PROJECT 2.2: TROPICAL CYCLONES IN THE NORTH-WEST

Principal Investigators

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Milestone 2.2.1 *Research paper submitted on the climatology and interannual variability of tropical cyclones in the Indian Ocean that affect the Western Australian coastline* (Completed 31/12/2009)

This milestone has been completed and was reported on in the IOCI3 Report 1.

List of Publications Accepted and Submitted:

Knutson, Thomas R., J McBride, J Chan, K A Emanuel, G Holland, C Landsea, Isaac Held, J Kossin, A K Srivastava, and M Sugi, March 2010: Tropical cyclones and climate change. Nature Geoscience, 3, doi:doi:10.1038/ngeo779.

Y. Kuleshov, R. Fawcett, L. Qi, B. Trewin, D. Jones, J. McBride and H. Ramsay: 2010: Trends in tropical cyclones in the South Indian Ocean and the South Pacific Ocean. J. Geophys. Res. 115, D1, D01101, 0148-0227

List of IOCI-Related Presentations at National or International Conferences, Symposia And Workshops.

Nil

Milestone 2.2.2 *A statistical forecast model for tropical cyclone activity along the Western Australian coastline (2-week lead time)* (Completed 31/12/2009)

This milestone has been completed and was reported on in the IOCI3 Report 1.

A paper has not yet been written from this milestone. With pressure of other commitments, it may not be written until the end of 2010. The work done under this milestone has resulted in an online real-time forecast system for tropical cyclone activity for 1-week, 2-weeks and 3-weeks ahead. The information is presented in probability maps across the Southern Hemisphere. These are available on a web-page maintained by the French Meteorological Service (Meteo France. The web-page acknowledges the assistance and funding of IOCI in developing this model. The forecasts are available at:

http://www.meteo.nc/espro/previcycl/cyclA.php

Milestone 2.2.3 *Research paper on theoretical framework for understanding interannual variability of tropical cyclone behaviour in the southern Indian Ocean.* (Progress Report – due to be completed 31/12/2010)

Key Research Findings

We have documented the response of the upper oceans to tropical cyclones through compositing on a 0.5^o by 0.5^o latitude-longitude grid the anomalies of sea surface temperature before and after tropical cyclone passage. Two primary variables have been defined as measures of the sea surface temperature response: sea surface temperature reduction, and sea surface temperature recovery time (Fig.1). As seen in the second panel of the figure, there is a general relationship that the greater the temperature reduction as the cyclone passes over, the longer the recovery time. However, the error barbs (standard deviation) for each SST anomaly class are so large, the two variables can be treated as primarily independent.

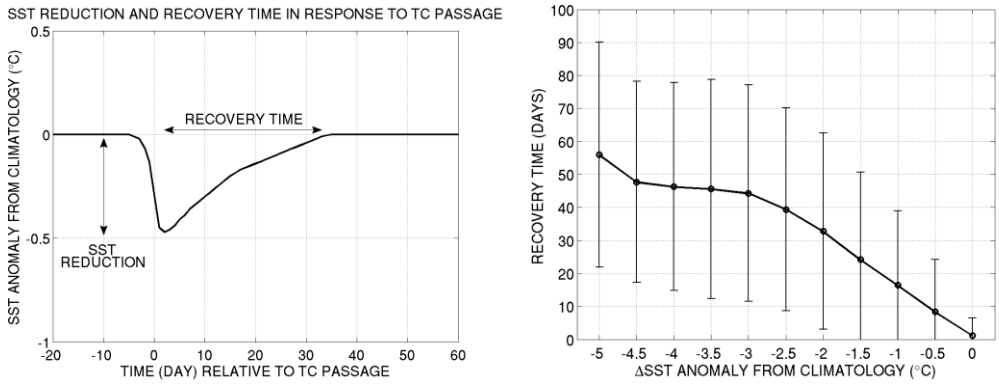

Figure 1: Left side: Schematic showing the definition of the two variables sea-surface-temperature (SST) reduction and recovery time. These have been developed by the current authors to quantify the effect of a tropical cyclone on the underlying ocean temperature.

Right panel: Scatter plot for a 28 year global tropical cyclone track data set of recovery time (ordinate) for each value of sst-reduction (abcissa) where the sst-reductions have been binned into classes the medians of which are separated by 0.5 degree C. The error bars are the standard deviations of recovery time for each sst- reduction class.

This work is important if we are to understand the impact of tropical cyclones on the circulation of the Indian Ocean region. It is also important for climate change studies. The study provides evidence that tropical cyclones can have a major impact on the heat balance of the underlying oceans. From examination of modelling studies in the literature it is clear that the major physical cause of the cooling is subsurface mixing with water from below the thermocline. The restoration to climatological values is believed to be through net surface flux.

Tropical cyclones have a large impact of the seasonal cycle of ocean surface temperature. Cyclones occurring in the first half of the season disrupt the seasonal warming trend which is not resumed until 30 days after cyclone passage. Conversely cyclone occurrences in the late half of the season bring about a 0.50C temperature drop from which the ocean never recovers due to the seasonal cooling cycle. This is shown in the following figure.

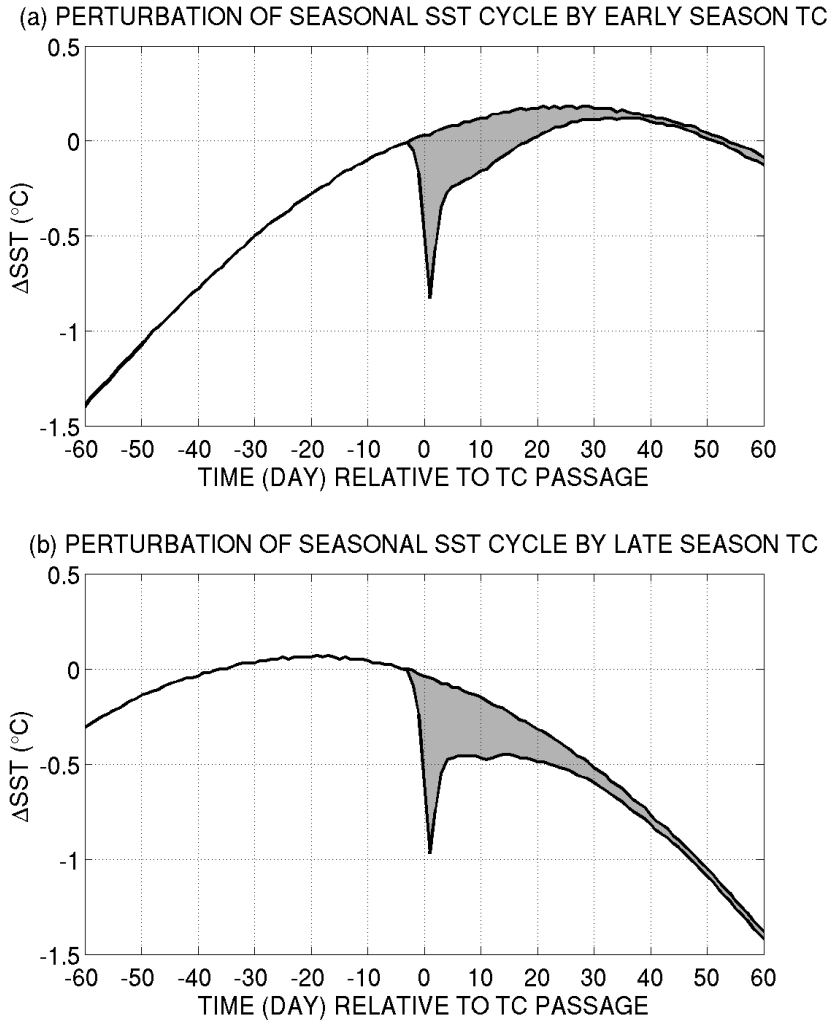

Figure 2: Mean time series of SST anomaly computed relative to SST one week before the TC's arrival. The smooth or upper line on each plot is global mean time series of sea surface temperature at the cyclone location, computed using all valid observations from all six global cyclone basins. The shaded region on each figure represents the disruption to the annual cycle of sea surface temperature due to a composite-mean tropical cyclone. The upper plot is a composite for cyclones occurring in the first half of the season, prior to the seasonal maximum in sea surface temperature. The lower plot is for cyclones occurring in the second half of the season.

Under this milestone, there is work in progress on the development of a new tropical cyclone genesis parameter which can be used to diagnose the physical mechanisms through which there is an increase in Western Australia tropical cyclones in a La Niña year and conversely a decrease in an El Niño year. The genesis parameter can also be used as a statistical downscaling tool for studies of climate-change impacts on tropical cyclones. This is being done in collaboration with non-IOCI funded colleagues in the Centre for Australian climate and Weather Research.

Milestone 2.2.4 *Report on extreme tropical cyclone behaviour in Western Australia and their economic impacts*

(Progress Report – due to be completed 31/12/2010)

Milestone 2.2.5 *State of Knowledge Report on tropical cyclone dynamics, databases and current practices relevant to Western Australia*

(Progress Report – due to be completed 31/12/2010)

Milestone 2.2.6 *Dependent on the research outcomes of the first two years, a series of expert statements, updates and research papers on the vulnerability of WA to changes in tropical cyclone activity under climate change*

(Progress Report – Work commenced 01/01/2010 due to be completed 31/12/2012)

Work on these three milestones is strongly interrelated and no reports are due until end 2010. Hence progress and findings are placed together.

Key Research Findings

The Report on extreme tropical cyclone behaviour will include an extensive review and synthesis of the published literature, on historical archives and on the resources and case studies of the Bureau of Meteorology, particularly its Perth Office. There will be a component of original research, focussing on a documentation of major events from the point of view of societal impact and of major events from the viewpoint of very intense cyclones and cyclones presenting rapid changes in direction of motion. The majority of this material has been collected.

Currently progress has been slow in collecting information on economic impacts. Discussions have been held with Geosciences Australia and with the Perth Office of the Bureau of Meteorology as to how to obtain this information. Approaches will be made to the WA Chamber of Minerals and Energy North West Region for assistance here. Any assistance from Stakeholders or readers of this progress report will be appreciated.

The State of knowledge report will draw very strongly on original and recent research on three themes: a) the tropical cyclone database; b) tropical cyclone climatology and dynamics in the region; c) Projections for North West Australia tropical cyclones under climate change. Extensive material has been gathered for all three and a report will be prepared by end 2010.

An analysis is underway to document the contribution of tropical cyclones to rainfall. Data has been extracted and preliminary results have been obtained. It is intended to write a journal paper on this during 2011. The preliminary results will be part of the State of Knowledge Report (Milestone 2.2.5).

Data have been analysed to determine the influence of sea surface temperature on cyclone frequency and on cyclone intensity. Data have been extracted globally. The case study for the Indian Ocean basin will form part of the State of Knowledge Report.

The series of expert statements and publications (milestone 2.2.6) will draw on the results of the preceding five milestones.

List of IOCI-Related Presentations at National or International Conferences, Symposia And Workshops.

John McBride. "Climate Change Impacts on Tropical Cyclones — the Current State of Knowledge, 14th Australasian Wind Engineering Society Workshop, Canberra 5-6 August, 2010. (Invited/Keynote Presentation).