Welcome

مشغلات البيانات المناخية

Climate Data Operators
CDO

م.د. سما خالد محمد

قسم علوم الجو - كلية العلوم - الجامعة المستنصرية

الاربعاء 2018-10-17

Climate Data Operators (CDO)

CDO software is a collection of many operators for standard processing of climate and forecast model data.

A single command with hundreds of operators!!!

Providing a range of climate data-related operations through the command-line, developed by the Max Planck Institute for use with GRIB 1/2, netCDF 3/4, and other data format.

The Climate Data Interface [CDI] is used for the fast and file format independent access to GRIB and NetCDF datasets.

Designed specifically for climate and NWP data analysis,

Can be run on Linux, Windows, MasOS and other OS.

Climate Data Operators (CDO)

(Network Common Data Form (netCDF) is a file format for storing multidimensional scientific data (variables) such as temperature, humidity, etc, it is a set of software libraries and self-describing that support the creation, access, and sharing of array-oriented scientific data.

GRIB is a WMO international standard for exchanging GRidded Binary data, and having smaller file size.

Climate Data Operators (CDO)

The main CDO features are:

❑ more than 700 operators available.

❑ can be typed directly into the command line, or scripted.

❑ Modular design and easily extendable with new operators

❑ Very simple command line interface

❑ A dataset can be processed by several operators, without storing the interim results in files

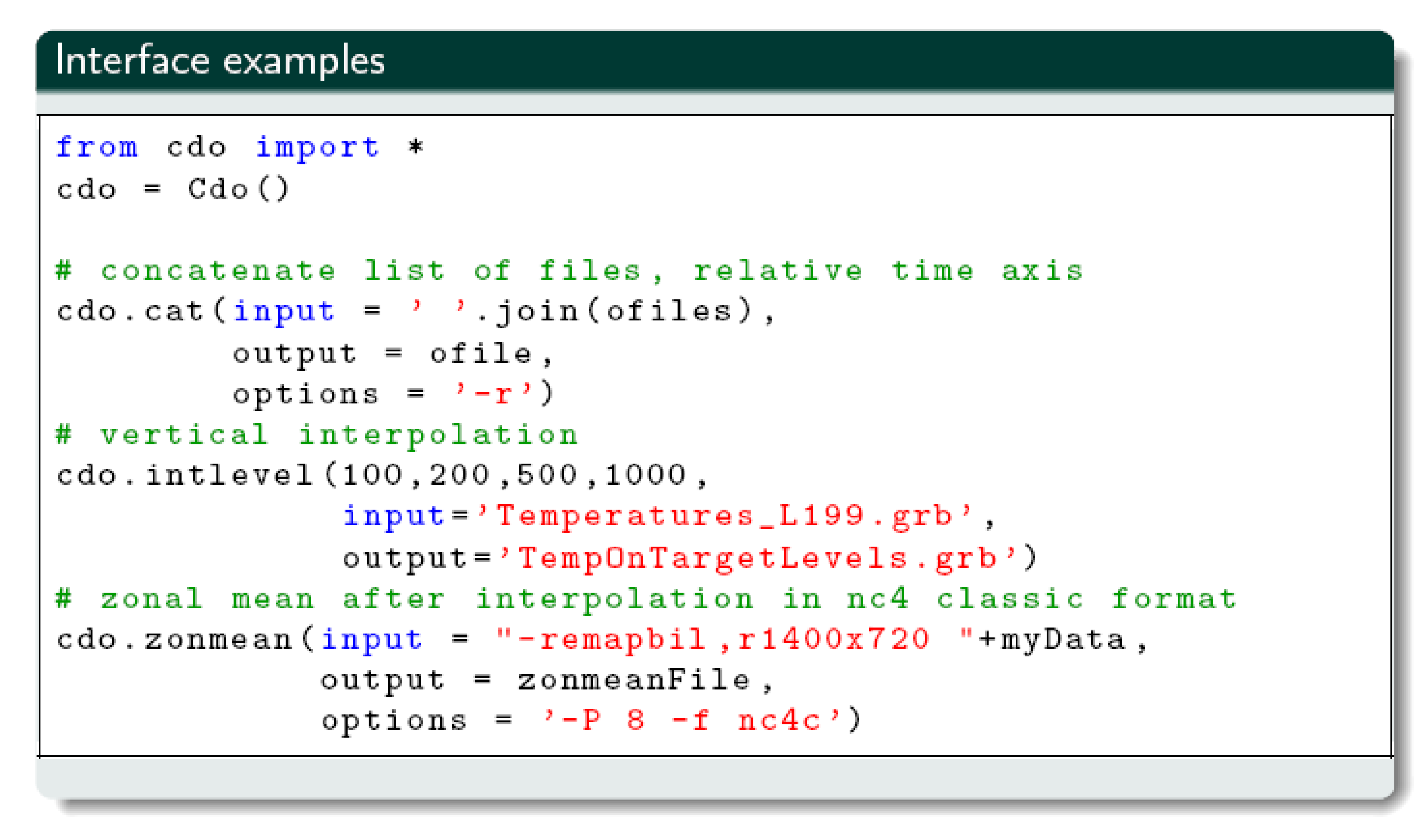
❑ Most operators handle datasets with missing values

❑ Fast processing of large datasets

❑ Support of many different grid types

Climate Data Operators (CDO)

❑ Scripting with Ruby/Python



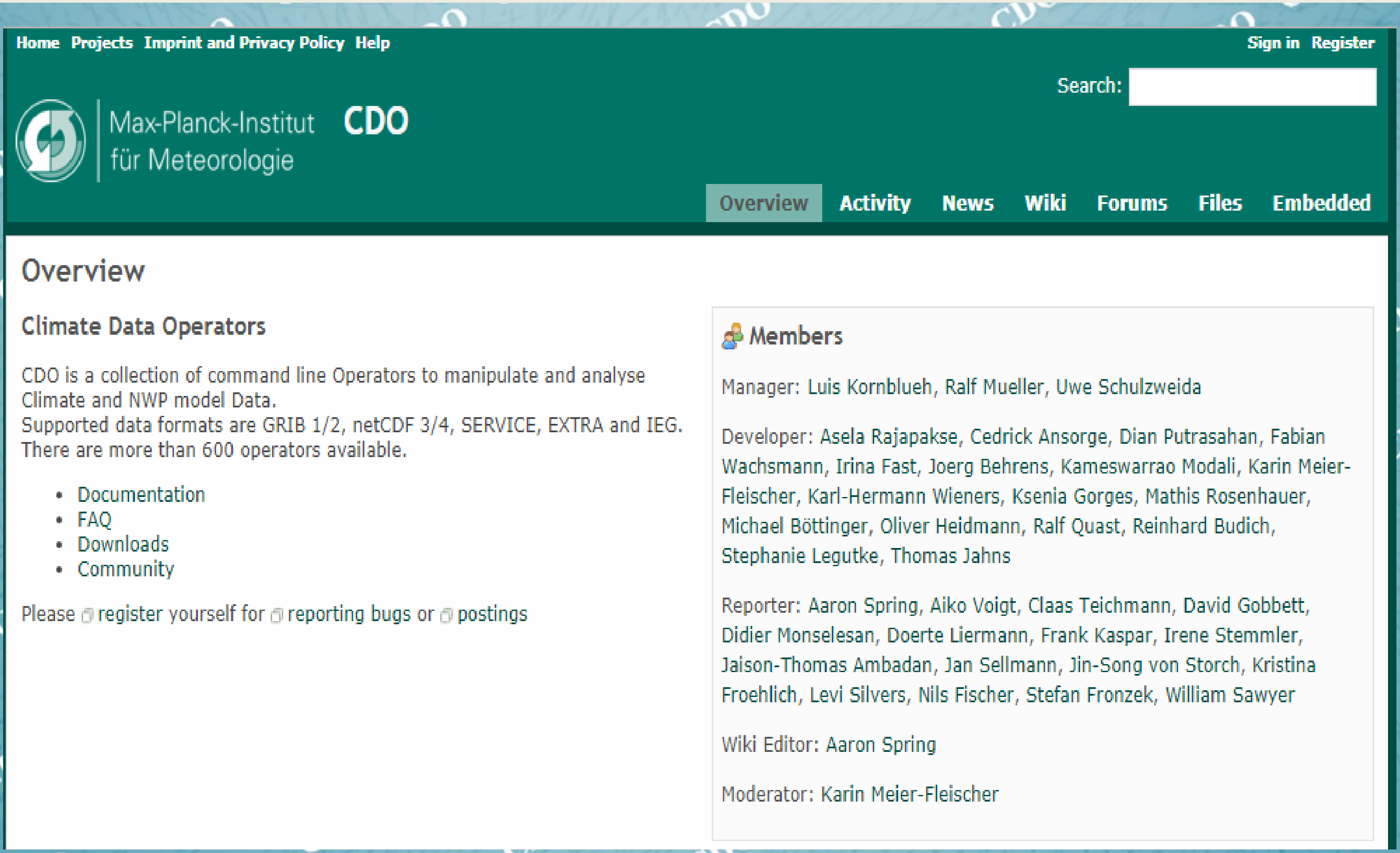
Interface examples

```
from cdo import *
cdo = Cdo()

# concatenate list of files, relative time axis
cdo.cat(input = ’ ’.join(ofiles),
        output = ofile,
        options = ’-r’)
# vertical interpolation
cdo.intlevel(100,200,500,1000,
             input=’Temperatures_L199.grb’,
             output=’TempOnTargetLevels.grb’)
# zonal mean after interpolation in nc4 classic format
cdo.zonmean(input = "-remapbil,r1400x720 "+myData,
            output = zonmeanFile,
            options = ’-P 8 -f nc4c’)
```

Climate Data Operators (CDO)

Free to download and documentation and support forums can be found at https://code.zmaw.de/projects/cdo


Home Projects Imprint and Privacy Policy Help
Sign in Register
Search:
Max-Planck-Institut für Meteorologie
CDO
Overview Activity News Wiki Forums Files Embedded

Overview

Climate Data Operators

CDO is a collection of command line Operators to manipulate and analyse Climate and NWP model Data.
Supported data formats are GRIB 1/2, netCDF 3/4, SERVICE, EXTRA and IEG.
There are more than 600 operators available.

- Documentation
- FAQ
- Downloads
- Community

Please register yourself for reporting bugs or postings

Members

Manager: Luis Kornblueh, Ralf Mueller, Uwe Schulzweida

Developer: Asela Rajapakse, Cedrick Ansorge, Dian Putrasahan, Fabian Wachsmann, Irina Fast, Joerg Behrens, Kameswarrao Modali, Karin Meier-Fleischer, Karl-Hermann Wieners, Ksenia Gorges, Mathis Rosenhauer, Michael Böttinger, Oliver Heidmann, Ralf Quast, Reinhard Budich, Stephanie Legutke, Thomas Jahns

Reporter: Aaron Spring, Aiko Voigt, Claas Teichmann, David Gobbett, Didier Monselesan, Doerte Liermann, Frank Kaspar, Irene Stemmler, Jaison-Thomas Ambadan, Jan Sellmann, Jin-Song von Storch, Kristina Froehlich, Levi Silvers, Nils Fischer, Stefan Fronzek, William Sawyer

Wiki Editor: Aaron Spring

Moderator: Karin Meier-Fleischer

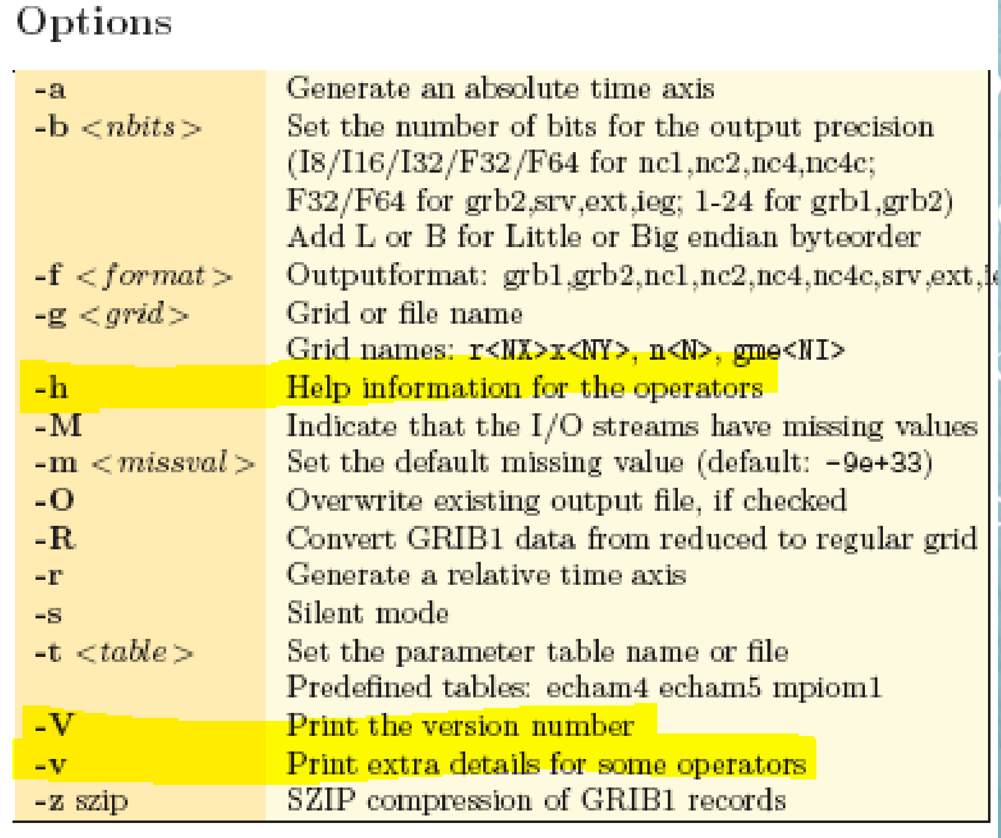
Climate Data Operators (CDO)

How to use CDO?

The syntax is:

cdo [Options] Operator1 [-Operator2 [-OperatorN]]

Note: All options have to be placed before the first operator.

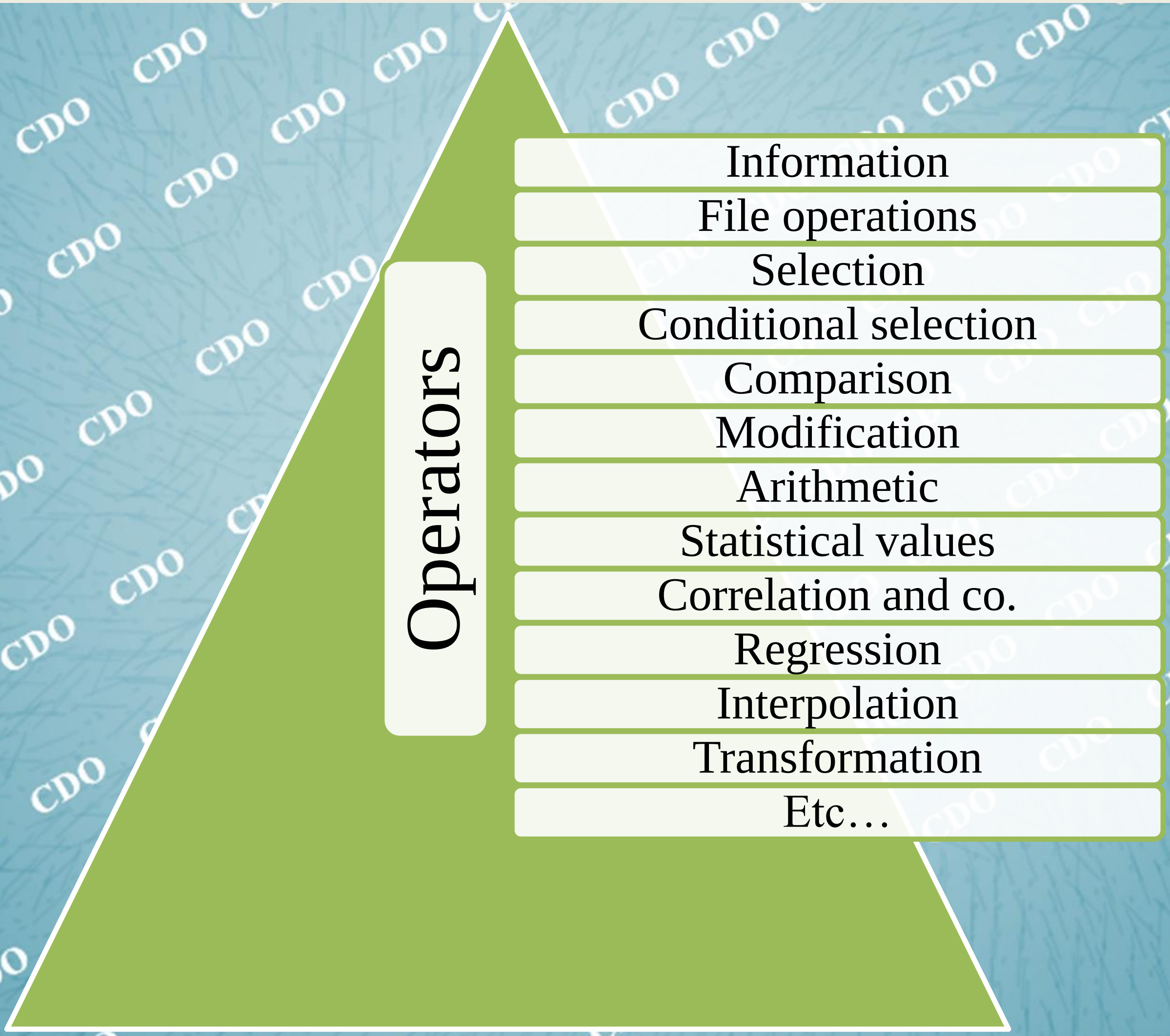


Options

-a	Generate an absolute time axis
-b <*nbits*>	Set the number of bits for the output precision (I8/I16/I32/F32/F64 for nc1,nc2,nc4,nc4c; F32/F64 for grb2,srv,ext,ieg; 1-24 for grb1,grb2) Add L or B for Little or Big endian byteorder
-f <*format*>	Outputformat: grb1,grb2,nc1,nc2,nc4,nc4c,srv,ext,
-g <*grid*>	Grid or file name Grid names: r<NX>x<NY>, n<N>, gme<NI>
-h	Help information for the operators
-M	Indicate that the I/O streams have missing values
-m <*missval*>	Set the default missing value (default: -9e+33)
-O	Overwrite existing output file, if checked
-R	Convert GRIB1 data from reduced to regular grid
-r	Generate a relative time axis
-s	Silent mode
-t <*table*>	Set the parameter table name or file Predefined tables: echam4 echam5 mpiom1
-V	Print the version number
-v	Print extra details for some operators
-z szip	SZIP compression of GRIB1 records

Climate Data Operators (CDO)

How to use CDO?



Operators

- Information
- File operations
- Selection
- Conditional selection
- Comparison
- Modification
- Arithmetic
- Statistical values
- Correlation and co.
- Regression
- Interpolation
- Transformation
- Etc…

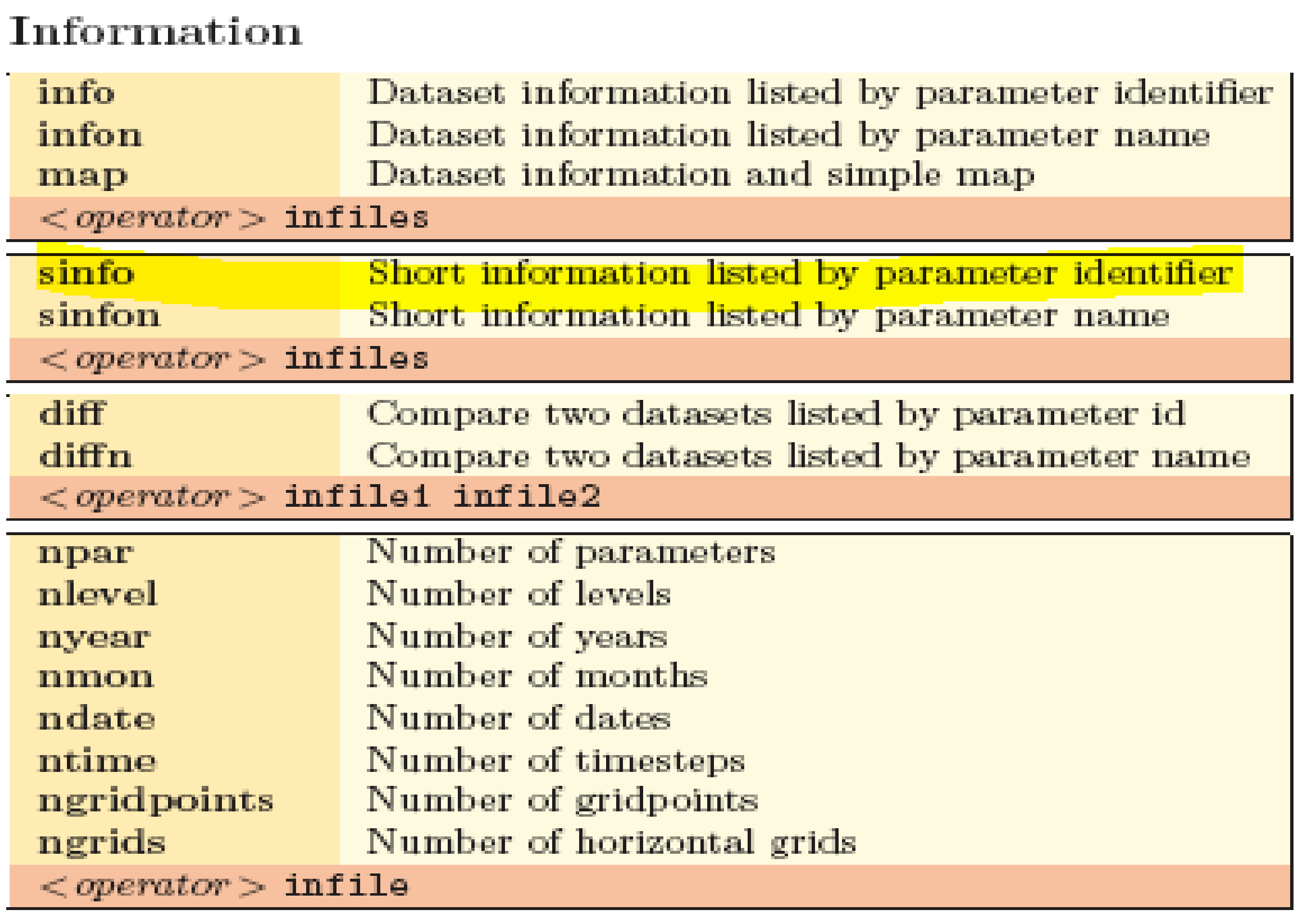
Climate Data Operators (CDO)

To have help information for the operators

```
cdo -h <operator>
ex      cdo -h sinfo
```

Climate Data Operators (CDO)

Information

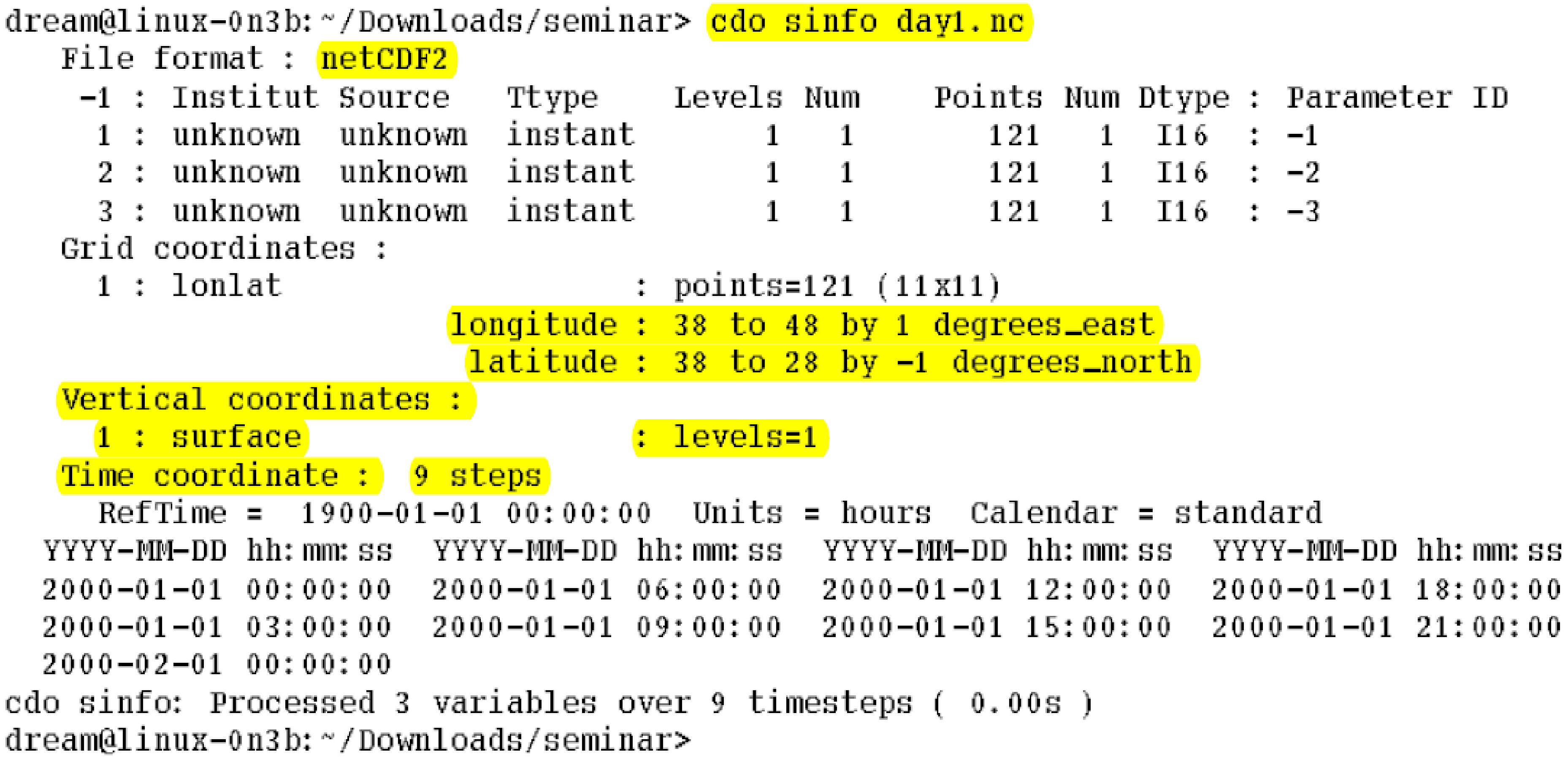


Information

info	Dataset information listed by parameter identifier
infon	Dataset information listed by parameter name
map	Dataset information and simple map
< *operator* > infiles	
sinfo	Short information listed by parameter identifier
sinfon	Short information listed by parameter name
< *operator* > infiles	
diff	Compare two datasets listed by parameter id
diffn	Compare two datasets listed by parameter name
< *operator* > infile1 infile2	
npar	Number of parameters
nlevel	Number of levels
nyear	Number of years
nmon	Number of months
ndate	Number of dates
ntime	Number of timesteps
ngridpoints	Number of gridpoints
ngrids	Number of horizontal grids
< *operator* > infile	

Climate Data Operators (CDO)

Information: Short information listed by parameter identifier **cdo sinfo infile**



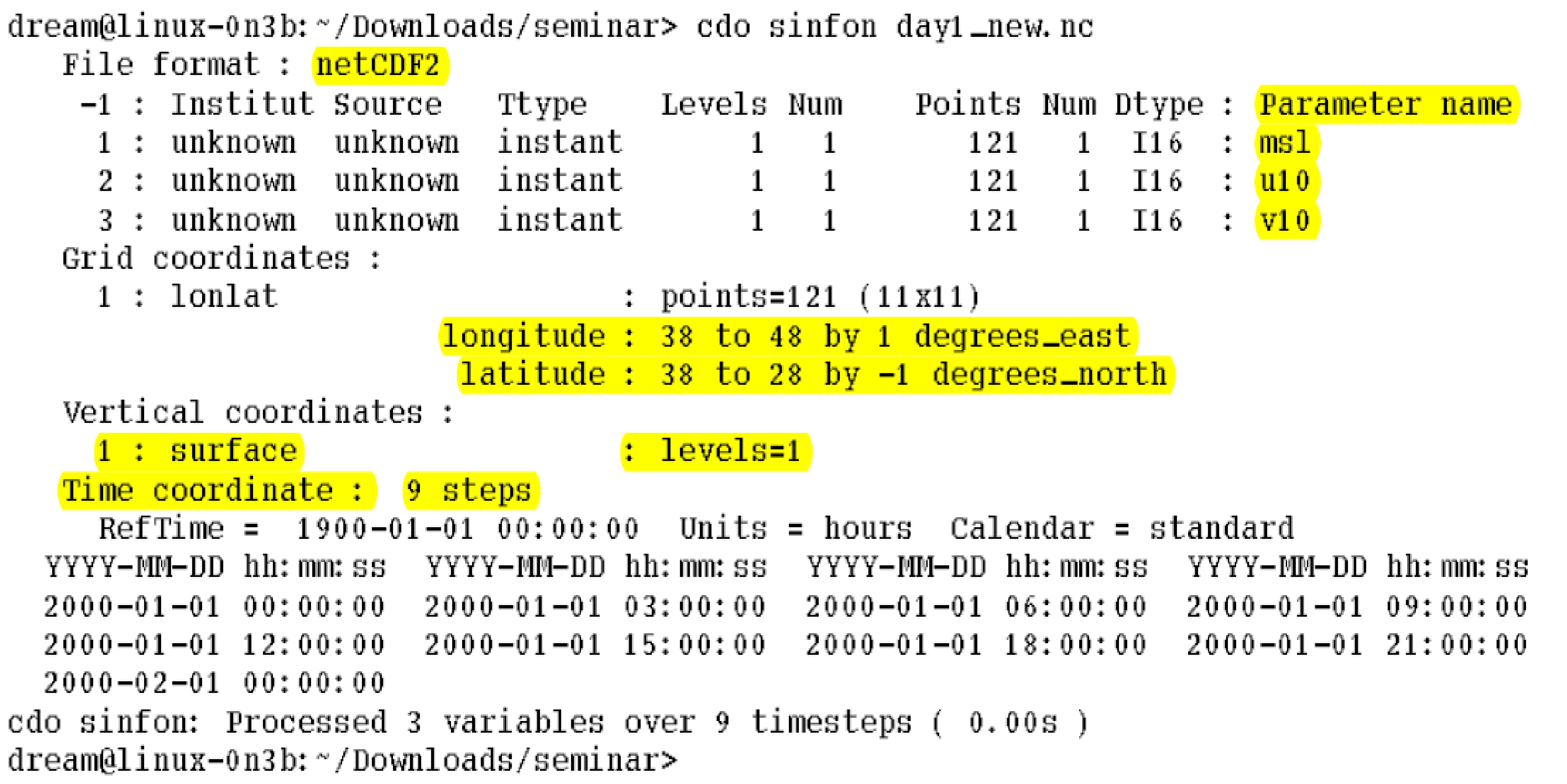
```
dream@linux-0n3b:~/Downloads/seminar> cdo sinfo day1.nc
   File format : netCDF2
    -1 : Institut Source   Ttype     Levels Num    Points Num Dtype : Parameter ID
     1 : unknown  unknown  instant       1   1       121   1  I16  : -1
     2 : unknown  unknown  instant       1   1       121   1  I16  : -2
     3 : unknown  unknown  instant       1   1       121   1  I16  : -3
   Grid coordinates :
     1 : lonlat                    : points=121 (11x11)
                         longitude : 38 to 48 by 1 degrees_east
                          latitude : 38 to 28 by -1 degrees_north
   Vertical coordinates :
     1 : surface                   : levels=1
   Time coordinate :  9 steps
     RefTime =  1900-01-01 00:00:00  Units = hours  Calendar = standard
  YYYY-MM-DD hh:mm:ss  YYYY-MM-DD hh:mm:ss  YYYY-MM-DD hh:mm:ss  YYYY-MM-DD hh:mm:ss
  2000-01-01 00:00:00  2000-01-01 06:00:00  2000-01-01 12:00:00  2000-01-01 18:00:00
  2000-01-01 03:00:00  2000-01-01 09:00:00  2000-01-01 15:00:00  2000-01-01 21:00:00
  2000-02-01 00:00:00
cdo sinfo: Processed 3 variables over 9 timesteps ( 0.00s )
dream@linux-0n3b:~/Downloads/seminar>
```

Climate Data Operators (CDO)

Information

Short information listed by parameter name

cdo sinfon infile



```
dream@linux-0n3b:~/Downloads/seminar> cdo sinfon day1_new.nc
   File format : netCDF2
    -1 : Institut Source   Ttype      Levels Num    Points Num Dtype : Parameter name
     1 : unknown  unknown  instant         1   1       121   1  I16  : msl
     2 : unknown  unknown  instant         1   1       121   1  I16  : u10
     3 : unknown  unknown  instant         1   1       121   1  I16  : v10
   Grid coordinates :
     1 : lonlat                    : points=121 (11x11)
                         longitude : 38 to 48 by 1  degrees_east
                          latitude : 38 to 28 by -1  degrees_north
   Vertical coordinates :
     1 : surface                   : levels=1
   Time coordinate :  9 steps
     RefTime =  1900-01-01 00:00:00  Units = hours  Calendar = standard
  YYYY-MM-DD hh:mm:ss  YYYY-MM-DD hh:mm:ss  YYYY-MM-DD hh:mm:ss  YYYY-MM-DD hh:mm:ss
  2000-01-01 00:00:00  2000-01-01 03:00:00  2000-01-01 06:00:00  2000-01-01 09:00:00
  2000-01-01 12:00:00  2000-01-01 15:00:00  2000-01-01 18:00:00  2000-01-01 21:00:00
  2000-02-01 00:00:00
cdo sinfon: Processed 3 variables over 9 timesteps ( 0.00s )
dream@linux-0n3b:~/Downloads/seminar>
```

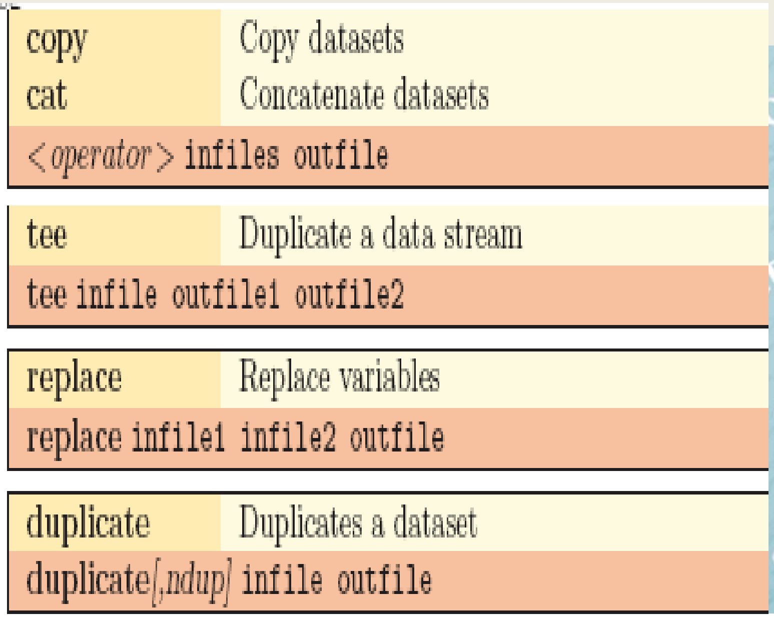
Climate Data Operators (CDO)

File operations

To change the format of a dataset to NetCDF

ex. to convert grib1 file to nc file

cdo -R copy grib_file.grib nc_file.nc

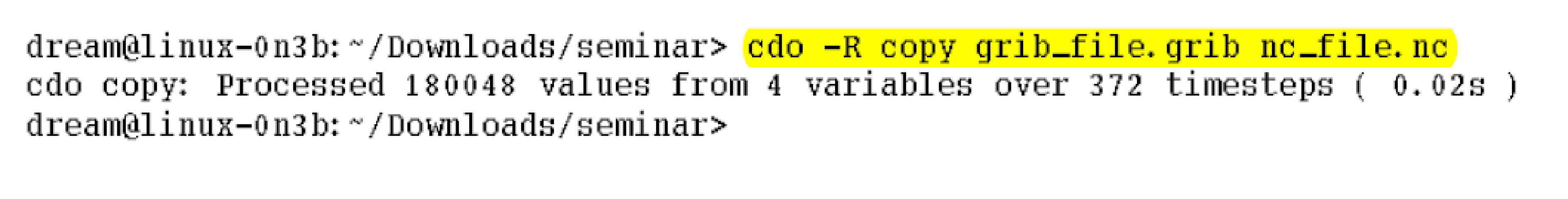


copy	Copy datasets
cat	Concatenate datasets
<*operator*> infiles outfile	

tee	Duplicate a data stream
tee infile outfile1 outfile2	

replace	Replace variables
replace infile1 infile2 outfile	

duplicate	Duplicates a dataset
duplicate[,*ndup*] infile outfile	

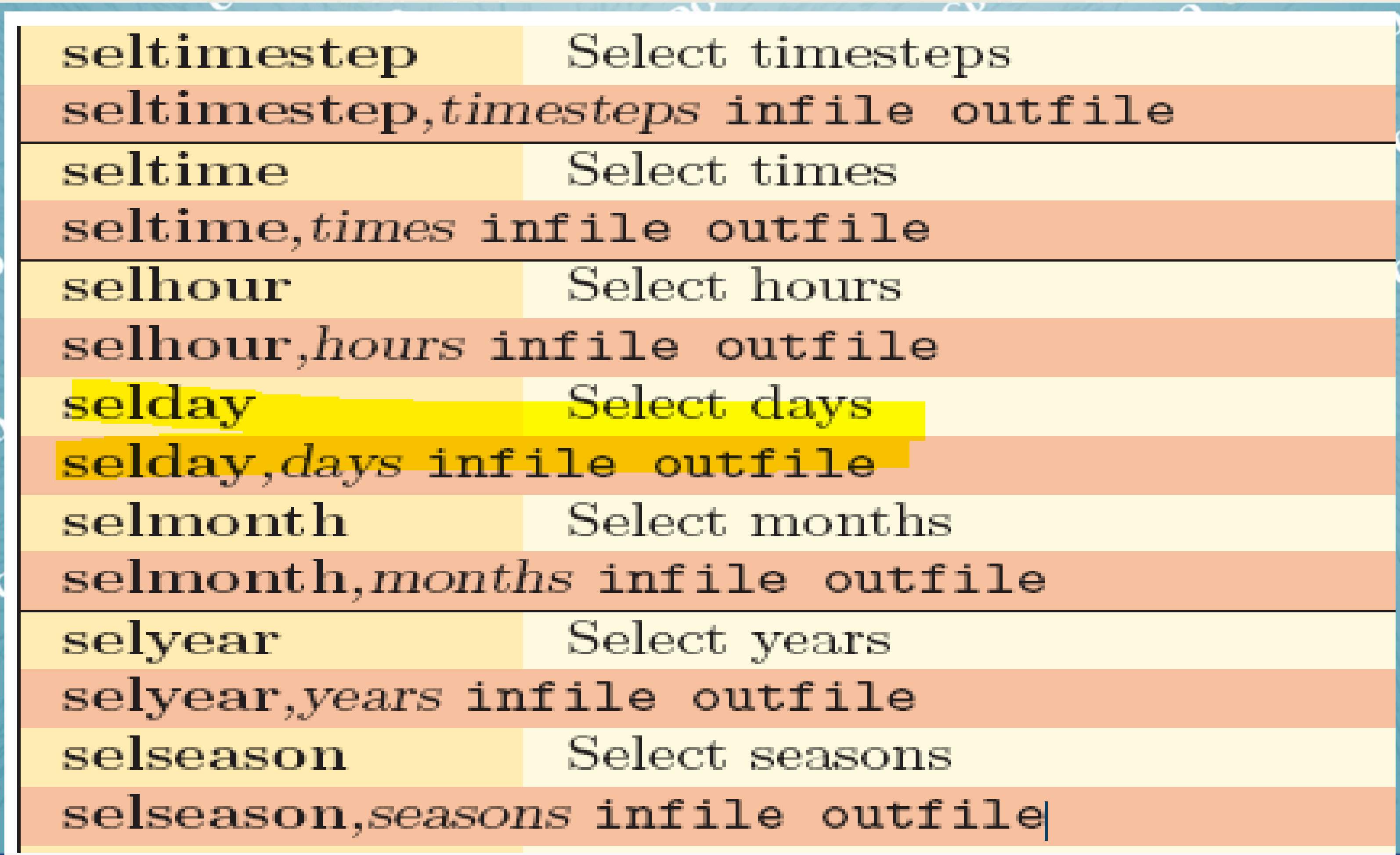


```
dream@linux-0n3b:~/Downloads/seminar> cdo -R copy grib_file.grib nc_file.nc
cdo copy: Processed 180048 values from 4 variables over 372 timesteps ( 0.02s )
dream@linux-0n3b:~/Downloads/seminar>
```

Climate Data Operators (CDO)

Selection :This section contains modules to select time steps, fields or a part of a field from a dataset.

ex. to select day **cdo selday,day infile outfile**



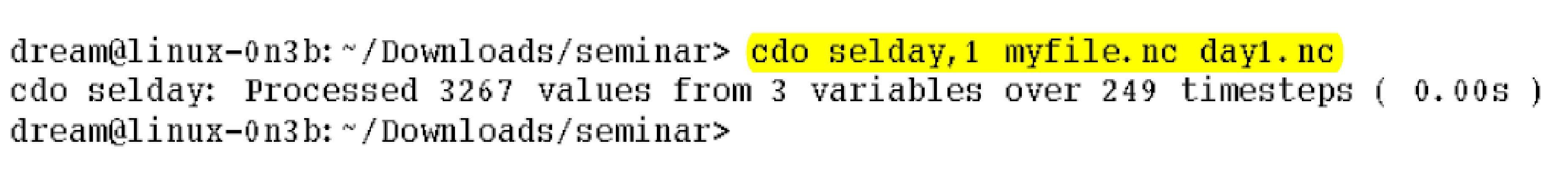
seltimestep	Select timesteps
seltimestep,*timesteps* infile outfile	
seltime	Select times
seltime,*times* infile outfile	
selhour	Select hours
selhour,*hours* infile outfile	
selday	Select days
selday,*days* infile outfile	
selmonth	Select months
selmonth,*months* infile outfile	
selyear	Select years
selyear,*years* infile outfile	
selseason	Select seasons
selseason,*seasons* infile outfile	

Climate Data Operators (CDO)

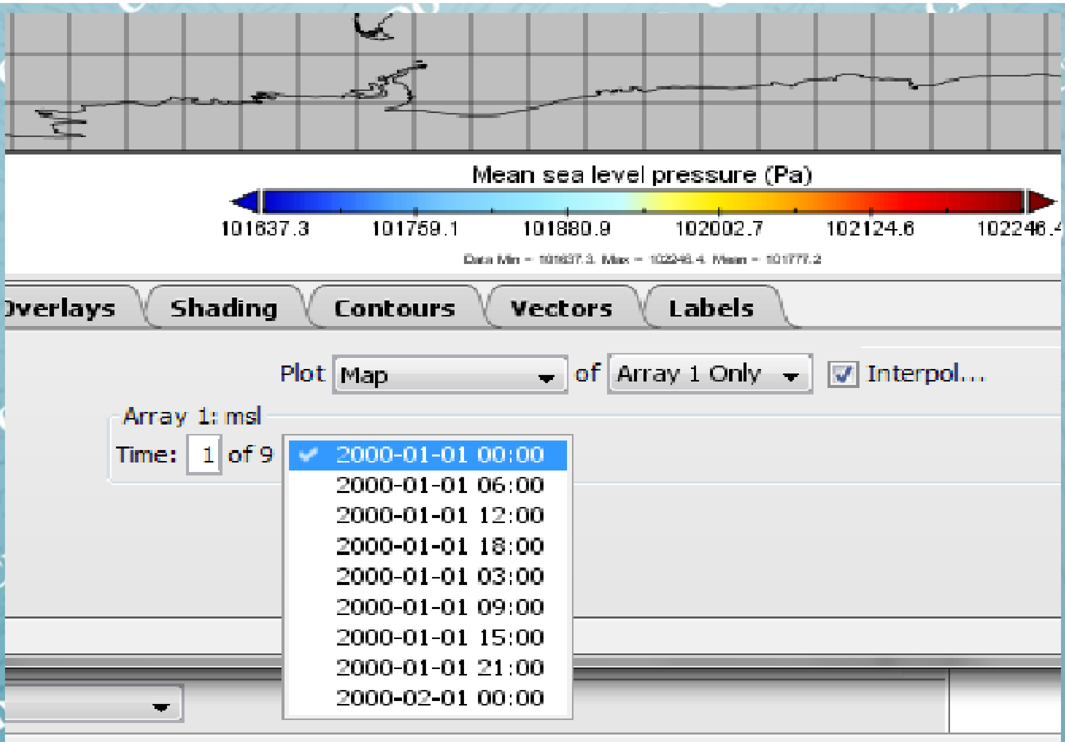
Selection :

ex. to select day

cdo selday,1 myfile.nc day1.nc



```
dream@linux-0n3b:~/Downloads/seminar> cdo selday,1 myfile.nc day1.nc
cdo selday: Processed 3267 values from 3 variables over 249 timesteps ( 0.00s )
dream@linux-0n3b:~/Downloads/seminar>
```



Mean sea level pressure (Pa)

Data Min = 101637.3, Max = 102248.4, Mean = 101777.2

Plot Map of Array 1 Only ☑ Interpol...

Array 1: msl

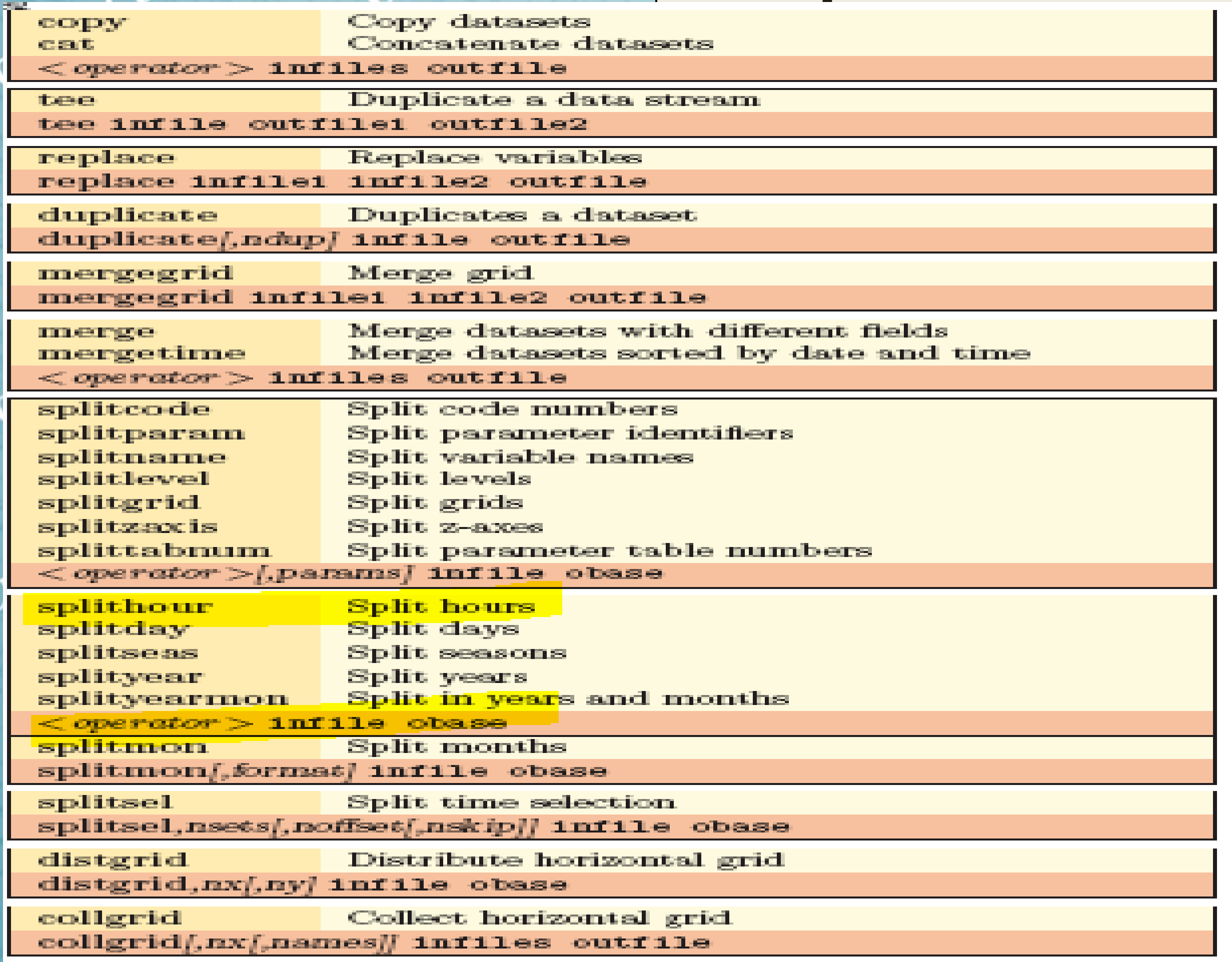
Time: 1 of 9

Climate Data Operators (CDO)

File operations : This section contains modules to perform operations on files.

Example

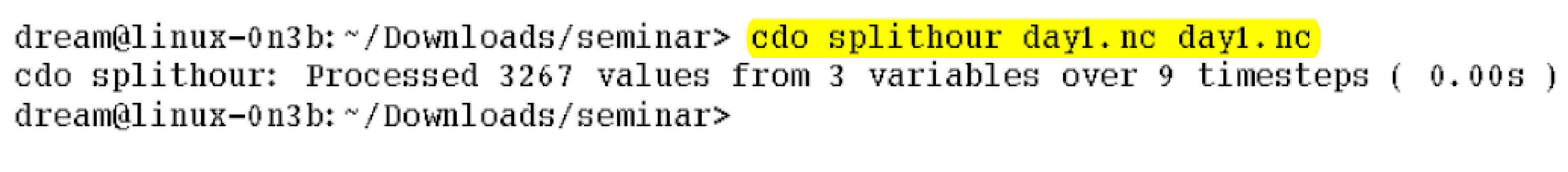
cdo splithour infile outfile



copy	Copy datasets
cat	Concatenate datasets
< *operator* > infiles outfile	
tee	Duplicate a data stream
tee infile outfile1 outfile2	
replace	Replace variables
replace infile1 infile2 outfile	
duplicate	Duplicates a dataset
duplicate[,*ndup*] infile outfile	
mergegrid	Merge grid
mergegrid infile1 infile2 outfile	
merge	Merge datasets with different fields
mergetime	Merge datasets sorted by date and time
< *operator* > infiles outfile	
splitcode	Split code numbers
splitparam	Split parameter identifiers
splitname	Split variable names
splitlevel	Split levels
splitgrid	Split grids
splitzaxis	Split z-axes
splittabnum	Split parameter table numbers
< *operator* >[,*params*] infile obase	
splithour	Split hours
splitday	Split days
splitseas	Split seasons
splityear	Split years
splityearmon	Split in years and months
< *operator* > infile obase	
splitmon	Split months
splitmon[,*format*] infile obase	
splitsel	Split time selection
splitsel,*nsets*[,*noffset*[,*nskip*]] infile obase	
distgrid	Distribute horizontal grid
distgrid,*nx*[,*ny*] infile obase	
collgrid	Collect horizontal grid
collgrid[,*nx*[,*names*]] infiles outfile	

Climate Data Operators (CDO)

File operations
to split hours
cdo splithour day1.nc day1.nc

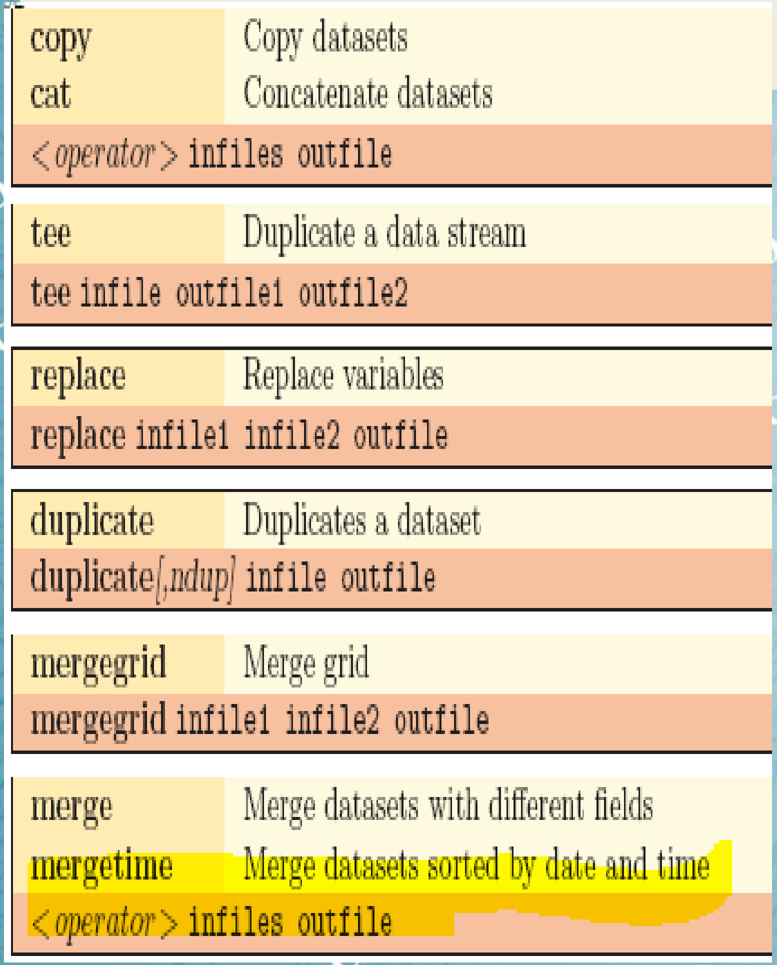


```
dream@linux-0n3b:~/Downloads/seminar> cdo splithour day1.nc day1.nc
cdo splithour: Processed 3267 values from 3 variables over 9 timesteps ( 0.00s )
dream@linux-0n3b:~/Downloads/seminar>
```

Climate Data Operators (CDO)

File operations

merge This module reads datasets from several input files, merges them and writes the resulting dataset to



copy	Copy datasets
cat	Concatenate datasets

```
<operator> infiles outfile
```

tee	Duplicate a data stream

```
tee infile outfile1 outfile2
```

replace	Replace variables

```
replace infile1 infile2 outfile
```

duplicate	Duplicates a dataset

```
duplicate[,ndup] infile outfile
```

mergegrid	Merge grid

```
mergegrid infile1 infile2 outfile
```

merge	Merge datasets with different fields
mergetime	Merge datasets sorted by date and time

```
<operator> infiles outfile
```

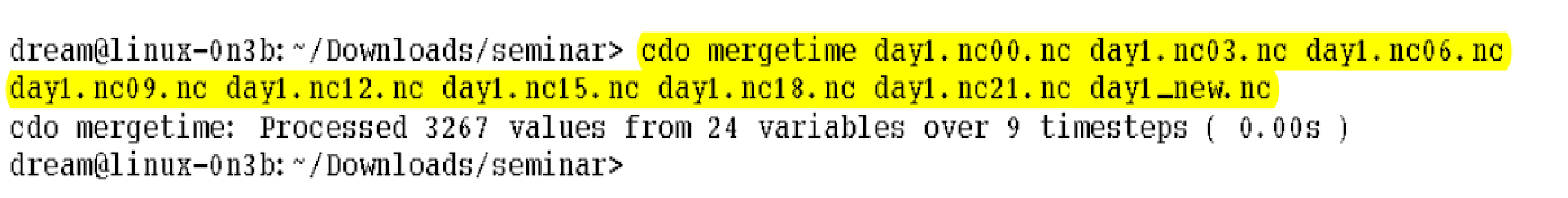
Example

```
cdo mergetime input.nc  output.nc
```

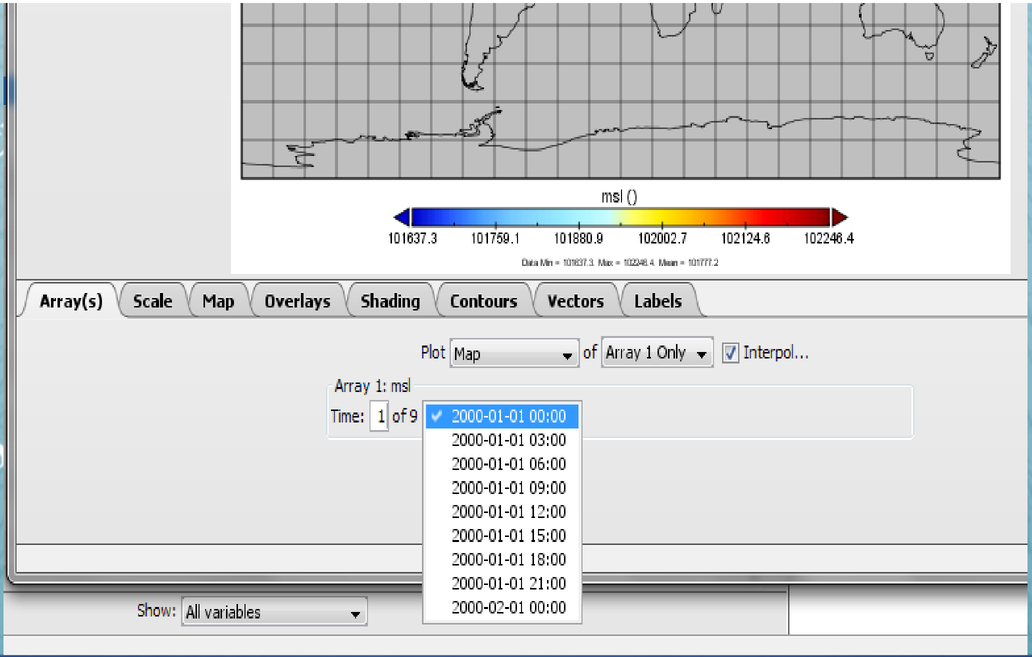
Climate Data Operators (CDO)

to merge datasets sorted by date and time

cdo mergetime day1.nc00.nc day1.nc03.nc day1.nc06.nc day1.nc09.nc day1.nc12.nc day1.nc15.nc day1.nc18.nc day1.nc21.nc day1_new.nc



```
dream@linux-0n3b:~/Downloads/seminar> cdo mergetime day1.nc00.nc day1.nc03.nc day1.nc06.nc
day1.nc09.nc day1.nc12.nc day1.nc15.nc day1.nc18.nc day1.nc21.nc day1_new.nc
cdo mergetime: Processed 3267 values from 24 variables over 9 timesteps ( 0.00s )
dream@linux-0n3b:~/Downloads/seminar>
```



Plot Map of Array 1 Only ☑ Interpol...

Array 1: msl

Time: 1 of 9

```
✓ 2000-01-01 00:00
  2000-01-01 03:00
  2000-01-01 06:00
  2000-01-01 09:00
  2000-01-01 12:00
  2000-01-01 15:00
  2000-01-01 18:00
  2000-01-01 21:00
  2000-02-01 00:00
```

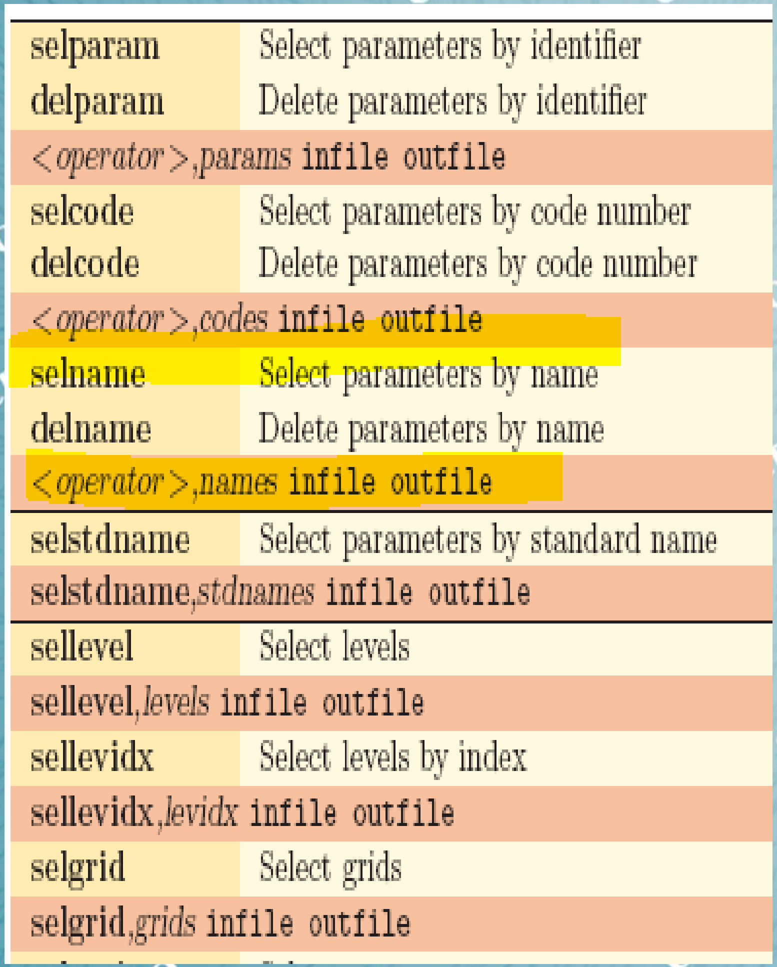
Show: All variables

Climate Data Operators (CDO)

Selection

Example

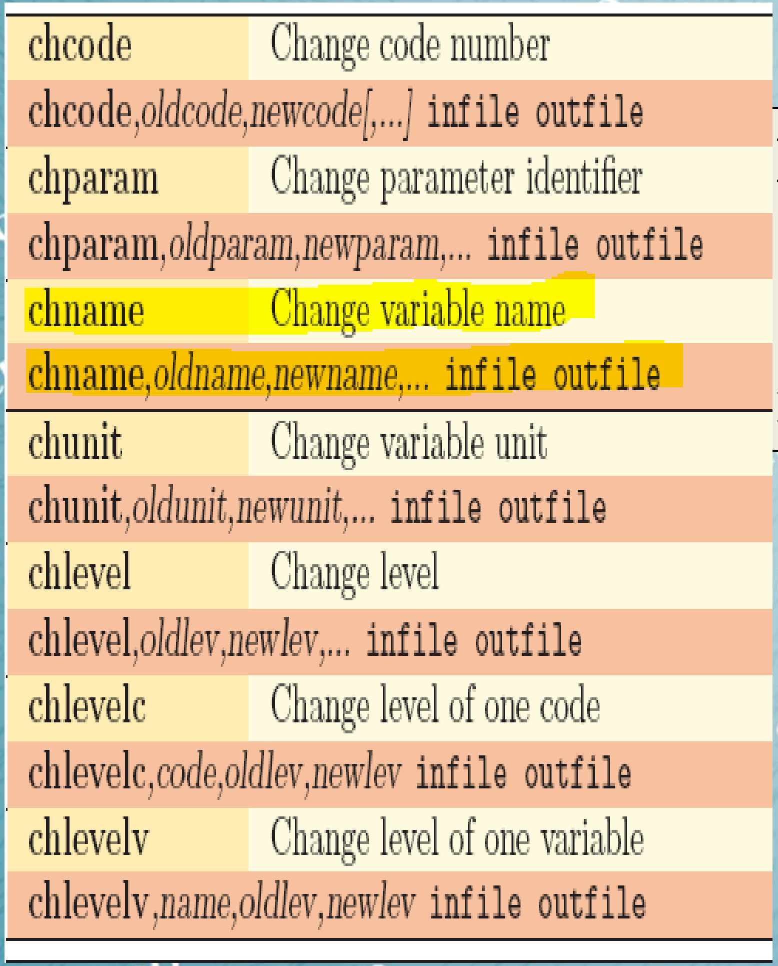
cdo –selname,name   infile outfile



selparam delparam	Select parameters by identifier Delete parameters by identifier
<*operator*>,*params* `infile outfile`	
selcode delcode	Select parameters by code number Delete parameters by code number
<*operator*>,*codes* `infile outfile`	
selname delname	Select parameters by name Delete parameters by name
<*operator*>,*names* `infile outfile`	
selstdname	Select parameters by standard name
selstdname,*stdnames* `infile outfile`	
sellevel	Select levels
sellevel,*levels* `infile outfile`	
sellevidx	Select levels by index
sellevidx,*levidx* `infile outfile`	
selgrid	Select grids
selgrid,*grids* `infile outfile`	

Climate Data Operators (CDO)

Modification: to modify the metadata, fields or part of a field in a dataset



chcode	Change code number
chcode,*oldcode,newcode[,...]* infile outfile	
chparam	Change parameter identifier
chparam,*oldparam,newparam,...* infile outfile	
chname	Change variable name
chname,*oldname,newname,...* infile outfile	
chunit	Change variable unit
chunit,*oldunit,newunit,...* infile outfile	
chlevel	Change level
chlevel,*oldlev,newlev,...* infile outfile	
chlevelc	Change level of one code
chlevelc,*code,oldlev,newlev* infile outfile	
chlevelv	Change level of one variable
chlevelv,*name,oldlev,newlev* infile outfile	

Example

cdo –v chname,om,nm infile outfile

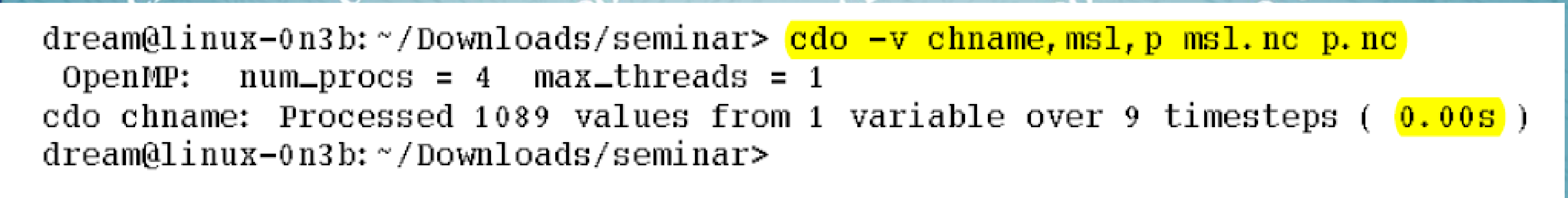
om:old name

nm:new name

Climate Data Operators (CDO)

Modification: to change the variable name

cdo -v chname,msl,p msl.nc p.nc

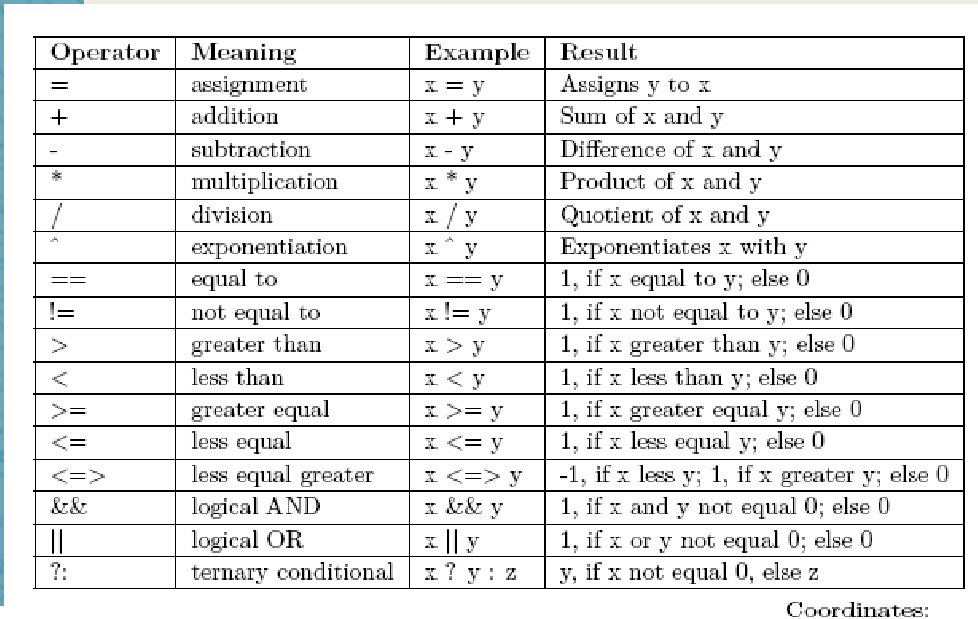


```
dream@linux-0n3b:~/Downloads/seminar> cdo -v chname,msl,p msl.nc p.nc
 OpenMP:   num_procs = 4   max_threads = 1
cdo chname: Processed 1089 values from 1 variable over 9 timesteps ( 0.00s )
dream@linux-0n3b:~/Downloads/seminar>
```

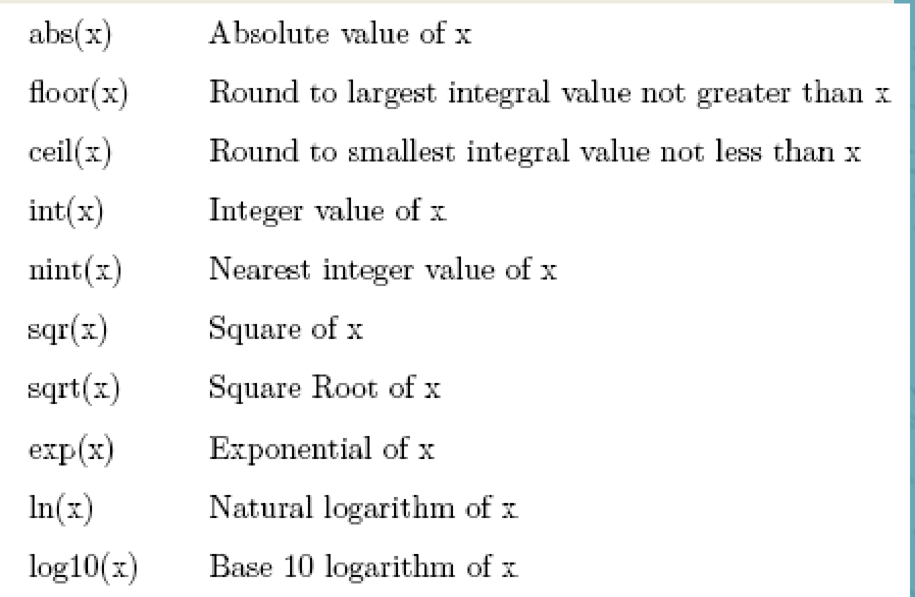
Climate Data Operators (CDO)

Arithmetic

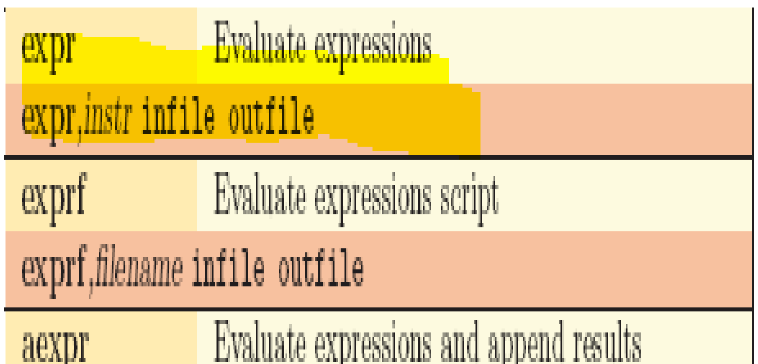
EXPR - Evaluate expressions: This module arithmetically processes every timestep of the input dataset



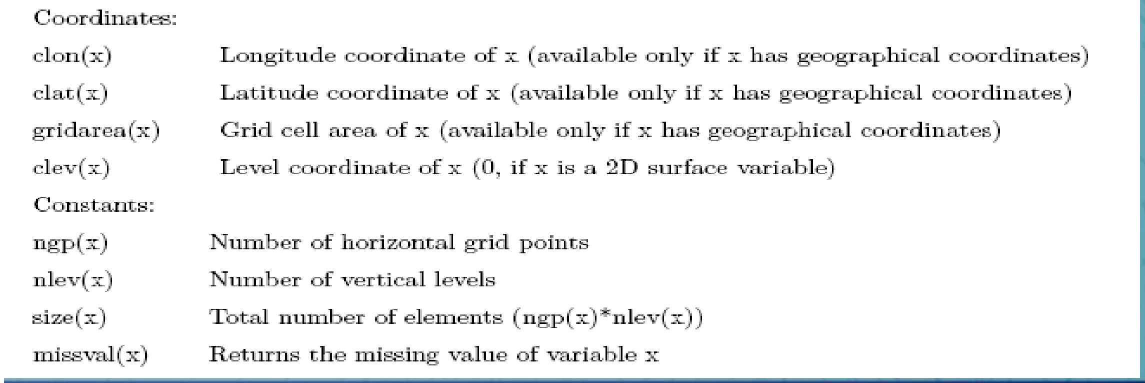
Operator	Meaning	Example	Result
=	assignment	x = y	Assigns y to x
+	addition	x + y	Sum of x and y
-	subtraction	x - y	Difference of x and y
*	multiplication	x * y	Product of x and y
/	division	x / y	Quotient of x and y
^	exponentiation	x ^ y	Exponentiates x with y
==	equal to	x == y	1, if x equal to y; else 0
!=	not equal to	x != y	1, if x not equal to y; else 0
>	greater than	x > y	1, if x greater than y; else 0
<	less than	x < y	1, if x less than y; else 0
>=	greater equal	x >= y	1, if x greater equal y; else 0
<=	less equal	x <= y	1, if x less equal y; else 0
<=>	less equal greater	x <=> y	-1, if x less y; 1, if x greater y; else 0
&&	logical AND	x && y	1, if x and y not equal 0; else 0
||	logical OR	x || y	1, if x or y not equal 0; else 0
?:	ternary conditional	x ? y : z	y, if x not equal 0, else z



abs(x)	Absolute value of x
floor(x)	Round to largest integral value not greater than x
ceil(x)	Round to smallest integral value not less than x
int(x)	Integer value of x
nint(x)	Nearest integer value of x
sqr(x)	Square of x
sqrt(x)	Square Root of x
exp(x)	Exponential of x
ln(x)	Natural logarithm of x
log10(x)	Base 10 logarithm of x



expr	Evaluate expressions
expr,instr infile outfile	
exprf	Evaluate expressions script
exprf,filename infile outfile	
aexpr	Evaluate expressions and append results



Coordinates:

clon(x)	Longitude coordinate of x (available only if x has geographical coordinates)
clat(x)	Latitude coordinate of x (available only if x has geographical coordinates)
gridarea(x)	Grid cell area of x (available only if x has geographical coordinates)
clev(x)	Level coordinate of x (0, if x is a 2D surface variable)

Constants:

ngp(x)	Number of horizontal grid points
nlev(x)	Number of vertical levels
size(x)	Total number of elements (ngp(x)*nlev(x))
missval(x)	Returns the missing value of variable x

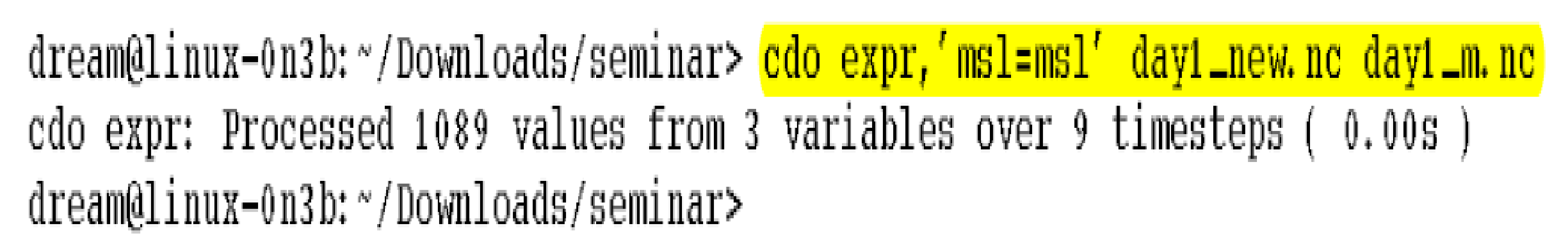
Climate Data Operators (CDO)

to select variables by name(without deleting the parameter from the original file)

```
cdo selname,msl day1_new.nc msl.nc
```

Or

```
cdo expr,'msl=msl' day1_new.nc day1_m.nc
```

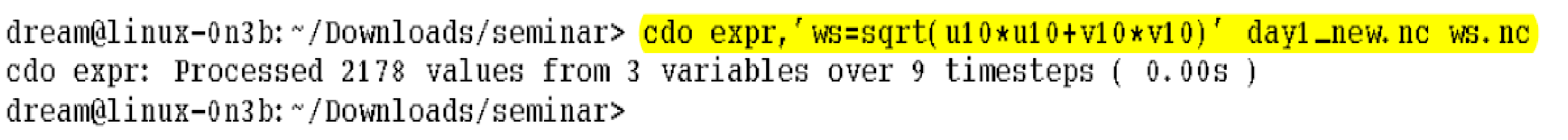


```
dream@linux-0n3b:~/Downloads/seminar> cdo expr,'msl=msl' day1_new.nc day1_m.nc
cdo expr: Processed 1089 values from 3 variables over 9 timesteps ( 0.00s )
dream@linux-0n3b:~/Downloads/seminar>
```

Climate Data Operators (CDO)

Example

cdo expr,'ws=sqrt(u10*u10+v10*v10)' input.nc output.nc



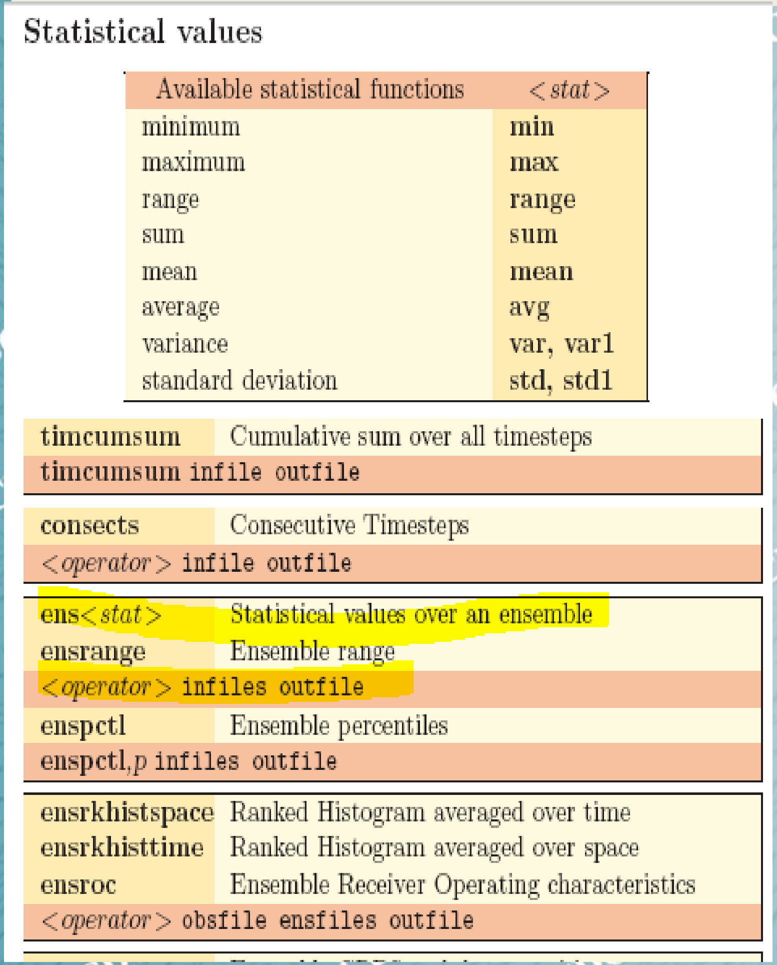
```
dream@linux-0n3b:~/Downloads/seminar> cdo expr,'ws=sqrt(u10*u10+v10*v10)'  day1_new.nc ws.nc
cdo expr:  Processed 2178 values from 3 variables over 9 timesteps ( 0.00s )
dream@linux-0n3b:~/Downloads/seminar>
```

To sum all input fields with the constant -273.15 use:

cdo addc,-273.15 ifile ofile

Climate Data Operators (CDO)

Statistical values



Statistical values

Available statistical functions	<*stat*>
minimum	min
maximum	max
range	range
sum	sum
mean	mean
average	avg
variance	var, var1
standard deviation	std, std1

timcumsum	Cumulative sum over all timesteps
timcumsum `infile outfile`	

consects	Consecutive Timesteps
<*operator*> `infile outfile`	

ens<*stat*>	Statistical values over an ensemble
ensrange	Ensemble range
<*operator*> `infiles outfile`	
enspctl	Ensemble percentiles
enspctl,*p* `infiles outfile`	

ensrkhistspace	Ranked Histogram averaged over time
ensrkhisttime	Ranked Histogram averaged over space
ensroc	Ensemble Receiver Operating characteristics
<*operator*> `obsfile ensfiles outfile`	

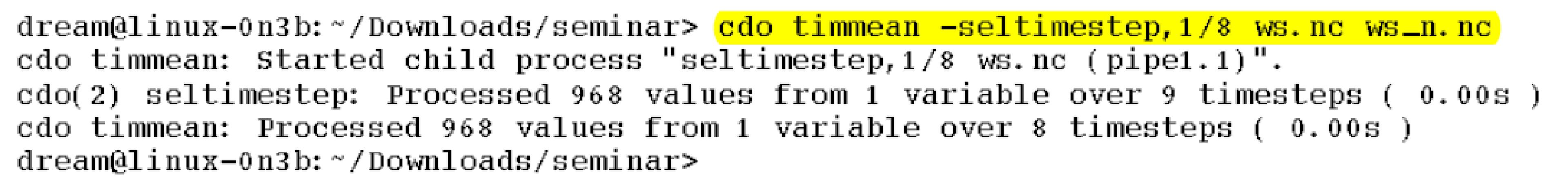
Example

cdo ensmean infiles outfile

To merge the data of two files (ex. Data for ocean and data for land)

Climate Data Operators (CDO)

Statistical values
to make an average
cdo timmean -seltimestep,1/8 ws.nc ws_n.nc

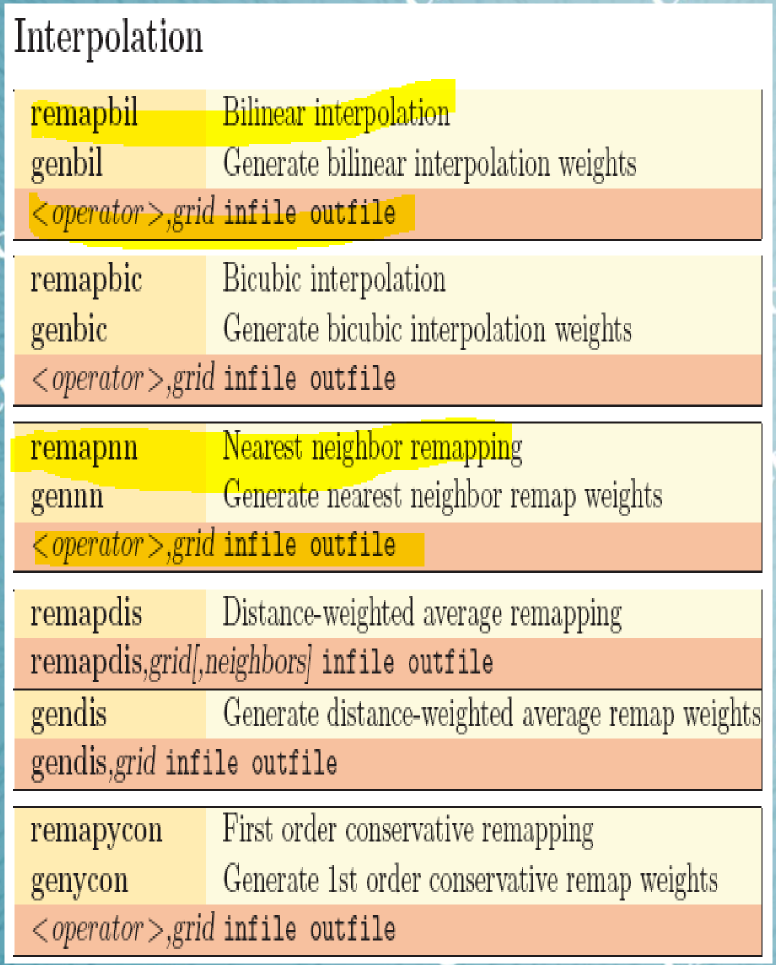


```
dream@linux-0n3b:~/Downloads/seminar> cdo timmean -seltimestep,1/8 ws.nc ws_n.nc
cdo timmean: Started child process "seltimestep,1/8 ws.nc (pipe1.1)".
cdo(2) seltimestep: Processed 968 values from 1 variable over 9 timesteps ( 0.00s )
cdo timmean: Processed 968 values from 1 variable over 8 timesteps ( 0.00s )
dream@linux-0n3b:~/Downloads/seminar>
```

Climate Data Operators (CDO)

How to use CDO?
Interpolation

Example
cdo remapbil,grid infiles outfile



Interpolation

remapbil	Bilinear interpolation
genbil	Generate bilinear interpolation weights
<operator>,grid `infile outfile`	
remapbic	Bicubic interpolation
genbic	Generate bicubic interpolation weights
<operator>,grid `infile outfile`	
remapnn	Nearest neighbor remapping
gennn	Generate nearest neighbor remap weights
<operator>,grid `infile outfile`	
remapdis	Distance-weighted average remapping
remapdis,*grid[,neighbors]* `infile outfile`	
gendis	Generate distance-weighted average remap weights
gendis,*grid* `infile outfile`	
remapycon	First order conservative remapping
genycon	Generate 1st order conservative remap weights
<operator>,grid `infile outfile`	

Climate Data Operators (CDO)

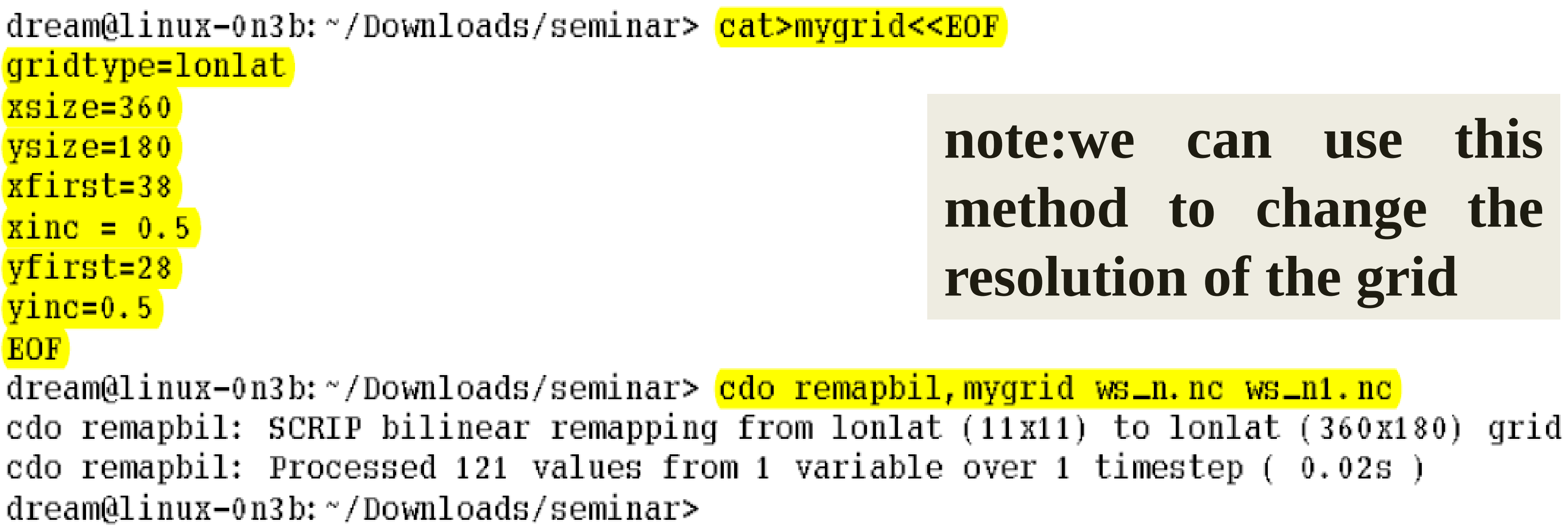
❑ to make a Bilinear interpolation

cdo remapbil,lon=44_lat=33 ws_n.nc ws_n1.nc

❑ to make a nearest neighbor remapping interpolation

cdo remapnn,lon=44_lat=33 ws_n.nc ws_n1.nc

❑ if it doesnt work, then we should build our grid as follows using the terminal"



```
dream@linux-0n3b:~/Downloads/seminar> cat>mygrid<<EOF
gridtype=lonlat
xsize=360
ysize=180
xfirst=38
xinc = 0.5
yfirst=28
yinc=0.5
EOF
dream@linux-0n3b:~/Downloads/seminar> cdo remapbil,mygrid ws_n.nc ws_n1.nc
cdo remapbil: SCRIP bilinear remapping from lonlat (11x11) to lonlat (360x180) grid
cdo remapbil: Processed 121 values from 1 variable over 1 timestep ( 0.02s )
dream@linux-0n3b:~/Downloads/seminar>
```

note:we can use this method to change the resolution of the grid

Climate Data Operators (CDO)

Climate Indices

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

```
cdo eca_cdd rrfile ofile
```

Where rrfile is a time series of daily precipitation amounts RR, then counted is the largest number of consecutive days where RR is less than 1 mm.

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

```
$ cdo eca_tr tnfile ofile
```

Where tnfile is a time series of daily minimum temperatures TN, then counted is the number of days where TN > T. The number T is an optional parameter with default T = 20°c.

Thanks!

Any questions ?