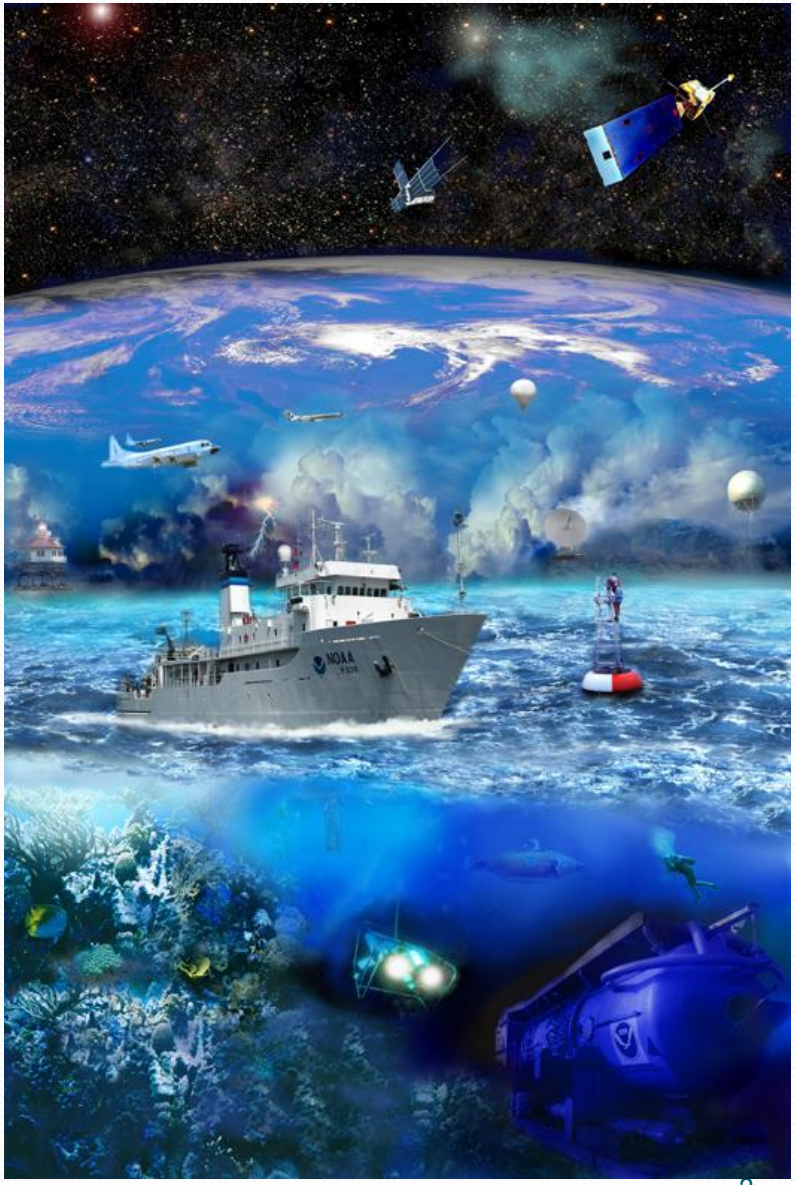
NDIA System Engineering Conference
24 October 2017

Benjie Spencer
Chief Engineer, NOAA/National Weather Service

NOAA

NOAA is an agency that enriches life through science. Our reach from sun to seafloor helps to keep citizens informed of the changing environment around them.

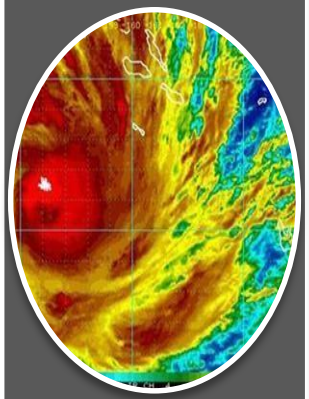
Mission: Science, Service, & Stewardship.
To *understand and predict changes in climate, weather, oceans, and coasts,*
To *share that knowledge and information with others, and*
To *conserve and manage coastal and marine ecosystems and resources.*



NOAA Line Offices

National Weather Service (NWS)

Oceanic and Atmospheric Research (OAR)



National Environmental Satellite Data & Information Service (NESDIS)

National Ocean Service (NOS)

National Marine Fisheries Service (NMFS)

Office of Marine and Aviation Operations (OMAO)

SCIENCE

SERVICE

STEWARDSHIP

NOAA's unique assets support our integrated mission

NOAA professionals

- 20,000 staff
  - 12,500 FTE
    - ~ 230 Engineers
  - NOAA Corps – the Nation's 7th Uniformed Service
  - 7,500 contractors
  - 18 National Labs & Science Centers

High Performance Computing

- 5 supercomputers

Observing Systems

- ~125 weather radars
- 10 satellites
- 3 buoy networks
- 210 tide gages

Ships and Aircraft

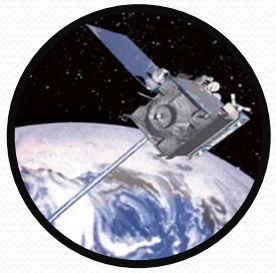
- 16 ships
- 9 aircrafts

Okeanos Explorer

NOAA G4 and P3

NOAA Employee Operating AWIPS

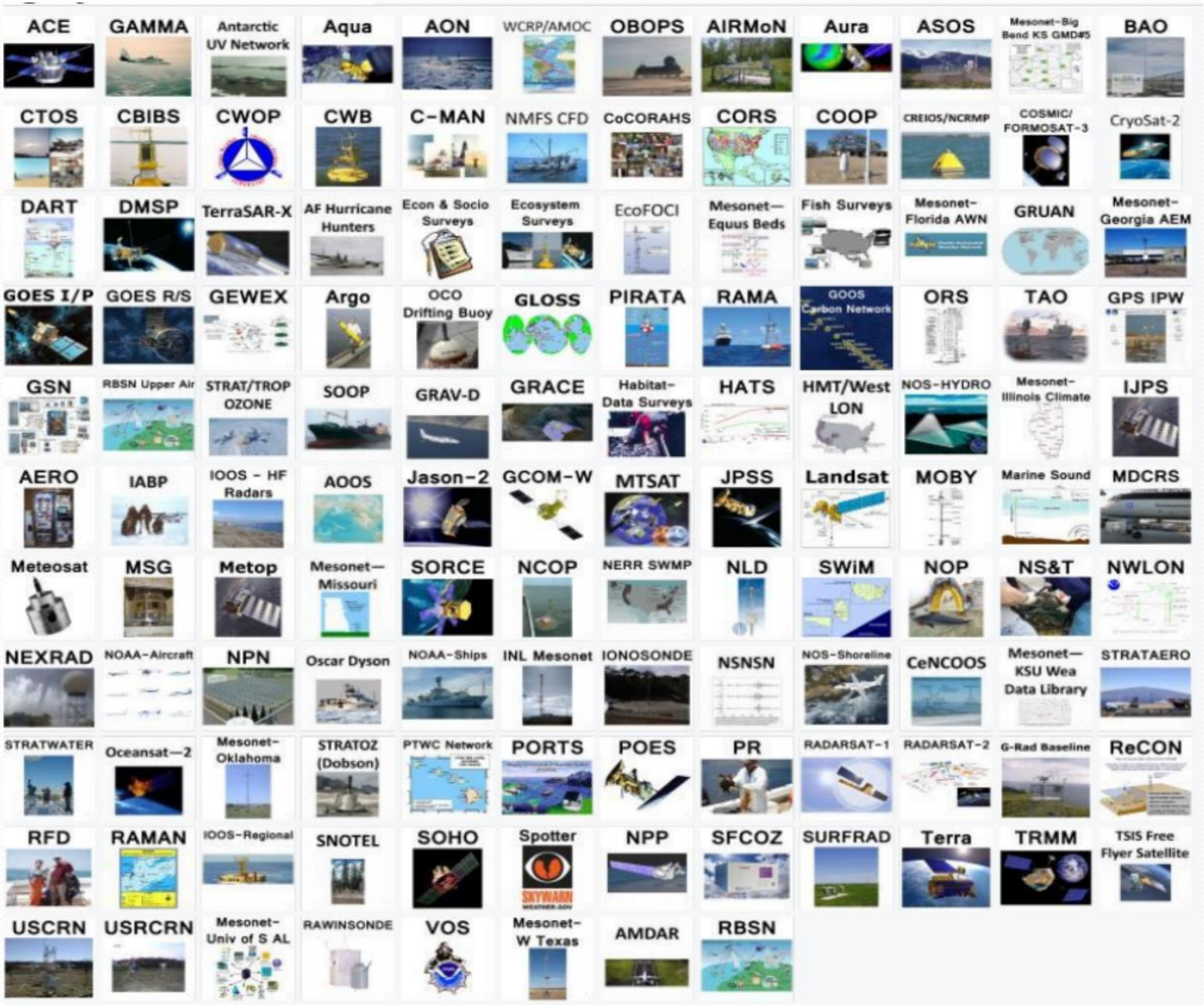
TAO Buoy



GOES

NOAA Observing Systems

(128)



Achievements

NEXRAD Backup Comms

- For a 10 year period from 2005 to 2015, the overall comms availability was 97% due to serve weather
- Implementation of 4G and VSAT Back Up Restores availability to 99.99% Reducing Downtime
  - Commercial T1 and Frame Relay service with auto fail-over (DoD and FAA radar data)
- Phased implementation approach
  - Networx contract extended in March 2017
  - Comms contract rebid in 2020 (unknown impact)
  - NEXRAD Software update in Build 18 to improve link stability & status reporting
- 84 sites installed
  - 11 NWS VSAT
  - 46 NWS 4G
  - 21 DoD 4G
  - 4 FAA 4G
  - 1 FAA VSAT

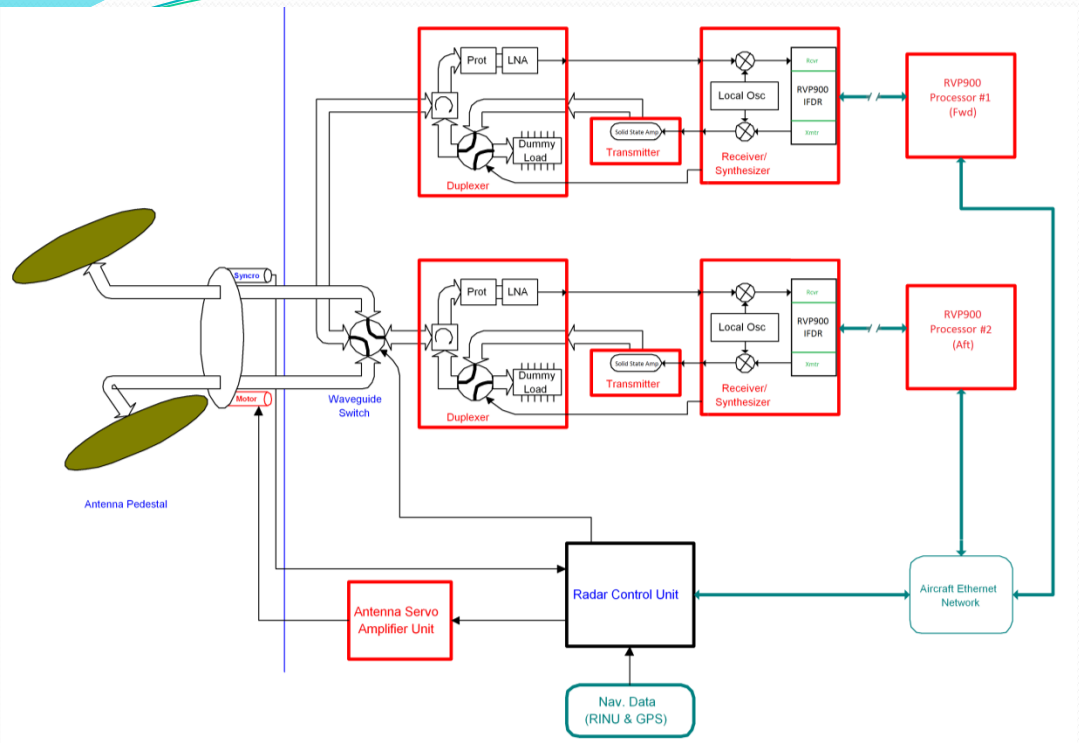
Joint NWS/DoD Radar Deployment to Puerto Rico

- **Hurricane Maria** severely damaged the FAA's WSR-88D Doppler Radar in PR. NWS, through the FEMA NRCC, requested DoD support to deploy two USMC tactical Doppler radars to re-establish coverage. The USMC radars were selected because of their ability to export NEXGEN Level 3 data.

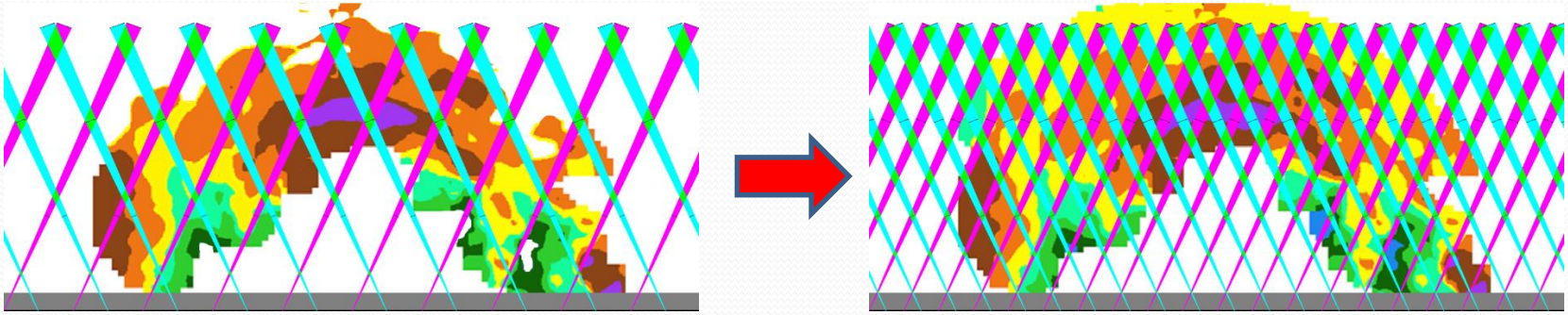
- With the support of the Navy PEO C4I PMW 120, Navy SPAWARS, Pacific, NORTHCOM, MARFORNORTH, and USMC 2MEF, an unprecedented joint engineering effort began to bring the X-band radar data into the NWS Advanced Weather Interactive Processing System (AWIPS, the primary forecasting support system for the NWS). The radars will be connected to NWS VSAT units to move the data into the NWS system where it can be utilized by forecasters in San Juan or at back-up forecast offices to provide life-saving forecasts and warnings.

- On 21 Oct 17, Marine forecasters and technicians will arrive with the radars in PR. They will link up with SPAWARS and NWS Radar Operations Center technicians to establish the two sites and begin the final efforts to assimilate the radar data into the NWS AWIPS. NWS will also support interim communications from the FAA's Terminal Doppler Weather Radar to the NWS AWIPS system to enable forecasters to utilize it for forecasts and warnings.

WP-3D Tail Doppler Radar Upgrade



- Completely dual system (Xmtrs, Rcvrs, Processors) for higher along-track resolution and redundancy
- 8 KW Solid State Power Amplifiers for improved sensitivity
  (5 dBZ -> -9 dBZ)
- Upgraded processors are the same as used in NOAA's NEXRAD WSR-88D ground radar
- Replacement antenna motors to double rotation speed and along-track resolution

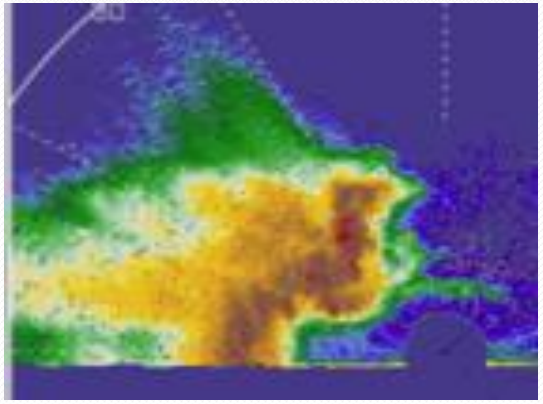


Tail Doppler Radar

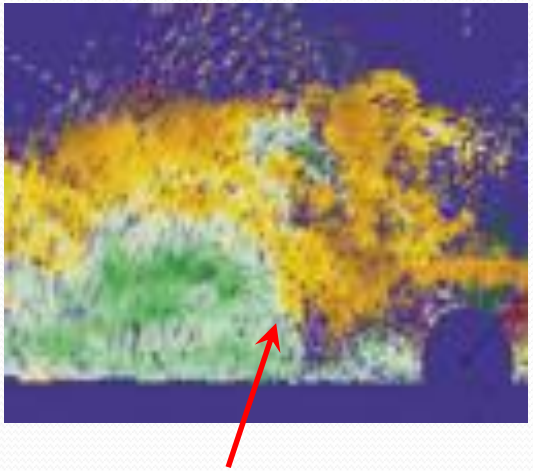
N42RF TDR Captures F0 Tornado Data on Vortex-SE Mission Flight

F0 Tornado from Ground Spotter

Reflectivity, showing very heavy rain and a strong inflow/updraft from the right



Doppler Velocity – Brown/orange away from aircraft and green/blue toward plane. Tornadic signature Is where the velocity direction changes

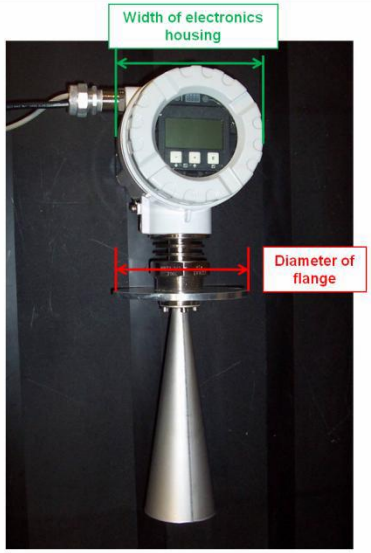


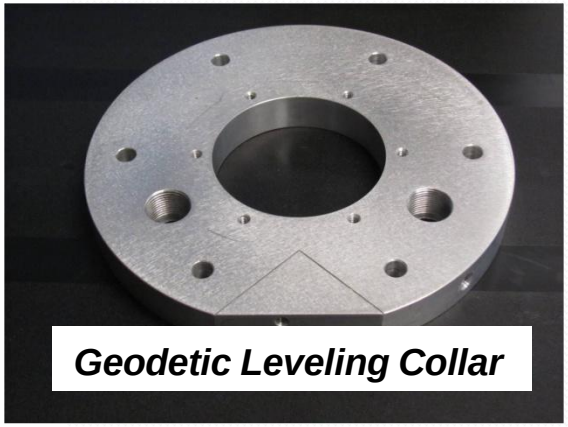
New TDR system is collecting research and operational data with higher sensitivity and resolution

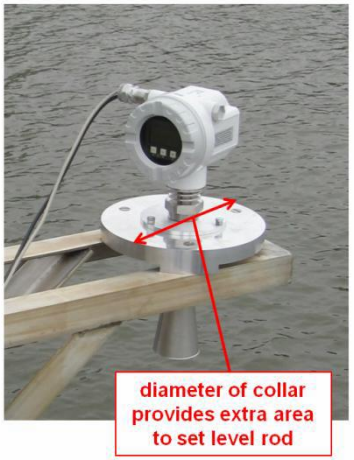
Transition to Operations

Micro-wave Water Level (MWWL) Measurement System

Mount Designs

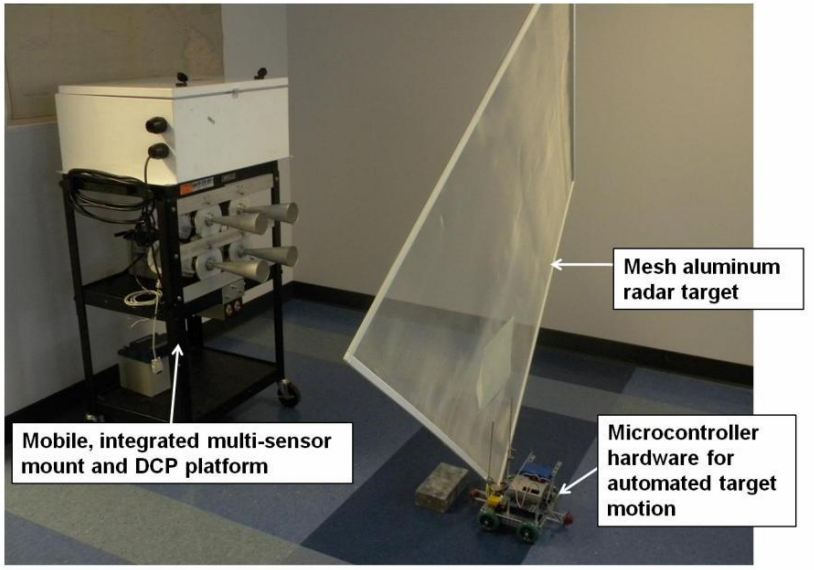






Laboratory Test Procedure and Facility

1) Fixed Target - Resolution Verification
2) Time Response Verification
3) Sensor Offset Derivation
4) Dynamic Liquid Tare test
5) Range Accuracy Verification



Saildrone 2017: Interdisciplinary Ocean Observations from the Arctic to the Tropics

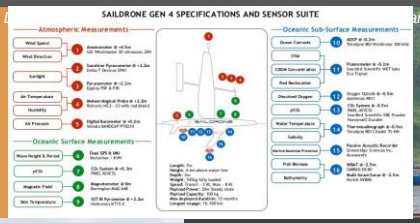
Christian Meinig[1], Edward Cokelet[1], Meghan Cronin[1], Jessica Cross[1], Alex De Robertis[3], Richard Jenkins[4], Carey Kuhn[3], Noah Lawrence-Slavas[1], Calvin Mordy[2], Phyllis Stabeno[1], Adrienne Sutton[2], Dongxiao Zhang[2], Jessica Crance[3], Jennifer Keene[2], Stacy Maenner[1], Heather Tabisola[2]

[1]NOAA/Pacific Marine Environmental L… …ans/PMEL, [3]NOAA/Alaska Fisheries Science Center, [4]Saildr…

TPOS 2020 Tropical Pacific Observing System

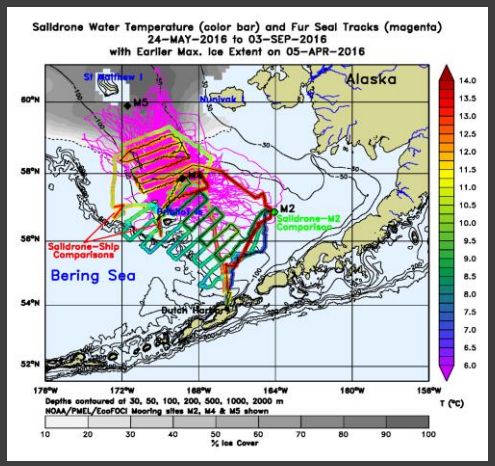
2017 Bering Sea & Chukchi Missions

- 3 Autonomous Surface Vehicles (ASVs)
- 2 integrated with Autonomous Surface Vehicle pCO_2 ($ASVCO_2$) sensor for Northern Chukchi Integrated Study
- 1 integrated with EK-80 echosounder for walleye pollock and northern fur seal study and passive acoustics
- ~3 month mission
- Deploy and recover from dock in Dutch Harbor, AK

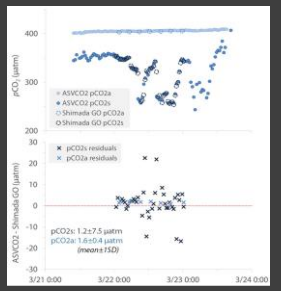


2017 Tropical Pacific Mission

- 2 Autonomous Surface Vehicles (ASVs) integrated with: Autonomous Surface Vehicle pCO_2 ($ASVCO_2$), ADCP, Heat Flux Sensor
- Participation in NASA SPURS II Field Campaign
- Climate quality comparison with instrumentation on ships, buoys and other platforms
- ~6 month mission
- Deploy and recover from dock in Alameda, CA

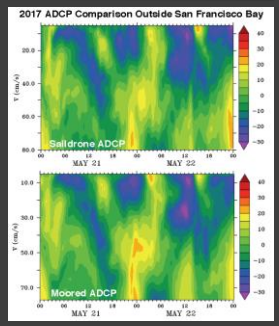


Carbon: TRL 7



- PMEL developed $ASVCO_2$ system measures pco2, pH
- 1-hour values transmitted via Iridium in near real time
- Compares favorably with ship and mooring observation testing completed off California

Ocean Current Profiling: TRL 5



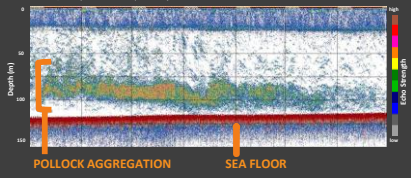
- Teledyne RDI Workhorse 300 kHz
- Dual GPS & Vectornav IMU
- Compares favorably with mooring observation testing completed off California

2016 Mission Results

Oceanography: TRL 5-9

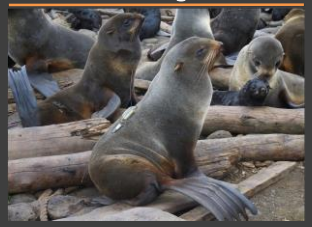
- Measured 14 atmospheric and oceanic parameters
- 1-Hz sampling with 1-minute data Transmitted via Iridium in near real time
- Compares favorably with ship and mooring observations

Fisheries Acoustics: TRL 7



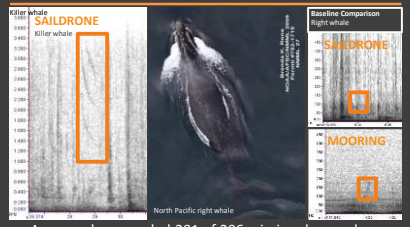
- Continuously measured fish acoustic backscatter with Kongsberg/Simrad AS echosounder
- High-quality measurements at wind speeds less than 20 knots
- Comparisons with research vessel indicate that shallow pollock react to ship noise

Fur Seal Tracking: TRL 7



- Tracked 30 satellite-tagged, adult-female fur seals as they foraged over ~70 days
- Saildrones spent 65 days covering fur-seal grid ~2 times
- Followed and recorded behavior and prey field of 2 fur seals for 1.3 and 2 days

Marine Mammal Acoustics: TRL 6



- Acousondes recorded 201 of 206 mission days and obtained ~5150 hours of recordings
- Saildrones spent 69 days within right whale critical habitat area and 12.5 days at two mooring locations for baseline acoustic comparisons
- Successful acoustic detection of killer whale with possible detection of right, fin and humpback whale(s)

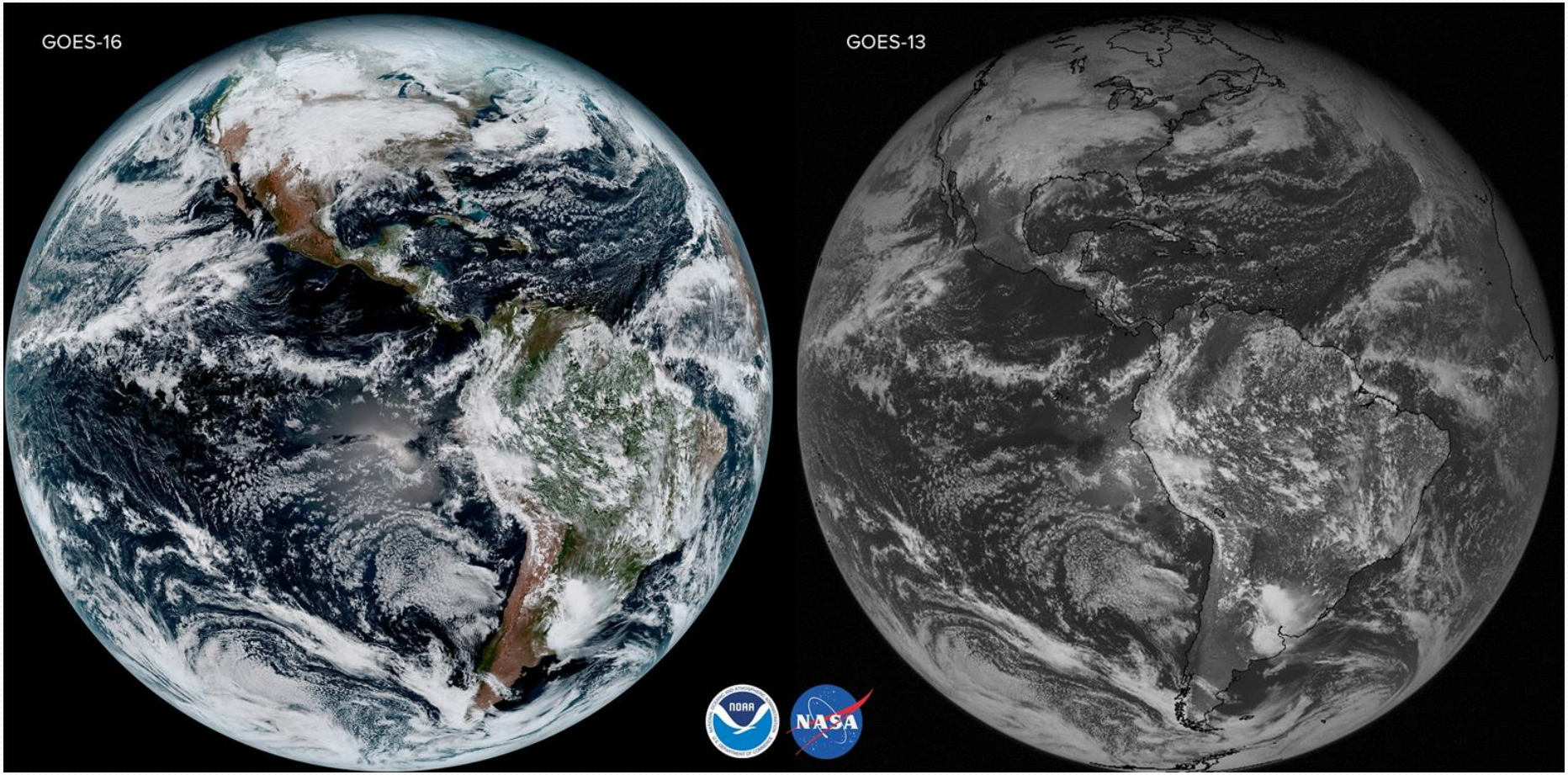
Acknowledgements: *This program is a multi-institutional effort and we thank all the teams of contributors in supporting the design, development, and operations of these missions towards our common goals. We thank the officers and crew of the NOAA ship Oscar Dyson and Bell Shimada for their invaluable assistance during the Saildrone comparisons. This work is funded by NOAA-OAR and CPO.*

NOAA RESEARCH NOAA FISHERIES

ITAE

GOES-R

GOES-16 vs GOES-13
JAN 2017



https://www.flickr.com/photos/noaasatellites/32441255306

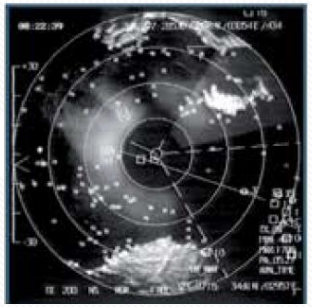
Challenges

WP-3D Lower Fuselage Radar Upgrade

Replace 360 degree scanning Lower Fuselage Weather Radar with AN/APY-11 Multimode Radar System

Inverse Synthetic Aperture (ISAR)

Weather, AIS, Air-to-Air



Synthetic Aperture (SAR)

GOES-16

Transition to operations and any remaining cal/val of the instruments and products, especially the Magnetometer

Thank You