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Quantifying the dynamics of aeolian dust erosion in dryland Central Asia

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Mineral aerosols are potentially a major forcing mechanism for climate change. Monitoring aeolian dust dynamics and improving our understanding of the controls influencing dust emissions is therefore a key scientific challenge. Meteorological records are regularly used to calculate wind erosion indices relevant to dust storm occurrence and remote sensing is increasingly being used for monitoring regional atmospheric aerosol loading. Given that direct measurements of dust fluxes are very limited in number, very few studies have investigated the associations between wind erosion indices, satellite monitoring of aerosol loadings and actual dust flux. We report the findings of a study aiming to validate correlations between measured dust deposition, meteorological conditions and TOMS aerosol index in the Aral Sea region.

Monthly measurements of dust deposition were collected at 7 sites in Karakalpakstan. Daily meteorological data were used to calculate a climatic index of wind erosion using various measures of available moisture and wind erosivity. Monthly TOMS AI data were extracted for a coincident period and region. Regression analysis was used to identify relationships between direct dust deposition measurements, various wind erosion index adaptations and TOMS data.

Findings indicate strong negative relationships between dust deposition rates and measures of available moisture at the annual and monthly scale. Surprisingly, relationships between dust flux and all measures of wind power were poor. Results suggest that dust storms in the region are strongly controlled by seasonally changing surface erodibility parameters rather than erosivity. Time lags associated with the dynamics of erodibility

resulted in weak associations between dust flux and environmental controls over periods less than one month, highlighting the complex role of surface characteristics in modelling dust emissions. Strong associations between TOMS AI and dust flux suggest that at temporal scales greater than one month satellite monitoring can provide a useful tool for describing regional dust occurrence.