

Satellite monitoring of the FDEP Gulf dispersal of the Piney Point treated wastewater

Report #8, 16 - 22 September 2003

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Background

For background information, please visit the Florida Department of Environmental Protection (FDEP) online at http://www.dep.state.fl.us/secretary/comm/2003/piney_point.htm.

Satellite Instruments and Color Interpretations

See Appendix A.

FDEP Dispersal Status (as of 15 September 2003)

Fifteen discharges have been completed, with a total of approximately 94.7 million gallons of treated wastewater transported via barge and dispersed offshore.

Satellite monitoring results

This document focuses on satellite imagery (remote sensing), and describes only one part of the monitoring efforts being undertaken by several groups. These other monitoring groups focus their efforts on water sample analysis, and will post their results independently.

Previous remote sensing reports can be found at http://imars.usf.edu/Piney_Point/reports/. Here we continue reporting our findings based on examining satellite imagery for the period of 16 – 22 September 2003.

Our X-band antenna, used to downlink the MODIS images from the Terra and Aqua satellites, suffered lightning damage and therefore we were unable to collect MODIS data for this period. Images from our backup data source at NASA's Goddard Space Flight Center (GSFC) showed no cloud-free MODIS data for the region of Gulf of Mexico where the dispersal was scheduled to occur. Due to hurricane Isabel, GSFC lost power and no data were collected for the remainder of the period.

Here we reproduce a SeaWiFS chlorophyll image taken on 19 September 2003 in Figure 1. Please note that this SeaWiFS image is provided here only for illustration purposes and with express permission by Orbimage, Inc., owner of the data. The image should not be reproduced except with express permission from Orbimage, Inc. (<http://www.orbimage.com>). Please contact

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Report 7 shows a MODIS composite image for 13-14 September that may be used for comparison (Figure 1 of Report #7). The dispersal area is shown as a white box. Purple color in the image shows the clearest ocean waters; these are some of the lowest ocean chlorophylls experienced in the Gulf. A segment of the warm (cyclonic) eddy located south of the Mississippi River delta is also visible in Figure 1. This clockwise eddy was shed by the Loop Current (see prior reports).

The spatial "chlorophyll" patterns in the SeaWiFS image show that the dispersal area is now fully contained within the Gulf of Mexico Loop Current, similar to that reported for the previous period (September 9-15, 2003). Therefore any discharge of treated water may be expected to move rapidly to the south.

The SeaWiFS image suggests that a new streamer of coastal water from the Cape San Blas area has been entrained into the northern front of the Loop Current and is being advected along the shelf break to the south – this streamer passes just to the east of the dispersal area.

Smaller streamers of very slightly elevated chlorophyll concentrations and which enter the dispersal box from the west and northwest cross the dispersal area – these streamers show concentrations that are only slightly above background concentrations seen in the clear waters of the Loop Current. Previous SeaWiFS images show that these streamers are connected with filaments of chlorophyll originating from a strong front between the Loop Current and the warm cyclonic eddy (image from 11 September), and also filaments originating off the Yucatan Peninsula (these are visible in Figure 1 and several other previous images as they trace the western edge of the Loop Current).

There are no patterns originating within the box and that may be associated with dispersal within the box.

We expect a major repair of the USF X-band antenna to be completed this week, and also expect restoration of power to the GSFC antenna shortly. Our next report will include an update in the time series of ocean color change that had been provided in previous reports.

Comments and suggestions are welcome.

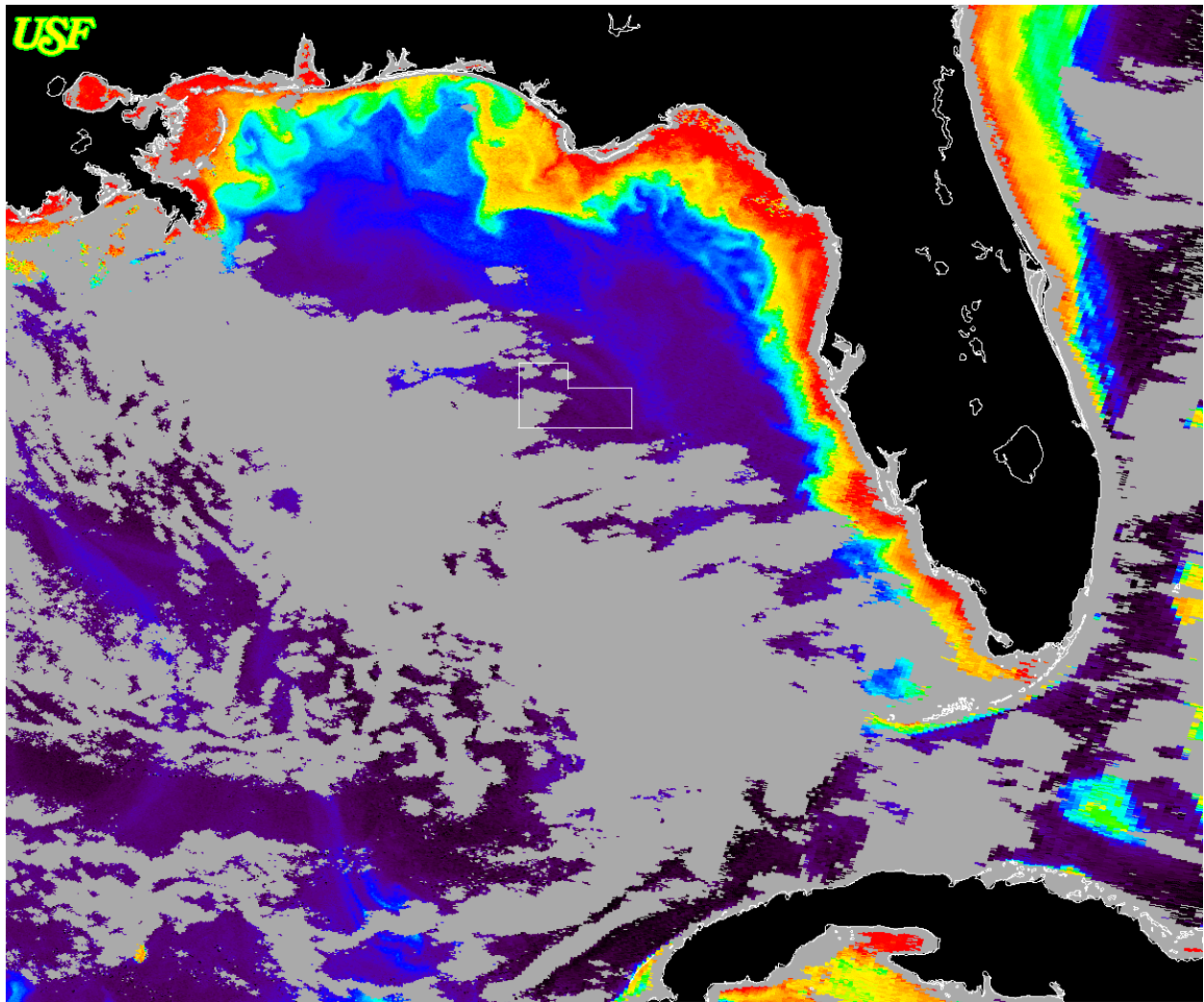


Figure 1. SeaWiFS satellite-derived "chlorophyll" product for 19 September 2003. Overlaid on the image is the outline (white box) of the dispersal area. **Please note that this SeaWiFS image is provided here only for illustration purposes and should not be reproduced except with express permission from Orbimage, Inc. (<http://www.orbimage.com>). Please contact Orbimage for any non-NASA SeaWiFS program use of data or derived imagery. Reproduction or redistribution (including media) of SeaWiFS data/imagery is prohibited without the permission or license from Orbimage.**

Appendix A. Satellite instruments and image interpretation

Satellite Instruments

The satellite instruments used in this monitoring project include the Sea-viewing Wide Field-of-View Sensor (SeaWiFS, <http://seawifs.gsfc.nasa.gov>), the Moderate Resolution Imaging Spectroradiometer (MODIS, <http://modis.marine.usf.edu>), and the Advanced Very High Resolution Radiometer (AVHRR, <http://www.ngdc.noaa.gov/seg/globsys/avhrr.shtml>). Table 1 lists the characteristics of these instruments.

Table 1. Satellite instruments used in the monitoring project.

<i>Satellite</i>	<i>Instrument</i>	<i>Owner</i>	<i>Measure</i>	<i>Swath (km)</i>	<i>Resolution (km)</i>	<i>Availability</i>
SeaStar	SeaWiFS	Orbimage	color	> 2000	~1.1	daily
Terra	MODIS	NASA	color temperature	> 2000	~1.1	daily
Aqua	MODIS	NASA	color temperature	> 2000	~1.1	daily
POES	AVHRR	NOAA	temperature	> 2000	~1.1	daily

These satellites instruments survey the surface ocean every day at approximately the same local time. They provide a synoptic view of the surface ocean (color and temperature) at regional to global scales. The satellite data are captured, processed, and archived by the Institute for Marine Remote Sensing (IMaRS, <http://imars.usf.edu>) at the College of Marine Science, University of South Florida. The algorithms used to generate these imagery data products can be found under IMaRS website <http://imars.usf.edu>.

Sea surface height data are obtained from the Colorado Center for Astrodynamic Research (CCAR) at the University of Colorado, Boulder (Dr. Robert Leben; http://www-ccar.colorado.edu/~realtime/gsfc_gom-real-time_ssh/)

Online Images for Piney Point

Near real-time imagery can be found at http://imars.usf.edu/Piney_Point for public access and distribution. Note, however, while MODIS and AVHRR data are public domain, SeaWiFS data is property of Orbimage, Inc. (<http://www.orbimage.com>). Please contact Orbimage for any non-NASA SeaWiFS program use of data or derived imagery. Reproduction or redistribution (including media) of SeaWiFS data/imagery is prohibited without the permission or license from Orbimage.

Conventions used to name a file (image) at http://imars.usf.edu/Piney_Point are as follows:

SeaWiFS: SYYYYDDDDHHMM: YYYY for year, DDD for day of the year, HH for GMT (Greenwich Mean Time) hour, MM for minutes. The images show surface chlorophyll

concentrations of the ocean, as derived by the standard NASA algorithms (SeaDAS version 4.4).

MODIS: MODIS.YYYYDDD.HHMM: similar to SeaWiFS. There are several data types available for MODIS, resulted from standard NASA algorithms for MODIS, including: surface chlorophyll concentrations, surface colored dissolved organic matter (CDOM, also called Gelbstoff) abundance, surface temperature, and red-green-blue (RGB) composite images.

AVHRR: nNN.YYYYDDD.HHm: NN for NOAA satellite number, MM for month, DD for day, HH for GMT hour, mm for minutes. The images show sea surface temperature.

Color interpretation of satellite images

It is important to note that by no means do the colors shown on the images reflect the actual color of the ocean. Instead, they simply represent various relative concentrations of water constituents. The color-concentration relationship can be found on a color legend, but please note caveats provided below. RGB composite imagery to some extent do reflect the real color of the ocean.

Various constituents in both particulate and dissolved forms determine ocean color. In the open Gulf the color is generally dominated by phytoplankton, the living, tiny organisms which serve as the base of the food chain. In waters where coastal runoff (river discharge and other terrestrial runoff) is significant the color is a mixture of phytoplankton, dissolved matter, and suspended inorganic particles (clay, sediments, etc.) where any of these species can dominate the color.

The chlorophyll images (with "florida" in the SeaWiFS filenames and with "chlor" in the MODIS filenames) show the surface concentration (in milligrams per cubic meter) of phytoplankton pigment, chlorophyll-*a* (the photosynthetic pigment that also exists in all green tree leaves). High values are indications of biologically active waters. The values are more accurate for open Gulf waters without river intrusion than for coastal waters or river plume waters. Indeed the yellow-red colors seen off the coasts reflect not only chlorophyll but also dissolved matter and suspended sediments (i.e., they are often overestimates of the real chlorophyll concentrations). The river plume band seen offshore in the Gulf of Mexico may contain high concentrations of colored dissolved organic matter, as well as variable amounts of plankton.

The temperature images show the surface temperature of the ocean. Different temperatures are represented by different colors (see color legend). Waters of various origins sometimes display different colors. For example waters from the tropics often show higher temperatures than the Gulf water.

IMaRS disclaimer:

The use of the images should be credited to IMaRS, NASA SeaWiFS and MODIS Projects, NOAA, and OrbImage. The images are provided by IMaRS on an "as is" basis and IMaRS is not responsible for any interpretation by any users other than those provided by IMaRS personnel, who use these images in research mode – interpretation is subject to error in the data and scientific uncertainty. The IMaRS Piney Point website (http://imars.usf.edu/Piney_Point) may be removed upon completion of the FDEP Piney Point discharge project. Orbimage has graciously permitted us to publish SeaWiFS images periodically (not routinely) for demonstration purposes.

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