

S-MODE Science Report: April 3-16, 2023

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Science Highlights:

The Sacramento River is more than 15 feet above its normal level right now, a level only exceeded once in the last 15 years (in 2017), which has contributed to the existence of a large pool of cool, fresh water offshore of San Francisco. This cool, fresh, high-chlorophyll water is being pulled westward through the S-MODE domain by the large-scale currents; an oceanic front has developed, and there is a long “train” of submesoscale eddies spread across our operations area (see plot below). We are currently beginning intensive sampling of the eddy that is just east of 124°W. This situation is perfect for addressing S-MODE goals!

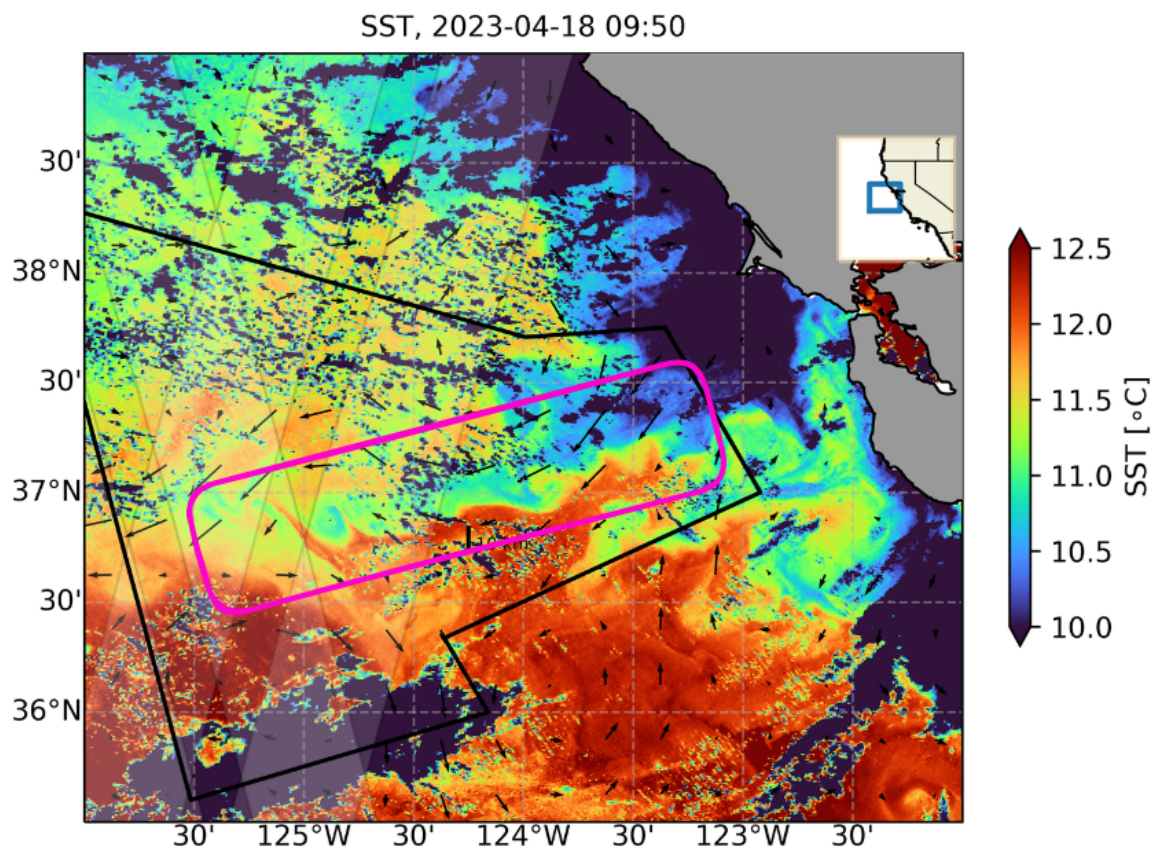


Figure 1: Sea surface temperature on the morning of April 18, with the S-MODE operations area indicated by a black polygon and the region of current focus indicated by a pink square. All three aircraft have been flying, and nine wave gliders, ten gliders, and ten floats have been deployed. SWOT is in orbit and is sampling most of the S-MODE study region at least once per day (faint swaths crossing western portion of the S-MODE operations area).

DopplerScatt (PI: Dragana Perkovic-Martin, JPL), MOSES (PI: Jeroen Molemaker, UCLA)

The Armstrong Flight Research Center (AFRC) King Air B200 aircraft (NASA801) transited to Moffett Field on April 5th and completed its first science flight on April 6th with DopplerScatt operators in tow. During the first science flight, only the DopplerScatt instrument was collecting data as the cloud cover did not allow for optical data collections by the UCLA IR sensor (MOSES) onboard the aircraft. Subsequent science flights have also included MOSES data collections. The team has completed 11 successful research flights over 46 hours of data collection in this period.



Figure 2: Air, ground and DopplerScatt operators after the first IOP-2 science collection left to right: Ruzbeh Akbar (334C), Alexander Wineteer (334D), Jeff Borton (AFRC), Tracy Phelps (AFRC), Roy Johnson (ARC), Mario Soto (AFRC), Leroy Marsh (AFRC), Randy Hobbs (ARC), bottom row: Thomas Lynn (ARC) and Joseph Piotrowski (AFRC).

As demonstrated in the IOP-1 field campaign, the DopplerScatt data processing duo of Ernesto Rodriguez and Alex Wineteer are producing surface velocity maps of the ops area within a few hours of the flight. The quick-look images are being used by the broader science team to target features of interest for the ship, which arrived on scene on April 10th, and in water autonomous vehicles. In the absence of visible satellite imagery, due to the thick cloud cover over the experiment area, DopplerScatt has provided invaluable insight into the “big picture” of the ocean circulation and helped interpret the in-situ results and better target the features of interest.

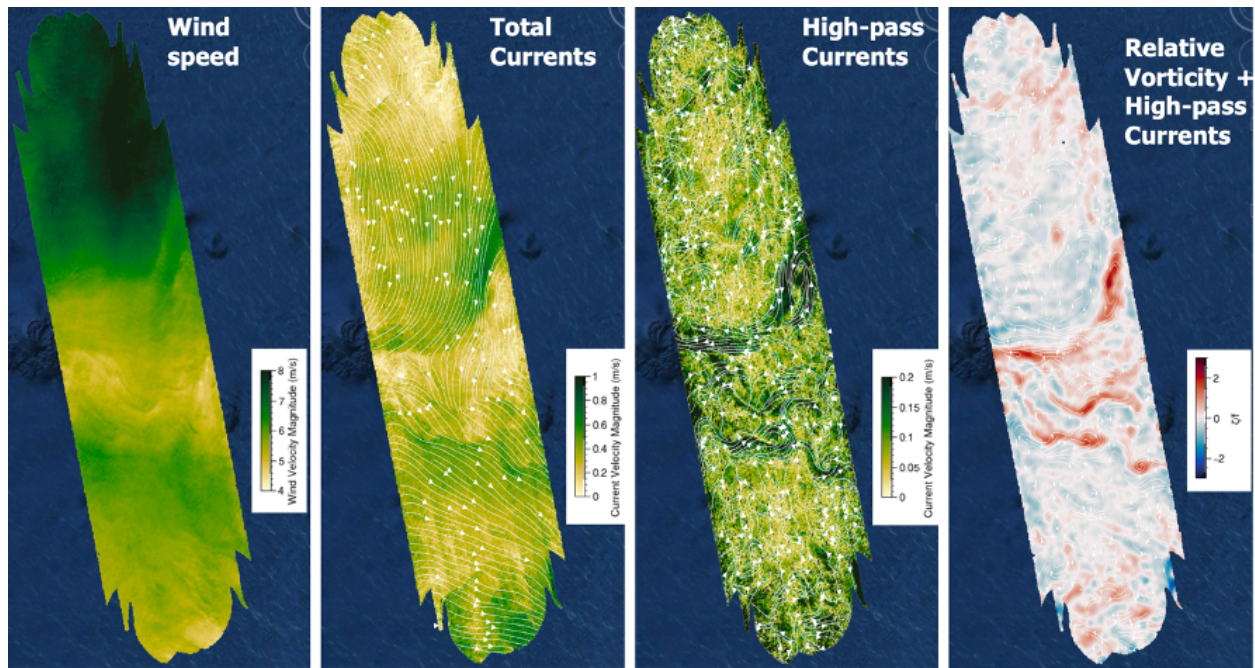


Figure 3: Quick-look images of DopplerScatt data collected during the April 6th science flight.

R/V Sally Ride (Chief Scientist: Andrey Shcherbina, UW)

R/V Sally Ride spent the first week of the S-MODE IOP-2 field campaign surveying the area for interesting submesoscale features. We have used underway instrumentation in conjunction with the towed CTD profilers (EcoCTD and Moving Vessel Profiler, MVP) to map the velocity, thermohaline, and biogeochemical variations associated with outflow of cold, fresh, nutrient- and chlorophyll-rich coastal waters. We have also deployed 10 NAVO APEX floats, 2 Seagliders, a Wave Glider, and about 40 surface drifters. These instruments are now joining the constellation of multiple autonomous platforms that form our growing distributed observing system in the region.

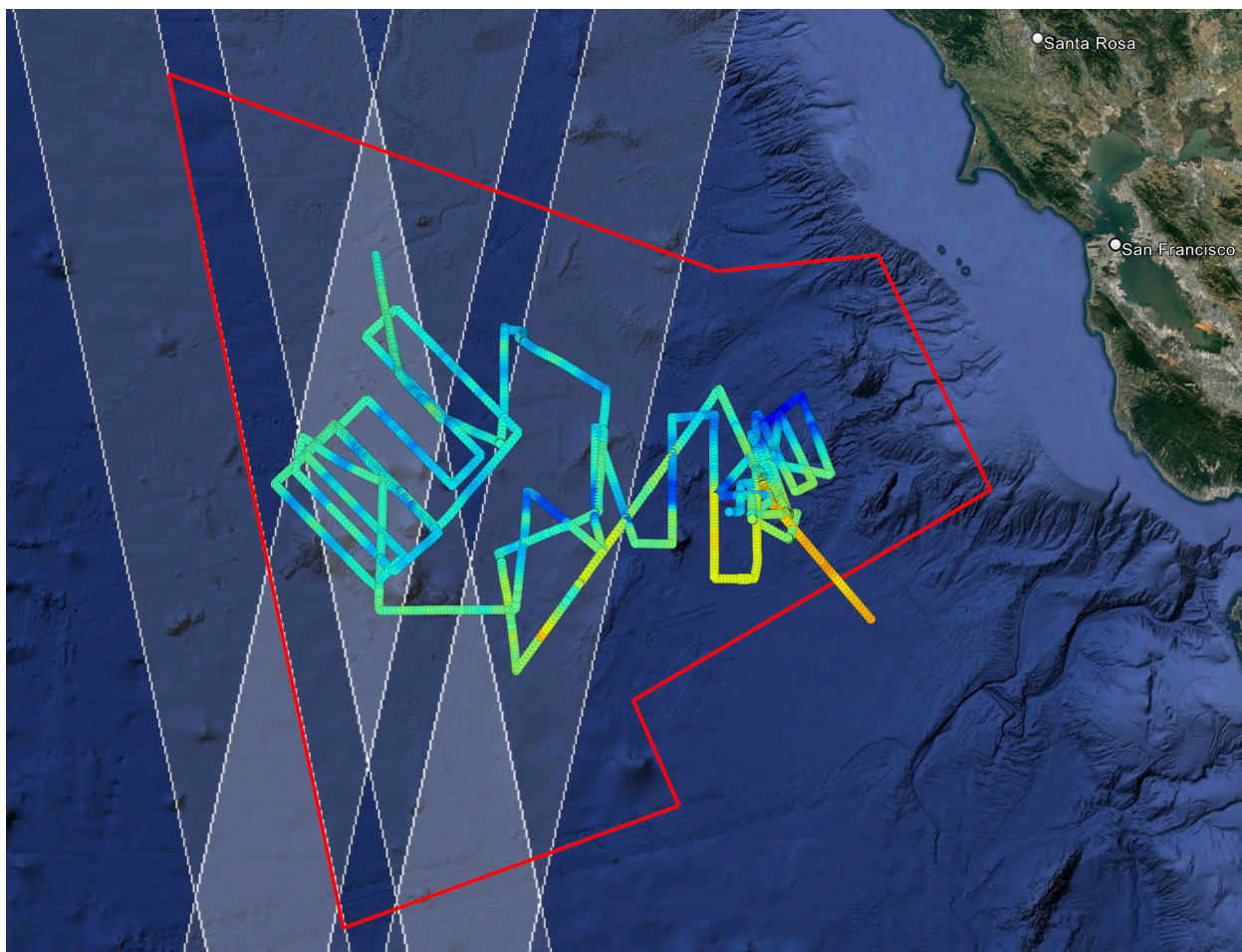


Figure 4. R/V Sally Ride track over the period of April 11–18, 2023, color coded by sea surface temperature. Red polygon shows the nominal extent of S-MODE IOP-2 operations area 100–300 km off San Francisco, CA. Grey shading shows the surface tracks of KaRIn swath altimeter onboard NASA Surface Water and Ocean Topography (SWOT) satellite.

MASS (PI: Luc Lenain, Scripps)

The MASS instrument was installed from April 4-5, 2023 in Grand Junction, CO on a Twin Otter International DHC-6 aircraft equipped with additional fuel tanks to extend the flight duration to 7+ hours. The aircraft arrived the next day in Monterey Airport (KMRY), its base of operations. So far, all components of the MASS instrument have been working well, with no technical problems to report. Despite persistent cloud layers, the MASS instrumented aircraft was able to fly under the cloud base to provide optical observations otherwise unavailable from orbital platforms and higher altitude flying aircraft.

To date, the Twin Otter has conducted six successful research flights.



Figure 5: The Twin Otter pilots (left) and Luke Colosi, UCSD/SIO graduate student and one of the MASS operators during the experiment at Monterey Airport on April 18, 2023.

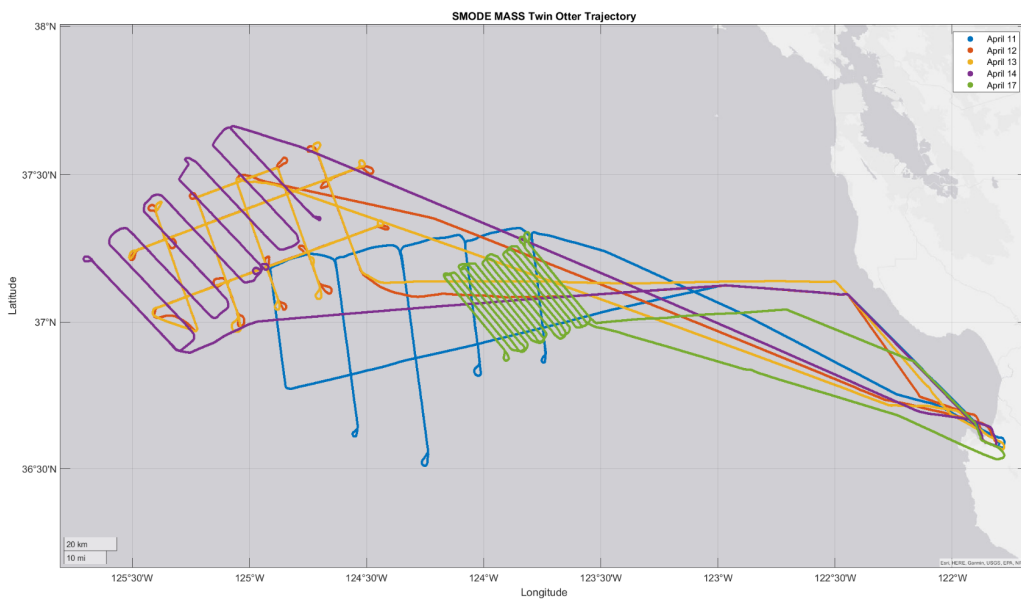


Figure 6: MASS Twin Otter flight tracks - Note, the trajectories on Apr 12, 2023 and Apr 13, 2023 were identical.

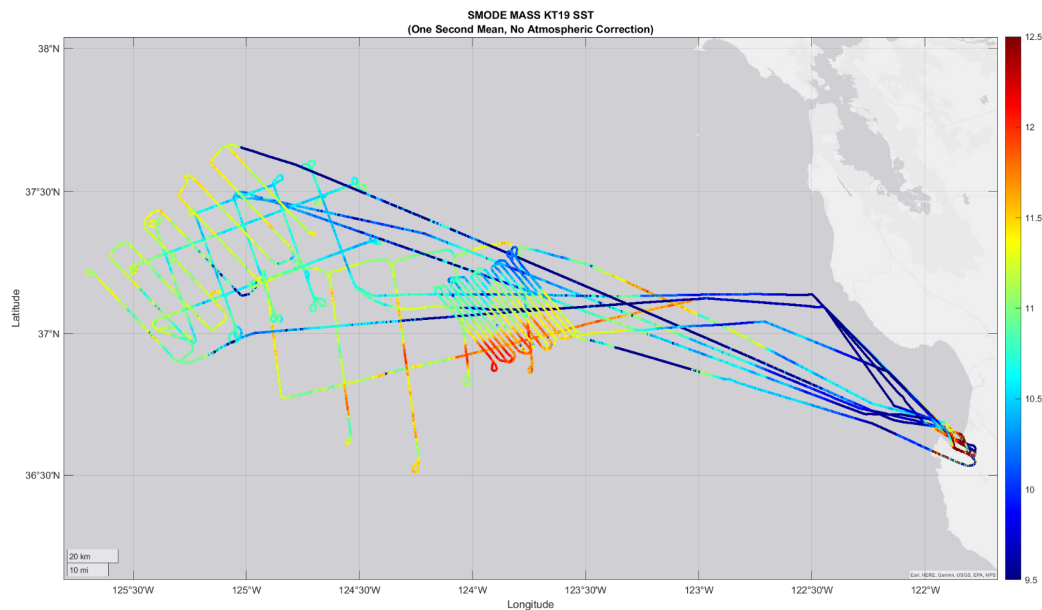


Figure 7: Same as previous figure, this time color coded for real-time, along-track sea surface temperature product. Disregard transit data as they were flown above clouds during most flights.

PRISM (PI: David Thompson, JPL)

The NASA LaRC G-III (NASA 520) arrived on scene on April 10th and completed the first PRISM data collection on April 11th together with the two other airborne assets. To date, the G-III has conducted three successful research flights with 12 hours of data collected.



Figure 8: G-III crew and PRISM operators following the first successful collection of PRISM data, left to right: Brian Baxley (LaRC), Jeff Sherwood (LaRC), Holly Bender (JPL), Eric Brunner (JPL), Greg Slover (LaRC), Ronald Nason (LaRC), Matt Brame (LaRC)

Wave Gliders (PIs: Tom Farrar, WHOI; Luc Lenain, Scripps)

All nine of the Scripps and WHOI Wave Gliders are deployed and have been helping to survey the S-MODE operations area. The Wave Gliders are currently converging on the submesoscale eddy that will be the focus of sampling for the next few days.



Figure 9: WHOI's Ben Hodges (left) and Scripps' Evan Harris (right) leaving Santa Cruz aboard the MV Shana Rae for Wave Glider deployments. (Photo credit: Luke Colosi, Scripps)

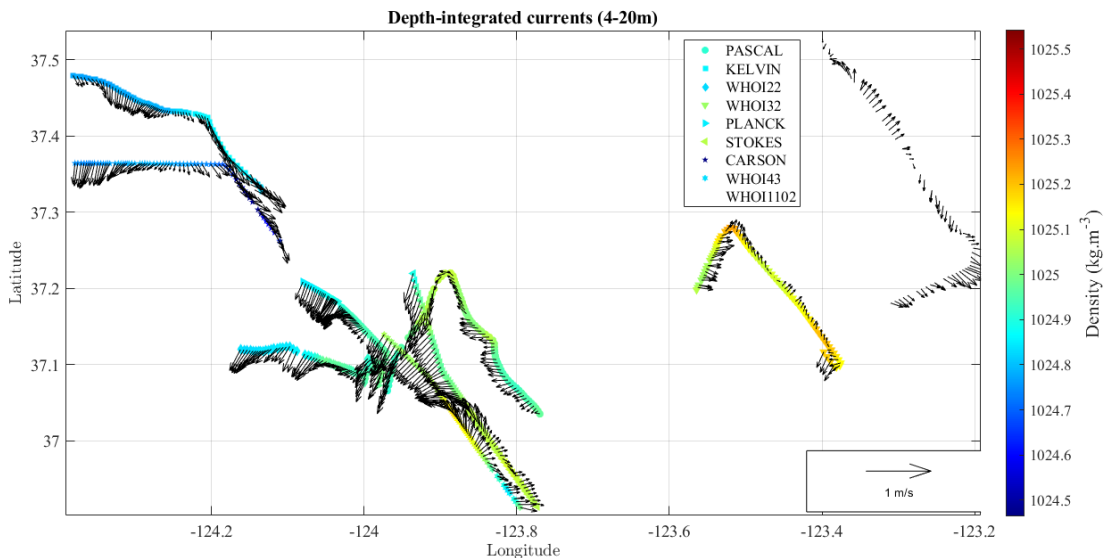


Figure 10: Example of surface density and depth-averaged observations collected from the fleet of instrumented wave gliders as they approach a small eddy on Apr 18, 2023 .

Seagliders (PI: Luc Rainville, UW)

Four UW Seagliders have been operating since early March collecting mesoscale data, which helps the science team put the smaller scale ocean physics data into broader context. These four gliders continue running survey lines in the western portion of the S-MODE operations area. Recently, two additional Seagliders were deployed from the Sally Ride and will operate in proximity to the ship and the autonomous platforms in the train of eddies shown in Figure 1.

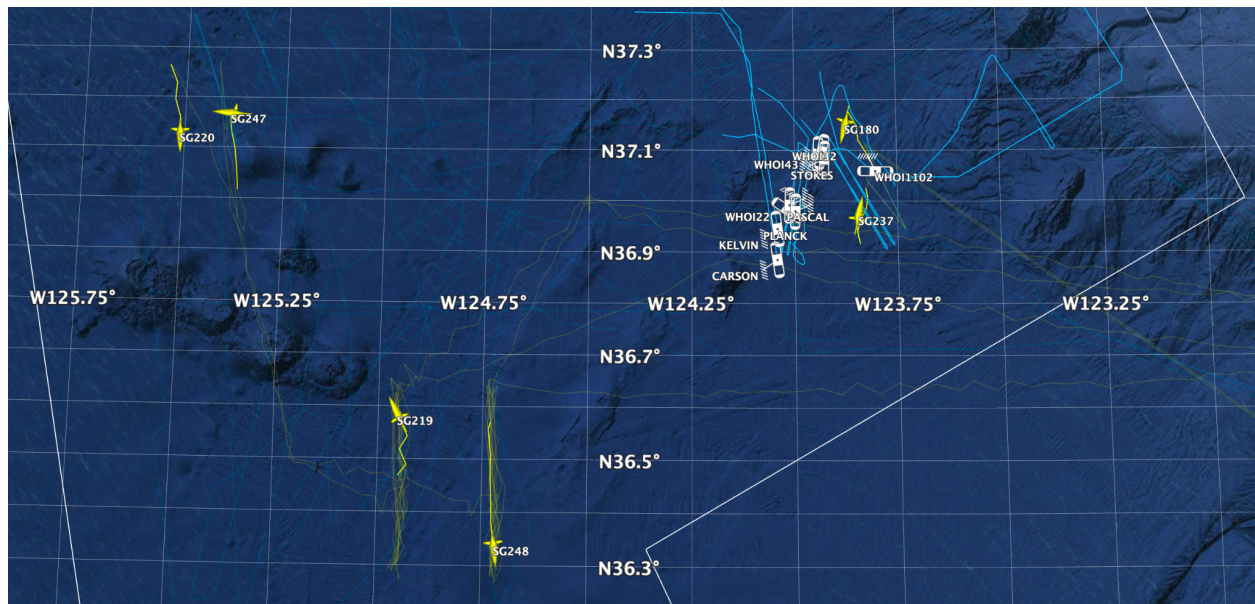


Figure 11: A snapshot of the center portion of the S-MODE operations area as of Apr 18, 2023. The UW Seagliders are represented by the yellow icons.