Soundscapes

Michael B. Porter and Laurel J. Henderson
Heat, Light, and Sound Research, Inc.
12625 High Bluff Dr., Suite 211
San Diego, CA 92130
phone: (858) 457-0800 fax: (858) 228-1734 email: mikeporter@hlsresearch.com

Award Number: N00014-12-C-0331
http://www.hlsresearch.com/

LONG-TERM GOALS

To develop and validate a regional and global nowcast capability for ocean noise. The ambient noise field is, of course, a key part of the marine mammal habitat, and in turn can inform regulatory decisions by conservationists.

OBJECTIVES

Eventually this system will be coupled to global oceanographic models to provide hindcasts, nowcasts, and forecasts of the time-evolving soundscape. In terms of the types of sound sources, we will focus initially on commercial shipping and seismic exploration. As the research evolves we will gradually expand the capability to include many other types of sources.

APPROACH

The modeling of the soundscape due to noise involves running an acoustic model for a grid of source positions over latitude and longitude. Typically have been doing points every degree around the globe so there are about 65,000 (360 *180) such virtual source locations. For each source one needs to calculate the 3D acoustic field it generates, which typically involves a model run on bearing every 10 degrees. The final stage is to weight each of the source points based on the global distribution of ships or wind noise. As an example of these steps, we show the sound fields for virtual sources in the N. Pacific in Fig. 1. (For purposes of illustration we have shown here a calculation done with a coarse grid of sources every 1500 km.) We then sum those sound fields using information about the global distribution of ships to get the final noise field as shown in Fig. 2.

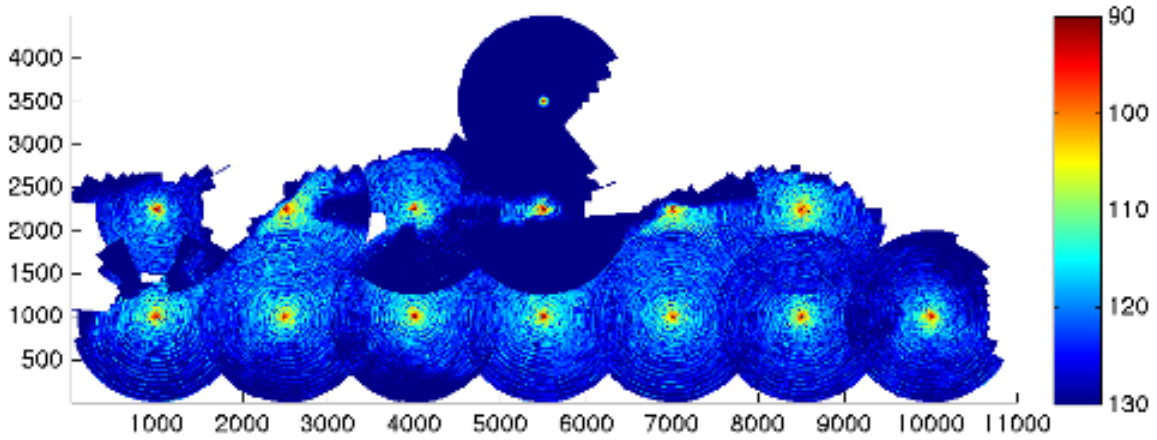

Figure 1. Modeled sound field due to sparse grid of "virtual" sources.

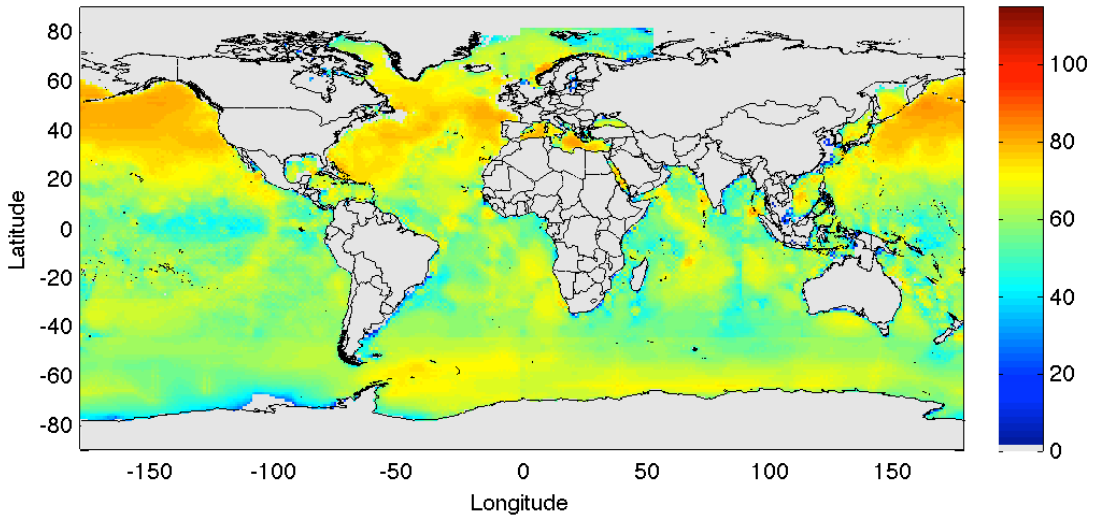

Figure 2. Modeled noise spectrum level at 200 Hz and 200m depth due to merchant shipping for the year 2004.

These types of simulations are easily described yet enormously complex. They involve enormous numbers of propagation calculations. That in turn requires a lot of computer time as well as robust acoustic models. The propagation modeling also depends on a variety of environmental databases. For oceanography, we integrated WOA-2013 (World Ocean Atlas), GDEM (Generalized Digital Environmental Model). For bathymetry we integrated SRTM30 (Shuttle Radar Topography Mission) and DBDB-V (Digital Bathymetric Data Base).

The interpretation of the final results can then become challenging. The main feature we observe is the high noise levels in areas with lots of shipping such as the arc between Europe and the U.S. or the U.S. and Asia. One can also see a zone of low noise over the mid-Atlantic ridge, which is causing increased propagation loss. Other features in the noise field can be associated with variations in the propagation due to either oceanographic features or bottom characteristics.

WORK COMPLETED

The first phase of this work ended early in FY2015 and focused on delivering an open software package (Soundscape 1.0) for distribution on the web. A key objective was to have a system that could easily be relocatable to regional areas around the world to provide fine resolution, while also being able to do coarse resolution soundscapes for very large, even global, areas.

RESULTS

As mentioned above the work this year was a small wrap-up effort to make the software suitable for general use in an easily relocatable way. The quality of the results obviously depends on the inputs, especially the information about the shipping density and associated source levels. For these examples we generally used our global databases, including shipping data from the VOS (Voluntary Observing Ship) program. Is some areas, such as Cape Cod and around the Channel Islands off southern California, we had access to very detailed AIS data, as well as more detailed bottom type information. We present some examples with different geographic resolutions from various programs below.

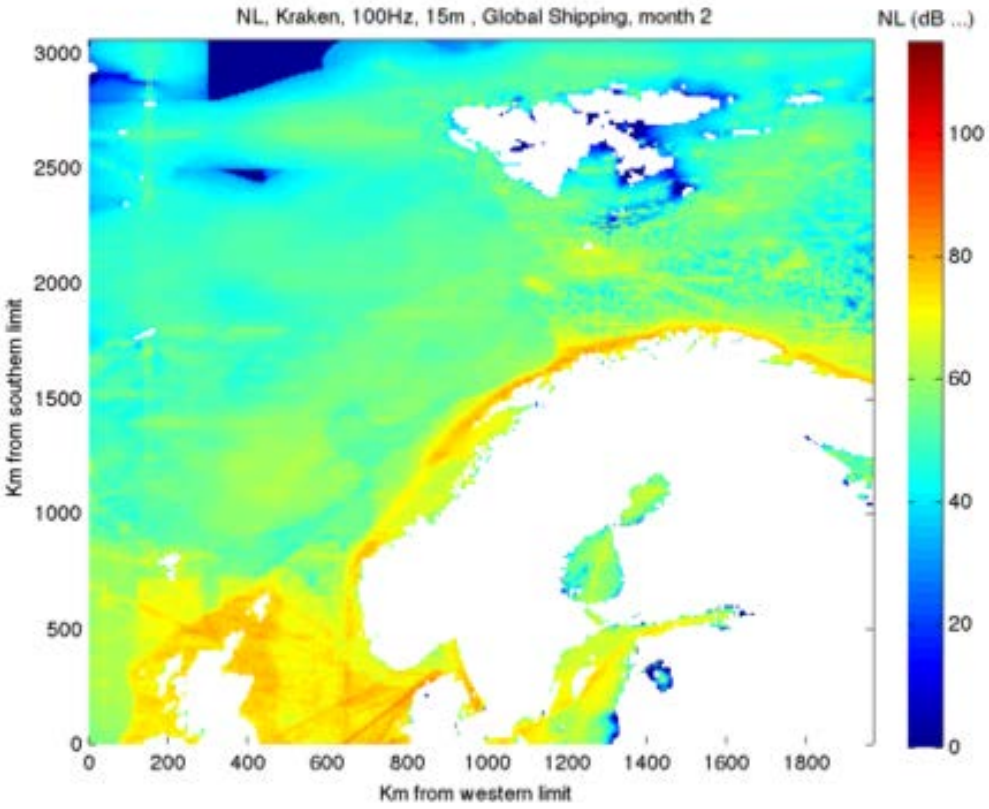

Figure 3. Modeled noise spectrum level at 100 Hz and 15 m depth due to shipping around Northern Europe.

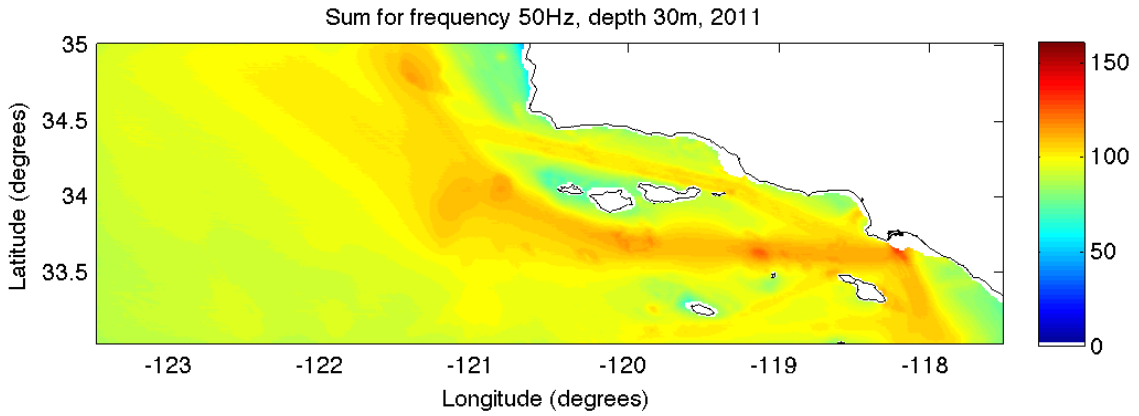

Figure 4. Modeled noise spectrum level at 50 Hz and 30 m depth due to shipping around the Channel Islands (California).

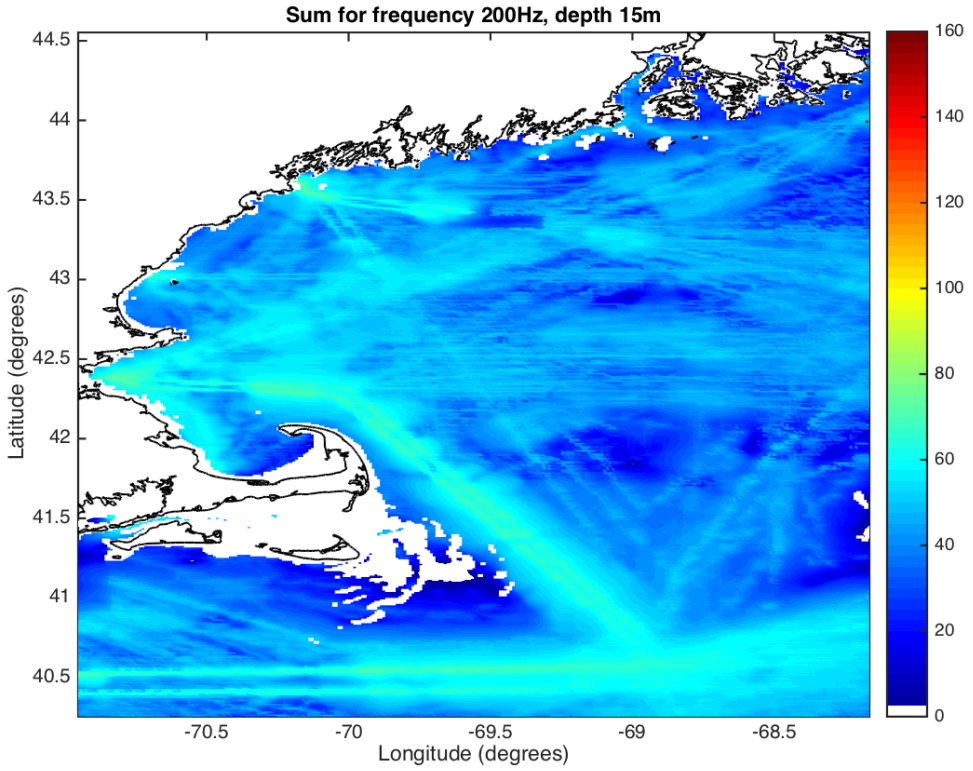

Figure 5. Modeled noise spectrum level at 200 Hz and 15 m depth due to shipping in the New England area.

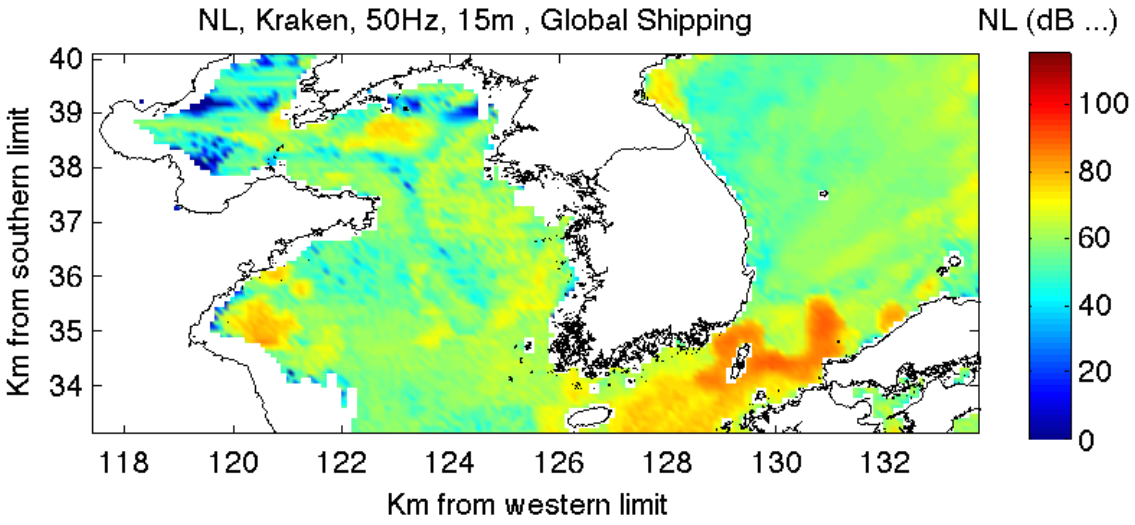

Figure 6. Modeled noise spectrum level at 50 Hz and 15 m depth due to shipping in the West, South, and East Korean Seas.

IMPACT/APPLICATIONS

The importance of this work is that it provides information on the ambient noise field, which is a key part of the marine mammal habitat, and in turn can inform regulatory decisions by conservationists. For instance, one may assess the value of ship quieting and the role of acidification. In addition, the ambient noise provides the background field against which new sound sources such as pile drivers are heard. It also facilitates the studies of masking effects on marine mammals.

RELATED PROJECTS

We would like to thank Carrie Kappel (National Center for Ecological Analysis and Synthesis) for making the VOS shipping data available. Documentation for Soundscape 1.0 was supported by NOAA (Jason Gedamke).

REFERENCES

Michael B. Porter and Laurel J. Henderson, “Global Ocean Soundscapes”, *Proceedings of the International Congress on Acoustics* 2013, Vol. 19, 010050 (Proceedings of Meetings on Acoustics), Montreal, Canada (2013).

J. Gedamke, et al., “Predicting Anthropogenic Noise Contributions to U.S. Waters in The Effects of Noise on Aquatic Life,” Eds. A. Popper and A. Hawkins (Conference Proceedings), 2013.

J. Redfern, L. Hatch, C. Caldow, M. DeAngelis, J. Gedamke, S. Hastings, L. Henderson, M. McKenna, T.J. Moore, M.Porter, "Assessing the risk of chronic noise from commercial ships to large whale acoustic habitat", Endangered Species Research (2016) [submitted]

HONORS/AWARDS/PRIZES

Pioneers Medal, Acoustical Society of America
Awarded at the Indianapolis Meeting, October 2014.