Reducing error in open-ocean acoustic measurements

Tim Ryan, Ryan Downie, Rudy Kloser and Gordon Keith

CSIRO Marine and Atmospheric Research

WGFAST Brest, 2012

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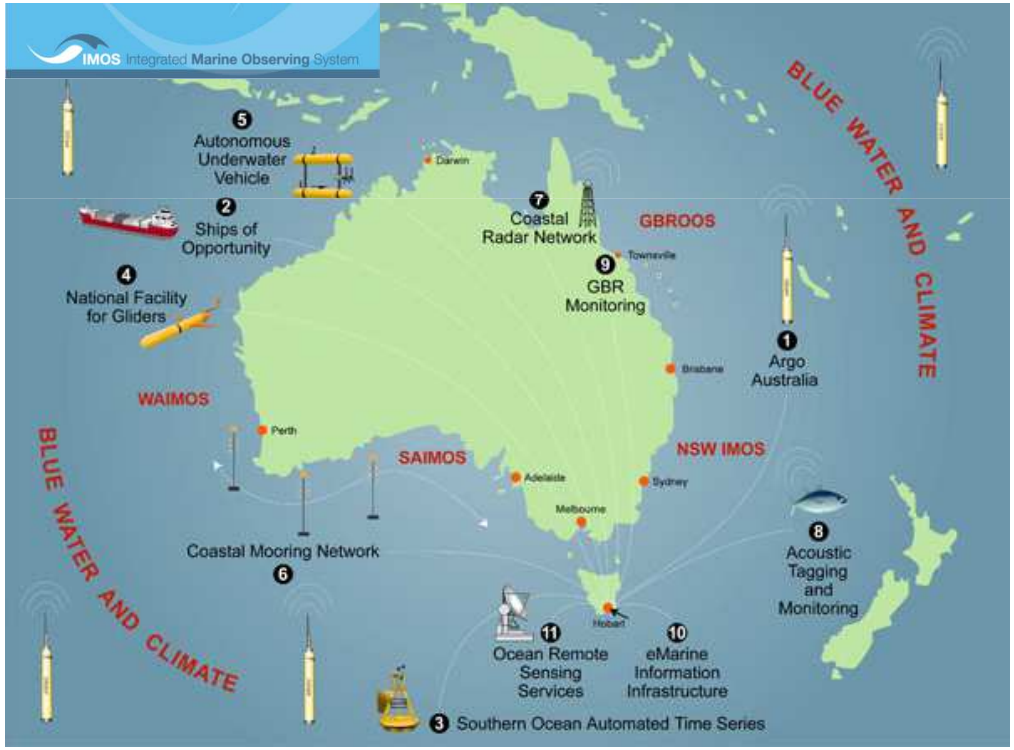
Integrated Marine Observing System (IMOS)

"IMOS is a distributed set of equipment and data-information services which collectively contribute to meeting the needs of marine climate research in Australia"



Facilities

Argo
Moorings
Gliders
AUVs
Ocean Radar
Satellite Remote Sensing
Animal tagging
Marine information (emII)
Ships of opportunty (SOOP)

- **Bio-acoustics**

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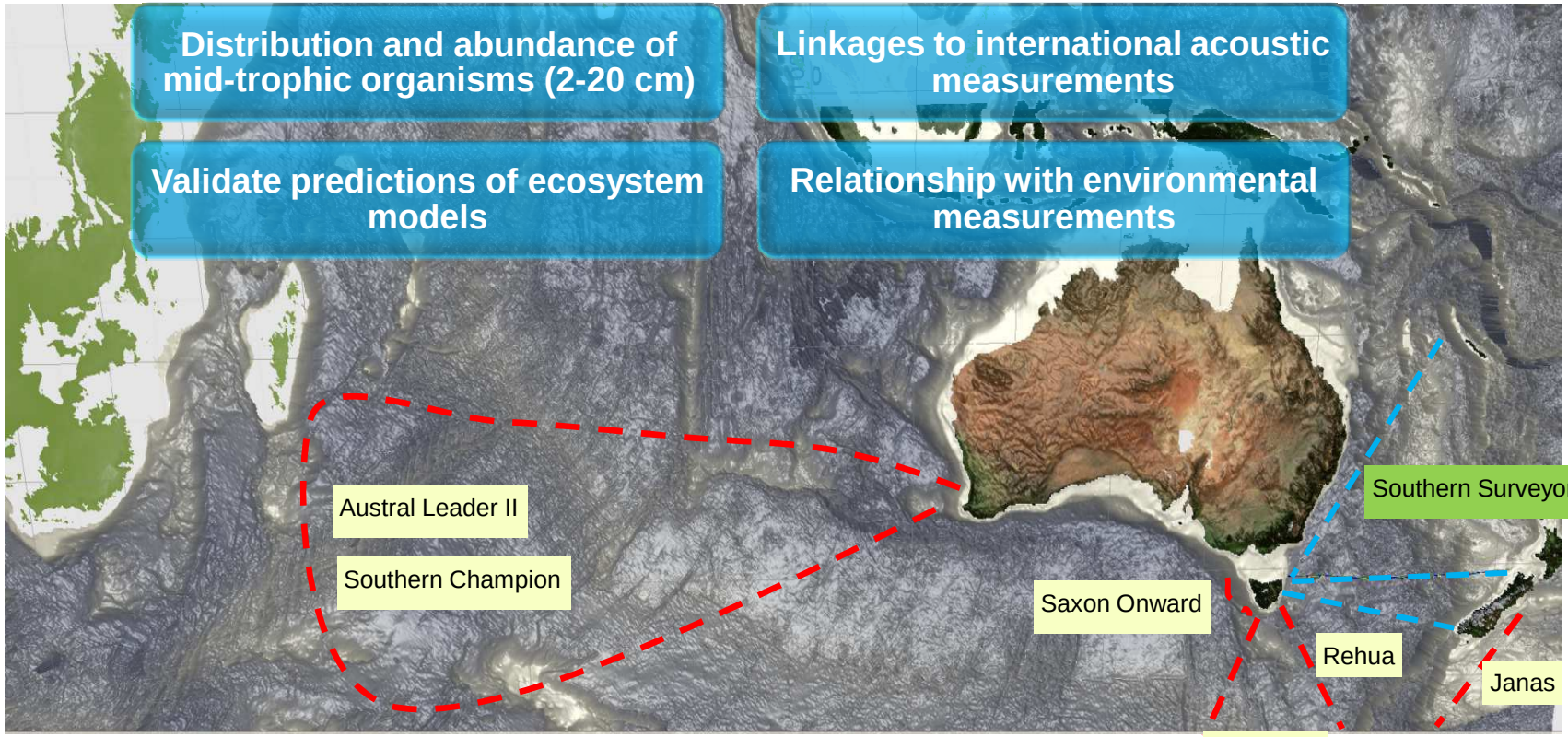
Bio-Acoustic Ship of Opportunity sub-facility (BASOOP)



Commercial and research vessels with calibrated digital echosounders

Vessel track : existing
: new

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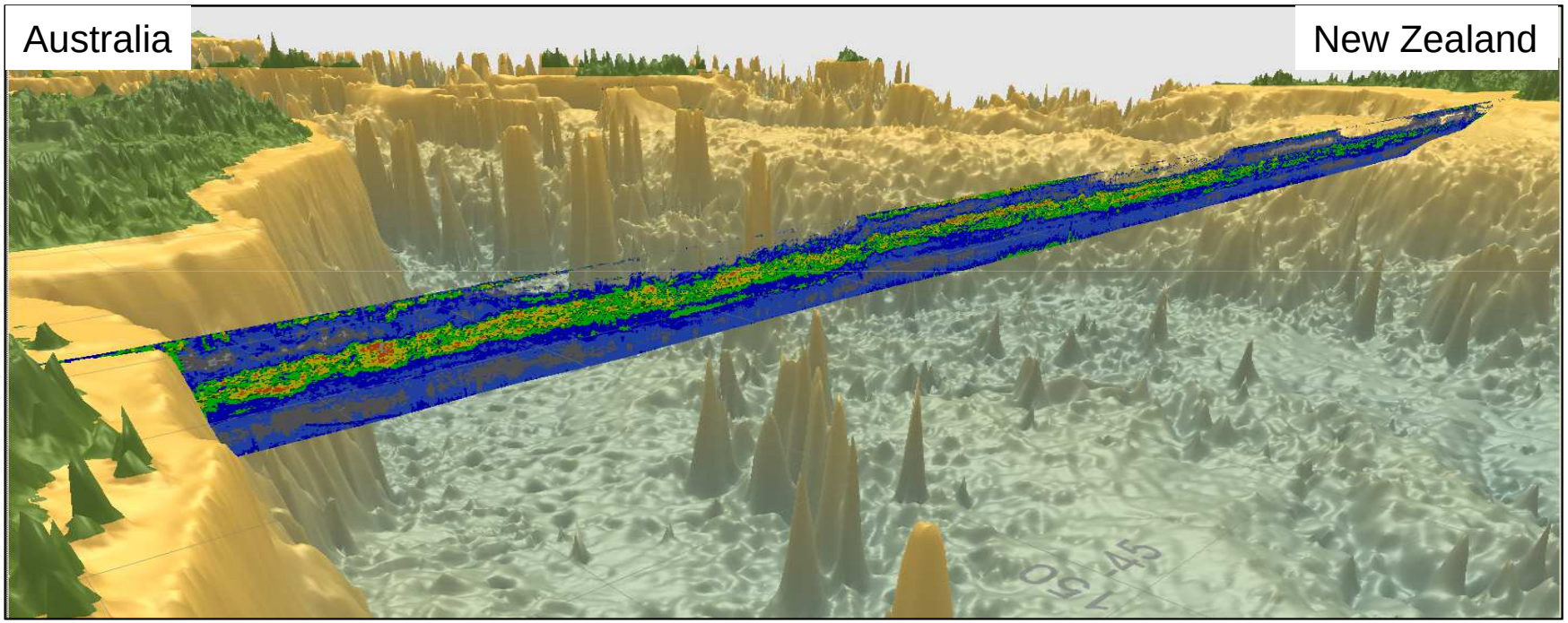
Biological acoustics ocean observing objective

To provide calibrated quality controlled measures of acoustic backscatter at ocean basin scales



Visualisation of 38 kHz volume backscatter (Sv) collected by FV Rehua Australia during a 4 day transit from New Zealand to Australia, August 2010

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Project data flow structure

July 2010 start

Establish fleet

Ships of opportunity

- Vessel 1
- Vessel 2
- Vessel 3
- Vessel 10

ICES FAST TG-AcMeta
Topic group on acoustic metadata

Metadata

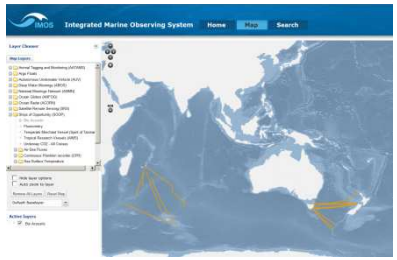
Develop methods

Processing and QC

Jan 2012

IMOS Ocean Data Portal

netCDF files of Sv values (1000 m by 10 height)



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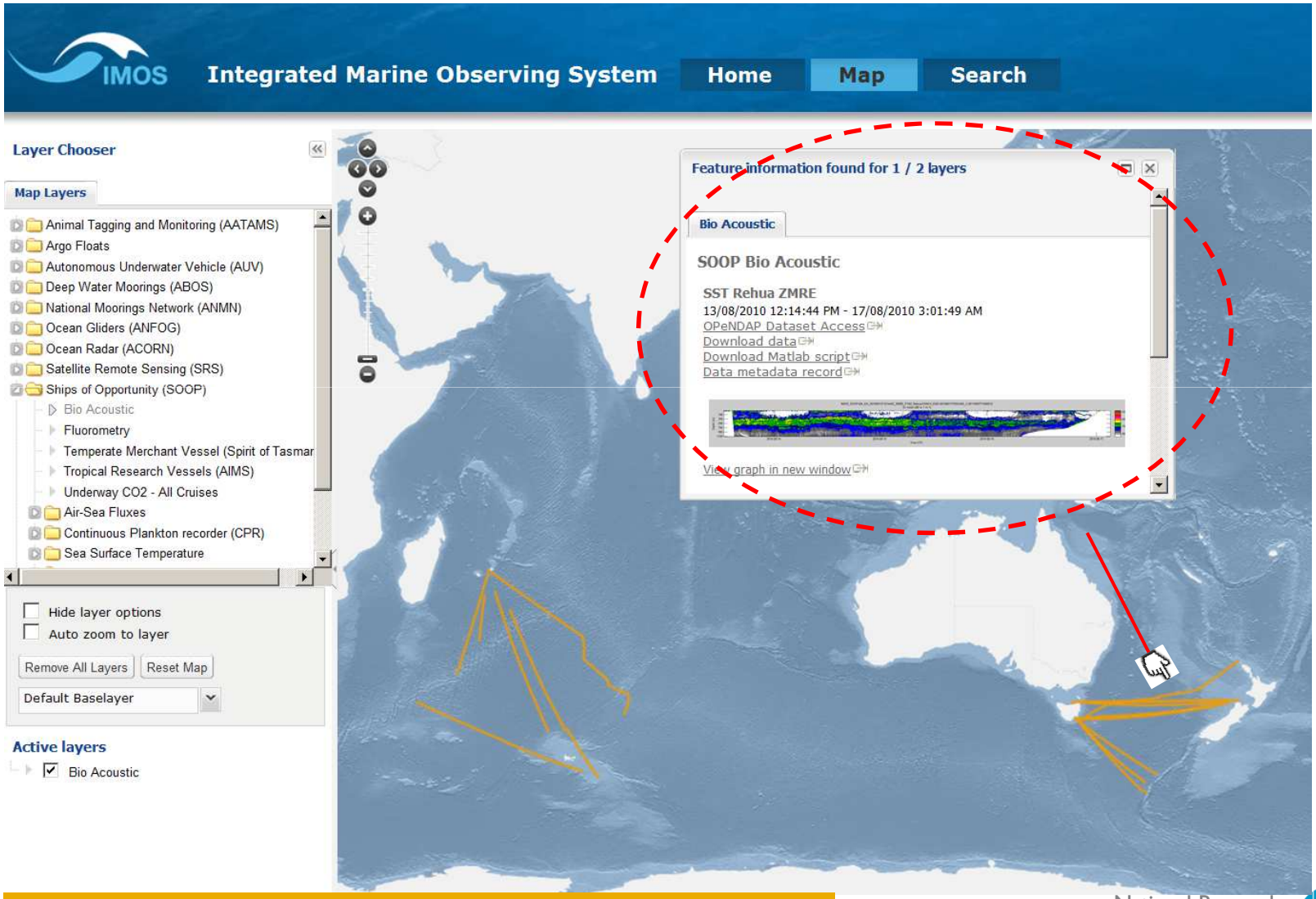
IMOS Ocean Portal



http://imos.aodn.org.au/webportal/

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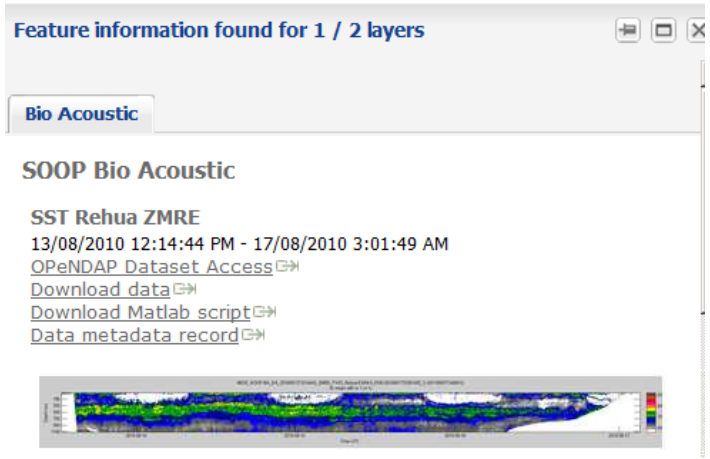
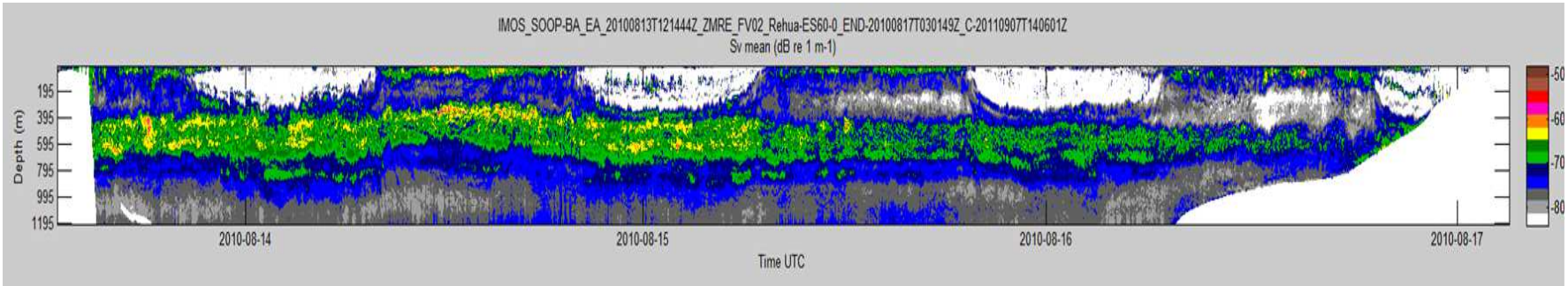
IMOS Ocean Portal



- OPenDAP Data Access
- Download data (netCDF)
- Matlab viewing script
- Metadata record
- Summary graphic



First iteration error corrections

July 2010 start

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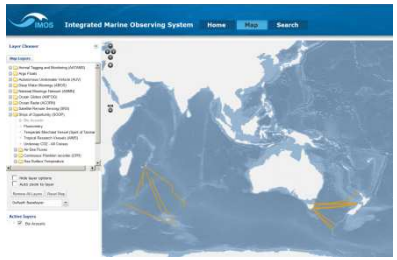

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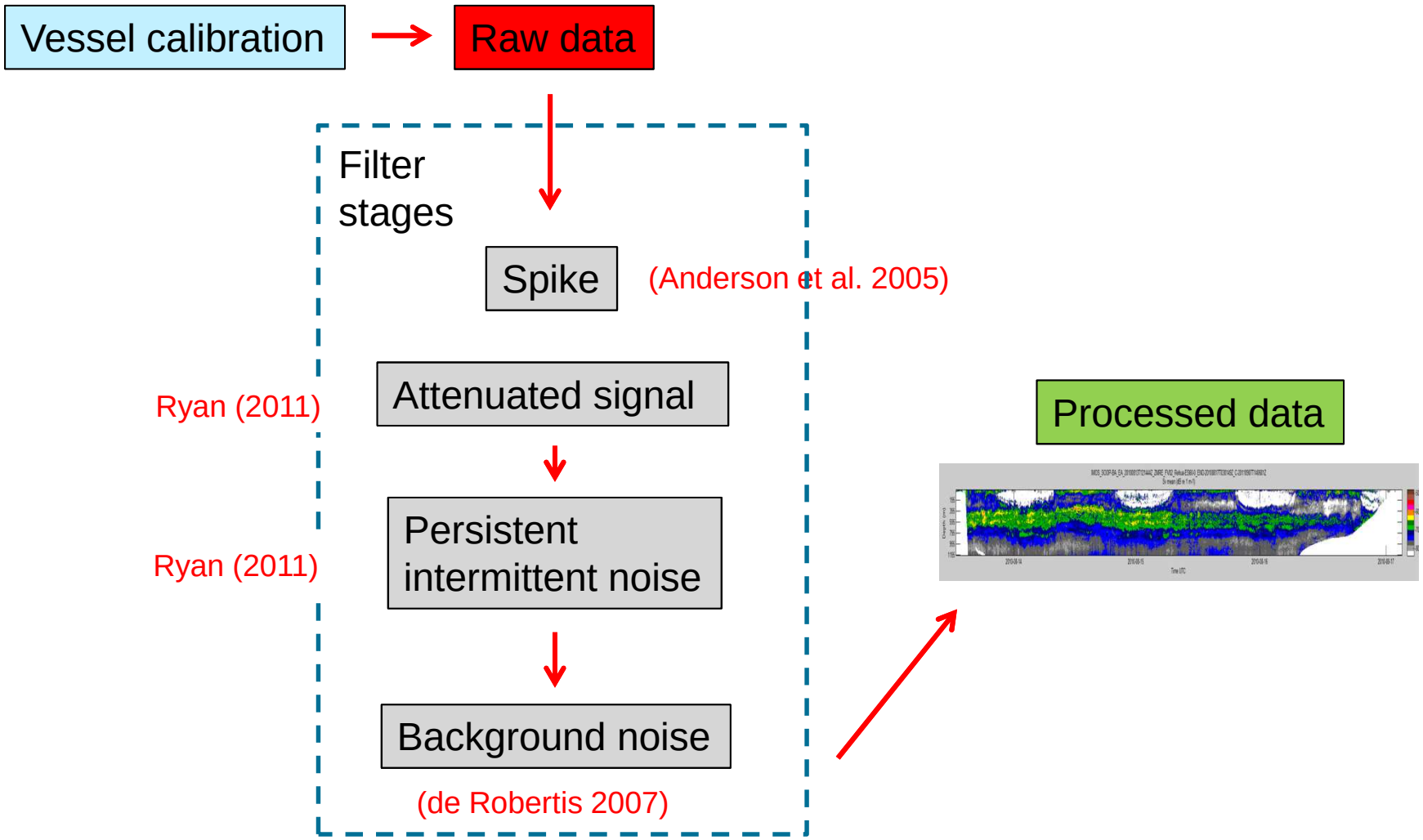
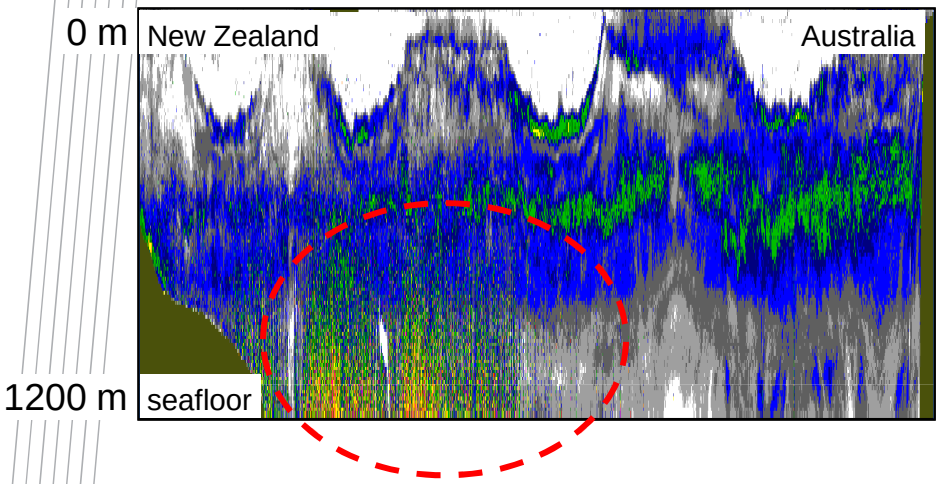
First iteration error corrections

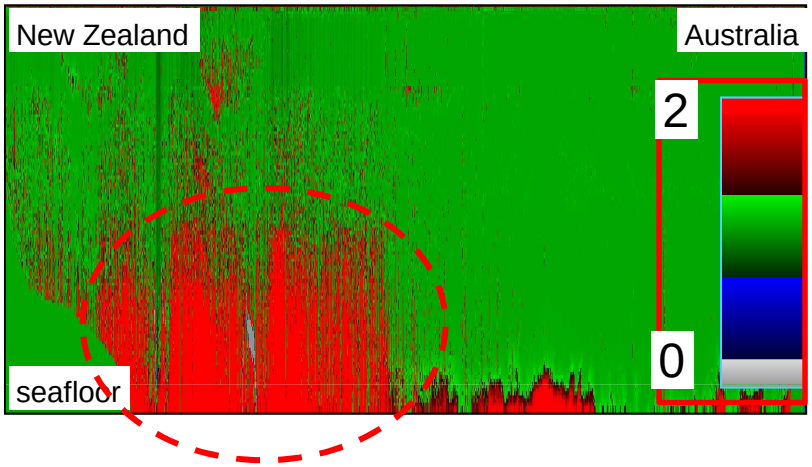


First iteration error corrections

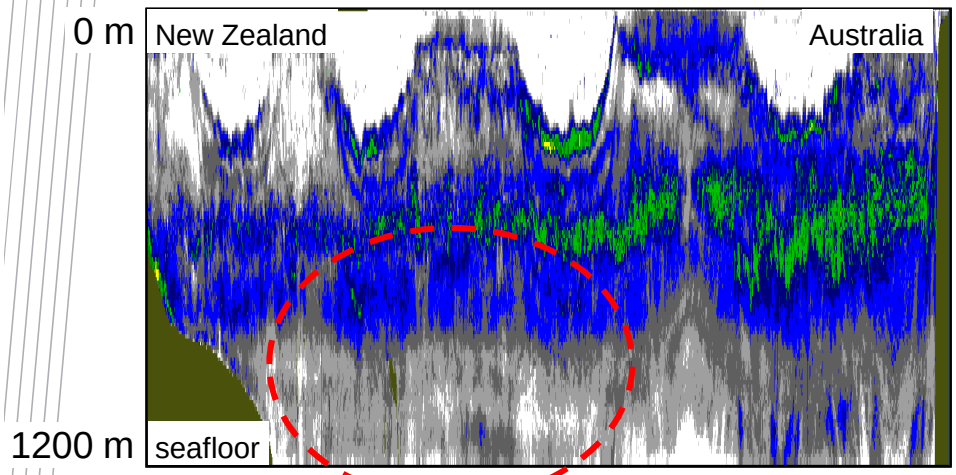
Unfiltered echointegrated data (1 km by 10 m cells)



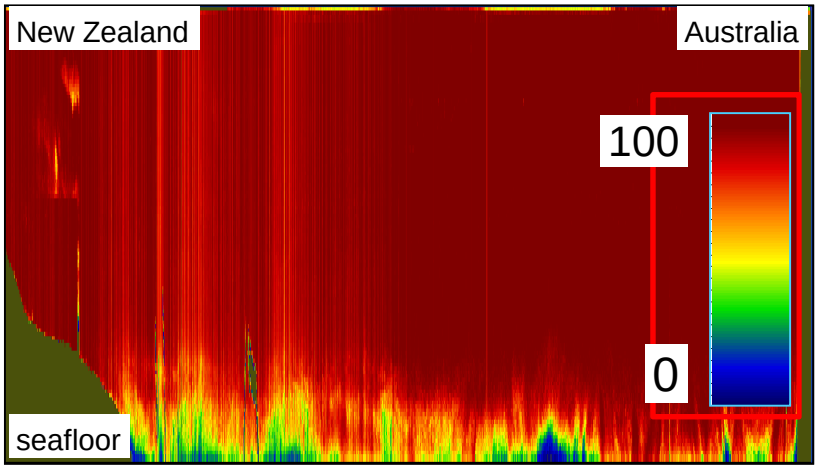
NASC Ratio: Unfiltered/filtered data



Filtered echointegrated data (1 km by 10 m cells)



Percentage data retained



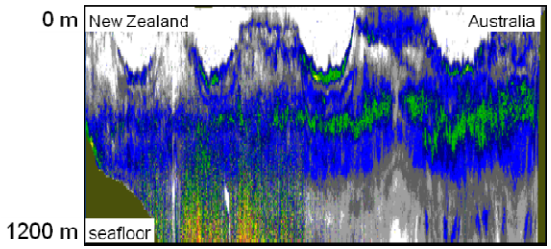
First iteration error corrections

- Filters effective at reducing gross errors

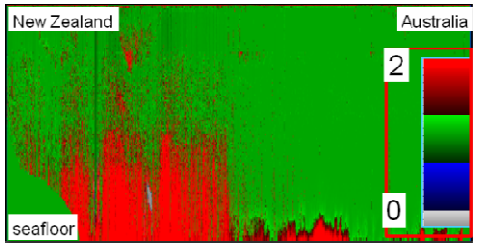
- Below threshold noise and attenuation will pass through filters leaving a residual error

- Difficult to quantify this residual error when signal characteristics are similar to valid data

Unfiltered echointegrated data (1 km by 10 m cells)



NASC Ratio: Unfiltered/filtered data



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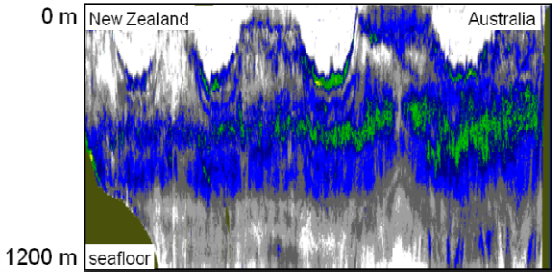

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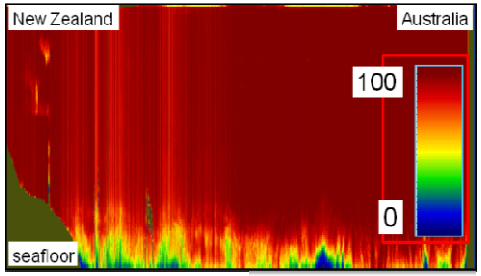

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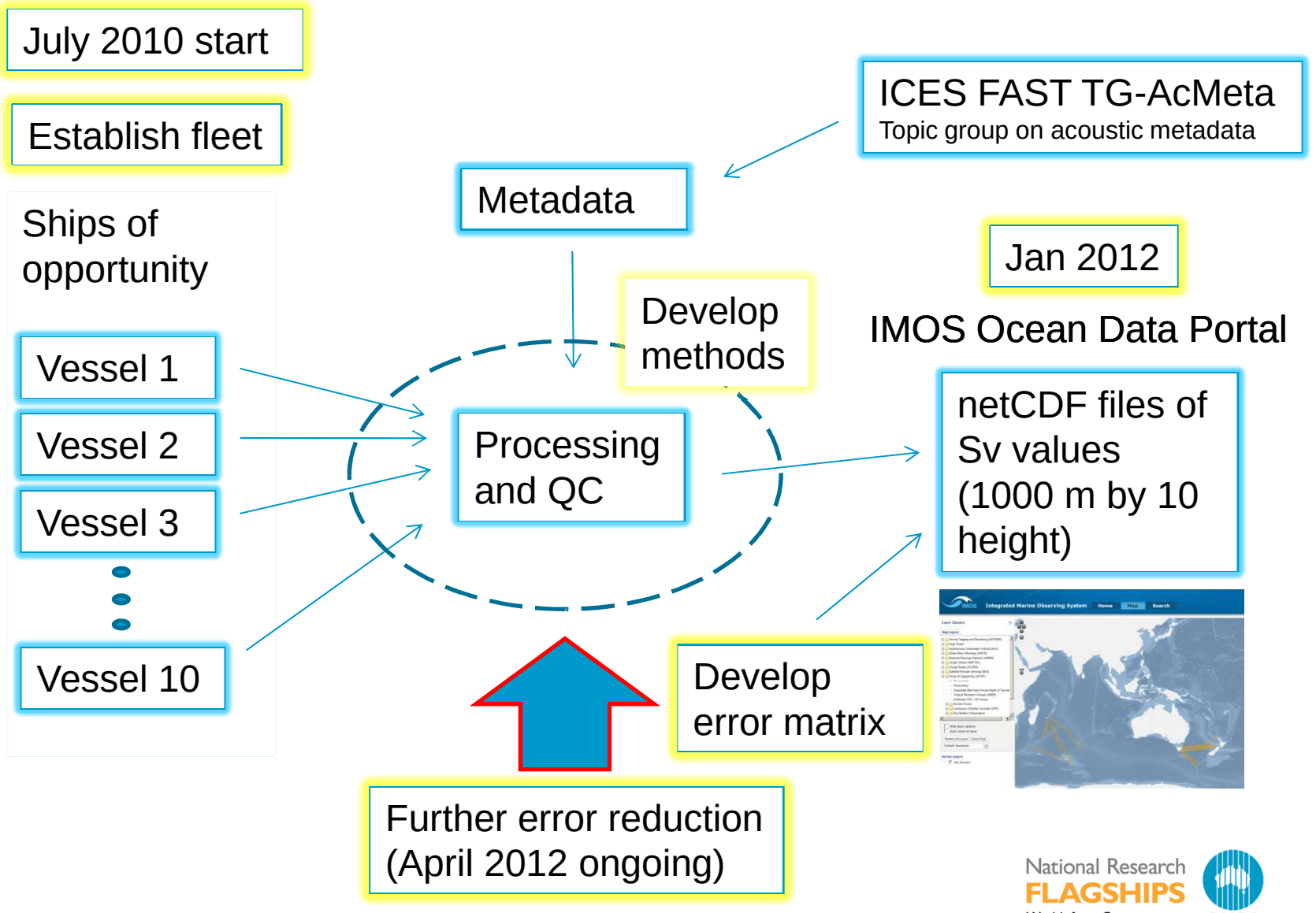
Project data flow structure



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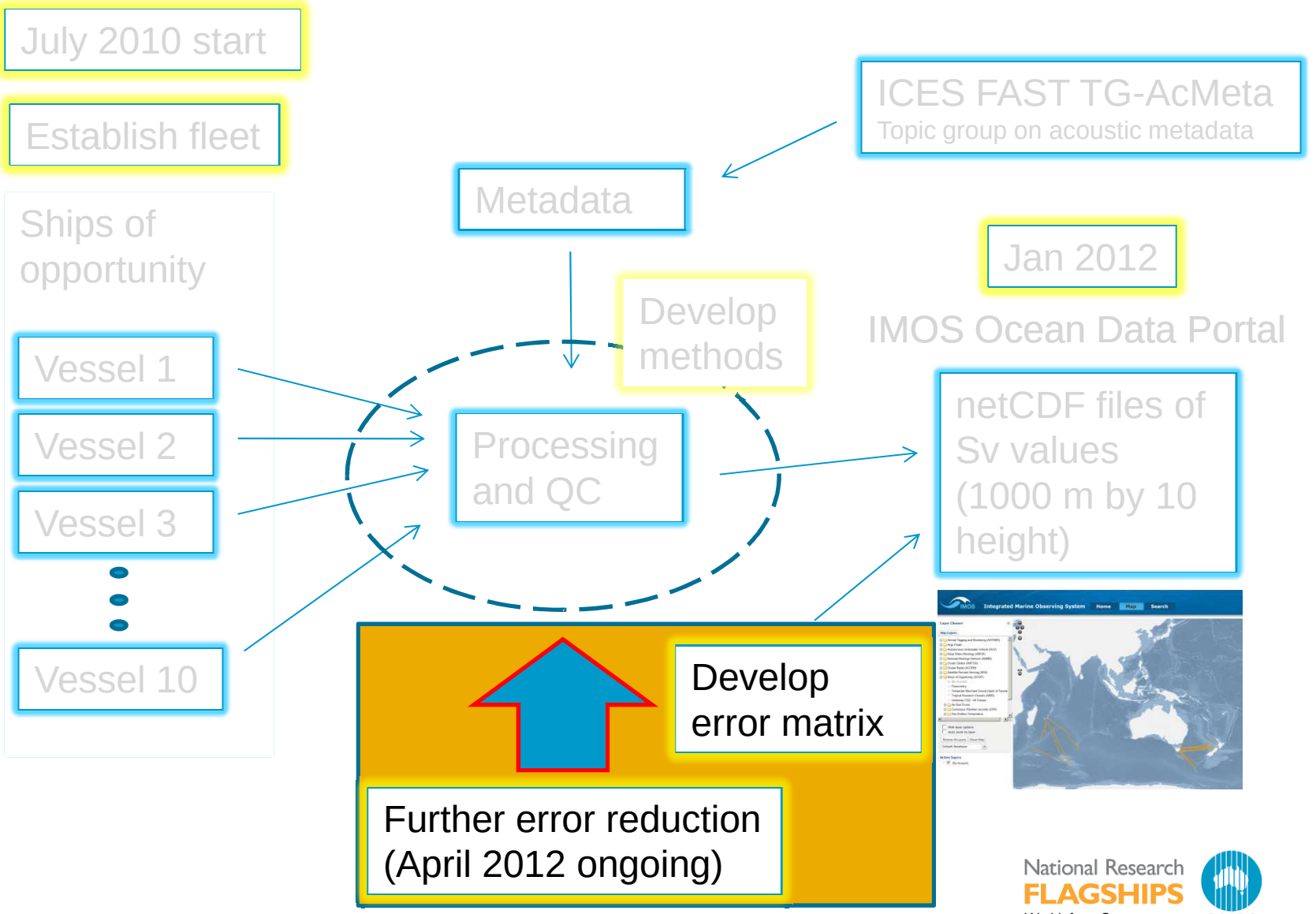

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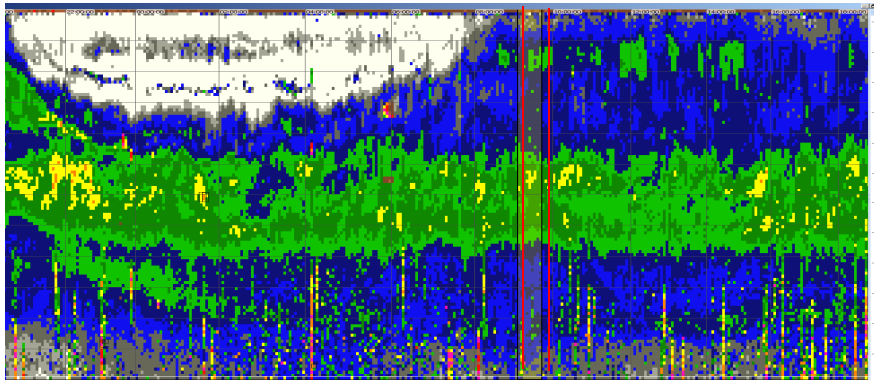
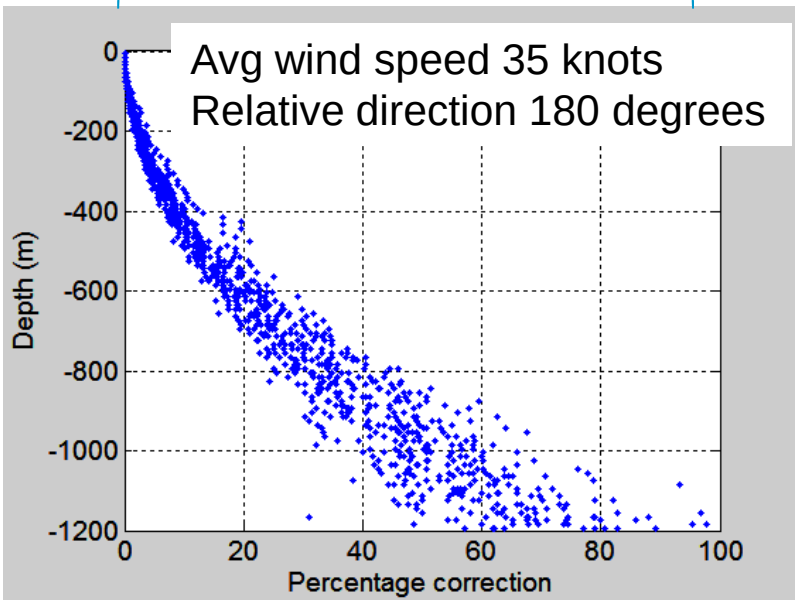
Further error reduction – Motion correction

Southern Surveyor 38 kHz 2- August 2011





Motion correction (Stanton 1982, Dunford 2005)

Can be significant at deeper depths

e.g. 20% at 600 m
40% at 800 m

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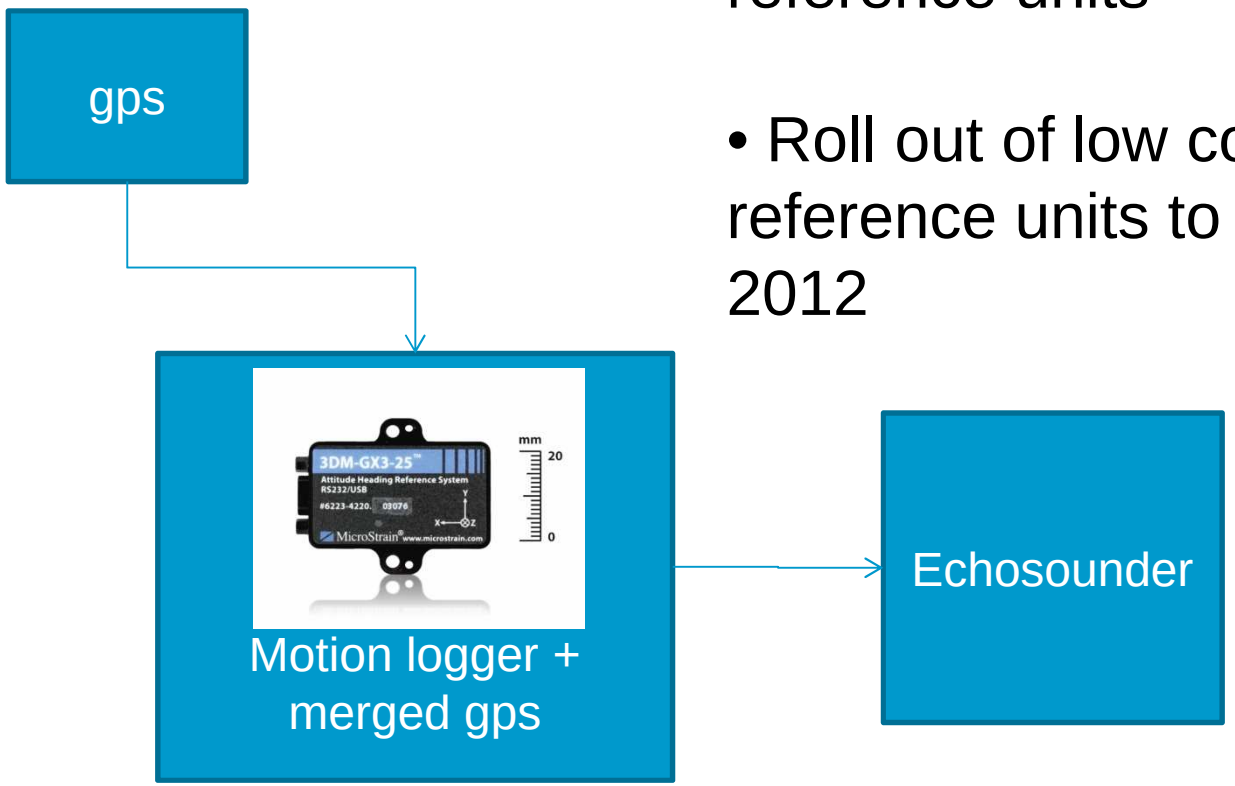
Further error reduction – Motion correction

- 2 out of 10 participating vessels presently have motion reference units
- Roll out of low cost motion reference units to vessels in 2012



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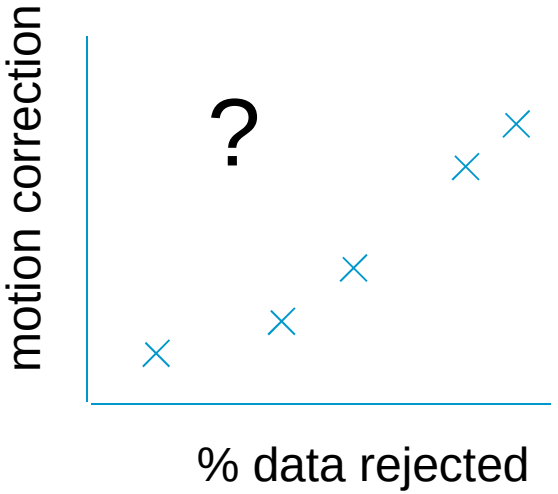
Further error reduction – can we infer motion correction?

- For each vessel collect acoustic data with mru in a range of conditions.
- Process data using noise and attenuation filters.
- Establish relationship between percentage data rejected and magnitude of motion correction.
- For historic data without mru, infer motion correction from percentage data retained.



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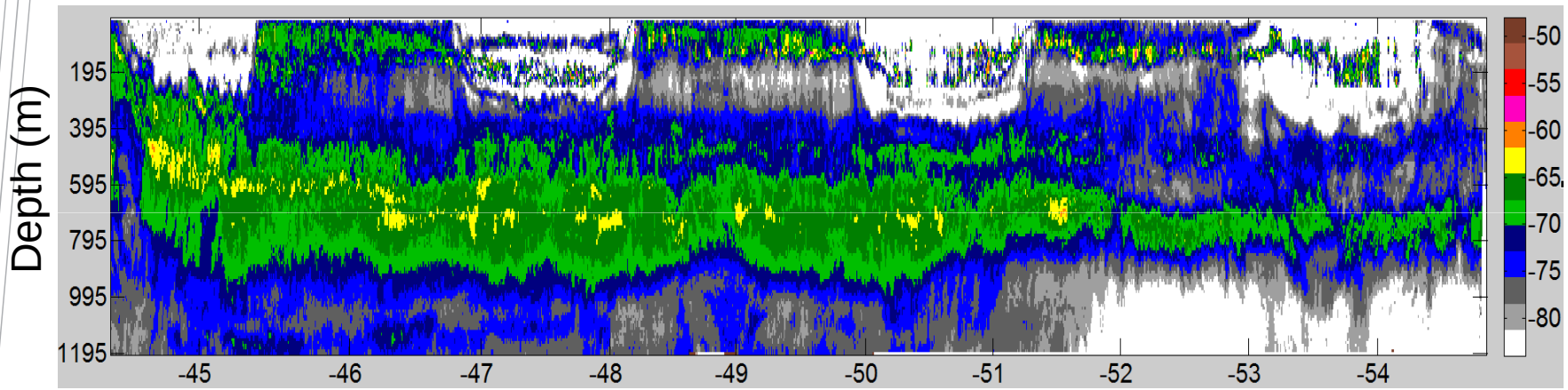
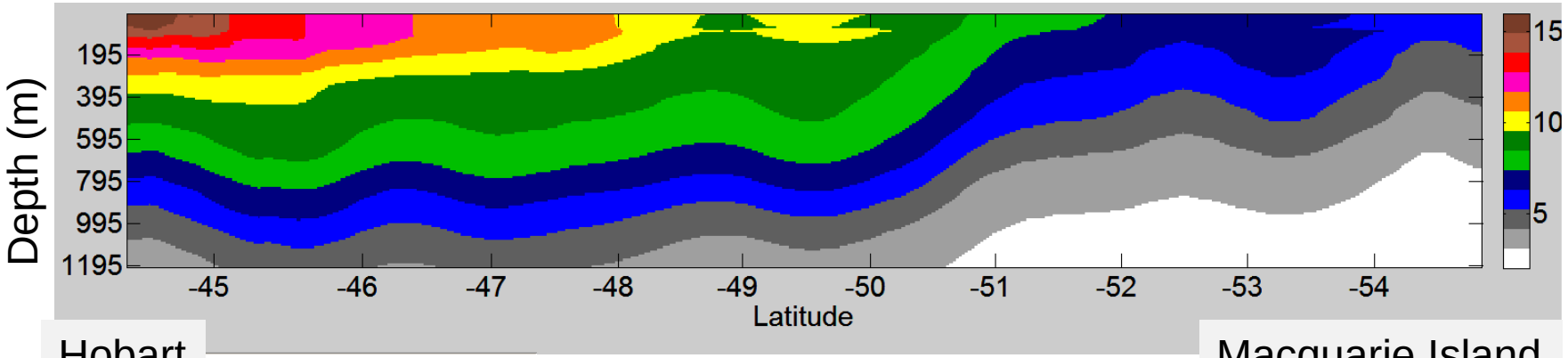
Corrections for environmental conditions

Open-ocean transects may pass through very different water masses.

FV Janas – Hobart to 55 degrees South



Along-transect temperature (synTS model)



Hobart

Macquarie Island

Corrections for environmental conditions

- Link open-ocean acoustic transect positions to satellite adjusted climatology model (synTS)
- Calculate absorption and sound speed
- Calculate Sv' (corrected Sv)

$$Sv' = Sv + 30 * \log\left(\frac{c}{co}\right) + 2 * R_o(\propto * \frac{c}{co} - \propto_o)$$

$\propto_o$ = *nominal absorption* c_o = *nominal sound speed*

c = *estimated sound speed* $\propto$ = *estimated absorption*

R_o = *nominal sample depth*

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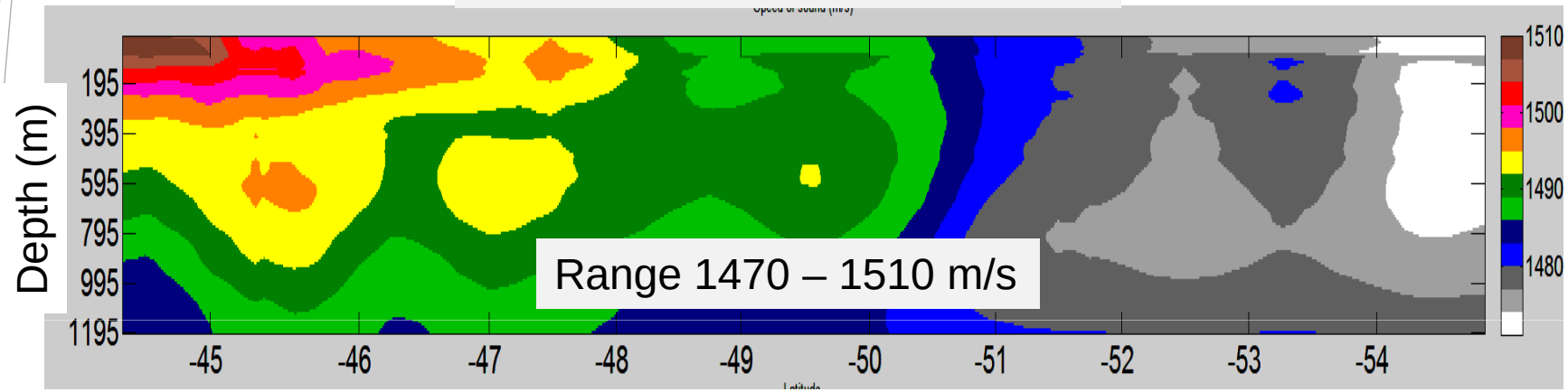
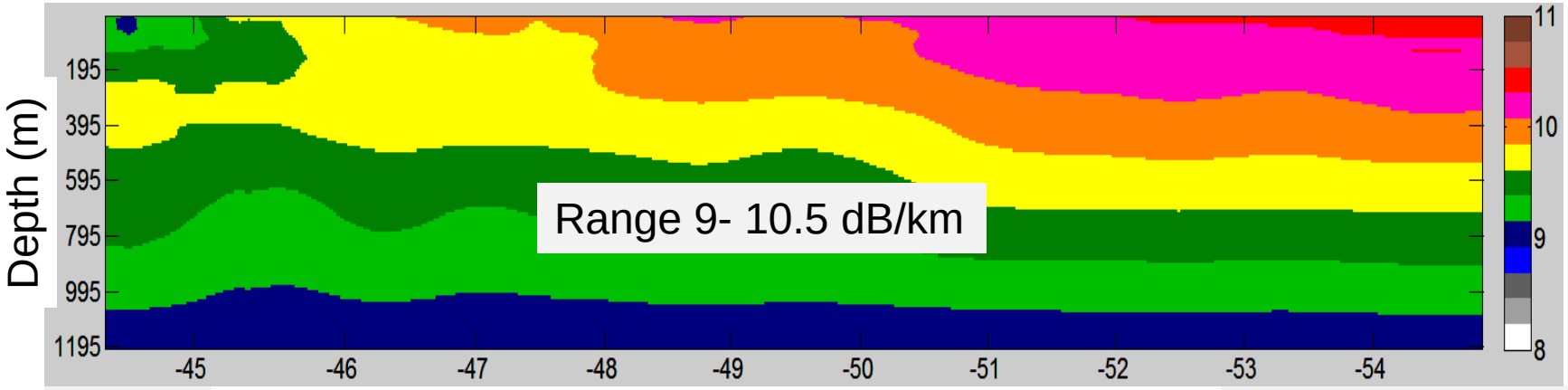
Corrections for environmental conditions
Absorption and sound speed estimates

Sound speed (Mackenzie, 1981)



Absorption (Francoise and Garrison 1982)



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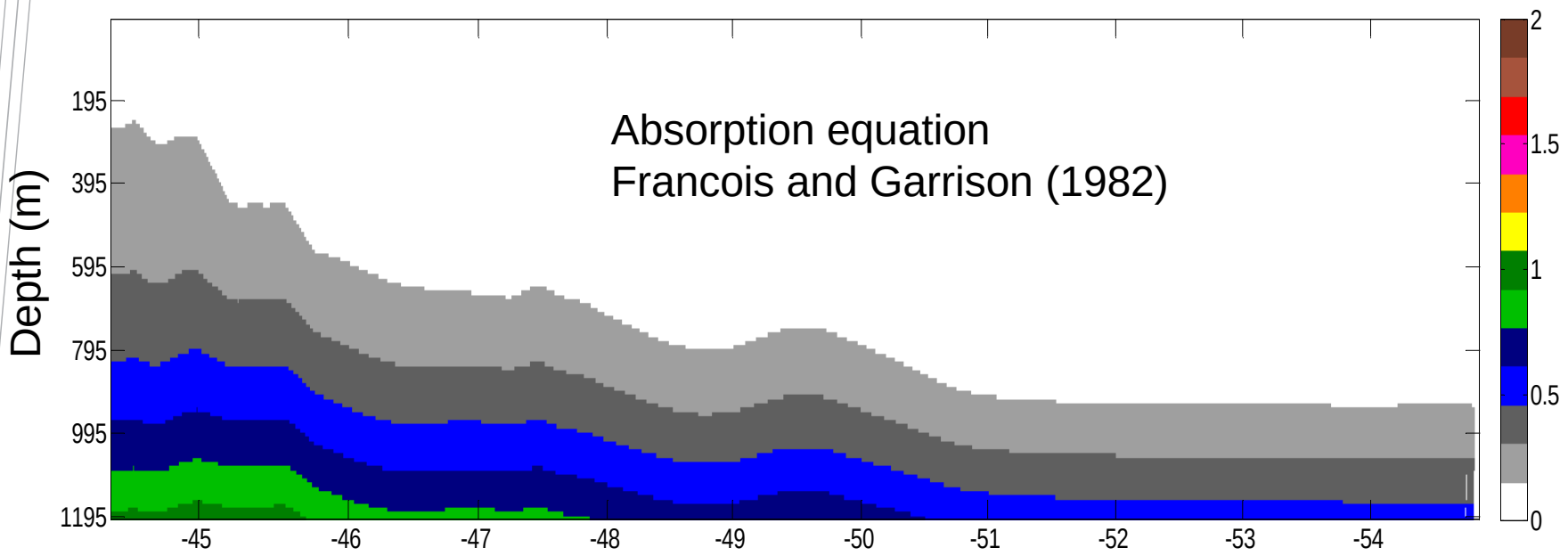
Corrections for environmental conditions
Absorption and sound speed estimates

Difference between corrected and uncorrected Sv in dB

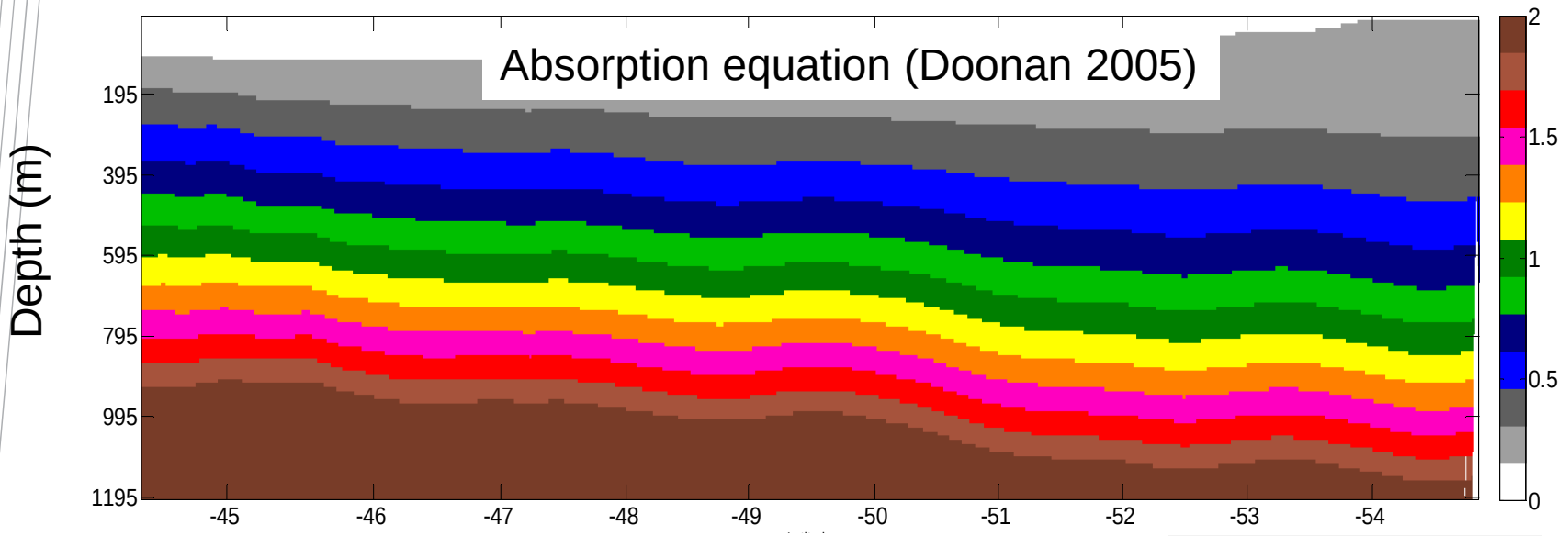


Changes in absorption and sound speed have opposing effects on Sv correction

→ Small difference between corrected and uncorrected Sv (typically <0.3 dB or less)

Corrections for environmental conditions
Absorption and sound speed estimates

Difference between corrected and uncorrected Sv in dB



Larger difference between corrected and uncorrected Sv (up to 2 dB)

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Corrections for environmental conditions Absorption and sound speed estimates

Conclusion:

Choice of absorption equation is having a larger effect than the changes temperature and salinity parameters

Summary

- Quality controlled data posted with first order errors removed

- Future data will be motion corrected, uncorrected historic data will require larger error term

- Environmental corrections sensitive to choice of equations

- Future work: Matrix of error estimates to accompany each Sv value