Emerging Technology - Advancing Technologies to Improve Ocean Monitoring

Christian Meinig, Scott Stalin, Noah Lawrence, Steven Anderson (CICOES), Nick Delich, Dirk Tagawa, Mike Craig, Sean O’Neill, & many scientists
NOAA
Pacific Marine Environmental Lab
Developing Emerging Technology for Ocean Observing Research

- **Vision:** To engineer cost effective platforms and sensors to deliver high quality EOV, ECV at global scale

- **GOMO** provides critical funding to advance promising technologies into ‘fit for purpose’ scientific tools that informs policy and improves livelihoods

**Example: Saildrone Observations (~6yrs)**

**Tropical Pacific**

**US Arctic**

**GOMO Investments: Emerging Tech Demonstration**
Developing Emerging Technology for Ocean Observing Research

- Critical funding to engineering promising technologies into ‘fit for purpose’ scientific tools that inform policy and improve livelihoods.

- Unique role of federal research labs/programs that have a long lever on the arc of system development to improve quality, relevance and performance of obs systems.

- Close collaboration of scientists and engineers to systematize platform/ sensor development for EOVs, ECVs.
GOMO Link: Sustained Funding

Saildrone: Arctic+TPOS
- Field missions in the Tropics (5 yrs) and Arctic (3 yrs) focused on scientific demonstration missions
- CRADAs (2)
- Transition Plans underway (4)

PRAWLER+TELOS: Tropics-to-Arctic Testing & Development
- CRADAs (2), Commercialization

Oculus: Arctic: Engineer new buoyancy engine
- CRADA (1), Partnership (UW & UW-APL), Kongsberg
Saildrone Development: GOMO support at critical time

GOMO: Sponsoring Arctic & Tropical Pacific Missions

Saildrone Science Capabilities Timeline

Science Demonstration Missions

Sustained observing

Timeline

Readiness Level (RL)
Saildrone: Science Demonstration Mission Impacts

- 5 TPOS & 3 Arctic Missions
- >10 peer reviewed publications
- 4 Transition Plans covering ~14 EOV, ECVs
- >$300M investment to date from private capital

Pioneered methods/techniques of validating and field testing climate quality sensors on USVs thru PPPs.

Meinig et al, 2019
Mooring PRAWLER (PRofiler+crAWLER) (Performance Example)

Ecosystem PRAWLER at M2 provided estimates of primary production filling a long-standing science gap in one of the largest fisheries in the US.
Mooring PRAWLER (PRofiler+crAWLER) (Performance Example)

PMEL Design/Build

Improved resolution by hourly profiles

Nielsen (EcoFOCI/ABL NRC Assoc), Eisner (ABL), Mordy (UW/PMEL), Lomas (Bigelow), Juranek (OSU), Stabeno, Stalin, Meinig (PMEL)
USVs ready for GOOS (caution on sensors & data!)

- Globally, >12 USVs operate commercially in the open ocean at RL 7-8.
- Climate quality sensors could be added per NOAA lessons on methods/techniques, comparisons, etc.

Outcome:

Uncrewed Surface Vehicle Network
for a remote, data-limited
Global Ocean Observing System

Update on an emerging network for OCG

Ruth Patterson¹, Meghan Cronin¹, Adrienne Sutton², Eugene Burger², Jack Reeves Eyre³, Dongxiao Zhang¹, Jim Thomson¹, Sebastiaan Swart¹, Marcel du Plessis³,³, Tom Farrar⁴, Luc Lenain⁴, Laurent Girardeau⁵, Iwao Ueki⁶, Samantha Wills⁷, Chris Meinig⁷, Jaime Palter⁸, Eric Lindstrom⁹, Sarah Nicholson¹⁰, Pedro Monteiro¹²
Achievements and Impacts

A USV network **FILL GAPS** in space, time, disciplines and complement existing GOOS infrastructure

**SPACE AND TIME**

- **Remote locations** of global ocean not currently covered by GOOS infrastructure, including semi-enclosed seas, gulfs, archipelagos and reef networks
- **Under persistent cloud cover** that can obscure some satellite observations
- **Clusters of USV** that periodically come together to form “Mesonet”, then spread apart for greater coverage
- **Pairs of USV**, in loose **follow-the leader or side-by-side formation** to observe EOV and spatial gradient

**DISCIPLINARY**

- In severe weather and developing phenomena
- In **frontal regions, and near ice edge**
- In **process studies**
- **Air-Sea interface studies at sub meter scale**

**COMPLEMENTARY**

- **Spatiotemporal coverage** around fixed point moorings
- **Air-sea surface surveys** at subsurface moorings or glider profiles
- **Acoustic gateway** data transfers

(From Patterson et al.)
Challenges:
Sustain funding is lacking for ‘operations’

- Gaps in methods of assessing & prioritizing obs
- Gaps in communicating the value of observations to range of stakeholders
- Limited NOAA capacity of data assimilation specialists to characterize impacts
Future plans and opportunities

● Next steps and future plans (next 5 years)
  ○ Grow from ‘patchwork of projects’ to a ‘cohesive USV science network’
  ○ Develop a COP as UN Decade Project (OASIS)
  ○ Establish a USV Data Acquisition Center that serves unique user needs

● How will these future plans advance the ocean observing enterprising?
  ○ Proven track record of going from ‘Ideation to Impact’
  ○ Sustainable, flexible, fit-for-purpose systems
  ○ Saildrones have proven to be ship-independent & responsive during COVID

“Patchwork of potentiality, and a network of promise”
Eric Lindstrom