Modeling the chemical and radiative effects of aerosol during the wildfires of 2007 in Greece

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The 2007 wildfires in Peloponnese were the most destructive in the modern history of Greece. The important fire tracers (gaseous and particulate phase) and aerosol radiative forcing are studied with the chemistry transport model COSMO-ART (Vogel et al., 2009).

Simulations are performed between August 15 and September 13 with a horizontal resolution of 2.8 km and a vertical extent up to 20 km. The anthropogenic emission database used is the TNO/MACC (Kuenen et al. 2011). Fires are represented as hourly emission rates of gaseous (e.g. Nitrogen Oxides, NO_x, speciated non-methane hydrocarbons, NMHC) and carbonaceous aerosol species (TC). The data processed and used are retrieved from the GFED, Version 3 (van der Werf et al., 2010; Mu et al., 2010). In order to quantify the effect of wildfires on air quality and radiation, the change in the concentrations of primary (TC and NO_x), secondary (Ozone, O_3) produced species, and radiation was calculated as the difference between the standard run and a scenario excluding fire emissions (Fig. 1).

First, it is shown that the wild fires affect an area extending more than 500 km downwind the fire spots, around 3.6 km agl in the vertical over the fire spots, and up to 4.5 km asl in distances greater than 150 km downwind (not shown), during a period of 13 days. During this event, fires shape the 80% of ground TC over Messenia, which results being 27 times higher than TC values during the rest of the month. The presence of NO_x determines whether the oxidation leads to O3 production or loss. Indeed, the burnt area acts as an urban zone for O_3, which at the very high ambient NO_x conditions that occur over the fire spots O_3 is destroyed, whereas downwind fires O_3 is accumulated due to the lower NO_x levels. The same effect appears also in the vertical, where O_3 changes become positive at around 300m height agl. Fires contribute to O_3 exceedances (daily value of 60 ppb) at the area with positive O_3 changes (daily value of 70 ppb).

The change in aerosol profiles and chemical composition due to the fires affects the net radiative flux by -10 Wm^{-2} at the surface over the fire spots and by 1-2.5 Wm^{-2} downwind. This leads to a decrease of the temperature over land and an increase over water. The contribution of the different aerosol species and the different feedback on the atmosphere over land and water will be presented during the conference.

Recently, the direct heat input of forest fires is also implemented in COSMO-ART through the fire radiative power, acquired from GFED. The aim was to compare its effect on air temperature, with the aforementioned temperature changes. Results towards this direction will be presented during the conference.

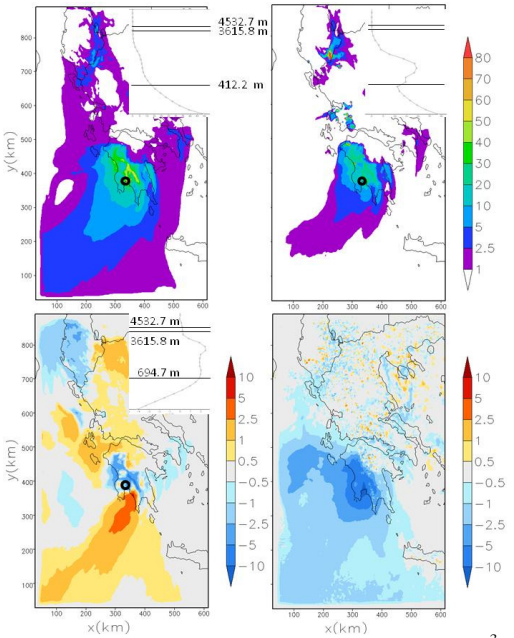

Figure 1. Spatial distribution of: (a) of TC (μgm^{-3}) averaged up to 412 m agl, (b) NO_x (μgm^{-3}) averaged up to 412 m agl, (c) O_3 (ppb) averaged up to 695 m agl and (d) total surface radiative forcing (Wm^{-2}), during the wildfires in Peloponnese, Greece (22 August – 02 September 2007). Embedded lie the vertical concentration profiles over the site marked in the map.

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