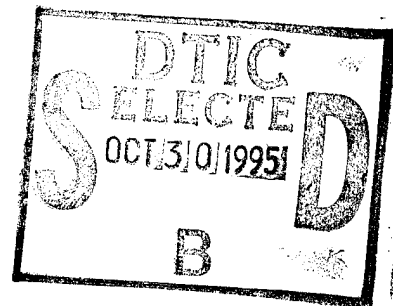


FINAL TECHNICAL REPORT
ONR GRANT #N00014-90-J-1050

John S. Allen

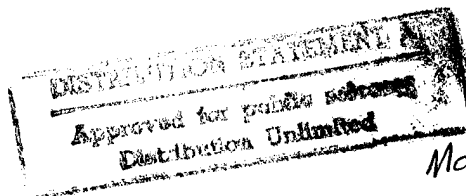
Modeling of Coastal Ocean Flow Fields



In Allen, Samelson, and Newberger (1991), we demonstrate the existence of a chaotic invariant set of solutions of an idealized model for wind-forced quasi-geostrophic flow over a continental margin with variable bottom topography. For weak (constant plus time-periodic) forcing and weak friction, we apply a recent extension (Wiggins and Holmes, 1987) of the method of Melnikov (1963) to test for the existence of transverse homoclinic orbits in the model. We find that in the presence of constant positive wind stress τ_0 (equatorward on eastern ocean boundaries) chaotic solutions exist when the ratio of an oscillating wind stress τ_1 to the bottom friction parameter is above a critical value that depends on τ_0/r and the bottom topographic height.

Research was continued on the development of intermediate models for the study of subinertial frequency mesoscale motion in stratified shelf, slope, and adjacent interior ocean flow fields. Intermediate models are derived under the assumption that the Rossby number ϵ is small. They filter out high frequency gravity-inertial waves while still being capable of representing flow over $O(1)$ topographic variations typical of the continental slope. Our recent research on intermediate models applied to the shallow-water equations has been extended to the continuously stratified case, where a new balance equation model (BEM) that is based on momentum equations and possesses global invariants of both energy and potential enstrophy has been formulated (Allen, 1991). In addition, a new set of iterated geostrophic (IG) intermediate models has been formulated (Allen, 1993). The IG models utilize the pressure field as the basic variable, are capable of providing solutions of formally increasing accuracy in powers of ϵ in a systematic manner, and are straightforward to solve numerically. In Allen and Newberger (1993), several stratified intermediate models, including two new IG models (IG2 and IG3), the geostrophic momentum (GM) approximation, the balance equations (BE), the balance equations based on momentum equations (BEM), and the quasi-geostrophic (QG) approximation, have been applied to initial-value problems for unstable baroclinic jet flow fields typical of the coastal transition zone. The accuracies of the models have been assessed by comparison to solutions from an explicit primitive equation model (PE). A semi-implicit primitive equation model (PESI) used with large time steps equal to those of the intermediate models, was also included. The results show that BE, IG3, BEM, and PESI give extremely accurate approximate solutions to PE over a wide range of Rossby numbers, from moderately small to $O(1)$. In contrast, the GM and QG models give quantitatively inaccurate solutions even at moderately small Rossby number. Overall, the results provide considerable encouragement for the potential use of intermediate models for coastal flow problems.

19951027 022



Mar 95

Final Technical Report (cont'd)
ONR Grant N00014-90-J-1050

REFERENCES

- Allen, J. S., 1991: Balance equations based on momentum equations with global invariants of potential enstrophy and energy, *J. Phys. Oceanogr.*, **21**, 265-276.
- Melnikov, V. K., 1963: On the stability of center for time-periodic perturbations. *Trans. Moscow Math. Soc.*, **12**, 1-57.
- Wiggins, S., and P. Holmes, 1987: Homoclinic orbits in slowly varying oscillators. *SIAM J. Math. Anal.*, **18**, 612-629 and Errata, **19**, 1988, 1254-1255.

LIST OF PUBLICATIONS

(with total or partial support from ONR Grant #N00014-90-J-1050)

- Allen, J. S., R. M. Samelson, and P. A. Newberger, 1991; Chaos in a model of forced quasigeostrophic flow over topography: An application of Melnikov's method. *J. Fluid Mech.*, **226**, 511-547.
- Allen, J. S., 1993: Iterated geostrophic intermediate models, *J. Phys. Oceanogr.*, **23**, 2447-2461.
- Allen, J. S., and P. A. Newberger, 1993: On intermediate models for stratified flow. *J. Phys. Oceanogr.*, **23**, 2462-2486.

Accession For	
NTIS ORA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
per letter	
By enclosed	
Distribution/	
Availability Codes	
Avail and/or	
Spec	Special
A-1	



OFFICE OF THE UNDER SECRETARY OF DEFENSE (ACQUISITION)
DEFENSE TECHNICAL INFORMATION CENTER
CAMERON STATION
ALEXANDRIA, VIRGINIA 22304-6145

IN REPLY
REFER TO

DTIC-OCC

SUBJECT: Distribution Statements on Technical Documents

TO: OFFICE OF NAVAL RESEARCH
CORPORATE PROGRAMS DIVISION
ONR 353
800 NORTH QUINCY STREET
ARLINGTON, VA 22217-5660

1. Reference: DoD Directive 5230.24, Distribution Statements on Technical Documents, 18 Mar 87.

2. The Defense Technical Information Center received the enclosed report (referenced below) which is not marked in accordance with the above reference.

FINAL REPORT
N00014-90-J-1050
TITLE: MODELING OF COASTAL
OCEAN FLOW FIELDS

3. We request the appropriate distribution statement be assigned and the report returned to DTIC within 5 working days.

4. Approved distribution statements are listed on the reverse of this letter. If you have any questions regarding these statements, call DTIC's Cataloging Branch, (703) 274-6837.

FOR THE ADMINISTRATOR:

1 Encl

GOPALAKRISHNAN NAIR
Chief, Cataloging Branch

FL-171
Jul 93

1995 1027 022
200 2001 5661

DISTRIBUTION STATEMENT A:

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION IS UNLIMITED

DISTRIBUTION STATEMENT B:

DISTRIBUTION AUTHORIZED TO U.S. GOVERNMENT AGENCIES ONLY; (Indicate Reason and Date Below). OTHER REQUESTS FOR THIS DOCUMENT SHALL BE REFERRED TO (Indicate Controlling DoD Office Below).

DISTRIBUTION STATEMENT C:

DISTRIBUTION AUTHORIZED TO U.S. GOVERNMENT AGENCIES AND THEIR CONTRACTORS; (Indicate Reason and Date Below). OTHER REQUESTS FOR THIS DOCUMENT SHALL BE REFERRED TO (Indicate Controlling DoD Office Below).

DISTRIBUTION STATEMENT D:

DISTRIBUTION AUTHORIZED TO DOD AND U.S. DOD CONTRACTORS ONLY; (Indicate Reason and Date Below). OTHER REQUESTS SHALL BE REFERRED TO (Indicate Controlling DoD Office Below).

DISTRIBUTION STATEMENT E:

DISTRIBUTION AUTHORIZED TO DOD COMPONENTS ONLY; (Indicate Reason and Date Below). OTHER REQUESTS SHALL BE REFERRED TO (Indicate Controlling DoD Office Below).

DISTRIBUTION STATEMENT F:

FURTHER DISSEMINATION ONLY AS DIRECTED BY (Indicate Controlling DoD Office and Date Below) or HIGHER DOD AUTHORITY.

DISTRIBUTION STATEMENT X:

DISTRIBUTION AUTHORIZED TO U.S. GOVERNMENT AGENCIES AND PRIVATE INDIVIDUALS OR ENTERPRISES ELIGIBLE TO OBTAIN EXPORT-CONTROLLED TECHNICAL DATA IN ACCORDANCE WITH DOD DIRECTIVE 5230.25, WITHHOLDING OF UNCLASSIFIED TECHNICAL DATA FROM PUBLIC DISCLOSURE, 6 Nov 1984 (Indicate date of determination). CONTROLLING DOD OFFICE IS (Indicate Controlling DoD Office).

The cited documents has been reviewed by competent authority and the following distribution statement is hereby authorized.

<p><u>A</u> (Statement)</p>	<p>OFFICE OF NAVAL RESEARCH CORPORATE PROGRAMS DIVISION ONR 353 800 NORTH QUINCY STREET ARLINGTON, VA 22217-5660</p>	<p>_____ (Controlling DoD Office Name)</p>
<p>_____ (Reason)</p> <p><u>Debra T. Hughes</u> (Signature & Typed Name)</p>	<p>DEBRA T. HUGHES DEPUTY DIRECTOR CORPORATE PROGRAMS OFFICE _____ (Assigning Office)</p>	<p>_____ (Controlling DoD Office Address, City, State, Zip)</p> <p>19 SEP 1995 _____ (Date Statement Assigned)</p>