new tools for forecasters: real-time cross sections produced in the field

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Abstract

Objective analyses on vertical cross sections are presented as examples of the type of real-time product available on the Penn State, Department of Meteorology, on-line minicomputer. The analyses are not new, but their real-time availability is. Our experience has been that such products improve forecaster diagnosis and understanding and suggest that the "man-machine mix" concept, extended to other types of analyses and diagnoses, may be as appropriate to small machines as to large ones.

1. Big jobs for small machines

During the next few years, weather forecasters and diagnosticians will be relying increasingly on rapid, minicomputer-based, real-time interactive systems. Even now, the National Weather Service (Wilkins and Johnson, 1975) is operating an experimental facility at Silver Spring, Md., to develop a prototype system for its Automation of Field Operations and Services (AFOS). Similar work is in progress elsewhere; the Federal Aviation Administration (FAA) (Bromley, 1975) has begun to move toward a computer-based pilot-briefing system, and at the University of Wisconsin, experimentation with the Man-Computer-Interactive-Data-Access-System (MCIDAS) (Smith, 1975) and with Innovative Video Applications in Meteorology (IVAM) (Bauer, 1974) is quite advanced on data displays linked to satellite imagery. At Penn State, we use a PDP-11 minicomputer to continuously monitor the FAA medium-speed (1200 baud) weather teletypewriter circuit, permitting the rapid presentation and analysis of many familiar fields, and some that are rarely seen in real time.

In what follows, we describe some of those fields, notably displays on vertical cross sections, but these are simply examples of what can be done. Given the appropriate equipment and solutions to some practical problems, the analyst of the future should be able to diagnose and depict many features that are now only guessed at. Some problems remain, however. Considerations of data storage, access to core, reliability, and operational requirements make the task rather formidable. But the tools exist, and at Penn State we have found it useful to rely on commercially available hardware and, where possible, software, using the method of achieving limited capability at first and building upon that capability for more difficult tasks. This report describes some of our early steps.

2. Isentropic cross sections

One of the major benefits of a real-time computer system is the routine availability of locally generated analyses, and these need not be confined to mesoscale versions of familiar charts. Other types of analysis, such as the cross section (a side view of the atmosphere that shows more detail about vertical structure than maps), are readily done. Several types of cross sections have been used in meteorology; we have adopted a very useful one that depicts the potential temperature (θ), called the isentropic section. The most useful property of isentropic surfaces, which is easily seen on a cross section, is that they "crowd up" in stable zones, such as in fronts and near jet streams, so that calculations over equal increments of potential temperature are preferentially concentrated into the regions of meteorological interest. Significant level observations tend to be crowded into these zones, as well.

It is essential to use all data from the soundings accurately. One analysis routine that is appropriate for doing this is a fairly simple but quite accurate analysis technique suggested by Shapiro and Hastings (1973). Values of $(\partial \ln p/\partial \theta)$, calculated from significant level data as well as mandatory level data, are used to linearly interpolate θ in the vertical between observed points. After the vertical interpolation is complete, horizontal interpolation generates equations for the pressure of specified isentropic surfaces as functions of horizontal distance, using a technique called Hermitian interpolation. Essentially, the method involves using observed data as arguments for a cubic polynomial and its quadratic derivative to obtain a piecewise, third-order fit. This technique works admirably for fields that are strictly monotonic in the vertical. A preprocessing routine insures that θ always increases with height, at least slightly; this increase is unrealistic only for very shallow layers, mainly near the ground. This technique, because it utilizes significant level data, produces a more detailed vertical picture than can be inferred from conventional analyses on quasi-horizontal surfaces.

Another reason that analyses of isentropic surfaces are especially revealing is that much motion in the atmosphere is adiabatic; this means that air flows along them. Accordingly, variables tend to be correlated along such surfaces, and structures tend to slope along them. Both

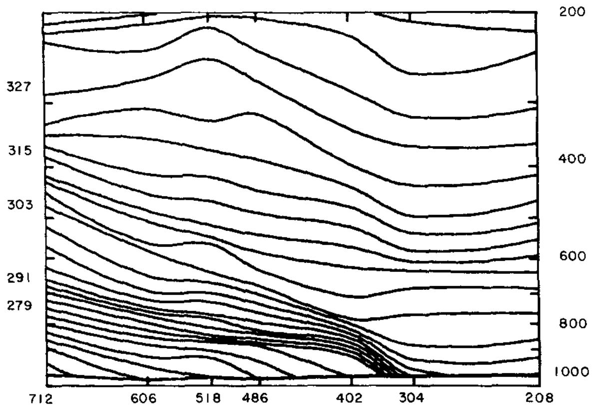

FIG. 1. Cross section of potential temperature from Caribou (712), Maine, to Charleston (208), S.C., 14 March 1975, 1200 GMT. Contour interval is 3 K. Contours are labelled along the ordinate, with indicated contours intersecting the base of the identifying number. The cross section passes through Portland (606), Albany (518), New York City (486), Wallops Island (402), and Cape Hatteras (304). Ordinate is natural logarithm of pressure, with vertical scale extending to 200 mb.

properties tend to simplify the analysis problem and still permit good resolution of the kind of fine-scale, sloping structures that interest forecasters.

Figure 1* is an example of a vertical cross section of potential temperature from Caribou, Maine, on the left, to Charleston, S.C., on the right, for 14 March 1975, 1200 GMT. Contours are values of potential temperature, θ, at a 3 K interval. That θ behaves rather regularly in the vertical can be seen from its definition differentiated in the vertical,

$$\Delta\theta/\Delta z = (\theta/T)\ [\Upsilon_d - \gamma], \tag{1}$$

where z is geometric height, T is absolute temperature, and the bracketed expression is the difference between the so-called dry adiabatic lapse rate Υ_d and the actual measured lapse rate at any point, $\gamma\,(= -\partial T/\partial z)$. Inasmuch as the great bulk of the atmosphere exhibits a lapse rate that is less than dry adiabatic, θ normally increases with height. Exceptions occur only very close to the ground, in perfectly mixed layers at any level, and in an occasional shallow "super." Mixed layers will be devoid of isentropes, and for most analysis routines, including the present one, supers are either smoothed out or ignored. This means that some errors may be present, especially very close to the ground during daytime.

The increase of potential temperature with height is a measure of static stability and is proportional to the crowding of the isentropic surfaces in the vertical. Where the atmosphere is most stable, such as near a frontal zone, a subsidence inversion, a nocturnal inversion, or in the stratosphere, the crowding is very great. In this case a pronounced frontal inversion shows up over Wallops Island (402), New York City (486), and Albany (518) and shows up less well at Portland (606) and Caribou (712). The top of the inversion slopes upward from about 775 mb over Wallops to about 650 mb over Albany. This upper boundary of the frontal zone is the potentially warm side, because the potential temperature increases upward. It is what most of us would call "the front," the warm edge of the cold air. No such inversion is present over Cape Hatteras (304) or Charleston (208); they are south of the surface front position and have deep columns of warm air overhead. Thus, we can infer that the surface front lies between Wallops and Hatteras, and it is easy to see its steeper slope close to the ground. Figure 2 shows its position on a map.

Furthermore, we can verify that the air is warm on the Hatteras-Charleston side of the front by two methods. First, by recalling that θ increases with height, we can conclude that wherever the isentropic surfaces sag down toward the ground, the highest temperatures are observed. Equivalently, we can calculate T from the definition of potential temperature, which is

$$\theta = T(1000/p)^{2/7}. \tag{2}$$

Since the surface pressure p is close to 1000 mb at Hatteras and Charleston and the surface potential temperature at each is about 292 K and 295 K, respectively, these are temperatures of about 20°–22°C, characteristic of warm air masses on any morning. By contrast, Caribou is at about −10°C; it is necessary to cross many isentropes traveling horizontally from Hatteras to Caribou, in accordance with the fact that the isentropes also depict the horizontal temperature gradient. Where they are crowded together, that is where the fronts are. Although the center of the cold air mass is plainly off the section north of Caribou, it is clear from the dome-shaped isentropes at higher altitudes that there are

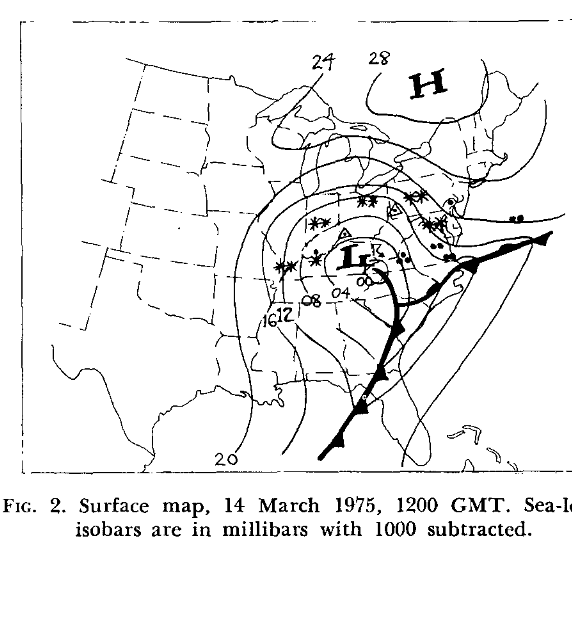

FIG. 2. Surface map, 14 March 1975, 1200 GMT. Sea-level isobars are in millibars with 1000 subtracted.

* All cross-section figures are presented exactly as they appear on the graphics terminal, except that the numerals have been enlarged. This practice may result in some extra effort for the reader, but the authors wish to show the depictions that are obtained on a limited-core computer in real time.

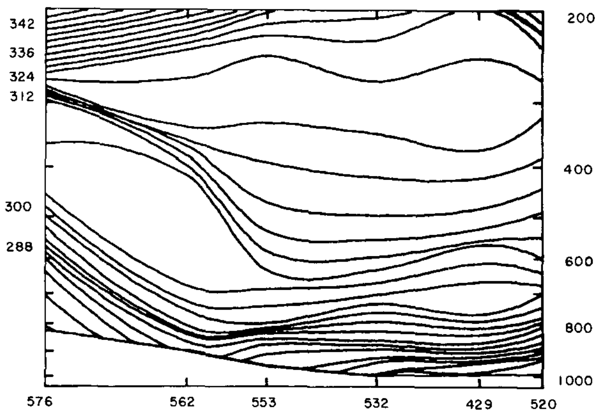

FIG. 3. Cross section of potential temperature from Lander (576), Wyo., to Pittsburgh (520), Pa., 27 March 1975, 1200 GMT. (See Fig. 1 for contouring information.) The cross section passes through North Platte (562), Omaha (553), Peoria (532), and Dayton (429). Ordinate is natural logarithm of pressure, with vertical scale extending to 200 mb.

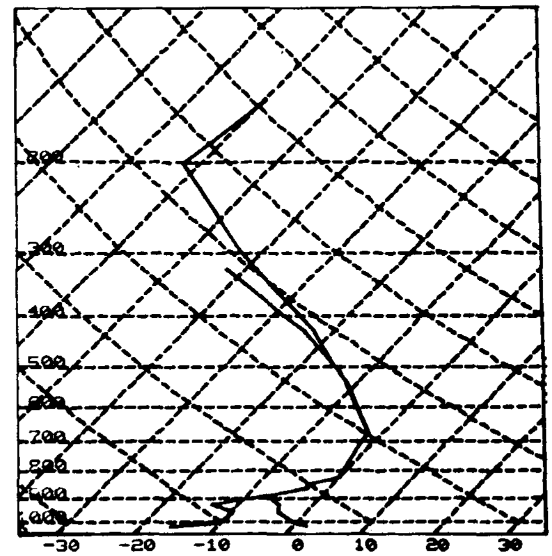

FIG. 4. Observed sounding for New York City, 14 March 1975, 1200 GMT. The base is a Skew T–Log p diagram. Normal video display includes listing of temperature, pressure, dew point, relative humidity, potential temperature, and equivalent potential temperature.

some distinct cold pockets aloft, with the most prominent one over the Albany vicinity.

Just as horizontal crowding of isentropes indicates a front, and vertical crowding, an inversion, wide vertical spacing of the isentropes indicates relatively unstable regions. The air between 700 and 900 mb south of Hatteras is relatively unstable, as is the air aloft at several locations. Pronounced instability exists near 500 mb from New York southward across New Jersey and in the high troposphere over New England. An example of deep instability is contained in Fig. 3, which is an isentropic cross section from Lander, Wyo. (576), to Pittsburgh, Pa. (520). It should not surprise a forecaster, with this information, to get reports of thunderstorms from Omaha (553) on this March morning even though surface temperatures are barely above freezing.

In Fig. 3, other interesting features can be seen. The east slope of the Rockies trends upward to the left, clearly depicting the all-important sloping ground. Most analyses will represent the terrain in an overly smoothed way, so care must always be exercised at the ground intersection. To the extent that data points depict differences in surface pressure, the isentropic cross sections automatically show the slopes. Further, the tropopause is much lower over the Rockies than it is farther to the east. This can be seen by the change in stability, indicated by packing of the isentropes in the stratosphere. In general, a high tropopause occurs over warm air and a low one over cold air; here, we can see very clearly the air mass contrast and the bounding upper front with the cold air behind it.

3. Relation between cross sections and soundings

Essentially, cross sections consist of soundings, plotted side by side. Figure 4 shows one of the actual soundings from which the section in Fig. 1 was drawn, that for New York City. This is a routine product that is always available as part of the cross-section analysis. Note the frontal inversion over the cold surface air; the front shows clearly at 680 mb, with unstable warm air above it. At about 400 mb, another slight inversion appears, in both the cross section and the sounding.

Further, the dew point curve lies right along the temperature curve between 900 and 500 mb; this relationship suggests that the front is marked by overrunning and deep clouds. But the real beauty of cross-section analysis is that we can now picture, or plot, what the sounding looks like at points in between the regular radiosonde stations. We can generate an Atlantic City sounding or any other sounding we like along the section. Figure 5 is the interpolated sounding at Atlantic City for 14 March 1975, 1200 GMT. It is easy to imagine that an actual sounding taken at Atlantic City might be similar, but we know that the smoothing that is implicit in the analysis has caused some degradation. A more accurate interpolation might be arrived at by taking two cross sections at right angles intersecting over Atlantic City and averaging, but it can be seen here that much of the structural detail is captured by the single interpolation, when it is taken across the mean flow. For instance, the frontal inversion shows plainly with its top near 700 mb. The fact that moisture increases upward through and above the front again implies that it is being overrun, just as was the situation at New York City and just as we would expect. Here, however, errors in the humidity analysis result in no layer being completely saturated; this result probably is incorrect. Nevertheless, here is a real-time "sounding" for Atlantic City that could be very useful for the local

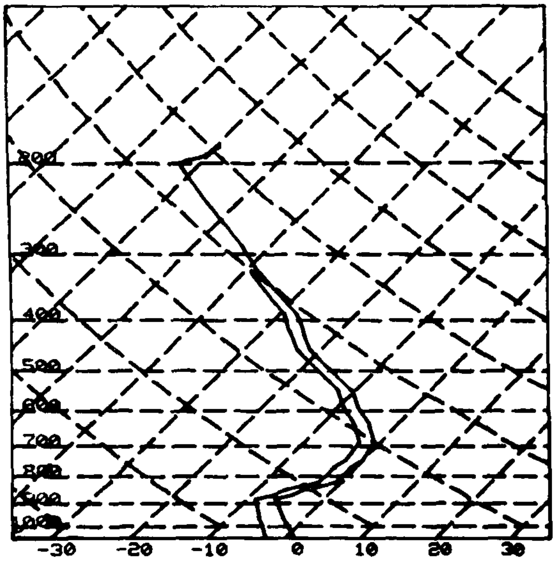

FIG. 5. Interpolated sounding for Atlantic City, N.J., 14 March 1975, 1200 GMT.

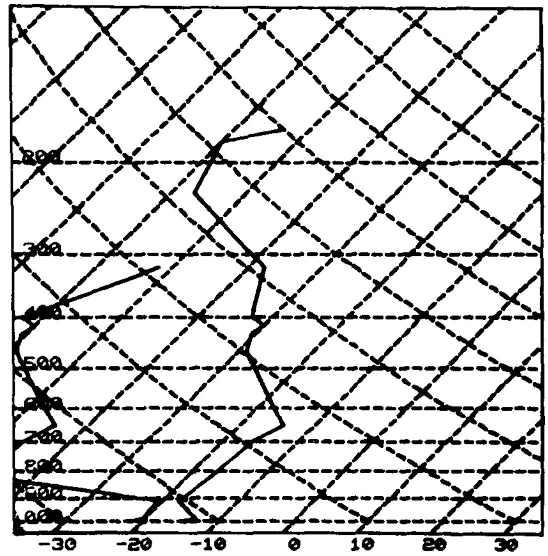

FIG. 6. Observed sounding for Caribou, Maine, 14 March 1975, 1200 GMT.

forecaster there. Such an approximate sounding is generated by the computer system in real time for any location.

Other aspects of structure require more information than is shown on these sections. The slope of the front between New York City and Cape Hatteras can be seen and is 1/188, which is close to a normal frontal slope for a warm or stationary front. However, we cannot identify the front type from the cross section. If the winds in the plane of the section were depicted, it would be possible to judge the front type and estimate its speed quite readily by consulting the winds close to the front on its cold side. Referral to Figs. 4 and 5 verifies that the soundings to the north look like warm or stationary front soundings with ample moisture coming in over the cold air. This particular one happens to be a stationary front.

On the northern end of the section, the Caribou sounding (Fig. 6) shows the cold, dry air mass well north of the front. However, the slight inversion and evidence of cirrus in the moisture profile hint of the front at 318 mb, and the northward-sloping isentropes show that there is still a temperature gradient.

4. Severe weather

It is a particularly valuable property of the cross section to depict the upper structure to make it easier for the forecaster to understand surface weather. During the early morning hours of 22 February 1975, several tornadoes struck the Altus-Duncan region of southwestern Oklahoma, killing 3 and injuring 77 persons. This locality, a climatologically favored region for tornadoes as a consequence of its frequent proximity to the "dryline," has been studied extensively, and typical tornado outbreaks are usually forecast very well. This particular set was especially difficult to forecast because it occurred with cold surface temperatures. Figure 7 shows a north-south cross section from Rapid City, S.Dak. (662), to Del Rio, Tex. (261), for 0000 GMT, 22 February 1975, about 6 h prior to the tornado outbreak. The Altus region of southwestern Oklahoma is a short distance east-southeast of Amarillo, Tex. (363), and corresponds to a point on the cold side of the surface front that shows up just north of Midland, Tex. (265), on this section. Temperatures at Altus remained only a few degrees above freezing during the outbreak. Severe weather was expected on the warm side of this front, but Fig. 7 shows that well back over the cold air, a

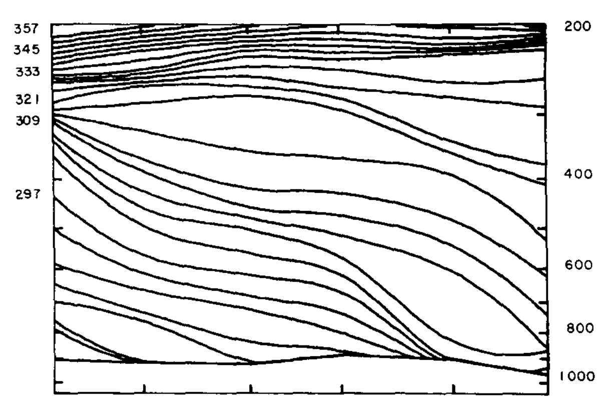

FIG. 7. Cross section of potential temperature from Rapid City (662), S.Dak., to Del Rio (261), Tex., 22 February 1975, 0000 GMT. (See Fig. 1 for contouring information.) The cross section passes through North Platte (562), Dodge City (451), Amarillo (363), and Midland (265). Ordinate is natural logarithm of pressure, with vertical scale extending to 200 mb.

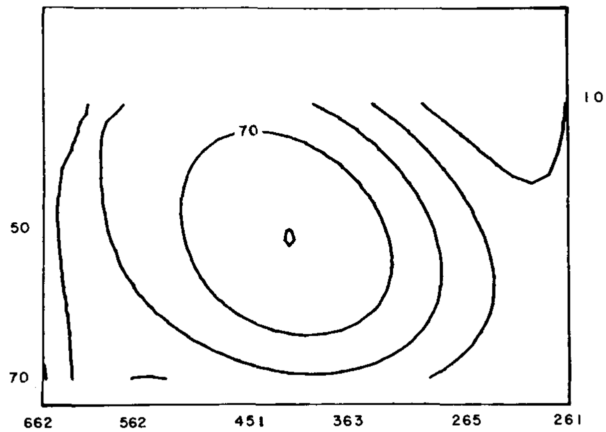

FIG. 8. Regression analysis of relative humidity for the section of Fig. 7. Isopleth interval is 20%. Ordinate is natural logarithm of pressure, with vertical scale extending to 200 mb.

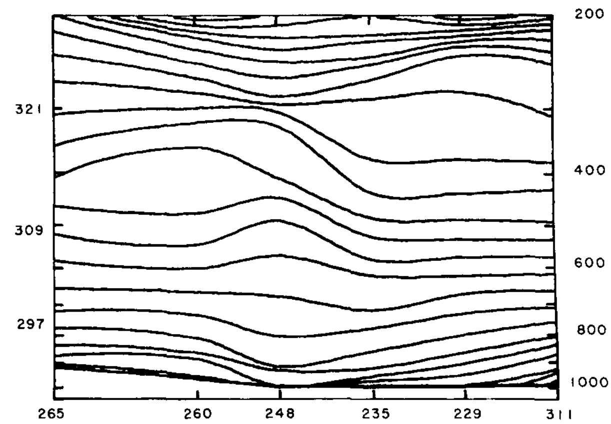

FIG. 9. Cross section of potential temperature from Midland (265), Tex., to Athens (311), Ga., 8 January 1975, 1200 GMT. (See Fig. 1 for contouring information.) The cross section passes through Ft. Worth (260), Shreveport (248), Jackson (235), and Birmingham (229). Ordinate is natural logarithm of pressure, with vertical scale extending to 200 mb.

deep unstable layer extended from near 850 mb to about 300 mb with a weak inversion in the middle troposphere. Thus, the most common type of tornado sounding was present over a very shallow layer of cold air. In fact, the cross section shows that the air was most unstable, neglecting moisture, toward the cold side of the surface front. Because data from the soundings west of Altus (not shown) indicated the characteristic middle-level dry intrusion that tornado forecasters look for, and because there was an approaching cyclone, with all these factors present, they issued a severe thunderstorm watch for the warm side of the front. It was a good forecast, but they might have been interested by a cross section of relative humidity (Fig. 8) that we have generated for the same time and stations as those in Fig. 7. The very moist air is located above the shallow layer of cold air, rather than out ahead of the front.

The relative humidity is computed from the temperature and dew point on each sounding at both mandatory and significant levels. Humidity fields contain large gradients and gradient reversals, and they are consequently very difficult to analyze without recourse to very complex schemes. But we believe that relative humidity cross sections are sufficiently interesting to justify their depiction, even if the analysis of shallow features suffers. We have accomplished this by a 13-term, fourth-order, least-squares fit in x and p using multiple regression (Draper and Smith, 1966). The result is a polynomial equation that is plotted on the graphics display terminal with a very small and efficient routine written especially for minicomputers. This technique produces a somewhat over-smoothed field, and, at first glance, it might appear that a more general contouring scheme, not based on least squares, would be more suitable. As a rule, general contouring routines require large computers for execution, but this regression scheme operates easily in a 16 000-word minicomputer. In addition, the availability of a mathematical equation facilitates easy manipulation of the resulting field for computation or interpolation. Typically, 50–60% of the variance in the humidity field is accounted for by the regression fit.

Even in rather subtle cases, stability changes can be diagnosed from the cross sections. Figure 9 shows an east-west isentropic cross section across the Gulf states for 8 January 1975, 1200 GMT. Winds were approximately from the west, that is from left to right along the section. Notice that in the Shreveport, La. (248), area, isentropes sag down toward the ground, indicating a warm tongue, but they also bend upward aloft, implying colder air aloft. In short, the air over Shreveport is unstable, and the westerly flow is advecting unstable air toward Jackson, Miss. (235). On this January moring, thunderstorms were reported in eastern Louisiana and Mississippi, including Jackson, as Fig. 10, the 1200

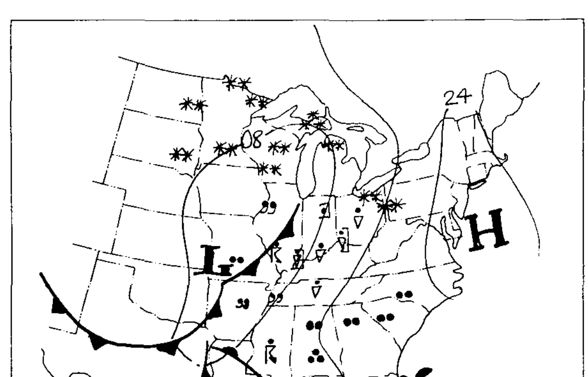

FIG. 10. Surface map, 8 January 1975, 1200 GMT.

GMT surface chart, shows. Again, the cross section shows the mechanism.

5. Thermal wind

There are several practical reasons for the usefulness of cross sections, but certainly a principal one is the reliable thermal wind relation linking the geostrophic wind shear to the horizontal temperature gradient.

Given the field of θ on the section, which by the Hermitian interpolation technique must be accurate at the radiosonde station locations, it is a reasonably easy matter to calculate the component of geostrophic wind perpendicular to the plane of the section by using the thermal wind relation. The actual procedure involves calculation of the Montgomery potential,

$$M \equiv c_p T + gz, \tag{3}$$

where c_p is the specific heat for dry air at constant pressure, T is its temperature, z is its elevation above sea level, and g is the apparent gravity. The gradient of Montgomery potential plays the same role in the isentropic framework that geopotential does in the pressure system. It is found at each level in a manner similar to that of Bleck (1973), where the derivative

$$\Delta M/\Delta\theta = c_p\ (p/1000)^{2/7} \tag{4}$$

can be determined directly from the already existing distribution of the pressures, p, of the various potential temperature surfaces, θ. The Montgomery potential, M, can then be determined under this hydrostatic calculation according to

$$M = M_s + \sum_{i=1}^{n} \left(\frac{\Delta M}{\Delta\theta}\right)_i \Delta\theta \tag{5}$$

if only the surface value M_s is known. Inasmuch as M_s is involved in the recovery of the horizontal surface pressure gradient in the plane of the section, it must be determined to very good accuracy (Danielsen, 1959). We have found that

$$M_s = c_p T_s + g z_s \tag{6}$$

gives a satisfactory representation of the surface Montgomery potential, M_s, for calculation of the surface pressure gradient. Here, T_s is surface temperature and z_s is surface elevation.

The integration is carried out at radiosonde stations, for which these values are known, and halfway between them, for which they are linearly interpolated. What must be remembered is that only the part of the temperature gradient that is in the plane of the section can be seen or measured, so only the component of thermal wind that is perpendicular to the section can be evaluated. However, by using sections across the flow, we obtain most of the temperature gradient and most of the shear. Of course, it is possible to depict and analyze the component of measured wind in the plane of the section, but we will confine our attention to the shear of the orthogonal component of geostrophic wind, which is related to the thermal field. In Fig. 1, the isentropes sag down on the right-hand end of the section; therefore, it is warmer there. Alternatively, they mound up over cold air to the north. Either way, warm to the south, cold to the north, means that the westerly component of wind increases with height in this section. If there are low-level easterlies, they will decrease upward and become westerlies. Where the greatest packing of sloping isentropes occurs, the vertical wind shear is greatest and the jet stream is likely to be found.

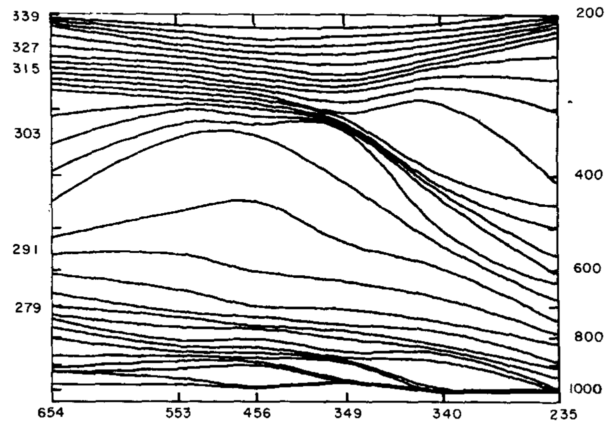

FIG. 11. Cross section of potential temperature from Huron (654), S.Dak., to Jackson (235), Miss., 6 February 1975, 1200 GMT. (See Fig. 1 for contouring information.) The cross section passes through Omaha (553), Topeka (456), Monet (349), and Little Rock (340). Ordinate in natural logarithm of pressure, with vertical scale extending to 200 mb.

The geostrophic wind can be determined quantitatively at points one-quarter and three-quarters of the distance between radiosonde stations (using centered differences) by solving for the geostrophic wind (V_g),

$$V_g = (1/f)\,(\Delta M/\Delta X), \tag{7}$$

where f is the Coriolis parameter, X is horizontal distance, and M is determined from (5).

One application of the geostrophic wind shear analysis lies in diagnosing regions of clear air turbulence (CAT) at high levels of the atmosphere. It has often been necessary to include overly large regions of possible CAT in forecasts despite the fact that the causes have been well understood for a number of years. This may be related to inadequate resolution in real-time analyses. The production of turbulence occurs, for many cases, from the large values of vertical wind shear associated with upper fronts and jet streams; other cases are related to mountain waves. Isentropic cross-section analysis on a minicomputer permits real-time calculation of the Richardson number, or, if geostrophic winds are used, a geostrophic Richardson number,

$$\mathrm{Ri} = \frac{g}{\theta}\frac{\Delta\theta}{\Delta z}\left(\frac{\Delta V_g}{\Delta z}\right)^{-2}, \tag{8}$$

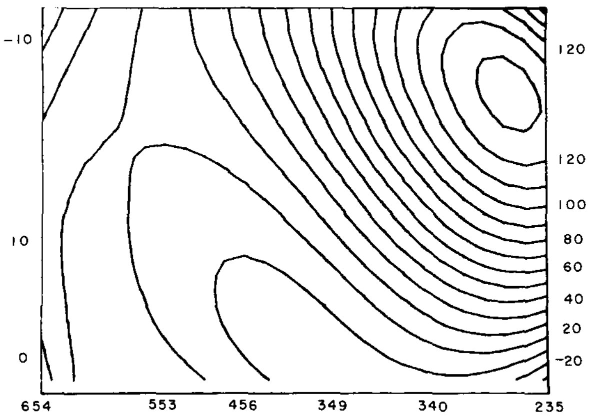

FIG. 12. Regression analysis of the component of geostrophic wind perpendicular to the plane of the section in Fig. 11. Isopleth interval is 10 kt. Ordinate is natural logarithm of pressure, with vertical scale extending to 200 mb.

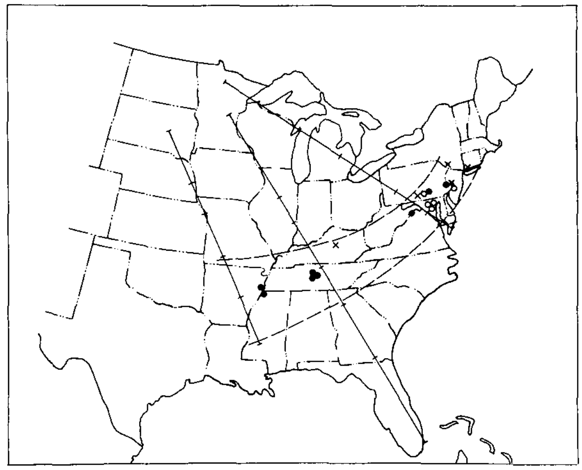

Fig. 13. Zone of small Richardson number diagnosed from isentropic cross sections. Data are from 6 February 1975, 1200 GMT. Turbulence reports are indicated as follows: moderate to severe or severe turbulence (crosses); moderate turbulence (solid circles); and light or light to moderate turbulence (open circles).

which typically becomes small near jet streams. Figure 11 contains an isentropic cross section from Huron, S.Dak. (654), to Jackson, Miss. (235); note the considerable crowding of potential temperature contours in a narrow zone over Arkansas, between Monet (349) and Little Rock (340). The geostrophic wind field, which is also analyzed by a fourth-order, least-squares regression, is shown in Fig. 12, where the jet exceeds 67 m/s (130 kt); here the regression accounts for about 85% of the variance of the computed geostrophic winds, which is typical. We have calculated Richardson numbers from these winds and temperatures and by using a critical Richardson number of 1.50, which is considerably larger than the actual critical value of 0.25 (Dutton and Panofsky, 1970), we can delineate minimums in that field. If several cross sections are drawn, it is possible to block out a relatively small area where CAT may be experienced. Such an area is indicated on Fig. 13 from three indicated cross sections. Also included on Fig. 13 is the location of all CAT reports from pilots carried on Service A in the eastern part of the United States during the 9 h subsequent to the analysis.

This is a first attempt at depicting regions of CAT, and we do not intend to imply that it is the best method; on the contrary, many refinements are possible. The essential point being made here is that with an on-line computer and some software, substantial amounts of information can be extracted from soundings only minutes after they are available. It is possible, if the minicomputers are employed advantageously and the data are accessible. In that situation, forecasters will be meeting new challenges with increasing confidence.

6. Conclusion

The cross-section analysis schemes discussed in this paper are simply an example of products that a forecaster can generate quickly on a minicomputer to assist in meteorological judgment. But the concept of man-machine interaction has much wider implications. Cross sections have not been used very much operationally because the labor required for hand preparation is extensive and slow. The on-line computer permits us to consider mainly the meteorological constraints of any particular scheme, rather than such external constraints as labor or time. To the present, computer applications in meteorology have been confined to some predetermined algorithms and there has been no way for the forecaster to intervene in the process when obvious errors were occurring; in fact, he usually had little information on what the computer was doing. Our experience suggests that an interactive relationship between an on-line computer and the forecaster can provide a useful combination of information and judgment.

Appendix: Description of the Penn State minicomputer system

The computer system that was used to develop the analysis capability described in this paper consisted of the following:

1) PDP-11/10 computer with 16 000 words of memory;
2) one 2.4×10^6 byte cartridge disk drive and controller;
3) dual-drive cassette tape;
4) Decwriter console terminal;
5) Tektronix 4012 graphics terminal and hard copier;
6) interface between computer and Bell Modem for direct input of data from FAA-1200 baud line.

All this equipment has been obtained unaltered from the manufacturers and is plug-to-plug compatible so that no interface development is required. The software operating system was purchased from Digital Equipment Corp. (RT-11, version 2) and supported macroassembler, Basic, and Fortran IV. This system would not simultaneously collect data from the 1200 baud line and process those data in a cycle stealing mode; collection of the desired data had to be completed before processing could commence. The addition of another 16 000 words of memory and implementation of the RSX-11M operating system allow us to continuously monitor and edit the 1200 baud data line while simultaneously processing any data that have been stored.

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announcements

Science—New regulations for Newcomb Cleveland Prize; New "AAAS News" policy

The American Association for the Advancement of Science (AAAS) has just inaugurated two activities that will be of interest to readers of the BULLETIN. Stanley A. Changnon, Jr., Secretary of Section W (the Atmospheric and Hydrospheric Sciences Section) of AAAS, and Councilor of the AMS, announced these two new developments.

The AAAS will offer an annual prize of $5000—the Newcomb Cleveland Prize—for the best paper published in the "Reports" section of *Science*. The first contest year began with the 1 October 1976 issue. Plans call for awarding the prize at the annual AAAS meetings, at which time the recipient will be asked to present a review paper on the allied field. This paper will also be published later in *Science*. Section W hopes that scientists in the atmospheric and hydrospheric areas will be alert to this and seek to publish potential award-winning papers.

A new policy for publishing Section news has also been established by AAAS. The 6 November 1976 issue of *Science* was the first issue devoting portions of the "AAAS News" segment of *Science* to Section information. This will be a regular feature of *Science* in the first issue of each month. Atmospheric scientists and oceanographers are encouraged to scan this feature for Section W activities. Those who have Section W news for *Science* should send it to: Stanley A. Changnon, Jr., Head of Atmospheric Sciences Section, Illinois State Water Survey, Urbana, Ill. 61801.

Las Vegas Air Resources Labs transferred to NWS

As of 26 September 1976, the Air Resources Laboratories' facility located in Las Vegas, Nev., became a National Weather Service (NWS) facility and was renamed the NWS Nuclear Support Office. Formerly a NOAA Environmental Research Laboratory, it is now under the direction of the NWS Western Region and is engaged mostly in supporting the Energy Research and Development Administration's nuclear testing in the Nevada desert area. The Nuclear Support Office has a staff of about 41 people who have been retained with the change in administration.

New air pollution monitoring platform

The Aerospace Corp. of El Segundo, Calif., has released a report on the first year of its atmospheric satellite program, ATMOSAT. The report, "ATMOSAT—A New Measurement Platform for Air Quality Monitoring," was presented to the Air Force Geophysics Laboratory Scientific Balloon Conference in October of this year. ATMOSAT is the first available means for the pursuit of a parcel of polluted air, allowing precise measurement of its physics and chemistry as well as its trajectory, over periods of hours to days and over distances of hundreds of miles. A low-cost, recoverable, manned, lighter-than-air vehicle that neither contaminates by propellant fumes the air to be sampled, nor agitates it by propeller wash, is the medium for the air quality measurements.

The developing company has surveyed air pollution monitoring programs to assess reaction to the concept and to organize a schedule for the single available balloon for the 1977 calendar year. The system has already made several test flights. Researchers interested in obtaining more information on ATMOSAT are encouraged to contact the authors of the report, T. F. Heinsheimer and P. C. Neushul, at the Aerospace Corp., 2350 East El Segundo Blvd., El Segundo, Calif. 90245.

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EPA air pollution course schedule

A schedule of the 1976–77 courses offered in air pollution control by the Environmental Protection Agency's Air Pollution Training Institute is now available. Thirty-seven courses, conducted either by lecture, self-instruction, or in the laboratory are being offered at several locations throughout the year. The courses range from those at orientation level, designed for personnel with little or no experience, to highly technical courses for the experienced air pollution control scientist/technician. Titles in this year's course offerings include: Control of particulate emissions; Effects on vegetation; Air pollution administration; Site selection for ambient air monitoring; Air pollution microscopy; Gas chromatographic analysis of air pollutants; Determination of polycyclic aromatic hydrocarbons; and Source sampling and analysis for gaseous pollutants.

Courses range in duration from 2 to 10 days; the average is 4 days. A flat tuition rate has been established for lecture and laboratory courses: $22 per student day for lecture courses; $35 per student day for laboratory courses. Prices for self-instructional courses vary. For more information about the courses offered and application procedures, request the "Chronological Schedule of Courses 1976–77" from: Air Pollution Training Institute Md 17, National Environmental Research Center, Research Triangle Park, N.C. 27711.

Coastal zone climatic studies

The National Climatic Center (NCC) recently published two climatic reports: *Climatic Study of the Near Coastal Zone, East Coast of the United States* and *Climatic Study of the Near Coastal Zone, West Coast of the United States.* The east coast study covers the marine area from 30° to 45°N, and east from the shore to 68°W; the west coast study covers the marine area from 34° to 49°N, and west from the shore to 130°W. Three methods of presenting data for each calendar month are used: isopleth analysis, tables by 1° squares, and graphs by 1° squares. Ceiling, visibility, combinations of ceiling and visibility, surface wind speed and wind roses, air and sea temperatures, wave heights, and surface currents are included.

Copies are available from: The National Technical Information Service, U.S. Dept. of Commerce, 5285 Port Royal Rd., Springfield, Va. 22151.

Continental shelf geophysical data available

A variety of new, multiagency data sets depicting the marine geophysical environment on the continental shelves is now available from the Environmental Data Service's National Geophysical and Solar-Terrestrial Data Center (NGSDC). According to the September 1976 issue of *EDS:* "U.S. Geological Survey data available through NGSDC consist of multichannel common depth point seismic and sound velocity profiles collected between Maine and Virginia and in Cook Inlet, Alaska. Complementing these are about 1800 nautical miles of single-channel seismic data collected by the University of Rhode Island during two cruises off the coast of New Jersey, and about 4000 nautical miles of similar data collected by the University of Washington and the U.S. Geological Survey in the Gulf of Alaska. U.S. Naval Oceanographic Office data available consist of digital gravity data from the western offshore areas of the United States, Gulf of Mexico, and waters near Iceland. About 117,000 gravity observations comprise the West Coast data coverage, 150,000 on the Gulf Coast, and 38,000 from Iceland water."

For more information on the availability of these and other energy-relevant data, contact: National Geophysical and Solar-Terrestrial Data Center, Code: D621, NOAA/EDS, Boulder, Colo. 80302 (tel: 303-499-1000, ext 6338).

Maps of Teton Dam flood available

A series of maps delineating areas inundated by the flood resulting from the 5 June 1976 failure of Teton Dam, Idaho, has been compiled by the U.S. Geological Survey (USGS) and is available for purchase.

Joseph S. Cragwall, Jr., Chief Hydrologist at the USGS National Center, Reston, Va., said that the Teton Dam flood produced a peak river flow nearly equal to the highest peak flow of the Mississippi River. Preliminary computation by USGS hydrologists indicated a peak flow of about 2 million cubic feet (15 million gallons) per second, 5 June, on the Teton River about 3 mi downstream from Teton Dam. "This water discharge," Cragwall said, "nearly equals the nation's previous highest instantaneous river flow—2,080,000 cubic feet (about 16 million gallons) per second—recorded on the Mississippi River at Vicksburg, Miss., on 17 February 1937."

The maps are part of a continuing USGS program designed to document actual flood events to aid in water and land-use planning and management. They show, in simple form, the area flooded by the sudden release of about 250 000 acre feet (80 billion gallons) of water in the reservoir when the dam was breached. The series of 17 maps was prepared as standard USGS Hydrologic-Investigations Atlases (HAs). The title of each atlas is "Teton Dam Flood of June 1976 (quadrangle name), Idaho." Each atlas is priced at $1.75 and bears a distinct HA number by which it should be ordered. For ordering information and a listing of the atlases by HA number, contact: U.S. Geological Survey, Branch of Distribution, Federal Center Bldg. 41, Box 25286, Denver, Colo. 80225.

FGGE newsletter

The U.S. First GARP Global Experiment (FGGE) Project Office has begun publication of an informal newsletter, the first edition of which was issued in September 1976. The purpose of the newsletter—*FGGE News*—is to provide the scientific community with the latest information on the status of planning in all phases of FGGE as well as to inform readers of forthcoming working group meetings, seminars, and other related activities. It is also meant to encourage meteorologists and oceanographers to participate in the FGGE research program since participation by a wide spectrum of the U.S. scientific community is necessary in order to fulfill the scientific objectives of the global experiment. The publication schedule is flexible; it is anticipated that the newsletter will be distributed as noteworthy information becomes available.

Individuals wishing to add their names to the *FGGE News* mailing list, or to comment on or contribute to the newsletter, should contact: FGGE Newsletter, Wayne McGovern, Editor, NOAA, EM-6, 6010 Executive Blvd., Rockville, Md. 20852.

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