The CSIRO Mk3L climate system model:

Configuring for past, present and future climate scenarios

Reminder: Input files

- The model requires three types of input files:

a 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 changing *either* the control file *or* one or more of the auxiliary files

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 to file

namelist groups

- A namelist group looks like this:

```
&control
  lcouple=T, locean=F
  mstep=20, nrad=6
  nsstop=0, ndstop=1, lastmonth=12, months=0
  co2_datafile='co2_data.18l', o3_datafile='o3_data.18l'
  irfilename='rest.start', orfilename='rest.end'
  runtype='tst'
  fluxadj=T
  csolar=1365.0, bpyear=0
&end
```

emacs

- `emacs` is a simple UNIX text editor
- To edit a file, enter the command:

```
emacs <file>
```

- Some basic `emacs` commands are:

`Ctrl-X Ctrl-F`	Open...
`Ctrl-X Ctrl-S`	Save
`Ctrl-X Ctrl-W`	Save as...
`Ctrl-X Ctrl-C`	Exit

Exercise: `emacs`

- Load `emacs` on the SGI Altix AC, using the command:

```
module load emacs
```

- Change to the directory `~/mk3l-1.0/core/control/`
- Create a copy of one of the control files, using a command such as:

```
cp input_cpl_1day input_copy
```

- Use `emacs` 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 parameters to have a non-zero value is the one which takes effect

Basic `namelist` options

`iocmn, iocyr`

- For the stand-alone ocean model, these determine the duration of the simulation:
  - If `iocmn` < 12, stop after `iocmn` months
  - If `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 AD 1950)
- `csolar` specifies the solar constant, in Wm^{-2}

`runtype`

- `runtype` specifies the name of the simulation

Exercise: basic `namelist` options

- Look at the control files in the following directories:

```
~/mk3l-1.0/core/control/
~/mk3l-1.0/workshop/control/
```

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

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

Exercise: basic `namelist` options

- Change to the directory `~/mk3l-1.0/core/control/`
- Edit the file `input_cpl_1day`
- Change the values of `bpyear` and/or `csolar` e.g.
  - change `bpyear` to `126000` (the last glacial inception)
  - change `csolar` to `1228.5` (a 10% reduction)
- Run the coupled model for one day, by changing to the directory `~/mk3l-1.0/core/scripts/` and entering the command:

```
qsub qsub_test_cpl
```

- How would you change the duration of this simulation?

Atmosphere model output

- This is controlled by the parameter `statsflag`

`statsflag=T` Save monthly-mean variables to netCDF files

`statsflag=F` Don't save this data

- The parameters in the group `statvars` control which variables are to be saved - see Section 4.2.4 of the User's Guide
- It's also possible to save instantaneous and daily-mean values - see Section 4.2.5 of the User's Guide

Changing the 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 `~/mk3l-1.0/pre/co2/`, and enter the commands:

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

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

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

The final exercise!

- Applying everything you've learnt so far, configure the model for a new scenario e.g.
  - change the value of `bpyear`
  - change the value of `csolar`
  - change the atmospheric CO_2 concentration
- Some ideas:
  - Last Glacial Maximum: `bpyear=21000`, CO_2 = 200 ppm
  - last glacial inception: `bpyear=126000`
  - Snowball Earth: reduce `csolar` by 30% to `955.5`
- Run the coupled model for 3–6 months

Summary: Basic configuration

- What we've covered so far:
  - How to configure the model via the control file
  - How to change the atmospheric CO_2 concentration by generating a new auxiliary file
- This enables you to vary:
  - the epoch
  - the solar constant
  - the atmospheric CO_2 concentration
  - the model output which is saved to file

Advanced configuration

- There are two ways of configuring other aspects of the model:
  - Modify the other auxiliary files
  - Modify the source code

Auxiliary files: atmosphere model

- Bottom boundary conditions:
  - Sea surface temperatures (`clim3f.sst`)
  - Ocean currents (`ocuv.3st`)
  - Topography (`psrk21f.dat`)
  - Albedo (`albnew21f`)
  - Vegetation and soil types (`sibrs.dat`, `sibsig.dat`, `sibsoil.dat`, `sibvegt.dat`, `sibz0.dat`)
- Radiative boundary conditions:
  - CO_2 transmission coefficients (`co2_data.18l`)
  - Ozone mixing ratios (`amip2o3.dat`)

Auxiliary files: ocean model

- Upper boundary conditions:
  - Sea surface temperatures (`sst.dat`)
  - Sea surface salinities (`sss.dat`)
  - Surface wind stresses (`stress.dat`)
- Bottom boundary conditions:
  - Bathymetry (`sttop.bot_ind`)

Auxiliary files: coupled model

- Bottom boundary conditions:
  - Topography (`psrk21f.dat`, `landrun21`)
  - Bathymetry (`sttop.bot_ind`)
  - Albedo (`albnew21f`)
  - Vegetation and soil types (`sibrs.dat`, `sibsig.dat`, `sibsoil.dat`, `sibvegt.dat`, `sibz0.dat`)
- Radiative boundary conditions:
  - CO_2 transmission coefficients (`co2_data.18l`)
  - Ozone mixing ratios (`amip2o3.dat`)
- Flux adjustments (`dtm1av`, `hfcor.dat12`, `s1coravth`, `sfcor.dat12`, `txcor.dat12`, `tycor.dat12`)

Examples of advanced configuration

- Applying anomalies within the atmosphere and ocean models:
  - modify the SSTs, SSSs, currents, wind stresses
- Applying anomalies within the coupled model:
  - modify the flux adjustments
- Configuring the model for a different era:
  - modify the topography and bathymetry
  - modify the albedo, and the vegetation and soil types
  - modify the epoch, solar constant, CO_2 transmission coefficients, ozone mixing ratios
  - issues with restart files, spin-up procedures and flux adjustments