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## I Impacts of Climate Change



2021 Germany Ertstadt, southwest of Cologne

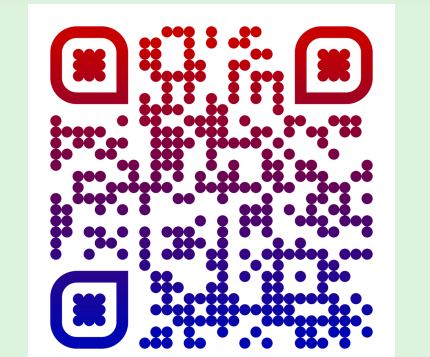
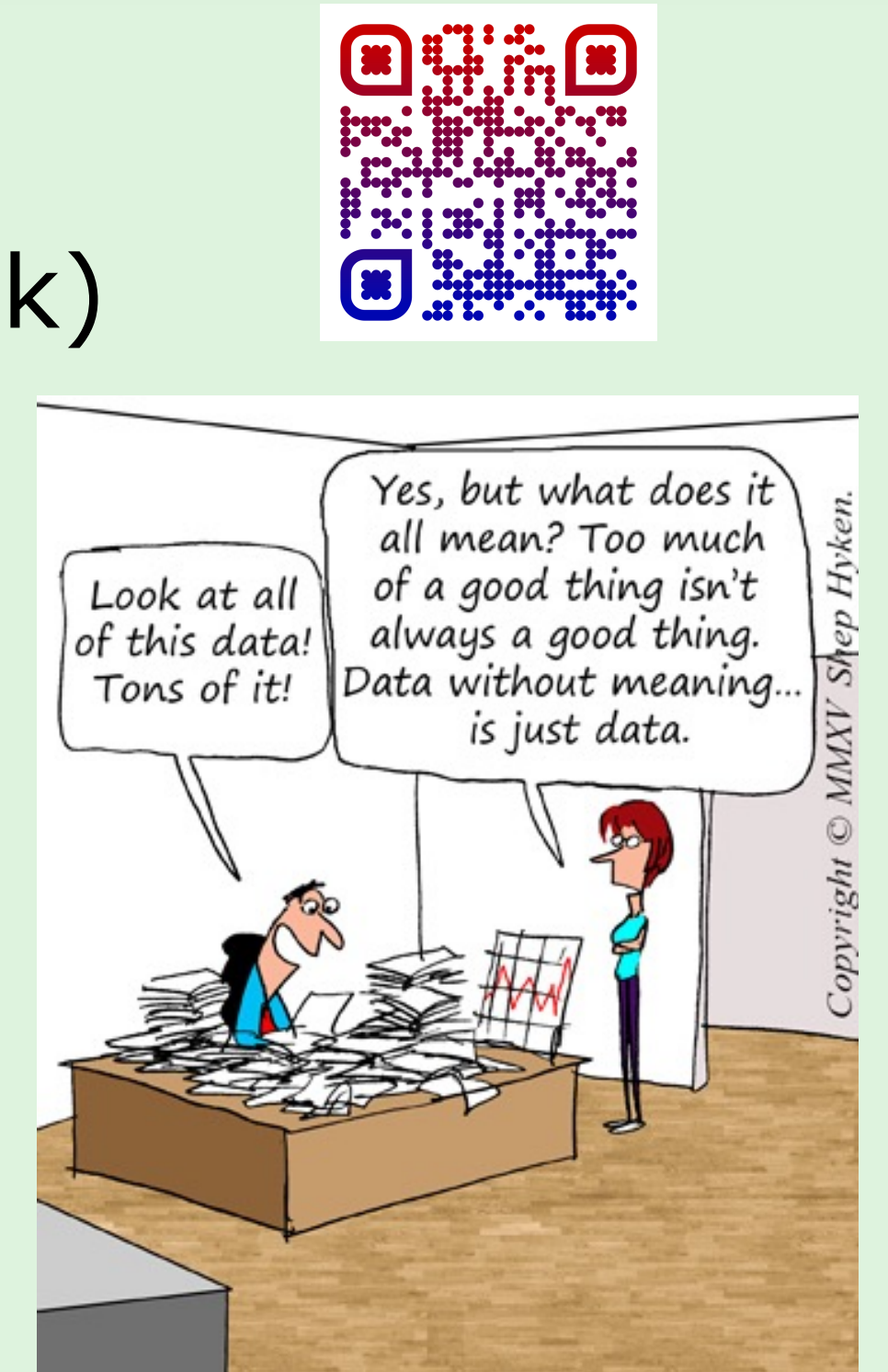


2020 Hurricane Delta causes damage to Louisiana's Gulf Coast

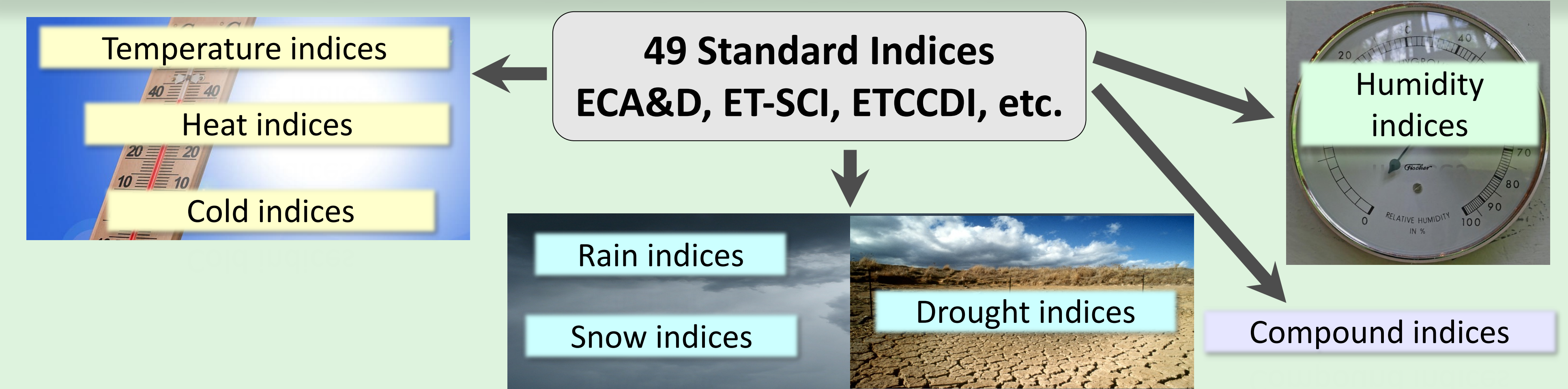
- Urgent needs of impact assessments
- Identify mitigation solutions
- Extreme events attribution
- Multiple domains: infrastructures, urban, agriculture, transportation, etc.
- Flexible tools needed for very diverse users
- Climate indices and indicators are widely needed**

## II icclim: Climate Indices

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



## III icclim: 50 Standard Climate Indices

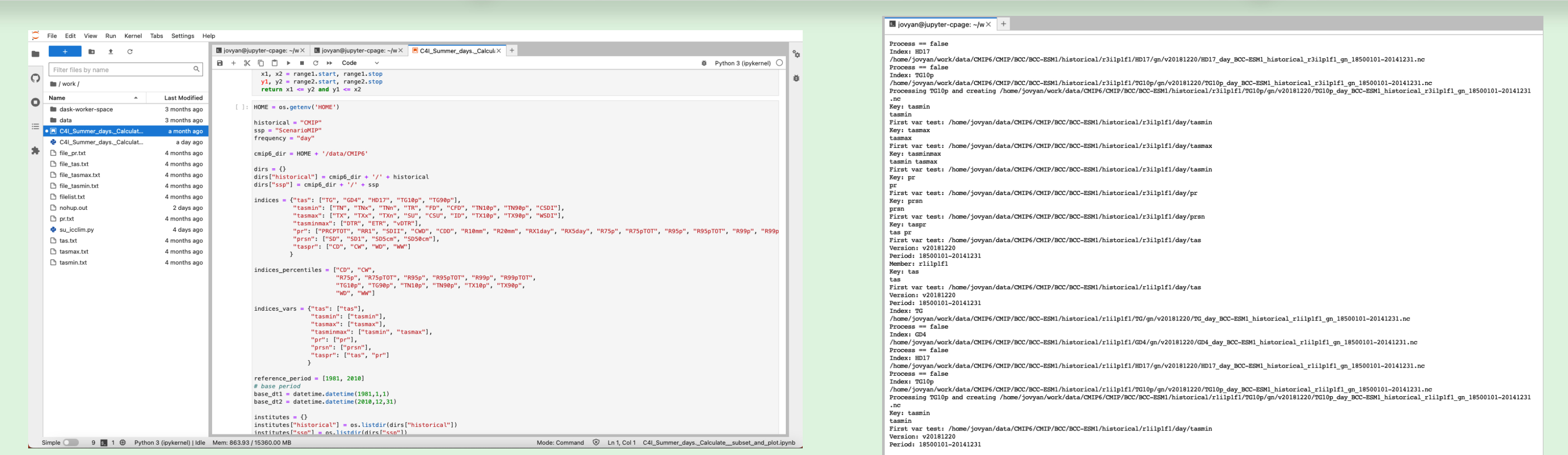


- Intra-period extreme temperature range [° C] - **ETR**
- Warm days (days with mean temperature > 90th percentile of daily mean temperature) - **TG90p**
- Summer days (days with max temperature ≥ 25 ° C) - **SU**

Standards for climate indices metadata clix-meta <https://github.com/clix-meta/clix-meta>

```
>>> 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.su(in_files=files, time_range=[dt1, dt2], slice_mode='JJA', out_file=out_f)
```

## IV Compute: ENES Data Space

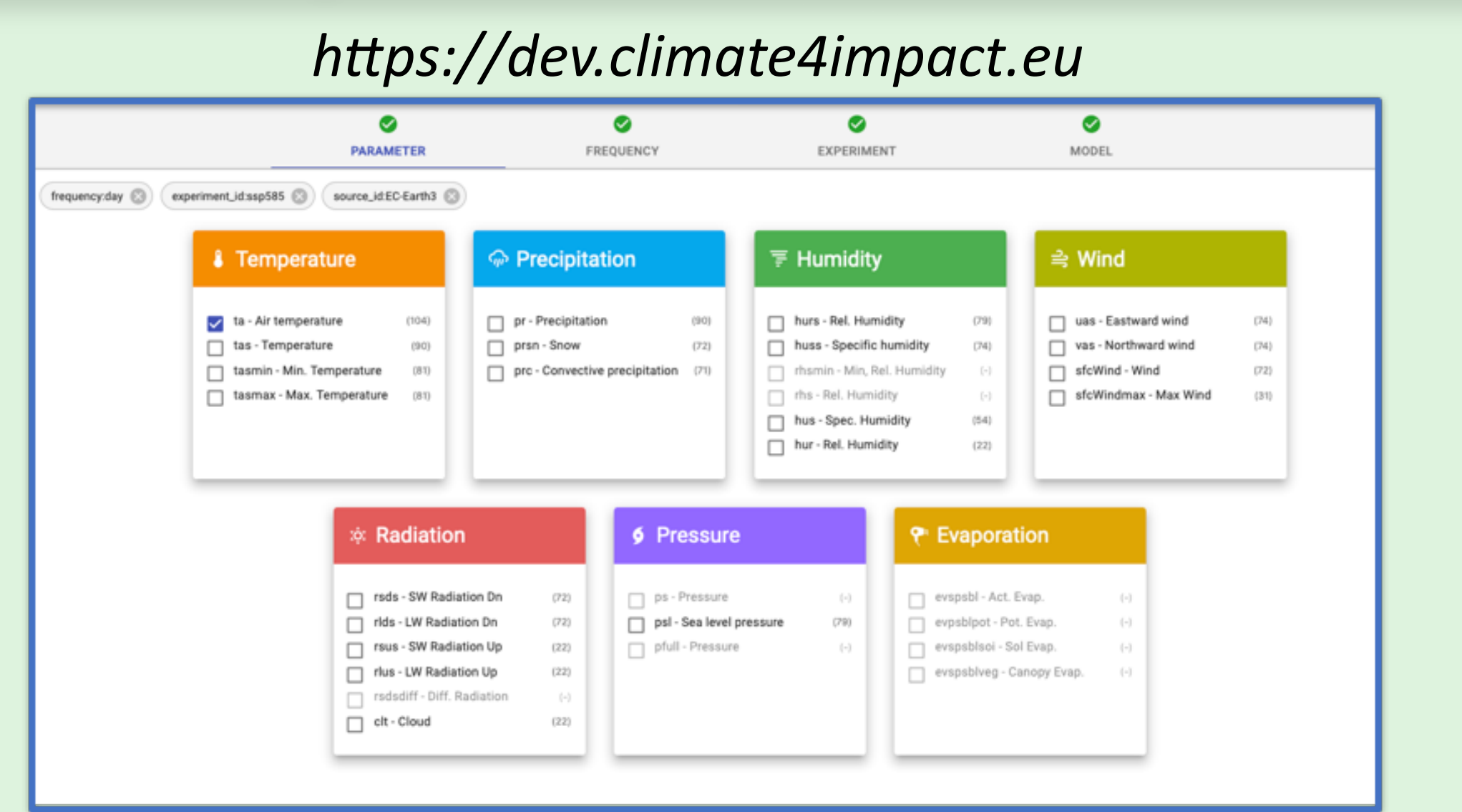


### Take Home Messages

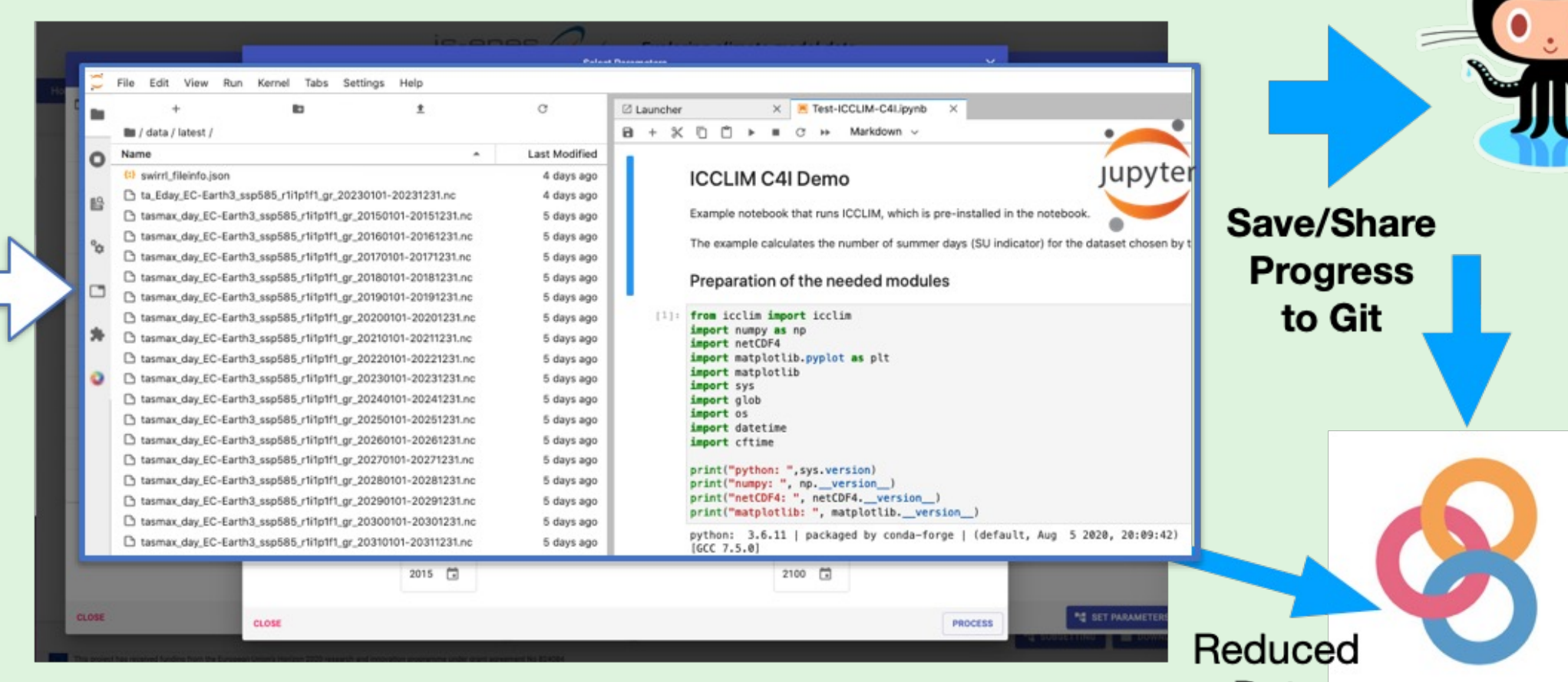
- Wide Needs for tools to easily calculate climate indices
- icclim is a flexible, robust and fast python software for calculating climate indices
- Creating pre-calculated standard indices datasets for CMIP6 is really a need
- A web platform for easy and FAIR-enabled access to climate data, tools and actionable products is essential

## V Climate4Impact: C4I

- Front-end to climate data infrastructure (ESGF)
- Tailored Search Interface with view modes
- Jupyter-Lab enhanced environment SWIRRL
- Notebooks gallery
- Flexible analysis features
- Climate indices calculation: icclim
- Personal store for processing outcome
- Pages for Models Performance Comparison (ESMValTool)
- Automated reproducibility mechanisms and documentation (Data/Analysis)



<https://dev.climate4impact.eu>  
<https://gitlab.com/is-enes-cdi-c4i/notebooks>



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

## VI Climate Indices Database

- 50 standard climate indices over most of CMIP6 simulations
- Institutes/Climate Models
- Historical and SSPs
- Members
- Versions
- Time Periods (1850-2100)
- Can be extended to CORDEX, CMIP5, ERA5, ...

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