

Flocculation in a nutrient-rich coastal area (southern North Sea): Measurements and modeling

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Knowledge on cohesive sediment transport processes is required to predict the distribution of suspended and deposited cohesive sediments in natural or anthropogenically created environments such as navigation channels and harbours. Settling of mud flocs is controlled by flocculation and hence also determines the transport of cohesive sediments. Flocculation is the process of floc formation and break-up which has a direct impact on settling velocity. The settling velocity is a function of the particle size and excess density and varies strongly in natural environments because Suspended Particulate Matter (SPM) consists of a population of flocs with heterogeneous sizes, densities, shapes and constituents (e.g. [Eisma and Kalf, 1987](#)).

Natural SPM comprises many different substances with concentrations that are generally site specific and time varying. Although an accurate taxonomy is currently lacking, the SPM can be divided by inorganic and organic fractions. The inorganic fraction mainly consists of clay minerals, carbonates, quartz and other silicates. The organic fraction of the SPM is prevalently made of a variety of micro-organisms, their metabolic products, residuals from dead organisms, and fecal pellets (e.g. Mehta, 1989; Droppo et al., 1997; Grossart et al., 2003; Bhaskar et al., 2005;). The two fractions of the SPM are intimately related by physical, biological and chemical processes which make the SPM a complex, reactive biomaterial distributed in the water body.

Maggi (2009) presented a flocculation model where a coupling between the mineral and micro-organism dynamics was implemented. The model was calibrated using in situ measurements of SPM concentration, turbulent shear rate and average floc size collected in the Belgian North Sea (Fettweis et al., 2006). Using the tuned coefficients, the model described the particle size observations well. The significant influence of micro-organism and organic matter on the particle size as well as the well-known variation of particle size with turbulent shear stress could be reproduced.

The aim of the presentation is to show results of calibration of the model against a large set of SPM concentration and particle size measurements from different location on the Belgian continental shelf, extended with turbulence shear rate modeled with COHERENS-3D.

References

- Bhaskar, P.V., Grossart, H.P., Bhosle, N.B., Simon, M., 2005. Production of macroaggregates from dissolved exopolymeric substances (EPS) of bacterial and diatom origin. *FEMS Microbiology Ecology* 53, 255–264.

- Droppo, I.G., Leppard, G.G., Flanning, D.T., Liss, S.N., 1997. The freshwater flocc: a functional relationship of water and organic and inorganic flocc constituents affecting suspended sediment properties. *Water, Air and Soil Pollution* 99, 43–54.
- Eisma, D., Kalf, J. 1987. Distribution, organic content and particle size of suspended matter in the North Sea. *Netherlands Journal of Sea Research*, 21, 265-285.
- Maggi, F. 2009. Biological flocculation of suspended particles in nutrient-rich aqueous ecosystems. *Journal of Hydrology*, 376, 116-125.
- Fettweis, M., Francken, F., Pison, V., Ven den Eynde, D., 2006. Suspended particulate matter dynamics and aggregate sizes in a high turbidity area. *Marine Geology*, 235, 63–74.
- Grossart, H.P., Kiorboe, T., Tang, K., Ploug, H., 2003b. Bacterial colonization of particles: growth and interactions. *Applied and Environmental Microbiology*, 69, 3500–3509.
- Mehta, A.J., 1989. On estuarine cohesive sediment suspension behavior. *Journal of Geophysical Research – Oceans* 94 (c10), 14303–14314.