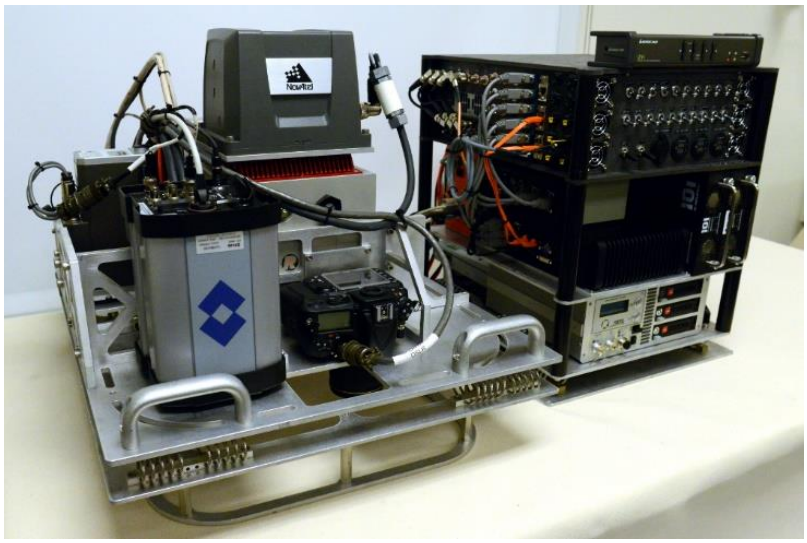
Modular Aerial Sensing System (MASS)

by the Air-Sea Interaction Laboratory at Scripps Institution of Oceanography

The MASS is a portable package of high-resolution instrumentation that is built specifically for airborne remote sensing applications. Instrumentation includes an airborne topographic lidar integrated with video, infrared, and hyperspectral imaging systems. The system is coupled to a highly accurate GNSS-aided inertial measurement unit, permitting airborne measurements of the sea surface displacement, temperature, and kinematics.

These data are used to measure ocean waves, currents, Stokes drift, sea surface height (SSH), ocean transport and dispersion, and biological activity. Hydrological and terrestrial applications include measurements of snow cover, sand erosion, and the built environment.

The MASS has over 600 hours of accumulated flight time over the course of over 20 different field campaigns and has been installed on Gulfstream V, DHC-6 Twin Otter, Partenavia P-68, and Cessna 206 fixed wing aircrafts as well as on a Bell 206 helicopter.



MASS instrument package (left) and acquisition rack (right).

MASS monitor stand (left), instrument package (center) and acquisition rack (right) as installed on a Partenavia P68.

Modified MASS instrument payload packages installed on the underside of a NASA Gulfstream V fuselage.

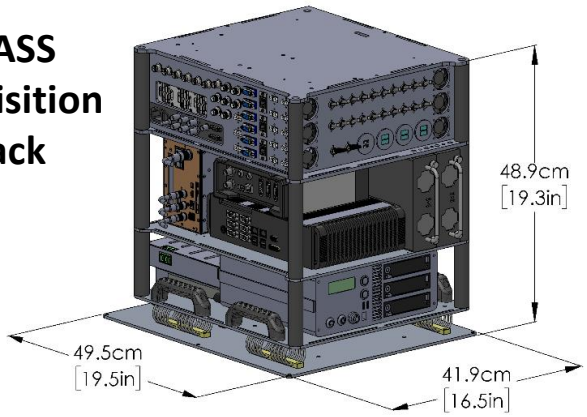
Selection of Previous MASS Fieldwork Campaigns:

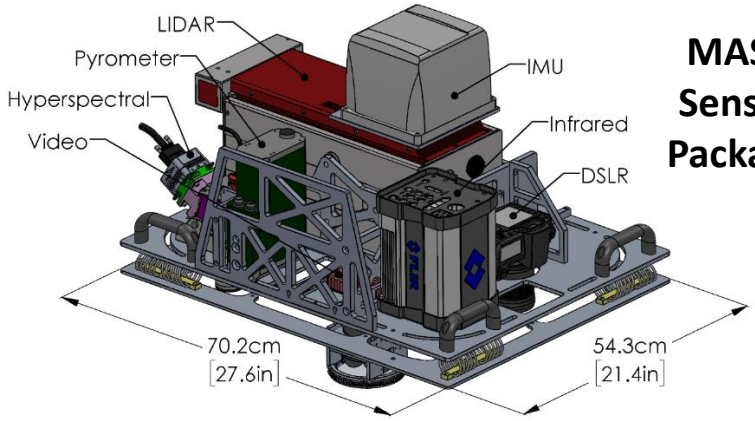
- Pioneer Array Experiment, 2018, mid-Atlantic waters
- DopplerSCAT Field Testing, 2018, Monterey Bay, CA
- Environmental Security Technology Certification Program, 2017/18, San Clemente Island, CA and Kaneohe Bay, HI
- Langmuir Cell Department Research Initiative, 2016/17, Channel Islands, CA
- Gulf of Mexico Research Consortium, 2016/17, Gulf of Mexico
- Consortium for Advanced Research on Transport of Hydrocarbon in the Environment, 2016, Gulf of Mexico
- Innershelf Department Research Initiative, 2015/17, Point Sal, CA
- El Nino Coastline Surveys, 2015/16, California coast
- Cross Surfzone/Inner-shelf Dye Exchange, 2015, Imperial Beach, CA
- AirSWOT Calibration/Validation, 2015, Monterey, CA
- Environmental and Ship Motion Forecasting, 2013, Channel Islands, CA
- New River Inlet Experiment, 2012, New River, NC
- Gulf of Mexico Experiment, 2011, Gulf of Mexico
- Sierra Snow Survey, 2010, Sierra Mountains, CA

MASS Technical Refererence: Melville, W. K., et al 2016: The Modular Aerial Sensing System. *Journal of Atmospheric and Oceanic Technology*, **33**, 1169-1184.

Specifications	Standard Configuration*
Weight	55 kg (120 lbs) instrument package, 50 kg (110 lbs) acquisition rack
Dimensions	70.2 cm x 54.3 cm x 54.0 cm tall (27.6” x 21.4” x 21.3”) instrument package with 44.0 cm (17.4”) height above the floor, 49.5 cm x 41.9 cm x 48.9 cm tall (19.5” x 16.5” x 19.3”) acquisition rack
Power Input	550 W power draw with 22-30 VDC or 110 VAC input

MASS Acquisition Rack





MASS Sensor Package

Instrument List*	Description
Riegl LMS-Q680i Lidar	Waveform scanning lidar with 1550 nm laser source with up to 400 khz pulse repetition rate (PRR) and up to 200 hz line scan rate (LSR).
Specim AISA Kestrel 10 Hyperspectral Camera	Pushbroom imager operating in the 400-1000 nm spectral range at up to 100 hz (80 hz typical) frame rate and 1024 pixel resolution.
FLIR SC6700 (or SC6000) Longwave Infrared Camera	640 x 512 resolution imagery at up to 125 hz (50 hz typical) frame rate in the 7.5-9.5 µm (8.0-9.2 µm, SC6000) spectral range with 15 µm (25 µm, SC6000) detector pitch.
Novatel SPAN LN200 GPS-IMU	200 hz output tactical grade IMU with fiber optic gyros and solid state accelerometers, PwrPak7 GPS receiver with 555 channels and tracking for all available constellations.
IO Industries Flare 12M125 Video Camera	4096 x 3072 resolution 10 bit imagery at up to 100 hz (5 hz typical) frame rate in either monochrome or color format.
Nikon D810 DSLR Camera	7360 x 4912 resolution 14 bit imagery at 1/4 hz (typical) frame rate, synchronized with lidar acquisition for point cloud colorization.
Heitronics KT19.85 II Infrared Radiation Pyrometer	30 hz (typical) point measurement in 9.6-11.5 µm spectral range with 30 msec response time (typical) and 0.01° C temperature resolution.

Instrument Field of View* (Cross x Along Track Angle)	Swath Width at 3000 ft (915 m) Altitude (function of Alt)	Data Resolution (Cross x Along Track) at 3000 ft (915 m) Altitude and 120 knots (62 m/s) Ground Speed
Lidar (60° line scan)	1.05 km (1.15 x altitude)*	50 cm x 50 cm (at 400 khz PRR, 125 hz LSR)
Hyperspectral (40° line image)	0.67 km (0.74 x altitude)	66 cm x 66 cm (at 94 hz frame rate)
LWIR (41° x 33°, SC6700)	0.68 km (0.74 x altitude)	1.06 m x 1.06 m
LWIR (63° x 52°, SC6000)	1.13 km (1.23 x altitude)	1.76 m x 1.76 m
Video Imagery (78° x 62°)	1.47 km (1.61 x altitude)	36 cm x 36 cm
DSLR Imagery (65° x 46°)	1.17 km (1.28 x altitude)	16 cm x 16 cm

*Standard configuration specifications, instrument package list, select sensor settings and mounting options can be modified for the platform or application. The field of view value is shown with standard available lenses. The *effective* lidar swath width and return rate over the ocean is sea state dependent and actually less than the theoretical value over terrestrial targets that is shown.