Intercomparision of ADEOS/IMG Measurements with the Sonde Observations in Korea

Ha-Man Cho, Won-Tae Yun, Seung-Hee Sohn, Ju-Kong Kim

Meteorological Research Institute, Korea Meteorological Administration,
2 Waryong-Dong, Chongno-Gu, Seoul 110-360, KOREA
Tel. : 82-2-765-7017 / Fax. : 82-2-766-5978 / E-mail : hmcho@iris.metri.re.kr

Abstract. ADEOS/IMG(Interferometric Monitor for Greenhouse Gases) measurements - temperature, water vapor(H_2O), Ozone(O_3) have been compared with the sonde observations to detect the difference between the ADEOS/IMG vertical profile data and the observations. In general, the vertical distribution pattern of the temperature and water vapor obtained by IMG were relatively well agreed with the radio-sonde observations. However, it was seen that the ozone concentration by IMG has a somewhat large difference from the ozone-sonde observations. The trace gases such as CO_2, N_2O, CH_4, HNO_3, CO obtained by IMG also showed quite a big difference from the reference values when it is compared with the vertical profile of U.S. standard values(HITRAN). It is understood that, at present, IMG data can not give the accurate measurement values of vertical profile, but it can give the general idea on the vertical distribution pattern of trace gases.

1. Introduction

In recent days, as the global environmental problems have been very important issues worldwide, monitoring of atmospheric constituents change has also been treated as very important global task to be done. In particular, WMO(World Meteorological Organization) has established GAW(Global Atmosphere Watch) Program in 1989 and has recommaned its member countries to enhance the monitoring of trace gases including greenhouse gases and ozone[1]. In Korea, greenhouse gases such as CO_2, CFC-11/12, N_2O, CH_4 have been measured at the Kosan, Chejudo by flask sampling since 1990, and total ozone has been measured at Seoul with the Dobson Ozone Spectrophotometer since 1984. These monitoring works have been one of major research themes related with global environments in Korea during the last decade. However, up to now, it has been very difficult to have observation of vertical profile of the trace gases. Therefore, it is very requested and is meaningful to have a vertical profile of trace gases by satellite, for it can provide the data over wide range and with real time.

IMG(Inter-ferometric Monitor for Greenhouse gases) is one of eight sensors boarding ADEOS (Advanced Earth Observing Satellite) which was launched by NASDA is August 1996. IMG produce vertical profile of temperature and trace gases such as H_2O, CO_2, O_3, N_2O, CH_4, HNO_3, CO. Although ADEOS ceased operating on 30 June 1997 due to sudden accident, the data of eight month obtained from ADEOS/IMG are still very important in studying on the vertical distribution pattern of greenhouse gases and ozone.

In this study, we tried to compare the ADEOS/IMG data with the sonde observations to understand how much the satellite trace gases data is different from the observations by sonde and reference value by HITRAN. The vertical profiles of trace gases, CO_2, O_3, N_2O, CH_4, HNO_3, CO including temperature and H_2O measured by ADEOS/IMG were also presented and discussed.

2. Data and method

The data used in this study are ADEOS/IMG Level II data from October 1996 to June 1997 at the region of 125E-130E, 33N-38N, and radio-sonde and ozone-sonde observations at Osan and Pohang upper air stations in Korea. The Osan station is a typical upper air station that produce the radio-sonde observations, however in Pohang station, both radio-sonde and ozone-sonde observation have been made since 1995. The ozone-sonde observation has normally been made with the interval of once everyweek. For the comparision of ADEOS/IMG data with the sonde observation, four cases were selected and those were 10 Jan., 28 Jan., 2 Apr. and 19 June 1997. For these four cases, vertical profile of temperature, water vapor(H_2O) and ozone(O_3) by ADEOS/IMG were compared with the sonde observations. For the H_2O comparision, the dewpoint temperature by radio-sonde was converted into H_2O in ppmv.

3. Comparision of ADEOS/IMG data with the sonde observation

• Temperature

Temperature profile measured by ADEOS/IMG was compared with the radio-sonde observations Fig. 1 shows the location of ADEOS/IMG observation points (a), (b), (c), (d) and the Pohang and Osan stations for the comparision. The cases (a) and (c) compared with Pohang station, while the cases (b) and (d) with Osan station, to compare the ADEOS/IMG data with the nearer upper air station..

It is seen from the Fig. 2 that cases (b) and (d) shows well agreement between the ADEOS/IMG data and RAOB, while the (a) and (c) shows quite a large difference between the two data. This implied there might be some errors in the ADEOS/IMG measurement when it passed over the ocean. However, when the ADEOS passed over the land, the temperature profile measured by ADEOS/IMG was well correspondent to the RAOB. From the cases (b) and (d), it was also seen that the temperature by ADEOS/IMG was slightly

0-7803-4403-0/98/$10.00 © 1998 IEEE

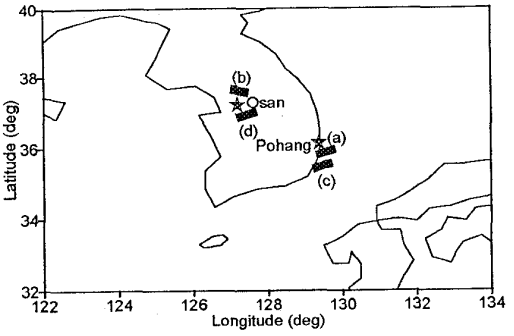

Fig. 1. Location of ADEOS/IMG measurement points, (a):10 Jan. 1997, (b): 28 Jan. 1997, (c): 2 Apr.1997, and (d) :19 June 1997 and upper air stations in Korea, Pohang and Osan.

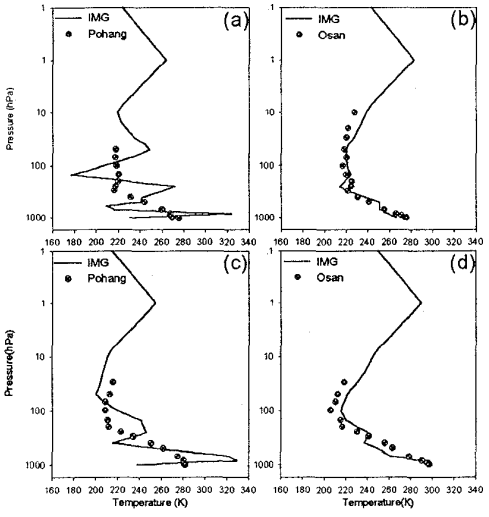

Fig. 2. The vertical profiles of temperature measured by ADEOS/IMG and by RAOB at Pohang and Osan upper air stations in Korea on 10 January (a), 23 January (b), 2 April (c), and 19 June 1997 (d).

higher than the RAOB at Osan in the lower troposphere, while was lower in the upper troposphere and lower stratosphere.

• Water vapor(H_2O)

Fig. 3 shows the vertical profile of H_2O by ADEOS and by RAOB at Pohang and Osan stations. The general vertical distribution pattern of two data set is not much different. But the surface measurements by ADEOS/IMG is too large in comparision with RAOB. So if we exclude some surface data it can be said that the by ADEOS/IMG and RAOB are quite well agreed each other.

• Ozone

The ozone profile measured by ADEOS/IMG was compared with the ozone-sonde data of Pohang station. Fig. 4 shows that the ozone concentrations at the different levels are somewhat lower than the

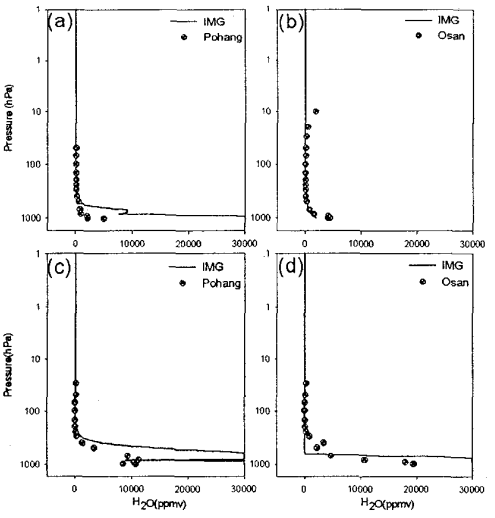

Fig. 3. The same as in Fig. 2 but for H_2O.

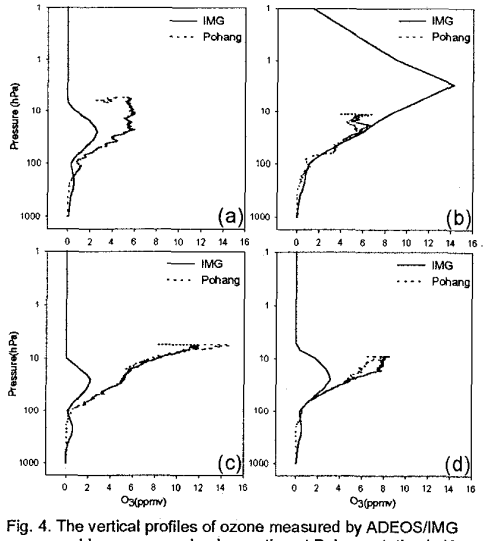

Fig. 4. The vertical profiles of ozone measured by ADEOS/IMG and by ozone-sonde observation at Pohang station in Korea on 10 January (a), 28 January (b), 2 April (c), and 19 June 1997 (d).

ozone-sonde observations except case (b) that has very unreasonable profile in ADEOS/IMG. It is likely that in cases (a), (c), (d), the vertical distribution patterns of ozone concentration of ADEOS/IMG are quite stable and show the maximum concentration height around 50 hPa which is not much different from the ozone-sonde data, though the difference in the concentration is quite large. The Fig. 4 indicated that the ADEOS/IMG ozone profile can give the information on the maximum concentration height approximately.

4. Vertical profile of trace gases by ADEOS/IMG

An example of vertical profile of trace gases measured

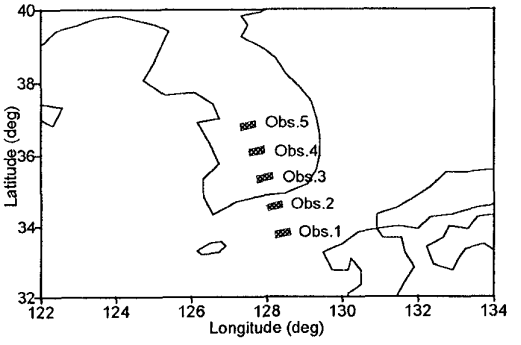

Fig.5. Locations of ADEOS/IMG observation points when the ADEOS passed over Korean Peninsula from Obs. 1 to Obs. 5 on 19 June 1997.

by ADEOS/IMG on 19 June 1997 when the ADEOS passed over Korean Peninsula from the south to north(Fig. 5) was presented with U.S. standard values (HITRAN) as in the Fig. 6. First, to see the temperature profile from Fig. 6, general distribution pattern of the ADEOS/IMG and the HITRAN is quite similar, showing slightly higher values in the ADEOS/IMG than the HITRAN. And the H_2O profile shows that there is a big error in the surface data of ADEOS/IMG. The other trace gases such as CO_2, O_3, N_2O, CH_4, HNO_3 and CO also show that there still exist a big error in the gases measurent by ADEOS/IMG.

Particularly, in cases of greenhouse gases, CO_2, N_2O, CH_4, the observations of 5 data sets are very unstable, and are very much different one another though the observations were made almost at the same time with the interval of a few seconds. To see the surface concentrations of these three greenhouse gases by ADEOS/IMG, CO_2 concentration is in the range of 150~550 ppmv, and N_2O is 0.0~0.4 ppmv, and CH_4 is 1.7~4.8 ppmv.

In Korea, the surface measurements of CO_2, N_2O, CH_4 are 367 ppmv, 0.3 ppmv and 1.8 ppmv, respectively[2], so the data of greenhouse gases by ADEOS/IMG have a large error at the moment. But the other trace gases, O_3 and HNO_3, CO shows the better results. Of course there are quite a big difference in concentration measurement between the ADEOS/IMG data and the HITRAN, however, the data of O_3, HNO_3 and CO seem to be much more stable than the three greenhouse gases. This means that the ADEOS/IMG measurement can show the general vertical distribution pattern of the gases.

Results

Intercomparision of ADEOS/IMG data with the sonde observations and U.S. standard (HITRAN) in Korea showed that there still exists quite a large error in ADEOS/IMG measurement for trace gases such as CO_2, O_3, N_2O, CH_4, HNO_3, CO. However, the temperature and H_2O profile measured by ADEOS/IMG correspond to the observation to some extent. It is recognized that, at

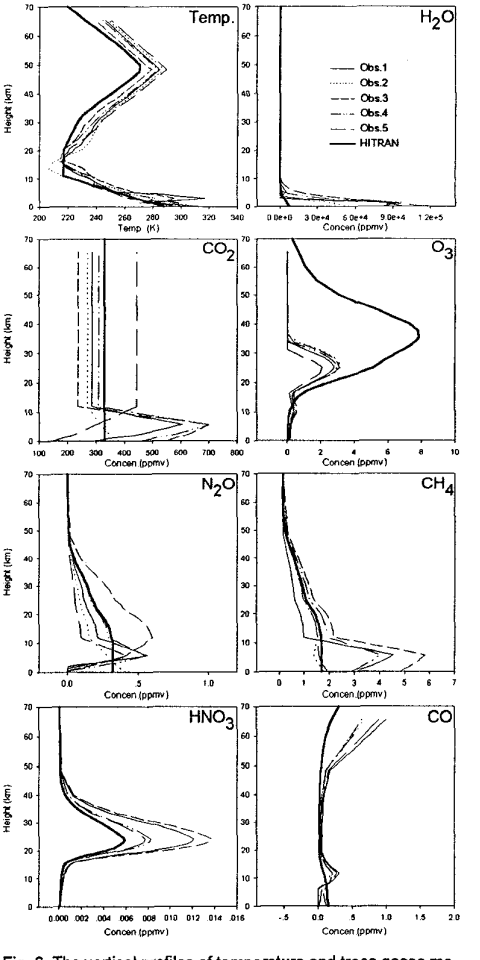

Fig. 6. The vertical profiles of temperature and trace gases measured by ADEOS/IMG on 19 June 1997 when the ADEOS passed over Korean Peninsula.

the moment, ADEOS/IMG can not provide accurate trace gases concentration by different height yet, however, it can give the general information on the lvertical profile of the gases, showing the possibility of providing the real-time trace gases data by satellite for the monitoring of atmospheric constituents change and for the research activity on global enviromental problems.

References

[1] IPCC, "Climate Change 1995 - The Science of Climate Change", IPCC, pp 572, 1995.

[2] Cho, H. M., M. K. Park, J. C. Nam, D. H. Min, K. R. Kim, B. H. Song, B. S. Kim, S. K. Kim and Y. S. Chong, "Trends of Background Concentrations of Atmospheric Carbon Dioxide in Korea", J. of Kor. Met. Soc., Vol. 31, No. 3, pp 301-312. 1995.