



Precipitation Chemistry in the Bulgaria-Turkey Cross – Border Region for Different Synoptic Situations

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Motivation and Objectives

- region rich in biodiversity, numerous natural parks and protected areas
- lack of big emission sources in the region
- lack of routine measurements on precipitation chemistry

Main objective:

- obtain new knowledge on deposition phenomena and air pollution transport, based on field campaigns, chemical analysis and modelling. **Main question – are precipitations acidic?**



Adapted www.ipacbc-bgr.eu

Conclusions

- pH values of rain samples are in general < 5.6 for the coastal Bulgarian sites, while pH > 6.5 is typical for the samples at the Turkish stations
- pH values at the “clean” coastal site Ahtopol have lowest values for all type of weather situations. Low pH values are most likely associated with flows from north and north-west
- Dominant ion at all sites is Ca²⁺, Mg²⁺ is more evident in BG samples, while NH₄⁺ is evident in TR samples
- Dominant heavy metals in BG samples: Fe and Zn, in TR samples: Fe, Mn, Mo, Cu.

Methodology

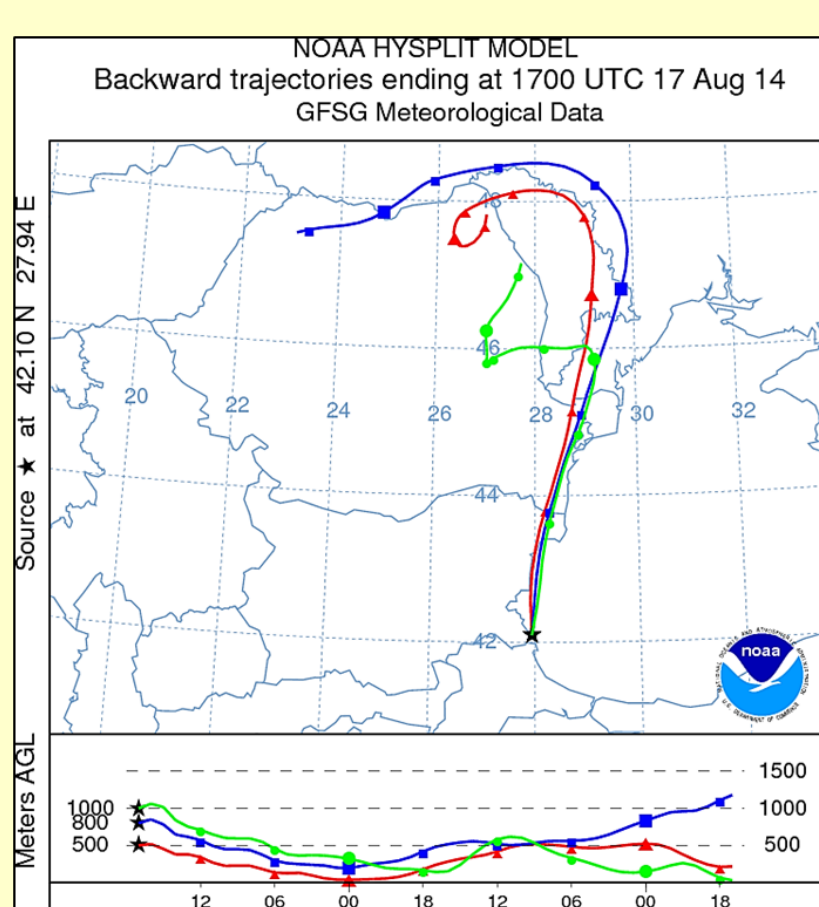
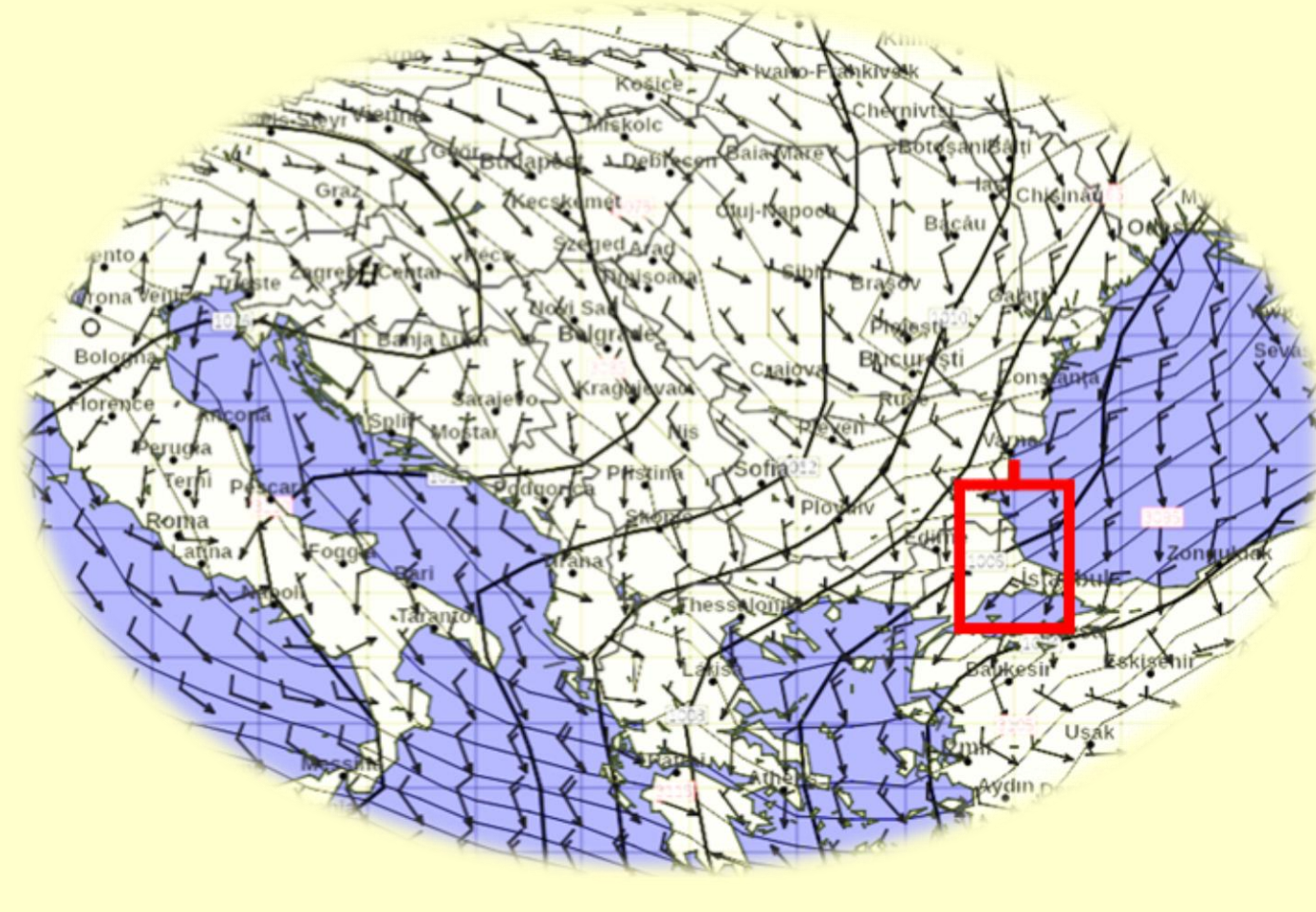
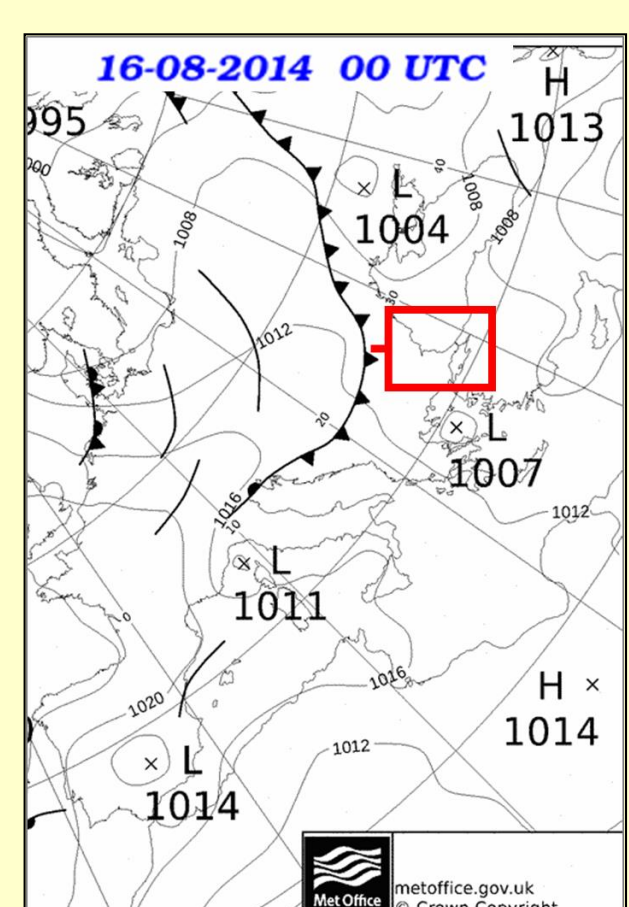
- **Manual sampling systems at 4 sites (see map) for collecting wet, dry and bulk atmospheric deposition, June – November 2014**
- **Acidity (pH)** and electro conductivity (EC) determined on site by portable pH/EC/TDS meters (HI9811-5 Hanna Instruments)
- **Analysis of ions** (Cl⁻, SO₄²⁻, NO₃⁻, NH₄⁺, K⁺, Na⁺, Mg²⁺, Ca²⁺) and **heavy metals** (Co, Cr, Fe, Mn, Mo, Zn, Cd, Cu and Pb). *For BG samples* – Water Lab University “Prof. Dr. Asen Zlatarov”- Burgas using standard cuvettes Hach LANGE photometric equipment and Inductively Coupled Plasma (ICP) technique. *For TR samples* – Lab of Atatürk Soil, Water and Agricultural Meteorology Research Station in Kirkilareli using ion chromatography (DIONEX ICS-5000) and ICP- OES (SPECTRO ARCOS)
- **Synoptic analysis** - UK MET surface weather charts [1]; variational analysis of GFS-NOAA (0.25° x 0.25°) visualizing GRIB files with free software [2] – Figures show vectors of surface wind, thick lines - isolines of 700hPa geopotential height (m), thin lines – MSL pressure (hPa)
- **Back trajectories** by HYSPLIT web based system calculated for 48h and different heights [3]

Results

4 different synoptic situations in August, September, October and November, 2014

Case 1 Flow from North

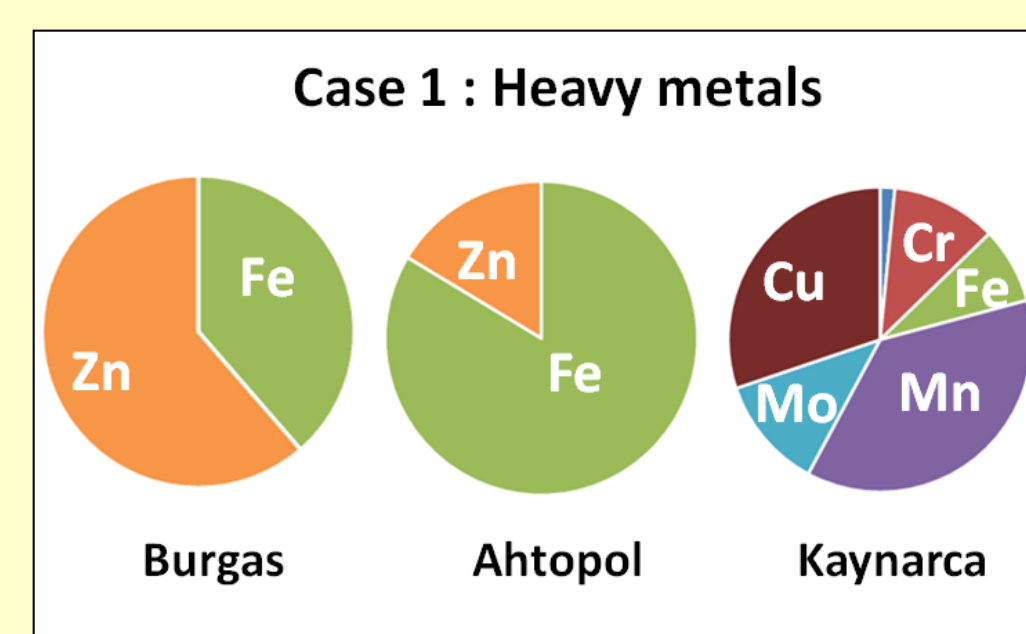
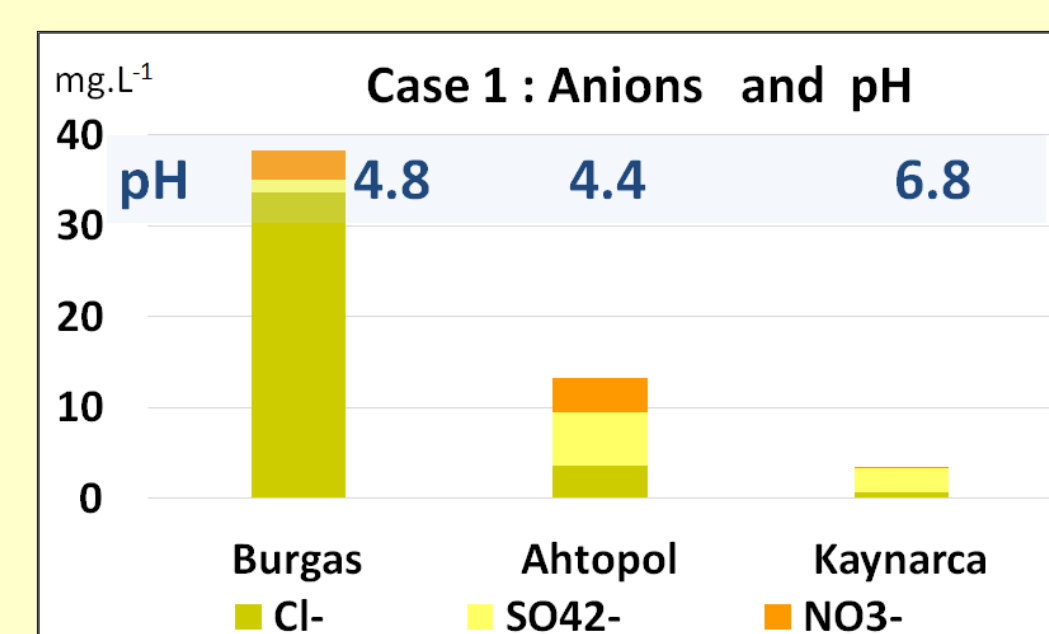
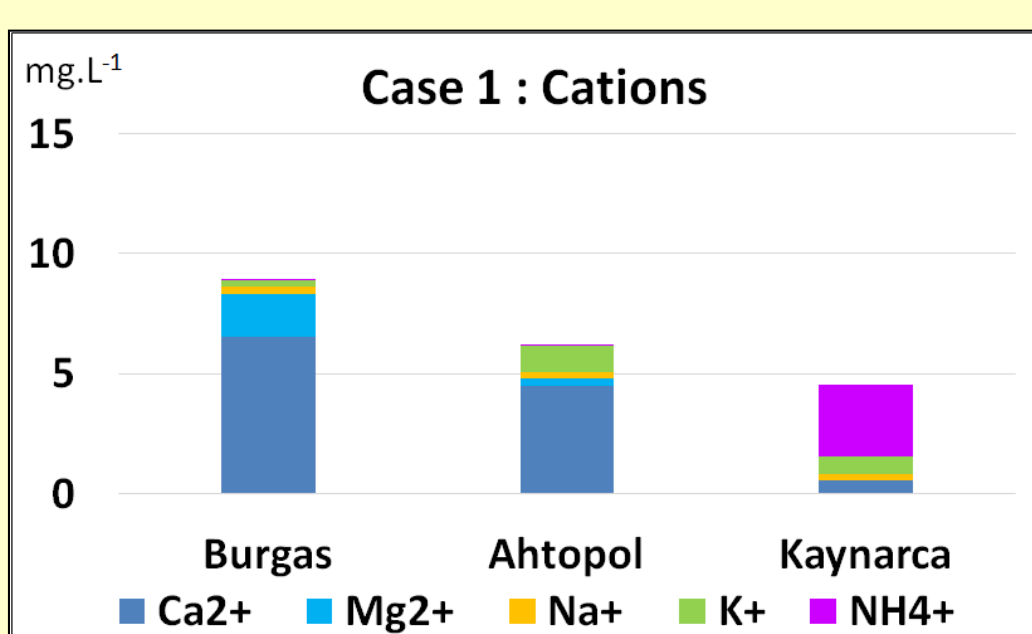
- Rain on 16-17. August 2014, after a dry period of about 10 days
- A cold front is approaching from NW, two low pressure centres located over Aegean Sea and Ukraine
- Predominantly N and NW flow over the region



pH at BG sites < 5.0,
pH at TR sites > 6.5.

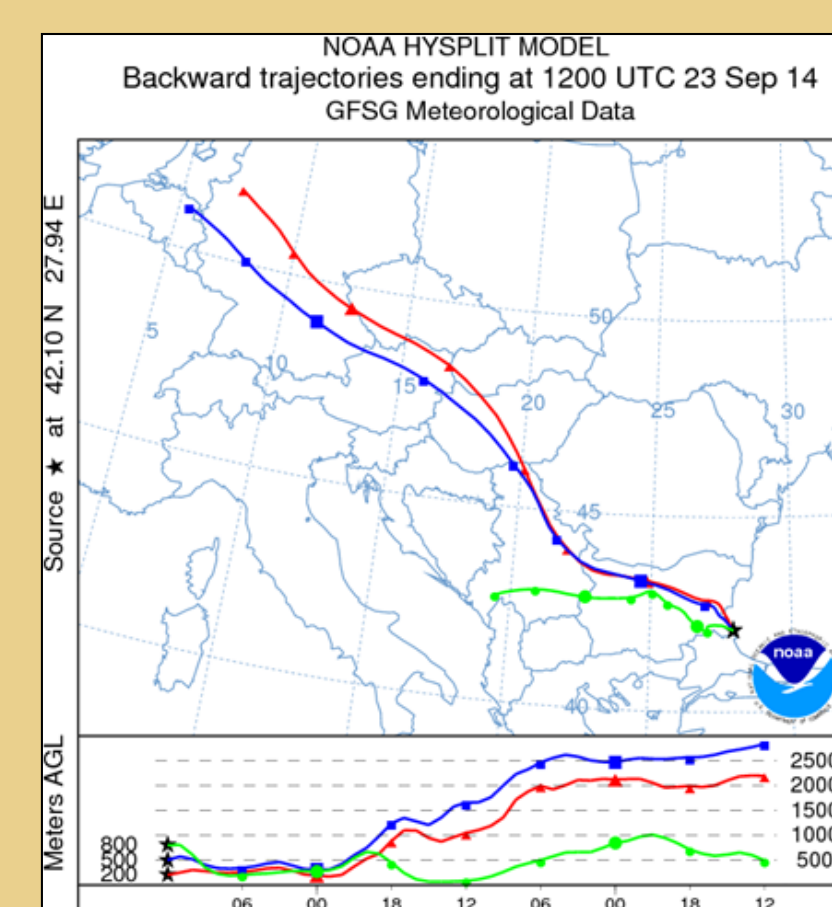
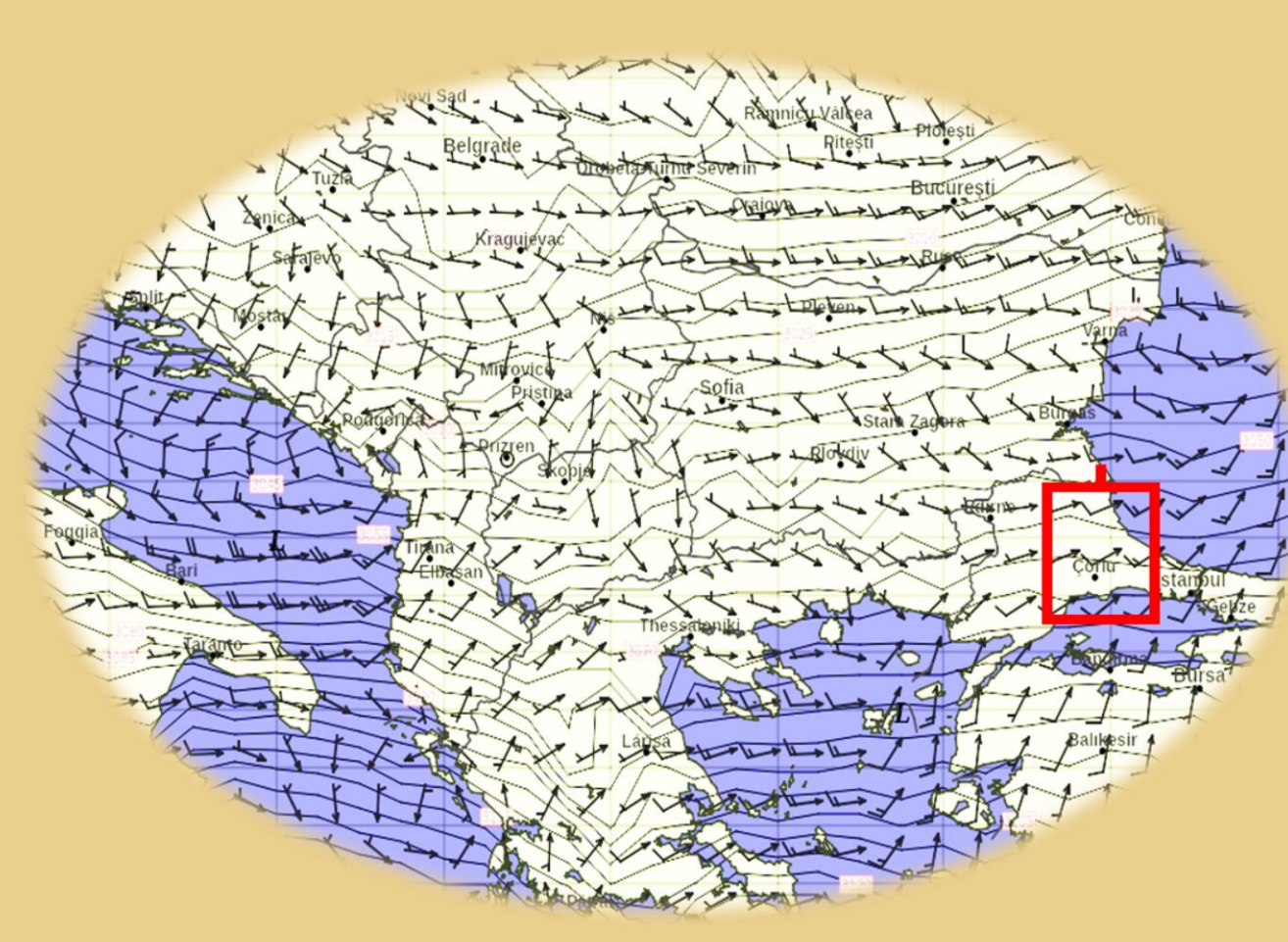
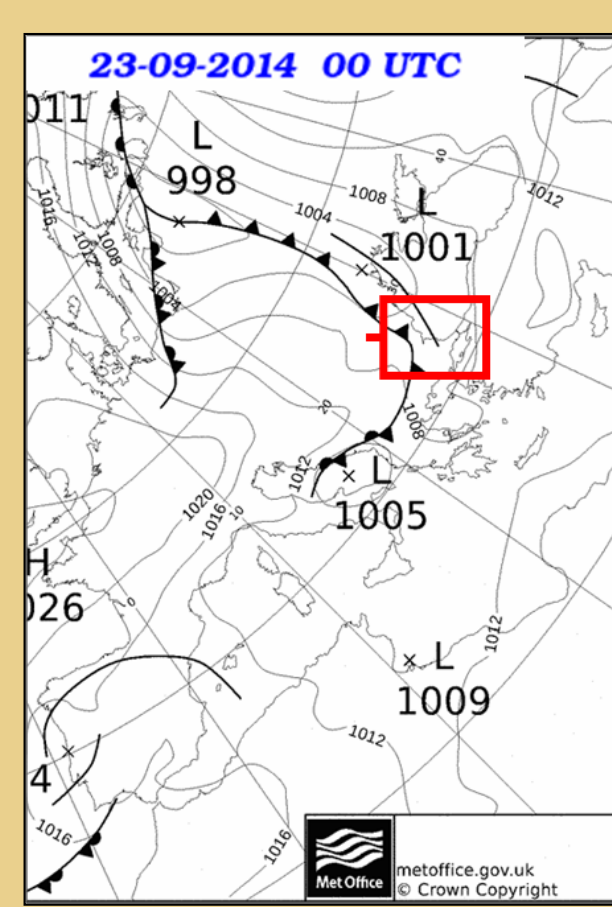
Main ions at BG sites :
Ca²⁺, SO₄²⁻ and Cl⁻,
at TR sites – NH₄⁺

Heavy metals:
Fe and Zn at BG sites



CASE 2 Flow from West - Northwest

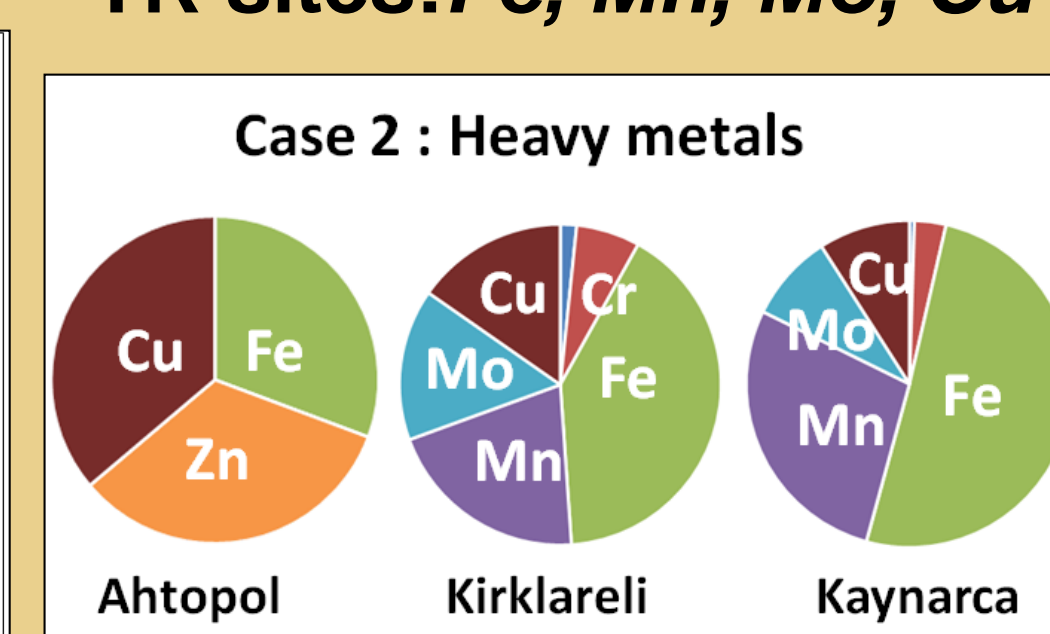
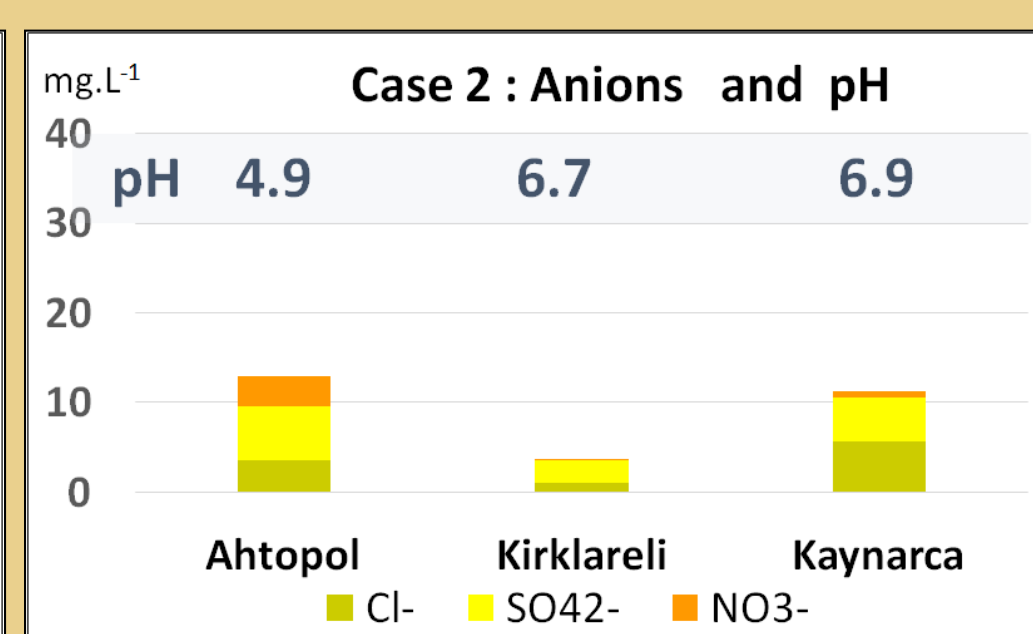
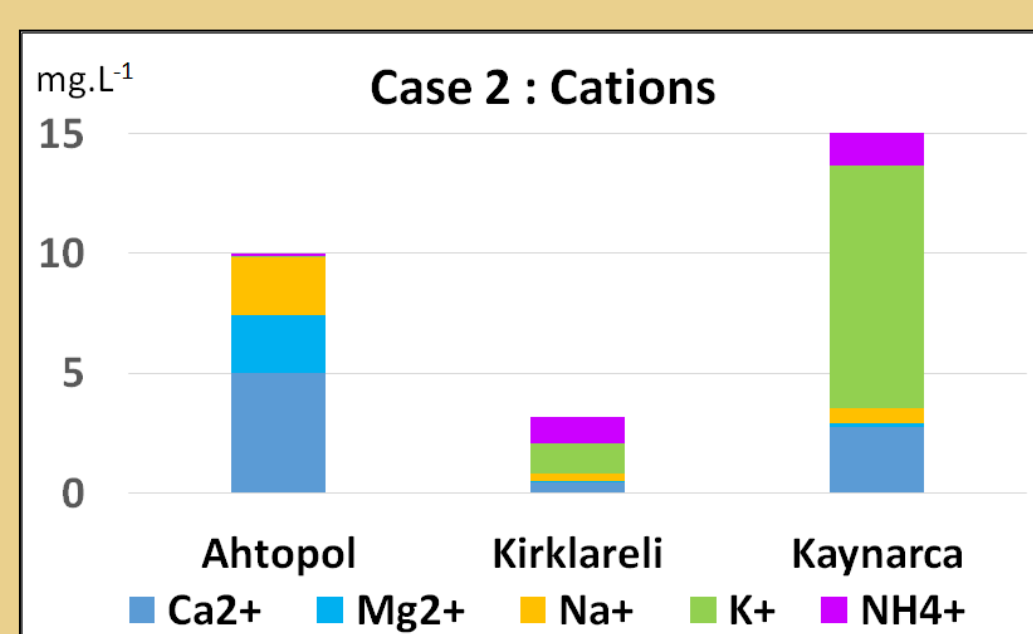
- Precipitation on 23 September 2014 – intense, of short duration along the coast
- A cold front approaching from west, two low pressure systems – one south of the region, another one - over the Northern Black Sea
- Prevailing winds over the region – from W - NW



pH at Ahtopol < 5
pH at TR sites > 6.5

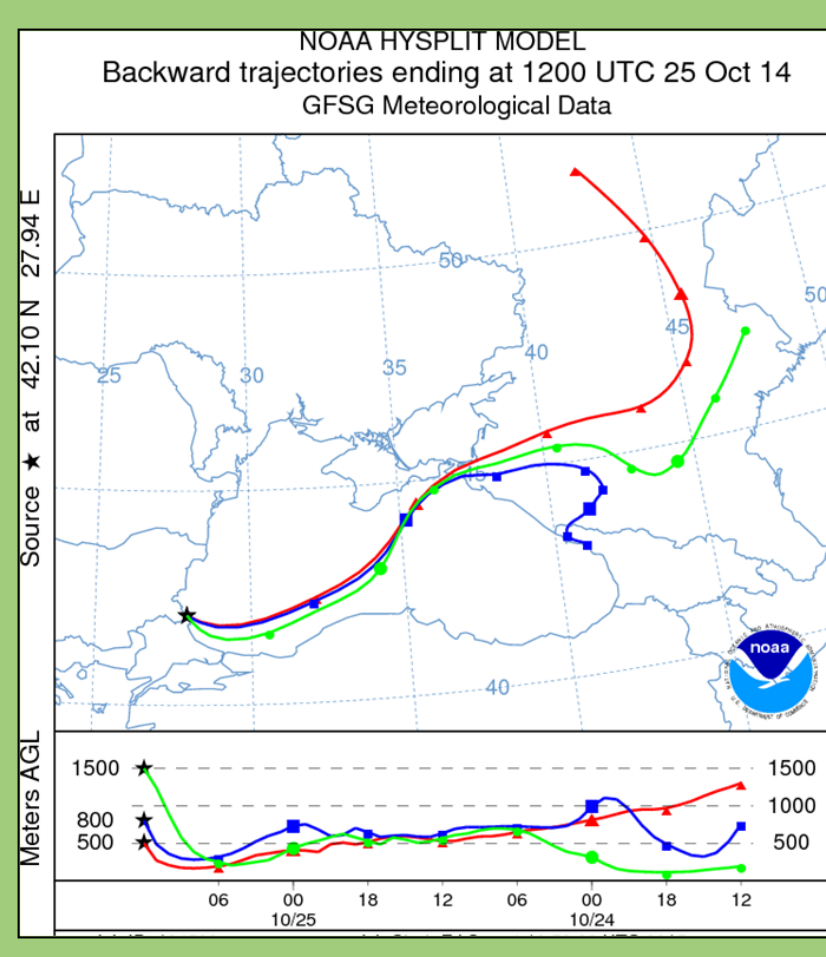
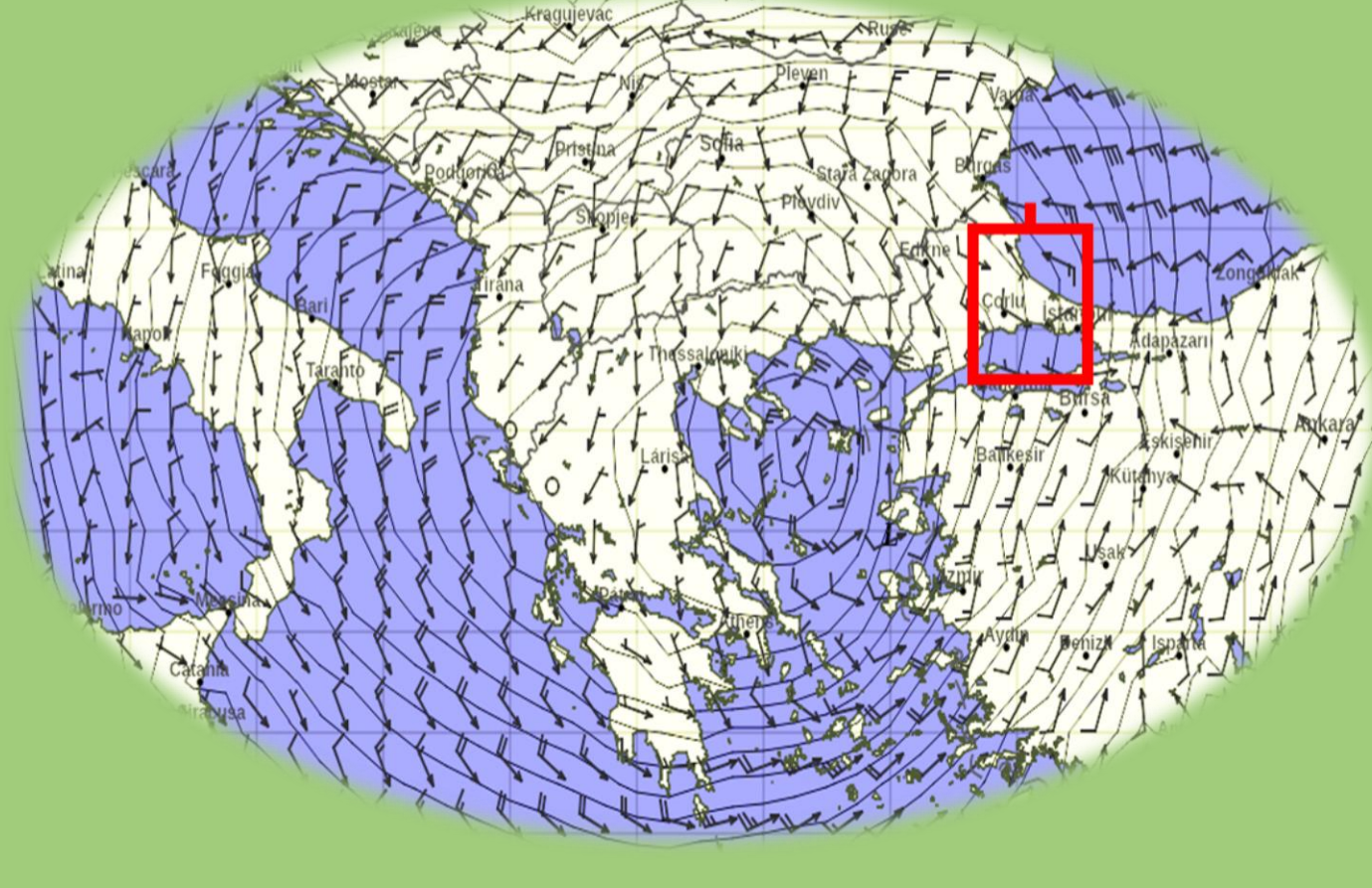
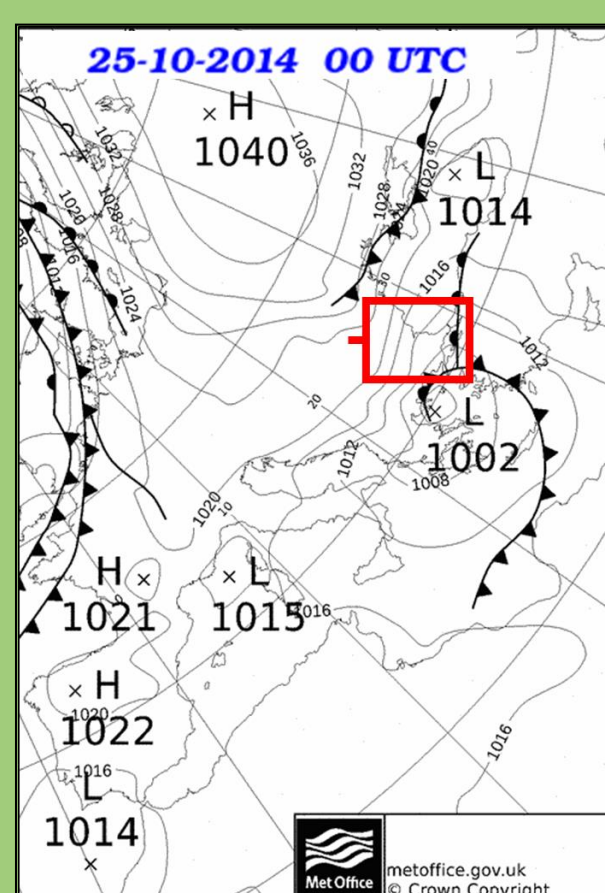
Main ions Ahtopol (AH):
Ca²⁺, Mg²⁺, Na⁺, SO₄²⁻
TR sites: K⁺, Ca²⁺, SO₄²⁻

Heavy metals (AH):
Fe, Cu, Zn
TR sites: Fe, Mn, Mo, Cu



Case 3 Flow from East

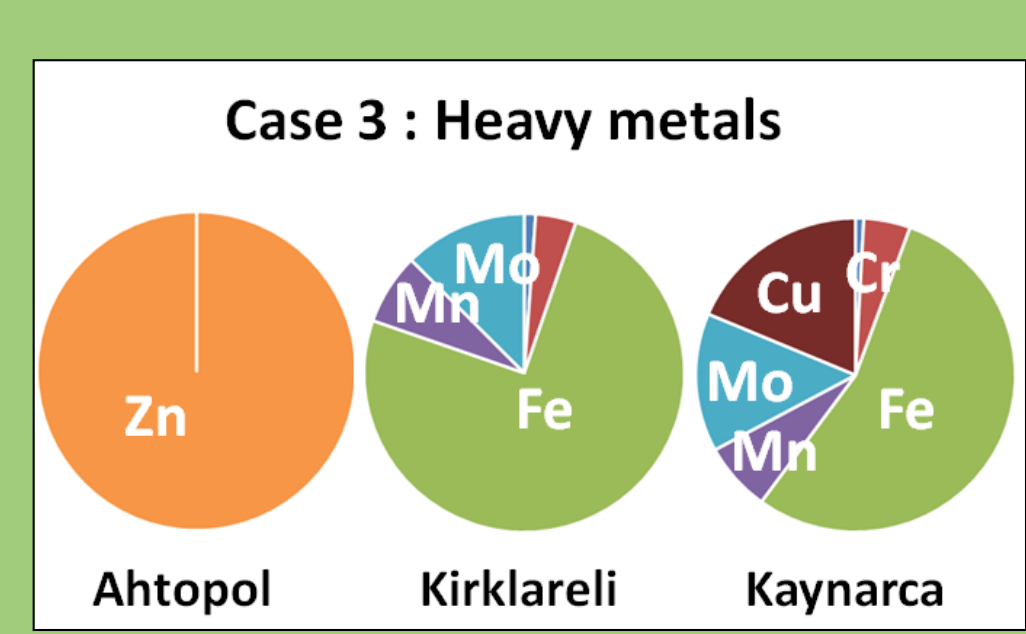
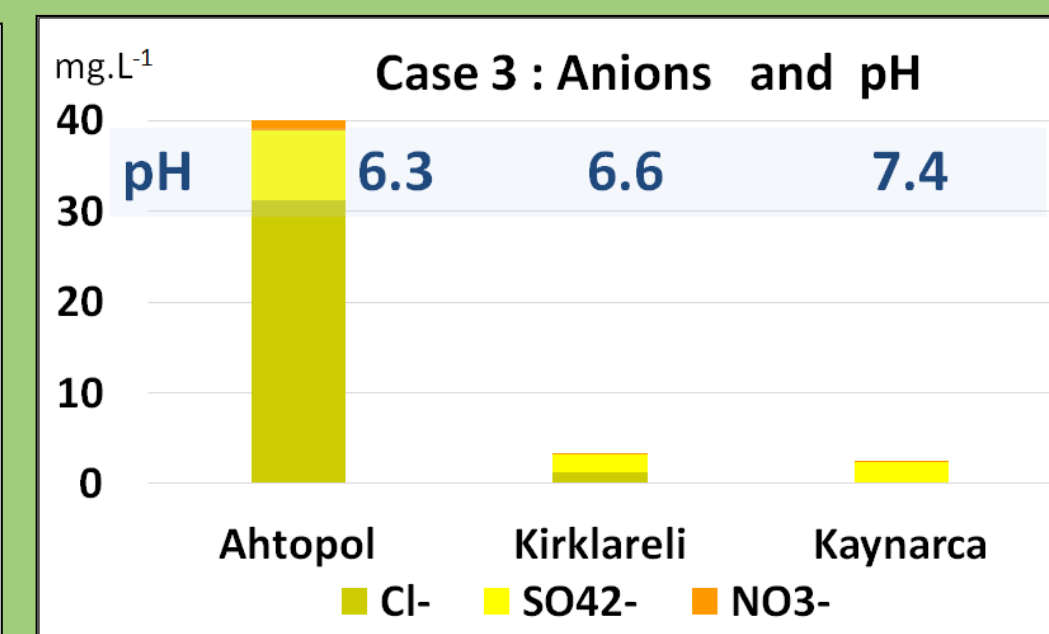
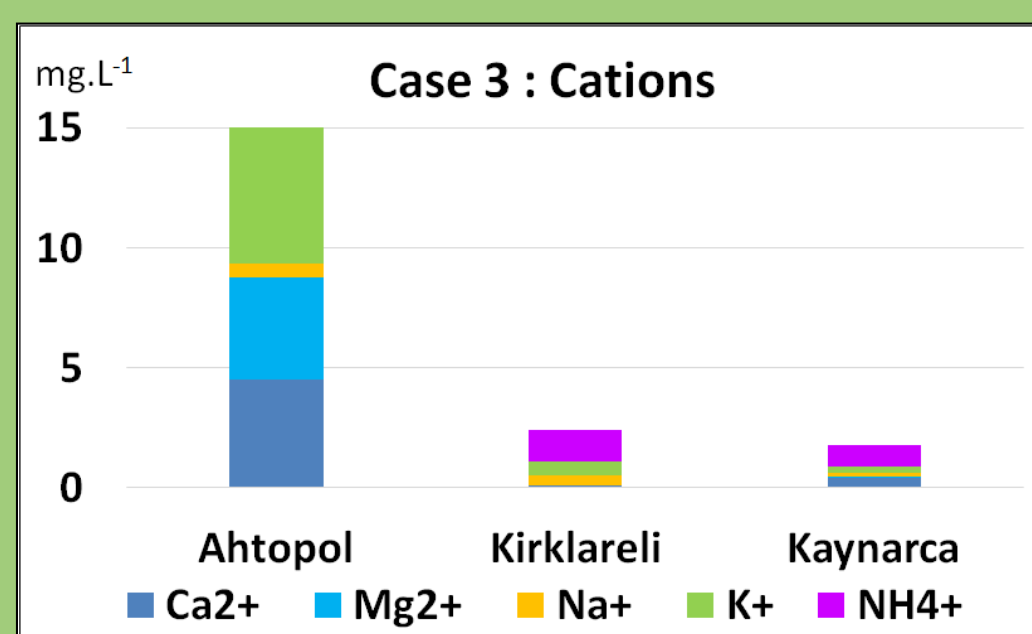
- Precipitation on 25 October 2014
- Passage of two Mediterranean cyclones to the south of the region and a blocking high pressure system over the Caspian Sea
- Strong winds and intense precipitations along the coast
- Prevailing winds over the region – from E



pH at Ahtopol 6.3
pH at TR sites > 6.5

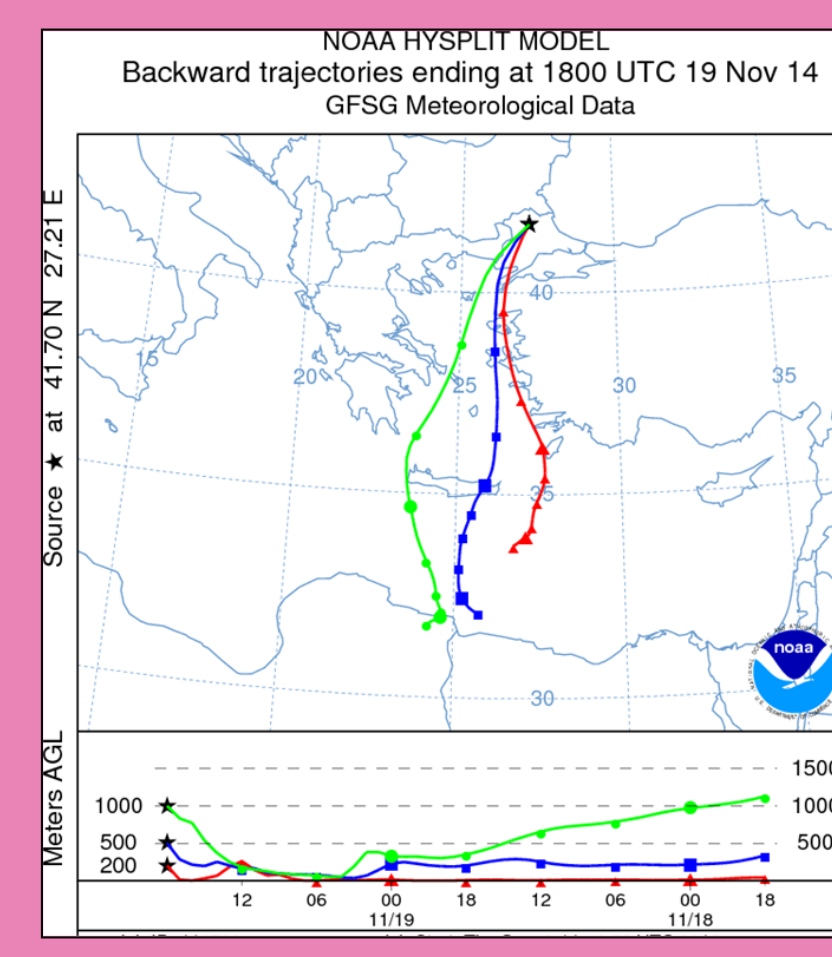
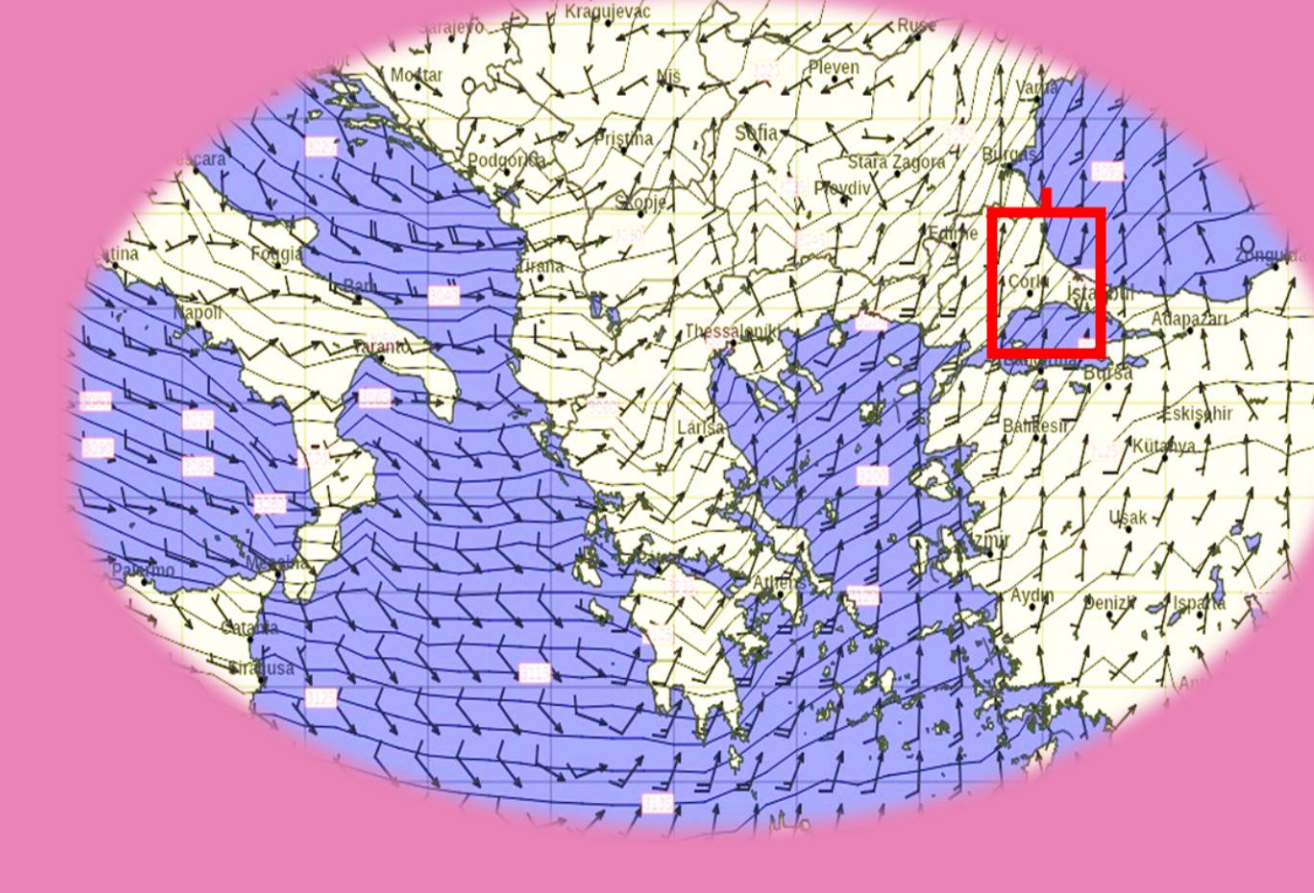
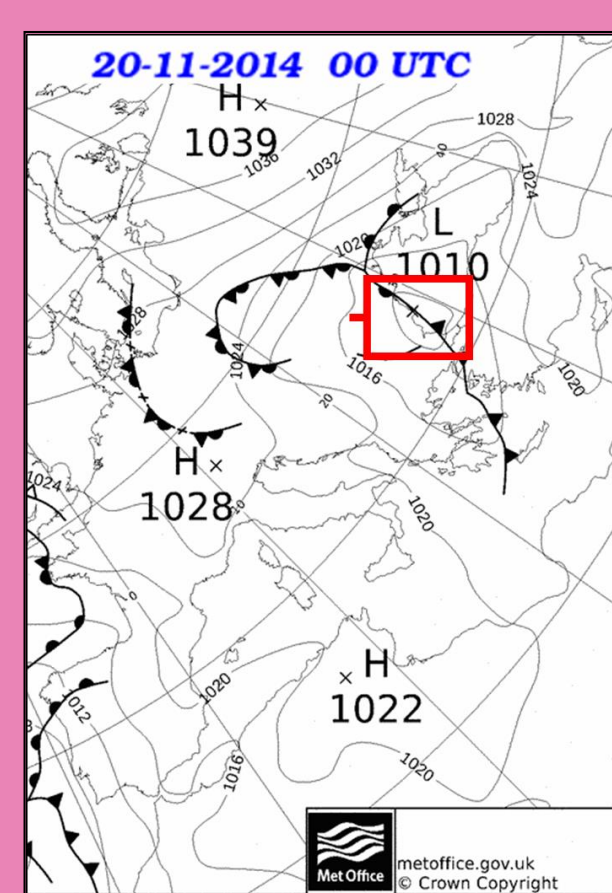
Main ions at AH:
Cl⁻, K⁺, Mg²⁺,
at TR sites: NH₄⁺

Heavy metals at AH:
only Zn detected
TR sites: Fe, Mo, Cu



Case 4 Flow from South

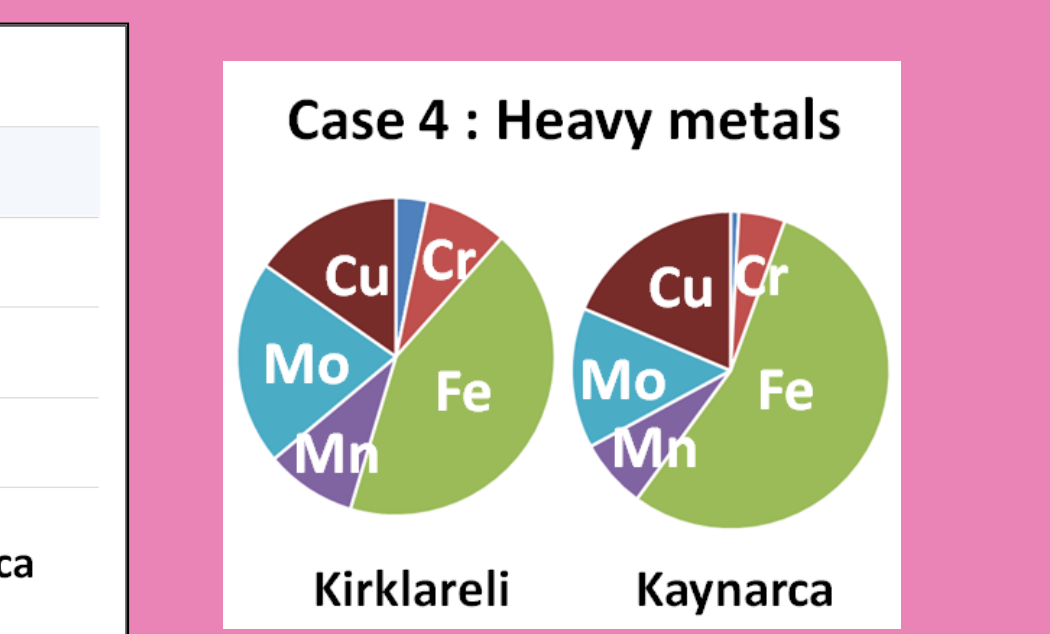
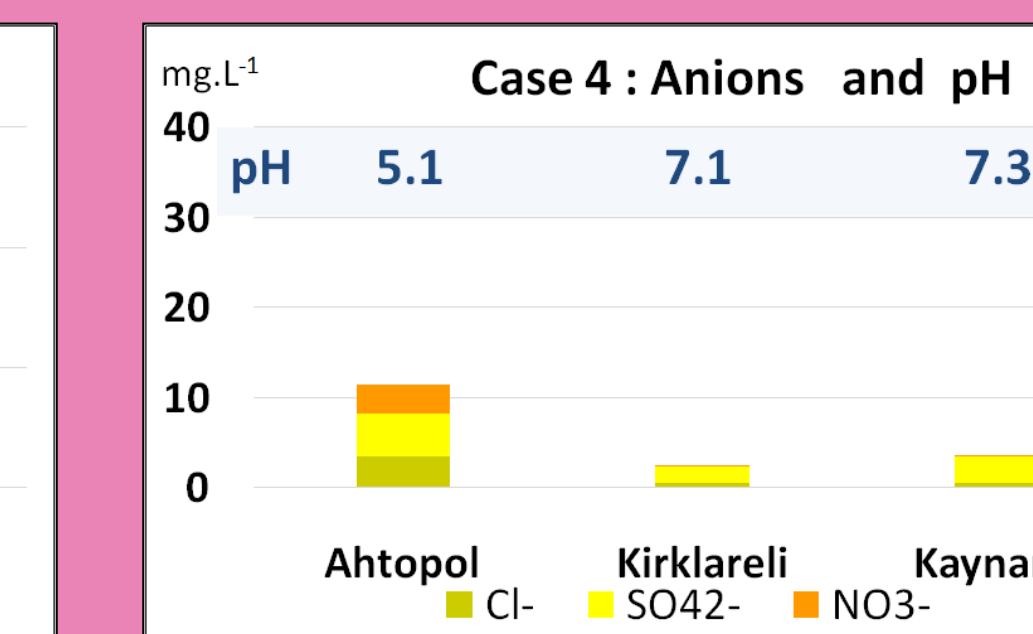
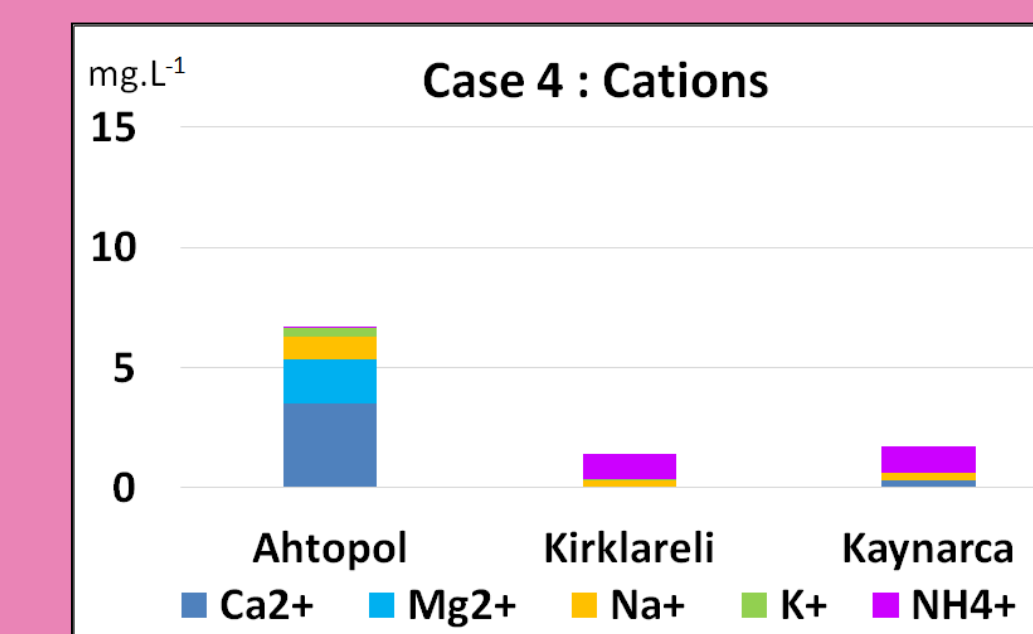
- Precipitation on 19-20 November 2014
- Passage of a cyclone from Central Europe towards Caspian Sea, dynamic weather with passage of warm, and cold fronts over the region
- Amount of 24 precipitation along the coast about 20-30 Lm⁻²
- Prevailing winds over the region – from S



pH at Ahtopol 5.1
pH at TR sites > 7.0

Main ions at AH:
Ca²⁺, Mg²⁺, SO₄²⁻
at TR sites: NH₄⁺, SO₄²⁻

Heavy metals at AH - not analysed
TR sites: Fe, Mo, Cu



REFERENCES: 1. <http://www2.wetter3.de>, 2. <http://zygrib.org>, 3. Draxler, R.R. and Rolph, G.D. (2013) 'HYSPLIT (Hybrid Single-Particle Lagrangian Integrated Trajectory) Model access via NOAA ARL READY Website (<http://www.arl.noaa.gov/HYSPLIT.php>). NOAA Air Resources Laboratory, College Park, MD

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