

EARTH SYSTEM MONITOR

Chlorophyll concentrations along the West Florida shelf

Analysis of temporal variability using remote sensing

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U.S. DEPARTMENT
OF COMMERCE
National Oceanic
and Atmospheric
Administration

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Several studies have demonstrated that the temporal and spatial patterns in chlorophyll concentrations in the deep Gulf of Mexico are dominated by a strong seasonal cycle and anomalies associated with El Niño-Southern Oscillation events (Muller-Karger *et al.*, 1991; Gilbes, 1996; Melo *et al.*, 2000). Very little, however, is known about how chlorophyll varies on the West Florida Shelf (WFL). Winds, currents, and nutrient inputs from rivers, as well as aeolian sources have all been identified as factors that influence phytoplankton on this shelf (Lenes *et al.*, 2001 in press), but their impact on phytoplankton communities remains unclear.

In recent years, several programs have collected *in situ* data on the WFL over limited spatial domains. Satellite data complements these programs with synoptic coverage. Sun-synchronous polar orbiting satellites such as NOAA's AVHRR (Advanced Very High Resolution Radiometer) and Orbimage's SeaWiFS (Sea-Wide Field-of-view sensor) offer daily sea surface temperature and ocean color data, respectively, for the entire WFL region. These sensors are a unique source of time series information.

The focus of the ECOHAB program (Ecology and Oceanography of Harmful Algal Blooms) in Florida is to gain a

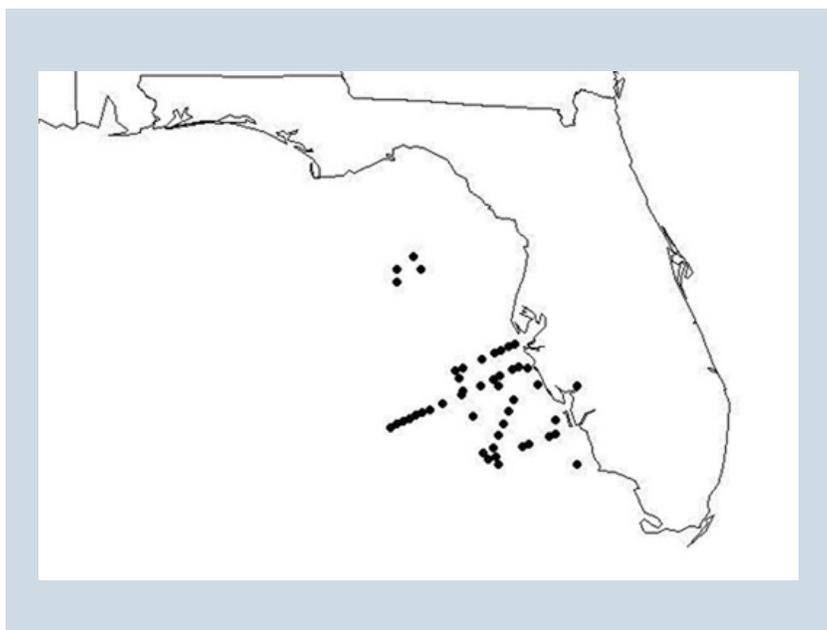
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better understanding of red tides and their underlying causes. Satellite data are currently being analyzed for identifying blooms of the major algal contributor, *Gymnodinium breve* (Brown, 1998). Identifying *G. breve* blooms may lead to the prediction and ultimate management of harmful algal bloom events.

In situ chlorophyll, pigment (HPLC), and other oceanographic data have been collected on a monthly basis along the WFL shelf as part of the ECOHAB program since 1997. Contributors include the University of South Florida, North Carolina State University, University of North Carolina, Mote Marine Laboratory, Florida Marine Research Institute, NOAA, EPA, and USDA. Monthly cruises are conducted along an established grid of stations in coastal waters adjacent to Tampa Bay, resulting in a comprehensive collection of biological, chemical, and physical oceanographic data for the ECOHAB region (Figure 1).

The *in situ* chlorophyll data were averaged for each monthly cruise (3-5 days duration) and compared with monthly averages of the SeaWiFS data at the station locations for 1997-2000. These comparisons reveal that, in general, the mean chlorophyll-a values derived from SeaWiFS

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▲ Figure 1. ECOHAB stations along the West Florida Shelf.

Chlorophyll, from page 1

overestimate concentrations measured *in situ* during the first half of the year. During the second half of 1999, the satellite data underestimated *in situ* values, particularly during October 1999 (Figure 2).

During the first week of October 1999, the ECOHAB data exceeded the SeaWiFS data by a factor of three, particularly in offshore waters deeper than 30 m. At nearshore stations with waters shallower than 30 m, SeaWiFS data overestimated the *in situ* observations throughout the remainder of the observation period (Figure 3).

During October 1999 there were elevated counts (>5000 cells/ml) of *G. breve* within the ECOHAB region possibly contributing to the disagreement between the SeaWiFS and *in situ* results during this period.

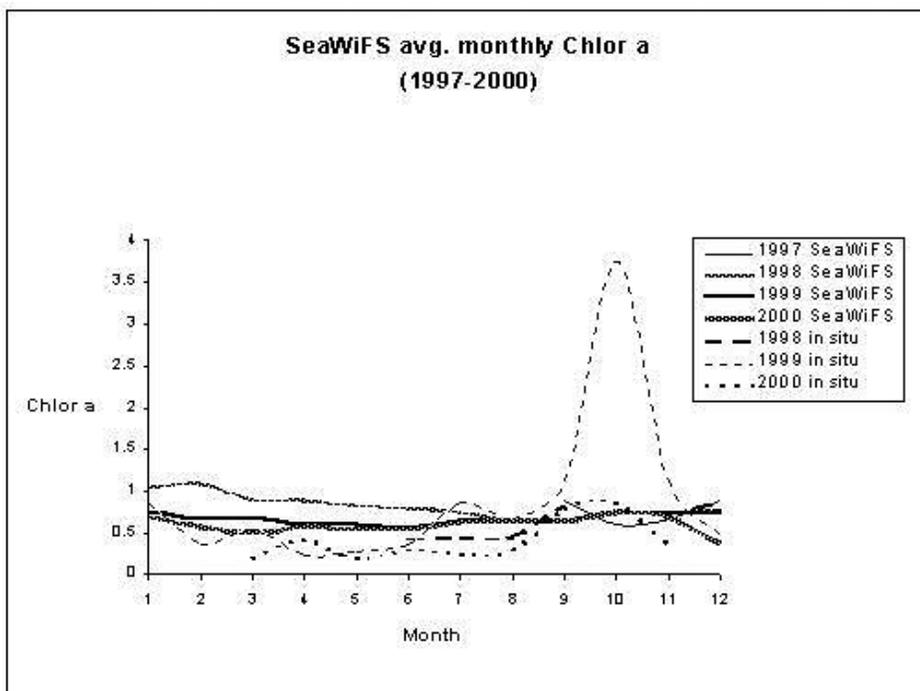
The good agreement between the SeaWiFS and *in situ* data suggested a seasonal chlorophyll pattern within the ECOHAB region (27-29° N, 82-82° W) of the WFL shelf, with peaks occurring during the winter months. Additional research is ongoing to examine the temporal and spatial patterns along the WFL shelf outside of the ECOHAB region from 1997-2000. Preliminary re-

sults indicate that in regions dominated by river influences the largest peaks occurred offshore (>30m) during the spring, while in regions not strongly influenced by rivers the largest peaks occurred inshore (<30m) during the winter months. These results suggest that rivers play a role in the spatial and temporal chlorophyll patterns but research is ongoing at USF to examine this further.

Ocean color satellite data is also being evaluated for its usefulness in the detection of blooms of such other important phytoplankton as *Trichodesmium*, nitrogen fixers that on occasion form large blooms within the Gulf of Mexico. Studies at the University of South Florida seek to develop algorithms that can be used for detecting both *G. breve* and *Trichodesmium* within the Gulf of Mexico using satellite data.

AVHRR sea surface temperature (SST) satellite data is also useful in studying and analyzing bloom development and movement. Eddies and fronts are readily detectable in AVHRR imagery thus indicating patterns of water movement and aiding in bloom detection.

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▲ **Figure 2.** Monthly SeaWiFS chlor-a versus *in situ* chlorophyll data acquired during monthly ECOHAB cruises.

EARTH SYSTEM MONITOR

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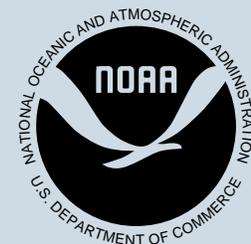
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U.S. DEPARTMENT OF COMMERCE

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NCDC reports on weather and climate events

The National Climatic Data Center has released three reports concerning weather and climate events: 1) a report on U.S. and global significant events of 2000; 2) Technical Report 2000-03 describing the 1999 hurricane season in detail, with numerous satellite image included; and 3) an update of the Billion Dollar Weather Disaster report for 1980-2000. The report on 2000 U.S. and global events is part of an overall report on the climate of 2000.

The report on the 1999 hurricane season, though delayed from previous such reports, includes information from a National Weather Service report on Hurricane Floyd, along with rainfall data from four land-falling storms. The updated Billion Dollar Disaster report includes the latest figures on the two events for 2000 — over \$2 billion in losses and costs from the western fire season and over \$4 billion in agricultural and related losses due to drought across the southern and central states. All reports are accessible via: <http://www.ncdc.noaa.gov/extremes.html>.

NOAA-wide metadata workshop

Metadata experts from all NOAA line offices gathered for a workshop, in early February, at the National Geophysical Data Center. They discussed benefits and problems of applying the FGDC (Federal Geographic Data Committee) Metadata Content Standard to NOAA data, metadata processing for the NOAA Server, and various metadata management techniques. The workshop was also attended by a representative of Blue Angel Technologies, a leading developer of metadata management and access tools. These tools were described to the group and demonstrated using NOAA metadata.

NOAA data appears in U.S. News & World Report

A map produced by NGDC's Paula Dunbar and David Anderson appeared in a January cover story of *U.S. News & World Report*. The science article reports on recent advances in studies of human evolution and early migrations around the world. The map, based on data distributed by NOAA, depicts shorelines of 65,000 years ago and reveals land bridges thought to be instrumental in human migration.

News briefs

The Maya civilization and drought

The NOAA/NGDC Paleoclimatology Program has archived new chemical tracer data from lake sediments in the Yucatan Peninsula of Mexico. Published by Hodell *et al*, in *Nature*, these data have been used to reconstruct the precipitation/evaporation ratio in Lake Chichancanab as a proxy for drought. Results indicate major drought in the period between 800 and 900 A.D., corresponding to the collapse of the Classic Maya civilization. The data and research summary are on the Paleoclimatology Program website at: http://www.ngdc.noaa.gov/paleo/drought/drght_mayan.html. Due to the interest in this topic, the NOAA/NGDC Paleoclimatology Program has been working with Dr. Hodell, of the University of Florida, to prepare an educational slide set on this topic that will be released later this year.

Paleoclimatology discussion list

NOAA's National Geophysical Data Center Paleoclimatology Program has launched an International Paleoclimate List-Server. This list-server provides a forum for Internet discussions and announcements among paleoclimatologists throughout the world. Of primary emphasis are periods of the recent past where data from the paleoclimatic record are of particular value to the modern climate community. Within the first five days of operation, the list-server had 626 members from a total of 40 countries. General topics that the list will focus on will include the availability of new proxy and historical data, national and international programs and program news, funding and employment opportunities, and recent reports on paleoclimate research. More information about the list can be obtained at: <http://www.ngdc.noaa.gov/paleo/listserve.html>.

Stuart Little 2

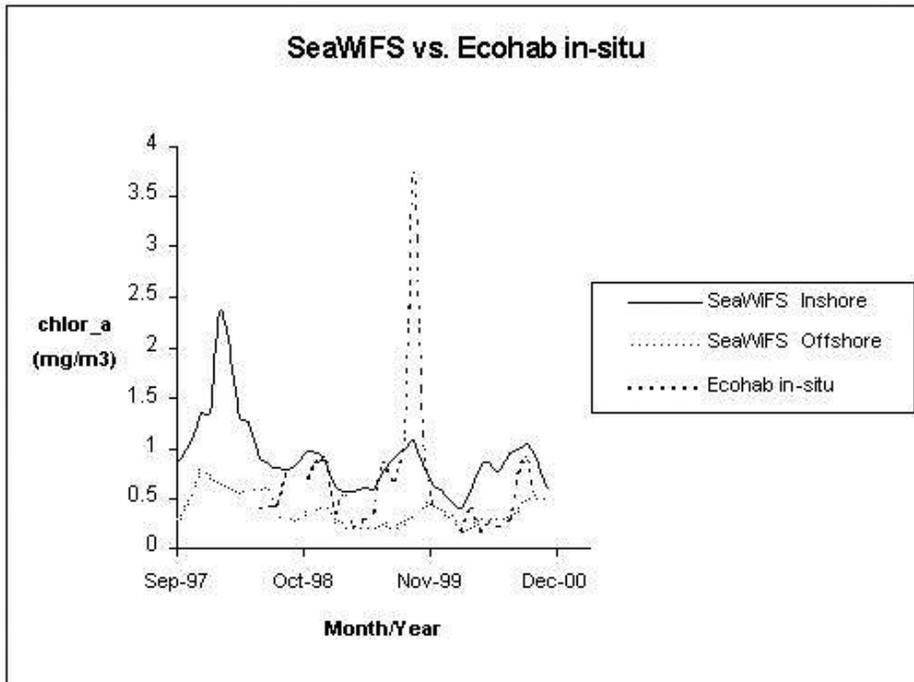
A film producer recently contacted the NCDC to obtain climatic data regarding selected cities in the northeastern United States. He is comparing climatic normals for different cities to determine the most desirable place for the upcoming *Stuart Little 2* feature film.

Lockwood Seamount imagery

The National Geophysical Data Center has prepared a triplet of images showing the location and topography, in contour and color-shaded relief, of Lockwood Seamount. Named for Millington Lockwood, of the National Ocean Service (NOS), it honors his memory as the interagency facilitator of many productive efforts. It is a fitting tribute to Millington, who among his myriad activities, headed the Joint Ocean Mapping and Research Office (a combined venture of NOAA and the United States Geological Survey), was active in the Defense Hydrographic Initiative (a cooperative project of NOAA, the National Imagery and Mapping Agency, and the U.S. Naval Oceanographic Office to share developments and technologies), and spearheaded several Federal Geographic Data Committee efforts to standardize Geographic Information System data, metadata, and interchange. The images were forwarded to the National Ocean Service for presentation to the Lockwood family and for permanent display at NOS in Silver Spring, Maryland.

Climate and health proposal

Dr. Earle Buckley from the NOAA Coastal Services Center, visited the NCDC to discuss a joint proposal for the Office of Global Programs (OGP) titled "Developing a Predictive Capability of the Influence of Weather and Climate Upon Human Health in Coastal Regions of the U.S." Dr. Buckley is one of the principal investigators of an interdisciplinary team comprised of members from ten academic and eight governmental organizations. A pre-proposal has been submitted to the Office of Global Programs and a full proposal is being prepared for submission in April. Dr. Buckley and NCDC personnel discussed the scope of NCDC's involvement in the project and what climatic data could be used. The project team will identify specific applications that will be part of regionally focused pilot projects which will allow NCDC to identify specific data sets and products. Dr. Buckley felt the visit was extremely beneficial in that it allowed him to gain a better understanding of the volume and type of data that will be needed for the project. A project web page will also be developed so that information such as references and links can be shared.



▲ **Figure 3.** SeaWiFS chlorophyll 1997-2000 time series for inshore and offshore sub-regions versus Ecohab in-situ data.

Chlorophyll, from page 2

The MODIS (Moderate Resolution Imaging Spectroradiometer) instrument combines the capabilities of both the AVHRR and the SeaWiFS into one sensor, currently being flown on the morning (10:30 am) Terra satellite. A second MODIS will be flown on the afternoon (1:30 pm) Aqua satellite. Aqua is scheduled to be launched in late 2001 or early 2002.

MODIS, SeaWiFS, and AVHRR data are available on a daily basis from the University of South Florida's Remote Sensing Laboratory where data are captured 1-2 times daily with tandem X-band and L-band antennas located in St. Petersburg, Florida. While MODIS and AVHRR data are openly available to all users, SeaWiFS data are restricted to NASA authorized users only. To become a SeaWiFS authorized user one must apply to the NASA SeaWiFS Project (see <http://seawifs.gsfc.nasa.gov>).

The Remote Sensing Laboratory at the University of South Florida is working closely with the Florida Marine Research Institute to develop applications of remote sensing tools to solve

coastal issues. This includes new atmospheric correction and bio-optical algorithms (Hu *et al*, 2000; Del Castillo *et al*, 2000; Lee *et al*, 1998). This work will have wide benefits for coastal resource managers in this region.

As technology continues to improve and sensors with greater spectral and spatial resolution are developed, remote sensing will become a standard tool in chlorophyll research within coastal environments. Future research will focus on developing remote sensing algorithms to differentiate between phytoplankton species and therefore identify harmful algal blooms. Remote sensing will also be used to ascertain the environmental conditions and underlying factors responsible for bloom initiation, making bloom prediction a reality.

Efforts are also underway to combine research efforts in these areas between academia and government agencies. Researchers at the University of South Florida, Florida Marine Institute, NOAA, and USGS are working together to reach the goals outlined above.

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South Slough National Estuarine Research Reserve

Monitoring short-term variability and change in the estuary's water quality

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Dynamics, transitions, and changes are at the heart of estuaries. Derived from the Latin word *aestus* for tide, estuaries are transitional places where salty ocean water meets and mixes with fresh water from rivers and streams. These semi-enclosed bodies of water include bays, lagoons, sloughs, and mangrove forests. Collectively they contribute over 21 million acres of shellfish-growing waters along the shoreline of the contiguous United States (<http://state-of-coast.noaa.gov/>).

Estuaries are among the most dynamic and productive environments known. Nutrients from decaying plants and animals are continually washed downstream by rivers and streams where they settle out in the shallow, protected bay water. Episodic storms provide periods of intense flooding and redistribute the soft sediments and decaying organic matter. Mixed by wind and tides, a rich, organic soup collects near the bottom of the estuarine tidal channels where it forms the base of the food web for many invertebrates and fish. Estuarine habitats provide vital spawning, feeding and rearing areas for more than 75% of the commercial fish and shellfish species in the United States. Estuaries also serve as important rest and refueling stops for migratory shorebirds, and as pollution filters, wave buffers, and sediment traps (www.nwi.fws.gov/ and www.epa.gov/owow/estuaries).

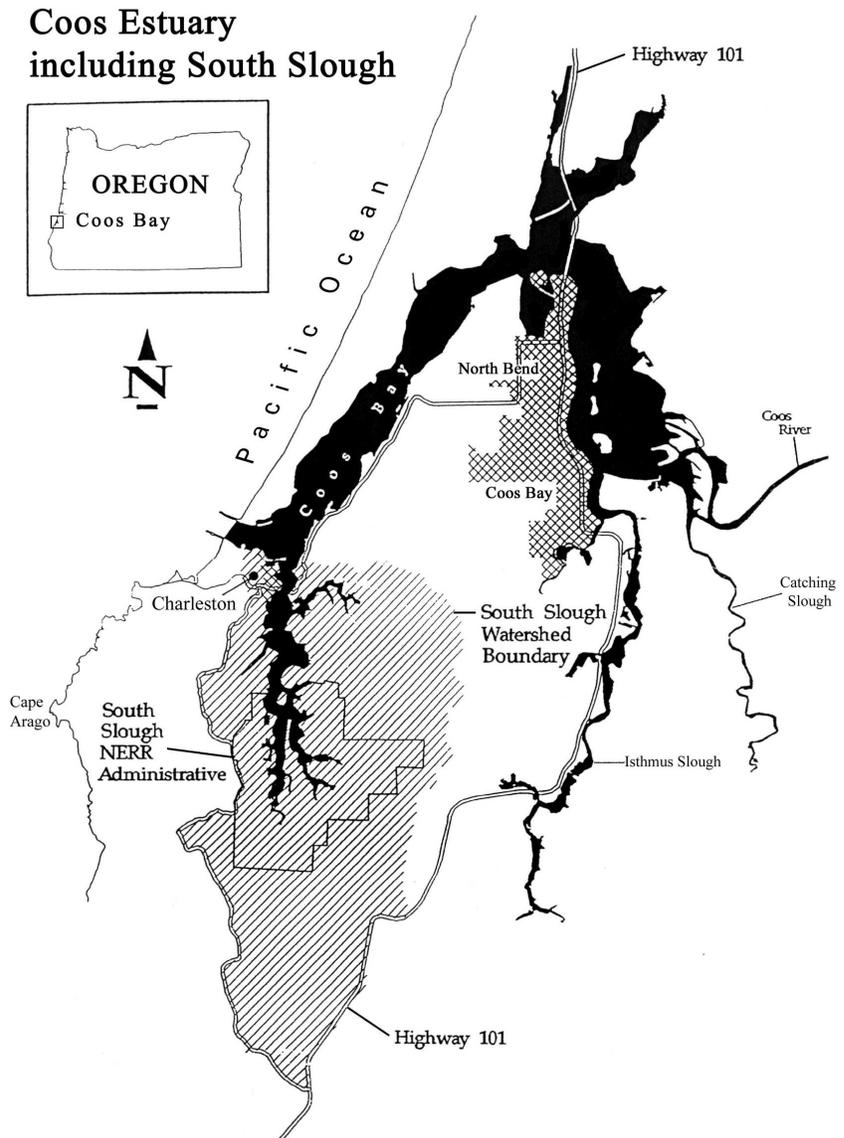
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▲ **Figure 1.** The Coos estuary system is located in southern Oregon. South Slough is a quiet arm of the larger Coos estuary.

Humans have placed a high value on estuaries for thousands of years. Besides the abundant food supply, estuaries serve as transportation corridors for commerce links between inland and coastal regions. Prosperous port cities abound near river mouths. The diverse recreation activities and aesthetic values are also important to the public. Due to this richness, estuaries have become densely populated; approximately 53% of the nation's population

lives within a thin strip of land bordering the coasts. Unfortunately, this popularity has led to the widespread destruction of estuarine habitats as shorelines have been altered to meet urban, industrial, and agricultural needs. Water quality degradation and the increased incidence of marine pathogens are recent consequences of the changing land use patterns. In

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South Slough NERR, from page 5

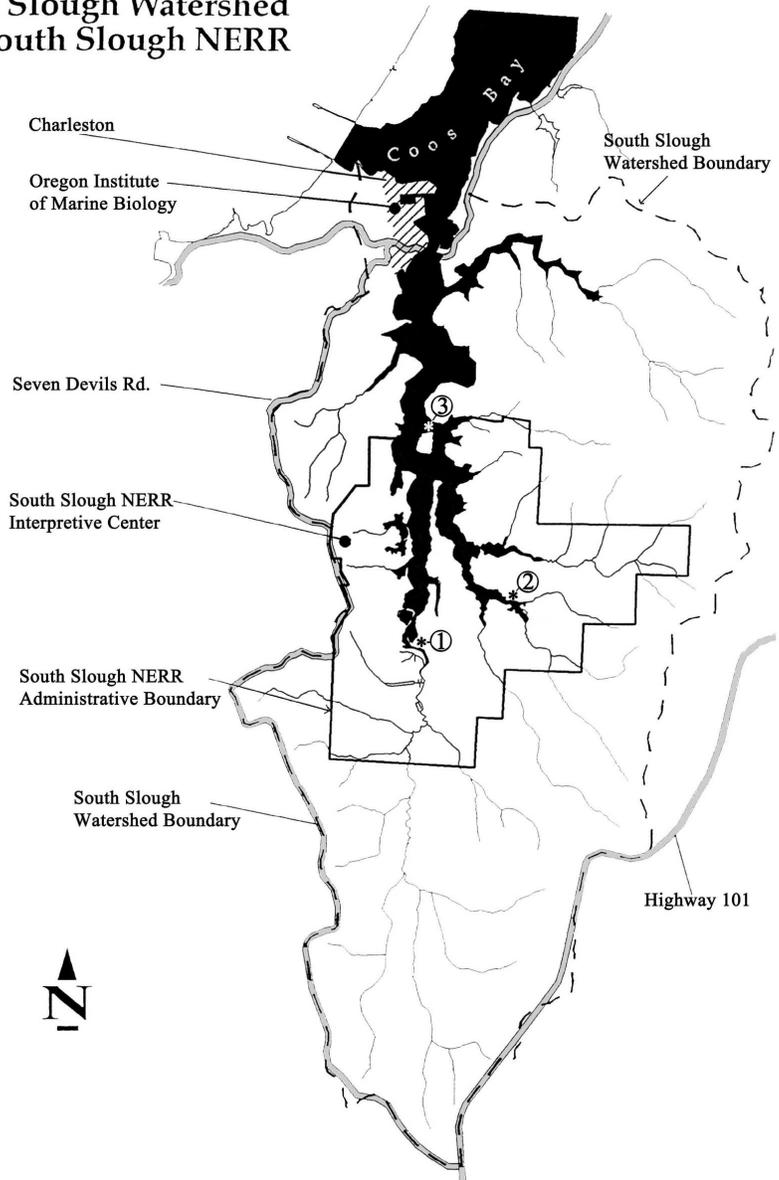
some estuaries nutrient levels may be very high leading to eutrophication and to low dissolved oxygen levels that are toxic to most organisms (www.nos.noaa.gov).

NERR System-wide Monitoring Program (SWMP)

Established in 1974, South Slough National Estuarine Research Reserve (South Slough NERR) was the first estuarine sanctuary designated under the Coastal Zone Management Act (CZMA). It is a drowned river mouth estuary, representative of the mid-Pacific portion of the Columbian Bioregion, extending from Cape Mendocino, CA north to the Columbia River, OR. South Slough is one of seven tidal inlets that collectively form the Coos estuary (Figure 1). Encompassing over 4,770 acres, South Slough NERR is managed by a partnership between NOAA/ Estuarine Reserves Division and the Oregon Division of State Lands. Since 1974, South Slough NERR has been joined by 25 other Reserves in 22 states and territories to protect over 1 million acres of estuarine waters, wetlands, and uplands (www.ocrm.nos.noaa.gov/nerr and www.southsloughestuary.com).

Understanding the dynamic nature of change in estuarine ecosystems requires long-term datasets that span many years and encompass several disturbance events. In 1995, the NERR system established the System-Wide Monitoring Program (SWMP), a nationally-coordinated plan to systematically assess and track estuarine habitat conditions. The mission of the NERR / SWMP is to characterize short-term variability and long-term change in water quality, biotic diversity, and land-use in estuaries and coastal watersheds. Information generated by the nationwide SWMP will contribute to a better understanding of estuarine ecosystem functions and improve management decisions that affect estuarine habitats throughout the coastal zone of the United States. The SWMP is currently implemented by all 26 NERR sites, and the datasets and metadata are collected and archived by a Central Data Management Office (CDMO) located at the University of South Carolina - Belle

South Slough Watershed & South Slough NERR



▲ **Figure 2.** Location of SWMP monitoring stations within the South Slough estuary: Station 1 — The west arm (Winchester Creek) provides the primary source of freshwater input and is the location of tideland restoration activities. Station 2 — The east arm (Sengstacken) is an undisturbed reference area. Station 3 — Valino Island serves as a reference site in the marine-dominated region of the estuary.

Baruch Marine Station (<http://inlet.geol.sc.edu/cdmohome.html>).

At the South Slough NERR, three long-term monitoring stations were established along the marine-freshwater estuarine gradient to improve our understanding of tidal dynamics and watershed inputs (Figure 2). In particular, the South Slough NERR SWMP stations collect continuous information to address three primary topics: (1) short-

term variability and long-term changes in estuarine water parameters within different regions of the estuary (i.e., localized impacts of seasonal storm events, variability in water quality parameters in association with re-establishment of tidal circulation, inter-annual differences in rainfall, magnitude and influence of El Niño - La Niña events, spatial extent of oceanic and tidal forcing, and long-term changes

associated with the Pacific Decadal Oscillation); (2) verification, calibration, and future refinement of an existing two-dimensional water quality model (CE-QUAL-W2) developed to predict levels of coliform bacteria and dispersion of environmental toxins; and (3) collection of fundamental hydrodynamic data for future development of a three-dimensional tidal circulation model for the greater South Slough / Coos Bay estuaries.

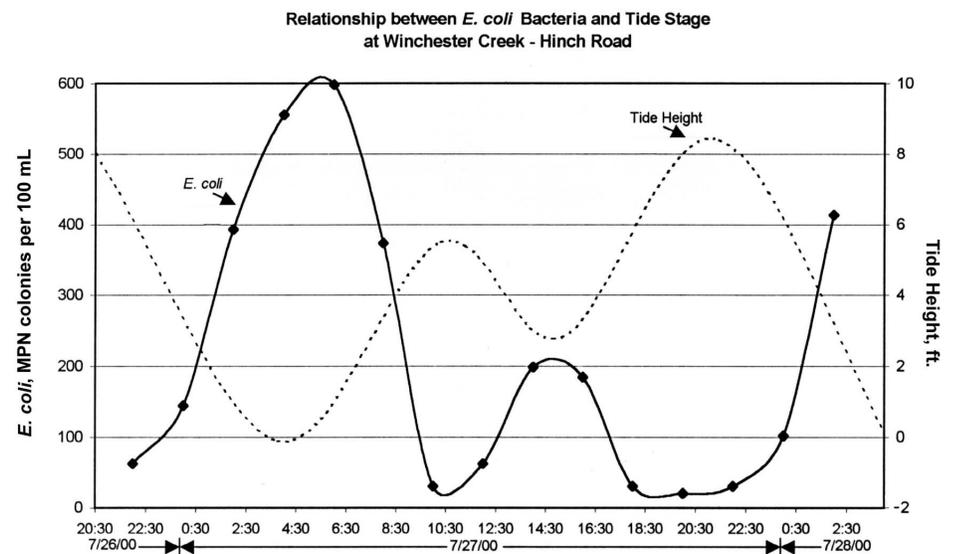
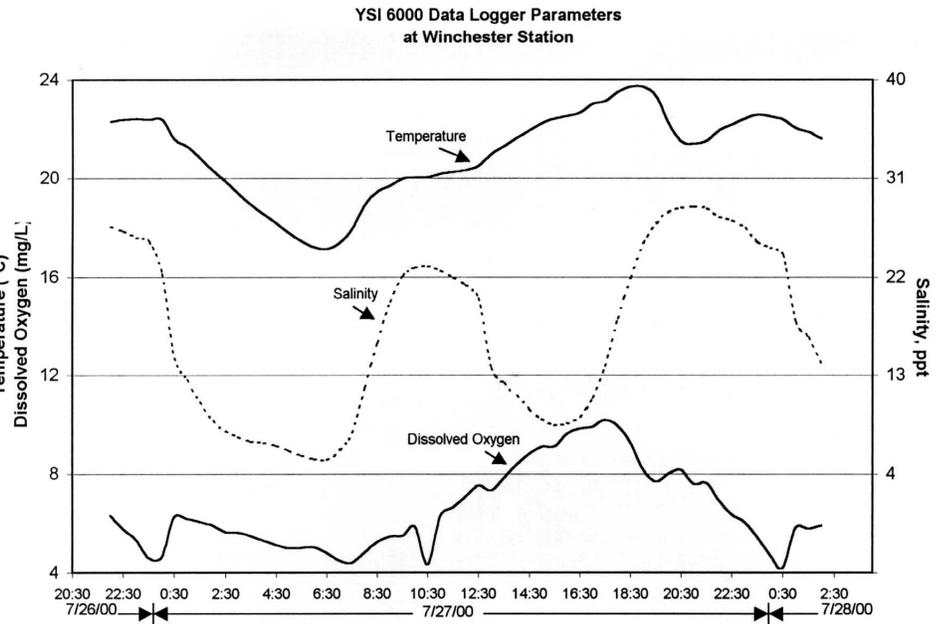
Yellow Springs Instruments (YSI) 6000 and 6600 data loggers are programmed to record water quality parameters including temperature, depth, pH, dissolved oxygen, specific conductivity, salinity, and turbidity. These parameters are indicative of general estuarine water column conditions and they are used by regulatory agencies to determine criteria for human uses. Unattended, the YSI datasondes record measurements every 30 minutes over 22-30 day periods at three stations:

1) Winchester Arm: [43° 16' 56.03" N, 124° 19' 7.16"W]

In operation since April 1995, this station is located at a management-treatment site (Figure 2). It is within the riverine (southern) portion of the Winchester Arm (Kunz Marsh) and is approximately 7.1 km from the mouth of the South Slough estuary. The site is adjacent to an experimental dike removal/marsh restoration area, where dikes were removed from a 5.1 ha area in 1996 and 1998. About 4.2 hectares of natural marsh surround the project site. Tidal range is approximately 8 ft., and salinity ranges between 0-28 ppt. Freshwater inputs range between 1 and 23 cfs.

2) Sengstacken Arm: 43° 17' 22.57" N, 124° 18' 2.75" W]

Also operational since April 1995, this station serves as a reference site and is located within the riverine (southern) region of the Sengstacken Arm immediately adjacent to 4.3 ha of natural salt marsh. The site is approximately 6.6 km from the mouth of the South Slough estuary. Tidal range is approximately 8 ft., and salinity ranges between 0-28 ppt. Freshwater inputs have not been quantified.



▲ **Figure 3.** This graphic shows a time-series combination of estuarine monitoring parameters; temperature, salinity and dissolved oxygen are on the top graph, while tide level and *E. coli* bacteria levels are shown on the lower graph. The sequence is 30 hours long and is from the Winchester SWMP station. Bacteria samples were collected every two hours. MPN refers to Most Probable Number of colonies per 100 mL of water sampled.

3) Valino Island: [43° 19' 1.55" N, 124° 19' 14.33" W]

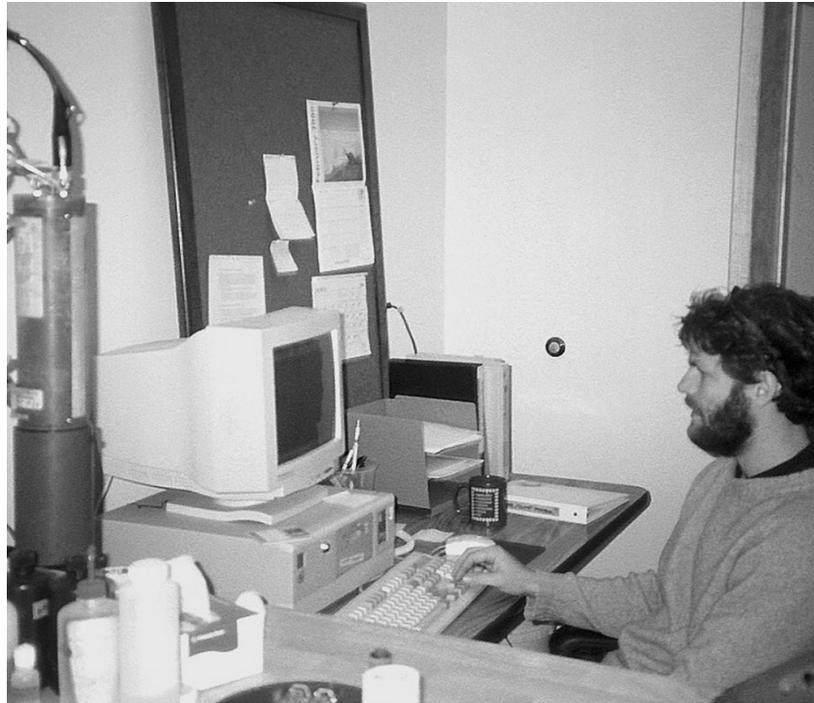
Installed June 1999, this station serves as a secondary reference area and is located in the marine-dominated central portion of the estuary immediately north of Valino Island. The site is approximately 3.6 km from the mouth of South Slough estuary. Situated in the primary tidal channel, the station is

adjacent to expansive eelgrass beds, tidal mudflats, sandflats, and commercial oyster cultivation areas. The tidal range is about 11.7 ft. and salinity ranges between 10-33 ppt.

During deployment, the datasondes are lowered by chain into protective cases (constructed from 4" diameter ABS plumbing pipe) that are

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affixed vertically to existing log pilings driven into the mud. The cases are perforated with holes to ensure adequate tidal flushing and exposure of the probes to ambient estuarine water. The sensor arrays are positioned 0.5 m off the bottom of the 3 m deep tidal channels. After three weeks of continuous recording, the datasondes are retrieved and returned to the laboratory for cleaning, downloading, and recalibration. Post-deployment calibration checks are performed immediately upon retrieval to determine if instrument drift has occurred. The sondes are reinstalled at the monitoring stations the following day, resulting in a monthly data gap of about 24 hrs.



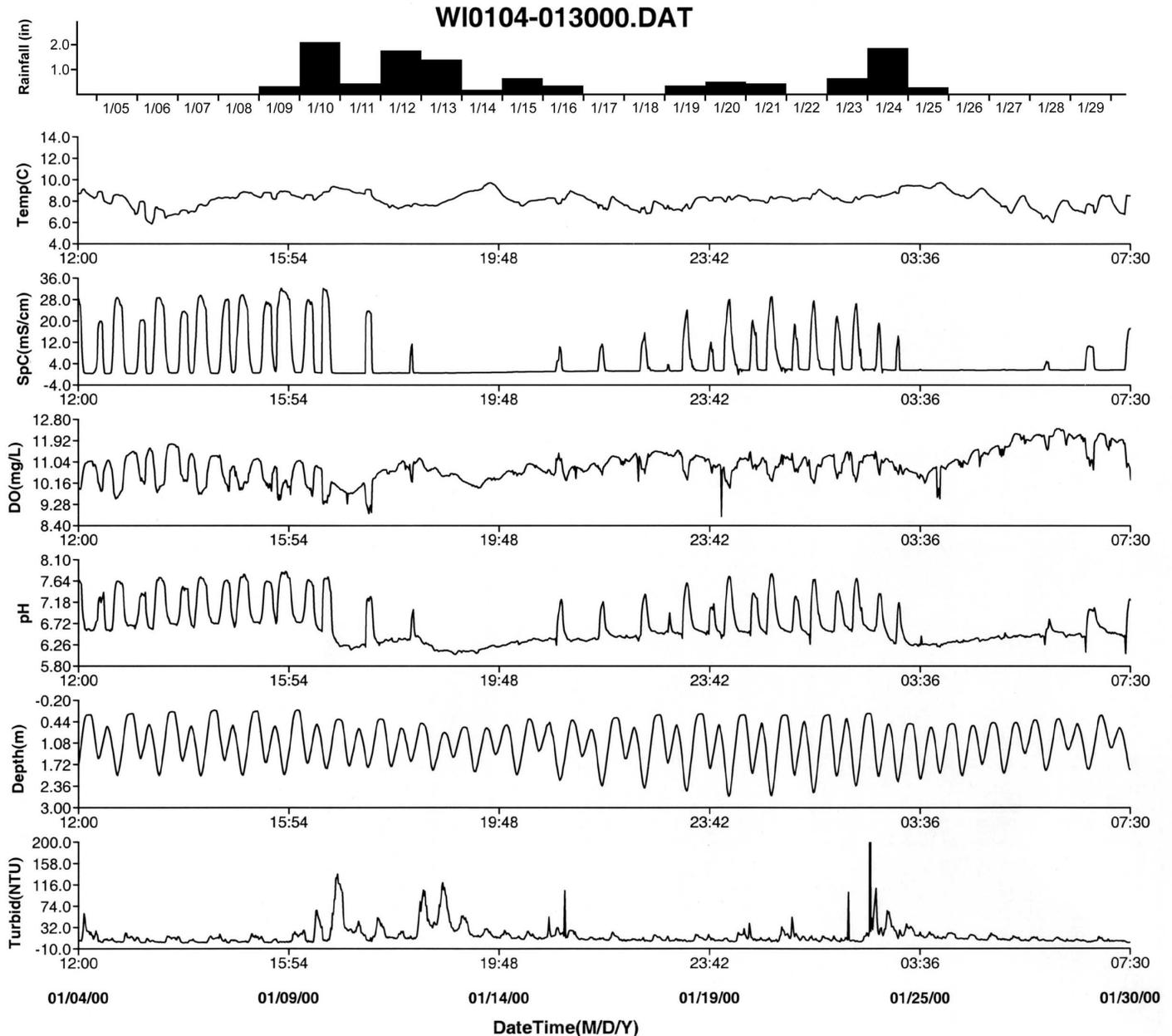
▲ **Figure 4.** A graduate student downloads the YSI datasondes in the laboratory.



▲ **Figure 5.** A labeled sonde on site; shows the Winchester SWMP station with a telemetry device attached to transmit real-time data to the interpretive center, for use in a water quality exhibit.



▲ **Figure 6.** A SWMP technician removing the YSI6000 from the ABS pipe that is attached to the log piling in the bay.



▲ **Figure 7.** The effect of rainfall on several water quality parameters at the Winchester SWMP station. Rainfall data are from the North Bend Weather Station about 17 km away. Notice how the heavy rainfall on 1/10 - 1/13 and on 1/24 had immediate effects on the specific conductivity, dissolved oxygen, pH, and turbidity levels.

Applications of the SWMP datasets

1. Winchester Tidelands Restoration Project

The Winchester Tidelands Restoration Project (WTRP) is a 50-acre special management area located on the western arm of the South Slough. Historically, this area consisted of highly productive salt marshes, mudflats, and estuarine channels. Near the turn of the century, streams were channeled and the tidelands were diked and drained to create pastures and freshwater ponds.

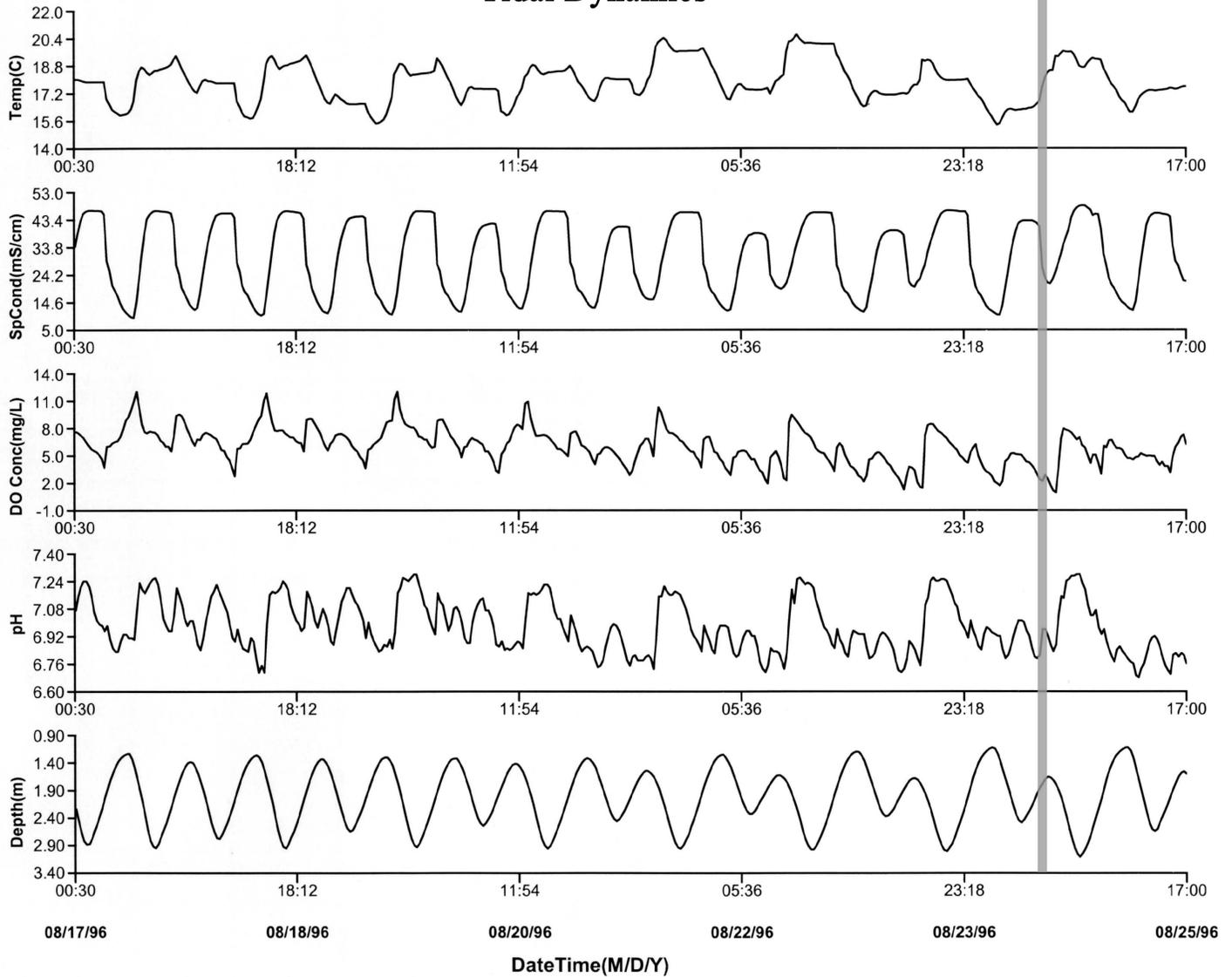
By 1970, agriculture had declined in the area, leaving the Winchester Tidelands high, dry, and fallow.

The WTRP was designed to restore tidal circulation and lost ecological functions that benefit diverse communities of tidelflat invertebrates, emergent vegetation, migratory shorebirds and waterfowl, and resident and anadromous fish. The 12-acre Kunz parcel was the first area targeted for restoration. Earth material from inside the dike was redistributed over the surface of four

experimental cells (ca.1.5 ac each) to create new marsh platforms that varied sequentially in elevation from 1.5 to 2.3 m above North American Vertical Datum (NAVD). The earth-moving activities occurred over a period of three weeks in August 1996, and the dike was finally breached on August 24, allowing the Winchester Creek tidal channel to flood freely over the experimental marsh cells for the first time in about 100 years.

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WINCHESTER SWMP STATION Tidal Dynamics



▲ **Figure 8.** An example of short-term variability in water quality parameters at the Winchester SWMP station. Data were collected before, during, and after an earthen dike was breached at the Kunz marsh in 1996 (heavy vertical line).

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During the planning phase of the WTRP, scientists were worried that the extensive pasture vegetation (uprooted by restoration activities, decaying due to seasonal die-off, and killed outright by flooding of saline tidal waters) would adversely affect water quality conditions in Winchester Creek following dike removal. Data records from the Winchester Creek SWMP station, however, showed that dissolved oxygen levels (mg/L and % sat) measured immediately downstream from the restoration project site were not substantially different from an unmanaged control site (adjacent to a natural saltmarsh). These findings provide some assurance that dike removal activities can proceed in the Pacific Northwest without increases in the frequency and duration of hypoxia or degradation of the tidal channel.

2. Pre-Restoration Monitoring at Anderson Creek

Another phase of the WTRP, scheduled for fall 2001, will reestablish stream meanders and other geomorphic features of Anderson Creek, a small tributary of Winchester Creek. Although the Winchester Creek SWMP station will collect water quality parameters pre- and post-restoration, the probe array is located about 2.4 km downstream from the future earth-moving activities. Consequently, any water quality impacts may be masked by dilution from other tributaries.

Restoration activities undertaken in one part of the estuary may have telegraphic effects in another region. For example, Coos Bay and South Slough are the largest commercial oyster-growing region in the state. The Oregon Department of Agriculture conducts monthly bacterial analysis on shellfish harvesting regions as part of their management of the industry. They recorded a high bacterial level possibly coinciding with the Kunz Marsh restoration activities in 1996. Because of this, and since many oyster growers are downstream from the WTRP, scientists felt it was important to monitor the effects of restoration activities on water quality.

Using equipment and supplies furnished by the Oregon Department of Environmental Quality, monitoring has begun for a new biotic parameter analysis of total coliform and *E. coli* bacteria levels (IDEXX Colilert method).

A recent college graduate (University of Oregon) and high school student (Apprenticeships in Science and Engineering) teamed up with the South Slough NERR to select monitoring sites, gather water quality data, and analyze the results. Sampling sites included areas upstream and downstream from the Anderson Creek restoration site, input from other tributaries, and three sites in lower South Slough. Using a hand-held YSI-85 meter, the team recorded dissolved oxygen, conductivity, and temperature in the field. They also collected water samples to analyze turbidity, pH and bacterial levels in the laboratory. During and after restoration, staff scientists will use the protocol developed by the team to assess water quality changes coinciding with restoration activities.

3. Tidal forcing of E. coli Bacteria

In another project, intensive water column sampling was conducted during July 2000 to quantify short-term variability in bacteria levels associated with forcing by the ebb and flood of the semi-diurnal tides. Estuarine water samples were collected from the Valino Island (marine) and Winchester Creek (riverine) SWMP stations at 2-hour intervals over a period of 30 hours (see Figure 3). Colony forming units are reported as Most Probable Number of colonies per 100 mL (MPN). Results from the Valino Island bacterial analysis indicate that *E. coli* levels fluctuate inversely with the tides, and that the greatest concentrations of bacteria (MPN > 50) occur during the lowest of the semi-diurnal tides. Dissolved oxygen levels climbed slowly during the monitoring period and reached a peak of ca. 10 mg/L immediately following the afternoon low tide. The time-series of bacterial concentrations followed a similar pattern at the Winchester creek site although the most probable numbers for *E. coli* were much greater (500 to 600 MPN).

Future plans and other applications of the South Slough NERR SWMP data

- Baseline understanding of short-term variability and long-term change in an estuarine tidal channel that is representative of the Lower Columbia bioregion (ongoing 1995-present)
- Real-time tracking of the Pacific Decadal Oscillation (PDO) and the extent of cooling of estuarine waters (1999 to 2004+)
- Case history of El Niño/Southern Oscillation ocean warming event in Pacific Northwest estuarine waters (1997 ENSO — repeated every 3-8 years)
- Influence of seasonal upwelling/ocean forcing on estuarine tidal waters and determination of nitrogen loading from oceanic versus watershed inputs (annual/seasonal 1999 - present)
- Dynamics of estuarine tidal waters in eelgrass beds and commercial oyster cultivation areas (annual/seasonal/tidal cycles 1999 - present)
- Biophysical impacts of salt marsh restoration on adjacent tidal channel and eelgrass beds (1996-1999)
- Identification of bacterial sources in estuarine waters with DNA sequence techniques (2001-2002)
- Temporal dynamics of estuarine tidal creeks during flushing by seasonal freshets (annually/Nov-Mar)

Notes:

South Slough website is at <http://southsloughestuary.com/>

IDEXX equipment (<http://www.idexx.com/>) and supplies furnished by the Oregon Department of Environmental Quality.

The Central Data Management Office in Georgetown, SC, manages water quality data recorded by all the Reserve sites (<http://inlet.geol.sc.edu/cdmoweb/home.html>).

EcoWatch for Windows program developed by YSI, Inc (<http://www.ysi.com/>).

Saturday Academy Apprenticeships in Science and Engineering (<http://www.ogi.edu/satacad/>). ■

Marine reserve design in Florida's Tortugas

Currents and coral reefs

Joanne M. Delaney

Florida Keys National Marine Sanctuary
NOAA/National Ocean Service

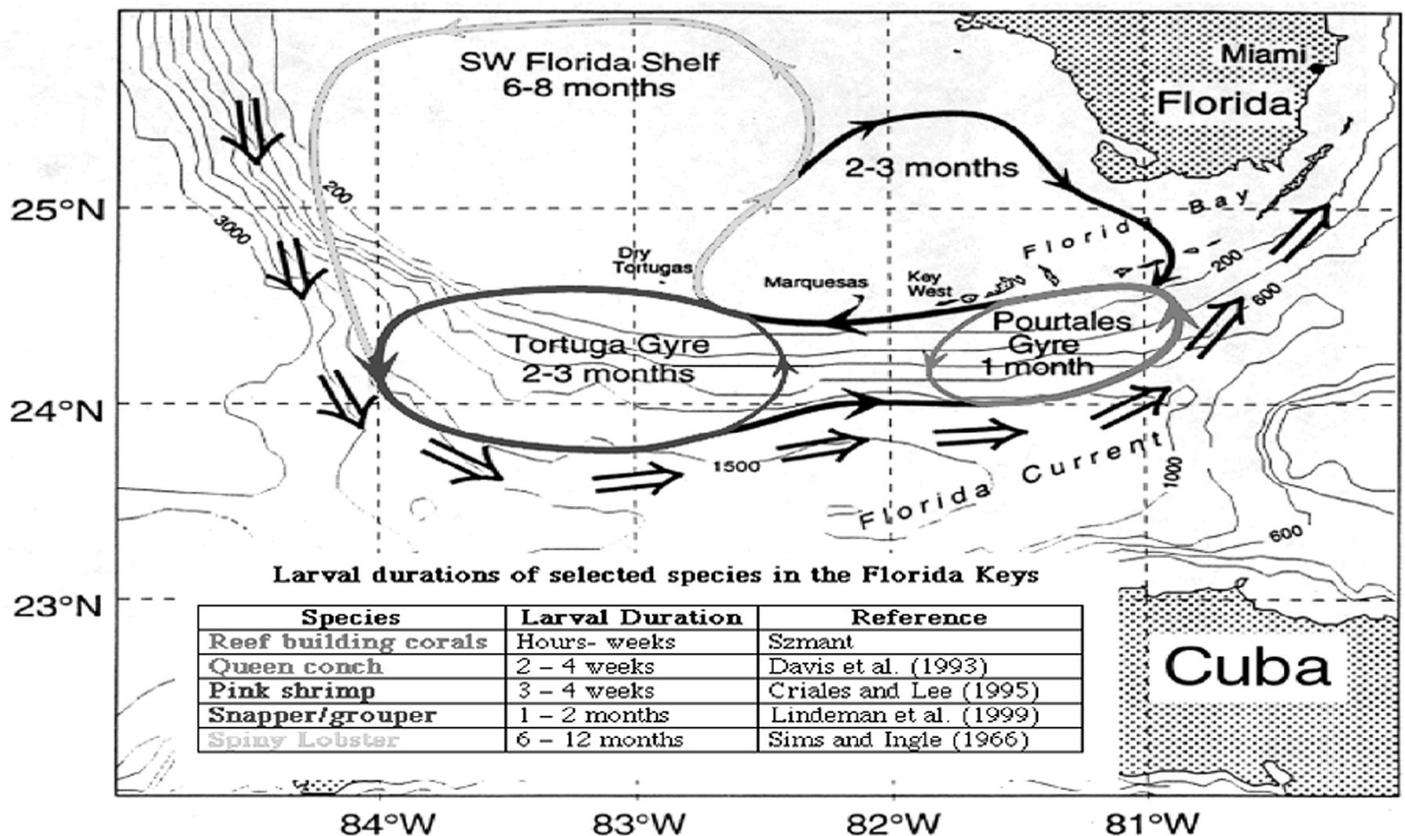
The Florida Keys National Marine Sanctuary (FKNMS) is a 2800 square nautical mile marine protected area that was designated in 1990 and is administered under the National Oceanic and Atmospheric Administration's National Ocean Service (NOAA/NOS). A comprehensive management plan for the Sanctuary was adopted in 1997 that contained an innovative tool for marine resource protection, the creation of a network of 23 no-take zones, or marine reserves. Marine reserves have been utilized successfully in other countries for decades and zoning, in

general, is a well-recognized management tool in terrestrial habitats. However, the use of marine zoning in the Florida Keys was a first for this country, representing a bold step in marine resource protection.

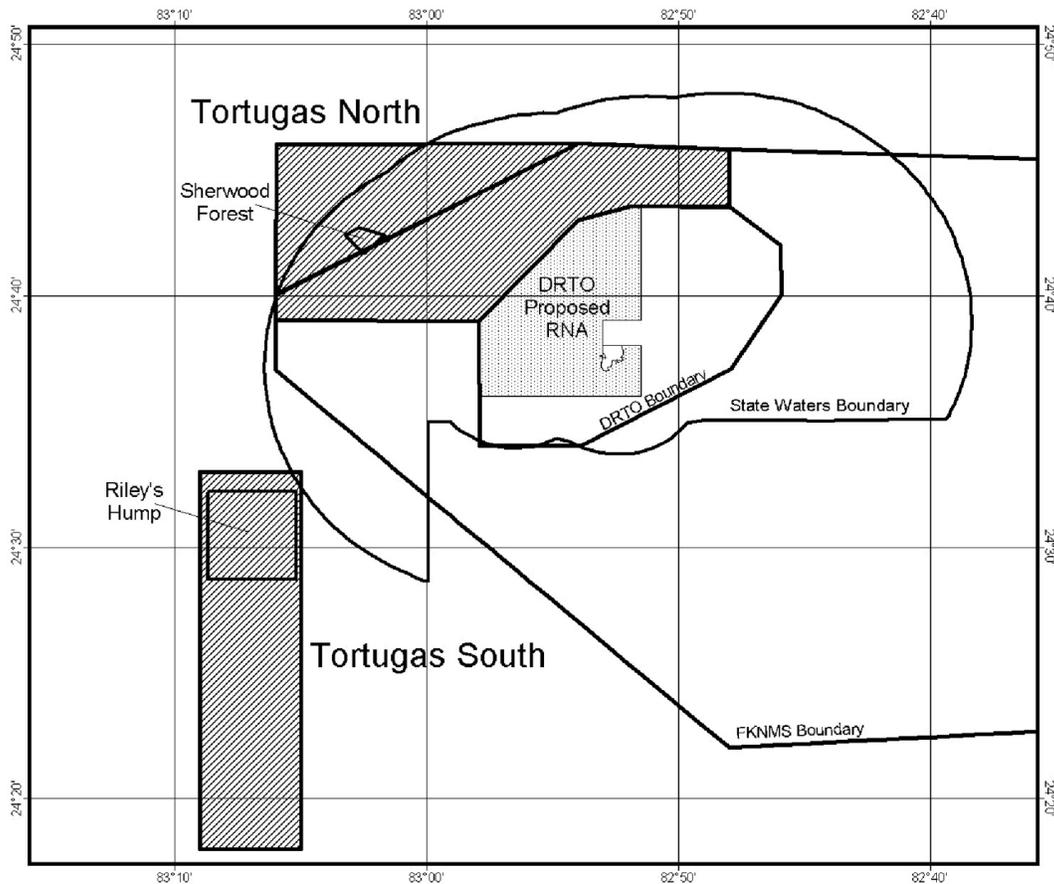
The FKNMS zoning network includes five different zone types designed to achieve various objectives. One zone type, ecological reserves, was specifically designed to protect a full-range of habitats and preserve biodiversity. In 1997, one ecological reserve was established in the Western Sambo area of the Sanctuary with the commitment to create a second ecological reserve in the Tortugas region, located in the westernmost reaches of the Florida Keys. In 1998, a process called

Tortugas 2000 was initiated and a diverse working group of 25 stakeholders and agency representatives convened to design the Tortugas Ecological Reserve.

One of the initial components of this reserve design process was supplying oceanographic and ecological data from the Tortugas region to the working group. Dr. Tom Lee and colleagues from the University of Miami's Rosenstiel School of Marine and Atmospheric Science collected and synthesized extensive physical oceanographic information for the Tortugas 2000 effort. These data were the product of ten years of research by Dr. Lee to map current patterns and water movements throughout the Florida Keys, Gulf of Mexico, and Florida Bay.



▲ Figure 1. Potential larval recruitment pathways in the Florida Keys (current data courtesy of Dr. T. Lee, University of Miami).



▲ **Figure 2.** Proposed boundary for the Tortugas Ecological Reserve, which will be comprised of two sections called Tortugas North and Tortugas South. The Dry Tortugas National Park plans to implement a no-take zone within park water that will protect critical shallow reef habitats and complement the Tortugas Ecological Reserve (labeled as "DRTO Proposed RNA").

Several satellite-tracked surface drifters were released at various locations and times of the year and monitored by project researchers. Data on individual drifters was presented to the working group to elucidate the varied oceanographic circulation in the Tortugas region. The persistence and direction of major surface currents was demonstrated by combining data from several drifter tracks with observations of coastal and offshore currents, sea temperature, and wind speeds, providing a clear picture of broad-scale circulation patterns. A research project supported by the Center for Marine Conservation that tracked the return of small drift bottles released in the Tortugas during a known reef fish spawning event and descriptions of

Caribbean-wide current patterns (after C. Roberts, 1997) were also provided to the working group. These data were then compared with known life history information (specifically, planktonic larval durations) of several key fish and invertebrate species. The combined physical and biological data created a comprehensive picture of potential larval recruitment pathways in the Florida Keys, and confirmed that the Tortugas region has high potential to serve as both a source and sink area for the larvae of many recreationally and commercially important marine species (Figure 1). Lastly, these physical and biological data were overlaid with socioeconomic information on the uses of the area to create a comprehensive picture of the region's resources and activities, and to assess the potential impacts and effectiveness of any given reserve boundary alternative.

A consensus proposal for the Tortugas Ecological Reserve was submitted by the working group in June 1999

to the six agencies with jurisdiction in the region. Final agency approvals are expected in April 2001, after which the FKNMS will implement its largest no-take zone, the Tortugas Ecological Reserve (Figure 2). At 151 square nautical miles, the Tortugas Ecological Reserve will be an order of magnitude larger than the rest of the Sanctuary's no-take zones combined.

The establishment of an ecological reserve in the Tortugas region attained much significance as a result of the oceanographic data gathered by Dr. Lee and other researchers. These data clearly demonstrate the potential benefits of an upstream, no-take reserve to the Florida Keys marine ecosystem and beyond. Marine reserve efforts worldwide will benefit from the Florida Keys National Marine Sanctuary's successes using oceanographic data in the design and establishment of the Tortugas Ecological Reserve. The sanctuary's website is www.fknms.nos.noaa.gov/tortugas. ■

Geostationary Operational Environmental Satellites (GOES) Users' Conference seeks participants

The National Oceanic and Atmospheric Administration (NOAA) will be holding a *Geostationary Operational Environmental Satellites (GOES) Users' Conference* in Boulder, Colorado, U.S.A. from May 22 through 24, 2001.

Goals

- inform GOES users of plans for next generation capabilities;
- provide information on potential applications;
- determine user needs for new products, data distribution, and data archiving;
- assess potential user and societal benefits of GOES capabilities; and
- develop methods to improve communication between the National Environmental Satellite, Data, and Information Service (NESDIS) and the GOES user community, including a formal process for receiving input.

The Conference is being organized by NOAA in cooperation of the National Aeronautics and Space Administration (NASA), the American Meteorological Society (AMS), the National Weather Association (NWA), the U.S. Department of Commerce's National Institute of Standards and Technology (NIST), and the World Meteorological Organization (WMO).

The format of the Conference will consist of two days of invited presentations followed by one day of breakout sessions with professional facilitators to assist the GOES user community in providing input to NESDIS.

Partial list of speakers

- Mr. Greg Withee, Assistant Administrator for Satellite and Information Services, NOAA;
- Dr. James Purdom, Director, NESDIS Office of Research and Applications (ORA);
- Dr. W. Paul Menzel, Senior Scientist, NESDIS/ORA;
- Dr. Louis Uccellini, Director National Weather Service, National Centers for Environmental Prediction (NWS/ NCEP);

- Mr. Gregory Mandt, Director, NWS Office of Climate, Water, and Weather Services (OCWWS);
- Dr. Elbert W. (Joe) Friday, Director, Board of Atmospheric Sciences and Climate, National Research Council; and
- Mr. Ray Ban, Senior Vice President of the Weather Channel.

For more information please see the web site: <http://www.osd.noaa.gov/conference>. When you visit this site, please fill out the "Conference Interest Questionnaire".

Online registration is available at the NIST web site: http://www.nist.gov/public_affairs/confpage/confutr.htm.

Information on Boulder and directions to NIST can be found at: http://www.nist.gov/public_affairs/visitor/visitor.htm.

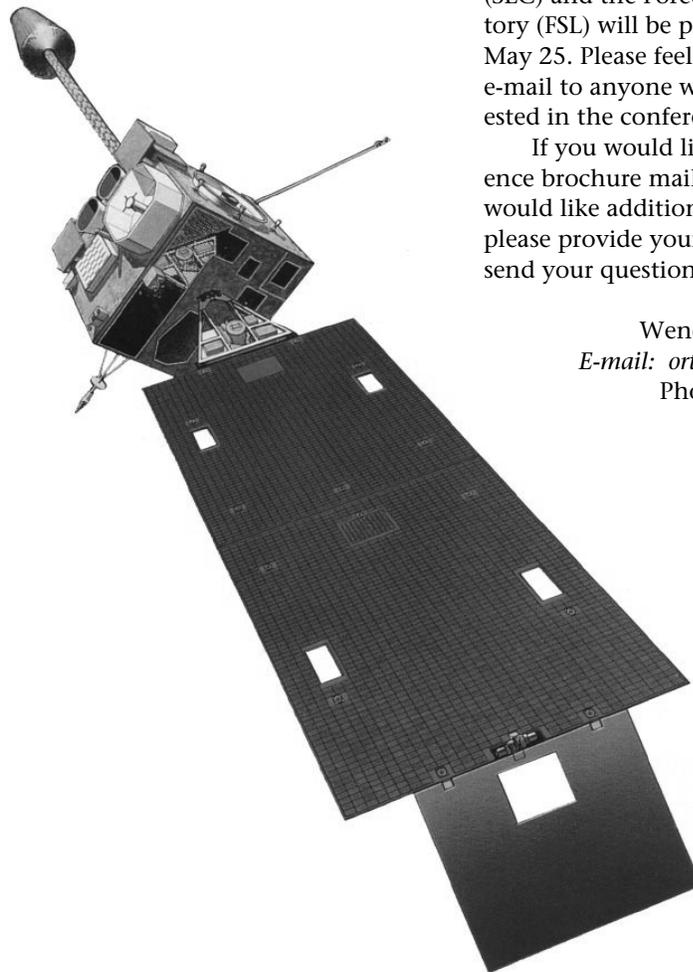
Hotel rooms and conference space are limited. A block of rooms has been set aside for Conference participants at the Regal Harvest House: +1-303-443-3850. For a list of other hotels, please contact Wendy Ortega Henderson at ortegaw@boulder.nist.gov.

When you call for reservations please mention the GOES Users' Conference for the rates of US\$90 per night or US\$120 per night.

Please note that the formal sessions run through May 24, but optional tours of local facilities, such as NIST, the National Center for Atmospheric Research (NCAR), the Space Environment Center (SEC) and the Forecast Systems Laboratory (FSL) will be provided on Friday, May 25. Please feel free to forward this e-mail to anyone who might be interested in the conference.

If you would like to have a conference brochure mailed to you, or if you would like additional information, please provide your mailing address or send your question to:

Wendy Ortega Henderson
E-mail: ortegaw@boulder.nist.gov
Phone 303-497-3693 ■



GOES ASOS Supplemental Cloud Product

Geo-Praxis contacted the National Climatic Data Center concerning the availability of a Geostationary Operational Environmental Satellite (GOES) product called the Automated Surface Observing System (ASOS) Supplemental Cloud Product. The GOES satellites measure cloud cover and cloud heights for over 500 Automated Surface Observation Stations on an hourly basis. The data supplements station cloud cover measurements for clouds above 12,000 feet, since ASOS ceilometers can only measure the presence of clouds below that level. The benefits of using GOES-derived cloud cover data can be applied to heating and cooling design criteria of new buildings. Geo-Praxis designs, implements, and evaluates energy-efficiency of technologies, materials, and practices.

Contact: NCDC

Space Weather CD-ROM

Joe H. Allen, the Secretary for The Scientific Committee on Solar-Terrestrial Physics, has compiled a CD-ROM with seven PowerPoint presentations focusing on Space Weather as it affects satellites, humans, and technology. One talk introduces the idea for an international scientific program "International Geophysical Year +50" to center on 2007-2008. The presentations span a wide range of sizes. All are available electronically; however, the largest (an encyclopedic 100 slides plus 70 electronic note pages) is difficult to transfer successfully. Dan Baker, Director, University of Colorado's Lab for Atmospheric and Space Physics, is co-compiler of the CD.

Contact: NGDC

Global Monthly Vegetation Cover

The NCDC has produced an updated CD-ROM containing a Time Series of Global Monthly Vegetation Cover from the POES AVHRR instrument. This updated CD-ROM contains a 12-year time series of global monthly mean NDVI (Normalized Difference Vegetation Index) data reprocessed from the AVHRR measurements. Data coverage is from April 1985 to December 1997. For more information: <http://nndc.noaa.gov/plolstore/plsql/olstore.prodspecif?prodnum=C00450-CDR-A0001>.

Contact: NCDC

Data products and services

Newly-enhanced Desert Storm satellite images

The National Climatic Data Center (NCDC), in response to the ten-year anniversary of Operation Desert Storm, has produced eight enhanced satellite images of the Persian Gulf Region from the Polar Orbiting Environmental Satellite, NOAA-11. These images, showing dramatic scenes of billowing black smoke stretching hundreds of miles, document the great environmental catastrophe that occurred when retreating Iraqi soldiers torched over 100 Kuwaiti oil wells. Several square miles of blazing oil well fires are depicted as bright red spots indicating intense heat, detected by one of the five channels on the Advanced Very High Resolution Radiometer (AVHRR) instrument. Each image is annotated with informative notes on the disaster and can be viewed at www.ncdc.noaa.gov.

Contact: NCDC

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Fax: 828-271-4876

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WWW: <http://www.ngdc.noaa.gov/>

National Oceanographic Data Center (NODC)

301-713-3277

Fax: 301-713-3302

E-mail: services@nodc.noaa.gov

WWW: <http://www.nodc.noaa.gov/>

NOAA Environmental Services Data Directory

301-713-0575

Fax: 301-713-0819

E-mail: help@esdim.noaa.gov

WWW: <http://www.esdim.noaa.gov/#data-products>

NOAA Central Library

Reference Services:

301-713-2600

Fax: 301-713-4599

E-mail: reference@nodc.noaa.gov

WWW: <http://www.lib.noaa.gov/>

High fuel prices and cold weather hurt truckers

This winter's below normal temperatures and accompanying high fuel prices have hit our nation's truckers hard. It is common practice for truckers to idle their engines when stopped at night when temperatures drop below 50 degrees F. Idling significantly increases maintenance costs, up to \$3.00 for each hour the engine idles. As a result, Espar Heating Systems is working with the Department of Transportation to develop an efficient fuel heater which costs only pennies an hour to operate. NCDC provided maps of the number of days below minimum temperature thresholds to Espar. The threshold maps will be used to identify routes and areas of the country where the new heaters will have the largest impact.

Contact: NCDC

Tree ring data helps prepare for drought

A press release issued by NOAA in January was featured in Federal news stories of *The Water Strategist Community*. The release describes work by Dr. Connie Woodhouse at NOAA's National Geophysical Data Center to study tree ring data from the past 300 years. The data provides information on Clear Creek, the main source of water for the City of Westminster, Colorado, and provides insight into the duration, severity, and magnitude of drought, and is useful in water resource management. Total annual streamflow was reconstructed from tree ring chronologies over a 300-year period. The tree ring data were compared with data from the instrumental record for the period 1912-1980. The full release is online at <http://www.publicaffairs.noaa.gov/releases2001/jan01/noaa01r301.html>.

Contact: NGDC

Illegal aliens abducted

The NCDC supplied the Immigration and Naturalization Service (INS) with weather data to support a prosecution involving individuals charged with endangering and transporting illegal aliens in the back of an unheated U-Haul truck. The Anti-Smuggling unit apprehended 18 illegal aliens near DeKalb, Illinois. The INS was supplied with weather observations from DeKalb and other locations along the traveled route, prior to apprehension.

Contact: NCDC

Spring weather outlook

Winter snow storms in the Northeast and Midwest have set the stage for potential flooding while drought conditions in the Northwest and water shortages in the Southeast will linger despite spring rains, NOAA scientists at the Commerce Department said today.

Retired Air Force Brig. Gen. Jack Kelly, director of the weather service, said, "The spring outlook presents forecasters with two concerns — drought and floods. "Heavy snows in the Northeast and Midwest now make some of those states vulnerable to floods if the snow pack melts too quickly. The water shortage in the Southeast is expected to remain. The Northwest will see above-normal precipitation, but the spring rainfall will be too little too late to replenish water resources there."

"U.S. Geological Survey stream-gauges and other monitoring systems show record-breaking dryness in many parts of the United States, particularly the Pacific Northwest, western North Carolina, and parts of Florida," said USGS Director Chip Groat.

For Spring 2001, the nation can expect:

- In the South, frequent rains since November in parts of Texas, Oklahoma, Arkansas, Alabama, Louisiana and Mississippi, have eliminated drought conditions. If these areas get additional significant rain, flooding is likely because streams are already running high;
- In the Western Great Lakes regions (Wis., Eastern Minn., and Upper Mich.) there is a potential for frequent rain. Snow from this month's Nor'easter has heightened flooding concerns along the Connecticut and Merrimack river basins, where at least 10-12 inches of water is stored in the snow pack — twice the normal amount. Above normal snowmelt flooding is possible across the region;
- Near normal average temperature conditions are expected for the 3 month period in the Mid-Atlantic region (60 degrees) and central United States (60s), including the Ohio, Tennessee (70s) and Mid- and Southern Mississippi Valleys (75), and most of the Plains states (60 degrees);

- The Midwest (55-60 degrees) is expected to have a normal spring. However, the weather service is closely watching the snow melt in many areas including Minnesota and the Dakotas for potential flooding. The region received above average snowfall this winter creating a likelihood for spring flooding if the snow pack melts too quickly.
- In the Southeast, including Florida, the weather service is forecasting a warm and relatively dry spring. Severe drought conditions have sparked wildfires in Florida, however, mid to late-March rains and season rains, which typically return by June, could provide some relief. Long term deficits will likely continue to impact water supplies;
- In the Southwest, expect above-normal temperatures; but normal precipitation.
- Though above-normal precipitation is forecast for parts of the Northwest, it will not be enough to offset the impact of already low precipitation levels and the resulting thin snow pack;
- Near normal precipitation conditions expected over Alaska, Hawaii and Puerto Rico leaving most of Hawaii and southern Puerto Rico in persistent dryness. Alaska has been relatively warm with below-normal snowpack. This spring above normal temperatures are expected for northern Alaska while the southern extremes should be cool.

"NOAA's recent climate initiatives and technology improvements have resulted in gains in the accuracy of long-term seasonal forecasts and short-term severe weather prediction," NOAA Acting Under Secretary Scott Gudes said. "NOAA's climate and weather forecast services are vital since \$1 trillion of the U.S. economy is weather sensitive with most of the major economic sectors including energy, agriculture, transportation, construction, and water resources affected."

To read the complete Spring 2001 Outlook, visit: <http://www.cpc.noaa.gov>. The outlook will be updated on April 12 at 3 p.m EST.

— Curtis Carey
(301) 713-0622 ■

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