F1 OCCURRENCE INCLUDING L CONDITION IN TUCUMAN AND BUENOS AIRES

M. Mosert de Gonzalez[1], R.G. Ezquer[2,3,4] and R. del V. Oviedo[2]
[1] CASLEO- CONICET, San Juan, Argentina
[2] LIIF, UNT, Tucuman, Argentina
[3] CONICET, Argentina
[4] Fac. Reg. Tucuman, UTN, Argentina

Abstract: An analysis of the occurrence of the F1 layer including the L condition has been done, using data from two Argentine stations: TUCUMAN and BUENOS AIRES, at different seasons and solar activity conditions. The comparisons between observations and the F1 occurrence predicted by the IRI-90 model show the need of reviewing the use of the DuCharme et al. (1973) formula adopted by the model to predict the occurrence of the intermediate F1 layer including the L condition.

Introduction

A typical bottomside ionogram for daytime hours shows generally the signatures of reflections from ionospheric regions E and F. Sometimes the F layer can be seen stratified in F1 and F2. When the F1 layer is very well developed a clear cusp is identified on the ionogram and the critical frequency of the layer, foF1, can be scaled. When it is not fully formed only a change of curvature is observed near the expected value of foF1. This condition is usually known as the "L condition" and it is scaled only with the descriptive letter L.

As it is known the International Reference Ionosphere 1990, IRI-90, (Bilitza, 1990) predicts the time of occurrence of the layer and the foF1 values using DuCharme et al. (1973) formula that also provides a critical solar zenith angle for the occurrence probability of the F1 layer. IRI-90 omits this layer at night and in winter.

Some authors (Ezquer et al, 1996; Mosert de Gonzalez et al., 1996; Zolesi and Mosert de Gonzalez, 1996; Mosert de Gonzalez, 1996) have shown that while the IRI-90 model predicts reasonably good the foF1 values, discrepancies in the time of occurrence of this layer occur. The objective of the present work is to analyze the occurrence of the F1 layer including the L condition, with data from two Argentine stations: TUCUMAN (26.9S; 294.6E) and BUENOS AIRES (31.5S; 301.5E).

Hourly values of ND (number of days in the month) in which F1 layer is observed have been compared with the ND predicted by the IRI-90 model using data recorded at both stations at different seasons and for the three levels of solar activity: high (HSA), moderate (MSA) and low (LSA).

Results

Tables 1 and 2 show for three typical daytime hours (LT:10.00, 12.00 and 14.00), for both stations, the four seasons (winter: July; fall: March; spring: September and summer: December) and for years of LSA (1976), MSA (1972, 1983) and HSA (1968,1979), the comparison

between Nexp (number of days in the month with F1 cusp) and NIRI (number of cases of F1 occurrence predicted by the IRI-90 model). The cases of F1 occurrence with **L condition has not been taken into account in these tables**.
It can be seen that during winter F1 predictions are absent, however experimental values are observed in both stations during MSA and LSA. On the contrary, during March the model predicts the F1 layer while the observations are practically absent. More frequent is the presence of foF1 values during the equinoctial month of September. The best agreement between observed and predicted F1 occurrence is found during summer (December).

Figures 1 to 6 illustrate the results of the comparison between the number of cases predicted by the IRI model (called **IRI** in Figures 1 to 6) and number of observed F1 occurrence including also the cases with L condition (called **EXP + L** in Figures 1 to 6), for BUENOS AIRES (Figures 1 to 3) and TUCUMAN (Figures 4 to 6) at different seasons and for years of HSA (1968, 1982), MSA (1972, 1983) and LSA (1976, 1977).

From the analysis of the figures can be seen:

(i) During the equinoctial months the occurrence of the F1 layer when the L condition is taken into account is closer to that predicted by the IRI-90 model during the hours in which the model predicts the F1 occurrence. Note that during March the occurrence is generally null if this condition is not considered (see Tables I and II). During both equinoctial months the model underestimates the time window of occurrence of the layer. The F1 layer is not predicted by the model for hours of large solar zenith angles.

(ii) During winter the F1 layer often occur if the L condition is taken into account, for the three levels of solar activity. Note that in winter during HSA (see Tables I and II) the occurrence of the F1 layer is null, if the cases with L condition are not considered.

(iii) During summer the agreement between observed and predicted F1 occurrence is also better during the hours in which the IRI model predicts the layer if the L condition is considered. Once more during this season the time range of the observed occurrence is larger than that given by IRI predictions.

Conclusions

The results of the present study indicate the need of reviewing the use of the DuCharme et al. (1973) formula adopted by IRI-90 to predict the F1 occurrence, in order to improve the current performance of the bottomside IRI model.

Aknowledgements: The authors undertook this work with the support of the International Centre for Theoretical Physics and the National Programme of Radiopropagation (PRONARP), CONICET, Argentina.

References

Bilitza, D., International Reference Ionosphere 1990, National Space Center/World Data Center A for Rockets and Satellites 90-22, Maryland. U.S.A., 1990.

DuCharme, E.D., L.E. Petrie and R. Eyfrig, A Method for Predicting the Fl-layer Critical Frequency based on Zurich Smoothed Sunspot Number, Radio Sci. 8, 837- 839, 1973.

Ezquer R.G., R.del V. Oviedo and C.A. Jadur, Ionospheric Predictions for South American Latitudes. Radio Sci. 31, No.2, 381-388, 1996.

Mosert de Gonzalez, M.E., R.G .Ezquer and R. del V. Oviedo, The Presence of the Fl layer over a Low Latitude Station, Proceedings IRI Task Force Activity 1995, International Centre for Theoretical Physics, Trieste, Italy, 1996.

Mosert de Gonzalez, M.E., Observed and Model N (h) Profiles For Two Argentine Stations, Adv. Space Res. 18, pp.(6) 53-(6) 56, 1996.

Zolesi B. and M.E. Mosert de Gonzalez, On the Prediction of the DuCharme Formula for Predicting the Fl-layer Critical Frequency, Proceedings IRI Task Force Activity 1995, International Centre for Theoretical Physics, Trieste, Italy, 1996.

TABLE I

TUCUMAN													
		JULY			MARCH			SEPTEMBER			DECEMBER		
Hour	Year	RZ12	Nexp	NIRI	RZ12	Nexp	NIRI	RZ12	Nexp	NIRI	RZ12	Nexp	NIRI
10	1976	13	18	-	12	-	31	14	19	30	15	21	31
10	1972	68.2	-	-	72.4	-	31	68.2	3	30	55	1	31
10	1979	155	-	-	137	-	31	156	-	-	165	3	31
12	1976	13	23	-	12	-	31	14	17	30	15	19	31
12	1972	68.2	5	-	72.4	-	31	68.2	6	30	55	4	31
12	1979	155	-	-	137	-	31	156	-	30	165	10	31
14	1976	13	18	-	12	-	31	14	19	30	15	21	31
14	1972	68.2	2	-	72.4	-	31	68.2	2	30	55	10	31
14	1979	155	5	-	137	-	31	156	-	-	165	17	31

Nexp: Days of month for which foF1 has been observed
NIRI: Days of month for which IRI gives foF1 predictions

TABLE II

BUENOS AIRES													
		JULY			MARCH			SEPTEMBER			DECEMBER		
Hour	Year	RZ12	Nexp	NIRI	RZ12	Nexp	NIRI	RZ12	Nexp	NIRI	RZ12	Nexp	NIRI
10	1976	13	9	-	12	4	31	14	18	30	15	15	31
10	1983	66	-	-	86	-	31	68	8	30	64	11	31
10	1968	105.2	-	-	104.7	-	31	107	1	30	110	3	31
12	1976	13	15	-	12	10	31	14	19	30	15	21	31
12	1983	66	6	-	86	-	31	68	13	30	64	21	31
12	1968	105.2	-	-	104.7	2	31	107	2	30	110	5	31
14	1976	13	10	-	12	7	31	14	12	30	15	23	31
14	1983	66	7	-	86	-	31	68	9	30	64	26	31
14	1968	105.2	-	-	104.7	-	31	107	1	-	110	3	31

Nexp: Days of month for which foF1 has been observed
NIRI: Days of month for which IRI gives foF1 predictions

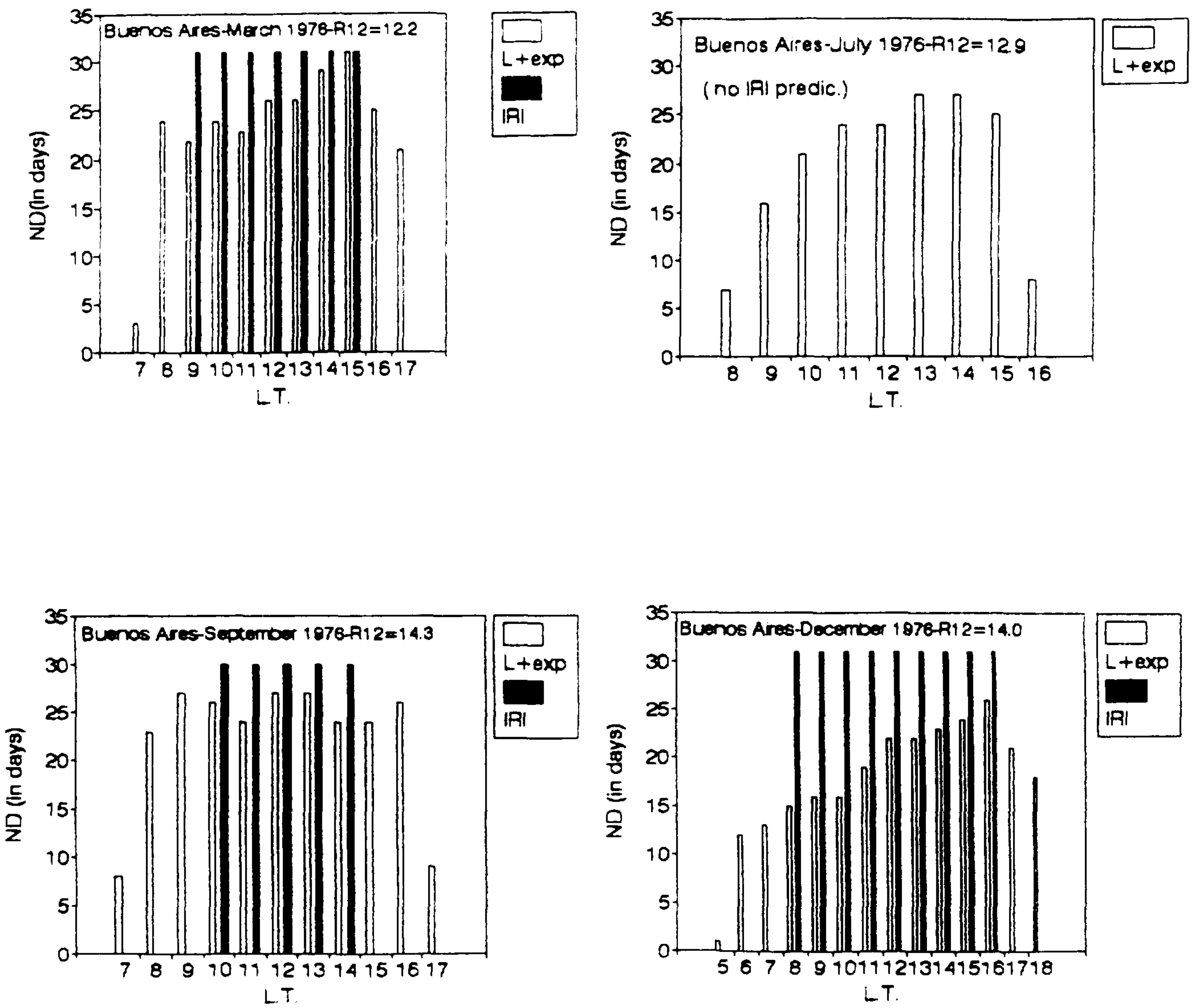
Buenos Aires-March 1976-R12=12.2
L+exp
IRI
ND(in days)
0
5
10
15
20
25
30
35
7 8 9 10 11 12 13 14 15 16 17
L.T.
Buenos Aires-July 1976-R12=12.9
(no IRI predic.)
L+exp
ND (in days)
8 9 10 11 12 13 14 15 16
L.T.
Buenos Aires-September 1976-R12=14.3
L+exp
IRI
ND (in days)
7 8 9 10 11 12 13 14 15 16 17
L.T.
Buenos Aires-December 1976-R12=14.0
L+exp
IRI
ND (in days)
5 6 7 8 9 10 11 12 13 14 15 16 17 18
L.T.

Fig.1

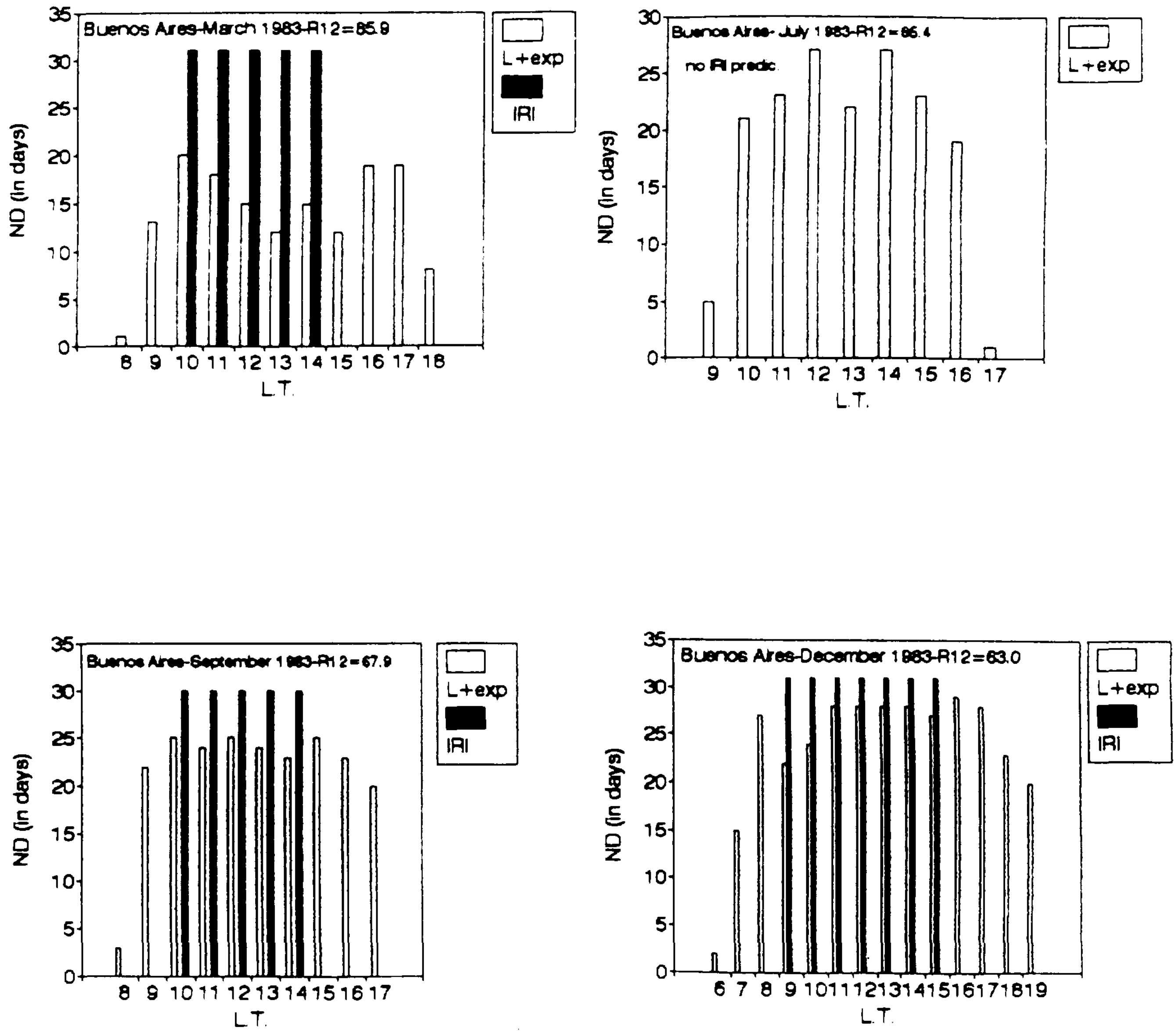
Buenos Aires-March 1983-R12=85.9
L+exp
IRI
ND (in days)
L.T.
Buenos Aires- July 1983-R12=86.4
no IRI predic.
L+exp
ND (in days)
L.T.
Buenos Aires-September 1983-R12=67.9
L+exp
IRI
ND (in days)
L.T.
Buenos Aires-December 1983-R12=63.0
L+exp
IRI
ND (in days)
L.T.

Fig.2

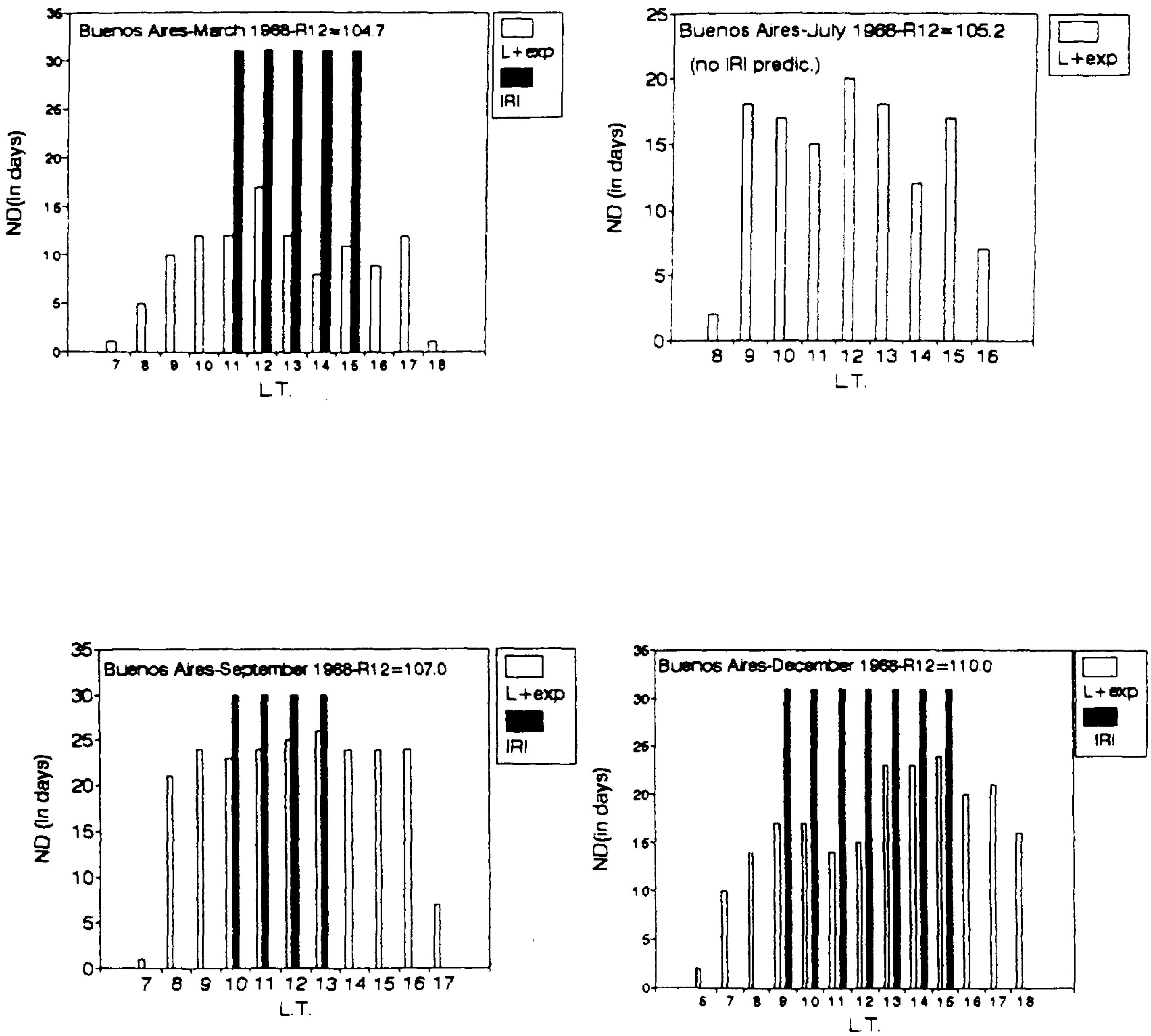
Buenos Aires-March 1968-R12=104.7
L+exp
IRI
ND(in days)
L.T.
Buenos Aires-July 1968-R12=105.2
(no IRI predic.)
L+exp
ND (in days)
L.T.
Buenos Aires-September 1968-R12=107.0
L+exp
IRI
ND (in days)
L.T.
Buenos Aires-December 1968-R12=110.0
L+exp
IRI
ND(in days)
L.T.

Fig.3

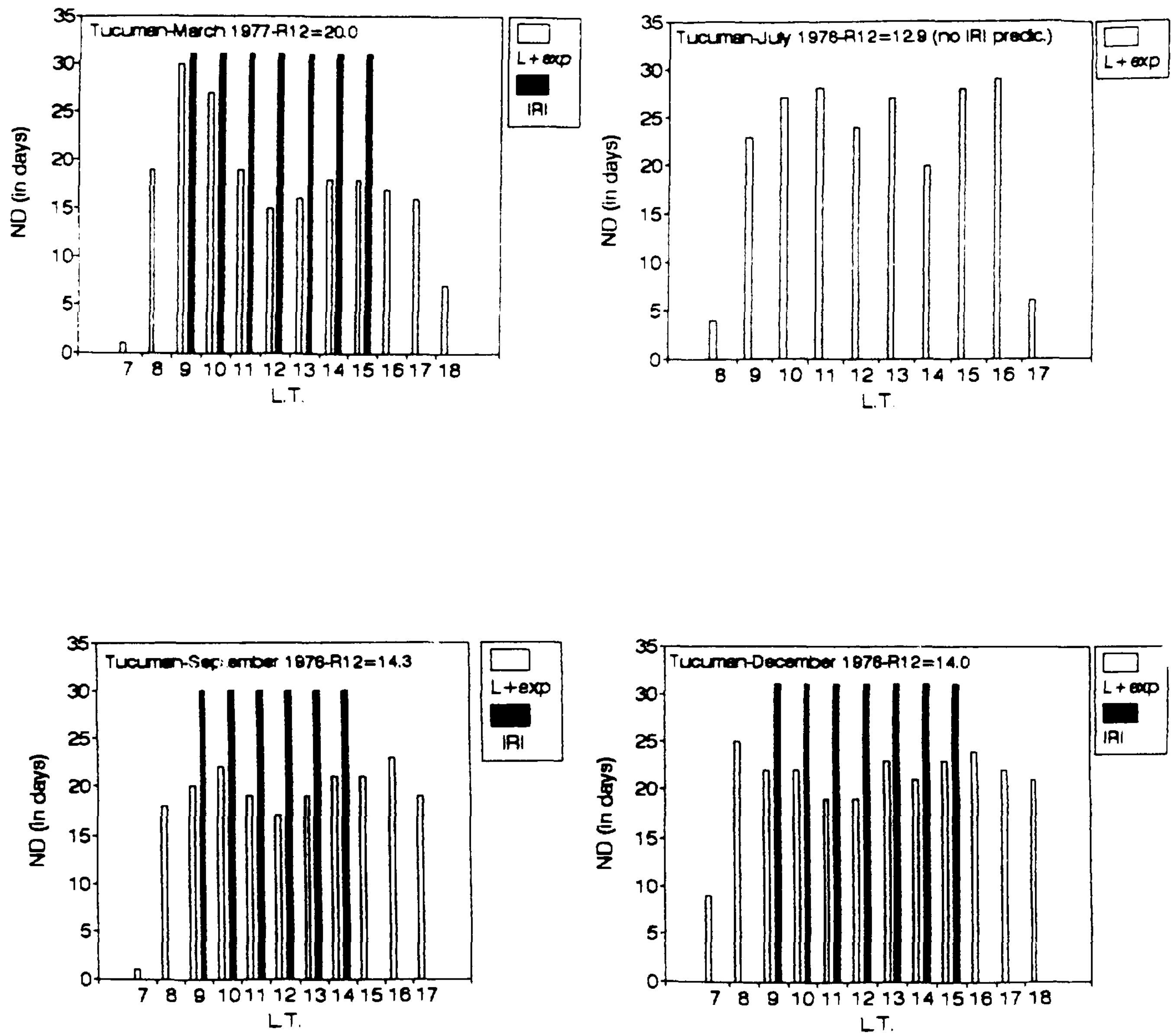
Tucuman-March 1977-R12=20.0
L+exp
IRI
ND (in days)
L.T.
Tucuman-July 1976-R12=12.9 (no IRI predic.)
L+exp
ND (in days)
L.T.
Tucuman-September 1976-R12=14.3
L+exp
IRI
ND (in days)
L.T.
Tucuman-December 1976-R12=14.0
L+exp
IRI
ND (in days)
L.T.

Fig.4

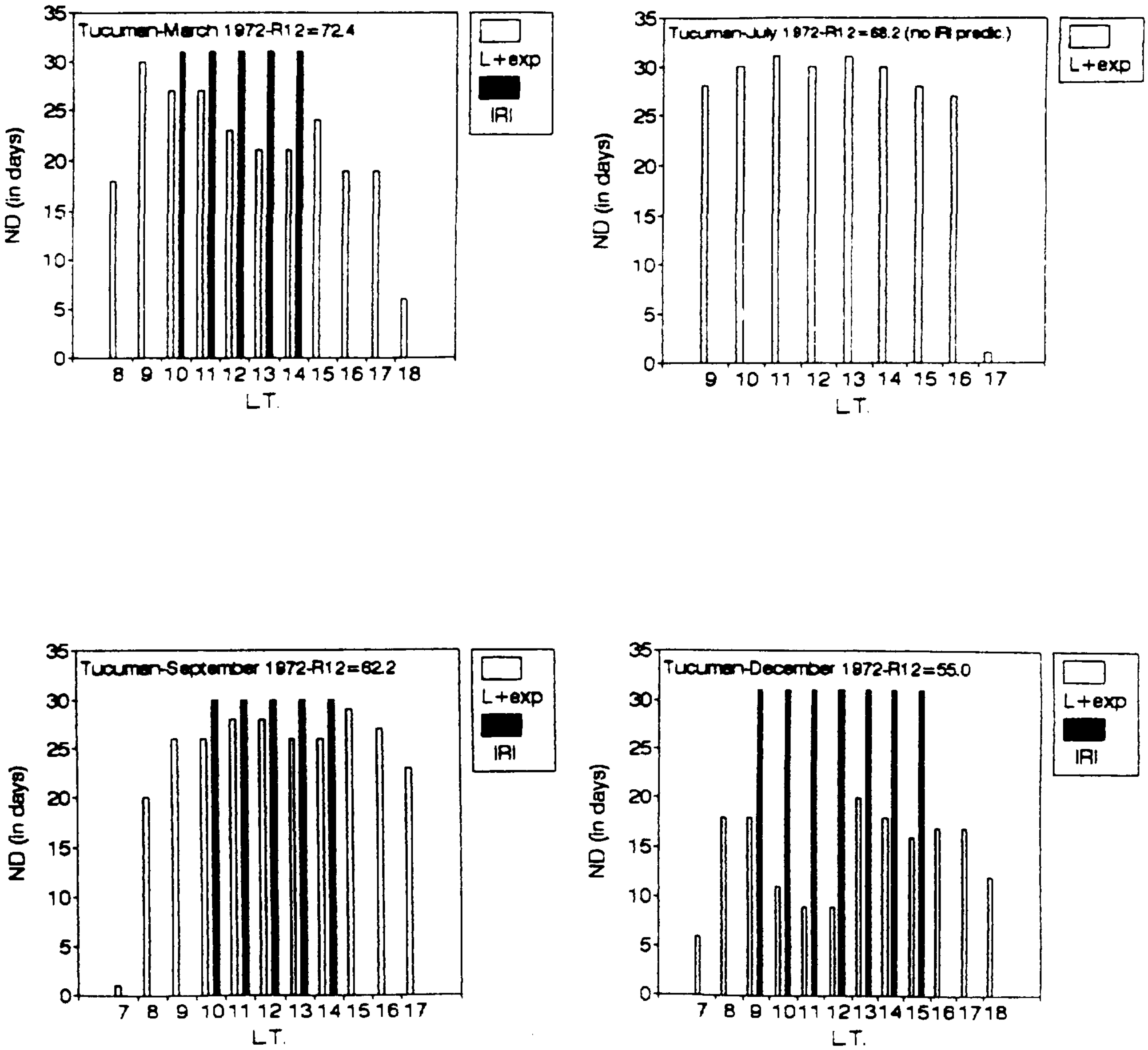
Tucuman-March 1972-R12=72.4
L+exp
IRI
ND (in days)
L.T.
Tucuman-July 1972-R12=68.2 (no IRI predic.)
L+exp
ND (in days)
L.T.
Tucuman-September 1972-R12=62.2
L+exp
IRI
ND (in days)
L.T.
Tucuman-December 1972-R12=55.0
L+exp
IRI
ND (in days)
L.T.

Fig.5

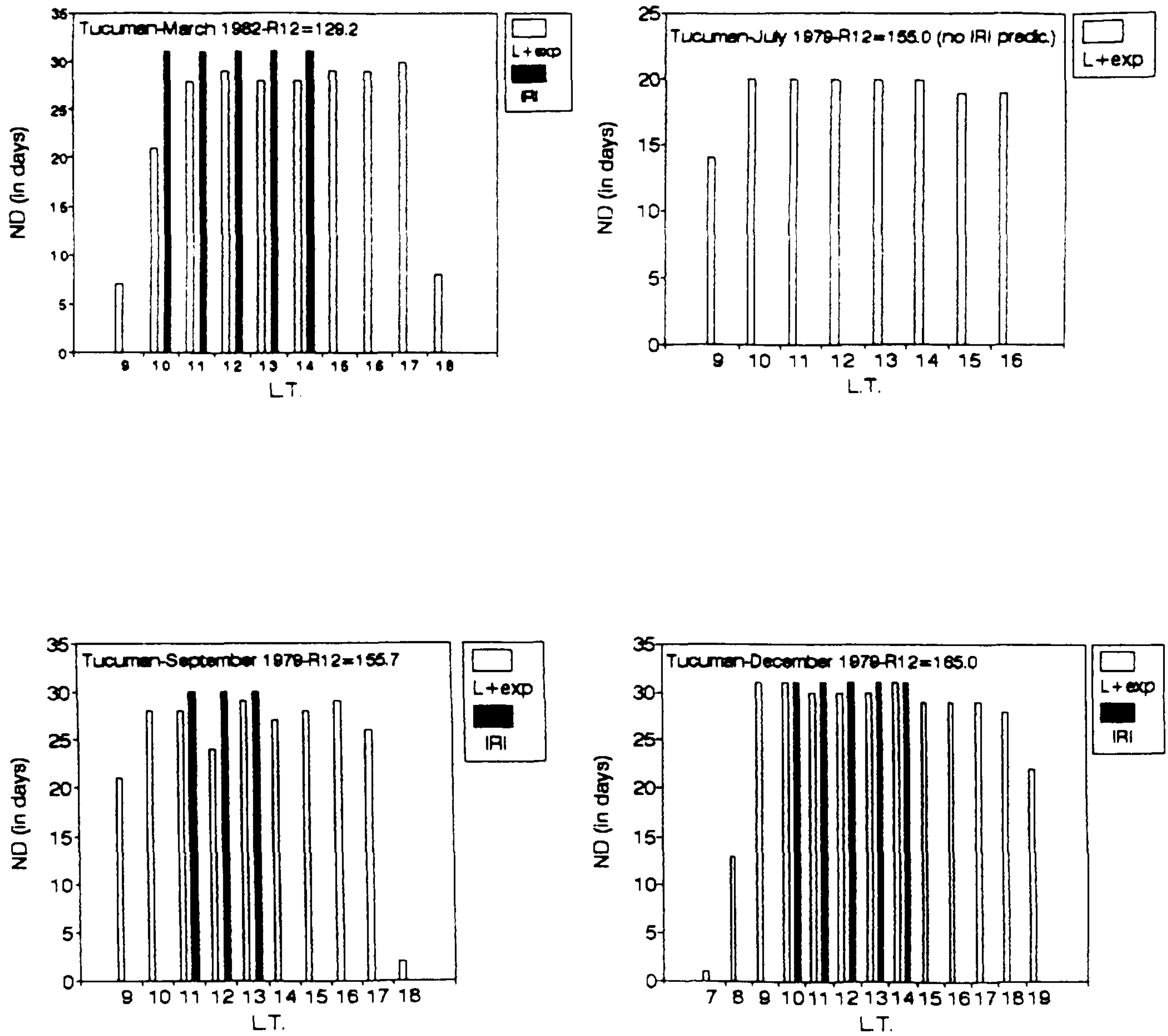
Tucuman-March 1982-R12=128.2
L+exp
IRI
ND (in days)
L.T.
Tucuman-July 1979-R12=155.0 (no IRI predic.)
L+exp
ND (in days)
L.T.
Tucuman-September 1979-R12=155.7
L+exp
IRI
ND (in days)
L.T.
Tucuman-December 1979-R12=165.0
L+exp
IRI
ND (in days)
L.T.

Fig.6