Statistical Analysis of the Interannual and Intraseasonal Variability of Waterspout Day Frequency in the Florida Keys

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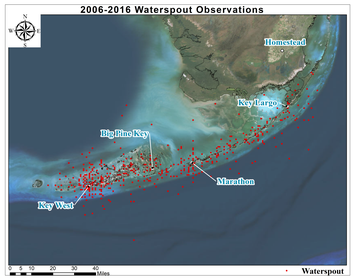
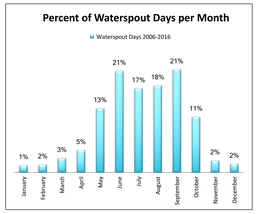
Background

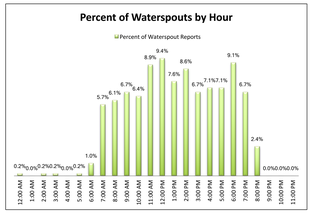
- Waterspout frequency in the Keys is likely the highest in the world.
- An estimated 50-500 waterspouts occur each year in Florida Keys waters.
- Approximately 40 are spotted and reported per wet season (June-Sep).
- Waterspouts ***are reported*** on approximately 19% of wet season days.
- During the wet season atmospheric changes can be incremental (quasi-barotropic).
- Daily waterspout probabilities can be statistically modeled (Devanas and Stefanova 2017-WAF submission) using parameters derived from sounding data (stability indices, wind speed/direction, temperature, heights, etc).

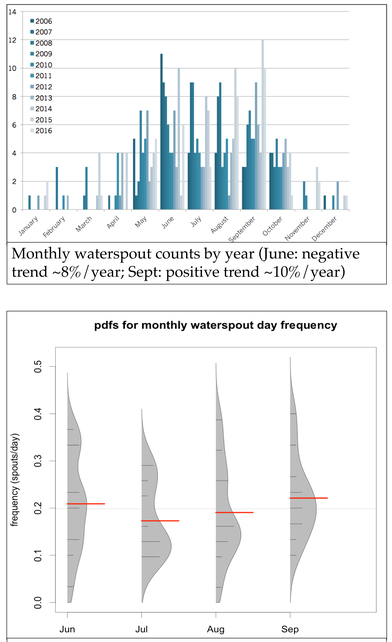
Data

- Eleven wet seasons examined (2006-2016).
- NWS LSR's from WFO Key West used to identify waterspout days.
- NCEP/NCAR Reanalysis and Reanalysis-2 data used.
- Two data sets created - waterspout report days, and days with no reports.
- Waterspout(s) were reported on 266 of the 1330 days examined.



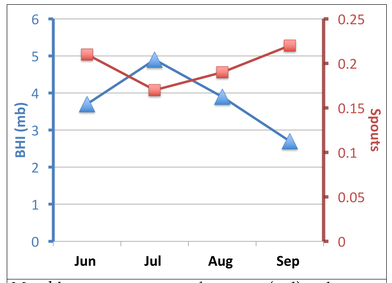






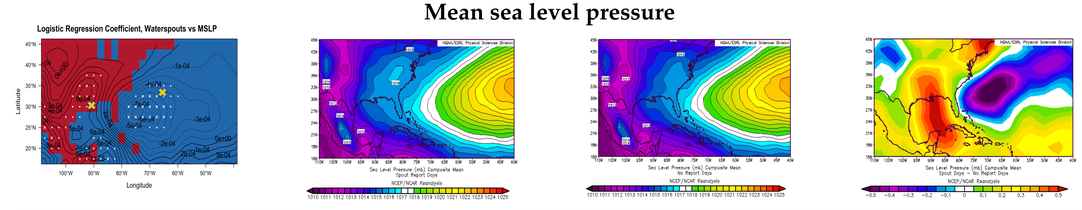
Monthly waterspout counts by year (June: negative trend ~8%/year; Sept: positive trend ~10%/year)

Estimated probability density functions for monthly waterspout frequency by month (2006-2016). Individual years (black ticks, stacked) and overall mean (red lines)

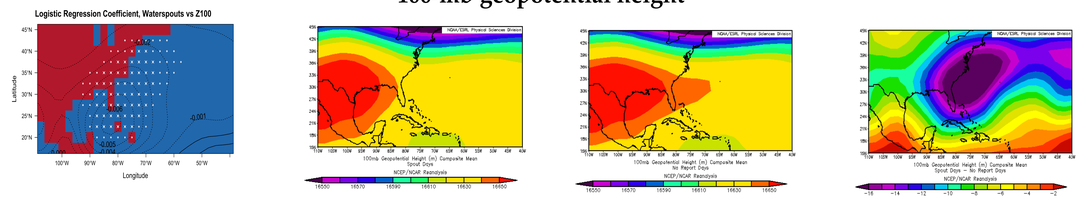


Monthly mean waterspout frequency (red) and Bermuda High Index - BHI (blue). (BHI defined as the sea level pressure difference between Bermuda and New Orleans)

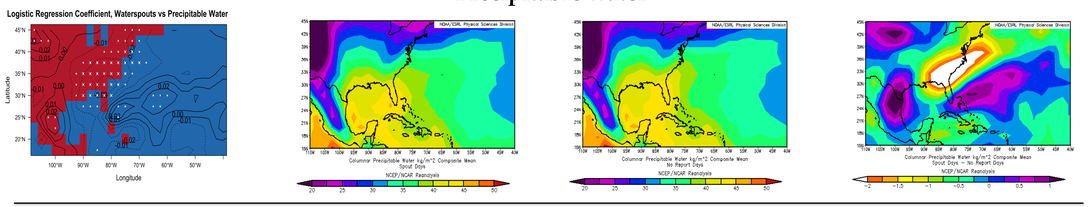
Mean sea level pressure



100-mb geopotential height



Precipitable water



- Left column: Spatial distribution of pointwise logistic regression fit of daily waterspouts (yes/no) on daily mean MSLP (top)/Z100 (center)/precipitable water (bottom) grid-point values obtained from Reanalysis-2. Contours represent the regression coefficient value (dashed contours for negative coefficients); Grid-points for which the regression coefficient is statistically significant at the 95% confidence level are marked by a dot, and at 99% - by a cross. Negative regression coefficient means that larger values of the grid point field are associated with less frequent waterspouts and vice versa.
- Second column: Composite mean on waterspout report days.
- Third column: Composite mean on no-waterspout report days.
- Right column: Difference between waterspout and no-waterspout report days composites.

Summary

- Florida Keys waterspouts are most frequently reported in June and September, with a localized minimum in July;
- There is a significant interannual variability, with statistically significant downward trend in June report counts and upward trend in September.
- There is a hint of a bimodal distribution of waterspout reports in a given month (particularly June) but this is not a robust finding, given the few years in the data.
- The Bermuda High Index (pressure difference between Bermuda and New Orleans) is a statistically significant predictor of daily waterspout probability; BHI is inversely related to waterspout probability; the intraseasonal variability of BHI may at least partially explain the intraseasonal variability in waterspout activity.
- The logistic regression Reanalysis-2 plots and related composites suggest a synoptic pattern favorable for waterspout development. As the Bermuda High retreats/weakens, a lower tropospheric trough pattern appears (either induced or advected) along the southern Atlantic seaboard (as indicated in MSLP and Precipitable water). Additionally, the upper tropospheric ridge (Z100) centered over northern Mexico and Texas retreats, resulting in deep layer troughing over the southeast.

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