CRUSER
Consortium for Robotics and Unmanned Systems Education and Research

PSAP: *Persistent Smart Acoustic Profiler*

Workshop on Monitoring Rice's Whales in the Gulf of Mexico

29-Sep-2023

John Joseph, NPS Oceanography

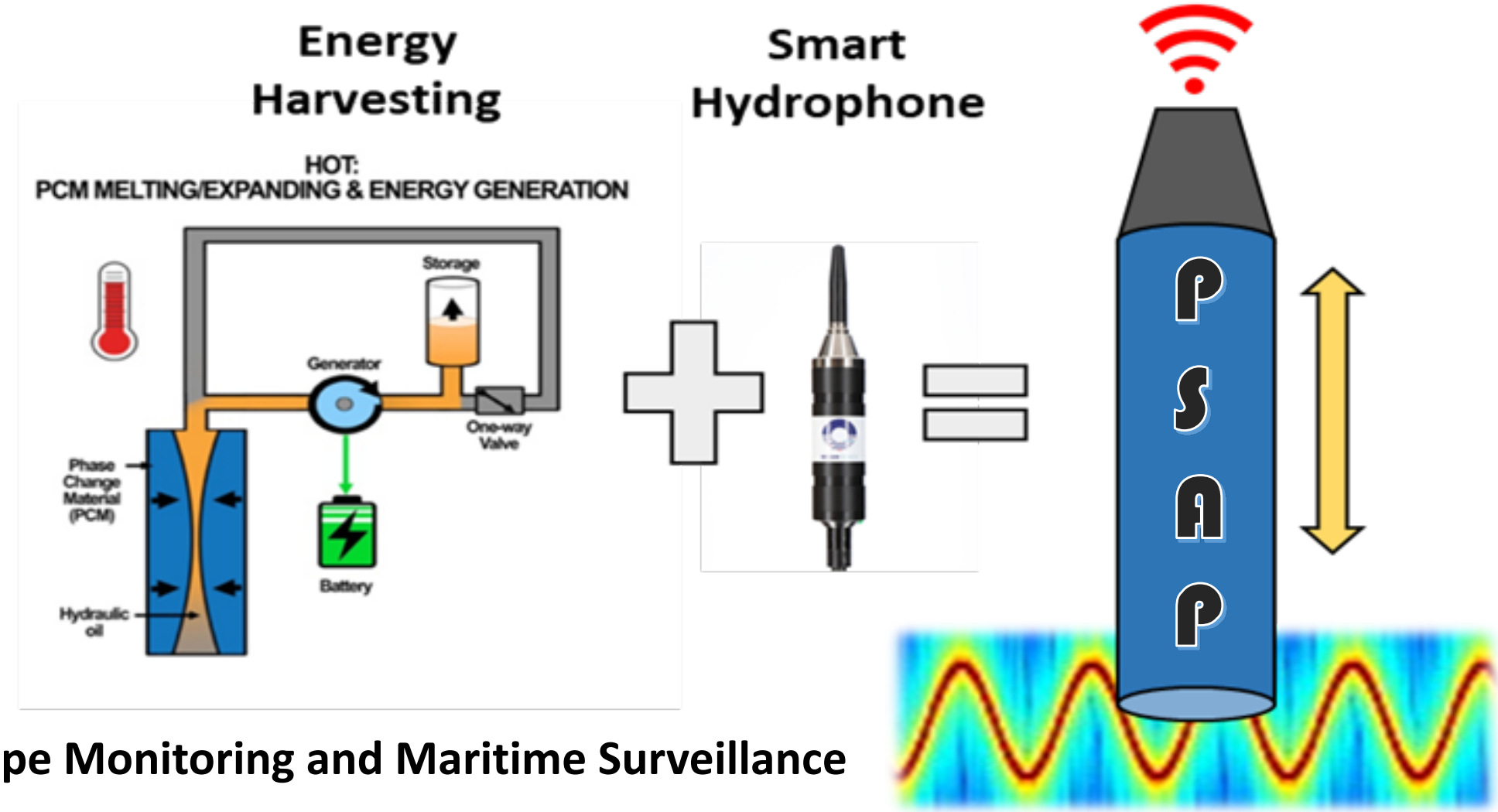
Yi Chao, Seatrec

John Ryan, MBARI

Background of the Proposed Concept

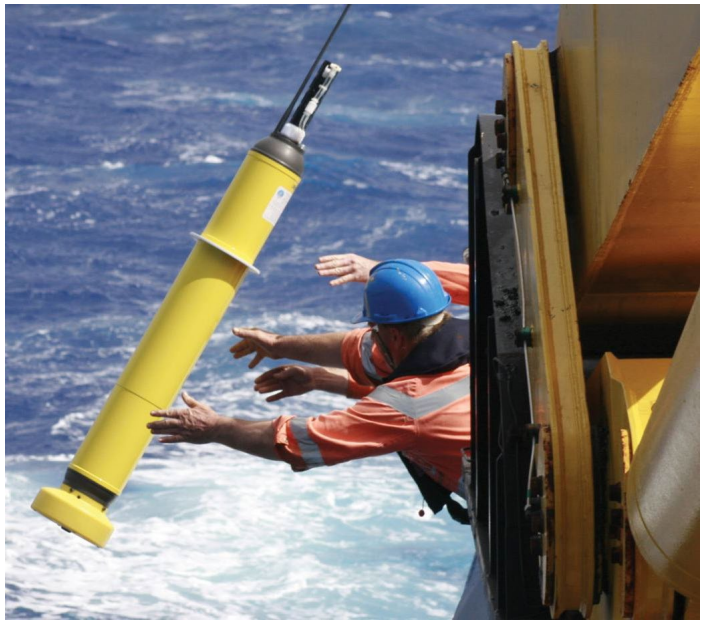
- **The Objective**: Combine groundbreaking technologies to develop easily-deployed, unmanned acoustic sensing platforms that can autonomously provide maritime surveillance in support of the Navy's Intelligent Autonomous Systems (IAS) Strategy
- **The Approach**: Work collaboratively with industry and research partners to integrate novel technologies into a state-of-the-art solution that provides operators intelligent information about the maritime environment, enabling more timely, informed, and precise decision making.
- **The Support**: NPS Consortium for Robotics and Unmanned Systems in Education and Research (CRUSER)

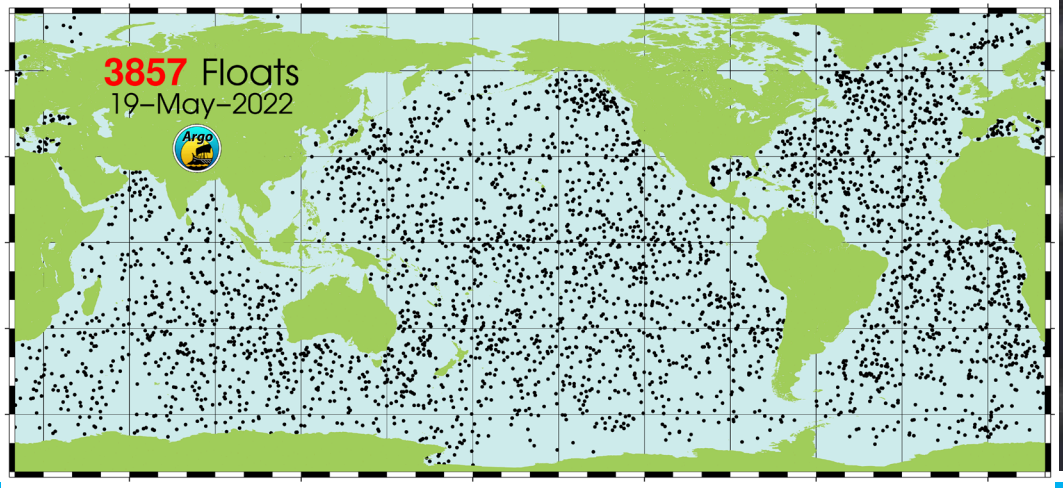
The Basic Idea

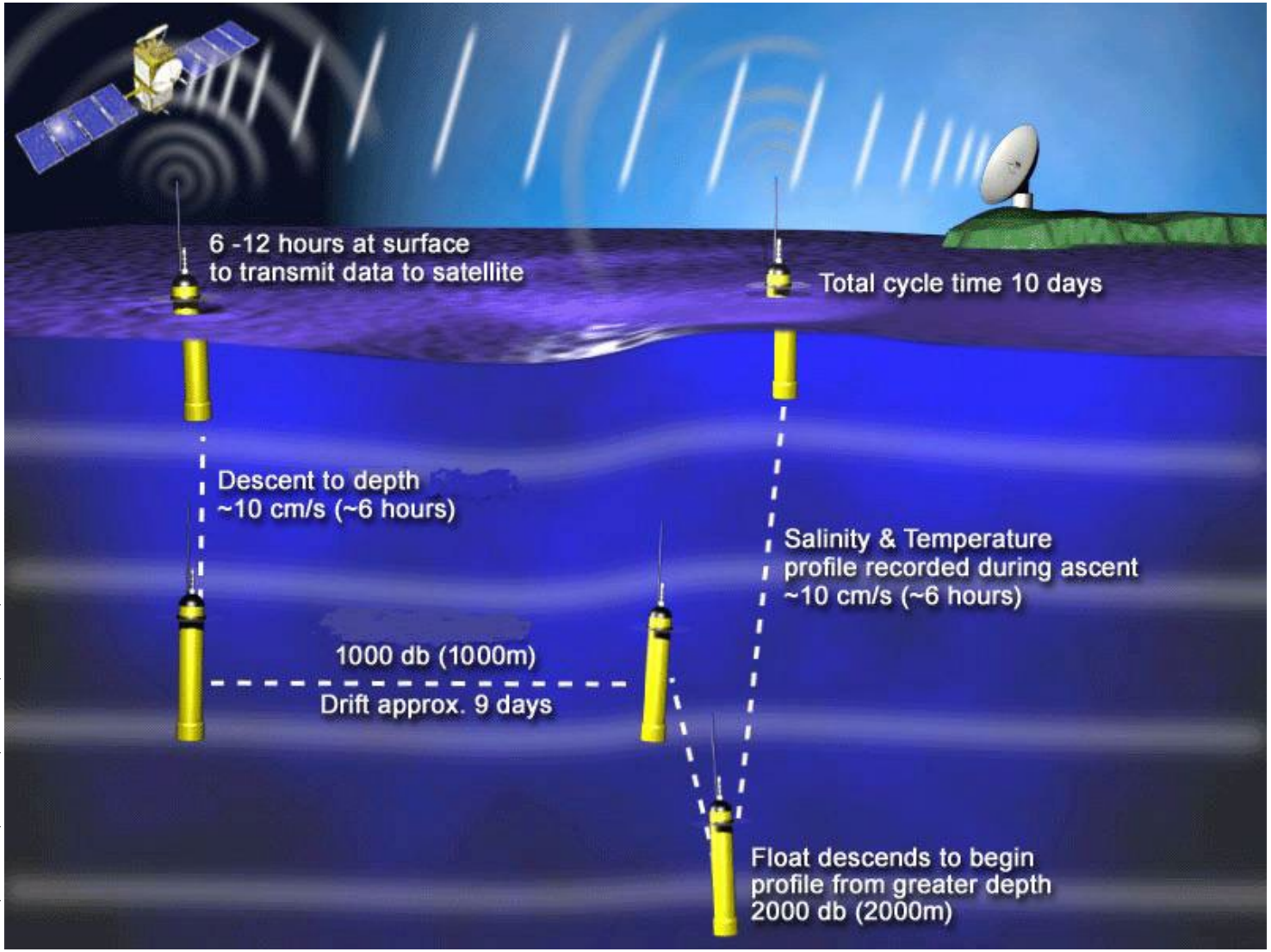


Soundscape Monitoring and Maritime Surveillance

Autonomous Profiling Floats with CTD and BGC Sensors – Argo

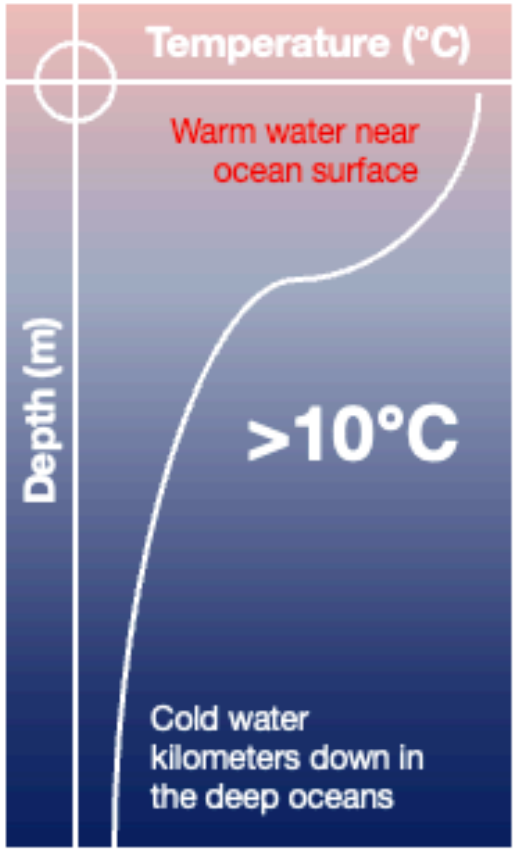






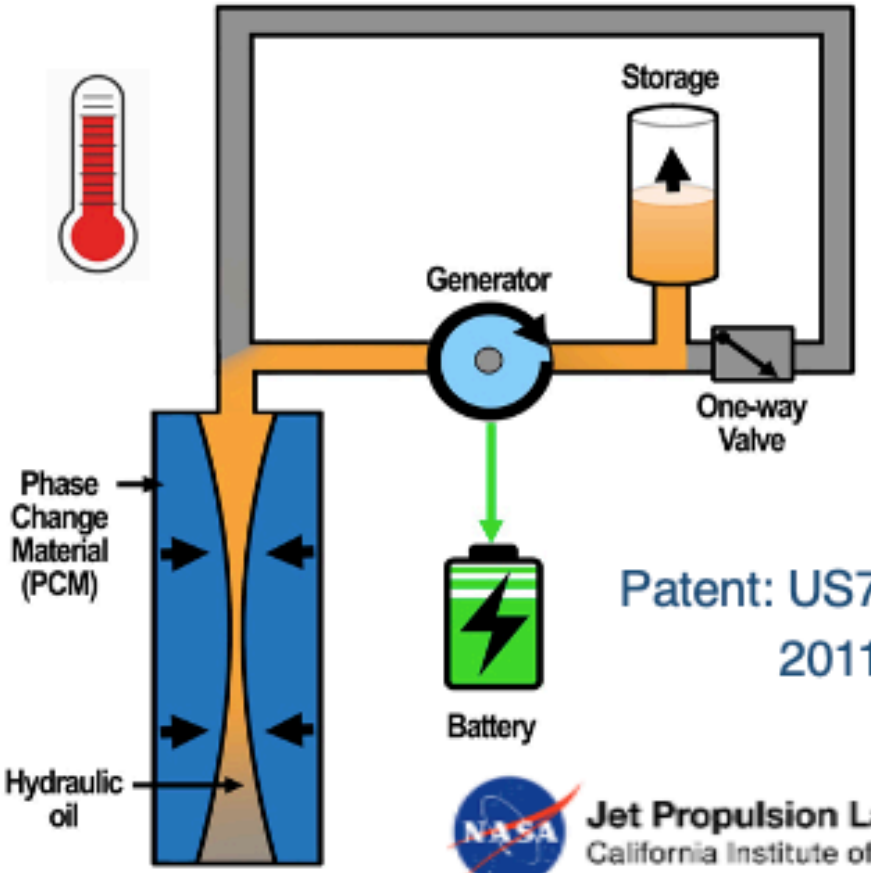
Seatrec Innovation to Harvest Energy from Temperature Differences

Temperature Differences → **Volume Expansion** → **Hydraulic Pressure** → **Electricity Generation**



Phase Change Materials (PCM)

Solid to Liquid (SL)



Patent: US7987674
2011

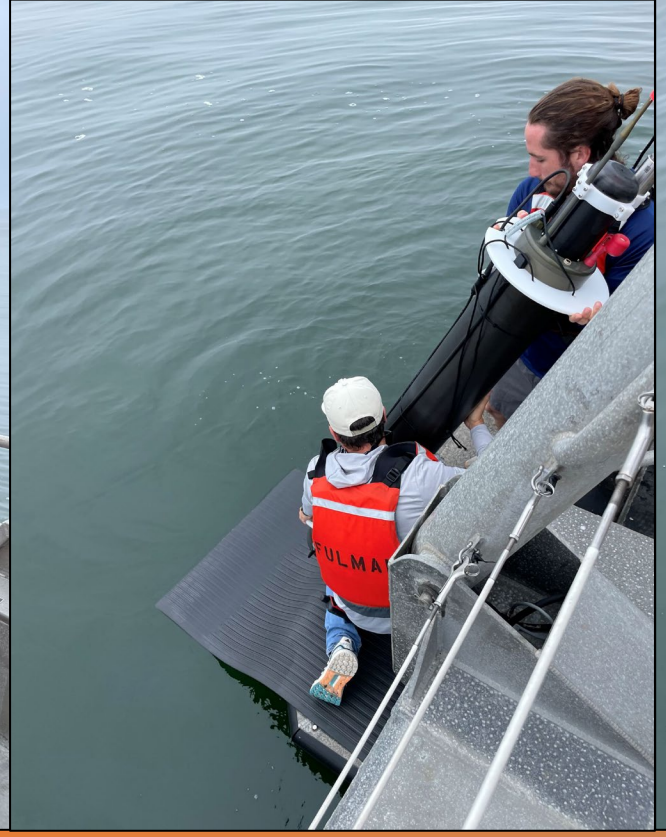
Jet Propulsion Laboratory
California Institute of Technology

Ocean Sonics RB9 icListen Smart Hydrophone

- Real-time listening and event detection
- Acoustic recorder
- Can pass raw acoustic data or signal processed data in real time
- Proven technology
  - used in NPS numerous field applications (riverine environments)
  - Currently on MBARI MARS Cabled Observatory (since 2016)

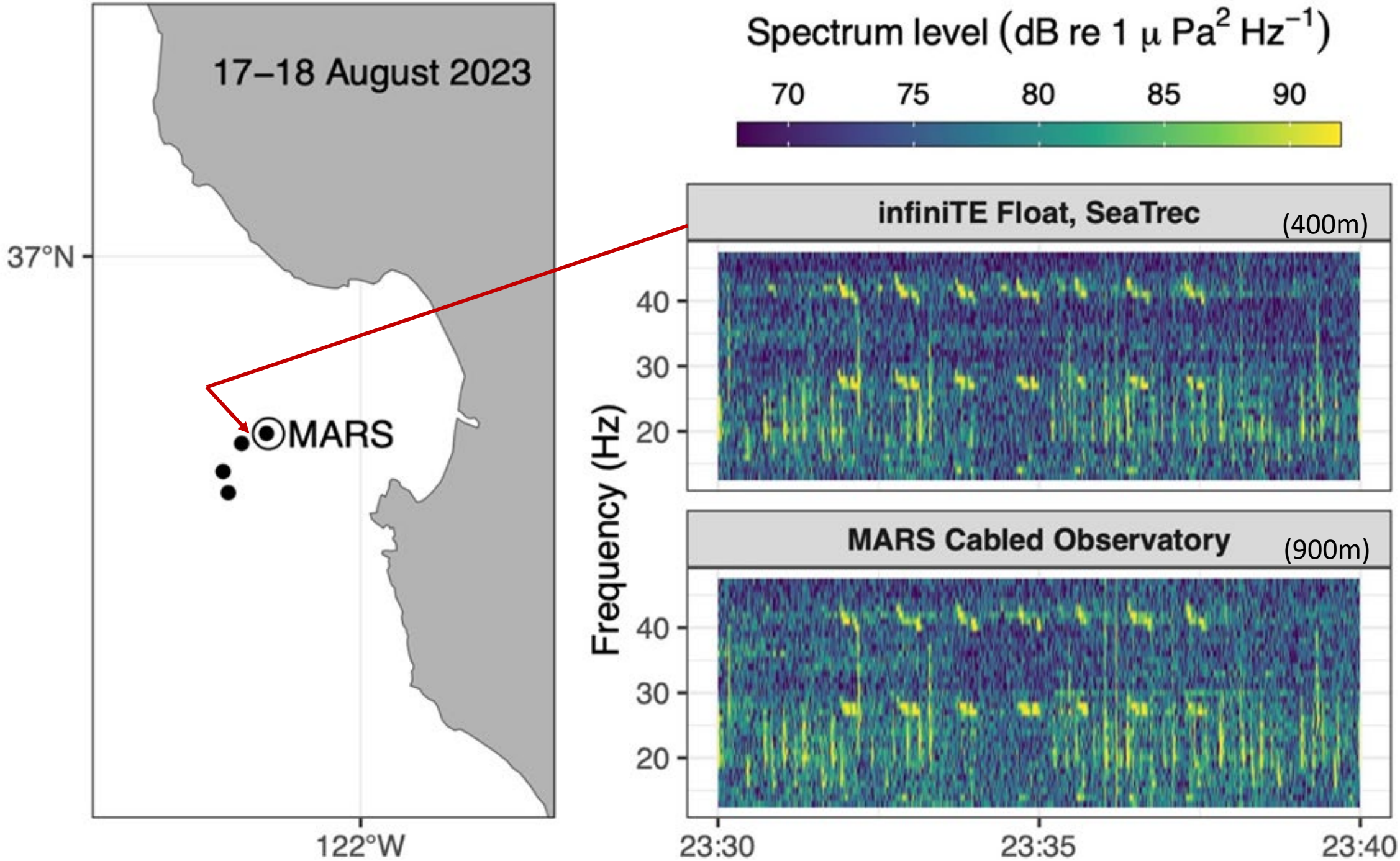
Modes of Operation

- **Passive listening mode** at optimal depth based on environmental conditions
- **Energy harvesting mode** using ocean thermal gradients to extract unlimited energy from the ocean
- **Communications mode** to report distilled information to home base where information from other platforms is consolidated into a coherent picture

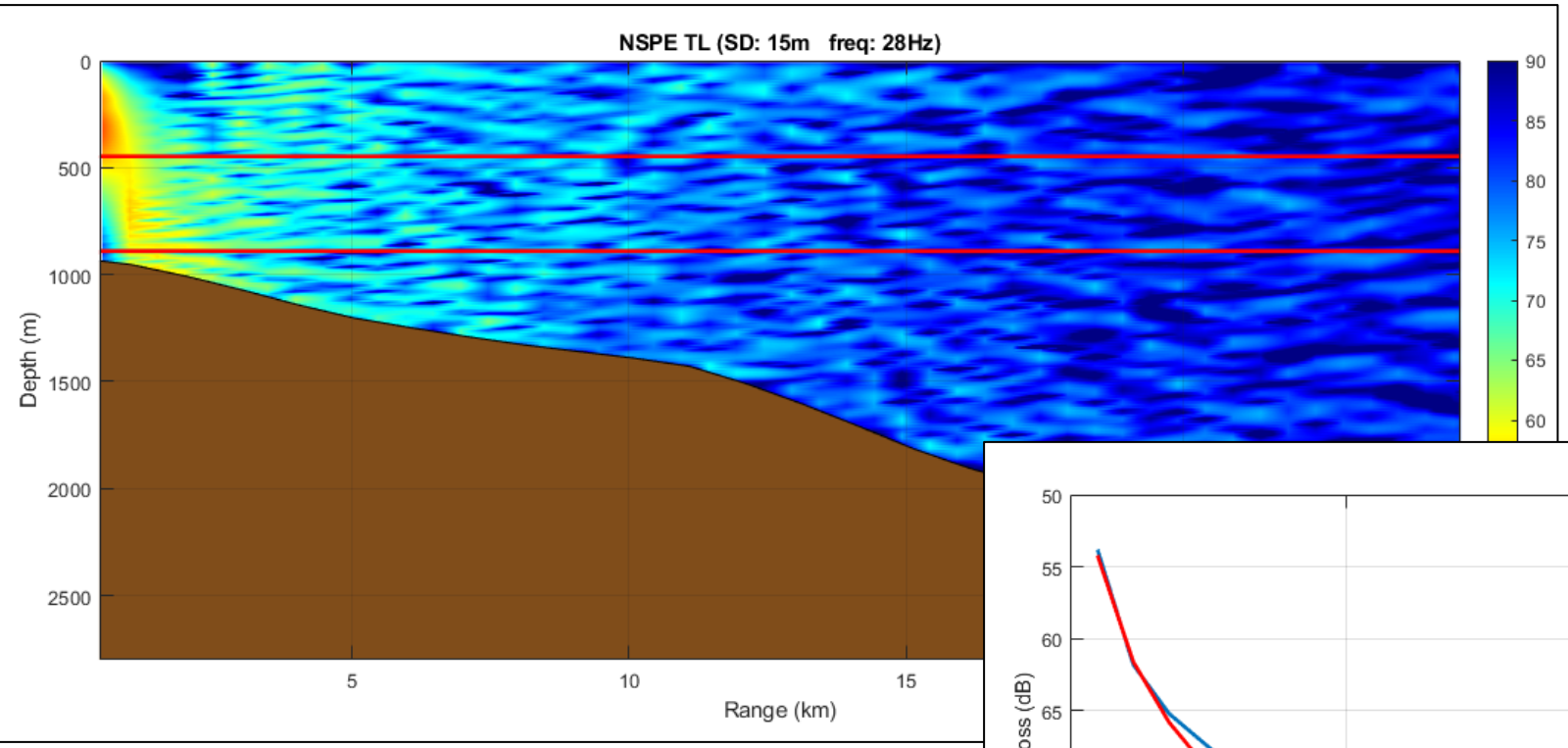



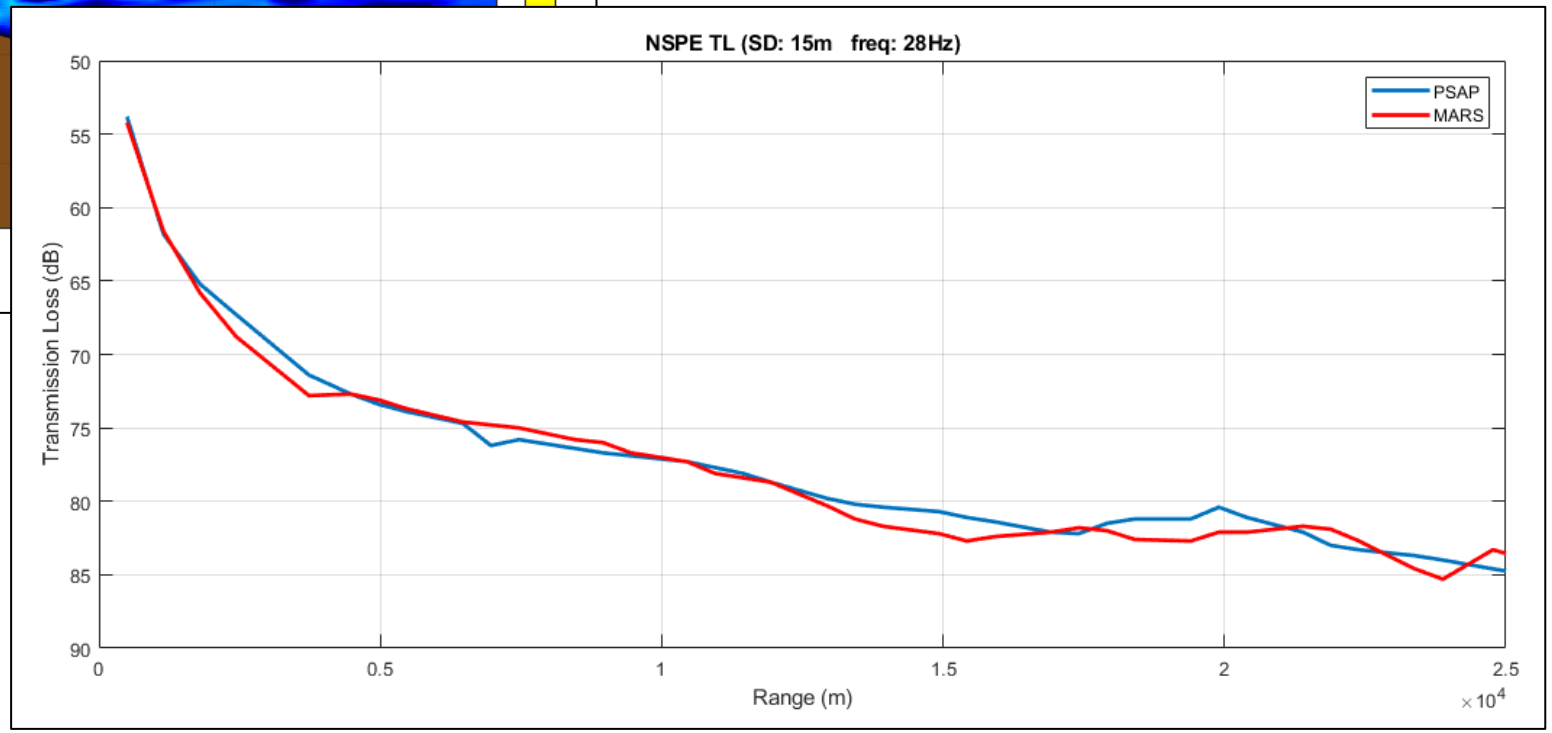

Initial 24h Wet-Test with Live Recording

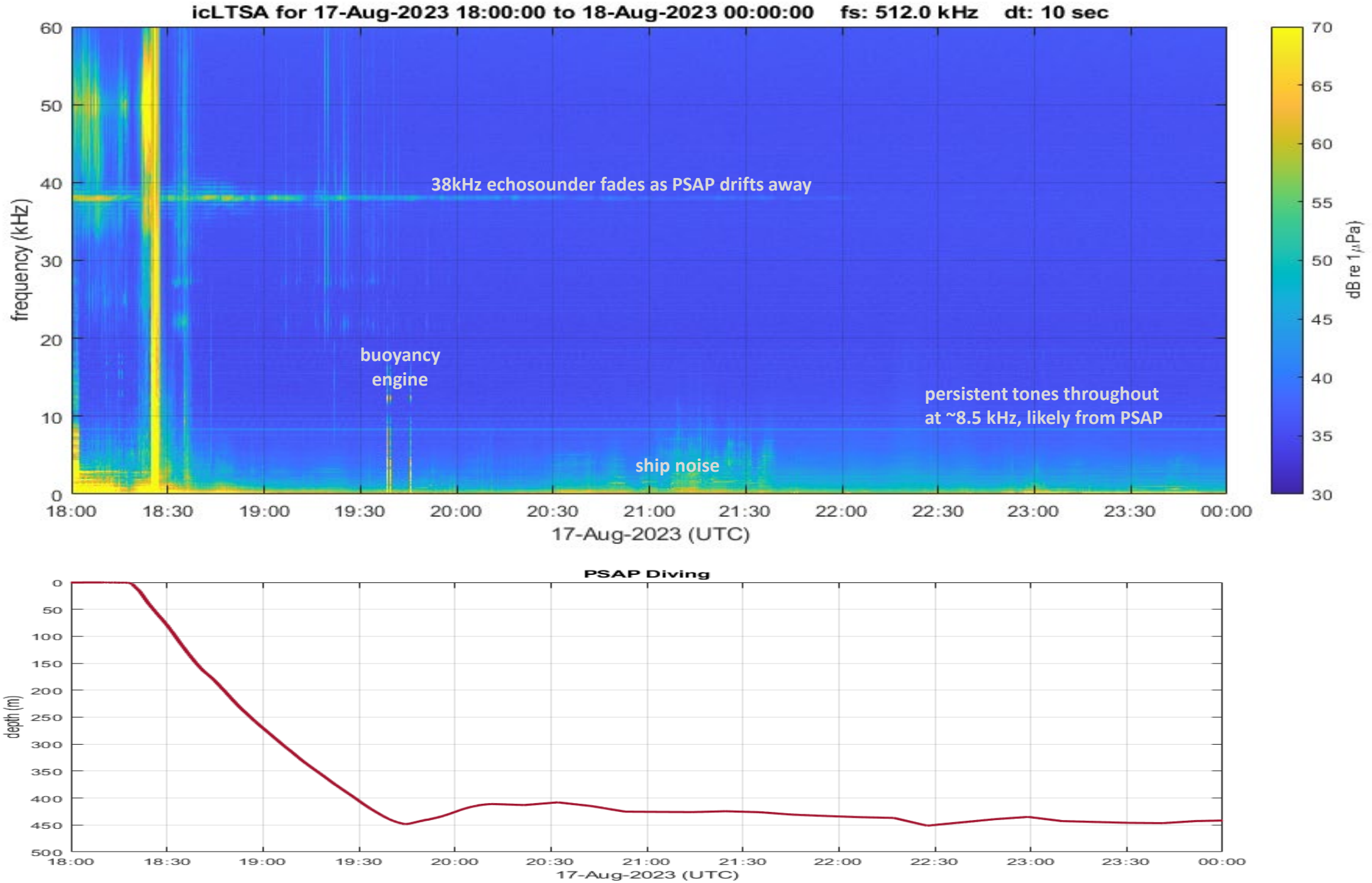
17-18 Aug 2023

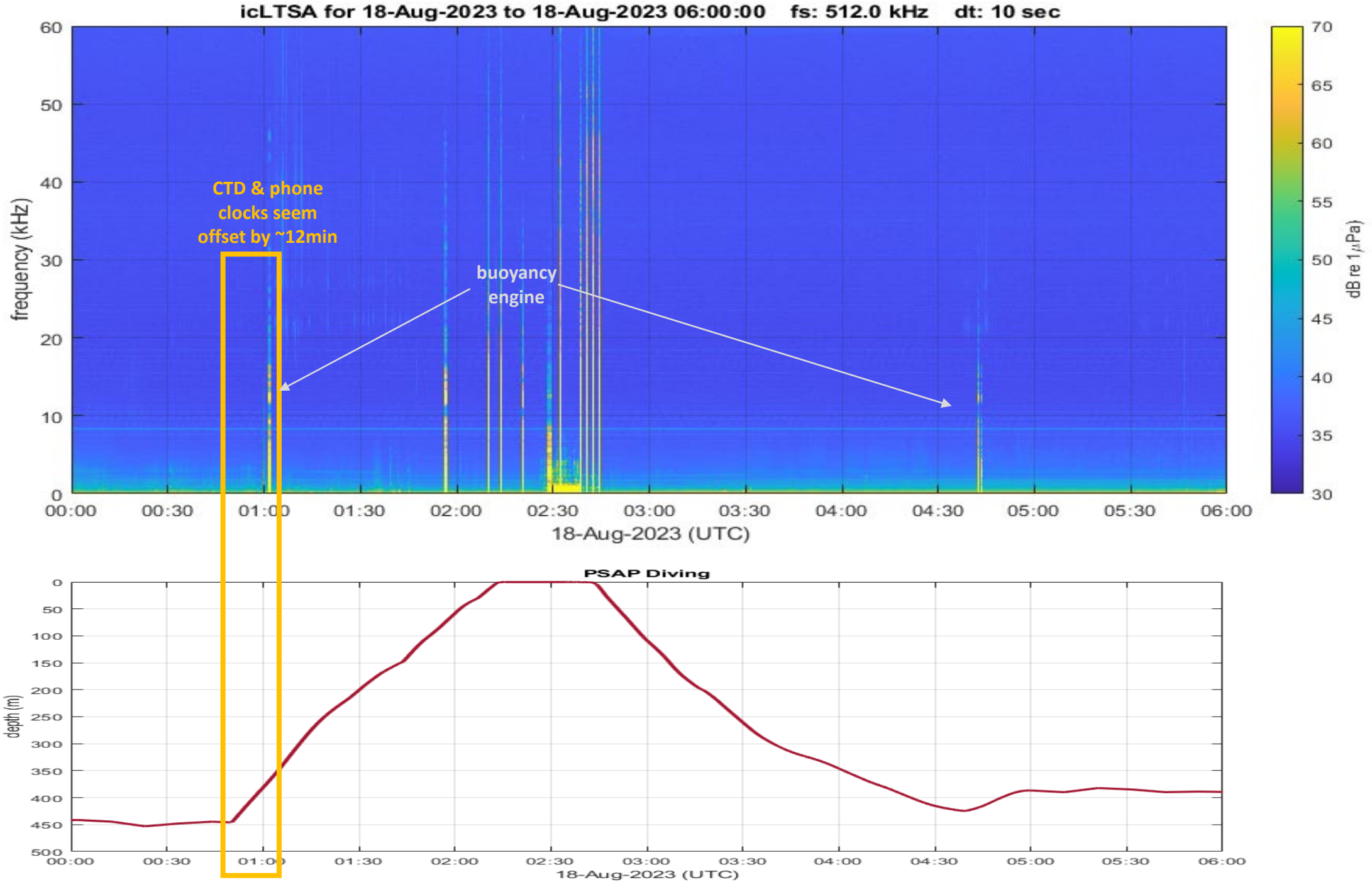

17–18 August 2023
37°N
MARS
122°W
Spectrum level (dB re 1 μ Pa² Hz⁻¹)
70
75
80
85
90
infiniTE Float, SeaTrec
(400m)
MARS Cabled Observatory
(900m)
Frequency (Hz)
40
30
20
23:30
23:35
23:40

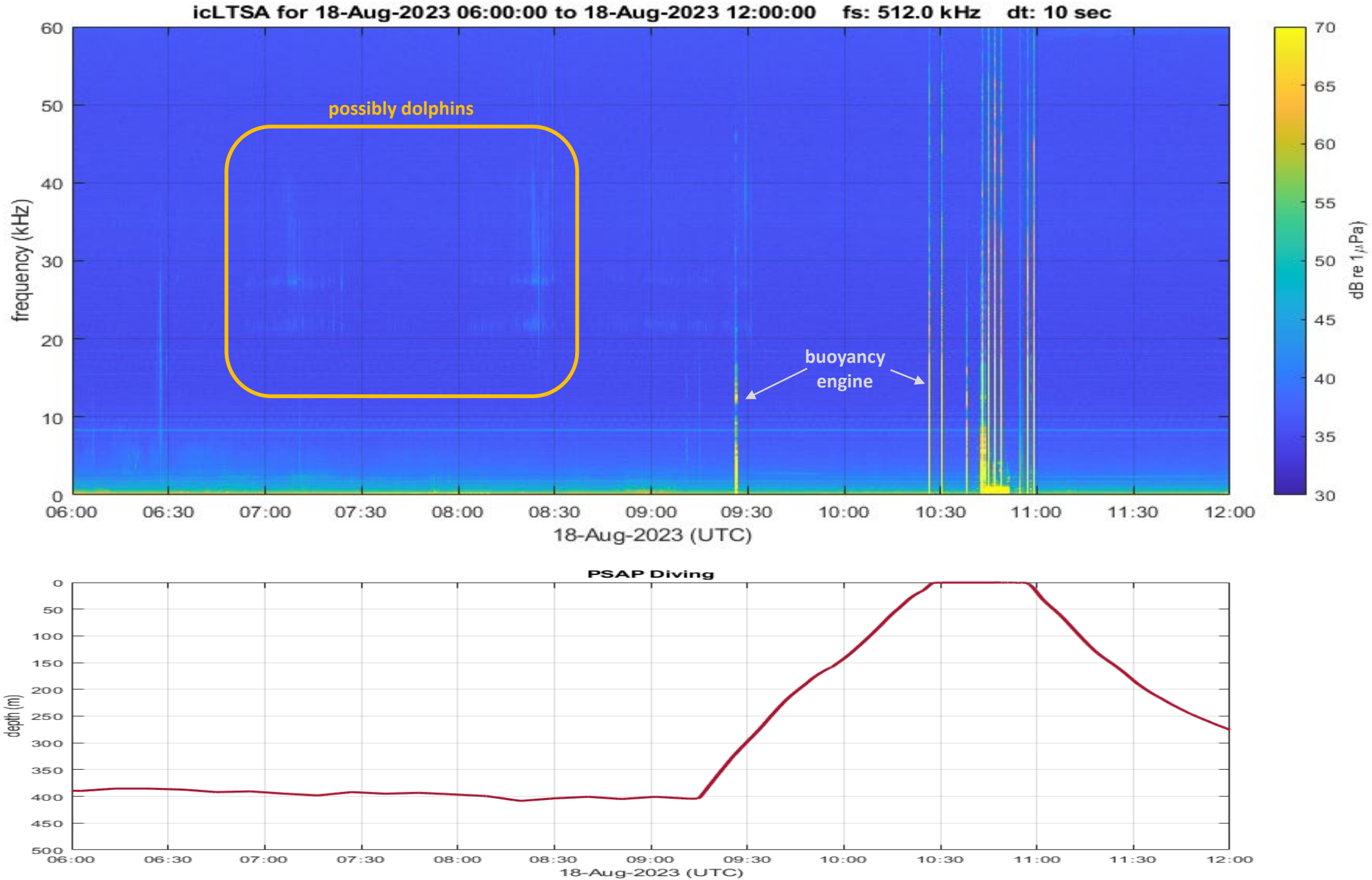
Acoustic modeling (NSPE) at 28 Hz

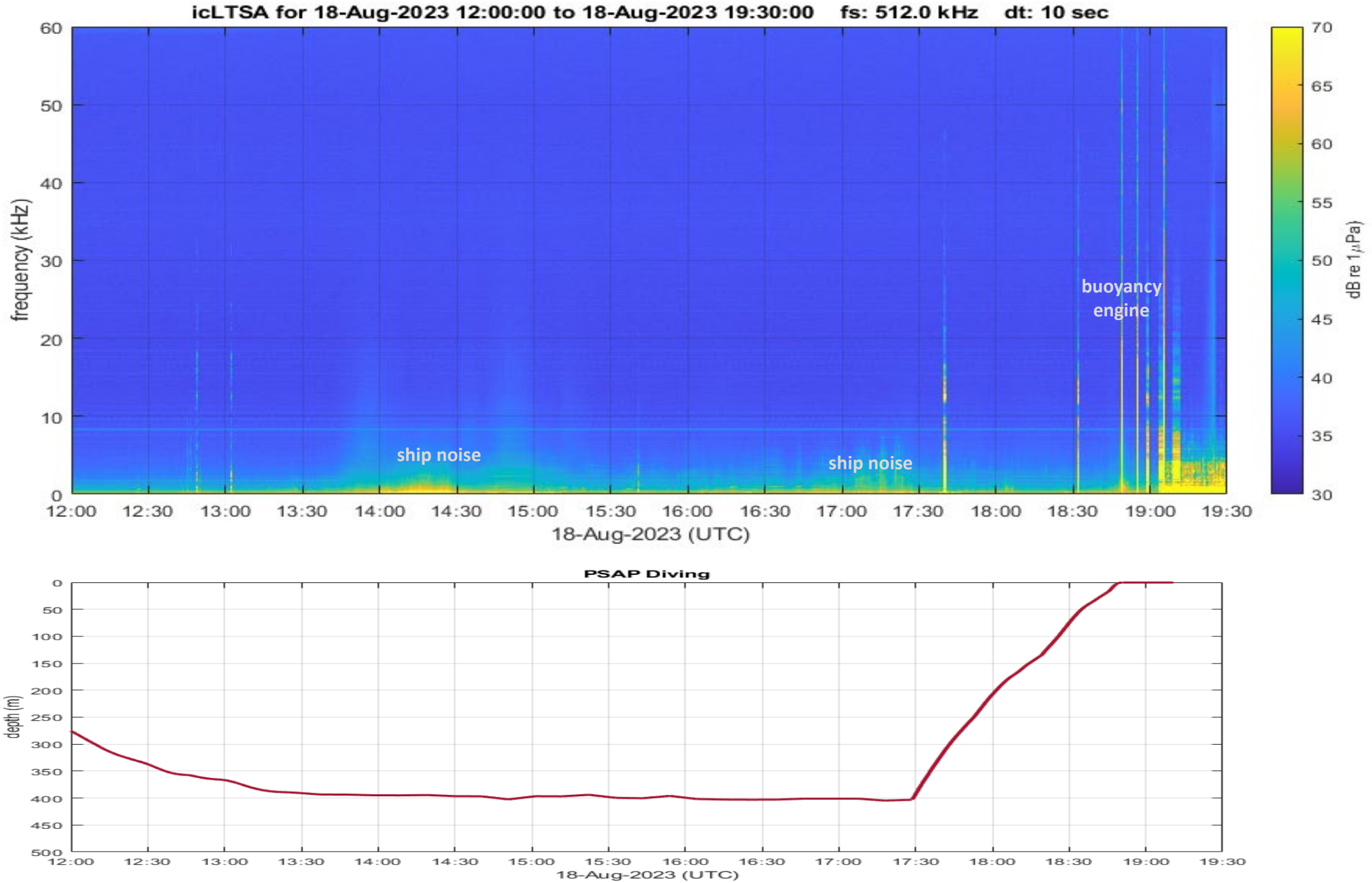





icLTSA for 17-Aug-2023 18:00:00 to 18-Aug-2023 00:00:00 fs: 512.0 kHz dt: 10 sec
frequency (kHz)
dB re 1 μPa)
38kHz echosounder fades as PSAP drifts away
buoyancy engine
persistent tones throughout at ~8.5 kHz, likely from PSAP
ship noise
17-Aug-2023 (UTC)
PSAP Diving
depth (m)
17-Aug-2023 (UTC)


icLTSA for 18-Aug-2023 to 18-Aug-2023 06:00:00 fs: 512.0 kHz dt: 10 sec
frequency (kHz)
dB re 1 μPa)
CTD & phone clocks seem offset by ~12min
buoyancy engine
18-Aug-2023 (UTC)
PSAP Diving
depth (m)
18-Aug-2023 (UTC)


icLTSA for 18-Aug-2023 06:00:00 to 18-Aug-2023 12:00:00 fs: 512.0 kHz dt: 10 sec
possibly dolphins
buoyancy
engine
frequency (kHz)
dB re 1 μPa)
18-Aug-2023 (UTC)
PSAP Diving
depth (m)
18-Aug-2023 (UTC)


icLTSA for 18-Aug-2023 12:00:00 to 18-Aug-2023 19:30:00 fs: 512.0 kHz dt: 10 sec
frequency (kHz)
18-Aug-2023 (UTC)
dB re 1 μPa)
ship noise
ship noise
buoyancy engine
PSAP Diving
depth (m)
18-Aug-2023 (UTC)

Some Questions to Address

- How much time in each mode is needed to meet mission requirements?
- What is an appropriate power budget for each mode?
- How do we optimize the listening capability based on the ocean environment?
- Scalability - how many units are needed to form a wide-area network?
- Where next? Do we want to add greater mobility? Are more sensors needed? Can we improve acoustic sensing?

Some Questions for me?

Contact info:

- Email: jejoseph@nps.edu
- Tel: 831-656-7994
- NPS Oceanography Dept