Comment on "Is the number of North Atlantic tropical cyclones significantly underestimated prior to the availability of satellite observations?" by Edmund K. M. Chang and Yanjuan Guo

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1. Introduction

[1] The question of whether tropical cyclones (TC) have increased in number and intensity is an issue of primary importance in view of the severe destruction caused by TC. However, this turns out to be highly complicated due to the large inter-annual variability and possible variations on longer time scales. The TC in the North Atlantic are influenced by the large-scale atmospheric circulation in particular associated with the El Niño/La Niña phenomenon. It is well known that during El Niño there are generally less TC in the North Atlantic. But other aspects of the atmospheric circulation are also important including the extra-tropical or sub-tropical circulation which affects the vertical wind shear and the overall steering flow. The capability of observing TC has gradually improved, in particular with the introduction of geostationary satellites from the late 1960's which greatly improved the detection of TC over the oceans. There are therefore good reasons to assume that TC were underestimated over ocean areas before the satellites became available. *Chang and Guo* [2007] have made a useful contribution towards a better estimate of the number of TC in the pre-satellite era. However, we disagree with their general conclusion and offer here an alternative interpretation of their results.

2. Results

[2] We used a somewhat different way to examine the results of *Chang and Guo* [2007, Table 1]. We regrouped the results into two time spans covering 40 years. The first period, A, covers the years 1920 through to 1965 and the second period, B, covers the years 1966 through to 2005. For the period B we may assume that the improved observing system over the North Atlantic provided by the space based observations has led to practically all TC in the area being observed or at least equally as well observed as in the last decade. The new result can be summarized in Table 1.

[3] If we assume that 40 years is a reasonable representative period, then the result clearly shows that there has been a substantial increase of detected TC in the regions where, before the advent of satellites, observations were sparse. These are regions which are less than 300 km from land and also well out over the oceans. However, in the areas, US and CC [*Chang and Guo*, 2007, Table 1], which presumably were well observed throughout both periods, the number of TC is actually less in the latter period B.

[4] What could then be a credible explanation of the large increase in TC over ocean areas, as found in the results of Chang and Guo? We would tend to consider it highly unlikely that the distribution of TC could have changed so drastically that there would be a more than doubling over ocean regions but no change in the number of TC having a landfall. A more credible explanation is the way data has been used. Chang and Guo base their conclusion on the Comprehensive Ocean-Atmosphere Data Set (COADS) ship data that has only just recently been included into the reanalysis of the hurricane database. The COADS data was not utilized for the reassessment of HURDAT for the period of 1851 to 1910 [*Landsea et al.*, 2004]. The ship database has now been incorporated into the reanalyses that are being completed for 1911 to 1920 [*Landsea et al.*, 2008]. The crucial point is that the COADS data and other sources have allowed the identification of 13 brand new tropical cyclones in a decade. The addition of more than one additional TC per year in the early 20th Century must be added to the numbers estimated to be missing over the ocean by Chang and Guo because the studies are premised on all tropical cyclones that could be monitored by COADS are currently in HURDAT. Clearly, this is not the case. Chang and Guo also assumed that only one observation of tropical storm force winds was needed to be included into HURDAT. As documented by *Landsea et al.* [2008], two independent observations are required for such an inclusion.

[5] It would seem that this result does not support the conclusions of the authors and needs to be documented. It also highlights the great difficulty in identifying trends in strongly chaotic phenomena when the observational conditions are not constant and as here have improved over time.

[6] Further it is interesting to note that results from recent climate modeling results using high resolution GCMs [*Sugi et al.*, 2002; *Oouchi et al.*, 2006; *Bengtsson et al.*, 2007] do not support any increase in the global number of TC, but rather a slight reduction in their numbers. However, an increase in intensity with a warmer ocean is obtained although the increase is modest. Any likely increase in

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Table 1. Regrouping of *Chang and Guo* [2007] Data

	40 Years From 1920 to 1965 (A)	40 Years From 1966 to 2005 (B)	Ratio B/A
All	347	444	1.28
US	136	130	0.96
CC	109	95	0.87
NS	56	125	2.23
OO	46	94	2.04

intensity may take another couple of decades to statistically demonstrate.

[7] Whether the tropical Atlantic is different in this respect is an open question and we must await more modeling studies at high resolution.

[8] **Acknowledgments.** The authors are grateful for the comments by C Landsea.

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