POTENTIAL INSIGHTS INTO PHYSICAL CHARACTERISTICS OF SEDIMENT FROM SIMULTANEOUS OPTICAL SIDE SCATTER AND BACK SCATTER TURBIDITY MEASUREMENTS

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Abstract: Turbidity is one of the most common surrogate measurements for suspended sediment concentrations (SSC) in natural systems. One weakness of turbidity measurements is that the data collected provide no information regarding the size or shape of the particles. The Campbell Scientific OBS500 measures both side scatter and back scatter simultaneously. Normally side scatter (SS) measurements are considered more accurate at lower turbidities (0.4-1000 TU) while back scatter (BS) measurements are regularly calibrated from 0.4-4000 TU and possibly up to 10000 TU in the future. Campbell Scientific Inc. (CSI) has noticed at multiple testing locations that SS and BS measurements often track closely both in magnitude and relative change, while in other systems the measurements track with regards to relative change but are offset by 10-30 turbidity units.

CSI hypothesized that the difference in measurement magnitude is tied to size, shape, color, absorption, biological matter or other physical attributes of the water. CSI paired a controlled laboratory study with field data from two deployment locations (Spring Creek near Mendon, UT and the Wilmington River near Priest's Landing, GA) to determine the impact of mineralogy on the SS and BS measurements. Sediment samples from both field sites will be analyzed for mineralogy and morphology by DCM Sciences in Denver, CO.

The controlled laboratory study completed simultaneous SS and BS measurements at multiple concentrations over the shared calibration range of the SS and BS sensors (0-1000 TU). Six different mineral suspensions were tested at each of the six concentrations (0, 10, 100, 250, 500, and 1000 mg/L). The mineral suspension included multiple size fractions – mineral combinations of kaolinite, bentonite, quartz, feldspar, mica, and anthracite (Mica 700, Mica 2400, Mica 4000, 200 Mesh Feldspar, 325 Mesh Feldspar, Bentonite, Calcined Kaolinite, Georgia Kaolinite, Natural Brown Sand, Utah Coal, and Wyoming Coal). Also quartz suspensions at the six concentration levels were created from sieved art sand. The colors tested included white, blue, red, green, and black to determine if SS, BS, or their interaction were significantly different for the same mineral and particle size but different colors. In total SS and BS data were collected for 96 suspensions by three OBS500 sensors. A total of 600 data points were collected per treatment level.

The data collected during the laboratory study were used to develop a multivariate, linear regression model to predict concentration (mg/L) as a function of SS, BS, and particle size. This model was then tested with an independent set of laboratory data. The verification test was completed using known concentrations of natural sediments from the Spring Creek field site near Mendon, UT. Five concentrations were chosen randomly over the modeled concentration range of 0-1000 mg/L. The prediction model was also tested with the long-term turbidity data collected at the two field sites and their sediment mineralogy and morphology.