Examining the Effects of Surface Waves on ALB Measurements

Matt Birkebak, Firat Eren, Shachak Pe'eri, Neil Weston

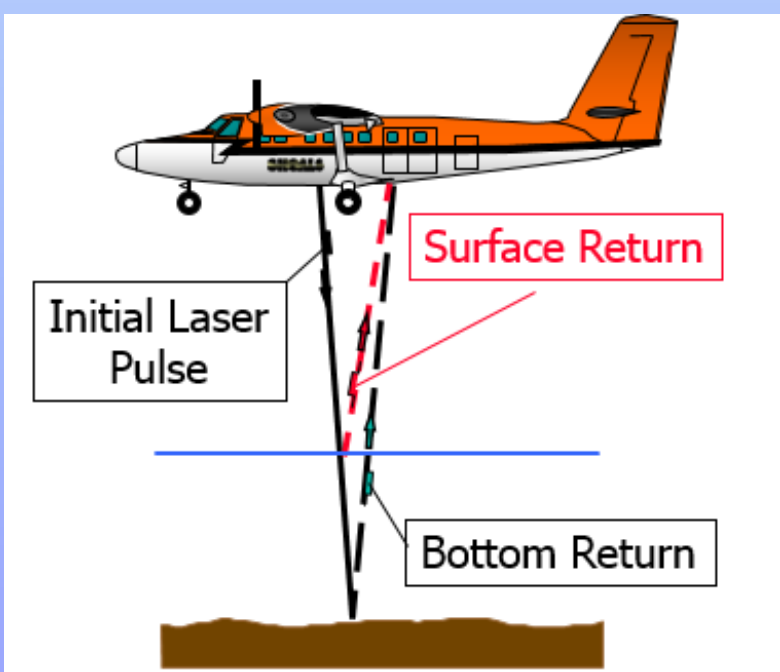
Center for Coastal and Ocean Mapping/ Joint Hydrographic Center

U.S. Hydro 2017

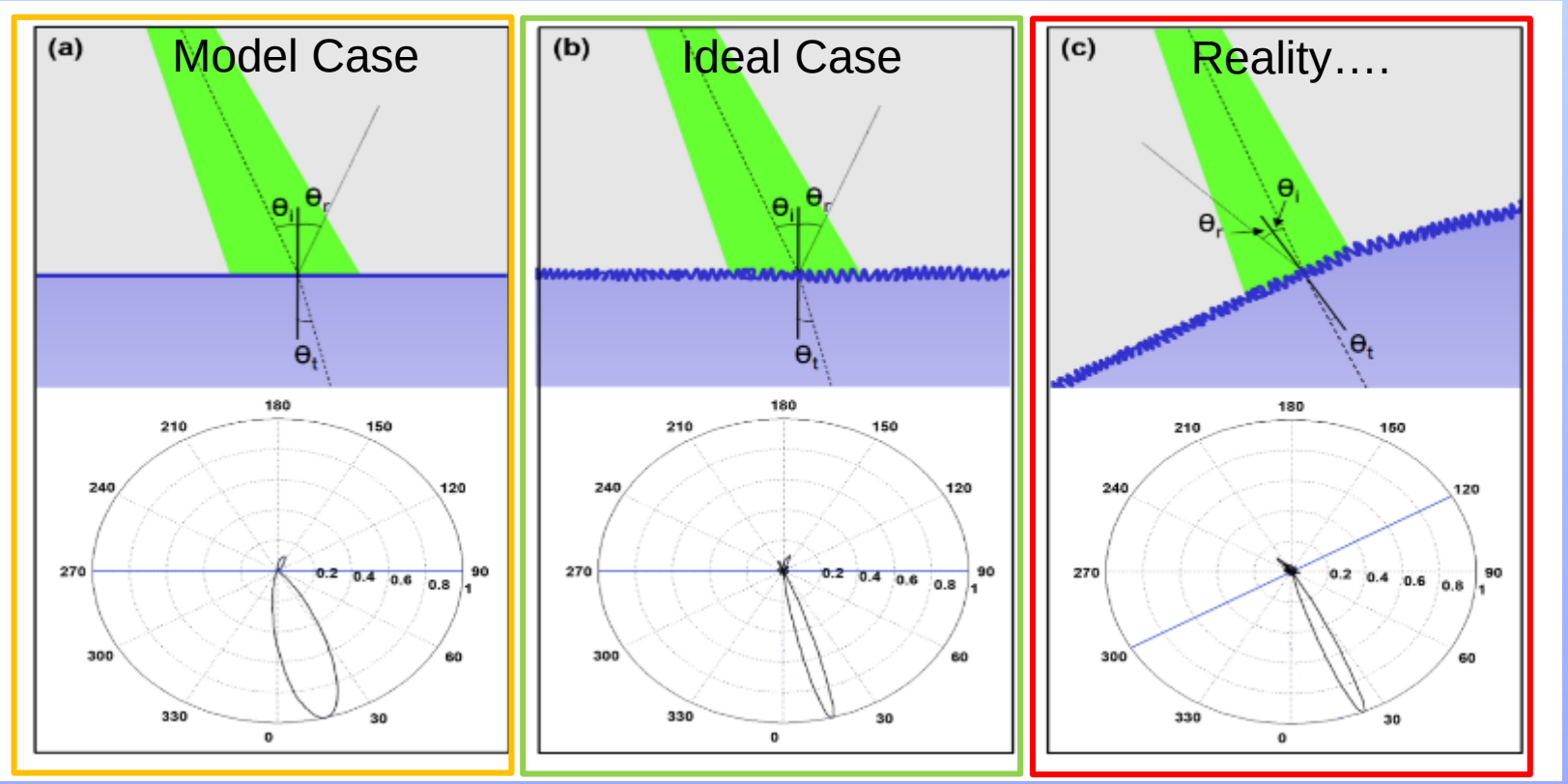
March, 2017

Airborne Lidar Bathymetry

- **Atmosphere**
- **Air-water interface**
  - Surface waves
- **Water column**
  - Absorption
  - Scattering
- **Seafloor characteristics**
  - Slope
  - Bottom composition



Optical Refraction



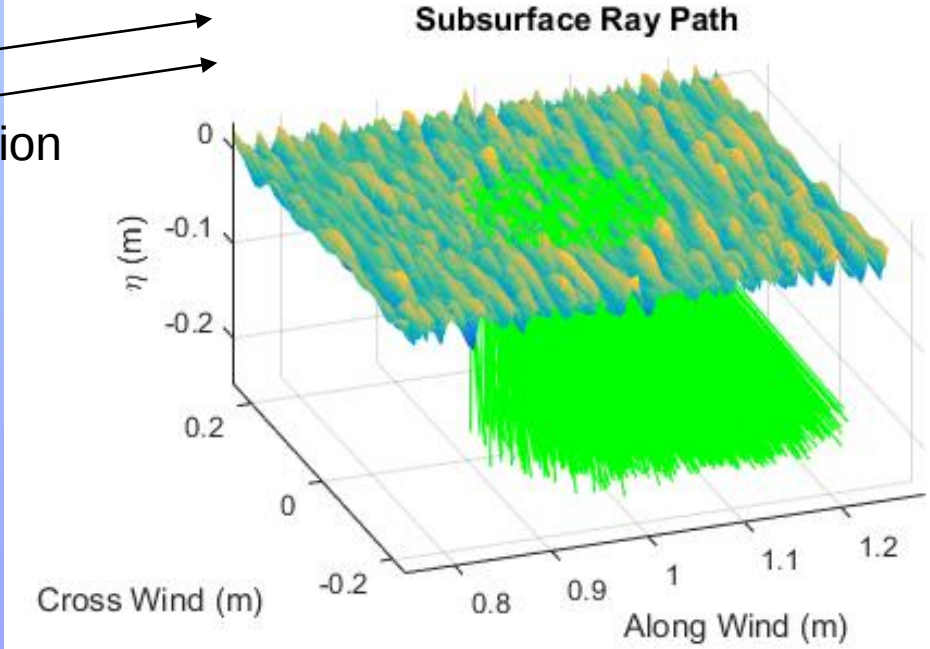
(a) Smooth Conditions (b) Surface ripples (c) Gravity waves

Surface ripples (short wavelength ~1cm) < Beam diameter (25cm)
Gravity waves (wavelength 1cm and up)

Pe'eri, Weber, Karlsson,2016

Monte-Carlo Ray Tracing

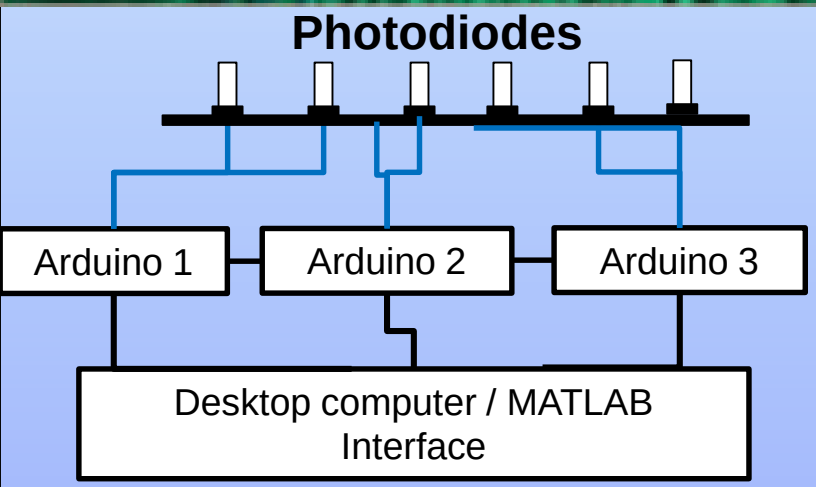
Wind Direction



Empirical Analysis

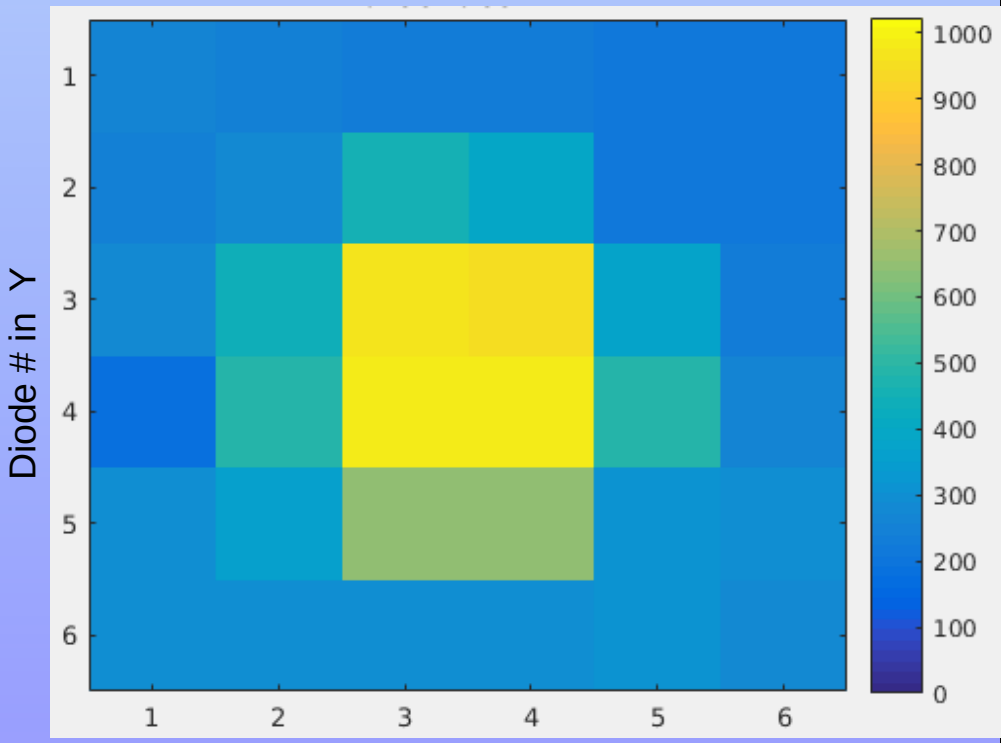
Water Surface Uncertainty due to Waves

Detector Array Concept

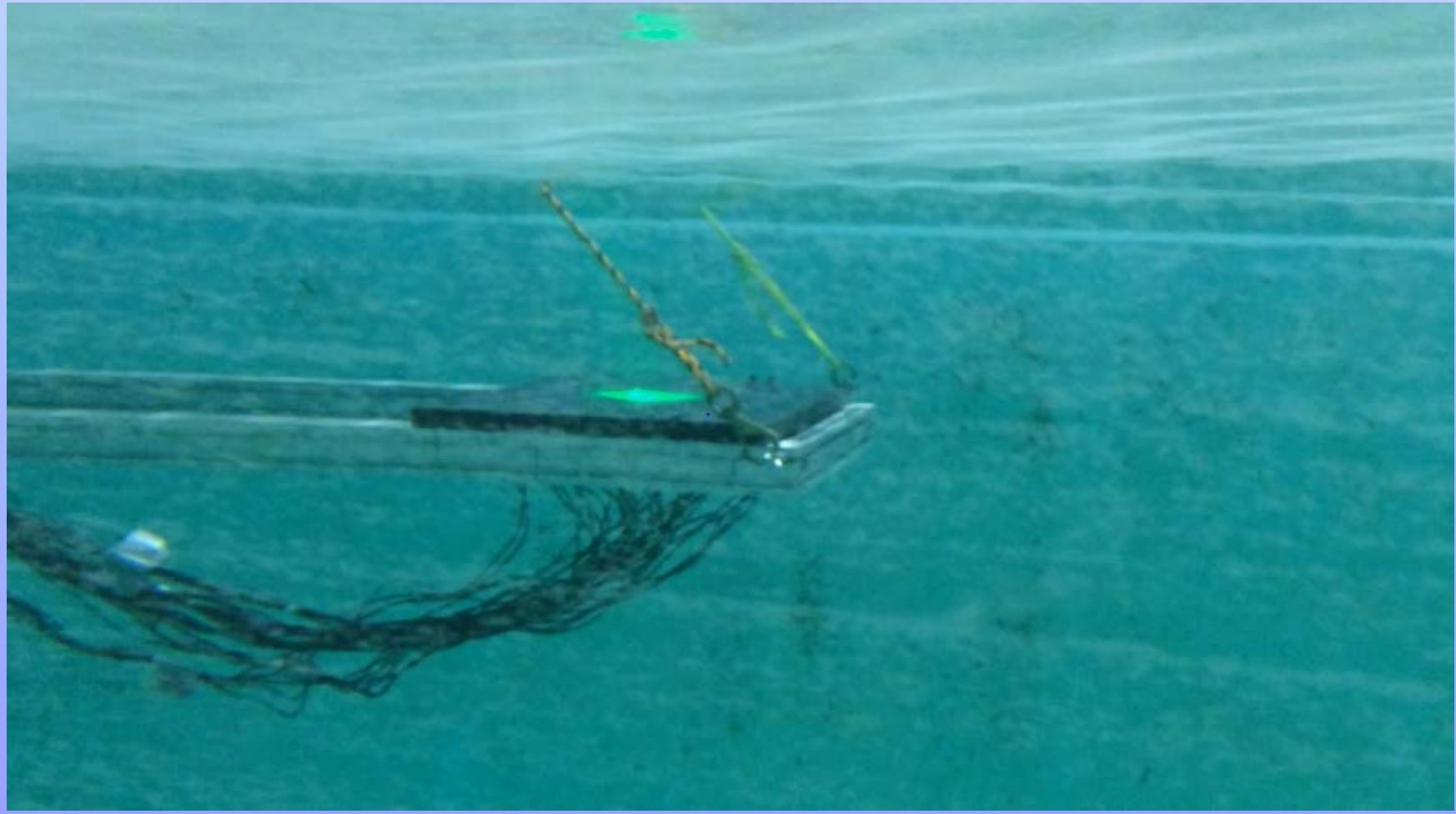


Optical Array (6X6 array)

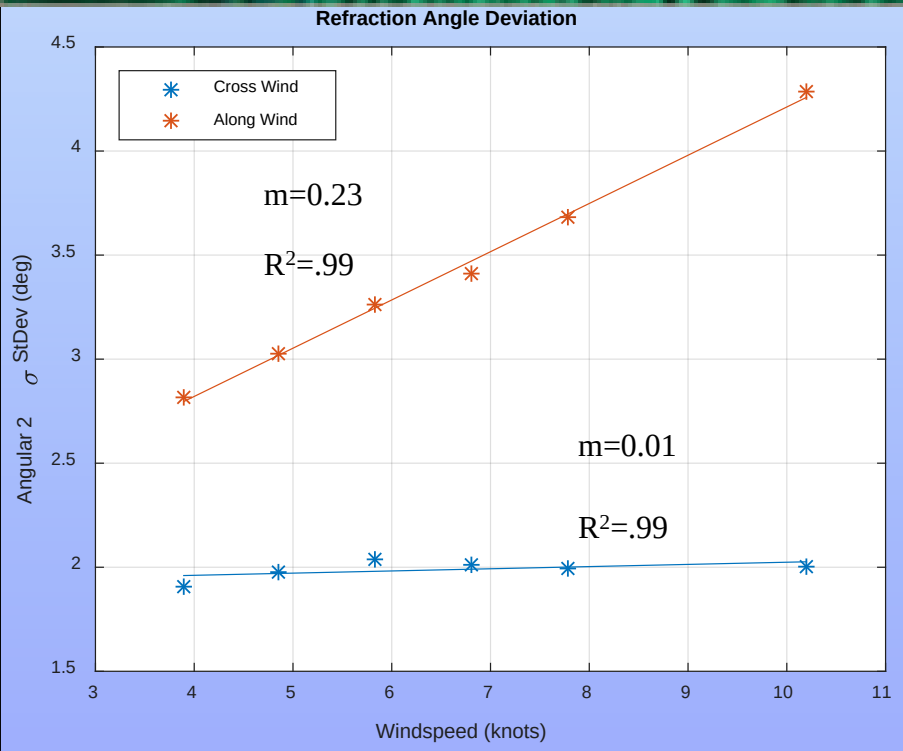
Laser Beam Energy Distribution

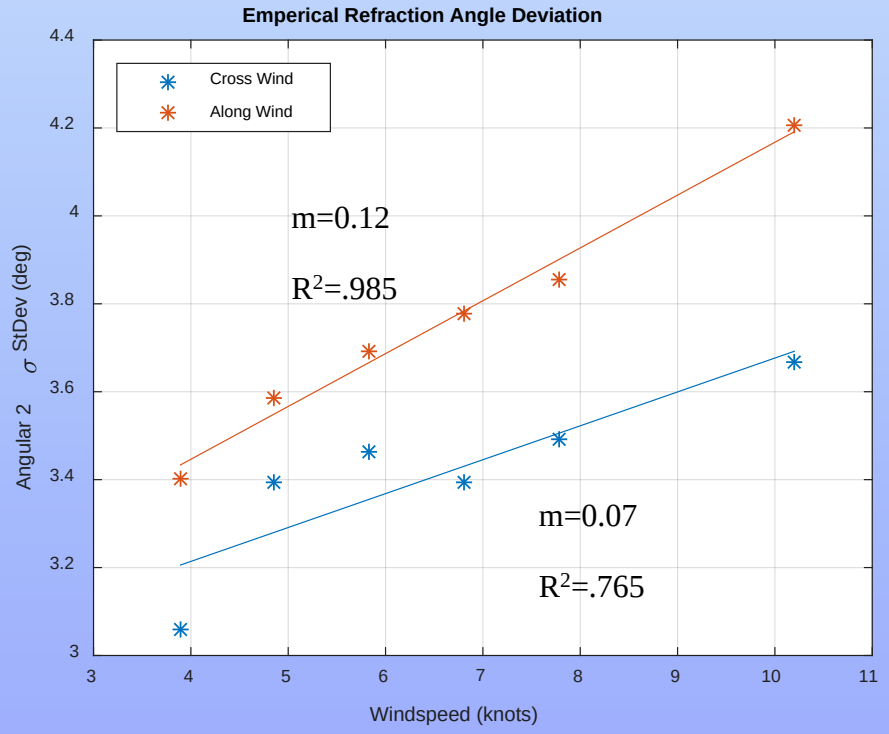


Water Surface Experiments



Water Surface Uncertainty





Wind Speed → Incidence Angle ↓	0 knots	4 knots	5 knots	6 knots	7 knots	8 knots	10 knots
0°	0	3.38	3.46	3.56	3.62	3.72	3.88
5°	0	3.4	3.48	3.58	3.66	3.74	3.92
10°	0	3.42	3.5	3.6	3.68	3.78	3.96
15°	0	3.64	3.78	3.94	4.08	4.24	4.54
20°	0	3.72	3.88	4.08	4.24	4.4	4.72

Conclusion

- The optical detector array developed can map the laser beam footprint and detect refraction angle deviations down to 0.1°.
- Small wind driven waves (wavelength< 0.1m) are capable of introducing refraction angle deviations up to 4.7° from the still water assumption.
- A look up table was produced for ALB Total Propagated Uncertainty reporting.

Questions?

Acknowledgements

– Naval Engineering Educational Center (NEEC)
  - Dr. Martin Renken (NAVSEA – Keyport, WA)
  - Prof. May-Win Thein (ME department, UNH)

– NOAA JHC Grant#: NA10NOS4000073
  - Paul Lavoie (CCOM, UNH)
  - Carlo Lanzoni (CCOM, UNH)
  - Yuri Rzhanov (CCOM,UNH)