

# Pygoda

An open source graphical user interface  
for geolocated time series visualisation

[pygoda.readthedocs.io](http://pygoda.readthedocs.io)

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# Who am I?

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(it's me, for people  
watching online)

Last ten years:

- PhD in geophysics @ IPGS, University of Strasbourg (FR):  
Earth rotation, gravimetry, polar motion, mantle rheology
- Postdoctoral Res. @ SYRTE, Paris Observatory (FR):  
free core and inner core nutation
- Res. Associate, GlobalMass project @ Univ. of Bristol (UK):  
glacial isostatic adjustment, GPS data

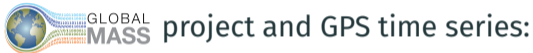
## Pygoda in a nutshell

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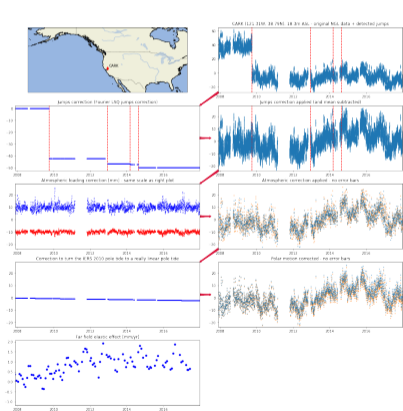
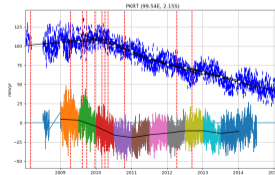
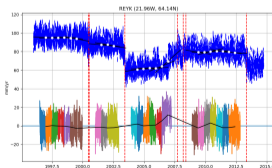


*Edessa (aka Pygoda) meditabunda* (Fabricius, 1794)  
"It's not a Bug, it's a Feature"

Reinventing the wheel is educational but inefficient: plotting time series/maps, fitting models, comparing corrections... What about automating all those things? Just another project on my to-do list.



thousands of stations and only a few plotted manually for quality control → *There must be a better way!*

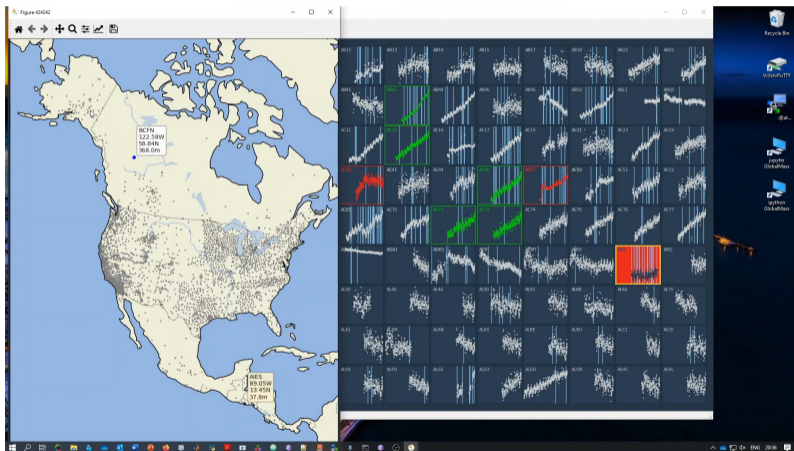


# Existing solutions: a brief overview

TOOLS	CAPABILITIES	MAIN LIMITATION	NOTE
<b>General purpose scientific software and programming language packages</b>			
Matplotlib/ Cartopy (Python & Julia), ggplot2/tmap (R), ...	versatile	require coding even for basic visualisation, limited interactivity by default	free, open source; Plotly is one of the more interactive alternative
Matlab, Mathematica, Maple	versatile	require coding, not available everywhere	proprietary, closed sources
IDL, GNU Data Language (GDL)	versatile	require coding	IDL is proprietary, closed source; GDL is a free alternative
<b>Geographic Information Systems software</b>			
QGIS	geographic data	geography-oriented, very limited	free, open source
ArcGIS	visualisation	for time series	proprietary, closed source
<b>Miscellaneous tools</b>			
The Generic Mapping Tools (GMT)	versatile, scripted data visualisation in geosciences	non-interactive, data analysis is out of scope	free, open source; an API is now available for several languages
Data science software	tailored for complex data visualisation and exploration, ready to use analytics, interactive	unwieldy for simple raw data visualisation and low-level data transformation	e.g. Tableau, Plotly Dash
(Semi-)specialised tools	tailored to a specific community needs	specialisation prevents generic usage	e.g. the Climate Data Store (CDS) toolbox, Tsoft for gravimetry
Other online generic tools	accessible, interactive, made for sharing results	unusable with large offline data sets	e.g. Plotly Chart Studio, Tethys Platform

Conclusion: a bespoke combination of existing tools is (was?) the best option for geolocated time series visualisation

`gps_plot_northamerica.py` (~ 400 loc): a map + a grid of subplots



*Pygoda*

*short enough*

*obvious pronunciation*

*Pythonic*

*found quickly (< 1h)*

*available (kind of)*



# What's in a name?

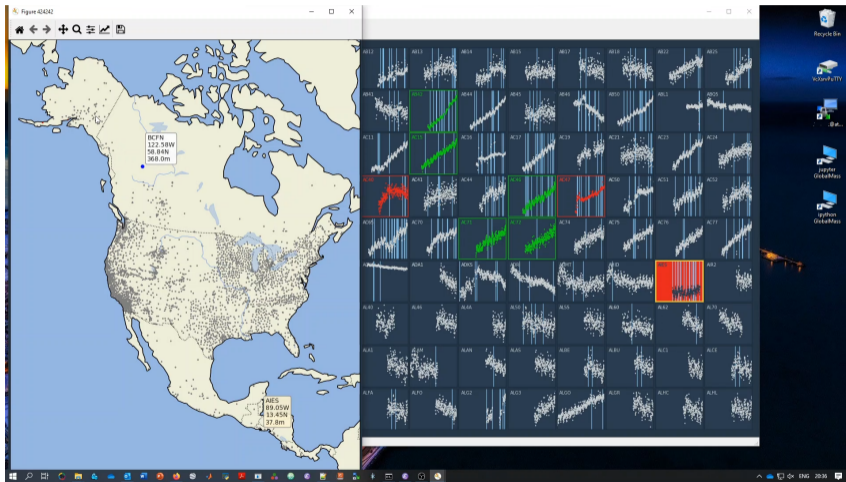


*PYthon for GeOreferenceD time series visualisation and Analysis*, or  
*PYthon for GeOlocated Data Analysis*, or my personal favourite  
*PYthon for GeOlocated time series DiAgnosis*

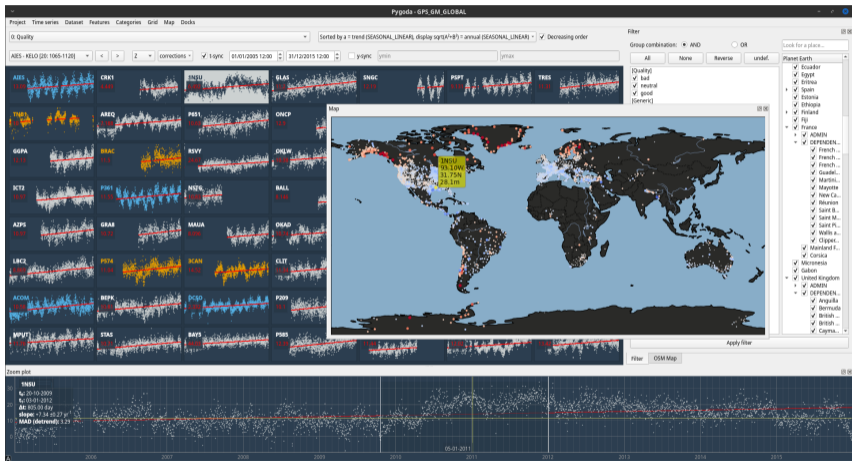
## In brief

A standalone GUI to visualise efficiently a large number of time series observed, recorded or computed at different locations on the Earth; distributed as Free Open Source Software (EURL-v1.2)

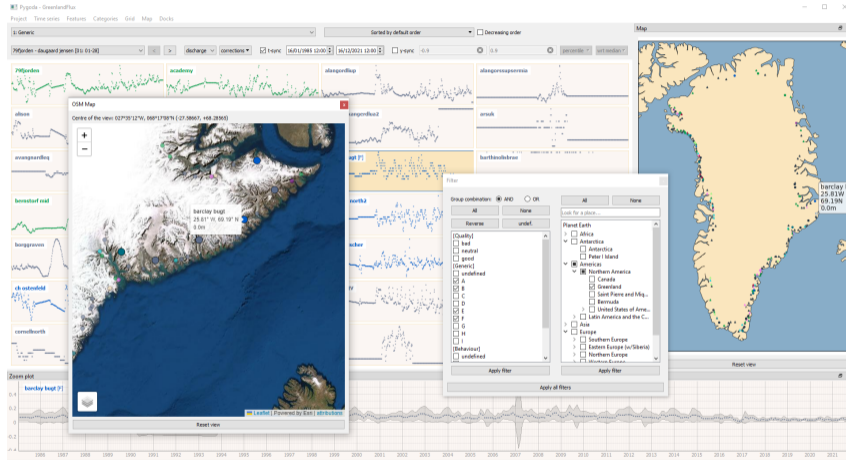




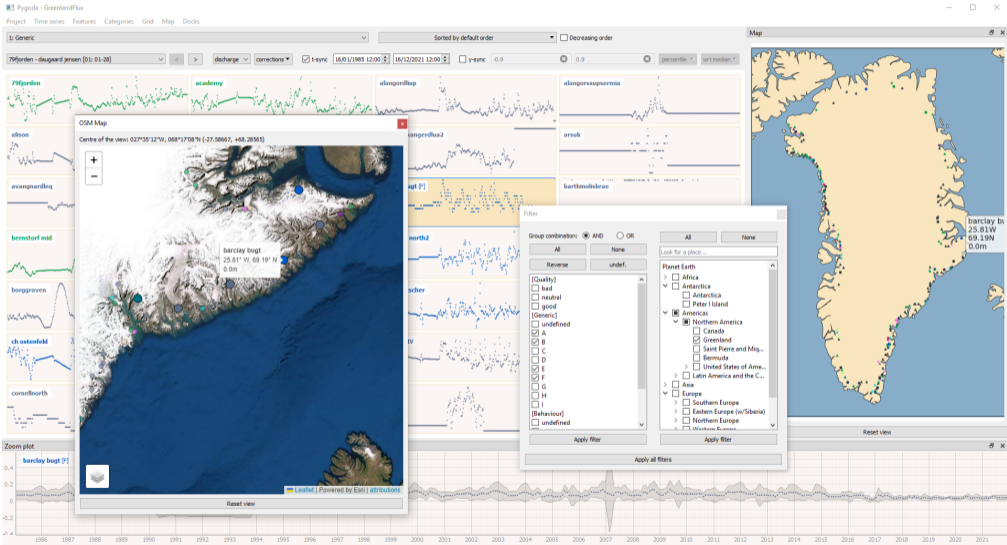
Hard coded map, 2 categories (good/bad), mouse and keyboard interaction



Zoom plot with basic statistics, group of categories, custom time and Y-range, online map, geographic and other filters, model fitting, features computation, docks...



Even satellite imagery and a light theme!



## A guided tour of Pygoda

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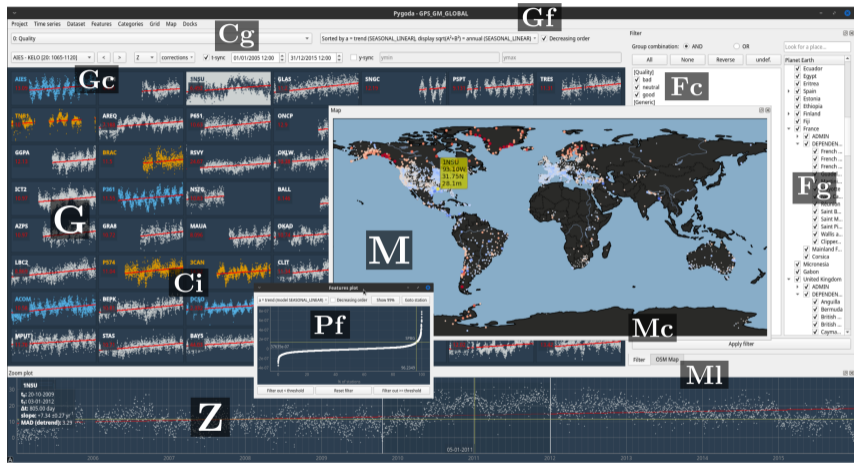


## Key features

- Spatio-temporal visualisation
- Visualise tens of time series at once
- Optimised modal GUI
- Load many data format
- Extract or compute time series features
- Fit standard models
- Sort and filter
- Geographic data selection
- Handy time and y-range customisation
- Colourful categories
- Online map layers
- Customisable theme

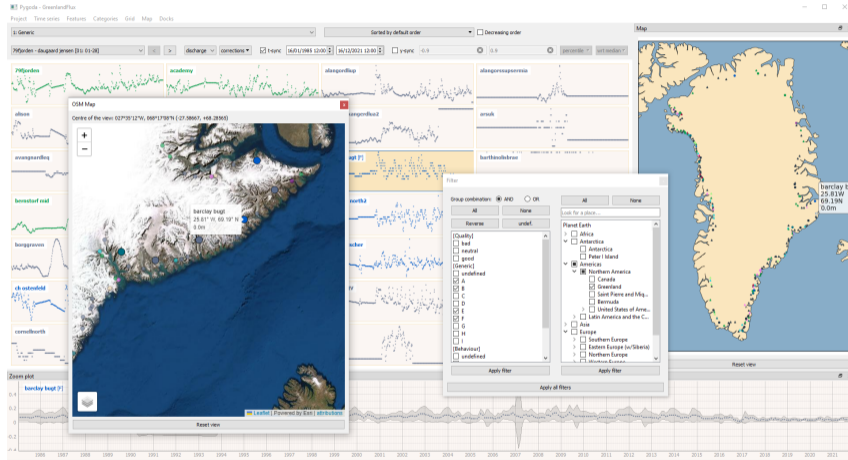
**Next slides:** demo with vertical land motion observed by GPS, river gauges data from United Kingdom and ice flux from Greenland glaciers.

# GUI overview



G: grid of time series subplots; M: maps with station locations; Z: “zoom plot” of hovered or selected time series; C: category-related controls; F: filters for data selection; P: auxiliary plots

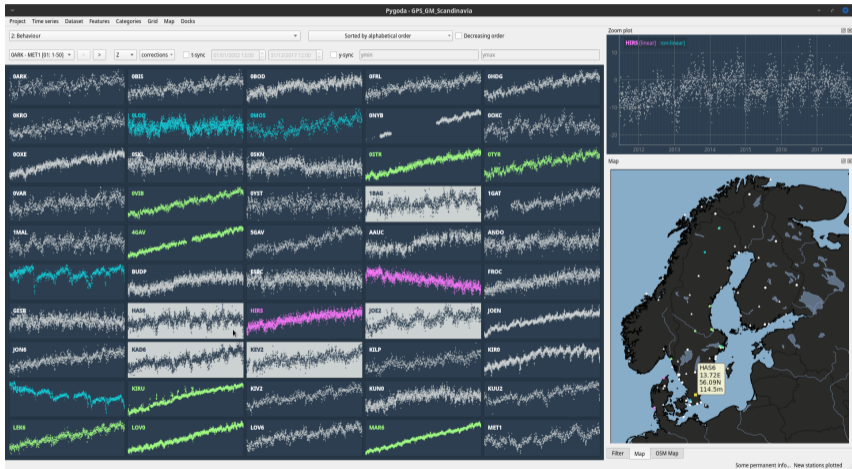
# Spatio-temporal visualisation



Synchronisation between the grid of subplots and the maps

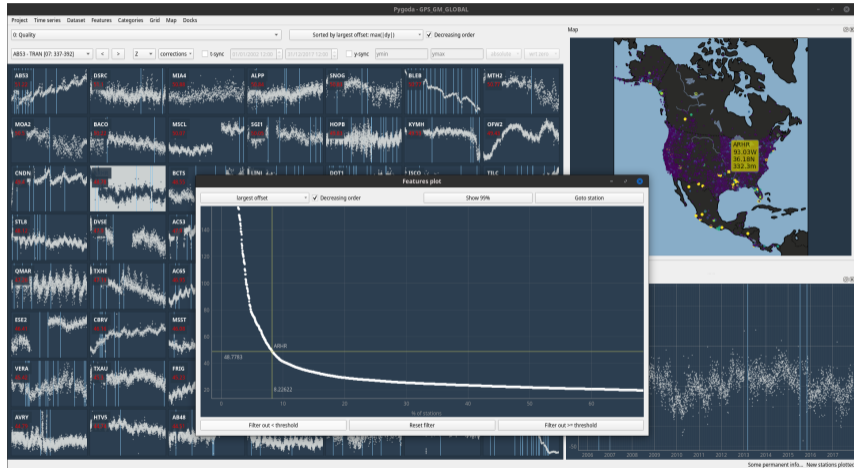


# Colourful categories & Modal (vim-like) GUI



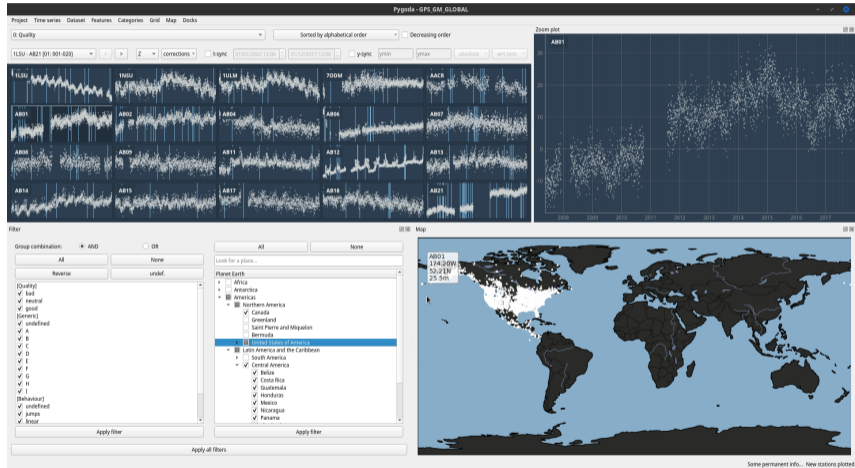
A colour for each category, set with keyboard or mouse on single or multi-selection

# Time series features extraction & Sorting



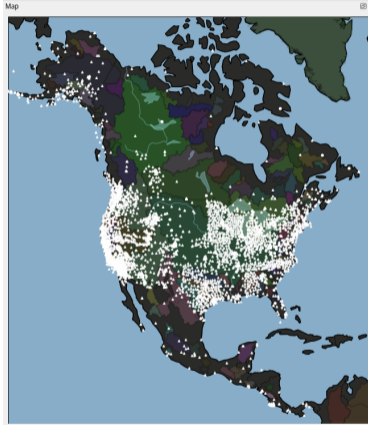
Sort the stations based on extracted or computed feature.  
Here the largest offset in the time series is shown.

# Geographic filtering: pre-defined



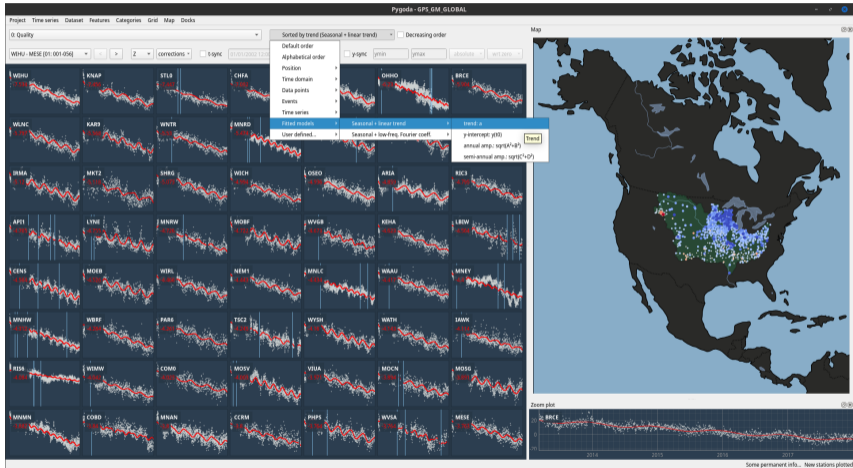
Select observations in chosen world regions in a few clicks.  
Here GPS stations in Northern America are selected from a global data set.

## Geographic filtering: custom



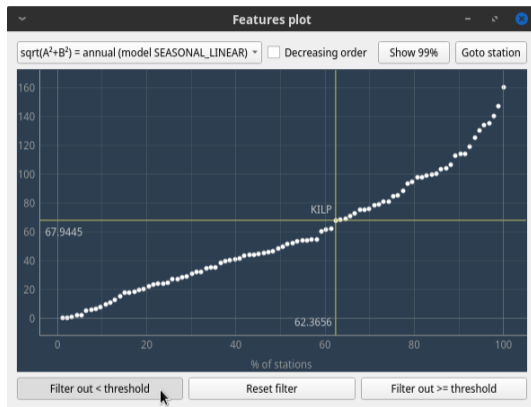
Select observations based on custom polygons (Shapefile).  
Here river basins of North America are shown (see next slide too).

# Model fitting & Geographic filtering



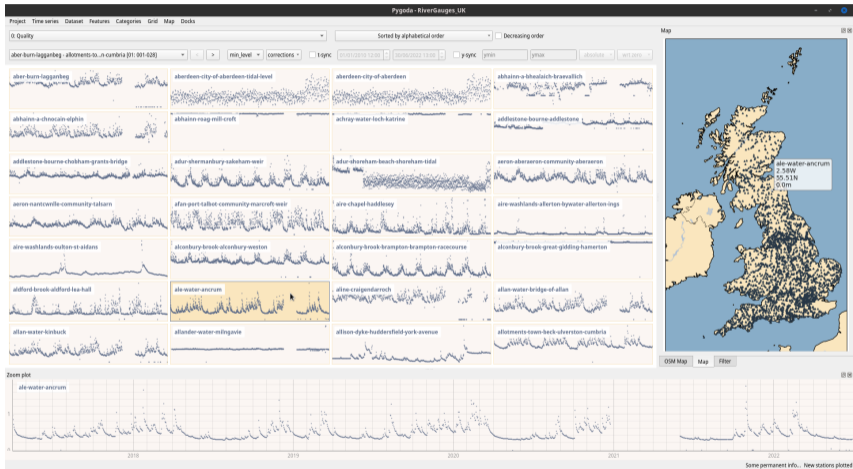
Fit a model and visualise the estimated model parameters.  
Here the trends in GPS vertical land motion in the Mississippi basin are shown.

# Model fitting & Sorting/Filtering



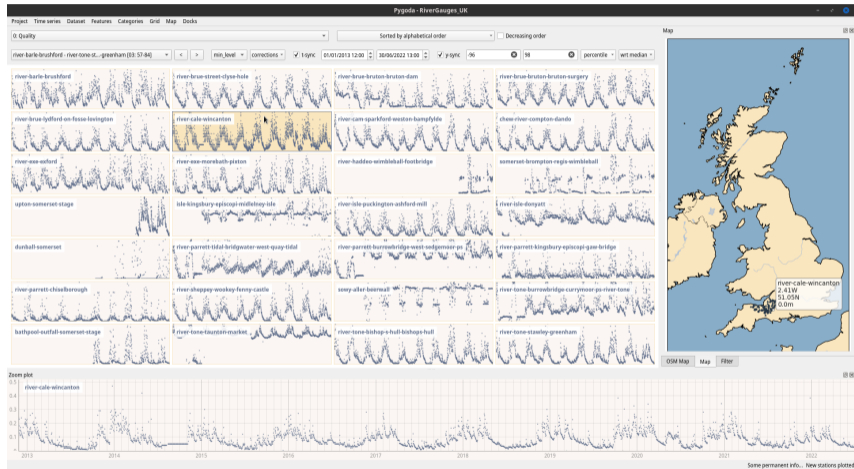
Sort and filter the stations based on estimated model parameters. Here the estimated annual amplitude (seasonal model) is shown.

# Data format & Customisable theme



Handle different file formats (HDF5, netcdf4, CSV, ...more coming soon).  
Here the data *and* metadata were automatically loaded from CSV files.

# Time- and Y-range customisation

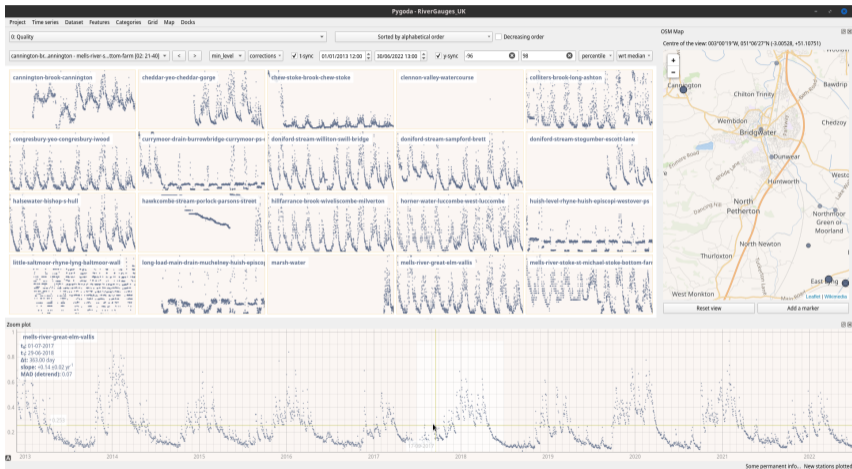


Fine-tune and synchronise t- and y-range with various options.

Here the time series median is the reference; the upper/lower bounds are percentiles.

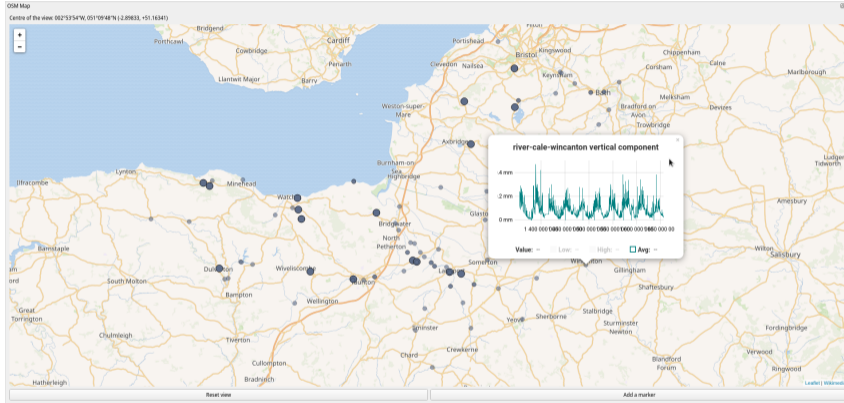


# Zoom plot



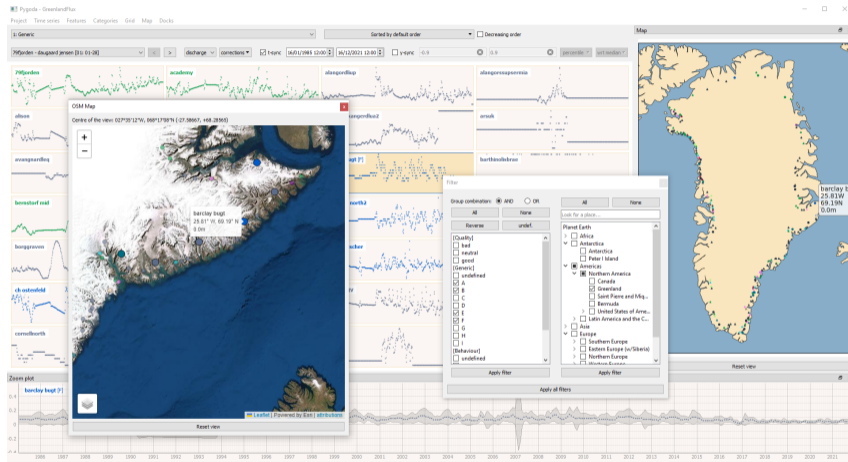
Basic statistics are provided on the zoom plot.  
Here a flooding event is investigated.

# Online maps



Online map with a set of map layers offers additional visualisation possibility. Here a time series from a river gauge in Somerset is directly plotted in its environment.

# And much more to come!



See more: [pygoda.readthedocs.io/en/latest/info/features.html](https://pygoda.readthedocs.io/en/latest/info/features.html)

# Practical & Technical Information

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## Great, I want to use it for my data set now!



**Please bear with me!** First public release planned this month or early December 2022. Pygoda v0.1-beta is already being tested and used at the University of Bristol, but still needs some polishing:

- Creating a user-friendly 'New Project' wizard (require manual config for now, i.e. *I need to setup the project for you*)
- Solving a few bugs here and there
- Completing the online documentation (see next slide)
- Improving data loading, especially time vectors (current bottleneck)
- Some more testing not to scare the first users away with unwieldy features

## Getting started (after the first public release)



1. Go to Pygoda's...
  - ReadTheDocs: *pygoda.readthedocs.io*, or
  - GitHub repository: *github.com/yannziegler/Pygoda*
2. Follow the guide:
  - 2.1 Installation: **conda** or download and install the package (Windows only)
  - 2.2 Read the Quick Start
3. **Enjoy!**
4. Contact me (*y.ziegler@bristol.ac.uk*) or, even better, open an issue on GitHub to report Pygoda's ~~stink~~ bugs or suggest improvements
5. **...and contribute!**




**Please bear with me (encore)!** Contributions and suggestions (very) welcome starting from 2023 onwards. Before that I would like to:

- Improve code documentation: add docstrings and more comments
- Describe implementation choices and overall code organisation
- Provide clear guidelines for contributors
- Do some housekeeping

If you want to contribute in any way, please start watching Pygoda's repository on GitHub to receive updates and/or contact me (see previous slide).

Pygoda's main dependencies:

- GUI: *PySide2*, the Python binding for Qt (porting to PySide6 is planned)
- plots: *PyQtGraph*, a “Scientific Graphics and GUI Library for Python” and “very fast” alternative to matplotlib
- local map: *cartopy*, built on top of *matplotlib*
- online map: *Leaflet* , an open-source JavaScript library for (mobile-friendly) interactive maps

As of now (November 2022),  $\approx$  8000 *loc* in Python (but like papers, quantity  $\neq$  quality), a few hundreds in Javascript, HTML/CSS; configuration in YAML format

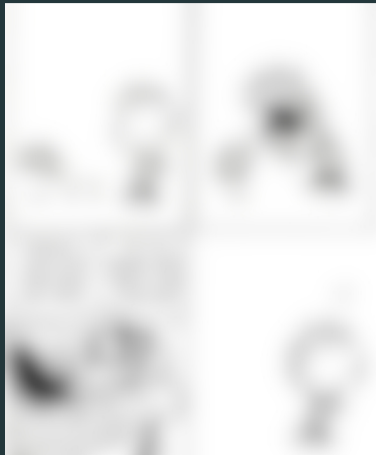
```
$ grep -r --include='*.py' '#TODO' Pygoda-beta/ | wc -l # return 41 :-]
```



- **Why not an online tool?** A personal choice (don't really like the current "cloudification" trend); also, less technological constraints.
- **Why Python and not C++?** The ideal tool has two characteristics: (1) you know how to use it well, (2) it is good enough for the task, even if not the best.
- **OS compatibility?** Tested on GNU/Linux (Archlinux, Debian, ...), Windows 8+ and through X-forwarding (run on CentOS, display on Windows). MacOS coming soon.
- **Next planned features?** (Too) many ideas; waiting for users feedback.
- **Next big feature, at least?** Prefer not to say, that's a surprise!
- **Next big surprise feature?** Nice try.

*The End*

Other questions?



There was a witty *Calvin and Hobbes* comic for you, but not all the nice creations can be shared freely.



## Pygoda

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## Pygoda

*The Swiss Army Knife of Geolocated Time Series Visualisation*

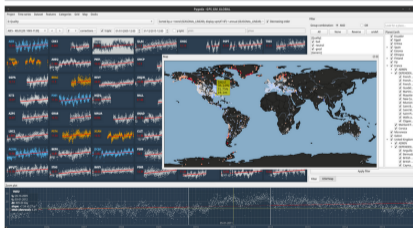
Release v0.1.0. ([Installation](#))

licence [EUPL-v1.2](#)

Pygoda is a Python GUI to visualise and analyse efficiently large sets of geolocated time series observed, recorded or computed at different locations on the Earth.

It is developed and maintained by Yann Ziegler @ [University of Bristol](#) (UK), [School of Geographical Sciences, Bristol Glaciology Centre](#)

This work is part of the [GlobalMass project](#).



Pygoda means any of the following, depending on your preference:

- PYTHON for GeOreferenceD time series visualisation and Analysis, or
- PYTHON for GeOLOcated Data Analysis, or my personal favourite
- PYTHON for GeOLOcated time series DIAgnosis



## Images attributions (with links to sources)

- Edessa mediatubunda (derivative work<sup>1</sup>): observed in Brazil by Andressa Mendes (from gbif.org)
- matplotlib and cartopy logos: matplotlib and cartopy websites
- Clever Acronyms cartoon excerpt: Jorge Cham © 2008 on PhD Comics
- Python logo: “two snakes” from the Python Software Foundation
- Robinson’s projection: from cartopy projection list
- Scientist illustration: Image by brgfx on Freepik
- Spacemacs logo: spacemacs website
- FOSS4G Teddy Bear: made with Tikz (yes, really)
- Missing Calvin and Hobbes comic: could have been © Bill Watterson, Andrews McMeel Publishing
- All other media are from the author (© Yann Ziegler)

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<sup>1</sup>NB: it is *not* an official or unofficial Pygoda logo!