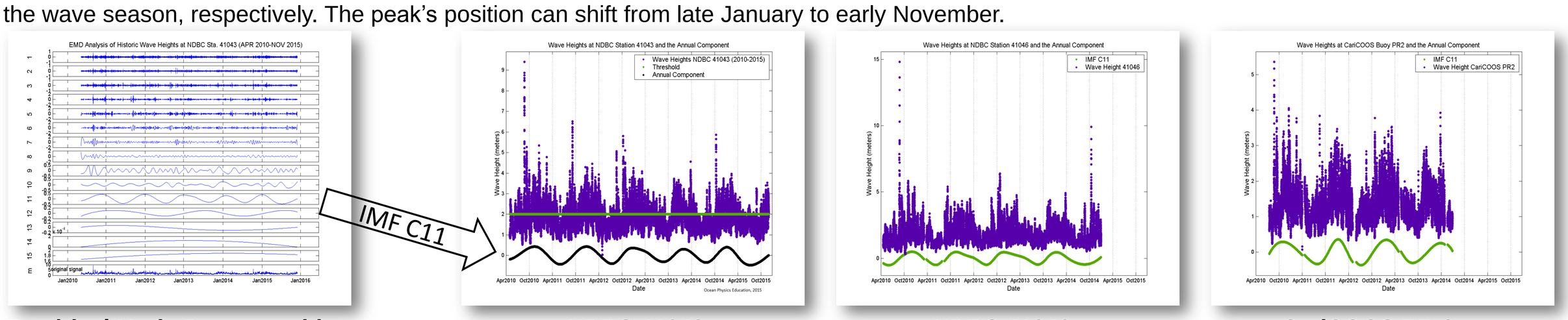
Changes in the Duration and Peak of the Wave Season on Puerto Rico

Edwin Alfonso-Sosa
Ocean Physics Education Inc.
http://oceanphysics.weebly.com/

INTRODUCTION

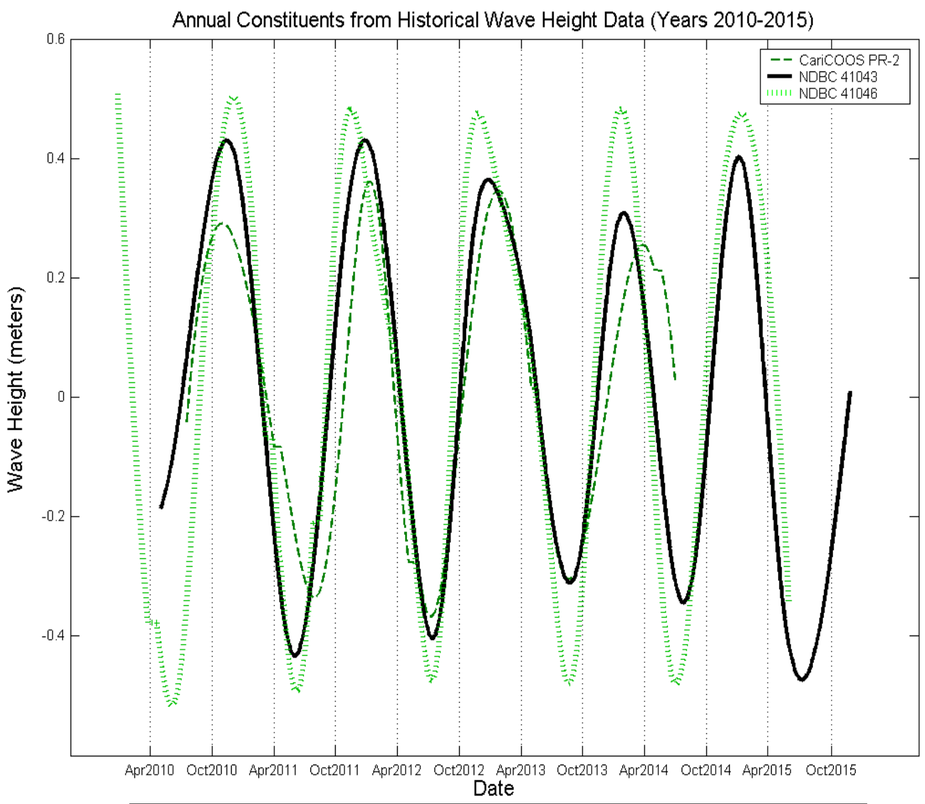
Empirical Mode Decomposition (EMD) analysis was performed on wave height data recorded between years 2010-2015 by NDBC and **CariCOOS** wave buoys located north of Puerto Rico. The analysis revealed that the eleventh intrinsic mode function (IMF), named C11, shows an annual time scale; this physical signal corresponds to the wave season on Puerto Rico. The peak and period between zero-crossings in C11 corresponds to the peak and duration of the wave season, respectively. The peak's position can shift from late January to early November.



Empirical Mode Decomposition | **NDBC 41043** | **NDBC 41046** | **CariCOOS PR-2**

UNDERSTANDING THE VARIABILITY OF THE WAVE SEASON ON PUERTO RICO

IMF C11 represents the gradual increase (or decrease) of wave heights in the Atlantic Ocean and does not include any big wave events. The shift of C11's peak and changes in the time span between zero-crossings revealed the annual variability of Puerto Rico's wave seasons. Some wave seasons showed peaks in wave height up to 2 months before January 1st and other 30 days after that date. The time span between zero crossings in C11 revealed that the duration of the wave season runs between 5 to 8 months.



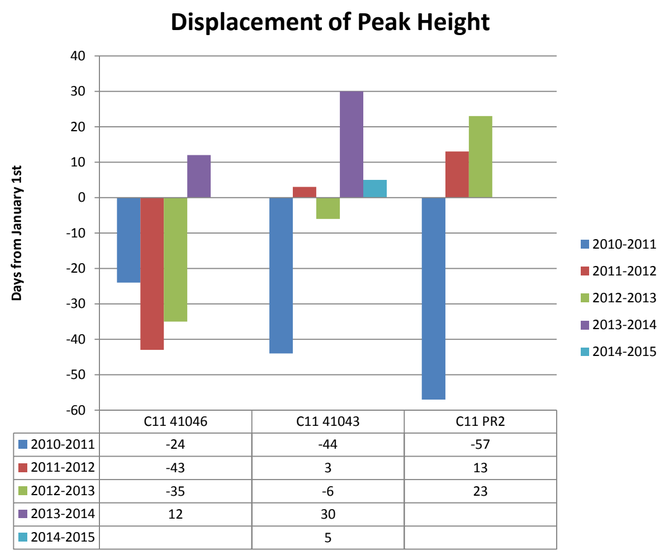
Dates of Maximum Height of the Annual Component IMF C11

NDBC 41046	NDBC 41043	CariCOOS PR2
8-Dec-10	18-Nov-10	5-Nov-10
19-Nov-11	4-Jan-12	14-Jan-12
27-Nov-12	26-Dec-12	24-Jan-13
13-Jan-14	31-Jan-14	
	6-Jan-15	

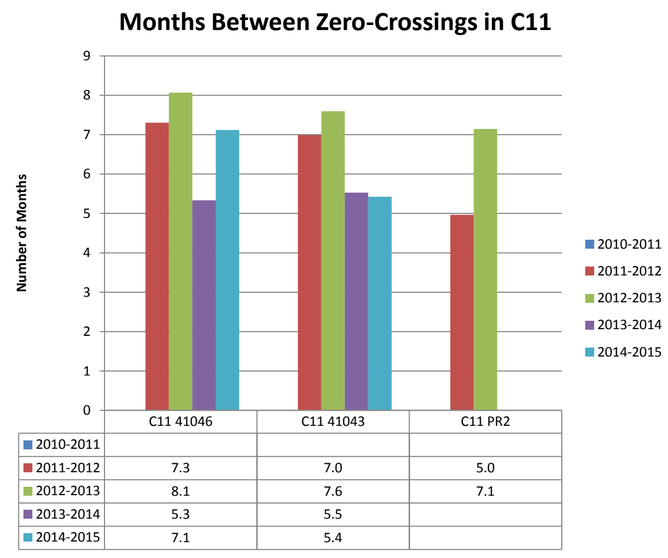
Dates of Zero Crossings of IMF C11

NDBC 41046			NDBC 41043		
Ascending	Descending	Duration	Ascending	Descending	Duration
	5-Mar-11			1-Mar-11	
7-Sep-11	13-Apr-12	7.3	16-Sep-11	13-Apr-12	7.0
16-Sep-12	16-May-13	8.1	5-Oct-12	21-May-13	7.6
5-Nov-13	14-Apr-14	5.3	15-Nov-13	30-Apr-14	5.5
27-Sep-14	29-Apr-15	7.1	14-Oct-14	26-Mar-15	5.4

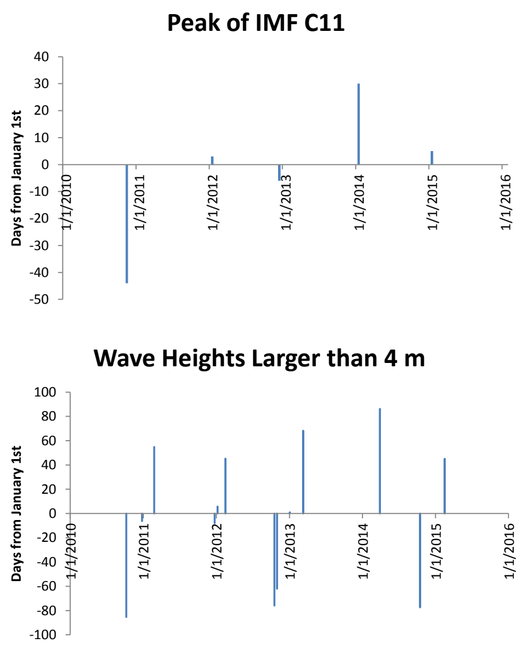
CariCOOS PR2		
Ascending	Descending	Duration
	15-Mar-11	
29-Oct-11	26-Mar-12	5.0
15-Oct-12	17-May-13	7.1
16-Dec-13		

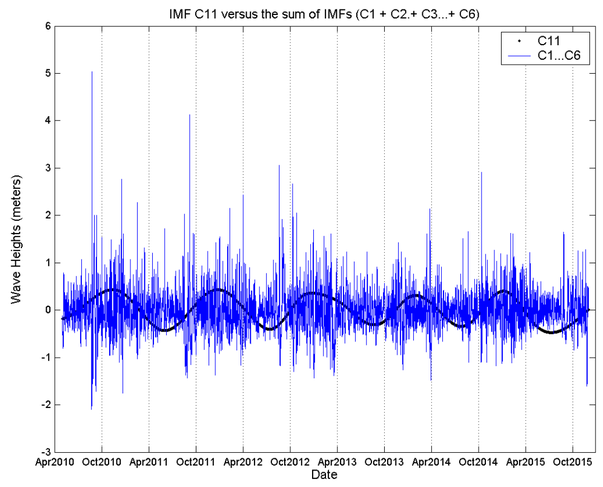


	C11 41046	C11 41043	C11 PR2
2010-2011	-24	-44	-57
2011-2012	-43	3	13
2012-2013	-35	-6	23
2013-2014	12	30	
2014-2015		5	



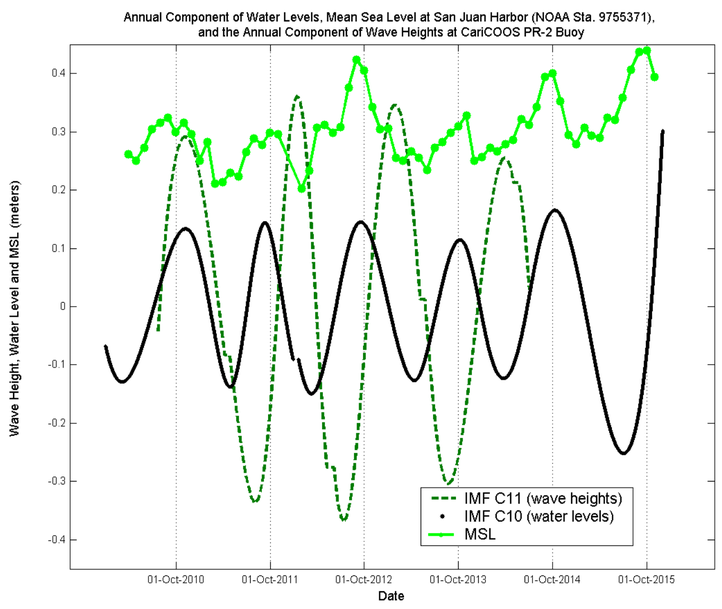
	C11 41046	C11 41043	C11 PR2
2010-2011			
2011-2012	7.3	7.0	5.0
2012-2013	8.1	7.6	7.1
2013-2014	5.3	5.5	
2014-2015	7.1	5.4	





COMBINATION OF THE ANNUAL WAVE HEIGHT SIGNAL AND THE ANNUAL TIDAL SIGNAL IN SAN JUAN HARBOR

The gradual increase of the annual wave heights in combination with the gradual increase in the annual tidal water levels could have an important effect on coastal erosion in Puerto Rico. The Figure shows a superposition of IMF C11 of CariCOOS-PR2, the Mean Sea Level (MSL) at station 9755371 and IMF C10 obtained from the EMD analysis of the water levels at station 9755371. IMF C10 represents the annual signal of the water levels at San Juan Harbor.



The peaks of IMF C11 usually do not coincide with the maximum annual tidal water levels (IMF C10) because during the peak of the wave season the annual tidal levels are decreasing. But an exception to this happen when the peak of IMF C11 shifted toward November 5th 2010, about 4 days from November 1st (peak of IMF C10), larger wave heights and higher tidal levels combined. The peak of wave height on November 5th was 0.2893 m and the peak in tidal level was 0.1329 m, its sum is 0.4222 m.

Dates of Peak of the Annual Tidal Component of Water Levels in San Juan Harbor (IMF C10)

1-Nov-2010
8-Sep-2011
16-Sep-2012
4-Oct-2013
5-Oct-2014

REFERENCES

- Alfonso-Sosa, E. (2016), Changes in the Duration and Peak of the Wave Season on Puerto Rico. Ocean Physics Education, 21 pp.
- Huang, N. E., Shen Z. and S. R. Long. 1999. A new view of nonlinear water waves: the Hilbert Spectrum, Annual Review of Fluid Dynamics 31:417-457.