Quantitative comparison of airborne remote-sensed and in situ Rhodamine WT dye during RIVET & IB09

Luc Lenain[1](llenain@ucsd.edu), David B Clark[2], Robert T Guza[1], Kai Hally-Rosendahl[1], Nick Statom[1] , Falk Feddersen[1]

[1]Scripps Institution of Oceanography, University of California, San Diego 9500 Gilman Dr., La Jolla, CA 92093-0213, [2] Woods Hole Oceanographic Institution, Woods Hole, MA

OS21B-1756

1. Introduction

The transport and evolution of temperature, sediment, chlorophyll, fluorescent dye, and other tracers is of significant oceanographic interest, particularly in complex coastal environments such as the nearshore, river mouths, and tidal inlets. The fate of littoral pollutants and contaminants is of significant interest to the Navy. Tracer transport in the nearshore is relevant to chemically detecting mines, avoiding contact with dangerous substances, and predicting where optical clarity will be clouded by fine sediments and silt.

Remote sensing improves spatial coverage over in situ observations, and ground truthing remote sensed observations is critical for its use. Here, we present remotely sensed observations of Rhodamine WT dye using the SIO Modular Aerial Sensing System (MASS) and compare them with in situ observations from the IB09 (0-300)m seaward of the surfzone, Imperial Beach, CA, October 2009) and RIVET (New River Inlet, NC, May 2012) field experiments. During RIVET, dye is also characterized using a pushbroom hyperspectral imaging system (SPECIM AISAEagle VNIR 400-990 nm). During IB09 and RIVET, in situ dye was measured with two GPS-tracked jet skis, a small boat, and moored observations. The in situ observations are compared with the remotely sensed data in these two complex coastal environments.

2. Modular Aerial Sensing System (MASS)

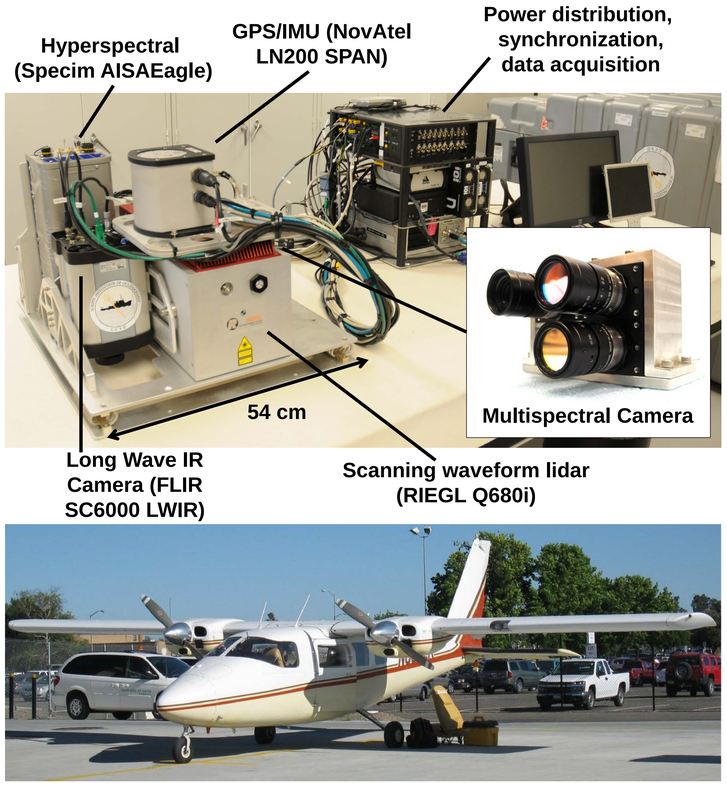
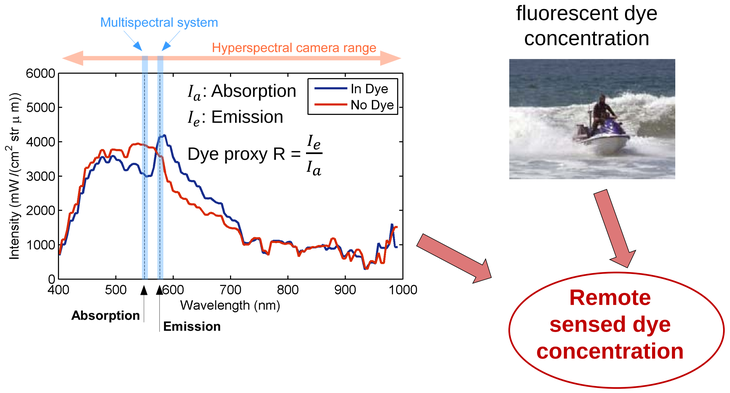


Fig. 1. (top panel) Modular Aerial Sensing System (MASS) at the Air-Sea Interaction Laboratory, Scripps Institution of Oceanography (upper panel). The instrument package was installed on an AspenHelo Partenavia P68 aircraft (bottom panel) for the RIVET experiment, May 2012. The airborne system includes a scanning waveform Lidar, Long-Wave Infrared (LWIR) camera, SST sensor, visible high resolution camera, hyperspectral (VNIR) imager, and a GPS/IMU system.

(See http://airsea.ucsd.edu for more MASS detailed specifications)

3. Quantitative remote sensing of Rhodamine WT dye using hyperspectral imagery & in-situ calibration

Dye concentrations are estimated from hyperspectral and multispectral camera systems that measures the emission and absorption wavelengths of Rhodamine WT dye calibrated with in-situ jetski based measurements (Clark et al., 2009).



4. IB09: Surfzone dye release

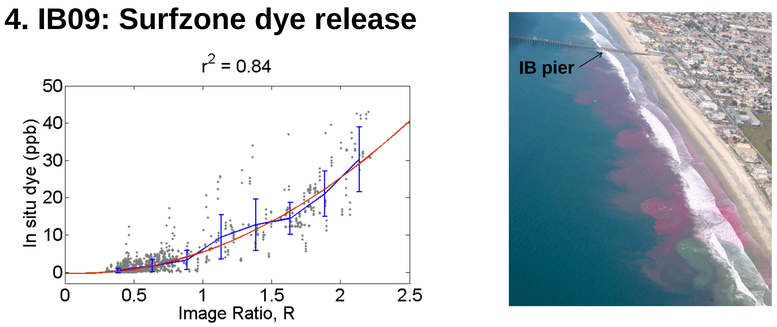
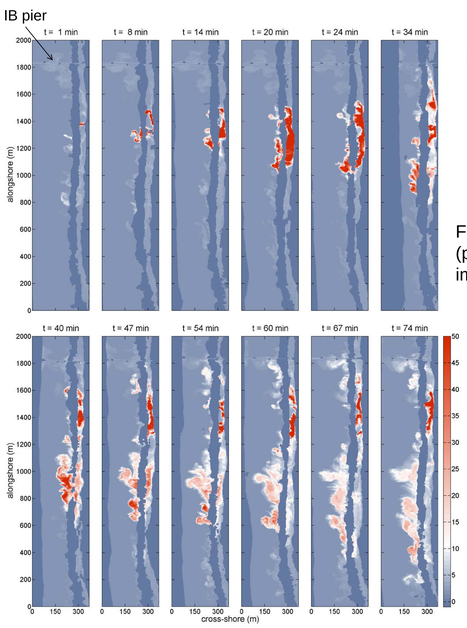


Fig. 2. (gray dots) In situ measured dye concentration as a function of the image ratio, R, (blue curve) bin-averaged values with error bars indicating the standard deviation and (red curve) quadratic fit to the data. The r^2 = 0.84 is determined from the full non-binned data set.



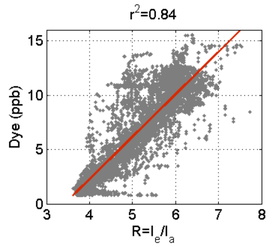
The IB09 Experiment took place at Imperial Beach, CA in the Fall of 2009 with the goal of understanding the exchange of tracers between the surfzone and inner-shelf

Fig. 3. Fluorescent dye concentration (ppb, in color) estimated from aerial images at Imperial Beach, California.

A continuous dye release began at time t=0 and was located at 325 m cross-shore and 1380 m alongshore. The dye is dispersed by surf zone currents and eddies, with dye covering nearly 2 km alongshore after 75 minutes. Regions (in gray) outside of the camera's field of view, containing white foam from breaking waves, or containing the beach face are removed. Note, traces of dye from a previous release are visible, especially for t < 14 minutes.

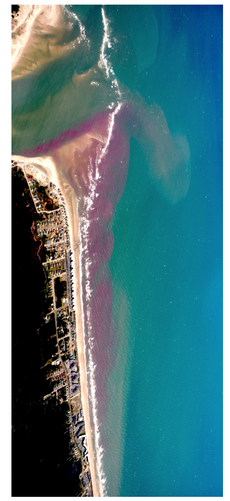
5. RIVET-I: River mouth dye release

The RIVET I field experiment took place in May 2012 at the New River Inlet, N.C., a small inlet with strong tidal currents and small to moderate waves that often broke on a shallow ebb shoal. During RIVET I, we measured dye transport and dispersion from within the New River Inlet to 2-3 km offshore and alongshore, at different tidal stages. Dye was measured from a variety of platforms including Wirewalkers, jetskis, and a boat-towed array. On five of the dye releases, there were also concurrent airborne observations using the MASS system.



Results from May 7th 2012 are shown where dye was continuously released for 140 min at a rate of 13 mL/s (30 gallons total) near the south side of the inlet (see star in bottom-right below). Dye was tracked in situ (bottom right panel) with the jetski.

Repeated flight passes over the dye plume were conducted approximately every 5 min for up to 4.5 hr in duration with a swath width ranging from 400 to 2000 m (altitude dependent), and provided a unique spatio-temporal depiction of the plume



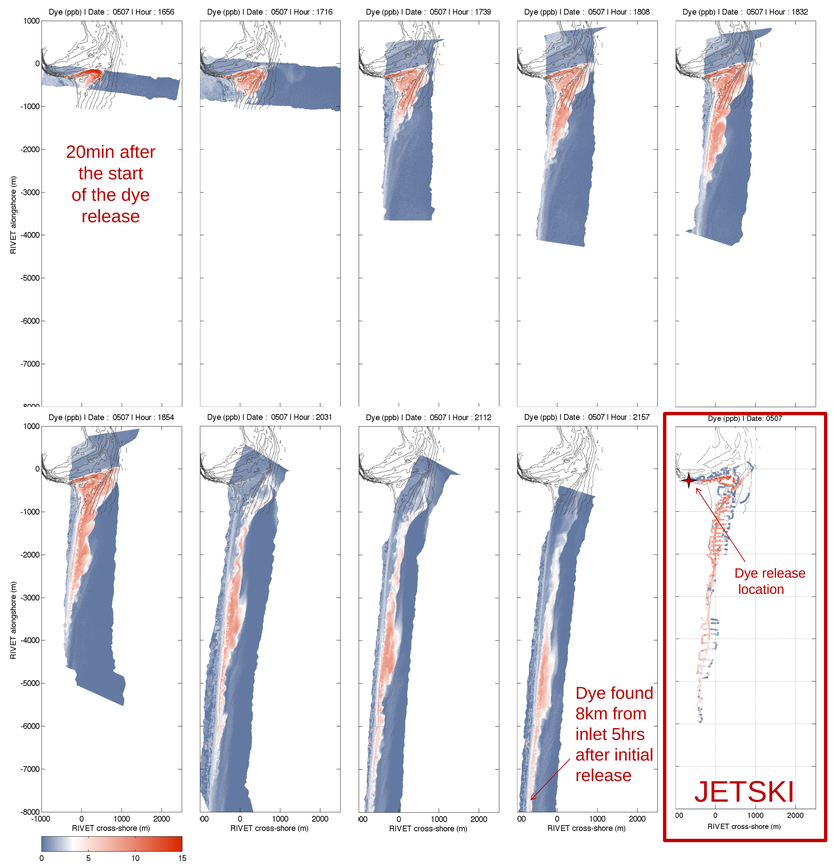


Fig. 4. Fluorescent dye concentration (ppb, in color) estimated from aerial images at New River Inlet, NC on May 7 2012. The bottom right panel is the in-situ jetski based dye observations spanning the airborne hyperspectral observations

6. Summary

- A dye proxy is developed using the measured radiance at the emission and absorption wavelengths of the Rhodamine WT dye.
- Unique spatio-temporal depiction of the evolution and transport of dye plume in two complex coastal environments.