Veery—The Small Satellite Scatterometer

Design and Mission Progress for Versions 0.3 and 1.0

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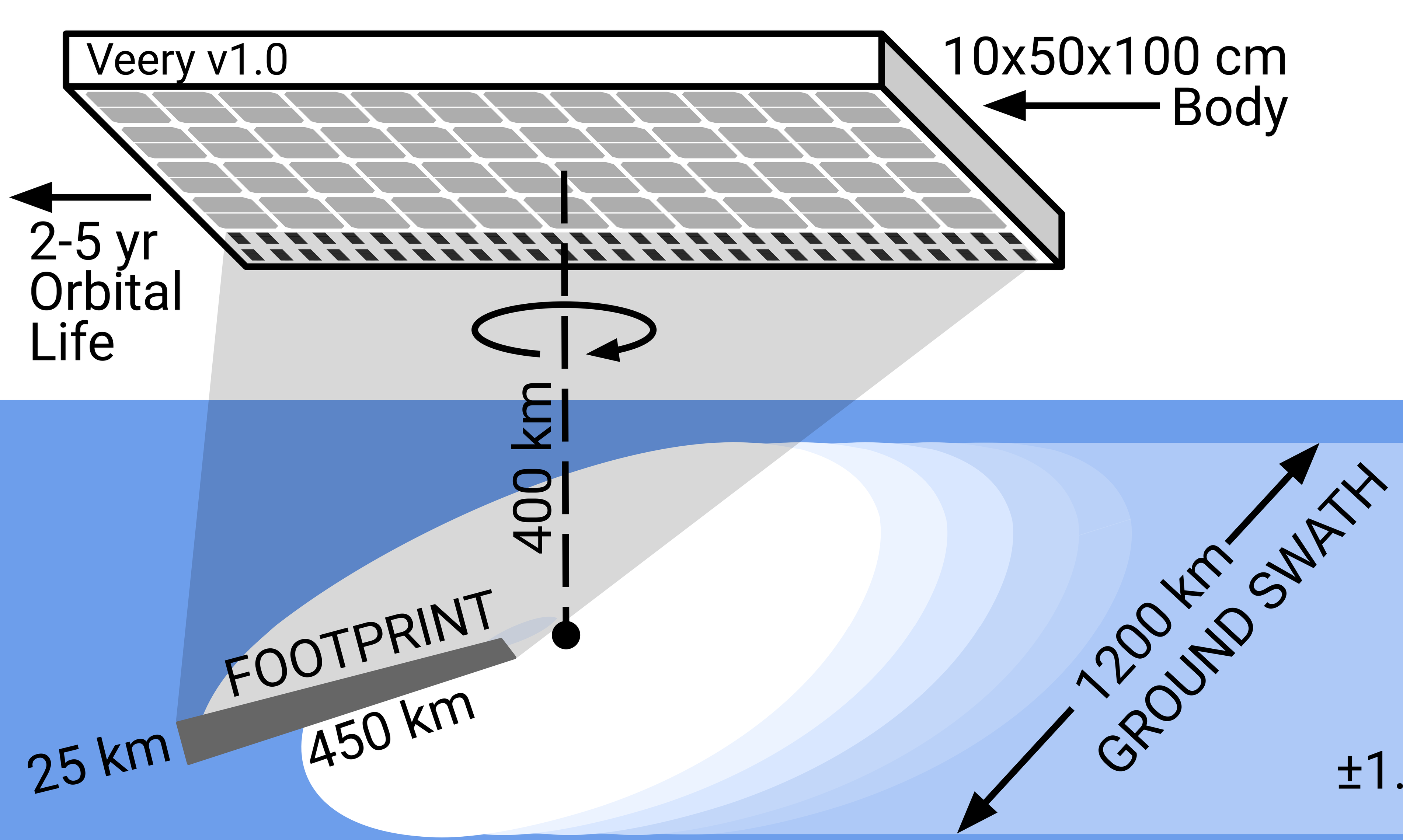
Intro – The global ocean surface vector winds (OSVW) constellation is limited to daily refresh. Resolving the diurnal cycle of OSVW without major simplifying assumptions [1] requires six-hourly refresh [2]. Even that will miss major evolution on 1-3 hourly time scales [3]. In reality, the current ±1 m/s temporal OSVW observability is closer to 12 days [4]. Without frequent, global OSVW, understanding of synoptic air-sea systems (hourly change over hundreds of kilometers) remains poor. Advanced understanding of mesoscale convective systems [5], associated cold pools [6-7] and squall lines, tropical cyclogenesis [8], westerly wind bursts, easterly waves, bomb cyclones, and extratropical cyclones [9] requires global, near-hourly refresh of OSVW.

Care Weather is developing Veery to achieve the performance of heritage scatterometers while reducing size, weight, and cost by 3 orders of magnitude. This makes Veery affordable for use in a constellation for hourly OSVW. Key to this miniaturization is risk tolerance through iterative development, including pathfinder iterations (v0.x) and full scatterometers (v1.x). Care Weather has partnered with Brigham Young University for design simulation and wind retrieval.

Veery version v1.0 – Veery v1.0 is a rotating fan beam scatterometer in a flat satellite. Veery transmits a 30 W C-band LFM-ICW signal. The entire spacecraft spins about nadir, conically scanning its 25x450 km footprint across a 1200 km swath in a lawn-mower pattern as illustrated below. The footprint is divided into 25 km resolution cells using range processing.

Veery takes lessons from smartphone design with vertical integration, tightly layered packing, component dual-use, and passive surface cooling. The flat form factor optimizes surface area vs. volume, giving significant solar power, antenna, and radiative cooling area. This also makes it aerodynamic. With it's thin side pointed in the flight direction, Veery can fly at 400 km with 2-5 year orbital life (depending on solar activity). This lower altitude gives Veery higher resolution, higher signal-to-noise ratio, and lower waste heat.



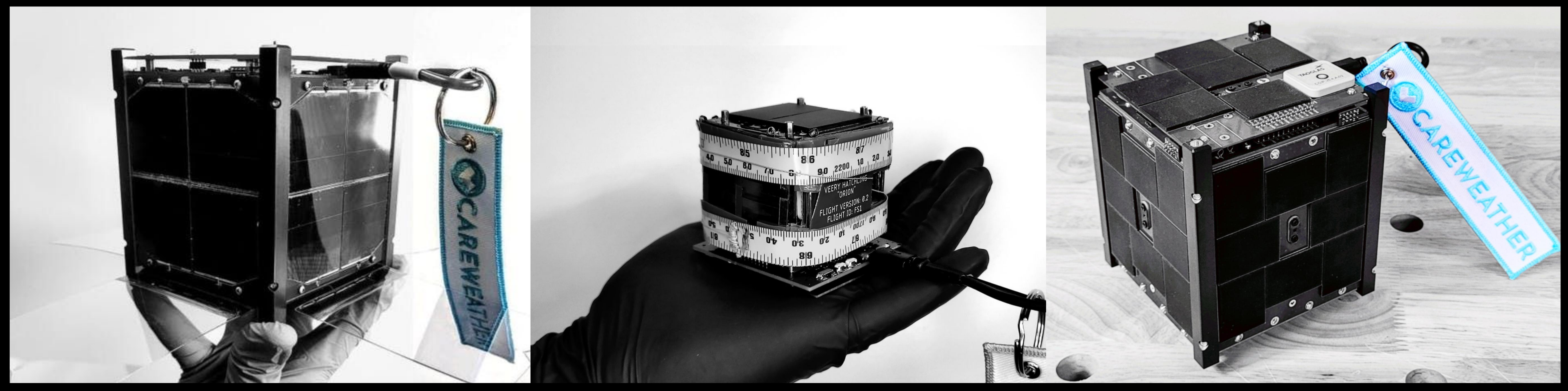
25 km spatial resolution reprocessed to 6 km. ±1.5 m/s, ±20° (3 - 30 m/s)

VEERY DESIGN V1.0.3

Pathfinder Missions – Veery versions 0.x

Reducing size, weight, and cost of Veery requires vertical integration. This lets us use modern integrated circuits and systems that fit the flat form factor. Veery pathfinder missions allow us to test in-house systems for power, computing, communications, attitude determination and control, and thermal management.

Next up, Veery v0.3 is launching in February. A 1U cubesat, it tests our mid-rate radio, Earth-pointing control, and an early version of the radar system that will support scatterometry on Veery 1.0.



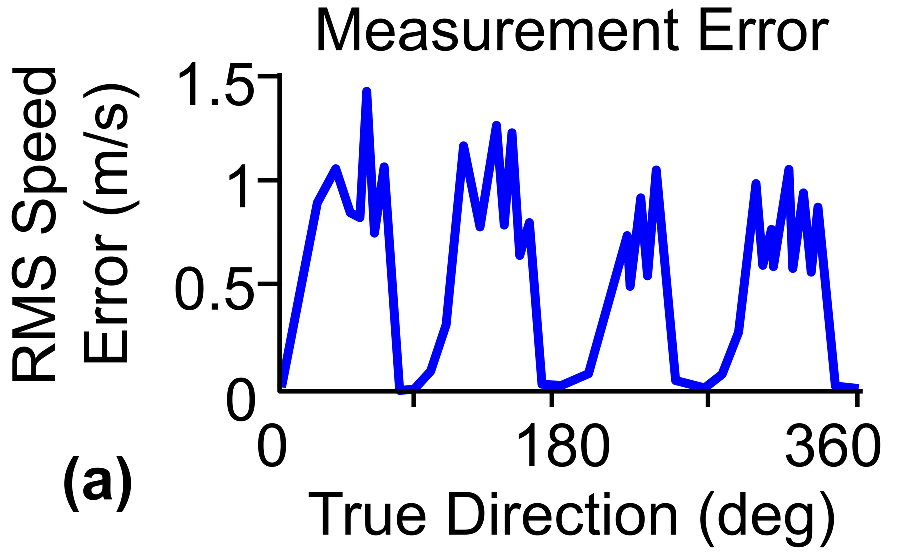
V0.1 with ROCKET·LAB 2021 | V0.2 with SPACEX 2022 | V0.3 with SPACEX February, 2024

Initial Results

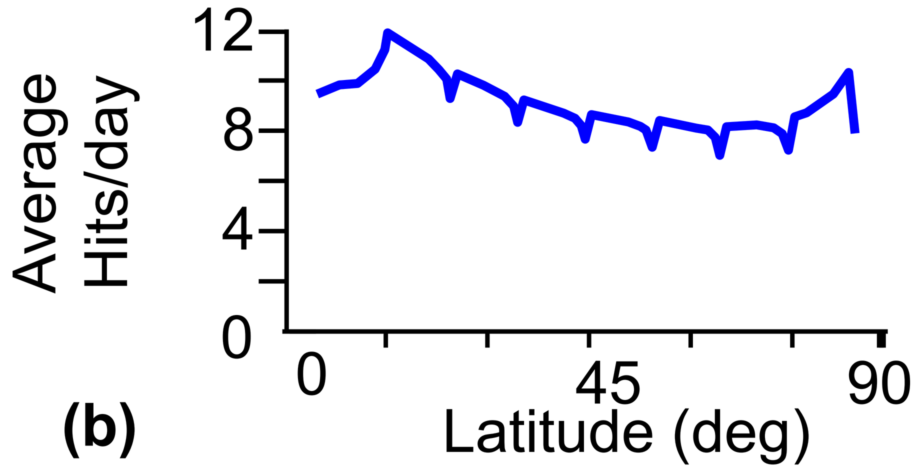
Veery models include a system calculations model, thermal simulations, a geometry and compass wind retrieval simulation, and a constellation coverage and revisit simulation. Initial compass simulation results (a) show Veery has potential for heritage performance at <1.5 m/s accuracy.

Initial constellation results suggested that the number of Veeries required for 3-hourly coverage could be as few as 8 satellites, though may be up to 12.

The system model suggests Veery will have a roughly 1200 km swath with 25 km resolution, to be reprocessed to 6 km.



(a)



(b)

References – [1] J. Turk, S. Hristova-Veleva, and D. Giglio, 2021. [2] A. Trindade, M. Portabella, W. Lin, and A. Stoffelen, 2017. [3] G. Priftis, T. Lang, and T. Chronis, 2018. [4] M. G. Schlax, D. B. Chelton, and M. H. Freilich, 2001. [5] T. J. Kilpatrick and S.-P. Xie, 2015. [6] P. Garg, S. Nesbitt, T. Lang, et al., 2020. [7] [7] G. Priftis, T. J. Lang, P. Garg, S. W. Nesbitt, R. D. Lindsley, and T. Chronis, 2021. [8] D. G. Long, R. Milliff, and E. Rodriguez, 2009. [9] P. S. Chang, Z. Jelenak, J. M. Sienkiewicz, et al., 2009.

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