A Long History of Satellite Remote Sensing Research at OSU

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CEOAS has a long history of research in satellite remote sensing of the ocean dating back to the early 1980s when most of the sensors were still in developmental stages. CEOAS faculty have been involved in every aspect of satellite remote sensing, including sensor and satellite mission design, development of algorithms for retrievals of the physical and biological variables of interest, and applications of satellite observations to study a host of oceanographic research questions.

Satellites are able to measure the sea surface temperature (SST), salinity and elevation, upper-ocean chlorophyll content, and surface wind speed and direction. The spatial resolution of these ocean properties depends on the electromagnetic wavelengths measured by the satellite sensor. For the short infrared and visible wavelengths at which SST and chlorophyll are measured from space, footprint sizes on the sea surface are a few kilometers but the measurements can only be made in clear-sky conditions. In contrast, measurements at the much longer microwave wavelengths can be made through clouds, but the footprint size is 25 km or larger. SST, salinity, sea surface height and winds can all be measured with microwave sensors.

Professor Dudley Chelton has been working with microwave data since the earliest instruments were launched in the late 1970s. His analysis of microwave measurements of SST and radar measurements of surface winds has revealed a previously unappreciated strong relationship between the ocean and atmosphere on scales of 100–1000 km. The surface winds are modified by the underlying SST in a way that feeds back on the ocean and alters the currents and the SST itself. The ocean and atmosphere thus fluctuate as a fully coupled system. The analysis of satellite data is leading to improvements in the forecasts of surface winds, as well as an improved understanding of oceanic variability.

Professor Chelton has also worked with microwave radar measurements of the sea surface elevation since the late 1970s. Present instruments are capable of measuring the sea surface height to an accuracy of better than 1 cm from an altitude of 1300 km. This is analogous to being able to measure the thickness of a sheet of paper from the altitude of a commercial airliner. Surprisingly, this accuracy is required for studies of ocean circulation since a change of only 1 cm over a distance of 10 km corresponds to a surface current speed of about 10 cm/s, which is large for ocean currents. The variability of surface currents throughout most of the ocean is dominated by swirling currents called eddies that are the oceanic analog of hurricanes in the atmosphere, though with much less devastating effects. The satellite data have revealed extensive new information about the dynamics of these eddies and their impacts on the mixing of water properties and upper-ocean biology.

Satellite data are also used by CEOAS faculty to improve the accuracies of computer model forecasts of ocean conditions along the coasts of Oregon and Washington. Prof. Ted Strub has developed special procedures for retrieving satellite data close to the coast, which is especially problematic for microwave sensors. Prof. Alexander Kurapov has developed a computer model of the coastal ocean circulation that assimilates these satellite observations to improve the accuracy of prediction of ocean currents and temperatures several days in the future. The model forecasts are available online (http://ingria.coas.oregonstate.edu/rtdav/) and are used routinely by fishermen, Coast Guard search and rescue teams and public agencies that are monitoring the movement of marine debris, hazardous spills and harmful algal blooms.

CEOAS faculty have also developed a strong program in satellite studies of ocean biology. Beginning in the late 1980s with Dean Mark Abbott and later with Professors Ricardo Letelier, Pete Strutton, Michael Berhenfeld, Curt Davis and Anglicque White, CEOAS faculty have developed new procedures for measuring and interpreting satellite measurements of ocean color. In addition to improved estimates of upper-ocean chlorophyll content, key contributions of this work include advances in the study of algal fluorescence and its use to estimate phytoplankton biomass and productivity. Satellite measurements of ocean color are also leading to improvements in our understanding on how eddies and fronts affect open ocean productivity, which may help explain the development and propagation of harmful algal blooms along the Oregon/Washington coast.

CEOAS is also home to one of only two non-commercial satellite direct broadcast stations in the US west coast (http://sugar.coas.oregonstate.edu/MODIS/). This station serves local and regional communities by downloading data directly from satellite color sensors and providing regional ocean, land and atmospheric products in near-real time. This near real-time access to the data is valuable to a diverse range of users, including recreational and commercial fishermen who use the location of temperature and color fronts to identify places of fish aggregation, public agencies charged with monitoring the health of coastal environments as it may be affected by source point pollution or harmful algal blooms, Coast Guard search and rescue teams who need to know the evolution of currents, and sea-going oceanographers who use the satellite data to locate particular oceanographic features that can be studied from instruments lowered from ships.