Data Portal

Stones Metocean Observatory

Stones Metocean Observatory: Technical Guide to the Data Portal

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GCOOS GULF OF MEXICO COASTAL OCEAN OBSERVING SYSTEM

The National Academies of SCIENCES ENGINEERING MEDICINE
GULF RESEARCH PROGRAM

FUGRO

JASCO APPLIED SCIENCES

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Introduction

Stones is the world's deepest oil and gas project, operating 9,500 feet of water in an ultra-deep area of the US Gulf of Mexico. The floating production, storage, and offloading (FPSO) facility, which started production in 2016, connects to subsea infrastructure, producing oil and gas from reservoirs nearly 30,000 feet below sea level. The Gulf Research Program of the National Academies of Sciences, Engineering, and Medicine (NAS), in collaboration with Shell, supported this pilot effort to convert an existing ocean mooring owned by Shell into the first long-term deep ocean observatory in the Gulf of Mexico. The collaboration, *Stones Metocean Observatory Project* (referred to as *Stones MetObs*), provides essential marine data to support scientific research and improve understanding of the Gulf of Mexico. The *Stones MetObs* Data Portal [1], accessible online via secured online Internet services, provides the infrastructure to view, investigate, and download data from the *Stones MetObs*.

Stones MetObs ingest and serve standard atmospheric data such as winds, air pressure, air temperature, and oceanographic data such as waves and currents. The Acoustic Doppler Current Profiler (ADCP) mounted on the buoy generates up to 170 readings per reporting period from a depth of 4 meters to a depth of 2,897 meters. The mooring is also equipped with an acoustic monitoring instrument, Autonomous Multichannel Acoustic Recorder (AMAR G4), that records ambient, anthropogenic, and marine mammal sound in the area. This data portal is part of a broader, long-term initiative NAS is currently developing called Understanding Gulf Ocean Systems (UGOS) [2]. UGOS is envisioned as a comprehensive, cross-disciplinary, multi-institutional research campaign to improve understanding of the various interacting physical, biological, and chemical processes at work in the Gulf of Mexico.

Data Flow and Cyberinfrastructure

Figure 1 summarizes the data flow of the data cyberinfrastructure. The station sensors collect the data (Table 1) and are pulled by the data servers of Fugro for oceanographic observations in regular intervals and by Jasco for the acoustics. The data are pushed to the Stones Data Server as they become available. The data providers have secured access to the Secured File Transfer Protocol (SFTP) facility of *Stones MetObs,* where data are pushed for processing. Data are in standard NDBC XML data format.

The *Stones MetObs* parses the data and returns a message to GCOOS if the data is defective. In cases where data cannot be read, Fugro is informed to re-push data for processing for the metoceanographic data, and JASCO for the acoustics. *Stones MetObs* evaluates the data and QC'd using the NOAA IOOS QARTOD recommended procedures [3]. The processing is automated and set to trigger on the 20-minute interval. The processing of metocean observations starts with parsing of the XML data, evaluated for form, QC'd, and published to the *Stones MetObs* Web Accessible Folder (WAF) infrastructure. The automated processing cyle continues as long as the data providers push new data. The *Stones MetObs* data are also regularly pulled by GCOOS for publication on GCOOS ERDDAP and

WAF. The acoustic data are processed manually, and careful conversion is needed to convert the MP4 data to FLAC data format and generate spectrogram for the data browsing.

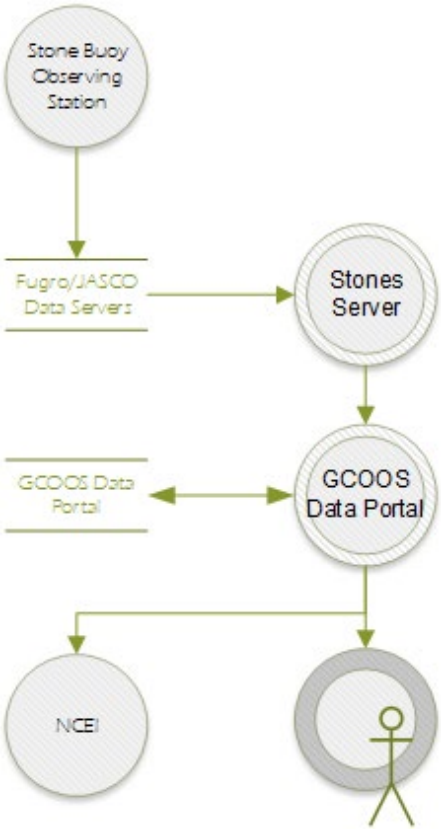


Figure 1. Data Flow Diagram of the Stones Metocean Observatory.

The *Stones MetObs* server is hosted by Harte Research Institute for Gulf of Mexico Studies, Texas A&M University-Corpus Christi. As part of the Disaster/Recovery strategy of the project, an alternate site was established at the outset of the project to ensure a 24/7 high availability of the data services in the cloud (DigitalOcean). Regular system backups are also performed by both hosts (TAMUCC and DigitalOcean).

The *Stones MetObs* is accessible using GCOOS domain (https://stonesdata.gcoos.org/) and, as an alternate, using the TAMUCC domain (https://stonesdata.tamucc.edu/). In either case, the synchronous facilities will serve data using the Hypertext Transfer Protocol Secure (HTTPS), a cyberinfrastructure the utilizes the HTTP with the Secured Socket Layer (SSL)/Transport Layer Security (TLS) protocols.

Table 1. Sensors in the Stones Met Ocean Observatory

Sensor	Parameter	UOM
Vaisala PTB330	Air temperature	degree C
	Atmospheric pressure	Mbar
R.M. Young 05106	Wind speed, direction and gust	m/s; degree N
Gill Windsonic	Wind speed, direction and gust	m/s; degree N
Aquadopp Profiler 400	Water temperature	degree C
	Ocean current speed and direction at depth (1-50 m)	cm/s; degree N
Nortek Signature 55	Ocean current speed and direction at depth (50-1,132 m)	cm/s; degree N
Teledyne Workhorse Long Range	Ocean current speed and direction at depth (>1,132 m)	cm/s; degree N
Fugro Wavesense 3	Wave height	M
	Dominant wave period	Sec
Autonomous Multichannel Acoustic Recorder (AMAR G4)	Acoustic readings	(in mp4)

The Landing Page

The *Stones MetObs* landing page has five parts: header, introductory message or overview, system status, system resources, and page footer.

Header

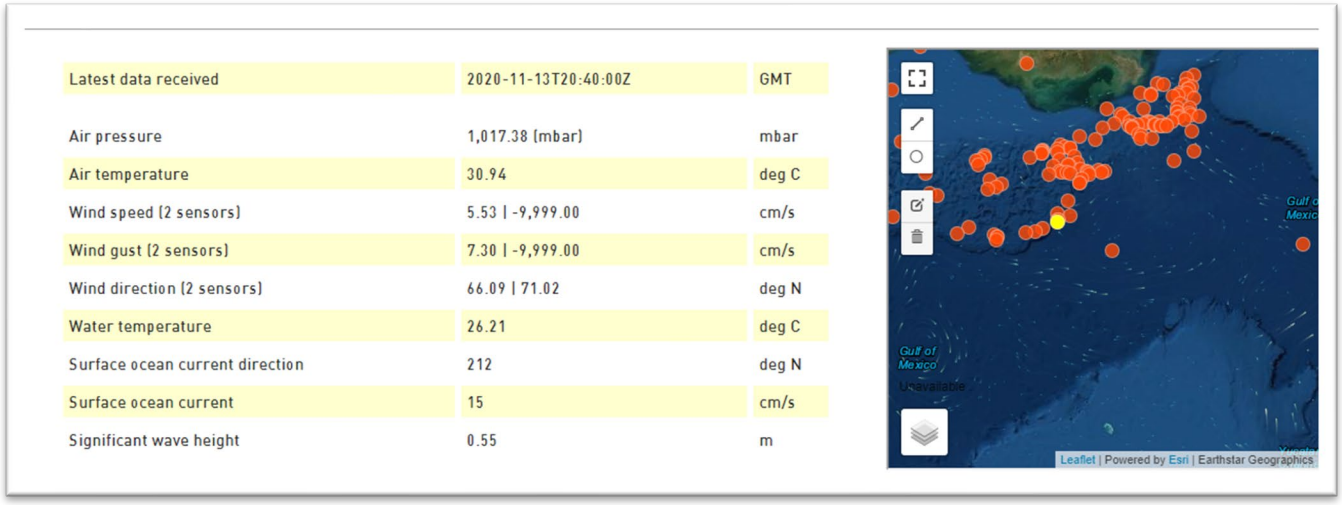
The 'Header' introduces the GCOOS logo and menu quick links to all other pages of the site. Occasionally, the header will also include messages (marquees) to inform users of scheduled system interruptions or important updates to the system. The news will stay there for a week before they are disabled.

Overview

The 'Overview' section of the landing page introduces the pilot project. To better understand the purpose of the project, a link is provided to a video that best explains the project (https://www.youtube.com/watch?v=n0XwUAV8OFw&t=2s).

Status

The system status report updates as data are published. Figure 2 is a facsimile representation of the section with the latest readings posted. In the right panel, the station is plotted on an interactive map. The default view includes a plot of other ADCP observing stations in the region to give users a geographic reference as to where the station is located. Storm tracks and NOAA HYCOM ocean current model are layers that can be plotted as needed (on by default).



Latest data received	2020-11-13T20:40:00Z	GMT
Air pressure	1,017.38 (mbar)	mbar
Air temperature	30.94	deg C
Wind speed (2 sensors)	5.53 | -9,999.00	cm/s
Wind gust (2 sensors)	7.30 | -9,999.00	cm/s
Wind direction (2 sensors)	66.09 | 71.02	deg N
Water temperature	26.21	deg C
Surface ocean current direction	212	deg N
Surface ocean current	15	cm/s
Significant wave height	0.55	m

Figure 2. The online status report of the latest observation from the Stones MetObs station.

Resources

The data in *Stones MetObs* can be browsed, downloaded from the WAF, and accessed via the GCOOS ERDDAP server. Figure 3 is a cutout of the 'Resources' section with links to these modules. Clicking on any of the three buttons will open a new tab.

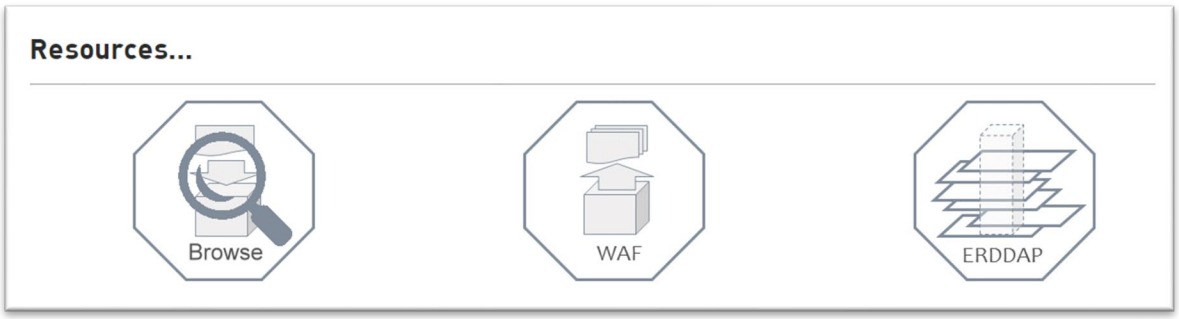


Figure 3. The resources of Stones MetObs: data browse function, Web Accessible Folder (WAF), and link to the data in the GCOOS ERDDAP server.

Footer

The 'Footer' of the landing page recognizes the National Academies of Science, Engineering and Medicine, Gulf Research Program (NAS-GRP), and Shell E&P collaborative agreement that lead to this project. The agreement funded the efforts of Fugro (https://fugro.com) to install, maintain and access sensor data from the *Stones MetObs* and Jasco Applied Science (https://www.jasco.com/) tasked to capture the acoustic readings from November 2018 to October 2019. Shell E&P funded the data management component of the cyberinfrastructure.

Data Browse Function

Stones MetObs provide pages to cursory view the data to facilitate browsing the data before data are downloaded. The data browsing pages will include user-interactive plot and hyperlinks to the sensor's registry record on the X-DOMES SensorML Registry and Repository [4].

To zoom to a region of the plot, highlight the section using a click-and-drag function with the mouse pointing device. Double-clicking on the plot returns the plot to the default state.

Atmospheric

The station's atmospheric data observations include air temperature, air pressure, wind speed, wind direction, and wind gust (Table 1). The data browser (Figure 4) includes an interactive user plot of the readings in the last three months.

Oceanographic

The station's oceanographic data include readings of the water surface temperature, wave height, dominant wave period, and ocean currents. The ocean currents are presented on a separate tab due to the size of the data.

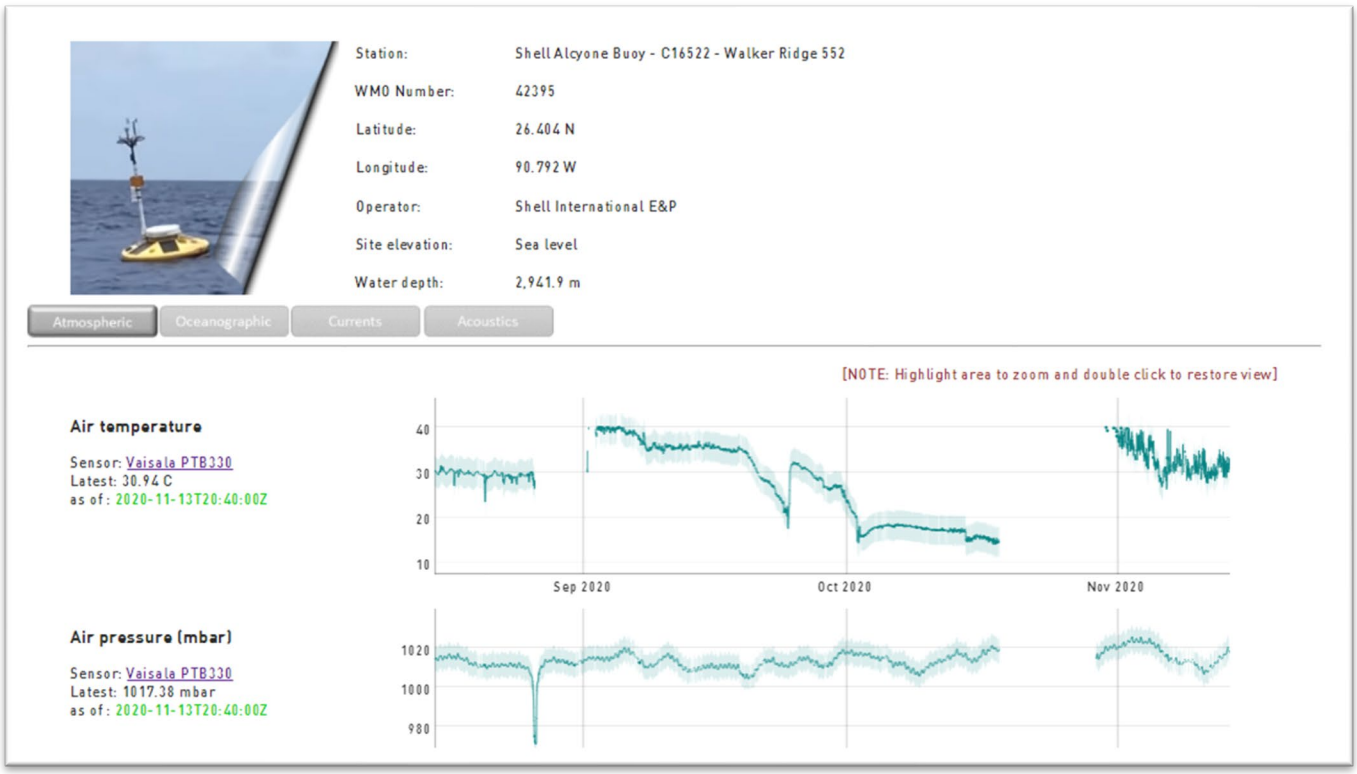


Figure 4. Cut-out of the data browse function showing the user-interactive plot that can be zoomed-in as may be needed.

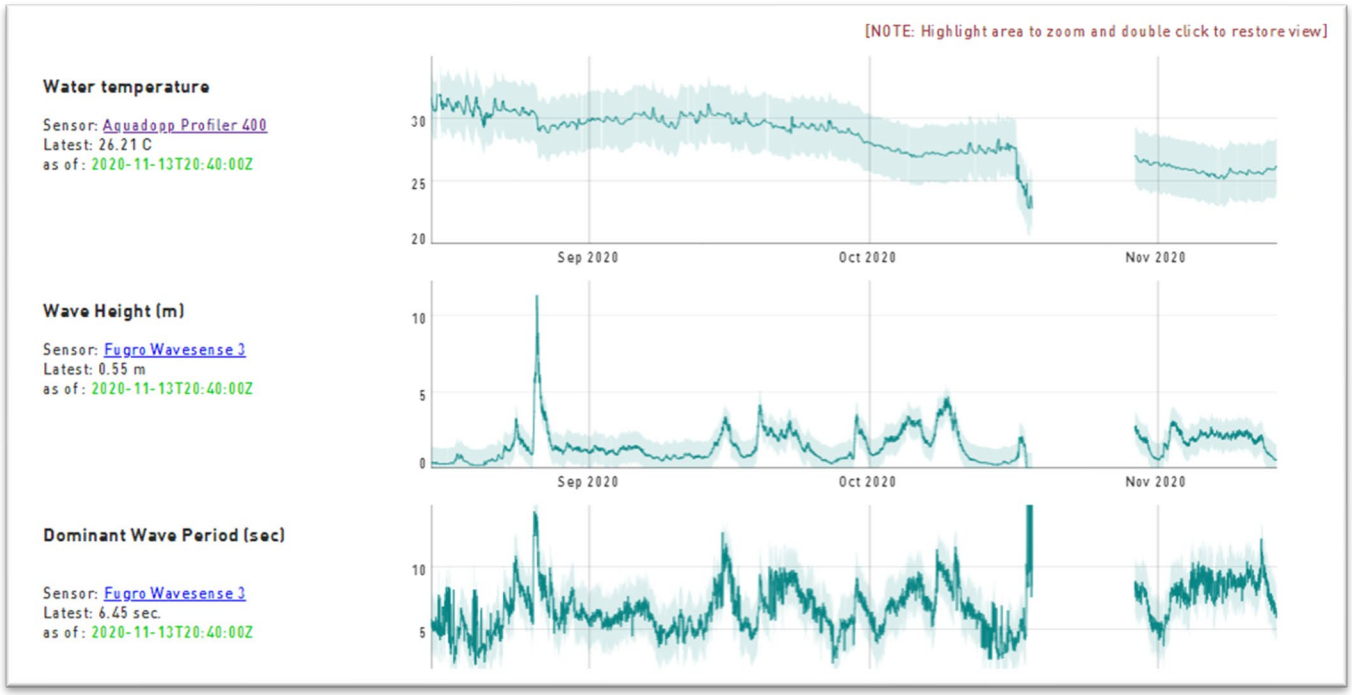


Figure 5. Interactive plots of the oceanographic observations as reported by the station.

Ocean Currents

The ocean currents are presented as stick-plots (Figure 6). The readings are grouped based on the depth range for the presentation. Data that fails the QARTOD test are not plotted.

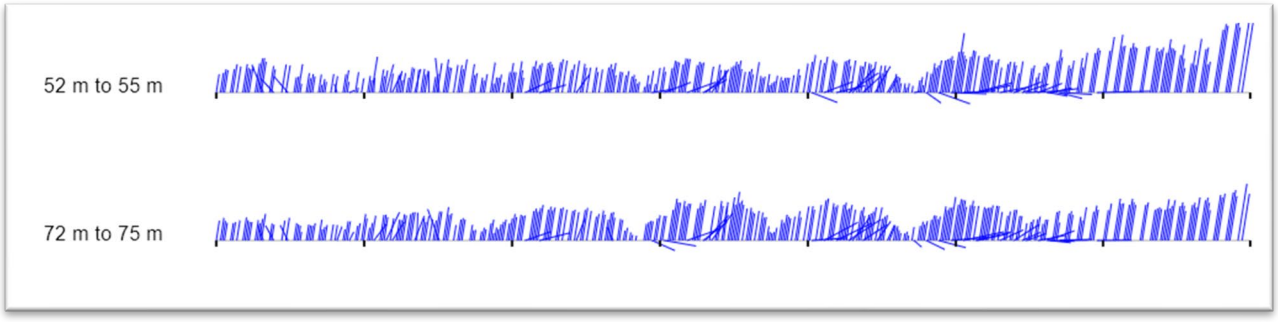


Figure 6. Sample stick plots generated by Stones MetObs to present the ocean current speed and direction.

Acoustics

The 1-year acoustic readings were captured using AMAR G4 Ultra Deep sensors (Hydrophone: M36-V35-600) with 128000 sps and 512000 sps, sampled synchronously. The data were submitted in MP4 data structure. The size of the files inhibits the system from serving the data efficiently, and were translated to Free Lossless Audio Codec (FLAC), saving as much as 60% of the space and prevents data losses (Figure 7).

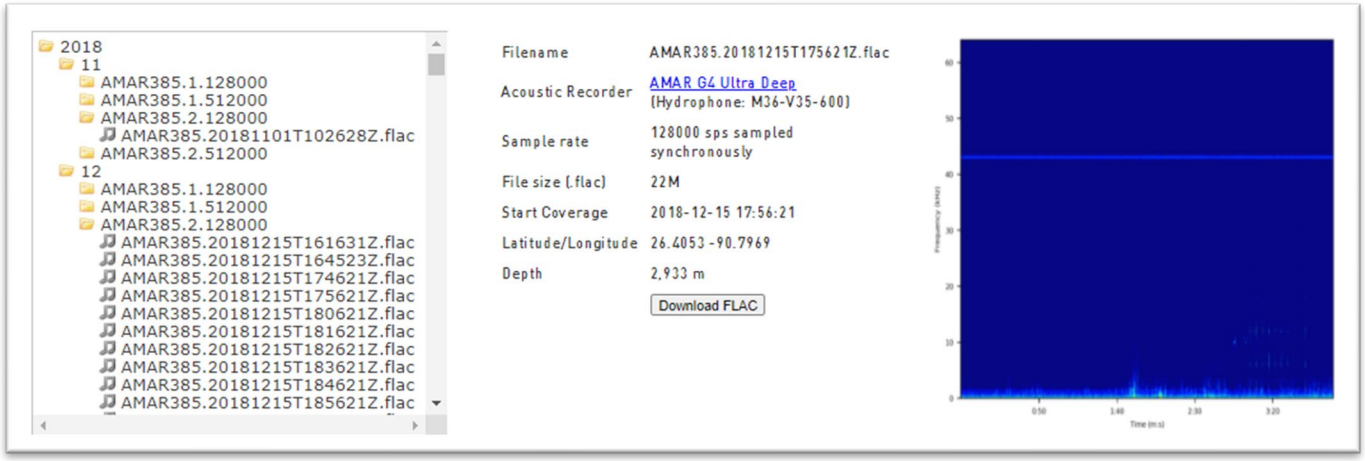


Figure 7. Facsimile representation of the acoustic readings with spectrogram to give an indication of the content of the file.

Web Accessible Folder

The Web Accessible Folder (WAF) is the facility users are most familiar with to obtain data, as it resembles the commonly used file folder functions of desktop computers. The *Stones MetObs* WAF contain five folders:

1. acoustics: acoustic data arranged by year and month of observation
2. archive: a compressed version of the monthly data processed by the system
3. csv_by_platform: data arranged by observing parameter and formatted using the Comma Separated Values (Text), a common data format
4. nc_by_platform: data in netCDF4 data structure following the NOAA IOOS Metadata Profile (v. 1.2) [5]
5. uploads: a temporary folder set to hold data that still require processing.

References

[1] Stones Metocean Observatory: Data Portal. https://stonesdata.gcoos.org/

[2] National Academies of Sciences, Understanding Gulf Ocean Systems., https://www.nationalacademies.org/our-work/understanding-gulf-ocean-systems-grants

[3] NOAA IOOS Quality Assurance/Quality Control of Real Time Oceanographic Data. https://ioos.noaa.gov/project/qartod/

[4] Cross-Domain Observational Metadata Environmental Sensing: SensorML Registry and Repository. https://xdomes.tamucc.edu/srr/

[5] IOOS Metadata Profile Version 1.2. https://ioos.github.io/ioos-metadata/ioos-metadata-profile-v1-2.html