Can We Blame Typhoon Morakot on Global Warming?

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There are abundant efforts to link global warming (GW) with increased frequencies and intensities of extreme weather events, building on the fact that a warmer atmosphere will contain more water vapor and latent heat as increased energy source for disturbed weather. The most promising result to demonstrate a link seemed to have been on tropical cyclones (TC). In the middle 2000s several theories on the thermodynamic potential of TC genesis were used to corroborate analyses of Atlantic and western Pacific TC data that show a link. However, recent observational and modeling studies have shown that these thermodynamic theories, while extremely valuable in evaluating long-term TC potential, were simplistic in some instances, particularly on ENSO scale, because they did not include dynamical processes. Meanwhile, it was realized that some observations that overwhelmingly supported the GW-TC link were based on incomplete or questionable data or interpretations. After accounting for the discrepancies the evidence of a link beyond natural variability is no longer discernible. On the other hand, current GW model projections suggest a modest increase of strong TCs and associated rainfall and a decrease of weaker TCs towards the end of the 21st century. These projections, however, are subject to the uncertainties and deficiencies of the current climate models.

This talk will first review some recent literatures including the ENSO-TC relationships and the report from the WMO expert team that addressed the GW-TC issue. While the report represents a consensus of different views represented by the team, there are also follow-on debates on how much confidence one can place on the part of the report based on climate model projections. This will be followed by examining the heavy rainfall produced by Typhoon Morakot, which produced record-breaking rainfall in southern Taiwan in August 2009. The resultant disastrous flood made Typhoon Morakot a central theme in various media for promoting awareness of the grave consequences of GW in Taiwan, despite of the caution from IPCC that no single event should be constructed as scientific evidence of the effect of GW.

We will show that Typhoon Morakot's heavy rainfall pattern is typical of most typhoons that interact with monsoon and terrain in Taiwan, and that the rainfall intensity for the system is within the range of rainfall associated with the 55 typhoons invading Taiwan in the past 33 years, during which a reasonably consistent 25-station conventional rainfall network was available. The record breaking rainfall in southern Taiwan is offset by the below-normal rainfall elsewhere and is due to the steep western slope of the Central Mountain Range in southern Taiwan. Consideration of both Typhoon Morakot and Typhoon Nari (2001), which produced even more total accumulated rainfall during the period the center was over land (because of its unusually long duration due to a track that transverses the island lengthwise), shows that heavy rainfall in both cases depends mainly on dynamical processes – the speed of typhoon movement that dictates the duration of rainfall over Taiwan. This is entirely different from GW propositions theorizing that a small increase in atmospheric water vapor capacity over the past century's warming can lead to a significant positive feedback to intensify the storm. Since Typhoon Morakot never exceeded category-2 intensity and it occurred during a season of very few storms with the cause of the low count attributable to El Nino, many of the issues concerning the relationships between GW and TC intensity or frequency are unlikely to be relevant.

These conclusions are consistent with the recently released report of the National Science Council Expert Team on Typhoon Morakot. In the report, the trapping of the storm in a broad summer monsoon trough due to the juxtaposition of two different types of intraseasonal oscillations, the continuous feeding of water vapor from the southwest monsoon winds over the warm South China Sea, and the steep terrain on the windward side in southern Taiwan, were highlighted as the reasons for the slow movement, continuous moisture supply, and heavy rainfall of Typhoon Morakot. None of these factors are directly associated with known GW theories. These results, supplemented by the system rainfall intensity analysis reported here, explain the heavy rainfall adequately and directly. At the same time, no currently valid GW theories can explain the heavy rainfall of Typhoon Morakot.