

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?
- Downloading the model
- Compiling the model
- Running the model

What is this thing called Mk3L?



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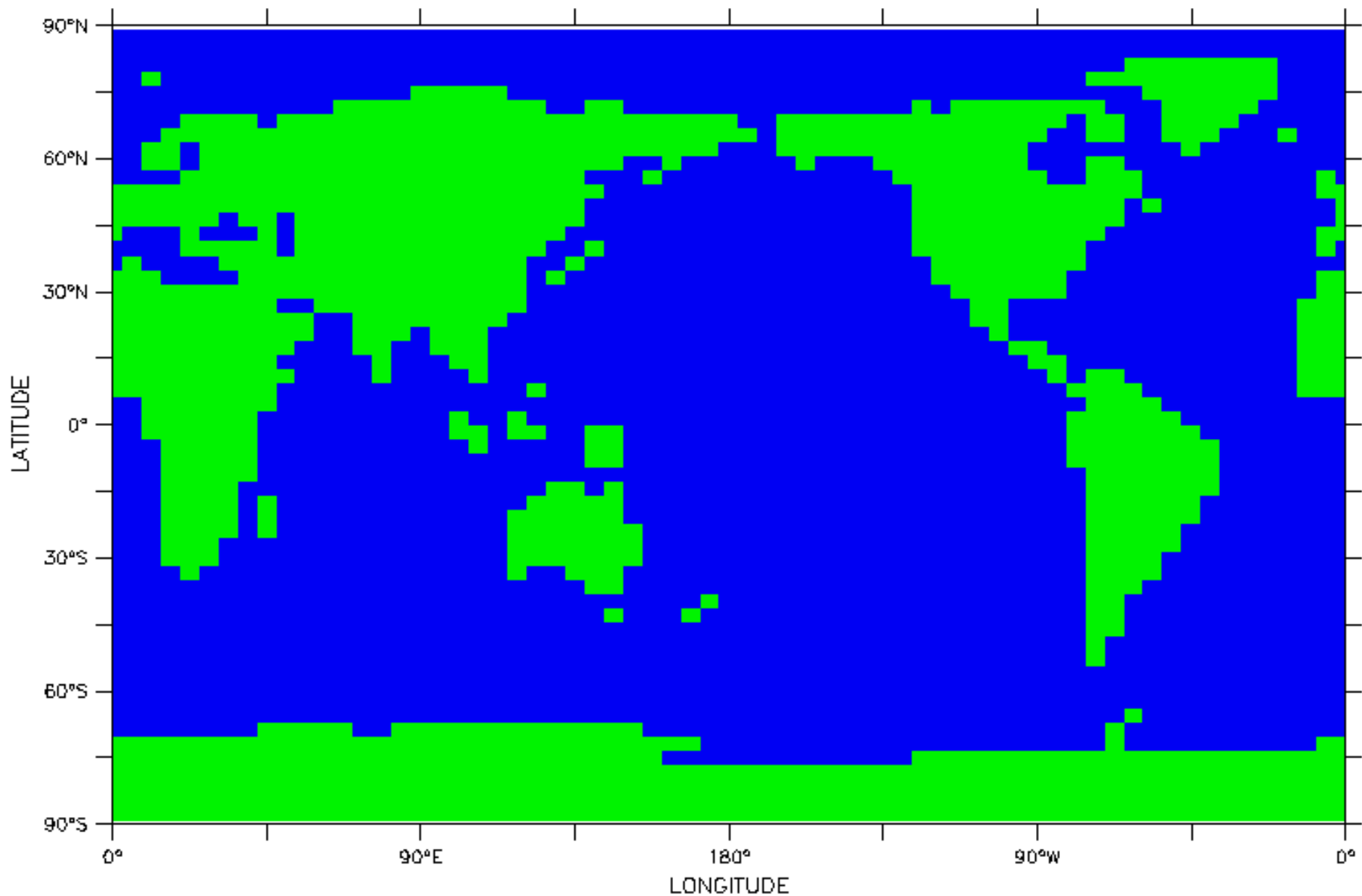
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The CSIRO Mk3L climate system model

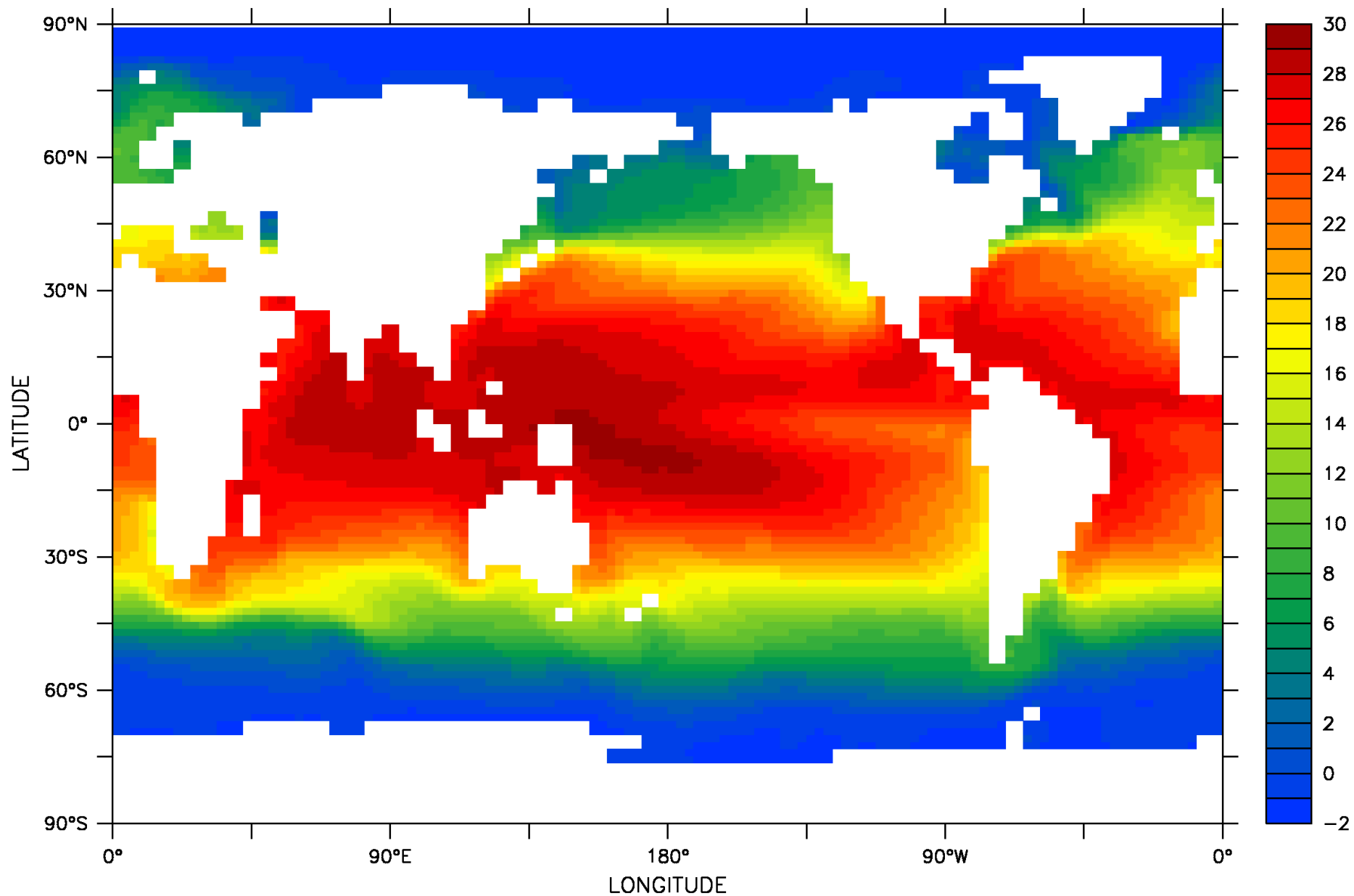
- Low-resolution version of the CSIRO climate system model
- Coupled atmosphere-sea ice-ocean general circulation model
- Designed to enable millennial-scale simulations of climate variability and change e.g.
 - palaeoclimate reconstructions
 - projections of future climate
 - low-frequency climate variability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

The CSIRO Mk3L climate system model

- Atmosphere:
 - Spectral general circulation model
 - Resolution of $5.6^{\circ} \times 3.2^{\circ}$, 18 vertical levels
- Ocean:
 - z -coordinate general circulation model
 - Resolution of $2.8^{\circ} \times 1.6^{\circ}$, 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



The CSIRO Mk3L atmosphere model grid



Simulated annual-mean sea surface temperature ($^{\circ}\text{C}$)

Benchmarks on NCI National Facility

SGI XE Cluster

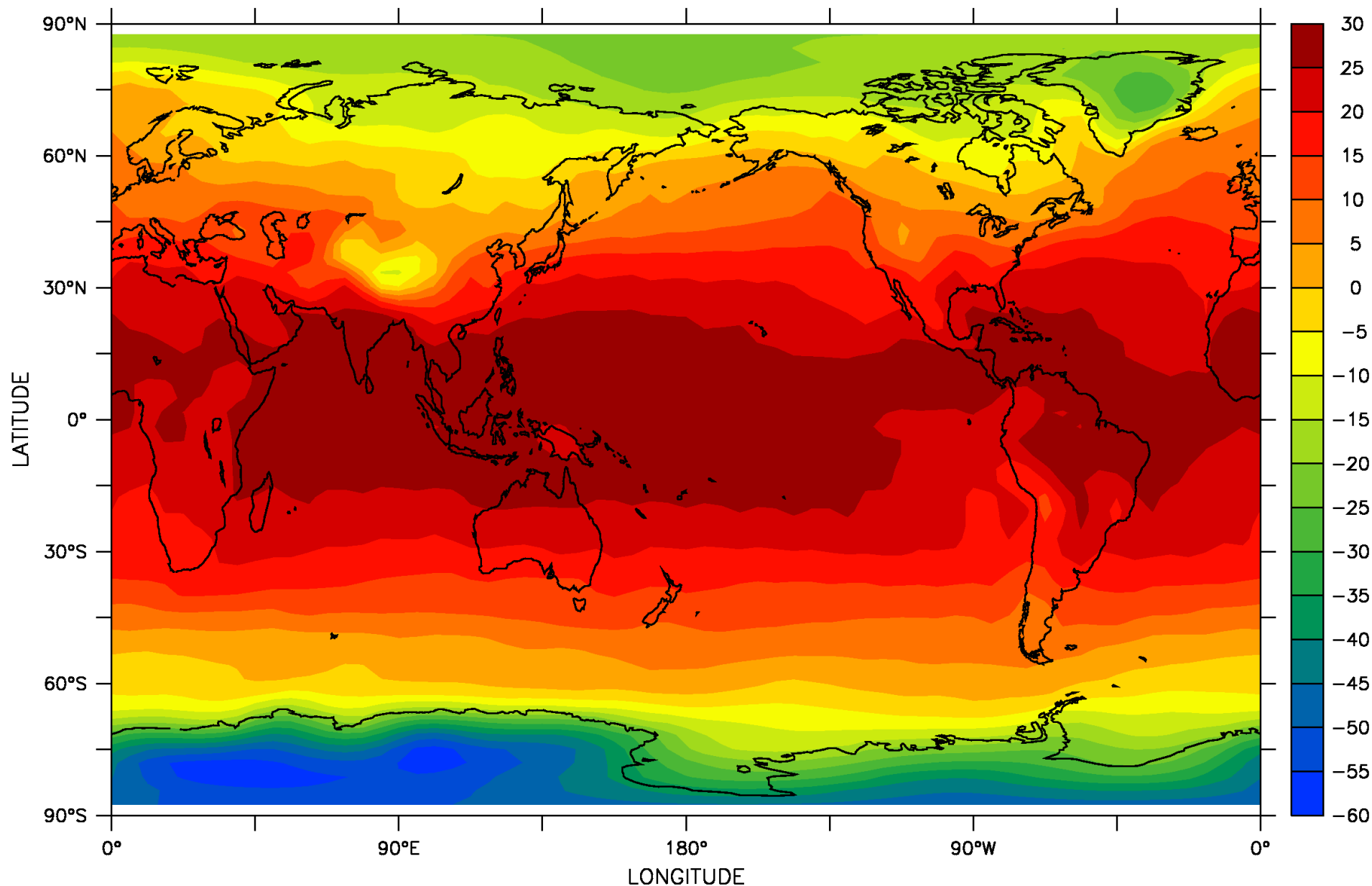
Number of cores	Speed (years/day)
1	9.9
2	16.5
4	24.0
8	31.7

What can it do?

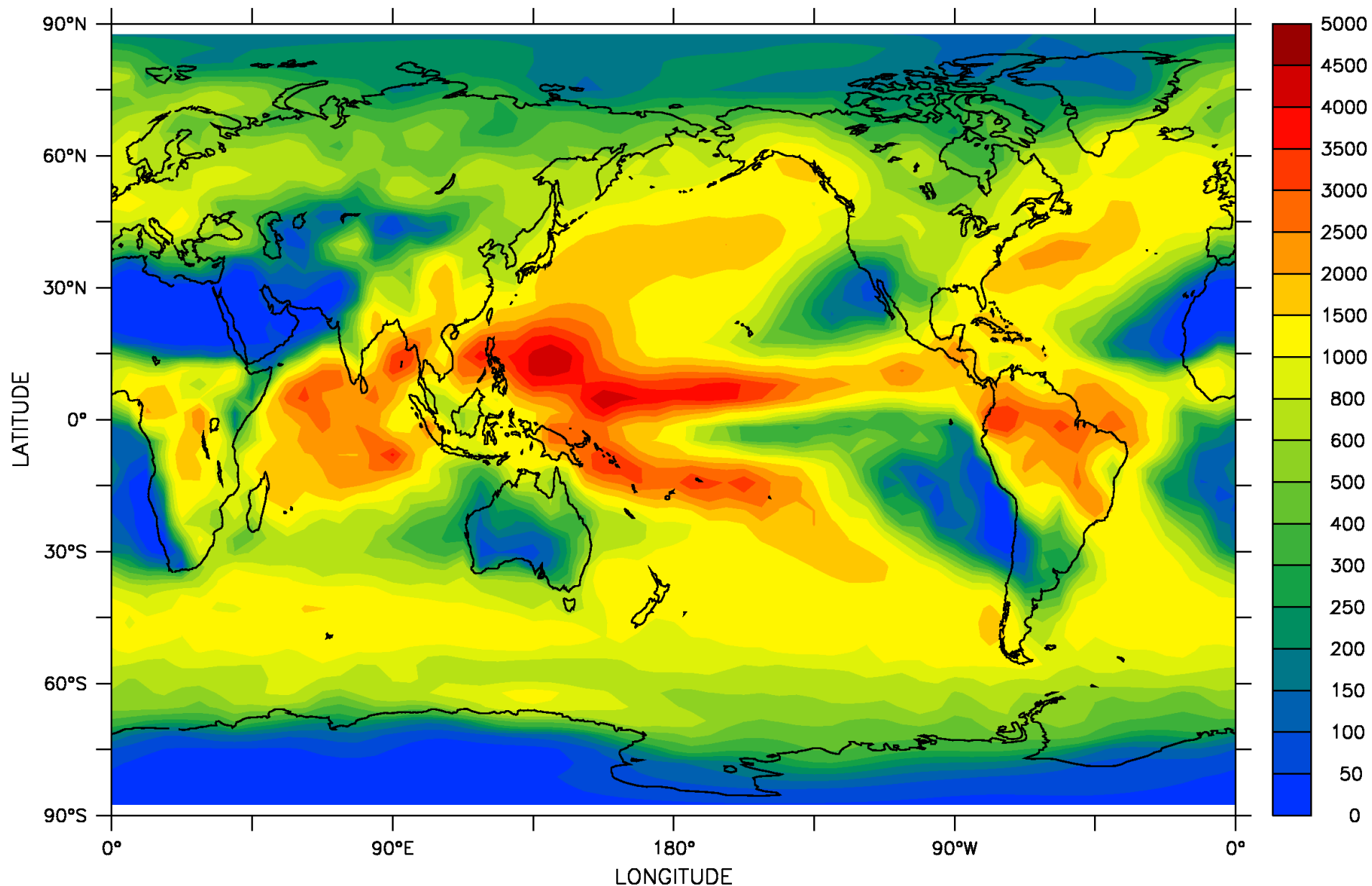


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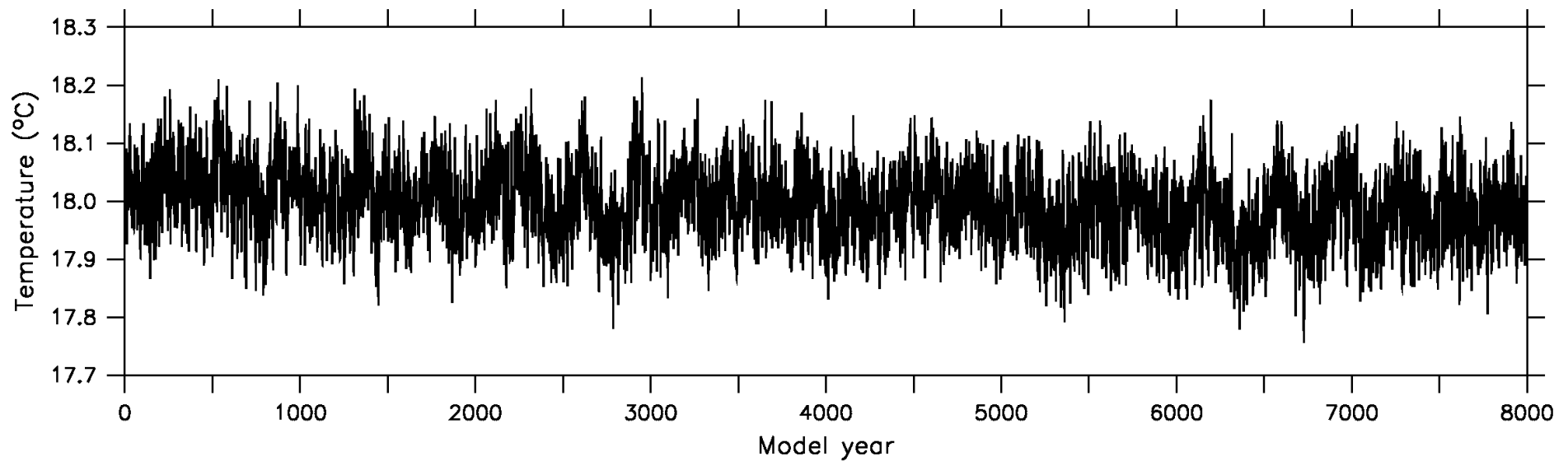
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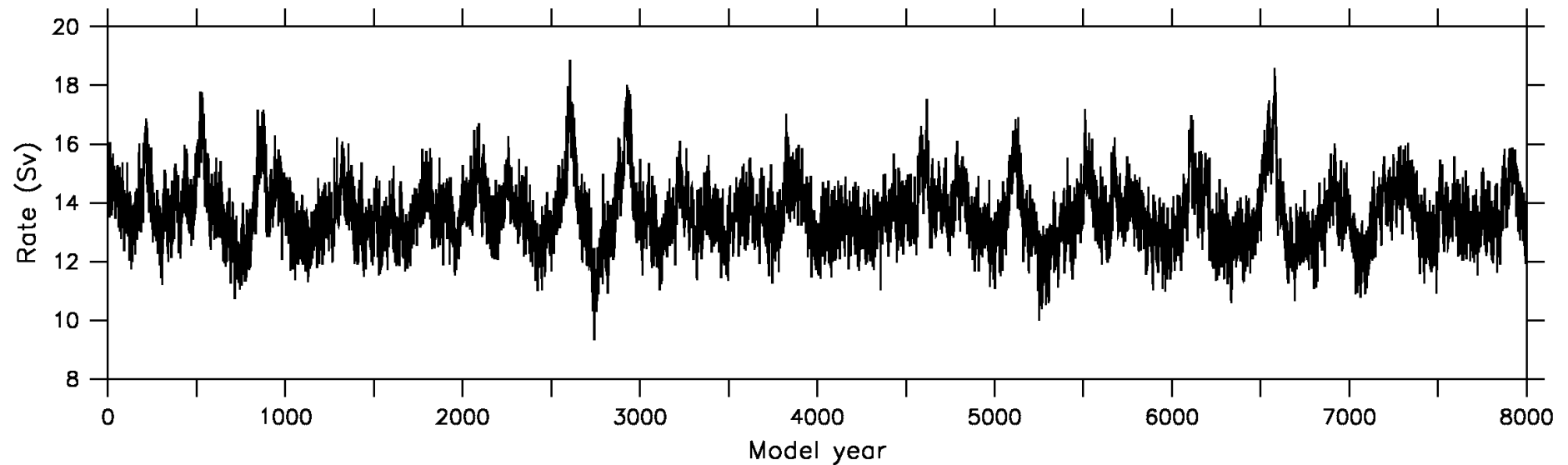
Simulated annual-mean surface air temperature (°C)



Simulated annual precipitation (mm)

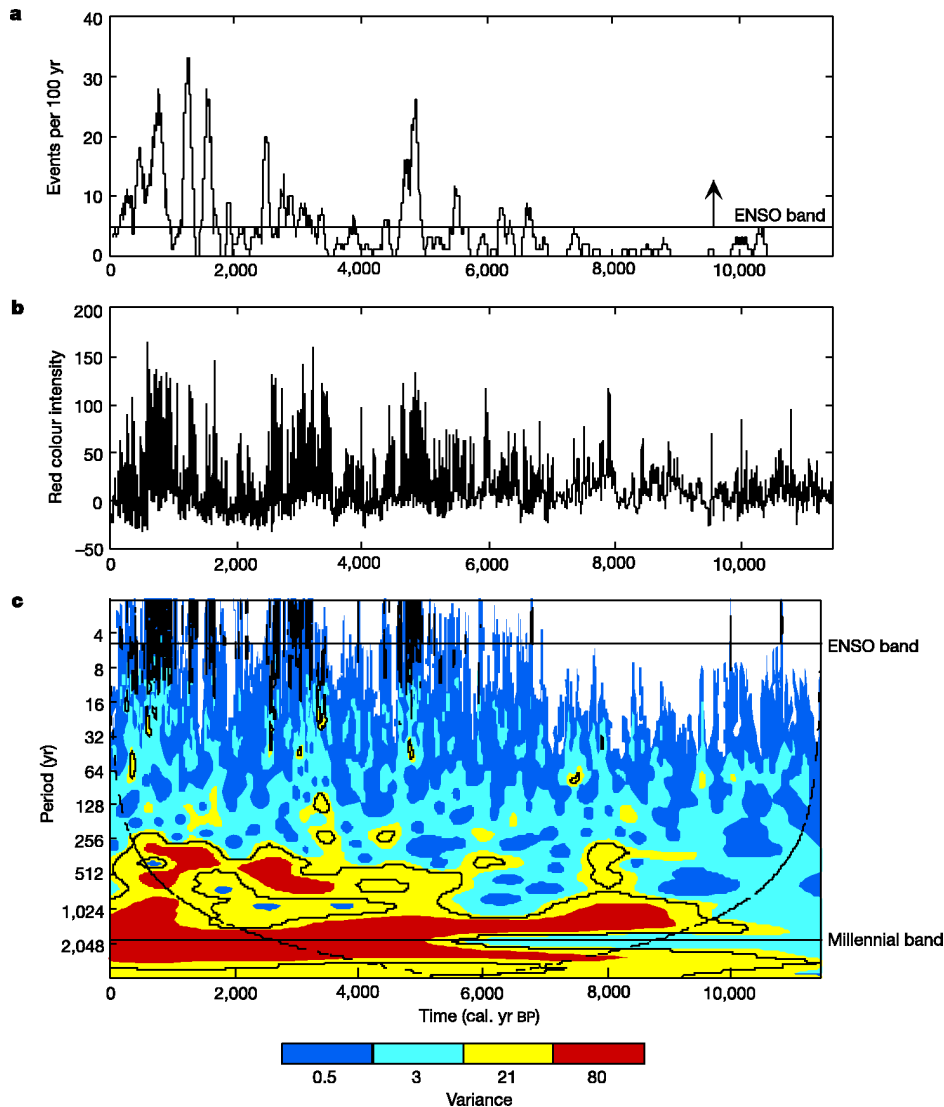


Global-mean sea surface temperature



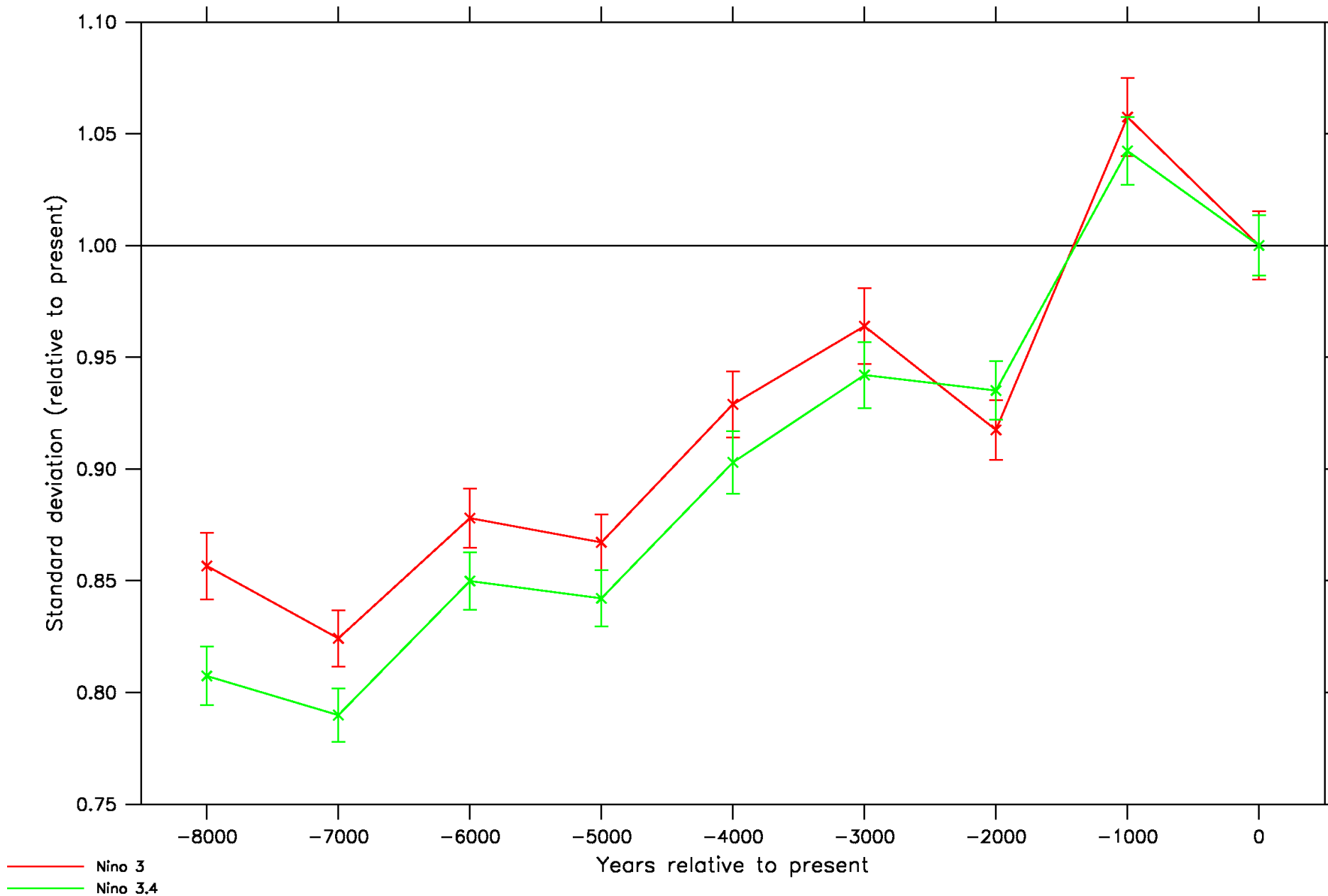
North Atlantic Deep Water formation

El Niño has changed ...

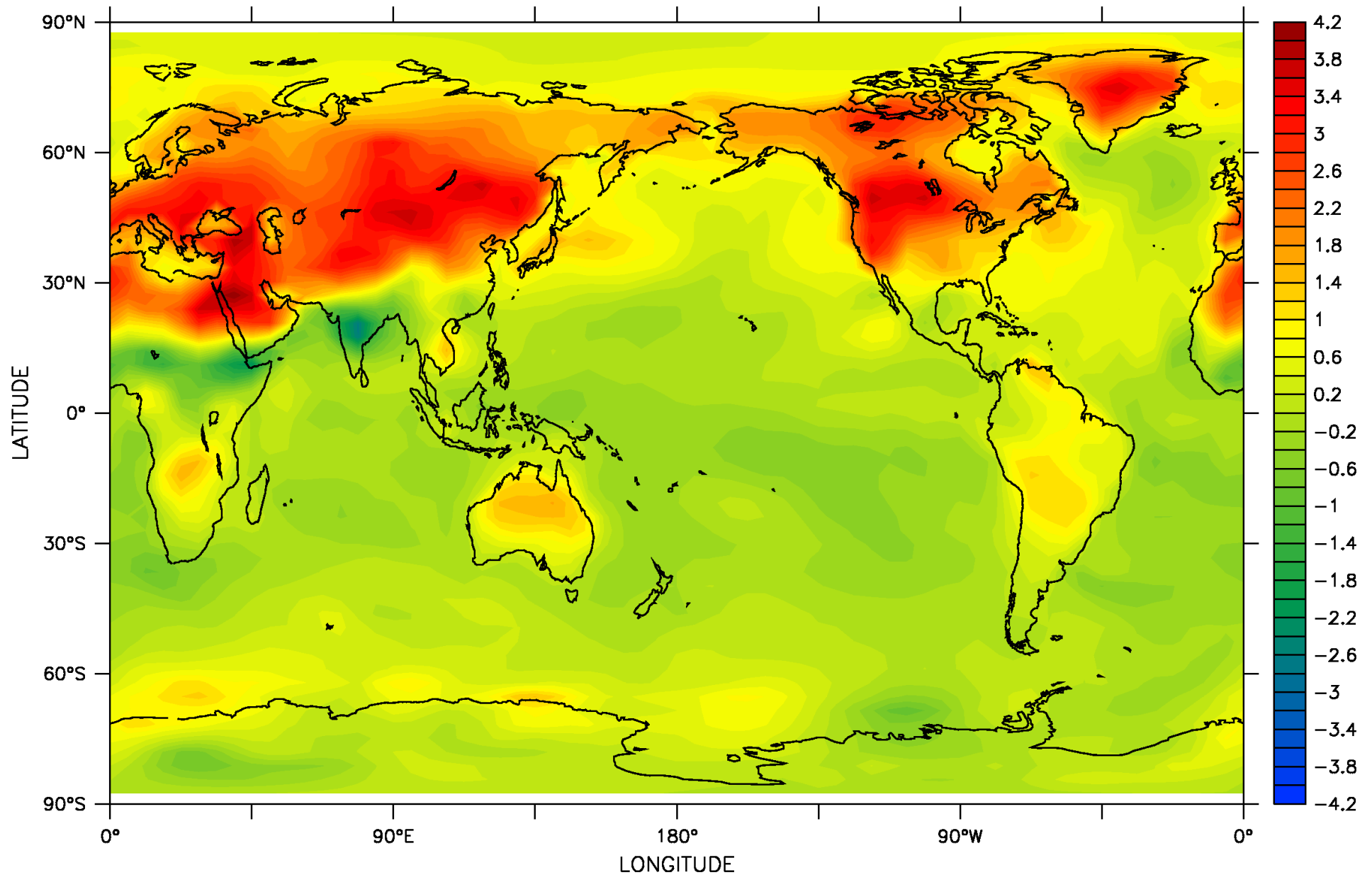


- “Modern” El Niño began 7–5 ka BP, with only weak decadal-scale variability beforehand
- El Niño was 15–60% weaker at 6 ka BP than at present
- Gradual strengthening of El Niño thereafter
- Evidence of a peak in variability at 2–1 ka, possibly earlier in the western Pacific than in the east

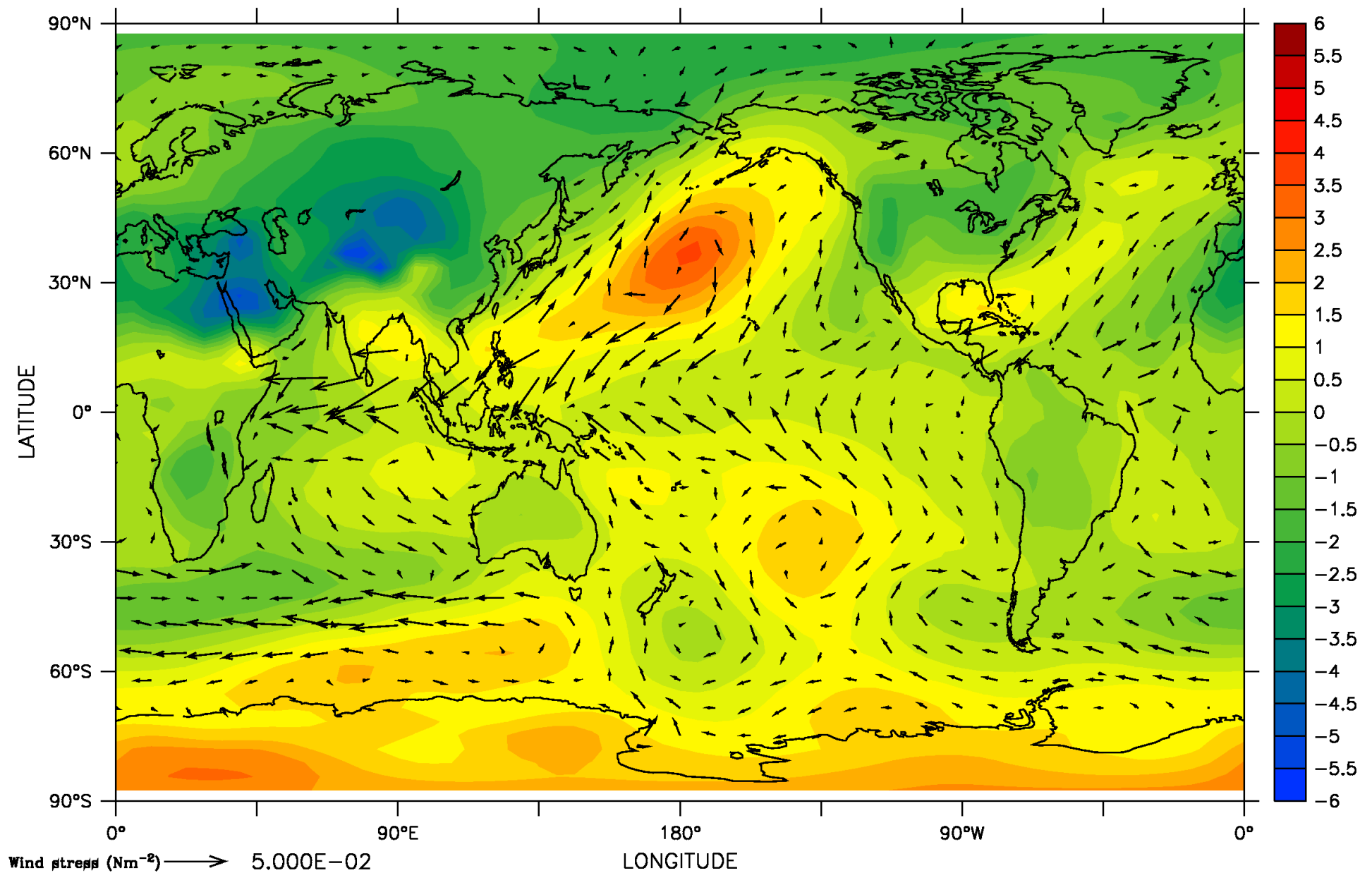
Moy et al. (2002), *Nature*



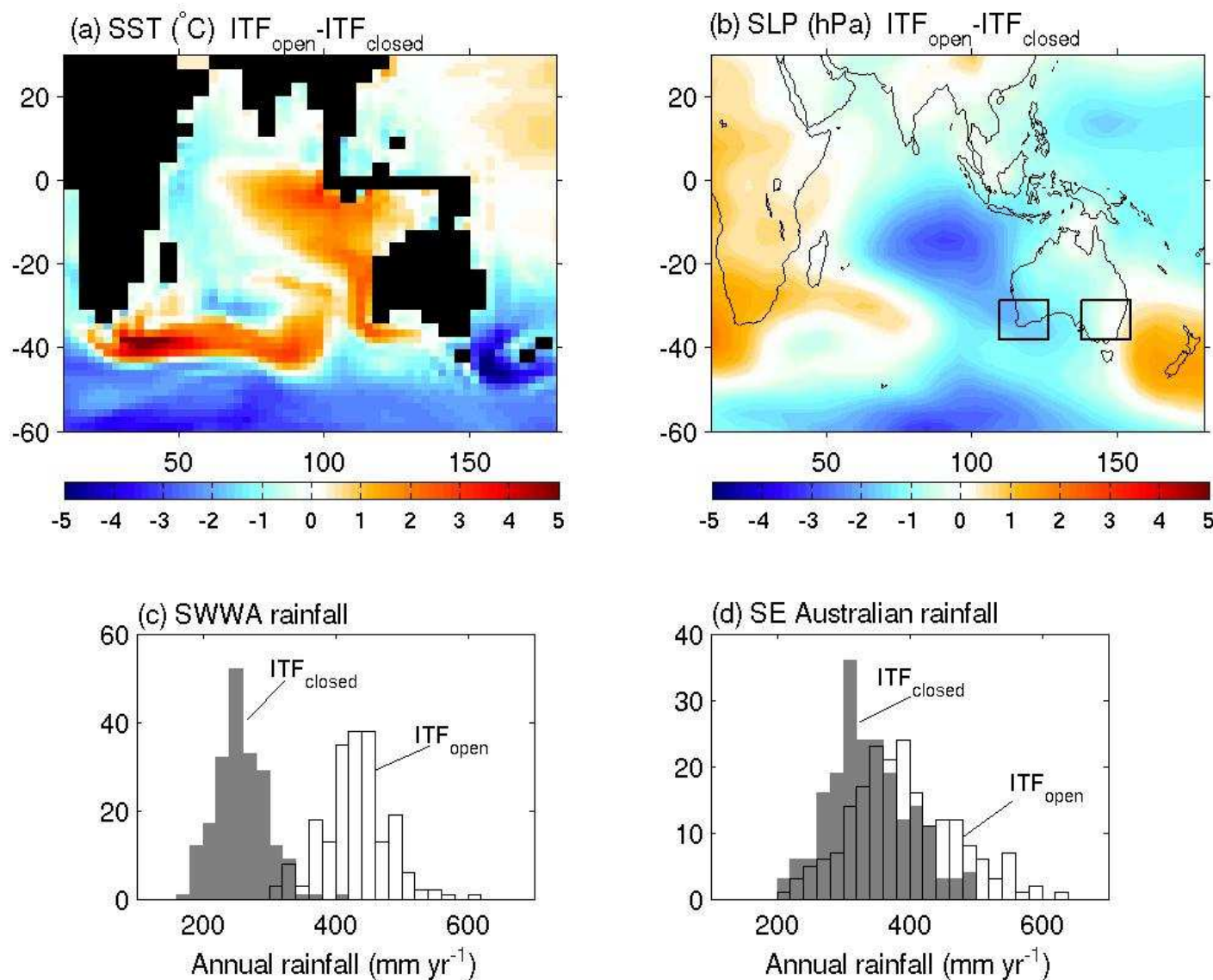
Standard deviation of Nino SST anomalies



June–July–August surface air temperature, 8ka minus 0ka BP (°C)

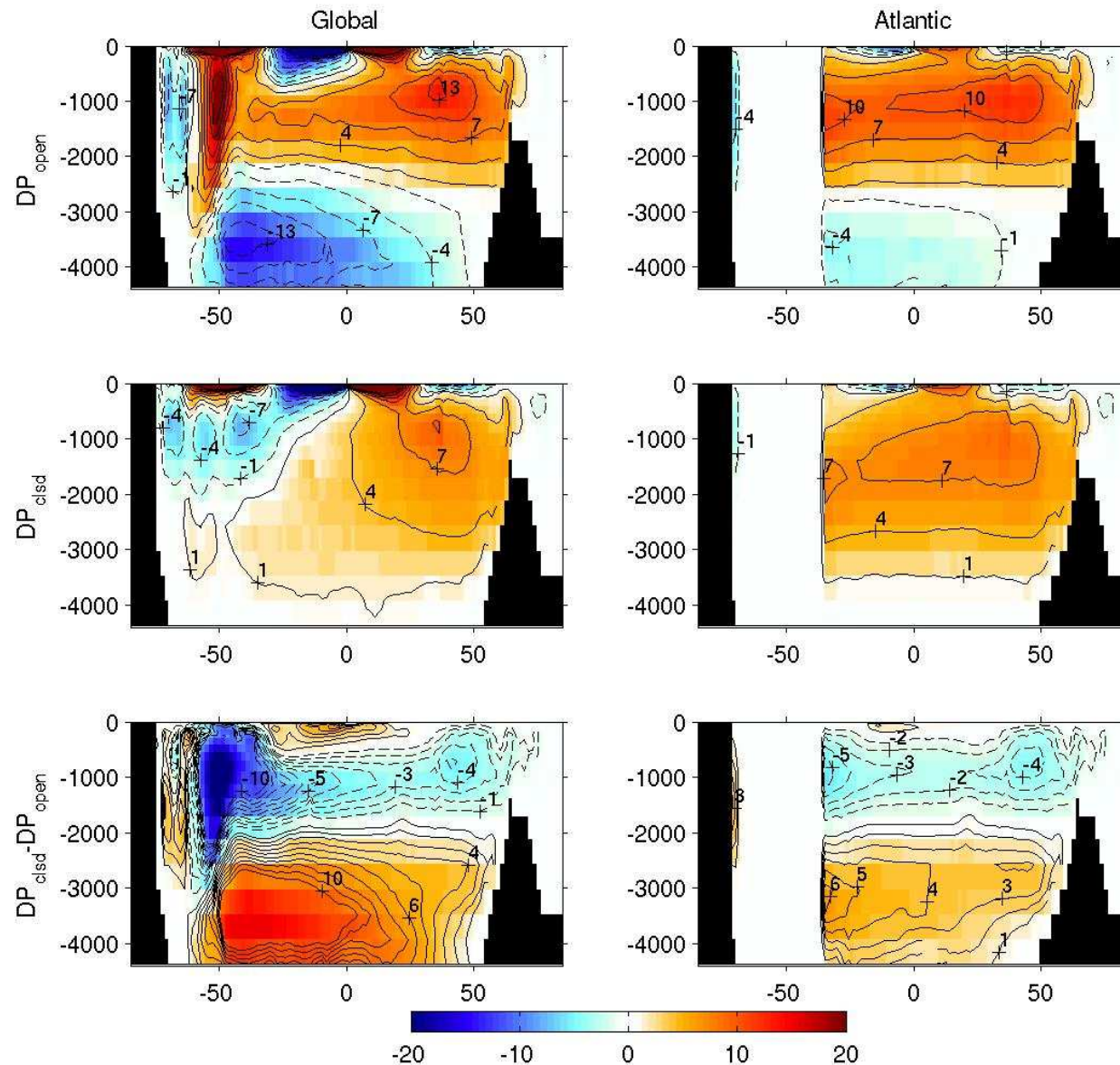


The effects of closing the Indonesian Throughflow



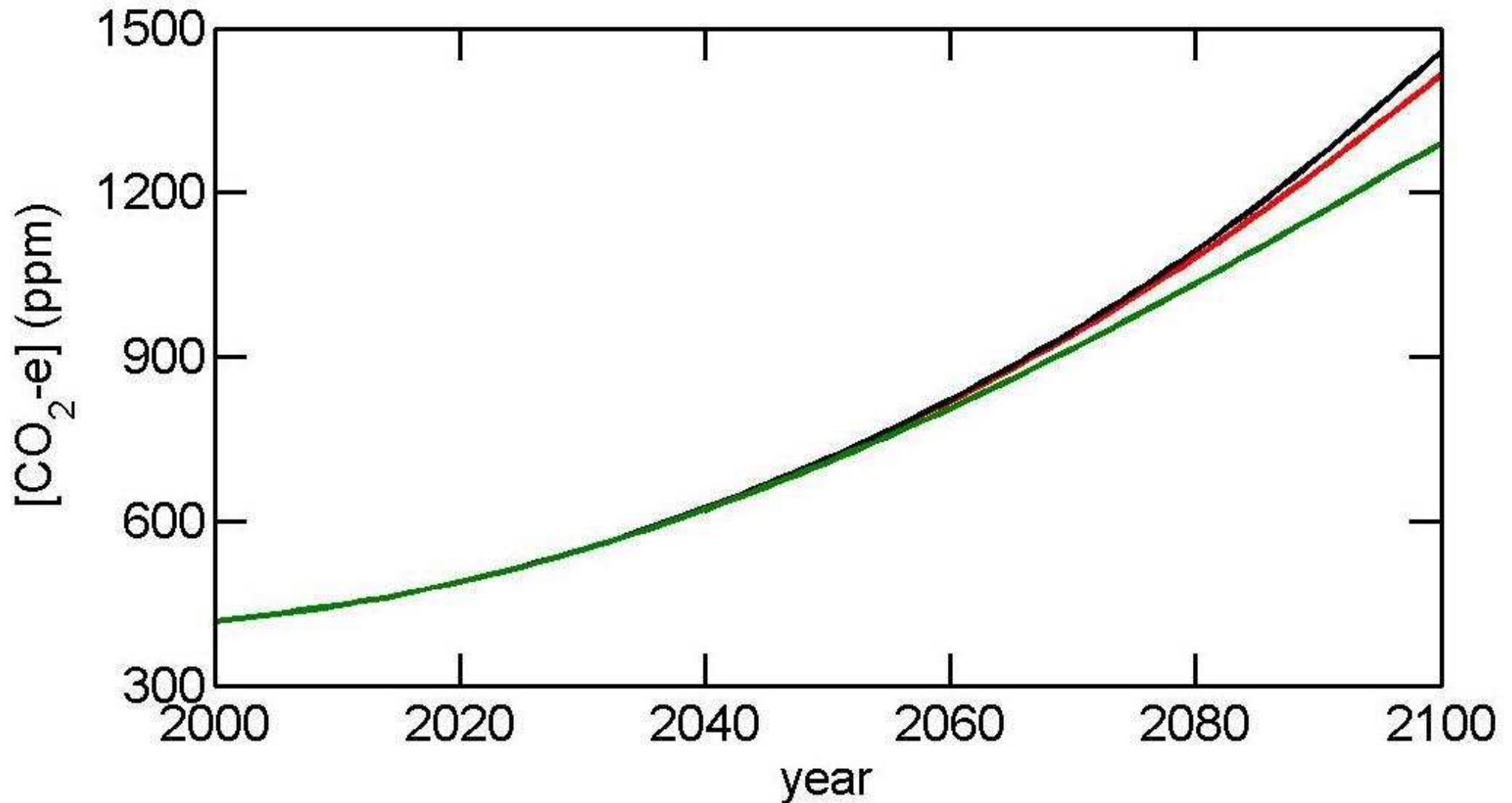
Courtesy: Agus Santoso

The effects of closing Drake Passage



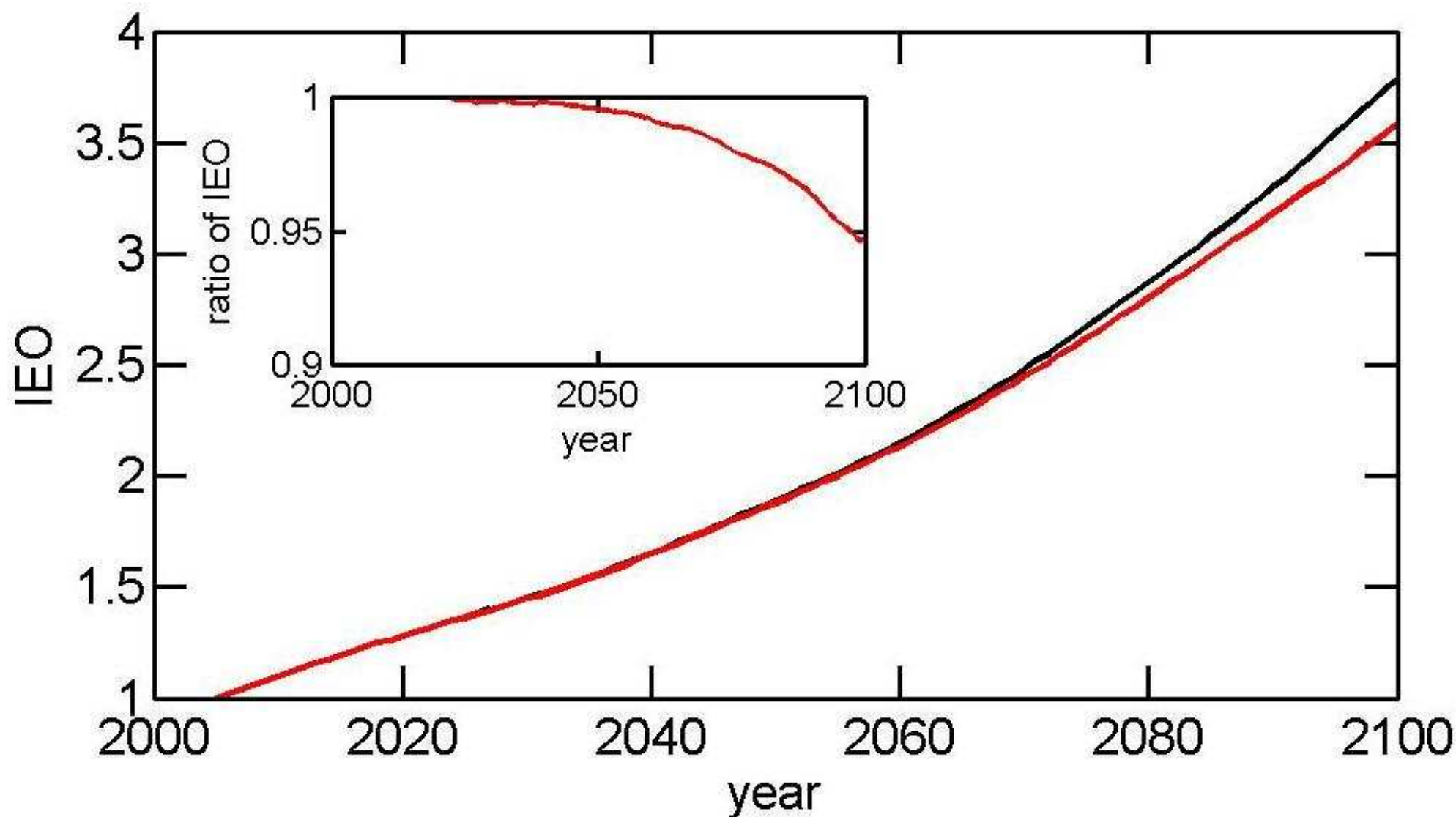
Courtesy: Agus Santoso

GIAM: Simulated changes in CO₂^e



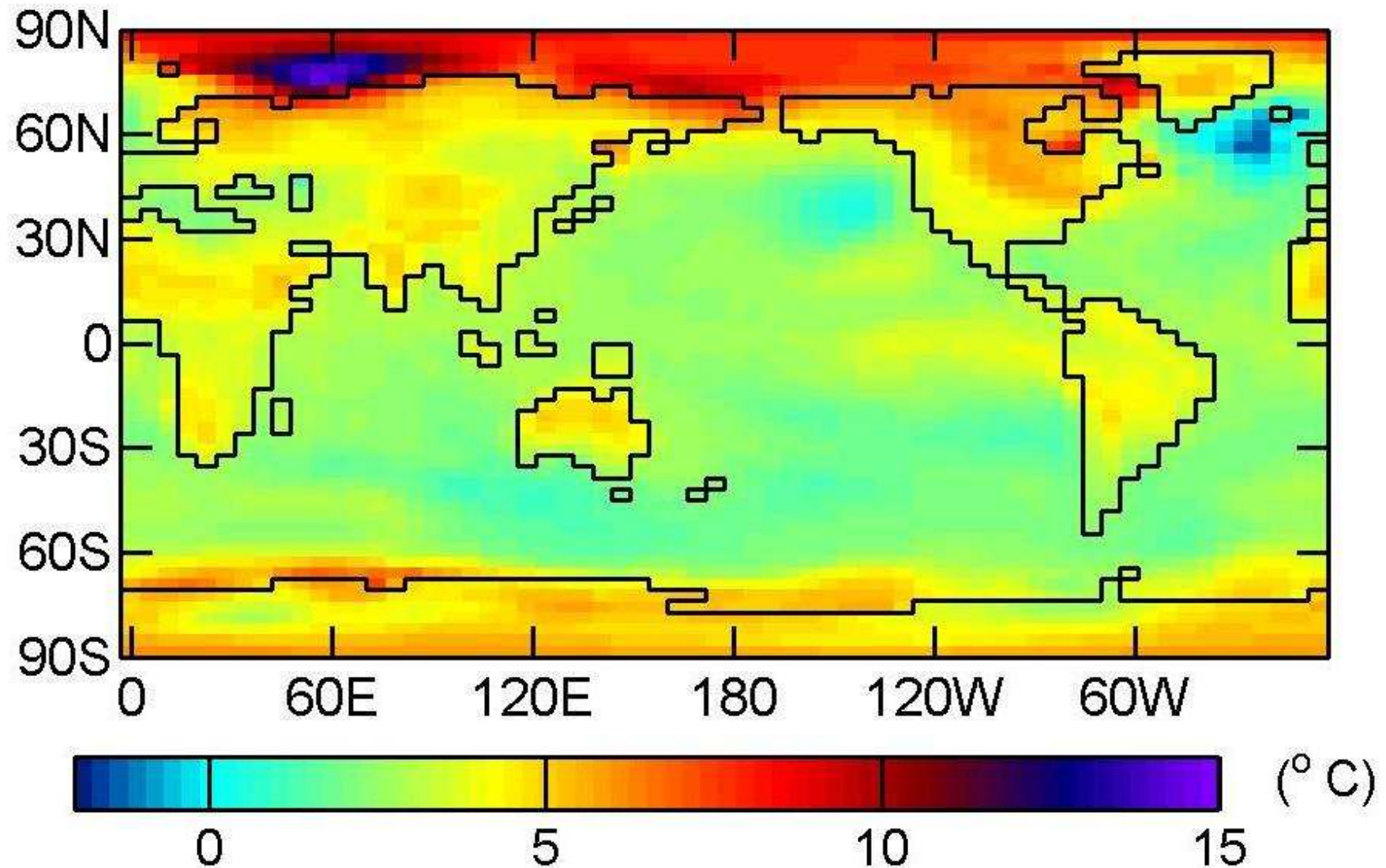
Courtesy: Ian Harman

GIAM: Simulated changes in economic output



Courtesy: Ian Harman

GIAM: Simulated changes in annual-mean SAT by 2091–2100



Courtesy: Ian Harman

Wow, how can I do that?



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Downloading Mk3L



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Exercise 1: Using the SGI XE Cluster

- Log on to the SGI XE Cluster:

```
ssh -X -l <username> xe.nci.org.au
```

- Familiarise yourself with the basic UNIX commands.

Basic UNIX commands

<code>ls</code>	lists the contents of a directory
<code>ls -l</code>	create a long listing
<code>mkdir <directory></code>	create the directory <directory>
<code>cd <directory></code>	change to the directory <directory>
<code>cp <file1> <file2></code>	copy the file <file1> to <file2>
<code>mv <file1> <file2></code>	move the file <file1> to <file2>
<code>rm <file></code>	delete the file <file>
<code>rmdir <directory></code>	delete the directory <directory>
<code>man <command></code>	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: Downloading Mk3L

- Download Mk3L version 1.2, by entering the following commands:

```
cd
mkdir CSIRO_Mk3L
cd CSIRO_Mk3L
module load subversion
svn co --username WinterSchool \
    http://svn.tpac.org.au/repos/CSIRO_Mk3L/tags/version-1.2/
```

- You will be prompted for a password. The model will then begin to download - this should take around one minute.

Exercise 2: Downloading Mk3L

- The subversion command will generate 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 need to run Mk3L

`data/` Useful datasets

`doc/` Documentation

`post/` Utilities for the analysis of model output

`pre/` Utilities for generation of restart and auxiliary files

Compiling Mk3L



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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



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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 `nqstat` 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.