



I Impacts of Climate Change



2021 Germany Erfstadt, southwest of Cologne



2020 Hurricane Delta causes damage to Louisiana's Gulf Coast

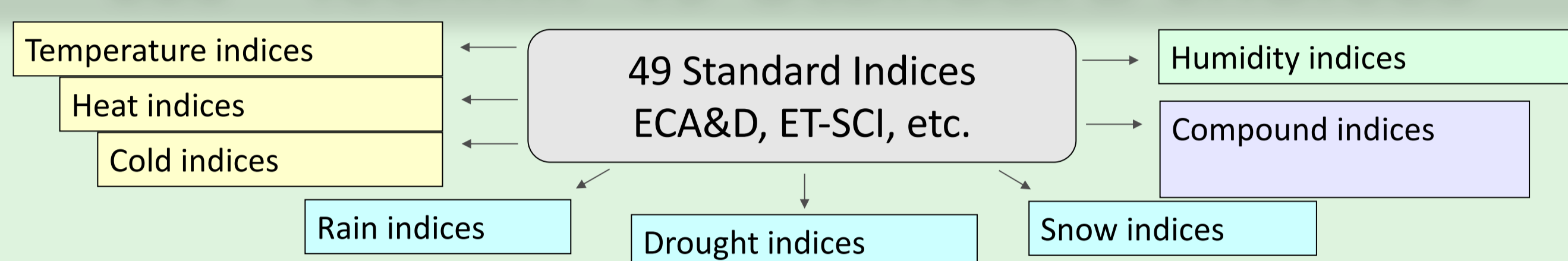
- Urgent needs of impact assessments
- Identify mitigation solutions
- Multiple domains: infrastructures, urban, agriculture, transportation, etc.
- Easy to use tools are needed for very diverse users
- **Climate indices and indicators are widely needed**

II icclim: Climate Indices

- Python code developed@CERFACS since 2013
- Performance optimized
- Fully compliant to CF and Metadata Standards
- **Validated** against climact & 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

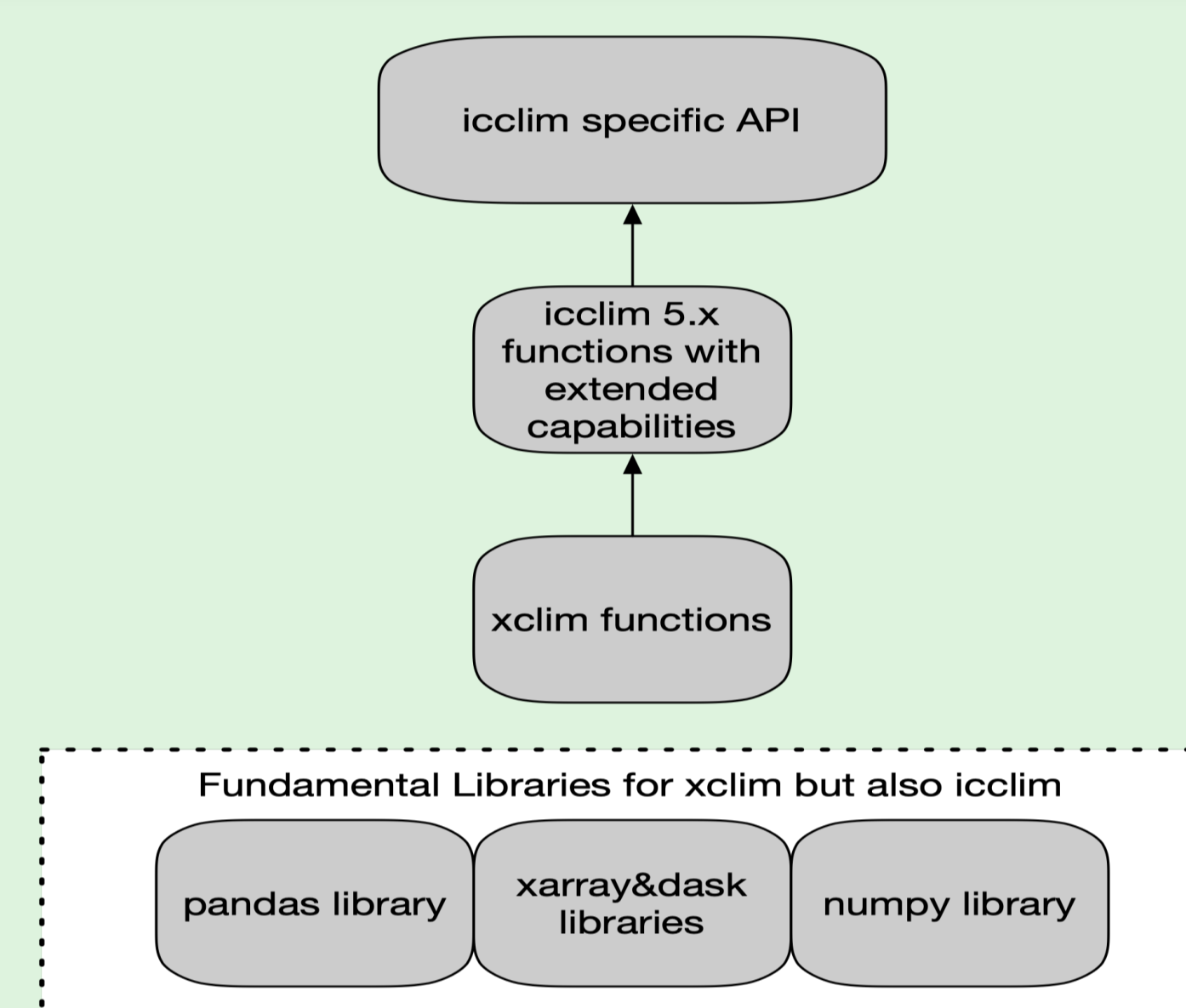


- Intra-period extreme temperature range [$^{\circ}$ C] - **ETR**
- Warm days (days with mean temperature > 90th percentile of daily mean temperature) - **TG90p**
- Summer days (days with max temperature $\geq 25^{\circ}$ C) - **SU**
- ...

```
>>> files = ['tasmax_day_CNRM-CM5_historical_r11p1_19950101-19991231.nc', 'tasmax_day_CNRM-CM5_historical_r11p1_20000101-20041231.nc', 'tasmax_day_CNRM-CM5_historical_r11p1_20050101-20051231.nc']
>>> dt1 = datetime.datetime(1998,1,1)
>>> dt2 = datetime.datetime(2005,12,31)
>>> out_f = 'SU_JJA_CNRM-CM5_historical_r11p1_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)
```

IV icclim: Code Architecture

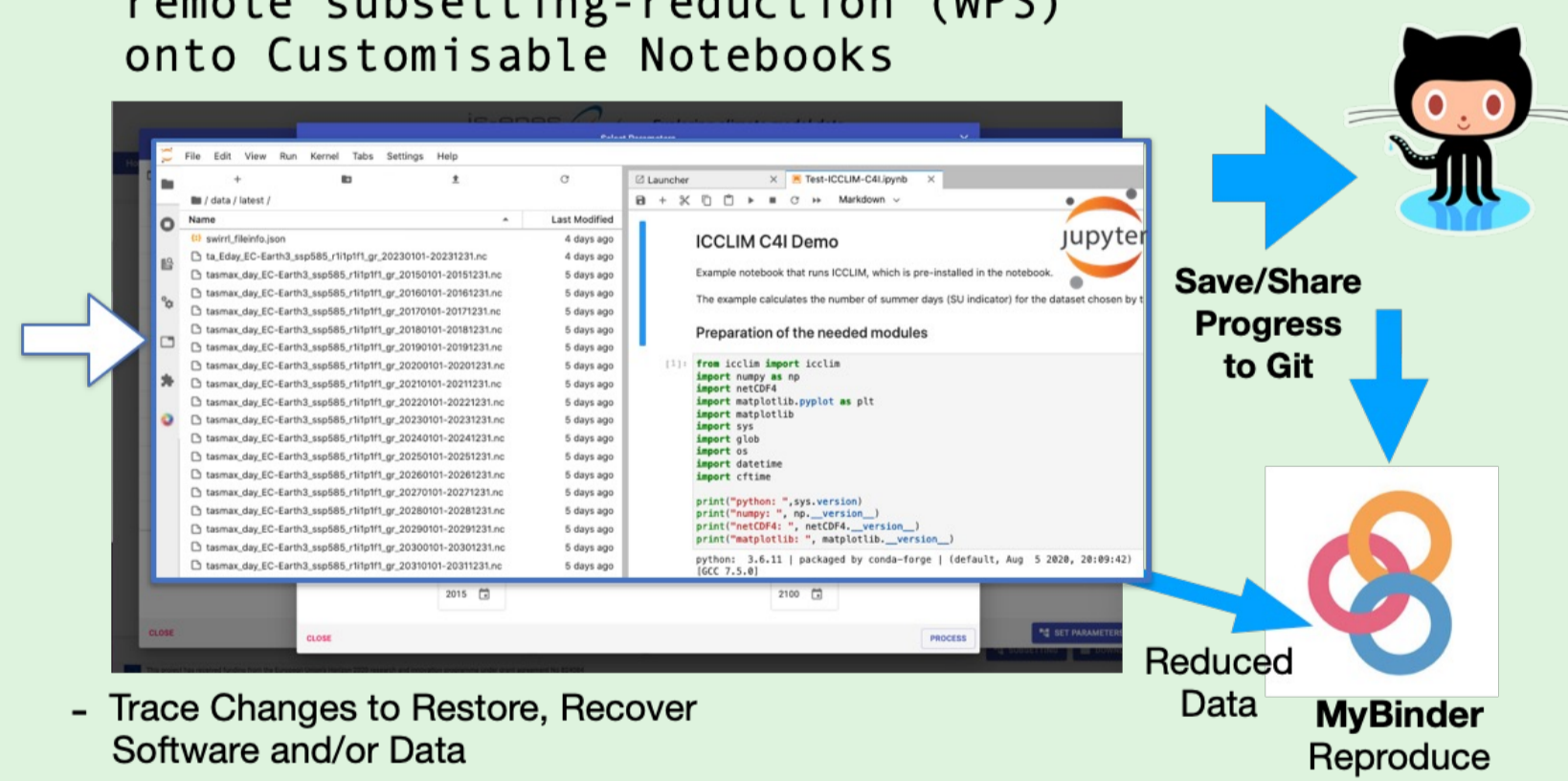
- Using many **xclim** climate indices functions as building blocks
- xclim functions are using **xarray, dask, pandas** and **numpy**: optimized and parallel execution
- icclim v5 implements a specific API very similar to v4
- Extended capabilities: user-defined indices, user-specific thresholds, etc.



V climate4impact (C4I)

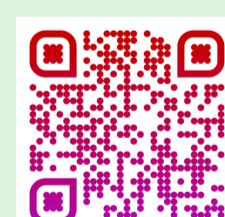
- Flexible analysis features (Notebooks with **icclim** - Data Staging/Reduction Workflows)
- Automated reproducibility mechanisms and documentation (Data/Analysis)

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



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

<https://dev.climate4impact.eu>



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. EGI-ACE through CMCC provides EOSC-based resources to generate large datasets for the climate research community**

VI EGI-ACE/EOSC Resources

- ENES Data Space resources provided by CMCC
- Computing close to storage with data locally available
- Jupyter-Lab interface
- ssh/terminal access too
- Large Data Science environment (16 cores, 16GB RAM)
- Several TB of storage for output
- Very fast and efficient tech support



VII Work Plan

- Summer Days (SU) index already processed
- Implementation of the generic processing script in progress
 - Especially complex with indices requiring a reference period (percentiles for example)
 - Some inhomogeneity in model data needs to be addressed
 - Need to choose the reference period: 1991-2020



Special thanks to the EGI-ACE and CMCC support!

