Brief Report of NOAA's Ecosystem Science and Management Working Group (ESMWG) Including Recommendations Related to the Ocean Color Satellite Continuity Mitigation Plan

Background

Data from satellite ocean color imagers are the only source of routinely acquired global ocean products (e.g. maps of near-surface phytoplankton chlorophyll *a*) that are related to ocean ecology and biogeochemistry. Wide-swath sensors (i.e. those that scan 1500-2000 km across the track of the satellite orbit) such as SeaWiFS and MODIS cover the global ocean every 1-2 days with a maximum pixel resolution of 1km X 1km. Imagery from these sensor are particularly useful for observing seasonal phytoplankton blooms, upwelling events, inter-annual variability such as that caused by ENSO, long-term trends in ocean basins, and the responses to other important processes affecting continental shelf and open ocean waters. However, this comparatively coarse spatial resolution imagery is of limited use for observing nearshore coastal or estuarine waters. NASA processing of data acquired from SeaWiFS and MODIS has provided a continuous source of ocean color imagery since 1997, but both missions are nearing the end of their expected lifetime. Furthermore, the quality of the data expected from the VIIRS instrument on the next U.S. satellite mission (NPOESS Preparatory Project or NPP) carrying an ocean color radiometer is problematic, as is NASA's role in processing NPP ocean color data. Thus, NOAA's Observing Systems Council directed the Technology, Planning and Integration Office to conduct a mitigation study with a limited scope focused on the anticipated gap in wide swath, coarse-resolution imagery once SeaWiFS and MODIS are not operating. The results of this study were presented to ESMWG on 7 October 2009 by Neil Wyse. Their findings included "moderate/significant risks associated with limited internal NOAA … processing capabilities" and the "2012 timeframe shows most significant, potential data gap." Mitigation options were proposed, including a NOAA end-to-end operational and science ocean color processing capability.

During the presentation to ESMWG, and in subsequent follow-up conversations with ESMWG member J.A. Yoder, Analysis of Alternatives study and other NOAA personnel discussed the possibility of completing a second phase to the mitigation study (or Analysis of Alternatives) to include satellite and other options to better monitor coastal and estuarine waters. One important application which is difficult or impossible to achieve with SeaWiFS and MODIS imagery is to identify, locate and track harmful algal blooms. Options for improved coastal monitoring could include: (1) access to higher spatial resolution (maximum 300m X 300m pixels, see Fig. 1) ocean color imagery from current and future satellites operated by the European Space Agency or possibly similar imagery from a satellite launched this past September by the Indian space agency; (2) imagery acquired from sensors carried by manned or unmanned aircraft; and (3) measurements from *in situ* platforms including moored buoys, floats and gliders.

ESMWG Recommendations.

1. NOAA should initiate and pursue discussions with NASA for an ocean color mitigation partnership to build on lessons learned in particular from SeaWiFS and MODIS and with an initial focus on the wide-swath data. The partnership organization should be independent of the NPOESS Integrated Program Office (IPO), but IPO participation should be encouraged. To further develop NOAA capabilities for processing and analyzing satellite ocean color imagery, a near-term option for the partnership should be a real or virtual "center" involving NOAA and NASA personnel and with contributions from the academic research community. An important step in any research to operations transition is for researchers to work directly with those developing operational capabilities. Thus, Center activities should include: research and development related to ocean color products to serve research and operational users; processing/reprocessing of data from U.S. and international sensors to ensure a sustained time series of calibrated imagery to identify long-term trends; and calibration and validation activities involving, for example, a new NOAA-operated "MOBY" (sophisticated bio-optical buoy) and other activities.

2. NOAA should conduct a full Analysis of Alternatives for full NOAA ocean color requirements with a particular focus as to how best to extend routine ocean color measurements into coastal and estuarine waters. This study should consider an optimum mix of *in situ*, aircraft and satellite assets, including imagery from satellites operated by ESA at present and in the future that can provide 300m X 300m pixel resolution imagery. Imaging coastal waters with sensors having higher spatial resolution than SeaWiFS or MODIS in support of NOAA missions could significantly enhance the return on investment (ROI) from satellite ocean color data.

3. NOAA/NESDIS should continue to encourage and support the Committee for Earth Observation Satellites (CEOS)-approved Ocean Color Radiometry Virtual Constellation (OCR-VC). Virtual Constellations are a new CEOS approach to improve cooperation among international agencies for global satellite and other measurements relevant to societal benefit areas defined by the Group on Earth Observations (GEO). The OCR-VC is a federation of those international agencies interested in satellite ocean color observations, and most of the international space agencies are now participating in the OCR-VC and cooperating with its activities. Although the OCR-VC is not an independent implementing organization with an independent budget, its activities will help facilitate NOAA access to satellite ocean color and other data collected by non-U.S. agencies.

Figure 1. A comparison of ocean color chlorophyll imagery from Long Island Sound from full resolution (300m x 300m pixels) data collected by ESA's MERIS instrument (upper panel) and data collected from SeaWiFS (which has maximum spatial resolution of 1km X 1km). Note that coastal features evident in the full resolution MERIS imagery are badly smeared in the SeaWiFS imagery.