Extreme values of suspended particulate matter concentration and their relation to swell and wind sea in the Belgian coastal zone

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SPM concentration is one of the key parameters to describe the environmental status, and to evaluate and understand the impact of human activities in both nearshore and offshore areas (Fettweis and Van den Eynde, 2003; Dobrynin *et al.*, 2010). Long-term measurements are needed in order to resolve all variations in SPM concentration. Processes affecting SPM concentration are turbulence, tides, neap-spring cycles, meteorological events, season, and other long-term fluctuations. SPM concentration has been measured since 2005 at two coastal observatory sites in the high-turbidity zone off the Belgian coast. The measurements have been carried out using a benthic tripod that allowed measuring during all meteorological conditions, including storms.

The effects of storms on sediment re-suspension and SPM concentration have been investigated using meteorological and wave data from IVA MDK (afdeling Kust - Meetnet Vlaamse Banken). SPM concentration data from MOW1 (51.358°N, 3.098°E) and Blankenberge (51.329°N, 3.107°E) were estimated using the backscatterance data from a 3MHz acoustic Doppler profiling current meter. Because of the large amount (about 1500 days) of SPM concentration data, a detection algorithm for identifying extreme events was developed. This peak detection function allowed eventually cataloging the extreme SPM concentrations and relating them to storm events and wave system data.

Many events of extreme SPM concentration were detected and were related to one of the following specific extreme weather conditions: 1) NNW storms with high swell activity, 2) SW storms and 3) strong NE winds. The wave systems responsible all have a distinct effect on the degree of erosion of the seafloor bed sediments, the re-suspension of SPM concentration and the upward mixing of SPM through the water column. A NNW storm, characterized by swell waves, will cause a stronger erosion of bed sediments forming a high-concentrated suspension layer of SPM near the bottom in comparison to SW storms. The latter, characterized by wind sea, results in the absence of the benthic suspension layer. However, an enhanced upward mixing of SPM through the water column can be observed in contrast to the situation during NNW storms (Fig. 1). This is a consequence of the occurrence of a hindered re-suspension and settling of SPM due to the increased concentration (saturation concept), leading to a dense suspension and a reduced turbulence energy level. In this case, an upward mixing of SPM is attenuated since this is directly related to turbulent energy levels (Winterwerp, 2002; McAnally *et al.*, 2007; Winterwerp *et al.*, 2002, 2012). The SPM processes in the case of strong NE winds is different. Extreme SPM concentrations are mainly caused by advection of SPM from a more remote SPM source (e.g. Scheldt River).

Additionally, the interaction of different wave systems, together with water depth and sediment type will play an important role in understanding this variation in impact of different extreme weather conditions and the presence of extreme values of SPM concentration.

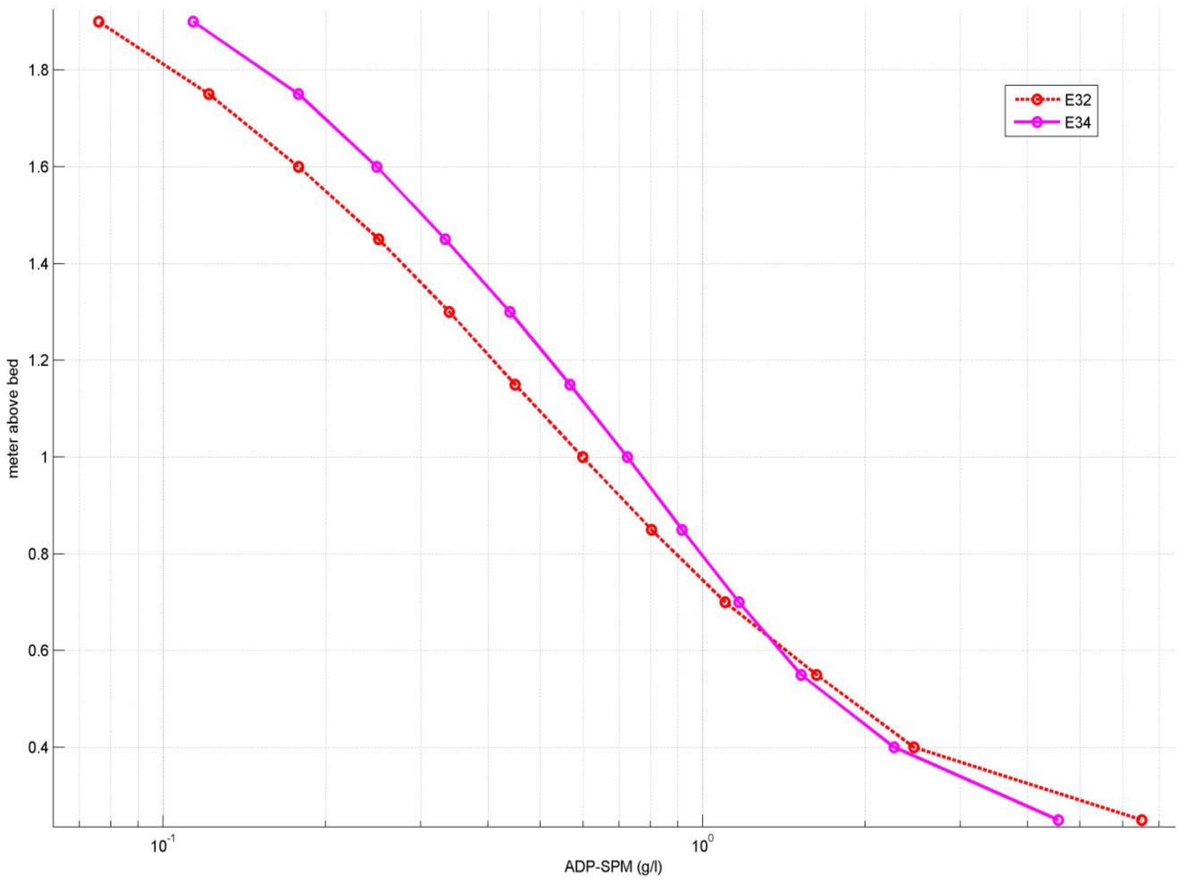

Fig. 4. Vertical profile of the averaged SPM concentration for a NNW storm event (E32, 10/10/2013) and a SW storm event (E34, 28/10/2013). SPM concentrations of E32 are higher at 0.3mab compared to E34, due to the higher erosion capacity of NNW storms. Concentrations at 1.8mab are higher for the SW event that is characterized by enhanced vertical mixing of SPM.

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