ASL Environmental Sciences

Special Sediment Newsletter

Fall 2016

This special edition demonstrates ASL's experience with diverse applications measuring and modelling sediment and bedload transport from river to ultra-deep ocean including:

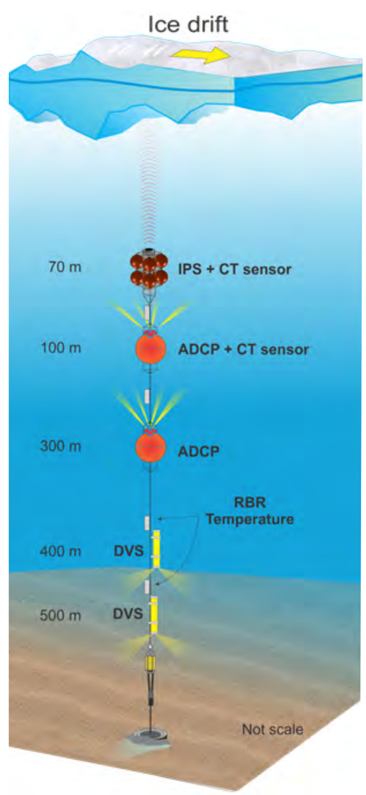
- Multi-parameter instrumentation
- Remote sensing
- Numerical modelling
- Water sampling

For further details please refer to www.aslenv.com

Measuring Sediment Processes, from Lakes to Deepwater

ASL has a long history of measuring sediment processes in challenging environments. Deployments vary from lake and coastal applications using small skiffs, holes in the ice and helicopter deployments, to deeper ocean work either on large vessels or profiling on autonomous vehicles. These deployments may be in the field for several days or for over a year.

Downward looking Acoustic Doppler Current Profilers (ADCP) and multi-frequency acoustic profilers can provide measurements of suspended sediment concentration, currents and bedload transport. Direct measurements of bedload can be achieved using a bedload sampler. Optical backscatter instruments provide a point measure of turbidity. Water samples collected using Niskin bottles provide calibration data for total suspended sediment values.



Mooring design and construction is critical to the success of each project. ASL use numerical modelling software to help account for current drag, buoyancy, and to calculate anchor requirements, thus achieving a load rating for each application. Deployments in strong tidal flows need to be low-drag to limit depression, or via bottom frames which provide a stable platform and can withstand debris and high suspended sediment.

Deepwater moorings must be rated for extreme depths, with syntactic foam flotation. Taut line moorings can be 1000's m long and require special vessel positioning capabilities. Recovery can be equally challenging and ASL recently have achieved a 100 % recovery rate for a Pacific LNG project over a three year period.

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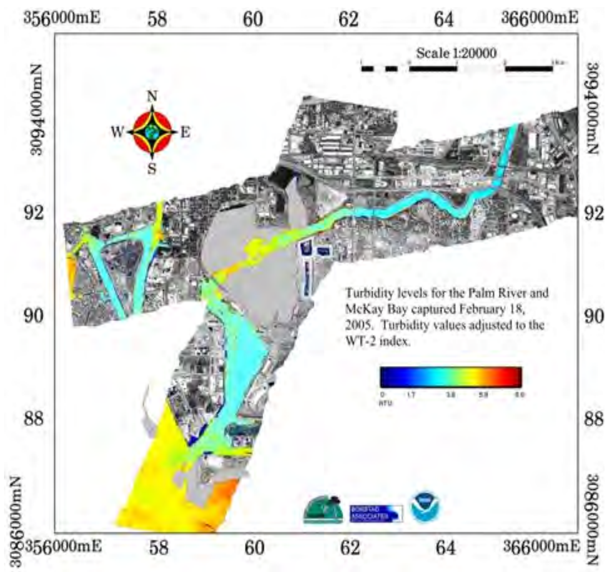
ASL Environmental Sciences Inc.
#1-6703 Rajpur Place, Victoria, BC, Canada V8M 1Z5
Phone: 1-250-656-0177 **Fax:** 1-250-656-2162 **Email:** asl@aslenv.com
www.aslenv.com

Water Quality in Florida's Waterways

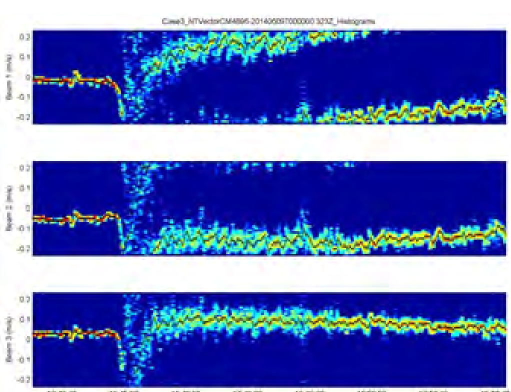
In 2005 ASL helped the Florida Department of Environmental Protection develop new ways of detecting and quantifying land runoff pollution using remote sensing; indiscrete pollutant runoff into waterways is far harder to detect, and thus monitor, than effluent discharge from a point source. For ASL this upheld our commitment to continue expanding the boundaries of marine remote sensing applications.

ASL flew their airborne multispectral sensor over selected waterways around Tampa Bay, West Florida. Two algorithms for estimating water turbidity were developed and validated against in situ data, achieving an $R2 = 0.91$ for turbidity samples drawn within 3 hours of the flight; a successful and informative result. The figure shows the results for the Palm River and McKay Bay region where sections of the river display moderately high values (yellow to orange). The project also successfully developed and tested algorithms for chlorophyll and dissolved organics.

Remote sensing technology constantly evolves and ASL continue to offer new commercial applications for sediment load detection and all other water quality parameters.



An investigation of Turbidity Flows for Natural Resources Canada (NRCan) in the Fraser River Delta



In collaboration with NRCan and Ocean Networks Canada, ASL is studying the highly energetic turbidity flows observed at the Delta Dynamics Laboratory (DDL) at the mouth of the Fraser River, Vancouver. In other parts of Canada and the World, marine landslides can be destructive to offshore infrastructure such as pipelines. On occasion at the Fraser Delta, small slides have tumbled the DDL bottom frame down slope making it an ideal laboratory to research this type of flow.

Dr. Gwyn Lintern, Geological Survey of Canada at NRCan, is leading this work. He recognised that ASL's specialist data analysis skills could help further understanding of these highly dynamic and disruptive flows.

ASL developed a method to quickly identify turbidity events within the huge 2 terabytes of multi-sensor data from 2012-2016. The previously unusable Acoustic Doppler Velocimeter data from the events were analyzed with a unique algorithm.

For 2016-2017, ASL will support the DDL by providing an Acoustic Doppler Current Profiler mooring free of charge. This will provide information on near-bed bottom currents and the moving sediment just above the seabed. The mooring, which has been used successfully in a tidal inlet with 3 ms^{-1} flows, is designed to survive near seabed turbidity flows that can generate speeds up to 8 ms^{-1}.

Numerical Modelling and Remote Sensing put Sediment Transport in Perspective for an LNG Project

ASL uses DELFT3D and our in-house COCIRM-SED 3D coupled numerical models to simulate sediment transport for dredging and pipeline projects. They provide a quantitative visualization of the sediment distribution patterns based on near realistic inputs of excavation equipment, trench sizes, sediment particle size distribution and the dynamical oceanography.

Recent modelling work for a planned LNG pipeline in British Columbia achieved very high resolution, using 10 m grid cells along the pipeline route. This enabled detailed representation of the dredge and backfill sediment release points and predicted dispersion pathways. An improved understanding of the bottom current shear and resuspension of material on the spoil piles was achieved; an important consideration for spoil pile stability and planning.

ASL combined modelled results with high resolution satellite data to support the Environmental Assessment (EA). The satellite images show the background sediment levels and plume pathways around the study region, providing a valuable view of the seasonal and tidally variant background sediment distribution. Areas pinpointed by the model as regions of high shear stress could be related to naturally occurring events, assisting planning and sequencing of the backfill.

Cooling Water Intake for a Nitrogen Plant in the Gulf of Mexico

ASL used satellite data to qualitatively describe the suspended sediment loads in the seawater used for cooling water by a large nitrogen generation plant. The plant was suffering extensive internal corrosion due to high suspended sediment loads in the intake.

The satellite image below shows the turbidity patterns in part of the Gulf of Mexico, with the orange/yellowish areas demarking river plumes with high sediment levels. The whitish areas are resuspended bottom sediments and the dark blue shows clear water. By analyzing a temporal sequence of data the seasonal and annual trends in turbidity were identified and the water quality around the intake zone could be characterized. Any re-entrainment of suspended sediment due to eddies could also be assessed.

With water shortage becoming an increasingly recognized problem in countries worldwide, industries requiring large quantities of water to operate are being encouraged to locate at the coast or large lakes. Sediment loads can vary significantly seasonally and can be an issue, ranging from clogging filters to corrosion.

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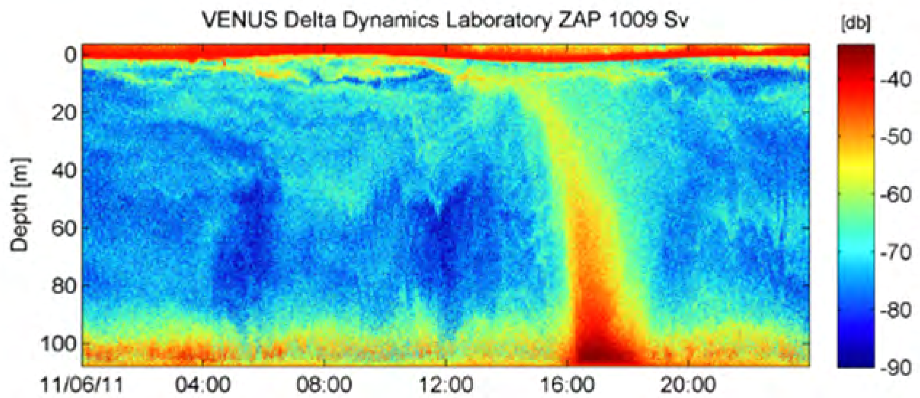
ASL's AZFP Detects Vertical Sediment Distribution off the Fraser River Delta



Ocean Networks Canada has been operating ASL's upward looking sonars since 2007 on the Venus network. One of ASL's instruments, a single frequency 200 kHz sensor, was deployed in 100 m of water at the mouth of the Fraser River, Vancouver at their Delta Dynamics Laboratory. It was deployed to view sediment distribution.

This was a new application for the Acoustic Zooplankton Fish Profiler (AZFP), but using its 200 kHz channel it successfully detected sediments throughout the water column. The figure shows the AZFP backscatter from river sediments flowing out as a pulse on the ebb tide. The strong, near bottom return (red) indicates the higher concentration near the seabed as the sediment sinks. Simultaneous ADCP data confirm the presence of the sediment and negative vertical velocities provide a measure of the vertical settling rate. This is a valuable new use of the AZFP instrument where high suspended sediment concentration is of interest, providing data over the entire water column, something traditional single sensor optical methods cannot achieve.

The AZFP now also offers a 2000 kHz (2 MHz) channel as a single-frequency instrument or part of a multiple-frequency instrument for monitoring of sediments and turbidity flows. The higher frequencies are more sensitive to smaller sediment particles and concentrations but have a shorter range. For more information see: www.aslenv.com/AZFP.html.

ASL Equipment Lease Pool for Sediment Measurements

- Turbidity loggers (OBS3A and Alec): OBS3A's can provide real-time data via cables. Alec units are wiped for long term stability in biofouling environments.
- Niskin water bottles for collection of suspended sediment that can be analyzed for suspended sediment concentration.
- Ponar bottom grab samplers, both petite and standard, for collection of bottom samples.
- ADCPs, downward looking with the bottom-track feature, can provide a measure of bedload transport.
- RBR CTD's with turbidity sensors for profiling or self-contained deployment.
- ASL AZFP accoustic multi-frequency water column profilers can map sediment distribution over the water column.
- Imagenex scanning sonar for bedform studies; both real-time or in combination with an IRIS data logger.

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