

Integrating Diverse Uncrewed Systems Into the GANDALF Piloting Portal

<https://gandalf.gcoos.org>

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Data Shaman
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About Me



- US Navy Intel Aircrew – VQ-1 NAS Agana, Guam
- 2 years at Duke Marine Lab as EE on R/V Cape Hatteras
- 30+ cruises: Maine to GOM, Bermuda, Sargasso Sea
- Seismic data cruises to Indian Ocean/Africa with LDEO/WHOI
- 18 years at Duke University as Director of Data Communications
- Patent for Beach Conditions I.T. architecture w/Barb Kirkpatrick
- Patent for HABscopeV2 w/Barb Kirkpatrick
- 9 years at Mote Marine Laboratory
- GCOOS since November 2014
- Research focus on data exploration/visualization



GANDALF In The Beginning

- First version 2005 at Mote Marine Lab for GJK
- Originally generated only KML
- Written in TCL
- Used SQLite as database
- Plotted only surface events
- In 2006 added dead reckoning track/time series
- In 2007 migrated to Python
- In 2008 added ARGOS



GCOOS

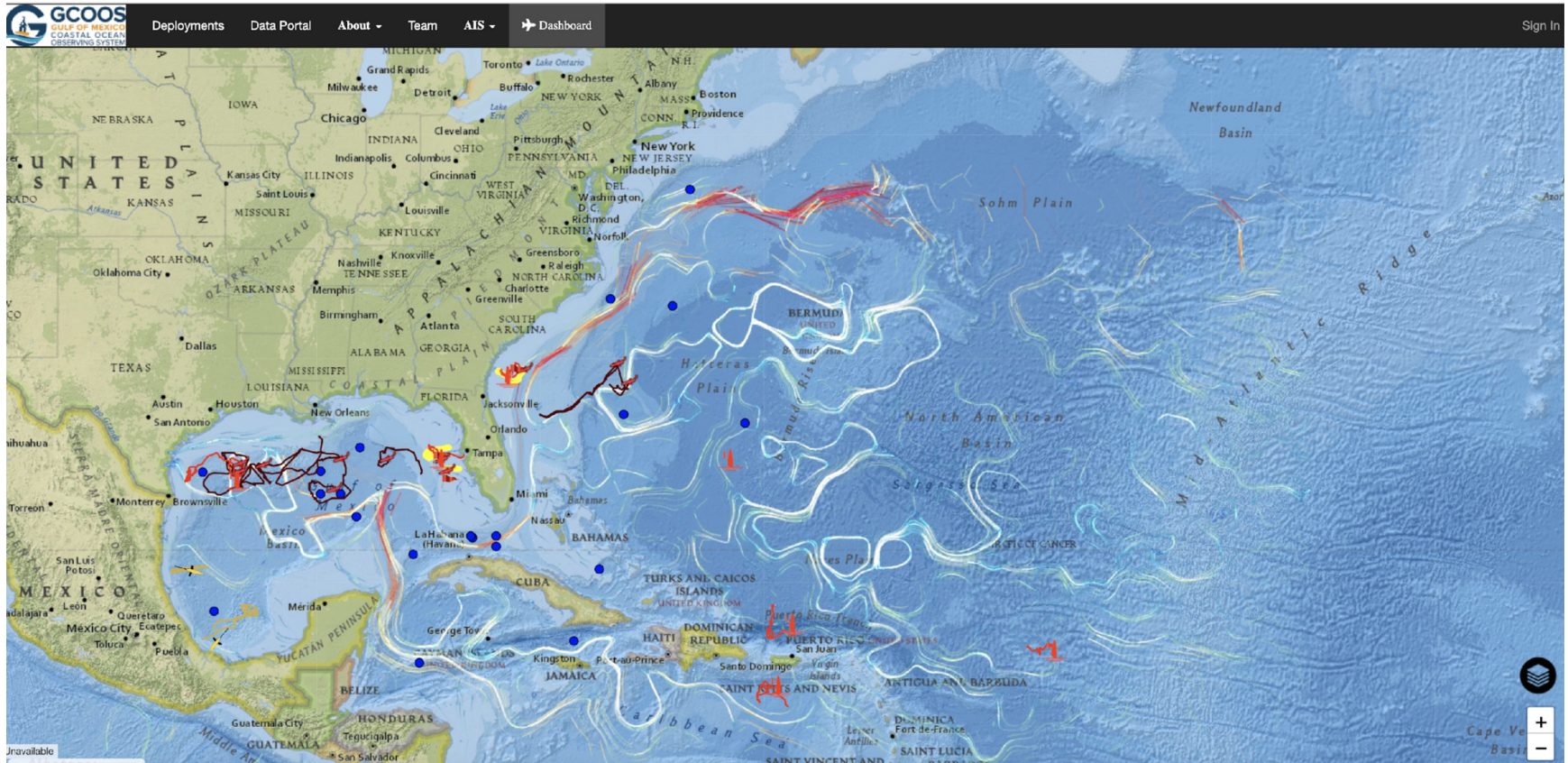
- Bob moved to GCOOS in November 2014
- Matt Howard asked for GOM AUV portal
- First: pick the acronym. Always!
- GANDALF: Global AUV Network, Data Archive and Layer Fusing



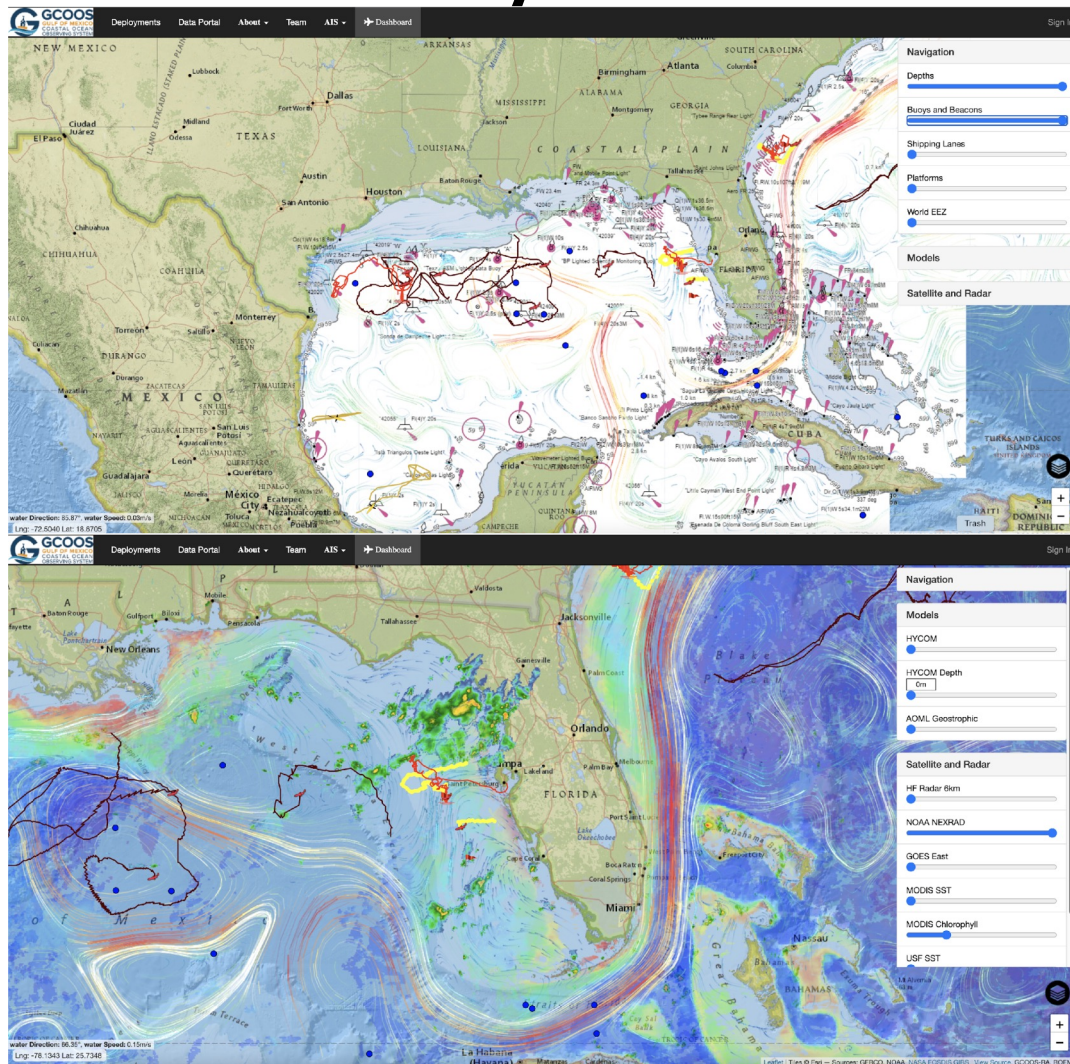
Design Considerations

- GCOOS does not operate Dockservers or Basestations
- We might not have logins on partner's servers
- Must have multiple methods of harvesting data
- Must have real-time plots
- Retain 'Dashboard' from Mote version
- Display waypoints
- Support multiple vehicle types natively
- Listen to the operators and give them what they want!

GANDOLF

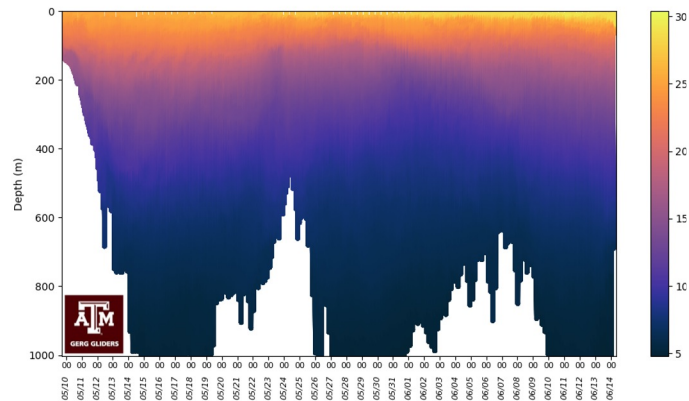


Layers

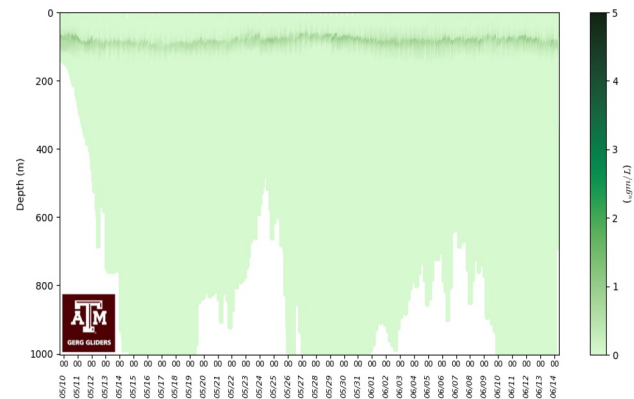


2D Scatter Plots

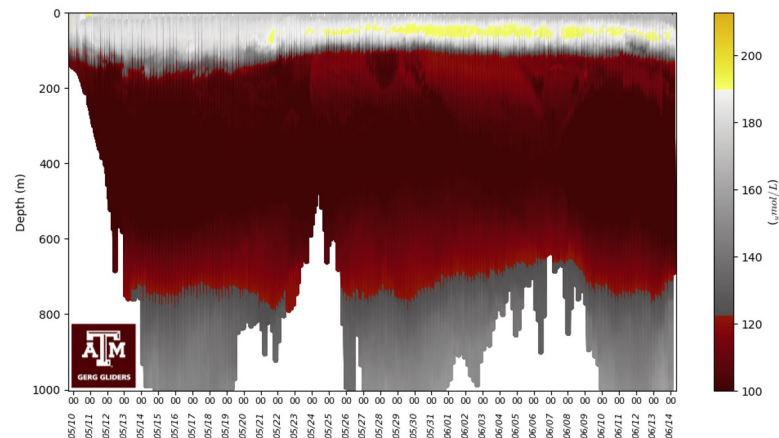
Sverdrup 2018-05-09 to 2018-06-14
Water Temperature ($^{\circ}\text{C}$)



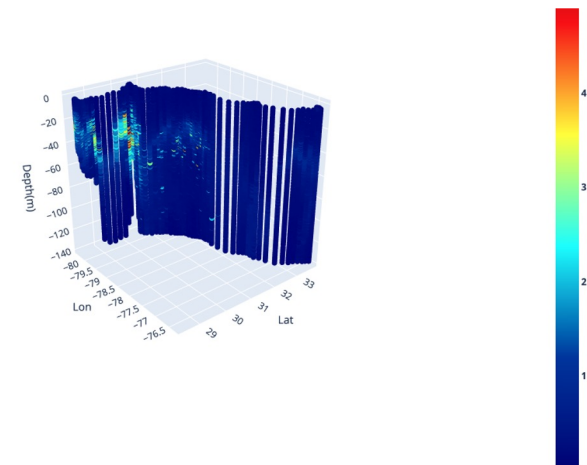
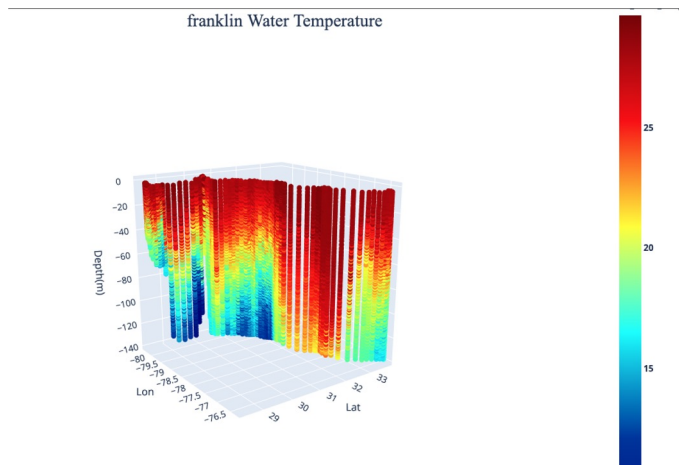
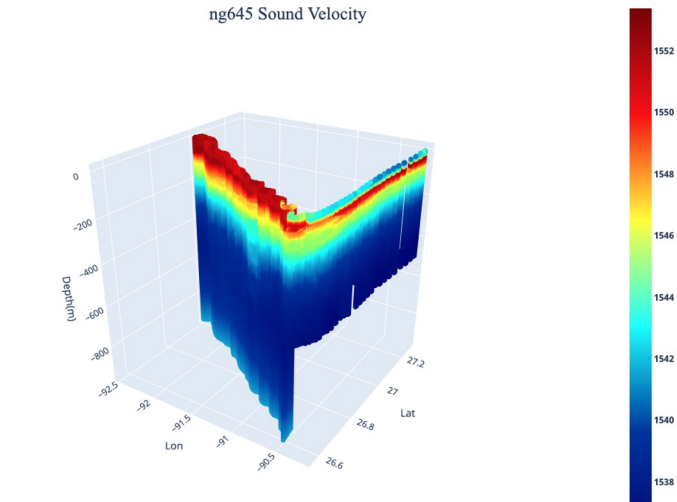
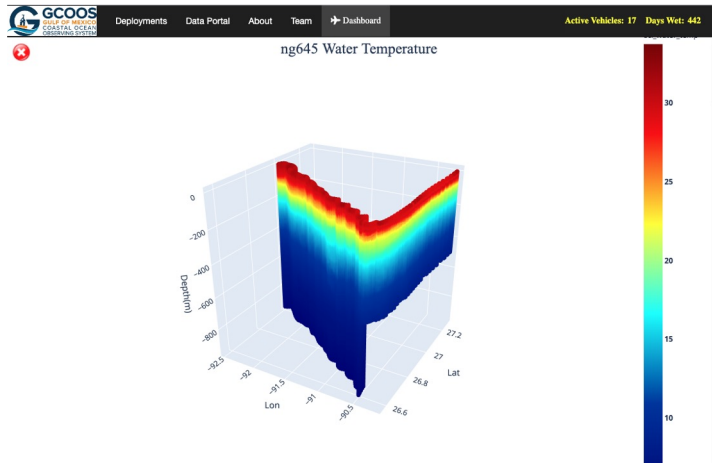
Sverdrup 2018-05-09 to 2018-06-14
Chlorophyll ($\mu\text{gm/L}$)



Sverdrup 2018-05-09 to 2018-06-14
Dissolved Oxygen ($\mu\text{mol/L}$)

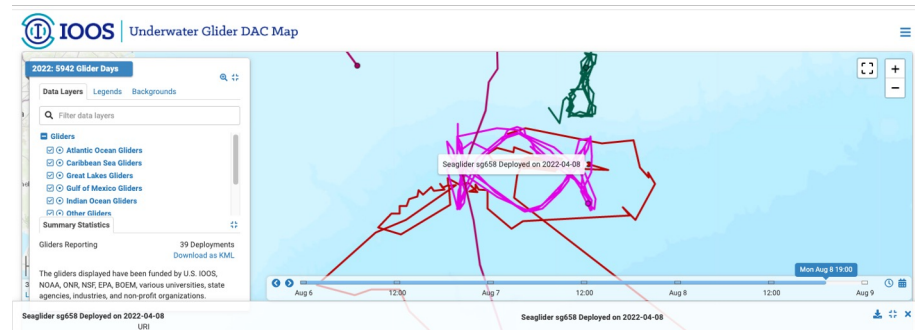
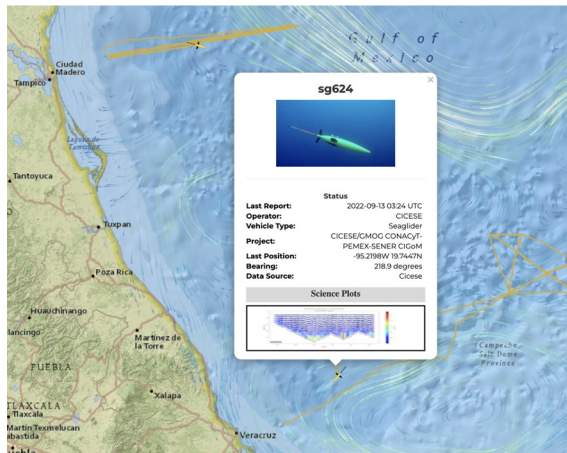


3D Plots



Integrating Seagliders

- Seagliders provide data in NetCDF format, but not IOOS compliant
- GANDALF Seaglider code harvests NC files via rsync, wget or ftp
- NC files are converted to Pandas Dataframes and then to MongoDB
- GANDALF plots and map feature collections all built from MongoDB
- First test of code was with Mexican CICESE Seagliders
- Next deployment was for URI (Jaime Palter) and SG658
- Harvesting, processing and map feature generation all hands-free



gandalf_sg2gdac

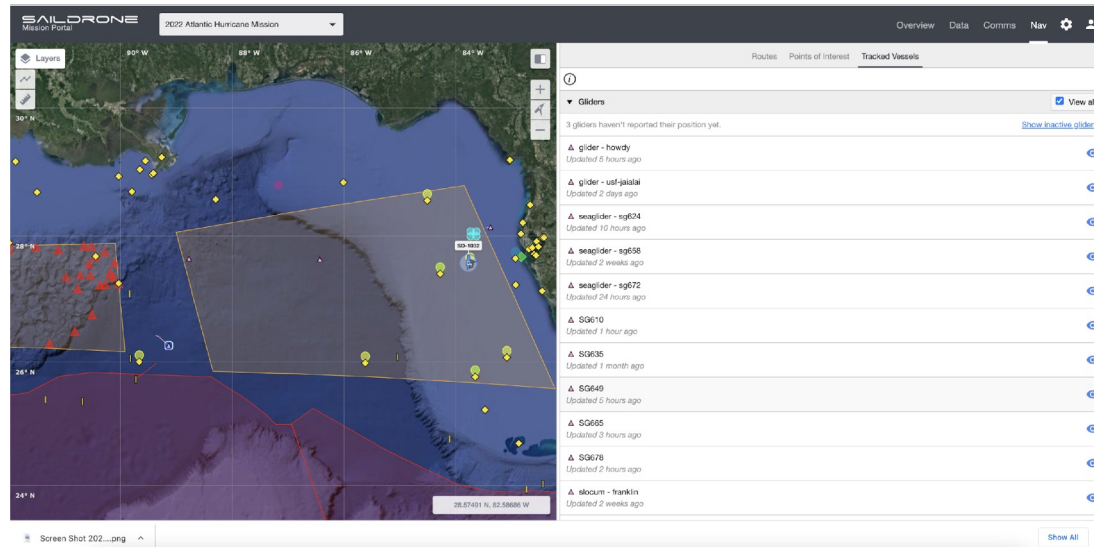
- Seaglider NetCDF format not IOOS/GDAC/GTS Compliant
- AOML developed sg2gdac script, but...
- Not easily integrated into GANDALF
- Config settings and code all mixed into one file
- So gandalf_sg2gdac was written over six weeks
- 700 lines of code and 700 lines of JSON config file
- Vehicle/Operator agnostic – all settings done via config file
- Suitable for integration into automated pipelines
- IOOS GDAC-3 Compliant NetCDFs
- Trial by fire: 1,300 NC files pushed to GTS for URI SG658

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Saildrones on GANDALF

- Data pulled from PMEL ERDDAP servers using GANDALF ERDDAP module
- All deployed assets on GANDALF pushed to SD Mission Portal in real-time
- Great example of cross-group coordination and cooperation

NOAA	sd1031	saildrone	Deployed	PMEL	NOAA	NOAA Hurricane Saildrones	2022-06-22 15:38	83	2022-09-13 09:50 UTC	Q	LM	⌕
NOAA	sd1032	saildrone	Deployed	PMEL	NOAA	NOAA Hurricane Saildrones	2022-06-22 15:38	83	2022-09-13 09:59 UTC	Q	LM	⌕
NOAA	sd1040	saildrone	Deployed	PMEL	NOAA	NOAA Hurricane Saildrones	2022-06-22 15:38	83	2022-09-13 09:59 UTC	Q	LM	⌕
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Upcoming UCS & Floats

Alseamar Explorer



Seatrak SP-48



Seatrec infiniTE Float

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Specifications:

- NAI diameter: 6" (152.4 mm)
- Length: 14' (4.27 m) (without antenna)
- Weight: 111 lbs (50 kg)
- Depth Rating: 4,000 meters
- Range: 1000 D (1000 km) depending on temperature
- Maxim Endurance: Energy no longer a limitation
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- System Communications: Modem, Iridium, GPS
- Data Processing: Linux computer

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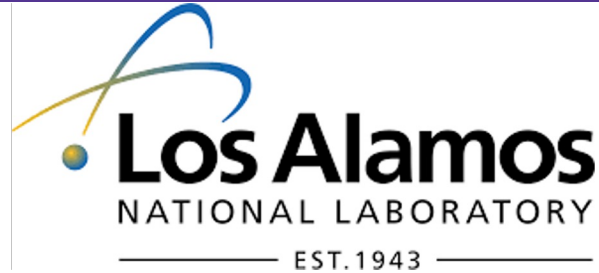
Plug and play modularity

Recycle products by 50%

Ongoing Collaborations

Argovis

A web app to visualize and access ocean data



VOICE OF THE
OCEANS





Architecture



- 100% Dockerized
- Five containers: Web, Tools, MongoDB, NCWMS and gncutils
- 100% Python server-side: Pandas and Xarray
- Individual vehicle flight and sensor config files
- Flask for web templates
- Apache/mod_wsgi for httpd
- Leaflet for maps
- Bootstrap for UI
- Plotly for live charting
- Matplotlib for static plots



Acknowledgements



Opportunity runs deep™



TEXAS A&M UNIVERSITY
Geochemical & Environmental
Research Group

