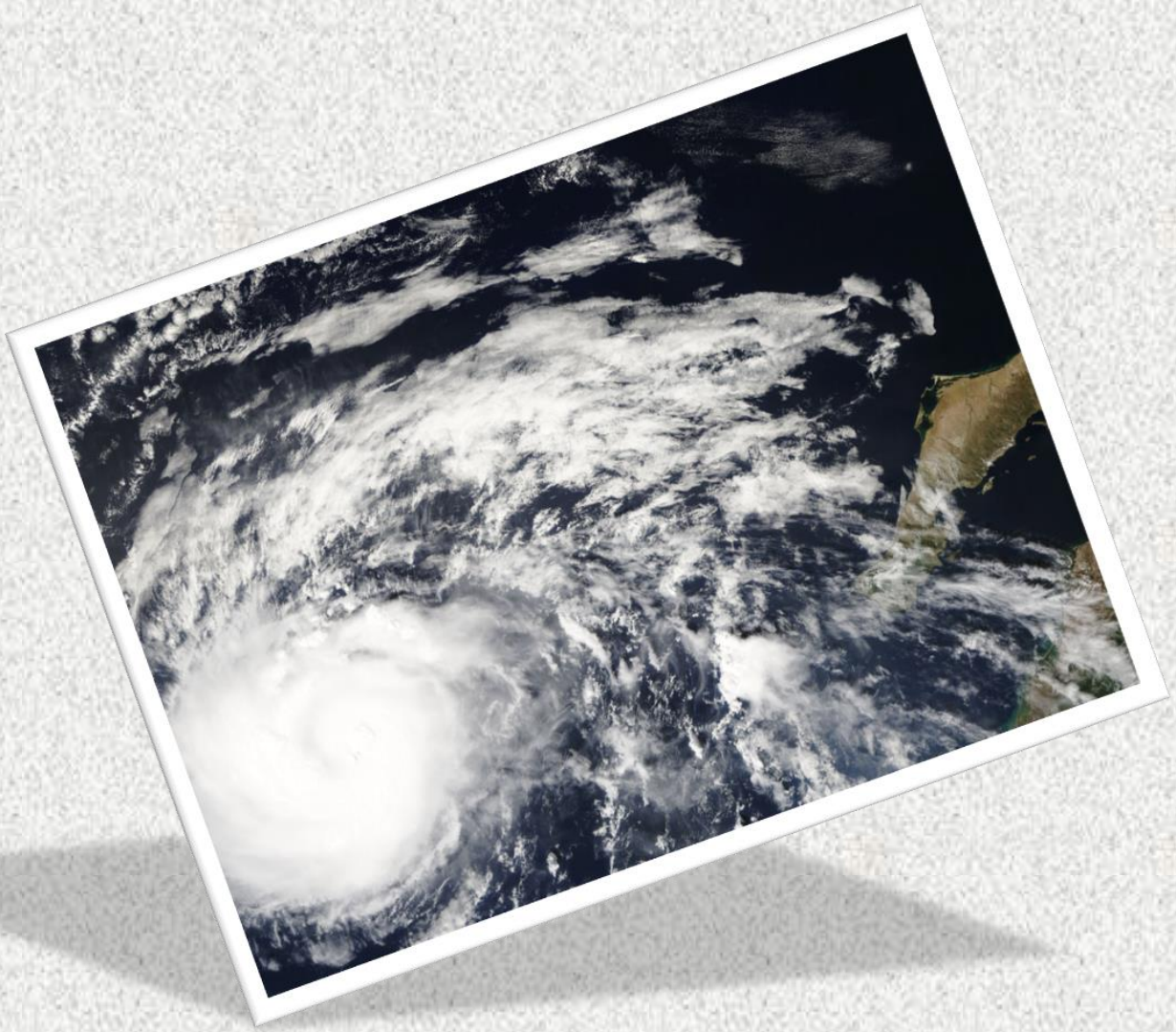
PACIFIC OCEAN HURRICANES AND GLOBAL WARMING



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Have hurricanes of the Pacific Ocean become more numerous and intense over the past century or so, in response to what climate alarmists typically describe as unprecedented global warming? To provide a firm foundation for answering this important question, this summary contains brief synopses of several *real-world* (as opposed to *climate-model*) studies that have appeared in the peer-reviewed scientific literature over the past few decades and have focused on this important question.

Chu and Clark (1999)[1] analyzed the frequency and intensity of tropical cyclones that either originated in or entered the central North Pacific (0-70°N, 140-180°W) over the 32-year period 1966-1997; and in doing so, they found that "tropical cyclone activity (tropical depressions, tropical storms, and hurricanes combined) in the central North Pacific [was] on the rise." This increase, however, appears to have been due to a *step-change* that led to the creation of "fewer cyclones during the first half of the record (1966-81) and more during the second half of the record (1982-1997)," and accompanying the abrupt rise in tropical cyclone numbers was a similar abrupt increase in maximum hurricane intensity.

Have hurricanes of the Pacific Ocean become more numerous and intense over the past century or so, in response to what climate alarmists typically describe as unprecedented global warming?

Although climate alarmists may claim these findings support their model-based contentions, i.e., that CO_2-induced global warming leads to more frequent and stronger hurricanes, Chu and Clark say that the observed increase in tropical cyclone activity *cannot* be due to CO_2-induced global warming, because, in their words, "global warming is a gradual processes" and "it cannot explain why there is a steplike change in the tropical cyclone incidences in the early 1980s."

Clearly, a much longer record of tropical cyclone activity is needed to better understand the nature of the variations documented by Chu and Clark, as well as their relationship to mean global air temperature; and the beginnings of such a history were presented by Liu *et al.*

[1] http://www.co2science.org/articles/V5/N33/C1.php.

(2001)[2], who meticulously waded through a wealth of weather records from Guangdong Province in southern China, extracting data pertaining to the landfall of typhoons there since AD 975. Calibrating the historical data against instrumental observations over the period 1884-1909, they found that the trends of the two data sets were significantly correlated (r = 0.71); and this observation led them to conclude that "the time series reconstructed from historical documentary evidence contains a reliable record of variability in typhoon landfalls." Therefore, they proceeded to conduct a spectral analysis of the Guangdong time series and discovered an approximate 50-year cycle in the frequency of typhoon landfall that "suggests an external forcing mechanism, which remains to be identified." Also, and very importantly, they found that "the two periods of most frequent typhoon strikes in Guangdong (AD 1660-1680, 1850-1880) coincide with two of the coldest and driest periods in northern and central China during the Little Ice Age."

Looking even further back in time in the Southern Hemisphere, Hayne and Chappell (2001)[3] studied a series of storm ridges at Curacoa Island, which were deposited over the past 5,000 years on the central Queensland shelf (18°40'S; 146°33'E), in an attempt to create a long-term history of major cyclonic events that have impacted that area, with one of their stated reasons for doing so being to test the climate-model-based hypothesis that "global warming leads to an increase of cyclone frequency or intensity." The primary finding of this endeavor, as they describe it, was that "cyclone frequency was statistically constant over the last 5,000 years." In addition, they could find "no indication that cyclones have changed in intensity," leaving one little to conclude but that the climate-model-based hypothesis is inconsistent with their findings.

In a similar study, Nott and Hayne (2001)[4] produced a 5000-year record of tropical cyclone frequency and intensity along a 1500-km stretch of coastline in northeast Australia located between latitudes 13 and 24°S by geologically dating and tropographically surveying landform features left by historic hurricanes, and running numerical models to estimate storm surge and wave heights necessary to reach the landform locations. These efforts revealed that several "super-cyclones" with central pressures less than 920 hPa and wind speeds in excess of 182 kilometers per hour had occurred over the past 5000 years at intervals of roughly 200 to 300 years in all parts of the region of their study. They also report that the Great Barrier Reef "experienced at least five such storms over the past 200 years, with the area now occupied by Cairns experiencing two super-cyclones between 1800 and 1870." The 20th century, however, was *totally devoid* of such storms, "with only one such event (1899) since European settlement in the mid-nineteenth century."

Also noting that "many researchers have suggested that the buildup of greenhouse gases (Watson *et al*., 2001) will likely result in a rise in sea surface temperature (SST), subsequently increasing both the number and maximum intensity of tropical cyclones (TCs)," Chan and Liu (2004)[5] explored the validity of this assertion via an examination of pertinent real-world data *because*, as they put it, "if the frequency of TC occurrence were to increase with increasing

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[2] http://www.co2science.org/articles/V4/N45/C1.php.
[3] http://www.co2science.org/articles/V4/N40/C2.php.
[4] http://www.co2science.org/articles/V6/N25/C2.php.
[5] http://www.co2science.org/articles/V8/N5/C1.php.

global air temperature, one would expect to see an increase in the number of TCs during the past few decades." Their efforts, which focused on the last four decades of the 20th century, resulted in their finding that a number of parameters related to SST and TC activity in the Western North Pacific (WNP) "have gone through large interannual as well as interdecadal variations," and that "they also show a slight decreasing trend." In addition, they say that "no significant correlation was found between the typhoon activity parameters and local SST," or "in other words," as they say to drive home their point, "an increase in local SST does not lead to a significant change of the number of intense TCs in the WNP, which is contrary to the results produced by many of the numerical climate models."

An increase in local SST (Sea Surface Temperature) does not lead to a significant change of the number of intense TCs (Tropical Cyclones) in the WNP (Western North Pacific), which is contrary to the results produced by many of the numerical climate models.

In further discussing their results, Chan and Liu write that the reason for the discrepancies between their real-world results and those of many of the numerical climate models likely lies in the fact that the models assume TCs are generated primarily from energy from the oceans and that a higher SST therefore would lead to more energy being transferred from the ocean to the atmosphere, or "in other words," as they once again say in striving to make their point as clear as possible, "the typhoon activity predicted in these models is almost solely determined by thermodynamic processes, as advocated by Emanuel (1999)," whereas "in the real atmosphere, dynamic factors, such as the vertical variation of the atmospheric flow (vertical wind shear) and the juxtaposition of various flow patterns that lead to different angular momentum transports, often outweigh the thermodynamic control in limiting the intensification process." Their final conclusion, therefore, is that "at least for the western North Pacific, observational evidence does not support the notion that increased typhoon activity will occur with higher local SSTs."

Much the same thing was found by Free *et al*. (2004)[6], who looked, not for increases in *actual* hurricane intensity, but for increases in *potential* hurricane intensity, because, as they put it, "changes in potential intensity (PI) can be estimated from thermodynamic principles as shown in Emanuel (1986, 1995) given a record of SSTs and profiles of atmospheric temperature and humidity." This they did using radiosonde and SST data from 14 island radiosonde stations in

[6] http://www.co2science.org/articles/V7/N31/C1.php.

both the tropical Pacific *and* Atlantic Oceans, after which they compared their results with those of Bister and Emanuel (2002) at grid points near the selected stations. And in doing so, they report that their results showed "no significant trend in potential intensity from 1980 to 1995 and no consistent trend from 1975 to 1995." What is more, they report that between 1975 and 1980, "while SSTs rose, PI decreased, illustrating the hazards of predicting changes in hurricane intensity from projected SST changes alone."

Hall (2004)[7] reviewed the characteristics of cyclones occurring south of the equator and eastward from longitude 90°E to 120°W in the South Pacific and southeast Indian Oceans, concentrating on the 2001-2002 cyclone season and comparing the results with those of the preceding four years and the 36 years before that. This analysis indicated that "the 2001-2002 tropical cyclone season in the South Pacific and southeast Indian Ocean was one of the quietest on record, in terms of both the number of cyclones that formed, and the impact of those systems on human affairs." In the southeast Indian Ocean, for example, he writes that "the overall number of depressions and tropical cyclones was below the long-term mean," while further east he found that broad-scale convection was near or slightly above normal, but that "the proportion of tropical depressions and weak cyclones developing into severe cyclones was well below average," which result represented "a continuation of the trend of the previous few seasons." More specifically, Hall writes that "in the eastern Australian region, the four-year period up to 2001-2002 was by far the quietest recorded in the past 41 years." Consequently, and in stark contrast to the climate-alarmist claim that tropical cyclone numbers and strength tend to increase with global warming, these real-world observations suggest that, if anything, just the opposite appears to be occurring.

In stark contrast to the climate-alarmist claim that tropical cyclone numbers and strength tend to increase with global warming, these real-world observations suggest that, if anything, just the opposite appears to be occurring.

Noting that "according to Walsh and Ryan (2000), future global climate trends may result in an increased incidence of cyclones," and realizing that "understanding the behavior and frequency of severe storms in the past is crucial for the prediction of future events," Yu *et al.* (2004)[8] devised a way to decipher the history of severe storms in the southern South China Sea. Working at Youngshu Reef (9°32'-9°42'N, 112°52 -113°04'E), they used standard radiocarbon

[7] http://www.co2science.org/articles/V8/N23/C1.php.
[8] http://www.co2science.org/articles/V8/N23/C2.php.

dating together with TIMS U-series dating to determine the times of occurrence of storms that were strong enough to actually "relocate" large *Porites* coral blocks that are widespread on the reef flats there. This program revealed that "during the past 1000 years, at least six exceptionally strong storms occurred," which they dated to approximately AD 1064 ± 30, 1218 ± 5, 1336 ± 9, 1443 ± 9, 1682 ± 7 and 1872 ± 15, yielding an average recurrence time of 160 years. Interestingly, *none* of these six severe storms occurred during the past millennium's last century, which climate alarmists claim was the warmest such period of that thousand-year interval.

Noting that Emanuel (2005) and Webster *et al*. (2005) had claimed that "tropical cyclone intensity has increased markedly in recent decades," and saying that because they specifically argued that "tropical cyclone activity over the western North Pacific has been changed in response to the ongoing global warming," Ren *et al*. (2006)[9] decided to see if any increases in tropical cyclone activity had occurred over China between 1957 and 2004. This they did by analyzing tropical cyclone (TC) precipitation (P) data from 677 Chinese weather stations for the period 1957 to 2004, searching for evidence of long-term changes in TCP and TC-induced torrential precipitation events. Interestingly, this search indicated, in their words, that "significant downward trends are found in the TCP volume, the annual frequency of torrential TCP events, and the contribution of TCP to the annual precipitation over the past 48 years." Also, they say that the downward trends were accompanied by "decreases in the numbers of TCs and typhoons that affected China during the period 1957-2004." In a conclusion that consequently differs dramatically from the claims of Emanuel (2005) and Webster *et al*. (2005) relative to inferred increases in tropical cyclone activity over the western North Pacific in recent decades, Ren *et al*. say their findings "strongly suggest that China has experienced decreasing TC influence over the past 48 years, especially in terms of the TCP."

Contemporaneously, Wu *et al*. (2006)[10] ran two independent checks on Webster *et al*.'s findings by performing analyses of best track data from the Regional Specialized Meteorological Centre (RSMC) Tokyo (Japan) and from the Hong Kong Observatory (HKO; Hong Kong, China); and this work revealed, as they describe it, that "in contrast to Webster *et al*.'s findings, there was no increase in western North Pacific category 4-5 typhoon activity," and that "neither RSMC-Tokyo nor HKO best track data suggest an increase in western North Pacific tropical cyclone destructiveness as measured by the potential destructive index (PDI)," in contrast to the findings of Emanuel (2005). In fact, they say that (1) the RSMC-Tokyo data "show a decrease in the proportion of category 4-5 typhoons from 18% to 8% between the two periods 1977-1989 and 1990-2004," that (2) "the result is the same if the analysis is extended to include 2005," and that (3) the trend is "statistically significant at the 5% level." In addition, they report that (4) "HKO best track data show a decrease in the proportion of category 4-5 typhoons, from 32% to 16%, between 1975-1989 and 1990-2004," that (5) this result too is "statistically significant at the 5% level," and that (6) it also "remains unchanged if the end year is extended to 2005."

Nott *et al*. (2007)[11] developed a 777-year-long annually-resolved record of landfalling tropical cyclones in northeast Australia based on analyses of isotope records of tropical cyclone rainfall

[9] http://www.co2science.org/articles/V10/N6/C1.php.
[10] http://www.co2science.org/articles/V11/N47/C3.php.
[11] http://www.co2science.org/articles/V10/N29/C1.php.

in an annually-layered carbonate stalagmite from Chillagoe (17.2°S, 144.6°E) in northeast Queensland. Perhaps their most important discovery in doing so was their finding that "the period between AD 1600 to 1800" - when the Little Ice Age held sway throughout the world - "had many more intense or hazardous cyclones impacting the site than the post AD 1800 period," when the planet gradually began to warm at a rate that rose to ultimately become what climate alarmists have characterized as *unprecedented over the past millennium or more*, and when temperatures rose to a level they claim was equally unprecedented. In harmony with the four researchers' feeling that "the only way to determine the likely future behavior of tropical cyclones is to first understand their history from high resolution records of multi-century length or greater," which is only common sense, it would thus appear that claims such as those of Emanuel (2005) and Webster *et al*. (2005) are lacking in real-world support from this region, as well as many areas throughout the Pacific Ocean.

Li *et al*. (2007)[12] analyzed real-world tropical cyclone data pertaining to the western North Pacific basin archived in the *Yearbook of Typhoon* published by the China Meteorological Administration for the period 1949-2003, together with contemporaneous atmospheric information obtained from the National Center for Environmental Protection reanalysis dataset for the period 1951-2003. Following this endeavor, they used their empirical findings to infer future tropical cyclone activity in the region based upon climate-model simulations of the state of the general circulation of the atmosphere over the next half-century. This protocol revealed, first of all, that there were "more tropical cyclones generated over the western North Pacific from the early 1950s to the early 1970s in the 20th century and less tropical cyclones from the mid-1970s to the present." They further found that "the decadal changes of tropical cyclone activities are closely related to the decadal changes of atmospheric general circulation in the troposphere, which provide favorable or unfavorable conditions for the formation of tropical cyclones." Based on simulations of future occurrences of these favorable and unfavorable conditions derived from "a coupled climate model under the [A2 and B2] schemes of the Intergovernmental Panel on Climate Change special report on emission scenarios," they then determined that "the general circulation of the atmosphere would become unfavorable for the formation of tropical cyclones as a whole and the frequency of tropical cyclone formation would likely decrease by 5% within the next half century, although more tropical cyclones would appear during a short period of it."

In a contemporary paper, Chan (2007)[13] searched for "possible physical causes responsible for the interannual variations of the activity of intense typhoons in the WNP [Western North Pacific] (here defined as the region 0-40°N, 120-180°E)." And in doing so, the City University of Hong Kong researcher reports that "in years with a high frequency of occurrence of intense typhoons, both the dynamic (relative vorticity in both the lower and upper troposphere as well as the vertical wind shear) and thermodynamic (as represented by the moist static energy in the low to mid troposphere) conditions in the atmosphere, especially in the eastern part of the WNP, are favorable for the formation of TCs [tropical cyclones]," and that "once formed, these TCs tend to have longer lifetimes over the ocean, and therefore have a high chance to become more intense." In addition, he notes that the factors responsible for increasing the number of

[12] http://www.co2science.org/articles/V10/N42/C1.php.
[13] http://www.co2science.org/articles/V10/N52/C1.php.

strong TCs are "also significantly correlated with the Niño3.4 SST anomalies." Consequently, as Chan describes it, "the frequency of occurrence of intense typhoons in this region is not likely determined by the average SST over the region," which is what would be expected to increase in response to greenhouse gas-induced global warming. And, therefore, Chan's primary finding - that "interannual variations of intense typhoons in the WNP are likely caused to a large extent by changes in the planetary-scale atmospheric circulation and thermodynamic structure associated with the El Niño phenomenon" - provides no support for the contentions of either Emanuel (2005) or Webster *et al*. (2005). In fact, it tends to argue *against* them.

Also publishing (again) in the same year, Nott (2007)[14] writes that "in tropical Australia, palaeo-tropical cyclone records occur in the form of low-resolution millennial-scale sedimentary ridges and high-resolution centennial-scale stalagmite records of isotopically depleted tropical cyclone rainfall," and he goes on to describe the various records to which he refers, recounting their findings and discussing their relevance to risk assessment and their role in "decoupling human induced changes in cyclone behavior from natural variability." In doing so, he states that the *clear message* of the several papers he reviews is that "the historical/instrumental record substantially underestimates the frequency of the most extreme tropical cyclone events," citing the findings of Chappell *et al*. (1983), Chivas *et al*. (1986), Hayne and Chappell (2001), Nott and Hayne (2001) and Nott *et al*. (2007). More specifically, he notes that "tropical cyclone activity in north-east Queensland has been in a phase of quiescence since before European settlement of the region," and that "the period between AD 1600 and 1800 [during the Little Ice Age] had many more intense or hazardous cyclones impacting the site than the post AD 1800 period." In addition, he notes that the *first* 200 years of the tropical cyclone record - from AD 1200 to 1400, which represents the latter part of the Medieval Warm Period (MWP) - had the *fewest* intense cyclones of all. As per the criterion he used to define them, in fact, this period of significant global warmth had *none*, as did the latter decades of the 20th century, which according to climate alarmists were the warmest of the past one to two millennia. In fact, the entire 20th century had but *one* such intense cyclone (and that was in its early stages in 1911), while there were as many as *seven* intense tropical cyclones during the global chill that prevailed between AD 1600 and 1800.

The entire 20th century had but one such intense cyclone (and that was in its early stages in 1911), while there were as many as seven intense tropical cyclones during the global chill that prevailed between AD 1600 and 1800.

[14] http://www.co2science.org/articles/V11/N38/C1.php.

One year later, Chan (2008)[15] further investigated possible causes of the multi-decadal variability in intense TC [category 4 and 5] occurrence in the WNP, choosing this basin because it generally has the largest number of TCs each year. And based on data for the period 1960-2005, he determined that decadal variations in intense typhoon activity largely resulted from a combination of the behavior of the El Niño-Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO). This finding led him to suggest that "the view that global warming would lead to more intense TCs owing to the enhancement of thermodynamic factors ignores the fact that for TCs to intensify significantly, the dynamic factors must 'cooperate'," and he notes that the latter has not been demonstrated to occur basin wide. Therefore, as he continues, "the more likely conclusion is that the major low-frequency variations in the frequency of intense TC occurrence is probably a multi-decadal one in response to similar variations in the factors that govern the formation, intensification and movement of TCs," and that "such variations largely result from modifications of the atmospheric and oceanographic conditions in response to ENSO and PDO." Consequently, "at least for the WNP," in the words of Chan, "it is not possible to conclude that the variations in intense typhoon activity are attributable to the effect of global warming."

Defining *rapid intensification* (RI) of a tropical cyclone as occurring when the maximum wind speed of a TC "reaches at least (a) 5 knots in the first 6 hours, (b) 10 knots in the first 12 hours, and (c) 30 knots in 24 hours," Wang and Zhou (2008)[16] state that "all category 4 and 5 hurricanes in the Atlantic basin and 90% of the equivalent-strength typhoons in the western North Pacific experience at least one RI process in their life cycles." Therefore, using best-track TC data obtained from the Joint Typhoon Warning Center for the 40-year period 1965-2004, Wang and Zhou determined the climatic conditions that are most critical for the development of RI in TCs of the Western North Pacific on annual, intra-seasonal, and inter-annual time scales. This work revealed, in their words, that "over the past 40 years, the annual total of RI in the western North Pacific shows pronounced interdecadal variation but no significant trend," and they note that this fact "implies that the super typhoons had likely no upward trend in the last 40 years." In addition, they found that "when the mean latitude, where the tropical storms form, shifted southward (either seasonally or from year to year), the proportion of super typhoons or major hurricanes will increase," noting that "this finding contrasts the current notion that higher sea surface temperature leads to more frequent occurrence of category 4 or 5 hurricanes."

In a contemporary study, Englehart *et al*. (2008)[17] developed what they call a "first cut" data set pertaining to the area immediately adjacent to Mexico's Pacific coast. Although noting that only 54% of the total number of Eastern Pacific storms reached TC status within this near-shore area over the period 1967-2005, they indicate that "near-shore storm activity is fairly well correlated with total basin TC activity, a result which suggests that over the longer period (i.e., 1921-onward), changes in near-shore activity can provide some sense of the broader basin activity." And their study of this region and time period revealed the existence of significant decadal variability in annual eastern Pacific near-shore TC frequency of occurrence. In addition, they

[15] http://www.co2science.org/articles/V11/N15/C2.php.
[16] http://www.co2science.org/articles/V11/N22/C1.php.
[17] http://www.co2science.org/articles/V11/N28/C2.php.

found that "long-term TC frequency exhibits a significant (p = 0.05) negative trend," which - as best can be determined from their graph of the data - declines by about 23% over the 85-year period 1921-2005. And this result was driven *solely* by an approximate 30% drop in TC frequency during the *late* (August-November) TC season, with essentially *no* long-term trend in the *early* (May-July) TC season. In addition, they present a graph of the maximum wind speed associated with each TC, from which one can calculate an approximate 20% decline in this intensity-related parameter over the period of their study. Therefore, their work provides *absolutely no support* for the climate-alarmist claim that global warming increases both the frequency and intensity of TCs and/or hurricanes. In fact, the data from this part of the world seem to suggest just the *opposite*.

About the same time, Hassim and Walsh (2008)[18] analyzed TC best track data pertaining to severe storms of the Australian region (5-30°S) forming off Western Australia and the Northern Territory (the western sector: 90-135°E, Indian Ocean) and off Queensland and the Gulf of Carpentaria (the eastern sector: 135-160°E, Pacific Ocean) for the presence of systematic intensity and duration trends over the cyclone season periods running from 1969/1970 through 2004/2005. And in the words of the two Australian researchers, "substantial differences in trends are found between the two sub-regions, with the number, average maximum intensity, and duration at the severe category intensities of tropical cyclones increasing since 1980 in the west but decreasing (in number) or exhibiting no trend (in intensity, severe category duration) in the east." Hence, there is as yet no compelling support from the Australian region for the oft-stated climate-alarmist contention that global warming leads to more frequent and intense tropical cyclones.

Also studying Western North Pacific (WNP) TCs during this time period were Lu *et al*. (2008)[19], who noted that the WNP "is an area where typhoon activity is the most frequent and strongest" and that "China is one of the countries that seriously suffered from typhoons in this area." And, therefore, using the latest TC data - "those in the yearbooks of TC of the WNP from 1960 to 2005" - they analyzed the interdecadal variation of WNP TCs and the large-scale circulation factors affecting them. This analysis revealed, in their words, that "the time period from 1960 to 2005 has two high frequency periods (HFPs) and two low frequency periods (LFPs)," with the overall trend being downward.

One year later, noting that "the variability of TC activity (including the frequency of occurrence and intensity) has become a great concern because it may be affected by global warming," Kubota and Chan (2009)[20] created a unique dataset of TLP (*tropical* cyclone *landfall* numbers in the *Philippines*) based on historical observations of TC tracks during the period 1901-1940 that were obtained from Monthly Bulletins of the Philippine Weather Bureau and combined with TLP data obtained from the Joint Typhoon Warning Center for the period 1945-2005, which they then used to investigate the TC-global warming hypothesis. In doing so, the two Asian researchers found that "the TLP has an apparent oscillation of about 32 years before 1939 and an oscillation of about 10-22 years after 1945," but they report that "no long-term trend is found." In addition, they determined that "natural variability related to ENSO [El Niño-Southern

[18] http://www.co2science.org/articles/V11/N44/C2.php.
[19] http://www.co2science.org/articles/V12/N20/C1.php.
[20] http://www.co2science.org/articles/V12/N39/C2.php.

Oscillation] and PDO [Pacific Decadal Oscillation] phases appears to prevail in the interdecadal variability of TLP," and their results show that all variability was merely oscillatory activity around a mean trend of zero slope.

During this same time period, and also studying the Western North Pacific, Ma and Chen (2009)[21] used NCEP/NCAR reanalysis data to determine the SST distribution over this region and to evaluate its temporal variability, utilizing TC frequency data obtained from the Joint Typhoon Warning Center, the *Tropical Cyclone Year Book* of the China Meteorological Administration, and the Tokyo-Typhoon Center of the Japanese Meteorological Agency to characterize TC frequency over the period 1949-2007. This work revealed, as they describe it, that "SSTs over the WNP have been gradually increasing during the past 60 years ... with a maximum increment of 1°C around the central equatorial Pacific for the last 10 years," and they say that "the warm pool, which is defined to be enclosed by a critical temperature of 28°C, has expanded eastward and northward in recent years," noting further that "there has been remarkable warming in the last decade, more than 0.8°C in some local areas." *Nevertheless*, and in spite of this "remarkable warming," the two researchers determined that "the frequency of TC against the background of global warming has decreased with time."

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In another study from the same year, Chan and Xu (2009)[22] used TC data obtained from the Joint Typhoon Warning Center for the period 1945-2004 and the Annual Tropical Cyclone Data Book (edited by the Shanghai Typhoon Institute) for the period 1951-2000 to conduct a comprehensive study of variations in the annual number of landfalling TCs in three sub-regions of East Asia: South (south China, Vietnam and the Philippines), Middle (east China), and North (Korean Peninsula and Japan), with the result that "wavelet analyses of each time series show that the landfalling frequencies go through large inter-annual (2-8 years), inter-decadal (8-16 years) and even multi-decadal (16-32 years) variations, with the inter-annual being the most dominant, and the multi-decadal explaining most of the rest of the variance." And in what they call "an important finding," they state that "none of the time series shows a significant linear temporal trend, which suggests that global warming has not led to more landfalls in any of the regions in Asia."

[21] http://www.co2science.org/articles/V12/N41/C1.php.
[22] http://www.co2science.org/articles/V12/N43/C2.php.

Moving ahead one year, Song *et al*. (2010)[23] write as background for their study that "in recent years, there has been increasing interest in whether global warming is enhancing tropical cyclone (TC) activity," as has been claimed by Emanuel (2005) and Webster *et al*. (2005). One of the main sources of contention over this matter has been the fact that Wu *et al*. (2006) and Yeung (2006) examined the best track data from the Regional Specialized Meteorological Center (RSMC), Tokyo, Japan, as well as that of the Hong Kong Observatory of China (HKO); and "in contrast to Webster *et al*. (2005)," as Song *et al*. describe it, they found "there was no increase in category 4-5 typhoon activity in the western North Pacific basin." In addition, they report that "neither RSMC nor HKO best track data suggest an increase in TC destructiveness." And they further state that "other studies also examined the differences in TC data sets from the Joint Typhoon Warning Center (JTWC) of the U.S. Naval Pacific Meteorology Oceanography Center in Hawaii, the RSMC, and the Shanghai Typhoon Institute (STI) of [the] China Meteorological Administration in Shanghai (Lei, 2001; Kamahori *et al*., 2006; Ott, 2006; Yu *et al*., 2007)," and they indicate that "so far, the reported trends in TC activity in the WNP basin have been detected mainly in the JTWC best track data set," which was the one employed by Emanuel (2005) and Webster *et al*. (2005) in drawing their anomalous conclusions. And, therefore, to help resolve the anomalies exhibited by the JTWC typhoon database, Song *et al*. analyzed differences in track, intensity, frequency and the associated long-term trends of those TCs that were *simultaneously recorded* and *included within* the best track data sets of the JTWC, the RSMC and the STI from 1945 to 2007.

When all was said and done, Song *et al*. determined that "though the differences in TC tracks among these data sets are negligibly small, the JTWC data set tends to classify TCs of category 2-3 as category 4-5, leading to an upward trend in the annual frequency of category 4-5 TCs and the annual accumulated power dissipation index, as reported by Webster *et al*. (2005) and Emanuel (2005)." And they add that "this trend and potential destructiveness over the period 1977-2007 are found only with the JTWC data set," while noting that actual *downward* trends "are apparent in the RSMC and STI data sets." And so it is that what climate alarmists long hailed as *proof positive* of their claim that global warming leads to more intense tropical cyclones/hurricanes actually provides no such evidence at all.

Also studying the identical subject ten years into the 21st century, Fengjin and Ziniu (2010)[24] used data on the time and site of TC generation and landfall, TC tracks and the intensity and duration of TCs in the WNP and China for the period 1951-2008 - which they obtained from the China Meteorological Administration - to analyze the characteristics of TCs making landfall in China over that period. This work revealed "a decreasing trend in the generation of TCs in the WNP since the 1980s," and they say that the number of TCs making landfall during this period "has remained constant or shown only a slight decreasing trend." Likewise, they also report that "the number of casualties caused by TCs in China appears to show a slight decreasing trend," as would be expected under these circumstances.

Concurrently, Terry and Gienko (2010)[25] analyzed various cyclone characteristics based on four decades of cyclone season data (1969-70 to 2007-08) contained in the regional cyclone archive

[23] http://www.co2science.org/articles/V13/N46/C2.php.
[24] http://www.co2science.org/articles/V13/N51/C2.php.
[25] http://www.co2science.org/articles/V14/N8/C1.php.

of the tropical South Pacific (160°E-120°W, 0°-25°S) that is maintained by the Regional Specialized Meteorological Centre (RSMC) located at Nadi in the Fiji Islands. And in doing so, they say that "no linear trends were revealed in cyclogenesis origins, cyclone duration, track length or track azimuth over the four decades of records," but they report that "anomalous activity for one or more cyclone parameters occurred in 1976, 1981, 1983, 1991, 1998, 2001-2002 and 2003," leading them to conclude that "there is as yet no evidence for climate-change forcing of these storm characteristics over recent historical times."

In further exploring this issue, Sun *et al*. (2011)[26] analyzed data pertaining to TCs over the northwestern Pacific and the South China Sea, which they obtained from China's Shanghai Typhoon Institute and the National Climate Center of the China Meteorological Administration, pertaining to the period 1951 to 2005; and in doing so, they determined that the frequency of all TCs impacting China "tended to decrease from 1951 to 2005, with the lowest frequency [occurring] in the past ten years." In addition, they say that the average yearly number of super typhoons was "three in the 1950s and 1960s" but "less than one in the past ten years." Similarly, they write that "the decrease in the frequency of super typhoons, at a rate of 0.4 every ten years, is particularly significant (surpassing the significance test at the 0.01 level)," and they additionally report that "there is a decreasing trend with the extreme intensity of these TCs during the period of influence in the past 55 years."

Callaghan and Power (2011)[27], as they describe it, developed and used "a new data base of severe land-falling TCs for eastern Australia derived from numerous historical sources, that has taken over a decade to develop." This data base, as they continue, includes: "peer-reviewed publications; Bureau of Meteorology publications, including comprehensive case histories for a large number of TCs - including all TCs since the mid-1950s, *Monthly Climatological Bulletins* and *Monthly Weather Reviews*, unpublished TC season reports, bounded operational analysis charts back to the 1890s stored in the National Archives, unpublished internal Bureau documents; publications by state and local governments; archives of several Queensland newspapers; newspaper clippings held by the Bureau of Meteorology; books describing land-falling TCs; information held by the Cairns and Townsville Historical Societies; a report to the QLD parliament (1918); and extensive unpublished information from the public including numerous damage photographs," as well as "reports on storm surge, wave action and shipwreck data from an extensive Australian shipwreck data base."

Based on this *wealth* of information, the two researchers with Australia's Bureau of Meteorology first note that their new data base allows them "to document changes over much longer periods than has been done previously for the Southern Hemisphere," and among the host of results they describe, two of them stand out with respect to their significance to the global warming debate. First, they report that "the sign and magnitude of trends calculated over 30 years periods vary substantially," highlighting the fact that "caution needs to be taken in making inferences based on *e.g.* satellite era data only." And second, they report that "the linear trend in the number of severe TCs making land-fall over eastern Australia declined from about 0.45 TC/year in the early 1870s to about 0.17 TC/year in recent times - a 62% decline."

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[26] http://www.co2science.org/articles/V14/N33/C2.php.
[27] http://www.co2science.org/articles/V14/N42/C2.php.

And they add that "this decline can be partially explained by a weakening of the Walker Circulation, and a natural shift towards a more El Niño-dominated era." Thus, they conclude the abstract of their paper with the remark that "the extent to which global warming might also be partially responsible for the decline in land-falls - if it is at all - is unknown," which highlights the irony of the suggestion that global warming might possibly be doing just the *opposite* of what climate alarmists typically claim it should do.

Noting that the Intergovernmental Panel on Climate Change (IPCC, 2001, 2007) has twice suggested that "precipitation and extreme winds associated with tropical cyclones may have become more intense," Ying *et al.* (2011)[28] remind us that this dual claim is "mainly based on numerical models," and they have had the good sense to demand something more substantial, such as *real-world observations*, before accepting such contentions. And, therefore, working with tropical cyclone best track and related observational severe wind and precipitation datasets created by the Shanghai Typhoon Institute of the China Meteorological Administration, the four researchers determined trends in various TC characteristics over the period 1955 to 2006 for the whole of China and four sub-regions: *South China* (SC) comprising Guangdong, Guangxi and Hainan Provinces, *East China* (EC) comprising Fujian, Hiangxi, Zhejiang, Anhui, Jiangsu and Shandong Provinces plus Shangahi, *Northeast China* (NEC) comprising Liaoning, Jilin and Heilongjiang Provinces, and *China's inland area* (CI) including all remaining provinces.

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[28] http://www.co2science.org/articles/V14/N44/C1.php.

This work revealed, as they continue, that over the past half-century there have been *no changes* in the frequency of TC occurrence, except within NEC, where they determined that "years with a high frequency of TC influence have significantly become less common." Second, they say that "during the past 50 years, there have been no significant trends in the days of TC influence on China," and they add that "the seasonal rhythm of the TC influence on China also has not changed." Third, they found that "the maximum sustained winds of TCs affecting the whole of China and all sub-regions have decreasing trends." And, fourth, they state that "the trends of extreme storm precipitation and 1-hour precipitation were all insignificant." Thus, for the whole of China and essentially all of its component parts, major measures of TC impact have either *remained constant* or *slightly decreased*, which is a much different consequence from what the IPCC has been predicting for the world as a whole over the past decade or more.

Working and publishing concurrently, Xiao *et al*. (2011)[29] "developed a Tropical Cyclone Potential Impact Index (TCPI) based on the air mass trajectories, disaster information, intensity, duration and frequency of tropical cyclones," using observational data obtained from the China Meteorological Administration's *Yearbook of Tropical (Typhoon) Cyclones in China* for the years 1951-2009, plus the *Annual Climate Impact Assessment* and the *Yearbook of Meteorological Disasters* in China, also compiled by the China Meteorological Administration, but for the years 2005-2009. And as for what they learned from this endeavor, the five researchers report that "China's TCPI appears to be a weak decreasing trend over the period [1949-2009], which is not significant overall, but significant in some periods." Once again, therefore, and in a huge *regional* contradiction of the claims of the IPCC (2001, 2007), the work of Xiao *et al*. (2011), like that of Ying *et al*. (2011), indicates that tropical cyclones impacting China have *not* been increasing in either frequency or ferocity over the past half-century or more.

In another contemporary study, Ren *et al*. (2011)[30] write that "the homogeneity of historical observations is important in the study of tropical cyclones and climate change," with "a large hurdle for climate change detection" being "the quality of TC historical databases" that they say "were populated over time without a focus on maintaining data homogeneity," which is obviously "a key requirement for databases that are used to assess possible climate-related trends." Therefore, in an effort to overcome this *hurdle*, which they describe as "a 'bottleneck' in tropical cyclone and climate change studies," Ren *et al*. took it upon themselves to carefully analyze three historical datasets for Western North Pacific TCs - those of the Joint Typhoon Warning Center (JTWC), the Japan Meteorological Agency (JMA) and the China Meteorological Administration (CMA) - focusing primarily on TC *intensity* and covering the 55-year period 1951-2005.

After all their work was completed, the five researchers concluded that "it is still difficult to judge which one [of the three datasets] is best." However, they indicate that *frequencies* of the common TCs in all three datasets "show no obvious increasing or decreasing trend over the past 50 years." Instead, they find a weak inter-decadal variation with "more TCs from the mid-1960s to the mid-1970s and in the early 1990s." On the other hand, they state that the *intensities* of the common TCs "differed largely from one dataset to another, leading to quite

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[29] http://www.co2science.org/articles/V14/N45/C1.php.
[30] http://www.co2science.org/articles/V15/N11/C2.php.

opposite conclusions for TCs of category 4 and 5." In regard to this latter subject, for example, they say that "for the period after 1970, the JTWC dataset shows an increasing trend that complies with those of Webster *et al*. (2005) and Emanuel (2005)," but they say that "for a longer time scale, the result may be well consistent with that of Chan (2006)," which suggests that "the so-called 'trend' is a fragment of the longer inter-decadal variation."

In one final study of the subject, Zhang *et al*. (2011)[31] analyzed both the frequency and intensity of TCs that made landfall on the Pacific coast of South China's Guangdong Province between 1965 and 2007. Employing data extracted from the database collected by the Shanghai Typhoon Institute of the China Meteorological Administration, together with pertinent *sea surface temperature* (SST) data for the entire Pacific Ocean that they obtained from the UK Met Office's Hadley Centre, the four Chinese researchers studied the changing properties of the frequency and intensity of the *TCs making landfall at the Guangdone Province* (TMLGP) as functions of time and temperature.

This work, as they describe it, indicated that the frequency of TMLGP after 1996 had "a nearly opposite trend compared to the period preceding 1996," and as a result, they determined that "the frequency of TMLGP for the period 1965-2007 as a whole is in an insignificant relation with SST in these two periods." They also found that various SST measures "only have a weak influence on TMLGP intensities." And by these means they explain the observational *fact* that "despite the long-term warming trend in SST in the Western North Pacific, no long-term trend is observed in either the frequency or intensities of TMLGP."

In concluding this summary, and in light of the several sets of *hard evidence* from the *real world* of *nature* that comprise it, as opposed to the *theoretical constructs* from the *virtual world* of *climate models*, it is readily evident that the climatic implications of the two different worlds are truly *worlds apart from each other*.

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[31] http://www.co2science.org/articles/V16/N11/C2.php.

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