An Interactive Platform for Climate Analysis using a Climate Indices Tool

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Climate Data Distribution through the ESGF

ESGF represents a multinational effort to securely **access**, **monitor**, **catalog**, **transport**, and **distribute** reference **data** for **climate** research experiments and observations.

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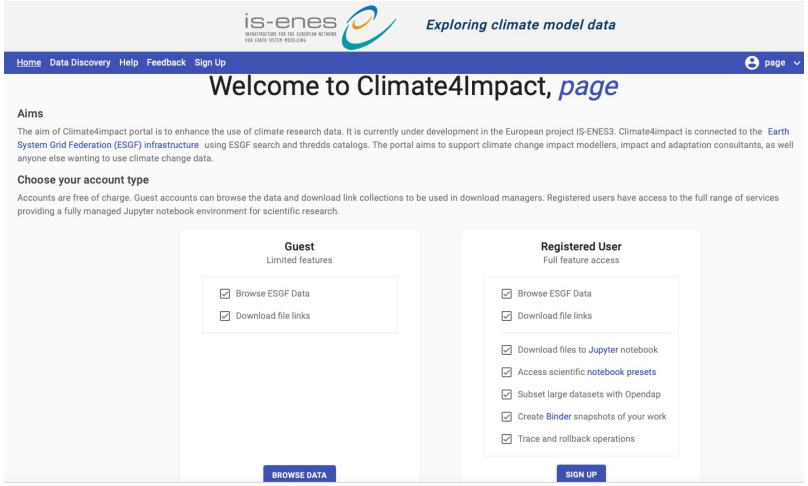
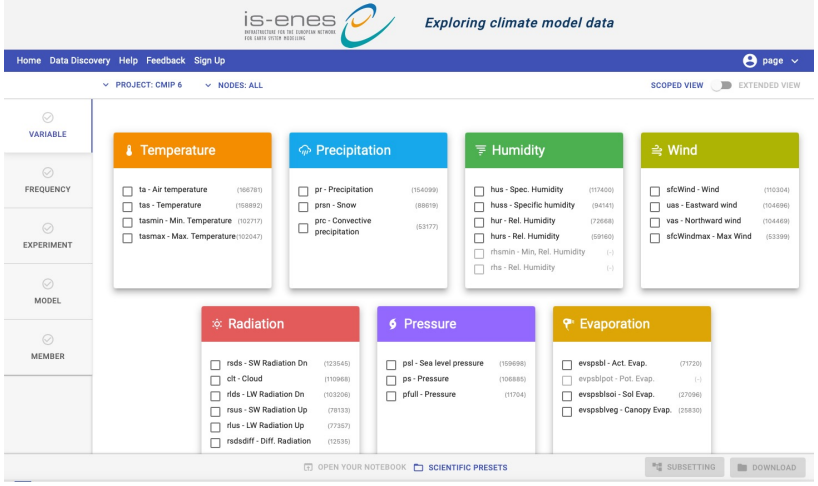
What is the climate4impact portal?

- Platform for researchers to explore climate data and perform analysis
- Connects to ESGF web services
  - ESGF Search and Drill Down
  - CMIP6, CMIP5, CORDEX (soon)
- Jupyter-Lab enhanced environment with SWIRRL
  - Ready-made Jupyter Notebooks
  - Step-by-step instructions with documentation
- Analysis using ICCLIM to perform climate indices calculations
  - Personal store for processing outcomes
- Alpha version available at https://dev.climate4impact.eu
  - A call for Beta testers will be out soon





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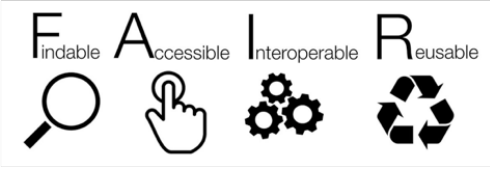
V2: Complete Redesign from current V1

- **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**

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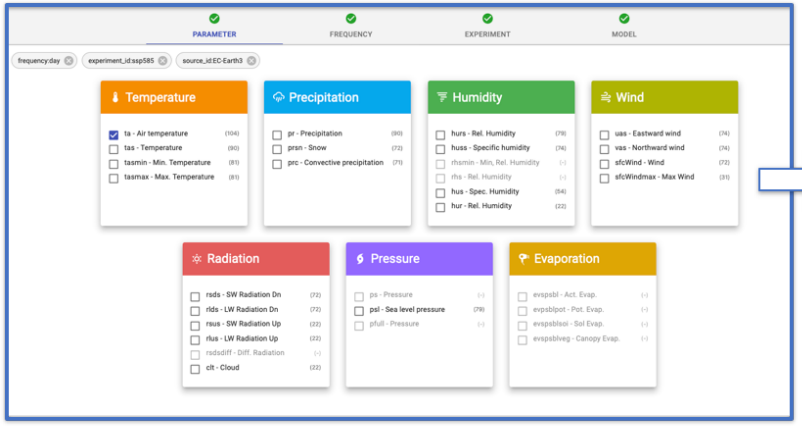
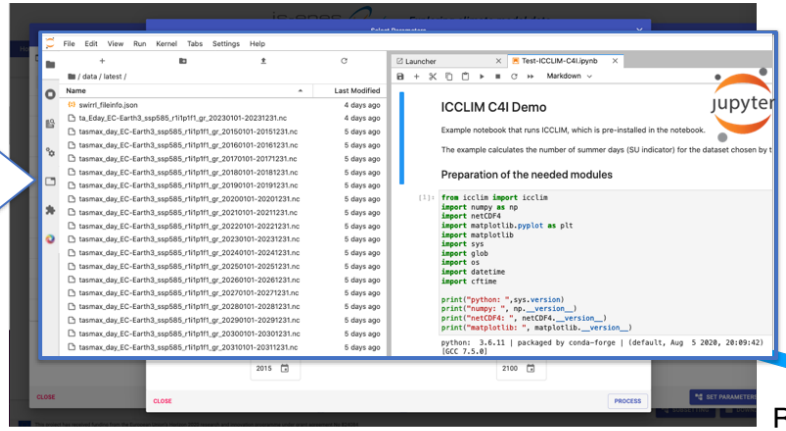
Climate4Impact (v2) Workflows & Workspaces

Climate4Impact Search for CMIP5/6 CORDEX Data (Distributed Data)
https://dev.climate4impact.eu



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



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

W3C PROV

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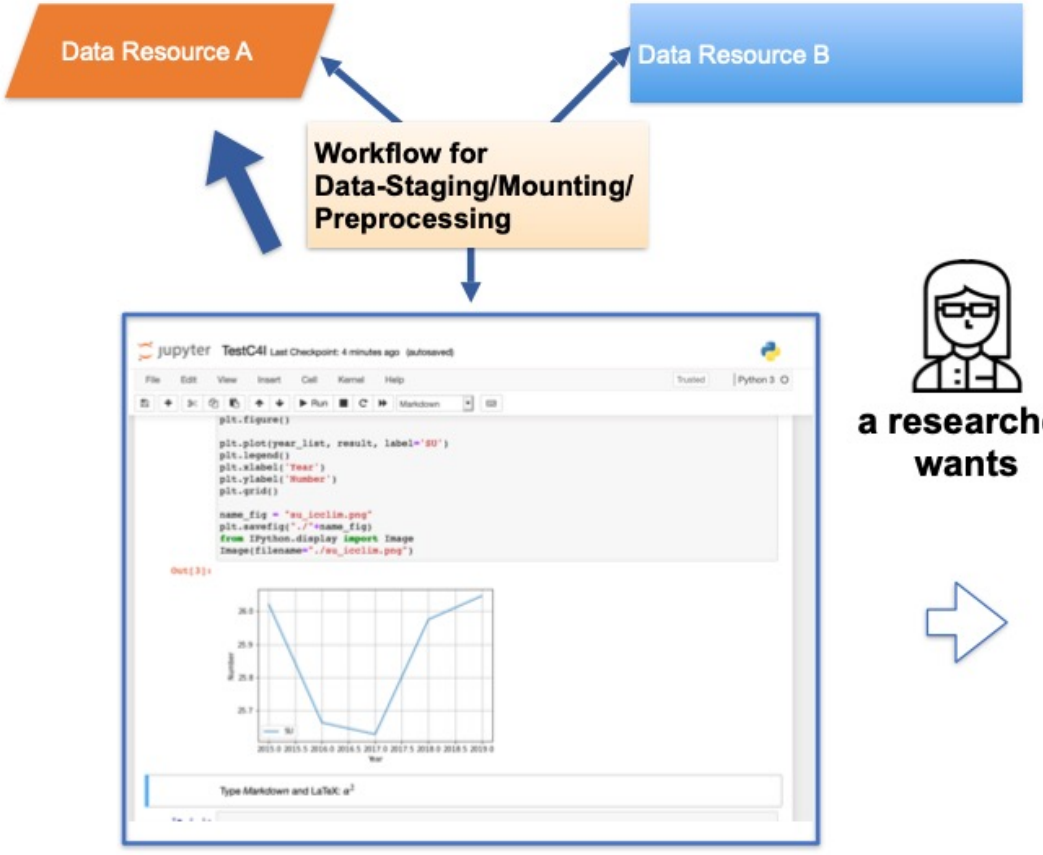
C4I Workspace Use Case



a researcher wants

- **access distributed raw data**
- **develop, document and reuse** methods for processing and visualisation.
- **update/extend** raw data and software
- **Track changes and rollback** (Traceability/Recovery)
- **keep old versions of the data** after updates (Reproducibility)
- **snapshot and restore** the state of a workspace software (Reproducibility)

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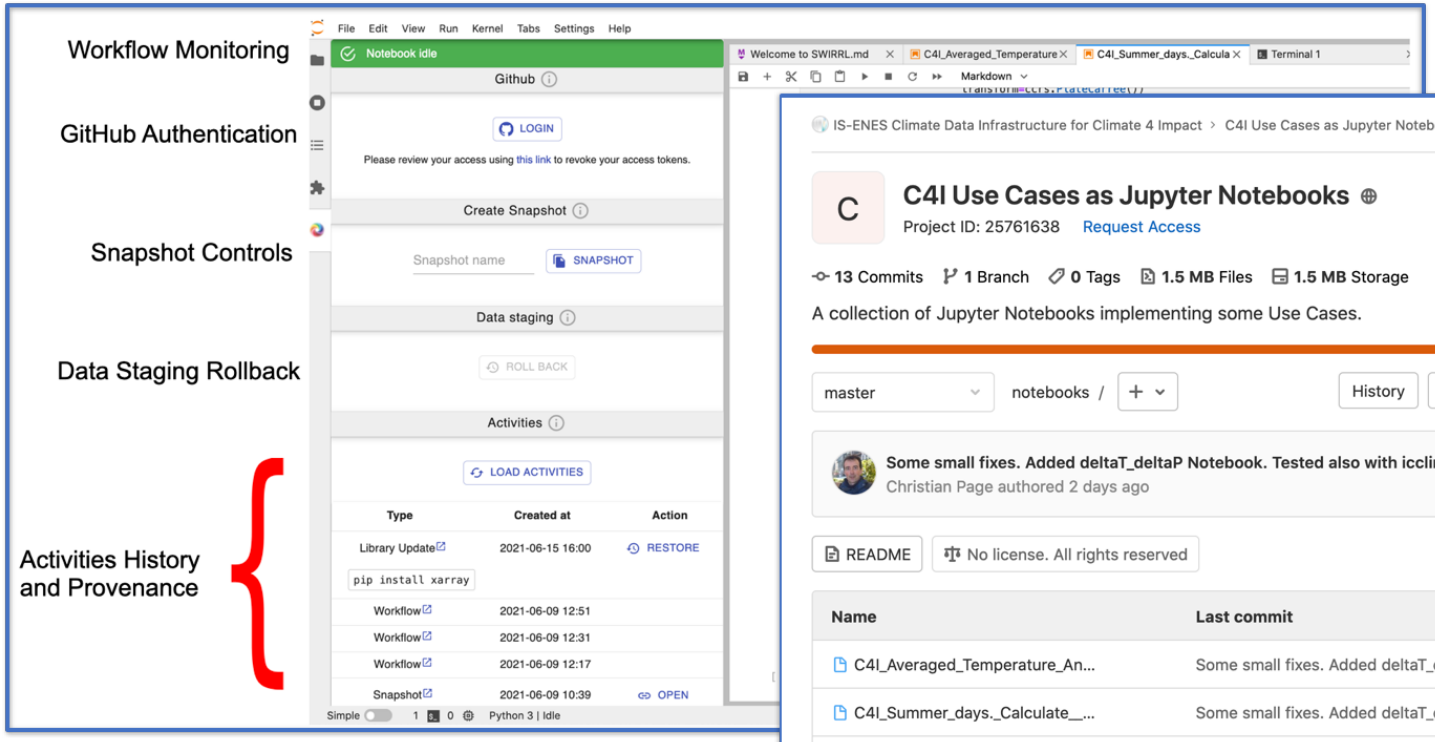
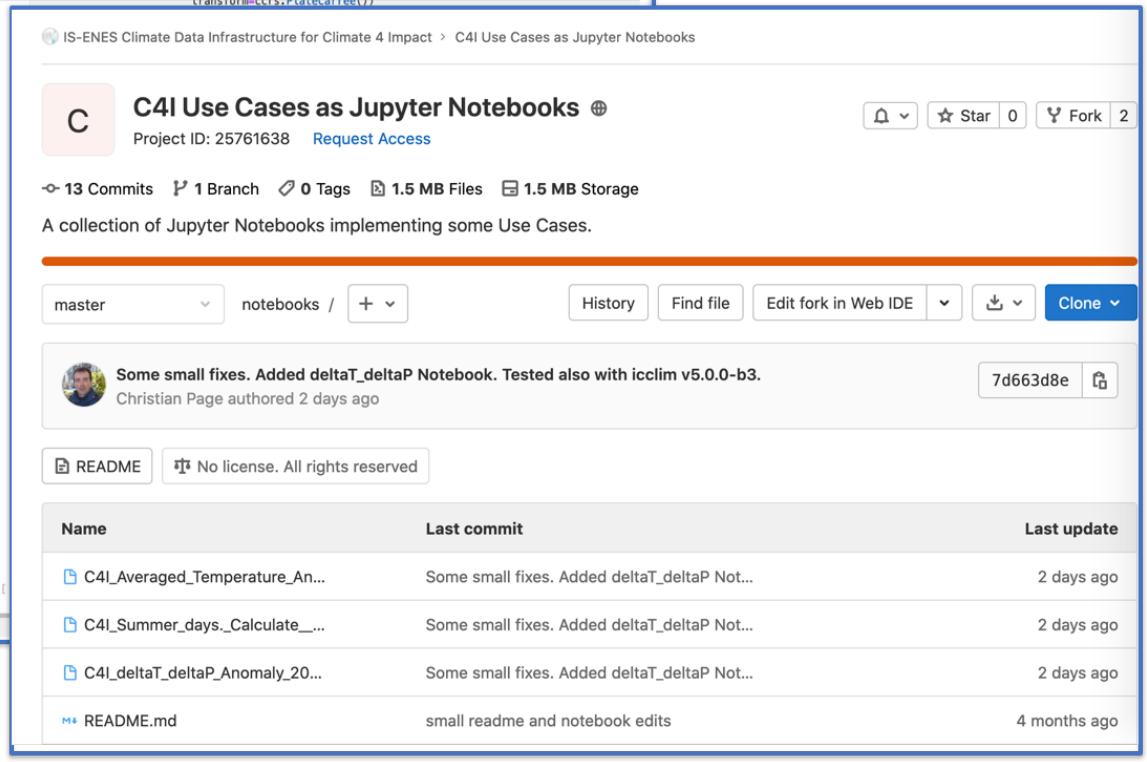
SWIRRL JupyterLab Extension and Sample Notebooks based on ICCLIM





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

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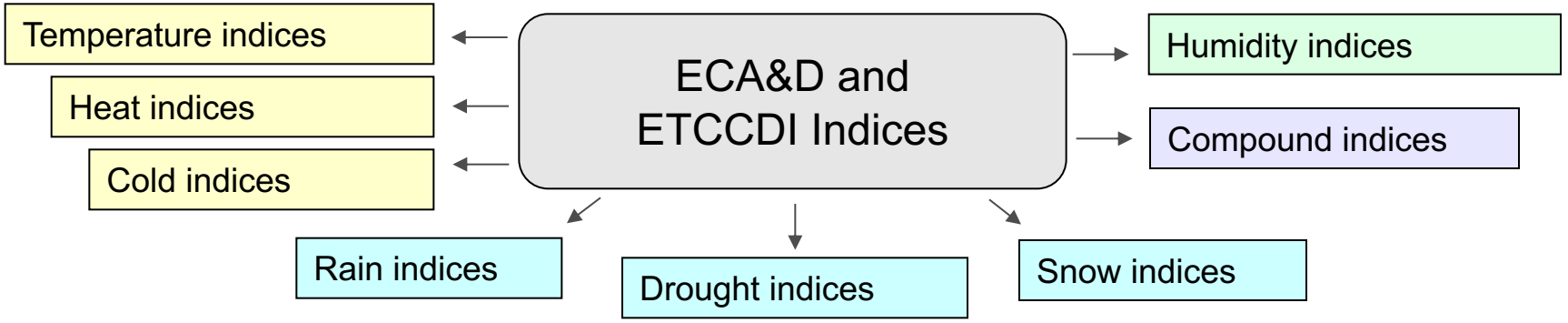
On-demand calculations

Climate indices calculation in climate4impact: **icclim**



- 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 at Cerfacs since September 2013
- Funded by EU FP7 IS-ENES2, FP7 CLIPC and H2020 IS-ENES3
  - Generic and modular approach, can be reused in other environments
  - New V5 completely rewritten and using underlying xclim functions, based on xarrays and dask
  - I/O interface is structured for optimal performance
  - Implement the proper percentile indices calculations when calculation period overlaps reference period (called bootstrapping method)

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icclim: climate indices

Documentation: https://icclim.readthedocs.io/en/latest/python_api.html

Source code: https://github.com/cerfacs-globc/icclim

Current Version 4.2.20: https://github.com/cerfacs-globc/icclim/releases/tag/4.2.20

Soon to be released 5.0.0 (within the next few weeks, now at 5.0.0-b5)

`icclim.indice()` - Compute indice

This is the main function to compute an indice:

`icclim.icclim.`**`indice`**(*in_files, var_name, indice_name=None, slice_mode='year', time_range=None, out_file='./icclim_out.nc', threshold=None, N_lev=None, lev_dim_pos=1, transfer_limit_Mbytes=None, callback=None, callback_percentage_start_value=0, callback_percentage_total=100, base_period_time_range=None, window_width=5, only_leap_years=False, ignore_Feb29th=False, interpolation='linear', out_unit='days', netcdf_version='NETCDF3_CLASSIC', user_indice=None, save_percentile=False*)

Indice	Source variable
TG, GD4, HD17, TG10p, TG90p	daily mean temperature
TN, TNx, TNn, TR, FD, CFD, TN10p, TN90p, CSDI	daily minimum temperature
TX, TXx, TXn, SU, CSU, ID, TX10p, TX90p, WSDI	daily maximum temperature
DTR, ETR, vDTR	daily maximum + daily minimum temperature
PRCPTOT, RR1, SDII, CWD, CDD, R10mm, R20mm, RX1day, RX5day, R75p, R75pTOT, R95p, R95pTOT, R99p, R99pTOT	daily precipitation flux (liquide phase)
SD, SD1, SD5cm, SD50cm	daily snowfall flux (solid phase)
CD, CW, WD, WW	daily mean temperature + daily precipitation flux (liquide phase)

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ICCLIM C4I: Calculate the percentage of days when Tmax > 90th percentil (TX90p)

Example notebook that runs ICCLIM, which is pre-installed in the notebook.

The example calculates the percentage of days when Tmax > 90th percentil (TX90p indicator) for the dataset chosen by the user on C4I.

The data is read using xarray and a plot of the time series over a specific region is generated, as well as an average spatial map. Several output types examples are shown.

The dataset that is expected for this notebook are tasmax parameter (needed to calculate the TX90p indicator) for one specific climate model and experiment as well as one member. The time period should be continuous.

The following time period is considered: 2081-01-01 to 2100-12-31 using the period 1981-01-01 to 2000-12-31 as a reference. Plots are shown over European region.

Preparation of the needed modules

[1]:
```
import icclim

import sys
import glob
import os
import datetime
import cftime

import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import cartopy.crs as ccrs

print("python: ",sys.version)
print("numpy: ", np.__version__)
print("pandas: ", pd.__version__)
```

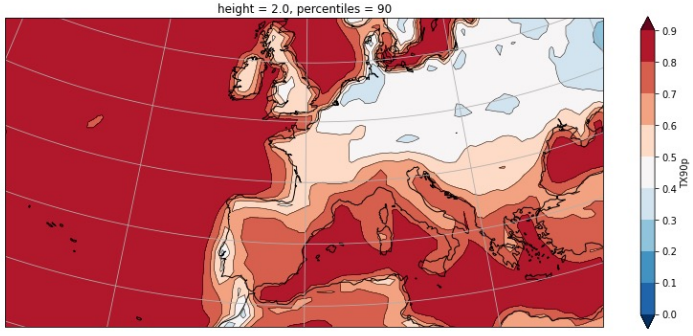
Specification of the parameters and period of interest

[2]:
```
# studied period
dt1 = datetime.datetime(2081,1,1)
dt2 = datetime.datetime(2100,12,31)

# reference period
dt1r = datetime.datetime(1981,1,1)
dt2r = datetime.datetime(2000,12,31)

out_f = 'tx90p_icclim.nc'
filenames = glob.glob('./data/latest/tasmax_day*.nc')

icclim.indice(indice_name='TX90p', in_files=filenames, var_name='tasmax', slice_mode='JJA', base_period_time_range=[dt1r, dt2r], t
```

```
2021-10-15 07:34:45,151    ********************************************************************************
2021-10-15 07:34:45,151    *                                                                              *
2021-10-15 07:34:45,152    *          Icclim               V5.0.0b5      *                                *
                                                                                                        *
                                                                                                        *
           Fri Oct 15 07:34:45 2021 GMT                                                                 *
                                                                                                        *
           BEGIN EXECUTION                                                                              *
                                                                                                        *
********************************************************************************
sing: 0%
ating climate indice: TX90p
climv5/lib/python3.8/site-packages/xclim/core/cfchecks.py:39: UserWarning: Variable has a non-confor
mean time: maximum`, expected `['time: maximum*']`

sing: 100%
********************************************************************************
                                                                                                        *
           Icclim               V5.0.0b5      *                                                        *
                                                                                                        *
                                                                                                        *
           Fri Oct 15 07:46:59 2021 GMT                                                                 *
                                                                                                        *
           END EXECUTION                                                                                *
                                                                                                        *
           CP SECS = 134.418                                                                            *
                                                                                                        *
```

```
p = tx90_avg.plot.contour(levels=levels,
                          colors='k',
                          linewidths=0.5,
                          transform=ccrs.PlateCarree())

# Contour filled colors
p = tx90_avg.plot.contourf(levels=levels,
                           cmap='RdBu_r',
                           extend='both',
                           transform=ccrs.PlateCarree())

# Plot information
plt.suptitle("Percentage of days when Tmax > 90th percentil Period 2081-2100 Reference 1981-2000 TX90P", y=1)

# Add the coastlines to axis and set extent
ax.coastlines()
ax.gridlines()
ax.set_extent(extent)

# Save plot as png
plt.savefig('c4i_tx90p_contours_icclim.png')
```

Percentage of days when Tmax > 90th percentil Period 2081-2100 Reference 1981-2000 TX90P



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Thanks !

On behalf of the climate4impact and icclim teams

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THE CONSORTIUM

Coordinated by **CNRS-IPSL**, the IS-ENES3 project gathers **22 partners** in **11 countries**

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