Analysis of the Relationship of Waterspout Day Frequency in the Florida Keys to Synoptic-Scale Patterns
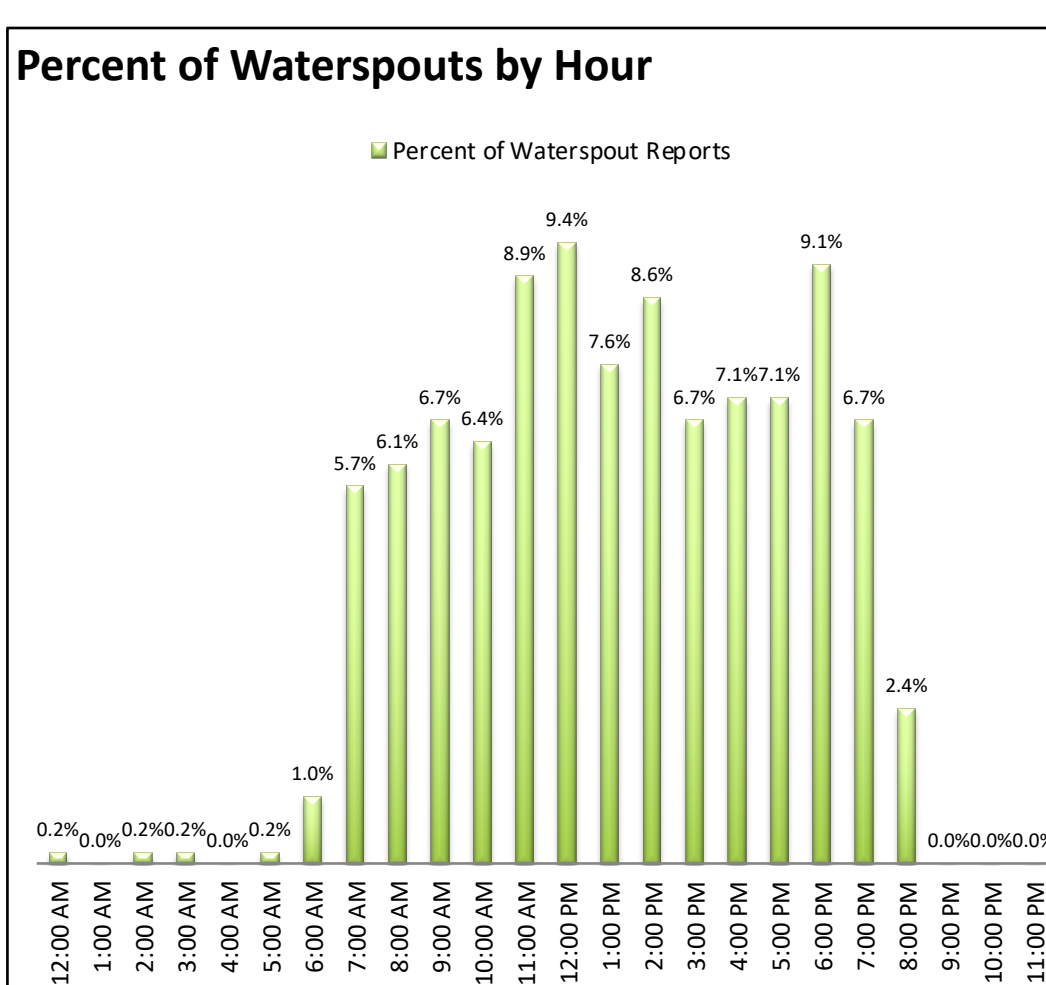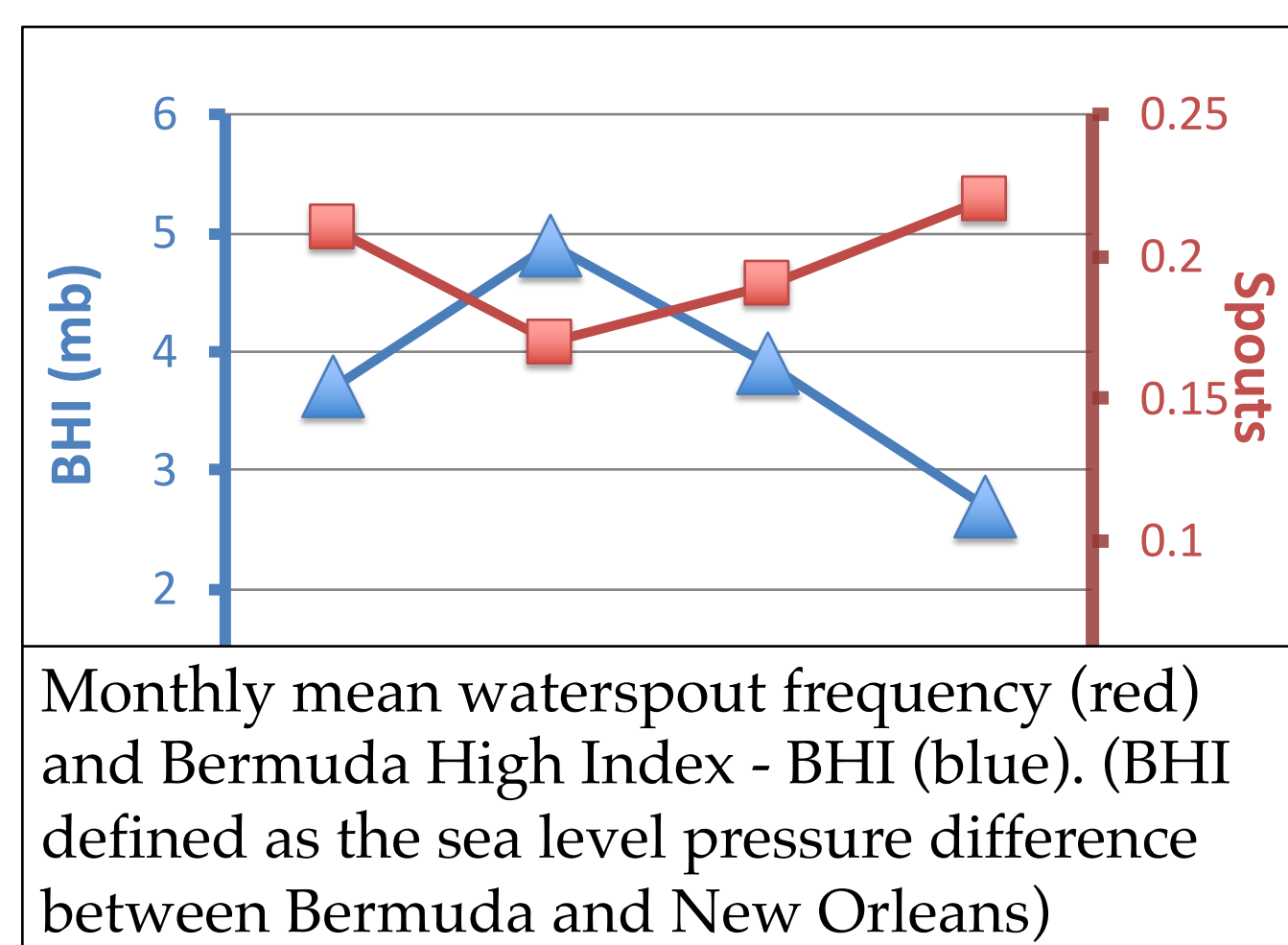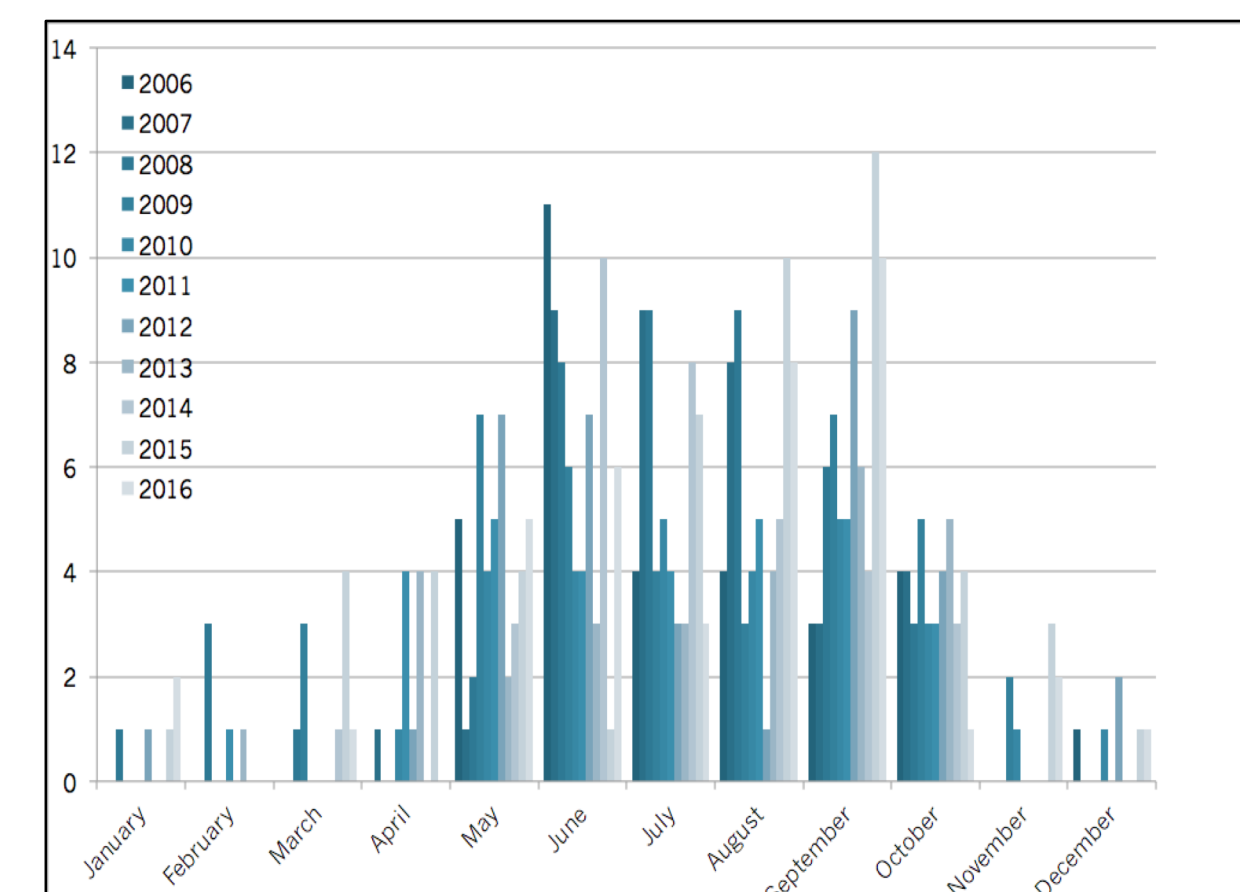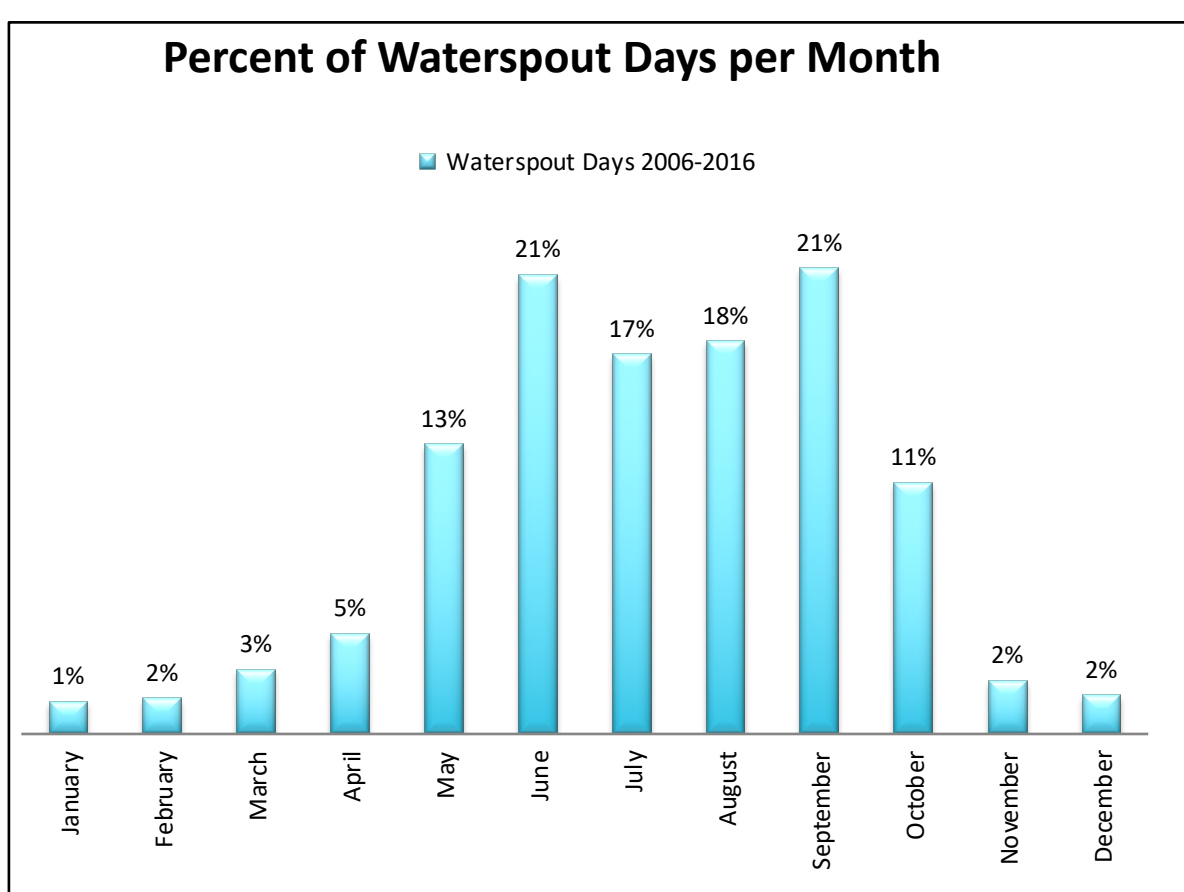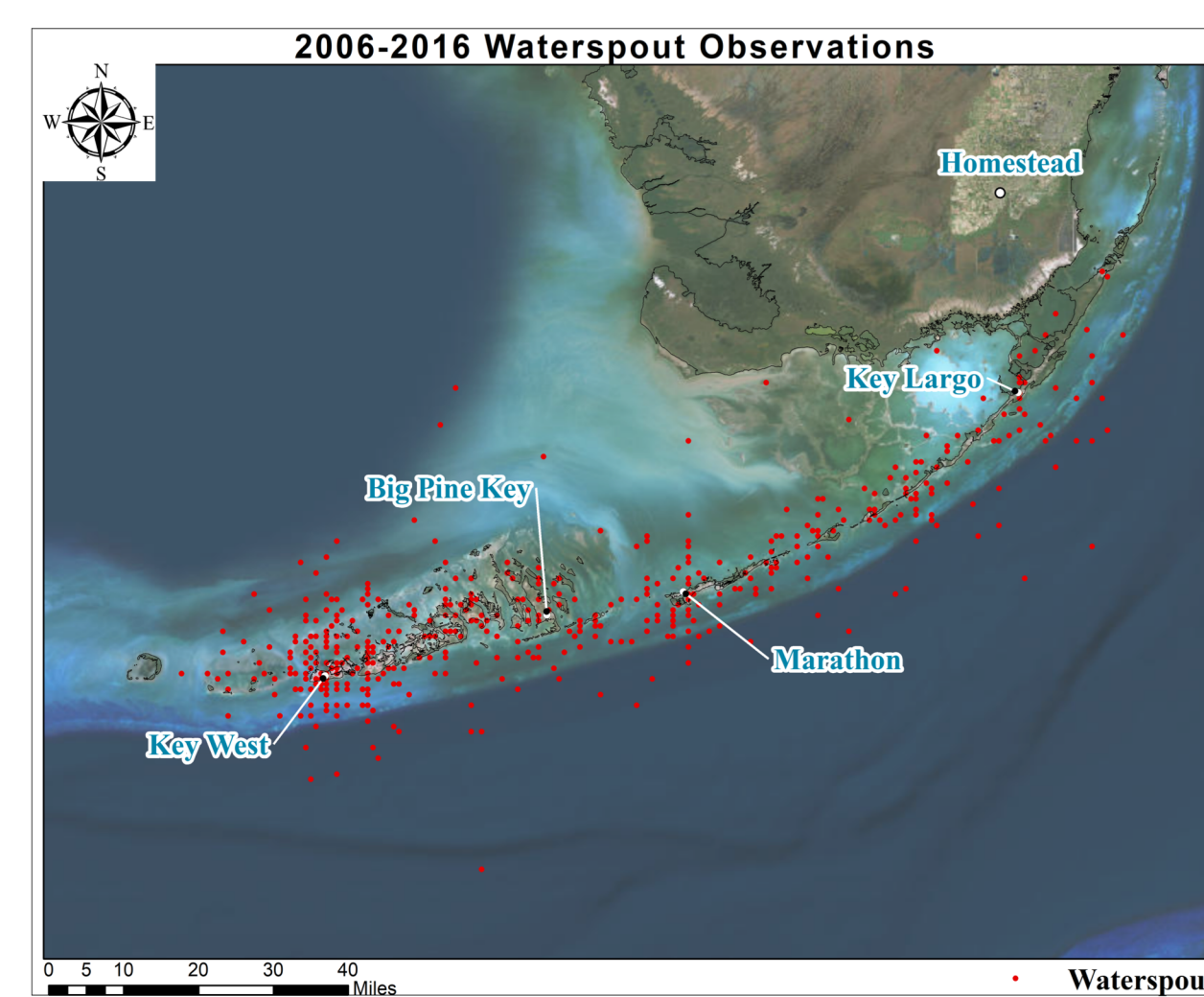
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Background

- Waterspout frequency in the Keys is likely the highest in the world.
- An estimated 50-500 waterspouts occur each year in Florida Keys waters.
- Waterspouts have been reported during all months of the year.
- Approximately 40 are spotted and reported per wet season (June-Sep).
- Waterspouts *are reported* on approximately 19% of wet season days.
- The Bermuda High is the dominant synoptic feature during wet season.
- Daily waterspout probabilities can be statistically modeled (Devanas and Stefanova 2018) using parameters derived from sounding data (stability indices, wind speed/direction, temperature, heights, etc.).

Data

- Eleven wet seasons examined in study (2006-2016).
- Two seasons were used for comparison to study results (2017-2018).
- 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.

2006-2016 Waterspout Observations

Percent of Waterspout Days per Month

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

Percent of Waterspouts by Hour

- Spatial distribution of pointwise logistic regression fit of daily waterspouts (yes/no) on daily mean 300mb Z/ 1000-700mb Total Wind/ Surface U Wind/ Surface V wind (columns). Grid-point values obtained from Reanalysis-2. Contours represent the difference in these mean fields between days with waterspouts, and days with no waterspout report during the wet season. Grid-points for which the regression coefficient is statistically significant at 99% are displayed with a cross.
- Rows 1-5: Composite difference of (Waterspout days – No report days) respectively from three days prior to waterspout occurrence, 1 day prior, waterspout report day, 1 day after report, and 3 days after report.

| 300mb Heights | 1000-700mb Wind | SFC U Wind | SFC V Wind |

DAY -3 / DAY -1 / DAY 0 / DAY +1 / DAY +3
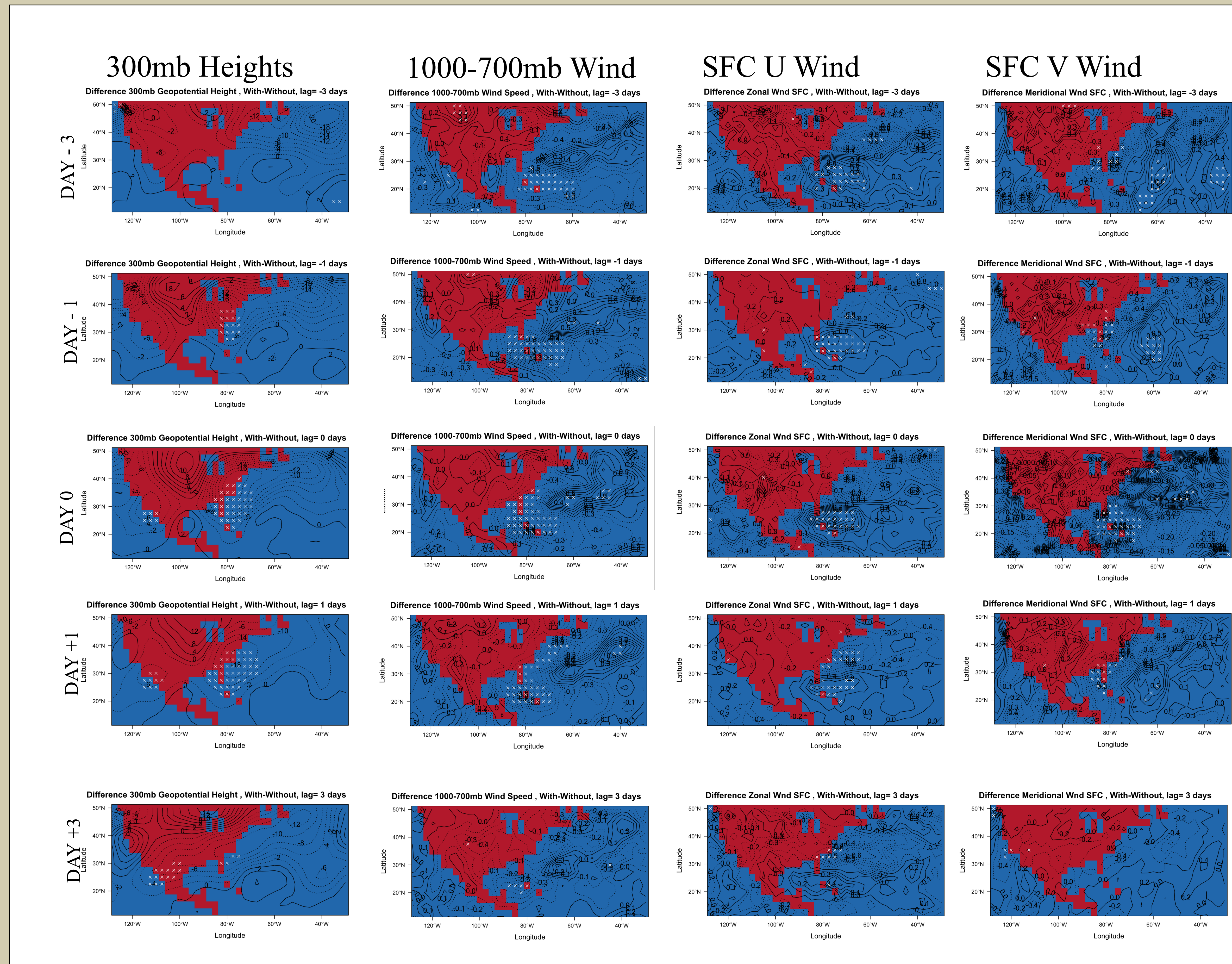
Summary

- Florida Keys waterspouts are most frequently reported in June and September, with a localized wet season minimum in July;
- 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. This is related to the strength and location of the Bermuda High.
- The logistic regression Reanalysis-2 plots suggest synoptic patterns favorable for waterspout development. A few synoptic patterns were identified which serve to disrupt (weaken, displace) the Bermuda High are: tropical waves east of Florida, shortwave troughs along the eastern seaboard/ southeast, upper tropospheric disturbances such as TUTTs and troughs.
- The disruption of the ridge leads to weaker than normal lower tropospheric winds (less easterly, less southerly) on average. Light northeasterly flow parallel to the island chain is the most favorable flow regime for waterspout development.

Waterspout Outbreak Days (2017-2018) (3 or more waterspout reports per day)

Synoptic features identified which disrupt the strength, location, and integrity of Bermuda High and are favorable for waterspout development. 1. Trough along the south east, mid-Atlantic coast region, 2. TUTT cell off the Southeast coast/ Bahamas region, 3. Tropical wave/inverted trough east of Florida

June 16, 2017 – (Ridge axis displaced south, Upper Trough over Southeast)

1000mb Climatology (June) | 1000mb Day0 | 300mb Climatology (June) | 300mb Day0

July 12, 2017 – (Ridge axis displaced north, inverted trough east of FL)

1000mb Climatology (July) | 1000mb Day0 | 300mb Climatology (July) | 300mb Day0

June 11, 2018 – (Short wave in southeast, upper trough over FL)

1000mb Climatology (June) | 1000mb Day0 | 300mb Climatology (June) | 300mb Day0

July 03, 2018 – (TUTT Cell/ Tropical Wave east of FL)

1000mb Climatology (July) | 1000mb Day0 | 300mb Climatology (July) | 300mb Day0

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