



I Impacts of Climate Change



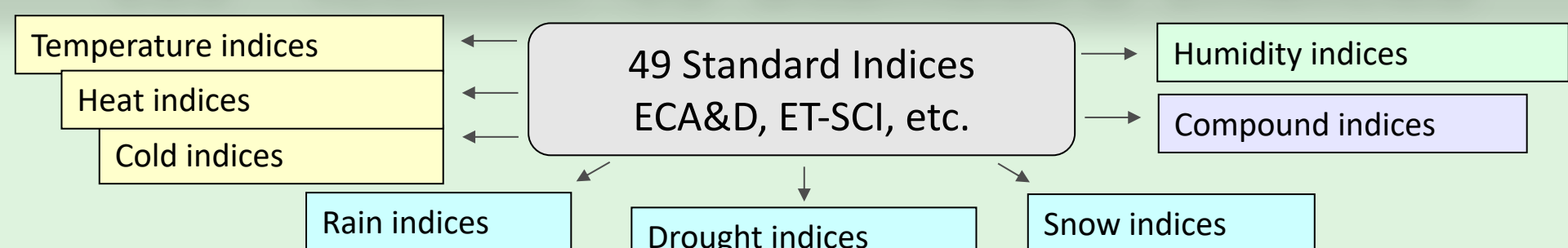
2021 Germany Erftstadt, southwest of Cologne



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**

III icclim: 49 Standard 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**
- ...

```
>>> files = ['tasmax_day_CNRM-CM5_historical_r1iip1_19950101-19991231.nc', 'tasmax_day_CNRM-CM5_historical_r1iip1_20000101-20041231.nc', 'tasmax_day_CNRM-CM5_historical_r1iip1_20050101-20051231.nc']
>>> dt1 = datetime.datetime(1998,1,1)
>>> dt2 = datetime.datetime(2005,12,31)
>>> out_f = 'SU_JJA_CNRM-CM5_historical_r1iip1_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)
```

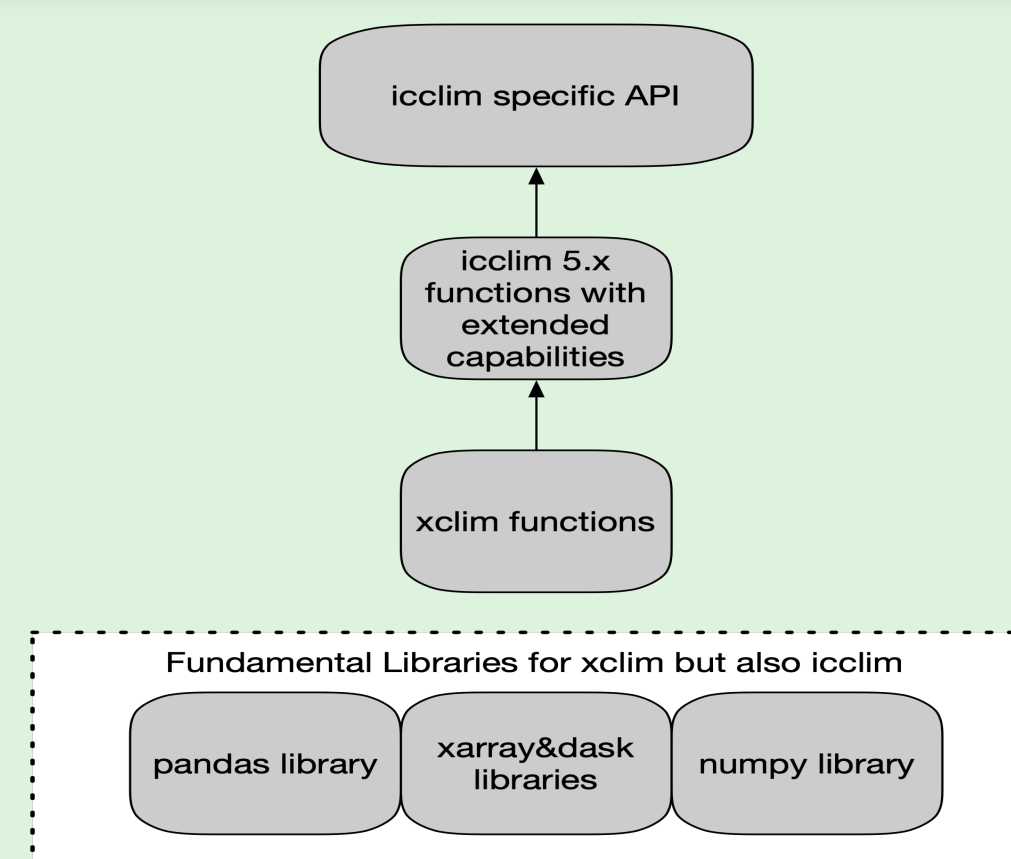
II icclim: Climate Indices

- Python code developed@CERFACS since 2013
- Performance optimized
- 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



IV icclim: Code Architecture

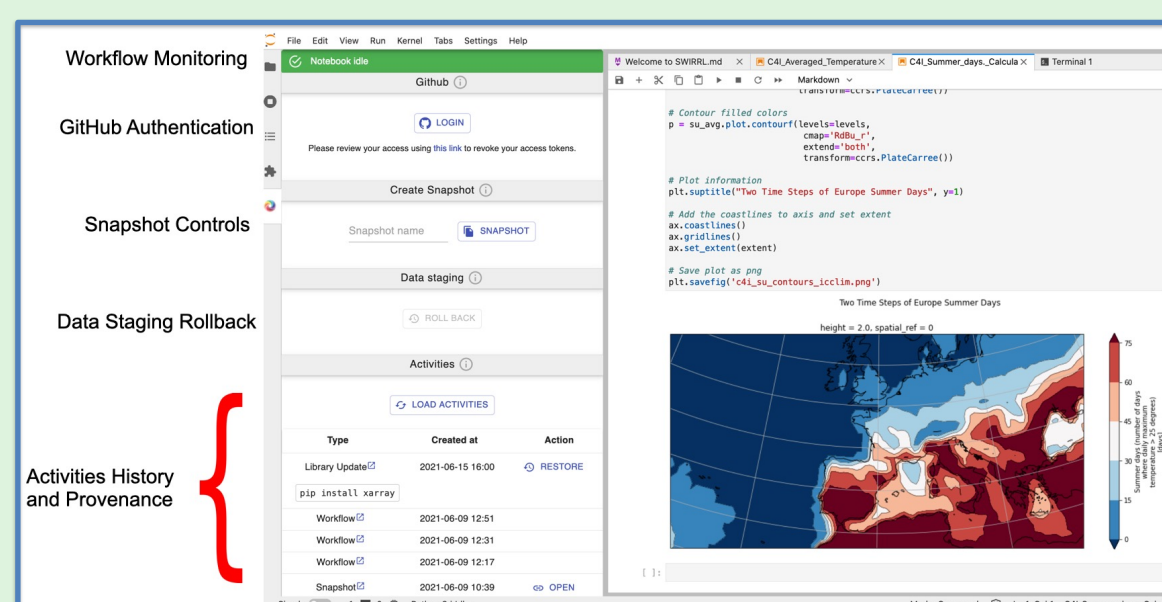
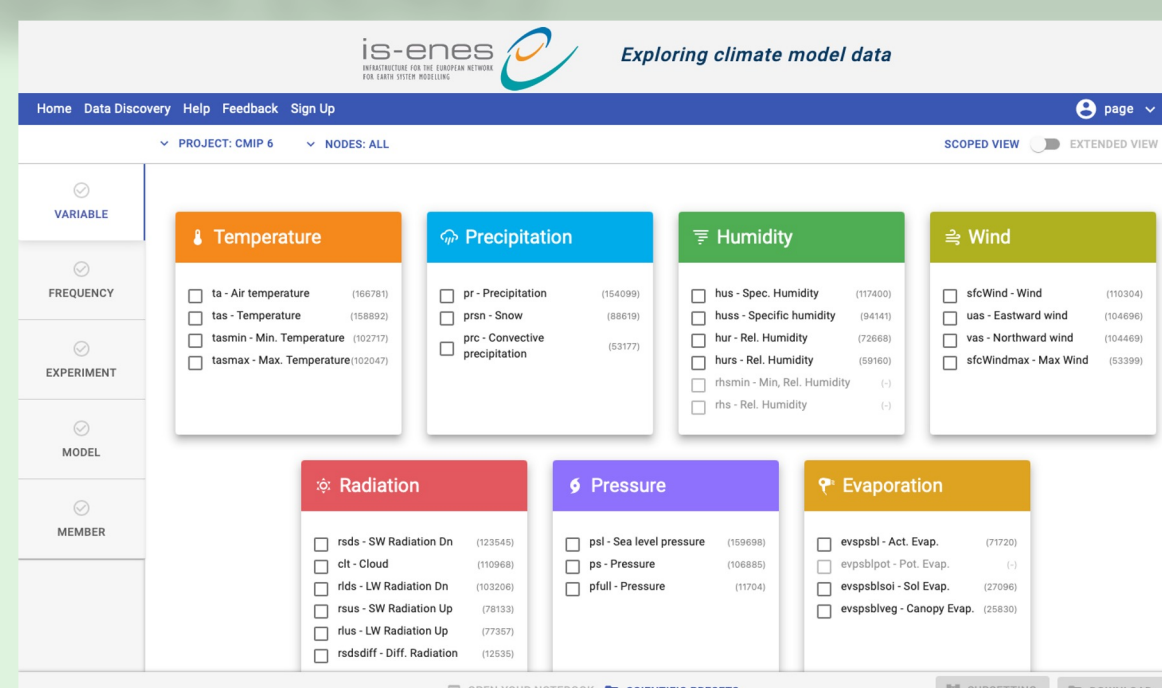
- Using many **xclim** climate indices functions as building blocks
- xclim functions are using **xarray**, **dask**, **pandas** and **numpy**: optimized and parallel execution
- icclim v5 implements a specific API very similar to v4
- Extended capabilities: user-defined indices, user-specific thresholds,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



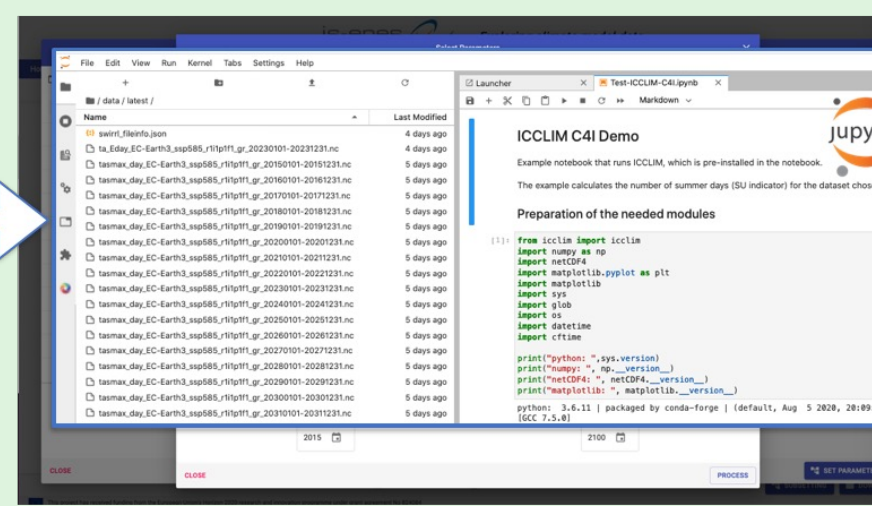
V Climate4Impact (C4I)

- Front-end to climate data infrastructure (ESGF)
- Tailored Search Interface with view modes
- Jupyter-Lab enhanced environment <https://gitlab.com/is-enes-cdi-c4i/notebooks>
- Notebooks gallery
- Flexible analysis features
- Climate indices calculation: icclim
- Personal store for processing outcome
- Pages for Models Performance Comparison (ESMValTool)
- Tailored Search Interface with independent facets
- Flexible analysis features (Notebooks with **icclim** - Data Staging/Reduction Workflows)
- Automated reproducibility mechanisms and documentation (Data/Analysis)

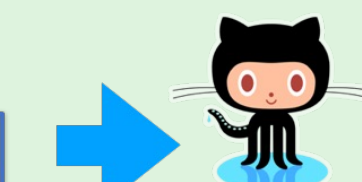
<https://dev.climate4impact.eu>



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



- Trace Changes to Restore, Recover Software and/or Data



Save/Share Progress to Git



Reduced Data MyBinder Reproduce

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. Creating pre-calculated standard indices datasets for CMIP6 is really a need
4. A web platform for easy and FAIR-enabled access to climate data, tools and actionable products is essential

VII In Progress

- Calculation of 49 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
- Production has started, goal is to make it accessible on C4I
- Implementation of the generic processing completed
 - Especially complex with indices requiring a reference period (percentiles for example)
 - Some inhomogeneity in model data needs had to be addressed
 - Need to choose the reference period: 1981-2010 (instead of 1991-2020) because of the historical period of CMIP6 (1850-2014)



Special thanks to the EGI-ACE and CMCC support!

