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PROFILER UPDATE

[Editor's Note: In October 1987, we published WRTA 87-39, "Wind Profiler Update", which served as an introduction to wind profiler technology and discussed the demonstration network which will be implemented in the next 2-3 years. In this TA, more information is presented, all excerpted (with permission) from the Profiler Forum, a publication of the Environmental Services Group of ERL in Boulder, Colorado.]

PROFILER PROGRAM UPDATE

The Profiler System Unisys received all the elements of the prototype profiler at its test site in Bloomfield, Connecticut. Each subsystem was individually checked out and met the performance specifications. Unisys integrated the system and testing began in December. After thorough check-out and acceptance testing, it will be disassembled and, except for the antenna, shipped to Platteville, Colorado, for installation. Another antenna will be in place and waiting there.

A functional prototype, developed by the Profiler Program, is now in place at Platteville, where it has been undergoing tests for the past year. Since October it has been sending spectral moment data to the development Hub computer, HUBOPS, every 6 minutes. Color displays of the 0th moment (reflectivity), 1st moment (Doppler velocity), and 2nd moment (spectral width) are produced. These can be used to identify the presence and nature of precipitation which may affect the quality of the wind calculations.

The two prototypes will be run in side-by-side tests for a month. In the spring, the Profiler Program's ERL prototype will be sent to Vandenberg Air Force Base on loan. The Unisys system, as the first of the 31 profilers in the demonstration network, will then begin full-time collection of wind data.

Communications The Statement of Work for the communications system is nearly complete; the procurement action should begin early in 1988, with the contract awarded in FY 1989. Studies indicate the system will probably be either dedicated telephone lines or a satellite-based system using VSAT very small aperture terminal) technology.

RETRIEVING TEMPERATURE AND GEOPOTENTIAL FIELDS FROM NETWORK WIND PROFILER OBSERVATIONS

—Ying-Hwa Kuo, NCAR
M.A. Shapiro, WPL

Over the past five years, considerable progress has been made in the development of a ground-based microwave radiometric profiler for measuring temperature and moisture. The radiometric profiler can provide very accurate integrated water vapor and liquid water measurements at the same high temporal resolution as the wind profiler. Westwater et al. (1984, 1985) showed that ground- and satellite-based microwave radiometric measurements can be combined to yield a temperature profile from the surface to 10 mb which is more accurate than the profile from either separate system.

However, at this stage of development, with six microwave channels and with climatology as a basis for radiometric retrieval, the vertical resolution of the temperature profile (~200 mb) is considerably less than that of the wind measurement (~300 m). This incompatibility in vertical resolution can create problems in mesoscale diagnostic studies and in numerical weather prediction. The poor vertical resolution also results in large errors in the radiometric temperature. Westwater et al. (1985) calculated the rms differences between the radiometric temperature and that of the radiosonde for 460 soundings (Fig. 1). The error is small near the ground, but increases quickly with height. It can be as large as 3 deg C near the tropopause and around 2 deg C for the mean troposphere. This is considerably larger than the typical measurement error of the radiosonde, which is less than 1 deg C for the whole troposphere.

Inspired by the success of retrieving temperature and pressure fields from ground-based multiple Doppler radar measurements for convective storms and small-scale systems (Gal-Chen, 1978), researchers began to develop procedures for retrieving thermodynamic fields from a regional array of wind profilers (Bleck et al., 1984; Kuo and Anthes, 1985). Recently we have extended the work of Kuo and Anthes (1985) to develop a method to derive temperature and geopotential information from network wind profiler observations using the

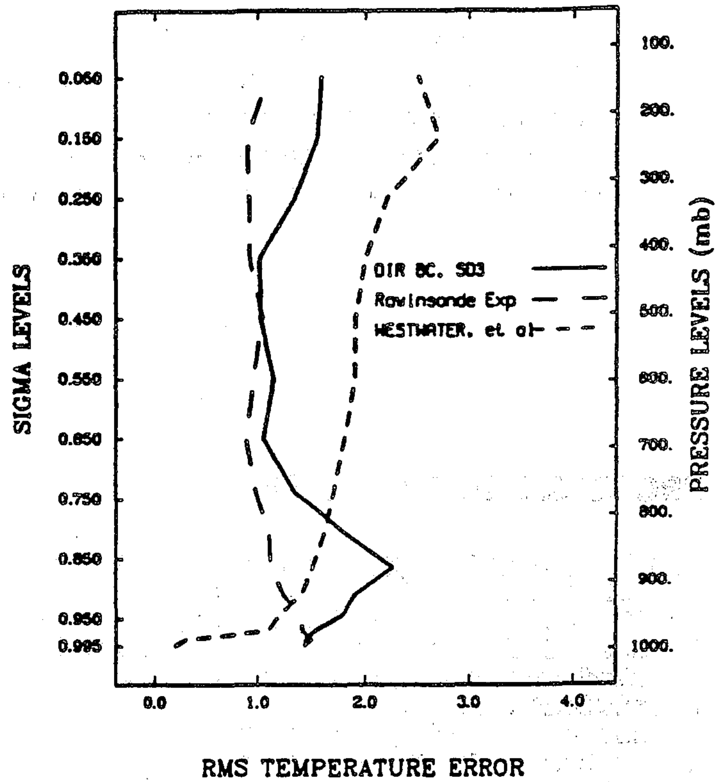

Fig. 1. Vertical profile of rms temperature errors for the combined satellite- and ground-based radiometric system (from Westwater et al., 1985), rms errors for temperatures retrieved from a network of hypothetical wind profilers stationed 360 km apart, and the measurement errors of a typical radiosonde system.

divergence equation (Kuo et al., 1987). We reformulated the retrieval procedure on a terrain-following σ-coordinate, similar to that used in most limited-area models. We then examined the accuracy of the derived temperature and geopotential fields for six different synoptic situations using basic data sets generated by a high-resolution mesoscale model.

Figure 1 shows the vertical profile of rms temperature errors for the combined satellite- and ground-based radiometric system (short-dashed line, from Westwater et al., 1985), rms temperature errors retrieved from a hypothetical network of profilers (solid line), and typical rawinsonde measurement error (long-dashed line). In the middle and upper troposphere, the temperature retrieved from the wind field is significantly more accurate than the direct temperature measurement from a combined satellite- and ground-based microwave radiometric system. At lower levels, however, the retrieved temperature is not as accurate, mainly due to the neglect of boundary layer momentum fluxes in the retrieval calculations. Because the boundary layer momentum fluxes are difficult to measure, this suggests a need for independent temperature measurements at these levels.

As a point of caution, one should not interpret this as implying that the radiometric temperature is useless. It is well-known that radiance measured by satellite- or ground-based microwave systems is highly accurate. As discussed by Westwater (personal communication, 1987), the measurement error in the radiance as observed by a ground-based microwave radiometer is less than 0.25%. The temperature error shown in Fig. 1 is largely caused by the use of climatology, which has little vertical structure, as a first guess for radiometric retrieval. If the temperature from a model forecast or the temperature retrieved from the wind profiler observations were used as the first guess, the accuracy of the radiometric temperature could be substantially improved. We are currently exploring the possibility of the latter in collaboration with Westwater. Preliminary results indicate that coupling the radiance measured by the satellite- and ground-based microwave systems with the temperature retrieved from the wind fields can provide a temperature profile close to the accuracy of that of a radiosonde system. These results will be summarized in a forthcoming paper.

References

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ONGOING WORK AT PENN STATE

The Meteorology Department at Penn State has been operating a 50 MHz profiler at McAlveys Fort, PA, since June 1985, and two more (another VHF and a portable 404 MHz) since April 1986.

One of their current profiler application programs is a comparison between profiler-measured winds and winds analyzed (from conventional network data) and forecast with the Nested Grid Model (NGM) of the National Meteorological Center. Dennis Thomson, William Syrett, Thomas Warner, and Nelson Seaman have done such a comparison for 00, 12, 24, 36, and 48 hour winds for the 700 and 500 mb levels for January and May 1987. They have stratified the data base into situations characterized by cyclonic, anticyclonic, and no streamline curvature at the level of interest. They demonstrate that on the average during situations involving cyclonic curvature the initial analysis results in wind speeds that are 21% too low. Further, these initial errors then propagate through the forecast period. This paper will be given at the 8th Conference on Weather Prediction in February 1988.

Other work at Penn State is a recently completed four-dimensional data assimilation experiment which used profiler measurements and the Penn State/National Center for Atmospheric Research mesoscale model. From that it appears that continuous profiler measurements, even on a synoptic rather than a mesoscale grid, will yield significant improvements in forecast winds.

AN INTERACTIVE EDITING PROGRAM FOR PROFILER DATA

--Keith Brewster
PROFS

Recently PROFS (Program for Regional Observing and Forecasting Services) has been developing and improving automated quality control (QC) procedures for wind profiler data (Brewster and Schlatter, 1986, 1988). In order to obtain statistics from quality-controlled data unaffected by the peculiarities of any automated routine, an interactive editing program was developed. The program is also useful for case studies where the meteorologist wishes to have complete control over data quality before plotting or doing computations with a profiler data set. This article describes the program and presents some ideas for future development.

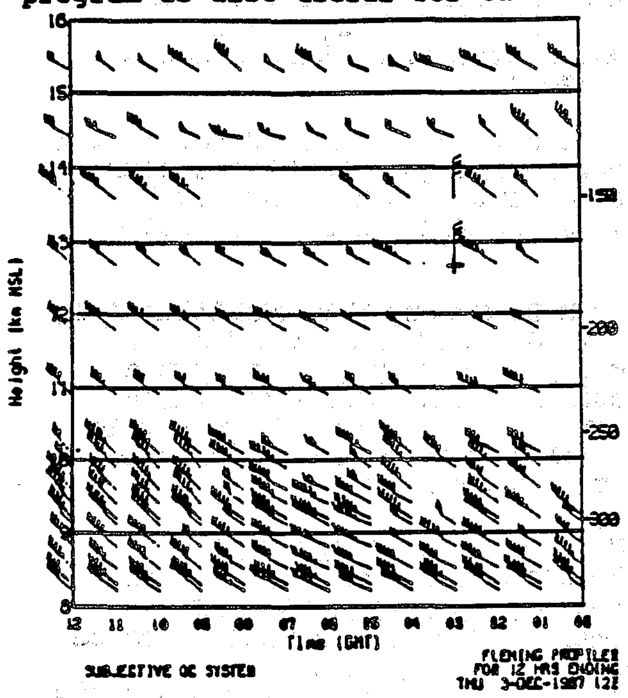

Fig. 1. Display of wind barbs in time-height cross section as it appears on the monitor. Time increases to the left Vertical range can be varied by the user to reduce clutter. Here 8-16 km data are displayed; measurements extend from 3 to nearly 20 km.

To edit the data, the user selects the time interval to be considered and then examines the data in 12-hour windows, one station at a time. The program displays the hourly averaged data on a color monitor as wind barbs in a time-height cross section (Fig. 1), and on a terminal as numbers in a table (Fig. 2). To help the analyst judge the data, the following information is displayed in the table for each wind observation:

- o height
- o wind direction and speed (knots)
- o u and v component (along-beam component)
- o vector difference from previous gate
- o returned power (reflectivity)
- o radar mode (fine resolution/low height, medium resolution/ medium height--1, coarse resolution/maxiumum height--3)

Data are selected for flagging by moving a cursor to the bad datum (the cursor on either the monitor or the terminal may be used). The wind direction and speed are both flagged bad by the proper menu selection. Flagged data are displayed in red on the monitor (good data are green) and in reverse video on the terminal. When all stations for a given hour have been edited, the data are written to the output file. The output file is identical to the input file except that the quality control bit assigned to each datum reflects the decisions made in the program.

P R O F I L E R   S U B J E C T I V E   Q C   S Y S T E M

FLMNG
1336. m

3-DEC-1987
03:20 Z

Hgt	Dir	Speed	Ucomp	Vcomp	Diff	Refl	Mode
18800	335	15.	6	-14	-14	24	3
17900	300	24.	21	-12	6	27	3
17000	313	26.	19	-18	-13	29	3
16200	301	38.	32	-20	-11	32	3
15300	296	42.	40	-12	19	26	3
14400	296	59.	53	-26	56	28	3
13600	2	40.	-1	-40	1	27	3
12700	2	40.	-1	-40	-72	26	3
9900	311	90.	68	-59	12	23	1
9100	312	102.	76	-68	-17	25	1
8800	303	96.	81	-52	-8	30	1
8500	299	92.	80	-44	6	34	1
8300	301	87.	74	-45	-1	38	3
8200	301	89.	76	-45	2	34	1
7900	301	87.	74	-45	8	34	1
7600	306	87.	70	-51	5	36	1

1:Set to good
2:Set to bad
3:Reselect
4:Save this hr
5:Write this h
6:Change Plot
7:Plot raob

Select option (^Z to quit):

Fig. 2. Data display as it appears on the user terminal. Menu options are listed on the right and station information is listed on the left. The subset of data that is displayed is determined by the position of the cursor on the monitor or terminal.