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A case study of aerosol effects impact on key meteorological characteristics in Ukraine during heat wave event in July-August 2010

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Aerosol effects play a significant role in Earth's radiative balance, cloud formation and thus redistribution and change of meteorological characteristics. This study focuses on the case of heat wave event during July-August 2010 accompanied with wildfires, modeled using the seamless online-integrated Enviro-HIRLAM modeling system. We used reference (REF) run and running modes to simulate direct (DAE), indirect (IDAE) and combined (DAE+IDAE) aerosol effects. These runs fulfilled for domain at 15 km horizontal resolution (includes European territory), with downscaling to 5 km (includes the territory of Ukraine).

During the heat wave event, aerosol effects caused the overall 2-m air temperature nighttime cooling and daytime warming being stronger for DAE. Locally, there were observed reversed dependencies reaching up to 5□ differences compared to REF runs. Specific humidity changes were consistent with air temperature fluctuations showing a decrease at night and increase during midday hours without heterogeneous spatial distribution. IDAE effects caused homogeneously distributed slight decrease in 2-m air temperature, with no sharp changes in specific humidity. At midday, homogeneity disappeared for 2-m air temperature, whereas aerosol effects had no significant impact on specific humidity. DAE+IDAE caused mostly warming effect during night time, with local increase and decrease for specific humidity. For all running modes, there were no significant changes in grid-scale precipitation driven by aerosol effects.

Occasionally, the heat wave event was accompanied with weather fronts. In comparison to anticyclonic synoptic conditions, the role of aerosol effects significantly increased during these weather fronts passage. In the case of a cold front, DAE showed a decrease in 2-m air temperature by -1,2□ following the cold front areas, and warming on some distance up to +1,4□ at midnight.

IDAE effects resulted in significant warming before front and cooling after it. Specific humidity falls after cold front up to -4 g/m^3. DAE+IDAE affected 2-m air temperature rise before cold front and cooling after during midday. Specific humidity changes unevenly and increases after cold front. Grid-scale precipitation amounts decreased during the cold front passage due to the impact of aerosol effects for all running modes.

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