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Total Column Water Vapour Concentration Measurement During Sea Voyage and at Maitri During 2002

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Abstract

Measurement of total column water vapour has been made using Microtop sun-photometer over at Maitri (70.44° S, 11.45° E), Antarctica The observation taken during 2002 showed that the monthly average concentration varied from 0.67 cm to 0.18 cm. Water vapour concentration found varying significantly with season and time of the day. The water vapor has also been measured during sixteenth and twenty-first Indian Antarctic Scientific Expedition on the way from Goa, India (15.24° N, 73.42° E) to Maitri, Antarctica (70.44° S, 11.45° E) on the ship Polar Bird and Magdalena Oldendroff respectively. It was found that total column water vapor decreased as the ship moved towards the higher latitudes. Water vapor values were also found to be in correlation with corresponding temperature.

Keywords: water vapour, green house gases, Antarctica, climate and global change, hydrological cycle.

Introduction

Water vapour is very important mechanism for heat energy transfer from earth's surface to its atmosphere. It strongly contributes to greenhouse effect and considered as a positive feedback. Water vapour feedback acting alone approximately doubles the warming from that it would be for fixed water vapour[1]. Atmospheric water vapour varies considerably with the temperature. The amount of water vapor varies widely through out the atmosphere and the average content fluctuates about a mean, determined by the other greenhouse gasses, and the nature of the earth land surface. In the upper troposphere and lower stratosphere the radiative[2] and chemical[3] effects of water vapor are large. Water vapor is the primary source of the hydroxyl radical and photochemical production of OH is largely determined by water vapor in the atmosphere[4]. Water Vapor under stratospheric conditions affects the heterogeneous chemistry and plays

significant role in the Antarctic ozone depletion by providing reaction site as polar stratospheric clouds in the form of H_20 ice[5].

The global database for water vapor is insufficient and therefore regular measurement is of immense importance for understanding the hydrological cycle in depth to carry out global change studies[6]. In view of the above, a Hand-held microprocessor based sun-photometer, Microtop-II[7], has been used to measure total column water vapour at Maitri (Antarctica). The technical details and theoretical consideration have already been discussed in the DOD technical Report of 16th expedition. In the present communications the results obtained will be discussed in detail.

Experimental Setup: MICROTOP-II

It is a five-channel hand held microprocessor based sun photometer with a full field of view of 2.5°. The instrument has five optical collimators aligned to aim in the same direction. A narrow-band interference filter and a photodiode suitable for the particular wavelength range are fitted with every channel. All the channels face directly the solar disc simultaneously when the image of the sun is centered at the cross hairs of the sun target. When the radiation captured by the collimators falls onto the photodiodes, it produces an electrical current proportional to the received radiant power, which is amplified and converted into digital form in a high resolution A/D converter. Signals are processed in a series of 20 conversions per second. Out of the five channels at 300, 305, 312, 940 and 1020 nm, the first three filter channels are used to derive atmospheric total ozone column and other two for water vapor[8].

Results and Discussion

Latitudinal distribution of water vapor carried out during the voyage from Delhi (India) to Maitri, Antarctica is depicted in Fig. 1. The gap in the graph is due to non-availability of the data during Airplane Journey from Goa, India to Cape Town, South Africa in the year 2002. The latitudinal variation of total column water vapor observed during both the expedition showed that total column water vapor decreased as the ship moved towards the higher latitudes. However, total column water vapor was observed higher in the year 2002 as compared to 1997 during sea voyage from Cape Town to Maitri, Antarctica. The total column water over Delhi was 1.18 cm whereas over Goa it was around 3.30 cm and at Maitri it was found to be around 0.5 cm in 1997 and 0.9 cm in 2002. Little rise

in water vapour concentration has also been observed in both the year when ship was cursing through the 40 degrees towards south. The water vapor was found to be maximum in tropical latitudes while it was minimum at polar latitudes. This may be attributed to very cold and dry condition at polar latitudes. The overall increase in water vapour concentration in the year 2002 may be attributed to the unusual heat flux transfer by planetary waves over 20° to 90° S[9].

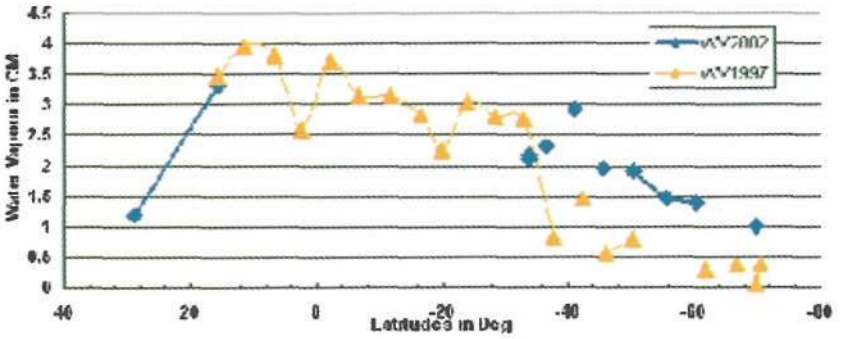

Fig. 1: Latitudinal distribution of total column water vapor during sea voyage (1997, 2002)

The Microptop data of monthly averaged total column water vapor over Maitri is shown in Fig. 2. Data was available only for January, February, March, April, August, October, November, and December. The maximum water vapour was found to be 0.64 cm in January and minimum

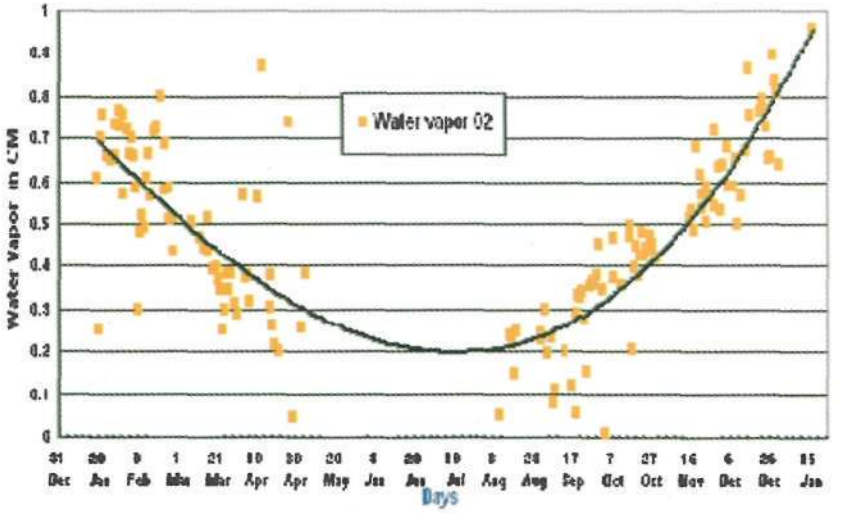

Fig. 2: Water vapor variation at Maitri, Antarctica during 2002

0.18 cm in August at Maitri in the year 2002. The Variation of total column water vapor during the observation period of year 2002 is depicted in Fig. 2. Day-to-day water vapor was found to be highly variable but in general it was maximum during summer and minimum during winter. Due to very low temperature during winter in Antarctica minimum recorded water vapor in the year 2002 was observed to be of the order of 0.01 cm and maximum 0.90 cm in summer 2002, while annual average was found to be 0.42 cm. The average water vapor was found to vary 0.02 cm in winter period to 0.6 cm in summer.

It was observed that the water vapor is very much dependent on the local meteorological conditions. Monthly averaged water vapour was found to be higher with corresponding monthly averaged surface temperature as seen in Fig. 3. In the year 2002, water vapor values were found to be in correlation with corresponding temperature. At higher temperature water vapor was found to be higher and vice versa. Fig. 4 shows the correlation between daily averaged water vapor and surface temperature at Maitri in the year 2002.

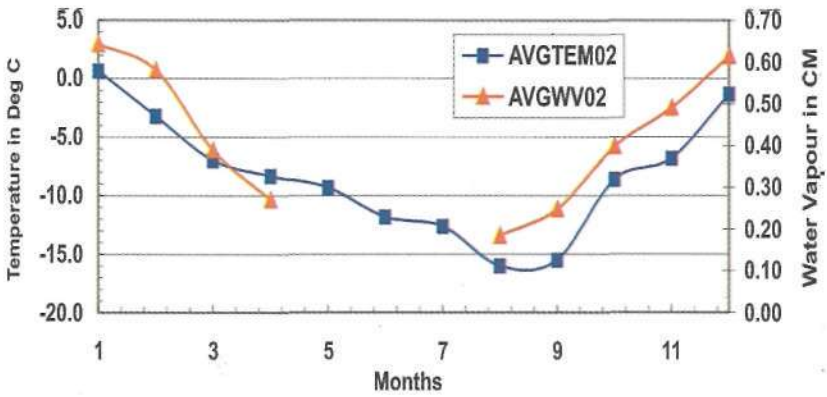

Fig. 3: Monthly average total column water vapour and surface temperature in 2002 at Maitri

As the water vapor is highly variable constituent in the atmosphere, it varies according to the local metrological conditions and in general was found to be maximum during noontime. Fig 5 shows the correlation of diurnal variation of water vapor with temperature. On 9th Feb 2002, minimum value of 0.25 cm was observed at 3:38 hours with corresponding temp of - 5.9°C and maximum value of 0.81 cm at 13:12 hours with corresponding temp of -0.8 ° C.

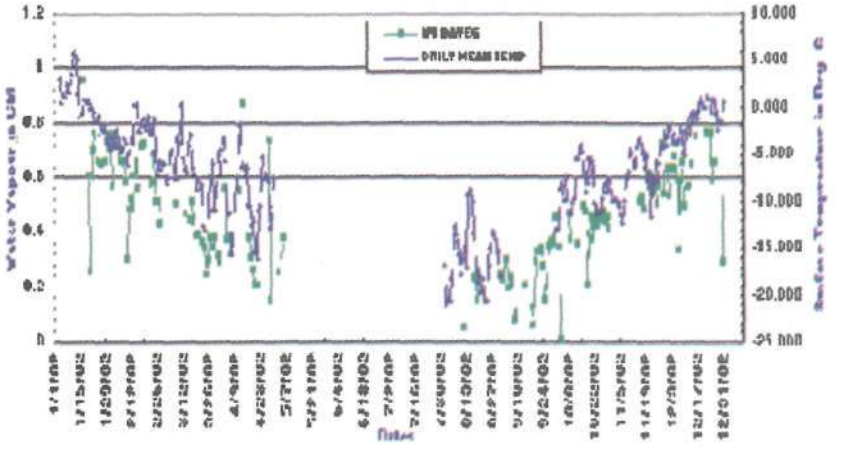

Fig. 4: Comparison of daily averaged water vapor with temperature in 2002 at Maitri

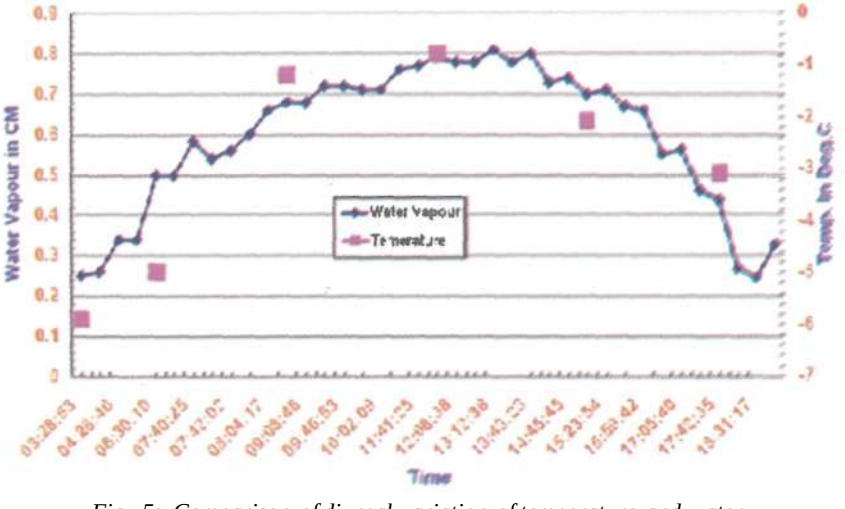

Fig. 5: Comparison of diurnal variation of temperature and water vapor on Feb 9, 2002 at Maitri, Antarctica

Conclusion

Measurement of total column water vapor by MICROTOP-II Sun photometer at Maitri Station Antarctica shows the increase in water vapour concentration in the year 2002 as compared to the 1997. Day-to-day water vapor showed highly variable nature but the trend showed maximum during summer and minimum during winter in polar latitudes. It also showed the correlation between water vapor and surface temperature, at

higher temperature water vapor was found to be higher and vice versa. The water vapor at Maitri Antarctica is very low compared to tropical latitude like Delhi and is a good site for astronomical observations.

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