and chemical sensors and systems. Smooth optical surfaces tend to foul slower than rougher surfaces. Liquid biocides have been found to be relatively effective, notably when allowed to reside inside optical tubes between sampling. Toxic tablets can also be released into these tubes. Darkness is also a good condition for biofouling reduction, so closure of optical (or chemical) sampling volumes is recommended. In the case of profiling devices, keeping sensors at depth between profiles is a good strategy. If chemicals (e.g. bromides) are used with optical systems, degradation of windows through discoloration can be problematic. Copper is a good material for reducing biofouling due to its toxicity for phytoplankton and is presently being used in a variety of ways. For example, copper screens can be used at inlets for flow-through type devices and copper-based shutters can be used for some optical (e.g. radiometers) and chemical (e.g. dissolved oxygen) devices. The body of experience of oceanographers doing autonomous sampling suggests that it is likely that solutions to biofouling may be quite site-specific and even dependent upon time of year and specific oceanic conditions (e.g. El Niño, passages of eddies, etc.).

Power

Offshore platforms are generally not limited by power, are very stable, and can be manned. However, they do present major measurement perturbation problems for observations of optical properties dependent on the ambient light field (apparent optical properties) and many chemical measurements because of local contamination. Shipboard sampling is still critical for many measurements which cannot be done autonomously and continue to provide excellent vertical (profile mode) and 3-D spatial (tow-yo) data. However, shiptime is very expensive and ships cannot be used during intense weather and sea-state conditions when often very important processes are occurring. Floats and drifters are often adequately powered for their payloads, but large numbers are generally needed to quantify processes and many optical, acoustic, and chemical sensors remain too expensive to be deployed from such expendable platforms. Moorings and bottom tripods minimize aliasing and undersampling, but are limited to local sampling, their expense restricts use to key selected locations, and their battery life can limit their sampling time.

Power remains a serious limitation for long-term autonomous systems both stationary and moving, either requiring expensive cables, limited solar power, or short-lived batteries. Larger buoys are often powered by solar cells, but most coastal applications require small buoys. Rechargeable batteries can save significant costs, but their power output is limited and recharging batteries inside a closed system can present risks. Higher capacity lithium batteries can provide much more power, but are expensive, are single use, and can be hazardous, making shipping difficult. Fuel cells are now being considered as an alternative power source for long-term autonomous systems, including AUVs.

Data Management

As coastal observation systems continue to grow in complexity, management of the rapidly increasing number of diverse datasets and the associated metadata is a recognized concern. Numerous site or even project specific systems with varying degrees of sophistication are being constructed or expanded, but no single system has emerged as the preferred choice for coastal applications. Data management issues should be no more difficult for a coastal GOOS than for other major systems or global projects over the past years, but it will obviously take considerable effort. It is primarily a matter of setting up the automated procedures to bring the data at some interval to the relevant national data centers. These data should have been quality controlled as much as possible prior to being sent to the archives to minimize the efforts of the data centers. The accumulated historical archives should reside in that same national data center. If this is not the case, resources and partners will be needed to find and quality control such historical data. This could conceivably be done on a regional basis with local and national partners helping the national data centers.

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RECOMMENDATIONS

Long-term Support for Long-term Measurements

The funding to ensure the permanent operation of coastal ocean sensors is a difficult problem. Even national systems run by the federal government, such as the National Water Level Observation Network operated by NOS/NOAA and the C-MAN and data buoy network operated by NWS/NOAA, have had funding problems. The operation of new real-time systems, such as NOAA's PORTS, depends on partnerships with state and local agencies. Partnerships will be the cornerstone of a coastal GOOS system, but Congressional funding should be sought to ensure the maintenance and operation of a network of core stations considered most critical for the uses of coastal GOOS. Such funding should include support for coordinated national standards, calibration, maintenance, quality control, and data archiving.

Training a New Generation of Science Support Staff

Modern observation networks are being constructed through partnerships between scientists and engineers.