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13. ABSTRACT *(Maximum 200 words)*
The STORM-FEST field campaign to investigate atmospheric frontal structure and evolution provided data on deformation frontogenesis observed 20-21 February 1992. These data have been analyzed, and the principal features compared with the theoretical predictions of a semi-geostrophic inviscid, adiabatic model. The overall agreement is good, although viscous and thermal diffusion in the planetary boundary layer is omitted from the theoretical model. The relative importance of terms neglected in the semi-geostrophic model, including ageostrophic accelerations, viscous and nonadiabatic conributions will be evaluated during the second year of the investigation. Modification of the theory to include neglected effects will be attempted to improve low-level predictions of frontogenesis. Completion by May 31, 1995 is anticipated.

14. SUBJECT TERMS
STORM-FEST field program, atmospheric frontogenesis deformation frontogenesis, semigeostrophic theory of frontogenesis, boundary layer in frontogenesis

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1. Introduction

A field effort, STORM-FEST, was carried out from 1 February - 13 March 1992 to investigate the structure and evolution of fronts and associated mesoscale phenomena. This experiment was conducted in the central United States, and the density of the surface observational array is shown in Figure 1. Vertical structure was determined from an array of National Weather Service and Cross-chain Loran Atmospheric Sounding Systems, Demonstration Network and Lower Atmospheric Sounding System wind profilers Radio Acoustic Sounding of temperature and aircraft traverses of fronts. The temporal density ranged from seconds to a few hours depending on the type of sensor. Specific details of the program are documented in the STORM I Experiment Design (1991, STORM Project Office).

The present investigation represents an analysis of deformation frontogenesis that occurred on 21 February 1992. This case represents almost a text book example of a deformation wind field causing frontgenesis in the temperature field (see Figure 2).

This work is being carried out by Mr. Vern Ostdiek as Ph.D. thesis research under the direction of Professor William Blumen. The thesis outline appears as TABLE 1 on pages 2-3. This interim report provides a summary of work completed, and proposed work that will be undertaken during the next twelve months. A May 1995 completion date is anticipated.

2. Work completed 1 June 1993 - 1 May 1994

The first four items in TABLE 1 have been completed. This work is currently being prepared for a submission to a meteorological journal in the near future.

The emphasis during the first year has been to analyze the 21 February 1992 frontogenesis case, and to compare the analyzed fields with predictions based on the semi-geostrophic theory of frontogenesis (Hoskins and Bretherton, 1972; Davis and Müller, 1988). The initial time is 2000 CST on 20 February 1992 and the model predictions are compared with the analyzed fields at 0100 CST on 21 February 1992. This comparison is made with model solutions that neglect both viscous and thermal diffusion. Yet there is relatively good overall agreement with the theory, particularly the rate of frontogenesis that occurred during the time period.

3. Proposed work 2 May 1994 - 31 May 1995

The neglect of planetary boundary layer processes in the theory is a limitation. This nighttime event was characterized by a relatively neutral boundary layer, and the wind profiles showed evidence of the Ekman spiral as displayed in Figure 3. Low-level jets were also observed ahead of the front, and cloud cover introduced along-front variability in the temperature field. Emphasis will be placed on establishing the relative importance of boundary layer processes on deformation frontogenesis. The observed fields will be used to evaluate the order of magnitude of all the terms in the Boussinesq equations for which data are avalable. The vertical motion will have to be computed, and the diffusion terms will be residuals. This will be accomplished to see what modification to the Ekman boundary layer model are appropriate to the present situation.

TABLE 1
Study of Deformation Frontogenesis

1. STORM-FEST Field Program
   a) Overview
   b) SF Instrumentation and Data Sets
      i) Surface Data
      ii) Upper Air Data
      iii) Radar, Satellite, and Aircraft Data
      iv) Model Data
      v) Boundary Layer Array

2. Frontogenesis on 21 February 1992
   a) Overview
   b) Deformation Flow Field
      i) Study Region
      ii) Nocturnal Cooling Effects
   c) Surface Frontogenesis
      i) Estimates of Deformation Parameter and Average Theta Gradients
      ii) Comparison to Simple Surface Frontogenesis Model
   d) Upper Air Considerations

3. Semi-geostrophic Deformation Frontogenesis
   a) SG Mathematical Model
      i) Governing Equations in Geostrophic Space
      ii) Fourier Series Solution Method
      iii) Simplifying Assumptions vs Reality
      iv) Numerical Difficulties
   b) Application of SG Model to 2-21-92 Event
      i) Initializing the Model
      ii) Comparison to Observed Surface Theta Distributions
      iii) Comparison to Soundings
      iv) Discussion

4. Frontogenesis on 11 February 1992
   a) Overview
   b) Deformation Flow Field
   c) Surface Frontogenesis
   d) Upper Air Data

5. Low-Level Jets in Nocturnal Baroclinic Boundary Layers
   a) Summary of Observed Jets
      i) Atmospheric Conditions
      ii) Evolution in Time
   a) Ekman Baroclinic Boundary Layer Model
      i) Steady State Model Equations
      ii) Time Dependent Model Equations
      iii) Comparison to Observed Jet Structures

6. Boussinesq Equations in Boundary Layer Frontal Zones
   a) Estimates of Terms in Momentum and Heat Equations
      i) Numerical Estimation Techniques
      ii) Study Region and Data Set
      iii) Results and Statistical Analysis
   b) Realistic Bousinesq Equations Frontogenesis Model

The introduction of boundary layer processes will then be introduced into the deformation model in order to improve the low-level predictions of frontogenesis. This work appears as items 5 and 6 in TABLE 1.

4. Meetings

Low-level frontogenesis during STORM-FEST. V. Ostdiek and W. Blumen. American Meteorological Scoiety Conference on Severe Local Storms. 4-8 October 1993. St. Louis Missouri.

Deformation frotogenesis during STORM-FEST. V. Ostdiek and W. Blumen. Accepted for presentation at the American Meteorological Society Conference on Mesoscale Processes. 18-22 July. Portland Oregon.

5.References

Davis, H.C. and J.C. Muller, 1988: Detailed description of deformation-induced semi-geostrophic frotogenesis. Q.J.R. Meteorol. Soc.,114,1201-1219.

Hoskins, B.J. and F.P. Bretherton, 1972: Atmospheric frotogenesis models: matematical formulation and solution. J.Atmos. Sci., 29,11-37.

STORM Project Oficce, 1991: STORM I Winter/Spring multiscale experiment, experiment design. Available from the STORM Project Office, NCAR, P.O.Box 3000. Boulder, CO 80307, 162pp.

STORMFEST Surface Sites

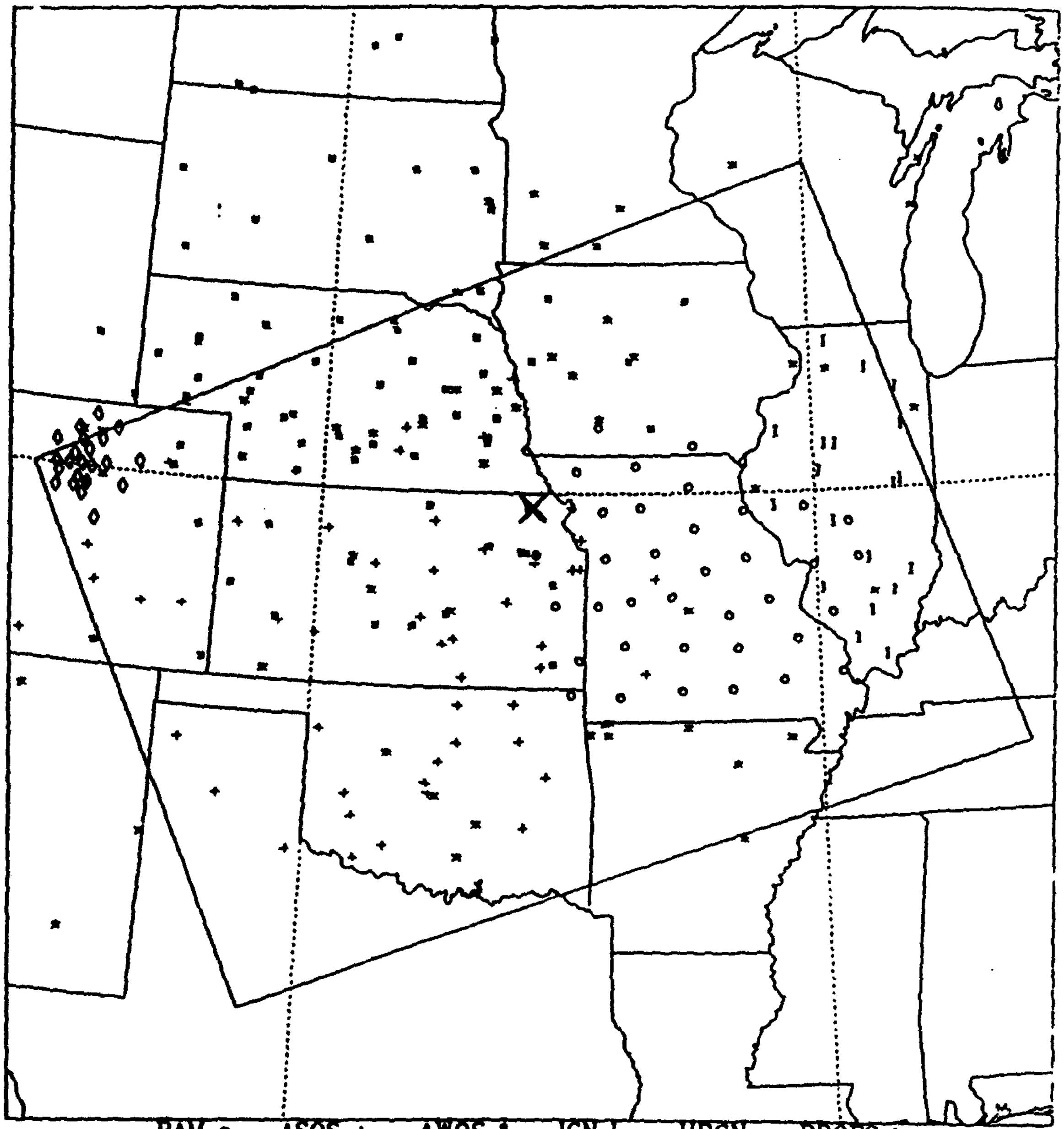

Figure 1

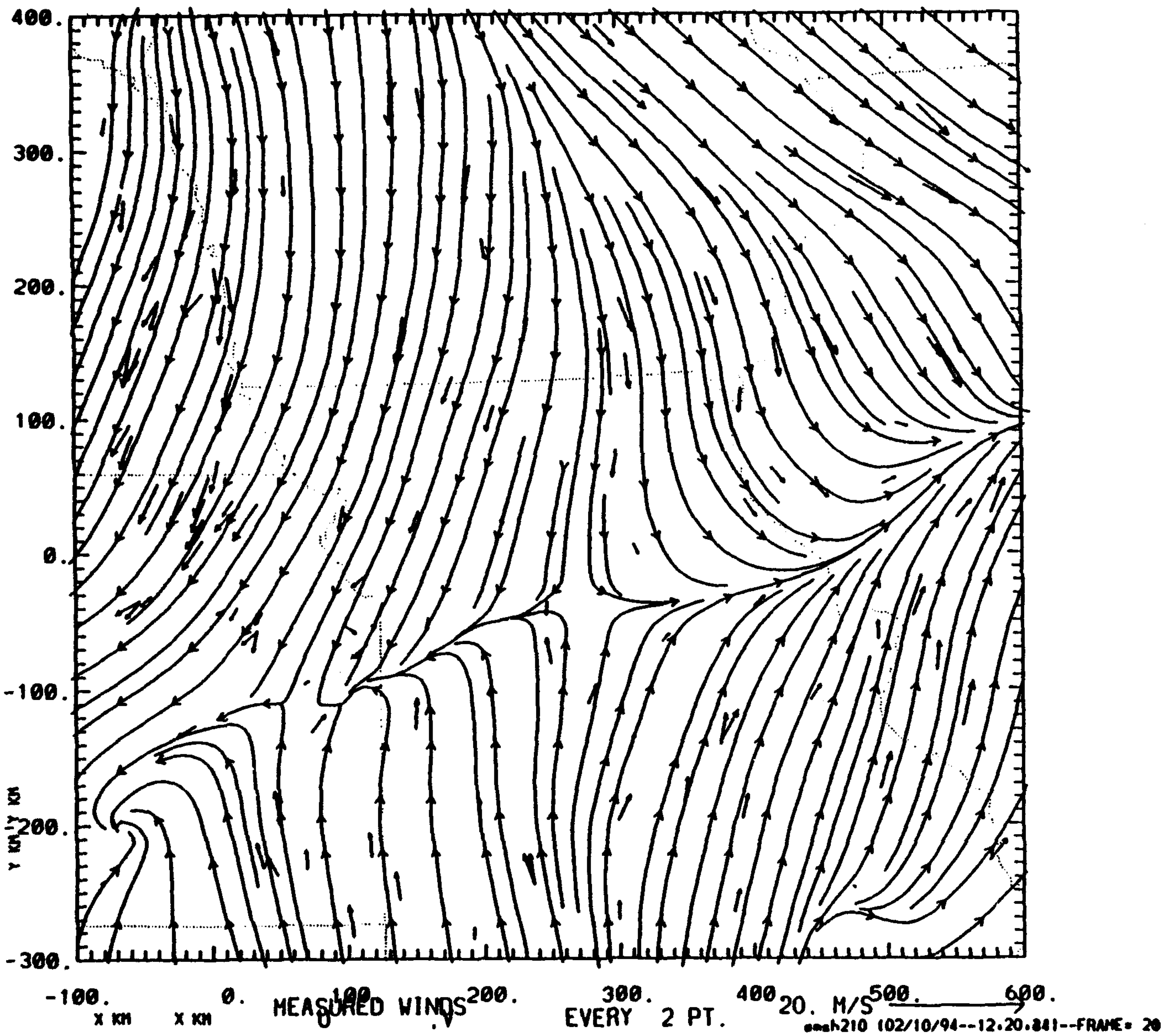

Figure 2. Wind field at 2000 CST on 20 February 1992 in the STORM-FEST area.

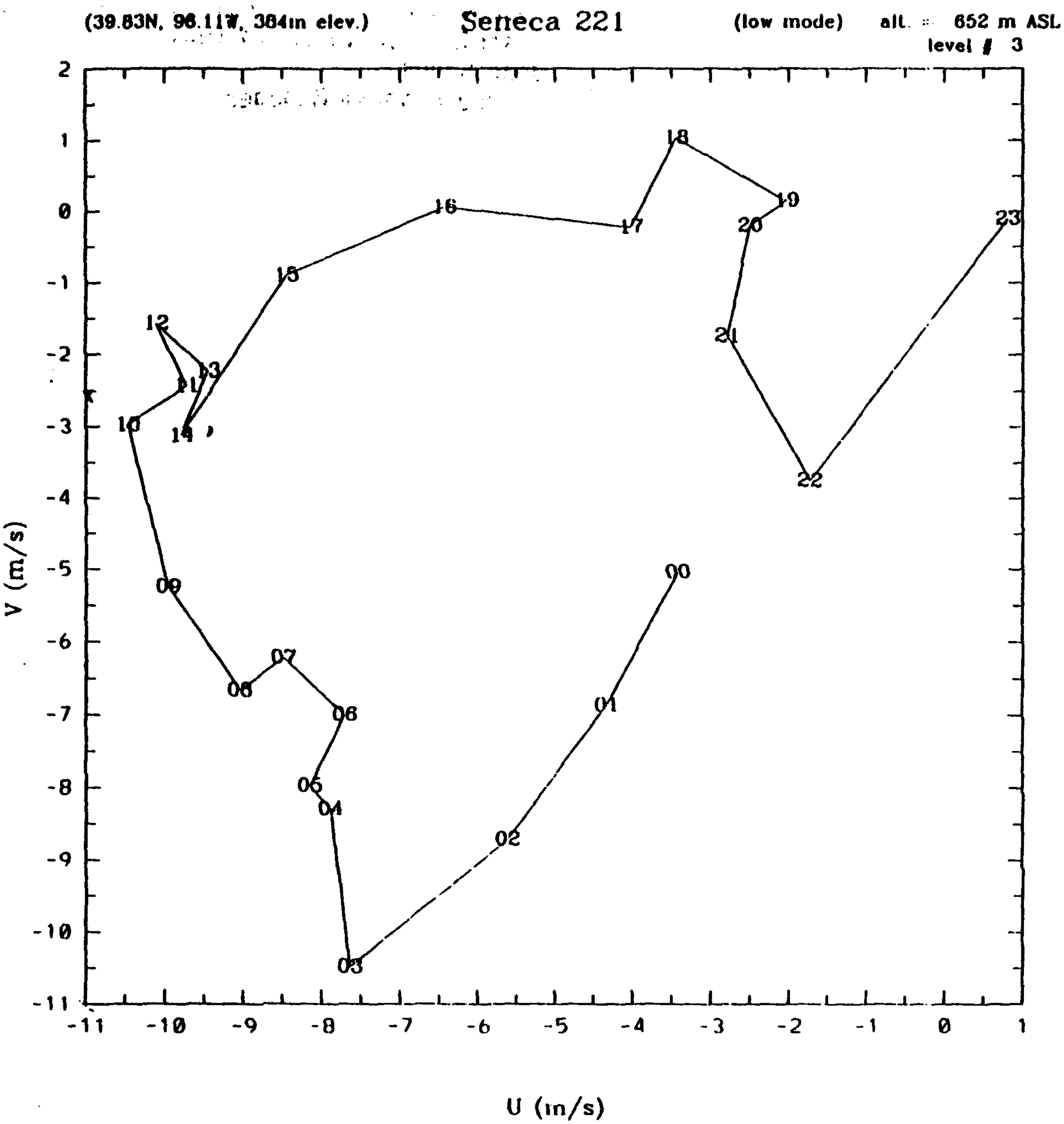

Figure 3. Wind hodograph at Seneca in Northeast Kansas