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Source region cluster analysis in the high-altitude measuring site of Chacaltaya with WRF and FLEXPART

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Measuring aerosol at high altitude sites is useful as it enables sampling of the free troposphere over long time frames. However, in order to draw conclusions from station measurement data, we need to determine which air mass sources are present at any given sampling time. This task is challenging at mountain sites, due to complex topography which in turn drives complex meteorology. Between December 2017 and May 2018, the Southern hemisphere high ALTitude Experiment on particle Nucleation And growth (SALTENA) campaign was conducted at Chacaltaya in Bolivia at 5240 m a.s.l. The data set obtained in this campaign contains records of nearly all relevant aerosol characteristics and aerosol precursors. To identify the source regions of the observed air masses we performed high resolution (down to 1 km) simulations with the Weather Research and Forecasting Model (WRF). The WRF model output is then used to as input to the Lagrangian particle dispersion model (FLEXPART). FLEXPART simulations are initialised every hour and 20 thousand particles are released per hour and track backwards in time for 96 hours. The FLEXPART footprint output is regridded onto a log-polar cylindrical grid where we perform a 'K-means' cluster analysis on the 3D cells defined by the grid. The cells are clustered based on the time series of their source receptor relationship (i.e. emission sensitivities), producing regions (clusters) resolved not only in the horizontal but also the vertical domain. Our results show that regions located close to the station (<100km) have a low but persistent influence with diurnal variations and close contact to the surface. Mid-range regions (100-800km) have the highest influence with a higher percentage of air masses from the free troposphere. Long-range regions (>800km) have a higher influence than the short-range regions but lower than the middle-range regions. Most of the air masses from these long-range regions come from the free troposphere. With this method we have successfully resolved the various air mass influences at the measurement site. The high meteorological resolution and the stochastic nature of FLEXPART are seminal for capturing the transport pathways.