NOAA-Pacific Marine Environmental Lab Engineering

Our mission is to solve technical observing problems to accelerate NOAA's science

- Committed group of ~16:
  - 10 Feds, 3 JISAO, 3 Contractors
- Involved in >90% of the Lab's observations
- Customers: Researchers, Program Managers, NOAA operations, NASA, Industry, Foreign Gov. Partners

Functions:
- Engineering
- Electronics Labs
- Machine Shop
- Mooring Shop
- Field Work Support
- Equipment Pool & R/V SP HAYES

Christian Meinig
Director of Engineering
NOAA-PMEL
Seattle, WA

Not Pictured: Noah Lawrence-Slavas, Sean O’Neill, Dirk Tagawa
Science Driven Technology Development

Form Partnerships & Establish Feedback Loops

Systematic Engineering, Science & Data Development

Platform Design and Sensor Integration

Operations and Field Test Planning

Automated Workflow and Data Validation

Integrated Research Missions

Transition
Engineering Relevance: End-to-End Development

From Innovation to Impact

Evaluate Opportunity
- Science drivers, mission requirements, fund raising?
- Fits OAR Vision?
- Form Partnerships

Develop
- Engineering designs
- Prototypes
- Field testing: local & full ocean depths
- Transition Evaluation

Launch
- Fabrication, integration, deployment
- Scientific evaluation & feedback
Saildrone-NOAA Co-Development
5 years ~20 sensors

~7m Mass=~750kg

Saildrone Sensor Suite

Specifications
- Length: 7 m
- Height: 4.6 m (above water line)
- Depth: 2 m
- Weight: 545 kg, (fully loaded)
- Speed: Transit ~ 3 Kt, Max ~ 8 Kt
- Payload Power: 30W Steady state
- Payload Capacity: 100 kg
- Max deployed duration: 12 months
- Longest voyage: 16,100 km

Measurements
1. Anemometer @ +5.0m
   Gill Windmaster 3D Ultrasonic 20Hz
2. Sunshine Pyranometer @ +2.5m
   Delta-T Devices SPHY
3. Pyrogometer @ 0.7m
   Eppley PIR
4. Meteorological Probe @ +2.4m
   RBR Model 3700 with shield
5. Digital Barometer @ +0.3m
   Vaisala BAROCAP PTB10
6. CO₂ System @ +0.5m
   PHAL ASVCO₂
7. ADCP @ -0.3m
   Teledyne RD Instruments Workhorse Sentinel
8. Passive Acoustic Recorder @ -1.3m
   Greenridge Sciences Inc. Acouzone
9. Scientific Echosounder @ -1.8m
   RBR WACS
10. Dual GPS & IMU
    VectorNav / KVH
11. Water Temperature
    RBR Sea Bird SBE 19plus
12. Magnetic Field
    Barrington MAG 64B
13. Skin Temperature
    SST IR Pyrometer @ +2.3m
    Helronics XT15
14. Chl
    SBE SeaBird 19plus
15. Salinity
    RBR Sea Bird SBE 19plus

Oceanic Surface Measurements
- Wave Height & Period
- Seawater pCO₂ & pH
- Dissolved Oxygen
- Water Temperature
- Salinity
- Magnetic Field
- Skin Temperature
- Chl
- CDOM Concentration
- Fluorometer and Backscatter
- Water Temperature
- Salinity
What we have:

Drivers: Partnership Opportunities in Marine Technology?

- Fill gaps in observing tech
- Enables new science discoveries
- Provide value to stakeholders: dissemination and transition

SMART OBSERVATIONAL INTELLIGENCE SOLUTIONS

The Innovative Technology for Arctic Exploration program at NOAA’s Pacific Marine Environmental Laboratory conceptualizes and builds effective research equipment for the assessment of the Arctic environment and ecosystem. Development and field tests of technologies to advance ocean observation included ITAE’s big four in the summer of 2017.

ACCOMPLISHMENTS

Connected over 30 partners in academia, government, & industry, with more than 500 days of data collection, ~40,000 km of remote territory traveled, and 3,600 dives.

PUSHING OBSERVATIONAL BOUNDARIES

- First to transit through Bering Strait
- First to make Arctic Basin observations
- First to travel 7 NM from sea ice edge
- FARthest NORTH an ASV has traversed

ECOSYSTEMS UP CLOSE

Collecting SEAL’S-EYE-VIEW video

MAKING NEW DISCOVERIES

Oculus dives show turbulent “CHIMNEYS”

ACHIEVING NOAA MISSIONS

- Built and expanded operational capacity
- CONNECTED: sustained arctic observing systems
- EXPLOREd: new scientific frontiers
Common Components

New Capability

Seaglider <1000m
Deepglider <6000m
Oculus <200m
## ITAE Development Supports *every* NOAA Line Office

<table>
<thead>
<tr>
<th>OMAO UxS</th>
<th>NMFS Fisheries</th>
<th>NOS Charting</th>
<th>OAR Climate / Oceans</th>
<th>NWS Weather</th>
<th>NESDIS Satellites</th>
</tr>
</thead>
<tbody>
<tr>
<td>OMAO in process of defining a new Unmanned Systems Operations Program at NOAA. PMEL has been asked to contribute.</td>
<td>NMFS uses both our platforms and sensors: -- Conservation / Recovery / Protected species / Endangered species (C. Kuhn) -- Fisheries stocks (A. De Robertis)</td>
<td>NOS has updated charts based on SD sounding and has outfitted a SD with multibeam sonar</td>
<td>OUR PRIMARY CUSTOMER! OAR Programs using ITAE developments: - CPO/ARP - OAP - TPO - OER NOAA labs using ITAE developments: - PMEL - ESRL - AOML</td>
<td>Surface ocean data currently transferred to the GTS</td>
<td>2019 mission has enhanced satellite SST products as its primary mission goal (MISST / GHRST)</td>
</tr>
</tbody>
</table>

**Over the past 5 years, we’ve collaborated with every NOAA LO**
Partnerships
Each is unique

Overlap is a Powerful Multiplier for Innovation
Southern Ocean Carbon 2019

Video taken from SD 1020’s onboard camera showing the extreme conditions in the Southern Ocean during the 2019 Antarctic Circumnavigation.
## External Collaborations

<table>
<thead>
<tr>
<th>Industry</th>
<th>Research Institutes/Academia</th>
<th>Public Agencies/Tribes</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYDROID</td>
<td>University of Victoria</td>
<td>NASA JPL</td>
</tr>
<tr>
<td>SAIC</td>
<td>MBARI</td>
<td>MAKAI INDIAN NATION</td>
</tr>
<tr>
<td>KONGSBERG</td>
<td>University of Washington</td>
<td>BUERK CENTER FOR ENTREPRENEURSHIP</td>
</tr>
<tr>
<td>SAIDRON</td>
<td>OOI</td>
<td>PARK NATION</td>
</tr>
<tr>
<td>McLANE</td>
<td>University of Victoria</td>
<td>PORT OF SEATTLE</td>
</tr>
<tr>
<td>RESEARCH LABORATORIES, INC.</td>
<td>MBARI</td>
<td>Department of Commerce</td>
</tr>
<tr>
<td>Paroscientific, Inc.</td>
<td>CSIRO</td>
<td>National Weather Service</td>
</tr>
<tr>
<td>DNV-GL</td>
<td>Pacific Northwest National Laboratory</td>
<td>National Oceanic and Atmospheric Administration</td>
</tr>
<tr>
<td>SEQUOIA</td>
<td>Seaclider Fabrication Center</td>
<td>National Oceanic and Atmospheric Administration</td>
</tr>
<tr>
<td>SEA BIRD</td>
<td>Scripps Institution of Oceanography</td>
<td>National Oceanic and Atmospheric Administration</td>
</tr>
<tr>
<td>Battelle</td>
<td>NASA</td>
<td>National Oceanic and Atmospheric Administration</td>
</tr>
<tr>
<td>The Business of Innovation</td>
<td>HARBOR BRANCH</td>
<td>National Oceanic and Atmospheric Administration</td>
</tr>
<tr>
<td>wework</td>
<td>Bigelow Laboratory for Ocean Sciences</td>
<td>National Oceanic and Atmospheric Administration</td>
</tr>
<tr>
<td>LI-COR</td>
<td></td>
<td>National Oceanic and Atmospheric Administration</td>
</tr>
<tr>
<td>PMEL</td>
<td></td>
<td>National Oceanic and Atmospheric Administration</td>
</tr>
</tbody>
</table>

Peregrine Engineering