Carbon export from permafrost catchments of the Qinghai-Tibet Plateau

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Permafrost carbon pool destabilization causes hydrological export of active layer and permafrost layer carbon, yet the export patterns and magnitudes are not well understood. Here we investigated the radiocarbon (14C) in dissolved organic and inorganic carbon (DOC and DIC, respectively) exported from a mid-sized permafrost river in the Qinghai-Tibet Plateau (QTP). We took advantage of radiocarbon dating and a statistical model and partitioned the riverine carbon from different age categories. DOC and DIC showed bomb-depleted 14C signatures corresponding to millennial ages, which were positively correlated to the permafrost top temperature and affected by active layer dynamics. Further, 83±34.4% of DOC was derived from active layer and permafrost layer pre-aged carbon. DIC export was comprised of a smaller portion of pre-aged carbon (38.5±2.5%) but a much larger flux of pre-aged carbon due to higher annual DIC export. Interestingly, approximately 58% of annual pre-aged DOC and DIC were exported in summer. The monsoon climate-induced high discharge and maximum active layer thaw depth in summer enhanced the remarkably rapid fluvial export of millennial-aged carbon. These results suggest a unique old carbon loss pattern in QTP permafrost region compared to higher latitude permafrost regions with a non-monsoonal climate. As climate warms, more old carbon export is expected and may alter the permafrost carbon-climate feedback and affect the river ecosystem health.