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Tropical Cyclone Motion in the Northwest
Pacific Ocean - Phase One

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Final Report on Contract N00014-88-K-0249
Office of Naval Research

June 1991

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91-03861



Introduction:

The University of Hawaii joined the Office of Naval Research Tropical Cyclone Motion initiative in the Spring of 1988. This report summarizes progress under Grant N00014-88-K-0249. The report comprises a discussion of tasks undertaken and three subsections reporting on specific scientific endeavours.

Discussion:

Our program involved observational studies of tropical cyclone cases, numerical simulation of a real-case, numerical studies of the "beta -drift" using a three dimensional model and post-doctoral visitations to the Joint Typhoon Warning Center(JTWC).

The principal investigator (Schroeder) and post-doctoral researcher (Lander) each participated in detailed planning for the Tropical Cyclone Motion 1990(TCM 90) experiment. This entailed participation in workshops in Rainbow Beach, Australia and San Diego as well a substantial amount of Lander's time at JTWC. Schroeder worked on surface station network augmentation ; Lander on synoptic forecasting in support of operations.

1. Judy-Irving (1979) Analysis and Modelling Exercise.

We conducted a collective study of Typhoons Irving and Judy. These storms developed sequentially during August 1979. This period corresponded to the second special observing period of the First Garp Global Experiment(FGGE) . Irving was a recurving storm which had a particularly large forecast error at the point of recurvature. The FGGE IIIb data are the most comprehensive available for the northwest Pacific prior to TCM 90. These factors made this case excellent for the combination observational/numerical study we had in mind.

Observational Aspects:

We demonstrate that the actual environment of tropical cyclones in the Northwest Pacific is characterized by a complex collection of synoptic entities. The mid-tropospheric structure as depicted in conventional 500-mb analysis is deceptively simple. Interesting complications included a tropical system unlabeled by JTWC but recognized by the Japan Meteorological Agency.

The complications of the real environment suggest that the TCM90 would encounter difficulties isolating simple vortex motion cases.

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Numerical Aspects :

We found that the FGGE IIIb data were quite good and that using these analyses to initialize the Florida State University (FSU) Regional Model led to good quality forecasts. This was a promising result for TCM 90. We also succeeded in implementing the FSU model on an Alliant mini-supercomputer. This afforded a substantial amount of convenience and cost savings compared to trying to procure Cray time elsewhere.

Numerical Studies of "Beta Drift".

This work has been accepted subject to modifications by the Monthly Weather Review. The work represents our decision to take a different course from other ONR contractors who were either :

1. Continuing barotropic model studies , or
2. Engaging in large-scale Numerical Weather Prediction Exercises.

We (specifically Bin Wang) considered it appropriate to explore full three-dimensional aspects of the "Beta Drift" phenomenon. The FSU model was used and a series of sensitivity studies pursued. The results provide the impetus for continued study emphasizing the coupling within multi-layered models. This work will comprise the doctoral dissertation of Xiao-Fan Li. This work was reported in the Preprint Volume for the 19th Conference on Hurricanes and Tropical Meteorology. We found that we are one of three groups exploring these aspects of motion.

JTWC Postdoctoral Program

In February 1988 Schroeder was asked by the Environmental Group Pacific Command (EGFACOM) about the possibility of providing a postdoctoral researcher who could spend up to six months in residence at JTWC. Mark Lander agreed to do this and spent between two and three months of 1988 and 1989 at JTWC. His mission was to identify basic research areas which would support the JTWC mission and to serve as a conduit by which research results could be passed on to Guam.

Lander identified two significant problems which are currently being pursued:

1. multi-vortex interaction. The typical situation in the northwest Pacific is one of more than one storm existing at any given time. This complicates the motion of an individual storm since vortices have long been known to interact. Lander's observational work has been merged with theoretical work by Greg

Holland of the Bureau of Meteorology (Melbourne) in a series of papers currently in preparation.

2. initial eastward motion of storms embedded within a monsoon trough. Prediction models continuously fail to capture the initial motion of storms which form within a deep monsoon flow. We are testing whether model physics is the reason.

The JTWC postdoctoral program has been successful. Support to continue this program is being sought.

Participation in TCM 90.

The University of Hawaii was represented by three individuals.

1. Mark Lander, Assistant Researcher. A principal forecaster in support of operations.
2. Scott Spratt. Masters candidate.
3. Colin S. Ramage. Professor Emeritus and Consultant.

Continuing Work:

Lander now has separate support. Schroeder and Wang continue under Phase Two. Lander is completing his work with Holland and is continuing work with JTWC. Schroeder and Lander are conducting model studies of storms within the monsoon trough. Wang has continued three-dimensional model studies and has developed a non-linear model in collaboration with researchers from the Geophysical Fluid Dynamics Institute at Florida State.

Index of Publications:

Wang, B, and X-F Li, 1991: The Beta-drift of Three Dimensional Vortices: A numerical study. Provisionally accepted by Monthly Weather Review.

Wang, B, and X-F Li, 1991: A numerical study of the Beta-drift of three dimensional vortices. Preprints, 19th Conf. on Hurricanes and Tropical Meteorology, Miami, Amer. Meteorol. Soc., 358-361.

Index of Reports:

Schroeder, T., M.A. Lander, B. Wang and X. Li, 1991: Typhoons Irving and Judy (1979) an observational and numerical study. (Forthcoming University of Hawaii).