SCCWRP #573

Stormwater plume detection by MODIS imagery in the southern California coastal ocean

Nikolay P. Nezlin [a], Paul M. DiGiacomo [b], Dario W. Diehl [a], Burton H. Jones [c], Scott C. Johnson [d], Michael J. Mengel [e], Kristen M. Reifel [c], Jonathan A. Warrick [f] and Menghua Wang [b]

[a] *Southern California Coastal Water Research Project (SCCWRP), Costa Mesa, CA*

[b] *NOAA/NESDIS Center for Satellite Applications and Research (STAR), Camp Springs, MD*

[c] *University of Southern California, Department of Biological Sciences, Los Angeles, CA*

[d] *Aquatic Bioassay and Consulting Laboratories, Ventura, CA*

[e] *Orange County Sanitation District (OCSD), Fountain Valley, CA*

[f] *USGS Coastal and Marine Geology Program, Santa Cruz, CA*

ABSTRACT

Stormwater plumes in the southern California coastal ocean were detected by MODIS-Aqua satellite imagery and compared to ship-based data on surface salinity and fecal indicator bacterial (FIB) counts collected during the Bight'03 Regional Water Quality Program surveys in February–March of 2004 and 2005. MODIS imagery was processed using a combined near-infrared/shortwave-infrared (NIR-SWIR) atmospheric correction method, which substantially improved normalized water-leaving radiation (nLw) optical spectra in coastal waters with high turbidity. Plumes were detected using a minimum-distance supervised classification method based on nLw spectra averaged within the training areas, defined as circular zones of 1.5–5.0-km radii around field stations with a surface salinity of $S < 32.0$ (''plume'') and $S > 33.0$ (''ocean''). The plume optical signatures (i.e., the nLw differences between ''plume'' and ''ocean'') were most evident during the first 2 days after the rainstorms. To assess the accuracy of plume detection, stations were classified into ''plume'' and ''ocean'' using two criteria: (1) ''plume'' included the stations with salinity below a certain threshold estimated from the maximum accuracy of plume detection; and (2) FIB counts in ''plume'' exceeded the California State Water Board standards. The salinity threshold between ''plume'' and ''ocean'' was estimated as 32.2. The total accuracy of plume detection in terms of surface salinity was not high (68% on average), seemingly because of imperfect correlation between plume salinity and ocean color. The accuracy of plume detection in terms of FIB exceedances was even lower (64% on average), resulting from low correlation between ocean color and bacterial contamination. Nevertheless, satellite imagery was shown to be a useful tool for the estimation of the extent of potentially polluted plumes, which was hardly achievable by direct sampling methods (in particular, because the grids of ship-based stations covered only small parts of the plumes detected via synoptic MODIS imagery). In most southern California coastal areas, the zones of bacterial contamination were much smaller than the areas of turbid plumes; an exception was the plume of the Tijuana River, where the zone of bacterial contamination was comparable with the zone of plume detected by ocean color.