

# Climate Explorer Usage I: Accessing and downloading data

Access the climate explorer here: <https://climexp.knmi.nl/start.cgi>

**Using this guide: on the annotated screenshots, red arrows indicate instructions that can be followed. Grey arrows and italic text are used to indicate additional points of note.**

## Landing page

1. **Sign in!** - Register your name, email address and institution to receive a nice greeting and several additional features: any datasets you generate will be remembered by the CE and will be available for 3 days after last use; permission to access certain datasets such as the extended ERA5 analysis; access to certain functions like uploading your own data or when using the Synthesis tool.
2. **Accessing data** - The sidebar shows a list of categories of the data contained on the climate explorer, divided into time series and gridded datasets. This sidebar remains visible on most pages on the website.

The screenshot shows the Climate Explorer landing page. At the top, there is a navigation bar with the text 'WMO European Climate Assessment & Dataset KNMI Climate Explorer'. Below this is a secondary navigation bar with links: 'Home', 'Help', 'News', 'About', 'World weather', 'Effects of ENSO', and 'Climate Change Atlas'. The main content area starts with 'Home — Starting point' and 'Starting point'. A welcome message for an anonymous user follows, explaining the tool's purpose. Below this is a world map titled 'Relative precipitation anomalies wrt 1981-2010 [fraction] in yr0 2023 (source: GPCC). More under "World weather"'. A red arrow points from the text 'log in or register.' to the map. On the right side, there is a sidebar with two main sections: 'Select a time series' and 'Select a field'. A red arrow points from the 'Select a time series' section to the text '1. Sign in'. Another red arrow points from the 'Select a field' section to the text '2. Navigation bar to access different datasets'. The 'Select a time series' section lists: 'Daily station data', 'Daily climate indices', 'Monthly station data', 'Monthly climate indices', 'Annual climate indices', and 'View, upload your time series'. The 'Select a field' section lists: 'Daily fields', 'Monthly observations', 'Monthly reanalysis fields', 'Monthly and seasonal historic reconstructions', 'Monthly seasonal hindcasts', 'Monthly CMIP scenario runs' (with sub-items: 'CMIP3+ scenarios', 'CMIP5 scenarios', 'CMIP5 EU44 CORDEX scenarios', 'CMIP6 scenarios', 'KNMI2023 NL Scenarios'), 'Annual CMIP5 extremes', 'Attribution runs', and 'View, upload your field'.

# Station data

From the home page, select 'Daily station data' under 'Select a time series'. Throughout this guide, we explore the Pacific Northwest Heatwave of 2021 as an example.

## Finding stations

- Select network and variable** - GHCN-D for stations globally, ECA&D for Europe only. In this example, we search for maximum temperatures from the global network.
- Search for stations** - *only fill in one line of this part of the table!* Generally use either:
  - Stations close to a point - specify the coordinates of the point and number of stations. In the example below, we select a point near Portland, Oregon.
  - Stations within a region - specify the boundaries of the domain
- Additional conditions** - specify number of years of data, minimum separation and elevation range. If blank, all stations are included. In the example, we require 50+ years.

Select a daily time series

Historical observations

| GHCN-D                                                                  | pure ECA&D                                                                                  | blended ECA&D                                                                               | HCDN                            |
|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|---------------------------------|
| <input type="radio"/> precipitation<br><input type="radio"/> precip+GTS | <input type="radio"/> precipitation                                                         | <input type="radio"/> precipitation                                                         | <input type="radio"/> US runoff |
| <input type="radio"/> average temperature                               | <input type="radio"/> mean temperature                                                      | <input type="radio"/> mean temperature                                                      |                                 |
| <input type="radio"/> minimum temperature                               | <input type="radio"/> minimum temperature                                                   | <input type="radio"/> minimum temperature                                                   |                                 |
| <input checked="" type="radio"/> maximum temperature                    | <input type="radio"/> maximum temperature                                                   | <input type="radio"/> maximum temperature                                                   |                                 |
| <input type="radio"/> snowfall                                          | <input type="radio"/> pressure                                                              | <input type="radio"/> pressure                                                              |                                 |
| <input type="radio"/> snow depth                                        | <input type="radio"/> snow depth                                                            | <input type="radio"/> snow depth                                                            |                                 |
|                                                                         | <input type="radio"/> cloud cover                                                           | <input type="radio"/> cloud cover                                                           |                                 |
|                                                                         | <input type="radio"/> global radiation                                                      | <input type="radio"/> global radiation                                                      |                                 |
| <a href="#">(full lists)</a>                                            | wind <input type="radio"/> speed <input type="radio"/> gust <input type="radio"/> direction | wind <input type="radio"/> speed <input type="radio"/> gust <input type="radio"/> direction |                                 |

1. Select network and variable

2. Search for stations:

- X close to a point
- All within area

3. Conditions on search: 50+ years recommended

At least 50 years of data

At least [ ]° apart and with [ ]m < elevation < [ ]m

Get stations Clear Form

- Select station of interest** - this choice should be made based on the number of years available. It is important to ensure that the event of interest is covered by the available range.

Looking up 10 stations

Searching for stations near 45.50N, -122.50E

Requiring at least 50 years with data

Found 10 stations

*Search criteria are displayed for reference*

TROUTDALE,\_OR (United States)

coordinates: 45.55N, -122.39E, 10.0m

GHCN-D station code: USC00358634 ([get data](#))

Found 72 years of data in 1948-2024

**4. Select station with get data: check number and range of years is appropriate.**

PORTLAND\_RFC\_CITY,\_OR (United States)

coordinates: 45.53N, -122.67E, 9.0m

GHCN-D station code: USW00024274 ([get data](#))

Found 100 years of data in 1874-1973

## Initial information provided

When 'get data' is selected, the time series is displayed along with supplementary information. The sidebar has an additional list titled 'investigate this time series', which is used to visualise the data in different ways, and boxes below to manipulate the time series in different ways.

### Time series

daily TROUTDALE, OR maximum temperature

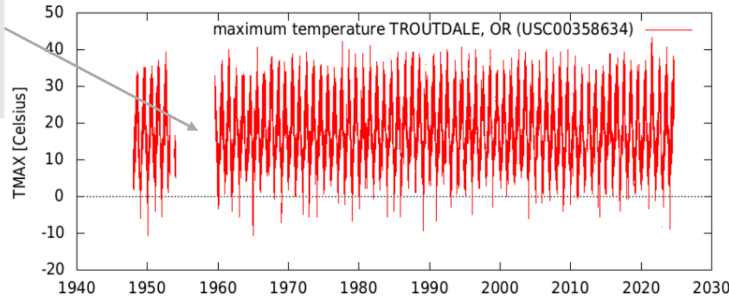
Retrieving data from [GHCN-D v2 database](#) ...

If it takes too long you can abort the job [here](#) (using the [back](#) button of the browser does not kill the data extraction job)

coordinates: 45.55N, -122.39E, 10.0m; GHCN-D station code: USC00358634 TROUTDALE, OR United States, TMAX [Celsius] daily maximum temperature. ([eps](#), [pdf](#), [metadata](#), [raw data](#), [netcdf](#))

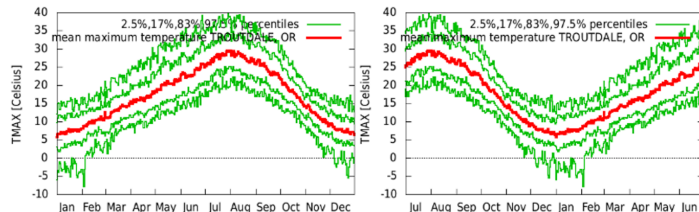
*Download possible in different formats*

**Note: extended period of missing data**



*Daily time series*

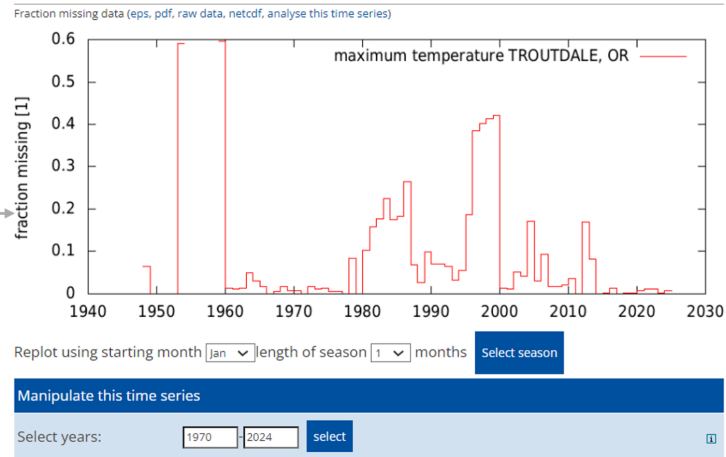
Annual cycles, computed with all data available (Jan-Dec: [eps](#), [pdf](#), [raw data](#)., Jul-Jun: [eps](#), [pdf](#), [raw data](#)).



*Seasonal cycle*

- **NOTE:** Periods of missing data may need to be removed to create a consistent time series in the extreme index of choice. This is done using the first option in the 'manipulate this time series' box below.

Missing data fraction is also displayed below



Select time period to remove major periods of missing data.

## Investigate time series

Once the data is sufficiently cleaned, you may want to investigate specific events using the 'investigate this time series' bar on the right hand side of the web page.

1. **Zoom in to specific periods** - select 'view last 30, 90, 365, N days' (any option is fine, you can change this later).

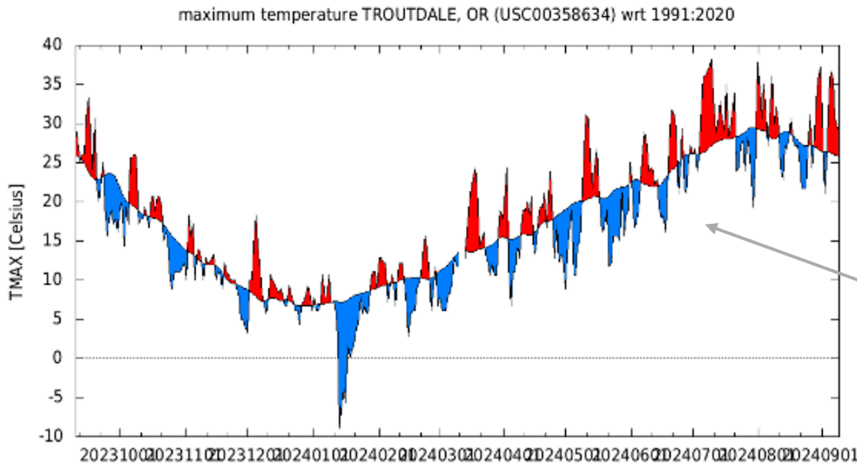
Investigate this time series

- > View last 30, 90, 365, N days
- > Correlate with other time series
- > Correlate with a field (correlation, regression, composite)
  - > only observations
  - > only reanalyses
  - > only seasonal forecasts
  - > only scenario runs
  - > only user-defined fields
- > Verify against another time series
- > Spectrum, autocorrelation function
- > Wavelet
- > Running mean/s.d./skew/curtosis
- > Trends in return times of extremes
- > Plot and fit distribution

View individual periods in more detail

- Edit period and replot** - having selected the last 365 days, it automatically displays the most recent period. Since in the example we are considering the PNW heatwave in summer 2021, we change the period to 60 days leading up to mid August 2021.

Last 365 days of maximum temperature observations at TROUTDALE, OR with climatology computed over the period 1991:2020 (eps, pdf, raw data)



Shows daily anomalies compared to 1991-2020 by default.

Replot:  days with end date

Plot:  observations  Ocumulatives

Compare with:  climatology  -

zero, data are already anomalies

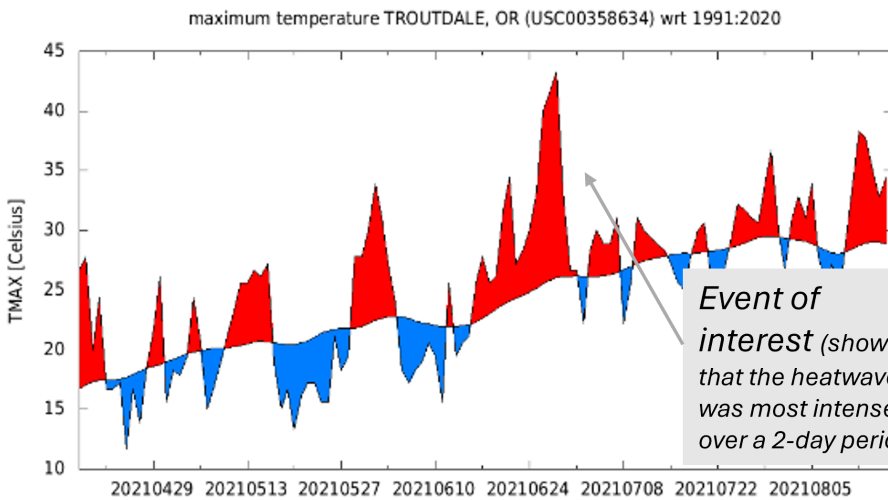
White centre leave white values between  and

Y axis  -

2. Edit period: number of days leading up to a given date.



120 days of maximum temperature observations at TROUTDALE, OR ending at 20210815 with climatology computed over the period 1991:2020 (eps, pdf, raw data)



Event of interest (showing that the heatwave was most intense over a 2-day period)

Replot:  days with end date

Plot:  observations  Ocumulatives

Compare with:  climatology  -

zero, data are already anomalies

White centre leave white values between  and

Y axis  -

Period can be adjusted again if necessary

- **Note:** If working with precipitation data, climate explorer will automatically display the data as a cumulative rather than daily anomaly. This is useful to show how wet or dry a longer period, such as a season, was compared to normal. However, if you want to see daily anomalies to pick out specific events such as storms, click 'observations' rather than 'cumulatives' in the line 'Plot:'.

Once you have investigated the time series, press back until you return to the page with the daily series and seasonal cycle displayed.

## Create time series of extreme index

Now that we have identified the duration and confirmed that there is data for the event of interest, we can create an index that can show us similar extremes over time:

1. **Find 'create a lower resolution time series' box**
2. **Specify event duration** - from our previous knowledge of this event, we apply a 2-day running mean, so that we can search for similar 2-day hot events each year
3. **Select 'annual' time scale** - we want the hottest 2-day heat event each year. Notes:
  - If there is a strong seasonal cycle in which extremes of interest occur late and early in the year, it may be appropriate to select 'Jul-Jun' instead of 'Jan-Dec'.
  - It is also possible to reduce to other timescales such as each month and reduce that further using 'manipulate this time series'. However, for more complex manipulation it is recommended to download the data and use other data analysis tools such as python.
4. **Select maximum** - in this case we want the hottest 2-day period of each year so identify that with the annual timescale and discard other data. Other extremes such as cold temperatures or rainfall deficits may require 'minimum' each year.

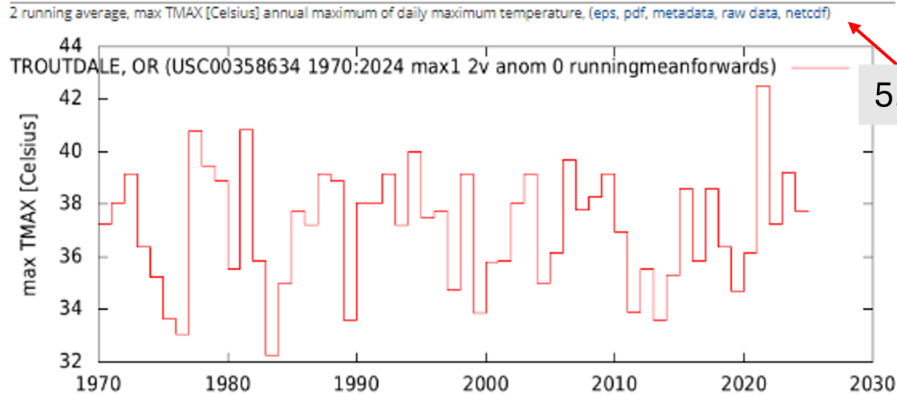
The screenshot shows the 'Create a lower resolution time series' interface. It includes a title bar, a 'First fill missing data' section with radio buttons for 'ignore', 'Oclimatology', 'Otrend', and 'Opersistence'. The 'Then apply:' section has a text input '2' and a dropdown 'forward'. The 'Then apply new time scale:' section has a dropdown 'annual (Jan-Dec)'. The 'New variable:' section has a dropdown 'max' and text 'of TROUTDALE, OR TMAX'. The 'Minimum:' section has a text input '0' and text '% valid data'. The 'Threshold:' section has a dropdown 'no cut'. A 'make new time series' button is at the bottom left. Four numbered callouts with red arrows point to these specific elements: 1. 'Find box at end of page' points to the title bar; 2. 'Specify event duration' points to the '2' input; 3. 'Select annual to get one value per year' points to the 'annual (Jan-Dec)' dropdown; 4. 'Find maximum value of similar events each year' points to the 'max' dropdown.

- Download data** - the data can be downloaded in various formats or viewed immediately using the 'raw data' option

## Time series

annual TROUTDALE, OR 2-day mean

Retrieving data ...



Additional options for studying this time series are now found within the 'investigate this time series' sidebar:

- View per year** - redisplay the time series above with a line representing the 15-year rolling mean. This gives a basic impression of any trends or decadal-scale variability.
- Analyse trends** - to study the possible influence of global warming on the extreme index, choose 'trends in return times of extremes', and proceed to the 'Trend analysis' section of this guide.

Investigate this time series

- > View per year
- > View last 10, 20, 50, N years
- > Correlate with other time series
- > Correlate with a field (correlation, regression, composite)
  - > only observations
  - > only reanalyses
  - > only seasonal forecasts
  - > only scenario runs
  - > only user-defined fields
- > Verify against another time series
- > Spectrum, autocorrelation function
- > Wavelet
- > Running mean/s.d./skew/curtosis
- > Trends in return times of extremes
- > Plot and fit distribution

6. Add running mean to visualisation

7. Analyse changes in extremes due to warming

# Gridded data

**About gridded data:** The climate explorer contains numerous gridded observational and reanalysis datasets suitable for studying extremes. As it covers all regions at regular intervals, gridded data is useful for exploring the spatial extent and statistics of events. No single dataset is perfect as all require some form of processing (such as interpolation, use of forecast models, integration of different observations such as satellite imagery, among others) in order to ‘fill in the gaps’ and create a homogenous grid. However, using multiple datasets that are built using different data and processing offers a way to capture the uncertainty that comes from this and identify datasets that perform poorly. This guide sets out which datasets are available on the climate explorer, how to select a subregion using coordinates or a geographical region, and how to create a time series to explore changes in extremes.

## Available datasets

Gridded data is accessed through the ‘select a field’ sidebar on most pages on the climate explorer. For studying extremes, daily resolution data (found in ‘daily fields’) is the most useful. However, monthly observations typically extend further into the past than daily and in some cases such as drought, monthly data may be acceptable. In these cases, select ‘monthly observations’. The table below shows the main datasets available in both cases. As a note, ‘monthly reanalysis’ generally does not extend any further into the past, so ‘daily fields’ is fine to access reanalysis datasets for all extremes.

| <b>Dataset</b>   | <b>Variables</b>   | <b>Time period</b> | <b>Regions</b>                                         | <b>Spatial resolution</b>           | <b>Temporal resolution</b> |
|------------------|--------------------|--------------------|--------------------------------------------------------|-------------------------------------|----------------------------|
| <b>ERA5</b>      | Most               | 1950-now           | Global                                                 | 0.5<br>(0.25 in Europe, NA, Africa) | Daily                      |
| <b>CPC</b>       | Tmax, tmin, precip | 1979-now           | Global                                                 | 0.5<br>(0.25 in US)                 | Daily                      |
| <b>GPCC</b>      | Precip             | 1982-now           | Global                                                 | 1.0                                 | Daily                      |
| <b>GPM-IMERG</b> | Precip             | 2000-now           | Global                                                 | 0.2                                 | Daily                      |
| <b>E-OBS</b>     | Most               | 1910-now           | Europe                                                 | 0.25                                | Daily                      |
| <b>CHIRPS*</b>   | Precip             | 1981-now           | Quasi-global<br>(50S - 50N)<br>*Only Africa on climexp | 0.25<br>(0.05 available online)     | Daily                      |

|                           |                          |           |        |        |         |
|---------------------------|--------------------------|-----------|--------|--------|---------|
| <b>MSWX**</b>             | Most                     | 1979-now  | Global | 0.1    | Daily   |
| <b>tamsat**</b>           | Precip                   | 1983-now  | Africa | 0.0375 | Daily   |
| <b>CRUTS</b>              | Tmax,<br>Tmin,<br>Precip | 1901-2023 | Global | 0.5    | Monthly |
| <b>GPCC<br/>(monthly)</b> | Precip                   | 1891-2020 | Global | 0.25   | Monthly |

## Accessing data

1. **Select a field** - choose the appropriate timescale for your needs. In the case of the 2-day Pacific Northwest Heatwave we are interested in daily data.
2. **Select a dataset and variable** - after selecting daily fields, there are two tables showing observations and reanalysis with the available variables. The table above shows the datasets that tend to be the most useful in terms of time period, available variables and geographical coverage. In this case, we want ERA5 reanalysis. As we are studying an event in North America, we can select the higher resolution 0.25 degree version.

Select a field

- > Daily fields
- > Monthly observations
- > Monthly reanalysis fields
- > Monthly and seasonal historical reconstructions
- > Monthly seasonal hindcasts
- > Monthly CMIP scenario runs
  - > CMIP3+ scenarios
  - > CMIP5 scenarios
  - > CMIP5 EU44 CORDEX scenarios
  - > CMIP6 scenarios
  - > KNMI2023 NL Scenarios
- > Annual CMIP5 extremes
- > Attribution runs
- > View, upload your field

1. Daily gridded data including both observations and reanalysis

Monthly observations contain longer time series

| Reanalysis                        | t2m  | prcp | slp  | z500 | v500 | z200 | v200     | evap     | wspd |   |
|-----------------------------------|------|------|------|------|------|------|----------|----------|------|---|
| NCEP/NCAR 1948-now                | ⌘    | ⌘    | ⌘    | ⌘    | ⌘    | ⌘    | ⌘        |          |      | 📄 |
| ERA5 1950-now 0.5°                | ⌘    | ⌘    | ⌘    | ⌘    |      |      |          | ⌘        | ⌘    | 📄 |
| ERA5 1950-now 0.25° Europe        | ⌘    | ⌘    | ⌘    | ⌘    |      |      |          | ⌘        | ⌘    | 📄 |
| ERA5 1950-now 0.25° Africa        | ⌘    | ⌘    | ⌘    | ⌘    |      |      |          | ⌘        | ⌘    | 📄 |
| ERA5 1950-now 0.25° North America | ⌘    | ⌘    | ⌘    | ⌘    |      |      |          | ⌘        | ⌘    | 📄 |
|                                   | Tmin | Tmax | Tdew | Twet | sp   | t850 | pot evap | max wspd |      |   |
| ERA5 1950-now 0.5°                | ⌘    | ⌘    | ⌘    | ⌘    | ⌘    | ⌘    |          | ⌘        |      | 📄 |
| ERA5 1950-now 0.25° Europe        | ⌘    | ⌘    | ⌘    | ⌘    | ⌘    | ⌘    |          | ⌘        |      | 📄 |
| ERA5 1950-now 0.25° Africa        | ⌘    | ⌘    | ⌘    | ⌘    | ⌘    | ⌘    |          | ⌘        |      | 📄 |
| ERA5 1950-now 0.25° North America | ⌘    | ⌘    | ⌘    | ⌘    | ⌘    | ⌘    |          | ⌘        |      | 📄 |

2. Select dataset and variable

## Selecting a subregion

When you have selected a dataset, you will see a page showing the details of the data, several boxes with additional options, as well as a new sidebar titled 'investigate this field'.

3. **Select region of interest** - there are two ways to do this:
  - a. Specify the boundaries of a box using latitude and longitude. In the example, we specify a region over northwestern US and southwestern Canada
  - b. Add a mask for some geographical region - to do so, follow 'add mask to the list', select from the pre-installed options (e.g. 'countries'). You will be returned to the page below, then use the drop-down on 'Mask' to select a region from the list.
4. **Subset the data** - this applies a 'cookie-cutter' procedure, discarding all data outside the region specified but keeping the selected region as a field

### Field

ERA5 Tmax

"ERA5 reanalysis, <https://www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/era5>"

X axis: regular grid with 313 0.25° steps, first point at 130.00° W, last point at 52.00° W

Y axis: regular grid with 121 -0.25° steps, first point at 54.00° N, last point at 24.00° N

1-daily data available from 01Jan1950 to 31Aug2024 ( 27328 times)

Variable tmax (Daily Maximum Near-Surface Air Temperature) in K

Full metadata. The associated land/sea mask is available for some operations

Get grid points, average area or generate subset

Mask:  [add a mask to the list](#)

Latitude: °N - °N

Longitude: °E - °E

Year range:  -

Boundaries:

Make:  average  max  min  set of grid points  subset of the field

Considering:  everything  land points  sea points [show/hide more](#)

Units:  convert to Celsius  leave in K

*Dataset details including grid edges and resolution, date range, variable name and units.*

3. Select region of interest using either:
  - a. Coordinates
  - b. A mask

4. Subset the field to 'cookie-cutter' region

- **Note:** When you click 'create', it may take several minutes to complete the operation, depending on the size of the dataset used.

- Plot the data** - to ensure that you have selected the correct area and captured the spatial extent of the event, select 'plot this field' on the 'investigate this field' sidebar. This brings up another . using 'lat-lon plot', choose the following options
- Select date and number of days of event** - as we currently have a grid at all times, to plot we need to just choose a single day or average over multiple days. In this case, to see the events on the 27-28th June, select the 27th and average over 2 days.

## Plot field

ERA5\_235-241E\_45-51N\_1950-2024 Tmax

Lat-lon plot

Time: year:  month:  day:

average over  days

Anomalies:  absolute anomalies wrt to  :  (default: all data)

Map type:  projection

Region:  °N to  °N,  °E to  °E

Contours:  to   logarithmic scale

Colours:

Shading:  shading and contours  shading  contours  grid boxes

Plot options:  no color bar  no title on plot,  no grid  no political boundaries  
label distance  ×  ° or  no labels

Output to:  browser  Google Earth (kml)  GIS (geotiff)

Units:  convert to Celsius  leave in K

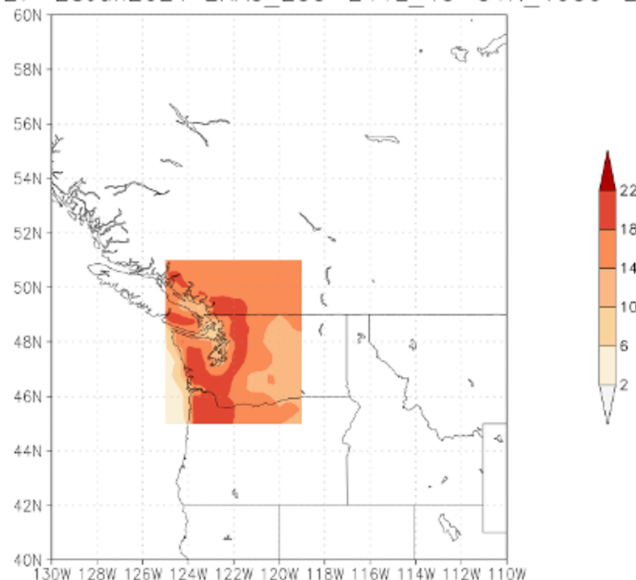
6. Select date and number of days of event

7. Tick anomalies

8. Choose wider region for plot



tmax-clim9120 27-28Jun2021 ERA5\_235-241E\_45-51N\_1950-2024 Tmax (eps, pdf)  
tmax-clim9120 27-28Jun2021 ERA5\_235-241E\_45-51N\_1950-2024 T



Event region captured correctly.

## Making a daily time series

Once the region of interest is confirmed, press back twice to return to the page titled 'Computing subset field' page. To create a time series, we need to average over the entire region.

- 7. Average field** - in the same box as 'subset of the field', select 'average' of the field instead

## Computing subset field

ERA5 Tmax

Field already exists

subset of "ERA5 reanalysis, <https://www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/era5>"

X axis: regular grid with 25 0.25° steps, first point at 125.00° W, last point at 119.00° W

Y axis: regular grid with 25 -0.25° steps, first point at 51.00° N, last point at 45.00° N

1-daily data available from 01Jan1950 to 31Aug2024 ( 27328 times)

Variable tmax (Daily Maximum Near-Surface Air Temperature) in K

Full metadata. The associated land/sea mask is available for some operations

Get grid points, average area or generate subset

Mask:  [add a mask to the list](#)

Latitude:  °N -  °N

Longitude:  °E -  °E

Year range:  -

Boundaries:

Make:  average  max  min  set of grid points  subset of the field

Considering:  everything  land points  sea points [show/hide more](#)

Units:  convert to Celsius  leave in K

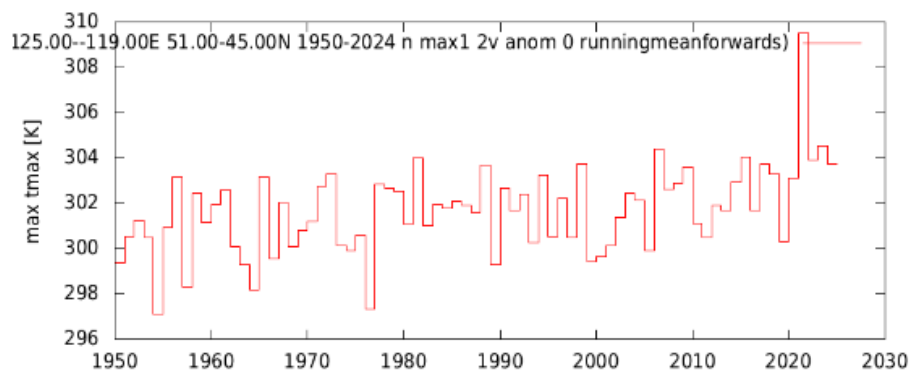
Region is selected in the same way as previously.

7. Average the field to get one value per day for the whole region.

## Create time series of extreme index

This is exactly the same as the process of creating a lower resolution time series for station data. Refer to the instructions on pages 6-7. The resultant time series appears as follows:

2 running average, max tmax [K] annual maximum of Daily Maximum Near-Surface Air Temperature, (eps, pdf, metadata, raw data, netcdf)



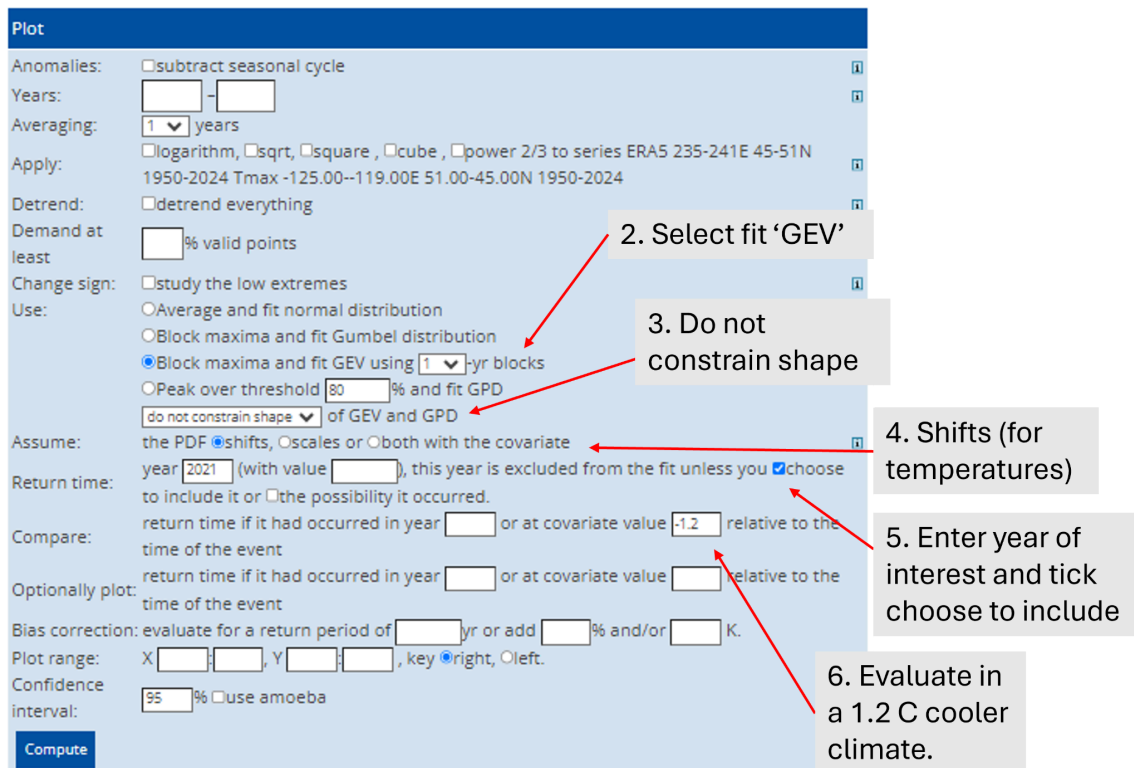
# Trend analysis

To investigate how the extreme index of choice varies with global mean surface temperature, select 'trends in return times of extremes' on the 'investigate this time series' sidebar.

1. **Select 'smoothed GMST'** - the 'covariate series' is what you evaluate changes in the extreme with respect to. We could just use 'time', but since we are interested in the effect of climate change we use smoothed global mean surface temperature (GMST)



2. **Select to use 'GEV'** - this is the statistical model fit to the data. GEV is appropriate for 'block maxima', such as the maximum or minimum values for a year. 'Normal distribution' would be appropriate for extremes over a fixed part of the year, such as an abnormally wet December-February.
3. **Do not constrain shape** - we include the event in the statistical model
4. **Assume the distribution shifts** - for temperature-based extremes, we assume the distribution shifts with GMST, for rainfall-based extremes we assume it scales. This assumption is based on physical reasoning and has been tested.
5. **Enter year of event and choose to include it in the fit**
6. **Choose covariate value** - this is the value to evaluate as the climate without human influence. In this case, as we are studying an event in 2021 we use -1.2 C. In 2024, we use -1.3 C as the covariate value.



# Results

The table of results is presented as follows. The key results are highlighted using red arrows showing both best estimate value and 95% confidence intervals. A result for probability ratio is statistically significant if the lower bound is above 1 or the lower bound is below 1, and for a change in intensity if the lower bound is above 0 or the upper bound is below 0.

In the example below, we note the following:

- The return period in the preindustrial climate was infinite, suggesting that it was statistically 'impossible'
- In the present day, it is still more than a thousand years, suggesting that it is still incredibly rare
- The probability ratio is infinite (due to the past return period value of infinity) and the lower bound is above 1, indicating that it is statistically significant
- The change in intensity is approximately 3.3 C with a lower bound above 0, suggesting that it is also statistically significant

| annual ERAS 235-241E 45-51N 1950-2024 Tmax -125.00--119.00E 51.00-45.00N 1950-2024 max_tmax [K] dependent on Global mean surface temperature (smoothed) |                |             |                    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-------------|--------------------|
| parameter                                                                                                                                               | year/covariate | value       | 95% CI             |
| covariate:                                                                                                                                              | -1.20          | -0.26708    |                    |
|                                                                                                                                                         | 2021           | 0.93292     |                    |
| N:                                                                                                                                                      |                | 75          |                    |
| Fitted to GEV distribution $P(x) = \exp(-1-\xi(x-\mu)/\sigma)^{-1/\xi}$                                                                                 |                |             |                    |
| with $\mu' = \mu + \alpha T$ and $\sigma' = \sigma$                                                                                                     |                |             |                    |
| $\mu$ :                                                                                                                                                 | -1.20          | 299.405     | 299.021... 299.967 |
| $\sigma$ :                                                                                                                                              | -1.20          | 1.591       | 1.302... 1.844     |
| $\mu$ :                                                                                                                                                 | 2021           | 302.665     | 302.282... 303.228 |
| $\sigma$ :                                                                                                                                              | 2021           | 1.591       | 1.302... 1.844     |
| $\xi$ :                                                                                                                                                 |                | -0.161      | -0.686... -0.046   |
| $\alpha$ :                                                                                                                                              |                | 2.717       | 1.182... 3.806     |
| return period event 2021 (value 309.52)                                                                                                                 | -1.20          | =           | 2369.7 ... =       |
| probability                                                                                                                                             | -1.20          | 0           | 0 ... 0.42200E-03  |
| return period event 2021 (value 309.52)                                                                                                                 | 2021           | 1548.6      | 122.92 ... =       |
| probability                                                                                                                                             | 2021           | 0.64574E-03 | 0 ... 0.81353E-02  |
| probability ratio                                                                                                                                       |                | =           | 8.4863 ... =       |
| p-value probability ratio (one-sided)                                                                                                                   | $\neq 1$       | 0.0014      |                    |
| change in intensity -1.20-2021                                                                                                                          | diff           | 3.261       | 1.418 ... 4.567    |

Best estimate value and confidence intervals

Return period of event in 1.2 C cooler climate

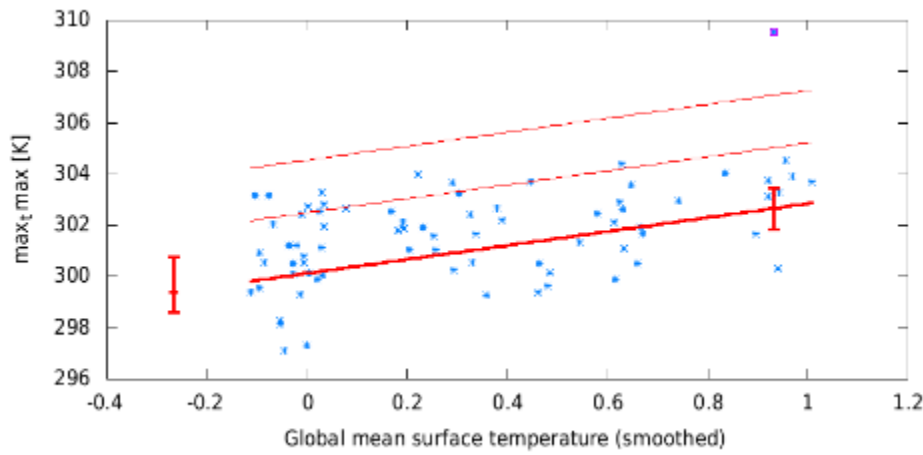
Return period of event in present climate

Probability ratio and change in intensity of 2021 event.

The following plots are also displayed on this page:

- **Trend** - the first plot shows that there is a strongly increasing trend with global warming. The event is highlighted in the purple box.
- **Statistical fit** - for this event we see that the model (the central red line) is a good fit to the data (red points) at lower values, but not so good at higher values, where it underestimates the largest event but overestimates most of the high values. This may be because the single event we are studying was so extreme that it is affecting the distribution by itself. As a result, in this case we may wish to reproduce the analysis but uncheck the box to include the event to see if that affects the results.

day mean ERA5 235-241E 45-51N 1950-2024 Tmax -125.00-119.00E 51.00-45.00N 1950-2024 1950:2024 (95% CI)



day mean ERA5 235-241E 45-51N 1950-2024 Tmax -125.00-119.00E 51.00-45.00N 1950-2024 1950:2024 (95% CI)

