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Distribution and cycling of terrigenous dissolved organic carbon in peatland-draining rivers and coastal waters of Sarawak, Borneo

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Abstract. South-East Asia is home to one of the world's largest stores of tropical peatland and accounts for roughly 10 % of the global land-to-sea dissolved organic carbon (DOC) flux. We present the first ever seasonally resolved measurements of DOC concentration and chromophoric dissolved organic matter (CDOM) spectra for six peatland-draining rivers and coastal waters in Sarawak, north-western Borneo. The rivers differed substantially in DOC concentration, ranging from 120–250 µmol L^{-1} (Rajang River) to 3100–4400 µmol L^{-1} (Maludam River). All rivers carried high CDOM concentrations, with a_{350} in the four blackwater rivers between 70 and 210 m^{-1} and 4 and 12 m^{-1} in the other two rivers. DOC and CDOM showed conservative mixing with seawater except in the largest river (the Rajang), where DOC concentrations in the estuary were elevated, most likely due to inputs from the extensive peatlands within the Rajang Delta. Seasonal variation was moderate and inconsistent between rivers. However, during the rainier north-east monsoon, all marine stations in the western part of our study area had higher DOC concentrations and lower CDOM spectral slopes, indicating a greater proportion of terrigenous DOM in coastal waters. Photodegradation experiments revealed that riverine DOC and CDOM in Sarawak are photolabile: up to 25 % of riverine DOC was lost within 5 days of exposure to natural sunlight, and the spectral slopes of photo-bleached CDOM resembled those of our marine samples. We conclude that coastal waters of Sarawak receive large inputs of terrigenous DOC that is only minimally altered during estuarine transport and that any biogeochemical processing must therefore occur mostly at sea. It is likely that photodegradation plays an important role in the degradation of terrigenous DOC in these waters.

1 Introduction

The annual flux of terrigenous dissolved organic carbon (tDOC) from rivers into the sea is an important part of the global carbon cycle, estimated at around 0.2 Pg C yr^{-1} (Dai et al., 2012). South-East Asian rivers contribute roughly 10 % of this flux (Baum et al., 2007; Huang et al., 2017; Moore et al., 2011), chiefly owing to the extensive peat deposits along the coasts of Borneo and Sumatra (Dommain et al., 2014; Page et al., 2011). The rivers draining these peatlands typically carry millimolar concentrations of DOC and are often called "blackwater" rivers (Alkhatib et al., 2007; Baum et al., 2007; Cook et al., 2017; Moore et al., 2011; Rixen et al., 2008).

However, our understanding of the fate of tDOC in rivers, estuaries, and in the ocean is still limited. Most tDOC is derived from soils, from which it is leached by rainwater, and it is thus rich in lignin and humic substances. Classically, these high-molecular weight, highly aromatic molecules have been assumed to be inherently refractory to degradation (Bianchi,