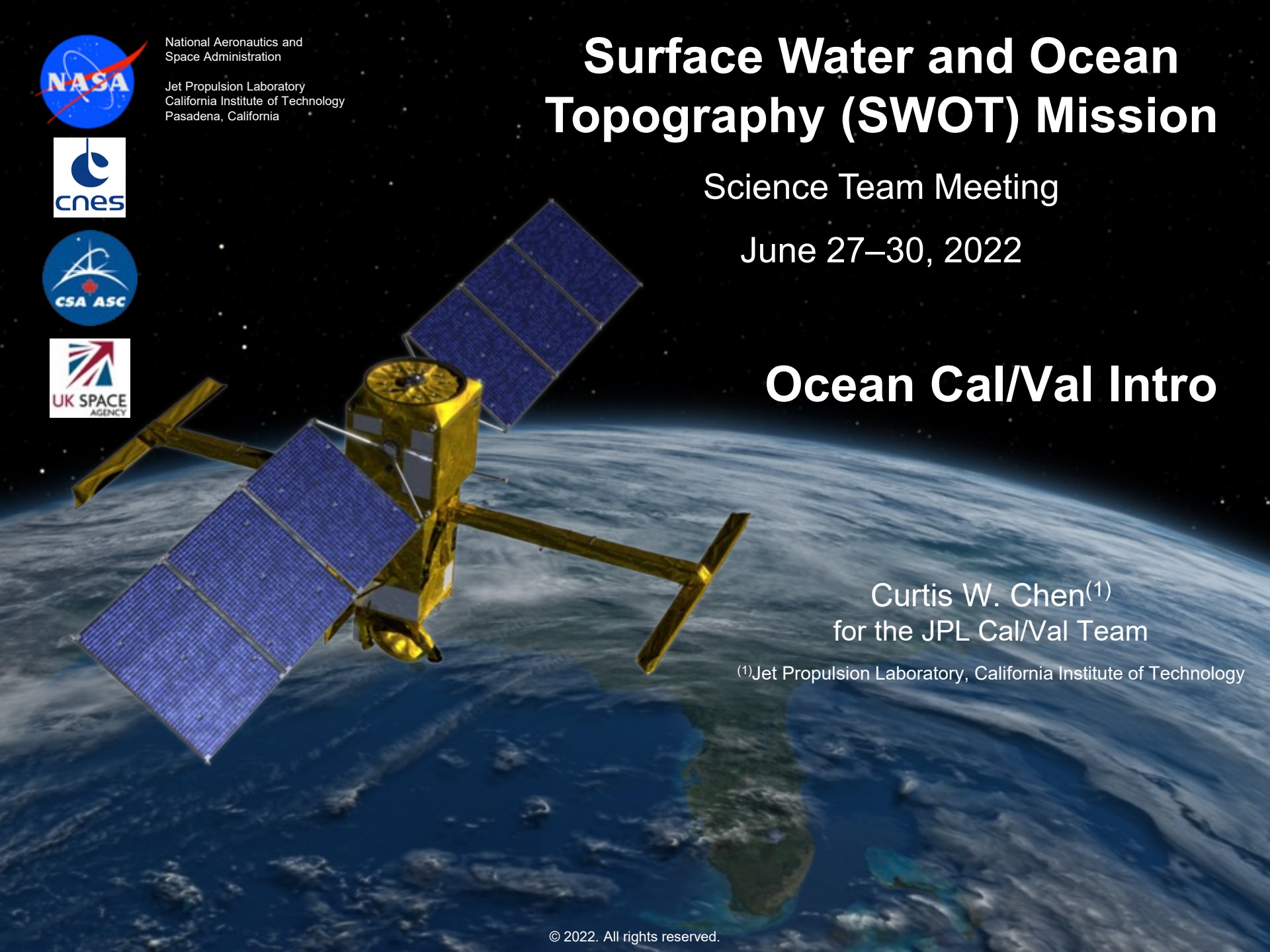

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Surface Water and Ocean Topography (SWOT) Mission

Science Team Meeting

June 27–30, 2022

Ocean Cal/Val Intro

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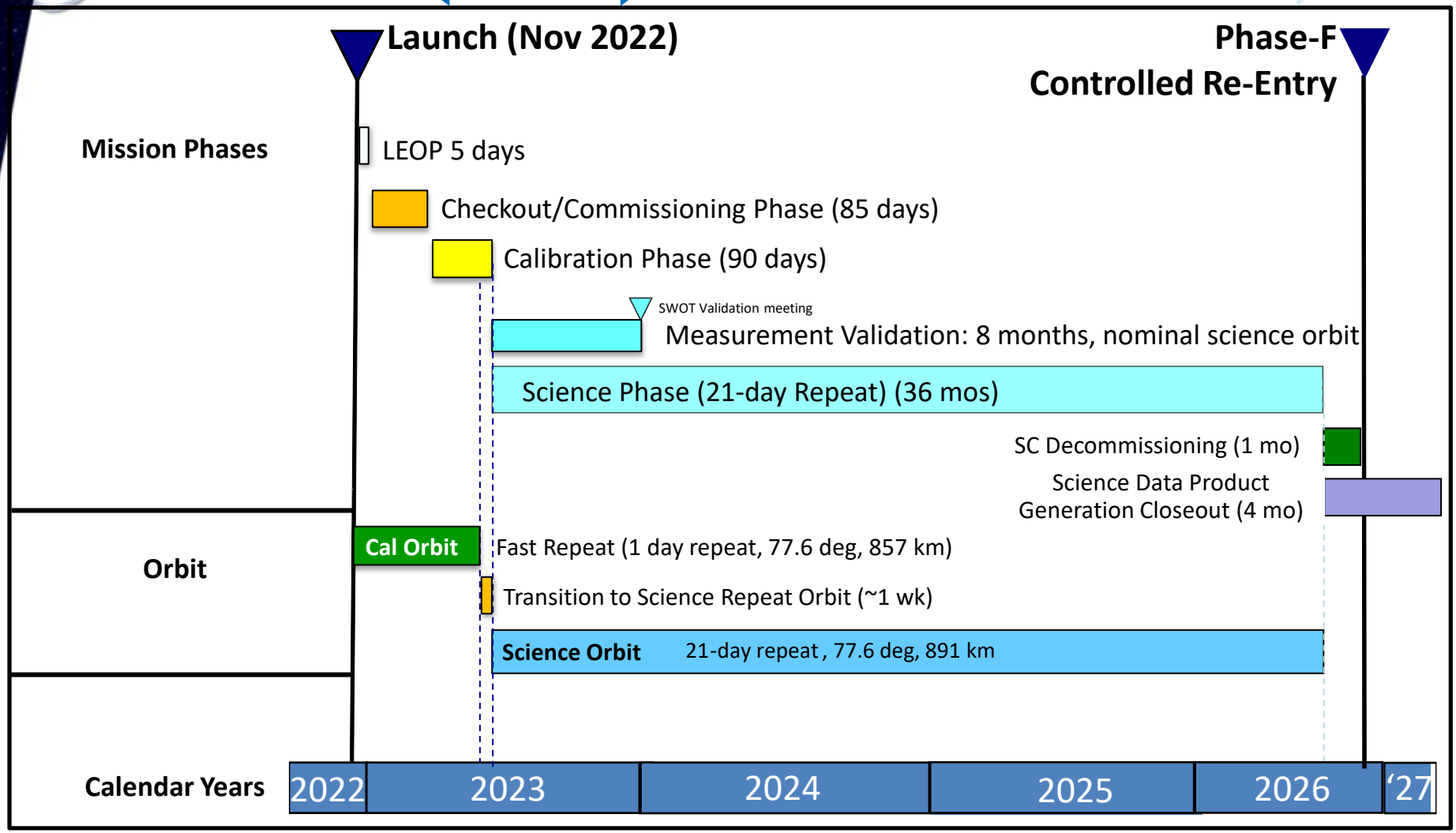
Cal/Val Objectives

- Basic objectives of Cal/Val[1]:
  - Calibration: Estimate calibration parameters for ground processing based on flight data
  - Error budget validation: Validate measurement performance ("*Does system behave as expected, and if not, what can/should we do?*")
  - Data product validation: Validate measurement with respect to high-level requirements ("*Does performance meet mission success criteria?*")
- Different sources of data may be useful for different Cal/Val objectives
  - Direct measurements of quantities related to SWOT measurement physics may best demonstrate that measurement performance is as expected—or enable diagnosis of problems if measurement performance is not as expected
  - Direct measurements of quantities of oceanographic science interest may best establish link between SWOT measurements and science objectives underlying SWOT requirements

[1] SWOT Cal/Val Plan, Sects. 1.2-1.3

Mission Phases/Timeline



Ocean and Hydro Cal/Val Relationships

- Calibration is in general split between instruments (KaRIn, AMR, etc.), not between ocean and hydro
  - Hydrology slope requirement drives phase screen calibration accuracy, but phase screen is likely to be calibrated with ocean data
- Crossover/operational calibration is area of direct overlap between ocean and hydro measurements
- Error budget validation involves overlap between ocean and hydro Cal/Val where objective is to validate fundamental measurement physics shared by ocean and hydro measurements
- Corner reflector deployment is bookkept as part of hydro Cal/Val budget but affects both hydro and ocean data
- **Ocean and hydro Cal/Val are not independent**

Timeline of US Ocean Cal/Val Plans

- Mid 2017: Monterey Bay experiment (in situ hydrographic, GPS collection)
- Mid 2018: Peer review of plans for pre-launch in situ campaign
- Mid 2019: Execute pre-launch MASS (lidar) campaign on Gulfstream V aircraft
- Late 2019: Execute pre-launch in situ experiment at CA crossover site
- Mid 2020: In situ key point
- Early 2021: Incorporate in situ campaign into SWOT US Cal/Val baseline
- Late 2021: MASS peer review
- Early 2022: Incorporate MASS into SWOT US Cal/Val baseline
- Late 2022: Solidify details of post-launch Cal/Val plans
- Early 2023 (L+3 months to L+6 months): Post launch Cal/Val data collection at California crossover site; KaRIn calibration and anomaly resolution
- Mid-late 2023 (L+6 to L+14 months): Continuing anomaly resolution, validation, and refinement

Cal/Val Data Priorities

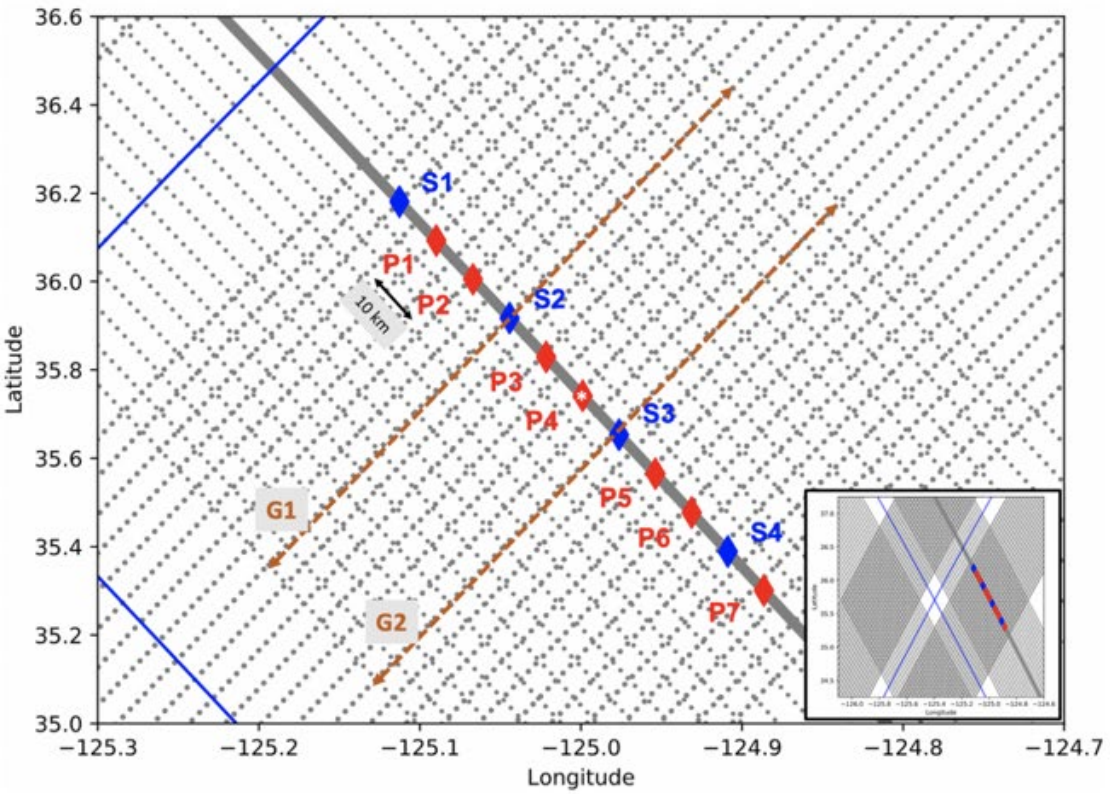
- Why we need external Cal/Val data:
  - **Gain insight into what to do if (when) SWOT results do not behave as expected**
  - Solve for calibration parameters
  - Demonstrate that SWOT is meeting its requirements
- Spatially distributed SSH data is key for ocean Cal/Val:
  - SWOT spectral requirements are necessarily spatial in nature
  - 2-D spatial measurement of SSH is most novel and most challenging aspect of SWOT
- Ideal ocean Cal/Val measurement would simply be idealized version of SWOT:
  - 2-D spatial measurements of SSH over scales comparable to SWOT measurement *O*(100 km x 100 km), or as close to this as possible (at least 1-D, not just individual points)
  - Height accuracy on par with or better than SWOT requirements
  - Contemporaneous with SWOT passes
  - Aligned with SWOT swath (along-track for spectral validation, cross-track for calibration and engineering validation)
  - For engineering validation:
    - Measurement of physical SSH in absolute Earth frame for direct comparison to SWOT measurements
  - Other considerations:
    - Flexibility and adaptability to deal with surprises, which we expect
    - Robustness to weather, logistics, etc.
    - Cost
- Additional high-priority information:
  - Directional wave spectra measured over 2-D area, coincident with SSH measurements
  - High-resolution, 2-D estimates of Ka-band radar reflectivity would be very helpful, too

US In Situ Ocean Plans

SWOT postlaunch in-situ campaign instrumentation
California site baseline

Tag	Instrument	Coordinate (Lat, Lon)
S1	Deep mooring	36.181, -125.113 (234.887)
P1	Prawler	36.093, -125.090 (234.910)
P2	Prawler	36.005, -125.067 (234.933)
S2	Deep mooring	35.917, -125.044 (234.956)
P3	Prawler	35.829, -125.022 (234.978)
P4	Prawler, barometer	35.741, -124.999 (235.001)
S3	Deep mooring	35.653, -124.976 (235.024)
P5	Prawler	35.565, -124.954 (235.046)
P6	Prawler	35.477, -124.931 (235.069)
S4	Deep mooring	35.389, -124.909 (235.091)
P7	Prawler	35.301, -124.886 (235.114)
G1	Glider	TBD
G2	Glider	TBD

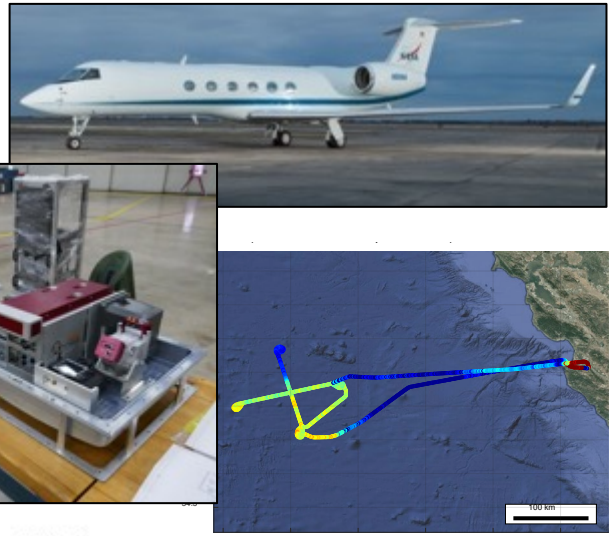
Last update: 8/20/2021
Contact: Jinbo.Wang@jpl.nasa.gov

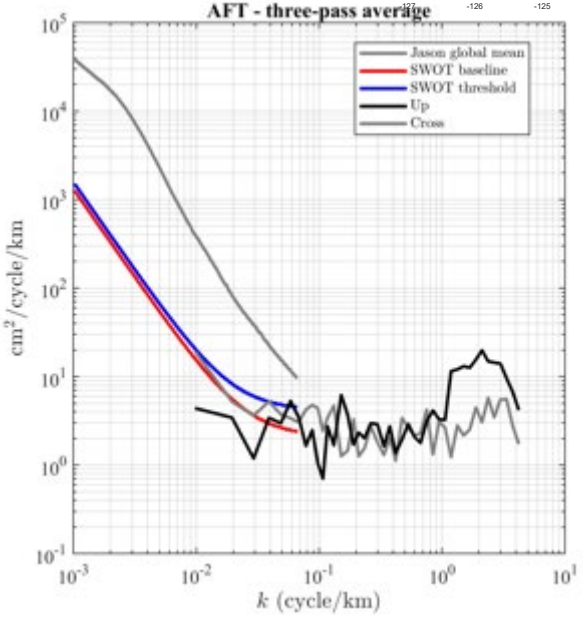


- 11 moorings, 10 km separation, 4 deep moorings, 7 shallow (500m) moorings, 2 gliders, 1 barometer
- Deployment: Bold Horizon (Eclipse Group), Feb 2023, two legs.

MASS Plans

- Modular Aerial Sensing System (MASS) operated by Scripps Institution of Oceanography
  - To be flown on NASA Gulfstream V (G-V) jet for SWOT Cal/Val
  - Includes dual-lidar configuration for SSH validation and KaRIn calibration
- 2019 experiment demonstrated:
  - Successful hardware integration of MASS with G-V
  - Successful flight operations, logistics, and back-end data analysis
  - Excellent SSH performance that meets SWOT Cal/Val needs
- Plan includes 20 post-launch flights split between early and late phases of L+3 to L+6 months
  - Need flights dedicated to different combinations ascending/descending and left/right for KaRIn calibration
  - Allows great flexibility for dealing with unexpected issues that may arise





Additional Details

- See SWOT Cal/Val plan online:
  - Go to https://swot.jpl.nasa.gov/resources/documents
  - Then search for “Calibration / Validation Plan” with whitespace and slash exactly as given here
- Cal/Val plan document was last modified several years ago, so some details are out of date