CLIM-RUN

Extracting, Analysing and visualizing climate model outputs

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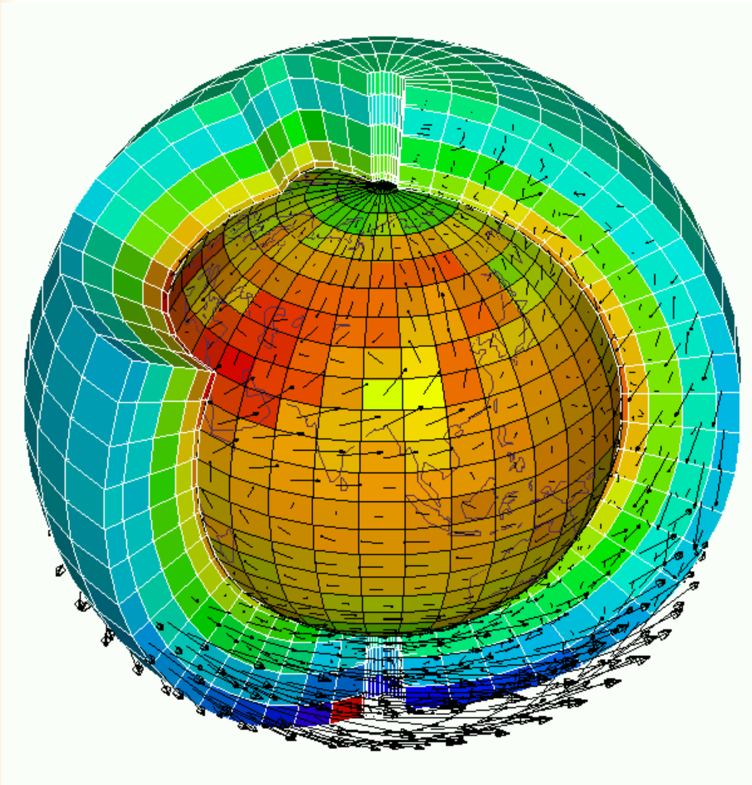
ENSEMBLES Database

ENSEMBLES

Climate model output data in netcdf format

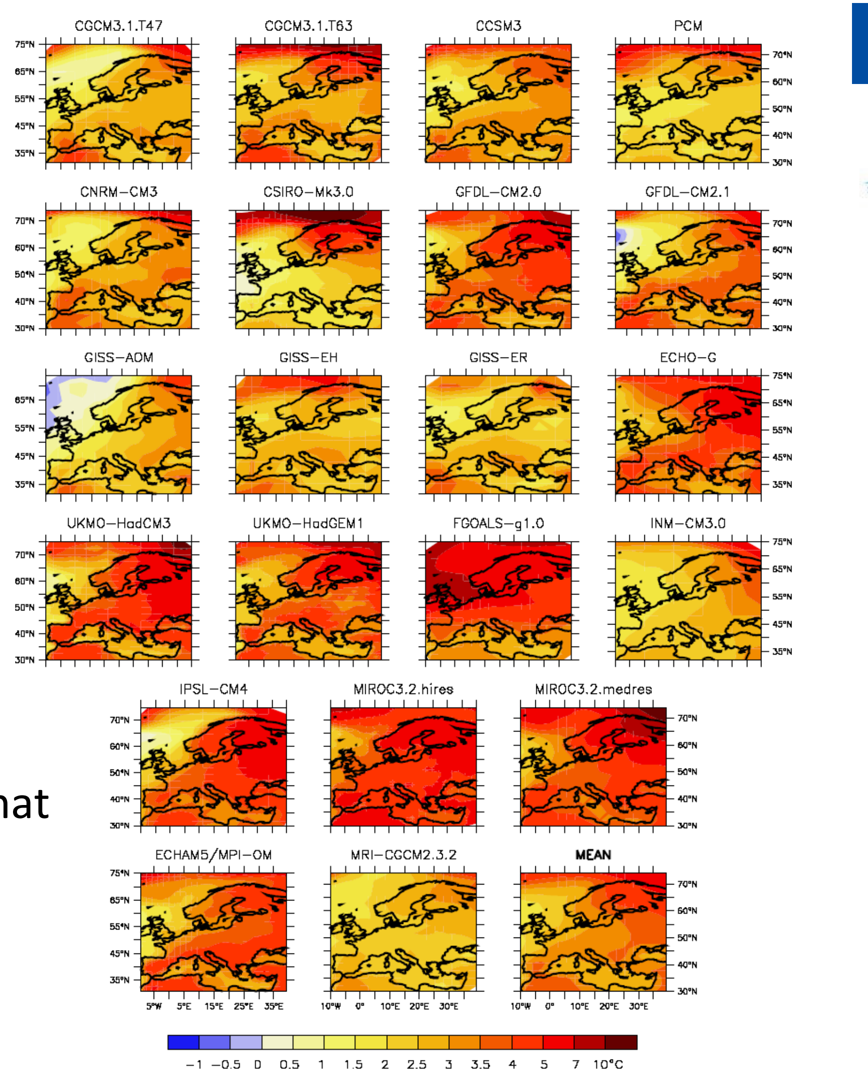
CLIM-RUN



Most climate simulations use netcdf format

to store the outputs variables which can

Be used by different users.



scénario A1B, 2080-2099 vs 1980-1999

Plan

- Database/Tools/Format
- Data processing
- Visualisation of data
- Let's play now with the data.
  - Example with CRU data.
  - Case studies with ENSEMBLES RCM dataset.

DATABASE/TOOLS/FORMAT

Different database

For the Mediterranean region

Project	Models	Scenario	Horizon	Resolution
ENSEMBLES	15 regional climate models	A1B	1950-2050 (2100)	25 kms
CIRCE	5 ocean-atmosphere coupled regional climate models	A1B	1950-2050	~50kms atmos-1/8°ocean
CORDEX	RCM of 12 official domain +ARAB domian	RCP4.5 RCP8.5	1950-2100	50 kms, 12 kms
MED-CORDEX	13-15 RCMs	RCP4.5 RCP8.5	1950-2100	50 kms, 12 kms

Different tools

- nco: good for file and header manipulation
- ncview: simple view on netcdf files
- ncdump, ncgen: nc to ascii and vice versa
  - options: -h (header only) -v [var] (var only)
- GMT/Gradsnc/ncl/ferret/Matlab: vizualisation tool, calculation of diagnostics
- cdo: climate data operators from the Max Planck Institute; good choice for data processing
- netcdf convention:
  - http://www.unidata.ucar.edu/software/netcdf
  - http://www.unidata.ucar.edu/software/netcdf/docs/BestPractices.html
  - http://www.unidata.ucar.edu/software/netcdf/netcdf-4

Other format/Linux command

- Other format: hdf, Grib, Netcdf, ascii…

- Change directory
  - **cd /home/dubois/DATA**
  - **cd .. (one up)**
- Copy a file
  - **cp file.nc /home/ictp/data/**
- Delete a file
  - **rm file.nc**

Different database

- Direct download from the CORDEX webpage, save file
  - http://ensemblesrt3.dmi.dk/data/CORDEX/DHMZ/ERAINT/historical/r1i1p1/DHMZ-REGCM42/v1/day/clt/file.nc
- Command line in Linux
  - wget http://ensemblesfp6:psswrd@ensemblesrt3.dmi.dk/data/A1B/ICTP/ICTP-REGCM3_A1B_ECHAM5_r3_DM_25kms_1971-1980_tas.nc
- Direct selection from the web, Dods
  - Selection of the domain/variables/period/frequency
- Linux environment on windows (cygwin)

All netcdf format

Netcdf Format: ncdump/ncgen

- ncdump is a netcdf utility that allows one to dump the content of the netcdf file to screen or file.

- Files are often too big to dump to screen, but one can look at subsets of the file using the different ncdump options.

  - ncdump slp.mon.mean.nc

  Dump entire content of netCDF to screen (generally not used: too much information)

  - ncdump -h slp.mon.mean.nc

  Dump header from netCDF file to screen

  - ncdump –v slp slp.mon.mean.nc

  Dump the slp variable to the screen, after the header

  - ncdump –v time slp.mon.mean.nc | less

  Display the entire content of the file

  - ncdump file.nc > file.cdl (Common Data form Language)

- ncgen: create netcdf

  - ncgen –o fileout.nc filein.cdl

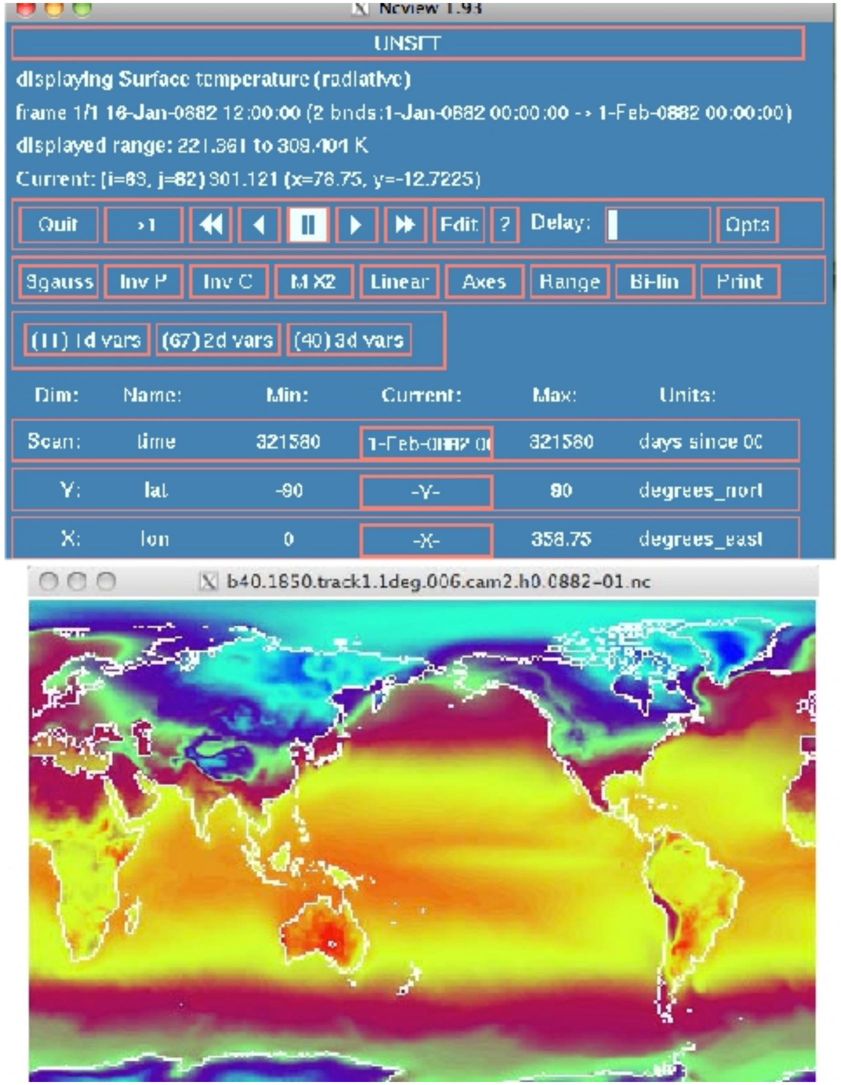
Netcdf Format: ncdump

```
netcdf zzz {
dimensions:
        lon = 192 ;
        lat = 96 ;
        lev = 1 ;
        time = UNLIMITED ; // (10 currently)
variables:
double lon(lon) ;
        lon:long_name = "longitude" ;
        lon:units = "degrees_east" ;
double lat(lat) ;
        lat:long_name = "latitude" ;
        lat:units = "degrees_north" ;
double lev(lev) ;
        lev:long_name = "pressure" ;
        lev:units = "Pa" ;
double time(time) ;
        time:units = "day as %Y%m%d.%f" ;
float q(time, lev, lat, lon) ;
        q:long_name = "specific humidity" ;
        q:units = "kg/kg" ;
        q:code = 133 ;
        q:table = 128 ;
        q:grid_type = "gaussian" ;
// global attributes:
        :CDO = "Climate Data Operators version 0.9.5 " ;
        :source = "ECHAM5.2" ;
        :institution = "Max-Planck-Institute for Meteorology" ;
data:
lon = ...... ;
....}
```

CLIM-RUN

Visualise file content: ncview

- Netcdf file
  - Var (time, lat, lon)
- Quick view: ncview
  - ncview is a graphical interface which allows one to quickly view the variables inside a netcdf file.
  - Example: ncview file1.nc
  - Ncview allows you to interactively visualize a selected variable across a selected range (time, spatial).



Data processing: Netcdf tools

CDO: Climate data operator

- Documentation
  - **Documentation in PDF can be found on the CDO**
  - **homepage: http://www.mpimet.mpg.de/cdo**
  - **Reference Card**
  - **Online reference manuals**
  - **cdo -h <operator>**
- Installation
  - **Installation from source code (with netCDF support):**
  - **Get the latest CDO archive from the homepage**
  - **gzip -cd cdo.tar.gz | tar xf –**
  - **cd cdo**
  - **./configure --prefix=$HOME/bin --with-netcdf=/client**
  - **make install**

More than 350 operators available

- **informations**
  - cdo info, showcode, showvar, showyear, showmonth, showlevel, ...
- **file operations**
  - cdo copy, merge, split
- **selections**
  - cdo selvar, selcode, sellevel, selyear, ... cdo sellonlatbox, cdo seltimestep
- **input/ ouput, can output ascii**.
  - cdo input, output, outputf...
- **statistic**
  - cdo yearmean, yearavg, yearmax, yearsum, yearvar, yearstd; cdo hour..., day..., mon..., seas...
- **Arithmetic**
  - cdo add, addc, sqr, sqrt, cos....
- **conditional selection**
  - cdo ifthen, ifnotthen, ifthenelse, ifthenc, ifnotthenc
- **comparison**
  - cdo eq, eqc, ne, nec, le, lec, ge, gec, lt, ltc, gt, gtc ...

CDO Climate data operator

cdo [options] \operator[,op[,op]]   ifile ofile

- **grid to netcdf**
  - cdo -f nc -t echam4 copy zzz.grb zzz.nc
- **create a mask**
  - cdo gtc,0.0 EH5_OM_A1B_1_MM_APRC_1-12.grb mask.nc
- **arithmetic**
  - cdo sqrt -add -sqr U1000.nc -sqr V1000.nc SPEED1000.nc
- **multiplication**
  - cdo mulc,86400 APRT.nc APRTmd.nc
- **time average/filed**
  - cdo seasmean/fldmean file.mon.nc file.seas.nc
- **interpolation**
  - cdo remapbil,grid.nc filein.nc fileout.nc
- **create ascii output**
  - cdo output file.nc > file.dat

Visualisation of data

NCL: NCAR Command Language

NCL is an interpreted language designed for data processing and visualization.

NCL is free, portable, allows for the creation of excellent graphics, can input/output multiple file formats, and contains numerous functions and procedures that make data processing easier.

http://www.ncl.ucar.edu

NCL is the official CESM processing language.

Support: Postings to the ncl-talk email list are often answered within 24 hours by the NCL developers or by other NCL users.

Many downloadable examples are provided.

Example Graphics

NCL is an interpreted language designed specifically for scientific data analysis and visualization.

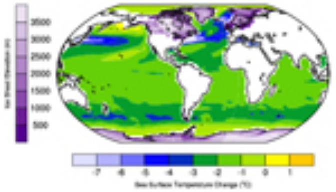
Portable, robust and free, NCL is available as binaries or open source

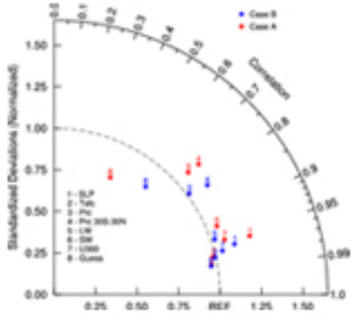
Supports netCDF3/4, GRIB1/2, HDF-SDS, HDF4-EOS, binary, shapefiles, and ascii files

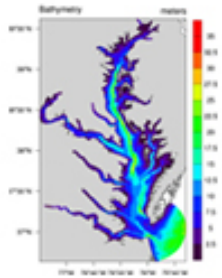
Numerous analysis functions are built-in

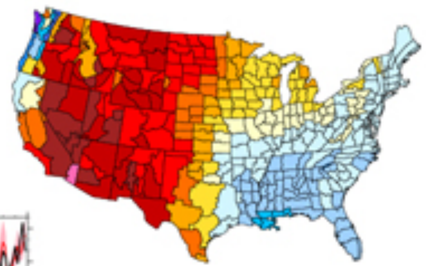
High quality graphics are easily created and customized with hundreds of graphic resources

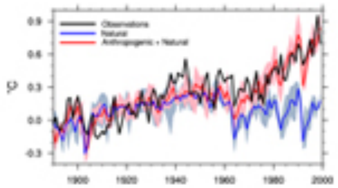
Many example scripts and their corresponding graphics are available

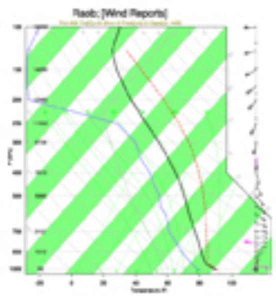


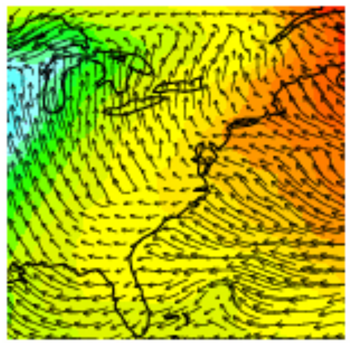












Example Graphics

NCL's graphics package is exceptionally flexible. There are thousands of plot options (called resources) available that allow one to customize plots:

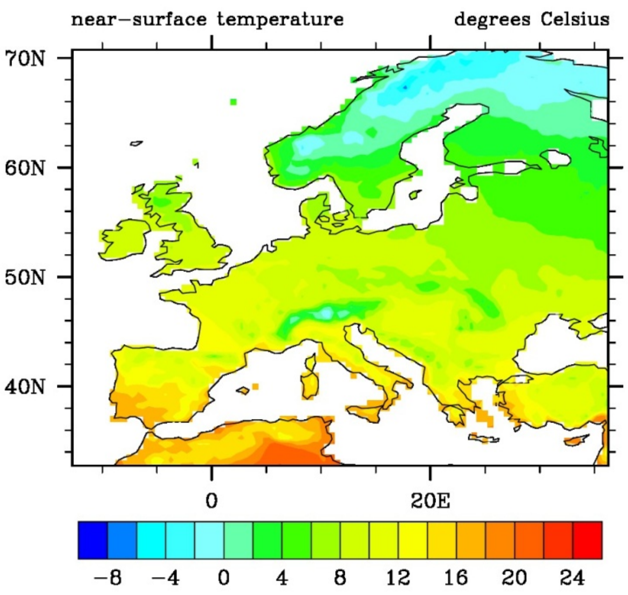
```
a = addfile("b40.1850.track1.1deg.
006.0100-01.nc","r")

ts= a->TS(0,:,:)

wks = gsn_open_wks("ps","test")

gsn_define_colormap(wks,"amwg")

res = True

res@mpCenterLonF= 180.

res@mpProjection= "WinkelTripel"

res@mpOutlineOn= True

res@mpGeophysicalLineColor= "gray70"

res@cnFillOn= True

res@gsnSpreadColors= True

plot = gsn_csm_contour_map(wks,ts,res)
```

LET'S PLAY NOW WITH THE DATA

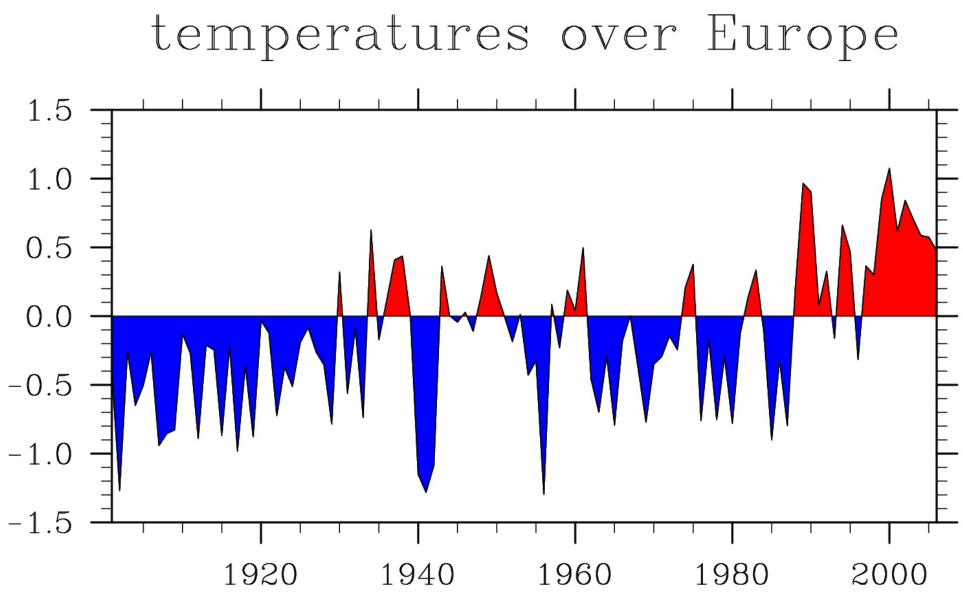
CRU DATASET

- **Climatic Research Unit (CRU)**
  - 0.5x0.5° global over land only, 1901-2006 monthly output (ref: Harris et al., under review)
  - Gridded analysis of in-situ observations
- **Where to access them?**
  - cd /labdata/DATA/CRU
- **files**
  - **Temperature:** cru_ts_3_00.1901.2006.tmp.nc (degrees °C)
  - **Precipitation:** cru_ts_3_00.1901.2006.pre_month.nc (mm/day)

CRU DATASET-Temperature



- **Average temperature for the present climate (period 1971-2000)**



- **Temperature anomalies over Europe from 1901-2006 compared to the reference periode 1971_2000**

CASE STUDIES

- Variables
  - Temperatures, precipitations, snow….
- Geography
  - Tunisia, Barcelona….
- Frequency
  - 6h, daily, monthly, yearly….
- Spatial
  - 50 kms, 25 kms……
- Temporal horizon
  - Last 50 years,
- Statistics
  - Mean, trends

ENSEMBLES DATASET

- **Where to access them?**
  - cd /labdata/DATA/ENSEMBLES/VARIABLES/
- **Structure of file**
  - **RCM model**: CNRM-RM5.1, ICTP-REGCM3, REMO
  - **GCM model**: ARPEGE, ECHAM
  - **Scenario**: A1B, ER40….
  - **Frequency**: 6H, DM (daily), MM (montly)
  - **Period**: 1980-1984, 1951-1960….
  - **Variable**: tas, pr, rsds, sund
- **Example file**
  - CNRM-RM4.5_SCN_ARPEGE_DM_25km_1980-1984_tas.nc

CASE STUDIES

- Variables
  - Temperatures: tas (C°)
  - Precipitations: pr (mm. s-1)
  - 2-meter relative humidity: hurs (%)
  - 10-meter wind speed: wss (m.s-1)
  - Total cloudiness (Fraction): clt (1)
  - Downward/net SW surface radiation: rsds and rss (W/m2)
- Geography
  - CLIM-RUN Case studies or choose your own domain
- Frequency
  - Monthly: MM, Daily: DM
- Spatial
  - 25 kms
- Temporal
  - A1B scenario (1950-2100)
- Statistics
  - Mean, trends, differences

CREATE YOUR ENVIRONMENT

- make your work directory
  - mkdir scripts
  - cd scripts (change directory)
  - vi case_study_ensembles.sh &
  - chmod 777 case_study_ensembles.sh
  - Create a directory for the data output

GEOGRAPHY

- Wild fires
  - Greece:country
- Tourism
  - Savoie: 5.87-7.07°W/45.17-46.5°N
  - Tunisia: 7.5-11.6°W/30.22-37.35°N
  - Croatia:13.3-15°W/44.3-45.7°N
- Energy
  - Morocco:Ain Bni Mathar: 2.01°W/34.05°N
  - Spain: Castilla y Leon: 6.67-2.26°W/40.76-43.01°N
  - Cyprus: all island
- Integrated
  - Venice laguna: 11.46-13.50°E/44.47-45.51°N

START YOUR OWN SCRIPT

- Select a model
  - C4I
  - **CNRM**
  - KNMI
  - SMHI_ECHAM5
  - SMHI_HadCM3
  - **MPI**
  - METNO_BCM
  - METNO_HadCM3
  - UCLM
  - ETHZ
  - **HadRCM** (3 physics)
  - DMI_ARPEGE
  - DMI_ECHAM
  - **ICTP**
  - VMGO
  - OURANOS

```
#!/bin/sh
for MODEL in KNMI ; do

FILE=KNMI-RACMO2_A1B_ECHAM5-
r3_DM_25km_1961-1970_tas.nc

done
```

START YOUR OWN SCRIPT

- Select a variable
  - **tas**
  - hurs
  - **pr**
  - clt
  - rsds
  - rss
  - wss

```
#!/bin/sh
for MODEL in KNMI ; do
        for VAR in tas;  do

FILE=KNMI-RACMO2_A1B_ECHAM5-
r3_DM_25km_1961-1970_${VAR}.nc

        done
done
```

START YOUR OWN SCRIPT

- Select a geographical domain
  - longitude
  - latitude

```
#!/bin/sh
for MODEL in KNMI ; do
        for VAR in tas;  do
                for DOMAIN in ANDALUCIA;do
                        case $DOMAIN in
                                ANDALUCIA)
                                        LON1=13.3
                                        LON2=15.0
                                        LAT1=44.3
                                        LAT2=45.7;;
                        esac
FILE=KNMI-RACMO2_A1B_ECHAM5-r3_DM_25km_1961-1970_${VAR}.nc
cdo selonlatbox,$LON1,$LON2,$LAT1,$LAT2 $FILE ${MODEL}-${VAR}-${VAR}.nc



                done
        done
done
```

START YOUR OWN SCRIPT

CLIM-RUN

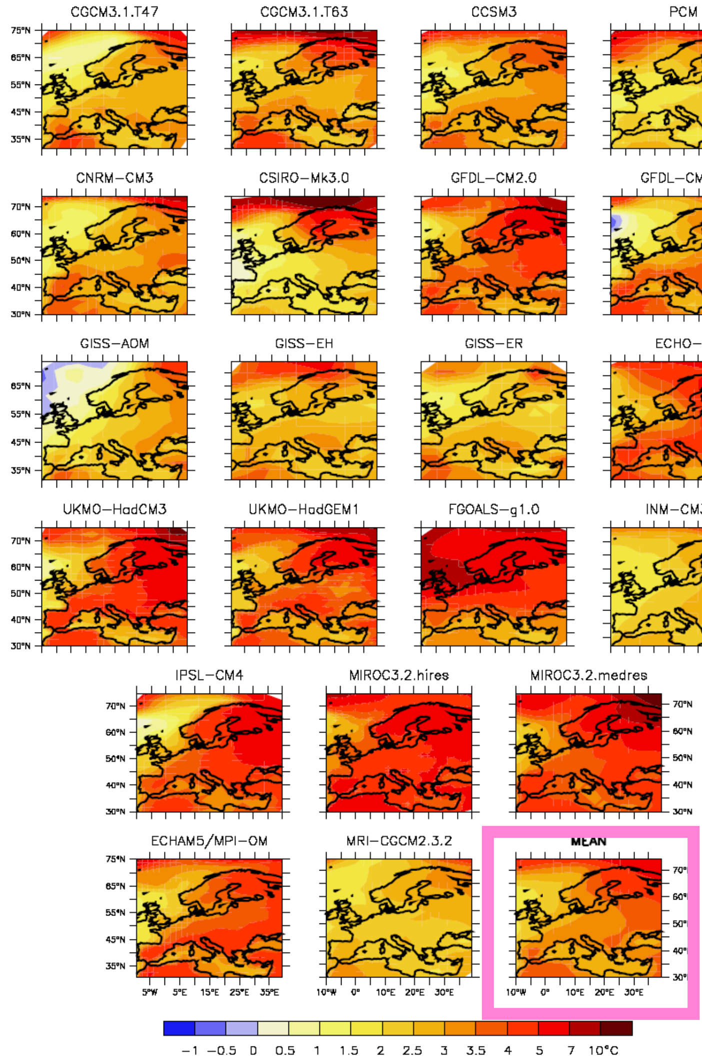
- Select a diagnostic
  - fldmean
  - seasmean
  - trend
  - diff

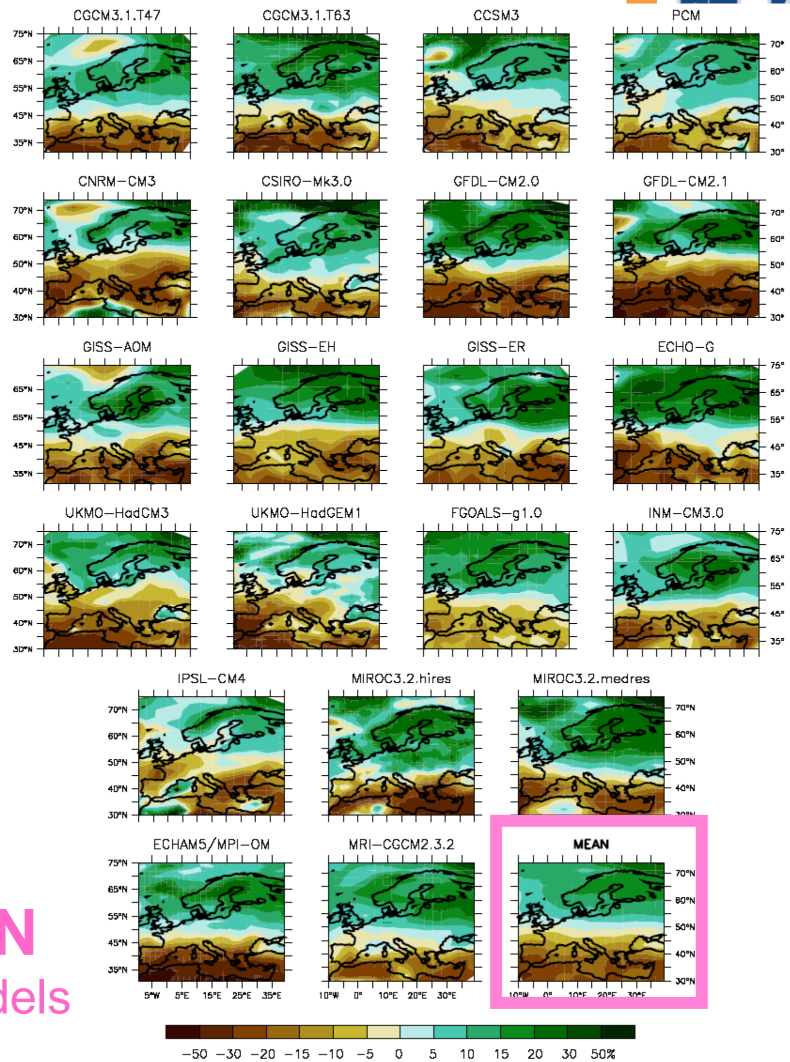
```
#!/bin/sh
for MODEL in KNMI ; do
    for VAR in tas;  do
        for DOMAIN in ANDALUCIA;do
            case $DOMAIN in
                ANDALUCIA)
                    LON1=13.3
                    LON2=15.0
                LAT1=44.3
                    LAT2=45.7;;
            esac
FILE=KNMI-RACMO2_A1B_ECHAM5-r3_DM_25km_1961-1970_${VAR}.nc
cdo selonlatbox,$LON1,$LON2,$LAT1,$LAT2 $FILE ${MODEL}-${VAR}-${VAR}.nc
cdo timmean ${MODEL}-${VAR}-${VAR}.nc tmp.nc
cdo fldmean ${MODEL}-${VAR}-${VAR}.nc tmp.nc
        done
    done
done
```

CREATE FIGURES

Scenarios for the XXIeme century

Temperature/Precip over Europe





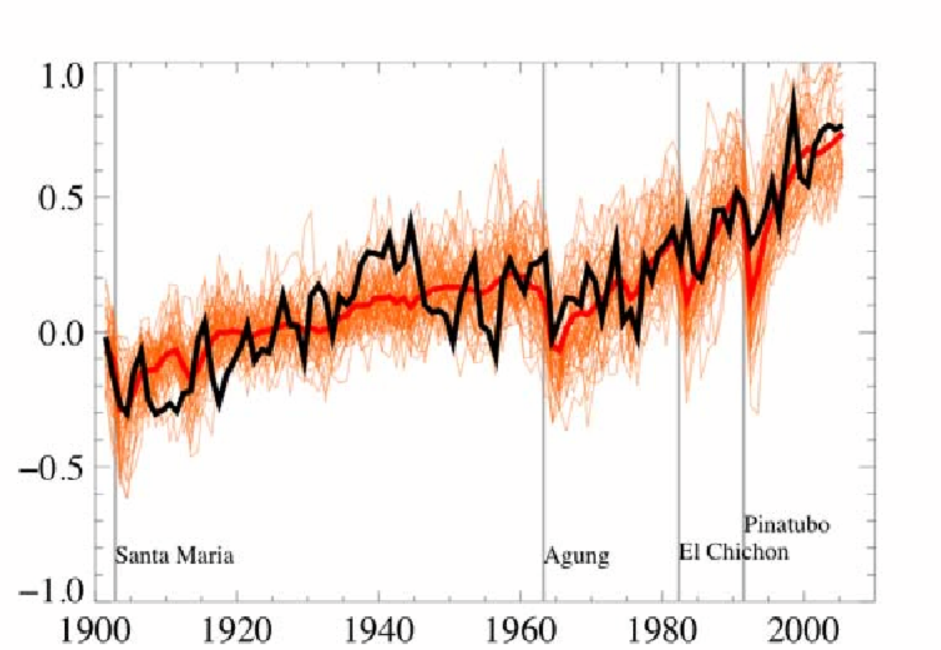
MEAN
21 models

scénario A1B, 2080-2099 vs 1980-1999

CLIM-RUN

SEVENTH FRAMEWORK PROGRAMME

CREATE FIGURES



CLIM-RUN

SEVENTH FRAMEWORK PROGRAMME

THANK YOU FOR YOUR ATTENTION

CLIM-RUN

Climate Local Information in the Mediterranean region Responding to User Needs

www.climrun.eu