

H I D R O M E T E O R O L O Š K I Z A V O D  
N A R O D N E R E P U B L I K E H R V A T S K E

---

M 8

Broj 3

Rasprave i prikazi

**ZRAKOPLOVNA KLIMATOLOGIJA  
AERODROMA ZAGREB - LUČKO**

BERISLAV MAKJANIĆ

Z a g r e b, travanj 1959

**HYDROMETEOROLOGICAL INSTITUTE  
OF THE PEOPLE'S REPUBLIC CROATIA**

---

M 8

Nr. 3

Memoirs

**AERONAUTICAL CLIMATOLOGY  
OF THE AIRPORT ZAGREB - LUČKO**

by

**BERISLAV MAKJANIĆ**

Zagreb, April 1959

ZRAKOPLOVNA KLIMATOLOGIJA  
AERODROMA ZAGREB-LUČKO

Berislav Makjanić

A d r e s a a u t o r a :

Dr. Berislav Makjanić  
Geofizički institut Prirodoslovno-matematičkog fakulteta  
Zagreb, Grič 3.

## P R E D G O V O R

Posljednjih godina ukazala se je potreba za prikazom meteoroloških prilika na aerodromima kako za to da se doprinese poboljšanju rada raznih službi civilnog zrakoplovstva, tako i u svrhu udovoljenja međunarodnim obavezama.

U ovom svesku "Rasprava i prikaza" Hidrometeorološki zavod NR Hrvatske daje klimatografiju zagrebačkog aerodroma Lučko sa zrakoplovnog gledišta. Rad je izrađen u odsjeku za publikacije i meteorološka i klimatološka istraživanja Zavoda.

Prikaz klime za potrebe zrakoplovstva zahtjeva da se meteorološki elementi prikazu u međusobnoj vezi, te u tom smislu postoje i preporuke Svjetske meteorološke organizacije u njenom Tehničkom pravilniku (Geneve 1955.). U ovom radu obrada je izvršena kompleksno koliko je to bilo moguće bez potrebnih tehničkih pomagala. Zbog toga su i preporuke Tehničkog pravilnika SMO uvažene samo djelomično, jer su mogućnosti takve obrade bez upotrebe perforiranih kartica i statističkih mašina ograničene.

Predajući ovaj rad javnosti nadamo se, da će on korisno poslužiti onima, kojima je namjenjen.

Ing M. Šikić  
Direktor Hidrometeorološkog zavoda NRH

S A D R Ź A J

1.	Uvod .....	1
1.1.	Geografski položaj i opis meteorološke stanice Lučko .....	1
1.2.	Klimatološka grada .....	2
2.	Opći prikaz klime Lučkoga .....	2
2.1.	Općenito .....	2
2.2.	Temperatura zraka .....	3
2.2.1.	Godišnji hod temperature zraka .....	3
2.2.2.	Najviše i najniže temperature .....	4
2.2.3.	Dnevni hod temperature zraka .....	6
2.3.	Vlaga zraka .....	8
2.3.1.	Relativna vlaga .....	8
2.3.2.	Omjer mijesanja .....	9
2.3.3.	Odnos omjera mijesanja i temperature zraka .....	11
2.4.	Oborina .....	36
2.4.1.	Godišnje i mjesečne količine .....	36
2.4.2.	Dnevne količine oborine i broj dana s oborinom .....	37
2.4.3.	Snijeg .....	41
2.4.4.	Oborina u odnosu na vjetar .....	43
2.5.	Godišnji hod naoblake .....	45
3.	Vidljivost .....	45
3.1.	Dnevni i godišnji hod vidljivosti .....	45
3.2.	Vidljivost manja od 2 kilometra .....	49
3.2.1.	Broj dana s maglom .....	49
3.2.2.	Dnevni i godišnji hod magle .....	53
3.2.3.	Odnos magle i vertikalnih gradijenata temperature zraka i specifične vlage .....	63
3.2.4.	Magla i temperatura zraka .....	69
3.2.5.	Magla i vjetar .....	70
3.2.6.	Smanjenje vidljivosti kisom i snijegom .....	75
3.2.7.	Prilike nepovoljne za rad zrakoplovstva .....	75
3.3.	Vremenska situacija i magla .....	79
3.3.1.	Pregled vremenskih situacija za vrijeme dugotrajnih magli .....	79
3.3.2.	Opis magli najduljeg trajanja .....	80
3.3.2.1.	Magla od 19.XII.1951 do 26.XII.1951 .....	80
3.3.2.2.	Magla od 28.I.1952 do 1.II.1952 .....	82
4.	Oblaci .....	84
4.1.	Općenito .....	84
4.2.	Čestina redova oblaka .....	87
5.	Vjetar .....	89
5.1.	Općenito .....	89
5.2.	Brzina vjetra .....	91
5.3.	Smjer vjetra .....	94
5.4.	Orijentacija piste s obzirom na vjetar .....	95
5.4.1.	Općenito .....	95

5.4.2. Kritična brzina 10 mi/h .....	97
5.4.3. Kritična brzina 15 mi/h .....	101
5.4.4. Kritična brzina 20 mi/h .....	103
6. Tlak zraka .....	103
6.1. Višegodišnje vrijednosti tlaka zraka .....	103
6.2. Gustoća zraka .....	105
7. Grmljavine .....	107
7.1. Broj dana s grmljavinom .....	107
7.2. Trajanje grmljavine .....	108
7.3. Smjer gibanja grmljavine .....	109
7.4. Grmljavina i ostale pojave .....	110
7.4.1. Grmljavina i oborina .....	110
7.4.2. Grmljavina i jaki vjetar .....	111
8. Literatura .....	112

P O P I S   T A B L I C A

2.2.1.(I)	Srednja mjesečna temperatura zraka .....	3
	Lučko, 1949 - 1955.	
2.2.2.(I)	Apsolutni maksimum (M) i apsolutni minimum(m) temperature zraka na Lučkome (1949 - 1955) .....	4
(II)	Srednji maksimum (M) i srednji minimum (m) temperature zra- ka na Lučkome (1949 - 1955) .....	5
2.2.3.(I)	Srednji dnevni hod temperature zraka na Lučkome (1949-1955)	6
(II)	Odstupanje srednje temperature za pojedine smjerove vjetra od srednje mjesečne temperature, Lučko, 1949 - 1955 .....	7
2.3.1.(I)	Srednji godišnji hod relativne vlage zraka. Lučko, 1949-1955	9
(II)	Terminski minimum relativne vlage (7,14,21) na Lučkome .....	9
2.3.2.(I)	Srednji godišnji hod omjera miješanja u g kg <sup>-1</sup> . Lučko, 1949 - 1955 .....	10
2.3.3.(I)	Srednja čestina istodobnog pojavljivanja određenih vrijed- nosti temperature zraka i omjera miješanja, Lučko, 1949-1955	12
2.4.1.(I)	Godišnji hod oborine na Lučkome .....	36
(II)	Višegodišnji srednji godišnji hod oborine na opservatoriju Zagreb - Grič ( u mm ) .....	37
2.4.2.(I)	Najveće dnevne količine oborine na Lučkome .....	38
(II)	Broj dana s oborinom $\geq 0,1$ mm na Lučkome .....	38
(III)	Broj dana s oborinom $\geq 1,0$ mm na Lučkome .....	38
(IV)	Broj dana s oborinom $\geq 5,0$ mm na Lučkome .....	39
(V)	Broj dana s oborinom $\geq 10,0$ mm na Lučkome .....	39
(VI)	Broj dana s oborinom $\geq 20,0$ mm na Lučkome .....	39
(VII)	Relativni broj dana s raznim kolicinama oborine (broj dana s kolicinom 0,1 mm jednako 100) .....	40
(VIII)	Srednji dnevni intenzitet oborine (mm po oborinskom danu). Lučko, 1949 - 1955 .....	40
(IX)	Trajanje i intenzitet oborine na Lučkome, izracunati po Köppenovoj metodi iz razdoblja 1950 - 1955 .....	41
(X)	Trajanje i intenzitet kiše na Lučkome, izracunati po Köppenovoj metodi iz razdoblja 1950 - 1955 .....	41
(XI)	Trajanje snijega na Lučkome, izracunato po Köppenovoj metodi iz razdoblja 1950 - 1955 .....	41
2.4.3.(I)	Broj dana s padanjem snijega na Lučkome .....	41
(II)	Broj dana sa snijegom na tlu na Lučkome .....	42
(III)	Maksimalne visine snijega na Lučkome, izmjerene u 7 sati (cm) .....	42
2.4.4.(I)	Oborina u odnosu na vjetar na Lučkome .....	43
(II)	Čestina slučajeva s oborinom u % čestine pojedinih smje- rova vjetra na Lučkome .....	44



2.5.(I)	Srednja mjesečna i godišnja naoblaka na Lučkome .....	45
3.1.(I)	Srednja čestina vidljivosti na Lučkome u razdoblju 1949-1955	46
3.1.(II)	Kumulativna čestina vidljivosti za godišnja doba u postoci- ma svih opazanja, Lučko, 1949 - 1955 .....	48
(III)	Percentili vidljivosti (u km) na Lučkome po terminima i go- dišnjim dobama. Razdoblje 1949 - 1955 .....	49
3.2.1.(I)	Broj dana s maglom ( $V \leq 1000$ m) na Lučkome .....	50
(II)	Broj dana s maglom ( $V \leq 1000$ m) na Lučkome po godisnjim do- bama .....	50
(III)	Broj dana s maglom na Lučkome ( $V < 1000$ m) .....	50
(IV)	Broj dana s maglom ( $V < 1000$ m) na Lučkome po godisnjim do- bama .....	51
(V)	"Apsolutni" broj dana s maglom na Lučkome .....	51
(VI)	"Apsolutni" broj dana s maglom na Lučkome po godisnjim do- bama .....	52
(VII)	Godišnji hod kvocijenta srednjeg broja dana s maglom i sred- njeg "apsolutnog" broja dana s maglom za Lučko .....	52
(VIII)	"Apsolutni" godišnji broj dana s maglom u Sisku .....	52
3.2.2.(I)	Apsolutna čestina magle ( $V < 2$ km) na Lučkome. Broj slučajeva u 7 godina (1949 - 1955) .....	54
(II)	Relativna čestina magle ( $V < 2$ km) na Lučkome u % broja poje- dinih termina (1949 - 1955) .....	55
(III)	Apsolutna čestina magle ( $V < 1000$ m) na Lučkome. Broj slučajeva u 7 godina (1949 - 1955) .....	55
(IV)	Relativna čestina magle ( $V < 1000$ m) na Lučkome u % broja po- jedinih termina. 1949 - 1955 .....	56
(V)	Relativna čestina magle ( $V < 500$ m) na Lučkome u % broja poje- dinih termina. 1949 - 1955 .....	56
(VI)	Relativna čestina magle ( $V < 200$ m) na Lučkome u % broja po- jedinih termina. 1949 - 1955 .....	56
(VII)	Relativna čestina magle ( $V < 50$ m) na Lučkome u % broja po- jedinih termina. 1949 - 1955 .....	57
(VIII)	Prosječno trajanje magle u satima po danu s maglom na Lučkome. 1949 - 1955 .....	58
(IX)	Čestina trajanja magle na Lučkome. Broj slučajeva u 7 godina (1949 - 1955). a: $V < 2$ km, b: $V < 1$ km .....	58
(X)	Čestina trajanja magle po godisnjim dobama na Lučkome. Broj slučajeva u 7 godina od 1949 do 1955 .....	59
(XI)	Čestina početka magle na Lučkome. Broj slučajeva u 7 godina od 1949 do 1955 .....	60
(XII)	Ovisnost trajanja magle ( $V < 1$ km) o satu početka u %. Lučko, 1949 - 1955 .....	61
(XIII)	Ovisnost trajanja magle ( $V < 2$ km) o satu početka u %. Lučko, 1949 - 1955 .....	62
3.2.3.(I)	Razdioba temperature visinom za vrijeme magle na Lučkome. Broj slučajeva u 7 godina 1949 - 1955 .....	64

3.2.3.(II)	Razdioba temperature visinom za magle u % Lučko, 1949-1955	64
(III)	Apsolutna čestina debljine sloja inverzije nad razinom Luckoga u metrima. Broj slučajeva u 7 godina 1949 - 1955	65
(IV)	Broj slučajeva u 7 godina 1949 - 1955 kad je bila: a) inverzija u čitavom sloju Lučko - Sljeme, b) izdignuta inverzija nad Lučkim c) opadanje temperature u čitavom sloju Lučko - Sljeme ...	66
(V)	Korelacija visine inverzije i vertikalnog gradijenta temperature Lučko - Sljeme. 1949 - 1955	67
(VI)	Razdioba čestina vertikalnog gradijenta specifične vlage Lučko - Sljeme u % uz temperaturnu inverziju unutar sloja Lučko - Sljeme	67
(VII)	Sezonski hod vertikalnog gradijenta specifične vlage Lucko-Sljeme (g kg <sup>-1</sup> /100 m)	68
(VIII)	Veza $\gamma$ i $\gamma_s$ za Lučko - Sljeme (Broj slučajeva u 7 godina 1949 - 1955)	68
3.2.4.(I)	Razdioba čestina temperature u % mjesečnog broja termina s maglom, Lučko, 1949 - 1955	69
(II)	Razdioba čestina temperature za magle u % broja magli u pojedinom terminu ( $V < 1$ km). Lučko, 1949 - 1955	70
3.2.5.(I)	Razdioba čestina magle u zavisnosti o jačini vjetra. Broj slučajeva u 7 godina 1949 - 1955 na Luckome	71
(II)	Srednja vidljivost u metrima za magle ( $V < 2$ km) u zavisnosti o jačini vjetra, Lučko, 1949 - 1955	72
(III)	Tip zavisnosti jačine magle o jačini vjetra, Lučko, 1949 - 1955	73
(IV)	Razdioba smjerova vjetra za magle ( $V < 2$ km) reducirana na 8 smjerova u %, Lučko, 1949 - 1955	73
(V)	Razdioba smjerova vjetra za magle ( $V < 1$ km) reducirana na 8 smjerova u %. Lučko, 1949 - 1955	74
(VI)	Razdioba smjerova vjetra po jačini na magle ( $V < 2$ km) u % ukupnog broja slučajeva s vjetrovom jačine 1 i više po godišnjim dobama, Lučko, 1949 - 1955	74
3.2.6.(I)	Srednji godišnji hod broja dana s kišom ili snijegom i vidljivošću (a) $< 2$ km, (b) $< 1$ km, Lučko, 1949 - 1955	75
(II)	Srednji godišnji dnevni hod kiše i snijega uz smanjenu vidljivost (a) na ispod 2 km, (b) na ispod 1 km u % Lučko, 1949 - 1955	75
3.2.7. (I)	Broj dana s prilikama lošeg vremena na Lučkome	76
(II)	Broj dana s minimalnim uvjetima na Luckome	77
(III)	Relativna čestina prilika lošeg vremena na Luckome, 1949 - 1955, u % broja pojedinih termina	77
(IV)	Relativna čestina minimalnih uvjeta na Lučkome, 1949 - 1955, u % broja pojedinih termina	78
(V)	Srednje trajanje prilika lošeg vremena (PLV) i minimalnih uvjeta (MU) u satima po danu s tim pojavama na Lučkome, 1949 - 1955	78
(VI)	Srednje, maksimalno i minimalno mjesečno trajanje prilika lošeg vremena na Lučkome u satima, 1949 - 1955	78

(VII)	Srednje, maksimalno i minimalno mjesečno trajanje minimalnih uvjeta na Lučkome u satima. 1949 - 1955 .....	79
3.3.1.(I)	Broj slučajeva s različitim prizemnim i visinskim situacijama nad Lučkim za vrijeme magli, koje su u razdoblju 1949 - 1955 trajale barem 30 sati .....	80
3.3.2.1.(I)	Podaci o temperaturi i tlaku zraka na Lučkome i o baričkoj stopi iznad Lučkoga za anticiklonalne situacije u prosincu 1951 .....	82
3.3.2.2.(I)	Podaci o temperaturi i tlaku zraka na Lučkome i o baričkoj stopi iznad Lučkoga za magle koncem siječnja 1952 .....	84
4.1.(I)	Srednja čestina stupnjeva naoblake na Lučkome u razdoblju 1949 - 1955 .....	86
4.2.(I)	Godišnji hod vjerojatnosti pojave oblaka na Lučkome. 1949 - 1955 .....	87
(II)	Srednja mjesečna količina rodova oblaka na Lučkome, 1949 - 1955 .....	88
5.1.(I)	Broj dana s jakim vjetrom ( $\geq 6$ B) na aerodromu Lučko .....	90
(II)	Broj dana s olujnim vjetrom ( $\geq 8$ B) na aerodromu Lučko .....	90
(III)	Čestina jakih vjetrova na Lučkome. Broj slučajeva u 7 godina 1949 - 1955 sa vjetrom $\geq 6$ B .....	90
(IV)	Razdioba jakih vjetrova po smjerovima na Lučkome. Broj slučajeva u 7 godina 1949 - 1955 .....	91
5.2.(I)	Srednja godišnja razdioba ( u % ) smjera i brzine vjetra na Lučkome, 1949 - 1955 .....	92
(II)	Srednji godišnji hod brzine vjetra u cvorovima na Lučkome, 1949 - 1955 .....	92
(III)	Srednja brzina vjetra po terminima u svorovima na Lučkome, 1949 - 1955 .....	93
(IV)	Srednje brzine vjetra u cvorovima po smjerovima na Lučkome, 1949 - 1955 .....	93
5.3.(I)	Srednja razdioba smjerova vjetra po godišnjim dobama u % svih opažanja. Lučko, 1949 - 1955 .....	94
5.4.(I)	Vrijednosti V za različite U i $\alpha$ .....	95
5.4.2.(I)	Čestina bočnog vjetra većeg ili jednakog 10 mi/h za razne pravce na aerodromu Lučko, 1949 - 1955 .....	97
(II)	Broj slučajeva u toku godine s najmanjom i najvećom vjerojatnošću nepovoljnih bočnih vjetrova ( $\geq 10$ mi/h) na aerodromu Lučko, 1949 - 1955 .....	100
(III)	Broj slučajeva, kad je pojedini pravac imao maksimum i minimum čestine nepovoljnih bočnih vjetrova u pojedinim terminima. Lučko, 1949 - 1955 .....	100

5.4.2.(IV)	Broj slučajeva simultanog pojavljivanja minimuma čestine nepovoljnog bočnog vjetrova za određeni pravac i maksimum čestine takvih vjetrova u ostalim pravcima. Lučko, 1949 - 1955 .....	101
5.4.3.(I)	Broj slučajeva u toku godine s najvećom odn. najmanjom vjerojatnošću nepovoljnih bočnih vjetrova ( $\geq 15$ mi/h) na aerodromu Lučko, 1949 - 1955 .....	102
(II)	Broj slučajeva simultanog pojavljivanja minimuma čestine nepovoljnog bočnog vjetrova ( $\geq 15$ mi/h) za određeni pravac i maksimuma čestine takvih vjetrova u ostalim pravcima, Lučko, 1949 - 1955 .....	102
5.4.4.(I)	Čestina najmanje vjerojatnosti nepovoljnih bočnih vjetrova ( $\geq 20$ mi/h) za pojedine piste u svijetlom dijelu dana. Lučko, 1949 - 1955 .....	103
6.1.(I)	Srednji mjesečni i godišnji tlak zraka na Lučkome (mb) ..	104
(II)	Apsolutni terminski ekstremi (7, 14, 21) tlaka zraka na Lučkome (1949 - 1955) u mb .....	104
(III)	Maksimalne vrijednosti barometrice tendencije u mb/3h. Lučko, 1949 - 1955 .....	104
(IV)	Razdioba čestina trosatnih promjena tlaka na Lučkome, 1949 - 1955 .....	105
6.2.(I)	Približne minimalne vrijednosti gustoće suhog zraka (u $\text{gm}^{-3}$ ) izračunate iz maksimalne temperature u 14 sati i pripadnog tlaka. Lučko, 1949 - 1955 .....	106
7.1.(I)	Broj dana s grmljavinom na Lučkome .....	107
7.2.(I)	Čestina trajanja grmljavine po danu s grmljavinom. Lučko, 1949 - 1955 .....	108
(II)	Dnevni hod vjerojatnosti grmljavine u promile. Lučko, 1949 - 1955 .....	109
7.3.(I)	Čestina smjerova iz kojih su grmljavine dolazile. Lučko, 1949 - 1955 .....	109
7.4.1.(I)	Količina oborine u zavisnosti o trajanju grmljavine u promile broja slučajeva. Lučko, 1949 - 1955 .....	110

P O P I S      S L I K A

- 1.1.(i) Aerodrom Lučko i okolica
- 2.2.3.(I) Izoplete srednje dnevne i mjesečne temperature na Lučkome, 1949 - 1955.
- (ii) Srednja godišnja termička ruža vjetrova. Lučko 1949 - 1955.
- (iii) Srednja termička ruža vjetrova zimi. Lučko, 1949 - 1955.
- (iv) " " " " u proljeće. " "
- (v) " " " " ljeti. " "
- (vi) " " " " u jesen. " "
- (vii) Zavisnost temperature o brzini i smjeru vjetra. Lučko, 1949 - 1955.
- 2.3.2.(i) Srednji godišnji hod relativnog omjera miješanja. Lučko, 1949-1955.
- (ii) Srednji dnevni hod omjera miješanja. Lučko, 1949 - 1955.
- 2.4.1.(i) Veza između godišnjih količina oborine na Lučkome i na opservatoriju Zagreb - Grič, 1949 - 1955.
- 2.4.2.(i) Srednji godišnji hod broja dana s oborinom na Lučkome, 1949-1955.
- (ii) Srednji relativni godišnji hod broja dana s oborinom na Lučkome, 1949 - 1955.
- 3.1.(i) Linije suma vidljivosti za Lučko, 1949 - 1955.
- a) Svi termini, b) Termin 07  
c) Termin 10 d) Termin 13  
e) Termin 16 f) Termin 19
- 3.2.2.(i) Izoplete vjerojatnosti magle (V manje od 2 km) na Lučkome, 1949-1955.
- (ii) Izoplete vjerojatnosti magle (V manje od 1 km) na Lučkome, 1949-1955.
- (iii) Izoplete vjerojatnosti magle (V manje od 500 m) na Lučkome, 1949-1955.
- (iv) Izoplete vjerojatnosti magle (V manje od 200 m) na Lučkome, 1949-1955.
- (v) Izoplete vjerojatnosti magle (V manje od 50 m) na Lučkome. 1949-1955.
- (vi) Razdjelba magle po jačini za mjesece i termine. Lučko, 1949 - 1955.
- (vii) Godišnji hod trajanja magle na Lučkome, 1949 - 1955.
- (viii) Grafikon za određivanje vjerojatnog trajanja magle na Lučkome (1949-1955)  
V manje od 1 km. Zima
- (ix) Isto. V manje od 1 km. Proljeće i ljeto.
- (x) Isto. " " Jesen.
- (xi) Isto. V manje od 2 km. Zima.
- (xii) Isto. " " Proljeće i ljeto.
- (xiii) Isto. " " Jesen.

- 3.2.7.(i) Izoplete prilika lošeg vremena na Lučkome, 1949 - 1955.  
(ii) Izoplete minimalnih uvjeta na Lučkome, 1949 - 1955.
- 3.3.1.(i) Šematski prikaz situacija s dugotrajnim maglama na Lučkome.
- 3.3.2.1.(i) 19.XII.1951. Prizemna situacija.  
(ii) " AT 500 mb  
(iii) " AT 700 mb i RT 500/1000 mb.  
(iv) 20.XII.1951. Prizemna situacija.  
(v) " AT 500 mb  
(vi) " AT 700 i RT 500/1000 mb.
- 3.3.2.2.(i) 29.I.1952. Prizemna situacija.  
(ii) " AT 500 mb  
(iii) " AT 700 i RT 500/1000 mb.  
(iv) 30.I.1952. Prizemna situacija.  
(v) " AT 500 mb  
(vi) " AT 700 i RT 500/1000 mb  
(vii) 31.I.1952. Prizemna situacija.  
(viii) " AT 500 mb  
(ix) " AT 700 mb i RT 500/1000 mb.  
(x) 1.II.1952. Prizemna situacija.  
(xi) " AT 500 mb  
(xii) " AT 700 i RT 500/1000 mb.
- 4.1.(i) Izoplete naoblake stupnjeva 0-2 i 8-10 na Lučkome, 1949-1955.
- 4.2.(i) Godišnji hod vjerojatnosti pojedinih rodova oblaka na Lučkome, 1949 - 1955.
- (ii) Izoplete vjerojatnosti pojavljivanja oblaka roda Ci na Lučkome, 1949 - 1955.  
(iii) Isto za rod Cs.  
(iv) Isto za rod Cc.  
(v) Isto za rod Ac.  
(vi) Isto za rod As.  
(vii) Isto za rod Ns.  
(viii) Isto za rod Sc.  
(ix) Isto za rod St.  
(x) Isto za rod Cu.  
(xi) Isto za rod Cb.
- 5.2.(i) Izoplete srednje brzine vjetra na Lučkome, 1949 - 1955.
- 5.3.(i) Srednja godišnja razdioba smjerova vjetra na Lučkome (1949-1955)
- 5.4.(i) K određivanju bočnog vjetra.  
(ii) Određivanje čestine bočnih vjetrova većih od 10 mi/h za pravac N - S. (Primjer, Lučko, siječanj 1949 - 1955, svi termini).
- 5.4.2.(i) Izoplete razlike čestine najpovoljnijeg i najnepovoljnijeg pravca uz kritičnu brzinu 10 mi/h. Lučko, 1949 - 1955.

C O N T E N T S

	Page
1. Introduction .....	1
1.1. Geographical location and description of the meteorological station Lucko .....	1
1.2. Climatological data .....	2
2. General survey of the climate of Lucko .....	2
2.1. General .....	2
2.2. Air temperature .....	3
2.2.1. Annual march of the air temperature .....	3
2.2.2. Highest and lowest temperatures .....	4
2.2.3. Diurnal march of the air temperature .....	6
2.3. Humidity of the air .....	8
2.3.1. Relative humidity .....	8
2.3.2. Mixing ratio .....	9
2.3.3. Relation between the mixing ratio and the air temperature .....	11
2.4. Rainfall .....	36
2.4.1. Annual and monthly amounts .....	36
2.4.2. Daily amounts of rainfall and numbers of days with rainfall .....	37
2.4.3. Snow .....	41
2.4.4. Relation between rainfall and wind .....	43
2.5. Annual march of cloudiness .....	45
3. Visibility .....	45
3.1. Diurnal and annual march of visibility .....	45
3.2. Visibility less than 2 kilometers .....	49
3.2.1. Number of days with fog .....	49
3.2.2. Diurnal and annual march of fog .....	53
3.2.3. Relation between fog and lapse rates of air temperature and specific humidity .....	63
3.2.4. Fog and air temperature .....	69
3.2.5. Fog and wind .....	70
3.2.6. Low visibility because of rain and snow .....	75
3.2.7. Conditions unfavourable for the aircraft operations .....	75
3.3. Synoptic conditions and fog .....	79
3.3.1. Survey of synoptic conditions during long lasting fogs .....	79
3.3.2. Description of the most long lasting fogs .....	80
3.3.2.1. Fog from Dec. 19, 1951 till Dec. 26, 1951 .....	80
3.3.2.2. Fog from Jan. 28, 1952 till Feb. 1, 1952 .....	82
4. Clouds .....	84
4.1. General .....	84
4.2. Frequency of cloud genera .....	87
5. Wind .....	89
5.1. General .....	89
5.2. Wind speed .....	91
5.3. Wind direction .....	94

5.4.	Layout of runways with regard to wind .....	95
5.4.1.	General .....	95
5.4.2.	Critical speed 10 mi/h .....	97
5.4.3.	Critical speed 15 mi/h .....	101
5.4.4.	Critical speed 20 mi/h .....	103
6.	Air pressure .....	103
6.1.	Air pressure averages .....	103
6.2.	Air density .....	105
7.	Thunderstorms .....	107
7.1.	Number of days with thunderstorms .....	107
7.2.	Duration of thunderstorms .....	108
7.3.	Direction of displacement of thunderstorms .....	109
7.4.	Thunderstorms and other phenomena .....	110
7.4.1.	Thunderstorms and rainfall .....	110
7.4.2.	Thunderstorms and strong winds .....	111
8.	Literature .....	112



L I S T O F T A B L E S

	Page
2.2.1.(I) Mean monthly air temperature, Lučko 1949-1955 .....	3
2.2.2.(I) Absolute maximum (M) and absolute minimum (m) of the air temperature, Lučko 1949-1955 .....	4
(II) Mean maximum (M) and mean minimum (m) of the air temperatu- re, Lučko 1949-1955 .....	5
2.2.3.(I) Mean diurnal march of the air temperature, Lučko 1949-1955	6
(II) Deviation of mean temperature for various wind directions from mean monthly temperatures, Lučko 1949-1955 .....	7
2.3.1.(I) Mean annual march of relative humidity, Lučko 1949-1955 ...	9
(II) Hourly minimum of relative humidity (7,14,21), Lučko 1949-1955 .....	9
2.3.2.(I) Mean annual march of mixing ratio ( $\text{g kg}^{-1}$ ), Lučko 1949-1955	10
2.3.3.(I) Mean frequency of simultaneous occurrences of specified va- lues of air temperature and mixing ratio, Lučko 1949-1955	11
2.4.1.(I) Annual march of rainfall at Lučko .....	36
(II) Mean annual march of rainfall (mm) at the Zagreb-Grič Obser- vatory .....	37
2.4.2.(I) Highest daily rainfall at Lučko .....	38
(II) Number of days with rainfall not less than 0,1 .....	38
(III) " " " " " " " " 1,0 .....	38
(IV) " " " " " " " " 5,0 .....	39
(V) " " " " " " " " 10,0 .....	39
(VI) " " " " " " " " 20,0 .....	39
(VII) Relative number of days with various amounts of rainfall (number of days with amount not less than 0,1 equals 100) .	40
(VIII) Mean daily intensity of rainfall (mm per day with rainfall), Lučko 1949-1955 .....	40
(IX) Duration and intensity of rainfall at Lučko, computed after Köppen's method, 1950-1955 .....	41
(X) Duration and intensity of rain at Lučko, computed after Köppen's method, 1950-1955 .....	41
(XI) Duration of snow at Lučko, computed after Köppen's method, 1950-1955 .....	41
2.4.3.(I) Number of days with snowfall at Lučko .....	41
(II) Number of days with snow cover at Lučko .....	42
(III) Maximum depths of snow at Lučko, measured at 7 a.m. in cm ..	42
2.4.4.(I) Rainfall related to wind at Lučko .....	43
(II) Frequency of rainfall in per cent of the frequency of wind directions at Lučko .....	44

2.5.	(I)	Mean monthly and annual cloudiness at Lučko .....	45
3.1.	(I)	Mean frequency of visibility at Lučko in the period 1949-1955 .....	46
	(II)	Cumulative frequency of visibility for seasons in per cent of all observations, Lučko, 1949-1955 .....	48
	(III)	Percentiles of visibility (km) at Lučko for hours of observation and seasons, 1949-1955 .....	49
3.2.1.	(I)	Number of days with fog (V less or equal 1000 m) .....	50
	(II)	Number of days with fog (V less or equal 1000 m) at Lučko for seasons .....	50
	(III)	Number of days with fog (V less than 1000 m) .....	50
	(IV)	Number of days with fog (V less than 1000 m) at Lučko for seasons .....	51
	(V)	"Absolute" number of days with fog at Lučko .....	51
	(VI)	"Absolute" number of days with fog at Lučko for seasons ..	52
	(VII)	Annual march of the ratio of mean number of days with fog and mean "absolute" number of days with fog at Lučko .....	52
	(VIII)	"Absolute" annual number of days with fog at Sisak .....	52
3.2.2.	(I)	Absolute frequency of fog (V less than 2 km) at Lučko. Number of occurrences in 7 years 1949 - 1955 .....	54
	(II)	Relative frequency of fog (V less than 2 km) at Lučko in per cent of particular hours of observation, 1949 - 1955 ..	55
	(III)	Absolute frequency of fog (V less than 1000 m) at Lučko. Number of occurrences in 7 years 1949 - 1955 .....	55
	(IV)	Relative frequency of fog (V less than 1000 m) at Lučko in per cent of particular hours of observation, 1949 - 1955 ..	56
	(V)	Relative frequency of fog (V less than 500 m) at Lučko in per cent of particular hours of observation, 1949 - 1955 ..	56
	(VI)	Relative frequency of fog (V less than 200 m) at Lučko in per cent of particular hours of observation, 1949 - 1955 ..	56
	(VII)	Relative frequency of fog (V less than 50 m) at Lučko in per cent of particular hours of observation, 1949 - 1955 ..	57
	(VIII)	Mean duration of fog in hours per day with fog at Lučko, 1949 - 1955 .....	58
	(IX)	Frequency of duration of fog at Lučko. Number of occurrences in 7 years-1949 - 1955 - a: V less than 2 km, b: V less than 1 km .....	58
3.2.2.	(X)	Frequency of duration of fog for seasons at Lučko. Number of occurrences in 7 years 1949 - 1955 .....	59
	(XI)	Frequency of the beginning of fog at Lučko. Number of occurrences in 7 years 1949 - 1955 .....	60
	(XII)	Duration of fog (V less than 1000 m) as the function of the hour of beginning, Lučko 1949 - 1955 .....	61
	(XIII)	Duration of fog (V less than 2000 m) as the function of the hour of beginning, Lučko 1949 - 1955 .....	62
3.2.3.	(I)	Distribution of air temperature with height during the fog at Lučko. Number of occurrences in 7 years 1949 - 1955 .....	64
	(II)	Distribution of air temperature with height during the fog at Lučko in per cent, 1949 - 1955 .....	64

(III)	Absolute frequency of the thickness of the ground inversion layer above Lucko in meters. Number of occurrences in 7 years 1949 - 1955 .....	65
(IV)	Number of occurrences in 7 years 1949 - 1955 with: a) inversion in the whole layer Lucko-Sljeme, b) upper inversion above Lucko, c) lapse conditions in the whole layer Lucko-Sljeme .....	66
(V)	Correlation between the thickness of inversion layer and the temperature lapse rate Lucko - Sljeme, 1949 - 1955 .....	67
(VI)	Frequency distribution of the lapse rate of specific humidity during the temperature inversion in the layer Lucko - Sljeme .....	67
(VII)	Seasonal march of the lapse rate of specific humidity Lucko-Sljeme (in $g\ kg^{-1}$ per 100 m) .....	68
(VIII)	Relation between lapse rates of air temperatures and specific humidity for the layer Lucko - Sljeme. Number of occurrences in 7 years 1949 - 1955 .....	68
3.2.4.(I)	Frequency distribution of air temperature in per cent of monthly number of hours of observation with fog, Lucko, 1949 - 1955 .....	69
(II)	Frequency distribution of air temperature in per cent of number of fogs in particular hours of observation (V less than 1 km). Lucko, 1949 - 1955 .....	70
3.2.5.(I)	Frequency distribution of fog as the function of wind speed. Number of occurrences in 7 years 1949 - 1955 at Lucko .....	71
(II)	Mean visibility in meters during the fog (V less than 2 km) as the function of wind speed at Lucko, 1949 - 1955 .....	72
3.2.5.(III)	Type of interdependence between fog intensity and wind force	73
(IV)	Distribution of wind directions during fogs (V less than 2 km), reduced to 8 directions in per cent. Lucko, 1949-1955	73
(V)	Distribution of wind direction during fogs (V less than 1 km) reduced to 8 directions in per cent. Lucko, 1949-1955 ..	74
(VI)	Distribution of wind directions according to force during fogs (V less than 2 km) in per cent of the total number of cases with wind force 1 or more according to seasons. Lucko, 1949 - 1955 .....	74
3.2.6.(I)	Mean annual march of number of days with rain or snow and visibility (a) less than 2 km, (b) less than 1 km, Lucko, 1949 - 1955 .....	75
(II)	Mean annual march of rain and snow with visibility lowered (a) under 2 km, (b) under 1 km in per cent. Lucko, 1949 - 1955 .....	75
3.2.7.(I)	Number of days with bad weather conditions at Lucko .....	76
(II)	Number of days with minimum conditions at Lucko .....	77
(III)	Relative frequency of bad weather conditions at Lucko, 1949-1955, on per cent of numbers of particular hours of observations .....	77
(IV)	Relative frequency of minimum conditions at Lucko, 1949 - 1955, in per cent of numbers of particular hours of observation .....	78

(V)	Mean duration of bad weather conditions (PLV) and minimum conditions (MU) in hours per day with such phenomena at Lučko, 1949 - 1955 .....	78
(VI)	Mean, maximum and minimum monthly duration of bad weather conditions at Lucko in hours. 1949 - 1955 .....	78
(VII)	Mean, maximum and minimum monthly duration of minimum conditions at Lucko in hours. 1949 - 1955 .....	79
3.3.1.(I)	Number of cases with various ground and height weather situations above Lucko during the fogs which lasted at least 30 hours in the period 1949 - 1955 .....	80
3.3.2.1.(I)	Temperature and air pressure at Lučko and the rate of pressure decrease above Lucko (gpm per mb) during the anticyclonal weather of December 1951 .....	82
3.3.2.2.(I)	Temperature and air pressure at Lučko and the rate of pressure decrease above Lucko (gpm per mb) during the fog at the end of January 1952 .....	84
4.1. (I)	Mean frequency of various degrees of cloudiness at Lučko, 1949 - 1955 .....	86
4.2. (I)	Annual march of probability of appearance of clouds at Lučko, 1949 - 1955 .....	87
(II)	Mean monthly amount of cloud genera at Lucko, 1949 - 1955 .	88
5.1. (I)	Number of days with strong wind (not less than 6 Beaufort) at Lucko .....	90
(II)	Number of days with gale (not less than 8 Beaufort) at Lucko .....	90
(III)	Frequency of strong winds at Lucko. Number of occurrences in 7 years 1949 - 1955 with wind not less than 6 Beaufort .	90
(IV)	Distribution of direction of strong winds at Lucko. Number of occurrences in 7 years 1949 - 1955 .....	91
5.2. (I)	Mean annual distribution of wind direction and speed in per mille at Lučko .....	92
(II)	Mean annual march of wind speed (kt) at Lucko, 1949 - 1955	92
(III)	Mean wind speed (kt) for hours of observation at Lučko, 1949 - 1955 .....	93
(IV)	Mean wind speed (kt) according to direction at Lucko, 1949-1955 .....	93
5.3. (I)	Mean distribution of wind directions according to seasons in per mille of all observations. Lucko, 1949 - 1955 .....	94
5.4. (I)	Values of V for various U and .....	95
5.4.2.(I)	Frequency of cross wind not less than 10 mi/h for various runways at Lucko, 1949 - 1955 .....	97
(II)	Number of cases during a year with the least and greatest probability of cross wind not less than 10 mi/h at Lucko, 1949 - 1955 .....	100

(III)	Number of cases with maximum and minimum frequency of unfavourable cross winds for different runways in particular hours of observation at Lucko .....	100
(IV)	Number of cases of simultaneous occurrence of minimum frequency of unfavourable cross wind for a given runway and maximum frequency of such winds in other runways at Lucko, 1949 - 1955 .....	101
5.4.3.	(I) Number of cases during a year with the greatest viz. the least probability of unfavourable cross winds not less than 15 mi/h at Lucko, 1949 - 1955 .....	102
	(II) Number of cases of simultaneous occurrence of minimum frequency of cross wind not less than 15 mi/h for a given runway and maximum frequency of such winds in other runways at Lucko .....	102
5.4.4.	(I) Frequency of minimum probability of cross winds not less than 20 mi/h at Lucko, 1949 - 1955 .....	103
6.1.	(I) Mean monthly and yearly air pressure at Lucko in mb .....	104
	(II) Absolute air pressure extremes at Lucko derived from observations at 7, 14 and 21 hours in mb .....	104
(III)	Maximum values of barometric tendencies in mb per 3 hours at Lucko, 1949 - 1955 .....	104
(IV)	Frequency distribution of barometric tendencies at Lucko, 1949 - 1955 .....	105
6.2.	(I) Approximate minimum values of density of dry air in $g\ m^{-3}$ computed from maximum air temperature at 14 hours and corresponding pressure at Lucko, 1949 - 1955 .....	106
7.1.	(I) Number of days with thunderstorm at Lucko .....	107
7.2.	(I) Frequency of thunderstorm duration per day with thunderstorm at Lucko, 1949 - 1955 .....	108
	(II) Diurnal march of thunderstorm probability in per mille at Lucko, 1949 - 1955 .....	109
7.3.	(I) Frequency of directions where thunderstorms came from. Lucko, 1949 - 1955 .....	109
7.4.1.	(I) Rainfall amount as a function of thunderstorm duration in per mille of number of cases. Lucko, 1949 - 1955 .....	110

L I S T O F F I G U R E S

- 1.1. (i) Lučko airport and surroundings
- 2.2.3. (i) Isopleths of the mean daily and monthly temperatures at Lučko, 1949 - 1955
- (ii) Mean annual thermal wind rose, Lučko 1949 - 1955
- (iii) Mean thermal wind rose in winter, Lučko 1949 - 1955
- (iv) Mean thermal wind rose in spring, Lučko 1949 - 1955
- (v) Mean thermal wind rose in summer, Lučko 1949 - 1955
- (vi) Mean thermal wind rose in autumn, Lučko 1949 - 1955
- (vii) Air temperature as the function of wind speed and direction, Lučko 1949 - 1955
- 2.3.2. (i) Mean annual march of the relative mixing ratio, Lučko 1949-1955
- (ii) Mean diurnal march of the mixing ratio, Lučko 1949 - 1955
- 2.4.1. (i) Relation of the annual amounts of rainfall at Lučko and at Observatory Zagreb-Grič, 1949 - 1955
- 2.4.2. (i) Mean annual march of the numbers of days with rainfall at Lučko, 1949 - 1955
- (ii) Mean relative annual march of the numbers of days with rainfall at Lučko, 1949 - 1955
- 3.1. (i) Cumulative curve of visibility for Lučko, 1949 - 1955
- a) all hours of observation
- b) 07 hour of observation
- c) 10 " " "
- d) 13 " " "
- e) 16 " " "
- f) 19 " " "
- 3.2.2. (i) Isopleths of probability of fog (V less than 2 km) at Lučko, 1949 - 1955
- (ii) Isopleths of probability of fog (V less than 1 km) at Lučko, 1949 - 1955
- (iii) Isopleths of probability of fog (V less than 500 m) at Lučko, 1949 - 1955
- (iv) Isopleths of probability of fog (V less than 200 m) at Lučko, 1949 - 1955
- (v) Isopleths of probability of fog (V less than 50 m) at Lučko, 1949 - 1955
- (vi) Distribution of fog according to intensity for months and hours of observation. Lučko, 1949 - 1955
- (vii) Annual march of the duration of fog at Lučko, 1949 - 1955
- (viii) Diagram for determining of the probable duration of fog at Lučko (1949-1955). Visibility less than 1 km in winter.

- (ix) The same as Fig. 3.2.2.(viii). V less than 1 km, spring and summer
  - (x) The same as Fig. 3.2.2.(viii). V less than 1 km, autumn
  - (xi) The same as Fig. 3.2.2.(viii). V less than 2 km, winter
  - (xii) The same as Fig. 3.2.2.(viii). V less than 2 km, spring and summer
  - (xiii) The same as Fig. 3.2.2.(viii). V less than 2 km, autumn
- 3.2.7. (i) Isopleths of the bad weather conditions at Lučko, 1949 - 1955
- (ii) Isopleths of minimum conditions at Lučko, 1949 - 1955
- 3.3.1. (i) Schematic representation of synoptic situations with long lasting fogs at Lučko
- 3.3.2. (i) 19. Dec. 1951. Surface synoptic map.
- (ii) 19. Dec. 1951. At 500 mb
- (iii) 19. Dec. 1951. At 700 mb and RT 500/1000 mb
- (iv) 20. Dec. 1951. Surface synoptic map
- (v) 20. Dec. 1951. AT 500 mb
- (vi) 20. Dec. 1951. AT 700 mb and RT 500/1000 mb
- 3.3.2.2. (i) 29. Jan. 1952. Surface synoptic map
- (ii) 29. Jan. 1952. AT 500 mb
- (iii) 29. Jan. 1952. AT 700 mb and RT 500/1000 mb
- (iv) 30. Jan. 1952. Surface synoptic map
- (v) 30. Jan. 1952. AT 500 mb
- (vi) 30. Jan. 1952. AT 700 mb and RT 500/1000 mb
- (vii) 31. Jan. 1952. Surface synoptic map
- (viii) 31. Jan. 1952. AT 500 mb
- (ix) 31. Jan. 1952. AT 700 mb and RT 500/1000 mb
- (x) 1. Feb. 1952. Surface synoptic map
- (xi) 1. Feb. 1952. AT 500 mb
- (xii) 1. Feb. 1952. AT 700 mb and RT 500/1000 mb
- 4.1. (i) Isopleths of the cloudiness of degrees 0-2 and 8-10 at Lučko, 1949 - 1955
- 4.2. (i) Annual march of probability of appearance of cloud genera at Lučko, 1949 - 1955
- (ii) Isopleths of the probability of appearance of clouds of genus Cirrus at Lučko, 1949 - 1955
- (iii) The same as Fig. 4.2.(ii) - genus Cirrostratus
- (iv) The same as Fig. 4.2.(ii) - genus Cirrocumulus
- (v) The same as Fig. 4.2.(ii) - genus Altocumulus
- (vi) The same as Fig. 4.2.(ii) - genus Altostratus
- (vii) The same as Fig. 4.2.(ii) - genus Nimbostratus
- (viii) The same as Fig. 4.2.(ii) - genus Stratocumulus
- (ix) The same as Fig. 4.2.(ii) - genus Stratus
- (x) The same as Fig. 4.2.(ii) - genus Cumulus
- (xi) The same as Fig. 4.2.(ii) - genus Cumulonimbus
- 5.2. (i) Isopleths of the mean wind speed at Lučko, 1949 - 1955

- 5.3. (i) Average annual wind rose. Lucko, 1949 - 1955
- 5.4. (i) Cross wind determination
- (ii) Determination of frequency of cross winds faster than 10 mi/h for the runway N - S. ( An example: Lucko, January, 1949 - 1955, all hours of observation)
- 5.4.2. (i) Isopleths of the difference of frequency of the most favourable and the most unfavourable runway for the critical wind speed 10 mi/h. Lucko, 1949 - 1955.