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Tidal influence on subtropical estuarine methane emissions

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The relatively unstudied subtropical estuaries, particularly in the Southern Hemisphere, represent an important gap in our understanding of global greenhouse gas (GHG) emissions. These systems are likely to form an important component of GHG budgets as they occupy a relatively large surface area, over 38 000 km2 in Australia. Here, we present studies conducted in the Brisbane River estuary, a representative system within the subtropical region of Queensland, Australia. This is a highly modified system typical of 80% of Australia's estuaries. Generally, these systems have undergone channel deepening and straightening for safer shipping access and these modifications have resulted in large increases in tidal reach. The Brisbane River estuary's natural tidal reach was 16 km and this is now 85 km and tidal currents influence double the surface area (9 km2 to 18 km2) in this system.

Field studies were undertaken to improve understanding of the driving factors behind methane water-air fluxes. Water-air fluxes in estuaries are usually calculated with the gas exchange coefficient (k) for currents and wind as well as the concentration difference across the water-air interface. Tidal studies in the lower and middle reaches of the estuary were performed to monitor the influence of the tidal stage (a proxy for kcurrent) on methane fluxes. Results for both investigated reaches showed significantly higher methane fluxes during the transition time of tides, the time of greatest tidal currents, than during slack tide periods. At these tidal transition times with highest methane chamber fluxes, lowest methane surface water concentrations were monitored. Modelled fluxes using only wind speed (kwind) were at least one order of magnitude lower than observed from floating chambers, demonstrating that current speed was likely the driving factor of water-air fluxes. An additional study was then conducted sampling the lower, middle and upper reaches during a tidal transition period. Although dissolved methane surface water concentrations were highest in the upper reaches of the estuary, experiencing the lowest tidal currents, fluxes measured using chambers were lower relative to middle and lower reaches. This supports the tidal study findings as higher tidal currents were experienced in the middle and lower reaches.

The dominant driver behind estuarine methane water-air fluxes in this system was tidal current speed. Future studies need to take into account flux rates during both transition and slack tide periods to quantify total flux rates.