

# **MULTIPLE DATASET WATER-QUALITY ANALYSES IN THE VICINITY OF AN OCEAN WASTEWATER PLUME**

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## **1. INTRODUCTION**

The White's Point ocean outfall is the method of disposal for approximately 374 million gallons of treated wastewater per day from Los Angeles County. The photosynthetic characteristics and particle distributions have well-defined properties that can be exploited to yield information on transport of the plume, mixing dynamics, and resuspension of bottom sediments during periods of bottom current velocity in excess of ca. 0.1 m/s. This plume of particles serves as a conservative tracer, which has been studied using a number of sampling platforms and strategies, including underway sawtooth, or "tow-yo" sampling, moored arrays of instruments, stationary profiling, and now for the first time with remotely-sensed multispectral color imagery.

Research in this area has previously focused on examination of the plume as it relates to the local current field and transport of particles, and on the resuspension of bottom sediments during periods of increased currents (Washburn et al, 1992). In addition, Wu et al (unpublished graduate work) have elucidated techniques for separating the particle signal into photosynthetic and nonphotosynthetic components, based on the beam attenuation to chlorophyll fluorescence ratio. High-frequency time series measurements of the current field and bio-optical characteristics at a site close to the waste diffusers have also been collected. These are being analyzed for the spectral characteristics of the longer-timescale variability, in order to predict particle transport through simple meteorological measurements (Dickey et al., unpub.). With the advent of high spectral and spatial resolution imaging spectrometers such as AVIRIS, it is now possible to construct causal relationships between particle distributions and signature of the upwelled radiance from the surface. The availability of a constant and well-characterized source of material lends itself well to models which predict upwelled light as a function of particle distributions, photosynthetic pigments, colored dissolved organic material, and detrital and degradation products of photosynthesis. In addition, the spatial coverage provided by the tow-yo sampling device, combined with the profile measurements of the light field, should facilitate the best inverse modeling attempts possible thus far.

## **2. STUDY SITE**

The White's Point/San Pedro Channel data were collected March 21, 1991, between the Palos Verdes Peninsula and Catalina Island off the coast of Southern California, at 33° 41.2' N, 118° 20.41' W. The day of the overflight was subsequent to several days of storms, and the sea state was somewhat rough. A few clouds are observed in the images, but overall visibility was quite

good. For this analysis, only the two images closest to White's Point are examined, for a total of 805 lines of image data.

### 3. *IN-SITU* MEASUREMENTS

The primary in-water instrument was a "tow-yo" platform operated by researchers at USCB and USC. Towed behind a ship, it is constantly raised and lowered to produce a sawtooth sampling pattern. Data collected in this manner can be interpolated to produce a grid of sampled points, at a spatial resolution that coincides with the SNR requirements of the analyses. Measurements collected with this instrument are: percent attenuation of a collimated beam of light at 660nm (transformed to beam attenuation coefficient, hereafter beam *c*), which is proportional to the concentration of particles in the size range 1-50 $\mu$ m; stimulated fluorescence of chlorophyll (chl-*fl*), where chl-containing particles in the sample volume are excited by a blue-green light, after which the emission of red light is collected and is proportional to the concentration of chl and chl-like pigments; photosynthetically available radiation (PAR), or broadband spectral irradiance, integrated from 400 to 700nm; microconductivity, used as a measure of small-scale turbulent processes that are proportional to the rate and intensity of mixing; and the underway current field.

Shipboard measurements were simultaneously carried out by a team from the Jet Propulsion Laboratory. Their measurements included the downwelling irradiance at 13 wavelengths, upwelling irradiance at 8 wavelengths, and upwelling radiance at 8 wavelengths, using a Biospherical Instruments MER-1048 bio-optical profiling system. Additional profiled measurements were PAR, chl-*fl* and beam *c*. Bottle samples for HPLC determination of chlorophyll and accessory pigments were collected for later analysis.

For the two months preceding the overflight, a physical and bio-optical mooring was placed near the location of the outfall by the USC Ocean Physics Group, with four instrument packages placed from 10m to 50m in the water column. The instrument packages contained suites of sensors measuring beam *c*, chl-*fl*, conductivity, dissolved oxygen, and orthogonal components of current. Each instrument at each depth collected a datapoint once per minute. Additionally, archived meteorological data were obtained from several sources for parameterization of the atmospheric correction to the images.

### 4. ANALYSES AND RESULTS

The images were processed by first modeling the propagation of surface measurements of water-leaving radiance to the aircraft, and determining recalibration coefficients that overcome the limitations of the laboratory calibration in the blue end of the spectrum (e.g. Carder et al., in press). The recalibrated images were then corrected for the effects of the atmosphere, using a combination of the CIBR (Carrere et al. 1990 ) water vapor parameterization, and the aerosol parameterization of Gordon et al. (1980). The SNR of the scenes was then increased by spatial averaging, depending on the requirements of the different analyses.

The *in-situ* data were resampled to a 100m X 100m grid of surface concentrations of particles, PAR, and chlorophyll. This grid was then used to either condition empirical models, parameterize an inverse model, or provide control to independent model estimates. Mooring data were examined to judge

the effect of ~48 h current history on observed oddities in the spatial distribution of suspended particle load.

The analyses then carried out describe the characteristics of a particle front in terms of its photosynthetic versus nonphotosynthetic components, separation of co-absorbing chlorophyll and colored dissolved organic matter, and the variation in the diffuse attenuation coefficient. Good agreement between measurements and model estimates was achieved, and strategies for improving the models were determined.

## 5. REFERENCES

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