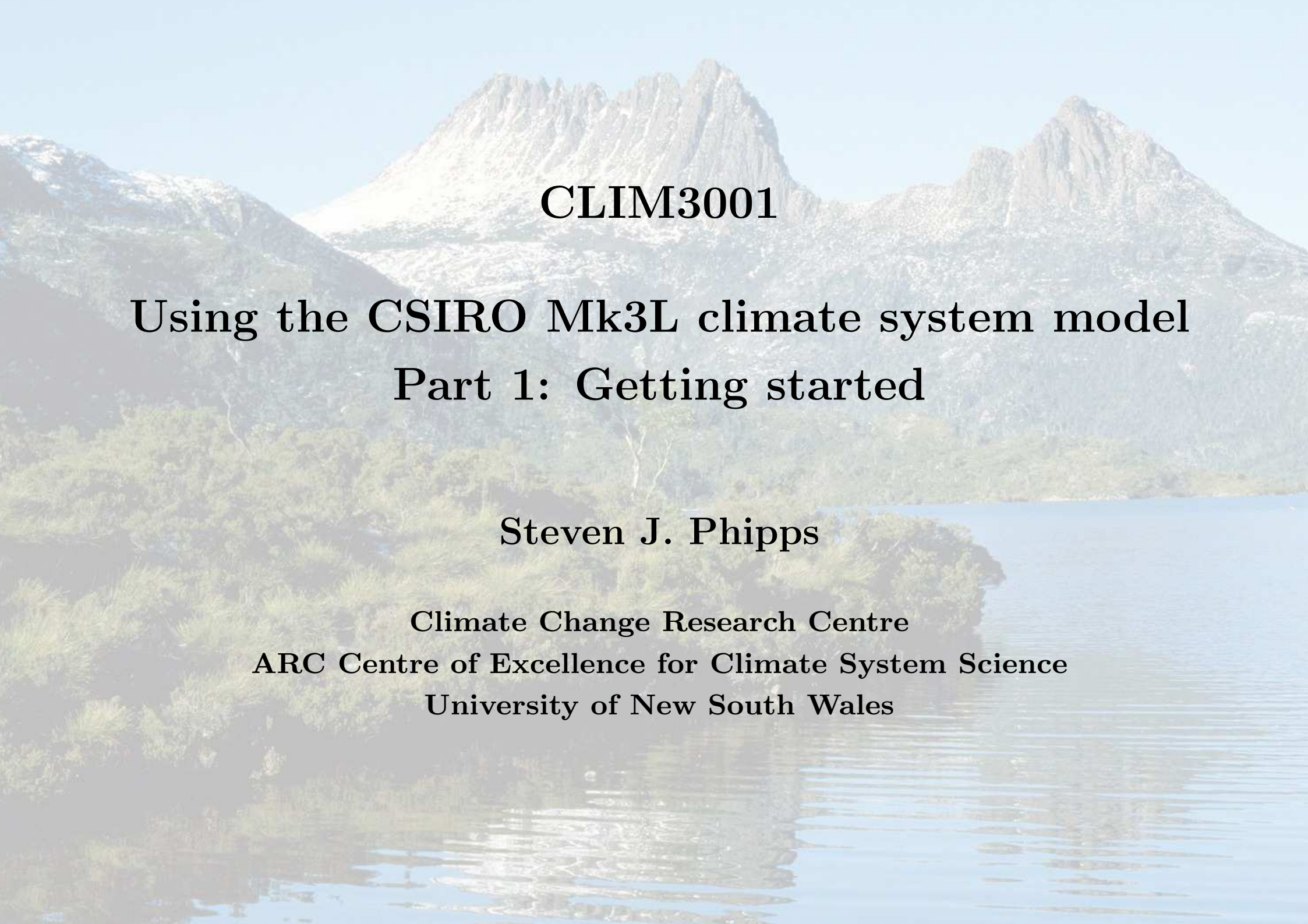

# CLIM3001

# Using the CSIRO Mk3L climate system model
# Part 1: Getting started


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# Overview

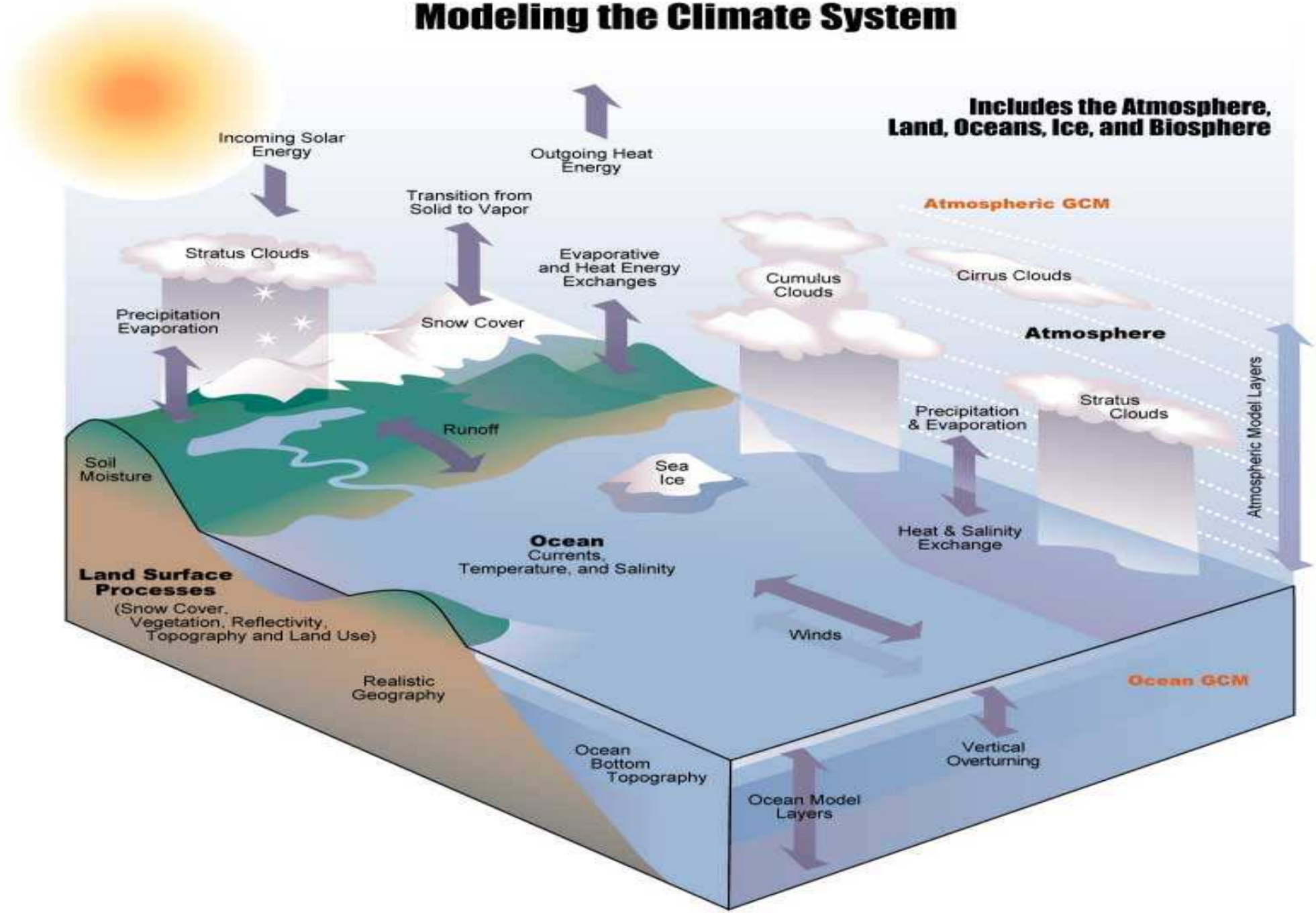
- What is this thing called Mk3L?
- What can it do?
- Getting the model
- Compiling the model
- Running the model

# What is this thing called Mk3L?

# The CSIRO Mk3L climate system model

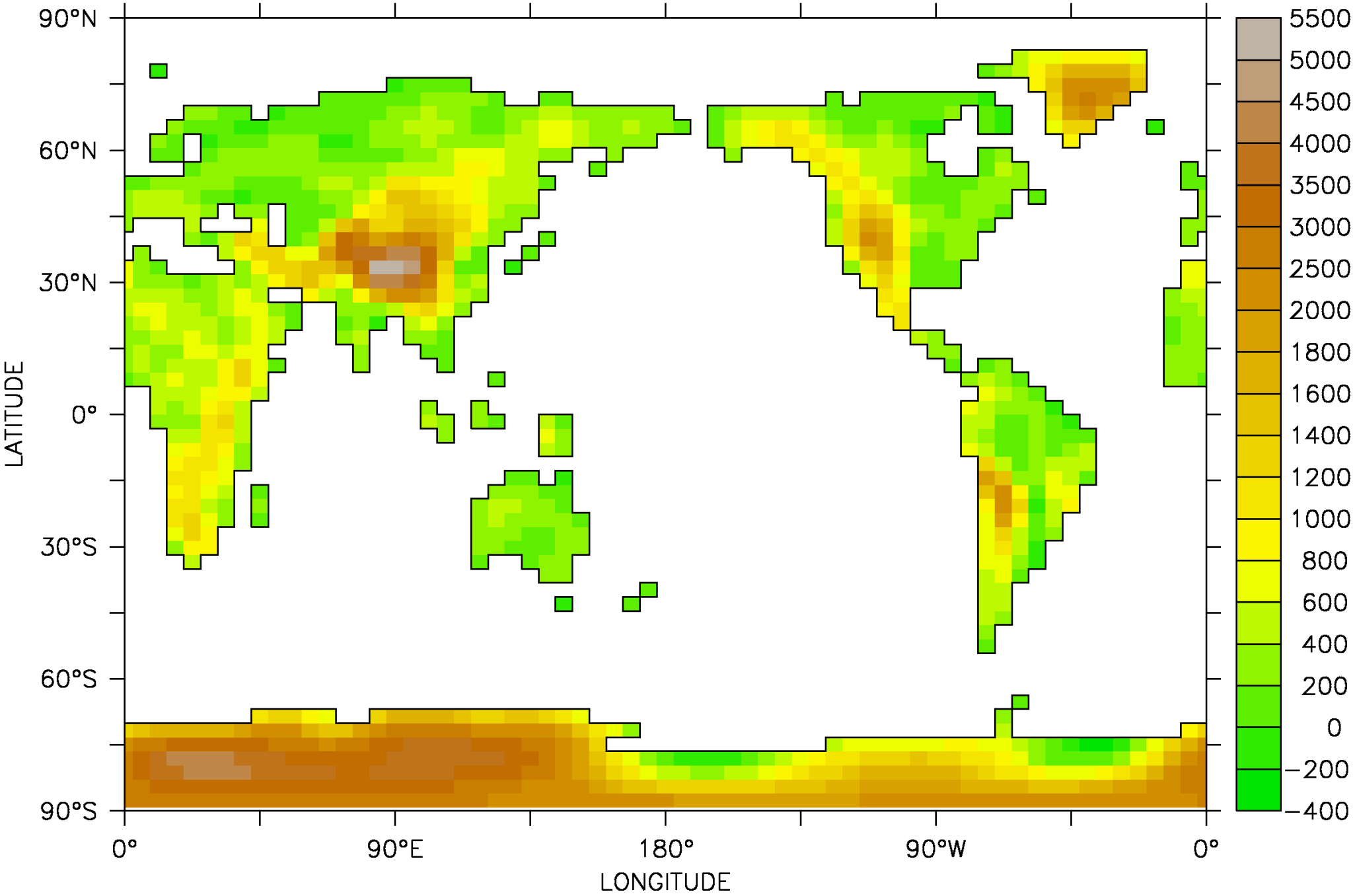
- Low-resolution version of the CSIRO climate system model
- Coupled atmosphere-land-sea ice-ocean general circulation model
- Designed to enable millennial-scale simulations of climate variability and change e.g.
  - palaeoclimate reconstructions
  - projections of future climate
  - low-frequency climate variability
  - process studies
- Can simulate 1000 years in around a month
- Community model

# Modeling the Climate System



# The CSIRO Mk3L climate system model

- Atmosphere:
  - Three-dimensional general circulation model
  - Horizontal resolution of $5.6^\circ \times 3.2^\circ$ with 18 vertical levels
- Ocean:
  - Three-dimensional general circulation model
  - Horizontal resolution of $2.8^\circ \times 1.6^\circ$ with 21 vertical levels
- Sea ice:
  - Dynamic-thermodynamic sea ice model
  - Three layers (two ice, one snow)
- Land surface:
  - Soil-canopy scheme (13 land surface/vegetation types, 9 soil types)
  - Six soil layers, three snow layers


90°N
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90°S
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180°
90°W
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LONGITUDE
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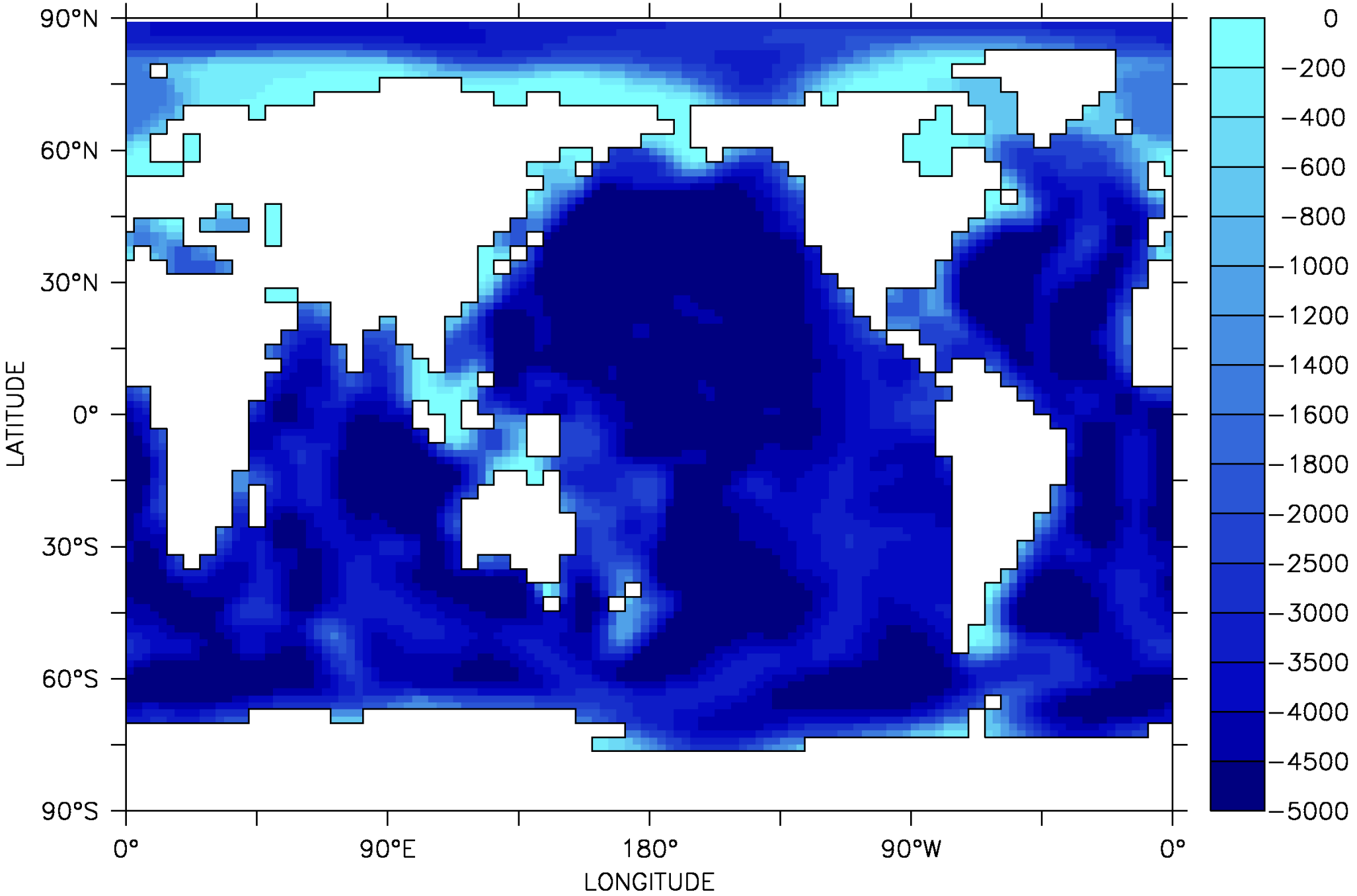
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−800
−1000
−1200
−1400
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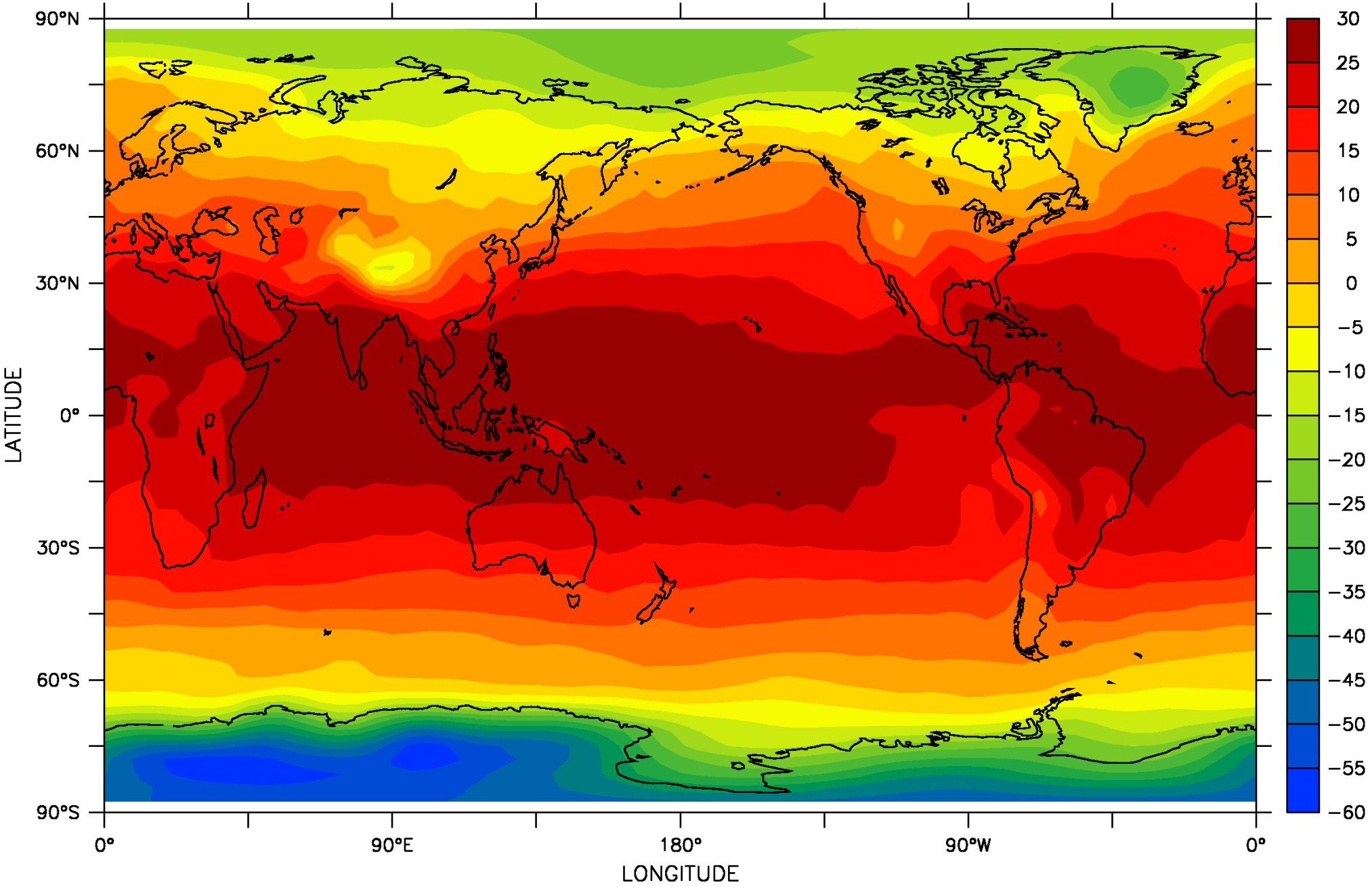
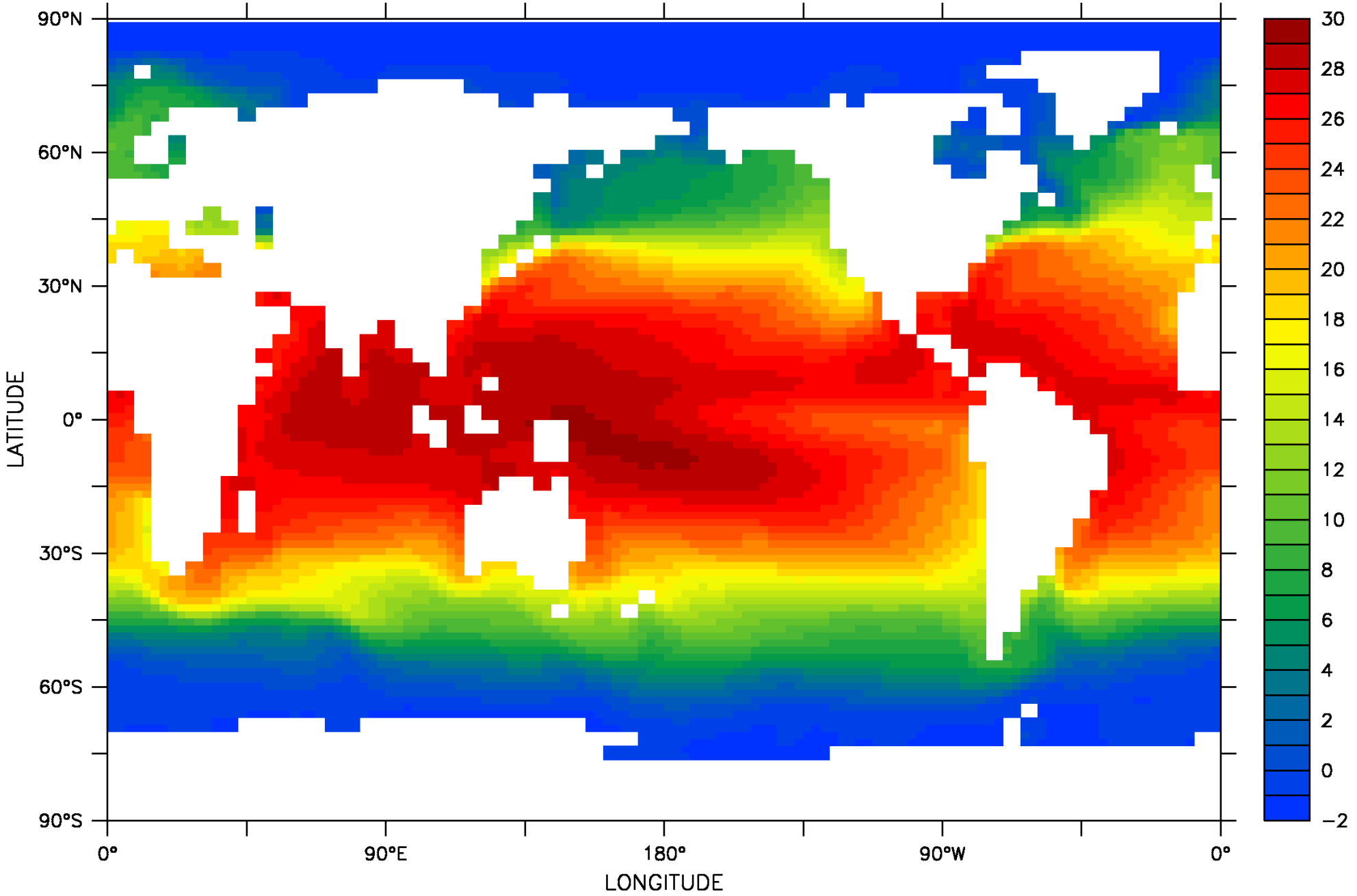
−2000
−2500
−3000
−3500
−4000
−4500
−5000

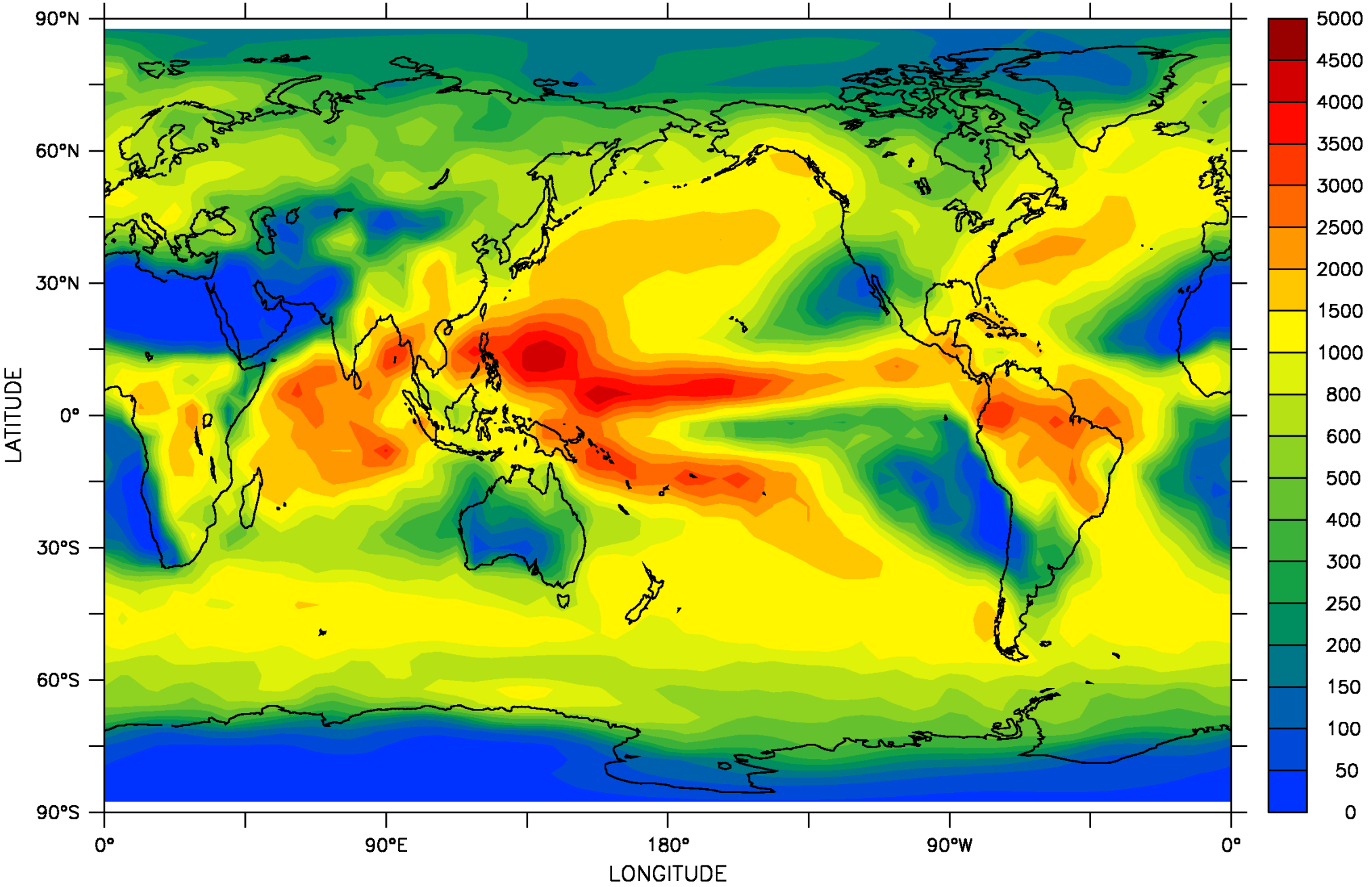
# What can it do?



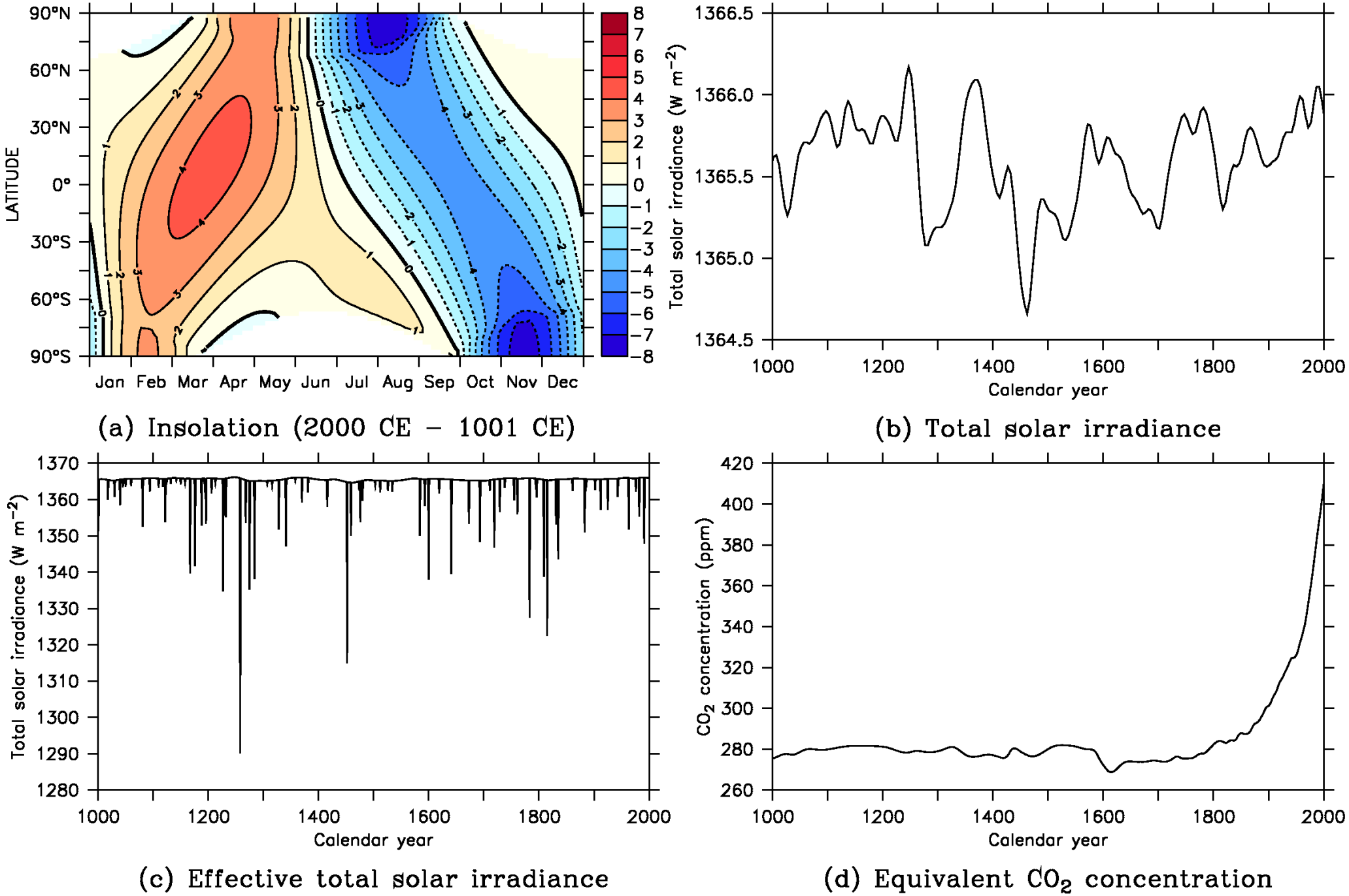

Simulated annual–mean surface air temperature (°C)

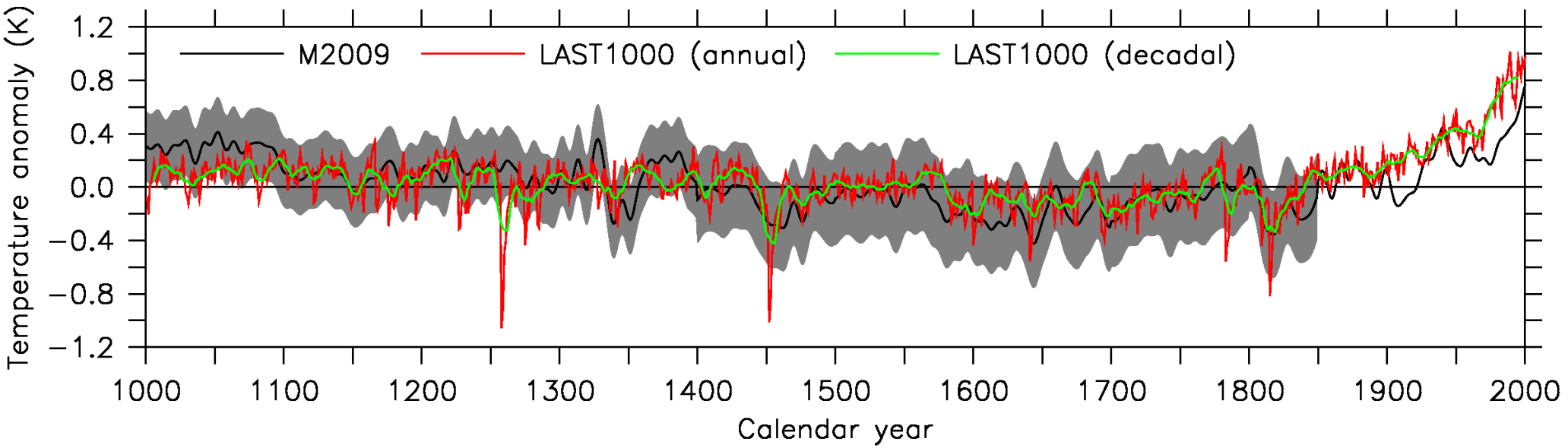



Simulated annual–mean sea surface temperature (°C)

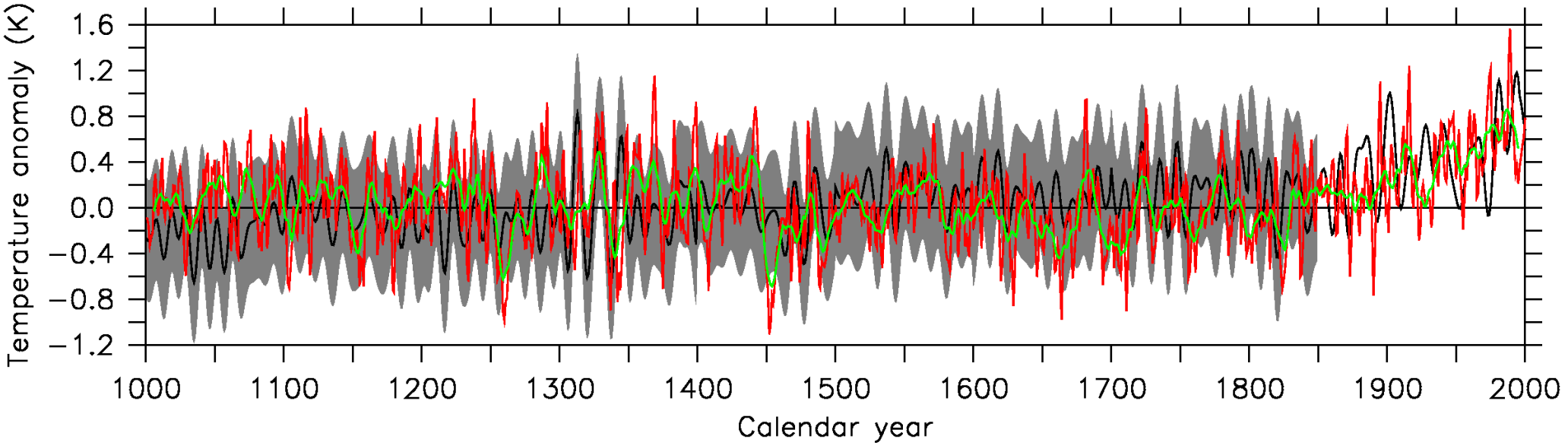



Simulated annual precipitation (mm)

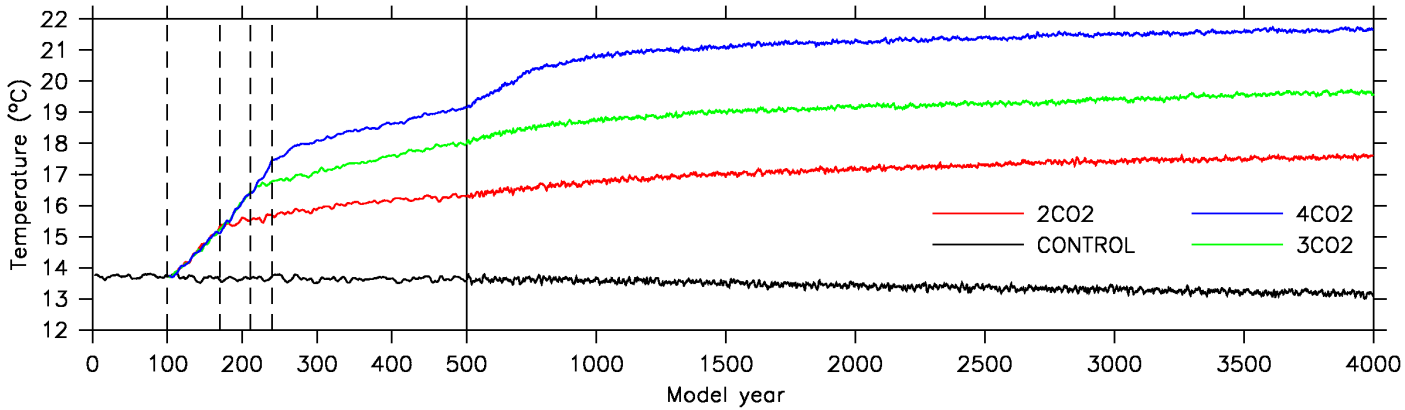

90°N
60°N
30°N
0°
30°S
60°S
90°S
LATITUDE
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
8 7 6 5 4 3 2 1 0 −1 −2 −3 −4 −5 −6 −7 −8
(a) Insolation (2000 CE − 1001 CE)
Total solar irradiance (W m−2)
1366.5
1366.0
1365.5
1365.0
1364.5
1000 1200 1400 1600 1800 2000
Calendar year
(b) Total solar irradiance
Total solar irradiance (W m−2)
1370 1360 1350 1340 1330 1320 1310 1300 1290 1280
1000 1200 1400 1600 1800 2000
Calendar year
(c) Effective total solar irradiance
CO2 concentration (ppm)
420 400 380 360 340 320 300 280 260
1000 1200 1400 1600 1800 2000
Calendar year
(d) Equivalent CO2 concentration



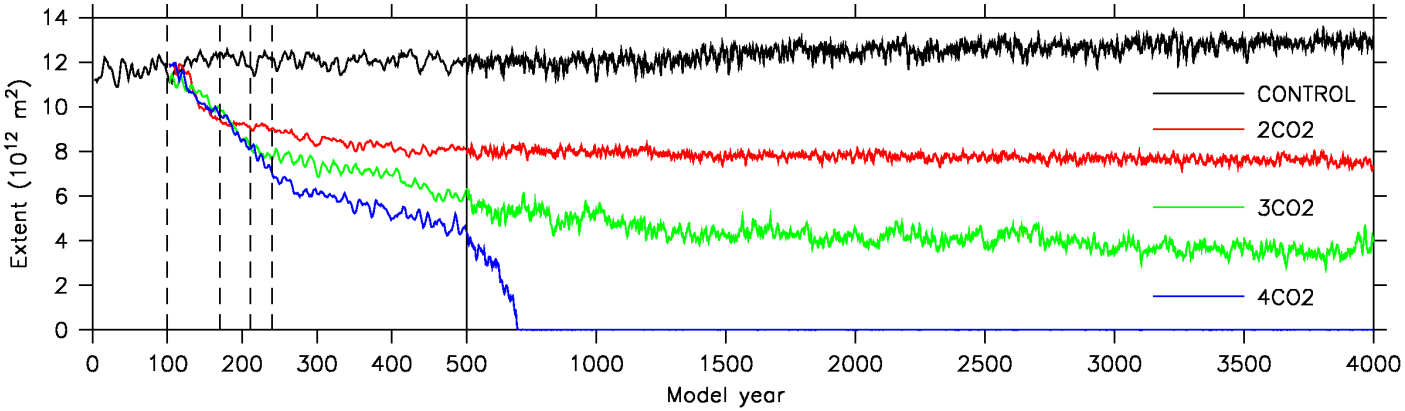

(a) Northern Hemisphere surface air temperature



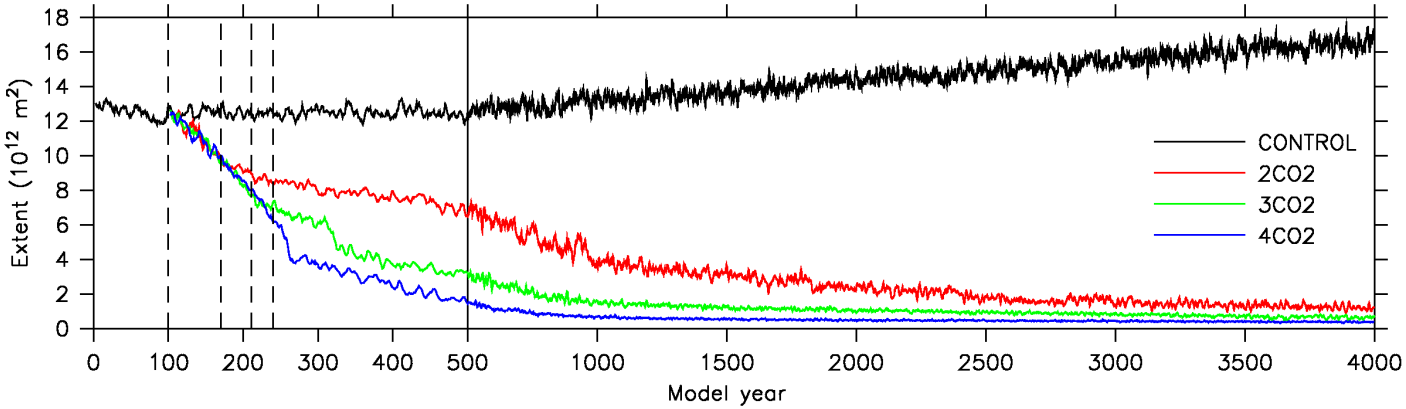

(b) Nino 3 sea surface temperature



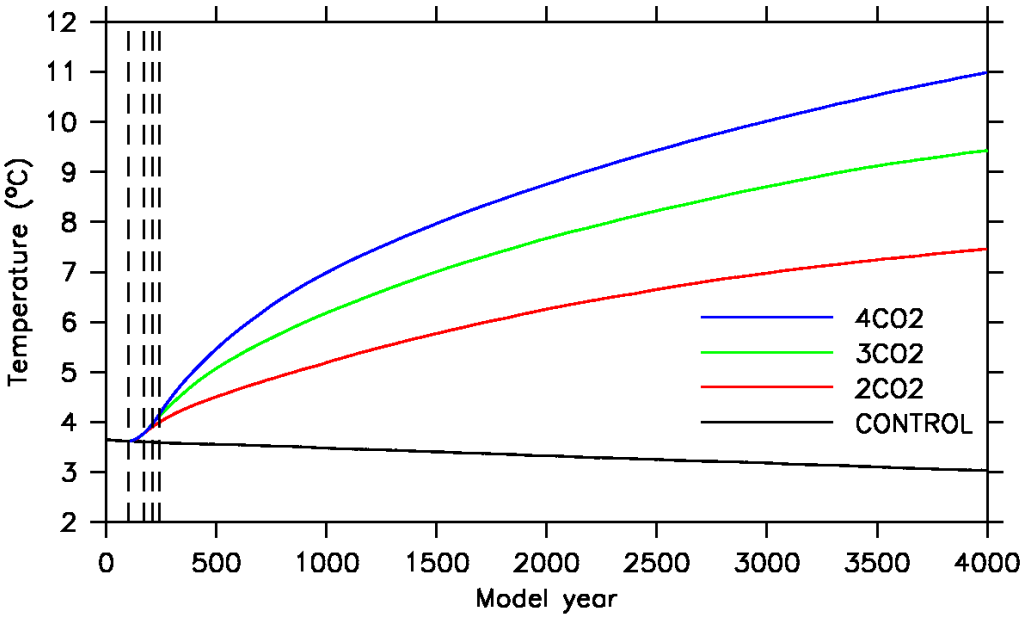

(a) Global–mean surface air temperature



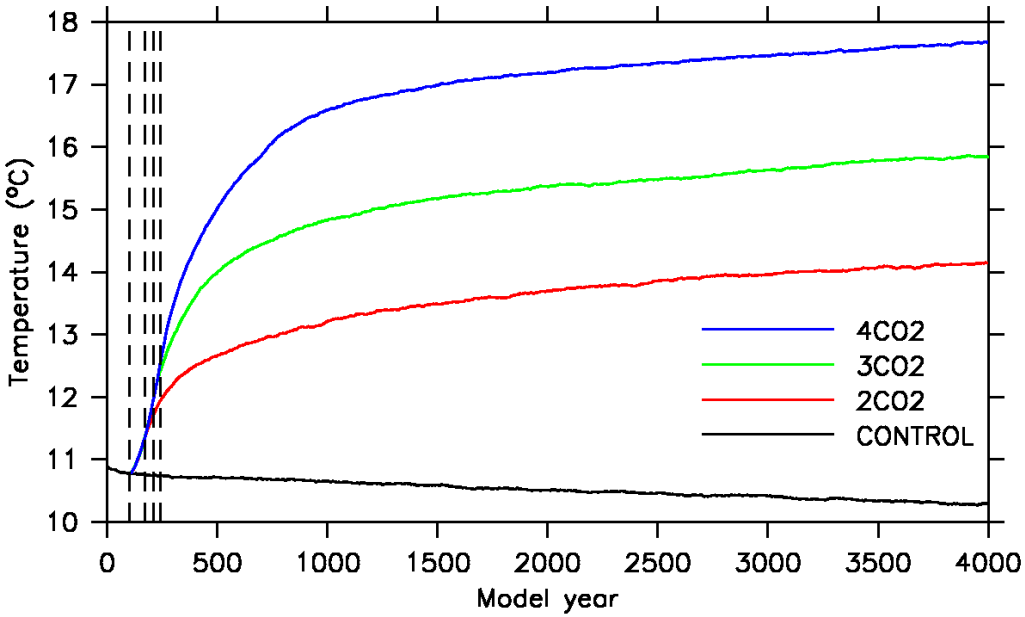

(b) Northern Hemisphere sea ice extent



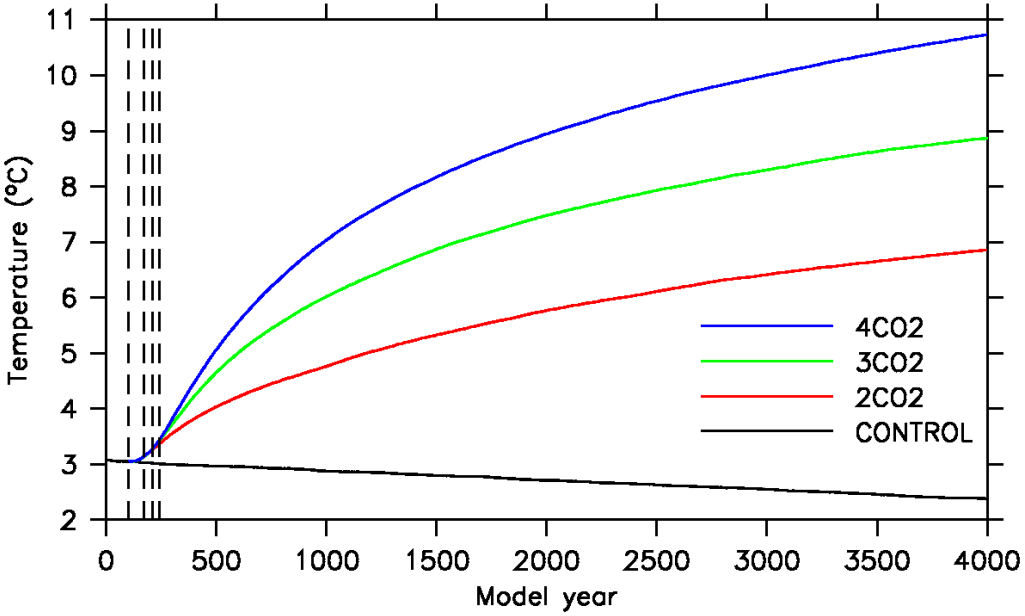

(c) Southern Hemisphere sea ice extent



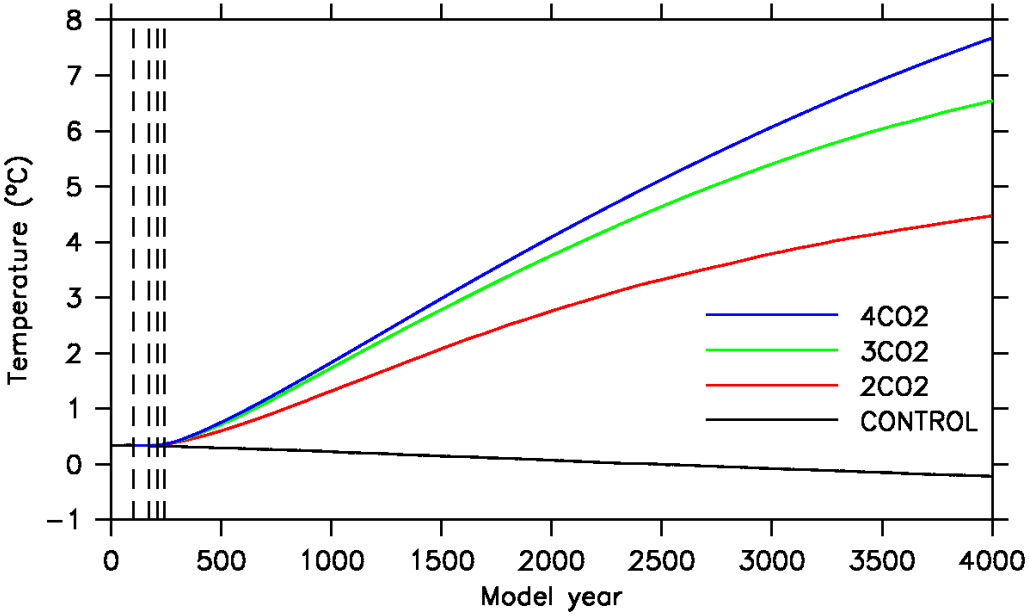

(a) Entire ocean



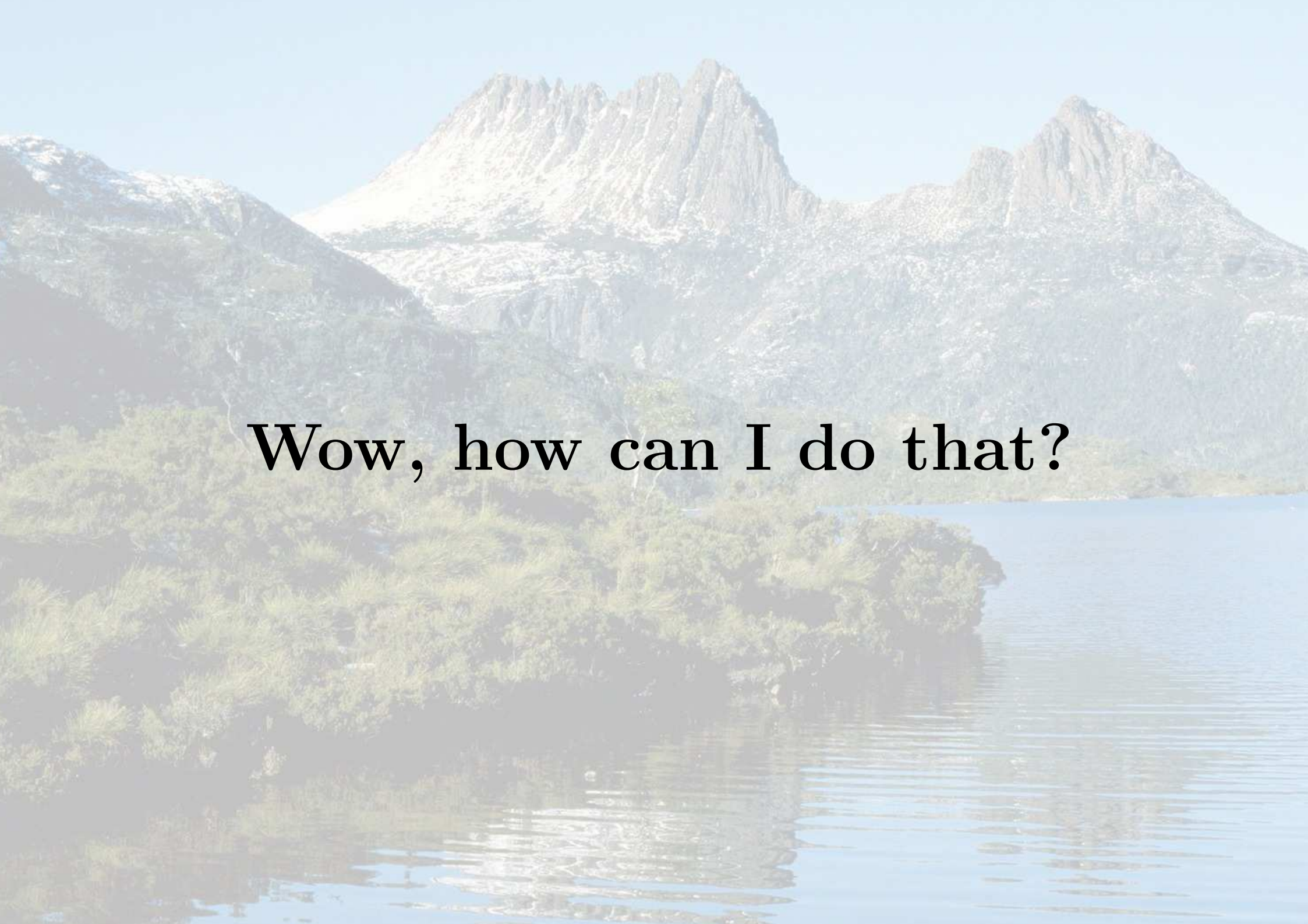

(b) Upper ocean (0–800 m)




(c) Mid-ocean (800–2350 m)




(d) Deep ocean (2350–4600 m)


Wow, how can I do that?

# Getting Mk3L

# Tensor: The UNSW parallel computing cluster

- SGI Altix XE320
- 84 quad core 3.0 GHz CPUs
- Total of 336 cores
- 720 GB memory
- 7 TB of disk space
- Linux operating system
- Portable Batch System (PBS) for running jobs
- `tensor.maths.unsw.edu.au`
- `http://www.hpc.maths.unsw.edu.au/tensor/intro`

# Exercise 1: Using tensor

- 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 `tensor.maths.unsw.edu.au`
  - Click `Open`
  - Log in using your zNumber and zPass
- Familiarise yourself with the basic Linux commands

# Basic Linux commands

| | |
|---|---|
| `ls` | list the contents of a directory |
| `ls -l` | create a long listing |
| `mkdir <directory>` | create the directory `<directory>` |
| `cd <directory>` | change to the directory `<directory>` |
| `cp <file1> <file2>` | copy the file `<file1>` to `<file2>` |
| `mv <file1> <file2>` | move the file `<file1>` to `<file2>` |
| `rm <file>` | delete the file `<file>` |
| `rmdir <directory>` | delete the directory `<directory>` |
| `man <command>` | display the manual page for `<command>` |

# Subversion

- Subversion is a *version control system*
- Used to manage current and historical versions of files
- Operates via the internet, allowing a community of users and developers to seamlessly share a piece of software
- Mk3L is managed and distributed using subversion
- The Mk3L repository is located at the Tasmanian Partnership for Advanced Computing in Hobart (but could be anywhere)
- See `http://subversion.tigris.org` (includes free book!)

# Exercise 2: Getting Mk3L

- We're not going to use subversion today. To save time, I've put a copy of the model distribution on tensor.
- Get Mk3L version 1.2 by entering the following commands:

```
cd
mkdir CSIRO_Mk3L
cd CSIRO_Mk3L
tar zxvf /srv/scratch/z3210932/mk3l-1.2.tar.gz
```

# Exercise 2: Getting Mk3L

- The previous command created a new directory, `version-1.2/`
- Explore the contents of this directory - this is what a climate model looks like!

| | |
|---|---|
| `core/` | Source code, data files and scripts needed to run Mk3L |
| `data/` | Useful datasets |
| `doc/` | Documentation |
| `post/` | Utilities for the analysis of model output |
| `pre/` | Utilities for the generation of restart and auxiliary files |

# Compiling Mk3L

# Exercise 3: Compiling Mk3L

- Compile the model, by entering the following commands:

```
cd ~/CSIRO_Mk3L/version-1.2/core/scripts/
./compile
```

- Test the model, by entering any of the following three commands:

| | |
|---|---|
| `./test_atm` | Runs the atmosphere model for one day |
| `./test_cpl` | Runs the coupled model for one day |
| `./test_oce` | Runs the ocean model for one month |

# Running Mk3L

# Running Mk3L

- The command which runs Mk3L is simply:

```
./model < input
```

- `model` is the *executable*. This is the "model".
- `input` is the *control file*. This contains the instructions which tell the model what to do.
- The above command *executes* the model, and feeds it the information contained within the control file.

# Running Mk3L

- The model is usually run using the command:

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

- This command takes the diagnostic information generated by the model, and *redirects* it to an output file.
- For short jobs, the model can be run interactively.
- However, for production purposes, we need to use a *queueing system*.

# Exercise 4: Running Mk3L

- Run the model, by entering any of the following three commands:

| | |
|---|---|
| `qsub qsub_test_atm` | Runs the atmosphere model for one day |
| `qsub qsub_test_cpl` | Runs the coupled model for one day |
| `qsub qsub_test_oce` | Runs the ocean model for one month |

- Use the command `qstat` to check the progress of your jobs.
- Using the `less` command, examine each of the above scripts. What do they do?
- Familiarise yourselves with the PBS directives.