

Chapter 2

Solar Eclipse Influences the Environment of the Earth

The effects of eclipse were observed in a part of China on 23 July 2009 which shows that the cosmic ray intensity decreases with the decrease in Electron flux recorded by the Sun Observatory Heliospheric Observatory (SOHO) satellite. The attempt was based on the changes in the concentration of atmospheric gases like Sulfur Dioxide, Nitrogen Dioxide, Aerosol, and Cloud cover. The paper shows direct correlation of cosmic ray intensity, heliophysical and atmospheric variation during the solar eclipse. It will be useful educational information to understand the atmosphere in variable condition.

United Kingdom BBC weather News UK and NOAA USA.

The Data Interpretation

Air Quality Monitoring and Forecasting in China (AMFIC) addresses atmospheric environmental monitoring over China. The system uses satellite and in situ air quality measurements and modeling to generate consistent air quality information over China. The data downloaded in this paper cover the status of nitrogen dioxide (NO₂), sulfur dioxide (SO₂), aerosol, and cloud cover (<http://www.amfic.eu/index.php>).

Tropospheric NO₂ Data

Column NO₂ retrievals with the Differential Optical Absorption Spectroscopy (DOAS) technique, and the Koninklijk Nederlands Meteorologisch Instituut (KNMI) data combined Modeling/retrieval/assimilation approach. The slant columns from Global Ozone Monitoring Experiment (GOME), Scanning Imaging

Absorption Spectrometer for Atmospheric Cartography (SCIAMACHY), and GOME-2 observations were derived by BIRA-IASB (Belgian Institute for Space Aeronomy), the slant columns from OMI by KNMI/NASA.

SO₂ Concentration in atmosphere:

Sulfur dioxide enters the atmosphere as a result of both natural phenomena and anthropogenic activities, such as coal and oil burning, and SO₂ is therefore one of the atmospheric species related to air pollution. These emissions may have an impact on air quality and therefore it is useful to monitor these compounds. For the Air Quality SO₂ Service, a set of geographic regions covering industrialized China has been defined and each of these regions was monitored. Concentrations of SO₂ were derived from UV measurements by satellite based instruments which are SCIAMACHY, OMI & GOME-2.

Aerosol Data

Global aerosol data are retrieved from GOME and SCIAMACHY measurements. The retrieval is carried out by top of atmosphere (TOA) reflectance's in nadir-viewing conditions, using channels selected in the most transparent atmospheric windows. The algorithms are able to retrieve aerosols over dark-surface as sea-surface.

Level 1B processing level GOME data have been re-calibrated using GOMECal package.

The Fast Retrieval Scheme for Clouds from the Oxygen A-band (FRESCO) cloud algorithm is a fast and robust algorithm providing cloud information from the O₂ A-band for cloud correction of ozone. FRESCO provides a consistent set of cloud products by retrieving simultaneously effective cloud fraction and cloud top pressure. The effective cloud fractions were derived by assuming that the clouds have an albedo of 0.8, and must therefore be interpreted as effective cloud fractions. Note that the derived cloud top pressures are rather insensitive to the assumed cloud albedo. (FRESCO GO-v3 data version) has been used to take into account the ground-pixel cloud coverage fraction. Aerosol classes have been selected among tropospheric aerosol types.

Cloud Data

For the retrieval of tropospheric trace gas columns it is essential to have information on the cloud cover conditions. Both the cloud fraction and the cloud pressure are needed as input for the trace gas retrieval algorithms. The (effective) cloud fraction and cloud pressure are derived from GOME and SCIAMACHY measurements with the FRESCO cloud algorithm. The OMI cloud information is derived with the OMCLDO₂ algorithm. The OMCLDO₂ Level 2 data product

contains the cloud fraction and cloud pressure and ancillary information produced by the OMI Cloud O_2-O_2 algorithm.

Cosmic Ray Data

Downloaded from Yangbajing International Cosmic ray laboratory. The YBJ International Cosmic Ray Observatory is located at in Yangbajing valley of Tibetan highland, a site chosen for its high altitude. This site was selected to compare the atmospheric variables of China and its surrounding area during Solar Eclipse of 23 July 2009. In this observatory, the records used for the present study were mainly cosmic γ -radiation intensity, at an energy threshold of few hundreds GeV, by detecting small size air showers at high altitude with wide-aperture and high duty cycle capability.

Electron Flux Data

Electron flux data were downloaded from SOHO site through www.spaceweather.com site. The electron flux data were measured by the SOHO Satellite in a continuous mode as electron flux. This electron flux plot contains the 5 min averaged integral electron flux (electrons/cm²-s-sr) with energies greater than or equal to 0.6 MeV and greater than or equal to 2 MeV. Result of correlation of Electron flux data with different atmospheric parameter are enumerated below.

During the total solar eclipse on 23 July 2009, it was possible to correlate some anomaly in atmospheric parameters like cloud cover, SO₂, NO₂, and Aerosol concentration in the air of China and its surrounding areas with the cosmic ray data and electron flux data. Change in electron flux may have changed the ionization of the atmosphere which further gets interrupted by cosmic rays. These mechanisms can lead to the formation of condensation centers. But at the same time interaction between cosmic ray and the atmosphere might change transparency of the atmosphere and the atmospheric temperature also. Calculations of changes of the condensation growth rate of water drops due to changes of the temperature might have been performed. Gradual concentration of Aerosol data has been recorded from 20 to 23 July 2009. Aerosol concentration was low in China–Tibet–Mongolia region, whole China and Japan on 20 and 21 July which found increasing in Guangzhou and Hong Kong areas on 23 July 2009. Gradual rise of cloud cover during the same period has been recorded. Cloud density was observed less intense over Lhasa on 20 July 2009 which was intensified over Beijing and North Korea on 23 July the day of solar eclipse. Slow rise of the Nitrogen Dioxide during the same period has been recorded. Nitrogen dioxide in troposphere column was of very low density on 20 July over Mongolia and north western part of China which was dramatically increased in its highest peak over Beijing on 23 July 2009. Only

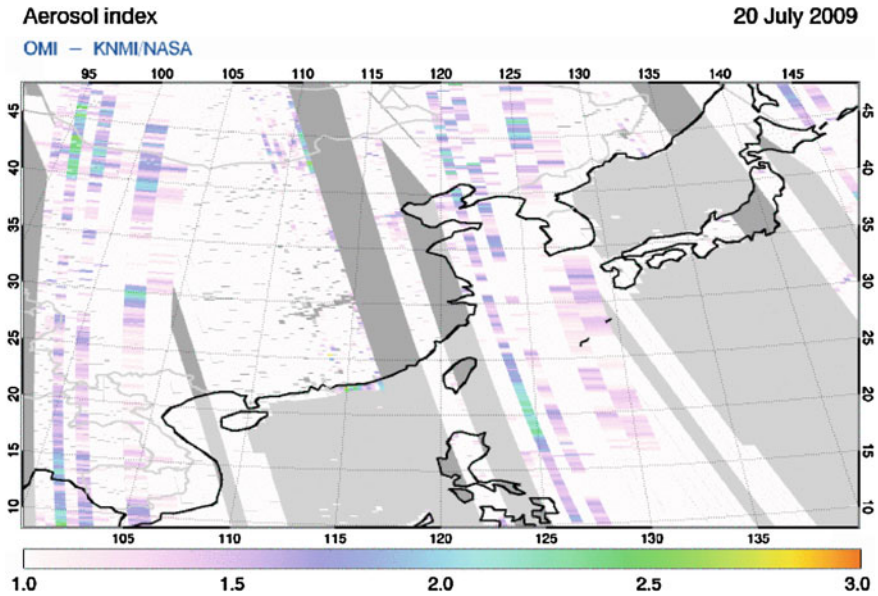


Fig. 2.1 Aerosol concentration over China on 20 July 2009 measured by Ozone monitoring Instrument showing low concentration of aerosol before the solar eclipse (*Source* KNMI NASA)

exception has been observed in the case of SO_2 which shows low concentration from 20 to 23 July. Sulfur dioxide was found high peak on 20–22 July 2009 over Xining and Lanzhou region of China, which reduced on 23 July 2009 (Figs. 2.1, 2.2, 2.3).

Cosmic ray data show a peak value of 5,420 on 20th July but it reduces to 3,850 on 23rd July on the day of Solar Eclipse. Sympathetic to the Cosmic ray data the electron flux data shows a low value on 23rd July 2009 with higher values on 20–22 July 2009 and 24–26 July 2009.

Observational data suggests that episodic change in the Sun during eclipse may influence the terrestrial climate locally. Direct correlation of Cosmic ray intensity and Electron flux in Sun-Earth environment has been done with the Aerosol, Cloud cover, NO_2 , and SO_2 concentration in atmosphere. The findings that: During Solar eclipse Cosmic ray intensity decreases locally. During Solar eclipse Electron flux decreases. Cosmic ray intensity and Electron flux has a role in deciding the Aerosol concentration, Cloud cover, NO_2 , and SO_2 concentration in terrestrial atmosphere on a local scale. It will be essential to monitor the global cosmic ray intensity in different location of the earth along with the variation of electron flux on regular basis to correlate the aerosol, cloud cover, NO_2 , and SO_2 concentration during non eclipse days also. The correlation may be useful to infer the variation of these atmospheric components with the changes in the cosmic ray intensity and electron flux anomaly. This observation can be replicated in various educational institutions for further correlation of atmospheric changes in space and time.

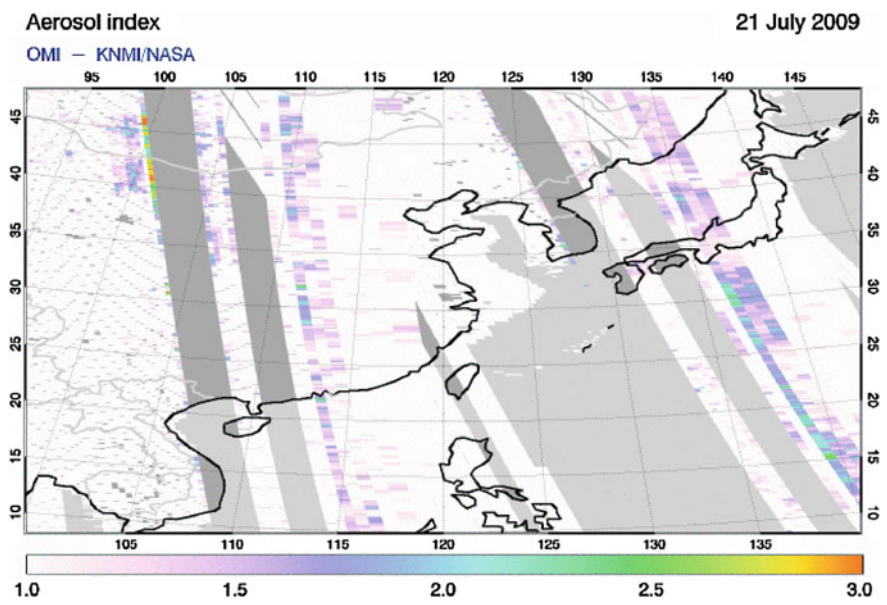


Fig. 2.2 Aerosol concentration over China on 21 July 2009. The Ozone monitoring instrument shows slow increase of aerosol concentration before approaching eclipse (*Source* KNMI NASA)

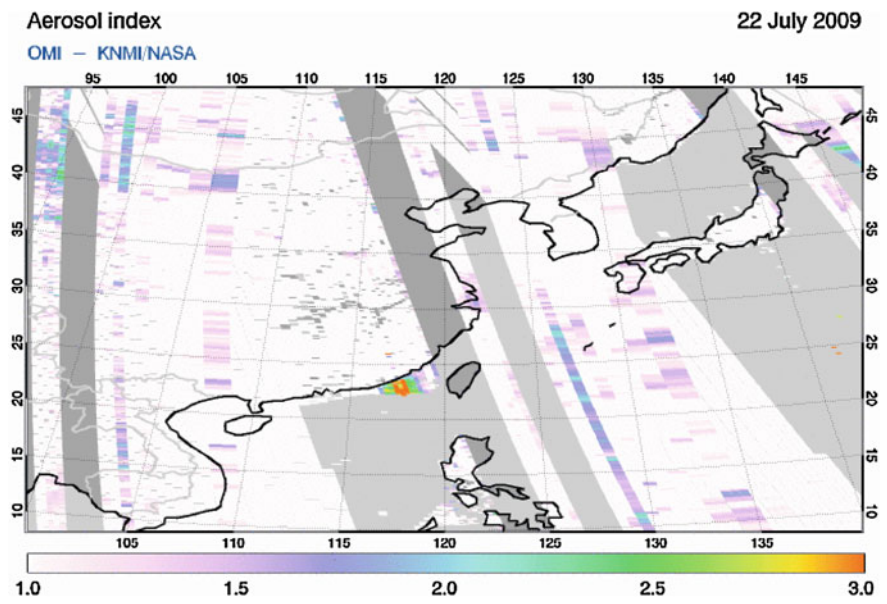


Fig. 2.3 Aerosol concentration over China on 22 July 2009. The Ozone monitoring instrument shows concentrated aerosol formation in China, one day before approaching eclipse (*Source* KNMI NASA)

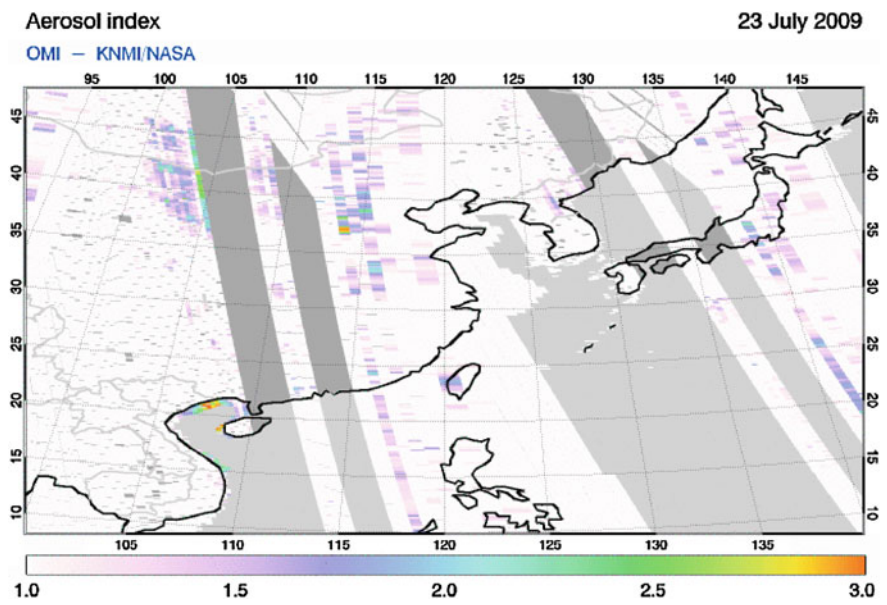


Fig. 2.4 Aerosol concentration over China on the solar eclipse day 23 July 2009 (Source KNMI NASA)

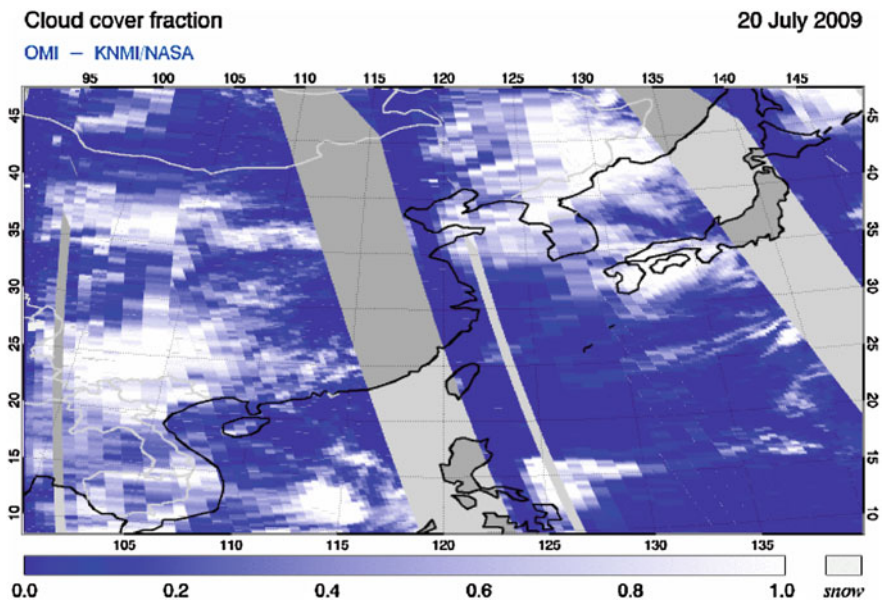


Fig. 2.5 Cloud covers over China on 20 July 2009 (Source KNMI NASA)

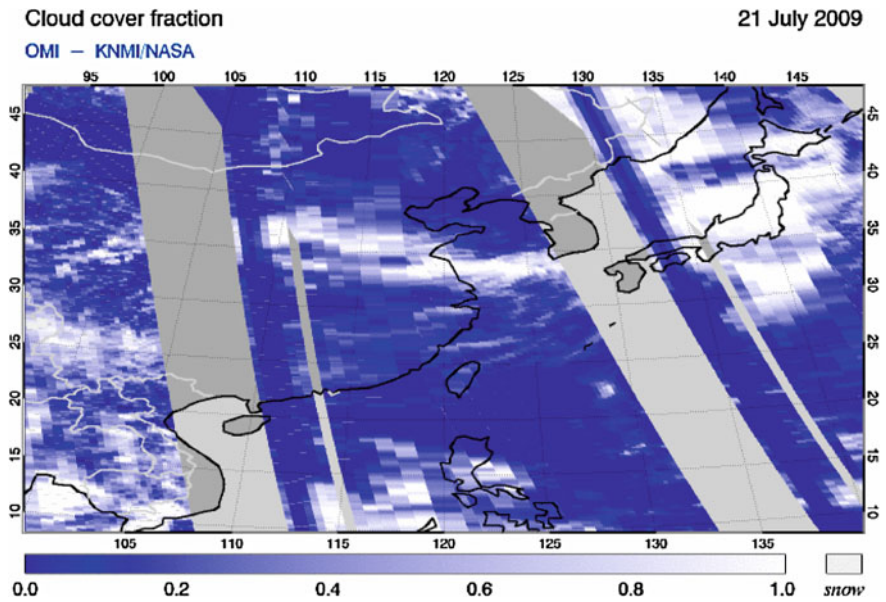


Fig. 2.6 Cloud cover over China on 21 July 2009 (Source KNMI NASA)

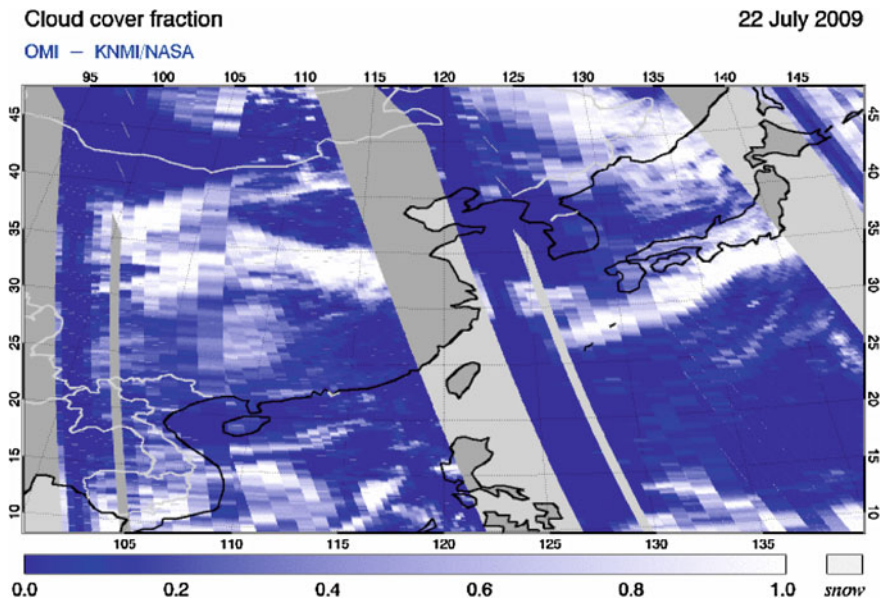


Fig. 2.7 Cloud cover over China on 22 July 2009 (Source KNMI NASA)

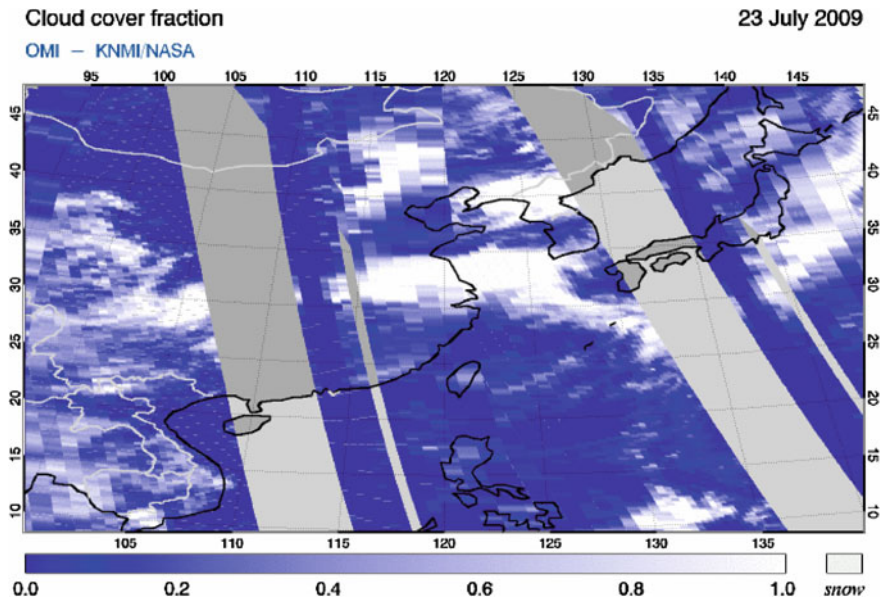


Fig. 2.8 Cloud covers over China on 23 July 2009 (Source KNMI NASA)

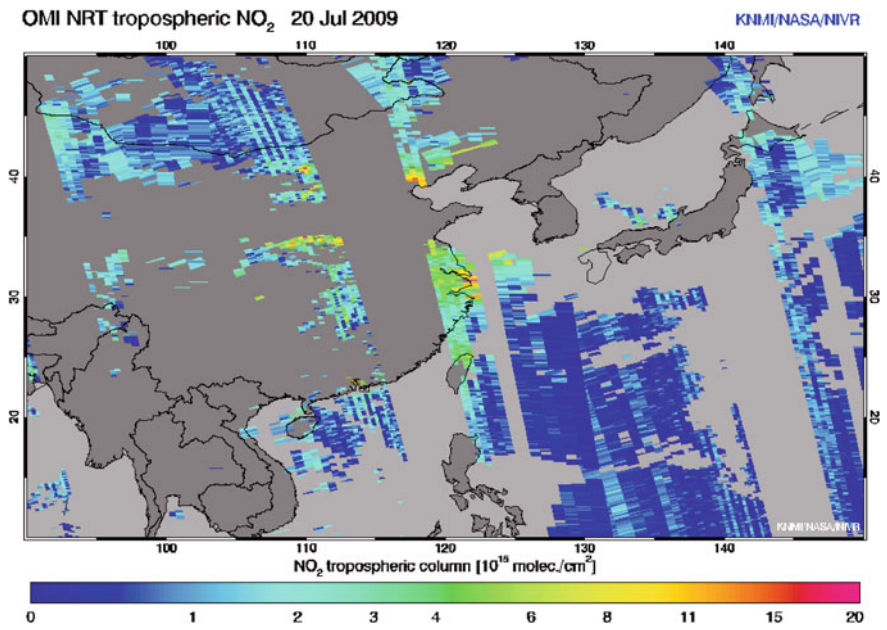


Fig. 2.9 Nitrogen dioxide concentration over China on 20 July 2009. It appears to be very low in comparison with the 23 July 2009 (Source KNMI NASA)

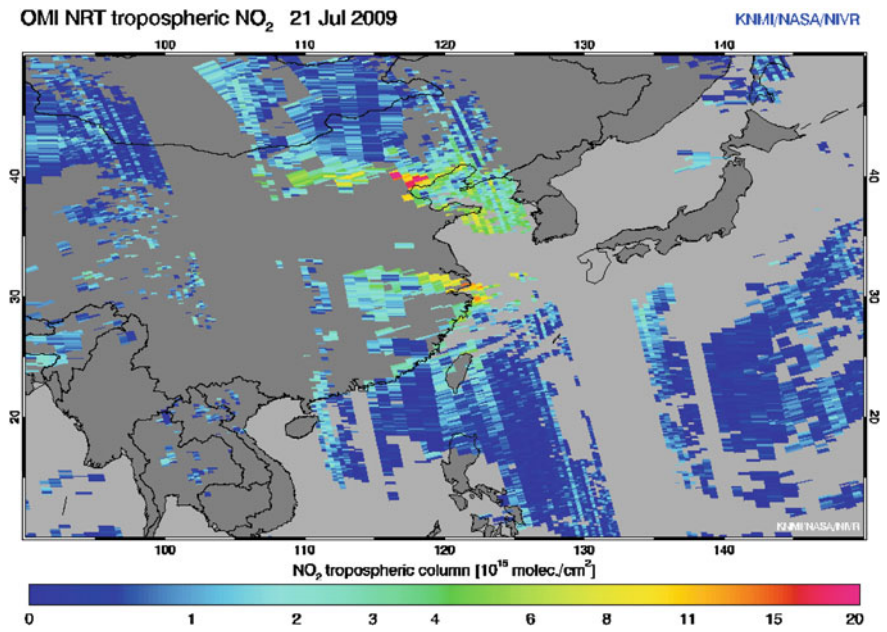


Fig. 2.10 Nitrogen dioxide concentration over China on 21 July 2009. Showing rising trend of NO₂ (Source KNMI NASA)

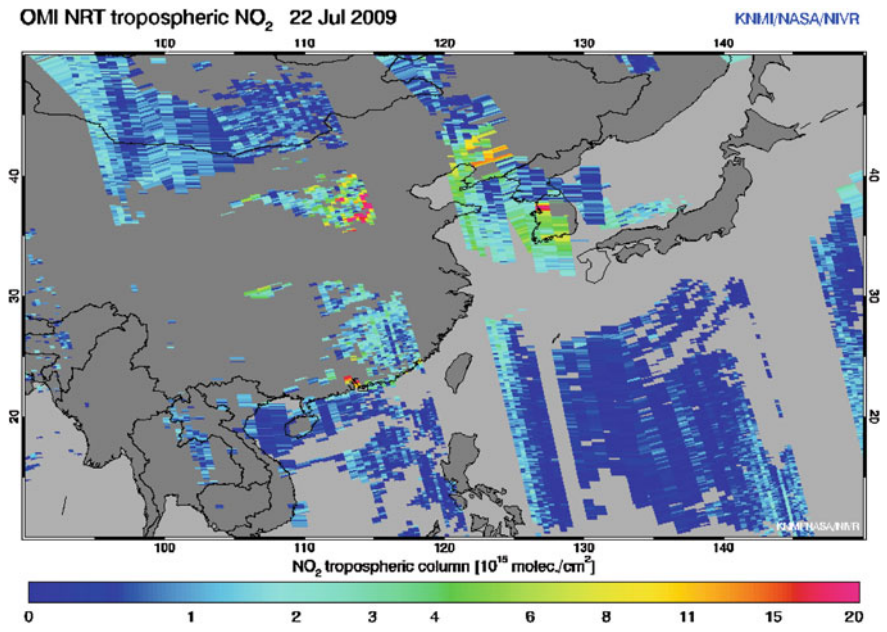


Fig. 2.11 Nitrogen dioxide concentration over China on 22 July 2009 showing increasing trend (Source KNMI NASA)

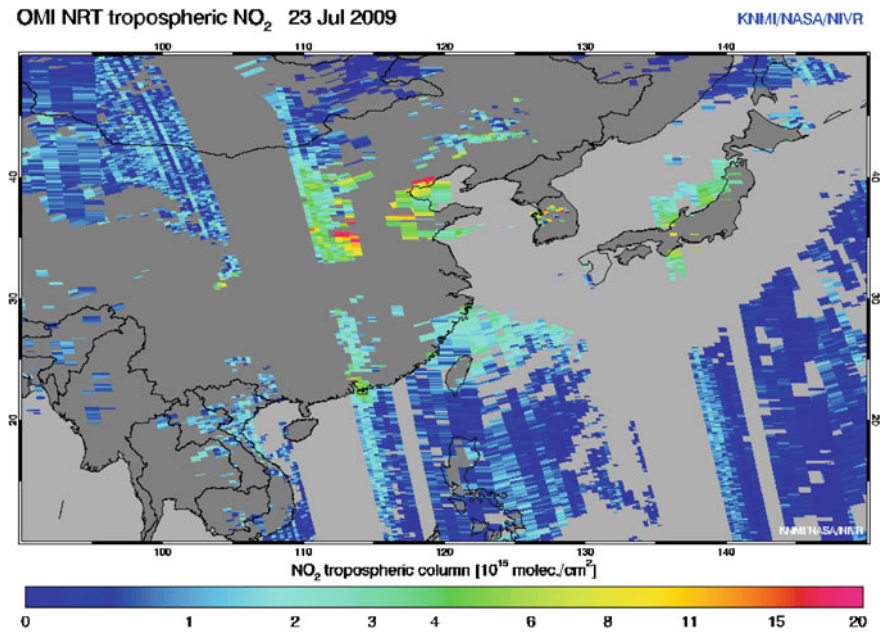


Fig. 2.12 Nitrogen Dioxide concentration over China on 23 July 2009. On the day of eclipse the concentration of NO₂ was higher (*Source* KNMI NASA)

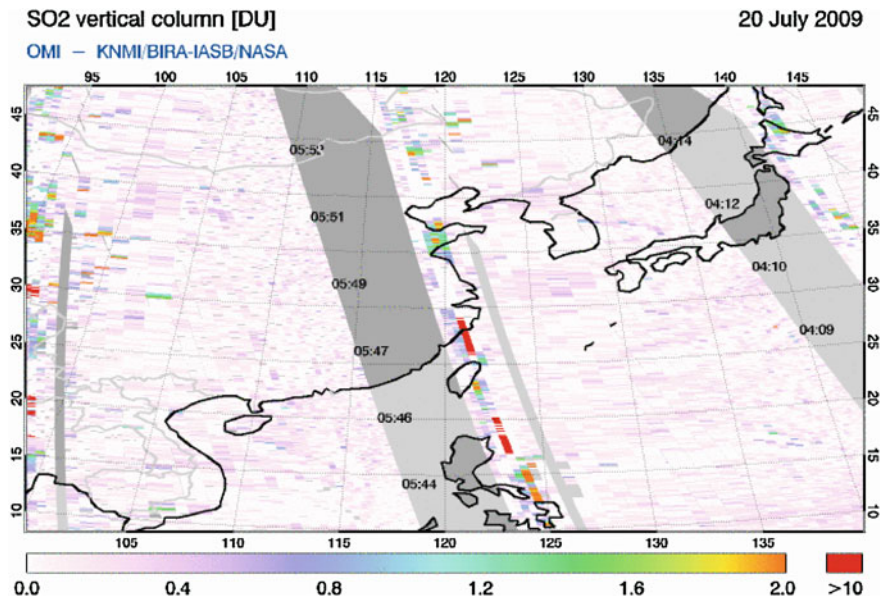


Fig. 2.13 Sulfur dioxide concentration over China on 20 July 2009 (*Source* KNMI NASA)

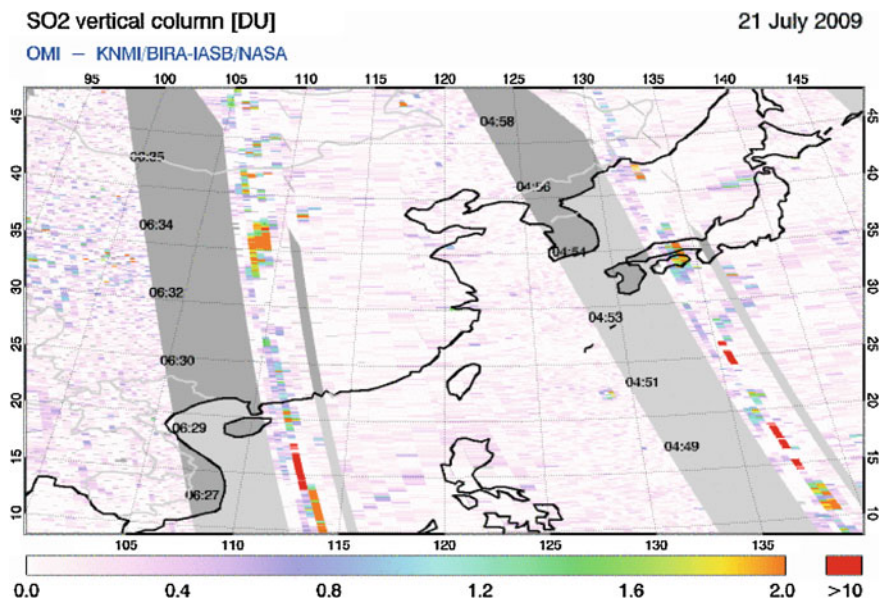


Fig. 2.14 Sulfur dioxide concentration over China on 21 July 2009 (Source KNMI NASA)

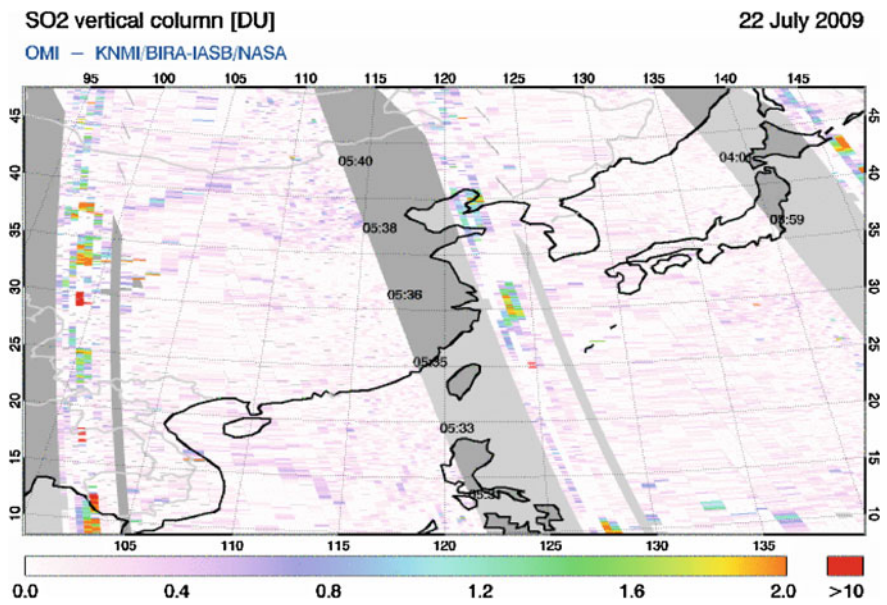


Fig. 2.15 Sulfur dioxide concentration over China on 22 July 2009. It shows that SO₂ concentration has decreased before the solar eclipse (Source KNMI NASA)

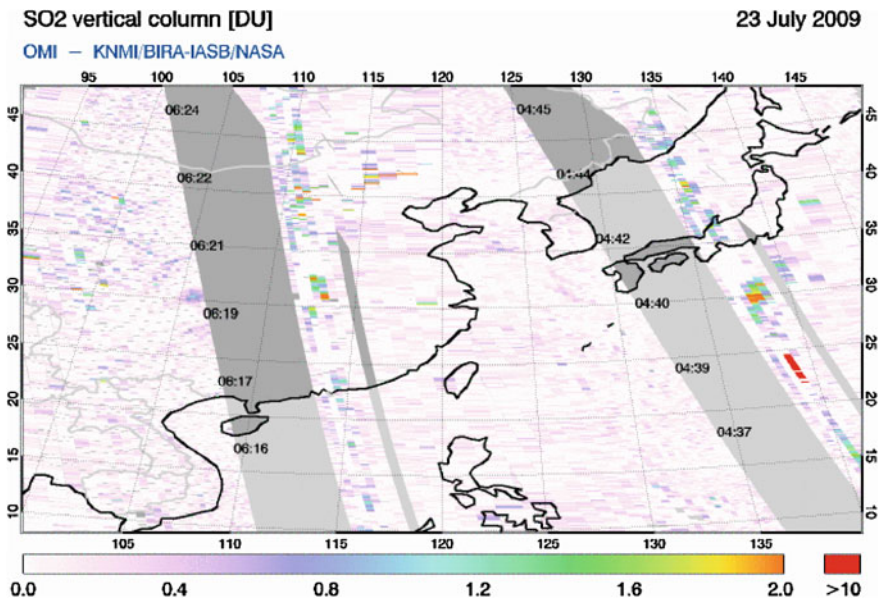


Fig. 2.16 Sulfur dioxide concentration over China shows much decrease on 23 July 2009 (Source KNMI NASA)

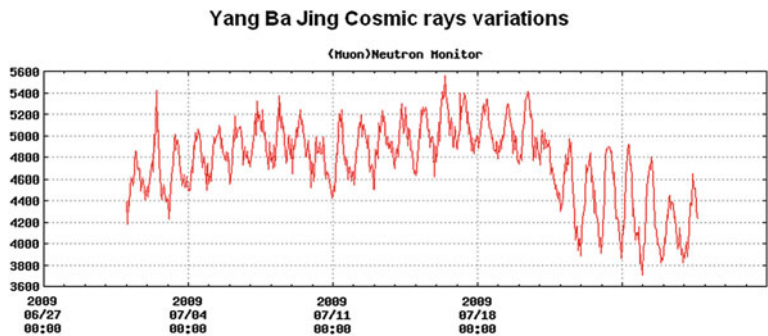


Fig. 2.17 Cosmic ray variation in China during solar eclipse on 23 July 2009. It shows that during the period of solar eclipse the cosmic ray intensity was decreased (Source YBJ Cosmic Ray Laboratory)

Solar spectral irradiance is being measured by Solar Radiance and Climate Experiment (SORCE). It measures the fluctuation of solar variability from 0.1 to 2,400 nm. During the Solar eclipse period the solar irradiance has shown a lower

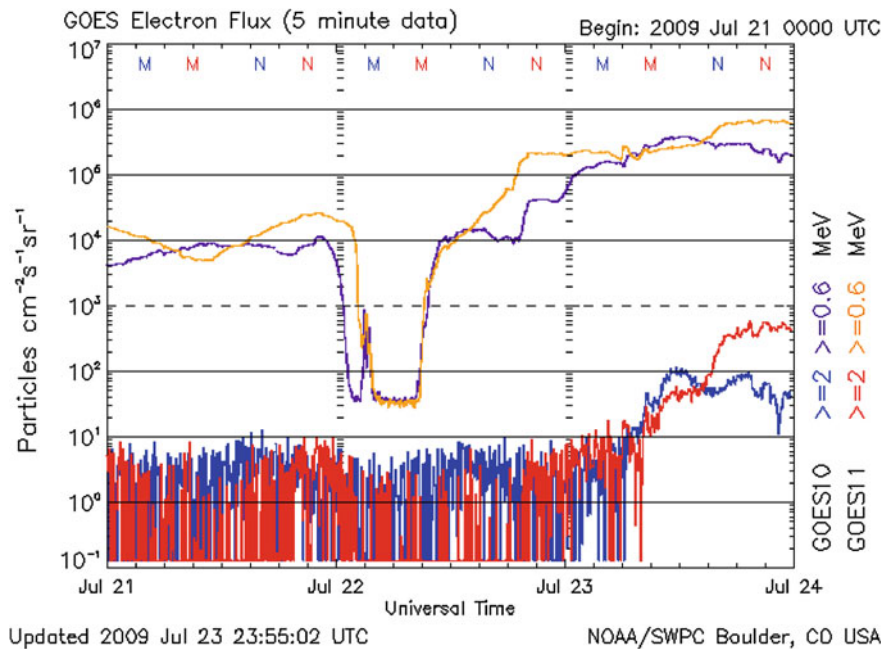


Fig. 2.18 Electron flux lowering during solar eclipse on 23 July 2009. Immediately after the solar eclipse the electron flux shows a rise (Source SOHO)

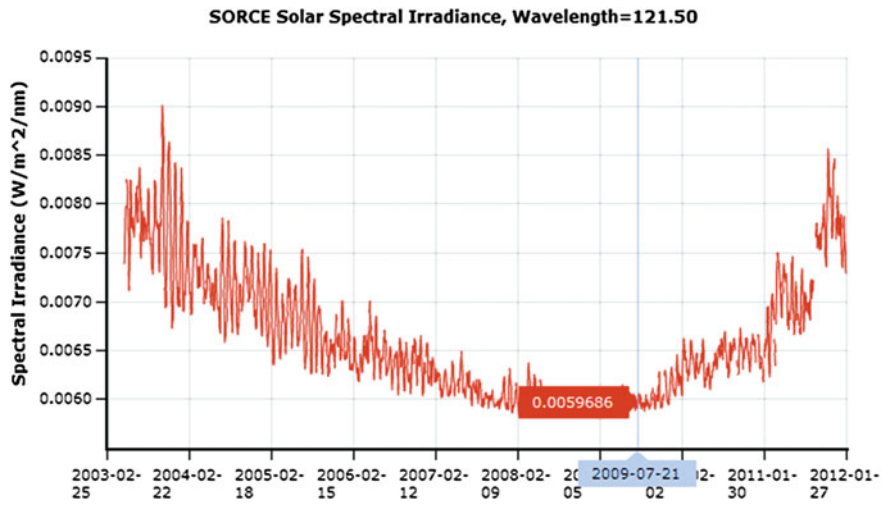


Fig. 2.19 Low solar spectral irradiance recorded during solar eclipse

value which has been found responsible for lowering down the Sulfur Dioxide concentration in the atmosphere (Figs. [2.4](#), [2.5](#), [2.6](#), [2.7](#), [2.8](#), [2.9](#), [2.10](#), [2.11](#), [2.12](#), [2.13](#), [2.14](#), [2.15](#), [2.16](#), [2.17](#), [2.18](#), [2.19](#)).



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