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FIRST TECHNICAL PROGRESS REPORT;
EFFECTS OF MESOSCALE WEATHER DISTURBANCES ON
CONTAMINATION CONCENTRATIONS

AEC Contract No. AT (11-1) - 2360

Period: June 1, 1973 - February 28, 1974 (9 months)

The objective of this work was to dynamically predict the motion and dispersion properties of the atmosphere on the mesoscale to permit calculation of contamination concentrations. A one-dimensional convection model serves as a subroutine in two and three dimensional hydrostatic primitive equation models. The dynamic feedback between convective and meso scales is provided for through this subroutine. The two dimensional hydrostatic primitive equation model serves as a test bed for development of techniques for inclusion in the three-dimensional model. For example, a planetary boundary layer model has been developed and tested in the two-dimensional model wherein frontal circulations are simulated and the effects diurnal heating and surface stress on boundary layer flow and mixing are computed.

Progress to date has included:

- 1) completion of the model meshing scheme whereby a hemispheric forecast model (NCAR's General Circulation Model) provides the initial conditions and time dependent lateral boundary conditions for our fine mesh cyclonic forecast over the U.S. The U.S. cyclonic forecast in turn provides the initialization and time dependent lateral boundary conditions for the mesoscale forecast model.
- 2) planetary boundary layer model development and initial testing in two dimensions. The model consists of a surface constant flux contact layer (usually 50 m deep) plus a logarithmically spaced fine-mesh grid of ten levels

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interspersed between the standard mesoscale grid below 1.5 km. Horizontal advection is calculated only on the mesoscale grid and interpolated to the fine-mesh grid for economy.

- 3) coastal interface studies to adequately deal with the transition from a maritime boundary layer to a continental boundary layer have begun. The surface energy budget will be calculated to predict surface temperature and a one-dimensional higher order closure scheme is being used to see how best to improve boundary layer eddy flux effects over the full diurnal cycle.
- 4) boundary layer diurnal temperature cycle modeling is being examined to see what processes are critical under different large scale conditions. Data in the Eastern United States for 13 months are being examined statistically.
- 5) upper boundary condition effects are being examined to see how their specification influences the dynamics of the model. For simplicity and clarity, an unconventional system of equations is being numerically integrated. These equations may be more consistent than the usual primitive equations in their elimination of vertically propagating gravity waves. Tests are being made to see how these alternate equations compare with our current mesoscale model; then the upper boundary condition effects can be systematically evaluated.
- 6) terrain coordinate equations have been formulated to study flow over irregular terrain and preliminary tests have been made.

The level of effort on this project during this first year has included:

- 1) Carl W. Kreitzberg, Associate Professor of Physics and Atmospheric Science; Principal Investigator 15% of summer and academic year.
- 2) Paul Gordon, Associate Professor of Mathematics; Associate Investigator, 25% of summer and 15% of academic year.

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- 3) Leonard Cohen, Associate Professor of Physics and Atmospheric Science; Associate Investigator, 25% beginning 1 January, 1974.
- 4) Donald J. Perkey, Research Associate; Associate Investigator, 50% of summer.
- 5) John Pinkerton, Graduate Research Assistant; 50% summer and fall terms.
- 6) Leon Ettinger, Graduate Research Assistant; 50% beginning 1 December, 1973.
- 7) Ronald Guy, Graduate Research Assistant; 50% beginning 1 September, 1973 and 100% winter term only.
- 8) Alice Trainer, Secretary, 15% summer and academic year.

This level of effort will continue until June, 1974.

Significant equipment and supplies purchased on this project include:

- 1) Hazeltine #H2000 Video Display Terminal (\$2485.00)
- 2) 3M Model 400-Microfilm Reader Printer (\$1694.50)
ADAC242 Acoustic Data Coupler (345.00)
- 3) Hewlett Packard HP-35 Scientific mini-calculator (\$295.00)
- 4) surface three-hourly reports and rawinsonde reports for 1 March, 1970 to 31 March, 1971 for the Eastern United States (on magnetic tape from the National Climatic Center, Asheville, North Carolina) - \$700.00

Visits have been made by the Principal Investigator to AEC affiliated laboratories at Livermore, California, Upton, New York., and Aiken, S.Carolina. It was decided that we would generate a mesoscale data tape from the prediction model to run concentration calculations at Livermore using their particle-in-cell diffusion model. We are formulating dynamic boundary layer mesoclimatology studies in the eastern United States jointly with Brookhaven.

Presentation of portions of this work have been made in three papers at American Meteorological Society Conferences:

"The Influence of Atmospheric Boundary Layer Processes on Frontal Structure"

John Pinkerton, Carl Kreitzberg, Second Conference on Numerical Prediction, American Meteorological Society, October, 1973, Monterey, Calif.

"Mesoscale Prediction Within A Cyclonic Scale Model," C. Kreitzberg, D. Perkey and D. Anderson, Second Conference on Numerical Prediction, American Meteorological Society, October, 1973, Monterey, Calif.

"Prediction of Mesoscale Convection Rainbands in an Extratropical Cyclone". Donald J. Perkey, Daniel McNaughton, Carl W. Kreitzberg, Daniel Anderson. Fifth Conference on Weather Forecasting and Analysis, American Meteorological Society, St. Louis, Mo. March, 1974.