Acoustic investigation of bigeye tuna at Cross seamount

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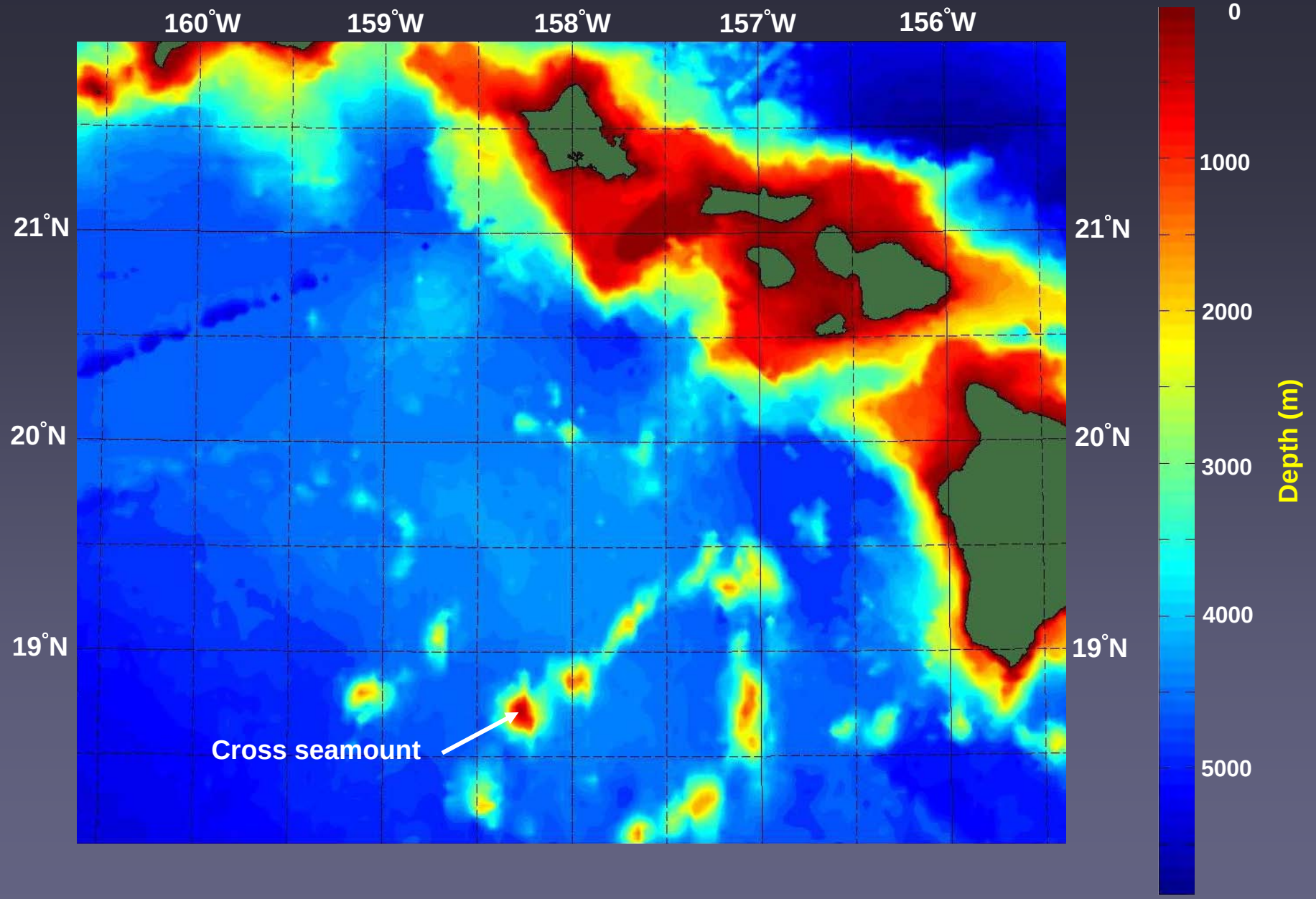
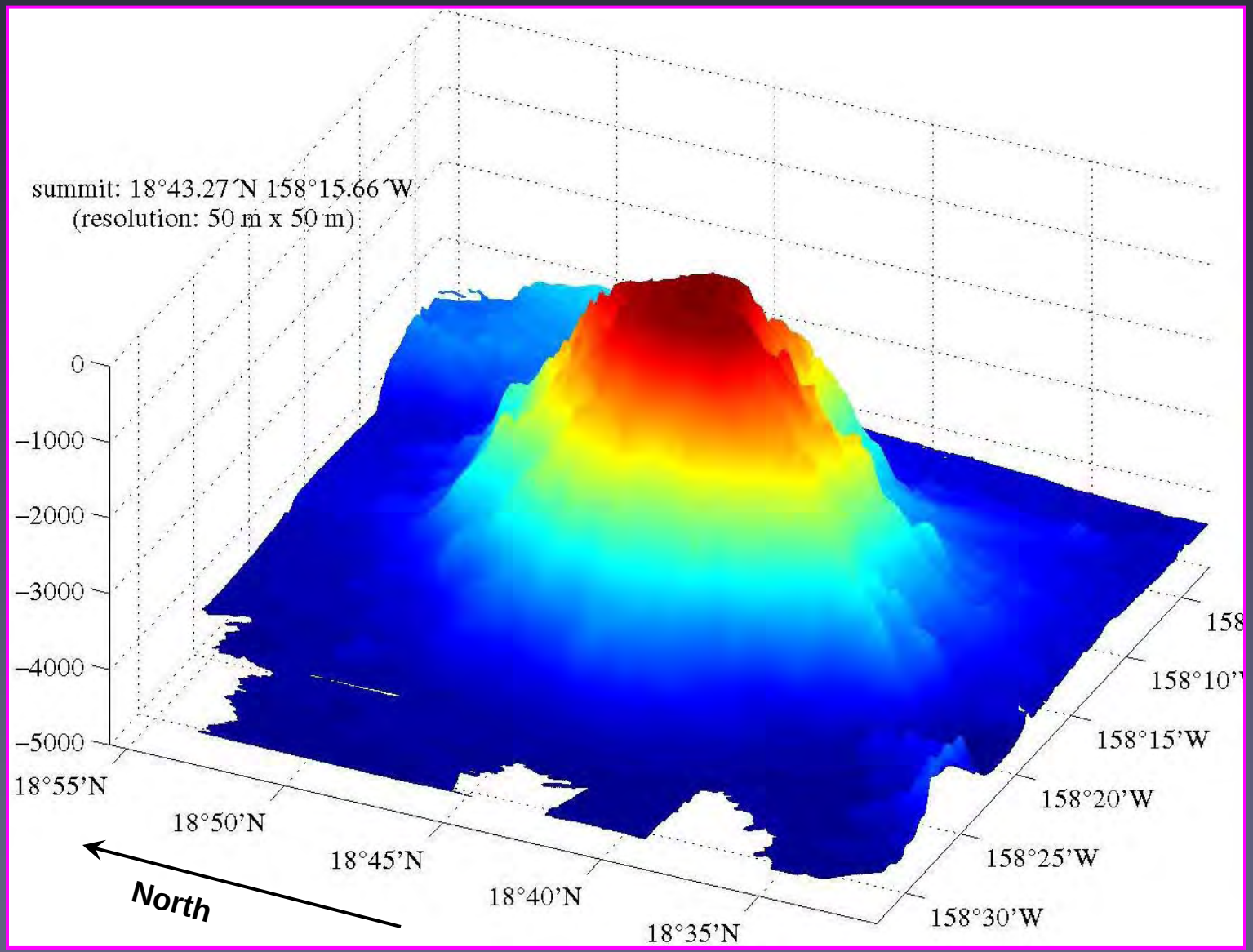
Motivation

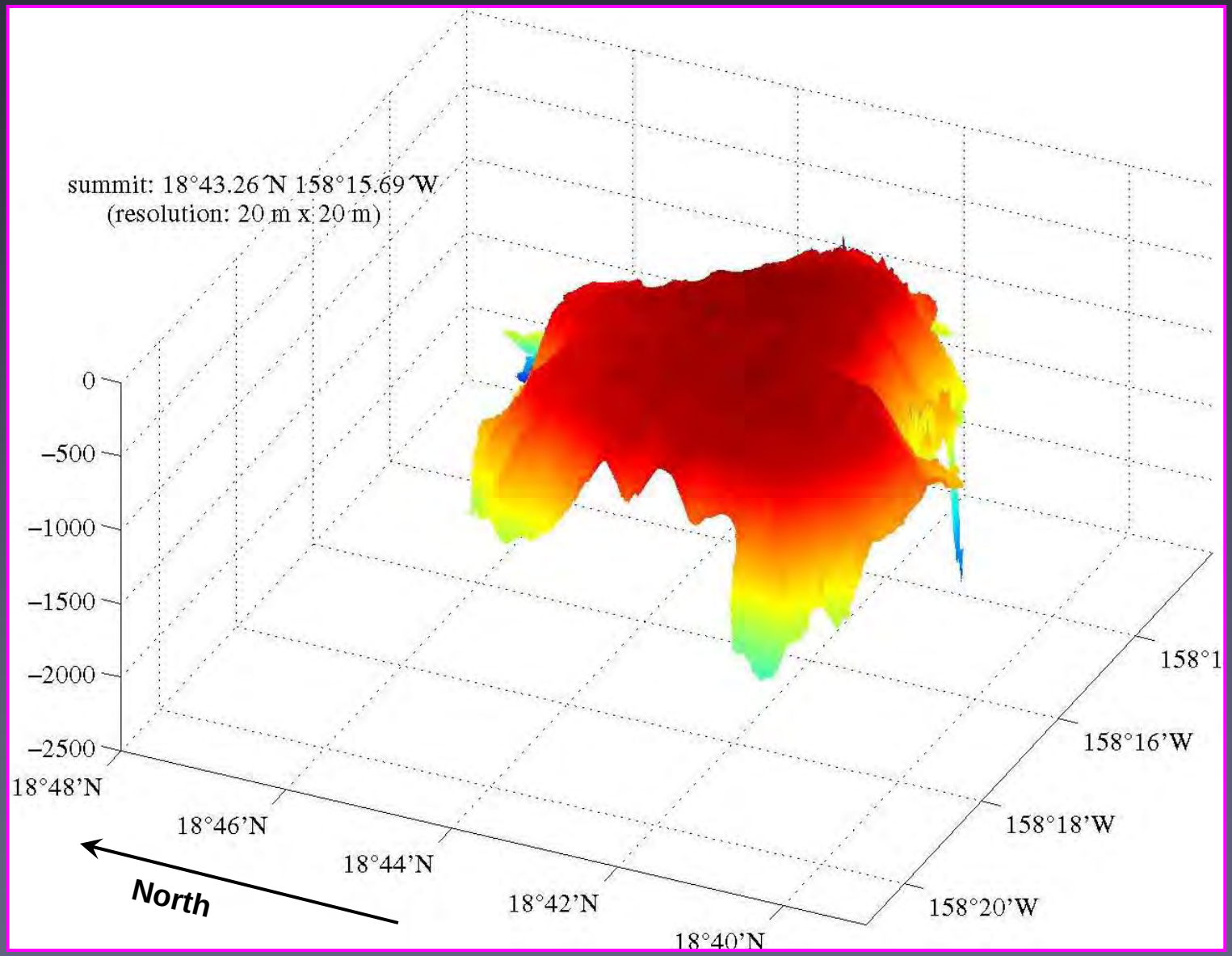
- Juvenile & subadult bigeye aggregates over Cross seamount – targeted by local fisheries
- Concerns: negative effects on recruitment due to moderate exploitation rates
- Increase knowledge of the spatiotemporal distribution and biomass of bigeye for management purposes


160˚W
159˚W
158˚W
157˚W
156˚W
21˚N
20˚N
19˚N
Cross seamount
0
1000
2000
3000
4000
5000
Depth (m)

Cross Seamount



Cross Seamount



Literature

62% BET, 28% YFT, 50 cm FL (main ref: Itano and Holland 2000)

100 – 150 m

74% BET, 15% YFT, 60+cm FL

11% POM 60 cm FL

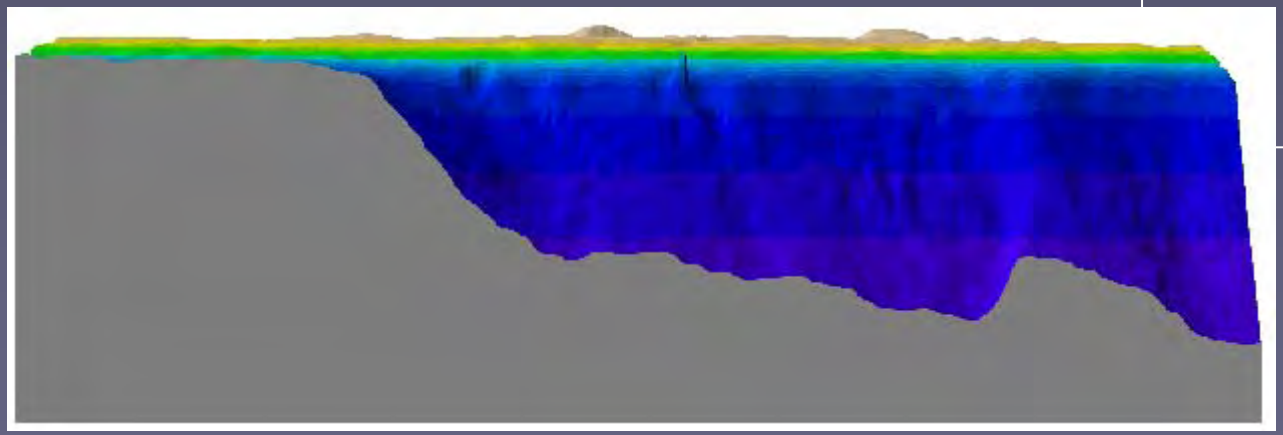
(main ref: Itano 2004)

~350 m

18% BET, 16% YFT, 80+cm FL

66% POM 60 cm FL

(main ref: Itano 2004)



Justification

- Relatively homogeneous environment
- Bigeye and other large fish have been extensively studied at Cross Seamount by
  - Experimental and commercial fishing
  - Tagging
- TS of bigeye (and other tunas) are known (IRD, Erwan Josse's lab*)

*Dr. Erwan Josse, Director of Fisheries Acoustic, IRD (Institute de recherche pour le développement)

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Expected Target Strength (TS)

TS of BET is ~ 5 dB higher than that of YFT of the same size (Bertrand et al., 1999)

$TS = a \log_{10} FL + b$ ⇄ BET → $a = 24.29$ $b = 73.31$
YFT → $a = 24.26$ $b = 80.62$


62% BET (50 cm FL) → -32 dB

28% YFT (50 cm FL) → - 38 dB

100 – 150 m



74% BET (60+cm FL) → -29 dB

15% YFT (60+cm FL) → -35 dB

11% POM (60 cm FL) → -36 -- -32 dB ??

~350 m

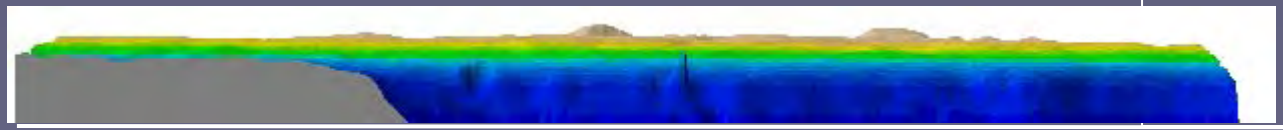


18% BET (80+cm FL) → -27 dB

16% YFT (80+cm FL) → -32 dB

66% POM (60 cm FL) →

-36 -- -32 dB ??



NOAA Ship *Oscar Elton Sette*

cruises:

2005 April – May
2007 April – May
2008 April – May

Transducer Pod

Acoustic Study of Bigeye Tuna

- **2005 Apr-May**
  - preliminary cruise
    - investigation of bigeye targets based on acoustic descriptors (aggregation shape, depth, density, target strength – Josse*)
- **2007 Apr-May**
  - survey strategy and design (Mathieu Doray) based on knowledge from
    - preliminary cruise
    - experimental and commercial fishing data
    - literature
  - adopted from design developed to estimate tuna biomass at FADS (Josse et al., 1999)
- **2008 Apr-May**
  - improve survey strategy and design based on 2007 observations

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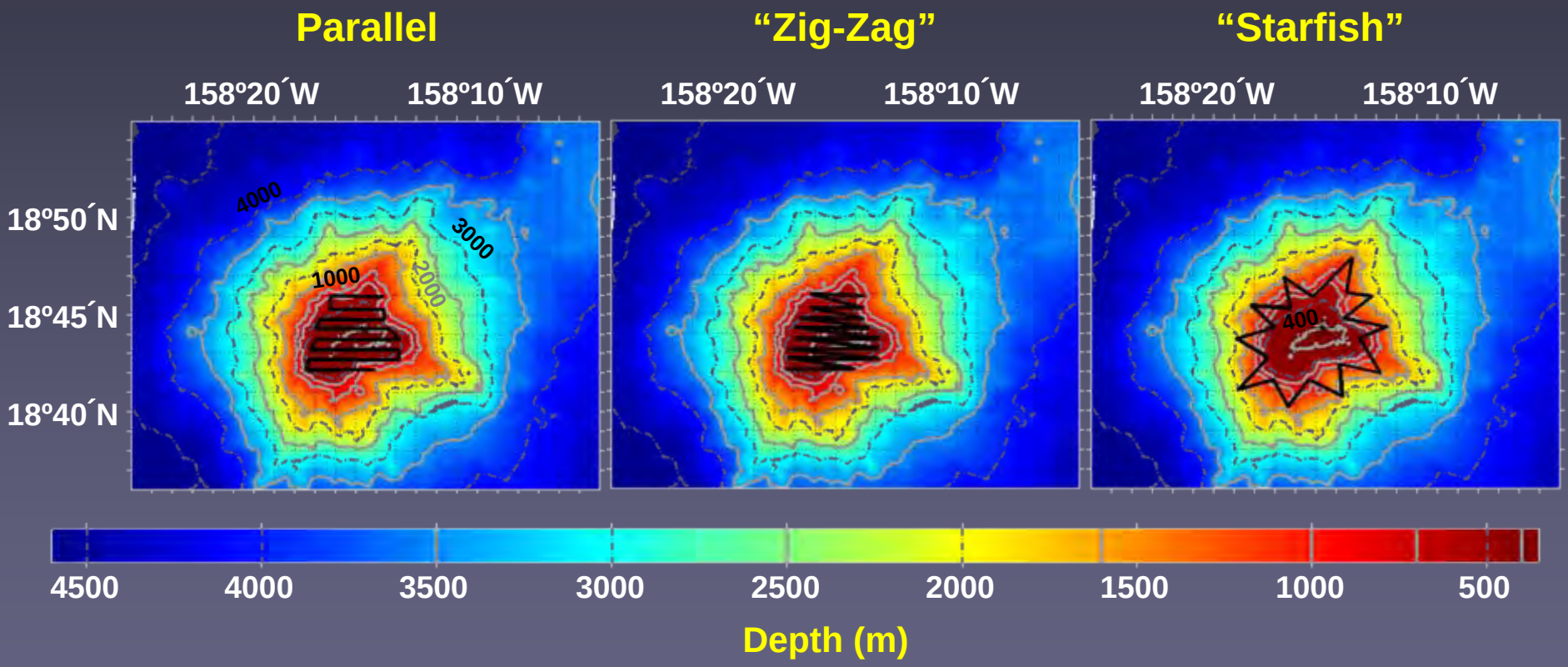
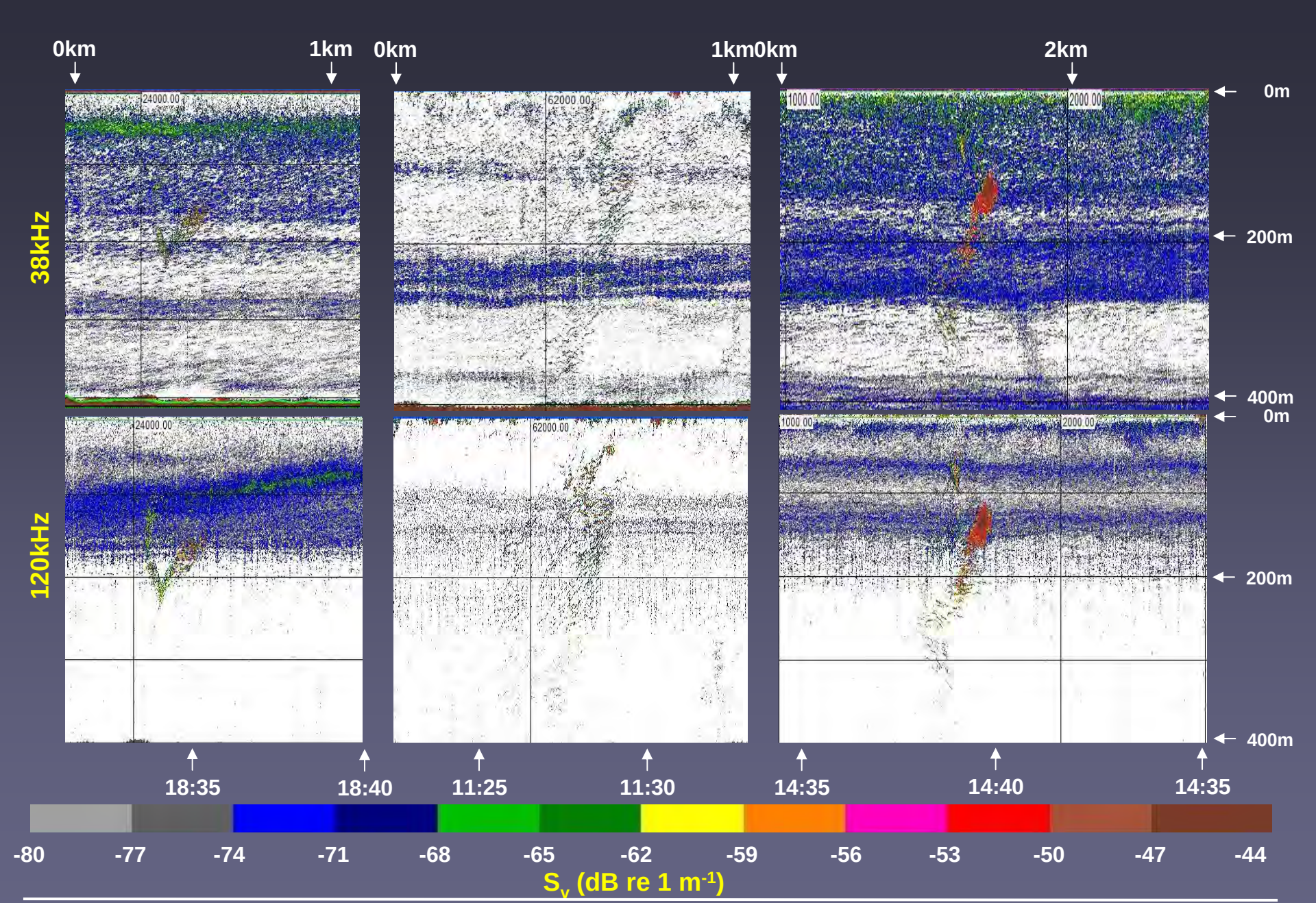
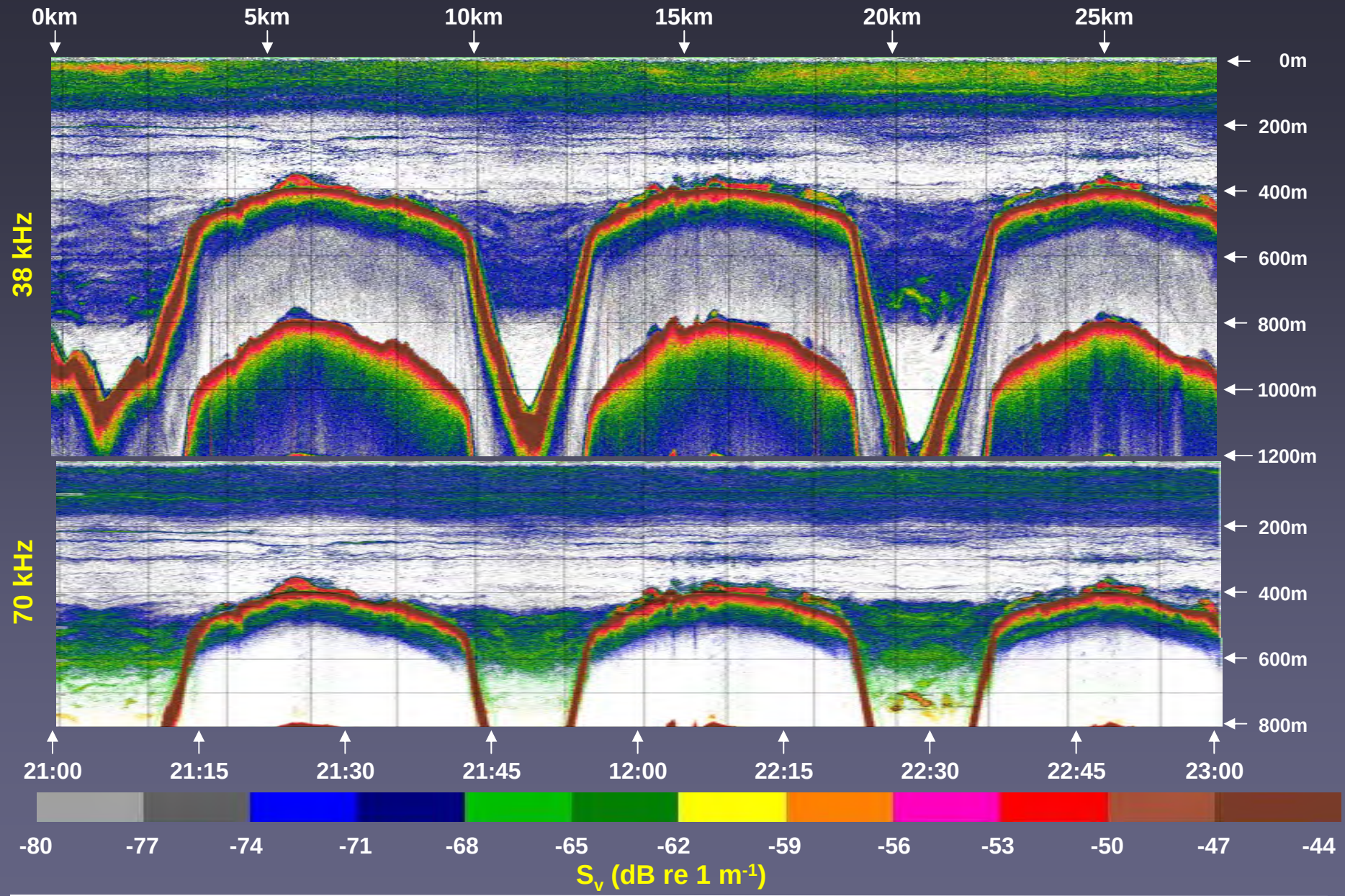
Survey Designs



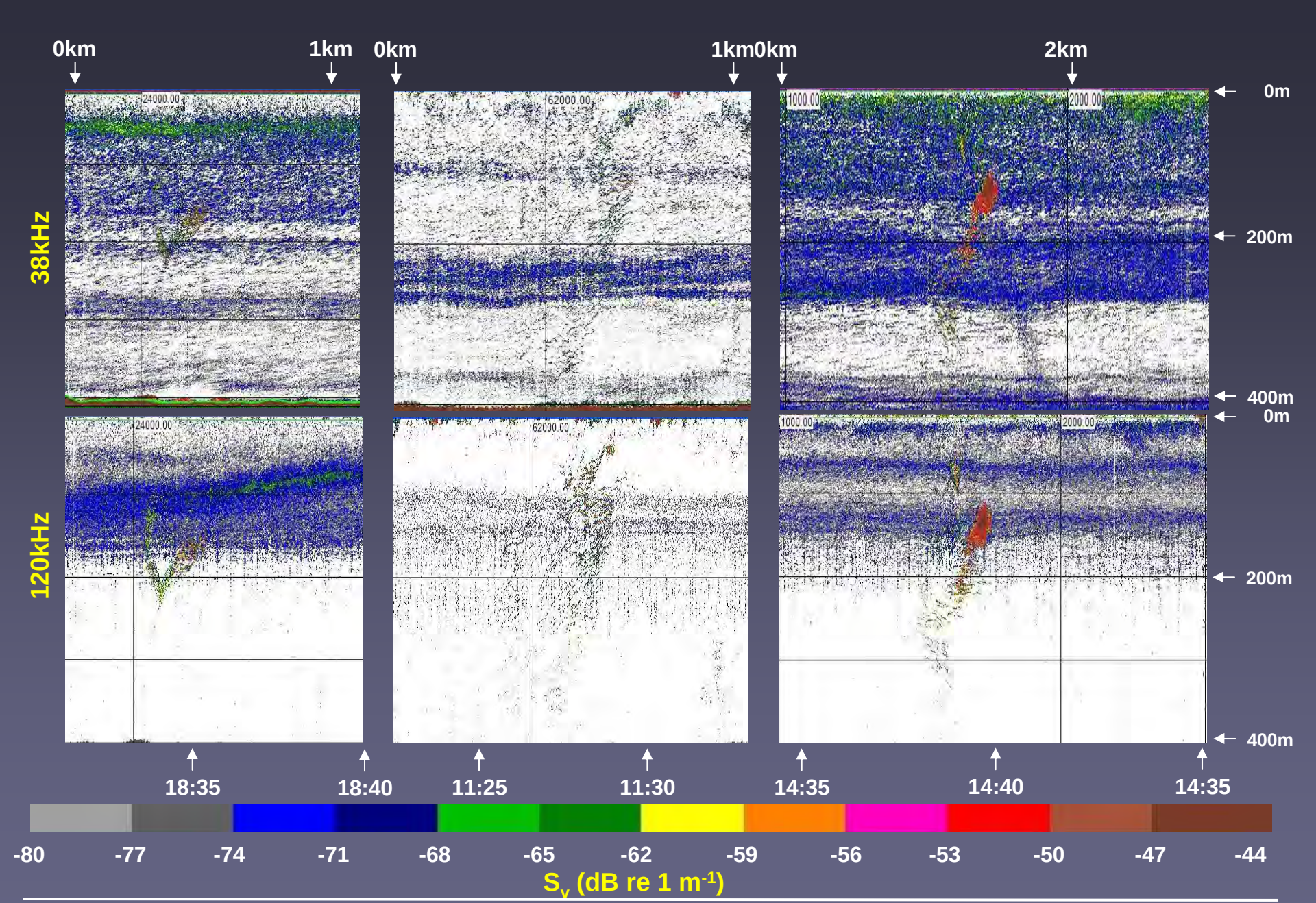

0km
1km
0km
1km0km
2km
38kHz
120kHz
0m
200m
400m
0m
200m
400m
18:35
18:40
11:25
11:30
14:35
14:40
14:35
-80
-77
-74
-71
-68
-65
-62
-59
-56
-53
-50
-47
-44
S_v (dB re 1 m^{-1})

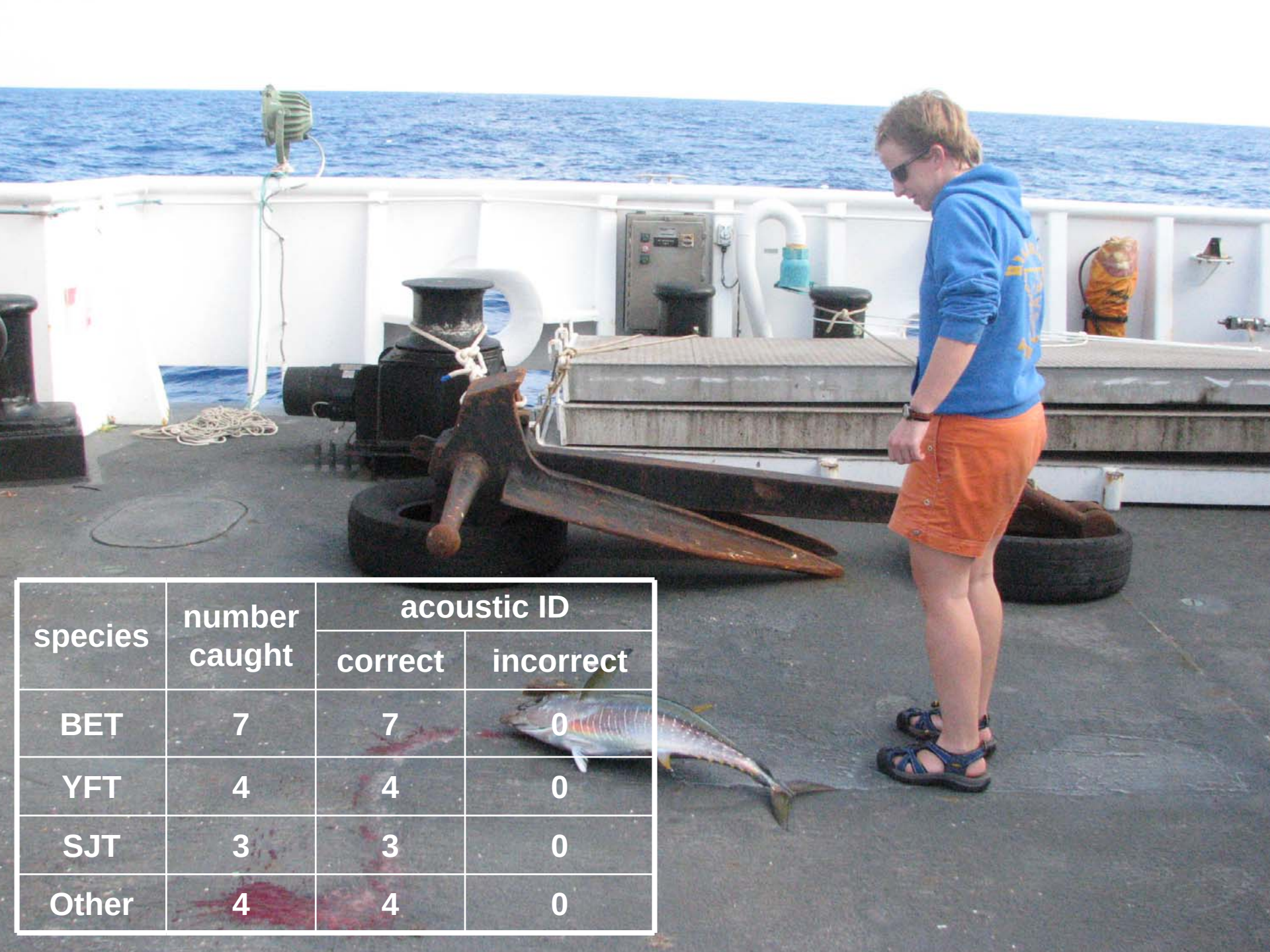
Acoustic backscatter at Cross Seamount



Pacific Islands Fisheries Science Center
Ecosystems and Oceanography Division

Pelagic Fisheries Research Program


0km
1km
0km
1km0km
2km
38kHz
120kHz
0m
200m
400m
0m
200m
400m
18:35
18:40
11:25
11:30
14:35
14:40
14:35
-80
-77
-74
-71
-68
-65
-62
-59
-56
-53
-50
-47
-44
S_v (dB re 1 m^{-1})

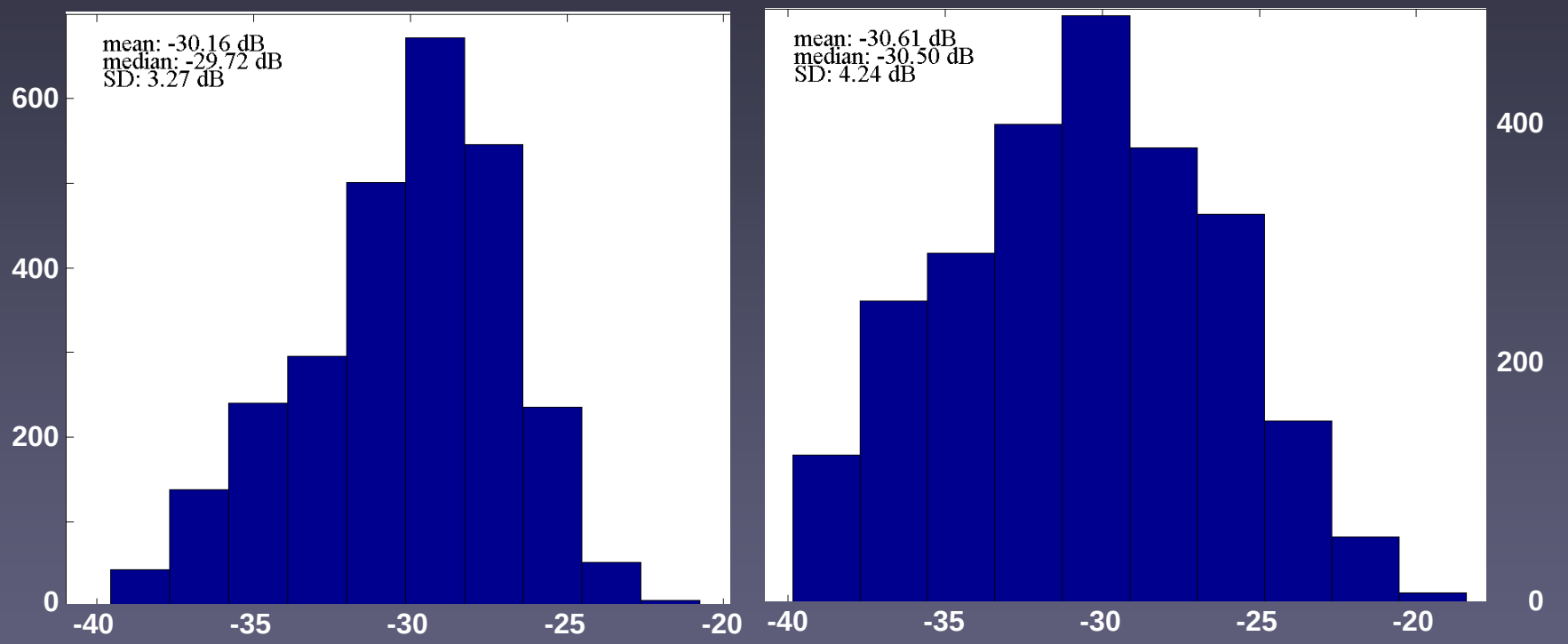


species	number caught	acoustic ID	
		correct	incorrect
BET	7	7	0
YFT	4	4	0
SJT	3	3	0
Other	4	4	0

TS from tracks

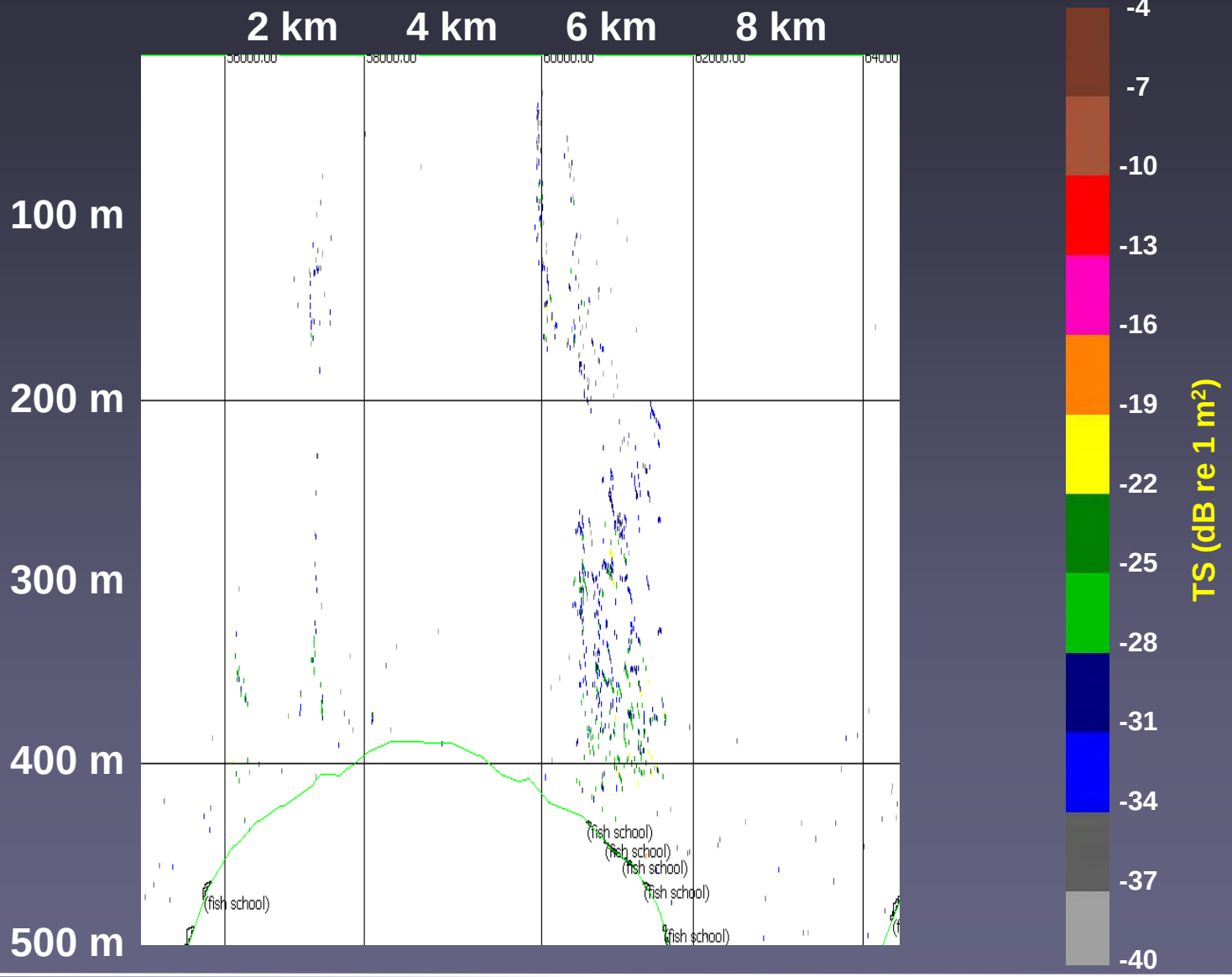
-30.16 dB ≡ 59.75 cm FL (99.42 YF)
2007

-30.61 dB ≡ 57.26 cm FL (95.42 YF)
2008

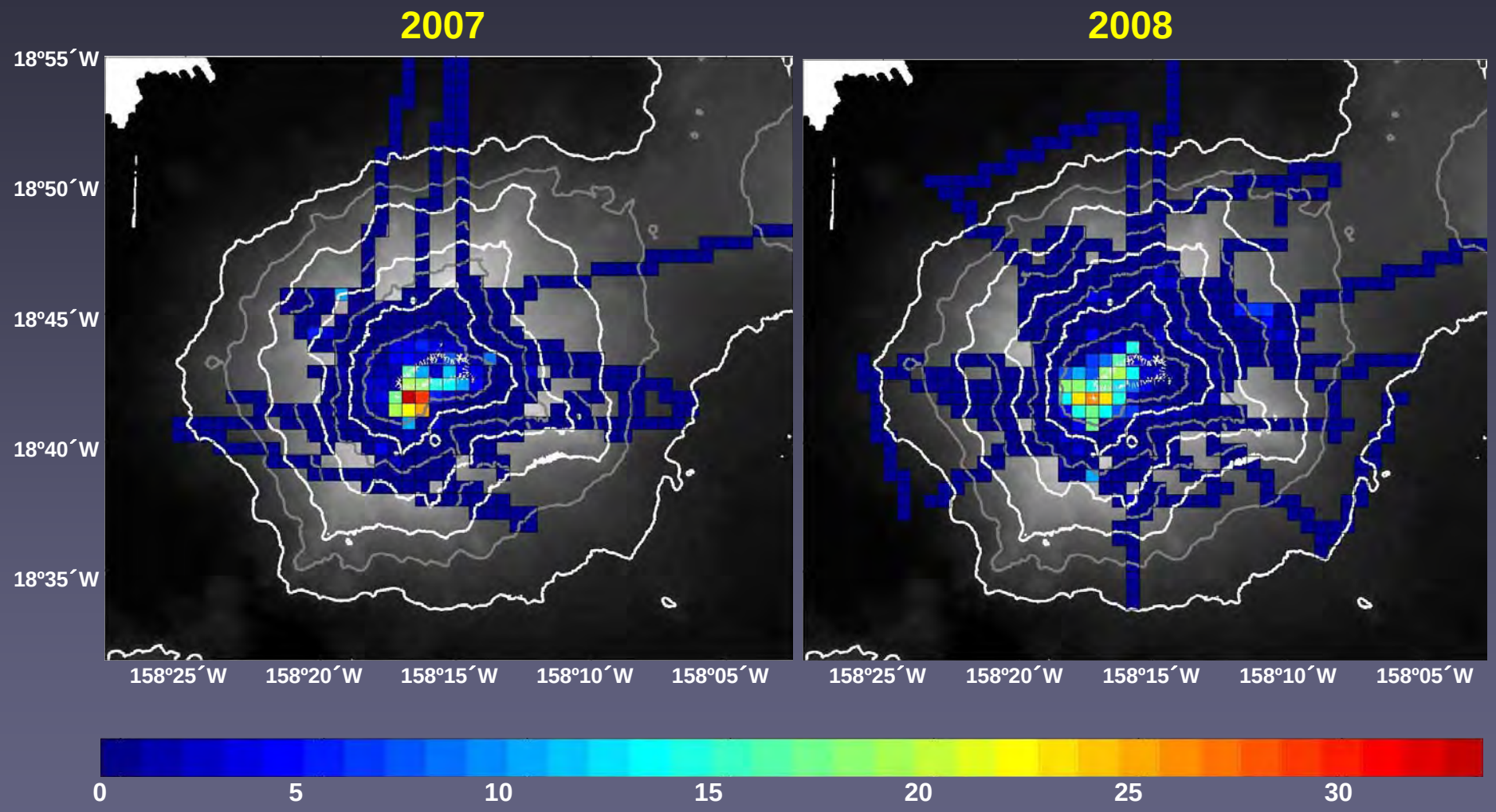


TS (dB re 1 m²)

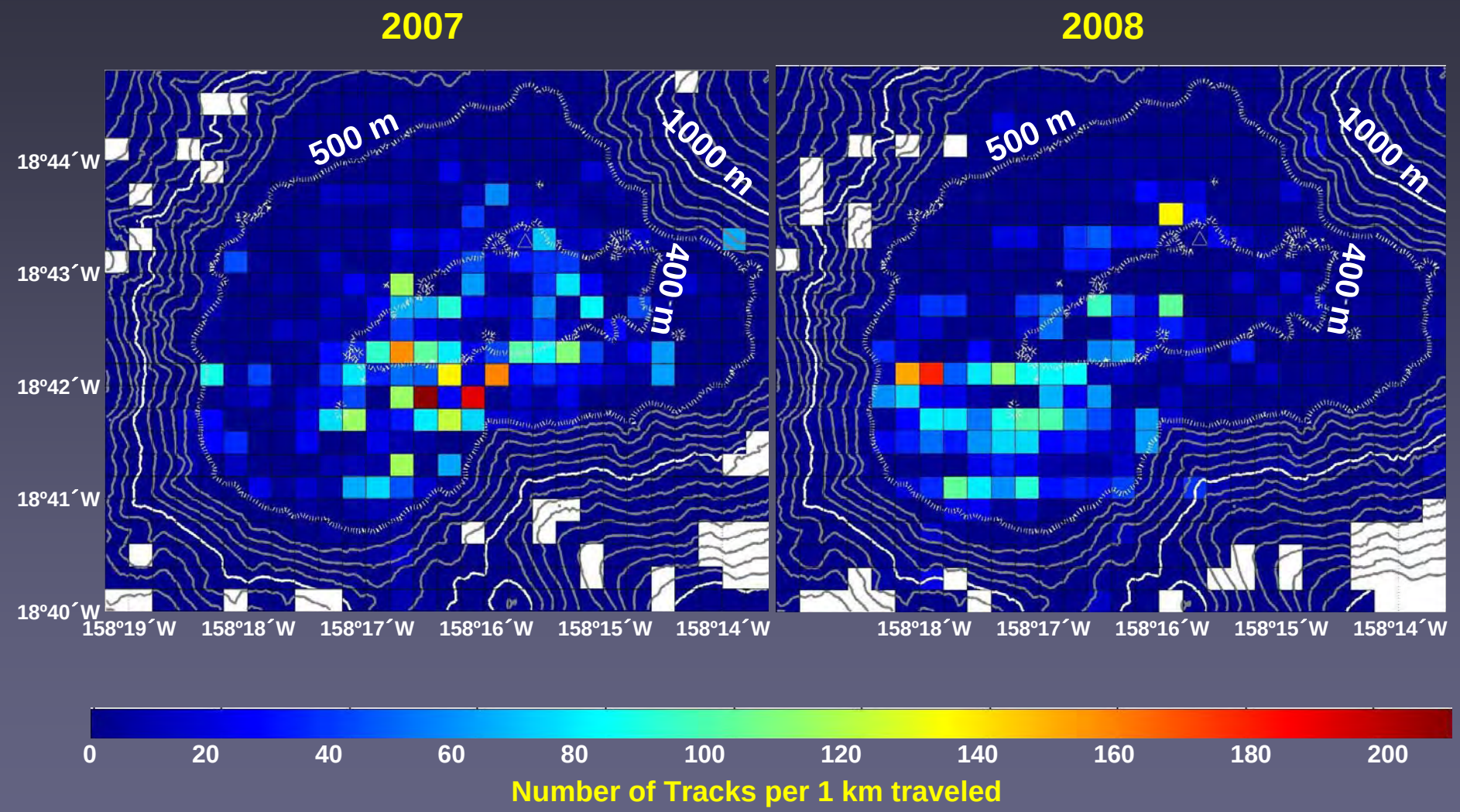
TS Depth Dependence



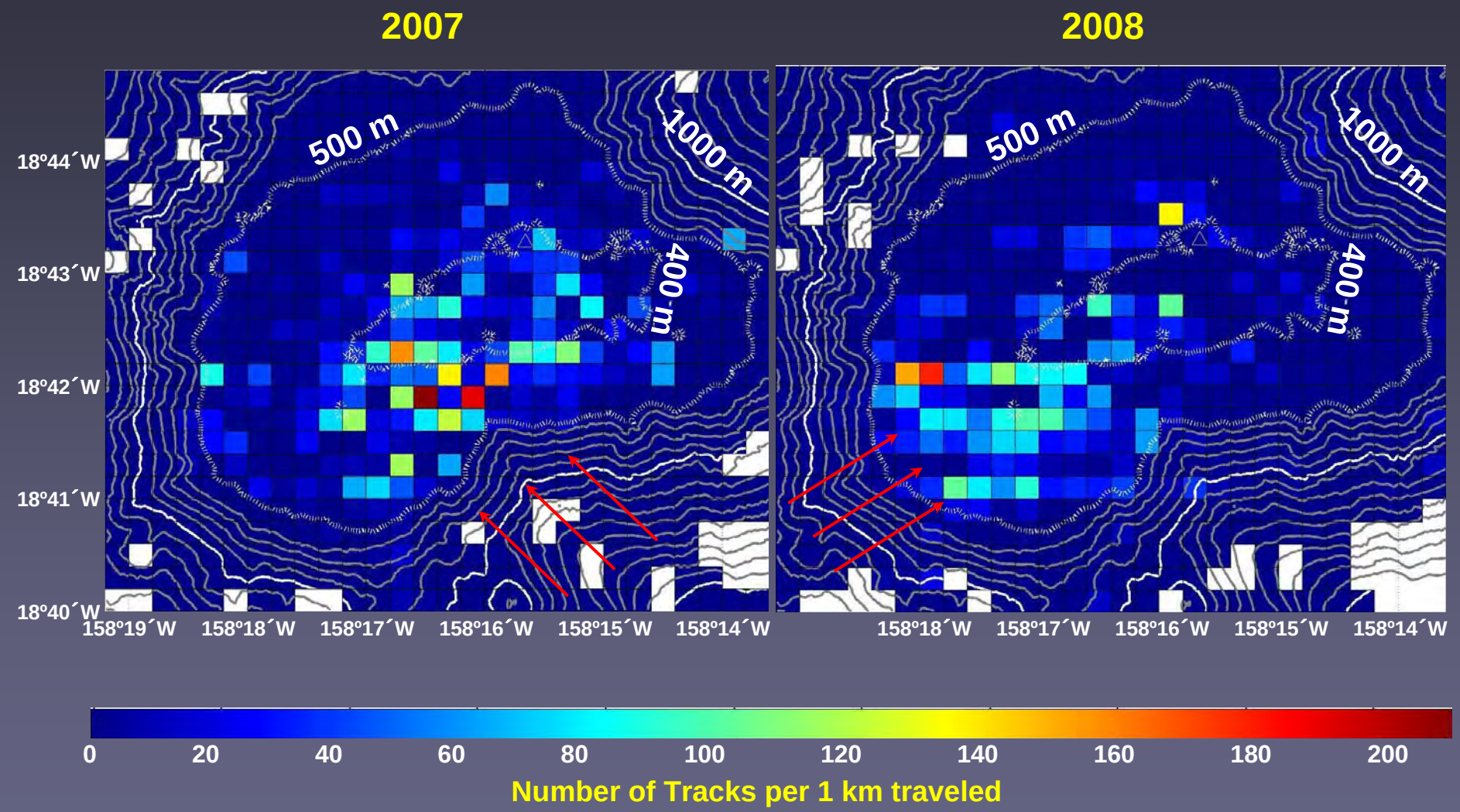
Number of Tracks Consistent with those of Bigeye



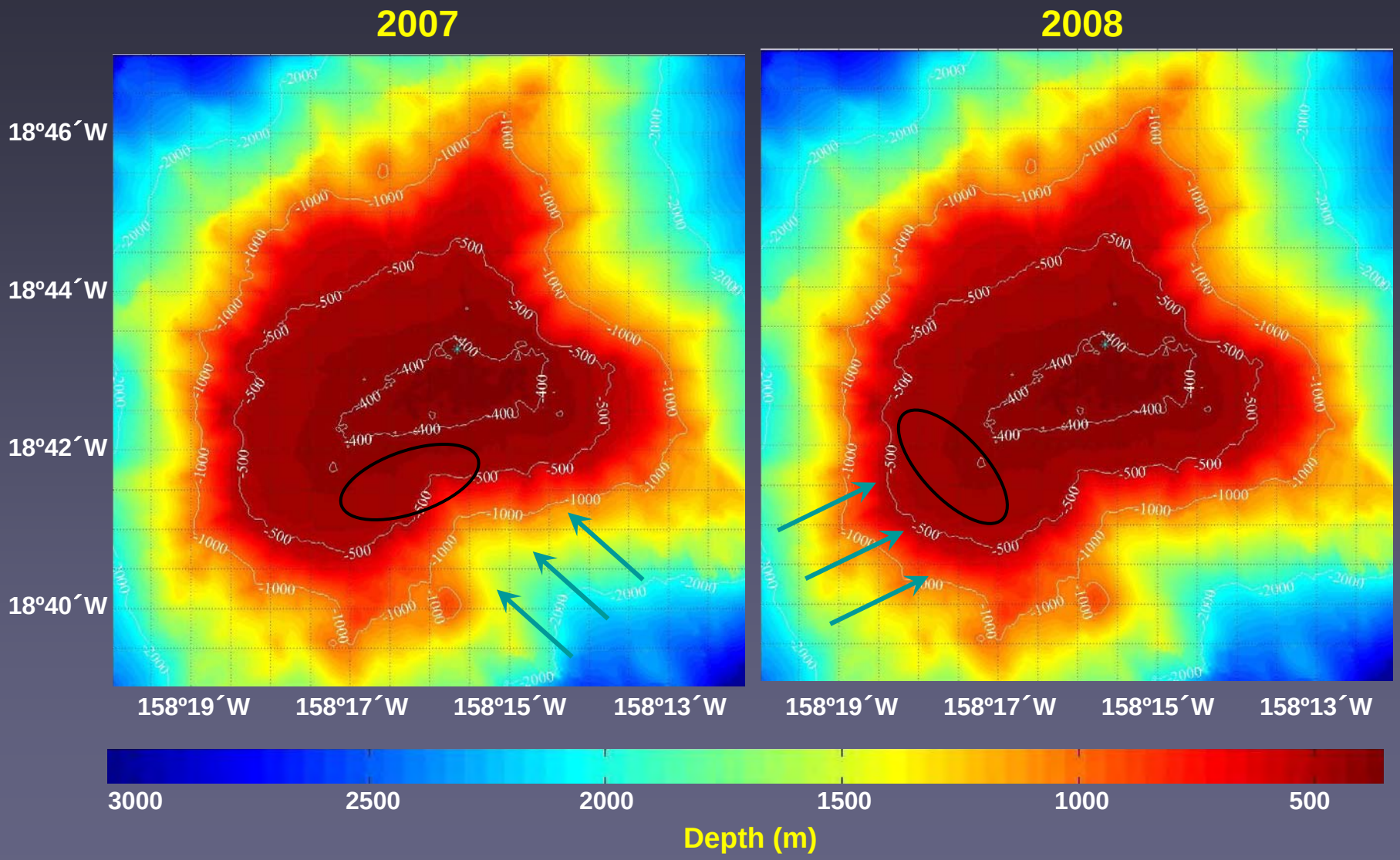
Number of Tracks Consistent with those of Bigeye



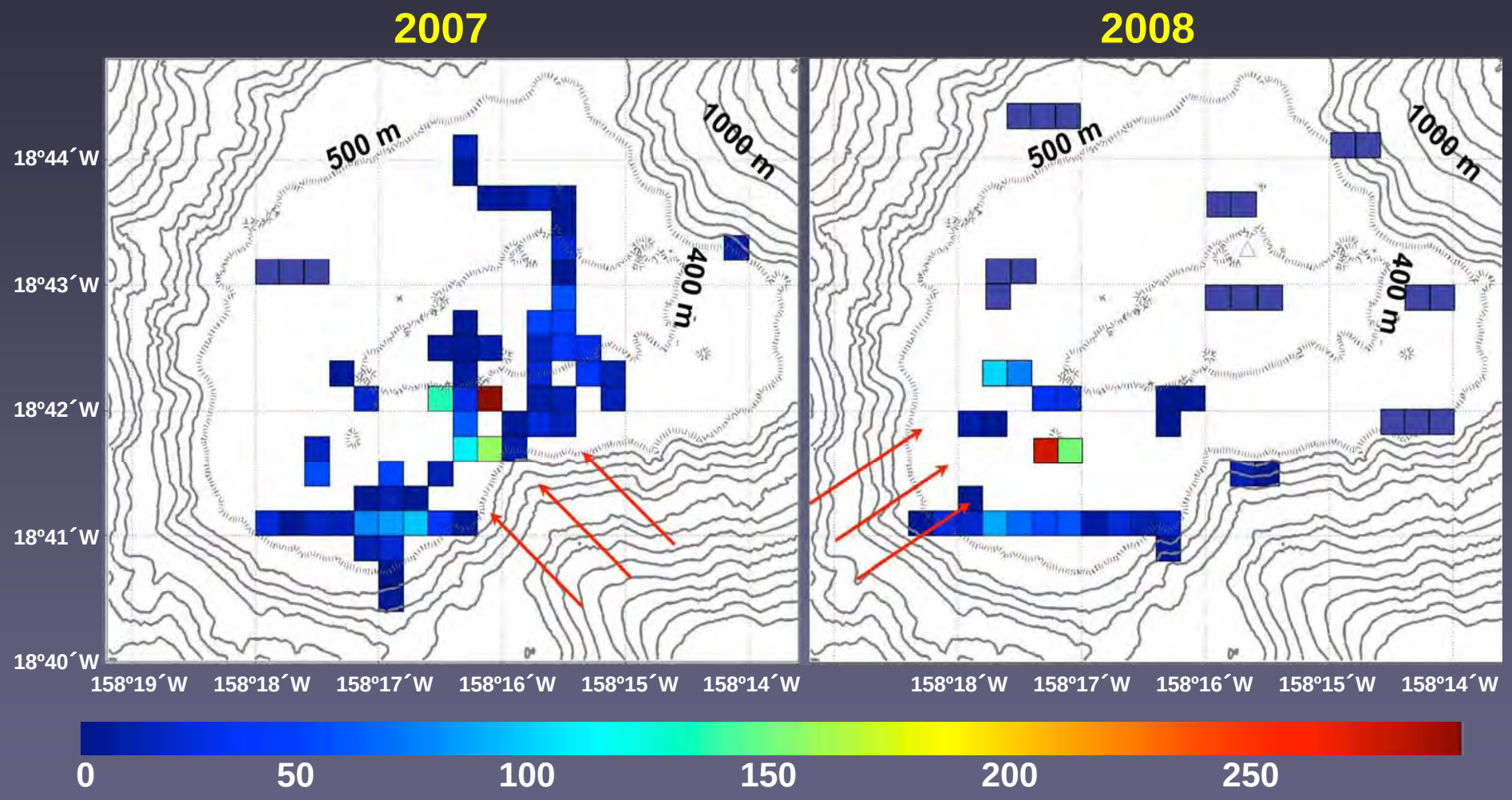
Number of Tracks Consistent with those of Bigeye

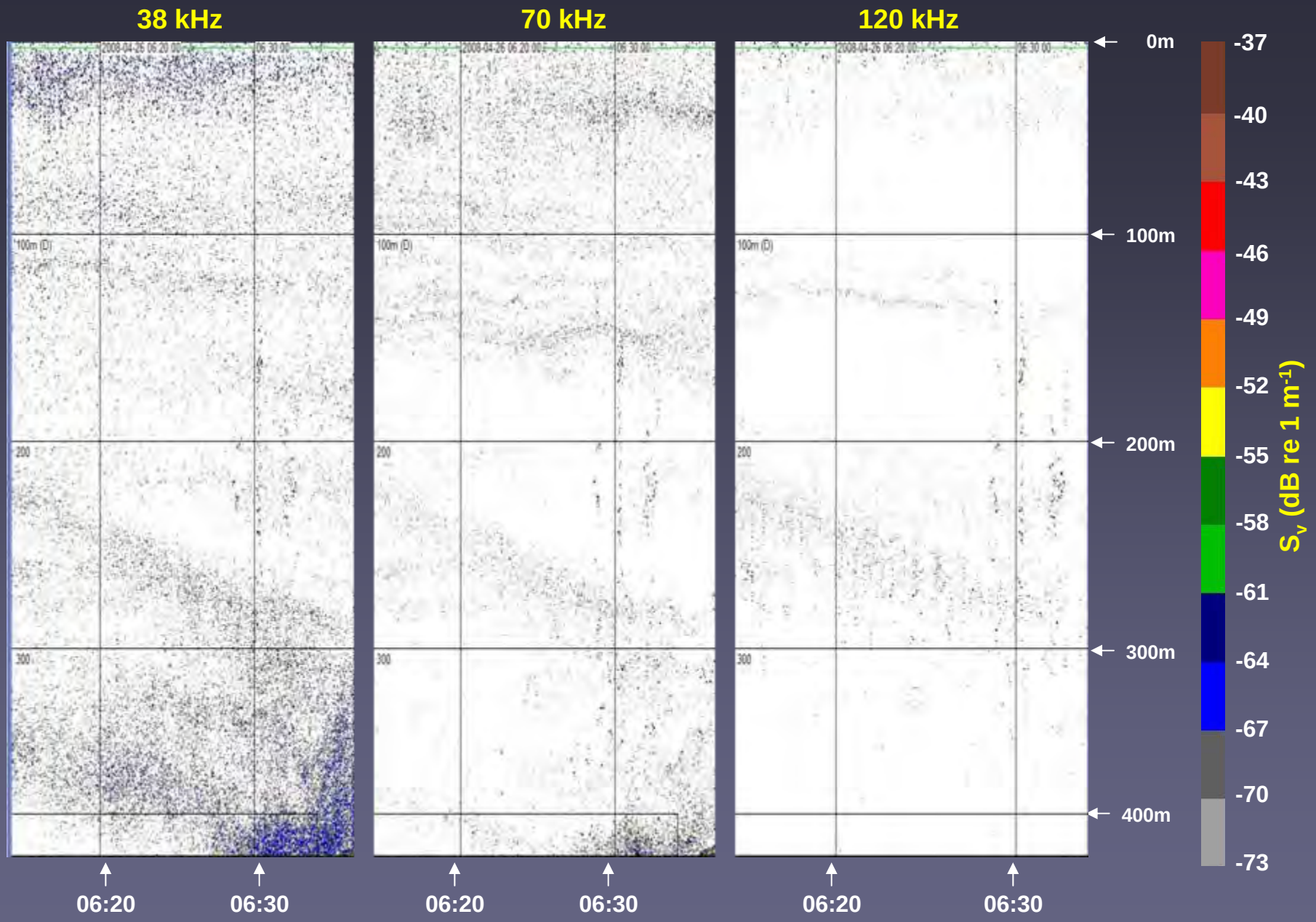


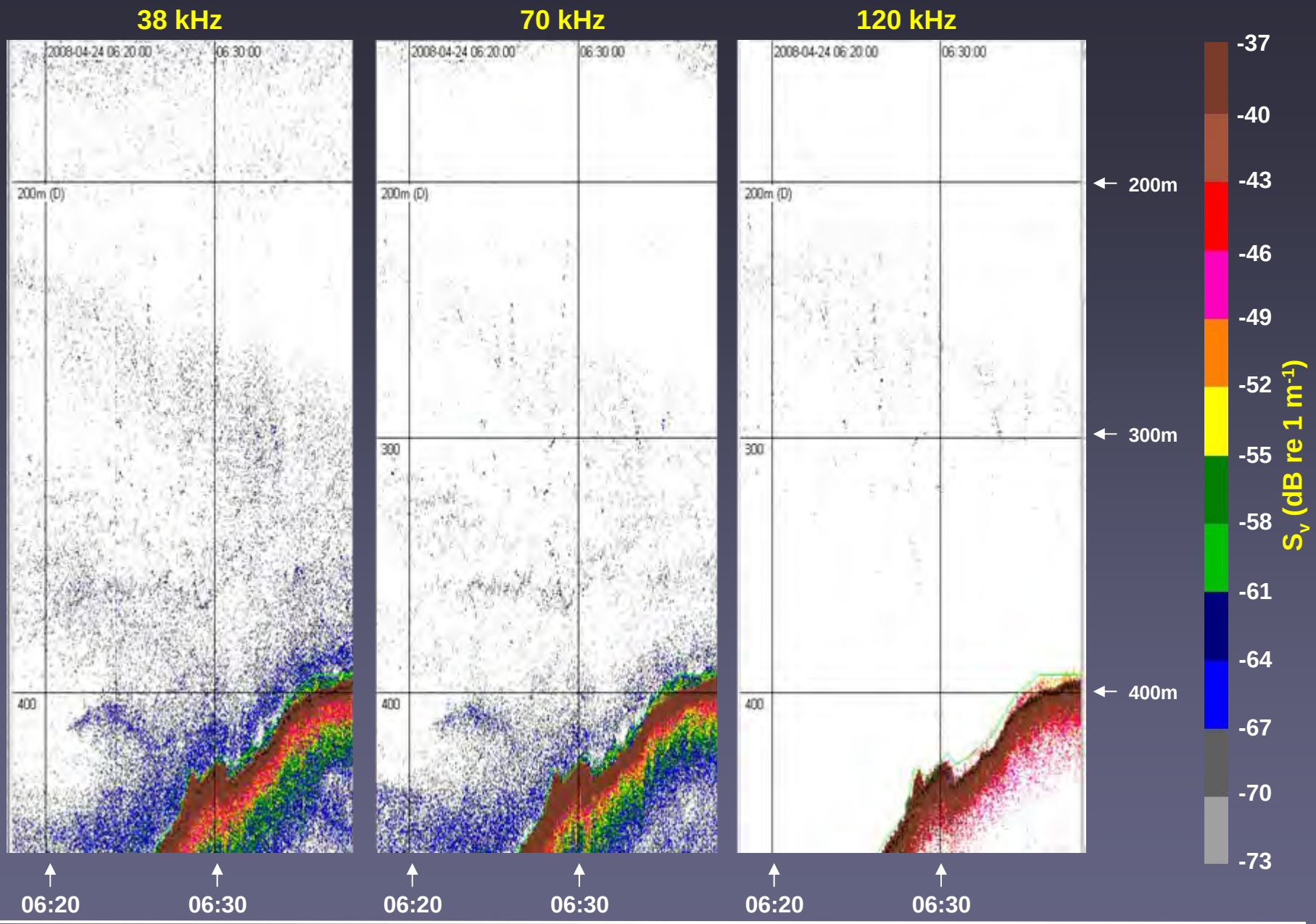
05:00 – 07:00


2007
2008
18°46´W
18°44´W
18°42´W
18°40´W
158°19´W
158°17´W
158°15´W
158°13´W
3000
2500
2000
1500
1000
500
Depth (m)

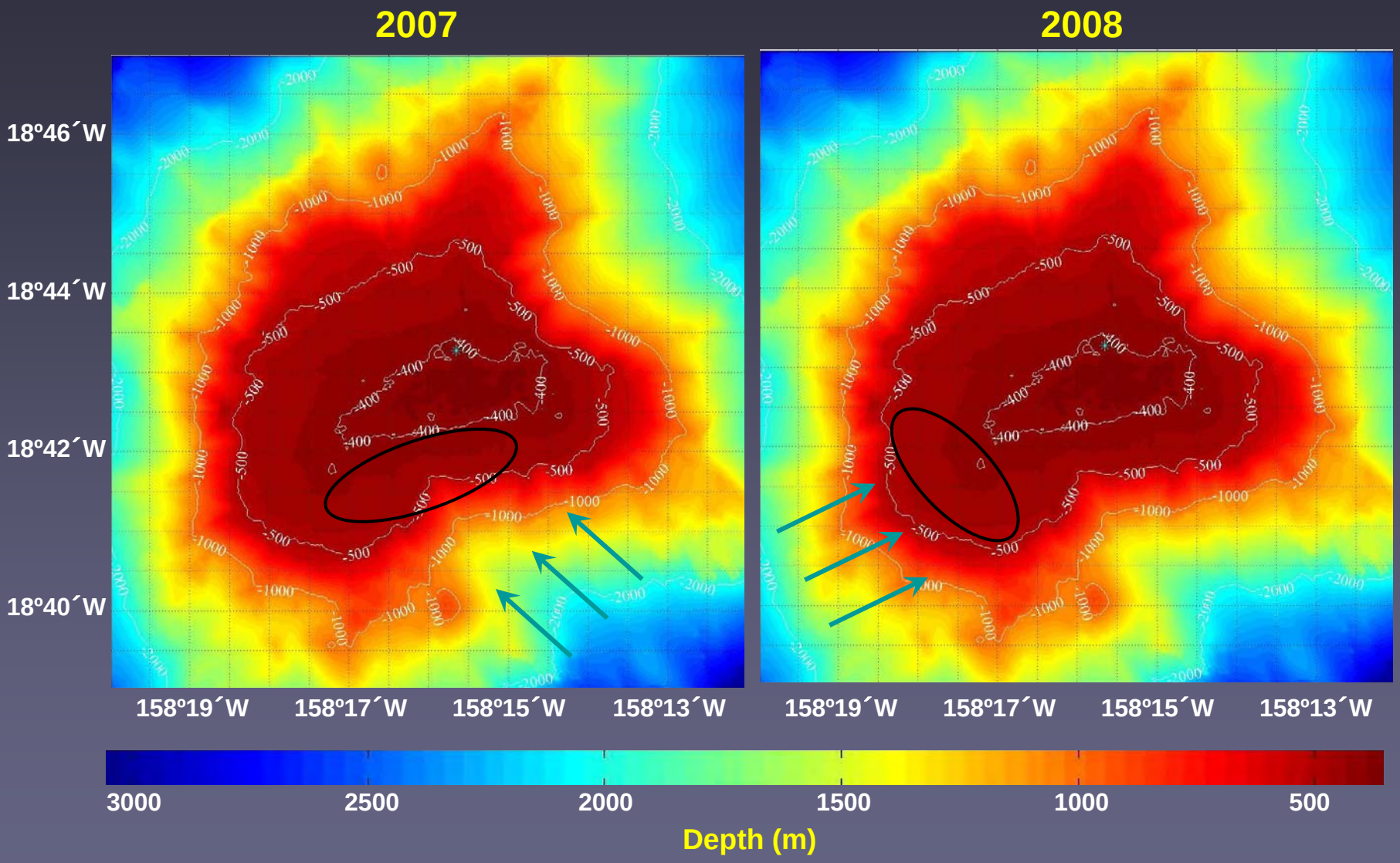
06:00 – 07:00


2007
2008
500 m
1000 m
400 m
18°44´W
18°43´W
18°42´W
18°41´W
18°40´W
158°19´W
158°18´W
158°17´W
158°16´W
158°15´W
158°14´W
0
50
100
150
200
250
Number of tracks per 1 km traveled

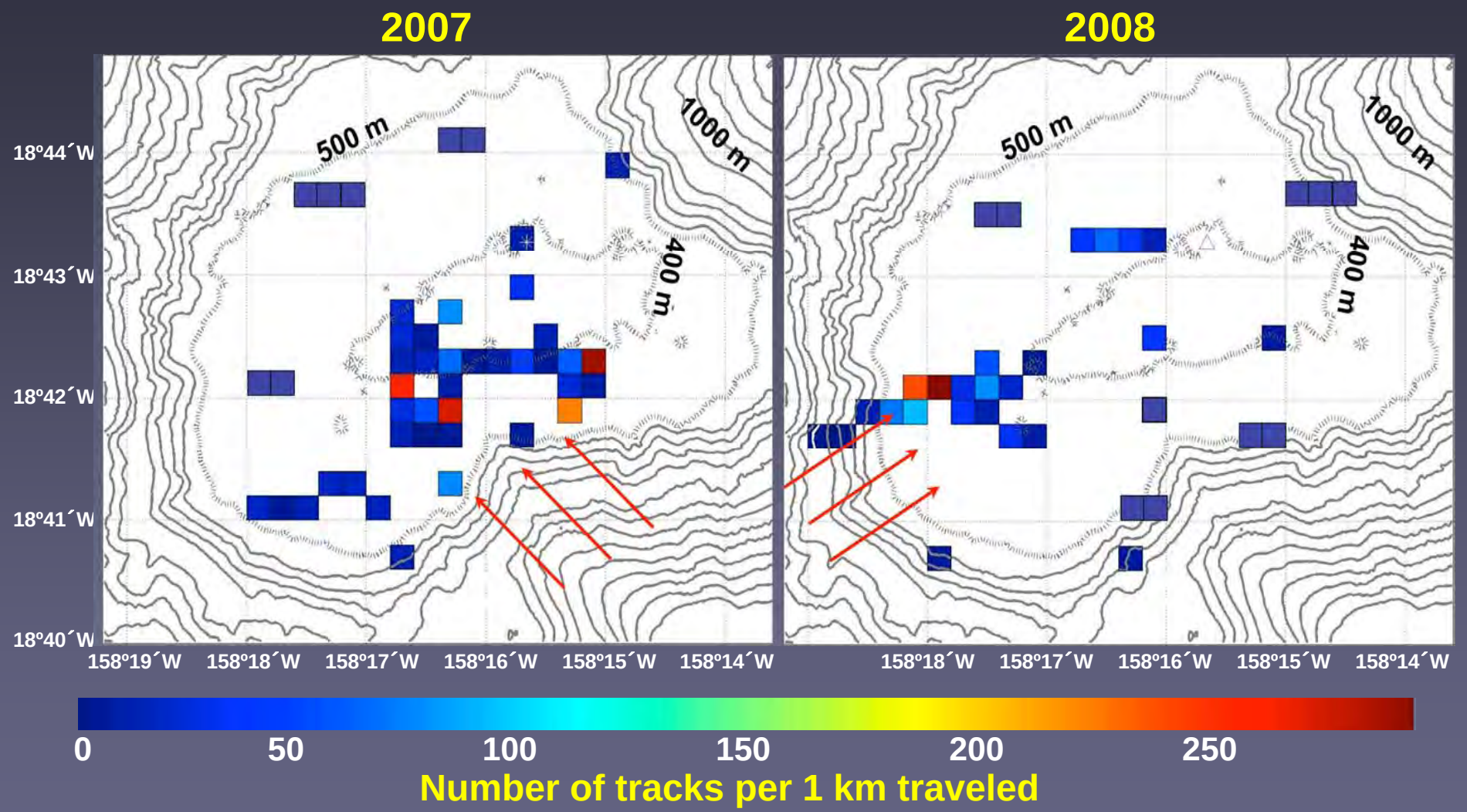

38 kHz
70 kHz
120 kHz
0m
100m
200m
300m
400m
-37
-40
-43
-46
-49
-52
-55
-58
-61
-64
-67
-70
-73
S_v (dB re 1 m^{-1})
06:20
06:30
06:20
06:30
06:20
06:30

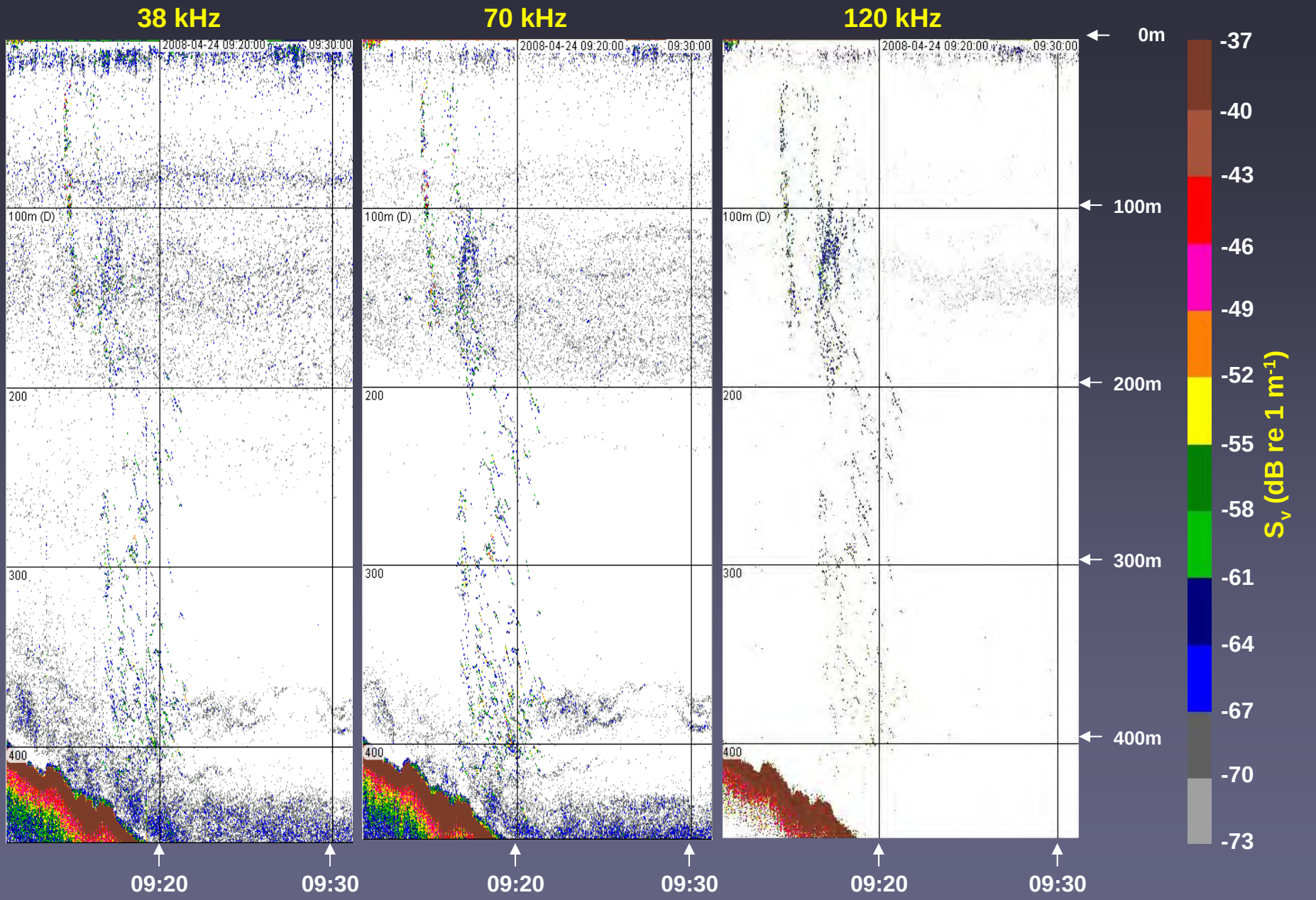

38 kHz
70 kHz
120 kHz
2008-04-24 06:20:00
06:30:00
200m (D)
300
400
200m
300m
400m
-37
-40
-43
-46
-49
-52
-55
-58
-61
-64
-67
-70
-73
S_v (dB re 1 m^{-1})
06:20
06:30
06:20
06:30
06:20
06:30

07:00 – 10:00

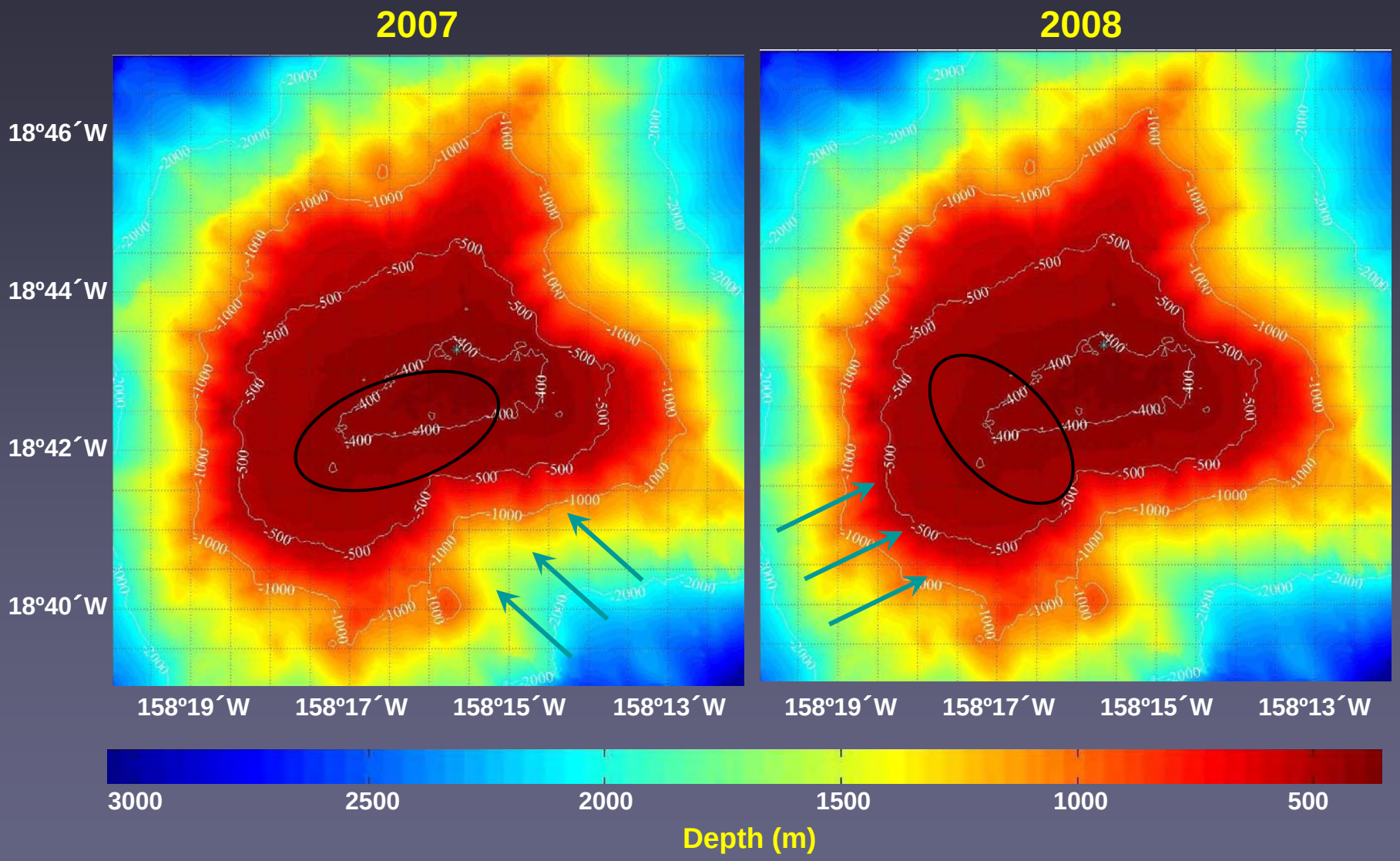

2007
2008
18°46´W
18°44´W
18°42´W
18°40´W
158°19´W
158°17´W
158°15´W
158°13´W
3000
2500
2000
1500
1000
500
Depth (m)

09:00 – 10:00

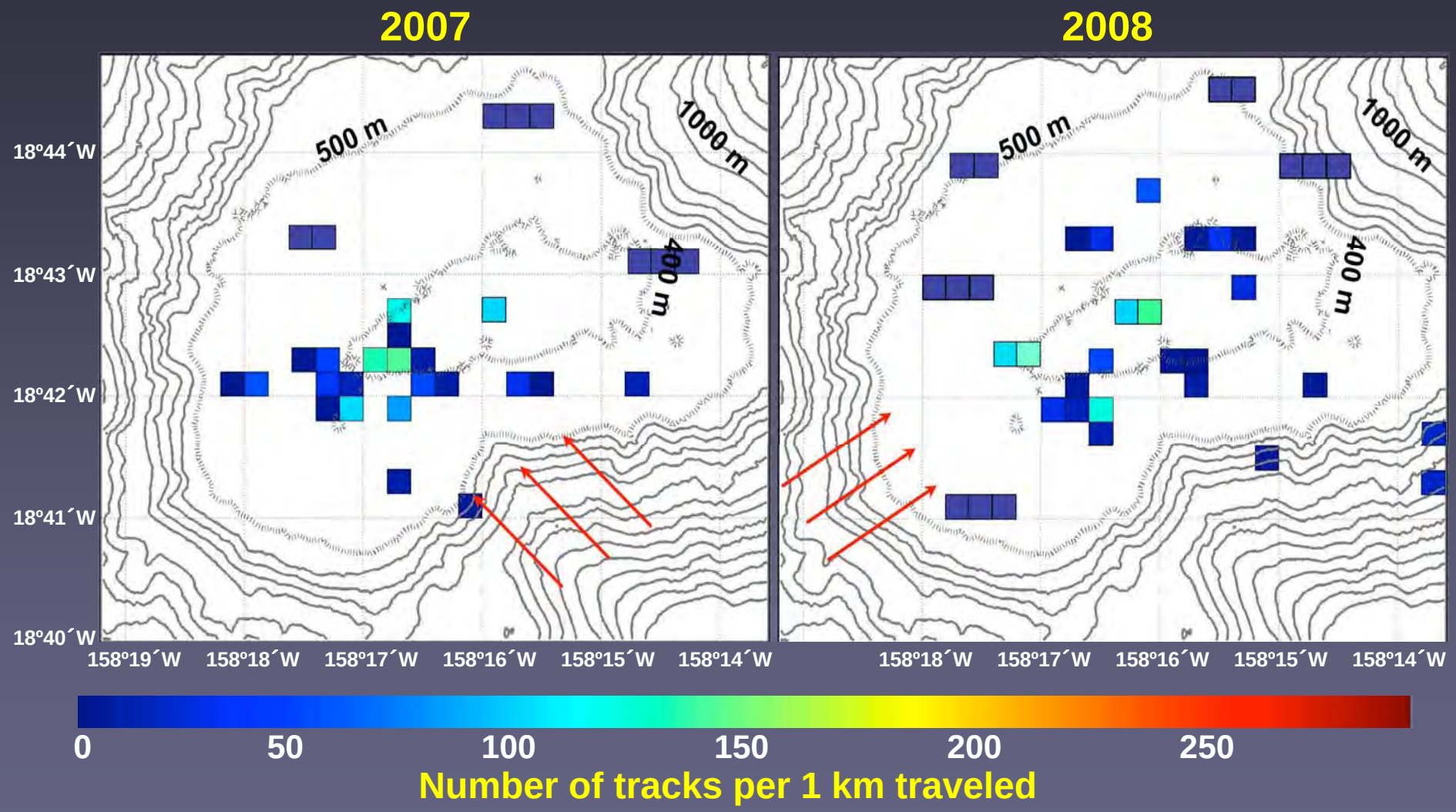

2007
2008
500 m
1000 m
400 m
18°44´W
18°43´W
18°42´W
18°41´W
18°40´W
158°19´W
158°18´W
158°17´W
158°16´W
158°15´W
158°14´W
0
50
100
150
200
250
Number of tracks per 1 km traveled

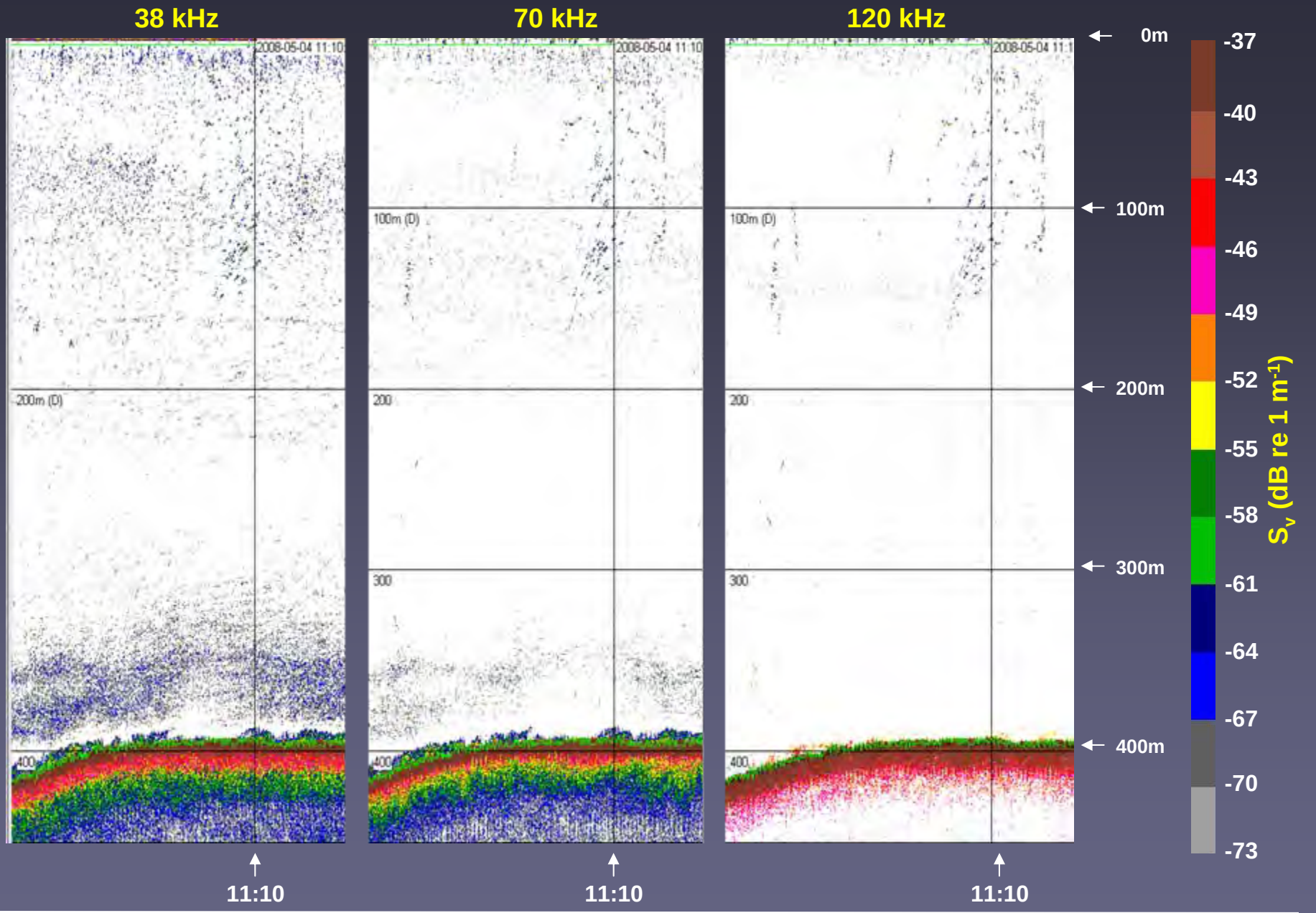

38 kHz
70 kHz
120 kHz
2008-04-24 09:20:00
09:30:00
100m (D)
200
300
400
0m
100m
200m
300m
400m
-37
-40
-43
-46
-49
-52
-55
-58
-61
-64
-67
-70
-73
S_v (dB re 1 m^{-1})
09:20
09:30

10:00 – 12:00

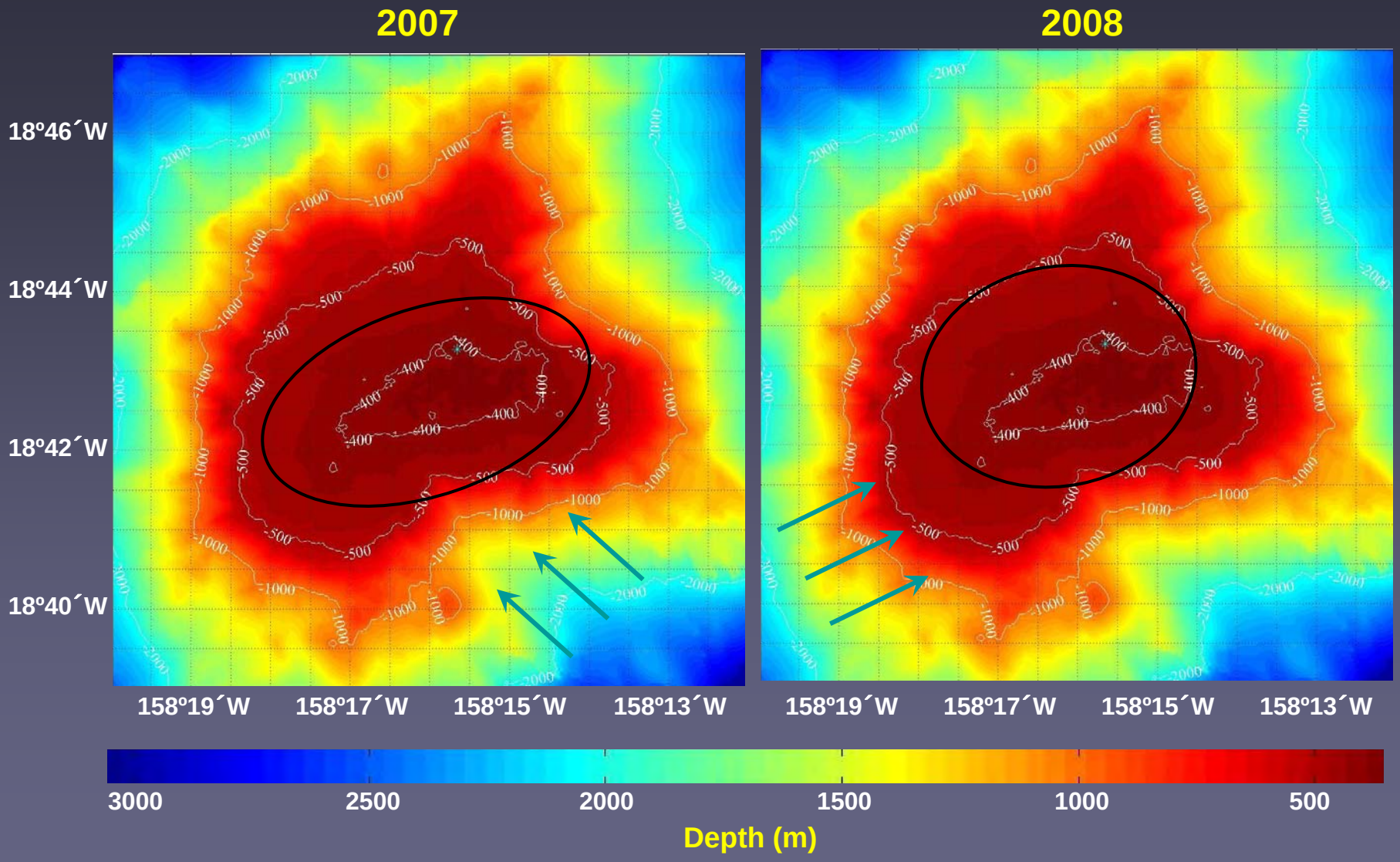

2007
2008
18°46´W
18°44´W
18°42´W
18°40´W
158°19´W
158°17´W
158°15´W
158°13´W
3000
2500
2000
1500
1000
500
Depth (m)

11:00 – 12:00

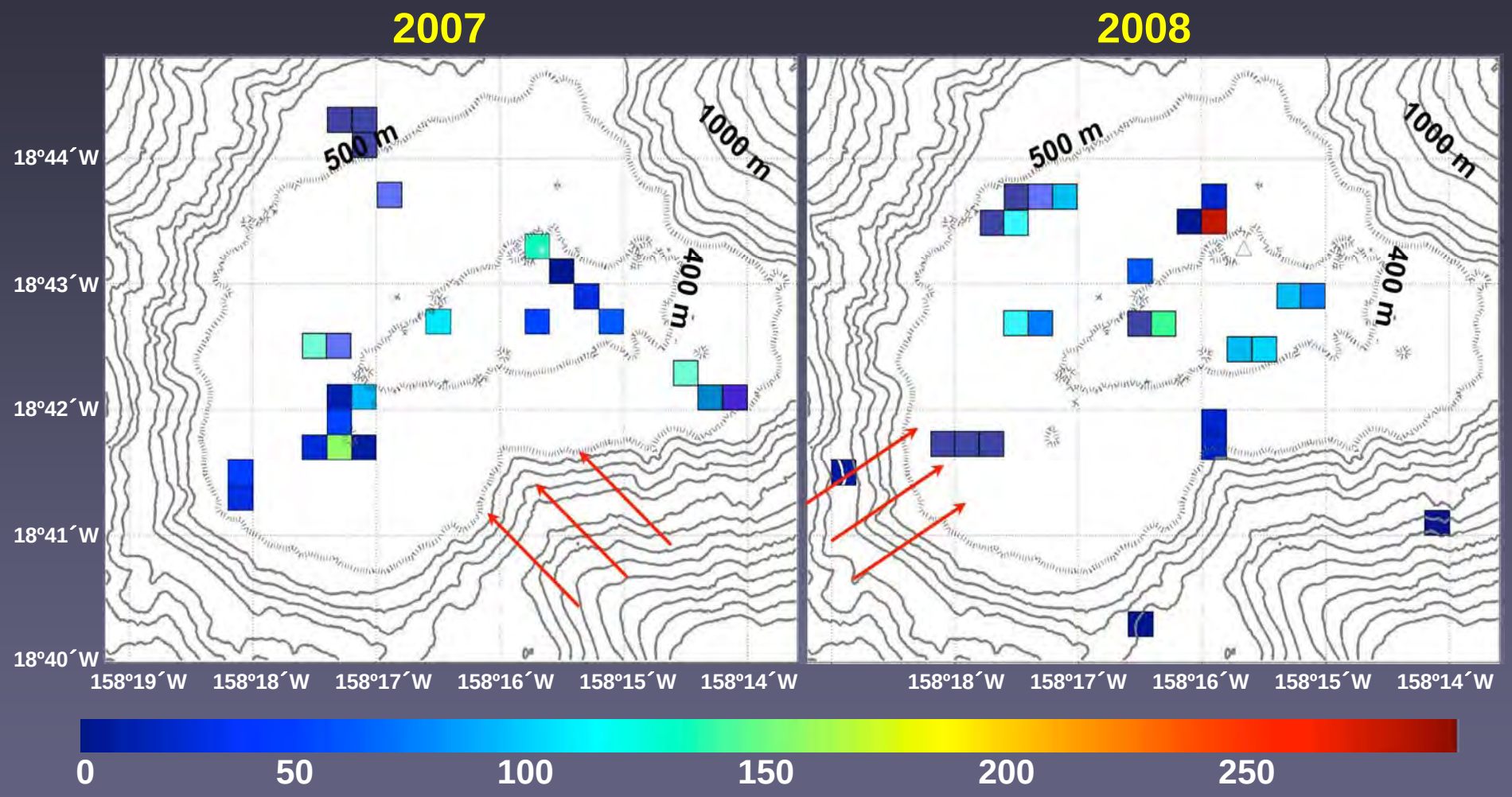

2007
2008
500 m
1000 m
400 m
18°44´W
18°43´W
18°42´W
18°41´W
18°40´W
158°19´W
158°18´W
158°17´W
158°16´W
158°15´W
158°14´W
0
50
100
150
200
250
Number of tracks per 1 km traveled

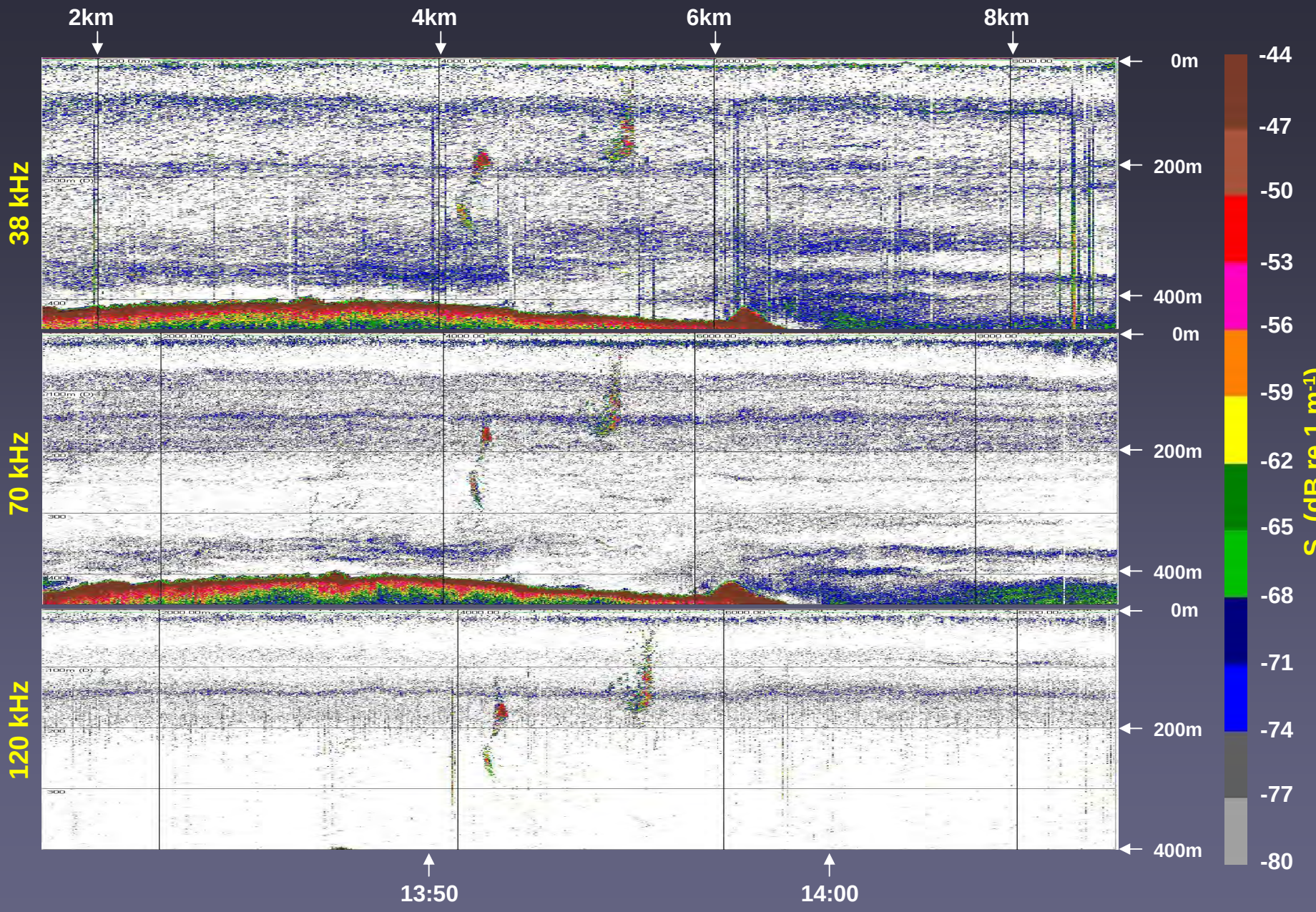

38 kHz
70 kHz
120 kHz
2008-05-04 11:10
200m (D)
100m (D)
200
300
400
0m
100m
200m
300m
400m
-37
-40
-43
-46
-49
-52
-55
-58
-61
-64
-67
-70
-73
S_v (dB re 1 m^{-1})
11:10
11:10
11:10

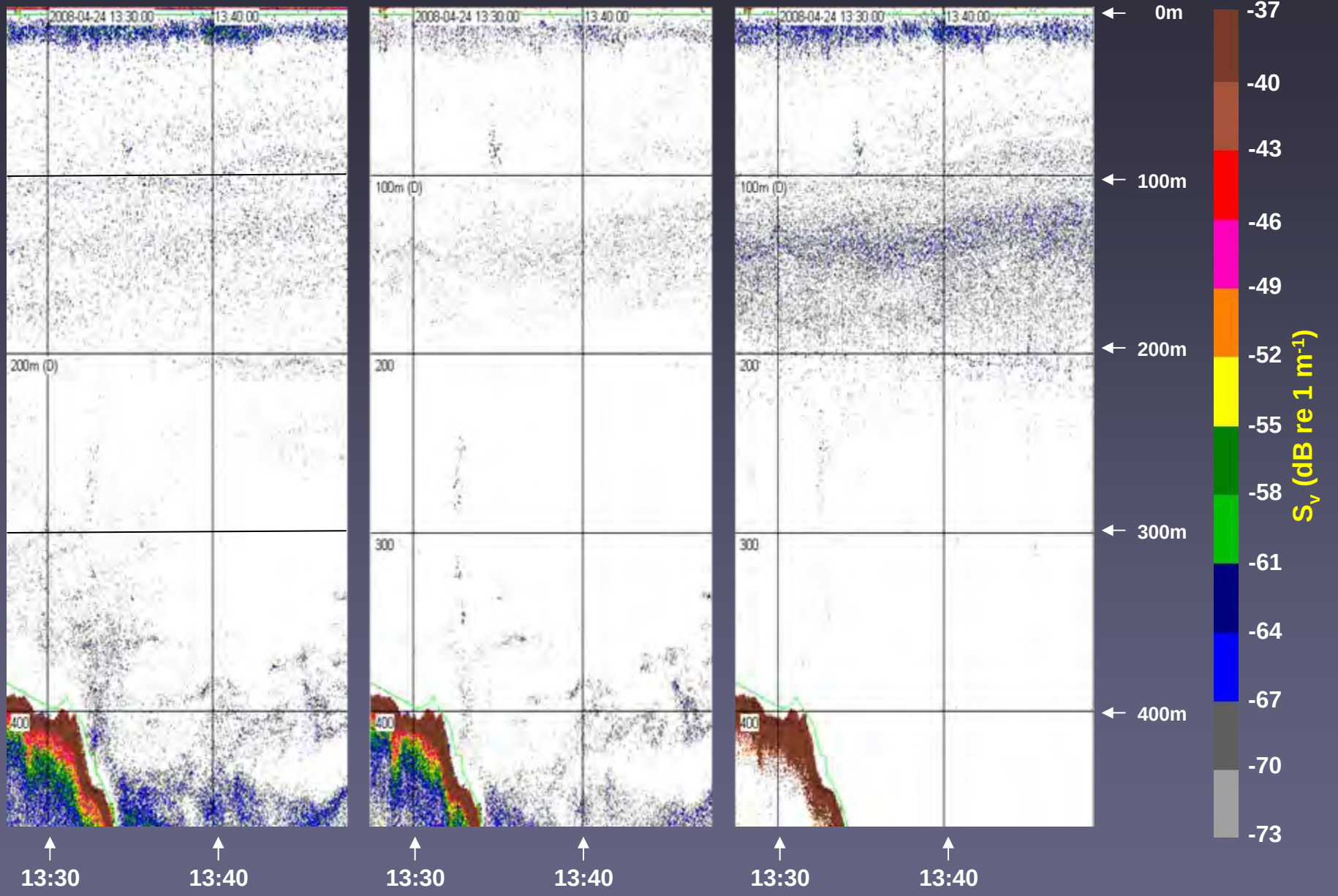
12:00 – 18:00


2007
2008
18°46´W
18°44´W
18°42´W
18°40´W
158°19´W
158°17´W
158°15´W
158°13´W
3000
2500
2000
1500
1000
500
Depth (m)

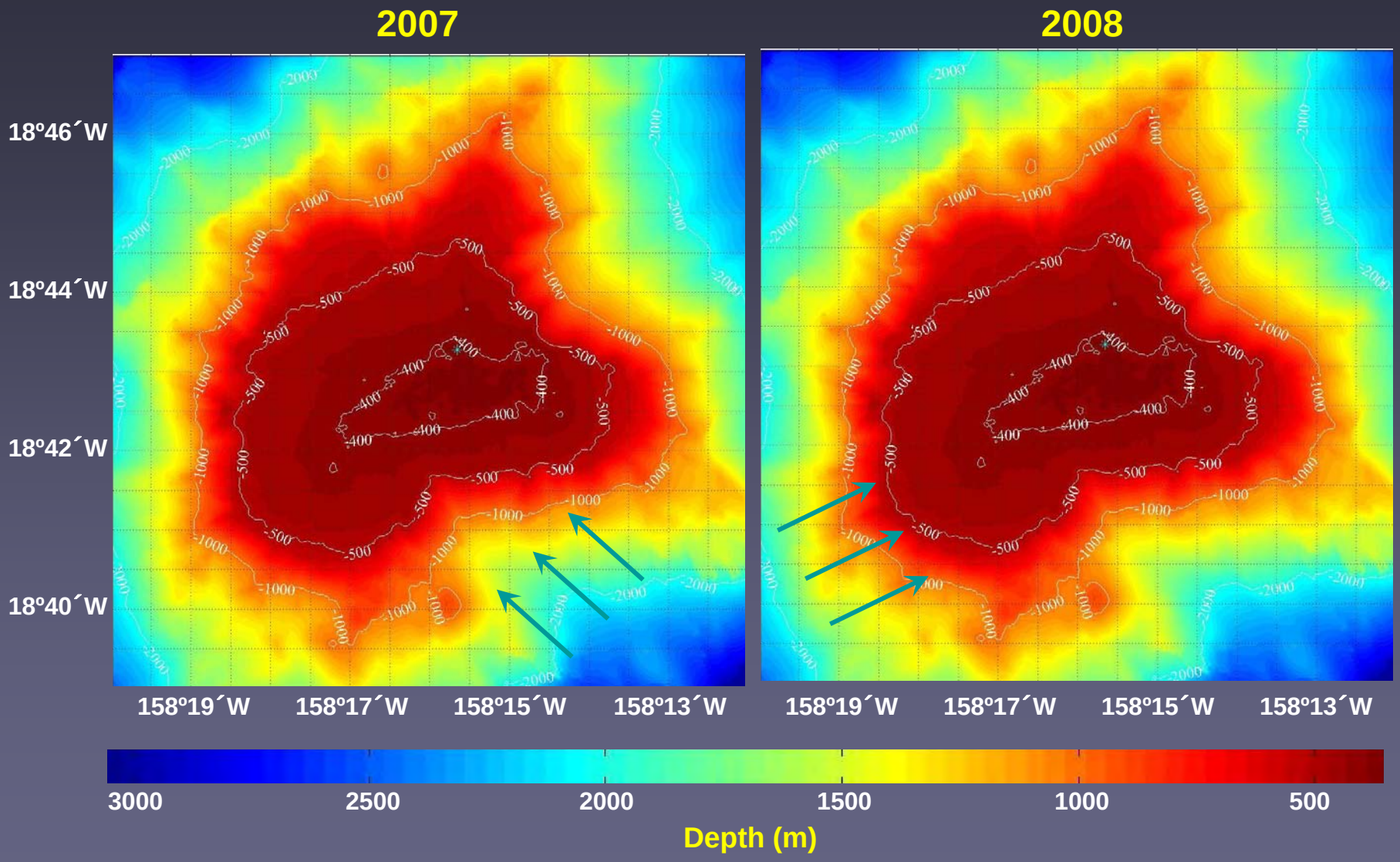
13:00 – 14:00


2007
2008
500 m
1000 m
400 m
18°44´W
18°43´W
18°42´W
18°41´W
18°40´W
158°19´W
158°18´W
158°17´W
158°16´W
158°15´W
158°14´W
0
50
100
150
200
250
Number of tracks per 1 km traveled

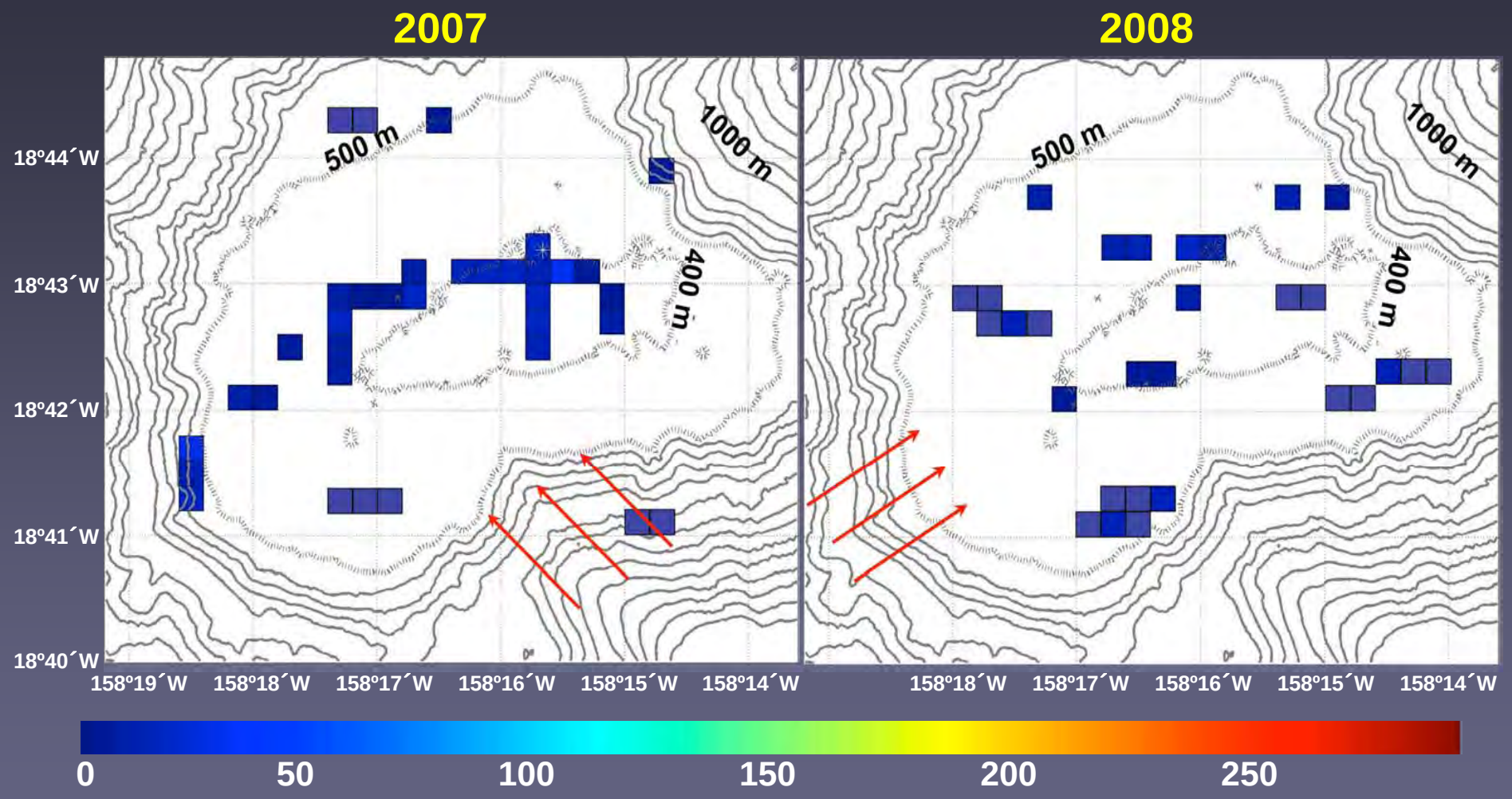

2km
4km
6km
8km
38 kHz
70 kHz
120 kHz
0m
200m
400m
0m
200m
400m
0m
200m
400m
-44
-47
-50
-53
-56
-59
-62
-65
-68
-71
-74
-77
-80
S_v (dB re 1 m^{-1})
13:50
14:00


38 kHz
70 kHz
120 kHz
2008-04-24 13:30:00
13:40:00
100m (D)
200m (D)
200
300
400
0m
100m
200m
300m
400m
-37
-40
-43
-46
-49
-52
-55
-58
-61
-64
-67
-70
-73
S_v (dB re 1 m^{-1})
13:30
13:40
13:30
13:40
13:30
13:40

18:00 – 05:00


2007
2008
18°46´W
18°44´W
18°42´W
18°40´W
158°19´W
158°17´W
158°15´W
158°13´W
3000
2500
2000
1500
1000
500
Depth (m)

01:00 – 02:00


2007
2008
500 m
1000 m
400 m
18°44´W
18°43´W
18°42´W
18°41´W
18°40´W
158°19´W
158°18´W
158°17´W
158°16´W
158°15´W
158°14´W
0
50
100
150
200
250
Number of tracks per 1 km traveled

Summary

- increased juvenile/subadult bigeye tuna biomass over the plateau confirmed
- aggregated deep diving behavior
- bigeye aggregate at Cross Seamount at least partially to feed
  - bigeye appear at dawn at upstream edge of plateau to feed on some of the layers of vertically migrating micronekton
  - apparent feeding frenzy at upstream edge of plateau at dawn
- bigeye disperse during day over the plateau, sometimes forming dense aggregations
- bigeye possibly leave Seamount during night
  - vast majority of targets consistent with bigeye were observed between dawn and dusk
  - bigeye at FADs leave for the night (Kim Holland)
- interannual variability
  - significantly less bigeye in 2008 than in 2007
  - anomalous currents?
  - changes in water characteristics (higher near-surface temperatures and salinity)?
  - effect of fishery?