Biogeosciences Discuss., 4, S1163–S1167, 2007
www.biogeosciences-discuss.net/4/S1163/2007/

Biogeosciences Discussions

Interactive comment on "Climate-driven enrichment of pollutants in peatlands" *by* A. Martínez Cortizas et al.

Anonymous Referee #1

Received and published: 15 August 2007

General comments

The manuscript presents the results of a detailed, multi-proxy study of one peat core from a Spanish bog. The aim of the study is "to show that the geochemistry of peat is strongly related to climatically controlled carbon dynamics and that the geochemical record in peat is sensitive to Holocene climate changes" (p. 2098). The evidence presented here and in previous studies by these authors suggests that peat geochemistry is indeed related to carbon dynamics (i.e., peat decomposition). The influence of carbon dynamics on peat geochemical records has been overlooked in many studies, and this alternative view is welcome. However, the evidence for climatic control of carbon dynamics and peat geochemistry is weak - see part 1 of the Specific comments, below. As the stated aim of the study cannot be addressed with the evidence presented, I recommend that the manuscript is rejected in its present form. It may be suitable for publication after major revision, but fundamental changes in the stated aims, data analyses, and interpretation and discussion of results would be required.

Specific comments

1. Links to climate change

Climate was reconstructed based on compositional changes in non-pollen palynomorphs (NPPs) sampled from the same core used for reconstruction of peat decomposition and measurement of element concentrations. There are two major issues here.

Firstly, the climate reconstruction is not independent of the other records. In the original paper outlining the use of NPPs as proxies for climate (Mighall et al. 2006), peat concentrations of different forms of mercury (Hg) were used to construct temperature and humidity indices. In the 2006 paper, the correspondence between changes in Hg-derived indices and the abundance of NPPs was used as evidence that NPPs were indicators of climate. In the present manuscript, two specific NPPs (T18 and T306) were used to reconstruct climate and hence provide a basis for interpreting changes in element concentrations (including Hg). Hence, the reasoning is circular: Hg – climate – NPPs – climate – element concentrations (including Hg).

Secondly, changes in peatland surface wetness (as indicated by humification and biological proxies such as testate amoebae, plant macrofossils and possibly NPPs) are not necessarily indicative of changes in climate. "Surface wetness" is related to water-table depth, which is the difference between the absolute elevations of the peatland surface and of the water table. Water-table elevation is partly dependent on climate, but may also vary independently of climate (in response to changes in hydraulic gradient driven by peat growth, for example). Peatland surface elevation may also vary independently of, or respond non-linearly to, climate (in response to biologically-driven changes in plant composition and litter production, for example). Peatland surfaces are spatially

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heterogeneous on scales of metres, and their spatiotemporal dynamics are complex. Surface structure (and hence surface wetness) can change due to internal processes. Responses to external forcing (such as regional climate change) may be non-linear and/or subject to hysteresis effects. An understanding of how peatlands function suggests that regional climate change cannot be inferred from temporal changes in proxies of peatland surface wetness at one core location (see for example, Foster and Wright 1990; Camill and Clark 2000; Higgins et al. 2002; Belyea and Malmer 2004; Belyea and Baird 2006).

Multi-proxy data obtained from the same peat core are not independent. Peat humification, testate amoebae, plant macrofossils and NPPs respond to surface wetness at a local (< 1 m) scale. Since peat decomposition rate is also related to surface wetness at this scale, it is hardly surprising that the indicators of carbon dynamics (C and N concentration, C/N, delta-15-N) co-vary with the biological proxies. As outlined by the authors, element concentrations become enriched as peat is mineralised, so co-variation between pollutant concentrations and indicators of peat decomposition is also expected. None of the variables measured are necessarily indicative of regional climate, and simultaneous changes in multiple variables may simply reflect common control by local changes in peatland surface wetness. Are there any independent records of regional climate change?

2. Data analysis

Very little information is provided on the data analysis. Since the records are time series, data points are not independent of one another. Time series analysis (i.e., cross-correlation), rather than simple correlation analysis, should be used to detect relationships among variables, and the statistics from these analyses should be presented in the manuscript.

3. Export of pollutants

The proposed link from increased concentrations of pollutants to increased export (via

DOM) is purely speculative. No evidence is presented in this study to show that dissolved organic matter becomes enriched in pollutants with increased peat decomposition. In the absence of any direct experimental data, it would be helpful to discuss some of the studies which have examined controls on Hg release into pore water (e.g., Branfireun et al. 2001; Holmes and Lean 2006).

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Interactive comment on Biogeosciences Discuss., 4, 2095, 2007.