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PROGRAM SUMMARIES FOR 1979 - ENVIRONMENTAL PROGRAMS

December 1979

MASTER

DEPARTMENT OF ENERGY AND ENVIRONMENT

BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK 11973

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UC-11

(Environmental Control Technology
and Earth Sciences - TID-4500)

PROGRAM SUMMARIES FOR 1979 - ENVIRONMENTAL PROGRAMS

B. MANOWITZ, Chairman

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December 1979

**DEPARTMENT OF ENERGY AND ENVIRONMENT
BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.**

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ABSTRACT

The research activities making up the Environmental Programs of the Department of Energy and Environment have been described. They have been organized according to the four units comprising the Environmental area: the Atmospheric Sciences Division, the Environmental Chemistry Division, the Oceanographic Sciences Division, and the Land and Freshwater Environmental Sciences Group. For each program, the Principal Investigator, research objectives, and funding levels for FY 1979 and FY 1980 are given. Some of the more significant accomplishments during 1979 are described and publications for the period are listed. Plans for 1980 are discussed briefly.

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CONTENTS

	<u>Pages</u>
Abstract	iii
I. Introduction	1
II. Organization	5
III. Atmospheric Sciences Division	7
A. Significant Accomplishments	7
B. Program Summaries	11
C. Future Plans for 1980	21
D. Publications	23
IV. Environmental Chemistry Division	32
A. Significant Accomplishments	32
B. Program Summaries	39
C. Future Plans for 1980	55
D. Publications	59
V. Land and Freshwater Environmental Sciences Group	71
A. Significant Accomplishments	71
B. Program Summaries	75
C. Future Plans for 1980	83
D. Publications	87
VI. Oceanographic Sciences Division	94
A. Significant Accomplishments	94
B. Program Summaries	97
C. Future Plans for 1980	115
D. Publications	117

I. Introduction

The thrust of the Environmental Programs area of the Department of Energy and Environment is toward the definition and measurement of energy-related pollutants in the environment, the evaluation of their effects on component ecosystems, particularly in the northeastern United States, and the development and verification of system models that will permit the prediction of the impacts of energy-induced activities on the environment. There are over 50 individual programs, involving studies in the atmospheric, oceanographic, limnological, and terrestrial ecology sciences.

These programs are organized under three Divisions and one Group: the Atmospheric Sciences Division, the Environmental Chemistry Division, the Oceanographic Sciences Division, and the Land and Freshwater Environmental Sciences Group. There is considerable interaction among these Divisions, with several cooperative programs under way. Major support for the programs is supplied by the Department of Energy's Office of Health and Environmental Research, but there is significant support by the Environmental Protection Agency and the National Science Foundation, with some funding coming from other Federal, state, and private agencies.

Current programs in the Atmospheric Sciences Division include major participation in the multilaboratory cooperative Multistate Power Production Pollution Study - Regional Acidity of Industrial Emissions (MAP3S-RAINE), involving both field and modeling studies related to power-plant produced atmospheric pollutants on a regional scale, the study of the meteorology of the coastal land-sea interface, including both field and analytical activities, and field and modeling studies of the exchange of momentum, heat, and water vapor between the atmosphere and the ocean. These latter field studies made use of the Air-Sea Interaction Buoy that had been designed and built at Brookhaven National Laboratory (BNL) under the direction of the Division.

The Environmental Chemistry Division is engaged in a wide range of programs involving laboratory, field, and modeling activities. Typical of these are (1) the development of methodologies and practical instrumentation for the detection and measurement of a variety of atmospheric constituents at ambient levels in real time in the field and in the laboratory, (2) development and measurement of atmospheric tracers at extremely low levels, (3) theoretical, laboratory, and field studies of the formation and behavior of aerosol particulates, (4) studies of gaseous and particulate emissions at power plants

and in stack plumes in the atmosphere, (5) tagging systems for predetonation detection of clandestine explosives, (6) modeling studies involving kinetics of chemical reactions taking place among pollutants and water vapor in the atmosphere, (7) participation in the MAP3S-RAINE program, (8) laboratory and analytical studies of the results of large-scale mixing of oleum and water as the result of maritime accidents, and (9) participation in the Northeast Regional Oxidant Study (NEROS). Analytical chemical services support was supplied to other Groups and Departments.

The instrumented twin-engine Britten-Norman Islander aircraft continued to be used in the field programs of both the Atmospheric Sciences and Environmental Chemistry Divisions. Improvements continued to be made in the analytical and meteorological instrumentation and the data-handling equipment installed in the aircraft, maintaining it at a state-of-the-art level.

The general objective of the programs in Oceanographic Sciences is to establish the potential impact of energy-related activities on the biota of the northeast coastal zone through development of a synoptic view of the physical, chemical, and biological parameters that interact on the coastal shelf. Individual programs include coastal transport and diffusion, primary production and utilization, food chain dynamics, and ecosystems analysis. Additional studies of the New York Bight are sponsored by the Marine Ecosystems Analysis (MESA) program of the National Oceanic and Atmospheric Administration. The National Science Foundation has sponsored several programs, including Coastal Upwelling Ecosystems Analysis (CUEA) studies of the Peruvian coastal upwelling system, Production and Resources of the Bering Sea (PROBES) studies of the pollock fishery on the Bering Shelf, and a biological investigation of the effects of upwelling off the Somali Coast. Cooperation with other oceanographic laboratories in the Northeast has continued, and the Division has continued to provide coordination of DOE's oceanographic programs in the Northeast.

Emphasis in the Land and Freshwater Environmental Sciences Group has been on the effects of acid rain caused by energy-related pollutants on field crops, microbiota, and forest and freshwater ecosystems. Laboratory and field studies are carried out at BNL. Studies at the year-round field experimental station at Raquette Lake for the cooperative Adirondack Lake Project (ALP) have continued, looking at the effects of acidification on the biota and biological processes of freshwater lakes. Areas in the eastern United States sensitive to acidification were evaluated and mapped in a field and library

study. An international workshop on the Effects of Acid Precipitation on Vegetation/Terrestrial Ecosystems was held at Brookhaven in June and was attended by 25 invited participants from five countries.

Ecological studies of the BNL site were continued under the National Environmental Research Park (NERP) program.

Programs were carried out involving detection and measurement of human viruses in tertiary-treated effluents for groundwater recharge and in shellfish from polluted beds.

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II. Organization

DEPARTMENT OF ENERGY AND ENVIRONMENT BROOKHAVEN NATIONAL LABORATORY

III. Atmospheric Sciences Division

A. Significant Accomplishments

In general the research in the Atmospheric Sciences Division is aimed at the development of the scientific knowledge needed for the 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 portion of the research is a part of the Multistate Power Production Pollution Studies (MAP3S). This program has been concerned with the long-distance transport and transformation of sulfur oxide and other pollutants. It has been carried out in collaboration with the Environmental Chemistry Division and with other National Laboratories. It was started under the auspices of the Department of Energy (DOE) but has been transferred to the Environmental Protection Agency (EPA). The direction of the program is being changed to emphasize the delivering of pollutants to the surface by both dry deposition and precipitation scavenging, with particular attention being given to the "acid rain" problem.

In the MAP3S modeling area, progress has been made on the development of an accurate, efficient means of solving the numerical equations that describe transport, diffusion, and chemical reaction on the regional scale. The method is implicit, multistep, and multigrid. The first application will be a two-dimensional simulation of regional transport using surrogate chemical mechanisms.

A procedure has been developed to diagnose the transport and diffusion properties of the atmosphere near the ground (surface layer) from standard and surface meteorological observations using similarity theory, radiation flux, and energy balance concepts. The method is especially useful for nighttime conditions, where suitable alternative procedures are not available.

A computerized on-line data system to provide program participants with needed information on sources of pollution within the continental United States has been developed in the MAP3S data-management program. This system, which contains both data for stationary sources and data for area sources, is managed with the help of a generalized data-base management system and

includes information needed for scientific studies in the areas of air quality and energy use. Original information was derived from the Environmental Protection Agency National Emissions Data System (NEDS) and the Department of Energy Form 67 data. Quality checks on existing data and searches for new data sources are proceeding on a continuing basis.

The MAP3S field experiment effort focused upon the Central Illinois Rainfall Chemistry Experiment (CIRCE), an interlaboratory, interagency, cooperative field study, which was conducted in the Bloomington area during the summer of 1979. This field study was designed to take advantage of the fact that major independent investigations will take place here during this period. Known by the acronyms VIN and SCORE-79, these independent efforts were addressed primarily to the study of convective storm dynamics and mesoscale precipitation chemistry variability. Their operations brought to the area a rather substantial ensemble of meteorological instrumentation, which resulted in the acquisition of an extensive set of background data. The goals of CIRCE were to study the flow of pollutants into convective storms and to examine the evolution of the vertical distributions of pollutants.

Data reports documenting the cooperative experiments with the SURE program have been compiled and published.

During 1979, coastal meteorology studies were continued on diffusion in the coastal zone, coastal internal boundary layer development, air-sea interaction, and climatology of the U.S. east and Gulf coasts. A number of smoke diffusion and boundary-layer experiments were carried out. Use of the Islander aircraft in these experiments provided more comprehensive data than were obtained in earlier studies.

Data and experience gained in the coastal meteorology program were used to prepare recommendations for the U.S. Nuclear Regulatory Commission (USNRC) on measurement methods and diffusion models for use at coastal nuclear reactor sites.

Air-sea interaction studies were carried out in the Atlantic Ocean 12 km off Shinnecock Inlet, Long Island, during May-June 1979 as part of the Mesoscale Experiments (MESEX I) conducted by the Oceanographic and Atmospheric Sciences Divisions of BNL. Field-phase testing of the BNL Air-Sea Interaction

Buoy preceded the experiment. The experiment consisted of continuous measurements of fluxes of momentum and heat in the marine surface layer and the observations of wind speed, direction, air and sea temperatures, and surface wave characteristics. The observations were transmitted via line-of-sight RF telemetry to the shore station at Tiana Beach and recorded digitally on magnetic tapes. The data are being analyzed and a data report will be published soon.

A series of boundary-layer measurements were made on the coast of the Bay of Bengal, Digha, India as a part of the International Monsoon Experiment (MONEX). This was organized by the World Meteorological Organization under the Global Atmospheric Research Programme (GARP).

In cooperation with DOE personnel, more efficient methods for the analysis of the effect of alternate energy scenarios on air quality are being developed. Those involve the calculation of "transfer matrices" that describe the transport of sulfur dioxide and sulfates over regional-scale distances. Such long-distances matrices have been developed taking Air Quality Control Regions as the emitter and receptor areas.

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B. Program Summaries

Title: Coastal Meteorology

FY 79: \$225,000.

Principal Investigator:
G. S. Raynor and S. SethuRaman

FY 80: \$250,000.

Sponsor: Office of Health and
Environmental Research,
Department of Energy

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 off-shore 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 off-shore sources, methods for rating potential plant sites with respect to on-shore wind frequency, diffusive capacity, severe weather prevalence, and data for predicting weather effects on energy production, transmission, and utilization in coastal areas.

Title: Coastal Meteorological Experiment during MONEX-1979

FY 79: \$21,000

Principal Investigator:
S. SethuRaman

FY 80: \$23,000

Sponsor: Climate Dynamics Research Section,
National Science Foundation

In order to understand the seasonally varying circulations associated with the Indian monsoons and their importance as a major energy source for the global circulation of the atmosphere, the International Monsoon Experiments (MONEX 79) were conducted as part of the Global Atmospheric Research Programme (GARP) of the World Meteorological Organization (WMO). Several countries participated in this experiment in which India was the lead country.

Coastal meteorological studies were conducted over the Bay of Bengal during July-August, 1979 as part of the Summer MONEX 79 to study air-sea interaction processes associated with the formation of monsoon depressions. The experiments were conducted at Digha, West Bengal, India located at $21^{\circ}30'N$ and $88^{\circ}E$. The boundary layer experiment at Digha consisted of a 10-m micrometeorological tower at the beach with instruments to observe turbulent fluxes over the ocean, a weather station that continuously recorded mean parameters and pilot balloon observations of wind speed and direction to a height of about 1000 m. The data are being analyzed to determine momentum, heat, and water vapor fluxes over the Bay of Bengal and to study the structure of the boundary layer during various synoptic conditions of the monsoon.

Title: MAP3S Transport and Transformation

FY 79: \$415,000.

Principal Investigator:
P. Michael

FY 80: \$415,000.

Sponsor: Office of Research and Development,
Environmental Protection Agency

As part of the Multistate Power Production Pollution Study (MAP3S), this project is aimed at improving the capability of predicting the atmospheric effects of emissions from fossil-fueled power plants. This specific project has as its objective the collection of field data to guide the development of, and to test, regional-scale air quality models.

Measurements have been made to characterize existing air quality in the Northeastern United States and to investigate atmospheric processes that are important in the regional-scale transport and transformation of air pollutants.

The characterization measurements emphasize pollutant concentrations above the surface and are made from aircraft. Pollutants routinely measured are SO_2 , SO_4 , NO, NO_2 , and light-scattering particulates. Meteorological measurements include temperature, relative humidity, solar radiation, and turbulence. Wind speed and direction are calculated from navigational measurements. The characterization experiments have been done in conjunction with intensive ground-based measurements conducted in the SURE program sponsored by EPRI. Current efforts are focussed upon data interpretation and analysis.

Process-oriented experiments have been aimed at mechanisms leading to long-range transport. These have examined processes that mix pollutants to higher altitudes by making vertical profile measurements under various meteorological regimes.

Current efforts are in the analysis of past experiments and in developing methodologies for use in clouds and in precipitation systems so that the chemical composition of rain may be investigated.

Title: MAP3S Aircraft Operations

FY 79: \$191,000.

Principal Investigator:
R. W. Garber*

FY 80: \$191,000.

Sponsor: Office of Research and Development,
Environmental Protection Agency

The objective of this program has been to outfit, maintain, and operate an aircraft for atmospheric sciences studies. A Britten-Norman Islander has been obtained on an exclusive-use lease for this purpose. This aircraft has been equipped with near state-of-the-art instrumentation for the measurement of pollutants such as SO_2 , NO , NO_x , O_3 , and aerosols, meteorological parameters including temperature and dew point, and navigational parameters. The principal use of this aircraft is in support of the MAP3S program for the conduct of field measurements. Several series of regional air mass characterization studies were carried out for MAP3S in coordination with the EPRI SURE intensive program. A box budget experiment was conducted in central Indiana under MAP3S sponsorship. Vertical atmospheric profile experiments have been conducted in the vicinity of Brookhaven National Laboratory and as part of the MAP3S CIRCE studies in central Illinois.

The equipment installed in the aircraft is changed and improved as technology becomes available. Recent improvements include a condensation nuclei counter with scanning diffusion battery for size distribution measurements, and a size-separation aerosol sampling system. Future improvements include a dual detector FPD sulfur analyzer which will measure both SO_2 and $\text{SO}_4^{=}$ simultaneously and be immune to the usual response variations caused by altitude changes. An improved NO_x analyzer is also planned.

* Environmental Chemistry Division

Title: MAP3S Data Management

FY 79: \$155,000.

Principal Investigator:
C. M. Benkovitz

FY 80: \$155,000.

Sponsor: Office of Research and Development,
Environmental Protection Agency

A major portion of the data generated by and needed for the MAP3S program is centralized in a data bank operated by BNL. This central facility collects, archives, and disseminates the appropriate experimental data generated by MAP3S and by collaborating programs and the auxiliary data needed by MAP3S program participants. Merging of the disparate data into working data sets will be accomplished once and will allow researchers access to desired information from one central location. Periodic reports are to be generated containing graphical and tabular displays of available data. User requests for data and direct user access to data and computational techniques are provided. This research includes the following tasks: (1) Development and implementation of methodologies needed to produce periodic reports with tabular and graphical displays and of procedures needed to process user requests for data, and to allow direct user access to data. (2) A source emissions inventory is maintained and periodically updated. (3) Creation of an integrated data set of air quality and precipitation chemistry data.

Title: MAP3S Modeling and Analysis

FY 79: \$165,000.

Principal Investigator:

R. E. Meyers

FY 80: \$165,000.

Sponsor: Office of Research and Development,
Environmental Protection Agency

The objective of this project is to develop and verify an advanced regional (multi-state) scale air quality model treating nonlinear chemistry (SO_x , O_3 , NO_x , etc.) capable of providing air quality analysis. The approach has centered on the development of an Eulerian grid numerical model (SCHEMATIC) using advanced numerical methods to solve for the evaluation of chemical species undergoing reaction, transport, and diffusion. Diagnostic meteorological models (BNLMET, TURBFLUX) which use observation, physical constraint, and terrain data are under development to supply processed meteorological data for the air quality models. The effects of mixing on chemical reaction is being studied using probability methods. A computer link from BNL to the National Weather Service (NWS), Suitland, Maryland, has been developed to acquire timely meteorological data.

Title: Recommendations for Supplemental Meteorological
Instrumentation for Incident Response

FY 79: --

Principal Investigators:
R. M. Brown and J. L. Tichler

FY 80: \$30,000.

Sponsor: Division of Site Safety
and Environmental Analysis,
U.S. Nuclear Regulatory Commission

The Atmospheric Sciences Division at Brookhaven National Laboratory was requested by the U. S. Nuclear Regulatory Commission (NRC) to provide technical assistance in evaluating types of supplementary meteorological instrumentation needed for incident response at nuclear power plant sites. The major aspect of this project is to survey and perform an evaluation of off-the-shelf meteorological instrumentation (including both direct and remote sensors) and data acquisition systems (including the capabilities of other Federal agencies) to supplement the on-site meteorological program and other locally available systems. Such instrumentation should be portable, capable of being deployed in minimal time frame, and capable of providing useful information for emergency planning and evaluation.

The tasks include defining the meteorological data needs during an incident response and making recommendations on the implementation and operation of a supplemental data system.

Title: Interregional Air Quality

FY 79: \$70,000.

Principal Investigator:
R. E. Meyers

FY 80: \$100,000.

Sponsor: Office of Technology Impacts,
EV, Department of Energy

The purpose of this project is to develop and apply air quality assessment methodologies for the Department of Energy for the analysis of the impact of alternative energy strategies. The approach initially emphasizes sulfur dioxide and sulfate transport among air quality control regions (AQCR's) using the BNL air quality model AIRSOX (Atmospheric Impact of Residual Sulfur OXide). Transfer matrices are developed representing the transport of sulfur dioxide and sulfate, both area- and population-weighted between emitter and receptor AQCR's for various months of the year. Industrial, area, and utility sources are considered. Budgets of pollutants imported from and exported to various geopolitical regions are also considered.

Title: Probabilistic Modeling of Atmospheric Transport and Diffusion

FY 79: \$23,000

Principal Investigator:
R. E. Meyers

FY 80: \$90,000

Sponsor: Atmospheric Science Laboratory,
Department of Defense

This program is concerned with developing advanced diffusion and transport models, using probability concepts, applicable to the problem of battlefield visibility. This project is developed in three phases. The first phase is the theoretical development of an interim model to calculate, in neutral meteorological conditions, the probability of visibility suitable for target detection and weapon use in smoke-screen battlefield conditions. The second phase of the project is the theoretical development of an advanced model applicable for more general meteorological use, and the development of a computer program for the interim model. In the third phase, the advanced model is to be computerized and tested against DOD experimental data. The scientific approach has been to (1) utilize surface boundary layer meteorological parameterization based on similarity theory together with (2) probability density functions for the concentration of smoke as derived from the conservation of mass equation.

C. Future Plans for 1980

The field portion of the MAP3S program will be aimed at experiments to determine the material balance in precipitating systems in order to aid in the understanding of the acidification of rain by air pollutants. The experiments envisioned will determine the pollutant concentration of the air flowing into clouds, the composition of cloud water, and of rain water. It is expected that much of the field work will be done in collaboration with the other MAP3S participants. The first step toward this goal will be the design, installation, and testing of equipment on the Islander aircraft for the sampling of cloud and rain water.

In order to be able to calculate the relationship between emissions and the deposition of air pollutants on the regional scale, the modeling effort will be directed at inclusion of a wider range of chemical constituents, the interphase transport, and the flows around and into storm systems.

The MAP3S data managements and coordination effort will continue to emphasize the maintenance of a regional source-emissions inventory with a substantial effort in the development of user-oriented data analysis tools.

The Coastal Meteorology program will concentrate on diffusion of the land-ocean interface. It is expected that future experiments will be done in areas with more complex shorelines.

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D. Publications

Publications

Atmospheric Sciences Division

1979

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- BNL 22879 METEOROLOGICAL AND CHEMICAL RELATIONSHIPS
FROM SEQUENTIAL PRECIPITATION SAMPLES
Gilbert S. Raynor
Presented at the AIChE 70th Annual Meeting: Atmospheric
Sulfur Compounds, Formation and Removal Process, New York
City, Nov. 13-17, 1977. AIChE Symposium Series, Vol. 75,
No. 188, ed. by William Licht, American Institute of Chemical
Engineers, 1979, pp. 269-273.
- BNL 23283R SEA SURFACE TEMPERATURE NEAR A BAY INLET ZONE
M. D. Powell and S. SethuRaman
J. Geophys. Res. 84, 7012-7016 (1979)
- BNL 24205 STRUCTURE OF TURBULENCE OVER WATER DURING HIGH WINDS
S. SethuRaman
J. of Applied Meteorology 18, 324-328 (1979)
- BNL 24206 MOMENTUM FLUX AND WAVE SPECTRA MEASUREMENTS FROM
AN AIR-SEA INTERACTION BUOY
S. SethuRaman
Boundary Layer Meteorology 16, 279-291 (1979)
- BNL 24229 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 16, 99-105 (1979)
- BNL 24543 ATMOSPHERIC TURBULENCE AND STORM SURGE DUE TO HURRICANE BELLE
(1976)
S. SethuRaman
Monthly Weather Review 107, 314-321 (1979)

^RRevised

Publications

Atmospheric Sciences Division

1979

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- BNL 25115 FORMATION AND CHARACTERISTICS OF COASTAL INTERNAL BOUNDARY LAYERS DURING ONSHORE FLOWS
G. S. Raynor, S. SethuRaman, and R. M. Brown
Boundary Layer Meteorology 16, 487-514 (1979)
- BNL 25529 A SCHEME FOR COMPUTING SURFACE LAYER TURBULENT FLUXES FROM MEAN FLOW "SURFACE OBSERVATIONS"
Martin I. Hoffert and Joel Storch
Boundary Layer Meteorology (in press)
- BNL 25684 MODELING REGIONAL ATMOSPHERIC TRANSPORT AND DIFFUSION: SOME ENVIRONMENTAL APPLICATIONS
R. E. Meyers, R. T. Cederwall, and W. D. Ohmstede
Advances in Environmental Science and Engineering, ed. by J. R. Pfafflin and E. N. Ziegler, London, Gordon and Breach, 1979, pp. 119-184.
- BNL 25731 DISCUSSION: ATMOSPHERIC DISPERSION AND TRANSPORT WITHIN COASTAL REGIONS: PARTS 1 AND 2
Gilbert S. Raynor
Atmospheric Environment 13, No. 4, p. 567 (1979)
- BNL 25930 ON TIME DEPENDENT MULTI-GRID NUMERICAL TECHNIQUE
H. N. Lee and R. E. Meyers
Presented at the TICOM Meeting, the University of Texas, Austin, TX, March 26-28, 1979.
J. Computers and Mathematics with Application (in press)

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Atmospheric Sciences Division

1979

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- BNL 25965 COMPARISON OF MEAN WIND SPEEDS AND TURBULENCE
AT A COASTAL SITE AND AN OFFSHORE LOCATION
S. SethuRaman and G. S. Raynor
Journal of Applied Meteorology (in press)
- BNL 26010 THE USE OF SYSTEM 2000 IN A SCIENTIFIC RESEARCH ENVIRONMENT
Garmen M. Benkovitz
The Association of System 2000 Users for Technical
Exchange, ASTUTE Proceedings for Spring 1979
Conference, Austin, TX, April 3-5, 1979, pp. 264-288.
- BNL 26146^a MODELING SULFUR OXIDE CONCENTRATIONS: AN ASSESSMENT
OF ENERGY UTILIZATION SCENARIOS
R. E. Meyers, R. T. Cederwall, and L. I. Kleinman
Presented at the Sixth National Conference on Energy and the
Environment, Pittsburgh, PA, May 21-24, 1979.
- BNL 26161 DATA COLLECTED ABOARD THE BNL AIRCRAFT DURING AMBIENS
P. Michael, J. Tichler, R. Garber, and R. Brown
- Informal Report
Limited Dist.
- BNL 26185R A LONG RANGE TRANSPORT MODEL FOR CALCULATING THE
ATMOSPHERIC IMPACTS OF RESIDUAL SULFUR OXIDES
Ronald E. Meyers, Ta-Yung Li, Richard T. Cederwall, and
Lawrence I. Kleinman
- Informal
Report
Limited Dist.

^aAbstract

C& ^RRevised version

Publications

Atmospheric Sciences Division

1979

- BNL 26229 A CASE OF PERSISTENT BREAKING OF INTERNAL GRAVITY WAVES IN
THE ATMOSPHERIC SURFACE LAYER OVER THE OCEAN
S. SethuRaman
Boundary Layer Meteorology (accepted)
- BNL 26369 MODELING SULFUR OXIDE CONCENTRATIONS: AN ASSESSMENT
OF ENERGY UTILIZATION SCENARIOS
Lawrence I. Kleinman, Richard T. Cederwall, Ronald E. Meyers
Presented at the Sixth National Conf. on Energy & Environment,
Pittsburgh, Pa., May 21-24, 1979. To appear in the
Proceedings.
- BNL 26371 ATMOSPHERIC PRODUCTION AND TRANSPORT OF SULFUR OXIDES
IN THE UNITED STATES
Informal Ronald E. Meyers, Richard T. Cederwall, Lawrence I. Kleinman,
Report and Stephen E. Schwartz
- BNL 26428^a ATMOSPHERIC FLOW OVER PARTIALLY DEVELOPED OCEAN WAVES
S. SethuRaman
Presented at the Second Conf. on Ocean-Atmosphere
Interaction, Los Angeles, CA, Jan. 30-Feb. 1, 1980.
- BNL 26577 MAP3S/SURE INTENSIVE STUDY, JULY 19-20, 1978, DATA COLLECTED
ONBOARD THE BNL AIRCRAFT
Informal Report P. Michael, J. Tichler, R. Garber, and R. Brown
Limited Dist.
- BNL 26581 CONTROL OF NO_x AND PARTICULATES FROM COAL-FIRED POWER PLANTS
Edward N. Ziegler and Ronald E. Meyers
Power (accepted)

^aAbstract

Publications
Atmospheric Sciences Division
1979

- BNL 26584 MAP3S CHARACTERIZATION FLIGHTS - AUGUST 2-12, 1977
Informal Report P. Michael, J. Tichler, R. Garber, and R. M. Brown
Limited Dist.
- BNL 26678R NUMERICAL SOLUTIONS OF SHALLOW WATER EQUATIONS USING AN
ACCURATE DISCRETIZING SCHEME FOR SPACE DERIVATIVES
H. N. Lee
J. of Applied Meteorology (submitted)
- BNL 26839^a ASSESSMENT OF REGIONAL-SCALE SULFUR OXIDES TRANSPORT IN
WINTER USING THE BNL AIRSOX QUALITY AIR MODEL
Thomas A. Carney
To be presented at 73rd Annual Meeting Air Pollution Control
Assoc., Place Bonaventure, Montreal, Canada, June 22-27, 1980
- BNL 26840 RECOMMENDED CHANGES IN METEOROLOGICAL MEASUREMENT
AND PREDICTION METHODS FOR COASTAL SITES
Gilbert S. Raynor, Paul Michael, and S. SethuRaman
Presented at 2nd Conf. on Coastal Meteorology, Los Angeles,
CA, Jan. 30 - Feb. 1, 1980
To appear in Preprint Volume.
- BNL 26841 CLIMATOLOGY OF INTERNAL GRAVITY WAVES IN THE MARINE SURFACE
LAYER IN A COASTAL ENVIRONMENT
S. SethuRaman, C. Nagle, and G. S. Raynor
Presented at 2nd Cont. on Coastal Meteorology, Los Angeles,
CA, Jan. 30 - Feb. 1, 1980.
Preprint Volume, pp. 244-246.

^aAbstract

^RRevised

Publications

Atmospheric Sciences Division

1979

- BNL 26843 COMPILING A MULTISTATE EMISSIONS INVENTORY
Carmen M. Benkovitz
Journal of the Air Pollution Control Association (submitted)
- BNL 26891 TRANSPORT AND DIFFUSION CLIMATOLOGY OF THE U.S.
ATLANTIC AND GULF COASTS
Gilbert S. Raynor and Janet V. Hayes
Presented at the Second Conf. on Coastal Meteorology (AMS)
Los Angeles, CA, Jan. 31-Feb. 1, 1980.
To appear in the Preprint Volume.
- BNL 26892 ATMOSPHERIC STABILITY COMPARISONS AT SHORE AND INLAND SITES
R. M. Brown, S. SethuRaman, and C. Nagle
Presented at the Second Conf. on Coastal Meteorology, Los
Angeles, Ca., Jan. 30-Feb. 1, 1980.
To appear in the Preprint Volume.
- BNL 27000 TEMPORAL VARIATION OF TOTAL SUSPENDED PARTICLES
AT BROOKHAVEN NATIONAL LABORATORY, NEW YORK
R. M. Brown and S. SethuRaman
J. of Atmospheric Environment (submitted)
- BNL 27001 CONTROL TECHNOLOGY FOR COAL-FIRED COMBUSTION IN NORTHEASTERN
U.S. PART A. OVERVIEW AND SULFUR EMISSIONS CONTROL
Edward N. Ziegler and Ronald E. Meyers
J. of Water, Air and Soil Pollution 12, 355-369 (1979)

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Atmospheric Sciences Division

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- BNL 27002 CONTROL TECHNOLOGY FOR COAL-FIRED COMBUSTION IN NORTHEASTERN
U.S. PART B. PARTICULATES, NO_x AND COMBINED SYSTEMS
E. N. Ziegler and Ronald E. Meyers
J. of Water, Air and Soil Pollution 12, 371-381 (1979)
- BNL 27095 RECOMMENDATIONS FOR METEOROLOGICAL MEASUREMENT METHODS AND
DIFFUSION MODELS FOR USE AT COASTAL NUCLEAR REACTOR SITES
Gilbert S. Raynor, P. Michael, and S. SethuRaman
Nuclear Safety (submitted)
- BNL 27098 STATISTICAL FEATURES OF THE TURBULENT DIFFUSION OF A PUFF
Arnold Levin
The Physics of Fluids (submitted)
- BNL 51004 STATUS OF POLLUTANT REMOVAL TECHNOLOGY FOR COAL
FIRED POWER PLANTS IN THE NORTHEASTERN U.S.
Edward N. Ziegler and Ronald E. Meyers
- NUREG
BNL 51045 RECOMMENDATIONS FOR METEOROLOGICAL MEASUREMENT PROGRAMS AND
ATMOSPHERIC DIFFUSION PREDICTION METHODS FOR USE AT
COASTAL NUCLEAR REACTOR SITES
Gilbert S. Raynor, Paul Michael, and S. SethuRaman
- BNL 51058 ANALYTICAL SUMMARY OF EXPERIMENTAL DATA FROM TWO YEARS OF
HOURLY SEQUENTIAL PRECIPITATION SAMPLES AT BROOKHAVEN
NATIONAL LABORATORY
Gilbert S. Raynor and Janet V. Hayes

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1979

- BNL 51071 DOE INTERLABORATORY WORKING GROUP FOR DATA EXCHANGE
 PROGRESS REPORT - OCTOBER 1978
 Carmen M. Benkovitz, Editor
- BNL 51098 DATA SUMMARY FOR EVALUATION OF THE TRANSPORT AND DIFFUSION
 CLIMATOLOGY OF THE UNITED STATES EAST AND GULF COASTS
 Gilbert S. Raynor and Janet V. Hayes
- BNL 51111 DESIGN, CONSTRUCTION, AND INITIAL OPERATION OF THE
 BNL-COASTAL TRANSPORT AND DIFFUSION, AIR/SEA INTERACTION
 RESEARCH BUOY
 D. Huszagh, W. Ripperger, and S. Fink
- BNL 51133 HOURLY VARIABILITY OF SAMPLE CHEMISTRY DURING PRECIPITATION
 EVENTS AND ITS RELATIONSHIP TO METEOROLOGICAL PARAMETERS
 Gilbert S. Raynor and Janet V. Hayes

IV. Environmental Chemistry Division

A. Significant Accomplishments

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 interdependence 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-Regional Acidity of Industrial Emissions (MAP3S-RAINE). 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).

1. Theoretical Studies. Methods have been developed for the construction of Surrogate CHEMical MEchanisms (SCHEME) which reduce the number of species necessary to accurately model the gas-phase homogeneous chemistry in atmospheric systems. A 12-species SCHEME for the olefin- NO_x - O_3 - SO_2 system reproduces the results obtained with a conventional (30-species) model and does so with a 70-80% savings in execution time. A second version of SCHEME is constructed to simulate Stack Plume REactions with Atmospheric Dilution (SPREAD) in order to determine the reaction kinetics influencing the nitrogen and sulfur chemistry within an expanding plume, e.g., factors affecting SO_2

conversion rates and $\text{HONO}_2/\text{H}_2\text{SO}_4$ ratios. A third version of SCHEME is developed to investigate the relative importance of anthropogenic and biogenic emissions on the formation of secondary pollutants, i.e., O_3 and sulfate aerosol. Methods involving linear free energy correlations have been developed for estimating rate coefficients of reactions which have not yet been experimentally determined.

The effect of the interworking of mass transport and chemical kinetics upon the uptake and oxidation of SO_2 in aqueous droplets has been examined. This treatment, applied to previous laboratory investigations disclosed the mechanism and extent of mass-transport limitation not recognized by the original investigators. Application of this analysis to SO_2 oxidation in clouds or fogs indicates that mass-transport limitation is not significant except for very high oxidation rates, e.g., at high ozone concentration.

The mathematical formulation needed for the computation of the collision rates between free molecular and transition regime particles with attractive, singular contact potentials was developed based upon the Fuchs method for computation of the coagulation coefficient with no interaction potential. Comparative calculations with older methods, valid strictly in the free molecular regime, indicate the approach is considerably better than the older method in fitting experimental data. This new method was next used to calculate the collision rate enhancement of water droplets because of their Lifshitz-van der Waals force attraction. Among the many new results was the first explanation of the significant deviation of the coagulation rate for 200 nm particles, as measured by Wagner and Kerker from that predicted by Fuchs' unmodified formula.

A model was developed which accurately predicts the emission rate of taggants solubilized in the end closures of electric blasting caps. The model also considered the effect of the temperature of the environment and provided a means to predict the useful lifetime of the tagged caps. Another model was developed to assess the effect of various containments on hindering the detectability of the taggant vapors.

2. Measurement Methodology. A real-time flame photometric detector (FPD) system for measurement of ambient levels of aerosol sulfur was constructed, automated, and tested in two major field studies. This instrument employs a temperature-cycled denuder for gaseous sulfur removal and aerosol

H₂SO₄ speciation, and includes SF₆ addition to the H₂ stream for sensitivity enhancement. It may be used for ambient levels to 0.1 ppb S.

Improvements were made in filter sampling technology including measurement of nitric acid by difference sampling onto NaCl-impregnated cellulose filters with and without a diffusion denuder for HNO₃. Development of a method for nanogram quantities of nitrate in a variety of environmental samples by nitro-derivatization-GC was essentially completed in early FY 1979, was tested on ambient atmospheric nitrate and nitric acid samples, and has now been published. A new technique for the continuous determination of atmospheric levels of ammonia and primary amines has been developed, based on fluorescent derivatization with o-phthalaldehyde. Development of a continuous analysis system for gaseous ammonia was significantly advanced by incorporation of a gaseous scrubber of known, reproducible efficiency in the analysis system. Preliminary studies in determination of acidic sulfur compounds by derivatization with diazomethane and analysis by gas chromatography with flame photometric detection (GC-FPD) were quite promising. Finally construction was completed and testing initiated of a system for determination of volatilizable and graphitic carbon in aerosols.

An optimized version of the intracavity Raman system has been constructed and operated. Approximately 1000 watts of single-frequency power is generated in an intracavity beam 30 m in diameter and is used to illuminate a monodisperse aerosol beam. The resulting Raman scattered light is analyzed in a 0.85 m double spectrometer and detected using a sensitive photon counting scheme. This arrangement allows particulate sulfate to be measured to levels as low as a few ppb.

Two schemes have been explored to increase the sensitivity of laser absorption measurements of trace gases. The first overcame a major limitation of conventional, non-resonant optoacoustic detectors, i.e., the interference caused by the coupling into the pressure medium of energy absorbed in the windows. The window signal can be cancelled out by using a dual-traverse cell of unequal path lengths. Using this scheme a sensitivity in absorptivity of 3×10^{-9} per centimeter was demonstrated. In the second scheme, a novel laser heterodyne interferometer was constructed and successfully operated. It also demonstrated extreme sensitivity, 10^{-9} - 10^{-10} per centimeter, and can be used with Stark tuning to avoid gaseous interferants. At this sensitivity many of the usual trace gases can be detected at sub ppb levels.

A fully automated laboratory chromatograph procedure for the determination of perfluorocarbon tracers (PFTs) collected from the atmosphere has been developed to perform analyses on a 7-minute cyclical basis with a resolution of 1 pp 10¹⁵ in a 2 L air sample. Air sampling for the PFTs was accomplished with two commercially fabricated prototypes of the Brookhaven-conceived automatic sequential sampler, named the Brookhaven Atmospheric Tracer Sampler (BATS). These can provide adequate sampling for multiple tracers. PFT standards in air for calibration of BATS and the chromatograph system have been successfully prepared down to levels of 1 pp 10¹³. In two other unrelated phases of the program, a new electron-capture gas-chromatographic procedure was developed for the simultaneous determination of SF₆, N₂O, and CO₂ found in high-altitude collected air samples, and a sulfur trioxide permeation tube was designed and tested for the calibration of sulfuric acid monitoring equipment used at combustion sources.

In a complementary tracer program, an automated 24-tube sequential sampler, which was developed in England for the adsorptive trapping of a single perfluorocarbon tracer (PFT) gas in up to 6 L of air, was modified at Brookhaven to be able to collect 3 PFTs in up to 15 L of air. The performance of this modified sampler and of BATS, the 23-tube sampler developed at Brookhaven, was documented in a comparative tracer release. Modifications were also made to a separate laboratory gas chromatograph which was used to analyze the 24-tube sampler.

3. Laboratory Investigations. Measurements of deliquescence properties have been made for single and mixed-salt aerosols composed of chlorides, sulfates, and nitrates. For each deliquescent salt aerosol, a threshold humidity was determined, which marks the transition of a solution droplet to a crystalline particle. An analytical study of the chemical equilibrium for the NH₃-HNO₃-H₂SO₄-H₂O system has been carried out to elucidate the parameters controlling the nitrate-to-sulfate ratios in droplets under ambient conditions. It is shown that humidity control during aerosol sampling could be crucial to the success of ambient nitrate determination.

A discharge flow-resonance fluorescence apparatus has been constructed, and measurements of the absolute bimolecular rate parameters have been made with the new apparatus for gas-phase reactions of the ground-state oxygen atom with organic sulfur compounds CH₃SCH₃ and CH₃SSCH₃.

A review of the solubility equilibria of the nitrogen oxides and oxyacids reveals a major discrepancy in existing values of aqueous-phase equilibrium constants and Henry's law coefficients. The available literature has been reviewed and possible loci of error have been identified. Subsequent laboratory investigation has shown an unsuspected dependence of the equilibrium constant for the reaction $2\text{HNO}_2 = \text{N}_2\text{O}_3 + \text{H}_2\text{O}$ upon acidity at high acid concentrations, thereby resolving the discrepancy noted above, permitting evaluation of Henry's law coefficients for NO_2 , N_2O_3 , and N_2O_4 . A first-order rate law for the reactive dissolution of NO_2 into water has been discovered that is dominant at low NO_2 partial pressures, and the mixed-phase rate constant has been determined.

Developments in the explosive-tagging program has led to the evaluation of microencapsulated taggant samples for emission rate and lifetime. The detection of tagged dummy blasting caps and tagged simulated bulk explosives was adequately demonstrated both for the screening of luggage on a conveyor belt and for detection of a clandestine bomb on board several commercial aircraft.

A program devoted to studies associated with the accidental large-scale release of sulfuric acid during intercoastal shipment has led to the development of a mathematical model to characterize the turbulent mixing of sulfuric acid in stagnant water and includes consideration of both instantaneous and continuous releases. The construction of a large spill facility consisting of a 4' x 4' x 8' stainless steel tank and other accessories has been completed in order to perform scale-up experiments with sulfuric acid samples up to 1 kg to validate the model. Oleum spill experiments have been performed to determine the amount of acid which could vaporize with steam to form an acid mist. The quantity of vaporized acid and the size of droplets formed are correlated with spill size and other important parameters controlling the aerosol formation processes.

4. Field Studies. A diagnostic field experiment was designed and performed at BNL to test the proximity to phase equilibrium of the H_2O - NH_3 - HNO_3 -aerosol (sulfate and nitrate) system in the ambient environment. New BNL-developed methodologies for $\text{NH}_3(\text{g})$ and HNO_3 were utilized.

An intercomparison of filter and real-time methods for the measurement of sulfur, sulfate, and mass in ambient aerosols was conducted in a field experiment in St. Louis. BNL participation consisted of real-time

flame-photometric detector (FPD) measurement of aerosol sulfur using denuder removal of SO_2 , H_2S , and for the first half of the study, H_2SO_4 speciation was obtained by denuder temperature cycling. Three-hr filter samples were also obtained and analyzed for strong acid, ammonium, sulfate, and, where appropriate, H_2SO_4 by benzaldehyde extraction. Extensive comparison of real-time and filter data is being conducted with initial indications of high correlation of BNL filter and real-time data.

Brookhaven National Laboratory was asked to participate at Claremont, CA in an intercomparison of methods for measurement of nitric acid and aerosol nitrate in ambient air. BNL measurements included nitric acid and nitrate by two methods: High-volume filter pack with quartz and NaCl-impregnated cellulose filters; and dual, low-volume filter packs with membrane and NaCl filters with and without a nitric-acid denuder. A real-time FPD aerosol sulfur instrument was also operating during the study to investigate interrelationships among nitric acid, nitrate, and acidic sulfate levels.

Results for more than 50 plume studies were examined for trends between sulfate formation and meteorological conditions. Although no strong connections were delineated, it could be concluded that most measurable oxidation of sulfur dioxide occurred during daylight hours. Interpretation is hampered since total plume sulfate was generally less than 5% of the total plume sulfur, and consequently the atmospheric oxidation rates are virtually unmeasurable under typical experimental conditions. Determination of acid and ammonium content of plume aerosol and correlation with sulfate content suggests that ammonium sulfate and Letovacite are principal plume aerosol components.

There have been several significant accomplishments related to measurements at power plant installations and these include: (1) comparison of sampling methodologies for determination of combustion-gas sulfuric acid and metal sulfates, (2) laboratory and field evaluation of modified versions of the best available techniques, (3) discrediting of the isopropyl alcohol bubbler approach for the determination of total water-soluble sulfates, (4) laboratory and field validation of the Brookhaven controlled condensation system (CCS) for the determination of flue gas H_2SO_4 and MSO_4 , (5) extension of the system to also provide determination of total suspended particulate (TSP), principal soluble and insoluble elements in the particulate including carbon, SO_2 , O_2 , CO , H_2O , CO_2 , and oxides of nitrogen, as well as total water-soluble

sulfate and H_2SO_4 , and finally, (6) implementation of the technique at oil- and coal-fired utility boilers for both final validation and determination of the range of emissions and the possible role that fuel composition and operating and control parameters would have on the extent and variability of those emissions. Recommendations for limiting sulfate formation in the power plant boilers have been made to the sponsors. These include operation with very low furnace oxygen, adequate use of magnesium-oxide additive, and use of efficient electrostatic precipitators for removal of particulate matter.

An experimental direction center was established at BNL to provide meteorological forecasts for the Northeast Regional Oxidant Study (NEROS) and to direct the operations of aircraft involved in the air-sampling program. An instrumented aircraft for chemical and meteorological measurements was operated by BNL. Computer-collated data has been provided to EPA.

B. Program Summaries

Title: Atmospheric Diagnostics

FY 79: \$275,000

Principal Investigators:
L. Newman and R. L. Tanner

FY 80: \$250,000

Sponsor: Office of Health and
Environmental Research (DOE)

To understand the generation, transport, transformation, and removal processes of atmospheric pollutants requires the development of atmospheric diagnostic tools including new analytical methods for characterizing species and determining their spatial and temporal concentration profiles. The Atmospheric Diagnostics program is thus designed to originate and apply analytical chemical methodologies for studying the physico-chemical properties of aerosol and related gaseous precursor species under the dynamic meteorological conditions, including precipitation scavenging, of the ambient atmosphere. The principal components of interest are size-classified aerosols containing carbonaceous, nitrogen, sulfur, and trace metal species. In addition, consideration is given to the gaseous species--hydrocarbons (including natural emissions), partially-oxidized hydrocarbons, sulfur and nitrogen oxides, ozone, ammonia, nitric acid--which are associated with these particulate species in the clear or precipitating atmosphere.

Scenarios of interest include the range from near-source conditions through stationary sources and urban plumes to near-homogeneous ambient conditions. Of special interest are diagnostic tools which will lead to an understanding of diurnal and seasonal variations, to source identification, and to estimating of effects of multiple plume interaction. A major goal is the measurement of sufficient components of the hydrocarbon-sulfur dioxide-nitric acid-ammonia-water vapor-aerosol particle system to define the level of thermodynamic and kinetic interaction of the carbon, nitrogen, and sulfur components (gaseous and aerosol) in the ambient atmosphere.

Title: Atmospheric Tracer and Instrumentation Developments

FY 79: \$145,000

Principal Investigator:
R. N. Dietz

FY 80: \$155,000

Sponsor: Office of Health and
Environmental Research

The primary goal of this program is the development and application of unique, highly sensitive detection methods and instrumentation for the determination of trace constituents in the atmosphere. Validation of plume-dispersion and long-range transport models applied at distances of 1000 km or more, the detection of tagged blasting caps and explosives in clandestine bombs in airport environments, and the assessment of heat loss in homes and buildings by ventilation are three of the immediate applications for recent BNL developments of ultra-sensitive detection techniques for perfluorocarbon compounds (PFCs) intentionally released into a known air mass or incorporated within explosive materials. The heart of these techniques is the electron capture detector, which, in combination with sampling and processing schemes, can provide very sensitive detections of the PFCs. By releasing a PFC into the air at a known rate and measuring the cross wind and vertical concentration profiles downwind, important information is learned about the effects of meteorological conditions on the transport and dispersion of air masses over great distances. For very long distances, i.e., greater than 500 km, ultra-sensitive detection (i.e., less than 1 part in 10^{12} parts of air) is necessary to minimize costs for the released tracer.

The direction of the program is to develop and validate field-deployable tracer samplers which collect PFCs in air by absorption onto a solid substrate, analytical equipment which can thermally desorb the collected samples and determine the concentration chromatographically in the laboratory, and versions of these processes which can provide essentially instantaneous measurements of the concentration in the field. Techniques and expertise developed for the PFCs will also be applied to new approaches for the determination of tracer atmospheric and energy-related source emission constituents including preparation of gas standards, new chromatographic procedures, and new continuous, real-time monitors utilizing physical and chemical processing methods.

Title: Real-Time Measurements Systems

FY 79: \$139,000

Principal Investigator:
A. J. Campillo

FY 80: \$149,000

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, and polynuclear aromatics), and free radicals (HO , and HO_2). Two 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 for aerosol particulate characterization and an optoacoustic system at CO_2 -laser wavelengths for trace gas analysis. 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 minimizing interferences are being explored. Additionally, the physical processes for radiative and non-radiative relaxation of aerosols interacting with visible radiation are being investigated.

Title: Aerosol Chemistry and Dynamics

FY 79: \$128,000

Principal Investigator:
I. N. Tang

FY 80: \$137,000

Sponsor: Office of Health and
Environmental Research (DOE)

Aerosols are known to play an important role in many atmospheric processes affecting local visibility and regional climatic conditions. Both primary and secondary combustion products often constitute a substantial portion of the ambient aerosol. The transport and effective removal of these pollutants from the atmosphere determine, to a large extent, the air quality. The purpose of this task is to elucidate the basic chemical and physical processes governing the dynamic behavior of an aerosol system. Currently, research activities include: (1) theoretical and experimental studies of the deliquescence properties and droplet growth characteristics of mixed-salt aerosols, (2) an investigation of multicomponent phase equilibrium on environmentally important chemical systems, (3) experimental studies of gas-phase chemical reactions leading to ambient aerosol formation, and (4) characterization of atmospheric trace gases including organic vapors with respect to adsorption on and chemical reaction with particulates. The results of this continuing research program will contribute to a better understanding of the basic mechanisms by which pollutants from energy-related activities may transform, transport, and concentrate in the environment. In addition, data on aerosol growth under humid conditions are essential in the medical field for realistically assessing the deposition of ambient hygroscopic particulates in the lung and for evaluating dosages of medicinal aerosols administered during inhalation therapy.

Title: Atmospheric Aerosol Microphysics

FY 79: \$110,000

Principal Investigator:
W. H. Marlow

FY 80: \$110,000

Sponsor: Office of Health and
Environmental Research (DOE)

Aerosols are a major factor in the formation, transformation, and removal processes of both natural and anthropogenic gaseous and particulate atmospheric emissions including those from energy production. In order that the undesirable effects of these emissions may be anticipated, measured, and controlled, detailed treatments of the elementary composition-related transformations and interactions involving aerosols must be available. The efforts under this program are directed toward evolving these treatments. Lifshitz-van der Waals theory is being developed for aerosol application including computations of molecular cluster and aerosol particle collision rates and computations of the free energy of thick-film formation. Special attention is given to free-molecular and transition regime particles and to natural causes of van der Waals interaction energy enhancement. Computational methods for the description of heterogeneous atmospheric chemistry, which ultimately will be useful for predictive purposes, are to be collaboratively developed and applied in the study of systems containing gaseous and particulate pollutants. New work on the optical, electronic, and other physical properties of small particles is being applied to questions relevant to the atmospheric impact of particles.

Title: Determining Fragile Molecules in the Environment

FY 79: \$110,000

Principal Investigator:
R. L. Tanner

FY 80: \$100,000

Sponsor: Office 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 techniques involving derivatization-chromatographic separation with selective detection. Since many substances of interest may be reactive under the conditions of analysis, 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 interferences from the derivative of interest. Selective detectors respond preferentially to specific elements or functional groups and thus greatly increase sensitivity for substances containing those moieties. This reduces the detector response of even gross amounts of potential interferences and simplifies the separation technology. The derivatization-chromatographic selective-detection principle has been applied to analysis of several environmental species of dynamically varying concentrations, e.g., nitrate and acidic sulfate in aerosol samples, and ammonia and nitric acid in gaseous samples, and is being applied for traces of carboxylic acids and aldehydes.

Title: Specific Molecular Property Detectors for Chromatographic Analysis

FY 79: -0-

Principal Investigators:
J. S. Gaffney and E. T. Premuzic

FY 80: \$45,000

Sponsor: Office of Basic Energy
Sciences (DCE)

This program is directed at developing new specific-property detectors for use in chromatography, e.g., gas chromatography (GC), high-pressure liquid chromatography (HPLC). Specific-property detectors, whose response is proportional to a particular molecular property, will simplify separation analysis by increasing the detection sensitivity for the molecules of interest while reducing the detector response from potential interferences. Detectors of this type are expected to find increasing applications in many areas of analytical chemistry ranging from process technology monitoring (e.g., coal liquefaction and gasification and enhanced oil recovery) to trace analysis (e.g., environmental chemistry and medicine).

Initially this program will focus on detection systems for monitoring optically-active hydrocarbons using standard separation techniques. Specifically, a far-ultra-violet (130-300 nm) detection system for monitoring optically-active compounds eluting from a chromatograph is being developed. Since saturated and mono-olefinic hydrocarbons will not appreciably absorb radiation > 200 nm, use of far-UV radiation will increase detection sensitivity since the absorption coefficients for these molecules increase below 200 nm. The approach will be to use a non-dispersive circular dichroism (CD) technique to signal the elution of an optically-active material.

Title: Development of Advanced Instrumentation and Methodology for Sulfur Measurement and Monitoring

FY 79: \$110,000

Principal Investigator:
R. N. Dietz

FY 80: \$195,000

Sponsor: Office of Research and
Development (EPA)

In most states, the emissions of certain pollutants from fossil-fueled power plants are limited by regulations comparable to or, in many cases, more stringent than Federal regulations. Of primary concern to the operator of a power plant, all attempts are made to maintain the emissions, including in-stack opacity, NO_x , total suspended particulate (TSP), and visible plume opacity in compliance with those regulations. However, there are many times when, with good intentions, units have not been able to be held in compliance with all regulations. Both for consideration of potential health effects and for determination of the mechanisms and parameters that affect the magnitude and distribution of the regulated emissions, their nature must be measured with reliable sampling techniques. This program is conducted with a goal of establishing a single reliable sampling system which quantitatively determines the important constituents in the emitted flue gases.

It has been shown that visible plume opacity can be due to TSP, but in many oil-fired power plants, the visible white plume which exceeds 20% opacity is generally caused by the condensation of emitted sulfuric acid (H_2SO_4). Thus a sampling technique was needed which would not just measure total emitted sulfates but which would differentiate between the acid form and the less noxious particulate metal sulfates (MSO_4).

The sampling system designed for this program provides for the separate determination of H_2SO_4 , MSO_4 , TSP, NO_x , and a number of other constituents. The system is carefully evaluated in the laboratory and in field experiments, many times in conjunction with other sampling techniques. The system will be expanded to include the capability for determining additional emission characterizations (e.g., organic matter) as they are needed.

Title: Northeast Regional Oxidant Study (NEROS)

FY 79: \$95,000

Principal Investigators:
L. Newman and G. Raynor*

FY 80: \$150,000

Sponsor: Office of Research and
Development (EPA)

In order to assess overall strategies for oxidant control and recognizing the significance of the transport of ozone and its precursors over long distances in the environment, the Environmental Protection Agency initiated a program to develop a regional scale photochemical air quality simulation model. Two major field experiments for the summers of 1979 and 1980 have been designed to evaluate, refine, and verify the first generation model. The 1979 study focused on regional air mass characterization and thereby addressed phenomenological features and data input requirements of the model. The 1980 study focuses on regional urban plume characterization and thereby addresses specific physical and chemical phenomena associated with the interactions of urban sources.

Brookhaven National Laboratory has been asked to participate in this program by assisting in the development and carrying out of the field programs. Participation involves the establishment of an experimental direction center through which meteorological data is used to prepare forecasts for field experiments to direct the operations of aircraft involved in the air sampling program, and direct the releases of tetroons. In addition, an aircraft, instrumented for chemical and meteorological measurements, is provided and operated by Brookhaven personnel.

*Atmospheric Sciences Division

Title: Claremont Nitrate Intercomparison Experiment

FY 79: \$17,000

Principal Investigators:
J. Forrest and R. L. Tanner

FY 80: -0-

Sponsor: Battelle Columbus
Laboratories for the Office of
Research and Development (EPA)

Accurate measurement of nitrate species is important to an understanding of (1) the fate of nitrogen oxides in polluted and unpolluted atmospheres, (2) the global nitrogen budget, and (3) potential health and ecological effects (e.g., acidic precipitation). Only recently have sensitive and selective methods for the determination of gaseous and particulate nitrates become available. A need to compare these methods was perceived and the Environmental Protection Agency organized and funded a program with this end in mind. Brookhaven National Laboratory was asked to participate at Claremont, CA in an intercomparison of methods for measurement of nitric acid and aerosol nitrate in ambient air. BNL measurements included nitric acid and nitrate by two methods: High-volume filter pack with quartz and NaCl-impregnated cellulose filters; and dual, low-volume filter packs with membrane and NaCl filters with and without a nitric acid denuder. A real-time FPD aerosol sulfur instrument was also operating during the study to investigate interrelations between nitric acid, nitrate, and acidic sulfate levels. An extensive comparison of data is planned to evaluate precision, accuracy, and freedom from artifact of methodologies employed.

Title: Rainout and Washout of Nitrogen Oxides and Oxyacids

FY 79: \$131,000

Principal Investigator:
S. E. Schwartz

FY 80: \$250,000

Sponsor: Federal Aviation
Administration (DOT)

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 four inter-related areas of investigation: (1) directed review of the literature pertaining to the equilibria and reaction kinetics affecting the solubility of the nitrogen oxides and oxyacids in aqueous solution, (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, (4) modeling the rates of washout and rainout of nitrogen oxides and oxyacids, including chemical reaction.

Title: Sulfuric Acid Spills in Marine Accidents

FY 79: \$98,000

Principal Investigator:
I. N. Tang

FY 80: \$134,000

Sponsor: U. S. Coast Guard (DOT)

Oleum and concentrated sulfuric acid are among the several hazardous chemicals routinely transported in bulk quantities on U. S. waterways. In the event of a marine accident, a large amount of acid could conceivably be discharged into water, causing damages to man and the marine life in the vicinity of the spill. In recognizing the need for technical assistance in evaluating the consequence of a potential spill accident, the United States Coast Guard (USCG) solicited and funded a three-year program at Brookhaven to quantitatively characterize sulfuric acid spills under conditions likely to occur in marine accidents. Both laboratory experiments and analytical studies are being performed. Specific areas of interest include: (1) an investigation of the formation mechanisms for sulfuric acid aerosols resulting from a spill, (2) the growth and dispersal of acid clouds formed during and immediately after a spill, and (3) the exothermic and turbulent mixing of sulfuric acid with water in the proximity of a release source.

The program is scheduled to conclude successfully in early FY 80. A new contract has been awarded by USCG to continue studies of potential aerosol formation during anhydrous ammonia spill accidents.

Title: A Comprehensive Study of the Atmospheric Interactions of the Emissions from an Oil-Fired Electric Generating Station

FY 79: \$73,000

Principal Investigators:
R. W. Garber and R. N. Dietz

FY 80: \$65,000

Sponsor: EPRI, ESEERCO and LILCO

The objective of this program is to provide a data base of field measurements which describe the chemical composition and atmospheric behavior of the plume from a large oil-fired power station. The principal area of interest for this program is the formation of sulfate and/or sulfuric acid in the flue gases and the plume and the conditions which affect or control its formation. The program is carried out in two separate parts: flue gas composition studies and airborne plume measurements.

Extensive detailed flue gas measurements are employed to determine the nature of the emissions. The relationship between power plant operating conditions and the composition of the flue gas is studied. In addition, the condition of the furnace and the use of anticorrosive additives are examined for their effects on the production of sulfate. Multiple plume measurements are made to determine the extent and rate of atmospheric oxidation of sulfur dioxide. Experiments are conducted under a variety of meteorological conditions to observe the effect of these conditions on the atmospheric interactions.

As a result of the flue gas studies, the important parameters affecting the formation of sulfate and sulfuric acid will be identified for oil-fired power plants. Recommendations for limiting sulfate formation in the power plant boilers will be made to the sponsors.

Title: Development of Sampling and Analysis Techniques in Support of NOAA
Atmospheric Tracer Experiments

FY 79: \$30,000

Principal Investigator:
R. N. Dietz

FY 80: \$40,000

Sponsor: National Oceanic and
Atmospheric Administration (DOC)

The studies conducted in this program are in direct support of the NOAA atmospheric tracer program and are complementary with the atmospheric tracer and instrumentation development ongoing at Brookhaven.

Having an ultimate goal of demonstrating the capability of perfluoro-carbon tracers (PFTs) for detection of tagged air masses at great distance (i.e., greater than 500 km), the NOAA program has supported Brookhaven participation in the areas of (1) instrumentation developments, (2) evaluation of existing instrumentation, (3) modification and improvements in sampling and analysis instrumentations, and (4) large scale meteorological tracer studies at distances up to 100 km.

A number of the instrumentation developments for the detections of PFTs have direct application to the NOAA program goals. Part of the direction of this program is to evaluate and intercompare existing sampling and analysis methodologies and techniques by performing laboratory and small scale field experiments with instrumentation developed at Brookhaven and elsewhere. Where a large number of field instruments are needed, this program will aide NOAA in implementing the commercial development of the devices. And finally, in conducting long-range transport studies, NOAA will use the expertise at Brookhaven to automate the analytical techniques for the determination of PFT samples collected during their field experiments.

Title: Evaluation of Vapor Taggants and Substrates for the Tagging of Explosives

FY 79: \$78,000

Principal Investigator:
R. N. Dietz

FY 80: \$ 8,000

Sponsor: Aerospace Corporation for
the Bureau of Alcohol, Tobacco, and
Firearms (Treasury Department)

The clandestine use of explosive devices at locations such as airports can be thwarted by the use of sensitive screening and detection systems. To increase the reliability of such detection schemes, a national program was implemented by the Treasury Department involving the tagging of explosive devices to enhance detection prior to detonation. This program is evaluating the use of volatile compounds (called taggants), deliberately added during the manufacture of explosive devices such as electric blasting caps and bulk explosives, for pre-detonation screening of luggage as it is checked at airports. The volatile taggants are detected by a sensitive continuous electron capture monitor.

There are two principal methods by which the vapor taggants are incorporated into the explosive devices. In one case, the taggant is dissolved into the end closure material of the electric blasting cap or into a modified version of the end closure material. In the other case, the taggant, which is a liquid perfluorocarbon compound, is incorporated into commercially manufactured microcapsules. These are then added directly to the bulk explosive formulations at about 0.05 to 0.10% by weight or by blending with rubber formulations prior to the manufacture of the electric blasting cap and closure plugs.

The main thrust of the program is to study the factors affecting the rate of emission of the taggant vapor which must be high enough to be detected in the various scenarios envisioned and yet low enough for the taggant material to last for a period of 5 to 10 years. Theoretical models of emission rate mechanisms are developed. Studies are made of the effectiveness of intentional counter measures to prevent the detection of the vapor taggants. Field tests are performed simulating the screening of luggage on a moving conveyor belt as well as detection of vapors on board commercial aircraft.

C. Future Plans for 1980

1. Theoretical Studies. Working with the Atmospheric Sciences Division, SCHEME will be employed as a sub-model within a regional and sub-continental air pollution transport model.

Collision rate enhancement because of the Lifshitz-van der Waals force will be calculated for n-alkane particle coagulation. Computation of this quantity will also be done for dissimilar size particles of different composition to illuminate effects of compositional specificity upon collision rates. Solar-illumination enhancement of particle collision rates will be investigated via a model calculation of silicon aerosols based upon published measurements for silicon slabs.

2. Measurement Methodology. Construction of a real-time, dual SO₂/aerosol sulfur FPD instrument with mass flow control for aircraft measurements should be completed this year. The effort in speciation of carbonaceous aerosols will be expanded. This will involve developing a routine technique for volatilizable and graphitic carbon with direct detection by non-dispersive infrared or conversion to methane and FID detection, and also investigation, for larger aerosol samples, of ¹⁴C/¹²C and ¹³C/¹²C isotope-ratio measurements for identification of carbon sources in ambient aerosols. Development of techniques for small quantities of selected, environmentally significant organic compounds using high-pressure liquid chromatography (HPLC) with post-column derivatization and selective detection. For example, derivatization-fluorescence detection schemes are planned for carboxylic acids, phenols, and amines. Additional effort in derivatization of acidic sulfur compounds by methylation and GC-FPD including speciation of S(IV) compounds by reaction-rate differences.

Spectroscopy efforts will continue to be directed at employing the principle of Stark tuning in conjunction with laser heterodyne interferometry as a means of measuring atmospheric trace gases such as ammonia. A radiometric spectrometer will be developed to study 0.1 to 2 μm particle composition. The principle employed is to electrostatically balance an individual charged aerosol particle against a laser-induced radiometric force. By varying the wavelength of the laser a photophoretic action spectrum can be obtained.

Improvements in the laboratory gas chromatographic system will extend the detection limit to 1 pp 10^{16} in a 2 L sample. A dual trap analyzer will be capable of an in-field analysis every 5 minutes at a level of less than 1 pp 10^{13} . Multiple continuous periodic injections into a short chromatographic column can provide a technique for continuous detection of multiple constituents in a gaseous sample. The technique will be examined as an aid to improving a continuous PFT analyzer as well as providing stand-alone detection capability. A new passive sampling technique will be examined for reliability as an inexpensive air-sampling device for tracers and pollutants.

Further validation of the BNL controlled-condensation system for sulfuric acid measurements will be performed at power plants thereby extending the capability of the system to include the sampling and determination of organic emissions. Tasks will include the complete laboratory and field testing of all new features of the sampling system as well as intercomparison studies with other interested groups, and finally, characterization and correlation of emissions at a range of conventional combustion sources.

A non-dispersive circular dichroism detection system will be coupled to a gas chromatograph for initial studies allowing the selectivity and sensitivity of a new optical-activity monitoring device to be tested using a number of model hydrocarbon systems. Upon evaluation of the CD/GC detection system, a high-pressure liquid chromatograph (HPLC) will be interfaced to an optical-activity detection system for comparable sensitivity and selectivity testing. This work will require investigation of suitable solvent systems for far-ultra violet HPLC work. For example, perfluorinated solvents appear to be promising, as these materials do not appreciably absorb in the region of interest. Depending on the observed instrument sensitivities, future work will involve continued development of vacuum ultra violet CD detectors using the National Synchrotron Light Source (NSLS) currently under construction at BNL.

3. Laboratory Investigations. Experimental and theoretical work on droplet growth will continue for aerosols composed of more than two inorganic salts. Measurements of thermodynamic properties of multicomponent electrolyte solutions will continue. Specific systems to be investigated include mixed sulfate-nitrate and ternary mixtures of sulfate, nitrate, and chloride. Analytical studies of trace gas-droplet equilibria will be extended to include

new components in the chemical system. Concurrent experiments will be carried out to validate and upgrade the analytical model. Kinetic measurements for oxygen-atom reactions with organic sulfur compounds such as CH_3SH , $\text{C}_2\text{H}_5\text{SH}$ and thiophene will be made. A study of chemical reactions involving free radicals such as OH, CS, and SH will be initiated using the technique of laser-induced fluorescence.

Kinetic studies of the reactive dissolution of NO_2 in water will be continued to better elucidate the dependence of the reaction rate upon phase mixing conditions, and thereby obtain a direct measurement of the Henry's law coefficient of NO_2 as will directly determine the aqueous-phase rate coefficient. Studies will be extended also to aqueous-phase reactions of NO_2 with H_2O_2 , O_3 , NO, and SO_2 .

Methods for surrogating reaction mechanisms and estimating rate coefficients will be coupled with laboratory experiments, e.g., long-path Fourier-transform infra-red spectroscopy to establish and evaluate mechanistic pathways leading to the formation and removal of organic molecules in the atmosphere.

Since the sulfuric acid spill program is scheduled to be completed in early FY 80, much effort will be expended to finishing up the work and writing the final report. A new program on anhydrous ammonia aerosols will commence, and work will be initiated immediately to design and construct a cryogenic aerosol generation system. A multicolor transmissometer will be built to monitor the mass concentration of the anhydrous ammonia aerosol generated in the system.

The program on vapor tagging of explosives was successfully completed in FY 79 and the final report as well as several interim field evaluation reports will be completed in FY 80.

4. Field Studies. Additional experiments will be conducted to test the proximity to phase equilibrium of the gaseous-aerosol, sulfur-nitrogen system.

The data collected by BNL will be compared with real-time aerosol sulfur and filter data obtained by other participants and its significant findings with respect to the equivalence of the methodologies discussed, probably at a future workshop. An extensive comparison of data is planned to evaluate precision, accuracy, and freedom from artifact of methodologies

employed. Special attention will be paid to systematic differences in nitrate and nitric acid levels measured by high-volume, low-volume, and diffusion-denuder difference filter-based methodologies.

Future work associated with power plants will include completion of last eight airborne experiments during winter 1979-1980. The final data analysis and report are planned for March 1980. A program to review and analyze data from real-time airborne instruments including NO-NO_x, O₃, B-scat, and SO₂ is being proposed to ESEERCO for conduct in 1980-1981. In addition a new coal-fired power plant flue gas study is being proposed to them. The objective of this new flue gas study is to determine the cause-effect relationships leading to sulfate production in coal-fired power plants and ascertain whether the relationship obtained during the oil-fired power plant study is valid to coal-fired operations.

The tracer experiment program will include attempts to improve the laboratory instrument for the analysis of BATS units, and providing one system to NOAA and retaining one at Brookhaven. These studies will also support NOAA in a 600-km tracer experiment, including the analysis of up to 30 to 40 BATS units and 60 bottle samplers for the determination of PFTs and sulfur hexafluoride tracer.

Field experiments will address the equilibrium of the gaseous nitrogen oxides and dissolved oxyacids in fogs and clouds.

The NEROS program will continue but the interest will shift from a regional air mass to an urban plume characterization.

D. Publications

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Environmental Chemistry Division

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I. N. Tang, H. R. Munkelwitz, and J. G. Davis
Aerosol Measurement, D. A. Lundgren et al., Editors,
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- BNL 23672 CHEMICAL COMPOSITION AS A FUNCTION OF PARTICLE SIZE IN NEW YORK SUMMER AEROSOL
R. L. Tanner, R. Garber, W. Marlow, B. Leaderer, and M. A. Leyko
Ann. N. Y. Acad. Sci. 322, 99 (1979)
- BNL 24023 PROCESSES LIMITING THE OXIDATION OF SULFUR DIOXIDE IN STACK PLUMES II
Stephen E. Schwartz and Leonard Newman
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- BNL 24063 CHEMICAL COMPOSITION CORRELATIONS OF SIZE-FRACTIONATED SULFATE IN NEW YORK CITY AEROSOL
Roger L. Tanner, William H. Marlow, and Leonard Newman
Environmental Science and Technology 13, 75 (1979)
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Tellus 31, 530 (1979)
- BNL 24703 COMMENTS ON "MEASUREMENT OF AEROSOL PARTICLES
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Roger L. Tanner
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- BNL 24766 ¹³C/¹²C ANALYSIS OF VEGETABLE OILS, STARCHES, PROTEINS,
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J. S. Gaffney, A. P. Irsa, L. Friedman, and E. A. Emken
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Robert F. Adamowicz and Kee P. Koo
Applied Optics 18, 2938 (1979)
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Robert L. Tanner, Ruby Fajer, and Jeffrey Gaffney
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William H. Marlow, P. C. Reist
J. Aerosol Sci. 10, 107 (1979)

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25322 THE INTERACTION OF CSI WITH HIGH CHROMIUM ALLOYS IN THE
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S. Aronson, M. Friedlander, I. N. Tang, and H. R. Munkelwitz
J. Inorg. Nucl. Chem. 41, 1209 (1979)
- BNL 25541 FORMATION OF SULFATE, AMMONIUM AND NITRATE
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J. Forrest, R. Garber, and L. Newman
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Roger L. Tanner
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January 9-12, 1979
- BNL 25849^a CONSIDERATIONS ON THE INCORPORATION OF SULFATE NITRATE AND
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Leonard Newman
Invited presentation. Proceedings of the International
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- BNL 25932 ON THE USEFULNESS OF SULFUR ISOTOPE RATIOS
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- William H. Marlow
- To appear in Aerosol Microphysics, I: Partical Interactions. Topics in Current Physics Series, Springer-Verlag, Berlin, Heidelberg, New York.
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- William H. Marlow
- To appear in Aerosol Microphysics, I: Particle Interactions. Topics in Current Physics Series, Springer-Verlag, Berlin, Heidelberg, New York.
- BNL 26142 DETERMINATION OF AMBIENT AEROSOL SULFUR USING A CONTINUOUS
PHOTOMETRIC DETECTION SYSTEM I. SAMPLING SYSTEM FOR AEROSOL
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- R. L. Tanner
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Ignatius N. Tang
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- BNL 26491 BRIDGED FERROCENES VII, HYDROGENATION TO POLYCYCLIC
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M. Hillman, B. Gordon, N. Dudek, R. Fajer, E. Fujita
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Presented at the 3rd International Symposium on
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Russell N. Dietz
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^RRevised version

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Russell N. Dietz

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L. Newman

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W. Marlow

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THE DIFFUSION PROCESSOR

W. Marlow

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V. Land and Freshwater Environmental Sciences Group

A. Significant Accomplishments

The objectives of the current projects are to assess the effects of energy-related pollutants on selected species of forest and field crop plants, on soil microbiota, and on biota and biological processes in the freshwater ecosystem; an ecological characterization of the BNL site and other sites preliminary to the possible establishment of a National Environmental Research Park; evaluation of the effectiveness of various wastewater renovation systems in removing viruses; and a study of the relationship of environmental variables to virus survival and accumulation in molluscs.

1. Effects of Acid Rain on Crops. Experiments conducted in an agricultural field using standard agronomic practices and in a greenhouse show that seed yields of soybeans and pinto beans were reduced when exposed to rain-fall solutions at and slightly below the acidity of rainfalls that occur in the northeastern United States. The decrease was attributed to fewer seed pods per plant, with no change in the weight of each seed or the number of seeds per pod.

Rates of gas exchange were found to be higher in plants exposed to more acidic precipitation, even at levels that produced no visible injury. The data suggest that plants exposed to acidic precipitation are more sensitive to gaseous pollutants than unexposed plants.

Injury to pinto beans occurs when plants are exposed to sub- μ m aerosols of ammonium sulfate. Methods are being developed to relate the doses and particle size distribution of ammonium sulfate aerosols to similar aerosols in nature.

2. Effect of Acid Rain on Soil Microbial Processes. Effects of soil acidity on microbial decomposition of organic matter and transformation of nitrogen in an acid forest soil were investigated in naturally acid soil and in pH-adjusted acid and neutral soils, by monitoring CO₂ evolution. In the oak-leaf-amended pH-adjusted acid soils, CO₂ production in 14- and 150-day preincubated samples decreased by about 6 and 37%, respectively. In the control (unamended) acidified soils, reductions in CO₂ production of 14% in 14-day preincubated samples and of 52% in 150 day samples were observed.

Ammonia formation in pH-adjusted acid soil was about 50% less than in naturally acid soil. Increased rates of ammonification and nitrification were

observed in the pH-adjusted neutral soil. Little autotrophic and heterotrophic nitrifying activity was detected in naturally acid and acidified forest soils. Soil enzyme studies indicate no apparent differences between the urease and dehydrogenase activities in the natural and pH-adjusted neutral soils. The acidified acid soil exhibited much less urease and dehydrogenase activities.

The effect of ^{14}C -labeled pesticides (2, 4-D, cacodylic acid, Methoxy chlor, Sevin, and Paraquat) on soil microbial activity and the fate of these compounds in acid, naturally acid, and pH-adjusted neutral soils are being investigated. Paraquat decomposition was completely arrested by a soil pH of 4.7. The decomposition rate of 2, 4-D was 53% lower at pH 4.7 compared to pH 6.5.

3. Limnological Impacts of Acid Rain. Acidification alters many aspects of lake ecosystems. Current work is centered on the hypothesis that materials cycling is reduced at low pH, leading to an accumulation of undecomposed litter and lowered nutrient availability. Work is conducted at Woods Lake (pH Ca. 4.9), Sagamore (pH Ca. 5.5), and Panther Lake (pH Ca. 7.0) in the Adirondack Mountains, a region heavily impacted by acid deposition. BNL efforts in the cooperative project are centered on the lakes, with studies of physical, chemical, and biological limnology in progress.

4. Identification of Regions Sensitive to Acid Deposition. The overall objective of the sensitive areas project has been to evaluate the eastern United States and to determine and map which areas are vulnerable to adverse impacts from acid precipitation. Vulnerability is based largely on the chemical characteristics of the bedrock. Limestone terrains yield "infinite" acid-neutralizing (buffering) capacity to acidic precipitation whereas granites (and related igneous rocks), their metamorphic equivalent, and non-calcareous sandstones yield minimal buffering. Analysis of geologic terrain was undertaken on the scale of the most recent state geologic maps. Rock formations have been classified according to their potential buffering capacity.

Information obtained from numerous sources of raw data and from computerized data bases was used to establish the Acidification Chemistry Information Database (ACID). This was used to plot surface water alkalinity on a county-by-county basis. This map, which for testing purposes was considered

to be the "correct" map, was compared to the geologically-based map definitions of sensitive areas for each county in North Carolina and New Hampshire. The geologically-based sensitive areas map was "correct" for 90% of the 42 counties in North Carolina, and for 100% of the 8 counties of New Hampshire, which had alkalinities $\leq 200 \mu\text{eq/l}$.

5. Ecological Characterization of the BNL Site. Three projects performed by students in the Graduate Program in Ecology and Evolution at SUNY-Stony Brook were designed to provide data on various natural systems at BNL. One is an analysis of the soils that documents the long-term effects of sewage effluent treatments on an oak-pine forest and a pine plantation. The second is a census of small mammals over two years in four different forest types: Upland oak forest, mesic oak forest, maple forest, and pine forest. The third contrasts the interactive effects of soil type and overlying vegetation on site at BNL with a comparable mixed deciduous forest at Stony Brook.

6. Human Viruses in Groundwater Recharge Systems. A three-year program to investigate the ability of a well-managed tertiary effluent-recharge system to return microbiologically acceptable water to the groundwater aquifer was completed. Major accomplishments during 1979 included: (a) demonstration of the overall success of the tertiary treatment system in removing human viruses, although viruses occasionally reached the aquifer; (b) the inability to correlate the presence of coliform bacteria in sewage effluent and renovated waters with the incidence of viruses; (c) virus removal during soil percolation was most affected by the infiltration rate (high rates resulting in little virus removal, low rates yielding efficient removal); (d) variations in virus adsorption efficiencies to soil were shown to be virus-strain dependent; (e) new methods for the efficient recovery of virus from tertiary wastewaters were developed; and (f) the role of rainwater in the desorption and migration of viruses through soil was delineated.

7. Viruses in Marine Environments and Their Uptake by Shellfish. A project funded by the U.S. Food and Drug Administration was started. Major contributions of this research included: (a) development, testing, and verification of a highly-sensitive method for the extraction and enumeration of human viruses from naturally-infected shellfish (clams and oyster); (b) a comparison of human virus incidence in marine sediments and waters, and their ambient shellfish; (c) studies of mechanisms of low-level virus uptake by

shellfish; (d) delineation of the role of algal species in the uptake of viruses by shellfish; (e) development of improved methods for the concentration and isolation of human viruses from marine sediments and waters; and (f) accumulation and stratification of human viruses in marine sediments.

B. Program Summaries

Title: Effects of Acid Rain on Terrestrial Ecosystems

FY 79: \$258,000

Principal Investigators:
G. R. Hendrey, A. J. Francis,
G. S. Raynor, L. S. Evans

FY 80: \$272,000

Sponsor: Energy Effects Div.
Energy Research/EPA

The objectives of this program are to provide estimates of damage to terrestrial ecosystem components caused by energy-related atmospheric pollutants. Effects of acidic precipitation on agronomic and forest plants and soil microbiology are investigated. Precipitation chemistry at the Brookhaven National Laboratory site and its relationships to climatic and meteorological events are analyzed.

A variety of forest and field-crop plants are exposed in rain chambers to simulate acidic precipitation. Plants are also exposed to sulfate and ammonium aerosols in an aerosol chamber. Types of ensuing morphological and/or physiological injury are described. Field experiments using standard agronomic practices, in which crops are exposed to simulated acidic precipitation, have demonstrated reductions of seed yield in the precipitation pH range 4.0-3.2 for soybean. Dose response functions are determined from this type of field work.

Effects of soil acidification on microbial decomposition of organic matter and on transformation of nitrogen are investigated to determine the impact on organic matter decomposition and nutrient availability and recycling. Effects of toxic substances (2, 4-D, Cacodylic acid, Methoxychlor, Sevin, and Paraquat) on soil microbial activity and the fates of these compounds at various pH levels in soils are also investigated.

Hourly precipitation samples are collected and analyzed to describe precipitation chemistry at the BNL site, and relate it to meteorological parameters associated with the precipitation event.

Title: Sensitivity of the Eastern United States to Acid Precipitation
Impacts on Surface Waters

FY 79: \$60,000

Principal Investigator:
G. R. Hendrey

FY 80: \$ 0

Sponsor: EPA-Corvallis
Environmental Research Lab.

A new analysis of bedrock geology maps of the eastern U.S. constitutes a simple model for predicting areas which might be impacted by acid precipitation and it allows much greater resolution for detecting sensitivity than has previously been available for the region. Map accuracy has been verified by examining current alkalinities and pH's of waters in two test states, New Hampshire and North Carolina. In regions predicted to be highly sensitive, alkalinities in upstream sites were generally low, $< 200 \mu \text{ eq./l.}$ Many areas of the eastern United States are pinpointed in which some of the surface waters, especially upstream reaches, may be sensitive to acidification. Pre-1970 data were compared to post-1975 data, revealing marked declines in both alkalinity and pH of sensitive waters of several states, e.g. North Carolina, where pH and alkalinity have decreased in 80% of 38 streams ($p < .001$) and New Hampshire, where pH in 90% of 49 streams and lakes has decreased ($p < .001$) since 1949. These sites are predicted to be sensitive by the geological map on the basis of their earlier alkalinity values. Thus this mapping of sensitive areas is validated by the observed temporal trends. The map is being improved by the addition of a soils component.

Title: Workshop on the Effects of Acid Precipitation on Terrestrial Ecosystems

FY 79: \$12,500

Principal Investigators:
G. R. Hendrey and L. S. Evans

FY 80: \$ 0

Sponsor: EPA/Corvallis
Environmental Research Lab.

The extent to which plants and terrestrial ecosystems are impacted by acid precipitation is a topic of intense interest to scientists and regulatory agencies. To assist the U.S. Environmental Protection Agency in evaluating the current state of knowledge concerning the effects of acid precipitation on vegetation, soils, and terrestrial ecosystems, an International Workshop was organized at Brookhaven National Laboratory in June 1979. The workshop brought together leading scientists in these fields of research from Europe, Canada, and the United States.

The objectives of the workshop were to determine (1) the current state of knowledge of the effects of acid precipitation on vegetation, soils, and terrestrial ecosystems, (2) research needed in these areas to understand the environmental impacts of acid rain, and (3) to help coordinate research groups to avoid excessive duplication of research. The workshop was designed so that researchers in the areas of effects of acid precipitation on vegetation, soils, and whole ecosystems approaches could communicate effectively. Research priorities were: for plants, (1) an evaluation of effects on crop sensitivities as reflected in yields, (2) interaction of acid rain with other pollutants, including particulates, on plants, (3) dose-rate effects studies, and (4) identification of sensitive life cycle stages; for soils, (1) increased leaching of exchangeable plant nutrients such as Ca, Mg, K, Fe, and Mn from soils, (2) reduced availability of phosphorus, and (3) increased soil acidification; and for terrestrial ecosystems, (1) interactions of acid rain with toxic elements such as Al, Fe, and Mn, (2) effects on nutrient cycling and (3) effects on nitrogen cycling.

Title: Lake Acidification Investigation: Allochthonous Litter Decomposition

FY 79: \$43,000

Principal Investigators:
G. R. Hendrey and A. J. Francis

FY 80: \$84,000

Sponsor: EPRI (Electric
Power Research Institute)

The objective of this study is to determine the effects of lake acidification on the decomposition of allochthonous litter and on microbial colonization of litter in Adirondack Mountain Lakes. Numerous studies indicate that microbial decomposition of organic materials is markedly reduced at pH levels commonly encountered in lakes. Accumulations of allochthonous organic debris may cover large areas of lake-bottom and contribute to an inhibition of chemical exchange between lake sediment and the overlying lake waters. Organically bound nutrients which normally would be mineralized and made available may be left bound into this undecomposed organic material. A reduction of microdecomposer activity and biomass may also directly impact on invertebrates, many of which feed upon microbial communities associated with allochthonous litter and are, in turn, important items of food for fish.

Leaf packs of beech, sugar maple, leather leaf, and red spruce were placed at 1, 3, and 5 meter depths in each of the three lakes with pH values 4.9, 5.7, and 7.1 to determine effects on decomposition. The analyses include loss of weight, loss in surface area, bacterial population and biomass (epifluorescence, Lipopolysaccharide, and muramic acid), fungal and algal population, chlorophyll content, invertebrate colonization, carbon, nitrogen, phosphorus, and caloric value of the leaves. In addition, coarse particulate organic matter entering the lakes will be determined to calculate the carbon budget in these lakes.

This program is part of the Integrated Lake Watershed Acidification Investigations (ILWAI).

Title: Effects of Acid Precipitation on Benthic Plant Communities

FY 79: \$69,000

Principal Investigators:
G. R. Hendrey and H. L. Conway

FY 80: \$66,000

Sponsor: New York State-ERDA

Investigations are 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. 4.9), 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 and benthic respiration, (2) contribute to a comprehensive ecosystem study of the three lakes, and (3) provide data for an integrative watershed-limnological model.

Incubation chambers are used in situ to increase production and respiration, sedimentation rates are measured using benthic traps, and regeneration of micronutrients at the sediment-water interface using bell jars. Laboratory experiments are used to evaluate the effects of acidity and heavy metals on productivity, population growth, and chemical composition of benthic microalgae. Work is coordinated and results integrated with the work of investigators from several institutions on aspects of both the terrestrial (watershed) and aquatic portions of the forest ecosystems.

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: National Environmental Research Park

FY 79: \$70,000

Principal Investigator:
G. R. Hendrey

FY 80: \$74,00

Sponsor: Office of Health and
Environmental Research/DOE

The purposes of this task are to (1) provide an ecological characterization of the Brookhaven National Laboratory (BNL) site and other sites with different habitats, and (2) provide information of ecological interest on specific populations, habitats, environmental stress, and recovery from stress. Ecological studies at BNL have been conducted by both staff personnel and scientists from other research institutions in the Northeast. The project seeks to encourage use of the BNL site and associated sites for research in the environmental sciences by qualified investigators at educational and research institutions in the Northeast. The study is determining the suitability of a Northeastern NERP with BNL as a focal point, providing an agency for making these facilities available on a cooperative basis.

Aquatic habitats (ponds and microcosms) are being investigated to describe zooplankton communities. Data on effects of ecosystem size and heterogeneity on community structure will provide a quantitative basis for ecological models designed to describe minimum ecosystem size and/or heterogeneity necessary to maintain a community. These models may be of use in determining minimum size for wildlife refuges, effects of dams or mining on existing ecosystems, or optimal planning for land reclamation. In another study, temporal and spacial variation of ecosystem components on "indicator species" is being studied to provide a basis for determining optimal species composition needed to support a consumer population in a forest ecosystem.

Title: Workshop on Environmental Effects of Photovoltaic Energy Technology Development

FY 79: \$ 0

Principal Investigator:
G. R. Hendrey

FY 80: \$50,000

Sponsor: DOE/ET Division of
Distributed Solar Technologies

Objectives: (1) Identify and provide a preliminary assessment of environmental hazards realistically associated with the release of toxic material from all stages of the expanding PV industry and of site-specific environmental problems associated with both large-scale central PV stations and distributed PV usage; (2) provide a reference for environmental considerations by obtaining 1980 state-of-the-art assessment of growth anticipated in the PV industry; and (3) disseminate the results obtained and conclusions drawn.

Approach: Invite a maximum of 25 experts informed in various phases of the PV industry including those involved in planning and in environmental considerations to a two-day workshop at BNL. Literature reviews and government planning documents dealing with the industry, its environmental issues, and technology development trends will be gathered and distributed in advance to participants. Workshop will be conducted involving formal presentations and working sessions in which subgroups will prepare preliminary assessments of PV-related environmental problems and assist in assigning priorities to research needs, including problems associated with resource acquisition, processing, utilization, disposal and with siting and operation of PV arrays for both central and dispersed applications. An attempt will be made to reach a consensus, compile a list of recommendations, and disseminate the results in printed form.

Benefits: Provide (1) information on potential environmental problems and offer options for mitigating or eliminating these problems, (2) valuable input for guidance of technology development, and (3) useful input to risk-benefit assessments.

C. Future Plans for 1980

1. Acid Rain Program. Impact of energy-related pollutants on plants will continue to be investigated in the laboratory aerosol chamber and in the field using standard agronomic practices and cultivars. Field experiments will include studies of alfalfa, potatoes, and bush beans to establish dose-response functions for the effects of H^+ concentration in rain on yield and marketability of these crops. This will be the second year of experiments with alfalfa. Plants will be dormant during the winter and regrowth will occur during the spring and summer of 1982. Potato tuber yields will be evaluated under field conditions. Field studies have shown that acid rainfalls had an effect on seed yield of pinto beans and soybeans. Bush beans will be field-tested since they are an agronomic bean. Laboratory experiments will include soybeans and pinto beans which will be exposed (foliar-applied and root-absorbed) to simulated acid rain (pH 5.7, 4.0, and 3.2) containing differing N:S ratios. Rates of N and S absorption, incorporation, leaching, cellular assimilation, plant translocation, and the distribution of these two anions in both protein and inorganic forms will be determined and related to crop yield and marketability.

Experiments on effects of acid precipitation on soil microbial processes will include: (1) decay of herbicides and pesticides in forest soils, (2) the rates of organic matter accumulation and decomposition, and (3) alterations in nitrogen cycle intermediates, in particular soil microbial production of nitric acid in lake watersheds. Studies on the effect of heavy metals on nitrogen cycle, decomposition of organic matter, and the degeneration of natural and synthetic compounds, complexing agents, and organometallics will be initiated.

Studies of acidification impacts on the rates of terrestrial litter decomposition and microbial colonization in the three Adirondack Mountain lakes will continue. Laboratory studies of microbial activity on litter will utilize pH-regulated aquaria.

Studies on the effect of acid precipitation on the benthic microalgae of these lakes will be done using in situ incubation chambers. Sedimentation rates will also be measured using benthic sediment traps. The regeneration of micronutrients at the sediment/water interface will be studied using a bell jar.

2. NERP Program. Studies of habitat utilization and dispersal of P. leucopus (white-footed mouse) will be continued. Radiotelemetry will be used to make more definitive measurements of these aspects of white-footed mouse life history than possible with live-trapping mark-recapture methods alone.

3. Virology Program.

a. Aquifer Entrainment of Human Viruses. The project designed to identify the contribution of subsurface septic systems to the pollution of groundwater on Long Island will be completed. It will define the extent (i.e. distance) to which viable human viruses, introduced to the aquifer via subsurface leaching, can be entrained through the aquifer. Data resulting from this study will have considerable impact on future regulation regarding the spatial placement of domestic septic systems and private drinking-water wells.

b. Mutagens and Human Viruses in Urban Stormwater Runoff. A study will be initiated of the role of stormwater runoff in the transmission of human viruses and chemical mutagens to groundwater aquifer and receiving surface waters (e.g. lakes, streams, bays). The program will be carried out in conjunction with a study being conducted by the U.S. Geological Survey to monitor chemical and physical parameters from identical sample composites.

c. Viruses in Marine Sediments and Shellfish. The 3-year study to determine the relationship of marine waters and sediments to virus survival and accumulation by bivalve molluscs will be concluded. Specific areas addressed include: persistence and seasonal variation of enteric viruses in marine sediments; comparison of the incidence of viruses in sediments versus the ambient water column; identification of the environmental factors which influence virus release from sediments; development of improved techniques for the extraction of viruses from shellfish; shellfish uptake of viruses from contaminated sediments; and the viral accumulation potential of shellfish residing in waters containing low levels of virus (0.1-0.01 per/ml).

d. "In-Vitro" Testing of Metal Mutagens. Analyses of the heavy metal uptake mechanisms of test cells involved in both the Salmonella/Ames mutagen test and the mammalian cell Sister Chromated Exchange analysis test system will be initiated. Modification of both testing methods will be carried out to enhance their sensitivities to metal-based mutagens.

4. Photovoltaics Program.

a. Workshop on Environmental Impacts of Photovoltaics. Potential effects of pollutants associated with the photovoltaic (PV) industry will be identified and a report on this topic will be published. Further activities dealing with PV effects on the environment will be started if serious problems are identified.

b. Photovoltaics Field and Laboratory Studies. Level 1 biological and chemical toxicity screening of bulk samples of emissions collected from industrial processes involved in the manufacture of silicon-photovoltaic devices will be organized. Chemical testing will involve qualitative and semi-quantitative analyses of bulk samples. Biological testing will include both acute (e.g. mammalian cell toxicity, invertebrate and phytoplankton toxicity models), and chronic (e.g. Ames Salmonella Mutagen Assay) toxicity assessment.

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D. Publications

Publications

Land and Freshwater Environmental Sciences Group

1979

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- BNL 24088 A SURVEY OF HUMAN ENTEROVIRUS OCCURRENCE IN FRESH AND
MARINE SURFACE WATERS ON LONG ISLAND
J. M. Vaughn, E. F. Landry, M. Z. Thomas, T. J. Vicale,
and W. F. Penello
Applied and Environmental Microbiology 38, No. 2, 290-295
(1979)
- BNL 25502 HUMAN ENTEROVIRUS OCCURRENCE IN THE WATERS OF ARTHUR KILL
Informal Report James M. Vaughn and Edward F. Landry
Limited Dist.
- BNL 25532R DIFFERENTIAL RESPONSES OF PLANT FOLIAGE TO
SIMULATED ACID RAIN
Lance S. Evans and Therese M. Curry
American Journal of Botany 66, 953-962 (1979)
- BNL 25702 VIRUSES IN A TERTIARY SEWAGE TREATMENT-AQUACULTURE SYSTEM:
SHELLFISH AND SHELLFISH-GROWING WATERS
Informal Report J. M. Vaughn, E. F. Landry, T. Vicale, and P. Davis
Limited Dist.
- BNL 25835^a EXPERIMENTAL STREAM ACIDIFICATION: EFFECTS ON
BENTHIC ALGAL PRODUCTIVITY
G. R. Hendrey, R. J. Hall, and G. E. Likens
Presented at the 42nd Annual Meeting of the American Society
of Limnology and Oceanography, Stony Brook, NY, June 18-21,
1979. To appear in the Preprint Volume.

^aAbstract

^RRevised version

Publications

Land and Freshwater Environmental Sciences Group

1979

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- BNL 26070^a THE ADSORPTION OF ENTEROVIRUS TO SOIL CORES, AND THEIR
SUBSEQUENT ELUTION BY RAINWATER: LABORATORY STRAINS
VERSUS FIELD ISOLATES

E. F. Landry, J. M. Vaughn, M. Z. Thomas, and N. Delihias

Presented at the 79th Annual Meeting, American Society for
Microbiology, Los Angeles, CA, May 4-8, 1979.
- BNL 26175 ADSORPTION OF ENTEROVIRUS TO SOIL CORES AND THEIR
SUBSEQUENT ELUTION BY ARTIFICIAL RAINWATER

Edward F. Landry, James M. Vaughn, McHarrell Z. Thomas, and
Cheryl A. Beckwith

Applied and Environmental Microbiology 38, No. 4; 680-687
(1979)
- BNL 26176R A MODIFIED PROCEDURE FOR THE RECOVERY OF POLIOVIRUS
FROM NATURALLY INFECTED OYSTERS

James M. Vaughn, Edward F. Landry, Thomas J. Vicale, and
Marilyn C. Dahl

Applied and Environmental Microbiology 38, No. 4; 594-598
(1979)
- BNL 26448^a AQUATIC BIOLOGICAL PROCESSES EFFECTED BY ACIDIFICATION

George R. Hendrey

Presented at the Sulfur Biogeochemistry Workshop, Oak Ridge
National Laboratory, Feb. 2/-March 3, 1978.
- BNL 26613 ISOLATION OF NATURALLY OCCURRING ENTEROVIRUSES FROM A VARIETY
OF SHELLFISH SPECIES RESIDING IN LONG ISLAND AND NEW JERSEY
MARINE EMBAYMENTS

James M. Vaughn, Edward F. Landry, Thomas J. Vicale, and
Marilyn C. Dahl

J. of Food Protection (submitted)

^aAbstract

^RRevised version

Publications

Land and Freshwater Environmental Sciences Group

1979

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- BNL 26683 A MODIFIED PROCEDURE FOR THE EXTRACTION OF HUMAN ENTERIC
VIRUSES FROM NATURALLY-INFECTED OYSTERS USING CAT-FLOC AND
BEEF EXTRACT
Edward F. Landry, James M. Vaughn, and Thomas J. Vicale
J. of Food Protection (submitted)
- BNL 26808^a EFFECT OF ACIDITY ON MICROBIAL PROCESSES IN A FOREST SOIL
A. J. Francis, D. Olson, and R. Bernatsky
To be presented at International Conf. on the Ecological
Impact of Acid Precipitation, SNSF Project Norway,
March 11-14, 1980.
- BNL 26809^a SENSITIVITY OF THE EASTERN UNITED STATES TO ACID
PRECIPITATION IMPACTS ON SURFACE WATERS
G. R. Hendrey, J. N. Galloway, S. A. Norton, and
C. L. Schofield
To be presented at the Int'l Conf. on the Ecological Impact
of Acid Precipitation, As-NLH, Norway, March 11-14, 1980
- BNL 26810^a TEMPORAL AND SPATIAL TRENDS IN THE CHEMISTRY OF ACIDIFIED
LAKES UNDER ICE COVER
George R. Hendrey, James N. Galloway, and Carl L. Schofield
To be presented at International Conf. on the Ecological
Impact of Acid Precipitation, As-NLH, Norway,
March 11-14, 1980.
- BNL 26811^a SPHAGNUM AND THE FUNGAL MAT: BENTHIC PLANT COMMUNITIES IN
ACIDIFIED LAKE COLDEN, NEW YORK
George R. Hendrey and Frank Vertucci
To be presented at International Conf. on The Ecological
Impact of Acid Precipitation, As-NLH, Norway,
March 11-14, 1980.

^aAbstract

Publications

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- BNL 26911 EFFECTS OF ACIDID SOLUTIONS ON SEXUAL REPRODUCTION
 OF PTERIDIUM AQUILINUM
 Lance S. Evans and Christine A. Conway
 American J. of Botany (in press)
- BNL 26971 EFFECTS OF SIMULATED ACID RAIN ON GROWTH AND
 YIELD OF SOYBEANS AND PINTO BEANS
 Lance S. Evans and Keith F. Lewin
 Presented at the Symp. on Potential Environmental and Health
 Effects of Atmospheric Sulfur Deposition, Oak Ridge National
 Lab., Oct. 14-18, 1979. To appear in the Proceedings.
- BNL 27054 LOWLAND RECHARGE PROJECT: OPERATIONS, PHYSICAL, CHEMICAL AND
 BIOLOGICAL CHANGES - 1975-1979
Informal Report G. R. Hendrey, J. Clinton, K. Blumer, and K. Lewin
Limited Dist.
- BNL 27078 IMPACTION CHARACTERISTICS AND BIOLOGICAL EFFECTS OF DRY AND
 WET DEPOSITION OF ANTHROPOGENICALLY PRODUCED SULFUR COMPOUNDS
 AND ASSOCIATED ACIDITY OF VEGETATION
 Lance S. Evans
 J. Air Pollution Control Assn. (submitted)
- BNL 27089 ACIDIFICATION ON AQUATIC ECOSYSTEMS: ECOSYSTEM SENSITIVITY
 AND BIOLOGICAL CONSEQUENCES
 George R. Hendrey
 Presented at Action Seminar on Acid Precipitation, Toronto,
 Canada, Nov. 1-3, 1979.

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SORPTION OF CADMIUM AND ITS EFFECT ON GROWTH AND THE
UTILIZATION OF INORGANIC CARBON AND PHOSPHORUS OF THE TWO
FRESHWATER DIATOMS

H. L. Conway and S. C. Williams

J. Fish. Res. Board Can. 36, 579-586 (1979)

EFFECTS OF THE LIGHT REGIME IN NUTRIENT ASSIMILATION BY
PHYTOPLANKTON IN THE BAJA CALIFORNIA AND NORTHWEST AFRICA
UPWELLING SYSTEMS

D. M. Nelson and H. L. Conway

J. Mar. Res. 37, 301-318 (1979)

THE EFFECT OF SEWAGE ON UPTAKE OF INORGANIC NITROGEN AND
CARBON BY NATURAL POPULATIONS OF MARINE PHYTOPLANKTON

J. J. MacIsaac, R. C. Dugdale, S. A. Huntsman, and
H. L. Conway

J. Mar. Res. 37, 51-66 (1979)

SILICON UPTAKE BY UNIALGAL POPULATIONS AND NATURAL
COMMUNITIES OF FRESHWATER PHYTOPLANKTON USING ^{68}Ge AS
A SILICON TRACER

H. L. Conway, S. C. Williams, and T. J. Sharpe

Presented at the American Society of Limnology and
Oceanography, SUNY at Stony Brook, June 17, 1979

INHIBITION INTERACTIONS BETWEEN NITRATE AND AMMONIUM UPTAKE
IN TWO MARINE DIATOMS

Q. Dortch and H. L. Conway

Presented at the American Society of Limnology and
Oceanography, SUNY at Stony Brook, June 17, 1979

Publications

Land and Freshwater Environmental Sciences Group

1979

- BNL 51058 ANALYTICAL SUMMARY OF EXPERIMENTAL DATA FROM TWO YEARS OF
HOURLY SEQUENTIAL PRECIPITATION SAMPLES AT BROOKHAVEN
NATIONAL LABORATORY
Gilbert S. Raynor and Janet V. Hayes
- BNL 51074 LIMNOLOGICAL ASPECTS OF ACID PRECIPITATION
PROCEEDINGS OF INTERNATIONAL WORKSHOP AT SAGAMORE LAKE
CONFERENCE CENTER, SEPT. 25-28, 1978
George R. Hendrey, Editor
- BNL 51133 HOURLY VARIABILITY OF SAMPLE CHEMISTRY DURING PRECIPITATION
EVENTS AND ITS RELATIONSHIP TO METEOROLOGICAL PARAMETERS
Gilbert S. Raynor and Janet V. Hayes

VI. Oceanographic Sciences Division

A. Significant Accomplishments

From the vast amount of data collected on 50 cruises over the last 5 years, it has been possible to construct an annual carbon budget of the coastal food web in the New York Bight (Cape May, New Jersey to Montauk Point, New York). This carbon budget suggests that the flux of particulate matter through the pelagic herbivores and thence pelagic fish occurs mainly in the summer-fall, while carbon flow is directed to the food web leading to the demersal fish in winter-spring. The resident time and fate of this organic matter, sinking to the shelf sediments, is important in terms of both dispersal of pollutant energy-related particulates and as an intermediate sink in the global CO₂ cycle. Approximately half of the carbon fixed by the phytoplankton in this region, not including the richer areas of Georges Bank and the Hudson River plume, appears to sink to the bottom, but not be consumed by the benthic community. Since there is little carbon in the sediments of the northeast continental shelf, the organic matter, like fine-grain sediments, may be transported off the shelf to the upper slope, where more carbon is found in the sediments. The amount of particulate nitrogen that is apparently exported off the shelf is the amount of dissolved nitrate imported onto the shelf each year, i.e., a mass balance of nitrogen exchange across the shelf-break is maintained.

The onshore subsurface transport of salt across the shelf-break provides a major nutrient supply for productivity of the coastal zone. Nitrogen is the most limiting nutrient. About 50% of the nitrogen demand of the annual production of $\sim 250 \text{ g C m}^{-2} \text{ yr}^{-1}$ on the shelf between Montauk Point and Cape May is supplied from onshore flux of nitrate. The rest of the nitrogen used in plant growth within this area is supplied from regenerated ammonium from the excretion of bacterioplankton, zooplankton, and benthos. This second nitrogen supply is more subject to disruption from energy-related activities. As a result of additional nitrogen inputs from tidal mixing and estuarine runoff, however, the annual primary production is $\sim 500 \text{ g C m}^{-2} \text{ yr}^{-1}$ on Georges Bank and within the Hudson River plume. In the process of consuming the estuarine input of nutrients, the nearshore phytoplankton can also assimilate pollutants such as heavy metals, accumulate them as much as 40,000-fold for

copper and lead, and pass this material up the food chain, possibly inducing perturbations of the coastal zone.

From the study of the natural variability of the northeast coastal zone, it has been possible to provide a basis for future understanding of the introduction, interaction, and fate of particulate-related pollutants within the Hudson River, Delaware Bay, and Chesapeake Bay, i.e., downstream of the oil refineries and coastal power plants clustered in these areas. Detrital particulate matter, introduced by society at the head of northeast estuaries, tends to sink out within the estuaries, e.g., Long Island Sound, New York Harbor, and Chesapeake Bay, but the dissolved fraction of nutrients and pollutants passes out of the estuary onto the shelf. For example, as a result of burning fossil fuel and of river runoff, each year 1×10^4 tons of the toxic heavy metals (cadmium, mercury, lead, and copper) are released just to the New York Bight. The concentration of cadmium in estuarine discharge is close to the limits set by the EPA.

During MESEX I (Mesoscale Experiment I), the Spar Buoy Oceanographic Telemetry System (SBOTS) was combined with fluorometer moorings, shipboard observations of rate processes, and installation of sediment traps off the south shore of Long Island in May 1979 to study the longshore fate of discharge from Long Island Sound. Cruises were made on R/V ALBATROSS in March 1979 before the experiment, on the R/V OCEANUS and ADVANCE II in May 1979 during the experiment, and on R/V KELEZ in June, July, and August 1979 after the experiment. The upstream boundary conditions of Nantucket Shoals were studied in cruises of the R/V EDGERTON over the same time period.

There are some questions as to whether chlorinated hydrocarbons are just absorbed or bioaccumulated by marine organisms and how long petrochemicals are toxic in the coastal zone. At present, the trajectory of these other pollutant-related particles within the northeast shelf ecosystem is not understood. With the MESEX studies over the next few years, it is hoped to specify how much of the energy-related pollutants leaves these estuaries, how much is retained on the shelf, and how much is exported to the slope. From this information specific areas will be identified within the coastal zone that are likely to be most sensitive to energy-related pollutants and field effects studies will be initiated in these areas.

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B. Program Summaries

Title: Primary Production and Utilization

FY 79: \$444,000

Principal Investigator:
P. Falkowski

FY 80: \$455,000

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: Food Chain Dynamics

FY 79: \$390,000

Principal Investigator:
M. J. Dagg

FY 80: \$400,000

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 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 limitations 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: Ecosystems Analysis

FY 79: -0-

Principal Investigator:
A. G. Tingle

FY 80: \$85,000

Sponsor: Office of Health
and Environmental Research
(DOE)

Environmental problems in the coastal ocean occur, by definition, 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 wait for 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 years an enormous data base on the Middle Atlantic Bight has been acquired and successful data-collection programs continue to expand this base. Part of the BNL approach is to design computer models for various subcomponents of the ecosystem and the stress caused by human activities, in order to distinguish conservation and non-conservative properties within the context of natural variability of the system. The goal is to link the models in such a way that they can be used as a credible tool in the overall analysis, because 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 a recent fish kill or the consequences of energy-related pollution, require that the data base be readily accessible for analysis and that a significant commitment to the reduction, presentation, and interpretation of data be supported.

Title: Oceanographic Ship Charter

FY 79: \$210,000

Principal Investigator:
T. Whitledge

FY 80: \$225,000

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, 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: Northeast Oceanography Coordination

FY 79: \$25,000

Principal Investigator:
J. J. Walsh

FY 80: \$40,000

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: Coastal Upwelling Ecosystems Analysis - Systems Models

FY 79: \$202,000

Principal Investigator:
J. J. Walsh

FY 80: \$45,000

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. Simulation analysis is now being used in a comparative analysis of the perturbation response of different upwelling ecosystems off Oregon-California, Northwest Africa, and Peru.

Title: Coastal Upwelling Ecosystem Analysis - Nutrient Regeneration

FY 79: \$112,000

Principal Investigator:
T. E. Whitledge

FY 80: \$84,000

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. 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-imported zooplankton species. Analysis of a large series of zooplankton samples collected by net and pump during August-September 1976 and April-May 1977 off Peru is now being completed. It is also planned 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: Coastal Upwelling Ecosystem Analysis - Carbon, Nitrogen, and
Phosphorus Cycles on the Sea Floor of an Upwelling Region

FY 79: \$31,301

Principal Investigator:
G. T. Rowe

FY 80: \$15,000

Sponsor: International
Decade of Ocean Exploration/
National Science Foundation

The goals of this component are to quantify how much organic matter produced in the water column in the JOINT II area off Peru is lost by sedimentation to the bottom, is utilized in the secondary production of benthic invertebrates, or is regenerated as important plant nutrients which are returned to the water column. A set of circumstantial evidence implicates resuspension from the bottom as a possible cause for the catastrophic aguaje of 1976 and CUEA-wide information is being assembled in pursuit of this possibility.

Title: Ecosystems Analysis in the Bering Sea - Systems Models

FY 79: \$91,000

Principal Investigator:
J. J. Walsh

FY 80: \$102,000

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 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: Ecosystems Analysis in the Bering Sea - Nutrient Fluxes

FY 79: \$63,000

Principal Investigator:
T. E. Whitley

FY 80: \$108,000

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

FY 79: \$31,000

Principal Investigator:
M. J. Dagg

FY 80: \$74,000

Sponsor: Office of Polar
Programs/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 higher 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: Ecosystem Analysis in the Bering Sea - Temporal and Spatial
Variability of Zooplankton

FY 79: -0-

Principal Investigators:
Sharon Smith and Julio Vidal

FY 80: \$178,206

Sponsor: Office of Polar-
Programs/National Science
Foundation

The objective of this study is to describe temporal and spatial variability of zooplankton populations in the southeastern Bering Sea. This study will be conducted within the framework of the PROBES project and is intended to establish: (1) spatial (vertical and horizontal) and temporal (diel and seasonal) patterns in the distribution of major species, in terms of numbers and biomass, in the outer shelf and middle shelf zones of the southeastern Bering Sea; (2) the magnitude and timing of the input of juvenile stages of oceanic species with monocyclic life cycles into the surface layers of the oceanic and outer shelf zones; (3) the development and population dynamics of the major species throughout spring and early summer within the somewhat isolated environment of the outer shelf zone; (4) the timing, composition, abundance, and possible succession of the major species inhabiting the middle shelf zone; and (5) the extent and timing of diel vertical migration of dominant species and their life stages in the oceanic, outer shelf, and middle shelf zones.

In addition to describing the dynamics of zooplankton populations in the southeastern Bering Sea, the data obtained will make it possible: (1) to estimate secondary production for the major species; (2) to evaluate the effect of typically oceanic and neritic zooplankton populations on patterns of production and standing stocks of phytoplankton; (3) to establish pathways of material flow through the lower trophic levels of the oceanic and neritic communities; and (4) to determine patterns of temporal and spatial availability of food for pollock larvae.

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

FY 79: \$16,000

Principal Investigator:
T. S. Hopkins

FY 80: \$31,000

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 off-shore). In addition, drogue and current-meter observations are available or in progress. The approach to the analysis of this physical data set is 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: Investigation of Fundamental Biological Characteristics of the
Upwelling Area off Somalia during the Southwest Monsoon

FY 79: \$34,000

Principal Investigator:
S. L. Smith

FY 80: \$16,000

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 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 should occur in conjunction with the Somalia Current during the southwest monsoon. 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.

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

FY 79: \$50,000

Principal Investigator:
J. J. Walsh

FY 80: \$26,000

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

A \$60 million fish kill occurred within the New York Bight during June-August 1976 as a result of low oxygen conditions. A simulation model is being constructed 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 perturbation of this system.

Title: New York Bight Monitoring Project - Chemistry

FY 79: -0-

Principal Investigator:
T. E. Whitledge

FY 80: ^{mn} \$51,000

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

Periodic monitoring cruises are proposed to study the distributions of nitrogen nutrients and chlorophyll concentrations. The cruises, times, and station locations are distributed in space and time to ensure coverage of the New York Bight.

Four cruises are proposed on or near the dates of 21-25 April, 9-13 June, 14-18 July, and 25-29 August on the R/V GEORGE B. KELEZ. Fixed station locations would be occupied which include coverage from eastern Long Island to Cape May. The stations are comprised mostly of locations (38) sampled on the expanded XWCC grid and additional stations (8) to the shelf break.

At each location an in situ continuous fluorescence profile using an FTD will be initially taken to locate any chlorophyll maxima which could later be sampled discretely. Both down and up traces will be collected on the FTD system. A continuous salinity/temperature/depth profile will be taken from the surface to the bottom or 125 meters, with the MESA InterOcean CSTD system. On the upcast, at each station, water sample bottles on a rosette multisampler mated to the CSTD will be closed at selected standard depths or at chlorophyll maxima depths if such features are observed. The discrete samples will be analyzed for nitrogen nutrients (nitrate, nitrite, and ammonium), extracted chlorophyll, and dissolved oxygen concentrations. Additionally 3 samples (near-surface, Chl maximum, and nearbottom) will be preserved in Lugol's solution for phytoplankton identification and enumeration. Ten of the phytoplankton samples distributed over the station grid and collected from the chlorophyll maximum will be microscopically examined for approximate numbers and identification of the 4 or 5 most dominant phytoplankters present. Additional samples will be examined if unusual species or numbers are found.

Title: Coastal Transport and Diffusion

FY 79: \$260,000

Principal Investigator:
T. S. Hopkins

FY 80: \$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 was completed 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.

C. Future Plans for 1980

MESEX II is scheduled off New Jersey in March-April 1981. It will include a SBOTS-moored fluorometer array, sediment traps, and the air-sea interaction buoy in a study of the natural transfer process at lower trophic levels, loss of pollutant-related particulates from the water column, and a study of longshore coherence in chlorophyll fields from the Hudson River plume. Experimental studies will include work on food quality, partitioning of assimilated carbon zooplankton, and fluorescent pigments vs. phytoplankton species. Simulation models will be upgraded to simulate the trajectory of pollutant-related particles from both the estuarine and Georges Bank release points.

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D. Publications

Publications
Oceanographic Sciences Division
1979

- BNL 24491 GULF OF MAINE INTERMEDIATE WATER
 T. S. Hopkins and N. Garfield III
 J. Marine Research 37, 103-139 (1979)
- BNL 24878 ESTIMATED, IN SITU, RATES OF EGG PRODUCTION FOR THE COPEPOD
 CENTROPAGES TYPICUS (Krøyer) IN THE NEW YORK BIGHT
 Michael Dagg
 J. exp. mar. Biol. Ecol. 34, 183-196 (1979)
- BNL 25238 DISTRIBUTION, FLUXES, AND BIOLOGICAL UTILIZATION OF INORGANIC
 NITROGEN DURING A SPRING BLOOM IN THE NEW YORK BIGHT
 H. Lee Conway (ANL) and Terry Whitledge (BNL)
 J. Marine Research 37, 657-668 (1979)
- BNL 25376R CHLOROPHYLL TURNOVER IN SKELETONEMA COSTATUM,
 A MARINE PLANKTON DIATOM
 Paul G. Falkowski
 J. Plant Physiology 64, No. 1, 49-54 (1979)
- BNL 25495 ATLANTIC COASTAL EXPERIMENT II, R/V DELAWARE II,
 17-24 May & 9-13 June 1976, DATA REPORT
Informal E. Wold, Editor
Report
Limited Dist
- BNL 25685 GULF OF NAPLES ECOLOGY PROGRAM DATA REPORT - YEAR 1975
 PART 1: HYDROGRAPHY
Informal Maurizio Ribera d'Alcala
Report
Limited Dist.

Revised

Publications
Oceanographic Sciences Division

1979

-
BNL 25686	GULF OF NAPLES ECOLOGY PROGRAM DATA REPORT - YEAR 1976
PART 1: HYDROGRAPHY
Informal
Report
Limited Dist.	Maurizio Ribera d'Alcala
BNL 25687	GULF OF NAPLES ECOLOGY PROGRAM DATA REPORT - YEAR 1976
PART 2: PHYTOPLANKTON
Informal
Report
Limited Dist.	Maurizio Ribera d'Alcala
BNL 25688	GULF OF NAPLES ECOLOGY PROGRAM DATA REPORT - YEAR 1977
PART 1: HYDROGRAPHY
Informal
Report
Limited Dist.	Maurizio Ribera d'Alcala
BNL 25848 ^a	STRATEGIES OF LIGHT-SHADE ADAPTATION IN MARINE PHYTOPLANKTON
Paul G. Falkowski and Thomas G. Owens

Presented at the 42nd Annual Meeting of the American Society
of Limnology and Oceanography, Stony Brook, NY, June 18-21,
1979. To appear in the Preprint Volume.

<u>Plant Physiol.</u> (in press) |
| | |
| BNL 25898 ^a | VERTICAL DISTRIBUTION OF ZOOPLANKTON AND CHLOROPHYLL IN THE
NEW YORK BIGHT

David C. Judkins

Presented at the 42nd Annual Meeting of the American Society
of Limnology and Oceanography, Stony Brook, NY, June 18-21,
1979. To appear in the Preprint Volume. |

^aAbstract

Publications
Oceanographic Sciences Division

1979

-
- BNL 25903^a ALONGSHORE MESOSCALE NUTRIENT DISTRIBUTION, UTILIZATION AND
REGENERATION OVER THE NORTHEAST CONTINENTAL SHELF
Terry E. Whitledge
Presented at the 42nd Annual Meeting of the American Society
of Limnology and Oceanography, Stony Brook, NY, June 18-21,
1979. To appear in the Preprint Volume.
- BNL 26013 NATURAL FEEDING RATES OF THE COPEPODS CENTROPAGES TYPICUS
FEMALES IN THE NEW YORK BIGHT
M. J. Dagg and D. W. Grill
Limnology and Oceanography (submitted)
- BNL 26058^a PHYSICAL CHARACTERISTICS OF GEORGES BANK WATER
T. S. Hopkins and N. Garfield III
Presented at the Conference of the Oceanography of the Gulf
of Maine and Scotian Shelf, Bedford Institute of Oceano-
graphy, Halifax, Nova Scotia, Canada, May 16-18, 1979.
J. Marine Res. (submitted)
- BNL 26059 AN EXPERIMENT TO MEASURE MESOSCALE VARIABILITY
ON THE INNER CONTINENTAL SHELF
Thomas S. Hopkins and Terry E. Whitledge
Presented at the American Geophysical Union 1979 Spring
Meeting, Washington, D.C., May 28-30, 1979.
- BNL 26061 PERTUBATION ANALYSIS OF THE NEW YORK BIGHT
Arthur G. Tingle, Dwight A. Dieterle, and John J. Walsh
Ecological Processes in Coastal and Marine Systems, ed. by
R. J. Livingston, Plenum Press, 1979, pp. 395-435.

^aAbstract

Publications
Oceanographic Sciences Division

1979

-
BNL 26335	ATLANTIC COASTAL EXPERIMENT, PHYTOPLANKTON SPECIES
Informal Report	COMPOSITION: 1976-1978, DATA REPORT
Limited Dist.	P. Falkowski and K. von Bock, Editors
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