The intra-annual variation of DOC and POC and its importance for the annual carbon balance of a blanket peat catchment

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Introduction

- Northern peatlands store about 1/3 of the global soil C but the predicted long-term global climate change may threaten this storage capacity (Gorham 1991)
- The carbon balance for a catchment should include both atmospheric C exchange (CO_2, CH_4) as well as fluvial C export (POC, DOC, DIC and dissolved CO_2) but CO_2, CH_4 and DOC being the major components
- Recent observations found rapidly rising DOC concentrations in lakes and streams in the UK (Worrall et al. 2004, Evans et al. 2005) and across large areas of Scandinavia and Northeast North America (Skjelkvåle et al. 2005)
- Literature: several influences on DOC concentrations have been proposed: air temperature, land management, pH, the amount and nature of flow, atmospheric CO_2, atmospheric deposition and eutrophication and the occurrence of severe droughts

Objectives (Koehler et al. submitted)

- Detailed analysis of short term variations of DOC concentration in response to changes in stream height
- Estimate of the 2007 riverine export of DOC and its contribution to the annual C balance including CO_2 and CH_4 measured in the Glencar bog in previous years

Site description

- Pristine Atlantic blanket bog situated at 150m asl in Glencar, Co. Kerry, Ireland (51°55'N, 9°55'W)
- Mean annual precipitation: 2571 mm yr^{-1}(2003 to 2006)
- Average temperature in the warmest month August 15.3°C and the coldest month February 6.1°C (2003 to 2006)

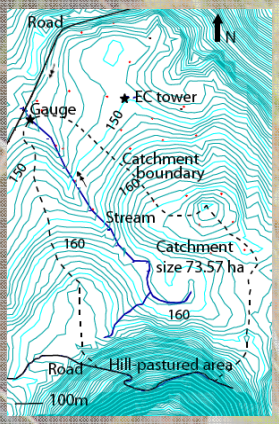

Fig. 1: Site layout map of the Glencar bog

Materials and Methods

- S::can spectro::lyser (scan Messtechnik GmbH, Austria) is constantly immersed in the stream at the gauge site (Fig. 1); it gives half hourly estimates of DOC and TOC concentration in the stream
- 24 bottle sampler (every six weeks from April to October 2007); analysis of the samples for DOC and TOC concentration (instrument: TOC-V cpH (SHIMADZU)) to correct the s::can values
- Stream height recorded at the gauge site (30 min interval)
- Manual measurements of the instantaneous discharge using a current meter to determine the stage discharge

Results

- Moderate change of annual DOC concentration with an absolute range from 2.7 to 11.5 mg L^{-1} (Fig. 2)
- Export of DOC 2007 (Fig. 3)
  - Summer export (May to October) contributed 49% of the annual export of DOC
  - Estimated annual DOC export of 13.7 g C m^{-2}
- Winter/spring 2007 (Fig. 4a)
  - DOC concentration seems to be independent of changes in stream height
  - TOC concentration did not show a clear relationship to changes in stream height
- Summer 2007 (Fig. 4b)
  - DOC and TOC concentrations were dependent on changes in stream height
- Autumn 2007 (Fig. 4c)
  - Minor changes in DOC but peaks in TOC concentration

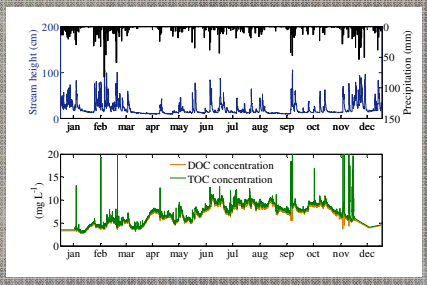

Fig. 2: Top: Half-hourly stream height and daily precipitation 2007; Bottom: half-hourly DOC and TOC concentration

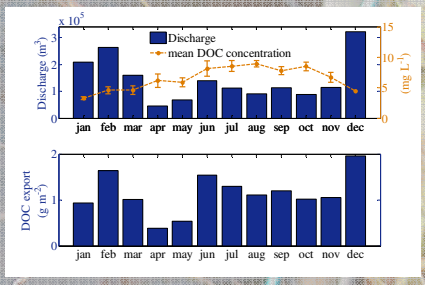

Fig. 3: Top: Monthly water discharge and mean monthly DOC concentration; Bottom: Resulting monthly DOC export for 2007

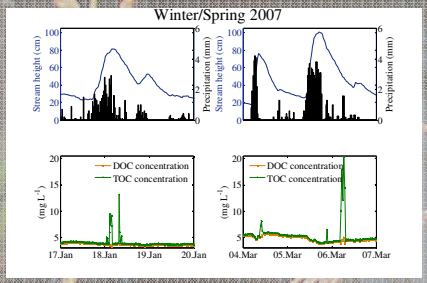

Fig. 4a: Selected flood events during winter/spring 2007 and the corresponding concentrations of DOC and TOC

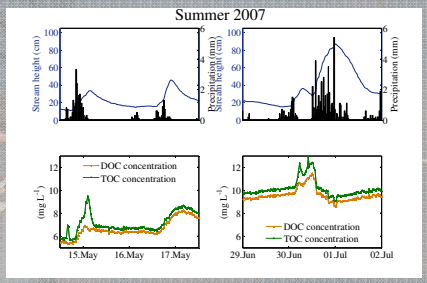

Fig. 4b: Selected flood events during summer 2007 and the corresponding concentrations of DOC and TOC

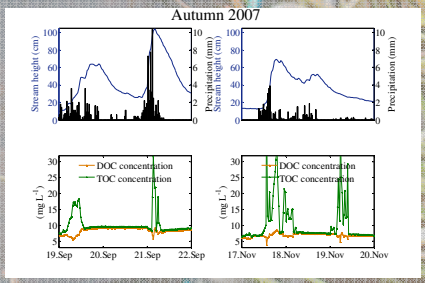

Fig. 4c: Selected flood events during autumn 2007 and the corresponding concentrations of DOC and TOC

Discussion I

Carbon budget including CO_2, CH_4 and DOC

- CO_2 flux 2002 to 2006: average uptake 63.3 g C-CO_2 m^{-2}; but inter-annual variation ranged between 26.4 and 95.9 g C-CO_2 m^{-2} (Sottocornola 2007)
- CH_4 flux 2003 to 2005: loss of 4.8 g C-CH_4 m^{-2}; no inter-annual variation was observed (Laine et al. 2007)

➢ Loss of C as DOC was about 20% the uptake of C as CO_2 and almost three times the loss of C as CH_4

Discussion II

Concentrations of DOC

Reason for autumn flushing of DOC as observed in other peatlands (Worrall et al. 2002):

A reservoir of available C, produced during the summer, accumulates due to a lower runoff in this season and is flushed in the early wet season (late summer / early autumn)

➢ Glencar bog: regular rainfall during summer time results in the continuous depletion of DOC and no flushing of DOC during the late summer / early autumn but instead peak losses in POC

Conclusion

- Both, summer and winter DOC export is important
- The annual export of DOC for 2007 is high (13.7 g C m^{-2}) compared to previously reported values from peatlands but the absolute range of concentrations (2.7 to 11.5 mg L^{-1}) is low (Fig. 2, Fig. 3)
  - ➢ the large amount of discharge (17.25x10^5 m^3 yr^{-1}) (Fig. 3) might cause a dilution effect of the concentrations of DOC and TOC
- Response of DOC and TOC concentration to stream height changes seasonally (Fig. 4)

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