Geophysical Research Abstracts
Vol. 16, EGU2014-633, 2014
EGU General Assembly 2014

OBSERVATIONS OF THE VARIABILITY OF FLOC SIZES ON THE LOUISIANA SHELF

Cihan Sahin (1) and Alexandru Sheremet (2)

(1) Department of Civil Engineering, Yildiz Technical University, Istanbul,Turkey (cisahin@yildiz.edu.tr), (2) Department of Civil and Coastal Engineering, University of Florida, Gainesville, Florida, USA (alex.sheremet@essie.ufl.edu)

The general principles of floc formation under variable turbulent stresses and sediment availability are well known, but the details of the dynamics are still unclear. Flocculation of primary particles occurs when these particles get close enough to collide, and a significant number of these collisions result in adhesion. Particle concentration, the intensity and number of collisions (turbulent shear) control the size of the flocs. However, aggregation transitions into fragmentation if the intensity of collisions or turbulent shear exceeds a certain threshold. In this case, a limiting maximum size might exist (Berhane et al., 1997; Dyer and Manning, 1999; Uncles et al., 2010).

This study investigates the relation between SSC (suspended sediment concentration), turbulent stresses, and floc size using the high-resolution observations of suspended sediment concentration, flow and acoustic backscatter made for 2 weeks in Spring 2008 on the muddy Atchafalaya Shelf. During the experiment, pressure, near-bed current velocities, and acoustic backscatter profiles were sampled using a downward-pointing 1500-kHz PC-ADP (Pulse-Coherent Acoustic Doppler Profiler, Sontek/YSI). In addition, a downward-pointing single frequency ABS (Acoustic Backscatter Sensor, 700-kHz, Marine Electronics, Isle of Guernsey) measured the intensity of acoustic return in the first meter above bed. Thus, acoustic backscatter profiles were observed by two different frequencies (700 kHz for the ABS and 1500 kHz for the PC-ADP). Direct SSC observations were provided by two OBS-3s at 15 and 40-cm above the bed, which sampled synchronously with the PC-ADP.

Simultaneous profiles of SSC and the mean floc size at cm-scale vertical resolution were obtained using acoustic backscatter intensity at the different acoustic frequencies. For the calibration of the instruments, which involves estimation of the instruments system constants, the algorithm described in Sahin et al. (2013) was followed. The mean floc size profiles were obtained at each range bin and propagated along the backscattered profile using the implicit iterative approach, which is based on calculation of SSC and mean size iteratively until the values in the last two iterations converge (Sahin, under review). Estimated SSC profiles are in agreement with OBS point measurements with a correlation coefficient of 0.88 and 0.12 kg/m3 RMS error. The range of floc size estimates is consistent with the floc-size measurements in 2006 at the same site.

Turbulent shear profiles were estimated using the current velocity profiles measured by the PC-ADP. As a first step, the friction velocities are estimated following Lacy et. al. (2005) by fitting the logarithmic profiles in a least-square sense to the current velocity profiles outside the wave boundary layer (Safak et al., 2013), which can then be used to approximate the dissipation of turbulent kinetic energy and the turbulent shear for each bin. The detailed investigation of the resulting SSC, floc-size and the turbulent shear rate profiles showed that low-to-mid values of shear rate promotes flocculation by increasing cohesive sediment particle collision. However, higher turbulent shear strongly affects large flocs, which have weaker internal bonds than those of the primary particles. These field observations support the findings observed in several previous experimental and numerical studies (Parker et al., 1972; Dyer, 1989).

Acknowledgements
This research was supported by the Office of Naval Research funding of contracts N00014-10-1-0363 and N00014-11-1-0269.

References

Berhane, I., Sternberg R.W., Kineke G.C., Milligan T.G., Kranck, K., 1997. The variability of suspended aggregates on the Amazon Continental Shelf. Continental Shelf Research 17, 267-285.

Dyer, K. R., 1989. Sediment processes in estuaries: future research requirements. Journal of Geophysical Research 97, 14327–14339.

Dyer, K. R., Manning A.J., 1999. Observation of size, settling velocity and effective density of flocs, and their fractal dimensions. J. Sea. Res., 41, 87-95.

Hay, A.E. and Sheng J., 1992. Vertical Profiles of Suspended Sand Concentration and Size From Multifrequency Acoustic Backscatter. J. Geophys. Res., 97, C10, doi:10.1029/92JC01240.

Lacy, J.R., Sherwood, C.R., Wilson, D.J., Chisholm, T.A., Gelfenbaum, G.R., 2005. Characteristics of suspended particles at an 11 hour anchor station in San Francisco Bay. Journal of Geophysical Research 110, C06014, http://dx.doi.org/10.1029/2003JC001814.

Parker, D.S., Kaufman, and W.J., Jenkins, D., 1972. Floc breakup in turbulent processes. Journal of the Sanitary Engineering Division, ASCE , SA1, pp. 79-99.

Safak, I., Allison M. A., Sheremet A., 2013. Floc variability under changing turbulent stresses and sediment availability on a wave energetic muddy shelf. Continental Shelf Research 53, 1-10, http://dx.doi.org/10.1016/j.csr.2012.11.015.

Sahin, C., Safak I., Hsu T.-J., Sheremet A., 2013. Observations of suspended sediment stratification from acoustic backscatter in muddy environments. Marine Geology 336, 24-32, http://dx.doi.org/10.1016/j.margeo.2012.12.001.

Sahin, C., under review. Investigation of the variability of floc sizes on the Louisiana Shelf using acoustic estimates of cohesive sediment properties.

Uncles, R.J., Bale A.J., Stephens J.A., Frickers P.E., Harris, C., 2010. Observations of floc sizes in a muddy estuary. Estuarine, Coastal and Shelf Science 87, 186-196.