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A TEST OF THE CLIMATIC NORMALITY OF SYNTHETIC PROFILES OF ATMOS--ETC(U)
JUL 79 Y IZUMI , C N TOUART

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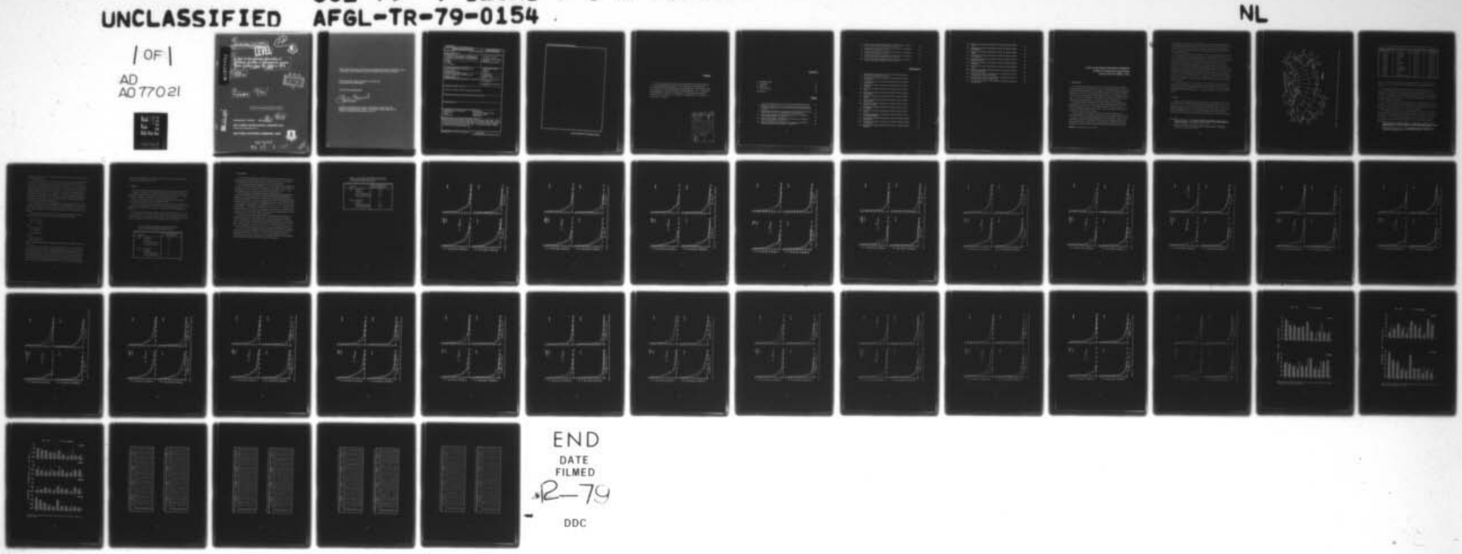

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A Test of the Climatic Normality of Synthetic Profiles of Atmospheric Liquid Water Content Over the USSR in 1973

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This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

John Howard

Chief Scientist

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To test the climatic normality of profiles of atmospheric liquid water content generated from conventional weather data for 11 stations in the USSR, profiles for the mid-seasonal months of 1973 were compared with profiles randomly selected from the 5-year period 1968-1972. No cause was found to suspect that 1973 was climatically atypical.

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Preface

R. W. Lenhard and R. M. Peirce were principals at the outset of this study. C. Vermette contributed tabulations. The 5-year sample was produced by S-L. Tung of Environmental Research and Technology, Inc. The sample for 1973 was generated by H. Dolan of Analysis & Computer Systems, Inc. J. Young laid out the graphics and nurtured the manuscript. The draft was constructively reviewed by M. L. Barad, A. A. Barnes, I. I. Gringorten, M. J. Kraus, I. A. Lund, and V. G. Plank.

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A Test of the Climatic Normality of Synthetic Profiles of Atmospheric Liquid Water Content Over the USSR in 1973

1. INTRODUCTION

The stuff that clouds are made of can be a decisive factor in processes of military importance; for instance, the erosion of exposed surfaces on high-speed vehicles and the attenuation of electromagnetic radiation along a path through the atmosphere. The mass concentration of hydrometeors is a property of frequent concern, but size distribution and other parameters also play a significant role at times. The term "hydrometeor" encompasses water particles of all sizes, the large ones called precipitation, as well as the smaller cloud particles.

Following a frequent convention, the mass concentration of hydrometeors, including snow and ice in all of its forms, will be denoted liquid water content (LWC) throughout this report. The imprecise qualifier "liquid" serves as a reminder that what is not included in LWC is water in the gaseous phase, which is almost invariably the more massive.

LWC and the other microphysical properties of hydrometeors are not observed routinely by the weather services of the world; consequently, there are no archives on which to base climatologies of these parameters. Instead, short of instituting a special observational program, one can generate such a climatology only indirectly, through the use of correlations established between the hydrometeoric parameter and weather parameters that are observed routinely

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and archived. The latter was the approach of the Environmental Definition Program (EDP) conducted during the years 1973-1977 by the Air Force Geophysics Laboratory (AFGL). One of the more ambitious endeavors of this program was the "11-station study" based on AFGL's second-generation EDP "model" commonly called AFGL-2.*

AFGL-2 is a tedious procedure which starts with a manually analyzed vertical time-section (altitude vs time) incorporating all meteorological data that are systematically available for the particular location. Then, wherever clouds or precipitation are reckoned to have existed, values of LWC are assigned according to typical values for the class of hydrometeor, temperature, and other circumstances. The 11-station study applied this procedure for the 12-month period starting 1 February 1973 to each of 11 meteorological stations in the USSR. These stations that were selected for the supposed diversity of their LWC climatology, as well as for the availability of suitable meteorological records, are identified in Table 1, and their locations are shown in Figure 1. For each of these stations, and for every 3 hours of the entire year, a vertical profile of LWC was extracted from the time-section. Thus the ultimate product of that study was some 32,000 profiles of LWC.

A natural question to ask is, Was this year, on which such analytical effort was lavished, anything like a typical year? An early attack on this question was made by Lenhard[1] who compared 1973 with a 10-year period in terms of precipitation and found 1973 somewhat drier. A more direct attack is the subject of this report.

2. THE TEST

Because of the magnitude of effort that would have been needed, AFGL-2 was not used in this LWC-comparison of 1973 with a longer span of time; AFGL-1 was employed instead. AFGL-1 is another model for estimating LWC from conventional meteorological data. It is a decision tree that uses a radiosounding and the surface observation as input. An automated version was used for this study. Unlike AFGL-2 which treats both cloud and precipitation LWC, AFGL-1 prescribes

1. Lenhard, Robert W. (1974) The Use of 1973 as a Sample of Erosion Climatology over USSR. INAP No. 98, Internal Report of the Design Climatology Branch, Aeronomy Laboratory, AFCRL, 56 pp.

* Prior to 1976, what is now AFGL was part of the Air Force Cambridge Research Laboratories (AFCRL), which no longer exists. Previously, AFGL-2 was known as AFCRL-2.

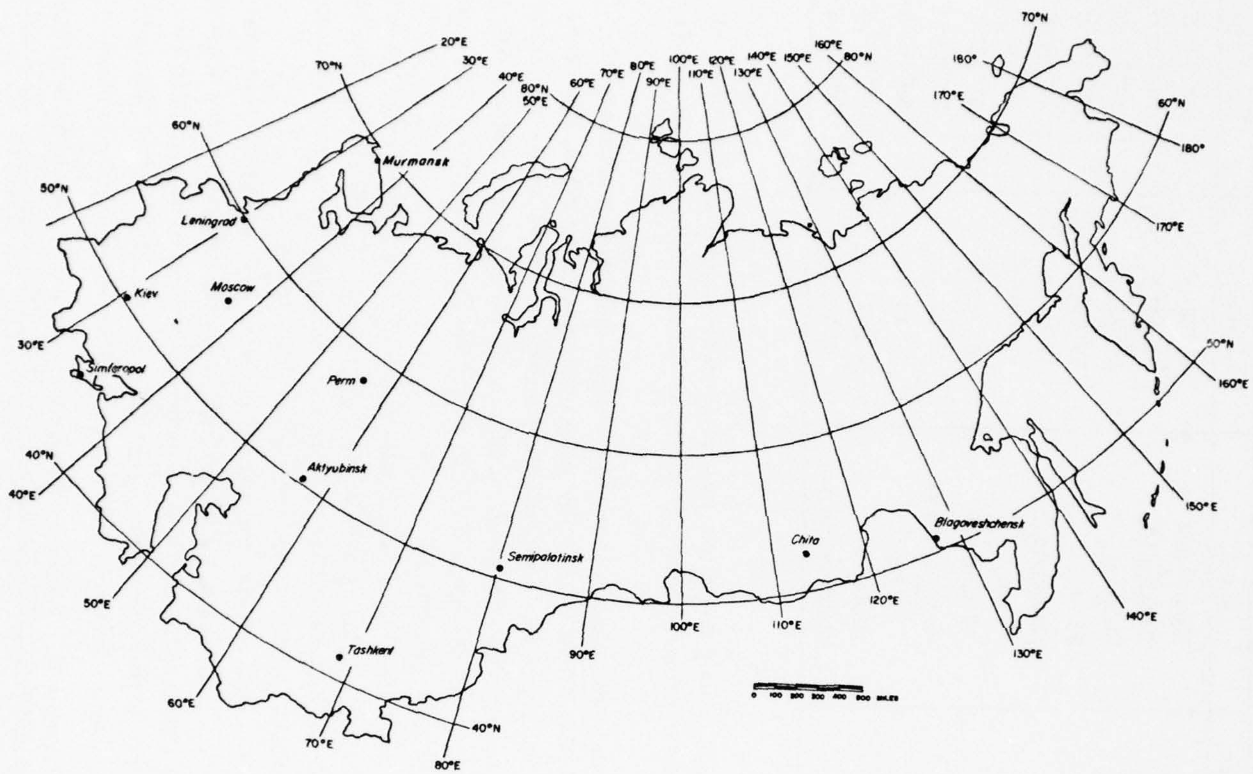

Figure 1. Geographical Distribution of the Eleven USSR Stations of the Environmental Definition Program

Table 1. The Eleven USSR Stations of the Environmental Definition Program

Station Number	Name	Latitude	Longitude
221130	Murmansk	68° 58' N	33° 03' E
260630	Leningrad	59° 58' N	30° 18' E
276120	Moscow	55° 58' N	37° 25' E
333450	Kiev	50° 24' N	30° 27' E
339460	Simferopol	45° 01' N	33° 59' E
282250	Perm	58° 01' N	56° 18' E
352290	Aktyubinsk	50° 20' N	57° 13' E
361770	Semipalatinsk	50° 21' N	80° 15' E
384570	Tashkent	41° 16' N	69° 16' E
307580	Chita	52° 01' N	113° 19' E
315100	Blagoveschensk	50° 16' N	127° 30' E

the water content of only the larger precipitation particles. By definition, all forms of ice are considered to be precipitation and are, therefore, covered by AFGL-1.

Although an attempt has been made to assess the absolute accuracy of AFGL-1 and AFGL-2[2] the results are indecisive, due to the rather few cases available in which there was an independent measurement of LWC. The accuracy of AFGL-1 is immaterial, however, to present purposes, which require only that any bias in AFGL-1 be the same for 1973 as for the longer interval. At present this is an unverified assumption.

Using AFGL-1 for the test of climatic normality was facilitated by the preexistence of 6-hourly AFGL-1 profiles of LWC for the 11 USSR stations for February, May, July, and October 1973. These had been generated for an intercomparison of AFGL-1, AFGL-2, and yet another LWC model.[3]

The longer period selected for comparison with 1973 was the 5-year period from 1968-1972. For each of the 4 seasons, randomly selected cases from the 0000Z and the 1200Z radiosoundings comprised the 5-year sample. The seasons were defined as: winter, December-February; spring, March-May; summer, June-August; autumn, September-November. (The reason for the particular

2. Peirce, Russell M., Lenhard, Robert W., and Weiss, Bernard F. (1975) Comparison Study of Models Used to Prescribe Hydrometeor Water Content Values, Part I: Preliminary Results, AFCRL-TR-75-0470, 20 pp.

3. Touart, C. N., and Izumi, Y. (1979) Comparison Study of Models Used to Prescribe Hydrometeor Water Content Values, Part II: USSR Data. AFGL-TR-79 (in press).

choice of months in 1973, or of "matching" seasons for the 5-year sample, is lost in the unrecorded past.)

In the random selection, any case for which the input data were found defective was rejected, and the process continued for each season until 100 cases had accumulated for which the total sky coverage was 6/8ths or more. An LWC profile was then generated for each of these cases. Meanwhile, the cases which had been selected, but for which the sky coverage was less than 6/8ths, were arbitrarily assigned an LWC of 0 at all altitudes. This black-or-white treatment of the profile, depending on the sky coverage, is a crude device for factoring into the statistics the probability that a randomly positioned trajectory will encounter the particular LWC profile. This is a common practice, although 4/8ths sky cover is the more frequent threshold value.

The individual station-month samples for 1973 range in size from 64 to 123 profiles, except for one station-month that is missing altogether. The individual station-season samples for the 5-year period range in size from 115 to 254 profiles. The grand totals are 4343 and 6372, respectively, for 1973 and the 5-year period.

The comparison is made in terms of two integrals of the profile of LWC: integrated LWC (ILWC) and the Environmental Severity Index (ESI).

$$\text{ILWC} \equiv \int_0^\infty M \, dz_1$$

$$\text{ESI} \equiv \int_0^\infty z_2 M \, dz_2$$

where

M is LWC ($g\ m^{-3}$)

z_1 is height (m)

z_2 is height (km)

so that

ILWC is in $kg\ m^{-2}$

ESI is in $g\ km^2\ m^{-3}$

(ESI is a parameter of particular significance in the erosion of ballistic reentry vehicles.)

To facilitate the comparison, cumulative distributions were constructed for each season, for each station, and for both integrals. From these, certain statistics were evaluated: average, median, 90th percentile, and 95th percentile. (The 90th percentile is the value below which 90% of the sample lies.) Because the distribution functions tended to be rough, the median and percentile values were not derived by simple interpolation of points on the curve. Instead, interpolation was made via a quadratic function fitted by least-squares to neighboring points of the distribution. The number of points used was decided subjectively, case-by-case, and varied from 3-10.

3. RESULTS

The basic distributions and detailed statistics are presented in the Appendix.

Figures A-1 through A-11 compare 1973 and the 5-year sample in terms of the cumulative frequency distribution of ESI by season for each of the 11 stations. Figures A-12 through A-22 make the same comparison for ILWC.

Figures A-23 through A-25 are bar graphs comparing the two samples by station and season, in terms of average ESI and ILWC.

Tables A-1 through A-4 make a numerical comparison by station and by season in terms of average ESI, median ESI, 90th and 95th percentiles of ESI. Δ is positive when 73 exceeds 5-yr. Tables A-5 through A-8 are the analogues for ILWC.

Table 2 compares the gross averages of the statistics for 1973 and 5-yr. By way of explanation, the first entry in this tabulation was derived from Table A-1. All 43 values of Δ were averaged, and this average was then divided by the average of the 43 73-values. The result as a percentage is the entry in Table 2.

Table 2. Difference between 1973 and 5-yr, Averaged Over All Stations and All Seasons, Expressed as a Fraction of the Corresponding Average for 1973

Statistic		Average Difference 1973-(5-yr)
ESI:	AVERAGE	2%
	MEDIAN	-5
	90TH PERCENTILE	7
	95TH PERCENTILE	2
ILWC:	AVERAGE	-6
	MEDIAN	5
	90TH PERCENTILE	-4
	95TH PERCENTILE	-7

4. CONCLUSIONS

A mere scan of the figures is sufficient to sow the suspicion that there is no great systematic difference between the two samples overall. True, there are local exceptions, notably Tashkent where 1973 is drier throughout.

The suggestion that these samples are cut from the same bolt is reinforced by Table 2, which shows that the differences, when averaged over all stations and all seasons, are quite small for all 4 statistics and for both integrals. Also, these differences are evenly balanced between plus and minus.

To guard against the possibility that this averaging may smother significant details, a test was made of the plausibility that the observed local differences could have arisen purely by chance. How the test works will be illustrated on the fifth entry of Table 3. This entry was derived from Table A-5 by first deleting all Δs which are less than 10% of the corresponding 73 value. These cases are arbitrarily judged to be ambiguous. Then a simple count of +'s and -'s was made among the residual Δs. The result in this instance is 15 +'s and 21 -'s. Under the null hypothesis that the 1973 and the 5-year sample come from the same parent population, the +'s and -'s are equally likely, and the binomial distribution gives 8.1% as the likelihood of a 15/21 split in 36 Bernoulli trails.

The same procedure was applied to each of the statistics of both integrals, even though these are not truly independent. The results are summarized in Table 3. Except in two of the eight cases, the chance probability is comfortably high, giving no reason to suspect any fundamental difference between the two samples. For comparison, a 50/50 split of +'s and -'s, which is the most likely outcome, has less than a 14% chance of occurrence in the circumstances of Table 3.

In view of all of the foregoing, the final conclusion must be that this study has uncovered no reason to doubt that 1973 was a perfectly representative year with respect to LWC over the 11 stations. Of course, this judgment is based on a comparison with a small 5-year sample, but whether that sample is itself climatically representative will be left as an exercise for the reader.

Table 3. Pure Chance Probability of the Observed Combination of Differences between 1973 and 5-yr for Individual Stations and Seasons

Statistic		Chance Probability of Observed Difference
ESI:	AVERAGE	12.9%
	MEDIAN	0.6
	90TH PERCENTILE	11.8
	95TH PERCENTILE	12.5
ILWC:	AVERAGE	8.1
	MEDIAN	6.7
	90TH PERCENTILE	10.8
	95TH PERCENTILE	3.4

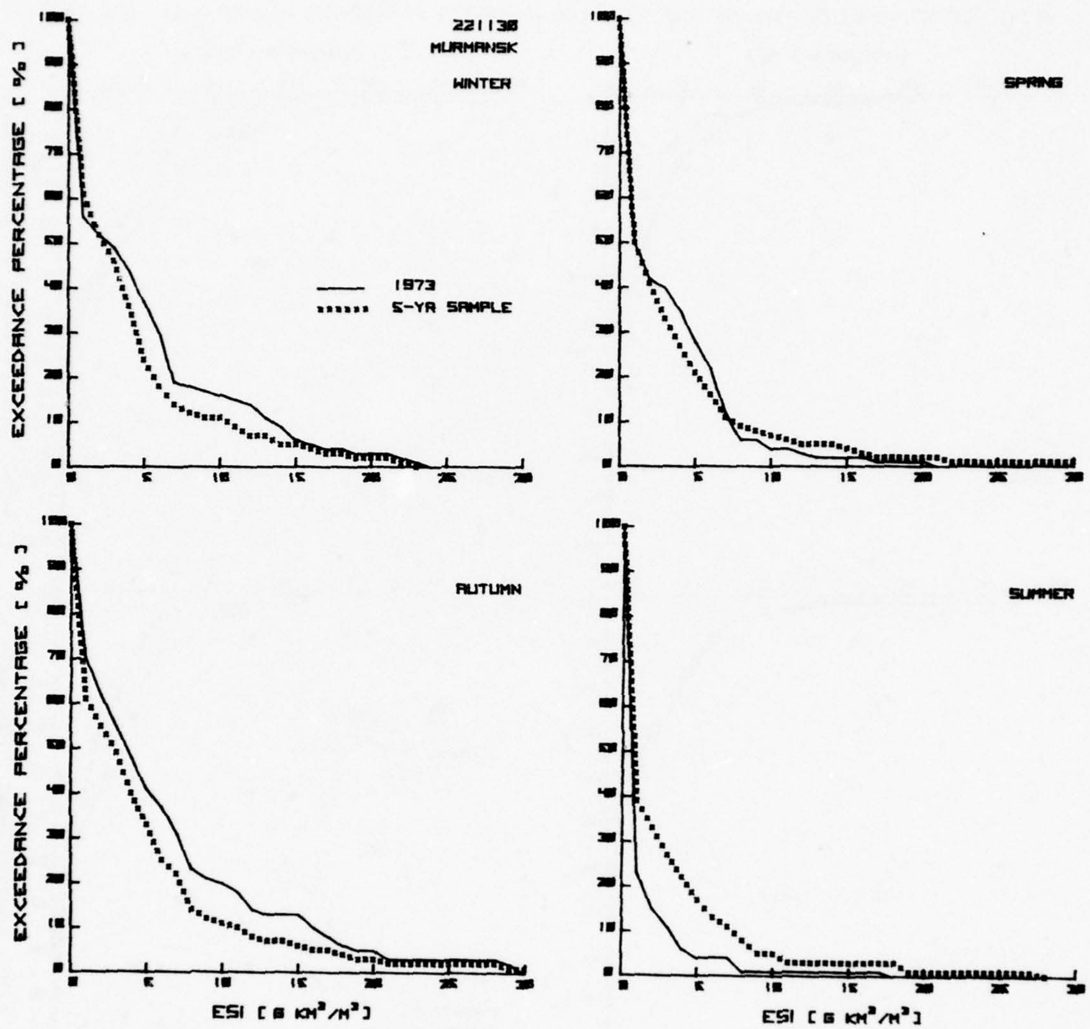

Figure A1. Cumulative Frequency Distribution of ESI for Station 221130, MURMANSK

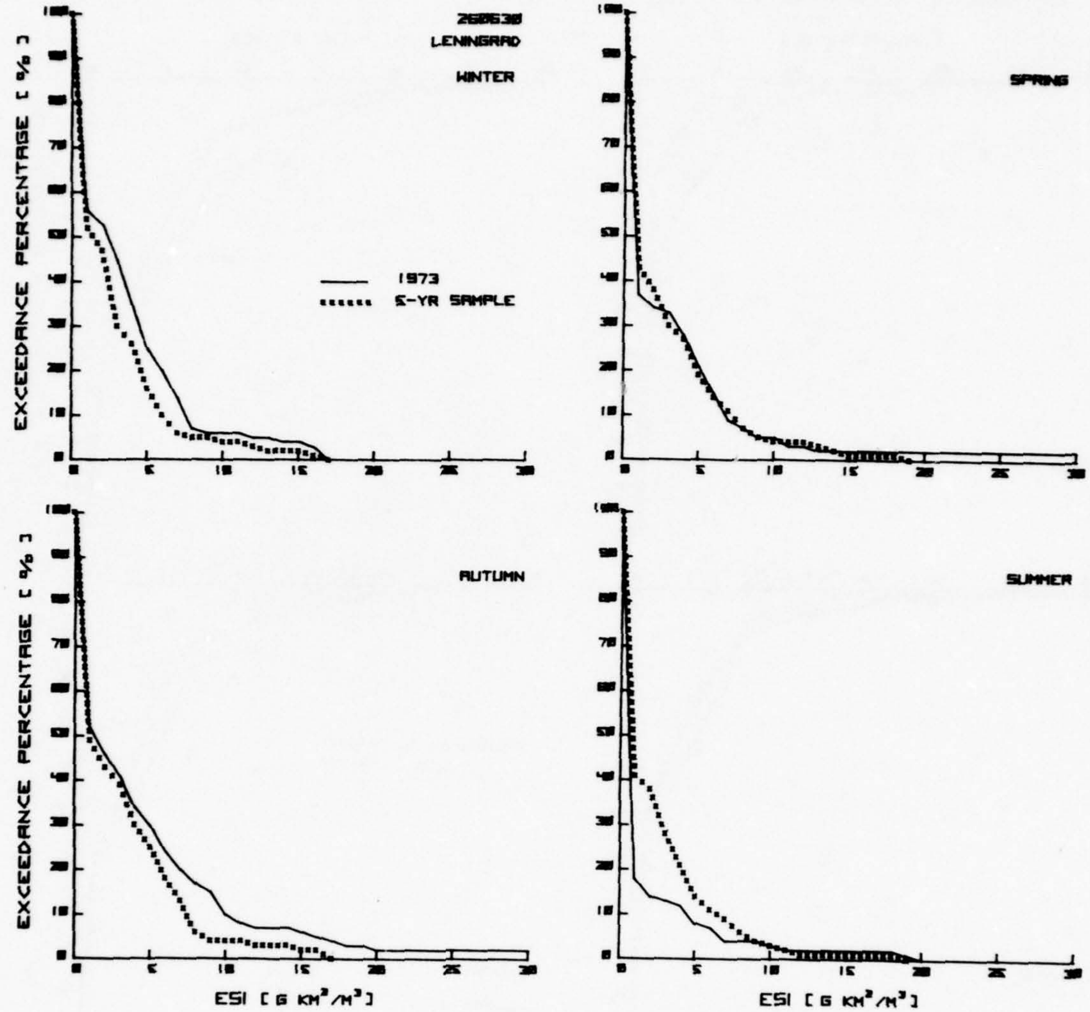

Figure A2. Cumulative Frequency Distribution of ESI for Station 260630, LENINGRAD

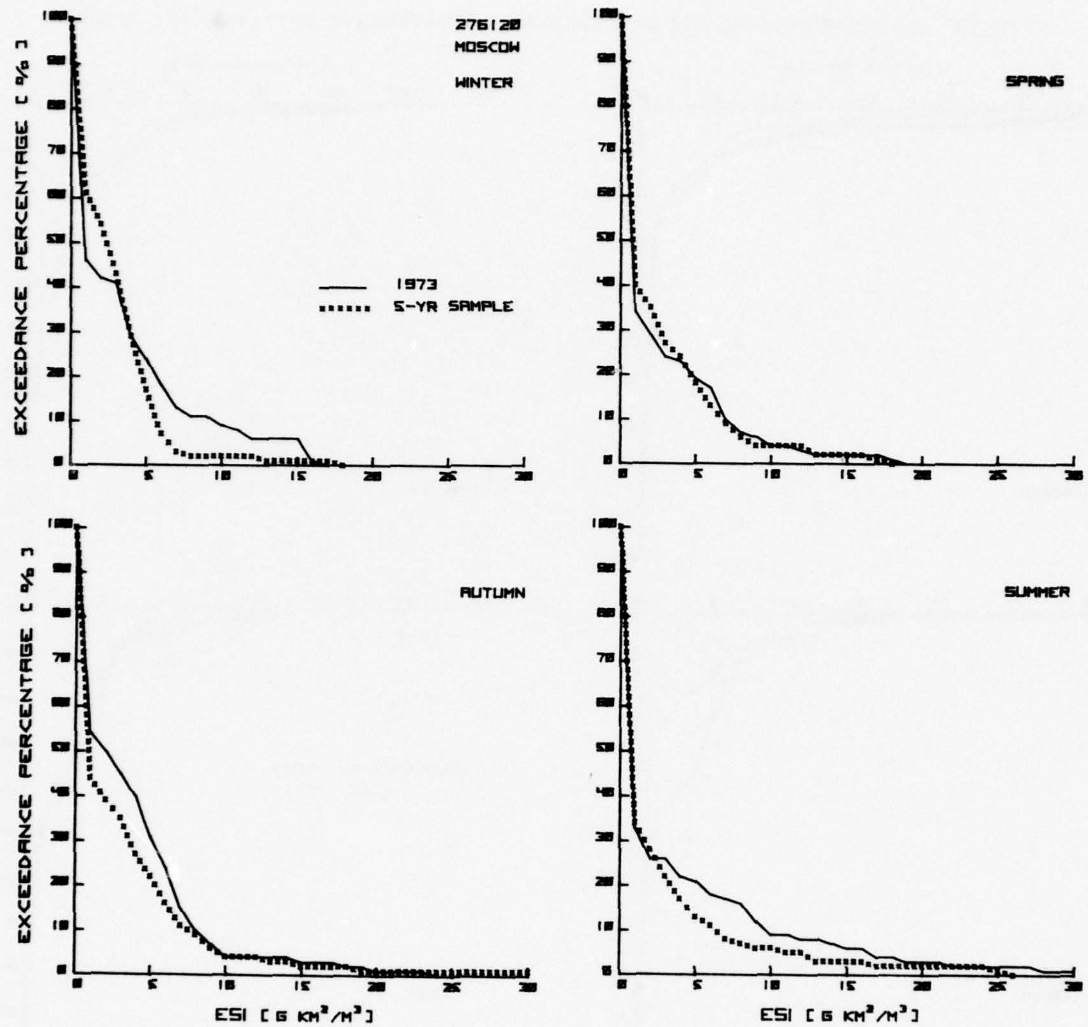

Figure A3. Cumulative Frequency Distribution of ESI for Station 276120, MOSCOW

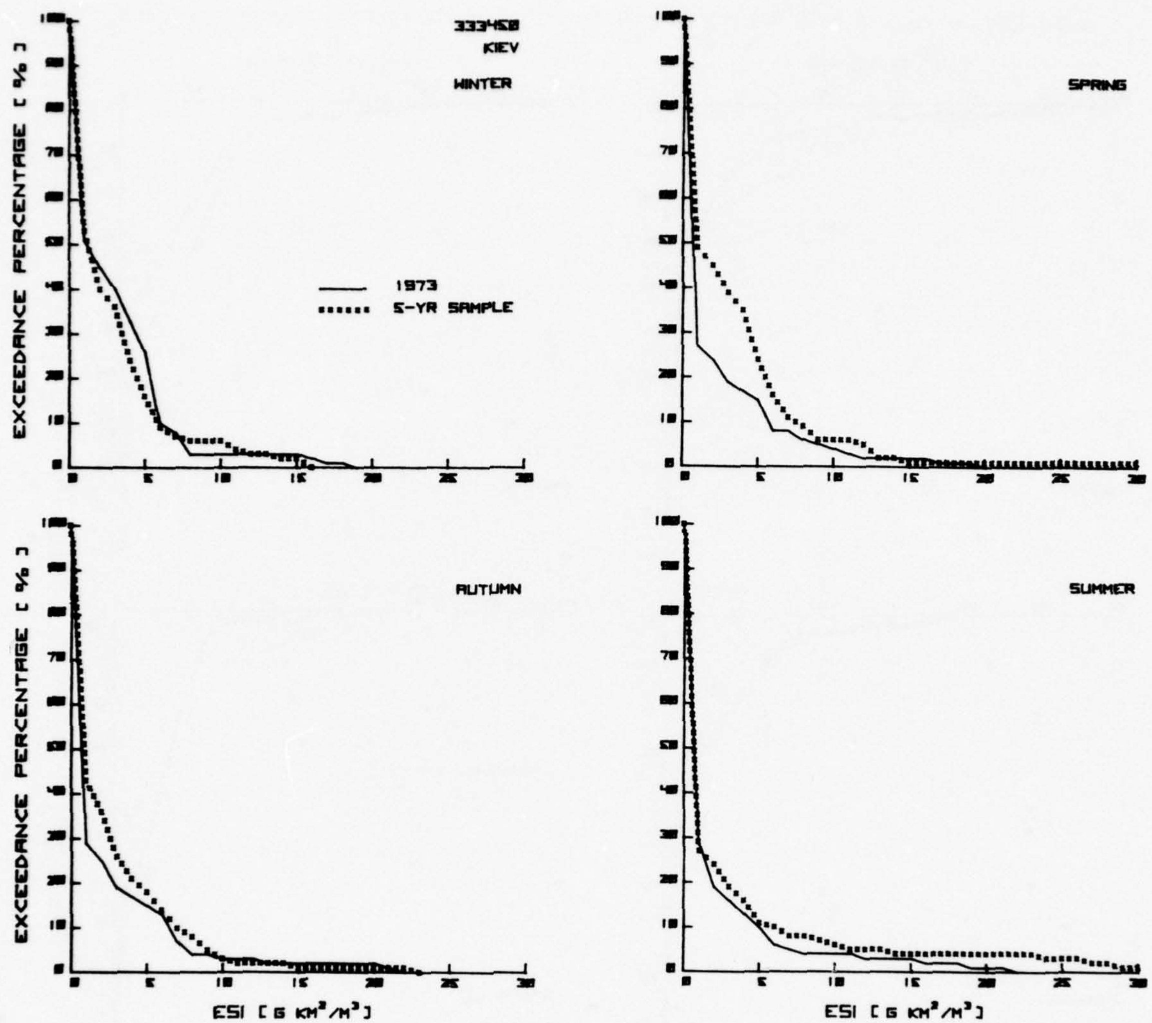

Figure A4. Cumulative Frequency Distribution of ESI for Station 333450, KIEV

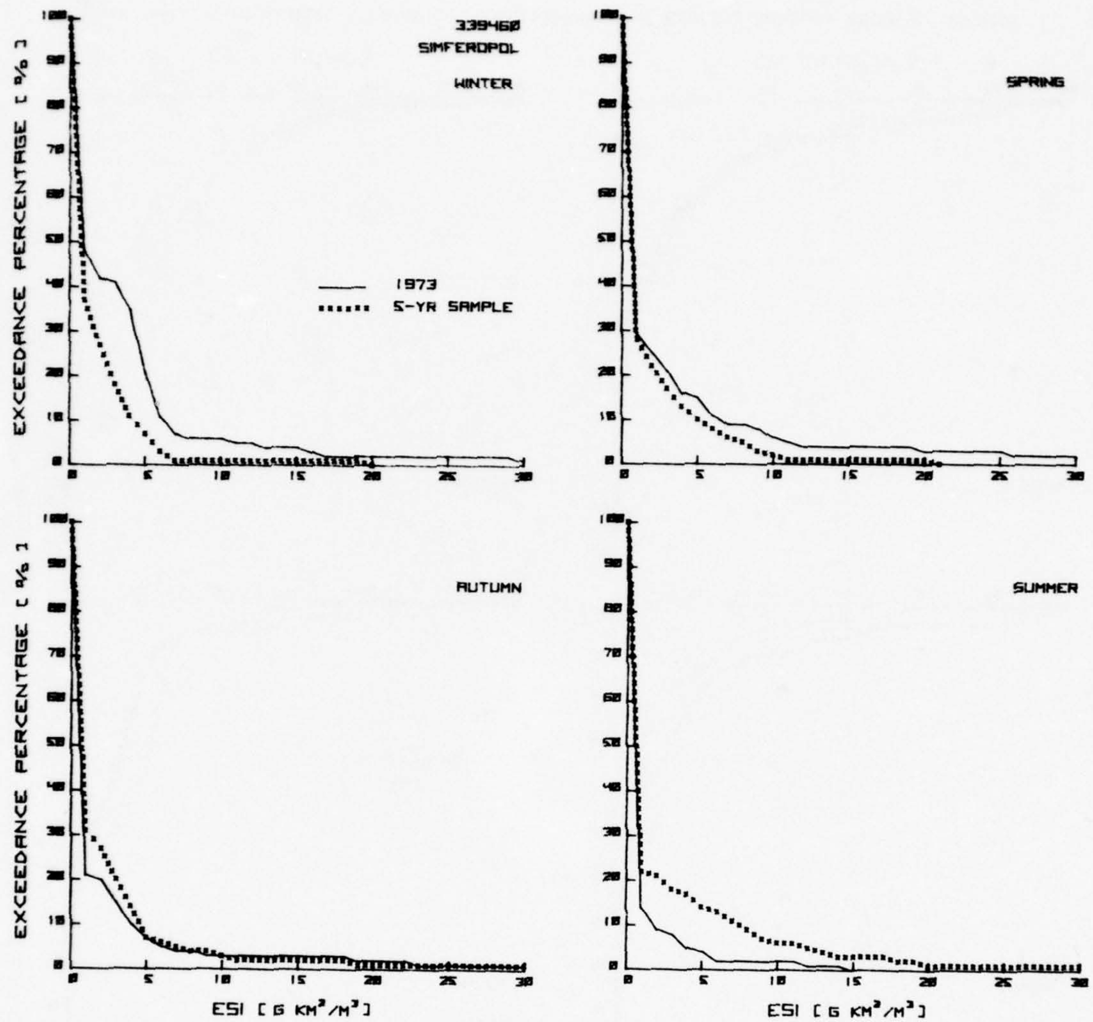

Figure A5. Cumulative Frequency Distribution of ESI for Station 339460, SIMFEROPOL

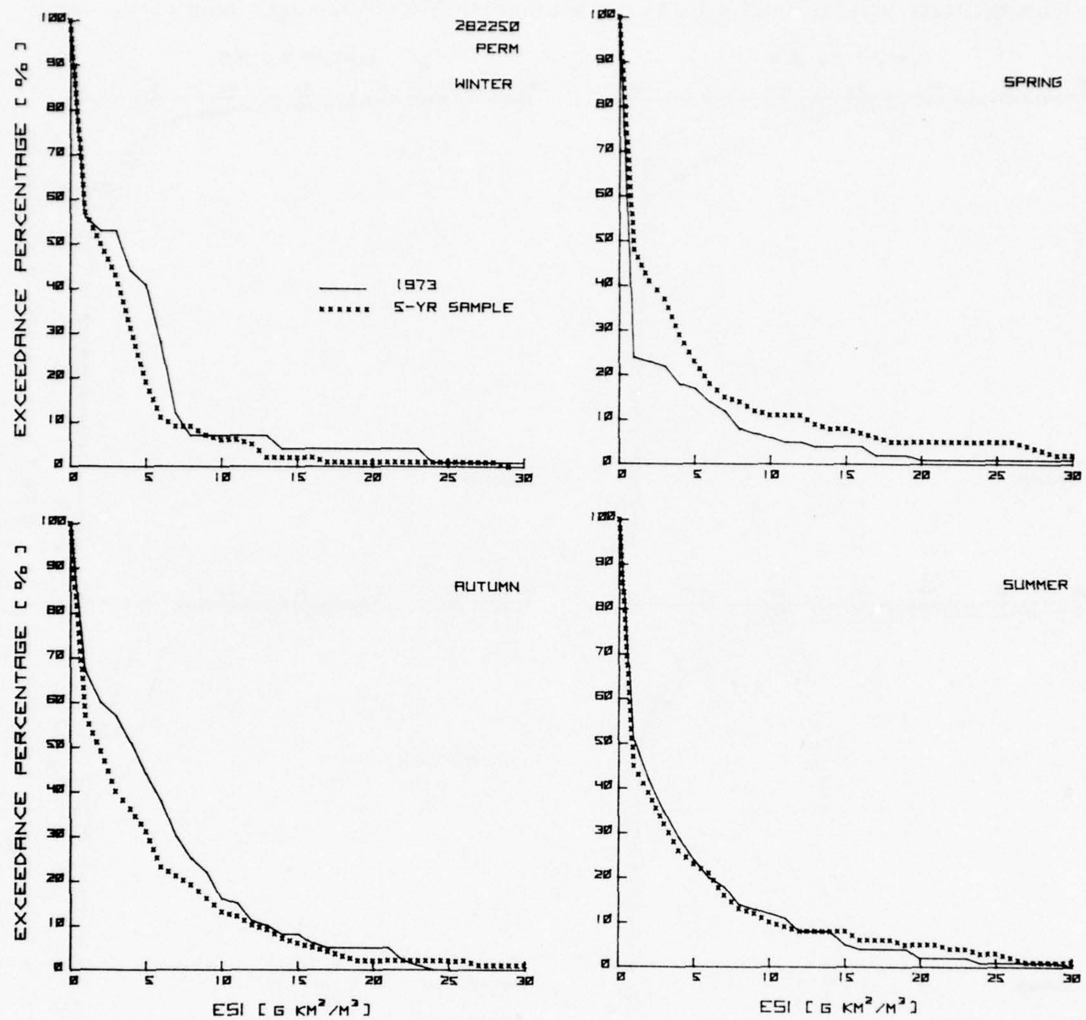

Figure A6. Cumulative Frequency Distribution of ESI for Station 282250, PERM

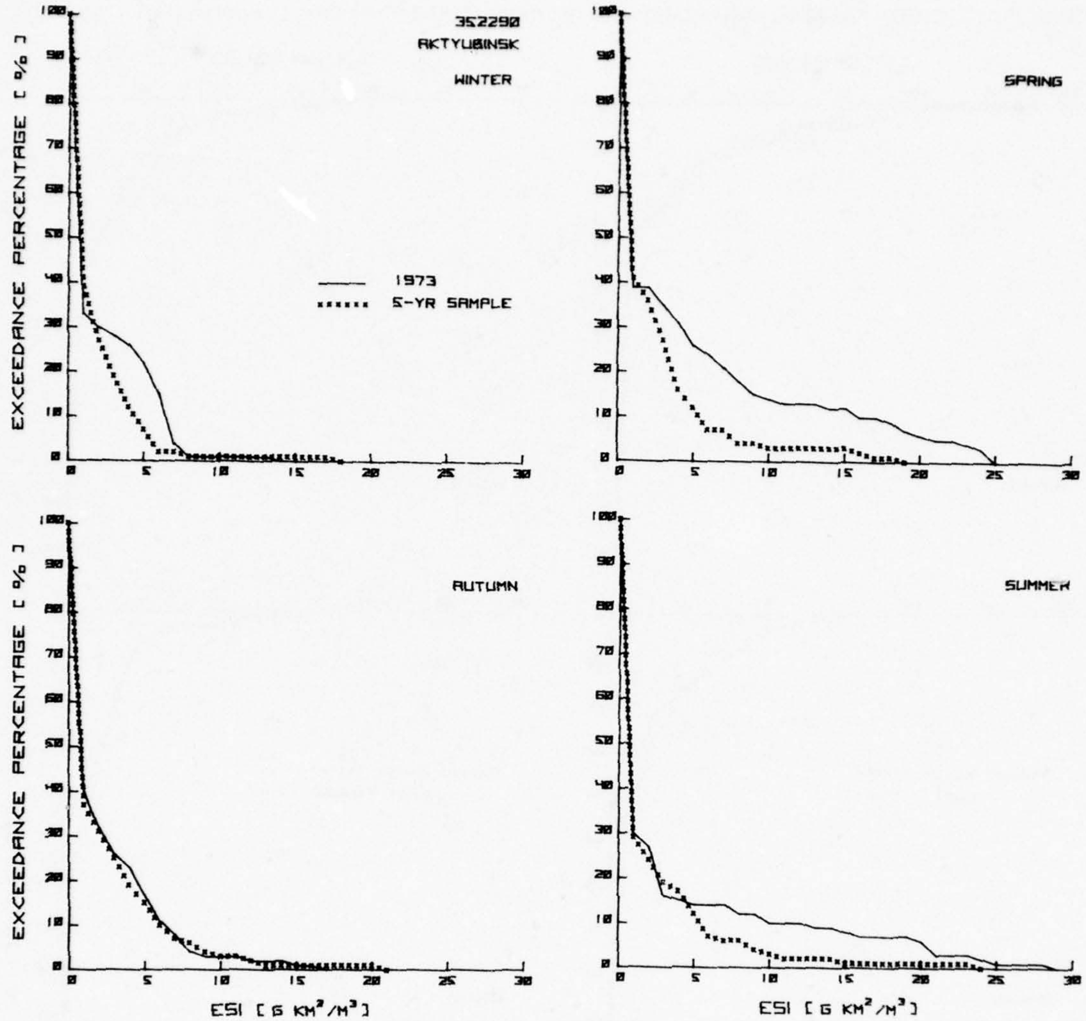

Figure A7. Cumulative Fr quency Distribution of ESI for Station 352290, AKTYUBINSK

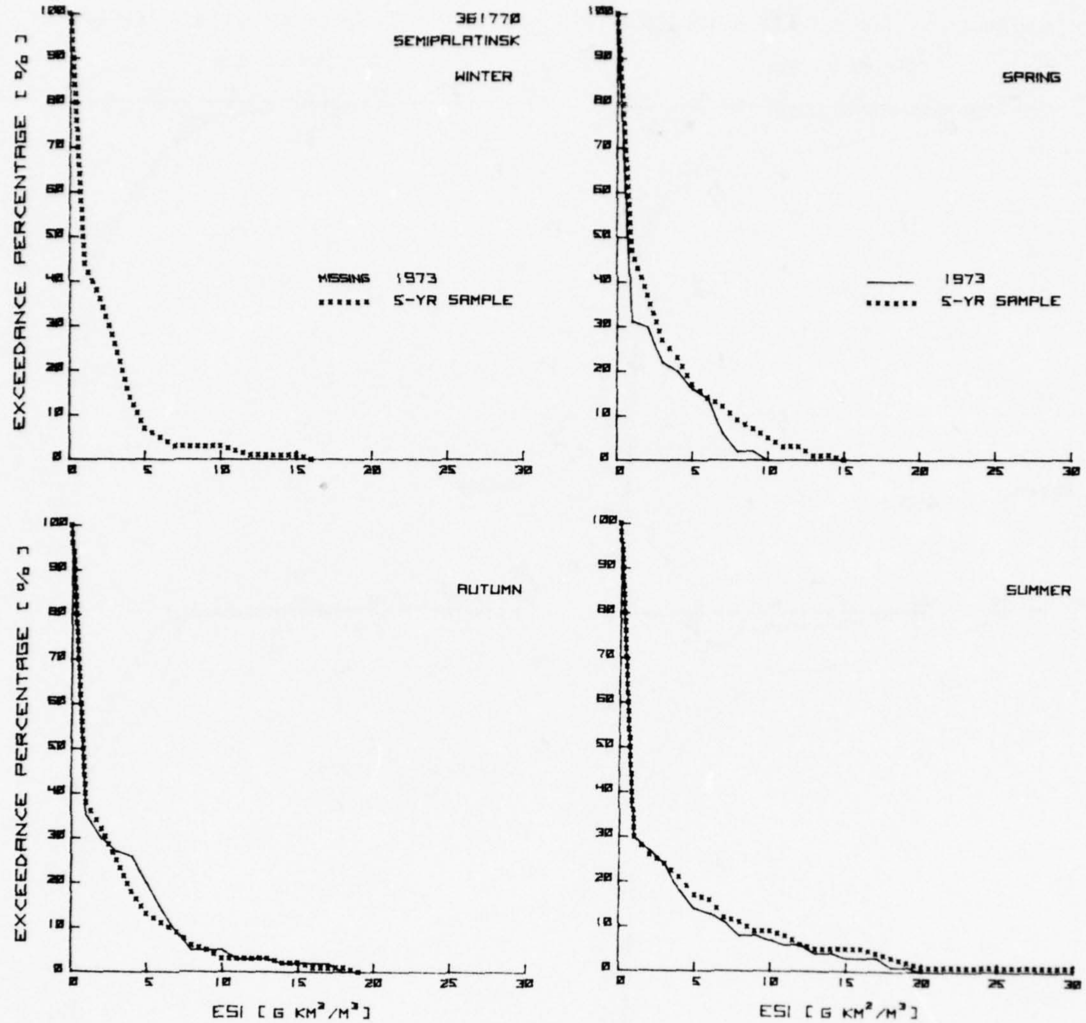

Figure A8. Cumulative Frequency Distribution of ESI for Station 361770, SEMIPALATINSK

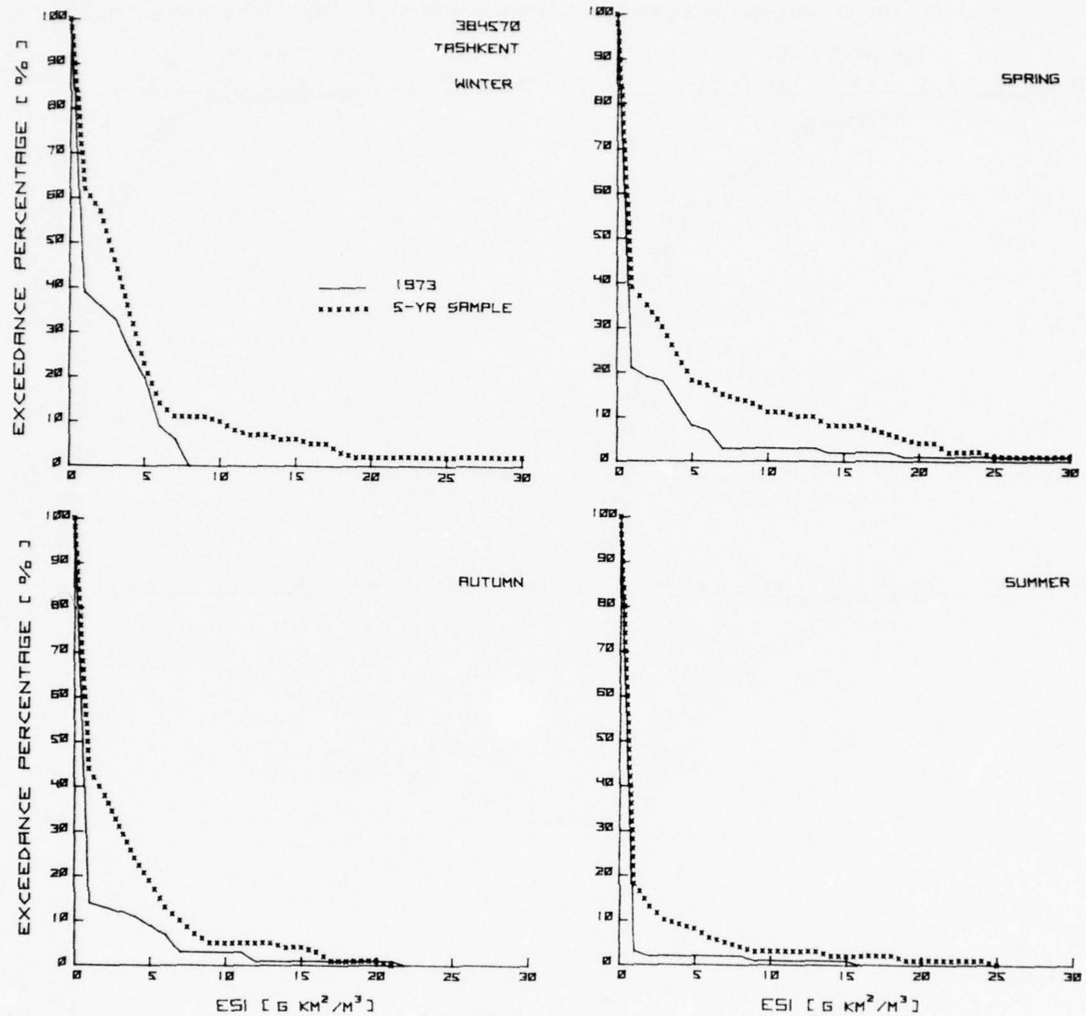

Figure A9. Cumulative Frequency Distribution of ESI for Station 384570, TASHKENT

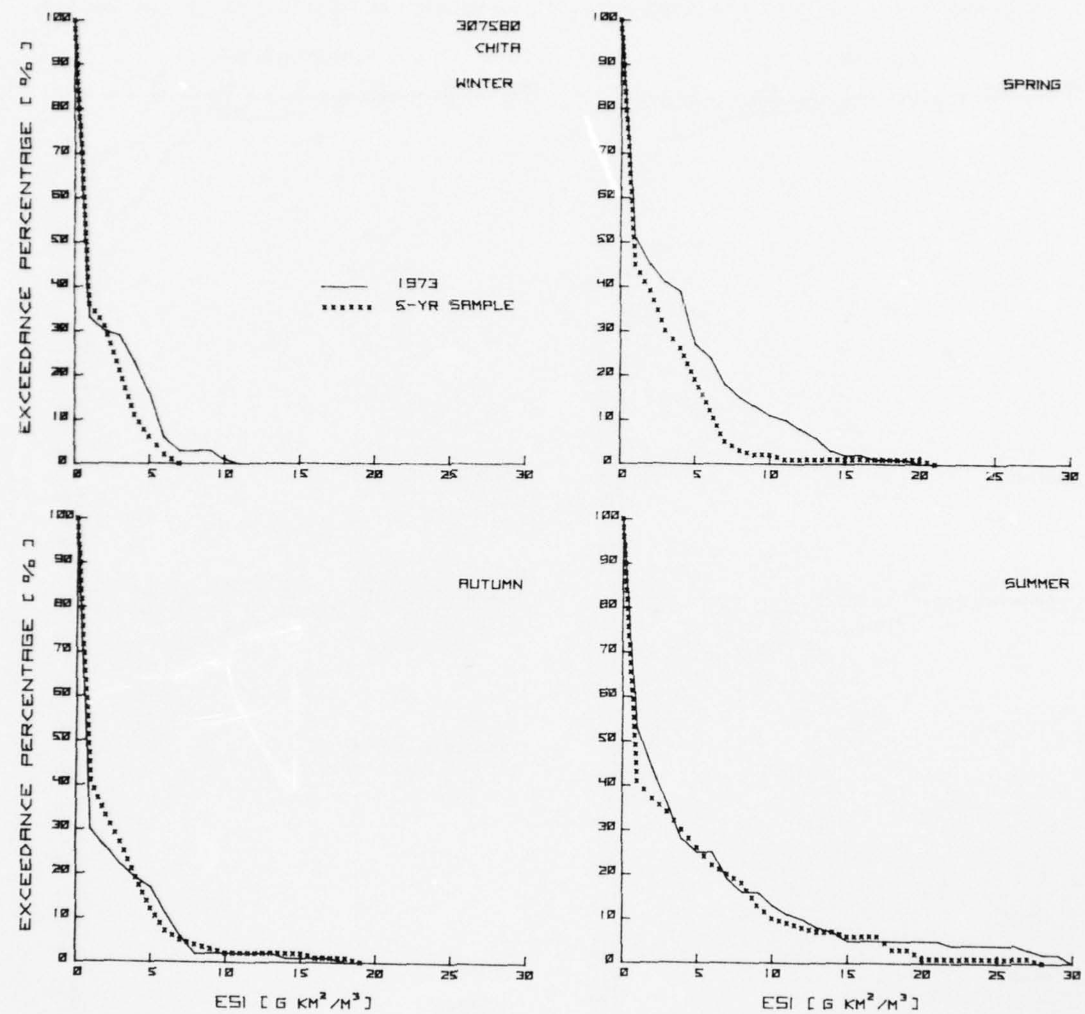

Figure A10. Cumulative Frequency Distribution of ESI for Station 307580, CHITA

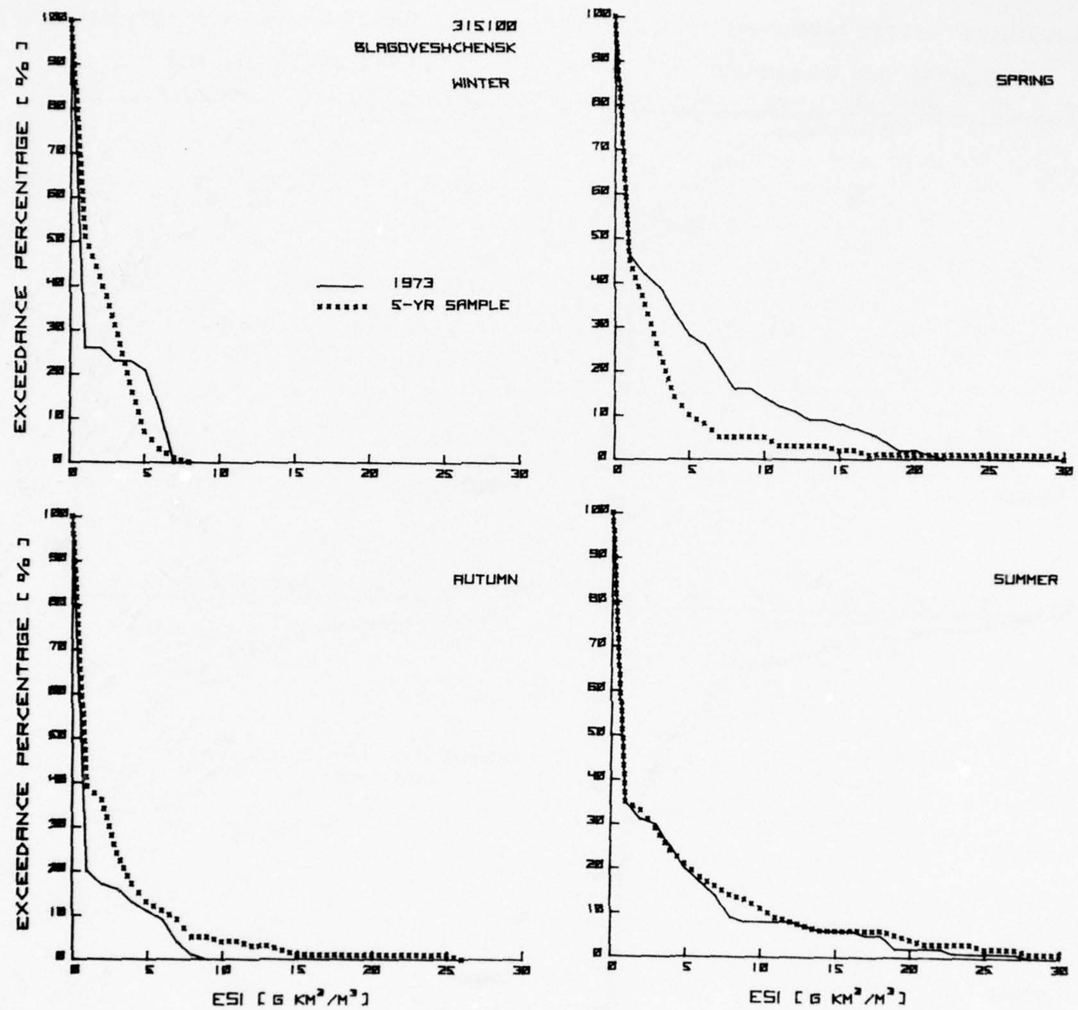

Figure A11. Cumulative Frequency Distribution of ESI for Station 315100, BLAGOVESCHENSK

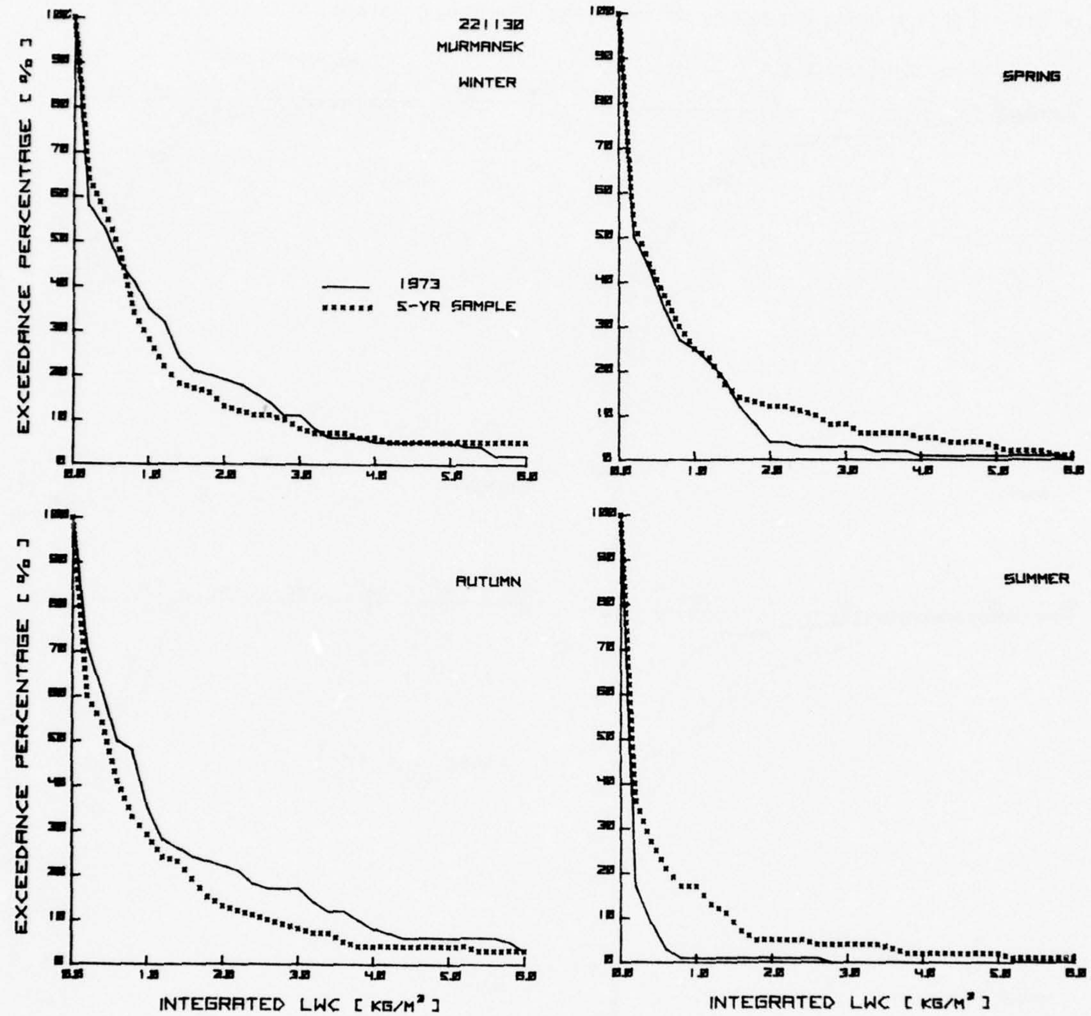

Figure A12. Cumulative Frequency Distribution of ILWC for Station 221130, MURMANSK

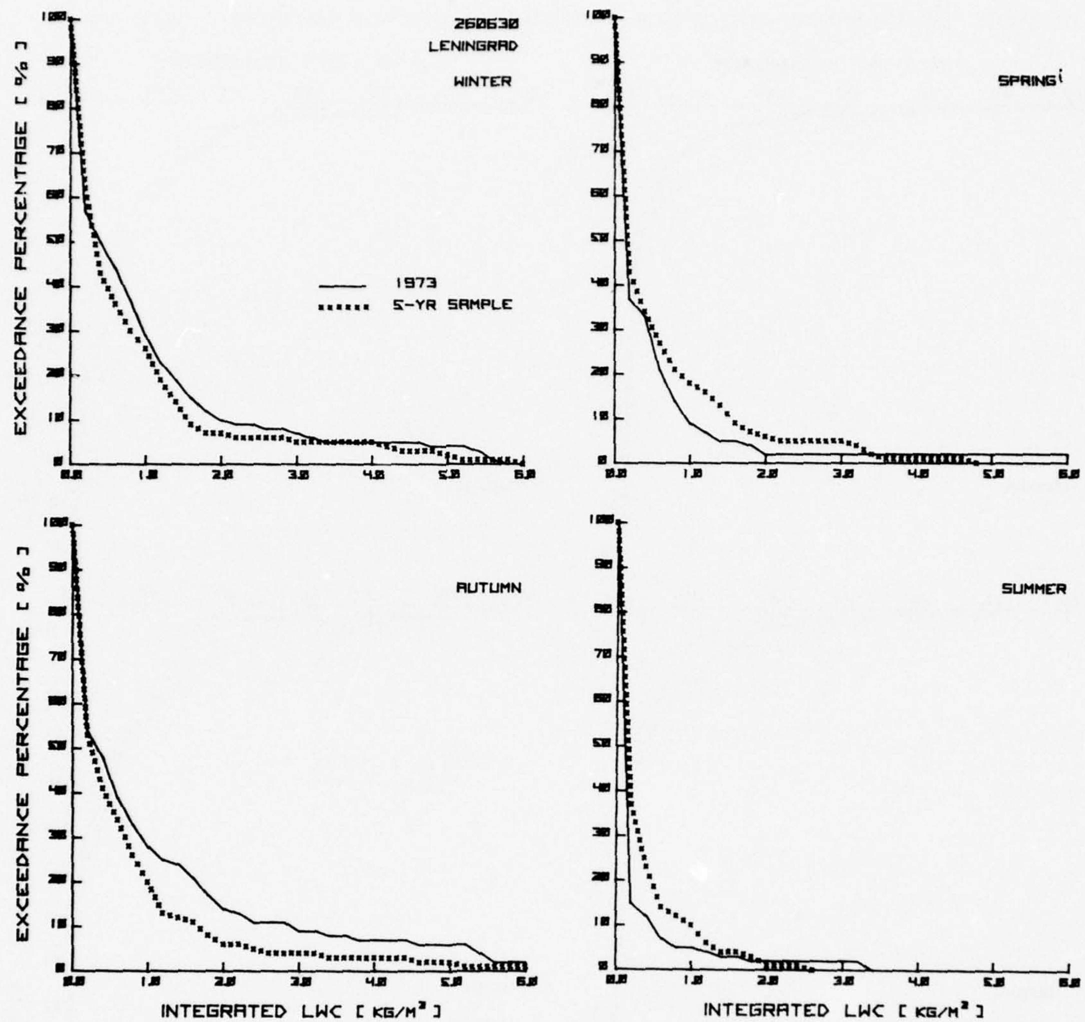

Figure A13. Cumulative Frequency Distribution of ILWC for Station 260630, LENINGRAD

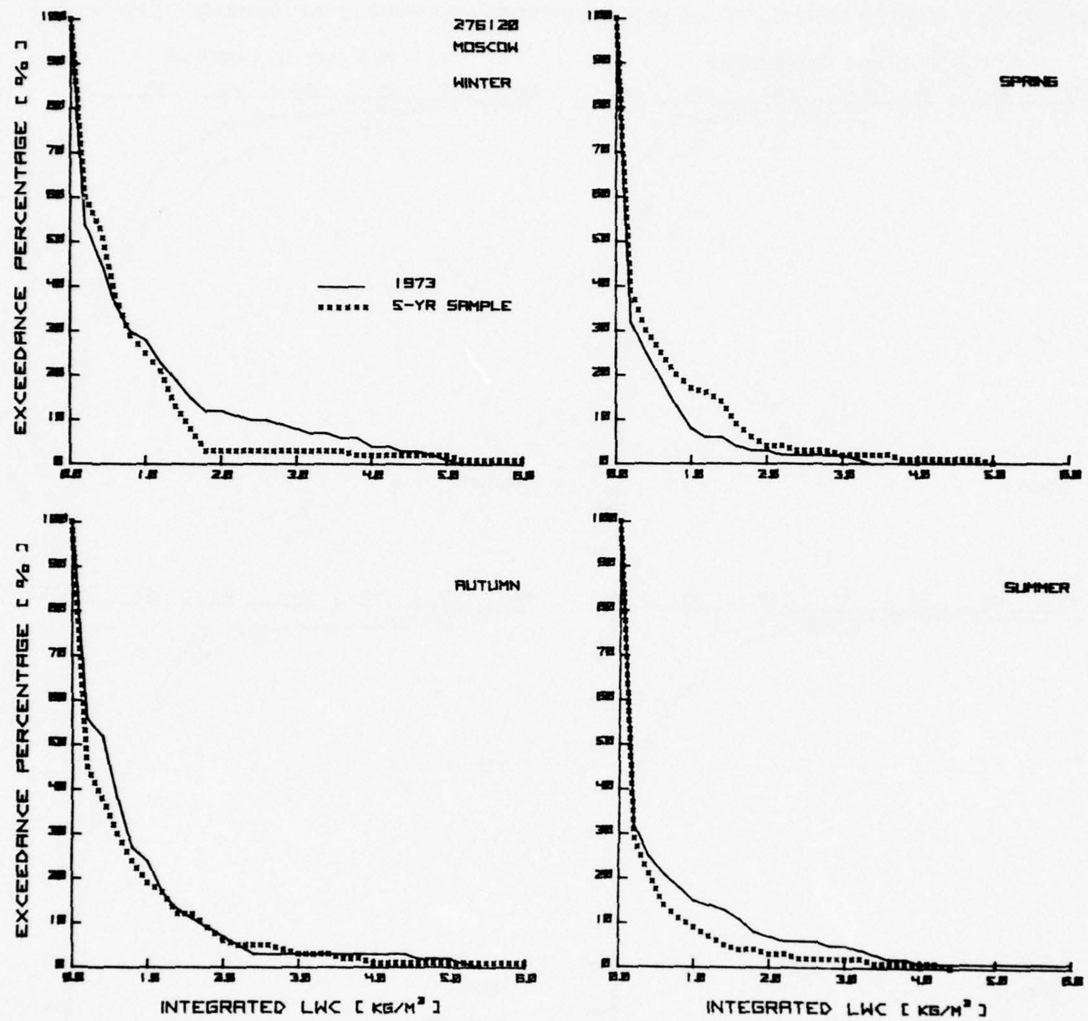

Figure A14. Cumulative Frequency Distribution of ILWC for Station 276120, MOSCOW

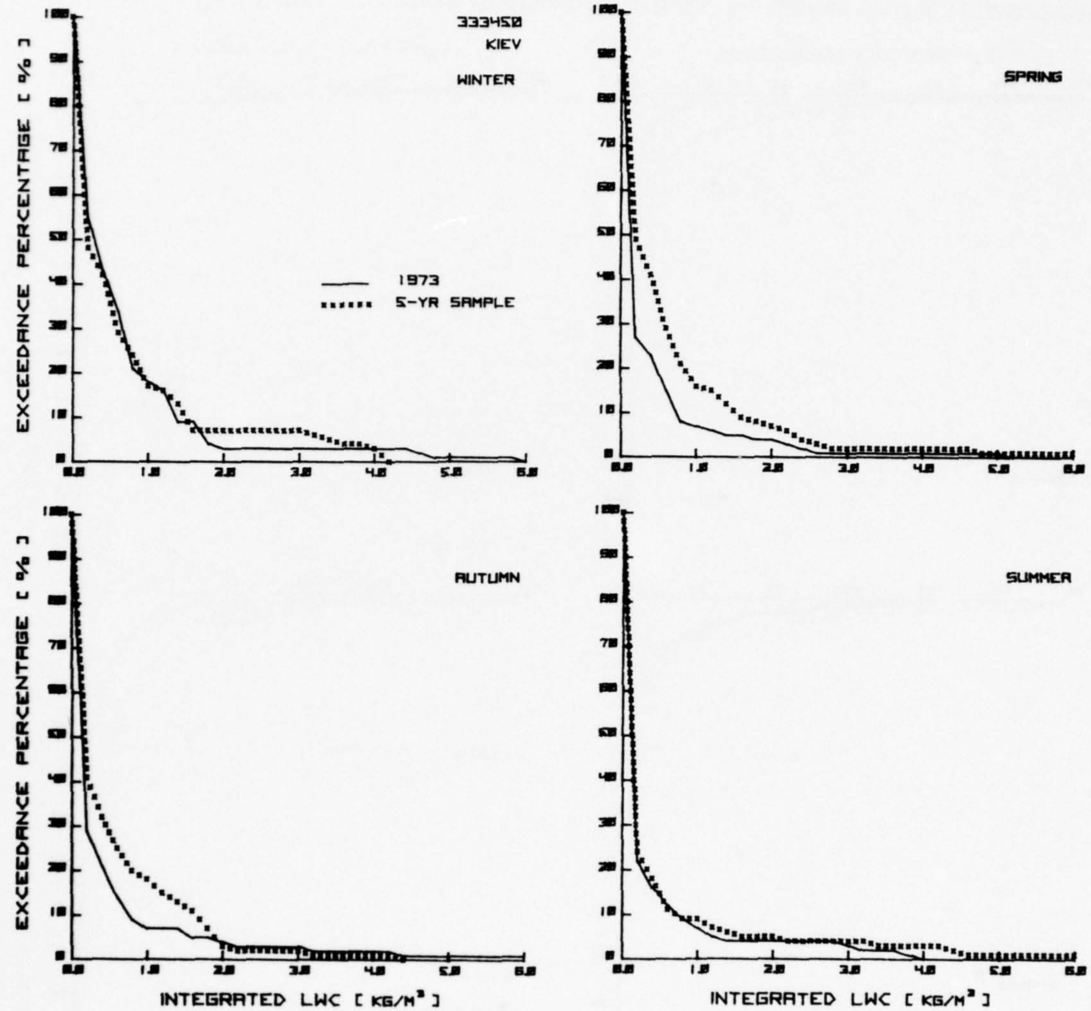

Figure A15. Cumulative Frequency Distribution of ILWC for Station 333450, KIEV

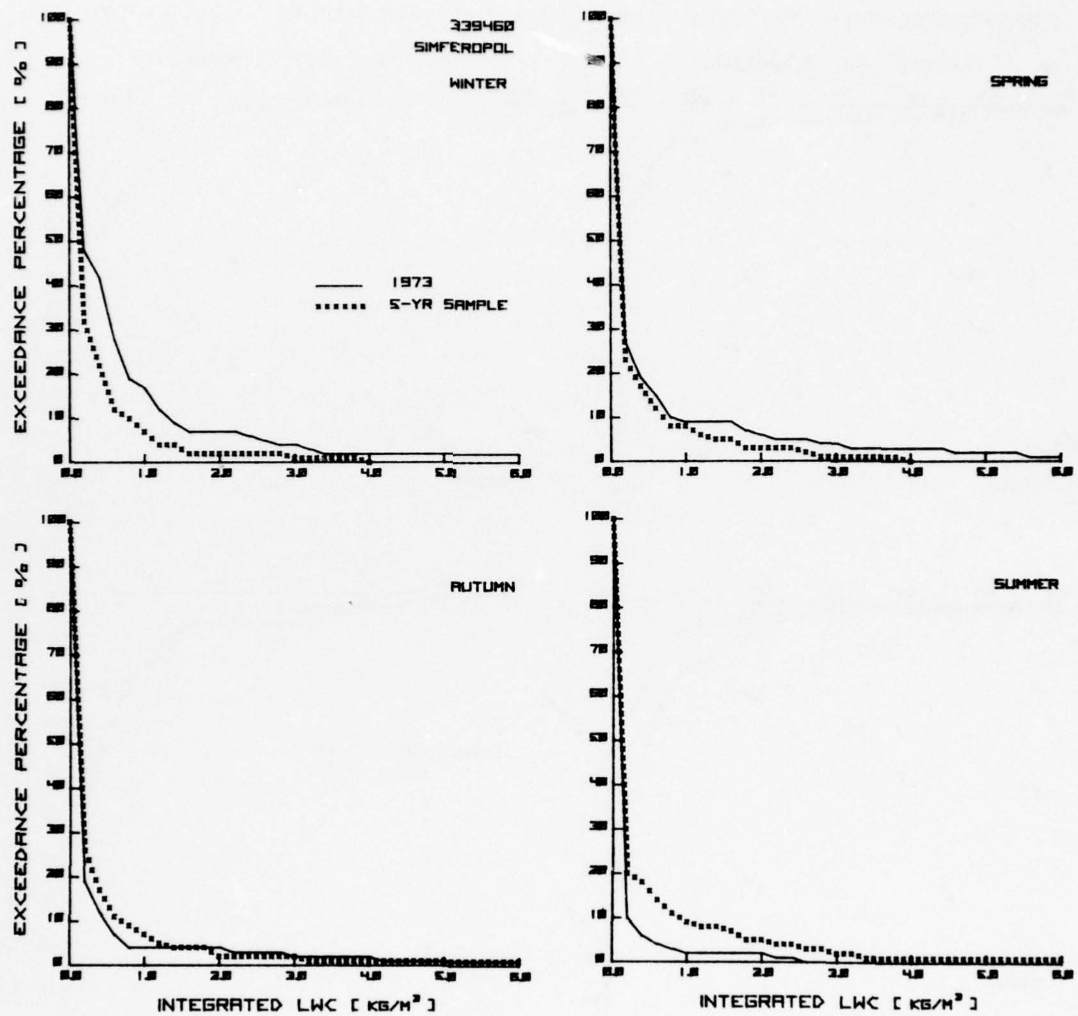

Figure A16. Cumulative Frequency Distribution of ILWC for Station 339460, SIMFEROPOL

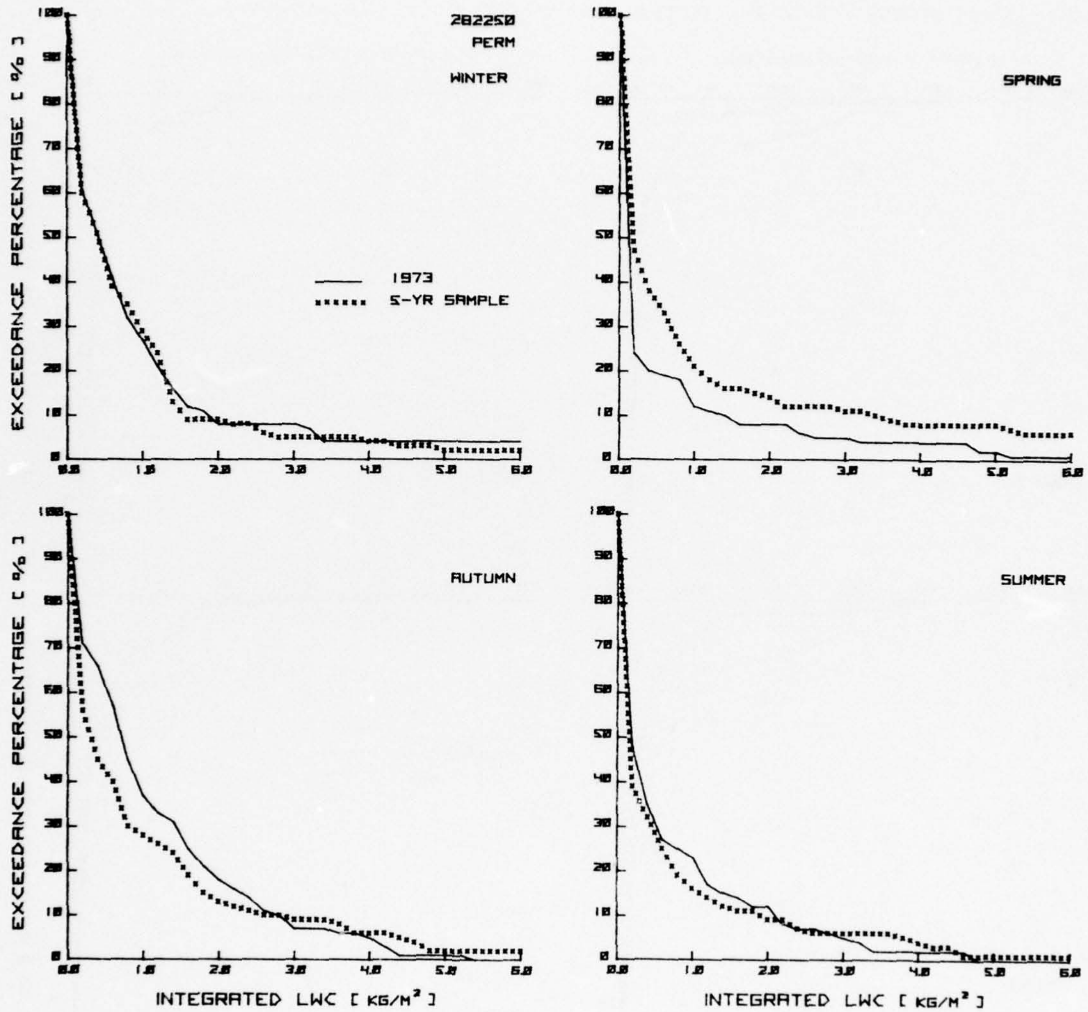

Figure A17. Cumulative Frequency Distribution of ILWC for Station 282250, PERM

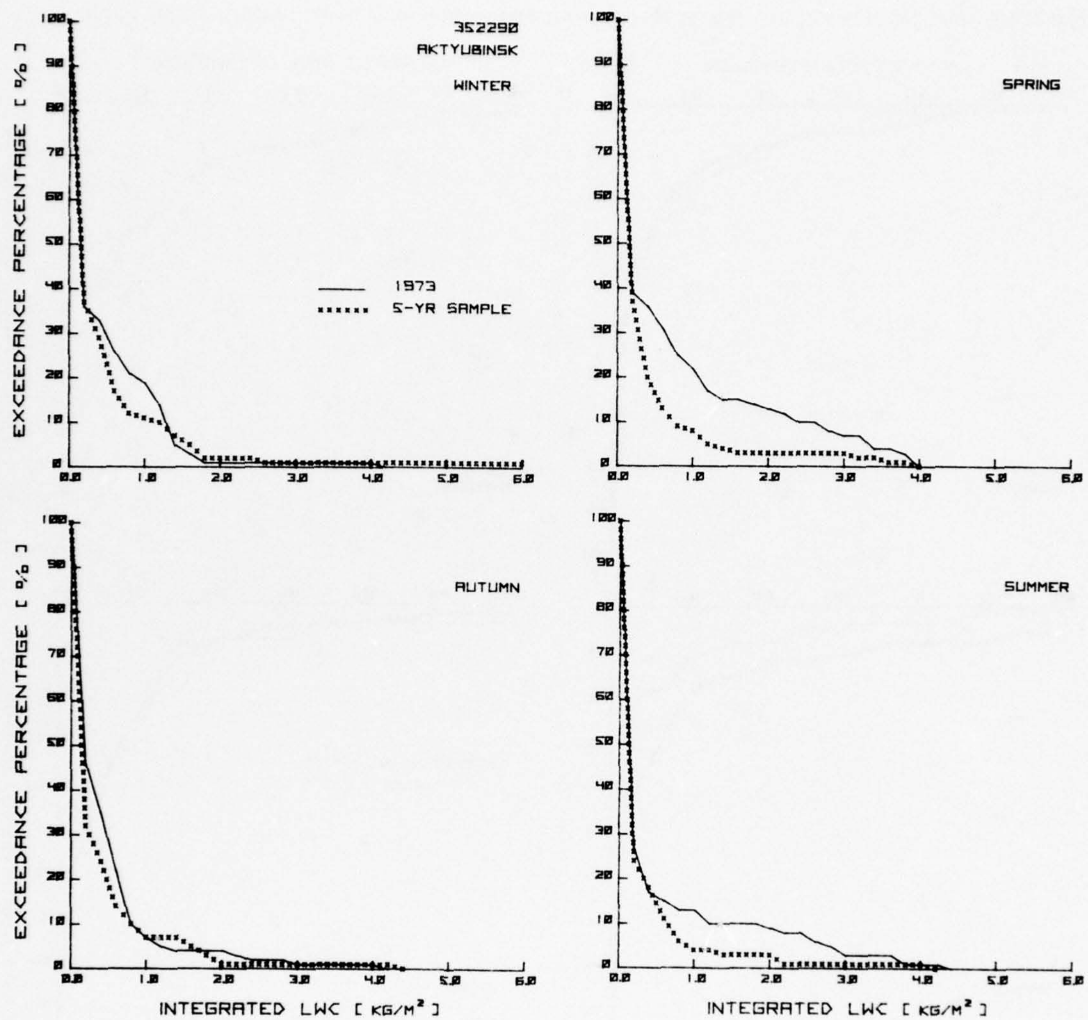

Figure A18. Cumulative Frequency Distribution of ILWC for Station 352290, AKTYUBINSK

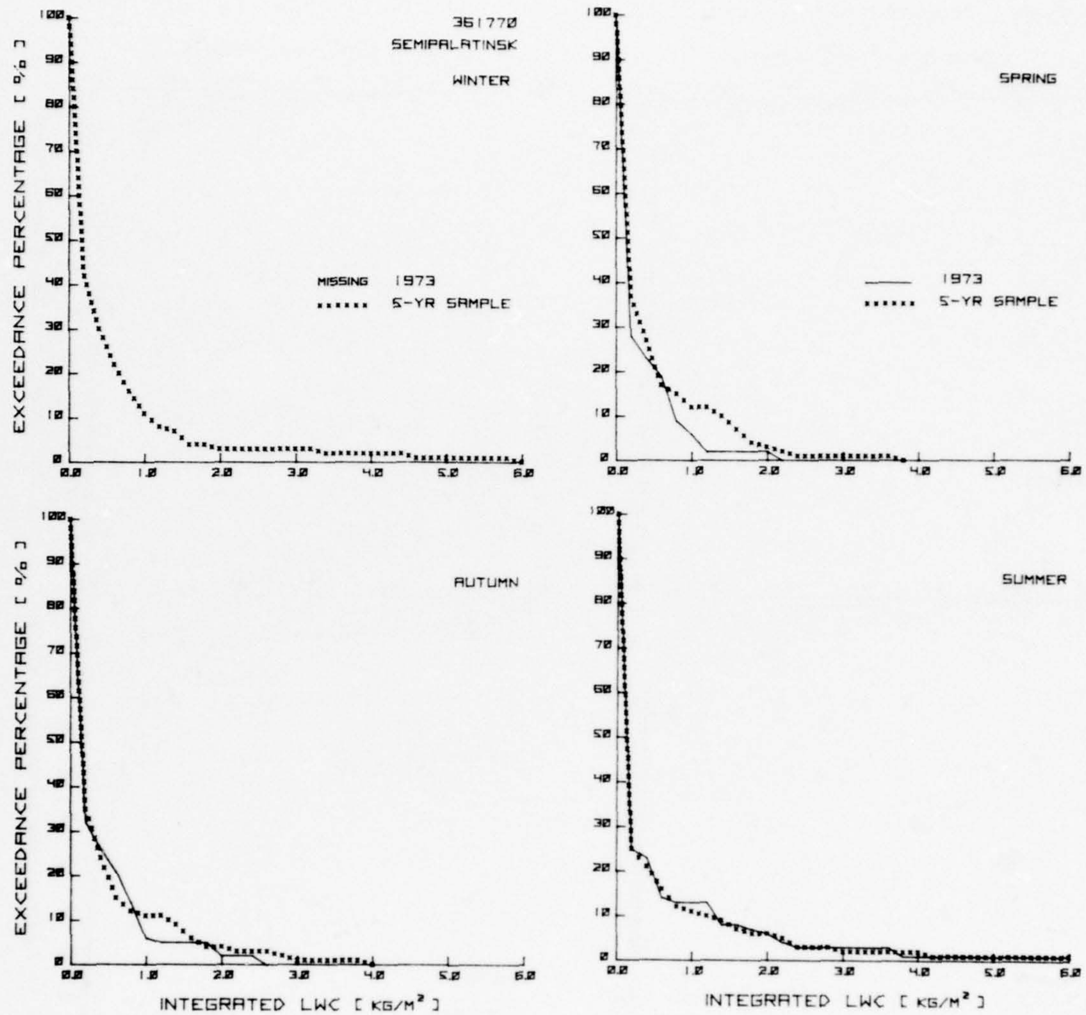

Figure A19. Cumulative Frequency Distribution of ILWC for Station 361770, SEMIPALATINSK

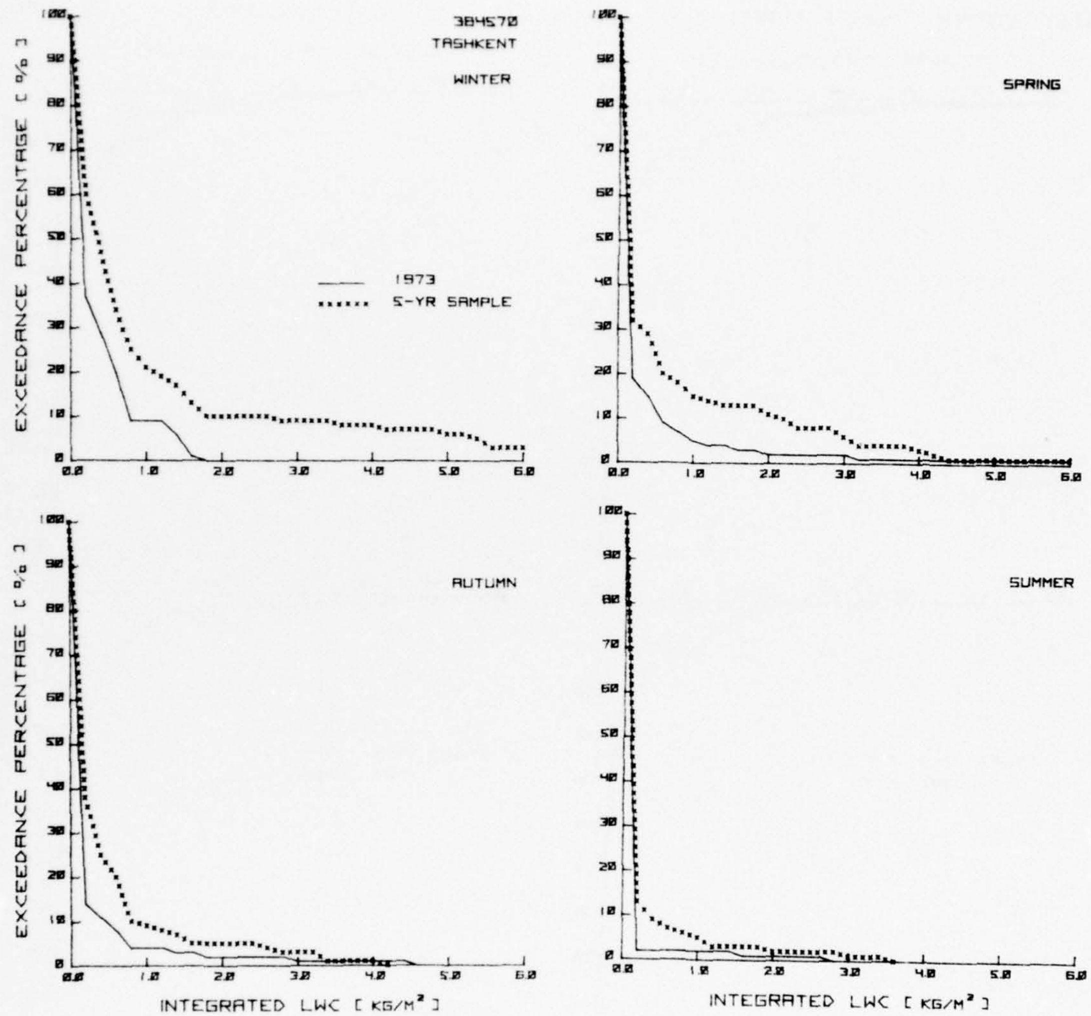

Figure A20. Cumulative Frequency Distribution of ILWC for Station 384570, TASHKENT

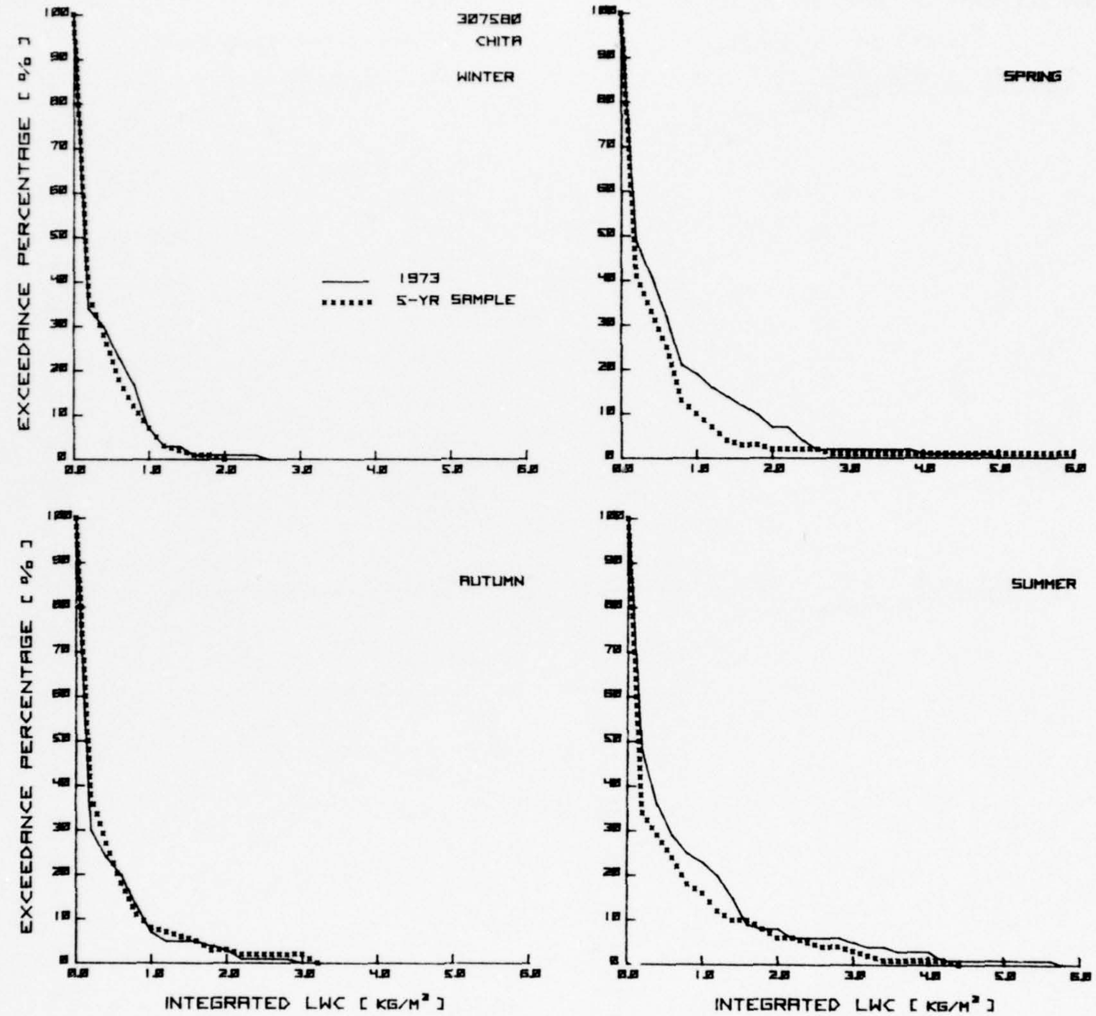

Figure A21. Cumulative Frequency Distribution of ILWC for Station 307580, CHITA

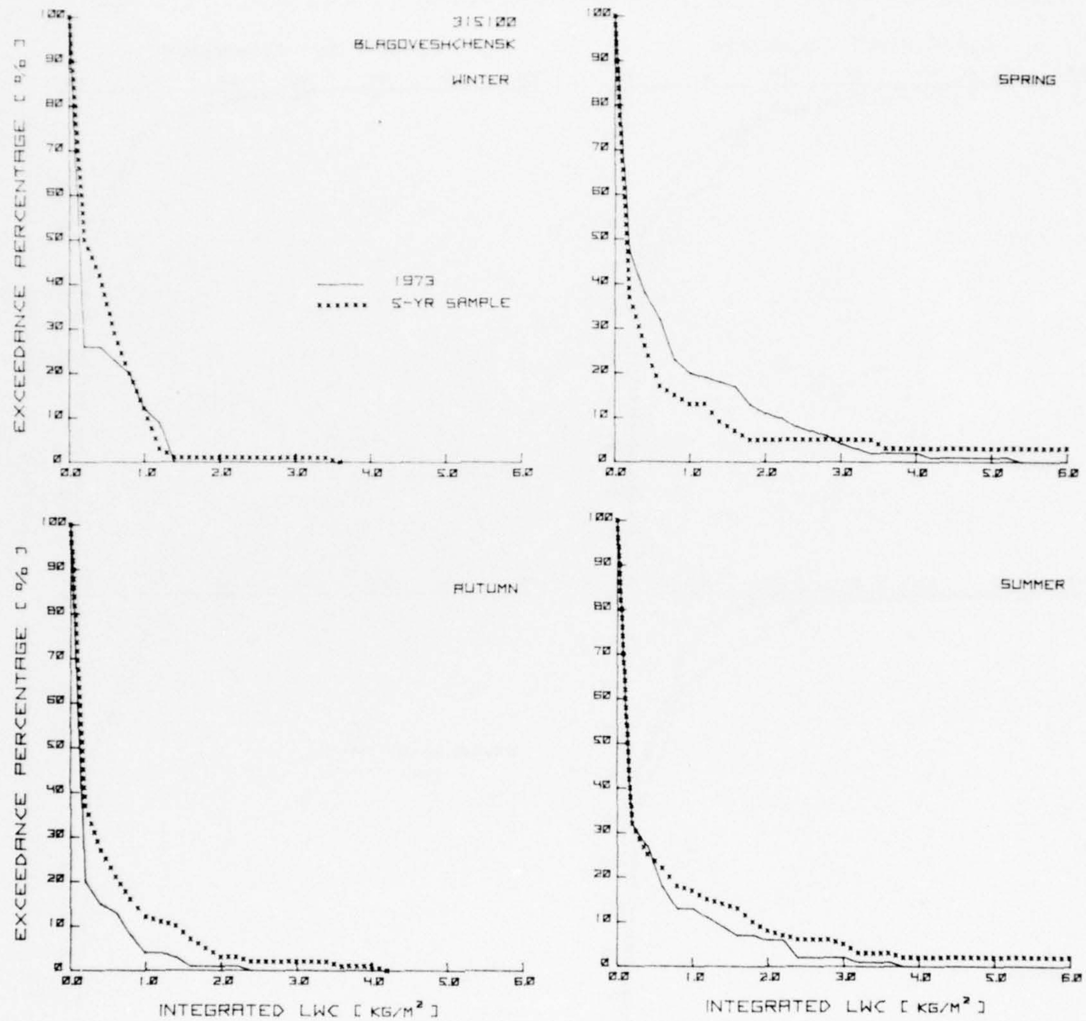

Figure A22. Cumulative Frequency Distribution of ILWC for Station 315100, BLAGOVESCHENSK

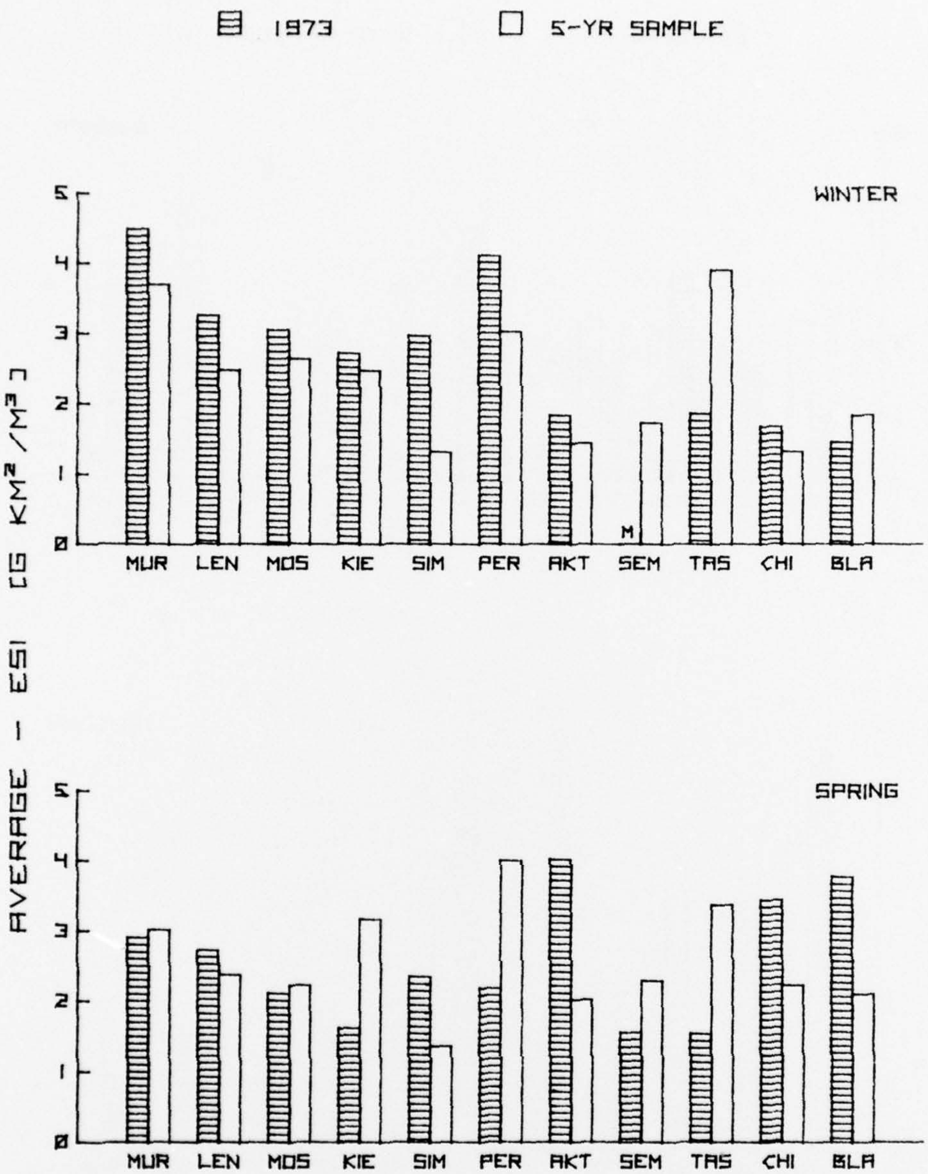

Figure A23. Comparison by Station of 1973 and the 5-yr Sample in Terms of Average ESI for Winter and Spring

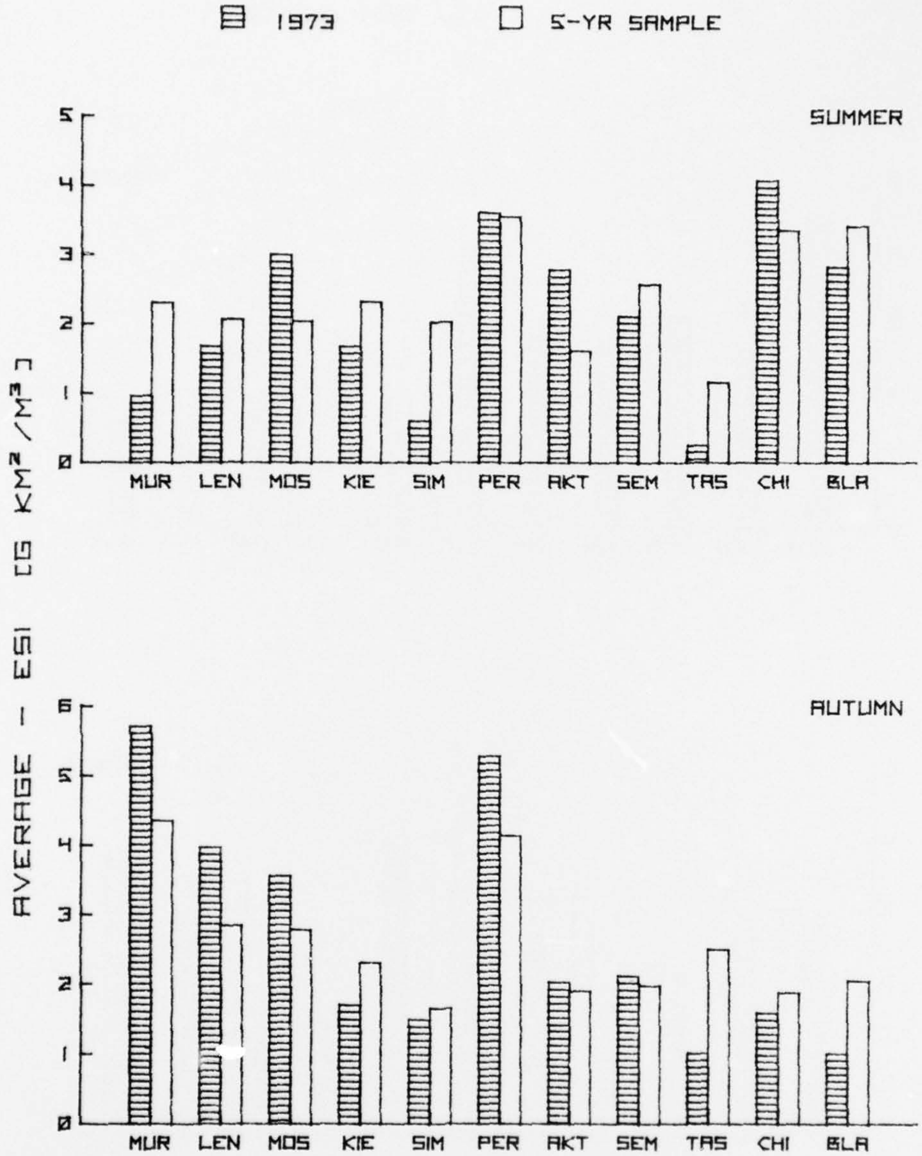

Figure A24. Comparison by Station of 1973 and the 5-yr Sample in Terms of Average ESI for Summer and Autumn

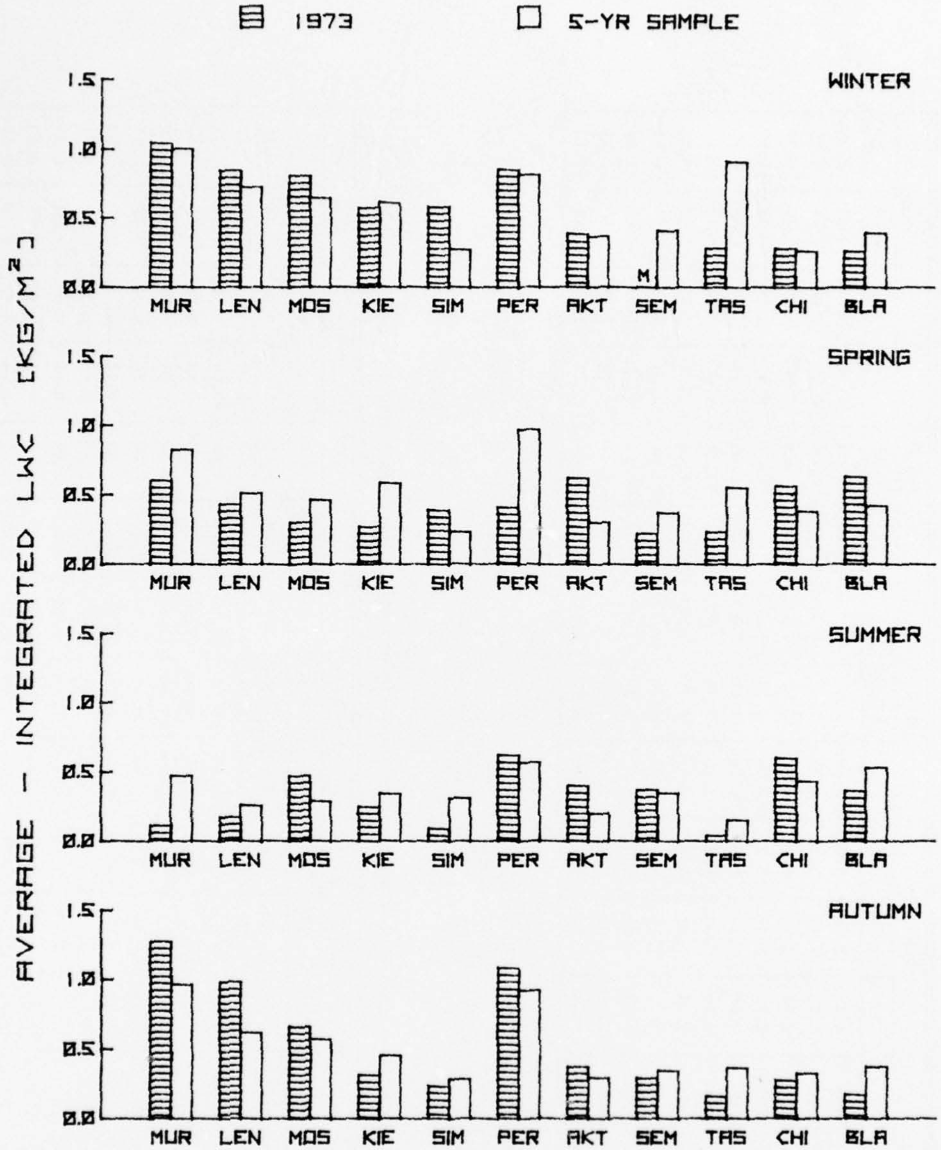

Figure A25. Comparison by Station of 1973 and the 5-yr Sample in Terms of Average ILWC

Table A1. Comparison by Station and Season of 1973 and the 5-yr Sample in Terms of Average ESI. (g km^2 m^{-3})

	WINTER			SPRING			SUMMER			FALL		
	73	5-YR	Δ	73	5-YR	Δ	73	5-YR	Δ	73	5-YR	Δ
MUR	4.48	3.69	0.79	2.90	3.01	-0.11	0.96	2.30	-1.34	5.71	4.35	1.36
LEN	3.25	2.47	0.78	2.72	2.37	0.35	1.67	2.06	-0.39	3.96	2.84	1.12
MOS	3.04	2.62	0.42	2.11	2.22	-0.11	2.99	2.03	0.96	3.55	2.78	0.77
KIE	2.71	2.46	0.25	1.62	3.16	-1.54	1.67	2.31	-0.64	1.70	2.30	-0.60
SIM	2.96	1.30	1.66	2.34	1.36	0.98	0.60	2.02	-1.42	1.49	1.65	-0.16
PER	4.10	3.02	1.08	2.18	3.99	-1.81	3.59	3.54	0.05	5.28	4.13	1.15
AKT	1.83	1.43	0.40	4.01	2.01	2.00	2.77	1.60	1.17	2.02	1.90	0.12
SEM	M	1.72	----	1.55	2.28	-0.73	2.10	2.56	-0.46	2.11	1.97	0.14
TAS	1.85	3.89	-2.04	1.53	3.36	-1.83	0.25	1.15	-0.90	1.01	2.49	-1.48
CHI	1.67	1.31	0.36	3.43	2.21	1.22	4.06	3.34	0.72	1.58	1.87	-0.29
BLA	1.45	1.83	-0.38	3.76	2.09	1.67	2.81	3.40	-0.59	1.00	2.04	-1.04

Table A2. Comparison by Station and Season of 1973 and the 5-yr Sample in Terms of Median ESI. (g km^2 m^{-3})

	WINTER			SPRING			SUMMER			FALL		
	73	5-YR	Δ	73	5-YR	Δ	73	5-YR	Δ	73	5-YR	Δ
MUR	2.64	2.02	0.62	1.19	1.38	-0.19	0.54	0.93	-0.39	3.71	2.76	0.95
LEN	2.42	1.39	1.03	0.69	1.04	-0.35	0.49	0.76	-0.27	1.32	1.19	0.13
MOS	1.10	2.40	-1.30	0.65	0.75	-0.10	0.64	0.83	-0.19	1.74	1.05	-0.31
KIE	1.27	1.23	0.04	0.57	0.96	-0.39	0.60	0.74	-0.14	0.59	1.03	-0.44
SIM	1.14	0.87	0.27	0.59	0.74	-0.15	0.46	0.52	-0.06	0.51	0.61	-0.10
PER	3.32	1.83	1.49	0.54	1.14	-0.60	1.24	1.08	0.16	4.16	1.89	2.27
AKT	0.64	0.74	-0.10	0.96	0.77	0.19	0.60	0.59	0.01	0.75	0.70	0.05
SEM	M	0.83	----	0.81	1.11	-0.30	0.77	0.76	0.01	0.84	0.71	0.13
TAS	0.72	2.70	-1.98	0.51	0.73	-0.22	0.40	0.49	-0.09	0.46	1.05	-0.59
CHI	0.64	0.68	-0.04	1.27	1.09	0.18	1.32	0.97	0.35	0.60	0.95	-0.35
BLA	0.73	1.25	-0.52	0.88	1.06	-0.18	0.50	0.86	-0.36	0.50	0.97	-0.47

Table A3. Comparison by Station and Season of 1973 and the 5-yr Sample in Terms of the 90th Percentile of ESI. (g km^2 m^{-3})

	WINTER			SPRING			SUMMER			FALL		
	73	5-YR	Δ	73	5-YR	Δ	73	5-YR	Δ	73	5-YR	Δ
MUR	13.50	10.19	3.31	7.23	7.55	-0.32	3.09	7.11	-4.02	16.22	10.58	5.64
LEN	7.66	6.01	1.65	6.90	7.11	-0.21	4.50	6.36	-1.86	10.26	7.33	2.93
MOS	9.40	5.68	3.72	7.27	6.69	0.58	10.05	6.20	3.85	8.00	7.46	0.54
KIE	6.47	5.93	0.54	6.14	7.43	-1.29	4.85	5.84	-0.99	6.40	7.15	-0.75
SIM	6.30	4.26	2.04	6.81	5.04	1.77	1.72	7.34	-5.62	4.07	4.56	-0.49
PER	7.54	6.97	0.57	7.47	12.19	-4.72	11.11	10.09	1.02	12.97	12.16	0.81
AKT	6.40	4.29	2.11	16.81	5.41	11.40	11.09	5.56	5.53	6.33	6.13	0.20
SEM	M	4.78	----	6.52	7.68	-1.16	7.18	8.77	-1.59	6.78	6.37	0.41
TAS	6.15	10.00	-3.85	4.57	12.00	-7.43	1.14	3.27	-2.13	4.54	6.92	-2.38
CHI	5.61	4.26	1.35	10.85	6.23	4.62	11.77	10.30	1.47	6.18	5.37	0.81
BLA	6.24	4.73	1.51	12.44	5.24	7.20	7.96	10.57	-2.61	5.56	6.19	-0.63

Table A4. Comparison by Station and Season of 1973 and the 5-yr Sample in Terms of the 95th Percentile of ESI. (g km^2 m^{-3})

	WINTER			SPRING			SUMMER			FALL		
	73	5-YR	Δ	73	5-YR	Δ	73	5-YR	Δ	73	5-YR	Δ
MUR	15.80	14.54	1.26	9.50	13.15	-3.65	4.37	9.40	-5.03	19.19	16.50	2.69
LEN	12.49	8.45	4.04	9.35	9.35	0	6.81	8.60	-1.79	16.00	9.06	6.94
MOS	14.83	6.85	7.98	9.45	8.66	0.79	16.50	10.83	5.67	9.70	9.50	0.20
KIE	7.65	10.33	-2.68	8.93	11.36	-2.43	6.78	11.80	-5.02	8.00	9.05	-1.05
SIM	11.50	5.50	6.00	11.00	7.65	3.35	4.33	11.51	-7.18	6.00	7.17	-1.17
PER	14.18	11.16	3.02	11.35	18.61	-7.26	15.81	19.76	-3.95	19.00	16.00	3.00
AKT	7.13	5.37	1.76	21.50	7.48	14.02	20.13	7.89	12.24	7.76	8.54	-0.78
SEM	M	5.89	----	7.18	10.00	-2.82	12.50	14.78	-2.28	8.78	9.05	-0.27
TAS	7.21	16.10	-8.89	6.47	18.96	-12.49	1.26	6.99	-5.73	6.44	10.51	-4.07
CHI	6.27	5.20	1.07	13.24	7.25	5.99	17.33	17.19	0.14	7.13	7.48	-0.35
BLA	6.64	5.53	1.11	17.54	8.41	9.13	17.21	18.49	-1.28	6.93	8.93	-2.00

Table A5. Comparison by Station and Season of 1973 and the 5-yr Sample in Terms of Average ILWC. (g m^{-2})

	WINTER			SPRING			SUMMER			FALL		
	73	5-YR	Δ	73	5-YR	Δ	73	5-YR	Δ	73	5-YR	Δ
MUR	1.04	1.00	0.04	0.60	0.82	-0.22	0.11	0.47	-0.36	1.27	0.96	0.31
LEN	0.84	0.72	0.12	0.43	0.51	-0.08	0.17	0.26	-0.09	0.98	0.62	0.36
MOS	0.80	0.64	0.16	0.30	0.46	-0.16	0.47	0.29	0.18	0.66	0.57	0.09
KIE	0.57	0.61	-0.04	0.27	0.58	-0.31	0.25	0.34	-0.09	0.31	0.45	-0.14
SIM	0.58	0.27	0.31	0.39	0.23	0.16	0.09	0.31	-0.22	0.23	0.28	-0.05
PER	0.85	0.81	0.04	0.41	0.97	-0.56	0.62	0.57	0.05	1.08	0.92	0.16
AKT	0.38	0.36	0.02	0.62	0.30	0.32	0.40	0.20	0.20	0.37	0.29	0.08
SEM	M	0.41	----	0.22	0.37	-0.15	0.37	0.35	0.02	0.29	0.34	-0.05
TAS	0.28	0.91	-0.63	0.23	0.55	-0.32	0.04	0.15	-0.11	0.16	0.36	-0.20
CHI	0.28	0.26	0.02	0.56	0.38	0.18	0.60	0.43	0.17	0.27	0.32	-0.05
BLA	0.26	0.39	-0.13	0.63	0.42	0.21	0.36	0.53	-0.17	0.17	0.37	-0.20

Table A6. Comparison by Station and Season of 1973 and the 5-yr Sample in Terms of Median ILWC. (g m^{-2})

	WINTER			SPRING			SUMMER			FALL		
	73	5-YR	Δ	73	5-YR	Δ	73	5-YR	Δ	73	5-YR	Δ
MUR	0.46	0.53	-0.07	0.25	0.26	-0.01	0.10	0.17	-0.07	0.66	0.45	0.21
LEN	0.40	0.31	0.09	0.14	0.20	-0.06	0.09	0.14	-0.05	0.29	0.25	0.04
MOS	0.28	0.42	-0.15	0.13	0.18	-0.05	0.13	0.15	-0.02	0.40	0.21	0.19
KIE	0.27	0.19	0.08	0.11	0.24	-0.13	0.11	0.11	0	0.12	0.15	-0.03
SIM	0.24	0.13	0.11	0.12	0.11	0.01	0.09	0.10	-0.01	0.10	0.11	-0.01
PER	0.42	0.36	0.06	0.11	0.22	-0.11	0.22	0.15	0.07	0.73	0.28	0.45
AKT	0.14	0.14	0	0.14	0.17	-0.03	0.12	0.11	0.01	0.18	0.13	0.05
SEM	M	0.16	----	0.12	0.14	-0.02	0.11	0.11	0	0.13	0.14	-0.01
TAS	0.14	0.32	-0.18	0.10	0.12	-0.02	0.08	0.09	-0.01	0.09	0.15	-0.06
CHI	0.13	0.14	-0.01	0.24	0.15	0.09	0.22	0.13	0.09	0.12	0.14	-0.02
BLA	0.15	0.20	-0.05	0.22	0.14	0.08	0.13	0.13	0	0.10	0.14	-0.04

Table A7. Comparison by Station and Season of 1973 and the 5-yr Sample in Terms of the 90th Percentile of ILWC. ($g\,m^{-2}$)

	WINTER			SPRING			SUMMER			FALL		
	73	5-YR	Δ	73	5-YR	Δ	73	5-YR	Δ	73	5-YR	Δ
MUR	3.06	2.65	0.41	1.69	2.57	-0.88	0.36	1.40	-1.04	3.81	2.60	1.21
LEN	2.21	1.58	0.63	0.95	1.56	-0.61	0.47	0.96	-0.49	2.93	1.59	1.34
MOS	2.50	1.51	0.99	0.91	1.54	-0.63	1.66	0.90	0.76	1.68	1.68	0
KIE	1.47	1.49	-0.20	0.80	1.54	-0.74	0.72	0.78	-0.06	0.77	1.64	-0.87
SIM	1.35	0.77	0.58	0.86	0.72	0.14	0.26	0.89	-0.63	0.47	0.72	-0.25
PER	1.81	1.61	0.20	1.30	3.36	-2.06	2.06	1.92	0.14	2.72	2.66	0.06
AKT	1.29	1.15	0.14	2.50	0.77	1.73	1.53	0.63	0.90	0.84	0.80	0.04
SEM	M	1.09	----	0.83	1.39	-0.56	1.35	1.21	0.14	0.89	1.19	-0.30
TAS	0.84	2.22	-1.38	0.59	2.13	-1.54	0.23	0.34	-0.11	0.47	0.85	-0.38
CHI	0.95	0.88	0.07	1.76	0.97	0.79	1.59	1.48	0.11	0.89	0.88	0.01
BLA	1.12	1.02	0.10	2.15	1.36	0.79	1.30	1.82	-0.52	0.73	1.32	-0.59

Table A8. Comparison by Station and Season of 1973 and the 5-yr Sample in Terms of the 95th Percentile of ILWC. ($g\,m^{-2}$)

	WINTER			SPRING			SUMMER			FALL		
	73	5-YR	Δ	73	5-YR	Δ	73	5-YR	Δ	73	5-YR	Δ
MUR	4.50	4.25	0.25	1.96	4.10	-2.14	0.52	2.05	-1.53	6.01	3.63	2.38
LEN	4.00	3.15	0.85	1.52	2.29	-0.77	0.87	1.37	-0.50	5.13	2.34	2.79
MOS	3.90	1.71	2.19	1.44	1.92	-0.48	2.93	1.44	1.49	2.19	2.16	0.03
KIE	1.76	3.41	-1.65	1.47	2.38	-0.91	1.21	1.69	-0.48	1.76	1.89	-0.13
SIM	2.64	1.17	1.47	2.36	1.44	0.92	0.48	1.91	-1.43	0.71	1.22	-0.51
PER	3.43	2.92	0.51	2.74	6.40	-3.66	2.99	3.76	-0.77	3.90	4.38	-0.48
AKT	1.47	1.55	-0.08	3.39	1.27	2.12	2.75	0.92	1.83	1.20	1.63	-0.43
SEM	M	1.57	----	1.02	1.74	-0.72	2.10	2.09	0.01	1.56	1.72	-0.16
TAS	1.41	5.29	-3.88	1.01	3.09	-2.08	0.25	0.94	-0.69	0.77	1.74	-0.97
CHI	1.07	1.10	-0.03	2.30	1.33	0.97	3.20	2.37	0.83	1.37	1.54	-0.17
BLA	1.27	1.17	0.10	2.90	1.85	1.05	2.18	2.89	-0.71	0.95	1.79	-0.84