Rapid seawater circulation through animal burrows in mangrove forests — A significant source of saline groundwater to the tropical coastal ocean

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A common approach for quantifying rates of submarine groundwater discharge (SGD) to the coastal ocean is to use geochemical tracers such as ^{222}Rn and short lived radium isotopes, which are naturally enriched in groundwater relative to seawater and have well understood chemistries within the marine environment. They occur in both fresh (continental) and saline (marine) groundwaters and thus the water source is often ambiguous. Here, we present a detailed investigation into the tidal circulation of seawater through animal burrows using ^{222}Rn and isotopes of radium in the Coral Creek mangrove forest, Hinchinbrook Island, Queensland, Australia. The study was conducted at the end of the dry season in a creek with no freshwater inputs. Significant export of radionuclides and salt from the forest into the creek indicates continuous tidally driven circulation through the burrows. Results demonstrate that the forest sediment is efficiently flushed, with a water flux of about 30 L/m^2/ day of forest floor, which is equivalent to flushing about 10% of the total burrow volume per tidal cycle. Importantly, annual average circulation flux through mangrove forest floors are of the same order as annual river discharge in the central GBR. However, unlike the river discharge, the tidal circulation should be relatively stable throughout the year. This work documents the importance of animal burrows in maintaining productive sediments in these systems, and illustrates the physical process that supports large exports of organic and inorganic matter from mangrove forests to the coastal zone. It also illustrates the importance of considering saline groundwater sources when interpreting SGD radionuclide tracers in the coastal ocean.

Observationally constrained estimates of carbonaceous aerosol transport and radiative effects

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Atmospheric aerosols play an important role in the global climate system. Carbonaceous aerosols stand out through their potential to warm (through absorption and semi-direct effects) and cool (through scattering and indirect effects) climate, depending on their microphysical properties and regional distribution. Current global aerosol models vary drastically in simulated abundance, transport and radiative properties of carbonaceous aerosols and show significant biases when compared to observations [1].

To advance our understanding of uncertainties in global models we utilise observational profile data obtained during the HIPPO aircraft campaigns [2] to constrain the remote transport in two microphysical aerosol climate models, ECHAM-HAM [3, 4] and HadGEM-UKCA [5]. In addition to mass concentrations, the SP2 instrument retrieves information about the mixing state of black carbon, providing constraints on the structural representation in microphysical models. In synergy with absorption optical depth retrievals from the AERONET sun-photometer network, such observations provide a unique constraint on transport and abundance of carbonaceous aerosols.

Comparison of the standard and observationally constrained setups will demonstrate the reduction of uncertainty in the simulated radiative effects. Nudged simulations using sector-specific emission inventories will allow quantifying sectoral contributions and the additivity of the individual contributions to the total carbonaceous radiative effects.

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