LONG-TERM ATMOSPHERIC RESEARCH AT THE FINOKALIA ENVIRONMENTAL RESEARCH OBSERVATORY

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ABSTRACT

The Finokalia environmental research station (35° 20'N, 25° 40'E) is located on the north coast of Crete island (http://finokalia.chemistry.uoc.gr/). The station was established in 1993 and has been operated continuously by the Environmental Chemical Processes Laboratory of the Chemistry Department of the University of Crete. Since its launch, the observatory provides continuously high quality data for a wide variety of atmospheric research topics. The nearest large urban centre is Heraklion with 150 000 inhabitants located 50 km west of the site. The station is located at the top of a hilly elevation (250 m asl) facing the sea within the sector 270° to 90°. The nearest village with 10 inhabitants is at 3 km to the south of the station and no significant human activities occur at a distance shorter than 15km. The station is considered therefore representative of maritime background conditions of the eastern Mediterranean as has been extensively documented in the literature. On a climatological basis, two distinct seasons can be found. The dry season from April to September that is characterized by high speed north-northwest winds and the wet season from October to April when the station is additionally influenced by the south-southwest winds from the Sahara desert. Air masses influenced by the marine boundary layer, continental Europe, the Sahara desert, and summer biomass burning areas are frequently observed. Subsequently, both human activities and natural processes contribute to the pollutant burdens in the region; anthropogenic pollutants from the industrialized continental Europe and the densely urbanized coastline, desert dust from the arid areas of northern Africa and Middle East, biomass burning products from combustion sources and wild fires, mix under the influence of intent insolation. Finokalia's strategic location at the crossroads of pollutants in the eastern Mediterranean, an area most vulnerable to climate change, makes the observatory an ideal natural laboratory for monitoring climatic perturbations and atmospheric processes in a varying time scale from seconds to decades.

The station has been part of the EUSAAR, ACTRIS and ACTRIS-2 Networks and is actively participating in the ACTRIS Preparatory Phase Project in H2020. ACTRIS has been selected to the ESFRI roadmap in 2016 as the Research Infrastructure (RI) for long-term coordinated aerosol, cloud and trace gas observations and relevant services in Europe, and Finokalia station is currently the core station of the RI in the eastern Mediterranean. ACTRIS RI is dedicated to observations of aerosols, clouds, and trace gases, and related research and thus establishes the scientific links to study feedbacks between climate change and atmospheric composition. Finokalia station is among the top 5 European sites that attracted scientists from EU and US within EUSAAR and ACTRIS. Finokalia is also part of the ICOS ESFRI, the European Integrated Carbon Observation System, a distributed international RI dedicated to measure, analyse and understand fluxes of greenhouse gases (GHGs) in the atmosphere, over the ocean and at the ecosystem level. Finokalia station reports to the EMEP database high quality data for more than 20 years, covering the national commitments of Greece under the LRTAP convention for monitoring transboundary pollution. It is also listed in MERIL database of European RIs in the category of Atmospheric Measurement Facilities. Currently, Finokalia is the core station of the nationwide RI for atmospheric measurements PANACEA.

The instrumentation available at Finokalia is state-of-the-art for atmospheric research and is operated under the recommendations of ACTRIS and ICOS ESFRIs. Measurements for aerosol number concentration, size distributions, PM_{10} concentration, absorption and scattering coefficient are taking place on a continuous basis. Aerosol samples are collected and chemical composition is analysed with a

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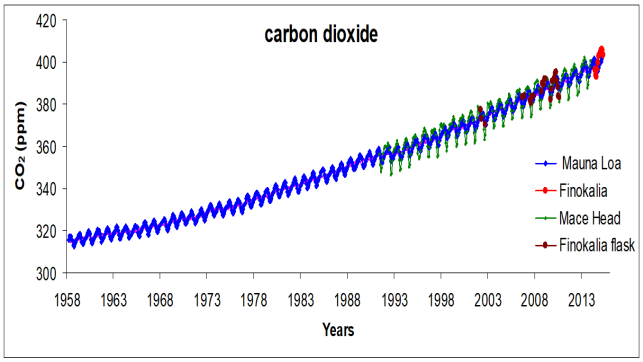
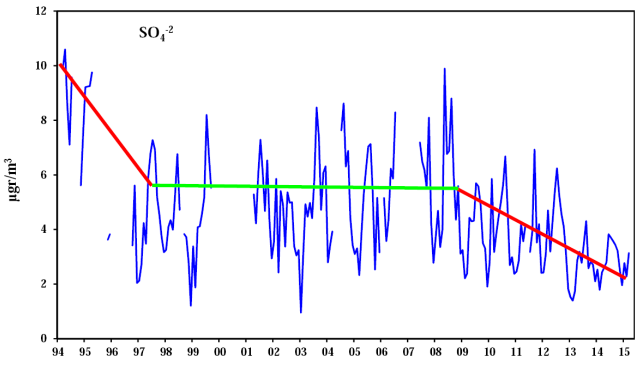
time step of at least 24 h. Real time chemical composition of atmospheric aerosols is provided by PILS-IC and ACSM. Radon/Thoron radionuclides are monitored on a continuous basis. Samples for wet deposition and dry deposition are collected on a regular basis. Sampling for bioaerosols (fungi, pollen etc) is also taking place regularly. The equipment available for trace gases research includes: O_3, CO and NO_x monitors, pyranometers for recording the photodissociation rates JO^1D/JNO_2, and filter samplers for specific trace gases measurement. For greenhouse gases (GHG) measurements, a PICARRO instrument is installed for real time monitoring of CO_2, CH_4, H_2O and CO concentrations and regular sampling in flasks is performed for further analysis. Remote sensing techniques are used for profiling of the atmosphere (LIDAR) and for columnar measurements (AERONET sunphotometer). Meteorological data of air temperature, wind velocity and direction, pressure, relative humidity, solar irradiance, rainfall rate and total rainfall are also continuously recorded.



a)



b)

Figure 1. a) Atmospheric CO_2 concentrations at Finokalia, Mace Head (Ireland) and Mauna Loa (USA); b) Atmospheric particles' SO_4^{2-} from the Finokalia station for the period 1994-2015

Long term monitoring of the atmosphere is now undertaken for over a quarter of century of continuous operation of the Finokalia observatory. GHG concentrations at Finokalia present the same trend as in the Atlantic or the Pacific Ocean for northern hemisphere. The CO_2 concentration increasing trend leading to global warming is well captured in the Mediterranean (Figure 1a). Furthermore, the annual cycle is reflecting the blossoming period in spring and summer when CO_2 concentrations present a minimum. The long-term operation of the Finokalia station also provides valuable feedback regarding effectiveness of environmental policies regarding air quality and socioeconomic changes impact on the environment. In Figure 1b the SO_4^{2-} concentrations of aerosol particles at Finokalia are presented. Two declining periods can be identified: the first one is reflecting the desulfurization legislation that took effect in 1993. The second declining period is however the result of the economic crisis in Greece and Europe in general, that led to less fossil fuel consumption and thus a decrease in the sulphate emissions.

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