



Химически състав на валежите

Организация на мрежата за валежите

The Bulgarian precipitation chemistry network is created and supported by NIMH. Until 2002, it consisted of 14 stations for sample collection, which were regularly transported to Sofia and analysed in NIMH's laboratory. In 2001, series of experimental works were conducted, on the base of which in 2002 the sampling method, the system of analysis and transport of the samples, the system of data collecting and archive making were changed [8]. Presently, the network encompasses all synoptic stations in Bulgaria, as well as some of the climatic ones. The samples are obtained manually at main synoptic hours 00, 06, 12 and 18 UTC as well as the 6-hourly precipitation amount. The precipitation acidity (in pH-units) is measured with portable pH-meter on-site immediately after sample taking and the data are transmitted in a special group by the code SYNOP. The rest of the sample is conserved in appropriate conditions and all samples are transported monthly to the nearest NIMH's laboratory for nitrates (NO_3^-), sulphates (SO_4^{2-}) and conductivity analysis in accordance to the standard methods.

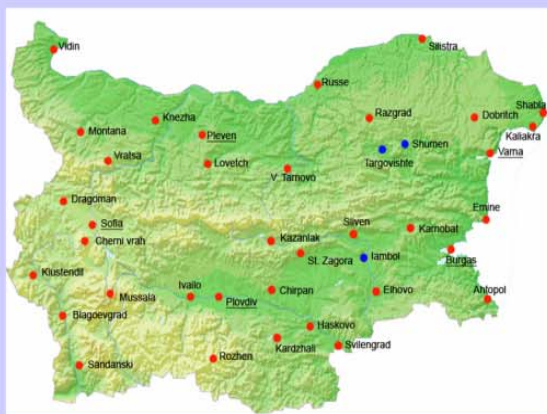


Figure 1. Precipitation chemistry network 2002 - 2009 – 6-hourly samples (red); daily samples (blue); underlined are the cities with chemical laboratories

Състав на валежите в градска среда

Investigating precipitation quality in industrial cities is important from ecological point of view.

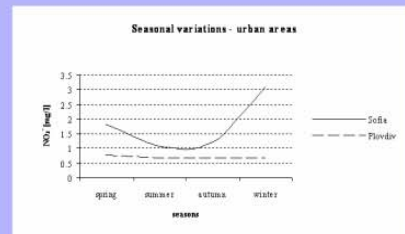


Figure 4. Seasonal variation (2002 - 2006) of nitrate concentrations in the cities of Sofia and Plovdiv – the two biggest Bulgarian cities. Plovdiv is a big city with a working industry, while Sofia is the biggest in the country and the rapid population growth of the last years, logically, led to an increased in the automobiles numbers as well as the generated traffic. The summer months (especially the second half of July and August) are traditionally the time for vacation and then Sofia is pretty much deserted, with a matching decrease in traffic, which may explain the minimum in the seasonal nitrate distribution.

Химически състав на валежите за специфични екологични райони

Investigating the local characteristics in the stations' vicinity is important for reasons of ecology, as well as from the viewpoint of interdisciplinary scientific work – soils' chemical composition and predicting precipitation acidity [1, 13]; the correlation between precipitation composition and rivers' chemical composition in mountains of over 2000 m in altitude [10]; co-dependence between precipitation quality and surface waters in the Bulgarian part of the Danube river basin [2 - 6].

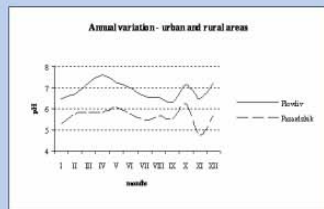


Figure 2. Annual variation (2002 - 2006) of the acidity (in pH) for two nearly situated stations – one urban (Plovdiv) and the other situated in an uncontaminated area considered as background (Pazardzhik). The pH values for the background station are near the norm for a clean precipitation (pH=5.6), while for Plovdiv are mildly alcal, which is typical for the majority of Bulgarian cities. [12]

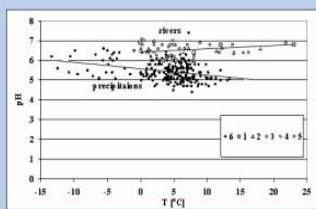


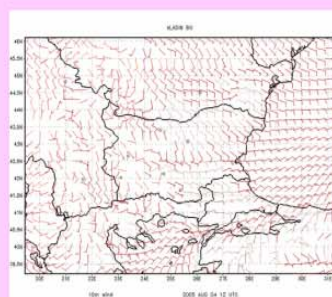
Figure 3. The relationship between the precipitation pH (6), the Vitoshka mountain rivers' water pH and the water temperature (1-Yanchovska river; 2- Dragalevska river; 3-Bojanska river; 4-Vladaiska river; 5-Struma river). [13]

Table 2. Results from ICP AES analysis of the precipitation samples from 17.11.2008. The concentrations are in mg/l. Precipitation from local clouds. The wind is very weak. The aerosol concentrations in Sofia are several times higher compared to Cherni vrah, considered as a background station, for the same precipitation.

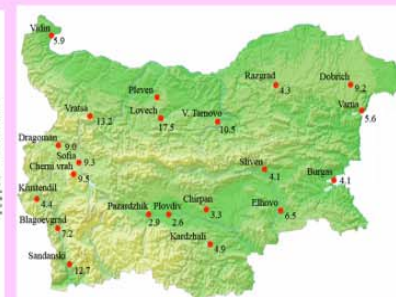
	Hour, GMT	Pb	Ni	Cr	Cd	Cu	Na	Zn	Ca
Sofia	6	0.012	0.004	<0.002	<0.002	0.093	6.279	0.3	38.9
Cherni vrah	6	<0.007	<0.002	<0.002	0.003	0.017	0.007	0.004	0.185
Cherni vrah	12	0.01	<0.002	<0.002	0.005	0.037	0.018	0.007	0.288
	Hour, GMT	K	Mg	Cl	F	SO4	NH4	NO3	pH
Sofia	6	190.8	4.255	141	<0.1	54.99	1.238	2.166	6.1
Cherni vrah	6	0.14	0.023	No water	No water	2.103	No water	No water	5.8
Cherni vrah	12	0.092	0.047	No water	No water	2.337	No water	No water	6

Химически състав на валежите в индустриални райони

Of particular ecological interest is precipitation composition during and shortly after industrial accidents emitting pollutants in the atmosphere. The NIMH network, owing to its station density and frequent sampling, as well as express pH obtaining in one centre, allows for rapid information flow and facilitation of managerial decision making in the social and agricultural spheres.



5-A. Direction of the transport of air masses before and during the rainfall over Cherni vrah (4 August 2005) [7]



5-B. A monthly distribution (August 2005) of sulphate concentrations over the country. The whole month was without precipitation for the town of Pleven [12]

Figure 5. A case of industrial accident in Maritsa Thermal Power Plant in the beginning of August 2005 and intense precipitations following on 4 August 2005. The reason for the precipitation is a Mediterranean cyclone. At this meteorological situation, the SO_4^{2-} content does not surpass 7 mg/l. Due to continuous air mass transfer from east, east-southeast (5-A), a sulphur compound transfer from the Maritsa complex towards north and west Bulgaria is presumed. The SO_4^{2-} concentrations in those stations during the precipitation reach 80 mg/l, which is considerably more than the median monthly figures (5-B).

Химически състав на валежите при различни синоптични условия

The precipitating clouds have different chemical composition based on the air pollution in their regions of creation and passing. Transborder contaminant traffic determines precipitation quality on m. Moussala (Rila mountain, 2925m), while its proximity to other mounts (Cherni vrah - Vitoshka mountain, 2290m and Rojen - Rodopa mountain, 1430m), through which the same cloud system pass, allows for more detailed study of subcloud layer influence over precipitation chemical composition [9, 11].

Table 1. Concentration (in mg/l) of contaminants in the precipitation, station Moussala (2925m), for different sampling hours. Precipitation beginning 4:30 GMT, end – 18:45, 22 November 2008. Sampling hours indicated. [13] The precipitation is from a very deep cyclone formed over the Arctic and having passed over Central and Western Europe. The values for cadmium (Cd), copper (Cu), zinc (Zn), potassium (K) are significantly high.

GMT	Pb	Ni	Cr	Cd	Cu	Na	Zn	Ca	K	Mg	Cl	F	SO4	NH4	NO3
6	<0.007	<0.002	<0.002	0.007	0.009	0.386	0.01	2.019	0.12	0.118	<2.5	<0.1	2.379	0.09	<0.4
12	0.013	<0.002	<0.002	0.024	0.093	0.092	0.04	0.265	0.101	0.023	No water	No water	0.456	No water	No water
18	0.01	<0.002	<0.002	0.008	0.006	<0.002	0.005	1.036	0.001	0.047	No water	No water	No water	No water	No water
0	0.021	<0.002	0.005	0.03	0.103	0.25	0.072	0.29	0.31	0.029	No water	No water	1.254	No water	No water

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- Project 2008: *Precipitation composition research: modelling of advective and local operators determining the chemical composition and acidity*, Princ. investigator: V. Spiridonov, No H3-1407/04, NSF MES, Bulgaria, (in Bulgarian)
- Project 2008: *Investigation on the precipitation chemistry over the country: detailing the sampling methods; modeling the advective and local factors determining chemical composition and acidity*, Princ. investigator: L. Iordanova, NIMH, Bulgaria, (in Bulgarian)