Geophysical Research Abstracts,
Vol. 10, EGU2008-A-11848, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-11848
EGU General Assembly 2008

Influence of atmospheric transport pathways on the chemical composition of aerosol particles over northern Zimbabwe

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Aerosol samples have been collected at Rukomechi research station (16.1˚S, 29.4˚E, 500 m a.s.l.), northern Zimbabwe, from September 1994 to January 2000. They were analyzed for particulate mass (PM), black carbon (BC) and 47 elements in the coarse (2-10 μm diameter) and fine ($<$2 μm diameter) fraction sizes. The principal component analysis technique was applied to the 5.5 years dataset to identify chemical aerosol sources, while the absolute principal component analysis was used to quantify the contribution of each source to the total PM. Several natural and anthropogenic aerosol sources were identified for dry and wet seasons. The main sources for northern Zimbabwe aerosols are mineral dust, biomass burning, and sea salt. The major anthropogenic sources related to regional non-ferrous smelters were only detected in the fine size fraction. The chemical dataset was combined with air flow patterns to Rukomechi (obtained from trajectory analysis) to yield improved knowledge of preferential transport pathways of pollutants to northern Zimbabwe and their potential source areas.

The HYSPLIT_4 (HYbrid Single-Particle Lagrangian Integrated Trajectory model 4) was employed to compute backward air mass trajectories using re-analyzed NOAA wind datasets of resolution 2.5˚ x 2.5˚ as input. Five-day back trajectories were calculated on a daily basis (start time: 1200 hrs local time, from January 1994 to De-

cember 1999) starting at a height of 1180 m above ground level ($\sim$ 800 hPa). Using a non-hierarchical cluster algorithm, trajectories were grouped into different air flows that elucidate seven pathways of air masses reaching Rukomechi: slow easterly; fast easterly, slow south-easterly, fast south-easterly, southern, north-north westerly and recirculation flows.

Correlating information from chemical data and trajectory cluster analysis shows that of the seven major pathways of air masses to the site, only the fast easterly, the slow south-easterly, the southerly and the local flows were found to be major transport routes for aerosols to northern Zimbabwe. Each of these four pathways (predominantly dry season flows) carries aerosols that contain different atmospheric aerosol species at different times of the year. Biomass burning aerosols are mainly transported along the fast easterly pathway; the slow south-easterly air masses contain aerosols from all the detected sources; the southerly flow is associated with aerosols that originate from mineral dust, sea salt and anthropogenic sources; while the re-circulation flow only carry air masses that contain anthropogenic related aerosols. By using back air mass trajectory information and chemical aerosol data, the potential source contribution function technique was used to ascertain source regions of BC and anthropogenic related aerosols (Cu, S and Pb) in the sub-continent.