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

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# 1. Analysing experiments

# Reminder: Using Katana

- Launch Xming (`Programs > Xming > Xming`).
- Launch PuTTY (`Programs > PuTTY > PuTTY`).
- Using PuTTY, do the following:
  - Select `Connection > SSH > X11`
  - Check the `Enable X11 forwarding` box
  - Select `Session`
  - In the `Host Name` box, enter `katana.science.unsw.edu.au`
  - Click `Open`
  - Log in using your zNumber and zPass

# 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 files** | initialise 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 that need to be specified

- Bottom boundary conditions:
  - topography
  - bathymetry
  - albedo
  - vegetation and soil types
- Radiative boundary conditions:
  - $CO_2$ transmission coefficients
  - ozone mixing ratios
- Applying a perturbation:
  - freshwater hosing mask

# 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
```

# Basic `namelist` options

`nsstop, ndstop, lastmonth, months`

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

`bpyear, csolar`

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

`runtype`

- `runtype` specifies the name of the experiment

# Exercise 2: Basic `namelist` options

- Look at the control files in the following directories:

```
~/CSIRO_Mk3L/version-1.2/core/control
~/week2/exp01
~/week2/exp02
~/week2/exp04
```

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

```
nsstop, ndstop, lastmonth, months
bpyear, csolar
runtype
```

# 3. Auxiliary files

# The control file versus auxiliary files

- Using the control file, we can specify:
  - the duration of a simulation
  - the physical configuration of the model
  - which model variables are to be saved
- However, to configure other aspects of the model we need to modify the auxiliary files. Examples include:
  - topography
  - bathymetry
  - albedo
  - vegetation and soil types
  - $CO_2$ transmission coefficients
  - ozone mixing ratios

# 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 3: 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`.
- This file contains a grid covering the Earth's surface, and tells the model where to add the freshwater into the ocean.
- A sample auxiliary file is provided with the model:

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

# Exercise 4: 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: $\pm 5\%$, $\pm 10\%$, more?
  - Change the $CO_2$ concentration: $\times \frac{1}{2}$, $\times 2$, $\times 4$?
  - 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.

# Design your own experiment: some guidance

- The run script:
  - Do you need to change any of the PBS options?
  - Do you need to change the name or duration of the experiment?
  - The name of the experiment should be the same as in the control file.
  - Make sure that you copy the right files into the run directory.
- The control file:
  - Do you need to change anything? For example, do you need to change the values of `bpyear` or `csolar`?
  - Ensure that the name of the experiment is set correctly (note: the name should be five characters long).
- Auxiliary files:
  - Do you need to generate any new auxiliary files? For example, do you want to change the $CO_2$ concentration or apply freshwater hosing?