Access to Analysis and Climate Indices Tools for Climate Researchers and End Users

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Abstract

Researchers and end users using climate data face a challenge when they analyze the data they need. Data volumes are increasing very rapidly, and the ability to download all needed data is often no longer possible. Most of the climate analysis tools for research and application needs must use very large datasets, often distributed among several data centres and into a large quantity of files. This is especially true when they are stored in a federated architecture like the ESGF. One of these tools is icclim (https://github.com/cerfacs-globc/icclim), a flexible python software package to calculate climate indices and indicators. This tool adhere as much as possible to metadata conventions such as CF, implementing also provenance information. It also aims at providing increasing support for all FAIR aspects. It is designed with performance and optimisation in mind, because the goal is to provide on-demand calculations for users. It provides the implementation of most of the international standard climate indices such as ECAD, ETCCDI, ET-SCI, including the correct methodology for calculating percentile indices using the bootstrapping method. It has been validated against R.Climdex as well (https://cran.r-project.org/web/packages/climdex.pcic/index.html). The new 5.x version of icclim is now based on functions from the xclim python library, which was inspired by earlier versions of icclim, but using xarray and dask for data access and processing. icclim is also a candidate as the software to calculate climate indices for the C3S toolbox (https://cds.climate.copernicus.eu/cdsapp#!/toolbox). An example of a complex analysis tool used in climate research and adaptation studies is a tool to follow storm tracks. In the context of climate change, it is important to know if storm tracks will change in the future, in both their frequency and intensity. Storms can cause significant societal impacts, hence it is important to assess future patterns. These tools are integrated in the IS-ENES C4I 2.0 platform (https://climate4impact.eu/), using a Jupyter notebook collection in a SWIRRL environment (Software for Interactive Reproducible Research Labs https://gitlab.com/KNMI-OSS/swirrl). Having access to this type of complex analysis tool is very useful, and integrating them with front-ends like C4I enable the use of those tools by a larger number of researchers and end users. This project (IS-ENES3) has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°824084.

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with Climate4Impact 2.0a and icclim 5.0-RC1

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I Impacts of Climate Change

2021 Germany Erftstadt, southwest of Cologne

2020 Hurricane Delta causes damage to Louisiana's Gulf Coast

- Urgent needs of impact assessments
- Identify mitigation solutions
- Extreme events attribution
- Multiple domains: infrastructures, urban, agriculture, transportation, etc.
- Flexible tools needed for very diverse users
- Compound Events

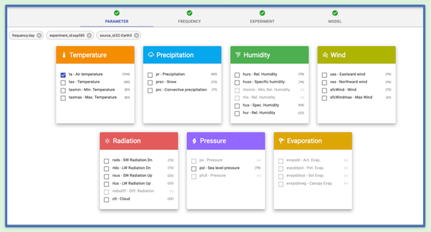
II Common Users' Needs

From Users *Surveys*

- Difficult to deal with the large number of climate simulation datasets
- Lost in which climate model, experiments to use
- Many climate indices are complex to calculate
- Cannot reproduce results easily

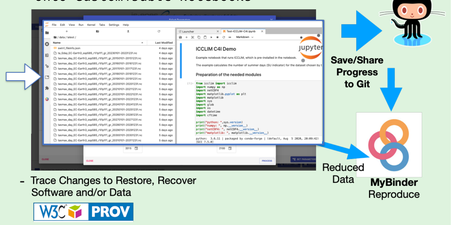
III Climate4Impact 2.0 (C4I)

- GUI usability & Help/Feedback pages
- Flexible analysis features (Notebooks with icclim - Data Staging/Reduction Workflows)
- Automated reproducibility mechanisms and documentation (Data/Analysis)
- Pages for Models Performance Comparison (ESMValTool)
- Modular Deployment & Decoupled Architecture



https://dev.climate4impact.eu

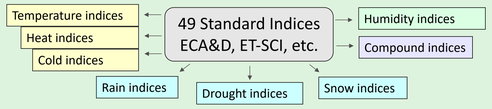
Workflows for data staging & remote subsetting-reduction (WPS) onto Customisable Notebooks



Take Home Messages

1. **Strong Needs for tools to address ensemble of climate change simulations**
2. **icclim is a flexible, robust and fast python software for calculating climate indices**
3. **Provenance & Lineage is very important for reproducibility**
4. **Standards are essential for sharing results**

IV icclim: Climate Indices

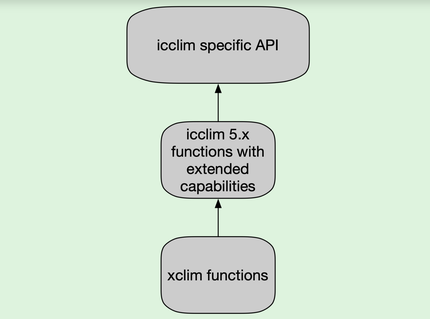


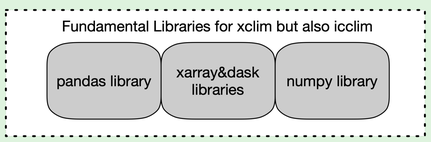
- Intra-period extreme temperature range [° C] - **ETR**
- Warm days (days with mean temperature > 90th percentile of daily mean temperature) - **TG90p**
- Summer days (days with max temperature > 25 ° C) - **SU**
- ...

- Python code developed@Cerfacs since 2013
- Performance optimized
- Fully compliant to CF and Standards
- Validated against climpact & xclim
- Easy install: `pip install icclim`
- Implement the proper percentile indices calculations when calculation period overlaps reference period: bootstrapping method

V icclim (python) Code Architecture

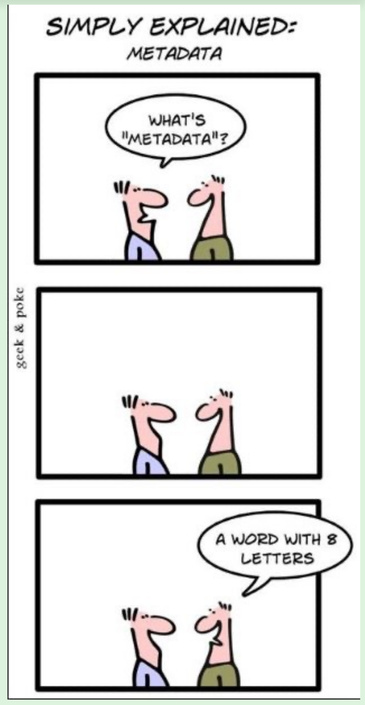
- Using xclim climate indices functions
- xclim functions are using xarray, dask, pandas and numpy: optimized and parallel
- icclim 5 implements a specific API very similar to v4
- Extended capabilities: user-defined indices, user-specific thresholds, etc.





VI Work Plan

- Expand testing of 5.0.0RC versions to more users in order to release 5.0.0
- Implements full support of provenance information (PROV-O)
- Finalize standards for climate indices metadata clix-meta
  `https://github.com/clix-meta/clix-meta`
- Release support tools: testing suite
- Provide more Jupyter Notebooks to include in C4I
  `https://gitlab.com/is-enes-cdi-c4i/notebooks`



IS-ENES: https://is.enes.org/ icclim v5.0.0RC1: https://github.com/cerfacs-globc/icclim (`pip install icclim`) climate4impact 2.0 beta: https://dev.climate4impact.eu/

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https://rebrand.ly/icclim