GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[x] ORIGINAL [ ] REVISION NO. _____

Project No. G-35-625 DATE 4/4/83

Project Director: Dr. George Chimonas School~~xxx~~ Geophysical Sciences

Sponsor: National Science Foundation

Type Agreement: Grant No. ATM-8217152

Award Period: From 3/15/83 To ~~8/31/84*~~ 9-30-85 (Performance) 11/30/84 (Reports)

Sponsor Amount: $48,920 Contracted through:

Cost Sharing: $4,808 (G-35-313) GTRI/~~GTxx~~

Title: A Study of Algebraic Disturbances in the Stratified Atmosphere

ADMINISTRATIVE DATA

OCA Contact Frank H. Huff

1) Sponsor Technical Contact: Program Officer
Dr. Jack Kornfield
Atmospheric Sciences Program
Division of Meterology
Directorate for
NSF
Washington, DC 20550 (202) 357-7624

2) Sponsor Admin/Contractual Matters: Grants Official
Lee A. DeHerrera
Division of Grants & Contracts
Directorate for Administration
NSF
Washington, DC 20550
(202) 357-9602

Defense Priority Rating: N/A

Security Classification: N/A

RESTRICTIONS

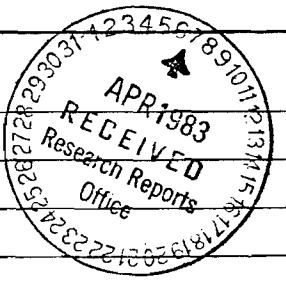
See Attached NSF Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with GIT

COMMENTS:

*Includes a 6 month unfunded flexibility period.



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FORM OCA 4-781

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date April 14, 1986

Project No. G-35-625 (R5601-0A0) School/Lab ~~XXX~~ Geophysical Sciences

Includes Subproject No.(s) _____

Project Director(s) G. Chimonas GTRC / ~~XXX~~ GIT

Sponsor National Science Foundation

Title A Study of Algebraic Disturbances in the Stratified Atmosphere

Effective Completion Date: 9/30/85 (Performance) 12/30/85 (Reports)

Grant/Contract Closeout Actions Remaining:

- [ ] None
- [ ] Final Invoice or Final Fiscal Report
- [ ] Closing Documents
- [X] ~~Final Report of Inventions~~ Patent Questionnaire
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other _____

Continues Project No. _____ Continued by Project No. _____

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PROGRESS REPORT-YEAR ONE

A STUDY OF ALGEBRAIC DISTURBANCES IN THE STRATIFIED ATMOSPHERE

The work is progressing in a satisfactory and rather exciting way. The calculations outlined in the proposal should all be completed within the planned time. Moreover, several additional problems on the algebraic disturbances have been brought close to completion.

Briefly, results to date are as follows:

(A) Four sets of numerical codes, required for the computations presented in the proposal, have been prepared and are now in their final stages of testing and debugging. The non-linear systems have provided most of the difficulties, but the schemes now appear to be under control.

(B) We have obtained a direct inversion of the initial value problem in an asymptotic limit. A previous result due to Case, 1960, used a two step treatment of this singular problem. But this led to a result that is in conflict with a special solution discovered by Phillips, 1966. Now we have found a one step procedure in place of Case's method. This results in a formula that agrees with the special solution.

(C) We have attempted to generalize Phillips' formulation of the linear shear flow problem to include the system that is bounded between parallel plates. So far we have demonstrated that the Phillips solution is not complete, and must be supplemented with some form of the normal modes. However, we have not yet been able to obtain the explicit representation of this.

(D) We have obtained the far field disturbance of the algebraic flow that results when a localized inhomogeneity is introduced into a shear flow. It is found

that far enough from the source the response field increases with time. But there is an ever growing zone around the initial disturbance in which the perturbations are decaying. This has some strange consequences for random disturbances in an infinite medium.

(E) We have set up the initial value problem for a quasi-random continuum of disturbances. The results are quite surprising. If a particular component is followed through its space-time trajectory, the standard decay is found for long times. However, if the amplitude at a given two dimensional wave number is examined, a different picture emerges. It is possible in certain cases to arrange that the amplitude of the entire spectrum grows for all times. This necessitates a re-examination of the way instability is defined for this system. The results are consistent with time reversal arguments presented by Willke (1967).

Case, K.M., (1960). Phys. Fluids, 3, 169.

Phillips, O.M., (1966). The Dynamics of the Upper Ocean.

Willke, H.L. Jr., (1967). J. Math. Phys., 46, 151.

APPENDIX VI

G35-625

NATIONAL SCIENCE FOUNDATION
Washington, D.C. 20550

FINAL PROJECT REPORT
NSF FORM 98A

PLEASE READ INSTRUCTIONS ON REVERSE BEFORE COMPLETING

PART I–PROJECT IDENTIFICATION INFORMATION

1. Institution and Address	2. NSF Program	3. NSF Award Number
Georgia Tech Research Institute Georgia Institute of Technology Atlanta, GA 30332	Atmospheric Sciences/Meteor	ATM-8217152
	4. Award Period From 3/15/83 To 9/80/85	5. Cumulative Award Amount $93,500

6. Project Title

A Study of Algebraic Disturbances in the Stratified Atmosphere

PART II–SUMMARY OF COMPLETED PROJECT *(FOR PUBLIC USE)*

The seemingly random small-scale motions of the atmosphere are generally called "turbulence", but their physical nature is still a mystery. The idea of this project is that some part of "turbulence" might be understood through the theory of the algebraic disturbances. These algebraic disturbances combine some of the properties of "waves" and some of the properties of "eddies". They convect with the mean wind, and turn over as they evolve. In the simplest (linear) theory of their evolution they extract energy from the shear of the background wind during the first half of their life cycle, but then fold down and return this energy in the second half of their life cycle. A truly "turbulent" system continuously extracts energy from the mean flow, using it to feed new disturbances and replace those lost to friction or by the completion of their life cycle.

Our project intended to find a higher order (non-linear) theory of the algebraic disturbances, to discover how (or whether) they could become more like true turbulence. The work was entirely theoretical - pencil and paper investigations of the basic ideas and equations.

We can report a most satisfying degree of success. At the non-linear level the disturbances can indeed continuously extract energy from the mean flow. They can also continue to turn over, mimicing a turbulent eddy rolling up around itself. Further work is needed, but the approach offers a new and semmingly fruitful way of describing some aspects of atmospheric turbulence.

PART III–TECHNICAL INFORMATION *(FOR PROGRAM MANAGEMENT USES)*

1. ITEM *(Check appropriate blocks)*	NONE	ATTACHED	PREVIOUSLY FURNISHED	TO BE FURNISHED SEPARATELY TO PROGRAM	
				Check (✓)	Approx. Date
a. Abstracts of Theses		X			
b. Publication Citations		X		X	1986
c. Data on Scientific Collaborators		X			
d. Information on Inventions	X				
e. Technical Description of Project and Results		X			
f. Other *(specify)*					

2. Principal Investigator/Project Director Name *(Typed)*	3. Principal Investigator/Project Director Signature	4. Date
George Chimonas		Dec 15 1985

NSF Form 98A (5-78) Supersedes All Previous Editions

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TECHNICAL SUMMARY

An extensive report of the research is being prepared for publication. Also, a proposal for future research, based on this work, will be submitted to N.S.F. sometime in 1986. Briefly, we now report the following results:

(1) An initial state spectral distribution "instability" has been demonstrated. It is not an instability in the usual wave sense, but it provides a disturbance field whose energy is always increasing.

(2) Inclusion of viscosity can be dealt with analytically. It limits the "instability" demonstrated in (1), so that the fields eventually all decay to zero.

(3) Non-linear interactions have been included. This is the major result of the study. It is demonstrated that these non-linearities provide the mechanism for continuous growth as conventionally required for an instability.

CITATIONS

Chimonas, G., and G. Kallos, 1986: Flow dynamics and stability in a severe rainband. Conditionally accepted for publication in J. Atmos. Sci.

Chimonas, G. A Study of the Algebraic Disturbances. In preparation.

COLLABORATORS

G. Kallos Worked as a graduate student with support from this project. Has now completed his doctoral studies and returned to the University of Athens.