Climate indices with CDO

Climate indices of daily temperature and precipitation extremes
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Contents

1 Introduction

The Climate Data Operator (**CDO**) software is a collection of operators for standard processing of climate and forecast model data.

This document describes additional **CDO** operators to compute climate indices of daily temperature and precipitation extreme. The definition of these climate indices are from the European Climate Assessment (ECA) project.

The climate indices were implemented in **CDO** by Ralf Quast (Brockmann Consult) on behalf of the Service Gruppe Anpassung (SGA) in 2006. SGA was part of the Model and Data Group (M&D) at the MPI for Meteorology. In 2010, the Model and Data Group became the Data Management department at DKRZ (Deutsches Klimarechenzentrum) and the SGA was disintegrated. For this reason there is no further user support available for these **CDO** operators.

2 Climate indices reference manual

This section gives a description of all **CDO** operators to compute the climate indices of daily temperature and precipitation extreme. Related operators are grouped to modules. For easier description all single input files are named `infile` or `infile1`, `infile2`, etc., and an arbitrary number of input files are named `infiles`. All output files are named `outfile` or `outfile1`, `outfile2`, etc. Further the following notion is introduced:

$i(t)$	Timestep t of `infile`
$i(t,x)$	Element number x of the field at timestep t of `infile`
$o(t)$	Timestep t of `outfile`
$o(t,x)$	Element number x of the field at timestep t of `outfile`

Here is a short overview of all operators in this section:

eca_cdd	Consecutive dry days index per time period
etccdi_cdd	Consecutive dry days index per time period
eca_cfd	Consecutive frost days index per time period
eca_csu	Consecutive summer days index per time period
eca_cwd	Consecutive wet days index per time period
eca_cwdi	Cold wave duration index w.r.t. mean of reference period
eca_cwfi	Cold-spell days index w.r.t. 10th percentile of reference period
etccdi_csdi	Cold-spell duration index
eca_etr	Intra-period extreme temperature range
eca_fd	Frost days index per time period
etccdi_fd	Frost days index per time period
eca_gsl	Growing season length index
eca_hd	Heating degree days per time period
eca_hwdi	Heat wave duration index w.r.t. mean of reference period
eca_hwfi	Warm spell days index w.r.t. 90th percentile of reference period
eca_id	Ice days index per time period
etccdi_id	Ice days index per time period
eca_r75p	Moderate wet days w.r.t. 75th percentile of reference period
eca_r75ptot	Precipitation percent due to R75p days
eca_r90p	Wet days w.r.t. 90th percentile of reference period

eca_r90ptot	Precipitation percent due to R90p days
eca_r95p	Very wet days w.r.t. 95th percentile of reference period
eca_r95ptot	Precipitation percent due to R95p days
eca_r99p	Extremely wet days w.r.t. 99th percentile of reference period
eca_r99ptot	Precipitation percent due to R99p days
eca_pd	Precipitation days index per time period
eca_r10mm	Heavy precipitation days index per time period
eca_r20mm	Very heavy precipitation days index per time period
etccdi_r1mm	Precipitation days index per time period
eca_rr1	Wet days index per time period
eca_rx1day	Highest one day precipitation amount per time period
etccdi_rx1day	Maximum 1-day Precipitation
eca_rx5day	Highest five-day precipitation amount per time period
etccdi_rx5day	Highest five-day precipitation amount per time period
eca_sdii	Simple daily intensity index per time period
eca_su	Summer days index per time period
etccdi_su	Summer days index per time period
eca_tg10p	Cold days percent w.r.t. 10th percentile of reference period
eca_tg90p	Warm days percent w.r.t. 90th percentile of reference period
eca_tn10p	Cold nights percent w.r.t. 10th percentile of reference period
eca_tn90p	Warm nights percent w.r.t. 90th percentile of reference period
eca_tr	Tropical nights index per time period
etccdi_tr	Tropical nights index per time period
eca_tx10p	Very cold days percent w.r.t. 10th percentile of reference period
eca_tx90p	Very warm days percent w.r.t. 90th percentile of reference period
etccdi_tx90p	Percentage of Days when Daily Maximum Temperature is Above the 90th Percentile
etccdi_tx10p	Percentage of Days when Daily Maximum Temperature is Below the 10th Percentile
etccdi_tn90p	Percentage of Days when Daily Minimum Temperature is Above the 90th Percentile
etccdi_tn10p	Percentage of Days when Daily Minimum Temperature is Below the 10th Percentile
etccdi_r95p	Annual Total Precipitation when Daily Precipitation Exceeds the 95th Percentile of Wet Day
etccdi_r99p	Annual Total Precipitation when Daily Precipitation Exceeds the 99th Percentile of Wet Day

2.0.1 ECACDD - Consecutive dry days index per time period

Synopsis

<operator>[,R[,N[,params]]] `infile outfile`

Description

Let `infile` be a time series of the daily precipitation amount RR, then the largest number of consecutive days where RR is less than R is counted. R is an optional parameter with default $R = 1$ mm. A further output variable is the number of dry periods of more than N days. Parameter is a comma-separated list of "key=values" pairs.

Operators

eca_cdd Consecutive dry days index per time period
The operator counts over the entire time series. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile`.

etccdi_cdd Consecutive dry days index per time period
The default output frequency is yearly. Periods within overlapping years are accounted for the first year. The date information of a timestep in `outfile` is the mid of the frequency interval.

Parameter

R	FLOAT	Precipitation threshold (unit: mm; default: R = 1 mm)
N	INTEGER	Minimum number of days exceeded (default: N = 5)
freq	STRING	Output frequency (year, month)

Example

To get the largest number of consecutive dry days of a time series of daily precipitation amounts use:

```
cdo eca_cdd rrfile outfile
```

2.0.2 ECACFD - Consecutive frost days index per time period

Synopsis

eca_cfd*[,N]* `infile outfile`

Description

Let `infile` be a time series of the daily minimum temperature TN, then the largest number of consecutive days where TN < 0 °C is counted. Note that TN have to be given in units of Kelvin. A further output variable is the number of frost periods of more than N days. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile`.

Parameter

N	INTEGER	Minimum number of days exceeded (default: N = 5)

Example

To get the largest number of consecutive frost days of a time series of daily minimum temperatures use:

```
cdo eca_cfd tnfile outfile
```

2.0.3 ECACSU - Consecutive summer days index per time period

Synopsis

eca_csu*[,T[,N]]* `infile outfile`

Description

Let `infile` be a time series of the daily maximum temperature TX, then the largest number of consecutive days where TX $> T$ is counted. The number T is an optional parameter with default $T = 25$℃. Note that TN have to be given in units of Kelvin, whereas T have to be given in degrees Celsius. A further output variable is the number of summer periods of more than N days. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile`.

Parameter

T	FLOAT	Temperature threshold (unit: ℃; default: T = 25℃)
N	INTEGER	Minimum number of days exceeded (default: N = 5)

Example

To get the largest number of consecutive summer days of a time series of daily maximum temperatures use:

```
cdo eca_csu txfile outfile
```

2.0.4 ECACWD - Consecutive wet days index per time period

Synopsis

eca_cwd*[,R[,N[,params]]]* `infile outfile`

etccdi_cwd `infile outfile`

Description

Let `infile` be a time series of the daily precipitation amount RR, then the largest number of consecutive days where RR is at least R is counted. R is an optional parameter with default $R = 1$ mm. A further output variable is the number of wet periods of more than N days. Parameter is a comma-separated list of "key=values" pairs.

Operators

eca_cwd Consecutive wet days index per time period
The operator counts over the entire time series. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile`.

Parameter

R	FLOAT	Precipitation threshold (unit: mm; default: R = 1 mm)
N	INTEGER	Minimum number of days exceeded (default: N = 5)
freq	STRING	Output frequency (year, month)

Example

To get the largest number of consecutive wet days of a time series of daily precipitation amounts use:

```
cdo eca_cwd rrfile outfile
```

2.0.5 ECACWDI - Cold wave duration index w.r.t. mean of reference period

Synopsis

eca_cwdi*[,nday[,T]]* `infile1 infile2 outfile`

Description

Let `infile1` be a time series of the daily minimum temperature TN, and let `infile2` be the mean TNnorm of daily minimum temperatures for any period used as reference. Then counted is the number of days where, in intervals of at least *nday* consecutive days, TN $<$ TNnorm - T. The numbers *nday* and T are optional parameters with default $nday = 6$ and $T = 5$℃. A further output variable is the number of cold waves longer than or equal to *nday* days. TNnorm is calculated as the mean of minimum temperatures of a five day window centred on each calendar day of a given climate reference period. Note that both TN and TNnorm have to be given in the same units. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile1`.

Parameter

nday	INTEGER	Number of consecutive days (default: nday = 6)
T	FLOAT	Temperature offset (unit: ℃; default: T = 5℃)

Example

To compute the cold wave duration index of a time series of daily minimum temperatures use:

```
cdo eca_cwdi tnfile tnnormfile outfile
```

2.0.6 ECACWFI - Cold-spell days index w.r.t. 10th percentile of reference period

Synopsis

<operator>[,nday[,params]] `infile1 infile2 outfile`

Description

Let `infile1` be a time series of the daily mean temperature TG, and `infile2` be the 10th percentile TGn10 of daily mean temperatures for any period used as reference. Then counted is the number of days where, in intervals of at least *nday* consecutive days, TG $<$ TGn10. The number *nday* is an optional parameter with default $nday = 6$. A further output variable is the number of cold-spell periods longer than or equal to *nday* days. TGn10 is calculated as the 10th percentile of daily mean temperatures of a five day window centred on each calendar day of a given climate reference period. Note that both TG and TGn10 have to be given in the same units.

Operators

eca_cwfi Cold-spell days index wrt 10th percentile of reference period
The operator counts over the entire time series. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile`.

etccdi_csdi Cold-spell duration index
The default output frequency is yearly. Periods within overlapping years are accounted for the first year. The date information of a timestep in `outfile` is the mid of the frequency interval.

Parameter

nday	INTEGER	Number of consecutive days (default: nday = 6)
freq	STRING	Output frequency (year, month)

Example

To compute the number of cold-spell days of a time series of daily mean temperatures use:

```
cdo eca_cwfi tgfile tgn10file outfile
```

2.0.7 ECAETR - Intra-period extreme temperature range

Synopsis

eca_etr `infile1 infile2 outfile`

Description

Let `infile1` and `infile2` be time series of thr maximum and minimum temperature TX and TN, respectively. Then the extreme temperature range is the difference of the maximum of TX and the minimum of TN. Note that TX and TN have to be given in the same units. The date information of a timestep in `outfile` is the date of the last contributing timesteps in `infile1` and `infile2`.

Example

To get the intra-period extreme temperature range for two time series of maximum and minimum temperatures use:

```
cdo eca_etr txfile tnfile outfile
```

2.0.8 ECAFD - Frost days index per time period

Synopsis

<operator>[,parameter] `infile outfile`

Description

Let `infile` be a time series of the daily minimum temperature TN, then the number of days where TN < 0 °C is counted. Note that TN have to be given in units of Kelvin. Parameter is a comma-separated list of "key=value" pairs.

Operators

eca_fd Frost days index per time period
The operator counts over the entire time series. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile`.

etccdi_fd Frost days index per time period
The default output frequency is yearly. The date information of a timestep in `outfile` is the mid of the frequency interval.

Parameter

freq	STRING	Output frequency (year, month)

Example

To get the number of frost days of a time series of daily minimum temperatures use:

```
cdo eca_fd tnfile outfile
```

2.0.9 ECAGSL - Thermal Growing season length index

Synopsis

eca_gsl[*,nday[,T[,fland]]*] `infile1 infile2 outfile`

Description

Let `infile1` be a time series of the daily mean temperature TG, and `infile2` be a land-water mask. Within a period of 12 months, the thermal growing season length is officially defined as the number of days between:

- first occurrence of at least nday consecutive days with TG $> T$
- first occurrence of at least nday consecutive days with TG $< T$ within the last 6 months

On northern hemisphere, this period corresponds with the regular year, whereas on southern hemisphere, it starts at July 1st. Please note, that this definition may lead to weird results concerning values TG $= T$: In the first half of the period, these days do not contribute to the gsl, but they do within the second half. Moreover this definition could lead to discontinuous values in equatorial regions.

The numbers *nday* and T are optional parameter with default $nday = 6$ and $T = 5$°C. The number $fland$ is an optional parameter with default value $fland = 0.5$ and denotes the fraction of a grid point that have to be covered by land in order to be included in the calculation. A further output variable is the start day of year of the growing season. Note that TG have to be given in units of Kelvin, whereas T have to be given in degrees Celsius.

The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile`.

Parameter

nday	INTEGER	Number of consecutive days (default: nday = 6)
T	FLOAT	Temperature threshold (unit: °C; default: T = 5°C)
fland	FLOAT	Land fraction threshold (default: fland = 0.5)

Example

To get the growing season length of a time series of daily mean temperatures use:

```
cdo eca_gsl tgfile maskfile outfile
```

2.0.10 ECAHD - Heating degree days per time period

Synopsis

eca_hd*[,T1[,T2]]* `infile outfile`

Description

Let `infile` be a time series of the daily mean temperature TG, then the heating degree days are defined as the sum of $T1$ - TG, where only values TG $< T2$ are considered. If $T1$ and $T2$ are omitted, a temperature of 17℃ is used for both parameters. If only $T1$ is given, $T2$ is set to $T1$. Note that TG have to be given in units of kelvin, whereas $T1$ and $T2$ have to be given in degrees Celsius. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile`.

Parameter

T1	FLOAT	Temperature limit (unit: °C; default: T1 = 17℃)
T2	FLOAT	Temperature limit (unit: °C; default: T2 = T1)

Example

To compute the heating degree days of a time series of daily mean temperatures use:

```
cdo eca_hd tgfile outfile
```

2.0.11 ECAHWDI - Heat wave duration index w.r.t. mean of reference period

Synopsis

eca_hwdi*[,nday[,T]]* `infile1 infile2 outfile`

Description

Let `infile1` be a time series of the daily maximum temperature TX, and let `infile2` be the mean TXnorm of daily maximum temperatures for any period used as reference. Then counted is the number of days where, in intervals of at least *nday* consecutive days, TX > TXnorm + T. The numbers *nday* and T are optional parameters with default $nday = 6$ and $T = 5$℃. A further output variable is the number of heat waves longer than or equal to *nday* days. TXnorm is calculated as the mean of maximum temperatures of a five day window centred on each calendar day of a given climate reference period. Note that both TX and TXnorm have to be given in the same units. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile1`.

Parameter

nday	INTEGER	Number of consecutive days (default: nday = 6)
T	FLOAT	Temperature offset (unit: °C; default: T = 5℃)

2.0.12 ECAHWFI - Warm spell days index w.r.t. 90th percentile of reference period

Synopsis

eca_hwfi[,nday[,params]] `infile1 infile2 outfile`

etccdi_wsdi `infile1 infile2 outfile`

Description

Let `infile1` be a time series of the daily mean temperature TG, and `infile2` be the 90th percentile TGn90 of daily mean temperatures for any period used as reference. Then counted is the number of days where, in intervals of at least *nday* consecutive days, TG > TGn90. The number *nday* is an optional parameter with default *nday* = 6. A further output variable is the number of warm-spell periods longer than or equal to *nday* days. TGn90 is calculated as the 90th percentile of daily mean temperatures of a five day window centred on each calendar day of a given climate reference period. Note that both TG and TGn90 have to be given in the same units. Parameter is a comma-separated list of "key=values" pairs.

Operators

eca_hwfi Warm spell days index wrt 90th percentile of reference period
The operator counts over the entire time series. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile`.

Parameter

nday	INTEGER	Number of consecutive days (default: nday = 6)
freq	STRING	Output frequency (year, month)

Example

To compute the number of warm-spell days of a time series of daily mean temperatures use:

```
cdo eca_hwfi tgfile tgn90file outfile
```

2.0.13 ECAID - Ice days index per time period

Synopsis

<*operator*>[,parameter] `infile outfile`

Description

Let `infile` be a time series of the daily maximum temperature TX, then the number of days where TX < 0 °C is counted. Note that TX have to be given in units of Kelvin. Parameter is a comma-separated list of "key=values" pairs.

Operators

eca_id Ice days index per time period
The operator counts over the entire time series. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile`.

etccdi_id Ice days index per time period
The default output frequency is yearly. The date information of a timestep in `outfile` is the mid of the frequency interval.

Parameter

freq	STRING	Output frequency (year, month)

Example

To get the number of ice days of a time series of daily maximum temperatures use:

```
cdo eca_id txfile outfile
```

2.0.14 ECAR75P - Moderate wet days w.r.t. 75th percentile of reference period

Synopsis

eca_r75p `infile1 infile2 outfile`

Description

Let `infile1` be a time series RR of the daily precipitation amount at wet days (precipitation >= 1 mm) and `infile2` be the 75th percentile RRn75 of the daily precipitation amount at wet days for any period used as reference. Then the percentage of wet days with RR > RRn75 is calculated. RRn75 is calculated as the 75th percentile of all wet days of a given climate reference period. Usually `infile2` is generated by the operator `ydaypctl,75`. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile1`.

Example

To compute the percentage of wet days with daily precipitation amount greater than the 75th percentile of the daily precipitation amount at wet days for a given reference period use:

```
cdo eca_r75p rrfile rrn75file outfile
```

2.0.15 ECAR75PTOT - Precipitation percent due to R75p days

Synopsis

eca_r75ptot `infile1 infile2 outfile`

Description

Let `infile1` be a time series RR of the daily precipitation amount at wet days (precipitation >= 1 mm) and `infile2` be the 75th percentile RRn75 of the daily precipitation amount at wet days for any period used as reference. Then the ratio of the precipitation sum at wet days with RR > RRn75 to the total precipitation sum is calculated. RRn75 is calculated as the 75th percentile of all wet days of a given climate reference period. Usually `infile2` is generated by the operator `ydaypctl,75`. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile1`.

2.0.16 ECAR90P - Wet days w.r.t. 90th percentile of reference period

Synopsis

eca_r90p `infile1 infile2 outfile`

Description

Let `infile1` be a time series RR of the daily precipitation amount at wet days (precipitation >= 1 mm) and `infile2` be the 90th percentile RRn90 of the daily precipitation amount at wet days for any period used as reference. Then the percentage of wet days with RR > RRn90 is calculated. RRn90 is calculated as the 90th percentile of all wet days of a given climate reference period. Usually `infile2` is generated by the operator `ydaypctl,90`. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile1`.

Example

To compute the percentage of wet days where the daily precipitation amount is greater than the 90th percentile of the daily precipitation amount at wet days for a given reference period use:

```
cdo eca_r90p rrfile rrn90file outfile
```

2.0.17 ECAR90PTOT - Precipitation percent due to R90p days

Synopsis

eca_r90ptot `infile1 infile2 outfile`

Description

Let `infile1` be a time series RR of the daily precipitation amount at wet days (precipitation >= 1 mm) and `infile2` be the 90th percentile RRn90 of the daily precipitation amount at wet days for any period used as reference. Then the ratio of the precipitation sum at wet days with RR > RRn90 to the total precipitation sum is calculated. RRn90 is calculated as the 90th percentile of all wet days of a given climate reference period. Usually `infile2` is generated by the operator `ydaypctl,90`. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile1`.

2.0.18 ECAR95P - Very wet days w.r.t. 95th percentile of reference period

Synopsis

eca_r95p `infile1 infile2 outfile`

Description

Let `infile1` be a time series RR of the daily precipitation amount at wet days (precipitation >= 1 mm) and `infile2` be the 95th percentile RRn95 of the daily precipitation amount at wet days for any period used as reference. Then the percentage of wet days with RR > RRn95 is calculated. RRn95 is calculated as the 95th percentile of all wet days of a given climate reference period. Usually `infile2` is generated by the operator `ydaypctl,95`. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile1`.

Example

To compute the percentage of wet days where the daily precipitation amount is greater than the 95th percentile of the daily precipitation amount at wet days for a given reference period use:

```
cdo eca_r95p rrfile rrn95file outfile
```

2.0.19 ECAR95PTOT - Precipitation percent due to R95p days

Synopsis

eca_r95ptot `infile1 infile2 outfile`

Description

Let `infile1` be a time series RR of the daily precipitation amount at wet days (precipitation >= 1 mm) and `infile2` be the 95th percentile RRn95 of the daily precipitation amount at wet days for any period used as reference. Then the ratio of the precipitation sum at wet days with RR > RRn95 to the total precipitation sum is calculated. RRn95 is calculated as the 95th percentile of all wet days of a given climate reference period. Usually `infile2` is generated by the operator `ydaypctl,95`. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile1`.

2.0.20 ECAR99P - Extremely wet days w.r.t. 99th percentile of reference period

Synopsis

eca_r99p `infile1 infile2 outfile`

Description

Let `infile1` be a time series RR of the daily precipitation amount at wet days (precipitation >= 1 mm) and `infile2` be the 99th percentile RRn99 of the daily precipitation amount at wet days for any period used as reference. Then the percentage of wet days with RR > RRn99 is calculated. RRn99 is calculated as the 99th percentile of all wet days of a given climate reference period. Usually `infile2` is generated by the operator `ydaypctl,99`. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile1`.

Example

To compute the percentage of wet days where the daily precipitation amount is greater than the 99th percentile of the daily precipitation amount at wet days for a given reference period use:

```
cdo eca_r99p rrfile rrn99file outfile
```

2.0.21 ECAR99PTOT - Precipitation percent due to R99p days

Synopsis

eca_r99ptot `infile1 infile2 outfile`

Description

Let `infile1` be a time series RR of the daily precipitation amount at wet days (precipitation >= 1 mm) and `infile2` be the 99th percentile RRn99 of the daily precipitation amount at wet days for any period used as reference. Then the ratio of the precipitation sum at wet days with RR > RRn99 to the total precipitation sum is calculated. RRn99 is calculated as the 99th percentile of all wet days of a given climate reference period. Usually `infile2` is generated by the operator `ydaypctl,99`. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile1`.

2.0.22 ECAPD - Precipitation days index per time period

Synopsis

eca_pd,*x* `infile outfile`

eca_r10mm `infile outfile`

eca_r20mm `infile outfile`

etccdi_r1mm*[,parameter]* `infile outfile`

Description

Let `infile` be a time series of the daily precipitation amount RR in [mm] (or alternatively in [kg m-2]), then the number of days where RR is at least x mm is counted. eca_r10mm and eca_r20mm are specific ECA operators with a daily precipitation amount of 10 and 20 mm respectively. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile` except for the etccdi operator. Parameter is a comma-separated list of "key=values" pairs.

Operators

eca_pd	Precipitation days index per time period Generic ECA operator with daily precipitation sum exceeding x mm.
eca_r10mm	Heavy precipitation days index per time period Specific ECA operator with daily precipitation sum exceeding 10 mm.
eca_r20mm	Very heavy precipitation days index per time period Specific ECA operator with daily precipitation sum exceeding 20 mm.
etccdi_r1mm	Precipitation days index per time period The default output frequency is yearly. The date information of a timestep in `outfile` is the mid of the frequency interval.

Parameter

x	FLOAT	Daily precipitation amount threshold in [mm]
freq	STRING	Output frequency (year, month)

Note

Precipitation rates in [mm/s] have to be converted to precipitation amounts (multiply with 86400 s). Apart from metadata information the result of eca_pd,1 and eca_rr1 is the same.

Example

To get the number of days with precipitation greater than 25 mm for a time series of daily precipitation amounts use:

```
cdo eca_pd,25 infile outfile
```

2.0.23 ECARR1 - Wet days index per time period

Synopsis

eca_rr1[,*R*] `infile outfile`

Description

Let `infile` be a time series of the daily precipitation amount RR in [mm] (or alternatively in [kg m-2]), then the number of days where RR is at least R is counted. R is an optional parameter with default $R = 1$ mm. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile`.

Parameter

R	FLOAT	Precipitation threshold (unit: mm; default: R = 1 mm)

Example

To get the number of wet days of a time series of daily precipitation amounts use:

```
cdo eca_rr1 rrfile outfile
```

2.0.24 ECARX1DAY - Highest one day precipitation amount per time period

Synopsis

<operator>[,parameter] `infile outfile`

Description

Let `infile` be a time series of the daily precipitation amount RR, then the maximum of RR is written to `outfile`. If the optional parameter *mode* is set to 'm' the maximum daily precipitation amounts are determined for each month. Parameter is a comma-separated list of "key=values" pairs.

Operators

eca_rx1day Highest one day precipitation amount per time period
The operator counts over the entire time series. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile`.

etccdi_rx1day Maximum 1-day Precipitation
The default output frequency is yearly. The date information of a timestep in `outfile` is the mid of the frequency interval.

Parameter

freq	STRING	Output frequency (year, month)

Example

To get the maximum of a time series of daily precipitation amounts use:

```
cdo eca_rx1day rrfile outfile
```

If you are interested in the maximum daily precipitation for each month, use:

```
cdo eca_rx1day,freq=month rrfile outfile
```

Apart from metadata information, both operations yield the same as:

```
cdo timmax rrfile outfile
cdo monmax rrfile outfile
```

2.0.25 ECARX5DAY - Highest five-day precipitation amount per time period

Synopsis

<operator>[,x[,params]] `infile outfile`

Description

Let `infile` be a time series of 5-day precipitation totals RR, then the maximum of RR is written to `outfile`. A further output variable is the number of 5 day period with precipitation totals greater than x mm, where x is an optional parameter with default $x = 50$ mm. Parameter is a comma-separated list of "key=values" pairs.

Operators

eca_rx5day Highest five-day precipitation amount per time period
The operator counts over the entire time series. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile`.

etccdi_rx5day Highest five-day precipitation amount per time period
The default output frequency is yearly. Periods within overlapping years are accounted for the first year. The date information of a timestep in `outfile` is the mid of the frequency interval.

Parameter

x	FLOAT	Precipitation threshold (unit: mm; default: x = 50 mm)
freq	STRING	Output frequency (year, month)

Example

To get the maximum of a time series of 5-day precipitation totals use:

```
cdo eca_rx5day rrfile outfile
```

Apart from metadata information, the above operation yields the same as:

```
cdo timmax rrfile outfile
```

2.0.26 ECASDII - Simple daily intensity index per time period

Synopsis

eca_sdii*[,R]* `infile outfile`

Description

Let `infile` be a time series of the daily precipitation amount RR, then the mean precipitation amount at wet days (RR >= R) is written to `outfile`. R is an optional parameter with default $R = 1$ mm. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile`.

Parameter

R	FLOAT	Precipitation threshold (unit: mm; default: R = 1 mm)

Example

To get the daily intensity index of a time series of daily precipitation amounts use:

```
cdo eca_sdii rrfile outfile
```

2.0.27 ECASU - Summer days index per time period

Synopsis

<operator>[,T[,params]] `infile outfile`

Description

Let `infile` be a time series of the daily maximum temperature TX, then the number of days where TX > T is counted. The number T is an optional parameter with default T = 25℃. Note that TX have to be given in units of Kelvin, whereas T have to be given in degrees Celsius. Parameter is a comma-separated list of "key=values" pairs.

Operators

eca_su Summer days index per time period
The operator counts over the entire time series. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile`.

etccdi_su Summer days index per time period
The default output frequency is yearly. The date information of a timestep in `outfile` is the mid of the frequency interval.

Parameter

T	FLOAT	Temperature threshold (unit: ℃; default: T = 25℃)
freq	STRING	Output frequency (year, month)

Example

To get the number of summer days of a time series of daily maximum temperatures use:

```
cdo eca_su txfile outfile
```

2.0.28 ECATG10P - Cold days percent w.r.t. 10th percentile of reference period

Synopsis

eca_tg10p `infile1 infile2 outfile`

Description

Let `infile1` be a time series of the daily mean temperature TG, and `infile2` be the 10th percentile TGn10 of daily mean temperatures for any period used as reference. Then the percentage of time where TG < TGn10 is calculated. TGn10 is calculated as the 10th percentile of daily mean temperatures of a five day window centred on each calendar day of a given climate reference period. Note that both TG and TGn10 have to be given in the same units. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile1`.

Example

To compute the percentage of timesteps with a daily mean temperature smaller than the 10th percentile of the daily mean temperatures for a given reference period use:

```
cdo eca_tg10p tgfile tgn10file outfile
```

2.0.29 ECATG90P - Warm days percent w.r.t. 90th percentile of reference period

Synopsis

eca_tg90p `infile1 infile2 outfile`

Description

Let `infile1` be a time series of the daily mean temperature TG, and `infile2` be the 90th percentile TGn90 of daily mean temperatures for any period used as reference. Then the percentage of time where TG > TGn90 is calculated. TGn90 is calculated as the 90th percentile of daily mean temperatures of a five day window centred on each calendar day of a given climate reference period. Note that both TG and TGn90 have to be given in the same units. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile1`.

Example

To compute the percentage of timesteps with a daily mean temperature greater than the 90th percentile of the daily mean temperatures for a given reference period use:

```
cdo eca_tg90p tgfile tgn90file outfile
```

2.0.30 ECATN10P - Cold nights percent w.r.t. 10th percentile of reference period

Synopsis

eca_tn10p `infile1 infile2 outfile`

Description

Let `infile1` be a time serie of the daily minimum temperature TN, and `infile2` be the 10th percentile TNn10 of daily minimum temperatures for any period used as reference. Then the percentage of time where TN $<$ TNn10 is calculated. TNn10 is calculated as the 10th percentile of daily minimum temperatures of a five day window centred on each calendar day of a given climate reference period. Note that both TN and TNn10 have to be given in the same units. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile1`.

Example

To compute the percentage of timesteps with a daily minimum temperature smaller than the 10th percentile of the daily minimum temperatures for a given reference period use:

```
cdo eca_tn10p tnfile tnn10file outfile
```

2.0.31 ECATN90P - Warm nights percent w.r.t. 90th percentile of reference period

Synopsis

eca_tn90p `infile1 infile2 outfile`

Description

Let `infile1` be a time series of the daily minimum temperature TN, and `infile2` be the 90th percentile TNn90 of daily minimum temperatures for any period used as reference. Then the percentage of time where TN $>$ TNn90 is calculated. TNn90 is calculated as the 90th percentile of daily minimum temperatures of a five day window centred on each calendar day of a given climate reference period. Note that both TN and TNn90 have to be given in the same units. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile1`.

Example

To compute the percentage of timesteps with a daily minimum temperature greater than the 90th percentile of the daily minimum temperatures for a given reference period use:

```
cdo eca_tn90p tnfile tnn90file outfile
```

2.0.32 ECATR - Tropical nights index per time period

Synopsis

<operator>[,T[,params]] `infile outfile`

Description

Let `infile` be a time series of the daily minimum temperature TN, then the number of days where TN $> T$ is counted. The number T is an optional parameter with default T = 20℃. Note that TN have to be given in units of Kelvin, whereas T have to be given in degrees Celsius. Parameter is a comma-separated list of "key=values" pairs.

Operators

eca_tr Tropical nights index per time period
The operator counts over the entire time series. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile`.

etccdi_tr Tropical nights index per time period
The default output frequency is yearly. The date information of a timestep in `outfile` is the mid of the frequency interval.

Parameter

T	FLOAT	Temperature threshold (unit: ℃; default: T = 20℃)
freq	STRING	Output frequency (year, month)

Example

To get the number of tropical nights of a time series of daily minimum temperatures use:

```
cdo eca_tr tnfile outfile
```

2.0.33 ECATX10P - Very cold days percent w.r.t. 10th percentile of reference period

Synopsis

eca_tx10p `infile1 infile2 outfile`

Description

Let `infile1` be a time series of the daily maximum temperature TX, and `infile2` be the 10th percentile TXn10 of daily maximum temperatures for any period used as reference. Then the percentage of time where TX < TXn10. is calculated. TXn10 is calculated as the 10th percentile of daily maximum temperatures of a five day window centred on each calendar day of a given climate reference period. Note that both TX and TXn10 have to be givenin the same units. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile1`.

Example

To compute the percentage of timesteps with a daily maximum temperature smaller than the 10th percentile of the daily maximum temperatures for a given reference period use:

```
cdo eca_tx10p txfile txn10file outfile
```

2.0.34 ECATX90P - Very warm days percent w.r.t. 90th percentile of reference period

Synopsis

eca_tx90p `infile1 infile2 outfile`

Description

Let `infile1` be a time series of the daily maximum temperature TX, and `infile2` be the 90th percentile TXn90 of daily maximum temperatures for any period used as reference. Then the percentage of time where TX > TXn90. is calculated. TXn90 is calculated as the 90th percentile of daily maximum temperatures of a five day window centred on each calendar day of a given climate reference period. Note that both TX and TXn90 have to be given in the same units. The date information of a timestep in `outfile` is the date of the last contributing timestep in `infile1`.

Example

To compute the percentage of timesteps with a daily maximum temperature greater than the 90th percentile of the daily maximum temperatures for a given reference period use:

```
cdo eca_tx90p txfile txn90file outfile
```

2.0.35 ECAETCCDI - ETCCDI conform index for a reference periode calculated with bootstrapping

Synopsis

<operator>,n,startboot,endboot[,m] `infile1 infile2 infile3 outfile`

Description

This module enables to compute Climate Extremes Indices according to the method recommended by the Expert Team on Climate Change Detection and Indices. It differs from the corresponding eca_* indices by applying bootstrapping for a reference period (see Zhang et al. 2005) given by startboot and endboot and using the R-type 8 method for percentile calculation. A requirement for correct percentile calculation is that CDO_PCTL_NBINS>=window*(endboot-startboot+1)*(sizeof(double)/sizeof(int))+2 This demands for high working storage since the entire data of the bootstrapping interval need to be hold in storage. Otherwise, a histogram is used to calculate the percentile. infile2 (infile3) contains the daily minimum (maximum) of the bootstrapping interval. If m=m, the output variable will be saved monthly, otherwise with yearly frequency.

Operators

etccdi_tx90p	Percentage of Days when Daily Maximum Temperature is Above the 90th Percentile
etccdi_tx10p	Percentage of Days when Daily Maximum Temperature is Below the 10th Percentile
etccdi_tn90p	Percentage of Days when Daily Minimum Temperature is Above the 90th Percentile
etccdi_tn10p	Percentage of Days when Daily Minimum Temperature is Below the 10th Percentile
etccdi_r95p	Annual Total Precipitation when Daily Precipitation Exceeds the 95th Percentile of Wet Day Precipitation
etccdi_r99p	Annual Total Precipitation when Daily Precipitation Exceeds the 99th Percentile of Wet Day Precipitation

Parameter

n	INTEGER	Window days, number of timesteps
startboot	INTEGER	First year of bootstrapping interval
endboot	INTEGER	Last year of bootstrapping interval
m	CHARACTER	Output frequency

Environment

`CDO_PCTL_NBINS`	Sets the number of histogram bins. The default number is 101.

Example

To compute the percentage of timesteps of each month with a daily maximum temperature greater than the 90th percentile of the daily maximum temperatures for a reference period 1960-1989 and a 5 consecutive days window use:

```
cdo etccdi_tx90p,5,1960,1989,m txfile -ydrunmin,5 txfile -ydrunmax,5 txfile outfile
```

Bibliography

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Index