Simulation of Asian atmosphere using an aerosol transport model
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Expanding human activities and developing industries have brought serious environmental problems. Especially, East Asia region is one of the most active region. Various sorts of aerosols, such as carbonaceous aerosols and sulfate aerosols from fossil fuel consumption and soil aerosols from dust storms are emitted in this region. In this study, we use the aerosol transport model to investigate the impact of aerosols emitted from East Asia region.

Model description
We used the three-dimensional aerosol transport model, SPRINTARS (Takemura et al., 2000, 2002) coupled with CCSR/NIES AGCM.
Horizontal resolution: T42 (approximately 2.8° by 2.8°)
Vertical resolution: L11
Time step: 20 min,
Tracer: carbonaceous (organic and black carbons), sulfate, soil dust, sea salt aerosols.

Simulation result
Figure 1 is aerosol optical thickness in April simulated by our model. Mineral dust aerosol are emitted from the Sahara desert in a large quantities. And sulfate aerosols and carbonaceous aerosols optical thickness are high value around industrial region. In East Asia, dust storms happen frequently in spring. Then mineral dust aerosol generated in the arid and semi-arid regions of the China-Mongolian area such as the Gobi and other deserts in East Asia are transported by westerly wind. Our simulated result shows that anthropogenic aerosols as, carbonaceous and sulfate aerosols are also transported with dust aerosols and these aerosols sometime cross the Pacific Ocean.

Figure 2 show aerosol emission flux used in our simulation. We used fixed emission data for carbonaceous and sulfate aerosols. Dust emission flux is according to the empirical relation as following equation under the following conditions.
1. The vegetation is limited to arid and semi-arid regions
2. Wind speed near the surface level is over 6.5 m/s
3. Soil wetness is under the threshold
4. Snow depth is under the threshold

\[ F = C \left( \frac{S_T}{S_T} \right) (V - V_T) |V|^2 \]

Influence of aerosols emitted from East Asia
We simulate without dust emission in Asian regions including Gobi and Taklimakan to study dust emission from other deserts. The simulated spring mean aerosol mass concentration at near surface level in cities of East Asia decreased by more than 90%. Therefore, dust emitted from Asia regions has a great influence on dust concentration near the surface in East Asian cities. Naturally, it seems that the influence of dust emission from other deserts cannot be disregarded, but this influence is found to be weak especially in spring. And aerosol optical thickness around East Asia in the simulation exclude anthropogenic aerosols, such as carbonaceous and sulfate aerosols in East Asia region are very low. Furthermore we simulated without dust and anthropogenic aerosol emission in East Asia, Aerosol optical thickness in East Asian is almost zero and the global mean aerosol optical thickness decreased by 20%. It seems that aerosol emitted from East Asia region influence not only near area but also global.

Long-term simulation of dust aerosol
Dust events were observed in Japan with a high frequency since 2000. On the other hand, it is said that the frequency of dust storms had decreased in the desert region of China since about the middle of the 1970s. We simulated long-term trend from 1981 to 2001 using the aerosol transport model. It is found that the wind speed near the surface level had a significant influence on the dust emission, and snow is also an important factor for the early spring dust emission. The simulated results suggested that dust emissions from northeast China have a great impact on dust mass concentration in downwind regions such as, the cities of northeastern China, Korea and Japan. When the frequency of the dust events was high in Japan, a low pressure system tended to develop over the northeast China region that caused strong winds. Then dust emissions in this region increase (Figure 3). From 2000 to 2001 simulated dust emission flux decreased in the Taklimakan desert and the northwestern part of China, while it increased in the Gobi desert and the northeastern part of China. Consequently, dust particles seems to be transported more from the latter region by the prevailing westerlies in the springtime to downwind cities as actually observed. However, a more realistic land surface and uplift mechanism of dust particles should be modeled to improve the model simulation. Desertification of the northeastern China region may be another reason for this disagreement.

Fig 1. Simulated aerosol optical thickness
Fig 2. Left: Spring mean mineral dust aerosol emission flux (kg/m²/s) Middle: Annual mean carbonaceous aerosol emission flux (kg/m²/s) Right: Annual mean sulfate aerosol emission flux (kg/m²/s)
Fig 3. The difference of dust emission flux between high frequency dust events years mean and low frequency dust events years mean (g/m²/s)