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# Future changes in tropical cyclones over the Australian region

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# Project Overview

## Regional Tropical Cyclone hazard for infrastructure adaptation to climate change

- CSIRO Climate Adaptation Flagship project
- Collaboration between CSIRO (D. Abbs, J. McGregor, K.Nguyen), Uni Melbourne (K. Walsh, S. Lavender), and Geoscience Australia (R. Cechet, C. Arthur)
- Provide better estimates of TC wind hazard in current and future climates
- Use in adaptation strategies e.g. wind speed based building design

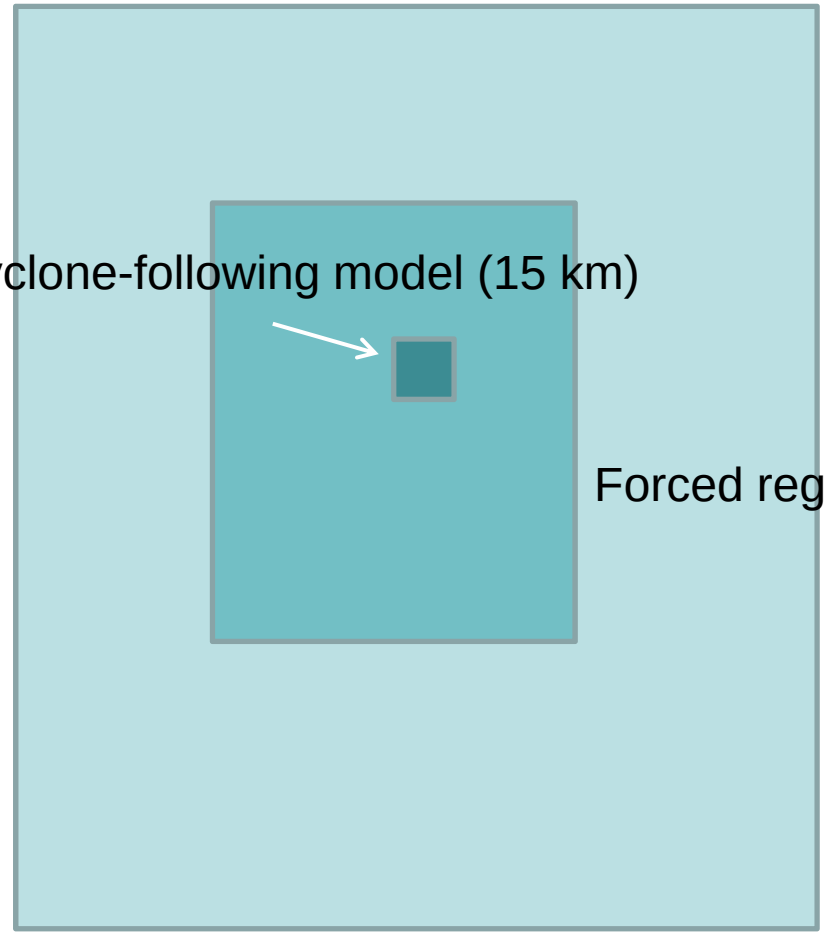
# Background

- Number of studies suggested TCs may become more intense in warmer world
- Increase in the number of strong TCs impacting the Australian coastline is a potential outcome
- Possible southward shift in region of impact

# Aims

- To use high resolution climate models to simulate TCs in the current and future climate.
- Evaluation of current climate models to determine whether they will be used or not.
- Downscaling using the CSIRO Conformal-cubic atmospheric model (C-CAM)
- Future changes and reasons for those changes

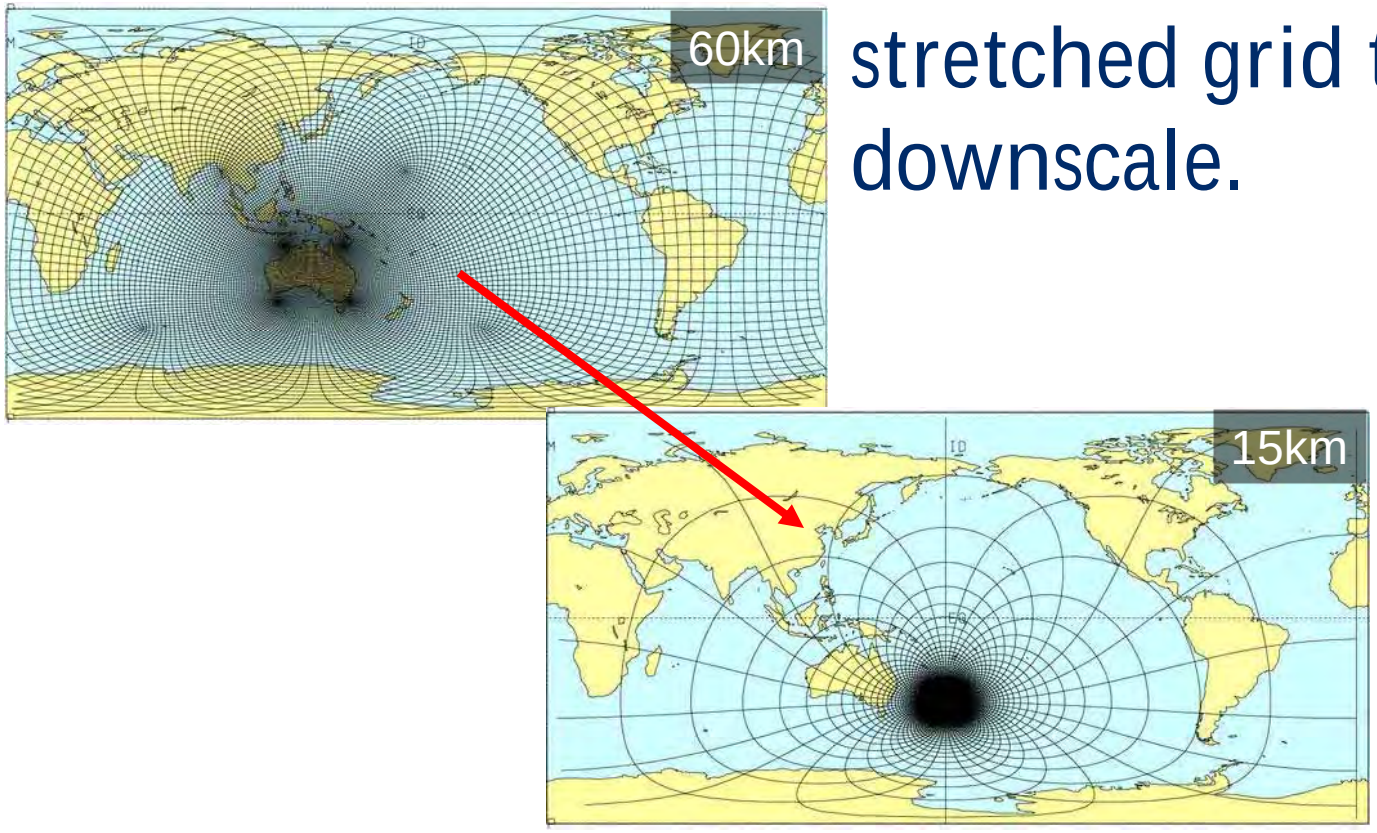
# Methodology: dynamical downscaling



# Methodology

- Conformal-cubic atmospheric model (C-CAM)
- Three host GCMs, CSIRO Mk3.5, GFDL CM2.1 and MPI ECHAM5
- Two methods of downscaling - Atmospheric nudging and bias-corrected SSTs
- 1981-2000, 20C3M experiment

# CCAM Example



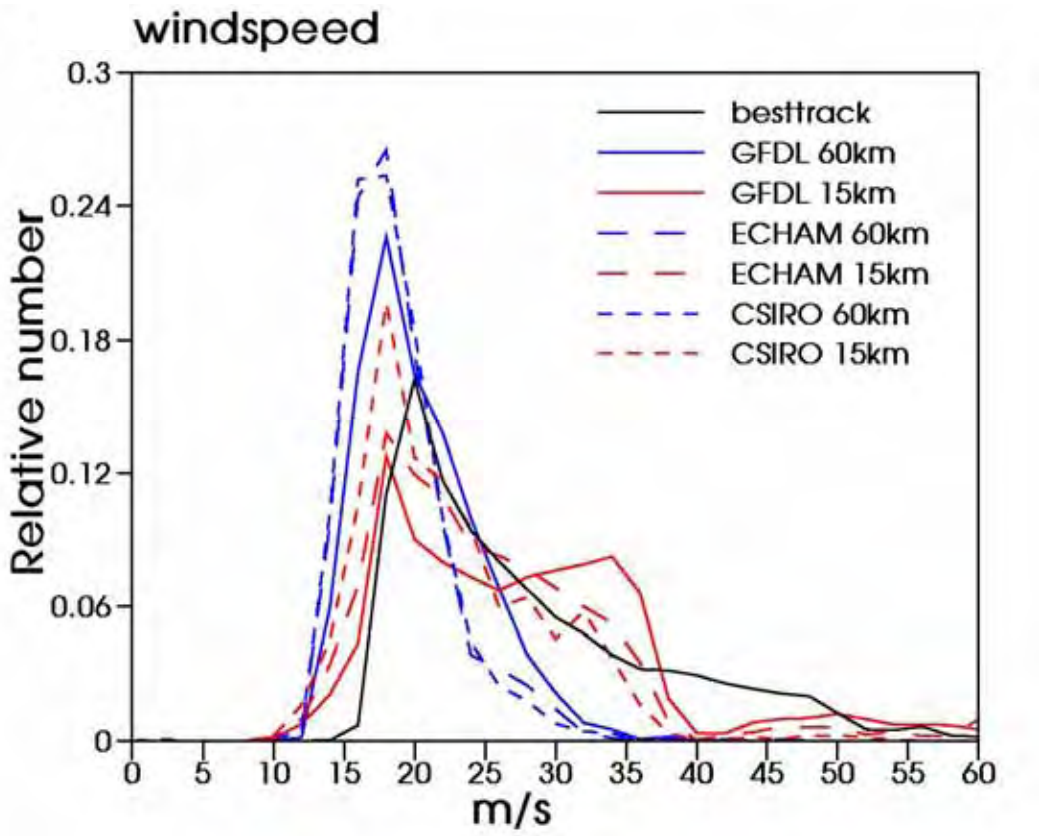

CCAM uses a multiple stretched grid technique to downscale.

15 km centered on TC in 60 km run. Grid moves with TC.

# Tracking the TC

- Force 60 km resolution model centred over Australian region with daily GCM data.
- Use CSIRO detection routine to detect possible cyclone
- Downscale to 15 km, centred on location of TC and forced from 2 days previously
- Simulate one day, centre on vortex, simulate one day, repeat until TC dissipates

# 60km -> 15km. Worth it?




Black = obs
Blue = 60 km
Red = 15 km

Big improvement in intensities at finer resolution.

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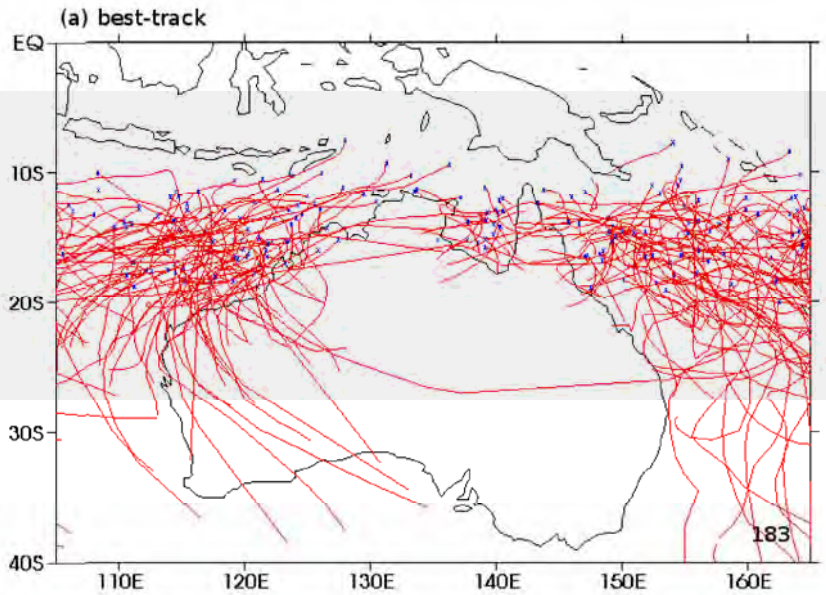
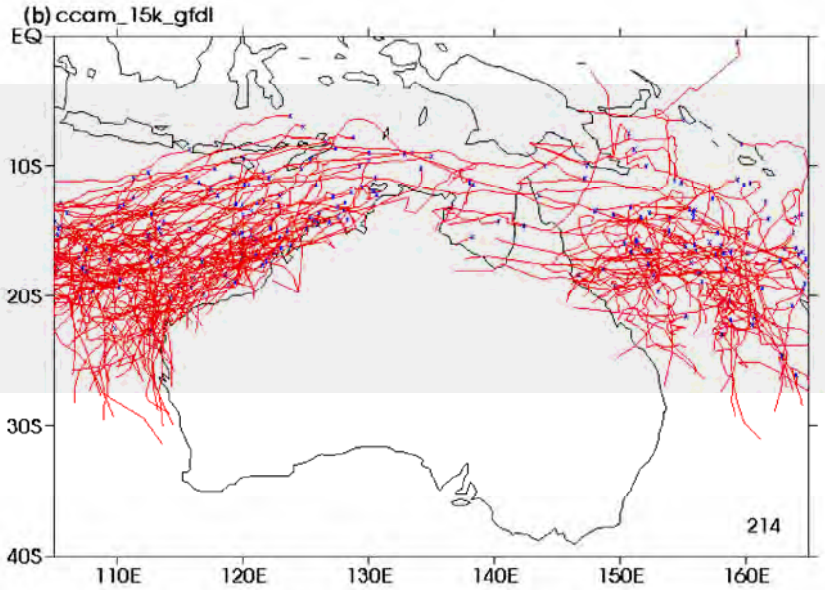
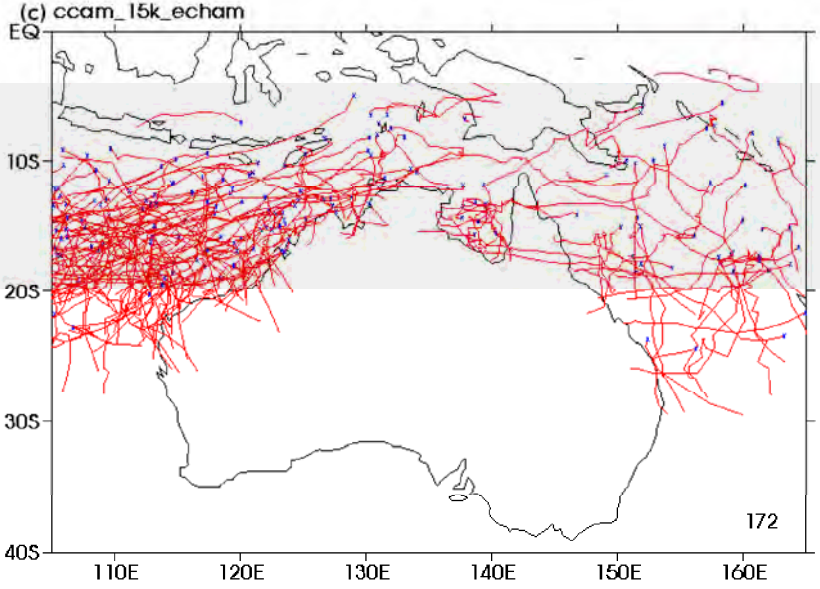
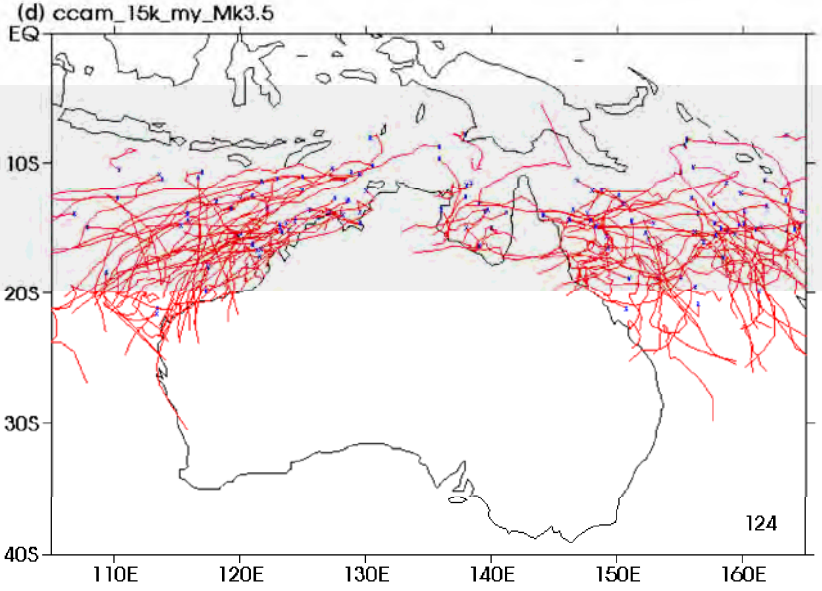
# TC Climatology (1981-2000)



# Future Simulations

- SRES A2 Scenario (a medium to high emissions scenario)
- Two time periods:
  - 2055 (2046-2065)
  - 2090 (2081-2100)
- Changes between these time periods and 1990 (1981-2000)

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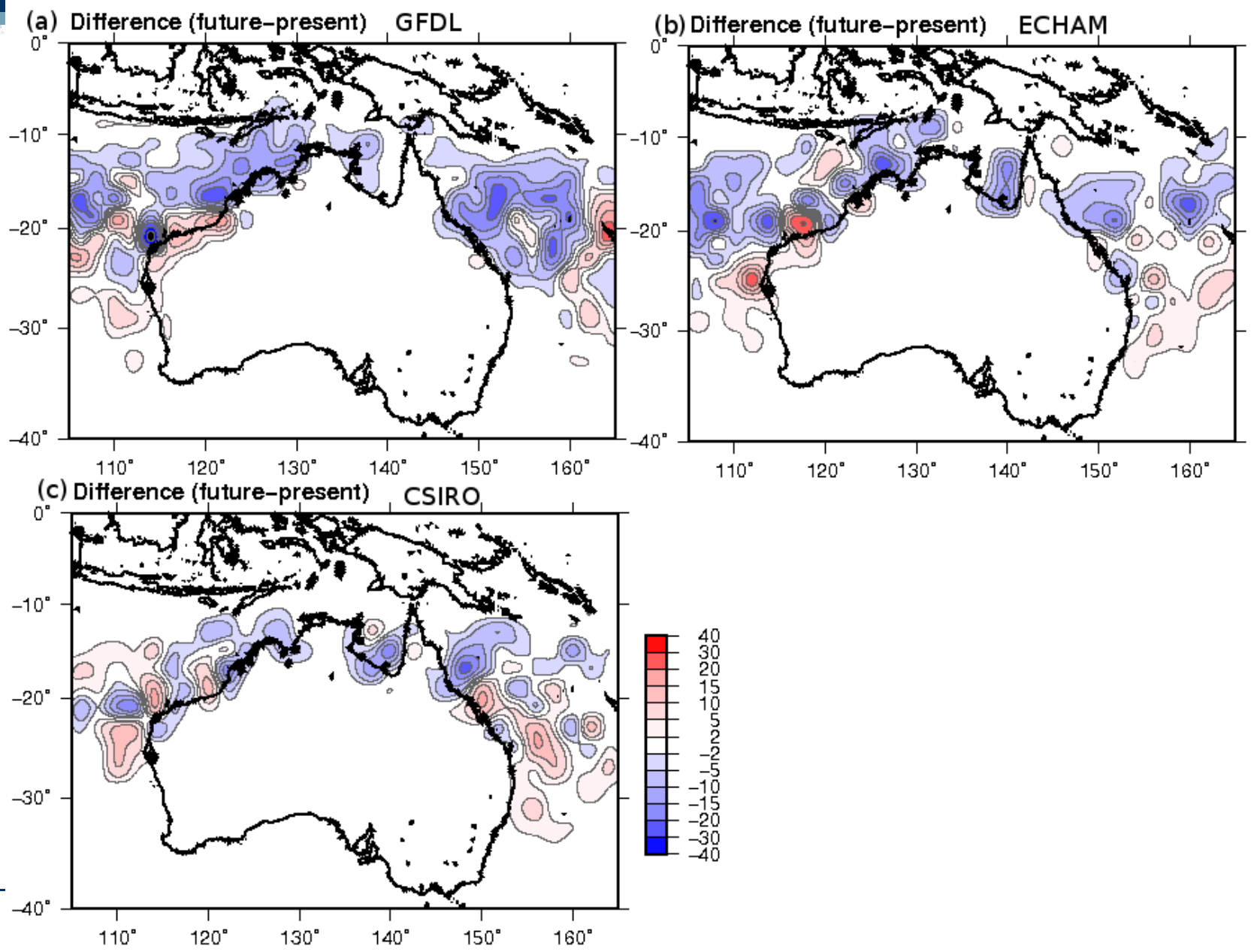
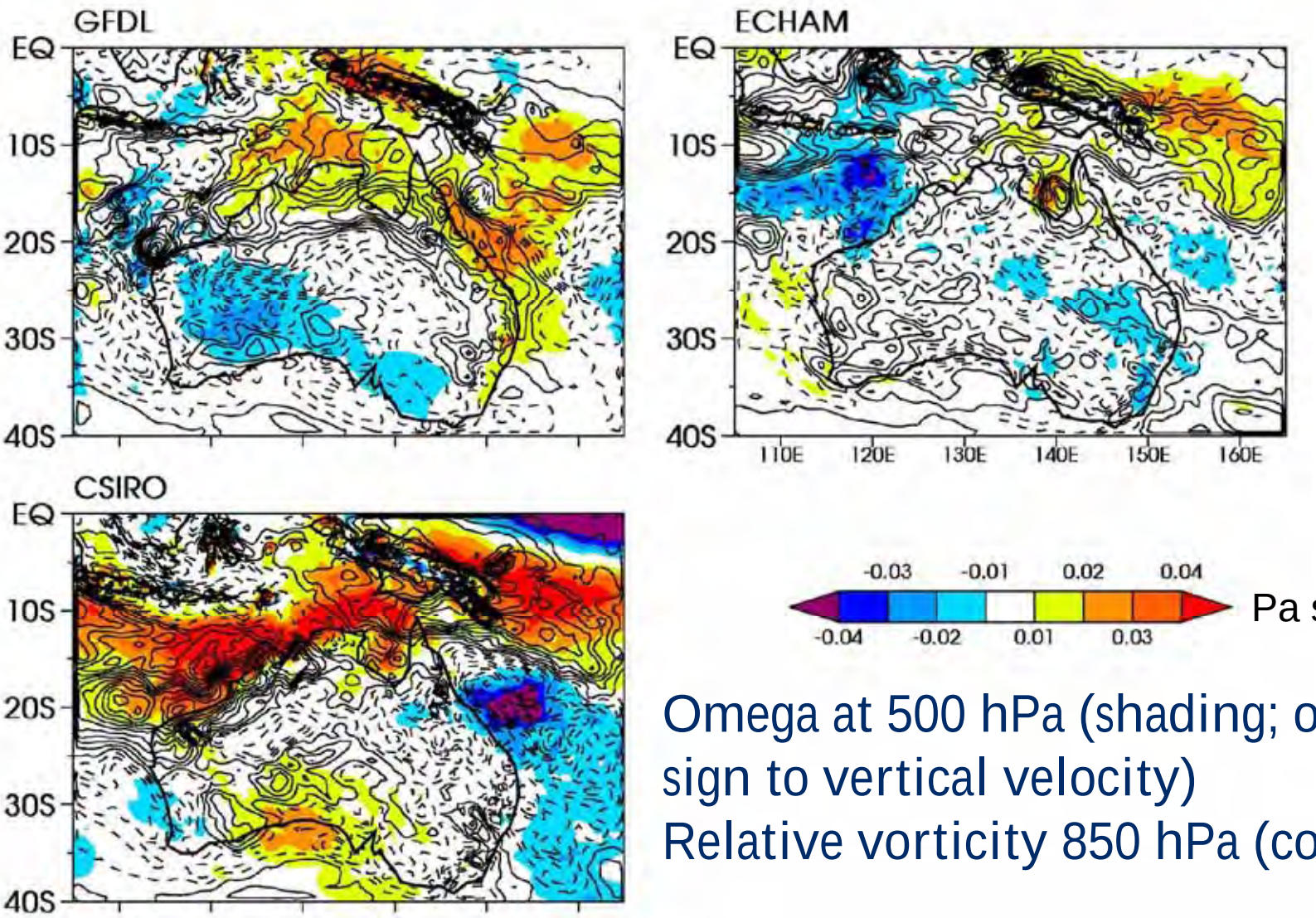
# Change in Occurrence by 2090



# Summary of results

- 2055: 0 to 29% decrease in numbers
- 2090:  27 to 38% decrease
- Some increases in maximum intensities of storms
  - Have not yet determined whether this also means a greater number of severe TCs
- A 2-3 degree (about 200-300 km) southward shift in typical TC formation off eastern Australia; a 3-6 degree southward shift in latitude of dissipation
- 0.5 to 1 day increase in lifetimes

# Dynamical reasoning




Omega at 500 hPa (shading; opposite sign to vertical velocity)
Relative vorticity 850 hPa (contours)

# Summary

- Decrease in numbers of TC by end of 21st Century in all models
- Some southward shifts in location of genesis and dissipation
- Change in the distribution of intensities (increase in maximum intensity, although decrease in total numbers of TCs)
- Vertical velocity and relative vorticity contributing to this decrease in TC numbers

# Future Plans

- Increase resolution to 3 km??

  (non-hydrostatic CCAM)

- Geoscience Australia statistical downscaling technique to provide estimates of wind risk in tropical Australia