Rapid Environment Picture

2017 Edition

Report by Miguel Nunes

Images courtesy of LSTS-FEUP


Marinha
700 anos
CASSIOPEIA

REP17 Participants

Participants

LSTS

Marinha

S&T organization CMRE

NTNU

Carnegie Mellon University

OceanScan Marine Systems & Technology

HIDROMOD

universidade de aveiro

U.PORTO

CTU CZECH TECHNICAL UNIVERSITY IN PRAGUE

Baseline plan

1. Create a document to capture the operations, the logistics and anything else related to making the REP exercise so that another exercises of the same nature can be recreated in Hawaii. Create a media album with pictures and videos of the event.
2. Support the REP17 exercises in any functions that could be helped with an "extra pair of hands" (LSTS software dev, operations support, etc.)
3. Discuss/plan the integration of the LSTS toolchain with COSMOS for a possible future mission using heterogeneous nodes from underwater, surface, air and space. HSFL CubeSat integrated into a REP 2018?

   Extra:

4. integrate the M100 and the two spectrometers for ocean color measurements, connect the LSTS toolchain to the drone and make it part of your fleet.

Technological Goals

1. Persistent operations with multiple vehicles with applications in security, defense, and science;
2. Simplified launch and recovery procedures for underwater, surface, and air vehicles to minimize logistic support;
3. Distributed ocean space center for remote situational awareness and tasking of heterogeneous vehicles;
4. Vehicles with multi-domain (air-surface) capabilities for sampling and communications networking;
5. MIDAR capability demonstrations;
6. Coordinated ASV/UAV operations with vision based landing;
7. Coupling remote sensing and field operations;
8. Integrated data management for situational awareness – distributed ocean space center.

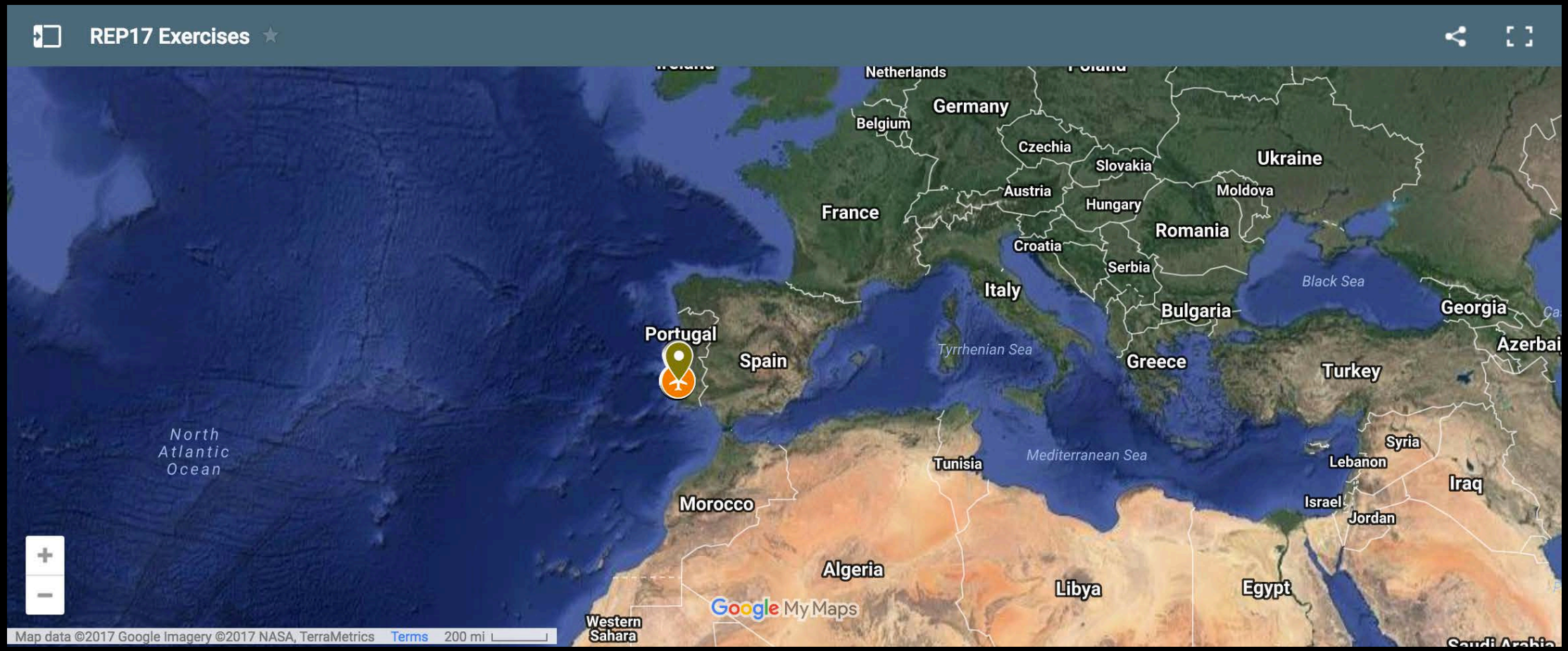
Scientific Goals

1. UAS-based sea surface temperature and ocean color measurements;
2. Sampling internal waves;
3. Coastal fronts/Lagrangian structures.

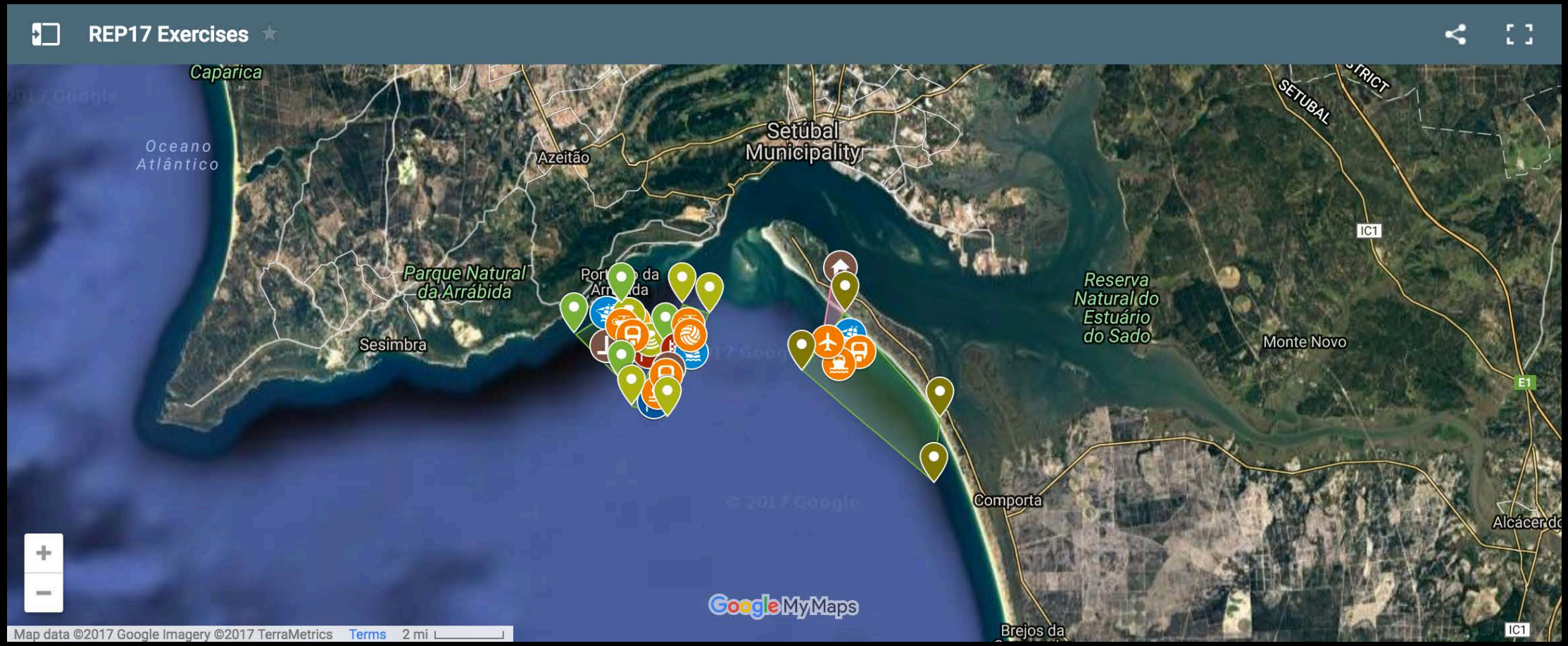
Security/Defense Goals

1. Characterization of side-scan and magnetometer performance;
2. Multi-vehicle cooperative mine warfare.

Operation Aereas: Portugal, Estuario do Sado

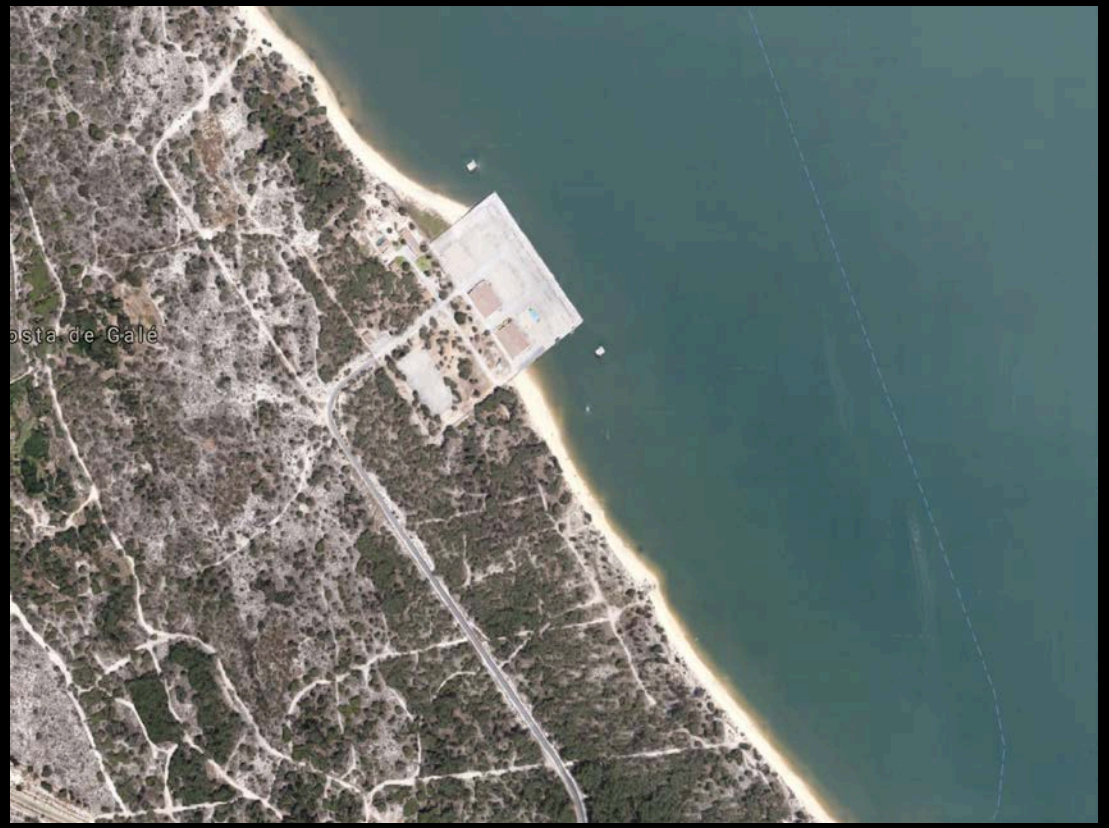


Operation Aereas: Portugal, Estuario do Sado



Naval Base Troia

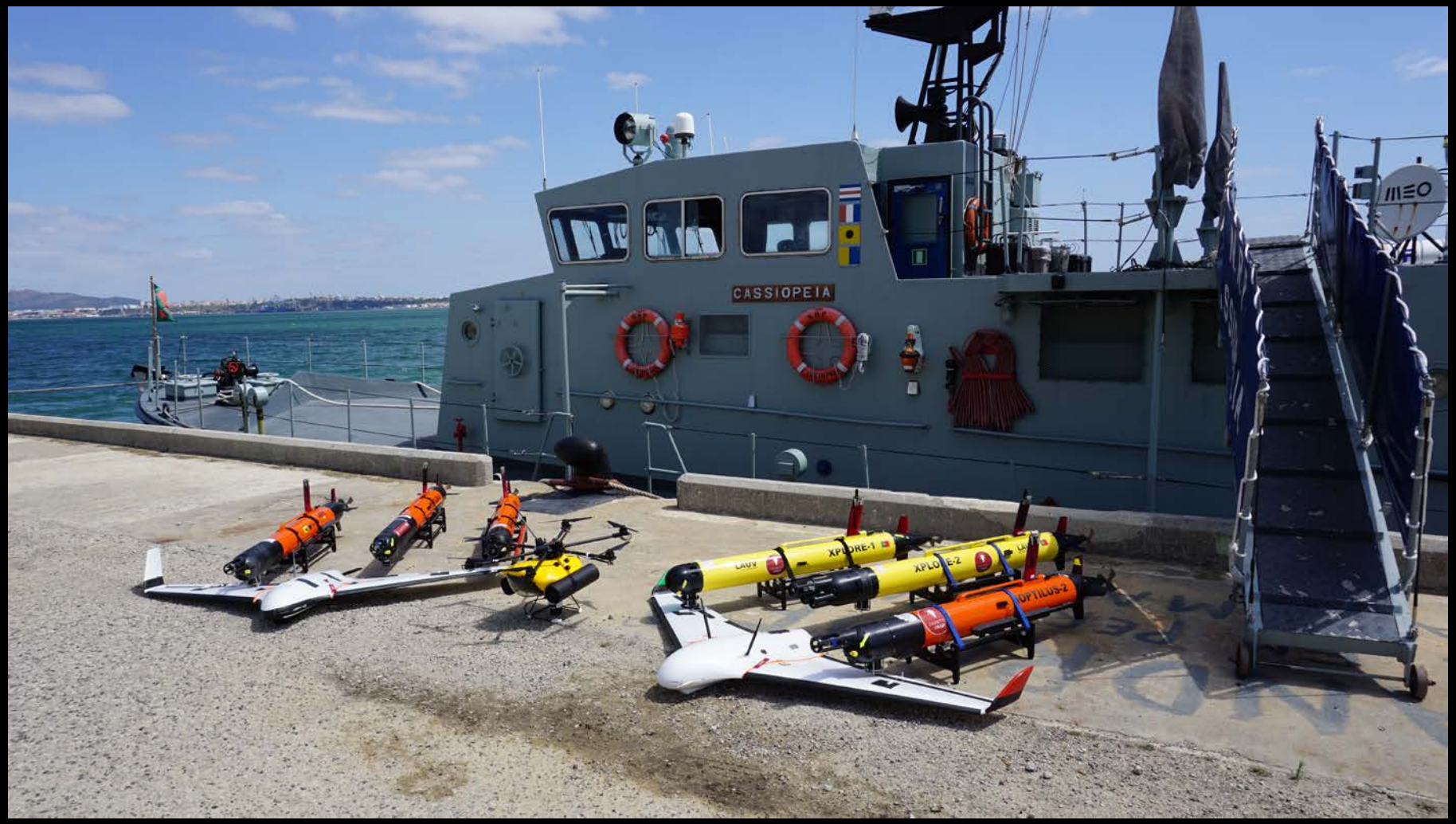
Naval Base Troia



Naval Base Troia

Naval Base Troia

Operations with NRP Cassiopeia



Loading Cassiopeia

Preparing for Deployment

Operations Center

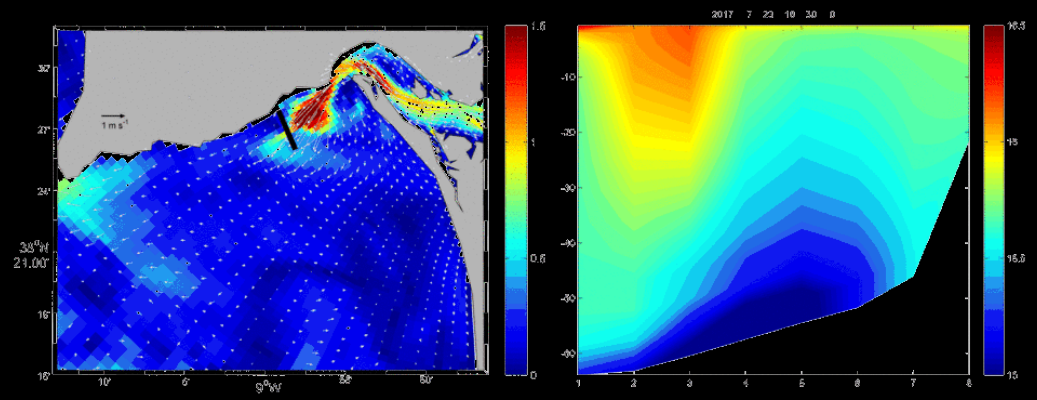
Exercises

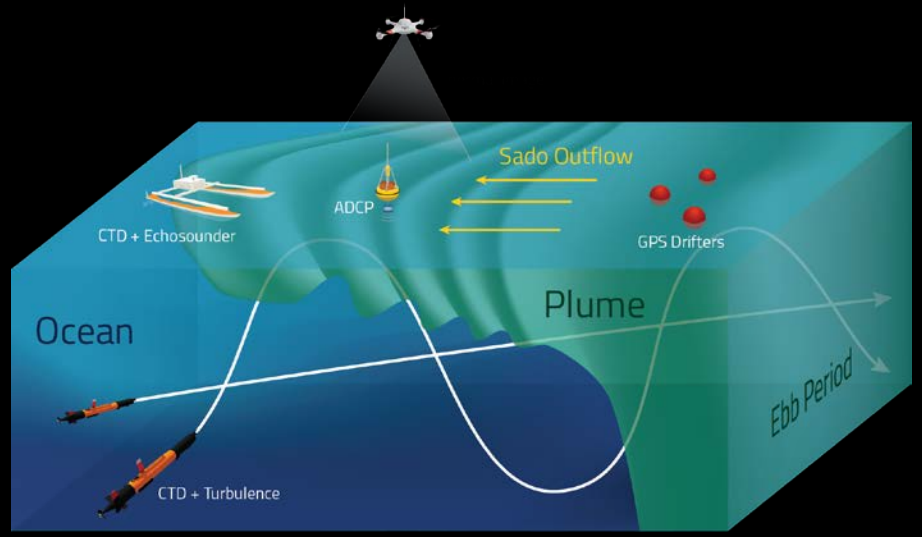
- Señora Rosário/ General Ops
- SAVEL - Sado Estuarine Outflow
- SNOW - Sado Nonlinear Internal waves
- Multi-vehicle control

REP17 - Exercise Timeline

Actualizado em: 23-06-2017

MAP OF OPERATION AREAS		
Link		
EXERCISE TIMELINE		
10 July		
NAME: Señora Rosário/ General Ops **LOC:** Comporta **TIME:** 0800 to 1600 **SHIP NEEDS:** NRP ORION	CMU ASV + UAVs LOC: Tróia TIME: All day SHIP NEEDS: Bote	**Lunches:** ORION - 4 BNTróia - 13 **Dinner:** BNTróia -17
11 July		
NAME: Señora Rosário/ General Ops **LOC:** Comporta **TIME:** 0800 to 1600 **SHIP NEEDS:** NRP ORION	CMU ASV + UAVs LOC: Tróia TIME: All day SHIP NEEDS: Bote	**Lunches:** ORION - 4 BNTróia - 13 **Dinner:** BNTróia - 17
12 July		
NAME: SAVEL **LOC:** Boca Sado **TIME:** 0600 to 1900 **SHIP NEEDS:** NRP ORION	CMU ASV + UAVs LOC: Tróia TIME: All day SHIP NEEDS: Bote	**Lunches:** ORION - 4 BNTróia - 13 **Dinner:** BNTróia - 17

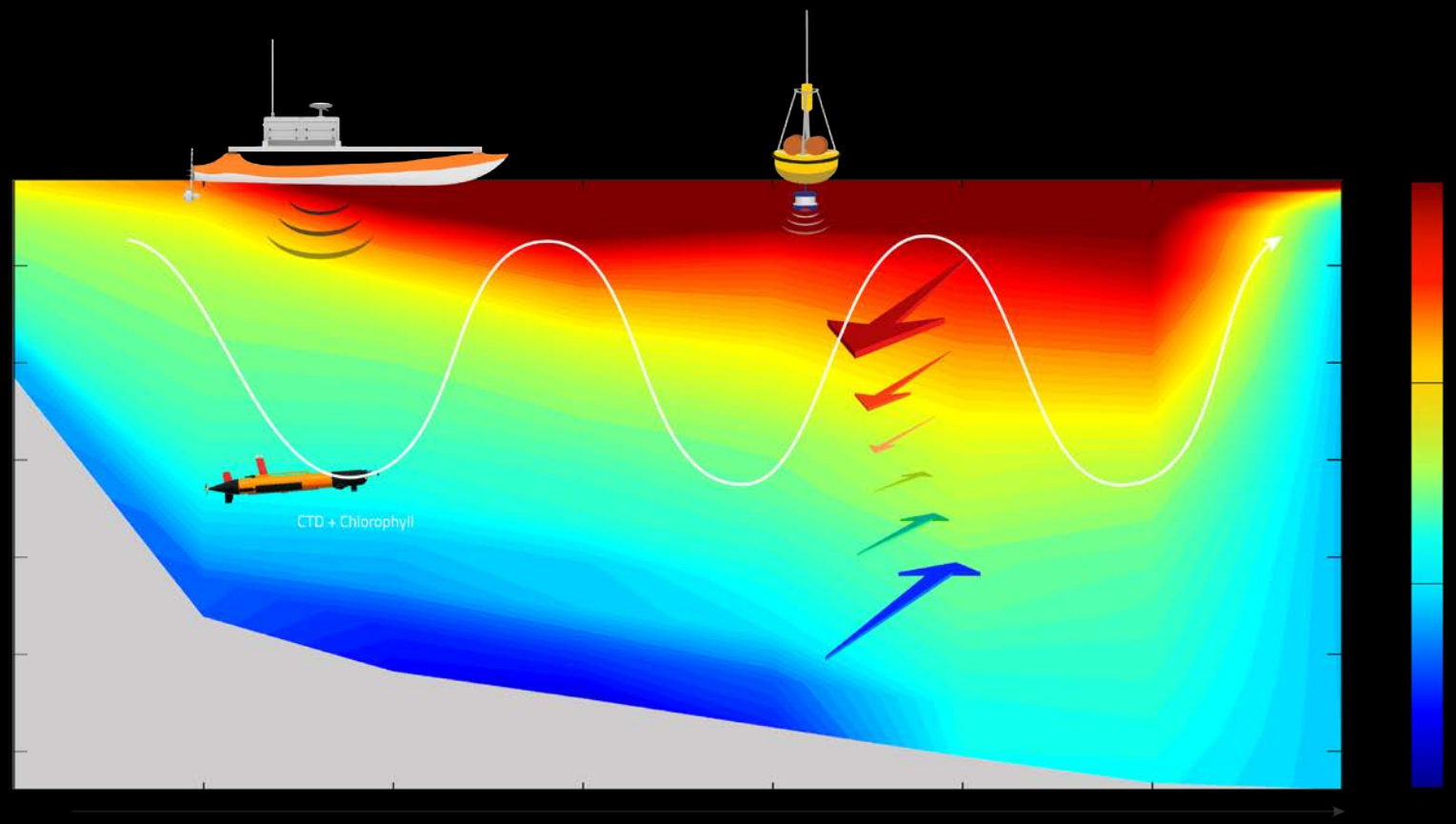


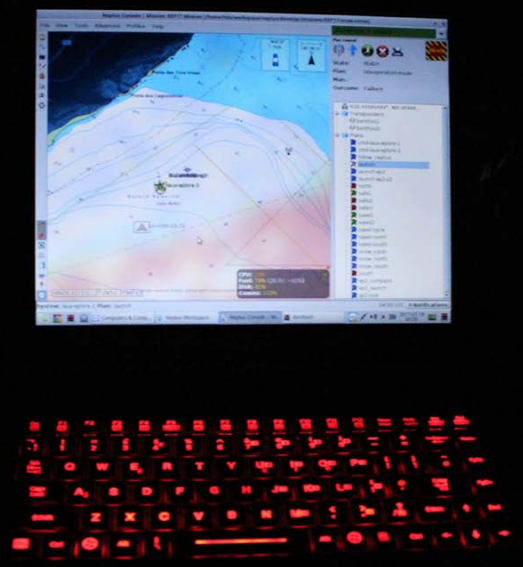


Exercise: SaVel - Sado Estuarine Outflow

- Objective:
  - Impact of Tidal Variability on Coastal Stratification
  - study the vertical structure and short-temporal variability of the region of influence of Sado estuary outflow
- Vehicles
  - LAUV-Xplore-2, equipped with an environmental probe measuring temperature, salinity, chlorophyll and turbidity.
  - LAUV-Xplore-1, equipped with an environmental probe measuring temperature, salinity, pH and Redox.
- Data
  - Collection of hydrographic data (CTD)
  - temperature, salinity, turbidity and chlorophyll data taken from a complete semi-diurnal tidal period (12 h 25 min)
- Operations
  - Vehicles transect of about 2.8 km, between surface and 20 m depth over 13 hours in a row

Exercise: SaVel - Sado Estuarine Outflow





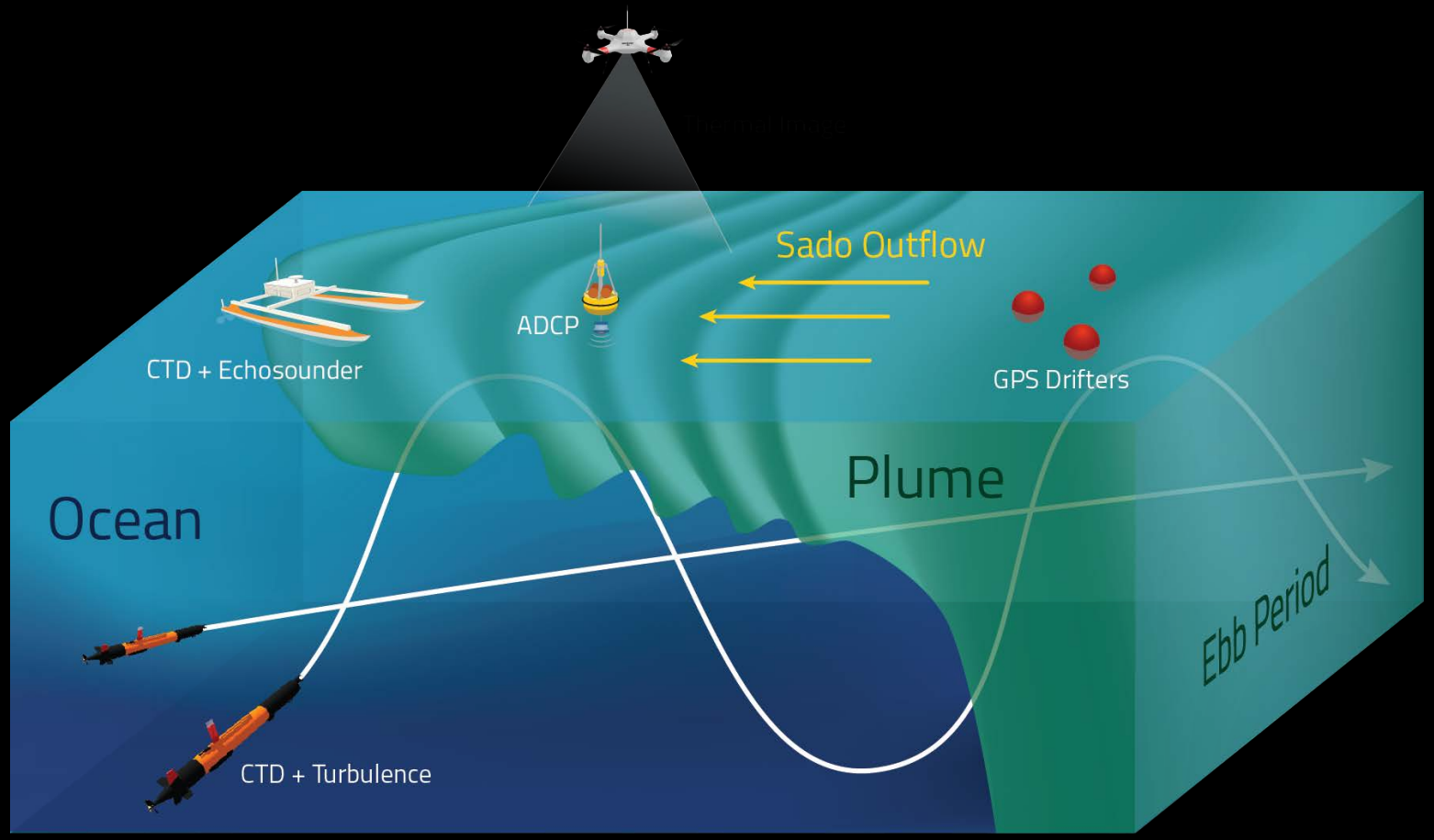

22°
27% 4:28 PM
ripples.lsts.pt
9
BOM JESUS
Pedra da Anixa
Praia do Portinho da Arrab
Complementary Protected Area
Baixo de Alpertuche
(see Note)
Praia de Alpertuche
Ponta das Tres Irmas
Ponta dos Lagosteiros
Barra de Setubal
Partial Protected Area
Setubal
Mandatory Pilotage Area
Login
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Map data © Transas Nautical Charts

Exercise: SNOW - Sado Nonlinear Internal waves

- Objective
  - Attempt observations of nonlinear internal solitary waves in the region of influence of the Sado Estuarine outflow
- Vehicles
  - LAUV-Xplore-2, equipped with an environmental probe measuring temperature, salinity, chlorophyll and turbidity;
  - LAUV-SeaCon-3, equipped with echo-sounder and CTD sensors;
  - UAV (X2O-01) equipped with thermal and hyperspectral cameras*
  - 3 surface drifting buoys (Wavy)
- Data
  - Salinity, water temperature, turbidity and optical backscatter throughout the water column, using a synergetic network between vehicles.
- Operational Area
  - place south east from Portinho da Arrábida

*Unfortunately the UAV, which would have been used to track the wave's front progression had problems during the launch and had to be aborted

Exercise: SNOW - Sado Nonlinear Internal waves



Exercise: SNOW - Sado Nonlinear Internal waves

- The survey scenario consisted on the collection of hydrographic data (CTD, chlorophyll, turbidity) with Xplore-2 during an ebb period (about 6 hours) along a perpendicular transect to the propagation of the estuarine front
- Simultaneously, Seacon-3 equipped with an EchoSounder and a CTD, was deployed along the same transect at the surface to identify the propagation and/or generation of solitons in the thermocline interface
- the operation was planned to coincide with Sentinel-2A (ocean color) overpassing at 1224am

Region of Influence of Sado Estuary - RGB composite - Acquired on 14 July 2017 at 11:21 UTC by Sentinel-2A (ESA), this image shows the turbid features propagation from the shallower region close the estuary mouth towards ocean during a ebb period

Exercise: control of multiple vehicles for seabed surveys

- Objective
  - test novel approach towards the control of multiple heterogeneous vehicles for seabed surveys
- Participants
  - Porto University and Czech Technical University
- Innovations
  - Loss of communication, the system predicts when the vehicles will be back to the base station to assigned new tasks.
  - The vehicles are constrained to never be away from the base station for more than a specified amount of time.
  - When vehicles undergo failures its behavior is adapted by an onboard planner (even when they are disconnected and underwater) trying to fulfill as many tasks as possible.
  - Vehicles and tasks (areas to be surveyed) can be added / removed at any time and system adapts to those changes.

Neptus Console | Mission: REP17 Mission [/home/zp/workspace/neptus/develop/missions/REP17/rep17.nmisz]

File View Tools Advanced Profiles Help

LAUV-XPLORE-1: SERVICE

[Simulating lauv-noptilus-1 for 6s]
[Simulating lauv-noptilus-3 for 4m 04s]
planning in 26...

ctd2
ctd3
t153 (mb)
t150 (mb)
center1
t152 (mb)
t149 (mb)
t156 (ctd)
t151 (mb)
t148 (mb)
(lauv-noptilus-3, 3.0 m)
np1
lauv-xplore-1
xp1
lauv-noptilus-3
ctd1
manta-1
Me

water
? m/s

23.39 m
N

Plan Control

Abort

Acoustic Operations

Acoustic Operations | Gateway state

benthos5
caravela
lauv-arpao
lauv-noptilus-1
lauv-noptilus-2
lauv-noptilus-3

GW: manta-1
Range system
Send Message
Abort
Clear ranges
Show ranges

Range lauv-noptilus-3 commanded to 1 systems
Distance to lauv-noptilus-3 is 157.1

l1
l2
l3
loiter1
loiter2
loiter3
mvplanner-001-xplore1
mvplanner-002-noptilus3
mvplanner-003-noptilus1

Real-Time plot

20
15
10
5
0
11:04:00
11:04:30

lauv-noptilus-1.depth
lauv-noptilus-1.altitude
lauv-xplore-1.depth
lauv-xplore-1.altitude

Settings
Clear

38N24.97968419 / 8W51.67287761

© open street map, transas nautical charts world overlay

System: lauv-xplore-1 Plan: mvplanner-002-noptilus3

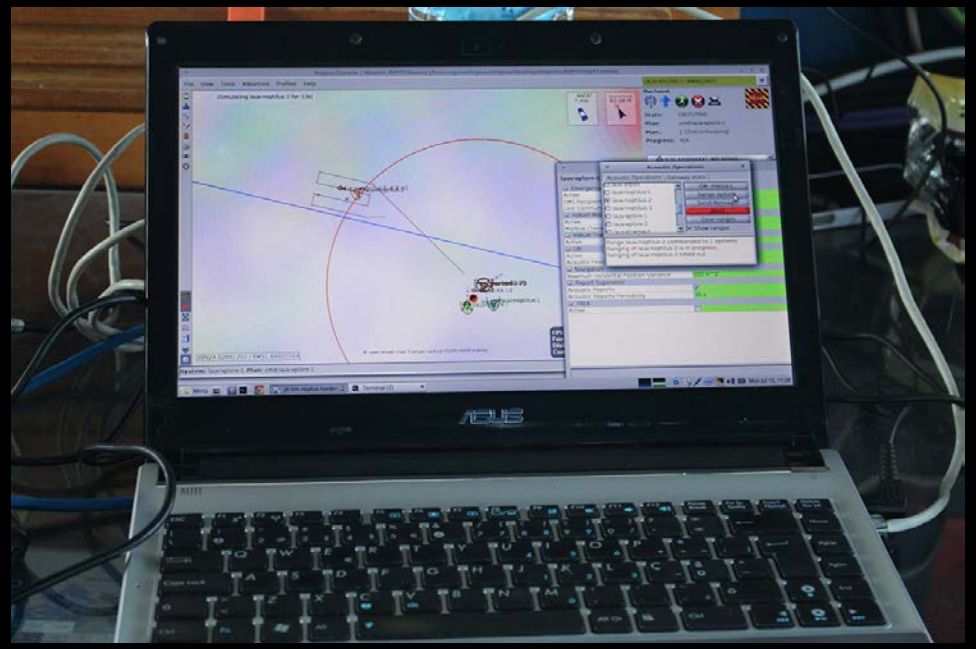
10:04 UTC 17 Notifications

CMU Software Engineering Institute participation

CMU Software Engineering Institute participation

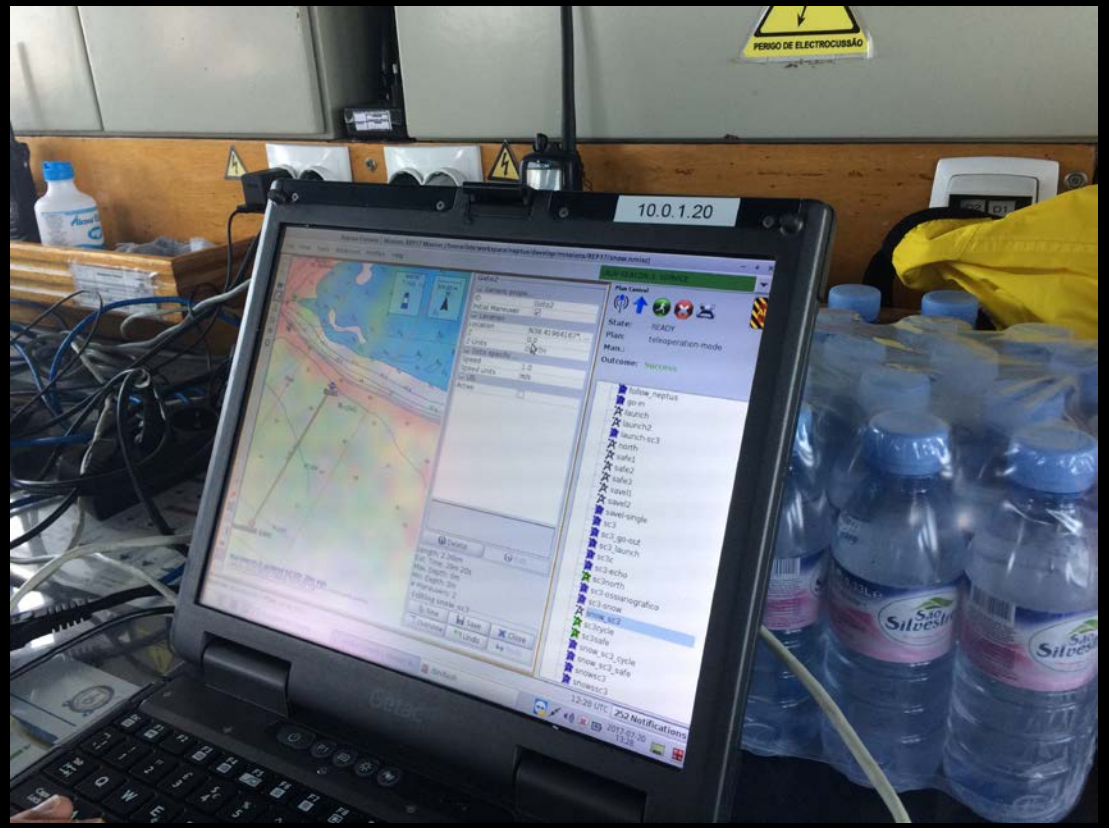
Operations Software

- Neptus, **Command and Control Software**



- DUNE, **Unified Navigation Environment**

Operations Software



LSTS Toolchain + COSMOS

- Meeting with Joao Souza (LSTS), Kanna Rajan and Mariusz Grøtte (NTNU)
- First step is to explore the message transport mechanism
  - Integrate IMC

Lessons learned

- Do not ever forget to bring “tape”!!!
- Always download all that you need before going to the field
- Make sure to charge all the batteries one day ahead
- Check weather information in advance, waves, temperature, rains, etc. (best to have a meteorologist)
- It might be handy to have soldering iron and power strips
- 220 V vs. 120 V ?!?
- sunscreen
- cellphone coverage
- 3D printer?

Lessons learned

- heat problems can jeopardize the mission
- aways test the vehicles 2-3 weeks before missions
- deployment location for vehicles is very important, otherwise could jeopardize mission

Little accidents ….

PR Drone

REP HAWAII

Technological Goals

- Daily operations during one week with multiple vehicles for applications in science objectives relevant to UH scientists
- Deployment and operation of UH and LSTS sensors for remote sensing
- Integration of LSTS sensors and/or vehicles
- Exercise the operation of heterogeneous vehicles: UAVs (multi-rotor and flying wing), AUVs and overhead passing satellites if possible;
- Test communications between vehicles and the command center;
- Use the LSTS toolchain to operate the fleet of vehicles;
- Distributed operations with automated task planning (AI planner)

Training/ STEM Outreach Goals

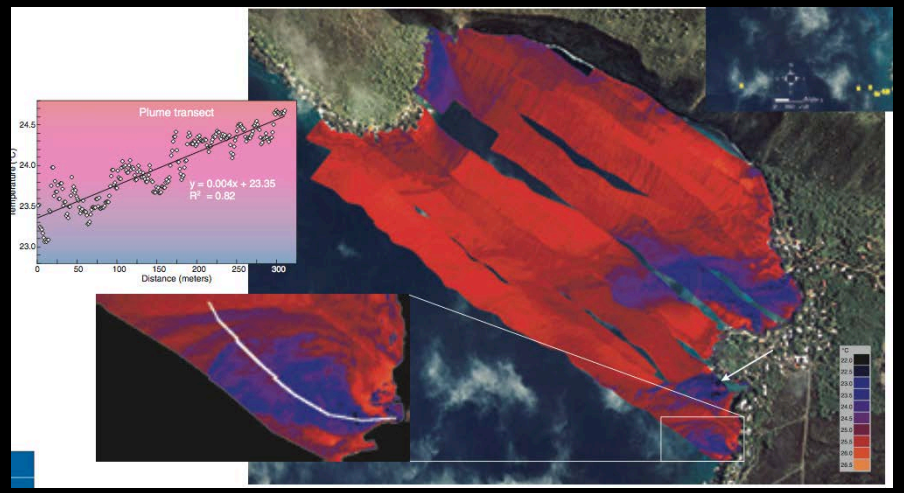
- Educate and train students in the technology, science and operations …

Science Goals

- Sea surface temperature and ocean color measurements
- Sampling volcanic gases
- Submarine groundwater discharge monitoring
- Measure ocean water acidity close to lava flows
- Sampling internal waves
- Map coral reefs

REP-Hawaii

- Dates
  - October workshop
  - Jan/Feb 2018
- Tentative Exercises
  - Volcanic Gases Measurements on Kilauea
  - Submarine Groundwater Discharge



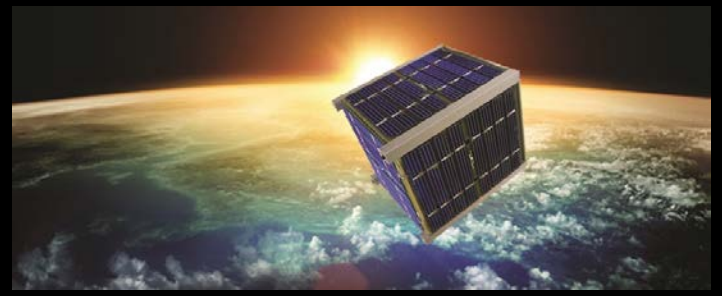
REP-Hawaii

- Tentative Vehicles/Sensors
  - DJI M100, Spectrometer
  - DJI M100, IR camera
  - Skywalker X8, visible camera, IR camera
  - MBARI-LRAUV, eDNA sampling, …

In conclusion

- REP-Hawaii 2017 Repository
  - https://drive.google.com/drive/folders/0Bx1mpfQB9ofyMlE1VndDVlBzLW8
- REP-Atlantic 2017 Pictures
  - https://drive.google.com/drive/folders/0Bx1mpfQB9ofyRUpYVlBxV2pNZVU

In conclusion



LSTS

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