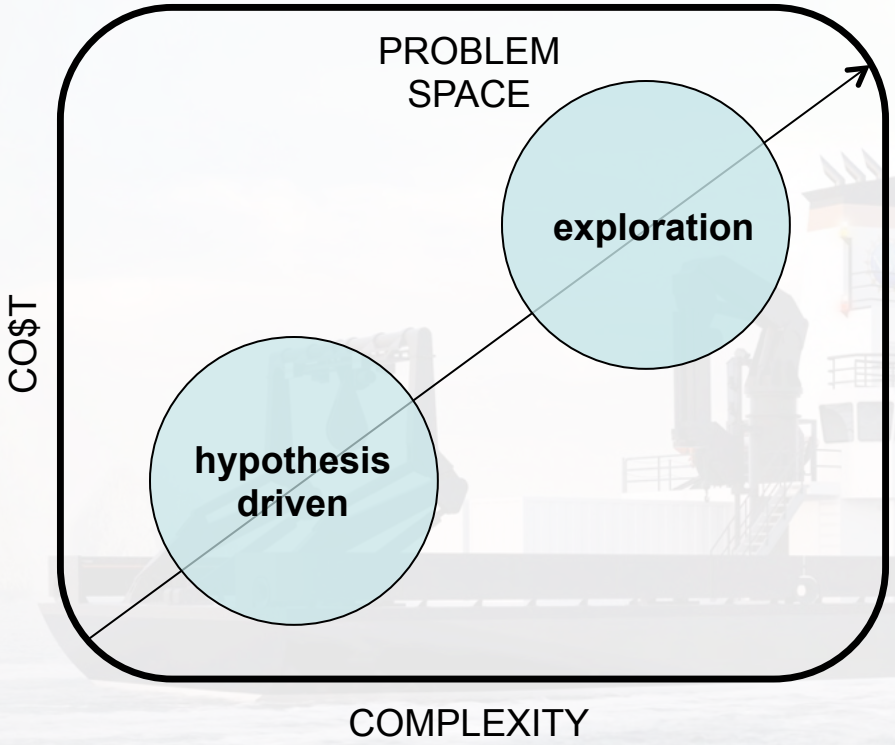
Continuous Observation Platforms.
Common Data Products.
QA/QC.

MAINTAIN a common sensor suite across class.

OPERATE resident sensors to run continuously.

PERFORM near real-time QC to promote QA

The datapresence problem space – where do we fit?



High Complexity / Unique:
Problem
Too many techs not enough shipboard science
Solution
connect shoreside science with A/V tech

Lower Complexity / More Common:
Traditional seagoing technician/scientist ratio –
science outnumbers tech support
Hidden Problem-
Awash in data, logistics, etc.
Solution –
Turn data to information off the ship

The Datapresence Problem Statement: In Other Words, Why?

By nature seagoing research is resource limited:

- **Time at sea – you've got the time you've got and only one chance**
- **Active participants – you've only got so many bunks**
- **Technology on hand – can't easily scale up and out**
- **Connectivity – information, social, other..**

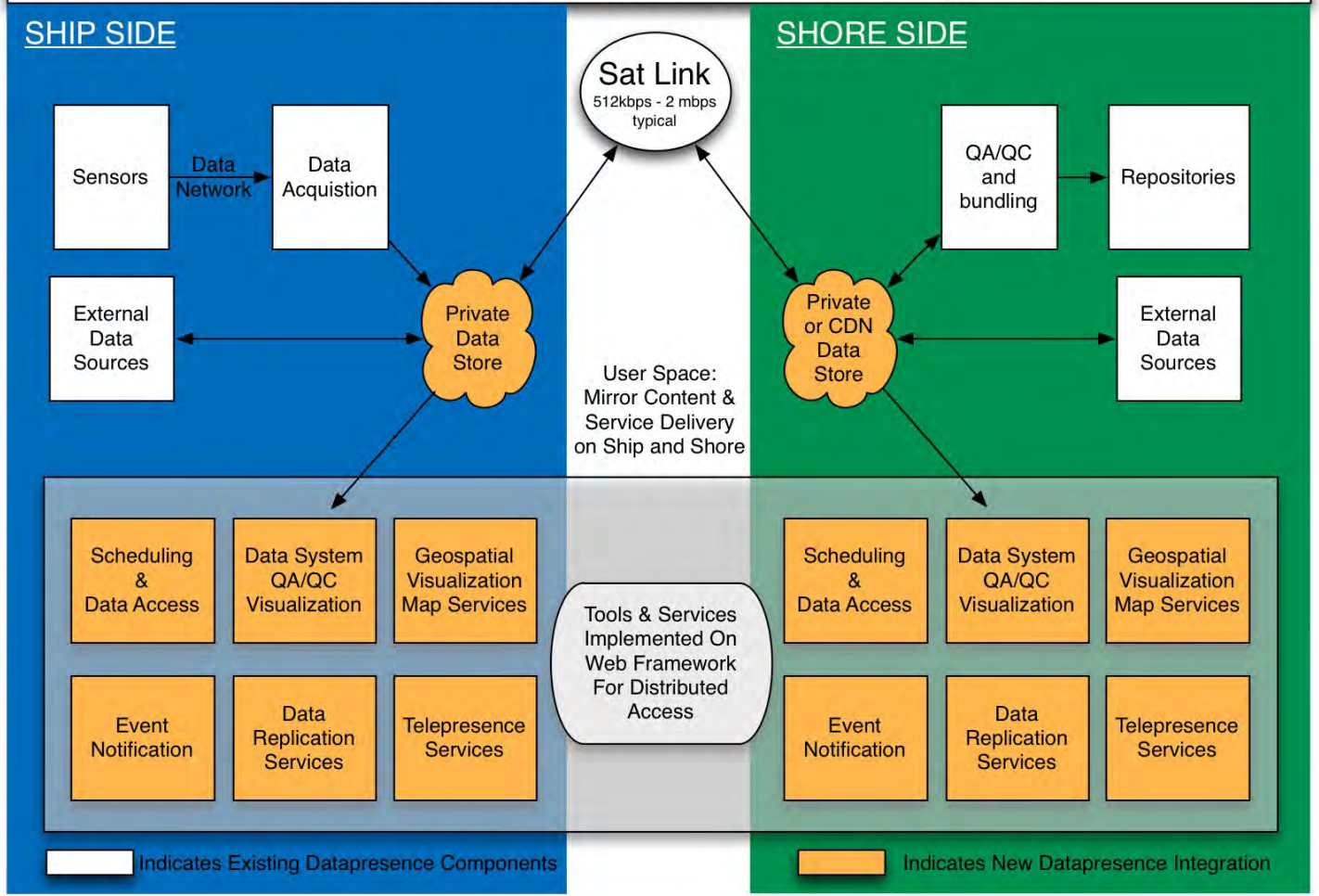
Potential Impacts:

- **Reduced situational awareness**
- **Reduced data quantity & quality**
- **Unrealistic expectations & workload**
- **Impaired ability to act adaptively**
- **Reduced access to traditional support networks**

Needs Assessment:

AUDIENCE - Who are we targeting?	YES.
DEMAND – What do they need?	YES..
PRODUCT – What are we offering?	YES...
SERVICE – How are we providing it?	YES....

RCRV Datapresence Functional Diagram



Service Requirements

- **Data Discovery** – UI has “portal like” capabilities
- **Data Access** – Erddap and other data services (map services, file shares..)
- **Chart/Plot Data Visualization** – UI time series visualizations
- **Map Data Visualization** – Sikuliaq like mapserver implementation with GMRT base layers
- **Data Replication** – mirror full resolution content to shore
- **Event Notification** – Users can create custom notifications
- **Shipboard QA/QC** – Flagging and notification
- **Shoreside QA/QC** – FTE for sensor technician oversight

Advanced Datapresence For a New Generation of Research Vessels

Datapresence System Architecture

Christopher Romsos, Jasmine Nahorniak, Katie Watkins-Brandt, Demian Bailey, Clare Reimers
College of Earth, Ocean, and Atmospheric Sciences, Oregon State University, Corvallis, Oregon, USA

Component Layers	Data Acquisition Workflow	Datapresence Workflow (Shares sensor, sensor-network interface, and data network with acquisition workflow)
CLIENT LAYER	**SUDS CLIENTS** Shipboard Scientific Party R2R & SAMOS rvdata.us	**DATAPRESENCE CLIENTS** Shipboard Scientific Party Shoreside Scientific Party & other shoreside actors Leaflet, MATLAB, R, tableau, ArcGIS Pro
SERVICE INTERFACE	**FILES:** SMB/CIFS, NFS, FTP	**FILES:** SMB/CIFS, NFS; **DATA:** ERDDAP, REST; **MAPS:** ESRI MAP, WMS, WFS; **PUB/SUB:** Websockets
SERVICE LAYER L1: Annotated Data L2: Calibrated Data L3: Binned Data L4: Derived Products	**LOCAL DATA ACCESS** Hourly files distributed via web accesible folders and network attached storage	File Server; Data Server; Map & GIS Server; Notification Server Calibration; Processing; Quality Assessment SHIPSIDE DATASTORE; SHORESIDE DATASTORE **STACK:** Django (w/channles), PostgreSQL, PostGIS, EDB Replication Server, Single Master Replication, Multi Master Replication, MongoDB, Cassandra
NETWORK-DATA STORE INTERFACE	**AGGREGATORS & UTILITIES** *Input:* Standardized UDP data packets *Output:* Files *Processes:* Parse XML, Write CSV Files	**AGGREGATORS** *Input:* Standardized UDP data packets *Output:* Database objects *Processes:* Parse XML, Write to DB **UTILITIES** Merge Sensors Georeference Derived Measures **2016-2017 Prototype Efforts:** ☑ Aggregator & Utilities ☑ Single master replication ☐ Multi master replication ☑ Map and Data Services ☐ Web Client development and testing **STACK:** Python, Django
TRANSPORT LAYER L1: Annotated Data (L0 Data encapsulated for transport)	**DATA NETWORK** Physically isolated (air-gapped) data distribution network	**DATA NETWORK** Physically Isolated (air-gapped) 10G OM4 Fiber & CAT7 Backbone
SENSOR-NETWORK INTERFACE	**SUDS DAS BOARD** *Input:* Analog & Serial Observations *Output:* UDP packets with Standardized XML payload	**2015-2016 Prototype Efforts:** Developed RPi Sensor-Network Interface Software RCRV RPi's broadcast SUDS Version 2 SML: ☑ serial ☐ analog **RCRV DAS BOARD (Raspberry Pi 3)** *Input:* Serial Observations *Output:* UDP packets with Standardized XML payload
SENSOR LAYER L0: Raw Data	*Example Sensors:* Singlebeam echosounder, Temperature, Pressure, and Humidity sensors, Pyrometer, Ocean Surface Radiometer, Anemometer, Rain gauges, and others.	Atmosphere; Ocean; Sensors; Observations

Synchronizing the data store

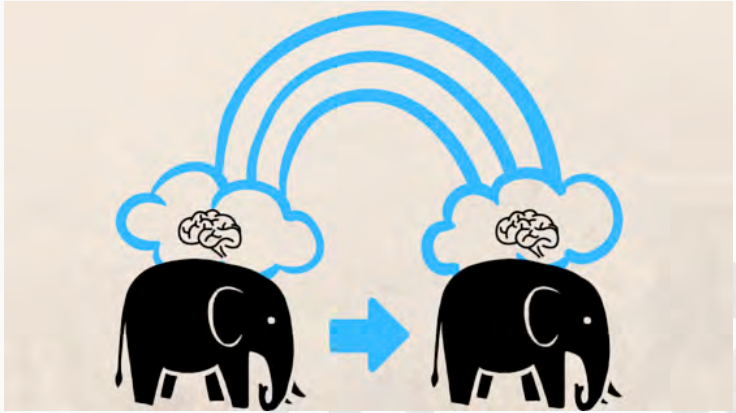
Target Requirements:

- Synchronize all “simple” vector time series data at full resolution
- Synchronize continuously instead of episodically
- Use COTS solution if possible, don’t roll-your-own
- Use a reliable or consistent method

Options:

- File Transfer (rsync) - simple (but you need to roll your own mgmt. logic), episodic
- **Shared Database –** pub/sub model, asynchronous (store and forward changes)
- Messaging – many models, some do guarantee reliable delivery, message-oriented-middleware (MOM), again some considerable assembly required.

Database Replication



Currently Testing EDB PostgreSQL's xDB Replication Server

- Write Ahead Logs are used to protect against data loss
- You can ship the logs to remote db and play them forward

- Performance is great in a local area network
  - Can push logs as frequently as once per second

- Out of the box performance isn't so great over high latency (RTT = 850ms) and high packet loss networks.

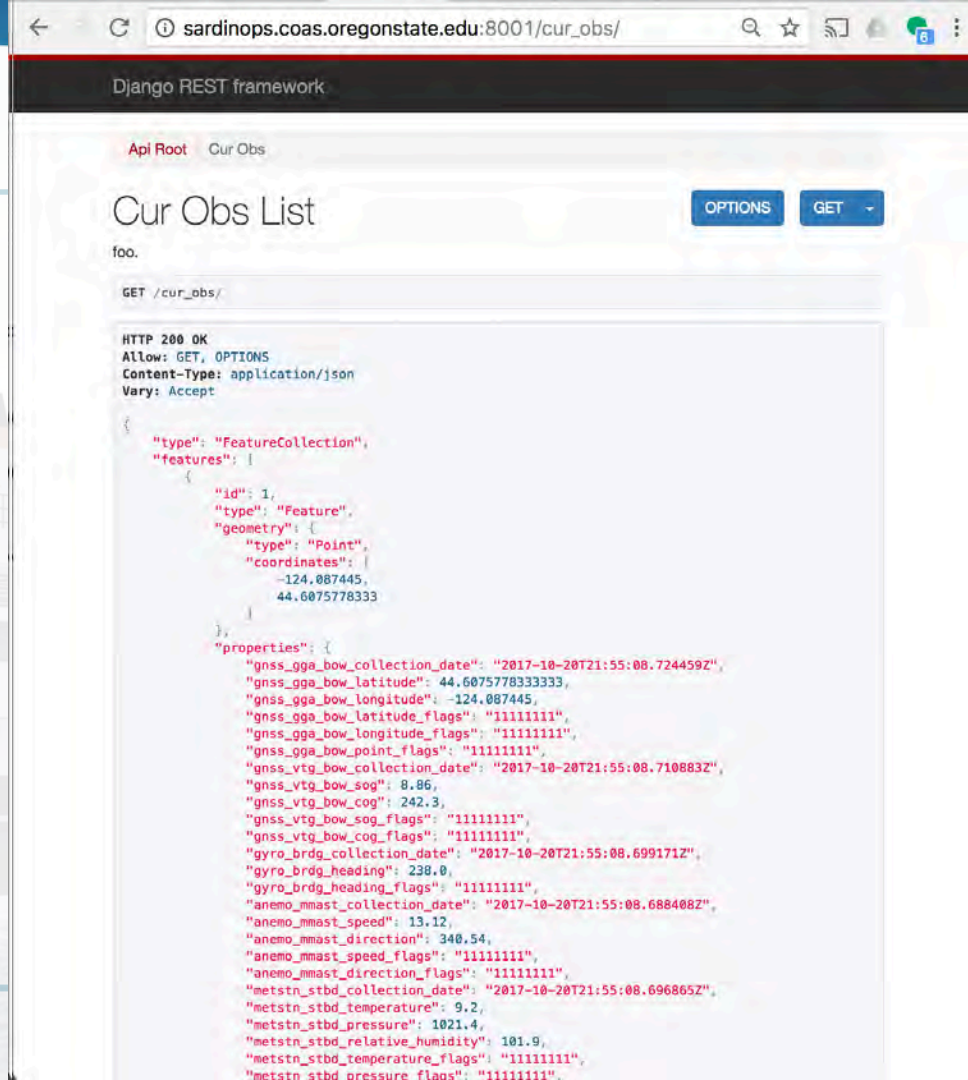
OPTIMIZATION

- Change TCP send and receive window size, disable slow start, selective acks, etc.
- During tests on *Endeavor* (April 2017) we replicated 12 sensors collecting at 2 Hz
  - Utilization - Ship to Shore **~59 kbps (175 kbps spikes)**
  - Gracefully handles outages: 20 minute outage (over 28,000 transaction backlog)

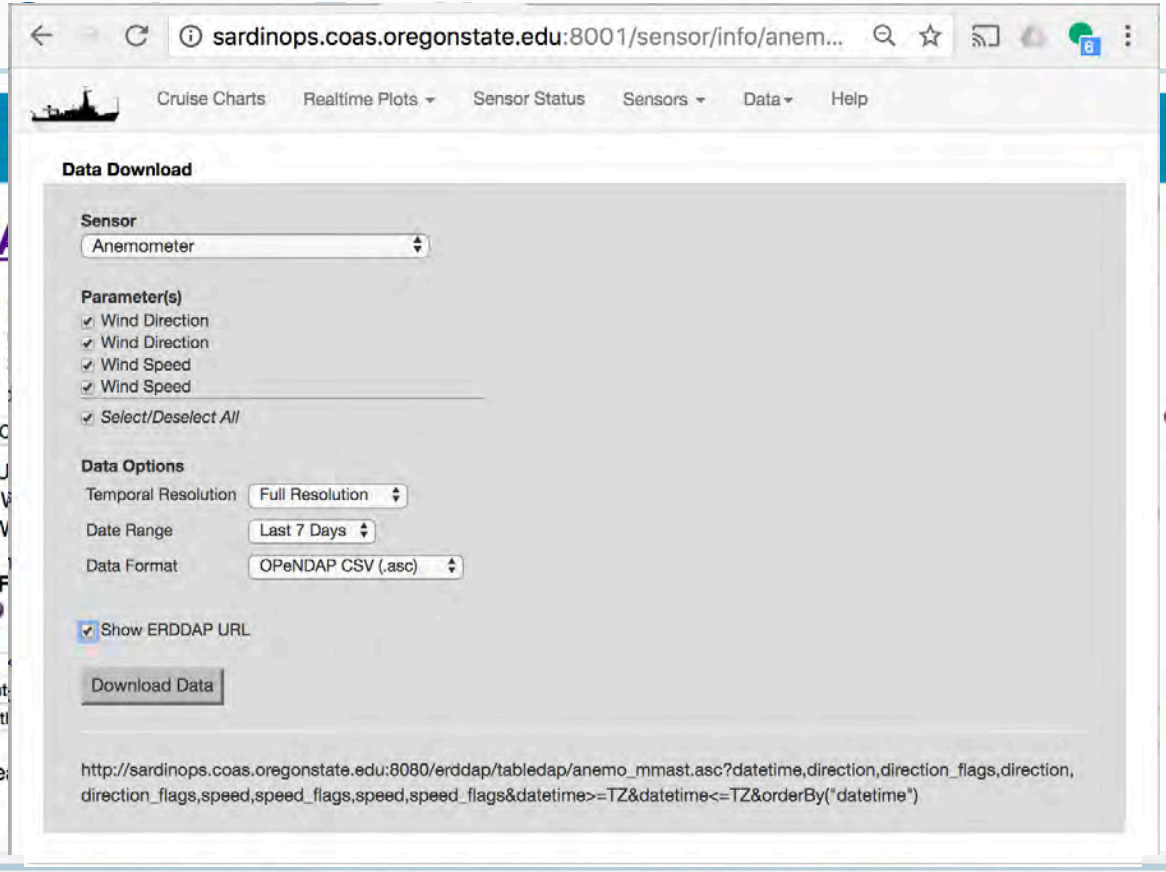
Data Services:

User Interface components built on the Django Rest Framework.

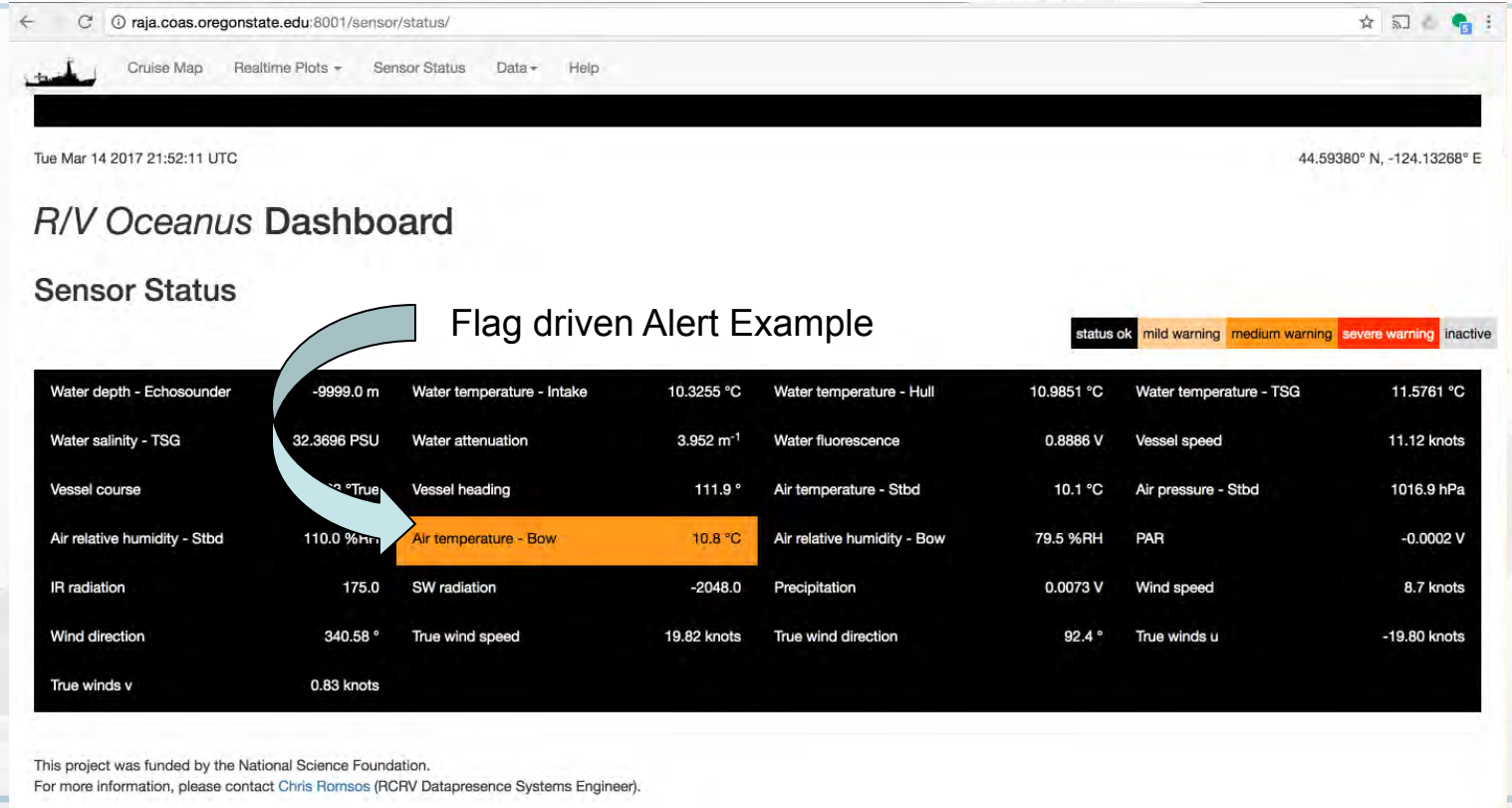
- Data is serialized as JSON & geoJSON
- Integrates easily into javascript plotting libraries like Highcharts, D3, etc.
- Modify URL with query parameters to:
  Window/Filter/Order/etc.



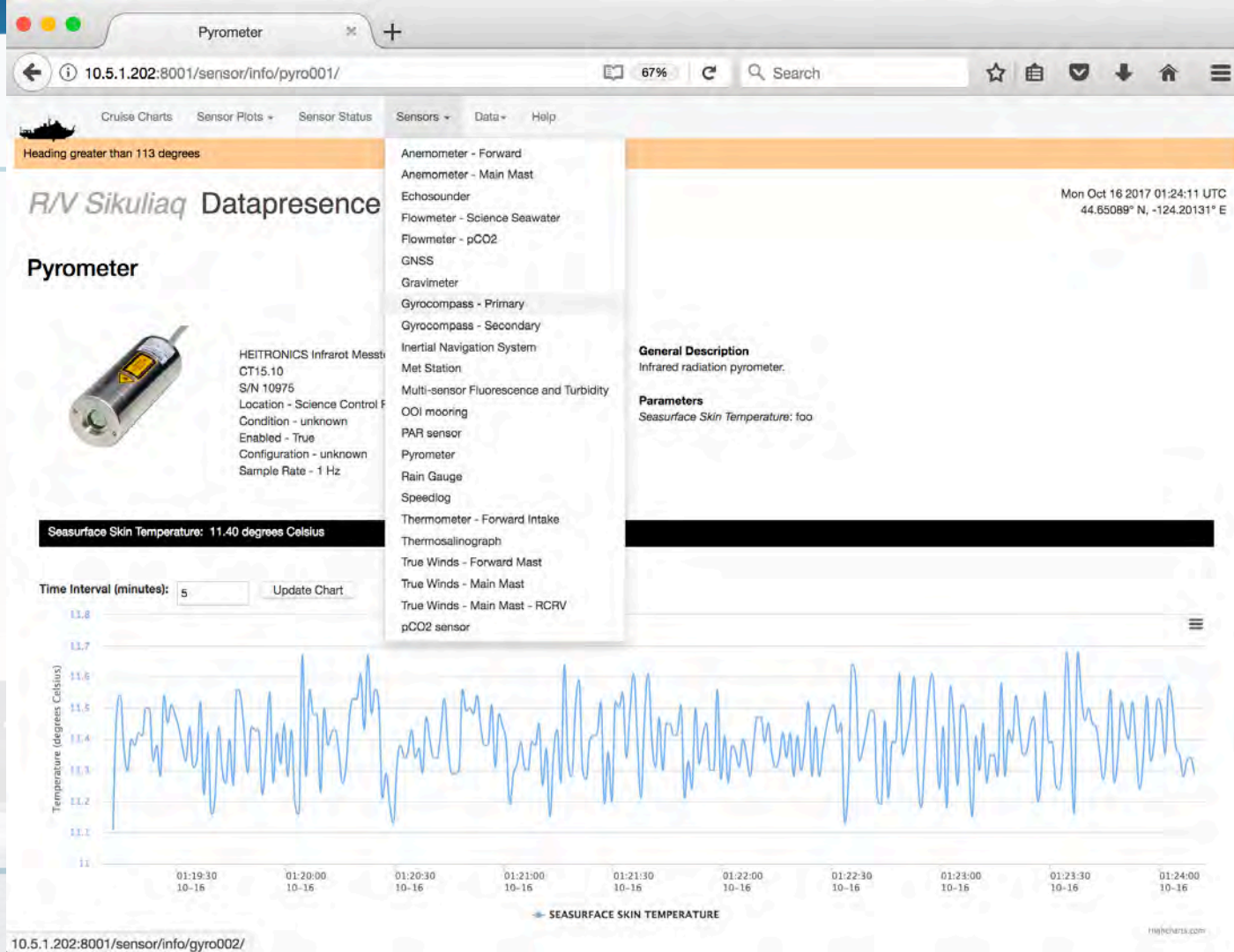
Data


sardinops.coas.oregonstate.edu:8001/sensor/info/anem...
Cruise Charts
Realtime Plots
Sensor Status
Sensors
Data
Help
Data Download
Sensor
Anemometer
Parameter(s)
Wind Direction
Wind Direction
Wind Speed
Wind Speed
Select/Deselect All
Data Options
Temporal Resolution
Full Resolution
Date Range
Last 7 Days
Data Format
OPeNDAP CSV (.asc)
Show ERDDAP URL
Download Data
http://sardinops.coas.oregonstate.edu:8080/erddap/tabledap/anemo_mmast.asc?datetime,direction,direction_flags,direction,
direction_flags,speed,speed_flags,speed,speed_flags&datetime>=TZ&datetime<=TZ&orderBy("datetime")

Web User Interface: Sensor Status



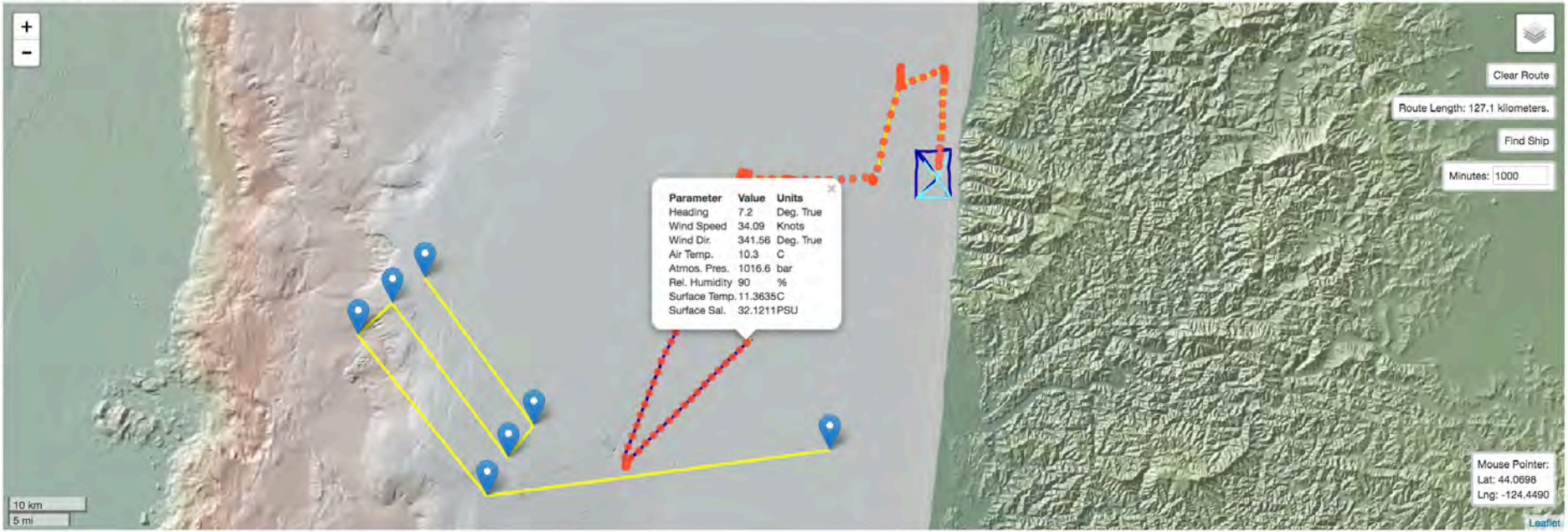
Web User Interface: Sensor Specific Time Series Plots



Datapresence Dashboard

Thu Oct 26 2017 02:41:39 UTC
44.07423° N, -124.43955° E

Cruise Map



Next Steps:

1. Collaborate:
   - I used to hear things like “you can’t do that” and “good luck”
   - Now I’m hearing “I want to do that also”
2. Fork:
   - Fork off branches to develop alternate methods for:
     - Synchronizing the data store (file or message models)
     - Data delivery to clients (web sockets)
3. Human engineering:
   - Noting beats demonstrated success and performance

Acknowledgements

Special thanks to the shipboard scientific support teams:

Oceanus – Andrew Woogen, Croy Carlin, Brendan D'Andrea

Endeavor - Bill Fanning, Lynn Butler, and Erich Gruebel

Sikuliaq Science Support - Steve Hartz, John Haverlack, Ethan Roth & Bern McKiernan

..and to our other science support heroes:

URI Inner Space Center – Dwight Coleman & Derek Sutcliffe

UHDAS – Jules Hummon & Toby Martin

MGDS @ LDEO – Vicki Ferrini & Rose Anne Weissel

R2R & SAMOS

...and finally to those brave enough to share with us their ship time:

OSU – Miguel Goni, Angel White, Clare Reimers

URI – Jamie Palter

OOI – Ed Dever, Jonathan Fram, Johna Winters, and Steve Lambert