Reviewer #1 Evaluations:
Science Category: Science Category 2
Presentation Category: Presentation Category A
Reviewer #1 (Comments to Author):
Review of manuscript: 2012GL051759
Title: Impacts of non-canonical El Niño patterns on Atlantic hurricane activity
Authors: S. Larson, S.-K. Li, C. Wang, E.-S. Chung, and D. Enfield
Recommendation: Accept with minor revisions

General Comments:
This manuscript revisits the modulation of the central Pacific El Niño on Atlantic Hurricane Activity. The results shown here contradict previous results (Kim et al. 2009) and are important. The main conclusion is that the central Pacific El Niño events are too weak to influence Atlantic tropical cyclone activity.

The paper is concise and well written and the analysis simple, with clear results. I have only a few suggestions, given below: add a couple of references, clear definitions for the indices used and years chosen for the composite. I also would strongly recommend that the authors tone down their last sentence, as it clearly exaggerates the importance of the results of this analysis.

We would like to thank reviewer #1 for encouraging comments and thoughtful suggestions. We have revised the manuscript following these suggestions as discussed below.

Specific Comments:
1. Page 2, line 15: Other environmental factors also contribute to the reduction of TC activity in warm ENSO years, such as reduced relative humidity, as shown using a genesis index (Camargo et al. 2007).

This point is now added on page 2, lines 62-64 citing Camargo et al. [2007].

2. Page 3, line 23: I would add here a reference to the results from Kossin et al. (2010) in this discussion, who showed that the modulation of ENSO is important to the storms that form in the deep tropics, but is not significant for storms forming in the Gulf of Mexico, as well as subtropical storms.

This point is now added by revising the following sentence in page 2, lines 59-61:

"El Niño events are thus associated with decreased tropical cyclone (TC) activity in the Atlantic basin as a result of increased VWS and atmospheric static stability over the MDR [e.g., Gray 1984; Goldenberg and Shapiro 1997]."
=>
"El Niño events are thus associated with decreased tropical cyclone (TC) activity in the Atlantic basin **especially in the deep tropics** as a result of increased wind shear and atmospheric static stability over the MDR [e.g., Gray 1984; Goldenberg and Shapiro 1997; **Kossin et al. 2010**]."

3. Pages 6-7: please clarify which season was used in defining the 8 strongest years for the warm phase of Nino4 and for Nino3. Were the indices calculated for ASO (peak hurricane season) or JJASON?

All ENSO indices are averaged for JJASON. To make this point clear, we added the following sentence in page 7, line 177-178:

"Note that each of these indices is first averaged for JJASON, and then is used in selecting the eight strongest positive phase years."

4. Pages 6-7: Please add a table with the a list of years that were used in the composites, and the values of each of the indices in the season that was used to define the top warm 8 years, clearly defining the season used in the definition. I would like to see the values of all indices for both ASO and JJASON in the 8 years chosen for the canonic and non-canonic cases. It is important to know which years are included in the composites for each of the different indices.

This is a very thoughtful suggestion. The Atlantic TC indices and MDR VWS for each of the eight strongest positive phase years for CPW, EMI, TNI, PMM, and EPW are now shown in Table S2, S3, S4, S5, and S6, respectively in the supplementary material. These tables are also reproduced by using only the ASO season. They are attached at the bottom of this reply. Table 1 is also reproduced using only the ASO (Table S7).

5. Page 7: Please add a table with the correlation coefficients (and their statistical significance) between all indices considered, when all months in the time-series are considered (which seems what was used in the discussion in page 7), as well as when the time-series is re-constructed for ASO and JJASON.

Table S1 is now added in the supplementary material. The correlation coefficients for JJASON and ASO are shown in the table. However, the correlation coefficients for all months are not shown because this manuscript mainly focuses on Atlantic hurricane seasons.

6. Page 8: Please add to your analysis (composites and composites with regression), additional composites in Table 1, using the same years considered in Kim et al. (2009) and Lee et al. (2010). Are your results consistent with Kim et al. (2009) and Lee et al. (2010) or different, when the same years are considered?

Kim et al. [2009] argued that CPW events are associated with an increasing frequency of cyclone activity in the Gulf of Mexico and Caribbean Sea. However, Kim et al. [2009] used only 5 CPW events to arrive that conclusion and only two of those five years were characterized with increased Atlantic TC activity (1969 and 2004) as shown in Table 1 and Table S1 in Lee et al. [2010]. The other three years (1991, 1994 and 2002) were under normal or below normal TC activity. Lee et al. [2010] further showed that the tropical North Atlantic was warmer than normal (or the Atlantic warm pool was larger than normal) during those two active years (1969 and 2004). They performed model experiments to argue that the increased tropical storm frequency in 1969 and 2004 could be readily explained by a large Atlantic warm pool and the associated reduction of MDR wind shear, without invoking a remote influence from the tropical

Pacific. Therefore, Lee et al. [2010] concluded that it was premature to associate CPW events with an increasing frequency of cyclone activity in the Gulf of Mexico and Caribbean Sea.

In summary, the composite analysis of Kim et al. [2009] was not a robust one because it had two critical problems. First, the number of samples used was not large enough to make a statistically robust case to support their conclusion. Second, they did not remove the influence of the tropical North Atlantic SSTs.

These points were already discussed in Lee et al. [2010]. So, the basic idea of the current study is to perform a new composite analysis using more cases and other definitions (i.e., EMI, TNI and PMM) of the non-canonical El Niño.

Nevertheless, we do understand reviewer's point that more in-depth comparison of this study with Kim et al. [2009] and Lee et al. [2010] is required (reviewer #2 also suggested this). Therefore, a new section (section 5) is added in the revised manuscript. In this new section, we attempt to compare our results with those of Kim et al. [2009] and Lee et al. [2010]. Table S9 shows the Atlantic TC indices and MDR VWS for the five strong CPW years (1969, 1991, 1994, 2002 and 2004) identified in Kim et al. [2009]. As shown in that table, the five-year averaged number of TS (10) is slightly increased from that of a normal year (8). But it is certainly not significantly different (at the 90% significance level) from the climatological value. Note that Kim et al. [2009] used this statistically insignificant difference to argue that CPW events are associated with increased Atlantic TC activity.

In the new section, we also discuss why 1991 and 1969 are not identified in the list of the eight strongest CPW years in our study. In particular, we find that ASO of 1969 was a weak-to-moderate canonical El Niño season because NINO3 was only 0.63^{o}C and greater than NINO4 (0.58^{o}C).

Kim et al. [2009] showed the detrended number of Atlantic TCs graphically (Figure 1 in Kim et al. [2009]) to argue that CPW is associated with increased Atlantic TC activity. However, they did not provide the numerical values for the detrended number of Atlantic TCs. These values were later provided in Lee et al. [2010] for both JJASON (Table 1 in Lee et al. [2010]) and ASO (Table S1 in Lee et al. [2010]). Note that the Atlantic TC indices shown in Table S1 of Lee et al. [2010] are almost identical to those in Table S9 of this paper. The numerical values for other Atlantic TC indices are slightly different in the two tables for two reasons. First, the climatological period is slightly different (1950-2006 in Lee et al. [2010] and 1950-2010 in this paper). Second, Atlantic TC indices are detrended in Lee et al. [2010], while they are not detrended in this study.

Kim et al. [2009] only provided numerical values for detrended ACE for JJASON in their Table S1. Their values were 101.9 for climatology and 102.8 for the five year-averaged CPW years. They stated (in page 78, line 10) "*The accumulated cyclone energy (ACE) also shows that the overall cyclone activity is larger in CPW events than in EPW events (table S1)*". This statement is not correct because 101.9 and 102.8 are surely not different in statistical sense. Note that ACE ranges between 29.8 and 220.4 in the five CPW years indentified in Kim et al. [2009].

7. Page 10: "single dominant factor": I would recommend that the authors modify this sentence. Even if the ENSO modulation becomes weaker, other climate modes will still influence Atlantic hurricane activity. As was shown in e.g. Kossin et al. (2010), ENSO is not the only factor modulating Atlantic TC activity, other climate modes also influence Atlantic TC activity, such as the Atlantic Meridional Mode, the Atlantic Multi-decadal Oscillation, the Madden-Julian Oscillation and the North Atlantic Oscillation. Furthermore, there is no evidence that La Niña events are becoming less frequent, or more restricted to the central Pacific, therefore, ENSO modulation on Atlantic TCs would still be occurring even if more non-canonical warm events become more common.

This is a very thoughtful suggestion. This sentence is now changed to "…… play a more important role in controlling Atlantic TC activity in the coming decades." both in the discussion section (page 11, lines 273-274) and in the abstract (page 1, line 41).

Minor Comments:
1. Page 2, line 5: "Horel and Wallance" should be "Horel and Wallace"

This is now corrected.

2. Page 2, line 21: "in the literatures" should be "in the literature"

This is now corrected.

References:
Camargo, S.J., et al. 2007: J. Climate, 20, 4819-4834.
Kossin, J.P., et al. 2010: J. Climate, 23, 3057-3076

These two papers now cited.

Table R1. Same as Table S2, but for August-October (ASO)

Year	Niño-4	TS (#)	HR (#)	MH (#)	ACE (10^4 kt^2)	USL(#)	VWS (ms^{-1})
2004	1.00	13 (10)	8 (6)	5 (4)	214.4 (167.7)	5 (5)	-1.2 (0.1)
1994	0.94	4 (6)	1 (2)	0 (1)	10.0 (31.1)	0 (0)	0.0 (-0.6)
2002	0.94	11 (10)	4 (4)	2 (2)	61.0 (49.7)	1 (1)	1.6 (2.0)
1991	0.79	7 (8)	4 (5)	2 (2)	38.0 (53.8)	1 (1)	0.6 (0.1)
1986	0.62	3 (5)	2 (3)	0 (1)	32.9 (62.2)	1 (1)	2.0 (1.2)
2003	0.61	10 (7)	5 (3)	3 (2)	155.4 (108.2)	1 (1)	-1.4 (0.0)
2001	0.54	12 (10)	7 (6)	4 (3)	100.8 (77.7)	0 (0)	-0.1 (0.6)
1990	0.48	11 (9)	7 (6)	1 (0)	79.4 (56.6)	0 (0)	-1.1 (-0.5)
Climatology	0.00	8	5	3	93.3	1	0.0

Table R2. Same as Table S3, but for August-October (ASO)

Year	EMI	TS (#)	HR (#)	MH (#)	ACE (10^4 kt^2)	USL(#)	VWS (ms^{-1})
1994	1.70	4 (6)	1 (2)	0 (1)	10.0 (31.1)	0 (0)	0.0 (-0.6)
2004	1.53	13 (10)	8 (6)	5 (4)	214.4 (167.7)	5 (5)	-1.2 (0.1)
1990	1.29	11 (9)	7 (6)	1 (0)	79.4 (56.6)	0 (0)	-1.1 (-0.5)
1977	1.29	6 (8)	5 (6)	1 (2)	26.5 (51.6)	1 (1)	1.6 (0.9)
1966	1.14	5 (5)	2 (2)	2 (2)	102.9 (108.4)	1 (1)	-0.6 (-0.7)
1991	1.13	7 (8)	4 (5)	2 (2)	38.0 (53.8)	1 (1)	0.6 (0.1)
1965	0.97	5 (7)	4 (5)	1 (2)	83.3 (106.6)	1 (1)	0.8 (0.1)
2001	0.84	12 (10)	7 (6)	4 (3)	100.8 (77.7)	0 (0)	-0.1 (0.6)
Climatology	0.00	8	5	3	93.3	1	0.0

Table R3. Same as Table S4, but for August-October (ASO)

Year	TNI	TS (#)	HR (#)	MH (#)	ACE ($10^4\ kt^2$)	USL(#)	VWS (ms^{-1})
2001	1.61	12 (10)	7 (6)	4 (3)	100.8 (77.7)	0 (0)	-0.1 (0.6)
2004	1.38	13 (10)	8 (6)	5 (4)	214.4 (167.7)	5 (5)	-1.2 (0.1)
1994	1.37	4 (6)	1 (2)	0 (1)	10.0 (31.1)	0 (0)	0.0 (-0.6)
1977	1.25	6 (8)	5 (6)	1 (2)	26.5 (51.6)	1 (1)	1.6 (0.9)
2005	1.13	17 (13)	11 (8)	5 (4)	167.9 (113.0)	4 (4)	-2.2 (-0.6)
1990	1.10	11 (9)	7 (6)	1 (0)	79.4 (56.6)	0 (0)	-1.1 (-0.5)
2002	0.83	11 (10)	4 (4)	2 (2)	61.0 (49.7)	1 (1)	1.6 (2.0)
1966	0.76	5 (5)	2 (2)	2 (2)	102.9 (108.4)	1 (1)	-0.6 (-0.7)
Climatology	0.00	8	5	3	93.3	1	0.0

Table R4. Same as Table S5, but for August-October (ASO)

Year	PMM	TS (#)	HR (#)	MH (#)	ACE ($10^4\ kt^2$)	USL(#)	VWS (ms^{-1})
1992	1.39	7 (8)	4 (5)	1 (1)	77.3 (92.3)	1 (1)	0.7 (0.3)
1990	1.33	14 (13)	8 (7)	1 (1)	93.0 (76.3)	0 (0)	-0.3 (0.1)
1958	1.08	10 (8)	7 (6)	5 (4)	127.2 (100.1)	1 (1)	-0.3 (-0.3)
2001	1.07	15 (13)	9 (8)	4 (3)	115.6 (91.6)	0 (0)	-0.3 (0.2)
1977	0.88	6 (8)	5 (6)	1 (2)	26.5 (51.6)	1 (1)	1.6 (0.9)
1996	0.76	9 (9)	6 (6)	5 (5)	147.4 (151.0)	1 (1)	-0.4 (-0.5)
2004	0.66	13 (10)	8 (6)	5 (4)	214.4 (167.7)	5 (5)	-1.2 (0.1)
2003	0.56	10 (7)	5 (3)	3 (2)	155.4 (108.2)	1 (1)	-1.4 (0.0)
Climatology	0.00	8	5	3	93.3	1	0.0

Table R5. Same as Table S6, but for August-October (ASO)

Year	Niño-3	TS (#)	HR (#)	MH (#)	ACE (10^4 kt^2)	USL(#)	VWS (ms^{-1})
1997	3.00	3 (2)	1 (1)	1 (1)	30.4 (15.2)	0 (0)	0.5 (1.0)
1982	1.88	4 (6)	1 (2)	1 (2)	26.1 (48.4)	0 (0)	0.8 (0.1)
1972	1.84	4 (6)	2 (4)	0 (2)	26.5 (58.5)	0 (0)	3.2 (2.3)
1987	1.58	7 (5)	3 (2)	1 (0)	30.2 (2.4)	1 (1)	0.8 (1.6)
1965	1.27	5 (7)	4 (5)	1 (2)	83.3 (106.6)	1 (1)	0.8 (0.1)
1976	0.98	8 (8)	6 (6)	2 (2)	82.2 (85.4)	1 (1)	-0.2 (-0.3)
1957	0.97	6 95)	2 (2)	1 (1)	74.6 (64.8)	0 (0)	-0.2 (0.1)
2009	0.96	8 (6)	2 (1)	2 (1)	46.9 (14.2)	0 (0)	1.5 (2.4)
Climatology	0.00	8	5	3	93.3	1	0.0