Drago Meze

KLIMATSKA PROUČEVANJA SLOVENIJE

Prve klimatološke proučitve za območje Slovenije so se pojavile pred nekako sto leti. Z njimi se začenja doba bolj ali manj sistematične klimatografske obdelave slovenskega ozemlja v stari Avstriji. Odsev dobe, za katero je značilna upravno-teritorialna razdrobljenost slovenskega ozemlja na posamezne dežele, se kaže tudi v klimatografskih obravnavah. Te se nanašajo le na dežele, medtem ko klimatskega opisa v celoti za vse slovensko ozemlje iz tega obdobja nimamo; obstajajo le nekateri orisi posameznih meteoroloških elementov. Čeprav so se ponekod začela vremenska opazovanja že zelo zgodaj, so bila marsikje pomanjkljiva in prekinjena, zato je bilo težko dobiti daljši uporaben niz opazovanj za postaje v posameznih deželah. Dunajski centralni meteorološki zavod je sicer določil osnovni niz 1876—1900, ki pa ni bil povsod izvedljiv. Primerjava klimatografskih študij iz tega časa je zato onemogočena. Pomanjkljivost starejšega obdobja je tudi v tem, da je bilo vremenskih opazovalnic premalo in še te so bile v večjem delu postavljene v nižinskem svetu. Do leta 1905 je vse uporabno gradivo iz opazovalnic zbrano v »Beiträge zur Hydrographie Österreich«, 1918, Wien.

Prva klimatografska razprava se pojavi že leta 1872 (Prettner, 28) in obravnava klimo Koroške; 31 let kasneje je bilo podnebje Koroške ponovno opisano (Conrad, 3). Štajersko deželo je obdelal Klein (20), avstrijski del Istre pa Mazelle (24) in mnogo kasneje, leta 1927, tudi Biel (2).

Posebno mesto zasluži Seidlov opis podnebja Kranjske (46), ki predstavlja njegovo življenjsko delo na klimatološkem področju. Čeprav spada v okvir zgoraj imenovanih del, se od njih bistveno loči. Seidlova razprava je klimatološka, druge imenovane pa so predvsem klimatografske. Zajel je vse meteorološke elemente, ki so bili opazovani. Za tiste čase je bilo to izredno delo, še posebej, če vemo, da so bili uporabni podatki skromni. Poleg nekdanje Kranjske je deloma zajel v obravnavo tudi sosednje pokrajine. Za osnovo mu je služila opazovalna doba 1851—1880, ponekod pa je izkoristil podatke do leta 1893. Delo obsega skupaj 725 strani in je izhajalo skozi 12 let. Izkoristil je izsledke, ki jih je objavil že prej (42, 43, 44, 45, 47 — in še nekatere manjše).

Celotno slovensko ozemlje je bilo v obdobju stare Avstrije zajeto v okviru študij, ki obravnavajo posamezne meteorološke elemente v vsej

monarhiji ali v njenih večjih regijah. Med temi so najpomembnejša Hannova dela o temperaturi avstrijskih alpskih dežel (17), o padavinah v Avstro-Ogrski (16) in o zračnem pritisku nad Srednjo in Južno Evropo (18). O izotermah v stari Avstriji je pisal Trabert (9,50), Fessler (4) pa je posvetil daljšo razpravo klimi Ljubljane, v katero je vključil dolgo dobo opazovanj ljubljanske meteorološke postaje; pred njim je intenzivno obdelal meteorološke podatke Ljubljane že Seidl pri opisu podnebja Kranjske (46), in sicer za obdobje 1851—1880, veliko kasneje pa je zajel 100-letno opazovalno dobo pri obravnavi temperatur in padavin v Ljubljani Manohin (25; isti je v GV 1948—1949 še posebej obdelal obdobja 1933—1947).

Ob nastanku Jugoslavije slovenska klimatologija ni imela ne izkušenj ne kadrov. Od strokovnjakov je bil med Slovenci Seidl edini, ki bi lahko vodil in organiziral klimatološko službo v Sloveniji, a za to ni bilo možnosti. Mreža vremenskih opazovalnic je bila za sistematično opazovanje preskromna, izpopolnjevala pa se je le počasi. Seidl, široko razgledan naravoslovec, se je usmeril drugam (geologija, botanika, seizmologija); s klimatologijo se je manj ukvarjal. V prvih letih nove države so bile tudi možnosti publiciranja slabe. Prelomnica nastopi z ustanovitvijo Geografskega društva Slovenije, še posebej z začetkom izhajanja njegovega glasila (leta 1925), z Geografskim vestnikom. Ker prirodoslovne vede takrat še niso imele nobenega svojega glasila, jim je GV na stežaj odprl vrata, tako tudi meteorologiji. Že v prvi številki GV je Artur Gavazzi, ki je takrat vodil Meteorološki zavod na univerzi, objavil dve zanimivi deli: »Geografski razpored največje in najmanjše povprečne mesečne množine padavin na Balkanskem polotoku«, kamor je vključil tudi 14 slovenskih vremenskih postaj, in »O meteoroloških postajah v Sloveniji«, kjer je zajel postaje vseh štirih kategorij in jih tudi kartografsko upodobil.

Leta 1928 se prvič pojavi v GV z meteorološko razpravo Oskar Reya (29), v obdobju med obema vojnama najplodovitejši pisec meteorološko-klimatoloških del s področja Slovenije. V tem obdobju skoraj ni številke GV brez njegovega prispevka. Tudi po drugi vojni se je še dolgo oglašal s tehtnimi klimatološkimi študijami. Obravnaval je posamezne meteorološke elemente, žal pa se ni lotil opisa klime v celoti, z izjemo, ko je pisal o vremenu Triglava (41). Zajel je široko področje klimatologije, še posebej z območja padavin (30, 32, 33, 37, 38, 40), in je izdelal leta 1945 tudi padavinsko karto Slovenije (39). Pisal je tudi o temperaturnih razmerah (29, 34, 35 in 36), v GV XII—XIII o toči v Dravski dolini leta 1936, o vetrovih (31), o učinku nočnika na meteorološke elemente pa posebej v GV XIV. Objavljal je tudi krajše klimatološke prispevke v različnih drugih revijah, tako o vremenski katastrofi v Žirovnici na Gorenjskem, o kraški burji (kasneje, leta 1957, je obdelal burjo v vsej Sloveniji Paradiž, 27), o zgodnjem snegu leta 1935, o vplivu podnebja in vremena na pšenico in koruzo, o neobičajno močni toči v Dravski banovini, o močnih in dolgih deževjih v Ljubljani, itd.

Iz medvojnega obdobja je tudi za Slovenijo zelo pomembno delo Knoch-Reichla (21) o padavinah v Alpah, posebej še priložena padavin-

ska karta. Zajema celotno Slovenijo. Obravnava 35-letno razdobje (1876—1910), ugotovljeno kot »Brücknerjeva perioda klimatskega kolebanja«, ki naj bi obsegala vlažno-hladni in suho-topli oddelek. Padavinska karta Slovenije iz tega obdobja se še danes pogosto uporablja.

Leta 1935 je Slovencem Melik (25) prvič pregledno podal glavne poteze celotne klime na Slovenskem, zajete v širok klimatografsko-klimatološki okvir, sestavljen na osnovi takratne moderne klimatologije. Upoštevano je vse pomembno dotakratno klimatološko znanje o Sloveniji in o klimatologiji nasploh. Melik je prikazal potek vremena v Sloveniji glede na velika vremenotvorna jedra v Evropi. Zajel je vse meteorološke elemente in jih podrobno razčlenil, posebej temperature in padavine, prikazane z mnogimi kartogrami, diagrami in tabelami. Slovenijo je razdelil tudi na glavne klimatske regije. Melikov prikaz podnebja na Slovenskem je še danes najpopolnejše klimatološko delo o naši domovini. Leta 1963 je v predelani izdaji Slovenije I dopolnil opis klime Slovenije z najnovejšimi klimatološkimi deli in spoznanji, leta 1958 pa je predstavil klimo Slovenije tudi v okviru zemljepisnega pregleda Jugoslavije (26); kasneje, leta 1968, je podal zgoščen opis klime Slovenije Furlan (14), ki pa se je v mnogočem, kljub modernejšim klimatološkim prijemom, naslanjal na Melika.

Pomembno klimatološko delo iz obdobja med obema vojnama je podroben Seidlov opis dinarskogorskega fena (48), ki se v hladni polovici leta pogosto javlja tudi v Sloveniji.

Druga svetovna vojna je zavrla tudi klimatološka proučevanja, a so se zato toliko bolj razmahnila v povojnem razdobju. K temu je največ pripomogla ustanovitev Hidrometeorološkega zavoda Slovenije v Ljubljani, ki je začel sistematično organizirati tudi meteorološko in z njo povezano klimatološko službo. Osnoval je serijo novih meteoroloških postaj, med njimi več tudi najvišjega reda, ki zbirajo poleg meteoroloških tudi fenološke podatke za potrebe agrarnega gospodarstva. Vzporedno z razširitvijo hidrometeorološke službe so se odpirale tudi nove možnosti publiciranja sprotnih vremenskih podatkov in njihove analize. Leta 1953 je začela Uprava hidrometeorološke službe LR Slovenije izdajati »Letno poročilo«, kjer so v obliki tabel in klimatogramov objavljeni zgoščeni letni meteorološki in fenološki podatki in eventualne obdelave daljših nizov opazovanj, razen tega pa je v zaključnem delu tudi rubrika »prispevki in razprave«, ki zajema številne klimatološke razprave in članke, med katerimi je za večino let posebej prikazana klimatska karakteristika in ločeno tudi izredni pojavi v letu. Ob desetletnici obstoja Hidrometeorološkega zavoda so izdali posebni zvezek z naslovom »10 let hidrometeorološke službe«, v katerem so večidel klimatološka dela. Štiri leta za »Letnim poročilom« je društvo meteorologov Slovenije začelo izdajati svoje glasilo »Meteorološki zbornik«, ki se je s tretjim zvezkom preimenoval v »Razprave«; v njem so tudi tujejezični povzetki, medtem ko teh v »Letnih poročilih« žal ni. Možnosti za objavljanje klimatoloških razprav pa so se odprle tudi v novoosnovanem »Geografskem zborniku« in v »Delih«, oboje v okviru Slovenske akademije znanosti in umetnosti.

Moderne smeri proučevanja klimatologije, ki so se pojavile v svetu v začetku petdesetih let, so začele prodirati tudi v slovensko klimatologijo. Glavni zagovornik in realizator teh je med Slovenci Danilo Furlan, vodilni povojni slovenski klimatolog, ki se je prvič pojavil v »Letnem poročilu« 1954 z obravnavo novejših podatkov padavin v Julijskih Alpah. Poglede na moderno klimatologijo je razgrnil v članku »Nova pota klimatologije« v »Letnem poročilu« 1955. Njeno jedro je v ugotavljanju singularitet, ob določenih terminih pogosto nastopajočih določenih vremenskih režimov (sušne dobe, padavinske dobe, zimski monsun, obdobje zelo nizkih temperatur, »kasna zima«, »babje poletje«, »ledeni možje« itd.); za Srednjo Evropo, torej tudi za Slovenijo, je ugotovil Flohn (5) 25 singularitet, o uveljavljanju teh v Jugoslaviji pa je pisal Furlan v GV XXXI/1959. Glavna razlika med klasično in moderno klimatologijo je v tem, da obravnava prva posamezne meteorološke elemente analitično, moderna pa skuša te med seboj povezati v posamezne vremenske režime v naslonitvi na velike baričnе tvorbe in s tem ugotoviti njihovo medsebojno vzročno povezavo. Podnebje torej »ni skup meteoroloških elementov, temveč celokupnost vremenskih režimov, iz katerih spoznamo strukturo klime in klimo samo« (str. 4). V moderni način obravnavanje klime se je vključil tudi France Bernot z razpravo o glavnih srednjeevropskih singularitetah in njihovem uveljavljanju v Sloveniji v letu 1955, objavljeno v »Letnem poročilu« 1955.

Tudi v povojnem razdobju so slovenski klimatologi proučevali največ posamezne meteorološke elemente. Med najpomembnejša tovrstna dela spadata vsekakor Furlanovi razpravi o padavinah (11) in temperaturi (12) v Sloveniji. Pri obravnavanju padavin je zajel obdobje 1925—1940, ker mu daljše takrat ni bilo dosegljivo. Upošteval je vseh 168 uporabljivih postaj, za tabele pa jih je izbral le 30. Uporabil je tabelarično in kartografsko metodo. Padavinsko karto 1925—1940 je primerjal s karto 1870—1910. Posebej je obravnaval tudi sušnost in vlažnost s sušnimi in mokrimi dobami; o teh je pisal tudi že v »Letnem poročilu« 1958. Kasneje, leta 1968, je s padavinskega področja pisal v »Razpravah«, št. X, o zoni maksimalnih padavin v Julijskih Alpah in njeni utemeljitvi. Z razpravo o temperaturah je bila prikazana izčrpna osnovna karakteristika temperaturnih razmer za vso Slovenijo, ki naj bi služila tudi za podrobnejše temperaturne analize. Pri temperaturah se je Furlan naslonil s številnimi interpolacijami v glavnem na obdobje 1925—1960, zajemajoč podatke 120 temperaturnih postaj, ki so bile postavljene vse v skladu z navodili Mednarodne meteorološke organizacije. Pri obravnavi snovi je skušal ubirati pota novo nastajajoče, a še ne izoblikovane dinamične klimatologije. V ta okvir sodi ugotavljanje karakterističnih odnosov med singularitetami in temperaturami meteorološke postaje v Ljubljani, ki naj bi veljale za vso Slovenijo. Novost pri tem je, da se opira na zaporedje baričnih singularitet (teh je v letu 39), za njih karakteristiko pa niso bile uporabljene srednje dnevne temperature, ampak število dni, ko je bila dosežena ali presežena izbrana meja ekstremnih temperatur.

Zelo zanimivo je vprašanje, kako vpliva na temperaturno razporeditev relief. S teoretičnega vidika in glede na konkretne razmere v Slo-

veniji ter na osnovi kritičnega pretresa uveljavljenega načina merjenja temperatur se je tudi tega vprašanja lotil Furlan (9) in prišel do nekaterih zanimivih zaključkov. Tako npr. ugotavlja, da nastopa zaradi zimske kotlinske megle do višine ca. 1400 m pozitivni temperaturni gradient, ki doseže tudi 1° C/100 m. Pravi tudi, da so zimske nočne temperature tropskega zraka v kotlinah za ca. 10° C večje kot na zračnih mestih; v polarnem zraku se ta razlika podvoji. Veter in oblačnost v toplem delu dneva zmanjšata dnevne maksimalne amplitude v tropskem in polarnem zraku anticiklona za 25-30° C; v ciklonalnem vremenu se ne glede na lego postaj amplitude zmanjšajo za polovico. Maksimalne opoldanske temperature so na postajah z najrazličnejšo lego, a z isto absolutno višino, zaradi praviloma nastopajočih opoldanskih vetrov zelo podobne.

Furlan je proučeval tudi veter (8), sneženje in snežno odejo (7) v Sloveniji, vse vrste megle pa je obravnaval na osnovi podatkov ljubljanske meteorološke postaje (6). Pri vetru je zajel prizemeljske in višinske vetrove ter njihovo odvisnost od reliefa. Za sneženje je uporabil podatke obdobja 1925—1940, o snežni odeji in njenem trajanju pa od 1948—1953. Megla nastopa ob nekaterih glavnih anticiklonalnih singularitetah (od dvanajstih sovpada megla s petimi). S problematiko v zvezi z meglo se je ukvarjal tudi Bernot ob študiju temperaturnega obrata v spodnjem delu Ljubljanske kotline, Petkovšek pa je proučil meglo ob slovenski obali; oba sta objavila rezultate v zborniku »10 let hidrometeorološke službe«. Pomembna je študija Vere Malovrh o zadnjih spomladanskih slanah v Sloveniji (22), ki je prva tovrstna študija za vso Slovenijo in posebej zanimiva s praktične strani za agrarce. Žal so se začela sistematična opazovanja slane šele v povojni dobi, zato je tudi obravnano obdobje (1948—1957) prekratko za trdnejše zaključke. Iz podatkov za Ljubljano pa je v okviru celotne Jugoslavije obdelal oblačnost v Sloveniji Furlan in objavil izsledke v »Letnem poročilu« 1957. Ob uveljavljanju srednjeevropskih sekularnih singularitet je ugotavljal singularitete oblačnosti.

Z ustanovitvijo meteorološke postaje na Kredarici, najvišje postaje v slovenskih Alpah (2515 m) in v Jugoslaviji nasploh, je omogočen študij vremena na Triglavu. O njem je pisal najprej Reya (41), kasneje pa še Vital Manohin v »Razpravah«, V, (»Deset let opazovanj na visokogorski postaji Kredarici«) in Dušan Košir v »Geografskem zborniku« IX/1965, ko razčlenjuje »Klimatske razmere na Kredarici v dobi od 1. avgusta 1954 do 31. oktobra 1962«.

Prvo shemo glavnih klimatskih regij na Slovenskem je postavil že Melik (25, 26). Furlan (10) jo je preizkusil z »novim in zelo obširnim dokumentarijem« (podrobna analiza temperatur in padavinskega režima po posameznih klimatskih pasovih v Sloveniji) in ugotovil, da se njegova klimatska razdelitev ne razlikuje od Melikove. Podrobnejšo shemo klimatskih območij Slovenije je v okviru Jugoslavije na osnovi termičnega in padavinskega režima podal Ilešič (19), ki je razdelil Slovenijo na dve glavni klimatski območji, na jadransko in zmerno kontinentalno panonsko. V okviru prvega zajema Slovenijo severnojadransko klimatsko območje, v drugem pa v pasu zahodno panonskega kontinentalnega območ-

ja loči dve podobmočji, pravo panonsko kontinentalno in panonsko-jadransko prehodno območje. Še podrobnejše klimatografske delitve Slovenije se je lotil Gams (13) in to »na osnovi razmerja med mesečnimi temperaturami in padavinami v vegetacijski dobi, višine temperatur in dolžine vegetacijske dobe«. S tem je hotel »predvsem pojasniti razlike v vegetaciji, zlasti v gojenju kulturnih rastlin«. Posebno pozornost je posvetil ugotavljanju vlažnostnega deficita in suficita. V okviru že znanih glavnih klimatskih območij (primorsko, osrednje slovensko in subpanonsko) je ločil več klimatskih provinc, v okviru teh pa klimatske rajone. V obravnavo je vključil prirodno, deloma pa tudi kulturno vegetacijo.

V »Razpravah« društva meteorologov Slovenije je izšlo, poleg že omenjenih, tudi nekaj zanimivih klimatoloških oziroma meteorološko-klimatoloških del. Zaradi pregleda bom pomembnejše samo citiral: Petkovšek, Z., Padavine ob hladnih frontah v Sloveniji. »Razprave«, V; isti — Oblačnost, vetrovi in megla ob hladnih frontah v Sloveniji. »Razprave«, VI; isti — Pogostnost megle v nižinah in kotlinah Slovenije. »Razprave«, XI; Vida, M., Nekatere značilnosti vremena v Sloveniji v ciklonih na poti V b. »Razprave«, VIII. Posebej omenjam na tem mestu Franceta Bernota, ki se je posvetil študiju morja ob slovenski obali, o čemer je pisal v »Razpravah« II, V, VII in IX.

Ob zaključku naj bo omenjeno, da je v vsaki regionalni gospodarsko-geografski monografiji tudi klimatografska obdelava. Teh monografij je veliko, zato jih ne kaže posebej navajati. Nekatere od njih presegajo zgolj opisni okvir in skušajo iskati medsebojne vzročne povezave klimatoloških pojavov. Tudi pri obravnavanju Triglavskega in Skutinega ledenika ter vremenskih katastrof (poplave, usadi, snežni plazovi, pozebe), o čemer so v povojni dobi slovenski geografi veliko pisali, so uvodoma podrobni klimatografki opisi. Deloma pa se dotikajo klimatologije, predvsem aplikacije klimatologije, agrometeorološka proučevanja, ki vsa izhajajo iz povojnega obdobja, ko se je v okviru Hidrometeorološkega zavoda osnoval tudi fenološki oddelek. Deloma spada v to področje tudi Furlanova študija o ugotavljanju evapotranspiracije s pomočjo normalnih klimatskih pokazateljev (13), ki jo zaradi obsežnosti in pomembnosti tudi za klimatologijo navajam posebej.

Drago Meze

STUDIES ON THE CLIMATE OF SLOVENIA

The first climatological studies concerning the area inhabited by Slovenes (the ethnic Slovenia) have appeared about hundred years ago. With them commenced an area of more or less systematic climatological research on Slovenian territories that were — at that time — included into the Austro-Hungarian empire. The monographs on the climate of the provinces where there was Slovenian population illustrate this situation well. They deal with climatic characteristics of those provinces, but not with the entire area of ethnic Slovenia. Although the weather observations had been started quite early in some areas the data are often scanty and not continuous. As a consequence, it is quite difficult to get a useful time series for weather stations in particular provinces. The former Central Weather Bureau in Vienna actually has established the basic statistical series (1876—1900) but, in practice, it could not have been applied for all areas. A comparative climatological study for that period was thus made impossible. A further shortcoming of the data for that period is the thin network of weater stations and even these were located mostly in the lowlands. All useful climatological information from the weather stations of the period until the year 1905 is assembled in a publication entitled »Beiträge zur Hydrographie Österreichs«, published in Vienna in 1918.

The first climatological study concerning the ethnic Slovenia, that on the climate of Carinthia, appeared as early as in 1872 (Prettner ,28) The climate of Carinthia, however, was dealt with again 31 years later in another study (Conrad, 3). Monographs were also compiled on Styria (Klein, 20), and on Istria, first by Mazelle (24) and, much later, by Biel (2).

Seidl's study of the climate of Carniola (46), which was his lifework in climatology, should be referred to separately. It was carried out in the general framework of the above mentioned monographs, but is also essentially different. Seidl's study is truly climatological, while the others are largely descriptive. All elements of weather, for which the data were available, had been considered. Seidl's study was a remarkable achievement for that time, in particular, since the data at his disposal were rather meagre. Conditions in the neighbouring provinces were also considered to some extent. The data for the 1851—1880 period provided the basis, but Seidl also used, when possible, additional data available till 1893. The entire study covers 725 pages and was published during the twelve year period ending in 1902. In this study he also made use of partial studies of his own that were published earlier (Seidl, 42, 43, 44, 45, 47; and some minor contributions).

Information on the entire ethnic Slovenia for the period prior to World War I. is also available in studies dealing with the old Austrian empire as a whole or with the larger regions within it. The most impor-

tant contributions are those by Hann on the temperatures in the Alpine areas of Austria (17), on precipitation in the Austro-Hungarian empire (16), on the air-pressure above Central and Southern Europe (18). The isotherms for the old empire were also studied by Trabert (49, 50), while Fessler (4) contributed a longer essay on the climate of Ljubljana. A long series of weather data collected by the Ljubljana weather station was used in that essay, but Seidl also made an extensive use of this information for the 1851—1880 period in his major study of the climate of Carniola. The temperatures and the precipitation in Ljubljana during the hundred years period (1851—1950) were analysed much later by Manohin (23; the same author separately treated the period 1933—1947 in the GV 1948—1949).

When Yugoslavia came into existence in 1918, the climatology in Slovenia lacked both the experience and the trained specialists. Seidl was the only person capable of organizing the weather observation service, but opportunities were unfavourable. For systematic observations the network of weather stations was too coarse and was only slowly getting denser. Seidl, who was a naturalist of wide knowledge, switched his attention to other phenomena (geology, botany, seismology). Also, it was difficult in the first years of the new state to get research findings published. The founding of the Geographical Society in Ljubljana marked a turning point, in particular since 1925, when its rewiev, the »Geografski vestnik«, began to be published. As the specialists of the natural sciences have not had — at that time — a specialized scientific magazine of their own, »Geografski vestnik« also published their contributions. Thus, A. Gavazzi, the head of the Meteorological Institute at the University of Ljubljana published two interesting essays in the first volume (1925) of the new magazine. The first dealt with »the geographical distribution of the highest and the lowest monthly amounts of precipitation in the Balkans« in which observations from the 14 weather stations in Slovenia were also considered. The second article was a comment on the »meteorological stations in Slovenia« dealing with all four categories of them.

Oskar Reya, who was the most prolific writer on meteorology and climatology in Slovenia in the inter-war period, published — in the 1928 volume of the »Geografski vestnik« — his first essay on meteorology (29). There was hardly a volume of the magazine since without some of his contributions. He continued to publish several important meteorological studies until recently. Reya was concerned with various elements of weather, but unfortunately he did not attempt a synthesis on the climate of Slovenia. He did, however, write on the climate of the Triglav mountain (41). In climatology Reya was concerned primarily with precipitations (30, 32, 33, 37, 38, 40) and produced the first map of precipitations of Slovenia (39). He also wrote about the temperatures (29, 34, 35, 36), about the winds (31), etc. He contributed an essay on the hail in the Drava valley in 1936 and in the next volume he wrote about the effects of the night wind on other elements of weather. Several of his articles were published also in other periodicals. E. g. on the weather

catastrophe in the Žirovnica valley in Upper Carniola, on the early snow in 1935, on the influence of the climate on wheat and maize growing, on long spells of persistent rain in Ljubljana, on severe hail-storms in Slovenia, on the Kras bora winds. (Bora winds were later analysed for the whole of Slovenia by Paradiž (27).

An important study from the interwar period by Knoch-Reichel (21) on the precipitation in the Alps should also be mentioned since the total area of Slovenia was also included into the study area. A precipitation map is added and is still widely used. The study deals with the »Brückner's period of climatic fluctuations« which includes both a cold-humid and a dry-warm section. Observations refer to the time span between 1876 and 1910.

The first attempt at a presentation of the main characteristics of the climate of Slovenia was made in 1935 by Melik (25). It was conceived in the conceptual framework of the contemporary climatology and meteorology and all existing sources of knowledge were used in compilation and synthesis. Melik analysed the weather conditions in Slovenia in ralation to major weather generation nuclei in and around Europe. All elements of weather and climate were considered and analysed in some detail; in particular, temperatures and precipitation. The text is illustrated by many maps and diagrams. The main climatic regions were also sketched. This overview by Melik is still the most comprehensive climatological study of Slovenia. In a new edition (1963) the chapters on climate include references to more recent findings and data. Melik also provides an overview of the climate of Slovenia in his book on Jugoslavia (26). A more recent characterisation of the climate of Slovenia by Furlan (14) draws largely on the work by Melik, although more up-to-date methods were used.

The analysis of the föhn winds in the Dinaric mountains which are during the winter season quite common in Slovenia is an outstanding piece of climatological research by Seidl (48) and dates back to the prewar period.

The research on the climate of Slovenia came to a still-stand during the war but was quickly revived and expanded since World War II. The revival was greatly enhanced by the creation of an official Weather Bureau, the Hydrometeorological Institute of Slovenia, viz. of its climatological section. A series of new weather stations was established and some of them are of the highest order and make also phenological observations required by the agriculture. The expansion of the weather service went hand in hand with the new possibilities for publishing the weather data as well as the analytical findings. In 1953 the Institute started to publish its »Letno poročilo« (»Yearly Report«) which provided condensed information on the meteorological phenomena in the previous year. Occasionally some data for longer time series are also published. In the concluding sections in each report many studies were also published as well as several short articles dealing with general climatic characteristics or with extraordinary phenomena observed in each year. In a special publication — »Ten years of the Hydrometeorological Service« —

most articles refer to the climatological research. In 1939 the newly founded Meteorological Society started its own periodical, the »Meteorološki zbornik« which was later renamed »Razprave« (»Papers«). Summaries of the studies published there are in several languages, mostly in English. Another opportunity to get the results of research published was offered by the new series of publications of the Slovenian Academy of Arts and Sciences (»Geografski zbornik« and »Dela«).

The modern research orientations in climatology which have appeared in the nineteen fifties soon began to show an impact on the climatological research in Slovenia, too. The main protagonist of the new direction was Danilo Furlan, now the leading climatologist in Slovenia. His first study, published in the »Yearly Report« for 1954 dealt with precipitation in the Julian Alps on the basis of new information that became available. In 1955 he outlined the new ideas in an article entitled »the new directions of climatology«. The core of the new approach is seen in the identification and interpretation of the singularities, i. e. of the specific types of wheather that often occur in certain times of the year (droughts, wet periods, winter monsoon, cold spells, late winters, Indian summer, etc.). Flohn (5) already has identified for Central Europe — and, consequently, for Slovenia — as many as 25 such singularities. Furlan, however, has analysed more in detail how these singularities are manifested in Yugoslavia (see: »Geografski vestnik« for 1959). The main difference between the classical and modern climatology is in the shift from the analytical treatment of particular elements of weather to a more synoptic view of the typical weather regimes in their relation to the major cyclones and anticyclones systems in order to establish the causes of their mutual interrelationships. The climate, therefore, »is not seen as an aggregation of the elements of weather but rather as the totality of weather regimes, from which the structure of the climate and the climate itself is recognized« (page 4). Franc Bernot also joined the modern orientation in climatological research with his study on the main singularities of Central Europe and their manifestations in Slovenia in the year 1955 (published in the 1955 »Yearly Report«).

Still, most of the work done by the Slovenian climatologists after the war was on particular elements of weather and climate. Some of the most significant studies were those by Furlan on precipitation (11) and temperatures (12) in Slovenia. The period from 1925 till 1940 was analysed since no longer consistent series of data was available at that time. Altogether data for 168 weather stations were considered, while only 30 appear in the attached tables. Both maps and tables were used as a method of presentation. Furlan also compared his map with an older map for the 1870—1910 period. He was, in his study, in particular concerned with dry and wet periods (see also the »Yearly Report« for 1958). Later, in 1968, he again wrote about the zone of the maximum precipitation in the Julian Alps and about its explanation (see »Razprave«, vol. X.). In the study of the temperatures in Slovenia he provided an exhaustive basic framework to serve as a starting point for more detailed analyses. The data refer to 120 weather stations (which were set up by the Wea-

ther Service of Slovenia in accordance with the specifications of the World Meteorological Organization) and cover mainly the period from 1925 till 1960. Furlan tried to embark on the new course of the emerging dynamic climatology which was taking form gradually. His study of the characteristic relations between the singularities and the temperatures registered at the Ljubljana weather station, which may be taken as representative for conditions in Slovenia, best expreses such altitudes. The new approach is manifested in the fact that he did not choose the mean daily temperatures but rather the number of days when the extreme temperatures reached or surpassed a selected limit for them serving as an indicator for comparison with the established weather singularities (39 of which appear in one year).

An interesting problem is the role played by the landforms in the vertical distribution of the temperatures. Furlan (9) approached this question both from the theoretical view-point and from the consideration of specific conditions in Slovenia; he also made a critical evaluation of the adopted methods of measuring temperatures. He arrived at some interesting conclusions. First, he established that a positive temperature gradient of as much as 1° C per 100 metres occurs up to the heights of some 1400 m altitude because of the winter fog in the basins. Also, he noted that the night temperatures of the tropical air masses in the basins are about 10° C higher than at windy places above them; but when polar air masses predominate, the difference is double. The wind and the cloudiness during the warmer part of the day tend to lower the maximum daily amplitudes both in the tropical and the polar anti-cyclone air-masses for 25° to 30° C, while the fluctuations — regardless of the site of the weather stations — are only half as great during the cyclonic weather spells. Maximum mid-day temperatures at the stations in any type of the sites, but at the same altitude, are very similar because of regularly appearing mid-day winds.

Furlan has also studied the winds (8), the snow-fall and the snow-cover (7) in Slovenia. Also he analysed all kinds of fog in Ljubljana using data for that weather station (6). Furlan has also analysed winds close to the surface and the high altitude winds and their dependance on the landforms. Snow-fall was analysed on the basis of the data from the 1925—1940 period and the analysis of the snow-cover in Slovenia referred to the 1948—1953 period. The fog was found to be appearing mainly in times of the anticyclone singularities (in five cases out of twelve). Problems related to fog were also studied by Bernot in his study of the temperature inversion in the lower part of the Ljubljana basin, while Petkovšek analysed fog along the coast of Slovenia; both studies were published in the publication »Ten years of the Hydrometeorological Service«. A significant study by Vera Malovrh, the first of this kind, deals with late spring frosts in Slovenia (22) and is of particular importance for the agriculturists. Unfortunately the systematic observations of the frost were started only in the post-war period and, consequently, the observation period (1948—1957) is too short to permit any firmer conclusions. Furlan also used the data on cloudiness for Ljubljana in his study

of this phenomenon in the entire Yugoslavia (published in the 1957 »Yearly report«). When dealing with secular singularities in Central Europe he also analysed those related to fog-cloudiness.

The establishment of a permanent weather station at Kredarica on the Triglav mountain (at the altitude of 2515 m) which is the highest in Yugoslavia, enabled the study of weather conditions on that mountain. The first article is by Reya (41); later, Vital Manohin wrote about the »ten years of observations at the weather station at Kredarica« (in »Razprave«, vol. V.), as well as Dušan Košir (in »Geografski zbornik«, vol. IX.) »The climatic conditions at Kredarica between August 1st 1954 and October 31st 1962«).

The first schematic outline of the main climatic regions in Slovenia was provided already by Melik (25, 26). This scheme has been later tested by Furlan (10) who — in the detailed analysis of the temperatures and of temperature regimes within particular climatic areas of the country — used »new and much improved documentation«. His conclusions about climatic areas do not differ essentially from those made by Melik. A more detailed model of climatic areas of Slovenia was later worked out — on the basis of the thermic and precipitation regimes — by Ilešič (19) in his characterisation of the climate of Yugoslavia. In Slovenia, he discerns two main climatic areas, the Adriatic area and the temperate continental Pannonian area. The former spreads over western Slovenia in its northern Adriatic variant. The latter, however, includes two sub-areas in its western, Pannonian part; i. e. the true continental Pannonian sub-area and a transitional Panonian-Adriatic sub-area. Gams (15) made an attempt at an even more detailed delineation of the climatic areas of Slovenia »on the basis of the relationships between monthly temperatures and precipitation during the vegetation period«. In using this approach he »first of all wanted to explain the differences in vegetation, in particilar, in the cultivation of domestic plants«. A special attention was paid to the identification of the moisture defficits or surplusses. He distinguished, within the three main climatic areas mentioned above, several climatic »provinces« and, in each of them, climatic subareas were discerned. This classification refers to natural vegetation and partly also to domestic plants.

Some other interesting studies concerned with climate were also published in the »Razprave« (»Papers of the Meteorological Society«). The list of the more important papers includes those by: Z. Petkovšek, Precipitation in connection with the cold front in Slovenia (vol. V.); idem: Cloudiness, winds and fog in connection with the cold front in Slovenia (vol. VI.); idem: The frequency of fog in the lowlands and basins of Slovenia (vol. XI.); M. Vida, Some characteristics of the weather in Slovenia when cyclones take route V b (vol. VIII.).

A special note should be added here on the studies by F. Bernot about the sea along the coast of Slovenia in the southern part of the Gulf of Trieste (see: »Razprave«, vol. II., V., VII. and IX.).

It should also be mentioned that all regional monographs on the economic geography contain chapters on climatology of the respective are-

as. Some of these are not limited to descriptions of the local climates but try to established the causal relationships of the observed phenomena of weather and climate. Introductory climatological chapters were also included in some other studies (e. g. on the fluctuations of the Triglav and Skuta glaciers, or in those on the weather catastrophes such as floods, landslides, avalanches, severe frosts, etc. about which much was written. Some are concerned in particular with the applied climatology. Climatology for agriculture was started only in the post-war period, when a special department for phenological research was established at the Hydrometeorological Institute. Furlan's study on the identification of the evapotranspiration by means of normal indicators of climate (13) also belongs into this category, but should be singled out because it is the most comprehensive of such studies.

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