FFI input to 2nd Seabed Characterization Workshop

January 10-11, 2012 ● Dag Tollefsen (FFI Team)

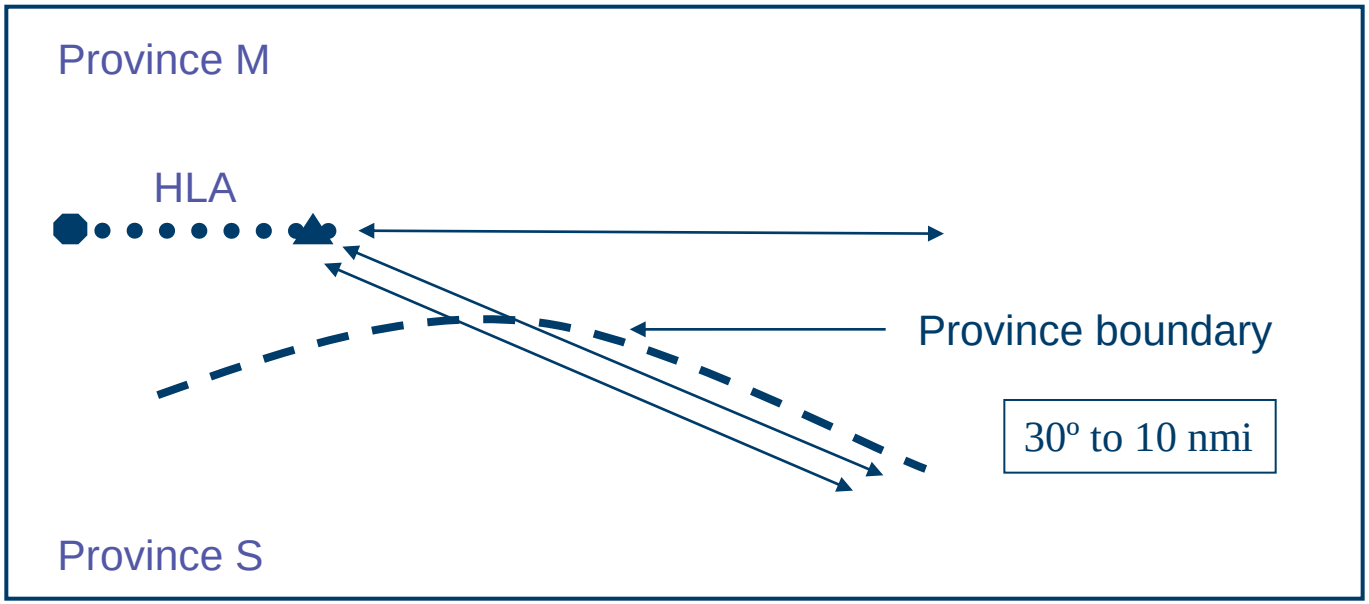
Research motivation:

1. Effects of variable seabed on long-range propagation
   - Range-dependent (cross-province) context
   - Side: thin geoacoustic layers (shear).
2. Quantify uncertainty→ sonar predictions & array processing.
   - Account for oceanographic variability in inversions.

Participation:

1. Main experiment: FFI-array (and data analysis).
2. Side: smaller-scale Arctic Shelf initiative (FFI to facilitate).

Experiment

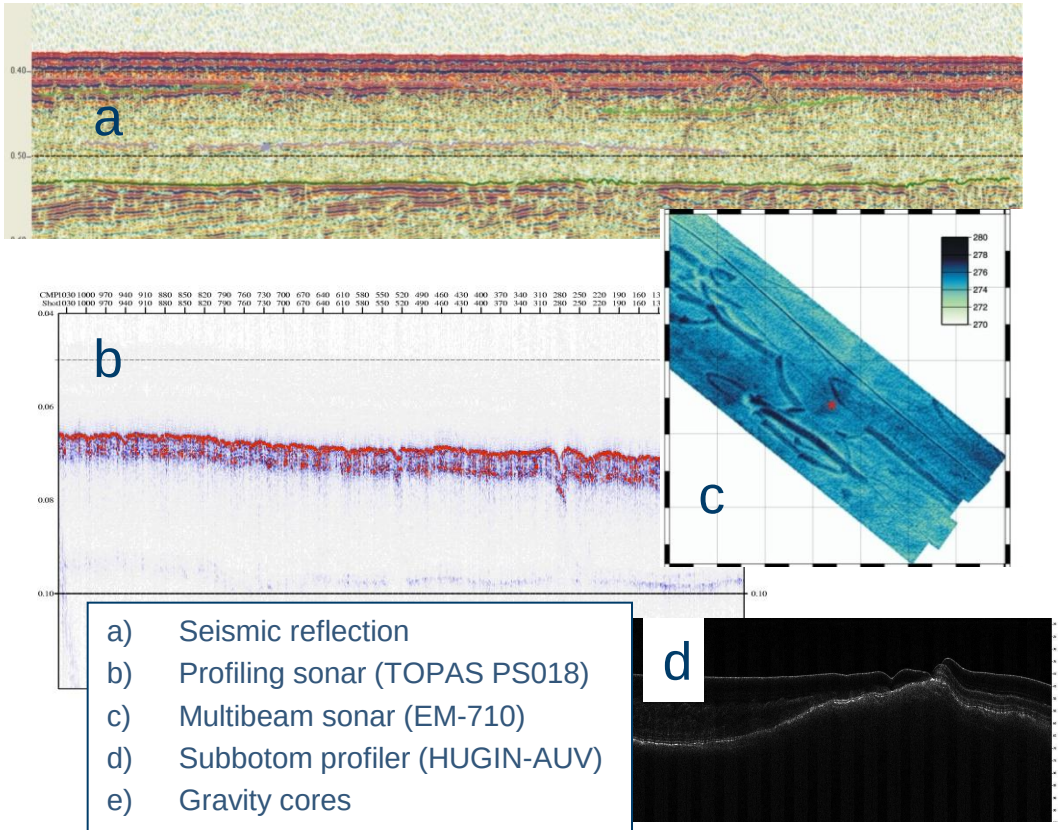


Oceanography buoy
VLA section

- Acoustic data:
  - Towed source (LF tones): EF & 30º to 10 nmi.
  - Repeated runs: sampling effects, model verification.
  - Short-range (broadband).
- Oceanographic: along-track & moored-buoy profiles.
- Geophysical: seismic profiler, cores, (shear).

Prior & inferred information

Site survey



a) Seismic reflection
b) Profiling sonar (TOPAS PS018)
c) Multibeam sonar (EM-710)
d) Subbotom profiler (HUGIN-AUV)
e) Gravity cores

Bayesian inference

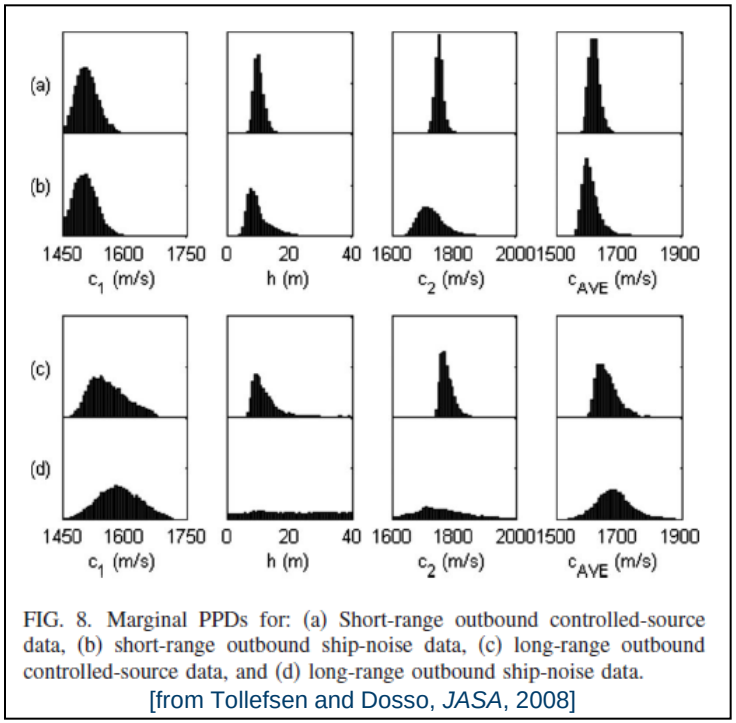
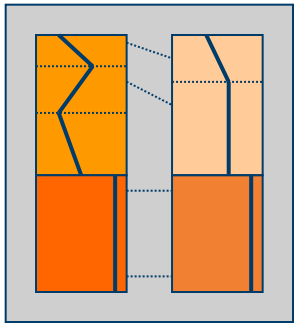


FIG. 8. Marginal PPDs for: (a) Short-range outbound controlled-source data, (b) short-range outbound ship-noise data, (c) long-range outbound controlled-source data, and (d) long-range outbound ship-noise data.

[from Tollefsen and Dosso, *JASA*, 2008]

Inference method

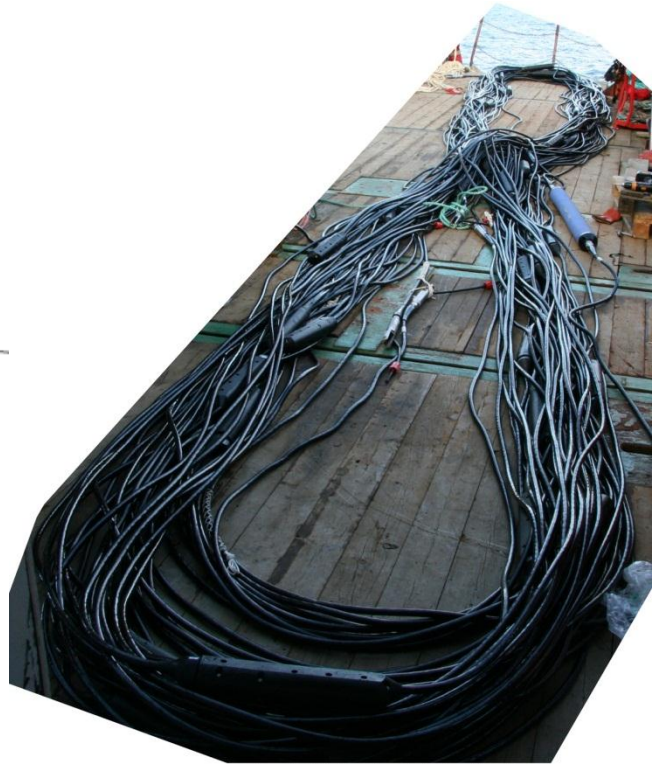
- Bayesian framework
  - Likelihood for Gaussian-distributed errors; data error C_d estimate, posterior analysis of residuals
  - Metropolis-Hastings sampling from PPD; heat-bath (Gibbs) sampling for source positions
  - Marginal posterior distributions and covariances.
- Model parameters:
  - *N*-layer (c,ρ,α) with gradients. Model selection via BIC.
  - extend to range-dependent context (segments).
  - variable oceanography via EOFs.
- Prior assumptions:
  - Wide (no-information) or narrow (prior-inversion) uniform bounds.
- Model parameter resolution: not assessed *a priori*.

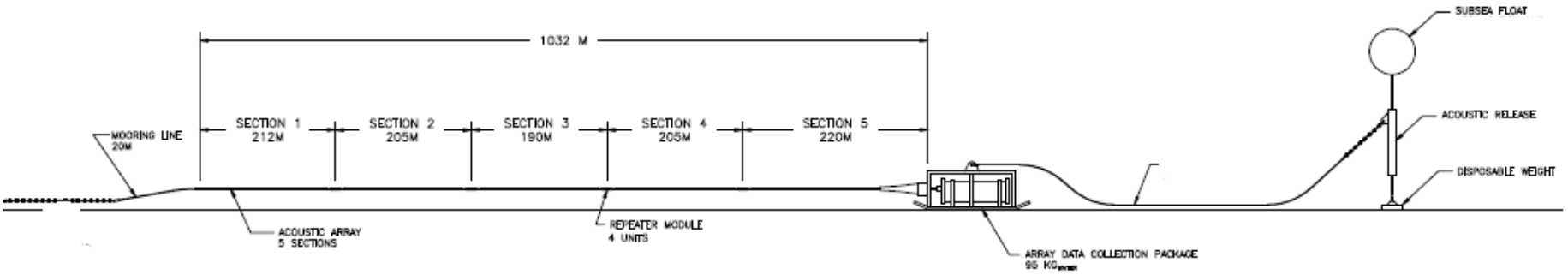


FFI-array

Specifications:

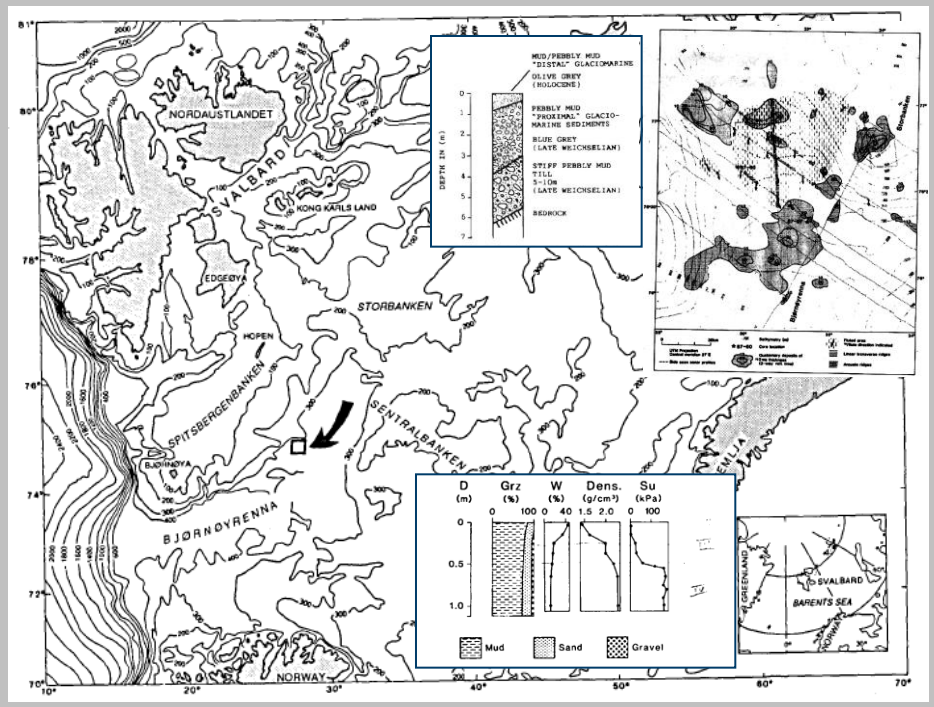
- Length 1032 m
- 63 hydrophones
- 10 Hz–2 kHz, 24-bit ADC
- 5 Tb memory
- 6 weeks endurance
- Depth rating 1000 m
- Acoustic link (status/control)
- Adjustable gain
- L-shape configuration TBD



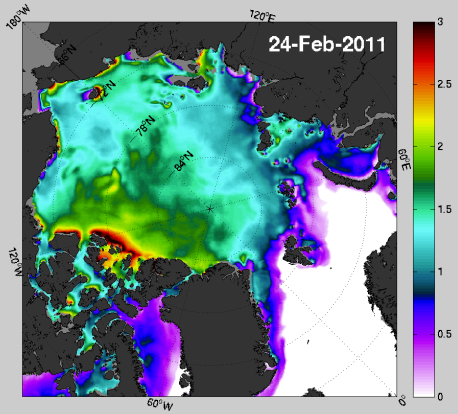


Arctic Shelf

- Environmental data:
  - 50m to >400m depth
  - Bathy (mb) in general scarce
  - Legacy geoac data in select areas
  - Some additional seismic data.
- Ice conditions:
  - mid-Aug to mid-Sep window
  - yearly variations.
- Ship operations:
  - FFI Research Vessel (Ice cl. C)
  - Site survey
  - Combine with FFI-array expt.



[Vibrocore sites and physical properties, and distribution of Quaternary sediment from Solheim *et al*, 1990; bathymetric map from Solheim & Elverhøy, 1993]



TOPAZ forecast sea-ice thickness (m)

David's questions

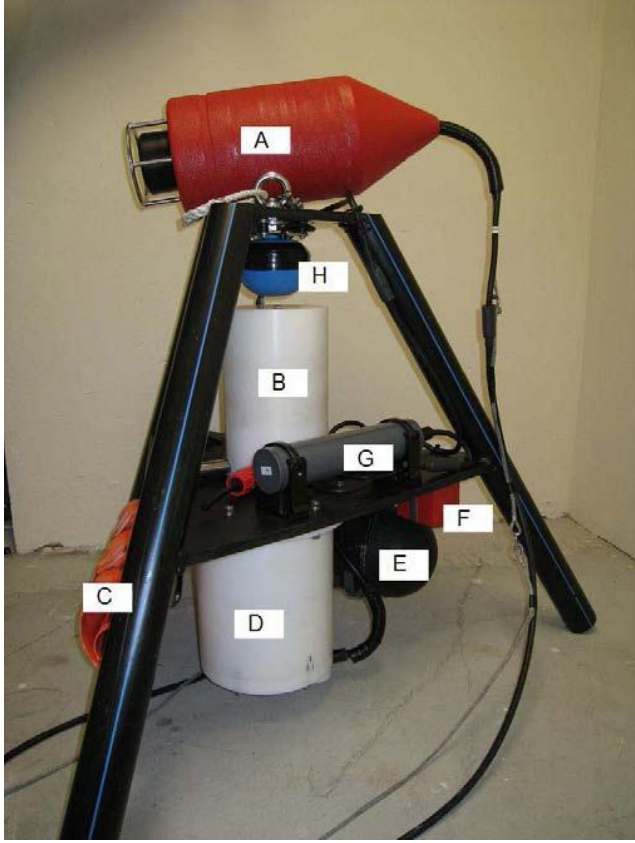
- New about these measurements:
  - moving-source/fixed-array data in cross-province context (with high-resolution supporting information).
  - side: high-quality data set in Arctic Shelf environment.
- Latest expected technology:
  - state-of-the-art acoustic array (and Bayesian inference method).

- Collaboration:
  - Interactions with the SBCX team
  - Explore (informal) collaborations with ESL and UVic.

- EXTRA

NILUS bottom node

- Sensor nodes dropped onto the sea floor
- Modem in water column (increase range)
- Acoustic sensors:
  - DIFAR hydrophone or
  - 4 hydrophones in tetrahedron
    30,3 cm between h/ps in plane;
    top h/p 16,7 cm above centre
- Magnetic sensor (3-axial fluxgate)
- Local signal processing
  - Atmel AP7000 processor
- Tripod structure
- Flotation bag for easy recovery
- 10-day battery endurance (per 2011).



R/V H U SVERDRUP II

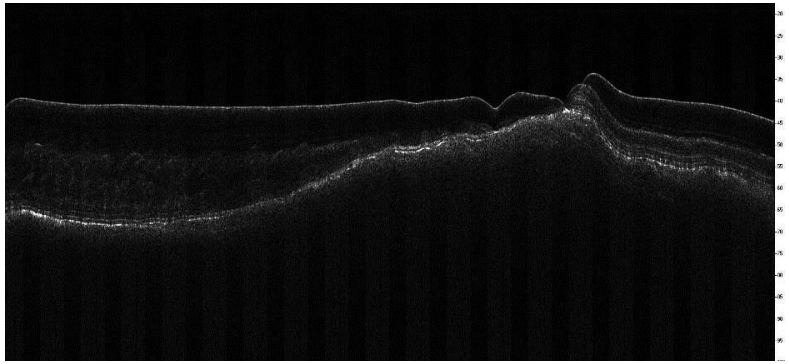
- 55-m length overall, 13m breadth, 5.5m draft, 1387GRT,
- Approx. 200 m^2 deck space, 10-ton A-frame, 3-ton crane, trawl winch, side winch, 150 m^2 wet and electronics labs.
- Echosounders: EA-600 SB, EM-710 MB, PS018 bottom profiling.
- HUGIN-1000 AUV; deck container, aft launch.
- 2x40 cu. in. airgun, Moving Vessel Profiler, ADCP.
- Berths for 15 scientists, 7 crew.
- Operates 11 months/yr, mainly mapping and survey tasks, external hire.

HUGIN 1000

1000 m depth rating, mobilization container,
L:4.5m, ○75cm, sp:2-6 kts, 24 hrs@4 kts.

Equipment (April 2011)

- Multibeam – KM EM2000 (200 kHz)
- Singlebeam – KM (300 kHz)
- Sidescan – EdgeTech 2200 (120 & 410 kHz)
- KM-HISAS-1030 (60-120 kHz)
- Subbottom Profiler – EdgeTech (2–16 kHz)
- Forward looking – BlueView (200 kHz)
- Oceanographic – FSI Micro CTD 2
- Methane sniffer – Contros HydroC
- ADCP, Optical camera, Navigation sensors.



SBP – example (630m depth, 35 m height)