Standards for project JOMOPANS: ocean noise monitoring for the North Sea

JOINT MONITORING PROGRAMME FOR AMBIENT NOISE IN THE NORTH SEA

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[with help from Niels Kinneging (RWS), Christ de Jong (TNO), Jens Fischer, Dennis Kühnel (BSH), Alain Norro (RBINS), Mathias Andersson, Markus Linné (FOI)]

UACE 2019, Crete. 1st July 2019.

Project Objectives & outputs

- **Aim**: to develop a framework for a fully operational joint monitoring programme for ambient noise in the North Sea

- **Outputs**: tools for managers, planners and other stakeholders
  - assessment of effects of ambient noise the environmental status of the North Sea
  - evaluation of measures

- Addresses the monitoring requirements of the Marine Strategy Framework Directive (MSFD) by collaboration between member states adjacent to the North Sea

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JOMOPANS: PARTNERS

- Rijkswaterstaat - NL(lead)
- Centre for Environment, Fisheries & Aquaculture Science (Cefas)– UK
- Federal Maritime and Hydrographic Agency – DE
- TNO – NL
- Aarhus University – DK
- Swedish Defence Research Agency – SE
- Royal Belgian Institute for Natural Sciences – BE
- Marine Scotland – UK
- Norwegian Defence Research Establishment - NO
- National Physical Laboratory – UK
- Institute of Marine Research - NO

- Funding: EU - Interreg North Sea Region
  - Priority 3 Sustainable North Sea Region: Protecting against climate change and preserving the environment
- Duration: Jan 2018 – Dec 2020
- Budget: € 3.5 Million
- Consortium: 11 partners
- Project Coordinator:
  Rijkswaterstaat, The Netherlands

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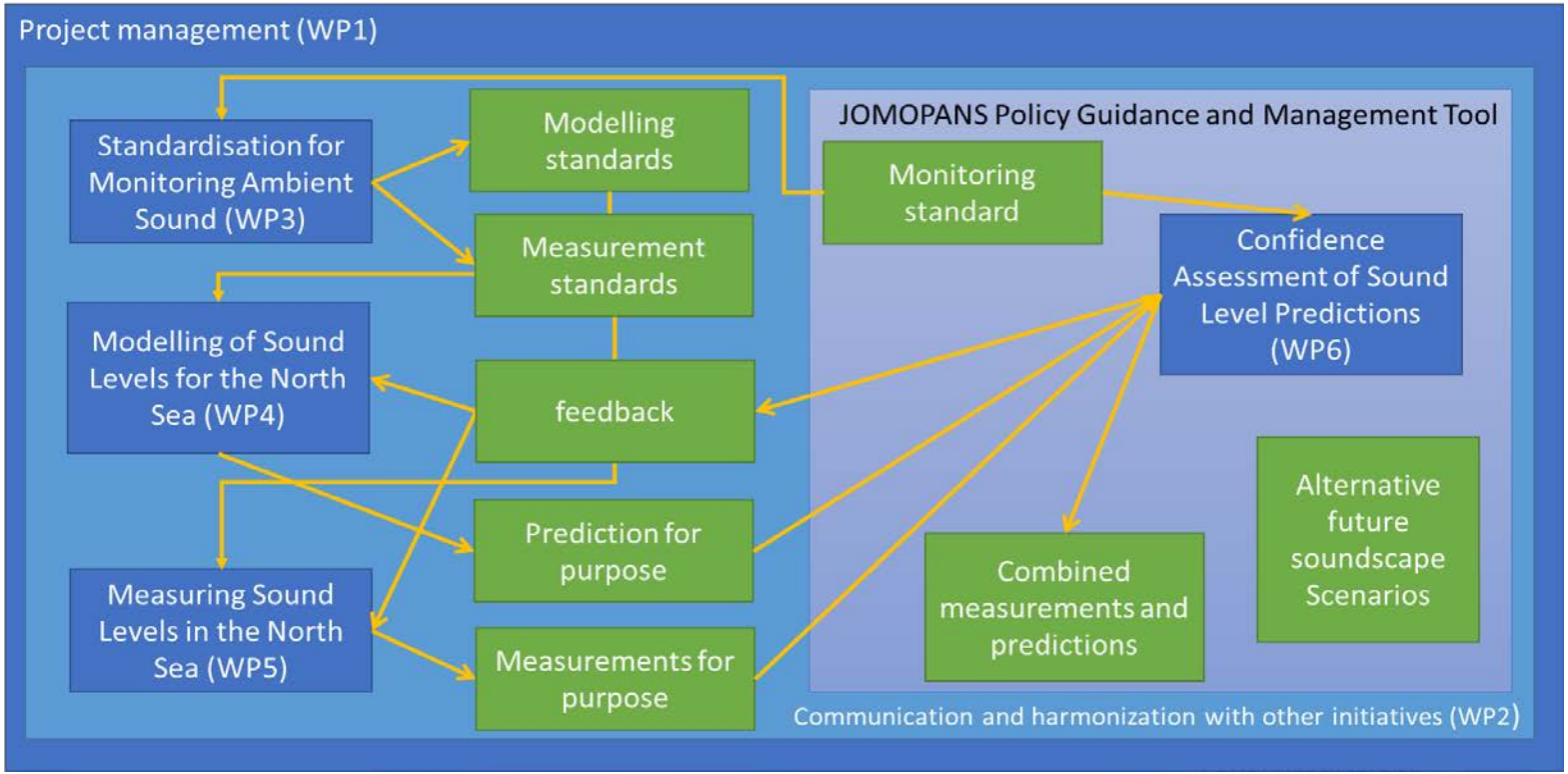
Project Set-up



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JOMOPANS approach

- **Measurements**
  - Measured at **14 monitoring stations** in North Sea **throughout 2019** (limited trials during 2018)
  - Mixture of hard-cabled **hydrophones in fixed monitoring stations** and **shorter-term recorder deployments**

- **Modelling**
  - **Sound maps** produced from source positions (ships), source level data, and propagation models
  - **AIS data** used to obtain ship traffic data
  - Comparison between modelling and measurement for **validation** and **verification**

- **Acoustic metric**: Sound Pressure Level (**SPL**) calculated over a **1 second window** over the frequency range from **10 Hz to 20 kHz**, calculated as 34 **Third-Octave Bands** (base10) expressed as statistical **percentiles** (5^{th}, 10^{th}, 25^{th}, 50^{th}, 75^{th}, 90^{th}, 95^{th}) in monthly intervals

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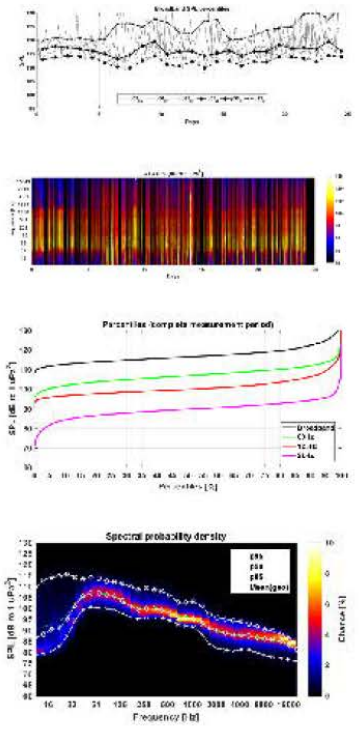
Measurements

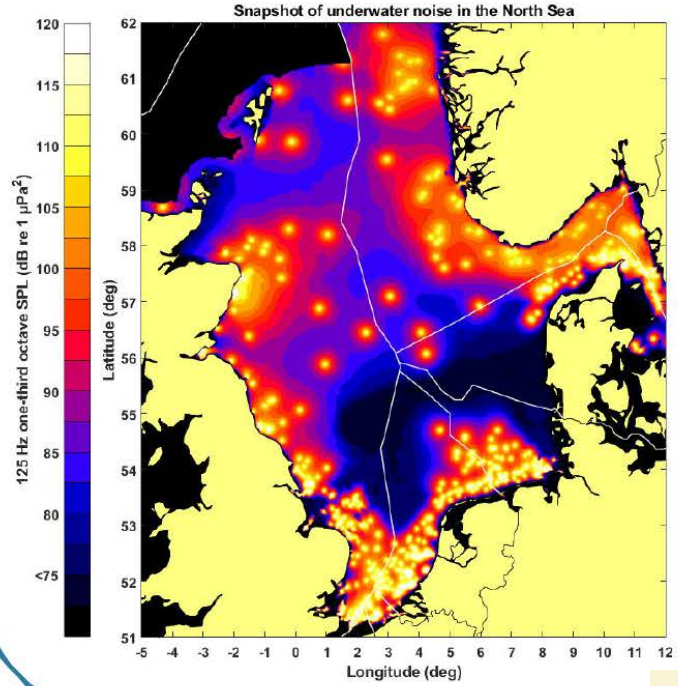
MEASUREMENTS

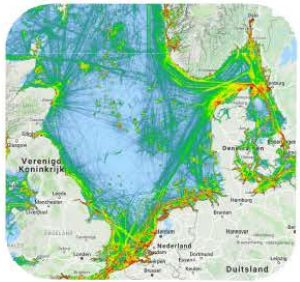


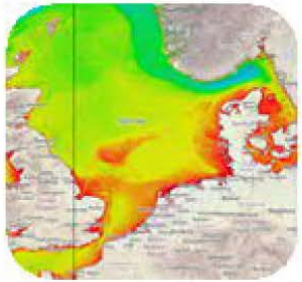
Coordinated field measurements of underwater noise at 14 locations (see map) will provide data and monthly statistics of the ambient sound levels. These help the development of numerical models through iterative validation and modification. The generated raw data will be processed in a standardized way to make these comparable across the North Sea.

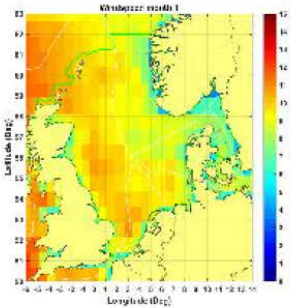
Modelling

MODELLING









See also: De Jong et al, 2019

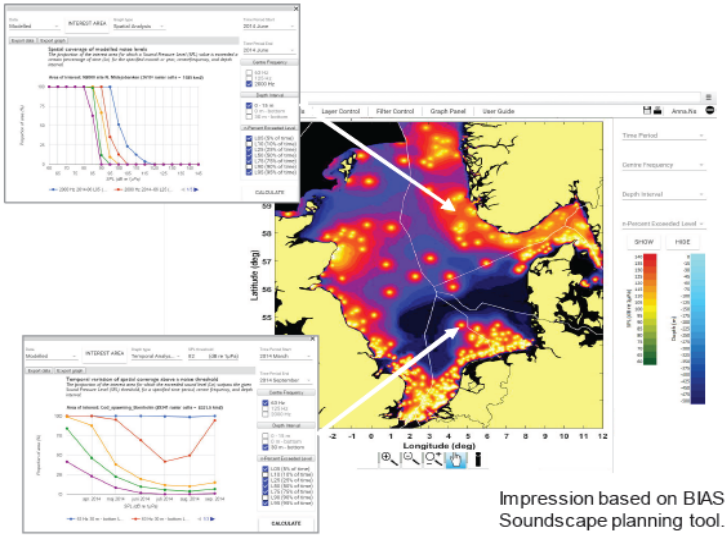
Modelling methods for generating maps of ambient noise in the North Sea will be developed. Appropriate models for the most important sound sources (such as ships and wind) and for underwater sound propagation in the North Sea will be implemented. The modelling will provide maps of the acoustic indicators specified by Merchant et al, 2018.

Bas Binnerts: Model benchmarking results for ship noise in shallow water; UACE2019; Sonar performance modelling; Tuesday, Room D, 10:10

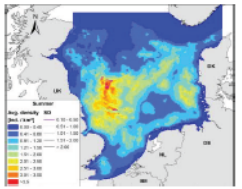
GES tool

- Output is **tool** to estimate **Good Environmental Status** (GES) with graphical interfaces displaying layers of sound maps ands other data (eg biotic data) over selected time periods, frequency ranges...

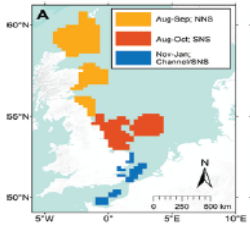
GES TOOL



Impression based on BIAS Soundscape planning tool.



Predicted harbour porpoise densities in the North Sea in summer (Jun.–Aug.) (Gilles et al., 2016)



Selected herring spawning areas in the NNS, SNS, and English Channel/SNS (from map used by UK regulators)

Marine manager who have to address underwater noise face the following questions:

1. Is there a problem?
2. Where is the problem?
3. What is causing the problem?
4. Will measure X solve the problem?
5. Will activity Y create a problem?

Jomopans will help the marine managers with a tool for the evaluation of Good Environmental Status in order to initially address the questions 1 to 3.

In addition biological information about distribution and sensitivity of key (indicator) species will be available in the tool as well.

JOMOPANS: standards for monitoring

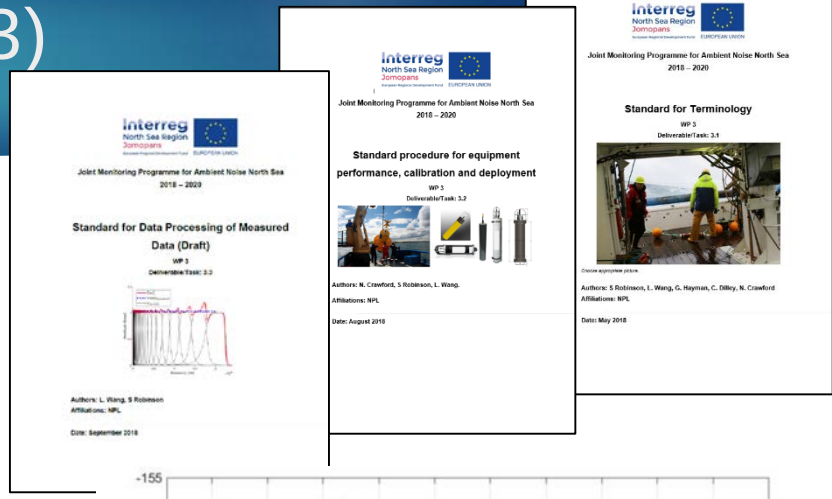
Getting the standards wrong…

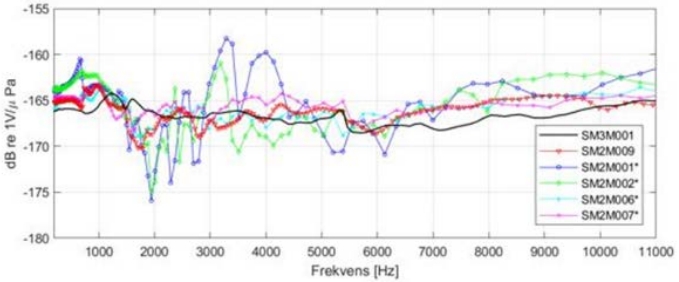
The Vasa warship

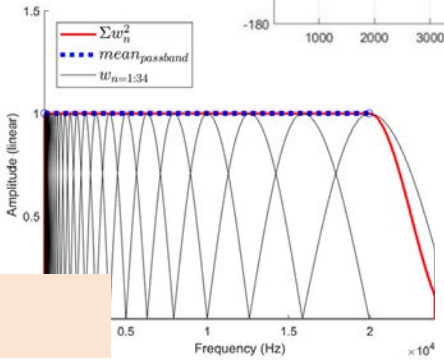
Laufenburg Bridge

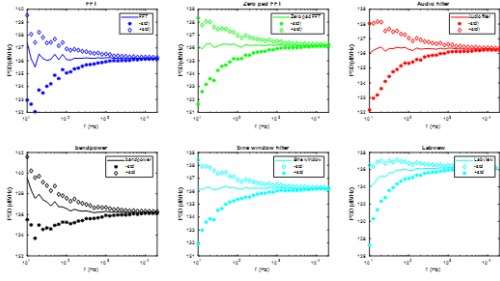
Standards work so far (WP3)

- No existing international standards for monitoring ocean ambient sound
- **Procedures** (project "standards") developed for:
  - Terminology
  - Equipment performance specification
  - Equipment calibration and deployment
  - Data processing and analysis
- Outputs to feed into future ISO standards
- **Terminology**
- Building on previous and current work …
  - **ISO 18406** standard
  - Strong coherence with US **ADEON project** (ADEON procedure used as basis for many definitions)









Jennifer Miksis-Olds: Atlantic Deepwater Ecosystem Observatory Network (ADEON): Soundscapes of Deep-Sea Habitats; Tuesday, 9:30, Room A

Equipment Specification

Metric	Specification
Frequency range:	10 Hz – 20 kHz (Note: focus frequencies are the 63 Hz and 125 Hz TOB)
Dynamic range:	Minimum 16 bit (nominal dynamic range 96 dB), Preferably 24 bit (nominal dynamic range 144 dB) Note: actual dynamic range is from noise floor defined by system self-noise to the maximum measureable undistorted sound pressure
Sensitivity:	In the range: -165 to -185 dB re. 1 V/µPa
Directionality:	Omnidirectional to within +/- 1 dB up to 20 kHz azimuthal, and to within +/- 2 dB in vertical elevation (see description of recorder performance when hydrophone is attached to body)
Sampling rate:	44 or 48 kHz (20 kHz frequency range)
Filtering:	Any filter characteristics should be known Especially, low and high pass filtering caused by frequency roll-off of instrumentation
System self-noise:	Better than 64 dB re 1 µPa^2/Hz at 63 Hz; Better than 59 dB re 1 µPa^2/Hz at 125 Hz. 6 dB below the lowest sound level.

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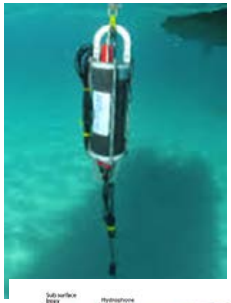
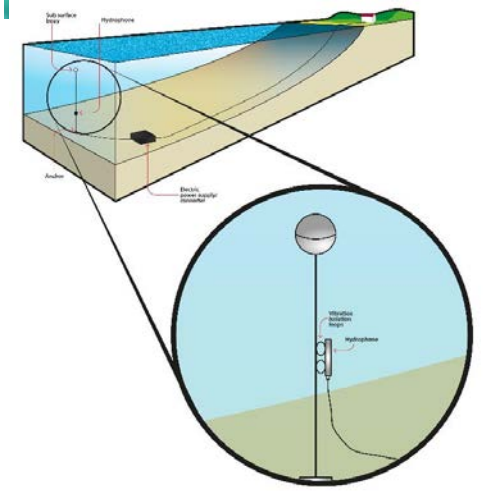
Equipment calibration

- traceability to international standards required
  - methods based on **IEC 60565:2006**
- frequency range for calibrations
  - between 10 Hz and 20 kHz
  - at least third octave centre frequencies.
- calibrations completed before and after the deployments, with absolute calibrations obtained for hydrophone and recording system deployed
- calibrations are ideally completed in the same (or as close as possible) mounting configuration for which the hydrophone is likely to experience in the field.
- in-situ field calibrations conducted prior to deployment and post recovery
  - Typically using an air “pistonphone” calibrator
- Calibration of marine autonomous recorders
  - Building upon EU EMPIR project **UNAC-LOW**

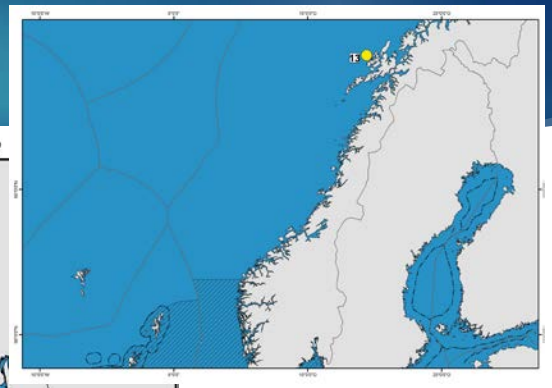
Equipment and deployments

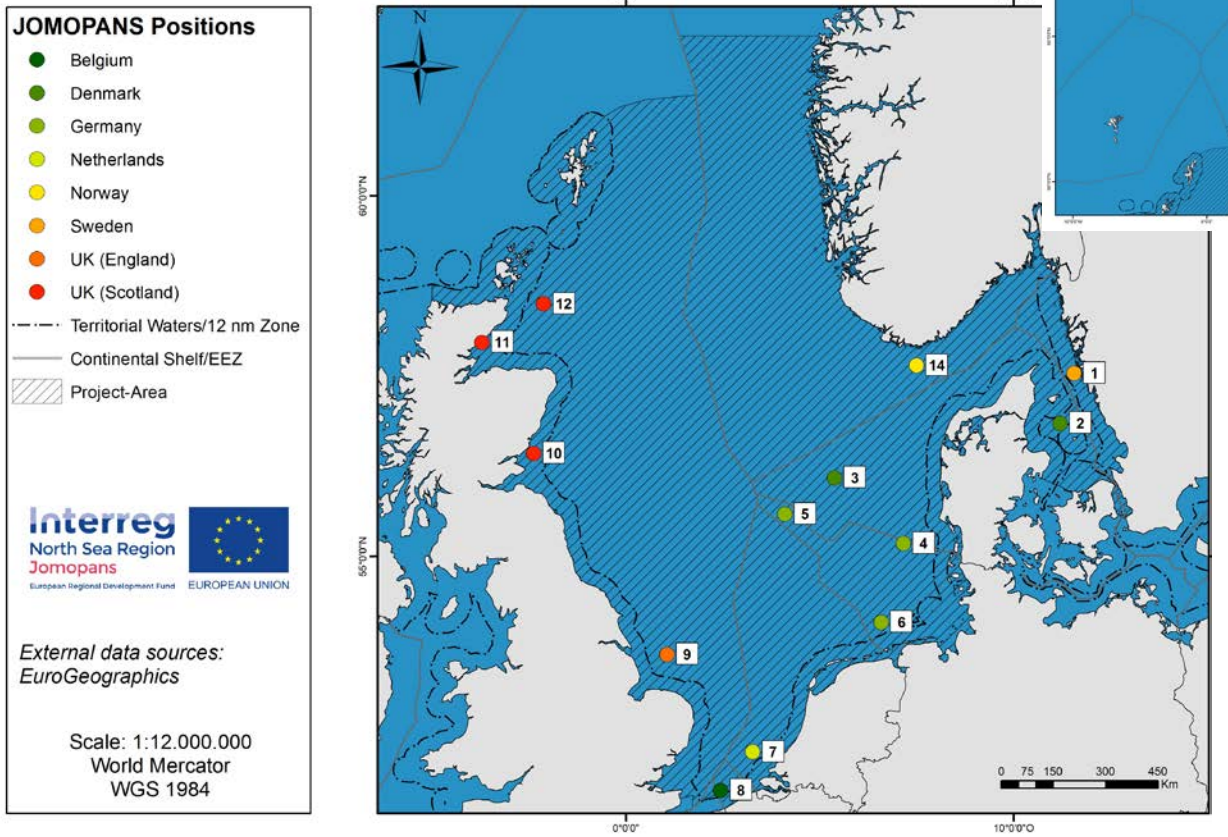
- Mixture of equipment types is being used
- Fixed cabled hydrophones
  - B&K 8106s, B&K8104, Ocean Sonics iCListen, Neptune Sonar hydrophone
  - Continuous recording (100% duty cycle)
- Shorter-term autonomous recorder deployments
  - RTSys EASDA-550
  - Wildlife Acoustics SM2M and SM3Ms
  - Ocean Instruments Sound Trap
  - JASCO AMAR
- Minimum duty cycle: 30% (10min on, 20 min off)





Monitoring Locations (WP5)





14 Stations

6 fixed cabled hydrophones

8 autonomous recorders

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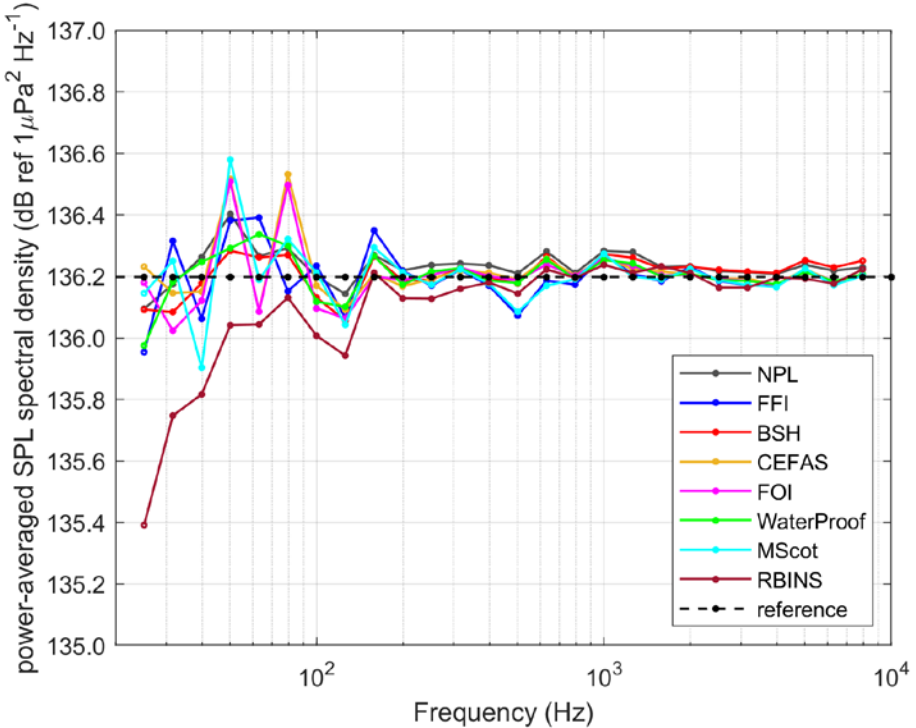
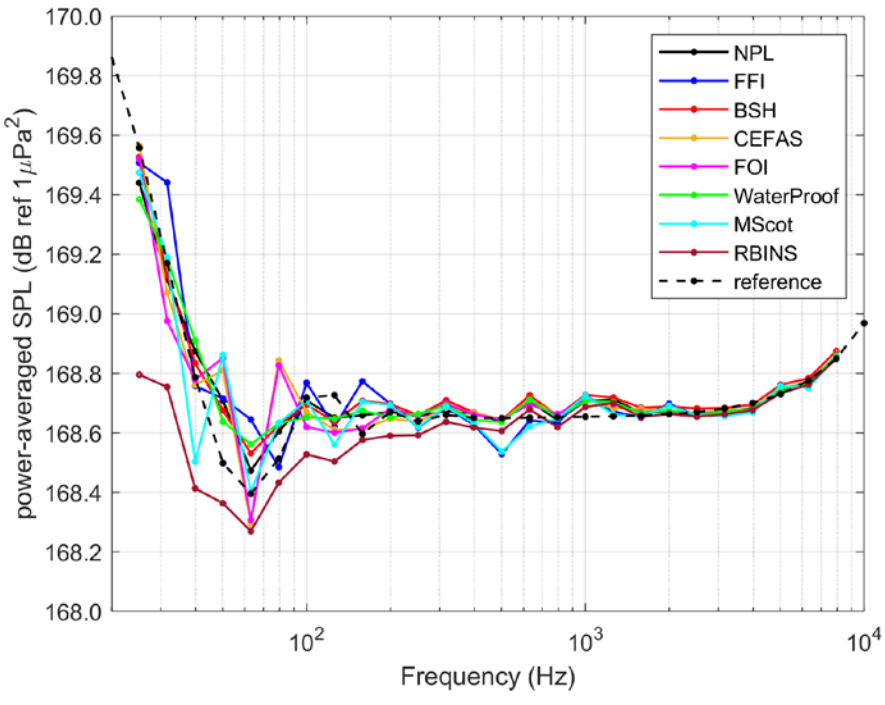
Data analysis procedures

- Specification for methods of calculating the key metrics from measurement data.
- Benchmarking:
  - As a check on performance of software algorithms used by partners, **benchmarked data sets** were created for validation of analysis algorithms.
  - These benchmarked data sets were be circulated to all partners undertaking data analysis (cf “Ring test”)
  - Benchmarked data consisted of two sets of synthesised data of known statistics and expectation value
  - “white” noise and “pink” noise

Data analysis benchmarking





Summary: JOMOPANS

- Developing a framework for a joint monitoring programme for ambient noise in the North Sea
- Project outputs include tools for managers, planners and other stakeholders
- Funding: EU - Interreg North Sea Region; Duration: Jan 2018 – Dec 2020
- Procedures (project standards) developed for:
  - Terminology
  - Equipment performance specification
  - Equipment calibration and deployment
  - Data processing and analysis
- Outputs to feed into future ISO standards

- Ongoing work to finalise modelling approaches and combining modelling and measurements and for production of GES tools

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Acknowledgements

- The authors acknowledge the funding of EU programme:
  - **INTERREG North Sea Region**
- Priority 3 Sustainable North Sea Region: Protecting against climate change and preserving the environment
- The work described has been undertaken by the entire JOMOPANS team, and the NPL authors would particularly like to thank those partners that contributed to the preparation of the project standards:
- Niels Kinneging (RWS), Christ de Jong (TNO), Jens Fischer and Dennis Kühnel (BSH), Alain Norro (RBINS), Mathias Andersson and Markus Linné (FOI)

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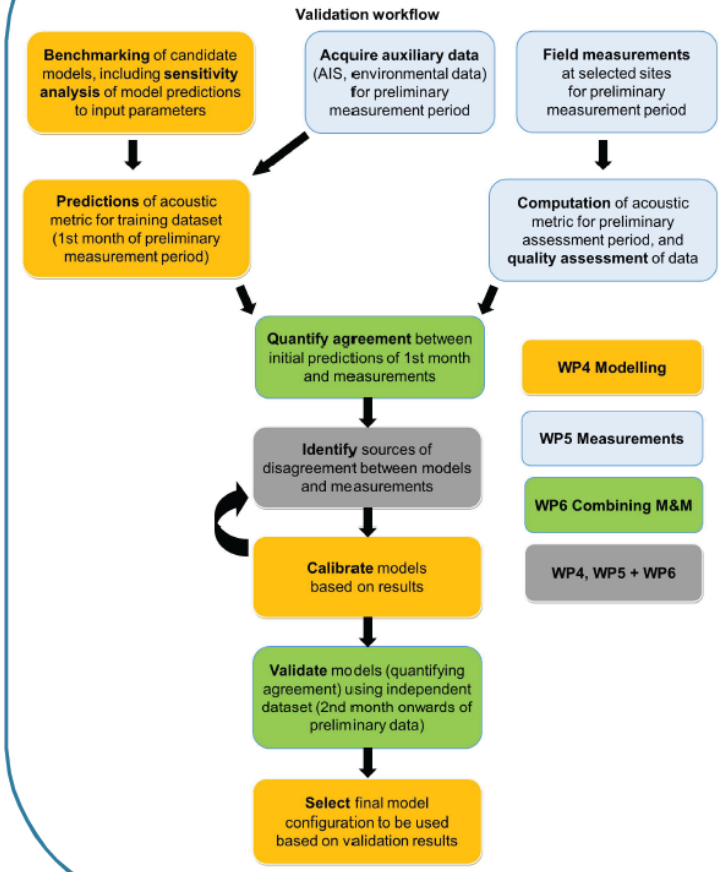
Spare slides

WORKFLOW



Jomopans has specified the acoustic indicator to be used by the project (see Merchant et al., 2018). Modelling and measurements of this indicator are used to generate validated maps of the indicator (with associated confidence levels) for the North Sea.

Measurements and predictions with geospatial data are used to assess errors and uncertainties and reported back to the measurement and modelling work packages. After updating the modelling and measurement data maps of confidence levels will be produced.

This division of roles among the work packages enables an independent and spatially explicit analysis of uncertainty in the indicator, which will be valuable to decision makers when interpreting assessments based on the indicator maps.

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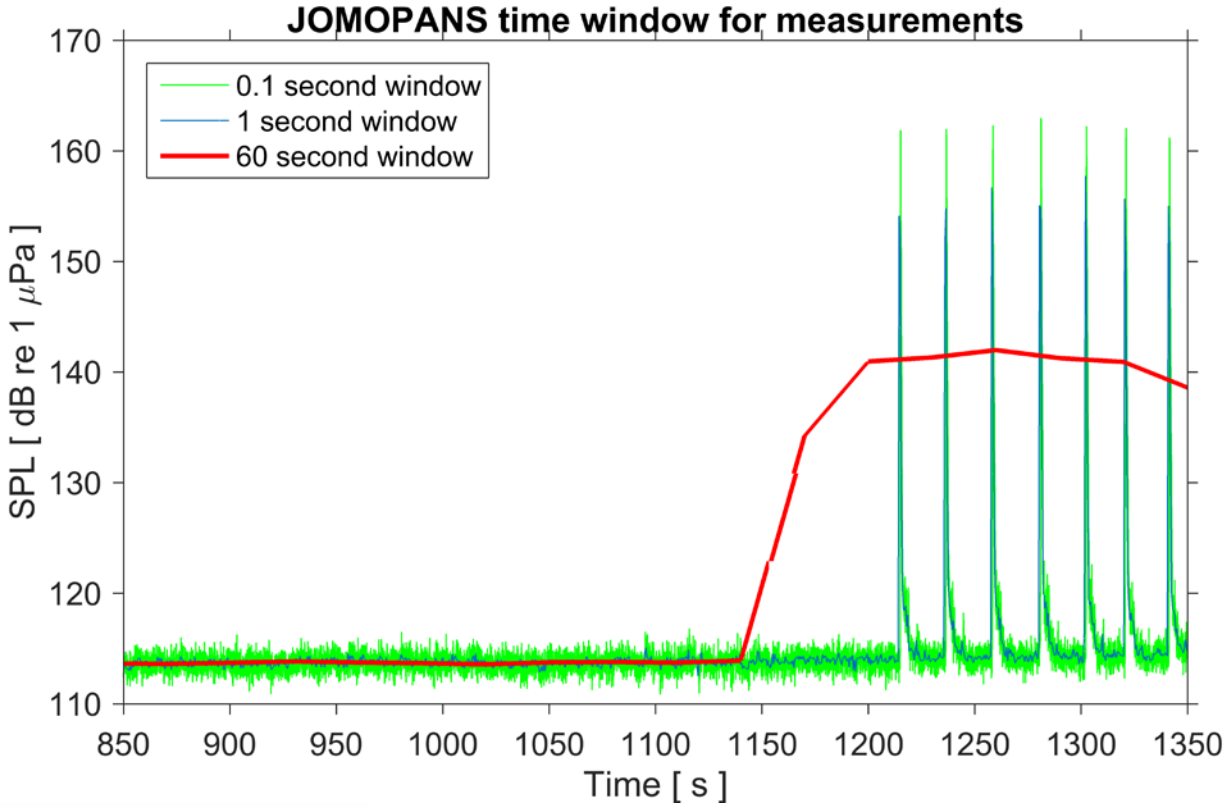
Time window for SPL



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