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Interactive comment on "Inversion of the volume scattering function and spectral absorption in coastal waters with biogeochemical implications" *by* X. Zhang et al.

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I have found this paper to be innovative and quite thorough in its description and analysis of a remarkably complete experiment in terms of the instrumentation used. It is certainly worthy of publication. I will therefore restrict my comments to some general caveats about the approach that amplify some of the comments of the authors themselves. A first specific caveat concerns the use of Log Normal distributions. Even though they are convenient mathematically and a reasonably good fit the size distribution one must be really quite careful particularly with the zero order Log Normal when using it to evaluate the cross-sectional area or the volume of the particles as this dis-

tribution has a very slowly decaying asymptote and the peak of the second and higher moments can in fact in some cases lie several sigma's away from where the parameters of the distribution where measured. An offset Gamma distribution may in fact be a better fit and has the benefit of a well behaved asymptote which restricts the dispersion of the moments. It also has a basis in physics as it accounts for the distribution of crushed minerals (see Rosin-Rammler or Weibull distribution) and would possibly be a good fit to the mineral part of the NAP. My other caveats are more of a general nature and concern the fact that when solving an undetermined inverse problem one must be extremely careful in assembling the constraints to make sure that the assignation itself does not imply the results. I.e. As in the case of LISST if we assume N populations with Log Normal distributions and use a Mie solution we will obtain a fit to any data the instrument collects. We have merely found the parameters of our model that fit the data. There is nothing that guarantees us that the model is anywhere close to the reality. Even though the authors are not using a Mie solution and have in fact wisely chosen a non-spherical model for the particles, it is still very simple when compared to real structures which have shells and inclusions with varying indices and transparencies. The effect of complex structure is in fact dominant in the back-scattering hemisphere as it is the part of the phase function for large particle that is controlled almost entirely by reflection from the envelope and internal components. Simply assuming a single shell will almost double the backscattering from any particle, never mind more complex internal structures. The assignation of a very small particle component which will obviously have a Rayleigh or Rayleigh-Gans distribution with very large proportion of backscattering will always fill any gap left between the theory for large particles and the experimental data in the backscattering hemisphere. This component may however in a very large part be there just to compensate for the inadequacy of the model used for the structures of the large particles. To my mind this is an open point at this time and is the one significant but unavoidable weakness of the approach presented by the authors. There may be ways of carefully teasing out weather those very small particles are really there or not from other correlations in the data from the various instruments. The correlation would obviously need to be strong for the argument to hold. In summary the paper is excellent. The VSF inversion is reasonable as an approach but a great deal of care must be applied as in the case of all underdetermined inverse problems where the actual constraints imposed on the solution may dictate the results. As always, one has to be very careful in solving inverse problems that you not simply get back what you put in. In this respect the one significant but unavoidable weakness of the approach presented by the authors is the assumption of the large particle phase function and whether its inadequacy to account for internal structures and other complex features of real particles is what creates a gap between theory and data that they need to fill with a large very small particle component.

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