

Satellite Observed Aerosol Impacts on Cloud Microstructure and Precipitation Forming Processes Over South and East Asia

DANIEL ROSENFELD¹

¹*Institute of Earth Sciences, The Hebrew University of Jerusalem, Israel*

Cloud drop effective radius (R_e) at the top of convective clouds is determined by the concentration of nucleated drops at the cloud base and the condensational growth of these drops inside the cloud, which is determined by the height above cloud base and by cloud base temperature. Extensive remote sensing and aircraft measurements showed that significant warm rain starts developing when R_e exceeds about 14 micron. Based on these physical considerations, relating satellite retrieved R_e to cloud top temperature (T) over areas with convective clouds having tops at different heights and temperature can be used to compose T - R_e relations that show the vertical development of cloud microstructure and precipitation forming processes, as has been already documented by Rosenfeld and Lensky (BAMS, 1998). Application of this methodology to the clouds measured over India during the summer of 2009, in the framework of CAIPEEX-I (Cloud Aerosol Interaction and Precipitation Enhancement Experiment), documented the great extent by which air pollution is suppressing warm rain over India. The preliminary findings are:

In the pre-monsoon clouds have extremely small cloud drops and have highly suppressed warm rain forming processes. In contrast, the high air pollution appears to nucleate ice at relatively high temperatures, which might offset to some extent the rain suppression effect. In the southwest monsoon clouds are moderately maritime (i.e., having large R_e and producing warm rain already at shallow depths) over the Western Ghats. The clouds microstructure loses its maritime characteristics as the clouds move further east and ingests air pollution. Shallow clouds lose their ability to precipitate. A look over China reveals dearth of convective clouds in the extremely polluted areas over Eastern China, probably due to the absorption of the solar radiation in the thick haze layer, and hence suppression of surface heating and convection. Convective clouds that manage to form have very small effective radius, but fast ice nucleation, to a greater extent than the pre-monsoon clouds over India.

The observations indicate that air pollution has a very extensive and profound impact on cloud microstructure and precipitation processes over the most populated areas of Asia. The implications of it with respect to the climate system and water resources are yet to be fully appreciated and understood.