# icclim: Calculating Climate Indices and Indicators Made Easy

Christian Pagé[1], Abel Aoun[1], and Alessandro Spinuso[2]

[1]CERFACS
[2]KNMI

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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 ). icclim is 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 analysis tool is very useful, and seamless integration 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.

# icclim: Calculating Climate Indices and Indicators Made Easy

*Christian Pagé & Abel Aoun (CERFACS, France), Alessandro Spinuso (KNMI, Netherlands)*

christian.page@cerfacs.fr https://linkedin.com/in/pagechristian https://www.researchgate.net/profile/Christian_Page

CECI, Université de Toulouse, CNRS, CERFACS, Toulouse, France

abel.aoun@cerfacs.fr (CERFACS) alessandro.spinuso@knmi.nl (KNMI)

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## I Impacts of Climate Change

*2021 Germany Erftstadt, southwest of Cologne*

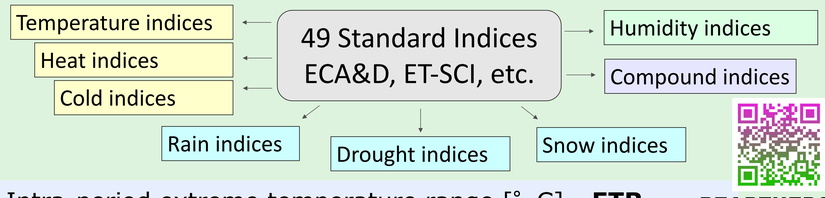
*2020 Hurricane Delta causes damage to Louisiana's Gulf Coast*

- Urgent needs of impact assessments
- Identify mitigation solutions
- Multiple domains: infrastructures, urban, agriculture, transportation, etc.
- Easy to use tools are needed for very diverse users
- **Climate indices and indicators are widely needed**

## II icclim: Climate Indices

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


## III icclim: 49 Standard Indices




READTHEDOCS

- 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**
- ...

Example: index **SU**

```
>>> files = ['tasmax_day_CNRM-CM5_historical_r1i1p1_19950101-
19991231.nc', 'tasmax_day_CNRM-CM5_historical_r1i1p1_20000101-
20041231.nc', 'tasmax_day_CNRM-CM5_historical_r1i1p1_20050101-
20051231.nc']
>>> dt1 = datetime.datetime(1998,1,1)
>>> dt2 = datetime.datetime(2005,12,31)
>>> out_f = 'SU_JJA_CNRM-CM5_historical_r1i1p1_1998-2005.nc'
# OUTPUT FILE: summer season values of SU
>>> icclim.index(index_name='SU', in_files=files, var_name='tasmax',
time_range=[dt1, dt2], slice_mode='JJA', out_file=out_f)
```

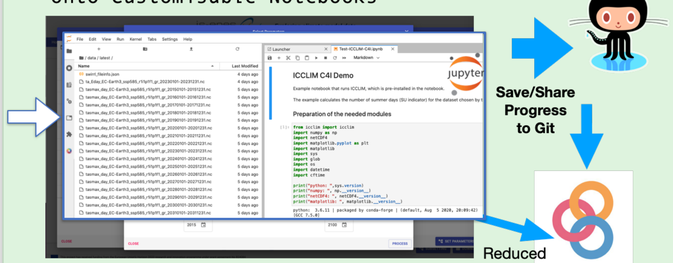
## Take Home Messages

1. **Wide Needs for tools to easily calculate climate indices**
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 climate4impact (C4I)

- Flexible analysis features (Notebooks with **icclim** - Data Staging/Reduction Workflows)
- Automated reproducibility mechanisms and documentation (Data/Analysis)

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

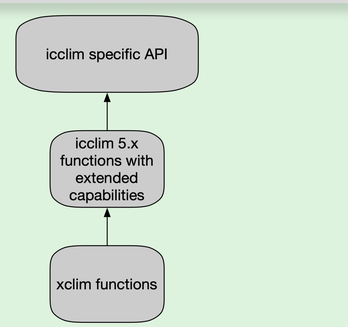



*https://dev.climate4impact.eu*

## V icclim: Code Architecture

- Using xclim climate indices functions as building blocks
- xclim functions are using xarray, dask, pandas and numpy: optimized and parallel execution
- icclim v5 implements a specific API very similar to v4
- Extended capabilities: user-defined indices, user-specific thresholds, etc.

GITHUB




## VI Work Plan

- Fix remaining issues in 5.0.0rc2 in order to release 5.0.0, expected on 31 Jan 2022
- Will be integrated in the Copernicus CDS toolbox early 2022
- Implement full support of provenance information (PROV-O)
- Finalize standards for climate indices clix-meta

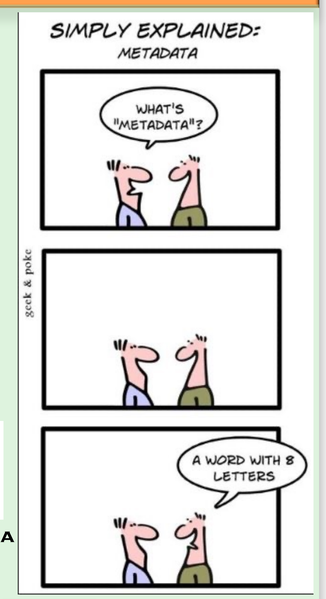
https://github.com/clix-meta/clix-meta

CLIX-META

- Release support tools: testing suite
- Provide more Jupyter Notebooks to include in C4I

https://gitlab.com/is-enes-cdi-c4i/notebooks

JUPYTER NOTEBOOKS




IS-ENES: https://is.enes.org/

icclim 5.0.0rc2: https://github.com/cerfacs-globc/icclim (`pip install icclim`)

climate4impact 2.0 beta: https://dev.climate4impact.eu/

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https://rebrand.ly/icclimposter