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## Ocean-Shot Submission Template

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**Title of Ocean-Shot Concept:** Southern Ocean Storms – Zephyr



**Relevant Ocean Decade Challenge(s):** Ocean-Climate Nexus; Ocean Observing Systems

### **Vision and potential transformative impact:**

Southern Ocean winds are powerful and strengthening. They are under-sampled by current wind-observing satellites, leading to knowledge gaps for a myriad of ocean-atmosphere processes. Specifically, uncertainties in the Southern Ocean carbon budgets are dominated by the lack of high-resolution and high-quality extreme wind measurements. This hampers predictions and challenges our carbon emission reduction projections to stabilize atmospheric CO<sub>2</sub> levels.

To quantify these “missing winds” and close the carbon budget, we are proposing a groundbreaking new NASA Earth Venture Mission that deploys an innovative scatterometer, optimally designed to improve observations of Southern Ocean storms. This mission, Southern Ocean Storms - Zephyr (SOS-Zephyr), will double the number of wind observations over the Southern Ocean and provide the critical temporal sampling of high surface winds (> 20 m/s) to characterize the wind regime, quantify the evolving air/sea carbon flux, and improve estimates of carbon supply from the deep ocean through wind induced ocean mixing. In combination with potential Ocean Shot efforts, such as the global network of surface platforms for the “Observing Air-Sea Interactions Strategy” (OASIS), SOS-Zephyr will transform our understanding of the global carbon cycle by significantly reducing the large uncertainties in the Southern Ocean and, therefore, global air/sea carbon fluxes.

**Realizable, with connections to existing U.S. scientific infrastructure, technology development, and public-private partnerships:**

Submitted to the *NASA Earth Venture Program-3*, SOS-Zephyr addresses the ES Decadal Survey C-2 Most Important Question: How to reduce the uncertainty in global climate sensitivity? It is innovative, exciting, and anticipated to be a leading candidate for selection.

The *SOS-Zephyr Team* is composed of academia, industry, NOAA, and NASA leaders; the collaboration resulted in an innovative instrument/mission concept to measure wind speeds needed to constrain the carbon fluxes in the Southern Ocean.

Prof. Russell co-leads the *NSF-funded SOCCOM Team* which has deployed hundreds of profiling floats around the Antarctic. The in-situ float data and the modeling infrastructure developed by the SOCCOM program are integral to enabling the SOS-Zephyr mission.

Finally, the *NOAA Aircraft "Hurricane Hunter"* team will provide field validation of SOS-Zephyr wind retrieval data. Equipped with tail Doppler radar and the ability to deploy weather data-gathering probes in flight, the NOAA team effort directly supports the SOS-Zephyr mission.

**Scientific/technological sectors engaged outside of traditional ocean sciences:**

The SOS-Zephyr mission is unique – it brings together experts, including industrial partners, in deployable antenna technology, small spacecraft, scatterometry and radiometry design, wind retrieval scientists with remote sensing experience, traditional Physical Oceanographers with extensive field campaign experience, and interdisciplinary Oceanographic Modelers focused on biogeochemistry. And for the first time, the Oceanographic Modeling community has led the effort to develop, plan, and implement a space-based experiment optimized to address their research needs – how can we best capture the missing winds and their impact on carbon sequestration by the ocean?

**Opportunities for international participation and collaboration:**

SOS-Zephyr leverages existing scatterometers, creating an “international constellation”. The mission optimizes temporal coverage, when combined with the ESA Metop ASCAT scatterometers. The ASCATS are in traditional mid-morning orbits; SOS-Zephyr will be in a sun-synched orbit with an LTAN of ~3:00 pm, creating the first climate-focused wind sensing constellation. The ASCAT orbits are optimized for data collection that supports weather observations; these systems don’t have the revisit capability needed to accurately measure

high-resolution winds and variability over the Southern Ocean. With the addition of SOS-Zephyr, the scatterometer revisit time over the Southern Ocean will increase from 2 to 4-5 times daily.

**Builds global capacity and encourages the development of the next generation of ocean scientists:**

The SOS-Zephyr mission combines space, airborne, and field/in-situ observations to address the critical societal issue of constraining global carbon fluxes. Its mission will capture the imagination of the next generation of ocean scientists. The PI - Prof. Russell is employed at a Hispanic and Native Serving Institution with a proven track record in SOCCOM of entraining underrepresented scientists into the field. Each critical position on the team has identified a Deputy Role filled by Early and Mid-Career professionals. And finally, Science Team members will fund and mentor postdocs, graduate students, and undergraduates to participate in science team activities.