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Integrated Interdisciplinary Platforms for the Future

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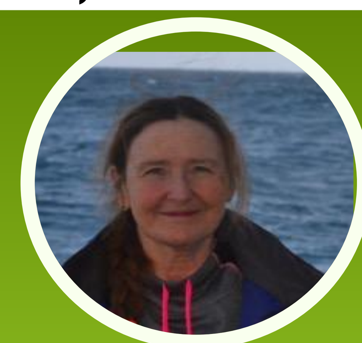

Science RoCS (Science Research on Commercial Ships)
A multi-institution ad-hoc group of scientists, engineers, technicians, ship operations personnel, & data managers partnering with international commercial shippers to transform ocean science

1. The Challenge

Repeat integrated interdisciplinary observations transecting strong currents, crossing the interface between open ocean and shelf regions, and sampling the broad interiors of ocean basins (e.g., Fig 1) are imperative to understanding how oceans are evolving and contributing to our changing climate. **Such observations, however, are difficult and expensive to obtain and maintain.**

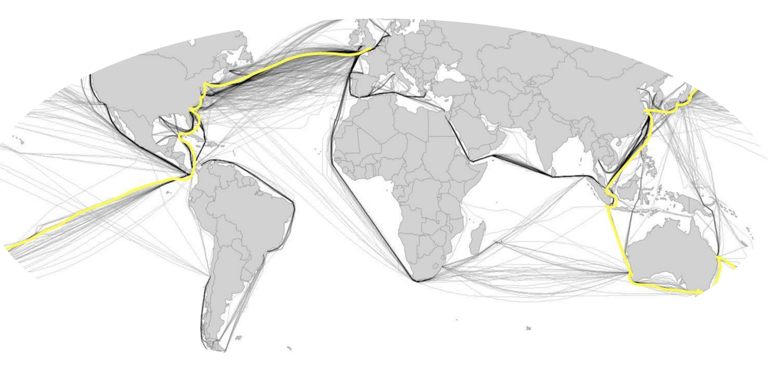

Fig 1a. *Map representing a 6-month period in 2020 of Wallenius-Wilhelmesen ship tracks. Science RoCS facilitated Tysla pCO2 route in yellow. (SMHI Weather Solutions image courtesy of G. Fagerheim)*

NOAA's Voluntary Observing Ship (VOS) program and the GOOS Ship of Opportunity Programme (SOOP) support meteorological weather stations, the global XBT and pCO_2 Networks, and occasionally float and other deployments. **Science RoCS seeks to facilitate the connection between science and industry, to organize individual efforts, and to integrate data sets.**

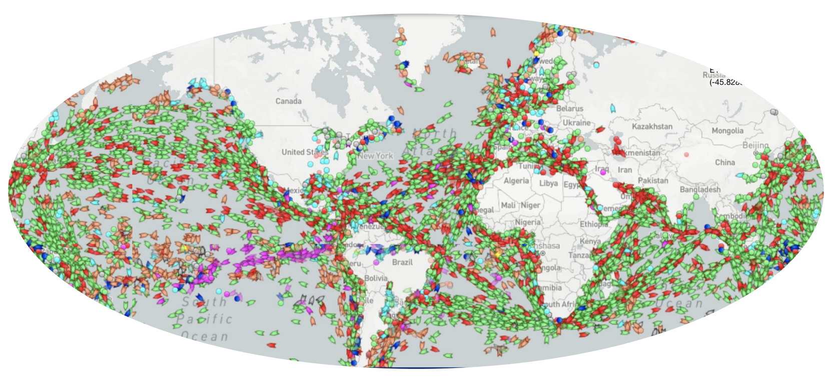

Fig 1b. *April 2023 marinetraffic.com snapshot of vessel locations.*

The 50,000+ commercial ships (e.g., Fig. 1b) in operation around the world today represent a viable underutilized platform - **an opportunity to obtain repeat direct observations of velocity and other parameters in under-observed regions on a scale unapproachable by research vessels.**

2. A Little History

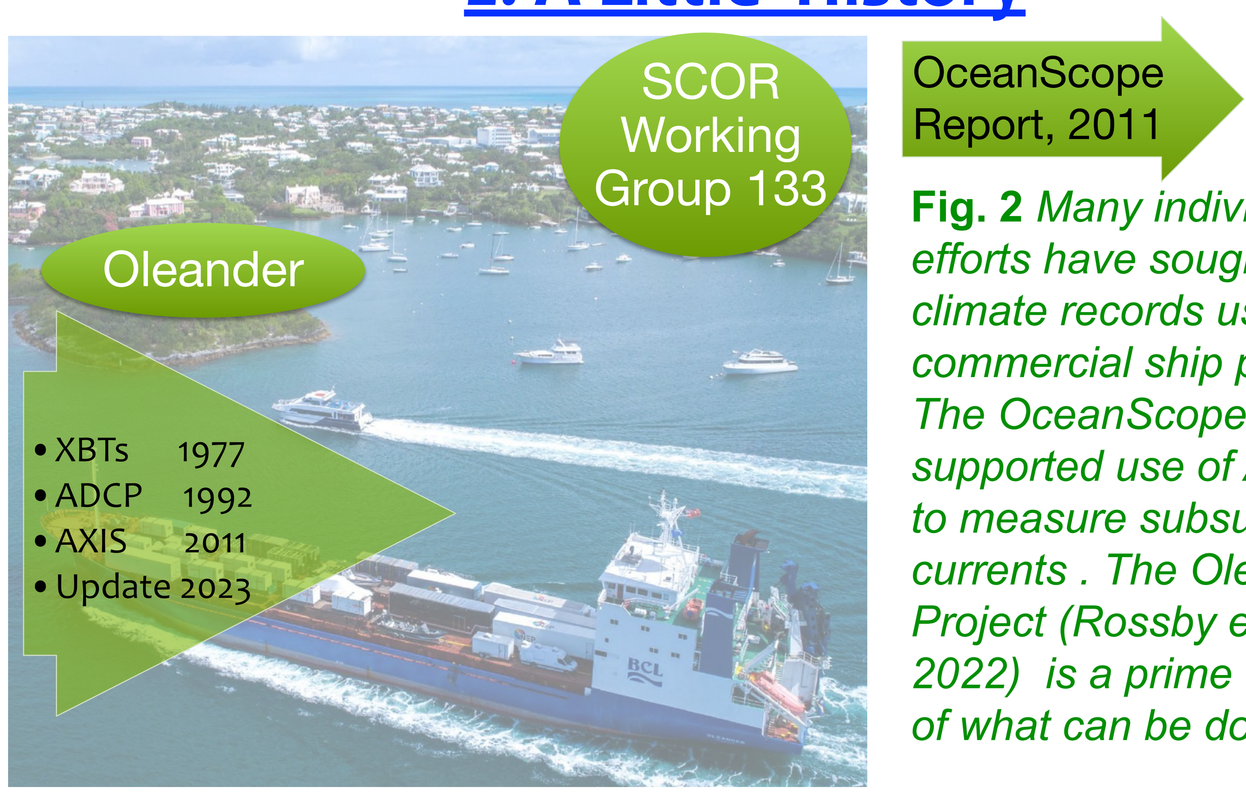

Fig. 2 *Many individual efforts have sought to build climate records using commercial ship platforms. The OceanScope report supported use of ADCPs to measure subsurface currents . The Oleander Project (Rossby et al., 2022) is a prime example of what can be done.*

References

Rossby, T. 2011. OceanScope: A Proposed Partnership Between the Maritime Industries and the Ocean Observing Community to Monitor the Global Ocean Water Column. Report of SCOR/IAPSO Working Group. Paris: SCOR

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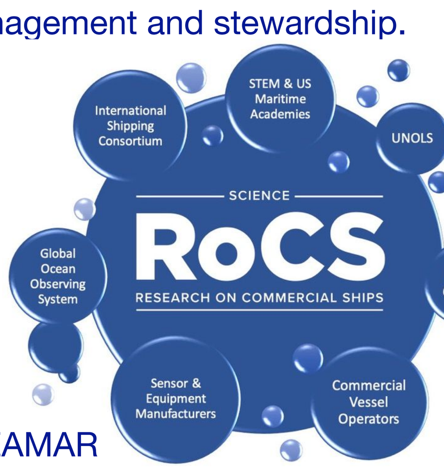

Acknowledgments

We thank personnel at Pangaea Logistic Solutions and SEAMAR for their enthusiasm, assistance & support in making the M/V Bulk Xaymaca our first Science RoCS vessel. Instruments presently installed on the Xaymaca were funded by ONR. Poster effort was partially funded by NSF Grant# OCE-2241601 "*The Oleander Project: High-resolution observations of the dynamic ocean between New Jersey and Bermuda*", WHOI Access-to-the-Sea Grant #RINFHART/SEA EN, & the WHOI Phys. Oceanogr. Department

3. The Vision

We envision a future where commercial vessels are, as a matter of course, designed and built with a suite of atmospheric <u>and</u> oceanographic sensors optimized for a vessel's trade route to address societally-relevant questions, with FAIR data *(Wilkinson 2016)* disseminated broadly amongst stakeholders.

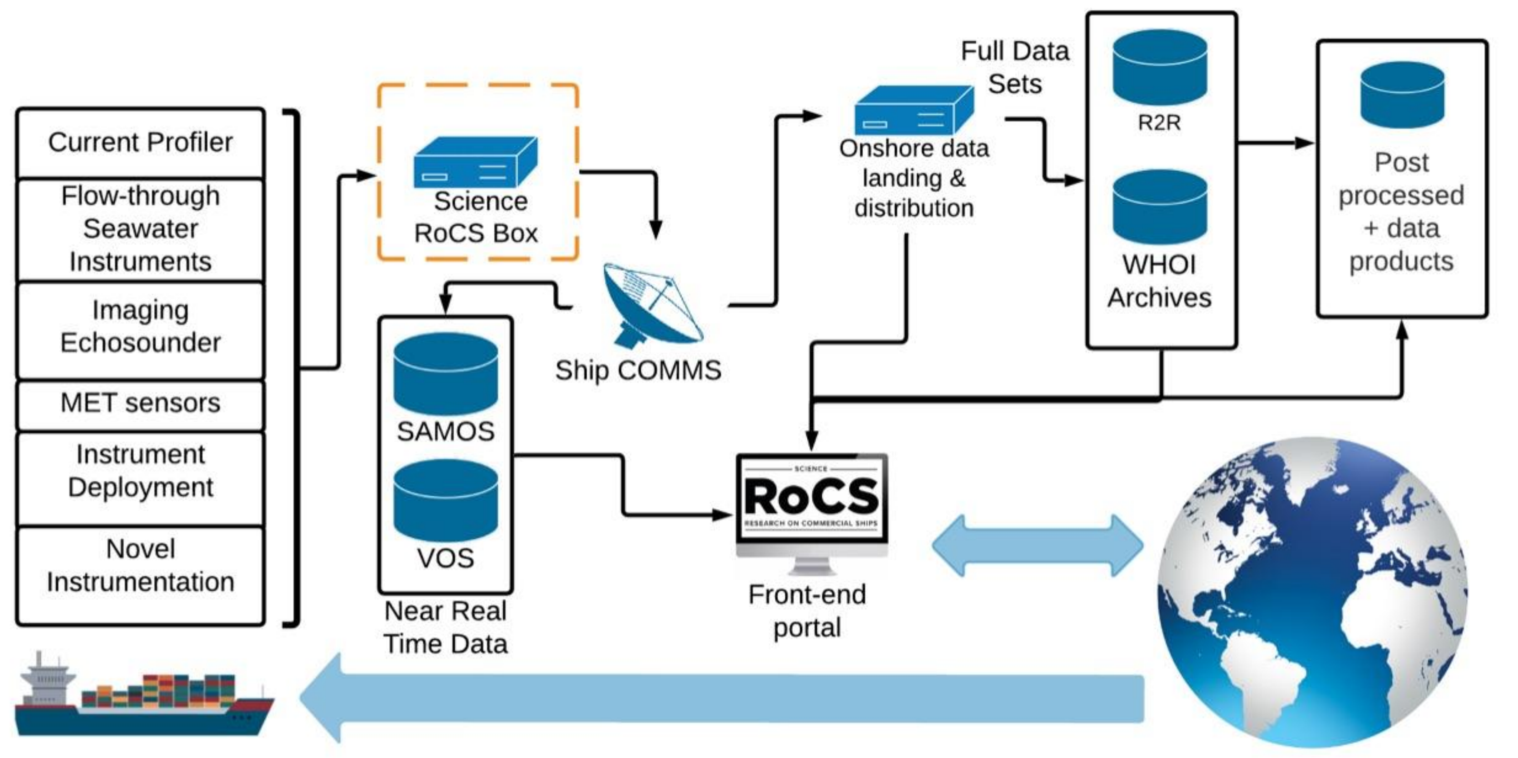

Fig. 3: *Schematic of envisioned Science RoCS flow:* ***from a front- end portal*** *to connect science to vessels & ship owners to science,* ***to integrated data acquisition, to F.A.I.R. data****.*
(Schematic courtesy of R Hudak).

Where <u>science</u> can include process studies, sensor developers & deployers, modelers, forecasters, emergency responders, those without access to research vessels, etc.

Benefits: increased access to interdisciplinary ocean-atmosphere sensors hosted on commercial ships to monitor, investigate, and mitigate the impacts of our changing climate; reduced fuel costs; and enhanced risk management for ships and society through improved weather and climate monitoring & prediction.

4. Science RoCS Today

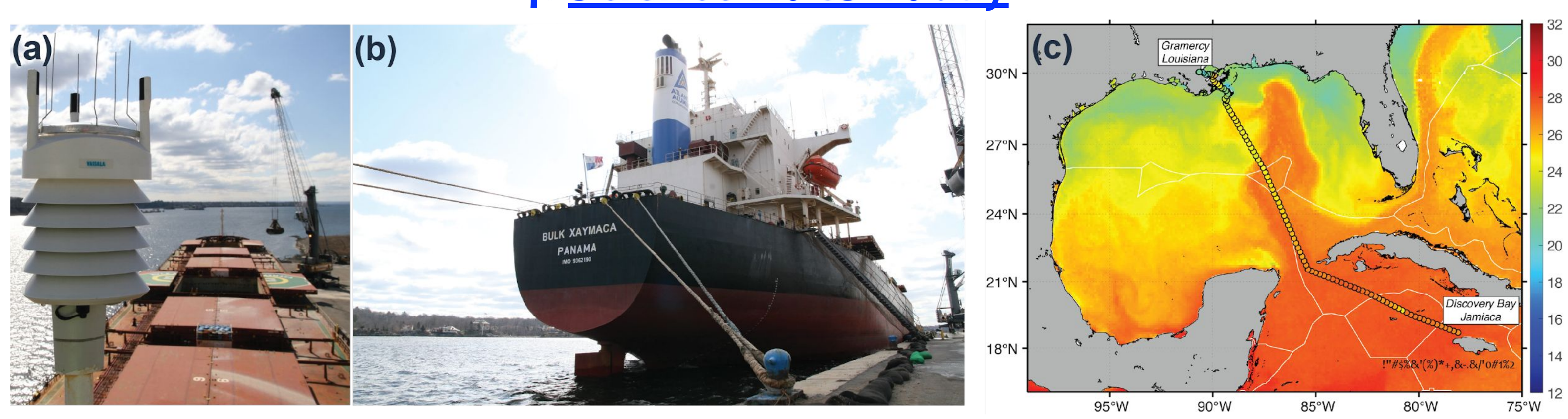

Fig. 4: ***a)*** *Xaymaca's Vaisala WXT-536 transmitting NRT data;* ***b)*** *M/V Xaymaca;* ***c)*** *CMEMS sea surface temperature (4-day average: April 20-24, 2022) with Xaymaca's NRT in situ air temperature along the ship track superimposed*

In January of 2021, a Vaisala weather station (Fig. 4a) and 75 KHz ADCP were install on the Pangaea Logistical Systems Ltd. vessel M/V Bulk Xaymaca (Fig 4b) running a roundtrip between Jamaica and New Orleans about every 3 weeks (Fig 4c).

5. M/V Xaymaca Observes Recent Loop Current Eddy Shedding

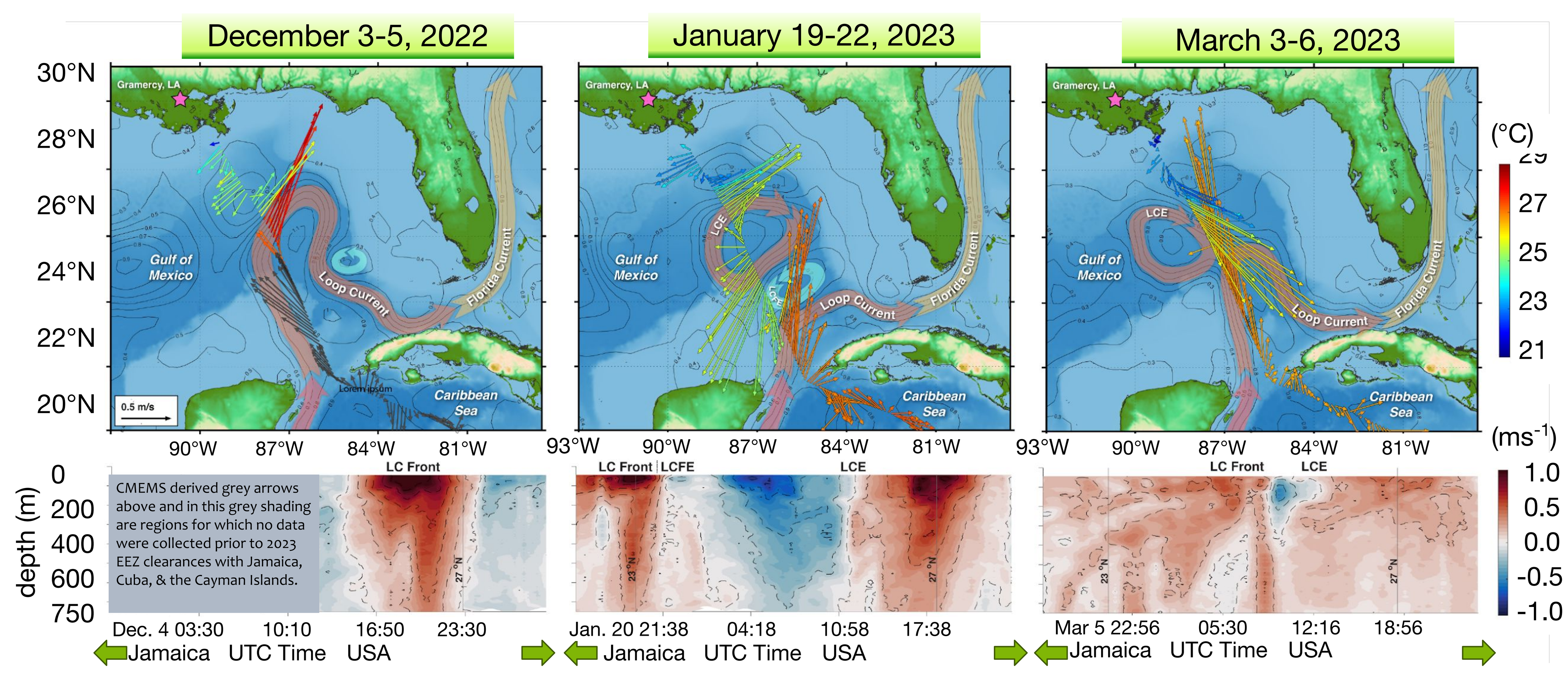

Fig. 5: ***SADCP engineering data****. Top:* ***vertically-averaged*** *(45-61 m)* ***ocean velocity*** *and near-surface temperature (colored arrows) in 40-minute intervals superimposed on SSH from CMEMS Copernicus sea level altimetry (black contours, m). Bottom:* ***cross-track velocity*** *(relative to ship) blue to red colors. Positive values indicate flow towards starboard on these USA bound transits. SADCP data collection and shipboard processing provided by UHDAS, University of Hawaii. Velocities to be further improved once an inertial navigation system is installed.*