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# 9.11A NETWORK ST RADAR AND RELATED MEASUREMENTS AT PENN STATE UNIVERSITY: A PROGRESS REPORT

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Mesoscale meteorological measurements, analysis and prediction are some of the principal areas of research in the Department of Meteorology at Penn State. For more than a decade those members of the faculty concerned with mesoscale analysis, numerical modeling and forecasting have been frustrated by the spatial and temporal inadequacy of conventional network observations for both research and operational applications. For more than five years the Department had sought the substantial financial resources required to deploy a network of VHF Doppler (ST) radars and millimeter wave radiometers for "operational" test and evaluation for wind and thermodynamic profiling, respectively. Construction of the ST radar network began in Fall of 1983 using funding provided by the Air Force Office of Scientific Research (through the DOD University Research Instrumentation Program) and the University.

For the foreseeable future the Penn State ST radar program will be focused entirely on applications rather than systems development research. Deployment of the systems now under construction would not have been possible without the outstanding cooperation provided by C. G. Little and R. Strauch and their colleagues at the Wave Propagation Laboratory, and also J. Brosnahan of Tycho Technology from whom we are buying all of the receivers, transmitters and antennas. With regard to other major systems components, we are assembling inhouse from WPL documentation the Time-Domain-Integrators and Computer Interfaces and have purchased WPL software-compatible Data General Eclipse computers for each system.

The Penn State Network will consist first of two 6-m radars; one sited south of State College on Shantytown Road near McAlevys Fort and the second NW of Dubois, PA. The third radar, a "portable" 70-cm system, is to be initially sited SW of Johnstown, PA. The three radars thus form a mesoscale triangle with about 160-km legs (Figure 1). Specifications for the three systems are summarized in Table 1.

In anticipation of a staged turn-on of the three systems during the Summer and Fall of 1984, the nonconstruction-related efforts in the Department have focused on the software development necessary to allow essentially immediate use of network data. A 16-bit microcomputer has been programed to serve as the network controller, communications interface and, at least for real-time purposes, the operational display system. Insofar as possible we have in this task built upon our substantial accumulated experience in working with the processing and display of Doppler sodar system signals. Once the radar-derived wind and turbulence profiles are communicated to the various interconnected Departmental computers they become just one component of a comprehensive data base (Figure 2) which can be applied to a diverse set of ongoing basic and operational research programs.

The scientific applications for which specific program planning is in progress include:

(1) Intercomparison of wind and turbulence statistics derived from spatial (aircraft and radar network) and temporal (radar) sampling
(2) Meso-synoptic scale analysis and forecasting studies

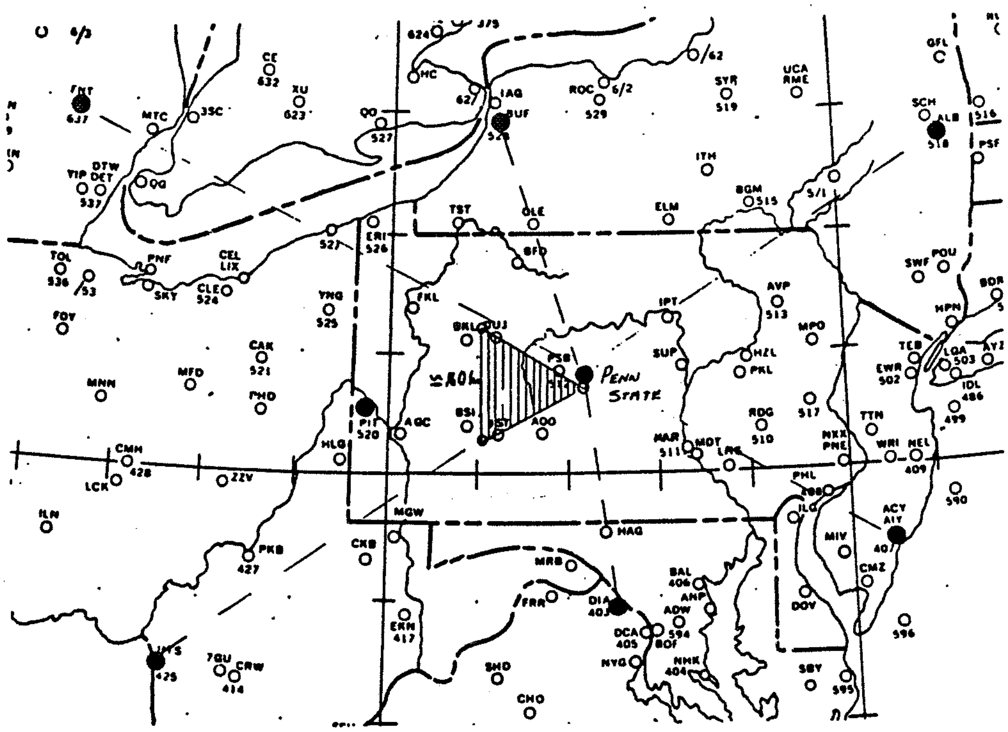


Figure 1. Mesospheric triangle of Penn State VHF (east and northwest) and UHF (southwest) radars. Station separations are approximately 160 km.

Table 1. Specifications for Penn State ST Radars

| Item | Units 1 and 2 | Unit 3 |
|---|---|---|
| Type | Pulsed Doppler | Pulsed Doppler |
| Location | 1: S of State College<br>2: NW of Dubois | SW of Johnstown |
| Frequency | 1: 49.92 MHz<br>2: 49.80 MHz | 405 MHz |
| Bandwidth | 0.4 MHz | 2% |
| Peak Power | 30 kW | 30 kW |
| Pulse Width | 3.67, 9.67 μs | 1, 4, 16 μs |
| Antenna: | | |
| Type | Phased Array CoCo | 64 7-element Yagis |
| Dimensions | 50 m x 50 m | 8 m x 8 m |
| Angle(s) | 75° and 90° | 75° |
| On Site Computer | Data General Eclipse | Data General Eclipse |
| On Site Processing at PW = | 3.67 μs or 9.67 μs | 1, 4, 16 μs |
| Time Domain Aver. | ≈400 or ≈125 | 112, 70, 35 |
| Spectral Aver. | 8 or 16 | 16, 32, 64 |
| Max. Radial Vel. | ±15.7 m/s or ±19.6 m/s | 18.25 m/s |
| Spectral Vel. Resol. | 0.49 m/s or 31 m/s | 0.29 m/s |
| Altitude Resolution | 290 m or 870 m | 100, 300, 800 |

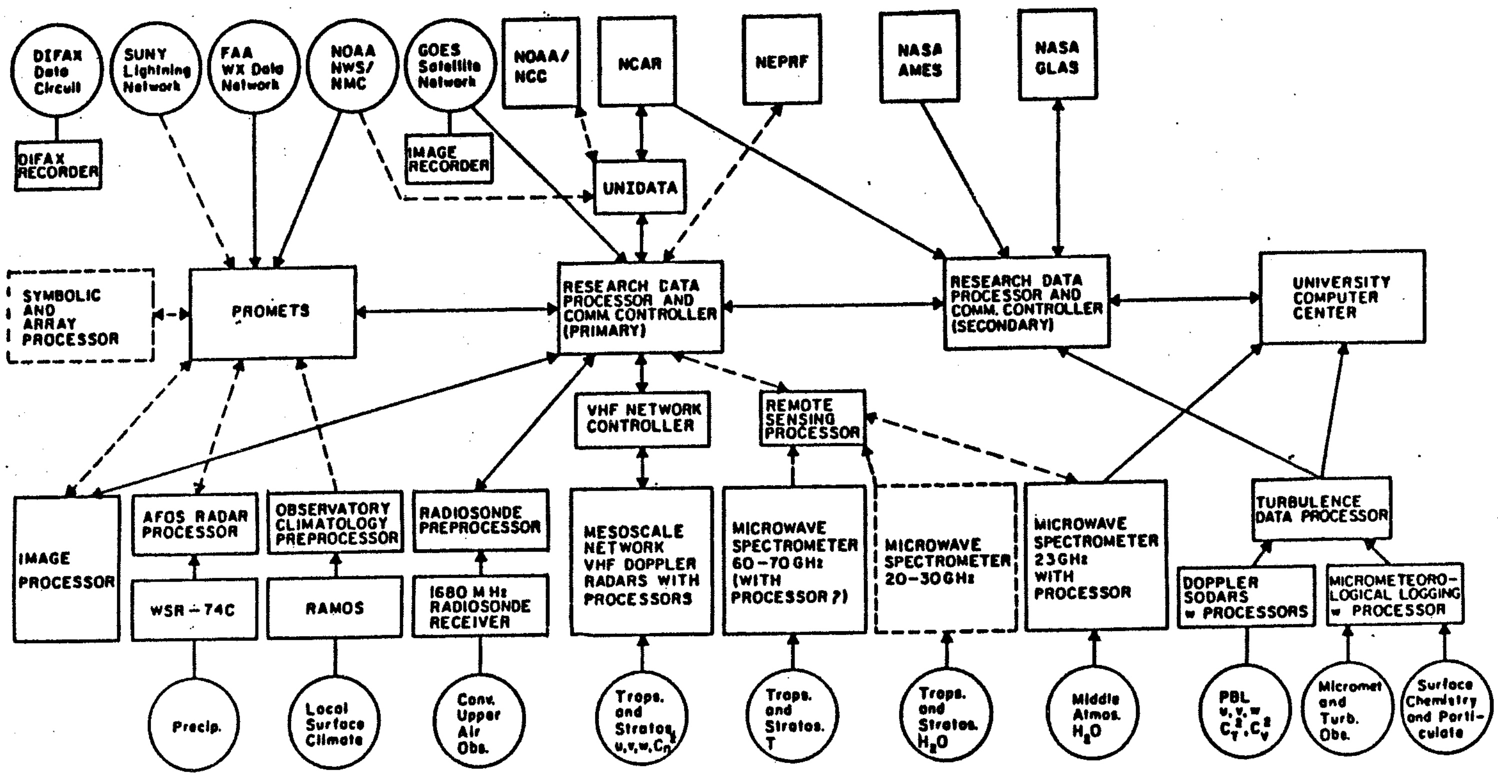


Figure 2. Schematic block diagram illustrating integration of measurement, data processing and modeling systems in the Department of Meteorology.

(3) Variability in mesoscale winds and turbulence
(4) Structure parameter statistics for NE U.S.
(5) Applications for assessment of acid deposition-related trajectories
(6) Assessment of forecast improvements for significant weather events in NE U.S.
(7) Deployment of a shipborne 400-MHz system (in conjunction with the network) for studies of coastal cyclogenesis.

Figures 3, 4, 5 and 6 are samples of the types of processed data available on a real-time basis in the University Weather Observatory with which the ST radar data will be combined and used. Figure 1 is a typical rawinsonde sounding from Pittsburgh as observed on 1 May 1984. For synoptic analysis purposes a cross section was evaluated along the computer-generated corridor illustrated in Figure 4. The vertical lines on the cross section (Figure 5) shown between stations 520 and 403 depict the scale between radars in the new ST network. Until thermodynamic profiler measurements are available we will use the existing PROMETS software to generate interpolated thermodynamic soundings from the analyzed cross sections. Such an interpolated sounding is shown in Figure 6.

Notification of funding for the 50-60 GHz millimeter wave radiometer for temperature sounding was recently received. The temperature profiler will be operated in conjunction with one of the VHF Doppler radars and a sodar. We hope it will be possible to use the radar and sodar measurements to infer probable inflection points (e.g. tropopause and PBL capping inversion) in the temperature profile and, thereby, improve the quality and resolution of the derived sounding. Development of software for this purpose is already in progress.

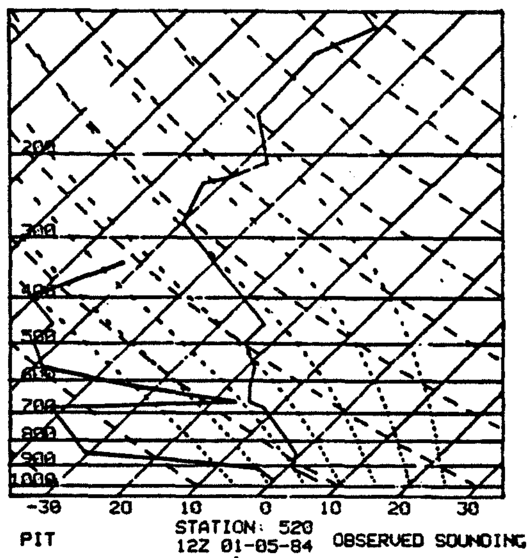


Figure 3. Example of plotted National Weather Service radiosonde sounding as plotted on PROMETS system from data received on the FAA network. Abscissa is temperature in °C and ordinate pressure is mb. The plotted data depict the temperature (R.H.) and dewpoint (L.H.) profiles.

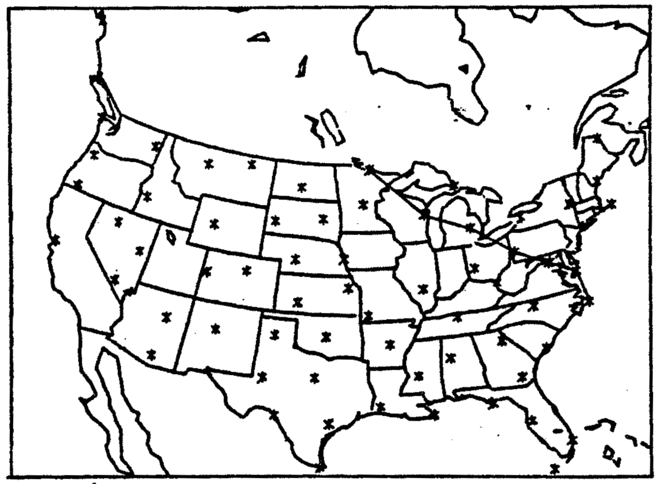

Figure 4. Corridor of upper air sounding stations chosen by the PROMETS software on the basis of specified end points. Station data subsequently processed by PROMETS to generate the isentropic cross section shown in Figure 5.

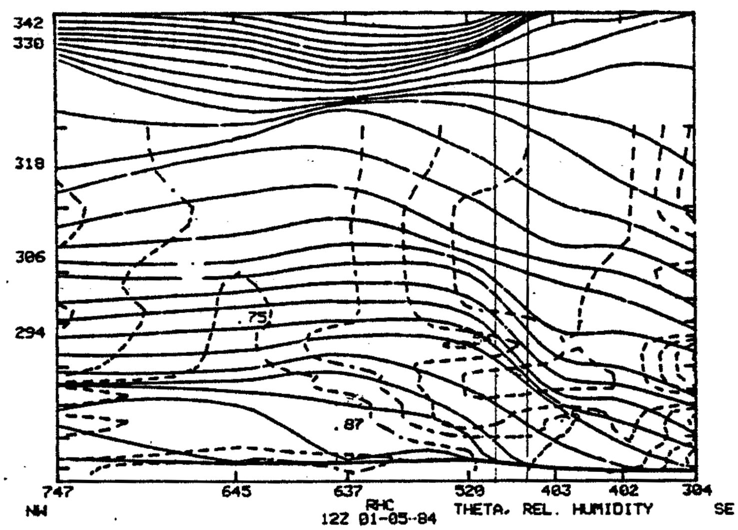


Figure 5. Isentropic cross section (solid sloping lines) including depiction of the smoothed relative humidity field (broken lines of varying orientation) along corridor shown in Figure 4. The two thin vertical solid lines depict the scale of the radar network in comparison to the spacing of the weather service radiosonde network.

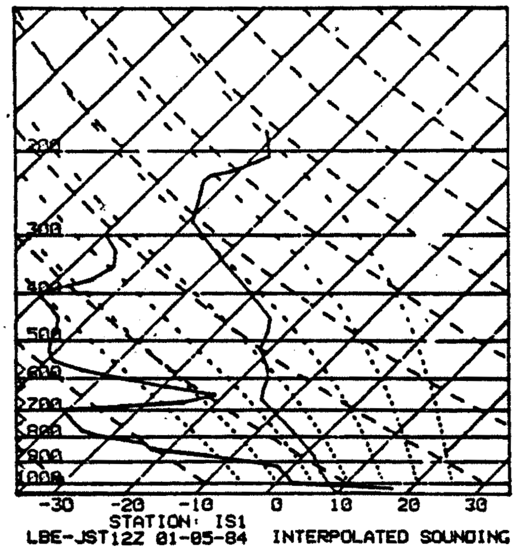


Figure 6. Example of vertical air and dewpoint temperature profiles generated from the preceeding isentropic cross section for a position corresponding to the placement of the new 400-MHz radar near Johnstown, Pennsylvania.