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NASA Airborne Doppler Lidar Program:

Data Characteristics of 1981 Wind Field Measurements

Technical Report No. 1

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Abstract

The first flights of the NASA/Marshall airborne CO2 Doppler lidar wind measuring system were made during the summer of 1981. Successful measurements of two-dimensional flow fields were made to ranges of 15 km from the aircraft track. This report examines the characteristics of the data obtained, and summarizes a study of various artifacts introduced into the data set by incomplete compensation for aircraft dynamics. Most of these artifacts can be corrected by post processing, which reduces velocity errors in the reconstructed flow fields to remarkably low levels.
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I. Introduction

As part of the NASA severe storms program NASA/Marshall has constructed an airborne lidar system designed to measure two-dimensional horizontal flow fields in the atmosphere. This system uses a pulsed coherent CO2 laser operated much as a Doppler radar. Velocity components along the lidar beam are measured by observing the Doppler shifts in the signals returned from naturally-occurring aerosol scatterers. The beam is steerable within a forty-degree cone to the left of the aircraft; by taking measurements with the beam oriented in the two horizontal extremes of the cone (70 and 110 degrees to the left of the aircraft heading) two components of the horizontal flow field are sensed. From these two components it is possible to reconstruct the two orthogonal components of horizontal flow.

This complex system was assembled by a group of NASA personnel and contractors over a three-year period. The first data flights using the NASA/Ames CV990 aircraft were completed during the summer of 1981. Data was obtained in a variety of situations: boundary-layer and orographic flows were observed in California, Colorado, Oklahoma, Nevada and Montana, while flows in the vicinity of convective storms were observed at many levels in Montana during participation in the CCOPE experiment.

It is no simple matter to operate a Doppler radar using an aircraft as a platform. The velocity of the aircraft is high compared with the atmospheric velocities which must be measured. This motion of the measuring instrument must of course be removed from the measurement, a feat which can only be accomplished by very accurate knowledge of the platform velocity and all the relevant angles relating aircraft motion, attitude and instrument pointing.

This much is required for accurate measurement of the velocity component parallel to the lidar beam. To obtain horizontal flow vectors, a second component must be measured by steering the lidar beam as described above. During a measurement run a series of measurements is obtained at each observation angle. Each series consists of a grid of velocity component measurements typically separated in range and track by 300 m (the range gate width and the scanner period). The two grids of measurements are then superimposed and processed to extract the velocity
vectors, just as vectors are derived in ground-based multiple Doppler measurements.

To make such interpretation possible the relative registration of the measurement points must be sufficiently well known - within a fraction of a grid spacing - to permit correlating the proper observations with each other, a requirement which places stringent limitations on the allowable errors in aircraft navigation and lidar beam pointing.

The flow-vector estimate produced by operations on the two component measurements can, at best, be only as good as the original radial velocity measurements. In fact, it is worse, since the poor geometry of the two measurements (with only a 40-deg included angle) triples the error in the vector component parallel to the aircraft track; such geometry mandates both very high accuracy on the part of the Doppler estimator and very high stability on the part of the lidar local oscillator and transmitter.

The state-of-the art in aircraft navigation and lidar systems is strained by such stringent accuracy requirements. Therefore the success of the 1981 field tests is all the more remarkable, and is a tribute to the efforts of all concerned.

While the program was a success in the sense that useful measurements of several types of flow fields were obtained, many of the measurements are clearly contaminated. The purpose of this report is to survey the problems present, to suggest corrections where corrections are possible, and to describe problems not now understood.

Most of the artifacts present in the data sets appear to stem from incomplete compensation for aircraft dynamics. Since the motion of the platform is so critical to these problems, Section II is devoted to examples of time-series plots of several important aircraft parameters: pitch, roll, velocity, etc. Examples of radial-velocity measurements and lidar pointing are also presented.

Section III uses "real-time" plots (obtainable on the aircraft in essentially real time for use in experiment management) to demonstrate the characteristic types of artifacts found in the raw data sets.

Section IV is devoted primarily to the major cause of these artifacts - incorrect interpretation of the aircraft drift angle. This
section opens with time-series examples of the important parameters and their derivatives. The cause of the drift-angle problem is suggested, and the argument is reinforced by means of simulated uniform flow fields wherein artificial drift-angle errors have been introduced. A first-order correction is suggested and tested—first on a time series of mean radial velocity, and then upon actual flow fields. This correction removes about 75% of the largest source of error in the data.

Other sources of error are present, however, as discussed in Section V. Included in this category are correctable errors due to incorrect horizontal pointing information, uncorrectable errors in the elevation angle of the lidar beam, and errors due to lidar moding and local-oscillator drift which are not yet understood.

Section VI is devoted to examples of interesting flow fields observed during the 1981 program. These samples (corrected to first-order for drift-angle errors) demonstrate the potential of the system for investigating orographic flows, boundary layer flows during convection, gust-fronts in clear air, and clear-air flow in the vicinity of convective storms at mid- and upper-levels.

The detective work in unravelling the mysterious problems with these data sets is not yet complete. It is felt that a significant part of the remaining errors in the data is correctable, and techniques for such correction have been devised but not tested. Section VII discusses briefly this work in progress.

During investigation of this mass of field test data the author attained a certain degree of familiarity with it, and a good deal of software was written to allow examination of the data and testing of various correction algorithms. While this software was written strictly for internal use, it does constitute a complete set of software for processing the data from original tape to gridded flow fields. It was thought worthwhile to include the software in this report, not so that all of the software will be used as such, but rather to explain, in a definitive way, questions of treatment.

Appendix A lists the format of the raw data tapes, with some comments on problems in the data headers. Appendix B lists the software just mentioned, with enough description to orient the reader.
II. Aircraft performance

As indicated in the introduction, aircraft dynamics are critical factors in the error budget of the data sets. The data acquisition system attempts to monitor the relevant aircraft parameters and to correct for platform motion and attitude. Correction is accomplished in two ways: the lidar scanner attempts to compensate for attitude changes, and the lidar second local oscillator attempts to compensate for velocity changes.

Section III will discuss the degree to which these corrections are successful. The intent of this section is to provide examples typical of platform motion during the field tests. The data set selected is run 10 of flight 19, a run at low altitude up the western side of the San Joaquin Valley in California. This run was selected because of its unusual length (about 40 minutes) and because the rather uniform wind field allows measurement errors to be easily seen.

Figure 1 shows ground speed as estimated by the inertial navigation system (INS) as a function of time over the 40-minute data collection period. The resolution of this measurement is 1 kt, and it is subject to errors due to INS drift. Since a fraction of this velocity of about \( \cos(70 \, \text{deg}) \) must be removed from the measurement to correct for platform motion, it is clear that the ultimate accuracy of an individual Doppler measurement of radial velocity referenced to ground cannot exceed 0.17 \( \frac{m}{s} = 1 \text{ kt} \times \cos(70) \).

The variation of altitude during the run is shown in figure 2. The aircraft normally flies at constant pressure altitude, to an accuracy of about 15 meters. Complications arise for the flow field measurement whenever the altitude is changed; at the longer ranges the delay between forward and aft measurements at the same point may be up to one minute, and if the altitude has changed the two measurements will reflect flows at two separate altitudes. This is significant in the boundary layer.

Figure 3 shows aircraft true heading during the run. The general trend of the plot reflects the aircraft course along the curving western edge of the San Joaquin Valley. The fine structure, amounting to about one degree peak-to-peak, reflects aircraft control-system stability in mild turbulence. The oscillations of a few degrees are aircraft responses to changing crosswind. True heading is obtained from the INS navigation unit with a resolution of 0.44 deg.
True airspeed is used by the data acquisition system only to estimate the probable Doppler shifts in the data (since the nominal Doppler shift is expected to be $TAS\cos(70)$). The form shown in figure 4 is quite similar to ground speed (figure 1), with a small offset due to a headwind.

The pitch of the CV990 aircraft is rather stable, as shown in figure 5, with transients on the order of 1 deg whenever altitude or airspeed is altered. Pitch is obtained from the INS unit with a resolution of 0.44 deg, and is used by the lidar scanner to hold the lidar beam in the horizontal plane. Aircraft roll, shown in figure 6, is used by the scanner in the same manner. Roll is subject to excursions on the order of degrees, often with a well-defined period.

Aircraft drift angle is critical to the correction for platform velocity. The plot shown in figure 7 exhibits a typical short-term variability of about 1 deg peak-to-peak, with larger variations where the flow field is complex. Drift angle often shows resonant oscillations related to the feedback characteristics of the aircraft control loops. Once again, the resolution of this measurement is 0.44 deg.

Using knowledge of ground speed, airspeed, and drift angle the INS unit estimates the wind vector in the vicinity of the aircraft. Figures 8 and 9 show the magnitude and direction of this estimate for the run. While this measurement is not always reliable, it has been a useful comparison for the lidar measurements.

Examples of the raw lidar radial velocity measurements are shown in figures 10 and 11. The radial velocities have been averaged over 30 range gates. While these measurements cannot be compared directly with the INS wind estimates (since the INS estimate is a magnitude, and the lidar measurements are components), several features on the curves agree and demonstrate that the lidar system is measuring something related to the wind field. Note that the fine structure in the lidar measurements is on the order of 1 m/s.

The look-angles at which the forward and aft lidar measurements were taken are shown in figures 12 and 13. The form of the curves closely approximates the aircraft true heading (figure 3), with 70- and 110-deg offsets. The resolution of these angular measurements is 0.1 deg.
Figure 7: Aircraft drift angle
Figure 8: Aircraft INS wind magnitude
Figure 9: Aircraft INS wind direction
Figure 12: Forward beam pointing angle
It should be noted that the examples shown above are typical of flight in mild turbulence. At high altitudes aircraft parameters are sometimes maintained to tighter tolerances, while in more severe turbulence excursions can be markedly higher.
III. Raw data characteristics

The data acquisition software used during the 1981 flight program provided for "real-time" plots of horizontal flow fields. The plots were updated on a scan-by-scan basis to allow rapid feedback to the experimenters. This section uses six of these plots to illustrate the characteristics of the uncorrected data. The cases were chosen for their relatively uniform flow fields, which make data errors more visible.

Figure 14 illustrates a rather smooth flow field with few artifacts present. As such it is typical of the better measurements. The format is similar to that of the figures to follow: the flight track is at the bottom of the figure, left to right. The grid spacing of the measurements is roughly 300x300 m, with a nearest-neighbor criterion used to match forward and aft scan points. At longer ranges, corresponding to the top of the figure, useful returns were not obtained, as indicated by various letter codes.

Figure 15 is taken from earlier data on the same flight. The flow vectors are confused and difficult to interpret. One might infer that there is a complex flow pattern arising from convection present; in fact, errors to the extent of a few m/s are present in the vectors, and the pattern of the errors is not readily apparent. Near the top of the figure are a few "wild" measurements, often found at long ranges where the returns are weak. The apparent complexity of this measurement on a nearly uniform field should be a warning to interpreters of flow fields: make sure the data is significant before engaging in deep interpretation.

More obvious artifacts are present in the example shown in figure 16. There is a definite tendency for vectors to line up on the 70- and 110-deg radials at which lidar measurements were made. This triangular appearance of the data was one of the first characteristics noted on many of the early plots. Also seen in this figure, in addition to a few isolated "wild" measurements, is a row of uniform, strong vectors in the upper left. A rather frequent a result of multiple-mode interference in the laser system, they are easily rejected.

This same triangular effect takes on a different appearance when the flow is primarily parallel to the aircraft track, as in figure 17. Note
Figure 14: Uncorrected smooth wind field
Figure 15: Uncorrected contaminated wind field
Figure 16: Wind field with diagonal errors
Figure 17: Wind field with longitudinal errors
that there is a modulation of the vector length in a roughly triangular pattern. Once again there is a line of strong, constant vectors due to laser moding.

When the system errors are periodic the errors seen in the previous examples take the form of braiding of the flow vectors, as in figure 18. One might imagine that the flow is dominated by organized horizontal rolls, or perhaps influenced by canyon topography; but the effect is instead produced by aircraft dynamics, as discussed in Section IV. Another example of the same effect is shown in figure 19, where the data was taken at 12,400 feet and the structure is due almost entirely to aircraft dynamics.

The moral of this section is clear. Some very interesting effects appear in the data, but unfortunately they are instrumental in origin. In many cases the artifacts are so severe that they completely obscure the nature of the flow field. This is particularly true in the boundary layer, where the flow-field perturbations of interest in convection studies are quite small.
Figure 18: Wind field with braided errors
Figure 19: Wind field with braided errors
IV. Drift angle correction

This section is devoted to an explanation of the most significant source of artifacts in the data, erroneous drift-angle information. To establish conventions for various angles, refer to figure 20. The body of the aircraft is aligned along the vector THDG (true heading), but the center-of-gravity of the aircraft is travelling along the vector TRK (track) relative to the ground. The two vectors do not coincide due to the assumed presence of a wind from the left; the difference between the two vectors is the drift angle, which in this case is positive. The direction of the lidar measurement is given by vector LOS (line-of-sight), and this angle is measured by angle SCAN with reference to THDG.

Note that the ground velocity is along vector TRK. It is the component of this velocity parallel to LOS which must be subtracted from the data measurements in order to reference the wind flow to the ground. Thus the angle between the laser measurement and the aircraft motion is SCAN+DRIFT. The angle SCAN is closely controlled and monitored by the lidar scanner; thus the angle DRIFT is crucial for proper application of the velocity correction.

Figure 20: Lidar-aircraft geometry
With this in mind one can conclude that drift angle and aircraft ground speed are the critical parameters required for removal of the component due to aircraft motion. Three aspects of these two parameters can cause errors in this correction: resolution, accuracy, and time delay. Clearly if the resolution of the measurement is limited the correction will be correspondingly limited. Similarly, if there are errors in the measurement of drift angle or ground speed there will be errors in the correction. Finally, if the correction quantity is outdated when it is used there will be errors, provided that the quantity changes fast enough. The latter effect dominates errors in the data sets.

Figure 21 shows a 2-minute sample of raw radial-velocity measurements taken during a portion of run 10, flight 19. The two plots are for the forward and aft measurements, and 30 range gates have been averaged together. The wind field was relatively uniform. The most obvious features of the figure are excursions on the order of a few m/s which are correlated in the two plots. One can easily show that such large excursions in a mean velocity are unlikely: the velocities are averaged over 10-km in range, and show changes in the means of up to 4 m/s in 300-m of flight. This implies a shear of 0.01/s over 10 km, an order of magnitude higher than that typical of the turbulent boundary layer, in a situation which was relatively smooth. Further, rapid changes in the two measurements are not consistent with correlation between them, since the averaged regions diverge from the aircraft, and are separated by 7 km at 10-km range. We may safely conclude that most of the excursions in figure 21 are due to some form of measurement error.

A study of the continuity in range of individual lidar shots indicates that the Doppler estimation errors within each shot are quite low. The source of error is thus likely to lie in the correction of the measured velocities to ground-based coordinates. Therefore the next step is to investigate these suspect measurements. Figure 22 shows two such measurements for the same 2-min time period. The relationship between true heading and the "errors" of figure 21 is not apparent, but clearly drift angle is somehow correlated.
Figures 23 and 24 plot the derivatives of true heading and the two line-of-sight angles of the forward and aft scans. These derivatives, which are estimated by taking 2-scan (approximately 2.2-sec) differences, are also somewhat correlated with the "errors" in figure 21.

Finally, figure 25 shows the 2-scan derivative of drift angle, plotted separately for the forward and aft scans. If this figure is held face to face with figure 21 a remarkable correlation will be observed. Not only is the correlation very accurate, but there is a time delay between the two figures amounting to about 2 seconds.

Obviously, since there is something remarkably similar between drift-angle changes and apparently erroneous mean radial velocity measurements, the next step was to find the connection. Simulation was used to ascertain the impact of oscillatory drift-angle errors upon derived wind fields, given a variation in radial velocity of a few m/s and differences in drift angle on the order of 1 deg. The results are shown in figures 26-28. In each case a uniform wind of 10 m/s was assumed, and an artificial sinusoidal perturbation in drift angle of about 0.3 deg was used in the model.

In the case of figure 26 the assumed constant wind field was normal to the aircraft track (along the bottom of the page in these three figures). The effect of the drift-angle perturbation is substantial, even though the perturbation was only 0.3 deg. When the wind field is parallel to the aircraft track as in figure 27 the appearance is quite different: a modulation of the vector length very much like that seen in figure 17. Finally, with the wind vector at 45 deg relative to the aircraft track the effect is a braiding of the flow vectors identical to that seen in figures 18 and 19.

To quantify this effect note that in terms of the geometry of figure 20 the magnitude of the velocity correction is GS*COS(SCAN+DRIFT). Assuming that the quantities GS (ground speed) and DRIFT are subject to errors (from whatever source) EGS and EDR, one can expand the expression and determine the errors in the correction term. The expansion contains three terms:

\[ EDR \times GS \times \sin(SCAN+DRIFT) \]
\[ EGS \times \sin(SCAN+DRIFT) \]
\[ EDR \times EGS \times \cos(SCAN+DRIFT) \]
Figure 24: Forward and aft differential line-of-sight angle
Figure 23  Forward and aft differential drift angle
Figure 26: Simulated transverse flow
Figure 27: Simulated longitudinal flow
Figure 28: Simulated 45-deg flow
Typical values for GS and SCAN+DRIFT are 130 m/s and 70 deg. In the plots shown above typical values for EGS and EDR are 1 m/s and 2 deg, for 2-sec differences; these values yield estimated contributions for the three terms of 0.4, 0.3 and 0.03 m/s, respectively. Clearly the cross term is not significant, and the second term is relatively small. However, the first term is quite significant, and produces errors of the proper magnitude.

With this confirmation of the critical factor a correction of the error can be attempted. Using the 2-lag drift difference as the error, and the geometry just described, the mean radial velocities can be corrected as shown in figure 29. The data is the same as shown in figure 21, but the variance has been reduced substantially.

Before further discussion of correction algorithms an explanation of the source of the drift-angle error is in order. The error arises not because the drift angle is in error, but because the drift angle used for velocity subtraction by the data acquisition system is not the current drift angle. The data gathering process is a complex one, depending upon the computer in the inertial navigation system, the computer in ADDAS (the CV990 data gathering system), and the computer in the lidar system. To take the case of drift angle in particular, it is first calculated by the INS system in what is termed the "slow" loop, updated at 0.9-sec intervals. This data is then output on the BCD bus at 0.9-1.0-sec intervals adding (on the average) an additional 0.48 sec to the delay. When this data is read by the lidar computer at the start of scanner motion it is about 1.38-sec old. By the time the scanner has moved to target position and the midpoint of the data sample has been reached another 0.84 sec has elapsed, for a total delay of 2.22 sec.

This 2.22-sec delay is nearly equal to 2 scan periods (2.2 sec on the average for this data set), and this explains why the 2-lag drift-angle difference correlates so well with the mean radial velocity "error". The 2.22-sec figure is a theoretical one, and must be confirmed for each situation. A routine is included in program FILEDI (see Appendix B) for finding the optimum 4-point transversal filter (or. interpolator) for this drift-angle correction. For most of flight 19 the optimum filter coefficients were found to be 0.32, 0.56, 0.12 and -1.0, corresponding to a time lag of 2.42 sec.
Using this optimal filter the data of figure 21 has been corrected to produce figure 30. The results are reasonably smooth, and definitely superior to the simple 2-lag result of figure 29. The wind field produced by the uncorrected data of figure 21 is shown in figure 31, and the corrected version is shown in figure 32. Considerable improvement is evident.

As an additional example another raw radial velocity data set is shown in figure 33. The velocity excursions are marked and regular, and appear to be due to an oscillation in the aircraft control system. Applying the optimal drift-angle correction to this data set produces figure 34. The comparable raw and corrected flow fields for these examples are shown in figures 35 and 36. The braided structure seen earlier is present in the former figure, but nearly gone in the latter.

As a final example a situation which exaggerates drift-angle effects is shown in figure 37. The aircraft began a slight turn midway through the example, producing artifacts consisting of counter-rotating flows in this uncorrected plot.

While drift-angle delays have been identified as the major contributor to the artifacts evident in the data sets, other effects are present as well, and the algorithm for correction discussed above is not completely satisfactory even for drift-angle correction. These additional considerations are discussed in the next section.
Figure 37: Flow field with errors due to aircraft turn
V. Other data errors

V.1 Errors due to delays in INS data

As mentioned in Section IV the correction for platform motion is also sensitive to delays in the INS ground-speed estimate. The error from this source is on the order of 0.3 m/s; though smaller than that due to the delay in drift angle it is still significant and should be taken into account.

The scanner control computer also relies upon INS attitude information in calculating the beam-pointing corrections required to compensate for roll and pitch. Errors due to the delayed angular information take the form of horizontal and vertical pointing errors on the order of 1 deg. The horizontal errors are easily corrected by interpolation of the INS estimates of true heading, with slight corrections from roll and pitch interpolations. Correction for the vertical errors is not possible. The magnitude of the errors may be estimated by interpolating the roll and pitch readouts, but the fact that the lidar beam did not travel in a horizontal plane cannot be changed. A 1-deg error in the vertical translates into a 175-m vertical displacement at 10-km range; this distance can be quite significant in the boundary layer. An example of this type of error (not included in the figures) is a case where the aircraft was flying about 100 m above the boundary layer in very smooth air; the measured wind field was very smooth, with the exception of a few shots where the lidar beam dipped into the boundary layer. Since shear at the boundary-layer interface was strong the resulting flow field was discontinuous.

The problem of estimating and correcting for these data-delay errors is complicated by the fact that the lidar system does not operate at a constant duty cycle. The time between scans may vary substantially, depending upon the mode chosen by the operator. Thus the data set may contain a series of scans separated by 1.1 sec, with scans requiring over 2 sec interspersed. Correction formulas used thus far have assumed constant scan rates, and more complex algorithms must be developed to allow for the variable scan rate.

V.2 Hardware problems
Reference has been made above to a problem in the lidar system
term "moding". The laser is capable of oscillation in more than one
mode, and when it does so the modes mix on the photodetector and create
strong monochromatic signals. Such a case is evident in figure 17 as a
row of strong, constant vectors. Data in such cases is lost, but it is
not difficult to recognize this type of error.

Many of the low-level flights in California were near foothill
regions. In several cases lidar returns from terrain were obtained,
allowing checking of velocity correction (since ground returns should
shown zero velocity). The actual location of the aircraft could be
obtained very accurately from pictures taken periodically during the
flights by a downward-looking camera. When terrain returns were compared
with topographic maps it was discovered that there may be some fixed
ers in the vertical elevations of the forward and aft beams. In
particular, returns were obtained from the aft beam which indicated a
bias of about -0.4 deg in that beam (that is, the beam tended to be below
the horizontal). No terrain returns were obtained from the forward beam
in situations where terrain was 1.0 deg above the horizontal, indicating
a bias of 1.0 deg or more for the forward beam. Terrain returns have also
suggested the possibility of a small bias error in lidar range.

Other hardware problems are suspected but less easily seen. There
are cases in the data where velocity measurements appear to be accurate
near the aircraft but deteriorate with range. Such cases are sometimes
due to errors in the vertical pointing of the beam, but it appears
possible that some are due to frequency modulation of the
local-oscillator laser. This laser is the master-oscillator laser for the
transmitter as well; as such, its frequency is by definition correct at
the time of the pulse transmission, but if its frequency is not stable
this relationship will deteriorate with time (or range). Strong
mechanical vibrations associated with flight through turbulent air may
excite such frequency drift. The extent to which this error source is
significant is not known.

Evident in the data are yet other types of errors whose sources are
not known. Fortunately most of these errors are large errors, and the
editing software developed previously can effectively reduce their
effects.
VI. Windflow examples

This section presents examples of several types of flows observed during the 1981 flight tests. These examples have been corrected to first order for drift-angle and true-heading delays, but they have not been smoothed.

Figure 38 shows a very uniform flow observed above the boundary layer at 9000 ft. The deep boundary layer was just below the aircraft, and it is likely that the discontinuous measurements at the right-center in the figure are due to the lidar beam penetrating the boundary layer. The discontinuous measurements at the left-center of the figure may be due to laser mounding, since they persist down to zero range.

Flow in the vicinity of a cumulus cloud is shown in figure 39. The regions in the figure with no measurements represent cloud regions not penetrated by the lidar. The velocity field is measured in the clear air around the cloud, and probably at the outer edge of the cloud itself. In some cases of this type regions at the sides of the cloud are not measured, since either the forward or the aft lidar returns were shadowed by the forward edges of the cloud.

Numerous examples of orographic flow modification are present in data taken in California at low levels. Figure 40 shows south-easterly flow impinging upon the foothills of the Sierra Nevada near Fresno. As the air mass rises against rising terrain the lidar sees flow progressively nearer the ground, where the flow is modified by the local topography. Figures 41 and 42 show flow diverging from the Carquinez Strait into the Sacramento-San Joaquin Delta. In figure 41 the southern portion of the flow exits from the strait at the lower right, forming eddies in the foothills in the upper part of the figure. In figure 42 the northern portion of the flow curls around a mountain forming the terminus of the strait.

Measurements were made in the San Gorgonio Pass region of southern California. At this point strongly divergent flow exits the narrow pass, offering opportunities for the operation of wind turbines. Figure 43 shows this strong flow entering at the lower right; weak confused flows are evident over foothills at the upper left. Figure 44 shows flow somewhat farther beyond the mouth of the pass, where complex patterns
Figure 38: Uniform wind field
result from flow over terrain features (including a small hill at lower center).

Some of the most spectacular flows observed were at low levels beneath convective storms. Figure 45 shows at first sight an uninteresting flow field. The two disturbed areas are quite significant, however: they represent the horizontal signatures of areas of convection or outflow. A more dramatic example is shown in figure 46. A relatively uniform low-level flow is perturbed by an outflow descending from a convective structure at the upper left. The structure itself is not seen, as the lidar returns are apparently attenuated by cloud in that area.

Still stronger outflow - a true gust front - is shown in figure 47. The flow seen at the lower left is typical of a large area now shown in the figure, and may be taken as the unperturbed low-level flow. The strong flow crossing most of the figure is outflow from a convective structure of considerable size beyond the top of the figure. Similar merging of outflows with the low-level flow is shown in figures 48 and 49. Finally, in figure 50 a dramatic interaction between the outflow at the top of the figure and the low-level flow is apparent.
Figure 45: Uniform flow with weak convection
Figure 47: Gust-front interaction
VII. Continuing work

1. Correction of navigation-delay errors. An optimal filter has been implemented for the drift-angle case. Similar filters need to be developed for ground-speed correction, line-of-sight angle correction in the horizontal, and line-of-sight angle estimation in the vertical. These filters must take into account the variable spacing of the scans in time.

2. Continuity-argument filter. After all known sources of error in the mean radial velocity measurements have been estimated and corrected for, there will remain a degree of uncertainty in the mean radial velocities. This will be due to errors in the INS estimates of attitude and velocity, and to the random nature of the delay between INS measurements and INS outputs. These errors are inherently unknowable, but they can for the most part be corrected by an argument involving windfield continuity.

Consider a time-series of mean radial-velocity measurements. Each item in the time series is an average over (for example) 10-km of range. The variance of each item will be due to that portion of the velocity fluctuation spectrum which is not averaged out by the 10-km integration. That is, the major part of the variance of the true time series will be due to spatial variations in the wind field on the order of several km. The observed time series will contain additional variance due to the unknown measurement errors just mentioned. Note that these measurement errors are independent from scan to scan. That is, this variance will cause addition of white noise to the true time series.

Since the variance of the true time series is due to very low frequency components (of long spatial scale), the true time series will fluctuate slowly and smoothly. This can be easily seen by noting that the 10-km velocity integrations from one scan to the next are separated by only about 300-m horizontally. This separation is quite small when compared with the several-km scales contributing to the variance of the true time series. Clearly the added variance due to the independent errors will contribute short-term fluctuations to the time series, while the true time series will contribute predominantly long-term fluctuations.
The solution to eliminating the error-contribution to the time series is obviously filtering. A low-pass filter will remove most of the contribution of the white errors, leaving most of the contribution of the true means. Note that this argument relies to a certain extent upon isotropy of the horizontal flow field, but only on scales smaller than 1 km. The most damage such an assumption could do to derived wind fields would be a reduction in the magnitude of 1-km and smaller flow features, and then the reduction would be suffered in only one dimension.

The errors of this approach can easily be evaluated with sample wind fields. It holds promise of reducing velocity errors to very low levels, a requirement for processing boundary-layer fields for convective studies.

3. Terrain returns. A careful examination of terrain returns will allow an independent check upon platform-velocity correction, since terrain would be expected to have zero velocity. Initial checks have shown terrain velocities on the order of 0-0.3 m/s. Terrain returns also have the potential for calibrating the lidar scanner both in elevation and azimuth.

4. Anomalous errors. Unexplained errors remain in the data sets. These errors probably are due to hardware problems such as local-oscillator drift. These errors may be correlated with aircraft accelerometer data. Whatever the cause investigation is warranted.
Appendix A: Magnetic tape format

The following is a description of the format of the raw data tapes. Comments on decoding the header parameters are included. The tape records contain 352 16-bit words, written in DEC format.

<table>
<thead>
<tr>
<th>Word</th>
<th>Name</th>
<th>LSB</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>X</td>
<td>20 m</td>
<td>East distance</td>
</tr>
<tr>
<td>02</td>
<td>Y</td>
<td>20 m</td>
<td>North distance</td>
</tr>
<tr>
<td>03</td>
<td>LOSD</td>
<td>0.1 deg</td>
<td>Add 180 deg</td>
</tr>
<tr>
<td>04</td>
<td>STATUS</td>
<td>Coded</td>
<td>See Integraph 81-029</td>
</tr>
<tr>
<td>05</td>
<td>PULSE WIDTH</td>
<td>Coded</td>
<td>See Integraph 81-029</td>
</tr>
<tr>
<td>06</td>
<td>PS</td>
<td>Coded</td>
<td>Processor status</td>
</tr>
<tr>
<td>07-11</td>
<td>SPARES</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>12-299</td>
<td>DATA</td>
<td>-</td>
<td>See text</td>
</tr>
<tr>
<td>300</td>
<td>NFL</td>
<td>1</td>
<td>Flight number</td>
</tr>
<tr>
<td>301</td>
<td>IDAY</td>
<td>1</td>
<td>Day number - Julian</td>
</tr>
<tr>
<td>302</td>
<td>NRUN</td>
<td>1</td>
<td>Run number</td>
</tr>
<tr>
<td>303</td>
<td>TSEC</td>
<td>0.1 sec</td>
<td>Seconds 0-59.9</td>
</tr>
<tr>
<td>304</td>
<td>TMIN</td>
<td>1 min</td>
<td>Minutes past midnight Z</td>
</tr>
<tr>
<td>305</td>
<td>PALT</td>
<td>16.48 ft</td>
<td>Pressure altitude</td>
</tr>
<tr>
<td>306</td>
<td>PALT</td>
<td>?</td>
<td>Not significant</td>
</tr>
<tr>
<td>307</td>
<td>RALT</td>
<td>2 ft</td>
<td>Radar altitude</td>
</tr>
<tr>
<td>308</td>
<td>DFP</td>
<td>0.1 deg C</td>
<td>Dew/frost point</td>
</tr>
<tr>
<td>309</td>
<td>SATM</td>
<td>0.1 deg C</td>
<td>Static air temperature</td>
</tr>
<tr>
<td>310</td>
<td>IR-SUR</td>
<td>0.1 deg C</td>
<td>IR surface temperature</td>
</tr>
<tr>
<td>311</td>
<td>TAT</td>
<td>0.1 deg C</td>
<td>Total air temperature</td>
</tr>
<tr>
<td>312</td>
<td>LAT</td>
<td>0.1 min</td>
<td>Latitude</td>
</tr>
<tr>
<td>313</td>
<td>LAT</td>
<td>1 deg</td>
<td>Latitude</td>
</tr>
<tr>
<td>314</td>
<td>LON</td>
<td>0.1 min</td>
<td>Longitude</td>
</tr>
<tr>
<td>315</td>
<td>LON</td>
<td>1 deg</td>
<td>Longitude</td>
</tr>
<tr>
<td>316</td>
<td>TH</td>
<td>0.04395 deg</td>
<td>True heading</td>
</tr>
<tr>
<td>317</td>
<td>TAS</td>
<td>0.5144 m/s</td>
<td>True air speed</td>
</tr>
<tr>
<td>318</td>
<td>GS</td>
<td>0.0628 m/s</td>
<td>Ground speed actually used</td>
</tr>
<tr>
<td>319</td>
<td>DA</td>
<td>0.04395 deg</td>
<td>Drift angle</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>320</td>
<td>WS</td>
<td>0.05144 m/s</td>
<td>INS wind magnitude</td>
</tr>
<tr>
<td>321</td>
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</tr>
<tr>
<td>322</td>
<td>P</td>
<td>0.04395 deg</td>
<td>Pitch</td>
</tr>
<tr>
<td>323</td>
<td>R</td>
<td>0.04395 deg</td>
<td>Roll</td>
</tr>
<tr>
<td>324</td>
<td>THETA1</td>
<td>0.1 deg</td>
<td>Inner wedge position</td>
</tr>
<tr>
<td>325</td>
<td>THETA2</td>
<td>0.1 deg</td>
<td>Outer wedge position</td>
</tr>
<tr>
<td>326</td>
<td>TTP</td>
<td>10 ms</td>
<td>Wedge time to position</td>
</tr>
<tr>
<td>327</td>
<td>SMT</td>
<td>?</td>
<td>Motor temperature</td>
</tr>
<tr>
<td>328</td>
<td>LOSE</td>
<td>0.1 deg</td>
<td>Scanner elevation</td>
</tr>
<tr>
<td>329</td>
<td>NINT</td>
<td>1</td>
<td>Pulses per integration</td>
</tr>
<tr>
<td>330</td>
<td>NLAG</td>
<td>1</td>
<td>Number of lags</td>
</tr>
<tr>
<td>331</td>
<td>TK</td>
<td>0.04395 deg</td>
<td>Track angle</td>
</tr>
<tr>
<td>332</td>
<td>LO</td>
<td>0.01 MHz</td>
<td>LO frequency</td>
</tr>
<tr>
<td>333</td>
<td>LOOFF</td>
<td>0.08 m/s</td>
<td>LO offset</td>
</tr>
<tr>
<td>334</td>
<td>GSSOURCE</td>
<td>1</td>
<td>GS source 0-2</td>
</tr>
<tr>
<td>335</td>
<td>GSD</td>
<td>0.0628 m/s</td>
<td>GS via Doppler radar</td>
</tr>
<tr>
<td>336</td>
<td>GSDA</td>
<td>0.0628 m/s</td>
<td>GS via Doppler/Addas</td>
</tr>
<tr>
<td>337</td>
<td>GSIA</td>
<td>0.0628 m/s</td>
<td>GS via INS/Addas</td>
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<td>NA</td>
</tr>
<tr>
<td>352</td>
<td>CKSM</td>
<td>1</td>
<td>Checksum</td>
</tr>
</tbody>
</table>

Note that DA, P, and R are 0-359 deg. They should be converted to bipolar values by subtracting 8192 if greater than 4096. The same is true of LOSD and LOSE, from which 3600 should be subtracted if they are greater than 1800. See the comments in the program FCONVT in Appendix B for further conversion information.

The data contained in words 12-299 is composed of 96 sets of 3 measurements, corresponding to the 96 320-m range gates. The first word of each set is a logarithmic amplitude (LSB=0.184 dB). The second is a bipolar velocity (LSB=0.08 m/s). The third is a coded width estimate (0-15).

TSEC and TMIN are subject to complex errors in flight 13. TK is not independent but is derived from DA and TH.
Appendix B: Data reduction software

The following are brief descriptions of several programs developed during the course of the investigation of the data properties. While they constitute a complete set of data reduction software, it is not expected that they will be used as such. Rather, they may be of some use in helping to expain the techniques of data conversion, correction and evaluation. All programs are written in DEC RT-11 Fortran. The plotting routines require a Hewlett-Packard 7221A plotter.

1) Program FILEDI. This program allows the user to examine raw data files on tape and to plot any item at any scale. Optimum coefficients for drift-angle correction can be determined for any data set length, based upon a 4-lag correction filter. It is also possible to plot certain differential quantities.

2) Program FTAPED. This program converts raw data files on tape to 568-word disk files. These disk files can also be examined, dumped or plotted.

3) Program FCONVT. This program operates on files produced by FTAPED and produces identical disk files as output with drift-angle corrections applied, X- and Y-coordinates corrected and added to the file, and mean powers and velocities computed. Plotting is also possible.

4) Program FEDIT. FEDIT operates on files produced by FCONVT and creates a file identical except for the addition of standard-deviation estimates for each velocity estimate.

5) Program FSMOTH. This program performs quadratic smoothing on files produced by FEDIT.

6) Program FGRID. FGRID produces gridded flow-field plots or files, operating on files created by FSMOTH. It can also produce gridded plots from files created by FEDIT, with nearest-neighbor algorithms used instead of interpolation.
7) Subroutines GRAPH1, SINV and MFSD. GRAPH1 is a plotting subroutine used by most of the above programs. It is designed to drive a Hewlett-Packard 7221A plotter. SINV and MFSD are used for matrix inversion in program FILED1.
PROGRAM FILEDI

REVISED 10-22-81 FOR NEW DRIFT DEFINITION

INTEGER*2 DBLK(4), ERROR(4), ARY(362), CODE, NWDS, ERRADR
INTEGER*2 IRANGE(3), IWIDTH(3), VELD(3), IDRIFT(4)
REAL*4 AMP(3), VEL(3), WD(4), B1(3), A1(600), ATA(6), B(200)
REAL*4 X1(3), DRIFT1(9)
REAL*8 TIME, FLEFT
BYTE A
DATA DBLK /3RMT01010, 0/
DATA ERROR /4*0/
DATA WD /0., 1., 0., -1./
ERRADR = IACDR(ERROR)
ICHAN = IGETC()

IF (ICHAN .LT. 0) STOP 'NO CHANNEL AVAILABLE'
IF (LOOKUP (ICHAN, DBLK, 0, -1).LT. 0) STOP 'BAD LOOKUP'
NRECD = 0
NSUM = 103
ZERO = -20.
FULLS = 20.
FMULT = 0.00267
SHIFT = 0.
ITAP13 = 0
CON1 = .04395
NWDS = 352
FACTR = 2.66
LAST = 1
LAGV = 3
NRANGE = 36

10 TYPE 905, NRECD
ACCEPT *, I
IF (I.EQ.0) GO TO 90  ! READ AND TYPE HEADER
IF (I.EQ.1) GO TO 100  ! READ A RECORD
IF (I.EQ.2) GO TO 200  ! PRINT A RECORD
IF (I.EQ.3) GO TO 300  ! FORWARD SPACE
IF (I.EQ.4) GO TO 400  !REWIND TAPE
IF (I.EQ.5) GO TO 500  ! BACKSPACE
IF (I.EQ.6) GO TO 600  ! PLOT ROUTINE
IF (I.EQ.7) GO TO 700  ! PLOT BOX
IF (I.EQ.8) GO TO 800  ! SET WEIGHTS AND SCALE
IF (I.EQ.9) GO TO 350  ! SPACE TO RECORD N
IF (I.EQ.10) GO TO 801  ! SET LAGV, NSUM
IF (I.EQ.11) GO TO 750  ! OPTIMUM COEFS
IF (I.EQ.12) GO TO 802  ! SET # RANGES
IF (I.EQ.13) GO TO 803  ! SET ITEM TO PLOT
IF (I.EQ.14) GO TO 804  ! SET PLOT TIME
IF (I.EQ.15) GO TO 805  ! SET FMULT, SHIFT
IF (I.EQ.16) GO TO 806  ! SET PLOT SCALE
IF (I.EQ.17) GO TO 807  ! SET ITAP13 - TIME CODE
IF (I.EQ.18) GO TO 750  ! PLOT OPTIMUM COEFS
IF (I.EQ.19) GO TO 750  ! TYPE OPTIMUM COEFS
IF (I.EQ.99) GO TO 999  ! EXIT FROM PROGRAM
GO TO 10
90  ITEST=0  | READ AND TYPE HEADER
GO TO 105
100  ITEST=1
105  ERROR(1)=0
ERROR(2)=0
ICODE=ISPFW(248,ICHAN,NWDS,ARY,ERRADR)
NRECD=NRECD+1

ARY(304)=ARY(304).AND.2047
ARY(303)=ARY(303).AND.1023
IT1=ARY(304)/60
IT2=ARY(304)-60*IT1
T3=ARY(303)/10.  | DECODE TIME
IX=20*ARY(1)
IY=20*ARY(2)  | IX, Y POSITIONS
N1=ARY(313)
N2=ARY(312)/10  | LATITUDE
IW1=ARY(315)
IW2=ARY(314)/10  | LONGITUDE
IFTL=ARY(300)
IRUN=ARY(302)  | FLIGHT AND RUN
IALT=ARY(305)*16.4  | ALTITUDE
FLOS=ARY(3)/10.+180.  | LINE OF SIGHT ANGLE
THDG=ARY(316)*CON1  | TRUE HEADING
DRIFT=ARY(319)*CON1  | DRIFT ANGLE
IF (DRIFT.GT.180.) DRIFT=DRIFT-360
FLOSE=ARY(328)/10.  | LOS ELEVATION
PITCH=ARY(322)*CON1  | PITCH ANGLE
ROLL=ARY(323)*CON1  | ROLL ANGLE
IF (ROLL.GT.180.) ROLL=ROLL-360.
TAS=ARY(317)*.5144  | TRUE AIRSPEED (M/S)
GS=ARY(318)*.0628  | GROUND SPEED (M/S)
WIND=ARY(320)*.05144  | INS WIND VELOCITY
DIRN=ARY(321)/10.  | INS WIND DIRECTION
IPROC=ARY(5)  | PROCESSOR STATUS
ISTAT=ARY(4)  | MAJOR STATUS WORD
ALOF=.01*ARY(332)  | LO FREQUENCY
OFF=.08*ARY(333)  | LO CORRECTION, M/S
GS1=.0628*ARY(335)  | DOPPLER GS VIA A/C
GS2=.0628*ARY(336)  | DOPPLER VIA ADDAS
GS3=.0628*ARY(337)  | INS GSPEED
DRIFT2=CON1*(ARY(331)-ARY(316))  | TRACK-THDG

110  TYPE 901,IX,IY,N1,N2,IW1,IW2,IFTL,IRUN,IT1,IT2,T3,IALT
TYPE 902,FLOS,THDG,DRIFT,FLOSE,PITCH,ROLL
TYPE 903,TAS,GS,WIND,DIRN,IPROC,ISTAT
TYPE 921,ALOF,OFF,GS1,GS2,GS3,DRIFT2
TYPE *

IF (ITEST.EQ.0) GO TO 410
I3=N RANGE/3
DO 150 I=1,I3  | PRINT NRANGE RANGE GATES
DO 160 J=1,3
IRANGE(J)=320*I+320*I3*J-3710
I4=3*I3*J+3*I
AMP(J) = 0.134 * ARY(I4-27)
VEL(J) = 0.08 * ARY(I4-26)
IWID(J) = ARY(I4-25)

CONTINUE

150 TYPE 904, (IRANGE(K), AMP(K), VEL(K), IWID(K), K=1, 3)
TYPE *
GO TO 410

200 PRINT 901, IX, IY, N1, N2, IW1, IW2, IPLT, IRUN, IT1, IT2, T3, IALT
PRINT 902, FLT, THDG, DRIFT, FCLOSE, PITCH, ROLL
PRINT 903, TAS, GS, WIND, DIRN, IPROC, ISTAT
PRINT *
DO 250 I=1, 12
DO 260 J=1, 3
IRANGE(J) = 320*I + 3840*J - 3710
AMP(J) = 0.184 * ARY(36*J+3*I-27)
VEL(J) = 0.08 * ARY(36*J+3*I-26)
IWID(J) = ARY(36*J+3*I-25)
260 CONTINUE
250 PRINT 904, (IRANGE(K), AMP(K), VEL(K), IWID(K), K=1, 3)
PRINT *
GO TO 10

300 TYPE 906
ACCEPT *, N
IF (N.EQ.0) GO TO 10

310 ERROR(1) = 0
ERROR(2) = 0
ICODE = ISPFNFW(254, ICHAN, N, ARY, ERRADR)
NRECD = NRECD + N
GO TO 410

350 TYPE 917
1SPACE TO RECORD N
ACCEPT *, N
N = N - NRECD
IF (N.GT.0) GO TO 310
IF (N.EQ.0) GO TO 10
N = -N
GO TO 510

400 TYPE *, 'REWIND TAPE'
ERROR(1) = 0
ERROR(2) = 0
ICODE = ISPFNFW(251, ICHAN, NWDS, ARY, ERRADR)
NRECD = 0

410 IF (ICODE.NE.0) TYPE *, 'ICODE=', ICODE, ERROR(1), ERROR(2)
GO TO 10

500 TYPE 907
ACCEPT *, N
IF (N.EQ.0) GO TO 10

510 ERROR(1) = 0
ERROR(2) = 0
ICODE = ISPFNFW(253, ICHAN, N, ARY, ERRADR)
NRECD = NRECD - N
IF (NRECD.LT.0) NRECD = 0
IF (ICODE.EQ.1) NRECD=0
GO TO 410

600 TYPE 914 !EXECUTE PLOT
ACCEPT *, MATCH IF MATCH THIS STATUS WORD (0=ANY)
IF (MATCH.LT.0) GO TO 10

XFACTR=2000./(XAXIS*60.) !UNITS PER SECOND
YFACTR=1400./(FULLS-)
A='p'
TYPE 915,155 !START PLOTTER
DO 650 I1=1,IRECDS

ERROR(1)=0
ERROR(2)=0
ICODE=ISPFNW(248,ICHAN,NWDS,ARY,ERRADR)
NRECD=NRECD+1

ISUM=0
ISUM SEVERAL RANGES
DO 610 K=16,ISUM,3
ISUM=ISUM+ARY(K)
610 CONTINUE
ARY(353)=ISUM

ARY(303)=ARY(303).AND.1023
ARY(304)=ARY(304).AND.2047 !MASK UNUSED BITS

IF (ARY(319).GT.4096) ARY(319)=ARY(319)-8192
IF (ARY(322).GT.4096) ARY(322)=ARY(322)-8192
IF (ARY(323).GT.4096) ARY(323)=ARY(323)-8192
IF (ARY(328).GT.1800) ARY(328)=ARY(328)-3600

ARY(354)=ARY(335)-ARY(336) IA/C DOPPLER-ADDAS DOPPLER
ARY(355)=ARY(335)-ARY(337) IA/C DOPPLER-ADDAS INS GS
ARY(356)=ARY(336)-ARY(337) IA/C ADDAS DOPPLER-ADDAS INS
ARY(358)=ARY(ITEMD)-IDEY1 IA/C AND ANY OTHER ITEM
ARY(359)=ARY(ITEMD)-IDEY2
ARY(360)=ARY(359)+ARY(358)
IDEY2=IDEY1
IDEY1=ARY(ITEMD)

IDRIFT(4)=IDRIFT(3)
IDRIFT(3)=IDRIFT(2)
IDRIFT(2)=IDRIFT(1)
IDRIFT(1)=ARY(331)-ARY(316) NEW DRIFT DEF'N - (ARY(319) IS OLD

DDRIFT=0. IWEIGHT DRIFT
DO 630 I=1,4
DDRIFT=DDRIFT+WD(I)*IDRIFT(I)
630 CONTINUE

ARY(357)=FACTR*DDRIFT*ARY(318)/176.216+VELD(LAGV)

VELD(5)=0.0
VELD(4)=VELD(3)
VELD(3)=VELD(2)
VELD(2)=VELD(1)
VELD(1)=ARY(353)

IF (MATCH.EQ.0) GOTO 640
IF (((ARY(4).AND.24).NE.MATCH) GOTO 650

640 TYPE 916
TIME=60.D0*ARY(304)+1.D0*ARY(303)

IF (ITAPI3.EQ.0) GOTO 647
! CODE TO FIX TAPE 13
ISEC=ARY(303)/10.
IF (MOD(ISEC,10).EQ.9) TIME=TIME-1.D0
IF (MOD(ISEC,10).NE.0) GO TO 645
IF (LAST.NE.0) TIME=TIME-1.D0
IF (LAST.NE.0) ISEC=ISEC-1
LAST=0
GO TO 646

645 LAST=1

CONTINUE
IF (ISEC.LT.10) TIME=TIME+60.D0

CONTINUE
IF (TIME.LT.43200.) TIME=TIME+86400.D0.
X=XFACTR*(TIME-FLEFT)
Y=(ARY(NITEM)*FMULT+SHIFT-ZERO)*YFACTR
IF (Y.GT.1400.) Y=1400.
IF (Y.LT.0.) Y=0.
IF (X.LT.0.) A='p'

CALL GRAPH1(X,Y,A)
A='q'

CONTINUE
TYPE 919,155 GO TO 10

700 TYPE *,'OUTLINE BOX'
TYPE 915,155
CALL GRAPH1(0.,0..'p')
CALL GRAPH1(2000.,0.,'q')
CALL GRAPH1(2000.,1400.,'q')
CALL GRAPH1(0.,1400.,'q')
CALL GRAPH1(0.,0.,'p')
TYPE 919,155
GO TO 10

750 ICASE=I
ITRIAL=0
TYPE *,'FIND COEFS. FOR CODE (8,24)':'
ACCEPT *,'MATCH'
IF (MATCH.LT.0) GOTO 10
TYPE *,'NUMBER OF SAMPLES':'
ACCEPT *,'NLSQ'
IF (ICASE.EQ.11) GOTO 754
TYPE *,'NUMBER OF TRIALS'
ACCEPT *,'NTRIAL'
IF (ICASE.EQ.19) GOTO 754
TYPE *, 'PLOT COEFFICIENT 1-4:'  
ACCEPT *, NCOEF  
A='P'  
TYPE 915, 155  I  TURN ON PLOTTER

754 N=-9  
755 ERROR(1)=0  
ERROR(2)=0  
ICODE=ISPFNW(248, ICHAN, NWDS, ARY, ERRADR)  
nrecd=nrecd+1  
IF (ICODE .NE. 0) GO TO 777  
IF (ARY(319).GT.4096) ARY(319)=ARY(319)-8192  
GS=.06279*ARY(318) 1M/S UNITS  
DRIFT1(9)=DRIFT1(8)  
DRIFT1(8)=DRIFT1(7)  
DRIFT1(7)=DRIFT1(6)  
DRIFT1(6)=DRIFT1(5)  
DRIFT1(5)=DRIFT1(4)  
DRIFT1(4)=DRIFT1(3)  
DRIFT1(3)=DRIFT1(2)  
DRIFT1(2)=DRIFT1(1)  
DRIFT1(1)=.04395*(ARY(331)-ARY(316))*GS*.01645 1M/S UNITS  
C ABOVE LINE REVISED FROM (ARY(319)) IN PARENS  
IVEL9=IVEL8  
IVEL8=IVEL7  
IVEL7=IVEL6  
IVEL6=IVEL5  
IVEL5=IVEL4  
IVEL4=IVEL3  
IVEL3=IVEL2  
IVEL2=IVEL1  
IVEL1=0  
do 760 K=16, NSUM, 3  
IVEL1=IVEL1+ARY(K)  
760 CONTINUE 1.00267 M/S UNITS  
IF (N.LT.1) GO TO 775  
IF ((MATCH.EQ.0) GO TO 765  
IF (((ARY(4).AND.24).NE.MATCH) GO TO 755  
765 B(N)=.00267*(2*IVEL6-IVEL4-IVEL8) 1M/S UNITS  
do 770 J=1,3  
N1=N+NLSQ*(J-1)  
AL(N1)=DRIFT1(J)-DRIFT1(J+1)-2.*DRIFT1(J+2)+2.*DRIFT1(J+3)  
AL(N1)=AL(N1)+DRIFT1(J+4)-DRIFT1(J+5)  
770 CONTINUE  
775 N=N+1  
NP1=NLSQ+1  
IF (N.LT.NP1) GO TO 755  
call gtprd(al, b, b1, nlsq, 3, 1)  
call mata(al, ata, nlsq, 3, 0)
CALL SINV(ATA,3,0001,IER)
CALL MPRD(ATA,B1,X1,3,3,1,0,1)

WD(1)=X1(1)
WD(2)=X1(2)-X1(1)
WD(3)=X1(3)-X1(2)
WD(4)=-X1(3)
ITRIAL=ITRIAL+1

777 IF (ICODE.NE.0) ITRIAL=NTRIAL
IF (ICASE.EQ.11) GO TO 790 !CRT TYPEOUT
IF (ICASE.EQ.19) GO TO 780 !PRINTOUT

X=10.*ITRIAL
Y=700.+WD(NCOEF)*350.
IF (Y.GT.1400.) Y=1400.
IF (Y.LT.0.) Y=0.
CALL GRAPH1(X,Y,A)
A='q'
IF (ITRIAL.LT.NTRIAL) GO TO 754
TYPE 919,155 !TURN OFF PLOTTER
GO TO 10

780 IT1=ARY(304)/60
IT2=ARY(304)-60*IT1
T3=ARY(303)/10.
PRINT 920,ITRIAL,NRECD,IT1,IT2,T3,WD
IF (ITRIAL.LT.NTRIAL) GO TO 754
GO TO 10

790 TYPE *;'WEIGHTING VECTOR=',X1
TYPE *;'COEFFICIENTS=',WD
GO TO 10

800 TYPE *;'WEIGHTING VECTOR (.3 1 0 -1)' ACCEPT *,WD
TYPE *;'SCALE FACTOR (3)' ACCEPT *,FACTR
GO TO 10

801 TYPE *;'VELOCITY LAG (3)' ACCEPT *,LAGV TYPE *;'NSUM (103)' ACCEPT *,NSUM
TYPE *;'ITEM TO DELAY' ACCEPT *,ITEMD
GO TO 10

802 TYPE *;'NUMBER OF RANGES (36)' ACCEPT *,NRANGE
GO TO 10

803 TYPE 908 ACCEPT *,NITEM !ITEM TO PLOT
GO TO 10
Type 911
ACCEPT *, IHour, MINUTE  # LEFT EDGE INFO
FLEFT = 3600.D0 * IHour + 60.D0 * MINUTE

Type 912
ACCEPT *, XAIXIS  # FS IN MINUTES

Type 913
ACCEPT *, IRECDS  # RECORDS TO PLOT
GO TO 10

Type 910
ACCEPT *, FMULT, SHIFT  # PLOT FACTOR
GO TO 10

Type 909
ACCEPT *, ZERO, FULLS  # PLOT SCALE
GO TO 10

Type *, 'TAPE 13? (0, 1)'  # TAPE 13?
ACCEPT *, ITAP13
GO TO 10

FORMAT (1X, 'X=1,16,' Y = ',I6,' N', I2, ':', I2,' W',
I13, ':', I2,' FLT ', I2,' RUN ', I3,' TIME ', I2,
1':', I2,:', F4.1,' ALT ', I6)

FORMAT (1X, 'LOS=', F6.1,' THDG=', F5.1,' DRIFT=', F5.2,
1' LOSE=', F5.1,' PITCH=', F6.2,' ROLL=', F6.2)

FORMAT (1X, 'TAS=', F5.1,' GSPD=', F5.1,' WIND=', F5.1,
1' WDIR=', F5.1,' PROC=', 06,' STATUS=', 06)

FORMAT (1X, 3(I5, F7.1, F6.1, I4, 5X))

FORMAT (1X, 'SPACE FORWARD N RECORDS: ',$)

FORMAT (1X, 'SPACE BACKWARD N RECORDS: ',$)

FORMAT (1X, 'PLOT ITEM M: ',$)

FORMAT (1X, 'ZERO AND FULL—SCALE FOR PLOT: ',$)

FORMAT (1X, 'MULTIPLIER AND OFFSET: ',$)

FORMAT (1X, 'LEFT EDGE HOUR, MINUTE: ',$)

FORMAT (1X, 'FULL SCALE IN MINUTES: ',$)

FORMAT (1X, 'NUMBER OF RECORDS: ',$)

FORMAT (1X, 'PLOT CODE TO MATCH (0,8,24): ',$)

FORMAT (1X, A1,'.(',$)

CALL CLOSEC(ICHAN)
STOP 'EXIT 99'
PROGRAM FTAPED

C REVISED 10-27-81
C TURNS MAGTAPE FILES INTO DISK FILES
C CAN ALSO EXAMINE/ PLOT TAPE DATA

INTEGER*2 DBLK(4), ERROR(4), ARY(354), CODE, NWDS, ERRADR
INTEGER*2 IRANGE(3), IWID(3)
REAL*4 AMP(3), VEL(3)
REAL*8 TIME, FLEFT
BYTE A, FILSPC(11)
DATA DBLK/3RMT0,0,0,0/
DATA ERROR/4*0/
ERRADR=IADDR(ERROR)
ICHAN=IGETC()
IF (ICHAN.LT.0) STOP 'NO CHANNEL AVAILABLE'
IF (LOOKUP(ICHAN, DBLK, 0, -1).LT.0) STOP 'BAD LOOKUP'
NRECD=0
FULLS=20.
ZERO=-20.
LAST=1
CON1=.04395
FMULT=CON1
SHIFT=0.
NWDS=352
NRANGE=36

10 TYPE 905, NRECD
ACCEPT *, I
IF (I.EQ.0) GO TO 90  !READ AND TYPE HEADER
IF (I.EQ.1) GO TO 100  !READ A RECORD
IF (I.EQ.2) GO TO 200  !PRINT A RECORD
IF (I.EQ.3) GO TO 300  !FORWARD SPACE
IF (I.EQ.4) GO TO 400  !REWIND TAPE
IF (I.EQ.5) GO TO 500  !BACKSPACE
IF (I.EQ.6) GO TO 600  !PLOT ROUTINE
IF (I.EQ.7) GO TO 700  !PLOT BOX
IF (I.EQ.8) GO TO 450  !CREATE A FILE
IF (I.EQ.9) GO TO 350  !SPACE TO RECORD N
IF (I.EQ.12) GO TO 802  !SET # RANGES
IF (I.EQ.13) GO TO 803  !SET ITEM TO PLOT
IF (I.EQ.14) GO TO 804  !SET PLOT TIME
IF (I.EQ.15) GO TO 805  !SET FMULT, SHIFT
IF (I.EQ.16) GO TO 806  !SET PLOT SCALE
IF (I.EQ.17) GO TO 807  !SET TAPE 113 - TIME CODE
IF (I.EQ.99) GO TO 999  !EXIT FROM PROGRAM
GO TO 10

90 ITEST=0
GO TO 105
105 ITEST=1
100 ITEST=1
ERROR(1)=0
ERROR(2)=0
ICODE=ISPFNW(248, ICHAN, NWDS, ARY, ERRADR)
NRECD=NRECD+1
IT1=ARY(304)/60
IT2=ARY(304)-60*IT1
T3=ARY(303)/10.
IX=20*ARY(1)
IY=20*ARY(2)
N1=ARY(313)
N2=ARY(312)/10
IW1=-ARY(315)
IW2=-ARY(314)/10
IFTL=ARY(300)
IRUN=ARY(302)
IALT=ARY(305)/1.64
FLOS=ARY(3)/10.+180.
THDG=ARY(316)*CON1
THDG=ARY(316)*CON1
DRIFT=ARY(319)*CON1
IF (DRIFT.GT.180.) DRIFT=DRIFT
FLOSE=ARY(328)/10.
PITCH=ARY(322)*CON1
ROLL=ARY(323)*CON1
TAS=ARY(317)*1.5144
GS=ARY(318)*.0628
WIND=ARY(326)*.05144
DIR=ARY(321)/10.
AMP(J)=.134*ARY(I4-27)
VEL(J)=.08*ARY(I4-26)
IWIDTH(J)=ARY(I4-25)

110 TYPE 901,IX,IY,N1,N2,IW1,IW2,IFTL,IRUN,IT1,IT2,T3,IALT
TYPE 902,FLOS,THDG,DRIFT,FLOSE,PITCH,ROLL
TYPE 903,TAS,GS,WIND,DIR,PITCH,ROLL
TYPE 921,ALOF,OFF,GS1,GS2,GS3,DRIFT2

IF (ITEST.EQ.0) GO TO 410.
I3=NRANGE/3
DO 150 I=1,I3
DO 160 J=1,3
IRANGE(J)=320*I+320*I3*J-3710
I4=3*I3*J+3*I
AMP(J)=.184*ARY(I4-27)
VEL(J)=.08*ARY(I4-26)
IWIDTH(J)=ARY(I4-25)
CONTINUE
150 TYPE 904,(IRANGE(K),AMP(K),VEL(K),IWIDTH(K),K=1,3)
TYPE *
GO TO 410
200 PRINT 901,IX,IY,N1,N2,IW1,IW2,IFTL,IRUN,IT1,IT2,T3,IALT
PRINT 902,FLOS,THDG,DRIFT,FLOSE,PITCH,ROLL

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PRINT 9013, TAS, GS, WIND, DIRN, IPROC, ISTAT
PRINT 921, ALOF, OFF, GS1, GS2, GS3, DRIFT2
PRINT *
DO 250 I=1, 12
DO 260 J=1, 3
IRANGE(J) = 320*I + 3840*J - 3710
AMP(J) = 184*ARY(36*J + 3*I - 27)
VEL(J) = 0.08*ARY(36*J + 3*I - 26)
IWID(J) = ARY(36*J + 3*I - 25)
260 CONTINUE
250 PRINT 904, (IRANGE(K), AMP(K), VEL(K), IWID(K), K=1, 3)
PRINT *
GO TO 10

300 TYPE 906
ACCEPT *, N
IF (N.EQ.0) GO TO 10
310 ERROR(1) = 0
ERROR(2) = 0
ICODE = ISPFNW(254, ICHAN, N, ARY, ERRADR)
NRECD = NRECD + N
GO TO 410

350 TYPE 917 !SPACE TO RECORD N
ACCEPT *, N
N = N - NRECD
IF (N.GT.0) GO TO 310
IF (N.EQ.0) GO TO 10
N = -N
GO TO 510

400 TYPE "REWIND TAPE"
ERROR(1) = 0
ERROR(2) = 0
ICODE = ISPFNW(251, ICHAN, N, ARY, ERRADR)
NRECD = 0
410 IF (ICODE.NE.0) TYPE *, 'ICODE=', ICODE, ERROR(1), ERROR(2)
GO TO 10

450 TYPE 451 !CREATE A NEW FILE
451 FORMAT (1X, 'CREATE FILE DL0: ', $)
ACCEPT 452, (FILSPC(I), I=1, 10)
452 FORMAT (10A1)
IF (FILSPC(1).EQ.0) GO TO 450
FILSPC(11) = 0
TYPE 453
453 FORMAT (1X, 'NUMBER OF SCANS: ', $)
ACCEPT *, NRECD
IF (NRECD.LE.0) GO TO 10
NBLOCK = 1.394*FLOAT(NRECD)+1
TYPE *, 'NBLOCK:', NBLOCK
OPEN (UNIT=8, NAME=FILSPC, RECORDSIZE=177, TYPE='NEW', IERR=460, FORM='UNFORMATTED', INITIALSIZE=NBLOCK)
DO 455 I=1, NRECD
ERROR(1)=0
ERROR(2)=0
ICODE=ISPFNW(248,ICHAN,352,ARY,ERRADR)
NRECD=NRECD+1
IF (ICODE.NE.0) GO TO 480
ARY(353)=NRECD-1
ARY(354)=0
WRITE (8) ARY
455 CONTINUE

456 CLOSE (UNIT=8)
GO TO 10

460 TYPE *, 'ERROR UPON OPENING'
GO TO 10

493 TYPE *, 'READ NON-STANDARD TAPE RECORD'
GO TO 456

500 TYPE 907
ACCEPT *, N
IF (N.EQ.0) GO TO 10

510 ERROR(1)=0
ERROR(2)=0
ICODE=ISPFNW(253,ICHAN,N,ARY,ERRADR)
NRECD=NRECD-N
IF (I.EQ.0) NRECD=0
GO TO 410

530 TYPE 914
EXECUTE PLOT
ACCEPT *, MATCH
MATCH THIS STATUS WORD (0=ANY)
IF (MATCH.LT.0) GO TO 10

XFACTR=2000./(XAXIS*60.)!UNITS PER SECOND
YFACTR=1400./(FULLS-ZERO)
A='p'
TYPE 915,155
START PLOTTER
DO 650 I1=1,IRECDS

ERROR(1)=0
ERROR(2)=0
ICODE=ISPFNW(248,ICHAN,NWDS,ARY,ERRADR)
NRECD=NRECD+1

IF (ARY(319).GT.4096) ARY(319)=ARY(319)-8192
IF (ARY(322).GT.4096) ARY(322)=ARY(322)-8192
IF (ARY(323).GT.4096) ARY(323)=ARY(323)-8192
IF (ARY(328).GT.1300) ARY(328)=ARY(328)-3600

IF (MATCH.EQ.0) GOTO 640
IF ((ARY(4).AND.24).NE.MATCH) GOTO 650

640 TYPE 916
TIME=60. D9 * ARY(304)+1D9 * ARY(303)

IF (ITAPl3.EQ.0) GO TO 647  ! CODE TO FIX TAPE 13
ISEC=ARY(303)/10.
IF (MOD(ISEC,10).EQ.9) TIME=TIME-1.D0
IF (MOD(ISEC,10).NE.0) GO TO 645
IF (LAST.NE.0) TIME=TIME-1.D0
IF (LAST.NE.0) ISEC=ISEC-1
LAST=0
GO TO 646

645 LAST=1
646 CONTINUE
IF (ISEC.LT.10) TIME=TIME+60.D0

647 CONTINUE
IF (TIME.LT.43200.) TIME=TIME+86400.
X=XFACTR*(TIME-FLEFT)
Y=(ARY(NITEM)*FMULT+SHIFT-ZERO)*YFACTR
IF (Y.GT.1400.) Y=1400.
IF (Y.LT.0.) Y=0.
IF (X.LT.0.) A='p'
CALL GRAPH1(X,Y,A)
A='q'

650 CONTINUE
TYPE 919,155 GO TO 10

700 TYPE *, 'OUTLINE BOX'
TYPE 915,155
CALL GRAPH1(0.,0.,'p')
CALL GRAPH1(2000.,0.,'q')
CALL GRAPH1(2000.,1400.,'q')
CALL GRAPH1(0.,1400.,'q')
CALL GRAPH1(0.,0.,'q')
TYPE 919,155
GO TO 10

802 TYPE *, 'NUMBER OF RANGES (36)'
ACCEPT *, NRANGE

803 TYPE 908
ACCEPT *, NITEM      ! ITEM TO PLOT
GO TO 10

804 TYPE 911
ACCEPT *, IHOUR, MINUTE       ! LEFT EDGE INFO
PLEFT=3600*D9*IHOUR+60*D9*MINUTE
TYPE 912
ACCEPT *, XAXIS         ! FS IN MINUTES
TYPE 913
ACCEPT *, IRECDs       ! # RECORDS TO PLOT
GO TO 10
901 FORMAT (1X,'X=',I6,' Y=',I6,' N',I2,' I2',,I2,' W', I13,',',I2,' FLT ',I2,' RUN ',I3,' TIME ',I2, 1',',I2,' ',F4.1,' ALT ',I5,' ')  
902 FORMAT (1X,'LOS=',F6.1,' THDG=',F5.1,' DRIFT=',F5.2, 1' LOSE=',F5.1,' PITCH=',F6.2,' ROLL=',F6.2)  
903 FORMAT (1X,'TAS=',F5.1,' GSPD=',F5.1,' WIND=',F5.1, 1' WDIRE=',F5.1,' PROC=',F6,' STATUS=',F6)  
904 FORMAT (1X,'AT RECORD',I5,' COMMAND: ',$)  
905 FORMAT (1X,'SPACE FORWARD N RECORDS: ',$)  
906 FORMAT (1X,'SPACE BACKWARD N RECORDS: ',$)  
907 FORMAT (1X,'PLOT ITEM M: ',$)  
908 FORMAT (1X,'ZERO AND FULL-SCALE FOR PLOT: ',$)  
909 FORMAT (1X,'MULTIPLIER AND OFFSET: ',$)  
910 FORMAT (1X,'LEFT EDGE HOUR, MINUTE: ',$)  
911 FORMAT (1X,'FULL SCALE IN MINUTES: ',$)  
912 FORMAT (1X,'NUMBER OF RECORDS: ',$)  
913 FORMAT (1X,'PLOT CODE TO MATCH (0,8,24:) ',$)  
914 FORMAT (1X,'SPACE TO RECORD N: ',$)  
915 FORMAT (1X,'SPACE TO RECORD N: ',$)  
916 FORMAT (1X,'SPACE TO RECORD N: ',$)  
917 FORMAT (1X,'SPACE TO RECORD N: ',$)  
918 FORMAT (1X,'SPACE TO RECORD N: ',$)  
919 FORMAT (1X,'SPACE TO RECORD N: ',$)  
920 FORMAT (1X,I4,I7,I5,':',I2,':',F4.1,4F10.4)  
921 FORMAT (1X,'LO:',F6.2,' OFFSET:',F6.1,' GS:',3F6.1, 1' DRIFT:',F5.2)  
999 CALL CLOSEC(ICHAN)  
STOP 'EXIT 99'  
END
PROGRAM FCONVT

REVISED 10-29-81, 11-5,16-81, 4-13-82
OPERATES ON FTPAEPED FILES (177 WORD RECORDS)
TO PRODUCE .RAW FILE3 (568 WORD RECORDS)

CAN ALSO EXAMINE 568-WORD RECORDS AND PLOT THEM

INTEGER*2 HEADER(56), DATA(12,90)
INTEGER*2 RAW(354), RAW1(354), RAW2(354), RAW3(354)
REAL*8 TIME, FLEFT
REAL*4 COEF1, COEF2, COEF3, COEF4
BYTE A, FILSPC(11)
ITAP13=0
FULLS=20.
ZERO=-20.
LAST=1
FMULT=.01
SHIFT=0.
MRANGE=1
NRANGE=36
COEF1=0.32 !DRIFT CORRECTION COEFFICIENTS
COEF2=0.56
COEF3=0.12
COEF4=-1.0

10 TYPE 905, NRECD
ACCEPT *, I
IF (I.EQ.0) GO TO 90 !READ AND TYPE HEADER
IF (I.EQ.1) GO TO 100 !READ A RECORD
IF (I.EQ.2) GO TO 200 !PRINT RECORD JUST READ
IF (I.EQ.4) GO TO 300 !REWIND FILE
IF (I.EQ.6) GO TO 600 !PLOT ROUTINE
IF (I.EQ.7) GO TO 700 !PLOT BOX
IF (I.EQ.8) GO TO 400 !CREATE A NEW FILE
IF (I.EQ.9) GO TO 350 !SPACE TO RECORD N
IF (I.EQ.10) GO TO 750 !OPEN READ FILE
IF (I.EQ.11) GO TO 770 !CLOSE READ FILE
IF (I.EQ.12) GO TO 802 !SET # RANGES
IF (I.EQ.13) GO TO 803 !SET ITEM TO PLOT
IF (I.EQ.14) GO TO 804 !SET PLOT TIME
IF (I.EQ.15) GO TO 805 !SET FMULT, SHIFT
IF (I.EQ.16) GO TO 806 !SET PLOT SCALE
IF (I.EQ.17) GO TO 807 !SET TAPE 113 - TIME CODE
IF (I.EQ.18) GO TO 808 !SET COEFFICIENTS
IF (I.EQ.99) GO TO 999 !EXIT FROM PROGRAM
GO TO 10

90 ITTEST=0
100 ITTEST=1
105 READ (8, ERR=670, END=660) HEADER, DATA
NRECD=NRECD+1
ITL=HEADER(4)/60
IT2=HEADER(4)-60*IT1
T3=HEADER(5)/10.  # DECODE TIME
IX=2*HEADER(6)
IY=2*HEADER(7)  # IX, Y POSITIONS
N1=HEADER(8)
N2=HEADER(9)/10  # ILATITUDE
IW1=HEADER(10)
IW2=HEADER(11)/10  # ILONGITUDE
IFLT=HEADER(2)
IRUN=HEADER(3)  # IFLIGHT AND RUN
IALT=HEADER(12)*2  # IALTITUDE
FLOS=HEADER(31)/10.  # LINE OF SIGHT ANGLE
THDG=HEADER(26)*.04395  # TRUE HEADING
DRIFT=HEADER(27)*.04395  # DRIFT ANGLE
FLOSE=HEADER(32)/10.  # ILOS ELEVATION
PITCH=HEADER(29)*.04395  # PITCH ANGLE
ROLL=HEADER(30)*.04395  # ROLL ANGLE
TAS=HEADER(20)/100.  # TRUE AIRSPEED (M/S)
GS=HEADER(42)/100.  # GROUND SPEED (M/S)
WIND=HEADER(43)/100.  # INS WIND VELOCITY
DIRN=HEADER(44)/10.  # INS WIND DIRECTION
IPROC=HEADER(19)  # IPROCESSOR STATUS
ISTAT=HEADER(18)  # IMAJOR STATUS WORD
ALOF=HEADER(33)/100.  # ILO FREQUENCY
OFF=HEADER(34)/100.  # ILO CORRECTION, M/S
GS1=HEADER(21)/100.  # IDOPPLER GS VIA A/C
GS2=HEADER(22)/100.  # IDOPPLER VIA ADDAS
GS3=HEADER(23)/100.  # INS GSPEED
DRIFT2=.04395*(HEADER(28)-HEADER(26))  # ITRACK-TRHDG
FLOSA=HEADER(46)/10.  # ACTUAL L.O.S.
POWER=HEADER(36)/100.  # IMEAN NOISE POWER
VAVG=HEADER(41)/100.  # IMEAN VELOCITY
VCOR=HEADER(40)/100.  # VELOCITY CORRECTION
110  TYPE 901, IX, IY, N1, N2, IW1, IW2, IFLT, IRUN, IT1, IT2, T3, IALT
TYPE 902, FLOS, THDG, DRIFT, FLOSE, PITCH, ROLL
TYPE 903, TAS, GS, WIND, DIRN, IPROC, ISTAT
TYPE 921, ALOF, OFF, GS1, GS2, GS3, DRIFT2
TYPE 922, FLOSA, POWER, VAVG, VCOR, HEADER(1)
TYPE *

IF (ITEST.NE.2) GO TO 111
PRINT 901, IX, IY, N1, N2, IW1, IW2, IFLT, IRUN, IT1, IT2, T3, IALT
PRINT 902, FLOS, THDG, DRIFT, FLOSE, PITCH, ROLL
PRINT 903, TAS, GS, WIND, DIRN, IPROC, ISTAT
PRINT 921, ALOF, OFF, GS1, GS2, GS3, DRIFT2
PRINT 922, FLOSA, POWER, VAVG, VCOR, HEADER(1)
PRINT *

111 IF (ITEST.EQ.0) GO TO 10
DO 150 J=MRANGE, NRANGE  # PRINT NRANGE RANGE GATES
IRANGE=320*J+32.
AMP=.01*DATA(1, J)
VEL=.01*DATA(2, J)
WID=DATA(3, J)

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IX=2.*DATA(4,J)
IX=2.*DATA(5,J)
V1=.01*DATA(7,J)
V2=.01*DATA(8,J)
V3=.01*DATA(9,J)
V4=.01*DATA(10,J)
V5=.01*DATA(11,J)
SIG=.01*DATA(6,J)
SIG2=.01*DATA(12,J)

IF (ITEST.NE.2) GO TO 150
PRINT 904, IRANGE, AMP, VEL, IWID, IX, IY, SIG, V1, V2, V3, V4, V5, SIG2
IF (ITEST.EQ.2) PRINT *
IF (ITEST.EQ.2) REWIND 6
GO TO 10

ITEST=2
!PRINT RECORD
GO TO 105

TYPE 917 !SPACE TO RECORD N
ACCEPT *, N
IF (N.LT.1) GO TO 350
IF (N.GT.MAXRCD) GO TO 350
IF (N.EQ.NRECD) GO TO 10
IF (N.GT.NRECD) GO TO 360
N1=NRECD-N
DO 355 J=1, N1
  BACKSPACE 8
  GO TO 370
355 N1=N-NRECD
DO 365 J=1, N1
  READ (8, ERR=670, END=660)
365 NRECD=N
GO TO 10

TYPE*, 'REWIND FILE'
REWIND 8
NRECD=1
GO TO 10

TYPE 401 !CREATE A NEW FILE
FORMAT (1X, 'CREATE FILE DL0: ', $)
ACCEPT 402, (FILSPC(I), I=1, 10)
FORMAT (10A1)
IF (FILSPC(1).EQ.0) GO TO 400
FILSPC(11)=0
TYPE 403
FORMAT (1X, 'NUMBER OF SCANS: ', $)
ACCEPT *, NRECD
IF (NRECD.LE.0) GO TO 10
NBLOCK=4.473*FLOAT(NRECD)+1
TYPE *, 'NBLOCK: ', NBLOCK
OPEN (UNIT=9, NAME=FILSPC, RECORDSIZE=568, TYPE='NEW', 1ERR=460, FORM='UNFORMATTED', INITIALSIZE=NBLOCK)
TYPE 404

FORMAT (1X, 'INPUT FILE: DL0: ', $)
ACCEPT 402, (FILSPC(I), I=1,10)
FILSPC(11) = 0
OPEN (UNIT=8, NAME=FILSPC, RECORDSIZE=177, TYPE='OLD',
1ERR=470, FORM='UNFORMATTED', READONLY)

READ (8, ERR=480, END=465) RAW1
READ (8, ERR=480, END=465) RAW2
READ (8, ERR=480, END=465) RAW3

DO 455 I=1, NRECDS

DO 410 J=1, 354
RAW(J) = RAW1(J)
RAW1(J) = RAW2(J)

410 RAW2(J) = RAW3(J)

READ (8, ERR=480, END=465) RAW3

C CONVERSION GOES HERE

HEADER(1) = RAW(353)  ! RECORD 
HEADER(2) = RAW(300)  ! FLIGHT 
HEADER(3) = RAW(302)  ! RUN 
HEADER(4) = RAW(304)  ! TIME, MIN
HEADER(5) = RAW(303)  ! TIME, .1 SEC
HEADER(6) = RAW(1)   ! X0, 20 M
HEADER(7) = RAW(2)   ! Y0, 20 M
HEADER(8) = RAW(313) ! LAT, DEG
HEADER(9) = RAW(312) ! LAT, .1 MIN
HEADER(10) = -RAW(315) ! LONG, DEG
HEADER(11) = -RAW(314) ! LONG, .1 MIN
IF (IABS(RAW(305)).GT.3900.) RAW(305) = 0
HEADER(12) = 8.2357*RAW(305)  ! PALT, 2 FT
HEADER(13) = RAW(307)  ! RALT, 2 FT
HEADER(14) = RAW(308)  ! IDEW PT, .1 DEG
HEADER(15) = RAW(309)  ! TEMP, .1 DEG
HEADER(16) = RAW(310)  ! IR TEMP, .1 DEG
HEADER(17) = RAW(311)  ! TOT AIR T, .1 DEG
HEADER(18) = RAW(4)   ! STATUS WORD
HEADER(19) = RAW(6)   ! PROCESSOR STATUS
HEADER(20) = 51.44*RAW(317)  ! ITAS, .01 M/S
IF (IABS(RAW(335)).GT.4500) RAW(335) = 0
HEADER(21) = 6.28*RAW(335)  ! GSD-OPLER, .01 M/S
IF (IABS(RAW(336)).GT.4500) RAW(336) = 0
HEADER(22) = 6.28*RAW(336)  ! GSD-DOP/ADDAS, .01 M/S
IF (IABS(RAW(337)).GT.4500) RAW(337) = 0
HEADER(23) = 6.28*RAW(337)  ! GSD-INS/ADDAS, .01 M/S
HEADER(24) = RAW(324)  ! WEDGE (I), .1 DEG
HEADER(25) = RAW(325)  ! WEDGE (O), .1 DEG
HEADER(26) = RAW(316)  ! thOG, .04395 DEG
HEADER(27) = RAW(319)  ! IDrift, .04395 DEG
HEADER(28) = RAW(331)  ! Itrack, .04395 DEG
HEADER(29)=RAW(322) 1PITCH, .04395 DEG
HEADER(30)=RAW(323) 1ROLL, .04395 DEG
HEADER(31)=RAW(3)+1000 1LOS DIRN, .1 DEG
HEADER(32)=RAW(328) 1LOS ELEV, .1 DEG
HEADER(33)=RAW(332) 1L.O., .01 MHZ
HEADER(34)=8*RAW(333) 1L.O. OFST, .01 M/S
HEADER(35)=RAW(306) 1PALT, FINE
HEADER(36)=0 1MEAN POWER, .01 DB
HEADER(37)=0 1DRIFT CORN, .01 M/S
HEADER(38)=0 1SMOOTH CORN, .01 M/S
HEADER(39)=0 1BAD SCAN FLAG
HEADER(40)=0 1V CORN ADDED, .01 M/S
HEADER(41)=0 1MEAN V, .01 M/S
HEADER(42)=6.28*RAW(318) 1GS USED, .01 M/S
HEADER(43)=5.144*RAW(320) 1INS WIND, .01 M/S
HEADER(44)=RAW(321) 1INS DIRN, .1 DEG
HEADER(45)=RAW(326) 1TIME TO POSN, .01 SEC
HEADER(46)=0 1ACTUAL LOS DIRN, .1 DEG
HEADER(47)=0 1SPARES FOLLOW
HEADER(48)=0
HEADER(49)=0
HEADER(50)=0
HEADER(51)=0
HEADER(52)=0
HEADER(53)=0
HEADER(54)=0
HEADER(55)=0
HEADER(56)=0

IF (HEADER(27).GT.4096) HEADER(27)=HEADER(27)-8192
IF (HEADER(29).GT.4096) HEADER(29)=HEADER(29)-8192
IF (HEADER(30).GT.4096) HEADER(30)=HEADER(30)-8192
IF (HEADER(31).GT.1800) HEADER(31)=HEADER(31)-3600
IF (HEADER(32).GT.1800) HEADER(32)=HEADER(32)-3600

POWER=0.
VEL=0.
DO 415 J=1,20
POWER=POWER+FLOAT(RAW(3*J+219))*18.4
VEL=VEL+FLOAT(RAW(3*J+13))*8.
415 CONTINUE
POWER=POWER/20.
IF (ABS(Power).GT.20000.) POWER=20000.
IF (ABS(VEL).GT.160000.) VEL=0.
HEADER(36)=POWER
HEADER(41)=(VEL/20.)

ALOS=.1*FLOAT(RAW(3))+180. 1LOS DIRECTION, DEG
THDGC=FLOAT(RAW1(316)-RAW(316)) 1THDG CHANGE, .04395 DEG
IF(THDGC.GT.4096.) THDGC=THDGC-8192.
IF(THDGC.LT.-4096.) THDGC=THDGC+8192.
ALOS=ALOS+.75*.04395*THDGC 1ACTUAL LOS DIRN, DEG
CCOS=16.*COS(ALOS/57.2958) 1Y INCREMENT PER RANGE, 20 M
CSIN=16.*SIN(ALOS/57.2958) 1X INCREMENT PER RANGE, 20 M
X0=.1*CSIN+FLOAT(RAW(1)) 1X FOR J=0

-96-
Y0 = 1.0 * CCOS + FLOAT(RAW(2)) I Y FOR J = 0
HEADER(46) = 10.0 * ALAS

V1 = COEF1 * FLOAT(RAW3(319))  ! DRIFT CORRECTION
V2 = COEF2 * FLOAT(RAW2(319))
V3 = COEF3 * FLOAT(RAW1(319))
V4 = COEF4 * FLOAT(RAW(319))
VCORN = FLOAT(HEADER(42)) / 1383.0  ! CORRECTION TO ADD TO V, .01 M/S
VCORN = VCORN * (V1 + V2 + V3 + V4)
IF (ABS(VCORN) .GT. 2000.) VCORN = 0.  ! CORRECT IOVFL
ICORN = VCORN
HEADER(37) = ICORN
HEADER(40) = ICORN
HEADER(41) = HEADER(41) + ICORN

DO 420 J = 1, 12
  DO 420 K = 1, 90
  DATA(J, K) = 0
420
  DO 430 J = 1, 90
    TEMP = 18.4 * FLOAT(RAW(3 * J + 9)) ! AMP, .01 DB
    IF (ABS(TEMP) .GT. 20000.) TEMP = 20000.
    DATA(1, J) = TEMP
    TEMP = 8.0 * RAW(3 * J + 10) + ICORN  ! VEL, .01 M/S
    IF (ABS(TEMP) .GT. 8000.) TEMP = 0.
    DATA(2, J) = TEMP
    DATA(3, J) = RAW(3 * J + 11)  ! WIDTH, CODED
    DATA(4, J) = X0 + J * CSIN  ! EAST DISTANCE
    DATA(5, J) = Y0 + J * CCOS  ! NORTH DISTANCE
430
  CONTINUE

WRITE (9, ERR=490) HEADER, DATA

455 CONTINUE

456 CLOSE (UNIT=8, ERR=485)
CLOSE (UNIT=9, ERR=485)
GO TO 10

460 TYPE *, 'ERROR IN OPENING OUTPUT FILE'
GO TO 10

465 TYPE *, 'END OF FILE'
GO TO 456

470 TYPE *, 'ERROR IN OPENING INPUT FILE'
GO TO 456

480 TYPE *, 'READ ERROR'
GO TO 456

485 TYPE *, 'CLOSURE ERROR'
GO TO 10

490 TYPE *, 'WRITE ERROR'
GO TO 456

600 TYPE 914 !EXECUTE PLOT
ACCEPT *, MATCH !MATCH THIS STATUS WORD (0=ANY)
IF (MATCH.LT.0) GO TO 10

XFACTR=2000./(XAXIS*60.) PUNITS PER SECOND  YFACTR=1400./(FULL;
A='p'
TYPE 915,155 !START PLOTTER
DO 650 I1=1,IRECDS

READ (8,END=660,ERR=670) HEADER, DATA
NRECD=NRECD+1
IF (MATCH.EQ.0) GOTO 640
IF ((HEADER(18).AND.24).NE.MATCH) GOTO 650

640 TYPE 916
TIME=60.DO*HEADER(4)+.1DO*HEADER(5)
IF (ITAPI3,.EQ.0) GO TO 647 !CODE TO FIX TAPE 13
ISEC=.1*HEADER(5)
IF (MOD(ISEC,1.0).EQ.9) TIME=TIME-.D0
IF (MOD(ISEC,1).NE.0) GO TO 645
IF (LAST,NE.0) TIME=TIME-.D0
IF (LAST,NE.0) ISEC=ISEC-1
LAST=0
GO TO 646

645 LAST=1
646 CONTINUE
IF (ISEC.LT.10) TIME=TIME+60.D0

647 CONTINUE
IF (TIME.LT.43200.) TIME=TIME+86400.
X=XFACTR*(TIME-FLEFT)
Y=(HEADER(NITEM)*FMULT+SHIFT-ZERO)*YFACTR
IF (Y.GT.1400.)=1400.
IF (Y.LT.0.) Y=0.
IF (X.LT.0.) A='p'
CALL GRAPH1(X,Y,A)
A='q'

650 CONTINUE
TYPE 919,155 GO TO 10

660 TYPE *, 'END OF FILE'
GO TO 10

670 TYPE *, 'READ ERROR'
GO TO 10

700 TYPE *, 'OUTLINE BOX'
TYPE 915,155
CALL GRAPH1(0.,0.,'p')
CALL GRAPH1(2000.,0.,'q')
CALL GRAPH1(2000., 1400., 'q')
CALL GRAPH1(0., 1400., 'q')
CALL GRAPH1(0., 0., 'q')
TYPE 919, 155
GO TO 10

750 TYPE 751
751 FORMAT(1X, 'OPEN FOR READING FILE DL0:', $)
ACCEPT 752, (FILSPC(I), I=1, 10)
752 FORMAT(10A1)
IF (FILSPC(1).EQ.0) GO TO 750
FILSPC(11)=0
TYPE *, 'TOTAL RECORDS:'
ACCEPT *, MAXRCD
OPEN(UNIT=8, NAME=FILSPC, RECORDSIZE=568, TYPE='OLD',
1ERR=760, FORM='UNFORMATTED', READONLY)
NRECD=1
GO TO 10

760 TYPE *, 'CANNOT OPEN FILE'
GO TO 10

770 CLOSE (UNIT=8, ERR=780)
TYPE *, 'CLOSE FILE'
GO TO 10

780 TYPE *, 'CANNOT CLOSE FILE'
GO TO 10

802 TYPE *, 'FIRST AND LAST RANGE'
ACCEPT *, MRANGE, NRANGE
GO TO 10

803 TYPE 908
ACCEPT *, NITEM !# TO PLOT
GO TO 10

804 TYPE 911
ACCEPT *, IHOUR, MINUTE !LEFT EDGE INFO
FLEFT=3600.D0*IHOUR+60.D0*MINUTE
TYPE 912
ACCEPT *, XAXIS !FS IN MINUTES
TYPE 913
ACCEPT *, IRECD$ !# RECORDS TO PLOT
GO TO 10

805 TYPE 910
ACCEPT *, FMULT, SHIFT !PLOT FACTOR
GO TO 10

806 TYPE 909
ACCEPT *, ZERO, FULLS !PLOT SCALE
GO TO 10

807 TYPE *, 'TAPE 13? (0, 1)'
ACCEPT *, ITAP13
GO TO 10

TYPE *,'COEFFICIENTS 1-4 (.32, .56, .12, -1.0):'
ACCEPT *,'COEF1,COEF2,COEF3,COEF4
GO TO 10

901 FORMAT (1X,'X=',I6,' Y=',I6,' N',I2,':',I2,' W',
1I3,':',I2,' FLT ',I2,' RUN ',I3,' TIME ',I2,
1' s',I2,':',F4.1,' ALT ',I6)
902 FORMAT (1X,'LOS=',F6.1,' THDG=',F5.1,' DRIFT=',F5.2,
1' LOSE=',F5.1,' PITCH=',F6.2,' ROLL=',F6.2)
903 FORMAT (1X,'TA$=',F5.1,' GSPD=',F5.1,' WIND=',F5.1,
1' WDIR=',F5.1,' PROC=',I6,' STATUS=',I6)
904 FORMAT (1X,I5,F6.1,F6.1,F6.1,F6.1,F6.1,'0',I6,'0',F6.2,'
905 FORMAT (1X,'AT RECORD',I5,'	 COMMAND: ',$)
906 FORMAT (1X,'SPACE FORWARD N RECORDS: ',$)
907 FORMAT (1X,'SPACE BACKWARD N RECORDS: ',$)
908 FORMAT (1X,'PLOT ITEM M: ',$)
909 FORMAT (1X,'ZERO AND FULL-SCALE FOR PLOT: ',$)
910 FORMAT (1X,'MULTIPLIER AND OFFSET: ',$)
911 FORMAT (1X,'LEFT EDGE HOUR, MINUTE: ',$)
912 FORMAT (1X,'FULL SCALE IN MINUTES: ',$)
913 FORMAT (1X,'NUMBER OF RECORDS: ',$)
914 FORMAT (1X,'PLOT CODE TO MATCH (0,8,24): ',$)
915 FORMAT (1X,I1,'0',A1,')')
916 FORMAT (1X,A1,$)
917 FORMAT (1X,'SPACE TO RECORD N: ',$)
918 FORMAT (1X,I5,$)
919 FORMAT (1X,'p}',A1,'}')
920 FORMAT (1X,'p}',A1,'}')
921 FORMAT (1X,'S',F6.1,' OFFSET=',F6.1,' GS:',F6.1,
1' DRIFT=',F5.2)
922 FORMAT (1X,'LOS=',F6.1,' POWER=',F6.1,' VAVG=',F6.2,
1' VCOR=',F6.2,' RECORD=',I5)
999 CALL CLOSEC(ICHAN)
STOP 'EXIT 99'
END
PROGRAM FEDIT

EDIT FILES CREATED BY FCNV

REVISED 10-30-81 AND 11-5-81

INTEGER*2 H1(56), H2(56), H3(56), H4(56), H5(56),
1D1(12,90), D2(12,90), D3(12,90), D4(12,90), D5(12,90)
BYTE INPFIL(11), OUTFIL(11)

K=0  ! RING BUFFER INDEX
TYPE 101

101 FORMAT(1X, 'INPUT FILE DL0: ', $)
ACCEPT 102, (INPFIL(I), I=1,10)

102 FORMAT(10A1)
INPFIL(11) = 0
OPEN (UNIT=8, NAME=INPFIL, RECORDSIZE=568, TYPE='OLD',
1ERR=900, FORM='UNFORMATTED', READONLY)

104 TYPE 105

105 FORMAT(1X, 'NUMBER OF RECORDS: ', $)
ACCEPT *, NRECD
IF (NRECD.LT.0) GOTO 104
NBLK = 4.473*NRECD+1
TYPE *, 'NBLK=', NBLK
TYPE 110

110 FORMAT(1X, 'OUTPUT FILE DL0: ', $)
ACCEPT 102, (OUTFIL(I), I=1,10)
OUTFIL(11) = 0
OPEN (UNIT=9, NAME=OUTFIL, RECORDSIZE=568, TYPE='NEW',
1ERR=910, FORM='UNFORMATTED', INITIALSIZE=NBLK)

READ (8, ERR=920, END=800) H1, D1
CALL FEDIT1(D1, H1(36))
READ (8, ERR=920, END=800) H2, D2
CALL FEDIT1(D2, H2(36))
READ (8, ERR=920, END=800) H3, D3
CALL FEDIT1(D3, H3(36))
READ (8, ERR=920, END=800) H4, D4
CALL FEDIT1(D4, H4(36))

200 K=K+1
IF (K.GT.5) K=1
GOTO (210, 220, 230, 240, 250) K
STOP 'ILLEGAL K'

210 READ (8, ERR=920, END=800) H5, D5
CALL FEDIT1(D5, H5(36))
CALL FEDIT2(D1, D3, D5)
WRITE (9, ERR=940) H3, D3
GOTO 200

220 READ (8, ERR=920, END=800) H1, D1
CALL FEDIT1(D1, H1(36))
CALL FEDIT2(D2, D4, D1)
WRITE (9, ERR=940) H4, D4
GOTO 200

230 READ (8, ERR=920, END=800) H2, D2
CALL FEDIT1(D2, H2(36))
CALL FEDIT2(D3, D5, D2)
WRITE (9, ERR=940) H5, D5
GOTO 200

240 READ (8, ERR=920, END=800) H3, D3
CALL FEDIT1(D3, H3(36))
CALL FEDIT2(D4, D1, D3)
WRITE (9, ERR=940) H1, D1
GOTO 200

250 READ (8, ERR=920, END=800) H4, D4
CALL FEDIT1(D4, H4(36))
CALL FEDIT2(D5, D2, D4)
WRITE (9, ERR=940) H2, D2
GOTO 200

800 CLOSE (UNIT=8, ERR=930)
CLOSE (UNIT=9, ERR=930)
STOP 'COMPLETED'

900 TYPE *,'ERROR OPENING INPUT FILE'
GO TO 800

910 TYPE *,'ERROR OPENING OUTPUT FILE'
GO TO 800

920 TYPE *,'READ ERROR'
GO TO 800

930 STOP 'CLOSURE ERROR'

940 TYPE *,'WRITE ERROR'
GO TO 800

END
SUBROUTINE FEDIT1(D,MSNR)

C LOAD ESTIMATES OF SIGMA INTO D
C REVISED 11-01-81 AND 11-5-81

INTEGER*2 D(12,90),SIGMA(60),MSNR,SNR

DATA SIGMA/3157,1571,1039,771,609,499,420,360,313,
1275,244,218,196,177,161,147,134,123,113,105,97,90,
184,78,73,68,64,60,57,54,51,48,45,43,41,39,37,35,33,
132,31,29,28,26,25,24,23,22,21,20,20,19,18,17,
116,16,15,15/ 11-SIGMA VEL ERROR PER .2 DB SNR

DO 200 I=1,90  I IS RANGE INDEX

SNR=(D(1,I)-MSNR+200)/20
IF (SNR.LT.1) SNR=1
IF (SNR.GT.60) SNR=60
D(6,I)=SIGMA(SNR)

200 CONTINUE

RETURN

END
SUBROUTINE FEDIT2(E1,E2,E3)

C PERFORM MAIN EDITING FUNCTION
C REVISED 11-01-81 AND 11-05-81

INTEGER*2 E1(12,90),E2(12,90),E3(12,90),V(9),SIGMA,
1VEL,S(9),V1(9),VMEAN

DO 200 IRANGE=1,89 I IS RANGE INDEX

VEL=E2(2,IRANGE) IV,S OF CENTRAL ELEMENT
SIGMA=E2(6,IRANGE) ICHECK FOR SMALL SIGMA (NO EDIT)
IF (SIGMA.LT.40) GOTO 200

IF (IRANGE.GT.1) GO TO 50

DO 20 J=1,3 11ST RANGE IS SPECIAL CASE
JP3=J+3
JP6=J+6
V1(J)=E1(2,J)
S(J)=E1(6,J)
V1(JP3)=E2(2,J)
S(JP3)=E2(6,J)
V1(JP6)=E3(2,J)
S(JP6)=E3(6,J)
20 CONTINUE.
GO TO 100

50 IM1=IRANGE-1
V1(1)=E1(2,IM1)
S(1)=E1(6,IM1)
V1(2)=E2(2,IM1)
S(2)=E2(6,IM1)
V1(3)=E3(2,IM1)
S(3)=E3(6,IM1)
IM=IM1+1
V1(4)=E1(2,IM)
S(4)=E1(6,IM)
V1(5)=E2(2,IM)
S(5)=E2(6,IM)
V1(6)=E3(2,IM)
S(6)=E3(6,IM)
IP1=IM+1
V1(7)=E1(2,IP1)
S(7)=E1(6,IP1)
V1(8)=E2(2,IP1)
S(8)=E2(6,IP1)
V1(9)=E3(2,IP1)
S(9)=E3(6,IP1)

100 ITHR=300 13 M/S THRESHOLD FOR USE
105 K=0
DO 110 J=1,9
IF (S(J).GT.ITHR) GOTO 110
K=K+1
V(K)=V1(J)
110 CONTINUE
IF (K.GT.0) GOTO 120
ITHR=ITHR*2
IF (ITHR.GT.120) GOTO 200
GOTO 105
105 CONTINUE
IF (K.GT-0) GOTO 120
ITHR=ITHR*2
IF (ITHR.GT.1200) GOTO 200
J=J+1
120 M=1
120 1SORT V'S THAT PASSED TEST
IF (K.LT.5) GOTO 170
KM1=K-1
DO 150 J=1,KM1
DO 140 J=1,KM1
IF (V(J).LT.V(J+1)) GOTO 140
ITEMP=V(J)
V(J)=V(J+1)
V(J+1)=ITEMP
140 CONTINUE
150 CONTINUE
MIN=10000
KM3=K-3
DO 160 J=1,KM3
ISUM=V(J)-V(J+3)
IF (ISUM.GT.MIN) GOTO 160
MIN=ISUM
M=J
160 CONTINUE
170 IF (K.GT.4) K=4
170 1FIND MEAN OF MOST LIKELY V'S
M=4
MPKM1=M+K-1
DO 180 J=M,MPKM1
SUM=SUM+FLOAT(V(J))
180 CONTINUE
VMEAN=SUM/FLOAT(K)
IDIFF=IABS(VMEAN-VEL)
IF (IDIFF.LT.400) GOTO 200
IF (IDIFF.LT.2*SIGMA) GOTO 200
E2(7,IRANGE)=E2(6,IRANGE)
E2(6,IRANGE)=IDIFF-200
200 CONTINUE
RETURN
END
PROGRAM FSMOT

C SMOOTH FILES CREATED BY FEDIT
C REVISED 11-2-81 AND 11-5-81

INTEGER*2 H1(56),H2(56),H3(56),H4(56),H5(56),H6(56),H7(56),
    H8(56),H9(56),D1(12,90),D2(12,90),D3(12,90),D4(12,90),
    D5(12,90),D6(12,90),D7(12,90),D8(12,90),D9(12,90)
BYTE INPFIL(11),OUTFIL(11)

K=0 !RING BUFFER INDEX
K1=0
TYPE 101

101 FORMAT(1X,'INPUT FILE DL0:',$)
ACCEPT 102,(INPFIL(I),I=1,10)

102 FORMAT(10A1)
INPFIL(11)=0
OPEN (UNIT=B,NAME=INPFIL,RECORDSIZE=56B TYPE='OLD',
    IERR=900,FORM='UNFORMATTED',READONLY)

104 TYPE 105

105 FORMAT(1X,'NUMBER OF RECORDS: ',$)
ACCEPT *,NRECS
IF (NRECS.LT.0) GO TO 104
NBLK=4.473*NRECS+1
TYPE *, 'NBLK=',NBLK
TYPE 110

110 FORMAT(1X,'OUTPUT FILE DL0:',$)
ACCEPT 102,(OUTFIL(I),I=1,10)
OUTFIL(11)=0
OPEN (UNIT=9,NAME=OUTFIL,RECORDSIZE=56B TYPE='NEW',
    IERR=910,FORM='UNFORMATTED',INITIALIZE=NBLK)

READ (8,ERR=920,END=800) H1,D1
READ (8,ERR=920,END=800) H2,D2
READ (8,ERR=920,END=800) H3,D3
READ (8,ERR=920,END=800) H4,D4
READ (8,ERR=920,END=800) H5,D5
READ (8,ERR=920,END=800) H6,D6
READ (8,ERR=920,END=800) H7,D7
READ (8,ERR=920,END=800) H8,D8

200 K=K+1
K1=K1+1
TYPE *, 'SCAN IN PROCESS: ',K1
IF (K.GT.9) K=1
GO TO (210,220,230,240,250,260,270,280,290) K
STOP 'ILLEGAL K'

210 READ (8,ERR=920,END=800) H9,D9
CALL FSMOT(D1,D3,D5,D7,D9)
WRITE (9,ERR=940) H5,D5
GO TO 200

220 READ (8,ERR=920,END=800) H1,D1
CALL FSMT1(D2, D4, D6, D8, D1)
WRITE (9, ERR=940) H6, D6
GO TO 290

230 READ (3, ERR=920, END=800) H2, D2
CALL FSMT1(D3, D5, D7, D9, D2)
WRITE (9, ERR=940) H7, D7
GO TO 200

240 READ (8, ERR=920, END=800) H3, D3
CALL FSMT1(D4, D6, D8, D1, D3)
WRITE (9, ERR=940) H8, D3
GO TO 200

250 READ (8, ERR=920, END=800) H4, D4
CALL FSMT1(D5, D7, D9, D2, D4)
WRITE (9, ERR=940) H9, D9
GO TO 200

260 READ (8, ERR=920, END=800) H5, D5
CALL FSMT1(D6, D8, D1, D3, D5)
WRITE (9, ERR=940) H1, D1
GO TO 200

270 READ (8, ERR=920, END=800) H6, D6
CALL FSMT1(D7, D9, D2, D4, D6)
WRITE (9, ERR=940) H2, D2
GO TO 200

280 READ (8, ERR=920, END=800) H7, D7
CALL FSMT1(D8, D1, D3, D5, D7)
WRITE (9, ERR=940) H3, D3
GO TO 200

290 READ (8, ERR=920, END=800) H8, D8
CALL FSMT1(D9, D2, D4, D6, D9)
WRITE (9, ERR=940) H4, D4
GO TO 200

800 CLOSE (UNIT=8, ERR=930)
CLOSE (UNIT=9, ERR=930)
STOP 'COMPLETED'

900 TYPE *, 'ERROR OPENING INPUT FILE'
GO TO 800

910 TYPE *, 'ERROR OPENING OUTPUT FILE'
GO TO 800

920 TYPE *, 'READ ERROR'
GO TO 800

930 STOP 'CLOSURE ERROR'

940 TYPE *, 'WRITE ERROR'
GO TO 800
END
SUBROUTINE FSMOTI(D1, D2, D3, D4, D5)

C PERFORMS SMOOTHING ON ONE SCAN FROM FSMOTH
C REVISED 03-NOV-81 AND 05-NOV-81

INTEGER*2 D1(12,90), D2(12,90), D3(12,90), D4(12,90), D5(12,90)
REAL*4 B(25), B1(25), B2(5), G(25,5), G1(25,5), G2(25), G4(15),
  G1(5), R(25), W(25), X0, Y0, DX, DY, SUM, S1, S2, T1, T2, T3, STDEV

INTEGER*2 IN(5,5)  !POINTER TO SYMMETRIC MATRIX G4
DATA IN/1,2,4,7,11,2,3,5,8,12,4,5,6,
  19,13,7,8,9,10,14,11,12,13,14,15/

T1=10000.0  !THRESHOLDS
T2=2.5
T3=1.0
IER=0

DO 800 IRANGE=1,87

IF (IRANGE.GT.3) GO TO 40
IF (IRANGE.EQ.3) GO TO 30
L1=1
I2=5
IF (IRANGE.EQ.2) GO TO 20
10 ITEST=11  !RANGE=1, LOAD SPECIAL G2
DATA G2/.7,.6,.5,.3,.2,.9,.8,.6,.5,.4,.7,.6,.5,.3,.2/
GO TO 100

20 ITEST=12  !RANGE=2, LOAD SPECIAL G2
DATA G2/.6,.7,.6,.5,.3,.8,.9,.8,.6,.5,.9,.95,.9,
  1.9,.7,.6,.9,.8,.6,.5,.6,.7,.6,.5,.3/
GO TO 100

30 ITEST=13  !RANGE=3, LOAD NORMAL G2
DATA G2/.5,.6,.7,.6,.5,.6,.8,.9,.8,.6,.5,.6,.7,.6,.5/

40 I1=IRANGE-2  !SET UP RANGE OF INDEX
I2=IRANGE+2  !FOR NORMAL RANGES

100 X0=D3(4,IRANGE)  !X,Y OF RELEVANT ELEMENT
  Y0=D3(5,IRANGE)

DO 200 I=I1,I2  !LOAD G,B AND W MATRICES
J1=I-I1+1  !SET UP INDICES
J2=J1+5
J3=J2+5
J4=J3+5
J5=J4+5

B(J1)=D1(2,I)/100.  !B IS RAW VELOCITIES
B(J2)=D2(2,I)/100.
B(J3)=D3(2,I)/100.
B(J4)=D4(2,I)/100.
B(J5)=D5(2,I)/100.

W(J1)=100./D1(6,I)  \text{W IS 1/STD DEVUS}
W(J2)=100./D2(6,I)
W(J3)=100./D3(6,I)
W(J4)=100./D4(6,I)
W(J5)=100./D5(6,I)

DX=D1(4,I)-X0  \text{FIRST POINT}
DY=D1(5,I)-Y0
G(J1,1)=DX**2
G(J1,2)=DX
G(J1,3)=DY**2
G(J1,4)=DY
G(J1,5)=1.

DX=D2(4,I)-X0  \text{SECOND POINT}
DY=D2(5,I)-Y0
G(J2,1)=DX**2
G(J2,2)=DX
G(J2,3)=DY**2
G(J2,4)=DY
G(J2,5)=1.

DX=D3(4,I)-X0  \text{THIRD POINT}
DY=D3(5,I)-Y0
G(J3,1)=DX**2
G(J3,2)=DX
G(J3,3)=DY**2
G(J3,4)=DY
G(J3,5)=1.

DX=D4(4,I)-X0  \text{FOURTH POINT}
DY=D4(5,I)-Y0
G(J4,1)=DX**2
G(J4,2)=DX
G(J4,3)=DY**2
G(J4,4)=DY
G(J4,5)=1.

DX=D5(4,I)-X0  \text{FIFTH POINT}
DY=D5(5,I)-Y0
G(J5,1)=DX**2
G(J5,2)=DX
G(J5,3)=DY**2
G(J5,4)=DY
G(J5,5)=1.

200 CONTINUE

IF (W(ITEST).GT.T3) W(ITEST)=W(ITEST)*T2
210 SUM=0.  !SUM WEIGHTS
220 SUM=SUM+W(I)

IF (SUM.LT.T1) GO TO 300 !EXIT IF THRESHOLD NOT REACHED

230 W(I)=W(I)*G2(I)  !CONVOLVE WEIGHTS
GO TO 210

300 CONTINUE

DO 310 I=1,25  !WEIGHT LSQ PROBLEM WITH W
B1(I)=B(I)*W(I)
DO 310 J=1,5
310 G1(I,J)=G(I,J)*W(I)

DO 320 I=1,5  !REPLACES GTFD
SUM=0.
DO 315 J=1,25
315 SUM=SUM+G1(J,I)*B1(J)
320 B2(I)=SUM

L=0  !G4 IS G1T*G1
DO 330 J=1,5  !THIS ROUTINE REPLACES MATA
DO 330 I=1,J
L=L+1
SUM=0.
DO 325 K=1,25
325 SUM=SUM+G1(K,I)*G1(K,J)
330 G4(L)=SUM

CALL SINV(G4,5,0.0001,IER)  !G4 IS INVERTED

DO 360 I=1,5  !REPLACES MPRD
SUM=0.
DO 355 J=1,5
355 SUM=SUM+G4(IN(I,J))*B2(J)
360 C1(I)=SUM

DO 550 I=1,5
J=I+6  !OUTPUT COEFFICIENTS
COEF=C1(I)*10000.
IF (I.EQ.5) COEF=COEF/100.  !VEL * 1.0
IF (COEF.GT.32767.) COEF=32767.
IF (COEF.LT.-32767.) COEF=-32767.
550 D3(J,IRANGE)=COEF

SUM=0.  !FIND MEAN-SQ ERROR IN SOLUTION
DO 610 I=1,25
SUM1=-B1(I)
605 SUM=SUM+SUM1**2
610 SUM=SUM+SUM1**2 -110-
S1=0.
S2=0.
DO 620 I=1,4
S1=S1+ABS(G4((I*(I+1))/2))
620 S2=S2+ABS(C1(I))  \( \text{SURFACE VARIATION} \)
S1=S1+ABS(G4(15))

STDEV=SQRT(.2*S1*SUM+20.*S2*S2)
STDEV=STDEV*100.
IF (STDEV.GT.32767.) STDEV=32767.
D3(12,IRANGE)=STDEV

800 CONTINUE

RETURN

END
PROGRAM FGRID
C REDUCE FILES FROM SMOOTH TO GRIDPOINTS
C REVISED NOV 9-11 81

INTEGER*2 H1(56),H2(56),H3(56),H4(56),H5(56),
1D1(12,90),D2(12,90),D3(12,90),D4(12,90),D5(12,90)
INTEGER*2 OUT(30,20,10),SOURCE,PAVG
REAL*4 Z(2,4)
BYTE INPFIL(11),OUTFIL(11)

COMMON OUT,X0,Y0,UCON,VCON,Z,RES,IFLAG,IFORD,
1SOURCE,PAVG,ALOS,SCALE,ITHRSH,M RANGE, NRANGE

NRECD=0
TYPE 52,NRECD  !COMMAND DECODER
52 FORMAT (1X,'AT RECORD',I6,' COMMAND: ',$)
ACCEPT *,ICOMD
IF (ICOMD.LT.1) GOTO 50
IF (ICOMD.GT.7) GOTO .
!ILLEGAL COMMANDS
GOTO (100,300,500,600,400,800,700) ICOMD
STOP 'ILLEGAL COMMAND'

100 K=0  !RING BUFFER INDEX
K1=0  !EXECUTE GRIDDING OPERATION
TYPE 150'

150 FORMAT(1X,'NUMBER OF SCANS: ',$)
ACCEPT *,NUMSCN
TYPE 152

152 FORMAT(1X,'STARTING X0,Y0 - METERS: ',$)
ACCEPT *,X0,Y0
X0=X0/20.  !**COMMAND LIST**
Y0=Y0/20.
TYPE 153

153 FORMAT(1X,'INITIAL AND FINAL RANGE (1-30): ',$)
ACCEPT *,MRANGE,NRANGE
TYPE 154  !1 - EXECUTE GRIDDING

154 FORMAT(1X,'AZIMUTH, DEG: ',$)  !2 - OPEN INPUT FILE
ACCEPT *,THETA
UCON=SIN(THETA/57.2958)
VCON=COS(THETA/57.2958)
TYPE 156  !6 - WRITE OUTPUT FILE

156 FORMAT(1X,'RESOLUTION, METERS: ',$)  !7 - STOP PROGRAM
ACCEPT *,RES
RES=RES/20.
TYPE 158

158 FORMAT(1X,'PLOT? (0,1): ',$)  !10 => NO PLOT
ACCEPT *,IFLAG
TYPE 159

159 FORMAT(1X,'SMOOTHED DATA? (0 OR 1): ',$) !1=>SMOOTHED DATA
ACCEPT *,SOURCE
IF (IFLAG.LT.1) GOTO 170 !PLOTTER NEEDED?

TYPE 162  !SET UP PLOTTER PARMS

162 FORMAT(1X,'M/S PER INCH OF VECTOR: ',$)
ACCEPT *, SCALE
TYPE 164

164 FORMAT (1X, 'ERROR THRESHOLD (M/S): ', $)
ACCEPT *, THRESH
ITHRESH = THRESH * 100.
TYPE 168, 155
168 FORMAT (1X, A1, '.', ($)

TURN ON PLOTTER

170 READ (8, ERR=920, END=800) H1, D1
READ (8, ERR=920, END=800) H2, D2
READ (8, ERR=920, END=800) H3, D3
READ (8, ERR=920, END=800) H4, D4
NRECD = NRECD + 4

DO 180 I1 = 1, 30
DO 180 I2 = 1, 20
DO 180 I3 = 1, 10
180 OUT (I1, I2, I3) = 0

ZERO OUTPUT MATRIX

190 K = K + 1
IF (K .GT. 5) K = 1
K1 = K1 + 1
IF (K1 .GT. NUMSCN) GOTO 800
GOTO (210, 220, 230, 240, 250) K
STOP 'ILLEGAL K'

210 READ (8, ERR=920, END=800) H5, D5
NRECD = NRECD + 1
IFORD = H3(18)
PAVG = H3(36)
ALOS = H3(46)
CALL FGRID1(D1, D3, D5)
GOTO 200

220 READ (8, ERR=920, END=800) H1, D1
NRECD = NRECD + 1
IFORD = H4(18)
PAVG = H4(36)
ALOS = H4(46)
CALL FGRID1(D2, D4, D1)
GOTO 200

230 READ (8, ERR=920, END=800) H2, D2
NRECD = NRECD + 1
IFORD = H5(18)
PAVG = H5(36)
ALOS = H5(46)
CALL FGRID1(D3, D5, D2)
GOTO 200

240 READ (8, ERR=920, END=800) H3, D3
NRECD = NRECD + 1
IFORD = H1(18)
PAVG = H1(36)
ALOS = H1(46)
CALL FGRID1(D4, D1, D3)
GOTO 200

250 READ (8, ERR=920, END=800) H4, D4
NRECD=NRECD+1
IFORD=H2(18)
Pavg=H2(36)
ALOS=H2(46)
CALL FGRID1(D5, D2, D4)
GOTO 200

300 TYPE 301
COMMAND 2 - OPEN FILE
FORMAT(1X, 'INPUT FILE DLØ: ',$)
ACCEPT 302, (INPFIL(I), I=1,10)
FORMAT(10A1)
INPFIL(11)=0
OPEN (UNIT=8, NAME=INPFIL, RECORDSIZE=568, TYPE='OLD',
1 ERR=900, FORM='UNFORMATTED', READONLY)
GOTO 50

400 CLOSE (UNIT=8, ERR=930)
COMMAND 5 - CLOSE FILE
TYPE *, 'CLOSE INPUT FILE'
GOTO 50

500 TYPE 502
FORMAT (1X, 'SPACE TO RECORD N: ',$)
ACCEPT *, NRECD1
IF (NRECD1.EQ.NRECD) GOTO 50
IF (NRECD1.LT.1) GOTO 50
IF (NRECD1.LT.NRECD) GOTO 550 !BACKSPACE
NUMSPC=NRECD1-NRECD
DO 520 N=1, NUMSPC
READ (8, ERR=920, END=800) H1, D1
NRECD=NRECD+1
520 CONTINUE
GOTO 50

550 NUMSPC=NRECD-NRECD1 !BACKSPACE REQD
DO 570 N=1, NUMSPC
BACKSPACE 8
NRECD=NRECD-1
570 CONTINUE
GOTO 50

600 TYPE *, 'OUTLINE BOX'
TYPE 168, 155
CALL GRAPH1(0., 0., 'p')
CALL GRAPH1(2000., 0., 'q')
CALL GRAPH1(2000., 1400., 'q')
CALL GRAPH1(0., 1400., 'q')
CALL GRAPH1(0., 0., 'q')
TYPE 822, 155
GOTO 50

700 STOP 'COMPLETED'
IF (IFLAG.LT.1) GOTO 820 IF PLOTTER ACTIVE?
TYPE 822,155
FORMAT(1X,'(p)',A1,'.') GOTO 820
IFLAG=0

WRITE OUTPUT FILE IF REQD
WRITE OUTPUT FILE? (0,1): 
ACCEPT *,IWRITE
IF (IWRITE.NE.1) GOTO 850
NO FILE WRITTEN
TYPE 802
FORMAT(1X,'OUTPUT FILENAME DLO: ')
ACCEPT OUTFIL(I),I=1,10
OUTFIL(11)=O
OPEN (UNIT=9,NAME=OUTFIL,RECORDSIZE=3000,TYPE='NEW',ERR=910,FORM='UNFORMATTED',INITIALSIZE=25)
WRITE (9,ERR=940) OUTFILE
CLOSE (UNIT=9,ERR=930)
GOTO 50

PRINT RESULTS (0,1)? 
ACCEPT *,IWRITE
IF (IWRITE.NE.1) GOTO 50
NO PRINT RESULTS
TYPE 855
WRITE(9,X;ITEM (1-10): '
ACCEPT *,NITEM
TYPE *,UI,UF,VI,VF (PRINT LIMITS):'
ACCEPT *,IUI,IUF,IVI,IVF
DO 870 IU=IUI,IUF
PRINT 860,(OUT(IU,IV,NITEM),IV=IVI,IVF)
CONTINUE
PRINT *
PRINT *
GOTO 50

ERROR OPENING INPUT FILE
GOTO 50

ERROR OPENING OUTPUT FILE
GOTO 820

READ ERROR
GOTO 800

CLOSURE ERROR
GOTO 50

WRITE ERROR
GOTO 50

END
SUBROUTINE FGRID1(D1,D2,D3)
C
REDUCE TO GRIDPOINTS DATA FROM FGRID
C
REVISED NOV 9-11 81

INTEGER*2 D1(12,90),D2(12,90),D3(12,90),OUT(30,20,10),
1SOURCE,PAVG
REAL*4 Z(2,4)

COMMON OUT,X0,Y0,UCON,VCON,Z,RES,IFLAG,
1IFORD,SOURCE,PAVG,ALOS,SCALE,ITHRSEI,MRANGE,NRANGE
COMMON /LOOP/X,Y

IFD=0 !FORWARD SCAN?
IF((IFORD.AND.24).EQ.24) IFD=5

DO 800 IRANGE=MRANGE,NRANGE !MAIN RANGE LOOP
IM=IRANGE-1
IP=IRANGE+1
CALL FGRID2(D1(4,IM),D1(5,IM),1)
CALL FGRID2(D1(4,IP),D1(5,IP),2)
CALL FGRID2(D3(4,IM),D3(5,IM),3)
CALL FGRID2(D3(4,IP),D3(5,IP),4)

UMIN=AMIN1(Z(1,1),Z(1,2),Z(1,3),Z(1,4)) !FIND EXTREMES OF U,V
UMAX=AMAX1(Z(1,1),Z(1,2),Z(1,3),Z(1,4))
VMIN=AMIN1(Z(2,1),Z(2,2),Z(2,3),Z(2,4))
VMAX=AMAX1(Z(2,1),Z(2,2),Z(2,3),Z(2,4))

IF (UMIN.LT.1.) UMIN=1. !CHECK LEGAL LIMITS
IF (VMIN.LT.1.) VMIN=1.
IF (UMAX.LT.1.) GOTO 800
IF (VMAX.LT.1.) GOTO 800

IU1=UMIN !SET LIMITS OF POSSIBLE GRID PTS
IV1=VMIN
IU2=UMAX+1.
IV2=VMAX+1.
IF (IU2.GT.30) IU2=30
IF (IV2.GT.20) IV2=20
IF (IU1.GT.30) GOTO 800 !IGNORE IF OUT OF RANGE
IF (IV1.GT.20) GOTO 800

DO 700 IU=IU1,IU2 !GRIDPOINT LOOP
DO 700 IV=IV1,IV2
X=X0+(IU*UCON-IV*VCON)*RES !GRID POINTS TO X-Y COORDS
Y=Y0+(IU*VCON+IV*UCON)*RES

DMIN=FGRID3(D2(4,IRANGE),D2(5,IRANGE))

DO 300 I=IM,IP
DIST=FGRID3(D1(4,I),D1(5,I))
IF (DIST.LT.DMIN) GOTO 700 !SKIP GRIDPOINT IF ANOTHER
DIST = FGRID3(D2(4, I), D2(5, I)) ! MEASUREMENT IS CLOSER
IF (DIST LT DMIN) GOTO 700
DIST = FGRID3(D3(4, I), D3(5, I))
IF (DIST LT DMIN) GOTO 700

300 CONTINUE  
IF THIS POINT IS REACHED THE POINT AT
C
D2(IRANGE) IS CLOSEST TO GRIDPOINT IU, IV

OUT(IU, IV, 1+IFD) = D2(1, IRANGE) - PAVG ! AMP-NOISE
OUT(IU, IV, 3+IFD) = D2(3, IRANGE) ! WIDTH. OUT(IU, IV, 5+IFD) = AL0:
IF (SOURCE GT 0) GOTO 400  
IGOTO 400 IF SMOOTHED
OUT(IU, IV, 2+IFD) = D2(2, IRANGE) ! RAW VELOCITY
OUT(IU, IV, 4+IFD) = D2(6, IRANGE) ! EDIT SIGMA
GOTO 500  
! EXIT TO PLOT TEST

400 DX = X - D2(4, IRANGE)  
! X, Y DIFFERENCES
DY = Y - D2(5, IRANGE)
VEL = DX * (D2(8, IRANGE) + DX * D2(7, IRANGE)) ! QUADRATIC SURFACE
VEL = VEL + DY * (D2(10, IRANGE) + DY * D2(9, IRANGE))
OUT(IU, IV, 2+IFD) = .01 * VEL + D2(11, IRANGE) ! SMOOTHED VELOCITY
OUT(IU, IV, 4+IFD) = D2(12, IRANGE) ! SMOOTHED SIGMA
GOTO 500  
! EXIT TO PLOT TEST

500 IF (IFLAG LT 1) GOTO 700  
IGOTO 700 IF NO PLOT,
IF (OUT(IU, IV, 4).EQ.0) GOTO 700  
! OR IF EITHER SIGMA
IF (OUT(IU, IV, 9).EQ.0) GOTO 700  
! IS ZERO,
IF (OUT(IU, IV, 4).GT.ITHRESH) GOTO 700  
! OR IF AFT OR FORWARD
IF (OUT(IU, IV, 9).GT.ITHRESH) GOTO 700  
! ISCAN FAILS TEST

ALP = OUT(IU, IV, 5)/572.958  
! LOOK ANGLES
BET = OUT(IU, IV, 10)/572.958
V1 = OUT(IU, IV, 2)/100.  
! AND RADIAL VELOCITIES
V2 = OUT(IU, IV, 7)/100.
SINBMA = SIN(BET - ALP)
XX = (V1*COS(BET) - V2*COS(ALP))/SINBMA  
! X, Y FOR PHI=90 DEG
YY = (V2*SIN(ALP) - V1*SIN(BET))/SINBMA
UU = YY*VCON + XX*UCON  
! IU, V COORDS IN M/S
VV = YY*UCON - XX*VCON

DX = 100.*UU/SCALE  
! VECTOR HALF-LENGTHS
DY = 100.*VV/SCALE
IF (ABS(DX).GT.400.) GOTO 700  
! EXIT IF VECTOR TOO LONG
IF (ABS(DY).GT.400.) GOTO 700
X = 60.*IU + 100. - DX  
! ORIGIN OF VECTOR
Y = 60.*IV + 100. - DY
CALL GRAPH1(X, Y, 'p')  
! MOVE TO ORIGIN
X = X + 2.*DX
Y = Y + 2.*DY
CALL GRAPH1(X, Y, 'q')  
! PLOT BODY OF VECTOR
X = X - .5*DX - .2*DY
Y = Y - .5*DY + .2*DX
CALL GRAPH1(X, Y, 'q')  
! PLOT BARB

700 CONTINUE

800 CONTINUE
RETURN
END

ORIGINAL PAGE IS
OF POOR QUALITY
REAL FUNCTION FGRID3(X1,Y1)
C CALCULATES SQUARE-DISTANCE TO X,Y
C CREATED 10-NOV-81
INTEGER*2 X1,Y1
COMMON /LOOP/X,Y
FGRID3=(X1-X)**2+(Y1-Y)**2
RETURN
END

SUBROUTINE FGRID2(X,Y,I)
C TRANSFORM X,Y COORDINATES INTO U,V COORDINATES
C REVISED 9-NOV-81
INTEGER*2 OUT(30,20,10),SOURCE,PAVG,X,Y
REAL*4 Z(2,4)
COMMON OUT,X0,Y0,UCON,VCON,Z,RES,IFLAG,IFORD,
SOURCE,PAVG,ALOS,SCALE,ITHRS
Z(1,1)=((X-X0)*UCON+(Y-Y0)*VCON)/RES
Z(2,1)=((Y-Y0)*UCON-(X-X0)*VCON)/RES
RETURN
END

REAL FUNCTION FGRID3(X1,Y1)
C CALCULATES SQUARE-DISTANCE TO X,Y
C CREATED 10-NOV-81
INTEGER*2 X1,Y1
COMMON /LOOP/X,Y
FGRID3=(X1-X)**2+(Y1-Y)**2
RETURN
END
SUBROUTINE GRAPH1(X,Y,A)
BYTE OUT(5),A
IF (X.GT.32767.) X=32767.
IF (Y.GT.32767.) Y=32767.
IF (X.LT.0.) X=0.
IF (Y.LT.0.) Y=0.
IX1=X/1024
IX2=X/16-64*IX1
IX3=X-16*IX2-1024*IX1
IY1=Y/4096
IY2=Y/64-64*IY1
OUT(1)=224+IX1
OUT(2)=128+IX2
IF (OUT(2).LT.160) OUT(2)=OUT(2)+64
OUT(3)=128+IY1+4*IX3
IF (OUT(3).LT.160) OUT(3)=OUT(3)+64
OUT(4)=128+IY2
IF (OUT(4).LT.160) OUT(4)=OUT(4)+64
OUT(5)=(128.+Y-64.*IY2-4096.*IY1)
IF (OUT(5).LT.160) OUT(5)=OUT(5)+64
TYPE 950,A,OUT
950 FORMAT (1X,6A1,')
RETURN
END
SUBROUTINE SINV(A, N, EPS, IER)
DIMENSION A(1)
REAL*8 DIN, WORK
CALL MFSD(A, N, EPS, IER)
IF(IER) 9, 1, 1
1 IPIV=N*(N+1)/2
IND=IPIV
DO 6 I=1, N
DIN=1.0D0/DBLE(A(IPIV))
A(IPIV)=DIN
MIN=N
KEND=I-1
LANF=N-KEND
IF(KEND) 5, 5, 2
2 J=IND
DO 4 K=1, KEND
WORK=0.0D0
MIN=MIN-1
LHOR=IPIV
LVER=J
DO 3 L=LANF, MIN
LVER=LVER+1
LHOR=LHOR+L
3 WORK=WORK+DBLE(A(LVER)*A(LHOR))
A(J)=-WORK*DIN
4 J=J-MIN
5 IPIV=IPIV-MIN
IND=IND-1
6 CONTINUE
DO 8 I=1, N
IPIV=IPIV+I
J=IPIV
DO 8 K=1, N
WORK=0.0D0
LHOR=J
DO 7 L=1, N
LVER=LHOR+L-K
WORK=WORK+DBLE(A(LHOR)*A(LVER))
7 LHOR=LHOR+L
A(J)=WORK
8 J=J+K
9 RETURN
END
SUBROUTINE MFSD(A,N,EPS,IER)
DIMENSION A(1)
REAL*8 DPIV,DSUM
IF (N-1) 12,1,1
1 IER=0
KPIV=0
DO 11 K=1,N
KPIV=KPIV+K
IND=KPIV
LEND=K-1
TOL=ABS(EPS*A(KPIV))
DO 11 I=K,N
DSUM=0.0D0
IF(LEND) 2,4,2
2 DO 3 L=1,LEND
LANF=KPIV-L
LIND=IND-L
3 DSUM=DSUM+DBLE(A(LANF)*A(LIND))
4 DSUM=DBLE(A(IND))-DSUM
IF(I-K) 10,5,10
5 IF(SNGL(DSUM)-TOL) 6,6,9
6 IF(DSUM) 12,12,7
7 IF(IER) 8,8,9
8 IER=K-1
9 DPIV=DSQRT(DSUM)
A(KPIV)=DPIV
DPIV=1.0D0/DPIV
GO TO 11
10 A(IND)=DSUM*DPIV
11 IND=IND+I
RETURN
12 IER=-1
RETURN
END