Using the CSIRO Mk3L climate system model
Part 3: Designing your own experiment

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1. Analysing experiments

Exercise 1: Analyse your experiment

- Last week you ran your own experiment
- The output was saved in a directory called

```
/srv/scratch/$USER/$run
```

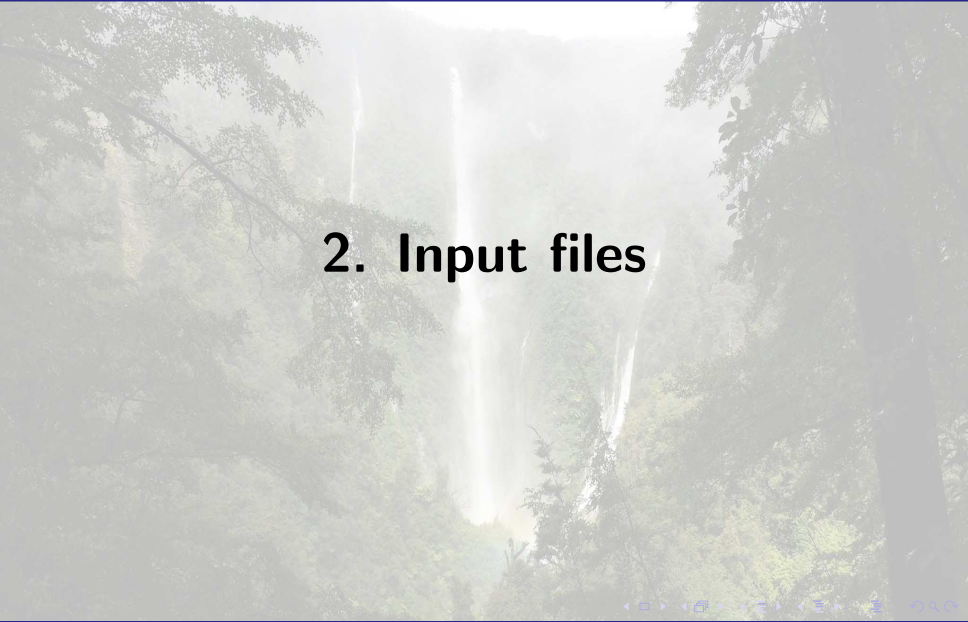
- `/srv/scratch` is a global "scratch" directory
- It is used for the temporary storage of data for running jobs
- Now change to the directory for your experiment e.g.

```
cd /srv/scratch/z3210932/exp01
```

- Analyse the output

Exercise 1: Analyse your experiment

- Use Ferret to analyse and plot the data
- Try using some of the Ferret commands that you've learnt over the past two weeks
- Try adapting some of the scripts from last week, or even try writing your own scripts
- Try looking at variables such as surface air temperature (`tsc`), precipitation (`rnd`) or sea-level pressure (`psl`)
- See Table 4.7 of the Users Guide for a complete list
- For experiment `aaaaa`, the data for the variable `bbb` is contained in the file called `sbbb_aaaaa.nc` e.g. `stsc_exp01.nc`
- Generate some GIF images and copy the files back to your local machine



2. Input files

Running and configuring Mk3L

- Remember that the three steps involved in running the model are:
  - Create a run directory
  - Copy everything that you need to this directory
  - Run the model
- The "everything" in this second step consists of:
  - The model itself (the "executable")
  - All the input files needed to run the model
- To configure the model for a particular experiment, we need to modify one or more of these input files

Input files

- The model requires three types of input files:

control file	configures the model for a particular simulation
restart file(s)	initialise(s) the model at the *start* of a simulation
auxiliary files	provide the boundary conditions *during* a simulation

- The model may be configured for a particular scenario by modifying one or more of these files
- Auxiliary files provide the boundary conditions that the model cannot simulate itself e.g. topography
- See Chapters 4 and 5 of the Users Guide for further information

Boundary conditions: atmosphere model

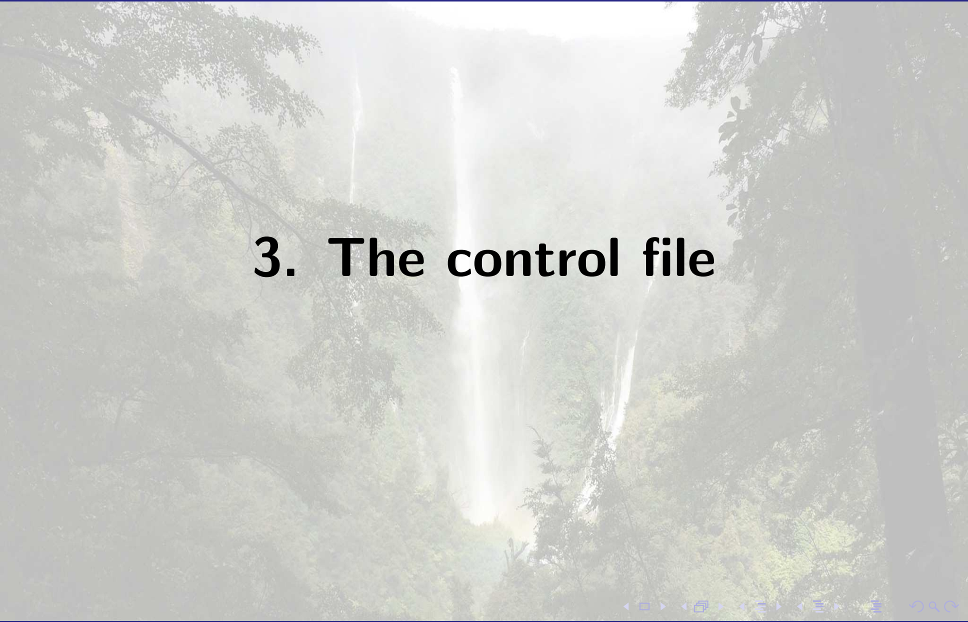
- Bottom boundary conditions:
  - Sea surface temperatures
  - Ocean currents
  - Topography
  - Albedo
  - Vegetation and soil types
- Radiative boundary conditions:
  - CO_2 transmission coefficients
  - Ozone mixing ratios

Boundary conditions: ocean model

- Upper boundary conditions:
  - Sea surface temperatures
  - Sea surface salinities
  - Surface wind stresses
- Bottom boundary conditions:
  - Bathymetry

Boundary conditions: coupled model

- Bottom boundary conditions:
    - Topography
    - Bathymetry
    - Albedo
    - Vegetation and soil types
- Radiative boundary conditions:
    - CO_2 transmission coefficients
    - Ozone mixing ratios



3. The control file

The control file

- To run the model, you use a command such as:

```
./model < input > output
```

- The file `input` is the *control file*
- This file contains a number of `namelist` groups
- The parameters contained within these groups specify:
  - the duration of a simulation
  - the physical configuration of the model
  - which model variables are to be saved

namelist groups

- A namelist group looks like this:

```
&control
  lcouple=T
  locean=F
  mstep=20
  nsstop=0
  ndstop=1
  lastmonth=0
  months=0
  nrad=6
&end
```

nano

- nano is a simple Linux text editor
- To edit a file, enter the command:

```
nano <file>
```

- Some basic nano commands are:

Ctrl-G	Get Help
Ctrl-O	Write (Save)
Ctrl-X	Exit

Exercise 2: Editing control files

- Change to the directory containing the test scripts:

```
cd ~/CSIRO_Mk3L/version-1.2/core/control
```

- Create a copy of one of the control files, using a command such as:

```
cp input_cpl_1day input_copy
```

- Use `nano` to examine and edit this file

Basic `namelist` options

`locean, lcouple`

These parameters determine the mode in which the model is to run:

`locean=T`	Stand-alone ocean mode (this overrides `lcouple`)
`locean=F, lcouple=F`	Stand-alone atmosphere mode
`locean=F, lcouple=T`	Coupled mode

Basic namelist options

`nsstop, ndstop, lastmonth, months`

For the coupled model and stand-alone atmosphere model, these determine the duration of the simulation:

`nsstop`	Stop after `nsstop` timesteps
`ndstop`	Stop after `ndstop` days
`lastmonth`	Stop at the end of calendar month `lastmonth` (1=January, 2=February, ..., 12=December)
`months`	Stop after `months` months

The first of these to have a non-zero value is the one that takes effect.

Basic namelist options

`iocmn, iocyr`

For the stand-alone ocean model, these determine the duration of the simulation:

iocmn < 12	Stop after iocmn months
iocmn $= 12$	Stop after iocyr years

Basic namelist options

`bpyear, csolar`

- `bpyear` specifies the epoch, in years before present (where the "present" is the year 1950 CE)
- `csolar` specifies the solar constant, in Wm^{-2}

`runtype`

- `runtype` specifies the name of the experiment

Atmosphere model output: monthly

- This is controlled by the parameter `statsflag`:

`statsflag=T`	Save monthly-mean statistics
`statsflag=F`	Don't save this data

- The parameters in the group `statvars` control which variables are to be saved – see Section 4.2.3 of the Users Guide

Atmosphere model output: daily

- This is controlled by the parameters `savehist` and `hist_interval`:

`savehist=T`	Save daily statistics
`hist_interval=1440`	Save these statistics every 1440 minutes

- It's possible to save statistics at two different frequencies – see Section 4.2.2 of the Users Guide
- The parameters in the group `histvars` control which variables are to be saved – see Section 4.2.4 of the Users Guide

Ocean model output

- The ocean model saves monthly-mean statistics only
- This is controlled by the parameters in the group osave e.g.

save_temp=T	Save the potential temperature
save_sal=T	Save the salinity
save_over=T	Save the meridional overturning streamfunctions

- See Table 4.11 of the Users Guide

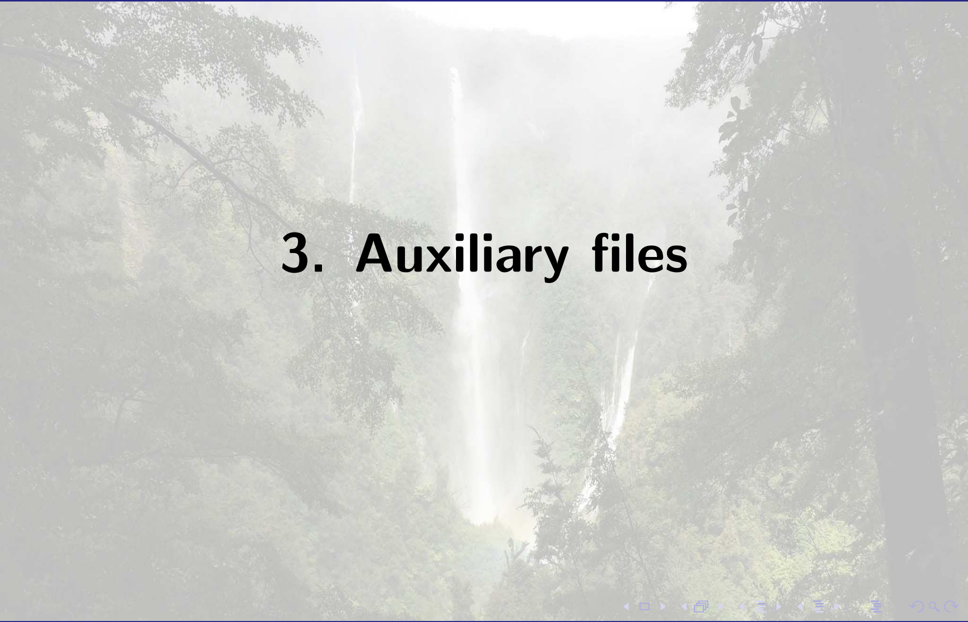
Exercise 3: Basic namelist options

- Look at the control files in the following directories:

```
~/CSIRO_Mk3L/version-1.2/core/control
~/week2/exp0?
```

- Find the following parameters, and see how the values differ:

```
locean, lcouple
nsstop, ndstop, lastmonth, months
iocmn, iocyr
bpyear, csolar
runtype
```



3. Auxiliary files

Changing the atmospheric CO_2 concentration

- The CO_2 transmission coefficients are read from an auxiliary file
- These files are generated by the utility `radint`
- To compile and initialise this utility, change to the directory:

```
cd ~/CSIRO_Mk3L/version-1.2/pre/co2
```

- Then enter the commands:

```
make
./pset -n 18
```

Changing the atmospheric CO_2 concentration

- To generate the auxiliary file for an atmospheric CO_2 concentration of `<concentration>` ppm, enter the command:

```
./radint -c <concentration>
```

- For example, for a CO_2 concentration of 280 ppm:

```
./radint -c 280
```

- This generates a file called `co2_data`

Exercise 4: Changing the atmospheric CO_2 concentration

- Compile and initialise `radint` by entering the commands

```
cd ~/CSIRO_Mk3L/version-1.2/pre/co2
make
./pset -n 18
```

- Now generate auxiliary files for CO_2 concentrations of 280, 560 and 1120 ppm e.g.

```
./radint -c 280
```

- Remember to rename the auxiliary file each time e.g.

```
mv co2_data co2_data.280ppm
```

Applying freshwater hosing

- To apply freshwater hosing, use these namelist parameters:

hosing_flag	If T, apply freshwater hosing
hosing_rate	The freshwater hosing rate (Sv)

- You must also supply the auxiliary file hosemask
- A sample auxiliary file is provided with the model:

~/CSIRO_Mk3L/version-1.2/core/data/atmosphere/hosing/hosemask

Exercise 5: Design your own freshwater hosing mask

- Change to the directory containing the sample freshwater hosing mask and create your own copy e.g.

```
cd ~/CSIRO_Mk3L/version-1.2/core/data/atmosphere/hosing
cp hosemask hosemask_exp07
```

- Now use nano to edit this file:

```
nano hosemask_exp07
```

- The number 7 indicates land: don't change these values!
- Put 1 where you want the water to go, and 0 everywhere else

4. Design your own experiment

Design your own experiment

- Design and run your own experiment
- Ideas:
  - Change the epoch: simulate the past or future
  - Change the solar constant: $\pm5\%$, $\pm10\%$, more?
  - Change the CO_2 concentration: $\times\frac{1}{2}$, $\times2$, $\times4$?
  - Freshwater hosing: melting of the Greenland or Antarctic ice sheets
- Tips:
  - Use one of the pre-configured experiments as a basis
  - Think about how long to run the model: 50 years, 100 years?
  - Be careful to request sufficient resources using PBS
  - Unless you're feeling extremely confident, get me to check your experiments before you run them
  - Once you've started your experiment, use `qstat` to monitor progress