Does GM Work Well in the Southern Ocean?

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Present Day Control Runs

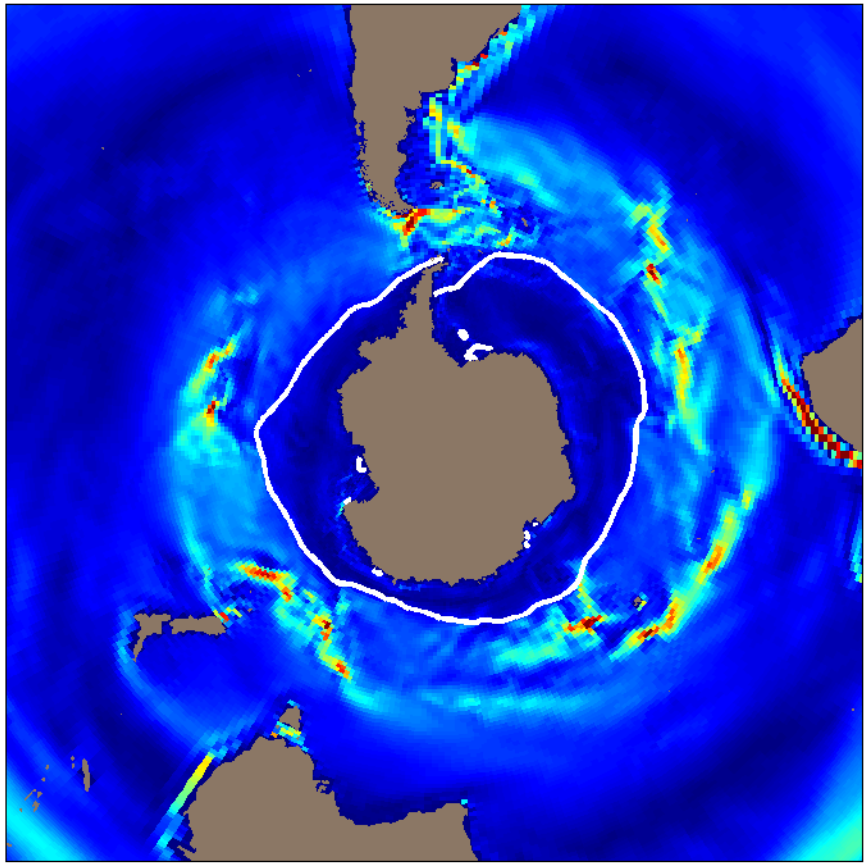
Two 167 year present day (2000 levels of carbon dioxide and other greenhouse gases) control runs completed.

A version of Community Climate System Model using 0.5^{o} horizontal resolution in atmosphere and land components and with the standard 1^{o} resolution in the ocean (eddies parameterized by GM) and sea ice components.

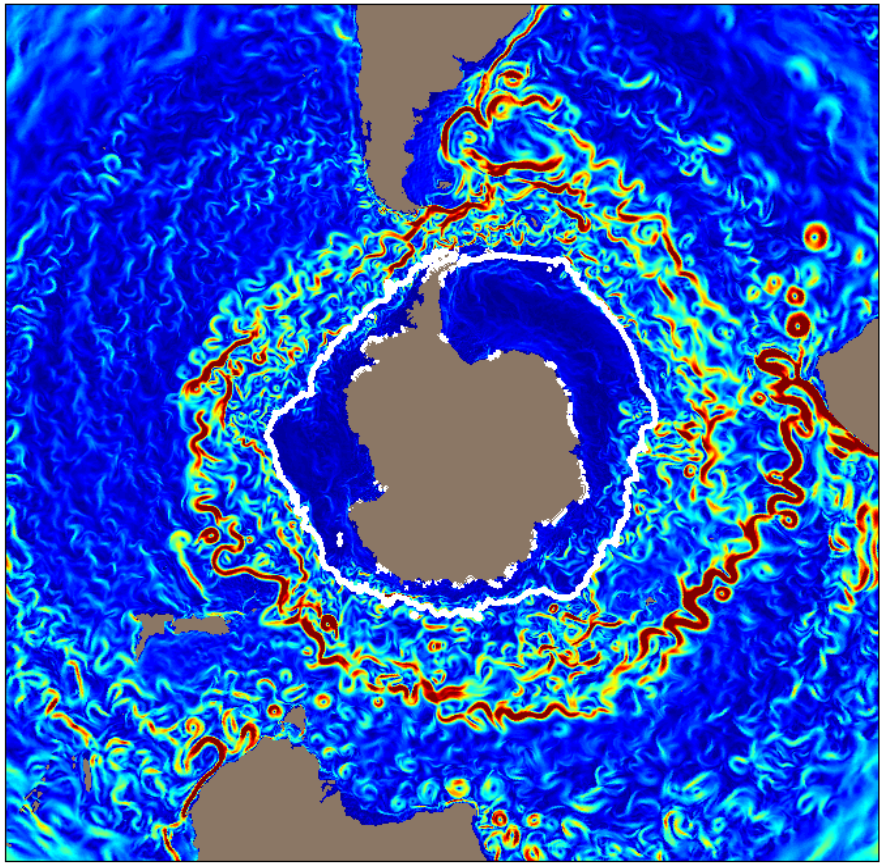
Another, non-standard version of the CCSM using the same 0.5^{o} atm/land components, but $1/10^{o}$ resolution in the ocean (eddies resolved) and sea ice components.

Simulated Surface Currents Around Antarctica

1 degree Simulation



0.1 degree Simulation

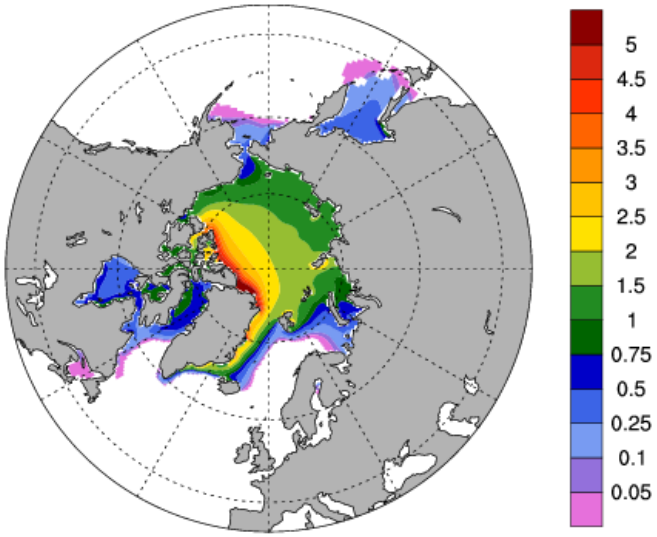


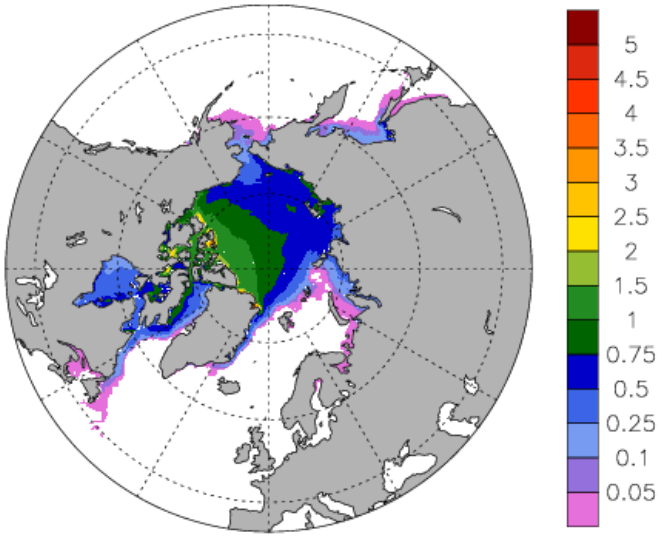
0 10 20 30 40 50 60

Current Speed in cm/s for randomly chosen October

Case LRC01
ANN Mean Years 0145-0154

grid cell mean ice thickness m

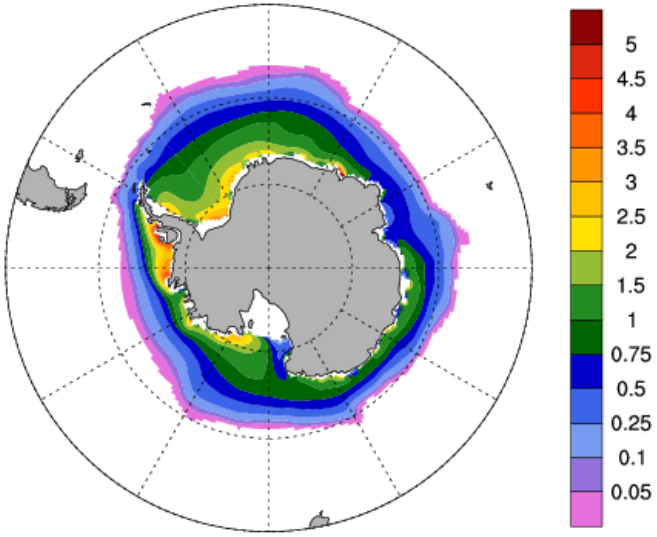


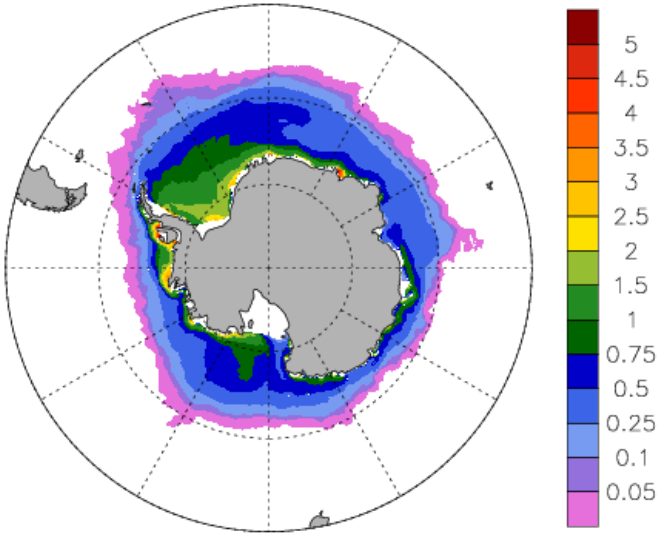


Case HRC06
ANN Mean Years 0114-0118

grid cell mean ice thickness m

grid cell mean ice thickness m





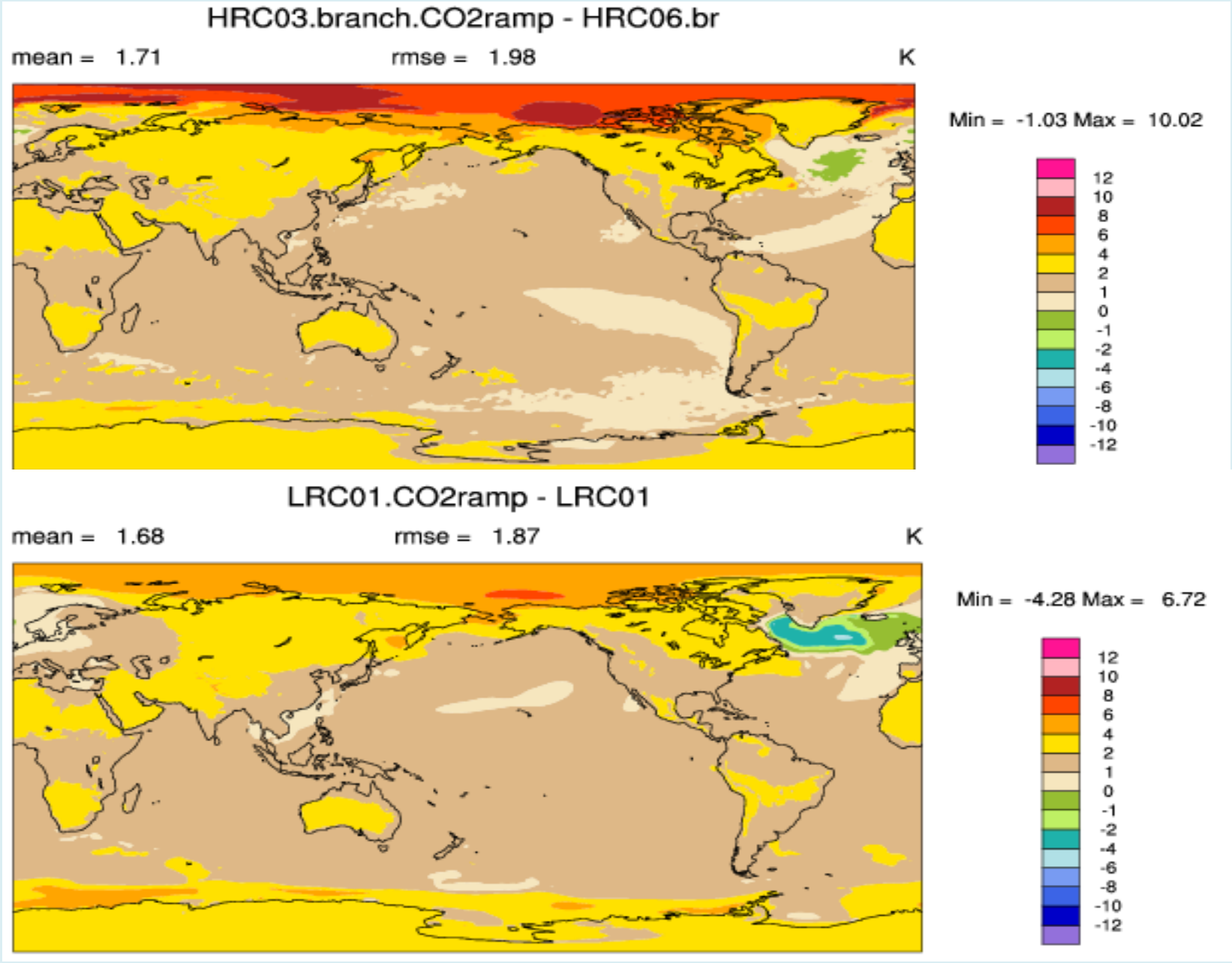
grid cell mean ice thickness m

1%/year Increasing CO_2 Runs

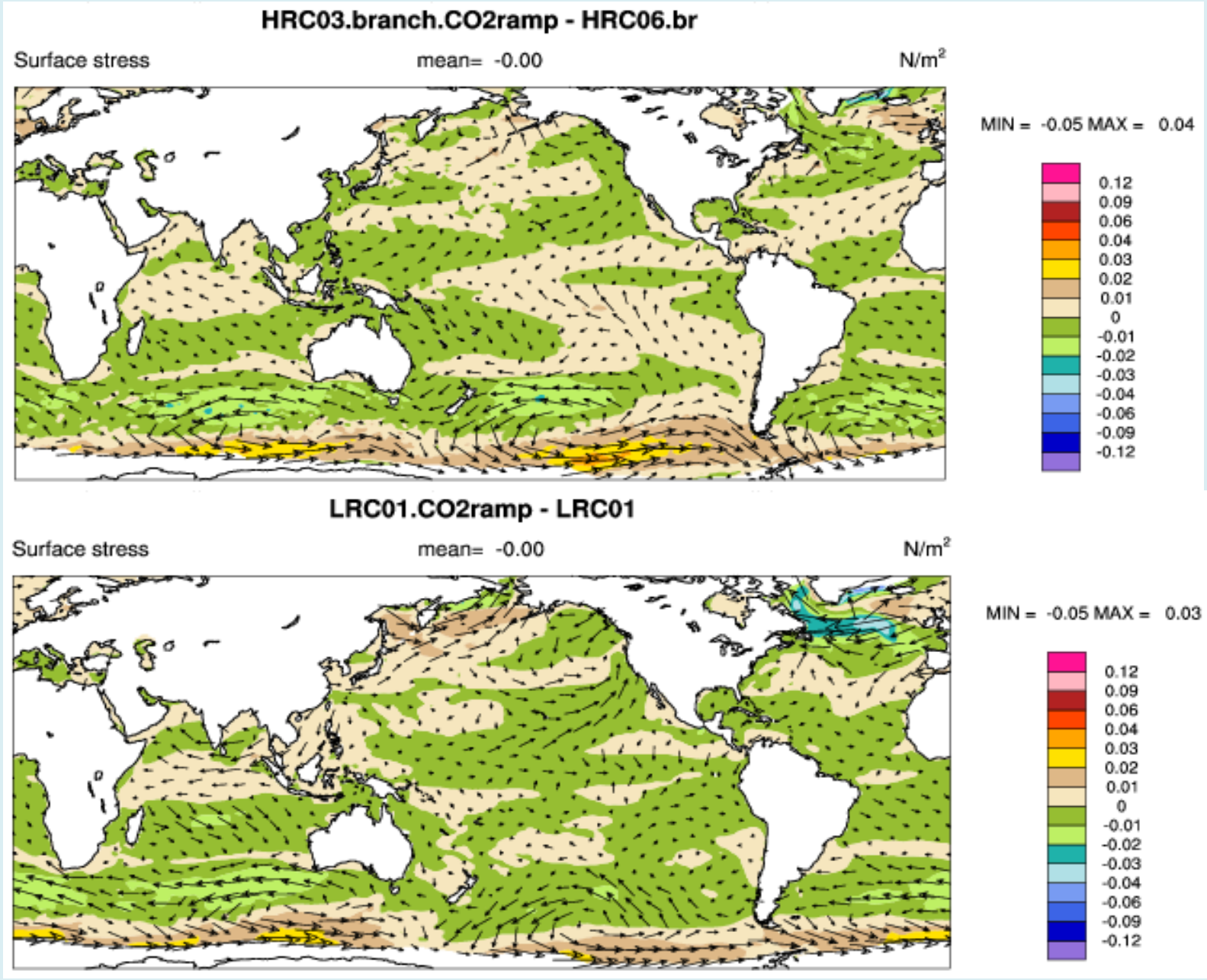
Frank Bryan and I obtained time on Kraken to do 1% increasing CO_2 runs for 70 yrs (doubling), starting from year 77 of the respective 1^o and 0.1^o control runs.

Both runs were extended for a further 20 years with doubled CO_2. Results averaged over these 20 years are compared to the 20 year averages from the 1^o and 0.1^o control runs over years 147 – 167 inclusive.

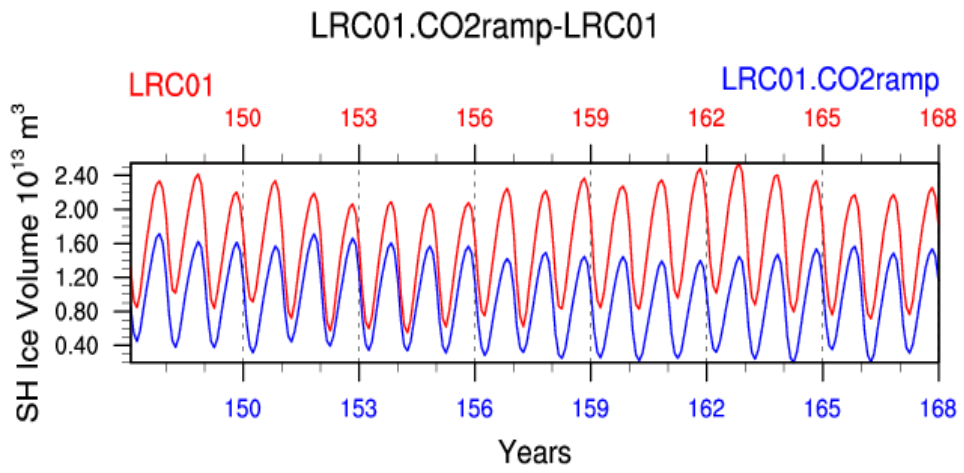
1% CO_2 runs: Change in surface temperature after doubling.

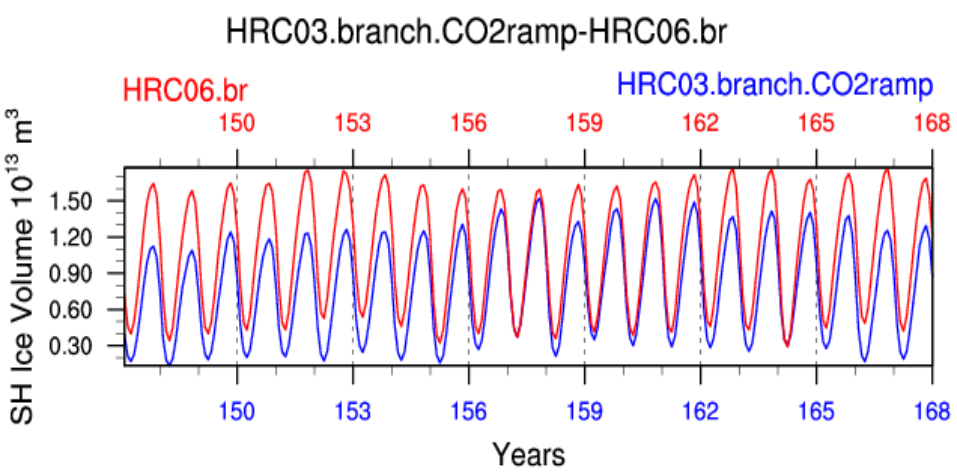


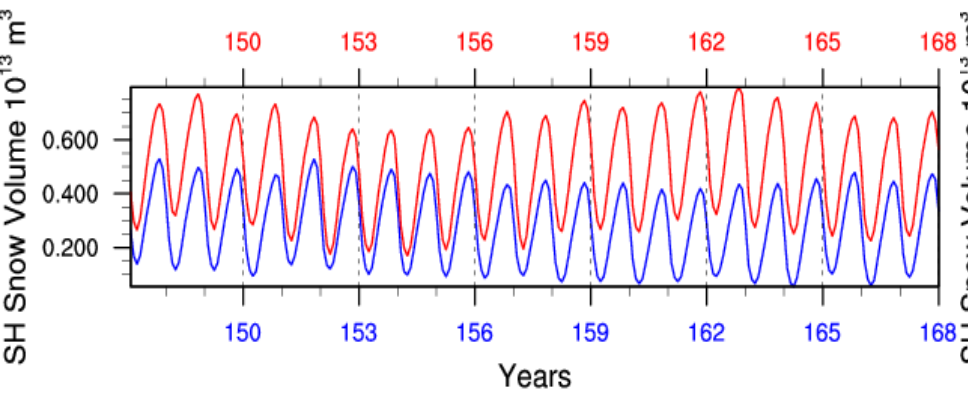
1% CO_2 runs: Change in surface wind stress after doubling.

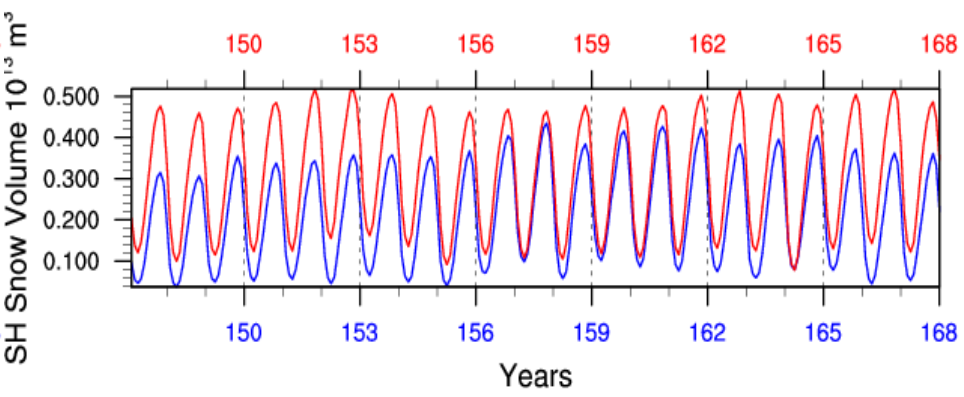


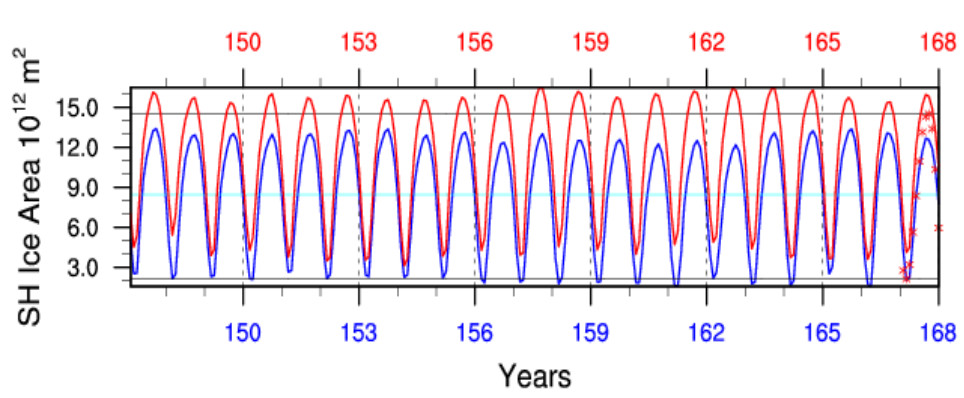
1% CO_2 runs: Changes in Antarctic sea ice after doubling.

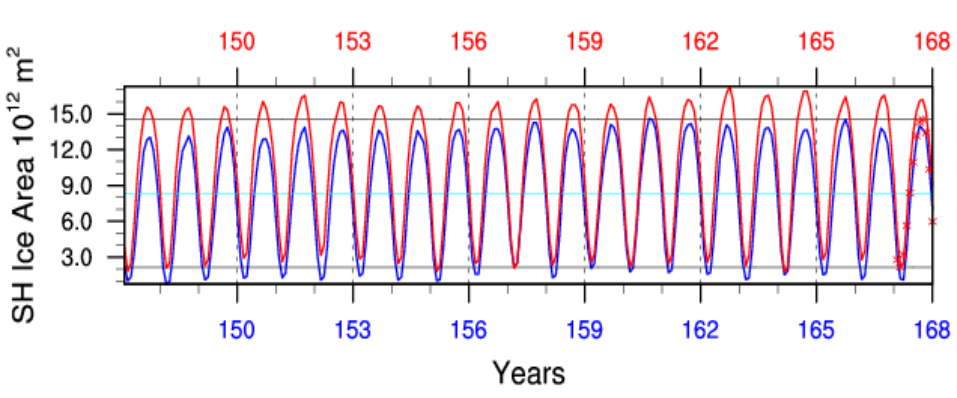




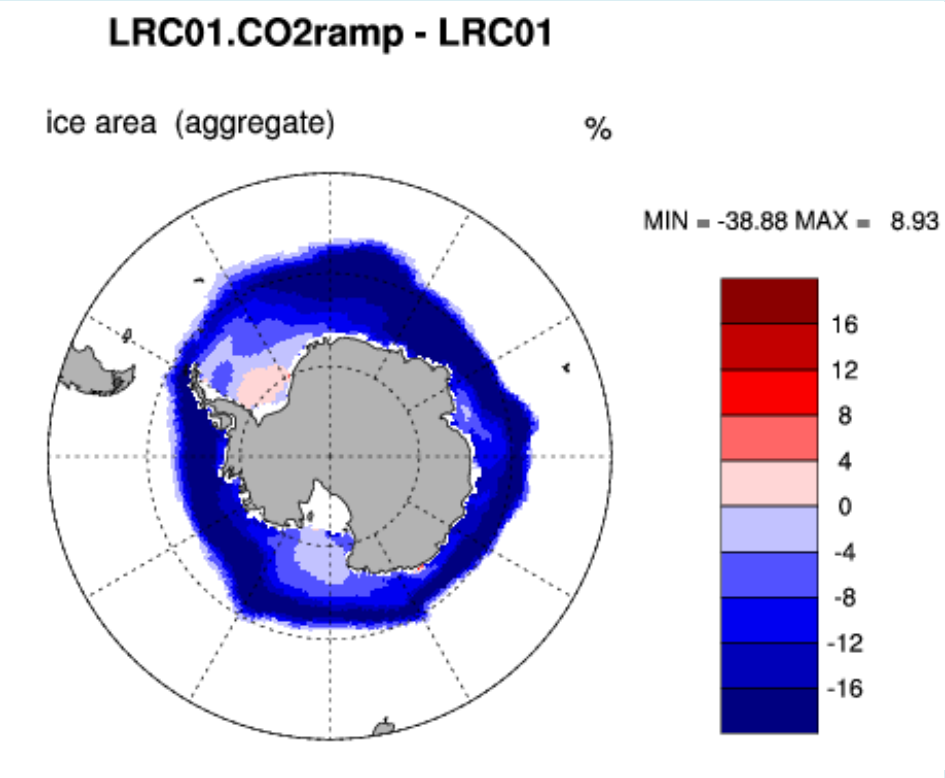


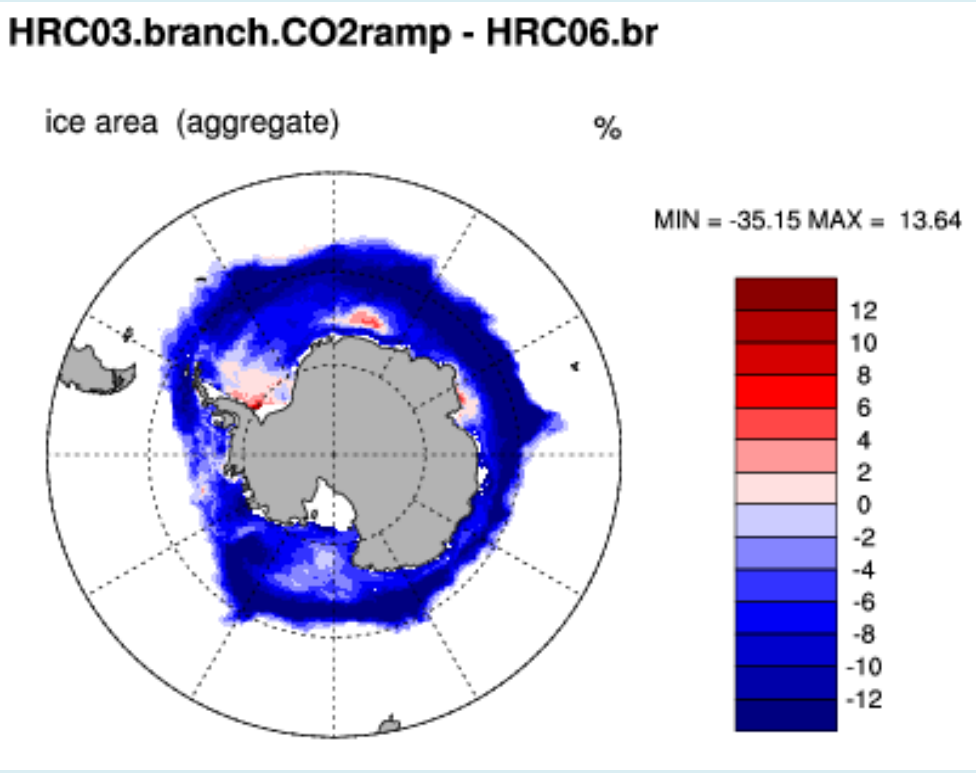






Change in Antarctic sea ice concentration after doubling CO_2





Note the different LR & HR scales

Antarctic mean <147-167> sea ice volumes in $10^{13}m^3$

	Mean	Standard Deviation
LR Control	1.578	0.131
LR 1% Run	0.940	0.085
HR Control	1.083	0.058
HR 1% Run	0.786	0.094

The LR decline is 40%, whereas the HR decline is 28%.

However, the standard deviations are quite large, so assuming favorable values of mean +/- 0.5 standard deviation can lead to similar declines of 34-35%.

CONCLUSIONS

- Going to high resolution doesn't automatically produce a control run with a better climate.
- Difficult to compare changes in HR and LR runs when control mean states are rather different.
- HR changes are smaller than LR changes in extent and volume of Antarctic sea ice and NA max MOC.
- Is this because of a) less sea ice in HR control run, b) larger increase in HR zonal wind stress over the ACC, or c) GM isn't working so well in the ACC?
- Most likely a combination of all three reasons !!