



**National Oceanography  
Centre, Southampton**

UNIVERSITY OF SOUTHAMPTON AND  
NATURAL ENVIRONMENT RESEARCH COUNCIL

# **Autonomy and Collision Avoidance**

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- Where the autonomy fits in
- Some Examples
- Some Questions



# Where The Autonomy Fits In

- **Survey Enhancement**
  - (adaptive sampling)
- **Vehicle Protection**
  - (collision avoidance)
- **Operational Simplification**
  - (mission planning)



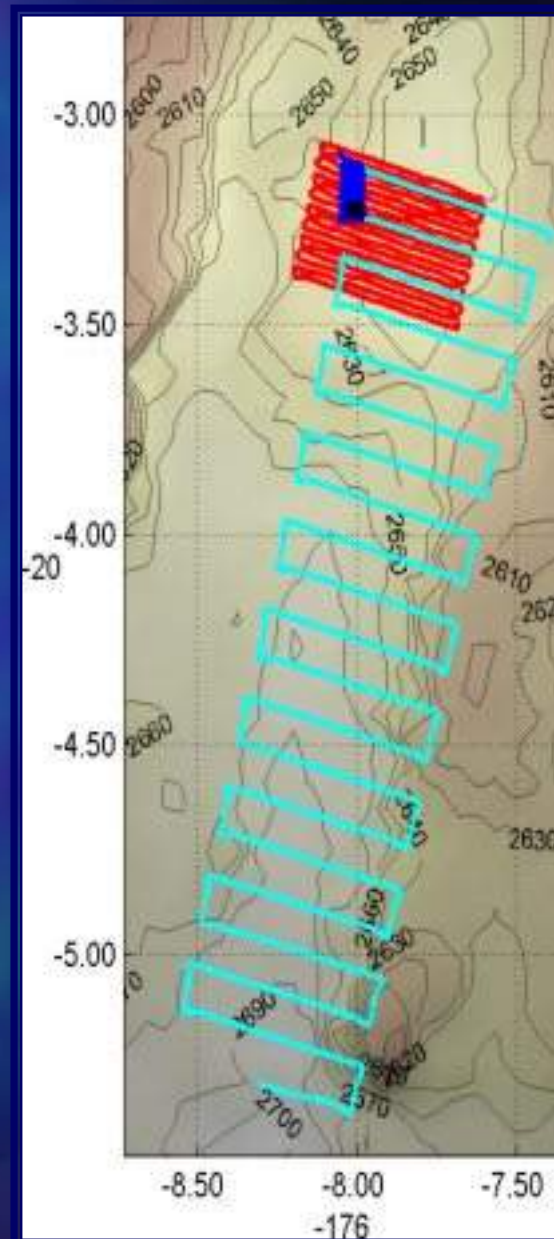
# Where The Autonomy Fits In





# Autonomy: Survey Enhancement

- Woods Hole vent plume tracking with Abe

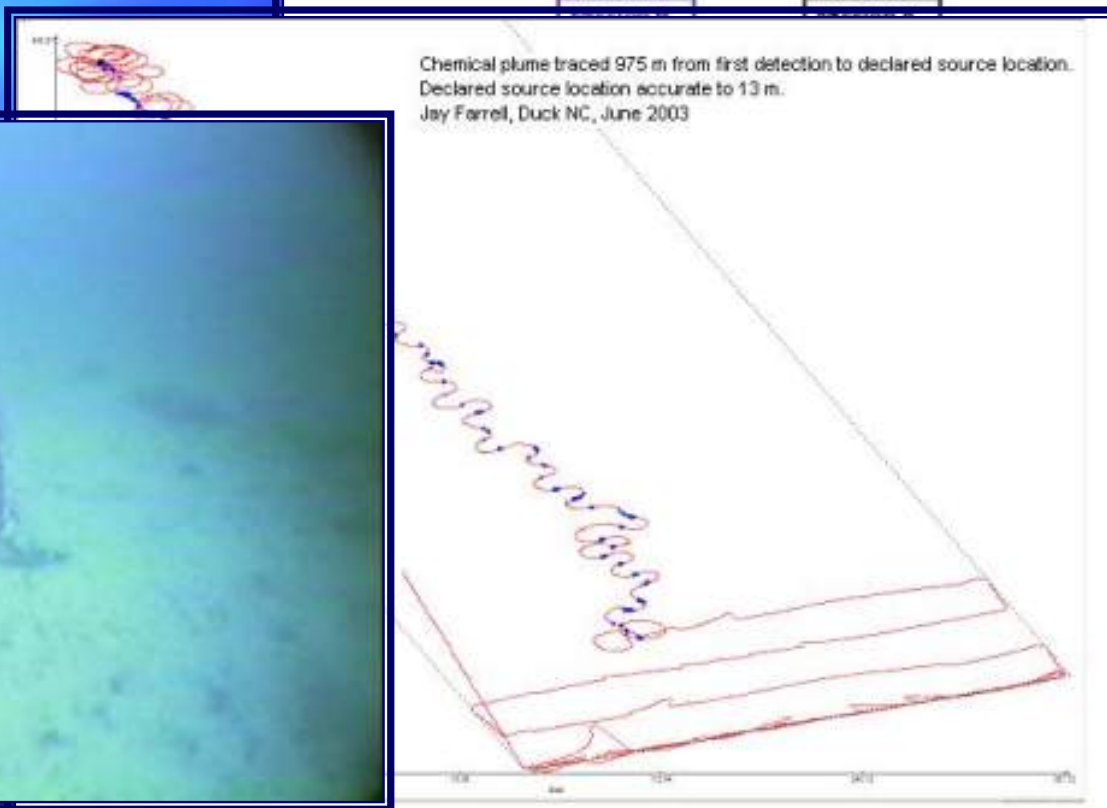




# Autonomy: Survey Enhancement

- Chemical Plume Tracing Experimental Results with a REMUS AUV

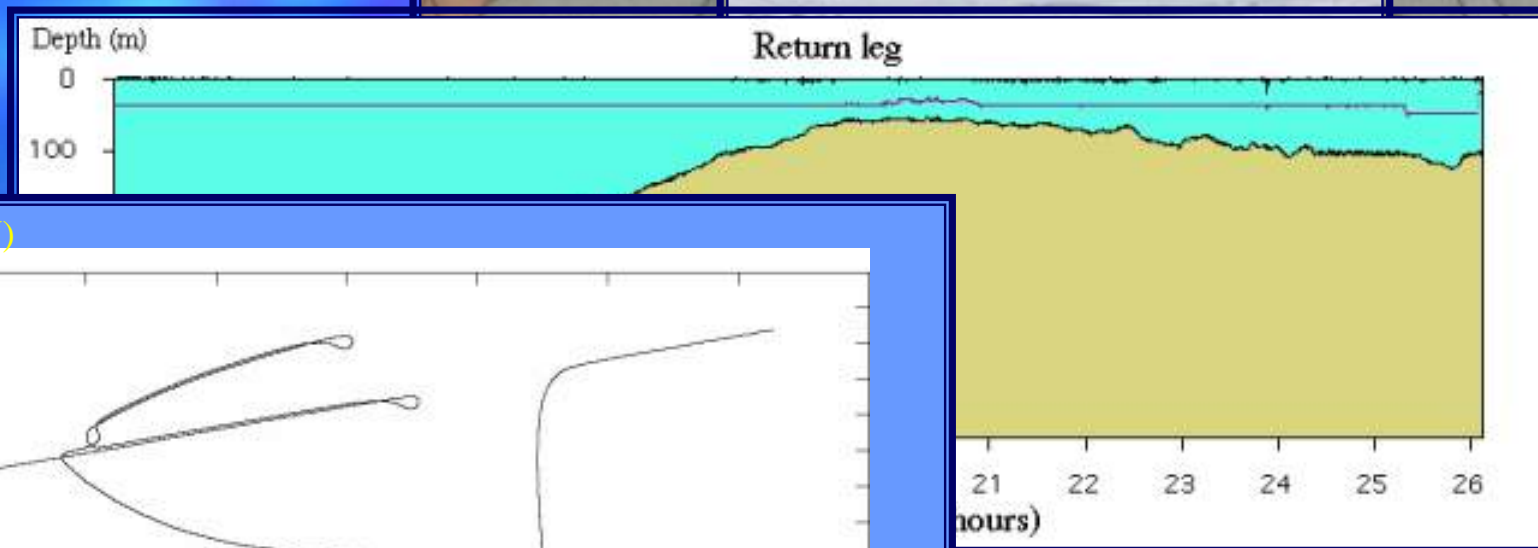
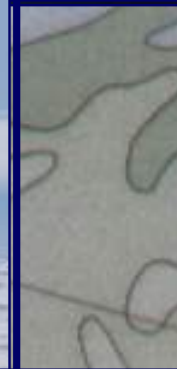
University of California Riverside, SPAWAR San Diego



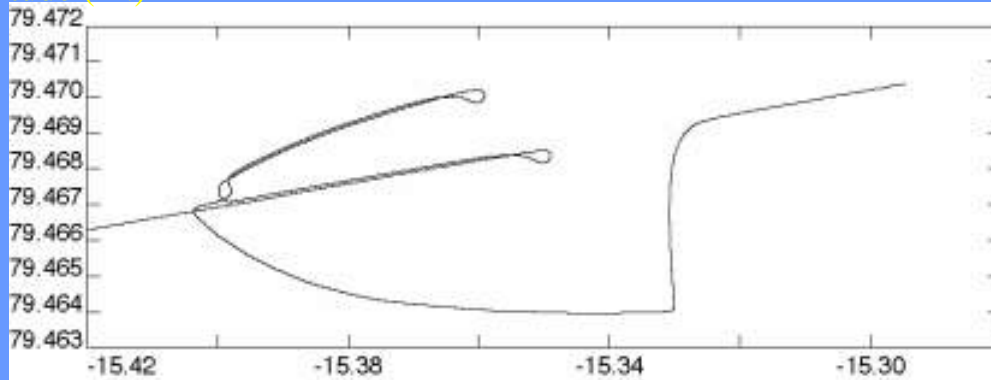


# Autonomy: Vehicle Protection

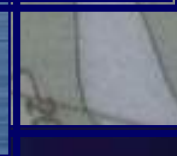
- Autosub  
Collision  
Avoidance



Latitude ( $^{\circ}$ N)

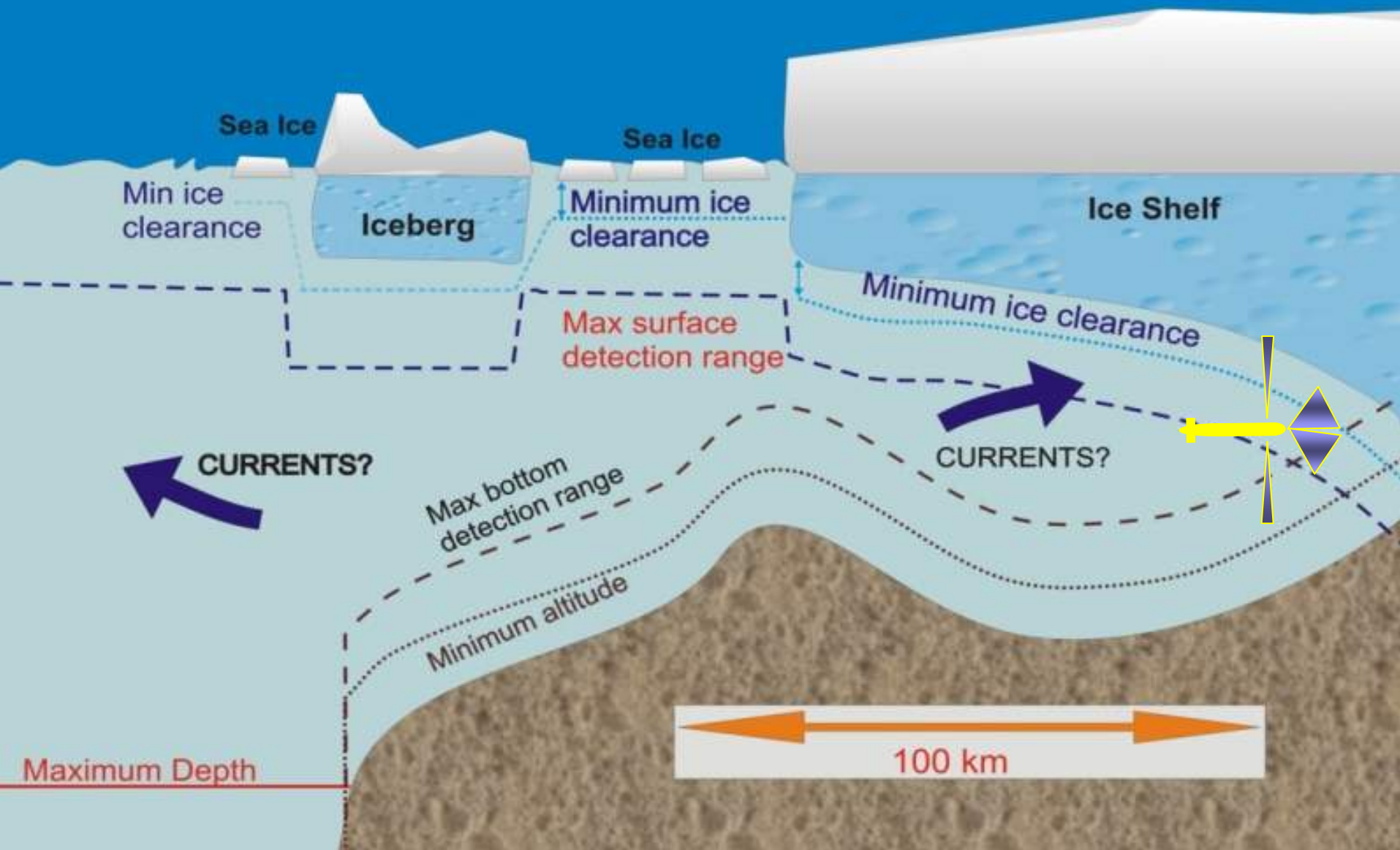


Longitude ( $^{\circ}$ W)





# Autonomy: Vehicle Protection





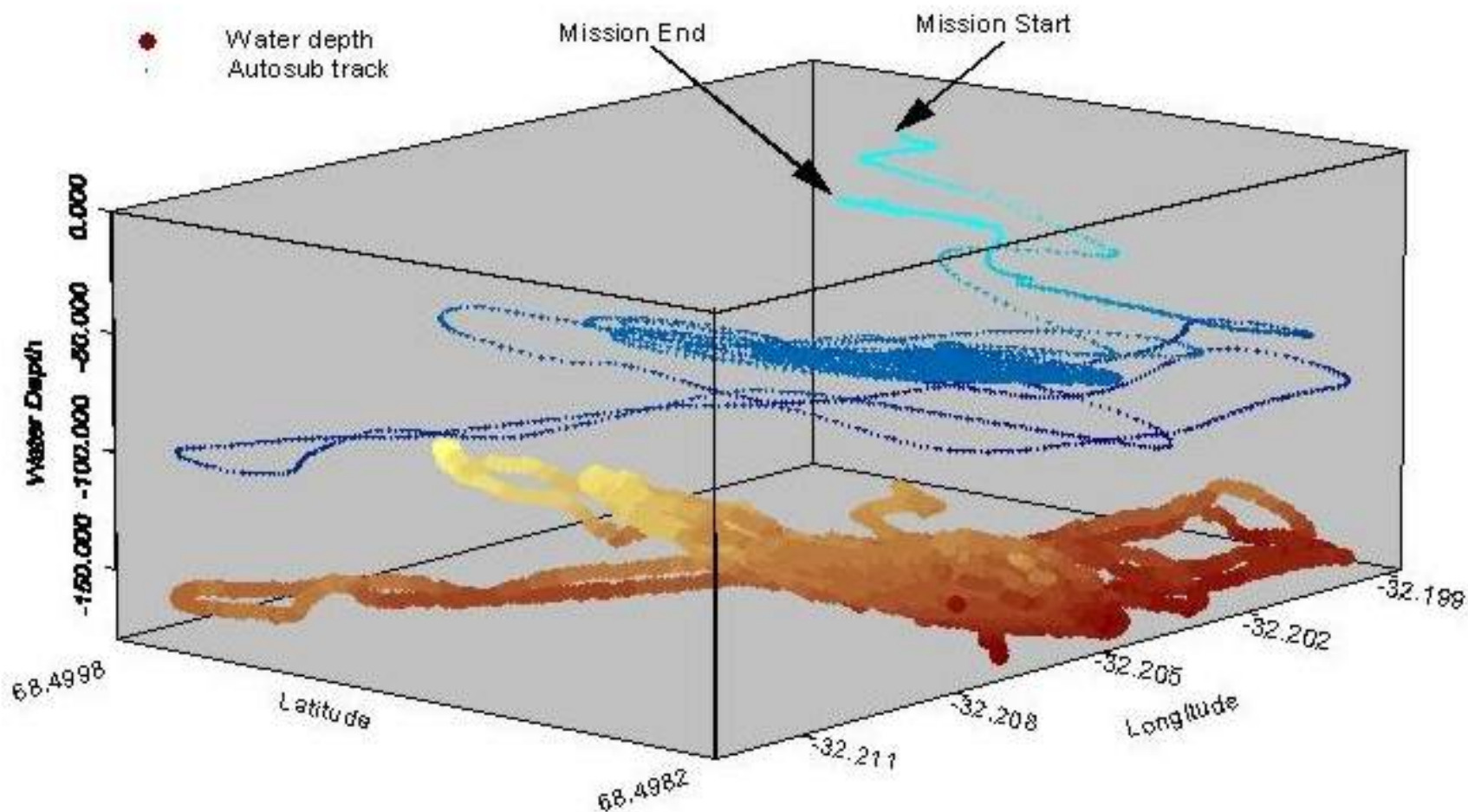
# Autonomy: Vehicle Protection

The balance between  
safety and wasting  
time





# Autonomy: Vehicle Protection





# Autonomy: Operational Simplification

- Mission Specification – Task oriented
  - Survey type
  - Bounds
  - Sensors/instruments
- Automatic fault detection and isolation
- Fault tolerance through redundancy



# Answers

- To what degree do we want to increase the **Autonomy of oceanographic AUVs?**

Not at the expense of reliability and mission completion

focus should be on robustness and reliability of the system.

change in complexity from what we are doing now is considerable. Is it really wanted?

What you want is ... a 90% prob of successful mission but a 99.5% mission that the vehicle survives



# Answers

- **What types of autonomous control behaviours would be useful?**

Nested survey – to allow higher resolution without need for relocating and revisiting a site.

Adaptive use of sensors – when to turn a side scan at a particular frequency on... adaptively change range settings... sampling rate... don't want to be wasting sampling volume (if collecting water samples).

Comment that these behaviours are very situation specific and probably not hard to implement – compared to other issues in AUV operations



# Answers

- **How can autonomous control behaviours be made to be fail safe?**

Safety mechanism... authority envelope needs to be built into the architecture, possibly running on a different processor

Autonomy is a systems approach. It is not intelligence. It is understanding the system well enough to solve your problem



# Answers

- **Has collision avoidance been solved?**

In specific cases possibly

Goalposts move – as improvements are made requirements become more testing.

Surface vessel detection and avoidance key

Collision detection yet to be implemented for AUVs.



# Answers

- **How can autonomy be used to deskill the operation of AUVs.**

Mission planning and pre-mission checking

Mission planning with model data

A danger of thinking in 2D rather than 3D.

Automatic processing of logged data for systems performance trends flagging of poorly performing components.