Atmospheric Optical Turbulence Characterization at Lazer Bay (San Nicolas Island) 27 August 2014

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Outline

- Overview
- Background
- Setup & Equipment
- Sample Data Sets
- Challenges
- Future Work / Conclusions
- Big-Picture Tie-Ins
Overview

- Conducting extended-duration measurements of Atmospheric Optical Turbulence
- Characterize the local environment at “Lazer Bay” of San Nicolas Island
- Determine viability for analog to maritime environment
  - Measurements over the ocean
  - Winds incident from over water, measured prior to significant land interference
Understanding the atmosphere’s impact on optical propagation is critical to developing HEL systems.

Data from maritime environments is needed to:
- Validate predictive atmospheric models
- Corroborate HEL test results
- Increase understanding of maritime atmospheric turbulence
- Improve prediction methodology from varying meteorological inputs

Future seaborne HEL system testing
NAVAIR-WD Sea Range Geography

NAVAIR-WD Sea Range can install targets and sensors on many offshore islands, with optical paths across a marine environment.
Wind direction can minimize the littoral effects of the island topography.

-- Upper-air wind roses for San Nicolas Island, to 10K ft --

(16-point compass directions)
June-September - (n=26501)
(Concentric circles depict percent incidence)
End of each statistic is avg speed from that direction
(Standard deviation of speeds in parentheses below)

North 24.5%

East 12%

West 12%

South 24.5%

Calm: 0.3% of time

(16-point compass directions)
October - (n=6555)
(Concentric circles depict percent incidence)
End of each statistic is avg speed from that direction
(Standard deviation of speeds in parentheses below)

North 30%

East 24.5%

West 24.5%

South 15.5%

Calm: 1.8% of time

(16-point compass directions)
November-January - (n=15185)
(Concentric circles depict percent incidence)
End of each statistic is avg speed from that direction
(Standard deviation of speeds in parentheses below)

North 30%

East 24.5%

West 24.5%

South 15.5%

Calm: 1.8% of time

(16-point compass directions)
January-March - (n=18400)
(Concentric circles depict percent incidence)
End of each statistic is avg speed from that direction
(Standard deviation of speeds in parentheses below)

North 30%

East 24.5%

West 24.5%

South 15.5%

Calm: 1.8% of time

TAS site, Thousand Springs Pt, looking North
Sea Range Weather Station Locations

Legend:  
H = Handar,  
D = Nomad Davis,  
W = Weatherflow,  
B = Anchored Buoy,  
P = Wind Profiler,  
A = ASOS,  
F = Field Mill,  
G = Planned Addition

Point Mugu Area Closeup

San Nicolas Island Closeup

San Miguel Island

Santa Cruz Island

San Nicolas Island

03 Nov 2014
San Nicolas Island Optical Path Test Setup

BLS 2000 Scintillometer System set up across “Lazer Bay” on San Nicolas Island, approximate 3.9 km path.
Measurement Path
Geometry
Measurement Path Elevation
Initial Results:
Substantial Land Influence Data

$C_n^2$ measurements integrated over the path with weighting toward the center
(approximately 20m above the surface of the ocean)

15 Jul 2014 (Local)
Initial Results:
Partial Land Influence Data

$C_n^2$ measurements integrated over the path with weighting toward the center
(approximately 20m above the surface of the ocean)
Initial Results:
Near-Maritime Influence Data

17 Aug 2014 (Local)

Hs (m) 1.26 1.29 1.3 1.28 1.26 1.27 1.29 1.34 1.38 1.39 1.4 1.39 1.36 1.25 1.43 1.33 1.35 1.35 1.32 1.31 1.32 1.31 1.32 1.4 1.49 1.56 1.62 1.68
Tp(s) 14.3 14.3 14.3 14.3 14.3 13.3 13.3 13.3 13.3 13.3 12.5 14.3 13.3 13.3 12.5 15.4 15.4 13.3 14.3 14.3 12.5 12.5
Ta(s) 5.31 5.42 5.51 5.57 5.64 5.71 5.76 5.75 5.71 5.72 5.65 5.61 5.66 5.66 5.7 5.77 5.71 5.63 5.63 5.59 5.6 5.6

Seas:

\( C_n^2 \) measurements integrated over path, weighting toward the center (approx. 20m above the ocean surface)
Challenges

- One device = One measurement
- Atmospheric Turbulence is only one part of Propagation
- Limitations of the Scintec BLS 2000
  - Maintaining alignment
  - Keeping sensor lens clean
- Range accessibility / geographical / environmental challenges
The Next Steps

- Compare to NPS $C_n^2$ model in collaboration with Peter Guest and Paul Frederickson
- Compare to other measurement and modeling methods in collaboration with AFIT, NUWC, SPAWAR
Future Work

- Include other turbulence sensors in addition to the BLS 2000
- Introduce sensor systems beyond turbulence
  - Transmissometers (Absorption/Extinction)
  - Profilers (Turbulence/Scattering)
  - Increased Weather Monitoring (Surface Temperature, Water Temperature Profile, sea conditions, air/sea temp difference)
- Other propagation paths beyond Lazer Bay
  - San Nicolas Island to Santa Barbara Island?
  - Port Hueneme Oil Platforms?
- Lazer Bay Improvements
  - Additional Weather Stations & Sensors
  - MILCON P591, DE Test Facilities added to SNI
Big Picture

- Synergies with other characterization work
  - Maritime Atmosphere Refraction Study (MARS)
  - Directed Energy Test Bed
  - Atmosphere Characterization Effort (ACE)
  - NUWC Measurements
- Collaboration
  - M&S Communities
  - HEL Test and Evaluation
  - Naval Postgraduate School Initiatives
- Opportunity to assess prediction capabilities with meteorological data that varies in availability and fidelity
- Characterization of a potential laser test range
Questions?