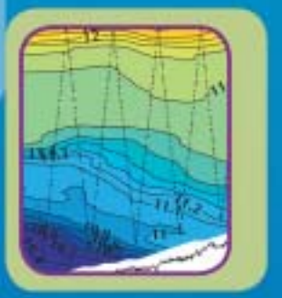
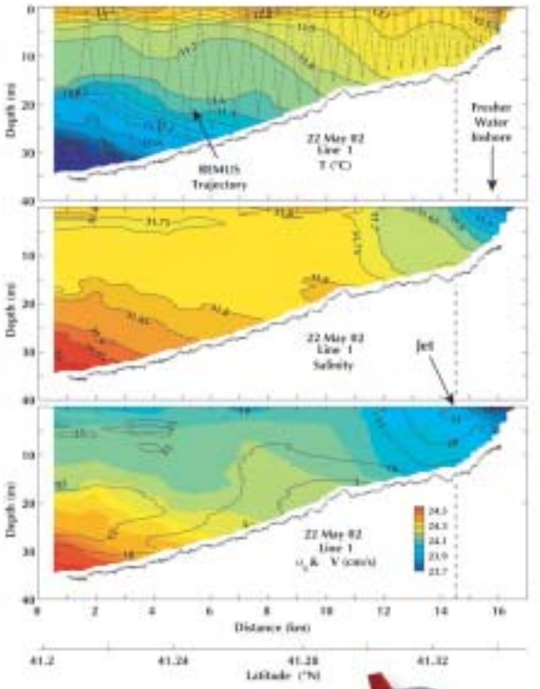


ALPS

Autonomous and Lagrangian Platforms and Sensors

Summary of the Workshop
Held March 31 - April 2, 2003
in La Jolla, California

Autonomous Underwater Vehicles Provide High Spatial Resolution



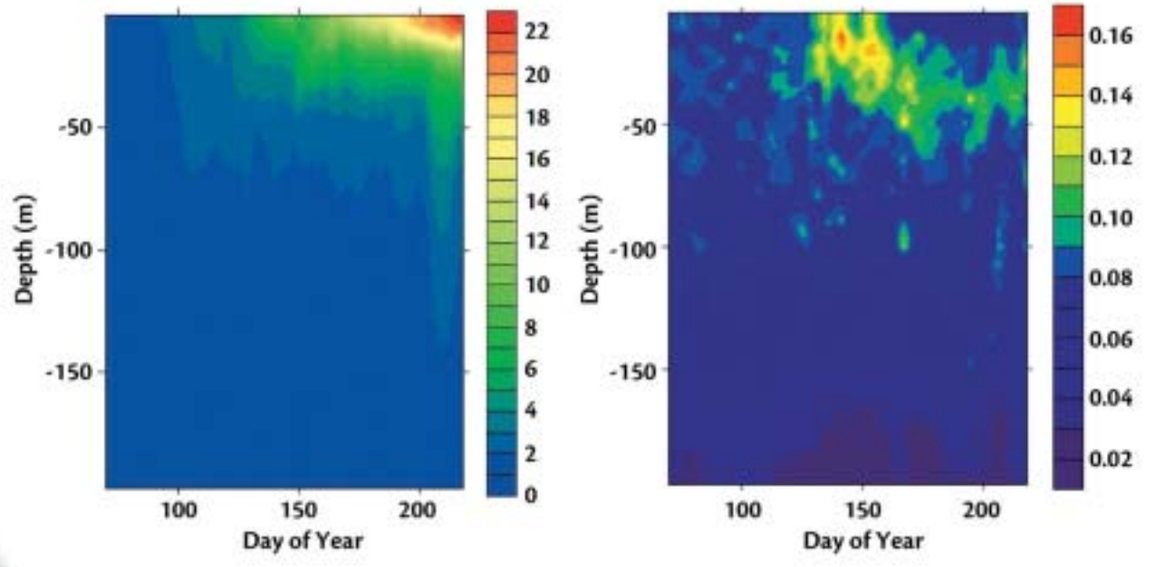
An autonomous underwater vehicle (AUV) at the Martha's Vineyard Coastal Observatory collected high-resolution sections of temperature (top), salinity (middle), and density (bottom, shaded), and westward currents (contoured). The spatial resolution of the observations are unprecedented for this region, and have helped reveal previously unknown features such as a near-shore buoyant plume that strongly affects the currents and stratification over the inner shelf. This feature and its dynamical characteristics had previously gone unobserved because traditional sampling techniques do not resolve the small spatial scales. Courtesy of R. Kipp Shearman, Woods Hole Oceanographic Institution.

Why are ALPS Needed?

The fundamental observational problem in oceanography is that of sampling a global, turbulent fluid with physical, biological, and chemical processes that are active over a wide range of scales. Autonomous and Lagrangian platforms and sensors (ALPS) provide a unique solution to this sampling problem in that they are scalable to the process of interest and easily portable to relevant, possibly remote, locations.

ALPS can support scientific questions related to climate change that require long-term observations on a global scale, as well as questions that require short-term observations in a local area, such as the evolution of harmful algal blooms. Adaptable networks of ALPS efficiently provide the essential spatial and temporal coverage to complement data collected with ships, fixed observatories, and satellites.

Autonomous Floats: Vertical Profiles over Seasons and Years



Autonomous profilers with simple optical sensors have effectively demonstrated that they can provide low-cost, high-resolution profiles to complement more traditional observation strategies. Profilers can capture phenomena, such as the onset of spring phytoplankton blooms (temperature, left , and spectral diffuse attenuation coefficient, right), which are difficult to sample by ships due to their unpredictable timing and complicated vertical structure. With higher bandwidth communications that now enable more data to be telemetered home, the integration of attenuation or backscattering meters, chlorophyll fluorometers , oxygen, pCO_2, pH, and perhaps nutrient sensors can be envisioned to create inexpensive "biogeochemical" floats to improve our understanding of physical-chemical-biological coupling and how this coupling influences biogeochemical cycles in the ocean. Courtesy of Greg Mitchell, Scripps Institution of Oceanography.

Background

During the last decade, oceanography has witnessed a revolution in observing capabilities as autonomous platforms, and the sensors they carry, have developed and rapidly matured. Numerous ALPS deployments have demonstrated the power and potential of these integrated sensing systems to study ocean physics, biology, chemistry, and geology. The unique capability of ALPS to make sustained ocean observations and to execute experiments that test specific hypotheses has been noted in all of the National Science Foundation-sponsored disciplinary and interdisciplinary reports on the future of oceanography.

What are ALPS?

ALPS platforms are characterized as "autonomous" because they operate without tethers to ships or the seafloor. These platforms include Lagrangian surface drifters, neutrally buoyant and profiling floats, highly controllable self-propelled autonomous underwater vehicles (AUVs), and underwater gliders. The sensors integrated into ALPS are, of necessity, small, robust, and able to sample at high frequency. The present suite of sensors measures a diversity of variables, including temperature, salinity, chlorophyll fluorescence, particle concentration, current velocity, oxygen, and captures images of seafloor topography; new sensors continue to expand ALPS' measurement capabilities. The data collected by ALPS are typically transmitted by wireless communication to the laboratory. Many platforms have two-way communication systems that allow them to receive instructions to change sampling protocol or location during the mission, making them even more-flexible sampling platforms.

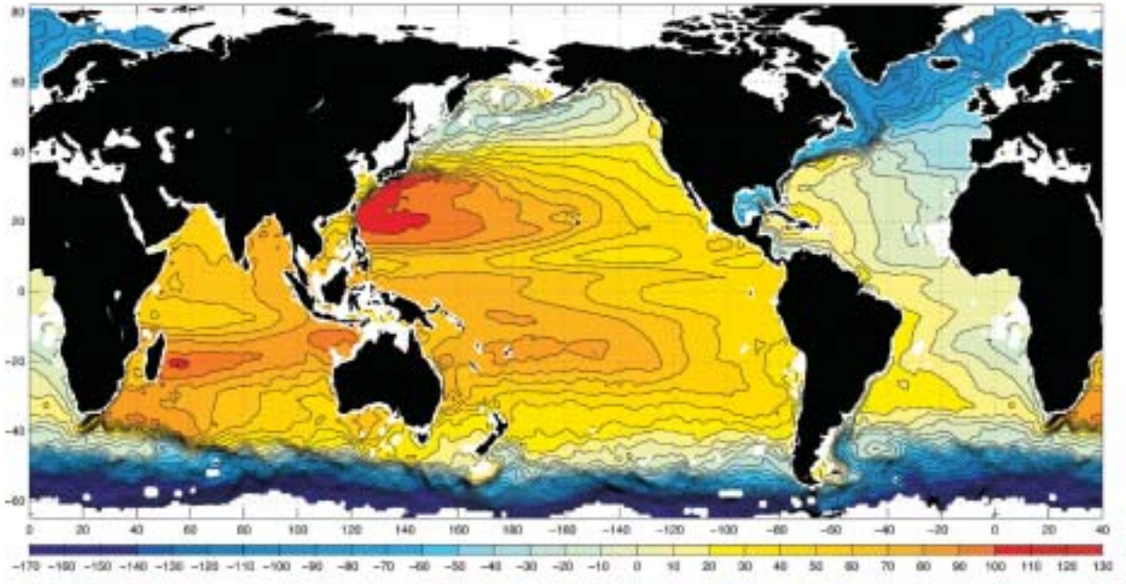
Moving Forward

A workshop* held in spring 2003 was the first step toward enabling all oceanographers to share in the major technological advances that ALPS has made possible and to participate in the coordinated development of ALPS science and technology. The ALPS workshop addressed issues such as the current capabilities of ALPS; scientific questions that could be uniquely addressed by ALPS alone and in conjunction with other sampling modes such as ships, cabled observatories, and satellites; technological developments needed to develop even more-capable sensors and platforms; mechanisms for enabling broader community access; and needs for training and education.

The vision that emerged from the workshop was of an ocean-observing network, flexible in scale and scope, comprising many relatively inexpensive platforms outfitted with the most advanced sensors, to enable new views of the ocean. ALPS, uniquely among all observational systems, hold the promise of solving the fundamental oceanographic problem of spatial sampling. Action now will foster accelerated and coordinated growth of both platforms and sensors, and will allow ALPS to play a major role in the future of oceanography. To continue to make progress on ALPS, workshop participants recommend the following:

1. Although individual ALPS are relatively inexpensive, with limited lifetimes, ALPS networks and technical support must be regarded as permanent infrastructure and funded as such.
2. A group of technology innovators and scientific users should be formed to develop an implementation plan and to ensure broad community participation.
3. Sustained development of platforms and sensors should continue —within the context of meaningful scientific goals—to create even more-capable platforms and sensors.
4. Existing platforms and sensors should be combined, with relatively little additional engineering, to create new observational systems targeted at important scientific questions.
5. A mechanism for supporting pilot projects should be established to foster the use of ALPS technologies to address important interdisciplinary problems.
6. Workshops, short courses, training programs, and fellowships are needed to address the critical shortage of trained engineers and scientists who are needed to develop and support ALPS infrastructure.

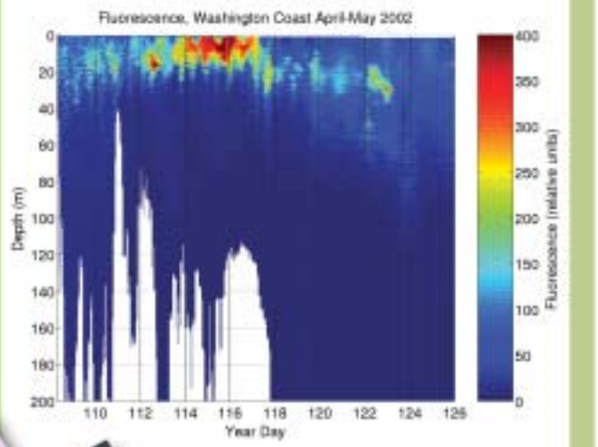
Modern Climate Observation: Drifters Plus Satellites



ALPS global observations can be used in conjunction with satellite sensing of the ocean surface to enhance the capability of both systems. For example, surface drifters and satellite altimetry are combined to produce a map of mean global sea level for 1992-2002. This combination of ALPS and satellite measurements is an excellent example of modern climate observation. Courtesy of Peter Niiler, Scripps Institution of Oceanography.

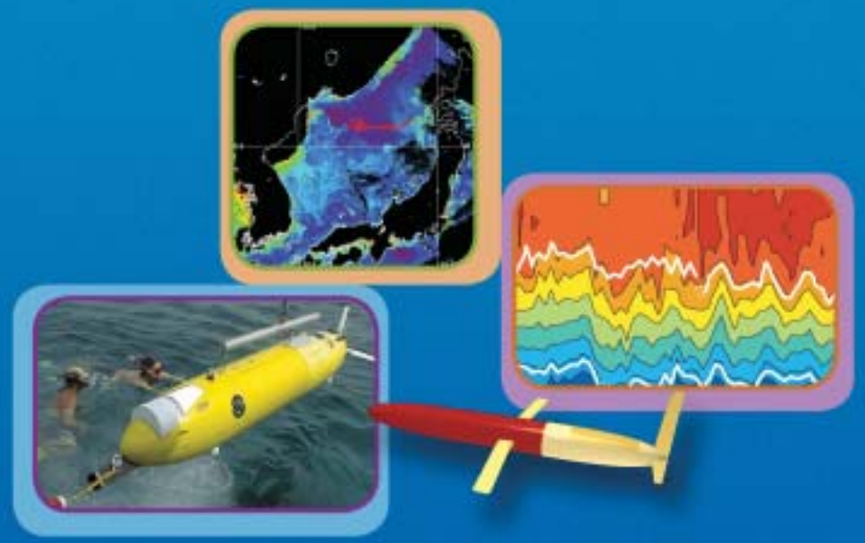
*Rudnick, D.L. and M.J. Perry, eds., 2003, *ALPS: Autonomous and Lagrangian Platforms and Sensors*, Workshop Report, 64 pp., www.geo-prose.com/ALPS

Gliders Measure Distributions Along Programmed Path



A Seaglider instrumented with an optical fluorometer/scatter sensor measured chlorophyll fluorescence, a proxy for phytoplankton biomass, off the Washington coast in April 2002. Active optical sensing allows phytoplankton biomass to be measured at night and below the euphotic zone. Autonomous gliders can provide information on the vertical distribution of phytoplankton biomass, complementing ocean color satellite remote sensing of the ocean surface. This particular instrument can measure several hundred profiles to a depth of 1 km over a track of thousands of kilometers. Courtesy of Mary Jane Perry, University of Maine, and Charlie Eriksen, University of Washington.

To view the full workshop report go to www.geo-prose.com/ALPS.
To request a single copy of the report, write to ocepubs@nsf.gov.



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