Climatology and Variability of Tropical Cyclones Affecting Charleston, South Carolina

B. Lee Lindner, Aaron Neuhauser, and Mikel Hannah-Harding

College of Charleston

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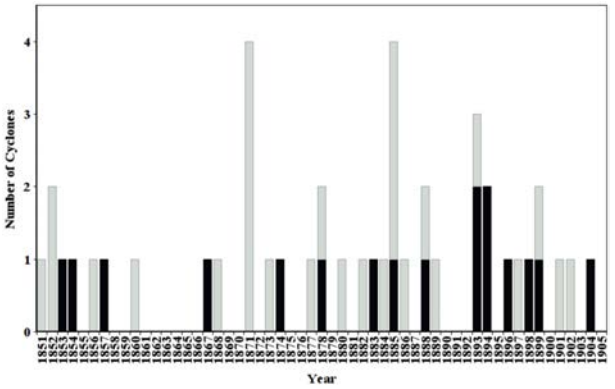
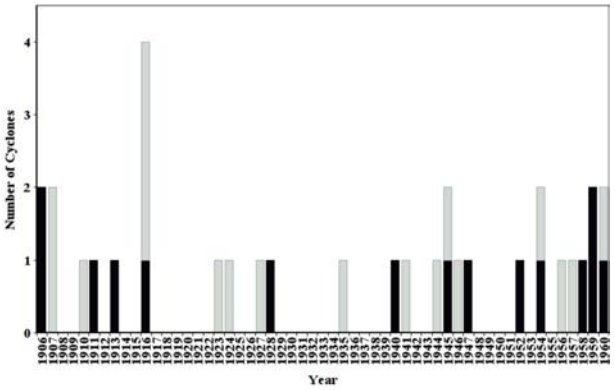
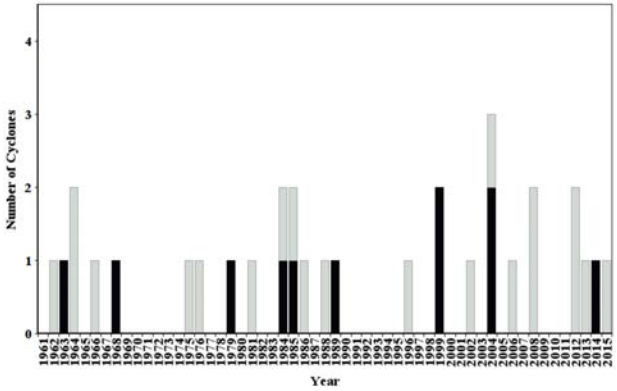
Approach

- Strike = passage within 75 n. mi.
- NHC HURDAT2 database covers 1851-2015
- 1670-1850; barometers, anemometers, etc were rare
- Instead, newspaper stories, ship logbooks, British Colonial Office records, weather diaries, plantation accounts, and personal letters recorded “data”
- Mock, Jordan, Calhoun, Ludlam, Chenoweth, Roth, Bright, Fraser; each list unique
- Combine earlier studies by Limited Meta-Analysis
  - Thorough search of literature yields 8 studies
  - Comprehensive list of 78 tropical cyclones
  - Weight each cited cyclone (3, 1, 0.5, 0)
  - Compute mean
  - Group as ‘notable’, ‘grazing’, ‘weaker’, ‘uncorroborated’

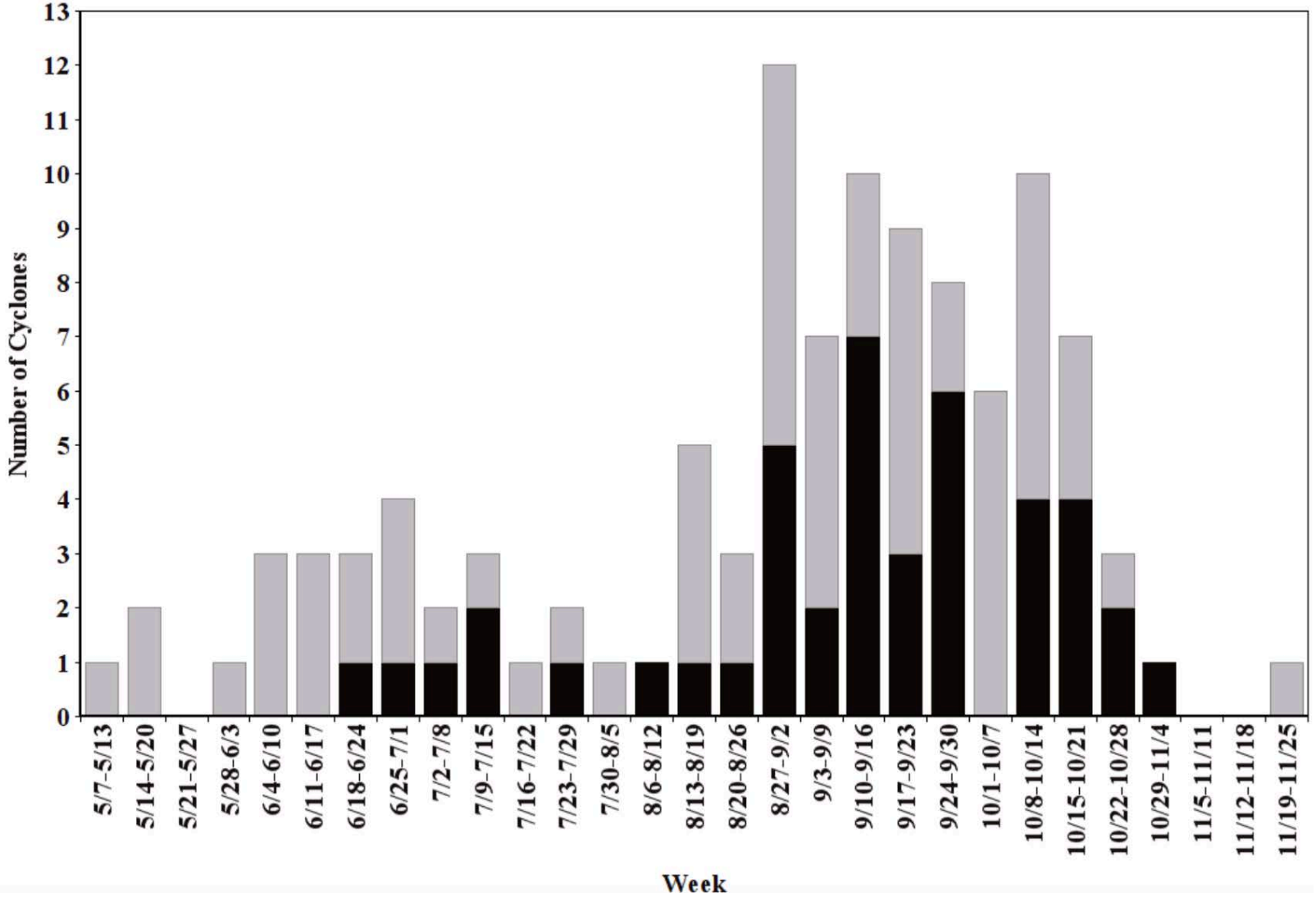

Number of Cyclones
Year


Number of Cyclones
Year


Number of Cyclones
Year

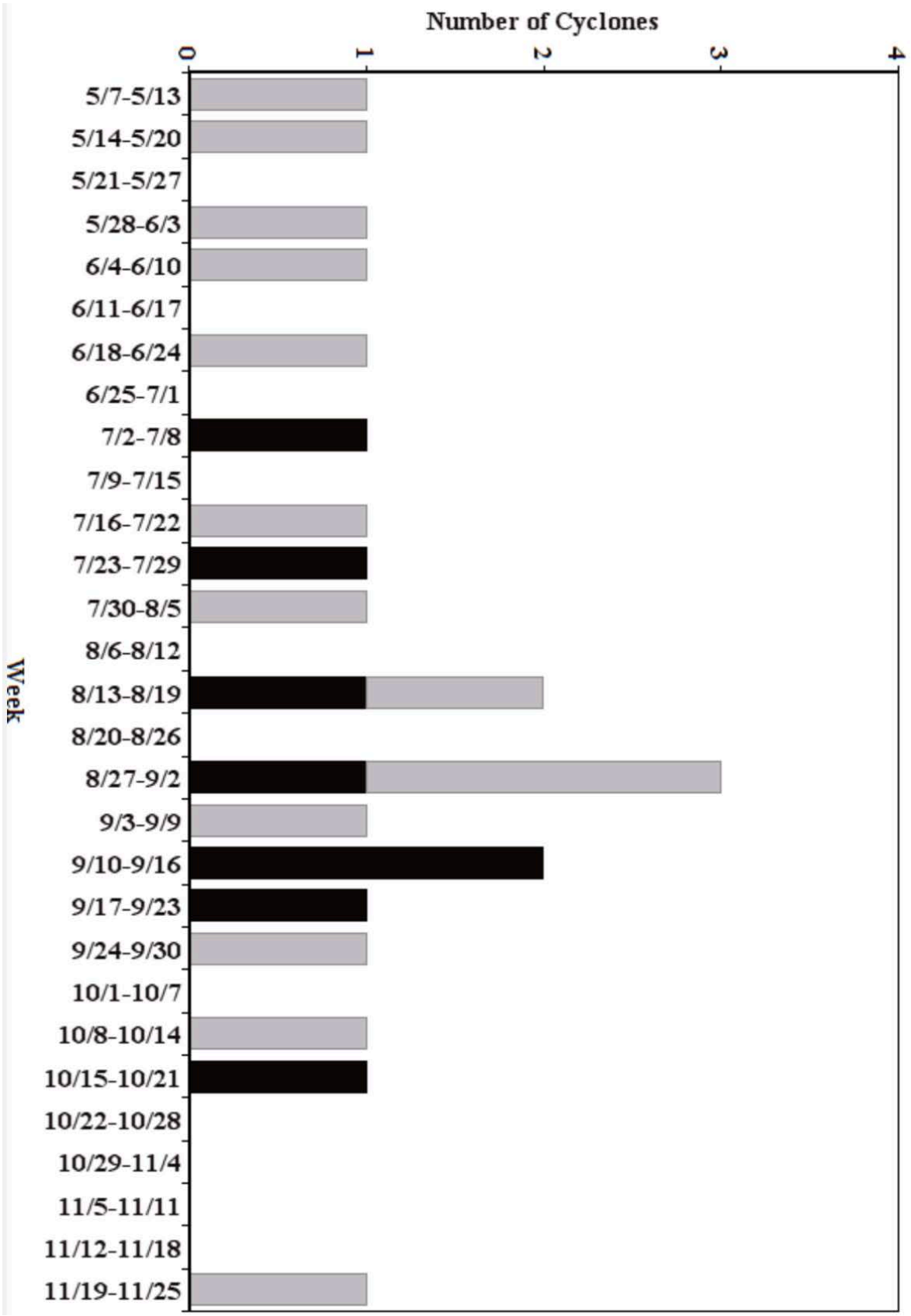
Multiple strike occurrence rate; Poisson Distribution vs. observations

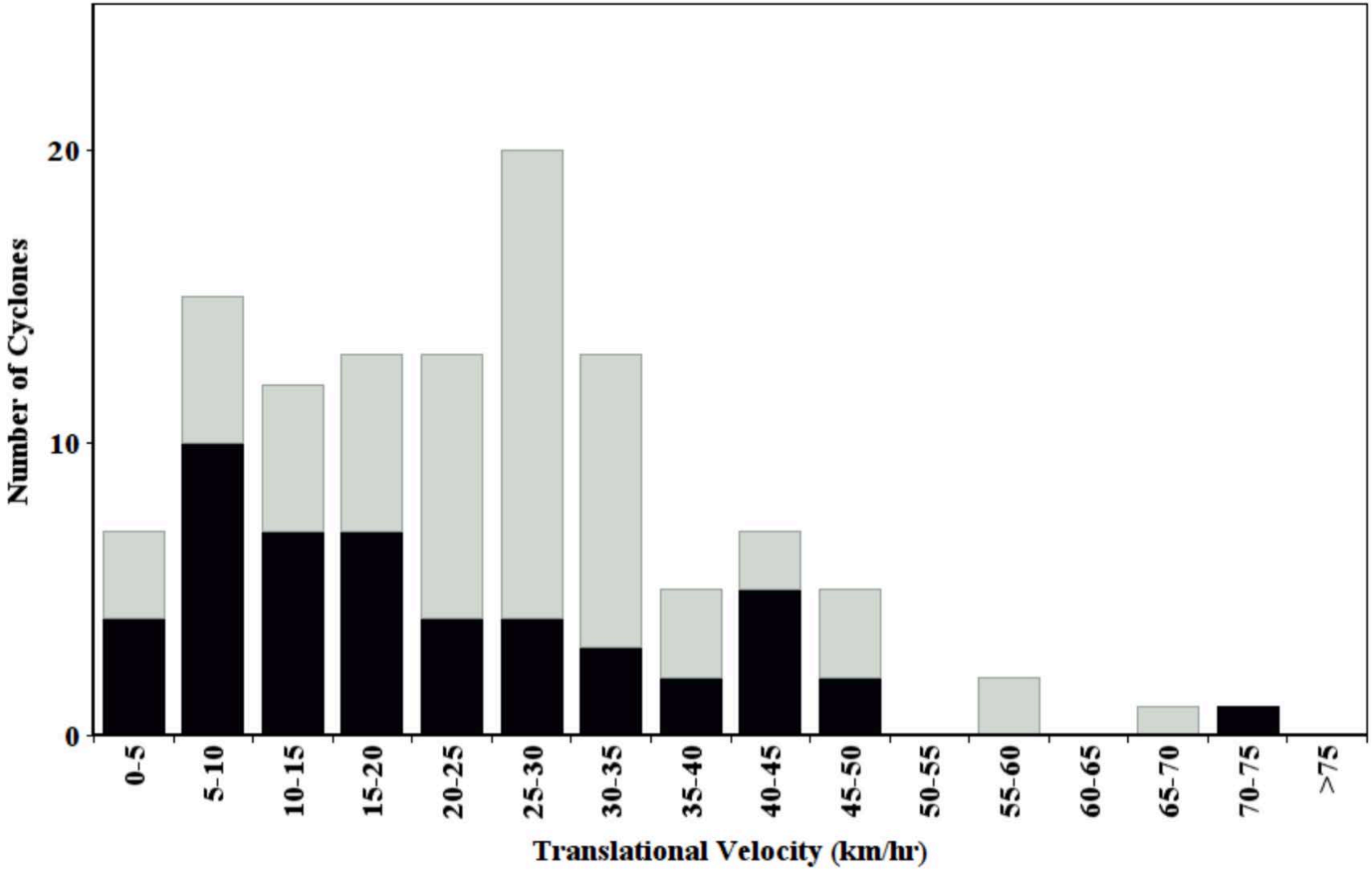
	Tropical Storms and Hurricanes		Hurricanes Only	
Strikes per year	Model	Observed	Model	Observed
0	52.6%	52.1%	77.5%	77.6%
1	33.8%	33.9%	19.7%	18.8%
2	10.9%	10.3%	2.5%	3.6%
3	2.3%	1.2%	0.2%	0.0%
4	0.4%	1.8%	0.01%	0.0%
5 or more	0.06%	0.0%	0.00%	0.0%

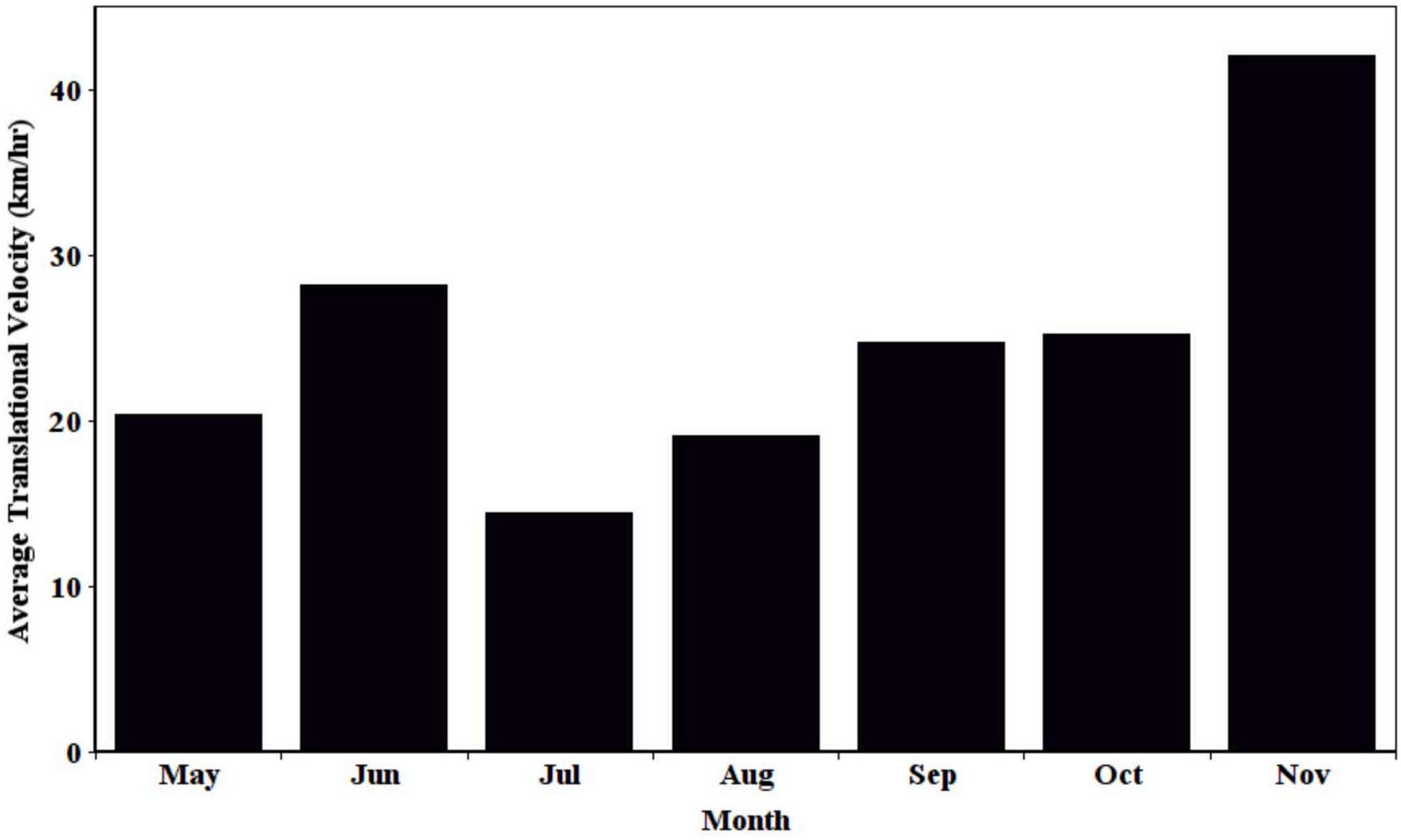

Number of Cyclones
0
1
2
3
4
5
6
7
8
9
10
11
12
13
5/7-5/13
5/14-5/20
5/21-5/27
5/28-6/3
6/4-6/10
6/11-6/17
6/18-6/24
6/25-7/1
7/2-7/8
7/9-7/15
7/16-7/22
7/23-7/29
7/30-8/5
8/6-8/12
8/13-8/19
8/20-8/26
8/27-9/2
9/3-9/9
9/10-9/16
9/17-9/23
9/24-9/30
10/1-10/7
10/8-10/14
10/15-10/21
10/22-10/28
10/29-11/4
11/5-11/11
11/12-11/18
11/19-11/25
Week

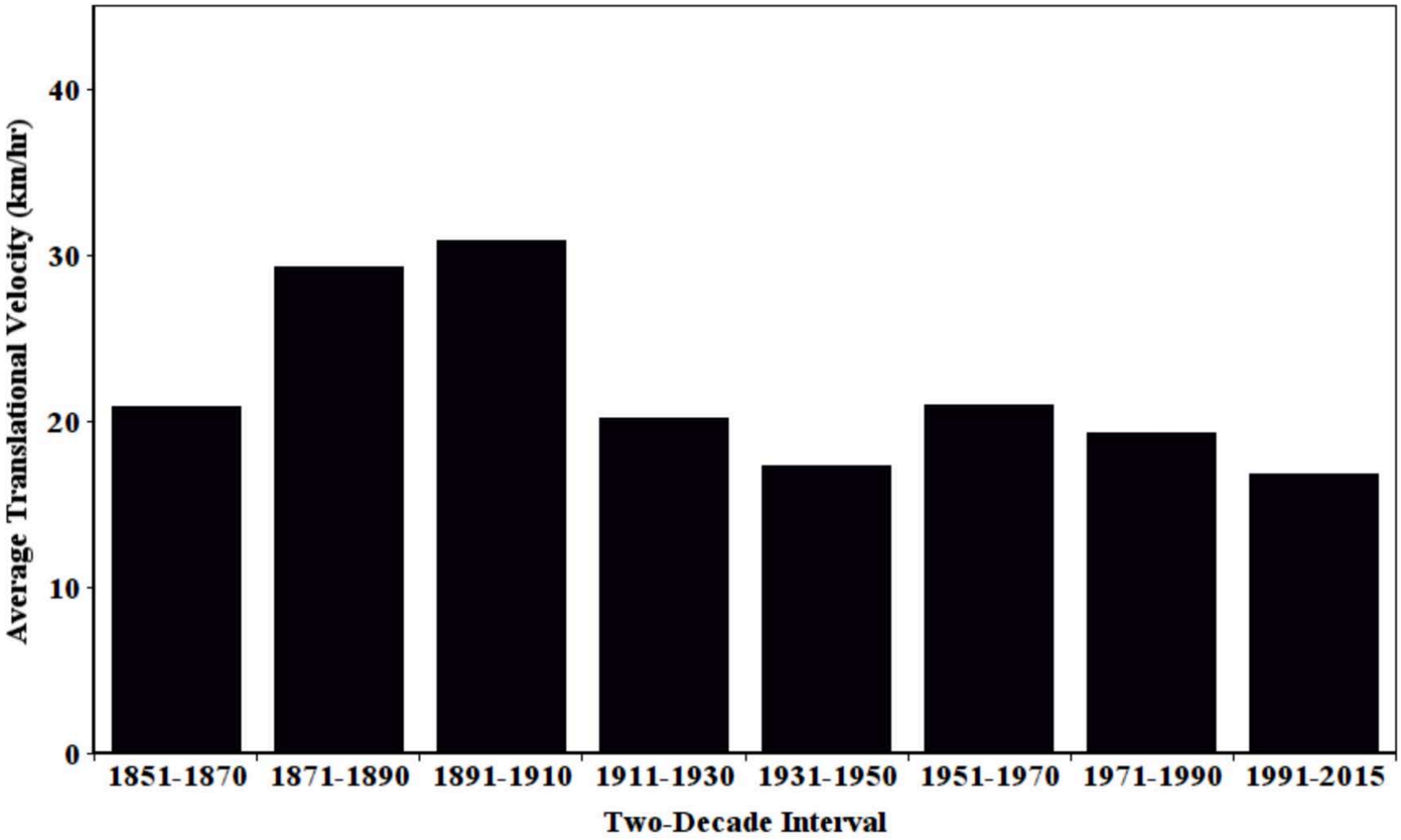
Tropical storms and hurricanes 1851-2015 vs. the Atlantic basin as a whole and vs. hurricanes that made landfall anywhere in the US

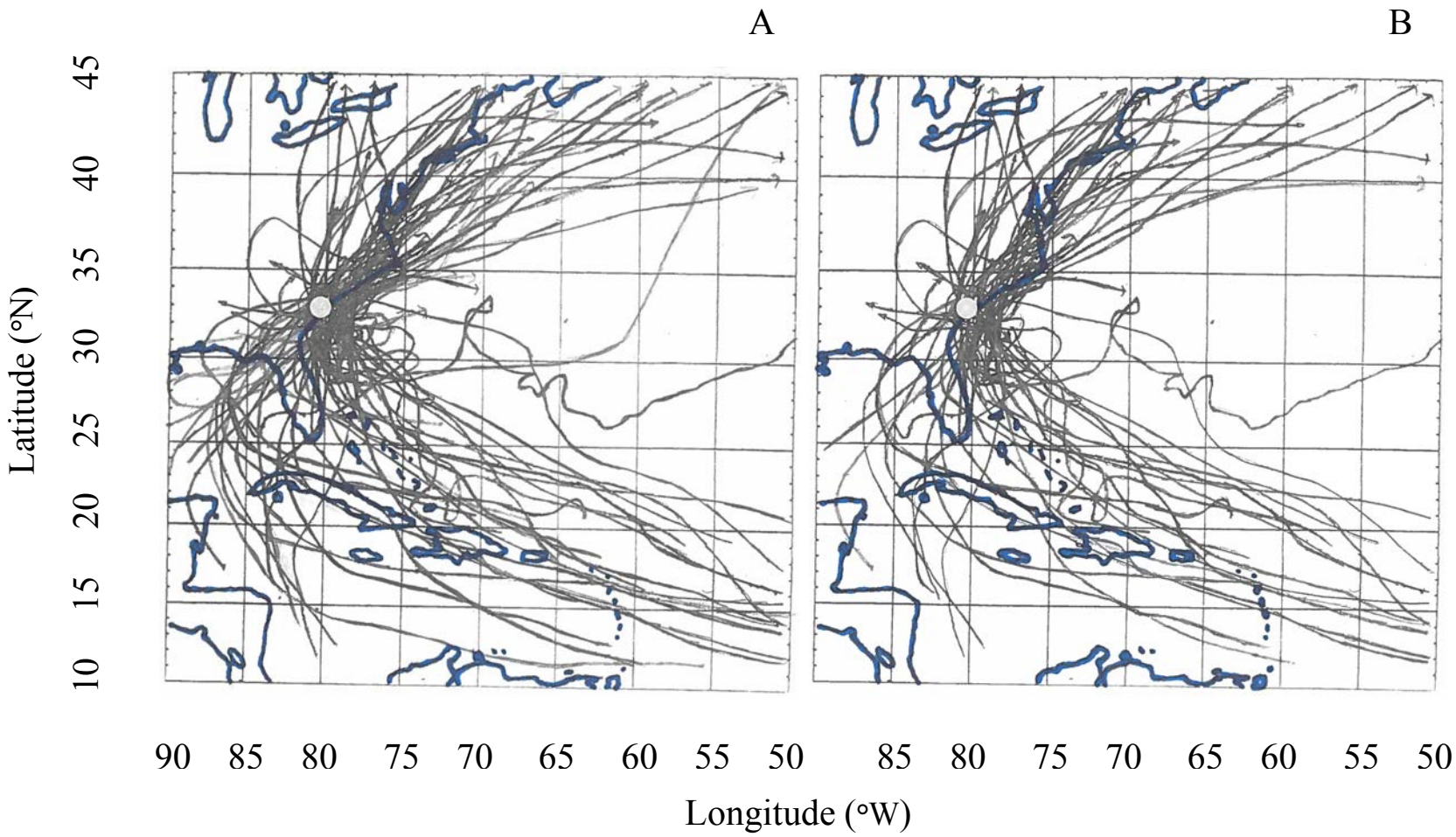
	TS&H		Hurricanes Only		
Month	Charleston	Atlantic	Charleston	Atlantic	Landfalling
Jan. to April	0.0%	0.3%	0.0%	0.1%	0.0%
May	6%	1%	0.0%	0.5%	0.0%
June	15%	6%	5%	4%	7%
July	8%	8%	9%	6%	9%
August	20%	25%	19%	26%	27%
September	26%	34%	40%	39%	38%
October	24%	20%	28%	19%	19%
November	2%	5%	0.0%	5%	1%
December	0.0%	0.7%	0.0%	0.5%	0.0%

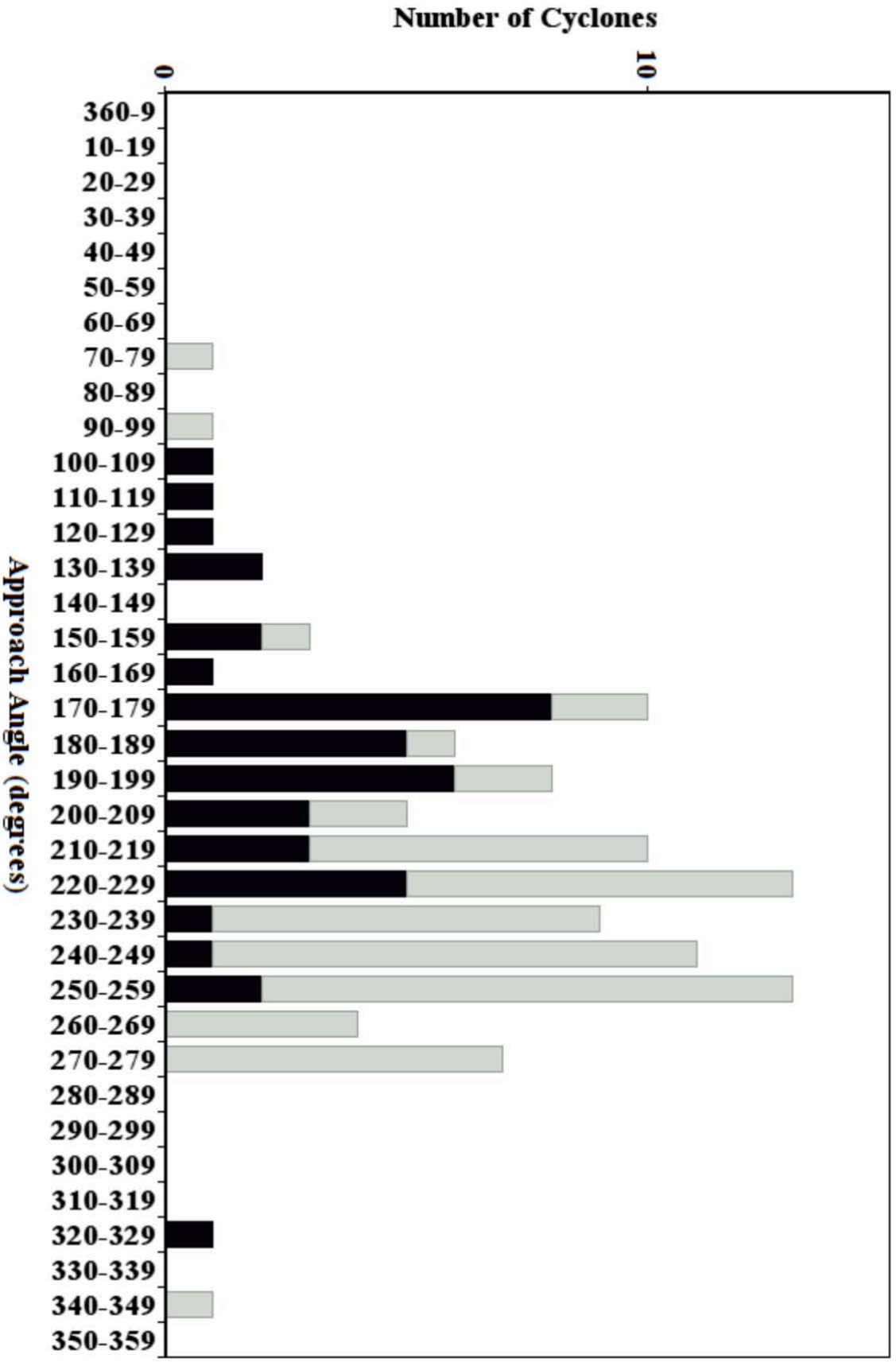

Number of Cyclones
0
1
2
3
4
Week
5/7-5/13
5/14-5/20
5/21-5/27
5/28-6/3
6/4-6/10
6/11-6/17
6/18-6/24
6/25-7/1
7/2-7/8
7/9-7/15
7/16-7/22
7/23-7/29
7/30-8/5
8/6-8/12
8/13-8/19
8/20-8/26
8/27-9/2
9/3-9/9
9/10-9/16
9/17-9/23
9/24-9/30
10/1-10/7
10/8-10/14
10/15-10/21
10/22-10/28
10/29-11/4
11/5-11/11
11/12-11/18
11/19-11/25

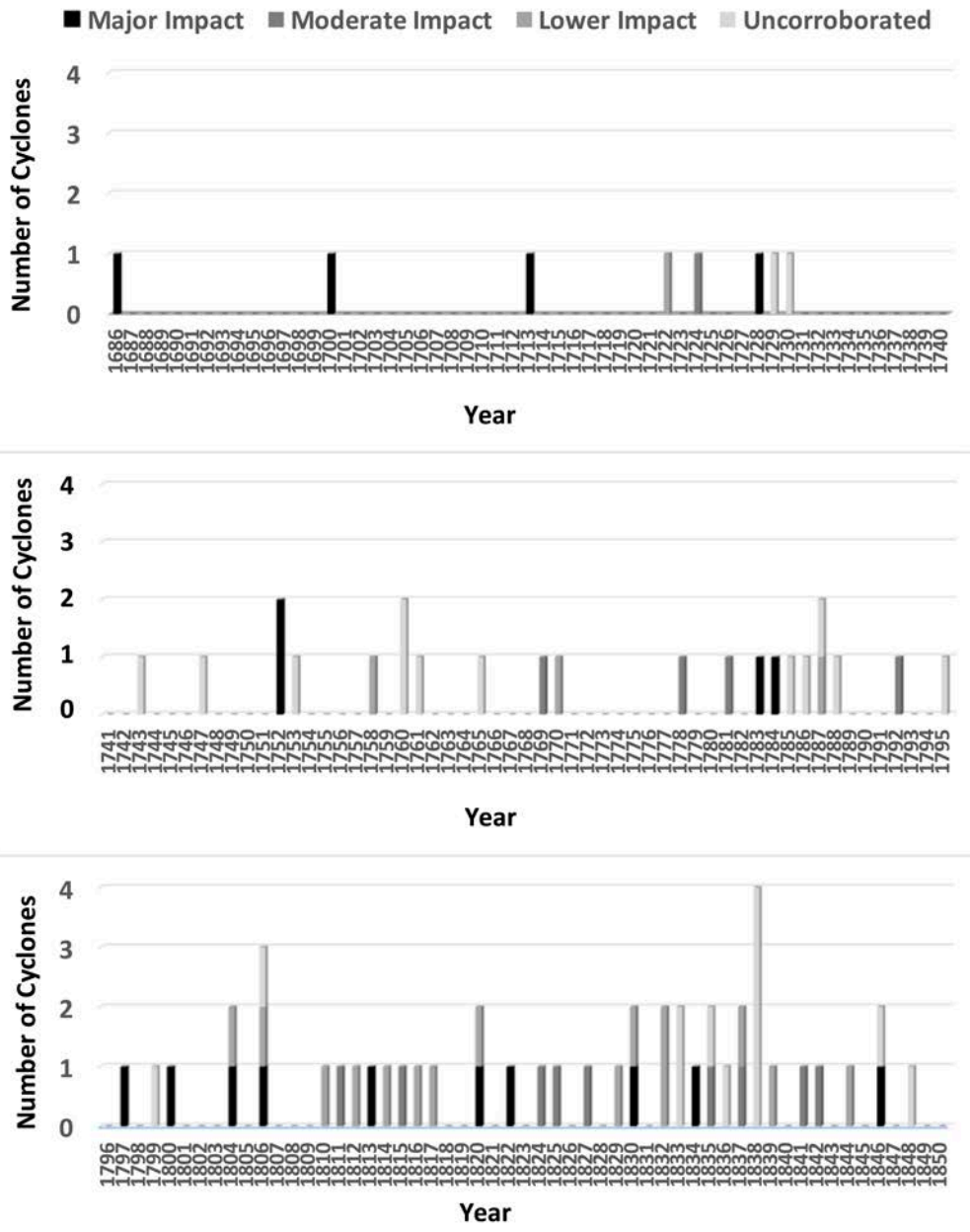

Number of Cyclones
0
10
20
0-5
5-10
10-15
15-20
20-25
25-30
30-35
35-40
40-45
45-50
50-55
55-60
60-65
65-70
70-75
>75
Translational Velocity (km/hr)

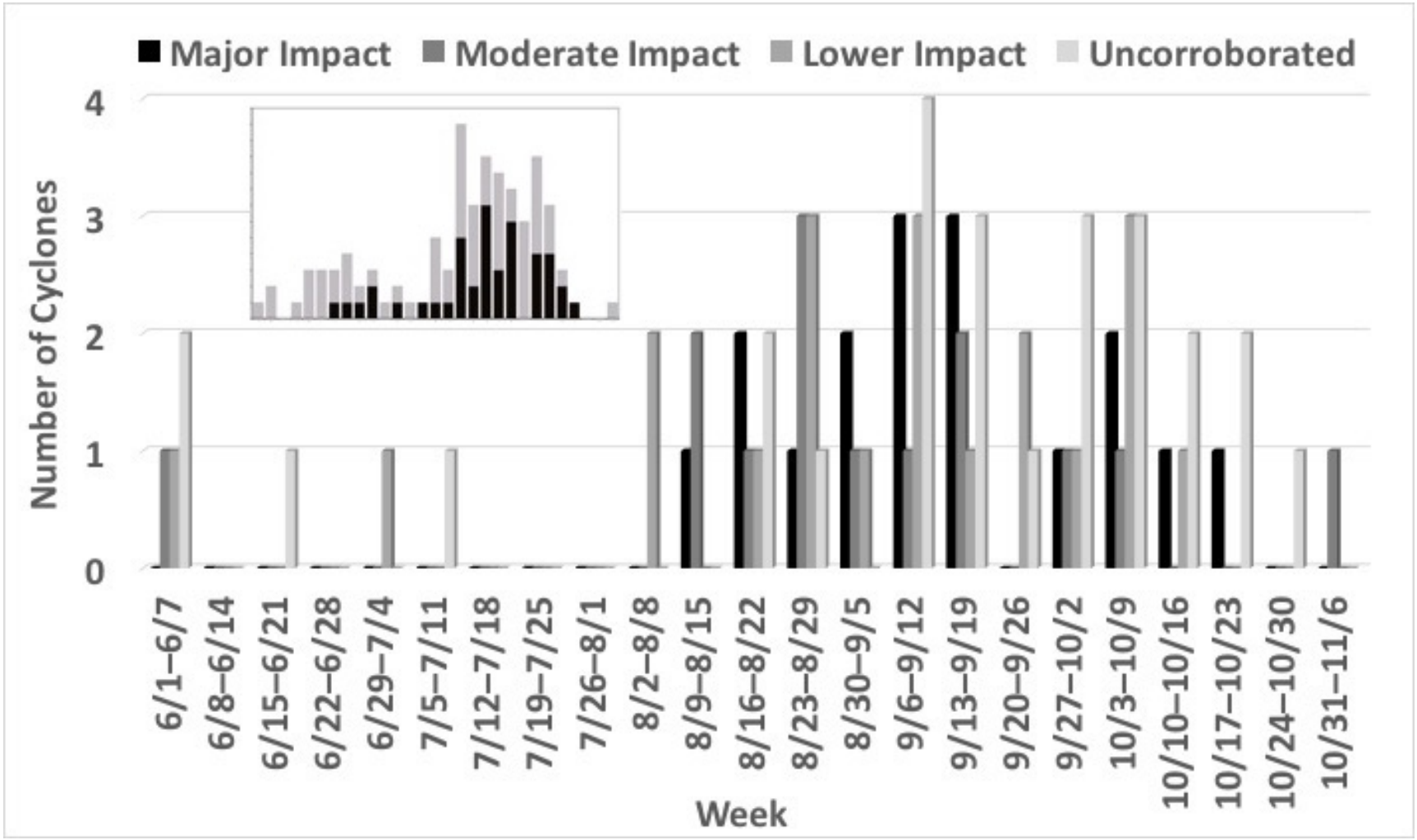

Average Translational Velocity (km/hr)
0
10
20
30
40
May
Jun
Jul
Aug
Sep
Oct
Nov
Month


Average Translational Velocity (km/hr)
0
10
20
30
40
1851-1870
1871-1890
1891-1910
1911-1930
1931-1950
1951-1970
1971-1990
1991-2015
Two-Decade Interval


A
B
Latitude (°N)
45
40
35
30
25
20
15
10
90 85 80 75 70 65 60 55 50
85 80 75 70 65 60 55 50
Longitude (°W)


Number of Cyclones
0
10
Approach Angle (degrees)
360-9
10-19
20-29
30-39
40-49
50-59
60-69
70-79
80-89
90-99
100-109
110-119
120-129
130-139
140-149
150-159
160-169
170-179
180-189
190-199
200-209
210-219
220-229
230-239
240-249
250-259
260-269
270-279
280-289
290-299
300-309
310-319
320-329
330-339
340-349
350-359


Major Impact
Moderate Impact
Lower Impact
Uncorroborated
Number of Cyclones
Year
0
1
2
3
4


Major Impact
Moderate Impact
Lower Impact
Uncorroborated
Number of Cyclones
0
1
2
3
4
6/1–6/7
6/8–6/14
6/15–6/21
6/22–6/28
6/29–7/4
7/5–7/11
7/12–7/18
7/19–7/25
7/26–8/1
8/2–8/8
8/9–8/15
8/16–8/22
8/23–8/29
8/30–9/5
9/6–9/12
9/13–9/19
9/20–9/26
9/27–10/2
10/3–10/9
10/10–10/16
10/17–10/23
10/24–10/30
10/31–11/6
Week

Return Rates

- Tropical storms and hurricanes
  - Modern era; 1.5 years
- Hurricanes
  - Modern era, 3.8 years
  - Historic era, 5.2 years (3.8 years 1778-1850)
- Major Hurricanes
  - Modern era, 28 years
  - Historic era, 12 years (9 years 1778-1850)

Other Conclusions

- Random strikes
- Secondary seasonal maximum
  - Shift to early dates in recent decades?
- Dichotomy in translational velocity, approach angle
  - Translational velocity and approach angle affect true wind speed, rain amounts, and storm surge
- Gulf of Mexico influence on return rate, seasonality, intensity, approach angle, translational velocity
  - Traditionally the public looks to the sea
- Active 1870-1910; Very active 1778-1850
- Meta-analysis potentially fruitful approach

Acknowledgements

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Notable Historic Hurricanes

- 1686 “Spanish Repulse Hurricane” destroyed most homes, ships in streets, many “great” trees lost, killed many people, flooded Beaufort
- 1700 “Rising Sun Hurricane” low tide & north, yet severe storm surge, 100 people dead, many homes destroyed, thousands of trees uprooted, new channels cut, many ships destroyed
- 1713 “Great Storm” north yet significant storm surge (two rivers connected), homes washed away, 70 deaths, ships ashore
- “Carolina hurricane of 1728” just south; streets filled with ships; inhabitants to upper stories; felled thousands of trees
- 1752 “Great Hurricane” just south; one of the worst; storm surge 3 m; coastal islands completely inundated, downtown homes & streets 2+ m water; residents to rooftops.
- 1752 ‘cane; surge, winds, rain; Wilmington 3 m storm surge

INTENSITY DISTRIBUTION OF TROPICAL CYCLONES THAT PASSED WITHIN 75 N. MILES OF CHARLESTON (1851-2015)