NASA Contractor Report 165814

NASA-CR-165814
19820011205

FINAL REPORT: 1981 SUMMER RESEARCH FELLOWSHIP PROGRAM

John H. Spencer (Compiler)

HAMPTON INSTITUTE
Hampton, Virginia 23668

NASA Contract NAS1-16455
October 1981

NASA
National Aeronautics and
Space Administration

Langley Research Center
Hampton, Virginia 23665

1981 SRFP

Table of Contents

Rationale

Historically, the academic programs at traditionally black institutions have not fostered active involvement in basic scientific research. College teachers with scientific backgrounds spend a substantial amount of time engaged in other activities which do not utilize their research capabilities and skills. The NASA-Hampton Institute Summer Research Fellowship Program offers capable scientists and engineers at traditionally black institutions an opportunity to participate in research activities in an environment at the Langley Research Center where basic research is of primary importance.

The Summer Research Fellowship Program has been specifically designed to assist these faculty members in identifying areas of research which correlate positively with their individual interest and capabilities. It is also designed to help them to initiate viable research which increases their technical knowledge about how research efforts at their institutions might be increased.

Programs similar to the Summer Research Fellowship Program also provide opportunities for university faculty members to engage in summer research activities, but these programs lack significant participation from faculty members representing predominately black institutions. This program actively solicits minority institutional involvement by providing fellowships which allow selected faculty members to become engaged in on-going research for ten-weeks during the summer at Langley Research Center. This experience should increase the quality and impact the quantity of research performed on these campuses, thus, giving more minority students the opportunity to participate in research activities. Through these activities, better research techniques will be developed by students and faculty members, therefore, a broader and more proficient base will be established from which capable scientists and engineers can be selected.

Objective

The Summer Research Fellowship Program involves professors from predominately black colleges and universities in research activities at the Langley Research Center. The program is specifically designed to:

1) Provide faculty members from participating institutions the opportunity to identify active research areas appropriate to their interests and capabilities;

2) Impact the academic programs of participating institutions through modifications resulting from changing emphasis in an academic discipline due to research,

3) Promote more cooperative ventures between participating institutions and the Langley Research Center;

4) Increase the resource base which provides proficient scientists and engineers.

Eligible Institutions

All predominately black colleges and universities are eligible for inclusion in the program. Six colleges and universities were represented in the 1981 program.

Eligible Faculty

Faculty members in the areas of computer science, chemistry, engineering (aeronautical, architectural, civil, electrical and mechanical), mathematics, physics and electronic technology at eligible institutions are eligible to participate in this program. Chemistry, mathematics and physics were the represented disciplines this year.

Program Statistics

ITEM	PROGRAM YEARS					
	1976	1977	1978	1979	1980	1981
Dollars Appropriated	42.5K	50K	43K	54K	62K	63.7K
Dollars Spent	42.5K	47.2K	41.7K	56K	48K	18.5 ***
Applicant Institutions	16	16	17	18	26	NA
Fellow Institutions	8	9	8	9	7	5
Applicants	42	44	47	32	42	NA
Females	(7)	(9)	(7)	(5)	(4)	NA
Males	(35)	(35)	(40)	(27)	(38)	NA
Fellows	9	11	8	11	7	8
Females	(1)	(2)	(2)	(2)	(0)	(1)
Males	(8)	(9)	(6)	(9)	(7)	(7)
Black	(4)	(4)	(6)	(4)	(3)	(5)
Caucasian	(5)	(5)	(1)	(5)	(3)	(2)
Asian	(0)	(2)	(1)	(2)	(1)	(1)
Fellow (Applicant) Disciplines						
Engineering	3(5)	0(3)	1(7)	1(4)	0(6)	0
Mathematics-Computer Science	1(28)	5(16)	5(21)	7(16)	3(18)	6
Chemistry-Physics	1(8)	5(13)	2(13)	2(10)	4(17)	1
Others	0(5)	1*(12)	0(6)	1**(2)	0(1)	1

*BIOLOGY **PHYSICAL SCIENCE ***AS OF JUNE 1981

During the first four years of the program faculty members from 25 of 26 participating institutions applied to the program and Fellows were chosen from 18 of the 26. Also, there were applicants from four institutions not included on the list and one Fellow was selected from among those applying. As of 1980, all predominately black colleges and universities were sent announcements of the program.

Program Management

The 1980 Summer Research Fellowship Program was the first to include all predominately black colleges and universities. The program was launched in October 1979 by writing the Academic Deans or Vice-Presidents for Academic Affairs of approximately seventy-five of the institutions to announce the program and request a list of eligible faculty members.

As the lists were received, letters and brochures were sent to the faculty members. The letter included information about the program and indicated how to obtain an application form and a list of the problems submitted by the Langley Research Center. Applications began arriving in late December and were accepted through January 1980, however, because of the schedules of some institutions, many faculty members did not collect their mail in time to submit an application. Also, some institutions did not submit lists so the brochures, application forms and list of problems were sent to department chairpersons at those institutions.

As the applications were received, they were reviewed by the Program Coordinator and most were taken to the Langley Research Center for distribution to the various research divisions. During the last week of February, Dr. John E. Duberg, Dr. Wayne D. Erickson, Dr. William H. Michael, Dr. Alvin F. Anderson, Mr. Franklin C. Owens (all at the Langley Research Center) and the Program Coordinator met to select ten participants and several alternates. These persons were notified of their selection by telephone and letter and were requested to notify the Program Coordinator of their decisions by March 15, 1980. Two persons declined the invitation so the alternates were contacted.

During April and May the Fellows were sent additional program information including, teh name, address and telephone number of his respective Research Associate, the general research problem to be investigated, some housing information, and the time and place of the orientation meeting on June 2, 1980.

In May 1981 Dr. Geraldine Darden resigned from her position at Hampton Institute and the position of Program Coordinator. The position was filled by Mr. John H. Spencer, Chairman of the Department of Architecture at Hampton Institute. Mr. Spencer assumed the duties of Program Coordinator in the middle of May 1981.

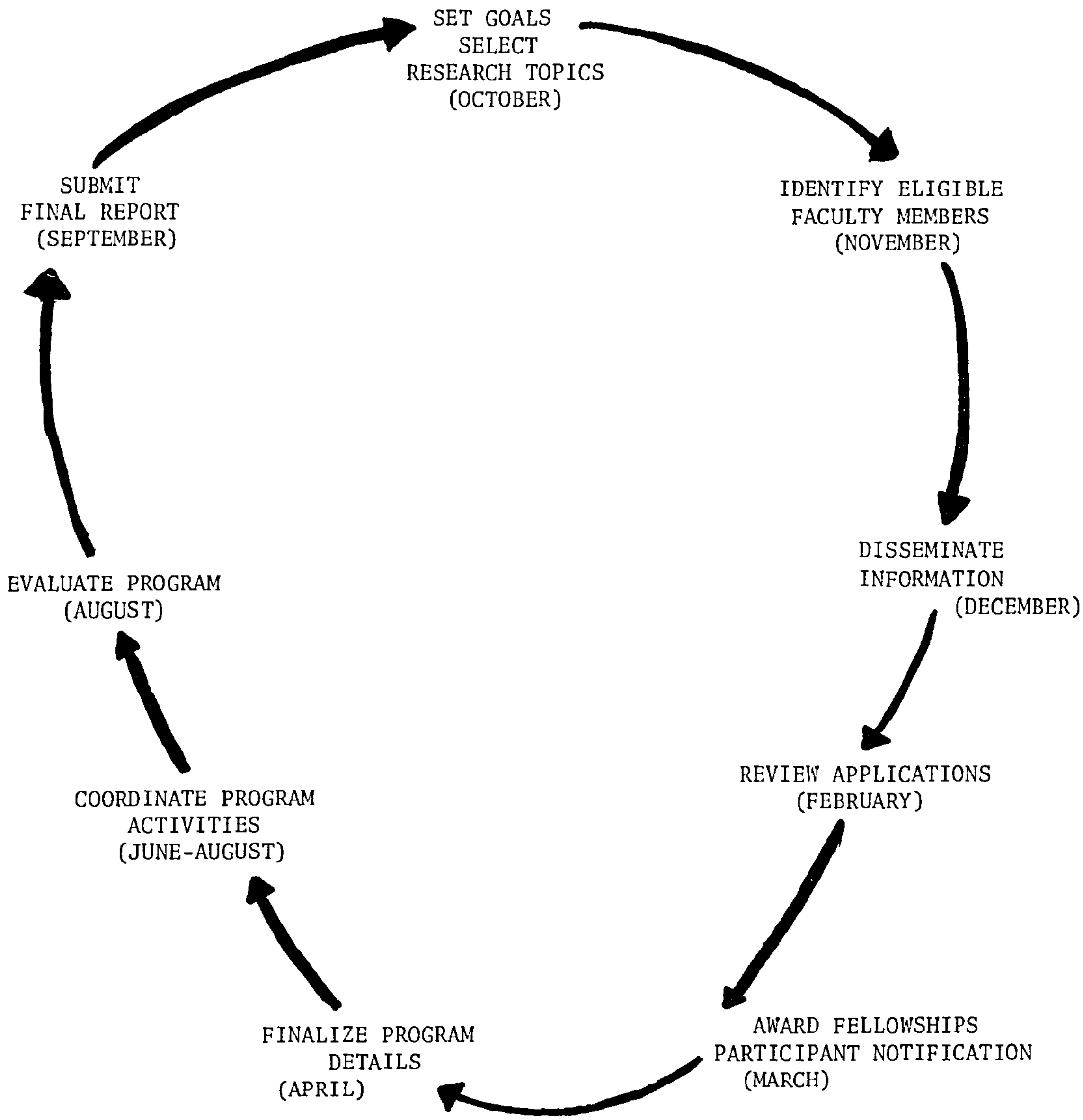
The Fellows and the Program Coordinator met each week for a lunch discussion period to review progress and to discuss any common problems. During the summer the fellows attended various programs and lectures at the center. The Program Coordinator visited each Fellow at least twice during the ten-week period to discuss progress and concerns. Fellows were urged to learn as much about the operations of the center as possible and to try to find some project they might possible conduct on their own campuses.

During the fifth week of the program one of the Fellows became ill and was out for approximately ten days. The time was made up by attending the work period at the end of the project time.

For the first time a Fellow outside the traditional Science/Mathematics/Physics disciplines was admitted to the program. This Fellow conducted research in the Acquisitions Division. The oral report was very well received and a synopsis is included in this report.

Each Fellow submitted a written synopsis on 27 July 1981 and gave an oral presentation on 29 July 1981. Division Chiefs and Research Associates were invited to hear the oral reports.

SUMMER RESEARCH FELLOWSHIP ACTIVITIES CYCLE



1981 SRFP Fellow Information

Name & Address	Age	Education	Area	Institution & Title	LaRC Division	LaRC Research Unit	LaRC Contact Extension (804) 827-
Billie, Annette	47	B.S. -(1956) M.S. -(1963) SC State College Ph.D (1974) University of Pittsburg	Mathematics Education Higher Education	Fayetteville State University	Aerodynamics (High Speed) Division	Fluid Mechanics Branch	J. Harris
Ghent, Robert C. Taladega College Taladega, Ala 35160	38	BA (1964) University of Oregon AM (1970) Harvard University	Mathematics Mathematics	Taladega College	Analysis and Computation Division	Computer Applications Branch	John Hogge 3547
Keepler, Manuel Box 1656 South Carolina State College Orangeburg, S.C 29117	37	B.S.(1965) Morehouse College M.A.(1967) Columbia University Ph.D(1973) University of Mexico	Mathematics Mathematics Statistics Mathematics	South Carolina State College	Analysis and Computer Division Division	Computer Applications Branch	J. Shoosmith 3466
Krishna, Gopala, M.V. Box 1814 South Carolina State College Orangeburg, S.C. 29117	44	B.S. (1959) M.S. (1960) University of Mysore M.S. (1971) Ph.D(1974) Clarkson College of Technology	 Mathematics	South Carolina State College	Subsonic-Transonic Aerodynamics Division	Fluid Dynamics Branch	Robert Kilgore 3711

Name & Address	Age	Education	Area	Institution & Title	LaRC Division	LaRC Research Unit	LaRC Contact Extension (804) 827-
Matthews, Nathaniel	45	B.S. (1962) M.S. (1967) Ed.D(1972) Memphis State University	Chemistry/ Mathematics Administration and Supervision Physical Science Education	LeMoyne Owen College Associate Professor	Aerospace Environmental Sciences Division	Aerosol Meas. Research Branch	Dave Woods 2401
O'Daniel, Richard M. 1556 Waterside Dr. Chesapeake, Va 23323	36	B.A.(1968) Lincoln U. (Pa.) M.B.A. (1975) D. Ed. (1978) University of Massachusetts (Amherst)	Political Science/ Economics	Norfolk State University Associate Professor	Acquisitions Division	Acquisitions Operations Branch	V. Vann 3438
Rudd, David 6501 Adair Ave. Norfolk, Va 23506	37	B.S.(1966) Rensselaer Polytechnic Institute M.S.(1967) Ph.D(1970)	Mathematics Mathematics Mathematics	Norfolk State University Assistant Professor	Marine and Applications Division	Mission and Operations Branch	David Brooks 2977
Stith, John J. 2605 Hatchett Rd. Petersburg, Va 23803	36	B.S.(1973) M.S.(1975) Virginia State University	Physics Physics Assistant Professor	Virginia State University Assistant Professor	Space Systems Branch	Space Technology Branch	Gil Walker 3781

Numerical Solution of The Time Dependent Convection-Diffusion Equation

Dr. Annette Billie
NASA-HI 1981 Fellow
Computational Methods Branch
High-Speed Aerodynamics Division

The distribution of temperature in a viscous flow is governed by the convection diffusion-equation. Various numerical schemes are used to obtain solutions for the convection diffusion-equation. A comparison between the numerical solution and the exact solution was done at different times for one and two dimensional problems.

In this research, one-dimensional, two-dimensional, weighted mean scheme (WMS), Dufort-Frankel (DUFRANK) and weighted mean scheme + Dufort - Frankel (WMS + DUFRANK) were tested and compared for accuracy. In testing the equation using the one-dimensional case, this was done by using the right difference, left difference and central difference, which gave very good results as shown from the graph of the equation. (See Appendices).

With the two-dimensional case, using the central difference only, the boundary layers reached a point of stability faster due to regions of large variations over short lengths.

Other numerical solutions were tested in completing this project, i.e., the two-dimensional weighted mean scheme, which gave very good results. The Dufort-Frankel showed stability for all Δt and increased accuracy. The final step of this project was to test the Dufort-Frankel plus the weighted mean scheme. Given many assigned values for Δt the test would not work. Therefore, a steady-state viscous flow could not be reached, in this research for the boundary-layer.

My research assignment was to use several methods of solving an equation in incompressible viscous flow. The most important equation is the advection-equation (The process of transport of an atmospheric property solely by the mass motion of the atmosphere; also the rate of change of the value of the advected property at a given pount). The incompressible viscous flow is governed by the following equations:

$$\frac{\partial T}{\partial t} = -u \frac{\partial T}{\partial x} + \sigma \frac{\partial^2 T}{\partial x^2} \qquad (1)$$

One-Dimensional Equation

$$\frac{\partial T}{\partial t} = -u \frac{\partial T}{\partial x} - v \frac{\partial T}{\partial y} + \sigma\left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2}\right) \qquad (2)$$

Two-Dimensional Equation

Given the two-dimensional Equation, there are three (3) parts that we must consider:

(1) T is the time-dependent term and evolves with time.

(2) uT and vT are convective terms. (In general, mass motions within a fluid resulting in transport and mixing of the properties of that fluid.)

(3) $\sigma \left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2}\right)$ is the diffusion (In an atmosphere, or in any gaseous systems, the exchange of fluid parcels between regions, in apparently random motions of a scale too small to be treated by the equations of motion expands).

Therefore, as the computation is done for the above equation, in part three (3) of the two-dimensional case, consideration must be given to the left difference, right difference, and the central difference. With these considerations, we can now determine what will happen when σ has small or large values. If σ is large, use the central difference, if σ is small, use the right or left difference.

Given equation (2), second derivative, the central difference which gives a strong diffusion and good stability. Somparisons of the approximate solutions with the exact solutions were done at different time level. Two phenomena were experienced, (1) transient and (2) steady. Two phonomena were expected: (1) transient and (2) steady-state solution.

Very good results were obtained from all the schemes used, except the combined Dufort-Frankel + Weighted Mean Scheme. This scheme would not work for any given values assigned.

The area of computational fluid dynamics is very interesting, rewarding, and most challenging. I would like to return to my institution and continue this type of research. As one objective I would like to develop and implement appropriate new numerical techniques and turbulence and reaction models that can be used. Hopefully, I can also return here another summer and further my research in this area.

Approximate Solution of Integral Equations

Robert Ghent
NASA-HI 1981 Fellow
Analysis and Computation
Division

For several decades, mathematicians interpolating data with a smooth curve have often selected some type of spline function. Langley Research Center recently received computer subroutines which generate families of splines incorporating a freely chosen "tension" parameter.

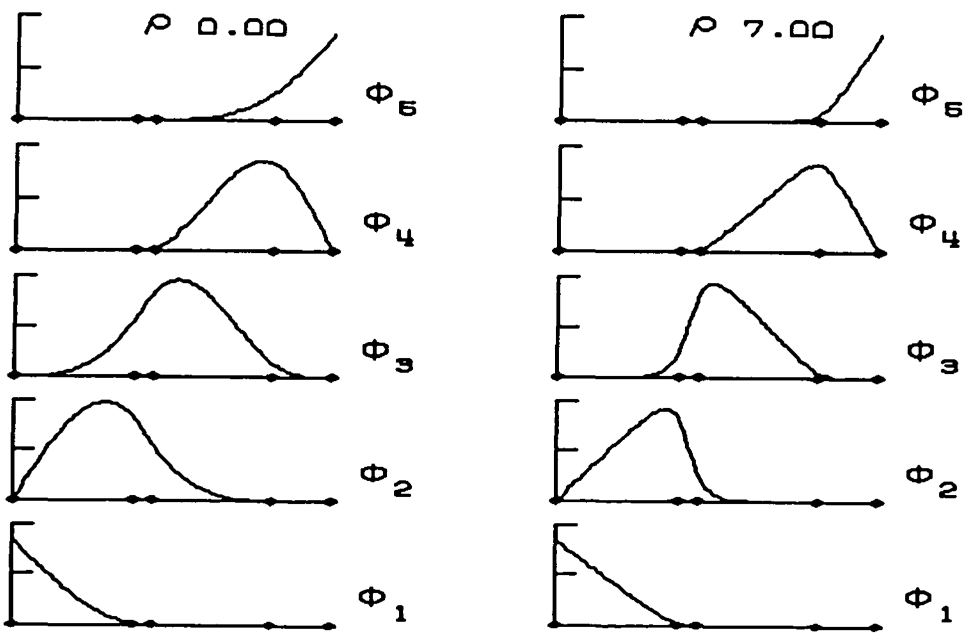
As an initial test of these algorithms, John Hogge of the Computer Applications Branch suggested solving a system of integral equations. Without using the tension parameter, CAB member Steve Park had already demonstrated the effectiveness of similar subroutines in finding the distribution of the earth's total radiation as a function of wavelength.

Draftsmen employ flexible wooden laths, called splines, to sketch smoothly through a sequence of fixed points, called knots. Pulling on the ends would cause a straightening between knots, A linear differential equation for elastic equilibrium of each section is $\phi'''' - p^2\phi'' = 0$, where p is the tension in the spline curve $y = \phi(x)$. Solutions can be expressed as linear combinations of 1, x, e^{px} and e^{-px}. Boundary conditions force the curve to pass through each know location with continuously varring slope and curvature.

To formulate an integral equation problem, imagine m sensors measuring radiation intensity. Ideally, each would detemrine the value of the unknown radiation function f(x) at one wavelength x. Realistically, readings are a weighted average over a short range of the spectrum. If $k_i(x)$ denotes the sensitivity of the i^{th} instrument, then its measurement is represented by $b_i = \int K_i(x)f(x)dx$, over a suitable interval of integration.

Many functions would satisfy the m equations. Physically it is reasonable to assume $f(x)$ can be approximated by a linear combination of well-behaved basis functions, splines under tension in this case. If $f(x) = \sum_{j=1}^{n} c_j \phi_j(x)$, where $\{ \phi_j \}_1^n$ denotes an appropriate basis set, then the integral equation problem reduces to one of linear algebra: $b_i = \int K_i(x)f(x)dx = \sum_{j=1}^{n} c_j \int K_i(x)\phi_j(x)dx$. By singular value decomposition techniques, the computer can solve for $\{ c_j \}_1^n$ and thus for $f(x)$, even if the $m \times n$ matrix $((K_i(x)\phi_j(x)dx))$ is not square.

In actual satelite observations, measurements not only have errors but are also partially redundant, due to overlapping sensitivity bands. The technique outlined here produced good final approximations nonetheless. Puzzling inconsistencies in early experiments this summer led to the discovery of a faulty computer subroutine. Langley Research Center now has the correct version.



Sample Spline Basis Functions Using Five Knots, with (right) and without (left) Tension

A Macsyma Application

Manuel Keepler
NASA-HI 1981 Fellow
Analysis and Computation
Division

Macsyma is a large and versatile computer programming system written in LISP which is specifically designed for performing algebraic and symbolic as well as numerical manipulations. It is implemented on a PDP-10 computer at the Massachusetts Institute of Technology which is accessible to NASA users from certain interactive terminals via the Advanced Research Projects Agency (ARPA) network. This summer, under the overall direction of Dr. John Shoosmith with assistance from Dr. Sandra J. DeLoatch, efforts were made to solve a substantive problem of interest to a member of the Analysis and Computation Division (ACD) using Macsyma.

A grid generation technique called the "two-boundary technique" has been developed and applied to the solution of the two or three-dimensional compressible Navier-Stokes equations by Dr. Robert E. Smith (ACD) and others. The compressible form of the Navier-Stokes equations adequately describes aerodynamic flow so if it was possible to efficiently solve these equations there would be little need for experimental tests to design flight vehicles. Currently, MacCormack's method for solving these equations is very popular for aerodynamic calculations The goal of the present endeavor is to apply MacCormack's implicit method to the grids generated by the two-boundary technique.

Macsyma has been used in an essential manner in this project to make certain matrix calculations. In applying MacCormack's implicit method with a grid transformation, it is necessary to calculate the eigenvalues of Jacobians associated with the transformed Navier-Stokes equations. After the Jacobians are calculated, Macsyma is employed to find the eigenvalue (a task that is impossible to do by hand). Although some progress has been made towards completion of this objective, due to the sheer magnitude of the problem and to technical difficulties with Macsyma (insufficient storage), more work is needed to reduce the Jacobians to a form where Macsyma can take over the eigenvalue determination This project has shown the advantages and shortcomings of computerized symbolic manipulation, Macsyma being the most advanced. Large complex problems with many variables are still unsolvable, but considerable insight into the solution process is obtained.

Application of MacCormack's Explicit Implicit Finite Difference Scheme

Dr. M. V. Gopala Krishna
NASA-HI 1981 Fellow
Subsonic-Transonic
Aerodynamics Division

The project was to apply the new MacCormack's Explicit Implicit Finite Difference Scheme to Euler equation solution for transonic flow about nonlifting airfoils and circles.

The implicit scheme uses the explicit scheme as its first stage. The equations are therefore first solved by using explicit scheme. In the explicit scheme computational grid consisted of 65 points in the horizontal direction and 25 in the verticle direction. A maximum of 300 iterations for the 1625 points were used to obtain Convergingıng Solution. On the lower boundary property of reflexion and one sided difference were used. To obtain better approximation after each time step the predictor and the corrector steps were switched. Various solid boundaries such as circular are airfoil, parabolic are airfoil, Kaplans bump, Wedge-ogive and NACA 0012 airfoil were considered. For each solid boundary, plots of CP and Mack number were obtained when Mack number is 0.4. The results are in very good agreement with those obtained by other methods for the same boundary conditions, but the computer time needed in this method in much less. In the case when Mack number is 0185 fourth under Smoothing term were used to capture the shock and dampen undesirable oscillations.

Two subprograms are written to impliment the Implicit Scheme. These subprograms are used to sweep first towards the lower boundary in the Predictor step and then away from this boundary in Corrector step by changing an index to 1 or 0. Similarity in the X direction step and in the opposite direction in the corrector step. Final results from the Implicit Scheme will be ready before the end of the summer program.

Effects of Altitude/Pressure on The Aerosol Sizing Characteristics of a Quartz Crystal Microbalance Cascade Impactor

Nathaniel Matthews
NASA-HI 1981 Fellow
Atmospheric Environmental Sciences Division

Over the past several years NASA has conducted a number of flight experiments aimed at assessing the effects of aerosols on global climate. These fine particles suspended in the atmosphere, will interact with solar radiation through scattering and absorption and thereby alter the earths temperature. The flight experiments are therefore designed to measure those parameters which affect the scattering and absorption of solar radiation. One such parameter which plays an important role in scattering radiation is the aerosol size distribution. The role of the size distribution N(r) is reflected in the expression for the scattering coefficient of an ensemble of polydisperse particles.

$$\sigma(r) = \int_{r_1}^{r_2} \pi r^2 \; N(r) \; K(\pi \; r/\lambda) dr \qquad \text{Eq. 1.}$$

where $\sigma(r)$ ≡ the scattering coefficient
r ≡ the particle radius
K ≡ scattering efficiency
λ ≡ the wavelength of light
$N(r)$ ≡ the particles size distribution

The method used to measure N(r) in these flight experiments employs a piezoelectric microbalance cascade impactor[1] which inertially separates particles into ten size intervals ranging from approximately 0.05 μm to 25 μm diameter. The mass of the particles in each size interval is measured directly by means of piezoelectric microbalances. The final data are in the form of mass as a function of particle diameter which is then converted to number concentration (number of particles per cm^3) as a function of particle diameter.

The expression for the diameter of particles which will impact in a given stage of the cascade impactor is given by

$$D^2 = \frac{1.9\ \mu\ dj}{C\ \ \rho\ Vj} \qquad \text{Eq. 2.}$$

where: D ≡ diameter of particles having 50% probability of impacting

μ ≡ viscosity of air

dj ≡ jet diameter

ρ ≡ mass density of the particles

Vj ≡ velosity of the particles through the jet

C ≡ the cunningham slip correction

An emperical expression for C is

$$C = 1 + \frac{0.16}{D}\ \frac{Ps\text{-}1}{Ps}$$

where: Ps ≡ pressure in stage s

Ps-1 ≡ pressure in stage s-1

When Ps=1, Ps-1 = ambient static pressure.

Since the Cunningham slip correction depends on pressure it can be seen from Eq. 2 that the diameter of particles which will impact in a given stage also depends on pressure. The instrument is flown over a wide range of altitudes (pressures) which means a separate set of Cunningham slip corrections and therefore impaction diameters for each altitude. The instrument is currently being calibrated with an inlet pressure equivalent to an altitude of 60,000 feet. The problem therefore is to calculate corrections to be applied to the calibration for other altitudes.

A calculator program written for the TI-59 desk calculator was used to calculate D from equation 2 by varying the ambient pressure. Table 1 shows the calculated impaction diameters for each impactor stage for altitudes of 45, 50, 60 and 70 thousand feet. It can be seen that the impaction diameter on a given stage decreases with increasing altitude. The diameters in Table 1 at 45, 50 and 70 thousand feet were compated to those at 60,000 feet and the differences were expressed in terms of a percent correction (Table 2). These corrections can be applied to the calibration for 60,000 feet to obtain the correct diameters for the other altitudes. Figure 1 shows the corrections graphically for stages 1 and 10.

---

[1] Chuan, R. L., "An Instrument for the Direct Measurement of Particulate Mass," Aerosol Science, 1, 111-114, 1970.

TABLE I

Calculated Particle Diameter Per Given Altitude

ALTITUDE IN 1000 FT (MICROMETERS)

STAGE #	45	50	60	70
1	33.37	32.8	31.1	28.8
2	16.68	16.4	15.56	14.4
3	8.34	8.2	7.78	7.2
4	3.97	3.95	3.63	3.27
5	1.80	1.72	1.50	1.25
6	0.83	0.756	0.628	0.49
7	0.369	0.322	0.251	0.18
8	0.189	0.165	0.126	0.09
9	0.122	0.106	0.078	0.06
10	0.096	0.084	0.061	0.04

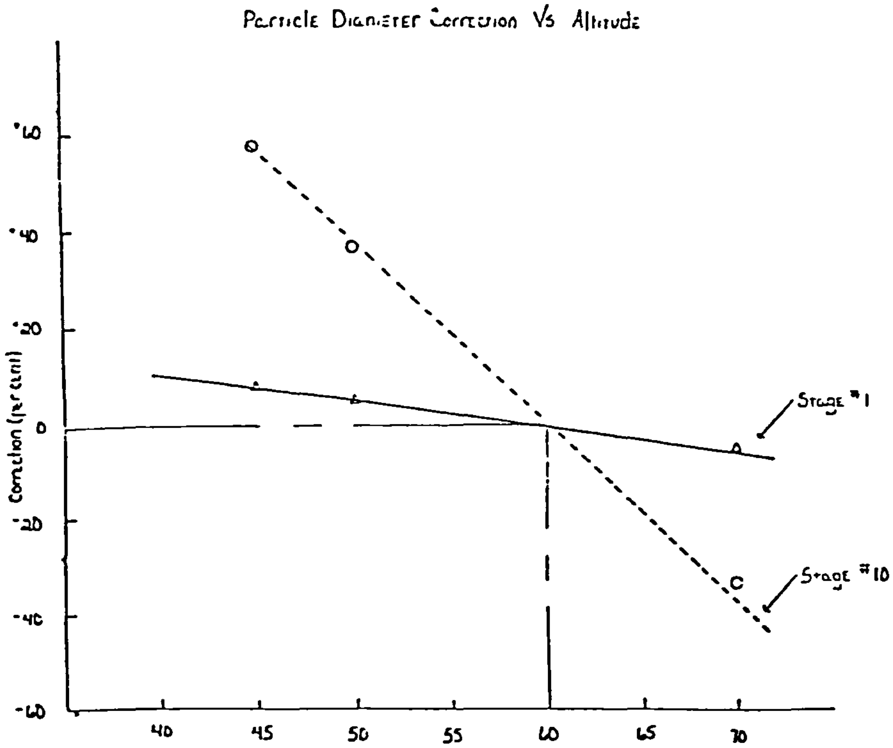
TABLE 2

CORRECTING PERCENTAGES BASED ON 60,000 FT

ALTITUDE IN 1000 FT (%)

STAGE #	45	50	60	70
1	+7.3%	+5.5%	0%	-7.3%
2	+7.2%	+5.5%	0%	-7.5%
3	+7.2%	+5.5%	0%	-7.5%
4	+9.9%	+8.8%	0%	-9.9%
5	+20%	14.6%	0%	-16.6%
6	32%	20%	0%	-22%
7	+47%	28%	0%	-28%
8	+50%	32%	0%	-26%
9	+56%	35%	0%	-28%
10	+57%	37%	0%	-33%

Figure 1


Particle Diameter Correction Vs Altitude
Correction (percent)
+60
+40
+20
0
-20
-40
-60
40
45
50
55
60
65
70
Stage #1
Stage #10

"An Acquisition Division Data Input and Retrieval System Design Study"

Richard M. O'Daniel
NASA-HI 1981 Fellow
Acquisition Division

This abstract provides a brief narrative overview of this summer's research project which consisted of a design study of the date input and retrieval requirements for a new Acquisition Division Information System. The main goal of the study has been to identify and analyze the basic logistical requirements necessary for developing a data input and retrieval plan, such as physical layout, organizational flow, procurement process, document flow, information flow, and data element responsibility.

To achieve this task and provide relevent recommendations the following six objectives were established. These objectives listed below represent the major actions taken during the course of this summer's study. All but the goal at this stage of the new systems development. Nonetheless, this objective might be further pursued in a future research effort.

1. Interview Contracts Branch Head and two Assistant Heads.
2. Interview Acquisition Operations Branch, Purchasing Section Head, Closeout Staff, Pricing Office, Operations Analysis Management Information System and Industry Assistance Staff.
3. Determine the average PR/PO and contract load by volume and data requirements associated with each.
4. Identify organization of staff by office location, numbers and average work load.
5. Develop estimate of logistic requirements for· data input time by total, PR/PO and contracts, location and number of input facilities; and personnel needs of new system.
6. Solicit and develop suggestions for data input document format, flow, timing, processing and input personnel.

In summary, the major thrust and most visible result of this summer's effort has been the development of an Acquisition Division Purchase Request/Order and Contract Data Information Flow Responsibility Graph or Chart. This Chart provides a valuable visual aid for understanding the procurement process and its data requirements. It has already proven itself to be a valuable visual aid to BCSD, the systems contractor P.R.C., other Langley Divisions and students in the classroom. This summer's experience has been a most rewarding endeavor which has permitted a mutual exchange of benefit between NASA Langley Research Center and Norfolk State University. In closing I would like to express my sincere appreciation for the opportunity to participate and hope to be involved in future research here at the center.

David Rudd
NASA-HI 1981 Fellow
Marine Applications
Technology Division

A Statistical Model for Diurnal Cloud-Cover Variation

Because the Earth experiences both an income (from the Sun) and an outgo (through reflection and emission) of radiant energy, the associated processes are referred to collectively as the Earth's radiation budget.

Variations in cloud cover play an important role in radiation-budget measurements (it is estimated that two thirds of the Earth's reflected radiation and one half of the emitted radiation come from clouds), but the general unpredictability of clouds, coupled with their imprecise physical nature, leads to obvious difficulties in attempts to account for them.

A data set known as the GOES data (Geostationary Operational Environmental Satellite) contains 24 hourly measurements (of cloud cover) for each day of an entire (30-day) month. The measurements were taken over an area of the globe containing the continental U.S., most of South America, and portions of the Atlantic and Pacific Oceans. The area was subdivided into 1600 regions, each 250 x 250 km.

Past work with this data set, involved computing the range R of the mean hourly cloud covers. Thus, if C_{ij} denotes the cloud cover (as a fraction between 0 and 1, inclusive) at hour j and day i, then R is the difference between the largest and smallest members of the collection

$$\left\{ \frac{1}{30} \sum_{i=1}^{30} C_{ij} \;\middle|\; j = 1,2,\ldots,24 \right\} .$$

In general, this number does not accurately represent the diurnal range, however. For example, there were regions over the U.S. where R was as small as 7 percent, yet for 20 out of the 30 days of the month, the diurnal variation in cloudiness was over 25 percent, and there were 8 days when the variation was over 80 percent.

As an attempt to describe the diurnal range and to ascertain its significance, it was decided to look at the mean and variance of the statistic $d_i = \max_{j=1,24} C_{ij} - \min_{j=1,24} C_{ij}$ for $i = 1,2...30$.

Because of the expected variation in patterns of cloud cover and because of previous work in analyzing cloud data, a beta distribution was postulated as describing the population.

The (transformed) beta density function is defined by

$$B_{a,b}(x) = \frac{\Gamma(a+b)}{\Gamma(a)\,\Gamma(b)}\, x^{a-1} (1-x)^{b-1} \quad \text{for } 0<x<1$$

$$= 0 \quad \text{otherwise.}$$

Of course, the population parameters a and b are not known, but by using the sample mean $\overline{x}$ and the sample variance s^2, we can obtain the approximations a* and b* given by

$$b^* = (1-\overline{x})\,[\overline{x}(1-\overline{x}) - s^2]/s^2 \text{ and } a^* = \overline{x}b^*/(1-\overline{x})$$

After these parameters were computed, a comparison was made for several regions using the sample cumulative distribution function and that given by the incomplete beta function

$$I(x) = \int_0^x B_{a,b}(t)\, dt.$$

The Kolmogorov-Smirnov Test for goodness of fit was applied at the rejection level $\alpha = .05$, and the results were well within the limits of the test.

Thus, given any of the 1600 regions, the beta function can be used to compute the probability that the diurnal variation in cloud cover will be greater than any preassigned number.

Electrochemical Technique for Evaluating Layers of Polycrystalline GaAs

John H. Stith
NASA-HI 1981 Fellow
Space Science Division

At the present time there is a large amount of interest on the growth of thin layers of polycrystalline N-type gallium arsenide for fabricating solar cells. This interest stems from the possibility that solar cells made from this material can be cost effective because the polycrystalline material can be grown on inexpensive substrates and the cells have reasonable efficiency due to the direct bandgap nature of GaAs. Conventional measurement techniques such as Hall Effect, four-point resistivity probe, and capacitance-voltage techniques, which are very useful for evaluating layers of single-crystal material are very difficult to interpret for polycrystalline material due to the presence of grain boundaries. Impurity segregation and a large density of defects associated with grain boundaries can cause the doping concentration in a polycrystalline material to be nonuniform not only over large areas, but even from grain to grain depending upon the size. Proper determination of the doping concentration in a polycrystalline material requires the use of a measurement technique capable of determining not the average doping concentration, but information concerning the percentage of area as a function of the doping concentration. Jose Borrego and Sarab Ghandhi, two researchers at Rensselaer Polytechnic Institute, proposed that an electrochemical technique could be used to determine the various doping concentrations and the corresponding area percentages for the sample.

During this summer at NASA the proposed electrochemical technique has been under investigation to determine whether it is reliable for evaluating polycrystalline samples of GaAs grown here.

The technique involve analyzing the time behavior of the anodizing current used to oxidize the surface of a polycrystalline sample. An oxide will only begin to form on the areas of the surface that have reached breakdown voltage. The voltages at which the various areas of the surface break down depend upon the doping concentration. The grain boundaries act as traps for the dopant and will usually have the highest concentration of dopant and are the first to oxidize. Dopant diffuse more rapidly from the grain boundaries into the smaller grains than into large grains and therefore the doping concentration is greater in the small grains than in the large grains. The areas of the surface made up of small grains will break down before the areas made up of the large grains because of the higher doping concentration in the small grains. As the oxide layer builds up the voltage across the sample increases and the areas of higher breakdown voltages will breakdown and begin to oxidize. With the build up of the oxide layer, the anodizing current decays exponentially for a particular surface area. If the surface area over which the oxidation is taking place is increased, (which occurs when other areas of the surface break down) the current will vary from its exponential decay. The voltages at which the various areas of the surface break down are determined by making a semilog plot of anodizing current versus time. The break down of the different areas are indicated by changes in the slope of the curve. The breakdown voltages can then be determined for these areas and from the voltages the doping concentration can be determined. The slope of each segment of the curve over which the exponential decay of the current is indicated is used to determine the percentage of area for each breakdown voltage.

At this point, preliminary results indicate that this electrochemical technique is very promising one for the polycrystalline layers' evaluation.

Some Significant Accomplishments, 1976-1981

The Summer Research Fellowship Program was initiated at the Langley Research Center during the summer of 1976. Since that time, some significant technical contributions have been made by Summer Research Fellows. Only one from each Program year is briefly discussed below.

1976 Plans for the future utilization of space indicate the necessity for the construction of large space structures. Since strong gravitational forces will be absent, these structures can be assembled using light-weight materials which are generally flexible.

Dr. Taft H. Broome, a Fellow from Howard University, investigated the feasibility of stiffening flexible large area space structures by means of cables. The scope of his analysis included cantilevered booms of constant cross-section. During that summer, Dr. Broome studied six different cable stiffening schemes which provided acceptable results, and upon returning l o Howard University for the 1976-1977 academic year, continued this research by studying additional schemes.

1977 During the past several decades, the use of the computer to solve research problems has increased to a level which in some cases demands optimal efficiency in computer utilization. One case is the solution of partial differential equations in steady-state time dependent problems.

Dr. William H. Lee, a Fellow from North Carolina Central University, developed a finite-difference numerical method which reduced, by a factor of ten, the amount of computer time generally necessary to solve this class of problems.

1978 Currently, there is international concern about pollution of the natural environment. The Marine Environments Branch at the Langley Research Center is developing methods of determining various levels of pollution in water. Although some data is gathered using remote-sensing techniques, an effort is also being made to develop mathematical models that may be used to predict pollution levels in water.

Dr. Demetrius D. Venable, a Fellow from St. Paul's College, developed a computer model using the Monte Carlo technique to evaluate solar radiation scattered from water for a non-homogeneous pollutant profile. The use of this model will reduce the amount of data gathered by aircraft to determine the levels of water pollution and improve the accuracy of predicting pollution levels in water.

1979 Graphite, a material formed from carbon and which because of its properties of durable strength, light weight, resistance to high temperatures and corrosive chemicals, is being used in the manufacture of aircraft, automobiles and various consumer goods. The Materials Research Branch of the Materials Division at Langley Research Center has been performing uniaxial compression tests of high strength graphite-epoxy laminates and have results showing that Young's modulus and fracture stress depend upon the specimen dimensions. Dr. Robert Reiss, a Fellow from Howard University developed an analytical model that explained the experimental results. This model is relatively easy to automate, therefore, some predictions will be possible with the use of the computer.

1980 Today, the use of robots for industrial purposes is more prevalent than ever before. Since most robots presently used are "blind", it is necessary for the software controlling these robots to be developed so that when it is more feasible for the robot to see, it will be able to do so.

Dr. John W. Bales of Tuskegee Institute developed a system of special marks to be placed on parts to be located and identified by a robot vision system. As a result, he was asked to write a NASA Technical Paper and he has done so.

1981 For several years scientist have been concerned with pollutants in the atmosphere. Fine particles suspended in the atmosphere, will interact with solar radiation through scattering and absorption and thereby alter the earths temperature. NASA has, over the years, conducted a number of flight experiments aimed at assessing the effects of aerosols on global climate.

Mr. Nathaniel Matthews of Lemoyne-Owen College has done research on aerosol size distribution as one of the many parometers of this problem. He plans to continue his research in the area of environmental sampling for pollutants that have upset the balance of life in the atmosphere

Evaluation

The 1981 Summer Research Fellowship Program operated very smoothly with no difficulties. This can be attributed to the advance planning by Dr. Darden prior to her departure and to the support given by NASA personnel.

The 1981 Research Fellows all reported that their research assignments were both interesting and challenging, their Research Associates were accessible and helpful and their office accommodations were adequate.

For the first time the program was expanded to include a Research Fellow outside the usual technical areas of Mathematics, physics and Computer Science. Dr. Richard O'Daniel was accepted for a position in the Acquisitions Division. His research into and his final report gave a new look at the Acquisitions process.

Each of the Fellows indicated they had discussed the possibility of returning to Langley/NASA and also the possibility of continuing the research project at their home institution.

In July the Coordinator was informed of Langley/NASA's intent to discontinue the NASA/HI Program. This information was passed on to the Research Fellows. Each expressed regret over the demise of a program which had provided research opportunities for faculty from minority institutions.

From the Coordinators point of view, the Fellows were cooperative, conscientious, hard-working and very easy to work with. All Langley personnel were very cooperative and took all possible steps to give support to the Summer Research Program.

1 Report No	2 Government Accession No	3 Recipient's Catalog No
NASA CR-165814		

4 Title and Subtitle	5 Report Date
FINAL REPORT: 1981 Summer Research Fellowship Program	October 1981
	6 Performing Organization Code
7 Author(s) John H. Spencer, (Compiler)	8 Performing Organization Report No
	10 Work Unit No
9 Performing Organization Name and Address Hampton Institute P. O. Box 6315 Hampton, Virginia 23668	11 Contract or Grant No NAS1-16455
	13 Type of Report and Period Covered Contractor Report June 1, 1981-Aug. 7, 1981
12 Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, DC 20546	14 Sponsoring Agency Code

15 Supplementary Notes

Langley Technical Monitor. Dr. Alvin F. Anderson

16 Abstract

Historically, the academic programs at traditionally black institutions have not fostered active involvement in basic scientific research. College teachers with scientific backgrounds spend a substantial amount of time engaged in other activities which do not utilize their research capabilities and skills. The NASA-Hampton Institute Summer Research Fellowship Program offers capable scientists and engineers at traditionally black institutions an opportunity to participate in research activities in an environment at the Langley Research Center where basic research is of primary importance.

The Summer Research Fellowship Program has been specifically designed to assist these faculty members in identifying areas of research which correlate positively with their indificual interest and capabilities. It is also designed to help them to initiate viable research which increases their technical knowledge about how research efforts at their institutions might be increased.

17 Key Words (Suggested by Author(s))	18 Distribution Statement
Educational matters (research) Fluid dynamics Airfoils Spline functions Retrieval system Aerosol sizing Macsyma application Diurnal cloud cover variation	Unclassified-Unlimited Subject Category 80

19 Security Classif (of this report)	20 Security Classif (of this page)	21 No of Pages	22 Price
Unclassified	Unclassified	35	A03

End of Document