5. an ability to plug in any type of new sensor, including cameras, acoustic imaging systems, and chemical sensors and to operate them over the Internet,
6. bottom-mounted winches cycling instruments up and down in the water, either automatically or on command,
7. docking stations for a new generation of autonomous (robotic) underwater vehicles (AUVs) to download data and repower batteries,
8. an ability to assimilate node data into models and make three-dimensional forecasts for the oceanic environment,
9. means for making the data available in real-time to schools and the public over the Internet, and
10. low cost relative to the cost of building and maintaining manned above- and below-water systems.

General goals for the LEO observation network include:
1. the construction of a distributed observation network using modern remote sensing, in situ and meteorological instrumentation,
2. an ability to process, visualize and combine diverse datasets in real-time to generate data-based nowcasts of the 3-dimensional ocean structure,
3. the development of a new coastal ocean circulation model with multiple turbulence closure schemes and improved boundary conditions obtained through coupling to atmospheric models, large scale ocean models, and surface wave models,
4. the ability to assimilate multivariate datasets into the ocean model in real-time to generate nowcasts and forecasts of the 3-dimensional ocean structure,
5. the development of new adaptive sampling strategies that use the nowcasts and forecasts to guide ship-towed and autonomous underwater vehicle sampling for interdisciplinary applications,
6. the development of an open access database management system for wide-spread distribution of LEO data, and
7. to provide scientists a user-friendly data-rich environment in which to conduct focused research experiments.

Capabilities

The two LEO nodes were installed on the ocean floor in 1996 about 10 km offshore in about 15 m of water. A buried electro-fiber optic cable links the nodes to the Rutgers University Marine Field Station (RUMFS), which provides power and access to the Internet. The cable transmits continuous power for instrumentation, and provides bi-directional communication and video links over three optical fibers. To allow for periodic servicing, the complete electronics/mechanical package from each node is recoverable by boat. Except during the busy summer season when demand is high, one node is often out of the water being serviced or upgraded while the other node maintains the long-term dataset.

Each node is equipped with an internal winch that moves a profiler vertically through the water column. The winch can be controlled by an onshore computer to automatically profile at specified intervals, or it can be manually controlled, either directly from the RUMFS shore base, or remotely over the Internet. The profiling package is typically equipped with pressure, temperature, conductivity, optical backscatter, light, chlorophyll, and oxygen sensors. The nodes are further equipped with several bottom-mounted systems, including a pressure sensor (for waves, tides and storm surge), an ADCP (for current profiles), a hydrophone, a fixed video camera, and a pan-and-tilt video camera. In addition, 8 guest ports provide power and Internet communications to additional sensors deployed by other investigators. Guest sensors have typically included tripods equipped with current meters, sediment size distribution sensors and fluorometers for resuspension and transport studies.

An autonomous underwater vehicle (AUV) docking port was installed on one of the LEO nodes during July 1998. On numerous occasions during this initial test phase, a Remote Environmental Measuring UnitS (REMUS) AUV (von Alt et al., 1997) successfully docked and was redeployed with a new mission profile downloaded from the shorebase over the fiber-optic cable. A third optical node was deployed on the sea bottom during the summer of 1999 and attached to the same fiber-optic cable. The optical node contains a winch operated profiler with a suite of sensors designed to provide data on inherent optical properties, particle size distributions, and fluorescence.

The network of observation systems surrounding the LEO nodes include satellite, aircraft and shore-based remote sensing systems to provide broad spatial coverage of surface properties, meteorological systems to provide forcing information, autonomous nodes to spatially extend the permanent LEO nodes during selected periods, and multiple shipboard and AUV systems for subsurface adaptive sampling. Satellite datasets include real-time sea-surface temperature and ocean color derived from locally-acquired direct broadcast transmissions from the AVHRR and SeaWiFS sensors, delay mode surface roughness data acquired from RADARSAT through NOAA, and delay mode hyperspectral data from the NEMO satellite scheduled for launch in 2000. Surface current data are updated hourly by a pair of CODAR HF-Radar stations located on the barrier islands to the north and south of LEO.

Local meteorological data currently are collected on a 64-meter tower located at the RUMFS. Recent upgrades include an atmospheric profiler onshore and a weather/optics buoy offshore. A single line of 6 autonomous nodes was deployed on a cross-shelf line during the summer of 1998 to act as a navigation network for the REMUS AUVs. RF-modem communications via a repeater located at the top of the meteorological tower allowed real-time tracking of the AUV survey missions. Twelve autonomous nodes were redeployed along 2