O1.3-787

# Trends in shipping sound for all European seas from 2016 to 2050

Özkan Sertlek[1],Michael Ainslie[1],Johan Bosschers[2],Marjolein Hermans[2],Thomas Lloyd [2], Alexander MacGillivray[1],Federica Pace[1],Roberto Racca[1],Max Schuster[1],Michael Wood[1]

(1) JASCO Applied Sciences, Germany, UK and Canada
(2) MARIN, The Netherlands

Presentation Date: 11 September 2025

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



# MSFD and sound maps

- Shipping sound is one of the key contributors to continuous low-frequency sound in EU marine waters.
- Understanding the time trends of ambient sound can aid in the analysis of the CTBTO's historical dataset
- Sound maps are essential tools for implementing Marine Strategy Framework Directive (MSFD) goals*
  - Provide spatial representations of underwater sound levels
  - Identify hotspots of high noise pollution
  - Investigate exposure in noise sensitive areas
  - Supporting maritime spatial planning and mitigation
  - Track temporal trends in underwater sound

*MSFD Descriptor 11 : Introduction of energy (including underwater noise) does not adversely affect the ecosystem

JASCO APPLIED SCIENCES

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



## MSFD and sound maps

- Shipping sound is one of the key contributors to continuous low-frequency sound in EU marine waters.
- Understanding the time trends of ambient sound can aid in the analysis of the CTBTO's historical dataset
- Sound maps are essential tools for implementing Marine Strategy Framework Directive (MSFD) goals*
  - Provide spatial representations of underwater sound levels
  - Identify hotspots of high noise pollution
  - Investigate exposure in noise sensitive areas
  - Supporting maritime spatial planning and mitigation
  - Track temporal trends in underwater sound

*MSFD Descriptor 11 : Introduction of energy (including underwater noise) does not adversely affect the ecosystem

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



# MSFD and sound maps

- Shipping sound is one of the key contributors to continuous low-frequency sound in EU marine waters.
- Understanding the time trends of ambient sound can aid in the analysis of the CTBTO's historical dataset
- Sound maps are essential tools for implementing Marine Strategy Framework Directive (MSFD) goals*
  - Provide spatial representations of underwater sound levels
  - Identify hotspots of high noise pollution
  - Investigate exposure in noise sensitive areas
  - Supporting maritime spatial planning and mitigation
  - Track temporal trends in underwater sound

*MSFD Descriptor 11 : Introduction of energy (including underwater noise) does not adversely affect the ecosystem

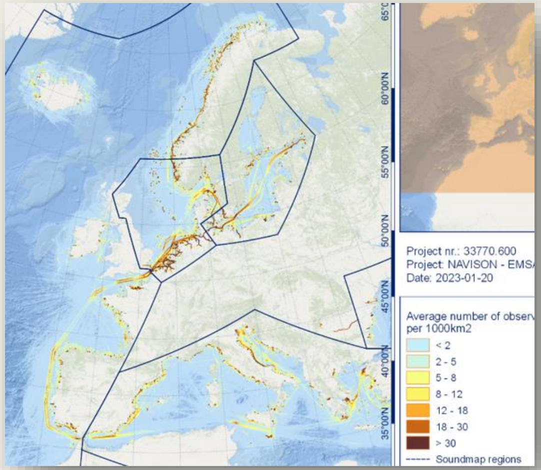
# Trends in shipping sound for all European seas from 2016 to 2050

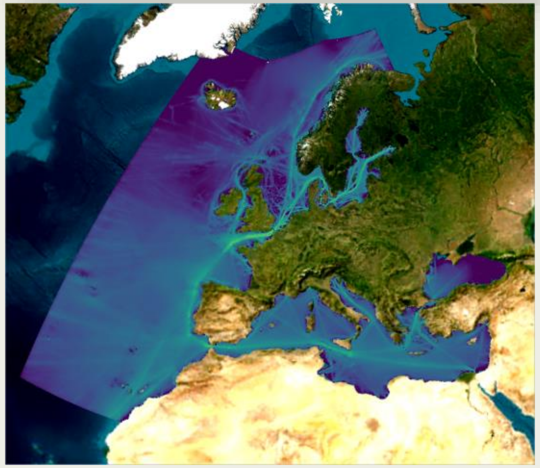
Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



## NAVISON (Navis Sonus)

- European Maritime Safety Agency(EMSA)Funded Project (2022 to 2024)
- Overarching goal:
  - Produce shipping sound maps of Europe in MSFD Descriptor 11 bands (63 Hz, 125 Hz)
- Shipping source levels
  - a new, enhanced predictive model (PIANO)
  - cavitation, machinery, operational conditions
  - 5 vessel categories
    - Cargo vessels and bulk carriers (CAR),
    - Container ships (CON),
    - Cruise and passenger vessels (PAS),
    - Tankers and gas carriers (TGC),
    - Roll-on-roll-off (ro-ro) vessels (cargo and passenger) (RRO).
- Sound maps and sound energy densities are calculated for
  - hindcast (2016-2023)
  - forecast: 2030, 2040, 2050



EMSA
European Maritime Safety Agency

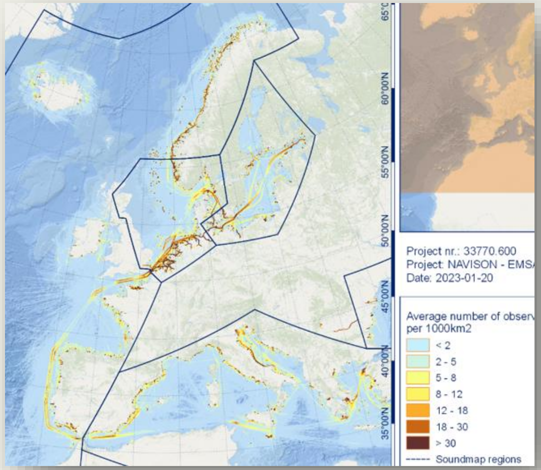
# Trends in shipping sound for all European seas from 2016 to 2050

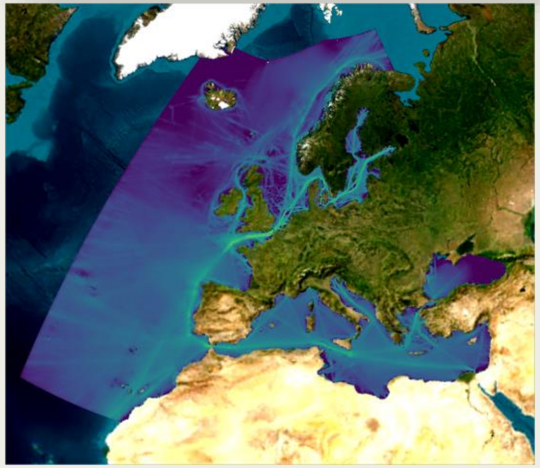
Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



## NAVISON (Navis Sonus)

- European Maritime Safety Agency(EMSA)Funded Project (2022 to 2024)
- Overarching goal:
  - Produce shipping sound maps of Europe in MSFD Descriptor 11 bands (63 Hz, 125 Hz)
- Shipping source levels
  - a new, enhanced predictive model (PIANO)
  - cavitation, machinery, operational conditions
  - 5 vessel categories
    - Cargo vessels and bulk carriers (CAR),
    - Container ships (CON),
    - Cruise and passenger vessels (PAS),
    - Tankers and gas carriers (TGC),
    - Roll-on-roll-off (ro-ro) vessels (cargo and passenger) (RRO).
- Sound maps and sound energy densities are calculated for
  - hindcast (2016-2023)
  - forecast: 2030, 2040, 2050



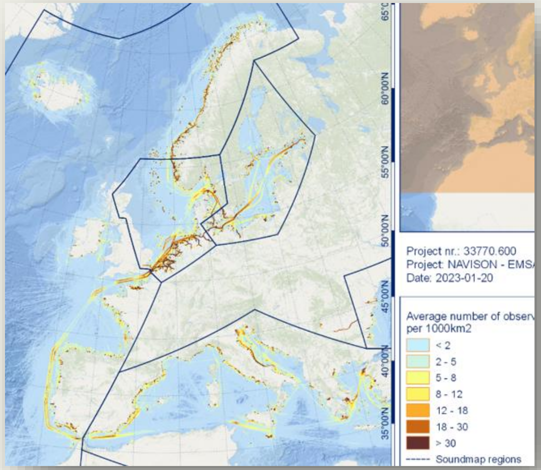
EMSA
European Maritime Safety Agency

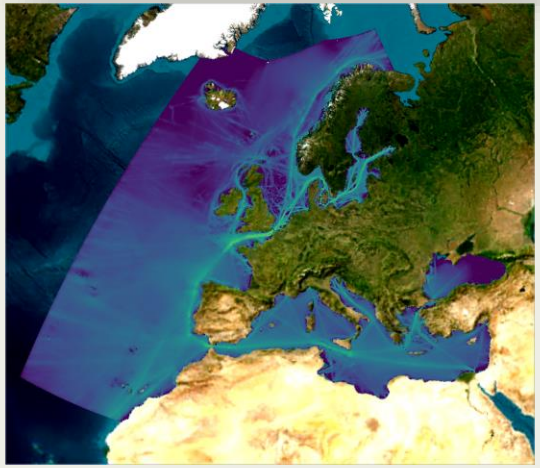
Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



## NAVISON (Navis Sonus)

- European Maritime Safety Agency(EMSA)Funded Project (2022 to 2024)
- Overarching goal:
  - Produce shipping sound maps of Europe in MSFD Descriptor 11 bands (63 Hz, 125 Hz)
- Shipping source levels
  - a new, enhanced predictive model (PIANO)
  - cavitation, machinery, operational conditions
  - 5 vessel categories
    - Cargo vessels and bulk carriers (CAR),
    - Container ships (CON),
    - Cruise and passenger vessels (PAS),
    - Tankers and gas carriers (TGC),
    - Roll-on-roll-off (ro-ro) vessels (cargo and passenger) (RRO).
- Sound maps and sound energy densities are calculated for
  - hindcast (2016-2023)
  - forecast: 2030, 2040, 2050



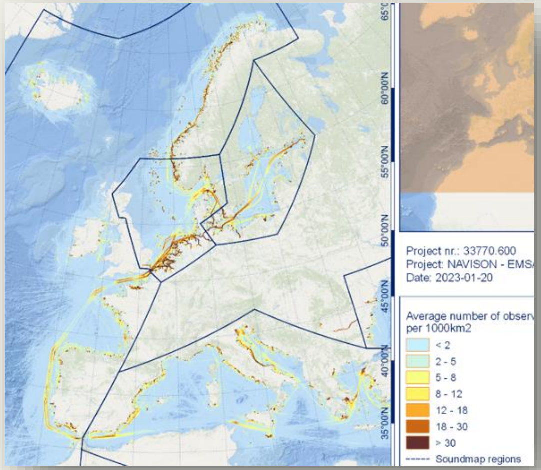
European Maritime Safety Agency

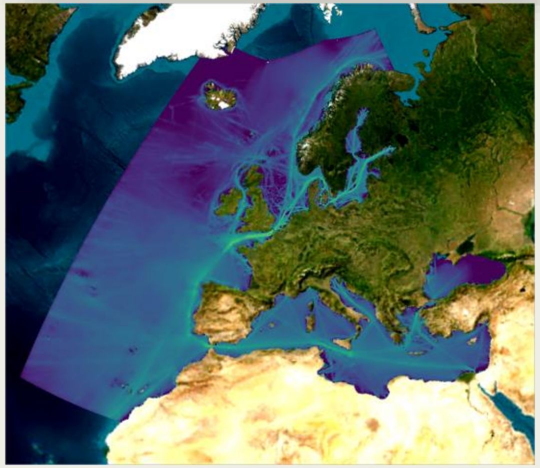
Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



## NAVISON (Navis Sonus)

- European Maritime Safety Agency(EMSA)Funded Project (2022 to 2024)
- Overarching goal:
  - Produce shipping sound maps of Europe in MSFD Descriptor 11 bands (63 Hz, 125 Hz)
- Shipping source levels
  - a new, enhanced predictive model (PIANO)
  - cavitation, machinery, operational conditions
  - 5 vessel categories
    - Cargo vessels and bulk carriers (CAR),
    - Container ships (CON),
    - Cruise and passenger vessels (PAS),
    - Tankers and gas carriers (TGC),
    - Roll-on-roll-off (ro-ro) vessels (cargo and passenger) (RRO).
- Sound maps and sound energy densities are calculated for
  - hindcast (2016-2023)
  - forecast: 2030, 2040, 2050



EMSA
European Maritime Safety Agency

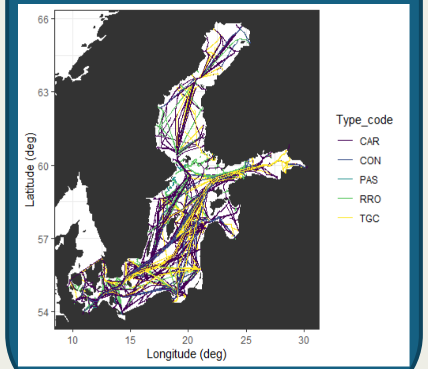
# Trends in shipping sound for all European seas from 2016 to 2050

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood

O1.3-787

## Ship Tracks(AIS), Ship Particulars and Characteristics Data

EMSA
European Maritime Safety Agency



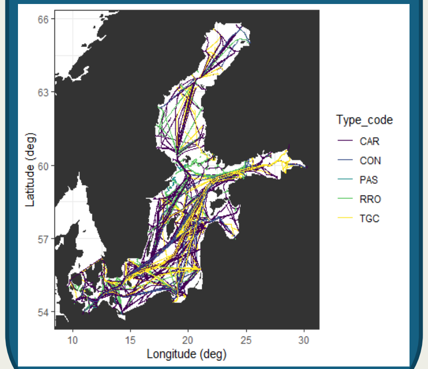
# Trends in shipping sound for all European seas from 2016 to 2050

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood

O1.3-787

Ship Tracks(AIS), Ship Particulars and Characteristics Data

EMSA European Maritime Safety Agency




PIANO

Cavitation Noise

MARIN

Machinery Noise

DW SHIPCONSULT

Validation Data

ECHO PROGRAM

PORT of vancouver | Vancouver Fraser Port Authority

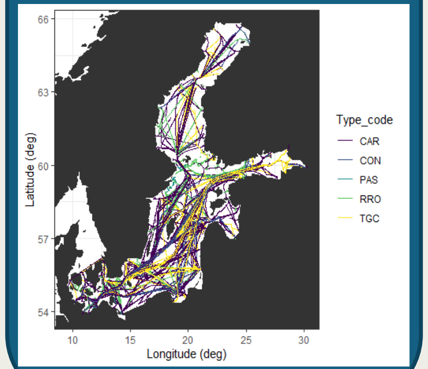
# Trends in shipping sound for all European seas from 2016 to 2050

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood

O1.3-787

Ship Tracks(AIS), Ship Particulars and Characteristics Data

EMSA European Maritime Safety Agency




PIANO

Cavitation Noise

MARIN

Machinery Noise

DW SHIPCONSULT

Validation Data

ECHO PROGRAM

PORT of vancouver | Vancouver Fraser Port Authority

$\int dt$

EMODnet

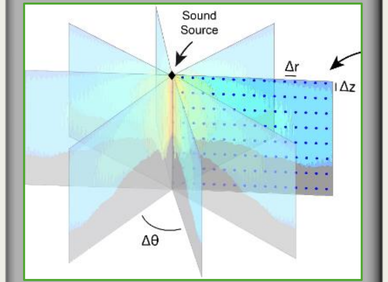
Copernicus

ARTEMIA

Sound Propagation

JASCO APPLIED SCIENCES

OpenMP

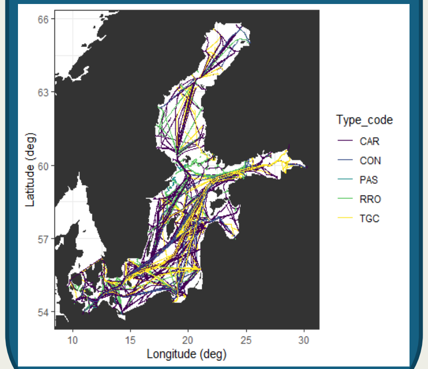


# Trends in shipping sound for all European seas from 2016 to 2050

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood

O1.3-787

Ship Tracks(AIS), Ship Particulars and Characteristics Data




PIANO

Cavitation Noise

Machinery Noise

Validation Data

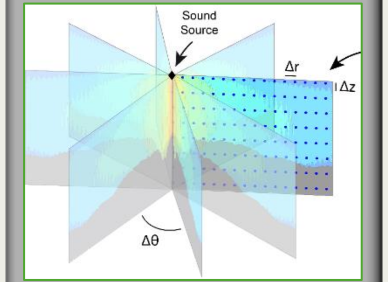
$\int dt$

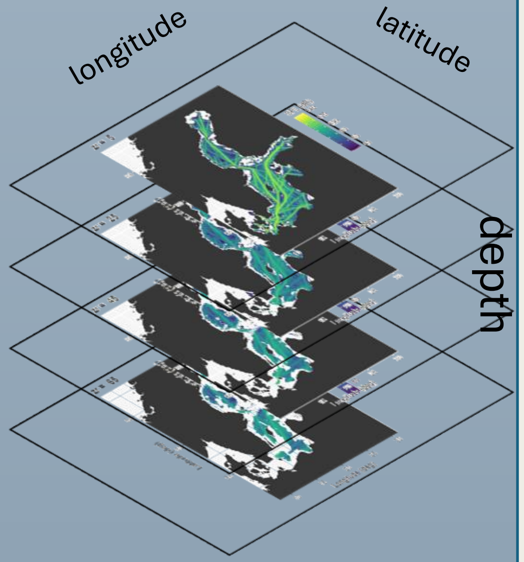
EMODnet

Copernicus

ARTEMIA

Sound Propagation




sound map layers

$L_p\ (\varphi, \lambda, z)$

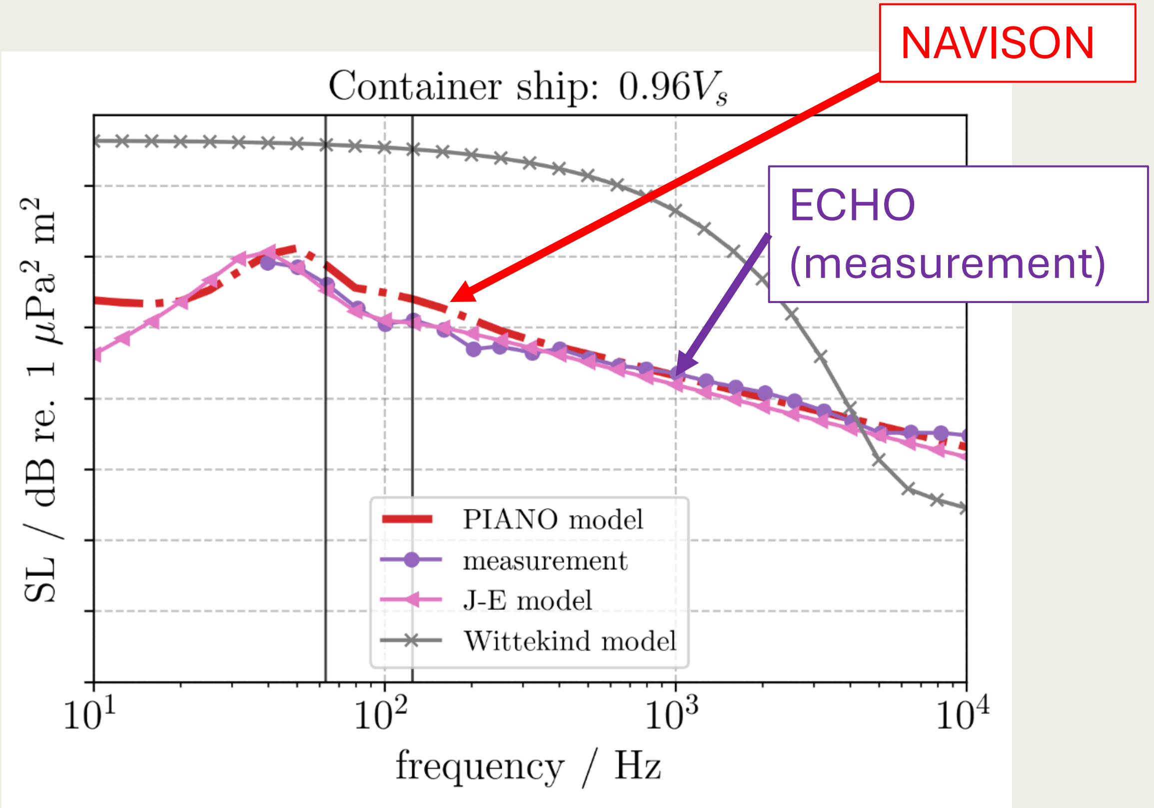
*by vessel type*
*by mechanism*
*by frequency band*
*by season*
*by year*
*by scenario*

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



# Source level model (Lloyd et al 2024)

## Container ship




Lloyd et al 2024, Eighth International Symposium on Marine Propulsors, March 2024

**Trends in shipping sound for all European seas from 2016 to 2050**

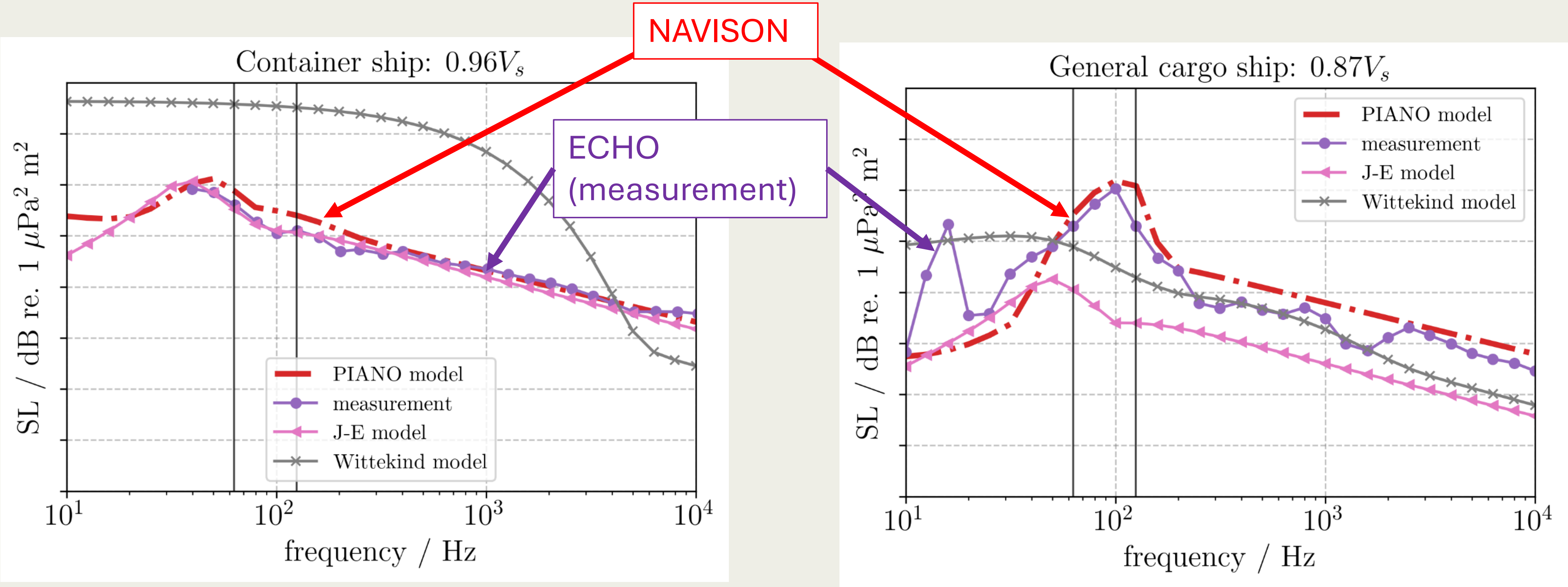
Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



# Source level model (Lloyd et al 2024)

Container ship

Cargo ship




Lloyd et al 2024, Eighth International Symposium on Marine Propulsors, March 2024

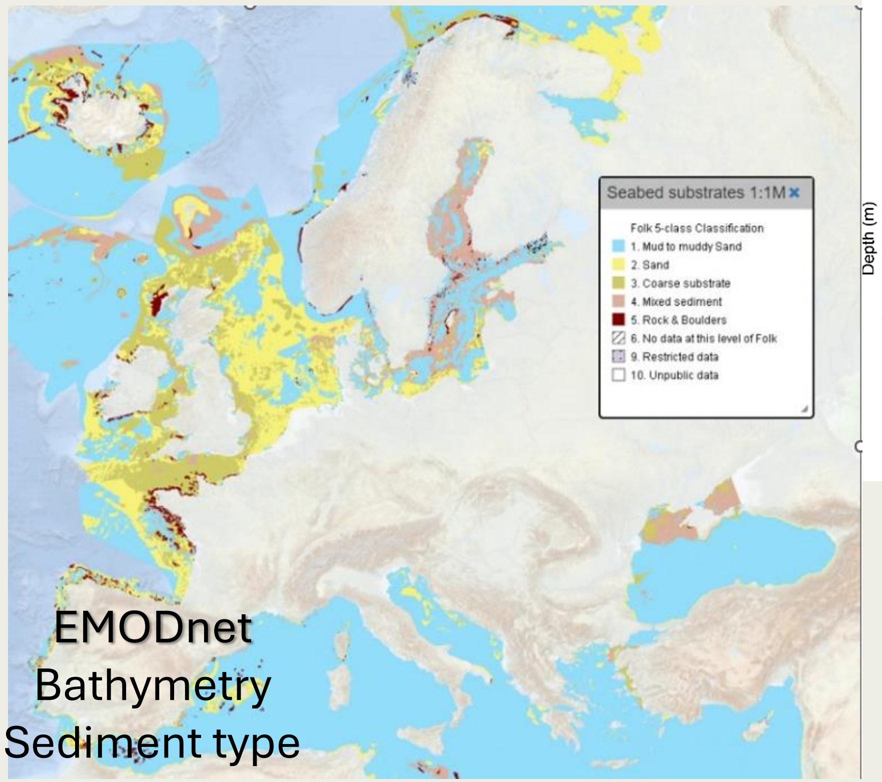
MARIN DW SHIPCONSULT

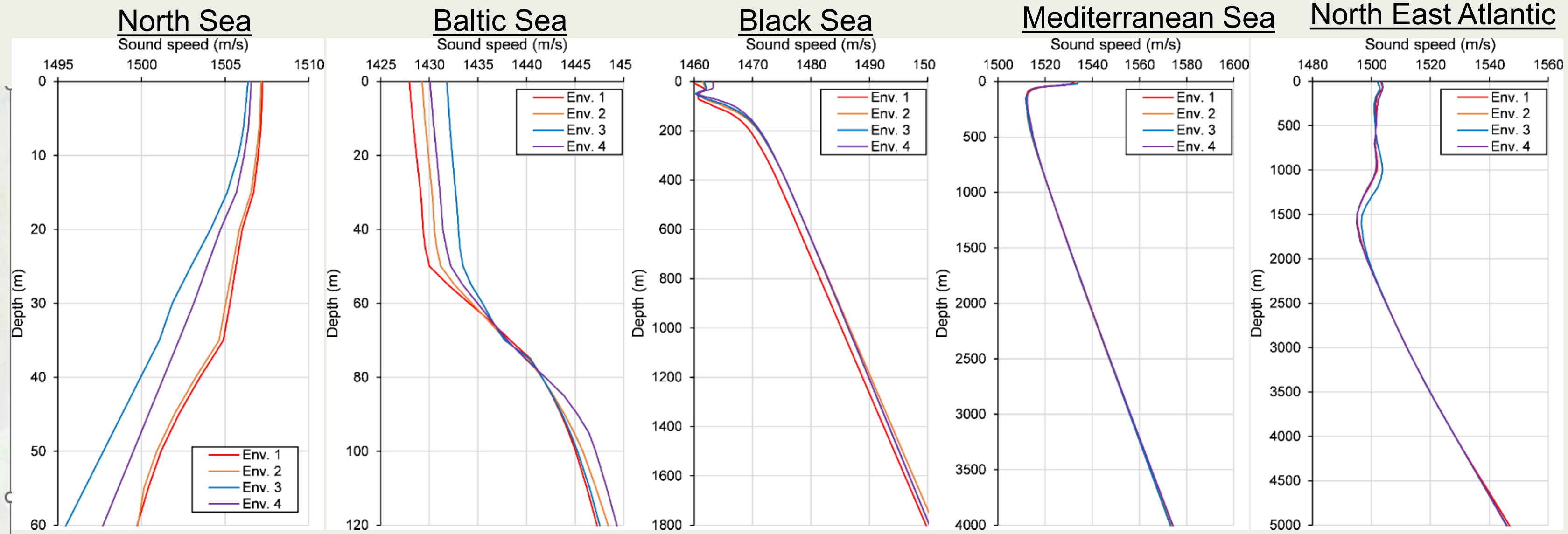
# Trends in shipping sound for all European seas from 2016 to 2050

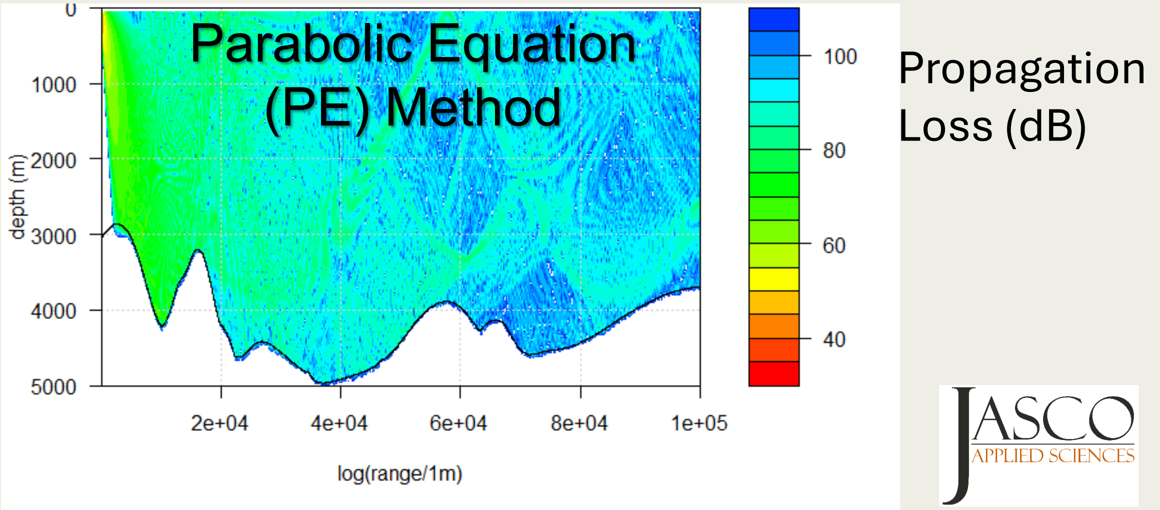
Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood

O1.3-787

## Sound propagation model




JASCO APPLIED SCIENCES

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



# Map layers (QGIS plugin)

PyQGIS scripts are used to visualize and post-process the sound map layers (as netCDF files)

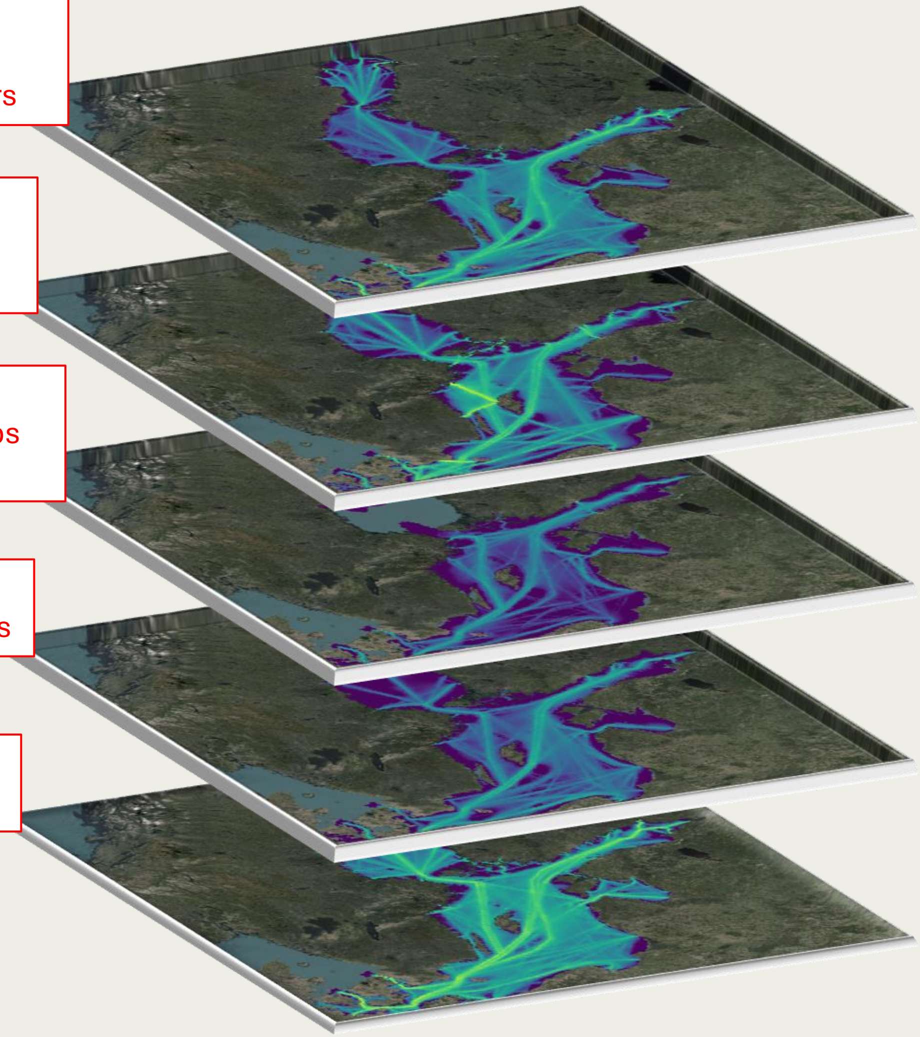
TGC
tankers
and gas carriers

RRO
roll on-roll off
(ro-ro)

PAS
passenger ships
(except ro-ro)

CON
container ships

CAR
cargo vessels



European Maritime Safety Agency

Source: NAVISON, EMSA (2025)

Trends in shipping sound for all European seas from 2016 to 2050

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood

O1.3-787

# Map layers (QGIS plugin)

PyQGIS scripts are used to visualize and post-process the sound map layers (as netCDF files)

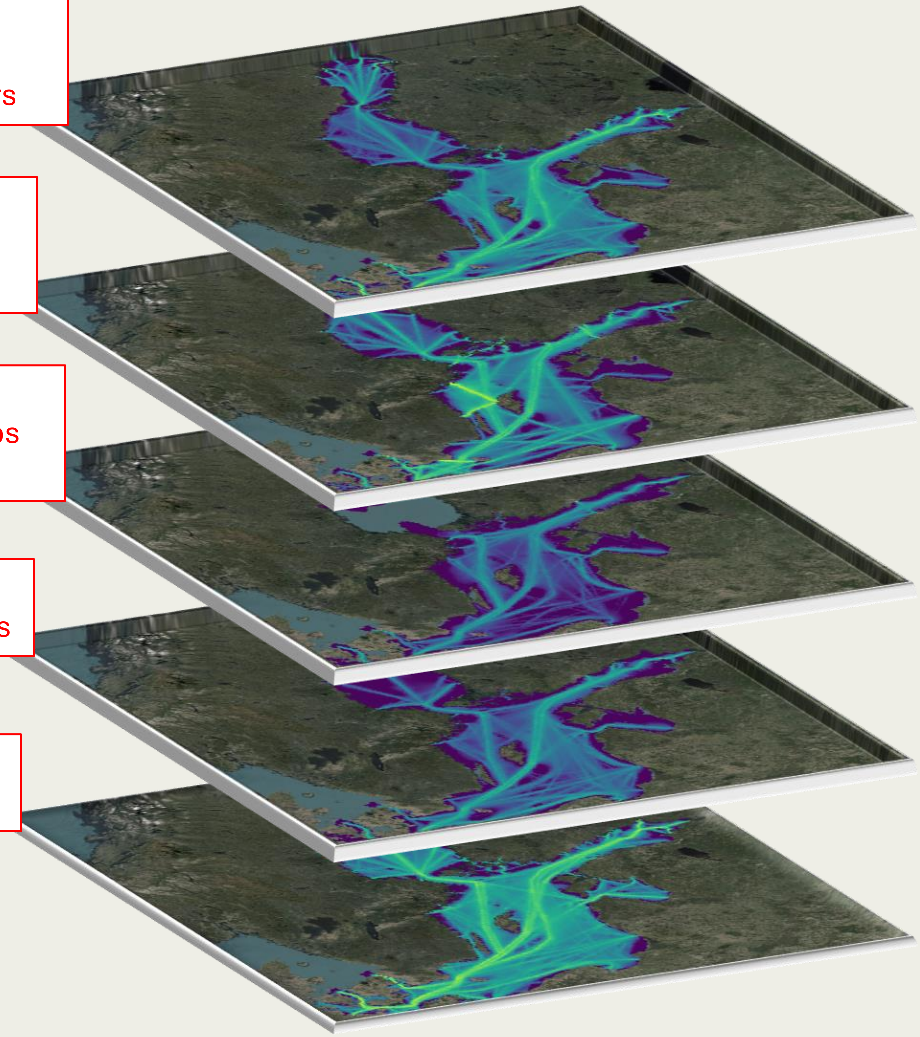
TGC
tankers
and gas carriers

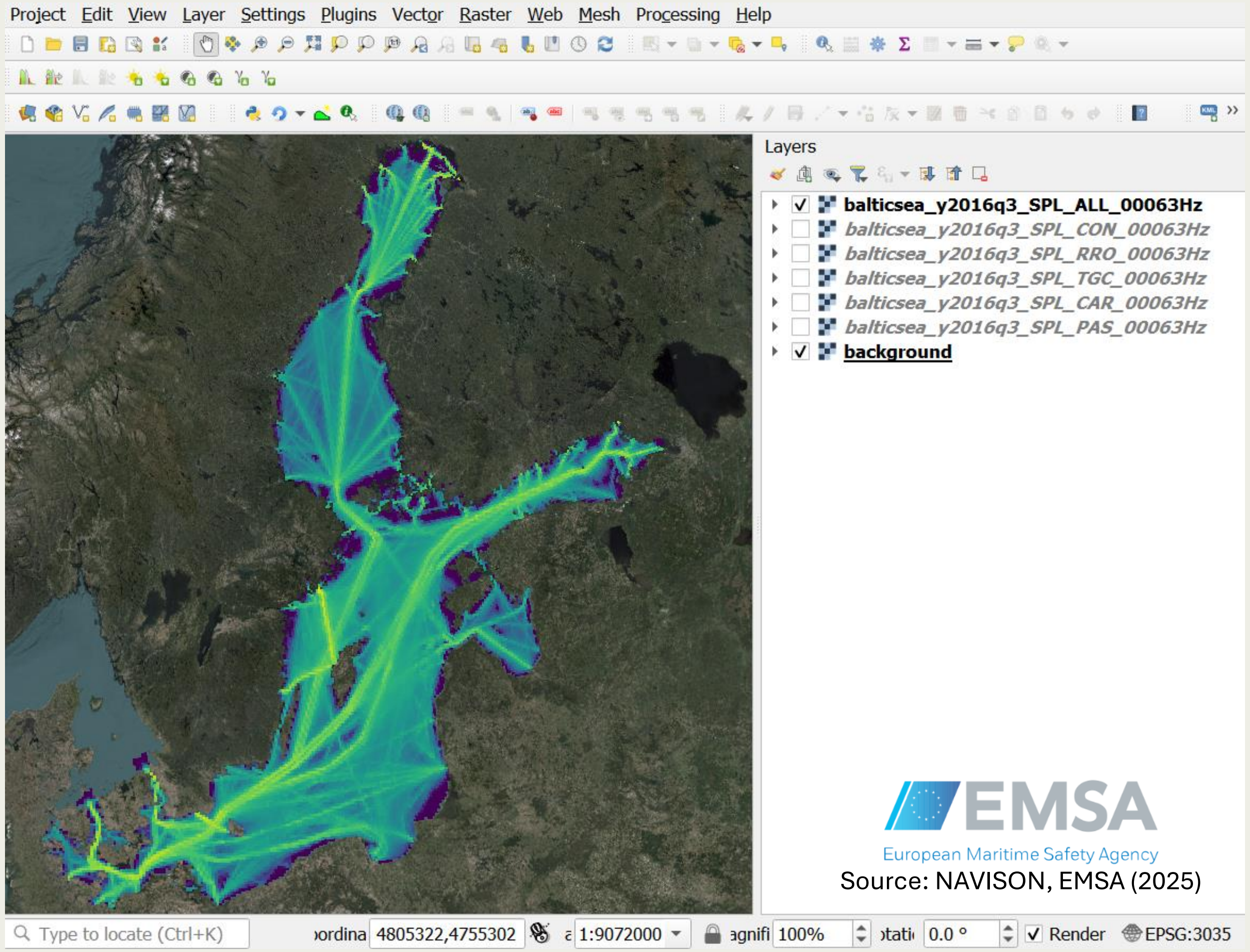
RRO
roll on-roll off
(ro-ro)

PAS
passenger ships
(except ro-ro)

CON
container ships

CAR
cargo vessels






EMSA
European Maritime Safety Agency

Source: NAVISON, EMSA (2025)

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



# Map layers (QGIS plugin)

PyQGIS scripts are used to visualize and post-process the sound map layers (as netCDF files)

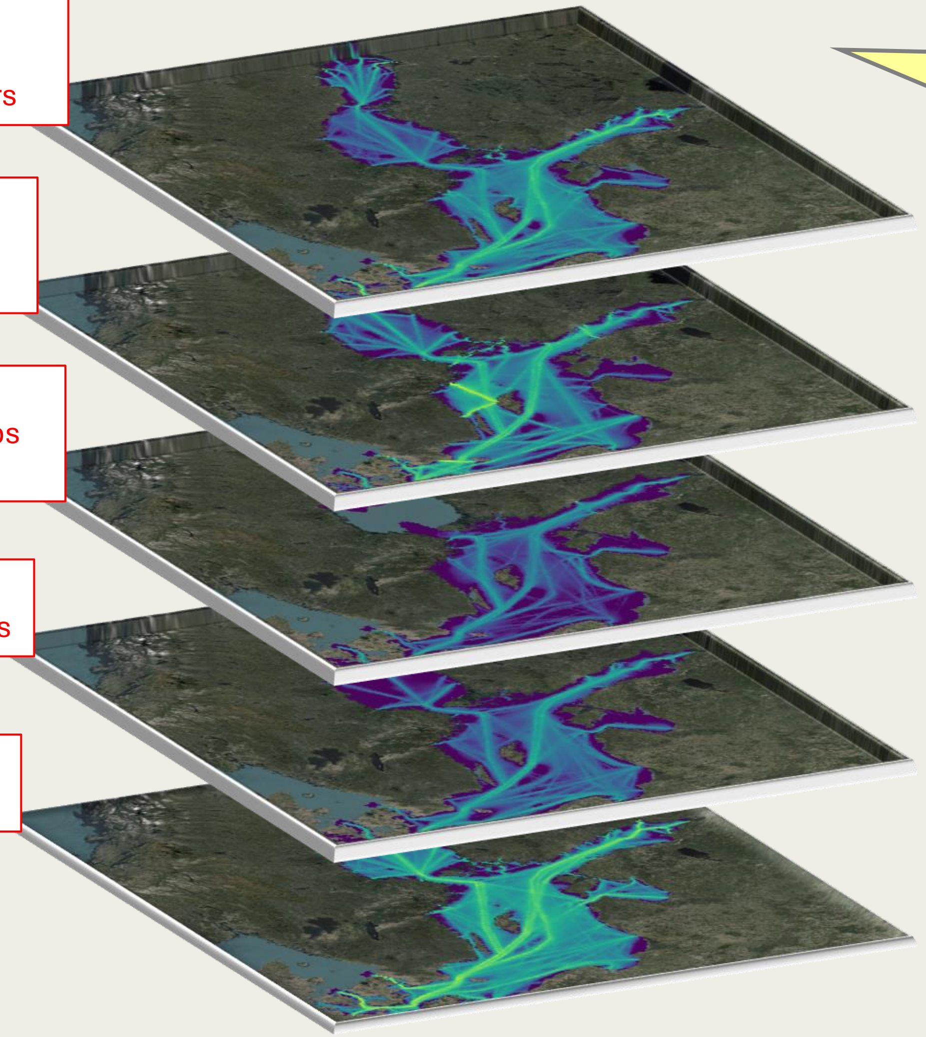
TGC
tankers
and gas carriers

RRO
roll on-roll off
(ro-ro)

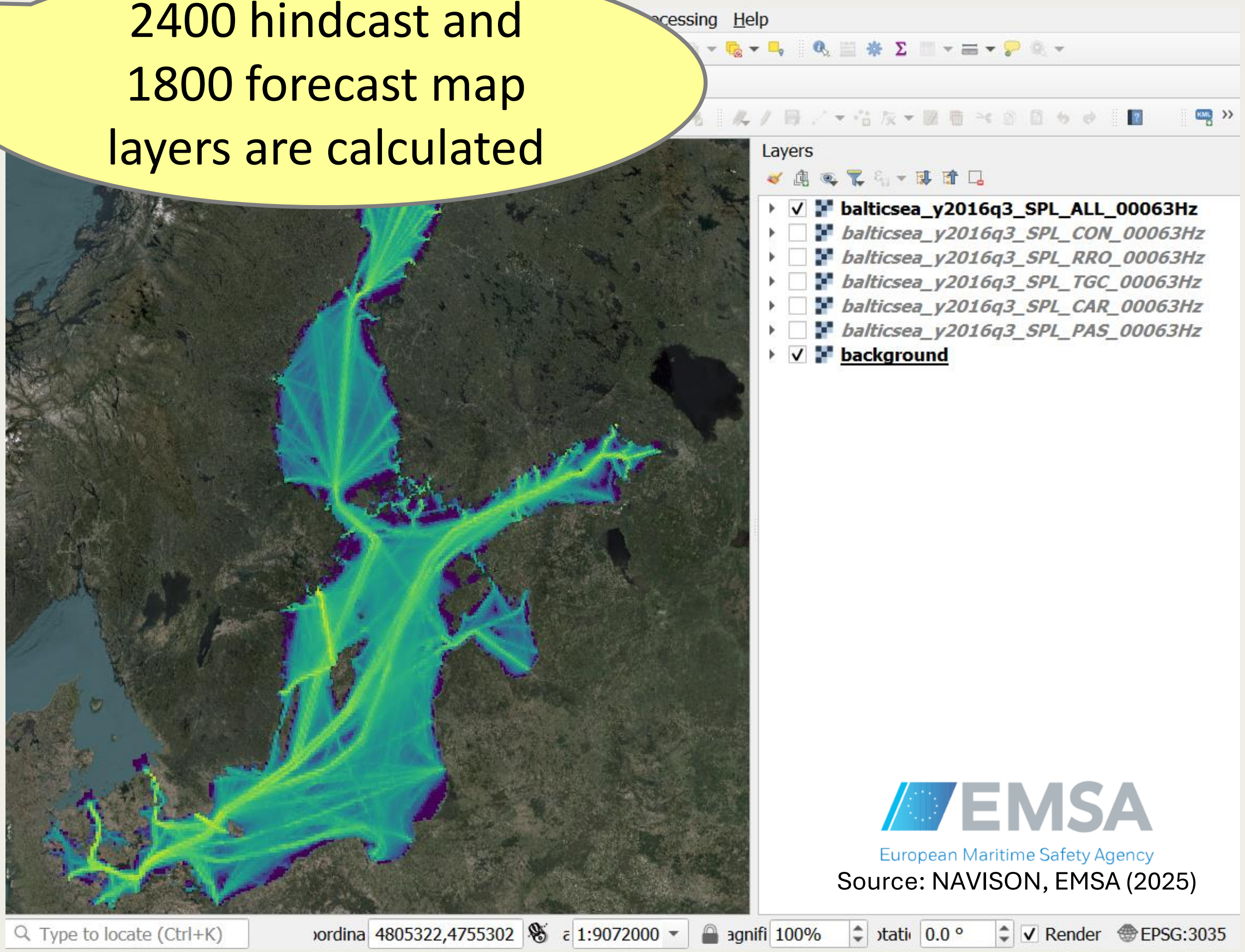
PAS
passenger ships
(except ro-ro)

CON
container ships

CAR
cargo vessels



2400 hindcast and
1800 forecast map
layers are calculated




Source: NAVISON, EMSA (2025)

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



# Map layers (QGIS plugin)

PyQGIS scripts are used to visualize and post-process the sound map layers (as netCDF files)

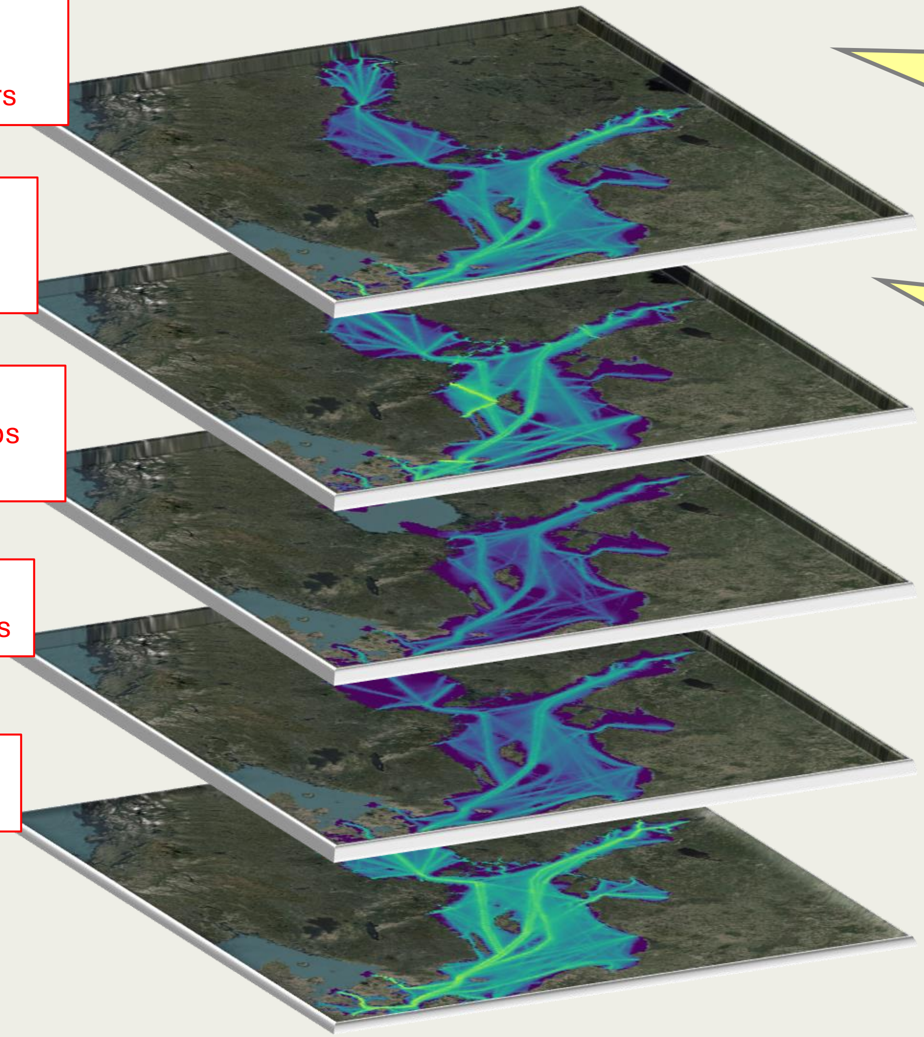
TGC
tankers
and gas carriers

RRO
roll on-roll off
(ro-ro)

PAS
passenger ships
(except ro-ro)

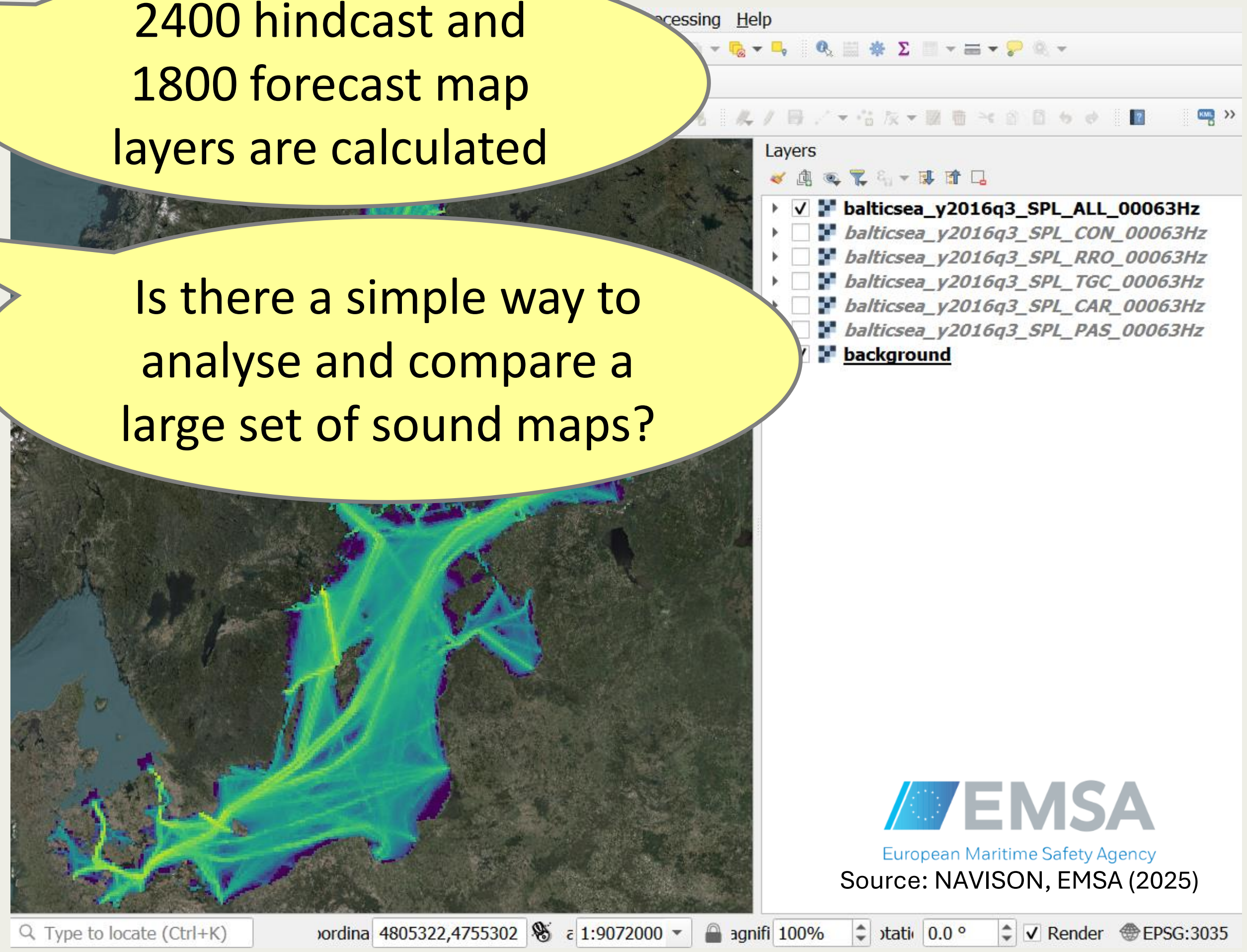
CON
container ships

CAR
cargo vessels



2400 hindcast and 1800 forecast map layers are calculated

Is there a simple way to analyse and compare a large set of sound maps?




EMSA European Maritime Safety Agency
Source: NAVISON, EMSA (2025)

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



# Map layers (QGIS plugin)

PyQGIS scripts are used to visualize and post-process the sound map layers (as netCDF files)

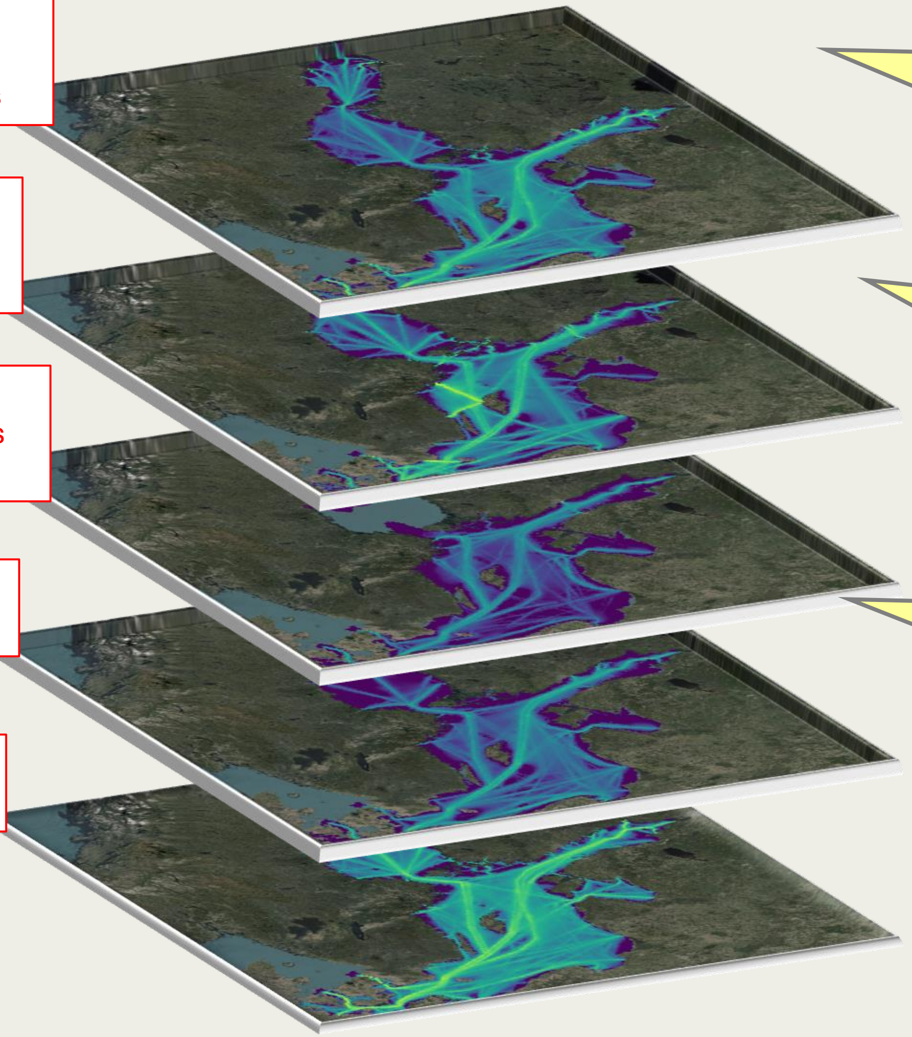
TGC
tankers
and gas carriers

RRO
roll on-roll off
(ro-ro)

PAS
passenger ships
(except ro-ro)

CON
container ships

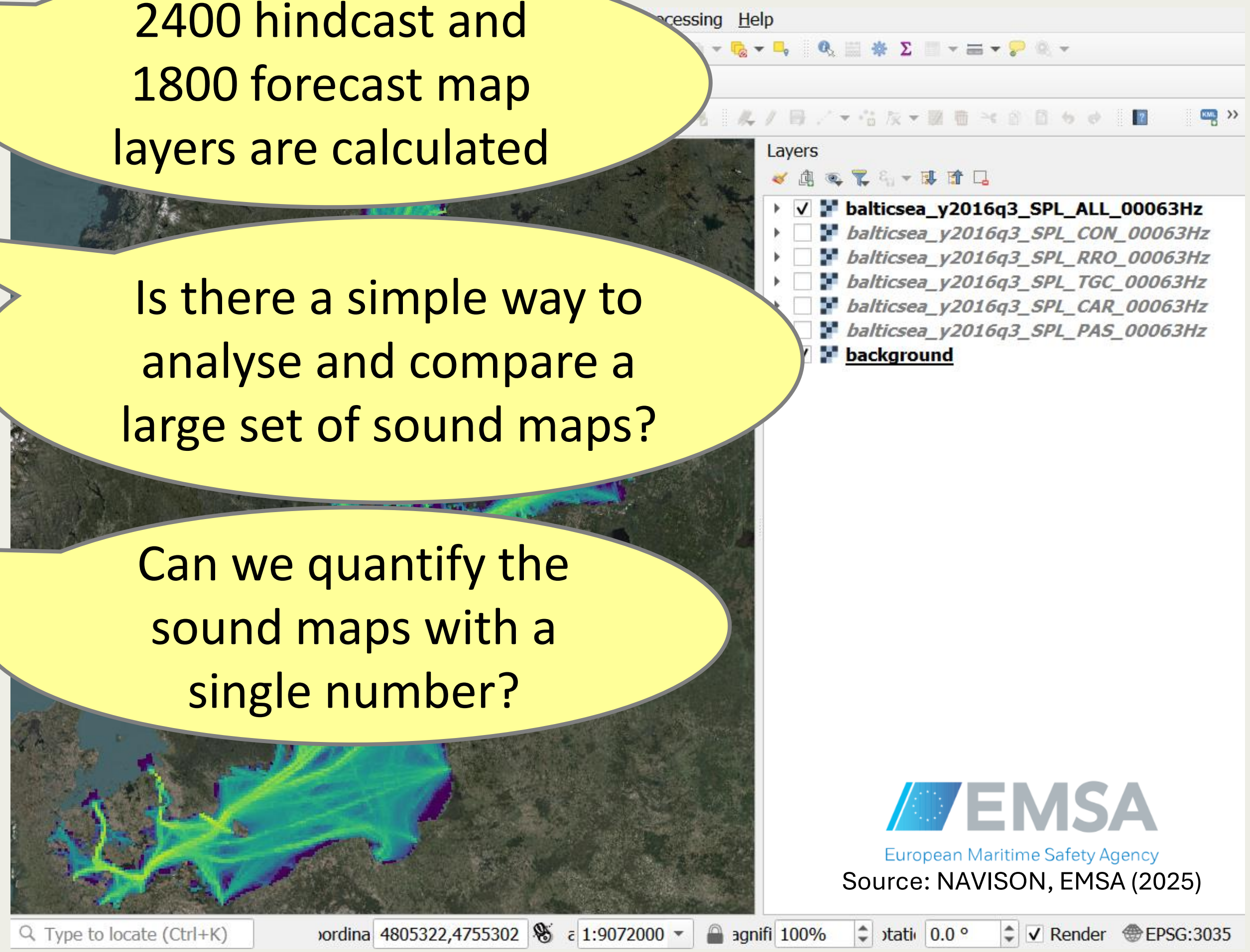
CAR
cargo vessels



2400 hindcast and 1800 forecast map layers are calculated

Is there a simple way to analyse and compare a large set of sound maps?

Can we quantify the sound maps with a single number?

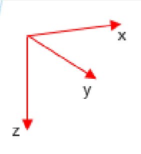


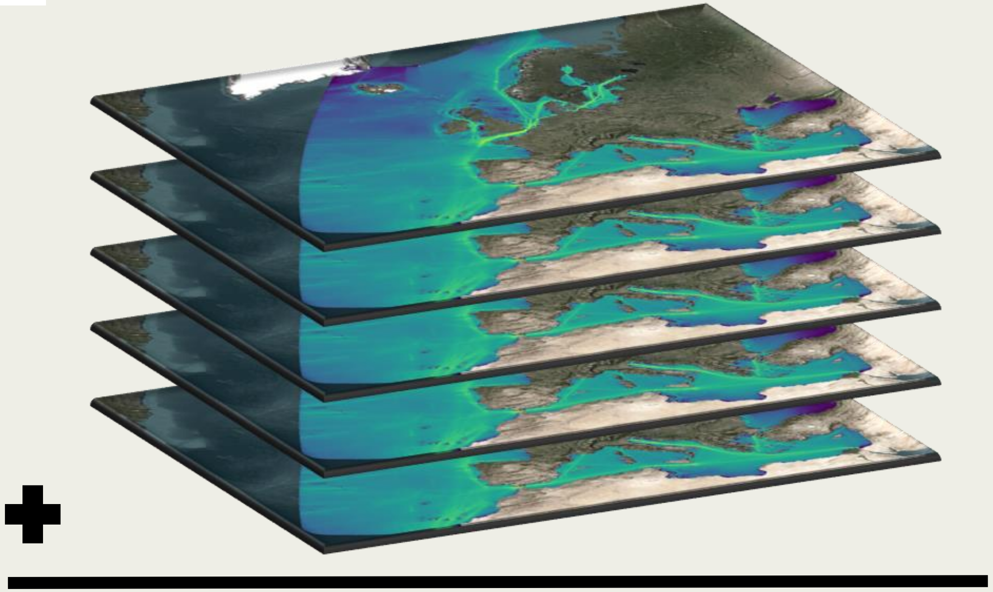

EMSA European Maritime Safety Agency

Source: NAVISON, EMSA (2025)

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood


# Post-processing of sound maps



**Total sound energy**

$$Total\ sound\ energy = \frac{1}{\rho c^2}\int p^2(f,x,y,z)dV \cong \frac{1}{\rho c^2}\sum_{i=1}^{N_x}\sum_{j=1}^{Ny} p_{ij}^2 H_{ij}\Delta x\Delta y$$

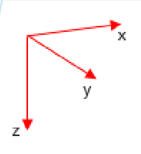
- We can calculate the sound energies from the sound maps

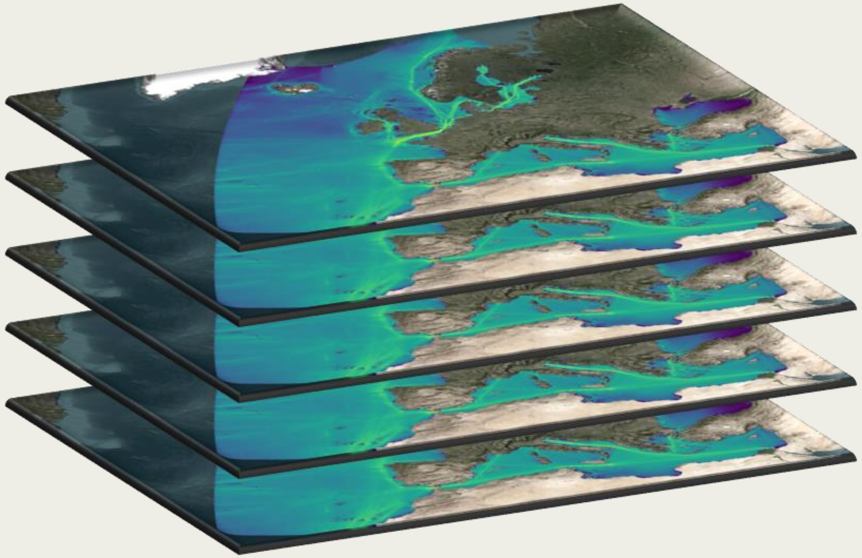
JASCO APPLIED SCIENCES

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



# Post-processing of sound maps



- We can calculate the sound energies from the sound maps

**Total sound energy**

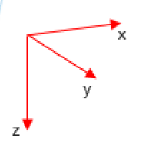
$$Total\ sound\ energy = \frac{1}{\rho c^2}\int p^2(f,x,y,z)dV \cong \frac{1}{\rho c^2}\sum_{i=1}^{N_x}\sum_{j=1}^{Ny} p_{ij}^2 H_{ij}\Delta x \Delta y$$

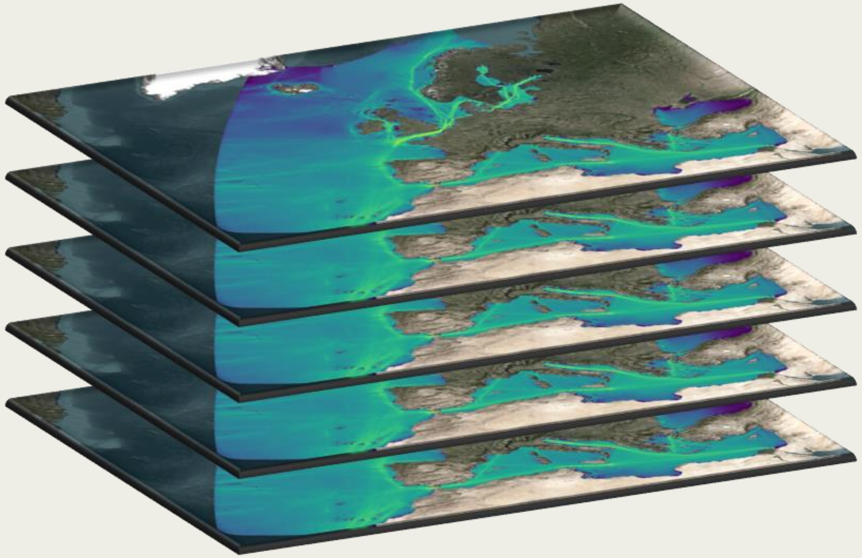
$$\textbf{Sound energy density} = \frac{\textbf{Total sound energy}}{\textbf{Volume of the sea water}}$$

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



# Post-processing of sound maps



- We can calculate the sound energies from the sound maps
- The sound energy density can help to analyze the time trend underwater sound
- By allowing linear summation, it can help identify the contribution of different ship categories

**Total sound energy**

$$Total\ sound\ energy = \frac{1}{\rho c^2}\int p^2(f,x,y,z)dV \cong \frac{1}{\rho c^2}\sum_{i=1}^{N_x}\sum_{j=1}^{Ny} p_{ij}^2 H_{ij}\Delta x \Delta y$$

$$\textbf{Sound energy density} = \frac{\textbf{Total sound energy}}{\textbf{Volume of the sea water}}$$

Sound energy density can be used to compare different regions

JASCO APPLIED SCIENCES

Trends in shipping sound for all European seas from 2016 to 2050

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood

O1.3-787

# NAVISON results at 63 Hz


European Maritime Safety Agency

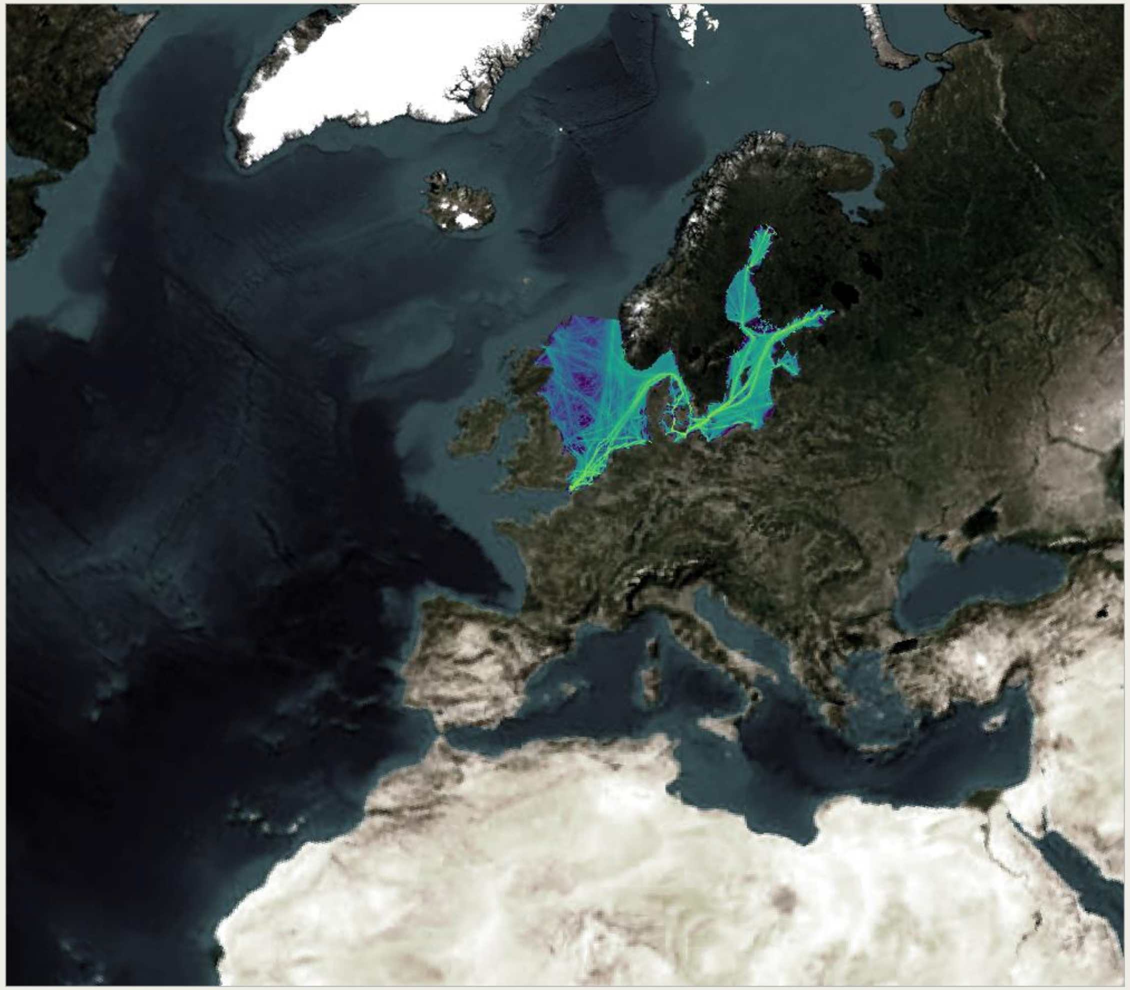
Source: NAVISON, EMSA (2025)

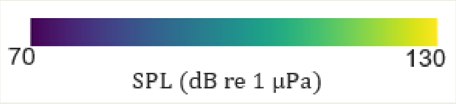
# Trends in shipping sound for all European seas from 2016 to 2050

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



## NAVISON results at 63 Hz





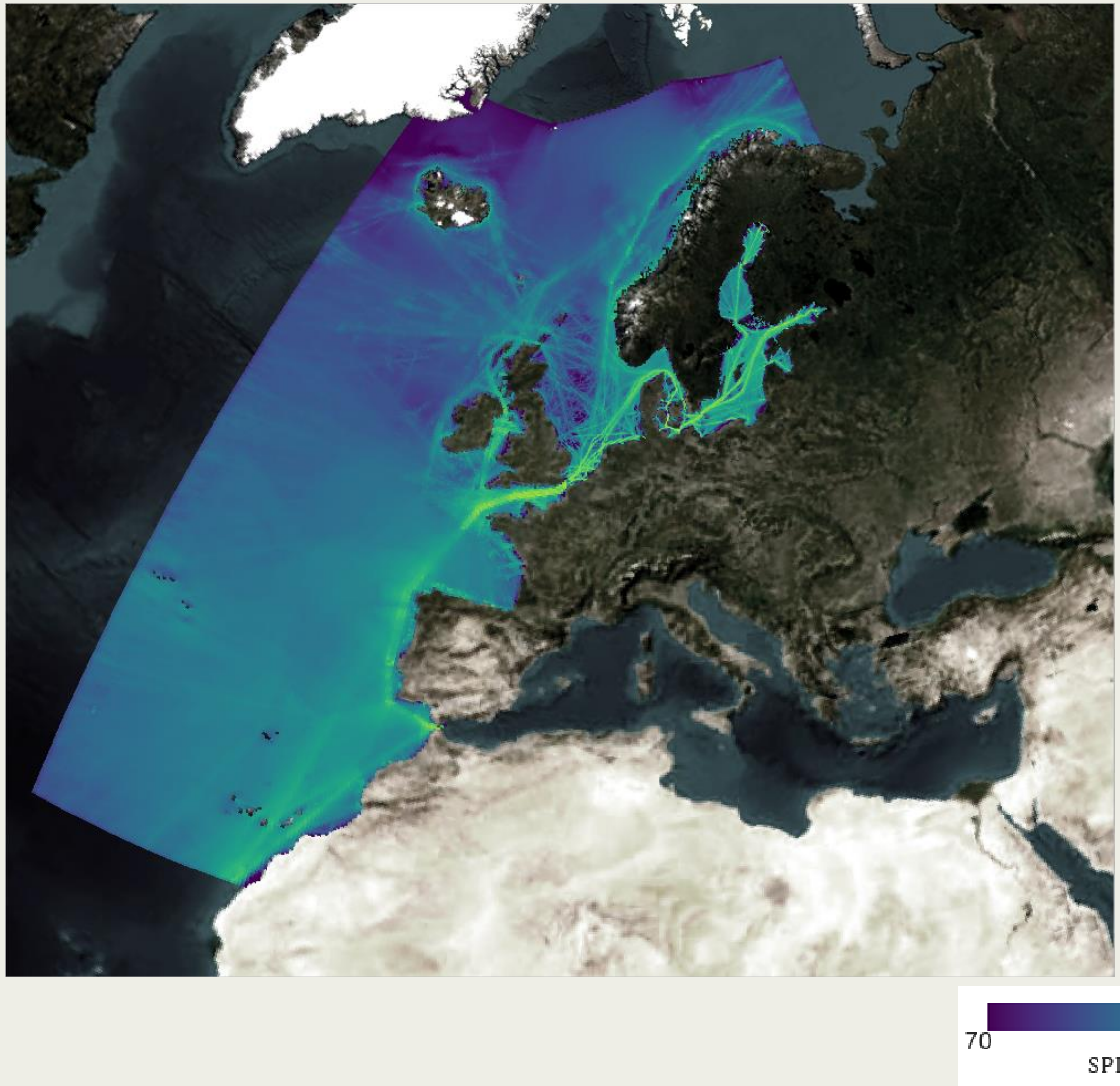

European Maritime Safety Agency
Source: NAVISON, EMSA (2025)

Trends in shipping sound for all European seas from 2016 to 2050

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



# NAVISON results at 63 Hz





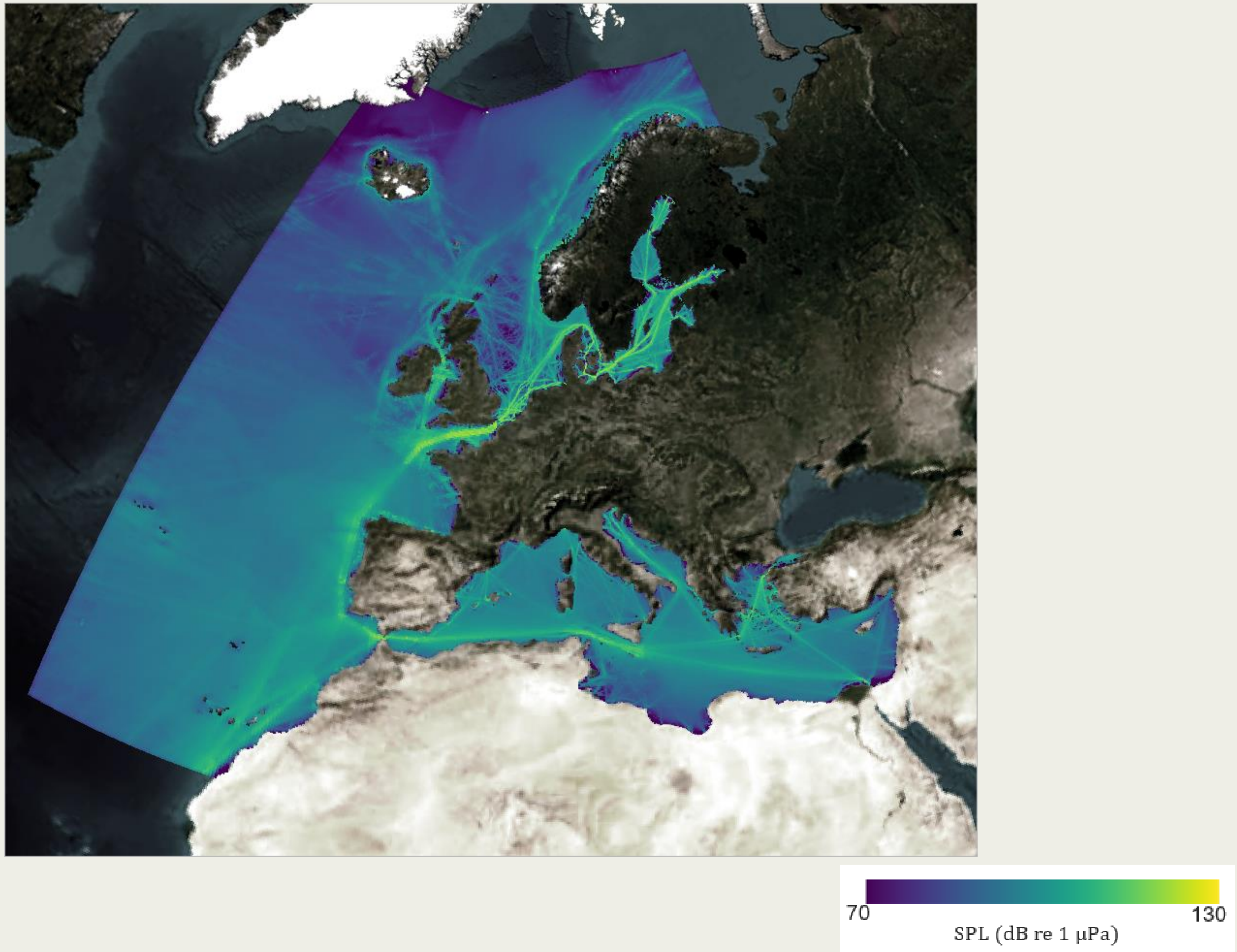

Source: NAVISON, EMSA (2025)

Trends in shipping sound for all European seas from 2016 to 2050

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood

O1.3-787

# NAVISON results at 63 Hz



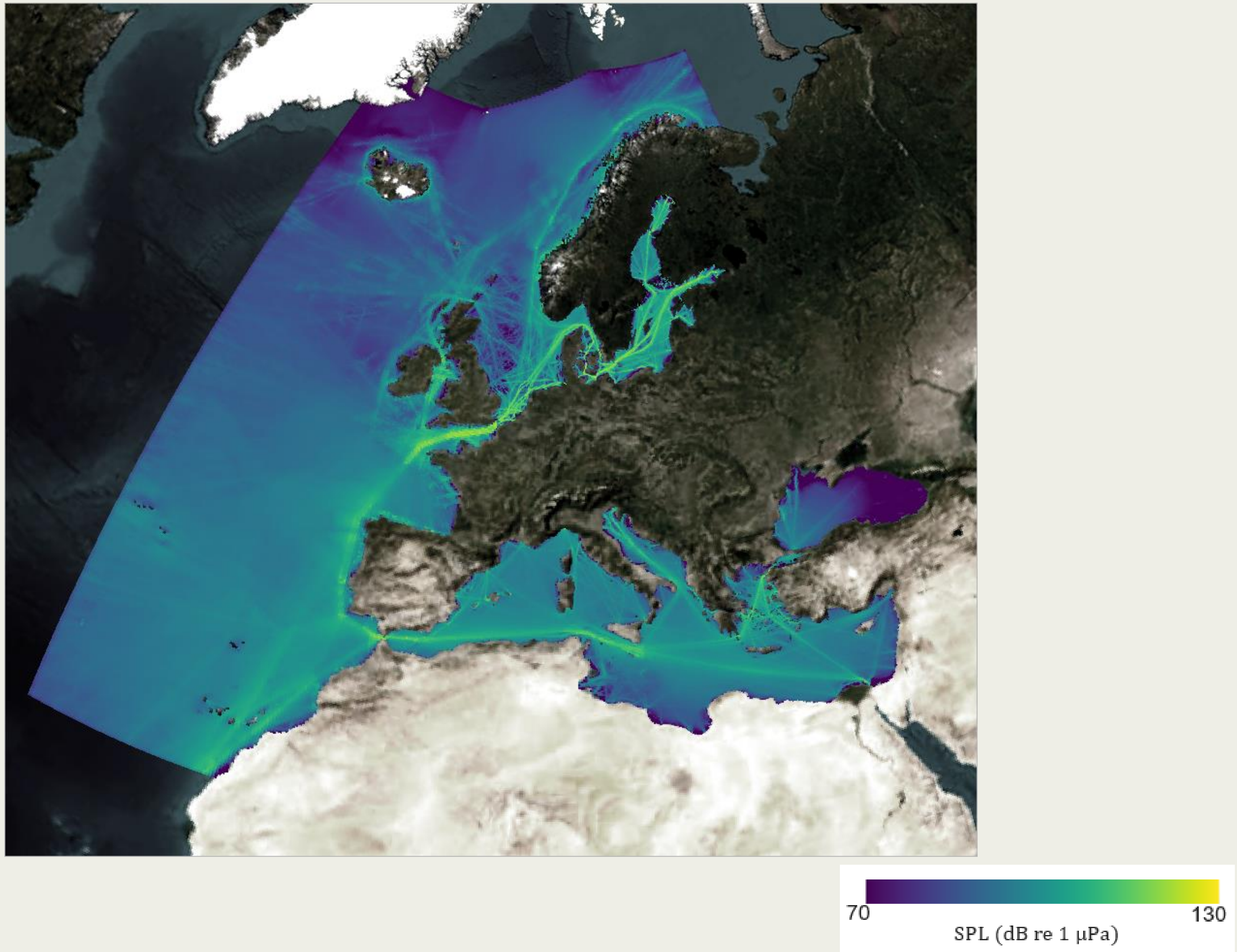

European Maritime Safety Agency

Source: NAVISON, EMSA (2025)

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



# NAVISON results at 63 Hz




EMSA
European Maritime Safety Agency

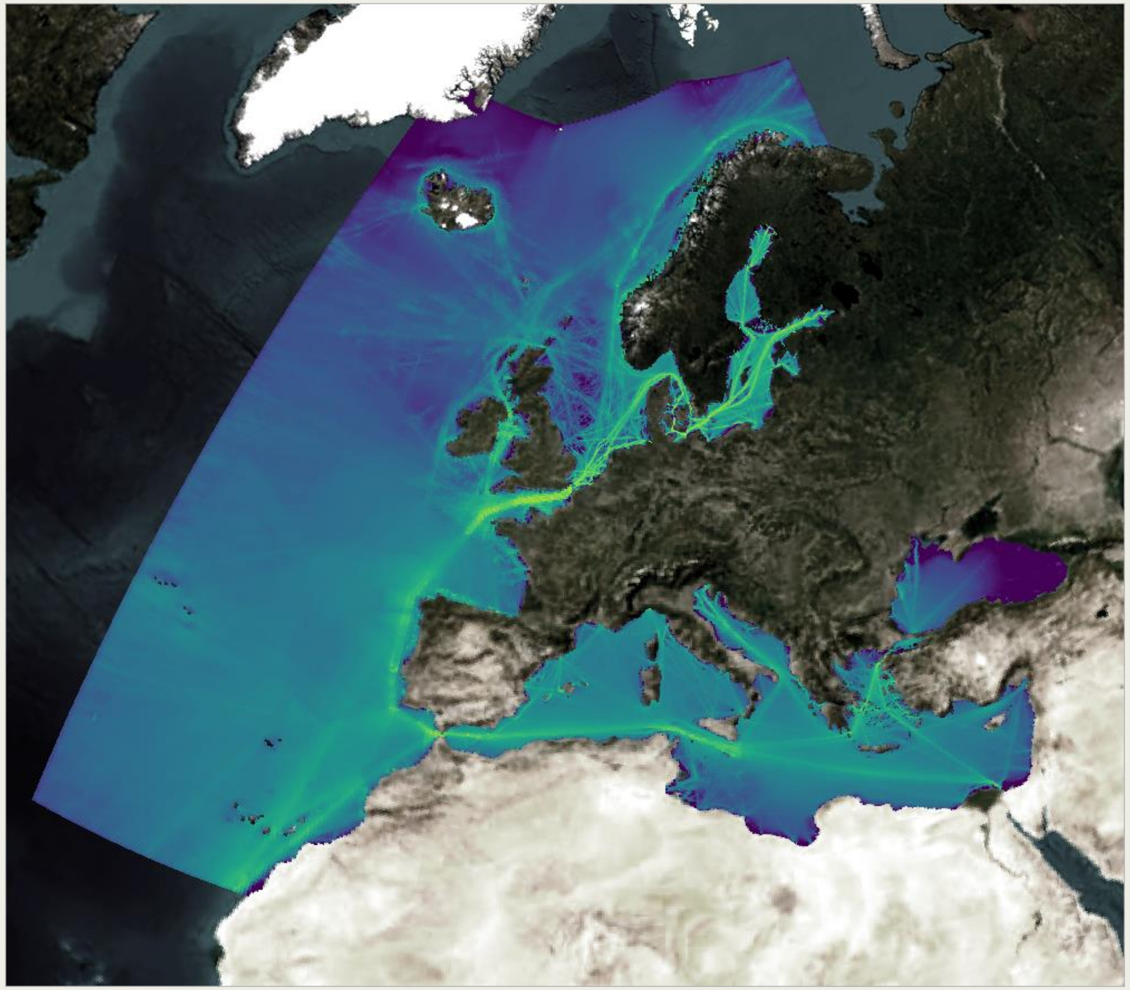
Source: NAVISON, EMSA (2025)

**Trends in shipping sound for all European seas from 2016 to 2050**

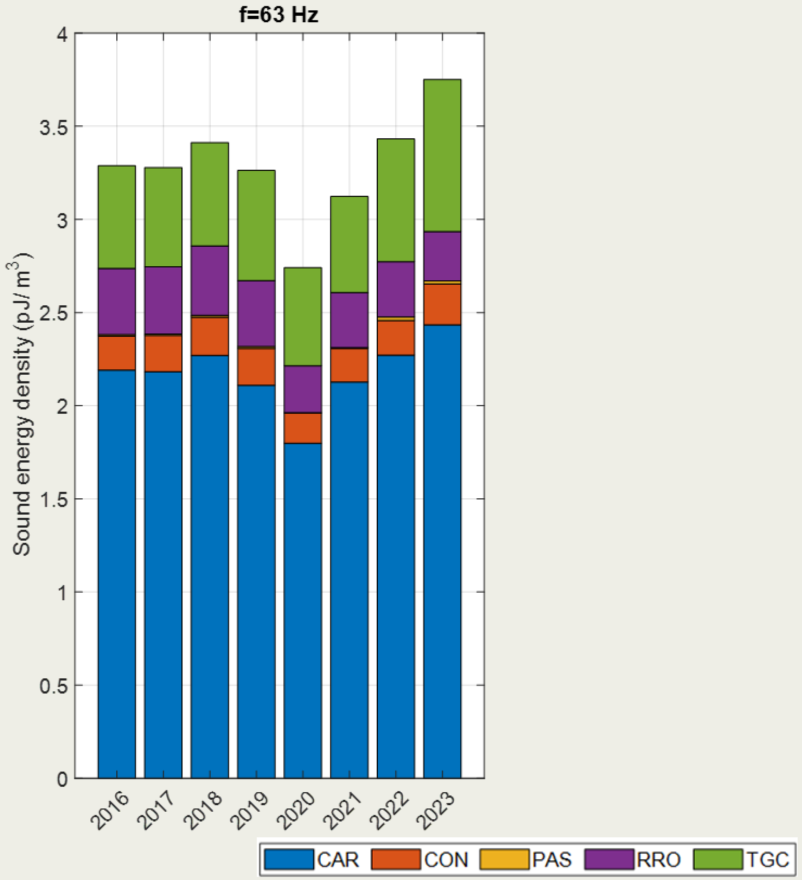
Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood

O1.3-787

# NAVISON results at 63 Hz




## Sound energy densities



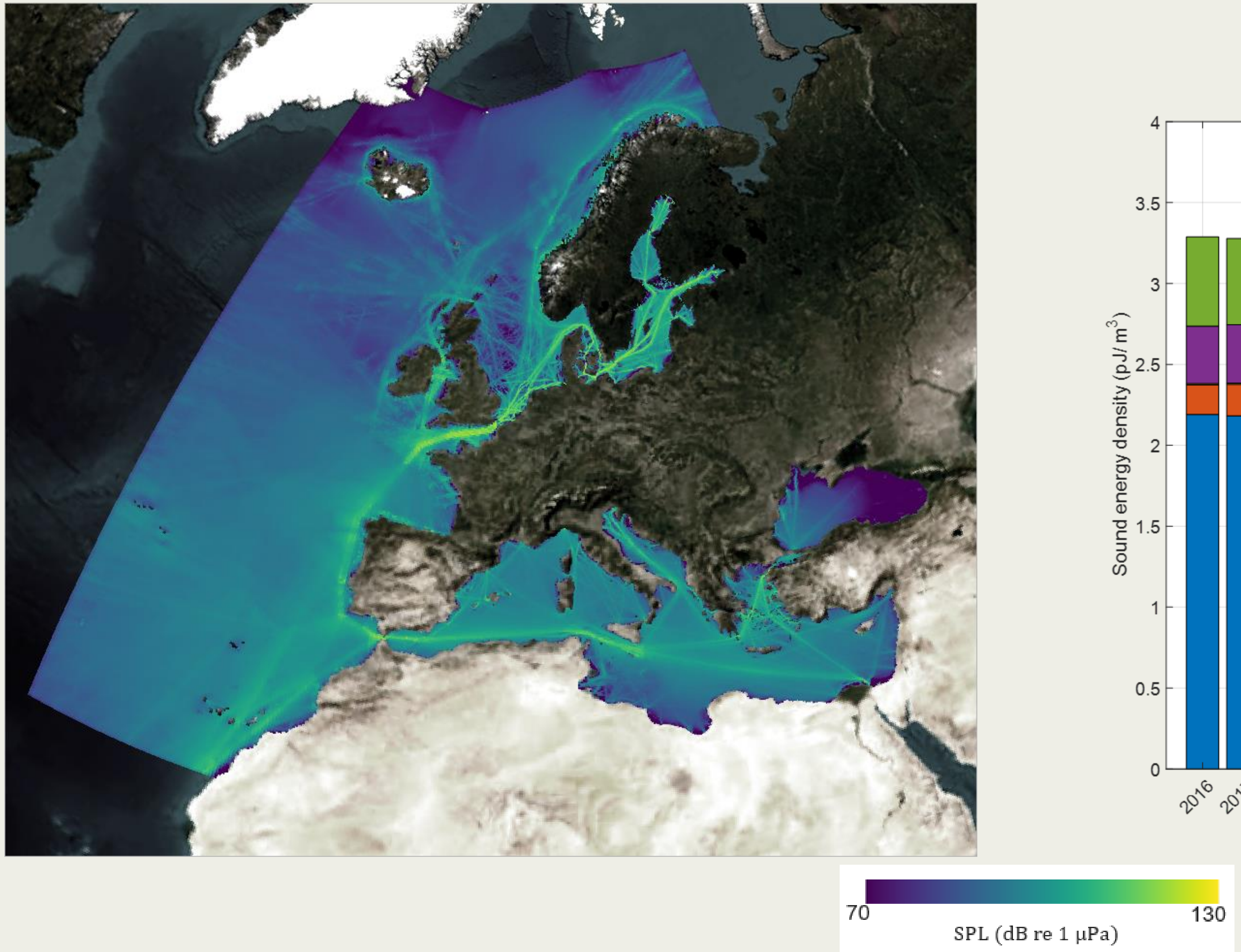

European Maritime Safety Agency

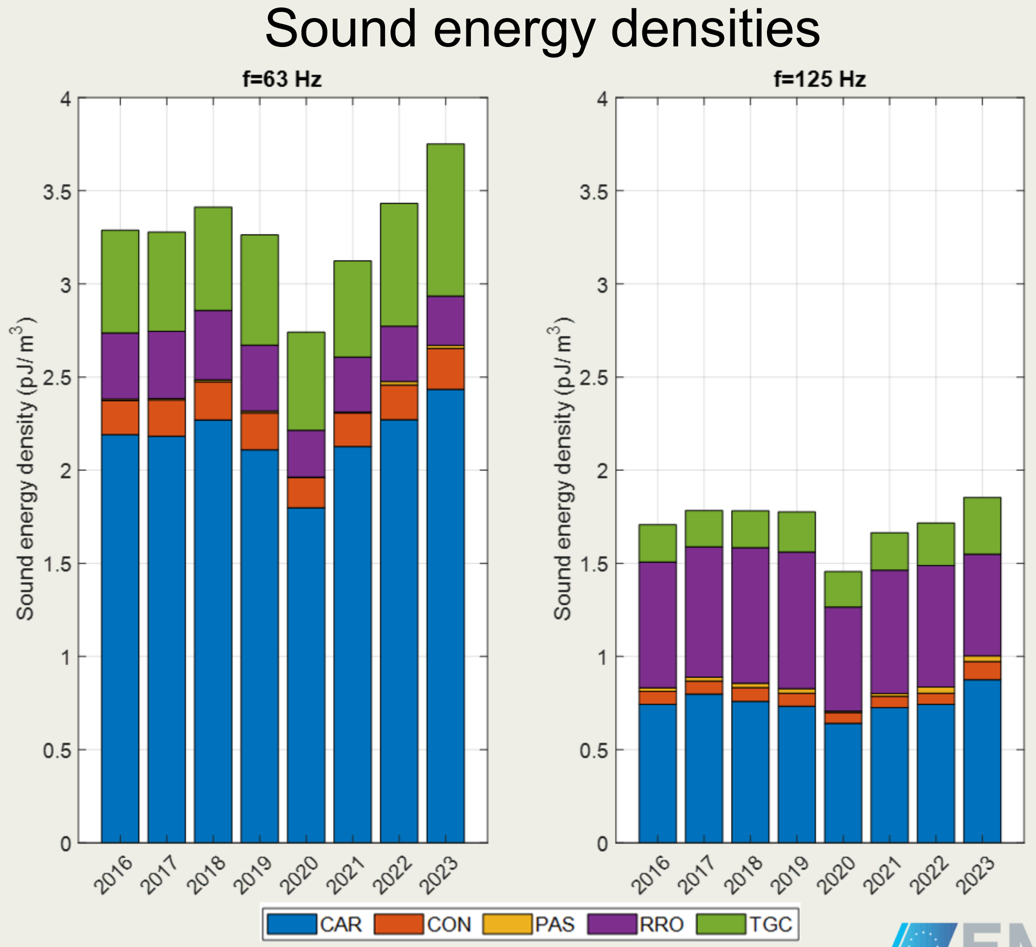
Source: NAVISON, EMSA (2025)

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



# NAVISON results at 63 Hz




European Maritime Safety Agency

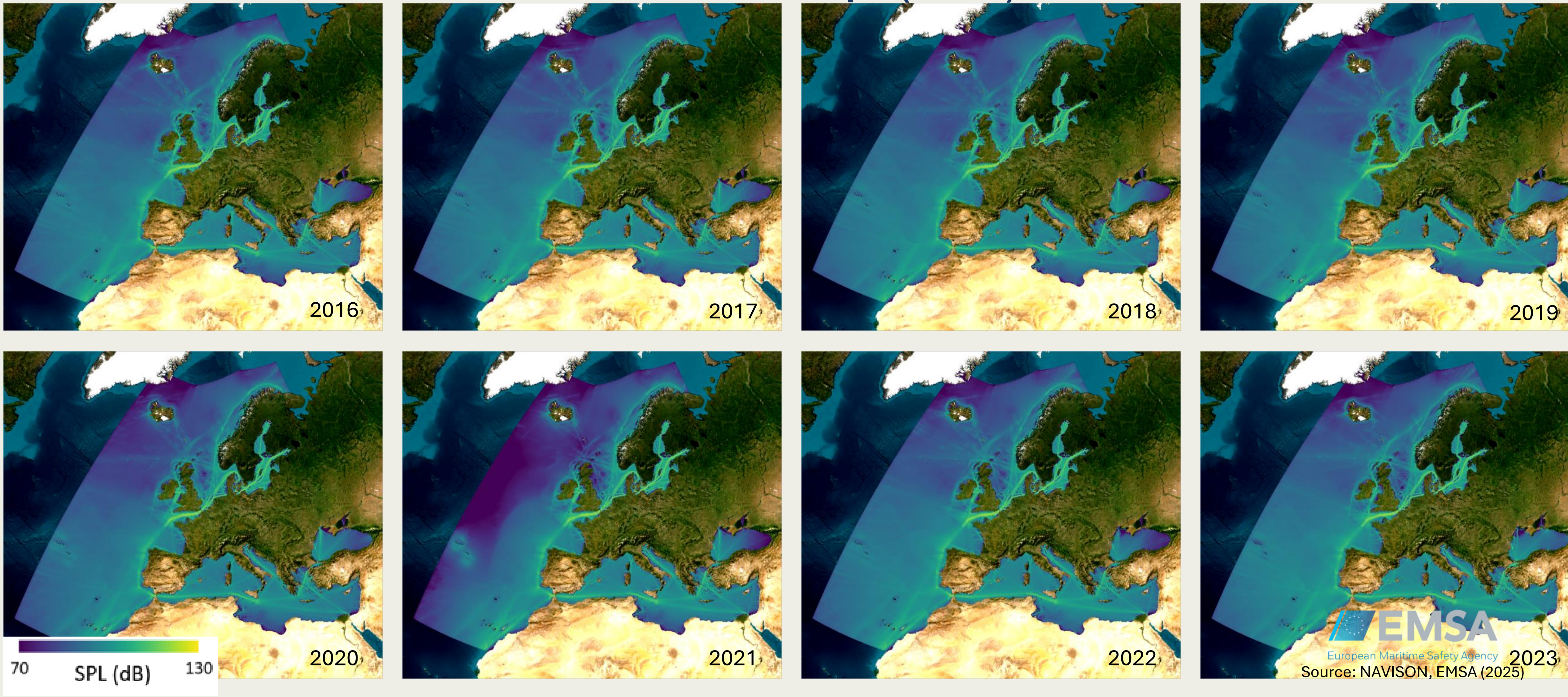
Source: NAVISON, EMSA (2025)

Trends in shipping sound for all European seas from 2016 to 2050

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



# NAVISON Hindcast sound maps (63 Hz): 2016-2023



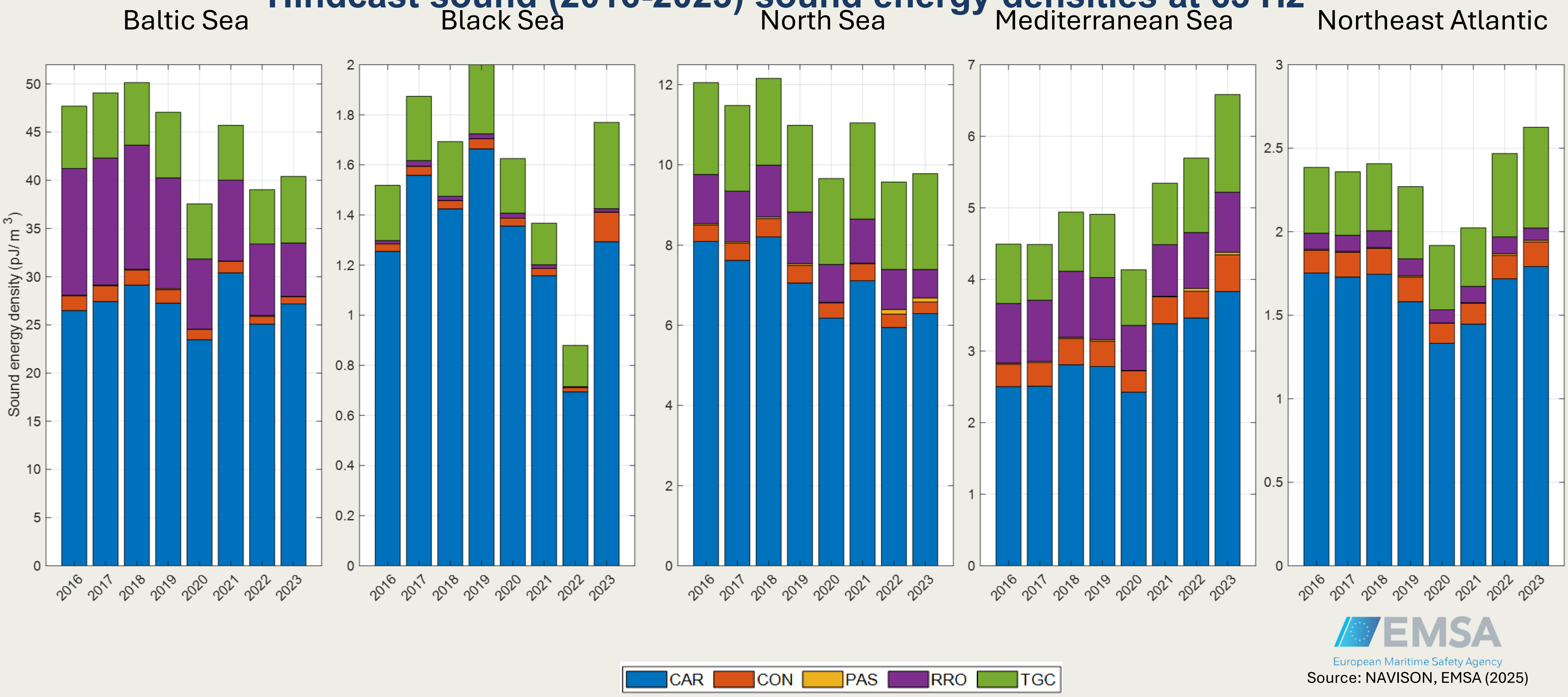

Source: NAVISON, EMSA (2025)

# Trends in shipping sound for all European seas from 2016 to 2050

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood

O1.3-787

## Hindcast sound (2016-2023) sound energy densities at 63 Hz




EMSA European Maritime Safety Agency

Source: NAVISON, EMSA (2025)

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



## Forecast scenarios (2030, 2040, 2050)

# Scenario 1: Business as Usual

Increasing traffic over time

# Scenario 2: GHG emissions roadmap

More efficient propellers (MEP)

Biofouling management

Optimized hull form (OHF)

Speed reduction (SRD)

# Scenario 3: URN management in isolation

Quiet propeller (QRP)

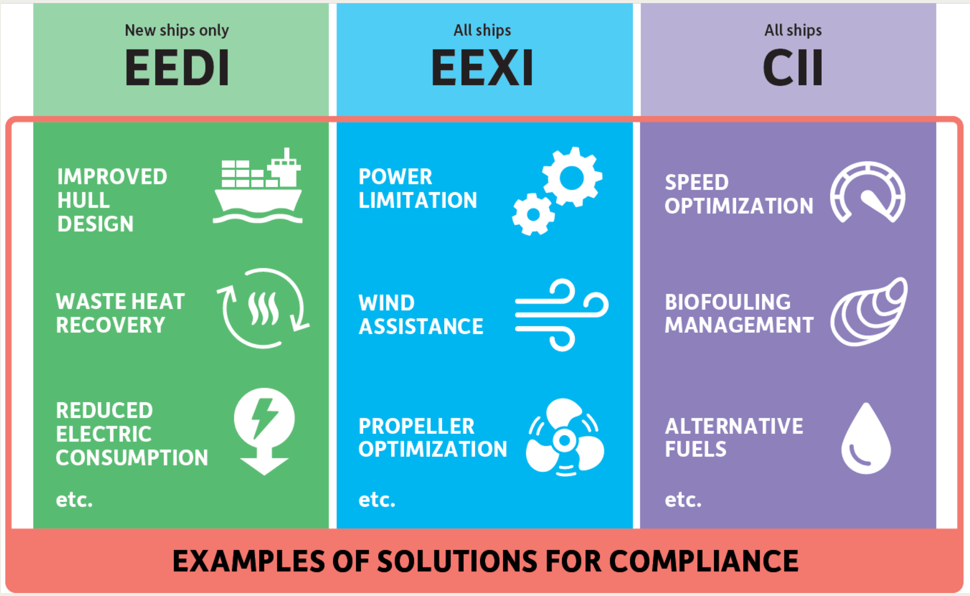
Air injection (AIN)

Speed reduction (SRD)

# Scenario 4: URN management plus GHG emissions roadmap

Six combined measures

IMO GHG emissions roadmap scenario




EMSA European Maritime Safety Agency

Source: NAVISON, EMSA (2025)

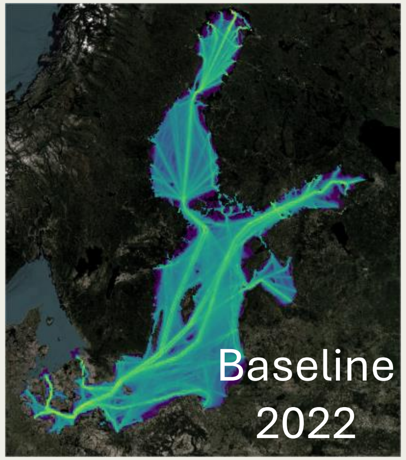
Trends in shipping sound for all European seas from 2016 to 2050

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood

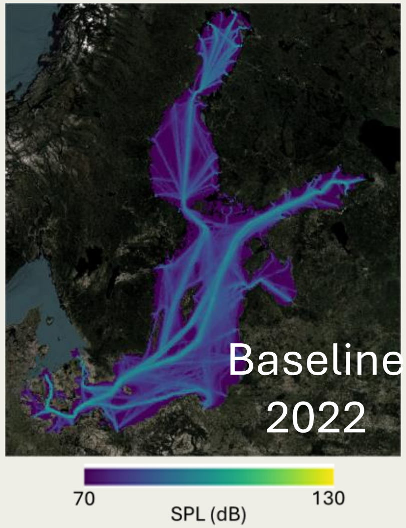


# Forecast modelling approach

Cavitation




Machinery



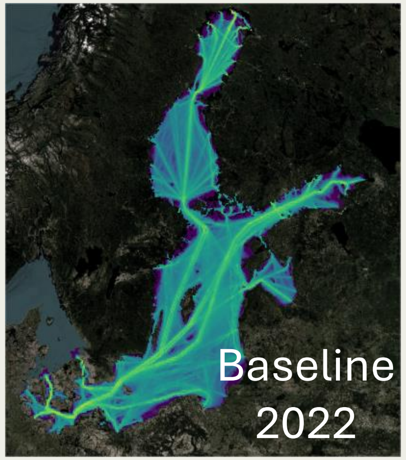
# Trends in shipping sound for all European seas from 2016 to 2050

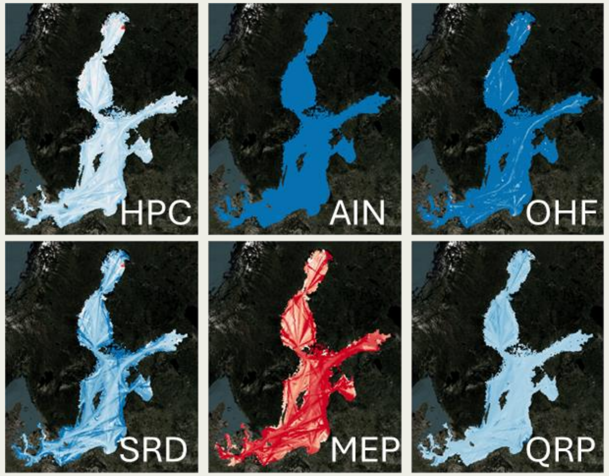
Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



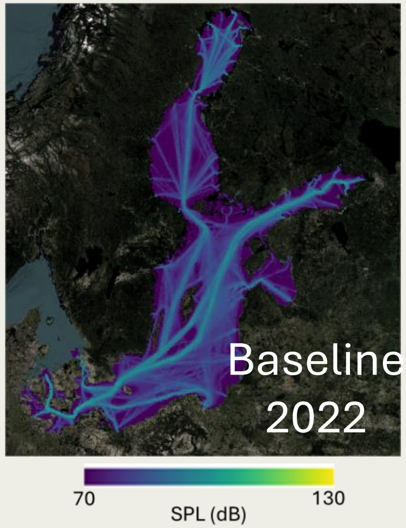
## Forecast modelling approach

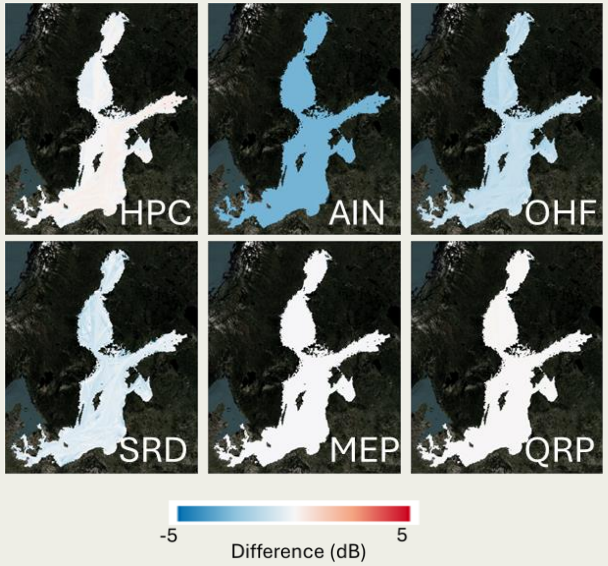
Cavitation




Machinery



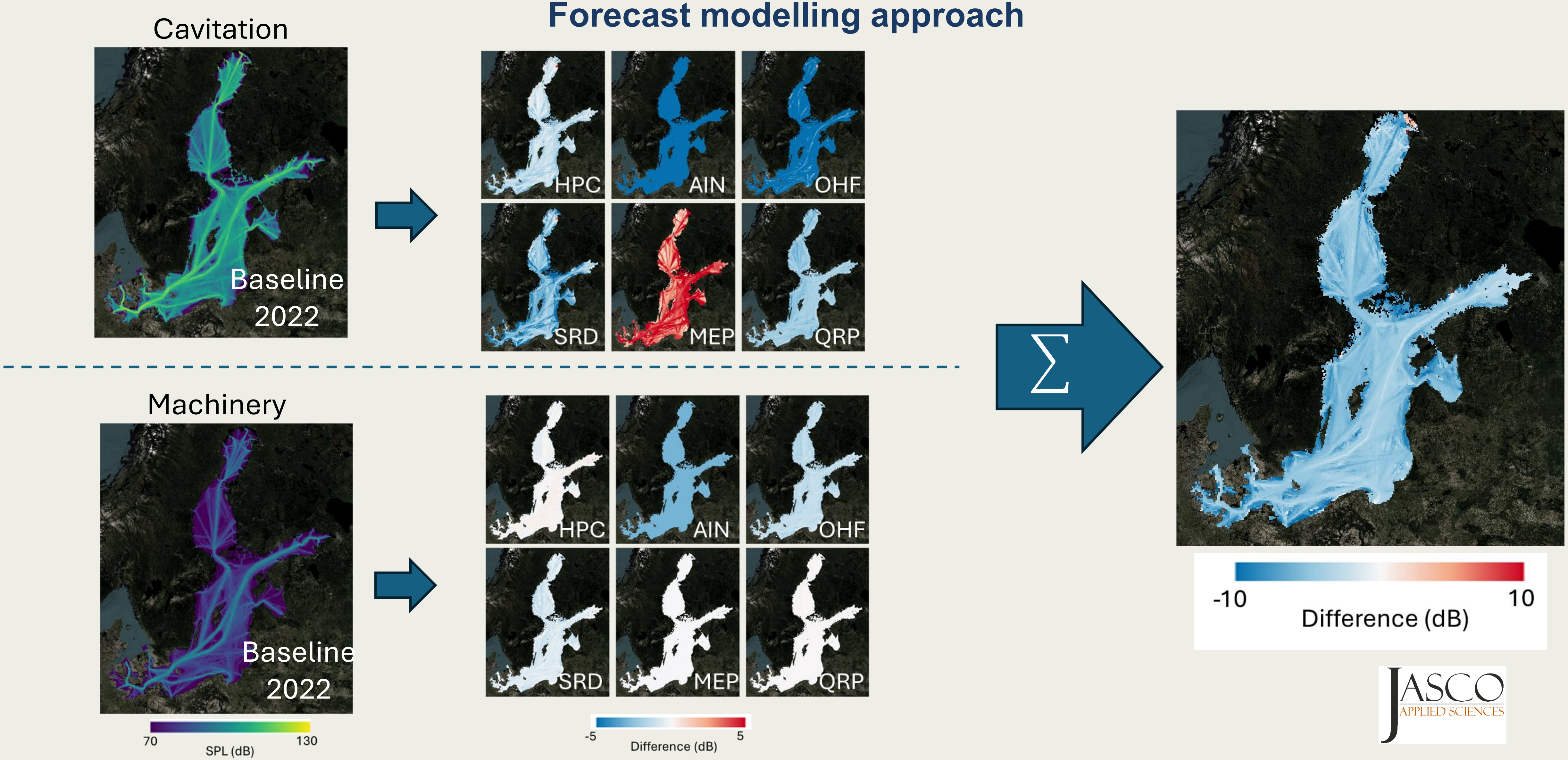



# Trends in shipping sound for all European seas from 2016 to 2050

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood

O1.3-787

## Forecast modelling approach

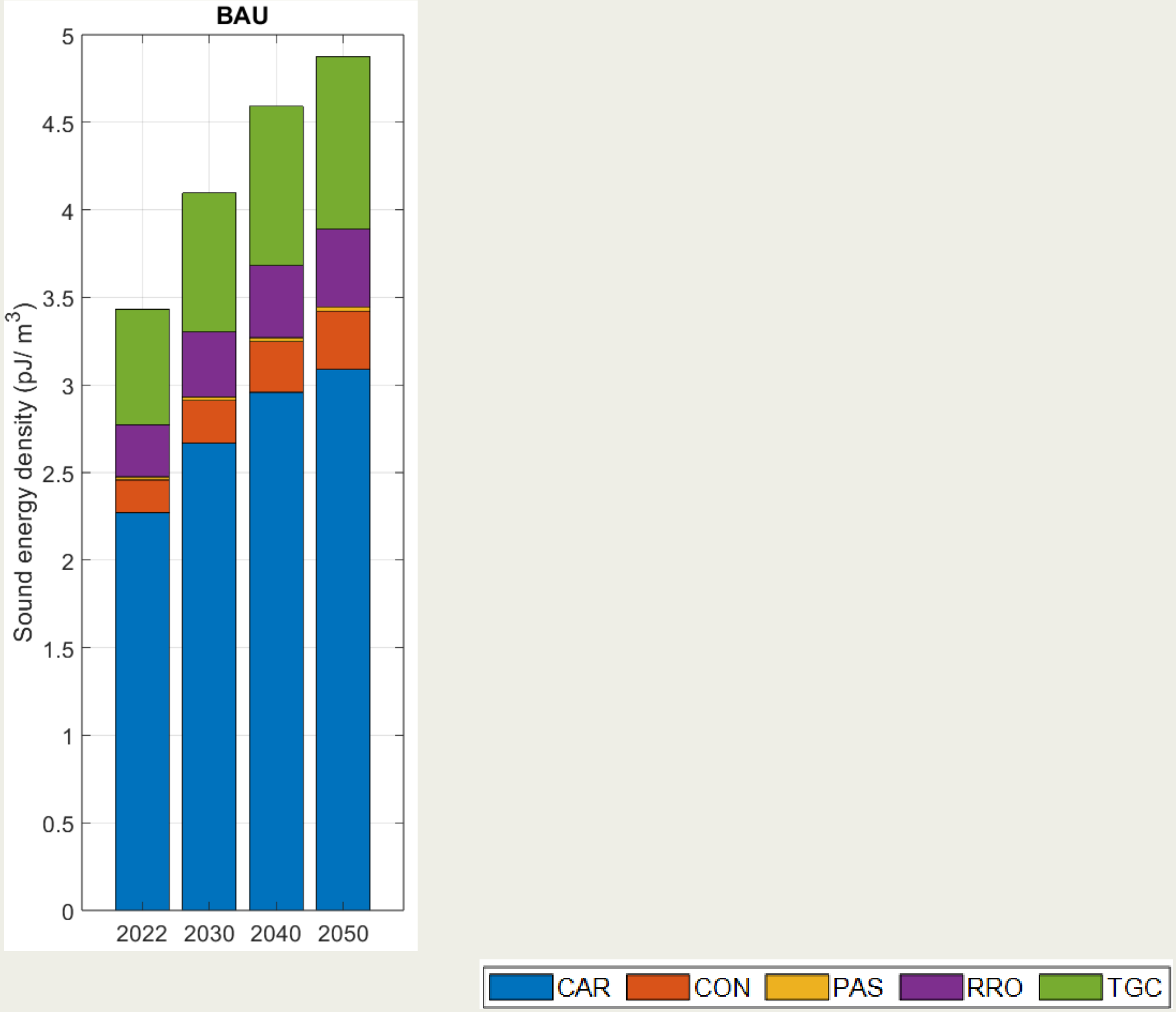



JASCO APPLIED SCIENCES

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood

O1.3-787

# Sound energy densities for different forecast scenarios at 63 Hz




EMSA
European Maritime Safety Agency

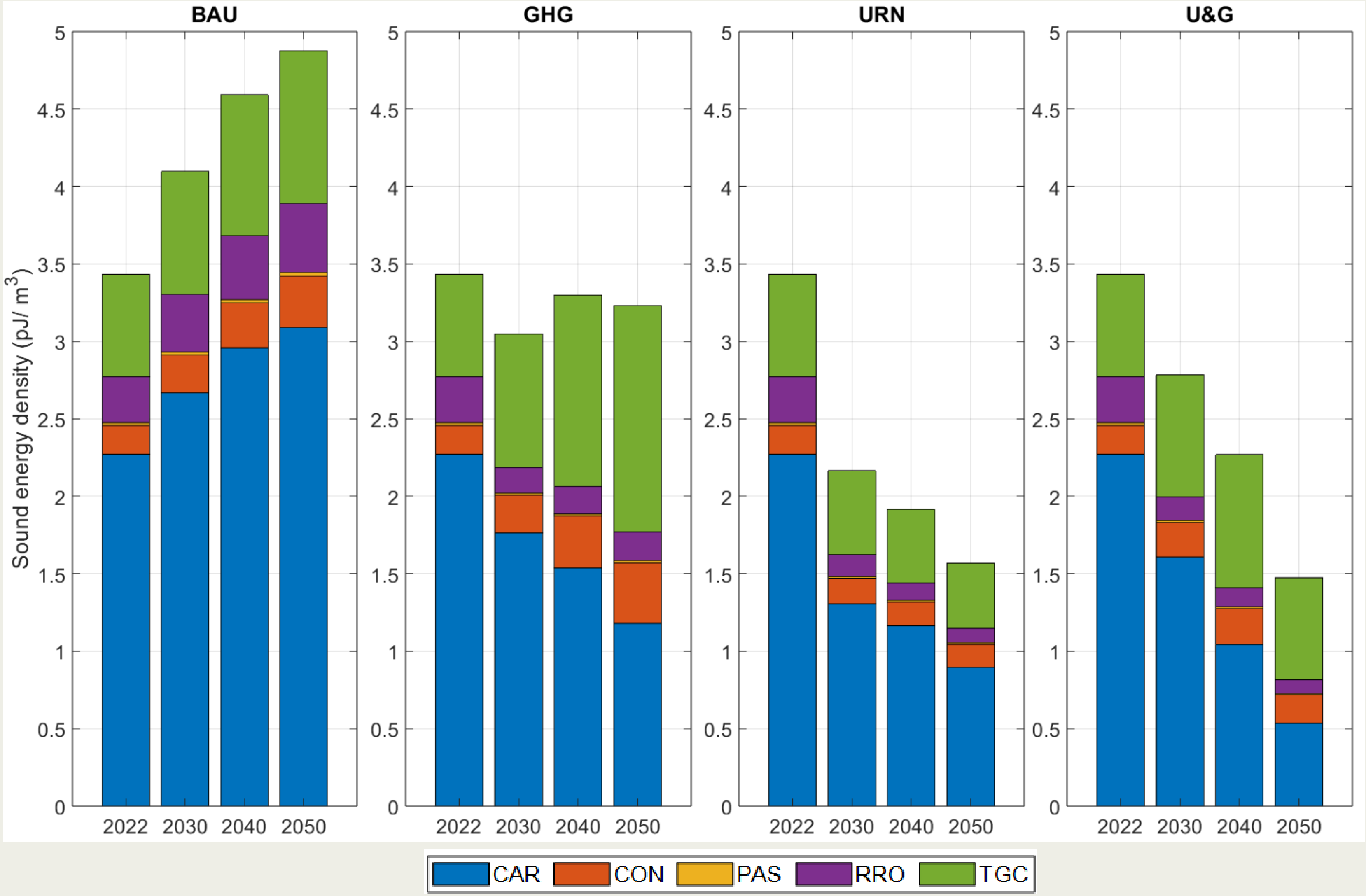
Source: NAVISON, EMSA (2025)

# Trends in shipping sound for all European seas from 2016 to 2050

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood

O1.3-787

## Sound energy densities for different forecast scenarios at 63 Hz




EMSA European Maritime Safety Agency

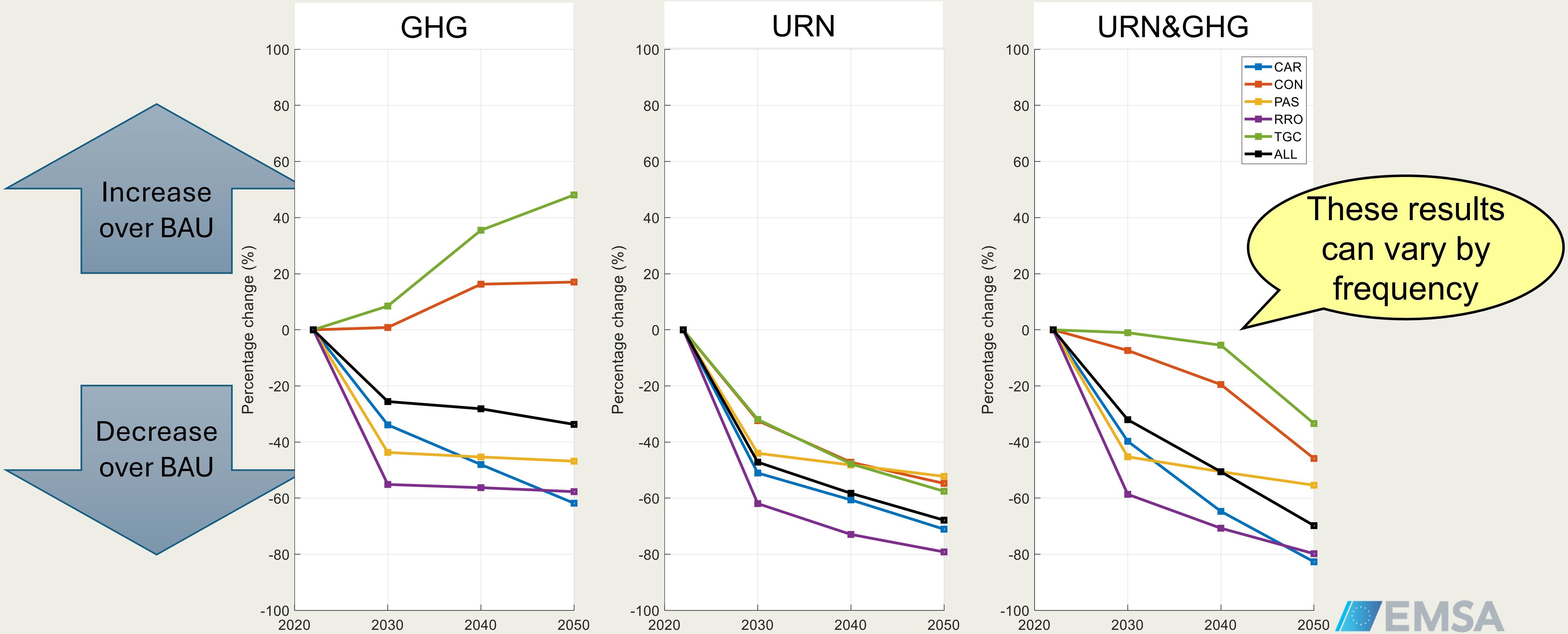
Source: NAVISON, EMSA (2025)

# Trends in shipping sound for all European seas from 2016 to 2050

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood

O1.3-787

## Sound energy densities for different forecast scenarios at 63 Hz




EMSA European Maritime Safety Agency

Source: NAVISON, EMSA (2025)

Ö.Sertlek, M.Ainslie, J.Bosschers, M.Hermans, T.Lloyd, A.MacGillivray, F.Pace, R.Racca, M.Schuster, M.Wood



## Summary & Conclusions

- Understanding the time trends of ambient sound can aid in the analysis of the CTBTO's historical dataset
  - Sound mapping can provide insights into the spatial variation of ambient sound.
  - Sound energy densities (SED) can provide complementary information for analyzing the large set of the sound maps.
  - Forecast modelling specific to vessel type and relevant mitigation measures can help to estimate potential future trends at the measurement stations' locations.
- The NAVISON's methodology (sound mapping, time trend analysis and ranking the contribution of different sources based on SED) can be helpful for modeling any basin-scale scenario,
  - such as the northwest Pacific Ocean to characterise CTBTO measurements at Wake Island.

# Project funding

EMSA

European Maritime Safety Agency

- *For additional project inquiries and data availability requests, contact Samy Djavidnia, EMSA Project Director:* Samy.Djavidnia@emsa.europa.eu

JASCO APPLIED SCIENCES

MARIN

DW SHIPCONSULT