Python pour la Géodésie et la *GeodeZYX* toolbox

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Introduction

- Need of a transversal and versatile software for geodetic purposes
  - Time or coordinate conversions, data cleaning, downloading ... are routine tasks
  - So far, simple and efficient high-level functions for those kinds of jobs are barely available,
  - It has have to be developed, again and again, by each student, engineer, even by senior scientists
  - Counter-example of "sister-sciences" toolboxs like *Obspy* (Seismology) or *Astropy* (Astronomy)

- What could be a good polyvalent toolbox for Geodesy ?
  - What should be the main functionnalities ?
  - How it has to be implemented ?

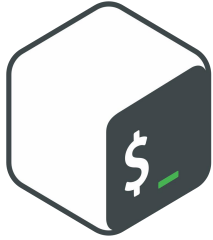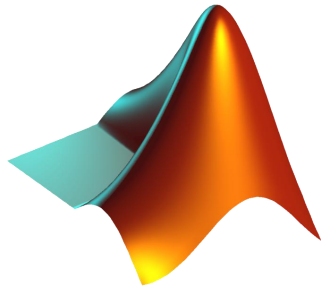- Why Python is a good language candidate

Scientific programming
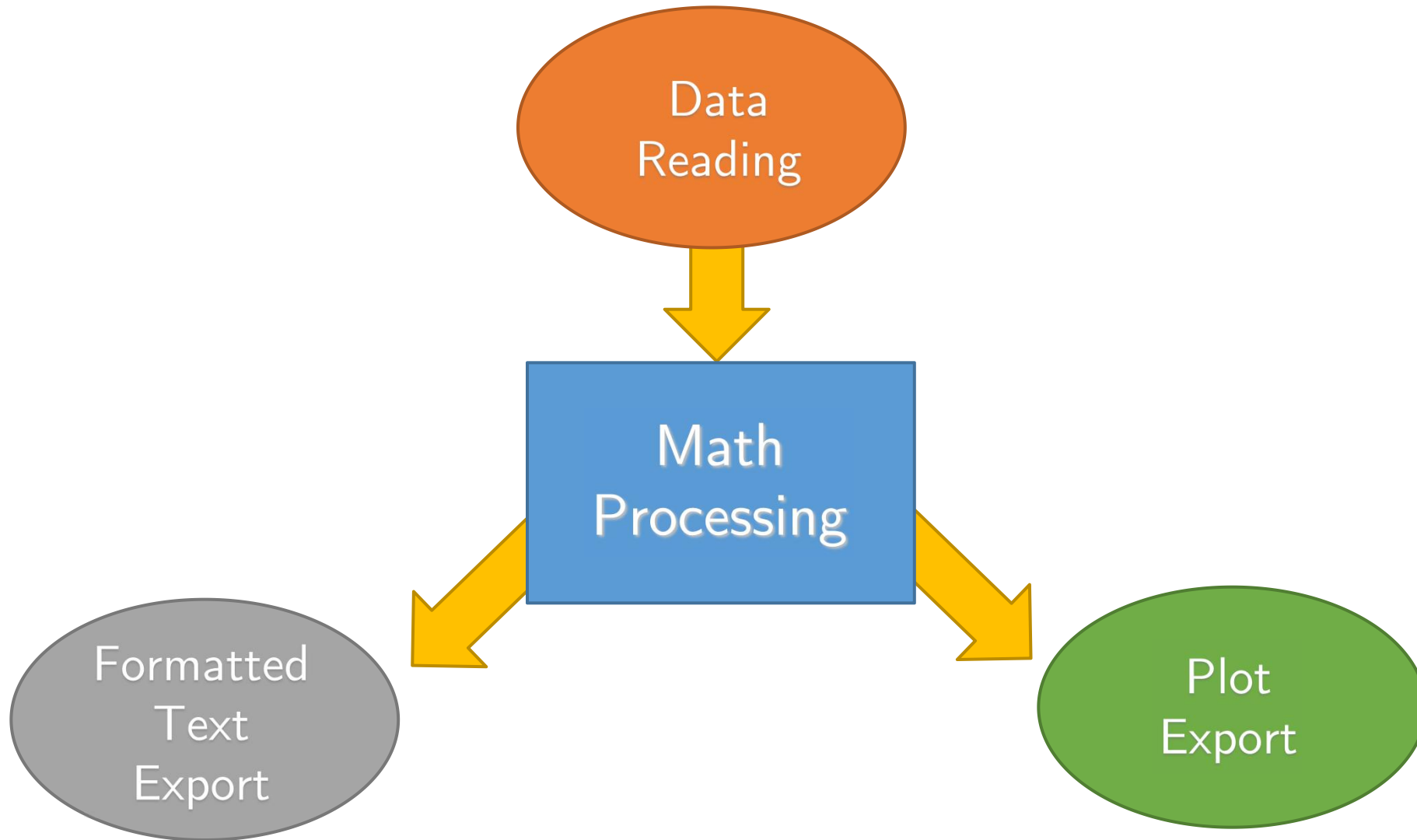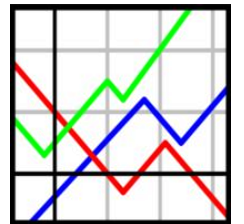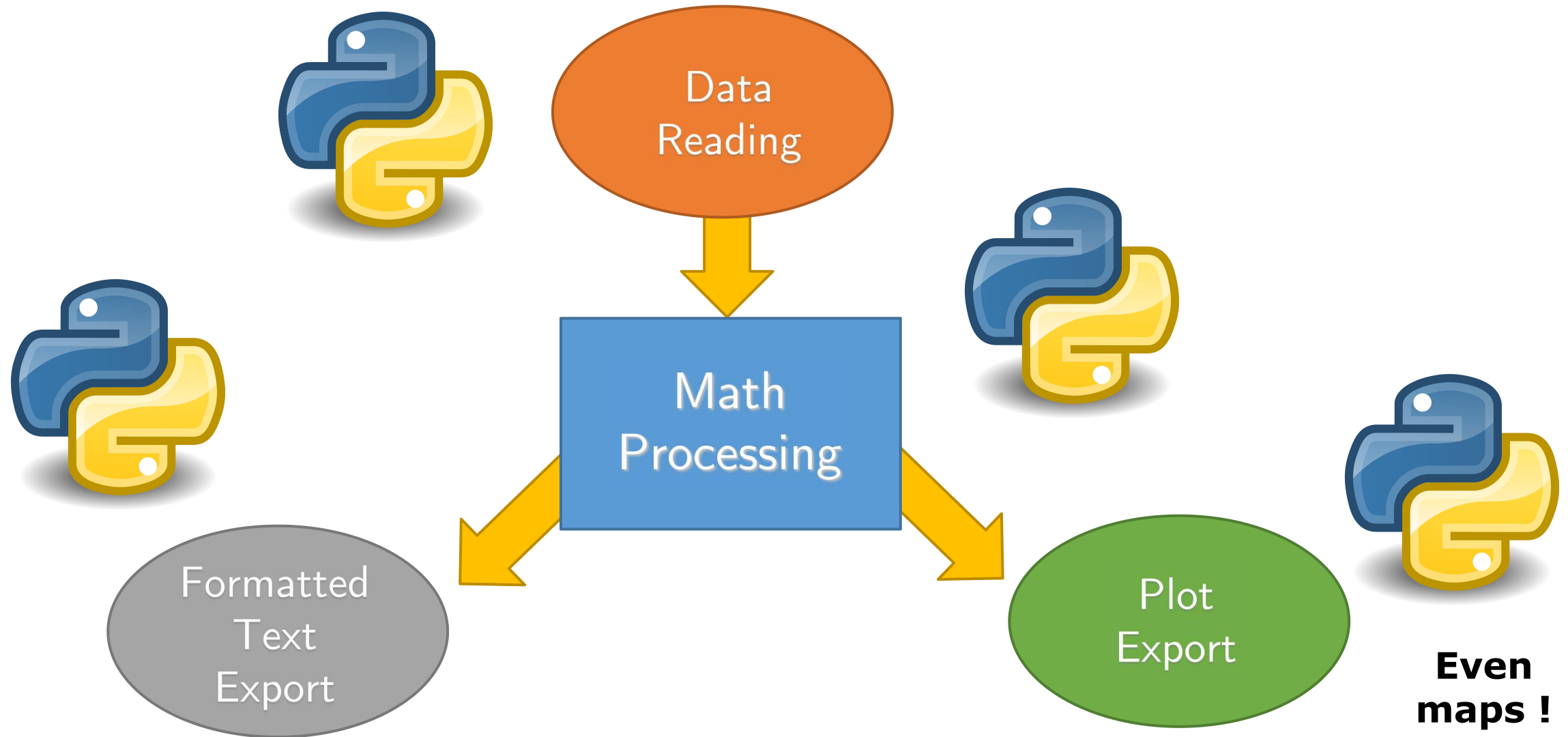
Scientific programming

Data Reading

Math Processing

Formatted Text Export

Plot Export

THE GENERIC MAPPING TOOLS

GNUplot

Scientific programming

Why Python ?

- Free (*libre*) & free (*gratuit*)

- Portable

- Aesthetics (meaningful indentation)

- Script Language combined with advanced scientific features
  - Simple & Powerful handling of files and strings

- Functions can be gathered in a same file (module)

- Tons of toolboxes, snippets, and forum Q&As on Internet

- No semicolon !

Why Not Python ... but ...

- *Interpreted, so what about the processing speed ?*

  - C under-layer for maths toolboxes

  - Basic functions (interpolation, Root-finding) exist and are highly optimized

  - Multiprocessing on several CPU cores is easy to implement
  - The trio **numpy**/**scipy**/**pandas** are perfect to manage large amount of data

- *It is Object-oriented ... I don't like it*

  - A matter of taste, you don't have to use it

- *We have already dedicated software, and they are working well*

  - The objective is definitely not to replace GINS-like software, Is to provide a complementary tool, more focused on data interpretation

Introducing the *GeodeZYX Toolbox*

The GeodeZYX Toolbox aims to:

- Provide simple but useful coordinates and time conversion functions
- Import easily into a Python environment data and output files from various geodetic software
- Operate simple operations (outliers detection, detrend) on coordinate time series
- Export quickly time series plots, and coordinates ASCII files for several velocities estimation software (MIDAS, HECTOR...)
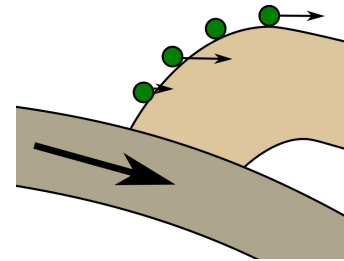
Main submodules
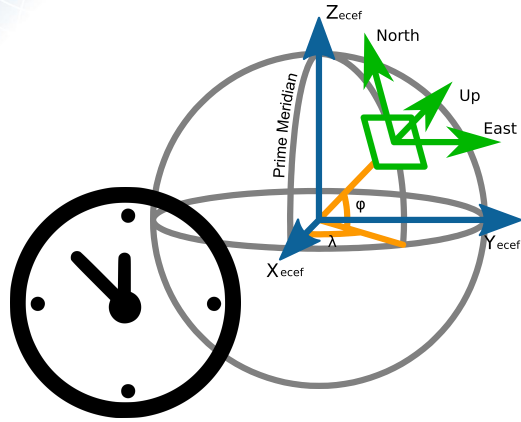
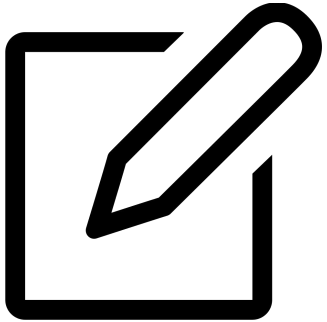Time and low-level coordinates conversion
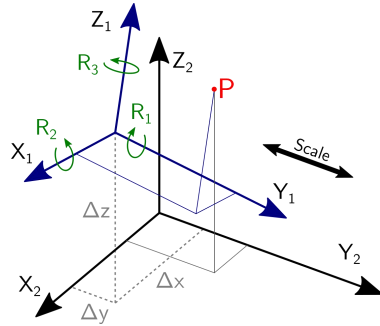
Reference Frame & high-level coordinates conversion
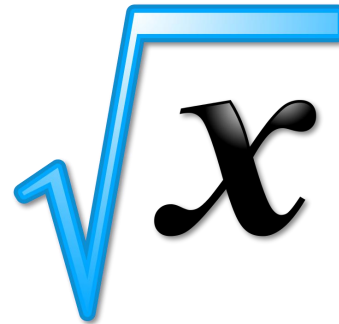
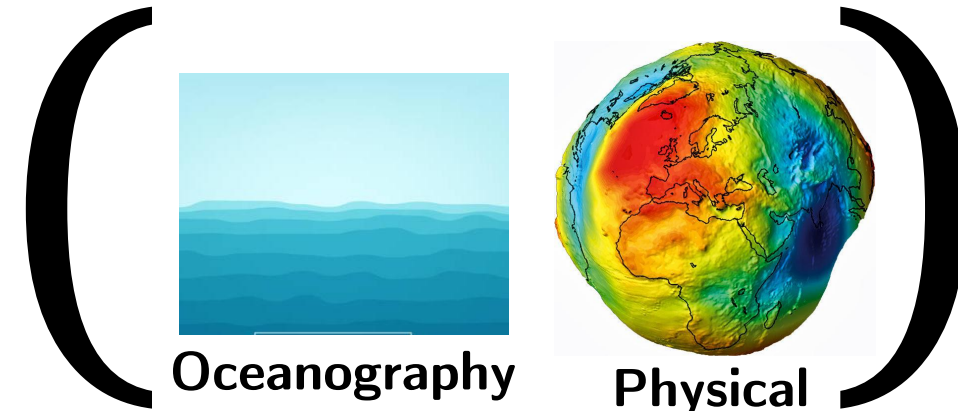Time Series Handling & Geodynamic

Atmosphere

Read/Write files

Shell-like and "operational" function

Low-level Statistics

(Oceanography   Physical geodesy)

Time/Coordinates Conversion

Use the Python DateTime object as a reference time convention from/to:
- Decimal Year
- Year / Day of The Year
- GPS Time (GPS Week, day of the week, seconds in the week)
- Julian Days (MJD, CNES convention)
- TAI/UTC (manage the leap seconds)
- POSIX & MATLAB time ...

Provides function for coordinates conversion (Geocentric, Geographic, Topocentric)

High level geodetic function (Helmert Transformations, Projections, ITRF coords. @ the wished epoch)
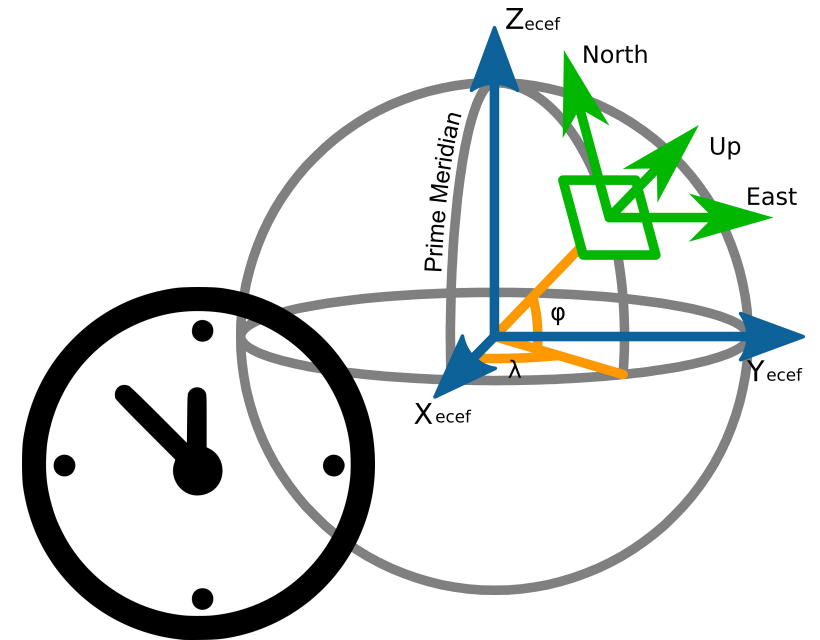
Time Series Handling

Coordinates output are imported in a **TimeSeries** object,

which allows:
- Coordinates conversion
(Geocentric, Geographic, Topocentric)
- Outliers detection (high sigma, threshold limit,
Median Absolute Deviation...)
- Linear detrend
- Point and Click manual discontinuities detection
- Quick plot export

Able to read coordinates output from :
- EPOS (GFZ)
- GAMIT/GLOBK (MIT)
- GINS (CNES)
- CSRS-PPP (NRCAN)
- GIPSY (JPL)
- NMEA ....
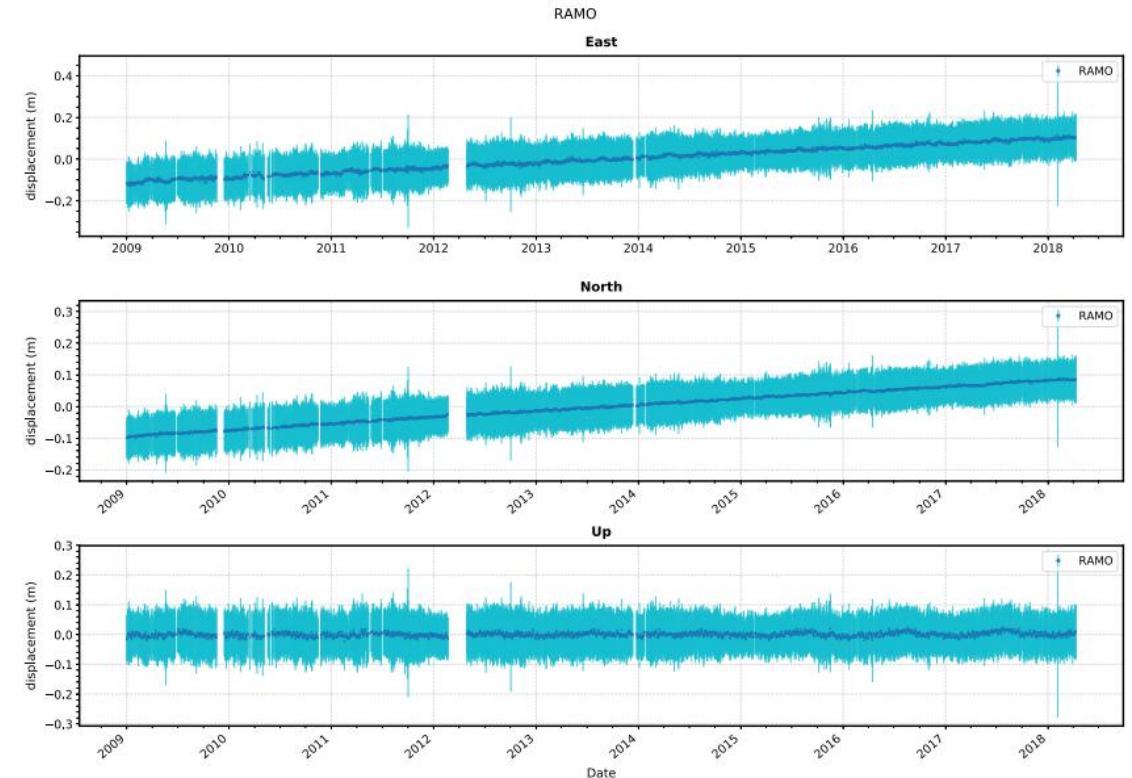
"Operational" functions

- IGS data (RINEX) and products (SP3 orbits and clocks offset) fast download on different data center servers
- Wrappers for TEQC (improved RINEX spliting)
- Modules to manage station metadata (Antenna & receiver manufacturers and types, date of installation ...) as Objects:
    - Import from sitelogs or RINEX headers
    - Export to station files (like GAMIT station.info for instance)
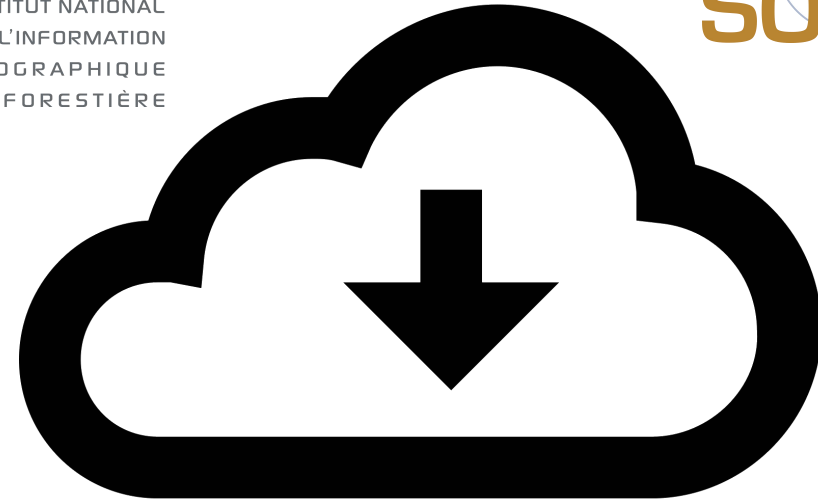
Similar projects within the national community

- J.-M. Nocquet @ *GéoAzur/IPGP*
  PyACS (geodynamics purposes)

- L Testut et al. @ *Université de La Rochelle/LEGOS*
  PyGOAT (altimetry purposes)

- J. Beilin et al. @ *ENSG/IGN*
  YaGNSS (and a Python upgraded version ?)

- A. Santamaría-Gómez @ *GET/OMP*
  SARI (Time series analysis)

And now ?

- The *GeodeZYX TB* has a simple but wide scope

- We are looking for volonteers to contribute

- Federate our efforts for a common, complete and efficent Geodetic toolbox ?

- Benefit from online development tools like GitHub

- Establish an associated forum/Wiki ?

- Take as example "sister-sciences" toolboxs like *Obspy* (Seismology) or *Astropy* (Astronomy)

The *GeodeZYX Toolbox* is forkable on GitHub

```
https://github.com/
    GeodeZYX/
GeodeZYX-Toolbox_v4
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