

# 三维声传播模型 BELLHOP3D 的 MPI 并行优化\*

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**摘要:** 近些年, 随着我国对海洋探索的不断深入, 对复杂环境中声场的快速预报提出了越来越高的需求。BELLHOP3D 是一种基于射线法的三维声传播计算模型, 在海洋声学中应用十分广泛。BELLHOP3D 的计算效率比其他常用模型高, 但是仍然有非常大的提升空间。本文使用 MPI (信息传递接口) 对 BELLHOP3D 进行粗粒度的并行优化, 并行后的程序计算结果稳定可靠, 并行效率高, 更适合在实际应用中实现快速的声场预报。本文首先介绍射线法的原理, 然后介绍 BELLHOP3D 的串行算法和并行优化算法, 之后通过数值模拟验证并行政程序的计算准确性并测试它的并行计算性能。计算结果表明使用 MPI 对 BELLHOP3D 进行并行优化, 计算精度非常高, 而且能大幅节约计算时间。并行 BELLHOP3D 程序可以在 [https://github.com/nj-zyq/BELLHOP3D\\_MPI.git](https://github.com/nj-zyq/BELLHOP3D_MPI.git) 下载。

**关键词:** 海洋声学; 水下声传播; 射线法; BELLHOP3D; MPI 并行

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## MPI parallel optimization of 3D sound propagation model BELLHOP3D

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**Abstract:** In recent years, with the development of marine science in China, there is a more and more demand for the rapid prediction of sound field in complex environment. BELLHOP3D is a sound propagation calculation model based on ray method, which is widely used in ocean acoustics. BELLHOP3D has higher computational efficiency than other commonly used models, but it is still possible to improve its efficiency. In this paper, the coarse-grained parallel optimization of BELLHOP3D is carried out by using MPI (Message Passing Interface). The results calculated by parallel program are stable and reliable, and the parallel efficiency is high, which is more suitable for realizing fast sound field prediction in practical application. This paper first introduces the theory of ray method, then introduces the serial algorithm and parallel algorithm of BELLHOP3D, and then verifies the computational accuracy of parallel program through numerical simulation and finally tests its parallel optimization computing performance. The calculation results show that the parallel optimization of BELLHOP3D using MPI has very high calculation accuracy and can greatly save calculation time. Code is available at [https://github.com/nj-zyq/BELLHOP3D\\_MPI.git](https://github.com/nj-zyq/BELLHOP3D_MPI.git).

**Keywords:** ocean acoustics; underwater sound propagation; ray method; BELLHOP3D; MPI

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