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Acoustic Tomography with Navy Sonars

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LONG-TERM GOALS

My long-term goal is to get enough data from the ocean so that its physical and acoustically induced fluctuations can be understood from theories and models. I hope to use this information to help the Navy with its operations.

OBJECTIVES

I want to demonstrate that passive and active Navy sonars can be used to map the sound speed fields by means of acoustic tomography. The Navy puts sound into the water and has passive arrays, both towed and fixed, that could be used to measure the travel times of acoustic multipath for subsequent inversion for the sound speed field. Also of interest is a measure of the coherent integration time that can be obtained with a towed versus fixed array with a stationary source.

APPROACH

I will work with the Navy to collect pulse-like acoustic signals on fixed and towed arrays. Previous simulations with ocean models indicate that accurate maps of the sound speed field can be made even when the locations of the sources and receivers are not well known and when the transmission times of sound are not well known (Spiesberger et al., 1997; Silivra et al., 1997; Fabrikant et al., 1998).

Along with XBT and hydrographic data, the acoustic data will be assimilated into a Kalman filter to map the sound speed field and its errors. Utilization of fixed SOSUS arrays has been demonstrated during the last twenty years (Spiesberger and Metzger, 1992). The additional use of towed arrays ought to provide a synthetic aperture by which the spatial resolution of the maps could be reduced to the mesoscale in the patrol areas. The spatial resolution of the maps will have coarser resolution in regions remote from the patrol areas.

WORK COMPLETED

Data have been collected from active Navy sonars, tomographic sources, and fixed and towed arrays. A Kalman filter has been developed to assimilate these data, allowing for fine resolution where required. Many of the algorithms required to process the acoustic data from towed arrays has been developed and tested.

RESULTS

Sounds transmitted over 3000 km have high signal-to-noise ratios on towed arrays. Tomographic maps have not yet been made from these transmissions.

Maps of the sound speed field have been produced for the northeast Pacific using all available hydrographic data and tomographic data between three sources and three SOSUS stations from 1987. This later work has been led by Andrew Jacobson at the Pennsylvania State University.

IMPACT/APPLICATIONS

Utilization of Navy sonars for tomographic purposes ought to yield an efficient and cost-effective way to estimate the sound speed field at mesoscales. These maps and their errors ought to be useful for predicting acoustic sonar performance and reliability due to the oceanic scales resolved with the data.

TRANSITIONS

The possibility of transitioning this technology to the fleet has been discussed with SPAWAR and CMNOC.

RELATED PROJECTS

REFERENCES

Fabrikant, A. L., Spiesberger, J. L., Silivra, A. A., and Hurlburt, H. E. 1998: Estimating climatic temperature change in the ocean with synthetic acoustic apertures, *IEEE Journal of Oceanic Engineering*, 23, 20-25.

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PUBLICATIONS

Jacobson, A. R. and Spiesberger, J. L. 1998: Observations of El Nino-Southern Oscillation induced Rossby waves in the northeast Pacific using in situ data, *Journal of Geophysical Research*, 103, C11, 24,585-24,596.