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# • Dynamics of Small–Scale Oceanic Motions •

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Research goals: Description and modeling of the kinematical structure and dynamical processes of oceanic motions that have horizontal scales from a few meters to a few kilometers. Understanding the role that these small–scale motions play in the redistribution and mixing of momentum, potential vorticity, heat, and salt.

Objectives: Arriving at a complete kinematical description of small–scale motions in terms of gravity and vortical (i.e., potential vorticity carrying) motions.

Assessing the feasibility of monitoring internal wave parameters from routinely taken measurements with ship mounted Acoustic Doppler Current Profilers.

Determining and parameterizing the effect of internal gravity waves absorbed in critical layers.

Approach: Theoretical and data analyses.

Tasks completed: Estimation of frequency spectra of relative vorticity and horizontal divergence from three–point measurements in the IWEX (Müller et al., 1978) array. Comparison with the predictions of Garrett and Munk spectral models.

Development of software to calculate spectra and to extract inertial and tidal amplitudes from Acoustic Doppler Current Profiler data taken under a variety of circumstances.

Theoretical estimation of the amount of momentum and energy lost in critical layers by an internal gravity wave field of Garrett and Munk spectral intensity propagating downward into an ambient geostrophic shear.

Scientific results: Estimates of relative vorticity and horizontal divergence from three–point measurements suffer from aliasing and mutual contamination. Both effects can be expressed by array response or filter functions. Estimated frequency spectra of horizontal divergence agree well with the prediction of the Garrett and Munk model at all resolved horizontal scales. Estimated spectra of relative vorticity are not reproduced by the Garrett and Munk model at small horizontal scales. The number of horizontal levels in the IWEX array is not sufficient to determine whether this discrepancy is due to the existence of small–scale vortical motions or to the Garrett and Munk spectral model not correctly representing small–scale internal gravity waves.

Internal waves absorbed in vertical critical layers of an ambient geostrophic shear are found to generate transverse Ekman flows of O(0.01 cms–1), which is insignificant, and to lose energy at a rate of up to 5 nanowatts per kilogram, which is comparable to the energy loss rate suggested for internal wave breaking due to chance superposition.

Accomplishments: Estimate of relative vorticity and horizontal divergence for horizontal scales from about 1 km to 5 m and in the frequency range between the local Coriolis and Brunt Vaisala frequencies.

Theoretical estimate of the momentum and energy lost by internal waves in vertical critical layers of an ambient geostrophic shear.

References

Müller, P., D. J. Olbers and J. Willebrand, 1978: The IWEX spectrum. J. Geophys. Res., 83, 479–500.

ONR–Sponsored Publications

P Chu, P. C., R. Garwood, Jr., and P. Müller, 1990: Unstable and damped modes in coupled ocean mixed layer and cloud models. J. Marine Systems, 1, 1–11.

PS Garwood, R. W., Jr., P. C. Chu, P. Müller and N. Schneider, 1990: Modeling the equatorial entrainment zone: Response to diurnal surface forcing. J. Geophys. Res.

PI Kunze, E. and P. Müller: Internal wave–driven Ekman flow in the ocean interior.

PI Lien, R. C. and P. Müller: Consistency relations of gravity and vortical modes.

PI Müller, P. Diapycnal mixing in the ocean. Proceedings of LES Workshop, Lecture Notes in Engineering, Springer–Verlag.

R Garwood, R. W., P. C. Chu, P. Müller and N. Schneider, 1989: Equatorial entrainment zone: The diurnal cycle. In: Proceedings of the Western Pacific International Meeting and Workshop on TOGA/COARE, 435–443.

C Lien, R. C. and P. Müller: Normal mode decomposition of small–scale oceanic motions. AGU/ASLO Ocean Sciences Meeting, New Orleans, February 1990.

C Karcher, M., A. Lippert, and P. Müller: The influence of spatially varying eddy–diffusivity on the deep circulation. European Geophysical Society XV General Assembly, Copenhagen, Denmark, April 1990.

C Schneider, N., P. Müller, and R. W. Garwood, Jr.: Richardson number adjustment of the Yoshida jet. International TOGA Scientific Conference, Honolulu, July 1990.

IC Müller, P.: Diapycnal mixing in the ocean: a review. AGU/ASLO Ocean Sciences Meeting, New Orleans, February 1990.

PI Summary Data - for ONR programs
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PI Peter Muller

Statistics

| | FY-90 |
|---|---|
| Number of papers published in refereed journals | 1 |
| Number of papers submitted or in press, refereed journals | 1 |
| Number of books or chapters published, refereed non-serial publications | 0 |
| Number of books or chapters submitted or in press, refereed non-serial | 0 |
| Number of invited presentations at scientific conferences | 1 |
| Number of contributed presentations at scientific conferences | 3 |
| Number of technical reports and papers in non-refereed journals | 1 |
| Number of undergraduate students supported (at least part time)* | 0 |
| Number of graduate students supported (at least part time)* | 1 |
| Number of post-docs supported (at least part time)* | 1 |
| Number of other professional personnel supported (at least part time)* | 0 |

Statement "A" per telecon Dr. Alan Brandt. ONR/code 1122SS.

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PI Summary Data - for ONR programs
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PI Peter Muller

EEO and Minority Support Documentation

| | FY-90 |
|---|---|
| Number of female grad students | 0 |
| Number of minority grad students | 0 |
| Number of Asian grad students | 0 |
| Number of female post-docs | 0 |
| Number of minority post-docs | 0 |
| Number of Asian post-docs | 1 |

FY 89 Patents and Awards

Please list Patents filed or granted and Awards, Honors and Prizes.