COMMENT ON DECONVOLUTION PROFILES IN SEDIMENT CORES

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Abstract. Heavy metals profiles in sediment cores are discussed in terms of their source profiles, using a simple approach where the mixing is considered as a diffusive process. The results are compared with the deconvoluted profiles obtained by the Fourier transform technique of Christensen and Osuna (1989). Agreement is found for cases of negligible and fast mixing respectively. For intermediate mixing the physical conditions lead to a result different from that of Christensen and Osuna. This comparison highlights the value of combining the two approaches.

1. Introduction

This article is a comment on the deconvolution analysis of sediment profiles, using as an example the authoritative work of Christensen and Osuna (1989). These authors applied Fourier transform deconvolution for the first time to heavy metal sediment profiles in five cores of Lake Michigan. Deconvolution is a sophisticated mathematical approach, especially in the present case where the source signal has no a priori analytical expression, together with a sophisticated mixing model in which diffusion decreases with depth. A question that may arise is to what extent is the information extracted from the deconvolution significant? Some indication concerning this point can be obtained by combining the deconvolution approach with a simpler one, based on the same assumption (mixing approximated by diffusional process). This simplified diffusional mixing approach (SDM) has been used by Mélières et al. (1988) and Pourchet et al. (1989). Such an approach does not replace deconvolution but does provide a test of the assumed mixing. In this approach the shape of the mixed profile is examined to determine whether it is consistent with the assumed mixing; according to the magnitude of this mixing the degree of distortion (and hence the necessity for the deconvolution), in the profile can be determined. From the shape of the mixed signal the main features of the unknown source input can in favorable cases, be extracted.

This approach can be of particular interest when the deconvoluted profiles do not show the same behavior for the different core locations, or display significant differences from the estimated input signals.

In applying such an approach to measurements published by Christensen and Osuna (1989) we first briefly recall the mixing model used by these authors and
then outline the SDM approach. We subsequently interpret the mixing parameters published for each core in terms of mixing type. Finally, we comment on the heavy metal depth profiles in terms of source input. Agreement or otherwise with the deconvoluted profiles is discussed.

2. Mixing Model

In the work of Christensen and Osuna, matter transport in sediment due to mixing is assumed to satisfy the classical advection diffusion equations. The diffusion coefficient, $D(z)$, is taken to be depth dependent with a Gaussian shape of width $\sigma$, with maximum value $D_0$ at the surface. The other parameters are the sedimentation rate $S$, the density $\rho(z)$, which includes a compaction effect that contains three parameters: $\rho_1$, $\rho_\infty$, and $\alpha$ the exponential constant. These parameters are determined from steady state $^{210}\text{Pb}$ activities and $D_0$ and $\alpha$, may be further supported by $^{137}\text{Cs}$ data.

The model used in the SDM approach is based on the same basic assumption: mixing is considered to be a diffusional process. $D$ is taken to be a constant down to a depth $L$, the mixing layer thickness, and zero for greater depths. The sediment profile is expressed as a function of dry matter per unit area rather than of $z$; the question of sediment compaction is thereby avoided. Mixing is described by the mixing function which is the concentration profile of a conservative tracer that results from a unit impulse falling on the sediment surface at a given time, as a

![Fig. 1. Displacement of the maximum of the mixing function with the Peclet number $G$. This curve is obtained from the results published by Guinasso and Schink (1975). $L$: mixing layer thickness, $D$: diffusion coefficient, $S$: sedimentation rate. The hatched area shows the two domains where the mixing function is approximated.](image)