Global Tropical Cyclone Damage Potential

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1 Introduction

Project Goal: Formulate climate information in decision relevant terms to promote integration of developing climate science with decision-making.

The example of Tropical Cyclone (TC) impacts is presented, for which TC damage potential is assessed using a combination of physical reasoning and empirical assessment.

Objective: Incorporate the key damaging TC parameters of intensity, size, and translational speed into a single index of Cyclone Damage Potential (CDP) that represents offshore wind, wave and current damage and onshore wind and coastal surge damage.

Data:
Extended Best Track Dataset and Joint Typhoon Warning Center (JTWC) archive.

The Willis Energy Loss Database; offshore and onshore physical property damage, and operator costs.

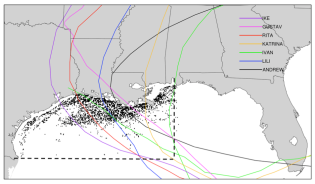

Fig. 1. Platform locations in the Gulf of Mexico as of 02/03/15 and tracks of seven hurricanes for which offshore loss data are available.

2 The Cyclone Damage Potential Index

$$CDP = 4\frac{\left(\left(\frac{v_m}{65}\right)^3 + 5\left(\frac{R_h}{50}\right)\right)}{v_t}$$

for $v_m > 65$, and if $v_t < 5$, set $v_t = 5$. The coefficient of 4 is introduced to scale the CDP across the approximate range of 0-10

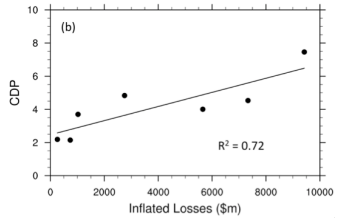

Fig. 2. Scatter plot of mean CDP against WELD offshore energy industry losses.

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3 Uses of CDP

Seasonal Basin Summaries: Seasonal and basin summaries provide insight into the spatial variability of damage potential for the major cyclone basins. All basins have been able to generate maximum CDP values of 10 (right side), with the Northwest Pacific containing the widest area and most frequent occurrences of maximum damage potential cyclones.

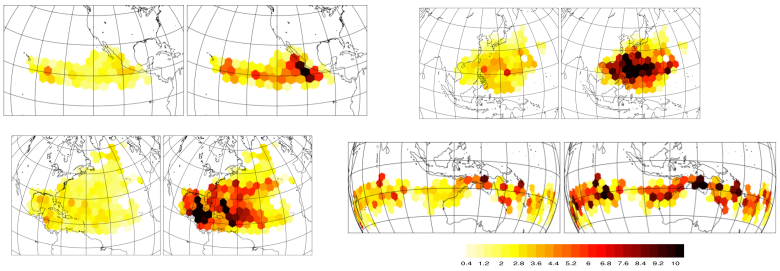

Fig. 3. (left) Median and (right) maximum seasonal CDP for the Eastern North Pacific (2001-2013), the Western North Pacific (2004-2013), the North Atlantic (1988-2013), and Southern Hemisphere (2004-2013).

A time series from 1988-2012 of seasonal (August to October) accumulated CDP for the North Atlantic indicates no real trend for the entire basin but a small increase for land falling storms. The El Niño Southern Oscillation (ENSO) appears to modulate seasonal, basin-wide Atlantic CDP, with a correlation that is statistically significant ($p < 0.04$), but not the land falling storms.

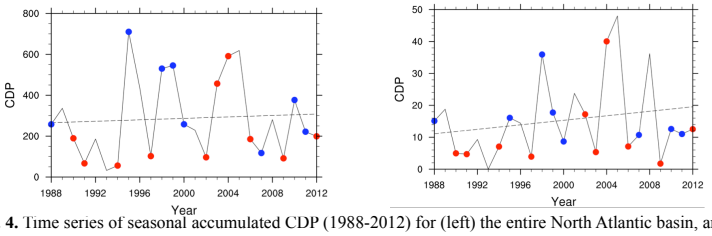

Fig. 4. Time series of seasonal accumulated CDP (1988-2012) for (left) the entire North Atlantic basin, and (right) land falling storms at the 6-hourly track points prior to landfall. Years with Oceanic Niño Index (ONI, 3 month running mean SST anomalies in the Niño 3.4 region 5°N-5°S, 120°-170°W) for August-September-October >0.5K (El Niño) are indicated in red, and ONI <0.5K (La Niña) are indicated in blue .

Real-time CDP forecasting: an ensemble real-time forecast of hurricane Wilma (2005) generated by the Advanced Research Weather Research and Forecasting model (Davis et al 2008).

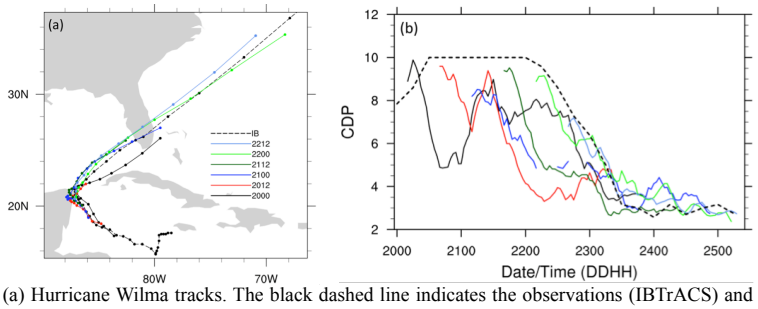

Fig. 6. (a) Hurricane Wilma tracks. The black dashed line indicates the observations (IBTrACS) and the colored lines indicate real-time forecasts initialized every 12 hours from 00Z Oct 20 to 12Z Oct 22, 2005. Filled circles indicate 6-hourly track locations. (b) Observed and forecast time series of CDP.

CDP offers an alternative presentation of the forecast information.

4 Summary

A new Cyclone Damage Potential (CDP) index has been developed that represents offshore damage and onshore wind and coastal surge damage.

The key damaging TC parameters of intensity, size, and translation speed have been combined into the CDP to provide a first order assessment of damage potential.

The approach developed here for cyclone damage potential is transferable to developing damage potential indices for other high-impact weather and climate phenomena. Such indices have broad societal applications.