0002CM Final Technical Report
Contract No. N00014-85-C-0785
Principal Investigator: Frederick Sanders

31 August 1991

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Marblehead MA 01945

This report will describe in general terms the work done under the contract since its inception 1 September 1985. The research has been directed, directly or indirectly, at the problem of explosive cyclogenesis over the western North Atlantic Ocean. It encompasses the planning and execution of the field phase of ERICA and subsequent work with the observational material obtained.

The ability of operational numerical models to predict explosive cyclogenesis has improved dramatically over the period of the contract. We do not claim to have been responsible for this improvement, but a major effort under the contract has been in the monitoring and evaluation of model performance. We find that during ERICA skill was retained by National Meteorological Center's global modal out to a range of at least five days, and that this model was somewhat superior in this respect to the models of the United Kingdom Meteorological Office and the European Centre for Medium-Range Weather Forecasting.

To complement this computational advance, a conceptual view of explosive cyclogenesis has developed, to which this research has significantly contributed. It is understood that the event occurs when a pre-existing prominent mobile upper-level trough propagates over the eastern continental coast where there is a strong horizontal temperature gradient at lower levels. This gradient is a nearly permanent feature of the winter pattern and is attributable to the contrast in sea-surface temperature between the Sargasso Sea (the Gulf Stream in particular) and the cooler continental shelf waters, and between the latter and the radiatively cooled continent itself. The cyclogenesis is particularly favored when relatively cold air occupies the entire western Atlantic area, so that the effective static stability is reduced by heat transfer from the sea yet the horizontal gradient of lower-tropospheric temperature is retained.

Details of the research work are contained in the enclosed reprints of published papers and preprints of papers submitted but not yet published. A listing of these is provided below. Some further detail can be obtained also from Progress Reports #1-#71, distributed on a monthly basis during the life of the contract. A listing is provided here of presentations of parts of this research at scientific meetings of one sort or another. Finally, brief mention is made of topics examined but not reported in formal papers.

A. Published papers

1986: Explosive cyclogenesis in the West-Central North Atlantic Ocean, 1981-84. Part I: Composite structure and mean behavior. Mon. Wea. Rev., 114, 1781-1794.

1986: _____. Part II: Evaluation of LFM model performance. Mon. Wea. Rev., 114, 2207-2218.

1986: An operational checklist for the forecasting of explosive cyclogenesis in the North Atlantic Ocean (with E. P. Auciello). National Weather Service Eastern Region Technical Attachment No. 86-7.

1987: A study of 500 mb vorticity maxima crossing the east coast of North America and associated surface cyclogenesis. Wea. Forecasting, 2, 70-83.

1987: Skill of NMC operational dynamical models in prediction of explosive cyclogenesis. Wea. Forecasting, 2, 322-336.

1987: Verification of the explosive cyclogenesis checklist (with E. P. Auciello). National Weather Service Eastern Region Technical Attachment No. 87-19(B).

1988: Life history of mobile troughs in the upper westerlies. Mon. Wea. Rev., 116, 2629-2648.

1988: Patterns of thickness anomaly for explosive cyclogenesis over the West-Central North Atlantic Ocean (with C. A. Davis). Mon. Wea. Rev., 116, 2725-2730.

1989: Skill in prediction of explosive cyclogenesis over the western North Atlantic Ocean, 1987/88: A forecast checklist and NMC dynamical models (with E. P. Auciello). Wea. Forecasting, 4, 157-172.

1989: Wind increases in rapid marine cyclogenesis (with A. I. Weinstein). Mon. Wea. Rev., 117, 1365-1367.

1990: Surface analysis over the oceans - searching for sea truth. Wea. Forecasting, 5, 596-612.

B. Unpublished material and papers submitted or in press

1989: A series of surface maps for ERICA IOP#1-#5. Copy can be obtained from the principal investigator at 9 Flint Street, Marblehead MA 01945.

1991: An early-season coastal storm: Conceptual success and model failure (with L. F. Bosart). Mon. Wea. Rev, 119, in press, to appear in October issue.

1991: Skill of operational dynamical models in cyclone prediction out to five days range during ERICA. Wea. Forecasting, submitted.

C. Presentations

1985: Presentations at NWS/AES Marine Forecaster Training Seminar, Seattle WA, September.

1985: Paper at NWA Annual Meeting, Kansas City KS, November.

1985: MIT seminar, Cambridge MA, November.

1986: FSU seminars, Tallahassee FL, April.

1986: University of Reading seminar, UK, May.

1986: DAMTP seminar, University of Cambridge, UK, May.

1986: Lecture at Symposium on Polar Lows, Sunvollen, Norway, May.

1986: Paper at 11th AMS Conference on Weather Analysis and Forecasting, Kansas City KS, June.

1986: Presentation at ERICA workshop, Drexel University, Philadelphia PA, September.

1986: MIT seminar, Cambridge MA, September.

1987: Presentations at 6th Cyclone Workshop, Asilomar Conference Center, Monterey CA, February.

1987: FSU seminars, Tallahassee FL, February.

1987: Seminar at AOML/HRD, Miami FL, March.

1987: Presentations at NMC, Camp Spring MD, April.

1987: Seminars at NC State, Raleigh NC, April.

1987: Paper at IAMAP, University of BC, Vancouver BC, August.

1987: Paper at AMS Conference on Mesoscale Processes, Vancouver BC, August.

1987: Presentation at ERICA Workshop, Duxbury MA, September.

1987: Paper at AES/CMOS Workshop on Operational Meterorology, Halifax NS, October.

1987: MIT seminar, Cambridge MA, October.

1988: Paper at AMS Conference on Numerical Weather Prediction, Baltimore MD, February.

1988: Seminar at NMC, Camp Spring MD, March.

1988: KIRO Radio and Television discussions, Seattle WA, April.

1988: Seminar at NWS, Seattle WA, April.

1988: UW seminar, Seattle WA, April.

1988: FSU seminars, Tallahassee FL, May.

1988: Presentations at Second NWS Winter Weather Workshop, Raleigh NC, September.

1988: Presentation at 7th Cyclone Workshop, Newtowne Square PA, October.

1988: Presentation at NWS Winter Weather Media Workshop, Needham MA, November.

1988-1989: Participation in ERICA Field Program, NWS Boston MA, NMC, Camp Spring MD, NAS Brunswick ME, December-Febraury.

1989: FSU seminar, Tallahassee FL, May.

1989: Participation (remote through C. Kreitzberg) in ERICA Field Phase Workshop, Drexel University, Philadelphia PA, May.

1989: Seminar at AOML/HRD, Miami FL, June.

1989: Paper at IAMAP, University of Reading, UK, August.

1989: MIT seminar, Cambridge MA, September.

1989: McGill University seminar, Montreal PQ, October.

1989: Presentation at NMC, Camp Spring MD, November.

1989: NCAR seminar, Boulder CO, December.

1990: FSU seminars, Tallahassee FL, March.

1990: PSU seminar, University Park PA, April.

1990: Papers at AES/CMOS Workshop on Operational Meteorology, Montreal PQ, May.

1990: Chair session at 4th AMS Conference on Mesoscale Processes, Boulder CO, June.

1991: Paper at First International Symposium on Winter Storms, New Orleans LA, January.

1991: FSU seminar, Tallahassee FL, March.

D. Research not written for formal publication

1. Investigation of static and symmetric stability environment of explosively intensifying cyclones. This was started for the

sample of storms from 1981-1984, and then for a sample of 10 storms from January-March 1985. The work was suspended because the upper-level analyses for the forthcoming ERICA cases should be much more reliable. Before this work was resumed, others had presented studies of the same question, although on the basis of uncertain data.

2. A case study of a Polar-Low type of development over Lake Superior on 29 November 1985. This case occurred on a small scale with the approach of an identifiable mobile trough at 500 mb, over an enclosed region of small stability. Peak wind at a mid-lake buoy was 27 m/s. It was not detected by NMC's operational dynamical models. The study was written up for presentation at the Polar Low Conference in Norway but no further, as other concerns took up the available time.

3. Measurements of large-scale difluence or confluence for the 1981-1984 sample of explosive cyclones. These were made because of the historical interest in the question and the general belief, with some theoretical basis, that difluence would be generally characteristic. On average, the flow over the developing center was slightly difluent, but there were many counter-examples, including the Ocean Ranger storm of February 1982, the most intense in the sample. The involvement with ERICA and other projects precluded completion of this study.

4. Preparation of upper-level analyses for ERICA IOP#1-#5. All ERICA flight data were plotted as a preliminary to this project. The coverage was not as comprehensive as might be hoped, and an analysis better than that provided operationally would require access to satellite sounding and cloud-motion data available at NMC or NCAR, but hard to obtain. The project bogged down.

5. Fractures in successive runs of dynamical prediction models. On some occasions during the ERICA field project, the forecasts from the MRF model verifying on the same date but initialized from dates 24 h apart showed large differences. A striking example was during IOP#4 when the run from 00 UTC 31 December showed no significant development, but the run from 24 h later showed a major development. In this instance the fracture was attributable to the failure of the earlier run to predict the development of the predecessor upper-level trough in the lee of the Rocky Mountains. The entire file of MRF forecasts for the three months has been culled to determine the statistics of fracture as well as their morphological character. It has been found that significant fractures in this model in the western Atlantic region did not occur at ranges up to 48 hours, and that the scenario described above is probably not the usual one. More often the fracture is due to variable behavior of what looks more like a normal-mode instability. Preliminary presentations have been made, but completion of this research and preparation of a paper for publication is the first order of business under further support for research on explosive cyclogenesis.

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ENCLOSURE NUMBER 1
CONTRACT DATA REQUIREMENTS LIST
INSTRUCTIONS FOR DISTRIBUTION

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The minimum distribution of technical reports and the final report submitted in connection with this contract is as follows:

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