Xeos Ares Turbidity Sensor - Field Comparison

Introduction

The Bay of Fundy, Canada, is filled and emptied of 100 billion tons of water twice each day. A portion of that water is forced through the Minas Channel in the Minas Basin, producing the world's highest tides. All of that energy keeps a lot of sediment suspended in the water, making it an interesting place to test the Xeos Ares turbidity sensor.

Field Test Setup

Masts were placed on the tidal flats at two locations along the north side of the Minas Basin: Economy and Portapique, Nova Scotia. The water levels in these areas vary by roughly 10 meters through the course of a tidal cycle. One mast is shown in the figure below. Data was collected in the summer of 2022 over the course of four weeks in July and August. Sensors were mounted at five heights from the bottom and connected to a data logger and battery pack. The sensors were oriented facing down to avoid sediment building up on the sensor faces. At three matching mast-heights, third party turbidity sensors from an industry leader were added for comparison purposes. The data logger cycled power to the Ares turbidity sensors, collecting data for 1-minute at 20-minute intervals and recorded the ASCII output from the Ares.

Figure 1: A satellite view of the Portapique estuary (left, image from Google Maps) and mast with sensors at Economy (right).

Example Data

In post-processing, data for each 1-minute of sampling was averaged to be able to compare to the third-party sensor. Data representing in-air measurements was then removed from both data sets. Data for the full deployment is shown below demonstrating the wide variation in turbidities and the excellent agreement between sensors. Upward spikes in readings from the third-party sensor on days 17 and 23 don't follow the typical tide cycle pattern and may be due to debris in the sensor's field of view.

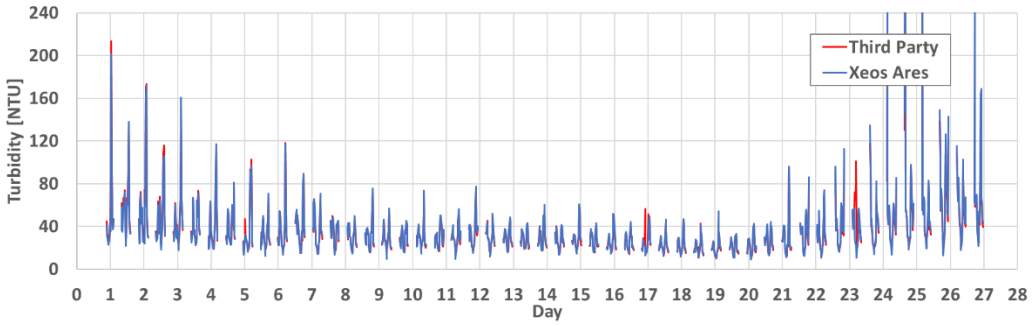

Figure 2: Comparing to a third-party sensor over 27-days moored in a sediment-rich tidal zone.

The plot below zooms into a portion of the same dataset showing the complex changes in turbidities through the tide cycle.

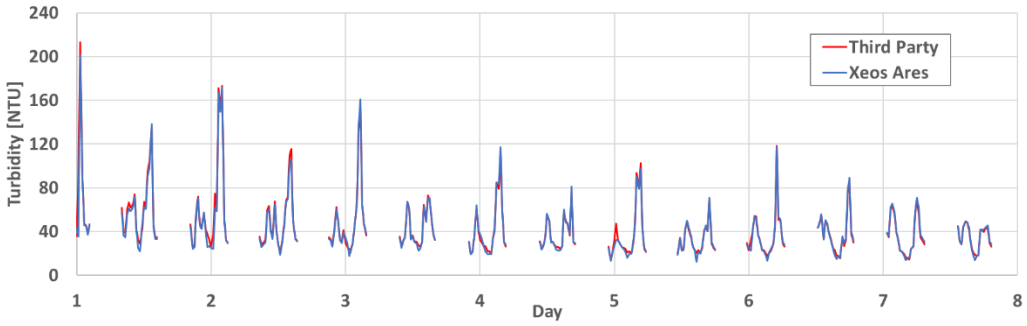

Figure 3: Detail showing the excellent agreement through the complex tidal cycle.

The plot below zooms in further, to the single tide cycle that produced the maximum turbidities on Day 24. The plot below shows the data with a linear time axis. As mentioned earlier, data was collected for 1-minute, every 20-minutes. Each of those 1-minute windows is represented by a cluster of points, with a variability that is dependent on the sediment conditions at that time.

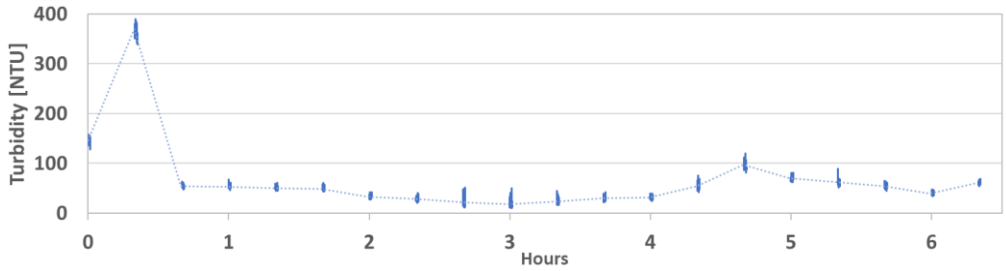

Figure 4: Detail of the data collected for a single tide cycle.

The plot below correlates the data for the entire moored period. The agreement is very good. As mentioned earlier, there are a few points where the third-party sensor was reading higher than expected, but that is likely due to debris in its field of view. The R^2 value is for the entire dataset, but the plot only shows NTU up to 200, as the data above that value are very sparse.

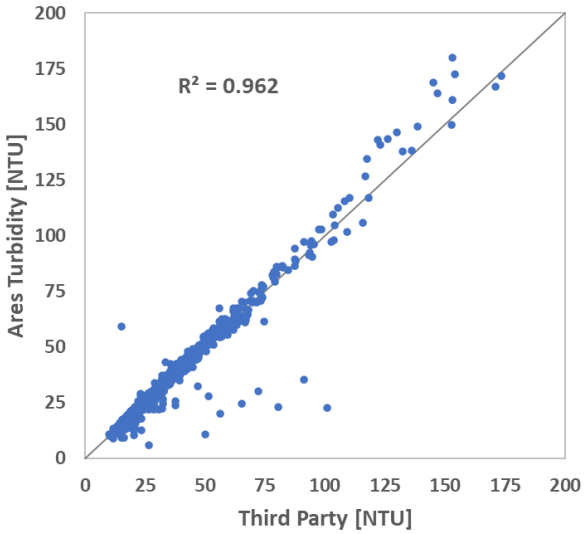

Figure 5: Correlation between NTU readings from the Ares and a third-party sensor, using one month of field data.

Other Field Comparisons

CTD profiles are presented for two localities. Bedford Basin, Nova Scotia is a well-studied deep body of water near the Beford Institute of Oceanography. Lime Kiln Bay, New Brunswick, is an aquaculture site.

Figure 6: Satellite view of the Bedford Basin, Nova Scotia (left; upper left of image) and Lime Kiln Bay, New Brunswick (right; upper part of image). Images from Google Maps.

Turbidity data from the profiles are shown below. The turbidity values here are much lower than the moored dataset. What appears to be noise in the Ares data is real particulate variability in these waters. It is easily shown with lab tests that the inherent sensor noise is negligible. This variability may be of interest in some scenarios. Statistical analysis and smoothing can be applied to the dataset post-collection. Or, if a smoother dataset is preferred, the Ares includes a setting to output frames that are an average of ten readings. That reduces the variability at the source, eliminating the need to do the step in post-processing.

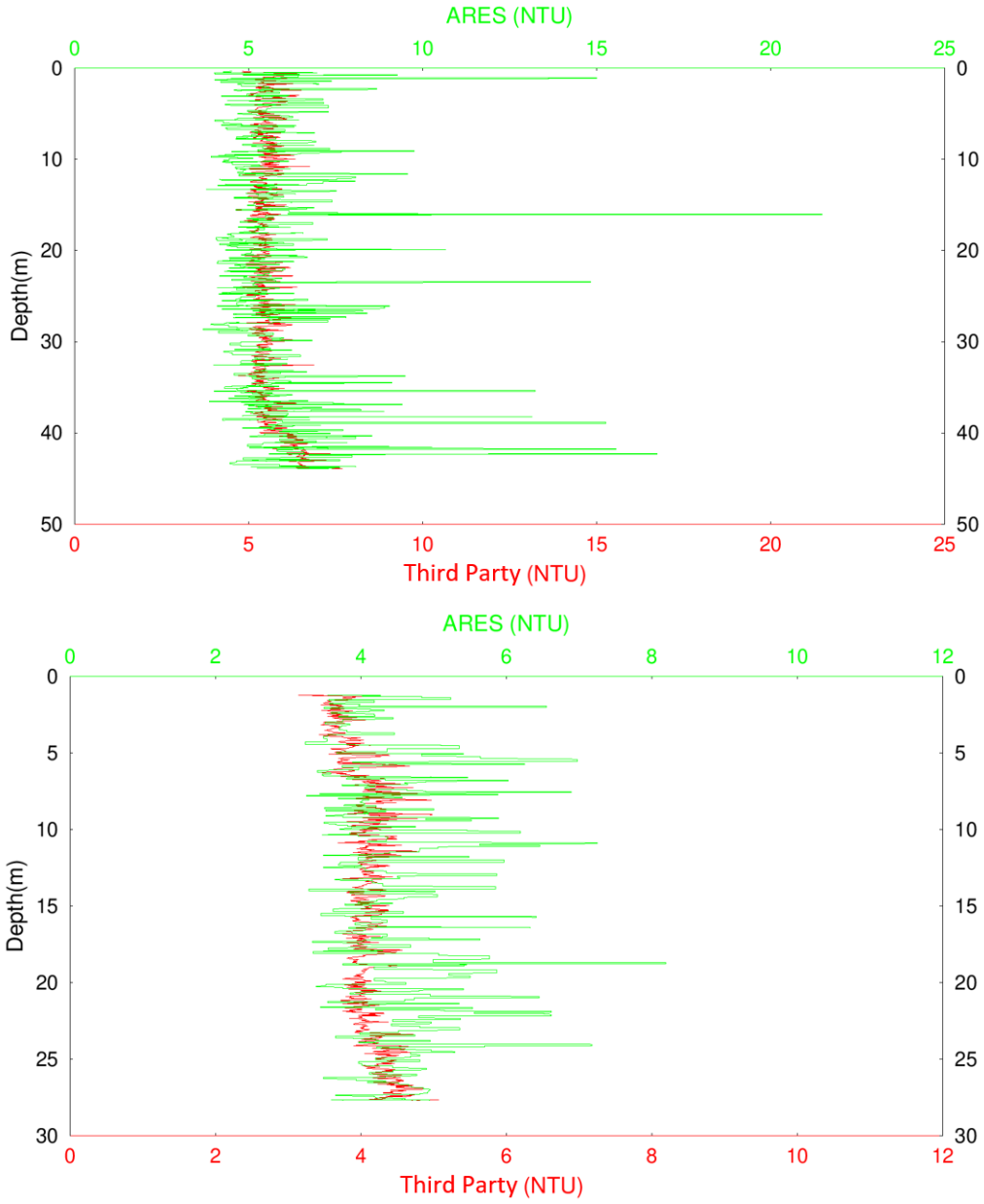

Figure 7: Example profile data for Bedford Basin(top) and Lime Kiln Bay (bottom).