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Comparison of positive matrix factorization and factor analysis for the source apportionment of particulate pollutants at the Black Sea coast of Turkey

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Sources affecting aerosol components at a rural site on the Black Sea coast of Turkey were investigated using two receptor oriented methods, namely positive matrix factorization (PMF) and factor analysis (FA). Aerosol data collected from April 1995 through July 1997 were used to compare the source apportionment of these two methods. Concentrations of 25 elements and ions measured in 230 samples collected at a rural station on the Black Sea coast of Turkey were used for the source apportionment with FA, whereas with the ability to replacing missing and below detection limit value in PMF, 354 samples and 34 species were used in the PMF analysis. Four and eight sources were identified with FA and PMF respectively. Three of the sources were similar: crustal, marine and arsenic. Factor scores of arsenic factor are higher in winter months, indicating local contribution. The fourth factor in FA has high loadings of V, Cr, Mn, K, Zn, As, Br, Cd, Sb, Ni, Pb, SO_4^{2-} , NO_3^- and NH_4^+ which are the elements and ions generally associated with combustion and industrial processes. Thus, this factor was named as mixed pollution factor. PMF identified three metal factors with different seasonal trends and different elemental composition. First metal factor was enriched with Mn, V, Cr, and Ni elements. There is no net seasonal variation of the source contribution for this factor. The species associated with the second metal source included Co and Th. In this factor, NH_4^+ has highest loading; besides NO_3^-, Cl^- and some crustal elements are also in high loadings. Cobalt, Br, Cl^-, As, Se, Sb and Zn are enriched in this factor. The factor scores are higher in summer months. The third metal source explains almost all variance in Zn and do not show net seasonal varia-

tion. Aside from Zn, this factor also explains some of the variances of NO_3^-, NH_4^+, Sb, Pb as well as crustal elements. The two other PMF sources were named as long range transport and combustion factors. The significant part of the variances of SO_4^{2-} and NH_4^+ are explained by long range transport factor. Also this factor also explains the variances of Sb, Pb and some crustal elements. Factor scores do not show significant seasonal variation. It is possible that this factor is affected from mixture of both the emissions from distant sources and relatively closer sources. Combustion factor explains almost all of the variance in Se concentrations. Besides, smaller fractions of variances of other anthropogenic and crustal elements are also explained. When the concentrations of the species are considered, the most significant specie is SO_4^{2-} ion. SO_4^{2-}, Cl^-, As, Se, Sb and Zn are enriched species in this factor. Factor scores are higher during summer season. In general PMF is more difficult to use and results obtained are more difficult to interpret. However, in this particular study it allowed us to use rare earth elements which proved to be important source markers.