1. Motivation

- Aerosol impact on the shortwave (SW) and longwave (LW) components of surface energy balance and phenomenologically active radiation (PAR, 400-700 nm) is an important part of land ecosystem-atmosphere interactions.

- East Asia is an active source of wind-blown dust aerosol, especially in the spring season that is consistent with the onset of vegetation growth. Dust aerosol can be transported downstream affecting the terrestrial ecosystems over the large region.

- The goal of this study is to assess the range of the impact of mineral dust on aerosol can be transported downwind affecting the terrestrial ecosystems over East Asia is an active source of wind-blown dust aerosol, especially in the spring season that is consistent with the onset of vegetation growth.

2. Data and Methodology

2.1 Computation of dust spectral optical properties

- The size-resolved mineralogical composition of Asian dust is represented by a mixture of individual minerals and iron oxides.

2.2 Spectral surface albedo of dryland ecosystems in East Asia

To obtain the spectral surface albedo for the different dryland ecosystems in East Asia, we used the MODIS climatology grid albedo product (MCD15A2). The MODIS data were processed to extract the SW and LW albedo of the study region during 2001 spring.

2.3 Dust impact on surface radiative balance: modeled and observed

- The dust positive LW effect compensates 6.1% of the dust negative SW effect.

3. Results

3.1 Dust impact on surface PAR: modeled and observed

- Different combinations of dust models and dryland ecosystems are fed to a radiative transfer code (SBDART) to compute surface spectral radiative fluxes, integrated over different wavelengths (SW, LW and PAR). Three dust loadings are considered: 250, 500 and 750 μg m⁻³. Dust profiles were constrained by using CALIPSO lidar observations (197 km away from the site) and MODIS C6.8 aerosol optical thickness data.

3.2 Dust impact on surface radiative balance: modeled and observed

- For a certain loading (mass), different dust models differ significantly in spectral Kext (and hence optical depth) and \( \omega \), resulting in significant differences in the dust impact on PARIN and PARDIF.

- PARDIF shows that there is the optimal light environment for plant growth for each dust model at a certain dust optical depth.

4. Summary

4.1 Findings

- The size distributions consider significant differences in both the modulation (by up to in order) and spectral behavior of the dust optical properties that result in a wide range of the impact on the surface PAR (amount and partitioning), SW, LW radiation and radiative balance.

- PARDIN is reduced by 60–171 W m⁻² over the studied when dust loadings of 500 μg m⁻³ range 65–200 W m⁻²/°C, depending on the dust type, controlling the diffusion of PAR with dust.

- PARDIN/SWDN displays weak diurnal change within 2%. At local noon, PARDIN/SWDN is between 43.1% and 45.5%, lower than reported SBDART/Beer-Solanki (B1993) for the study region during 2001 spring.

4.2 Implication to aerosol-ecosystem interaction studies

- The dust positive LW effect compensates 6.1% of the dust negative SW effect. Both SWNET and SRB reveal large spectral differences in magnitude from PARIN.

- CERES observations reveal poor agreement with the modeled dust impact on PAR and surface radiative balance, except for the diffuse PAR. Future work is needed to deepen the model-sensor observations.

References


Acknowledgments

This work was funded by the NASA LCLUC program.