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MAX-DOAS measurements of tropospheric vertical profiles of aerosols, NO_2, SO_2 and HCHO in the suburban area of Xintai city, China: comparisons with aircraft and ground-based measurements, and investigation of transport

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Xingtai is one of the most polluted cities in China and is located on the western edge of the large industrial zone of the North China plain. The Taihang Mountains in the west of Xingtai block transport of polluted air mass towards western China and cause accumulation of pollutants along the mountains. Severely polluted air harms health of about seven million inhabitants in Xingtai. Air pollution also affects condensation nuclei for the formation of convective clouds, and thus potentially initiates heavy rainfall. In order to study the interaction of pollutants and clouds, the Atmosphere-Aerosol-Boundary Layer-Cloud (A2BC) Interaction Joint Experiment was held around Xingtai in the period from May to June 2016. Various instruments measuring gaseous pollutants, aerosols, clouds, precipitation, and radiance are operated at a monitoring station (37.18° N, 114.36° E) in the suburban area of Xintai city and aboard two aircrafts which fly up and down in spirals between 0.2 km and 4 km over the station. We operated a Multi Axis (MAX-) Differential Optical Absorption Spectroscopy (DOAS) instrument at the station in order to derive tropospheric vertical profiles of aerosols, NO_2, SO_2 and HCHO during daytime with a time resolution of about 10 minutes. We apply our profile inversion algorithm PriAM based on the optimal estimation theory to retrieve trace gas and aerosol profiles. The results are compared with other ground-based and aircraft measurements. In general reasonable consistency was found, but the comparison also revealed a considerable smoothing effect of the MAX-DOAS retrievals. The MAX-DOAS results are applied to characterize the vertical profiles and the diurnal cycles of the trace gas and aerosol pollutants. Lifted layers of pollutants, especially aerosols and SO_2, were frequently observed during the campaign indicating frequent transport events of pollutants over the station. Rapid cleaning events of pollutants were also observed. We further investigate the effect of transport and the distribution of emission sources (e.g. the wind dependence of pollutants) using MAX-DOAS results in combination with satellite observations, and the HYSPLIT trajectory model.