

Periodic sedimentation rates revealed by high-temporal-resolution view of biological carbon pump



We used an optical sediment trap to observe the biological carbon pump at 890 m depth, 3 x an hour for ~3 months in 2023.

Crissy Huffard*, Colleen Durkin, Richard Henthorn, Irene Hu, Paul McGill, Alana Sherman and Yanwu Zhang
chuffard@mbari.org

Context and aims

Sinking biological particles bring important quantities of carbon to the deep sea.

Our goal is to reveal mechanisms of the biological carbon pump that can be used to improve deep-sea carbon sequestration models.

Measuring particles sinking to the deep sea

- The Sedimentation Event Sensor (SES) is a 4000 m-depth-rated, low-power optical sediment trap that images sinking particles, and then discards them.

- The SES was deployed on the seafloor at 890 m depth, near Monterey Bay, California, USA. Here we present data from May–August 2023.

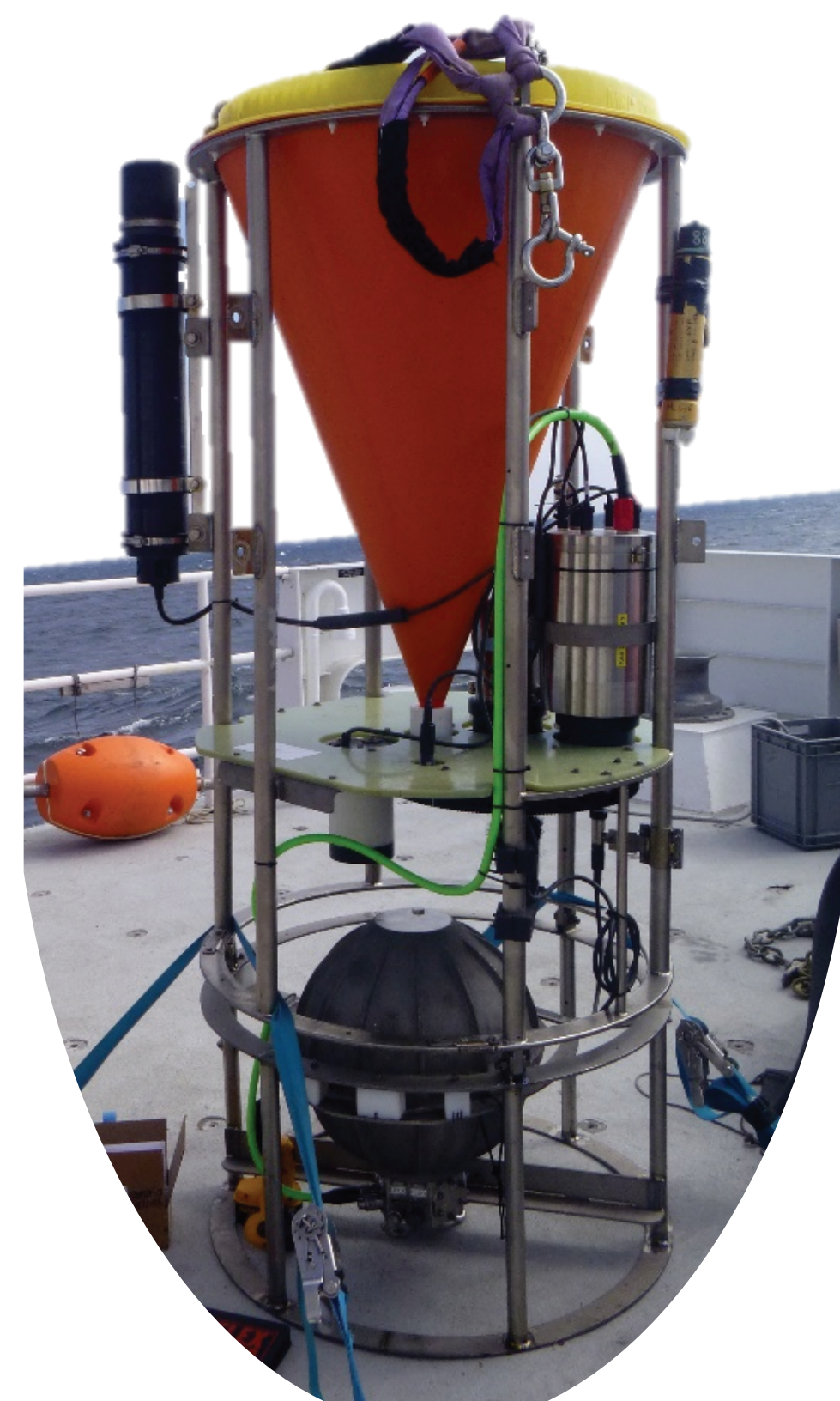
- The SES collected and imaged 3 samples/h (5 minute collections followed by a 15 minute flow-through period).

- Automated image analysis detected particles for calculations of light attenuation by material on the slide. The more material on the slide, the higher the attenuation.

- Light attenuation calculated from SES images can be considered a proxy for particulate organic carbon (POC) flux. Higher light attenuation means higher POC flux.**

- Two Lowell tilt current meters were deployed nearby.

- Data were averaged hourly.



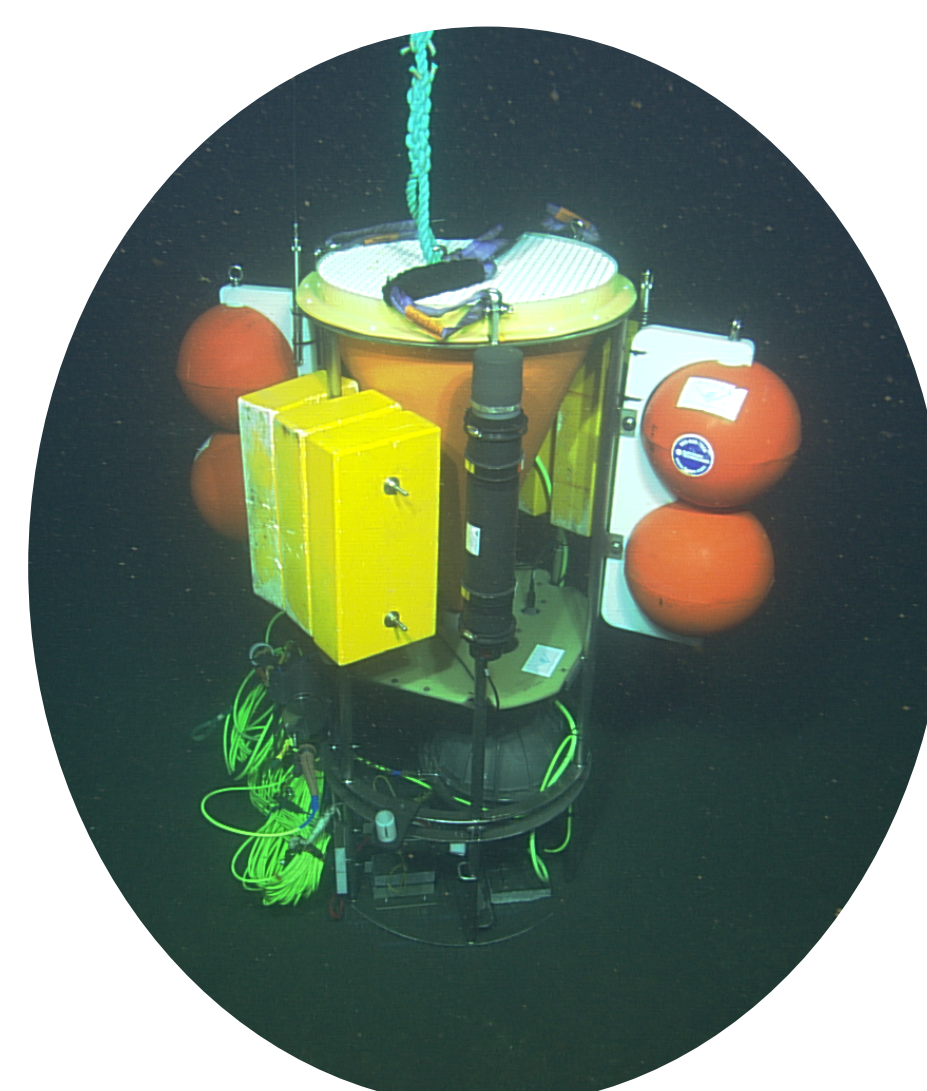
SES on deck



SES image



Detected particles

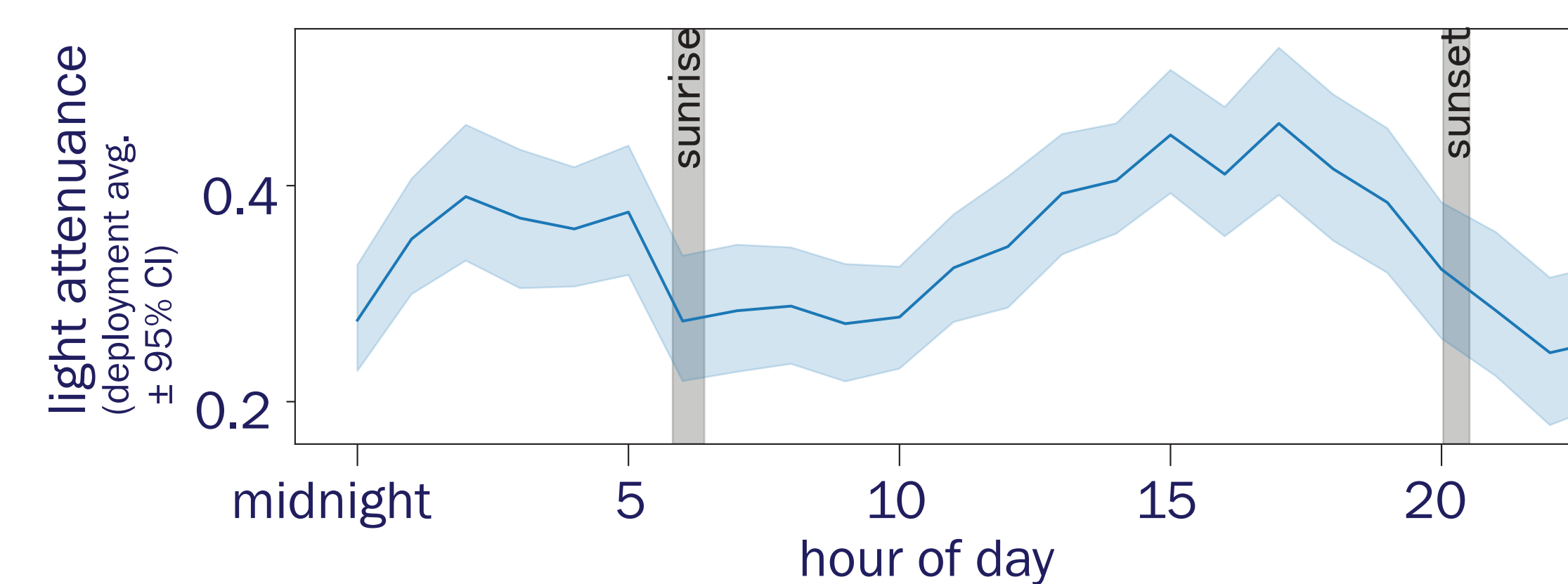


SES on seafloor

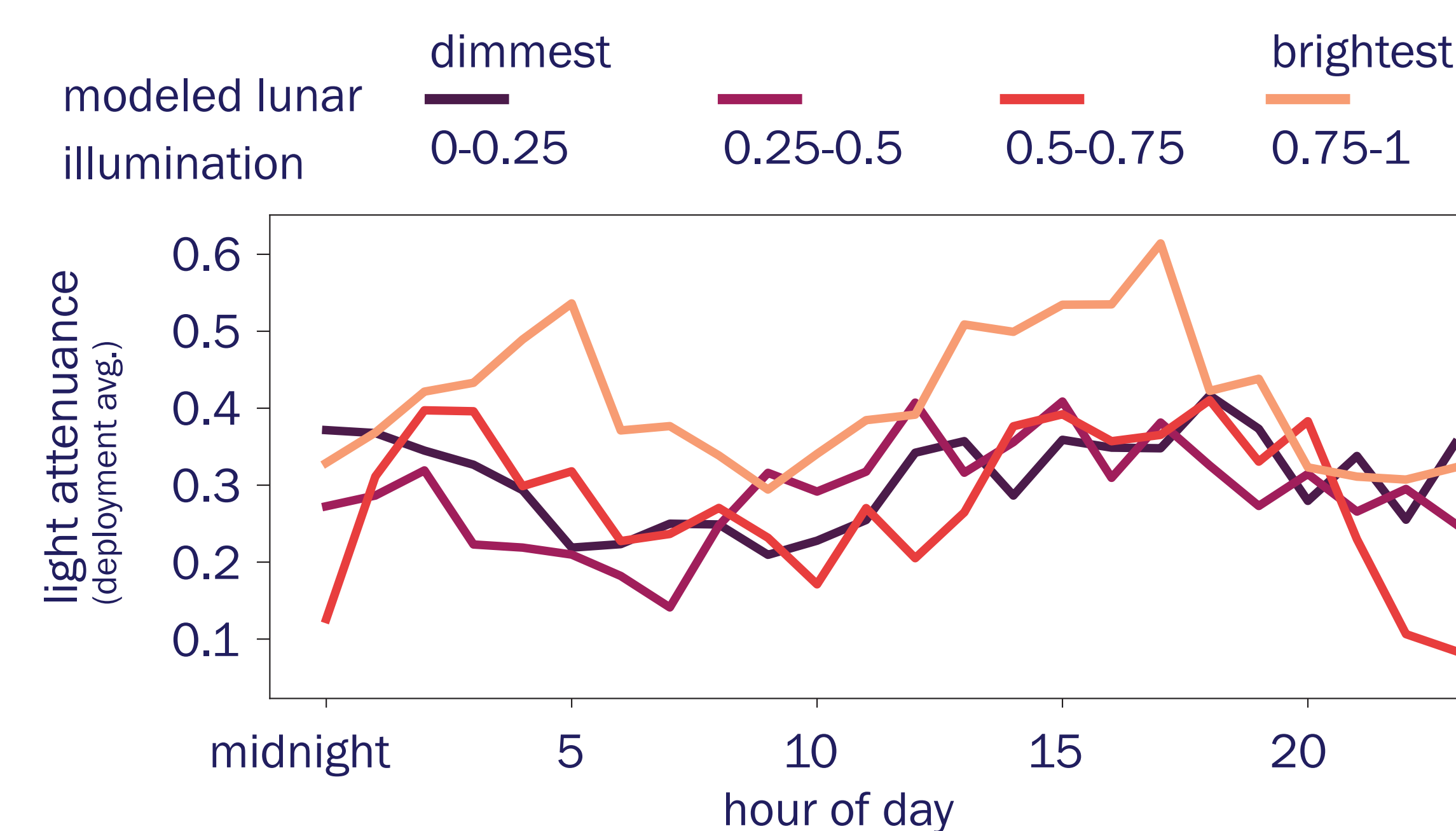
Results

Timing of light attenuation peaks suggests biological sources of variability.

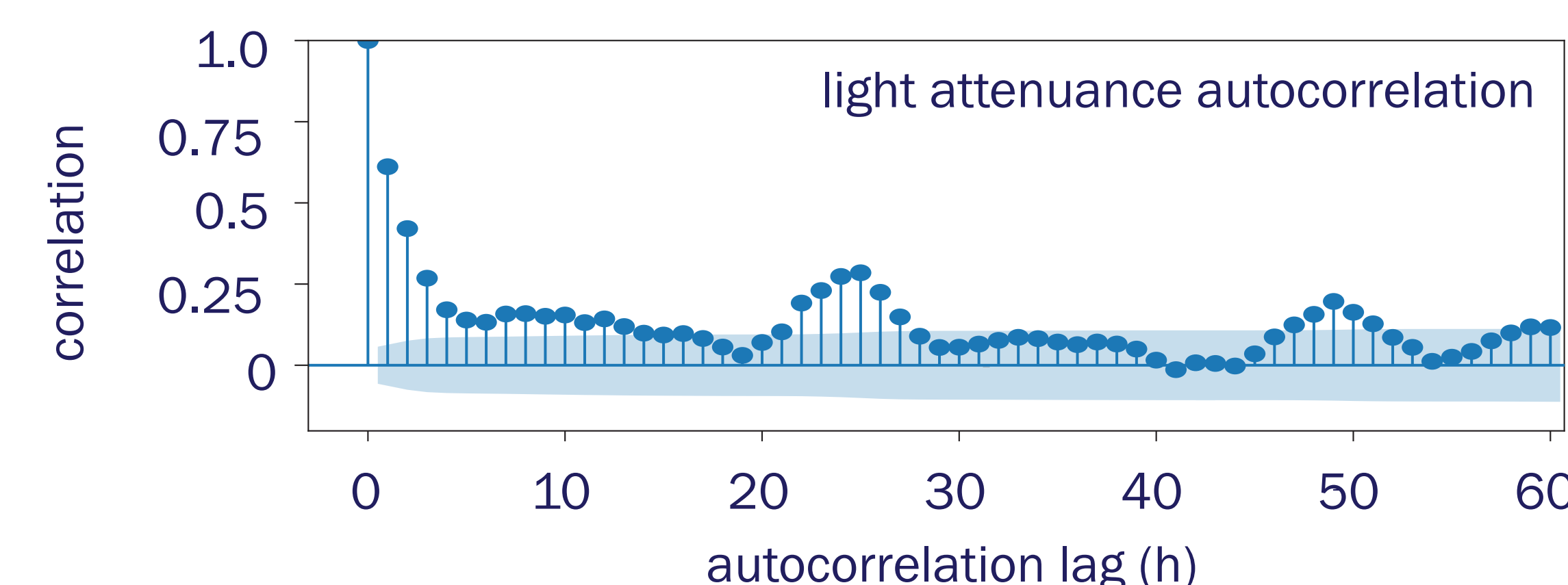
- Light attenuation of images taken at 890 m depth peaked before sunrise and sunset.



- Light attenuation of images taken at 890 m depth was higher when modeled lunar illumination at the surface was brightest.



- Diel cycles in light attenuation were consistent.



- Current speed did not correlate with light attenuation.

Biology drove flux

- Twice-daily peaks in light attenuation suggest the SES mainly detected particles produced by animals that vertically migrate twice a day

- Light attenuation was higher during full moons. Lunar light is also known to affect vertical migrations by animals

- Diel patterns in POC flux may be consistent enough to be modeled.

- Local bottom-sediment resuspension did not drive the dominant patterns seen here.

Opportunities

Vertically migrating animals are thought to account for 5 to 50% of downward carbon flux. We are working to help resolve this large uncertainty by:

- Quantitatively assessing influence of lunar and diel cycles on active transport of carbon to 890 m depth:

- a) Identify particle types

- b) Compare to overlying zooplankton vertical migrations, and lunar/diel cycles.

- Evaluating the consistency of these cycles:

- a) throughout the year

- b) at interannual scales.

Acknowledgements

This SES deployment was made possible by Karen Martinez, Knute Brekke, DJ Osborne, Evan Mattiasen, the RV Rachel Carson crew and the MBARI Telepresence team. Kelly Benoit-Bird provided insights that improved this poster. This research was supported by the David and Lucile Packard Foundation.

Light attenuation: hourly averages

