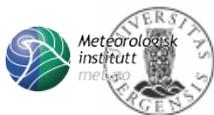


icclim: A climate indices Open-Source python package C4I Integration

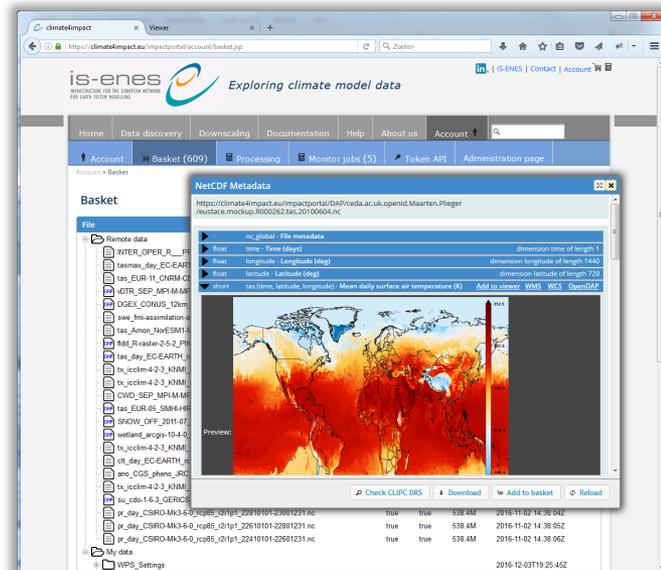
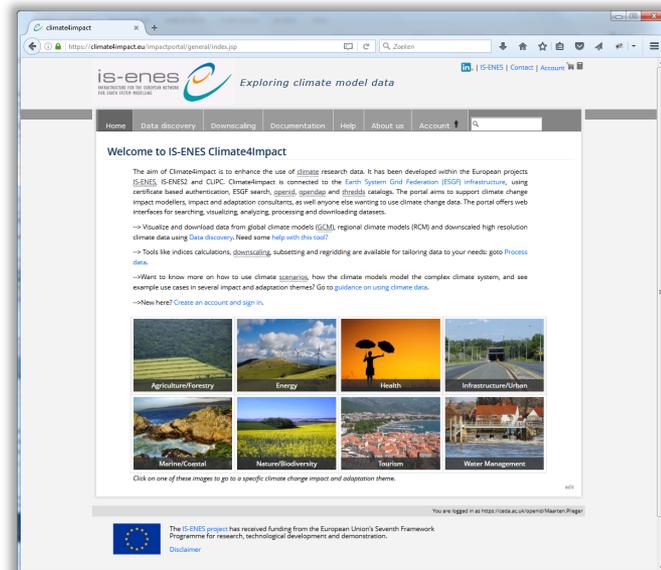
Christian Pagé

CERFACS, Toulouse, France



What is the climate4impact portal?

- Platform for researchers to explore climate data and perform analysis
- Connects to ESGF web services
 - ESGF search, THREDDS support, Security
 - CMIP6, CMIP5, CORDEX, other MIPS
- Visualization via ADAGUC
 - Web Map Services for visualization
 - Web Coverage Services for data transformation
- Analysis using PyWPS to perform calculations
 - ICCLIM climate indices calculation, data reduction
 - Personal store for processing outcomes
- Upload and store your own data
 - Visualize your own data online
 - Process your own data online



Web based faceted search for any (climate) data via ESGF

- Drill down search results
- Tooltips for acronyms
- Quick select menus
- ES-DOC integration
- Preview of data
- Export search list to CSV

The screenshot displays the is-enes web application interface. At the top, there is a search bar and navigation links for Home, Data discovery, Downscaling, Documentation, Help, About us, and Account. Below the navigation is a search bar and a 'Filters' section. The 'Filters' section shows a 'Quick select Parameter' menu with categories: Temperature, Precipitation, Humidity, Wind, Radiation, Pressure, and Evaporation. Each category has a list of parameters with checkboxes. Below the filters, there is a 'Selected filters' section showing 'none'. A message indicates 'Found 672402 datasets. Displaying page 1 of 26897.' Below this is a pagination control and an 'Export to CSV' button. The bottom of the page shows a list of search results, each with a play button icon and a file name, followed by an 'es-doc' logo.

Web processing interface for controlling your processes

- Generated user interface
- Lightweight
- Links to preview
- Links to basket / cart
- jQuery based...

The screenshot shows the climate4impact web interface. The main content area displays the details for a processor named "CLIPC Create statistics per NUTS region Execute". Below this, the "Processing inputs" section shows a file named "File A (input1)" with the type "application/netcdf".

title identifier

File A (input1)
application/netcdf

http://opendap.knmi.nl/knmi/thredds/dodsC/CLIPC/storyline_urbanheat/geojson/NUTS_2010_L0.geojson.nc

abstract value

What is the climate4impact portal? - Processing

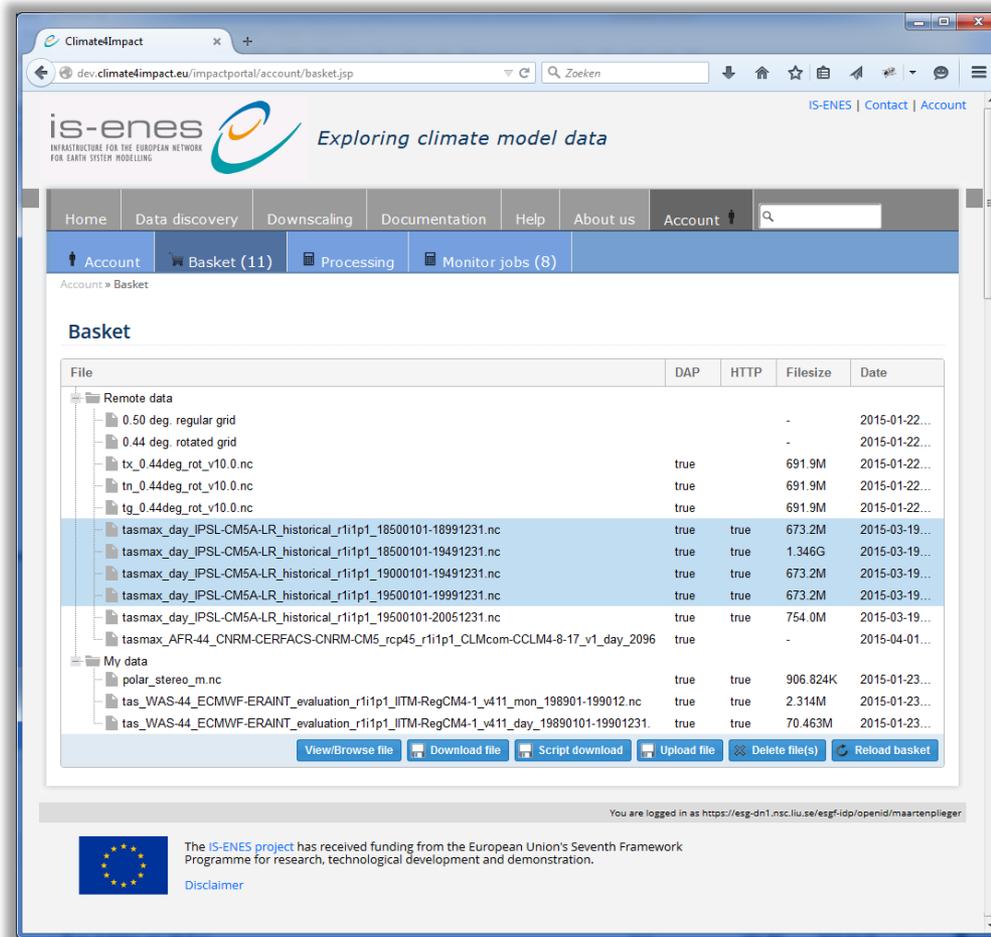
basket

preview

delete

Personal basket

- By default the basket contains:
 - “Remote data” for links
 - “My data” for your own data
- Script based download allows to select and download multiple files
- The basket allows for uploading your own files
 - Can be used in processing or visualization
 - NetCDF, CSV, GeoJSON
- Share your data located in your basket with others

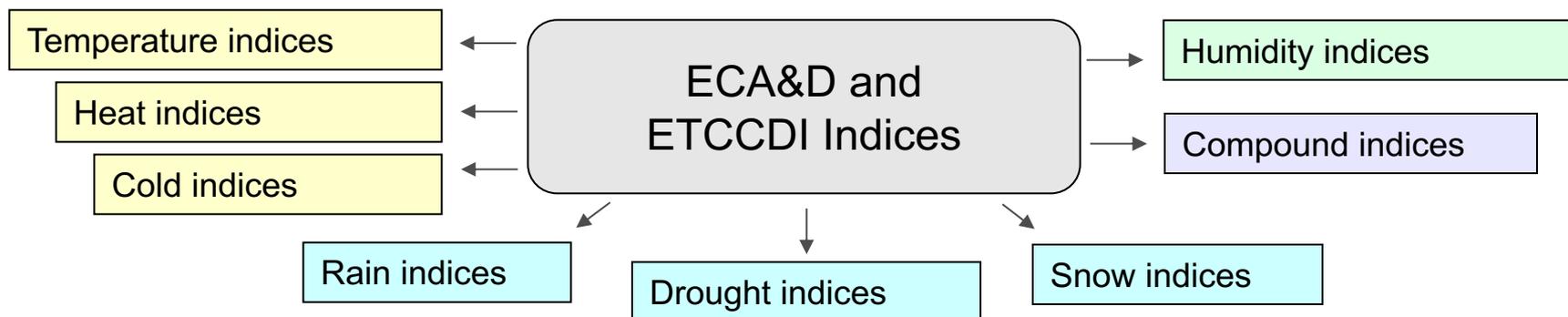


The screenshot shows the 'Basket (11)' interface with the following table of files:

File	DAP	HTTP	Filesize	Date
Remote data				
0.50 deg. regular grid			-	2015-01-22...
0.44 deg. rotated grid			-	2015-01-22...
tx_0.44deg_rot_v10.0.nc	true		691.9M	2015-01-22...
tn_0.44deg_rot_v10.0.nc	true		691.9M	2015-01-22...
tg_0.44deg_rot_v10.0.nc	true		691.9M	2015-01-22...
tasmax_day_IPSL-CM5A-LR_historical_r1i1p1_18500101-18991231.nc	true	true	673.2M	2015-03-19...
tasmax_day_IPSL-CM5A-LR_historical_r1i1p1_18500101-19491231.nc	true	true	1.346G	2015-03-19...
tasmax_day_IPSL-CM5A-LR_historical_r1i1p1_19000101-19491231.nc	true	true	673.2M	2015-03-19...
tasmax_day_IPSL-CM5A-LR_historical_r1i1p1_19500101-19991231.nc	true	true	673.2M	2015-03-19...
tasmax_day_IPSL-CM5A-LR_historical_r1i1p1_19500101-20051231.nc	true	true	754.0M	2015-03-19...
tasmax_AFR44_CNRM-CERFACS-CNRM-CM5_rcp45_r1i1p1_CLMcom-CCLM4-8-17_v1_day_2096	true		-	2015-04-01...
My data				
polar_stereo_m.nc	true	true	906.824K	2015-01-23...
tas_WAS-44_ECMWF-ERAINT_evaluation_r1i1p1_IITM-RegCM4-1_v411_mon_198901-199012.nc	true	true	2.314M	2015-01-23...
tas_WAS-44_ECMWF-ERAINT_evaluation_r1i1p1_IITM-RegCM4-1_v411_day_19890101-19901231.nc	true	true	70.463M	2015-01-23...

On-demand calculations

Climate indices calculation in climate4impact: **icclim**



- 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 > 25° C) - **SU**
- ...

- Python code developed at Cerfacs since September 2013 (EU FP7 IS-ENES2)
 - Generic and modular approach, can be reused in other environments
 - C functions called for optimization
- I/O interface is structured for optimal performance, with wrapper functions and dynamic chunking
- Implement the proper percentile indices calculations when calculation period overlaps reference period (called bootstrapping method)

icclim: climate indices

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

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

Current Version 4.2.14: <https://github.com/cerfacs-globc/icclim/releases/tag/4.2.14>

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)

Account » Processing

Processing wizards

Choose a wizard to help you guide through processing, analysis and data extraction options.

Name	Description
Convert and subset	Extracts a region in space and time, regrid and converts to other formats. Uses the WCS_subsetting WPS in the background.
CLIPC DRS Checker	Checks files against the CLIPC DRS metadata standard.
ICCLIM simple climate indicator calculation	Calculates simple climate indices with ICCLIM.
ICCLIM Time averaging	Computes time averages for any parameter by month, year of various seasons using ICCLIM.
Combine two fields	Performs operation like normalisation and raster arithmetic on two nc files and return the answer as a new file
Polygon overlay	Polygon overlay function to calculate statistics for a gridded file by extracting geographical areas defined in a GeoJSON file. The statistics per geographical area include minimum, maximum, mean and standard deviation. The statistics are presented in a CSV table and a NetCDF file. Statistics can be calculated for several dates at once.

[WPSClient](#)

You are logged in as <https://ceda.ac.uk/openId/Page.Christian>



The [ENES3 project](#) has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824084.

[Disclaimer](#)



Account » Processing

Web Processing Services

Web processing services are processing services used by the wizard but can be controlled manually.

Select a WPS:

Service:

Name	Abstract
Polygon overlay	Polygon overlay function to calculate statistics for a gridded file by extracting geographical areas defined in a GeoJSON file. The statistics per geographical area include minimum, maximum, mean and standard deviation. The statistics are presented in a CSV table and a NetCDF file. Statistics can be calculated for several dates at once.
CLIPC Create statistics per NUTS region Identify	Identify process for statistics per NUTS region calculations
CLIPC Create statistics per NUTS region Execute	The NUTS extractor calculates statistics for any NetCDF file by extracting geographical areas defined in a GeoJSON file. The statistics per geographical area include minimum, maximum, mean and standard deviation. The statistics are presented in a CSV table and a NetCDF file.
CLIPC Combine Identify	Lists possible operations for two resources for the CLIPC Combine processor.
CLIPC Combine Execute	Performs operation on two nc files and returns the answer as nc file
CLIPC ICCLIM simple indicator calculator Identify	Identify function for ICCLIM simple indicator calculator
CLIPC ICCLIM simple indicator calculator Execute	Using ICCLIM, single input indices of temperature TG, TX, TN, TXx, TXn, TNx, TNn, SU, TR, CSU, GD4, FD, CFD, ID, HD17; of rainfall: CDD, CWD, RR, RR1, SDII, R10mm, R20mm, RX1day, RX5day; and of snowfall: SD, SD1, SD5, SD50 can be computed.
CLIPC DRS Checker	Checks file for correct DRS
SimpleIndices	Computes single input indices of temperature TG, TX, TN, TXx, TXn, TNx, TNn, SU, TR, CSU, GD4, FD, CDD, CWD, RR, RR1, SDII, R10mm, R20mm, RX1day, RX5day; and of snowfall: SD, SD1, SD5, SD50

use

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Account » Processing

Web Processing Services

Web processing services are processing services are used by the wizard but can be controlled manually.

Select a WPS Service:

Name	Abstract
SimpleIndices Cached	Computes single input indices of temperature TG, TX, TN, TXx, TXn, TNx, TNn, SU, TR, CSU, GD4, FD, CFD, ID, HD17; of rainfall: CDD, CWD, RR, RR1, SDII, R10mm, R20mm, RX1day, RX5day; and of snowfall: SD, SD1, SD5, SD50.
RangeIndices	Computes temperature range indices: ETR, DTR, DTRv.
PercentileIndices	Computes single input, percentile based indices of temperature: TG10p, TX10p, TN10p, TG90p, TX90p, TN90p, WSDI, CSDI; and of rainfall R75p, R95p, R99p, R75TOT, R95TOT, R99TOT.
RainTemperatureIndices	Computes dual input indices of rain and temperature: CD, CW, WD, WW.
SpatialSelection	Spatial extraction/subsetting.
TimeAveraging	Computes time averages for any parameter by month, year of various seasons.
AnomalyCalculation	Calculates an anomaly of a variable: average of a long period compared to a base reference period (e.g. 2071-2100 compared to 1971-2000 for example).
Perform operation on two numbers	Performs operation on two numbers and returns the answer
Perform operation on two numbers 10 seconds	Performs operation on two numbers and returns the answer, updates every second its status for 10 seconds.
CLIPC Advanced Combine	KNMI WPS Process: CLIPC Advanced combine two inputs into a single netCDF. The combine function provides a visual exploration tool for dataset pairs. Any two datasets can be resized via a single

use

You are logged in as <https://ceda.ac.uk/openid/Page.Christian>



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Example use case with Climate4Impact - Search

- Calculate number of days where maximum temperature is above 25 degrees per European country, based on experiment RCP 2.6 and model MIROC5

- Go to C4I and sign in
- Go to Search and select:

1. Model: CMIP5
2. Parameter: tasmx
3. Time frequency: daily
4. Experiment: rcp26
5. Model: MIROC5,
6. Ensemble: r1i1p1
7. Select the latest version

- Select a file from the dataset and add it to your basket

The screenshot displays the Climate4Impact search interface. At the top, there is a navigation bar with links for Home, Data discovery, Downscaling, Documentation, Help, About us, and Account. Below this is a search bar and a secondary navigation bar with links for Search, Catalogs, Explore your own catalogs or files, Map & Plot, and Processing.

The main search area is titled "Filters" and includes a "Help" icon. It shows a summary of filters: Project (1), Parameter (30), Frequency (1), Experiment (1), Model (1), Access (3), Date, Geobox, and Free text. There are buttons for "show all filters" and "clear all filters".

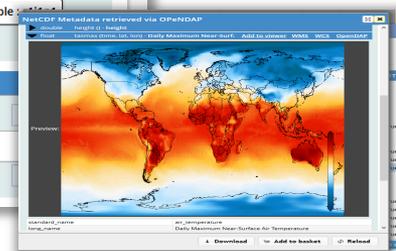
Below the filter summary, there are several "Quick select Parameter" panels for different categories:

- Temperature:** Includes checkboxes for Temperature (tas), Min. Temperature (tasmin), Max. Temperature (checked), and Air Temperature (ta).
- Precipitation:** Includes checkboxes for Precip. (pr), Conv. Precip. (prc), and Snow (prsn).
- Humidity:** Includes checkboxes for Specific Humidity (huss), Rel. Humidity (hurs), Max. Rel. Humidity, Min. Rel. Humidity (rhsm), Rel. Humidity (rhs), Spec. Humidity (hus), and Rel. Humidity (hur).
- Wind:** Includes checkboxes for Wind (sfcWind), Max. Wind (sfcWindmax), E. Wind (uas), and N. Wind (vas).
- Radiation:** Includes checkboxes for SW Radiation Dn (rsds), SW Radiation Up (rsus), LW Radiation Dn (rls), LW Radiation Up (rlus), Diff. Radiation Dn (rdsd), and Clouds (clt).
- Pressure:** Includes checkboxes for Pressure (ps), SL Pressure (psl), and Pressure (pfull).
- Evaporation:** Includes checkboxes for Act. Evap. (evspsbl), Pot. Evap. (evspsblpot), Soil Evap. (evspsblsol), and Canopy Evap. (evspsblveg).

Below the parameter panels, there is a "Selected filters" section showing:

- Project: CMIP5
- Parameter: tasmx
- Frequency: day
- Experiment: rcp26
- Model: MIROC5
- Ensemble: r1i1p1
- Version: 20161012

The search results section shows "Found 1 datasets. Displaying page 1 of 1." with navigation buttons for "Previous" and "Next". A single dataset is listed: "cmip5.output1.MIROC.MIROC5.rcp26.day.atmos.day.r1i1p1.v20161012".



Example use case with Climate4Impact - Calculate SU

- Go to Processing and select ICCLIM simple indicator calculations
- Select SU, Summer days. Leave the threshold to 25 degrees Celsius
- Select the file from your basket and click “Start processing”
- Inspect the output

Processor CLIPIC ICCLIM simple indicator calculator Execute

Title: CLIPIC ICCLIM simple indicator calculator Execute

Identifier: clipc_simpleindicator_execute

Abstract: Using ICCLIM, single input indices of temperature TG, TX, TN, TXn, TNn, TNn, SU, TN, CSU, GD4, FD, CFD, ID, HD17: of rainfall: CDD, CWD, RR, RR1, SD14, R10mm, R20mm, R11day, R15day; and of snowfall: SD, SD1, S05, S050 can be computed.

Location: https://climate4impact.eu/impactportal/WPS?service=WPS&version=1.0.0&request=describe&process=identifier=clipc_simpleindicator_execute

Processing succeeded! Showing report:

Identifier	Title	Type	MimeType	Value
opendapURL	opendapURL	integer		https://climate4impact.eu/impactportal/DAF/veda.ac.uk/openid/Maarten.Piingler/WPS_Scratch/WPS_clipc_simpleindicator_execute_201904041124422/output.tiff

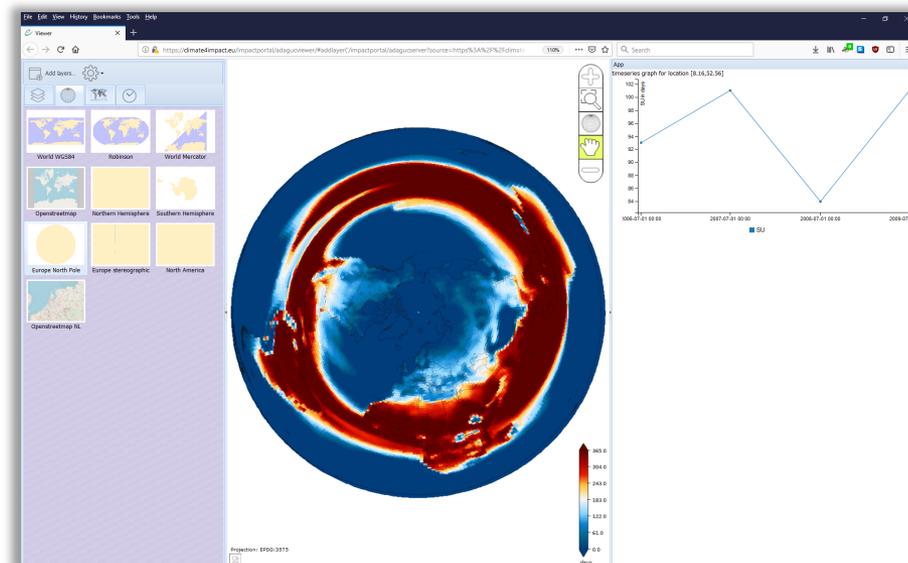
Processing inputs

Indicator name (indicatorName)
The indicator to calculate:
SU - Number of Summer Days (Tmax > ...)

Time slice mode (timeSliceMode)
Selects temporal grouping to apply for calculation:
Year - Yearly time period

Indicator threshold (threshold)

NetCDF Metadata retrieved via OPENDAP



Example use case with Climate4Impact - Region statistics

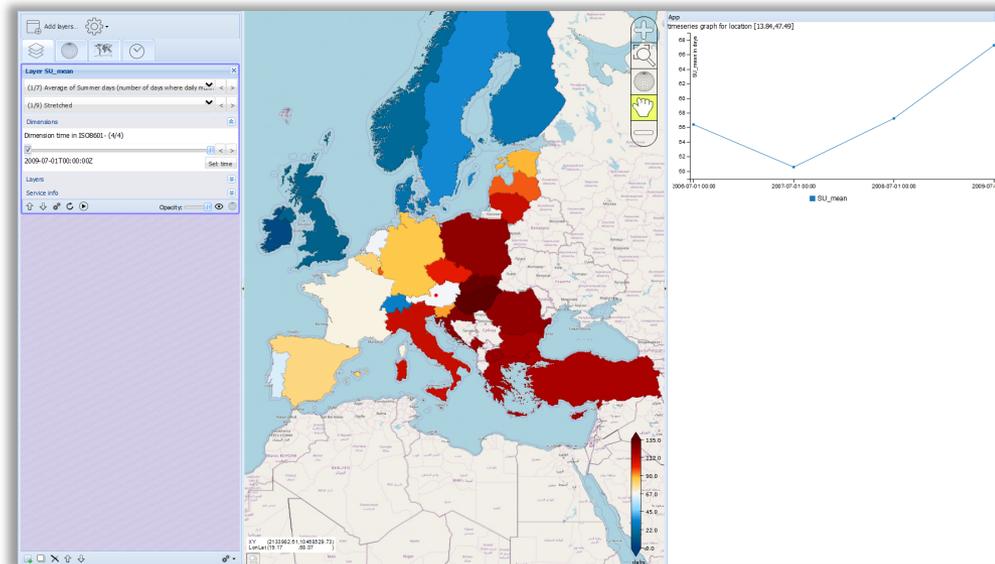
- Go to Processing and select Polygon overlay
- For “Input File B - Gridded data”, choose the latest result with SU from your basket. This is the most recent folder under WPS_Scratch
- As variable select “SU”, as time range select “*”
- Click “Start processing”

Processor Polygon overlay

File	DAP	HTTP	Filesize	Date
Remote data				
cmp5_output1_NCC_NorESM1-ME_historical_mon_land_Lmon_r11p1_v2			0	2018-11-09 15:02:28Z
cmp5_output1_NOAA-GFDL_GFDL-ESM2G_piControl_day_atmos_day_r			0	2018-11-09 15:06:00Z
px_0_25deg_reg_v17.0.nc	true		4.632G	2018-12-05 11:03:23Z
tas_Amon_MIROC5_historical_r11p1f1_gn_195001-201412.nc	true		-	2019-03-29 09:16:10Z
tasmax_Amon_MIROC6_historical_r11p1f1_gn_195001-201412.nc	true	true	56.81M	2019-03-29 09:18:23Z
tasmax_day_GISS-E2-1-G_historical_r11p1f1_gn_19500101-20141	true		-	2019-03-29 09:23:37Z
cmp5_output1_MIROC_MIROC5_historical_day_atmos_day_r51p1_v201			0	2019-03-29 13:52:25Z
tasmax_day_MIROC5_historical_r51p1_20000101-20091231.nc	true	true	478.5M	2019-03-29 13:52:46Z
tasmax_day_ACCESS1-3_historical_r31p1_18500101-18741231.nc	true	true	1.017G	2019-04-01 08:57:12Z
tasmax_day_MIROC5_rcp26_r11p1_20060101-20091231.nc	true	true	191.4M	2019-04-04 12:33:28Z
My data				
WPS_Settings				2019-04-04T12:34:22Z
WPS_Scratch				2019-04-04T12:34:22Z
WPS_clip_simpleindicator_execute_20190404T123422Z				2019-04-04T12:34:24Z
out_lcclim.nc	true	true	572.5K	2019-04-04 12:36:27Z
WPS_clip_simpleindicator_execute_20190401T090210Z				2019-04-01T09:02:10Z
WPS_is_enes_wps_polygonoverlay_20190329T140922Z				2019-03-29T14:09:33Z
WPS_is_enes_wps_polygonoverlay_20190329T140621Z				2019-03-29T14:06:26Z

Output CSV filename (csvnutstafilename)

Name of the comma separated value (CSV) output file. Will contain statistics in table form. Can be opened in a spreadsheet program.



Thanks !

On behalf of the climate4impact team

- For questions, suggestions, feedback and help, please contact
 - Christian Pagé christian.page@cerfacs.fr

