GEORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[X] ORIGINAL [ ] REVISION NO. _____

Project No. G-35-669 GTRI/~~GIT~~ DATE 1 / 3 / 84

Project Director: Dr. George Chimonas School/~~XXX~~ Geo. Sci.

Sponsor: National Science Foundation

Type Agreement: Grant No. ATM-8317367

Award Period: From 12/15/83 To 5/31/85* (Performance) 8/31/85 (Reports)

Sponsor Amount:	This Change	Total to Date
Estimated:	$ 42,700	$ 42,700
Funded:	$ 42,700	$ 42,700

Cost Sharing Amount: $ 1,827 Cost Sharing No: G-35-317

Title: "Instabilities of Plane Parallel Flow with a Tilted Shear"

ADMINISTRATIVE DATA

OCA Contact Lynn Boyd ext. 4820

1) Sponsor Technical Contact:

William Beasley
National Science Foundation
Atmospheric Sciences Meteorology
1800 G Street, NW
Washington, DC 20550
(202) 357-7624

2) Sponsor Admin/Contractual Matters:

Hugh Lee Lyon
National Science Foundation
Washington, D.C. 20550
(202) 357-9602

Defense Priority Rating: _____ Military Security Classification: _____

(or) Company/Industrial Proprietary: _____

RESTRICTIONS

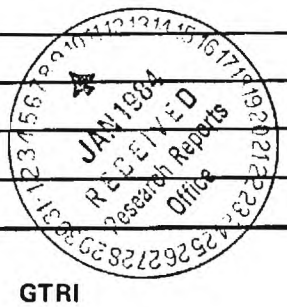
See Attached NSF Supplemental Information Sheet for Additional Requirements.

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 usual 6-month unfunded flexibility period.



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FORM OCA 4:383

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

N-B

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date 11/15/85

Project No. G-35-669 School/Lab GEO SCI

Includes Subproject No.(s) N/A

Project Director(s) George Chimonas GTRC /

Sponsor National Science Foundation

Title Instabilities of Plane Parallel Flow with a Tilted Shear

Effective Completion Date: 5/31/85 (Performance) 8/31/85 (Reports)

Grant/Contract Closeout Actions Remaining:

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

Continues Project No. None Indicated Continued by Project No. None Indicated

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FORM OCA 69.285

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 Sci/Meteorology	ATM-8317367
	4. Award Period From 12/15/83 To 4/31/85	5. Cumulative Award Amount $42,700

6. Project Title

Instabilities of Plane Parallel Flow with a Tilted Shear

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

Winds in the atmosphere change with height (vertical shear) and with the cross-wind horizontal direction (lateral shear). We postulated that small scale waves and turbulence could be generated more easily by the combination of these shears than by either of them separately. Most theoretical studies of the wind in the lower atmosphere have concentrated on the vertical shear alone. This leads to laws that set very severe limitations on what type of wind profile can become turbulent: limitations that seem to contradict observations and make modelling of such flows difficult.

The combination of shears generally leads to a mathematical system that is so hard to solve that the output hardly merits the effort. However, we discovered a model that is very easy to deal with, and still contains the essence of the physical problem. On investigating it, we found that indeed the combined shears produced instabilities much more readilly than the classical vertical shear models. We quote a reviewer of one paper submitted to Physics of Fluids: "I believe the problem the author addresses is scientifically interesting and original. I also find the numerical results quite believable and informative".

We feel the project has been extremely productive, both in results, publications and new ideas.

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	✓				
b. Publication Citations		✓			
c. Data on Scientific Collaborators		✓			
d. Information on Inventions					
e. Technical Description of Project and Results		✓			
f. Other *(specify)*					

2. Principal Investigator/Project Director Name *(Typed)*	3. Principal Investigator/Project Director Signature	4. Date
George Chimonas		10/30/85

NSF Form 98A (3-83) Supersedes All Previous Editions

Form Approved OMB No. 3145-005

(A) DATA ON SCIENTIFIC COLLABORATORS

I.	D. Fua	Visiting Scientist (Post Doc.)
II.	J. R. Grant	Graduate Student
III.	C. O. Hines	Professor, York University, Toronto, Canada

(B) PUBLICATION CITATIONS

1. Apparent counter-gradient heat fluxes generated by atmospheric waves. *Boundary-Layer Meteor.*, 31, 1-12, 1985.

2. Dispersion of small-scale shear instabilities. (Co-author D. Fua). *J. Atmos. Sci.*, 41, 1085-1091, 1985.

3. Shear excitation of gravity waves. Part I: Modes of a two scale atmosphere. (Co-author J.R. Grant). *J. Atmos. Sci.*, 41, 2269-2277, 1984.

4. Shear excitation of gravity waves. Part II: Upscale scattering of Kelvin-Helmholtz waves. (Co-author J.R. Grant). *J. Atmos. Sci.*, 41, 2278-2288, 1984.

5. Doppler ducting of atmospheric gravity waves. (Co-author C.O. Hines). Accepted for publication in *J. Geophys. Res.*

6. On the combined Rayleigh, Kelvin-Helmholtz problem. Submitted to *Physics of Fluids*.

(C) TECHNICAL SUMMARY OF ACTIVITIES

The project has been concerned with the stability of shear flows, and waves that such flows support. Throughout, we have examined how to get a better agreement between theory and observation by removing some of the idealizations that the theories usually contain.

We can claim considerable success. The six papers cited in (B) all offer improved understanding of observations because they are less restrictive in their theoretical outlook. To summarize:

(a) The Richardson criterion $Ri < \frac{1}{4}$ for instability does not hold if we allow some laterial wind shear (paper 6).

(b) The non-dispersive nature of Kelvin-Helmholtz waves disappears with more realistic atmospheric profiles. This is important for their non-linear interactions (paper 2).

(c) Non-linear interactions between small scale instabilities can force the larger scale gravity wave modes. This removes the theoretical need for very strong (and unrealistic) wind shears to generate the gravity waves directly (papers 2 and 5).

(d) Analysis of wave/turbulence fluxes in the boundary layer often assumes a stationary mean flow. If the mean is not so restricted the standard theory does not hold, and trying to apply it leads to inconsistancies such as counter-gradient fluxes (paper 1).

(e) Modal analysis of the atmosphere usually ignores the wind fields, or makes them uniform in some way. If we include the natural maxima and minima of the winds, a whole spectrum of new ducted modes is obtained, and these provide a ready explanation of many observations (paper 5).

Work along such lines is continuing and is the subject of a new proposal "Theoretical Studies of Waves in the Atmospheric Boundary Layer", recently submitted to N.S.F.