Veery Fledglings

Prototype Scatterometry from Cubesats

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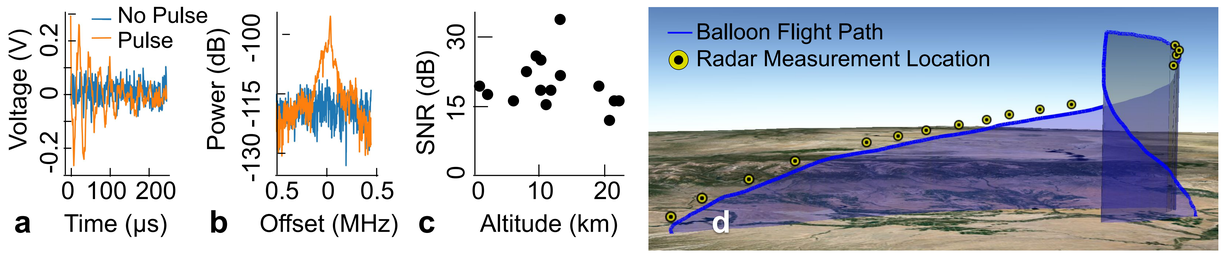
Abstract — The Veery v0.x ("Fledglings") satellites are prototype scatterometers in standard cube satellites (CubeSats). Fledglings iteratively demonstrate increasing fidelity to Veery v1.0, Care Weather's future small scatterometer. The next Fledglings improve upon Veery v0.3, Care Weather's recent 1U (10 cm cube) CubeSat surface-detection radar. Veery v0.4 is expected to demonstrate very coarse wind speed detection with limited uptime this Fall. An additional Fledgling, Veery v0.5, is planned to demonstrate coarse detection of ocean surface vector winds (OSVW) using a body-spun broadbeam architecture in early 2025. The final system, Veery v1.0 will scale up these demonstrations into a high-accuracy system with high resolution and high uptime.

Iterative Methodology — Satellite cost is the main barrier to high refresh OSVW. That cost is driven by high-cost launch and the risk-averse development processes that accompany it. Small satellite and CubeSat rideshare reduce the cost and associated risk of flight-qualifying new subsystems and high-performance terrestrial components. In turn, these new technologies enable state-of-the-art performance from a smaller satellite that costs less to launch.

Many technologies need to be flight qualified to make scatterometers orders of magnitude lower cost. Doing so in one satellite compounds the risk of mission failure. We split the qualification process into multiple flight iterations (see below) to limit the risk of each individual mission and the development program on the whole. Each iteration builds on the last until the final iteration achieves the original goal of providing state-of-the-art performance from a scatterometer that costs orders of magnitude less.

Minimum Viable Radar — Veery v0.3 is Care Weather's first radar demonstration with a minimum goal to demonstrate statistically significant detection of a return signal reflected off Earth's surface. This is accomplished while the satellite tumbles, without a complete pointing control solution.

Veery v0.3 was launched in March, 2024 and is returning radar data. A recent fundraise delayed full processing of the v0.3 flight data, but ground test results (below) are available from mountain reflection (a-b) and high-altitude balloon operation (c-d):



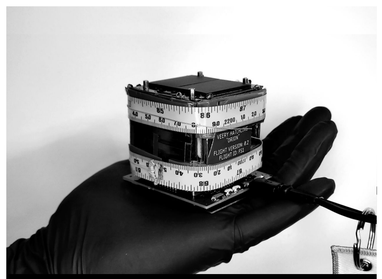
Wind Speed Radar — Veery v0.4, launching in October, 2024, improves radar sensitivity and completes the pointing control system, enabling the satellite to point at nadir and measure ocean surface wind speed. While data quantity will be limited due to power constraints, this prototype data informs priorities for improving future iterations.

Prototype Scatterometer — Veery v0.5, launching in the first half of 2025, expands the control system with body-spun nadir-scanning. This makes Veery v0.5 a fully-fledged scatterometer, capable of retrieving OSVW with multiple geometry-diverse looks. Veery v0.5 also demonstrates other operational modes, including dedicated sun charging, ground station pointing, and orbital maneuvering via differential drag.

Full-scale Scatterometer — Veery v1.0, launching in 2026, scales up previous iterations to the full 1-meter by 0.5-meter flat-panel satellite required to obtain high-accuracy, high-resolution OSVW across a 1050-km swath with 70% uptime.

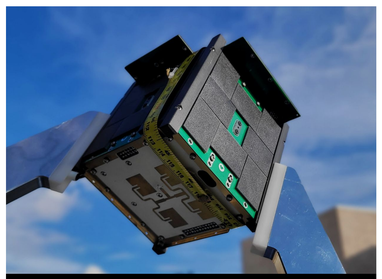
V0.1 with ROCKET LAB 2021

Minimum Viable Satellite
Microcontroller, batteries, solar panels, satcom radio microcontroller, sun sensors



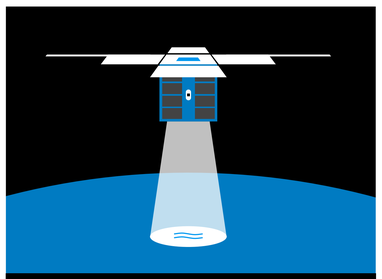
V0.2 with SPACEX 2022

Satellite Bus Improvements
VHF radio, magnetorquers, fine sun sensors — launch broker failed to deploy



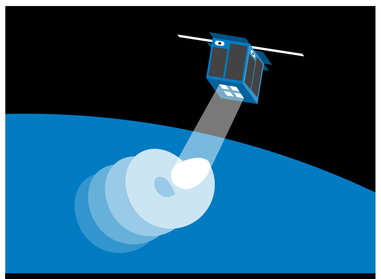
V0.3 with SPACEX March, 2024

Minimum Viable Radar
Surface detection radar with patch array antenna, GPS, brushless reaction wheels



V0.4 with SPACEX October, 2024

Wind Speed Radar
Improved radar, nadir pointing control, wind speed retrieval, better satcom



V0.5 with SPACEX Q2 2025

Prototype Scatterometer
OSVW retrieval, nadir spinning, high-rate downlink, static offset antenna

V1.0 with SPACEX 2026

Full-scale Scatterometer
Flat-panel scatterometer for high-accuracy, high-uptime OSVW monitoring

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