WESTERN GRAY WHALE ADVISORY PANEL **WGWAP 5/16**

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ENGLISH

Considerations about acoustic propagation modelling in environments with solid substrates

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Submitted by SEIC

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Considerations about acoustic propagation modelling in environments with solid substrates

Issues for discussion

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- Importance of shear wave conversion to results of acoustic propagation modelling
- Implementation of shear effects in the CDPE sound propagation code used in MONM
- Validation of CDPE modelling results against widely recognized modelling codes
- Validation of array source model against alternative approach based on summing at receiver point
- Validation of overall modelling results against high quality recordings from seismic survey

Importance of shear conversion to sound propagation modelling

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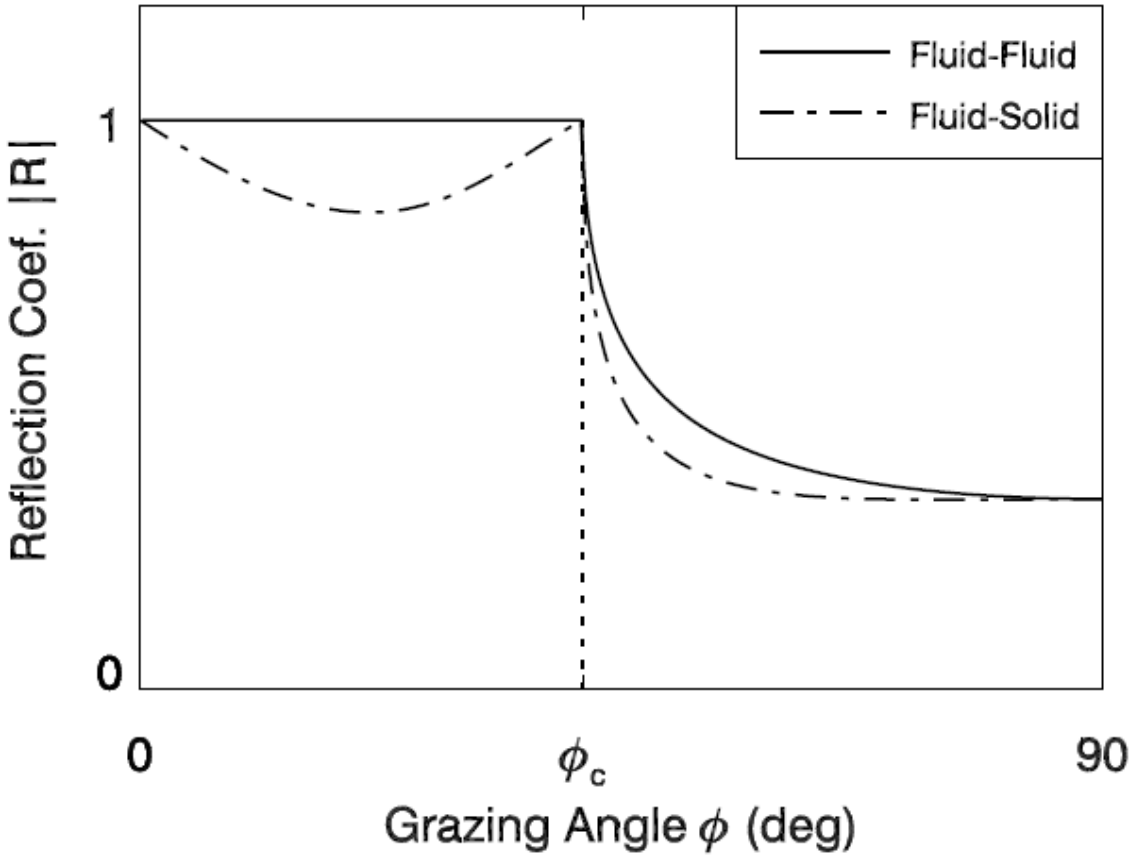
- Water medium only supports compressional propagation (P-waves), not shear (S-waves)
- PE model codes such as RAM also treat seafloor as a fluid, that is, only model propagation of P-waves
- In reality, at interface with solid bottom energy is transferred from water both as P- and S-waves
- Propagation of S-waves in sediment may well not be a major contributor to RL; loss of waterborne energy to S-waves, however, is an influential factor

Effect of shear wave coupling on the reflection coefficient



Influence on propagation losses in shallow water

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- At grazing angles below critical, shear conversion strips away energy that would otherwise be trapped in water column by total internal reflection
- In shallow water propagation to long ranges, near-horizontally propagating sound energy is stripped from waveguide into substrate on which it impinges at shallow grazing angles
- A model ignoring shear wave conversion can significantly underestimate transmission loss

Complex Density approximation to liquid-solid layer interface

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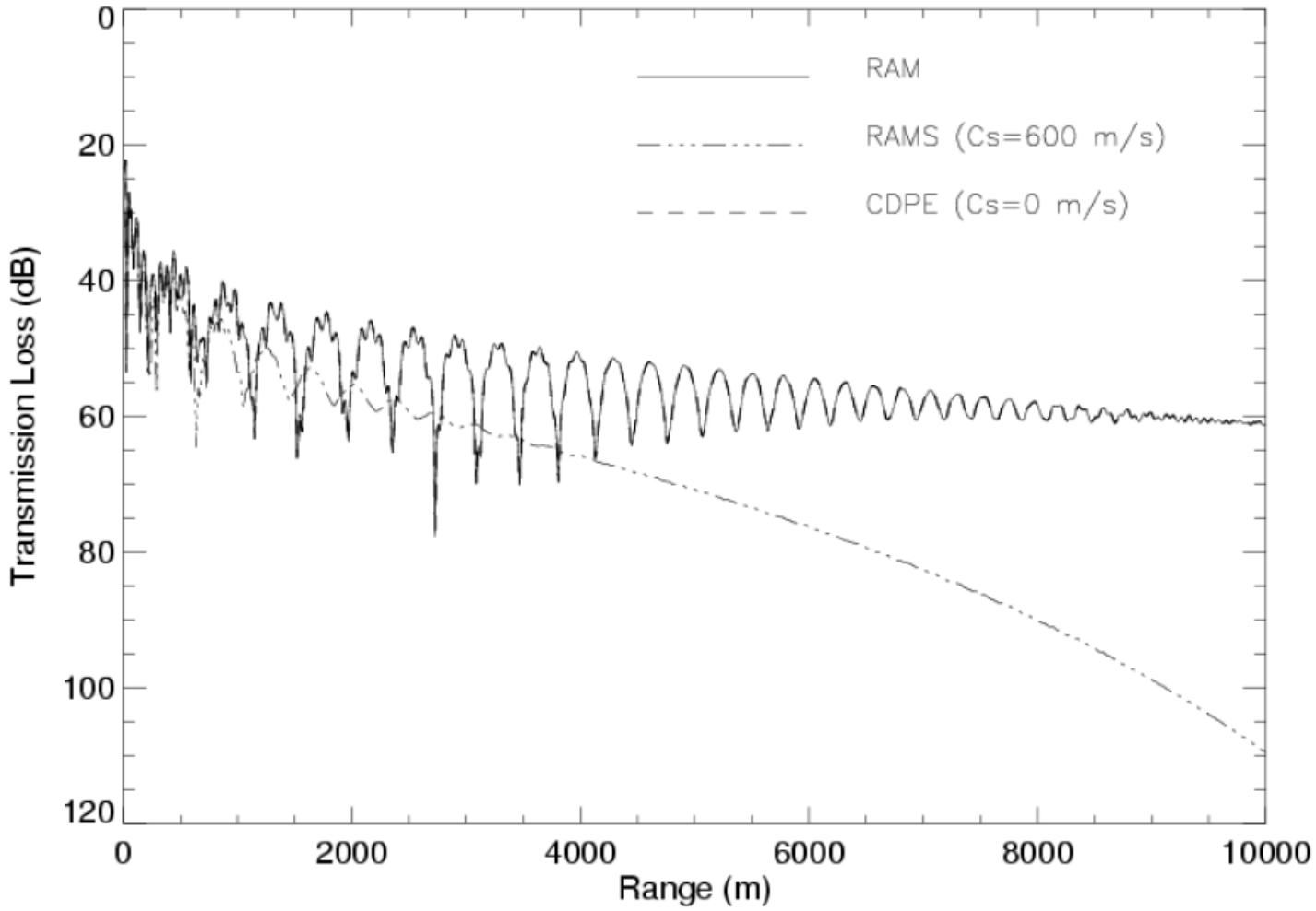
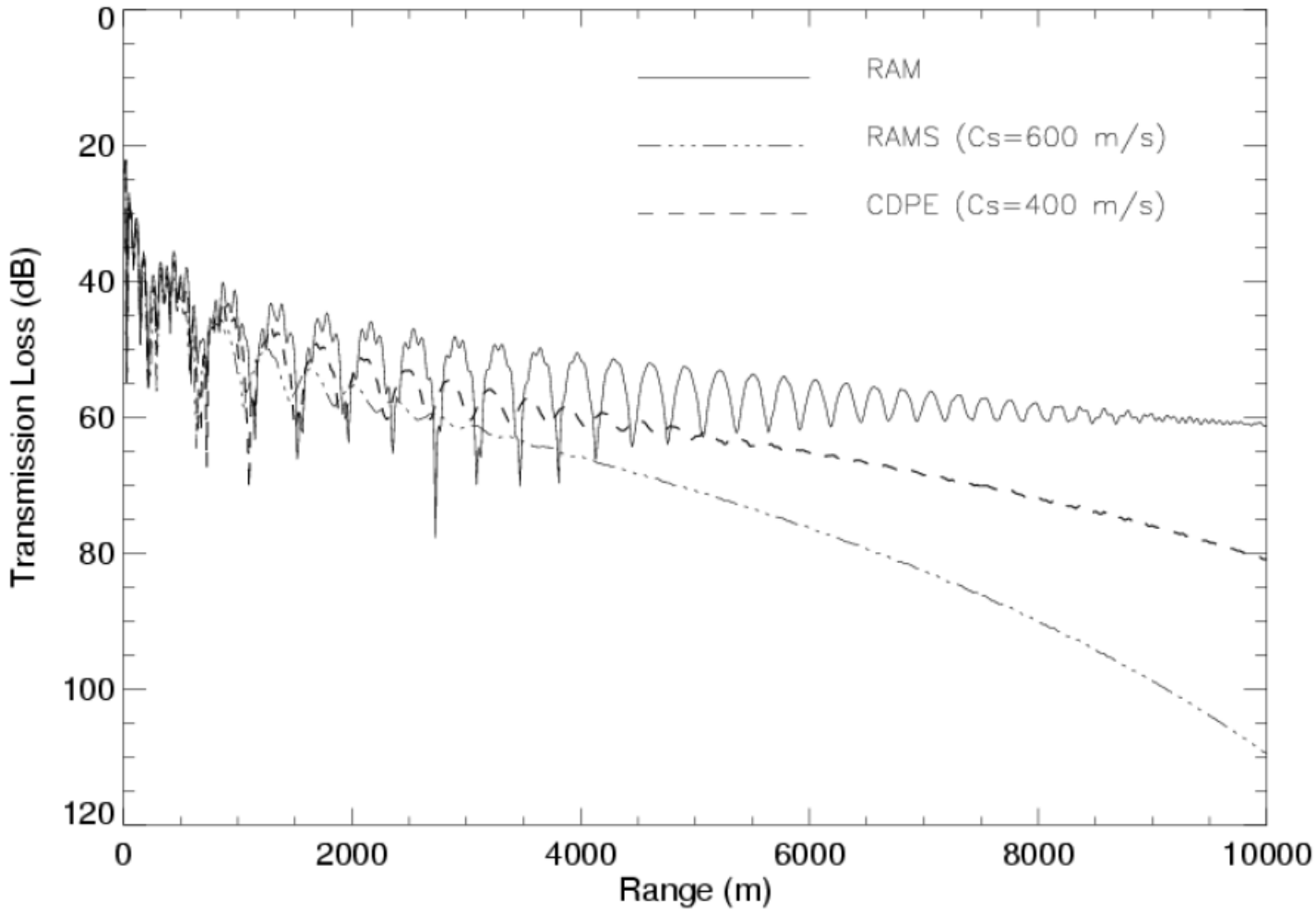
- Treats seafloor as an “equivalent fluid” that simulates reflection coefficient of a solid seabed by using a complex valued density whereby fluid reflection coefficient equates elastic at small grazing angles
- Does not actually model propagation of S-waves in sea bottom, thus much less computation than a full elastic bottom model like RAMS
- Provides a computationally efficient means of accounting for shear conversion losses at seafloor

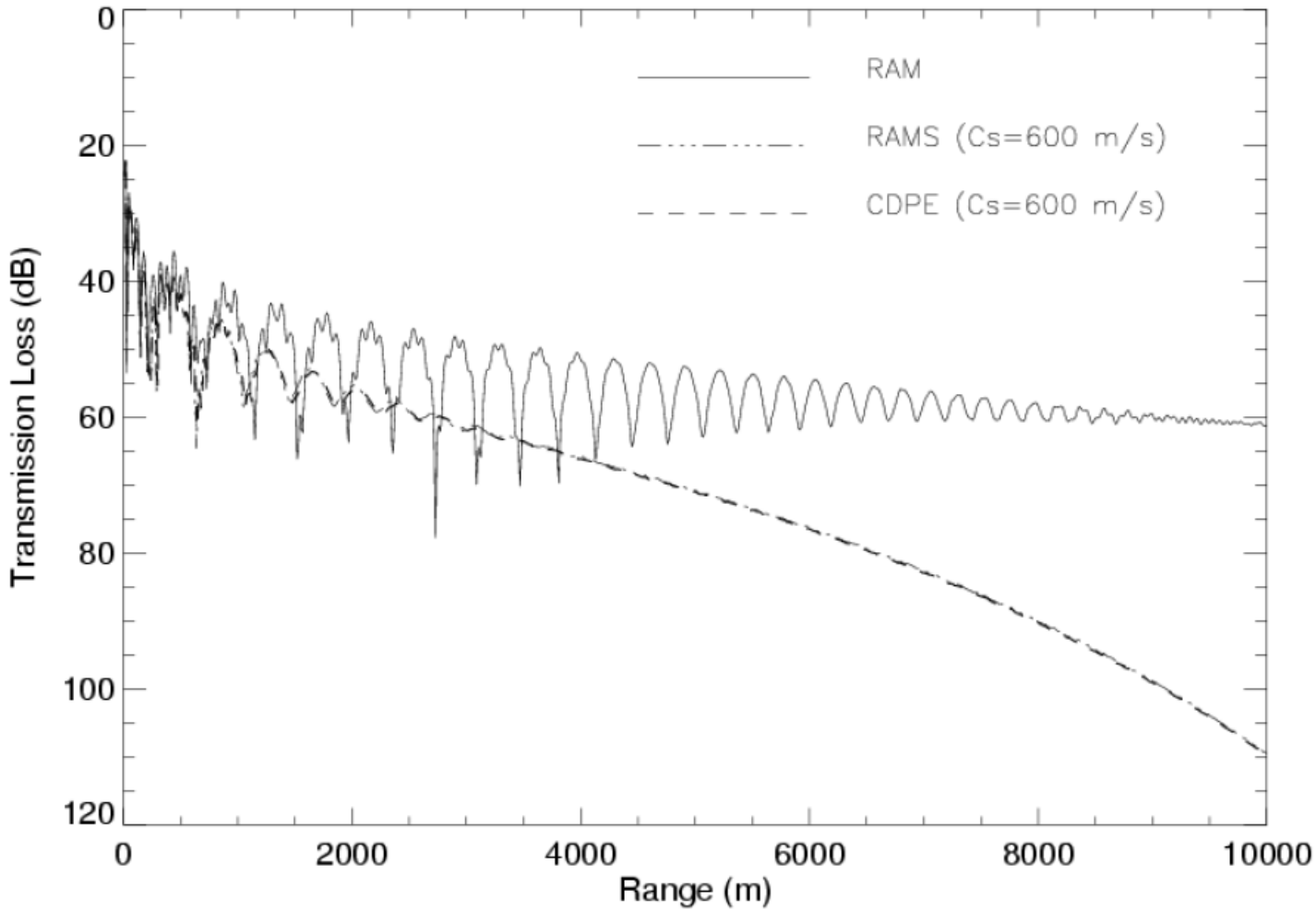
Comparison of RAM and RAMS to CDPE with Cs = 0



Comparison of RAM and RAMS to CDPE with Cs = 400m/s



Comparison of RAM and RAMS to CDPE with Cs = 600m/s



Comparison of airgun array model to summing at receiver

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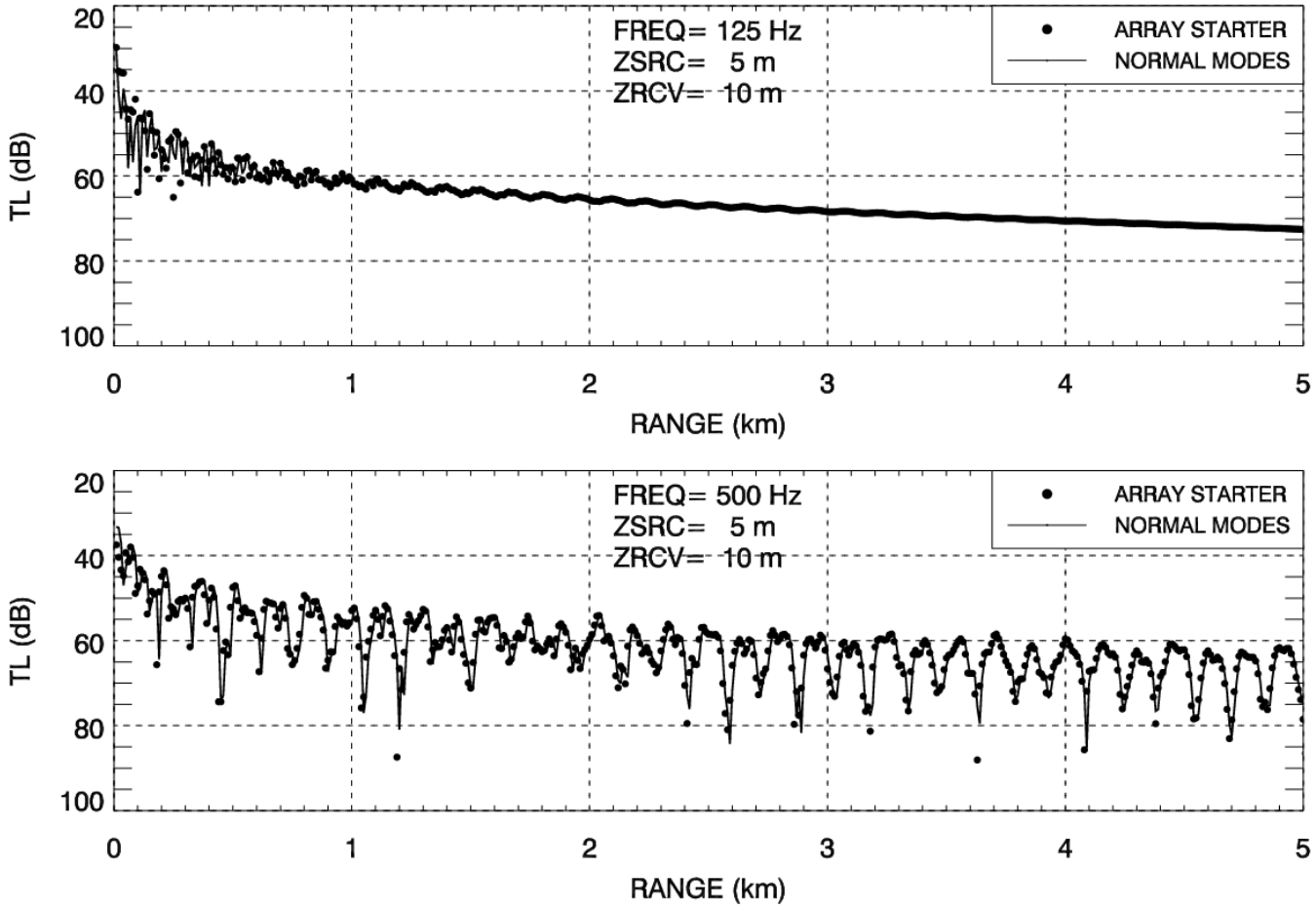
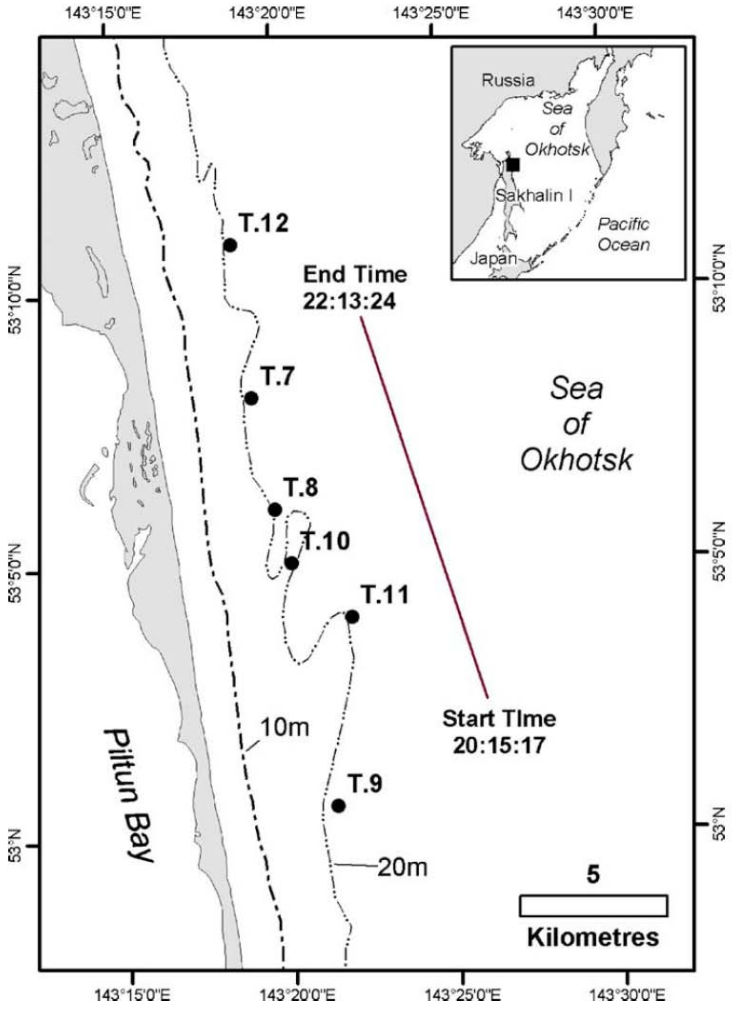
- Airgun array starter model creates equivalent of a directional point source that is coupled to sound propagation model
- In benchmarking of array source model, results of single-source equivalent were compared to summing of levels from each airgun propagated using normal mode model ORCA in shallow water environment
- Results presented here for case of uniform 20m bottom depth and a two-layer substrate

Benchmark of array starter model against sum of individual airguns

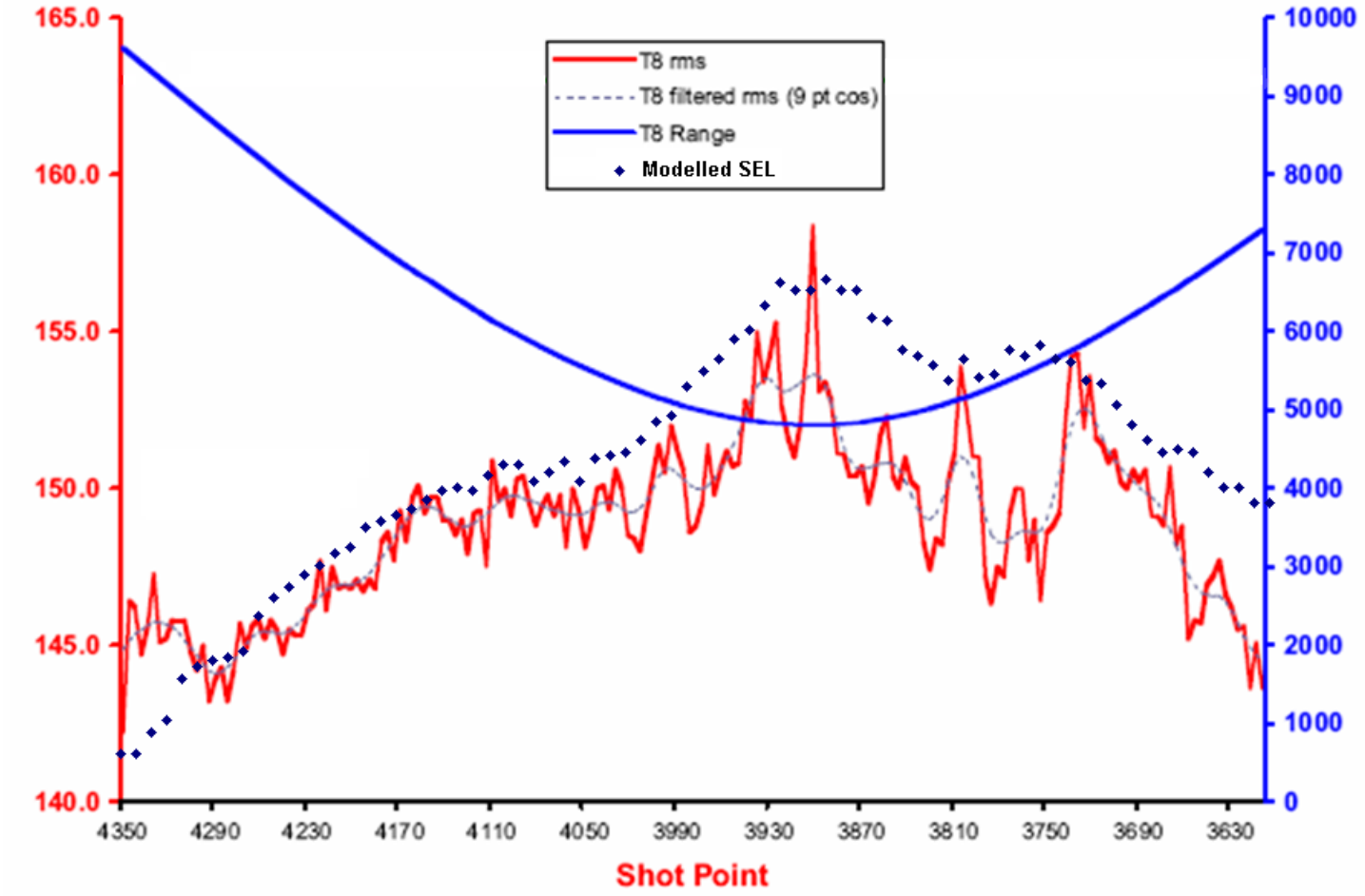


Comparison of overall modelling results to 2001 seismic dataset

- Survey line shot on 8.sep.01 with 1640 in^3 airgun array in south to north direction
- Measurements performed at bottom depth using calibrated radio telemetry sonobuoys
- All six measurement stations located on 20m bathymetry contour



Comparison of measured and modelled sound levels at T.8



Comparison of measured and modelled sound levels at T.10