

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

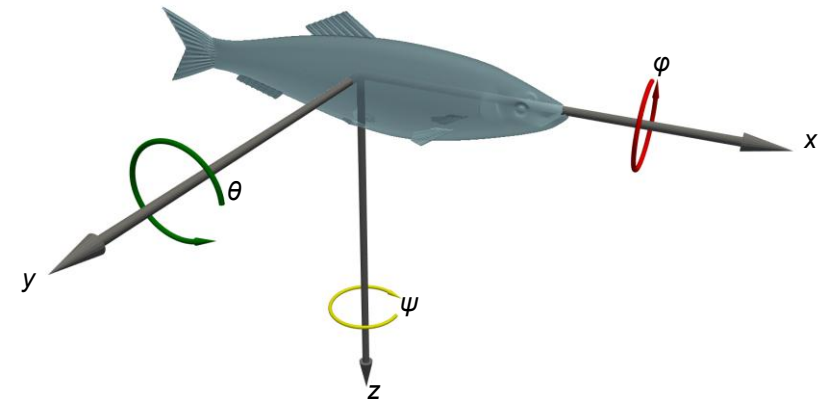
Open-source implementation of Jech et al. (2015) and other models

Analytical and numerical models

Consistent coordinate and unit conventions

Validated results

Option to run models via a webpage



DECEMBER 21 2015

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

J. Michael Jech; John K. Horne; Dezhang 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



+ Author & Article Information

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<https://doi.org/10.1121/1.4937607> Article history 

echoSMs Python package

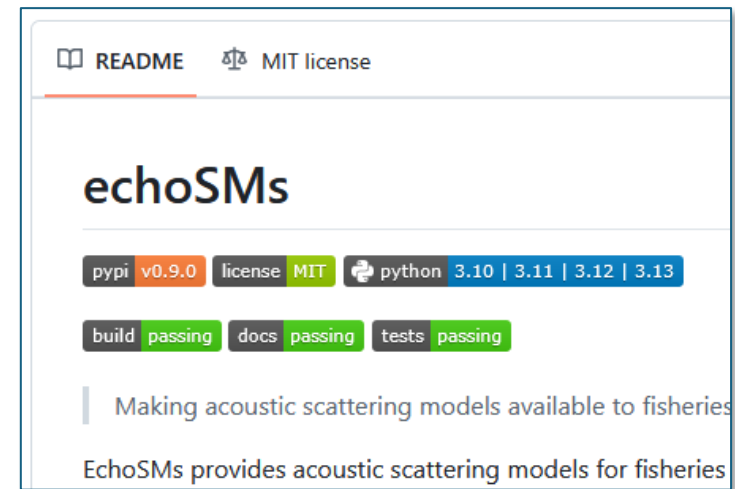
pip install echosms

Consistent interface (API) on all models

Extensive documentation

Tested against Jech et al. (2015) benchmarks

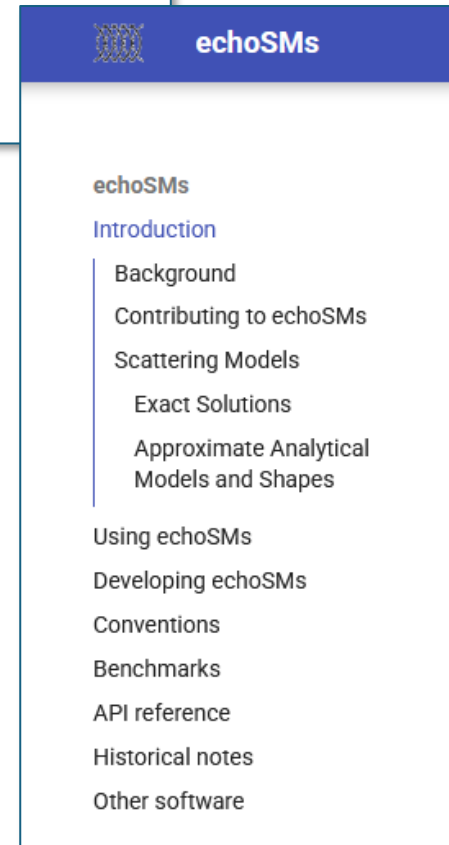
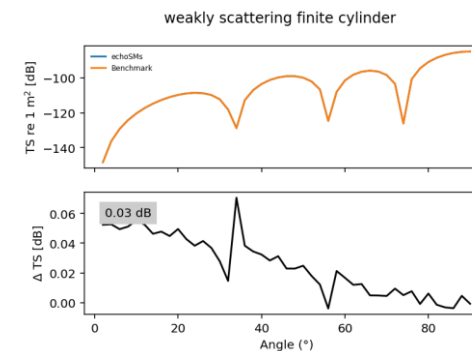
github.com/ices-tools-dev/echoSMs



```
meth calculate_ts(data, expand=False, inplace=False,
multiprocess=False, progress=False)
```

Calculate the target strength (TS) for many parameters.

Parameters:



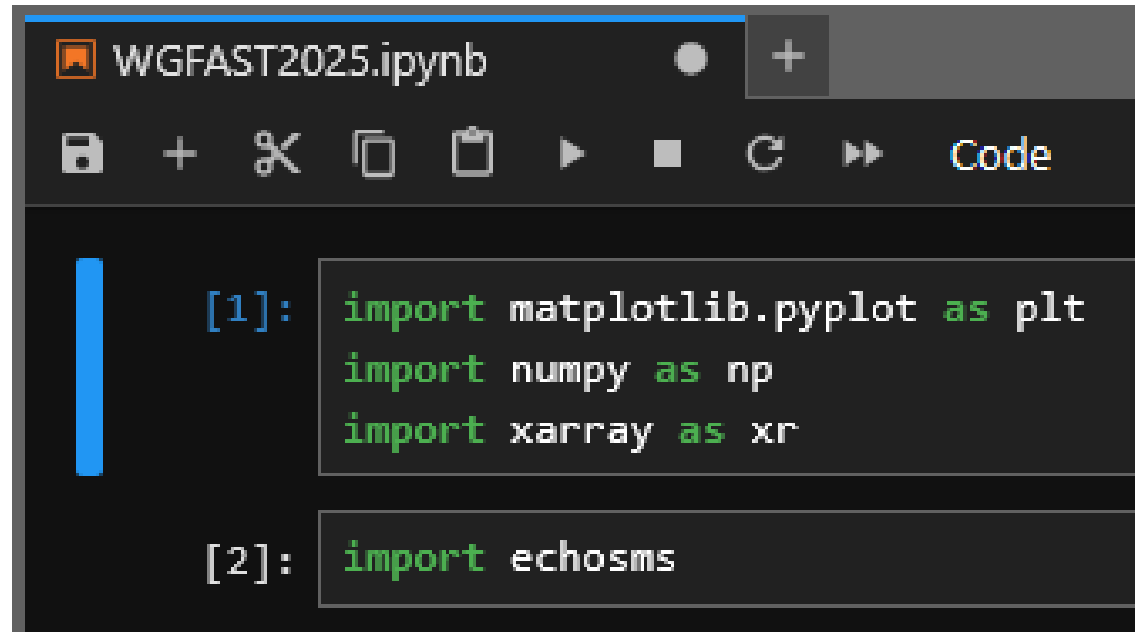
echoSMs models

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



```
WGFAST2025.ipynb  
[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

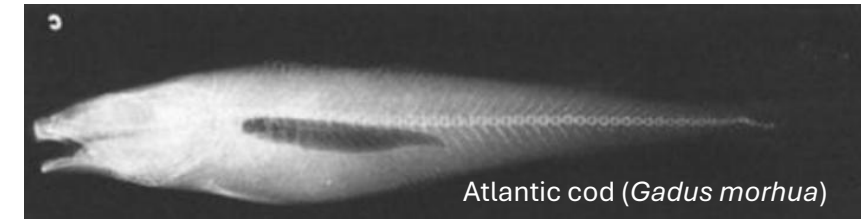
- Permanently available

Purpose is:

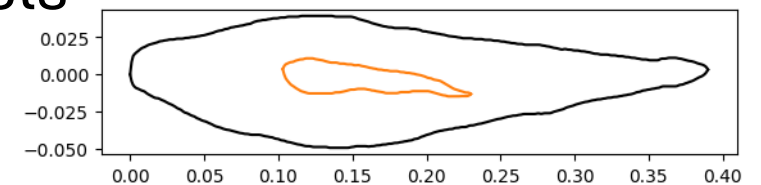
- Reference datasets for model testing

- Facilitate use and comparison of different models

- Help understand and select appropriate models



Atlantic cod (*Gadus morhua*)



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 of calibration spheres.
- **Coupled BEM acoustic**: Julia code that (swimbladder).
- **FishAcoustics**: Contains a Python module
- **Hydrac**: Contains Python code that implements pass models. Hydrac is a package for c
- **KRM Model**: A web page that uses the K 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/10.1121>

GOTO 12

```
200 'compute
'Computations are reduced, S(ka)/L
' b0 = -1/(1+ic0)
'S(ka)/L = -i(1/pi) b0 = (1/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)