Autonomous detection and adaptive sampling of unpredictable carbon flux events monitored by a deep-sea optical sediment trap

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General Poster

Quick summary

We conducted targeted study of unpredictable events through monitoring, event detection and command communication by a low-power instrument that then acoustically woke up and initiated physical sample collection by a separate instrument with limited collection capacity.



Background

- Quantifying, and eventually modelling, deep-ocean carbon storage requires detailed understanding of "Pulse" events, when large amounts of biological material sink to the deep-sea over a short period of time.
- Pulse events can account for a significant fraction of annual deep-ocean carbon storage in the California Current, but remain unpredictable and hard to study.

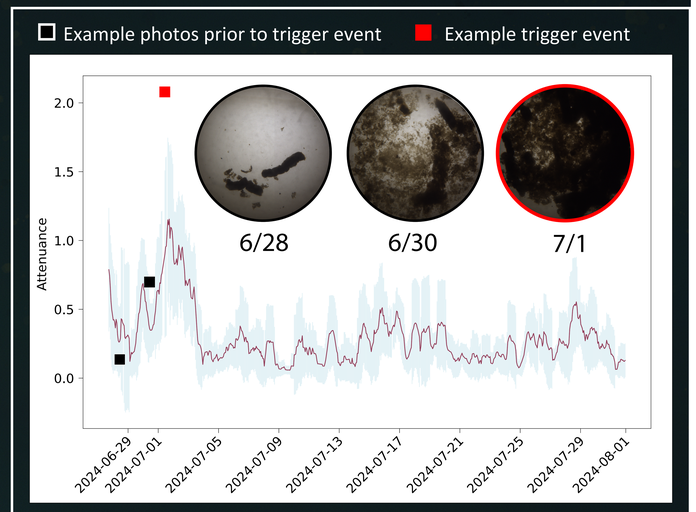
Methods: Detect the onset of, and collect during, pulse events.

- We added on-board image analysis and adaptive event detection to the Sedimentation Event Sensor (SES), an optical sediment trap with acoustic communication capabilities (McGill et al. 2016).
- After each sample collection, the SES calculated image attenuance, which correlates with particulate organic carbon flux (Estapa et al. 2024) and checked for rapid increases in this value.
- If the slope of running mean attenuance exceeded a predetermined value, then the SES sent an acoustic "trigger" signal to initiate sampling by a nearby acoustics-enabled conventional sediment trap.
- Two triggering approaches were tested: (1) single slope threshold, (2) adaptively toggling between two slope thresholds based on time rate of recent triggering events.
- SES and the comms-enabled conventional sediment trap were deployed as landers ~300--500 m apart.



Results

- In three field trials (2024–2025; Monterey Bay, California, USA; ~900 m deep), the SES successfully detected carbon storage pulse events and sent acoustic trigger commands.
- The SES successfully toggled between different triggering thresholds based on recent triggering rates.



Conclusion

Event detection by the SES is a useful approach for studying unpredictable and temporally fleeting events.

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References:

- Estapa et al. 2024. Limnology and Oceanography: Methods, 22(2), 77-92.
- McGill, et al. 2016. Limnology and Oceanography: Methods, 14(12), 853-863.