

# The Sea-Breeze Low-Level Jet: Real or a Model's Imagination?

Authors: Arthur J. Weissmann and John W. Nielsen-Gammon

Presenters: Arthur J. Weissmann (Tues) and John W. Nielsen-Gammon (Wed-Thu)

Affiliations: Tom Clark High School and Texas A&M University

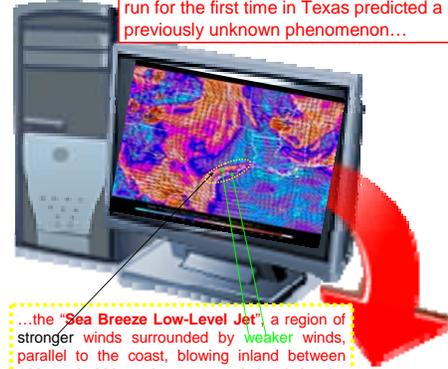
## Abstract:

During the Texas Air Quality Study, the MM5 high-resolution weather forecast model often predicted a "Sea-Breeze Low-Level Jet," a band of stronger winds surrounded by weaker winds that occurs in the evening, is located between 100 and 600m above ground level parallel to the coast, and often moves inland. This research project had two objectives: (1) to characterize a previously unknown meteorological phenomenon (the sea-breeze low-level jet), and (2) to obtain and analyze data to determine if this phenomenon really exists. The first objective required defining several descriptive and quantitative characteristics totaling 616 data points. The latter objective was accomplished by comparing 203 model forecasts to corresponding wind profiler observations. This comparison found 83.3% direction matches and over 63% speed interval and direction matches. Linear regression was used to fit a zero-intercept line to the predicted and observed wind speeds, resulting in a 96% adjusted R2 for a fitted line with slope of 1.078. Additional research is necessary to confirm these initial results and then to investigate the impacts of the sea-breeze low-level jet on pollution transport and sensible weather.

# Where does the Sea Breeze Go at Night?

## Characterization and Validation of the Sea-Breeze Low-Level Jet Phenomenon in Coastal Texas

### 1. Purpose, Scope and Significance of the Idea



...the "Sea Breeze Low-Level Jet" a region of stronger winds surrounded by weaker winds, parallel to the coast, blowing inland between 100 and 600m above ground level in the evening.

Scientists believe the sea-breeze low-level jet may carry pollution inland and affect thunderstorm formation in Texas, but...

### 2. Hypothesis and Research Approach

...before they use this new discovery to improve weather and air quality forecasts, scientists need to investigate if the sea-breeze low-level jet:

1. Can be properly characterized in the model and, if so,
2. IF IT REALLY EXISTS!

This is the original research that performed this work in two phases:

Project Phase	Specific Questions Answered	Variables Analyzed
I. Characterization	Are there specific and reproducible indicators of the sea-breeze low-level jet (SBLLJ) in the forecasts?	<b>Descriptive indicators:</b> wind direction, wind direction evolution, location, and spatial continuity. <b>Quantitative indicators:</b> timing, wind speed, wind speed differentials, and temporal continuity (duration).
II. Validation	Does the SBLLJ appear in wind measurements? In other words, does it really exist?	<b>Dependent variables</b> 1. Wind speed forecasts 2. Wind direction forecasts <b>Independent variables</b> 1. Wind speed measurements 2. Wind direction observations

### 4. Procedure

1. Check daily forecasts from 4PM to 1AM.
2. Record date, time, and SBLLJ pattern (yes or no).
3. If yes, record weak & strong wind speeds and direction forecasts corresponding to wind profiler locations.
4. Record wind profiler data corresponding to each predicted SBLLJ forecast.
5. Tabulate, plot and analyze data.

### 5. Data Recorded and Analyzed

The researcher observed daily weather forecasts between 6/1/06 and 7/22/06, finding 35 days totaling 145 hours with predicted sea-breeze low-level jet. Out of these hours, the researcher recorded the following data points:

#### Phase 1 – Characterization

- 377 wind speed forecasts
- 145 wind direction forecasts

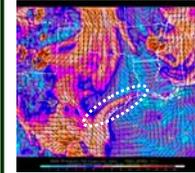
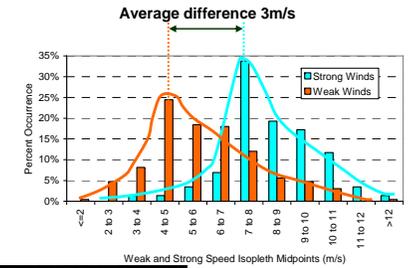
#### Phase 2– Validation

- Independent Variables**
- 205 wind speed measurements
  - 205 wind direction measurements

#### Dependent Variables

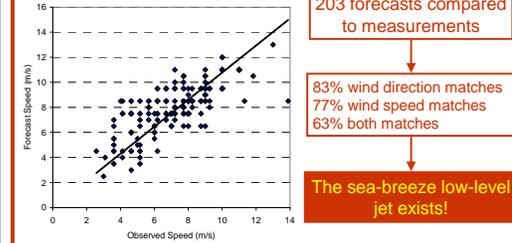
- 377 wind speed forecasts
- 145 wind direction forecasts

### 6. Phase I Results and Conclusions



Region of strong winds at least 4m/s  
Surrounded by winds at least 2m/s weaker  
Parallel to the coastline, at least 100mi long  
Blowing inland between 4PM and 1AM  
Lasting between 3 and 9 hours  
Dissipating 200-300mi inland

### 7. Phase II Results and Conclusions



### 8. Future Applications and Usefulness of Conclusions

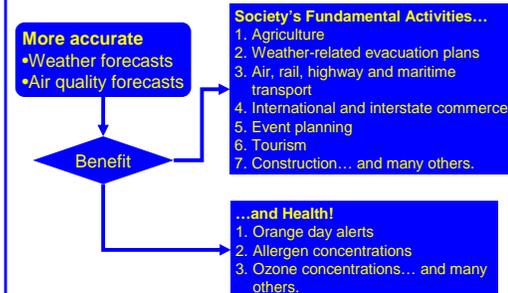
Confirm this study's original results by researching:

1. Wind heights other than 300m
2. Additional forecast observations and profiler measurements.

Then, investigate how the sea-breeze low-level jet:

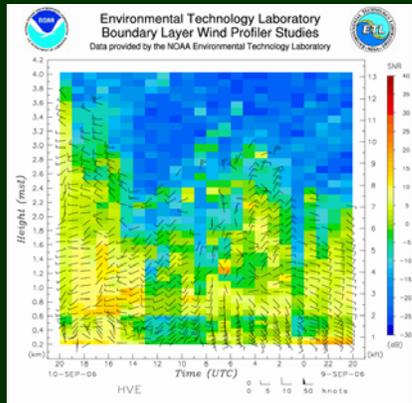
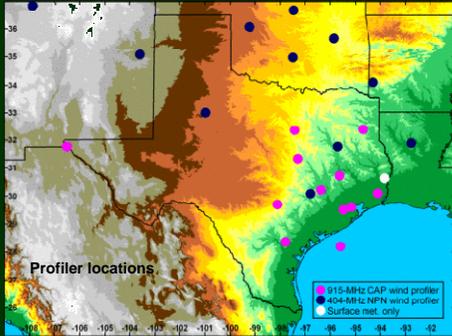
1. Carries pollution inland
2. Affects thunderstorm formation.

Use these results to improve weather and air quality forecasts.



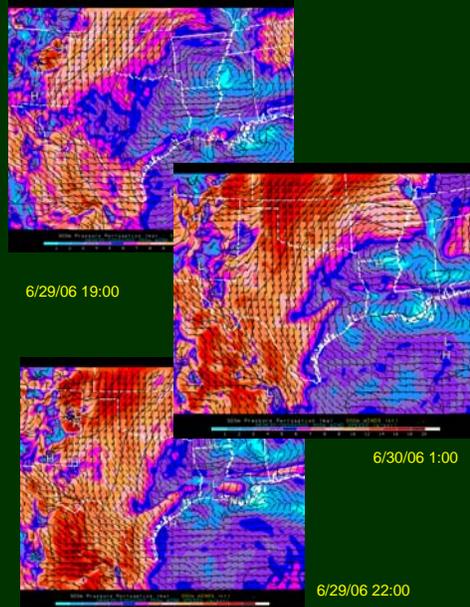
### 3. Materials and Methods

#### 3.1. Wind Profiler Measurements



Source: National Oceanic and Atmospheric Administration, <http://www.etl.noaa.gov/>

#### 3.2 Model Forecasts



Source: Texas A&M University, Mesonet, MM5 Model Images, <http://www.mesonet.tamu.edu>