Ozone and BVOC exchanges between biosphere and atmosphere

Silvano Fares

Council for Agricultural Research and Economics, Research Centre for Forestry and Wood, Arezzo, Italy.

Ozone is the main oxidant stressor in regions with warm climates, where high temperatures and large emission of precursors (Nitrogen oxides and hydrocarbons) from anthropic sources lead to the formation of this secondary pollutant. Plants can remove ozone from the atmosphere through stomatal absorption (i.e. ozone penetrates stomata and reacts with leaf tissues) and various non-stomatal deposition processes. Many vascular plants can produce and emit into the atmosphere large amount of Biogenic Volatile Organic Compounds (BVOC), largely represented by isoprenoids. BVOC emission is particularly stimulated by high temperatures, similar conditions promoting high levels of tropospheric ozone. One of the reason why plants invest energy to produce BVOC is that these molecules can play as antioxidant, thus defending leaf tissues from the adverse effects of oxidant molecules. Chemical lifetime of isoprenoids such as sesquiterpenes is very short due to fast reactions with ozone and other reactive molecules.

In order to fully explore plant-atmosphere interactions under environmental stress, bi-directional exchanges of BVOC, CO_2, water, and ozone should be investigated simultaneously. Gas exchange studies through laboratory experiments using branch enclosures and through field measurements at canopy level with the Eddy Covariance technique help to understand possible links between BVOC emission and ozone removal inside leaves and in the gas phase in the sub-canopy region.

In my talk, I will introduce examples of such studies, mostly performed in agricultural and forest ecosystems located in ozone stressed Mediterranean areas. Mediterranean forest ecosystems are indeed exposed to high loads of anthropogenic pollutants and are among the most threatened ecosystems on Earth by climate changes. Advantages and disadvantages from using state of the art instrumentation for fast detection of ozone and BVOC will be analysed, as well as the most advanced modelling approaches currently adopted to predict BVOC emission, and ozone sequestration in the soil-plant-atmosphere continuum. Future research needs will emerge after deep evaluation of what has been discovered so far and what is highly needed to better understand the link between BVOC emission and ozone removal by plants.