

EchoSMs – open-source fisheries acoustics scattering models

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“Make acoustic scattering models available to fisheries and
plankton acoustic scientists via the world wide web”

“Make anatomical datasets as widely available as possible”

Easy to use scattering models

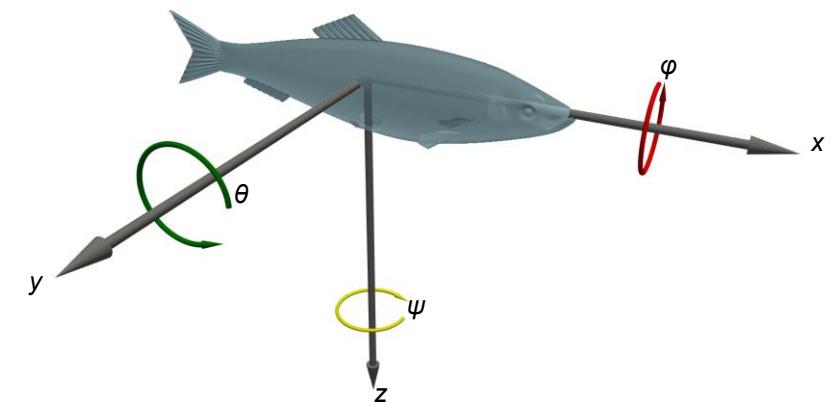
Open-source implementation of Jech et al. (2015) and other models

Analytical and numerical models

Consistent coordinate and unit conventions

Validated results

Option to run models via a webpage



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Comparisons among ten models of acoustic backscattering used in aquatic ecosystem research

J. Michael Jech; John K. Horne; Dezhong Chu; David A. Demer; David T. I. Francis; Natalia Gorska; Benjamin Jones; Andone C. Lavery; Timothy K. Stanton; Gavin J. Macaulay; D. Benjamin Reeder; Kouichi Sawada

 Check for updates

+ Author & Article Information

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echoSMs Python package

pip install echosms

Consistent interface (API) on all models

Extensive documentation

Tested against Jech et al. (2015) benchmarks

github.com/ices-tools-dev/echoSMs

The screenshot shows the GitHub README page for the echoSMs package. At the top, there are links for 'README' and 'MIT license'. Below the title 'echoSMs', there are badges for 'pypi v0.9.0', 'license MIT', and 'python 3.10 | 3.11 | 3.12 | 3.13'. Further down are badges for 'build passing', 'docs passing', and 'tests passing'. A description states 'Making acoustic scattering models available to fisheries' and 'EchoSMs provides acoustic scattering models for fisheries'. On the right side, there is a sidebar with a blue header 'echoSMs' containing a grid icon and a navigation menu with items like 'echoSMs', 'Introduction', 'Background', 'Contributing to echoSMs', 'Scattering Models', 'Exact Solutions', 'Approximate Analytical Models and Shapes', 'Using echoSMs', 'Developing echoSMs', 'Conventions', 'Benchmarks', 'API reference', 'Historical notes', and 'Other software'. The main content area contains code snippets and plots. One plot shows 'weakly scattering finite cylinder' target strength (TS) in dB versus angle in degrees, comparing 'echoSMs' (blue line) and 'Benchmark' (orange line). Another plot shows the difference in TS (Δ TS) in dB versus angle.

weakly scattering finite cylinder

TS re 1 m² [dB]

Angle (°)

Δ TS [dB]

0.03 dB

echoSMs

Introduction

Background

Contributing to echoSMs

Scattering Models

Exact Solutions

Approximate Analytical Models and Shapes

Using echoSMs

Developing echoSMs

Conventions

Benchmarks

API reference

Historical notes

Other software

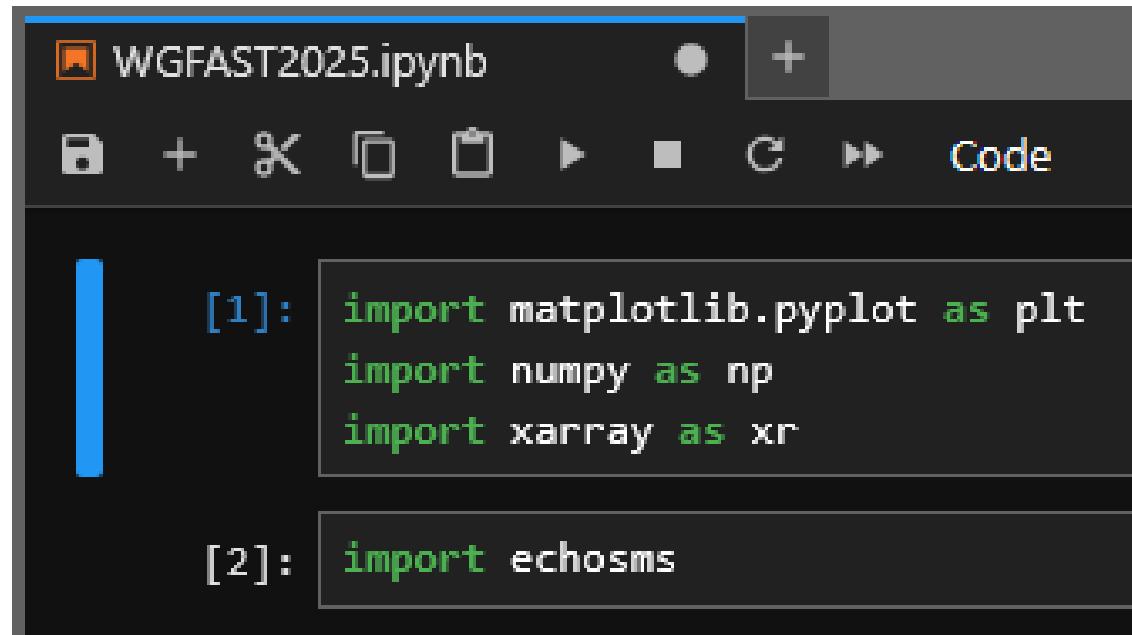
echoSMs models

Model type	Description
Deformed cylinder	Truncated cylinders
Distorted-wave Born approximation	Weakly scattering objects and the stochastic version (SDWBA)
*Elastic sphere	Calibration spheres
*High pass	Approximations for simple shapes
Kirchhoff approximation	Complex shapes at high frequencies
Kirchhoff ray mode	Complex shapes at low and high frequencies
Model series solution	Spheres with various boundaries
Prolate spheroidal model series	Prolate spheroids with various boundaries
Phase-tracking distorted-wave Born approximation	Weakly scattering objects with inhomogeneous interiors

Jech et al. models not currently in echoSMs: FMM, FEM & BEM

* Models not in Jech et al.

echoSMs demonstration



The screenshot shows a Jupyter Notebook interface with a dark theme. The title bar says "WGFAST2025.ipynb". The toolbar includes icons for file operations, a plus sign for new cells, and a "Code" button. Below the toolbar, two code cells are visible:

```
[1]: import matplotlib.pyplot as plt  
import numpy as np  
import xarray as xr  
  
[2]: import echosms
```

colab.research.google.com/github/ices-tools-dev/echoSMs/blob/main/docs/WGFAST2025_demo.ipynb

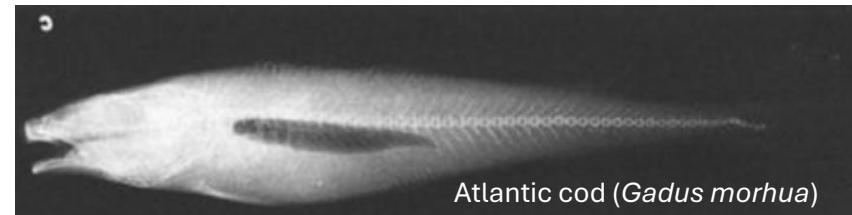
Anatomical datasets



Alewife (*Alosa pseudoharengus*)

Objective is:

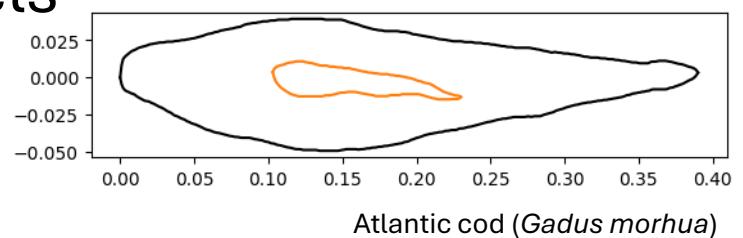
- Freely-available & well-documented datasets
- Material properties and shapes
- Metadata
- Permanently available



Atlantic cod (*Gadus morhua*)

Purpose is:

- Reference datasets for model testing
- Facilitate use and comparison of different models
- Help understand and select appropriate models



Atlantic cod (*Gadus morhua*)

Other echoSMs objectives

A place to list other model codes

ices-tools-dev.github.io/echoSMs/other_software/

A place to store model codes & data (if wanting a home)

Clay & Horne KRM BASIC code & data

We welcome other historical codes & data

To facilitate large-scale use of scattering models

Other software

Other software that provides source code for

- [acousticTS](#): R code for calculating scattering from calibration spheres.
- [Coupled BEM acoustic](#): Julia code that simulates acoustics around swimbladder).
- [FishAcoustics](#): Contains a Python module for fish acoustics.
- [Hydrac](#): Contains Python code that implements various scattering pass models. Hydrac is a package for calculating scattering from fish.
- [KRM Model](#): A web page that uses the KRM model to calculate scattering from fish given input parameters.

SEPTEMBER 01 1994

Acoustic models of fish: The Atlantic cod (*Gadus morhua*)

Clarence S. Clay; John K. Horne



J. Acoust. Soc. Am.

<https://doi.org/10.112>

GOTO 12

```
200 'compute
'Computations are reduced, S(ka)/L
'b0 = -1/(1+ic0)
'S(ka)/L = -i(l/pi) b0 = (l/pi)[c0/(1+c0^2) +i/(1+c0^2)]
'Use Clay J. Acoust .Soc.89, 2168-2179 (1991)
'Use polynomial approximations for the Bessel functions.
'subroutines for J0(x), J1(x),Y0(x) and Y1(x) are short
'when the range of ka is less than .5.
```

Acknowledgements

NOAA Fisheries Active Acoustic Strategic Initiative

Existing scattering model codes:

ices-tools-dev.github.io/echoSMs/other_software

Shape datasets

github.com/ElOceanografo/SDWBA.jl (DWBA)

www.fisheries.noaa.gov/data-tools/krm-model (KRM)