COLLEGE OF ENGINEERING AND COMPUTER SCIENCE
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Announces the Ph.D. Dissertation Defense of

Kobold, Michael

for the degree of Doctor of Philosophy (Ph.D.)

"Background Structure Functions, A Basis to Reduce Acoustic Power Requirements and Improve Images"

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DEPARTMENT:
Department of Ocean and Mechanical Engineering

ADVISOR:
Pierre-Philippe J. Beaujean, Ph.D.

PH.D. SUPERVISORY COMMITTEE:
Pierre-Philippe J. Beaujean, Ph.D., Chair
Pak-Cheung An, Ph.D.
Manhar Dhanak, Ph.D.
Francisco Presuel-Moreno, Ph.D.

ABSTRACT OF DISSERTATION
Background Structure Functions, A Basis to Reduce Acoustic Power Requirements and Improve Images

Background Structure Functions (BSFs) are wavefront distortion metrics, functions of Sound Speed Profiles (SSPs) that are functions of depth. Use of these BSFs is a *synthesis* form of Matched Field Processing (MFP) that detects signals that are otherwise lost to receivers. Underwater Acoustics (UWA) can use these models to forecast communication and imaging performance and to reduce power radiated into the sea. This reduction of Transmission Loss (TL) occurs because the commercial wavefront control has an input format that accepts BSFs. The BSF plots represent the purely statistical distortion for communications and remote sensing. Another source of TL reduction comes from the enclosed BSF-based phase and phase variance forecasting that protects equalizers from losing phase-lock. Protecting the equalizers protects the Signal To Noise (SNR) ratios. This dissertation derives the UWA version of these metrics and applies them to the following locations of our SSPs: The BSFs use measured, corrected, and verified SSP groups for 132 different locations in the Atlantic Ocean and the Gulf of Mexico from a Navy Ocean Atlas, as well as 64 SSPs in two areas in the littorals, Port Everglades, and Saint Andrew Bay, plus tidal variations. Since BSFs digitize the propagation into one or more segments, our *purely* statistical phase screen model uses only 3 or 4 degrees of freedom (DOFs) per segment compared to many dozen DOFs for conventional structure functions. The BSFs forecast communications and imaging performance, including range, in locations where acoustic measurements are not available, but SSPs are. A separate algorithm forecasts Gouy phase anomalies from background SSPs, which otherwise requires *a priori* knowledge of anomaly location and use of Catastrophe theory due to ray theory failure at focuses. Avoiding these anomalies and loss of Phase-Locked Loops (PLLs) also helps maintain SNR and lowers transmission power requirements. Combining with phase parameters and performance forecasts improves UWA propagation efficiency using the background (SSPs). In a spatial version of delay equalization, BSF analysis also produces the enclosed Shear Distortion Ratios (SDRs) for the same locations mentioned above, to allow optimum selection of image enhancement algorithms that mitigate image shear distortion.

BIOGRAPHICAL SKETCH
USA
B.S. Physics and Math, University of Texas, Arlington, Texas, 1984
M.S. Physics, University of Michigan, Ann Arbor, Michigan, 1994
M.S. Electrical Engineering, Air Force Institute of Technology, WPAFB (near Dayton), Ohio, 2006
Ph.D., Florida Atlantic University, Boca Raton, Florida, 2024

CONCERNING PERIOD OF PREPARATION
& QUALIFYING EXAMINATION

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Published Papers: OCEANS 22, AIP-Advances, and two US Patents

1) Michael C. Kobold and Pierre-Philippe Beaujean, "Background Structure Functions for statistical acoustic propagation characterization", IEEE OCEANS 22, Hampton Roads, VA, Oct 2022.
2) Michael C. Kobold and Pierre-Philippe Beaujean. "Acoustic error approximation due to Gouy phase in the sea," AIP Advances 13, 075310 (2023).
3) US Patent 11431421, "Caustic Expander And Local Waveguide To Improve Acoustic Communications," 30Aug22
4) US Patent 11653125, "Method of Collecting Field-Based Data to Reduce Collected Data Error," 16my23