Prediction and Detection of Variability in Asian Dust Emission and Transport Affected by Climate Change

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[Abstract]

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This project was dedicated to the investigation of the relationship between climate change and the long-term variability of Asian dust. It comprised three subthemes: monitoring, numerical experiments, and parameterization of surface conditions in source regions. The outcomes obtained were conveyed to East Asian countries via the framework of the Tripartite Environment Ministers Meeting Joint Research on Dust and Sand Storms (TEMM-DSS).
Continuous monitoring of Asian dust was conducted by the AD-Net lidar observation network, and a sustainable dust detection method based on surface air-quality monitoring was proposed. A SPM-PM2.5 threshold value was determined for dust detection and applied to a severe dust event in March 2021. In addition, annual variations in the number of Asian dust days determined by this method were compared with those reported by the Japan Meteorological Agency. The impacts of Asian dust exceeding national standards for PM2.5 were examined based on numerical predictions of future atmospheric conditions. Historical experiments and future projections using a global aerosol model with five warming scenarios were conducted to investigate changes in DSS emissions and the factors contributing to the changes. The results suggested that the decrease in snow cover associated with warming in early spring and late autumn might significantly increase DSS emissions and PM2.5 concentrations in the Gobi Desert and its downstream regions. In addition, it was confirmed that the model's DSS reproducibility could be improved by incorporating data on surface conditions and information on DSS emission processes provided by the results of the other subthemes into a regional chemical transport model. To improve numerical dust models, observation data on surface conditions were analyzed. The results showed that (1) Raupach's model worked well with observed stone and dead vegetation coverages; (2) SoilGrids 2.0 global mesh data correlated with the observed stone coverage; and (3) the Soil Tillage Index (STI) obtained from satellite data correlated with the observed dead grass coverage. These results were used to develop a methodology for producing data on the spatial extent of these coverages. Investigation of the impact of the spatial distribution of vegetation on dust emission revealed that the risk of sand and dust emissions increased when vegetation was heterogeneous with large intershrub distances. Novel vegetation indices related to sand and dust emissions were also developed, and their usefulness in setting goals for land and vegetation management was demonstrated.

[References]

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