

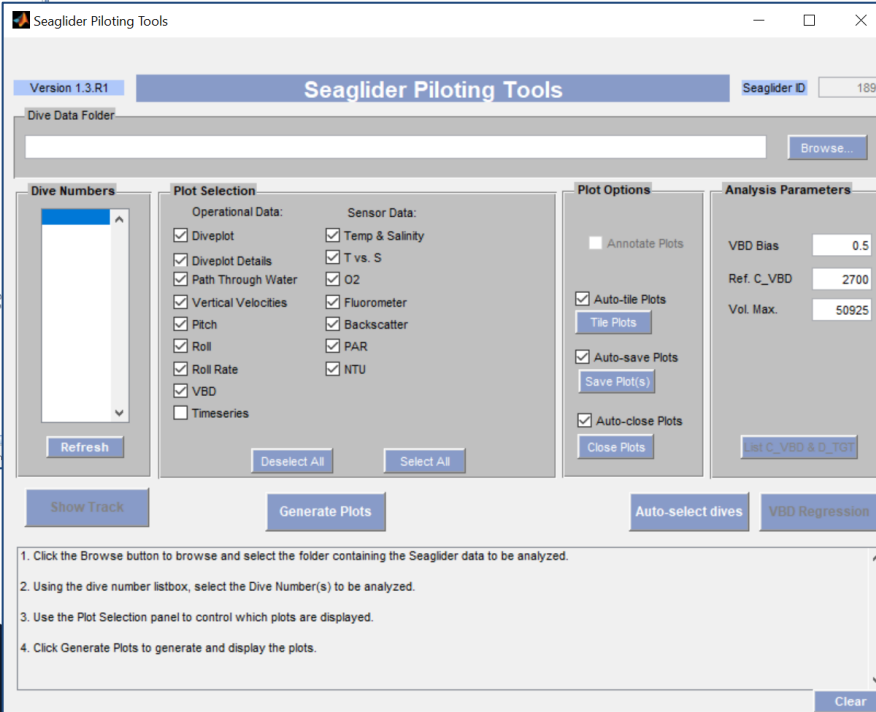
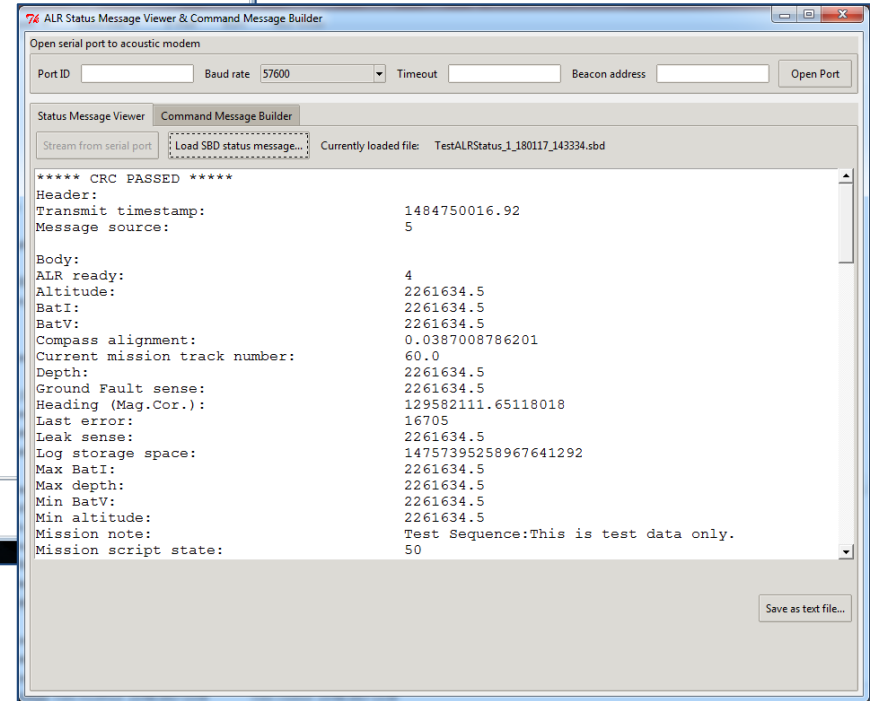
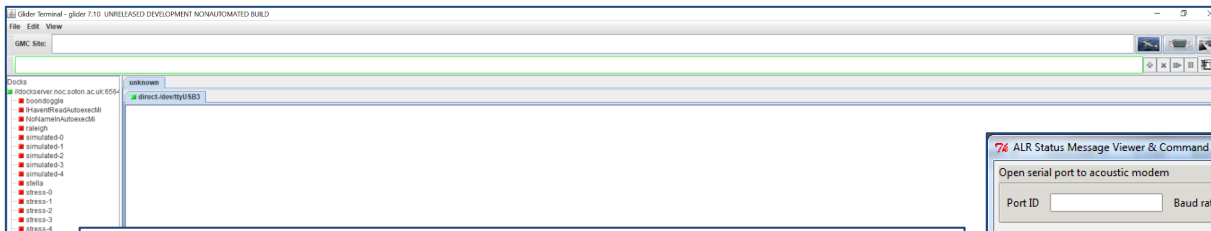
Oceanids - Developing a command and control system for the UK long-range fleets

ALVARO LORENZO-LOPEZ, DR CATHERINE HARRIS AND THE FANTASTIC C2 TEAM

Motivation



4 years ago ...





Multi-vehicle deployments are becoming increasingly commonplace

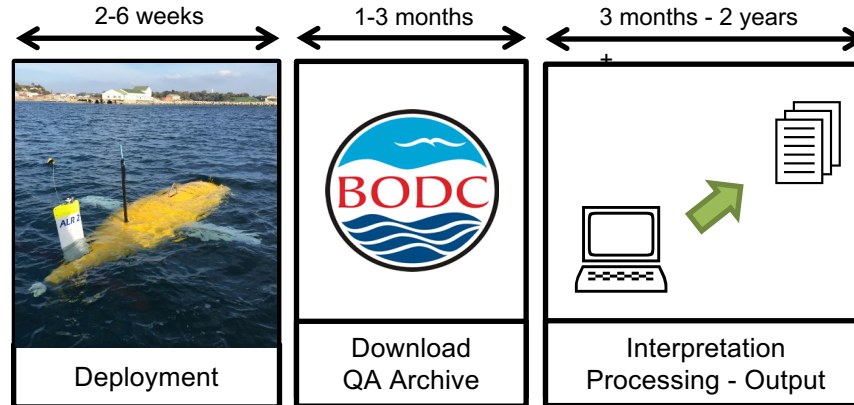
Pilots have to be experts, trained on each individual interface, which limits participation by scientists

Pilots have to juggle many interfaces, leading to human error

The current piloting approach doesn't scale

Problem 2:

The management and processing of deployment data is currently slow and labour intensive



Data Problem

Ask that guy →



Unified Piloting UI



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Oceanography Centre**
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NERC SCIENCE OF THE
ENVIRONMENT



Vehicle Connection History

Connection history of active platforms & vehicles on Deployment

| Vehicle | On Deployment | Last Seen | Active | Actions |
|----------|-------------------------------------|---------------------------------------|---------------|---------------|
| sim-1 | <input checked="" type="checkbox"/> | Currently Active | | |
| alr-4 | <input checked="" type="checkbox"/> | 20/05/2019, 11:37:49 (16 minutes ago) | | |
| unit_398 | <input checked="" type="checkbox"/> | 20/05/2019, 11:31:59 (22 minutes ago) | | |
| lab-1 | <input checked="" type="checkbox"/> | 20/05/2019, 10:18:13 (1 hour ago) | | |
| unit_345 | <input checked="" type="checkbox"/> | 20/05/2019, 10:08:13 (1 hour ago) | | |
| unit_304 | <input checked="" type="checkbox"/> | 20/05/2019, 10:01:00 (1 hour ago) | | |
| unknown | <input type="checkbox"/> | 19/05/2019, 10:32:22 (1 day ago) | | |
| india | <input checked="" type="checkbox"/> | 19/05/2019, 10:31:51 (1 day ago) | | |

sim-1

sim-1

Deployment start: 14/02/2019 (3 months ago)

Deployment end: None specified

Campaign: Autosub Simulation

Last connection status

Connection made: 20/05/2019, 11:53:52 (53 seconds ago) (currently active)

Status: not ready

PILOT

ALR-4

alr-4

Deployment start: 10/05/2019 (10 days ago)

Deployment end: None specified

Campaign: ALR Loch Ness May 2019

Last connection status

Connection made: 20/05/2019, 11:37:49 (16 minutes ago)

Status: not ready

PILOT

Churchill

unit_398

Deployment start: 01/12/2018 (5 months ago)

Deployment end: 01/12/2019 (6 months from now)

Campaign: CUSTARD 1

Last connection status

Connection made: 20/05/2019, 11:31:59 (22 minutes ago)

Status: unknown

PILOT

LAB-1

lab-1

Deployment start: 12/12/2018 (5 months ago)

Deployment end: 29/12/2018 (4 months ago)

Campaign: LAB-1 Trial

Last connection status

Connection made: 20/05/2019, 10:18:13 (1 hour ago)

Status: mission log

PILOT

Cabot

unit_345

Deployment start: 11/03/2019 (2 months ago)

Deployment end: None specified

Campaign: AlterEco 7

Last connection status

Connection made: 20/05/2019, 10:08:13 (1 hour ago)

Status: pitch not commanded

PILOT

Ammonite

unit_304

Deployment start: 11/03/2019 (2 months ago)

Deployment end: None specified

Campaign: AlterEco 7

Last connection status

Connection made: 20/05/2019, 10:01:00 (1 hour ago)

Status: pitch not commanded

PILOT

india

india

sim-4

sim-4

sim-2

sim-2



Current 12V Battery Status

Daily Usage: 5.0 Ah

Used: 365.1 Ah (52%) Remaining: 340.5 Ah

unit_345 at a glance

Last Connection: 20/05/2019, 09:47:53 (2 hours ago)

Surface Reason: pitch not commanded

Current Waypoint: 5535.729 N 113.738 E (14 km / 8 nautical miles away, bearing 225°)

Last Leak Detect: 2.497V 2.496V(f)

Last Vacuum on Surface: 9.472inHg

Device Warning Counts


| | | | |
|---------|---|----|------|
| Total | 0 | 11 | 2413 |
| Mission | 0 | 0 | 100 |
| Segment | 0 | 0 | 4 |

SEE ON TERMINAL

Current device statistics




name in ALLCAPS means CRITICAL device (* => SUPERCRITICAL)



| Name | Use | Stats |
|---------------|-----|---|
| ARGOS* | u | |
| BUOYANCY_PUMP | u | <div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div> |
| CONSOLE* | u | |

LATEST |< < Dive of 658 dives > >| 

Per Page


Event History [SHOW FILTERS](#) 10

 **Device Report**
4 segment oddities  
20/05/2019, 10:05:16 (1 hour ago)


 Goto file sent by unknown
 File goto_l10.ma received by glider
 20/05/2019, 09:48:32 (2 hours ago)
 

✍ Glider Call-in
Surface reason: pitch not commanded
20/05/2019, 09:47:53 (2 hours ago)

 Device Report
5 segment oddities
20/05/2019, 06:30:32 (5 hours ago)

↗ Goto file sent by unknown
File goto_l10.ma received by glider
20/05/2019, 06:14:04 (5 hours ago) 

✍ Glider Call-in
Surface reason: unknown
20/05/2019, 06:13:25 (5 hours ago)

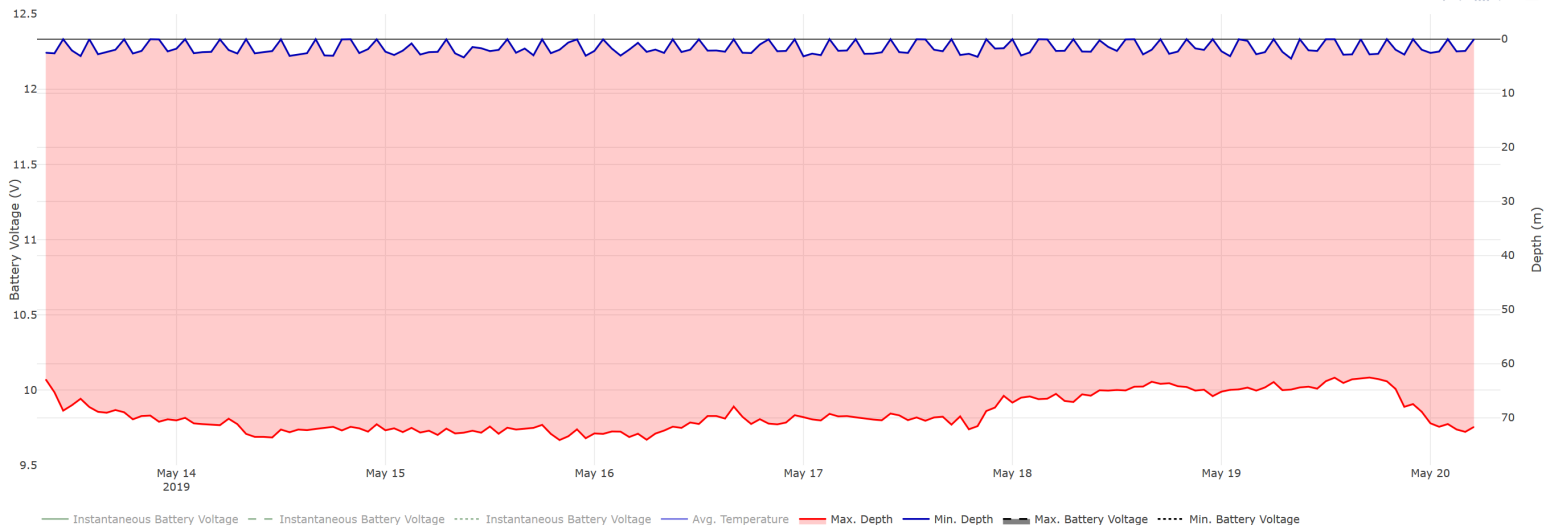
Device Report
3 segment oddities
20/05/2019, 02:54:37 (9 hours ago)

Goto file sent by unknown



Battery Voltage

for the deployment
Battery voltage over deployment

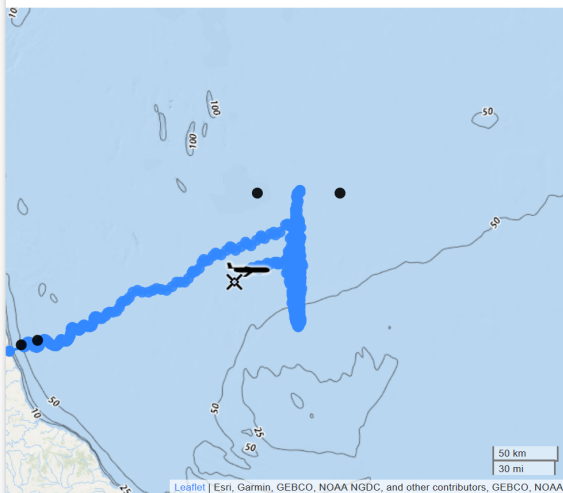


REDRAW GRAPH





AlterECO ✎



Oxygen & PAR Sensor

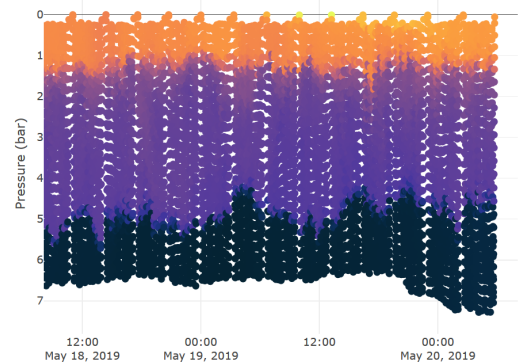
for the last 2 days
Oxygen & PAR Sensor

☒ Graph Sync

CTD

for the last 2 days
Conductivity, temperature and density

☒ Graph Sync

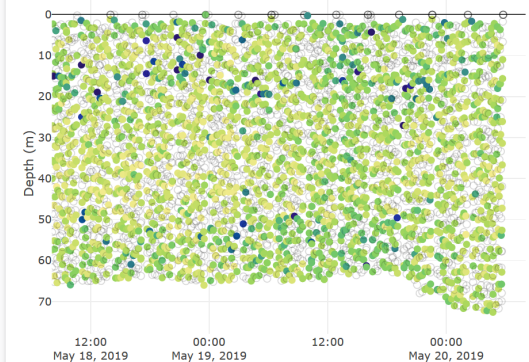


Temperature scale
7.309 11.405
Color variable: CONDUCTIVITY TEMPERATURE

Wetlabs

for the last 2 days
Wetlabs Sensor

☒ Graph Sync



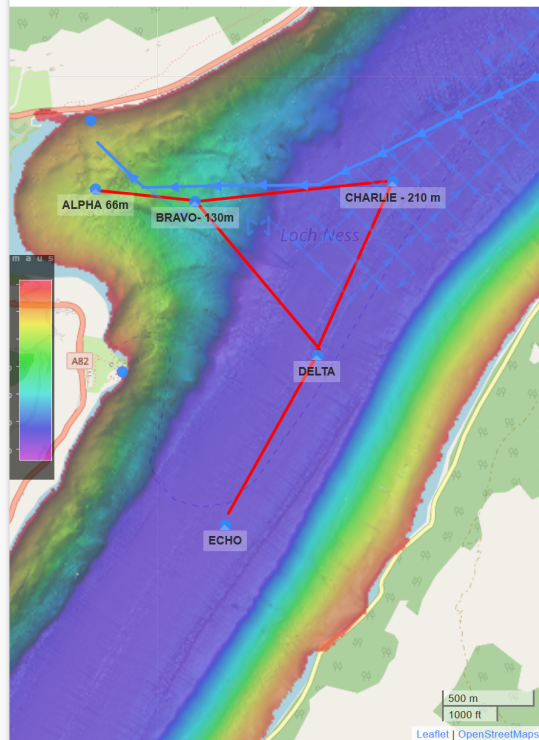
Backscatter scale
0.002 0.007
Color variable: BACKSCATTER COLORED DISSOLVED ORGANIC MATTER
CHLOROPHYLL CONCENTRATION



ALR Loch Ness Trials



Show All Missions



Ed's ADCP bottom lock profiling mission
100m alt to 170m alt repeat
Total Distance: 2.79 km Worst Time: 33:20:00



Down
100m alt to 170m alt repeat
Distance: 232.25 m



Up - Copy
New Track
Distance: 210.57 m



Down - Copy
100m alt to 170m alt repeat
Distance: 233.06 m



Up
New Track
Distance: 210.04 m



Down - Copy
100m alt to 170m alt repeat
Distance: 233.07 m



Up - Copy
New Track
Distance: 210.05 m



New Mission



New Track

Editing Mission: Ed's ADCP bottom lock profiling mission



Mission Name

Ed's ADCP bottom lock profiling mission

Mission Description

100m alt to 170m alt repeat

☒ Do Dive☐ Update Compass Alignment

Surface Potter Power (W)

30

W

Surface Potter Speed (m/s)

0.4

m/s

Hold-at-Depth Timeout (min)

0

min

Values not used by vehicle

Extra Factor

1.5

Compass Calibration Distance (m)

1200

m

Map Colour

#448aff



DELETE MISSION



























SAVE CHANGES

Dialog History

Per Page

15

|< < > >|

| Server | Start Time | End Time | Duration | Actions |
|----------------------|----------------------|----------------------|------------|---|
| nocs_dockserver | 20/05/2019, 09:47:53 | 20/05/2019, 10:08:13 | 20 minutes |   |
| nocs_dockserver | 20/05/2019, 06:13:37 | 20/05/2019, 09:47:53 | 34 minutes |   |
| nocs_dockserver | 20/05/2019, 02:37:17 | 20/05/2019, 06:13:37 | 36 minutes |   |
| nocs_dockserver | 19/05/2019, 23:15:48 | 20/05/2019, 02:37:17 | 21 minutes |   |
| nocs_dockserver | 19/05/2019, 20:06:20 | 19/05/2019, 23:15:48 | 9 minutes |   |
| nocs_dockserver | 19/05/2019, 16:54:30 | 19/05/2019, 20:06:20 | 12 minutes |   |
| nocs_dockserver | 19/05/2019, 13:39:31 | 19/05/2019, 16:54:30 | 15 minutes |   |
| pipeline_slocum_logs | 19/05/2019, 10:32:22 | 19/05/2019, 10:32:22 | |   |
| pipeline_slocum_logs | 19/05/2019, 10:32:21 | 19/05/2019, 10:32:21 | |   |
| pipeline_slocum_logs | 19/05/2019, 10:32:21 | 19/05/2019, 10:32:21 | |   |
| pipeline_slocum_logs | 19/05/2019, 10:32:12 | 19/05/2019, 10:32:12 | |   |
| pipeline_slocum_logs | 19/05/2019, 10:32:12 | 19/05/2019, 10:32:12 | |   |

DOWNLOAD SELECTED

Tags

UPLOAD FILES

| <input type="checkbox"/> | Filename | Size | Category | Tags | Uploaded By | ↓ Created |
|-------------------------------------|-----------------------------|-------------|----------|-------------------------------------|-------------|------------------------------------|
| <input type="checkbox"/> | unit_345-2019-118-0-365.sbd | 25867 Bytes | data | timeseries_archived slocum unit_345 | Unknown | 20/05/2019, 10:01:35 (2 hours ago) |
| <input type="checkbox"/> | unit_345-2019-118-0-364.sbd | 788 Bytes | data | timeseries_archived slocum unit_345 | Unknown | 20/05/2019, 10:01:35 (2 hours ago) |
| <input type="checkbox"/> | unit_345-2019-118-0-365.tbd | 51812 Bytes | data | timeseries_archived slocum unit_345 | Unknown | 20/05/2019, 09:58:52 (2 hours ago) |
| <input type="checkbox"/> | unit_345-2019-118-0-364.tbd | 3708 Bytes | data | timeseries_archived slocum unit_345 | Unknown | 20/05/2019, 09:58:51 (2 hours ago) |
| <input type="checkbox"/> | goto_110.ma | 365 Bytes | upload | compiler unit_345 None slocum | Unknown | 20/05/2019, 09:48:22 (2 hours ago) |
| <input type="checkbox"/> | unit_345-2019-118-0-363.sbd | 26399 Bytes | data | timeseries_archived slocum unit_345 | Unknown | 20/05/2019, 06:27:05 (5 hours ago) |
| <input type="checkbox"/> | unit_345-2019-118-0-362.sbd | 758 Bytes | data | timeseries_archived slocum unit_345 | Unknown | 20/05/2019, 06:27:05 (5 hours ago) |
| <input type="checkbox"/> | unit_345-2019-118-0-363.tbd | 52311 Bytes | data | timeseries_archived slocum unit_345 | Unknown | 20/05/2019, 06:24:14 (5 hours ago) |
| <input type="checkbox"/> | unit_345-2019-118-0-362.tbd | 3708 Bytes | data | timeseries_archived slocum unit_345 | Unknown | 20/05/2019, 06:24:14 (5 hours ago) |
| <input type="checkbox"/> | goto_110.ma | 365 Bytes | upload | compiler unit_345 None slocum | Unknown | 20/05/2019, 06:13:54 (5 hours ago) |
| Rows per page: 10 1-10 of 3,565 < > | | | | | | |

Hide Navigation

Al alvaro.lorenzo@noc.ac.uk

Piloting Home

Logs

Search by platform serial...

sim-1
Autosub Simulation
Seen at 20/05/2019, 12:09:04

alr-4
ALR Loch Ness May 2019
Seen at 20/05/2019, 11:56:15

unit_398
CUSTARD 1
Seen at 20/05/2019, 11:31:59

lab-1
LAB-1 Trial
Seen at 20/05/2019, 10:18:13

unit_345
AlterEco 7
Seen at 20/05/2019, 10:08:13

unit_304
AlterEco 7
Seen at 20/05/2019, 10:01:00

unknown
Seen at 19/05/2019, 10:32:22

unit_304 - AlterEco 7

HEALTH

SCIENCE

PLAN

DIALOGS

FILES

TERMINAL

Console

Scroll Lock

```

m_iridium_dialed_num(nodim) 4307.000000
m_lat(lat) 5534.549600
m_lon(lon) 124.320300
m_pump_stress_remaining_cycles(nodim) 24972.120920
m_pump_stress_track(nodim) 27.879080
m_tot_ballast_pumped_energy(kjoules) 1104.540053
m_tot_horz_dist(km) 1802.528301
m_tot_num_inflections(nodim) 12995.000000
m_tot_num_thermal_valve_cmd(nodim) 2302.000000
m_weight_drop(bool) 0.000000
s_water_depth_avg(m) 200.000000
s_water_depth_delta(m) 0.000000
s_water_depth_wavelength(m) 100.000000
x_hover_ballast_deep(cc) 0.000000
x_hover_ballast_shallow(cc) 0.000000
x_hover_depth_deep(m) 0.000000
x_hover_depth_shallow(m) 0.000000
x_last_wpt_lat(lat) 5545.000000
x_last_wpt_lon(lon) 200.000000
The instantaneous lag time between the system and gps clock is -9.0 seconds.
The average lag time between the system and gps clock is -9.0 seconds.
Housekeeping is done
2245518 38 01470435.mlg LOG FILE OPENED
Megabytes used on CF file system = 1186.906250
Megabytes available on CF file system = 814.031250
2245522 init_gps_input()
2245523 behavior surface_3: SUBSTATE 7 ->10 : Waiting for final gps fix
surface_3: Waiting for final GPS fix.
2245525 disabling Iridium con


```

NOCS DOCKSERVER

Primary

AlterecoC2.xml in state sendModemTbd

Command



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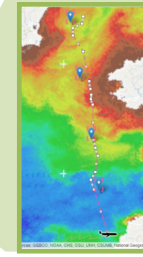
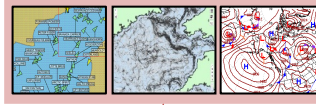
Autonomous Piloting Framework

DR CATHERINE HARRIS – CATHERINE.HARRIS@NOC.AC.UK

Mission planning algorithms
Generation of mission plans



External data sources and models
e.g. ship traffic, currents, weather



User Interface
Pilot supervises mission execution



Automated Piloting Framework
Analysis of vehicle health
Validation of produced plans

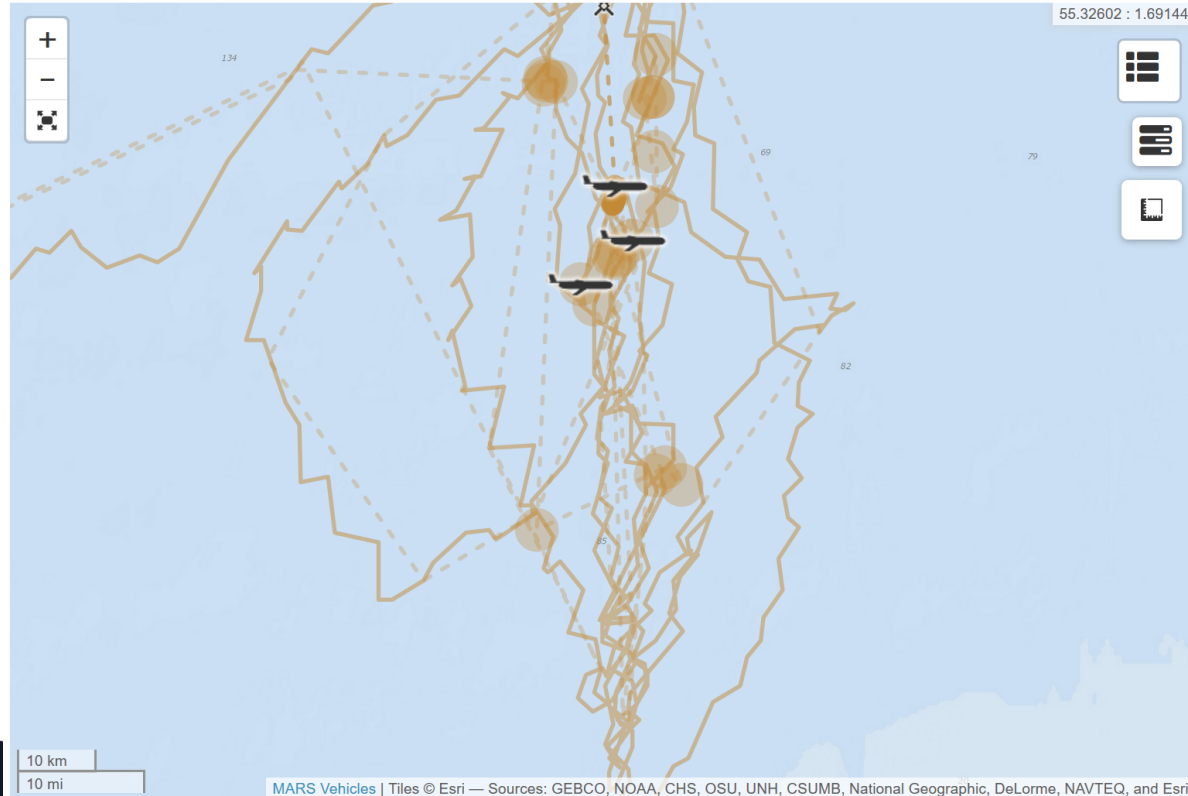


Satellite communication
Vehicles send status and receive commands

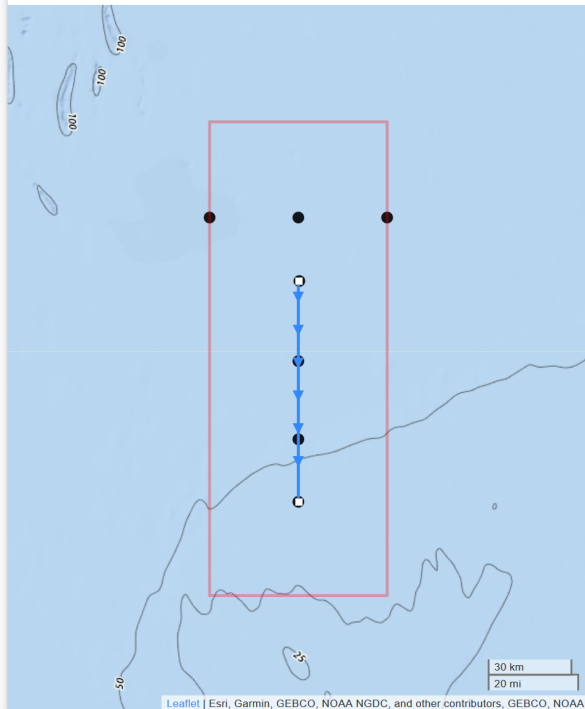
Remote vehicles
Running existing on-board control systems



AlterECO



AlterECO



Goals



AlterEco Go South



Constraints



New Nonempty Plan



AlterEco Bounding Shape



Depth Limits



Editing Goal: AlterEco Go South



Track Name

AlterEco Go South

Track Description

Start Longitude

2

Start Latitude

56

End Longitude

2

End Latitude

55.3

DELETE TRACK



SAVE CHANGES

Console

Scroll Lock

```

Changed u_use_ctd_depth_for_flying from 0 to 0
Changed c_science_on from 1 to 0
1817637 save_and_change_sensors()....
Changed c_science_printout from 0 to 0
Waiting for motors idle
START
**B01000800275775
Starting zModem transfer of goto_l10.ma to/from unit_345 size is 365
Total Bytes sent/received: 365
zModem transfer DONE for file goto_l10.ma

<dockserver command="!dockzr -archive *.*">
sending >goto_l10.ma< Sent
archiving >/var/opt/gmc/gliders/unit_345/to-glider/goto_l10.ma< as >/var/opt/gmc/gliders/unit_345/archive
/20190520T100349_goto_l10.ma< Successful
deleting >/var/opt/gmc/gliders/unit_345/to-glider/goto_l10.ma< Successful
</dockserver>
1817655 restore_sensors()....
Restored u_use_ctd_depth_for_flying from 0 to 0
Restored c_science_on from 0 to 1
1817655 restore_sensors()....
1817655 restore_sensors()....
Restored c_science_printout from 0 to 0

Done!

-----
1817656 behavior surface_3: ! succeeded:zr
  
```

NOCS DOCKSERVER

Primary

AlterecoC2.xml in state sendzModemTbd

Command

Autopilot

Enable Algorithm

- Disconnect**
3 hours after connect
- Updated plan sent**
20/05/2019, 09:48:09
- Connect**
Connected 20/05/2019, 09:48:09
- Checks**
Completed 16 seconds after connect
- Generating Plan**
Completed 12 seconds after connect
- Verifying**
Completed 12 seconds after connect
- Compiling**
Completed 13 seconds after connect
- Compiled files**
[goto_l10.ma](#)
- Approval**
Approved 23 seconds after connect by Autopilot Oscar
- Sending Plan**
Completed 15 minutes after connect
- Disconnect**
20 minutes after connect

Hydrobase QC NRT Webservice

STEFAN GARY & JAMES BACON



data-fusion
localhost:8080/doc

Temperature Salinity Measurement v1

Compare measurements against acceptable envelopes.

POST /ts/v1/measurement Function called on receiving a post to this end point

Parameters Try it out

| Name | Description |
|---|-----------------------|
| payload * required | |
| (body) | Example Value Model |

```

{
  "lat": 56.376,
  "lon": -7.346,
  "depth": 40.2,
  "temperature": 6.4,
  "salinity": 26.4,
  "date": "2019-03-20"
}

```

TS Measurement Request v1

```

{
  "lat": 56.376,
  "lon": -7.346,
  "depth": 40.2,
  "temperature": 6.4,
  "salinity": 26.4,
  "date": "2019-03-20"
}

```

Latitude in decimal degrees.
Longitude in decimal degrees.
Measurement depth in metres measured positive from the surface.
Measured temperature in degrees centigrade.
Measured salinity in practical salinity units.
Date of measurement. Today assumed if this is omitted.

Responses
Response content type application/json

| Code | Description |
|------|------------------|
| 200 | Success |
| 400 | Validation error |

Example Value | Model

```

{
  "lat": 56.376,
  "lon": -7.346,
  "depth": 40.2,
  "temperature": 6.4,
  "salinity": 26.4,
  "pressure": 40.4,
  "potential_temperature": 6.3,
  "potential_density": 27.1,
  "date": "2019-03-20",
  "season": "spring",
  "sea_depth": "95",
  "sea": "shelf",
  "msl0": "7500",
  "msl1": "67",
  "passed": "true",
  "justification": "Measurement falls within acceptable envelope.",
  "plot": "https://path/to/shelf/spring7500_67.pdf"
}

```

Example Value | Model

```

{
  "message": "Request validation error.",
  "error": "{0: {'lat': ['Latitude 156.376 is out of range.']}}"
}

```


Please contact us

Alvaro Lorenzo-Lopez – C2 Delivery lead: alvaro.lorenzo@noc.ac.uk

Dr Catherine Harris – Autonomy : catherine.harris@noc.ac.uk

Dr Justin Buck - Data: justin.buck@noc.ac.uk