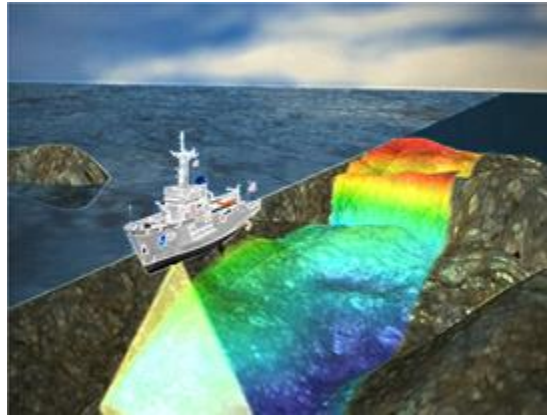


AML Oceanographic



The Importance of Sound Velocity for MBES Operation North Indian Ocean Hydrographic Commission April 2018 Goa, India

James Walton
Sales Manager

2071 Malaview Avenue Sidney, British Columbia Canada, V8L 5X6



Outline:

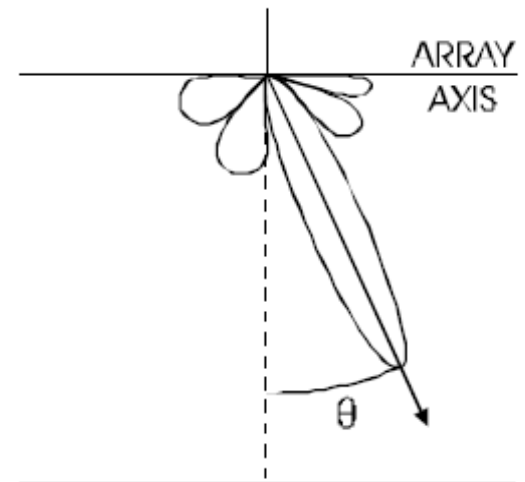
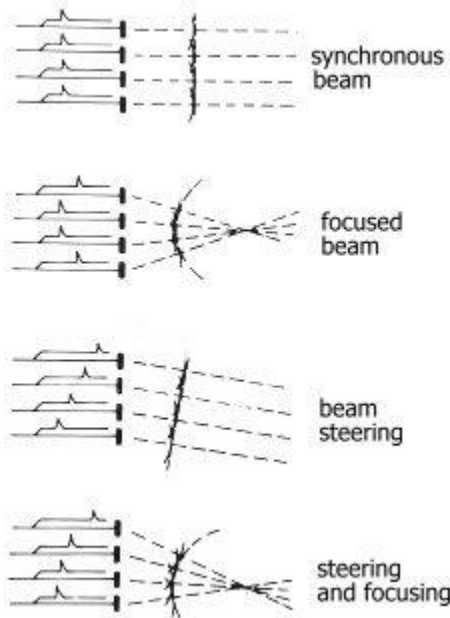
1. Recap on SV use by modern MBES
2. How frequently should I be profiling?
3. MVP (Moving Vessel Profiler)
4. Case studies



Where is sound velocity measurement used in multibeam systems?

Two places. First place – at the multibeam head for the purposes of beam steering.

Induced time delay
between elements is a
function of local SV.



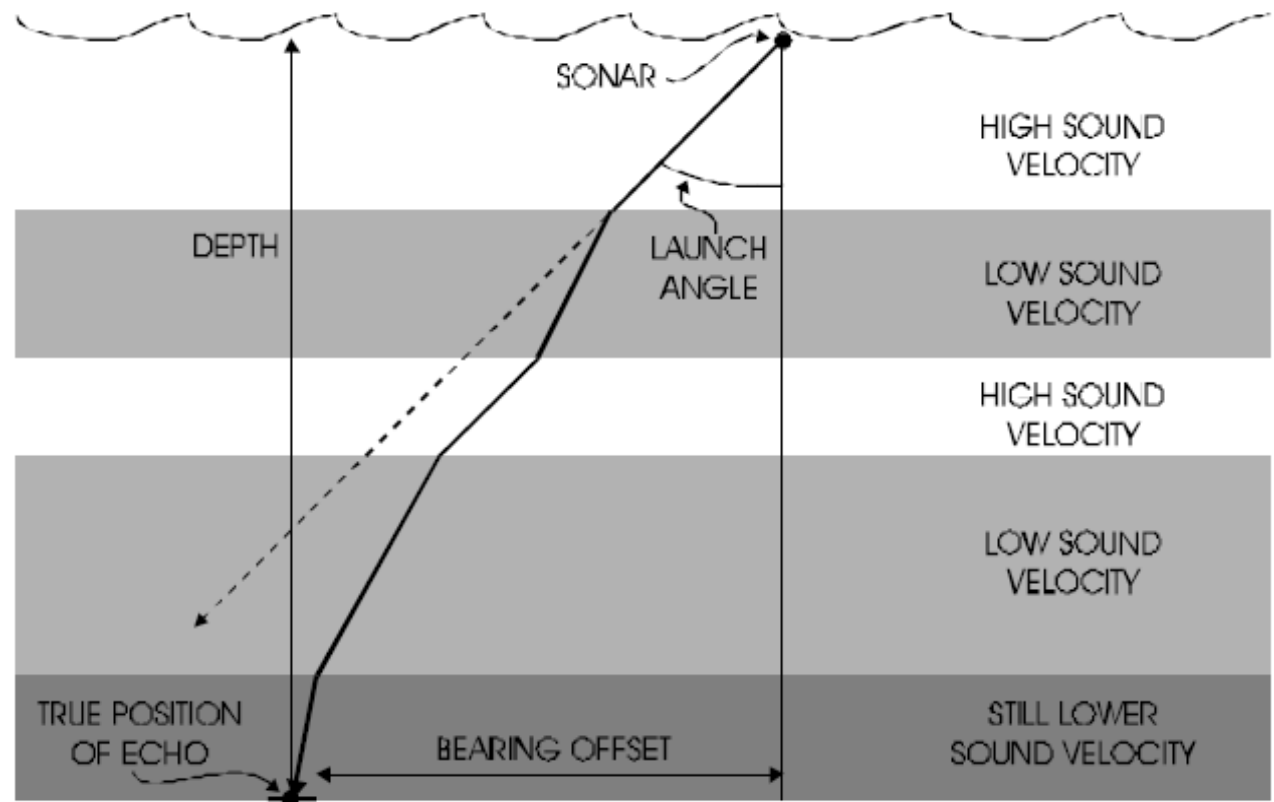
Source: <https://physics.stackexchange.com/questions/1263/how-can-you-focus-sound>

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Second place – within the water column itself to correct for both refraction and range errors.

Snells Law:

$$n_1 \sin(\theta_1) = n_2 \sin(\theta_2)$$



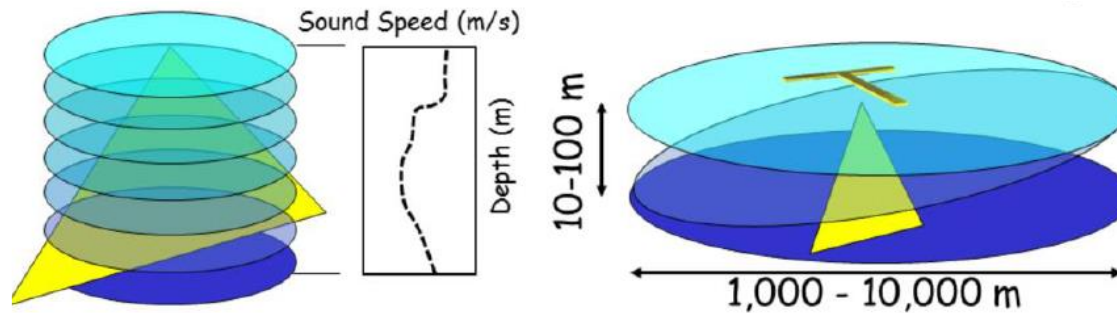
How often should I be taking a profile?

Answer: there are no hard and fast rules, but example guidelines include:

- Time interval: simply once per hour, give or take
- Distance interval: once every x km
- Anytime the sea surface SV changes by more than some fixed amount (~ 1 m/s)
- Once per day
- Never?

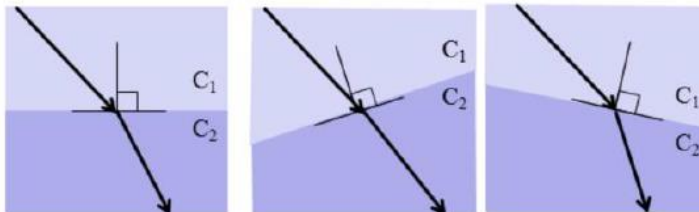
Certainly not done by anyone doing an IHO-level survey

What if the ocean is not vertically stratified?



Lateral Oceanographic Variability:

What if the ocean is NOT just vertically stratified?



In typical shallow tidal seas, the velocline is NOT level.

Differential motion between layers will result in interface roughness.

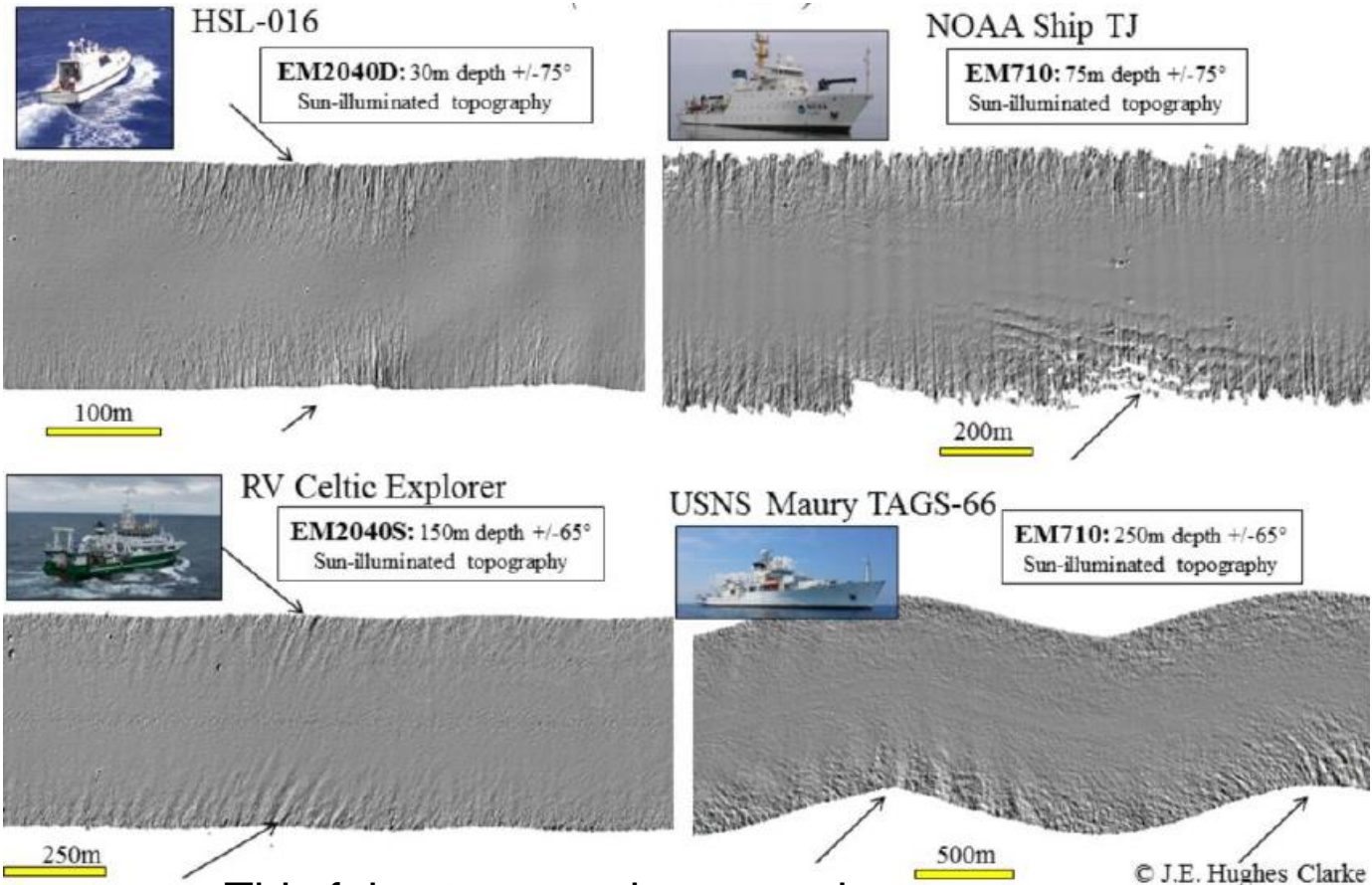
1 – Internal waves; undulations with wavelengths around 500-1000m, amplitudes of 5-50m. Will propagate 100's of km.

2 – Kelvin-Helmholtz waves; wavelengths, 10-200m, 0.5-5m amplitude

Source: JHC. Sonar swath training 2018

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What does a tilted, undulating veloclone do?



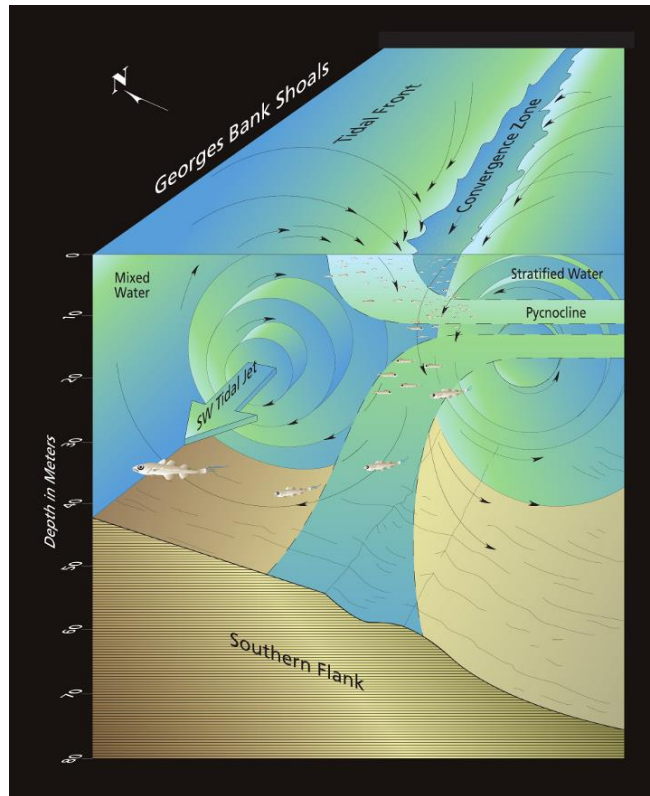
This false topography exceeds IHO Order 1 in all cases.

Source: JHC. Sonar swath training 2018

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How often should I be taking a profile – A Case Study

Demonstration dataset: - example of what happens when we progressively under-sample a watermass



- Deep water shoals over the bank.
- In summer, the water column has a very strong thermocline
- This thermocline is constantly migrating back and forth in response to tidal variation.
- This results in large soliton internal wave which propagate slowly along the thermocline onto the shelf
- Well mixed tidal front hits the stratified water very abruptly
- Demarcation between the two masses ebbs and flows over many km
- Area has high spatial SV structure variation and is representative of conditions encountered by Canadian survey vessels

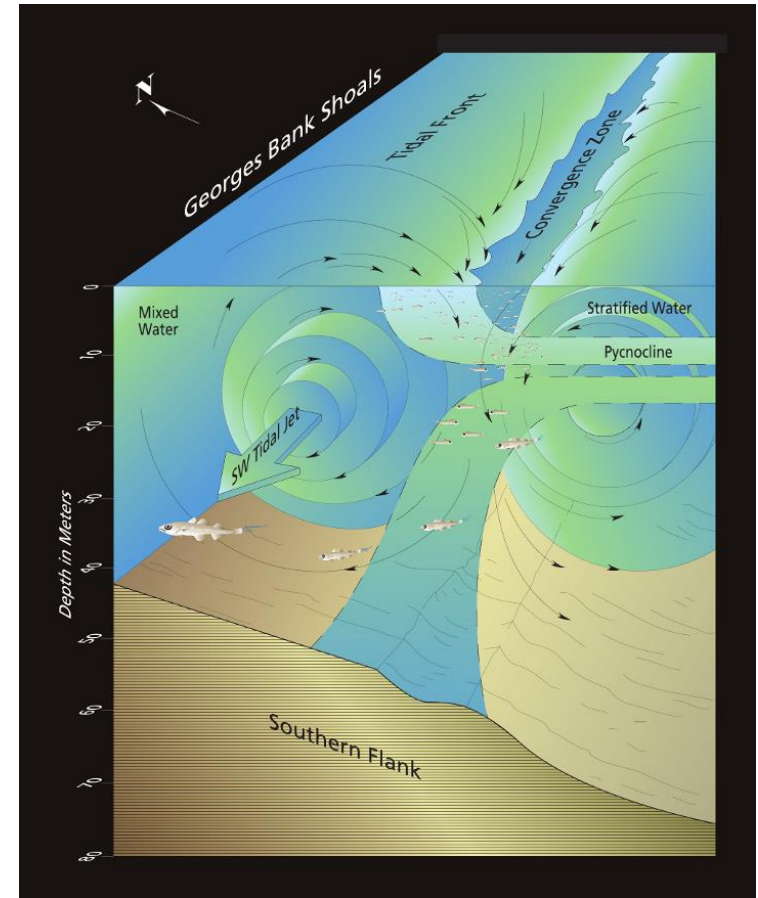


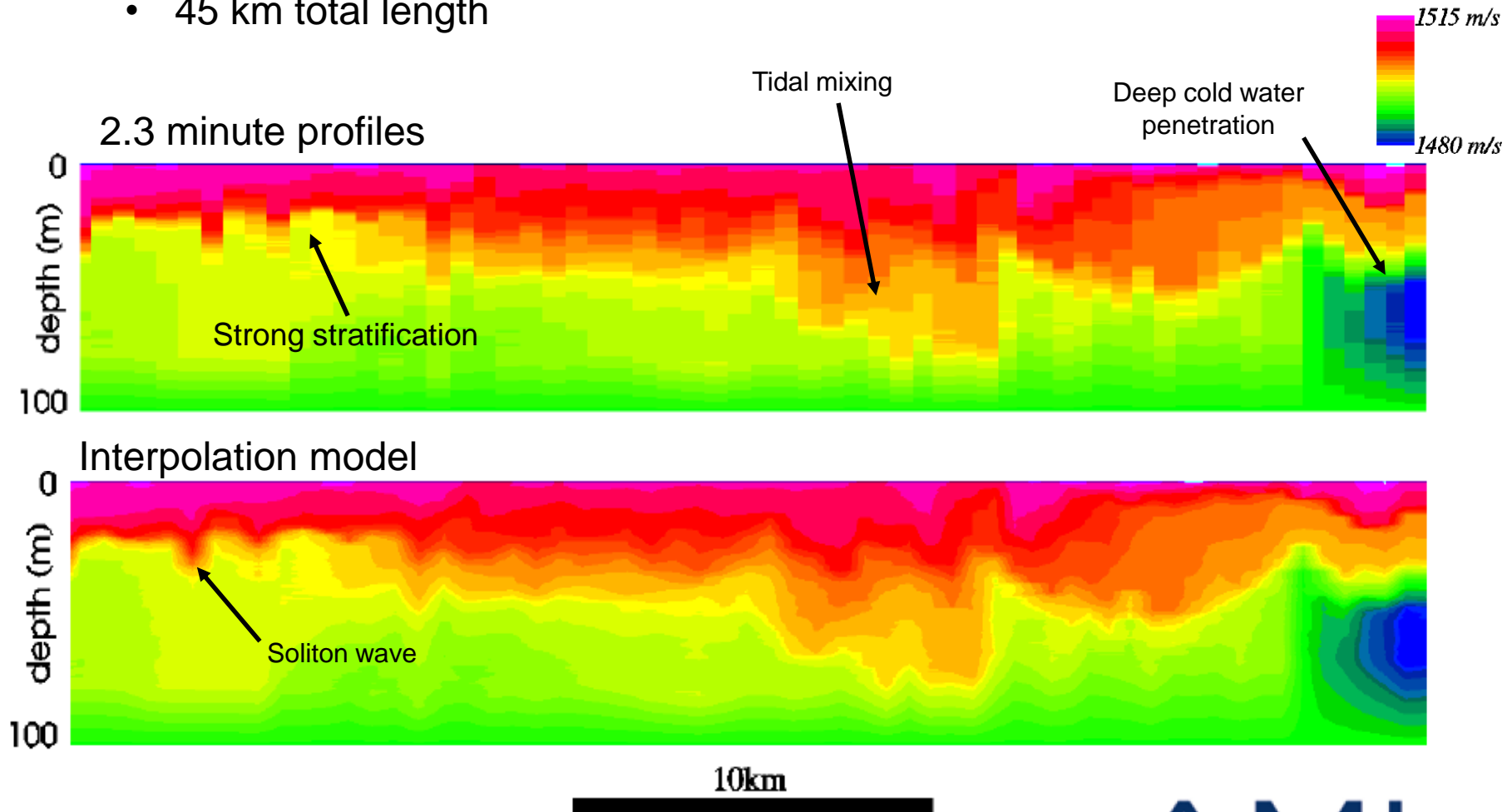
Figure 1-1. Map of the northwest Atlantic Shelf region, including the Gulf of Maine, Bay of Fundy, Georges Bank, and the Scotian Shelf.



Approx. ship path.

- Conducted a survey over the bank with an MVP operating in continuous mode
- At the depths achieved, this resulted in an SV cast period of about 2.3 minutes
- Data were post-processed with a progressive reduction in sound velocity casts.
- Results assessed both qualitatively and quantitatively

- 60 individual casts (1 cast every 2.3 minutes)
- 45 km total length



Source: Integration of near-continuous sound speed profile information. J. H. Clarke, M. Lamhugh, E. Kammerer. May 2000

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Real Time

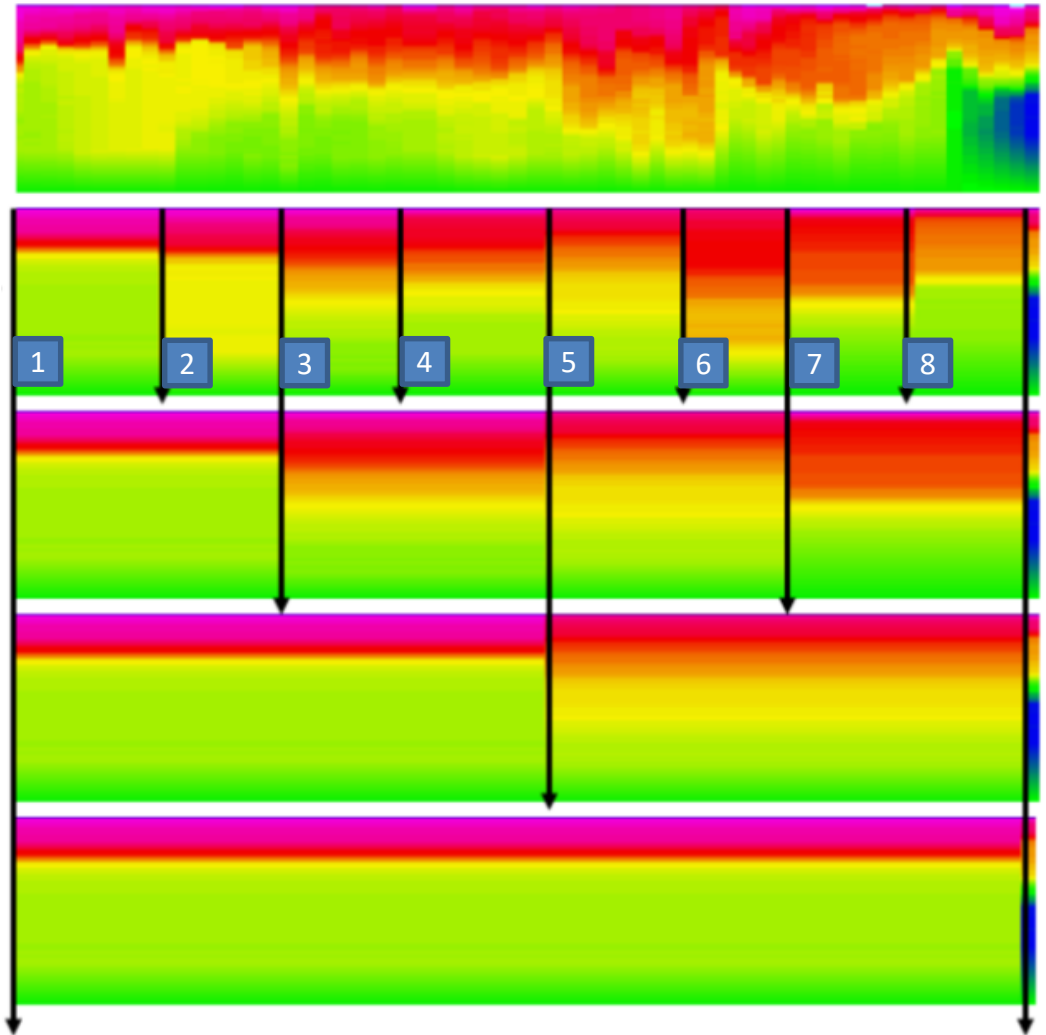
2.3 minute profiles
(reference)

17.5 minute profiles

35 minute profiles

70 minute profiles

140 minute profiles



Source: Integration of near-continuous sound speed profile information. J. H. Clarke, M. Lamlugh, E. Kammerer. May 2000

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Interpolated

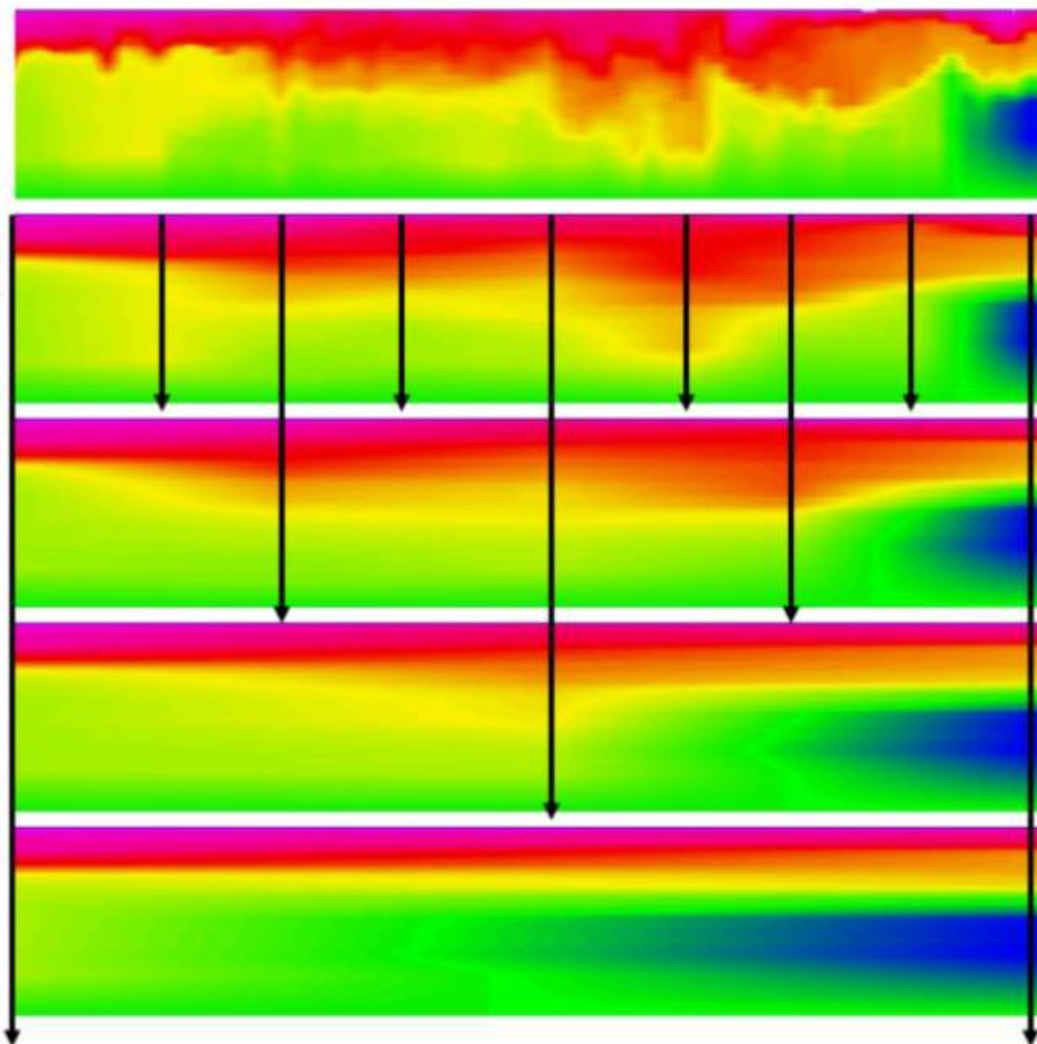
2.3 minute profiles
(~continuous)

17.5 minute profiles

35 minute profiles

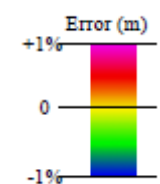
70 minute profiles

140 minute profiles



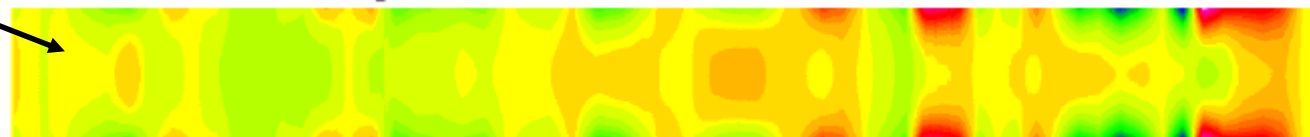
Source: Integration of near-continuous sound speed profile information. J. H. Clarke, M. Lamlugh, E. Kammerer. May 2000

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Depth difference

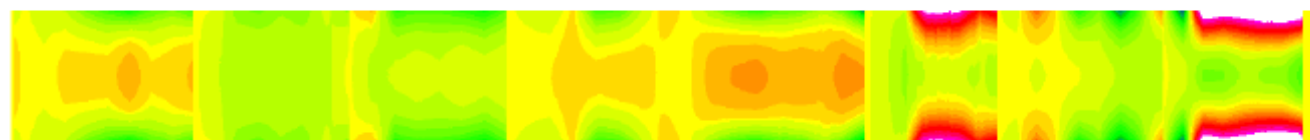
17.5 minute MVP's interpolated



Profile weightings

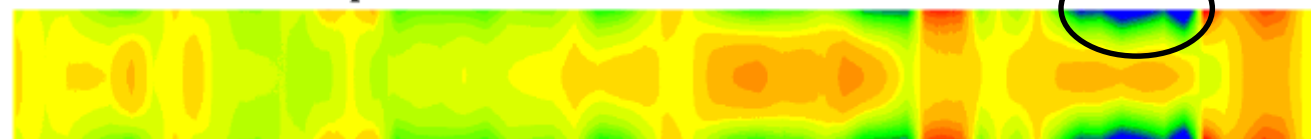


17.5 minute MVP's real-time



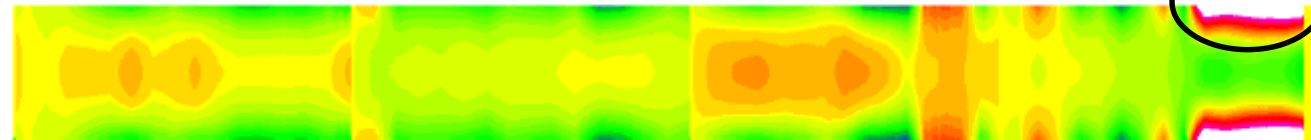
17.5 – Some error, but generally good agreement between interpolated and real time.

35 minute MVP's interpolated

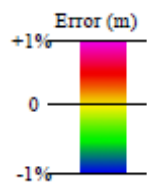


35 – Errors starting to get worse.

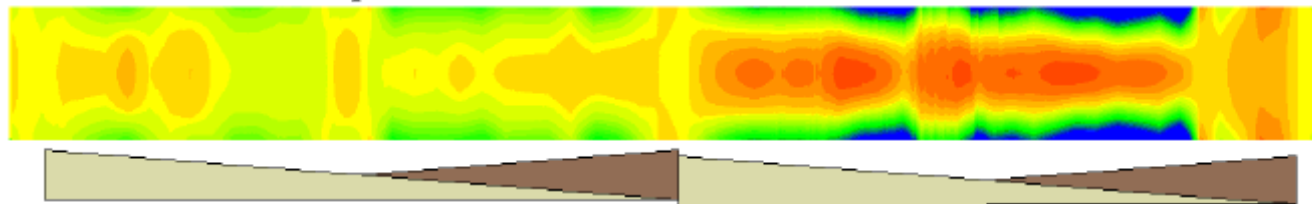
35 minute MVP's real-time



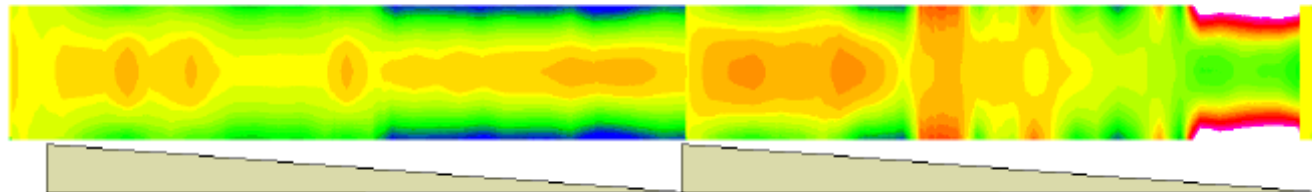
70 min – Notably worse
than previous results



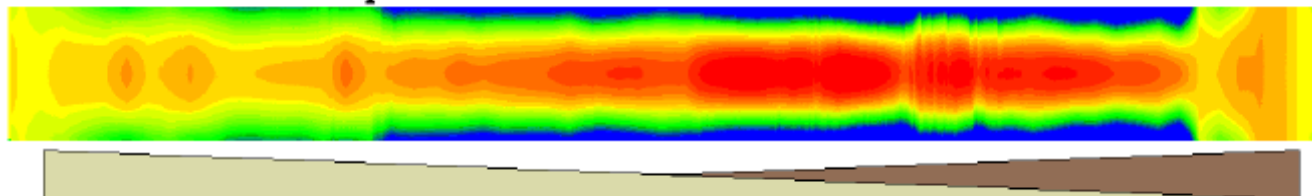
70 minute MVP's interpolated



70 minute MVP's real-time

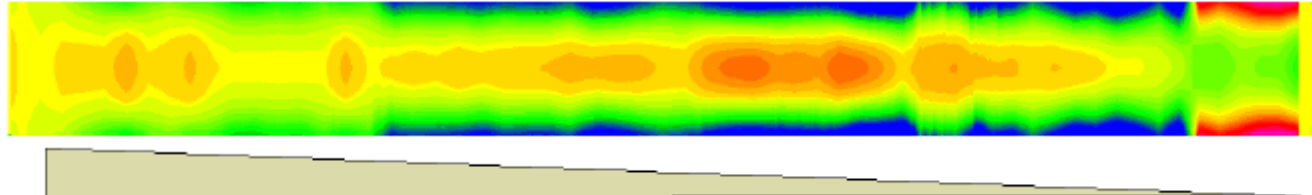


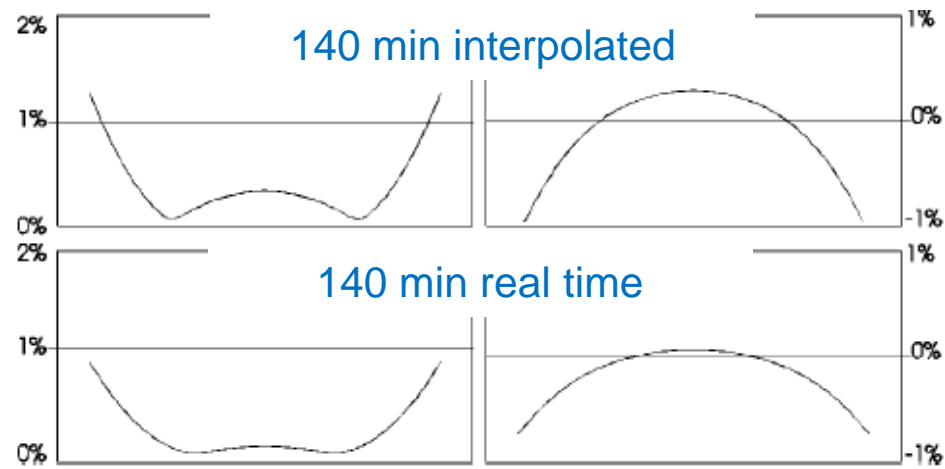
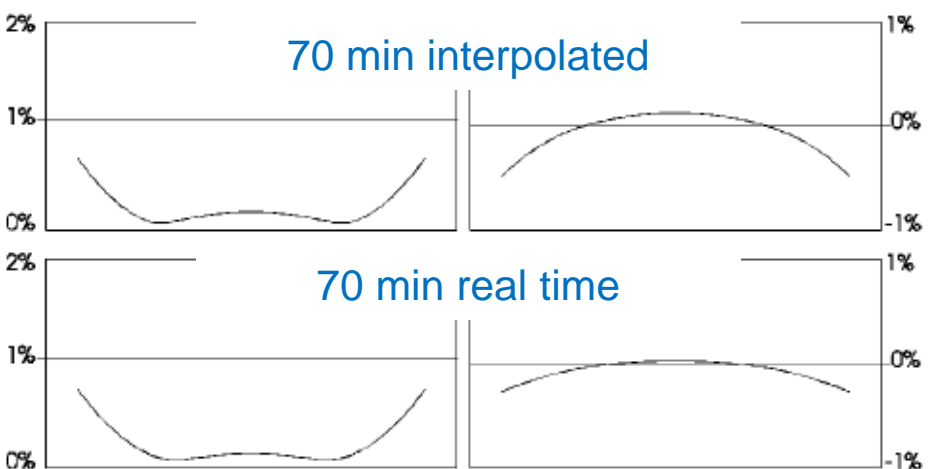
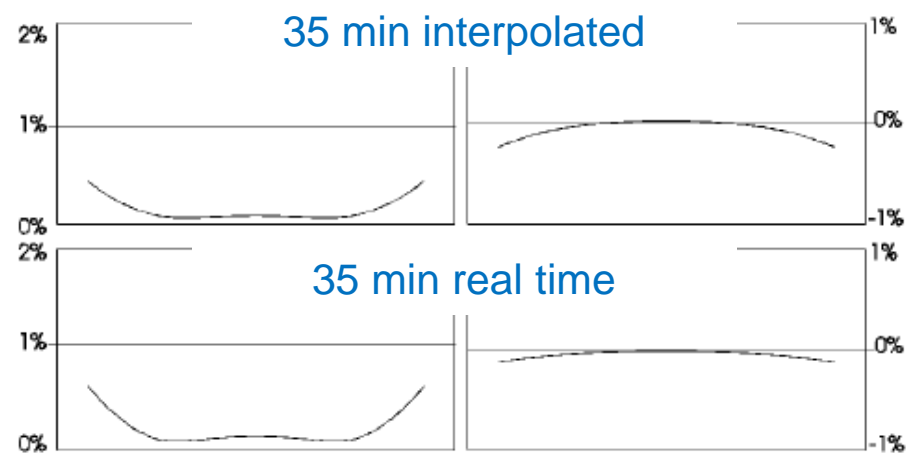
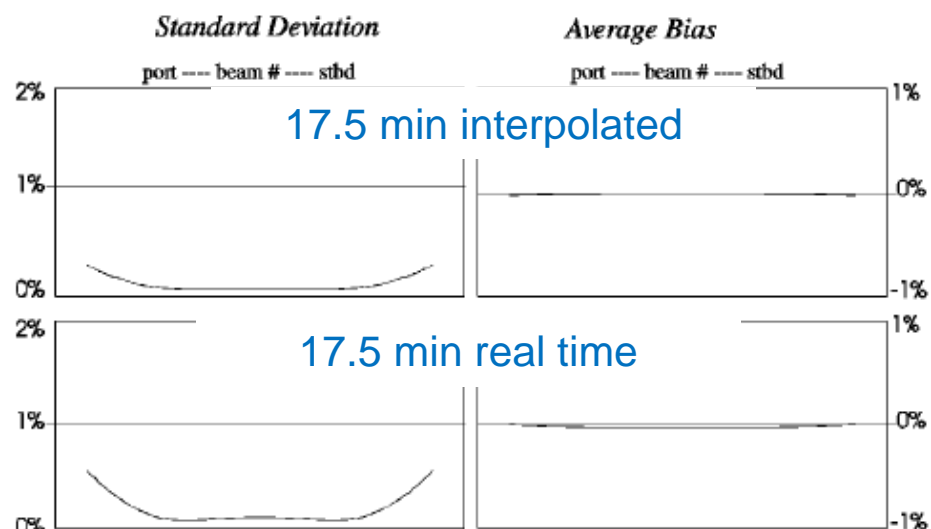
140 minute MVP's interpolated



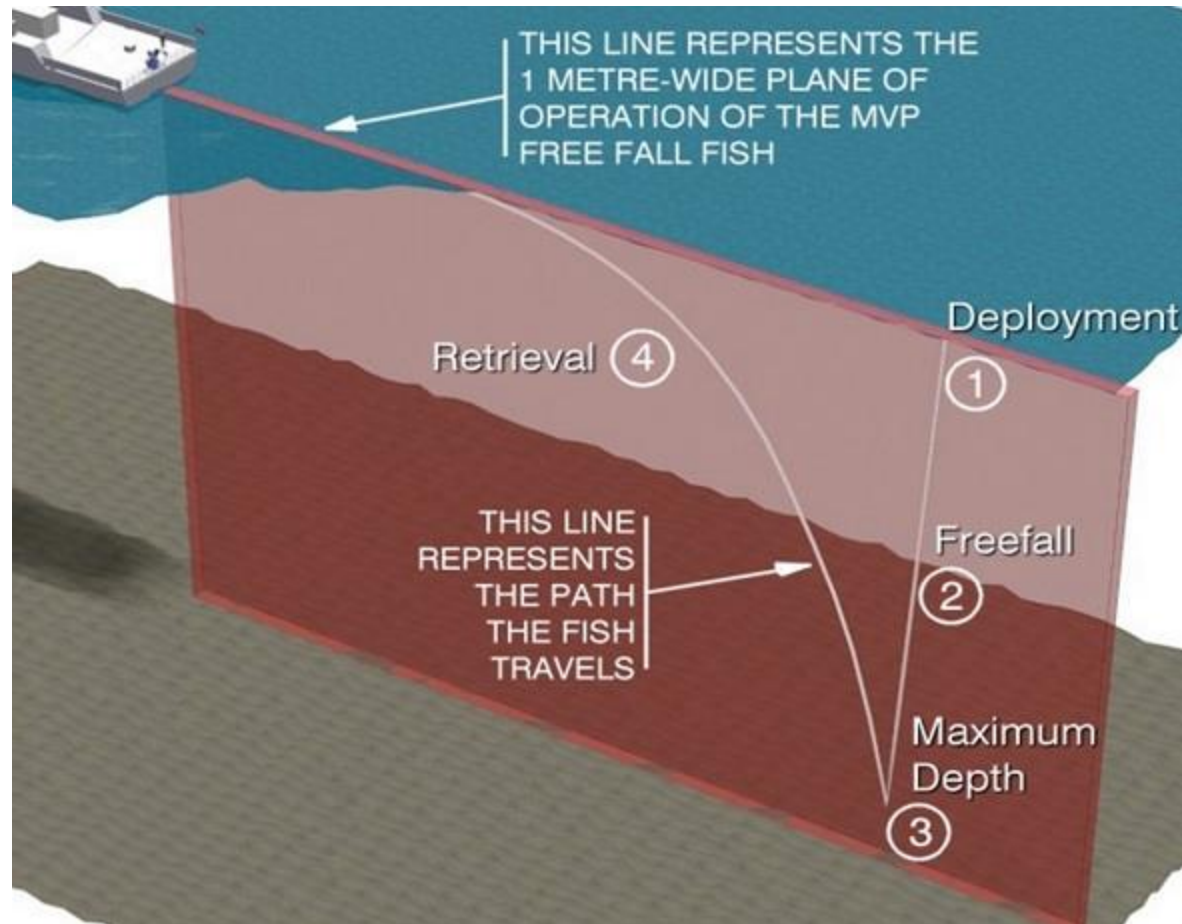
140 min – Disaster

140 minute MVP's real-time





MVP underway profile collection





NAMP

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Royal Australian Navy



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Malaysian Navy



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Japanese Coast Guard



2071 Malaview Avenue Sidney, British Columbia Canada, V8L 5X6

Chinese Academy of Science



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