TRACEO3D Ray Tracing Model and its Parallel Implementation

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Abstract

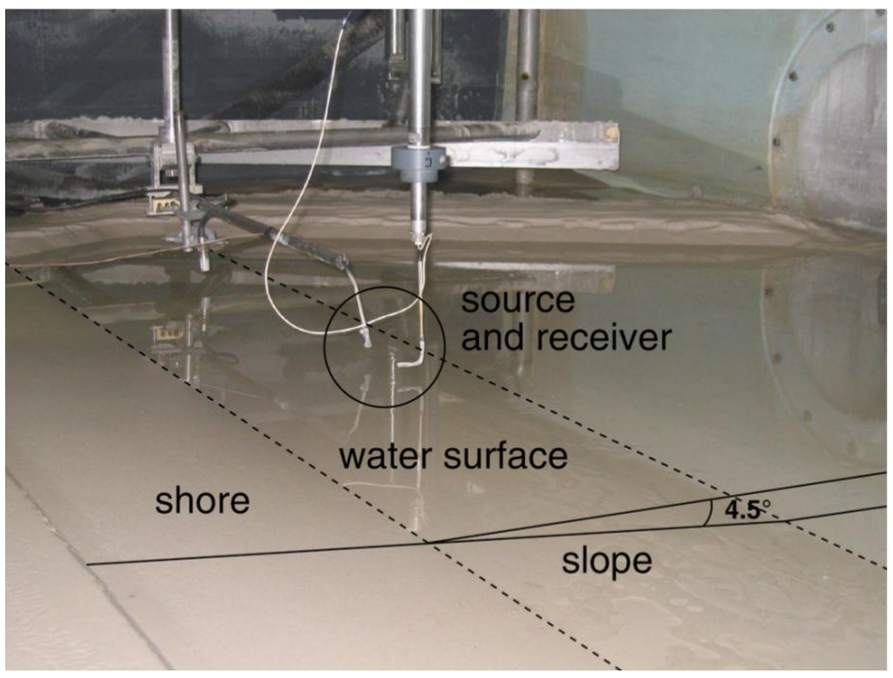
Ray tracing models are important numerical tools of Underwater Acoustics, that provide a detailed description of sound propagation in the ocean waveguide. This is achieved through the calculation of the pressure field transmitted by a set of acoustic sources, and received on a set of hydrophones. TRACEO is a ray tracing model which was developed at the Signal Processing Laboratory (SiPLAB) of the University of Algarve; this model was developed in order to predict acoustic pressure and particle velocity in environments with elaborate upper and lower boundaries.

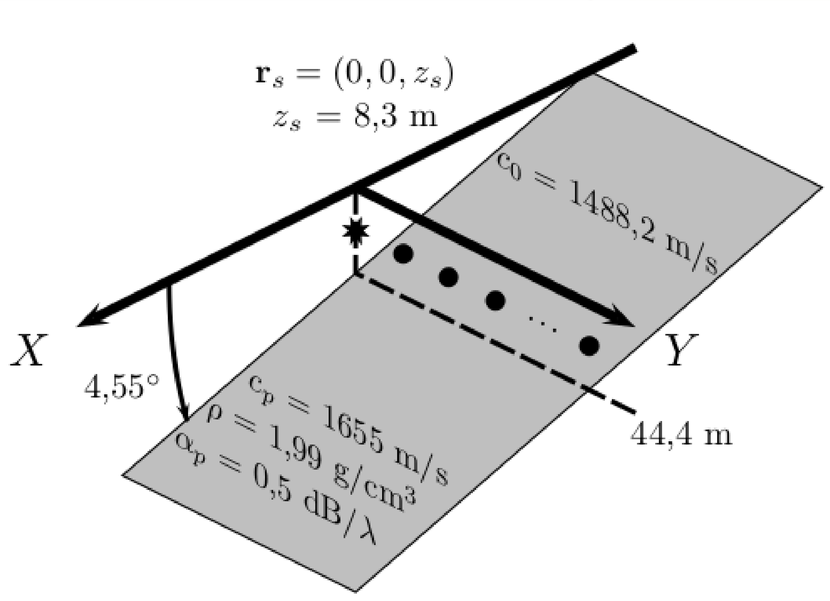
TRACEO is a two-dimensional model that has been carefully benchmarked against experimental tank data. However, it is well known that even in the simplest of cases a three-dimensional bathymetry, either by itself or combined with a sound speed field, can induce propagation not confined to a two-dimensional plane, an effect known as *out-of-plane propagation*. Additionally, accurate acoustic simulations can be time consuming due to the complexity of the underwater environment.

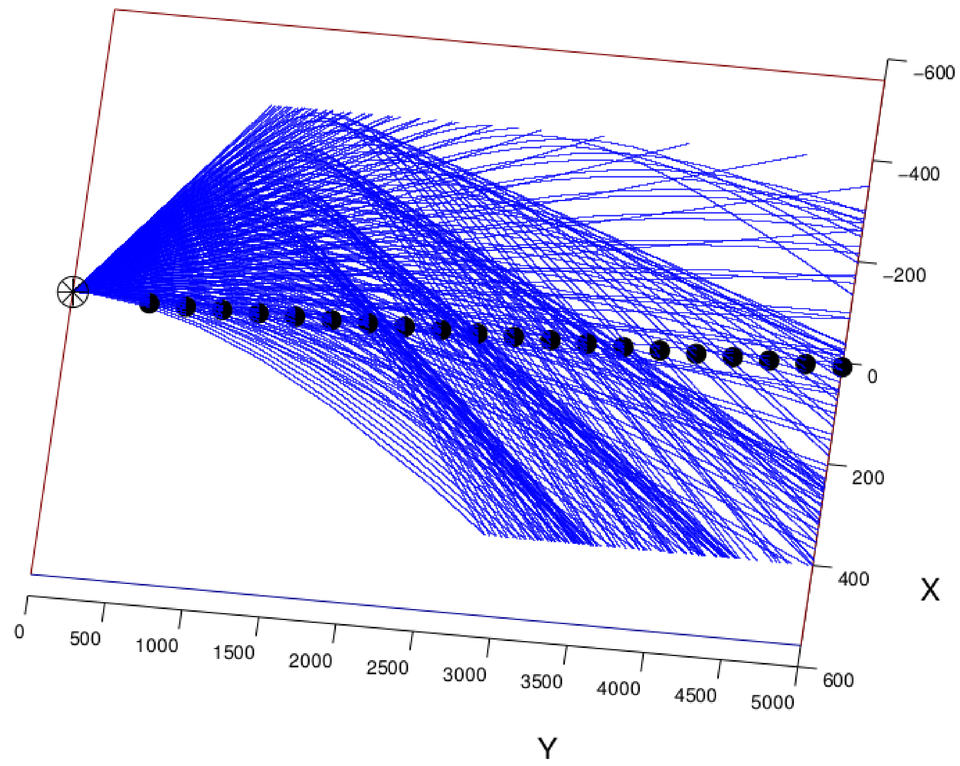
As the computing power of the Graphics Processing Units (or GPUs) increased they started to be used in scientific computing as a coprocessor. The GPU is optimized for the execution throughput of a massive number of threads, combined with a high memory bandwidth. The main goal of the thesis is to develop a complete parallel version of TRACEO, that will take advantage of GPU hardware as a ray tracing coprocessor, and will use the latest tools available. However, parallelization will not be considered independently of the physical problem of propagation, and validation of three-dimensional predictions with experimental data will be performed.

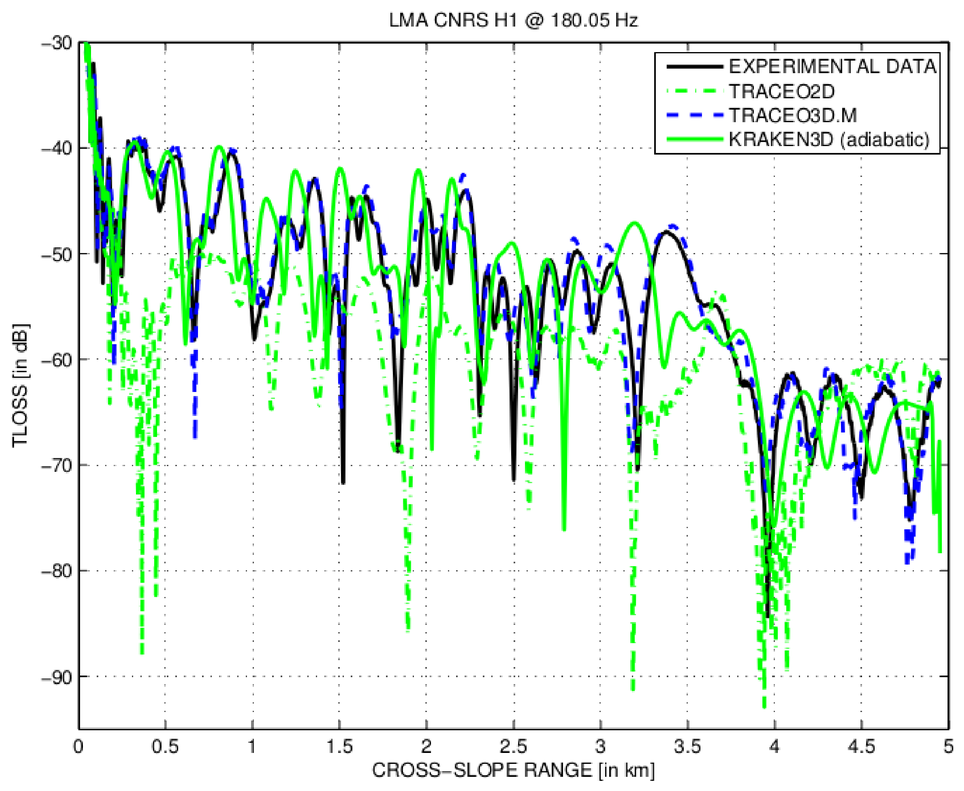
Work in progress

Parallelization, in order to be efficient, requires a clear understanding of the propagation problem from the physics point of view. Therefore, it is of fundamental importance to assimilate such formalism through the conversion of a three-dimensional version of TRACEO called TRACEO3D (under current development at SiPLAB) from Fortran to Matlab, called TRACEO3D.M. This development implements most fundamentals aspects of the ray tracing problem and it is important to debugging of TRACEO3D. TRACEO3D.M was validated against experimental tank data and predictions produced by other 2D and 3D models (see figure).









Future work

The next step of the investigation is to develop an assessment regarding the run time memory requirements, and also the computation time consuming functions, providing a guide to find hotspots and bottlenecks. After that, the main task will be focused in developing a parallel algorithm, which should strive for distributing the amount of computation across the highest number of work units. Once concluded, the algorithm will be implemented in a GPU.

Aknowledgments

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