Dust and Sandstorms

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Ministry of the Environment

Dust and Sandstorms Phenomena

Dust and Sandstorms (DSS) have been understood as a natural phenomenon of wind carrying dust from the Yellow River basin, deserts etc. Recently however, their frequency and the intensity have been increasing, highlighting DSS's relation to the soil degradation caused by rapidly expanding overgrazing and to the increasing conversion of land for agricultural use.

It is now regarded that DSS is an environmental problem due to human's impact caused by forest reduction, soil degradation, and desertification, rather than being simply a natural seasonal phenomenon.

Scenes before and after a dust storm
(Cele, in the southern part of the Takla Makan Desert in China)

Imminent dust storm
(Southern part of Mandalgobi in Mongolia)

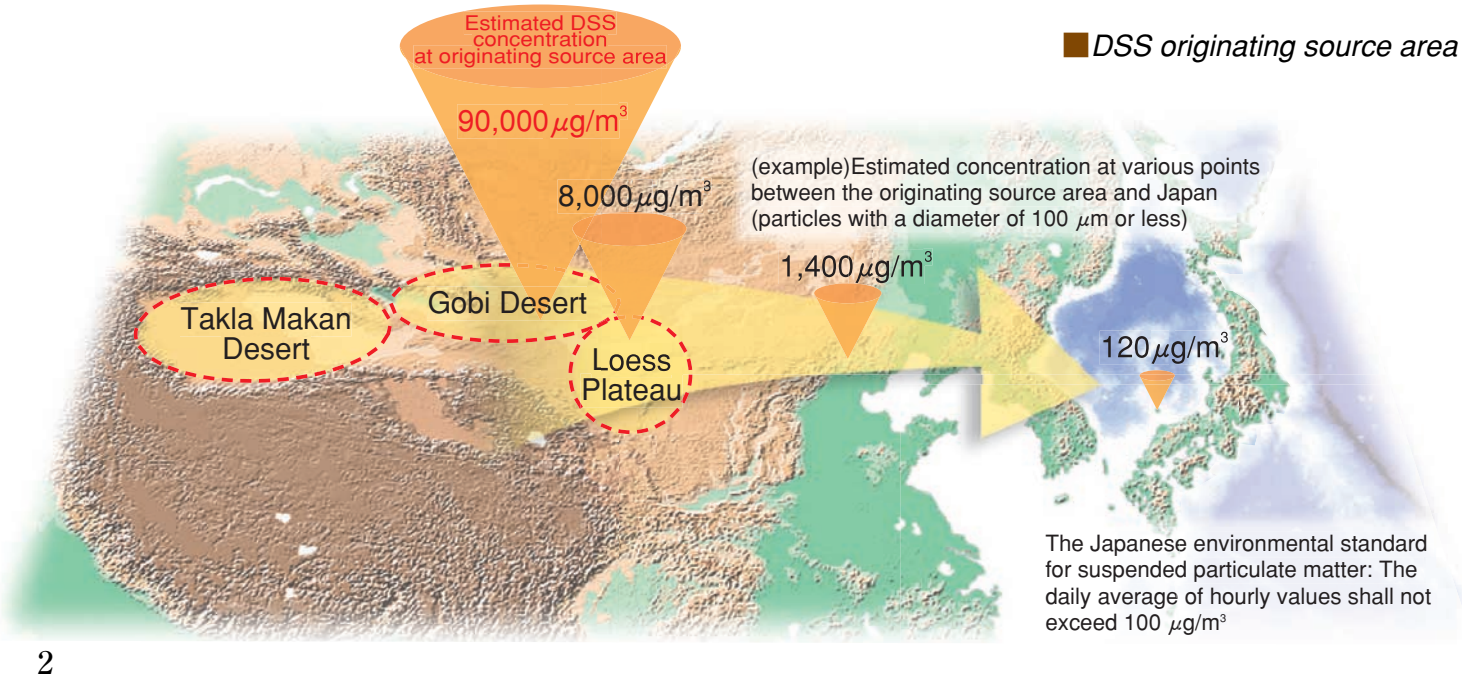
What is DSS?

DSS is a phenomenon of wind-borne soil and mineral particles raised thousands of meters into the air in the arid and semi-arid regions inland China, such as the Takla Makan and Gobi deserts and the Loess Plateau. They arrive at Japan by prevailing westerlies, suspending in the air or falling to the ground.

Wind-borne DSS not only seriously damage agricultural production and living conditions in the DSS source area but also impacts global climate by forming clouds of DSS suspended particulate acting as nuclei to form precipitation.

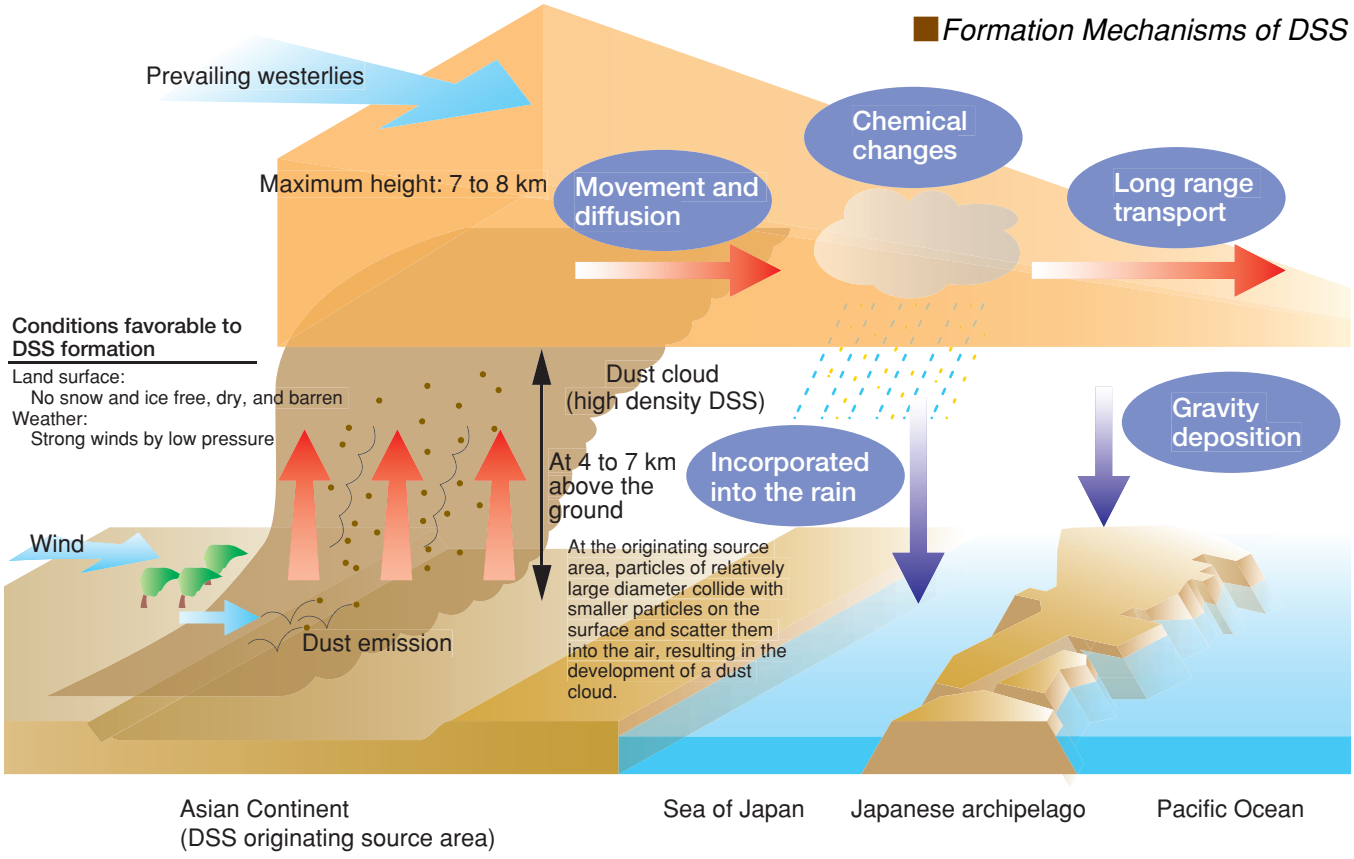
It is also thought that the particulate falls to the ocean and significantly affects the oceanic ecosystem by altering the mineral supply to surface plankton, but its impact has not yet been understood.

A MODIS image, March 31,2002
A MODIS data analysis result obtained from the Integrated Environmental Monitoring (IEM) of the Asia-Pacific Environmental Innovation Strategy Project (APEIS).

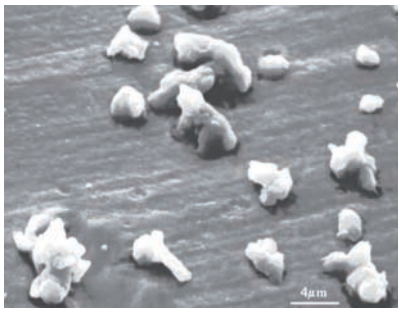


Formation and Transport Mechanisms of DSS

The mechanisms of DSS formation, growth, and movement to Japan, and the physical and chemical changes during transport, etc., are governed by the complicated interaction of factors such as weather and geological features.
It has been shown by satellite imagery and model calculations that DSS originating in Northeast Asia are carried by prevailing westerlies across the North Pacific Ocean and reach the North American continent.



Characteristics of DSS Airborne Particulate



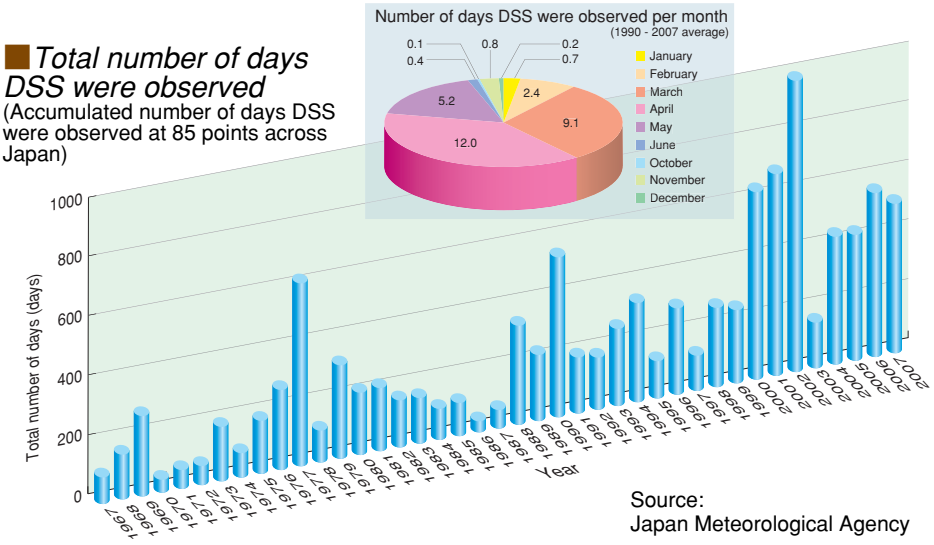
An electron-microscope image of DSS particulate

DSS particulate is principally composed of rock-forming minerals such as quartz and feldspar, and clay minerals such as mica, kaolinite, and chlorite. The range of particle diameters reaching Japan peaks at approximately 4 microns. Analysis of DSS particulate showed the presence of ammonium ions, sulfate ions, and nitrate ions etc., which are not considered to originate from the soil. The possibility has been suggested that DSS particulate adsorbs anthropogenic atmospheric pollutants during transport.

Frequency of Airborne DSS and Resulting Damage

Dust and sandstorms have been a well-known weather phenomenon since ancient times. Recently however, the frequency of DSS and the damage by them have been increasing.

Frequency of DSS

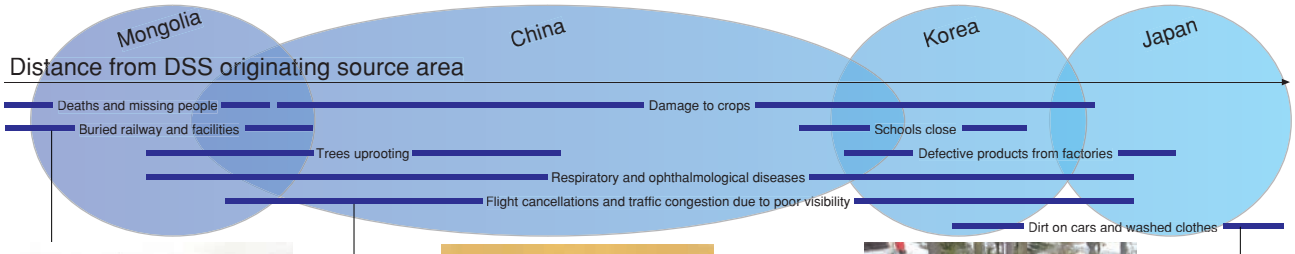


Source:
Japan Meteorological Agency

Dust and sandstorms fly over Japan throughout the year, but they increase from February and peak in April. From DSS records at 85 meteorological observatories across Japan, until the mid 1980s there were few years when the total number of days exceeded 300. But after 1988, DSS records frequently exceeded 300 and increased especially after 2000 (except 2003).

Damage Resulting from DSS

DSS is a common problem throughout Northeast Asia, however the type and degree of damage by them vary and are dependent on the distance from the originating source area.

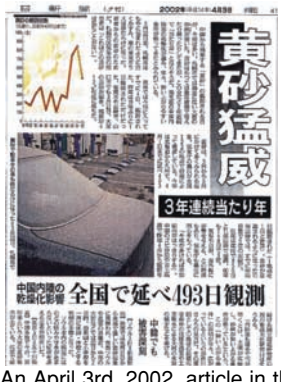


Railway buried by shifting sand
Source: The Secretariat of the Chinese National Committee for the UNCCD

Dim sky in Beijing due to DSS

Aftermath of rain mixed with yellow sand

A Social Problem caused by DSS



An April 3rd, 2002, article in the Asahi Shimbun newspaper reported a record number of DSS sitings in Japan during the spring of 2002.

In March 2002, a DSS was observed in Sapporo, a rare occurrence which made wide headlines. The issue attracted public attention and was even discussed in the National Diet. In response to this situation, the regular meeting with related ministries on DSS was established in February 2005. Then related ministries on DSS can liaison with each other; linkages between various countermeasures are being planned.

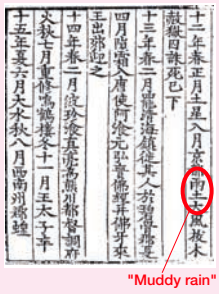
Column 1

Dust and Sandstorm Historical Records: "Dust Rain", "Muddy Rain", and "Red Snow"

Since ancient times dust and sandstorms were a natural phenomenon usually observed in early spring and a well-known cause of disasters. In Chinese scripts dating from 1150 B.C., the expression "dust rain" was already in use.

In ancient Korean texts, the first description of "muddy rain" appeared in 174 A.D. during the reign of King Adalra of the Silla Dynasty. After this, references to DSS appear frequently (See figure on the right).

DSS have been observed since ancient times in Japan, too, and in Honcho Nendaiki (the chronicle of the dynasty), compiled in the Edo era, it was recorded that "red snow" was observed in Japan's northern region in 1477 (Year 9 of Bummei).



Record of "muddy rain" during the Silla Dynasty (Year 850)

Fact-finding Efforts on Dust and Sandstorms

The following measures are being taken in Northeastern Asia to grasp the facts about DSS.

DSS Research

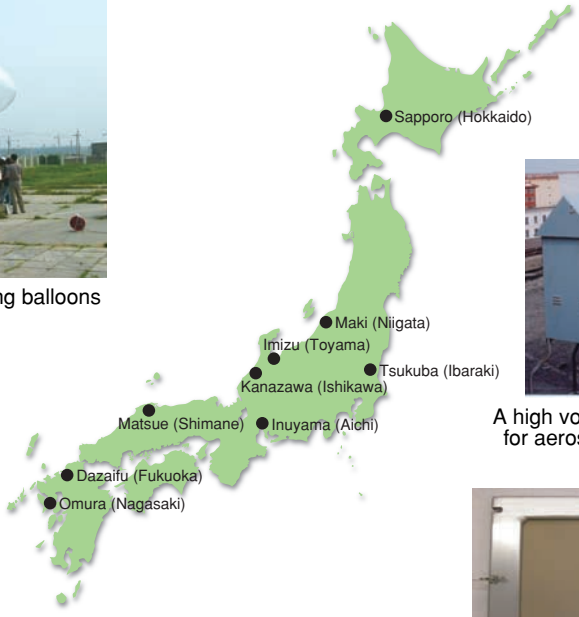
The onset and movement of DSS depend on various factors such as regional weather, land use, topography and geological features and these mechanisms are the subject of continuing research. Even though the direct damage to the environment and industry caused by DSS is known to some degree, its relation to global warming and acid rain is still not clear.
Therefore, it is important to understand the phenomena, by accumulating scientific findings.

Observations of blowing up of dust

Observations of aerosol using balloons

Fact-finding Study on DSS

To understand the characteristics of the DSS that fly over Japan, aerosol (fine solid or liquid particles that float in the air) was collected simultaneously at many points during a DSS event. By examining the size distribution and analyzing the chemical components of the collected aerosols, the quantity of DSS aerosol reaching Japan and its physical and chemical properties are scientifically understood.

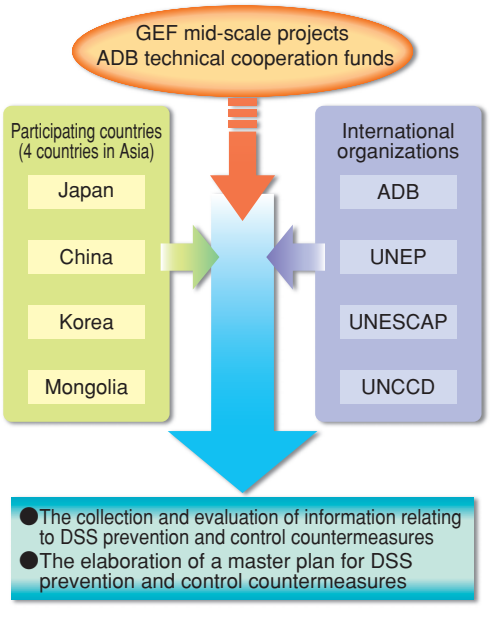


■ *DSS sampling bases*

A high volume sampler for aerosol collection

Yellow sand collected on filter paper

ADB/GEF Project on Prevention and Control of Dust and Sandstorms



As DSS is a transboundary environmental problem, cooperation between affected countries is vital so as to realize effective investigations and countermeasures. Particularly, as the DSS source areas are not in Japan, joint international cooperative efforts are necessary for the implementation of countermeasures and the collection of data in these areas.
For that reason, one of the preliminary investigations of Global Environment Facility (GEF) was to launch a joint project (ADB/GEF Project on Prevention and Control of Dust and Sandstorms in Northeast Asia) in January 2003 by 4 international organizations (United Nations Environment Programme (UNEP), United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), United Nations Convention to Combat Desertification (UNCCD), and Asian Development Bank (ADB)) and 4 countries (Japan, China, Korea, and Mongolia).
Elaborated in this project are the phased program of a monitoring and early warning network in Northeast Asia, and a master plan relating to prevention and control skills in the source areas and investment strategies.

The ADB/GEF Project on Prevention and Control of Dust and Sandstorms Report

DSS Countermeasure Approaches

There are many approaches for DSS prevention and control countermeasures. Some are short-term, such as forecasting and early warning, and others are long-term, such as source area rehabilitation. It is important to review these countermeasures and make a plan to prioritize the implementation of short, middle, and long-term countermeasures.

Countermeasures at DSS Originating Areas

Various methods are being tested to improve the land surface of DSS originating areas and thus control the blowing up of dust.

Photo 1
A tree windbreak

Photo 2
Straw checker-boards

Photo 3
Recuperating vegetative cover by fencing

Rehabilitating and improving the land surface

- Reducing barren land through reforesting and planting degraded land
- Preventing land surface loosening caused by spring ploughing (the cultivation of perennial crops, etc.)

Controlling the movement and encroachment of sand by wind

- Creating tree windbreaks (Photo 1)
- Reducing ground level wind velocity by inserting straw bundles into the sand in a checkerboard pattern (Photo 2)
- Controlling the movement of sand using creeping plants

Mitigating human impacts

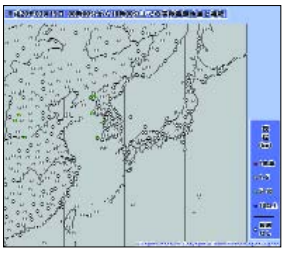
- Rehabilitating vegetation (Photo 3) by erecting a fence around degraded land and restricting the entry of people and domestic animals (grazing ban)
- Laws enforcing the prohibition of land reclamation and felling of trees
- Supporting the resettlement of people from degraded land
- Maximizing the heat efficiency of cooking stoves and the insulation efficiency of houses in order to reduce the cutting of trees for fuel

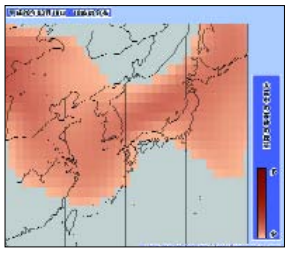
Improving the environmental capacity of the soil

- Introducing water-saving and water management techniques for the efficient use of water
- Improving land productivity by the application of farm animal manure

DSS Forecasting

In addition to presenting meteorological information on DSS, the Japan Meteorological Agency provides visual maps that show the state of visibility of DSS and next-day prediction maps based on DSS Modeling (see the Column 2) on its homepage.





"DSS Information", from the homepage of the Japan Meteorological Agency
http://www.data.kishou.go.jp/obs-env/kosahp/info_kosa.html

Tripartite Director General Meeting on Dust and Sandstorms among Korea, China and Japan

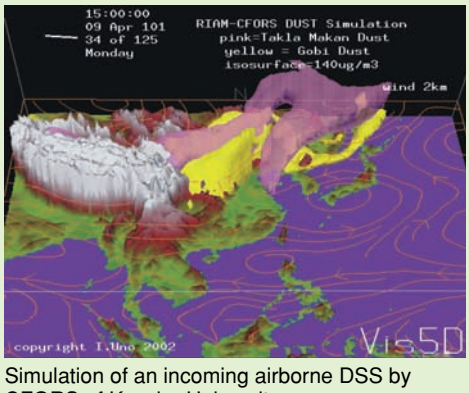
2nd Tripartite Director General Meeting on Dust and Sandstorms among Korea, China and Japan (September 2007, Tokyo)

Based on the agreement of the 8th Tripartite Environment Ministers Meeting among China, Japan and Korea held in 2006, a meeting on the director generals' level between the 3 countries was established in order to promote regional cooperation towards addressing DSS issues in the northeast Asian region. In addition to director generals from the three countries, representatives from Mongolia and relevant international organizations also participate in these meetings, during which exchange of opinions on measures for DSS and joint research on DSS are promoted.

Column 2

DSS Modeling

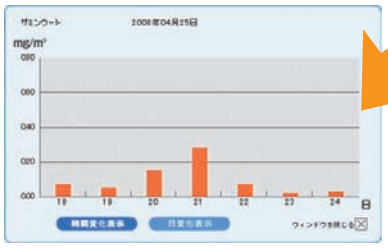
DSS Modeling is used to forecast and verify an approaching DSS and its concentration by numerical simulations. To elaborate a DSS transfer model, various models such as regional weather, dust emission, movement and diffusion of DSS in the atmosphere, deposition and elimination of DSS particulate, and chemical reaction models are combined. The results of these simulations are used for many purposes: weather information; estimating DSS origin; and forecasting the impact on climate change.



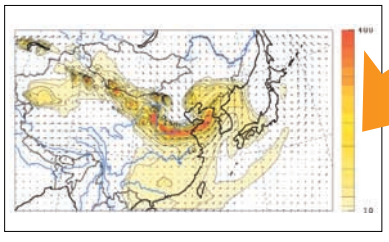
Simulation of an incoming airborne DSS by CFORS of Kyushu University

DSS Monitoring Network

A wide ranging DSS monitoring network is being established from the northwestern part of the China to the Japanese archipelago to detect any dust and sandstorm activity as soon as possible and to grasp its development and movement.
It is important to install three types of equipment-PM10 (to measure concentration of particulate matter of 10 microns or less), Visibility (to measure distance at which visibility is possible), and LIDAR (see the Column 3)-appropriately, and to monitor DSS even more accurately. It would enable alleviation of damages through improved prediction accuracy and effective countermeasures at DSS originating area based on the clarification of the mechanism with which DSS formation and transport.
Ministry of the Environment actively contributes to related international projects and installs and maintains monitoring equipment.
In addition, since public interests in DSS increase recently, real-time information on DSS that is obtained from the above mentioned monitoring network has been provided on the Ministry of the Environment's homepage since spring 2007. In the future, the Ministry will make efforts to share the observation data with relevant countries, and to promote developing a DSS monitoring network in the northeast Asian region and establishing an early-warning system.



Display example of hourly and daily changes of DSS concentration for each point



Display example of CFORS (distribution of DSS concentration based on model calculations)

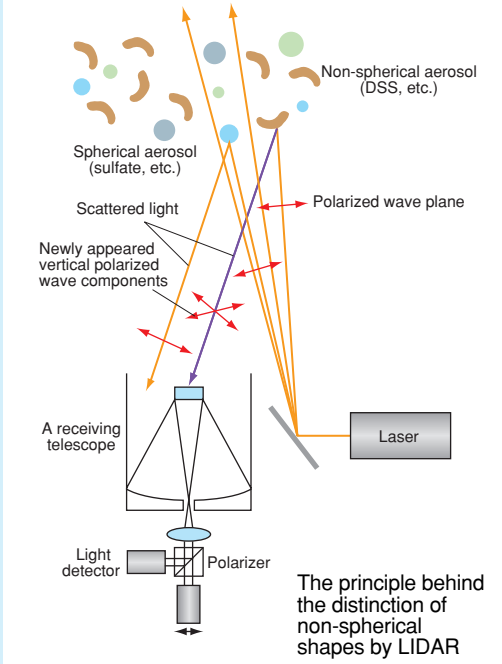
Real time DSS information by MOE
http://soramame.taiki.go.jp/dss/kosa/

Column 3

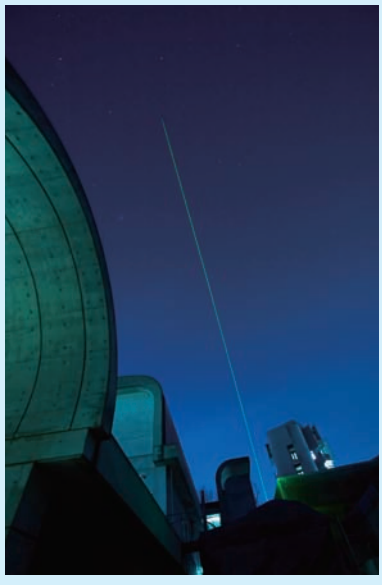
LIDAR

(LIDAR: Light Detection And Ranging)

LIDAR is a radar using laser light instead of radio waves. It is a remote sensing that can measure from the ground a DSS passing above. The laser light emitted from the ground is scattered by fine particles in the air. By measuring the scattered laser light, the vertical distribution of DSS particulate concentration, and the change with time, can be determined. By using polarized laser light, an estimation of the non-spherical character of airborne fine particles can be determined. The shapes of DSS particles are not spherical comparing with atmospheric pollutant particles, therefore with this method it is possible to distinguish DSS from atmospheric pollutants.
LIDAR has the added feature that it can continuously and fully automatically monitor in real time all the DSS passing in the troposphere above the monitoring sites, except when the concentration of floating fine particles is extremely high (such as clouds).



The principle behind the distinction of non-spherical shapes by LIDAR



LIDAR at work

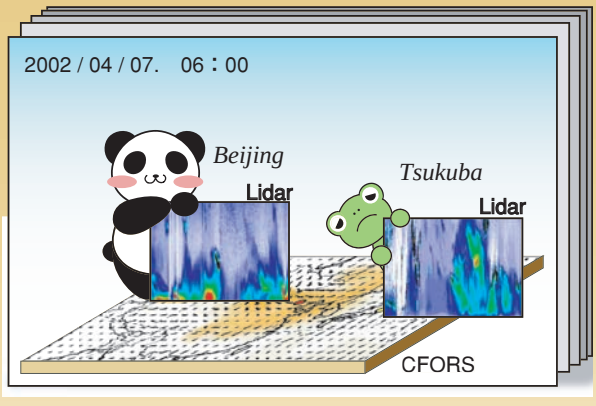
Dust and Sandstorms

DSS Homepage
http://www.env.go.jp/earth/dss/index.html

Ministry of the Environment Homepage
http://www.env.go.jp/en/

Real time DSS information by MOE
http://soramame.taiki.go.jp/dss/kosa/

Let's see the movement of DSS - Flipbook on the global environment: Cartoon series (4)
DSS flip-flop...is it from the Gobi Desert?



Source: Center for Global Environmental Research, National Institute for Environmental Studies
http://www-cger.nies.go.jp/parapara/sand_all.pdf

2nd Version (March 2008)

For more information please contact:
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