Climate indices with CDO

Climate indices of daily temperature and precipitation extremes
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Contents

1 Introduction

The Climate Data Operators (**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 `ifile` or `ifile1`, `ifile2`, etc., and an arbitrary number of input files are named `ifiles`. All output files are named `ofile` or `ofile1`, `ofile2`, etc. Further the following notion is introduced:

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

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

eca_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
eca_etr	Intra-period extreme temperature range
eca_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
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
eca_rr1	Wet days index per time period
eca_rx1day	Highest one day precipitation amount per time period
eca_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
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
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

2.0.1 ECACDD - Consecutive dry days index per time period

Synopsis

eca_cdd[,*R*[,*N*]] `ifile ofile`

Description

Let `ifile` 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. The date information of a timestep in `ofile` is the date of the last contributing timestep in `ifile`. The following variables are created:

- consecutive_dry_days_index_per_time_period
- number_of_cdd_periods_with_more_than_<N>days_per_time_period

Parameter

R	FLOAT	Precipitation threshold (unit: mm; default: R = 1 mm)
N	INTEGER	Minimum number of days exceeded (default: N = 5)

Example

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

```
cdo eca_cdd rrfile ofile
```

2.0.2 ECACFD - Consecutive frost days index per time period

Synopsis

eca_cfd[,*N*] `ifile ofile`

Description

Let `ifile` 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 `ofile` is the date of the last contributing timestep in `ifile`. The following variables are created:

- consecutive_frost_days_index_per_time_period
- number_of_cfd_periods_with_more_than_<N>days_per_time_period

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 ofile
```

2.0.3 ECACSU - Consecutive summer days index per time period

Synopsis

eca_csu*[,T[,N]]* `ifile ofile`

Description

Let `ifile` 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 `ofile` is the date of the last contributing timestep in `ifile`. The following variables are created:

- consecutive_summer_days_index_per_time_period
- number_of_csu_periods_with_more_than_<N>days_per_time_period

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 ofile
```

2.0.4 ECACWD - Consecutive wet days index per time period

Synopsis

eca_cwd*[,R[,N]]* `ifile ofile`

Description

Let `ifile` 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. The date information of a timestep in `ofile` is the date of the last contributing timestep in `ifile`. The following variables are created:

- consecutive_wet_days_index_per_time_period
- number_of_cwd_periods_with_more_than_<N>days_per_time_period

Parameter

R	FLOAT	Precipitation threshold (unit: mm; default: R = 1 mm)
N	INTEGER	Minimum number of days exceeded (default: N = 5)

Example

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

```
cdo eca_cwd rrfile ofile
```

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

Synopsis

eca_cwdi*[,nday[,T]]* `ifile1 ifile2 ofile`

Description

Let `ifile1` be a time series of the daily minimum temperature TN, and let `ifile2` 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 `ofile` is the date of the last contributing timestep in `ifile1`. The following variables are created:

- cold_wave_duration_index_wrt_mean_of_reference_period
- cold_waves_per_time_period

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 ofile
```

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

Synopsis

eca_cwfi*[,nday]* `ifile1 ifile2 ofile`

Description

Let `ifile1` be a time series of the daily mean temperature TG, and `ifile2` 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. The date information of a timestep in `ofile` is the date of the last contributing timestep in `ifile1`. The following variables are created:

- cold_spell_days_index_wrt_10th_percentile_of_reference_period
- cold_spell_periods_per_time_period

Parameter

nday	INTEGER	Number of consecutive days (default: nday = 6)

Example

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

```
cdo eca_cwfi tgfile tgn10file ofile
```

2.0.7 ECAETR - Intra-period extreme temperature range

Synopsis

eca_etr ifile1 ifile2 ofile

Description

Let `ifile1` and `ifile2` 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 `ofile` is the date of the last contributing timesteps in `ifile1` and `ifile2`. The following variables are created:

- intra_period_extreme_temperature_range

Example

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

```
cdo eca_etr txfile tnfile ofile
```

2.0.8 ECAFD - Frost days index per time period

Synopsis

eca_fd ifile ofile

Description

Let `ifile` 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. The date information of a timestep in `ofile` is the date of the last contributing timestep in `ifile`. The following variables are created:

- frost_days_index_per_time_period

Example

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

```
cdo eca_fd tnfile ofile
```

2.0.9 ECAGSL - Thermal Growing season length index

Synopsis

eca_gsl*[,nday[,T[,fland]]]* `ifile1 ifile2 ofile`

Description

Let `ifile1` be a time series of the daily mean temperature TG, and `ifile2` 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 hemispere, this period corresponds with the regular year, whereas on southern hemispere, 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 $T = 5$℃. 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 `ofile` is the date of the last contributing timestep in `ifile`. The following variables are created:

- thermal_growing_season_length
- day_of_year_of_growing_season_start

Parameter

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

2.0.10 ECAHD - Heating degree days per time period

Synopsis

eca_hd*[,T1[,T2]]* `ifile ofile`

Description

Let `ifile` 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 `ofile` is the date of the last contributing timestep in `ifile`. The following variables are created:

- heating_degree_days_per_time_period

Parameter

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

Example

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

```
cdo eca_hd tgfile ofile
```

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

Synopsis

eca_hwdi*[,nday[,T]]* `ifile1 ifile2 ofile`

Description

Let `ifile1` be a time series of the daily maximum temperature TX, and let `ifile2` 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 `ofile` is the date of the last contributing timestep in `ifile1`. The following variables are created:

- heat_wave_duration_index_wrt_mean_of_reference_period
- heat_waves_per_time_period

Parameter

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

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

Synopsis

eca_hwfi*[,nday]* `ifile1 ifile2 ofile`

Description

Let `ifile1` be a time series of the daily mean temperature TG, and `ifile2` 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. The date information of a timestep in `ofile` is the date of the last contributing timestep in `ifile1`. The following variables are created:

- warm_spell_days_index_wrt_90th_percentile_of_reference_period
- warm_spell_periods_per_time_period

Parameter

nday	INTEGER	Number of consecutive days (default: nday = 6)

Example

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

```
cdo eca_hwfi tgfile tgn90file ofile
```

2.0.13 ECAID - Ice days index per time period

Synopsis

eca_id `ifile ofile`

Description

Let `ifile` be a time series of the daily maximum temperature TX, then the number of days where TX < 0 ℃ is counted. Note that TX have to be given in units of Kelvin. The date information of a timestep in `ofile` is the date of the last contributing timestep in `ifile`. The following variables are created:

- ice_days_index_per_time_period

Example

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

```
cdo eca_id txfile ofile
```

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

Synopsis

eca_r75p `ifile1 ifile2 ofile`

Description

Let `ifile1` be a time series RR of the daily precipitation amount at wet days (precipitation >= 1 mm) and `ifile2` 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 `ifile2` is generated by the operator `ydaypctl,75`. The date information of a timestep in `ofile` is the date of the last contributing timestep in `ifile1`. The following variables are created:

- moderate_wet_days_wrt_75th_percentile_of_reference_period

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 ofile
```

2.0.15 ECAR75PTOT - Precipitation percent due to R75p days

Synopsis

eca_r75ptot `ifile1 ifile2 ofile`

Description

Let `ifile1` be a time series RR of the daily precipitation amount at wet days (precipitation >= 1 mm) and `ifile2` 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 `ifile2` is generated by the operator `ydaypctl,75`. The date information of a timestep in `ofile` is the date of the last contributing timestep in `ifile1`. The following variables are created:

- precipitation_percent_due_to_R75p_days

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

Synopsis

eca_r90p `ifile1 ifile2 ofile`

Description

Let `ifile1` be a time series RR of the daily precipitation amount at wet days (precipitation >= 1 mm) and `ifile2` 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 `ifile2` is generated by the operator `ydaypctl,90`. The date information of a timestep in `ofile` is the date of the last contributing timestep in `ifile1`. The following variables are created:

- wet_days_wrt_90th_percentile_of_reference_period

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 ofile
```

2.0.17 ECAR90PTOT - Precipitation percent due to R90p days

Synopsis

eca_r90ptot `ifile1 ifile2 ofile`

Description

Let `ifile1` be a time series RR of the daily precipitation amount at wet days (precipitation >= 1 mm) and `ifile2` 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 `ifile2` is generated by the operator `ydaypctl,90`. The date information of a timestep in `ofile` is the date of the last contributing timestep in `ifile1`. The following variables are created:

- precipitation_percent_due_to_R90p_days

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

Synopsis

eca_r95p `ifile1 ifile2 ofile`

Description

Let `ifile1` be a time series RR of the daily precipitation amount at wet days (precipitation >= 1 mm) and `ifile2` 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 `ifile2` is generated by the operator `ydaypctl,95`. The date information of a timestep in `ofile` is the date of the last contributing timestep in `ifile1`. The following variables are created:

- very_wet_days_wrt_95th_percentile_of_reference_period

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 ofile
```

2.0.19 ECAR95PTOT - Precipitation percent due to R95p days

Synopsis

eca_r95ptot `ifile1 ifile2 ofile`

Description

Let `ifile1` be a time series RR of the daily precipitation amount at wet days (precipitation >= 1 mm) and `ifile2` 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 `ifile2` is generated by the operator `ydaypctl,95`. The date information of a timestep in `ofile` is the date of the last contributing timestep in `ifile1`. The following variables are created:

- precipitation_percent_due_to_R95p_days

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

Synopsis

eca_r99p `ifile1 ifile2 ofile`

Description

Let `ifile1` be a time series RR of the daily precipitation amount at wet days (precipitation >= 1 mm) and `ifile2` 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 `ifile2` is generated by the operator `ydaypctl,99`. The date information of a timestep in `ofile` is the date of the last contributing timestep in `ifile1`. The following variables are created:

- extremely_wet_days_wrt_99th_percentile_of_reference_period

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 ofile
```

2.0.21 ECAR99PTOT - Precipitation percent due to R99p days

Synopsis

eca_r99ptot `ifile1 ifile2 ofile`

Description

Let `ifile1` be a time series RR of the daily precipitation amount at wet days (precipitation >= 1 mm) and `ifile2` 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 `ifile2` is generated by the operator `ydaypctl,99`. The date information of a timestep in `ofile` is the date of the last contributing timestep in `ifile1`. The following variables are created:

- precipitation_percent_due_to_R99p_days

2.0.22 ECAPD - Precipitation days index per time period

Synopsis

eca_pd,*x* `ifile ofile`

eca_r10mm `ifile ofile`

eca_r20mm `ifile ofile`

Description

Let `ifile` 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 `ofile` is the date of the last contributing timestep in `ifile`. The following variables are created:

- precipitation_days_index_per_time_period

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.

Parameter

x	FLOAT	Daily precipitation amount threshold in [mm]

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 ifile ofile
```

2.0.23 ECARR1 - Wet days index per time period

Synopsis

eca_rr1[*,R*] `ifile ofile`

Description

Let `ifile` 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 `ofile` is the date of the last contributing timestep in `ifile`. The following variables are created:

- wet_days_index_per_time_period

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 ofile
```

2.0.24 ECARX1DAY - Highest one day precipitation amount per time period

Synopsis

eca_rx1day[*,mode*] `ifile ofile`

Description

Let `ifile` be a time series of the daily precipitation amount RR, then the maximum of RR is written to `ofile`. If the optional parameter *mode* is set to 'm' the maximum daily precipitation amounts are determined for each month. The date information of a timestep in `ofile` is the date of the last contributing timestep in `ifile`. The following variables are created:

- highest_one_day_precipitation_amount_per_time_period

Parameter

mode	STRING	Operation mode (optional). If mode = 'm' then maximum daily precipitation amounts are determined for each month

Example

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

```
cdo eca_rx1day rrfile ofile
```

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

```
cdo eca_rx1day,m rrfile ofile
```

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

```
cdo timmax rrfile ofile
cdo monmax rrfile ofile
```

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

Synopsis

eca_rx5day*[,x]* `ifile ofile`

Description

Let `ifile` be a time series of 5-day precipitation totals RR, then the maximum of RR is written to `ofile`. 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. The date information of a timestep in `ofile` is the date of the last contributing timestep in `ifile`. The following variables are created:

- highest_five_day_precipitation_amount_per_time_period
- number_of_5day_heavy_precipitation_periods_per_time_period

Parameter

x	FLOAT	Precipitation threshold (unit: mm; default: x = 50 mm)

Example

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

```
cdo eca_rx5day rrfile ofile
```

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

```
cdo timmax rrfile ofile
```

2.0.26 ECASDII - Simple daily intensity index per time period

Synopsis

eca_sdii*[,R]* `ifile ofile`

Description

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

- simple_daily_intensity_index_per_time_period

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 ofile
```

2.0.27 ECASU - Summer days index per time period

Synopsis

eca_su[,*T*] `ifile ofile`

Description

Let `ifile` 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. The date information of a timestep in `ofile` is the date of the last contributing timestep in `ifile`. The following variables are created:

- summer_days_index_per_time_period

Parameter

T	FLOAT	Temperature threshold (unit: ℃; default: T = 25℃)

Example

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

```
cdo eca_su txfile ofile
```

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

Synopsis

eca_tg10p `ifile1 ifile2 ofile`

Description

Let `ifile1` be a time series of the daily mean temperature TG, and `ifile2` 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 `ofile` is the date of the last contributing timestep in `ifile1`. The following variables are created:

- cold_days_percent_wrt_10th_percentile_of_reference_period

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 ofile
```

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

Synopsis

eca_tg90p `ifile1 ifile2 ofile`

Description

Let `ifile1` be a time series of the daily mean temperature TG, and `ifile2` 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 `ofile` is the date of the last contributing timestep in `ifile1`. The following variables are created:

- warm_days_percent_wrt_90th_percentile_of_reference_period

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 ofile
```

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

Synopsis

eca_tn10p `ifile1 ifile2 ofile`

Description

Let `ifile1` be a time serie of the daily minimum temperature TN, and `ifile2` 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 `ofile` is the date of the last contributing timestep in `ifile1`. The following variables are created:

- cold_nights_percent_wrt_10th_percentile_of_reference_period

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 ofile
```

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

Synopsis

eca_tn90p `ifile1 ifile2 ofile`

Description

Let `ifile1` be a time series of the daily minimum temperature TN, and `ifile2` 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 `ofile` is the date of the last contributing timestep in `ifile1`. The following variables are created:

- warm_nights_percent_wrt_90th_percentile_of_reference_period

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 ofile
```

2.0.32 ECATR - Tropical nights index per time period

Synopsis

eca_tr*[,T]* `ifile ofile`

Description

Let `ifile` 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. The date information of a timestep in `ofile` is the date of the last contributing timestep in `ifile`. The following variables are created:

- tropical_nights_index_per_time_period

Parameter

T	FLOAT	Temperature threshold (unit: ℃; default: T = 20℃)

Example

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

```
cdo eca_tr tnfile ofile
```

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

Synopsis

eca_tx10p `ifile1 ifile2 ofile`

Description

Let `ifile1` be a time series of the daily maximum temperature TX, and `ifile2` 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 `ofile` is the date of the last contributing timestep in `ifile1`. The following variables are created:

- very_cold_days_percent_wrt_10th_percentile_of_reference_period

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 ofile
```

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

Synopsis

eca_tx90p `ifile1 ifile2 ofile`

Description

Let `ifile1` be a time series of the daily maximum temperature TX, and `ifile2` 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 `ofile` is the date of the last contributing timestep in `ifile1`. The following variables are created:

- very_warm_days_percent_wrt_90th_percentile_of_reference_period

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 ofile
```

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