

# **Crowdsourced bathymetry on the Great Barrier Reef: total propagated uncertainty**

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# Aims

- Generate uncertainty values\* for crowdsourced bathymetry (CSB) data:
  - (1) *a priori* total propagated uncertainty (TPU) with Caris HIPS software
  - (2) empirical values standard deviation comparison with bathy LiDAR data
- Three vessels using TeamSurv SmartLog data logger, NMEA values extracted
- Treatment - offsets to waterline RP, predicted tides applied, cleaned of noise

\* [IHO Standards for Hydrographic Surveys, 2020. IHO Publication No. 44, IHO, Monaco, pp. 49.](#)

See page 36. A "Crowd Sourced" bathymetric dataset acquired in deep water, with a single beam echosounder and no sound velocity correction, could be classified by the use of TVU and THU (the coverage is of no use as it is not a systematic survey).

# FlyingFishV (23 m)



HIPS - Vessel configuration file\*

HIPS - Compute TPU

Position Nav = 3.0 m

Transducer 1	Motion Gyro (d...)	Heave % Amp	Heave (m)	Roll (deg)	Pitch (deg)	Position Nav (m)	Timing Trans (s)	Nav timing (s)	Gyro Timing (s)
1	0.000	0.000	0.000	0.000	0.000	3.000	0.000	0.000	0.000
2									

Input	Selection
Source	Selection
<b>Tide</b>	
Measure	0.200000000000000000 (m)
Zoning	0 (m)
<b>Sound Speed</b>	
Measured	5 (m/s)
Surface	0 (m/s)
<b>Uncertainty Source</b>	
Source	Vessel
Position	Vessel
Sonar	Vessel
Heading	Vessel
Pitch	Vessel
Roll	Vessel
Vertical	Vessel
Tide	Static
<b>Sweep parameters</b>	
Peak to peak heave	0.200000000000000000 (m)
Maximum Roll	0.0
Maximum Pitch	0.0

Tide = 0.2 m

Sound = 5 m/sec

Heave = 0.2 m

\*not simple fit into Caris HIPS software TPU values

# FlyingFishV – TPU results

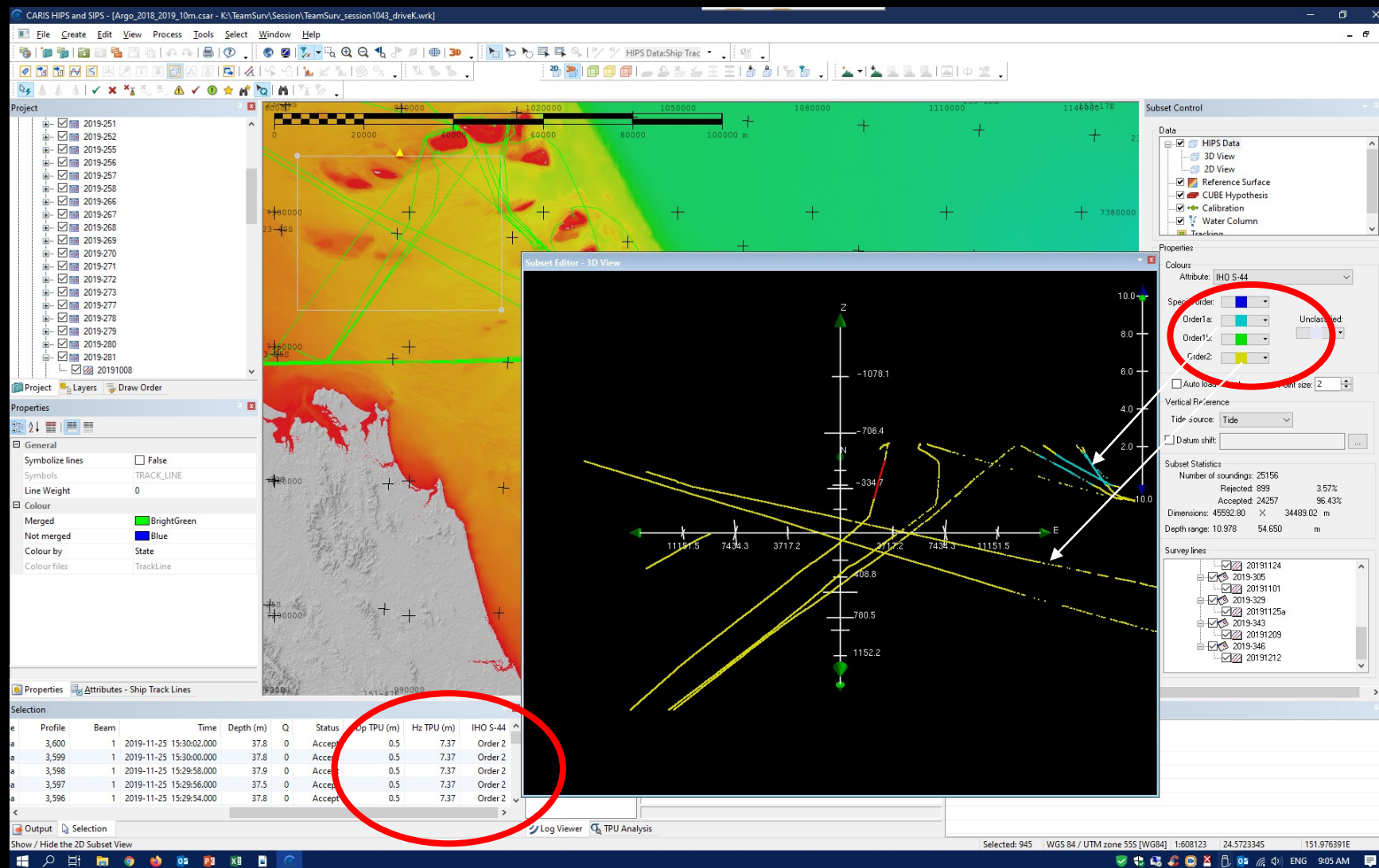
TVU = 0.5-0.6 m

THU = 7.37 m

IHO S-44 = Order 2

IHO S-44 = (minor) Order 1a

e.g. depth sounding is 37.8  
+/- 0.5 m within position  
uncertainty of 7.37 m



# Argo (24 m)



HIPS - Vessel configuration file\*

Position Nav = 3.0 m

	Motion Gyro (d...)	Heave % Amp	Heave (m)	Roll (deg)	Pitch (deg)	Position Nav (m)	Timing Trans (s)	Nav timing (s)	Gyro Timing (s)
1	0.000	0.000	0.000	0.000	0.000	3.000	0.000	0.000	0.000
2									

HIPS - Compute TPU

Input	
Source	Selection
<b>Tide</b>	
Measure	0.20000000000000000 (m)
Zoning	0 (m)
<b>Sound Speed</b>	
Measured	5 (m/s)
Surface	0 (m/s)
<b>Uncertainty Source</b>	
Source	Vessel
Position	Vessel
Sonar	Vessel
Heading	Vessel
Pitch	Vessel
Roll	Vessel
Vertical	Vessel
Tide	Static
<b>Sweep parameters</b>	
Peak to peak heave	0.20000000000000000 (m)
Maximum Roll	0.0
Maximum Pitch	0.0

Tide = 0.2 m

Sound = 5 m/sec

Heave = 0.2 m

\*not simple fit into Caris HIPS software TPU values

# Argo – TPU results

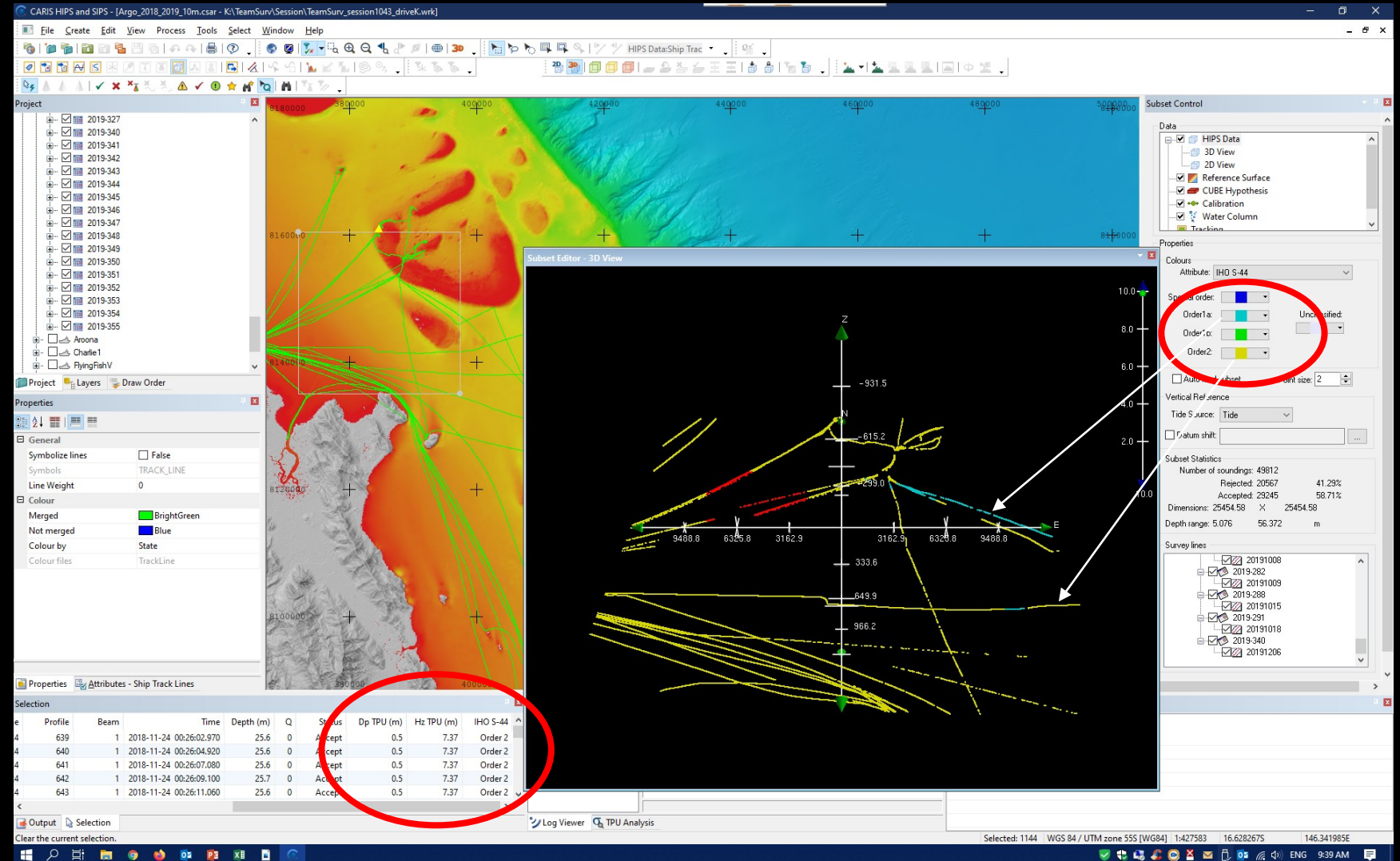
TVU = 0.5-0.6 m

THU = 7.37 m

IHO S-44 = Order 2

IHO S-44 = (minor) Order 1a

e.g. depth sounding is 25.6  
+/- 0.5 m within position  
uncertainty of 7.37 m



# Charlie1 (4.2 m)



HIPS - Vessel configuration file\*

Position Nav = 3.0 m

Transducer 1	Motion Gyro (d...	Heave % Amp	Heave (m)	Roll (deg)	Pitch (deg)	Position Nav (m)	Timing Trans (s)	Nav timing (s)	Gyro Ti
1	0.000	0.000	0.000	0.000	0.000	3.000	0.000	0.000	0.000
2									

HIPS - Compute TPU

Input	Selection
Source	Selection
Measure	0.20000000000000000 (m)
Zoning	0 (m)
Measured	5 (m/s)
Surface	0 (m/s)
Source	Vessel
Position	Vessel
Sonar	Vessel
Heading	Vessel
Pitch	Vessel
Roll	Vessel
Vertical	Vessel
Tide	Static
Peak to peak heave	0.20000000000000000 (m)
Maximum Roll	0.0
Maximum Pitch	0.0

Tide = 0.2 m

Sound = 5 m/sec

Heave = 0.2 m

\*not simple fit into Caris HIPS software TPU values

# Charlie 1 – TPU results

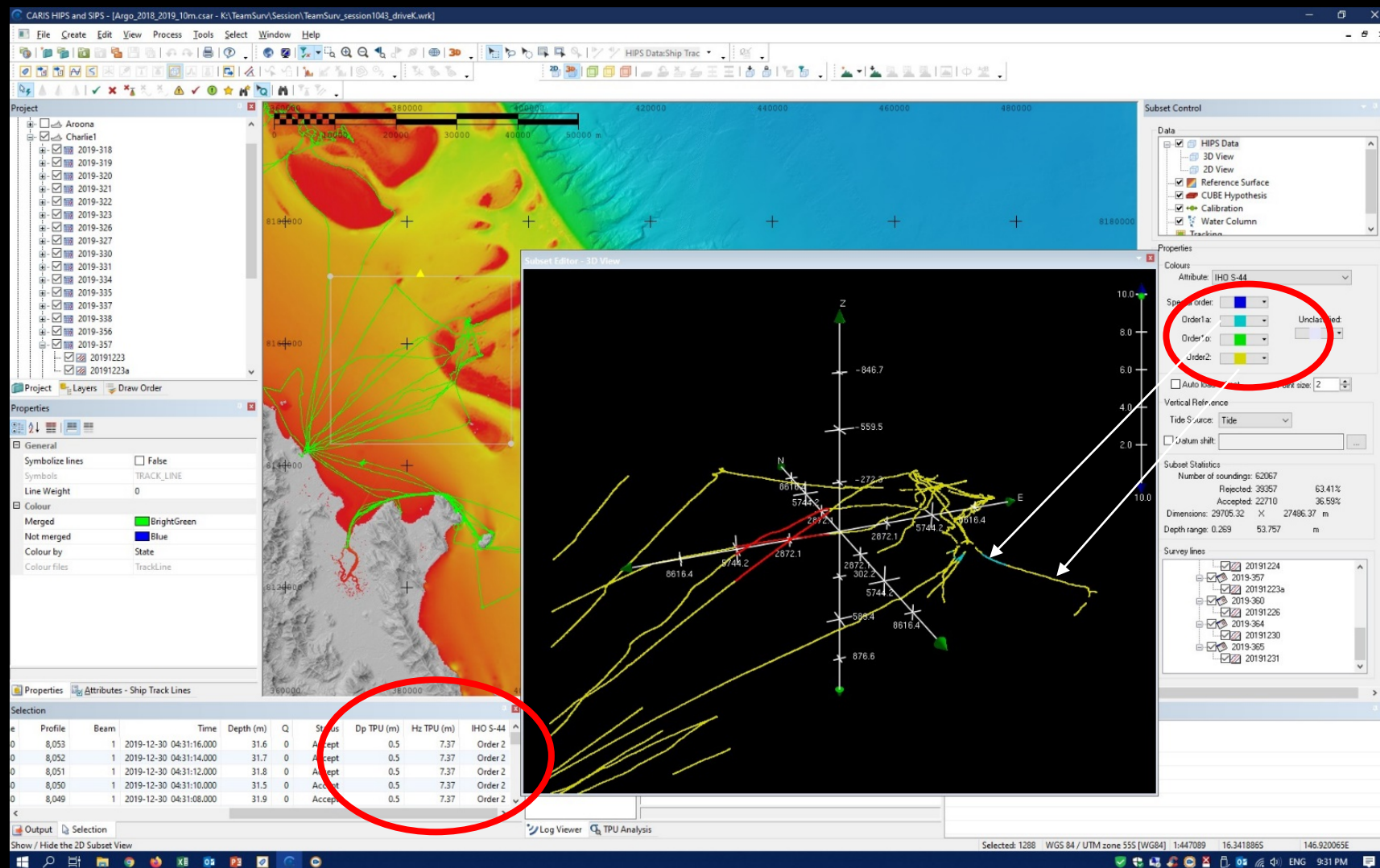
TVU = 0.5-0.6 m

THU = 7.37 m

IHO S-44 = Order 2

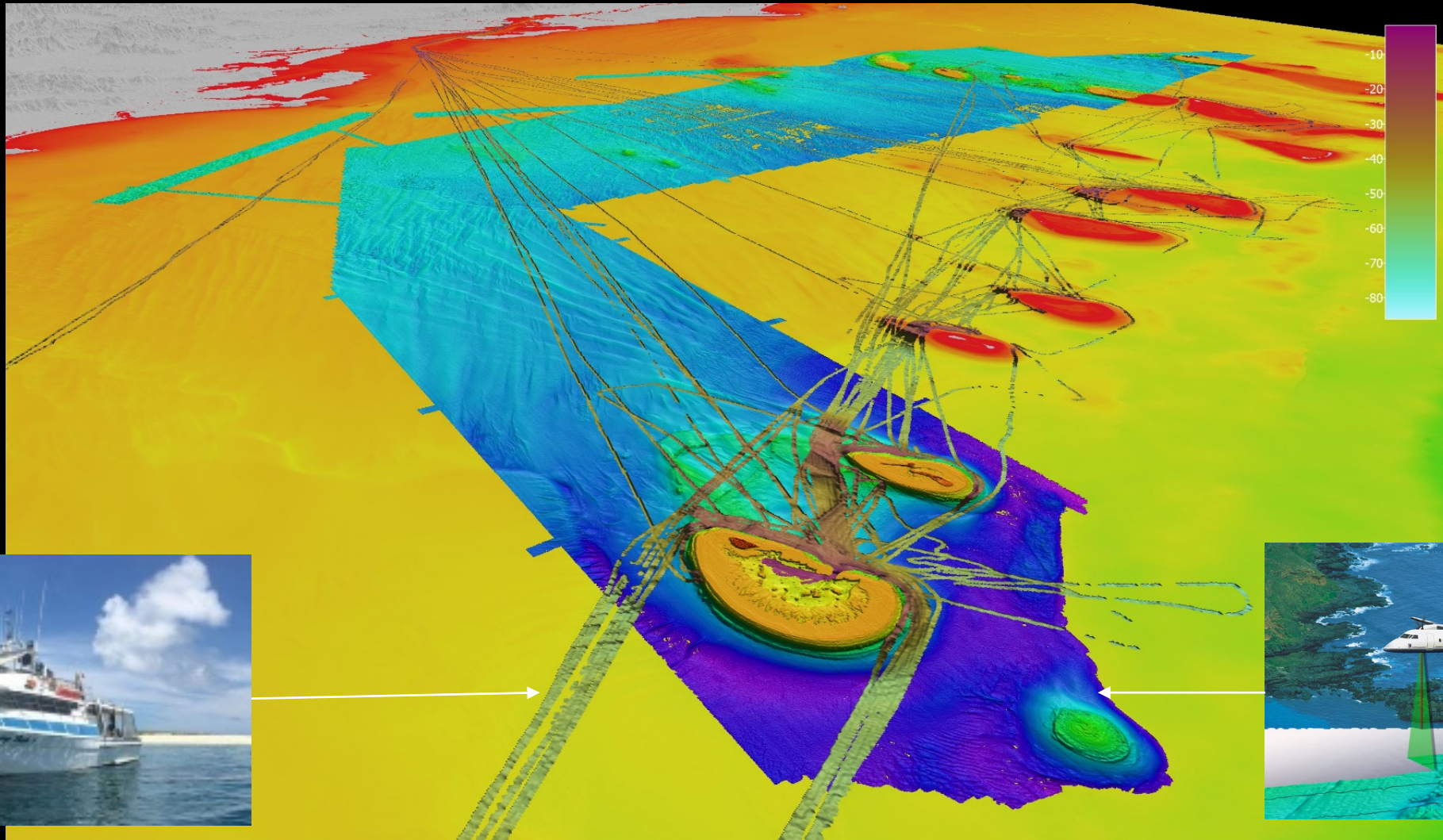
IHO S-44 = (minor) Order 1a

e.g. depth sounding is 31.6  
+/- 0.5 m within position  
uncertainty of 7.37 m

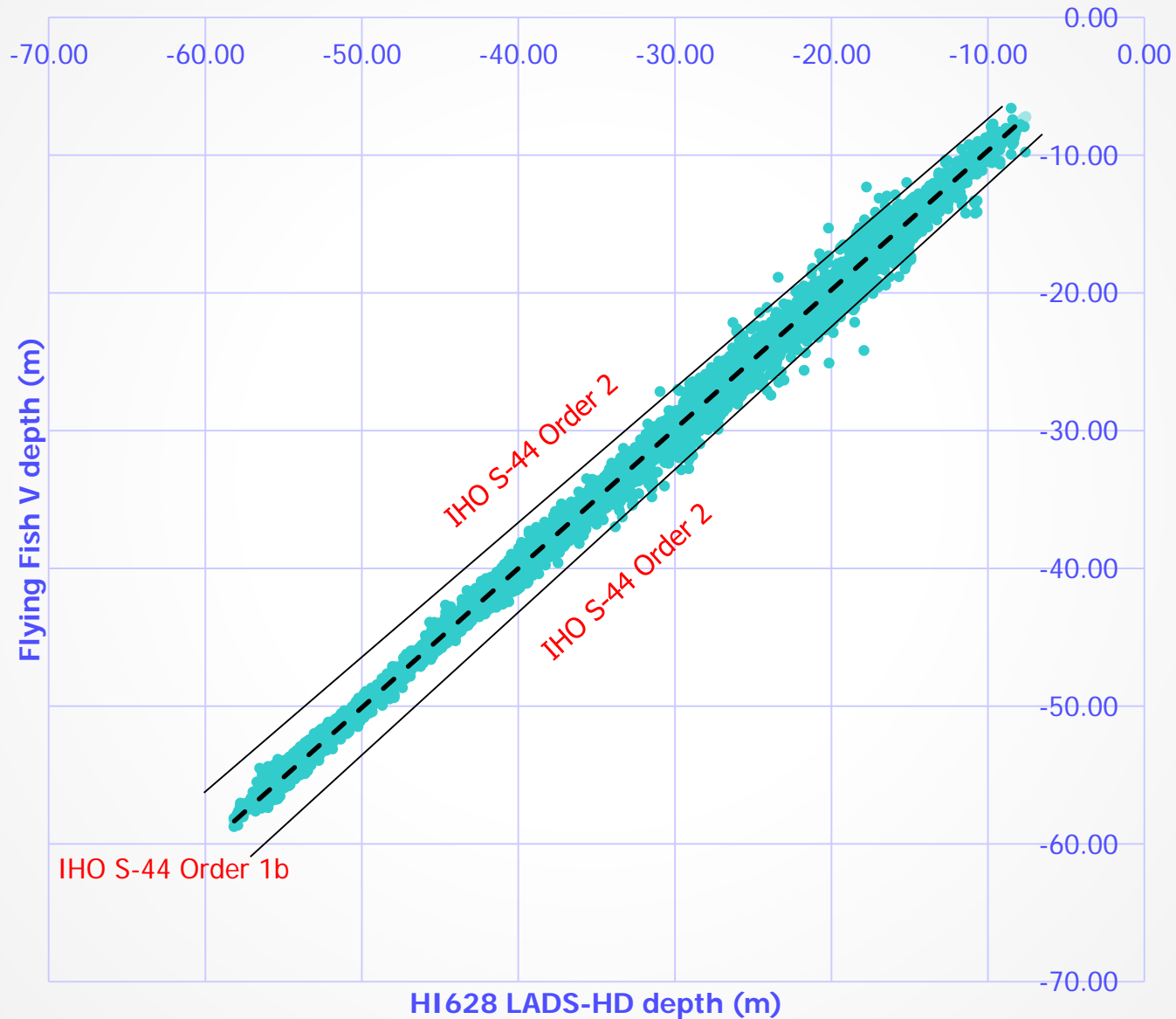




# FlyingFishV CSB vs HI628 LADS-HD data



## FlyingFishV CSB vs HI628 LADS-HD data



R Square = 0.997900827 (1 = match)

Standard Deviation = 0.398528331 m

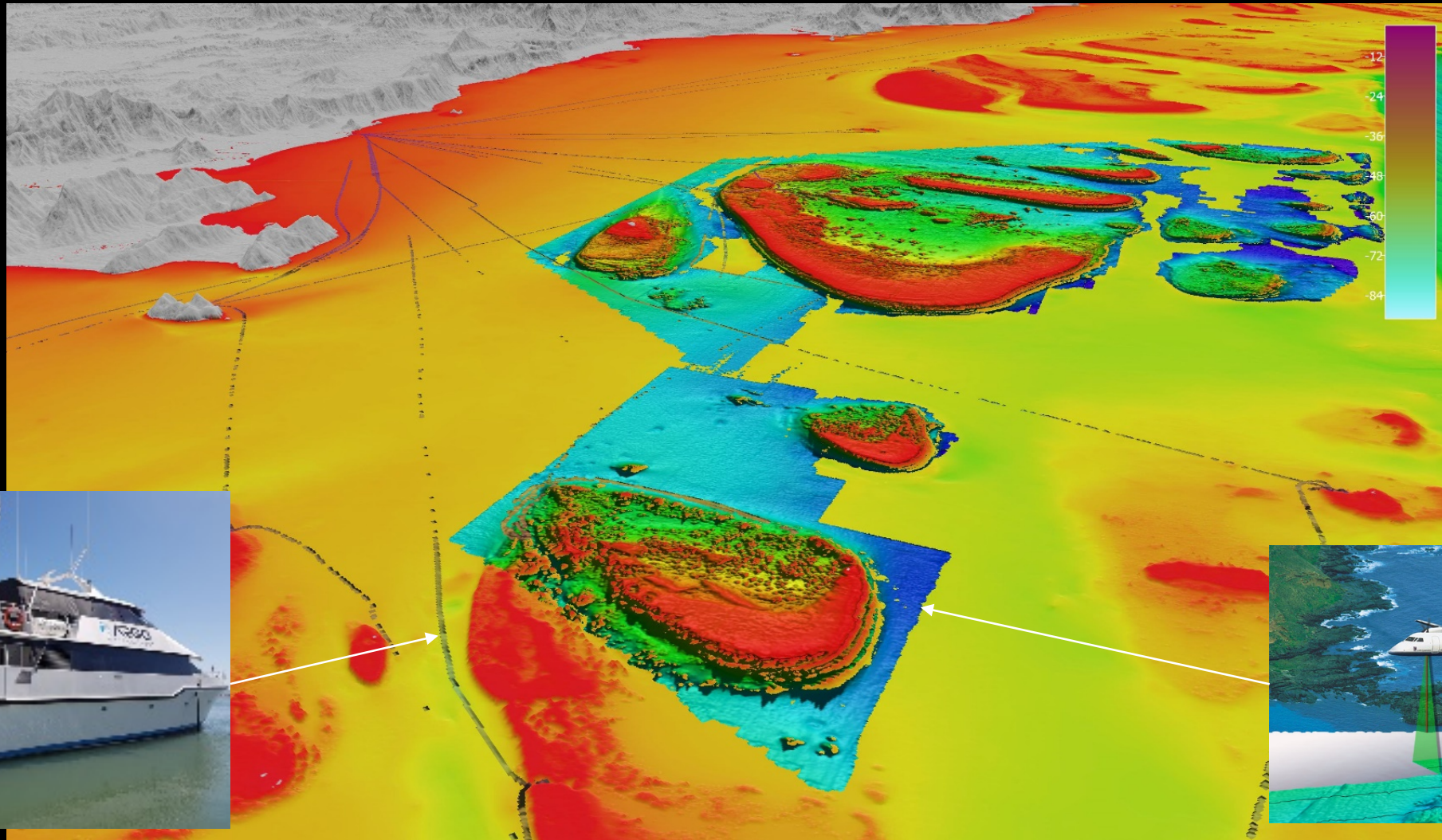
Observations = 73,995

So 95% of CSB data falls within  $\pm 2^*$  0.40 m from the regression line

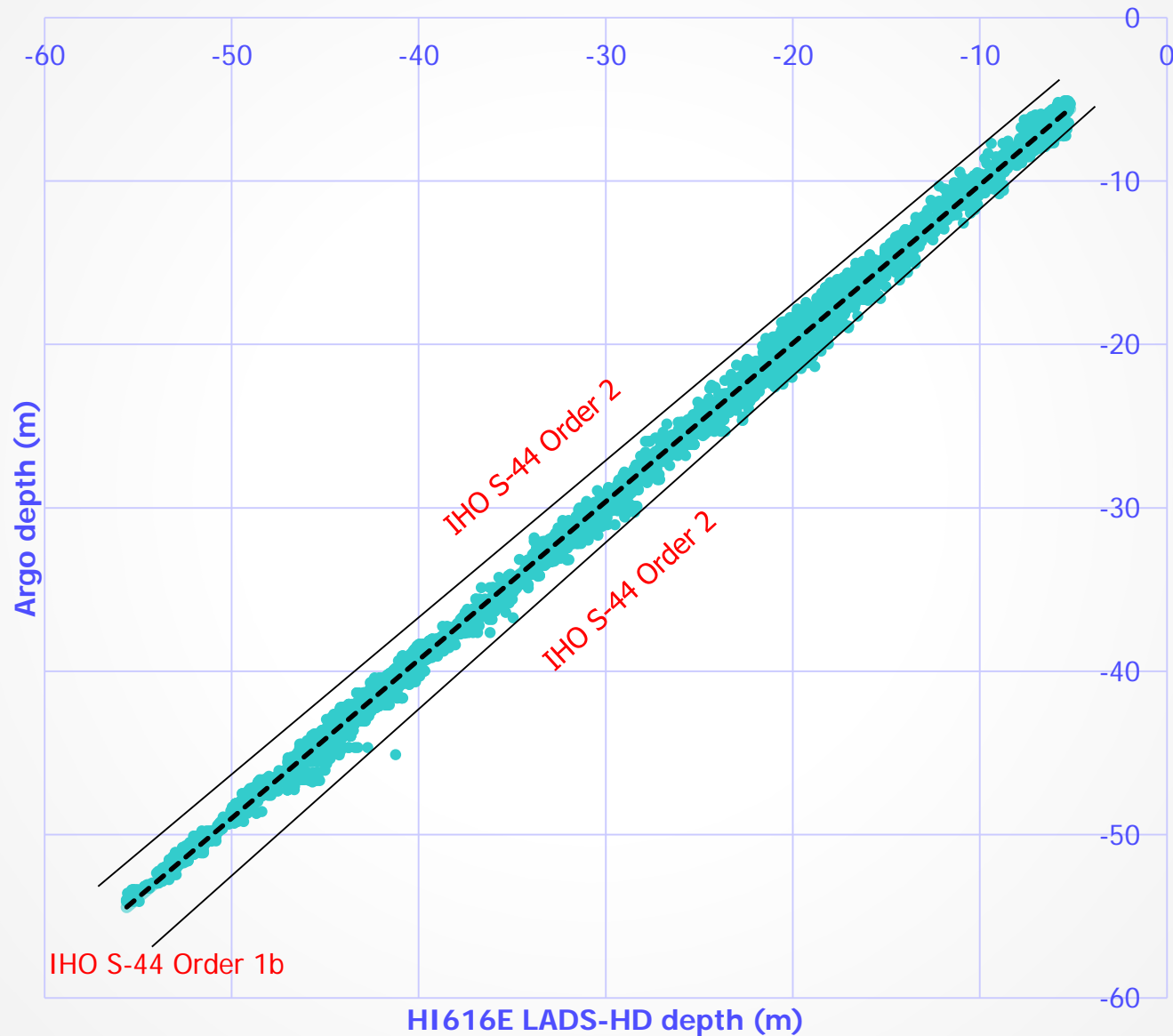
IHO S-44 = Order 1b

IHO S-44 = (minor) Order 2

# Argo CSB vs HI616E LADS-HD data



## Argo CSB vs HI616E LADS-HD data



R Square = 0.998886119 (1 = match)

Standard Deviation = 0.444183688 m

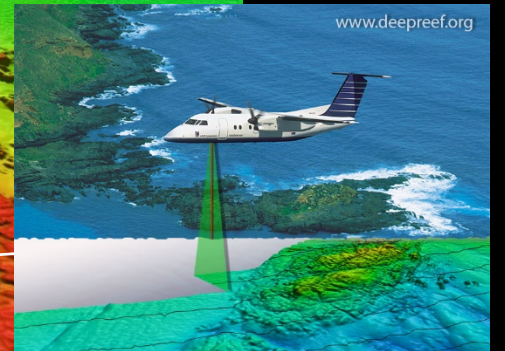
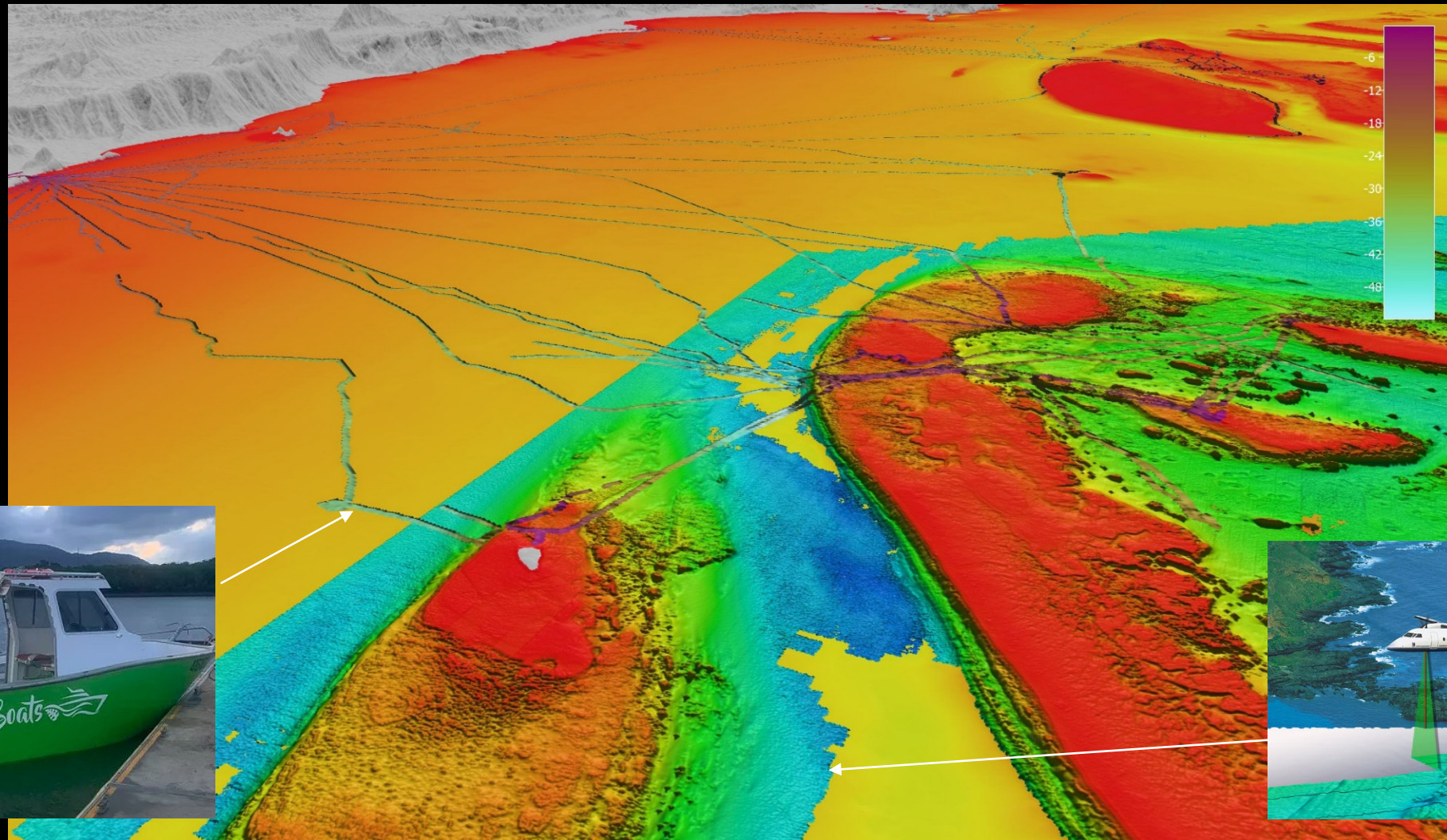
Observations = 12,329

So 95% of CSB data falls within  $\pm 2^*$   
0.44 m from the regression line

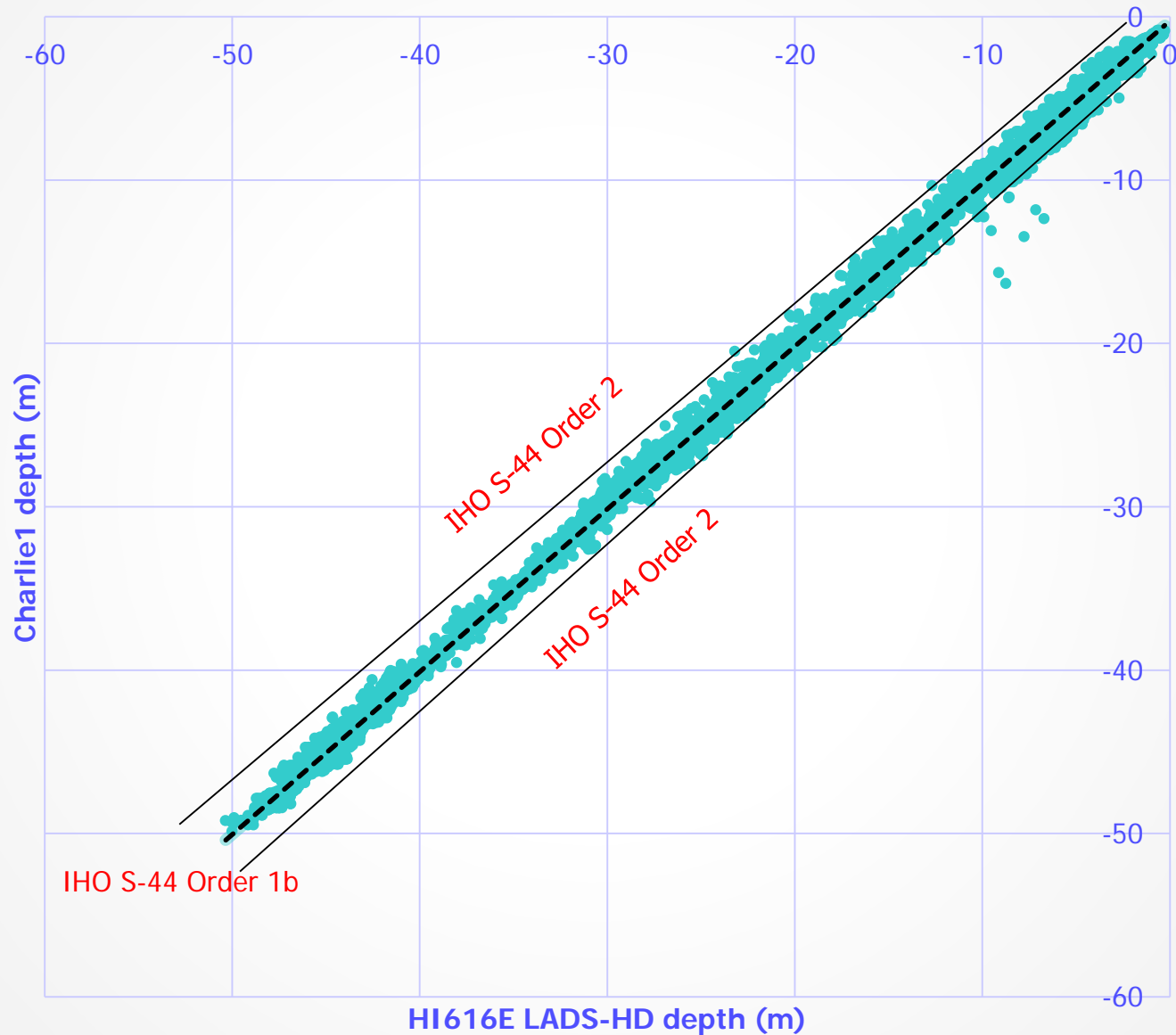
IHO S-44 = Order 1b

IHO S-44 = (minor) Order 2

# Charlie1 CSB vs HI616E LADS-HD data



## Charlie1 CSB vs HI616E LADS-HD data



R Square = 0.998691468 (1 = match)

Standard Deviation = 0.477666818 m

Observations = 18,753

So 95% of CSB data falls within  $\pm 2^*$  0.48 m from the regression line

IHO S-44 = Order 1b

IHO S-44 = (minor) Order 2

# Conclusions

- CSB data *a priori* total vertical uncertainty +/- 0.5-0.6 m (95% confid level)
- CSB data *a priori* total horizontal uncertainty +/- 7.37 m (95% confid level)
  
- CSB data empirical comparison with LiDAR +/- 0.80-0.96 m (95% confid level)
- So is reasonable to say that CSB data TVU +/- ~1 m (95% confid level)
- And CSB data conforms to IHO S-44 Order 1b\* or (minor) Order 2
  
- Improved TVU if offsets to waterline RP, tide applied, cleaned of noise etc.
- Improved THU if able to use SBAS, modern GNSS receiver etc.

\* Classified according to the S-44 Matrix as: Ba7 (THU=7.37 m), Bc8 (a=0.5 m), Bd6 (b=0.013)