Algorithm Comparison for Shallow-water Remote Sensing

Curtis D. Mobley
Sequoia Scientific, Inc.
2700 Richards Road, Suite 107
Bellevue, WA 98005
phone: 425-641-0944 x 109 fax: 425-643-0595 email: curtis.mobley@sequoiasci.com

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LONG-TERM GOAL

The goal of this work is to evaluate several existing algorithms for inverting remotely sensed hyperspectral reflectances to extract environmental information such as water-column optical properties, bathymetry, and bottom classification.

OBJECTIVES

A number of investigators worldwide have been developing algorithms for recovery of bathymetry, bottom classification, and water-column optical properties (in particular, absorption and backscatter coefficients) from airborne hyperspectral imagery of optically shallow waters. Each of those algorithms presumably has its own strengths and weaknesses, or environments for which it may provide better or poorer retrievals than other algorithms. It is therefore necessary to determine the performance characteristics of all available retrieval algorithms. This objective of the present small effort is to finish an on-going comparison of those algorithms via the preparation of a paper on the comparison results.

APPROACH

A formal comparison of retrieval algorithms began in 2008 with previous funding under contract N00014-06-C-0177. In February 2009 a workshop was held in Brisbane, Australia, with sponsorship by the U.S. Office of Naval Research (ONR-Global) and the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO). Participants at that workshop compared the results obtained by applying their own algorithms to a common set of images. Participants then mapped out a corresponding publication (Phinn et al., in preparation), which is being finished with the present funding.

WORK COMPLETED

Reprocessing of the Moreton Bay, Australia image using an expanded remote-sensing reflectance database was completed (discussed in the report on the predecessor contract N00014-06-C-0177). I

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wrote various sections of the comparison paper on my spectrum-matching and look-up-table (LUT) methodology and on work performed under the predecessor contract. That paper is now in its final stages of revision by the various authors.

RESULTS

Figure 1 shows an example of bathymetry retrievals for six different algorithms as applied to two images (one from the Bahamas and one from Australia). The row labeled "Mobley" refers to the spectrum-matching and look-up-table (LUT) methodology developed with previous ONR funding. The "Lyzenga" row refers to a band-ratio algorithm for bathymetry retrieval (Lyzenga, 1978). The other rows are variants of the Lee et al. (1998, 1999) semi-analytical non-linear search algorithm.

IMPACT/APPLICATION

The problem of extracting environmental information from remotely sensed ocean color spectra is fundamental to a wide range of Navy needs as well as to basic science and ecosystem monitoring and management problems. Extraction of bathymetry and bottom classification is especially valuable for planning military operations in denied access areas.

RELATED PROJECTS

This work is a follow-on of research begun under contract N00014-06-C-0177. The other investigators are separately funded for their algorithm development and participation in the comparison exercise.

REFERENCES

Lee, Z. P., K. L. Carder, C. D. Mobley, R. G. Steward, and J. S. Patch, 1998. Hyperspectral remote sensing for shallow waters: 1. A semi-analytical model. *Applied Optics* 37, 6329-6338.

Lee, Z. P., K. L. Carder, C. D. Mobley, R. G. Steward, and J. S. Patch, 1999. Hyperspectral remote sensing for shallow waters: 2. Deriving depths and optical properties by optimization. *Applied Optics* 38, 3831-3843.

Lyzenga, D. R., 1978. Passive remote sensing techniques for mapping water depth and bottom features. *Applied Optics* 17, 379-383.

PUBLICATIONS

Phinn, S., A. Dekker, M. Lyons, C. Roelfsema, J. Anstee, P. Bissett, V. Brando, P. Fearns, J. Hedley, W. Klonowski, Z.-P. Lee, M. Lynch, and C. Mobley. Comparison of algorithms for retrieval of bathymetry, bottom classification, and water optical properties from hyperspectral imagery of shallow waters. In preparation for submission to *Limnol. Oceanogr. Methods*.

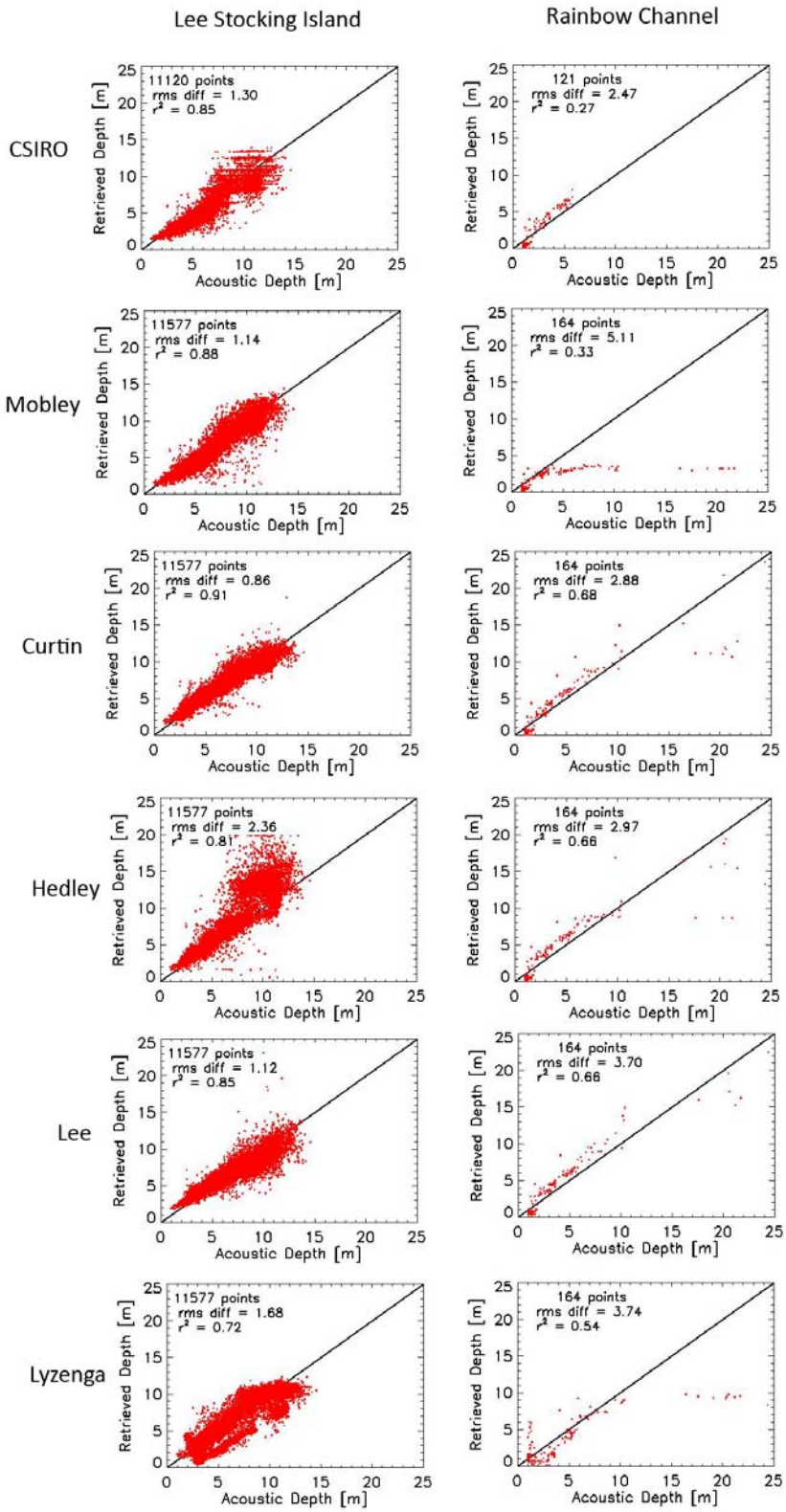

Fig. 1. Depth retrievals for six algorithms applied to two images. The left column is for an image from Lee Stocking Island, Bahamas and the right column is an image from Moreton Bay, Australia. [Figure shows scatter plots of retrieved vs. acoustic depths.]