I.O.S.

SEASOAR SECTIONS FROM THE ANTARCTIC CIRCUMPOLAR CURRENT AT 52°S, 32°E TO THE SUBTROPICAL FRONT AT 37°S, 52°E

BY

R.T. POLLARD, J.F. READ, J. SMITHERS & M.W. STIRLING

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ABSTRACT

During RRS *Discovery* Cruise 164, four SeaSoar sections were worked in the vicinity of the Crozet Plateau in the Southern Ocean at 45°E. The SeaSoar sections ran for a total length of 2870km, about half running eastwards on the south and north sides of the Plateau, the remainder running northwards across the Plateau and across the Subtropical Front at 39°S, 52°E. The SeaSoar run also crossed the Antarctic Circumpolar Current, and contains evidence for many eddies. Temperature, salinity, density and chlorophyll *a* are presented as contoured plots down to 350dbar, as well as the geostrophic shear relative to 325dbar.

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NARRATIVE

RRS Discovery sailed from Mauritius on Cruise 164 (Pollard et al, 1987) on 19 December 1986. After working a 50 cast CTD section southward to 52°S, 32°45'E (Pollard, Read & Smithers, 1987; hereinafter PRS), the SeaSoar was deployed and towed along the track shown in Fig.1 (details in Table 1). A distance of 2866km was run over 8 days 15 hours with only one break, the second leg being a continuous tow of 5d 23 hours. The SeaSoar was recovered north of the Subtropical Front, and a final CTD section worked back towards Mauritius.

Early in the cruise, the SeaSoar was deployed for a test run on 22/12/86. The data were noisy, and conductivities were bad (because of a faulty component on the conductivity board), so the SeaSoar was retrieved after 7 hours (with difficulty, Pollard et al, 1987), and the data are not reported here.

Deployment for the main run, on 6/1/87, was delayed for seven hours while a hydraulic fitting on the HIAB crane was remade. Once deployed, Discovery ran north for 90km before turning east along 50°42'S, in order to cross the Antarctic Circumpolar Current during the eastward run. The CTD section (PRS) had crossed a meander of the ACC, with the most Antarctic characteristics being observed at 50°40'S, together with southward surface flow from the ship's EM log (Pollard et al, 1987). As anticipated, 1°C water was encountered between longitudes 31°48'E and 32°48'E (contour plots of GR164003), and by 33°30'E the ACC had been crossed to warmer (3°-4°C) Subantarctic water.

During the run east (Section 3, Table 1) the signal was noisy whenever the wire was under strain, suggesting damage to a cable core, but it was opted to continue, as the editing programs were capable of despiking the data. Ship speed had to be restricted to 6.5-7 knots however. Antarctic water (less than 2°C) was grazed at 35°E (GR164004) and temperatures less than 1°E were encountered between 38°E and 42°E (GR164006-7). Sudden loss of signal terminated the eastward run at 42°21'E, and on recovery it was found that the cable was severely twisted at the cowtail to the SeaSoar bridle, indicating that the SeaSoar had twisted through 360°. During repairs, Discovery continued to steam eastwards. The cable was cut and remade and cable cores were tested to find good ones.

After redeployment, Sections 4-6 were run over 6 days without pause at an average speed of 15km/hr (8 knots). Antarctic (2°) water was soon lost on the northward section 4, by 50°S, but 3° water recurred in eddies at around 49°S and

47°36'S. Eddies occur all along the sections, at spacings of, crudely, 100-200km, and occasionally major intrusions were observed (e.g. GR164014, 48°24'E). Soon after turning north for Section 6, the Subtropical Front was dramatically crossed (GR164016) at 42°S, where 150m temperatures rose from 5° to 11°C in 35km. A second baroclinic zone was crossed at 41°30'S (GR164017), across which 150m temperatures rose further to 15°C. Salinities rose from Antarctic values of 34.0 to 34.8 and thence to 35.4 across the two baroclinic zones.

At 39°S (GR164018-19) temperatures and salinities fell, indicating an eddy or meander in the Subtropical Front. The SeaSoar had to be recovered at 37°30'S in order to keep to schedule and complete the final CTD section.

DATA ANALYSIS AND CALIBRATION

Sampling

Data sampling, reduction to one-second averages, and transfer to the PSTAR system proceeds exactly as described by PRS. On Cruise 164, the preferred route, through a Level A logger, with Ship Message Protocol (SMP) RS232 transfer of averaged raw data to the PDP11/34, was used throughout.

Initial calibration

Calibration is done in two stages. Program CTDCAL provides final calibration of temperature and pressure, but only preliminary calibration of salinity and chlorophyll α. The equations used were

$$P_{CAL}\ (\text{dbar}) = 0.01 * P_{RAW} - 0.4$$

$$T_{CAL}\ (\text{deg C}) = 0.0005 * 0.99987 * T_{RAW} + 0.116$$

$$C_{CAL}\ (\text{mmho/cm}) = 0.001002 * C_{RAW}$$

$$F_{CAL}\ (\text{mg/m}^3) = \exp\ (3.797 * F_{RAW} - 5.103)$$

where F_{RAW} is the voltage measured by the Chelsea Instruments fluorometer, and F_{CAL} is chlorophyll α. Pressure is the default calibration with a 0.4m deck offset. Temperature was obtained from a recent laboratory calibration. Prior to the first SeaSoar run, the shallow CTD was lowered on the midships winch to 600m for two calibration casts. Five reversing thermometer readings were only sufficient to establish that the temperature calibration was not grossly in error (at the 0.02°C level, limited by thermometer resolution).

The conductivity ratio of 1.002 was determined from these two casts. Salinity was calculated using the 1983 equations of state after speeding up the response of the platinum thermometer to match that of the conductivity cell with a time constant of 0.18 seconds. The time constant was itself determined at the start of SeaSoaring by overplotting down and up T/S curves and adjusting the time constant to minimise hysteresis between them.

The fluorometer calibration was the best available from a previous cruise.

Editing

A calibrated file of about 7200 data cycles is produced every two hours, and hardcopy profile plots of all parameters, also T/S plots and plots against time, are routinely produced. These are examined in two ways. Data spikes that have not been eliminated by DGPRES are located with PLIST or PHISTO if necessary (PRS) and deleted with PEDITA or PEDITB.

This technique is also used to eliminate the worst of the salinity spikes caused in strong temperature gradients by time constant mismatch. Because the gridding step that follows (below) further averages about 20 1-second averages, only salinity spikes larger than about 0.1 need to be edited. Salinity spikes often occur in 'equal' and opposite pairs, and a 0.1 spike is reduced to 0.005 after averaging.

The second editing step is to search for occasions where the conductivity cell has fouled. When this occurs catastrophically; it is observed on the BBC micro monitor plots and the SeaSoar can be deliberately surfaced to shake off the fouling. More subtly, fouling can cause a sudden salinity offset of up to 0.1. Careful examination of T/S curves is used to detect such offsets, which usually recover after a while, or when the SeaSoar surfaces. The period of fouling are determined from the time series plots, and the offending salinity values are either deleted, or adjusted by adding a constant offset (program FINCTD) to bring the T/S curves in line with surrounding profiles.

The procedure maintains the <u>relative</u> salinity calibration. <u>Absolute</u> calibration is described below.

Gridding and contouring

Every 12 hours, the edited 2-hourly files are appended, merged with navigation, gridded and contoured (PAPEND, PMERGE, PGRIDS, PCONTR).

In the Southern Ocean, while GPS was available for short periods, the only routinely available fixes were from transit satellites. Every 12 hours, these were carefully culled to delete poor fixes, or fixes less than an hour from a better fix. Combining the fixes with dead reckoning from the ship's electromagnetic log (which had been calibrated against drifting transponders) allows a track plot to be produced, and the distance run (DISTRUN) along track to be calculated (programs PEDSAT, PNENDR, DELDST, DSTRUN).

The object of merging navigation with SeaSoar data (matching times after subtracting 150 seconds from the SeaSoar times to allow for the fact that it trails up to 600m behind the ship - Pollard, Read & Smithers, 1986) is to replace TIME by DISTRUN as the alongtrack independent variable.

The gridding parameters used at sea, and again after final calibration to produce the contour plots in this data report, were as follows. A column of data is produced every 4km of DISTRUN. Each column has a data value every 8dbar of pressure from 6 to 398dbar. Vertical averaging is over ±4bar of the pressure level (thus 2-10 dbar for the 6dbar level). Horizontal averaging is over ±2km of each DISTRUN value. Thus each grid point is an unweighted average of all 1-second data cycles that fall in a 4km x 8dbar box. For a fall or rise rate of about 1m/s and with 2 to 3 profiles in 4km (Pollard, 1986; Pollard, Read & Smithers, 1986), there are 16-24 data cycles per gridded average. The GRidded output file GR164--- is used to produce the contour plots of potential temperature, salinity and chlorophyll a against pressure.

To contour salinity against density, two further steps are needed. The density SIGMA0 is calculated using the 1983 equations of state for the gridded file. Then the file is regridded (PGRIDG) in the vertical by interpolation on SIGMA0 for each column to give a gridded point every 0.02kg/m^3.

Restriction to 4km horizontal averaging allows strong thermoclinicity to be resolved (e.g. GR164008 at 5780km). The minimum scale for density variations is restricted by the Rossby radius to be of order tens of km, however, and it is desirable to smooth over more than 4km to minimise internal wave noise and permit meaningful geostrophic calculations. The gridded file is therefore further smoothed by averaging over three adjacent columns (PADPAV), so that columns 4km apart contain 12km horizontal averages and are not independent. This smoothed gridded file is used to produce the contour plots of density (SIGPOT) on the plots).

Finally, dynamic height is calculated for each column of the smoothed file, with a 325dbar reference level, and then differenced between adjacent columns to calculate geostrophic shear relative to 325dbar, which forms the final contour plot of each series. The horizontal gradient (in the direction) of two overlapping 12km averages 4km apart (at x = n - 2 and x = n + 2 km) of a variable P can be written

$$\frac{dP}{dx} = \frac{1}{4}\left[\frac{1}{12}\int_{n-4}^{n+8} P\,dx - \frac{1}{12}\int_{n-8}^{n+4} P\,dx\right]$$

$$= \frac{1}{12}\left[\frac{1}{4}\int_{n+4}^{n+8} P\,dx - \frac{1}{4}\int_{n-8}^{n-4} P\,dx\right]$$

so the geostrophic shear is effectively being calculated from two 4km averages of the density field centred 12km apart.

Absolute salinity calibration

In the absence of CTD casts along the SeaSoar track, the only way of obtaining absolute salinity calibrations is to compare near-surface SeaSoar values with water samples tapped off the ship's non-toxic supply (cf Pollard, Holford & Sherrocks, 1985). Samples were accordingly drawn every 30 minutes (48 samples per day, several hundred in all). Post cruise reconciliation of the SeaSoar salinities with the bottle samples was achieved as follows. The bottle samples were typed into a file (YPSTAR). The 6dbar data cycles in the gridded files (i.e. 2-10dbar vertical averages) were extracted (PLEVEL), appended (PAPEND), and merged with the bottle samples by interpolating the SeaSoar values on time to give a value at each bottle sample time.

Fig.2 shows the SeaSoar (SSRSAL) and bottle salinities (BOTSAL) at the bottom, the difference B-SSAL on an expanded scale in the middle, and the SeaSoar temperature SSRTEMP for comparison at the top. Ignoring outliers, the calibration differences range from 0.01 to -0.04. The comparison is bound to fail whenever there are horizontal gradients in the water, because we are comparing samples drawn from an intake 3m deep and pumped to a tap in a laboratory with CTD averages from an instrument 600m behind the ship. The failure is most apparent when Discovery crossed the Subtropical Front at day 14.0, but accounts for most other spikes of order 0.02m in magnitude. Discounting those spikes leaves a noise level of about 0.01, slow drifts of up to 0.02 in 12 hours, and occasional jumps of 0.01 (day 11.6). It is encouraging, however, that many rapid changes of order 0.01 to 0.05 in BOTSAL are matched by corresponding changes in SSRSAL (lower traces of Fig.2), showing that the relative calibration holds well for the most part.

The drifts and jumps arise from subjective human errors in the relative calibration technique. If the conductivity fouls, the scientist on watch may over- or under- correct, causing jumps of order 0.01. Slow drifts as deposits build up on the cell will be taken to be genuine slow changes in T/S relations.

It is reasonable therefore to obtain a final calibration correction to the SeaSoar salinities by fitting a smooth curve by eye through B-SSAL, and adding this time varying correction to the GRidded files. Fig.3 is a replot of Fig.2 after making such a correction. The residual error B-SSALC has a mean ± standard deviation of 0.000 ± 0.004 over 372 values. Our belief is that salinities are absolutely calibrated to better than 0.01.

Absolute chlorophyll calibration

A two stage process was used to calibrate the Chelsea Instruments Fluorometer on the SeaSoar. Throughout the cruise, samples were drawn from the non-toxic supply as well as from sample bottles on CTD casts. Chla was extracted in 90% Acetone and evaluated using a Turner 112 fluorometer which had been previously calibrated with pure chlorophyll at IOS (chlorophyll supplied by Sigma). The number of samples had to be limited because of a shortage of reagents.

The samples were used to calibrate a flow-through Turner Designs fluorometer in the after rough laboratory which was connected to the non-toxic seawater supply, giving a continuous trace of surface Chla (actually about 3m down) throughout the cruise. The ship mounted fluorometer could be used in turn to calibrate the SeaSoar mounted instrument, making use of the gridded 6m data as has been described for salinity.

It was found that the calibration changed dramatically at the Subtropical Front at around 42°S. North of the front the dominant chlorophyll containing species were coccolithophores and dinoflagellates. The dinoflagellates became more significant in the frontal region. South of the front diatoms were the dominant chlorophyll containing organisms.

Least squares fitting of all available calibration data, split into the two regimes gives

$$F_{CAL}\ (mg/m^3) = \exp\ (1.231 * F_{RAW} - 1.711)$$

north of the Subtropical Front and

$$F_{CAL}\ (mg/m^3) = \exp\ (1.082 * F_{RAW} - 2.557)$$

south of the Front.

For a given F_{RAW} there is a factor of 3 difference in FCAL north and south of the Front, and hence there is a step change in the contoured values of Chla at 42°S at a distance run of 7230km at which the calibration phase has been somewhat arbitrarily applied. The Chla values may thus be up to a factor of three in error in the vicinity of 42°S.

ACKNOWLEDGEMENTS

These data were collected on Cruise 164 of RRS Discovery. Shortly after cast 11408, in the early hours of Christmas Day, a fire in one of the main generators nearly terminated the cruise in its early stages. Only the courageous intervention of the Chief and Third Engineers (Ian Bennett and Paul Marsh) put it out before it could spread. Exceptional skill by all the Engineers, and the dedication of the Master, Mike Harding, allowed the cruise to continue as far south as the Polar Front. Our grateful thanks are due to all the Officers and Crew for their wholehearted support in difficult circumstances, and for getting us safely back to Mauritius. The scientific crew all assisted in ensuring high quality SeaSoar data were collected, especially John Moorey, who analysed most of the 300 surface salinity samples.

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TABLE 1

SeaSoar Runs

Section	Direction Towards	Computer runs (1)	Time: Start (DD/MM/YY) (HHMM)	Time: End (DD/MM/YY) (HHMM)	Duration (hours)	Start position S	Start position E	End position S	End position E	Distance run (km)	Comments
1	SW	1	22/12/86 1010	22/12/86 1730	7.3 (2)	26°55'	49°07'	27°37'	48°19'	110 (2)	Test run. Poor data. Oxygen cell damaged. Not contoured.
2	N	2	6/1/87 1500	6/1/87 2230	7.5	51°29'	31°39'	50°42'	31°40'	92	Signal noisy, but could be cleaned.
3	E	2-7	6/1/87 2230	9/1/87 0700	56.5	50°42'	31°40'	50°41'	42°21'	710	Sudden loss of signal ended run.
4	N (010°)	8-13	9/1/87 1300	12/1/87 0200	61.0	50°47'	43°02'	42°51'	44°58'	897	
5	E	13-16	12/1/87 0200	13/1/87 1600	38.0	42°51'	44°58'	42°46'	52°04'	580	
6	N	16-19	13/1/87 1600	15/1/87 1200	44.0	42°46'	52°04'	37°31'	52°21'	587	

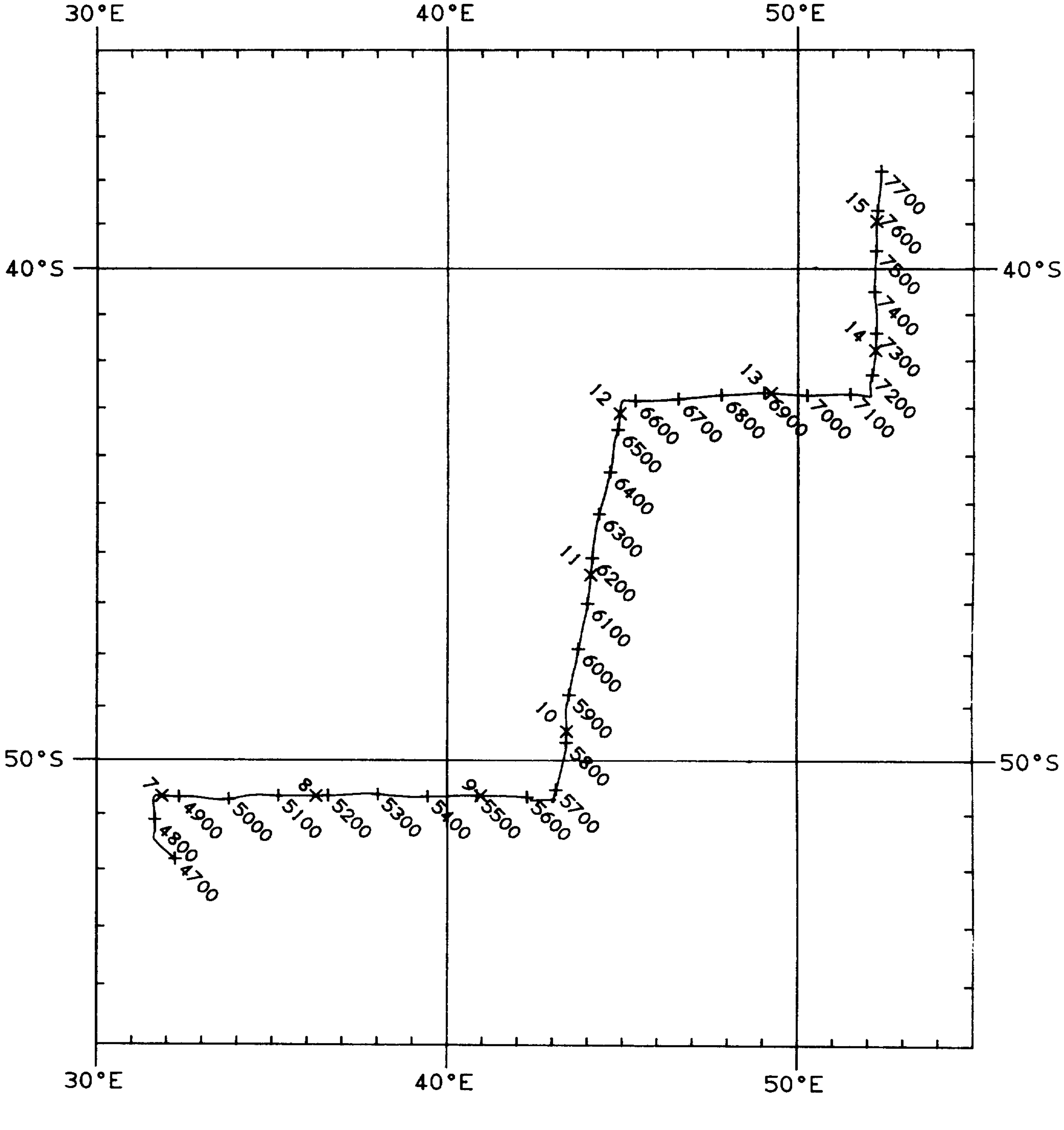
Total duration: 207 hours = 8d 15h

Total distance run: 2866km

Notes: (1) Computer runs crossreference contour plots, where label GR 164013 (say) is Run 13.

(2) Excluded from totals.

FIG. 1 SEASOAR TRACK
ON DISCOVERY CRUISE 164



X DAY OF YEAR
+ DISTANCE RUN (KM)
MERCATOR PROJECTION

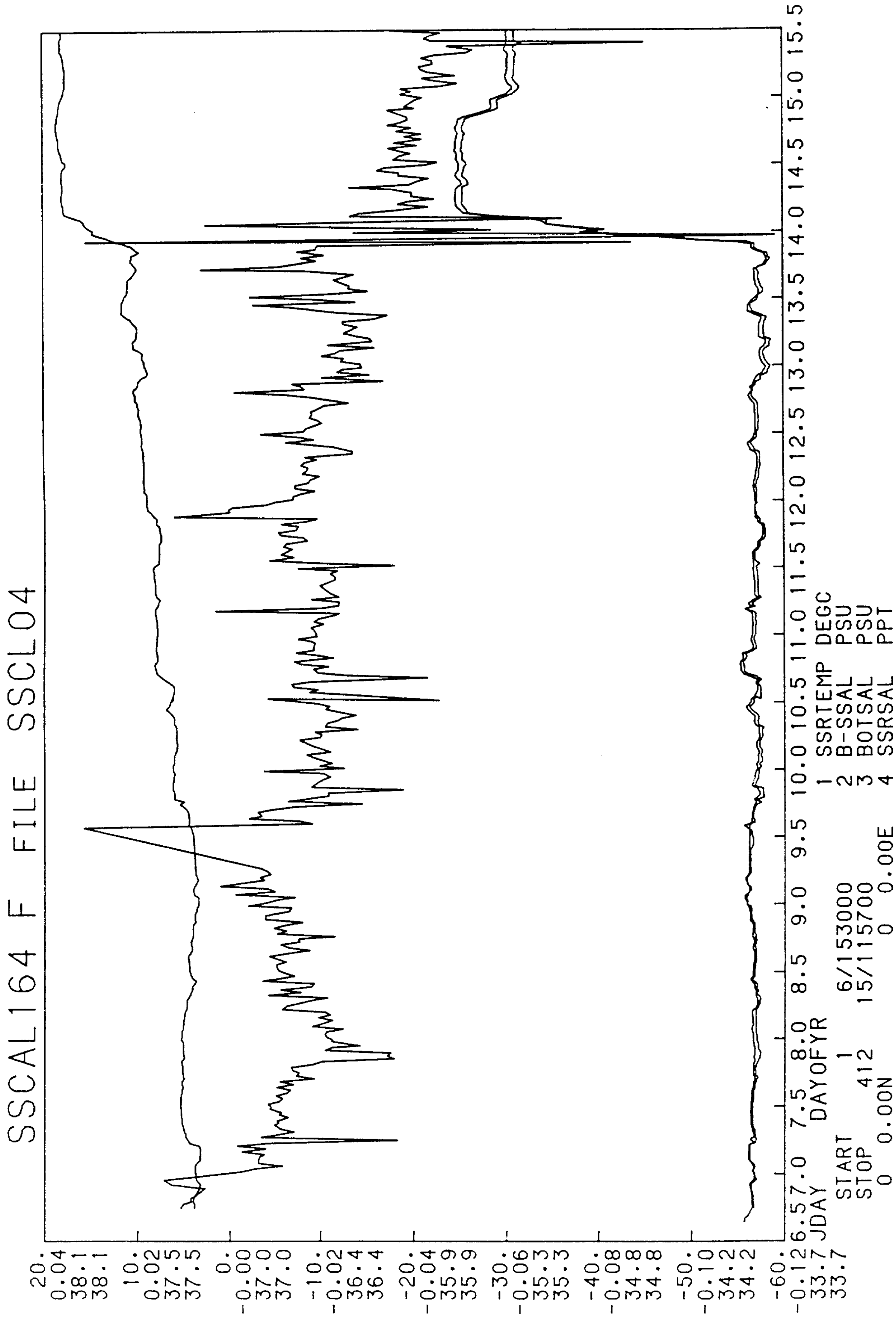


Fig.2 Comparison of SeaSoar and bottle salinities

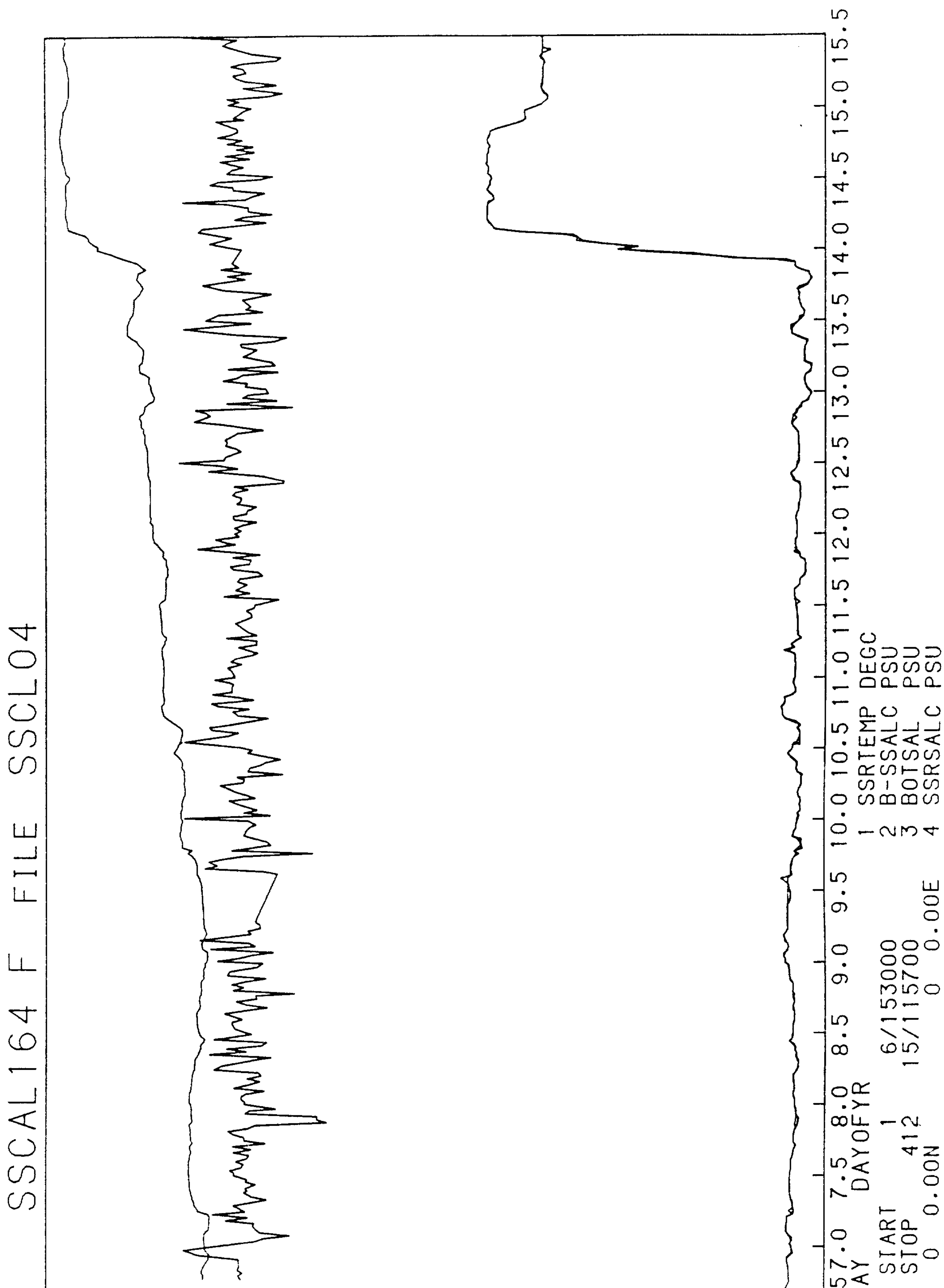
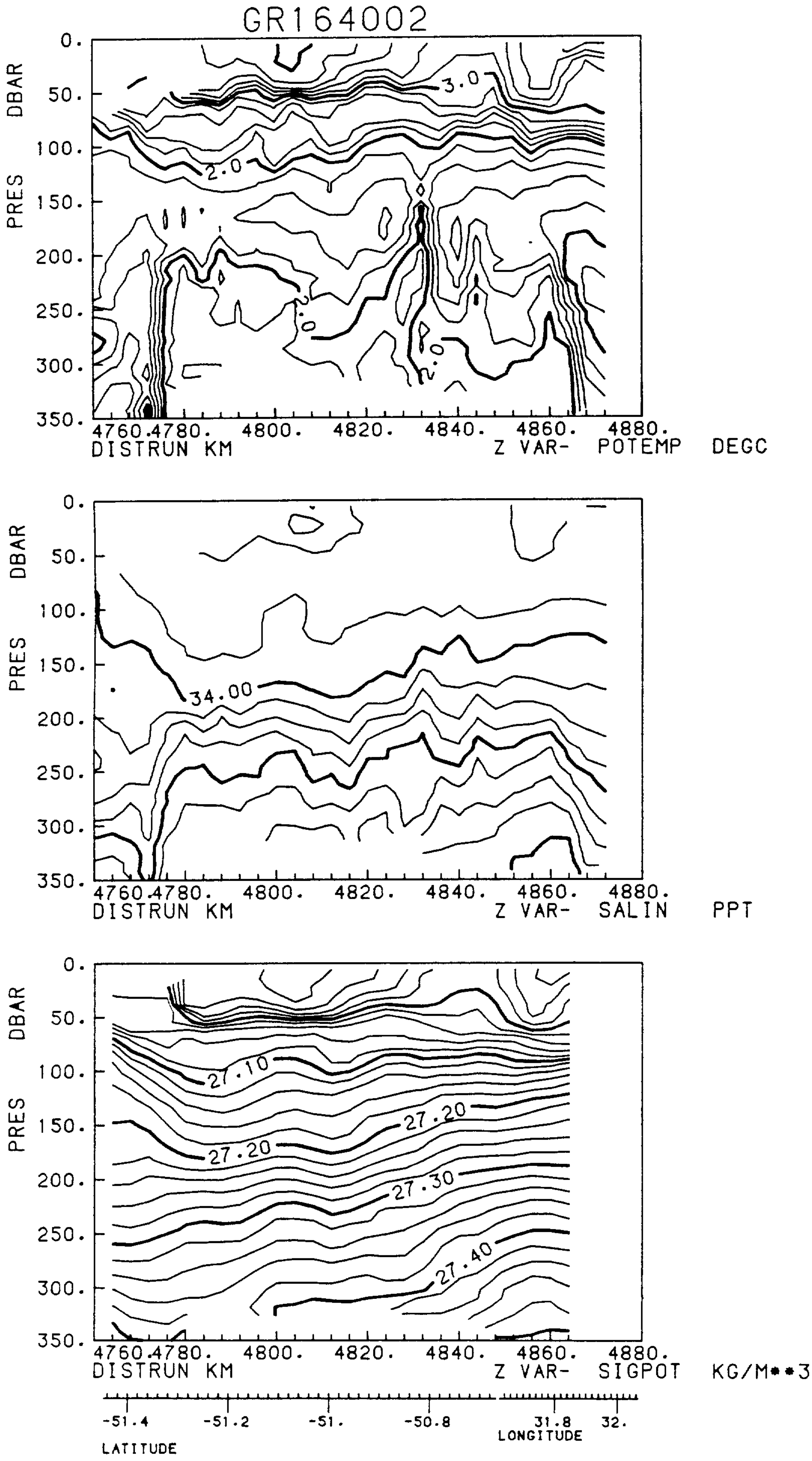
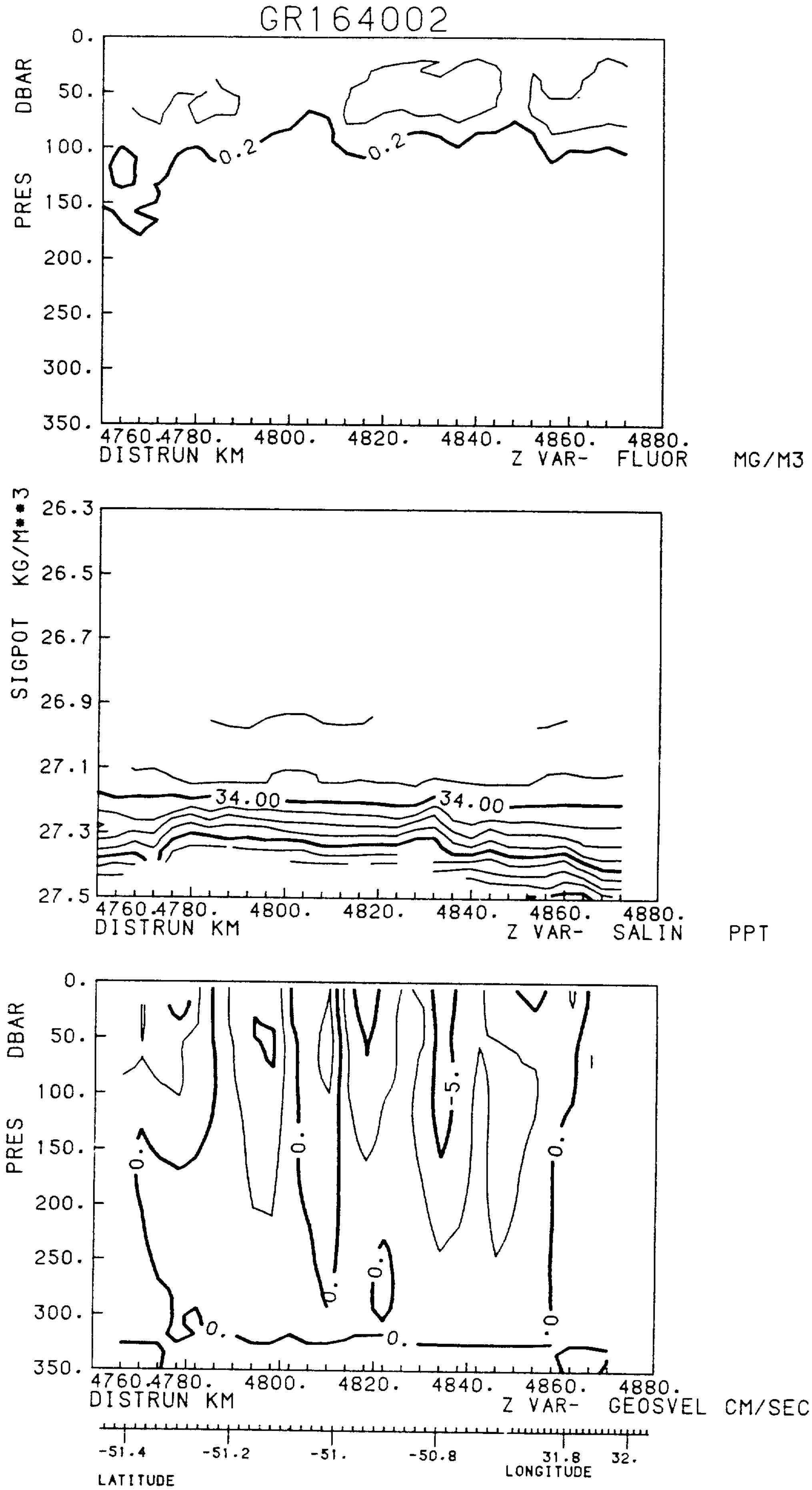


Fig.3 Comparison of SeaSoar and bottle salinities after final absolute calibration


GR164002
PRES DBAR
0.
50.
100.
150.
200.
250.
300.
350.
3.0
2.0
4760.4780. 4800. 4820. 4840. 4860. 4880.
DISTRUN KM
Z VAR- POTEMP DEGC
34.00
Z VAR- SALIN PPT
27.10
27.20
27.30
27.40
Z VAR- SIGPOT KG/M**3
-51.4 -51.2 -51. -50.8
LATITUDE
31.8 32.
LONGITUDE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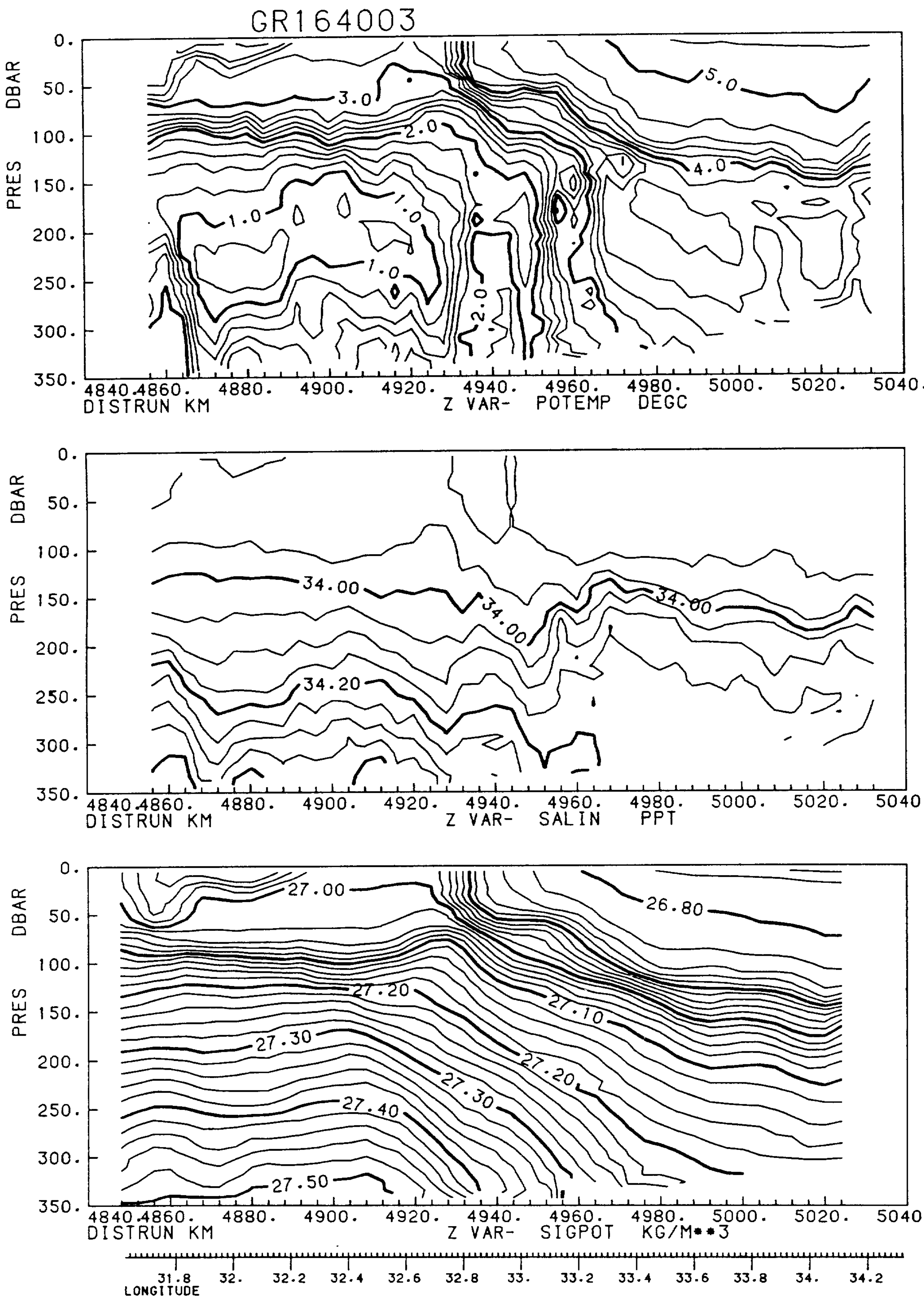
50.
100.
150.
200.
250.
300.
350.
PRES DBAR
0.2
0.2
4760.4780.
4800.
4820.
4840.
4860.
4880.
DISTRUN KM
Z VAR- FLUOR MG/M3
26.3
26.5
26.7
26.9
27.1
27.3
27.5
SIGPOT KG/M**3
34.00
34.00
4760.4780.
4800.
4820.
4840.
4860.
4880.
DISTRUN KM
Z VAR- SALIN PPT
0.
50.
100.
150.
200.
250.
300.
350.
PRES DBAR
-5.
0.
0.
0.
0.
0.
0.
0.
0.
0.
4760.4780.
4800.
4820.
4840.
4860.
4880.
DISTRUN KM
Z VAR- GEOSVEL CM/SEC
-51.4
-51.2
-51.
-50.8
31.8
32.
LATITUDE
LONGITUDE


GR164003
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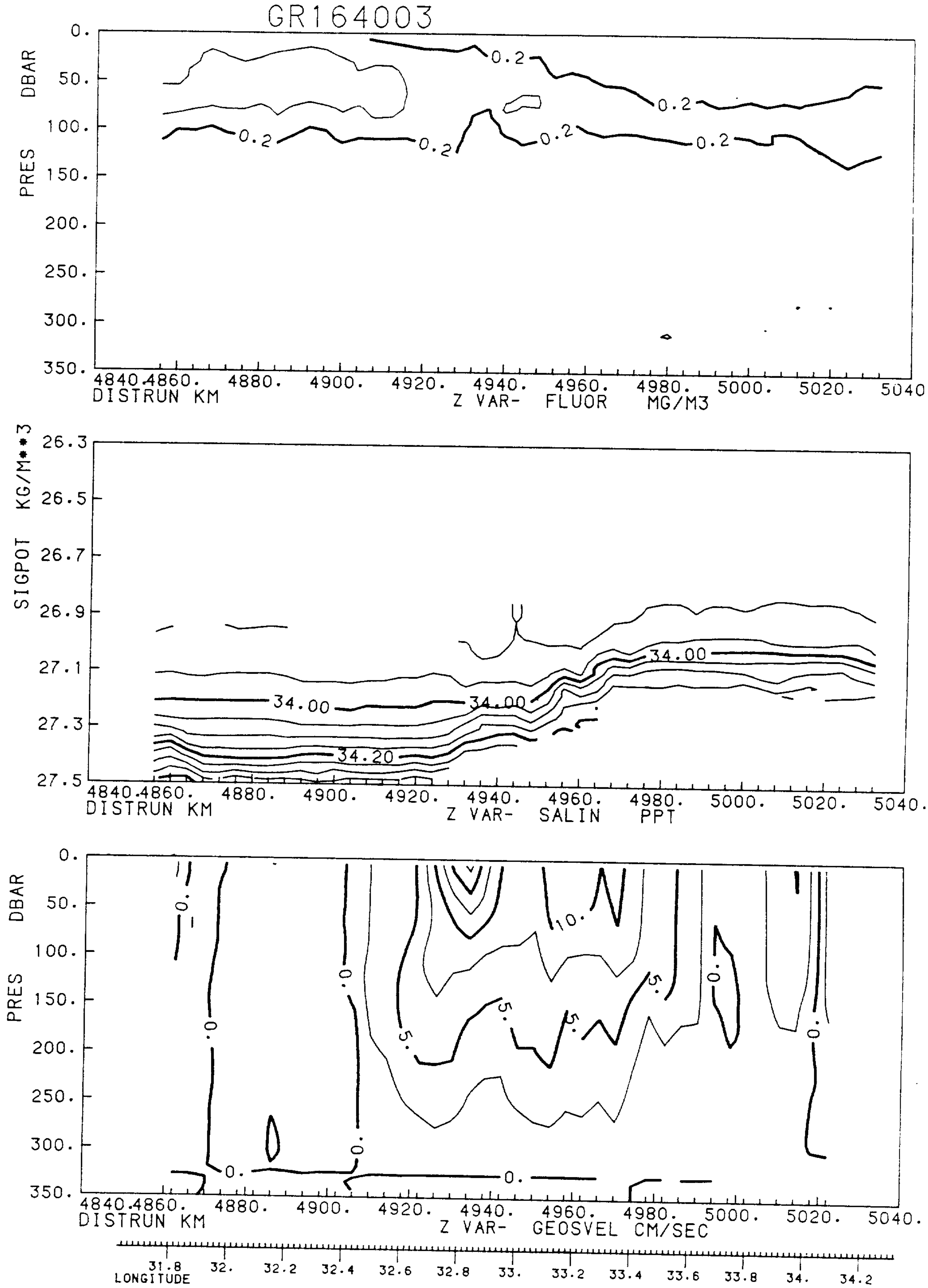
0. 50. 100. 150. 200. 250. 300. 350.
3.0
5.0
2.0
4.0
1.0
1.0
1.0
2.0
4840.4860. 4880. 4900. 4920. 4940. 4960. 4980. 5000. 5020. 5040.
DISTRUN KM
Z VAR- POTEMP DEGC
34.00
34.00
34.00
34.20
Z VAR- SALIN PPT
27.00
26.80
27.20
27.10
27.30
27.20
27.30
27.40
27.50
Z VAR- SIGPOT KG/M**3
31.8 32. 32.2 32.4 32.6 32.8 33. 33.2 33.4 33.6 33.8 34. 34.2
LONGITUDE



GR164003
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DISTRUN KM
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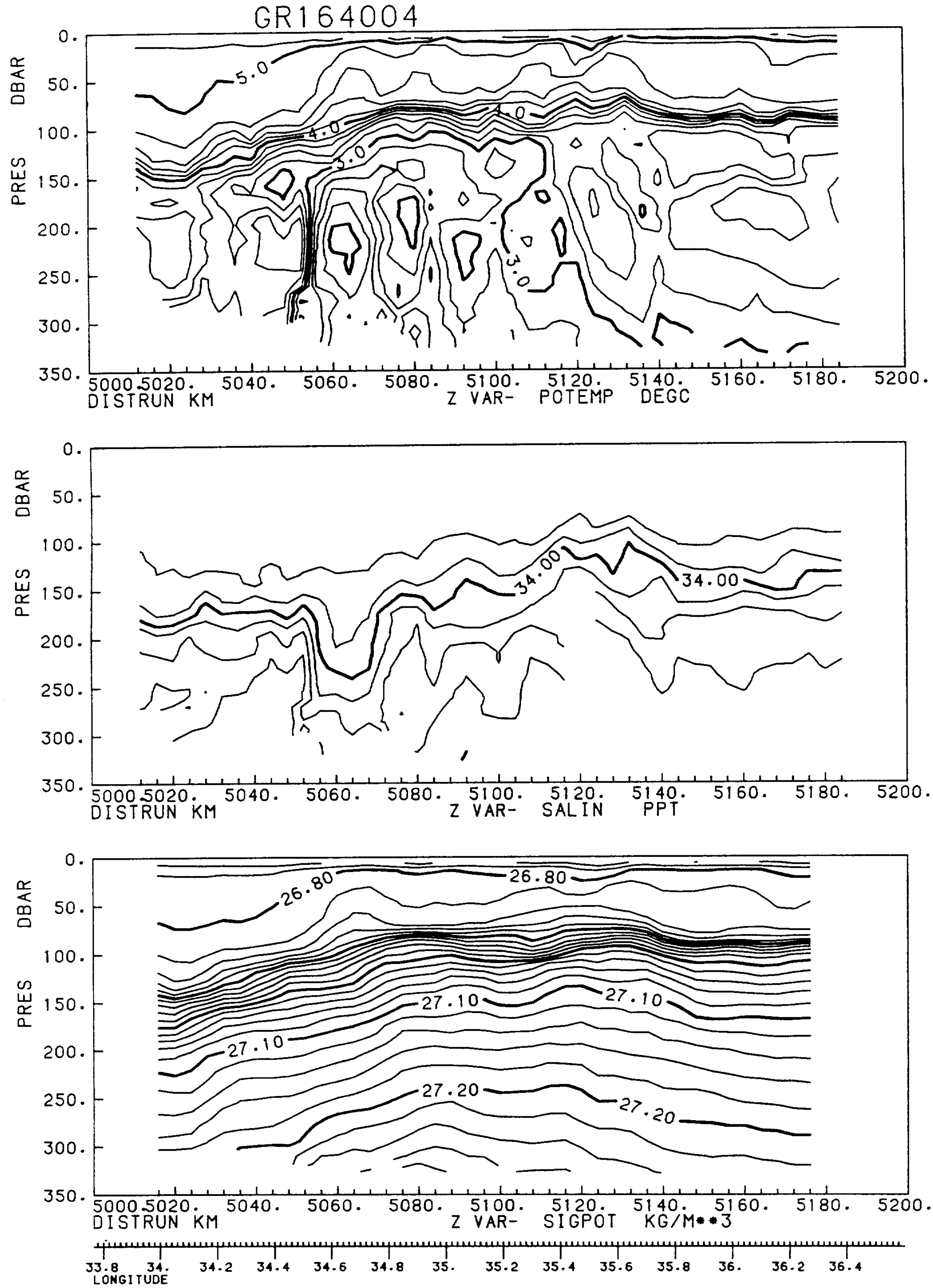
SIGPOT KG/M**3
Z VAR- SALIN PPT
Z VAR- GEOSVEL CM/SEC
LONGITUDE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50.
100.
150.
200.
250.
300.
350.
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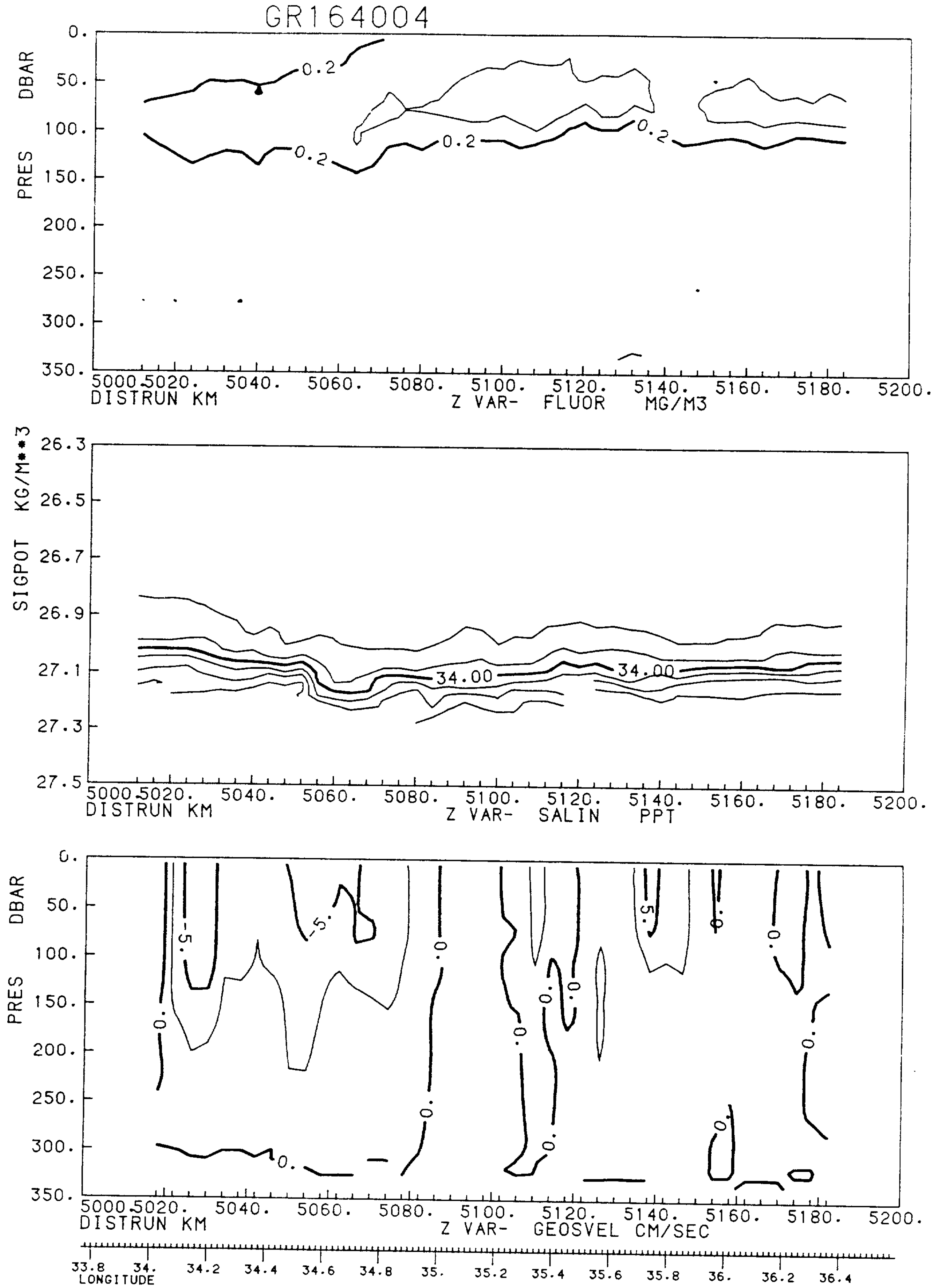
DISTRUN KM
Z VAR- POTEMP DEGC
5.0
4.0
3.0
Z VAR- SALIN PPT
34.00
Z VAR- SIGPOT KG/M**3
26.80
27.10
27.20
33.8 34. 34.2 34.4 34.6 34.8 35. 35.2 35.4 35.6 35.8 36. 36.2 36.4
LONGITUDE



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PRES DBAR
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DISTRUN KM
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SIGPOT KG/M**3
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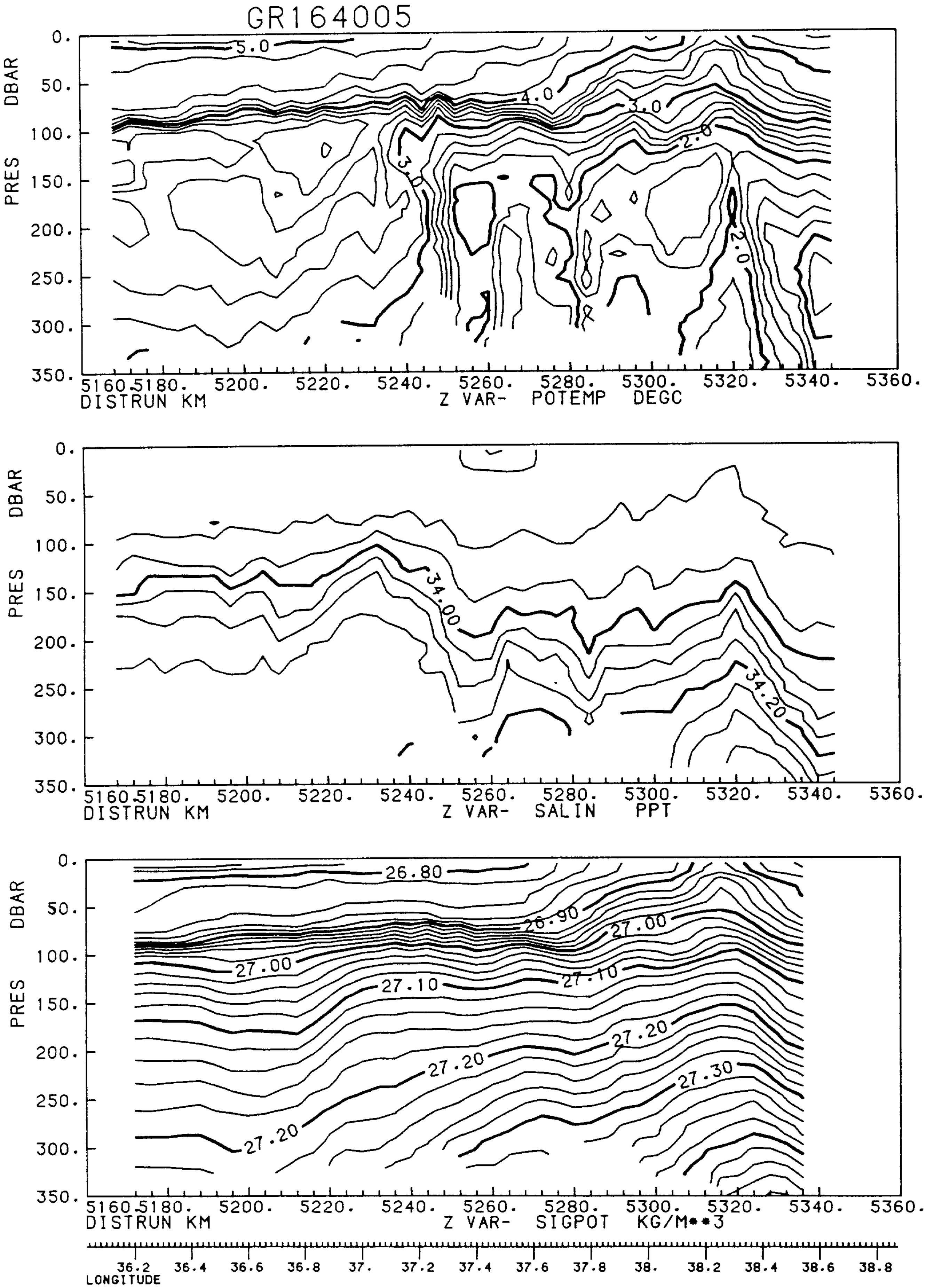
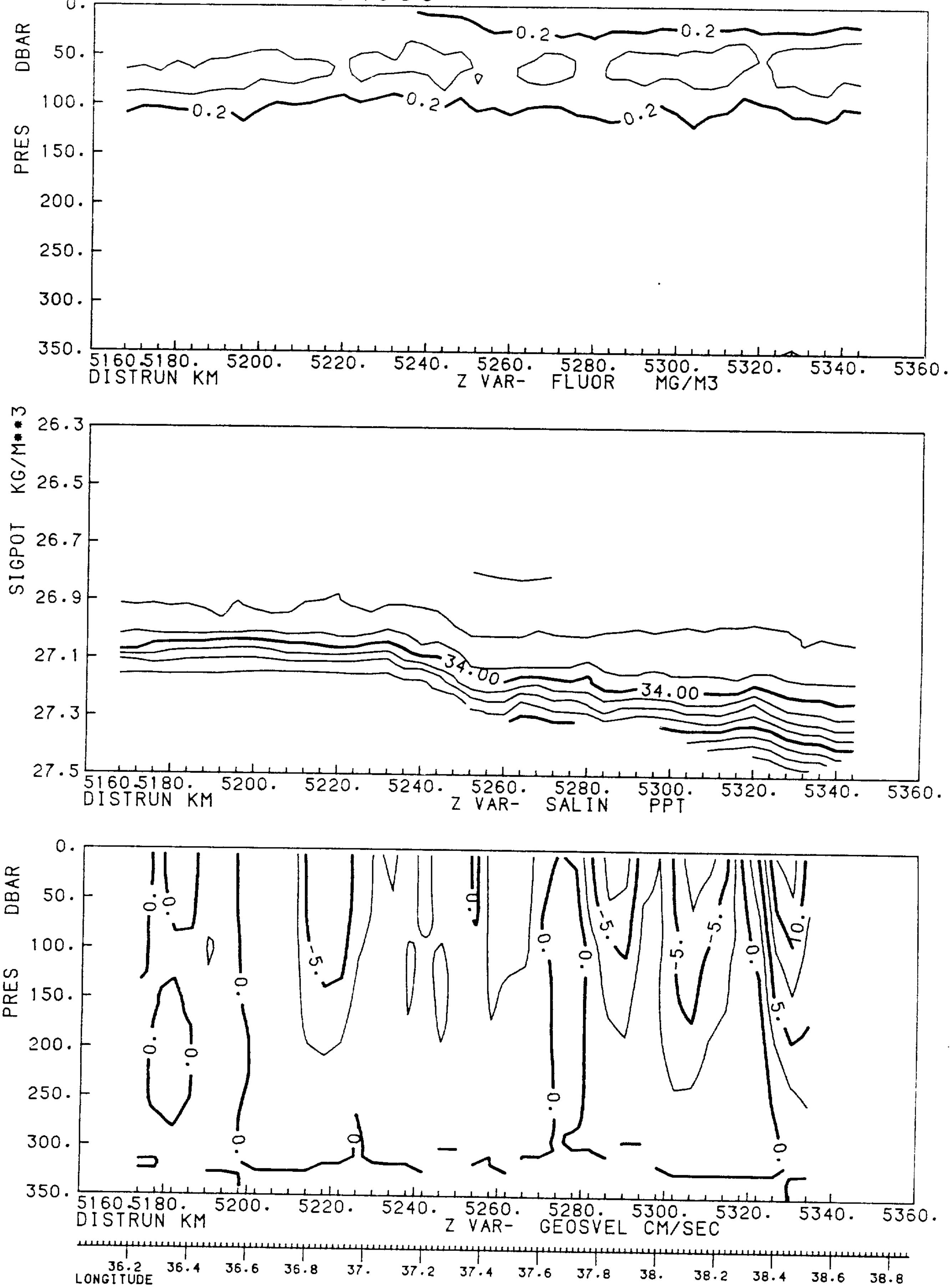
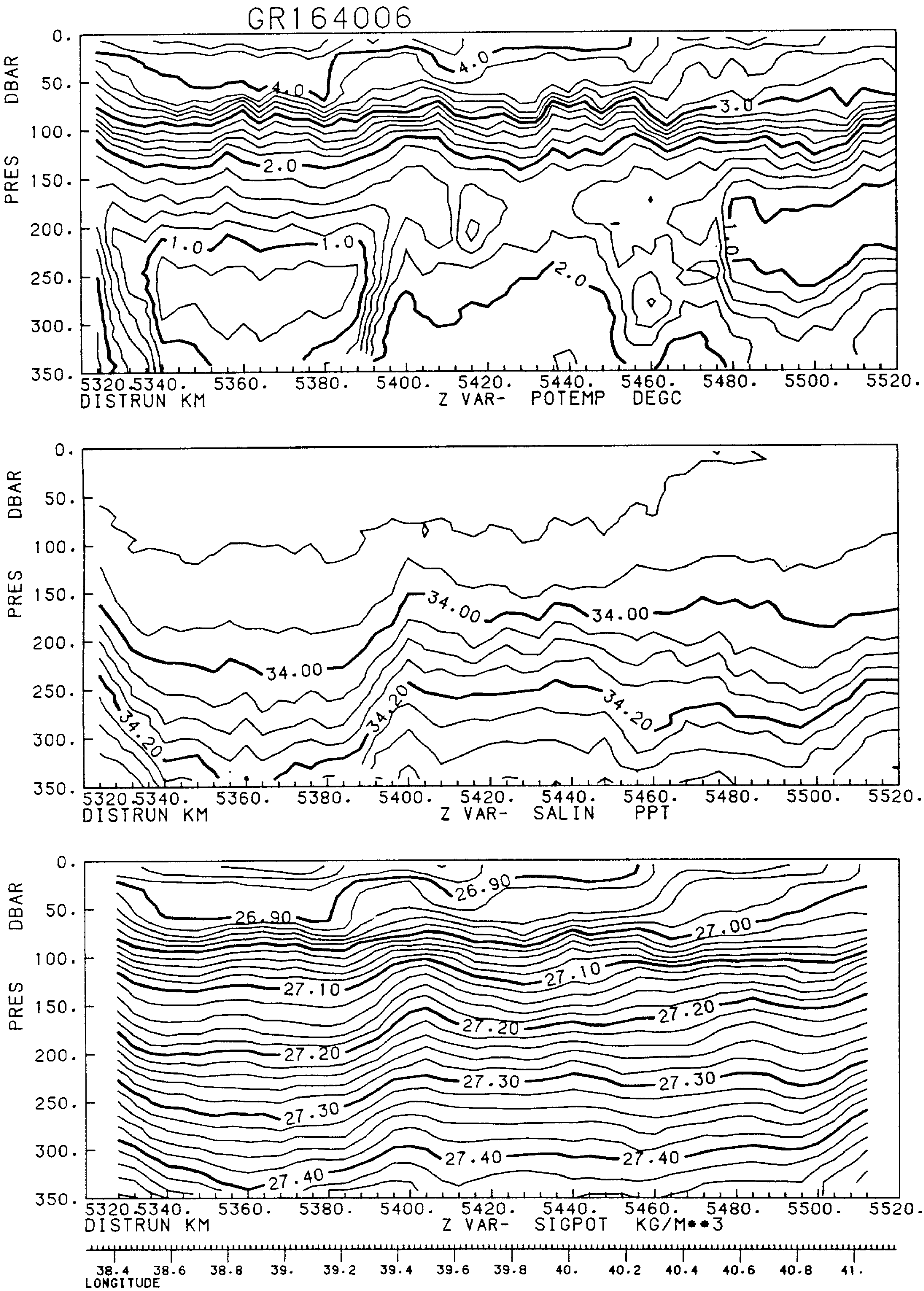
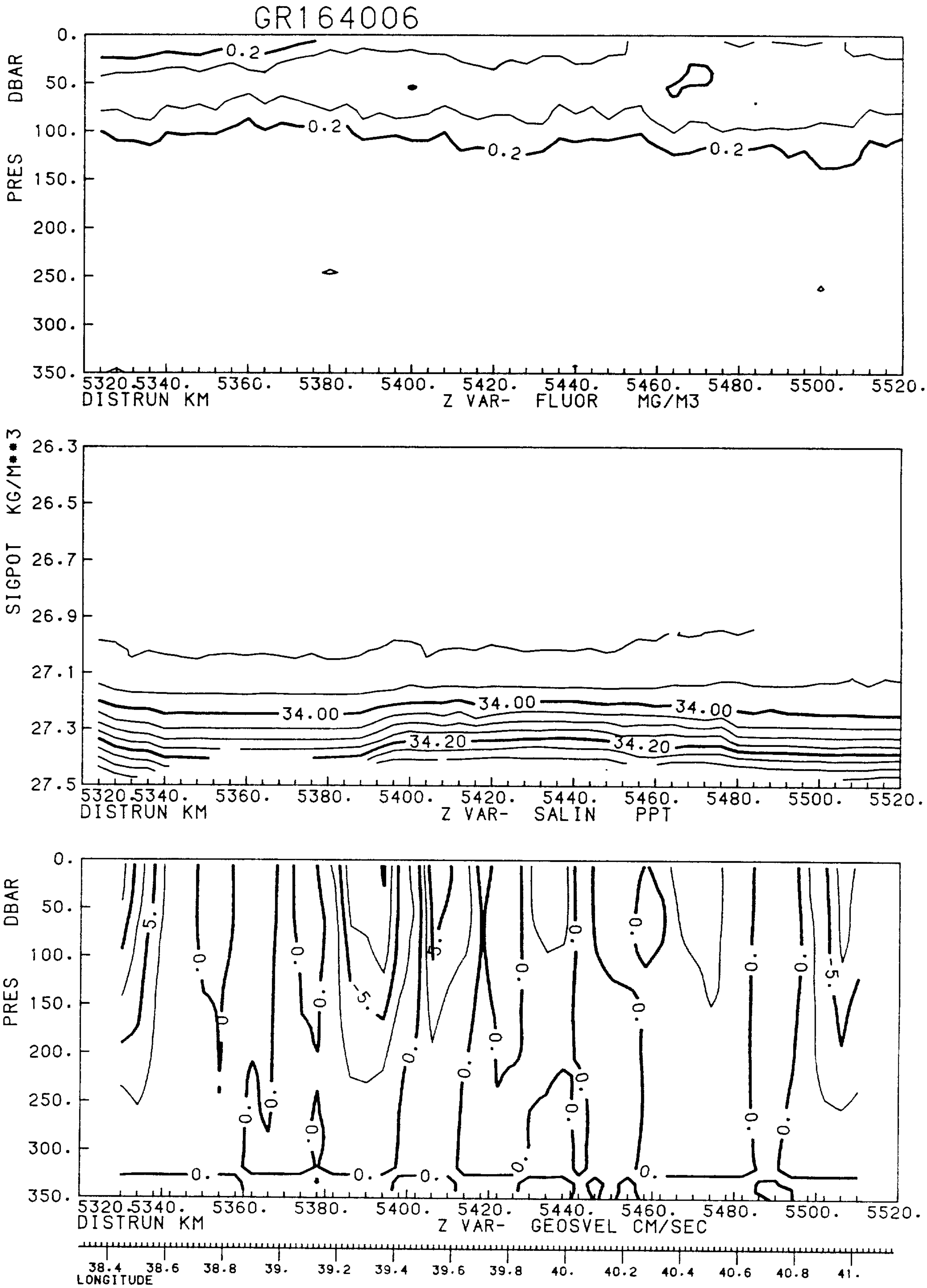
Z VAR- SALIN PPT
0.
-5.
Z VAR- GEOSVEL CM/SEC
LONGITUDE

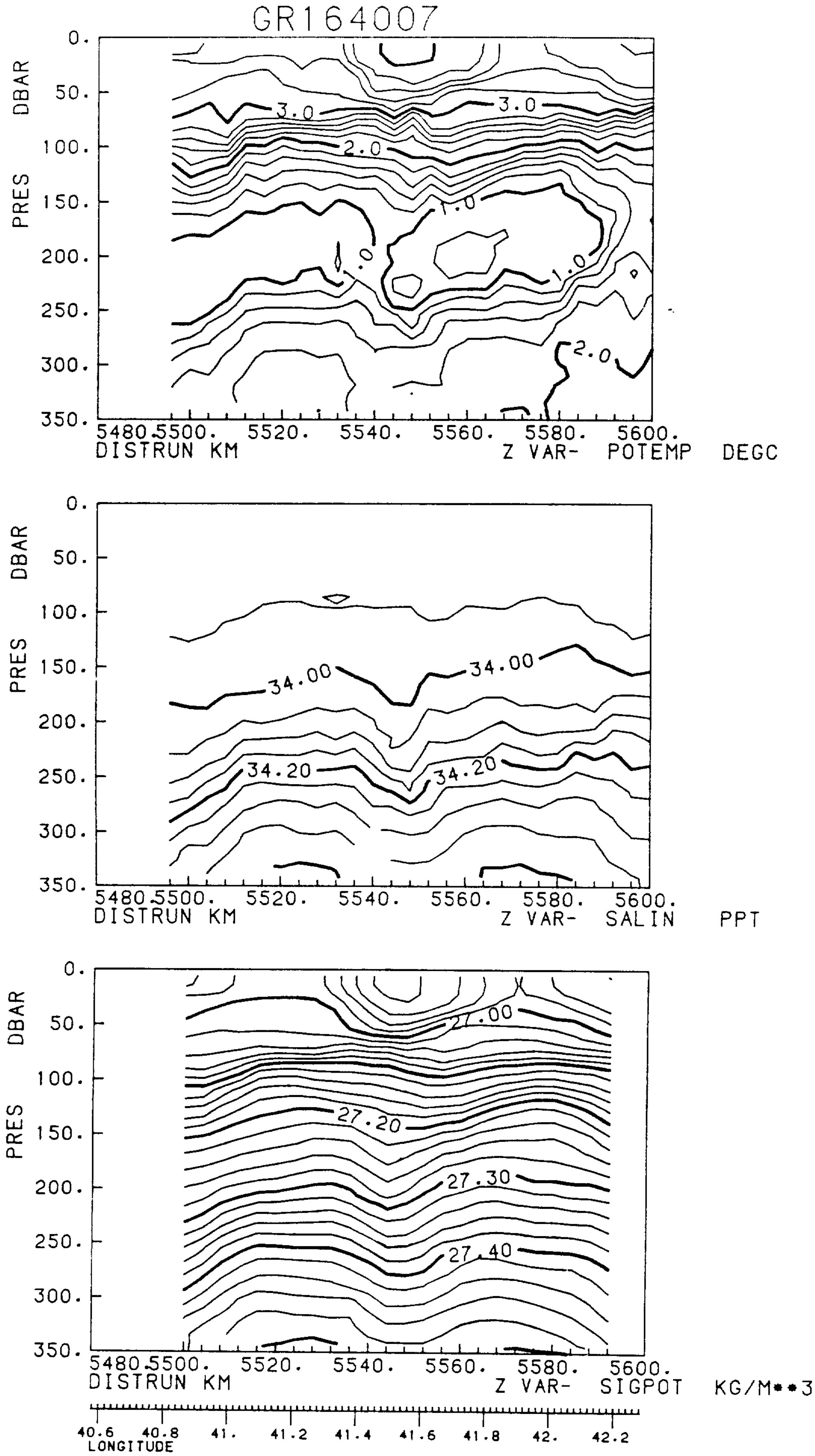

GR164005
5.0
4.0
3.0
2.0
3.0
2.0
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
5160.5180. 5200. 5220. 5240. 5260. 5280. 5300. 5320. 5340. 5360.
DISTRUN KM
Z VAR- POTEMP DEGC
34.00
34.20
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
5160.5180. 5200. 5220. 5240. 5260. 5280. 5300. 5320. 5340. 5360.
DISTRUN KM
Z VAR- SALIN PPT
26.80
26.90
27.00
27.00
27.10
27.10
27.20
27.20
27.20
27.30
27.20
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
5160.5180. 5200. 5220. 5240. 5260. 5280. 5300. 5320. 5340. 5360.
DISTRUN KM
Z VAR- SIGPOT KG/M**3
36.2 36.4 36.6 36.8 37. 37.2 37.4 37.6 37.8 38. 38.2 38.4 38.6 38.8
LONGITUDE

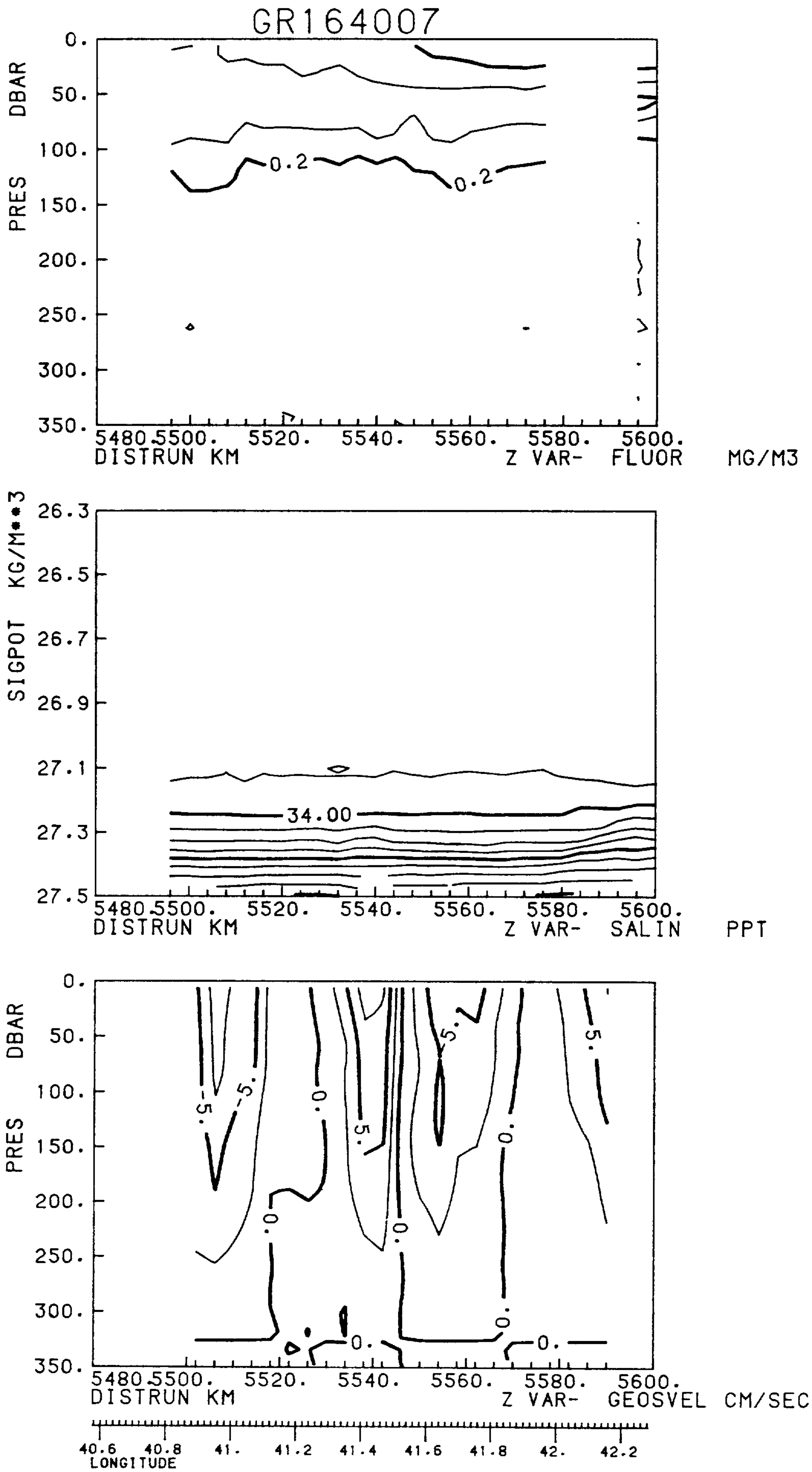
GR164005

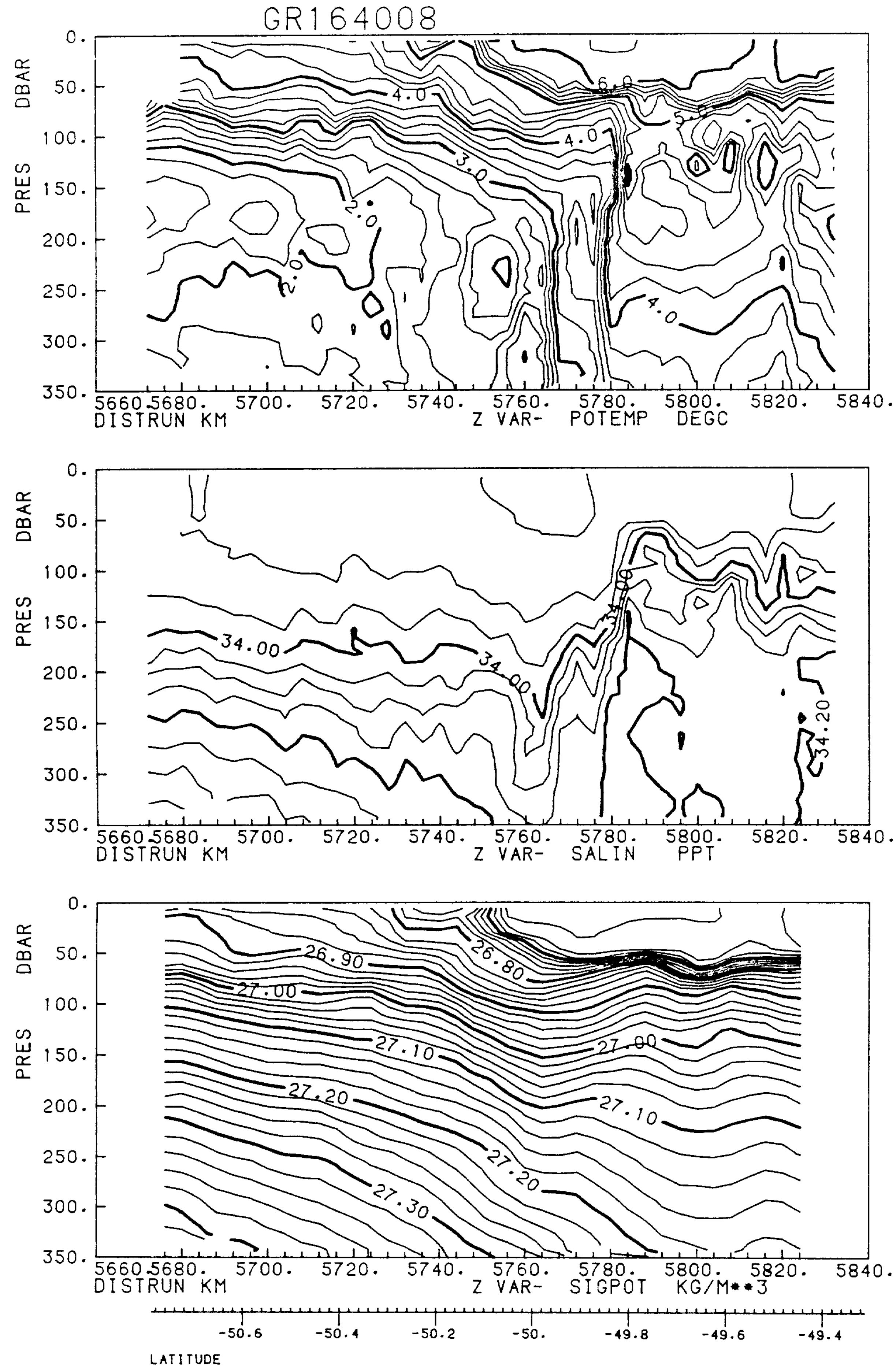

PRES DBAR
0.
50.
100.
150.
200.
250.
300.
350.
0.2
5160. 5180. 5200. 5220. 5240. 5260. 5280. 5300. 5320. 5340. 5360.
DISTRUN KM
Z VAR- FLUOR MG/M3
SIGPOT KG/M**3
26.3
26.5
26.7
26.9
27.1
27.3
27.5
34.00
Z VAR- SALIN PPT
0.
-5.
5.
10.
Z VAR- GEOSVEL CM/SEC
36.2 36.4 36.6 36.8 37. 37.2 37.4 37.6 37.8 38. 38.2 38.4 38.6 38.8
LONGITUDE

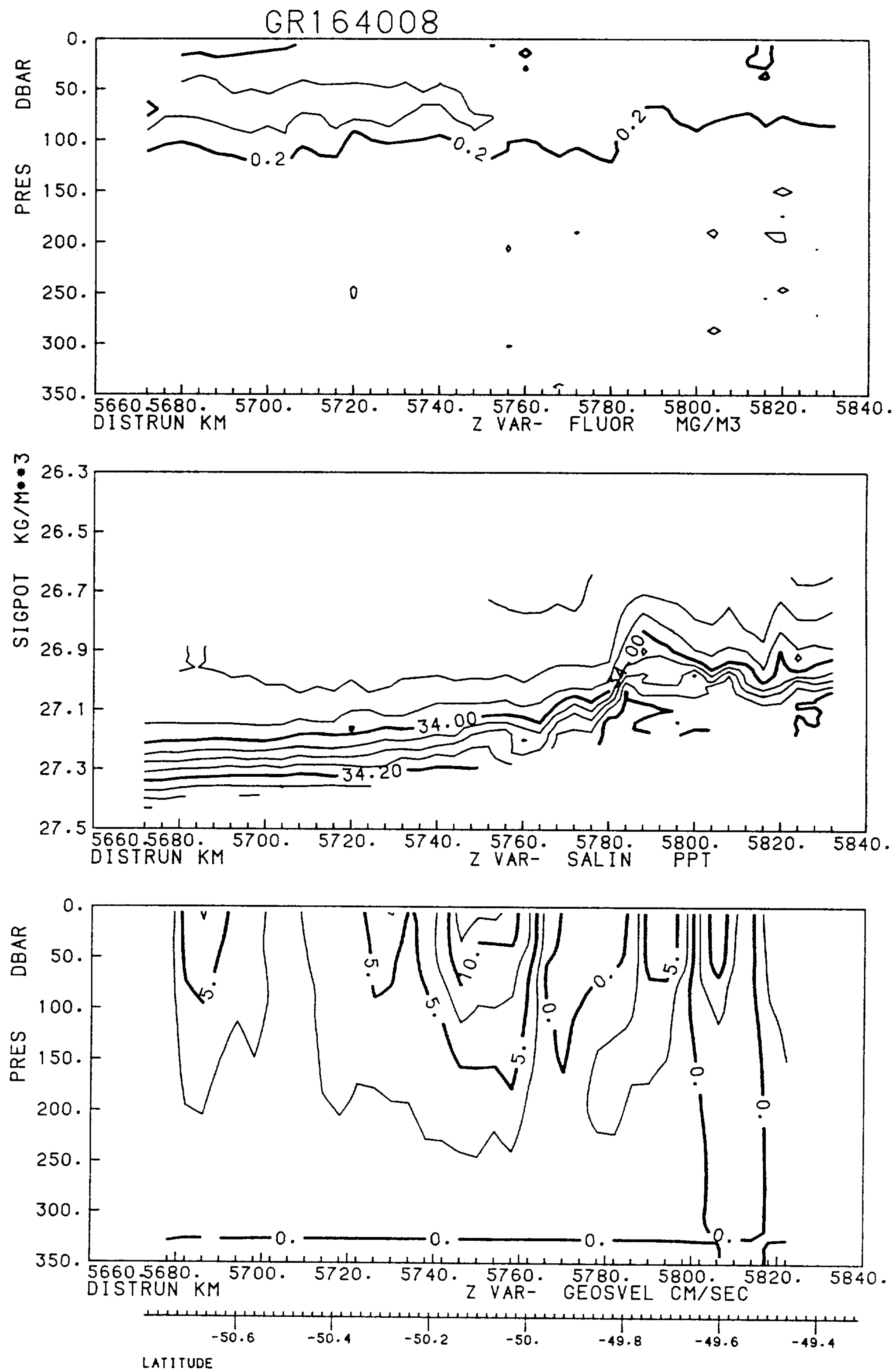

GR164006
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
4.0
3.0
2.0
1.0
2.0
5320. 5340. 5360. 5380. 5400. 5420. 5440. 5460. 5480. 5500. 5520.
DISTRUN KM
Z VAR- POTEMP DEGC
34.00
34.20
DISTRUN KM
Z VAR- SALIN PPT
26.90
27.00
27.10
27.20
27.30
27.40
DISTRUN KM
Z VAR- SIGPOT KG/M**3
38.4 38.6 38.8 39. 39.2 39.4 39.6 39.8 40. 40.2 40.4 40.6 40.8 41.
LONGITUDE

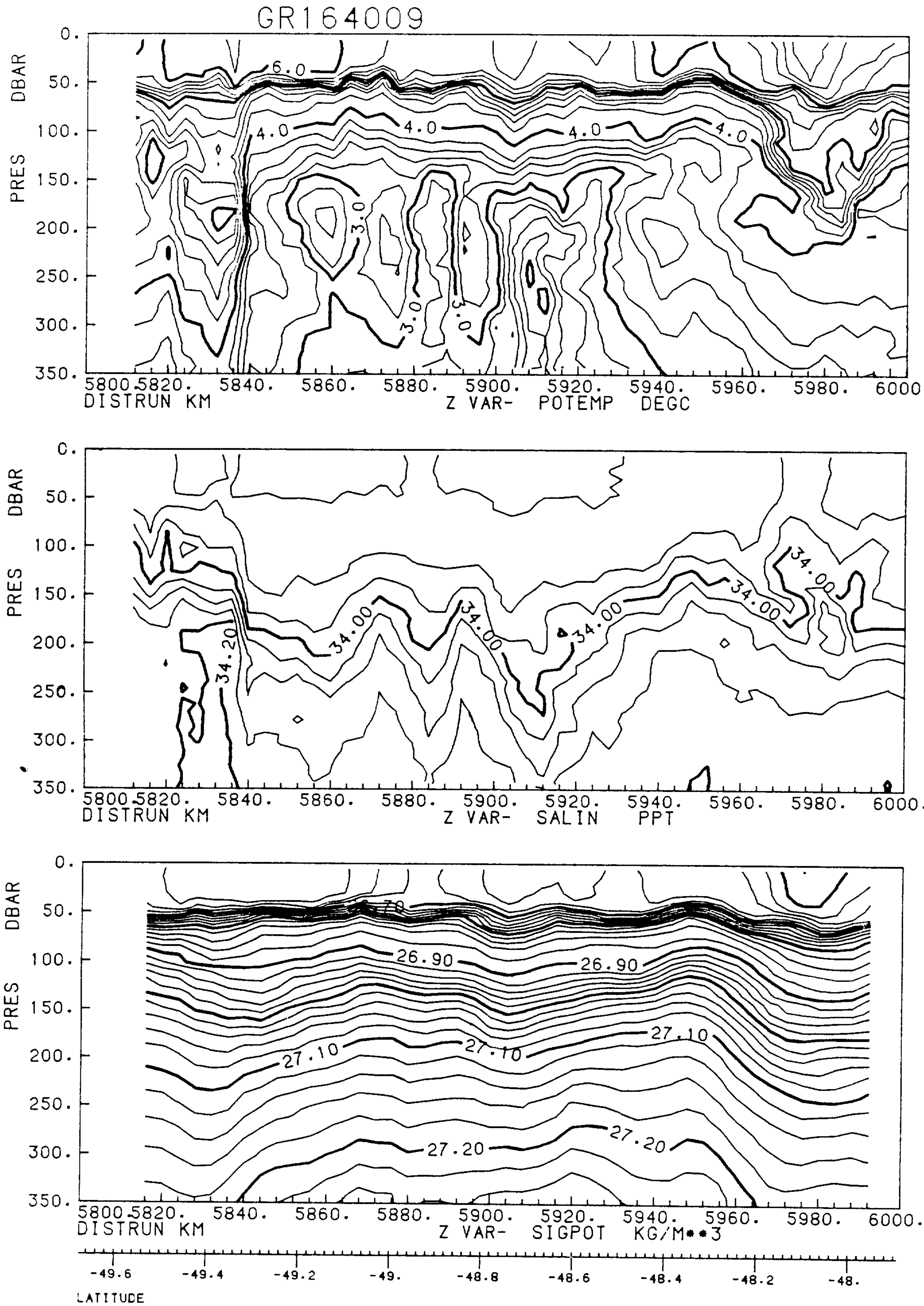

GR164006
0.
50.
100.
150.
200.
250.
300.
350.
PRES DBAR
0.2
5320. 5340. 5360. 5380. 5400. 5420. 5440. 5460. 5480. 5500. 5520.
DISTRUN KM
Z VAR- FLUOR MG/M3
26.3
26.5
26.7
26.9
27.1
27.3
27.5
SIGPOT KG/M**3
34.00
34.20
Z VAR- SALIN PPT
0.
5.
-5.
Z VAR- GEOSVEL CM/SEC
38.4 38.6 38.8 39. 39.2 39.4 39.6 39.8 40. 40.2 40.4 40.6 40.8 41.
LONGITUDE

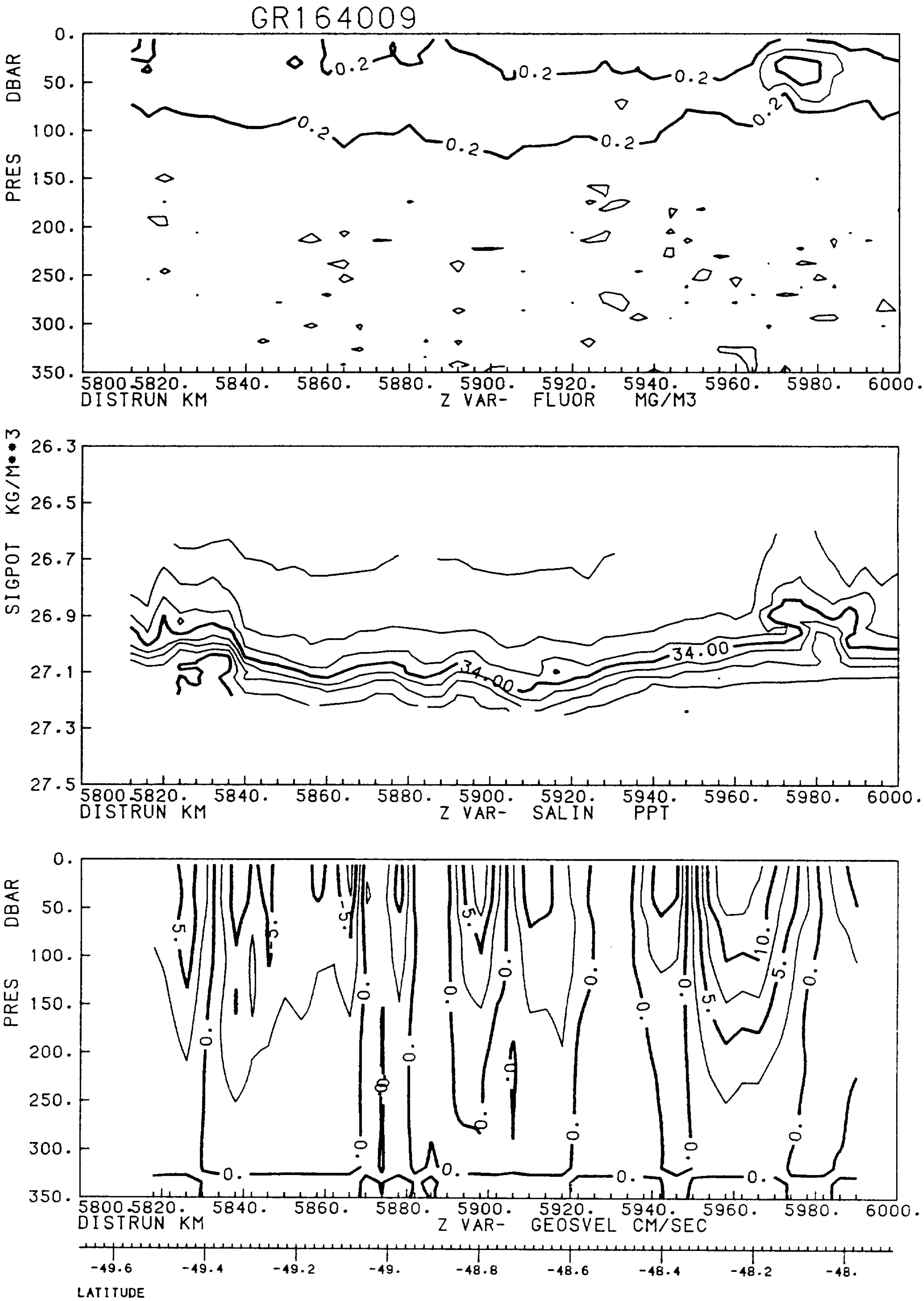

GR164007
PRES DBAR
0.
50.
100.
150.
200.
250.
300.
350.
3.0
2.0
1.0
2.0
5480.5500. 5520. 5540. 5560. 5580. 5600.
DISTRUN KM
Z VAR- POTEMP DEGC
34.00
34.20
Z VAR- SALIN PPT
27.00
27.20
27.30
27.40
Z VAR- SIGPOT KG/M**3
40.6 40.8 41. 41.2 41.4 41.6 41.8 42. 42.2
LONGITUDE


GR164007
PRES DBAR
0.
50.
100.
150.
200.
250.
300.
350.
0.2
0.2
5480.5500. 5520. 5540. 5560. 5580. 5600.
DISTRUN KM
Z VAR- FLUOR MG/M3
SIGPOT KG/M**3
26.3
26.5
26.7
26.9
27.1
27.3
27.5
34.00
5480.5500. 5520. 5540. 5560. 5580. 5600.
DISTRUN KM
Z VAR- SALIN PPT
PRES DBAR
0.
50.
100.
150.
200.
250.
300.
350.
-5.
-5.
0.
5.
5.
5.
0.
0.
0.
0.
0.
0.
5480.5500. 5520. 5540. 5560. 5580. 5600.
DISTRUN KM
Z VAR- GEOSVEL CM/SEC
40.6 40.8 41. 41.2 41.4 41.6 41.8 42. 42.2
LONGITUDE

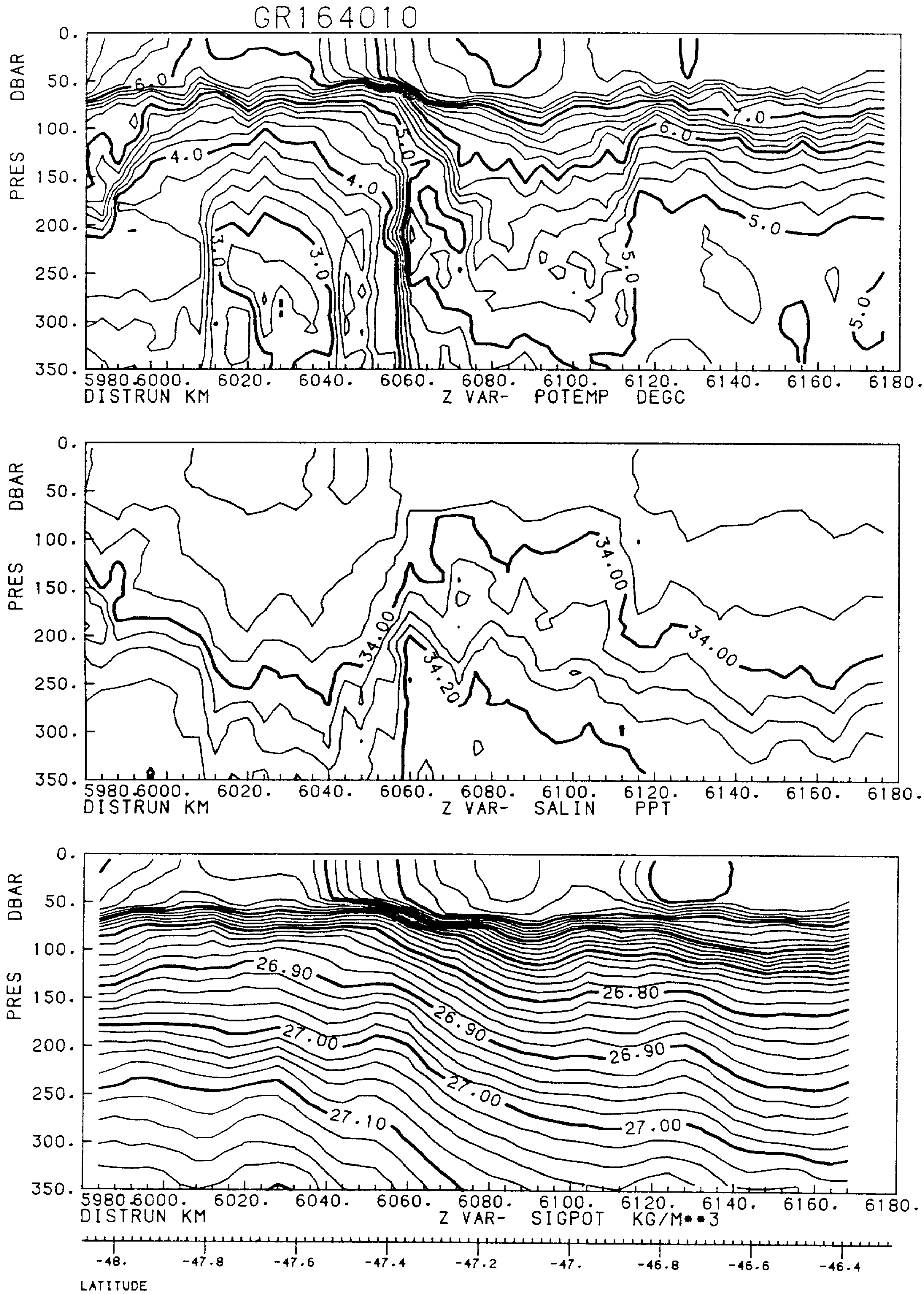

GR164008
PRES DBAR
DISTRUN KM
Z VAR- POTEMP DEGC
2.0
3.0
4.0
5.0
6.0
Z VAR- SALIN PPT
34.00
34.20
Z VAR- SIGPOT KG/M**3
26.80
26.90
27.00
27.10
27.20
27.30
LATITUDE
-50.6
-50.4
-50.2
-50.
-49.8
-49.6
-49.4

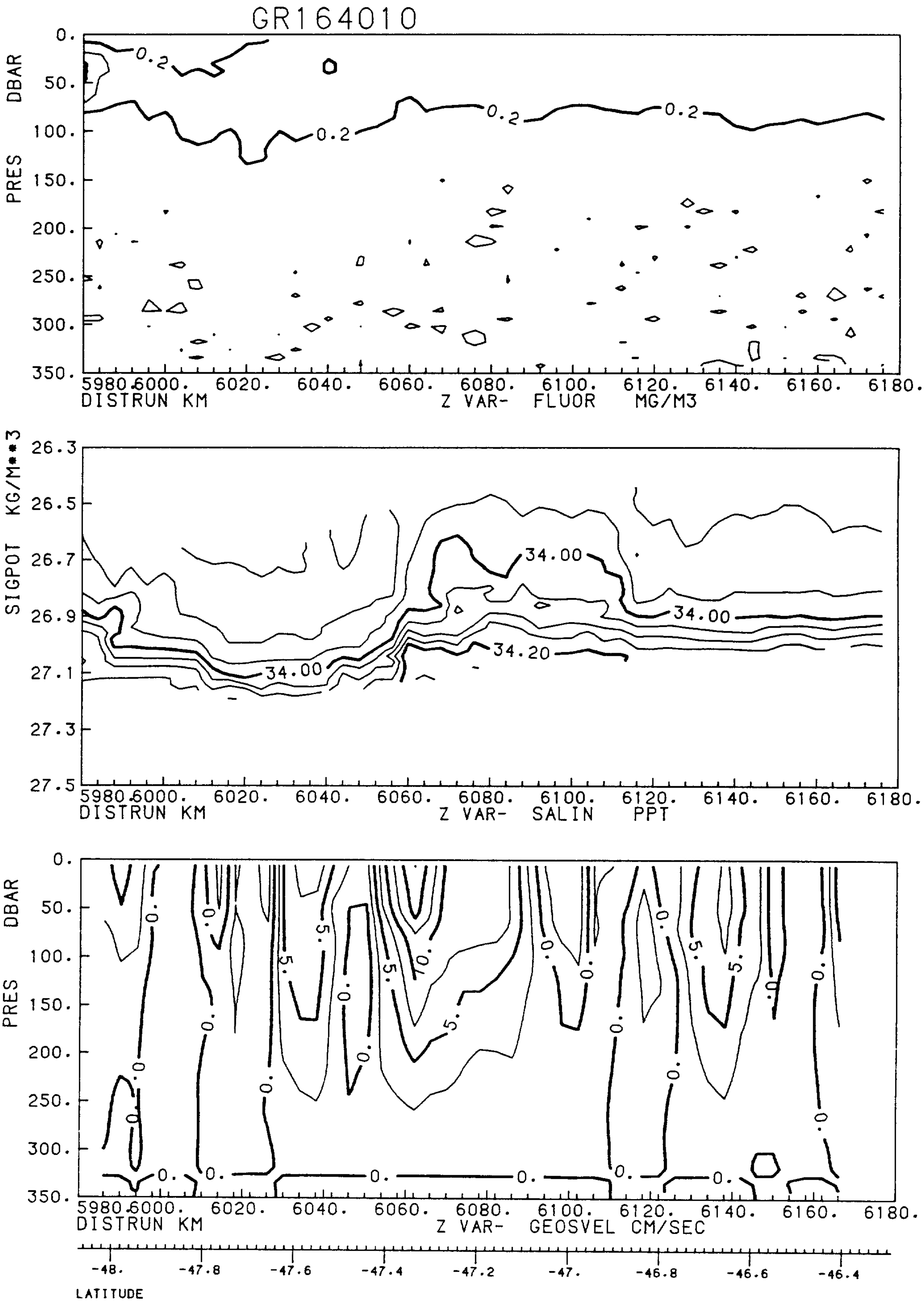

GR164008
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
0.2
DISTRUN KM
5660. 5680. 5700. 5720. 5740. 5760. 5780. 5800. 5820. 5840.
Z VAR- FLUOR MG/M3
SIGPOT KG/M**3
26.3 26.5 26.7 26.9 27.1 27.3 27.5
34.00
34.20
Z VAR- SALIN PPT
5.
10.
0.
Z VAR- GEOSVEL CM/SEC
-50.6 -50.4 -50.2 -50. -49.8 -49.6 -49.4
LATITUDE

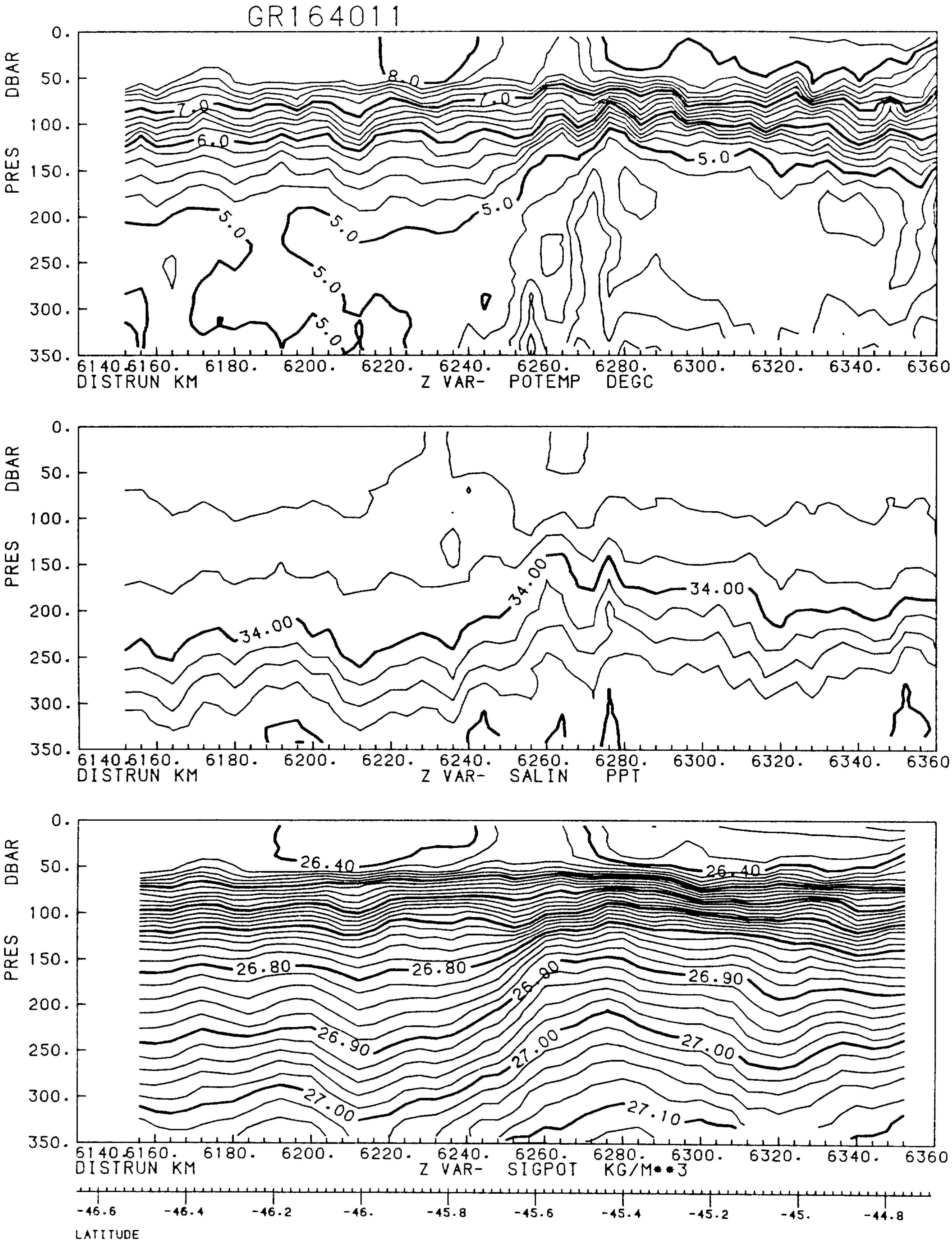

GR164009
PRES DBAR
DISTRUN KM
Z VAR- POTEMP DEGC
Z VAR- SALIN PPT
Z VAR- SIGPOT KG/M**3
6.0
4.0
3.0
34.00
34.20
26.90
27.10
27.20
LATITUDE

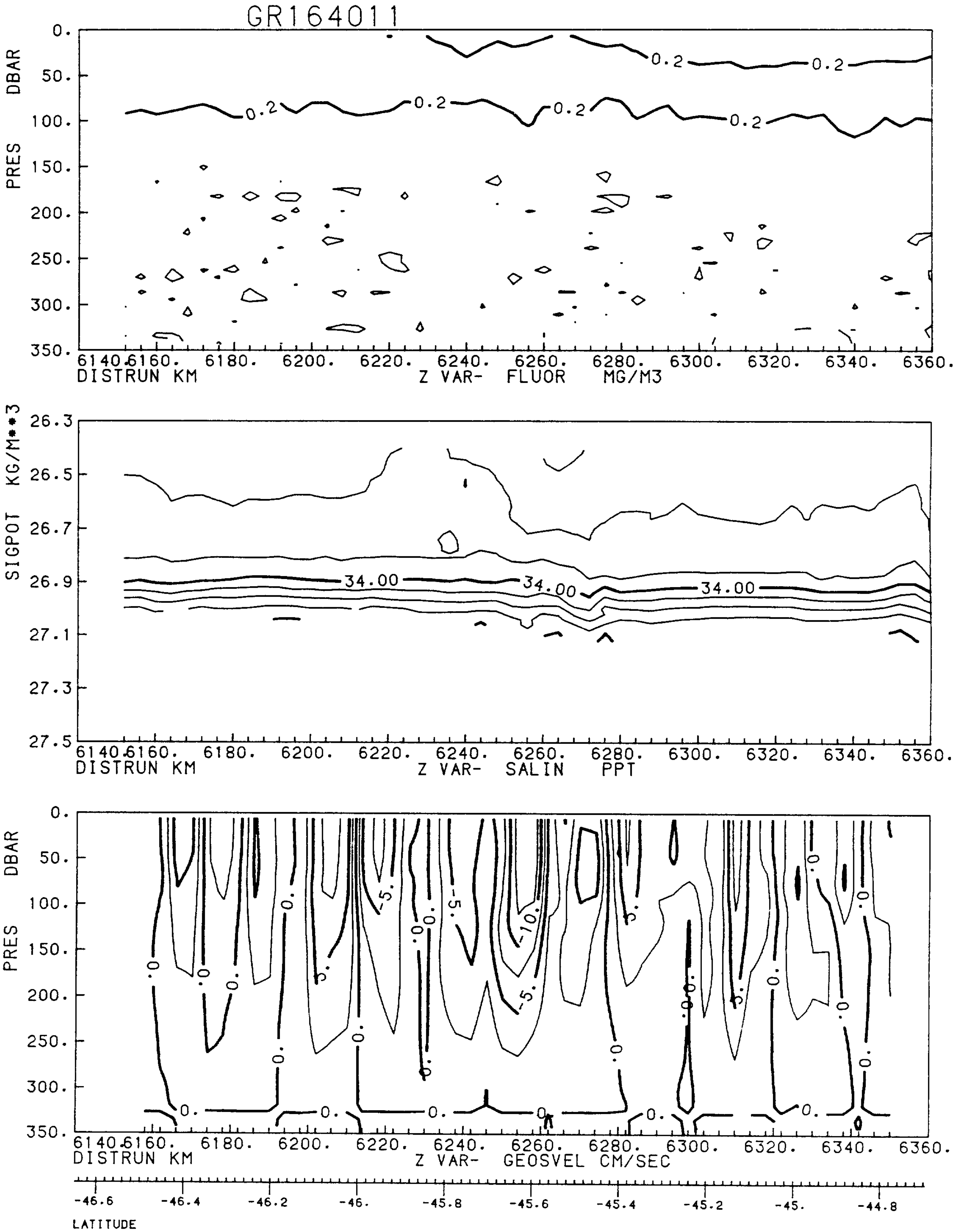


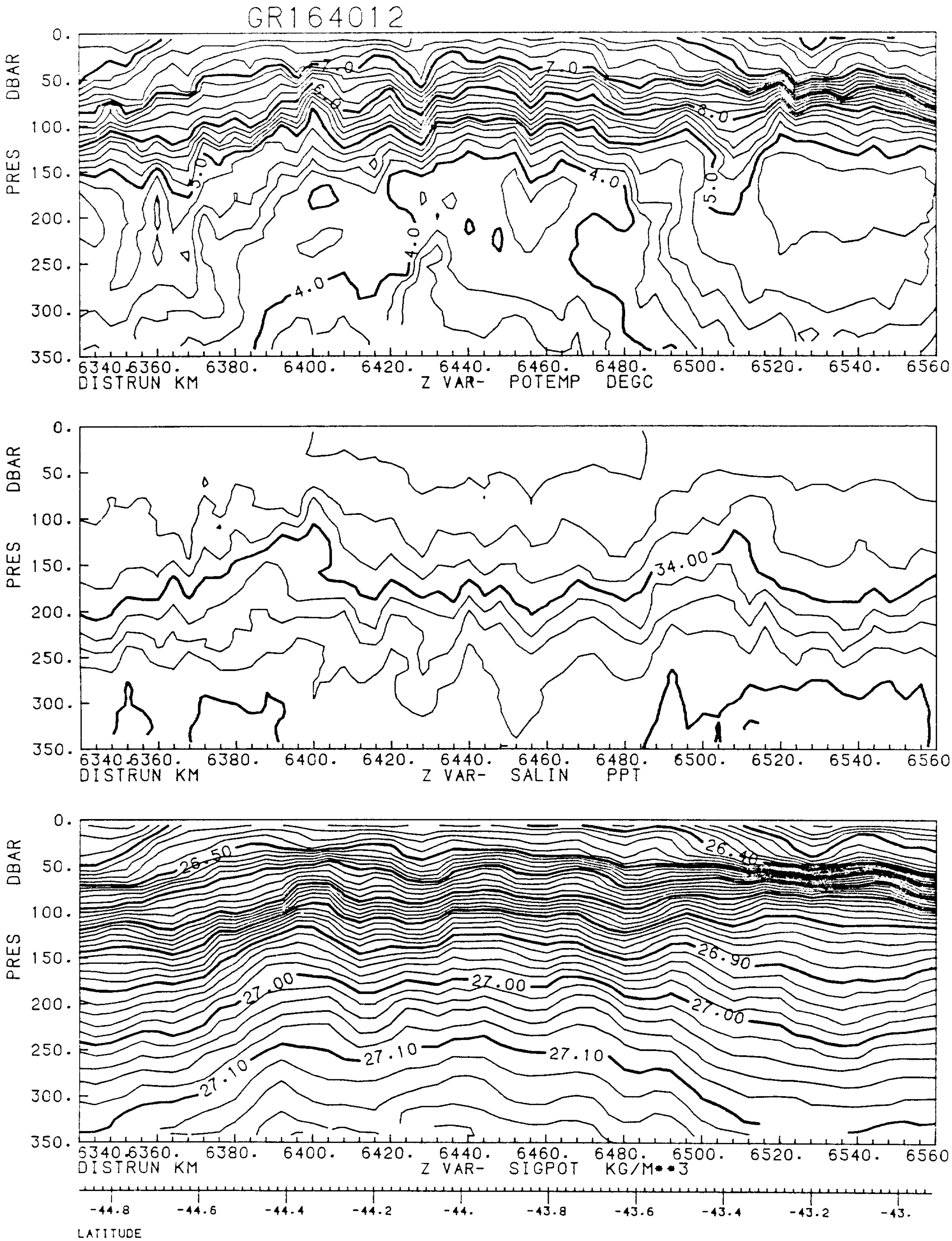
GR164009
PRES DBAR
0.
50.
100.
150.
200.
250.
300.
350.
0.2
5800 5820. 5840. 5860. 5880. 5900. 5920. 5940. 5960. 5980. 6000.
DISTRUN KM
Z VAR- FLUOR MG/M3
SIGPOT KG/M**3
26.3
26.5
26.7
26.9
27.1
27.3
27.5
34.00
5800 5820. 5840. 5860. 5880. 5900. 5920. 5940. 5960. 5980. 6000.
DISTRUN KM
Z VAR- SALIN PPT
PRES DBAR
0.
50.
100.
150.
200.
250.
300.
350.
5.
0.
10.
5800 5820. 5840. 5860. 5880. 5900. 5920. 5940. 5960. 5980. 6000.
DISTRUN KM
Z VAR- GEOSVEL CM/SEC
-49.6
-49.4
-49.2
-49.
-48.8
-48.6
-48.4
-48.2
-48.
LATITUDE


GR164010
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
6.0 7.0 6.0 4.0 4.0 5.0 5.0 5.0 5.0 3.0 3.0 3.0
5980. 6000. 6020. 6040. 6060. 6080. 6100. 6120. 6140. 6160. 6180.
DISTRUN KM
Z VAR- POTEMP DEGC
34.00 34.00 34.00 34.20
Z VAR- SALIN PPT
26.90 26.80 26.90 27.00 26.90 27.00 27.10 27.00
Z VAR- SIGPOT KG/M**3
-48. -47.8 -47.6 -47.4 -47.2 -47. -46.8 -46.6 -46.4
LATITUDE

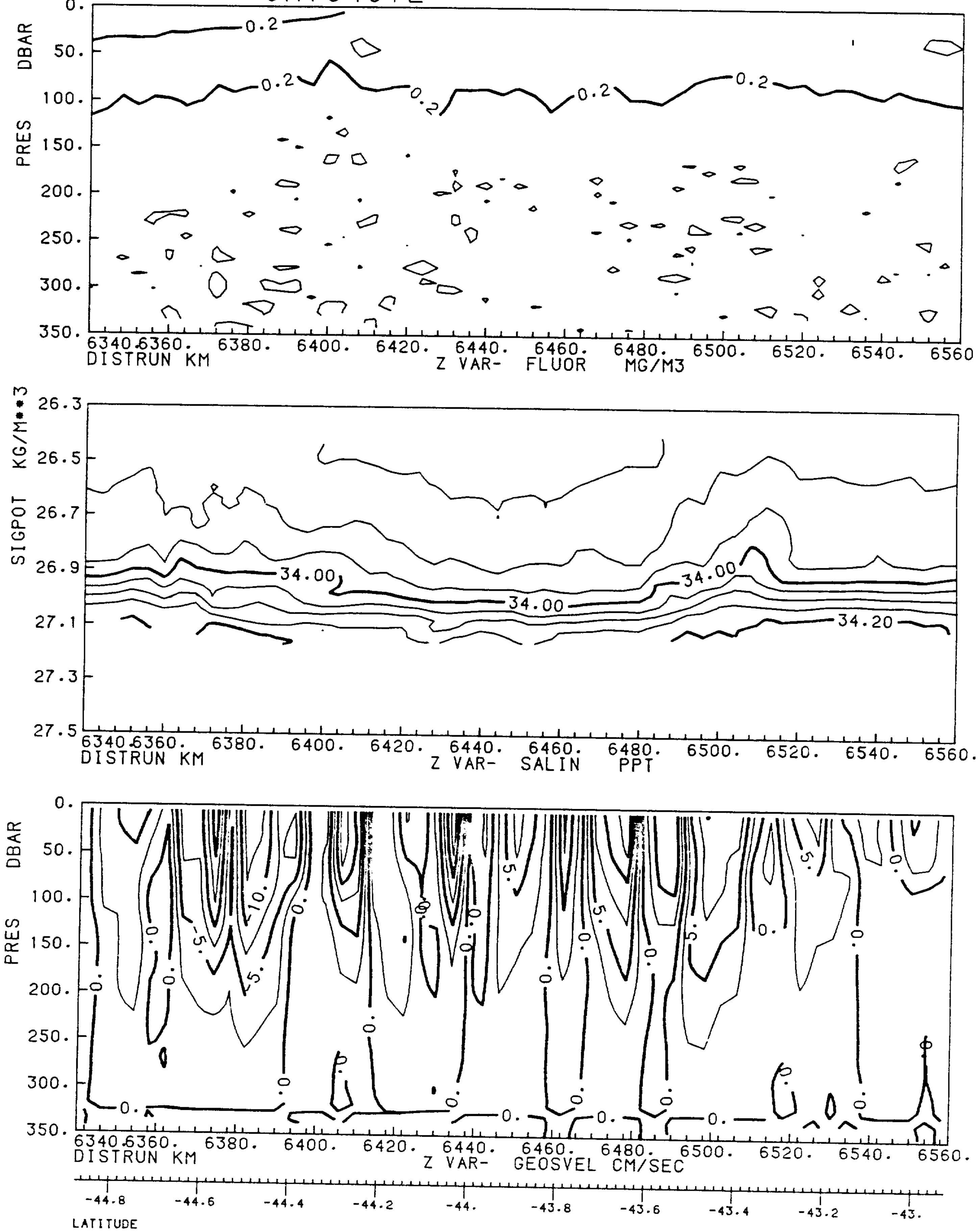

GR164010
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
0.2
5980. 6000. 6020. 6040. 6060. 6080. 6100. 6120. 6140. 6160. 6180.
DISTRUN KM
Z VAR- FLUOR MG/M3
SIGPOT KG/M**3
26.3 26.5 26.7 26.9 27.1 27.3 27.5
34.00
34.20
Z VAR- SALIN PPT
0.
5.
10.
Z VAR- GEOSVEL CM/SEC
-48. -47.8 -47.6 -47.4 -47.2 -47. -46.8 -46.6 -46.4
LATITUDE

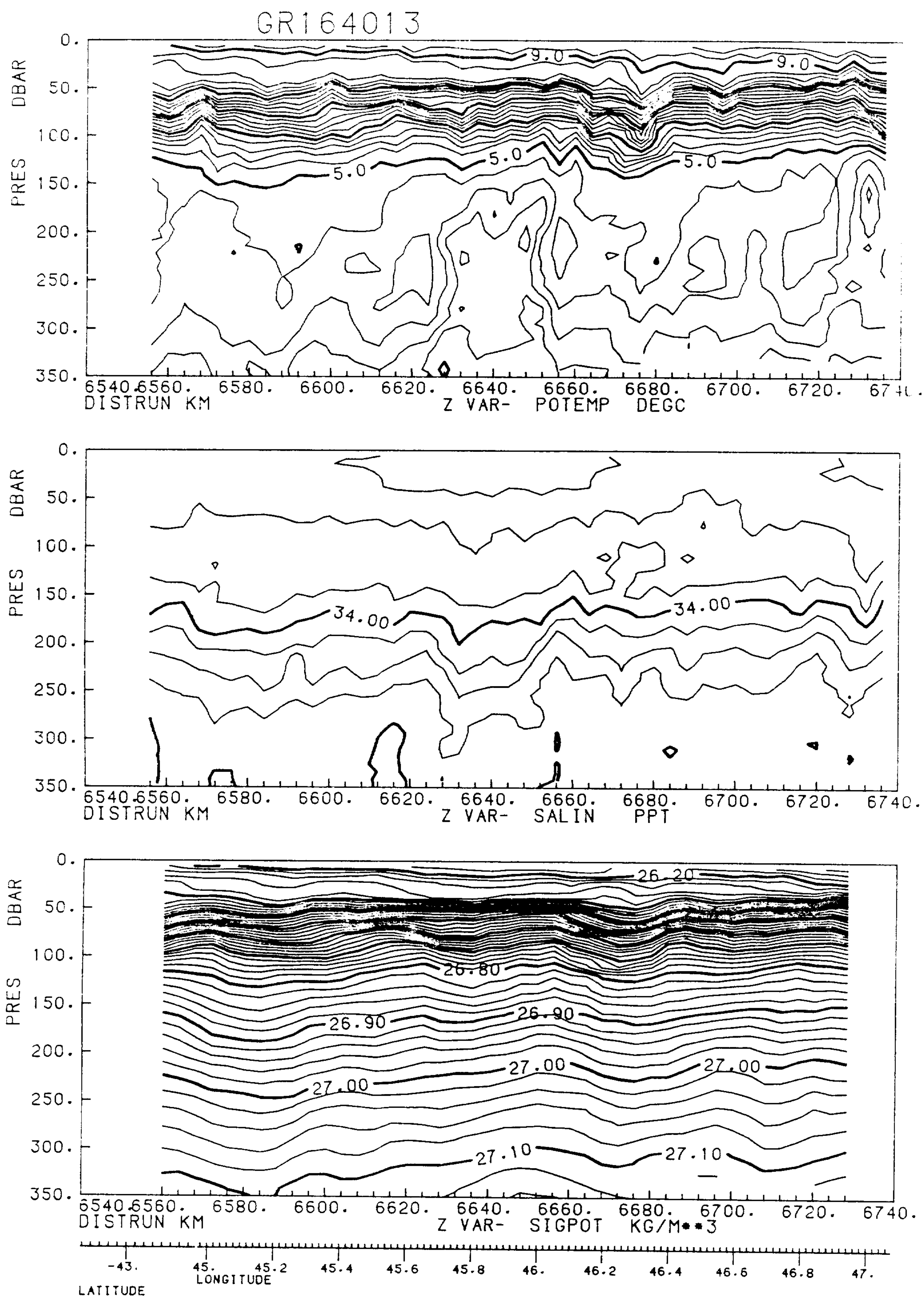

GR164011
PRES DBAR
DISTRUN KM
Z VAR- POTEMP DEGC
8.0
7.0
6.0
5.0
Z VAR- SALIN PPT
34.00
Z VAR- SIGPOT KG/M**3
26.40
26.80
26.90
27.00
27.10
LATITUDE

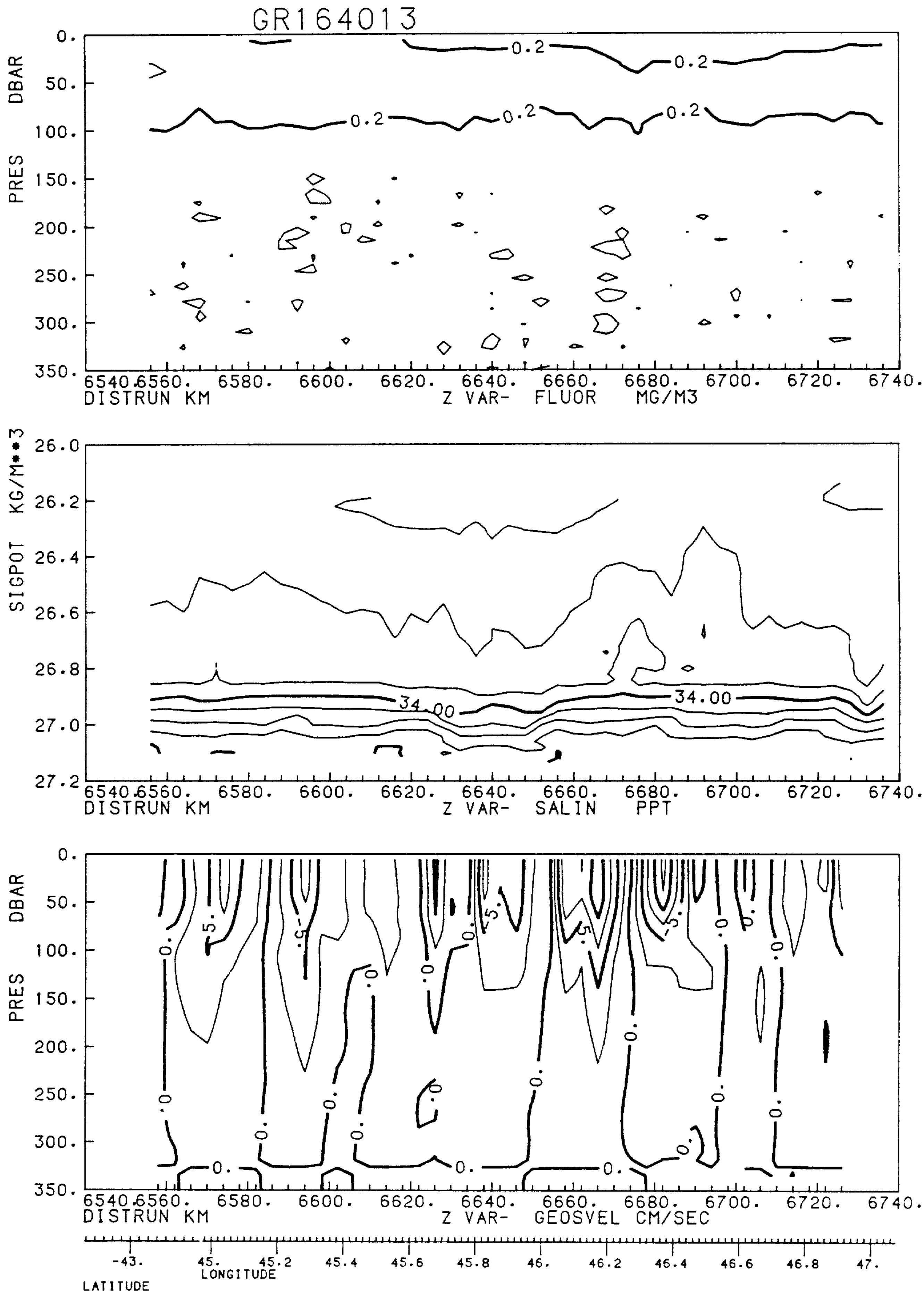

GR164011
0.
50.
100.
150.
200.
250.
300.
350.
PRES DBAR
0.2
6140.6160. 6180. 6200. 6220. 6240. 6260. 6280. 6300. 6320. 6340. 6360.
DISTRUN KM
Z VAR- FLUOR MG/M3
26.3
26.5
26.7
26.9
27.1
27.3
27.5
SIGPOT KG/M**3
34.00
DISTRUN KM
Z VAR- SALIN PPT
PRES DBAR
0.
-5.
-10.
5.
DISTRUN KM
Z VAR- GEOSVEL CM/SEC
-46.6 -46.4 -46.2 -46. -45.8 -45.6 -45.4 -45.2 -45. -44.8
LATITUDE

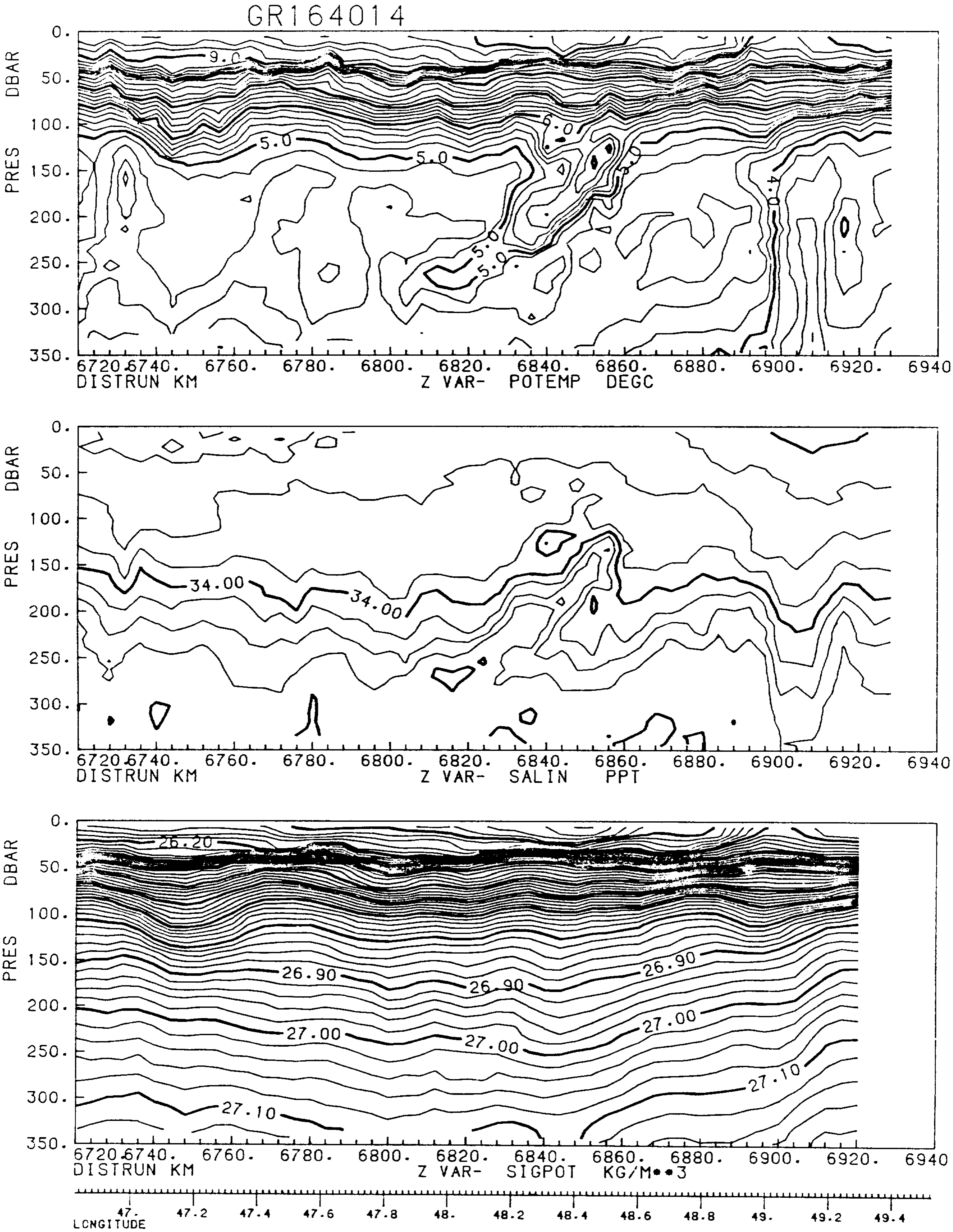

GR164012
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
7.0
7.0
6.0
6.0
5.0
5.0
4.0
4.0
4.0
6340. 6360. 6380. 6400. 6420. 6440. 6460. 6480. 6500. 6520. 6540. 6560.
DISTRUN KM
Z VAR- POTEMP DEGC
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
34.00
6340. 6360. 6380. 6400. 6420. 6440. 6460. 6480. 6500. 6520. 6540. 6560
DISTRUN KM
Z VAR- SALIN PPT
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
26.50
26.40
26.90
27.00
27.00
27.00
27.10
27.10
27.10
6340. 6360. 6380. 6400. 6420. 6440. 6460. 6480. 6500. 6520. 6540. 6560
DISTRUN KM
Z VAR- SIGPOT KG/M**3
-44.8 -44.6 -44.4 -44.2 -44. -43.8 -43.6 -43.4 -43.2 -43.
LATITUDE

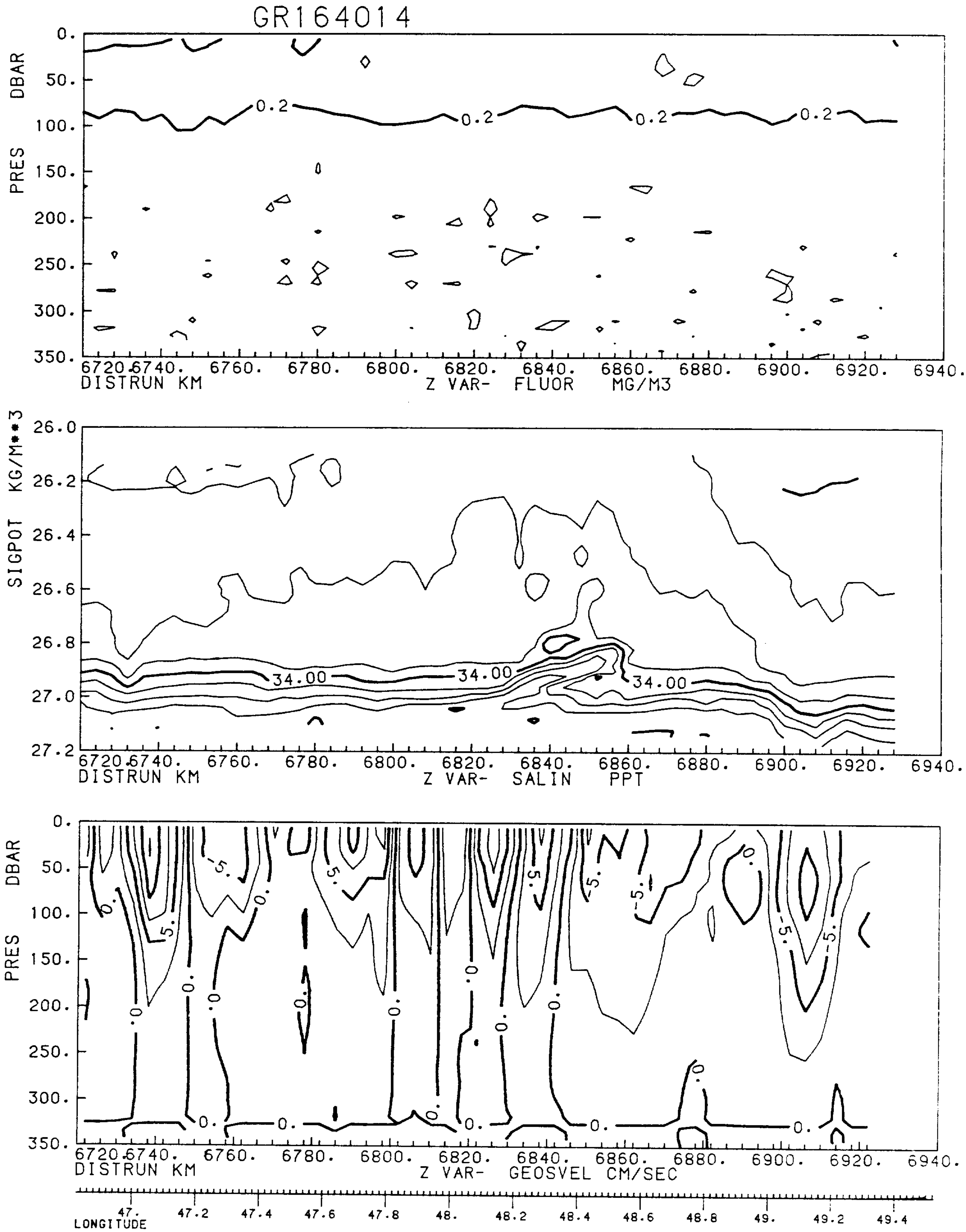
GR164012

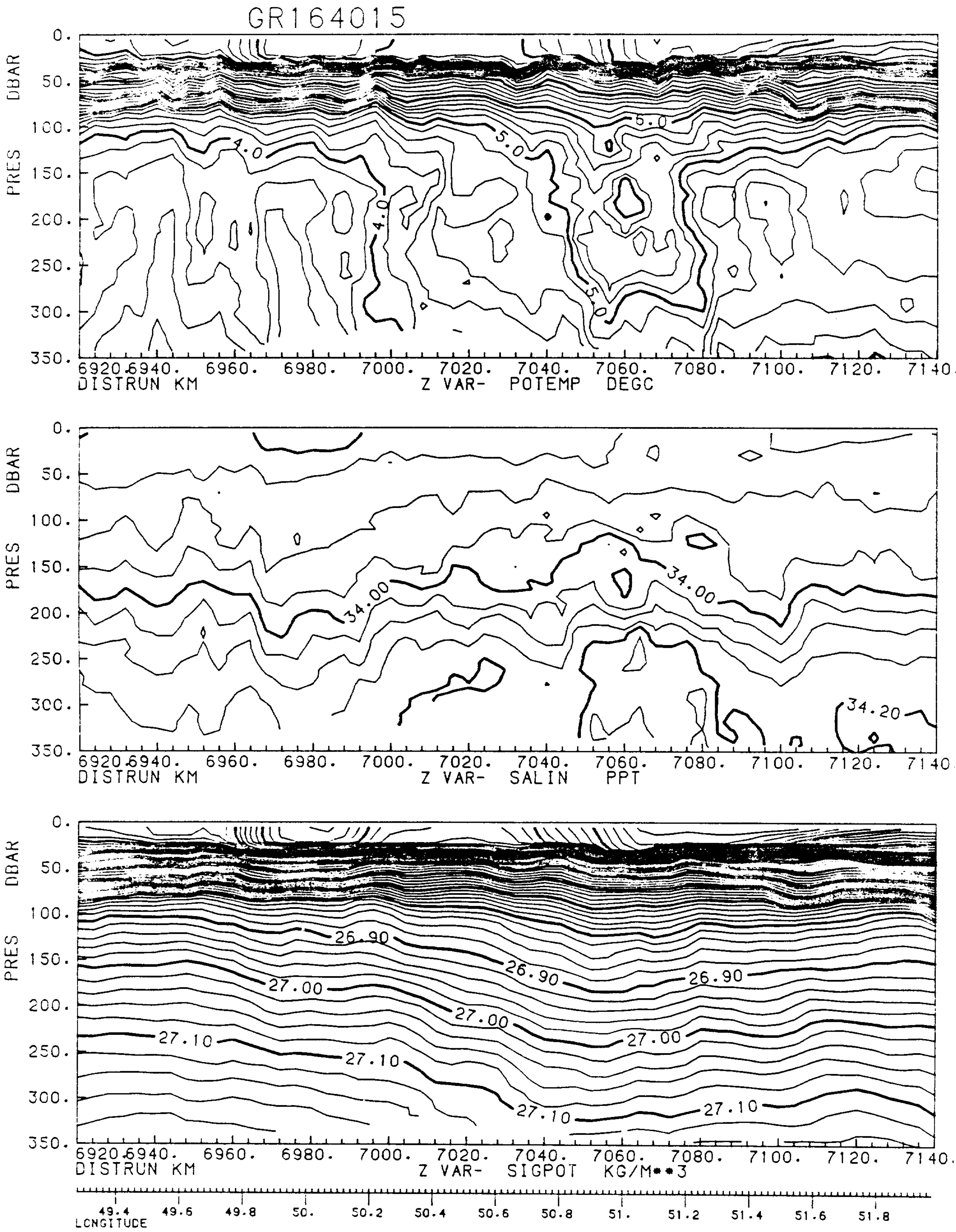

PRES DBAR
0.
50.
100.
150.
200.
250.
300.
350.
0.2
6340. 6360. 6380. 6400. 6420. 6440. 6460. 6480. 6500. 6520. 6540. 6560.
DISTRUN KM
Z VAR- FLUOR MG/M3
SIGPOT KG/M**3
26.3
26.5
26.7
26.9
27.1
27.3
27.5
34.00
34.20
6340. 6360. 6380. 6400. 6420. 6440. 6460. 6480. 6500. 6520. 6540. 6560.
DISTRUN KM
Z VAR- SALIN PPT
PRES DBAR
0.
50.
100.
150.
200.
250.
300.
350.
0.
5.
-5.
10.
6340. 6360. 6380. 6400. 6420. 6440. 6460. 6480. 6500. 6520. 6540. 6560.
DISTRUN KM
Z VAR- GEOSVEL CM/SEC
-44.8 -44.6 -44.4 -44.2 -44. -43.8 -43.6 -43.4 -43.2 -43.
LATITUDE

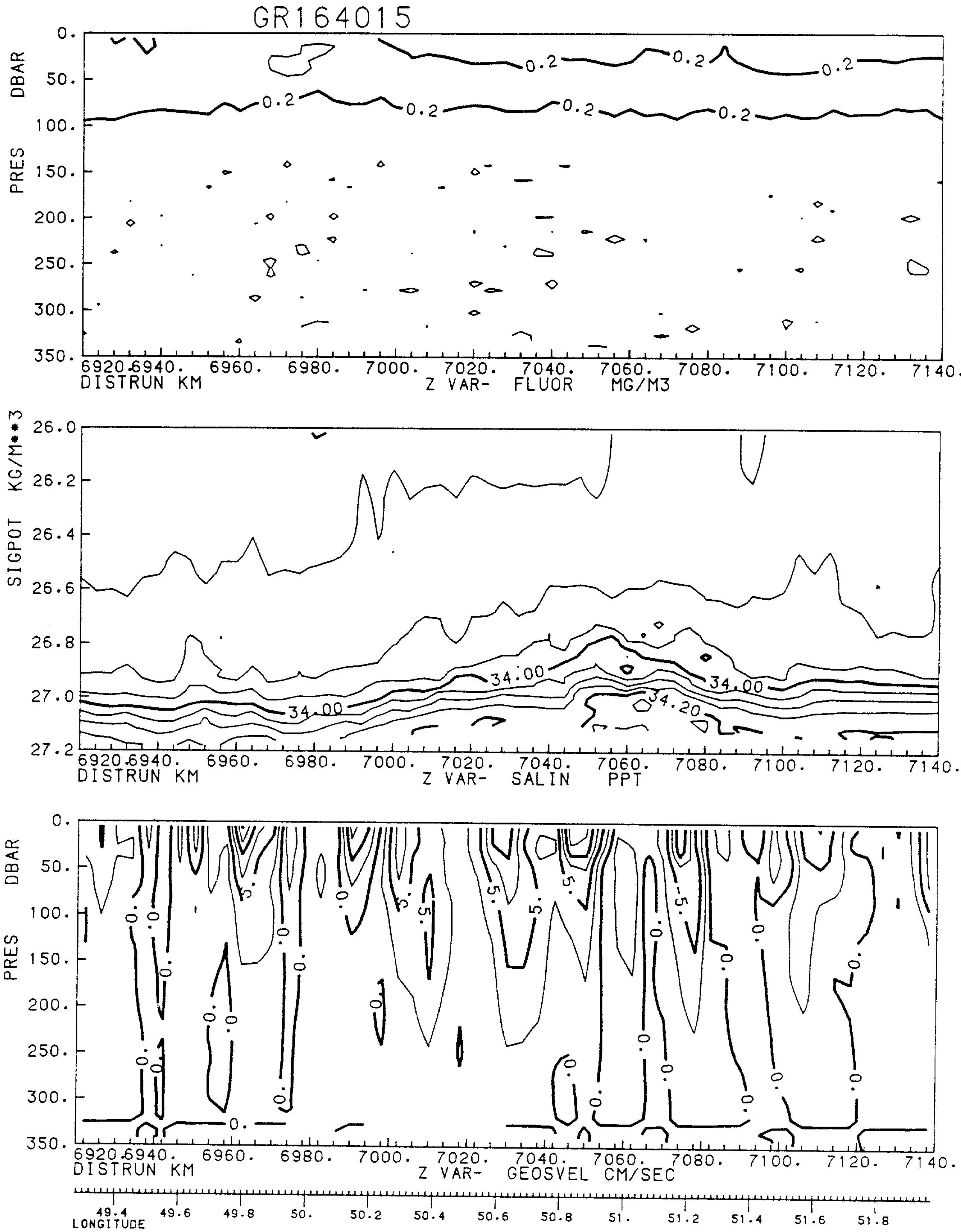

GR164013
PRES DBAR
DISTRUN KM
Z VAR- POTEMP DEGC
9.0
5.0
Z VAR- SALIN PPT
34.00
Z VAR- SIGPOT KG/M**3
26.20
26.80
26.90
27.00
27.10
LONGITUDE
LATITUDE

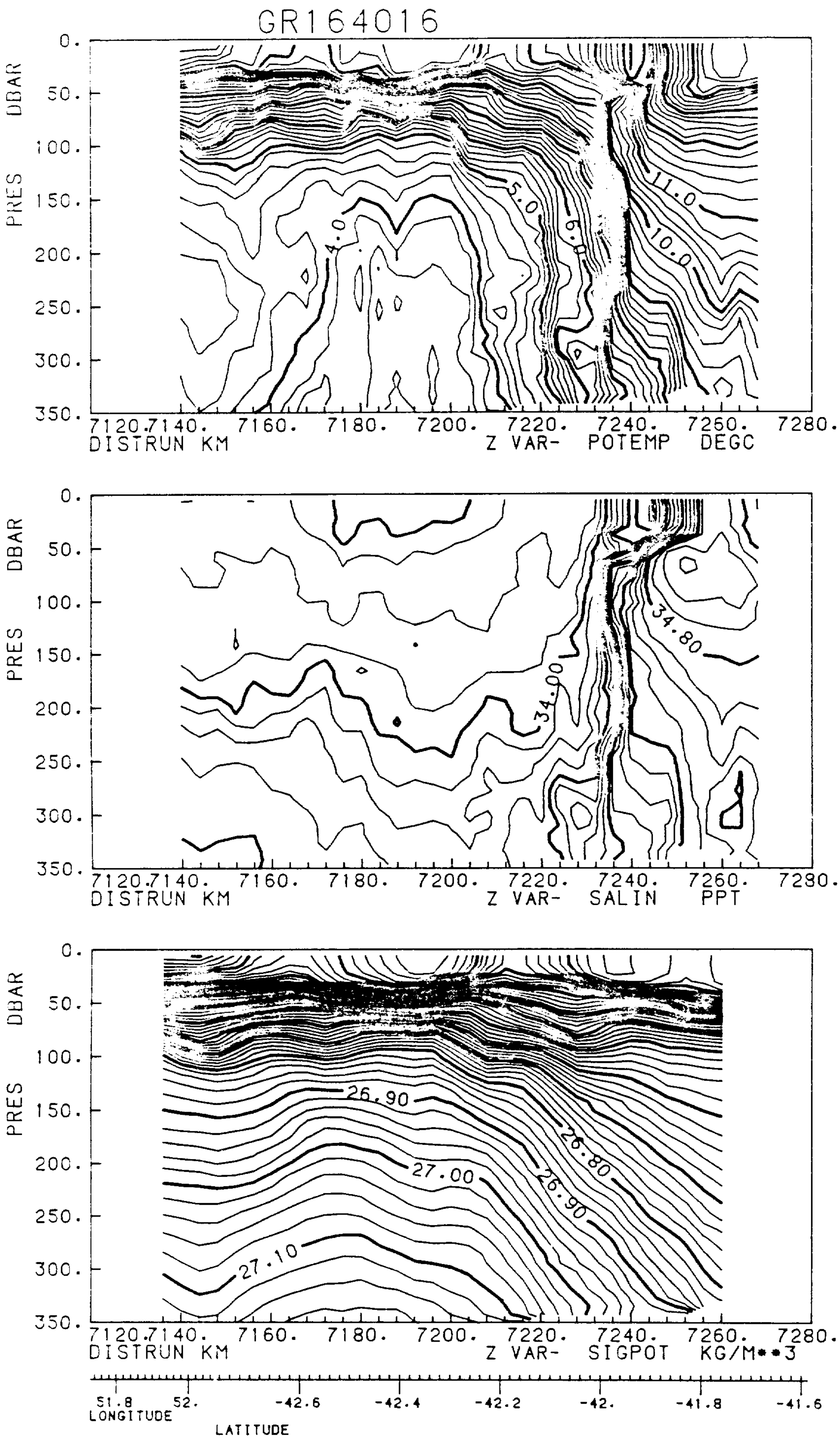

GR164013
PRES DBAR
0.2
DISTRUN KM
Z VAR- FLUOR MG/M3
SIGPOT KG/M**3
34.00
Z VAR- SALIN PPT
Z VAR- GEOSVEL CM/SEC
LONGITUDE
LATITUDE

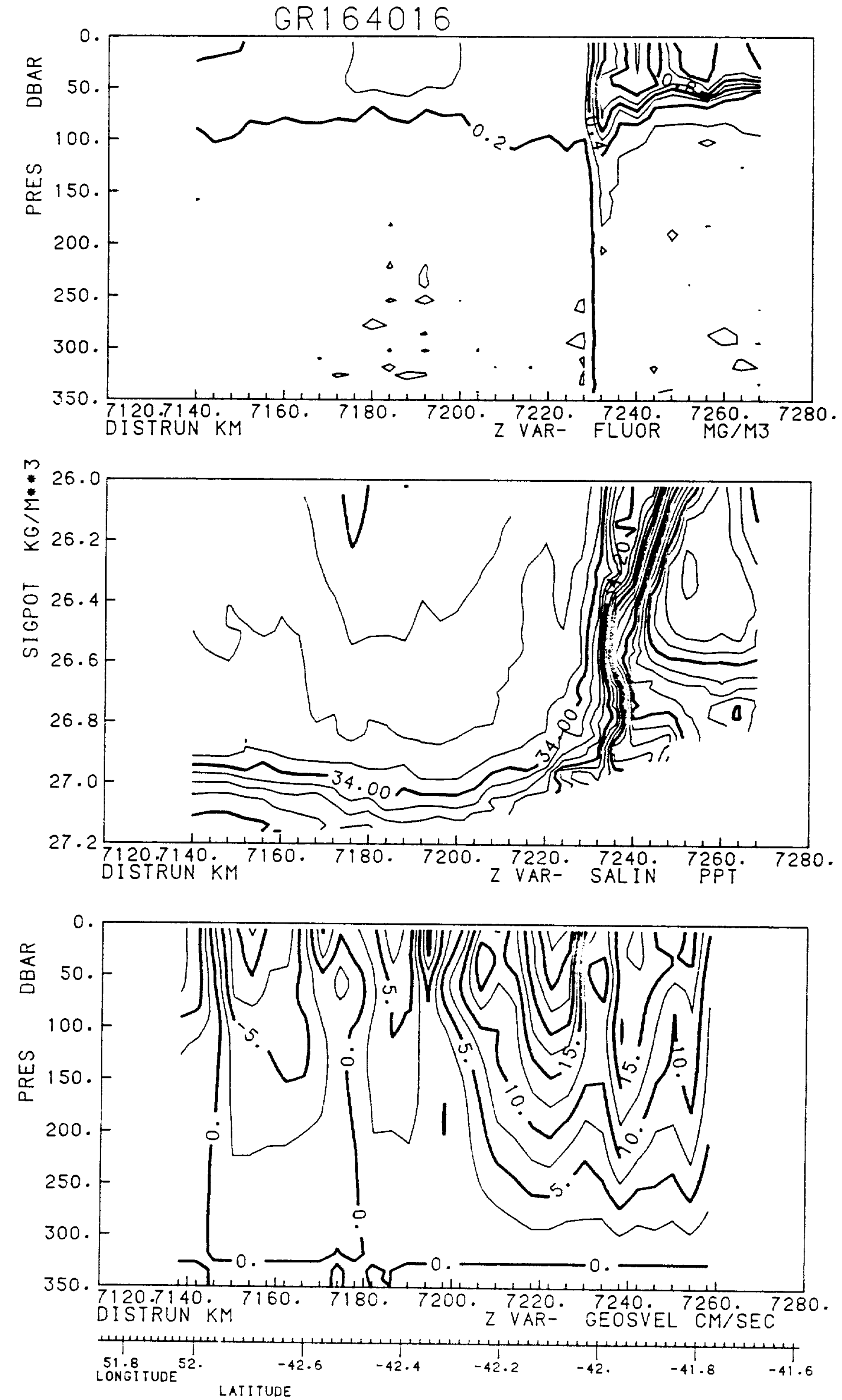

GR164014
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
9.0
5.0
6.0
6720. 6740. 6760. 6780. 6800. 6820. 6840. 6860. 6880. 6900. 6920. 6940
DISTRUN KM
Z VAR- POTEMP DEGC
34.00
Z VAR- SALIN PPT
26.20
26.90
27.00
27.10
Z VAR- SIGPOT KG/M**3
47. 47.2 47.4 47.6 47.8 48. 48.2 48.4 48.6 48.8 49. 49.2 49.4
LONGITUDE

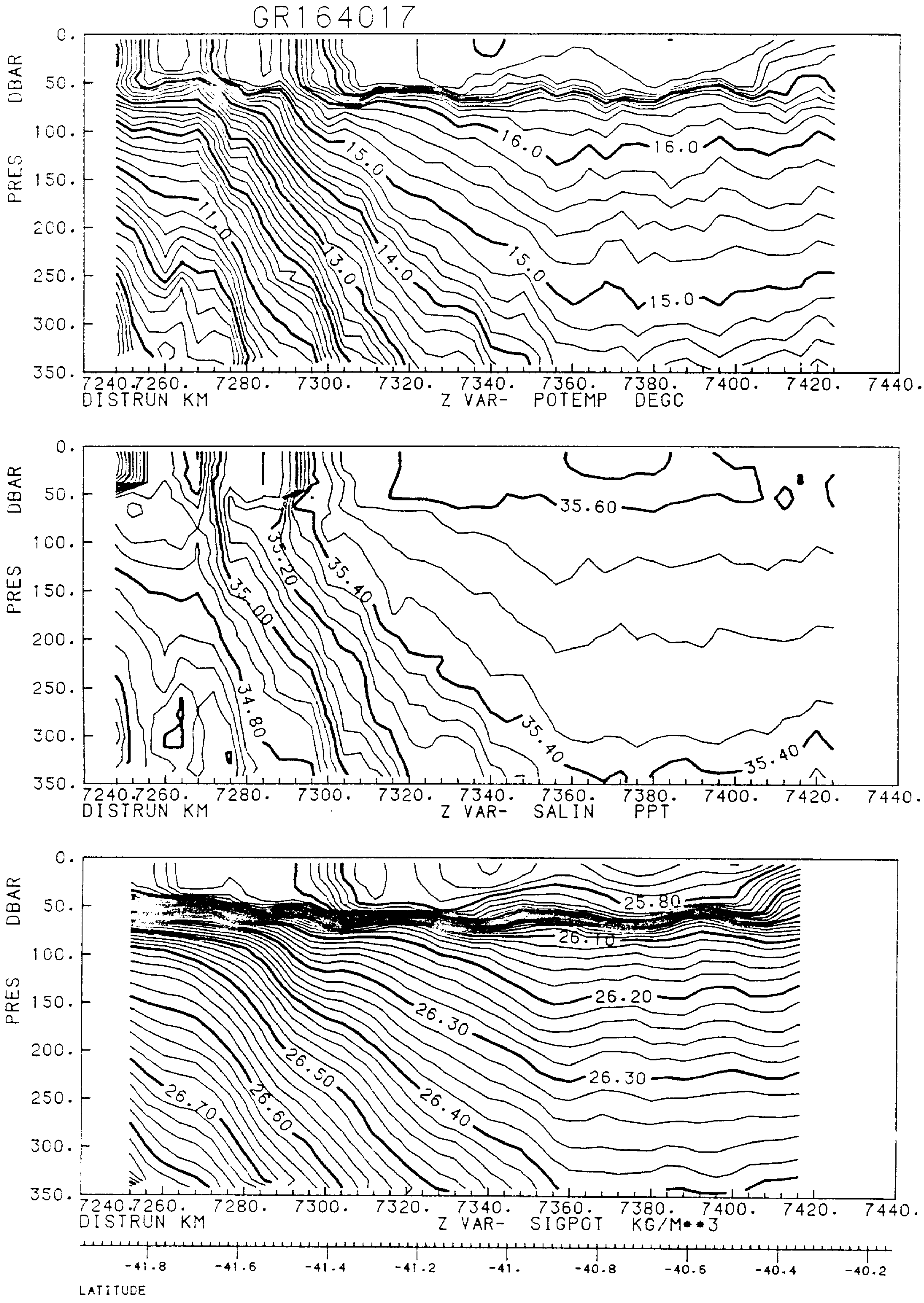

GR164014
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
0.2
6720. 6740. 6760. 6780. 6800. 6820. 6840. 6860. 6880. 6900. 6920. 6940.
DISTRUN KM
Z VAR- FLUOR MG/M3
SIGPOT KG/M**3
26.0 26.2 26.4 26.6 26.8 27.0 27.2
34.00
6720. 6740. 6760. 6780. 6800. 6820. 6840. 6860. 6880. 6900. 6920. 6940.
DISTRUN KM
Z VAR- SALIN PPT
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
0. -5. 5.
6720. 6740. 6760. 6780. 6800. 6820. 6840. 6860. 6880. 6900. 6920. 6940.
DISTRUN KM
Z VAR- GEOSVEL CM/SEC
47. 47.2 47.4 47.6 47.8 48. 48.2 48.4 48.6 48.8 49. 49.2 49.4
LONGITUDE

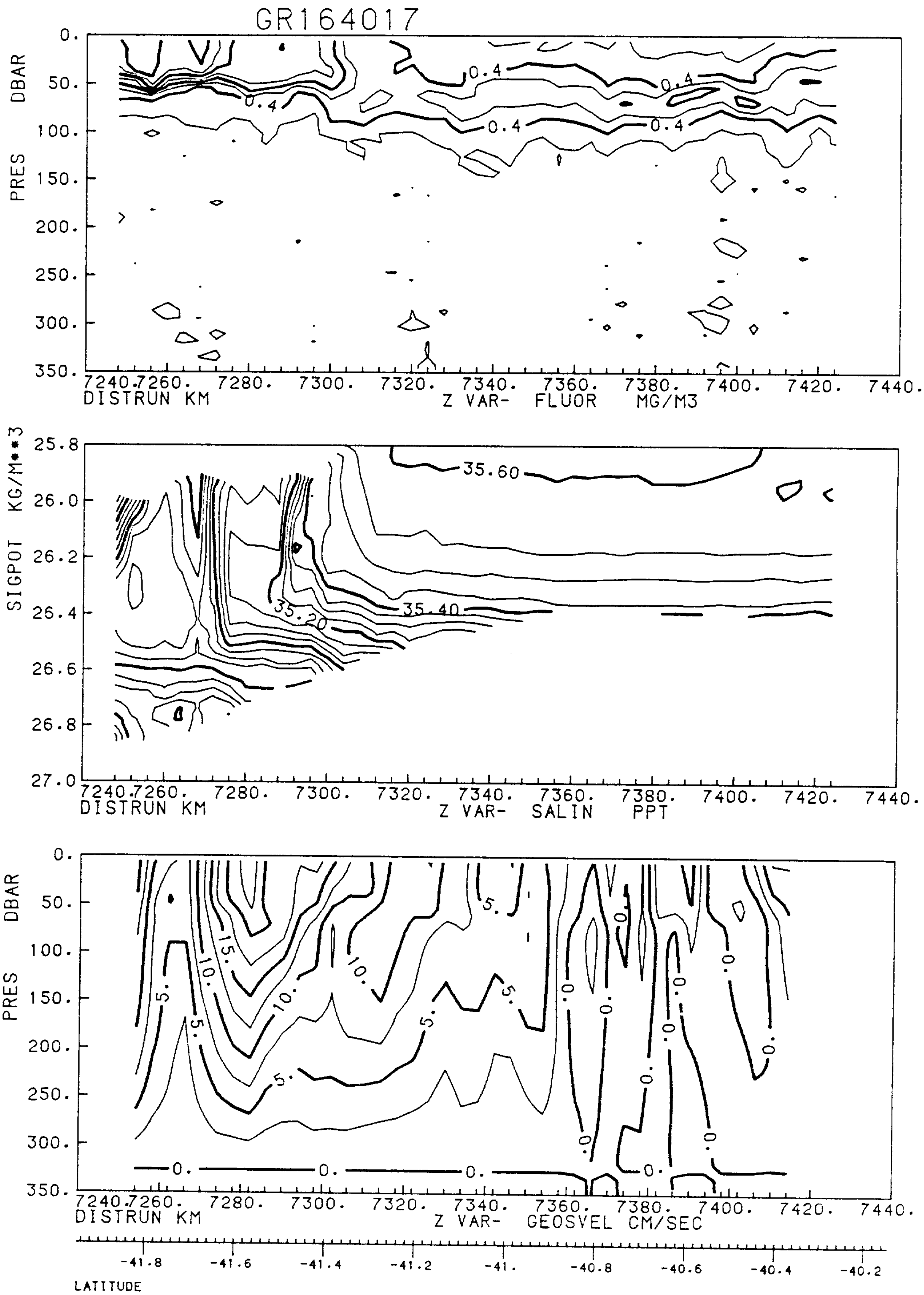

GR164015
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
4.0
5.0
6920.6940. 6960. 6980. 7000. 7020. 7040. 7060. 7080. 7100. 7120. 7140.
DISTRUN KM
Z VAR- POTEMP DEGC
34.00
34.20
Z VAR- SALIN PPT
26.90
27.00
27.10
Z VAR- SIGPOT KG/M**3
49.4 49.6 49.8 50. 50.2 50.4 50.6 50.8 51. 51.2 51.4 51.6 51.8
LONGITUDE

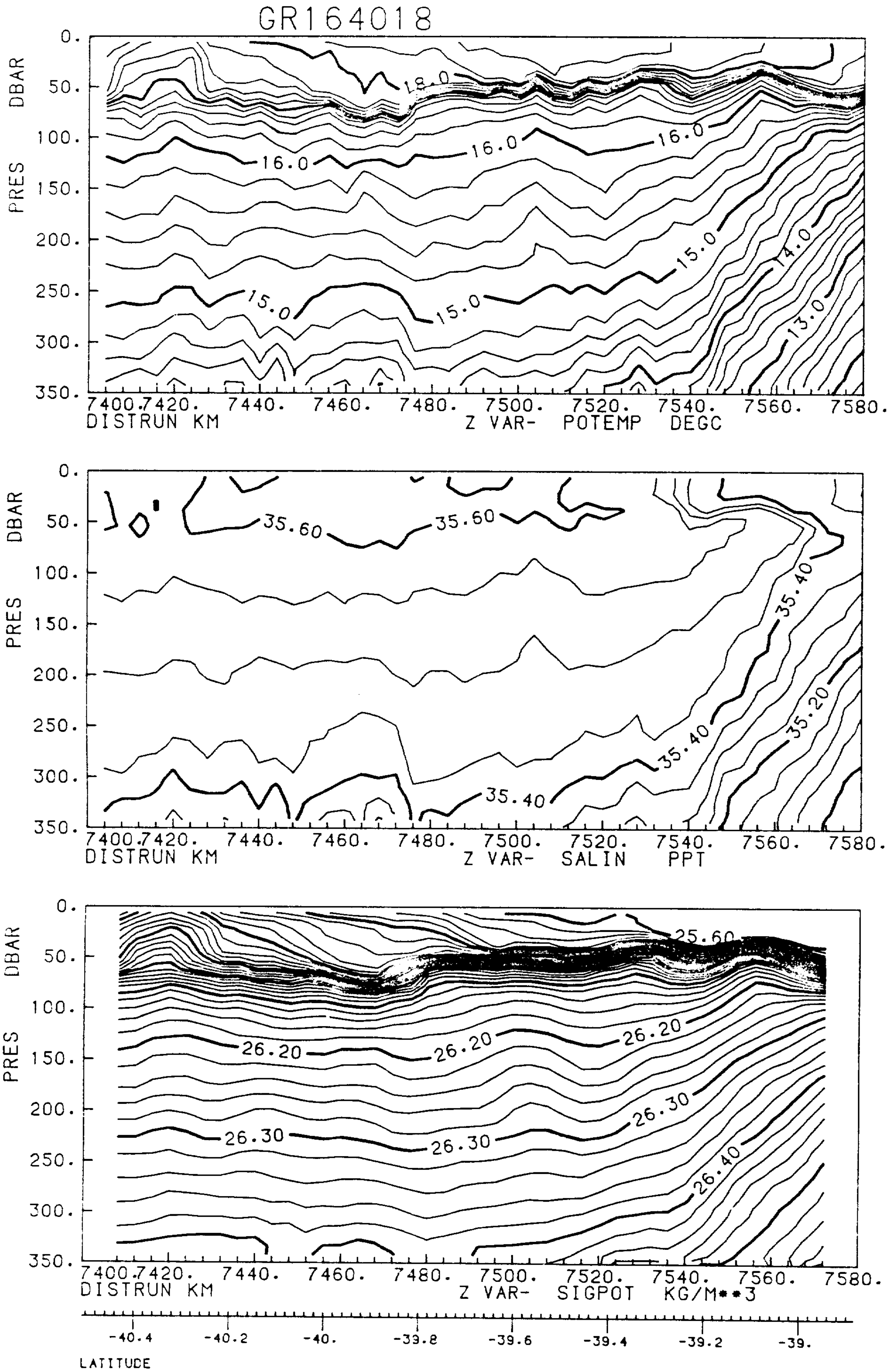

GR164015
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
0.2
6920. 6940. 6960. 6980. 7000. 7020. 7040. 7060. 7080. 7100. 7120. 7140.
DISTRUN KM
Z VAR- FLUOR MG/M3
SIGPOT KG/M**3
26.0 26.2 26.4 26.6 26.8 27.0 27.2
34.00
34.20
Z VAR- SALIN PPT
5.
0.
Z VAR- GEOSVEL CM/SEC
49.4 49.6 49.8 50. 50.2 50.4 50.6 50.8 51. 51.2 51.4 51.6 51.8
LONGITUDE

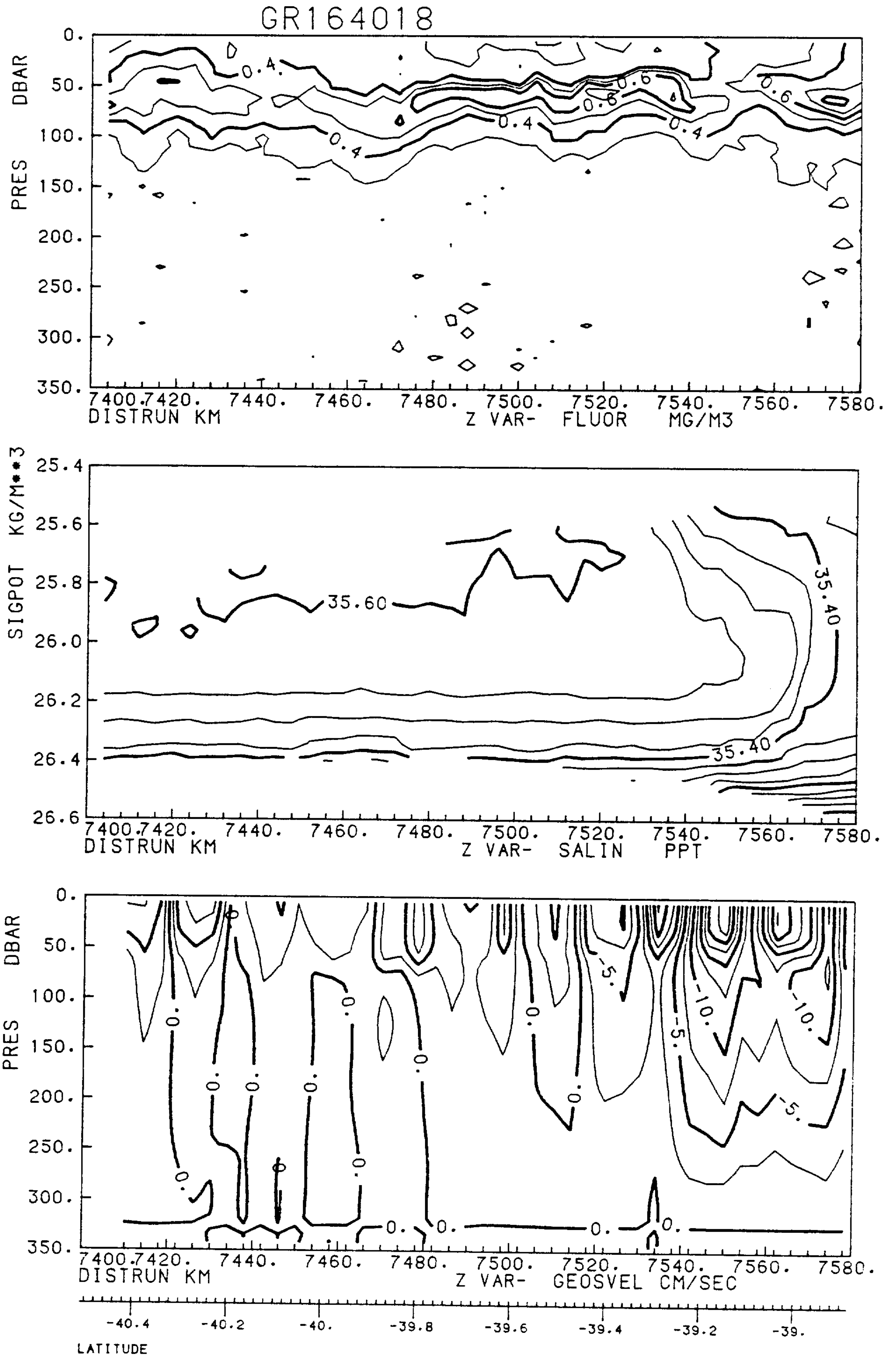

GR164016
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
4.0
5.0
6.0
11.0
10.0
7120.7140. 7160. 7180. 7200. 7220. 7240. 7260. 7280.
DISTRUN KM
Z VAR- POTEMP DEGC
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
34.00
34.80
7120.7140. 7160. 7180. 7200. 7220. 7240. 7260. 7280.
DISTRUN KM
Z VAR- SALIN PPT
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
26.90
26.80
27.00
26.90
27.10
7120.7140. 7160. 7180. 7200. 7220. 7240. 7260. 7280.
DISTRUN KM
Z VAR- SIGPOT KG/M**3
51.8 52. -42.6 -42.4 -42.2 -42. -41.8 -41.6
LONGITUDE
LATITUDE

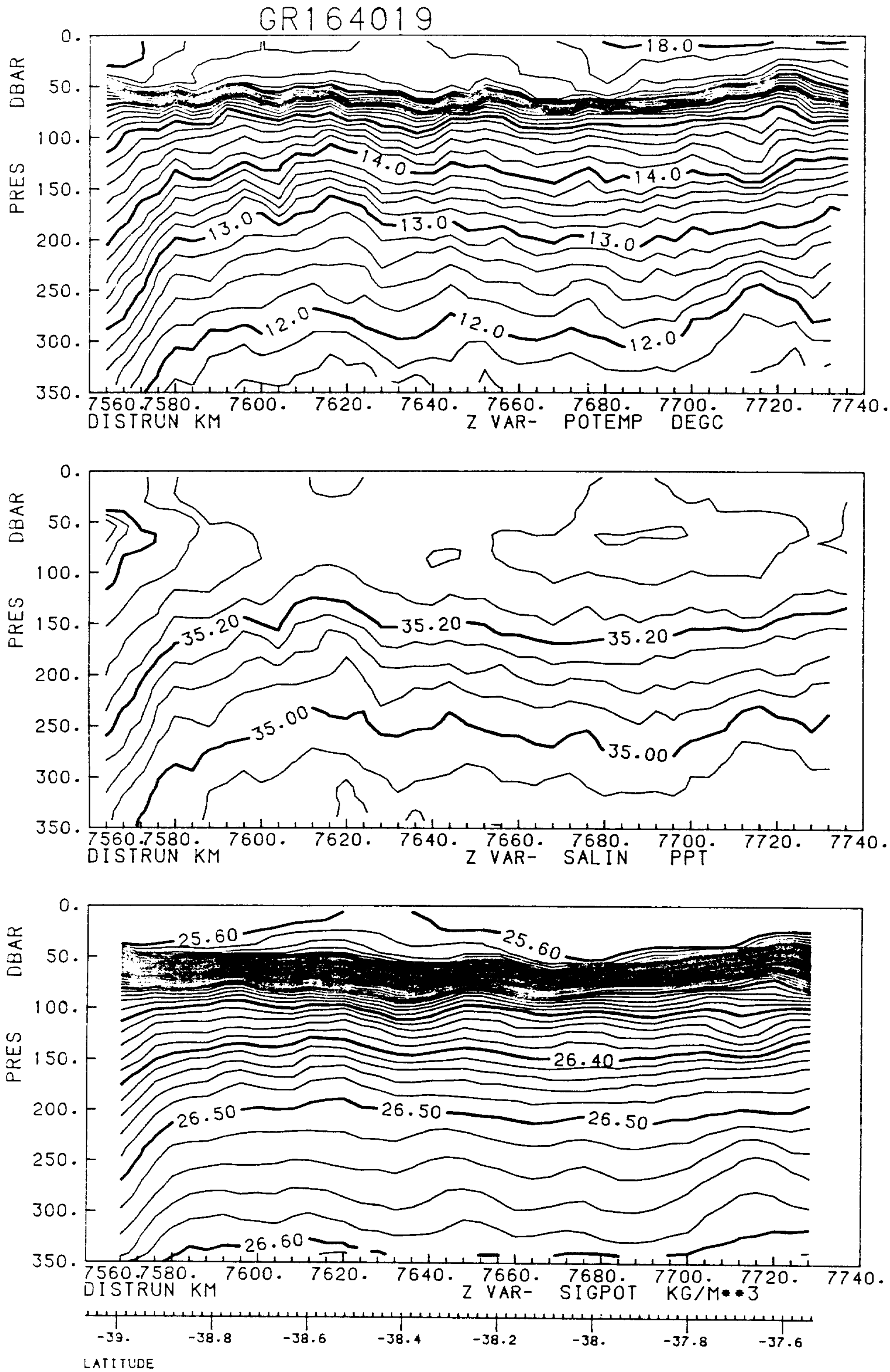

GR164016
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
7120. 7140. 7160. 7180. 7200. 7220. 7240. 7260. 7280.
DISTRUN KM
Z VAR- FLUOR MG/M3
0.2
0.8
SIGPOT KG/M**3
26.0 26.2 26.4 26.6 26.8 27.0 27.2
Z VAR- SALIN PPT
34.00
Z VAR- GEOSVEL CM/SEC
0.
5.
10.
15.
51.8 52.
LONGITUDE
-42.6 -42.4 -42.2 -42. -41.8 -41.6
LATITUDE

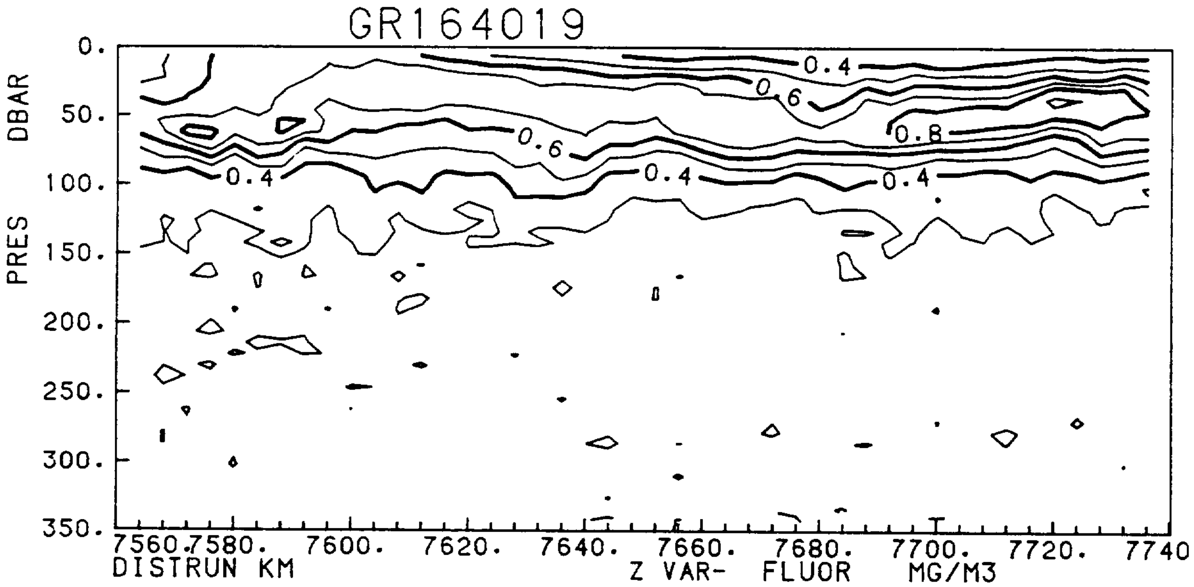

GR164017
PRES DBAR
DISTRUN KM
Z VAR- POTEMP DEGC
16.0
15.0
14.0
13.0
11.0
Z VAR- SALIN PPT
35.60
35.40
35.20
35.00
34.80
Z VAR- SIGPOT KG/M**3
25.80
26.10
26.20
26.30
26.40
26.50
26.60
26.70
LATITUDE

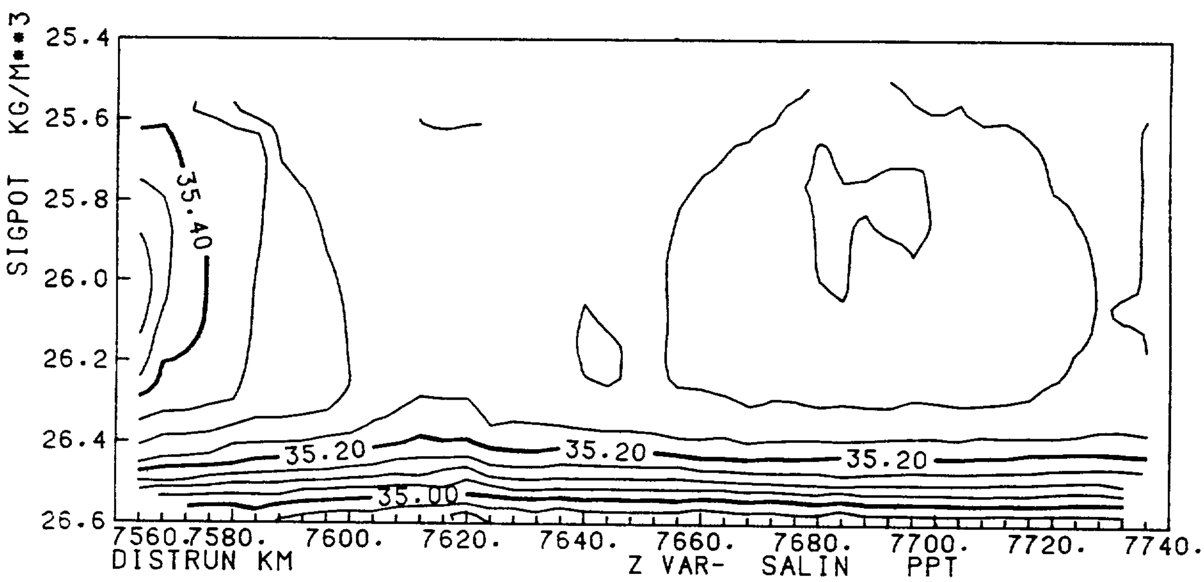

GR164017
PRES DBAR
DISTRUN KM
Z VAR- FLUOR MG/M3
SIGPOT KG/M**3
Z VAR- SALIN PPT
Z VAR- GEOSVEL CM/SEC
LATITUDE

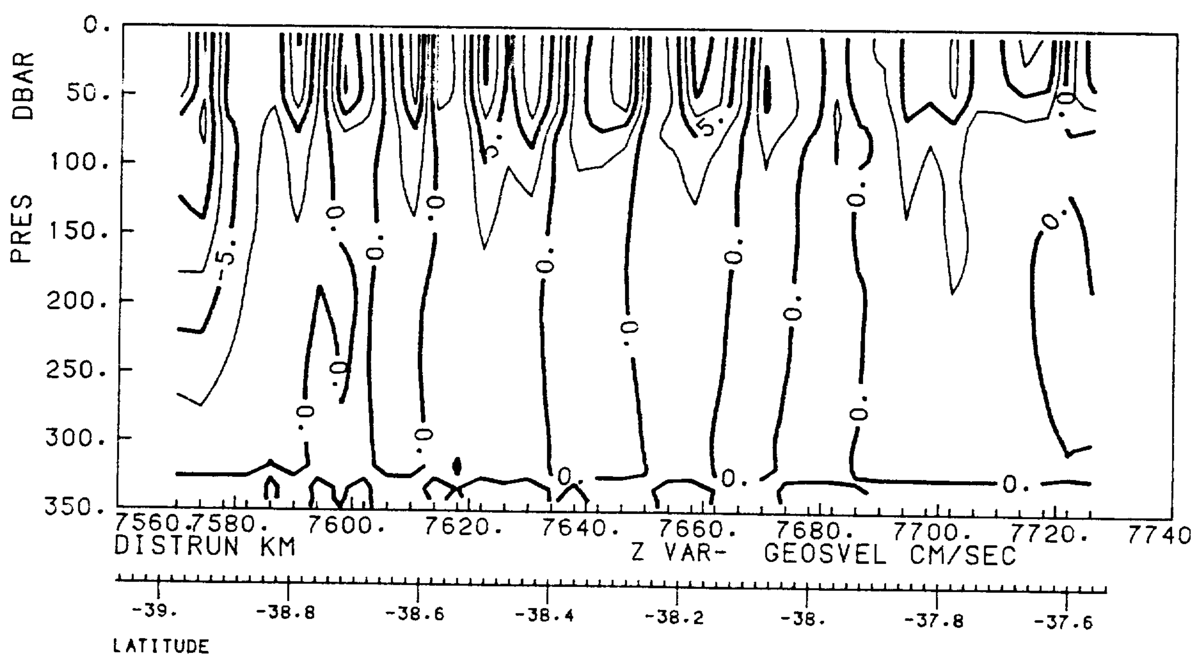

GR164018
0.
50.
100.
150.
200.
250.
300.
350.
PRES DBAR
18.0
16.0
16.0
16.0
15.0
15.0
15.0
15.0
14.0
13.0
7400.7420. 7440. 7460. 7480. 7500. 7520. 7540. 7560. 7580.
DISTRUN KM
Z VAR- POTEMP DEGC
35.60
35.60
35.40
35.40
35.40
35.20
Z VAR- SALIN PPT
25.60
26.20
26.20
26.20
26.30
26.30
26.30
26.40
Z VAR- SIGPOT KG/M**3
-40.4
-40.2
-40.
-39.8
-39.6
-39.4
-39.2
-39.
LATITUDE


GR164018
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
0.4 0.6 0.4 0.4 0.6 0.6 0.4 0.4
7400. 7420. 7440. 7460. 7480. 7500. 7520. 7540. 7560. 7580.
DISTRUN KM
Z VAR- FLUOR MG/M3
SIGPOT KG/M**3
25.4 25.6 25.8 26.0 26.2 26.4 26.6
35.60 35.40 35.40
7400. 7420. 7440. 7460. 7480. 7500. 7520. 7540. 7560. 7580.
DISTRUN KM
Z VAR- SALIN PPT
PRES DBAR
0. 50. 100. 150. 200. 250. 300. 350.
0. -5. -10. -5. -10. -5.
7400. 7420. 7440. 7460. 7480. 7500. 7520. 7540. 7560. 7580.
DISTRUN KM
Z VAR- GEOSVEL CM/SEC
-40.4 -40.2 -40. -39.8 -39.6 -39.4 -39.2 -39.
LATITUDE


GR164019
0.
50.
100.
150.
200.
250.
300.
350.
PRES DBAR
18.0
14.0
13.0
12.0
7560.7580. 7600. 7620. 7640. 7660. 7680. 7700. 7720. 7740.
DISTRUN KM
Z VAR- POTEMP DEGC
35.20
35.00
Z VAR- SALIN PPT
25.60
26.40
26.50
26.60
Z VAR- SIGPOT KG/M**3
-39. -38.8 -38.6 -38.4 -38.2 -38. -37.8 -37.6
LATITUDE


GR164019
PRES DBAR
0.
50.
100.
150.
200.
250.
300.
350.
0.4
0.6
0.8
0.6
0.4
0.4
0.4
7560.7580. 7600. 7620. 7640. 7660. 7680. 7700. 7720. 7740.
DISTRUN KM
Z VAR- FLUOR MG/M3


SIGPOT KG/M**3
25.4
25.6
25.8
26.0
26.2
26.4
26.6
35.40
35.20
35.20
35.20
35.00
7560.7580. 7600. 7620. 7640. 7660. 7680. 7700. 7720. 7740.
DISTRUN KM
Z VAR- SALIN PPT


PRES DBAR
0.
50.
100.
150.
200.
250.
300.
350.
-5.
5.
0.
7560.7580. 7600. 7620. 7640. 7660. 7680. 7700. 7720. 7740.
DISTRUN KM
Z VAR- GEOSVEL CM/SEC
-39.
-38.8
-38.6
-38.4
-38.2
-38.
-37.8
-37.6
LATITUDE