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

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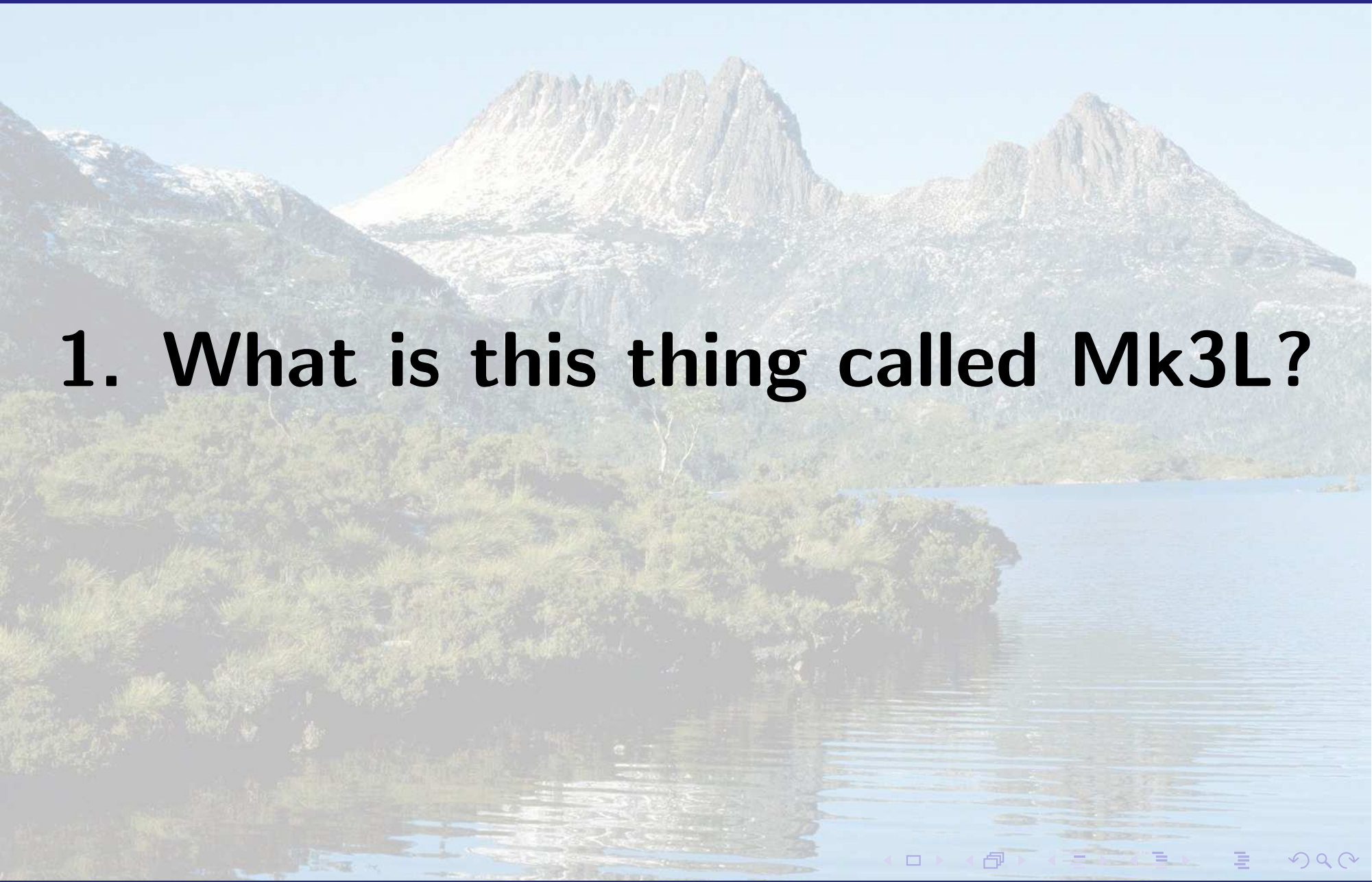
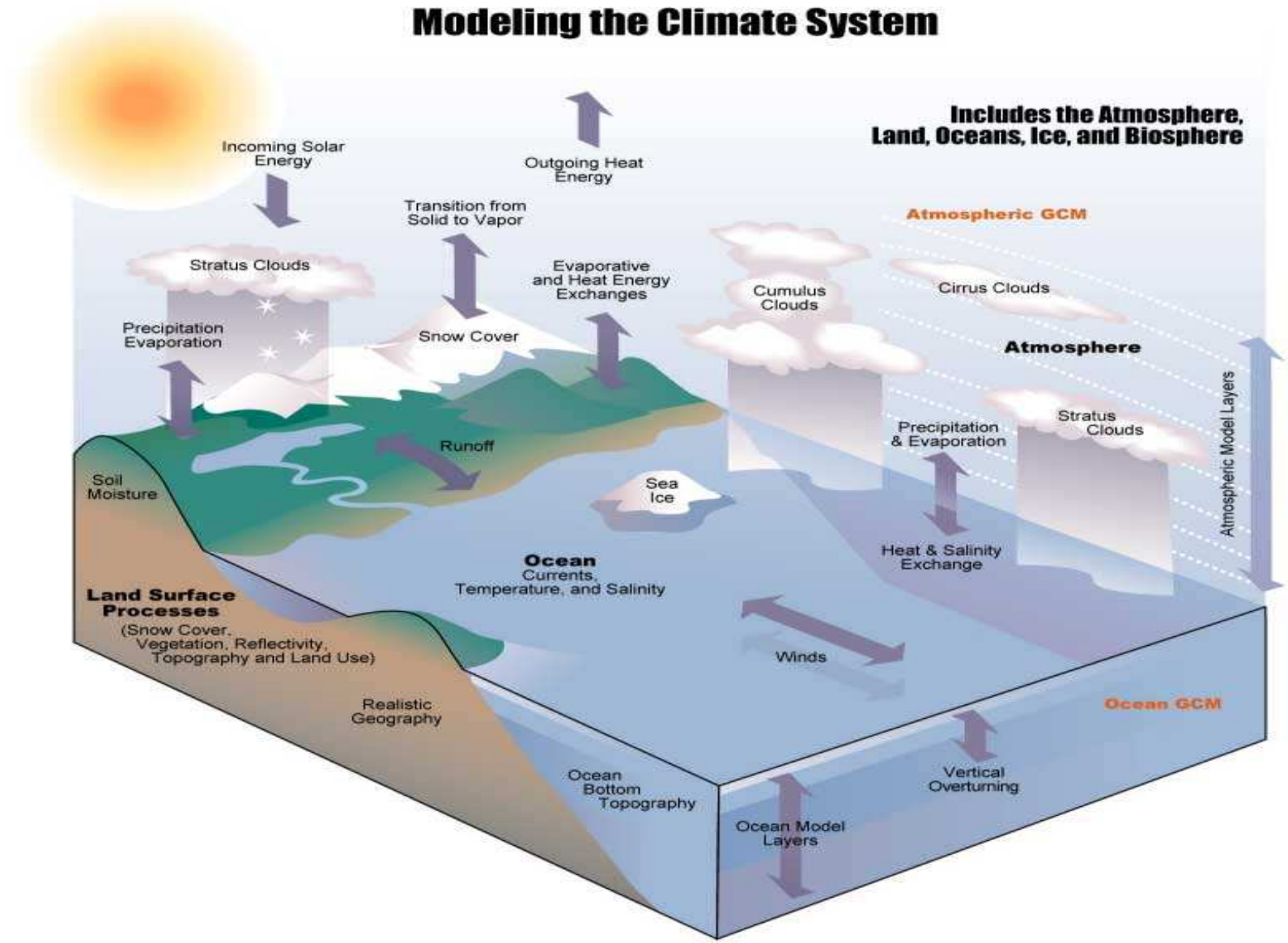


1. What is this thing called Mk3L?

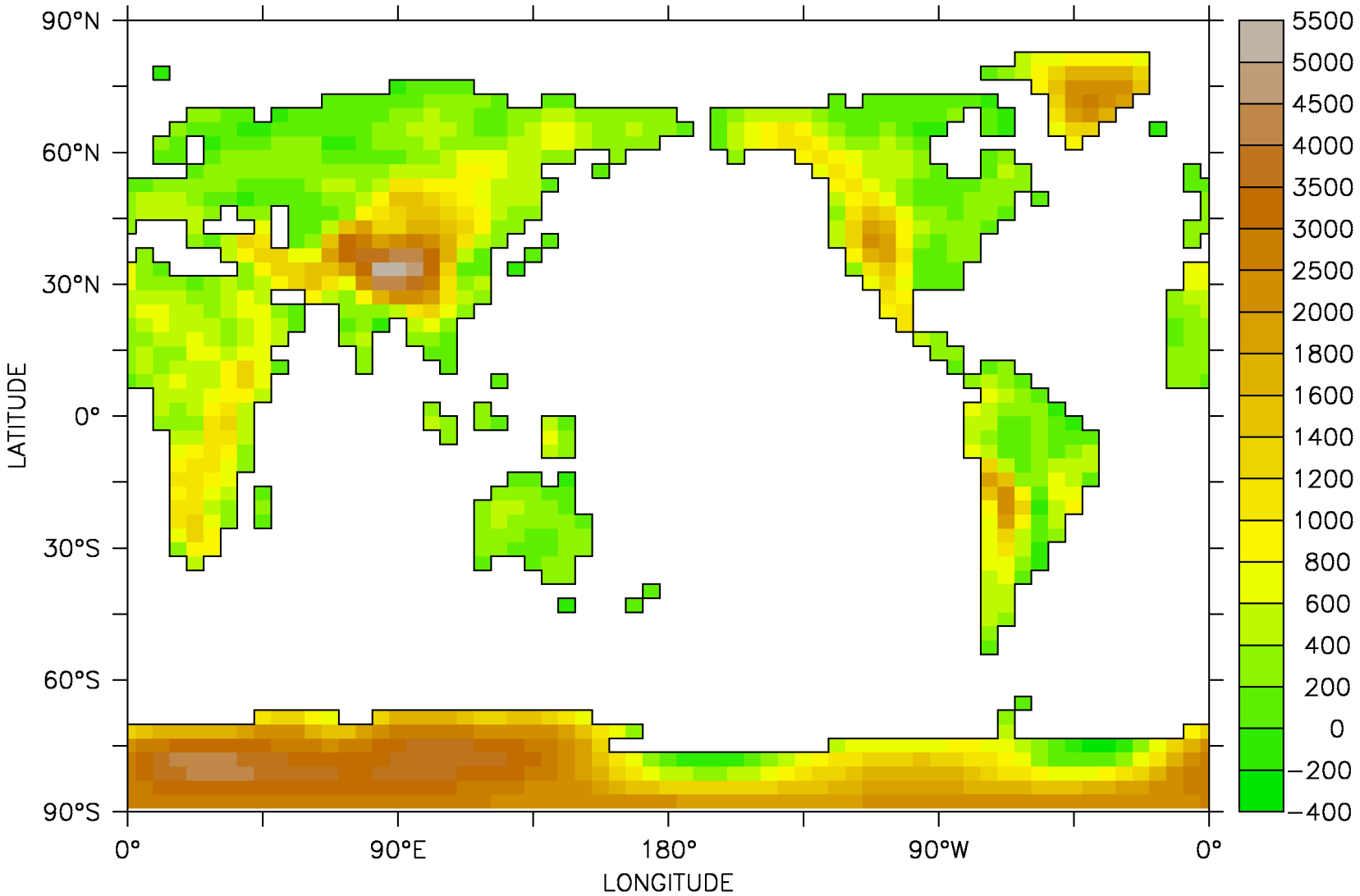
The CSIRO Mk3L climate system model

- 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
Includes the Atmosphere, Land, Oceans, Ice, and Biosphere
Incoming Solar Energy
Outgoing Heat Energy
Transition from Solid to Vapor
Atmospheric GCM
Stratus Clouds
Evaporative and Heat Energy Exchanges
Cumulus Clouds
Cirrus Clouds
Precipitation Evaporation
Snow Cover
Atmosphere
Precipitation & Evaporation
Stratus Clouds
Atmospheric Model Layers
Runoff
Soil Moisture
Sea Ice
Heat & Salinity Exchange
Ocean
Currents, Temperature, and Salinity
Land Surface Processes
(Snow Cover, Vegetation, Reflectivity, Topography and Land Use)
Winds
Realistic Geography
Ocean GCM
Ocean Bottom Topography
Vertical Overturning
Ocean Model Layers

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
60°N
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30°S
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LATITUDE
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LONGITUDE
5500
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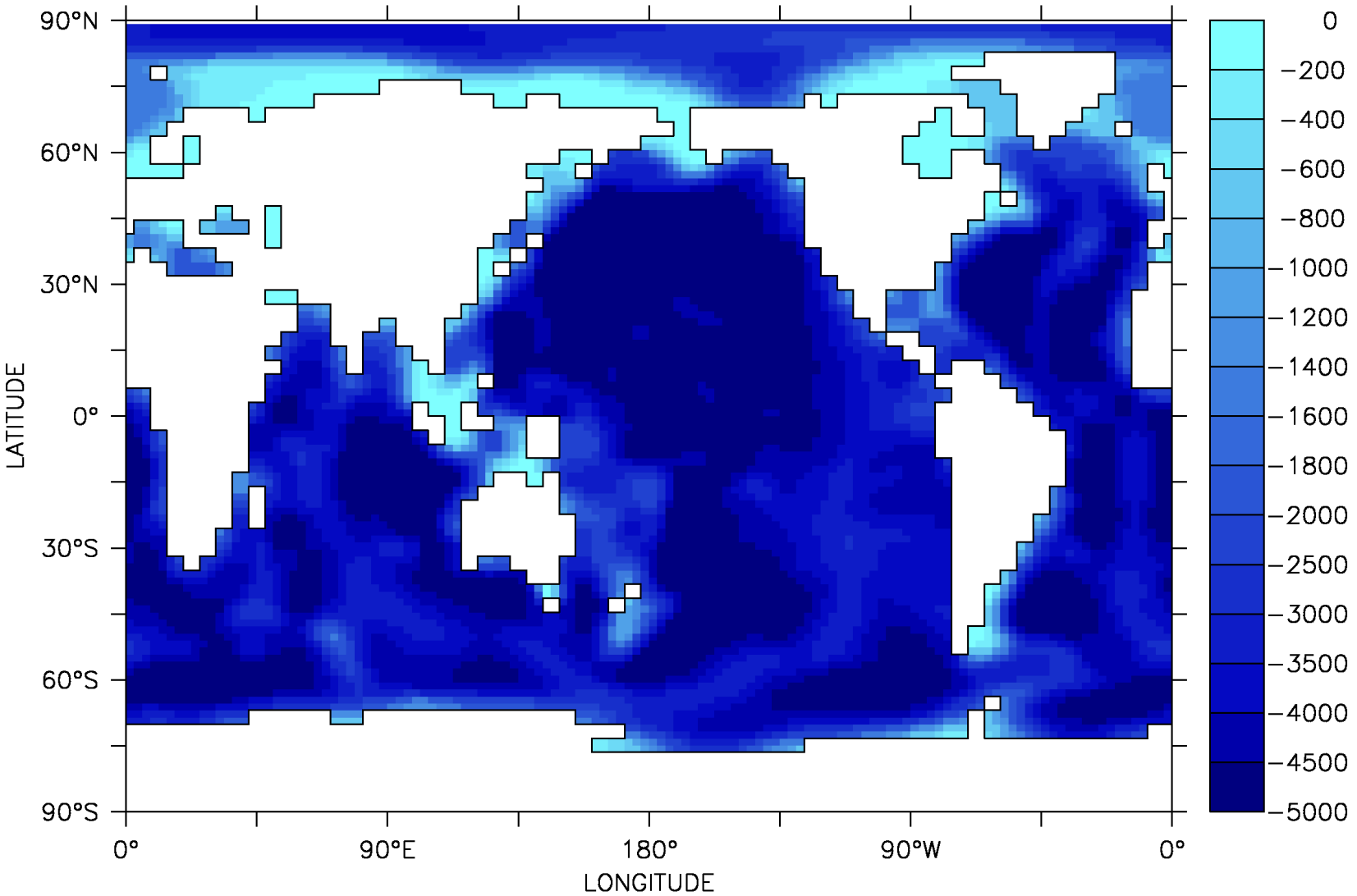
90°N
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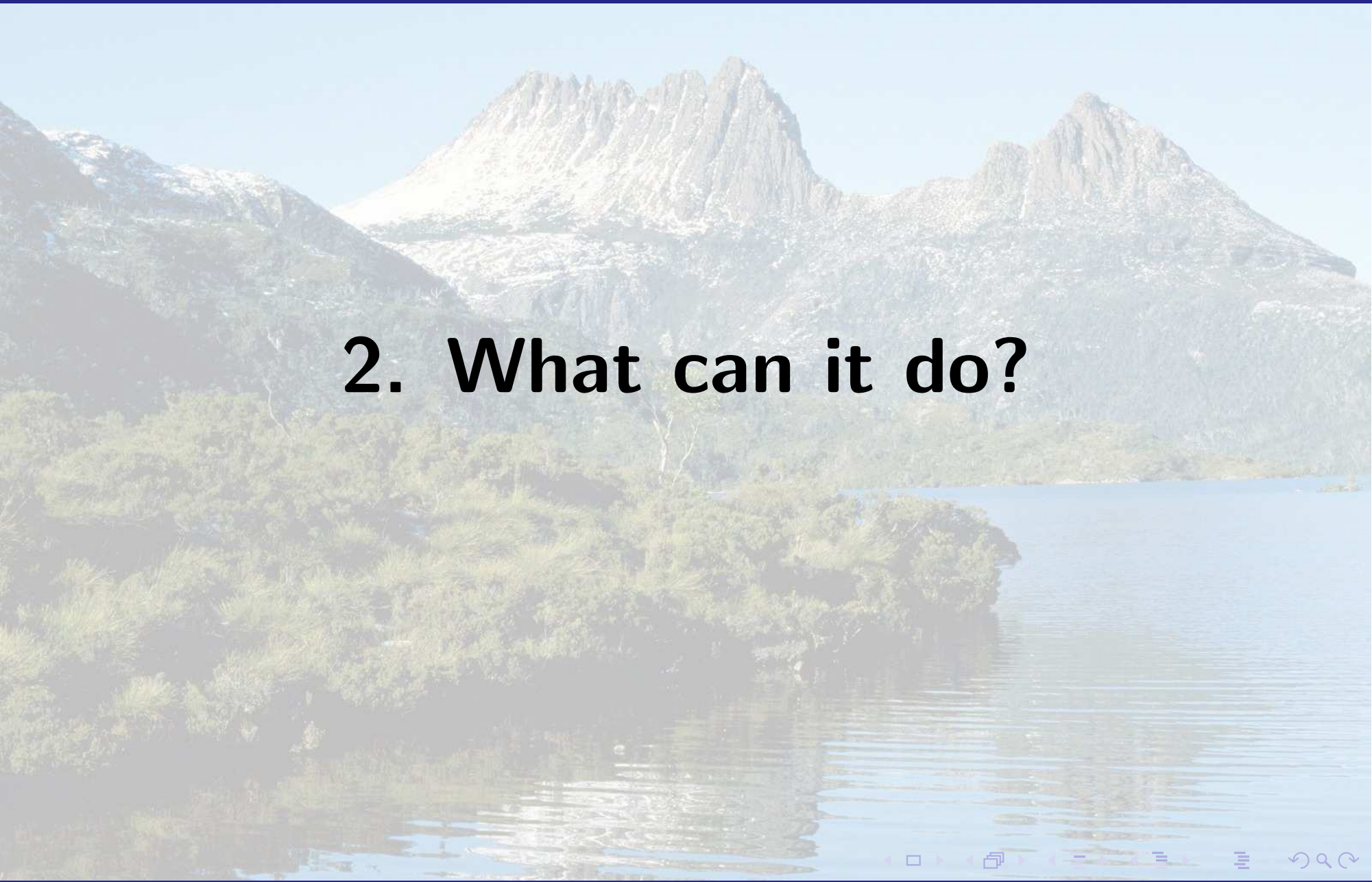
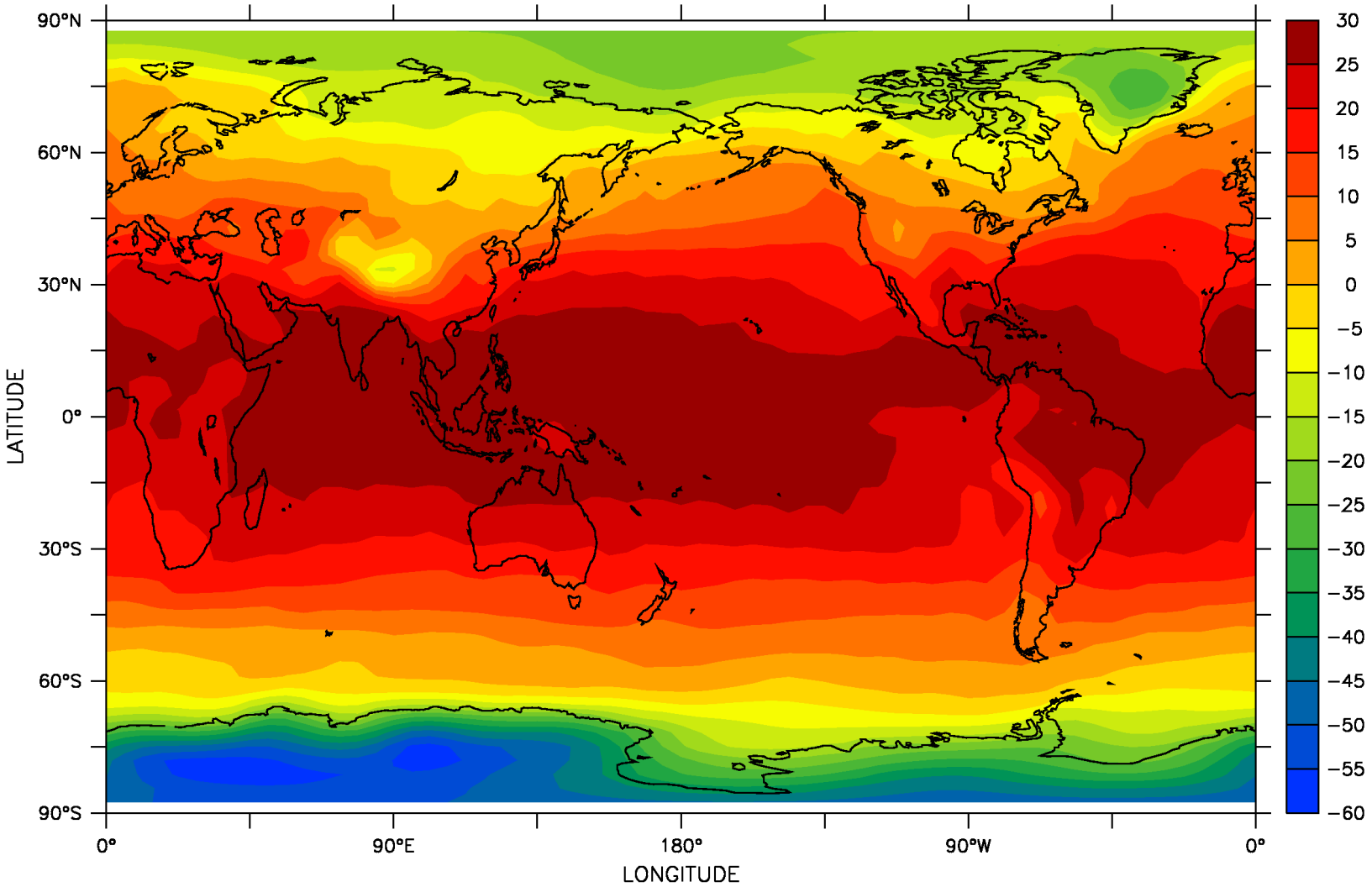
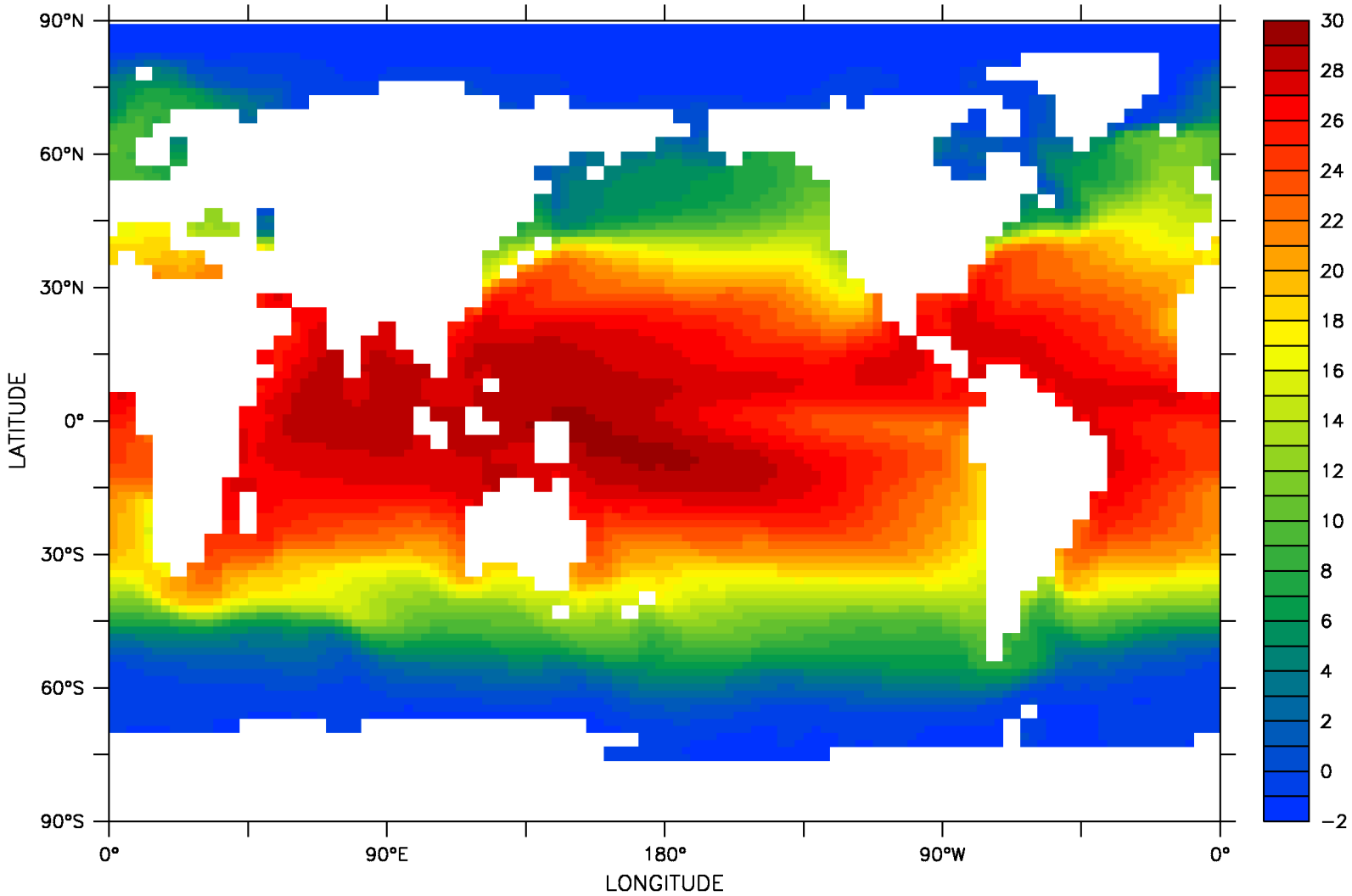


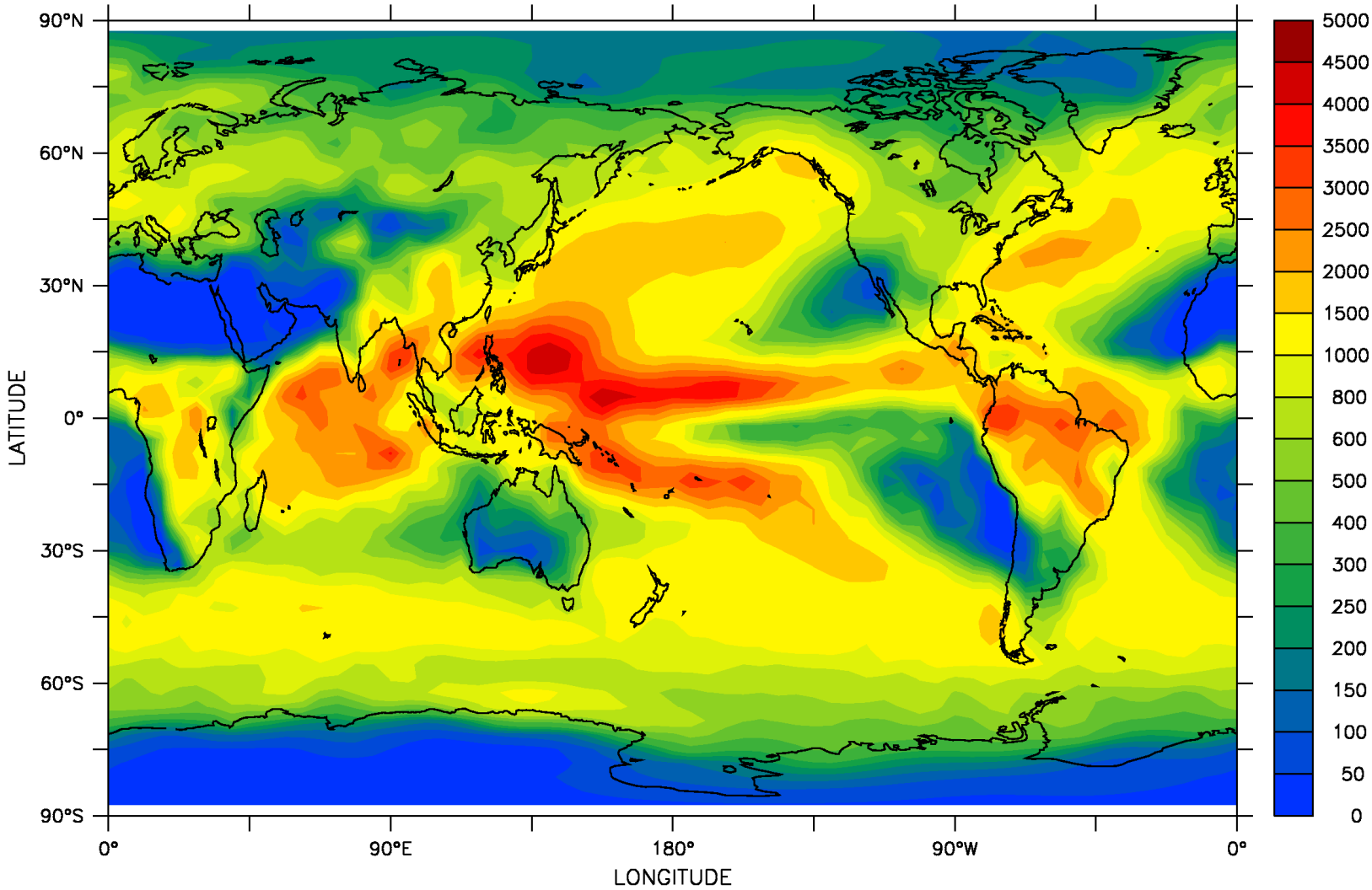
2. What can it do?



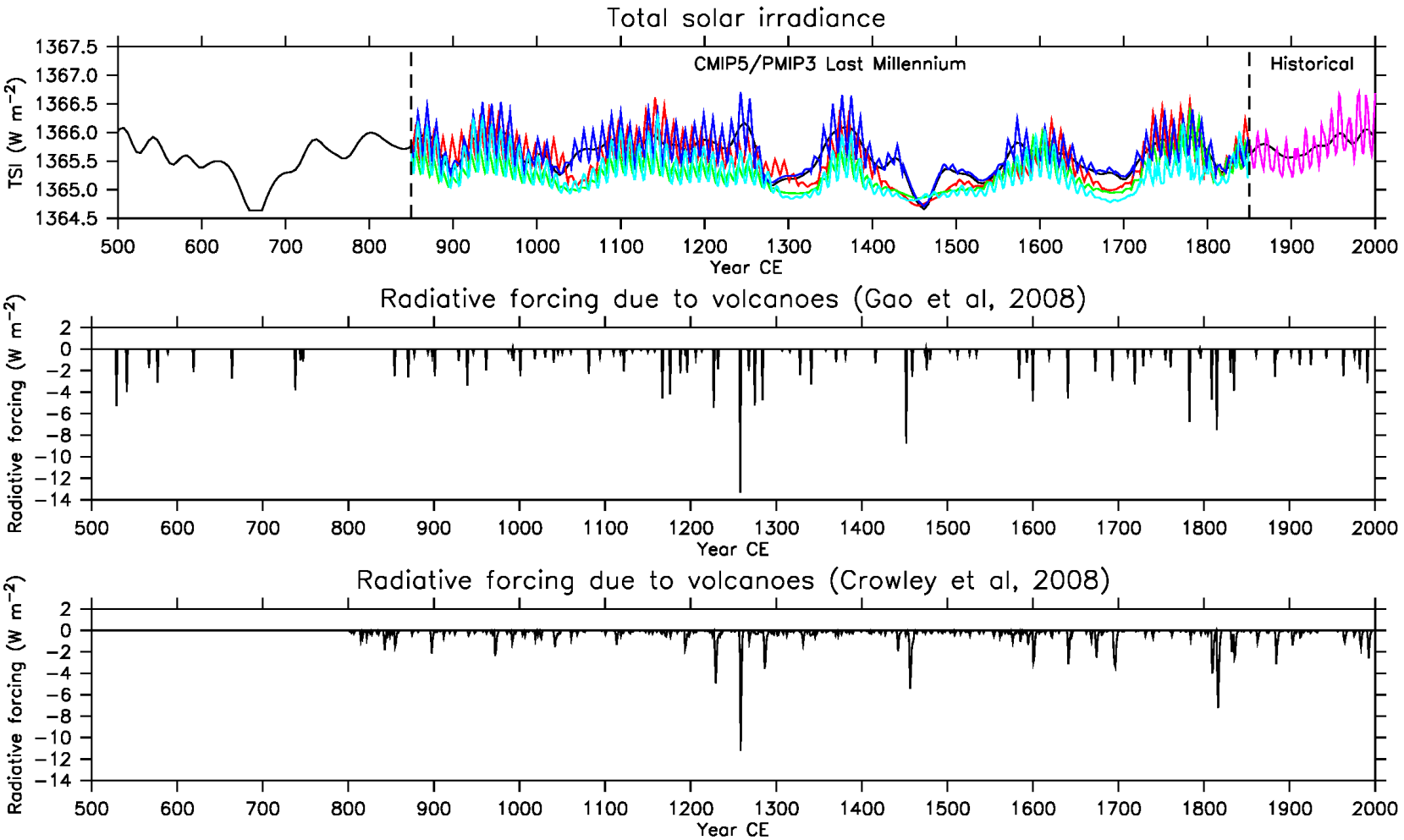
Simulated annual–mean surface air temperature (°C)

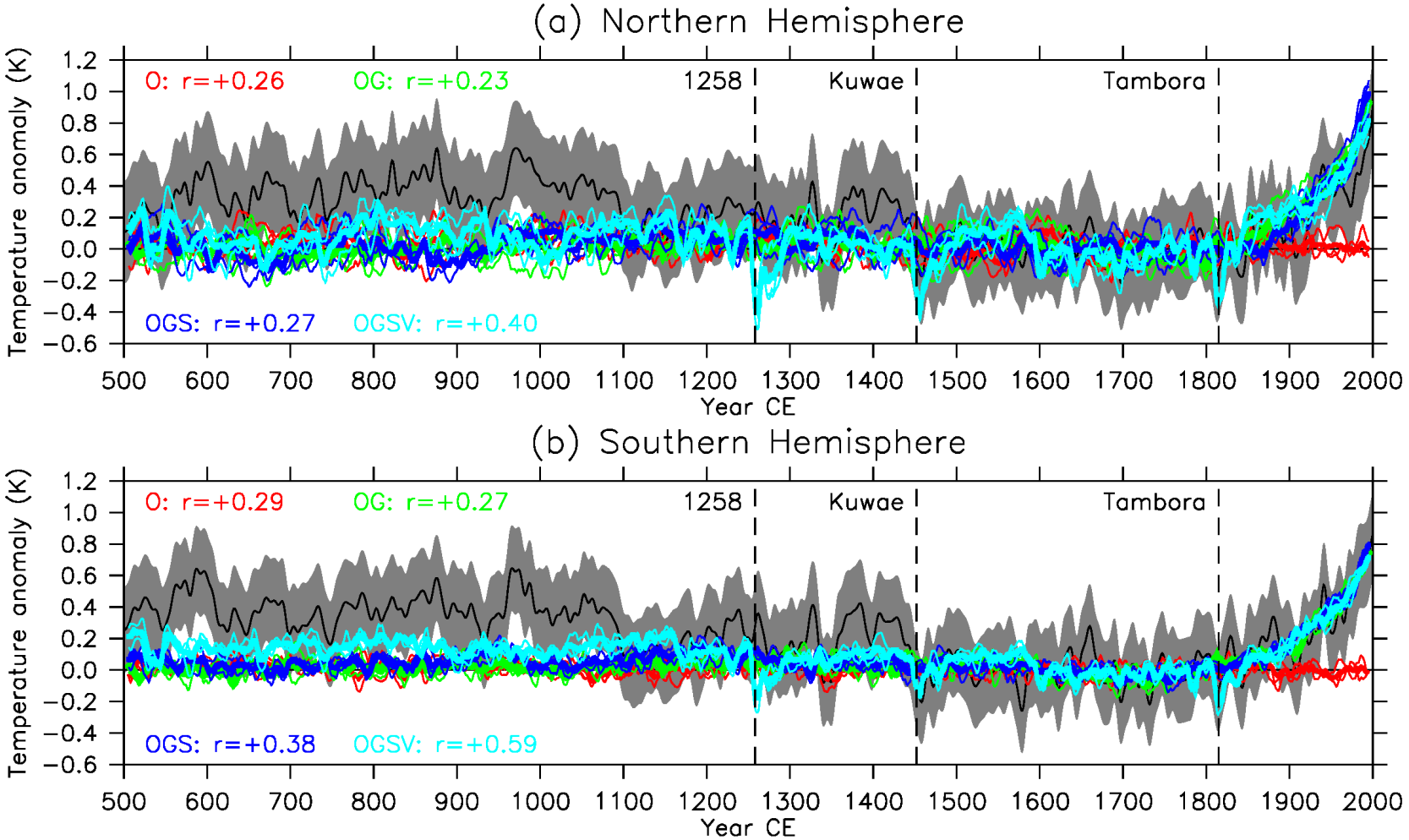


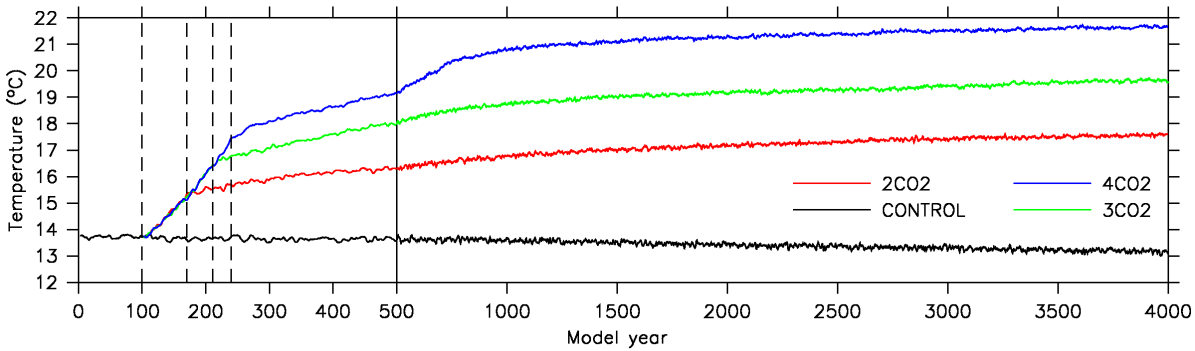
Simulated annual–mean sea surface temperature (°C)



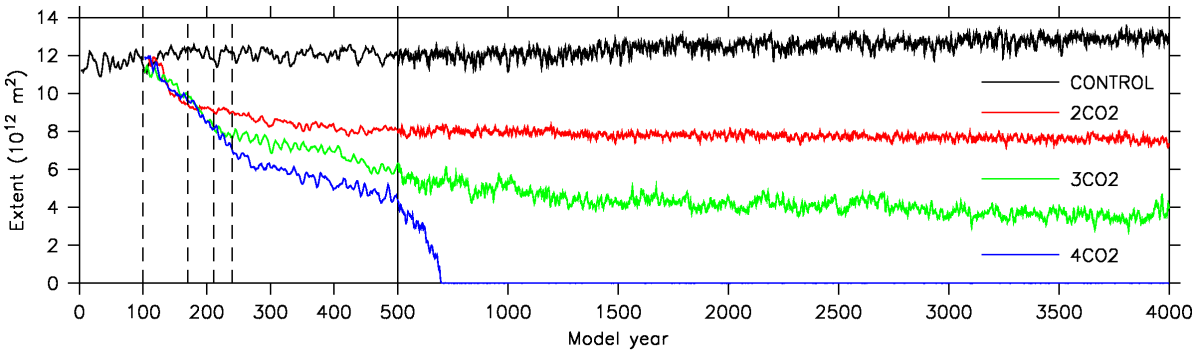
Simulated annual precipitation (mm)


Total solar irradiance
CMIP5/PMIP3 Last Millennium
Historical
TSI (W m^{-2})
1367.5
1367.0
1366.5
1366.0
1365.5
1365.0
1364.5
500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000
Year CE
Radiative forcing due to volcanoes (Gao et al, 2008)
Radiative forcing (W m^{-2})
2 0 −2 −4 −6 −8 −10 −12 −14
500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000
Year CE
Radiative forcing due to volcanoes (Crowley et al, 2008)
Radiative forcing (W m^{-2})
2 0 −2 −4 −6 −8 −10 −12 −14
500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000
Year CE

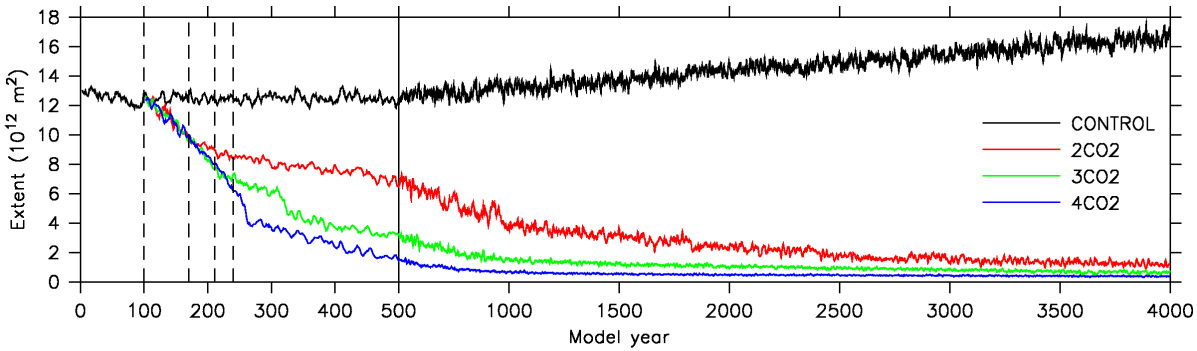

(a) Northern Hemisphere
O: r=+0.26
OG: r=+0.23
OGS: r=+0.27
OGSV: r=+0.40
1258
Kuwae
Tambora
Temperature anomaly (K)
Year CE
(b) Southern Hemisphere
O: r=+0.29
OG: r=+0.27
OGS: r=+0.38
OGSV: r=+0.59
1258
Kuwae
Tambora
Temperature anomaly (K)
Year CE



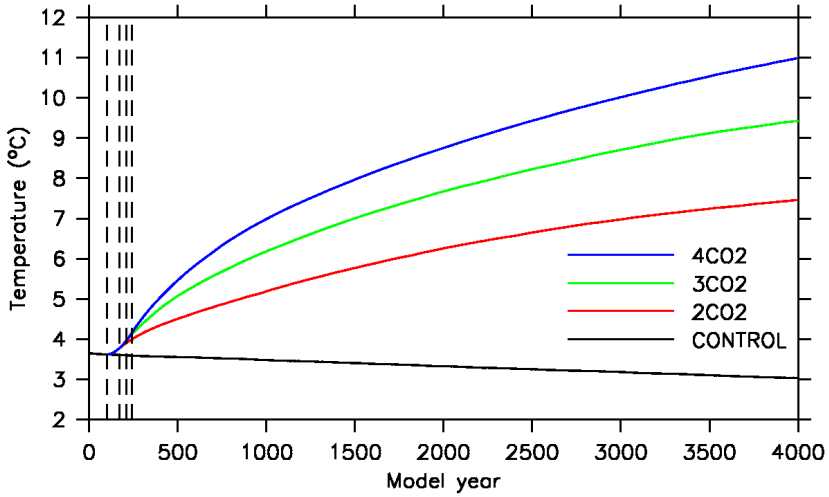
(a) Global–mean surface air temperature



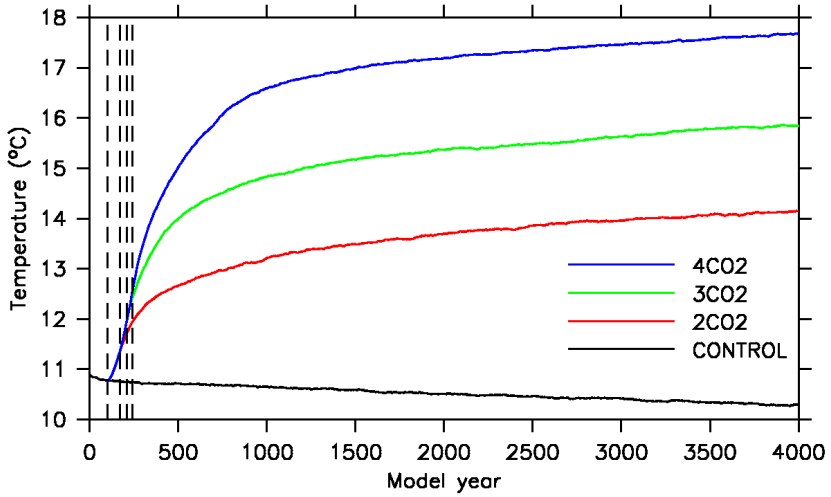
(b) Northern Hemisphere sea ice extent



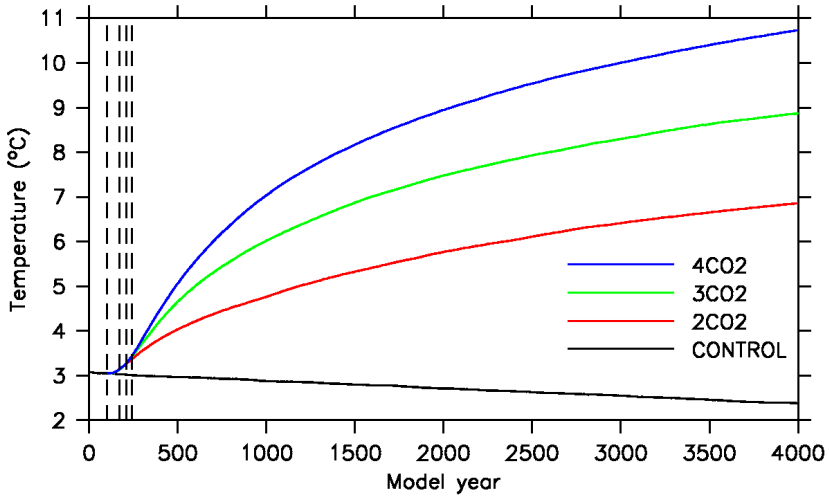
(c) Southern Hemisphere sea ice extent



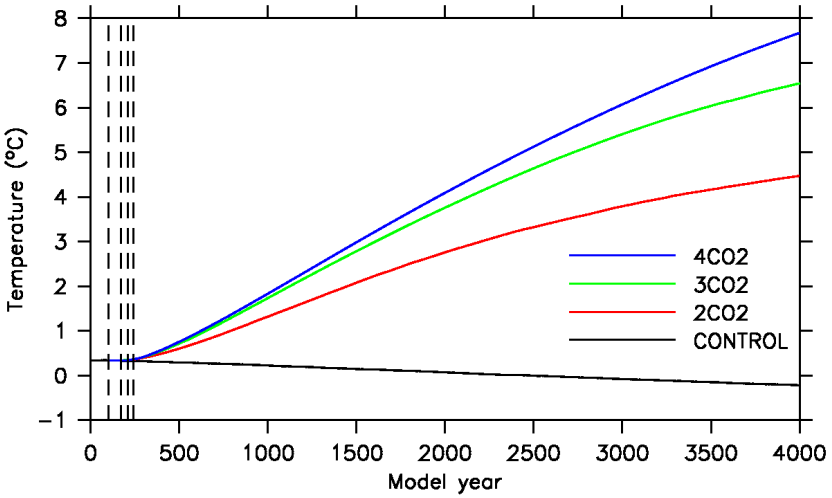
(a) Entire ocean



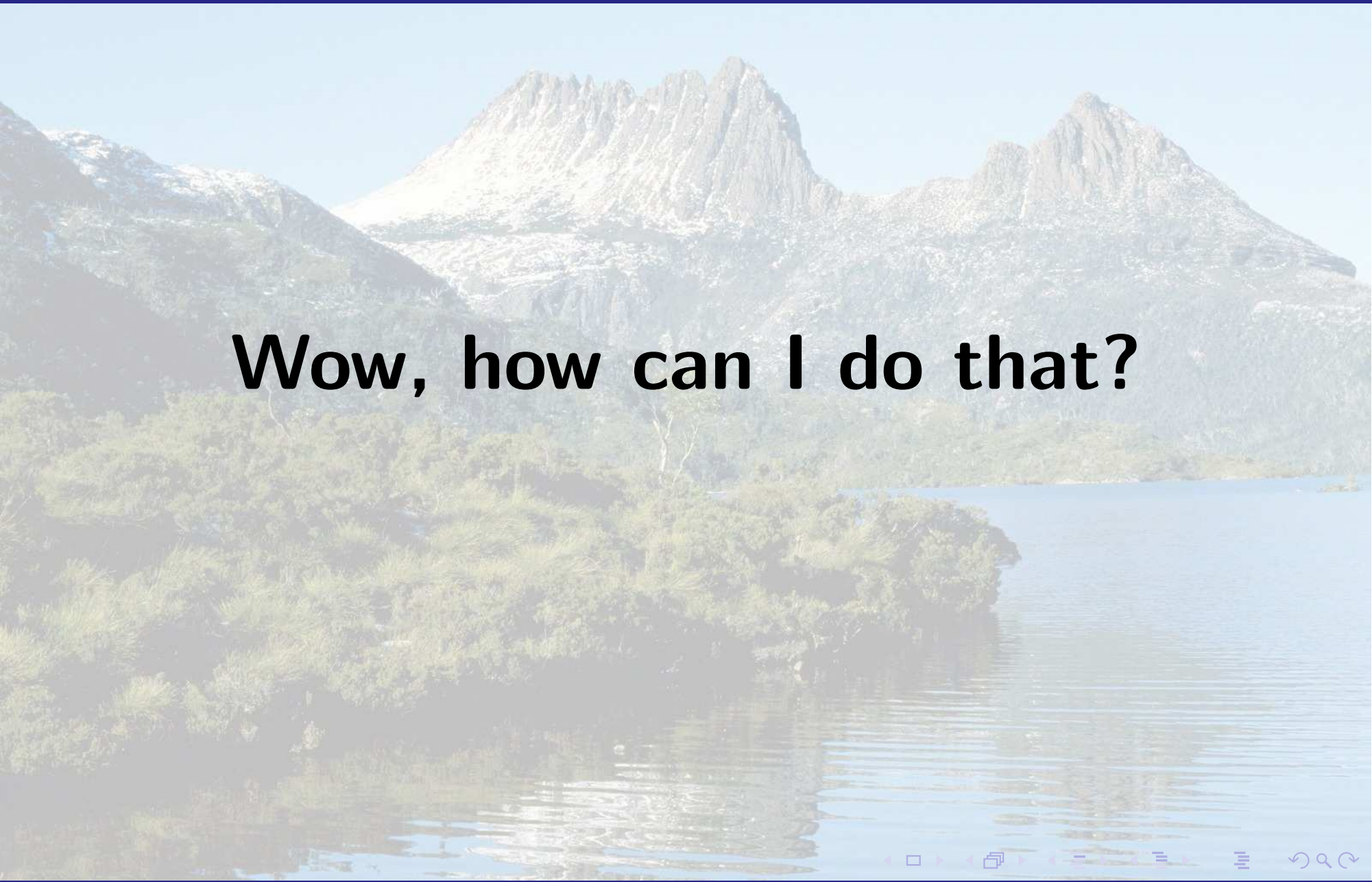
(b) Upper ocean (0–800 m)



(c) Mid–ocean (800–2350 m)



(d) Deep ocean (2350–4600 m)



Wow, how can I do that?

3. Getting Mk3L

Katana: A Faculty of Science computational cluster

- 63 x Dell blade compute nodes
- Total of 768 cores
- 5.5 TB memory
- Linux operating system
- Portable Batch System (PBS) for running jobs
- `katana.science.unsw.edu.au`
- `www.hpc.science.unsw.edu.au/katana/getting-started`

Exercise 1: 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
- 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 katana.
- 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

4. 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

5. 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*.

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.