Zephyr

Closing the Carbon Budget

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DPI: Dr. Joellen Russell, UA

BYU UA CU/LASP UCSC UCSD Rutgers JPL Ball Tendeg

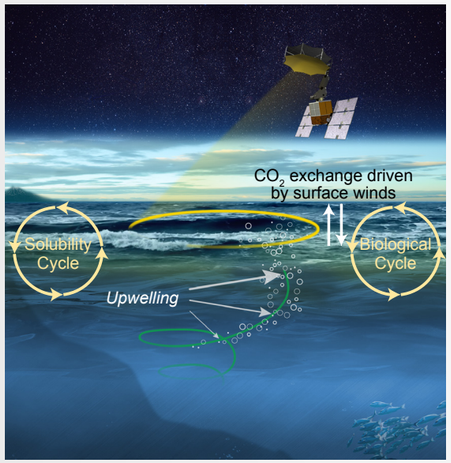
A Process-Study Investigation to Quantify Coastal Oceanic Carbon Flux using Surface Vector Wind Fields and High Resolution Models

Investigation Overview

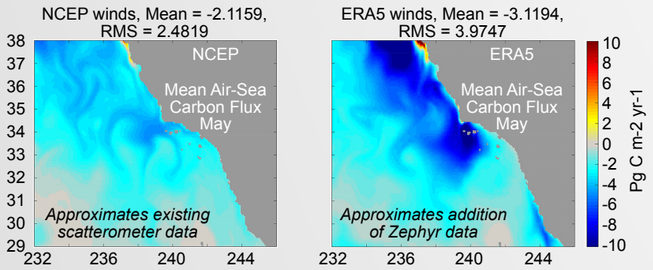
Zephyr is a small, low-cost scatterometer suitable for flight on a SmallSat. An innovative use of a well-proven technique, Zephyr will produce groundbreaking wind vector datasets over critical coastal areas at unprecedented temporal and spatial resolutions.

The team is led by PI Prof. David Long, BYU, who for over 30 years has been at the forefront of scatterometry system engineering and science, from NASA's QuikSCAT to ESA's ASCAT.

He is joined by Assoc. Prof. Joellen Russell, UA, a leader in Earth System Modeling and a science team focused on assimilating Zephyr data into high resolution models to quantitatively assess coastal air-sea carbon exchange.



Why Ocean Winds are Key



OSSEs of carbon flux state estimates for the California Current Region shows that adding the high spatial and temporal resolution Zephyr wind data to the models significantly improves their ability to capture the real amplitude and variability (not shown) of air-sea carbon flux in coastal domains.

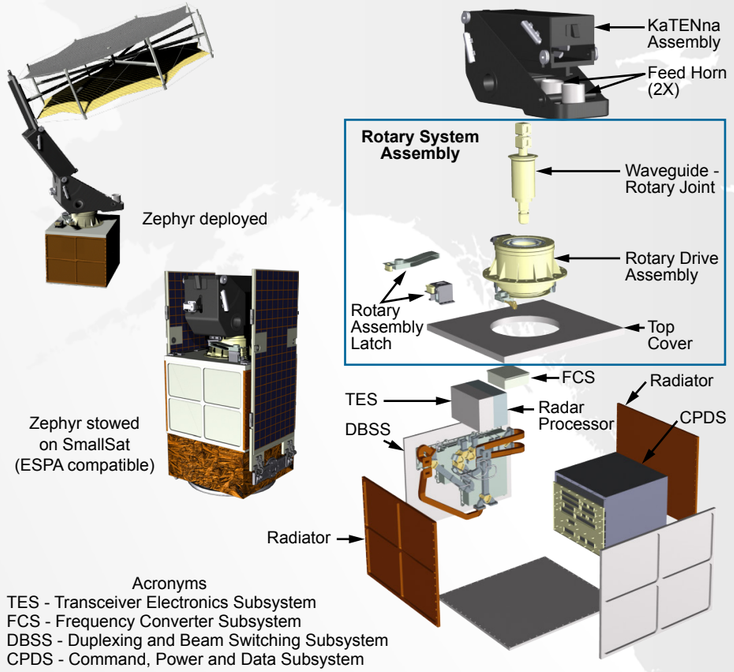
Science Objectives

- Use Zephyr high spatial and temporal surface vector wind measurements to improve computations of air-sea carbon flux in the coastal ocean
- Improve coastal ocean carbon flux estimates in data assimilative dynamical-BGC model calculations for selected coastal ocean domains, as well as in a coarser resolution global "data assimilative dynamical-BGC model", using carbon fluxes generated from Objective 1
- Combine high resolution coastal assimilations from Objective 2 with global 1/3° assimilations to construct a global carbon flux state estimate

Significance to NASA

- First high-resolution, coastal zone investigation to study the interaction between ***carbon exchange*** and ocean surface winds
- Specifically addresses key questions from the NRC ESAS 2017, including
  - Ecosystem Change (E-3): What are the fluxes of ***carbon***, water, nutrients, and energy within ecosystems, and how and why are they changing
  - Climate (C-4a): Improve the estimates of global air-sea fluxes of heat, momentum, water vapor and other gases, like ***carbon*** and methane
- Fulfills critical parts of the ***Aquatic Biogeochemistry*** and ***Ocean Surface Winds and Currents*** Targeted Observables

Instrument & Key Characteristics

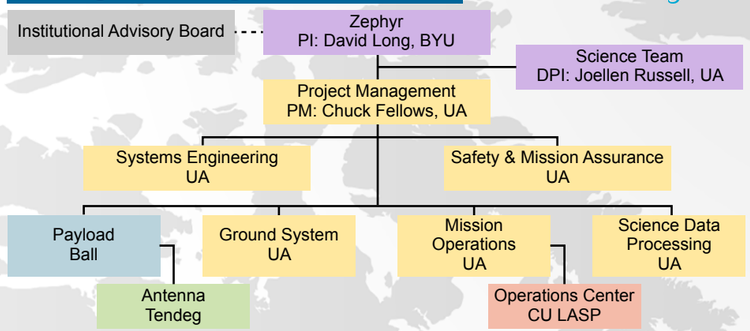


Acronyms
TES - Transceiver Electronics Subsystem
FCS - Frequency Converter Subsystem
DBSS - Duplexing and Beam Switching Subsystem
CPDS - Command, Power and Data Subsystem

Accommodation Parameter	Value
Orbit altitude	550 km ±50 km
Orbit inclination	Sun-synch
Orbit ascending node time	3:00 pm ±1 hr
Instrument mass	70.8 kg
Instrument orbit average power	98.5 W (science orbit) 61.0 W (non-operating orbit)
Instrument volume	Stowed: 0.45 x 0.49 x 0.71 m Deployed: 1.35 x 1.29 x 1.84 m
Instrument peak data rate	52 kbps
Pointing control required	0.1 deg, 1σ
Pointing knowledge req'd	0.025 deg, 1σ

Instrument Parameter	Value
Ground resolution (processed data)	2.5 km
Antenna spin rate	18 RPM
Swath width	1200 km
Frequency	13.4 ±0.05 GHz
Transmit power (at antenna)	≥32 W
Beam angles	42° and 48° off-nadir
Chirp bandwidth	250 kHz
Pulse repetition frequency	187 Hz
Pulse length	1.5 msec
On-orbit calibration	Loopback and noise (gain and Tx power on the ground)

Investigation Management



Participating Organizations

Investigation Management and Instrument Development	
BYU	PI Institution, Mission and Investigation Leadership, Instrument Science and Calibration, L1 – L3 Science Data Processing
UA	Project Management, Systems Engineering, S&MA, Data Archive and Distribution
Ball	Flight Instrument Development, AI&T, Sustaining Engineering Instrument Science
TENDEG	Deployable Antenna, Development and AI&T
CU/LASP	Mission and Instrument Operations Center

Science, Data, and Applications	
UA EDO	Deputy PI and Science Team Leadership, Earth System Model (ESM) Evaluation, Applications POC, L4 Products
UCSC	BioGeoChemical (BGC) Flux Calculation and Analyses in the California Current System (CCS)
UCSD SIO	Regional and Global Data Assimilation and State Estimation
Rutgers	BioGeoChemical (BGC) Flux Calculations and Analyses in the Middle Atlantic Bight (MAB)
CU	Instrument Science, Carbon Flux Calculations and Analyses in the Antarctic Circumpolar Current (ACC)
JPL	Calibration and Validation Lead

Science Team

David Long, PI ……..BYU
Joellen Russell, DPI…….. UA
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Matthias Morfzeld, Co-I…… UA
Andrew Moore, Co-I……. UCSC
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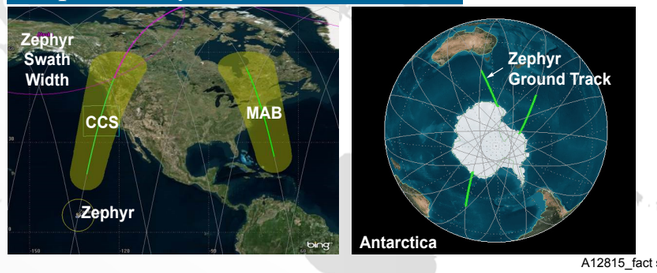
Oscar Schofield, Co-I.....Rutgers
Enrique Curchitser, Co-I…….. Rutgers
Scott Glenn, Co-I……..…….....Rutgers
Javier Zavala-Garay Co-I…….Rutgers
Ralph Milliff, Co-I……..…….. CU
Nicole Lovenduski, Co-I…….. CU
Manoja Weiss, Liaison..... Ball
Quinn Remund, Liaison..... Ball

Proposed Study Sites



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