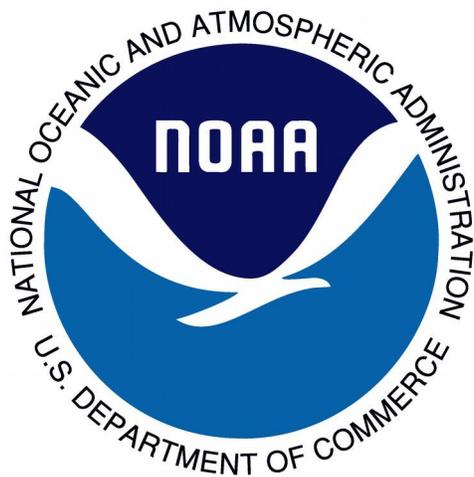


# AOML High Density XBT system setup instructions and troubleshooting manual.



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2016

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## Hardware

### 1) Hardware List

- Autolauncher
- Mk21 USB DAQ or MK21 Ethernet
- AOML Autolauncher Interface box
- Autolauncher H-base
- Autolauncher Cable (CAT5)
- Hand Launcher
- Mounting base or pipe
- Iridium Antenna with GPS and mounting hardware
- Computer (laptop)
- USB to Serial converter (Startech)
- Iridium/GPS interface box
- Test Canister
- Serial cables for interface boxes (4)
- Handheld GPS for use when deploying floats/drifters (not included in all equipment)
- C-clamps
- UPS
- Various tools

### 2) Hardware Setup Guide

#### a) Antenna Installation:

- Mount the Antenna on the bridge wing with hose-clamps. Ensure that the installation location does not interfere with ship operations. If there is any question regarding the location, ask the officer on duty if the location you are using is okay. Run the cable down and tie wrap it out of the way close to your room. From there, lower the cable to your cabin window and bring the excess into your room.
- Zip tie the antenna cable to the window or a supportive structure in the room to relieve strain on the cable.

#### b) CAT5 Installation:

- Take a short amount of cable off the roll and leave it in the room so that you have enough space to connect it up to the interface box. From there, zip tie part of it off to either the window or a supporting structure in the room to keep that amount in the room and relieve strain later on.
- Lower the CAT5 cable out of your window to the nearest deck below it.

-From there, zip tie the cable on railings or wherever it is out of the way of ship operations all the way to the stern where the autolauncher will be mounted.

c) Autolauncher Installation:

- Install the pipe or flat rail mount with the given C-clamps.
- Unpack the Autolauncher, take the Autolauncher H-base and assemble it on deck.
- Tie the Autolauncher off to the ship somewhere with a length of rope, then lift the launcher and set it on the mount.
- Tighten the screws on the autolauncher to ensure that it does not turn from side to side.
- Attach the cover of the autolauncher to prevent the salt spray from building up on the launcher.
- Once every day or two, please spray silicone lubricant on the pins of the Autolauncher to ensure smooth operation.

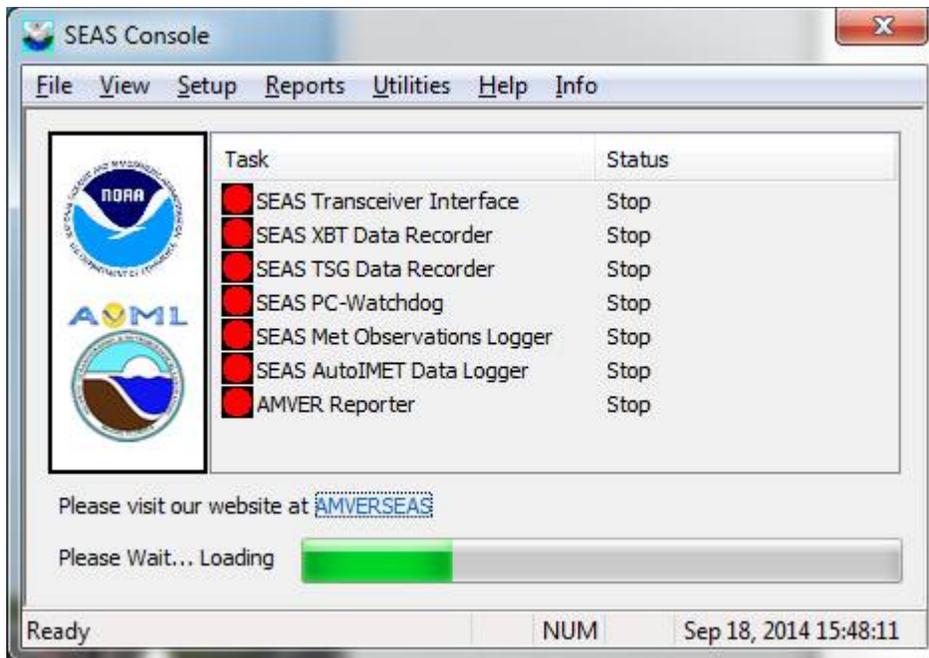
d) Cabin Equipment Installation:

- Find a place in the room that is connected to the hull of the ship and remove the paint down to bare metal with a file or wire brush. (usually the window or a bolt inside the room.)
- Attach the grounding cable to the cleaned area with the included C-clamp.
- Plug in the UPS either to the converter and turn it on.
- Plug in the computer, AL interface box, Antenna interface box, and Mk21 to the UPS. Please ensure that the Mk21 is plugged into either the #1 or #2 spot on the UPS.
- Plug the Mk21 into the ethernet switch in port 1 and plug the computer into the ethernet switch port 2. (If Ethernet Mk21)
- Plug in all of the Serial cables from the interface boxes to their relevant ports on both the Mk21 and the USB to serial box. Ports will be labeled on the USB to serial converter.
- Plug the Antenna and CAT5 cables into their respective interface boxes.
- Turn on the Computer and wait for Amverseas to start.

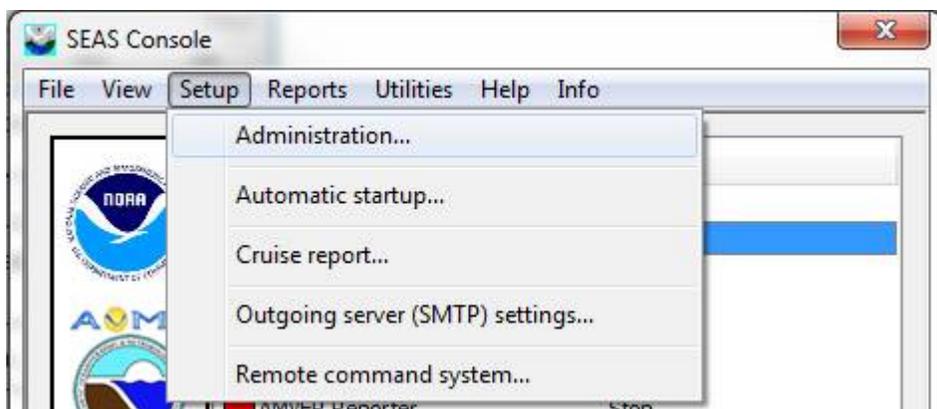
**Software:**

**Amverseas Setup and Operation:**

-There is a new SEAS console, which was previously the blue Seas Window. This is the controller that starts all of the programs in SEAS. Start a program by double clicking on it.



-Start by setting up the Administration page, which now has more areas for deeper information. This is located in the SEAS Console, under Setup-> Administration. The new fields are all important. Many are the same, such as ship name, speed, call sign, IMO number, and Medical Staff. Cruise Line is the standard AX designation for the transect, such as AX08. Cruise name is used mainly by SCRIPPS and has to have seven characters. There is also a Ship Rider section where we ask that you put your name and e-mail address. You do not need to put your phone number if you do not wish, but it is appreciated. The transect number is the number for the realization of that transect for that calendar year. For instance, if it is the AX07 and it's the 4<sup>th</sup> in 2014, the number would be 4.



Administration

Cruise

Cruise Line AX10 Start Date 8/15/2014 Transect Number 1

Cruise Name P123456 End Date 8/19/2014

Ship

Company Name Call Sign\* WPGK

Ship Name\* Horizon Navigator  Has IMO number?

Maximum Speed\* 22.50 IMO Number\* 7116315 \*Mandatory

Medical staff\* Forward INMARSAT

Nurse  MD  AMVER  MAREP

PA  None  JASREP

INMARSAT Number

Equipment type

Ship rider

Name Pedro Pena

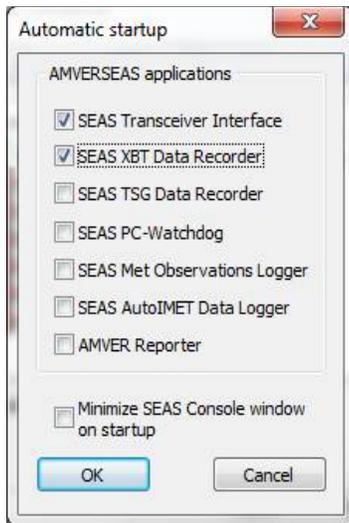
E-mail pedro.pena@noaa.gov

Phone

OK

Cancel

-Next, please check the applications that automatically set up when the SEAS console is started. This can be done by going to Setup->Automatic Startup. This will bring up a window that has check boxes to show which applications to start up. Please check the applications that you want to start up when the Seas console starts.



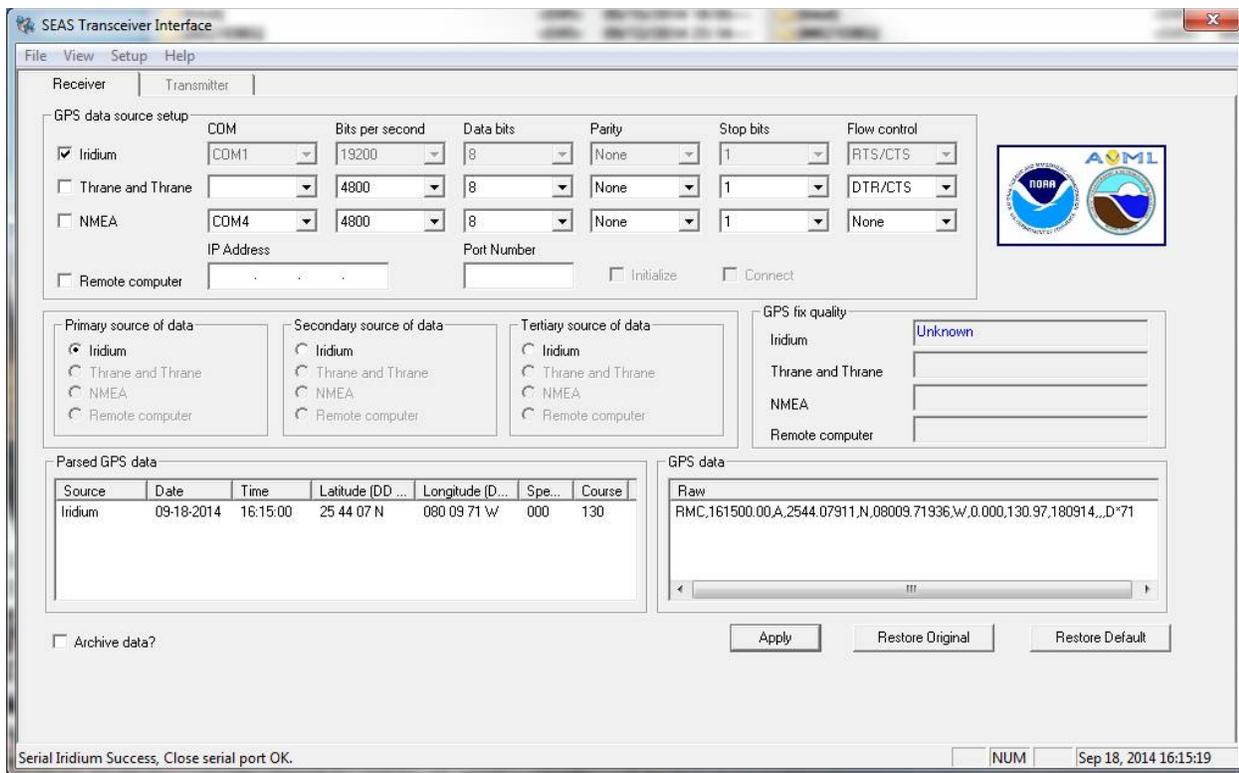
-Once the Transceiver interface starts, please ensure that the settings for the GPS are correct in the “Receiver” tab.

-For Iridium, it should be 19200 Bits per second, 8 data bits, no parity, 1 stop bit, and RTS/CTS flow control. (Note, the checkbox to the left of the settings should be unchecked to change the values, however there can never be all unchecked boxes, so another box must be checked to change the value of the relevant source.

-For NMEA, settings should be 4800 Bits per second, 8 data bits, no parity, 1 stop bit, and no flow control.

-For Thrane, it should be 4800 Bits per second, 8 data bits, no parity, 1 stop bit, and DTR/CTS flow control.

-The com ports for these selections should correspond to the ports the respective sources are connected to. The source of data groups allow you to select what sources are used for primary, secondary, and tertiary GPS.



-Under the Transmitter tab, the main thing that needs to be checked is the transmission queue location and ensure that its in C:\users\Public\Public Documents\transmissionQueue. Please also ensure that “transmit on” and “Use MS RAS dialer” The “check Queue every \_\_\_\_ minutes” should be set at 5-10 minutes.

**SEAS Transceiver Interface**

File View Help

Receiver Transmitter

FTP

Transmission queue location  
 Browse

FTP server info

Server

Upload path

User name

Password

Configure transmission

Phone-book entry name

Transmit on

Use MS RAS dialer

Check queue every  minute(s)

Transmission queue

- \5646654\_TSG\_120731184559.zip
- \5646654\_TSG\_120731195625.zip
- \5646654\_TSG\_120731201227.zip
- \5646654\_TSG\_120731202200.zip
- \5646654\_TSG\_120731202911.zip
- \5646654\_TSG\_120731203113.zip
- \TEST\_TSG\_120731203757.zip

Transmission status

Server configuration

On

IP Address

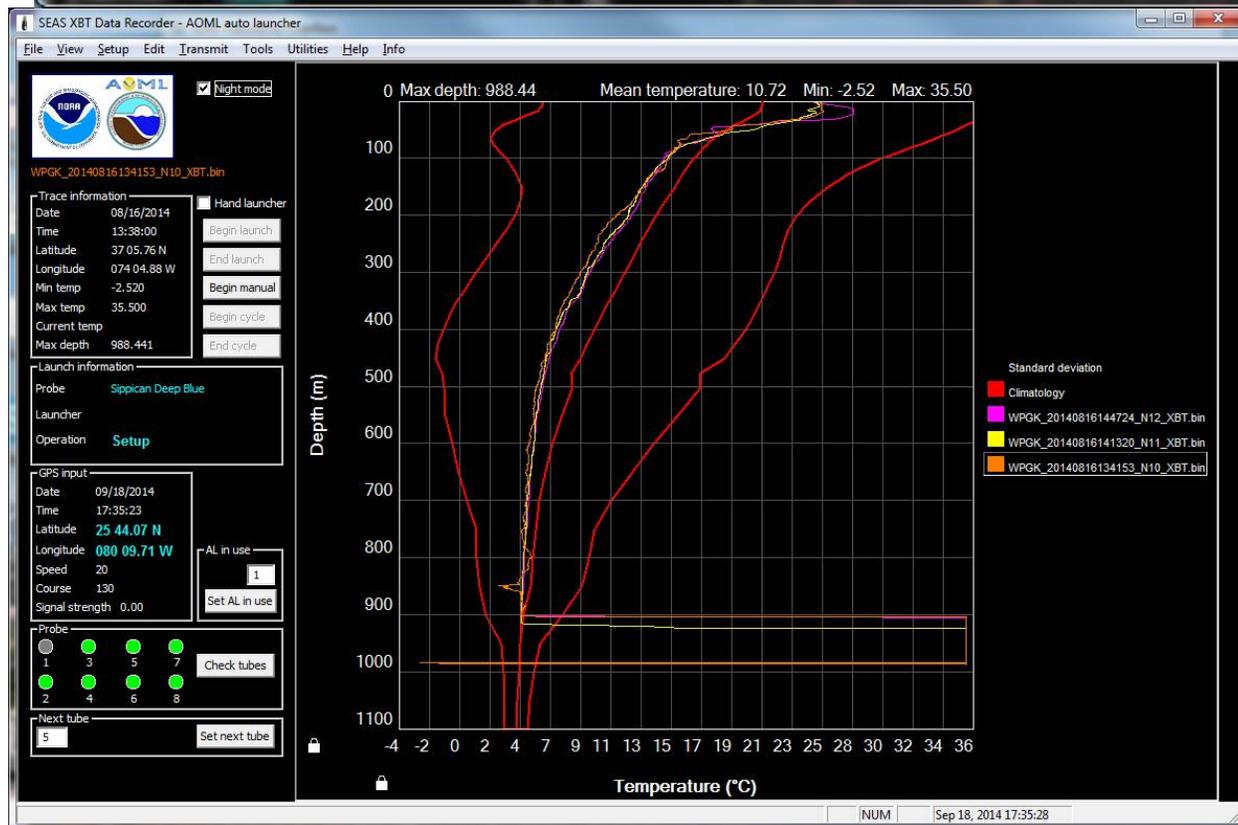
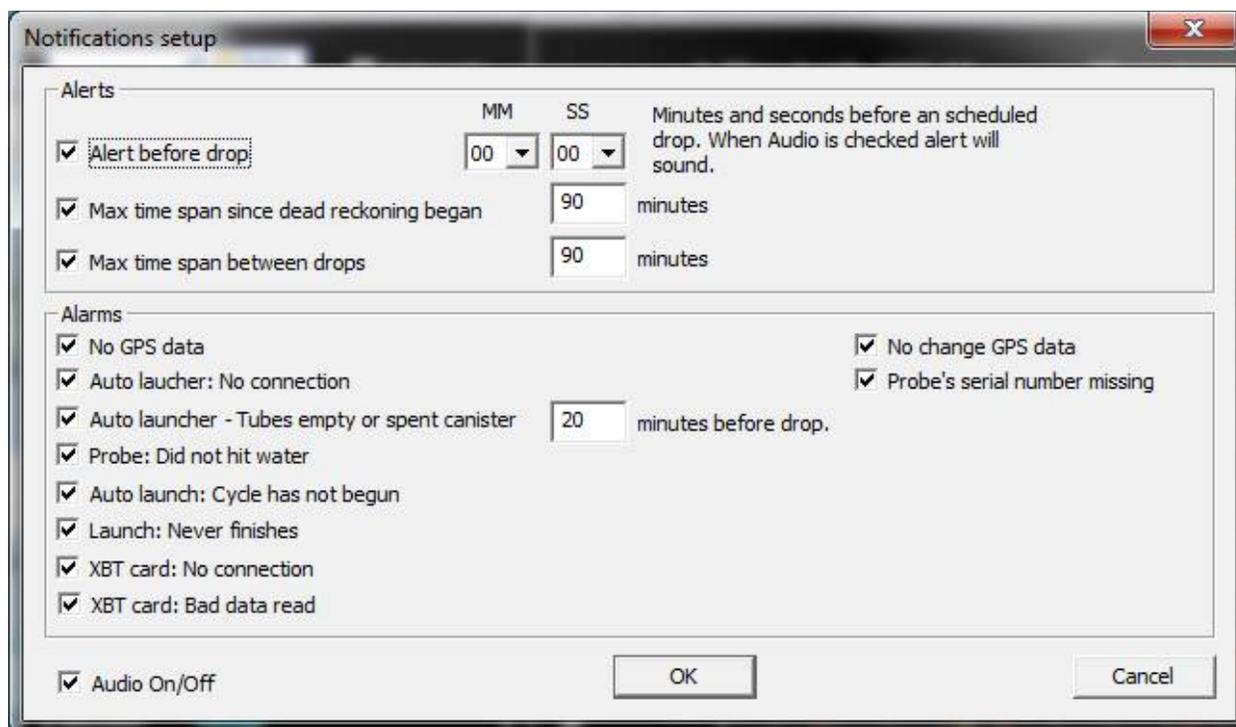
Port number

Save



NUM Aug 20, 2012 16:30:13

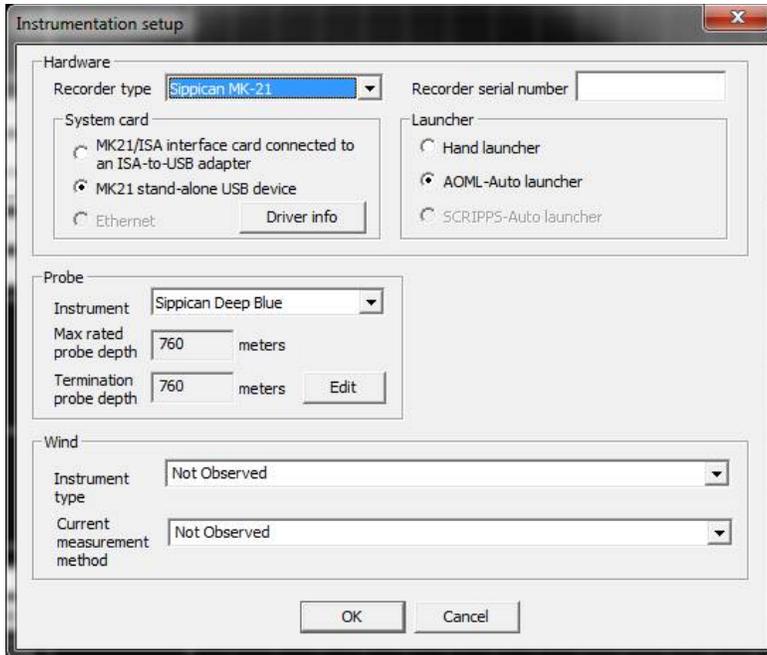
-Next, we enter the XBT Data recorder.



-If this is the beginning of a new cruise, please select Tools -> Start new cruise. This will

automatically archive any old data and will reset important values internally.

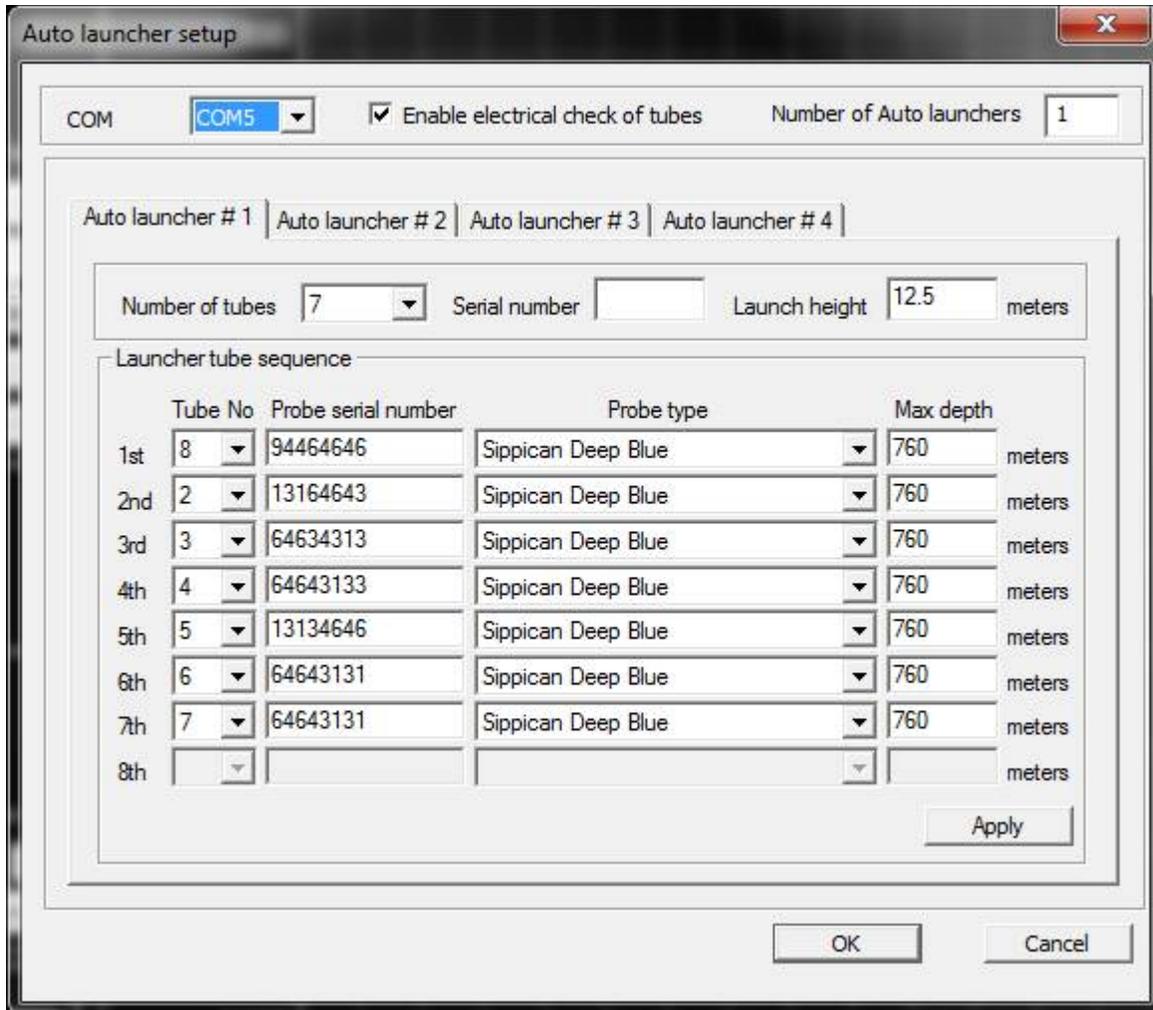
-To select the number of profiles to display, please select Setup-> Graph and choose your number of profiles to display there.



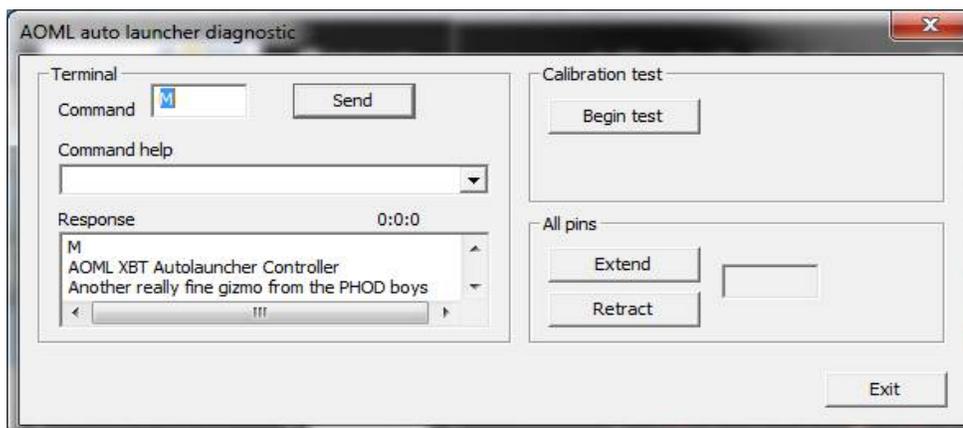
Next, ensure that the XBT recorder is set correctly. Please go to Setup-Instrumentation. Here you can select the type of Mk21, the serial number for the Mk21, and the overall type of probe.

-Next, set up the autolauncher by going to Setup->Autolauncher->Setup. Here you can set the com port

of the Launcher, the number of tubes, and the type of probe in each tube. Also, another important piece of information is input here, the Launch Height. Please ensure that you set the height of the launcher.

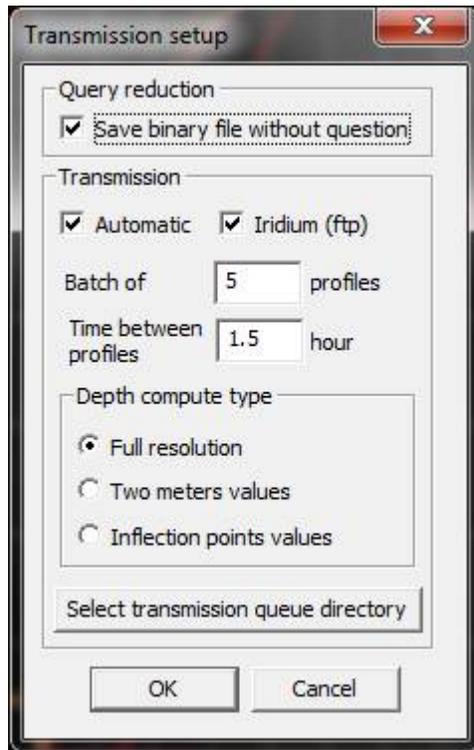


-To test the launcher, please go to Setup->Autolauncher->AOML autolauncher->Diagnostic. This will allow you to send the 'M' command and see the response.



-Next, set up the Notifications. Go to Setup->Notifications. Here you can set up the alarms and when they sound.

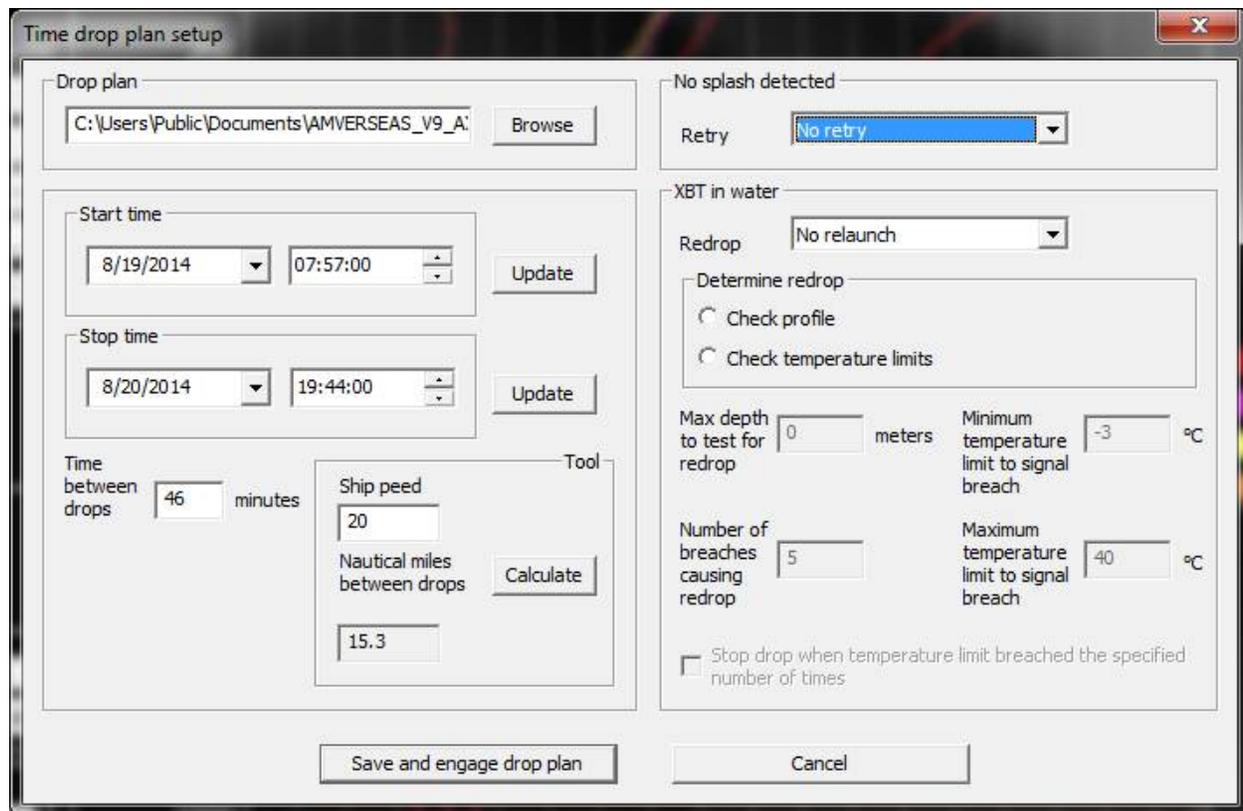
-Next, we'll check that the Transmissions are set correctly. Go to Setup->Transmission. In this window, please ensure that Save binary file without question is checked as well as automatic, Iridium, and full resolution. Batches should be 5, and the time between profiles can be roughly estimated. Also, please check that the transmission queue is the same location as was set in the Transceiver interface.



-To start a drop plan, go to Setup->Autolauncher->drop plan → Time. If this is the first time that you are starting a drop plan, please load the example plan first, located in:

C:\Users\Public\Documents\AMVERSEAS\_V9\_AX10\DropPlan\TimedropPlan

-Here you can input the start time, and an approximate end time. You can also calculate the distance between drops by inputting the time between drops, and clicking the calculate button. Here you can also set the parameters for what SEAS will do if it sees a bad probe or does not detect a splash. Please set them to retry and redrop after checking profile and temperature limits.



-In the main XBT data recorder window, you can perform an electrical check of the tubes by clicking the “check tubes” button. After you perform a tube check, a window will appear for you to input the serial numbers of the probes.

-You can also set which tube will be the next one to be dropped by inputting a number and clicking set next tube. To start a manual Autolaunch, click the Begin Manual button. If you wish to make a hand launch, check the Hand Launcher box and click begin launch.

-In the drop window, you will see climatology which will be two outlying paths that give the historical range for climatology in that region. In the middle will be an average drop from that location. This should be similar to the XBT trace that you obtain.

-At the end of your cruise, you will need to generate a cruise report. There is an option for Amverseas to automatically generate a report of the cruise. In the XBT recorder, select tools->Generate Cruise report

-This brings up a window where you can put in notes, confirm your name, show the number of launches and number of deployed XBTs, and add notes for the rest of the report.

-To add additional information to the report, click on “Additional Information” Once you are done, click “Generate Cruise Report” This will allow you to print and preview

the print of the cruise report.

-To generate a file of the cruise report, click “Generate Cruise Report” at the bottom of the cruise report window. -Please also print it and select Microsoft xps printer or PDF printer to save it to a file so we have an additional copy.

-Please also generate a “historyallprofiles” file by clicking Utilities -> Generate and open profiles history file. This file will be located in:

C:\Users\Public\Documents\AMVERSEAS\_V9\Report\XbtDataRecorder\HistoryProfile  
s.txt

File View Help

Ship rider

Ship rider name

Ship rider

Ship rider

XBT

Deployed XBTs

Number of

Deployment notes

XBT(s)

Drifter(s)

Argo(s)

Launch's note

Launch#

Note

Transmission

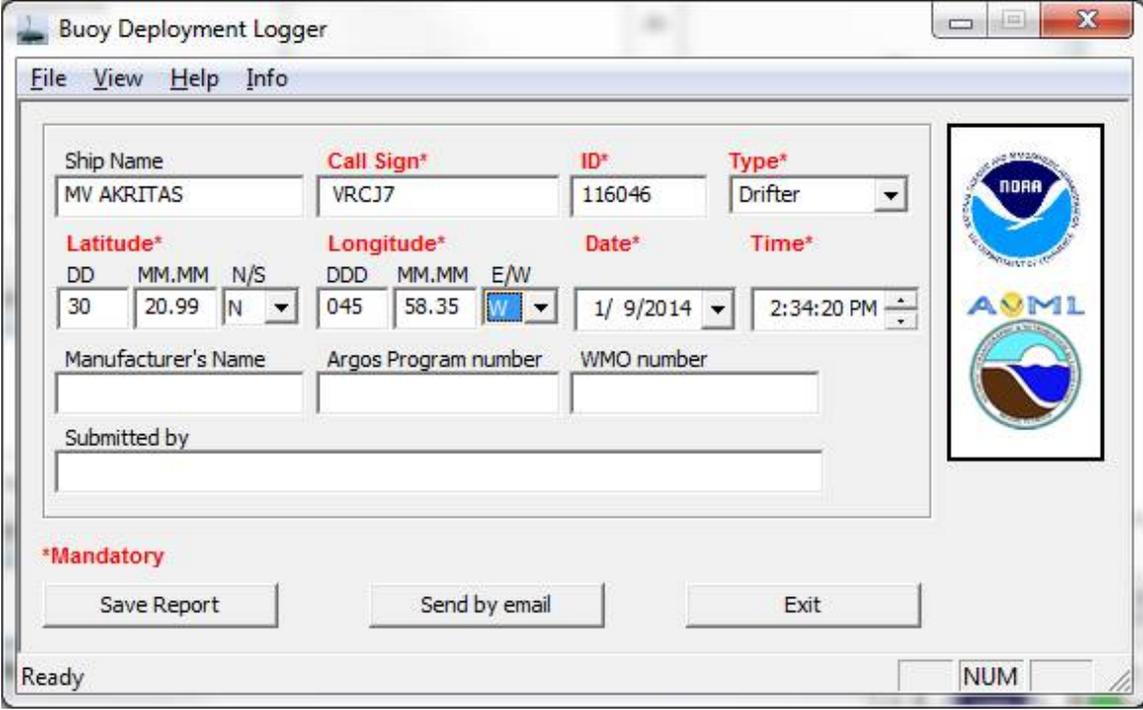
For Help, press F1

-The XBT data files can be accessed from the XBT window, under Utilities - > Open Folder Containing Archive Data. The generated cruise report should be here as well.

## Argo and Drifter Deployments:

-There is a new reporter for Argo and Drifter deployments. To do this, go to reports->Buoy deployment logger. The window that pops up should have the ship name, call sign, and IMO already input.

-You can input the type of instrument, position, time, date, and any other information you deem necessary. Then you can save it or send it by e-mail to the appropriate agency/person.



The screenshot shows a Windows-style application window titled "Buoy Deployment Logger". The window has a menu bar with "File", "View", "Help", and "Info". The main area contains several input fields and dropdown menus for recording deployment data. The "Ship Name" field is filled with "MV AKRITAS". The "Call Sign\*" field is "VRCJ7", "ID\*" is "116046", and "Type\*" is a dropdown menu set to "Drifter". The "Latitude\*" section has fields for "DD" (30), "MM.MM" (20.99), and "N/S" (N). The "Longitude\*" section has fields for "DDD" (045), "MM.MM" (58.35), and "E/W" (W). The "Date\*" is "1/ 9/2014" and "Time\*" is "2:34:20 PM". There are also empty fields for "Manufacturer's Name", "Argos Program number", and "WMO number", and a "Submitted by" field. On the right side of the window, there is a vertical stack of logos: NOAA, AOML, and another NOAA logo. At the bottom, there are three buttons: "Save Report", "Send by email", and "Exit". A status bar at the bottom left shows "Ready" and a "NUM" indicator on the right.

Ship Name	Call Sign*	ID*	Type*
MV AKRITAS	VRCJ7	116046	Drifter

Latitude*	Longitude*	Date*	Time*				
DD	MM.MM	N/S	DDD	MM.MM	E/W		
30	20.99	N	045	58.35	W	1/ 9/2014	2:34:20 PM

Manufacturer's Name	Argos Program number	WMO number

Submitted by

Submitted by

\*Mandatory

Save Report      Send by email      Exit

Ready      NUM

## **Troubleshooting:**

### **Quick checks:**

#### **AmverSeas:**

- Is AmverSeas frozen, needing a restart? Note: During initial deployments, amverseas will appear to windows to have frozen. Please give this a few minutes as it takes a long time to initialize the Mk21 and start a drop sometimes.
- Is the computer frozen, needing a restart?
- Is there just one seas window that is frozen?
- Are there any software alarms? What are they?
- Are there any error dialog boxes present?

#### **Autolauncher:**

- Do communications between the computer and autolauncher occur? (Check in the setup window in AmverSeas.)
- Is the Launcher Detecting probes? Is the failure in one tube or all? Was the pin pulled on the XBT?
- Are there wires from a previous drop that might be interfering with current drops?
- Is there any unusual weather or extreme weather?

#### **Mk 21:**

- Can you hear the MK21 click as it tests the probe?
- Does AmverSeas freeze when a profile starts?
  - The MK21 would need to be power-cycled and the xbt program might need to be restarted.

#### **Remember to check the easy things first, such as:**

- Check the software settings
- Power everything off, then back on
- Check connections
- Re-Terminate connections if there is issue
- Check that the pin retracted on the autolauncher
- Make sure that the pin was pulled on the XBT
- Make sure there is an XBT in the corresponding tube to the one that was tried.

-If the result is the same issue, begin hand launching. The priority is to get the data. The hand launcher can assist with troubleshooting. For instance, if the hand launcher and the autolauncher are giving the same type of error, the problem could be in the cable, or with the computer or MK21.

## **Some Common Error Methods:**

### **1) Seas has performed normally, and the XBT was detected, but there was no data collected. (No Splash)**

- Make sure that the XBT pin was pulled
- After AmverSeas times out, try the next tube. (It could be that the probe itself malfunctioned.)
- See if the XBT left the launcher. (It could be either a pin not dropping or not a large enough angle on the autolauncher.)
- An empty canister with a wire still attached can show a probe where there is none. Check for trailing wires.

### **2) The Hand launcher or Autolauncher will not detect probes or collect data.**

- Check the USB connection, and check in the device manager to make sure that the computer is recognizing the MK21.
- Check the hardware version for the MK21 in the seas software. Seas>XBT Hardware Versions
- Try swapping the MK21. The first one may have intermittent problems, or may not be working correctly.

### **3) Seas seems to be working properly, but the Autolauncher does not recognize the XBTs.**

- Try a different tube. If the tube is not recognizing any probe, the tube may be faulty at some point. Discontinue use of that tube and do not fill that one with XBTs
- If no XBTs are detected, perform a hand launch with the test canister.

### **4) The Hand Launcher recognizes probes, but the Autolauncher doesn't.**

- This points to a problem with the autolauncher or connections. The MK21 should be working properly.
- Check the connections to the autolauncher again, looking for corrosion and places where wires might not be making connections.
- Check communications with autolauncher. (Use the Setup>Autolauncher>Diagnostics menu to test communication.)
- Check Software configuration again, just to be sure.
- Check the ground for the autolauncher. Try cleaning it and the surface it attaches

to again, just to make sure that there is a clean surface and good connection.

- Try the spare autolauncher. Swap them out, performing hand launches if any drops occur as you replace it.

#### **5) The hand launcher works with the secondary cable, but not with the primary.**

- This points to either a bad cable, or bad terminations (cat5 only) at either end of the cable.
- Try re-connecting everything first.
- Use the CAT5 Checker, if supplied. This consists of two ends, one to be placed on either side of the cable, and sends a signal to all wires and looks for bad connections or losses, giving indications of issues with lights. **This is not a perfect tester. It can give good status when something is bad.**
- If that doesn't work, or there are still issues, try re-terminating the original cable first. With the CAT5, Make sure you use the "B" termination style, which is as follows for the pairs: Pins 1-8 correspond to these wires – orange/white, orange, green/white, blue, blue/white, green, brown/white brown.
- If that does not work, begin running the secondary cable, hand launching for each drop in between. The easiest way to do this is to bring the hand launcher with you as you run the cable. Disconnect it when you run the cable, and reconnect it before you go to start the drop.
- To perform a hand launch away from the computer, stop the Autolauncher cycle, click "perform manual hand launch" and make sure it gets to the "load probe" stage. Head down to the launcher, load the probe, wait 30 seconds, then drop the probe. Allow the probe to deploy for 3 minutes, or until the wire breaks. Head back to the cabin to make sure that the drop went well.

#### **6) The seas program freezes in the middle of a drop.**

- This points to a MK21 power issue.
- Restart the XBT program and see if that fixes it. If not, restart the XBT program and perform a drop again.
- Try to find the place with the cleanest power as this is usually caused by a power source that is fluctuating enough for the MK21 to brown out and not be detected by the computer.
- If you have a UPS, ensure that the MK21 is plugged into the section that provides battery backup for the power.

#### **Other troubleshooting options:**

**The Mk21 keeps losing connection between drops:**

- Please check that the “USB sleep” option is not checked in power settings> advanced settings.
- Please ensure that the Mk21 and the Serial to USB converter are the only USB devices plugged into the computer.
- Please also ensure that only Amverseas and its programs are running. Other programs can interfere with the successful operation of the software.
- As another test, you can try to make sure that it is not dirty power somehow coming through the UPS, even though it shouldn't. To do this, unplug the UPS, and power cycle the Mk21 before a drop and let the drop happen. If this continues, it might be a dirty power issue.

**The mouse goes wild and moves all around the screen:**

- The main cause of this issue is an issue where Windows thinks that the GPS input is a mouse. It will show up in the device manager as “serial ballpoint mouse”.
- To stop this, unplug the GPS when the mouse is going wild. Go to the device manager and under mouse, locate “Microsoft serial ballpoint mouse”
- Next, right click on the ballpoint mouse and select “Disable” This will ensure that the issue does not happen with that serial port in the future.

**The XBT equipment is causing an alarm on the ship when the ground is connected:**

- This can be caused by many things, but is most likely an issue on the boat side. If it cannot be remedied by the electrician or chief engineer in the engine room, you can try a few things:
- If you are using a power strip, please remove it. The UPS can handle all of the power connections for the gear and will not be an issue. Power strips with surge protectors can cause issues with some of the active systems in a ship and create an alarm.
- You can also try unplugging the UPS before a drop and connect the ground cable to the ship.

## Appendix A:

### XBT - Principle of Operation

The circuit diagram of the XBT probe is shown in Figure 21. Supplying a constant current (about  $30 \times 10^{-6}$  A) through both the thermistor and resistor to ground allows  $V_1$  and  $V_2$  to be measured with respect to ground (point D in Figure 12). Using  $V = I \cdot R$ :

$$V_1 = I \cdot (R_{\text{thermistor}} + R_{\text{wire}} + R_{\text{water}}), \text{ and}$$

$$V_2 = I \cdot (10^4 \Omega + R_{\text{wire}} + R_{\text{water}}).$$

The difference,  $V_2 - V_1 = I \cdot (10^4 \Omega - R_{\text{thermistor}})$ , yields  $R_{\text{thermistor}}$  and hence the ocean's temperature, given the calibration curve of the thermistor. Resistances of thermistors vary inversely with temperature. Depth is simply inferred from time. The probe lightens as its wire unspools, so depth is calculated from a second degree polynomial (Sippican, 1994, MK12 Oceanographic Data Acquisition System, User's Manual 306677-1: Sippican Ocean Systems, Inc., Marion, Massachusetts.) to include acceleration:

$$z \text{ (meters)} = 6.472 t - 0.00216 t^2 \quad (t \text{ in seconds}).$$

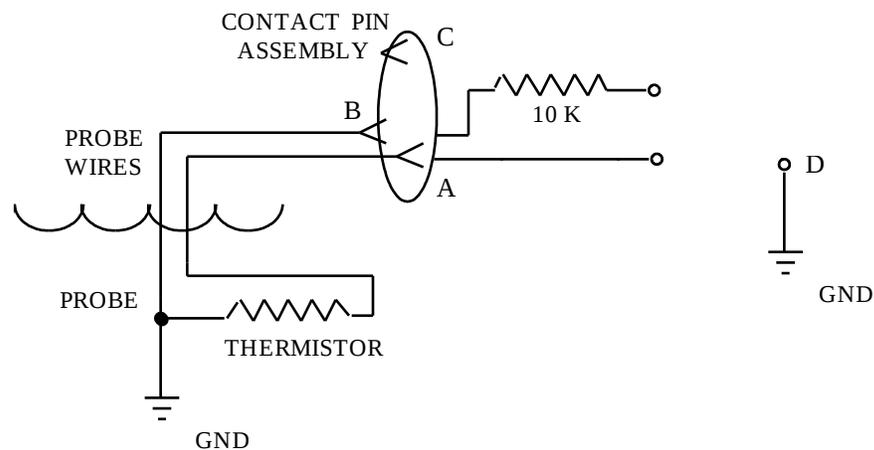


Figure 1: Circuit diagram of the XBT probe.



## Appendix C: XBT equipment pictures

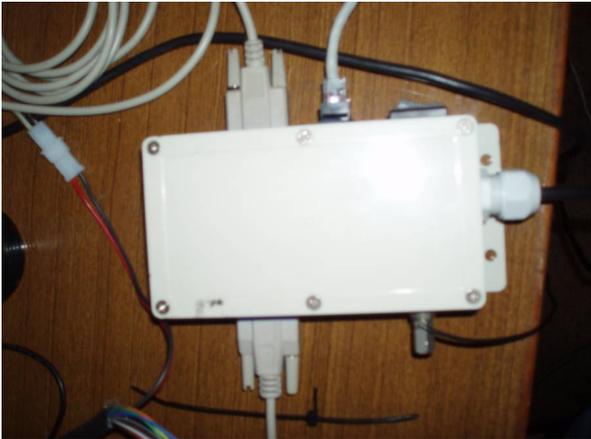
- AOML 8 Shooter AL



- MK21 USB DAQ



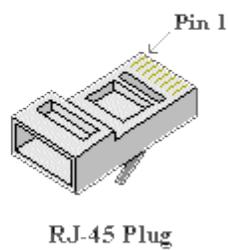
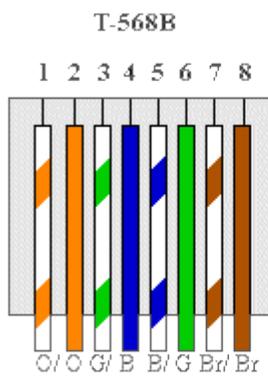
- AOML auto-launcher (AL) interface box



- Test Canister



- AL cable (CAT5)



Please use the “b” format for re-crimping the CAT5 cable, shown above.

- Hand-launcher



- Flat Rail Mount and plastic ground isolation



- Iridium Antenna Mounted on bridge wing



## Appendix D:

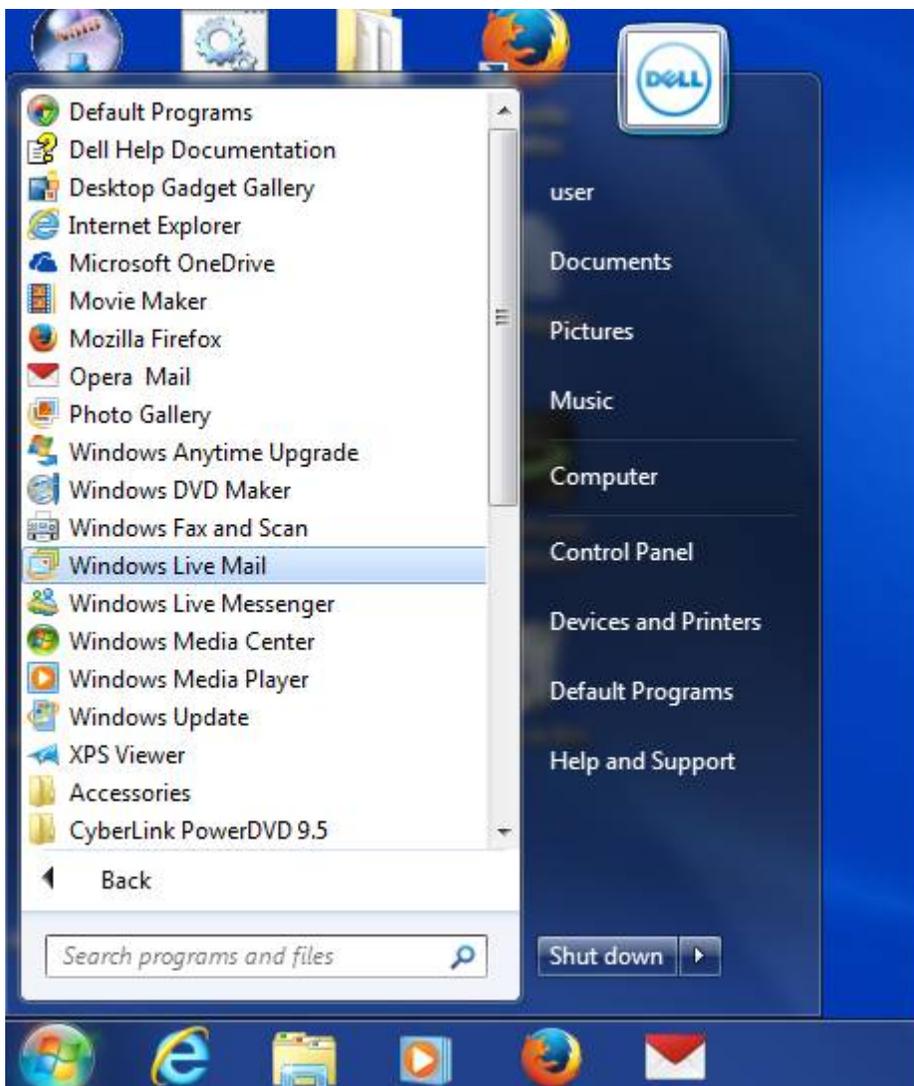
### Sending and receiving emails with Iridium

Note: Sending and receiving emails over a satellite connection is slow and potentially expensive.

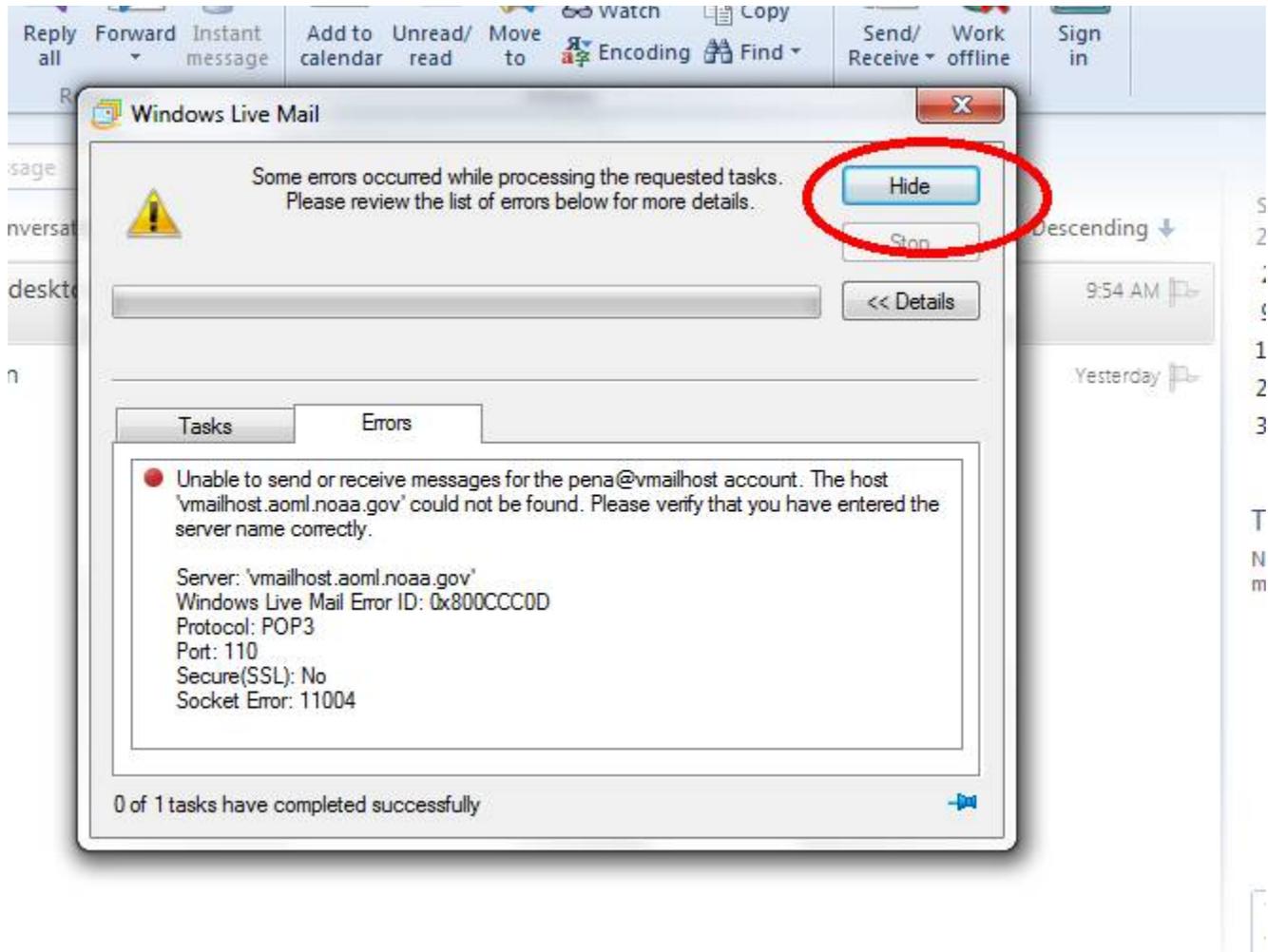
Please follow these steps when sending and receiving emails. This will help to minimize connection times and keep costs down.

1. Open “Windows Live Mail” You can find this under “start--->All Programs-->Windows Live Mail”

If you don't see it in the list, you can click on start and begin typing in the search field for “live mail”



Since you will probably not be connected to the iridium gateway when starting windows live mail, you might see an error dialog. Disregard this error and click on the hide button.

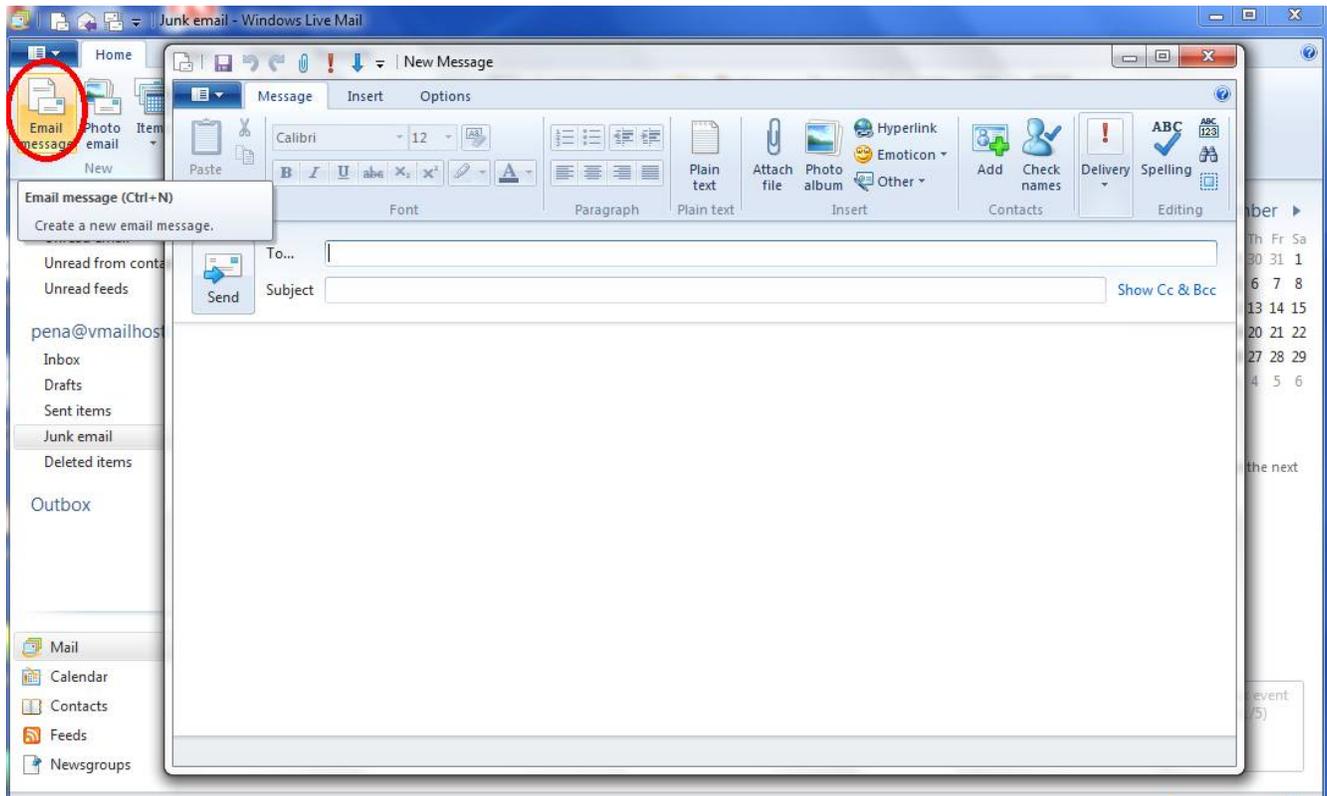


2. To compose a message(s), click on the on the “Email message” icon in the upper left hand corner.

A window where you can compose a message opens up.

When done click on the send button.

If you’re only going to check for messages then disregard this and go to the next.

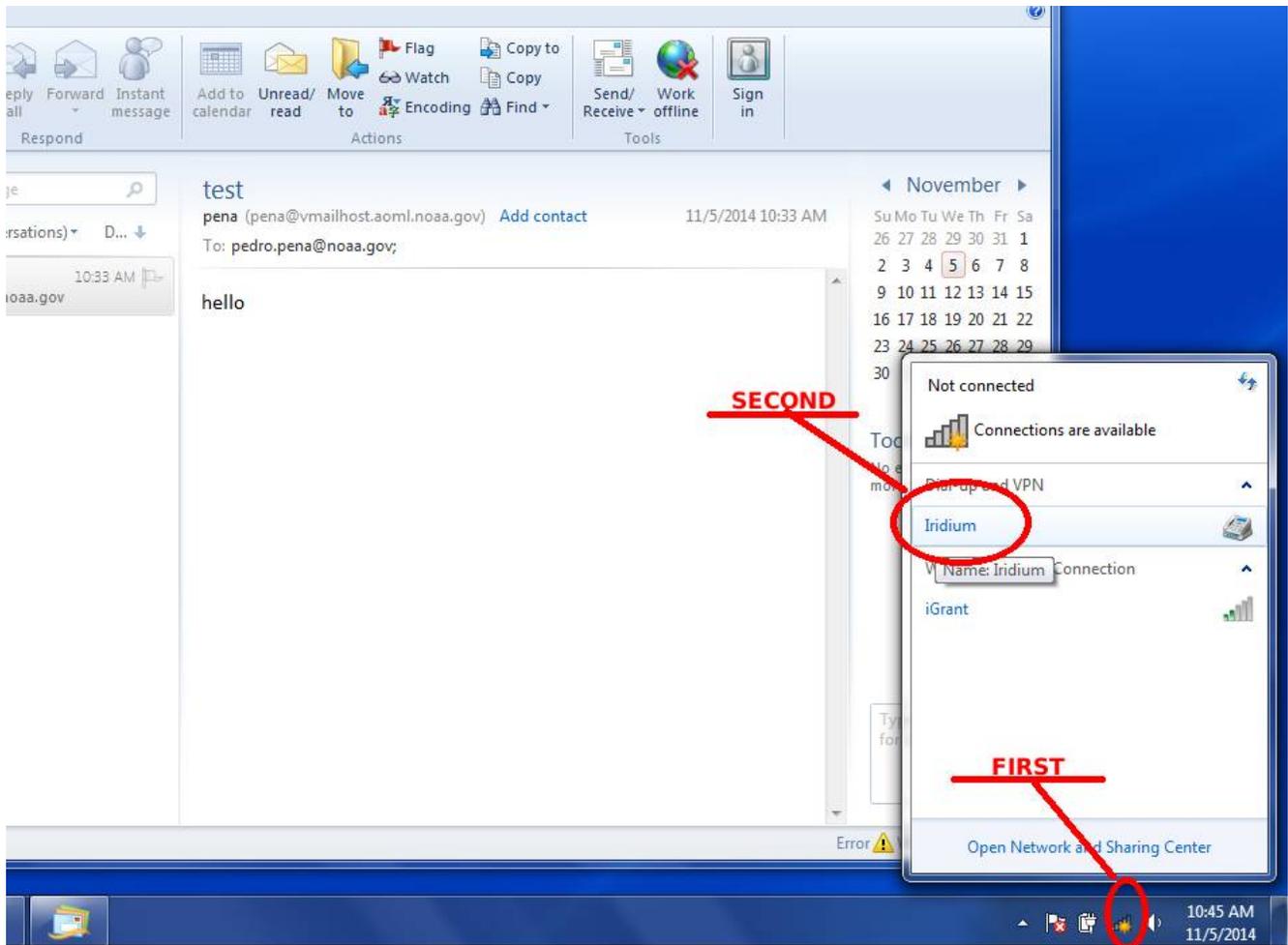


Your message(s) will now be in the outbox folder.

3. To send these messages and receive new ones, connect to the iridium gateway. To do this, click on the network connection icon in the lower right hand corner of the screen.

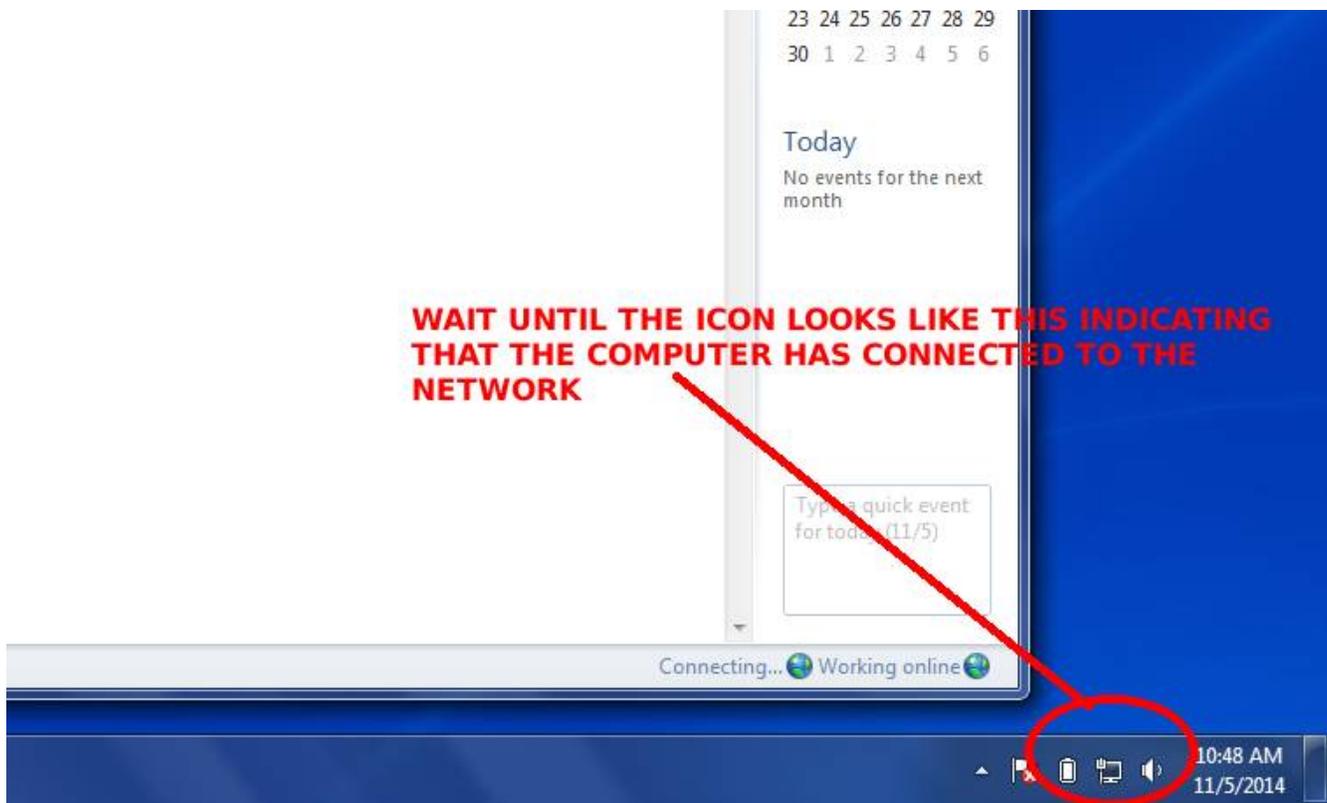
A mouse over message should appear indicating that the connection is offline. “Not connected”

Under “Dial-up and VPN”, Click on Iridium and click on dial. The dial option will appear when you click on “Iridium”



4. Wait for the connection to be established.

The network icon on the bottom right hand side of screen will indicate that a network connection was established.



5. When the connection is established click on the send/receive icon in the upper right hand corner of the mail client.

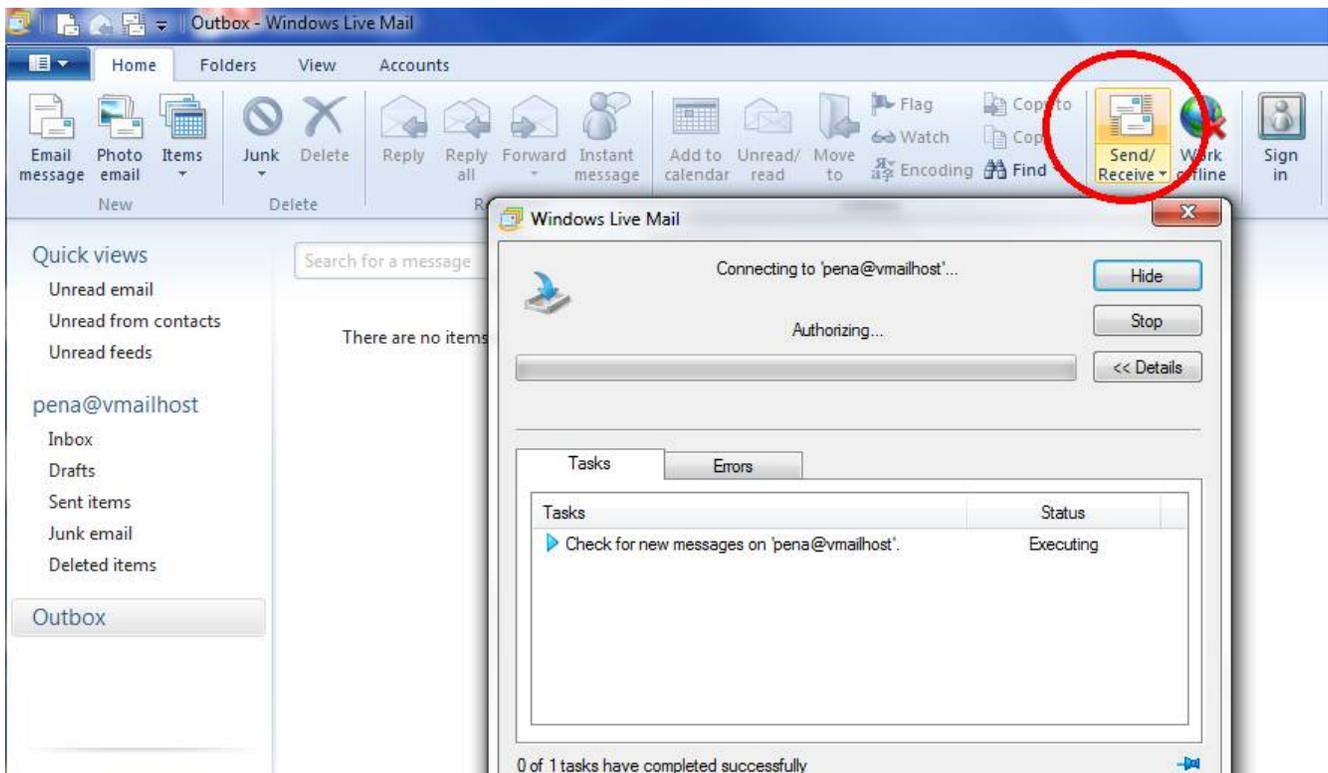
A smaller window will appear showing the status of the mail client while trying to send/receive.

Sometimes this window doesn't show up but it's still nonetheless connecting to the mail server.

If it doesn't appear you can click on the send/receive icon again and it should appear.

It is recommended to un-hide the details by clicking on the details button so that one can have more info and diagnose possible connection problems.

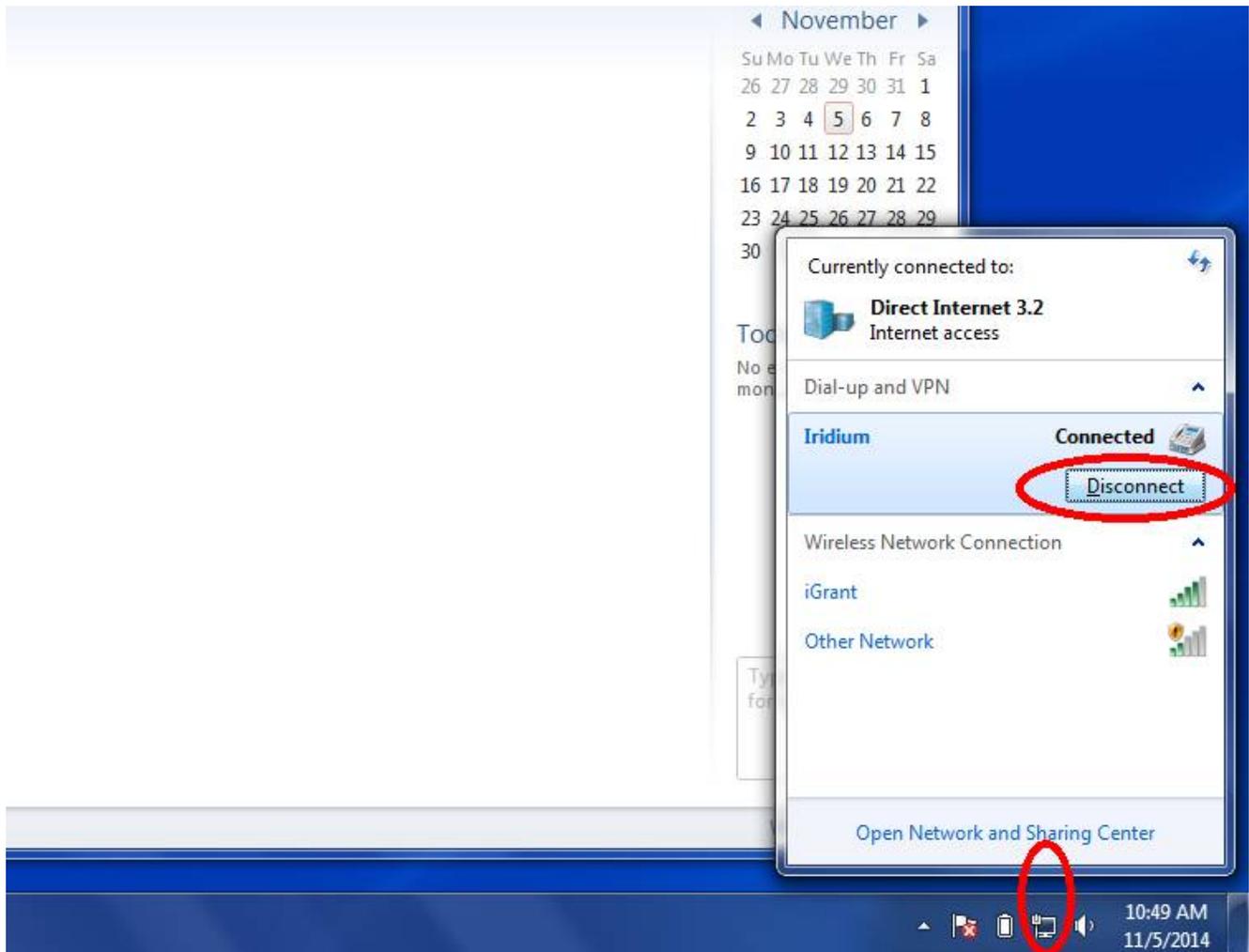
This part can take several minutes depending on the satellite link quality and/or the number of messages to send/receive.



6. Once the messages have been sent and received, it is important to disconnect from the iridium gateway.

These satellite connections are charged by the minute and can get expensive.

To disconnect, bring up the network connection by clicking on the network icon on the bottom right hand side of the screen. Find Iridium and click on disconnect.



## Appendix E:

### XBT Profile Examples and Troubleshooting

- 1 - Standard Good Profiles.
- 2 - Faulty Profiles.
- 3 - Anomalous Good XBT Profiles.

#### 1 Standard Good Quality Profiles

This section gives examples of standard AOML XBT profiles.

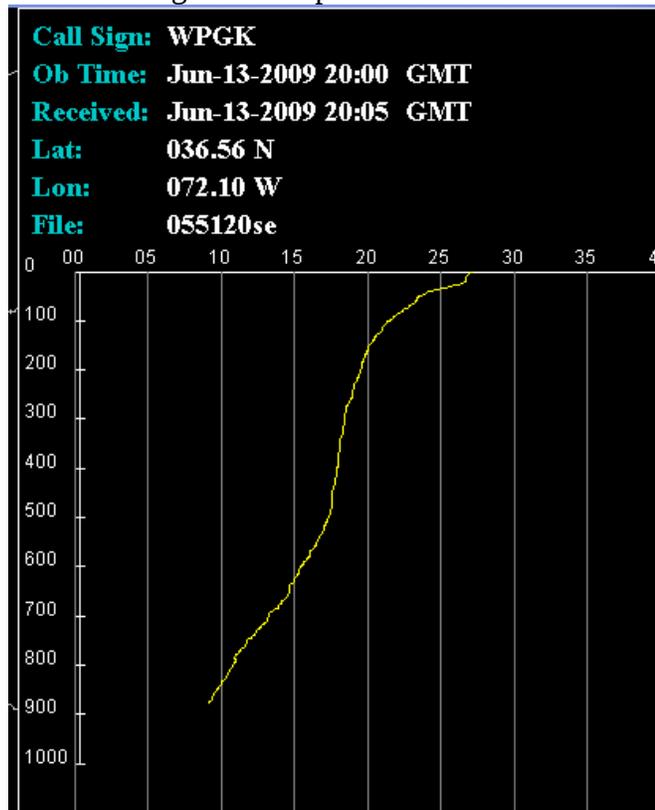
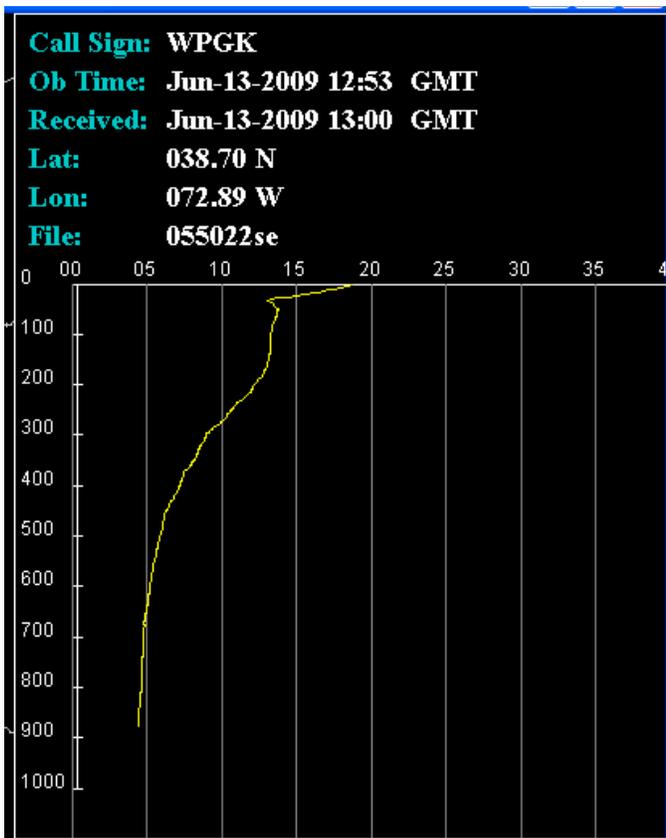
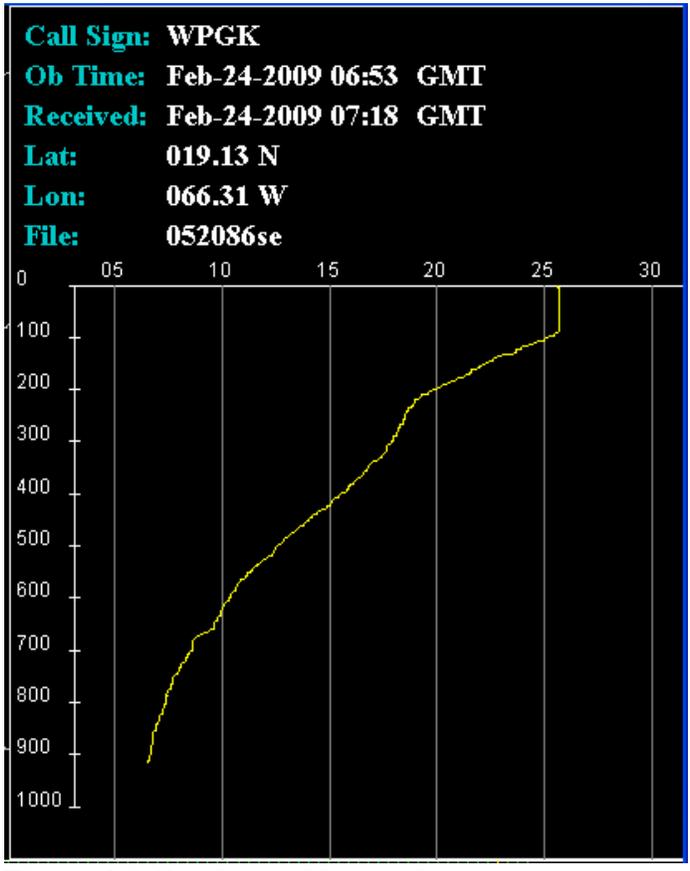


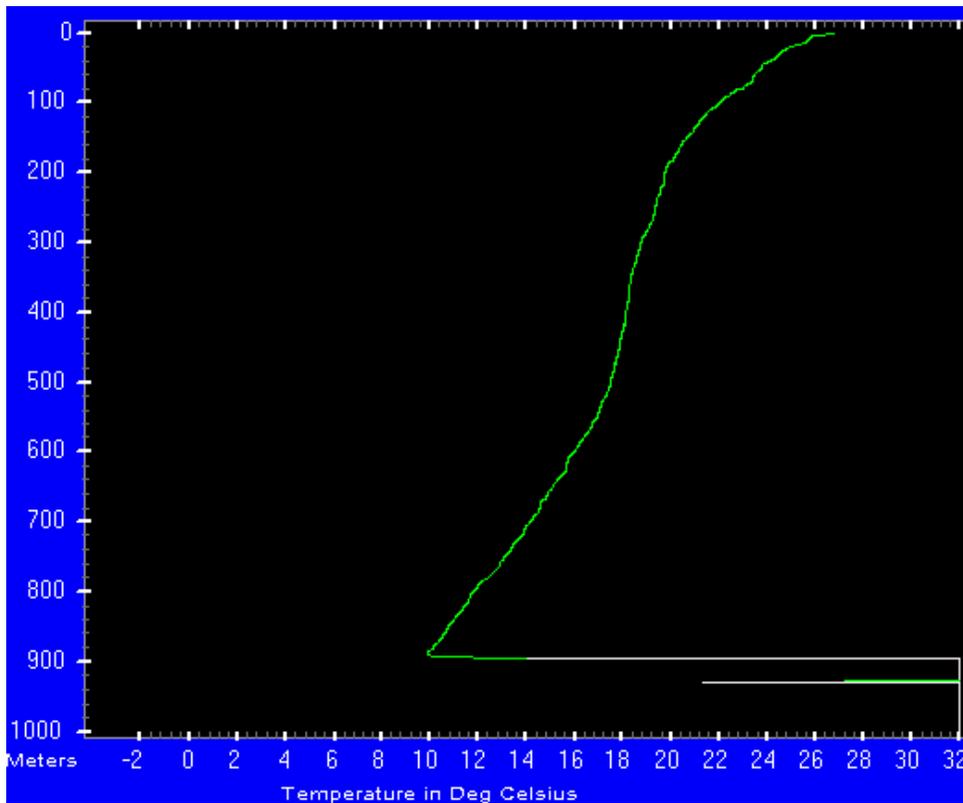
Figure 1.1 This plot is a good plot east of Gulf Stream.



**Figure 1.2 This plot is a good plot west of Gulf Stream.**



**Figure 1.3 Good mixed layer plot.**



**Figure 1.4 Good plot with bottom hit at 900 meters.**

## 2 ANALYSIS OF XBT FAULTY TRACES

Much of the content was taken from the “Devil XBT System User Manual” May 2008, Royal Australian Navy

### 2.1 INTRODUCTION

All XBT traces need to be analyzed to determine which data points constitute good data and which data points are erroneous. For instance, the thermistor temperature needs time to adjust once it enters the water so true sea temperature isn't sensed until about 4m depth. Additionally, data points further down the profile may need to be rejected for a number of reasons, including:

- ☐☐ **Damaged to the probe or wire**
- ☐☐ **Fouling of the electrical contacts in the launcher**
- ☐☐ **A hit-bottom event**
- ☐☐ **Electrical interference**
- ☐☐ **False Splash Detect**

This section summarizes the main causes of erroneous XBT data and gives specific examples of affected profiles. Where relevant, this section also suggests some operation and maintenance procedures that will minimize the occurrence of erroneous data. Any remarks concerning faults that occur during XBT deployment can be included with the XBT Log. Some erroneous profiles may appear very similar and this information greatly assists with data analyses and generally increases

understanding of the system.

## 2.2 WIRE DAMAGE

The XBT wire is very thin and will break with less than 0.5 kg tension. Damage to the insulation coating and contact of metal to seawater causes unpredictable changes in wire electrical resistance, which in turn results in erroneous temperature readings. The XBT wire may also be stretched through fouling on the launcher tube or floating objects. For all types of wire damage (insulation, stretch, and break) data is erroneous beyond the initial point of damage.

### 2.2.1 Wire Break

#### **Cause and Effect:**

Too much tension in the wire will cause it to break prematurely. A wire break causes an open circuit or a short circuit, deflecting temperature values off the scale in the positive or negative direction. A positive deflection indicates the wire break from the probe spool, negative deflection indicates wire break from the launcher spool. If the break occurred at launch no visible profile is produced because the measurement is off the scale.

[See Figures 2.1, 2.2, 2.3](#)

#### **Remedy:**

Expendable bathythermographs should always be handled with care and stored in their protective boxes in a cool environment free from salt spray. If a probe is loaded with its wire in a tangled mess, then most likely the wire will break shortly after launching. If wires are breaking regularly examine the end of the launcher tube and make sure it is smooth and free from burrs. Try Turning and/or moving Auto Launcher to a better location

### 2.2.2 Wire Insulation Penetration

#### **Cause and Effect:**

Abrasion to the wire against the ships hull or launcher will damage the XBTs wire. Damaged wire results in sharp spikes toward the high temperature end of the scale that may or may not recover to normal.

[See Figures 2.4, 2.5](#)

#### **Remedy:**

Most probable cause is a slight burred edge or groove at the end of the launcher tube; examine to make sure it is smooth. Other possible sources of damage are wire contact with ships hull or wire contact with floating debris; examine these possibilities also if wire insulation damage consistently reoccurs. Salt crystals may build up in the launcher tube, which can abrade the XBT wire. To remove salt deposits cleaning with a cloth and fresh water is recommended.

### 2.2.3 Leakage

#### **Cause and Effect:**

This malfunction is a result from slight (not complete) damage or distortion to the wire's protective coating. The result is a jittery profile over a range of depths. This fault is very similar to wire insulation penetration and often precedes it.

[See Figures 2.6, 2.7](#)

#### **Remedy:**

Correct storage of the probes is important in keeping the wire in good condition. Ensure the XBTs are kept in their protective boxes in a cool environment free from salt spray. The life span of a probe is around four years and the insulation material may begin to decay after this time.

## 2.2.4 Wire Stretch

### Cause and Effect:

A wire stretch results from an increase in tension in the wire often due to restricted unreeling. The result is a false increase in temperature until the wire ceases stretching or breaks.

See Figures 2.8, 2.9, 2.10

### Remedy:

As with wire breaks the same care needs to be taken when handling and storing XBTs. However, it is difficult to accurately distinguish a wire stretch from a real oceanographic feature and the best course of action if a wire stretch is suspected is to launch another XBT. Try Turning and/or moving Auto Launcher to a better location.

## 2.2.5 Wire Hitting Hull

### Cause and Effect:

A wire into the Hull may be caused by ship motion or AutoLauncher placement

See Figures 2.11

### Remedy:

Try Turning and/or moving Auto Launcher to a better location.

## 2.2.5 Examples of Wire Break

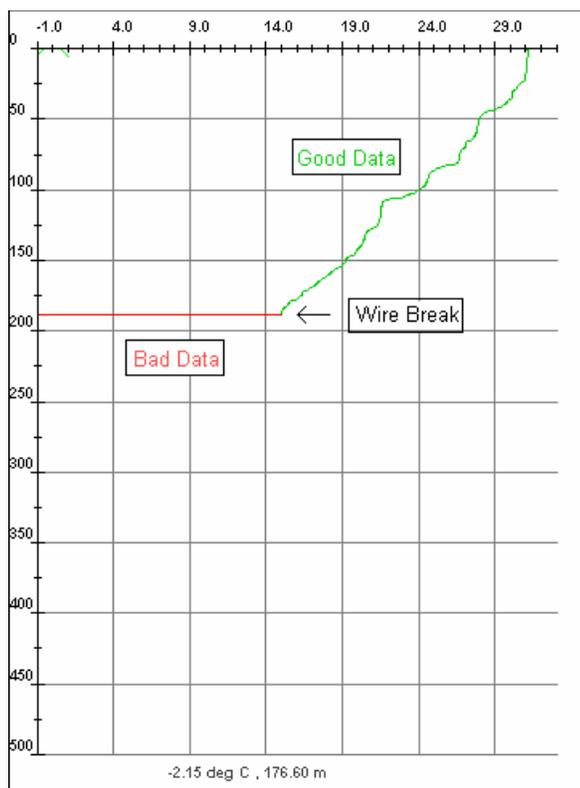
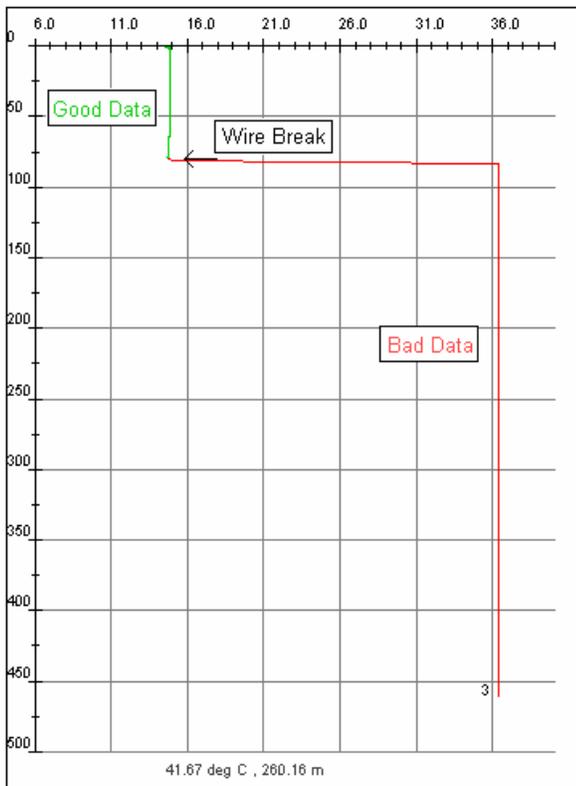
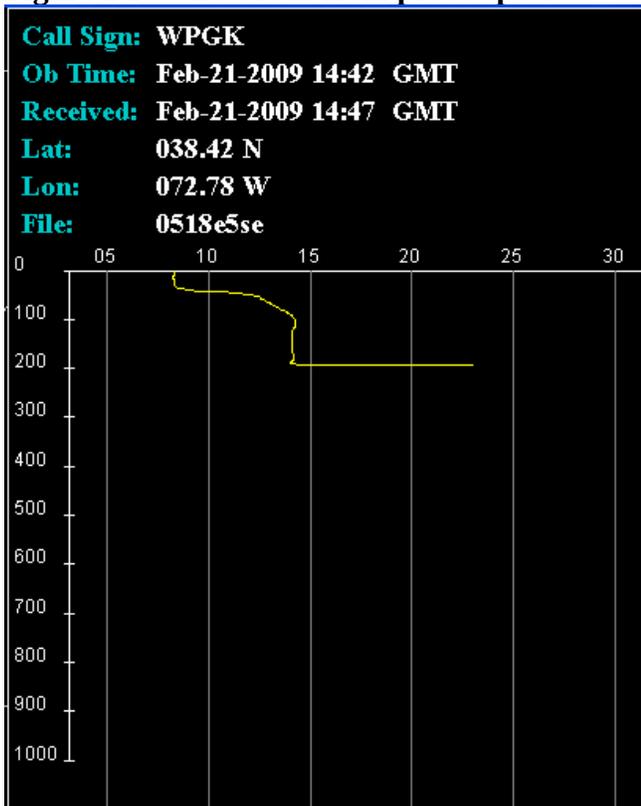


Figure 2.1: Wire break from launcher spool



**Figure 2.2: Wire break from probe spool**



**Figure 2.3: Wire break from probe spool**

## 2.2.6 Examples of Wire Insulation Penetration

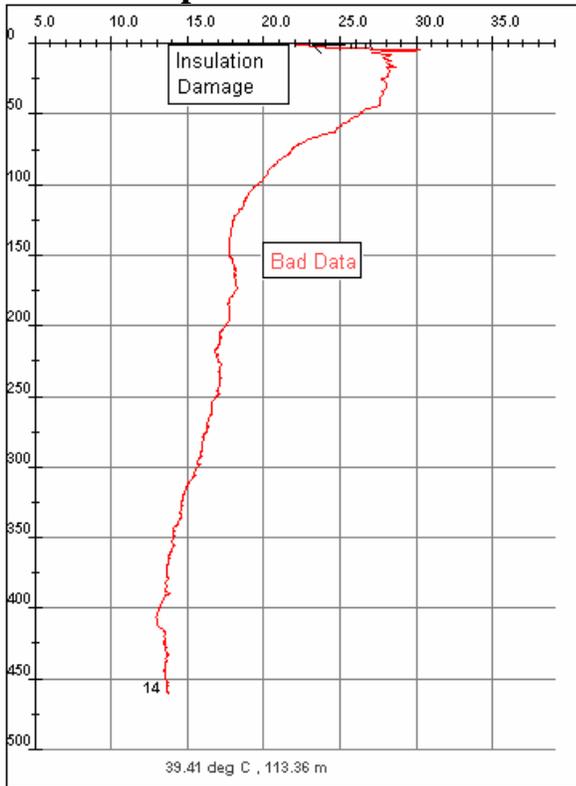


Figure 2.4: Wire Insulation Penetration near the surface

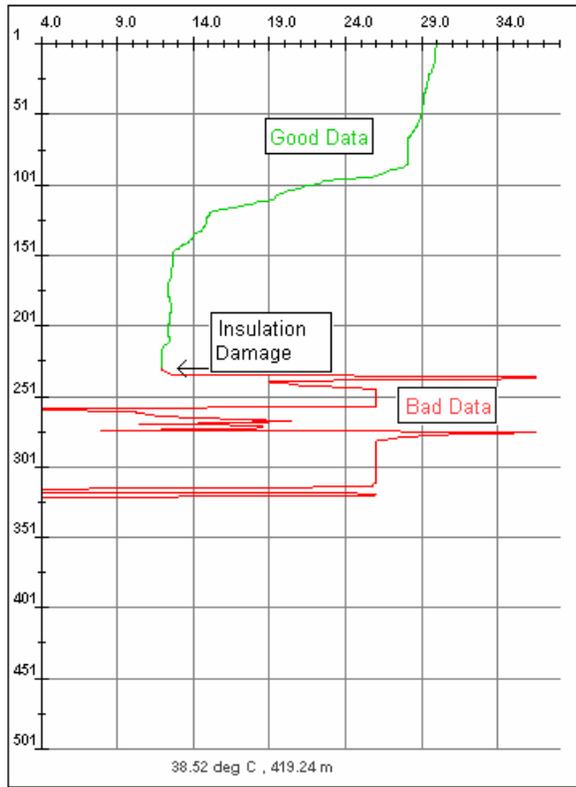


Figure 2.5: Wire Insulation Penetration at about 230m

### 2.2.7 Examples of Leakage

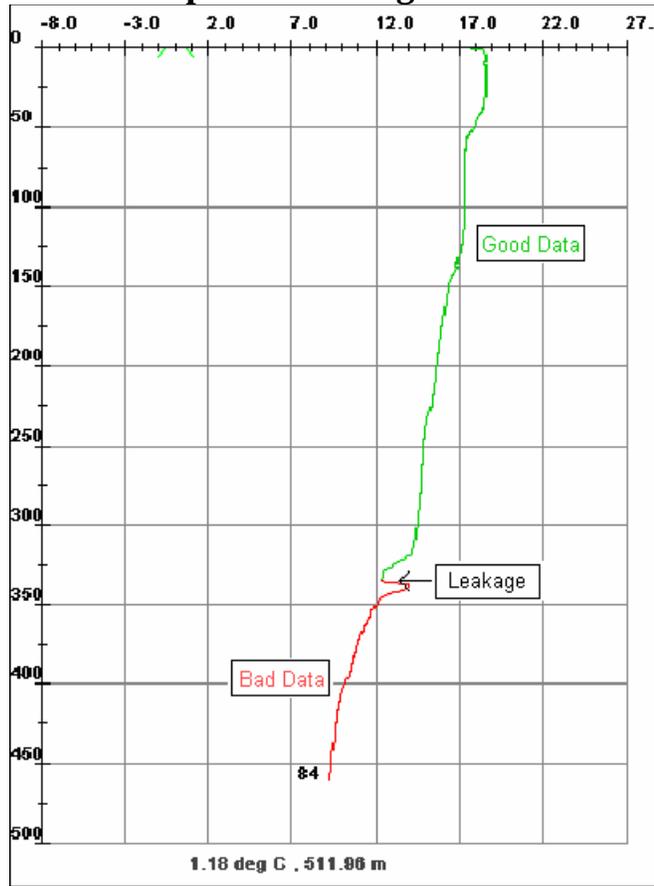
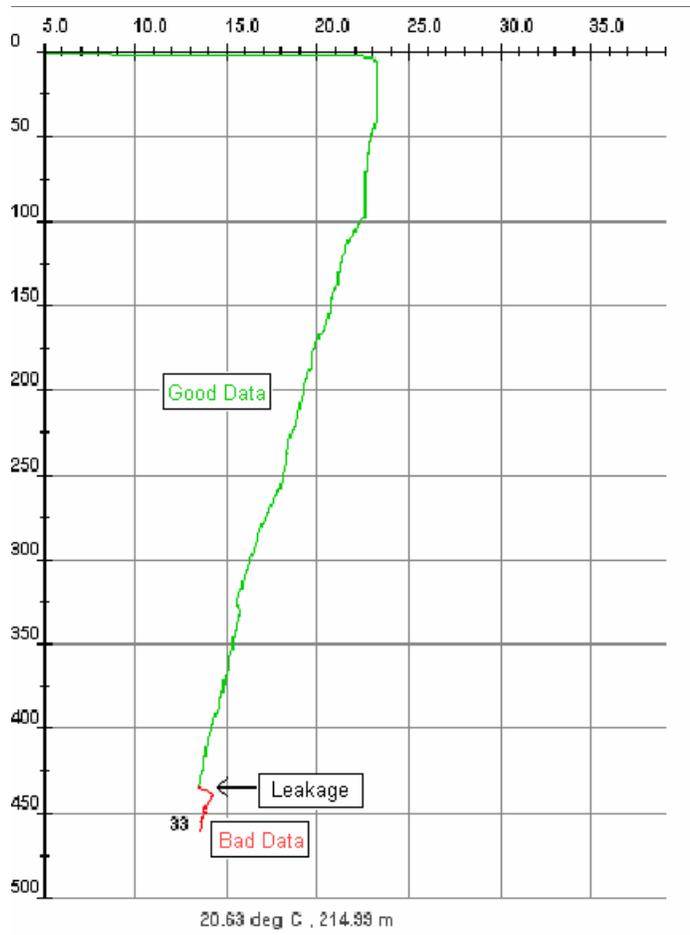
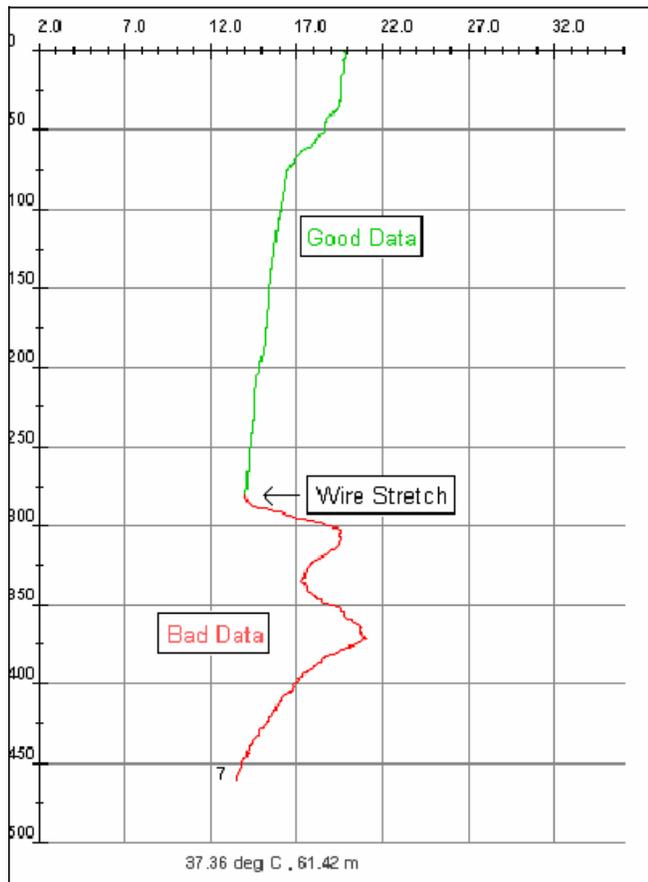


Figure 2.6: Leakage occurring at about 340m (Devil)

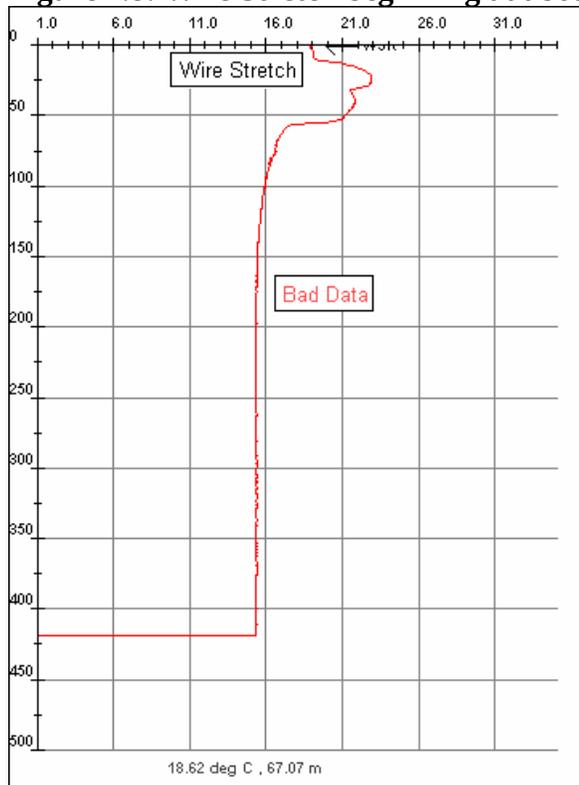


**Figure 2.7: Leakage occurring at about 440m (Devil)**

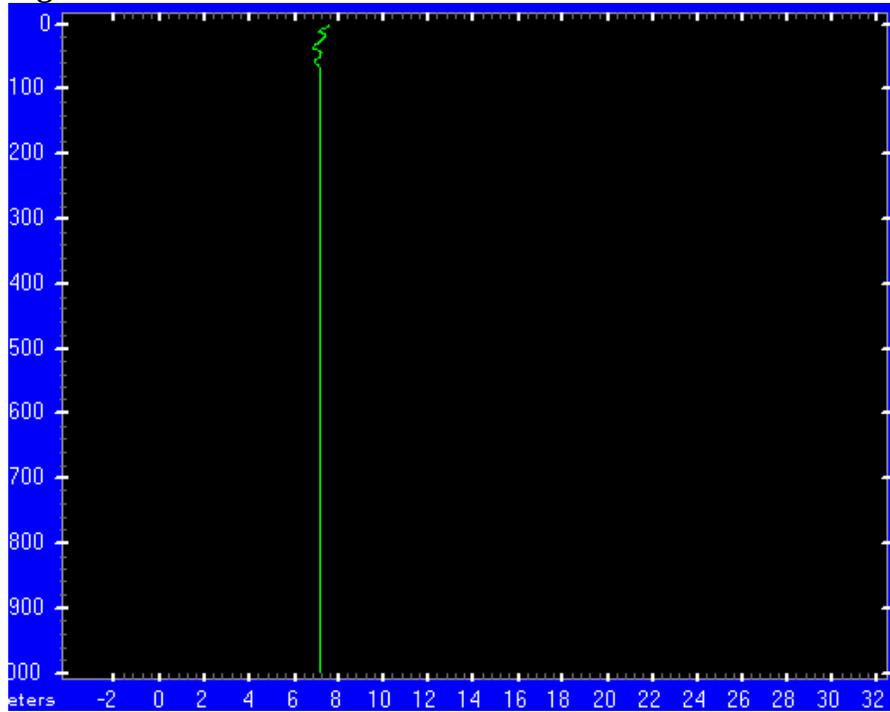
## 2.2.8 Examples of Wire Stretch



**Figure 2.8: Wire Stretch beginning at about 320m**



**Figure 2.9: Wire Stretch near the surface**



**Figure 2.10: Wire Stretch near the surface**

### 2.2.9 Examples of Wire into Hull

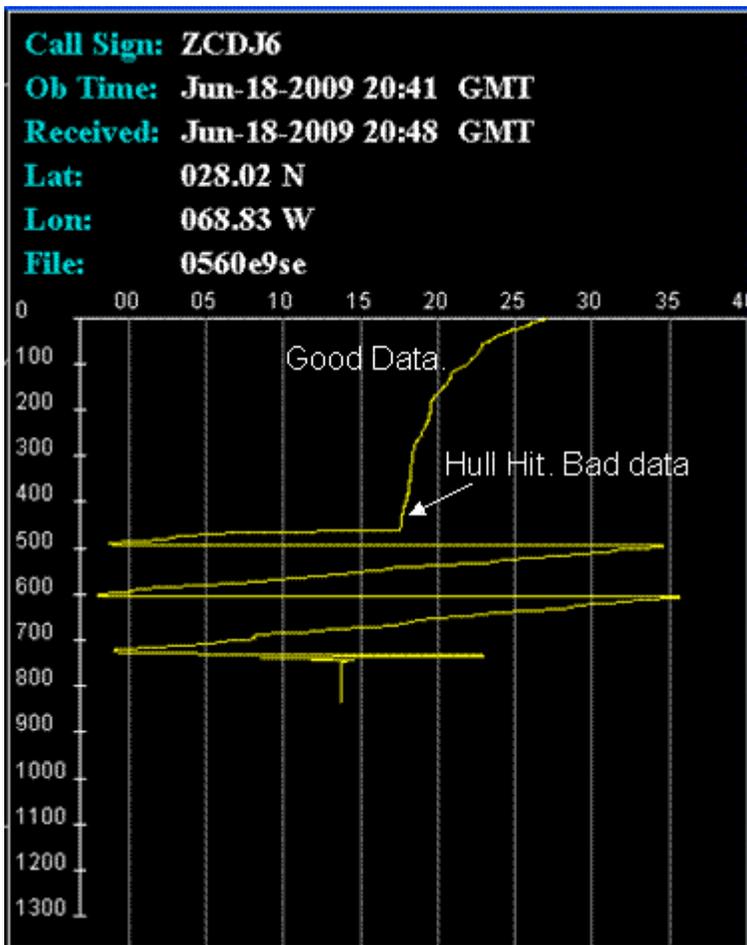


Figure 2.11: Wire into hull.

## 2.3 LAUNCHER FAULTS

The XBT launcher is particularly susceptible to faulty electrical contacts between the three launcher breech pins or a faulty launcher earth connection to the ship's hull. Faulty contacts may occur due to corrosion or moisture at cable junction points between the launcher and the recorder. Such faulty contacts will cause erroneous temperature recordings.

### 2.3.1 Faulty Launcher Breech Contact

#### **Cause and Effect:**

When a probe canister is loaded into a launcher for deployment, the canister seal breaks providing a point of electrical contact with the launcher. When this contact is not fully made no data is gathered until the contact is established. If there is no contact from the start of deployment then the data is rejected. Profiles with this fault exhibit a sharp drop off the negative end of the temperature scale at the surface then recover to normal temperature when the breech pin re engages the canister contact. Fig 2.13.2 show a hand launcher opened mid drop.

See Figures 2.12, 2.13.1, 2.13.2

#### **Remedy:**

This malfunction often keeps re-occurring until the launcher breech is inspected and cleaned. See

cleaning procedure for the Thru-Hull Launcher in Mandatory Maintenance -1.6.2.

### 2.3.2 False Launch Trigger

#### Cause and Effect:

Due to the electrical arrangement used in the XBT system it is possible for XBT data recording to be initiated without the actual launching of the XBT probe. In some cases the probe will falsely trigger just prior to launch making the event difficult to discern. False launches can be caused by seawater temporarily contacting the XBT probe sea electrode when the XBT probe is in the launcher tube eg. during high seas or rain. There may also be a shorting of the recorder to launcher cable wire to earth resulting in false launch trigger. Profiles affected by this event can be isothermal or deviate sharply to a negative value shortly after launch.

See Figure 2.14, 2.15, 2.16

#### Remedy:

It is recommended that the launcher cable be checked for integrity of the cabling and connections. Make sure that launcher cabling connections are in good condition and that connections are clean any dry. Look at grounding issues.

**Comments:** Carrie W - “It happens when there's another ground, bad ground or a ground loop somewhere in the system . I can usually make the SIO AutoLaunchers do it with test canisters when I have them grounded at the rail and on the bridge, but I have seen it most with HandLaunchers with metal connectors dragging on the deck or bad wiring.”

### 2.3.3 Examples of False Launcher Breech Contact

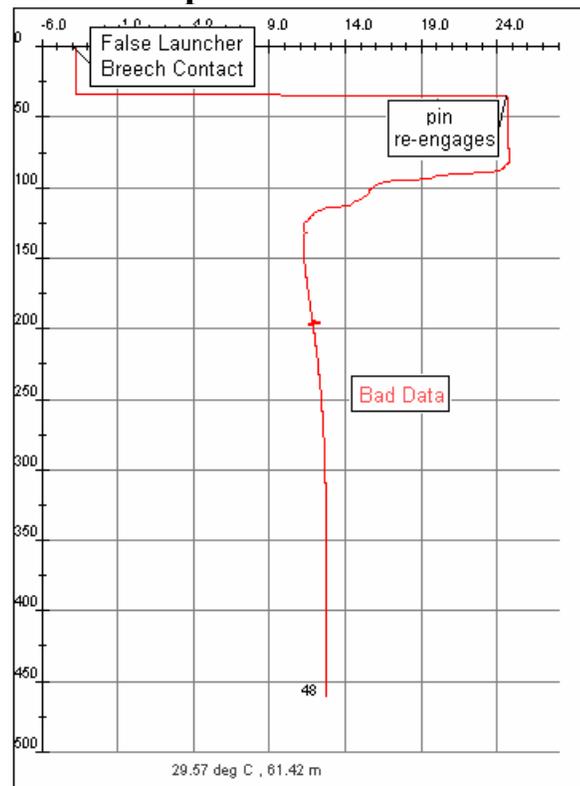
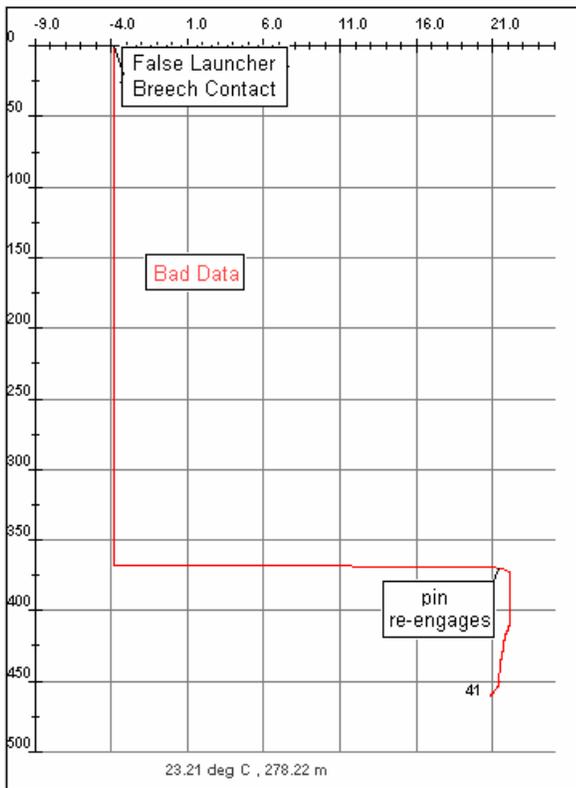


Figure 2.12: False Launcher Breech Contact until about 40m



**Figure 2.13.1: False Launcher Breech Contact until about 370m**

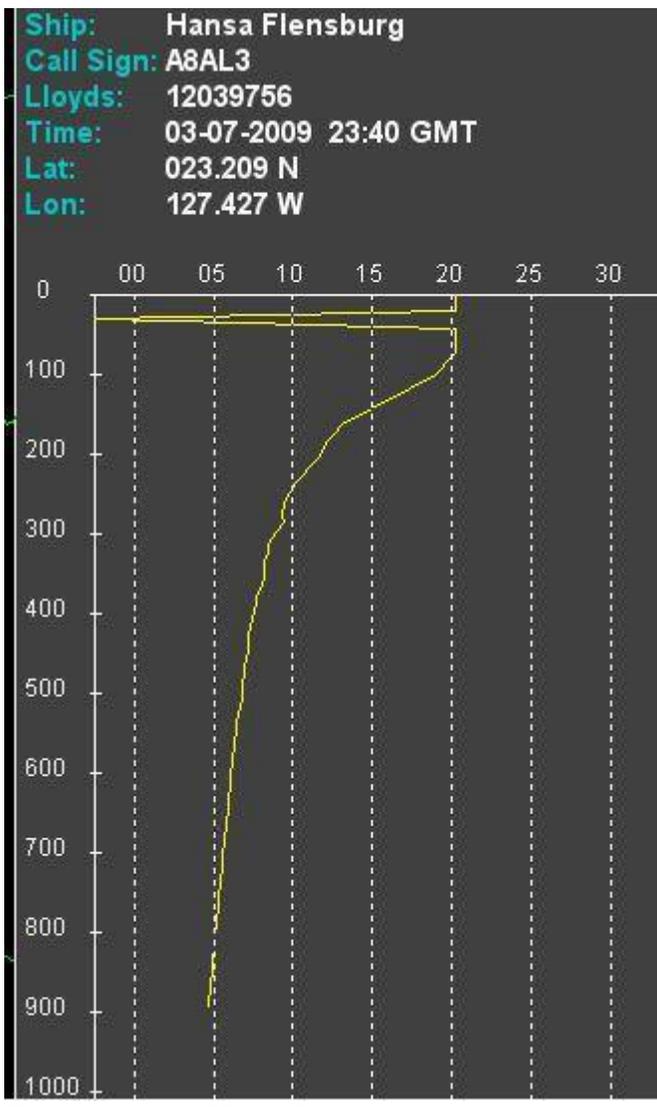


Figure 2.13.2: Hand Launch Opened - mid drop

### 2.3.4 Examples of False Launch Triggering

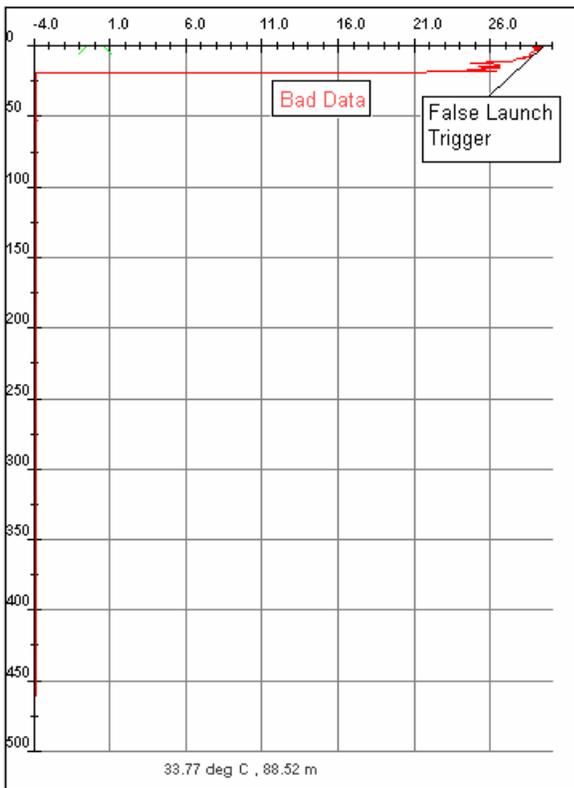


Figure 2.14: False Launch Triggering

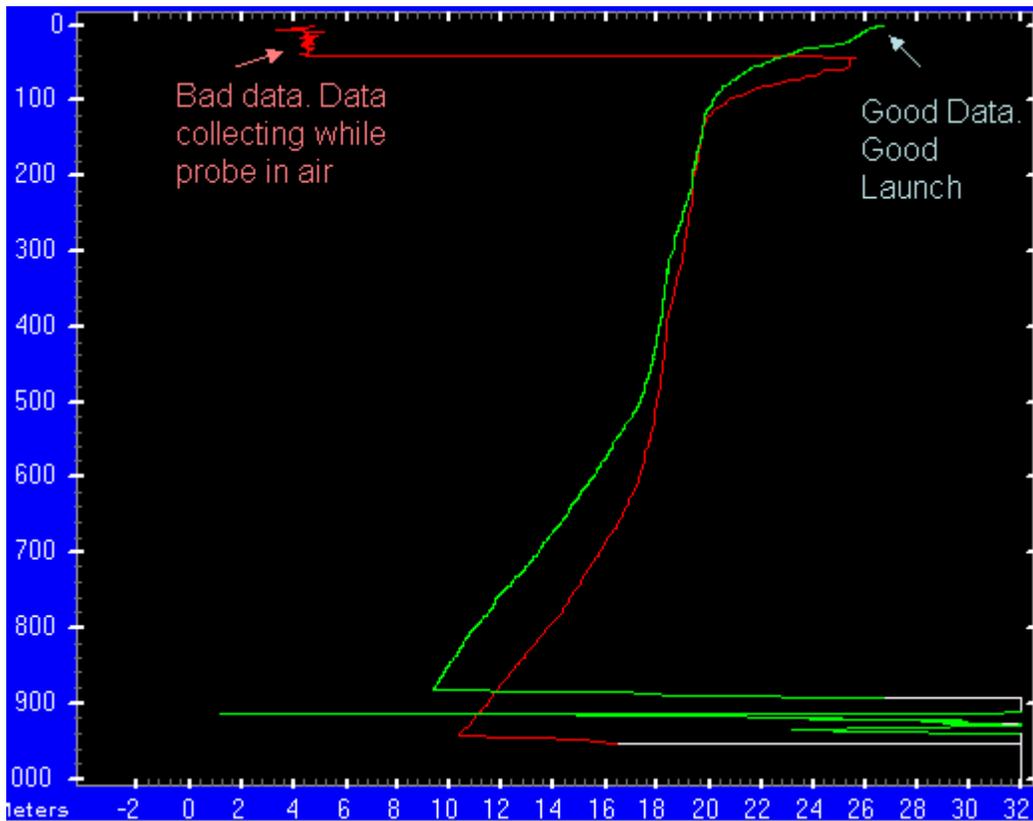


Figure 2.15: False Launch Triggering

## 2.4 OTHER FAULTS

The expendable bathythermograph consists of a number of different components: nose, thermistor, wire spools and copper wire. If the cause of an erroneous profile is unclear, then it will generally be categorized as a faulty probe. Another rare cause of erroneous profiles is electrical interference from one of the ships electromagnetic transmitters.

### 2.4.1 Faulty Probe

#### **Cause and Effect:**

If the entire profile is isothermal, it is most likely that one of the probe's components is faulty. For example, if the nose weight detaches or the thermistor is faulty the profile will be isothermal. In other cases the profile will be inconsistent with nearby profiles and is considered erroneous.

#### **Remedy:**

Unfortunately there will always be a small percentage of manufacturing defects. Whenever a faulty probe is suspected note all probe details such as manufacturer, estimated age and physical.

[See Figures 2.16, 2.17](#)

### 2.4.2 Electrical Noise

#### **Cause and Effect:**

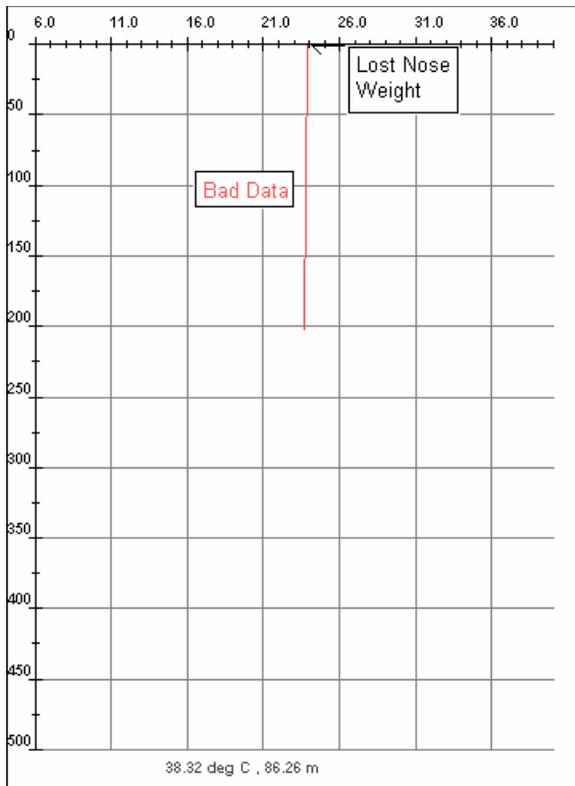
The copper wire used by the XBT system is susceptible to interference from electromagnetic sources. This fault is exhibited by sharp oscillations about the undisturbed trace, which tend to be related to the frequency of the electromagnetic wave. Welding or electrical activity on ship can be an issue.

[See Figures 2.18, 2.19, 2.20,2.21](#)

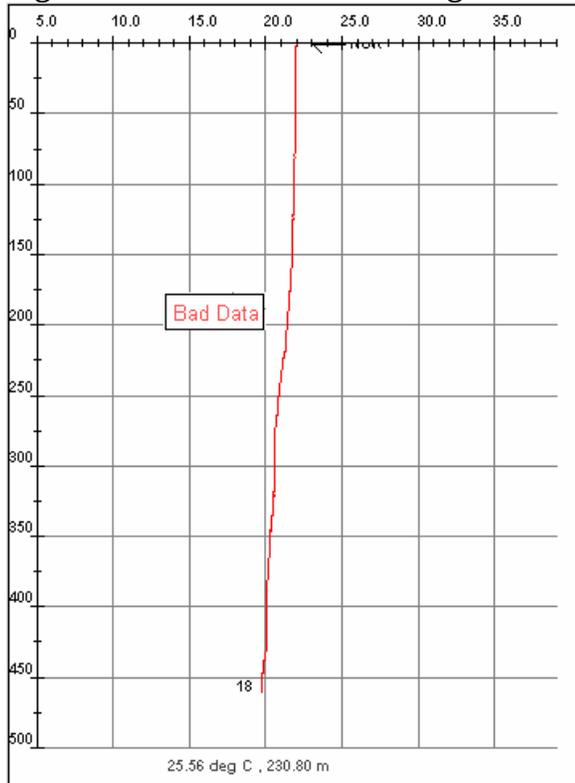
#### **Remedy:**

Ensure that XBTs are not deployed during periods of strong electromagnetic activity. Welding or Charge in Hull could cause problems. Try to drop around weldng schedule

### 2.4.3 Example of Faulty Probe

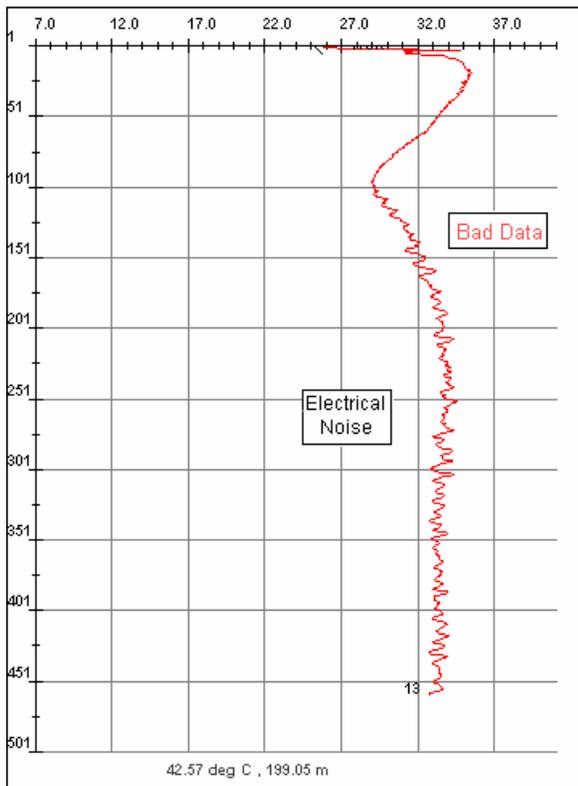


**Figure 2.16: Loss of the nose weight causes a near isothermal profile**

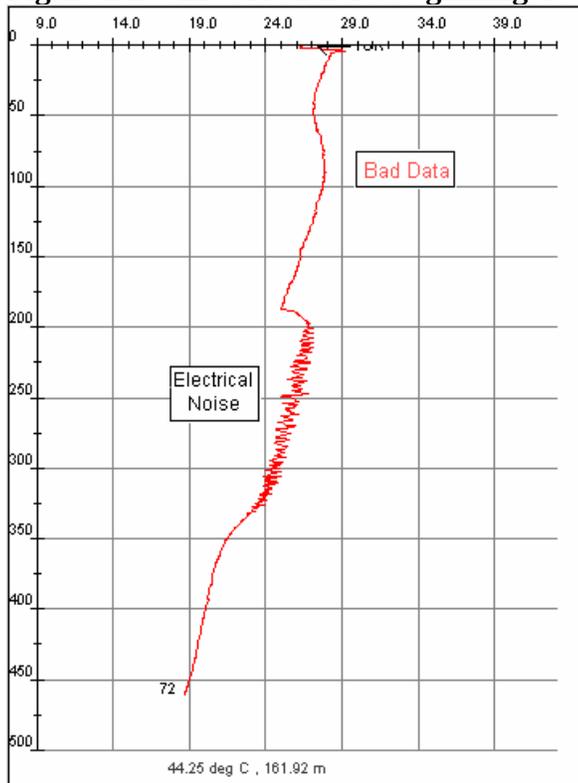


**Figure 2.17: Faulty probe causes an unrealistic profile when compared with neighbours**

## 2.4.4 Examples of Electrical Noise



**Figure 2.18: Electrical noise beginning at about 100m**



**Figure 2.19: Burst of Electrical noise between 200m and 340m**

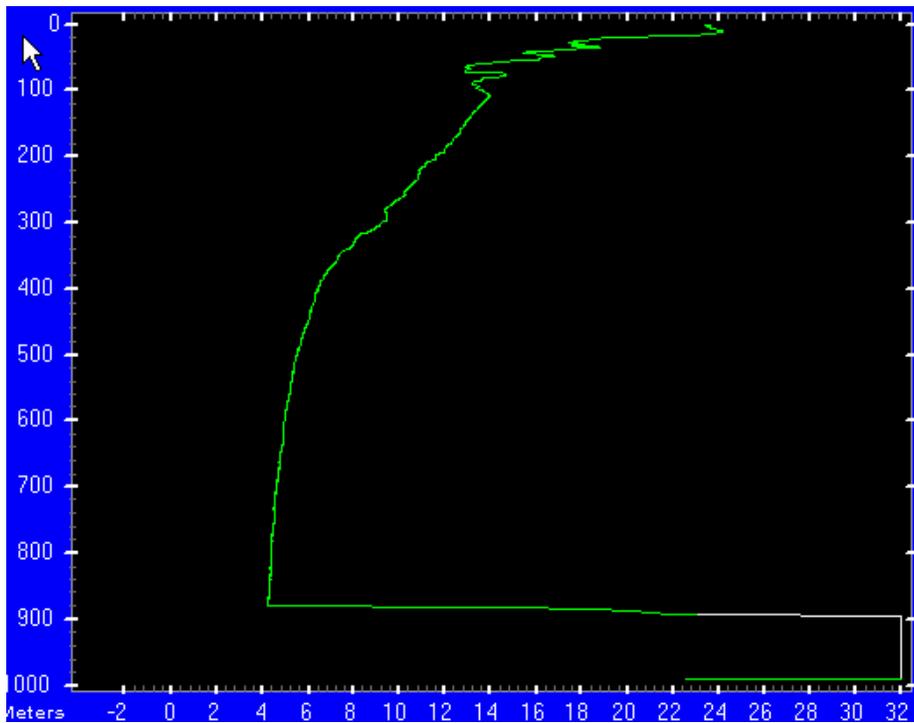


Figure 2.20: Burst of Electrical noise

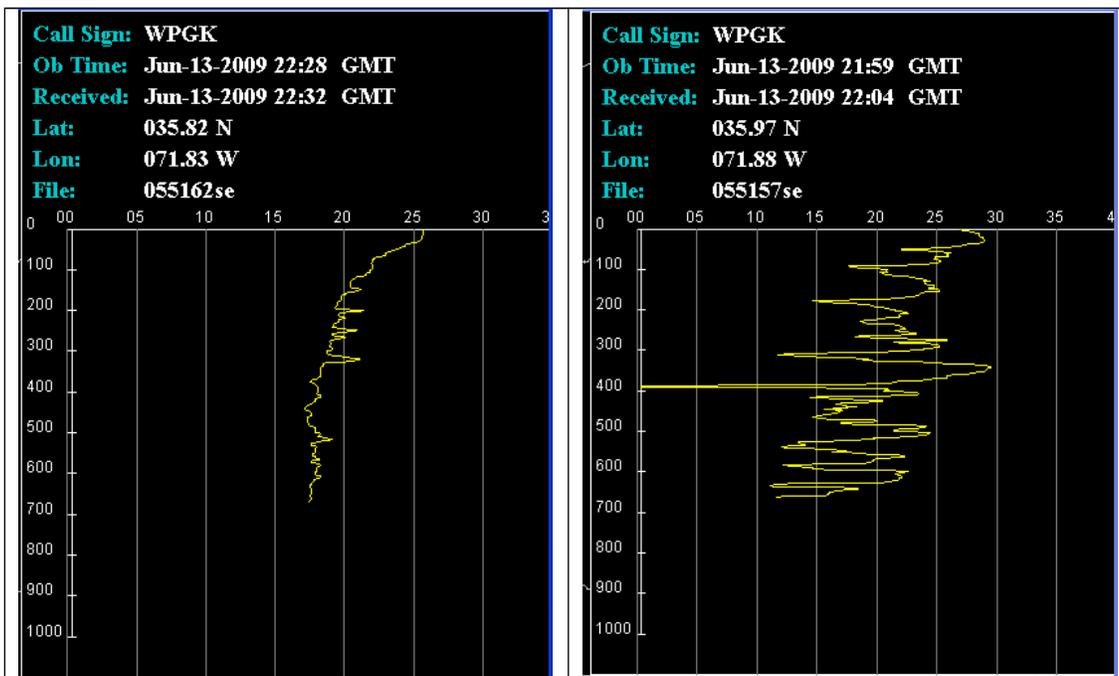


Figure 2.21: Noise due to welding.

## 2.5 PROBE HITS BOTTOM

When an XBT is deployed in a water depth shallower than the probes rated depth a 'hit-bottom' event is recorded. A small spike on the temperature trace and isothermal looking data after the spike usually

indicates the bottom hit. In some cases the spike may be very small and difficult to discern. Data recorded beyond the hit bottom point is rejected as erroneous. In shallow areas (< 200 m deep) such as on the continental shelf, it is important for operators to know the bottom depth so that false data do not result from encoding data below the actual bottom. An accurate bottom depth should be obtained near to launch time preferably from the ship's echo sounder rather than from a chart.

In shallow areas where the bottom is soft and the water column is isothermal the bottom hit point may be difficult to discern and detailed examination of the trace may be required to determine the hit bottom depth. Data recorded after the hit bottom point is normally of a constant temperature; however stagnation of water flow past the thermistor leads to increase resistive heating of the thermistor. This heating effect leads to a slight temperature increase as the probe lies on the bottom. This temperature increase allows approximate identification of the bottom-hit depth.

### 2.5.1 Hard Bottom

A small undulation or a more obvious spike on the trace usually indicates the hit bottom point. The trace disturbance is more marked if the bottom is hard.

See Figures 2.22, 2.23

### 2.5.2 Soft Bottom

The hit bottom spike may not always be clearly marked and data recorded after the hit bottom event is isothermal.

See Figures 2.24, 2.25

### 2.5.3 Examples of Hit Bottom

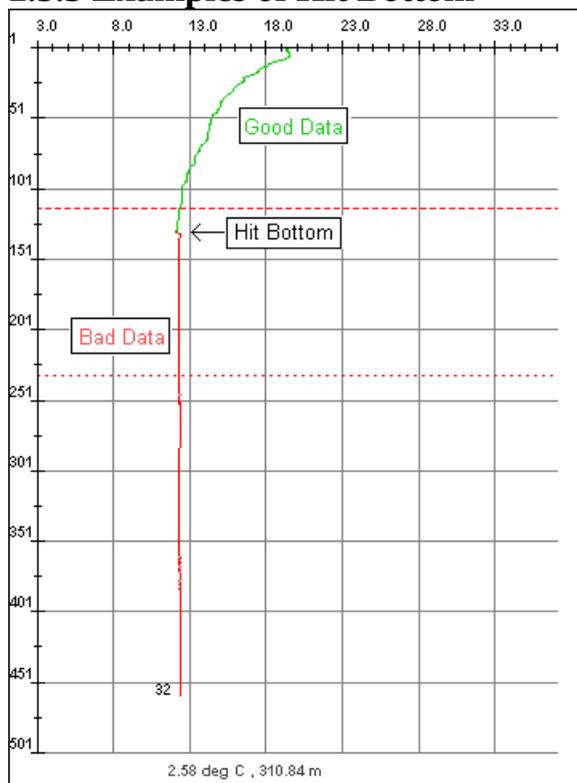
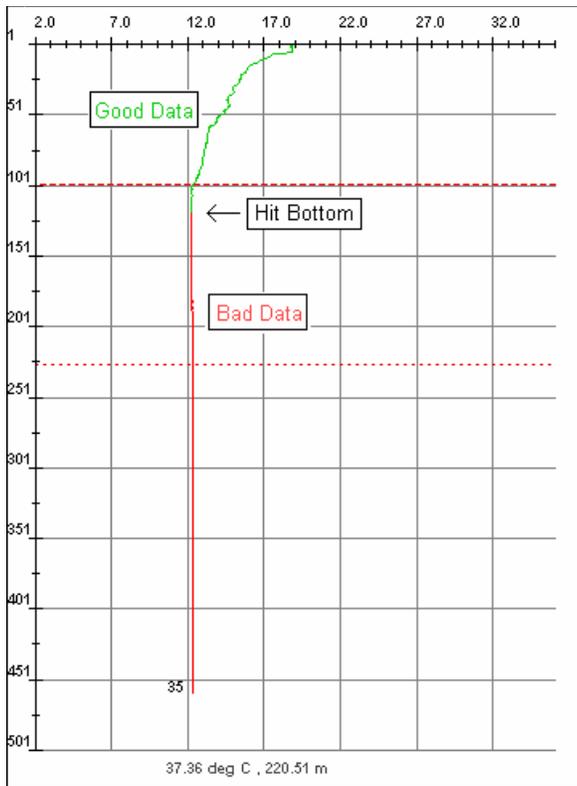
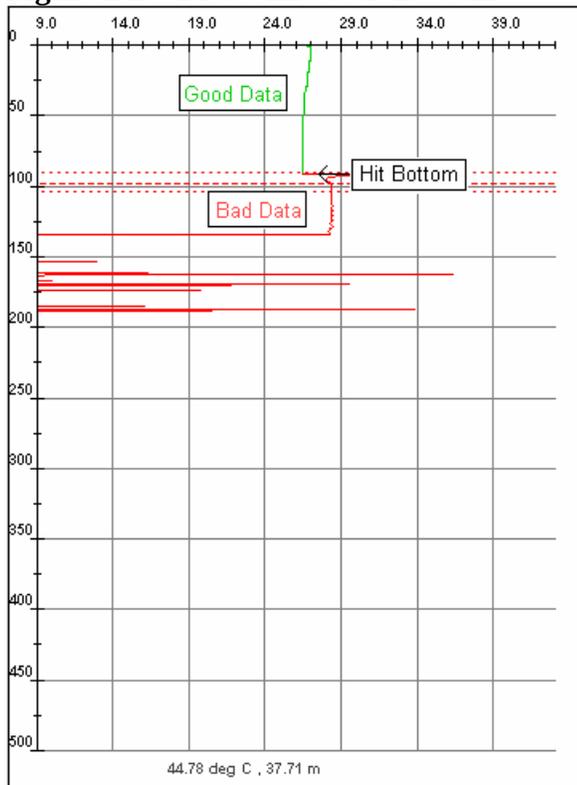


Figure 2.22: Probe Hits Hard Bottom



**Figure 2.23: Probe Hits Soft Bottom**



**Figure 2.24: Hit Bottom causing wire damage**

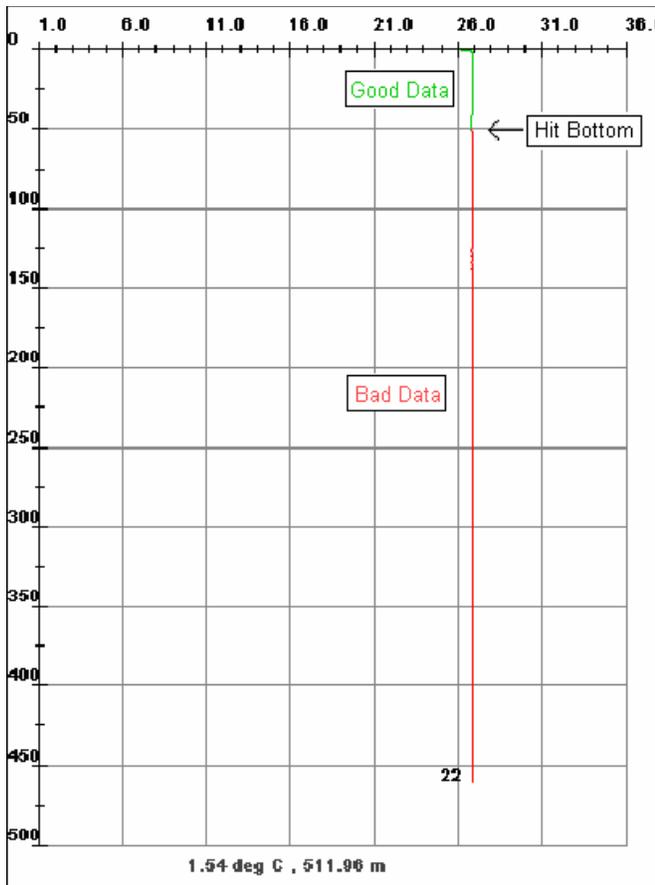


Figure 2.25: Unclear Hit Bottom due to Shallow Water & Soft Bottom

### 3 UNUSUAL OCEANOGRAPHIC CONDITIONS

Much of the content was taken from the “Devil XBT System User Manual” May 2008, Royal Australian Navy

#### 3.1 INTRODUCTION TO ANOMALOUS XBT TRACES

Certain oceanographic conditions may produce anomalous looking XBT traces, which may be mistaken for XBT recording malfunctions.

Profiles may exhibit temperature increases with depth, a *temperature inversion*, which may be mistaken for a wire stretch or leakage fault.

Very deep isothermal layers (> 200m deep) may occur within warm core East Australian Current (EAC) eddies. Profiles with unusually deep isothermal layers may be mistakenly attributed to a faulty probe or false launch triggering.

Another type of unusual profile found in the off the east coast and west coasts of Australia are *stepped profiles*. In these profiles up to three isothermal layers may be found

#### 3.2 TEMPERATURE INVERSIONS

Temperature inversions are known to occur in areas where water masses of different salinities meet such as ocean frontal zones. For example the outflow of high salinity water from the Persian Gulf into the Gulf of Oman leads to a high salinity layer and a temperature inversion near 200-300 m depth in the

Gulf of Oman. Temperature inversions may also occur where freshwater outflow from rivers results in cooler, less saline layer overlying a warmer saltier layer.

Trace examples in this section show unusual oceanographic features, which may be mistaken for faulty data. If an unusual XBT trace is obtained the operator should deploy another XBT probe within 15 minutes to assist in deciding whether the trace represents a 'real' oceanographic feature or is an equipment malfunction. The extra probe should be deployed as soon as possible especially if the ship is transiting at speed.

### 3.2.1 Temperature Inversions in The Sea of Marmara

The Sea of Marmara connects the Black Sea with the Mediterranean Sea. The temperature inversion is caused by cold, low saline water flowing in from the Black Sea and forming a layer over the warmer, saltier waters of the Mediterranean Sea. Figure 3.2.1.1 shows a typical example of this inversion where the surface temperature is approximately 12°C and the underlying layer is up to 4°C warmer.

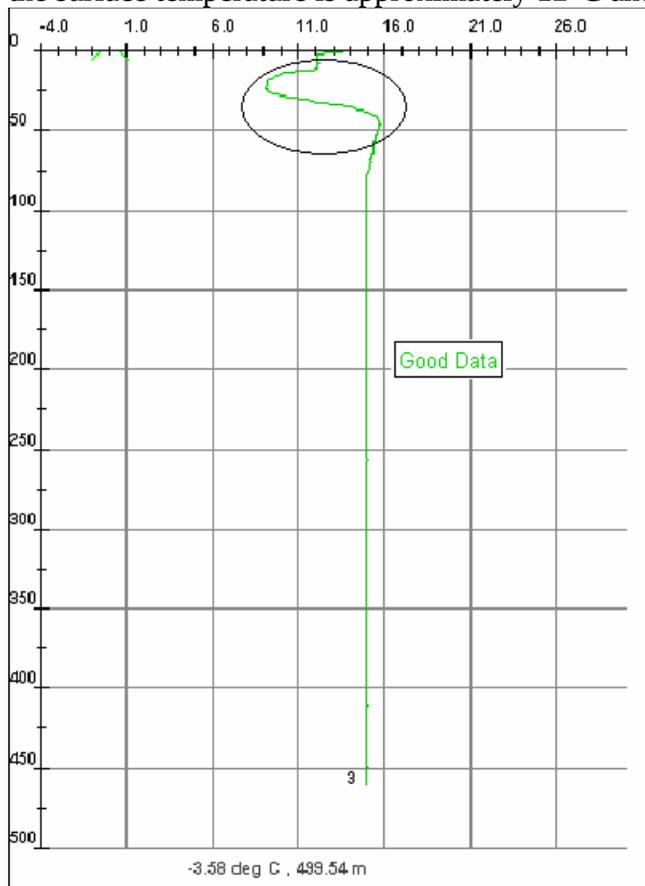
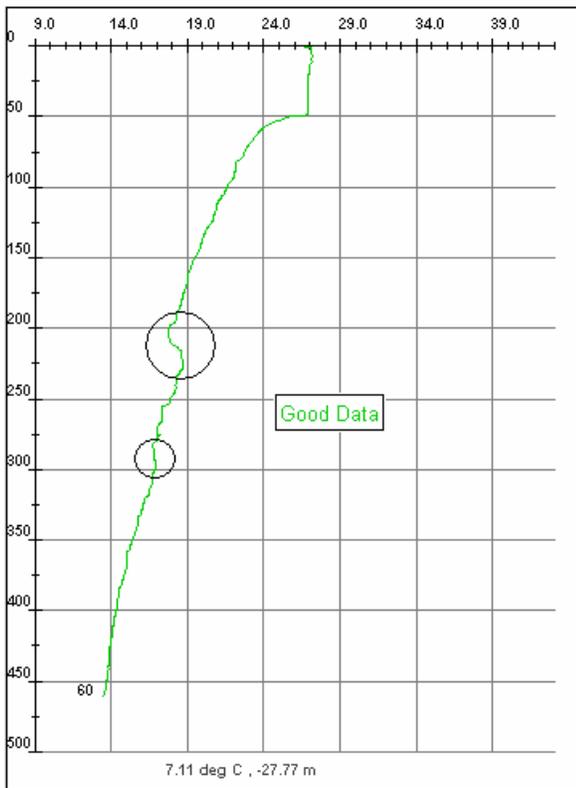


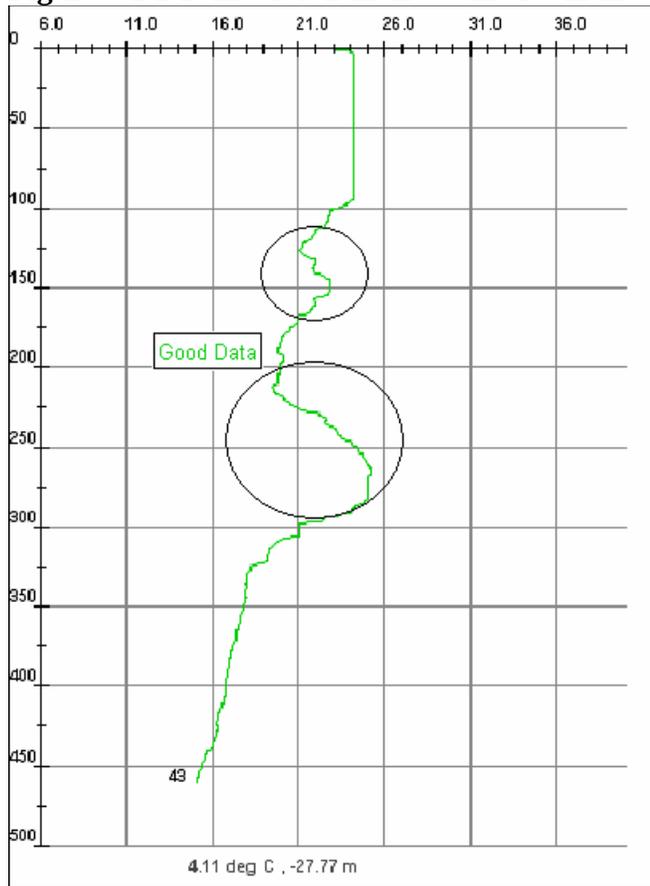
Figure 3.2.1.1: Inversion in the Sea of Marmara

### 3.2.2 Temperature Inversions in The Gulf Of Oman

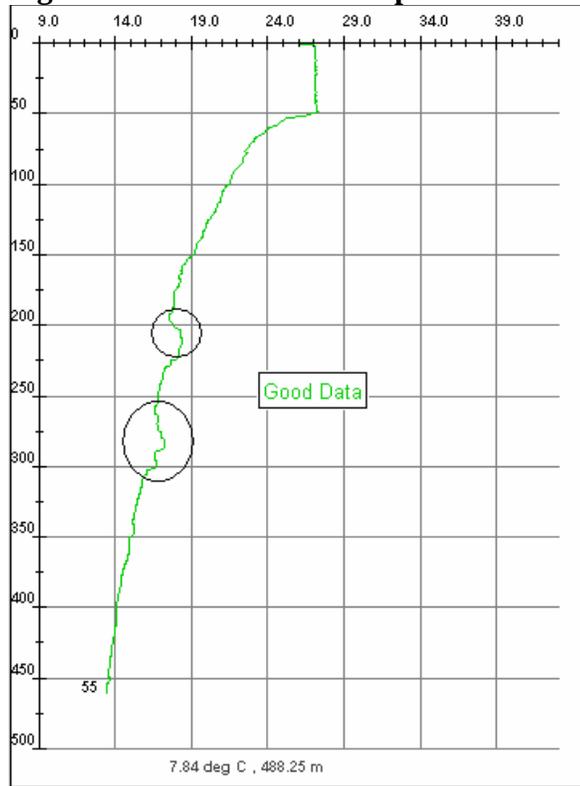
Temperature inversions often occur in the Gulf of Oman. The inversions are caused by warmer high salinity water flowing out of the Persian Gulf. By virtue of its greater density relative to surrounding water the high salinity water sinks as it enters the Gulf of Oman and forms a distinct layer near 150-300m depth. Figures 3.2.2.1-3.2.2.5 show various types of temperature inversions that are encountered in the Gulf of Oman.



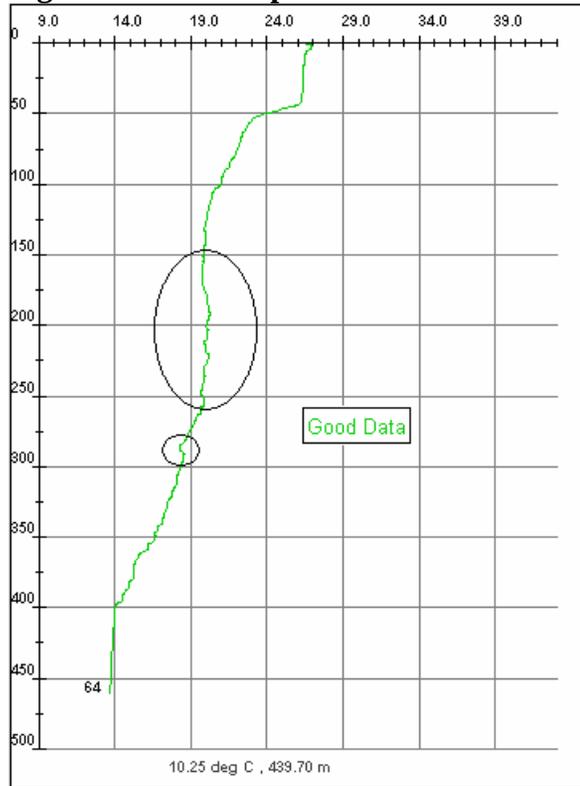
**Figure 3.2.2.1: Inversion in the Gulf of Oman**



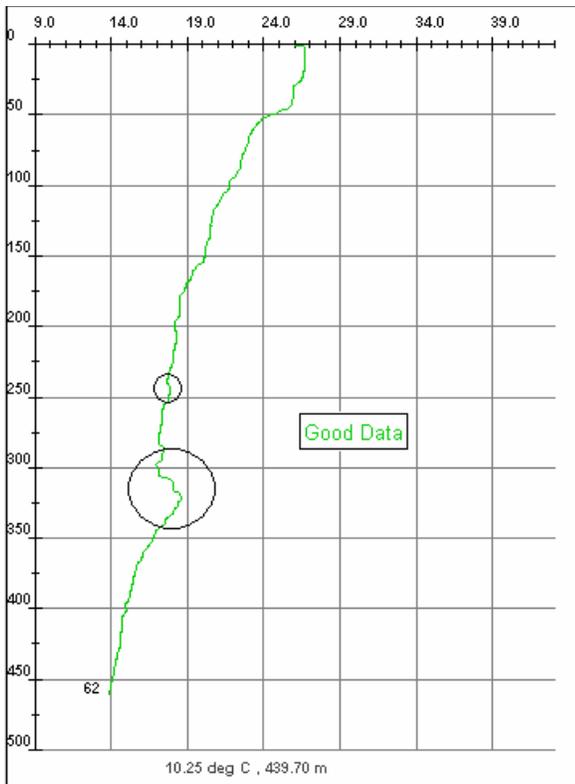
**Figure 3.2.2.2: Extreme Temperature Inversions in the Gulf of Oman**



**Figure 3.2.2.3: Temperature Inversions in the Gulf of Oman**



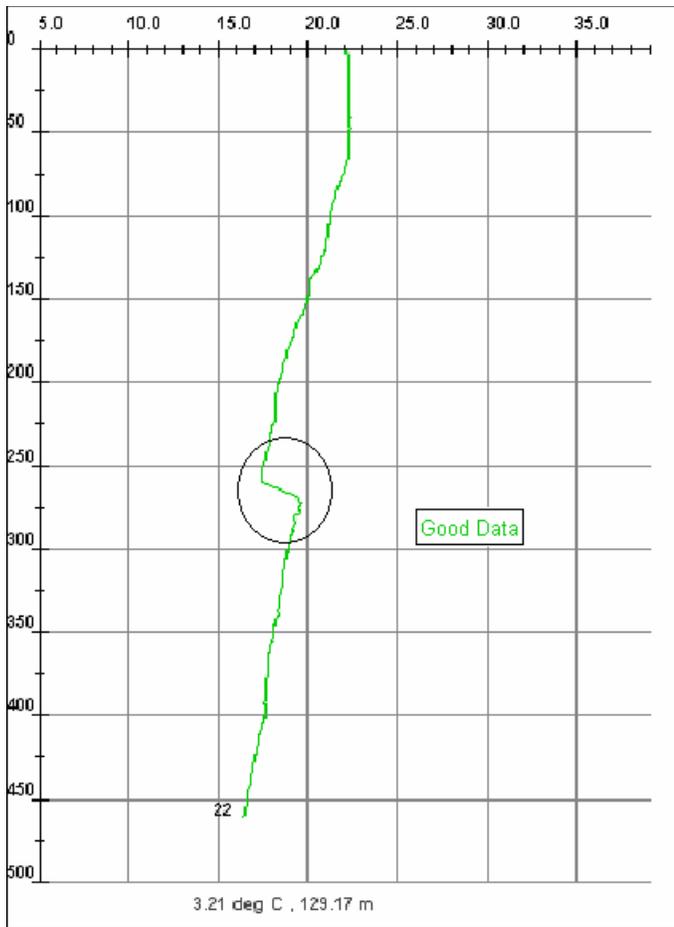
**Figure 3.2.2.4: Elongated Temperature Inversion in the Gulf of Oman**



**Figure 3.2.2.5: Temperature Inversion in the Gulf of Oman**

### 3.2.3 Temperature Inversions near South Africa and Madagascar

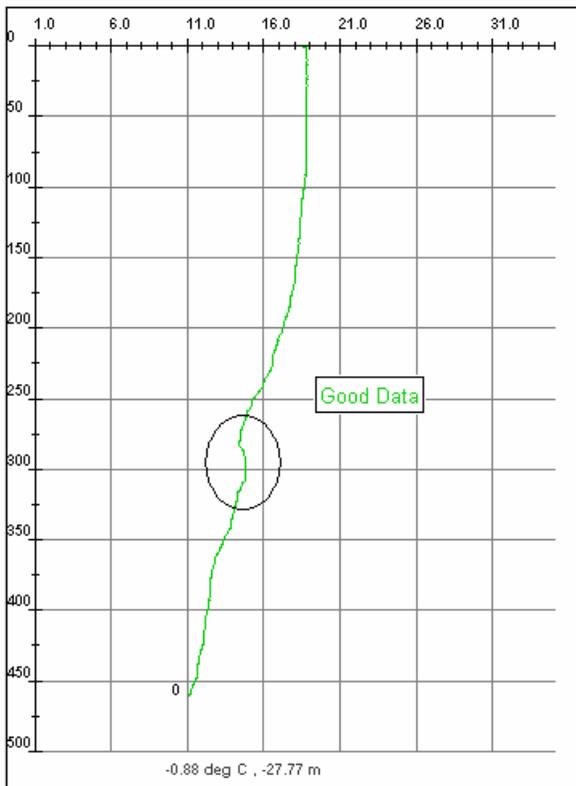
Water flows around South Africa and Madagascar are dominated by interactions between the Agulhas Current system and the Madagascar Current System. In July and August the numbers of phytoplankton in the sea increase dramatically, a phenomenon that is linked to the enhanced stratification of the water column. Due to these layers, temperature inversions are found between depths of 200-300m. Figure 3.2.3.1 is an example of a warm layer at approximately 260 metres causing the temperature inversion.



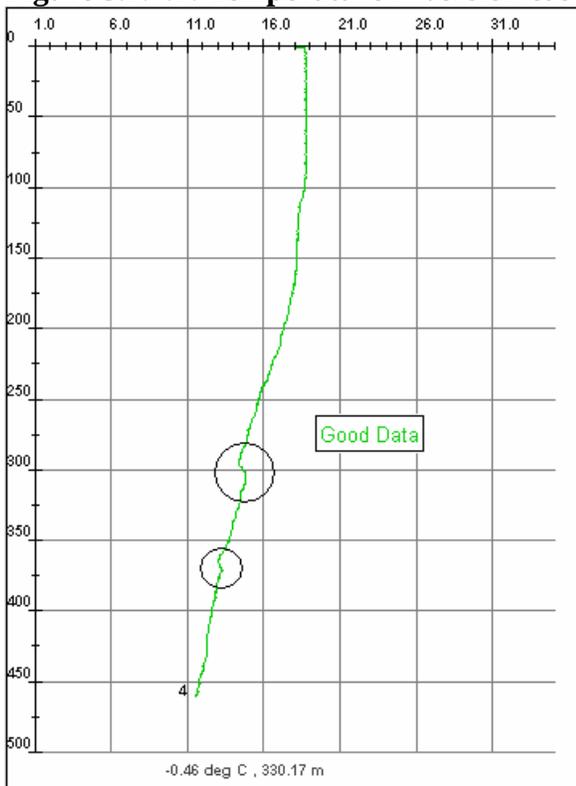
**Figure 3.2.3.1: Temperature Inversion near Madagascar**

### **3.2.4 Temperature Inversions caused by Intrusion of Salty Continental Shelf Water**

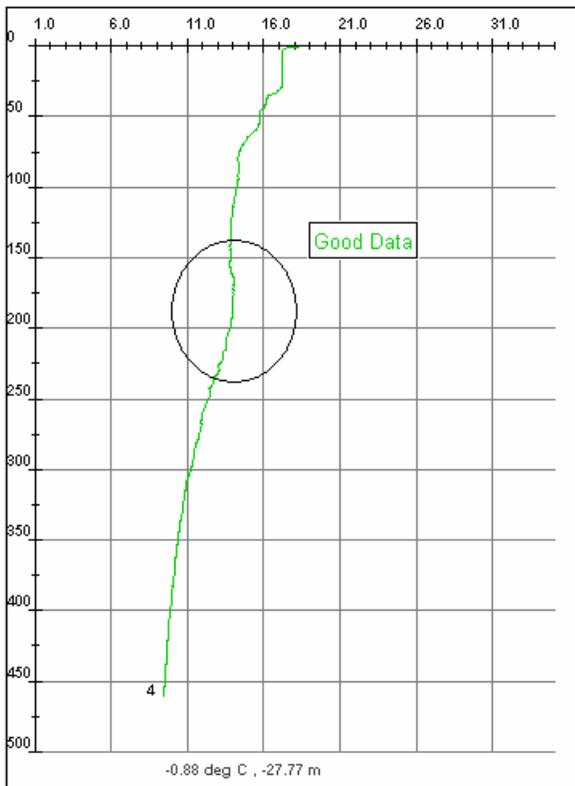
Temperature inversions may be caused by an intrusion of Bass Strait Water into the Tasman Sea. This results in a phenomenon known as the Bass Strait Cascade in which Bass Strait water enters the Tasman Sea, sinks to a depth where it encounters water of its own density and flows northward along the N.S.W continental slope as a narrow undercurrent. At the undercurrent depth Bass Strait Water is cooler and saltier than the surrounding Tasman Sea Water resulting in the temperature inversion. Bass Strait Water is most frequently encountered during winter over the N.S.W. continental slope between Eden (37°S) and Newcastle (33°S) at depths between 150m and 350m. In Figures 3.2.4.1-3.2.4.2 show temperature inversions created by the Bass Strait Cascade. Similar-looking temperature inversions have been observed a few hundred kilometres off the southern Australian Coast as shown in Figure 3.2.4.3. The hot dry South Australian summer leads to warm, high saline waters in the Spencer Gulf and Gulf St. Vincent. The warm waters then cascade off the shelf and sink to waters of equal density, thus causing the temperature inversion.



**Figure 3.2.4.1: Temperature Inversion east of Jervis Bay**



**Figure 3.2.4.2: Temperature Inversion east of Cape Howe**

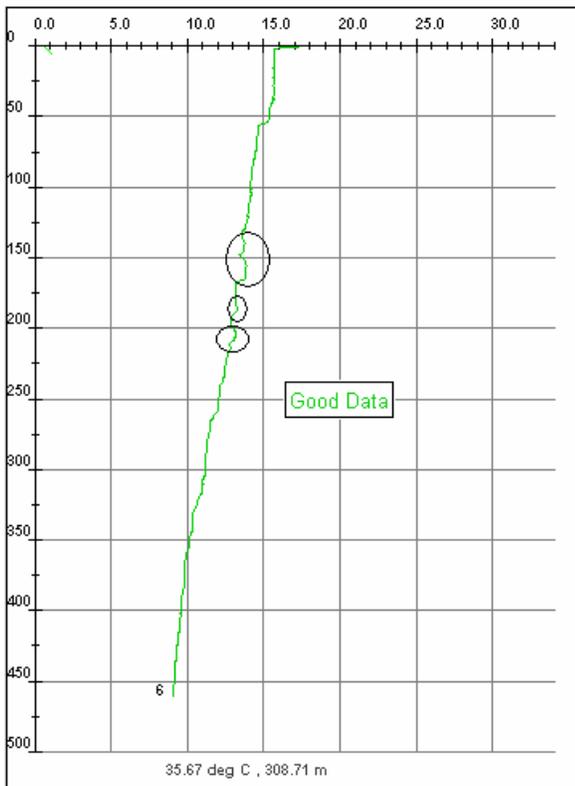


**Figure 3.2.4.3: Temperature Inversion south of Adelaide**

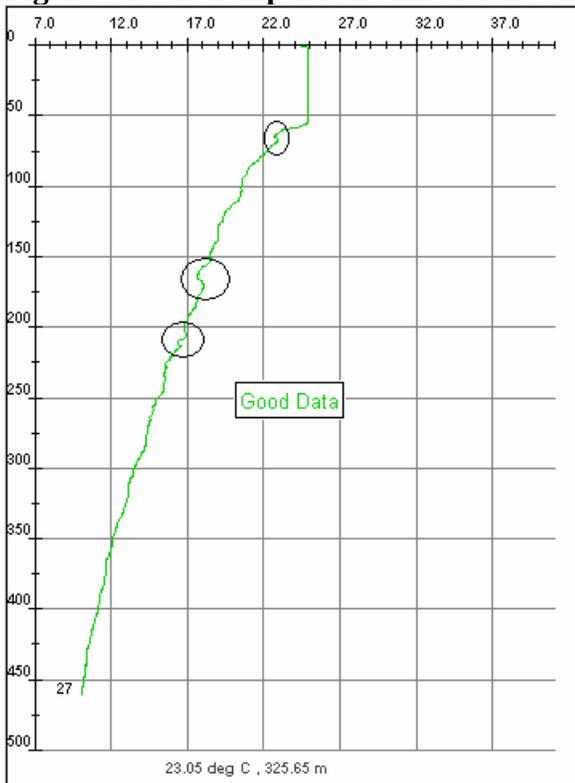
### **3.2.5 Temperature Inversions along Edge of Continental Shelf**

Minor temperature inversions are known to occur on edge of the continental shelf where strong currents exist. In the western Tasman Sea the temperature inversions are caused by the dominating flows of the East Australian Current. A similar effect can be observed along the edge of the continental shelf in the Indian Ocean off the northwest coast of Australia as the Leeuwin Current flows southwards. Figure 3.2.5.1 shows example on the edge of the shelf east of Jervis Bay.

Figure 3.2.5.2 shows an example on the edge of the shelf off northwest Australia.



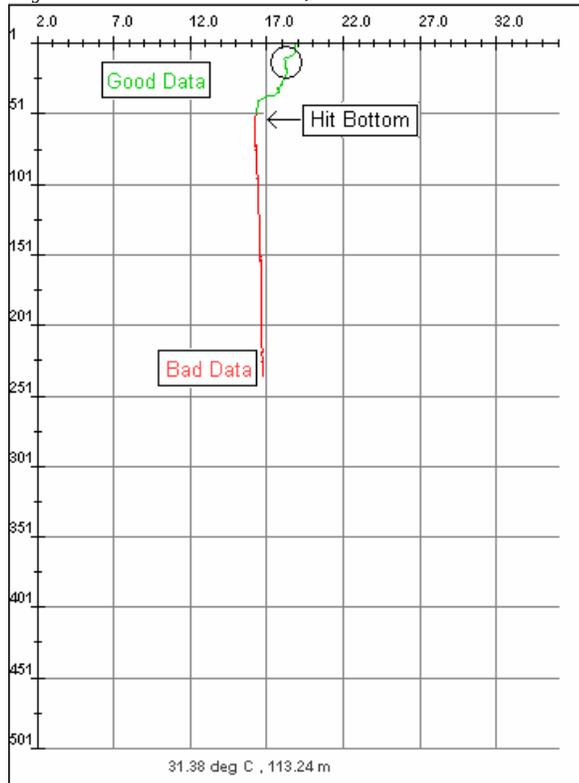
**Figure 3.2.5.1: Temperature Inversions on the edge of the shelf, east of Jarvis Bay**



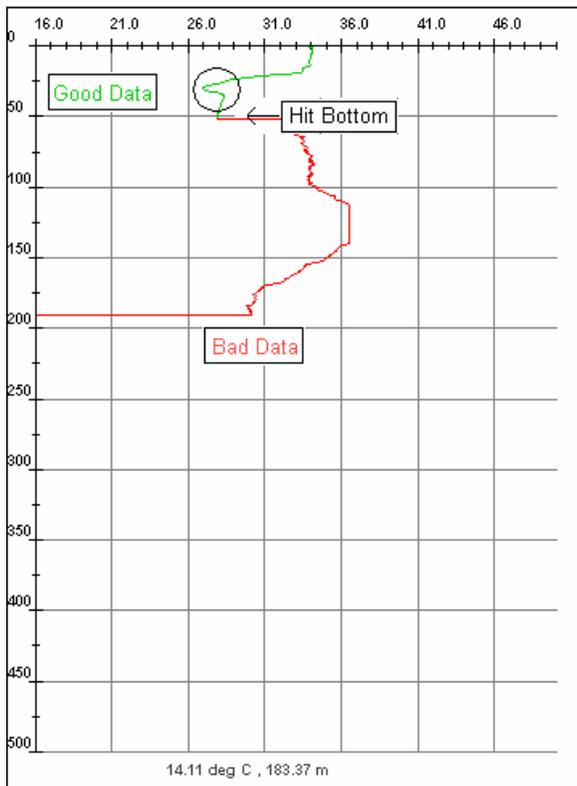
**Figure 3.2.5.2: Temperature Inversions on the edge of the shelf off northwest Australia**

### 3.2.6 Temperature Inversions caused by River Water Outflow

Temperature inversions sometimes occur in the shallow waters where large amounts of fresh water outflow from rivers after the Wet season. The fresh water is less dense than the warmer, saltier seawater and a shallow temperature inversion is created. Figures 3.2.6.1, show this type of inversion occurring when cooler water from Queensland rivers flows into the Great Barrier Reef Lagoon after the wet season. The GBR lagoon is the region of water between the coastline and the start of the reefs. Figures 3.2.6.2 show an event where heated river water at about 34°C flows into the Persian Gulf and forms a layer of over the cooler, saltier seawater.



**Figure 3.2.6.1: Temperature Inversion in the shallow waters of the Great Barrier Reef Lagoon**

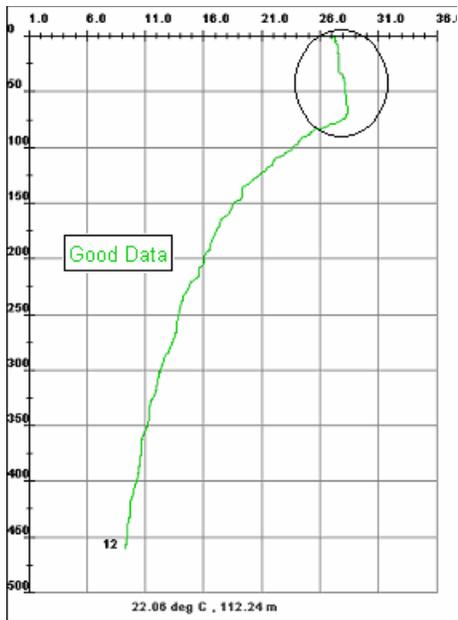


**Figure 3.2.6.2: Temperature Inversion in the shallow waters of Persian Gulf**

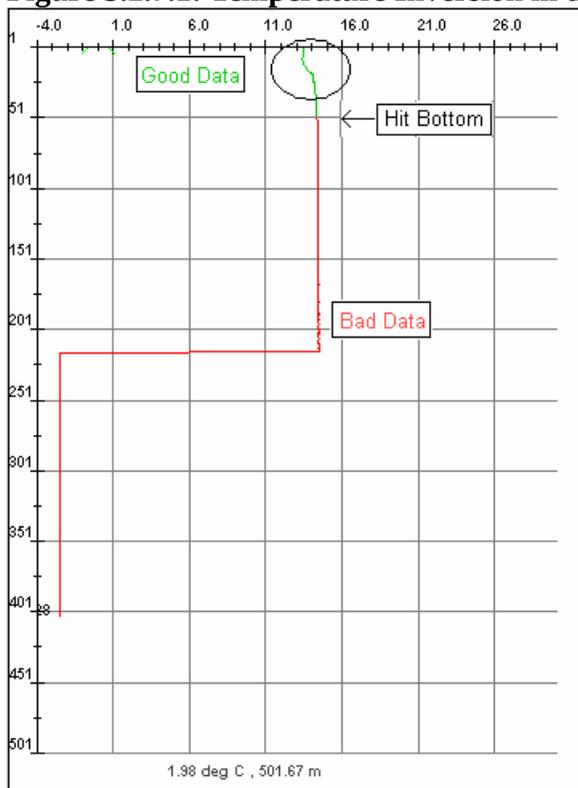
### 3.2.7 Temperature Inversions within the Mixed Layer

A special type of inversion that displays an increase in temperature with depth may be observed within or at the base of the Mixed Layer. As this may appear like the result of a wire stretch, a repeat drop should be made to confirm the inversion. Figure 3.2.7.1 shows a temperature inversion within the mixed layer in the Arafura Sea. Figure 3.2.7.2 shows a temperature inversion within the mixed layer off the northeast coast of New Zealand

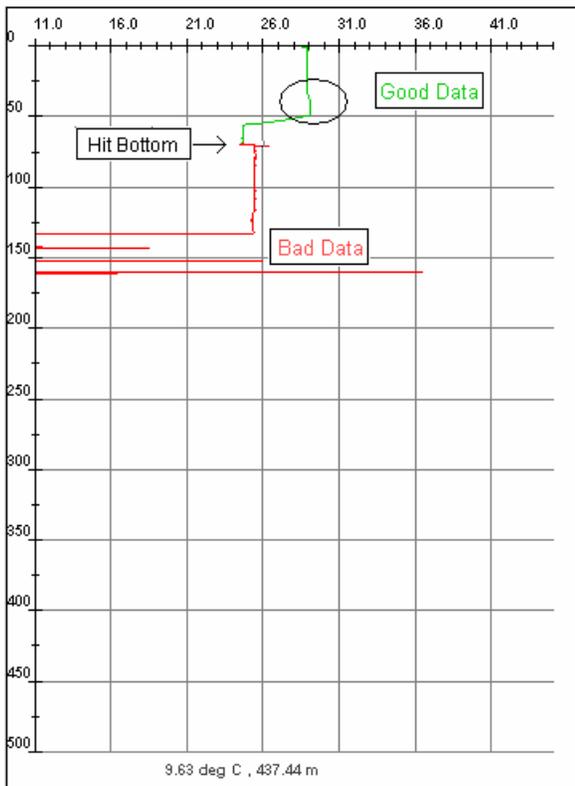
Figure 3.2.7.3 shows a small temperature inversion at the base of the mixed layer in the South China Sea.



**Figure 3.2.7.1: Temperature Inversion in the mixed layer of the Arafura Sea**



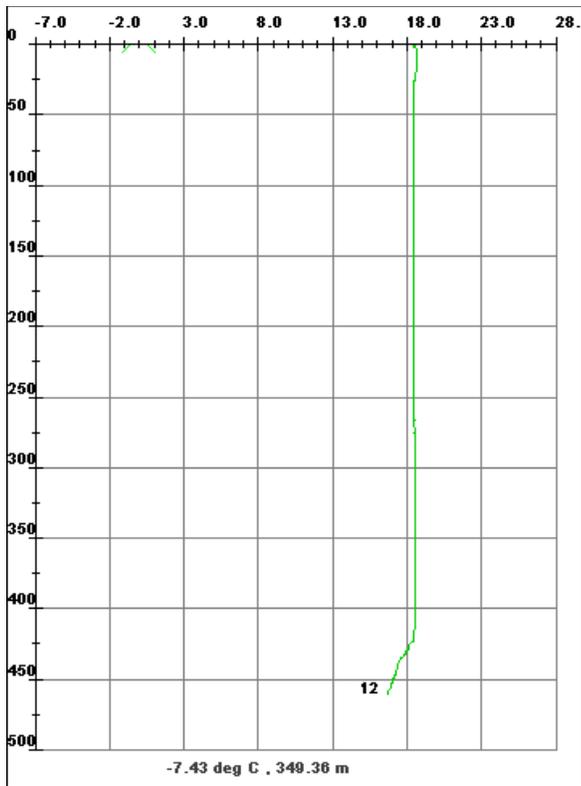
**Figure 3.2.7.2: Temperature Inversion in the mixed layer of the Hauraki Gulf, New Zealand**



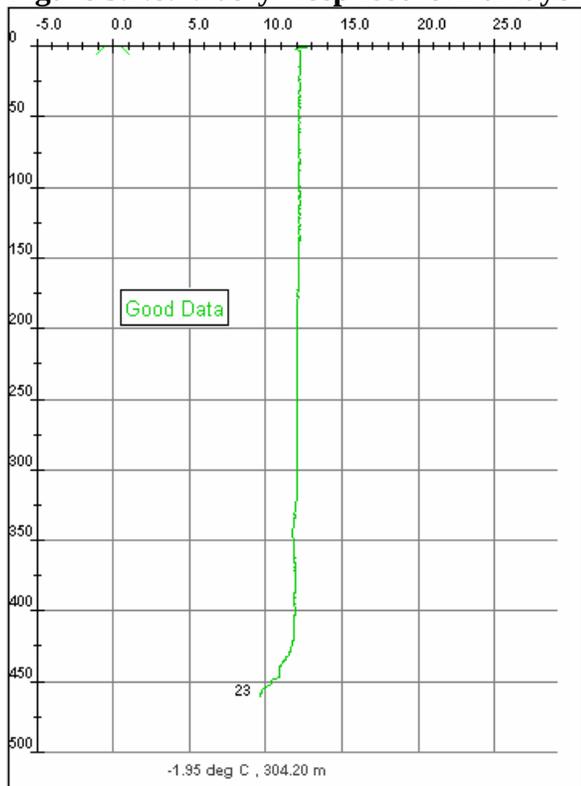
**Figure 3.2.7.1: Temperature Inversion at the base of the mixed layer in the South China Sea east of Malaysia**

### 3.2.8 Very Deep Isothermal Layers

Very deep isothermal layers are known to occur inside the cores of both warm (anticyclonic) and cold (cyclonic) East Australian Current (EAC) eddies in the Tasman Sea. Deep isothermal layers may also occur in Leeuwin Current eddies off the western coast of Australia. Without prior knowledge of the existence of these deep layers the XBT operator may assume that the XBT probe is faulty by its apparent failure to record any temperature changes.



**Figure 3.2.8.1: Very Deep Isothermal layer to about 420m in the core of a warm EAC eddy**



**Figure 3.2.8.2: Very Deep Isothermal layer to about 325m associated with upwelling in a cold core Eddy in the EAC system**

### 3.2.9 Multiple Mixed Layers

Another type of unusual profile found in the off the east coast and west coasts of Australia are *stepped profiles*. In these profiles up to three isothermal layers may be found. The multiple layers are caused by the interaction between eddies and the forcing of the winds on the surface.

Figures 3.2.9.1 show an example of dual mixed layers in the Leeuwin Current system.

Figures 3.2.9.2 shows an example of triple mixed layers in the EAC system.

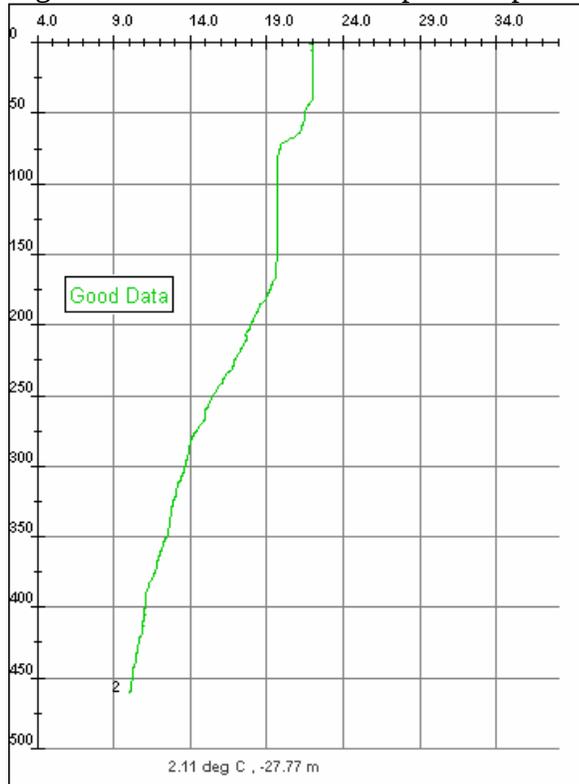
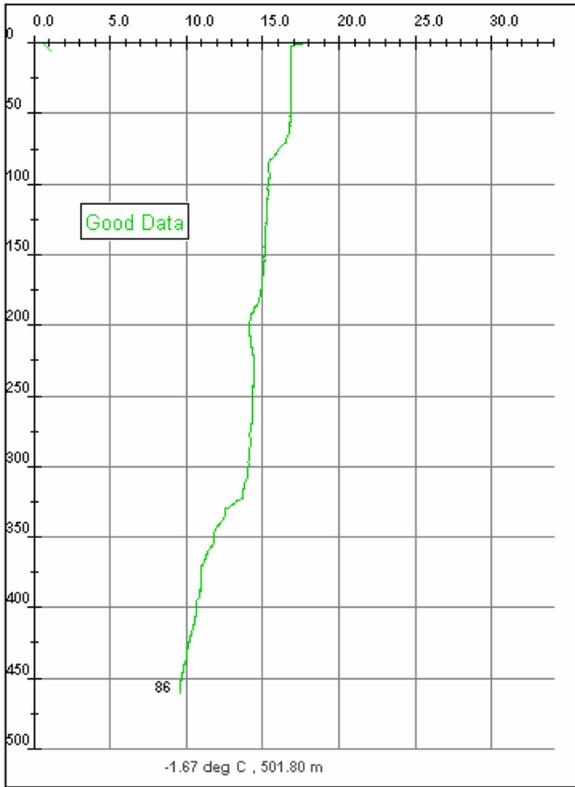


Figure 3.2.9.1: Two Mixed Layers in the Leeuwin Current system



**Figure 3.2.9.2: Three Mixed Layers in the EAC System**