Description and Key Messages for NCRA TC Hazards

Key messages:

- All TC detections analysed here are from CMIP5 global climate models (GCM). The period analysed from the historical scenario of GCM outputs was 1970-2000, with a high-emissions future scenario RCP 8.5 used for 2070-2100.
- There are large differences in the numbers of tropical cyclones detected in different GCM simulations.
- Different detection methods can produce differing projected changes in tropical cyclone frequency. The use of multiple methods of tropical cyclone detection is seen as essential to help assess the uncertainty around the risk of their occurrence.
- There are large differences in the spatial changes produced between GCMs. Combining the detections from multiple GCMs into ensembles of models allows us to produce more realistic historical densities of tropical cyclones and spatially coherent projected changes in frequency. The ensemble approach also reduces the uncertainty associated with projections from a single GCM.
- Plots of annual tropical cyclone frequency and of spatial frequency changes were obtained from the Tropical Cyclone Projections Portal (https://shiny.csiro.au/Tropical-Cyclone-Projections-Portal/). The screen shots can be obtained from the ACS "TC_hazards" github repository (https://github.com/AusClimateService/hazards-TC).
- The data displayed in the spatial density plots are also available in netCDF format via Thredds server at the following addresses (use the 'HTTP server' link to download the file):
    - CDD: https://data-cbr.csiro.au/thredds/catalog/catch_all/oa-climatesrv/dynamic/TC_Tracks_numbers/ensembles/SH/catalog.html?dataset=allDatasetScan/oa-climatesrv/dynamic/TC_Tracks_numbers/ensembles/SH/Clim_ensemble-common_CDD_2.5dx2.5d_SH_interpolated_2070-2100-minus-1970-2000_per-decade_normalised_diff_trimmed.nc
    - OWZ: https://data-cbr.csiro.au/thredds/catalog/catch_all/oa-climatesrv/dynamic/TC_Tracks_numbers/ensembles/SH/catalog.html?dataset=allDatasetScan/oa-climatesrv/dynamic/TC_Tracks_numbers/ensembles/SH/Clim_ensemble-common_OWZ_2.5dx2.5d_SH_init_interpolated_2070-2100-minus-1970-2000_per-decade_normalised_diff_trimmed.nc

Annual frequencies of TCs around Australia

Key points:

- These plots show the distribution of annual counts of tropical cyclones in the west Australia (90°-135°E) and east Australia (135°-160°E) domains for the "historical" period 1970-2000 and the "future" period 2070-2100.
- The statistical elements of each box-and-whisker plot are, from top to bottom:
    - Largest annual total,
    - Quartile 3 (75th percentile),
    - Median (solid line) and Mean (dashed line),
    - Quartile 1 (25th percentile), and
    - Lowest annual total

  ...over the domain for the period plotted.
- These statistics have also been made available for each model and detection method in separate CSV files.
- There is a large variation in the number of tropical cyclones detected in the various CMIP5 GCMs examined. Some models produce more than are observed in the IBTrACS best track data, however more often they produce too few; some produce so few (less than half the observed average) that they are excluded from the model ensembles used for further analysis.
- Most GCMs project decreases in tropical cyclone frequency by the late 21st century, but some GCMs project increases in frequency.
- Although the lines of evidence mainly point to decreases, there remains uncertainty around the magnitude (and in some places, the sign) of changes in tropical cyclone frequency around Australia.

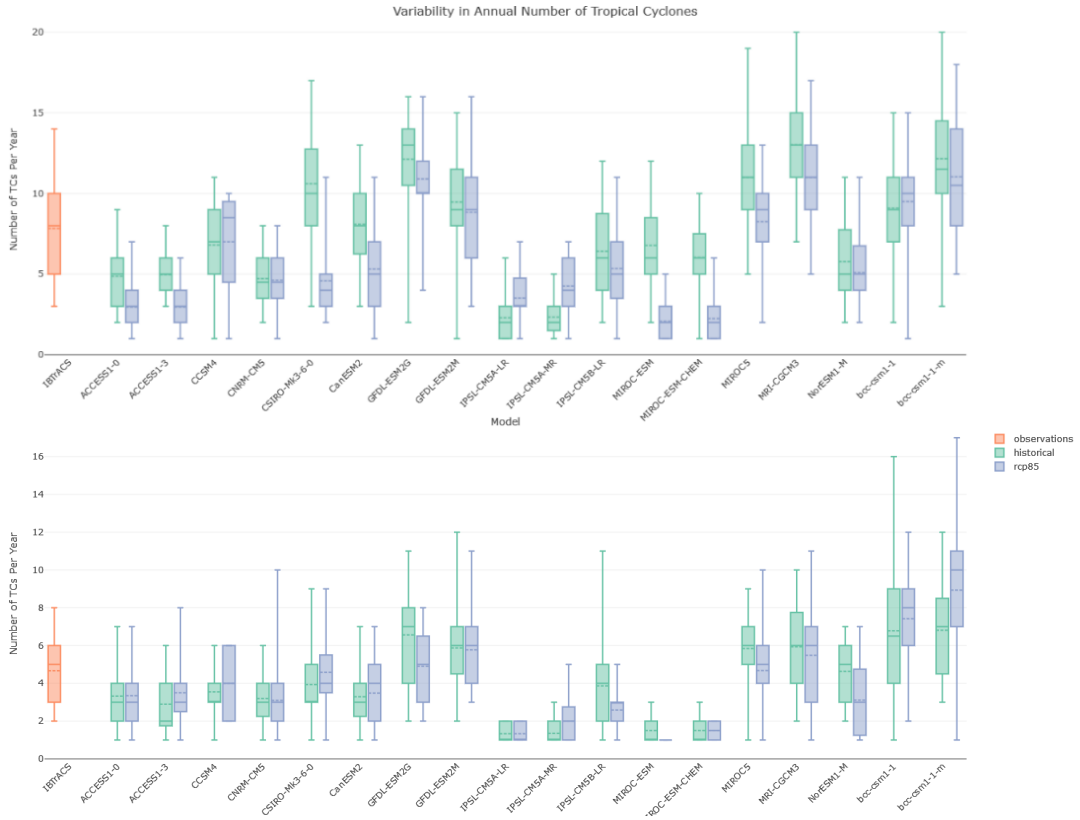

Figure 1 Variability in annual count of tropical cyclones in the Australian region using the CDD method. Top row, Australia West (90°-135°E); bottom row Australia East (135°-160°E)

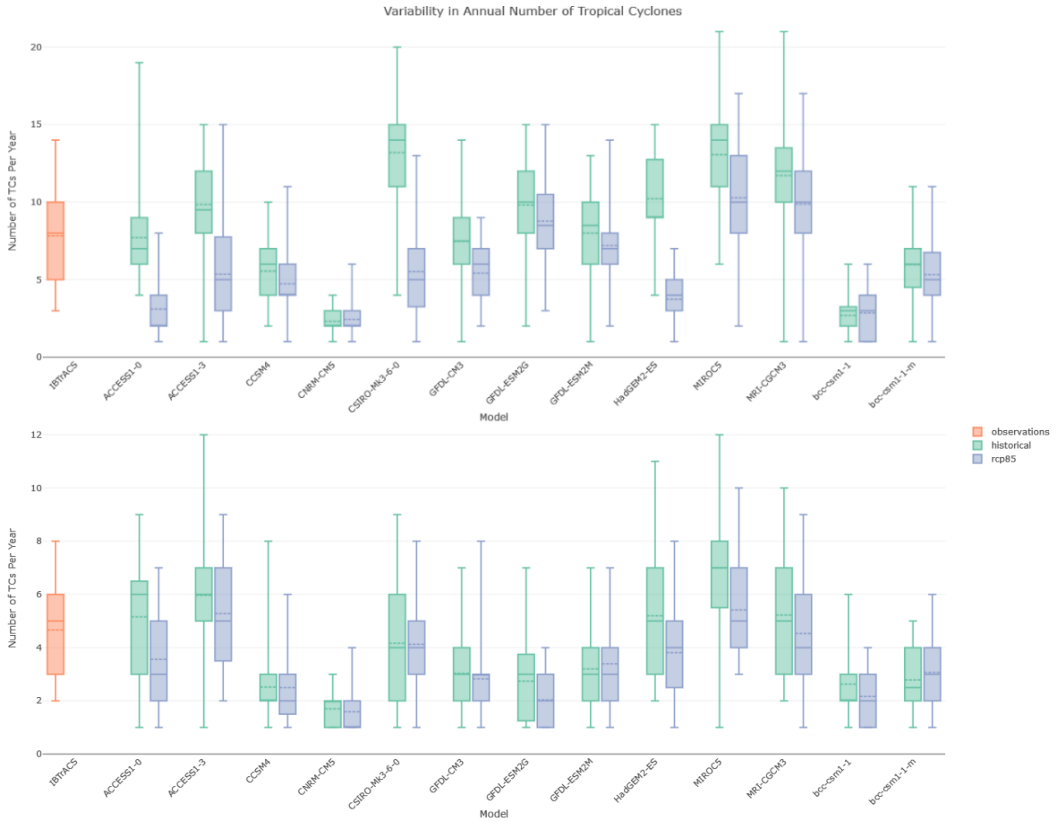

Figure 2 As for Figure 1 except results from using the OWZ detection method. Top row, Australia West (90°-135°E); bottom row Australia East (135°-160°E)

Spatial densities of tropical cyclones

Key messages:

- Spatial patterns of tropical cyclone frequency of occurrence (number of storms per decade) are displayed as a density field on a 2.5° longitude-latitude grid. The gridded frequency of occurrence for the "historical" period (1970-2000) is subtracted from the "future" period (2070-2100) to display the projected change in number of storms per decade.
- Individual models display large variations in their spatial representation of tropical cyclones (not shown). Combining the density of tropical cyclone frequency from multiple GCMs into a multi-model ensemble helps to form a more spatially coherent evaluation of tropical cyclone risk throughout the domain.
- The two tropical cyclone detection methods used here – CDD and OWZ – produce differing spatial frequencies and thus patterns of future change.
- When using tropical cyclone tracks detected within a common set of GCMs:
    - Both detection methods display large decreases in frequency in the Indian Ocean including off NW Australia, though larger decreases are seen using the CDD method.
    - Projected changes in frequency for the region off eastern Australia are less clear with changes derived from the CDD method showing consistent decreases, while results using the OWZ method have some isolated areas of increases amongst large areas of decrease or little change.
- Overall, the OWZ method produces a smaller reduction in tropical cyclone frequency than using the CDD method.
- Given the relatively poor resolution of GCMs and their inability to accurately simulate many features of tropical cyclones (e.g. their wind speeds and central pressures are usually much less intense than in reality), there remain large areas of uncertainty around future tropical cyclone behaviour, both for the Australian region and globally.

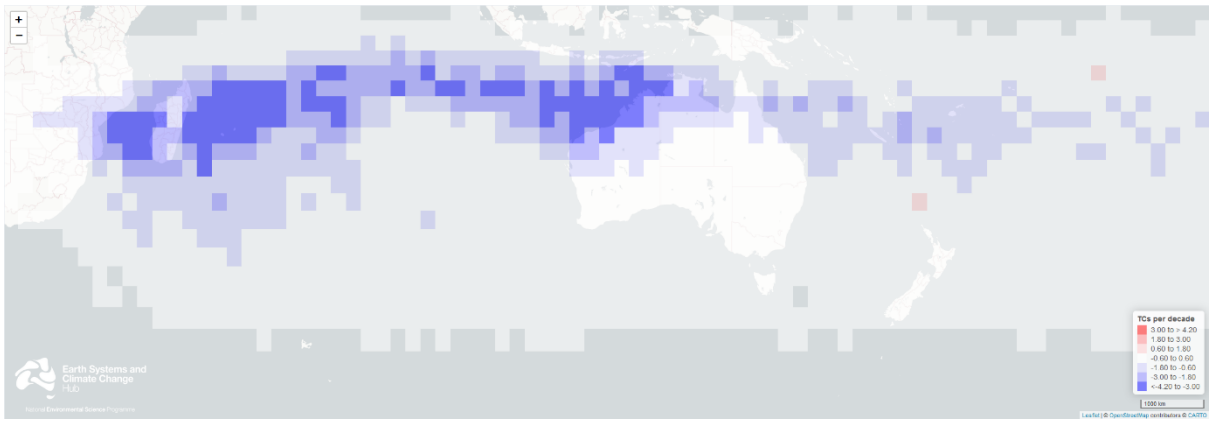

Figure 3 Change in spatial frequency (on a 2.5° longitude-latitude grid) of tropical cyclones detected using the CDD method by late 21st century (2070-2100, RCP 8.5). Projections are derived from a subset ensemble of 9 GCMs that were also analysed using another detection method (OWZ) to enable cross-method comparison of projections.

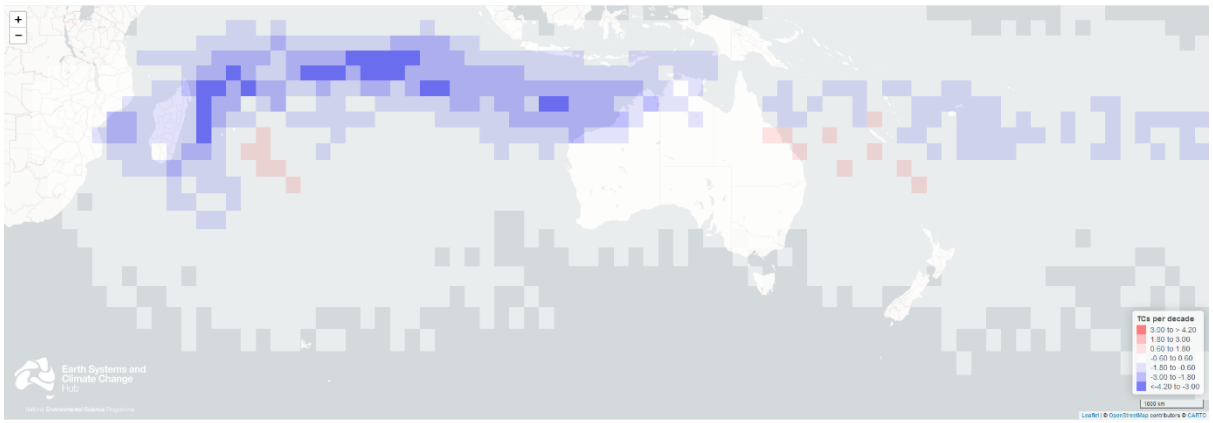

Figure 4 As for Figure 3, but using the OWZ detection method.