Toward an Operational Observing System for the Gulf of Mexico

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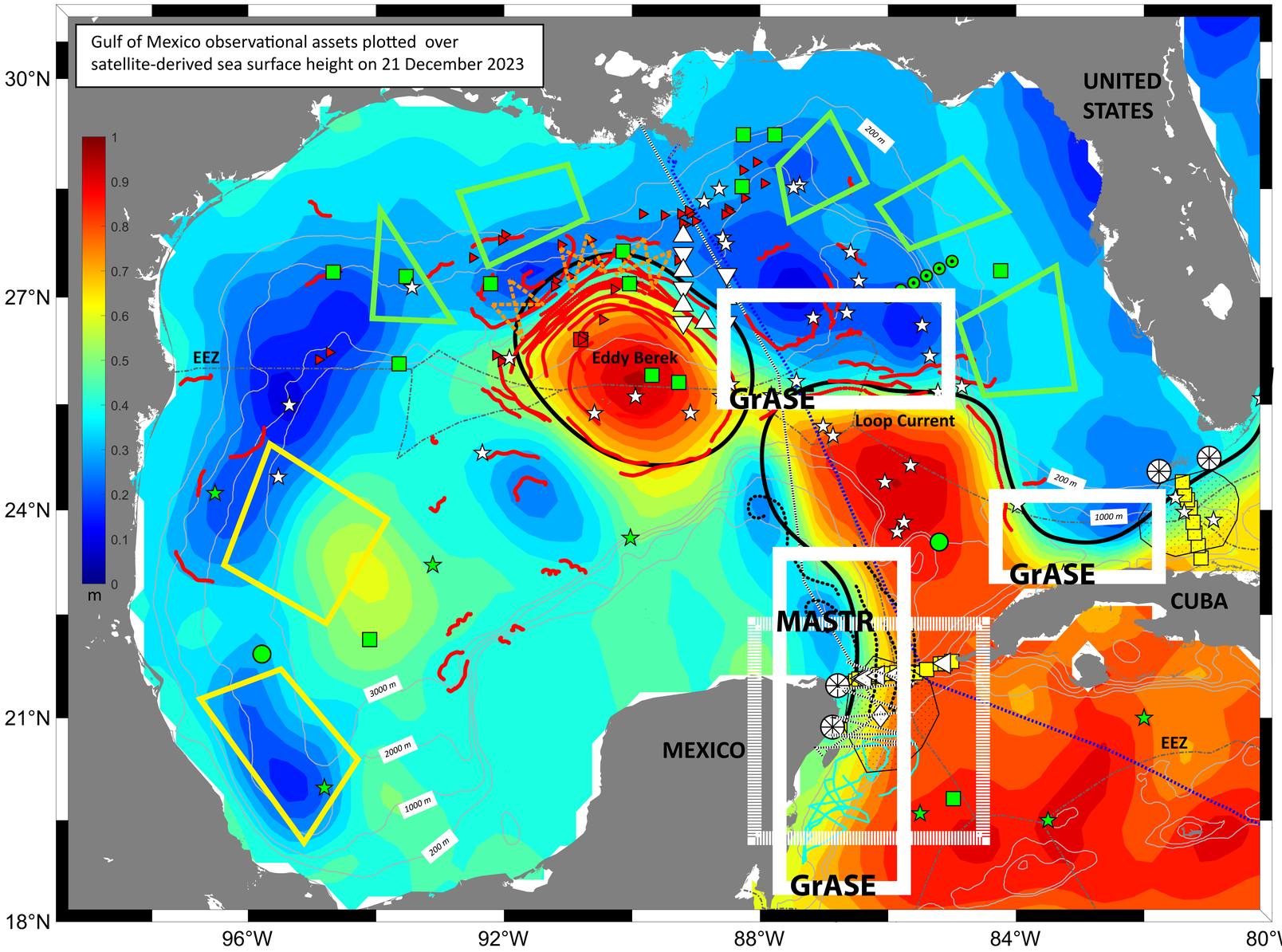
Introduction

The physical environment of the Gulf of Mexico (GOM) has a profound impact on the lives of the millions of people who live and work around it. Hurricane prediction, safe and efficient offshore energy extraction, deep-sea commercial fishing and agriculture are just a few examples of human activities that are directly, or indirectly through air-sea interaction, affected by the currents and hydrography of the GOM. The positions of the primary circulation feature in the GOM, the Loop Current, and its associated anticyclonic Loop Current Eddies, fundamentally influence these activities. Our ability to predict the evolution of the Loop Current System is, however, still limited, putting lives, livelihoods and economic stability at risk across the U.S., Mexico and Cuba.

UGOS Aims

The international "Understanding Gulf Ocean Systems" (UGOS) initiative (2018-2027), funded by the National Academies of Sciences, Engineering and Medicine (NASM), aims to firstly **improve dynamical understanding and prediction of the Loop Current and associated circulation**, and secondly **contribute to better tropical cyclone forecasting and fisheries management**, in a highly collaborative effort between academia, federal agencies and industry partners. A specific objective is to identify the most cost-effective combination of operational *in situ* and remote observing systems that will significantly improve forecast models via deeper understanding of governing physics and data assimilation. UGOS activities related to this objective include, but are not limited to, development of innovative techniques to provide subsurface observations of currents at strategic locations in near-real-time, rapid, adaptive sampling before and during eddy shedding events, as well as strategic deployment of gliders, profiling floats, surface drifters, Remote Ocean Current Imaging System (ROCIS) flights and HF (high-frequency) radar installations.

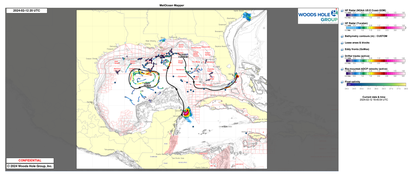
Here we present an overview of the coordinated UGOS observational elements, along with complementary government and industry observing systems, concentrating on deep-water platforms and programs (water depth > 200m). Note that many of the UGOS-funded observational components are not yet operational in the sense that there is not yet a funding stream to sustain them beyond the end of the UGOS program (2027). Over the next few years, we plan to determine which systems provide the most effective forecast improvement and should therefore be the focus of a transition to operational status.



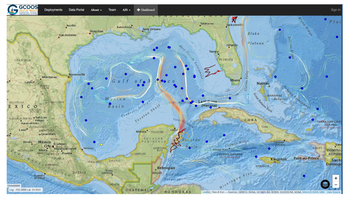
Data Visualization Tools

Data visualization websites are helpful to assess ocean conditions in the Gulf and understand what instrument platforms are active. These sites are updated with real-time data and provide option to layer different data types, with links to the individual datasets. Two example websites are shown to the right.

Woods Hole Group Metocean Mapper: This tool displays industry-funded measurements such as near-surface drifters, vessel ADCP surveys, platform measurements, and surface frontal analyses, combined withpublically available data such as HF RADAR surface velocity fields, Argo temperature, mixed layer depth, and satellite data. *https://www.woodsholegroup.com*



GCOOS Gandalf: Displays current locations of publicly available data from gliders, model-derived surface currents, and Argo float locations. *https://gandalf.gcoos.org/*



MASTR: Mini Adaptive Sampling Test Run

GrASE: Grand Adaptive Sampling Experiment

Observing Systems currently active or planned in the Gulf of Mexico

(* indicates UGOS-funded)

Drifting/Autonomous Platforms

* Profiling Floats ("Argo-equivalent") : 35 UGOS-funded T/S floats are currently parked at 1500m, profiling 0-2000m every five days, mostly in the eastern Gulf.

* EM-APEX Floats. 6 T/S/V profiling floats are being deployed adaptively in Yucatan Strait and eastern Gulf with park depth and profiling range set according to time and geographic location.

* Near-Surface Drifters 25 drogued drifters are being deployed adaptively in Yucatan Strait and eastern Gulf, most recently in Yucatan Straits.

* Gliders: Multiple glider missions are planned as part of adaptive sampling programs; four are currently crisscrossing Yucatan Straits in 90-day missions.

Hurricane Gliders : During hurricane season, about 10-15 gliders—some in deep water—supported by NOAA, NAVOCEANO and others define the essential ocean features in the Gulf that tropical cyclones pass over on their way to landfall.

Eddy Glider Surveys (Mexico/CICESE): Glider surveys of Loop Current eddies are routinely carried out in the western Gulf.

Profiling Floats (NOAA): Two BGC and 4 Core Argo floats currently complement the UGOS-funded profiling float fleet in the Gulf.

Near-surface Drifters: About 10 industry-funded drifters are air-deployed mainly in northern Gulf every 2 weeks.

ALAMO Floats: Up to about 6 are air-deployed in the Gulf annually during hurricane season to rapidly profile the top 300m of the water column along tropical cyclone paths.

Fixed/Moored Platforms

* HF Radar –Radar arrays in Yucatan and Florida Straits continuously provide maps of surface currents in real time at the inlet and outlet of the Gulf.

* Topographic Rossby Wave Antenna: An array of 10 CPIES and ADCP-PIES deployed on the northern slope, combined with Autonomous Surface Vessel (ASV) data harvesting, will provide advance warning of strong currents associated with TRWs to offshore energy interests.

* PIES NRT Transport Array: Array of 5 PIES/bottom pressure sensors across the Yucatan Current with data telemetry to surface buoys will provide near-real-time Loop current transport structure at the inlet to the Gulf.

NDBC (NOAA): Active moored weather buoys.

Moored and rig-fixed current measurements: Mounted on industry infrastructure as part of BOEM Notice to Lessees (NTL) Program; continuous full-water-column current observations.

Moored current and T/S Observations (Mexico/CICESE): Long-standing moored arrays of T/S/V sensors across Yucatan (15 moorings) and Florida (8 moorings) Straits measure hydrographic and current structure of the inflow and outflow currents (full arrays continuously since 2012); (PMEX/CICESE): 7 surface buoys and 11 moorings in western Gulf. (not shown).

Vessel- or Aircraft-Based Platforms

* ROCIS Surveys: Aircraft-based surveys of surface currents along flight path planned adaptively to capture key features of the circulation (eddy pinch-off; cyclonic frontal eddies; LC front and position of current maximum)

VM-ADCP Surveys : industry-funded "on demand" surveys occur when fronts/strong currents are approaching the location of offshore drilling operations.

VOS (ScienceRoCS): Since 2022, commercial vessel Bulk Xaymaca (Pangaea Logistics Solutions) has been transiting from New Orleans through Yucatan Strait and return every 17 days, collecting VM-ADCP and meteorological observations (and more sensors proposed).

Other

Frontal Analysis: Industry-funded daily map of position of 1.5-knot contour based on all available *in situ* and remote sensing observations.

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