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Assessing the in-situ sedimentation rate of zooplankton carcasses in lakes using a custom-made particle tracking velocimetry (PTV) system

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Understanding the fate of organic carbon (OC) inputs in aquatic ecosystems is of primary importance for comprehending their functioning, in particular in relation to their carbon cycle. A large part of terrigenous OC, coming from the watershed, enters aquatic ecosystems in the form of refractory organic matter (ROM), which are difficult to oxidise. Recent studies in the literature have suggested, however, that ROM mineralisation rates may be enhanced in presence of labile organic matter (LOM), making ROM compounds easier to degrade, with a consequent alteration of the carbon budget in those systems. This process refers to as priming effect.

In lakes, zooplankton carcasses represent an abundant and high quality LOM substrate for microorganisms that has the potential of priming ROM mineralisation in water column and creating new and overlooked pathways in the lake carbon cycle. To investigate this, it is crucial to measure the in-situ sedimentation rate and residence time of dead zooplankton, as a function of hydrodynamic conditions, microbial decomposition and organisms' characteristics (such as size and density).

Current velocimetry acoustic methods cannot measure, however, velocities of single millimetre-sized carcasses because particles are too small and measurements are not accurate due to the low correlation of the acoustic pings. To overcome this, we propose an inexpensive particle tracking velocimetry (PTV) system to estimate the instantaneous 3D velocity of particles in the field. From the data it is possible to measure sinking rates of dead zooplankton and potentially infer carbon fluxes in lakes in relation to the priming effect.

The PTV rig consists of two GoPro cameras arranged in a frontal parallel arrangement and installed in a waterproof case. The case is mounted on a stainless-steel frame with a laminate blank screen placed in front of the cameras to restrict the system sampling volume. A torch was also attached on the frame to enhance lighting underwater conditions. The cameras are set up to acquire stereoscopic films of sinking particles at 48 frames per second and calibrated in a calibration tank to estimate their distortion and rectification parameters. A software package was also developed with new stereo algorithms to sync the videos, detect and track carcasses, as they move in the water, and measure their velocity and length.

In this study, we also present early results of sedimentation rates from the PTV system, estimated from 2 deployments in summer 2018 in the mesocosm of Lake Stechlin (Germany) at 7m. Finally, the settling rates are compared with (1) those inferred from the Stokes' law and (2) the daily settling rates estimated from sedimentation traps installed in the mesocosm at the same depth.