National Institute of Meteorology and Hydrology

CLOUD AND RAIN WATER CHEMICAL COMPOSITION AT PEAK CHERNI VRAH, BULGARIA

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OUTLINE

- *Atmospheric deposition – brief intro*
- *Objectives of the study*
- *Sampling site, equipment and chemical analysis*
- *Results*
- *Conclusions*

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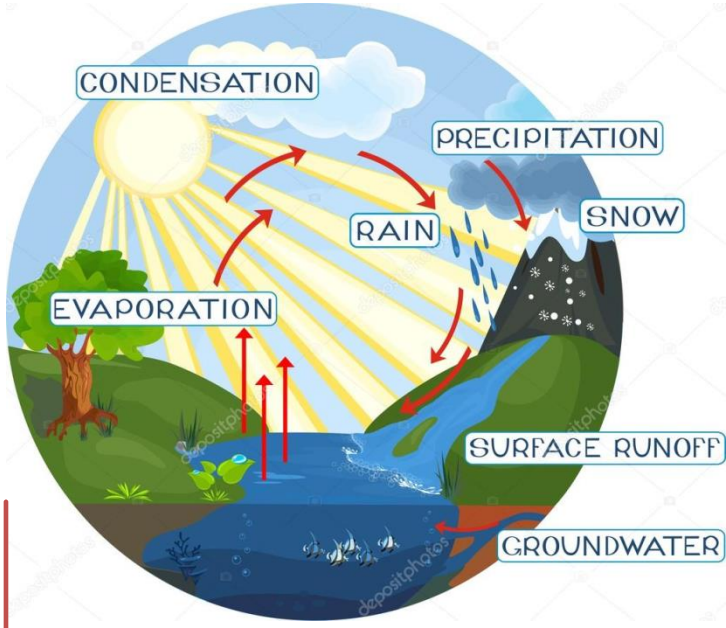
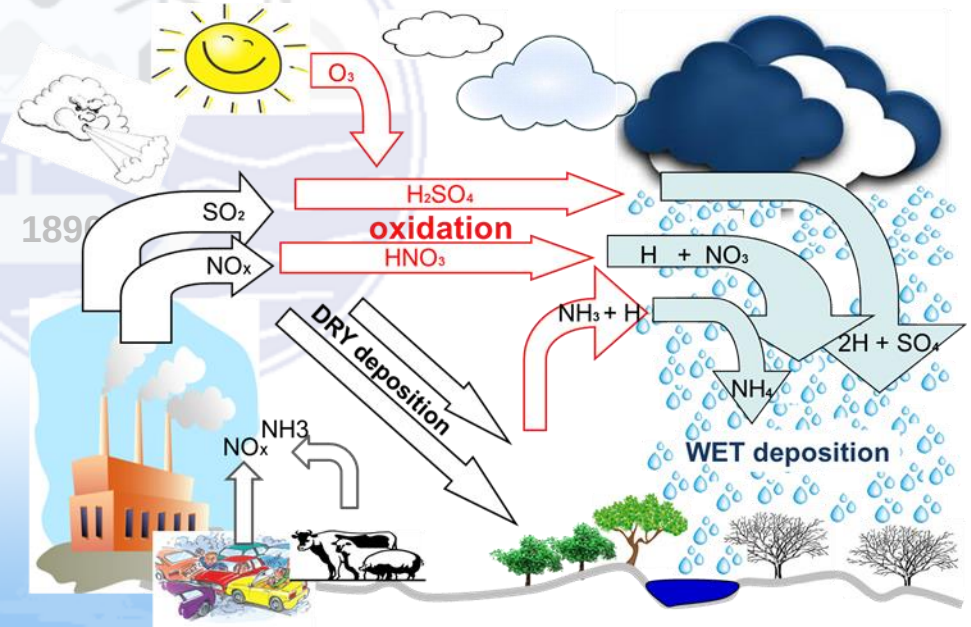
Atmospheric deposition

Cloud water (CW) and **rain water (RW)** play important roles in:

- Water cycle;
- In remote high-altitude areas, rain and snow may be the main source of solutes and nutrients for aquatic ecosystems.
- removing particles and dissolved gaseous pollutants from the atmosphere;
- scavenge sulphur dioxide (SO_2), nitrogen oxides (NO_x), and other atmospheric pollutants;



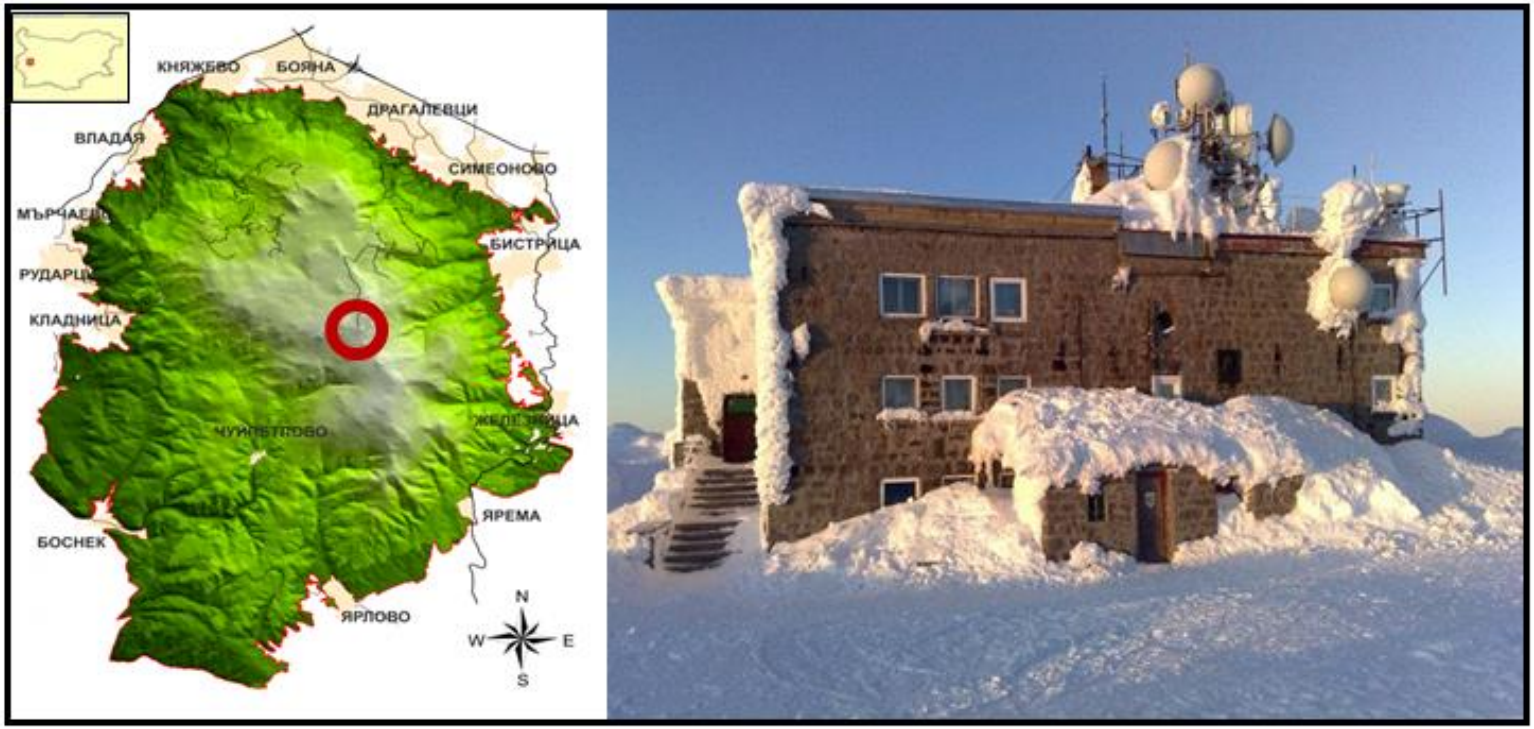


- atmospheric deposition of acidifying compounds, organic chemicals and heavy metals.
- cause ecological damage to ecosystems

Objectives of the study

- To compare and discuss newly obtained data for the chemical composition of CW and RW at a high-elevation site in Bulgaria - Cherni Vrah (ChV), Vitosha Mountain.
- To analyse the effect of long-range transport processes on the chemical composition for selected case periods.

Sampling location



- Meteorological station **Cherni vrah** (42.6167 N, 23.2667 E, 2286 m asl),

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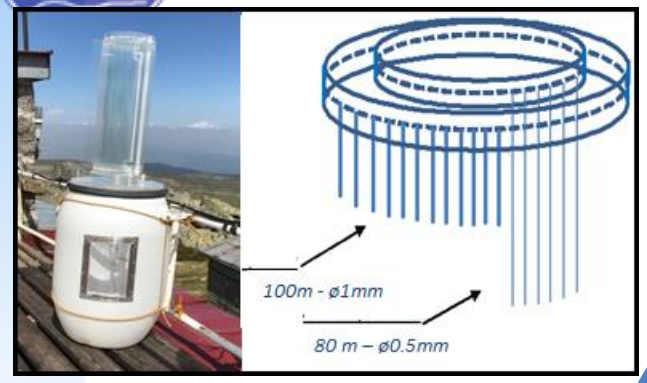
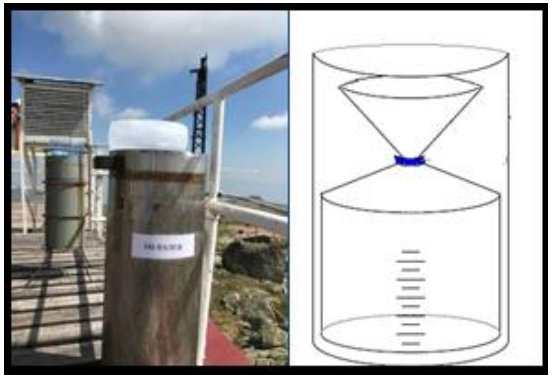
Sampling and analysis

Cloud water sampler



Rain water sampler



Equipment

June 2017- November 2018

Sampling

118 samples

Chemical analysis

Anion

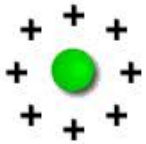
Cl-, SO_4^{2-}, NO_3^-

Ion Chromatograph (ICS 1100, DIONEX)

pH and EC

Checker Hanna Instruments

Cation



Ca, Mg, K, Na, Fe, Si, Zn, Cu, NH_4^+

ICP OES (Vista MPX CCD) Spectrophotometer S-20

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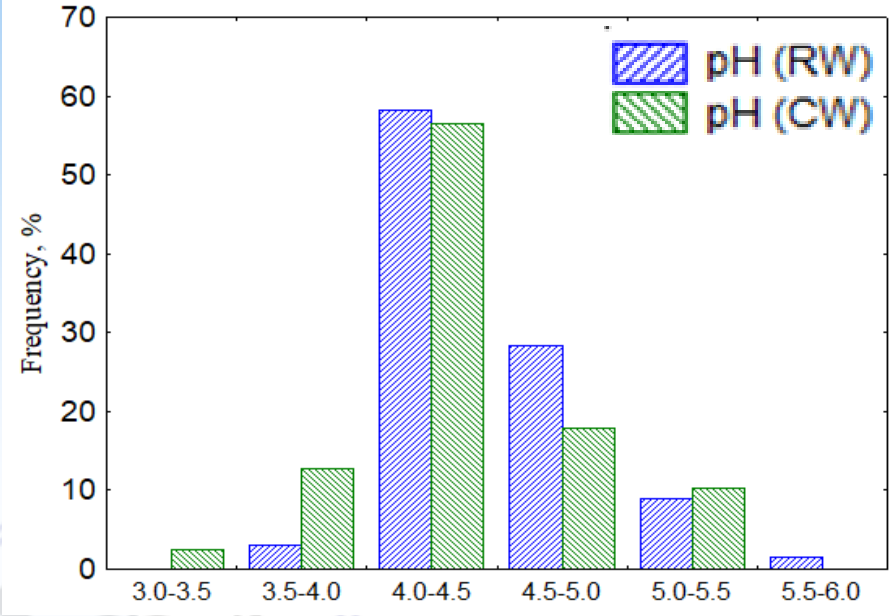
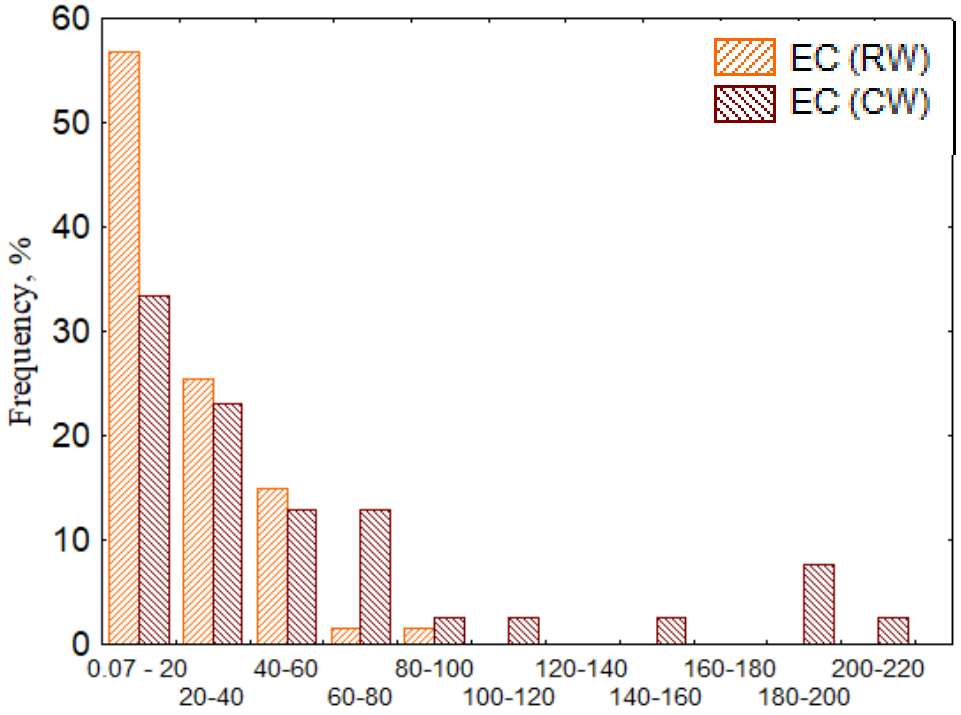
Physico-chemical parameters



Acid-alkaline range

pH <5 - acidic,
pH <5,6 slightly acid,
pH = 5,6 - neutral
pH> 5,6 slightly alkaline,
pH> 6 - alkaline.

Electro conductivity



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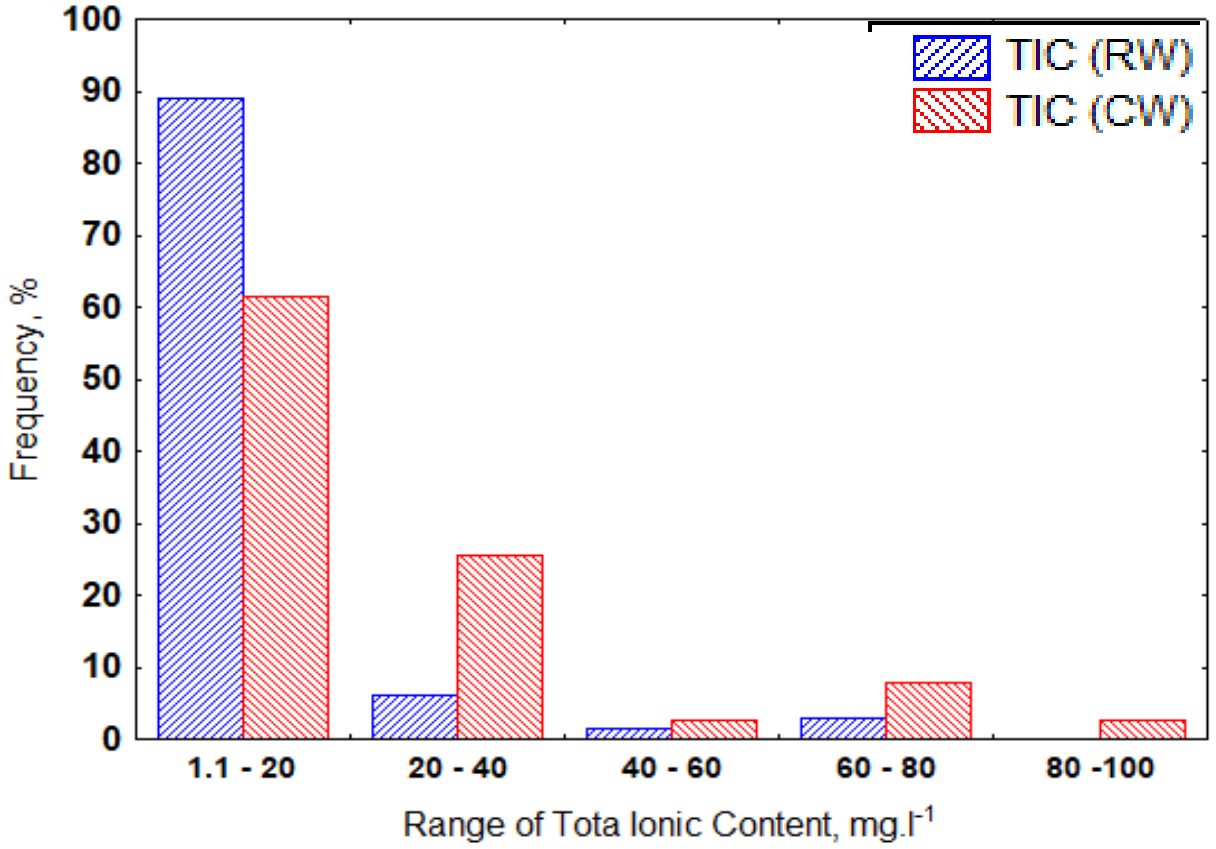
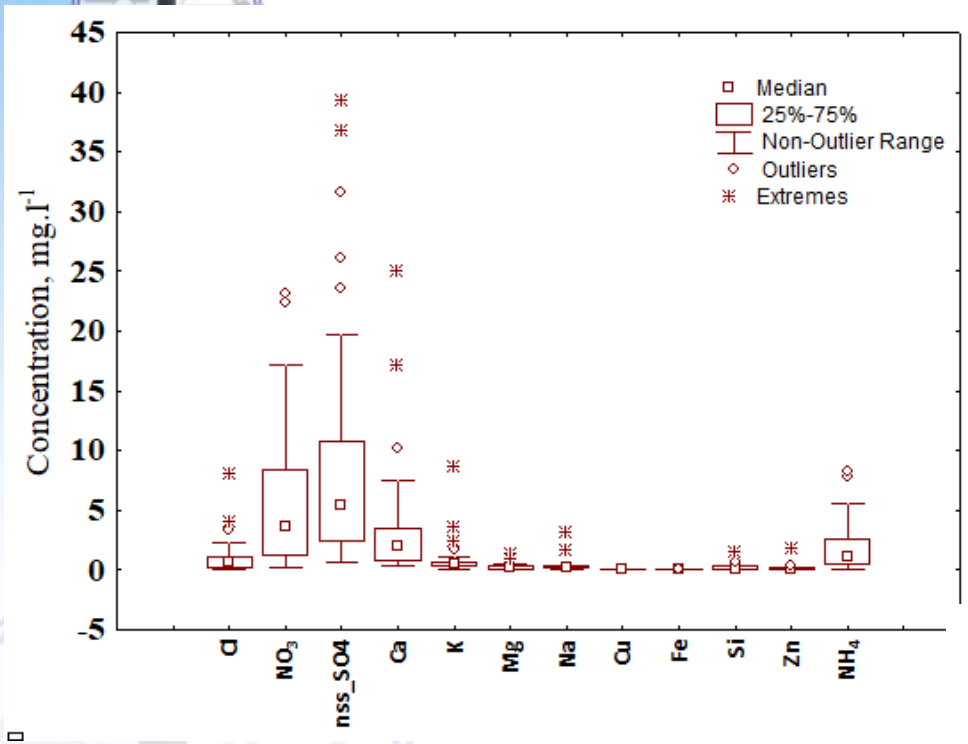
Total ionic concentration (TIC)



- The rain water TIC - ranged from 1.1 to 68 mg l^{-1}
- The cloud water TIC - 4 to 90 mg l^{-1}.
- 89% of the RW and 62% of the CW have concentrations between 1 and 20 mg l^{-1}
- 2.6% of the CW samples have TIC in the range 80-100 mg l^{-1}.

Concentrations of the studied elements

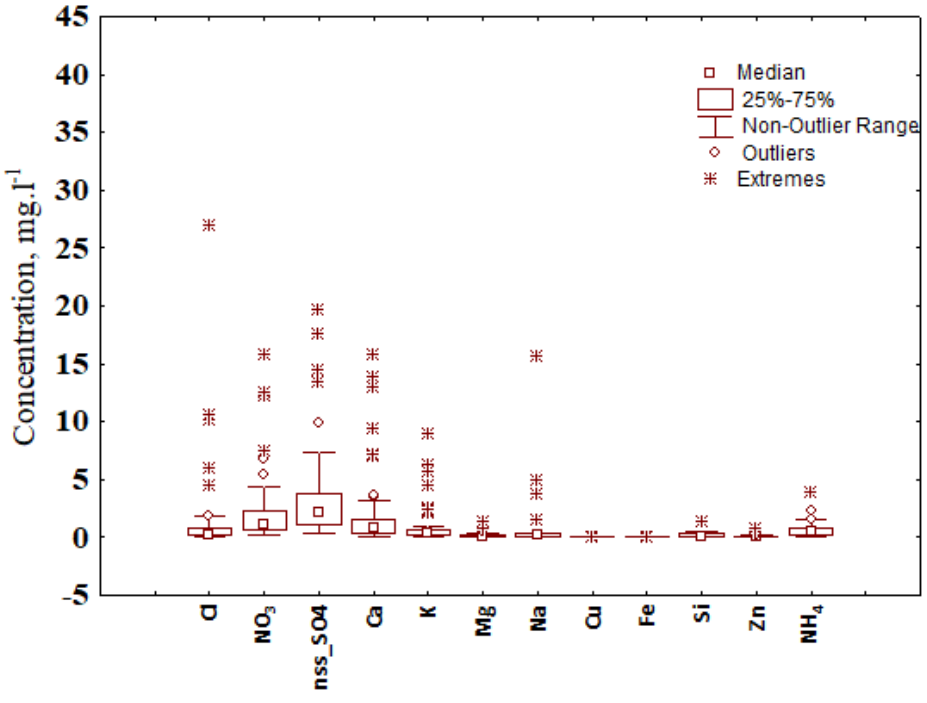


Cloud water

75% of TIC from $nssSO_4^{2-}$, NO_3^-, Ca, NH_4^+

Rain water

63% of TIC from $nssSO_4^{2-}$, NO_3^-, Ca, NH_4^+



non-sea-salt sulphate

$$[nss\_SO_4^{2-}] = [SO_4^{2-}] - (0.25 \times [Na])$$

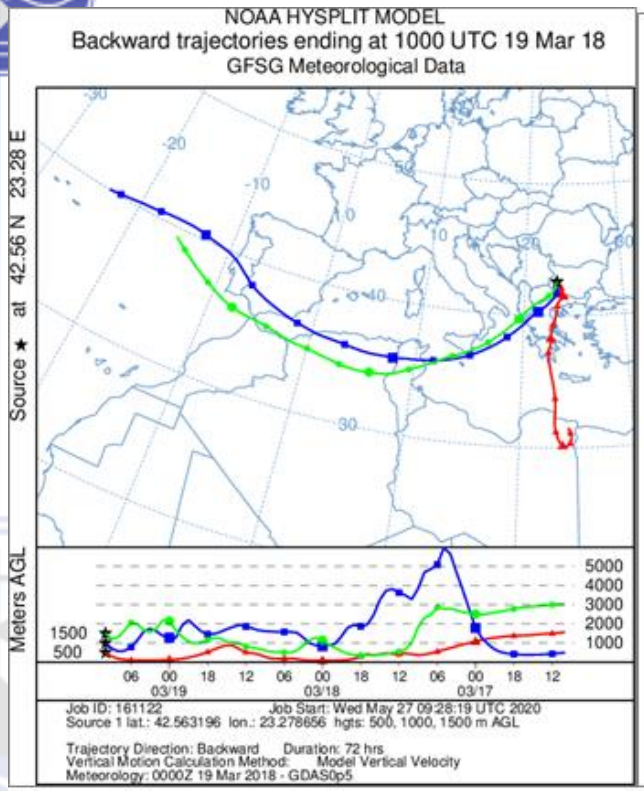
Back trajectory analysis

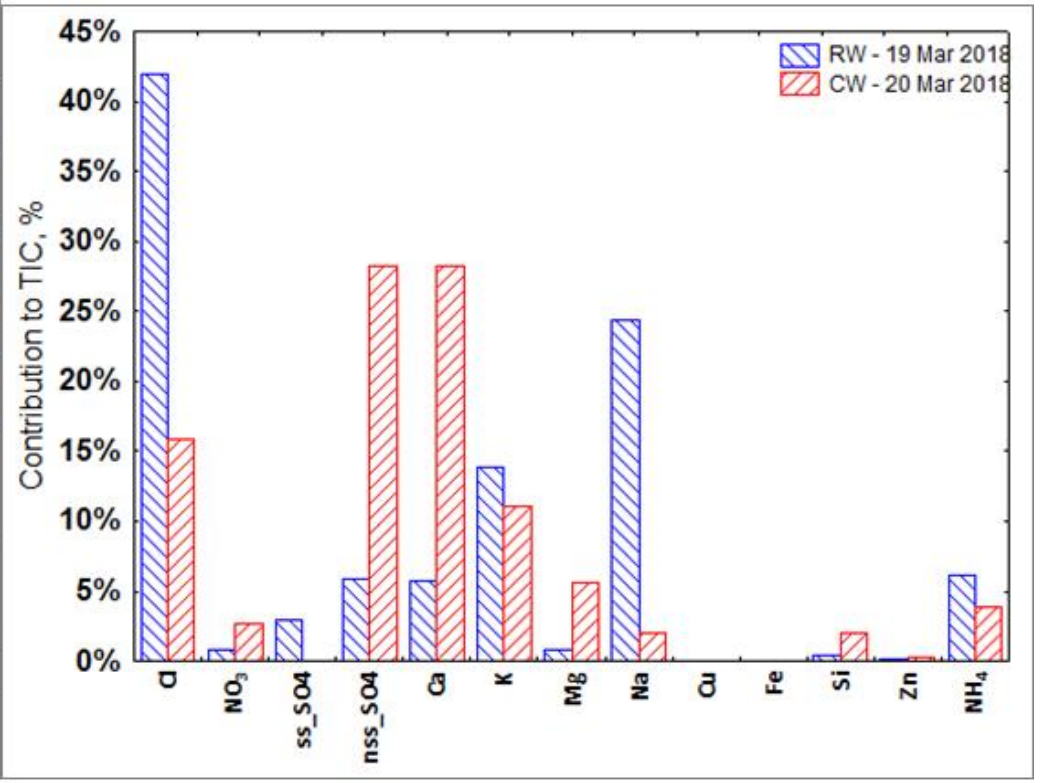
The Hybrid Single-Particle Lagrangian Integrated Trajectory model (HYSPLIT)

http://www.ready.noaa.gov)

- Three different heights are used: 500, 1000 and 1500 m AGL
- Calculations for 72h.
- Meteorological situations for 19 – 20 March 2018 and 30 June – 4 July 2018 have been analyzed.

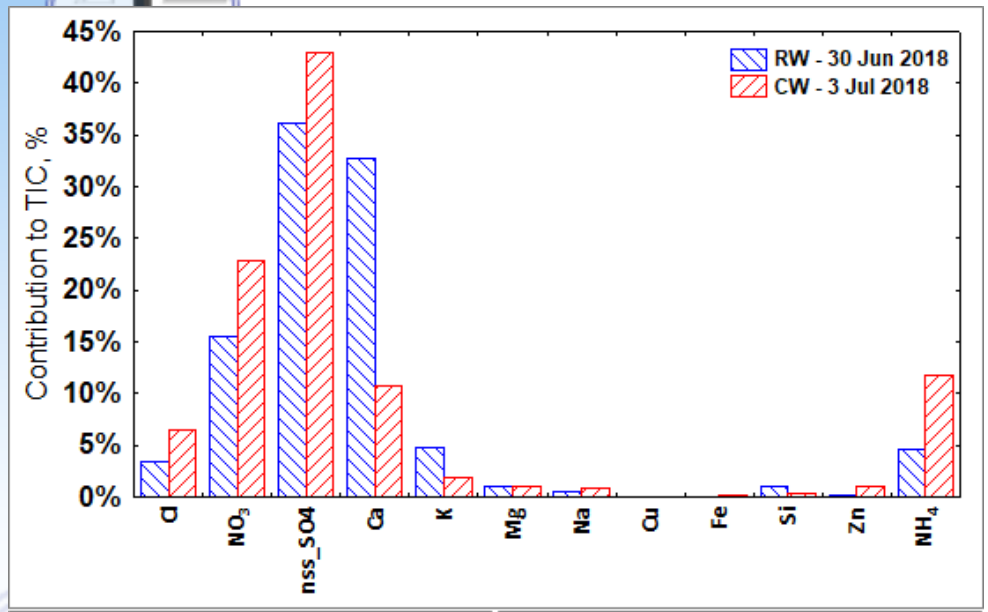
Case 1: 19 – 20 March 2018

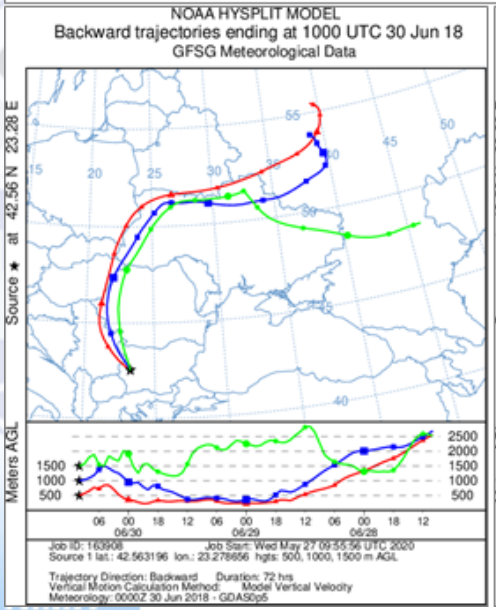


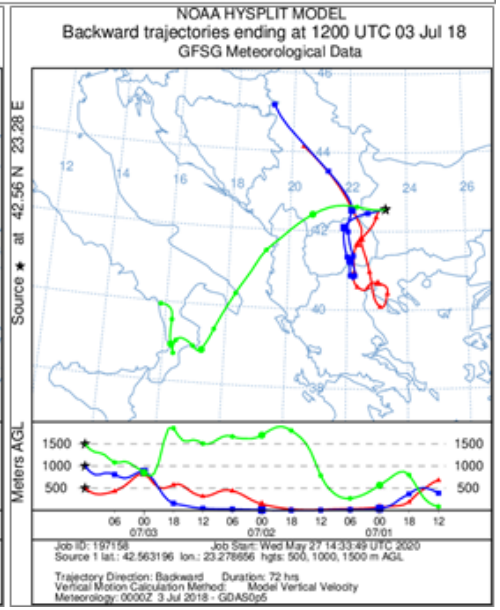


- **Saharan outbreak towards the Balkans, associated with coloured rain and orange snow in many parts of Eastern Europe.**
- **The highest concentrations of Cl and Na in the whole data set**
- **The RW TIC is 64.1mg.l^{-1} with 42% contribution of Cl, 24% of Na, 3% ss_SO_4^{2-} (sea salt SO_4^{2-}) and only 6% of the sulfates from anthropogenic source (nss_SO_4^{2-})**
- **The CW TIC is 3.9 mg.l^{-1} containing 28% nss_SO_4^{2-}, 28.3% Ca, 15.9% Cl and 11.1% K.**

Case 2: 30 June – 4 July 2018







- The trajectory analysis shows that on 30 of June the transport of air masses to the ChV is from North and from W, NW on 3 of July.
- Higher TIC in RW sample (48.5 $mg.l^{-1}$) than this for CW sample (36.7 $mg.l^{-1}$).
- The TIC is consisted mainly of $nss\_SO_4^{2-}$, NO_3^-, NH_4^+ and Ca (RW-83% and CW-88%).
- Higher contribution of $nss\_SO_4^{2-}$, NO_3^- and NH_4^+ ions in the CW sample (43%, 23% and 12%) than in the RW sample (36%, 16% and 5%).
- Three times higher contribution of Ca in the RW sample than in the CW sample.

In conclusion…

- New results for the chemical composition of cloud water (CW) and rain water (RW) at the high-elevation site Cherni Vruh were presented.
- The comparison of the cloud and rain water presents systematic differences concerning the pH, the electric conductivity, and concentrations of most elements.
- The frequency analysis showed that 100 % of the cloud and 98% of the rain samples have pH value in the acidity range (<5.0).
- Mean concentrations were generally higher in cloud water than in rainwater samples.
- The study of the origin of the air masses contributed to better understanding of variations in the chemical composition and concentration levels in two specific cases in 2018.

ACKNOWLEDGEMENTS

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http://meteorology.meteo.bg/deposition/index.html

We acknowledge also to the NOAA Air Resources Laboratory (ARL) for the provision of the HYSPLIT model and READY website (http://www.ready.noaa.gov)

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Thank you for your attention!

30.09.2020

Air Pollution, Climate and Health. Natural Hazards and Risks. Biodiversity.

11:00 - 11:15 - EFFECT OF SAHARAN DUST INTRUSIONS ON PRECIPITATION CHEMISTRY IN BULGARIA - Presenter: Emilia Georgieva

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