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Effects of anthropogenic aerosols on spatial redistribution and amount of precipitation: simulations of rain events in Eastern Mediterranean and California coastal zones using a mesoscale spectral (bin) microphysics model

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Givati and Rosenfeld (2004) reported a substantial negative trend in precipitation in the coastal regions of the Eastern Mediterranean and California during the past 50 years**.** In both regions, a decrease in precipitation occurred downwind of urban coastal areas, along mountain ridges parallel to the coastline. To the east of the mountain ridges, a compensating increase in precipitation was found, but the increase in precipitation was significantly smaller than that of the precipitation decrease over the upwind ridges. As a result, there was a net decrease in precipitation over the hydrological basin. The inhibition of precipitation and its spatial redistribution were attributed to the effects of anthropogenic aerosols. In fact, north and south of the urban areas no precipitation trend was found in spite of similar conditions (winds, topography, etc.).

We present results of numerical simulation of aerosol effects on precipitation in these regions. The simulations were performed using a nested grid mesoscale model, MM5, coupled to the spectral (bin) microphysics (SBM) code of the Hebrew University Cloud Model. SBM was used on the finest grid with resolution of 3 km. On the coarser resolution grids both an explicit bulk scheme and the cumulus parameterization were used.

For sake of comparison, simulations on the finest grid were performed also using the bulk-parameterization scheme of Reisner2 (considered one of the better schemes within the standard set of the MM5 microphysical packages). Simulations of cloud

and precipitation formation were performed for well documented time periods. Two different concentrations (and size distributions) of aerosols (CCN) were used in parallel simulations for the same initial and boundary conditions pertinent to both locations. First, simulations with aerosol typical of maritime conditions (150cm^{-3} at 1% supersaturation) The effect of anthropogenic aerosols was then simulated by prescribing the initial CCN with a concentration of 2500 cm^{-3} typical of very continental conditions).

The results of the model simulations supported the findings of Givati and Rosenfeld and allow explanation of them. Orographic clouds that formed in clean air precipitated rapidly over the mountain ridges At the same time, the formation of raindrops and ice in orographic clouds growing in polluted air took place with a significant time delay because the collision process was ineffective in the polluted clouds. In addition, the formation of a larger amount of ice particles with lower fall velocity also led to a time delay in the development of surface precipitation. As a result, precipitation over the mountain ridge from polluted clouds was significantly smaller than in the simulations with clean air. Moreover, the time delay in precipitation onset led to the transport of precipitation mass downwind (eastward). As a result, precipitation in polluted air takes place further inland within a drier air environment. Here, ice sublimation and droplet evaporation led to a significant loss of precipitating mass. As a result, net precipitation turned out to be significantly smaller in polluted air.

A comparison of results obtained using SBM and bulk-parameterization microphysical schemes will be presented. Significant difference was found in spatial distribution of precipitation. Preliminary results indicate the bulk-parameterization predicts precipitation amount that is closer to the very continental case.