PROCEEDING
MEDIA DIRGANTARA
LAPAN

No : D-IV/03-94 Desember 1994 ISBN 9795554-00-0

THE PROCEEDING OF WORKSHOP ON AEROSOL AND OZONE IN THE TROPICAL STRATOSPHERE

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Presented at : Workshop on Aerosol and Ozone in The Tropical Stratosphere

Held at : Bandung, Indonesia, October 5th, 1994

Organized by

- LAPAN : Atmospheric Research and Development Center of The Indonesian National Institute of Aeronautic and Space
- STEL : Solar Terrestrial and Environment Laboratory, Nagoya University Japan

DITERBITKAN OLEH:
LEMBAGA PENERBANGAN DAN ANTARIKSA NASIONAL
JL. PEMUDA PERSIL NO. 1, JAKARTA 13220, INDONESIA

WORKSHOP ON AEROSOL AND OZONE IN THE TROPICAL STRATOSPHERE BANDUNG, INDONESIA, OCTOBER 5, 1994

Schedule

10:00 - 10:05	Welcome address by organizing commitee
10:05 - 10:20	Opening Ceremony by Deputy Chairman of LAPAN (DR. Ing. Agus Nuryanto)
10:20 - 10:35	Coffee Break
Session I	**Moderator : Drs. Sri Kaloka**
10:35 - 11:05	Heterogeneous Processes in The Stratosphere: Tropical Stratospheric Aerosol and Ozone (DR. Y. Iwasaka / DR. T. Shibata)
11:05 - 11:25	Atmospheric Chemistry Research by LAPAN (Ir. Siti Asiati)
11:25 - 11:40	Observation NO_2 and O_3 During Thunderstorm (Ir. Timbul Manik, MSc.)
11:40 - 13:00	Lunch
Session II	**Moderator : Drs. Hariadi T.E.**
13:00 - 13:25	Ozone Observation at Watukosek (Drs. Slamet Saraspriya)
13:25 - 13:40	Tropospheric Ozone Behaviour at Watukosek (Dra. Ninong Komala, Msc.)
13:40 - 14:05	Aerosol Measurement at Watukosek (DR. M. Hayashi)
14:05 - 14:20	Total Ozone Observation at Watukosek (Ir. Agus Suripto, MSc.)
14:20 - 14:40	Solar Ultraviolet at Watukosek on Nov.23-Dec.03 1993, and Sept.23-30, 1994 (Drs. Sri Kaloka)
14:40 - 14:55	Coffee Break
Session III	**Moderator : Ir. Siti Asiati**
14:55 - 15:15	OPC Technology (DR. M. Hayashi)
15:15 - 15:45	Future Plan on the Tropical Atmosphere Research with LIDAR (DR. Uchino)
15:45 - 16:00	Discussion

HETEROGENEOUS PROCESSES IN THE STRATOSPHERE: TROPICAL STRATOSPHERIC AEROSOL AND OZONE

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ABSTRACT

Heterogeneous processes including sulfuric acid droplets are considered an important ozone loss processes. Equatorial stratosphere is strong source of stratospheric aerosols and stratospheric ozone. Heterogeneous processes in the equatorial region should be actively made after now.

INTRODUCTION

The Equatorial atmosphere is considered to play an important role in the the global budget and/or circulation of minor constituents in the stratosphere. Active photochemical processes in the equatorial atmosphere produce lots of ozone, NOx, SOx, and aerosol particles. Therefore equatorial stratosphere has been considered to be most important source of those gases and particles.

Existence of very cold tropopause in the tropical region is essential factor activating phase changes from vapor to particulate matter of water and others in the equatorial stratosphere. Freeze out of water from the tropical tropopause is believe to be an important process to control humidity of the stratosphere.

Satellite measurements suggested that there was highly concentrated region of particulate matter on the equatorial tropopause. This is possibly due to active sulfuric acid droplets formation through photochemical reactions of SOx. Recently it is suggested that not

only polar stratospheric clouds (PSCs) but also sulfuric acid droplets disturbe stratospheric ozone since the stratosphere is denitrified through the reaction.

N_2O_5 + sulfuric acid droplet —>
$2HNO_3$ + sulfuric acid droplet

$ClONO_2 + HCl$ –>
$HNO_3 + Cl_2$
(on surface of sulfuric acid droplet)

From the viewpoint of heterogeneous reaction chemistry in the equatorial stratosphere seems to play an important role in global ozone and aerosol budget. However, there are few observations about those constituents in the equatorial region have been made.

EQUATORIAL STRATOSPHERIC OZONE

As described above, equatorial stratosphere is the region where ozone is actively formed through photochemical reactions. The fresh ozone diffuses through transportation from tropical to polar region associating with planetary wave activities, and consequently ozone content in the tropical stratosphere becomes relatively low comparing with the ozone level of mid and high latitudes. In figure 1, global distribution of ozone content is shown on the basis of TOMS (Total Ozone Mapping System) measurement.

Typical ozone distribution is shown in Fig. 1 on the basis of TOMS measurements suggesting that relatively low ozone area is in the equatorial region. In Fig. 2a-d, ozone distribution of 1993 is compared with averaged value of 1979-1992. Shaded area suggested the region where negative deviation was observed. The trend in ozone depletion is observed world-widely in the figures. Trend of ozone content change is plotted in latitude-time cross section (Fig.3). This cross-section shows that ozone depletion in the equatorial region was not larger than the loss in mid- and high-latitudes.

AEROSOLS IN THE EQUATORIAL STRATOSPHERE

Measurements on equatorial stratospheric aerosols are extremely limited. About 10 years ago, first balloon observations on stratospheric aerosols was made by Rosen et.al. (1975) (Fig. 4).

After then equatorial stratospheric aerosols was observed only by satellite and not by balloon. We can estimate aerosol load in mass from the satellite measurements (Fig. 5), but not aerosol number density and size. Stratospheric aerosol surface concentration which is estimated from size and number density is an important parameter to discuss the effect of surface reaction to ozone depletion, and balloon measurements are essential to know the aerosol surface concentration.

In figure 6, stratospheric aerosol concentration is shown on the basis of balloon measurements which made by Japan-Indonesia scientific team with balloon borne laser particle counter on November 30, 1993 at Watukosek. The vertical profile of particles suggests that there were many sub-layers which is possibly due to different chemical-dynamical history each other. The peak value seems to be extremely larger than the expected level from the measurements of undisturbed stratospheric aerosols.

Possible explanation on the enhancement is disturbance due to the volcanic eruption of Mt. Pinatubo (June, 1991: Philippine). According to measurements with LIDAR, satellite, and others lots of particulate matter were formed after the eruption of Pinatubo.

HETEROGENEOUS PROCESSES IN THE EQUATORIAL STRATOSPHERE

As described above, tremendous ozone loss are not found out in the equatorial region although there are lots of particulate matter. This tendency is interesting point concerning photochemistry of the equatorial stratsophere.

Active dynamical motion always disturbes chemical processes in the equatorial stratosphere. Therefore there is the possibility that ozone depletion cannot be detected in the equatorial region even though ozone loss reactions advances there. If so, heterogeneous reaction in the equatorial region can disturbe ozone density in mid and high latitudes but not in low latitudes. Chemical processes strongly combine with dynamical processes in the equatorial stratosphere, and there have been few systematic measurements on equatorial heterogeneous processes. It is strongly desired to make observations on equatorial stratospheric chemistry much more. Therefore the

measurements of ozone and aerosol particles in the tropical stratosphere, which is just now made by Japan-Indonesia Scientific Team, should be evaluable to understand heterogeneous reactions destructing ozone and their effect on the global budget of ozone.

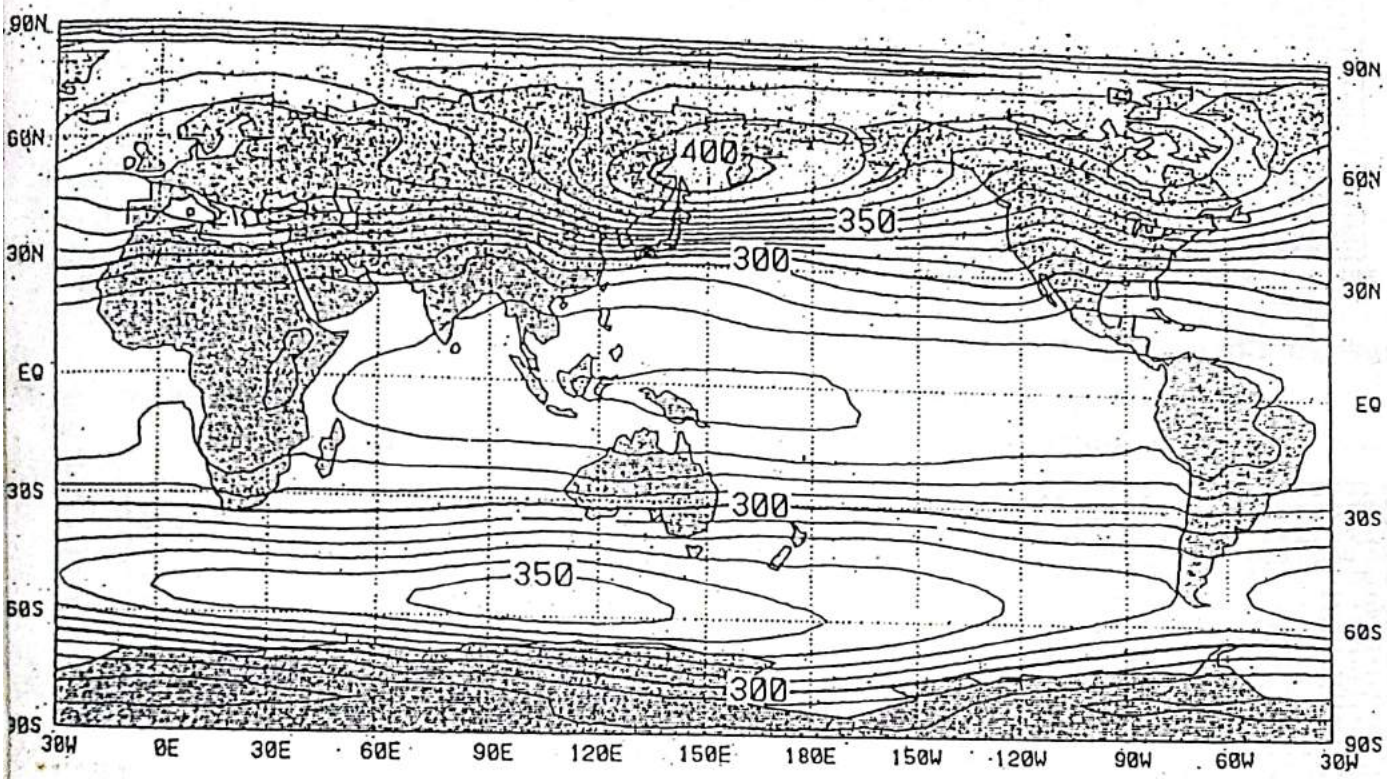

Fig. 1 Total ozone content from averaged value of TOMS 1979~1992 (made by Japan Meteorological Bureau). unit in m atom-cm.

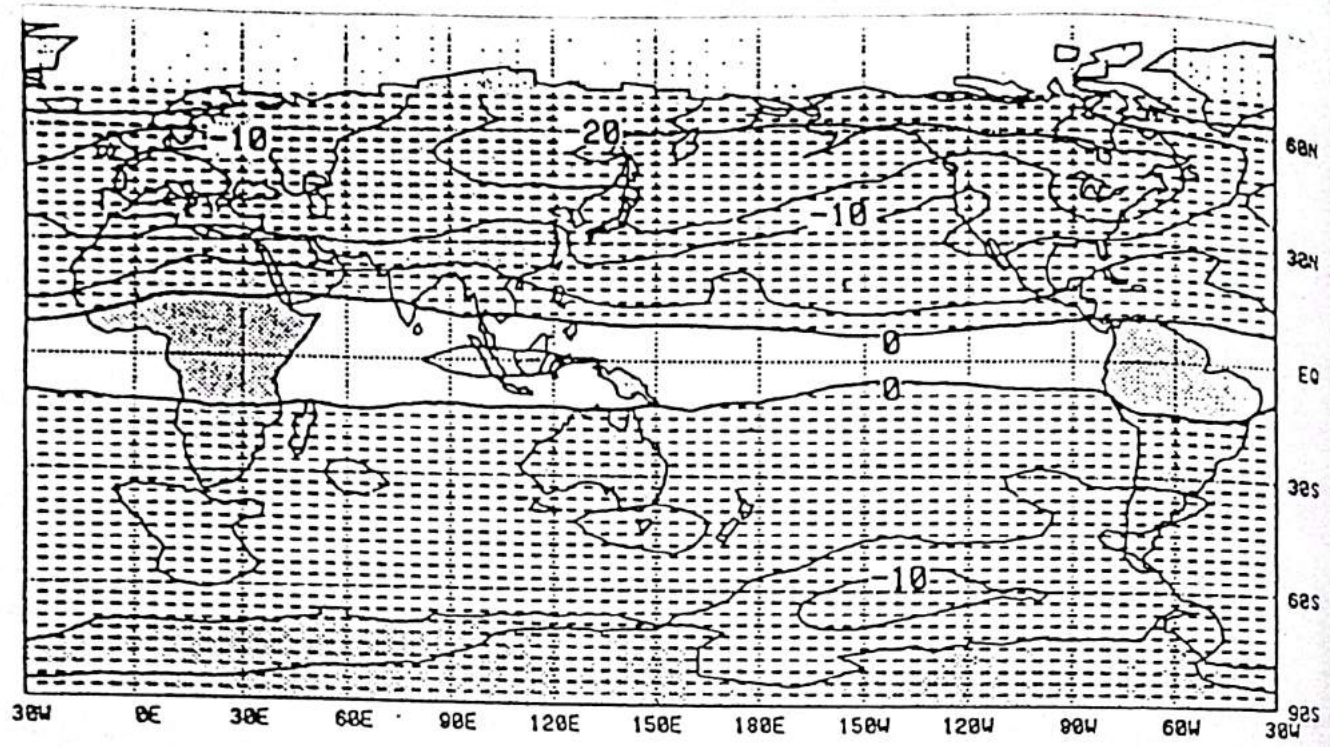

Fig. 2a Change in total ozone content of January 1993 from TOMS. Difference of [Average O3(1978~1992)-O3(1993)]. Shaded region suggests that the difference is negative

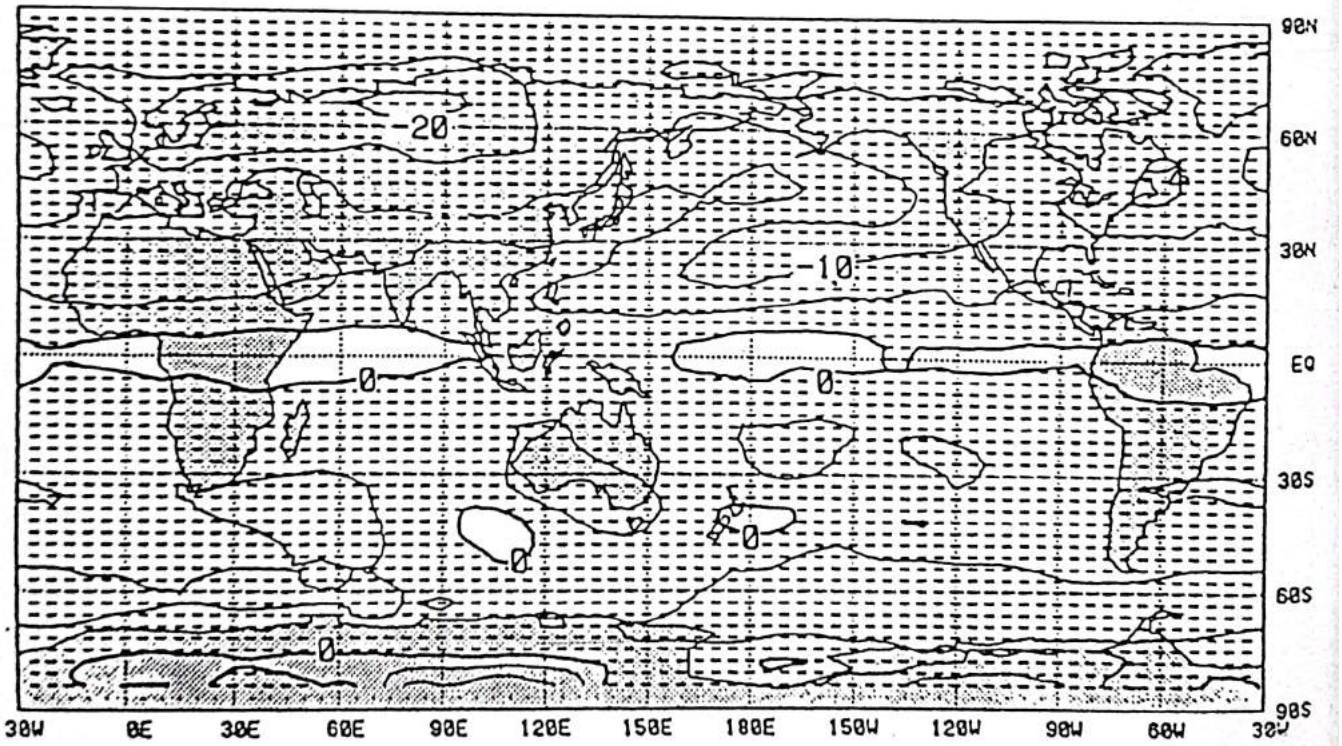

Fig. 2b Change in total ozone content of April 1993 from TOMS. Difference of [Average O3(1978~1992)-O3(1993)]. Shaded region suggests that the difference is negative

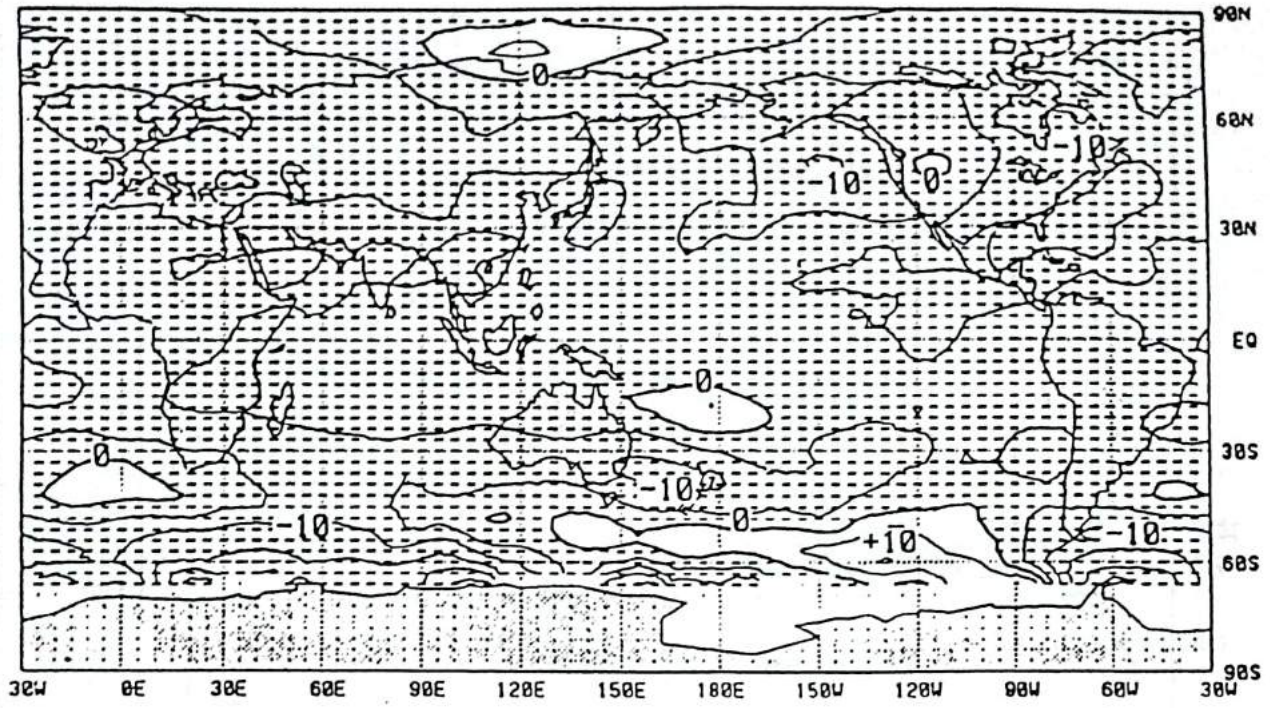

Fig. 2c Change in total ozone content of July 1993 from TOMS. Difference of [Average O3(1978~1992)-O3(1993)]. Shaded region suggests that the difference is negative

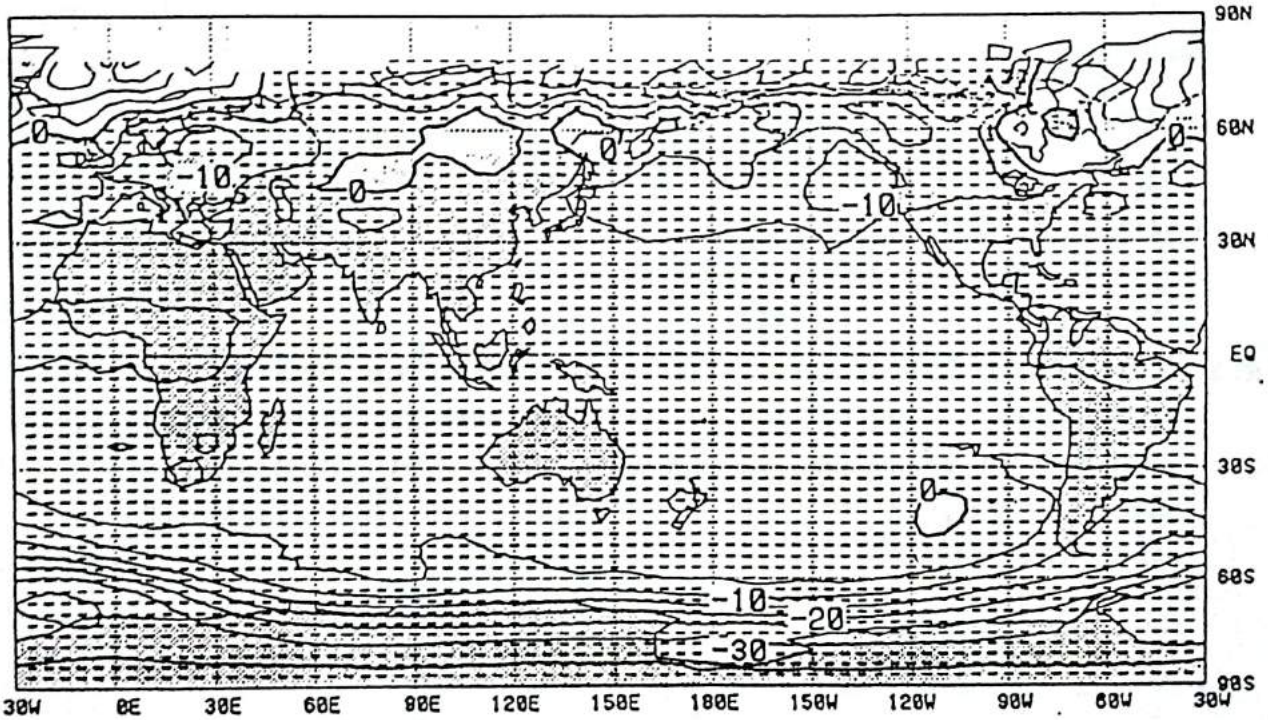

Fig. 2d Change in total ozone content of October 1993 from TOMS. Difference of [Average O3(1978~1992)-O3(1993)]. Shaded region suggests that the difference is negative

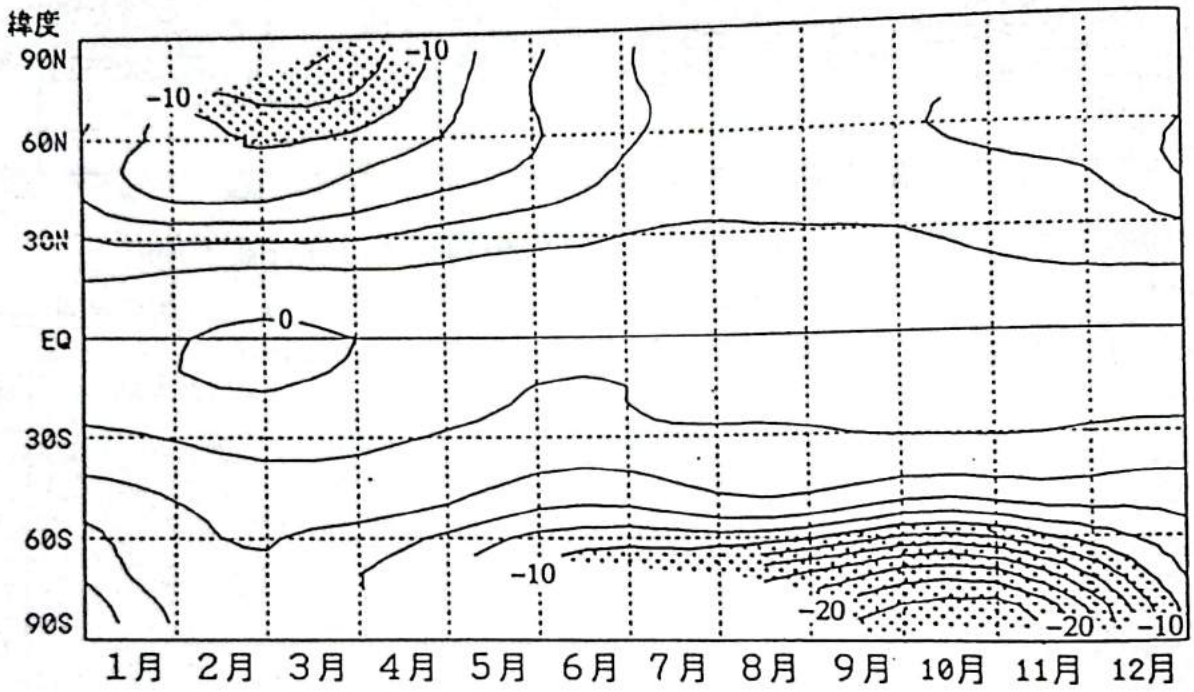

Fig. 3 Trend in total ozone content estimated from TOMS of 1979~1993. The effect of seasonal change, solar activity, and QBO on ozone ocntent is reduced. Unit in %/10 years. Negative region suggests ozone depletion rate is larger than 10%/10years.

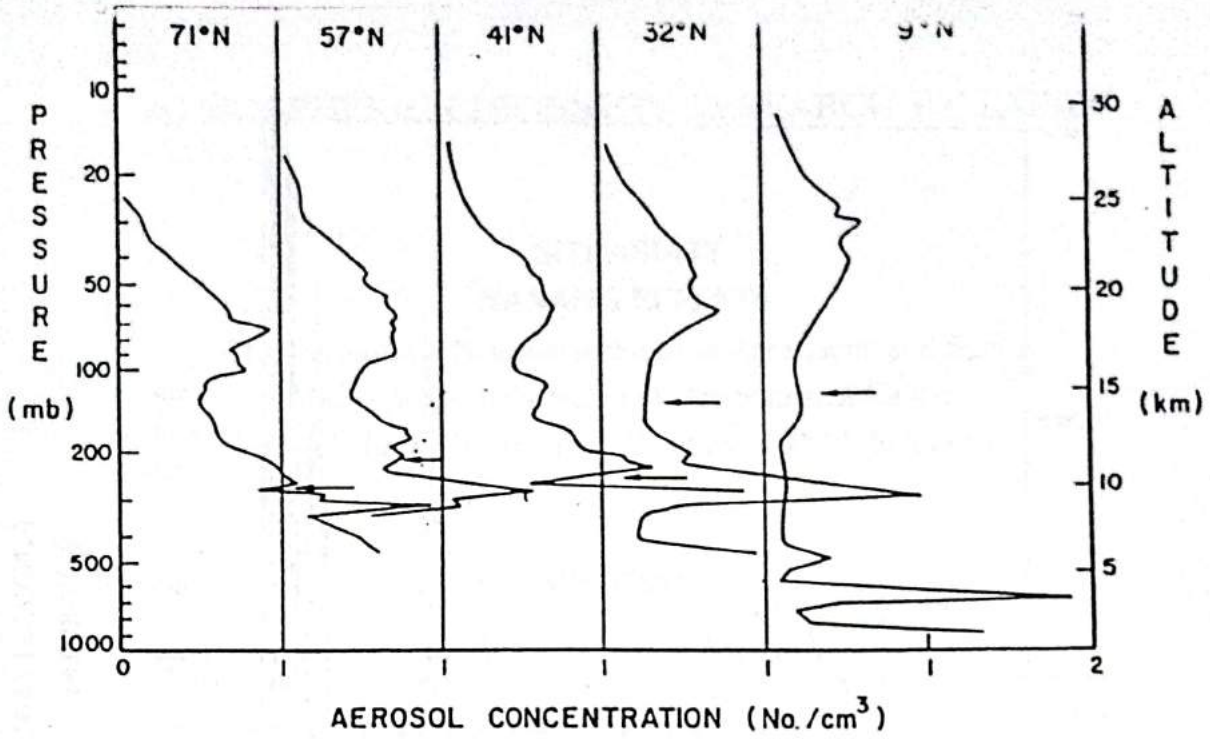

FIG. 4. A comparison of five Northern Hemisphere soundings made in June of 1973. Reading from left to right the dates of the soundings are as follows: 27 June, 19 June, 19 June, 19 June and 27 June. The arrows mark the observed position of the tropopause.

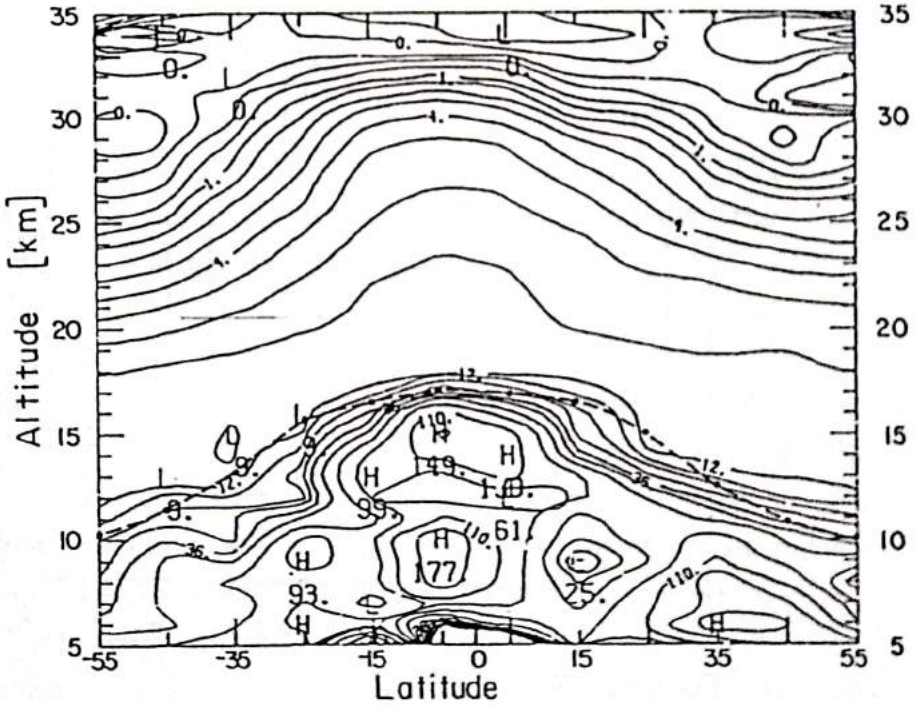

Fig. 5 Aerosol extinction at 1.0 μm measured by the SAGE satellite. Isopleths of extinction are given in units of 10^{-5} km^{-1}. The data, consisting of about 900 individual vertical extinction profiles obtained during April 1979, have been zonally averaged. The dashed line defines the mean tropopause height. (Figure supplied by M. P. McCormick [from *McCormick*, 1981*a*].)

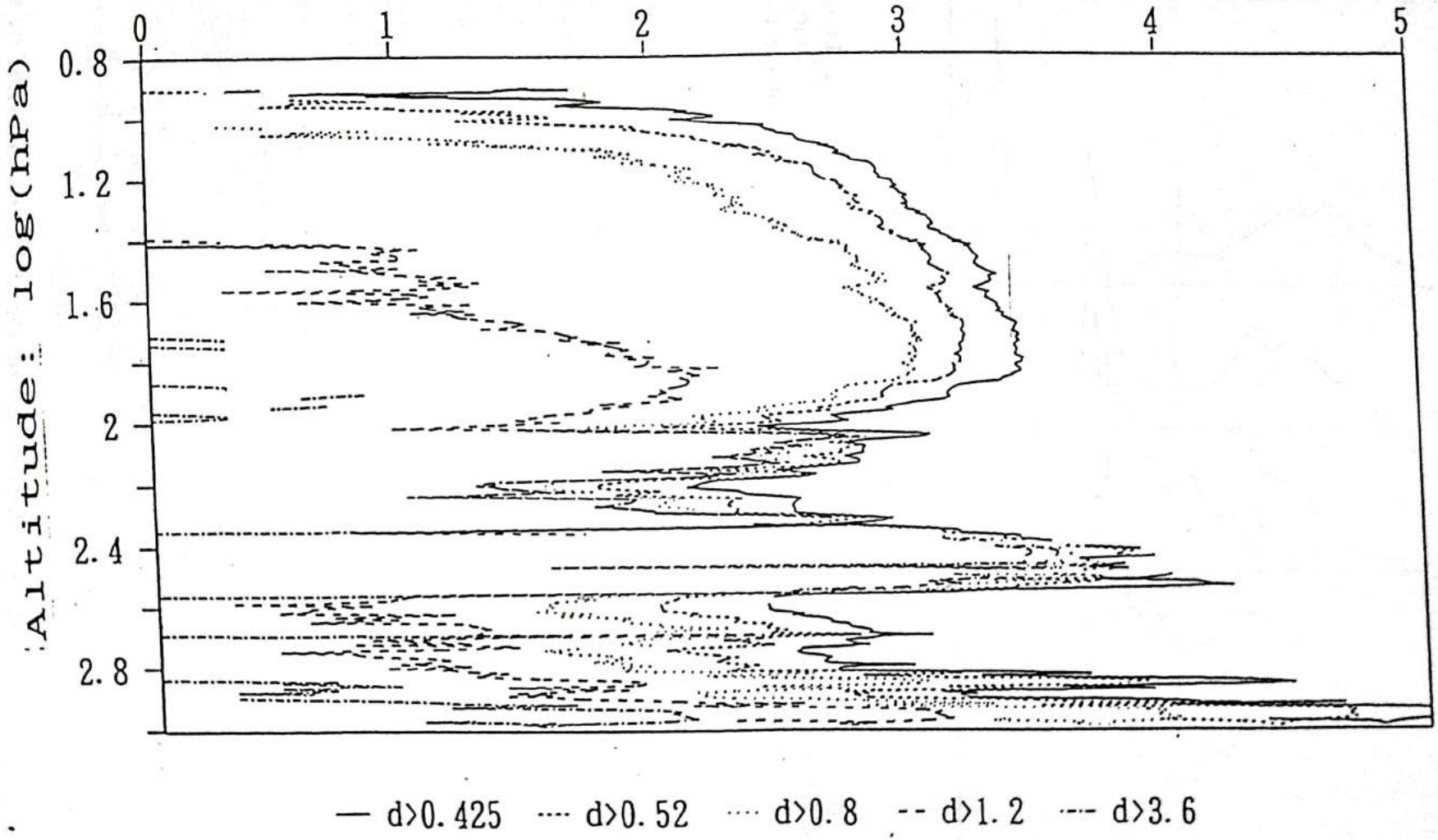

Fig. 6 Aerosol size and number density measured at Watukosek on November 30, 1993. Unit in log(particles/1000cm³)