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G Griffiths[1], B Dupee[2], G Watson[3], P Spain[4] & T Nguyen[4]

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ABSTRACT

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1. Introduction

Shipboard Acoustic Doppler Current Profilers (ADCPs) have been routinely used by IOSDL since 1986. The information that they provide on ocean currents and on acoustic backscatter due to zooplankton distribution has contributed greatly to the observational programmes of UK WOCE and the Strategic Research Projects of the laboratory.

We have sought to improve and extend the ADCP measurements: by applying new technology such as 3DF GPS to provide accurate ship's heading (e.g. King and Cooper, 1993, Griffiths, 1994); implementing long range DGPS to improve navigation (King and Cooper, 1994); improving our knowledge of the backscatter measurement, Griffiths and Diaz (in press).

However, a major limitation on the 150 kHz ADCP systems fitted to NERC research vessels is the penetration range. Experience has shown that, even under favourable acoustic conditions, the expected range may vary from 90 to 500+ m, from the oligotrophic region south of Mauritius, to the highly productive North Atlantic Polar Front in spring. The 75 kHz ADCP from RD Instruments improves range to 500 m +, but requires a bulky and expensive transducer. An alternative approach is to use a correlation rather than a Doppler technique. The correlation technique is well established for use as a bottom tracking log, for example Dickey and Edward (1978), Denbigh (1984), and Atkins and Smith (1987), but has yet to emerge as a proven method for accurate profiling of water currents. Trials of a prototype Acoustic Correlation Current Profiler (ACCP) were reported by Bradley (1992, 1994), and the results were encouraging (a water profiling range of 1000 - 1500 m, and a predicted bottom track range of 3000 - 5000 m).

In light of these developments with ACCPs, a case was made (by GG) to the UK WOCE Scientific Steering Committee in February 1993 for a Capital Fund award for the purchase of an ACCP. The case was successful, and during the dry-docking of RRS Discovery in late summer 1993 the construction of a new transducer well for an ACCP was arranged by RVS. Discussions proceeded with RD Instruments, San Diego, U.S.A. and with Sonar Research and Development, Beverley, U.K. (who market a correlation log). Both companies were invited to tender for the contract in autumn 1994. The contract included a stipulation that the instrument should meet basic performance criteria before acceptance, and that the instrument should be ready for installation on RRS *Discovery* cruise 214 to the Agulhas Current in February 1995. Only RD Instruments accepted the offer to tender.

In view of the short delivery time, RD Instruments offered to install the prototype transducer and deck electronics for the cruise, and to provide two support staff at 25% of their normal rate. The transducer was fitted to the ship in Durban, South Africa on 23 February, 1995, and the electronics unit and post processing computers arrived on 26 February from the U.S.A (late, due to airfreight difficulties). Their late arrival delayed the ship sailing by 24 hr. On unpacking, the equipment worked immediately, and data acquisition began only hours later on leaving port.

This brief report describes the ACCP system as installed on *Discovery* for cruise 214, the methods used to gather, process and present the data, and some early comparisons between the ACCP, the standard ship-mounted ADCP and a lowered 150 kHz broadband ADCP fitted to the CTD (on its first use by IOSDL). We conclude with recommendations to be considered by RD Instruments and reflect on the utility of the instrument for our science programmes.

2. The RD Instruments Acoustic Correlation Current Profiler

Research on the use of acoustic correlation techniques for measurement of current profiles at RD Instruments was supported by NOAA and ONR under the SBIR scheme. A Phase I feasibility study was followed by a Phase II prototype development (RDI, undated), and a sea trial on board the NOAA ship *Discoverer* in November 1991. Some further work was done by RDI on the prototype in the intervening years, but it is not a standard product and this cruise was its first use for gathering data for science.

2.1 Principle of operation

The principle of operation of a correlation profiler is more complex than an Doppler profiler. Bradley (1994) and Dickey and Edward (1978) aimed to explain the concepts in simple ways, and the reader of this note is referred to those texts. In one sentence ... "Thus the objective, in the correlation system, is to transmit two identical signals separated by a known time interval and then to search for a separation vector and a time delay for which the correlation *(of the received signal)* is a maximum.", from Dickey and Edward (1978), p. 257.

2.2 Transducer installation

In the RDI ACCP the acoustic transducer is made up of 13 elements - 6 receive only elements, 5 transmit only elements, and 2 receive-transmit elements. The spacing and positions of the elements within the transducer were arranged to maximise the vector information for the received correlation function, in order to provide three axis velocity information, and also to keep the transducer dimensions similar to those of a 150 kHz ADCP unit. The transmit transducers have a diameter of ca. 5 cm, and have a cavitation power limit of some 200 watts. On this cruise, the transmit power amplifier was operated through a variac transformer set at a supply voltage of 70 Vac, corresponding to an electrical input power of ca. 100 W.

The transducer was installed by divers into the pre-prepared sea chest on the hull of Discovery on 23 February, 1995. There was no clear orientation mark on the prototype transducer, the angular alignment of the x and y axes was determined later by comparison of water track speeds with GPS navigation. No sound absorbing material was fitted to the sea chest, and no acoustic window was fitted. Discussions with RDI on their experience with the system on the *Discoverer* trials identified ship-related acoustic noise as a major limiting factor on the performance of the ACCP. Part of the ship-related noise comes from flow noise and bubble clouds on the hull over the transducer well. Fitting acoustic windows and baffles to the hull help to cut down interference from such sources, but we took the view that we would gain experience of the system 'as is' first, before making decisions about windows and baffles.

2.3 ACCP Deck Electronics, Data Acquisition and Processing

The hardware of the ACCP is based the electronics and signal processing technology developed at RDI for the Broadband range of ADCPs. As such, it uses a pseudo-random binary sequence (of '0' and '1', encoded as 0° and 180° phase) to modulate the carrier (22 kHz) frequency. By increasing the time-bandwidth product, more energy is put into the water, yet maintaining an acceptable spatial resolution by time compressing the received signal using a correlator. We list in Annex A the pulse lengths and depth bin positions and resolutions for four settings: fine, medium, coarse and boomer.

The one sentence statement of the correlation technique presented the method as using two identical signals transmitted at a known time interval. This method was patented by GE, and so the method used by RDI uses a single transmitted pulse, but with two time windows on the received signal, a time τ_C apart. However, the optimum τ_C varies with ship's speed. In the prototype, the operator sets τ_C manually, aided by a look-up table. The effect of a sub-optimum τ_C is to (a) increase the scatter in the velocity estimates if it is too small when speeds are low, and (b) to cause aliasing or velocity wrap-round, due to phase shifts of over 180°, if it is set too large when speeds are high.

The complex signal processing within the ACCP requires extensive use of high-performance computing power. Within the electronics chassis, a TMS320 series DSP processor controls the receive functions and sends data to a 90 MHz Pentium™ PC with an Intel iapx860 co-processor. The PC / co-processor performs the data analysis in two steps:

❑ correlation at zero lag and at time τ_C on the received signal, which can be done in near real time - stage 1.

❑ these first estimates of the correlation function from the real data are used as inputs to a maximum likelihood (ML) method for determining the velocities in the three axes - stage 2. The method employed is complex, using iterative techniques to solve non-linear equations, and as a consequence, takes longer than the acoustic propagation time to 1500 m and back (2 seconds).

The ACCP ping rate is therefore limited by the ML processing, a typical ping interval being 30 s. As the variance of the velocity estimates is dependent on the number of pings within an ensemble, a higher ping rate than is possible with on-line ML processing is desirable. This can be done by on-line processing to stage 1 only, and archiving the data for ML processing by an offline system. We employed this method for part of the cruise, using a second Pentium - iapx 860 PC. However, each hour of data took 6 hours to process.

☞* We look to improvements in computer technology to reduce the time taken for ML processing. Another possible approach that RDI could take is to seed the ML computation with the results of the previous ping or bin. (P. Spain, personal communication).

* We use this symbol to identify action points for RDI

On this cruise, the display on the PC focused on engineering and signal processing information. Graphical views of the spatial correlation functions as received (at lags of 0 and τ_C) and after ML processing were very helpful indicators of data quality. The 'oscilloscope display' of fragments of the hard-limited received signals from the eight transducers were generally less useful, though the originators of the instrument could well determine noise and interference sources from the display patterns. The numeric display of signal parameters was low-key, signal quality indicators were readable, but the velocity readouts Vx, Vy and Vz were difficult to track from ping to ping.

☞ A revised velocity display, perhaps based on a reference layer, would be an improvement.

The control program and the user interface for the ACCP is clearly targeted toward the knowledgeable user.

☞ The biggest improvement would be automated variation of τ_C to suit ship speed, with accompanying header information in the data file.

☞ It is also possible for the user not to log data to the disk, a reminder on the acquisition display to indicate that data are not being logged would be valuable.

The data acquisition system records ASCII files either to the hard disk of the PC, or to a Panasonic 1 GByte read/write optical disk on a SCSI port. The files contain individual ping data, rather than the ensemble averages as in the ADCP DAS. File sizes were typically tens of MBytes. The PC was not connected to Ethernet.

☞ RDI should consider connection to Ethernet and direct data transfer from within their program, but as this may add to the processing load, it may be better to keep to the off-line data transfer.

3. Post Processing

The optical (or 1.4 MByte floppy for small files) disk written by the ACCP was transferred to a PC connected to the shipboard Ethernet network and the ASCII files then copied to the Unix Level C computer. A naming convention for the files was adopted that included Julian day, transmission type (superboomer, boomer, coarse, medium, fine) and a file number. Files varied in duration from minutes to some 10 hours. A typical day would include files of different types, each with a different number of vertical bins. For experimental and evaluation purposes, this was necessary, but when used for routine data collection, there will be a need to minimise changes, and to use file sizes of up to 24 hr.

The level C ASCII files were read into the Pstar processing system to allow for post processing, the data following a similar path to those from the ADCP. Flowcharts and listings of the scripts written on the cruise for Pstar processing are in Annex A. These are by no means a definitive set of processing steps, they merely take the data to a stage where filtering, further quality control and comparison can take place. As with our ADCP data, some element of manual editing and quality control will be needed with the ACCP.

The ASCII files were also read into Matlab for rapid evaluation of data quality.

3.1 Heading and Navigation

The ACCP prototype electronics does not include provision for a heading input from the ship's gyrocompass. As heading is an essential parameter for conversion of the velocities from ship- to earth- coordinates, this is a serious omission. Merging the ACCP data with heading at the post-processing stage is definitely second-best. Accurate timekeeping is essential if serious heading errors are to be avoided, especially when underway. The ACCP fortunately uses the hardware clock in the PC to timestamp its data. This clock is more accurate that the DOS software clock (as used by the ADCP DAS), but the drift can be some seconds a day. We kept track of the clock drift and corrected using the same scheme as in our ADCP scripts.

☞ RDI need to provide either a hardware gyro interface, or an interface that can take serial gyro data from the shipboard computer system.

There is also no navigation input to the ACCP. This is less of a concern to us as it is our practice to merge ship-relative velocities with GPS at the post processing stage. This path requires Pstar to be in use to obtain absolute velocities, and it may not be in use on all cruises, however, for the foreseeable future the ACCP is likely to be used in conjunction with Pstar post processing.

3.2 Data Quality

The theoretical limits to the performance of the ACCP have been well established by Bradley (1990, 1991, 1992, 1994) for both the single ping velocity variance and bias. The thoroughness of this work may be gauged from the fact that some 20 sources of bias were investigated. This theoretical work was confirmed by nearshore trials off San Diego and on the trials in 1991 on *Discoverer*. With bin centres and lengths approximately the same as the 'medium' setting used on this cruise, he found the standard deviation to be 10.1 cm s^{-1} for the Vx and Vy components, some 1 cm s^{-1} higher than the Cramer Rao lower bound.

Table 1 shows the standard deviation as a function of range for a run on day 62, with the setting on 'fine'. Clearly the velocity values above a depth of 130 m are unacceptable, the standard deviations were above 1 m s^{-1}, and there was a consistent bias toward zero velocity. In practice we discounted much of the data above 200 m. As this is the region of strongest signal return, the reason for poor performance is not clear. It may be related to decorrelation caused by turbulence, or to ringing in the transducer mount

☞ RDI need to investigate the problem of poor data in the upper 2-300 m on this cruise.

Table 1 Mean, standard deviation, and number of valid data points during the south-going calibration run at ca. 0220Z on day 62.

Depth (m)	V_x m s^{-1}	σ_x (m s^{-1})	N_x	σ_y (m s^{-1})	V_y m s^{-1}	N_y
46.935	0.097	2.290	144	0.935	2.672	144
60.258	-0.032	2.354	171	1.094	2.479	170
75.411	0.210	2.043	182	1.327	2.293	184
91.637	0.421	1.255	199	1.926	2.160	202
109.368	0.673	1.099	206	2.313	1.732	209
129.01	0.667	0.641	219	2.709	1.014	221
151.357	0.588	0.317	236	2.791	0.743	238
176.022	0.576	0.319	223	2.860	0.687	222
204.182	0.614	0.230	225	2.921	0.640	226
236.23	0.600	0.250	231	2.915	0.599	231
272.167	0.603	0.228	221	2.869	0.654	223
313.166	0.630	0.236	238	2.945	0.604	236
360.008	0.642	0.215	184	2.905	0.669	185
413.475	0.669	0.176	239	3.001	0.567	242
474.345	0.702	0.170	234	3.004	0.583	235
543.792	0.704	0.263	227	3.081	0.498	226
622.985	0.634	0.321	206	3.047	0.630	208
713.484	0.672	0.386	204	2.946	0.624	205
816.85	0.726	0.286	195	2.981	0.750	199
935.034	0.608	1.223	145	2.587	1.210	143
1070.375	0.793	2.962	58	0.664	3.453	58
1225.213	0.489	3.834	46	-0.293	3.784	46
1402.281	-0.319	3.987	42	-0.187	3.761	42

Between 300 m and 1000 m, as a rule, data were acceptable. The range was dependent on sea conditions, on the ship speed, and (critically according to P. Spain) on the roll of the ship. There were occasions when the range reached 1200 m reliably. We did not achieve reliable profiling to 1500 m.

Contrary to our preconceptions, the performance on-station for CTD casts was, for the most part, poorer than underway at slow speeds. It was clear that this was due to noise (acoustic or electrical?) from the winch system, with its hydraulic power packs and electric motors, which occupies the same machinery space as the ACCP transducer.

☞ RDI should advise if we need to install sound absorbing material around the transducer.

Interference from the Simrad EA500 echo sounder operating at 12 kHz was present, shown on the ACCP echo trace as an uncorrelated spike. Although the correlation technique provided some immunity to noise, a method of synchronising the transmission of the ACCP to the Simrad would be an advantage.

☞ RDI to provide an external sync input to the ACCP to enable synchronisation with the EA500.*

We found the 'Valid' flag output from the ACCP to be useful in identifying poor data, however, the flag was not 100% reliable either way - acceptable data were flagged as invalid and vice versa. This occurred at all depths, but tended to happen less frequently at mid depths (300 - 900 m).

☞ RDI need to document the quality control criteria, and to revisit in light of experience gained on this cruise.

3.3 Calibration

A planned calibration of the ACCP had to be abandoned due to bad weather on day 60, however, a box survey of the mooring site on day 59, under good conditions, enabled an initial working calibration of the transducer misalignment angle and the amplitude scaling factor.

We used a north - south pair of tracks, and 7 depth cells from 236 m to 543 m on the 'fine' setting, assuming exact reciprocal courses, and no change in the current over the time of the measurement. 5 minute averages of ACCP velocities were used.

Time:	1320Z	Time:	1400
Heading:	354.3°	Heading:	181.8°
GPS V_e:	-0.0673 m s^{-1}	GPS V_e:	-0.0762 m s^{-1}
GPS V_n:	2.1066 m s^{-1}	GPS V_n:	3.2483 m s^{-1}

Assuming that the current cancels out on the reciprocal tracks, the magnitudes of the velocity differences for the GPS and ACCP should be identical. For the GPS, the magnitude difference was 5.3549 m s^{-1}. For the ADCP the magnitude differences are listed in Table 2:

Table 2 Calibration ratios of ACCP / GPS for a box survey on day 59.

Depth (m)	ACCP (m s^{-1})	Ratio ACCP/GPS
236	5.589	1.0436
272	5.501	1.0273
313	5.468	1.0211
360	5.491	1.0254
413	5.733	1.0706
474	5.545	1.0355
543	5.401	1.0086

The mean ACCP/GPS ratio over 236 - 543 m was 1.0332, a scale factor of 1/1.0332 or 0.96787.

* Note that in Spring 1996, we may well be operating the ACCP in conjunction with a Simard EK500 system operating at 38, 120 and 200 kHz. It will be essentail to synchronise transmissions to avoid mutual interference.

This scaling factor was applied to the ACCP data, maintaining a misalignment angle of 0°, and a north - east pair of tracks (part of the same survey) were used to calculate the misalignment angle, following the procedure in Pollard and Read (1989?). If we let V_{de}, V_{dn} be the differences in east and north ship velocity over the ground from GPS across a 90° turn, and A_e and A_n the differences in ship relative to water measurements from the ACCP then:

$$\phi = \mathrm{Atan}\,(V_{de} * A_n - V_{dn} A_e) / (V_{dn} * A_n + V_{de} * A_e)$$

and as a check on the previous computation of A:

$$A = V_{dn} * A_n + V_{de} * A_e / (\cos\phi\,(A_e^2 + A_n^2))$$

Using mean values for A_e and A_n over the 7 depth cells noted above, and 10 or 15 minute averages (1320Z & 1325Z for the north run, 1340Z, 1345Z 1350Z for the east run), ϕ was found to be -2.88°, and A was 1.000015, confirming that 0.96787 obtained from the north-south run was a good approximation for A.

'SNEW' Calibration

A few days later, it was possible to attempt a more controlled calibration using a set of four tracks in each of the cardinal direction (S-N-E-W). These tracks were run on 3 March (Day 62) between 02:15 and 04:45Z, using the fine resolution mode. The ship's heading was held as constant as possible for half an hour in each direction. The southwestward current produced a significant drift during these runs.

The use of half-hour tracks enabled longer averages of ACCP data to be used in the calibration, and so the uncertainty in the result was reduced. A similar method to that used above in the initial calibration was used here. The ship's average velocity over ground was computed from the Trimble GPS-4000 data. Average heading was computed from the Ashtech GPS data. Some of the heading data were bad, but these values were excluded from the average. Results are given in the following table:

Table 3 Times, speeds and headings for the SNEW calibration run

Leg	Start Time	Stop Time	Ave. V_e	Ave. V_n	Ave. Hdg
S	02:18:12	02:47:58	-0.6132	-3.2047	176.3
N	02:56:02	03:25:58	-0.9332	2.0342	355.1
E	03:31:00	04:00:57	1.9770	-0.3143	085.9
W	04:08:03	04:37:56	-3.2358	-0.7404	265.1

Means and standard deviations of ACCP-measured velocities, in the coordinate system of the ACCP, were computed for each depth bin during each of the four legs. Data from bins with only a small number of valid points, or with a particularly large standard deviation, were discarded. In practice this meant that only data from bins 10 to 17 were used (236 - 622). Some of these were also discarded because there were too few valid data points.

The orientation and scaling factor of the ACCP reference frame may be estimated from a pair of measurements on legs with different headings, in order to eliminate the unknown water velocity (as above). This was done using two separate pairs of runs:

S-N and E-W. A general algorithm was written using Matlab to enable the calculation to be done for data measured on legs of arbitrary heading.

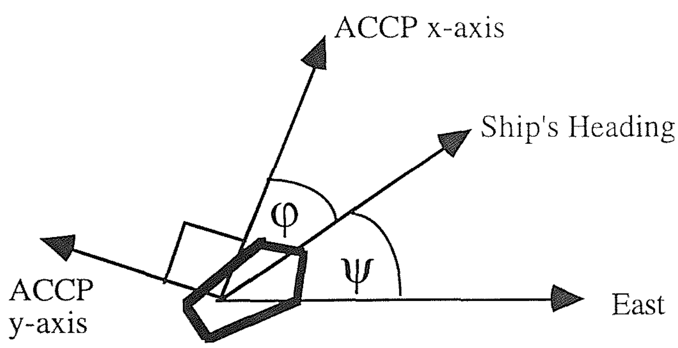


Figure 1   Axes orientation for the SNEW calibration

Assume that the ACCP correctly measures the flow relative to the ship, in its own coordinate system ($\boldsymbol{C}'$). On each leg, and for each depth bin, the true velocity of the water ($\boldsymbol{U}$) is equal to its true velocity relative to the ship ($\boldsymbol{C}$) plus the velocity of the ship($\boldsymbol{V}$). For two legs 1 and 2 therefore we may write two equations, and subtract to eliminate the unknown water velocity:

$$\boldsymbol{U} = \boldsymbol{V}_1 + \boldsymbol{C}_1$$

$$\boldsymbol{U} = \boldsymbol{V}_2 + \boldsymbol{C}_2$$

$$\Rightarrow \boldsymbol{C}_1 - \boldsymbol{C}_2 = \boldsymbol{V}_2 - \boldsymbol{V}_1$$

Referring to Figure 1, let the orientation of the ship's heading, clockwise from east, be φ. Let the orientation of the ACCP x-axis, clockwise from the ship's heading, be ψ. Assume also that there is a scaling factor A by which the ACCP-measured flow ($\boldsymbol{C}'$) must be multiplied to give the true flow. Then the flow in true coordinates ($\boldsymbol{C}'$) is related to $\boldsymbol{C}'$ by:

$$\boldsymbol{C} = A\boldsymbol{M}_\varphi \boldsymbol{M}_\psi \boldsymbol{C}'$$

Where $\boldsymbol{M}_\varphi$ is a matrix of rotation though angle φ:

$$\boldsymbol{M}_\varphi = \begin{pmatrix} \cos\varphi & -\sin\varphi \\ \sin\varphi & \cos\varphi \end{pmatrix}$$

Then

$$A\boldsymbol{M}_\varphi [\boldsymbol{M}_{\psi 1}\boldsymbol{C}_1' - \boldsymbol{M}_{\psi 2}\boldsymbol{C}_2'] = \boldsymbol{V}_2 - \boldsymbol{V}_1$$

where φ_1 and φ_2 are the headings on legs 1 and 2. Everything in this equation is known except for A and φ, which may therefore be determined from the magnitude and direction of the vector equation.

This was done for each pair of legs and for each depth bin, with the results given in Table 4:

Table 4 Amplitude scaling factors and misalignment angles at each depth for the SNEW calibration run

Depth (m)	A_{SN}	A_{EW}	φ_{SN}	φ_{EW}
46.935	4.367	31.081	82.715	146.634
60.258	2.897	10.502	100.178	59.728
75.411	3.695	13.582	90.172	274.791
91.637	2.236	18.411	98.128	38.412
109.368	1.665	13.692	100.100	150.931
129.01	1.200	11.923	97.301	99.885
151.357	1.118	4.357	93.859	104.604
176.022	1.090	1.616	93.775	100.410
204.182	1.055	1.123	93.432	97.707
236.23	* 1.057	1.028	* 92.838	95.409
272.167	* 1.070	1.054	* 93.031	98.768
313.166	* 1.063	1.042	* 93.310	95.354
360.008	* 1.065	1.049	* 93.705	95.645
413.475	* 1.047	* 1.018	* 93.565	* 95.064
474.345	* 1.072	* 1.012	* 93.137	* 95.525
543.792	1.066	* 1.016	92.835	* 96.504
622.985	* 1.050	* 1.015	* 93.428	* 96.729
713.484	1.094	1.005	92.598	96.607
816.85	1.107	0.997	94.792	97.195
935.034	1.235	0.999	103.494	97.416
1070.375	2.931	2.059	118.589	104.939
1225.213	5.564	4.573	-85.585	275.840
1402.281	5.257	2.725	-79.287	48.803

As explained above, only the results tagged with a '*' were considered reliable enough to include in the overall calibration estimate. The large values of A in the upper and lower depth bins reflect the trend in the data to exhibit a mean of zero towards the extremes of the range. The mean and standard deviation of the tagged values are:

$$A = 1.04 \pm 0.02$$

$$\varphi = 94.3° \pm 1.4°$$

The value of φ agrees to within 1.4° of the previously estimated value, enabling us to conclude that the y-axis of the ACCP was pointing about 4 degrees to starboard of astern. The value of A does not agree: it suggests that the ACCP was under-reading by about 4%, whereas the previous estimate suggested that it was over-reading by about 3%. This discrepancy remains to be resolved. It is important since a 7% uncertainty in the size of measured currents is unacceptable.

4. Comparison with other instruments

On this short cruise, beginning from scratch with the processing, we were only able to make limited comparisons between the ACCP and other means of measuring currents. A full comparison of underway ACCP and ADCP data will take some time to emerge. On board, comparisons on station between the ACCP, the lowered broadband 150 kHz ADCP on the CTD frame and the VM 150 kHz ADCP were made on all the stations where the lowered ADCP was used - see Annex B. The degree of agreement between the current measurements varied between stations, but here we show one example, gathered on the third CTD station, Figure 2.

The east and north components for the three instruments are shown separately. The LADCP profile is the average of the up- and the down- casts, the instrument being set up to record 16 m bins, with a ping every 2 s. At a typical lowering speed of 1 m s^{-1}, the standard error of the mean for the LADCP is estimated to be 0.14 cm s^{-1} ($\sigma / \sqrt{n}$), and is not shown on the figure. For the VM ADCP, the profile is an average of all the profiles obtained on the station. At 100 pings per 2 minute ensemble, and depth bins of 8 m, the estimated standard error of the mean for the VM ADCP is also 0.14 cm s^{-1}, and is not shown. For the VM ADCP and the LADCP we feel that the predominant sources of error were bias and navigation. The ACCP profile shown is the average of all valid velocities over the period of the station, and the standard error of the mean for the ACCP, calculated from the ensemble averages making up the profile, varied from 3.5 cm s^{-1} to 1.07 cm s^{-1}. The higher values occurring below 800 m and above 200 m.

Most of the differences between the average profiles from the three instruments were due to internal waves. The lower vertical resolution of the ACCP tends to average out short vertical wavelength features ($\lambda < \sim 300$ m), however, the non-uniform spacing of the ACCP depth cells does improve its near surface resolution. Curiously, on this station, the problem of bias on the velocities above 200 m is not obvious, however, the noise levels (standard error of the mean) are higher. Few points in either the east or north profiles are far from one standard error of the mean from either the LADCP or the VM ADCP profiles. The largest differences are below 1000 m, where there were fewer data points (9 out of 16 possible at 1038 m). The difference of ~ 8 cm s^{-1} on the north profile at ca. 400 m is statistically significant; given the bin response weighting it may be due to a strong signal return from the lower part of the bin (and indeed the upper part of the next lower bin) due to a biological scattering layer.

Figure 2(a)

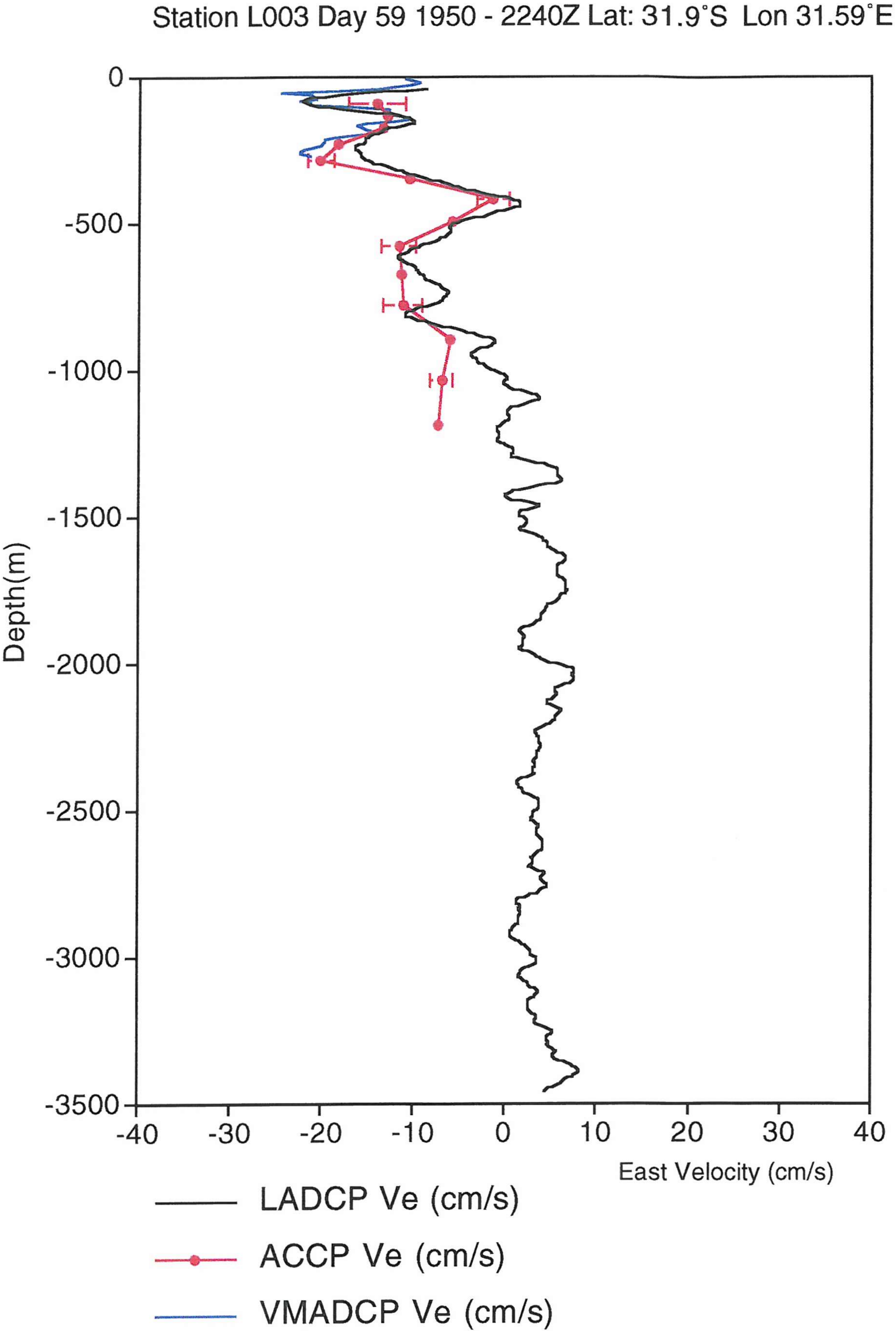
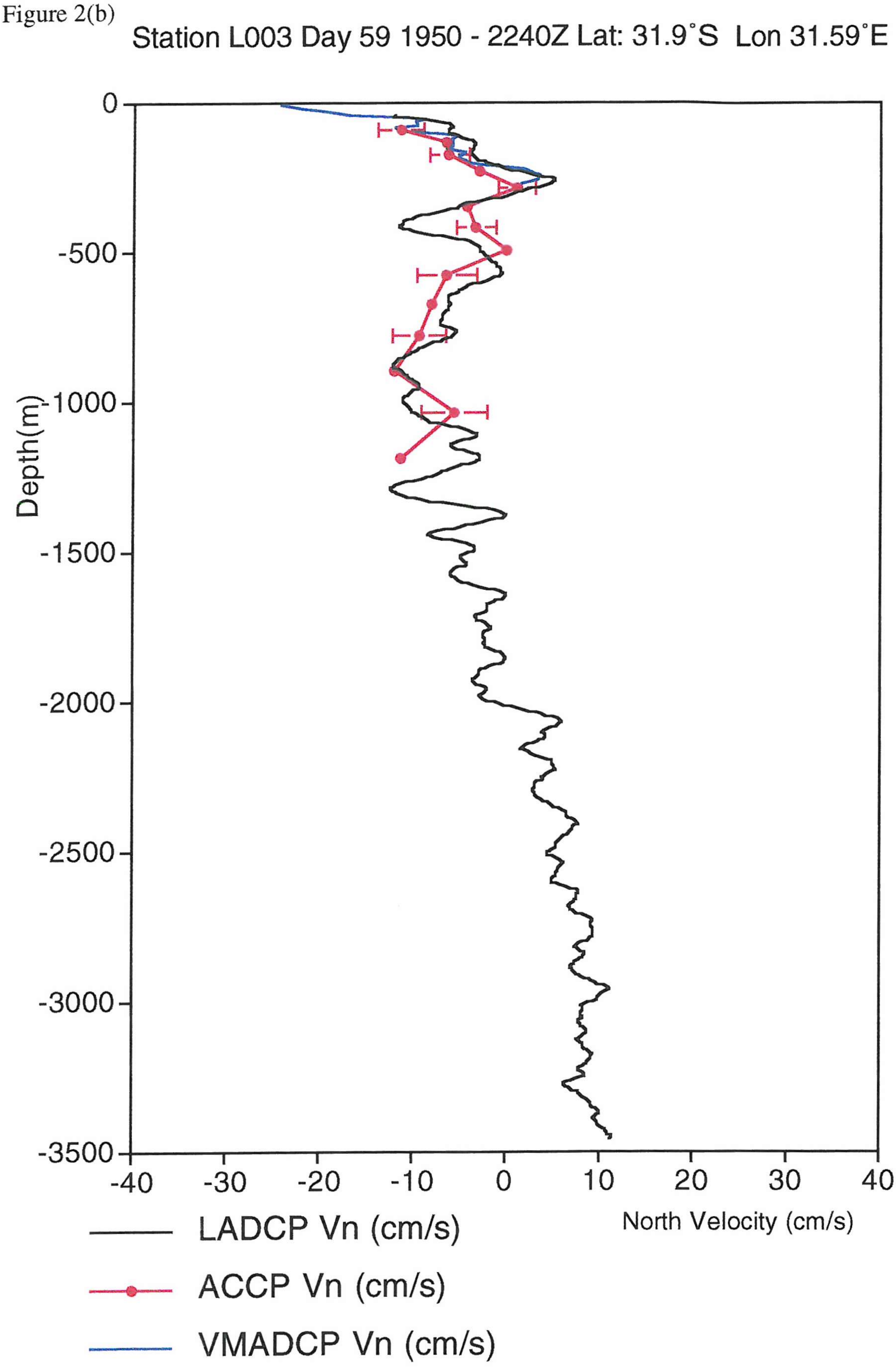

Station L003 Day 59 1950 - 2240Z Lat: 31.9˚S Lon 31.59˚E
0
-500
-1000
-1500
-2000
-2500
-3000
-3500
Depth(m)
-40
-30
-20
-10
0
10
20
30
40
East Velocity (cm/s)
LADCP Ve (cm/s)
ACCP Ve (cm/s)
VMADCP Ve (cm/s)

Figure 2(b)


Station L003 Day 59 1950 - 2240Z Lat: 31.9˚S Lon 31.59˚E
0
-500
-1000
-1500
-2000
-2500
-3000
-3500
Depth(m)
-40
-30
-20
-10
0
10
20
30
40
North Velocity (cm/s)
LADCP Vn (cm/s)
ACCP Vn (cm/s)
VMADCP Vn (cm/s)

5. Recommendations, Conclusions and Further Work

Recommendations to RDI have been made in this text, as marked with ☞. They are repeated here as a summary:

- ❑ We look to improvements in computer technology to reduce the time taken for ML processing. Another possible approach that RDI could take is to seed the ML computation with the results of the previous ping or bin. (P. Spain, personal communication).
- ❑ A revised velocity display, perhaps based on a reference layer, would be an improvement.
- ❑ The biggest improvement would be automated variation of τ_C to suit ship speed, with accompanying header information in the data file.
- ❑ It is also possible for the user not to log data to the disk, a reminder on the acquisition display to indicate that data are not being logged would be valuable.
- ❑ RDI should consider connection to Ethernet and direct data transfer from within their program, but as this may add to the processing load, it may be better to keep to the off-line data transfer.
- ❑ RDI need to provide either a hardware gyro interface, or an interface that can take serial gyro data from the shipboard computer system.
- ❑ RDI need to investigate the problem of poor data in the upper 2-300 m on this cruise.
- ❑ RDI should advise if we need to install sound absorbing material around the transducer.
- ❑ RDI to provide an external sync input to the ACCP to enable synchronisation with the EA500.*
- ❑ RDI need to document the quality control criteria, and to revisit in light of experience gained on this cruise.

Additional points to consider are:

- ❑ There is an apparent difference in the Vx and Vy noise levels which needs investigating. Is the difference due to the properties of the spatial correlation function, or due to pitch in one axis and roll in the other?
- ❑ Many of the time series of single ping data, especially from the upper 200 m show a non-Gaussian distribution of outliers.
- ❑ Might the poor data in the upper 200 m be due to prolonged receiver saturation? Being able to move the origin of the 'oscilloscope' display on the PC may help to test such theories.

---

* Note that in Spring 1996, we may well be operating the ACCP in conjunction with a Simard EK500 system operating at 38, 120 and 200 kHz. It will be essentail to synchronise transmissions to avoid mutual interference.

- ❑ How can SNR0 be converted to mean volume backscattering strength (Sv)? Are the system constants available, and are the temperature sensitivities of critical components known?
- ❑ A short technical training course would be useful prior to installation of our own system on *Discovery*.

We plan to discuss these items with RDI so that the ACCP delivered to us (in late summer 1995) will match our requirements more closely than the prototype tested on this cruise. In turn, the data gathered on this cruise will (we feel sure!) lead to a better instrument.

The technology of current measurement continues to evolve, though sometimes slowly. Since the 1991 paper by Bradley on the ACCP, many research groups use lowered ADCPs on CTD frames to gather current profile information to full ocean depth. It is an attractive technique, and on our first attempt, we have probably convinced ourselves that the technique should become standard on IOSDL CTD cruises. However, the LADCP provides measurements on station only. Although the ACCP cannot profile to full ocean depth, its ability to measure currents underway, conservatively to 1000 m, will still be unique for some years yet. The ACCP has shown it can work, it will undoubtedly add to our science by increasing the depth horizon for underway hydrography.

5.1 Further Work

All the work reported here took place on the cruise, further data analysis will be required ashore for a full appreciation of the data.

5.1.1. Standard Deviations of Data

Our preliminary analysis has shown several areas where the noise behaviour of the instrument differed from previous trials. The data set should be merged with Ashtech 3DF information to study the effects of pitch and roll and with the meteorological data to study the effects of different angles of attack relative to wind and waves. Any ageing effects should be studied.

5.1.2. 2468 Calibration

This data set gathered at 2, 4, 6, and 8 kt should show the variation of penetration depth with speed, the noise level of valid data against speed, and in conjunction with the ADCP current data, it can act as a check on the calibration - see Annex B.

5.1.3. Zigzag calibration

A zig zag calibration, done primarily for the ADCP - see Annex B, can be used as a check on the ACCP calibration especially as the difference noted in section 4 needs to be resolved.

5.1.4 Velocity sections underway

The *raison d'etre* of the ACCP is to make velocity measurements underway. The underway data need to be cleaned up (an editing program for pstar gridded files was written on the cruise by Mark Brandon), merged with (D)GPS, and rotated into cross track and along track components (track direction of 130°T), and plotted as distance from the ACE origin. They then need to be compared to the geostrophic velocity section and the LADCP section.

5.1.4. Mean Volume Backscattering Strength (MVBS)

We have an interest in using the 22 kHz ACCP to measure acoustic backscatter, to complement the data we already gather at 150 kHz from the ADCP. We will examine the ADDCP SNR0 data gathered on this cruise, and we will seek to calibrate to obtain MVBS (Sv).

6. Acknowledgements

Many people contributed to the successful installation and trial of the ACCP. In particular we would like to thank Tony Poole of RVS for co-ordinating the design and construction of the transducer chest on *Discovery*, Nick Crisp and Mike Griffiths for ensuring we could acquire data from the instrument, Rob Bonner, Keith Goy and Dave White for installing the cable on cruise 213, and especially George Low of RDI (UK) for efficiently attending to a number of minor crises along the way. We thank Mike Griffiths, Robin Tokmakian, Sheldon Bacon, Nick Crisp and Lisa Beal for the comparison data from the L- and VM- ADCPs, and Mark Brandon for writing a gridded file editing program. Finally, the support and encouragement of the Principal Scientist, Harry Bryden, was greatly appreciated.

7. References

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8 Annexes

Annex A - ACCP cell information for settings used on cruise 214

1. Boomer - bin depths (mid interval), lengths in m, and modulation code chips

Boomer	Mid-depth	bin length (m)	Code start	Code length
Cell 1	105.9	105.4	4736	1024
Cell 2	184.9	122.4	5760	1600
Cell 3	276.8	131.8	7360	1792
Cell 4	375.6	142.6	9152	2048
Cell 5	482.6	153.9	11200	2192
Cell 6	598.1	168.2	13392	2432
Cell 7	724.2	184.9	15824	2672
Cell 8	862.8	204.8	18496	2960
Cell 9	1016.4	228.1	21456	3296
Cell 10	1187.5	255.4	24752	3680
Cell 11	1379	287	28432	4144
Cell 12	1594.2	323.6	32576	4672

2. Coarse - bin depths (mid interval), lengths in m, and modulation code chips

Coarse	Mid-depth	bin length (m)	Code start	Code length
Cell 1	82.155	60.873	2688	800
Cell 2	127.763	64.93	3488	848
Cell 3	176.475	70.742	4336	1024
Cell 4	229.564	75.782	5360	1072
Cell 5	286.694	82.998	6432	1216
Cell 6	348.918	90.612	7648	1296
Cell 7	417.144	100.654	8944	1472
Cell 8	493.013	111.81	10416	1616
Cell 9	577.346	125.32	12032	1824
Cell 10	671.733	140.642	13856	2032
Cell 11	777.755	158.738	15888	2304
Cell 12	897.766	179.569	18192	2608
Cell 13	1033.334	203.362	20800	2944
Cell 14	1186.808	230.831	23744	3344
Cell 15	1361.313	262.442	27088	3808
Cell 16	1559.583	298.424	30896	4320

3. **Medium - bin depths (mid interval), lengths in m, and modulation code chips**

Medium	Mid-depth	bin length (m)	Code start	Code length
Cell 1	59.157	31.925	1664	400
Cell 2	83.103	35.055	2064	512
Cell 3	109.159	37.16	2576	512
Cell 4	136.795	40.692	3088	592
Cell 5	167.359	44.455	3680	640
Cell 6	200.519	49.009	4320	704
Cell 7	237.102	54.445	5024	784
Cell 8	277.915	60.866	5808	880
Cell 9	323.362	68.139	6688	976
Cell 10	374.234	76.74	7664	1104
Cell 11	431.71	86.649	8768	1248
Cell 12	496.574	97.981	10016	1408
Cell 13	569.609	110.848	11424	1584
Cell 14	652.379	125.85	13008	1808
Cell 15	746.838	143.097	14816	2064
Cell 16	853.765	162.34	16880	2320
Cell 17	975.113	184.794	19200	2656
Cell 18	1113.223	210.084	21856	3008
Cell 19	1270.045	239.061	24864	3424
Cell 20	1448.702	272.205	28288	3904

4. **Fine - bin depths (mid interval), lengths in m, and modulation code chips**

Fine	Mid-depth	bin length (m)	Code start	Code length
Cell 1	46.935	17.58	1152	224
Cell 2	60.258	19.691	1376	304
Cell 3	75.411	21.162	1680	304
Cell 4	91.637	23.508	1984	352
Cell 5	109.368	25.801	2336	368
Cell 6	129.01	29.039	2704	432
Cell 7	151.357	32.568	3136	480
Cell 8	176.022	36.53	3616	528
Cell 9	204.182	41.648	4144	624
Cell 10	236.23	47.036	4768	688
Cell 11	272.167	53.452	5456	784
Cell 12	313.166	60.876	6240	896
Cell 13	360.008	69.426	7136	1024
Cell 14	413.475	79.219	8160	1168
Cell 15	474.345	90.374	9328	1328
Cell 16	543.792	103.257	10656	1520
Cell 17	622.985	117.859	12176	1728
Cell 18	713.484	134.795	13904	1984
Cell 19	816.85	153.93	15888	2256
Cell 20	935.034	176.128	18144	2592
Cell 21	1070.375	201.376	20736	2960
Cell 22	1225.213	230.41	23696	3392
Cell 23	1402.281	263.464	27088	3872

Annex B. Filenames of Pstar format ACCP data, with times and notable events

Jday	Filename root	Times	Events
58	accp214m58901	0050-0140; 0250-0600; 0640-0800; 1240-1550	Run from the shelf to the end of the mooring line at 5 kt.
58	accp214c58901	0150-0230; 0830-1210; 2100-0000; 0000-0320*	"
58	accp214b5801	0440-0500	
59	accp214c58902	0000-0320	LADCP stn 002
59	accp214f59901	0330-0500; 1320-1820	
59	accp214m59901	0730-0750	
59	accp214c59901	?	
59	accp214f59902	1950-2240	LADCP stn 003
59	accp214f5993	1320-1550	Box survey calibration
60	accp214c60901	0010-0220;1700-0000	
60	accp214c60902	0026-0140	LADCP stn 004
60	accp214f60901	0930-1340	
60	accp214c6101	0000-0620	
61	accp214b6101	0510-0530	
61	accp214f61901	0620-1050	
61	accp214f61902	1100-0000	
61	accp214f61903	1920-2200	LADCP stn 005
62	accp214f62901	0000-0820; 1520-1930; 2340-0000	0215-0445 SNEW calibration run 1530-1805 2, 4, 6, 8, 10 kt calibration run, 30 min at each speed
62	accp214f62902	2330**-0210	LADCP stn 006
62	accp214b6201	2220-2330	
63	accp214b6301	1020-1940	
63	accp214f63901	0000-0210; 0310-0810; 1610-2310	
63	accp214f63902	2340**-0210	LADCP stn 007
63	accp214f63903	0440-0730	LADCP stn 008
63	accp214f63904	2020-2250	LADCP stn 009
64	accp214f64901	0310-0440; 0740-0920; 1030-1320; 1350-1550; 1650-0000	
64	accp214f64903	1140-1320	LADCP stn 011
65	accp214f65901	0000-0730; 0940-2400	zig zag calib 1300-1530
65	accp214f65902	0240-0520	LADCP stn 014
65	accp214f65903	0940-1230	LADCP stn 015

* next day

** previous day

C. Pstar data processing - flow charts and listings

Processing

This phase took the data from the PC and processed the data into 'pstar' format and corrected time before navigation information was added. The data were transfered from the PC system to Unix systems on diskette or Erasible Optical disk for large files. The Erasible Optical was a Panasonic LF - 7300B 1 GB per side device. These devices are not common and if there is a choice NERC Computing Services would recommend using HP or Sony Erasible Optical devices (1.3 GB capacity).

Data handling would be simplified if the PCs were networked. Serial transfer would be too slow. RVS currently use Ethernet with 10Base2 connections with PC-NFS to mount UNIX filesystems as PC drives. There were problems getting PC-NFS and the Optical Driver to work together - perhaps a clash of BIOS interupt settings. A workaround was to boot the machine with one driver or the other.

Because of the bulk only the summary files were transfered to Unix hard disk. Typically there was about 5 MB of '*.sum' files per day. The processing on the PC and UNIX was in large batches which meant a delay of about 36 hours before seeing fully processed data.

Another problem early in the cruise was unreliable hardware. One RVS machine (discovery3) and a hard disk failed. Fortunately Bruce Dupée saved the cruise from disaster by carrying bringing out a SUN from the U.K.

The '*.sum' files were processed in two ways. Firstly each 'sum' files was processed using **accpexec0** and **accpexec1** with an individual clock correction file because the drift between the ship's atomic clock and the PC DOS clock seemed excessive. The actual drift turned out to be less as the data were stamped by the CMOS hardware clock in the PC which drifted 1-2 seconds a day. A single clock correction per day was used from day 60 onwards.

It was also found that a concatenation of several files was easier to handle so initially the 'corr' files were concatenated using the script **accpexec1a** to produce '*90?.corr' files and from day 60 the '*.sum' files were concatenated and processed to produce a '*90?.corr' in one run of **accpexec0a** without producing '.corr' files for each '.sum' file.

The data and programs to process the data were run in the directory:

/nerc/packages/pstar/data/accp

The first step was to validate the data. Some of this was incoporated in the

script **accpexec0a** but a summary of other validation scripts used include:

accpexec0check checks line and 'word' counts matches the number of bins in the ASCII files and that there are 15 fields per record.

accpexec0mono the times should be in sequence. This script detects data errors and batches that span midnight in ASCII data.

accpexec0tim* Lists summary details of ASCII data.

A time field of seconds from year (century) start would be easier to manage. There were gaps and evidence of characters arriving (at the Unix end) in the wrong sequence. In addition Matlab proved to be a useful tool in being able to view large data sets in a short time.

The RVS Unix machines need more memory to get the best from applications like Matlab (currently 24MB).

Archiving

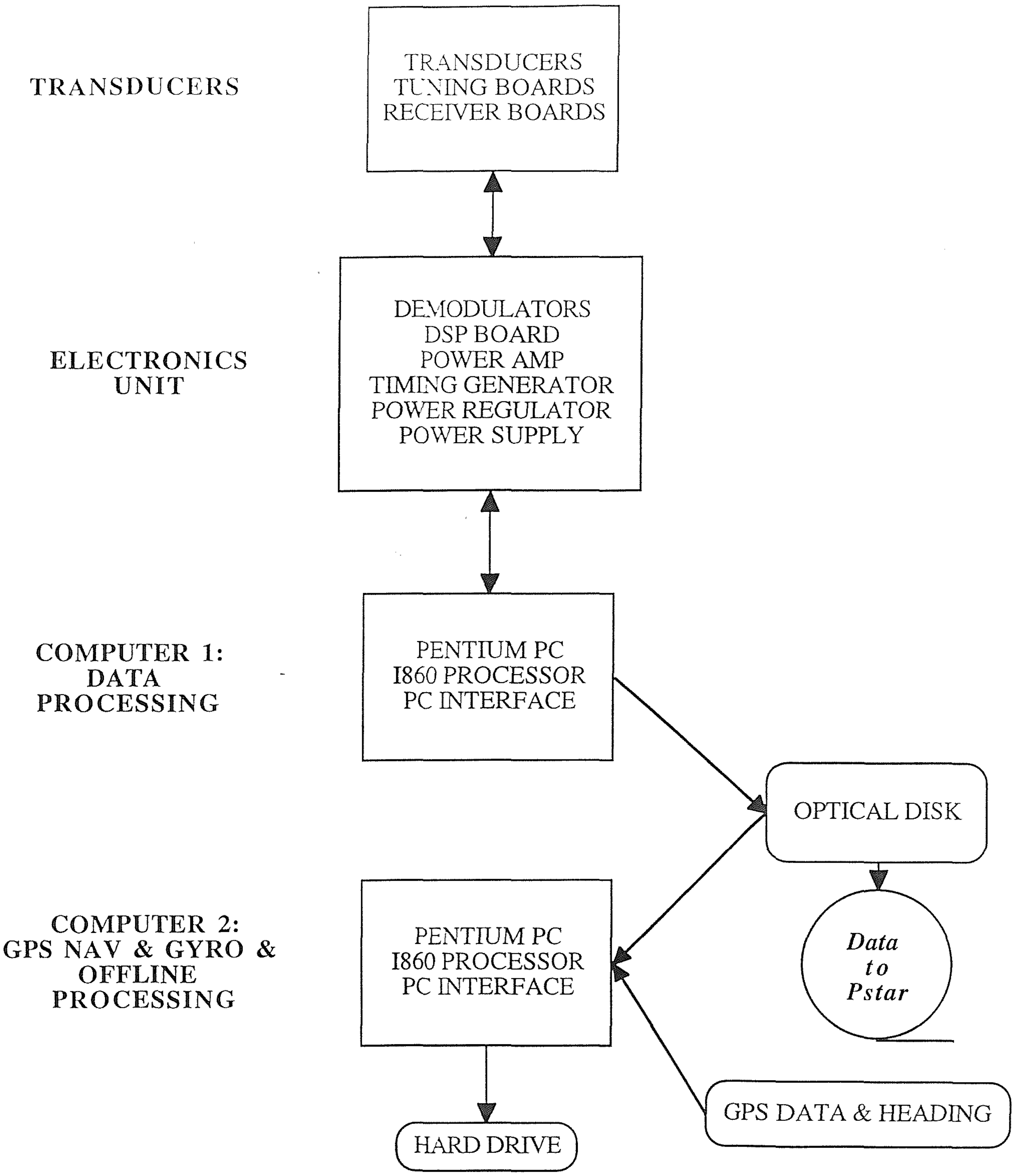
pstar data with a user name: Use arch_cp to archive

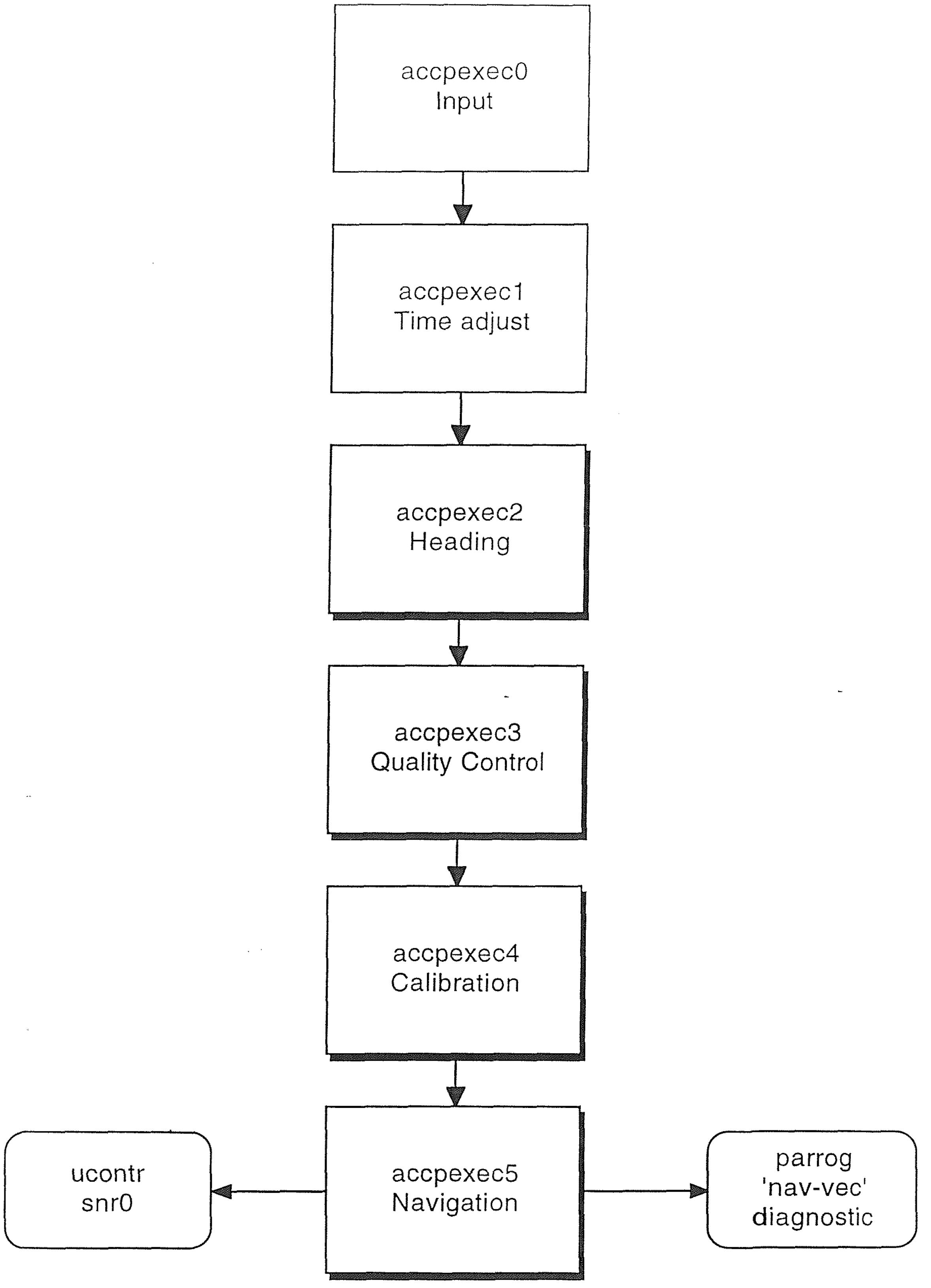
pstar data without dataname: cp to ~pexec/archive/ACCP_NO_DATANAME

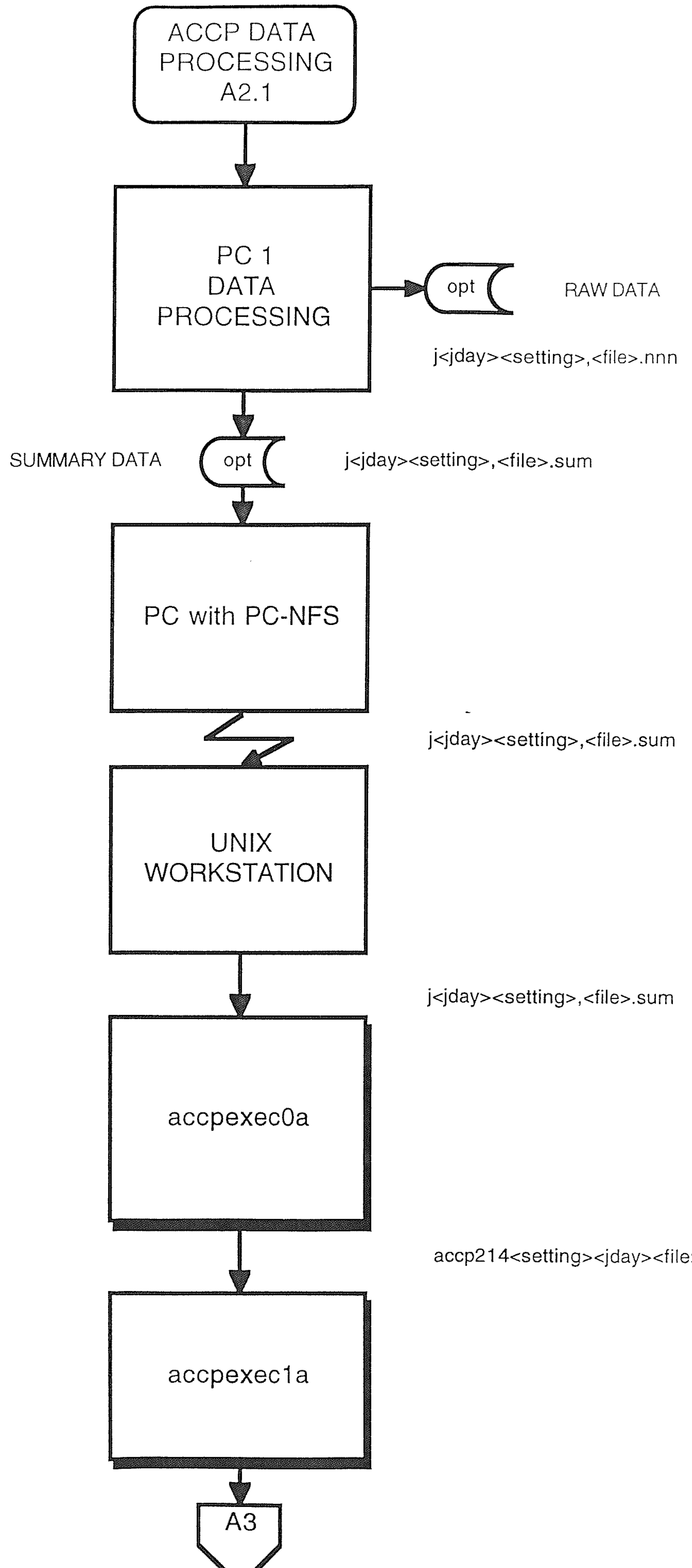
asciidata (non pstar): cp to ~pexec/archive/NON_PSTAR

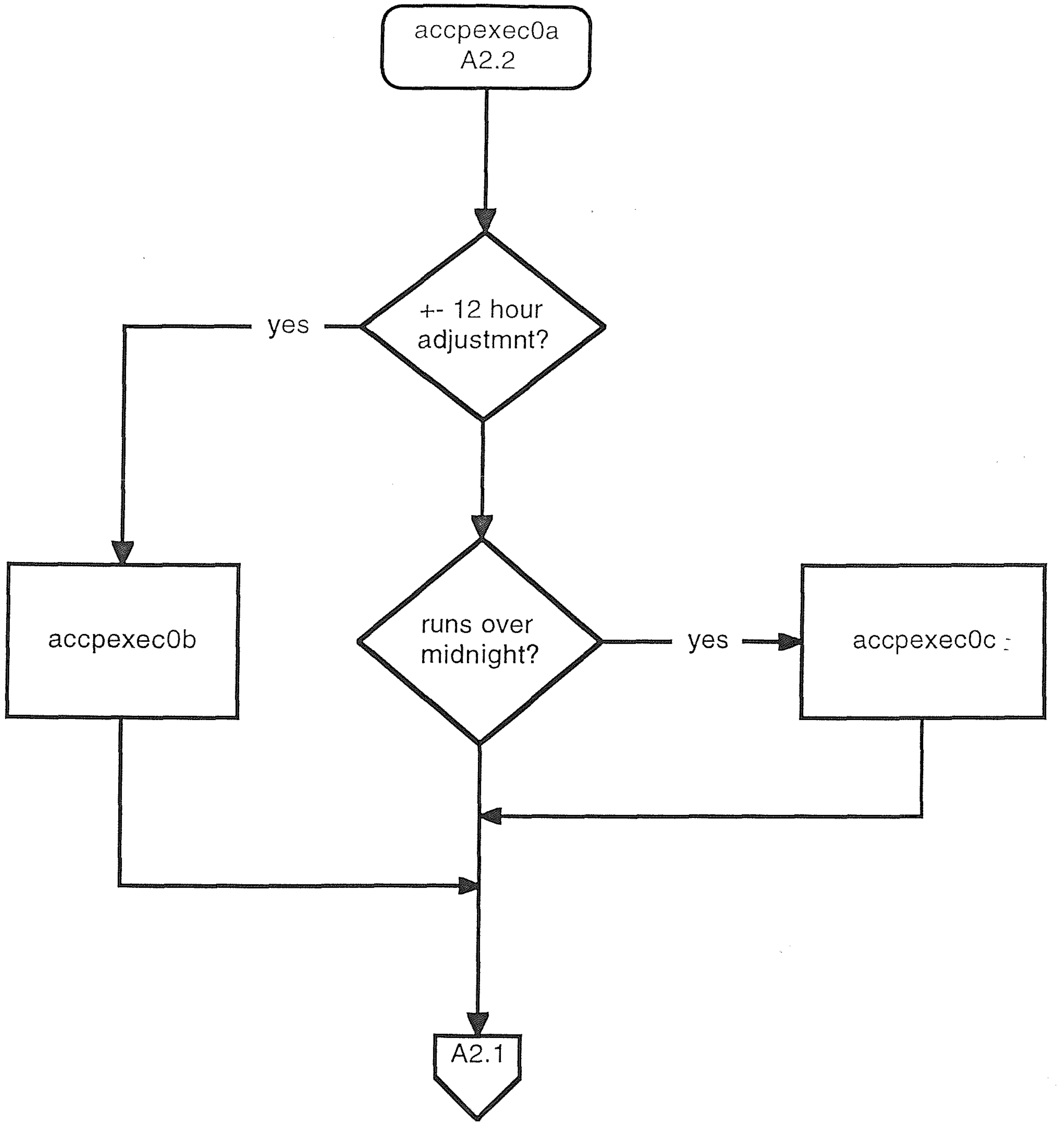
This to be done after the data is to be unchanged.

Back at base the data will appear on the James Rennell Centre Epoch system as: /data/d214/raw/accp


TRANSDUCERS
TRANSDUCERS
TUNING BOARDS
RECEIVER BOARDS
ELECTRONICS UNIT
DEMODULATORS
DSP BOARD
POWER AMP
TIMING GENERATOR
POWER REGULATOR
POWER SUPPLY
COMPUTER 1: DATA PROCESSING
PENTIUM PC
I860 PROCESSOR
PC INTERFACE
OPTICAL DISK
Data to Pstar
COMPUTER 2: GPS NAV & GYRO & OFFLINE PROCESSING
PENTIUM PC
I860 PROCESSOR
PC INTERFACE
GPS DATA & HEADING
HARD DRIVE


accpexec0
Input
accpexec1
Time adjust
accpexec2
Heading
accpexec3
Quality Control
accpexec4
Calibration
ucontr
snr0
accpexec5
Navigation
parrog
'nav-vec'
diagnostic


ACCP DATA PROCESSING A2.1
PC 1 DATA PROCESSING
opt
RAW DATA
j<jday><setting>,<file>.nnn
SUMMARY DATA
opt
j<jday><setting>,<file>.sum
PC with PC-NFS
j<jday><setting>,<file>.sum
UNIX WORKSTATION
j<jday><setting>,<file>.sum
accpexec0a
accp214<setting><jday><file>
accpexec1a
A3


accpexec0a
A2.2
+- 12 hour
adjustmnt?
yes
accpexec0b
runs over
midnight?
yes
accpexec0c
A2.1

```
###########################################################
# accpexec0
#
# Description:
# exec to read in data from accp SUMMARY file which has been transfered
# from the accp pc data logger.
#
# Processing steps:
# STEP_01 read in the data using pascin converting to pstar format
#
# STEP_02 calibrate time using pcalib (from Hour / 24 + Julian Day (in file
#        name) )
#
# History:
# Version Date     Author Description
# 00      27/02/95 BWD    orginal version
#
# NEXT    ??/??/?? ???    Please make a note of your changes here -
#                         using as many lines as necessary.
#                         If the changes are substantial perhaps
#                         a new exec might be better?
#
###########################################################################################

########## Initialisation ##################################
# Check directories
# This exec looks at P_ACCP for a directory to run from and...
  if ($?P_ACCP) then
    echo " "
    echo " Changing directory to P_ACCP: $P_ACCP"
    cd $P_ACCP
  endif

# set up variables and files

  /bin/rm -f accptmp
  /bin/rm -f accpexec0.talk
  touch accpexec0.talk
########## Get information from the user ###################
  echo "> Starting accpexec0 - should have params: setting jday filenum"
  set setting = $1
  set jday = $2
  set filenum = $3
  echo $setting$jday$filenum
# fine=23,med=20,course=16,boomer=12
  switch ($setting)
  case "f"
    set nrows=23
  breaksw
  case "m"
    set nrows=20
  breaksw
  case "c"
    set nrows=16
  breaksw
  case "b"
    set nrows=12
  breaksw
  default:
     echo "Resolution setting not one of fine=23,med=20,course=16,boomer=12"
     exit
  endsw
```

```
  set filename="accp$CRUISE$setting$jday$filenum"
  set dataname="ac$setting$jday$filenum"
  if ( -e $filename ) then
    echo "> The file $filename already exists.  If you mean"
    echo "> to overwrite it, you must remove it first."
    exit
  endif
#
  if ! ( -e j$jday$setting$filenum.sum ) then
    echo "> The file j$jday$setting$filenum.sum does not exist."
    exit
  endif
#
########## Main processing steps ##########################
# STEP_01
# read in SAMPLE file from PC LOGGER and create pstar file
#
  echo "accpexec0 - running pascin step"
  cat << ! | pascin >> accpexec0.talk
$filename
-1
1
$dataname
8
15 99999999
$nrows 0
-1
0
Ping
units
Hour
Hour-gmt
Vx
m/s
Vy
m/s
Vz
m/s
SNR0
dB
SNRT
dB
Aztilt
radians
Nadtilt
radians
Spacial
cm
Wing
units
Cost
units
Ncbeg
units
Nlag
units
Valid
0or1
y
j$jday$setting$filenum.sum
*
!
  if ($status != 0) then
```

```
    echo "> *** problem running pascin - see accpexec0.talk ***"
    exit
   endif
#
# STEP_02
# Calibrate SAMPLE file to make time = jday + hour / 24
#
   echo "accpexec0 - running pcalib step"
   cat << ! | pcalib >> accpexec0.talk
$filename
y
2,$jday,0.0416666666666,0
/
!
# make copy of raw file for archive
#
#  mv accptmp accp$CRUISE$num
#  arch_cp accp$CRUISE$num

########## Keep directories tidy ###########################
# tidy up
  /bin/rm -f accpexec0.talk
  echo " "
  echo "> file created: $filename"
  endif

########## The End ###########################################

  the_end:
  echo "> End of accpexec0"
  exit
```

accpexec0a

```
#!/bin/csh
if ( "$1" == "" ) then
  echo -n "> Enter accp file name (eg: j59m01.sum): "
  set filename = $<
else
  set filename=$1
endif
echo "accpexec0a - Using: $filename"
set jday=`echo $filename | sed 's/[a-z]/ /g' | awk '{print $1}'`
set setting=`echo $filename | sed 's/[0-9]/ /g' | awk '{print $2}'`
set filenum=`echo $filename | sed 's/[a-z]/ /g' | awk '{print $2}' | sed 's/\.//'`
echo Deciphered: $setting $jday $filenum
wc -w $filename | awk '{print $1}' > $0.$$
  switch ($setting)
  case "f"
    set nrows=23
    awk '{print $1/345}' $0.$$
  breaksw
  case "m"
    set nrows=20
    awk '{print $1/300}' $0.$$
  breaksw
  case "c"
    set nrows=16
    awk '{print $1/240}' $0.$$
  breaksw
  case "b"
    set nrows=12
    awk '{print $1/180}' $0.$$
  breaksw
  default:
     echo "Resolution setting not one of fine=23,med=20,course=16,boomer=12"
     exit
  endsw
echo "NUMBERS ABOVE MUST BE INTEGER"
/bin/rm $0.$$

#j60c06 and j61c01 joined and then split at 0000 GMT by hand
foreach i (j58c04.sum)
  if ( $filename == $i ) then
    echo "file $i needs preprocessing with accpexec0c"
    accpexec0c $i
  endif
end
foreach i (j58b01 j58c01 j58m01 j58m02 j58m03)
  if ( $filename == $i.sum ) then
    echo "file $i.sum needs preprocessing with accpexec0b"
    accpexec0b $i.sum
    accpexec0 $setting $jday $filenum
    rm $i.sum
    accpexec1 $setting $jday $filenum
    exit
  endif
end
accpexec0 $setting $jday $filenum
accpexec1 $setting $jday $filenum
```

accpexec0b

```
#!/bin/csh
awk '{print $1 " " $2-12 " " $3 " " $4 " " $5 " " $6 " " $7 " " $8 " " $9 " " $10 " " $11 " " $12 " " $13 " "
$14 " " $15}' $1.badtime > $1
```

accpexec0c

```
#!/bin/sh
awk '
BEGIN{t=0}
{ if ( $2 < t ) s=$2+24; else s=$2;
{ t=s; print $1 " " s " " $3 " " $4 " " $5 " " $6 " " $7 " " $8 \
          " " $9 " " $10 " " $11 " " $12 " " $13 " " $14 " " $15}
}
' $1 > .$1
/bin/mv .$1 $1
```

```
###########################################################################################
#
# accpexec1
#
# Description:
#         exec to create a time correction file
#         it assumes the user has kept track of the drift in time of the
#         accp pc clock with respect to the RVS clock used in logging
#         navigation
#
# Processing steps:
# STEP_01  create pstar file with time information in it (ypstar)
#          create time in seconds (parith and pcalib)
# STEP_02
# STEP_03
# STEP_04
#
# History:
# Version Date    Author     Description
# 00              BWD        original but copied from adpexec1
#
# NEXT   ??/??/?? ???        Please make a note of your changes here -
#                            using as many lines as necessary.
#                            If the changes are substantial perhaps
#                            a new exec might be better?
#
###########################################################################################

# Check directories
# This exec looks at P_ACCP for a directory to run from and...
  if ($?P_ACCP) then
    echo " "
    echo " Changing directory to P_ACCP: $P_ACCP"
    cd $P_ACCP
  endif

########## Initialisation ####################################

# set up variables and files
  /bin/rm -f accpexec1.talk
  /bin/rm -f accptmp1
  /bin/rm -f clocktmp*
  touch accpexec1.talk

############################################################

########## Get information from the user ##################
  echo "> Starting accpexec1 - should have params: setting jday filenum"
  set setting = $1
  set jday = $2
  set filenum = $3
# fine=23,med=20,course=16,boomer=12
  switch ($setting)
  case "f"
    set nrows=23
  breaksw
  case "m"
    set nrows=20
  breaksw
  case "c"
    set nrows=16
  breaksw
  case "b"
```

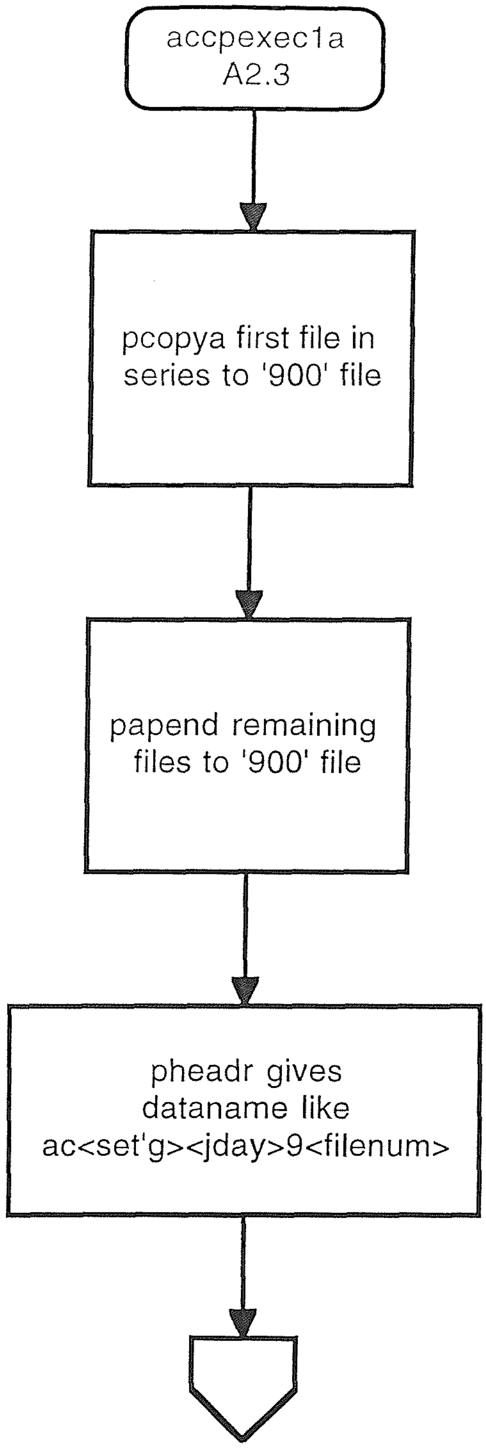
```
    set nrows=12
   breaksw
   default:
     echo "Resolution setting not one of fine=23,med=20,course=16,boomer=12"
     exit
   endsw
   set ident="$setting$jday$filenum"
   set filename="accp$CRUISE$ident"
   echo "Using: $filename"
   if ! ( -e $filename ) then
    echo "> file $filename does not exists."
    exit
   endif

   /bin/rm -f $filename.corr

   set ans = "c"
   if (-e "clock"$jday) then
    echo -n "> file clock$jday already exists, continue (y/n)? "
    set ans = "y"
#    set ans = $<
#    if ($ans != "y") exit
  endif

  if($ans == "c") then
# ask user for times
  /bin/rm -f .list
  echo "clocktmp"      > .list
  echo "1"            >> .list
  echo "clock"$jday >> .list
  echo "2"            >> .list
  echo "accpclock"    >> .list
  echo "ship"         >> .list
  echo $SHIPNAME       >> .list
  echo cr$CRUISE      >> .list
  echo "/"            >> .list
  echo "3"            >> .list
  echo "19" $YEAR "0"  >> .list
  echo "8"            >> .list
  echo "3 86400/"     >> .list
  echo "0/"           >> .list
  echo "-1"           >> .list
  echo "1"            >> .list
  echo "jday"         >> .list
  echo "of year"      >> .list
  echo "2"            >> .list
  echo "secs"         >> .list
  echo "secs"         >> .list
  echo "3"            >> .list
  echo "dtime"        >> .list
  echo "secs"         >> .list
  echo "-1"           >> .list
  echo "/"            >> .list
  set n = 0
  set day = 99999
  while ($day >  0)
   echo -n "> enter day hhmmss dtime (space separated, -ve day to end): "
   set lin1 = $<
   set day = `echo $lin1 | awk '{print $1}'`
   if ($day < 0) break
   set h   = `echo $lin1 | awk '{print substr($2,1,2)}'`
   set m   = `echo $lin1 | awk '{print substr($2,3,2)}'`
   set s   = `echo $lin1 | awk '{print substr($2,5,2)}'`
```

```
    set dt  = `echo $lin1 | awk '{print $3}'`
    @ sec = ($h * 3600) + ($m * 60) + $s
    @ n = $n + 1
    echo $day $sec $dt >> .list
  end
  echo "-9999/" >> .list
  echo " "

##################################################################


########## Main processing steps ############################

##################################################################
# STEP_01
#
# create pstar file with time information in it

  echo "> accpexec1 - running ypstar"
  ypstar < .list >> accpexec1.talk
  if ($status != 0) then
   echo "> *** Problem running ypstar - see accpexec1.talk ***"
   exit
  endif
  print_datnam clocktmp new

#-------------------------------------------------------
# convert days to seconds

  echo "> accpexec1 - running pcalib"
  print_datnam clocktmp old
  cat << ! | sed 's/^  //' | pcalib >> accpexec1.talk
  clocktmp
  /
  jday,-86400,86400,0/
  /
!
  if ($status != 0) then
   echo "> *** Problem running pcalib - see accpexec1.talk ***"
   exit
  endif
  print_datnam clocktmp new
#-------------------------------------------------------
# add days in seconds to secs variable

  echo "> accpexec1 - running parith"
  print_datnam clocktmp old
  cat << ! | sed 's/^  //' | parith >> accpexec1.talk
  clocktmp
  clocktmp2
  dtime/
  add jday secs/
  0/
  time
  secs
!
  if ($status != 0) then
   echo "> *** Problem running parith - see accpexec1.talk ***"
   exit
  endif
  print_datnam clocktmp2 new
#
# swap round dtime and time
```

```
#
  echo "> accpexec1 - running pcopya"
  print_datnam clocktmp2 old
  cat << ! | sed 's/^  //' | pcopya >> accpexec1.talk
  clocktmp2
  n
  clock$jday
  2,1/
  /
  /
!
  if ($status != 0) then
   echo "> *** Problem running pcopya - see accpexec1.talk ***"
   exit
  endif
  print_datnam clock$jday old
  endif

#----------------------------------------------------
# STEP_02
#
# convert time to seconds
#
  print_datnam $filename old
  echo "> accpexec1 - running ptime"
  cat << ! | sed 's/^  //' | ptime >> accpexec1.talk
  $filename
  y
  2
  3
  1
  0000
  000000
  000000
  time
  secs
!
  if ($status != 0) then
   echo "> *** Problem running ptime - see accpexec1.talk ***"
   exit
  endif
##################################################################
# STEP_03
#
# now put time field first so merge works

  echo "> accpexec1 - running pcopya"
  print_datnam $filename old
  cat << ! | sed 's/^  //' | pcopya >> accpexec1.talk
  $filename
  n
  accptmp1
  2,1,3,4,5,6,7,8,9,10,11,12,13,14,15/
  /
  /
!
  if ($status != 0) then
   echo "> *** Problem running pcopya - see accpexec1.talk ***"
   exit
  endif

##################################################################
# STEP_04
```

```
#
# edit start time to 1995 - there  will be a better way of
# doing this!

  echo "> accpexec1 - running pheadr"
  print_datnam accptmp1 old
  cat << ! | sed 's/^   //' | pheadr >> accpexec1.talk
  accptmp1
  y
  3
  19,950101,000000
-1
-1
y
!
  if ($status != 0) then
    echo "> *** Problem running pheadr - see accpexec1.talk ***"
    exit
  endif
  print_datnam accptmp1 new
#
#################################################################
# STEP_05
#
# now merge time file with the file from accpexec0 (gridded)

  echo "> running pmerge"
  print_datnam accptmp1 old
  cat << ! | sed 's/^   //' | pmerge >> accpexec1.talk
  accptmp1
  $filename.corr
  /
  clock$jday
  time,dtime/
!
  if ($status != 0) then
    echo "> *** Problem running pmerge - see accpexec1.talk ***"
    exit
  endif
  print_datnam $filename.corr new
#
#################################################################
# make copies for archiving

# arch_cp clock$jday
# arch_cp $filename.corr
# arch_cp $filename.corr

########## Keep directories tidy ###########################

  /bin/rm -f clocktmp
  /bin/rm -f accptmp1
  /bin/rm -f accptmp2
  /bin/rm -f accpexec1.talk

  echo "> files created: clock$jday"
  echo ">              $filename"
  echo ">              $filename.corr"
  echo
  echo "> End of accpexec1"


########## The End ##########################################
```

```
the_end:
exit
```

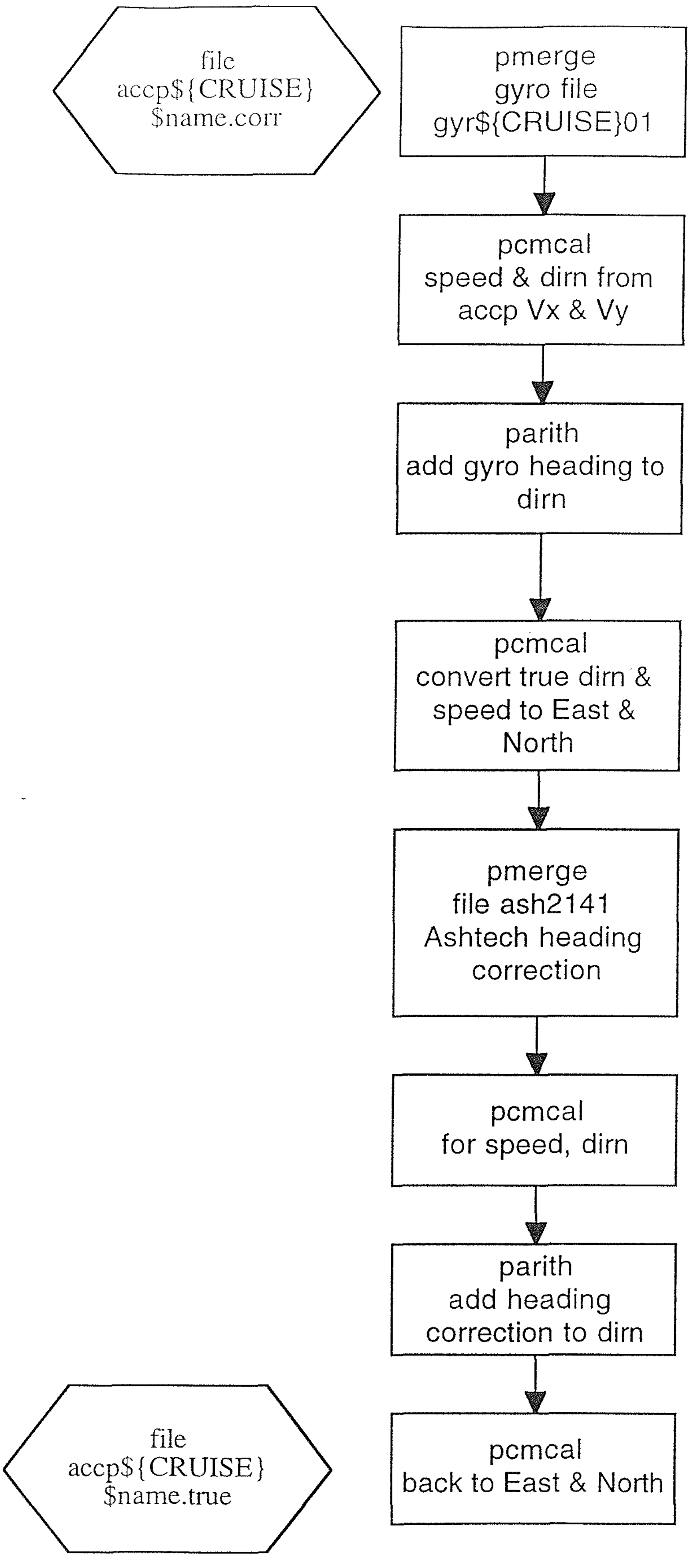

accpexec1a
A2.3
pcopya first file in series to '900' file
papend remaining files to '900' file
pheadr gives dataname like ac<set'g><jday>9<filenum>

accpexec1a

```
#!/bin/csh
##########################################################################################
#
# accpexec1a
#
# Description:
#         exec to append pstar files together like papend should do
#         call like accpexec1a fileout filein1 filein2 ...
#
# Processing steps:
# STEP_01  pcopya
# STEP_02  papend
# STEP_03
# STEP_04
#
# History:
# Version Date    Author      Description
# 00              BWD         original but copied from adpexec1
#
# NEXT   ??/??/?? ???        Please make a note of your changes here -
#                           using as many lines as necessary.
#                           If the changes are substantial perhaps
#                           a new exec might be better?
#
##########################################################################################

# Check directories
# This exec looks at P_ACCP for a directory to run from and...
  if ($?P_ACCP) then
   echo " "
   echo " Changing directory to P_ACCP: $P_ACCP"
   cd $P_ACCP
  endif

########## Initialisation ###################################

# set up variables and files

set fileout=$1
set filein=$2
echo "> Example call: accpexec1a accp214f59901.corr accp214f590*.corr"
echo "> Enter pstar dataname in form:"
echo -n "> ac<setting><jday>9<filenum> - eg: acf59901: "
set dataname = $<
touch /tmp/accp.$$
touch accpexec1a.talk
shift
shift
while($1 != "")
 echo $1 >> /tmp/accp.$$
 shift
end
echo "none" >> /tmp/accp.$$
echo "Appending:"
echo "$filein"
cat /tmp/accp.$$
echo "To: $fileout"

############################################################

############################################################
```

```
########## Main processing steps ##########################

##################################################################
# STEP_01
#
# copy to first file from first file on list (params 2 onwards)

  echo "> accpexec1a - running parith"
  print_datnam $filein old
  cat << ! | sed 's/^  //' | pcopya >> accpexec1a.talk
  $filein
  n
  $fileout
  /
  /
  /
!
  if ($status != 0) then
    echo "> *** Problem running pcopya - see accpexec1a.talk ***"
    exit
  endif
  print_datnam $fileout new
#
##################################################################
# STEP_02
#
# now append the rest

  echo "> running Papend"
  print_datnam $1 old
  cat << ! | sed 's/^  //' | papend >> accpexec1a.talk
  $fileout
  y
  y
  /tmp/accp.$$
!
  if ($status != 0) then
    echo "> *** Problem running pmerge - see accpexec1a.talk ***"
    exit
  endif
  print_datnam $2 new
#
##################################################################
# STEP_03
#
# now update the header with a 900 series dataname

  echo "> running pheadr"
  print_datnam $fileout old
  cat << ! | sed 's/^  //' | papend >> accpexec1a.talk
  $fileout
  1
  $dataname
  -1
  -1
  y
!
  if ($status != 0) then
    echo "> *** Problem running pheadr - see accpexec1a.talk ***"
    exit
  endif
  print_datnam $2 new
```

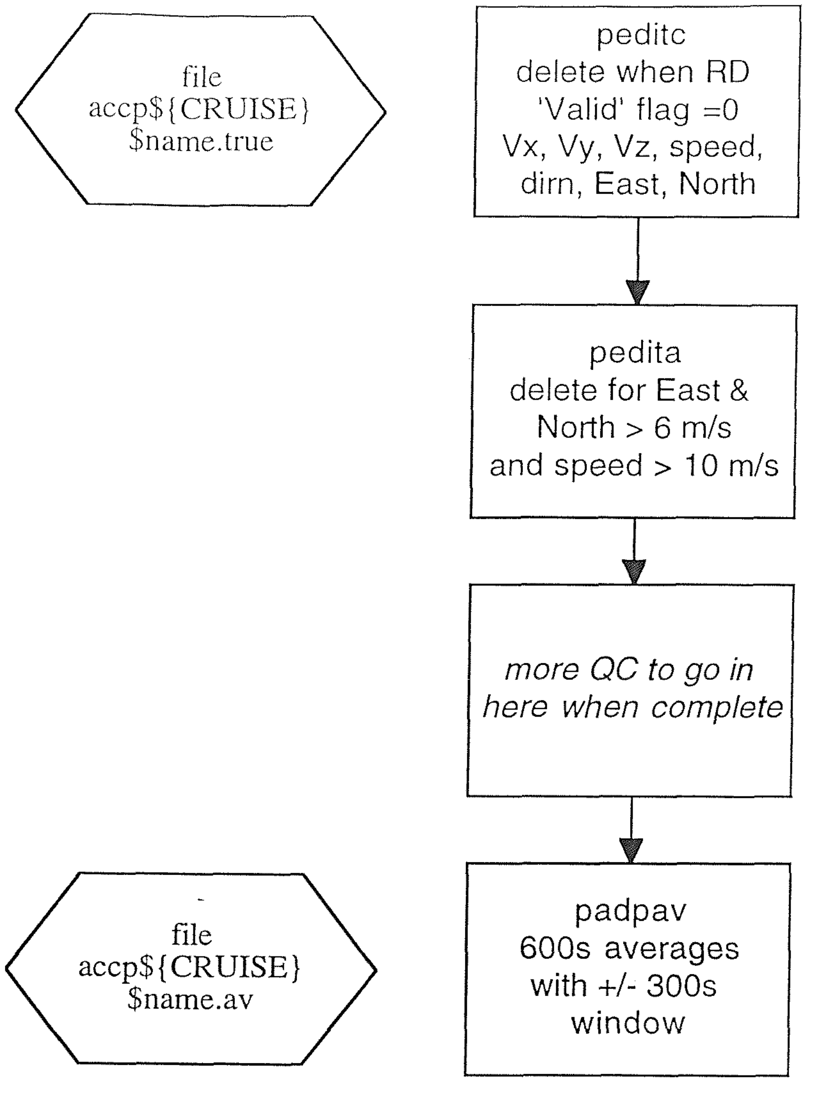
```
#
#######################################################################

########## Keep directories tidy ############################
  /bin/rm /tmp/accp.$$
  /bin/rm accpexec1a.talk

  echo "> Files created::"
  echo "> $fileout"
  echo
  echo "> End of accpexec1a"


########## The End ###########################################
  the_end:
  exit
```


file
accp${CRUISE}
$name.corr
pmerge
gyro file
gyr${CRUISE}01
pcmcal
speed & dirn from
accp Vx & Vy
parith
add gyro heading to
dirn
pcmcal
convert true dirn &
speed to East &
North
pmerge
file ash2141
Ashtech heading
correction
pcmcal
for speed, dirn
parith
add heading
correction to dirn
pcmcal
back to East & North
file
accp${CRUISE}
$name.true

```
#####################################################################################
#
# accpexec2
#
# Description:
#           exec to merge accp data with  gyro & ashtech data, from
#           gyroexec0 and master gyro file
#
# History:
# Version Date    Author Description
# 00    28/02/95 GXG   D214 version.
#                                         Test version with prototype accp.
# NEXT   ??/??/?? ???   Please make a note of your changes here -
#                 using as many lines as necessary.
#                 If the changes are substantial perhaps
#                 a new exec might be better?
#
#####################################################################################
#

 if ($?P_ACCP) then
  echo " "
  echo " Changing directory to P_ACCP: $P_ACCP"
  cd $P_ACCP
 endif
 /bin/rm -f accpexec2.talk
 touch accpexec2.talk
#
################################################################

########## Get information from the user ##################

  echo "> This exec will require the following information:"
  echo ">    accp file number"
  echo -n "> Continue (y/n)? "
  set ans = $<
  if ($ans != "y") exit
#
echo " "
 echo -n "> enter accp file number: "
 set num = $<
################################################################

########## Main processing steps ###########################


################################################################
#
# merge with gyro data from the master file
#
echo ">running pmerge with gyro:"
#
#
pmerge << ! >> accpexec2.talk
accp$CRUISE$num.corr
temp1
/
../gyro/gyr${CRUISE}01
time,heading/
!
 if ($status != 0) then
  echo "> problem running pmerge"
  exit
```

```
  endif
 #
 #
 # calculate speed and direction from accp  Vx and Vy
  echo "> running pcmcal"
 pcmcal << ! >> accpexec2.talk
 temp1
 temp2
 1
 3,4
 !
  if ($status != 0) then
   echo "> problem running pcmcal - see accpexec2.talk"
   exit
  endif
 print_datnam temp2
 #

 # now add the gyro heading to the accp current direction
 #
 echo "> running parith"
 #
 parith << ! >> accpexec2.talk
 temp2
 temp1
 /
 1,19,17
 /
 true
 degrees
 !
  if ($status != 0) then
   echo "> problem running parith - see accpexec2.talk"
   exit
   endif
print_datnam temp1 new
#
#
# convert speed and corrected direction back to east and north
 echo "> running pcmcal"
pcmcal << ! >> accpexec2.talk
temp1
accp$CRUISE$num.true
2
18,20
!
 if ( $status != 0 ) then
  echo "> problem running pcmcal - see accpexec2.talk"
  exit
  endif
print_datnam accp$CRUISE$num.true
#
#
#
# merge accp and ashtech files
 echo "> running pmerge with ashtech"
pmerge << ! >> accpexec2.talk
accp$CRUISE$num.true
temp1
/
$P_ASH/ash2141
time,a-ghdg/
!
```

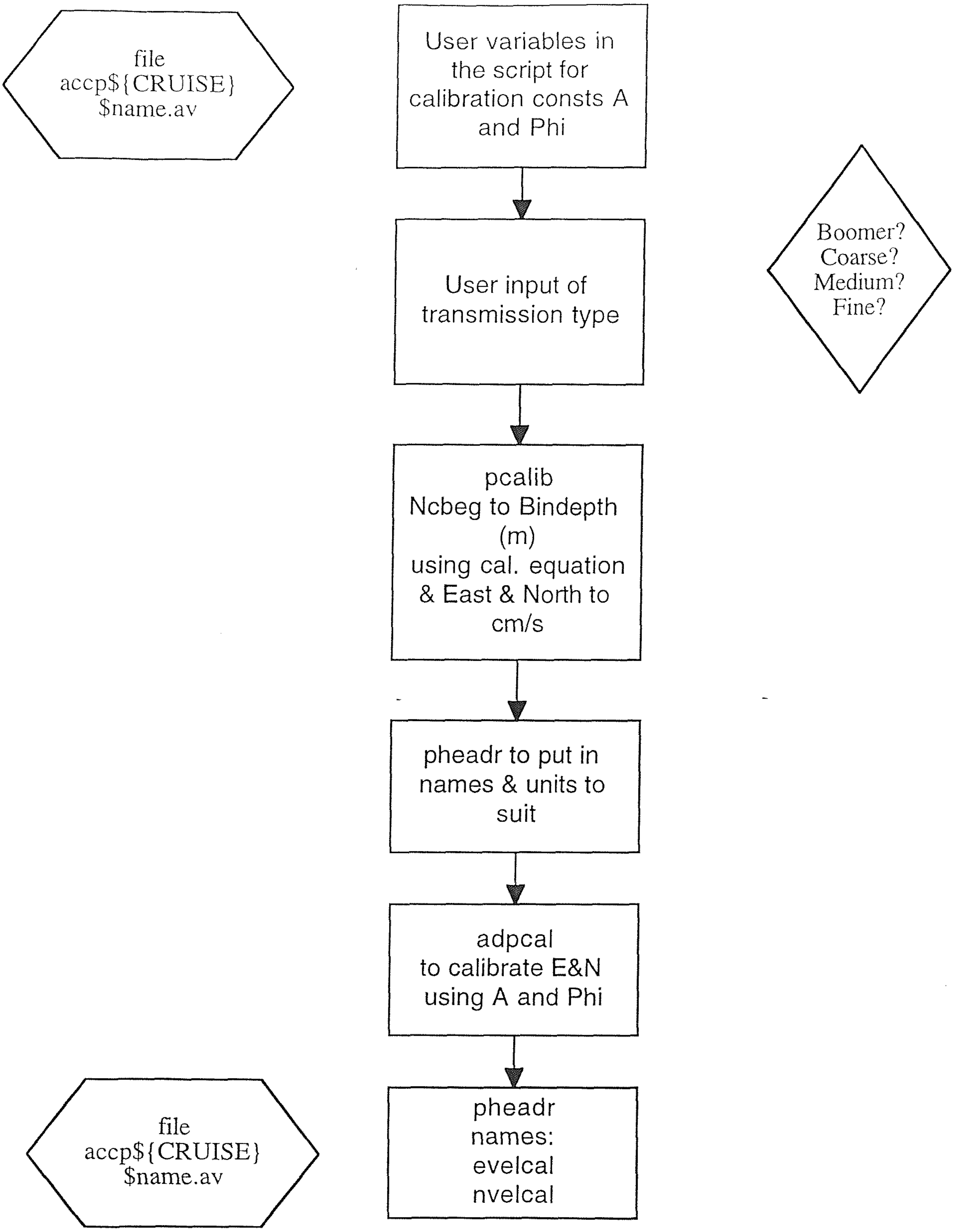
```
 if ($status != 0) then
  echo "> problem running pmerge - see accpexec2.talk"
  exit
 endif
print_datnam temp1 new
#
# calculate speed and direction from accp east and north
 echo "> running pcmcal"
pcmcal << ! >> accpexec2.talk
temp1
temp2
1
21,22
!
 if ($status != 0) then
  echo "> problem running pcmcal - see accpexec2.talk"
  exit
 endif
print_datnam temp2 new
#
#
# add a-ghdg to adcp direction
#
echo "Now running parith"
parith << ! >> accpexec2.talk
temp2
temp
/
1,25,23
/
adirn
degrees
!
 if ($status != 0) then
  echo "> problem running parith - see accpexec2.talk"
  exit
  endif
print_datnam temp new
#
# convert speed and corrected direction back to east and north
 echo "> running pcmcal"
pcmcal << ! >> accpexec2.talk
temp
accp$CRUISE$num.true
2
24,26
!
 if ( $status != 0 ) then
  echo "> problem running pcmcal - see accpexec2.talk"
  exit
  endif
print_datnam accp$CRUISE$num.true
#
# tidy up
/bin/rm -f accpexec2.talk
/bin/rm -f temp
/bin/rm -f temp1
/bin/rm -f temp2

echo " "
echo "> end of accpexec2"
exit
```


file
accp${CRUISE}
$name.true
peditc
delete when RD
'Valid' flag =0
Vx, Vy, Vz, speed,
dirn, East, North
pedita
delete for East &
North > 6 m/s
and speed > 10 m/s
more QC to go in
here when complete
file
accp${CRUISE}
$name.av
padpav
600s averages
with +/- 300s
window

```
#££££££££££££££££££££££££££££££££££££££££££££££££££££££££££££
# accpcxec3
#
#
# Description:
#           exec to  perform QC checks on accp data, (a) using the 'Valid'
#           flag for, the instrument, (b) using an acceptance range of +/-
#                  6 m/s for ship velocity and
# YET TO BE IMPLEMENTED,
#                  a std dev computation.
#
# History:
# Version Date    Author Description
# 00     28/02/95 GXG   D214 version.
#                    Test version with prototype accp.
# NEXT   ??/??/?? ???   Please make a note of your changes here -
#                  using as many lines as necessary.
#                  If the changes are substantial perhaps
#                  a new exec might be better?

#
# set up files
  /bin/rm -f accpexec3.talk
  touch accpexec3.talk
# check directory


############################################################

########## Get information from the user ###################

  echo "> This exec will require the following information:"
  echo ">    accp file number"
  echo -n "> Continue (y/n)? "
  set ans = $<
  if ($ans != "y") exit

  echo " "
  echo -n "> enter accp file number: "
  set num = $<

############################################################

########## Main processing steps ##########################


############################################################
  echo "> running peditc"
  print_datnam accp$CRUISE$num.true old
  cat << ! | sed 's/^   //' | peditc >> accpexec3.talk
  accp$CRUISE$num.true
  y
  /
  3/
  15,0.5,1.5,0/
  n
  y
  4/
  15,0.5,1.5,0/
  n
  y
  5/
  15,0.5,1.5,0/
```

```
  n
  y
  24/
  15,0.5,1.5,0/
  n
  y
  26/
  15,0.5,1.5,0/
  n
  y
  27/
  15,0.5,1.5,0/
  n
  y
  28/
  15,0.5,1.5,0/
  n
  y
  0/
!
  if ($status != 0) then
   echo "> *** problem running peditc - see accpexec3.talk ***"
   exit
  endif
#
# now run pedita to limit v to +/- 10 ms-1
#
echo "> running pedita"
  print_datnam accp$CRUISE$num.true old
  cat << ! | sed 's/^  //' | pedita >> accpexec3.talk
  accp$CRUISE$num.true
  y
  /
  27,-6,6
  y
  28,-6,6
  y
  24,0,10/
  y
  0/
!
  if ($status != 0) then
   echo "> *** problem running pedita - see accpexec3.talk ***"
   exit
  endif
  print_datnam accp$CRUISE$num.true  new

#
#-----------------------------------------------------
# make 10 minute averages, need to change 600,300 if you want
# different averaging interval.

  echo "> running padpav"
  print_datnam accp$CRUISE$num.true old
  cat << ! | sed 's/^  //' | padpav >> accpexec3.talk
  accp$CRUISE$num.true
  accp$CRUISE$num.av
  1,13,3,4,5,6,7,23,24,27,28/
  0,100000000,600,300
!
  if ($status != 0) then
   echo "> *** problem running padpav - see accpexec3.talk ***"
   exit
```

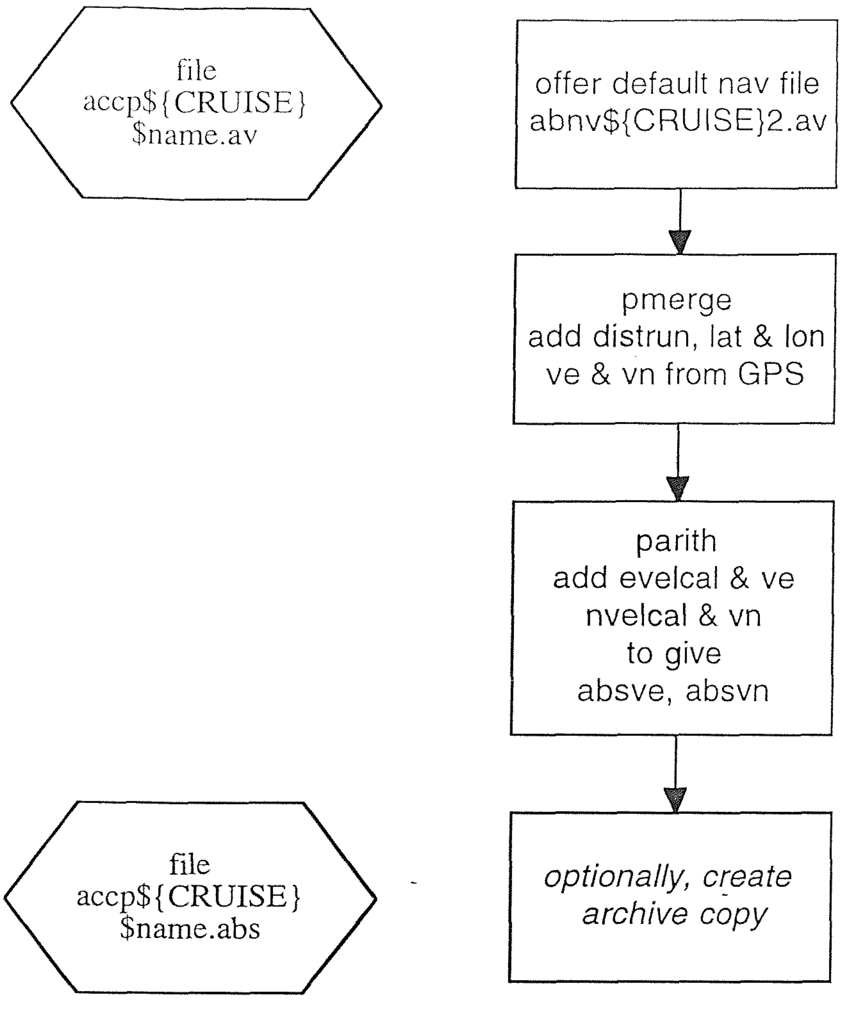
```
  endif
  print_datnam accp$CRUISESnum.av new

#---------------------------------------------------

# tidy up
/bin/rm -f accpexec3.talk


echo " "
echo "> end of accpexec3"

exit
```


file
accp${CRUISE}
$name.av
User variables in the script for calibration consts A and Phi
User input of transmission type
Boomer?
Coarse?
Medium?
Fine?
pcalib
Ncbeg to Bindepth (m)
using cal. equation & East & North to cm/s
pheadr to put in names & units to suit
adpcal
to calibrate E&N using A and Phi
pheadr
names:
evelcal
nvelcal
file
accp${CRUISE}
$name.av

```
#£££££££££££££££££££££££££££££££££££££££££££££££££££££££££££
# accpexec4 -
#          to calibrate the bindepth the exec uses the transmission type code
#     also converts east and north to cm/s and multiplies each by -1
#     to rotate to conventional adcp frame of reference
#     before merging with gps velocity of the ship
#     padpcal applies a calibration to A and phi
#
#    PROVISIONAL Calibration by GXG 2 March 1995
#
# History:
# Version Date     Author Description
# 00      28/02/95 GXG    D214 version.
#                         Test version with prototype accp.
# NEXT    ??/??/?? ???    Please make a note of your changes here -
#                         using as many lines as necessary.
#                         If the changes are substantial perhaps
#                         a new exec might be better?
#
#
# set up files
  /bin/rm -f accpexec4.talk
  touch accpexec4.talk
# check directory

  if ($?P_ACCP) then
    echo "changing directory to P_ACCP: $P_ACCP"
    cd $P_ACCP
  endif

##############################################################

########## Get information from the user ##################

  echo "> This exec will require the following information:"
  echo ">    accp file number, and transmission type"
  echo ">    a backup copy of the file is made with extension .bak"
  echo -n "> Continue (y/n)? "
  set ans = $<
  if ($ans != "y") exit
  /bin/rm -f accpexec4.talk
  touch accpexec4.talk
# These parameters were calculated from a square box
#  survey on D214
#
   set calA = 0.96787
   set calp = -2.88

  echo "> using calibration A=$calA , phi=$calp  Discovery 214"
#
  echo " "
  echo -n "> enter accp file number: "
  set num = $<
# now make backup
  cp accp$CRUISE$num.av accp$CRUISE$num.av.bak

echo -n "Enter transmission type (b(oomer), c(oarse), m(edium), f(ine))?"
set ans = $<
if ($ans == "c") then
  set offset = '-46.5'
 else
  if ($ans == "f") then
    set offset = '-8.2'
```

```
   else
     if ($ans == "m") then
       set offset = '-22.0'
     else
     if ($ans == "b") then
       set offset = '-124'
     else
     echo 'unknown input'
     exit
     endif
    endif
   endif
 endif

 echo "running pcalib on depth, east, north to cm/s and sign reversal"
 pcalib << ! >> accpexec4.talk
 accp$CRUISE$num.av
 y
 2,$offset,5.2176e-2/
 10,0,-100/
 11,0,-100/
 0/
 !
 if ($status != 0) then
 echo "> problem running pcalib - see accpexec4.talk"
 exit
 endif

 echo "running pheadr"
 pheadr << ! >> accpexec4.talk
 accp$CRUISE$num.av
 y
 -1/
 2/
 bindepth
 metres
 10/
 /
 cm/s
 11/
 /
 cm/s
 -1
 y
 !
 if ($status != 0) then
 echo "> problem running pheadr - see accpexec4.talk"
 exit
 endif
 print_datnam accp$CRUISE$num.av new

#---------------------------------------------------

  echo "> running adpcal"
  print_datnam accp$CRUISE$num.av old
  cat << ! | sed 's/^  //' | adpcal >> accpexec4.talk
  accp$CRUISE$num.av
  y
  y
  1
  east,north,$calA,$calp/
!
  if ($status != 0) then
```

```
    echo "> *** problem running adpcal - see accpexec4.talk ***"
    exit
  endif
  print_datnam accp$CRUISE$num.av new

#---------------------------------------------------

  echo "> running pheadr"
  print_datnam accp$CRUISE$num.av old
  cat << ! | sed 's/^  //' | pheadr >> accpexec4.talk
  accp$CRUISE$num.av
  y
  /
  east
  evelcal
  /
  north
  nvelcal
  /
  /
  y
!
  if ($status != 0) then
    echo "> *** problem running pheadr - see accpexec4.talk ***"
    exit
  endif
  print_datnam accp$CRUISE$num.av new

#---------------------------------------------------
# tidy up
/bin/rm -f accpexec3.talk

echo "end of accpexec4"
exit
```


file
accp${CRUISE}
$name.av
offer default nav file
abnv${CRUISE}2.av
pmerge
add distrun, lat & lon
ve & vn from GPS
parith
add evelcal & ve
nvelcal & vn
to give
absve, absvn
file
accp${CRUISE}
$name.abs
optionally, create
archive copy

```
####################################################################################
#
# accpexec5
#
# Description:
#       exec to merge accp data with smoothed navigation as created by
#       navexec0 and 1
#       the navigation file is found automatically using the find
#       command from directory $HOME
#       NB need to check that variable names in navigation file
#         agree with those used here, distrun is sometimes different
#
# Processing steps:
# STEP_01  merge with navigation file
# STEP_02  tidy up
#
# History:
# Version Date     Author Description
# 00               GXG        orginal version
# NEXT    ??/??/?? ???        Please make a note of your changes here -
#                             using as many lines as necessary.
#                             If the changes are substantial perhaps
#                             a new exec might be better?
#
####################################################################################

########## Initialisation ###################################

# check directory

  if ($?P_ACCP) then
    echo "changing directory to P_ACCP: $P_ACCP"
    cd $P_ACCP
  endif
  if ($?P_ARCH) then
    set list = `echo $P_ARCH | tr ':' ' '`
    set arch_dir = $list[1]
    unset list
  else
    set arch_dir = '.'
  endif

# set up variables and files

  /bin/rm -f accptmp
  /bin/rm -f accpexec5.talk
  touch accpexec5.talk

##############################################################

########## Get information from the user ##################

  echo "> This exec will require the following information:"
  echo ">    accp file number (eg 58C01)"
  echo ">    smoothed navigation file number (eg 1)"
  echo -n "> Continue (y/n)? "
  set ans = $<
  if ($ans != "y") exit
   echo " "

  echo -n "> enter accp file number "
  set num = $<
  if ( ! -e accp$CRUISE$num.av ) then
```

```
    echo "Sorry, file accp$CRUISE$num.av does not exist"
    exit
   endif

 # navigation
 #
   set def_navfil = "/nerc/packages/pstar/data/nav/abnv${CRUISE}2.av"
   echo " "
   echo    "> Require a navigation file,"
   echo    "> Enter full pathname (ie start with /): "
   echo    "> return for default ($def_navfil)"
   set navfil = $<
   if ( $navfil == "" ) set navfil = $def_navfil
   if ( ! -e $navfil ) then
    echo "Sorry, file $navfil does not exist"
    exit
   endif


#####################################################################

#####################################################################
# STEP_02
#
# add in distrun, lat and long

  echo "running pmerge"
  print_datnam accp$CRUISE$num.av old
  cat << ! | sed 's/^  //' | pmerge >> accpexec5.talk
  accp$CRUISE$num.av
  temp1
  time,bindepth,Vx,Vy,Vz,SNR0,SNRT,a-ghdg,speed,evelcal,nvelcal/
  $navfil
  time,lat,lon,vn,ve,distrun/
!
  if ($status != 0) then
   echo "> *** problem running pmerge - see accpexec5.talk ***"
   exit
  endif
  print_datnam temp1 new

#-------------------------------------------------------
# calculate abs velocity

  echo "running parith"
  print_datnam temp1 old
  cat << ! | sed 's/^  //' | parith >> accpexec5.talk
  temp1
  accp$CRUISE$num.abs
  /
  add evelcal ve/
  add nvelcal vn/
  0/
  absve
  cm/s
  absvn
  cm/s
!
  if ($status != 0) then
   echo "> *** problem running parith - see accpexec5.talk ***"
   exit
  endif
  print_datnam accp$CRUISE$num.abs new
```

```
####################################################################

# create archive copy    disable for now!!!
# /bin/cp adp$CRUISE$num.abs $arch_dir/adp$CRUISE$num.abs.arch
#   arch_cp adp$CRUISE$num.abs

########## Keep directories tidy ############################
# tidy up
  /bin/rm -f temp1
  /bin/rm -f accpexec5.talk

  echo " "
  echo "> files created: accp$CRUISE$num.abs"
  echo " "
  endif

########## The End ############################################

  the_end:
  echo " "
  echo "> End of accpexec5"
  exit
```

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