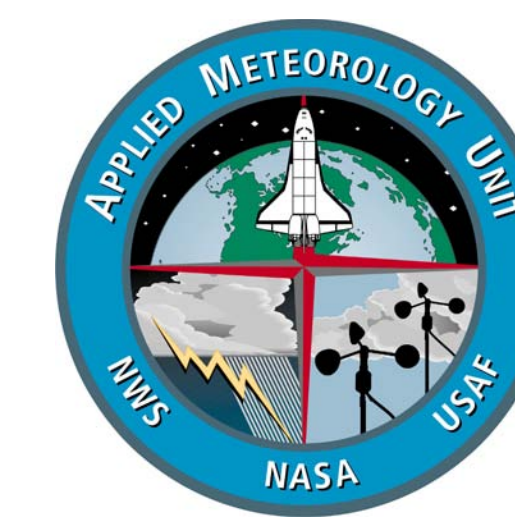


FORECAST RULES FOR PREDICTING THE NOCTURNAL LAND BREEZE OVER EAST-CENTRAL FLORIDA

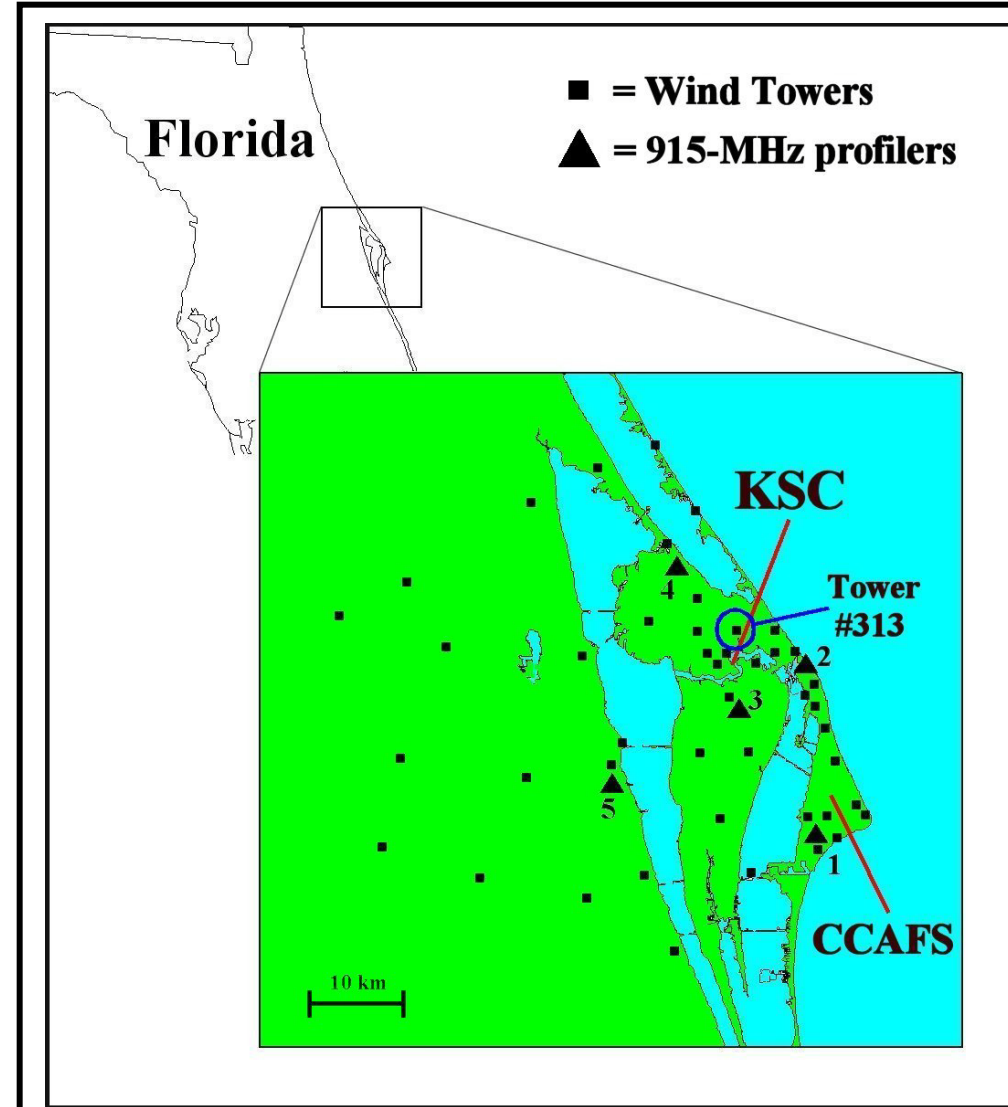


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David A. Short, and John Manobianco
NASA Kennedy Space Center /
Applied Meteorology Unit / ENSCO, Inc.

MOTIVATION FOR STUDYING LAND BREEZES

The land breeze can impact:

- Low-level winds
- Atmospheric stability near the surface
- Low temperatures
- Fog development
- Dispersion of toxic material during launch operations



DATA

- Local wind towers
 - 44 sites, 5-min data
 - Avg. spacing ~ 5 km
 - 915-MHz Wind Profilers
 - 5 sites, 15-min data
 - 130 m up to 6000 m*
 - NCEP/NCAR reanalysis data
 - MSLP fields
 - 2.5° x 2.5° resolution
 - Shuttle Landing Facility (TTS) surface observations
- *(depends on meteorological conditions)

DEFINITIONS USED FOR CLIMO

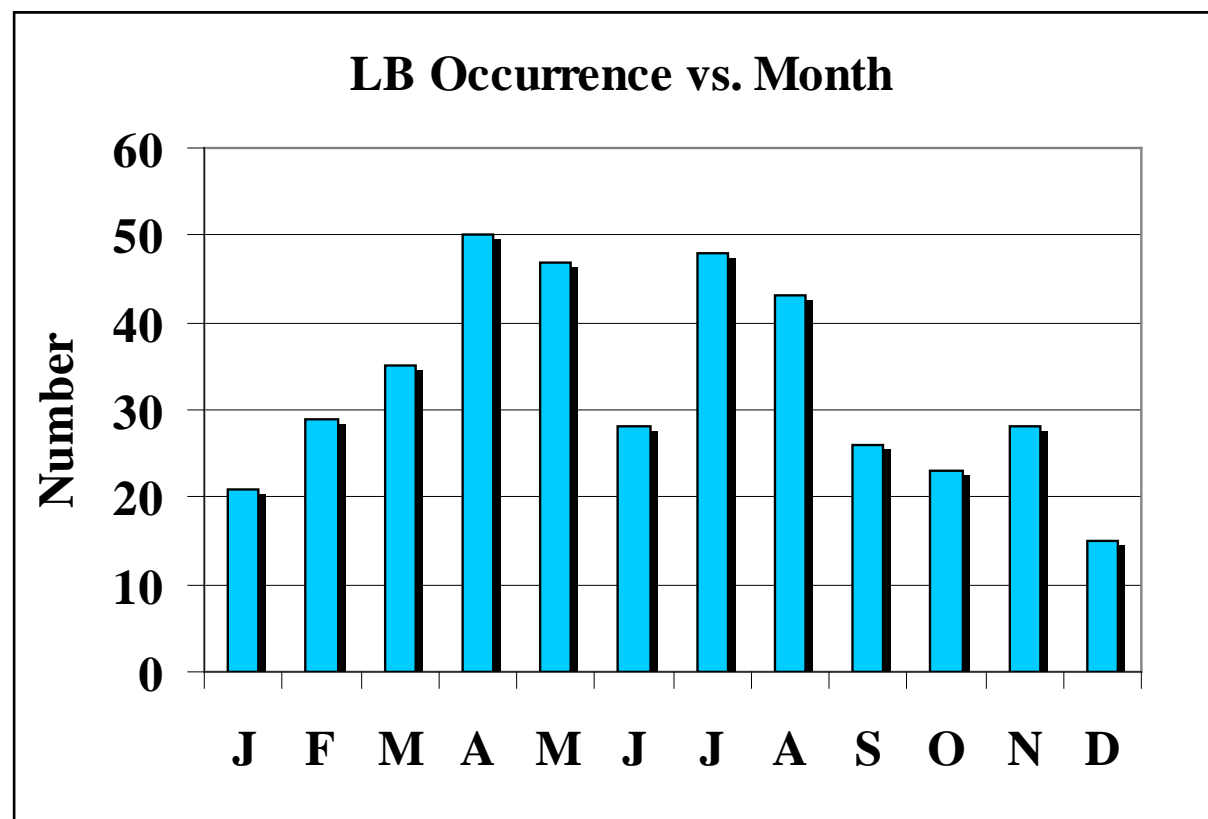
- Wind shift from onshore to offshore
- Wind-shift line must move towards the coast (W to E)
- Boundary must be continuous in space and time
- NOT associated with any synoptic features, such as fronts
- NOT associated with any precipitation outflow boundaries

OBJECTIVE IDENTIFICATION

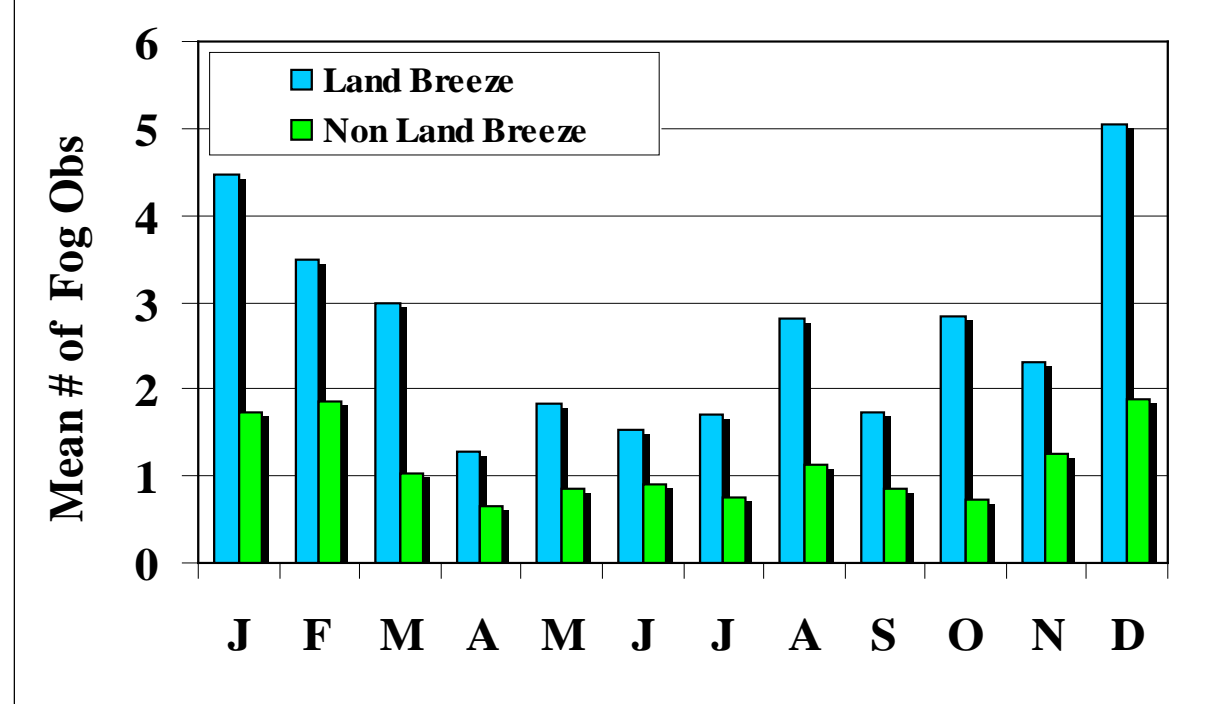
- Barnes objective analysis of wind towers every 5 min, on a 1.25-km grid
- 0000 to 1300 UTC, Feb 1995 to Jan 2002
- Program written to identify boundaries meeting definitions (left)
- Nights rejected from consideration:
 - Any precipitation report at TTS
 - > 50% cloud-ceiling reports at TTS
 - Pressure troughs/ large tendencies
 - Mean wind speeds above 7 kt

CLIMATOLOGY RESULTS

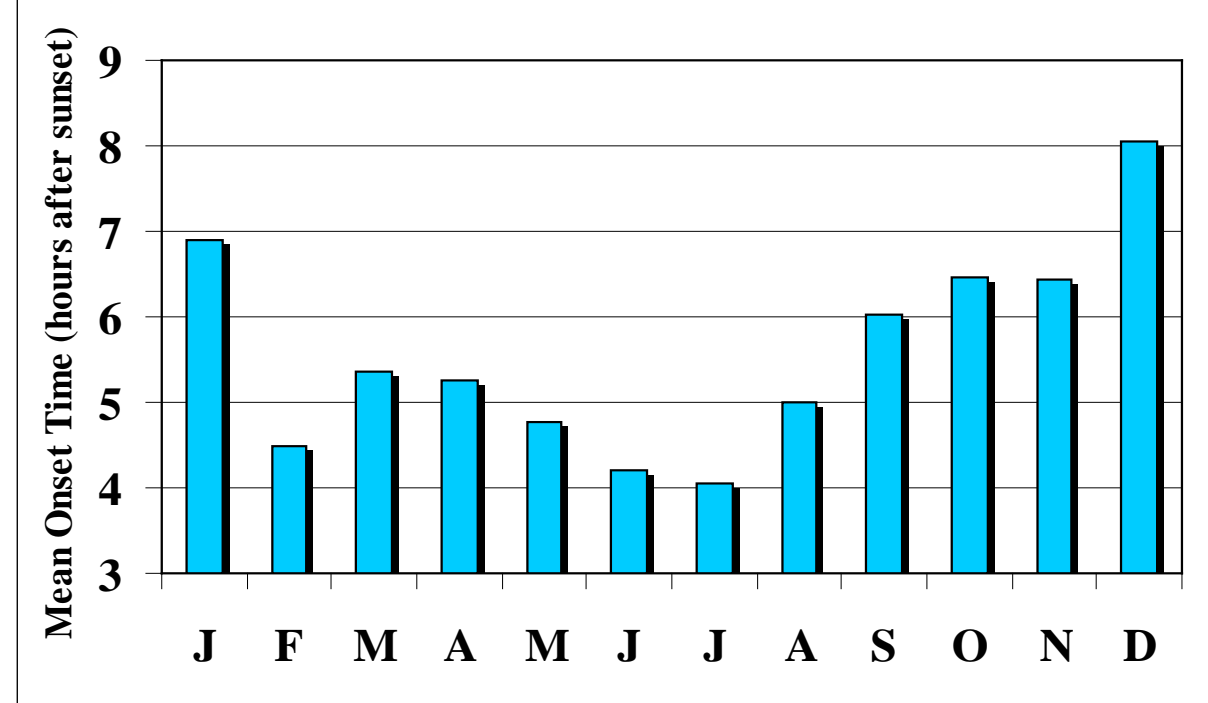
Breakdown by Month



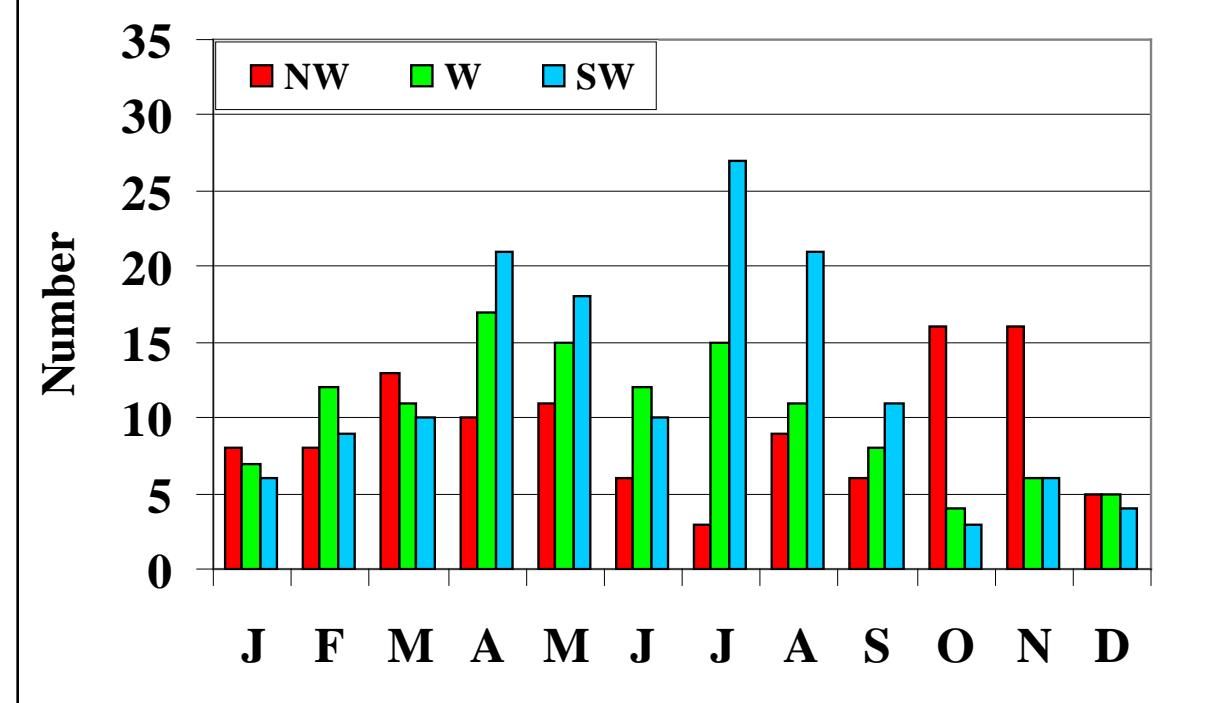
Mean # of Hourly TTS Fog Reports per Night



Mean Land Breeze Onset Times vs. Month

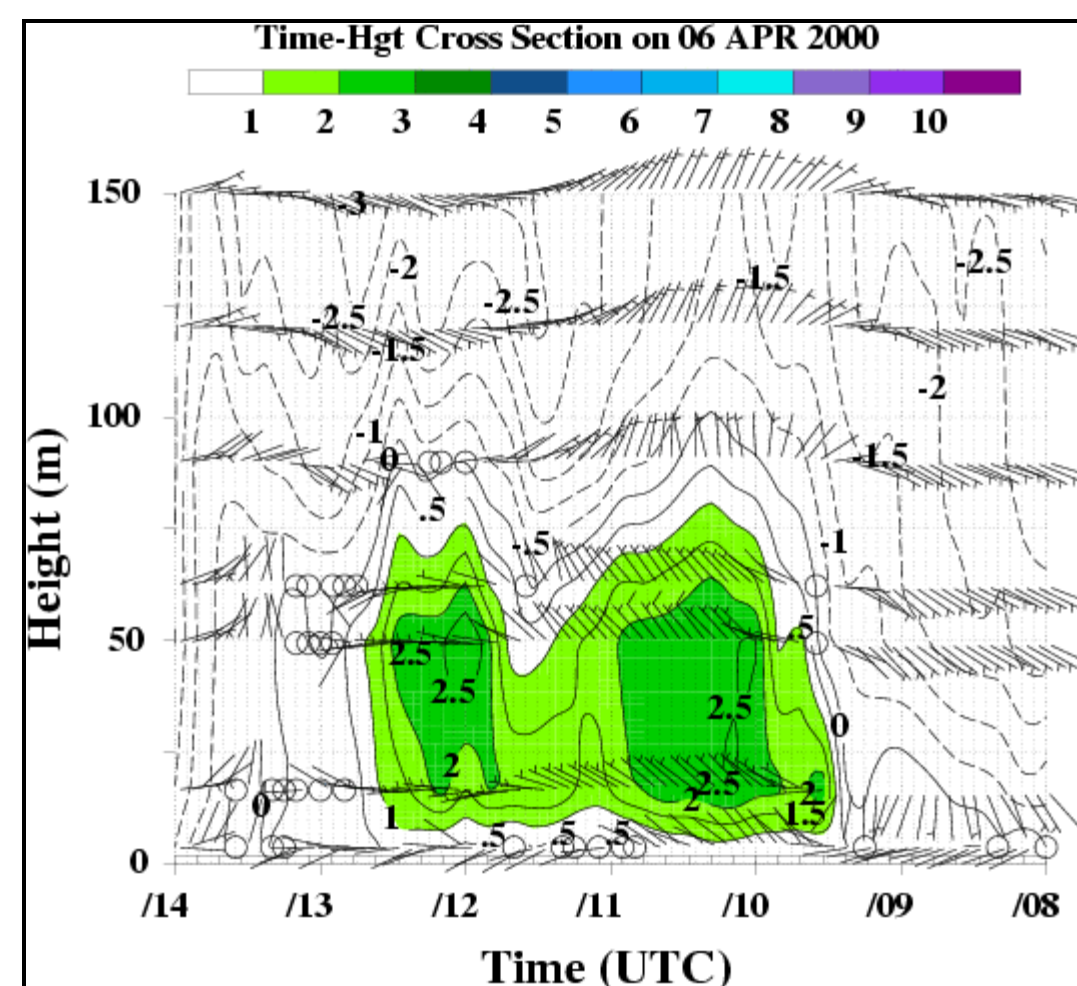


LB Direction vs. Month

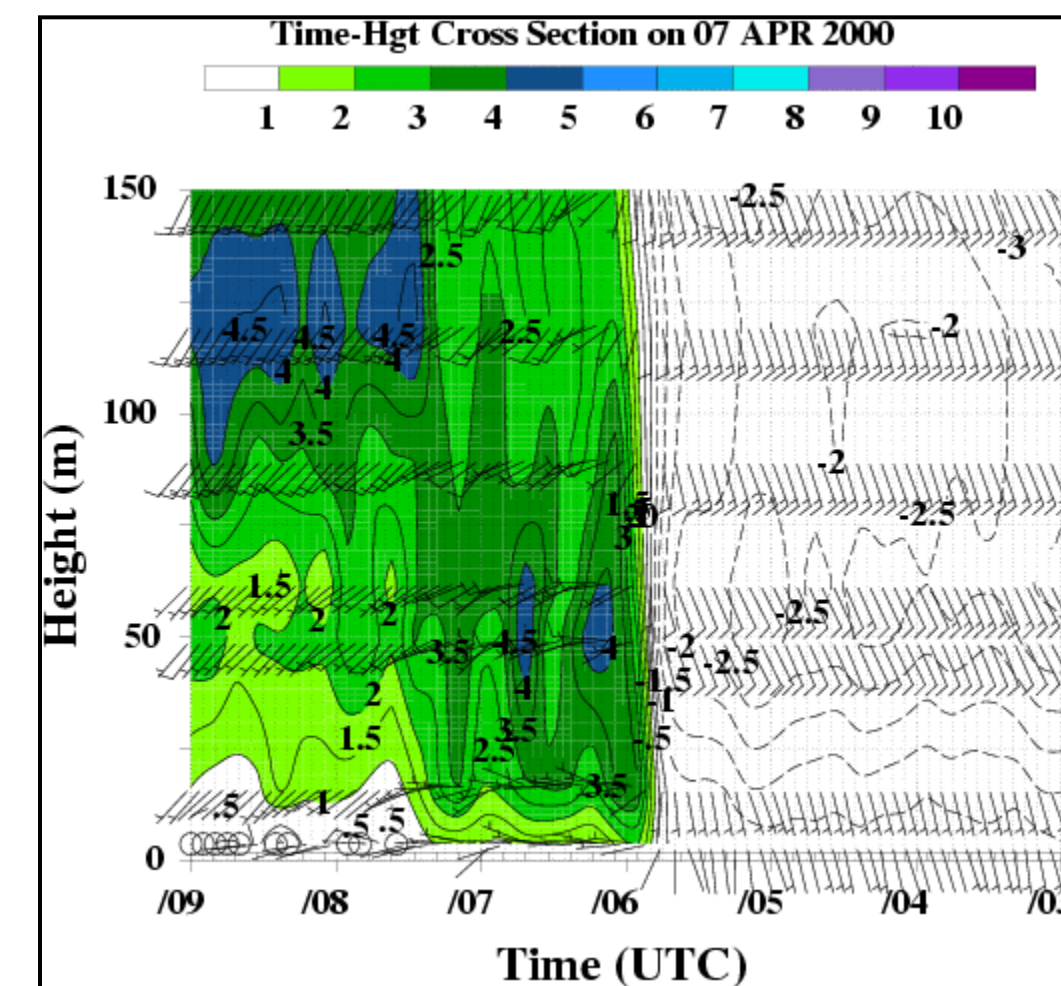


Land-Breeze (LB) Events at 492-ft tall tower #313

Shallow LB Example



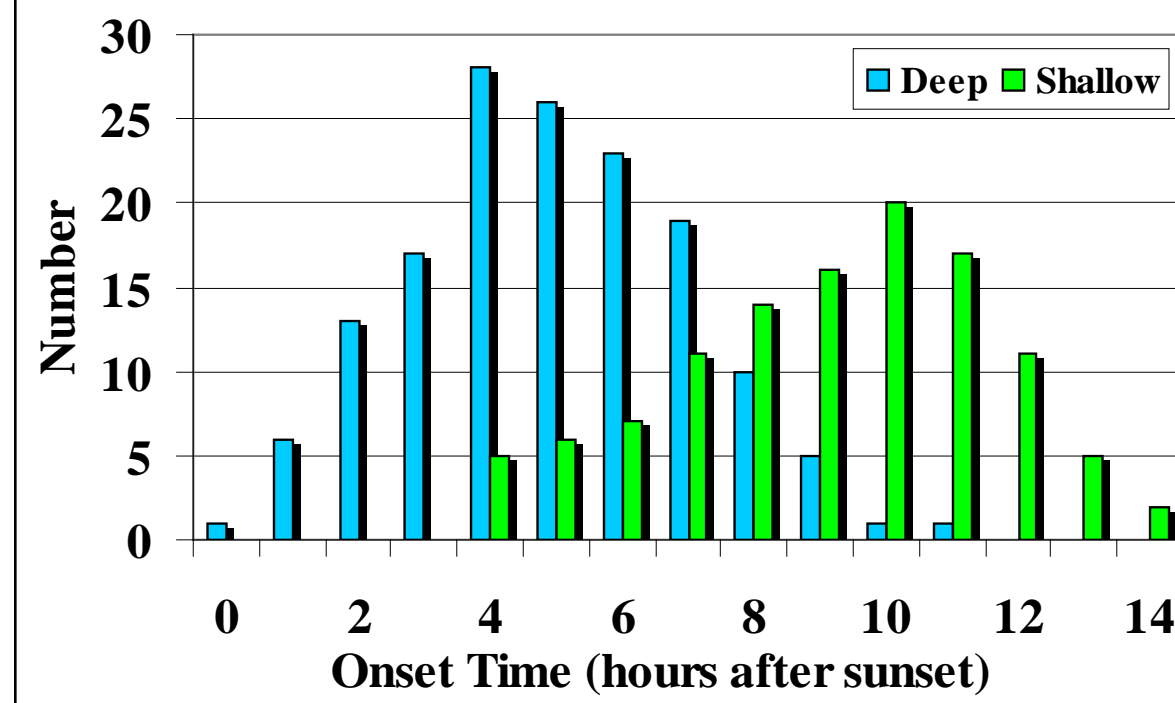
Deep LB Example



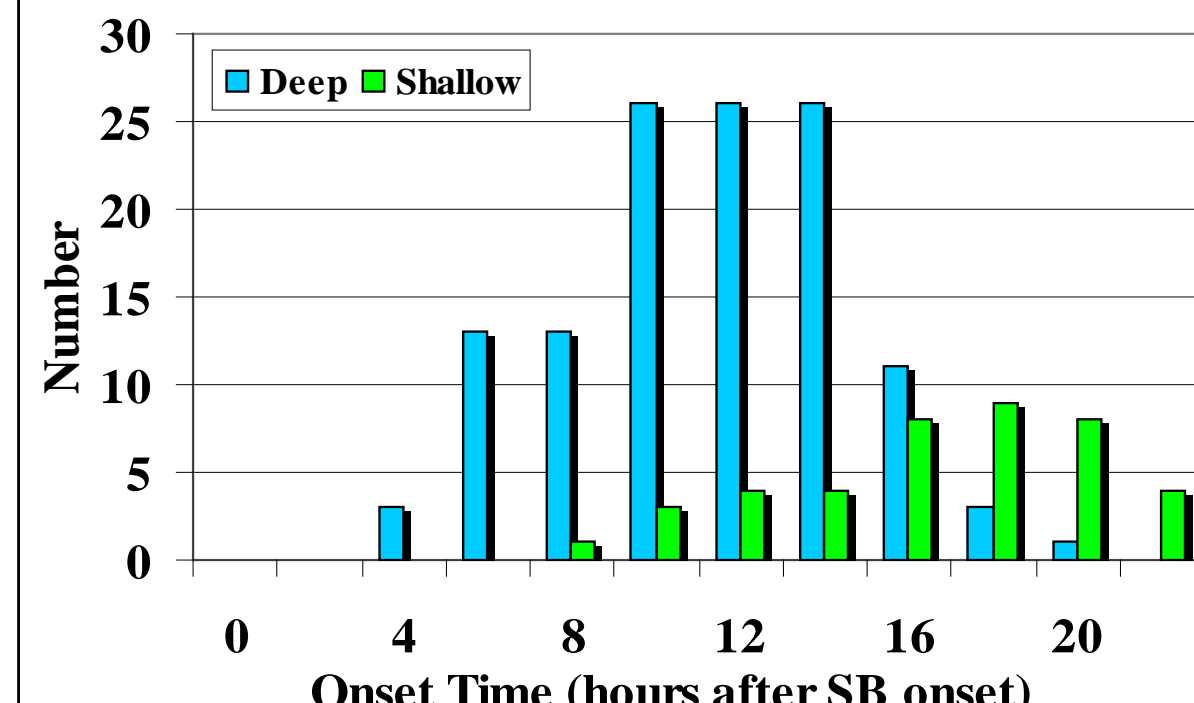
LB statistics at tower #313

Parameter	Deep: All	Shallow: All	Deep: Oct-May	Shallow: Oct-May	Deep: Jun-Sep	Shallow: Jun-Sep
# Days	150	114	84	78	66	36
Median	4.35	8.93	4.35	8.98	4.26	8.43
Min. Time	-0.27	3.23	0.88	3.32	-0.27	3.23
Max. Time	10.12	13.80	8.57	13.80	10.12	11.80
Day SB	122	41	66	24	56	17
No Day SB	28	73	18	54	10	19
% SB	81%	36%	79%	31%	85%	47%

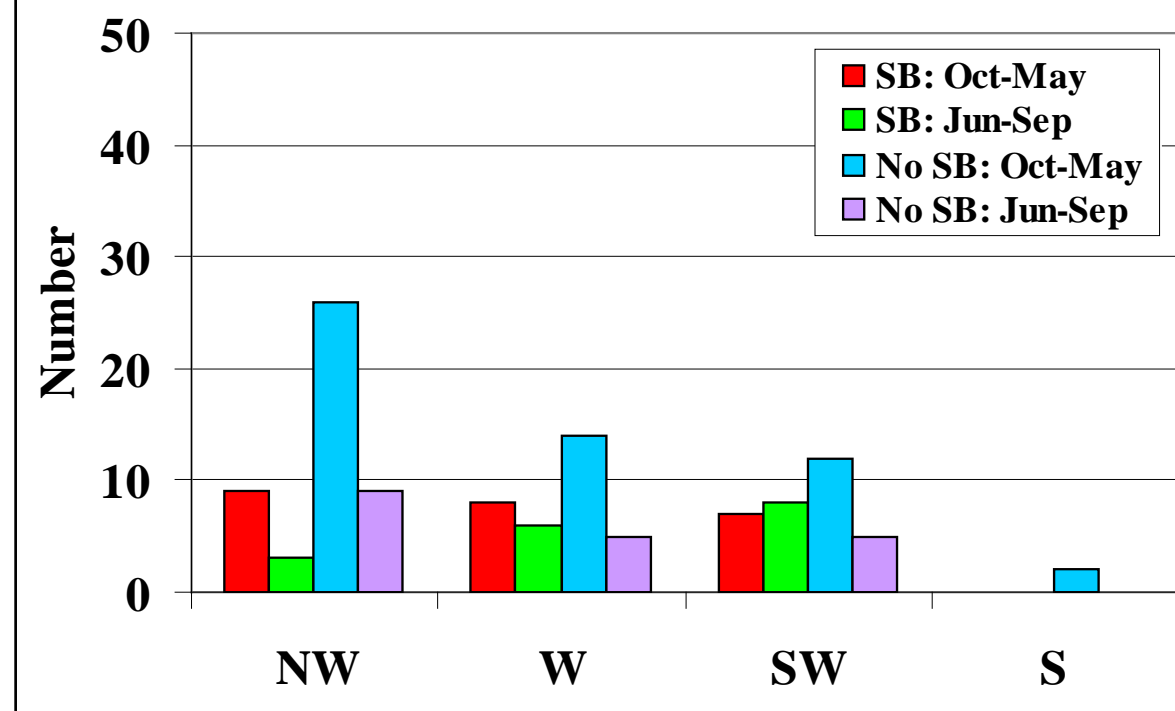
Tower 313, Deep vs. Shallow Events



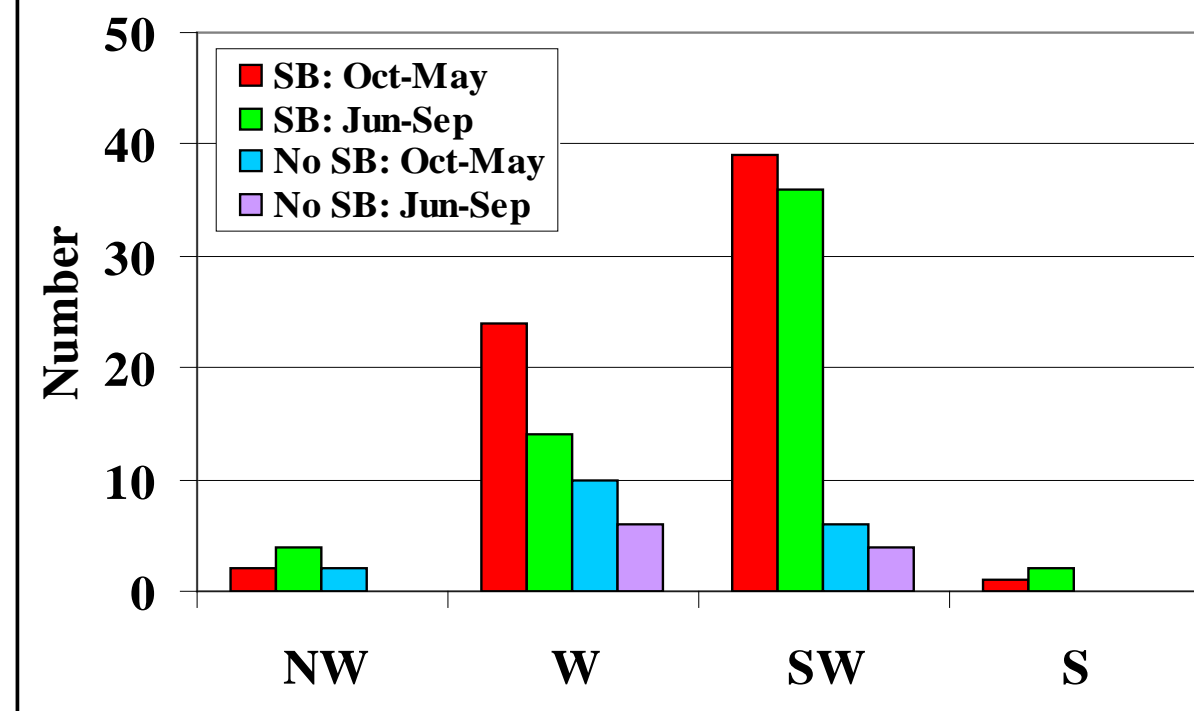
Tower 313, SB Events



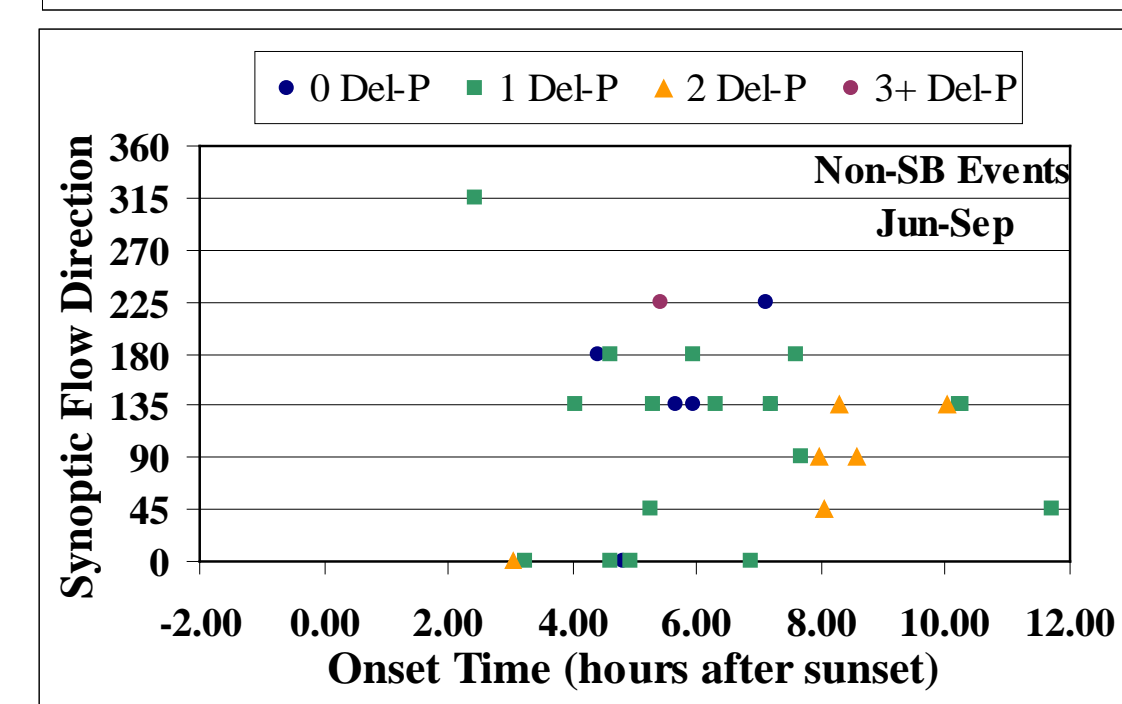
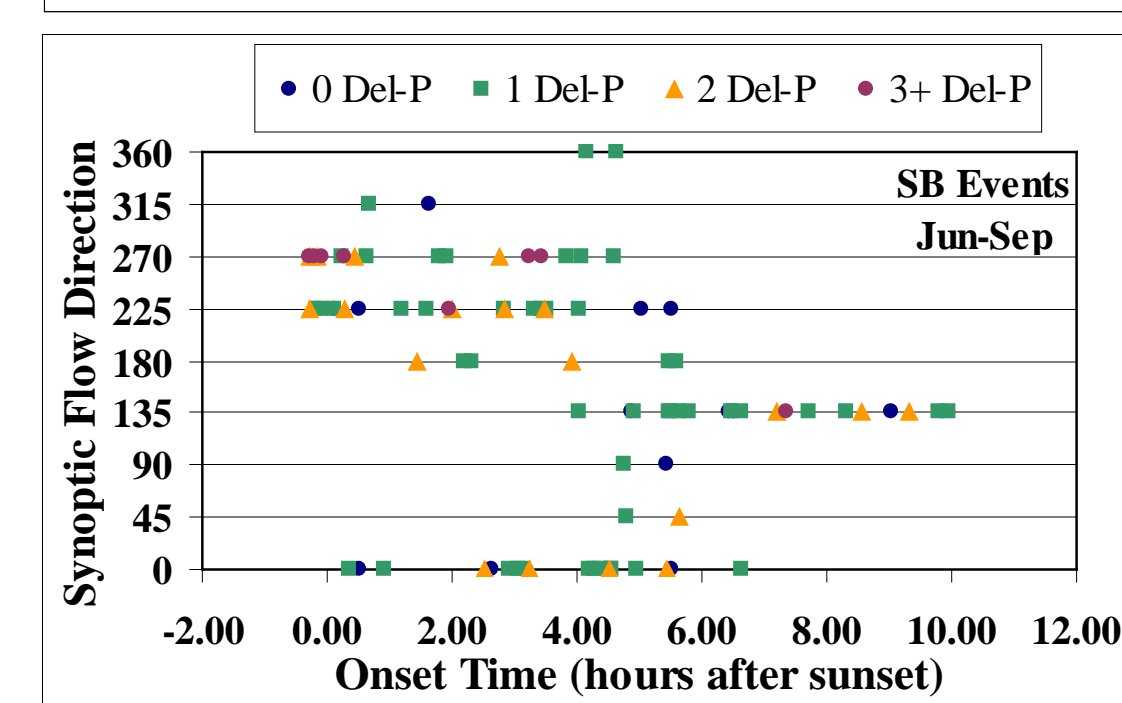
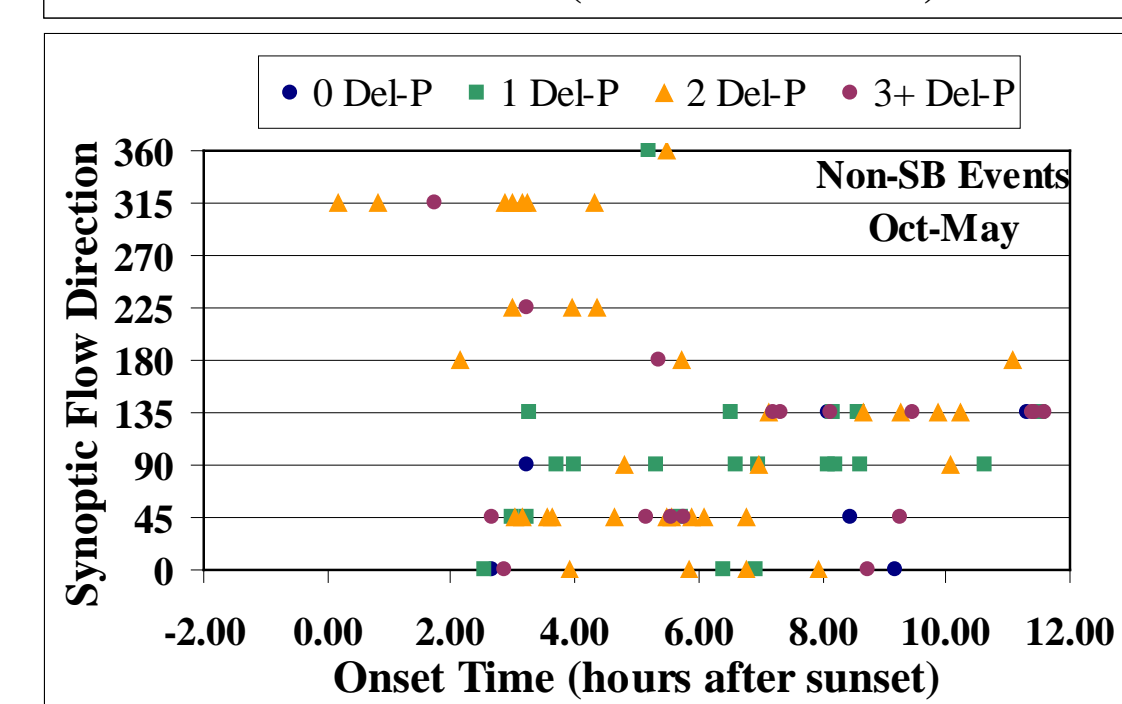
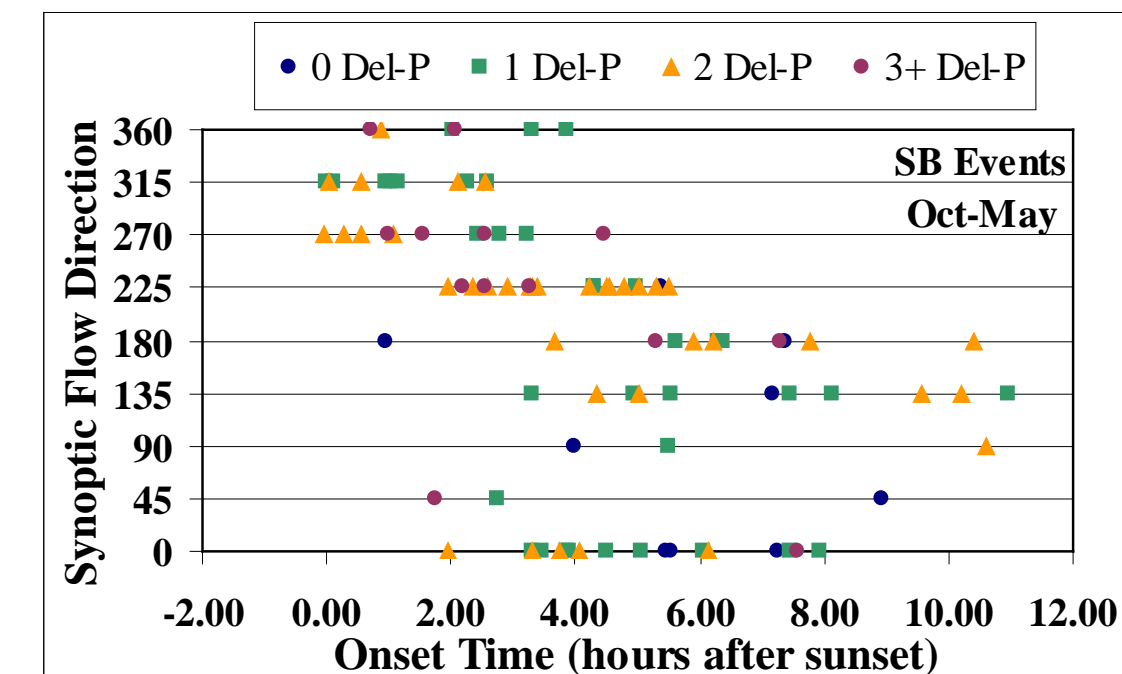
Tower 313 Shallow Events, LB Direction



Tower 313 Deep Events, LB Direction



Onset Time vs. MSLP Flow



FORECAST RULES & GUIDANCE TOOLS

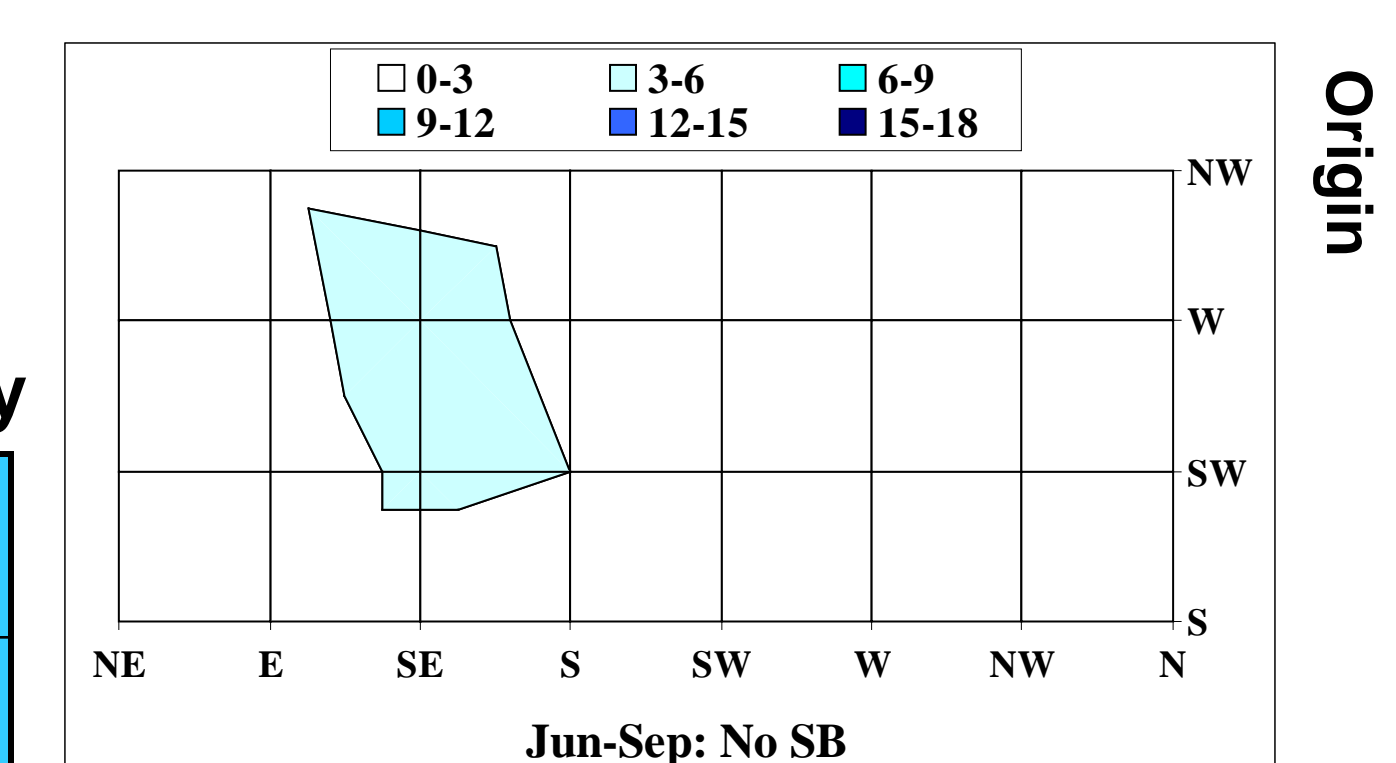
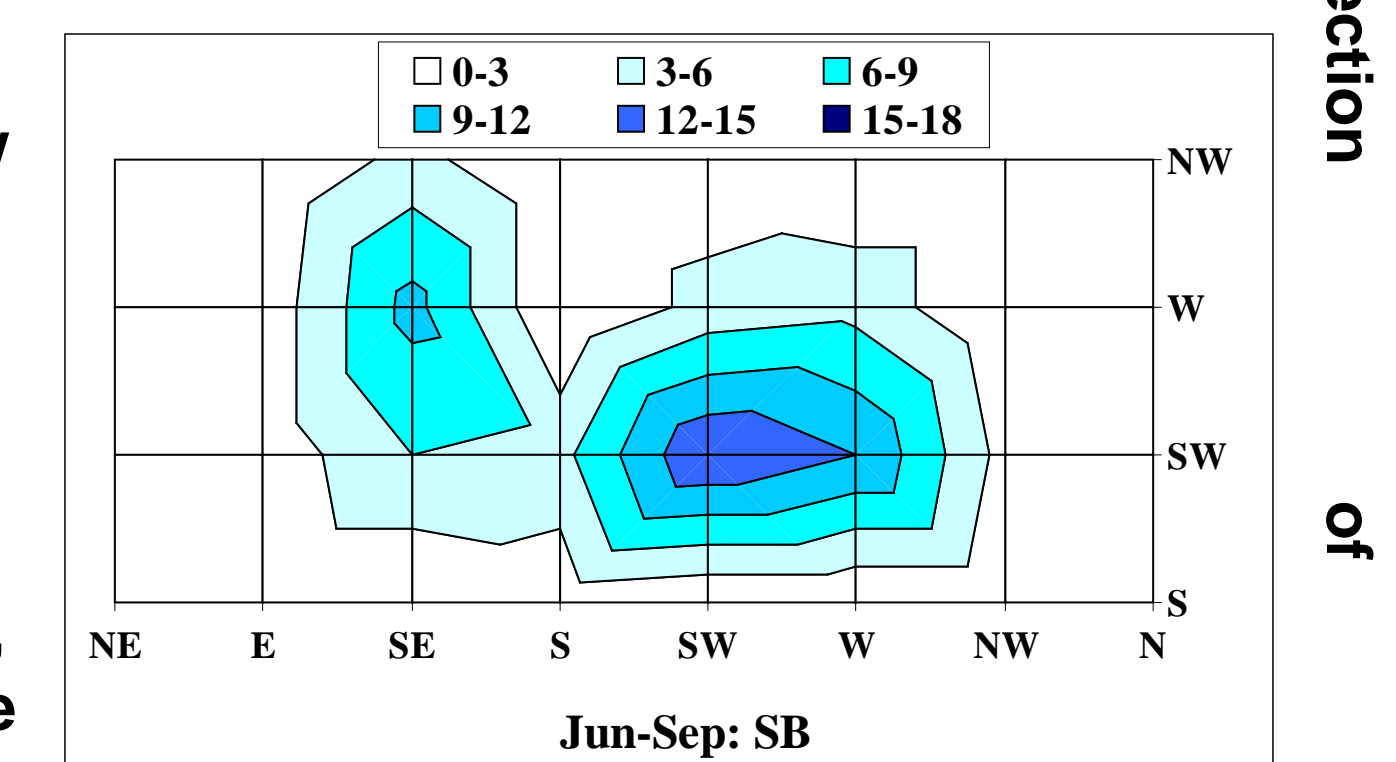
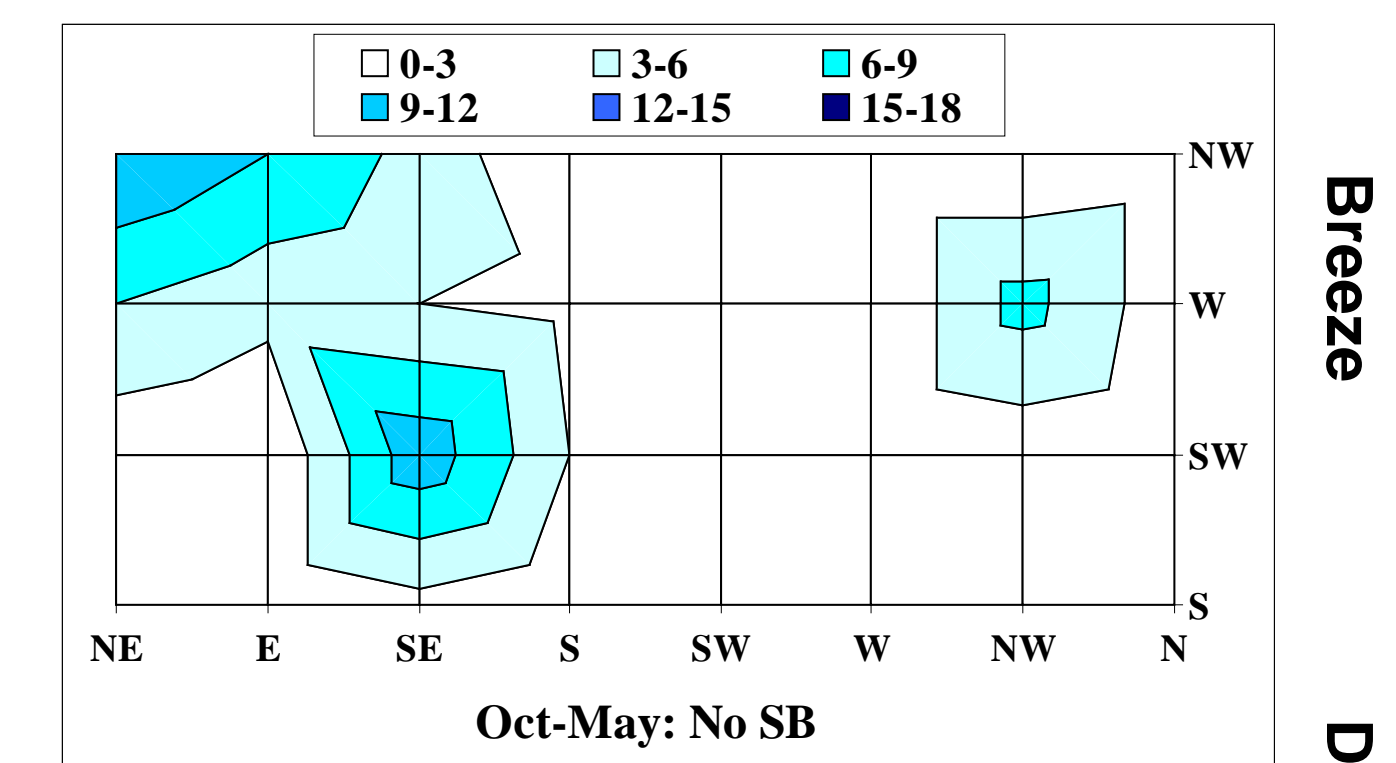
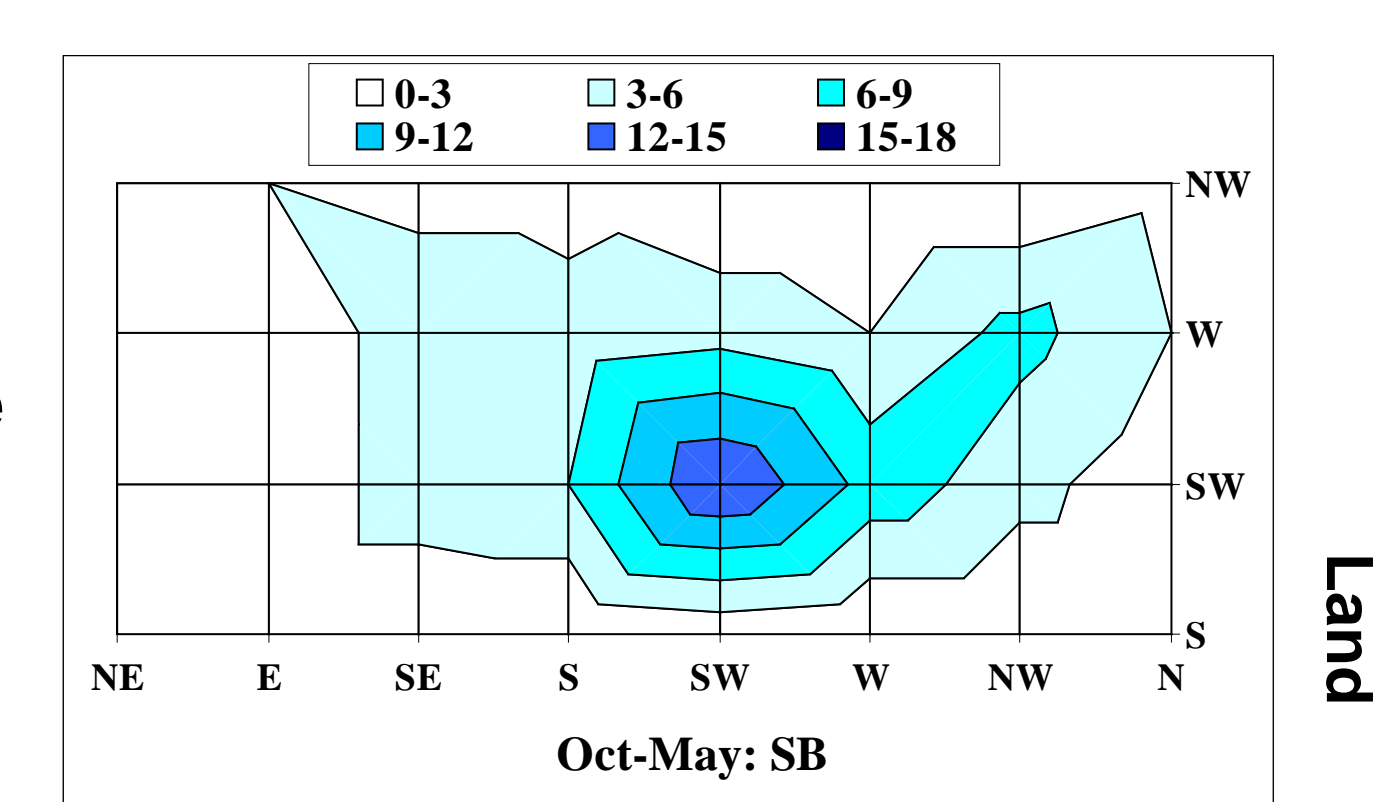
- Flow chart / decision tree
- Determine likelihood of occurrence based on climatology results
- Handouts provided
- Onset time tables
- Provide likely ranges based on synoptic flow, time of year, and sea-breeze occurrence
- Scatter diagrams shown to the left
- Sample table shown below
- Direction distributions
- Examine likely land-breeze direction based on synoptic flow, time of year, and sea-breeze occurrence
- Charts shown to the right

Sample Onset-Time Guidance Table: Jun-Sep, SB During Day

Surface Flow	Median Time	50% of Events	80% of Events	Min	Max	St. Dev.	Sample Size
Offshore	1.6	0.2 to 3.3	-0.2 to 4.0	-0.3	5.5	1.7	39
Onshore	6.5	5.5 to 7.9	4.8 to 9.2	4.0	10.0	1.7	24
Shore-Parallel	4.0	Too few*	Too few*	1.5	5.6	1.6*	8*
Light & Variable	4.2	2.8 to 4.6	0.8 to 5.4	0.4	6.7	1.7	19

*The percentile ranges were excluded for sample sizes less than 10. Use the standard deviation with caution for categories with such small sample sizes.

Frequency of LB Dirn vs. MSLP Flow



MSLP Flow Direction

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