Economics
Jurisprudence
Construction...
Computer...
Electrical...
Systems...
Materials...
Materials...
Heat...
Process...
Mechanics...
Production...
Water...
Geography
Geochemistry...
Geophysics...
Geology...
Atmospheric...
Mathematics
Astrophysics...
Statistical...
Particles...
Optics...
Condensed...
Polymer...
Biological...
Analytical...
Physical...
Chemical...
Molecular...
Basic...
Plant...
Zoology
Microbiology...
Medicine
Neurosciences
Agriculture...

Retrieve Data

- Typically download of one or more files
- An API for programmatic retrieval may be available
- Data repositories generally support search
- Often data are retrieved as they were deposited (original format)
- Repository may standardize data during ingestion


Kühl, N; Litt, T (2003): Re
Sicher | https://doi.pangaea.de/10.1594/PANGAEA.548373?format=html#do
Parameter(s):
Name | Short Name | Unit
1 DEPTH, sediment/rock | Depth | m
2 AGE | Age | ka BP
3 Sample code/label | Sample label
4 Duration | Duration | ka
5 Biozone | Biozone
6 Temperature, coldest month | CMT | °C
7 Temperature, coldest month | CMT | °C
8 Temperature, coldest month | CMT | °C
9 Sigma | Sigma
10 Sigma | Sigma
11 Temperature, warmest month | WMT | °C
12 Temperature, warmest month | WMT | °C
13 Temperature, warmest month | WMT | °C
14 Covariance | Cov
License:
Creative Commons Attribution 3.0 U
Size:
960 data points
Data
Download dataset as tab-delimited text (use the fo
1 Depth [m] | 2 Age [ka BP] | 3 Sample label | 4 Duration [ka] | 5 Biozon
19.100 115.125 80 10.875 E7
19.300 115.325 79 10.675 E7
19.500 115.525 78 10.475 E7
19.700 115.790 77 10.210 E7
19.900 116.060 76 9.940 E7
20.100 116.310 75 9.690 E7
9.560 E7
https://doi.pangaea.de/10.1594/PANGAEA.548373?format=textfile
Bispingen_tempera....t...
Alle anzeigen
AutoSave Off
Bispingen_temperature - Excel
Sign in
File Home Insert Page Layout Formulas Data Review View Tell me what you want to do Share
Paste Clipboard Calibri 11 Font Alignment General Number Conditional Formatting Format as Table Cell Styles Styles Insert Delete Format Cells Editing Office Add-ins Add-ins
A1
Citation: Kühl, Norbert; Litt, Thomas (2003): Reconstruction of Eemian temperatures based on the pollen record of site Bispin
In supplement to: Kühl, N; Litt, T (2003): Quantitative time series reconstruction of Eemian temperature at three Eur
Coverage: LATITUDE: 53.666667 * LONGITUDE: 9.983333
MINIMUM DEPTH, sediment/rock: 19.100 m * MAXIMUM DEPTH, sediment/rock: 26.660 m
Event(s): Bispingen * LATITUDE: 53.666667 * LONGITUDE: 9.983333 * LOCATION: Germany, Lower Saxony * DEVICE: Core (CORE)
Paramete DEPTH, sediment/rock [m] (Depth) * GEOCODE
AGE [ka BP] (Age) * GEOCODE
Sample code/label (Sample label) * PI: Kühl, Norbert (kuehl@uni-bonn.de)
Duration [ka] (Duration) * PI: Kühl, Norbert (kuehl@uni-bonn.de) * COMMENT: duration since beginning of Eemian i
Biozone (Biozone) * PI: Kühl, Norbert (kuehl@uni-bonn.de) * COMMENT: Eemian biozone
Temperature, coldest month [°C] (CMT) * PI: Kühl, Norbert (kuehl@uni-bonn.de) * COMMENT: T Januar + 1.65*sigma
Temperature, coldest month [°C] (CMT) * PI: Kühl, Norbert (kuehl@uni-bonn.de) * COMMENT: Mean T Januar
Temperature, coldest month [°C] (CMT) * PI: Kühl, Norbert (kuehl@uni-bonn.de) * COMMENT: T Januar - 1.65*sigma
Sigma (Sigma) * PI: Kühl, Norbert (kuehl@uni-bonn.de) * COMMENT: of T Januar
Sigma (Sigma) * PI: Kühl, Norbert (kuehl@uni-bonn.de) * COMMENT: of T July
Temperature, warmest month [°C] (WMT) * PI: Kühl, Norbert (kuehl@uni-bonn.de) * COMMENT: T July + 1.65*sigma
Temperature, warmest month [°C] (WMT) * PI: Kühl, Norbert (kuehl@uni-bonn.de) * COMMENT: Mean T July
Temperature, warmest month [°C] (WMT) * PI: Kühl, Norbert (kuehl@uni-bonn.de) * COMMENT: T July - 1.65*sigma
Covariance (Cov) * PI: Kühl, Norbert (kuehl@uni-bonn.de)
License: Creative Commons Attribution 3.0 Unported (CC-BY)
Size: 960 data points
*/
Depth [m] | Age [ka BP | Sample la | Duration [| Biozone | CMT [°C] (| CMT [°C] (| CMT [°C] (| Sigma (of | Sigma (of | WMT [°C] | WMT [°C]
19.1 115.125 80 10.875 E7 5 -5.6 -16.2 6.4 2.5 19.6 15.6
19.3 115.325 79 10.675 E7 -1.3 -7.8 -14.4 4 1.9 18 14.7
19.5 115.525 78 10.475 E7 -1.3 -7.8 -14.4 4 1.9 18 14.7
19.7 115.79 77 10.21 E7 0 -5.5 -11 3.3 1.7 18.6 15.9
19.9 116.06 76 9.94 E7 4.5 -2.9 -10.3 4.5 1.9 19.9 16.7
20.1 116.31 75 9.69 E7 6.4 -1.5 -9.4 4.8 2.4 20.9 17
6.4 -1.5 -9.4 4.8 2.4 20.9 17.0 13.1 2.9
8.8 -3.7 -16.3 7.6 3.6 21.3 15.3 9.4 13.5
Bispingen_temperature
Ready
100%

Reuse Data

- Complicated!
- Generally substantial processing needed to make reuse possible
- Even if accessible, data are generally not interoperable
- Little syntactic interoperability due to different formats
- Little semantic interoperability due to different terminology
- Data quality may not be adequate
- Data need to be integrated: common syntax and semantics
- A lot of time required to prepare for reuse

Data Processing

- Assume integrated data
- Your next step is to process them for your purpose
- Staggering amount of methods
- Programming (scripting) languages
- Computational environments and other tools

Curating and Storing Data

- As a result of processing, you'll produce new data
- Data need to be identified, described, quality controlled, etc.
- Curated data are stored and possibly preserved
- How you curate and store data depends on various factors
- Example factors
  - Longevity: from temporary to preserved data
  - Sharing: with yourself or a community
  - Dynamism: from static files to queriable databases

Databases

- Many kinds but relational most common
- Help structuring data, be consistent with datatypes
- Flexible data retrieval with declarative language (SQL)
- Access to data from programming languages (Python, R, Java, ...)
- Processing of large data quantities
- Access management and security
- Backup and replication

Databases

```
create table data (
  id integer primary key,
  time timestamp,
  latitude double precision,
  longitude double precision,
  temperature double precision
)
```

Databases

```
insert into data values(
  1,
  timestamp '2016-07-26 00:00:00',
  -70.650000,
  -8.250000,
  -19.3
)
```

Databases

```
select
  id, time, latitude, longitude, temperature
from data

select * from data where temperature < -15
```

```
 id |         time          | latitude | longitude | temperature
----+-----------------------+----------+-----------+-------------
  1 | 2016-07-26 00:00:00 |   -70.65 |     -8.25 |        -19.3
```

Backup and Versioning

- Your (Word) manuscripts are data
- Backup your data as you backup your manuscripts
- Avoid memory sticks as backup media
- Test your backup strategy: can you recover lost files?
- Make sure to version your data
- Including if you collaborate only with yourself
- Remote version control can act as backup

Take aways