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ANNUAL HIGHLIGHTS
ENVIRONMENTAL PROGRAMS

BERNARD MANOWITZ
Associate Chairman

December 1978

DEPARTMENT OF ENERGY AND ENVIRONMENT

BROOKHAVEN NATIONAL LABORATORY
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ENVIRONMENTAL PROGRAMS
OF THE
DEPARTMENT OF ENERGY AND ENVIRONMENT**

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**BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.
UPTON, NEW YORK 11973**

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ABSTRACT

Environmental Sciences is one of the four areas comprising the Department of Energy and Environment at Brookhaven National Laboratory. It carries out a wide range of activities in atmospheric sciences, environmental chemistry, oceanographic sciences, and land and freshwater environmental sciences. In general, these programs are concerned with identification and measurement of pollutants introduced into the environment by energy-related activities and the evaluation and prediction of the effects or potential effects of these pollutants on the environment.

This highlights report for Environmental Programs covers the year 1978 and describes the objectives and funding levels of each of the programs, major accomplishments during the year, planned future activities, and current publications.

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I. Introduction

Environmental Programs is a broad-based segment of the Department of Energy and Environment made up of some 48 individual programs covering a wide range of activities in the atmospheric, oceanographic, and terrestrial ecology areas. While the majority of these activities are supported by the Department of Energy's Office of Health and Environmental Research, a significant number are supported by other governmental and private agencies. In general, these programs are involved with the study of pollutants resulting from the production of energy and their effects or potential effects on the environment.

Programs in meteorology and plume dispersion have been conducted since the inception of the Laboratory in 1946. Early programs were developed for tracing plumes from the tall stacks of fossil-fuel-burning power plants. The interest has broadened steadily over the years to the present time, where current programs include major participation in the direction and implementation of MAP3S (the Multistate Atmospheric Power Production Pollution Study), including both field and modeling studies related to atmospheric pollutants in the Northeastern United States, field and analytical studies of the meteorology of the coastal land-sea interface, and field and modeling studies of the interchange of momentum, heat, and water vapor between the atmosphere and the ocean. Administratively, the MAP3S program has been transferred as a unit from the Department of Energy to the Environmental Protection Agency, maintaining the same mission and structure. During the year the MAP3S ground level particulate sampling in the Greater New York subregion confirmed the theoretically anticipated regional sulfate levels which were correlated with meteorological variables. Modeling activities with respect to the atmospheric transport and transformation of pollutants are carried out in support of the regional assessment programs of the National Center for the Analysis of Energy Systems.

During the year a new Division, Environmental Chemistry, was formed and split off from the Atmospheric Sciences Division. The progenitor of the Environmental Chemistry Division was the Analytical Chemistry Services Group, which is now incorporated into the Division. The Group became involved in the early stack-plume tracing program by being called upon to establish a capability for determining stable sulfur isotope ratios ($^{34}\text{S}/^{32}\text{S}$) in coal, oil, stack gas, and the ambient atmosphere. This interest has expanded and deepened to the present time, where a high degree of expertise now exists in several fields, including

laboratory and field work on the measurement and behavior of gaseous and aerosol particulate pollutants at power plants and in the atmosphere, including the speciation and quantification of sulfate particulates, laboratory studies on the physics and chemistry of aerosols and their formation and growth, development of tracer systems for following movements of air masses over long distances and for tagging blasting caps for predetonation detection of clandestine explosives, together with the related instrumentation, and instrument systems for the measurement of a series of pollutants at ambient levels in real time. Analytical chemistry services are also supplied to other Departments and Divisions at BNL, as requested.

This year a new method was developed for the measurement of ambient concentrations of nitric acid. Improvements in sensitivity in a variety of other analytical techniques for measuring ambient concentrations of other pollutants were activated as well.

Maintenance and operation of a twin-engined Britten-Norman Islander aircraft has continued, in support of the field programs of both the Atmospheric Sciences and Environmental Chemistry Divisions. Improvements have been made during the year in the sampling equipment and the analytical and meteorological instrumentation installed aboard this plane.

Programs in Oceanographic Sciences were initiated in 1973. The general objective is to assess the potential impact of energy-related activities (reactor releases, oil spills, etc.) on the Northeast coastal zone and its biota through development of a synoptic view of the physical, chemical, and biological parameters that interact on the shelf. Efforts are being made to understand the transport and diffusion processes, particularly in the coastal boundary layer, and to couple such understanding with studies of important biological processes that are occurring. Biological emphasis is on the dynamics of the lower trophic level. Current programs include coastal transport and diffusion, primary production and utilization, food chain dynamics, larval fish mortality, a National Oceanographic and Atmospheric Administration/Marine Ecosystems Analysis (MESA)-sponsored program on an ecosystems analysis of the New York Bight and National Science Foundation-sponsored studies on Coastal Upwelling Ecosystems Analysis (CUEA) and Production and Resources of the Bering Sea (PROBES). Within this program, there is a high degree of collaboration with other oceanographic laboratories in the Northeast, as well as the responsibility for coordination of all of the DOE's oceanographic programs in this area.

This year saw a successful Coastal Boundary Layer Transect (COBOLT) study of the near-shore water circulation, temperature, and salinity. Experiments were done at 16 locations during March, May, and August of '78 and represent the first high-resolution analysis of water movements in the near-shore coastal zone.

The earliest program to be instituted in the Land and Fresh Water Environmental Sciences was the Upland Recharge Project, designed to provide an ecologically and economically sound method of recharging water and nutrients to the environment from sewage and septage streams. The project was instituted as part of the ecology program of the Biology Department. It was transferred to the Department of Applied Sciences in 1973, and it has been developed to the point where it is now ready for large-scale demonstration and thus work at BNL is being phased out. Major emphasis is currently being placed on the study of the effects of acid rain on forest and aquatic ecosystems and on field crops. A year-round field experimental station has been established at Raquette Lake in Northern New York State for the Adirondack Lake Project (ALP), studying the effects of acidification on the biota and biological processes of fresh water lakes. In September a very successful International Workshop on Limnological Aspects of Acid Precipitation was held there, with 22 participants from five countries. At BNL, data from a sequential precipitation collector indicated that the highest acidity in precipitation is found in squall-line and cold-front weather patterns during the summer months.

Several studies of human virus distribution have been carried out at the laboratory established for the study of environmental virology. These include surface, ground, and well waters, recharge systems, and shell fish. They have involved both on-site and off-site projects. Emphasis is now being given to the refining of procedures for the culturing of human epithelial cells in preparation for use in the development of a new procedure for screening the mutagenic/carcinogenic properties of pollutant materials.

II. Organization

The programs in Environmental Sciences at Brookhaven National Laboratory are organized as a major area of the Department of Energy and Environment, under the direction of Bernard Manowitz, Associate Chairman for Environmental Programs. This is shown in the organization chart in Figure 1. The programs are distributed among four units that have been organized to carry them out. These are the Atmospheric Sciences Division with Dr. Paul Michael as Division Head, the Environmental Chemistry Division with Dr. Leonard Newman as Division Head, the Oceanographic Sciences Division with Dr. John J. Walsh as Division Head, and the Land and Fresh Water Environmental Sciences Group with Dr. George R. Hendrey as Group Leader. The Environmental Chemistry Division had been part of the Atmospheric Sciences Division until October 1978, when the Atmospheric Chemistry Group and the Analytical Chemistry Services Group were split off and combined to form the new Division. The Analytical Chemistry Services Group will continue to provide analytical chemistry support not only for Environmental Programs but also for other Divisions and Departments throughout the Laboratory, as requested.

DEPARTMENT OF ENERGY AND ENVIRONMENT BROOKHAVEN NATIONAL LABORATORY

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III.

Atmospheric Sciences Division

Paul A. Michael
Division Head

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Atmospheric Sciences Division

A. Program Objectives

The central theme of the research in the Atmospheric Sciences Division is the development of the scientific knowledge needed for realistic evaluation of the effect of energy production upon air quality. Activities include field experiments, theoretical and modeling studies, data management, and instrument development.

A major fraction of the research is coordinated through the Multi State Power Production Pollution Study (MAP3S). This program, performed jointly with the Environmental Chemistry Division and in which several DOE laboratories are involved, has as its primary goal the development of the capability to predict the effect of changes in coal-utilization patterns on the ambient concentration of sulfur oxides in the Northeastern United States. The projects that are part of MAP3S are MAP3S Modeling and Analysis, MAP3S Data Management, Transport and Transformation Experiments, and Aircraft Operations. As partially indicated by the project titles, MAP3S research includes the atmospheric chemistry of sulfur oxides, mesoscale transport, model development, the characterization of pollutant distributions in the Northeast, and the establishment and operation of a data base for the use of MAP3S participants.

The coastal meteorology program is aimed at the identification and quantification of coastal processes that affect the transport and diffusion of pollutants over the ocean and across the land-sea interface.

Considerable interaction exists with others at BNL. Air-quality calculations are done as a part of the assessment of energy impact on the environment performed in the Regional Studies program of the National Center for the Analysis of Energy Systems. The coastal meteorology program is closely coordinated with the physical oceanography research performed within the Oceanographic

Sciences Division. Precipitation chemistry studies have been done in conjunction with the Land and Fresh Water Environmental Sciences Group.

The Meteorological Services provides weather forecasting for general Laboratory operations, maintains climatological records for the BNL site, and participates in the atmospheric diffusion aspects of safety analysis reports for Laboratory facilities.

B. Highlights of 1978

Data-exchange protocols between the MAP3S Data Management project at BNL and its counterpart for the Electric Power Research Institute's Sulfur Regional Experiment (SURE) were established and exchanges of data between MAP3S and SURE participants were initiated.

An accessible data base containing information on known emitters of SO_2 (and other pollutants) was assembled from files of the Environmental Protection Agency, the Federal Power Commission, local governments, and other sources.

A computer link between BNL and the National Weather Service was established allowing for immediate access to a wide variety of meteorological data in near real-time.

Methods based upon probability density functions were developed for the analysis of chemical reactions in turbulent flows.

New numerical methods for the efficient and accurate solution of the equations for atmospheric transport and transformation of pollutants on the regional scale were developed and tested.

In cooperation with other MAP3S participants and with SURE contractors, a multi-aircraft experiment to examine meteorological conditions considered to cause long-range transport was undertaken.

A series of measurements of the vertical distribution of pollutants done over a period of ten days revealed that synoptic-scale vertical motions in the atmosphere can significantly enhance long-range transport.

In the Coastal Meteorology Program key experiments contrasting flow over land with that over water have been performed.

An analysis of NRC of the state of knowledge of diffusion in the coastal region has pointed out gaps in the understanding of the effect of wind meander, i.e. low-frequency variations, upon concentrations and the growth of the internal boundary layer in the near-shore region.

In support of programs in the National Center for the Analysis of Energy Systems, the long-range transport model has been applied on a national scale to evaluate the air-quality effects of coal-utilization strategies contained in the National Energy Plan.

C. Major Activities Planned for 1979

The MAP3S Data Management project will publish a "check point" source-emissions inventory for use by the MAP3S modeling community. This inventory will result from a merger of EPA and FPC files and will be released only after extensive quality checks. Major emphasis will be placed upon the development of computer-generated graphical displays of the contents of the MAP3S data base.

The BNL variational wind-field model will be used to produce improved interpolations of the meteorological fields for periods during which MAP3S/SURE major experiments were performed.

A multi-dimensional grid model will be applied to the transport of chemically reacting pollutants. Realistic wind fields for the Northeastern United States will be used.

MAP3S aircraft experiments will probe the vertical transport of pollutants under a variety of conditions. Measurements will be performed to investigate spatial inhomogeneties that occur on the regional scale.

Key experiments on diffusion through the transition region will be performed on the south shore of Long Island. The development of the sea breeze will be probed using equipment on the Islander aircraft as well as pilot balloon and sodar soundings.

There will be participation in the Global Atmospheric Research Program's (GARP) experiment to understand the monsoons. Flux measurements are to be made on the shore of the Bay of Bengal.

An improved Air/Sea Interaction Buoy will be put into service with an advanced data acquisition and telemetry system.

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D. Scope of Projects

Title: Evaluation of Recommended Meteorological
Measurements and Diffusion Models
for Coastal Nuclear Power Plant Sites

FY 78: \$35,000

Principal Investigator(s):
G. Raynor
S. SethuRaman

FY 79: \$ - 0 -

Sponsor: N R C

This study is designed to examine currently recommended meteorological measurement programs and atmospheric transport and diffusion prediction methods for nuclear power plants to determine their adequacy for plants located in coastal zones where meteorological conditions are more complex than at inland sites. A literature review will be conducted to determine available knowledge on coastal meteorological processes and their influence on diffusion. Data from experimental diffusion measurements will be examined and related to associated meteorological conditions. The effect on diffusion and the fate of effluents of temporally varying factors, such as sea breezes, and spatially changing factors, such as internal boundary layers, will be evaluated. The data will then be used to test the adequacy of presently used diffusion models, to determine what changes and improvements, if any, are needed for acceptably accurate prediction under coastal conditions and to determine what meteorological measurements are necessary as input to the prediction models. Appropriate changes in measurement requirements and prediction methods will be recommended. If current knowledge is found inadequate to meet these goals, recommendations for further research will be made.

Title: Aircraft Operations

FY 78: \$185,000

Principal Investigator:

R. Garber

FY 79: \$191,000

Sponsor: EPA

A twin engine-aircraft has been leased for exclusive use to carry out research projects which are part of the Atmospheric Sciences programs at Brookhaven National Laboratory. Provision is made for taking air samples through high volume filters, aerosol size sampling making chemical measurement, meteorological measurement, and special navigational measurement. Data is recorded on magnetic tape for post flight analysis. Routine observation of the horizontal and vertical distribution of pollutants which are conducted for the MAP3S program require about one half of its scheduled flight time. Plume studies require about one quarter of the scheduled flight time. The remaining scheduled flight time is used principally for cooperative atmospheric studies with observation teams from other organizations which are part of the MAP3S program. Other BNL programs also use this aircraft.

For certain studies which are conducted for the MAP3S program and for other atmospheric sciences programs, utilization of a second small aircraft is necessary. Additional aircraft will be obtained on a short-term rental basis and outfitted with easily-installed equipment for the purposes of the specific study.

As part of Aircraft Operations a program of equipment testing, calibration, and modification is required to maintain an effective atmospheric sampling and analysis system for the aircraft.

Title: Modeling and Analysis (MAP3S)

FY 78: \$160,000

Principal Investigator:

R. E. Meyers

FY 79: \$165,000

Sponsor: EPA

This project is designed to perform modeling and analysis functions and one research-coordination function for the Multistate Atmospheric Power Production Pollution Study (MAP3S).

The modeling and analysis functions consist of development of: 1) An advanced three-dimensional Eulerian-grid pollution model treating nonlinear chemistry, long-distance transport and diffusion of sulfur compounds, NO_x , O_3 , and related chemicals on the regional scale; 2) a "variational" diagnostic three-dimensional meteorological analysis model capable of objectively resolving inversions and fronts on the regional and subregional scale; 3) advanced plume-laboratory reaction models incorporating lumped chemistry and the major effects of turbulent mixing upon chemical reactions; 4) a computer link from BNL to the National Weather Service at Suitland, Md., to supply MAP3S with timely meteorological data for experiments and modeling.

Title: MAP3S Data Management

FY 78: \$150,000

Principal Investigator:

C. Benkovitz

FY 79: \$155,000

Sponsor: EPA

A major portion of the MAP3S program is concerned with the collection, evaluation, and codification of both newly-measured and selected historical data that pertain to the distribution and evolution of energy conversion-related pollutants over the Greater Northeast. The program is building a readily-accessible data bank against which submodel parameterization schemes and, eventually, full-parameterized, regional-pollutant transport and transformation simulations can be tested. This data bank includes data gathered both by MAP3S participants as well as cooperating projects such as the EPRI-sponsored SURE program. It also includes supporting source inventory data initially gathered by other agencies. Longer range goals include the gathering of additional ancillary data (such as meteorological parameters) and the development of techniques for graphical and tabular display of all available data.

Title: Coastal Meteorology

FY 78: \$210,000

Principal Investigator:

G. S. Raynor

FY 79: \$225,000

Sponsor: Office of Health
and Environmental Research
(DOE)

The purpose of this task is to obtain an understanding of and a predictive capability for those meteorological processes that occur in coastal zones and that affect the siting, operation, or safety of power-producing or other energy-related facilities or activities located near coastlines. Methods include meteorological measurements and observations on the micro- and meso-scale, tracer, experiments, climatological investigations, theoretical studies, and modeling efforts.

A major goal of the task is to develop a reliable system for describing diffusion conditions affecting airborne effluent releases from coastal or offshore sites and to develop and test operational predictive methods from measurable meteorological and surface parameters such as synoptic situation, type of flow (gradient or sea breeze), wind and temperature structure, sea-surface and land-surface conditions, and coastal terrain. Meeting this goal requires an understanding of air sea interaction processes and of processes in the transition region where air is modified as it flows from land to water or water to land.

Results of this task will include improved techniques for predicting transport and diffusion of airborne and sea-surface pollutants from coastal or offshore sources, methods for rating potential plant sites with respect to onshore wind frequency, diffusive capacity, and severe weather prevalence, and data for predicting weather effects on energy production, transmission, and utilization in coastal areas.

Title: Transport and Transformation (MAP3S)

FY 78: \$400,000

Principal Investigator:

P. Michael

FY 79: \$415,000

Sponsor: EPA

This program is a part of the Multistate Atmospheric Power Production Pollution Study (MAP3S). The purpose of this study is to develop the ability to assess the effects of the use of fossil fuel upon health and the environment. This ability will require the development of simulation models. The overall effort is interdisciplinary and involves various laboratories, institutions, and other agencies.

A major aim of this project is to obtain experimental results documenting the spatial and temporal distribution of pollutants, primarily but not exclusively, sulfur oxides, over the Northeastern United States. These results are intended for use in the identification of mechanisms that control the transformation and long-distance transport of pollutants, for testing model parameterization, and helping to build a data base for verification of integrated models. Particular measurements are planned to measure vertical pollutant distribution, pollutant distribution in seabreeze flows, and perturbation induced by urban areas.

Within the scope of this project is collaboration with other MAP3S participants in the performance of large scale field experiments.

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E. Publications

Publications
Atmospheric Sciences Division

1978

BNL 23890
Jan. 1978

USING SYSTEM 2000 WITH PROPOSED ANSI
STANDARDS FOR DATA EXCHANGE

Carmen M. Benkovitz, Richard A. Wiley (Los Alamos)

Presented at the Association of System 2000 Users
for Technical Exchange, 1977 Fall Conf., San Francisco,
Calif., October 17-19, 1977.

BNL 24122
March 1978

ATMOSPHERIC TURBULENCE AND DIFFUSION IN A COASTAL AREA

S. SethuRaman

Presented at the Fluid Dynamics Seminar, Colorado State
Univ., Fort Collins, Colorado, April 12, 1978.

BNL 24187
March 1978

FINITE ELEMENT NUMERICAL STUDY OF ATMOSPHERIC TURBULENT
MOTION AND DIFFUSION IN PLANETARY BOUNDARY LAYER

H. N. Lee

Presented at the International Conf. on Numerical Methods
in Laminar & Turbulent Flow, Univ. College of Swansea,
United Kingdom, July 18-21, 1978.

BNL 24189
March 1978

INFLUENCE OF MEAN WIND DIRECTION ON SEA SURFACE
WAVE DEVELOPMENT

S. SethuRaman

J. of Physical Oceanography 8, pp. 926-929 (1978)

BNL 24190
March 1978

TURBULENCE DURING HIGH WIND EPISODES IN A COASTAL REGION

S. SethuRaman

Presented at the Third U. S. National Conf. on Wind
Engineering, Gainesville, Fla., February 26-March 1, 1978.
To appear in the Proceedings.

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Atmospheric Sciences Division
1978

BNL 24191   A COMPARATIVE STUDY OF DIFFUSION CLASSIFICATION BY
March 1978   LAPSE RATE, GUSTINESS AND A MODIFIED PASQUILL METHOD

Abstract   Gilbert S. Raynor and Janet V. Hayes

                 See BNL 24844

BNL 24205   STRUCTURE OF TURBULENCE OVER WATER DURING HIGH WINDS
March 1978   S. SethuRaman

J. of Applied Meteorology 18 (in press)

BNL 24206   MOMENTUM FLUX AND WAVE SPECTRA MEASUREMENTS FROM
March 1978   AN AIR-SEA INTERACTION BUOY

                 S. SethuRaman

J. Boundary-Layer Meteorology (in press)

BNL 24226   BROOKHAVEN NATIONAL LABORATORY LONG-TERM
March 1978   GAUSSIAN DISPERSION MODEL

Informal   C. Dopazo, H. N. Lee, and P. Michael
Report
Limited Dist.

BNL 24298   INSTRUMENTATION AND DATA ACQUISITION SYSTEM
April 1978   FOR AN AIR-SEA INTERACTION BUOY

                 S. SethuRaman, W. A. Tuthill, and J. McNeil

Bulletin of the American Meteorological Society 59, 1102-1112 (1978)

Publications
Atmospheric Sciences Division
1978

BNL 24299
April 1978

CALIBRATION AND USE OF A SAIL PLANE VARIOMETER
TO MEASURE VERTICAL VELOCITY FLUCTUATIONS

S. SethuRaman, R. M. Brown, G. S. Raynor, and
W. A. Tuthill

Boundary-Layer Meteorology 15 (in press)

BNL 24300
April 1978

RESPONSE CHARACTERISTICS OF A NEW BI-DIRECTIONAL VANE

S. SethuRaman and W. A. Tuthill

Bulletin of the American Meteorological Society 59, 1114-1118 (1978)

BNL 24390
May 1978

A RADIO-CONTROLLED AIR SAMPLING
SYSTEM FOR DIFFUSION EXPERIMENTS

Gilbert S. Raynor

J. Applied Meteorology 17, 1619-1624 (Nov. 1978)

BNL 24542
June 1978

MODELING SULFUR OXIDE CONCENTRATIONS IN THE EASTERN UNITED STATES:
MODEL SENSITIVITY, VERIFICATION AND APPLICATIONS

R. E. Meyers, R. T. Cederwall, and J. A. Storch

Pres. at AMS 4th Symp. on Turbulence, Diffusion and Air Pollution,
Reno, Nev., Jan. 15-18, 1979. To appear in the preprint volume.

Publications
Atmospheric Sciences Division
1978

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BNL 24543 June 1978	ATMOSPHERIC TURBULENCE AND STORM SURGE DUE TO HURRICANE BELLE (1976) S. SethuRaman <u>Monthly Weather Review</u> 106 (in press)
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BNL 24544 June 1978	EFFECTS OF CHANGES IN THE UPWIND SURFACE CHARACTERISTICS ON THE MEAN WIND SPEED AND TURBULENCE S. SethuRaman and G. S. Raynor Presented at AMS 4th Symp. on Turbulence, Diffusion and Air Pollution, Reno, Nev., Jan. 15-18, 1979. To appear in the preprint volume.
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BNL 24545 June 1978	ATMOSPHERIC TURBULENCE AND DIFFUSION BOUNDARY LAYER TRANSPORT MODEL Hsi-Nan Lee Presented at AMS 4th Symp. on Turbulence, Diffusion and Air Pollution, Reno, Nev., Jan. 15-18, 1979. To appear in the preprint volume.
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BNL 24559 June 1978	DETAILS OF INSTRUMENTS AND DATA ACQUISITION SYSTEM FOR THE 1977 AIR-SEA EXPERIMENTS
Informal Report	S. SethuRaman, W. A. Tuthill, and J. McNeil
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BNL 24754 July 1978	COMPARISON OF PARTICULATE AND GASEOUS MATERIAL ABOVE AND BELOW AND MIXED LAYER
Abstract	Paul Michael and Robert M. Brown See BNL 25002
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Publications

Atmospheric Sciences Division

1978

BNL 24844
Aug. 1978

A COMPARATIVE STUDY OF DIFFUSION CLASSIFICATION BY
LAPSE RATE, GUSTINESS AND A MODIFIED PASQUILL METHOD

Gilbert S. Raynor and Janet V. Hayes

Pres. at 9th Intl. Tech Meeting on Air Pollution
Modeling and Its Applications, Toronto, Ont.,
Aug. 28-31, 1978. To appear in the proceedings.

BNL 24845
Aug. 1978

COMPILING A MULTISTATE EMISSIONS INVENTORY

Carmen M. Benkovitz

Abstract

Pres. at Special Conf. on Emissions Inventories and Factors,
APCA-TP7 Committee, Anaheim, Calif., Nov. 13-16, 1978.

BNL 25002
Sept. 1978

COMPARISON OF PARTICULATE AND GASEOUS MATERIAL
WITHIN AND ABOVE THE MIXED LAYER

Paul Michael, Robert M. Brown, and Robert W. Garber

Pres. at Fourth Symposium on Turbulence, Diffusion, and
Air Pollution, Reno, Nevada, Jan. 15-18, 1979. To appear
in the Preprint Volume.

BNL 25026
Sept. 1978

ATMOSPHERIC TURBULENCE AND DIFFUSION
BOUNDARY LAYER TRANSPORT MODEL

H. N. Lee

Pres. at Fourth Symposium on Turbulence, Diffusion, and
Air Pollution, Reno, Nevada, Jan. 15-18, 1979. To appear
in the Preprint Volume.

Publications

Atmospheric Sciences Division

1978

BNL 25043
Oct. 1978

COMPILING A MULTISTATE EMISSIONS INVENTORY

Carmen M. Benkovitz

Presented at the Conference on Emissions Inventories and Factors APCA-TP7 Comm., Anaheim, Calif., Nov. 13-16, 1978.
To appear in the Proceedings.

BNL 25068
Oct. 1978

CORRELATION BETWEEN WAVE SLOPES AND NEAR-SURFACE OCEAN CURRENTS

S. SethuRaman

Presented at the Tenth Colloquium on Ocean Hydrodynamics, Liege, Belgium, May 1978. To appear in Series in Oceanography, Elsevier Publishing Co., Special Edition.

BNL 25069
Oct. 1978

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R. E. Meyers, R. T. Cederwall, J. A. Storch, and L. I. Kleinman

Presented at the Fourth Symp on Turbulence, Diffusion, and Air Pollution, AMS, Reno, Nev., Jan. 15-18, 1979.

BNL 25115
Oct. 1978

FORMATION AND CHARACTERISTICS OF COASTAL INTERNAL BOUNDARY LAYERS DURING ONSHORE FLOWS

G. S. Raynor, S. SethuRaman and R. M. Brown

J. Boundary-Layer Meteorology (in press)

BNL 25178
Nov. 1978

EFFECTS OF CHANGES IN UPWIND SURFACE CHARACTERISTICS ON MEAN WIND SPEED AND TURBULENCE NEAR A COASTLINE

S. SethuRaman and G. S. Raynor

Presented at the Fourth Symp. on Turbulence, Diffusion, and Air Pollution, AMS, Reno, Nev., Jan. 15-18, 1979.

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Atmospheric Sciences Division

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BNL 25224 Nov. 1978	NUMERICAL METHODS IN MULTI-GRID ANALYSIS Hsi-Nan Lee and Ronald E. Meyers Presented at the Second International Conf. on Computational Methods in Nonlinear Mechanics, Austin, Tex., March 26-28, 1979.
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BNL 25292 Nov. 1978	FORMATION AND TRANSPORT OF OZONE IN THE NORTHEAST QUADRANT OF THE UNITED STATES G. D. Wight, G. T. Wolff, P. J. Liroy, R. E. Meyers, and R. T. Cederwall Presented at the ASTM Symp. on Air Quality and Atmospheric Ozone, Boulder, Colo., Aug. 1-6, 1977.
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BNL 50857 May 1978 Formal Report	CLIMATOLOGY OF BROOKHAVEN NATIONAL LABORATORY 1974 THROUGH 1977 Constance M. Nagle
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IV.

Environmental Chemistry Division

Leonard Newman

Division Head

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Environmental Chemistry Division

A. Program Objectives

Research in the Environmental Chemistry Division is directed toward the development and implementation of techniques to determine the concentrations of environmental pollutants arising from energy production and to study the interactions among them. Activities include development of measurement methodology, theoretical and laboratory studies of the reactions and properties of these substances, and field experiments. The disciplines represented on the staff include chemistry, physics, and engineering, and an analytical chemistry support activity. Emphasis within the Division has been placed on developing highly sensitive techniques for measuring gaseous pollutants, developing methods for determining the size distribution and molecular composition of ambient aerosols, theoretical studies and laboratory measurements of aerosol properties, modeling the chemical reactions of pollutants, laboratory studies of the mechanisms and rates of fundamental reactions, field experiments to determine transformation mechanisms and rates of reactions occurring under ambient conditions, and field experiments to elucidate the interaction of transport and transformation. Considerable scientific interaction exists with the Atmospheric Sciences Division, especially with respect to the programs of the Multistate Atmospheric Power Production Pollution Study (MAP3S). In addition, analytical chemistry support is provided for these programs, as well as those of the Land and Fresh Water Environmental Sciences Group (precipitation chemistry), Biology Department (mutagenic studies), Nuclear Energy Department (radionuclide wastes), and the Accelerator Department (mass spectroscopy).

B. Highlights of 1978

1. Measurement Methodology

A system was devised and implemented for the real-time measurement of aerosol sulfur compounds, utilizing a flame-photometric detector. Employment of a heated diffusion tube for removal of sulfur dioxide and gaseous sulfuric acid with the cyclic addition of ammonia permits discrimination between sulfuric acid and other sulfate aerosols while eliminating problems associated with system response to sulfuric acid. A limit of detection of 0.5 ppb aerosol sulfur is possible. Good correlations are obtained with sulfate data obtained by previously developed filter-pack collection methods.

A technique employing sodium-chloride impregnated filters has been developed, evaluated, and implemented for the measurement of ambient concentra-

tions of nitric acid. A limit of detection of 0.1 ppb is possible with a sample taken for 2 hours. A filter-pack assembly was developed to sample, in tandem, aerosol sulfate and nitrate, gaseous nitric acid, and gaseous sulfur dioxide. In studies to date, the ambient nitric acid concentration has generally been found to range between equal-to and 10-times the aerosol nitrate level.

Nitro-derivitization with gas-chromatographic separation and electron-capture detection has been employed to develop a method for the determination of nitrates in a variety of environmental samples. The determination of ammonia and primary amines with a limit of detection of 1 ng/m can be accomplished by derivitization with a fluorescent material such as o-phthalaldehyde.

Instrumentation was developed to allow use of chromatography with electron-capture detection as a technique to measure tracers for air masses by aircraft and fixed-station sampling.

The use of electron-capture detection in a BNL designed instrument to measure perfluorocarbons used as taggants for explosives has been demonstrated to be applicable to determining the presence of bombs in clandestine situations.

The development of sensitive techniques for determining ambient constituents was pursued through a theoretical analysis establishing the inherent advantage of low-frequency optoacoustic detectors over higher-frequency acoustically resonant cells. A dual-traverse highly coupled cell was constructed and found to have a sensitivity equal to a pressure change of 8×10^{-10} atmospheres.

A Brookhaven designed and fabricated aerosol sampling system consisting of a dichotomous virtual impactor, a slit-to-cylinder impactor, and diffusion processor has been assembled for use on the BNL aircraft. It has a flow capability of 200 l/m, which permits the collection of sufficient material for chemical analysis.

Improvements have been made in laboratory analyses involving ion chromatography for sulfur dioxide and sulfate, the use of methylthymol blue with the autoanalyzer for sulfate, the use of benzaldehyde for selective separation and analysis of sulfuric acid, the Gran titration for the measurement of the total acidity of aerosols, and methodology for determining primary sulfuric acid and metal sulfate emissions. A capability has been established of performing gas chromatography-mass spectroscopy.

2. Theoretical and Laboratory Studies

Theory was developed to describe deliquescent properties of the aerosol systems sodium chloride-potassium chloride and sulfuric acid-ammonium sulfate. It was established by laboratory study that the stagewise phase transformation and subsequent droplet growth were in good agreement with the theory. An experimental technique was developed and utilized to obtain light-scattering information on nonspherical submicron particles.

An atmospheric model for sulfur involving 30 chemical species was constructed from which a surrogate chemical mechanism was developed that employs only 12 species but which can produce results comparable to the more complex model. The diurnal modulation of the atmospheric oxidation of sulfur dioxide was examined and it was concluded that for most purposes it is adequate to model such processes according to their diurnal average rate coefficients.

The oxidation of sulfur dioxide to sulfate in cloud or fog water has been examined theoretically and an evaluation made of the relative importance of mass transport and reaction kinetics. Mass transport may be controlling in laboratory studies, whereas the rate of reaction is controlling in clouds or fogs. It was shown that the rate at which a power-plant plume expands exerts a controlling influence upon reactions that are higher-than-first-order in plume constituents, and that these reactions are quenched at high expansion rates. It was established that with data to date, no inferences may be drawn concerning catalyst depletion as a mechanism for limiting in-plume reactions.

Addressing the problem of marine mishaps involving vessels carrying sulfuric acid, consideration was given to the endothermic reaction and a model was developed which adequately describes the turbulent-mixing process resulting from density nonhomogeneities in the fluid.

3. Field studies

Flue-gas measurements at an oil-fired power plant resulted in a correlation for predicting sulfuric-acid emissions based on fuel composition and plant operating parameters.

A number of sulfur-hexafluoride tracer experiments were performed using a continuous fluorocarbon detector with a sensitivity of 1 part in 10^{12} .

The BNL aircraft was engaged in a number of studies of chemical reactions in power-plant stack plumes. A study of the formation of sulfate, ammonium, and nitrate in an oil-fired plume indicates that sulfate formation

seldom exceeds 3% of sulfur emissions for time scales as long as 2 hours, that progressive ammonia neutralization of sulfuric acid is discernable, and that formation of particulate nitrate is not discernable.

During a study of a coal-fired power-plant plume, as part of the EPA sulfur transport and transformation experiment, the continuous detector and a BNL-designed radio-controlled air-sampling system was deployed. In addition, the BNL aircraft was used to follow and sample the plume for sulfate and nitrate.

An aerosol characterization study was performed in New York City during a summer and a winter period. Aerosol sulfate in the respirable region was always found to consist of sulfuric acid partially neutralized by ammonia. The ammonia-to-sulfur ratio averaged 1.5 (mole basis) during the summer, but in the winter there was considerably greater neutralization.

C. Major Activities Planned for 1979

1. Measurement Methodology

The newly developed analytical techniques will be refined and their use implemented in field situations. The nitric-acid and nitrate method will be validated by engaging in an intercomparison program sponsored by EPA.

The sensitivity of the flame-photometric instrument employed for sulfur will be increased by introducing a constant level of sulfur hexafluoride to take advantage of the quadratic response of the detector.

The fluorescence derivatization method for ammonia will be developed into a semi-real-time technique with a time resolution of < 15 min.

The optoacoustic technique will be explored for use as a means to measure ambient ammonia.

Use of an intracavity laser-Raman technique will be explored as a technique for real-time characterization of ambient aerosols.

Photophoresis (light-induced motion of aerosols) will be explored as a means of examining single aerosol particles.

Electrochemical techniques will be explored towards developing a method for the determination of sulfur (IV) species in ambient aerosols.

A commercial prototype of a BNL atmospheric tracer sampler will be developed for ultimate production of numerous units for deployment in several transport and dispersion model-validation experiments.

2. Theoretical and Laboratory Studies

The chemical equilibria and phase properties of the ammonia nitric-acid, sulfuric-acid systems will be studied.

A discharge flow-resonance fluorescence apparatus will be constructed to measure rate constants for homogeneous chemical reactions of trace gases and free radicals that are of atmospheric importance.

Advances will be made in the chemical modeling activities by refinement of the concepts heretofore developed, especially with regard to their utilization with meteorological models.

An evaluation of the literature on the incorporation of nitrogen oxides into water droplets will be completed. Laboratory experiments will be initiated to measure this incorporation in conjunction with field experiments to be conducted during fogs to ascertain whether it is governed by equilibria or reaction kinetics.

A theory will be developed and measurements made of the production and growth of aerosols from local vaporization of sulfur trioxide arising from a sulfuric acid release in a maritime spill accident.

3. Field Experiments

The data already obtained from the New York aerosol study will be further studied to obtain an understanding of the temporal variability of the sulfur and nitrogen aerosol.

Diurnal fluctuations in ambient nitric acid concentration will be measured.

A concerted measurement program will be initiated to determine all of the components of sulfur and nitrogen oxides, with short-enough time resolution to test for the microscale equilibria which may exist in an incompletely mixed atmosphere and the spatial limitations of these equilibria. Special attention will be directed towards obtaining temporal information with the real-time sulfate systems.

A trial implementation of the explosives-tagging will commence with the cooperation of the manufacturers of various explosives.

D. Scope of Projects

Title: Atmospheric Diagnostics

FY 78: \$275,000

Principal Investigator
L. Newman

FY 79: \$275,000

Sponsor: Office of Health
and Environmental Research
(DOE)

To understand the generation, transport, transformation, and removal processes of atmospheric pollutants requires the development of chemical models and new analytical methods as well as implementation of existing models and methods for characterizing species and modeling their spatial and temporal concentration profiles. The Atmospheric Diagnostics program is thus designed to originate and apply analytical and chemical modeling methodologies for studying the physico-chemical properties of aerosol and related gaseous, precursor species under the dynamic meteorological conditions of the ambient atmosphere. The principal components of interest are size-classified particulate sulfur, nitrogen, carbon and trace metal species and the gaseous species--sulfur and nitrogen oxides, ozone, ammonia, nitric acid, and methane, non-methane and partially oxidized hydrocarbons--which are precursors to or in equilibrium with particulate species.

Scenarios of interest include the range from near-source conditions through stationary source and urban plumes to near-homogenous ambient conditions. Of special interest are analytical and modeling techniques that will lead to predictive capability for diurnal and seasonal variations, for source identification and for effects of multiple plume interaction. A primary goal is the measurement of all of the components of the sulfur dioxide-nitric acid-ammonia-water vapor-aerosol particle system with sufficient time resolution to indicate the spatial scale of thermodynamic equilibrium of this system if such exists in the ambient environment.

Title: Atmospheric Tracer and Instrumentation Developments

FY 78: \$130,000

Principal Investigator:
R. N. Dietz

FY 79: \$145,000

Sponsor: Office of Health
and Environmental Research (DOE)

This task is comprised of two principal efforts--one, the development and utilization of atmospheric tracer compounds for dispersion and long range transport studies and a second, the development and validation of unique instrumentation for application in tracer studies and determination of energy-related atmospheric and source emission pollutants.

For the sub-task of atmospheric tracer developments, efforts are directed at the testing and validation of state-of-the-art samplers and analytical procedures for the family of perfluorocarbon tracers (PFTs), the search for new PFTs with lower ambient background levels and the preparation of the respective gas standards, participation in interlaboratory comparison and validation test programs, assistance to other laboratories in DOE-supported field tracer studies, and finally implementation of an effort in Brookhaven-directed tracer programs for validation of short and long range dispersion and transport models as applied to energy-related pollution problems.

The sub-task of instrumentation developments is directed towards the development and improvement of new and existing analytical instrumentation for the determination of meteorological gas tracers (PFTs), the development and commercialization of new atmospheric sampling and concentration procedures for application to the determination of PFTs and energy-related pollutants, the application of chemical conversion principles for the novel development of sensitive techniques for the determination of trace atmospheric constituents, and the development and validation of new gas standard sources in support of the above efforts.

Title: Aerosol Chemistry and Dynamics

FY 78: \$120,000

Principal Investigator:
I. N. Tang

FY 79: \$128,000

Sponsor: Office of Health
and Environmental Research (DOE)

Aerosols are known to play an important role in many atmospheric processes such as local visibility, regional climatic changes, and, on a larger scale, the total radiation balance of the earth. Moreover, since ambient aerosols are frequently products from pollution sources, their subsequent transport and removal from the environment are of considerable ecological significance. The purpose of this task is to elucidate the chemical and physical processes which govern the dynamic behavior of an aerosol system. Ongoing research activities include: (1) theoretical and experimental studies of condensational growth of particles composed of mixed salts such as sulfates and nitrates, (2) measurement of multicomponent phase equilibria for systems of environmental importance, (3) experimental studies of gas-phase reactions which are precursory to the formation of ambient aerosols. The results of this continuing research program are expected to provide a better understanding of the basic mechanisms by which pollutants from energy-related activities may transform and transport in the atmosphere. In addition, data on aerosol phase transformation and growth are essential in realistically assessing the health effects associated with various toxic hygroscopic particulates which deposit along respiratory tracts after inhalation.

Title: Aerosol Measurements and Microphysics

FY 78: \$110,000

Principal Investigator(s):
W. H. Marlow

FY 79: \$110,000

Sponsor: Office of Health
and Environmental Research
(DOE)

Aerosols are principal agents by which air pollution has its impact on man, animals, plants, and the atmosphere. Little is known about their origin, evolution (either physical or chemical), atmospheric interactions, or eventual removal processes. The efforts under this program are concerned with the development of both instrumentation for field studies of the atmospheric aerosol and methods for the analysis and interpretation of these measurements. The planning and design of this instrumentation as well as its utilization in field studies is done with considerable input and cooperation from other Atmospheric Sciences groups. The analytical work relates to instrumental methods and measurement methodology while the interpretive work draws largely upon fundamental chemical physics.

Title: Real-Time Measurement

FY 78: \$130,000

Principal Investigator:
S. E. Schwartz

FY 79: \$139,000

Sponsor: Office of Health
and Environmental Research (DOE)

This task is directed to the development of techniques and instrumentation for real-time characterization and determination of trace atmospheric constituents resulting from energy production and of compounds that influence their atmospheric chemistry. Compounds of concern include gases (SO_2 , H_2S , HNO_2 , HNO_3 , NH_3 , hydrocarbons, and other organics), aerosols (H_2SO_4 , bisulfate and sulfate salts, carbonaceous materials, polynuclear aromatics), and free radicals (HO , HO_2). Three spectroscopic systems that would allow for ultrasensitive measurement of a number of different pollutants and which require no premeasurement treatment of the samples are: an intracavity-laser-Raman system, an optoacoustic system at CO_2 -laser wavelengths, and a UV-resonance fluorescence system. Prototype instruments for the laser-Raman and optoacoustic systems have been constructed and their sensitivities are being examined. Theoretical calculations and preliminary tests indicate a sensitivity of 1 ppb and possibly greater, although interferences may serve to limit this sensitivity. Techniques for improving sensitivity and reducing sensitivity to interferences are being explored. Additionally, the physical processes for radiative and non-radiative relaxation of aerosols interacting with visible radiation are being investigated.

Title: Fragile Molecules

FY 78: \$110,000

Principal Investigator:
R. L. Tanner

FY 79: \$110,000

Sponsor: Division of Basic Energy
Sciences (DOE)

The long term goals of this program are to devise and develop fundamentally new analytical methods of high sensitivity and selectivity for the determination of traces of potentially reactive substances in the environment based on derivatization-chromatographic separation-selective detection techniques. Since many substances of interest may be reactive under analysis conditions, derivatization is used to convert the reactive, or otherwise fragile substance, to a derivative which can be separated from interferences and delivered quantitatively to a detector. Chromatographic techniques (gas, liquid, thin layer, ion exchange) are well-established methods for increasing analytical specificity by separating co-derivatized substances and other interferents from the derivative of interest. Selective detectors, whose response is keyed to a single element or functional group, increase sensitivity by orders of magnitude for substances containing that element or functional group. This reduces the detector response for even gross amounts of potential interferences and simplifies the separation technology. The derivatization-chromatography-selective detection principle is broad and applicable to analysis of environmental species of dynamically varying concentrations, e.g., nitrate, sulfate, sulfite, organics in aqueous and aerosol samples and ammonia, nitric acid, others in gaseous samples.

Title: Sulfate Emissions from Fossil Fueled Combustion Sources

FY 78: \$ 80,000

Principal Investigator:
R. N. Dietz

FY 79: \$108,000

Sponsor: E P A

The field utilization of the Brookhaven controlled condensation system at several oil-fired power plant units demonstrated the capability of a reasonably simple but quite reliable approach to the sampling of flue gas for the specific constituents, H_2SO_4 and total particulates; the latter were subsequently separated into a water soluble and insoluble fraction. The soluble fraction was shown to be entirely composed of water soluble metal sulfates--principally of Mg, V, and Na. Carbon was the main element in the insoluble fraction which also contained metal oxides primarily of Mg, V, and iron.

Furthermore, it was conclusively shown that unless the flue gas sampling method used to study the effect of operating parameters on the emission of total sulfates was specific for H_2SO_4 and metal sulfates, the exact nature of the mechanisms responsible for the variability of sulfate emissions would have been more difficult to ascertain.

As a result of these two years of experimental field measurements, a correlation for predicting H_2SO_4 emissions has been successfully derived, providing a demonstrated reliability of better than $\pm 25\%$. It should be emphasized that although the correlation is empirical in nature, it is not entirely without a foundation based on expected effects of particular parameters including furnace oxygen, power level, sulfur and metals content of the fuel oil, and the amount of unburned carbon.

Title: Sulfate Formation in Oil Fired Power Plant Plumes

FY 78: \$140,000

Principal Investigator(s):

R. N. Dietz
R. W. Garber
L. Newman

FY 79: \$136,000

Sponsor: EPRI/ESEERCO/LILCO

This research program was undertaken to provide an understanding of the formation of sulfate in the emissions from oil-fired power plants and the conditions controlling this formation. This program is being carried out on two parts. One part is a detailed study of the emissions from an oil-fired power plant and how plant operating conditions affect the composition of these emissions. The emissions study requires sampling the power plant exhaust gases at several locations in the plant under a variety of plant operating conditions. The resultant samples are analyzed for sulfate, sulfuric acid, sulfur dioxide, particulate loading, oxygen, carbon monoxide, carbon, and the principal metals in the particulates. The results from this part of the program are expected to show the conditions which affect the in-situ formation of sulfate and sulfuric acid.

The second part of the program is a study of the mechanisms governing the change of sulfur species in the plume of the same power plant as the plume travels downwind for up to 50 to 100 km. An aircraft equipped with a special filter-pack assembly and certain real-time monitors (SO_2 , temperature, humidity, etc.) traverses the plume in the crosswind direction at several distances from the stack--typically 1/2 to 10 miles. Samples are analyzed primarily for SO_2 and total sulfate in order to document the mechanisms of chemical transformation and/or particulate fallout. The samples are collected under various meteorological conditions which may have an influence on the plume chemistry.

Title: Sulfuric Acid Release in Maritime
Spill Accidents

FY 78: \$250,000

Principal Investigator(s):
I. N. Tang

FY 79: \$150,000

Sponsor: U.S. Coast Guard/DOT

Concentrated sulfuric acid and oleum are among the several hazardous chemicals which are transported in large quantities on U.S. waterways. There have been incidents in the past when hundreds of tons of sulfuric acid were accidentally discharged into water during marine mishaps. Because of the high exothermicity of sulfuric acid when mixed with water and the high volatility of oleum, a substantial fraction of the spilled acid could become airborne in the form of an acid mist, thereby posing threats to the safety of the personnel directly involved in the accident, as well as the general public in certain cases. The objective of this research program is to quantitatively characterize the spill of sulfuric acid on water under conditions likely to occur in marine accidents. Specific areas of interest include (1) an investigation of the formation mechanisms for sulfuric acid aerosols resulting from a spill, (2) the growth of acid cloud formed during and immediately after a spill, and (3) the exothermic and turbulent mixing of acid with water in the vicinity of a release source. Pertinent data will be obtained to provide a basis for the U.S. Coast Guard to formulate emergency response procedures and make realistic environmental impact statements concerning a given acid spill.

Title: Evaluation of Vapor Taggants and Substrates
for the Tagging of Blasting Caps

FY 78: \$ 25,000

Principal Investigator(s):

R. N. Dietz

G. I. Senum

FY 79: \$106,000

Sponsor: Aerospace Corp./BATF

Vapor tagging of electric blasting caps (EBC) is accomplished with the use of perfluorocarbon taggants. These taggants are absorbed in either the present EBC and closures or in substitute fluoroelastomeric end closures to approximately 5-10% of the total weight of end closure. The specific taggants have been chosen to allow a 0.5 to 5 nanoliter per minute vapor taggant emission rate from the tagged EBC over a 5 year lifetime.

The taggant emission rates from tagged EBC have been experimentally observed to be well described by a taggant emission rate model. This model provides for experimental selection of the proper taggant for projected lifetimes of ten years based on just several months of observed emission measurements.

Another model has been derived which can predict the taggant concentrations in various realistic scenarios such as room, building, lockers, etc. The model takes into consideration the effect of barriers such as boxes, suitcases, etc., in impeding the release of the taggant vapors from the tagged EBC into the scenario and the dilution effect of the scenarios air circulation system. Taggant concentrations have been experimentally determined using a 425 liter sampling chamber with various barriers and the results are used with the model to predict various scenario taggant concentrations.

Title: Rainout and Washout of Nitrogen Oxides and
Oxyacids

FY 78: \$200,000

Principal Investigator:
S. E. Schwartz

FY 79: \$200,000

Sponsor: Federal Aviation
Administration

A major uncertainty affecting present ability to model the effects of injection of nitrogen oxides in the stratosphere is the net rate of transport of these compounds from the stratosphere to the troposphere. This rate is governed by the rate of removal of nitrogen oxides and oxyacids from the troposphere. This latter process takes place to a large but uncertain extent through interaction with water in clouds and in rain, viz., solution, re-release, and aqueous-phase chemical reaction. This research addresses these processes in a program comprising three inter-related areas of investigation: (1) modeling the rates of washout and rainout of nitrogen oxides and oxyacids, including chemical reaction, (2) directed fundamental laboratory studies of the solubility equilibria and reaction kinetics important in the aqueous chemistry of nitrogen oxides and oxyacids in the atmosphere, (3) selected field investigations of rainout and washout of nitrogen oxides and oxyacids in the lower troposphere.

Title: Tennessee Plume Study

FY 78: \$120,000

Principal Investigator
L. Newman

FY 79: \$ - 0 -

Sponsor: Sulfur Transport and
Transformation In the Environment
(STATE)/Environmental Protection
Agency

The major objective of this project is to measure the parameters which govern the transport, transformation, and removal of sulfur-containing pollutants from coal-fired power plants. In this regard the Environmental Protection Agency organized a study at a Tennessee Valley Authority Operation. BNL provides and operates an instrumented aircraft and supplies analytical support for other participants in the study. This includes the filter-pack method for sulfur dioxide and sulfate, continuous monitors for sulfur hexafluoride tracer, ultra-high-sensitivity techniques for some tracer measurements, and in-stack measurement of sulfur dioxide, sulfuric acid and sulfate. The power-plant plume data will be interpreted in terms of the rates of formation of sulfate and nitrate.

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E. Publications

Publications
Environmental Chemistry Division
1978

BNL 24023   PROCESSES LIMITING THE OXIDATION OF SULFUR
Feb. 1978   DIOXIDE IN STACK PLUMES II

Stephen E. Schwartz and Leonard Newman

Presented at the 70th Meeting AIChE, New York City,
November 13-17, 1977. To appear in Conf. Proceedings.

BNL 24063   CHEMICAL COMPOSITION CORRELATIONS OF SIZE-
Feb. 1978   FRACTIONATED SULFATE IN NEW YORK CITY AEROSOL

Roger L. Tanner, William H. Marlow, and Leonard Newman

Environmental Science and Technology (submitted)

BNL 24064   THE OPTICAL AND THERMODYNAMIC PROPERTIES OF
Feb. 1978 $(\text{NH}_4)_3\text{H}(\text{SO}_4)_2$ (LETOVICITE) AEROSOLS

I. N. Tang and H. R. Munkelwitz

Presented at the American Industrial Hygiene Assn.,
Los Angeles, Calif., May 8-12, 1978.

BNL 24188   CONVERSION OF SULFUR DIOXIDE TO SULFATE
March 1978   DURING THE DA VINCI FLIGHTS

Joseph Forrest, Stephen E. Schwartz, and Leonard Newman

Atmospheric Environment (Submitted)

BNL 24192   A NEW AIRBORNE AEROSOL SAMPLING SYSTEM
March 1978

William H. Marlow and Robert W. Garber

Presented at the 71st Annual Air Pollution Control
Assn. Meeting, Houston, Tex., June 25-30, 1978.

Publications

Environmental Chemistry Division

1978

BNL 24366   OPERATING PARAMETERS AFFECTING SULFATE
May 1978   EMISSIONS FROM AN OIL-FIRED POWER UNIT

Russell N. Dietz, Robert F. Wieser, and Leonard Newman

Presented at Workshop on Measurement Technology and
Characterization of Primary Sulfur Oxides Emission from
Combustion Sources, Southern Pines, N. Carolina, April 24-26, 1978

BNL 24367   AN EVALUATION OF THE MODIFIED EPA METHOD 6
May 1978   FLUE GAS SAMPLING PROCEDURE

Russell N. Dietz, Robert F. Wieser, and Leonard Newman

Presented at Workshop on Measurement Technology and
Characterization of primary Sulfur Oxides Emission from
Combustion Sources, Southern Pines, N. Carolina, April 24-26, 1978.

BNL 24383   MODELING HOMOGENEOUS OXIDATION OF ATMOSPHERIC SO₂
May 1978   BY A SURROGATE CHEMICAL MECHANISM (SCHEME)

S. Z. Levine and S. E. Schwartz

Presented at the Meeting of American Chemical Society, Miami
Beach, Florida, September 10-15, 1978.

BNL 24547   PARTICLE SAMPLING FROM HIGH TEMPERATURE AND PRESSURE GAS STREAMS
June 1978

W. H. Marlow and N. Abuaf

Presented at Symp. on Instrumentation and Control for Fossil
Demonstration Plants, Newport Beach, Calif., June 19-21, 1978.

Publications

Environmental Chemistry Division

1978

BNL 24610R
June 1978

CONSTRUCTION OF SURROGATE CHEMICAL MECHANISMS
(SCHEMES) FOR ATMOSPHERIC PHOTOCHEMICAL SYSTEMS

Stuart Z. Levine and Stephen E. Schwartz

Presented at the IX International Conf. on Photochemistry,
Cambridge, England, Aug. 7-9, 1978.

J. Photochemistry 9, 104-106 (1978)

BNL 24631
June 1978

AEROSOL GROWTH STUDIES IV. PHASE TRANSFORMATION
OF MIXED SALT AEROSOLS IN A MOIST ATMOSPHERE

I. N. Tang, H. R. Munkelwitz, and J. G. Davis

J. Aerosol Science (submitted)

BNL 24650
July 1978

RESIDENCE TIMES IN RESERVOIRS UNDER NON-STEADY STATE CONDITIONS:
APPLICATION TO ATMOSPHERIC SO₂ AND AEROSOL SULFATE

Stephen E. Schwartz

Tellus (submitted)

BNL 24702
July 1978

INVESTIGATION OF MAINTAINED AND INSTANTANEOUS BUOYANCE SOURCES

C. Dopazo and I. N. Tang

J. Fluid Mechanics (submitted)

BNL 24703
July 1978

COMMENTS ON "MEASUREMENT OF AEROSOL PARTICLES
AND TRACE GASES IN METROMEX"

Roger L. Tanner

J. Applied Meteorology (submitted)

Publications
Environmental Chemistry Division
1978

BNL 24846   DELIQUESCENT PROPERTIES OF MIXED SULFATE AND
Aug. 1978   NITRATE AEROSOLS IN A MOIST ATMOSPHERE

I. N. Tang and H. R. Munkelwitz

Pres. at 11th Aerosol Tech. Meeting, Univ. of Calif.,
Davis, Calif., Sept. 6-8, 1978.

BNL 24889   CHARACTERISTICS OF A PHOTOACOUSTIC AIR
Aug. 1978   POLLUTION AT CO₂ LASER FREQUENCIES

Robert F. Adamowicz and Kee P. Koo

J. Applied Optics (Submitted)

BNL 24959   EVALUATION OF DETECTION OF TAGGED BLASTING CAPS UTILIZING THE
Aug. 1978   U.S. CUSTOMS AUTOMATED BAGGAGE EXAMINER AND THE BROOKHAVEN
CONTINUOUS ELECTRON CAPTURE MONITORS

Informal
Report   Russell N. Dietz, Gunnar I. Senum, Robert W. Goodrich

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BNL 25004   DETERMINATION OF ATMOSPHERIC NITRIC ACID WITH NaCl-
Sept. 1978   IMPREGNATED FILTERS AT HIGH VOLUME FLOW RATES

Joseph Forrest, Roger L. Tanner, Daniel Spandau,
Ted D'Ottavio, and Leonard Newman

Pres. at General Papers Session of Environmental Chemistry
Divn., ACS Meeting, Honolulu, April 1979. To appear in
Preprint Volume.

Publications
Environmental Chemistry Division

1978

BNL 25027   CONTINUOUS DETERMINATIONS OF AMMONIA AT AMBIENT ATMOSPHERIC
Oct. 1978   CONCENTRATIONS USING FLUORESCENT DERIVATIZATION

Abstract   Roger L. Tanner and Joseph Lepore

Presented at the Division of Environmental Chem., American
Chem. Soc., Honolulu, Hawaii, April 1-16, 1979.

BNL 25028   DELIQUESCENCE PROPERTIES AND PARTICLE
Oct. 1978   SIZE CHANGE OF HYGROSCOPIC AEROSOLS

Abstract   I. N. Tang

Presented at the Division of Environmental Chem., American
Chem. Soc., Honolulu, Hawaii, April 1-16, 1979.

BNL 25050   DETECTION OF PERFLUORINATED TAGGANTS IN ELECTRIC
Oct. 1978   BLASTING CAPS BY ELECTRON CAPTURE MONITORS

Russell N. Dietz, Robert W. Goodrich, and Edgar A. Cote

Presented at New Concepts Symp. and Workshop on Detection and
Identification, Reston, Vir., Oct. 30, 31-Nov. 1, 1978.
To appear in the Proceedings.

BNL 25051   VAPOR TAGGING OF ELECTRIC BLASTING CAPS WITH
Oct. 1978   PERFLUORINATED COMPOUNDS

G. I. Senum, R. P. Gergley, M. Greene, and R. N. Dietz

Presented at New Concepts Symp. and Workshop on Detection and
Identification, Reston, Vir., Oct. 30, 31-Nov. 1, 1978.
To appear in the Proceedings.

Publications
Environmental Chemistry Division
1978

BNL 25114
Oct. 1978

GENERAL CONSIDERATIONS ON HOW RAINWATER MUST
OBTAIN SULFATE NITRATE AND ACID

Leonard Newman

Presented at the Division of Environmental Chem., American
Chem. Soc., Honolulu, Hawaii, April 1-16, 1979

BNL 25116
Oct. 1978

DETERMINATION OF PARTS PER BILLION CONCENTRATIONS OF AQUEOUS
NITRATE BY DERIVATIZATION GAS CHROMATOGRAPHY WITH ELECTRON
CAPTURE DETECTION

Rober L. Tanner, Ruby Fajer, and Jeffrey Gaffney

J. Analytical Chemistry (submitted)

BNL 25123
Oct. 1978

AUTHOR'S REPLY

William H. Marlow, P. C. Reist

J. Aerosol Sci. (in press)

BNL 25124
Nov. 1978

ABSOLUTE RATE CONSTANT FOR THE REACTION OF $O(^3P)$
WITH CH_3SCH_3 FROM 472 TO 273 K

J. H. Lee, R. B. Klemm, and I. N. Tang

Presented at the Division of Environmental Chem., American
Chem. Soc., Honolulu, Hawaii, April 1-16, 1979.

BNL 25130
Nov. 1978

A STUDY OF SULFURIC ACID RELEASE IN MARITIME SPILL ACCIDENTS

I. N. Tang and C. Dopazo

Informal
Report
Limited Dist.

Publications
Environmental Chemistry Division
1978

BNL 25223
Oct. 1978

SULFUR AND NITROGEN COMPOUNDS IN URBAN AEROSOLS

Roger L. Tanner

Presented at the New York Academy of Sciences Conf. on Aerosols:
Anthropogenic and Natural-Sources and Transport, New York, N.Y.,
Jan. 9-12, 1979.

BNL 50908

GEOLOGY OF OIL AND GAS IN WESTERN SIBERIA
(Translation of Selected Sections)

Formal
Report
(in press)

E. T. Premuzic

V.

Land and Freshwater Environmental Sciences Group

George R. Hendrey
Leader

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Land and Freshwater Environmental Sciences Group

A. Program Objectives

In order to provide a comprehensive coordinated assessment of the actual or potential impacts of man's activities on both terrestrial and freshwater ecosystems, a multidisciplinary team has been assembled in the Land and Freshwater Environmental Sciences Group. Specialists in the fields of limnology, terrestrial ecology, plant sciences, bacteriology, virology, and systems engineering are included. The Group also interacts closely with consultants from other academic institutions.

The objectives of the Group's current research projects are to:

1. Assess the effects of energy-related pollutants on precipitation chemistry on the BNL site.

2. Determine whether or not energy-related atmospheric pollutants cause injury to selected species of forest and field crop plants and to describe the nature of injuries observed.

3. Determine the effects of energy-related atmospheric pollutants on soil microbiota, and assess potential impacts of these pollutants on the interaction with plants.

4. Contribute to the development of prognostic models of the effects of energy-related atmospheric pollutants on forest and field-crop growth, yield, and value.

5. Determine the effects of energy-related pollutants on the biota and biological processes in freshwater ecosystems.

6. Provide an ecological characterization of the BNL site and other sites preliminary to the possible establishment of a National Environmental Research Park.

7. Develop and evaluate the use of artificial wetlands or modified natural wetlands for the renovation of wastewater from intermediate-sized communities.

8. Evaluate the effectiveness of various wastewater renovation systems in removing viruses and provide local and regional officials with information concerning the virus content of wastewaters and receiving waters, for use in long-range water resource planning.

9. Develop new methods for evaluating mutagenicity and carcinogenicity of environmental pollutants.

B. Highlights of 1978

Additional data on precipitation chemistry as a function of meteorological parameters were obtained and integrated into the existing data base.

Sulfate, nitrate, and pH concentrations were highest in summer, lowest in winter, and generally varied in parallel. Nitrate concentration appeared to increase during thunder storms.

Improvements were made in chambers for exposing plants to artificial rain and aerosols. Instrumentation has been installed to monitor aerosol particle sizes. A variety of forest and field crop plants showed leaf lesions or gamete inhibition at chemical concentrations similar to those in ambient rainfall. Under certain experimental conditions some plants were found to be unaffected or even enhanced by dry ammonium sulfate aerosols well in excess of ambient concentrations, or free of visible leaf injury at acid rain pH levels as low as 3.1 while others were severely injured.

Laboratory studies of agricultural and forest soils indicated that acid rain can inhibit autotrophic nitrogen fixation at pH 4.4 and halt it at pH 3.2. There is also an inhibition of complete denitrification in these soils, resulting in N_2O release to the atmosphere. Decomposition of organic matter was reduced by 35% at pH 3.5, relative to untreated soil at pH 5.0.

Research is being conducted in three Adirondack Mountain Lakes to assess the effects of acid precipitation on production and biomass of benthic plant communities. The information obtained contributes to a series of coordinated yet autonomous investigations which seek to describe the effects of acid precipitation on lake ecosystems.

An International Workshop on Limnological Aspects of Acid Precipitation was organized by the Land and Freshwater Environmental Sciences Group. Twenty-two Scientists from Norway, Sweden, Canada, and the United States met at the Adirondack Mountains research site to discuss on-going and future research in this area. Discussions centered on specific methods of measurement, data interpretation, and identification of problem areas. A prioritized list of studies judged to be essential in advancing the knowledge of lake acidification was prepared.

Testing of mutagenic potential of toxic materials with the Ames bioassay was begun. This work looks at the toxicity of substances which are released into the environment.

Culturing of human epithelial cells was refined in a cooperative effort with BNL's Department of Medicine and Boston University, preparatory to developing a new test procedure for mutagenic/carcinogenic potential of toxic substances.

C. Major Activities Planned

Full analyses of precipitation and meteorological data will be carried out. The effects of acid rain on soybean and corn will be investigated in field plot studies. Effects of sulfate aerosols on plants will be tested under different humidity regimes in the aerosol chamber.

Effects of acidification on benthic plant communities and on microbial biomass and community respiration will be examined in Adirondack Lakes.

Experiments on effects of acid precipitation on soils and soil microbiology include: (1) decay of herbicides and pesticides in forest soils, (2) the rates of organic matter accumulation and decomposition, (3) changes in dehydrogenase and urease enzymes, (4) and alterations in nitrogen cycle intermediates. Studies on the relationship between heavy-metal concentrations and nitrogen fixation, nitrification, and decomposition of several natural and synthetic compounds will be initiated.

Studies of the interaction of viruses with soils and with marine organisms will be conducted.

Investigations of the mutagenic/carcinogenic (M/C) potentials of toxic substances which may be released into the environment are planned. Existing tissue-culturing facilities will be expanded to accommodate the development of new M/C test methods stressing human cell lines.

Cooperation is expected with New York State Dept. of Environmental Conservation in feasibility studies for incorporating State lands into a National Environmental Research Park.

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D. Scope of Projects

Title: Effects of Acid Rain on Terrestrial Ecosystems

FY 78: \$250,000

Principal Investigator(s):
G. R. Hendrey, A. J. Francis,
G. Raynor, L. Evans

FY 79: \$258,000

Sponsor: Office of Energy,
Minerals, and Industry/EPA

Precipitation is collected by a sequential sampler at 5-min. to 1-hr. intervals and analyzed chemically. Relationships to meso- and synoptic-scale meteorology, and mechanisms of pollutant "scrubbing" by precipitation are studied. Data is provided for air-pollution transport model verification and to the MAP3S network.

A variety of Northeastern forest and field-crop plants are exposed in environmental chambers to artificial acid rain, and ensuing damage is observed. Preliminary field and greenhouse experiments dealing with long-term effects of acid rain on various leguminous plants suggest that discernable reductions in seed yield may occur because of pH 2.7 and lower. Larger-scale tests are in progress to confirm these trends. The effects of precipitation composition on gametophyte sperm motility was examined in the lab. Chloride, nitrate, and sulfate at concentrations equivalent to rainwater caused up to 60% reduced motility. Recent field tests have reconfirmed these findings. Uptake and leaching of various ions from plant surfaces in the presence of acid rain is being studied.

A chamber for the study of aerosol effects on plants is being updated with improved climate control and optical and sub-optical particle-sizing equipment. Tests studying acute effects of $(\text{NH}_4)_2\text{SO}_4$ aerosols are under way. A 20-25 mg/m³ (two-three orders of magnitude above usual ambient) load of aerosol with nighttime humidities at 100% has been found to cause severe Pinto Bean leaf injury.

Application of artificial acid rain to forest and agricultural soils continued. Autotrophic nitrogen fixation was inhibited at pH 4.4 and completely halted at pH 3.2. Organic matter decomposition was reduced by 35% at pH 3.5 compared to untreated soil of pH 5.0.

Title: Ecosystems Engineering

FY 78: \$75,000

Principal Investigator(s):
M. M. Small

FY 79: \$37,500

Sponsor: Rockefeller
Foundation

A report describing the construction and operation of artificial wetland ecosystems for the renovation of wastewater is being developed. The major portion of the report will present data to be used for scaling and building wetland systems that will recycle sludge and renovate water to either effluent or drinking water standards, depending on the rechargeability and size of the natural recharge area following the system. It will enable designers to understand principles of nutrient uptake and adsorption by the different components of the system and accompanying hydrologic and engineering considerations.

The components, or nutrient sinks being dealt with are: (1) wetland meadows, similar to overland flow treatment (2) marshes of varying depths and design and (3) ponds, either alone or as combined marsh-ponds. Design specifications will be based on data analysis from Brookhaven's two experimental meadow/marsh/pond systems, a series of experimental mini-marshes, regional pilot studies, and work done elsewhere on wetland systems treating sewage.

Studies in the field system have been completed. Emphasis is now on data analysis. Special attention is being given to the hydrology of the system and mass-balance models.

Title: National Environmental Research Park

FY 78: \$50,000

Principal Investigator(s):
G. R. Hendrey
G. S. Raynor

FY 79: \$70,000

Sponsor: Office of Health and
Environmental Research/DOE

The study is providing an ecological characterization of the Brookhaven National Laboratory (BNL) site and other nearby sites with different habitats as a preliminary step in establishing a Northeastern National Environmental Research Park (NERP). Programs relating to the environment have been carried out at BNL since its inception thirty years ago. Studies in meteorology, in the movement of surface and groundwater, and in terrestrial ecology were instituted to establish baselines against which potential impacts of BNL could be measured and control strategies developed. This interest in problems of the environment has continued and with the recent development of public concern about effects of energy-related activities, these studies have served as foci for greatly-expanded efforts in the atmospheric, marine and land and freshwater environmental sciences. In the interest of promoting research and study in the environmental sciences on the part of qualified investigators at educational and research institutions in the Northeast, it is planned to establish a NERP with BNL as a focal point that will provide an agency for making these facilities available on a cooperative basis. Special attention is now being given to describing the vegetation, mammals, soils and aquatic resources of the site. Other sites which typify the Long Island pine barrens near to the BNL site but under the control of other agencies, will also receive attention.

Title: Effects of Acid Precipitation on Benthic Plant Communities

FY 78: \$76,000

Principal Investigator(s):
G. R. Hendrey

FY 79: \$69,000

Sponsor: New York State-ERDA

Investigations are being conducted in three high-elevation, dilute, oligotrophic lakes in the western Adirondacks to quantify impacts of acid precipitation. The watersheds selected are situated in similar geological settings in the vicinity of Old Forge, N.Y. and are morphometrically comparable. Differences are in watershed area and soil development which result in a series of lakes representing acidified (Woods Lake, pH ca. 4.7), poorly buffered (Sagamore Lake, pH variable around 5.5), and buffered (Panther Lake, pH ca. 7.0) states. The objectives are to: (1) determine the effects of acidification on the productivity and biomass of benthic plant communities; (2) determine the degree to which lakes at differing pH levels have bottom sediments covered over by (a) fungal mats, (b) Sphagnum, (c) macrophytes, and (d) undecomposed litter; (3) contribute to a comprehensive ecosystem study of the three lakes; (4) provide data for an integrative watershed-limnological model.

The emphasis of the several biological studies is on materials cycling, productivity, and biomass within several ecosystem compartments. The amount of energy within a compartment available to other compartments or trophic levels will be determined. By comparing data from among the study lakes it should be possible to locate major interruptions in the flow of energy through the ecosystem.

These studies are integrated with projects conducted by other institutions in these same lakes including lake and watershed chemistry, paleolimnology, hydrology and geology of the three lake watersheds, precipitation quantity and chemistry, and biogeochemical models of the three lakes.

Title: The Fate of Human Viruses in a Land Application Wastewater Treatment System

FY 78: \$50,000

Principal Investigator(s):
J. Vaughn

FY 79: \$25,000

Sponsor: Rockefeller
Foundation

Few studies have previously addressed the fate of pathogenic microbes in overland flow-land application systems. The present program which is now nearing completion has provided some answers to several basic questions. Viral and bacterial pathogens have demonstrated limited survival capabilities in the individual marsh and pond systems. Routine analyses of large-volume final-effluent samples conducted over the past one and one half years have yielded few isolations of virus or pathogenic bacteria. Coliform analyses were found to be unreliable indices for pathogens in this system because of the regrowth potential of the coliform organisms. Effluents from the meadow-marsh system were relatively free from chlorine- or ozone-inhibiting particulates and would likely lend themselves to efficient final-step disinfection for occasionally occurring pathogens.

It is hoped that these data will provide a basis for more extensive land application programs.

Title: Fate of Human Viruses in Groundwater Recharge Systems Utilizing
Tertiary Treated Effluent

FY 78: \$106,000

Principal Investigator(s):
J. Vaughn

FY 79: \$97,000

Sponsor: Environmental
Protection Agency

Numerous questions have arisen concerning the overall safety of wastewater reuse procedures as a result of the inability to determine the fate of human viruses in such systems. Programs previously undertaken to ascertain this information have been subject to the following shortcomings: (1) data have been derived principally from laboratory-scale studies with questionable applicability to large-scale operations, (2) studies conducted at field sites have often incorporated use of non-human viruses (i.e. bacteriophage) or bacterial species, with extrapolation of resulting data to the human virus situation being inappropriate, (3) many studies which have dealt with human viruses occurring in field systems were conducted previous to the development of satisfactory technologies for sampling viruses from large volumes of water.

Studies conducted over the past two years have identified the virus-removing capabilities of a groundwater recharge system operating in Medford, Long Island. Several important criteria have been established which influence virus adsorption by sandy soil during wastewater percolation. These criteria include rate and frequency of wastewater application, turbidity, pH and conductivity of applied wastewater, and ambient soil pH. Soil adsorption--desorption characteristics of various members of the enterovirus group have been shown to vary significantly.

The above criteria will be applied to a recharge-basin management regime which will insure maximum virus removal during operation.

Title: Human Enterovirus Occurrence in the Waters of Arthur Kill

FY 78: \$16,000

Principal Investigator(s):
J. Vaughn

FY 79: \$ - 0 -

Sponsor: Power Authority
of the State of New York

The New York State Power Authority is currently proposing the construction of a large power plant facility along the banks of Arthur Kill on Staten Island. Plant coolant will be provided by drawing ambient waters from the Kill. As there are numerous sewage treatment facilities discharging treated and partially treated domestic wastes at points above the power plant site, concern was expressed over the possible aerosolization of human viruses by the cooling process.

A brief survey was conducted to provide background information on human virus occurrence in the waters of the Kill. The study included virus enumerations and identifications. Enterovirus concentrations in Arthur Kill were low, never exceeding 6.7 plaque forming units per gallon. Based upon the data resulting from this survey, it was decided by the New York State Department of Health that such virus levels presented no health hazard sufficient to influence the use of Kill water in a power plant cooling tower.

E. Publications

Publications

Land and Freshwater Environmental Sciences Group

1978

-
- BNL 23874   A SURVEY OF HUMAN VIRUS OCCURRENCE IN WASTEWATER
Jan. 1978   RECHARGED GROUNDWATER ON LONG ISLAND
- J. M. Vaughn, E. F. Landry, L. J. Baranosky,
C. A. Beckwith, M. C. Dahl, and N. C. Delihias
- Applied and Environmental Microbiology 36, No. 1, p. 47-51 (1978)
-
- BNL 24088   A SURVEY OF HUMAN ENTEROVIRUS OCCURRENCE IN FRESH AND
March 1978   MARINE SURFACE WATERS ON LONG ISLAND
- J. M. Vaughn, E. F. Landry, M. Z. Thomas, T. J. Vicale,
and W. F. Penello
- Water Research (accepted)
-
- BNL 24355   ELUTION EFFICIENCY OF BEEF EXTRACT FOR THE RECOVERY
April 1978   OF POLIOVIRUS FROM WASTEWATER EFFLUENTS
- Edward F. Landry, James M. Vaughn, McHarrell Z. Thomas,
and Thomas J. Vicale
- Applied and Environmental Microbiology 36, No. 4, 544-548 (1978)
-
- BNL 24391   AN AUTOMATIC SEQUENTIAL PRECIPITATION SAMPLER
May 1978
- Gilbert S. Raynor and John P. McNeil
- Atmospheric Environment (submitted)
-
- BNL 24431   THE OCCURRENCE OF HUMAN ENTEROVIRUSES IN A GROUNDWATER
May 1978   AQUIFER RECHARGED WITH TERTIARY WASTEWATER EFFLUENTS
- J. M. Vaughn and E. F. Landry
- Presented at the International Symp. on Land Treatment of
Wastewater, Hanover, N.H., Aug. 20-25, 1978. To appear
in the Proceedings.
-

Publications

Land and Freshwater Environmental Sciences Group

1978

BNL 24474   WETLANDS AS WASTEWATER TREATMENT SYSTEMS ENGINEERING ASPECTS
June 1978
Abstract   M. M. Small
Presented at Symp. on Freshwater Wetlands, Tallahassee,
Florida, March 2, 1978.

BNL 24475   PLANT COMMUNITIES RECYCLING SEWAGE
June 1978
Abstract   Karen Blumer
Presented at The Torrey Botanical Club, New York Botanical
Garden, Bronx, N.Y., April 18, 1978.

BNL 24476   AQUATIC BIOLOGICAL PROCESSES EFFECTED BY ACIDIFICATION
June 1978
Abstract   George R. Hendrey
Presented at the Sulfur Biogeochemistry Workshop, Oak Ridge
National Laboratory, Oak Ridge, Tenn., Feb. 27-March 3, 1978.

BNL 24511   SEED YIELD AND PLANT BIOMASS REDUCTIONS IN PLANTS OF PINTO BEAN
June 1978   (PHASEOLUS VULGARIS) AFTER FOLIAGE APPLICATION OF SIMULATED
ACID RAIN
Abstract   Lance S. Evans
Presented at the Sulfur Biogeochemistry Workshop, Oak Ridge
National Laboratory, Oak Ridge, Tenn., Feb. 27-March 3, 1978.

BNL 24519   THE USE OF WETLANDS FOR TREATING WASTES--WISDOM IN DIVERSITY?
May 1978
Abstract   Karen Blumer
See BNL-24611

Publications

Land and Freshwater Environmental Sciences Group

1978

BNL 24604
June 1978

PHYSIOLOGICAL RESPONSES OF LEAVES OF PHASEOLUS
VULGARIS TO SIMULATED ACID RAIN

Lance S. Evans, Filomena Da Costa, and Nicholas F. Gmur

Physiologia Plantarum (submitted)

BNL 24611
June 1978

THE USE OF WETLANDS FOR TREATING WASTES--WISDOM IN DIVERSITY?

Karen Blumer

Presented at Symp. on Freshwater Wetlands, Tallahassee,
Florida, March 2, 1978. To appear in the Proceedings.

BNL 24880
Aug. 1978

BIOGENIC EMISSION OF NITROUS OXIDE BY
ACID AND ACIDIFIED SOILS

A. J. Francis and R. Bernatsky

J. Air Pollution Control Assn. (submitted)

BNL 25066
Nov. 1978

IMPACTS OF ACID PRECIPITATION ON DECOMPOSITION
AND PLANT COMMUNITIES IN LAKES

George R. Hendrey and Frank W. Barvenik

Presented at the Public Meeting on Acid Precipitation,
The Assembly of the State of N.Y., May 4-5, 1978, Lake Placid.

BNL 25237
Nov. 1978

EFFECT OF NUTRIENT MEDIUM pH ON SYMBIOTIC NITROGEN FIXATION
BY RHIZOBIUM LEGUMINOSARUM AND PISUM SATIVUM

Lance S. Evans, Keith F. Lewin, and Frank A. Vella

Plant and Soil (submitted)

Publications
Land and Freshwater Environmental Sciences Group
1978

BNL 25502 Dec. 1978 Informal Report	HUMAN ENTEROVIRUS OCCURRENCE IN THE WATERS OF ARTHUR KILL James M. Vaughn and Edward F. Landry

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BNL 50818 Jan. 1978 Published May 1978	THE BROOKHAVEN AUTOMATIC SEQUENTIAL PRECIPITATION SAMPLER Gilbert S. Raynor and John P. McNeil

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BNL 50826 Apr. 1978 Published May 1978	EXPERIMENTAL DATA FROM ANALYSIS OF SEQUENTIAL PRECIPITATION SAMPLES AT BROOKHAVEN NATIONAL LABORATORY Gilbert S. Raynor and Janet V. Hayes

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BNL 50889 Aug. 1978 In press	SOME POTENTIAL EFFECTS OF ACID RAIN ON FOREST ECOSYSTEMS: IMPLICATIONS OF A COMPUTER SIMULATION D. B. Botkin and J. D. Aber (Woods Hole)

BNL 50932 Nov. 1978 Formal Report (in press)	AQUATICS TASK FORCE ON ENVIRONMENTAL ASSESSMENT OF THE ATIKOKAN POWER PLANT: EFFECTS ON AQUATIC ORGANISMS George R. Hendrey

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BNL 50932 Nov. 1978 Formal Report (in press)	THE 1978 BREEDING BIRD CENSUSES Gilbert S. Raynor

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Oceanographic Sciences Division

John J. Walsh
Division Head

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Oceanographic Sciences Division

A. Program Objectives

Over the last 40 years it has been realized that dilution by mixing processes of the sea can no longer be considered a simple or permanent removal process for pollutants, either in the open ocean or in nearshore waters. The increasing utilization of the continental shelf for oil drilling and transport, siting of nuclear-power plants, and various types of planned and inadvertent waste disposal, as well as for food and recreation, requires a careful analysis of the impact of these energy-related activities on the coastal marine ecosystem. The continental shelves comprise 10% of the area of the world's ocean and yield 99% of the global fish catch. This ecosystem is presently subject to both atmospheric and coastal input of pollutants in the form of heavy metals, synthetic chemicals, petroleum hydrocarbons, radionuclides, and other urban wastes. Overfishing is an additional man-induced stress. The present finfish stocks on the U.S. Northeast continental shelf are 25% of their virgin biomass, while the Peru anchovy fishery has now been reduced to less than 10% of its peak harvest in the late sixty's. Elucidation of cause and effect within a perturbation response of the food web of this highly variable and complex continental-shelf ecosystem is thus a difficult matter.

Physical transport of pollutants, their modification by the coastal food web, and transfer to man are problems of increasing complexity on the continental shelf. After 30 years of discharging mercury into the sea, for example, the Minimata neurological disease of Japan was finally traced to consumption of fish and shell-fish containing methyl mercuric chloride, while the Itai itai disease is now attributed to high cadmium ingestion. Discharges

of chlorinated hydrocarbons, such as DDT off California, PCB in the Hudson River, New York, and Escambia Bay, Florida, Mirex in the Gulf of Mexico, and vinyl chloride in the North Sea, have led to inhibition of photosynthesis, large mortality of shrimp, and reproductive failure of birds and fish. Oil spills, such as in the Santa Barbara and Ekofisk oil fields and from the tankers Torrey Canyon, Argo Merchant, Amoco Cadiz, Metula, Florida, and Arrow, constitute an estimated annual input of 2 million metric tons of petroleum to the continental shelves, with an unresolved ecological impact. Another 2 million tons of petrochemicals are added each year from river and sewer runoff. Fission and neutron-activation products of coastal reactors, such as San Onofre, Hanford, and Windscale, are concentrated in marine food chains with, for example, cesium-137 found in muscle tissue of fish, ruthenium-106 in seaweed, zinc-65 in oysters, and cerium-144 in phytoplankton. Their somatic and genetic effects on man are unknown. Disposal of dissolved and floatable material from New York City has been implicated as a possible factor in both a \$60-million shellfish loss off New Jersey and the closing of Long Island beaches during the summer of 1976. Future energy-related pollutants (liquefied natural gas, antifouling agents, and coal-derived liquids) also have a potential for perturbing the coastal zone. To provide such a quantitative assessment of the impact of present and future energy demands of the Northeast region on adjacent coastal zones, the objectives of the multidisciplinary research team within the Oceanographic Sciences Division are:

1. Assess natural sources of variability of food chain components of the continental shelf in order to distinguish between the effects of man-related and natural perturbations.

2. Provide a unique data base on dynamic ecological processes that link primary production to higher trophic levels and man.

3. Link meteorological (in cooperation with the Atmospheric Sciences Division) and physical studies of the coastal habitat to the transport and diffusion of energy-related pollutants and planktonic organisms.

4. Study food chain alterations as a function of species replacement in response to past and present perturbations at climatological, seasonal, and weekly time scales.

5. Analyze the importance of larval survival of zooplankton and ichthyoplankton in relation to increased mortalities of this life stage and future oscillations of the living resources of the northeast continental shelf.

6. Distinguish the importance of local oscillations of the New York Bight ecosystem in comparison with import from longshore transport of organisms and pollutants from the upstream areas of Georges Bank and the Gulf of Maine.

7. Determine the longshore coherence of plankton populations on the northeast continental shelf in relation to increasing freshwater discharge of energy-related pollutants from Long Island Sound, Hudson River, Delaware Bay, and Chesapeake Bay.

8. Refine quantitative simulation models of the energy flow within coastal ecosystems of the Mid-Atlantic Bight (Cape Hatteras-Nova Scotia), upwelling regions (Peru, Northwest Africa, Oregon-California), and the Bering Sea to provide a comparative analysis of the relative

resiliency of these systems to energy-related and natural perturbations.

9. Continue to coordinate the Department of Energy-funded research in the Northeast and to collaborate with other federal agencies (National Oceanic Atmospheric Administration-Marine EcoSystems Analysis Program, NOAA-National Marine Fisheries Service, Environmental Protection Agency, U.S. Coast Guard) and universities (State University of New York-Stony Brook, SUNY-Albany, Lamont-Doherty, Bigelow Laboratory, Woods Hole Oceanographic Institution, Argonne National Laboratory) in field, laboratory, and theoretical studies of the Northeast continental shelf.

B. Highlights of 1978

The major field emphasis during 1978 was a series of studies during the spring of 1978 (ACE-IV), centered around a March-April cruise on R/V ATLANTIS II (WHOI). Data on the lower trophic levels were compared with 1975, 1976, and 1977 data, with particular attention devoted to the sequence of spring phytoplankton blooms and to zooplankton grazing pressure. It was of interest to establish whether the spring bloom on the shelf was dominated by diatoms or whether a dinoflagellate bloom of the type that occurred during 1976 was underway. The unusually massive flowering of the dinoflagellate Ceratium tripos during the spring of 1976 was followed by bottom-water anoxia off the New Jersey coast during the summer. A major purpose of the 1978 ACE-IV series thus was to define the environmental conditions leading to such blooms. A more general purpose was to increase understanding of the cycling of spring-bloom fixed carbon into the zooplankton, bacterioplankton, ichthyoplankton, and benthos, and to estimate the magnitude of export from the mid-Atlantic shelf ecosystem. In addition, work was underway to estimate the importance of benthic and pelagic

regeneration in the supply of nutrients for the continuation of the spring bloom during the transition to stratified conditions.

The format on the 1978 R/V ATLANTIS II cruise included time-series stations, transect stations, and underway surface and subsurface mapping in the New York Bight and across Georges Bank. Zooplankton sampling was done using the High-Yield Pumping System (HYPS). Zooplankton feeding and gut fluorescence studies were also conducted. Several near-bottom profiles of nutrient gradients were measured with an interface sampler to quantify benthic nutrient input. Diel and vertical variations in phytoplankton pigment composition and primary productivity were investigated. Bacterioplankton biomass and activity were studied using microscopic and kinetic-uptake techniques. Detailed hydrographic sections were made, especially in the shelf-bread region and in the inshore area at the vicinity of the current-meter moorings. Telemetered real-time current-meter data from these buoys made it possible to alter the shipboard sampling plan in response to wind-induced events. Successful COBOLT (Coastal Boundary Layer Transect) experiments were performed with the current meters in both April and August 1978.

The Soviet research vessel ARGUS, available through a cooperative arrangement with the NMFS, was used during March-April and May 1978, and an NMFS vessel, R/V DELAWARE II, was used in June-July 1978 to provide broad-scale geographic and seasonal coverage while R/V ATLANTIS II provided more intensive and localized investigation during the mid-bloom period. Additional shorter cruises were conducted in cooperation with the MESA-New York Bight Project of NOAA using R/V CAPE HENLOPEN (U. of Delaware) in November 1977 and NOAA's R/V KELEZ during the spring of 1978. These cruises, part of the MESA-funded

Synoptic Investigation of Nutrient Cycling (SINC) Program, provided sediment-water nutrient flux information obtained with the interface sampler, in comparison with nutrient, hydrographic, and phytoplankton data for the overlying water column. Additional data from the area between Cape Hatteras and Georges Bank were obtained on these cruises in cooperation with NMFS, and nutrient chlorophyll data were obtained on a R/V ONRUST (SUNY-Stony Brook) cruise. Two other cruises on R/V EDGERTON (WHOI) collected nutrient and chlorophyll data around Nantucket shoals in June and September 1978 in a cooperative program with a WHOI investigator as part of a NOAA Sea Grant to WHOI.

BNL's LCM and R/V COBOLT, R/V SHAWNA (Seouthampton College) and R/V ONRUST (SUNY-Stony Brook) were used several times for biological oceanographic purposes within several kilometers of Shinnecock Inlet. These included collection of zooplankton, phytoplankton, and microbiological samples for experimental purposes, collection of routine chlorophyll, nutrient, salinity, and temperature data, and testing of instrumentation. The LCM and R/V COBOLT have also been used extensively by the Coastal Meteorology Program, primarily for servicing the Massachusetts Institute of Technology (MIT) meteorological buoy and for installing instruments on this facility for specific experiments. A large open-deck work vessel (LCU) has been under charter from the U.S. Naval Underwater Systems Center in New London, Connecticut, for the deployment of battery packs and servicing of the current meter buoys. This vessel has also been used during the deployment and recovery of the moored in situ fluorometer. During these operations, which occurred during September-October 1977, February-March, May, and July-August 1978, the smaller BNL vessels (LCM and R/V COBOLT) were used in support of the LCU. In addition, weather permitting, R/V COBOLT and the NOAA

vessel, R/V JOHNSON, occupied a series of flag stations to provide supporting data sets for the current-meter buoys of the COBOLT studies. Construction of the air-sea interaction buoys was completed by December 1978 and field tests are planned for the spring of 1979.

Finally, a cruise in late October 1978 using R/V ATLANTIS II investigated the biological effects of the breakdown of the seasonal pycnocline in the New York Bight and participated in a joint larval herring study with the Canadians, Poles, and Soviets on Georges Bank. This time period is ecologically important because of the generation of large populations of phytoplankton and zooplankton. The influx and dispersal of nutrients in the euphotic zone at this time along with good quantities of light make this period one of the more productive seasons of the year. In contrast to the spring period, some pelagic fish species such as the menhaden and herring now have critical first-feeding periods. Much of the effort on the R/V ATLANTIS II October cruise was devoted to small scale (vertical and horizontal) distribution studies and to feeding experiments with zooplankton. The station plan was similar to the April 1978 cruise of R/V ATLANTIS II. By means of these comprehensive and cooperative Atlantic Coastal Experiments (ACE 0-IV) it is intended to develop a unique synoptic data set on the distribution of zooplankton in relation to other biological (several trophic levels), chemical, and physical parameters. Modeling activities have been initiated with these data to determine the cause of the 1976 fish kill off New Jersey and closure of beaches on the south shore of Long Island.

At the end of FY 78 a theoretical physical-oceanography program conducted by G. Csanady of Woods Hole Oceanographic Institution was funded directly by DOE, rather than as a subcontract from BNL. This has been a highly successful program

of interpreting data from the BNL COBOLT system. A list of significant publications resulting from this effort is included in the Division's publication list. Interaction between WHOI and BNL will continue under the new funding arrangement.

C. Major Activities Planned for 1978-1981

A March 1979 cooperative cruise on a NMFS vessel, R/V ALBATROSS IV, is planned in order to investigate the longshore coherence of lower-trophic-level response on the continental shelf between Cape Hatteras and the New York Bight. Underway surface and sub-surface mapping of chlorophyll, nutrients, salinity, and temperature are planned, as well as time-series stations in the near-shore and shelf-break regions for the deployment of sediment traps. A similar cruise was conducted in the Nantucket shoals area during January 1979 aboard R/V EDGERTON, in collaboration with WHOI investigators. This information is required as a precursor to the MESEX-I experiment off Long Island in May 1979 and MESEX-II off New Jersey in May 1981. January-March data provide the winter initial condition for the development of the spring (May) food chain and storage of energy-associated particulates on the bottom of the shelf.

A joint physical-biological Mesoscale Experiment (MESEX I) is planned for early May 1979 using R/V OCEANUS, a WHOI vessel, and R/V BELOGORSK, A soviet-NMFS cooperative vessel, in a study involving the current-meter and fluorometer moorings. A triangular array of current meters will be deployed south of Long Island Sound influx to the shelf to provide data for water-mass budget calculation in the study area. In the center of the triangular current-meter deployments will be located in situ fluorometers at two depths and a vertical current meter. The fluorometers will be positioned in and below the upper mixed layer. R/V OCEANUS will sample a grid of stations in the immediate study area to examine

the spatial distribution of temperature, salinity, and chlorophyll fields which will ultimately be compared to the data from the moored instruments. R/V BELOGORSK will sample a larger-scale grid centered on the instrument moorings but extending to the shelf break and upstream and downstream of the sensors. The LCM, R/V COBOLT, and small charter vessels will continue to be used in support of the physical oceanography, coastal meteorology, and biological oceanography programs in the near-shore region, especially in the MESEX experiments. The air-sea interaction buoy will be deployed at this time.

The ACE series will continue with a June 1980 ACE-V cruise on R/V KNORR, which will address the question of the fate of the spring phytoplankton bloom by deploying sediment traps, measuring fluxes of materials near the bottom, and measuring the consumption rates of primary productivity by zooplankton. Additionally, the temporal changes in zooplankton populations will be investigated in the "cold pool" with a two-ship Lagrangian experiment (in cooperation with R/V KELEZ). It is believed that the relative isolation of the "cold pool" from surface physical forcing will enhance the likelihood of success of the experiments. It may be possible, as a secondary goal, to document that the cold pool can be used as a transport mechanism to distribute some biological populations along the Northeast continental shelf. Moorings will be placed longshore to monitor onshore forcing from the cold pool region, which is considered to be the offshore boundary of the biologically "active" summer continental-shelf ecosystem.

In May 1981, the MESEX II experiment will be performed in the near-shore waters off New Jersey. The experiment will again employ current-meter and fluorometer moorings to measure field standing stocks and a large UNOLS

vessel for rate measurements of Lagrangian currents, productivity, grazing, and decomposition and regeneration processes. The study location will provide details of environmental factors downstream of the Greater New York area, specifically south of the Hudson River estuary. This area has been shown to be one of enhanced benthic regeneration rates. It is believed that the plankton community is different south of New Jersey and it is planned to examine the longshore coherence of the planktonic habitat on the Northeast continental shelf. In future years, these studies will be repeated, with MESEX-III south of the Delaware Bay influx and MESEX-IV south of the Chesapeake Bay influx of energy related pollutants, to specify differences in the perturbation response of the inner half of the Northeast continental shelf to these boundary conditions.

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D. Scope of Projects

Title: Northeast Oceanography Coordination

FY 78: \$25,000

Principal Investigator:

B. Manowitz

FY 79: \$25,000

Sponsor: Office of Health
and Environmental Research
(DOE)

The DOE-funded oceanographic programs in the northeast include a diverse array of facilities, talents, and research objectives, and are located at geographically-dispersed laboratories and universities. The environments under study range from the open ocean, continental slope and shelf, estuaries, bays, and coastal lagoons to the intertidal zone, with particular strength in the study of estuarine and shelf ecosystems. The expertise and current research of the investigators include physical, chemical, and geological oceanography, several specialities within biological oceanography, and ecosystems analysis, with emphasis on the shelf and estuarine systems.

In order to maximize the usable output from these programs, a high degree of coordination and communication among the investigators and with other federally-funded programs in the northeast is desirable.

Using three types of meetings as primary mechanisms, Brookhaven National Laboratory (BNL) proposed to encourage better information exchange and liaison among the northeast DOE contractors. These meetings will include: 1) Annual program-review meetings among this entire group of contractors; 2) meetings and/or experiments for the intercomparison of methods and instruments; and 3) meetings on single topics of timely nature. Reports from these meetings will be made available to DOE for the periodic reevaluation of program goals, deficiencies, and accomplishments.

Title: Oceanograph Ship Charter

FY 78: \$200,000

Principal Investigator:
T. Whitledge

FY 79: \$210,000

Sponsor: Office of Health
and Environmental Research
(DOE)

Research vessels are required for multidisciplinary studies of coastal oceanography at Brookhaven National Laboratory (BNL). This research includes projects on Ecosystem Analysis, Primary Productivity and Utilization, Food Chain Dynamics, Larval Fish, Coastal Transport and Diffusion, and Mid-Atlantic Bight Coordination. The closely associated Coastal Meteorology and Instrumentation Development programs also require vessel support.

Vessel requirements are based on the nature, location, and timing of the scientific work to be conducted. Shelf and shelf break biological-process cruises involve the investigation of biological, chemical, and physical phenomena and require cooperative effort among scientists representing the several disciplines. The resulting need for a large scientific complement together with a stable oceanographic platform during adverse conditions generally leads to the requirement for one or more large vessels. The well-equipped major vessels of the University National Oceanographic Laboratory System (UNOLS) meet these requirements and have been very effectively utilized. In addition, cooperative use of National Oceanic and Atmospheric (NOAA) vessels has proved to be feasible and advantageous to both agencies.

Vessels are also required for inshore biological-process investigations near the COBOLT current-meter array, nearshore physical oceanography cruises associated with the COBOLT experiment, and nearshore meteorology field work in support of the coastal meteorology program. These operations are carried out by the BNL-operated LCM and R/V COBOLT plus the charter of other small research vessels. Charter of the LCU operated by the U.S. Naval Underwater Systems Center has provided an effective support for the current-meter buoy program.

Title: Food Chain Dynamics

FY 78: \$375,000

Principal Investigator:
M. J. Dagg

FY 79: \$390,000

Sponsor: Office of Health
and Environmental Research
(DOE)

The goal of this program is an understanding of coastal trophic-dynamics, as affected by natural stimuli and anthropogenic perturbations. This knowledge includes the differentiation of responses of heterotrophic planktonic populations to natural and man-caused events and a description of the ultimate effects of these events on the transfer of energy between trophic levels. Continental-shelf waters are subject to high daily, weekly, and seasonal stimuli and may be subject to high-amplitude energy-related perturbations in the future, such as offshore nuclear reactors and oil fields. Fish larvae and zooplankton are both components of the coastal ecosystem which are extremely vulnerable to damage by entrainment in heat exchangers, by oil pollution, and by critical limitation of food supply.

Mesoscale seasonal and geographical variations in coastal ecosystems are now reasonably well described, but the small-scale and short-term processes which appear to immediately control zooplankton community structure and dynamics remain poorly understood. An understanding of these processes of secondary production requires an integrated field program encompassing physical parameters, phytoplankton production and physiology, zooplankton and ichthyoplankton behavior, growth and survival, and nutrient regeneration by bacteria, benthos, and the other higher trophic levels. Intensive ecosystem studies of a variety of coastal habitats coordinated with laboratory experimentation will provide the basis for predictive models and the evaluation of potential effects of human activities in the coastal environment.

Title: Primary Production and Utilization

FY 78: \$430,000

Principal Investigator:
P. Falkowski

FY 79: \$444,000

Sponsor: Office of Health
and Environmental Research
(DOE)

The Primary Production and Utilization Program is designed to provide basic quantitative information on the primary producers and their utilization by the dominant herbivores in the context of the dynamics of the New York Bight ecosystem. Such information is necessary in order to understand the regulating and controlling factors for primary and secondary productivity in the coastal shelf waters and the mechanisms by which the significant factors work in the ecosystem. Without this understanding, the assessment and prediction of the effects of energy-related activities on the continental shelf will not be possible. Basic information on the effects of light (quality and quantity) and nutrients on phytoplankton growth ultimately can relate to the structure and function of phytoplankton communities. The disruption of timing and composition of the primary producers by energy-related perturbations would have effects on the structure and function of zooplankton communities. The mechanisms for this response can also be partially evaluated in laboratory situations. To relate laboratory-derived information to the ocean, it is necessary to use temporal and spatial scales relevant to the phytoplankton and zooplankton. The system selected is oriented around this approach. Biological instrumentation is being developed that ultimately will permit continuous, real-time evaluation of significant variables.

Title: Coastal Transport and Diffusion

FY 78: \$450,000

Principal Investigator:
T. S. Hopkins

FY 79: \$260,000

Sponsor: Office of Health
and Environmental Research
(DOE)

The goal of this project is to understand the processes of transport and diffusion as they relate to the possible environmental effects of energy-related activities in the Mid-Atlantic Continental Shelf region. These processes must be understood because of their direct effect on the movement of pollutants and other materials and because of the important role of circulation processes in the dynamics of shelf ecosystems. While initial studies emphasized the coastal boundary region, present studies have increased the focus to shelf-wide problems. The research has been divided into five components: 1) Coastal Boundary Layer, 2) Shelf Circulation, 3) Water Mass Analysis, 4) Water Property Dispersion, and 5) Air-Sea Interaction. The observational phase of the original COBOLT program will be complete by the end of FY 1978. The spar-buoy telemetry system, which has been considerably improved, will then be used as an observational facility for the remaining components. Other sources of observational data come from hydrographic cruises, an air-sea interaction buoy, the development of a deep shelf mooring, drogues, and laboratory dispersion studies. Theoretical interpretations continue to integrate physical data into coastal ecosystem models. Internal cooperation continues with the Atmospheric Sciences and Instrumentation Divisions, as does external cooperation with Woods Hole Oceanographic Institution, Bigelow Laboratory, Oregon State University, Lamont-Doherty Geophysical Observatory, and others. Within the Oceanographic Sciences Division, the project is considered an integral and essential part of the DOE multidisciplinary research program to understand the impact of energy-related activities within the Northeast Coastal Zone.

Title: Larval Fish

FY 78: \$100,000

Principal Investigator:
J. J. Walsh

FY 79: \$ 85,000

Sponsor: Office of Health
and Environmental Research
(DOE)

The total finfish biomass of the Middle Atlantic Bight is now 25% of the estimated virgin stocks. Differences in recruitment and size of year classes of fish are believed to be a function of variable mortality rates during their larval phase. Thus, emphasis at Brookhaven National Laboratory (BNL) has been placed on predictive methods of determining the rate of survival of larval fish under varying environmental conditions and adult spawners. For survival of these larvae, food must fall within narrow particle-size ranges, must be above a critical concentration, and must have nutritional value adequate for further growth and development. Fish larvae in the coastal ecosystem are also extremely vulnerable to damage by entrainment in heat exchangers, by oil pollution, and by chlorine and heavy metals. Recently acquired data on the mesoscale spatial and seasonal distributions of larval fish in the New York Bight are now sufficient to permit the location, tracking, and intensive sampling of cohorts of newly-spawned larvae. However, the additional determination of larval-fish growth and survival can be achieved only through a multidisciplinary approach encompassing laboratory and field measurements of all ecosystem processes impinging on the fish and their potential prey and predators. Only through such an approach can predictive models and adequate management of eventually-harvestable fish stocks be developed to distinguish between natural fluctuations and environmental deterioration.

Title: Coastal Upwelling Ecosystems Analysis - Systems Models

FY 78: \$173,000

Principal Investigator:
J. J. Walsh

FY 79: \$152,000

Sponsor: International Decade of
Ocean Exploration/National
Science Foundation

Environmental problems in the coastal ocean by definition occur at the system level of complexity and require a group effort of systems analysis as an approach to their solution. Studies of total marine ecosystems were advocated over 40 years ago, but environmental problems are even greater now. The implementation of systems studies has had to await the development of an adequate technology and sufficient interest in a multidisciplinary group effort approach to oceanography. At Brookhaven National Laboratory (BNL) a research group has been assembled and has made significant progress towards the assessment of the coastal marine ecosystem. Over the past six years an enormous data base on coastal upwelling areas has been acquired and simulation models have been used to analyze this system. The causes and consequences of ecosystem behavior are extremely difficult to identify. Solutions to problems at the systems level of complexity, such as the cause of the decline in the Peru anchovy fishery, require that data bases be readily accessible for analysis and that a significant commitment to the reduction, presentation, and interpretation of data be supported. We are thus now using simulation analysis in a comparative analysis of the perturbation response of different upwelling ecosystems off Oregon-California, Northwest Africa, and Peru.

Title: Ecosystems Analysis in the Bering Sea - Systems Models

FY 78: \$68,000

Principal Investigator:
J. J. Walsh

FY 79: \$25,000

Sponsor: Office of Polar Programs/
National Science Foundation

Research is examining the hypothesis that a specific combination of oceanographic factors including aspects of circulation in surface and intermediate depth water and bathymetry, coupled with the wide shallow shelf and local meteorology, promote conditions which annually favor a high production of biomass in the southeastern Bering Sea. Given this Bering Sea environment, it is proposed that the key to the success of a given year class of higher consumers (eg. the pollock) is in the sequencing of the physical and biological events. Since it is generally believed that the year-class strength of a stock is determined during some critical phase in the early life history, usually associated with first feeding, the field effort has been specifically designed to examine the larval and juvenile phases of pollock survival within a complex matrix of associated oceanographic and weather observations. Initial simulation analysis thus considers the trajectory and larval survival of Alaska pollock from its spawning grounds within the Bering Sea.

Title: Ecosystem Analysis of the Carbon, Oxygen, and Nitrogen
Distributions within the New York Bight

FY 78: \$119,000

Principal Investigator:
J. J. Walsh

FY 79: \$ 75,000

Sponsor: National Oceanic
Atmospheric Administration/
Marine EcoSystems Analysis
(MESA)

A \$60 million fish kill occurred within the New York Bight during June-August 1976 as a result of low oxygen conditions. We are constructing a simulation model to provide a quantitative ecosystem analysis of the spatial and temporal interactions of carbon, nitrogen, oxygen, phytoplankton, zooplankton, larval fish, detritus, and benthos within the New York Bight. Primary emphasis will be directed towards anoxic conditions as exemplified in the summer of 1976 with an evaluation made of the relative significance of the various sources and sinks of oxygen. Each of the significant waste inputs over which human control is possible will be assessed for their relative impact on the development of anoxia. Various wastewater management strategies can then be evaluated using this series of simulation models with an assessment made of man-induced and natural perturbations of this system.

Title: Coastal Upwelling Ecosystems Analysis - Nutrient Regeneration

FY 78: \$ 82,000

Principal Investigator:
T. E. Whitledge

FY 79: \$110,000

Sponsor: International Decade of
Ocean Exploration/National
Science Foundation

The Peru coastal waters have long been noted for their cold temperatures and high levels of plant and animal production, but until recently little effort has been devoted to zooplankton studies in this Peruvian upwelling ecosystem with virtually nothing known about their vertical distribution and migratory behavior. There has been a similar lack of experimentally-derived information on rates of ingestion of phytoplankton, excretion of plant nutrients, and respiration rates by regionally-important zooplankton species. We are now completing analysis of a large series of zooplankton samples collected by net and pump during August-September 1976 and April-May 1977 off Peru. We also plan to incorporate the resulting abundance and biomass estimates with shipboard measurements of excretion, grazing, and respiration rates of zooplankton and nekton populations to establish nutrient and food-chain budgets for the Peru upwelling system.

Title: Ecosystems Analysis in the Bering Sea - Nutrient Fluxes

FY 78: \$88,000

Principal Investigator:
T. E. Whitledge

FY 79: \$48,000

Sponsor: Office of Polar Programs/
National Science Foundation

A study of nutrient inputs and distributions is being conducted as part of an investigation of the Processes and Resources of the Bering Sea Shelf (PROBES). This investigation involves nutrient excretion rates of zooplankton and nekton, the nutrient release by the sediments, and their relation to the input of regenerated nitrogen for the nitrogen requirements of phytoplankton production. The excretion data are also used to estimate ingestion rates of the zooplankton and nekton species. The ambient concentrations of nutrients are measured in all hydrographic and productivity samples and repeated sampling at a station to estimate the diel and event scales of variability in this high-latitude ecosystem. Underway mapping of near-surface nutrient concentrations, chlorophyll fluorescence, salinity, and temperature are also used to examine the spatial distribution and the relative patchiness of properties in the upper ocean.

Title: Physical Oceanographic Support for the Gulf of Naples
Ecological Program

FY 78: \$ - 0 -

Principal Investigator:
T. S. Hopkins

FY 79: \$18,000

Sponsor: Gulf of Naples Ecological
Program (GONEP)/National Science
Foundation

This project is designed to provide a physical oceanographic component of the Gulf of Naples Ecological Program (GONEP). This is an ongoing program of the Stazione Zoologica, Naples, Italy, designed to describe the pollution-stressed ecology of the Gulf of Naples. It is funded by the National Research Council of Italy.

An active physical component is required to generate a broad-based data set from which the internal circulations and the water property residence times can be inferred. The present data base includes observations of 6 major cruises, 16 surface-contour track mappings of the inner part of the Gulf, and 24 bi-weekly samplings of Station L-20 (at the head of Ammontatura 10 km offshore). In addition, drogue and current meter observations are available or in progress. The approach of the analysis of this physical data set is being conducted as follows:

1. circulation/water mass descriptions: (a) by establishing the gross barotropic and frictional circulation responses as forced by local winds and as controlled by local bathymetry, (b) by defining the seasonal and geographic water mass structure within the Gulf, and (c) by observing the velocity field under different conditions of forcing and by approximating the baroclinic component through comparison with (a) and (b).

2. water property mixing and residence time approximations by determining the water mass mixture as a function of source water types over a space-time grid: (a) from a knowledge of (1) above, and (b) from a knowledge of the atmospheric induced changes in heat and water vapor.

Title: Ecosystem Analysis in the Bering Sea - Zooplankton
Feeding and Egg Production

FY 78: \$ - 0 -

Principal Investigator:
M. J. Dagg

FY 79: \$57,000

Sponsor: Office of Polar Program/
National Science Foundation

PROBES is an interdisciplinary and multiinstitutional program designed to understand the processes that contribute to the large production of animals in secondary and higher trophic levels in the Bering Sea ecosystem. Since the primary production does not appear excessive but typical for a subarctic ocean, the high secondary production is presumed to be a result of effective transfer mechanisms between primary and all higher trophic levels.

This component of the program is designed to provide knowledge of the relationship between phytoplankton and grazers in the Bering Sea.

The objectives of this study are: to determine the in situ feeding activities of the copepod species important to the diet of larval and juvenile pollock, to construct areal and temporal maps of the food environments of adult and immature copepods, to construct areal and temporal maps of naupliar-sized particles, and to determine the significance of short term variations in food abundance to the survival of immature copepods.

Title: Investigation of Fundamental Biological Characteristics
of the Upwelling Area off Somalia during the Southwest
Monsoon

FY 78: \$ - 0 -

Principal Investigator:
S. L. Smith

FY 79: \$50,000

Sponsor: National Science
Foundation

The biological characteristics of the area of upwelling off Somalia during the southwest monsoon are virtually unknown. Based upon previous investigations of the coastal upwellings off Peru and the northwest Africa, several hypotheses are suggested. These are: that the biological processes along the axis of the upwelling off Somalia have the downstream-coherence observed off Peru and northwest Africa; that the spatial distribution of zooplankton is both consistent with the model of downstream-coherence and responsive to the oxycline; and that the metabolic rates of zooplankton are high because of high rates of growth during the seasonal upwelling. Additionally, the distribution of zooplankton biomass and species within and without the large scale eddies which occur in conjunction with the Somali Current during the southwest monsoon will be compared. Measurements of primary productivity, standing stocks of phytoplankton, standing stocks of zooplankton, and metabolic rates of zooplankton will be made during pre-monsoon, monsoon-onset, and monsoon-peak periods in conjunction with the funded, on-going INDEX physical oceanographic experiment of W. Duing. Biological measurements will be made from the same ship and at the same stations at which current profiles, hydrography, and other measurements of the physical regimes will be made and will be enhanced by the supporting data on water-column structure and water-mass movements. Although the biological data by themselves will be a significant contribution, the results of this interdisciplinary research will be integrated with results of experiments in other areas of upwelling that have been studied, to extend the understanding of such systems.

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E. Publications

Publications

Oceanographic Sciences Division

1978

BNL 23958   FRACTIONATION OF ^{13}C and ^{12}C BY MARINE PHYTOPLANKTON:
Jan. 1978   EVIDENCE FOR MULTIPLE PATHS OF CARBON IN PHOTOSYNTHESIS

Paul G. Falkowski
Phycology (submitted)

BNL 24016   ERDA's OCEANOGRAPHIC PROGRAM FOR THE MID-ATLANTIC
Jan. 1978   COASTAL REGION. WORKSHOP AT BROMKHAVEN NATIONAL
LABORATORY, January 5-7, 1977

B. Manowitz, Coordinator; F. W. Barvenik, Editor

BNL 24094   SEASONAL INCIDENCE OF CHITINOCLASTIC
Feb. 1978   BACTERIA IN NOVA SCOTIAN LOBSTER POUNDS

Stewart C. Malloy
Canadian J. of Microbiology (submitted)

BNL 24097   ATLANTIC COASTAL EXPERIMENT I - PART I:
Feb. 1978   R/V KNORR CRUISE 46, 24-30 January 1975
DATA REPORT

Informal   F. Barvenik and E. Wold, Editors
Report
Limited Dist.

BNL 24098   ATLANTIC COASTAL EXPERIMENT I - PART II:
Feb. 1978   R/V ATLANTIS II CRUISE 87, 26 March-9 April 1975
DATA REPORT

Informal   T. Whitley and E. Wold, Editors
Report
Limited Dist.

Publications

Oceanographic Sciences Division

1978

-
- BNL 24176   SOME PHYSICAL PROCESSES AFFECTING THE DISTRIBUTION
March 1978   OF PRIMARY PRODUCTION IN THE NEW YORK BIGHT
- Abstract   T. S. Hopkins and J. J. Walsh
- Presented at the Conference of American Society of Limnology
                     and Oceanography, Victoria, British Columbia, June 19-22, 1978.
-
- BNL 24177-R   REGENERATION OF NUTRIENTS BY ZOOPLANKTON
March 1978   AND FISH OFF NORTHWEST AFRICA
- Sharon L. Smith (Dalhousie Univ., Halifax, N. S.) and
                     Terry E. Whitledge
- Presented at the International Council for the Exploration of
                     the Sea, Las Palmas, Gran Canary Islands, Spain, April 14-16, 1978.
-
- BNL 24204   A SIMULATION STUDY OF BIOLOGICAL RESPONSES TO ENVIRONMENTAL CHANGES
April 1978   ASSOCIATED WITH COASTAL UPWELLING OFF NW-AFRICA
- Steven O. Howe
- Presented at the International Council for the Exploration of
                     the Sea, Las Palmas, Gran Canary Islands, Spain, April 14-16, 1978.
-
- BNL 24464   THE SPAWNING HABITAT OF THE PERUVIAN ANCHOVY ENGRAULIS RINGENS
June 1978   John J. Walsh, Terry E. Whitledge, Wayne E. Esaias,
                     Robert L. Smith, Susan A. Huntsman, and Haydee Santander
- Deep-Sea Research (submitted)
-

Publications
Oceanographic Sciences Division
1978

BNL 24490
June 1978

STUDIES OF δ -AMINOLEVULINIC ACID DEHYDRASE FROM
SKELETONEMA COSTATUM, A MARINE PLANKTON DIATOM

Thomas G. Owens, David M. Riper, and Paul G. Falkowski

Plant Physiology (in press)

BNL 24491
June 1978

GULF OF MAINE INTERMEDIATE WATER

T. S. Hopkins and N. Garfield III

J. Marine Research (Submitted)

BNL 24549
June 1978

VERTICAL DISTRIBUTION OF ZOOPLANKTON IN RELATION
TO AN OXYGEN MINIMUM OFF PERU

Abstract

David C. Judkins

Presented at American Society of Limnology and Oceanography
Meeting, Victoria, British Columbia, June 19-22, 1978.

BNL 24550
June 1978

THE BIOLOGICAL CURRENT METER - A MOORED FLUOROMETER

Terry E. Whitledge

Abstract

Presented at American Society of Limnology and Oceanography
Meeting, Victoria, British Columbia, June 19-22, 1978.

BNL 24553
June 1978

HETEROTROPHIC MICROBIAL ACTIVITIES IN AN UPWELLING ECOSYSTEM

F. W. Barvenik

Abstract

Presented at the Annual Meeting of the American Society for
Microbiology, Las Vegas, Nevada, May 14-19th, 1978.

Publications
Oceanographic Sciences Division

1978

BNL 24770   ATLANTIC COASTAL EXPERIMENT O - SURVEY CRUISES
Aug. 1978   JULY 1974 - SEPTEMBER 1975 - DATA REPORT, VOLUME 1

Informal   E. Wold, Editor
Report
Limited Dist.

BNL 24771   ATLANTIC COASTAL EXPERIMENT O - SURVEY CRUISES
Aug. 1978   JULY 1974 - SEPTEMBER 1975 DATA REPORT, VOLUME 2

Informal   E. Wold, Editor
Report
Limited Dist.

BNL 24876   COPEPOD FEEDING RATES IN NATURAL SEAWATER
Aug. 1978

Abstract

M. J. Dagg and D. Grill

Presented at the Conference of American Society of Limnology
and Oceanography, Victoria, British Columbia, June 19-22, 1978.

BNL 24877   SOME EFFECTS OF VERTICAL MIXING ON PRIMARY
Aug. 1978   PRODUCTION IN THE NEW YORK BIGHT

Abstract

P. G. Falkowski, T. G. Owens, and D. Riper

Presented at the Conference of American Society of Limnology
and Oceanography, Victoria, British Columbia, June 19-22, 1978.

BNL 24878   ESTIMATED, IN SITU, RATES OF EGG PRODUCTION FOR THE COPEPOD
Aug. 1978   CENTROPAGES TYPICUS (Krøyer) IN THE NEW YORK BIGHT

Michael Dagg

J. Experimental Marine Biology and Ecology (in press)

Publications
Oceanographic Sciences Division

1978

-
BNL 24940 Aug. 1978	MICROBIOLOGY OF NERITIC WATERS SOUTH OF LONG ISLAND DURING STRATIFIED CONDITIONS. II. HETEROTROPHIC AMINO ACID FLUX Frank W. Barvenik, Stewart C. Malloy, Randolph L. Ferguson <u>J. Limnology and Oceanography</u> (submitted)
-
BNL 25122 Oct. 1978	COMPOSITION, ABUNDANCE, AND DISTRIBUTION OF ZOOPLANKTON IN THE NEW YORK BIGHT, SEPTEMBER 1974 - SEPTEMBER 1975 David C. Judkins, Creighton D. Wirick, and Wayne E. Esaias National Oceanic and Atmospheric Admin. (NOAA) Special Scientific Report (submitted).
-
BNL 25238 Nov. 1978	DISTRIBUTION, FLUXES, AND BIOLOGICAL UTILIZATION OF INORGANIC NITROGEN DURING A SPRING BLOOM IN THE NEW YORK BIGHT H. Lee Conway (ANL) and Terry Whitley (BNL) <u>J. Marine Research</u> (submitted)
-
BNL 25275 Nov. 1978	ATLANTIC COASTAL EXPERIMENT III: R/V CAPE HENLOPEN CRUISE, 18-21 NOVEMBER 1977 - DATA REPORT
Informal Report Limited Dist.	Terry E. Whitley, Editor
-
BNL 25374 Nov. 1978	LIGHT-SHADE ADAPTION: TWO STRATEGIES IN MARINE PHYTOPLANKTON Paul G. Falkowski and Thomas G. Owens <u>Science</u> (submitted)
-

Publications

Oceanographic Sciences Division

1978

BNL 25376R
Nov. 1978

CHLOROPHYLL TURNOVER IN SKELETONEMA COSTATUM,
A MARINE PLANKTON DIATOM

Paul G. Falkowski

J. Plant Physiology (submitted)

BNL 25394
Dec. 1978

DOE OCEANOGRAPHY PROGRAMS IN THE MID-ATLANTIC COASTAL REGION.
Second Annual Meeting at Brookhaven National Laboratory,
March 7-8, 1978

B. Manowitz, Coordinator; F. W. Barvenik, Editor

BNL 50895
May 1978

DATA REPORT - OCEANOGRAPHIC DATA FROM MOORED INSTRUMENTATION
VOLUME I

In press

J. T. Scott, T. S. Hopkins, R. D. Pillsbury, and E. G. Davis

Publications
Oceanographic Sciences Division

1978

THE COASTAL JET CONCEPTUAL MODEL IN THE DYNAMICS OF SHALLOW SEAS

G. T. Csanady

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