2C.1 ON THE IMPORTANCE OF REVIEWING HISTORICAL TROPICAL CYCLONE INTENSITIES

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1. INTRODUCTION

Globally, historical tropical cyclone (TC) datasets ("best tracks") have been used extensively to establish broad climatology, identify relative changes in frequency and occurrence between basins and to estimate intensity on a regional basis. In the Atlantic, where the quality of the data has been underpinned by aircraft reconnaissance since the 1940s, apparent multi-decadal cycles have been detected and ascribed to larger scale climate features (e.g. Gray *et al.* 1997). In the South West Pacific, the influence of the Southern Oscillation Index (SOI) (e.g. Nicholls 1984) has been identified as an apparently strong regional indicator of tropical cyclone occurrence. Increasingly, the proposed potential effects of anthropogenic climate change has naturally led to global best track datasets being used to infer possible trends in *intensity change* (e.g. Emanuel 2005, Webster *et al.* 2005). This paper examines the likely variation in quality, consistency and accuracy of historical tropical cyclone intensities and identifies potential pitfalls for inferring intensity trends on the basis of such data. An example of a partial reanalysis of TC intensity in the Western Australian region is presented for illustration.

2. INCREASING TECHNOLOGY, METHODOLOGY, KNOWLEDGE AND SKILL

The advent of aerial TC reconnaissance in the US during the 1940s can be hailed as the beginning of quantitative studies of tropical storm structure and behaviour. Without doubt though, the advent of routine satellite imaging *circa* 1965 had a profound influence on the ability of meteorologists to track and better study TCs in a global context, leading to development of objective analyses (e.g. Dvorak) in the 1970s. The march of technology, methodology, knowledge and skill has been increasing more rapidly, with each decade providing <u>very significant</u> advances in intensity estimation, e.g.:

1960s: Polar VIS, AWSs, Radars, US NHRP, WMO/WWW/ESCAP, AMS Confs;
1970s: Polar IR, Dvorak VIS, Geostationary VIS/IR, Atkinson and Holliday, WMO TC Committees;
1980s: Met Buoys, Doppler Radar, Dvorak EIR; WMO/TCP/IWTCs/RSMCs; McIDAS
1990s: Scat, MI (TRMM, SSMI/I, AMSU), ODT, WWW (NOAA/NESDIS, NRL/TC), WMO/Global Guide
2000s: AMSR, Aerosonde, AODT, High resolution numerical modeling, WMO++

While not all global TC regions were able to immediately take up technology improvements, there has undoubtedly been an accelerating trend in capabilities. Importantly, improvements in intensity estimation are expected well into the future.

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3. THE NEED FOR REANALYSIS

With its already leading role in many facets of TC knowledge, the US must also be credited with recognizing the advantages of and need for reanalysis of historical storms. Neumann (e.g. WMO 1993) was instrumental in devising the "best track" philosophy and has personally striven to standardize, merge and correct the various global TC datasets to assist understanding and to facilitate wind risk studies. The US Hurricane Reanalysis Project (e.g. Landsea *et al.* 2004) focused on the desire to extend the Atlantic historical record backwards in time prior to 1900 so as to obtain longer datasets for statistical analysis. Meanwhile, Holland (1981) was instrumental in highlighting the deficiencies of the TC best track database in the Australian region.

However, notwithstanding past efforts, it is argued that the impact of the aforementioned improvements in the accuracy of the global best track dataset storm *intensities* over <u>even the past 30 years</u> has been significantly underestimated. This particularly impacts those in the industrial/commercial and research communities who rely upon objective metrics of intensity or otherwise seek to explore climatological links or trends. Without a mandated central coordinating authority, original global datasets have remained largely unadjusted, except for example, occasional typographical corrections and consistency checks. The US reanalysis project is the only known example of a thorough organizational review of the original meteorology and currently has funding available until 2008.

One reason for this situation is that there has been little imperative on behalf of most agencies originally contributing to the best track datasets to undertake reviews of their historical data while the technology, methodology, knowledge and skill has advanced. Ironically, those agency forecasters who have personally built the databases over time are now typically more aware of these acute deficiencies than anyone else, yet their organizations have not traditionally been actioned, resourced or necessarily inclined to undertake such reviews. Likewise, researchers across many disciplines have naively tended to assume unreasonable levels of objectivity and accuracy in respect of best track data when using it to support developing theories, for underpinning numerical modeling or when estimating risks.

Our <u>collective oversight</u> has led us to a situation where, on the cusp of needing accurate intensity trend information, we are likely to be frustrated by doubts and uncertainties about the quality of much of the global TC datasets. Redressing this situation is a major undertaking.

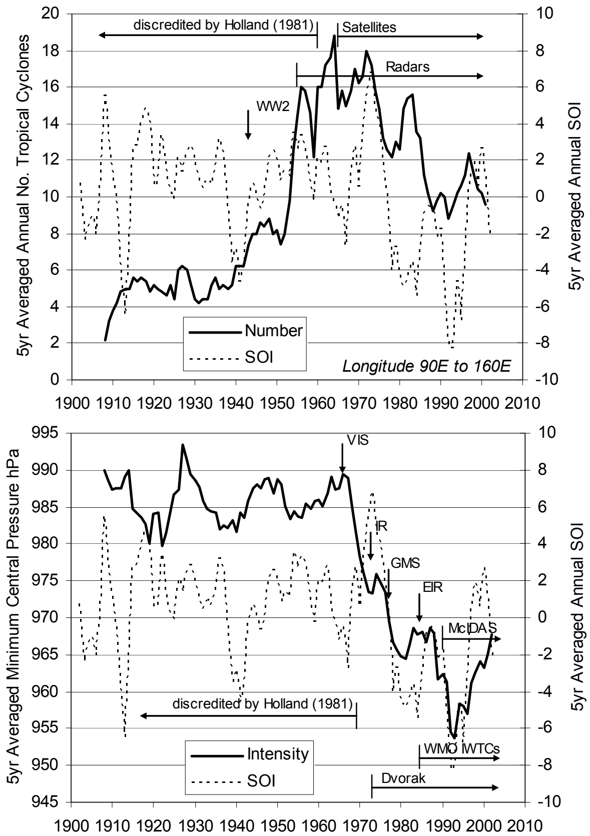

Figure 1 Australian Region best track data example.

4. THE AUSTRALIAN REGION EXAMPLE

Figure 1 provides an overview of the Australian Bureau of Meteorology (BoM) best track dataset in terms of pentadal averaged occurrence and intensity, overlaid with SOI [http://www.bom.gov.au/climate/how/]. Holland (1981) was able to largely discredit occurrence statistics prior to 1960 and intensity estimates prior to 1970 (with some caveats). Occurrences in the 1960s are also inflated by errors and misclassifications. However, even since the mid-1970s there is compelling evidence here that the continuing advances in intensity estimation could be influencing a suggested strong trend in climatology. Also, the prolonged El Ni̕no trend over much the same period would seem to warrant investigation.

Faced with increasing doubts as to the accuracy and consistency of TC intensity in the Western Australian region (North West Shelf / Timor Sea), Woodside Energy embarked on a program of review in 2001/2002 (e.g. Harper 2004). With the support of the BoM, experienced Dvorak analysts were employed in an attempt to rectify the best track intensities since 1968/69 within the region of interest to Woodside operations. The result of that review, largely limited to a consistent application of the Dvorak rules, is summarized in Figure 2. The Woodside review did not seek to recover any additional information other than that available in BoM archives. Accordingly it should not be regarded as perfect; however it uncovered a very wide range of differences from the original BoM dataset, well into the 1990s. A clear bias of intensity underestimation was detected and trends in PDI and ACE were removed, although a temporal trend in intensity still remained. Whether the temporal trend can be ascribed to SOI, an inability to recover pre-1980 data adequately or indeed climate changes will be considered in the presentation.

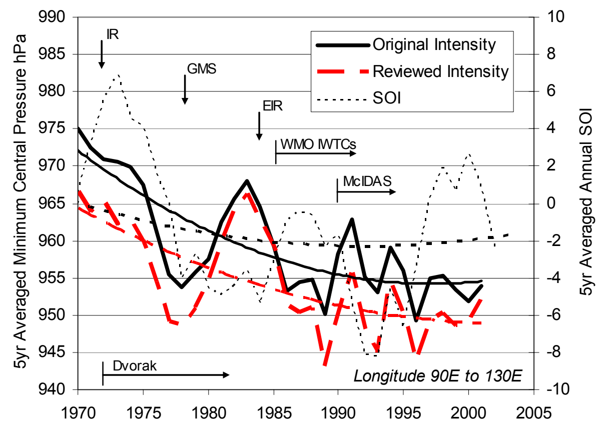

Figure 2 Western Australian review summary outcome; 183 storms with quadratic trends shown.

5. CONCLUSIONS

Because of the very significant changes in technology, methodology, knowledge and skill over the past 30 years, there is an urgent need to consistently review and revise global historical best track data for tropical cyclones. This is essential to ensure more reliable estimation of current climatic risks and to form a basis for inferring potential climate change trends into the future.

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