Episodic Events: Great Lakes Experiment

EEGLE

The Impact of Episodic Events on the Nearshore-Offshore Transport and Transformation of Biogeochemically Important Materials in the Great Lakes

Episodic Event: Recurrent Coastal Plume

In 1996, GLERL scientists monitoring NOAA satellite images tracked the development of a massive turbidity plume that ultimately extended over 10 miles off-shore and 200 miles along the southern coastline of Lake Michigan. While previously known to occur, our satellite "view" of the annual late winter/early spring plume in years past has been obscured by cloud cover typical for the Great Lakes region during that time of year. The unusually clear conditions in 1996 enabled scientists to see the full extent of the plume for the first time.

The plume is believed to consist of newly eroded bluff material from the western shore near Milwaukee, Wisconsin as well as materials washed into the lake over the last several decades. These very small clay and silt particles then slowly settle into temporary reservoirs all along the coastline. Each year the ice that builds along the coastline breaks up, and large storms generates wind and waves strong enough to stir these particles back off the lake bottom, resuspending them into the water column. A conservative estimate is that the 1996 plume moved over one million tons of material. Offshore eddies in the southeastern portion of the plume coincide with the area of maximum sediment accumulation in the lake, implying that this event plays an important role in how particles are moved around in the lake (nearshore-offshore transport) and where they eventually accumulate on the lake bottom.

Ecological Importance

Although relatively short in duration, lasting on the order of one month, the annual plume is hypothesized to have a profound impact on the overall ecology of Lake Michigan. While the plume is hypothesized to contain virtually 100% of the new "mud" that is washed into the lake each year, some of the material that is stirred up off the bottom in this event has been in the lake for decades and is being "reinjected" into the water column. Nutrients and contaminants adhere to the fine-grained materials and are transported by the plume.

Contaminants such as PCBs may be scoured from the water column by particles in transit and ultimately buried in high depositional zones where they are no longer a threat to the food chain.

The high levels of phosphorous (P) in the plume, a nutrient that is necessary for primary production, likely plays a critical role in the development of Lake Michigan's spring diatom bloom.

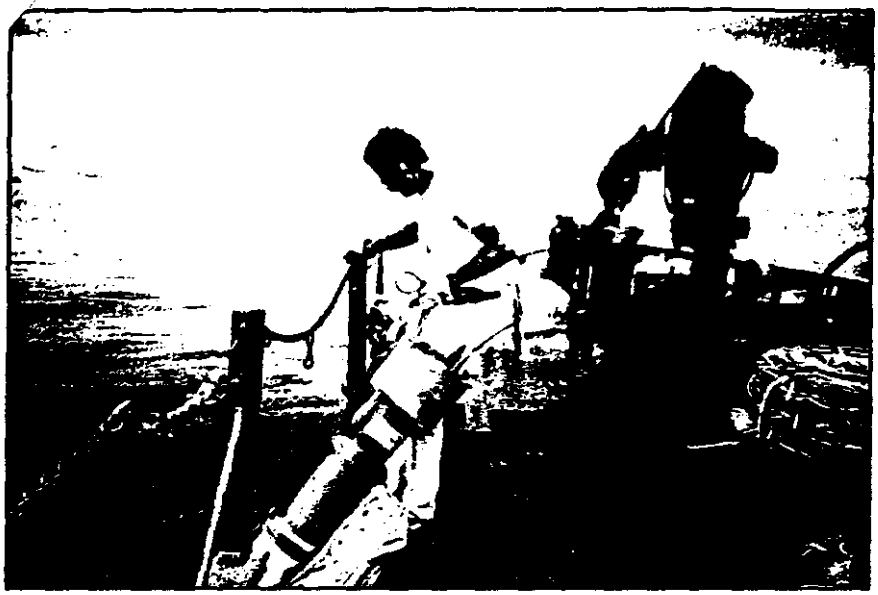
The plume eventually settles, creating a cloudy bottom layer that is important in chemical interactions between the surface sediments and water throughout the year.

Study Approach

One of the challenges of studying episodic events is "unpredictable" timing of the particular event. The onset of the annually recurrent southern Lake Michigan plume has been documented as early as February (1995) and as late as May (1994). A team of over 40 environmental scientists from federal agencies and universities have put together a comprehensive interdisciplinary 5 year research program to study the Lake Michigan plume. Teams of specialists in remote sensing, physical oceanography, HF radar, hydrodynamic, meteorological, and sediment transport modeling, post-depositional sediment behavior, environmental radiotracers, phosphorous processes, phytoplankton processes, copepod reproduction, and lower food web structure are all coordinating their efforts. The simultaneous efforts being conducted across several different disciplines, focusing on the same region, provides a unique opportunity for new insights into coupling between biological, chemical, and physical processes.

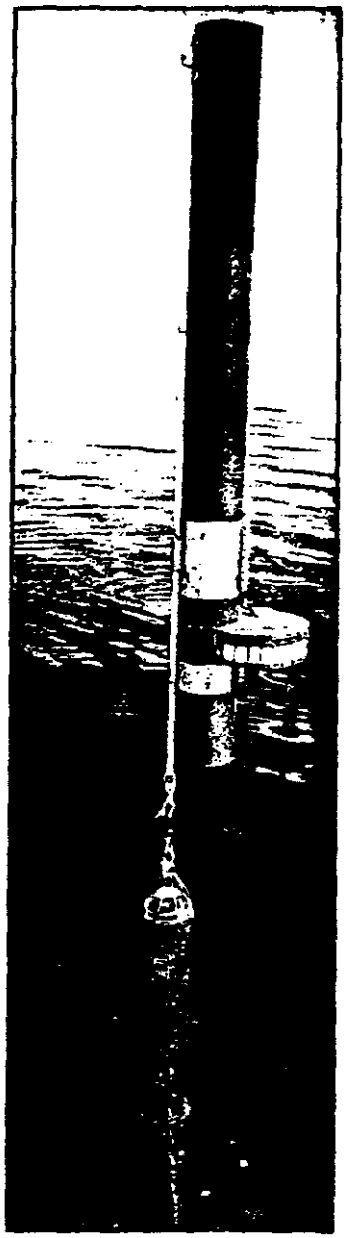
In early fall of 1997, the first large array of scientific equipment will be deployed in a

Visible band satellite imagery of southern Lake Michigan AVHRR Channel 1.
3/16/96: Shore-fast ice along eastern shore, large ice floes in the south.
3/22/96 & 4/1/96: Highly reflective plume (+) = stations sampled by helicopter).
4/10/96: Off-shore eddying of plume coincides with zone of maximum sediment deposition in lake (+) = stations sampled by small boat.
4/24/96: Dissipation of plume.
(Clouds are masked out on 3/22/96, 4/10/96 and 4/24/96 images.)



▲ *Satellite-tracked drifters such as these and 18 current meter arrays will provide information about currents and the net offshore transport of water in the coastal plume.*

Eleven of these sequential sediment samplers developed at GLERL will be strategically deployed in Lake Michigan offshore from St. Joseph and Michigan City to collect plume particles as they settle towards the lake bottom. The traps are programmed to collect 23 samples over a period of 10 days each. ▶



1,500 square mile region off of St. Joseph, Michigan. Some of these moorings will measure water velocities and temperatures throughout the water column, others will collect the plume materials as they sink towards the lake bottom. These measurements will be complemented by satellite-tracked drifters used to measure the large scale circulation and to track the plume itself when it occurs. For the first time anywhere in the Great Lakes, two coastal over-the-horizon radar sites will also be installed and used to study surface currents, winds, and wind waves. During the plume, multiple shipboard surveys, including rare late-winter cruises, are planned for collecting data and samples for further analysis.

Expected Products

The research program, which includes three seasons of intensive data collection starting fall 1997, is expected to be completed in 2002. Expected research products include the most extensive Great Lakes data collection in over 25 years, and the development of the most sophisticated research models ever created for the Great Lakes. These will incorporate hydrodynamic models (currents, temperature, wave, and ice), sediment transport data, and lower food web simulations. These will be useful in evaluating future lake management options, providing a more realistic assessment of how nutrients and contaminants in the sediments continue to recycle within the lake.

Participants Include:

- National Oceanic and Atmospheric Administration (NOAA) COP
- NOAA/Great Lakes Environmental Research Laboratory (GLERL)
- National Science Foundation (NSF) CoOP
- University of Texas
- University of Wisconsin-Milwaukee
- Academy of Natural Sciences, Estuarine Research Center
- Argonne National Laboratory
- Michigan Technological University
- Cooperative Institute for Limnology and Ecosystem Research
- Rutgers University
- University of Georgia
- Ohio State University
- University of Southern Mississippi
- Texas A&M University
- USDA-Agricultural Research Service
- University of Michigan
- University of Wisconsin-Milwaukee
- USGS - St. Petersburg

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WWW Additional information can be downloaded from:
http://www.glerl.noaa.gov/eegle/eegle.html
WWW Satellite images of the Lake Michigan plume can be downloaded from:
http://www.glerl.noaa.gov/news/plume.gif
WWW and the GLERL Home Page URL is: **http://www.glerl.noaa.gov**