FIJI

Summary

Ozone monitoring in Fiji is carried out only by the University of the South Pacific (USP) in collaboration with NASA/GSFC/NOAA/CMDL mainly under the SHADOZ (Southern Hemispheric Additional Ozonesondes) programme. Using ozonesondes, total column ozone (TCO), stratospheric ozone, tropospheric ozone and surface ozone profiles and amounts are being obtained since 1997. TCO, stratospheric and tropospheric ozone have shown a seasonal trend of spring maximum and fall minimum. Stratospheric ozone in particular has shown a slight decreasing trend (about 1%) since 1997-2003. Monitoring of ^{7}Be for certain time intervals has also been done to study stratosphere-to-troposphere exchange (STE) processes in the region. No proper long-term UV-B monitoring programme is in place for the country yet, though measurements using a broad-spectrum spectrophotometer have been going on for some time. Data however is also available, for about a year, from measurements done using a narrow band UVB-1 pyranometer.

Recent research at USP has focused on identifying ozone trends at a few South Pacific sites (Samoa, Tahiti and San Cristobal) including Fiji. Study has also been done to explain the trends and variations seen in ozone amounts at all levels (TCO, stratosphere, troposphere and surface) at each of these sites. Future research plans at USP mainly include setting up a proper continuous UV-B monitoring programme and improving the method of studying STE processes. A Dobson or a Brewer spectrophotometer is also planned to be introduced along with ozonesonde measurements.

INTRODUCTION

Fiji is located within the South Pacific region (18.1°S, 178.2°E). The only institution involved with scientific research and monitoring of ozone is the University of the South Pacific (USP) located in the capital city Suva in the main Island of Viti Levu. The ozone research at USP is carried out in collaboration with NASA/GSFC/NOAA/CMDL. The lead agencies at USP for this major project are the Department of Chemistry and the Pacific Centre for Environment and Sustainable Development (PACE-SD).

OBSERVATIONAL ACTIVITIES

Relevant observational activity in Fiji involves monitoring of vertical ozone profiles using electrochemical concentration cell (ECC) ozonesondes and periodic UV-B monitoring using broad and narrow band UV meters.

Profile Measurements of Ozone

Since 1997, vertical ozone profiles have been measured on a weekly basis, using a model 6A ECC ozonesondes. The vertical profile data from these measurements are being used to obtain the total column ozone and stratospheric ozone levels over Fiji since 1997.

UV-B Measurements

Currently there is no continuous UV-B monitoring programme in place for Fiji. Some measurements are being done by the Department of Physics and by the Fiji Meteorological Services using a broadband meter. However, with the absence of a proper validation method the accuracy of the data is questionable.

UV-B was continuously measured for nearly one year, from July 2003 to July 2004 by the Department of Physics using a narrow band UVB-1 pyranometer with a spectral response in the 280-320 nm range. After July 2004, no measurements were done and now the pyranometer is being moved to the Fiji Meteorological Services (Nadi) where continuous monitoring is being planned to be carried out.

Calibration Activities

Since each ozonesonde is a new instrument, pre-launch procedures are designed to ensure valid data recording is done. The ozonesonde being used is a model 6A sonde provided by NOAA and it has taken part in sonde inter-comparison experiments such as stratospheric ozone inter-comparison (STOIC) in 1989 (Komhyr *et al*., 1995) and Julich ozonesonde inter-comparison experiment (JOSIE) in 1996 (Smit *et al*., 1996).

There is currently no proper calibration method in place for any UV-B monitoring done.

RESULTS FROM OBSERVATIONS AND ANALYSIS

Stratospheric Ozone

Figure 1 shows the stratospheric ozone trend from 1997-2003 drawn from 0.25 km averaged ozone profiles. In the plot the whiskers represent the inner 90th percentile of the data, boxes the inner 50th percentile, the black bar the median, the red bar the mean and the black dots are the outliers in each (monthly) data set.

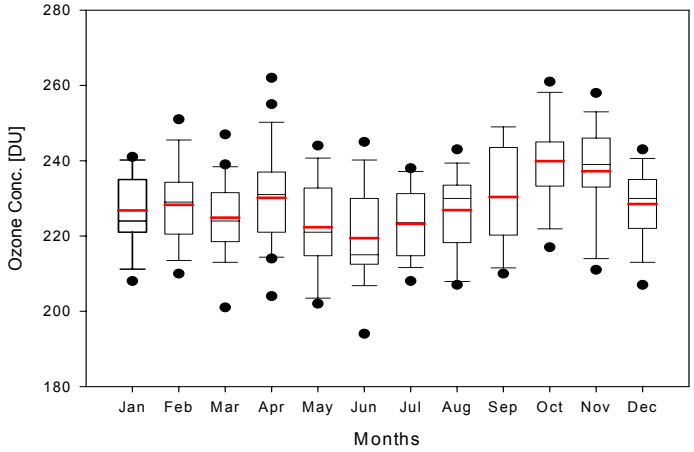

Figure 1: Stratospheric ozone trend for Fiji during 1997-2003.

The ozonesonde analysis has shown a seasonal cycle with high values during the spring months of September-November (SON) and low values during fall/winter months of May-July. The variability in ozone amounts appears to be highest during the SON months. These results are similar to those reported by Thompson *et al*. (2003).

Figure 2 shows the monthly averaged stratospheric ozone trend during 1997-2003. There appears to be a downward trend in stratospheric ozone over the 7-year period.

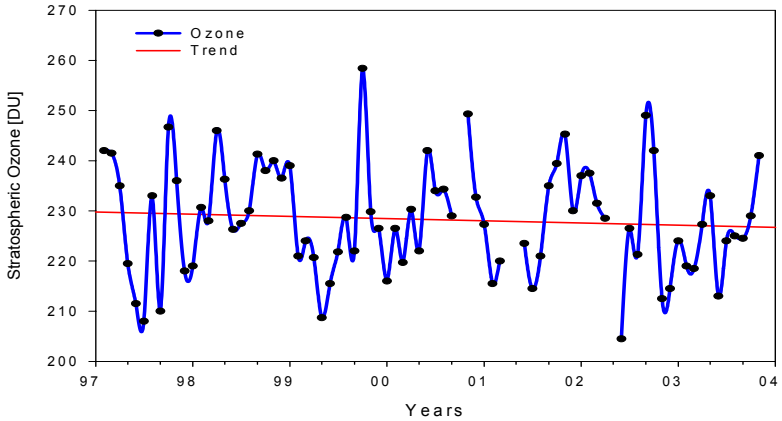

Figure.2: Monthly mean stratospheric ozone trend for Fiji during 1997-2003.

Total Column Ozone (TCO)

Figure 3 shows the TCO trend during 1997-2003 for Fiji, which reveals a seasonal trend and variability similar to that of stratospheric ozone.

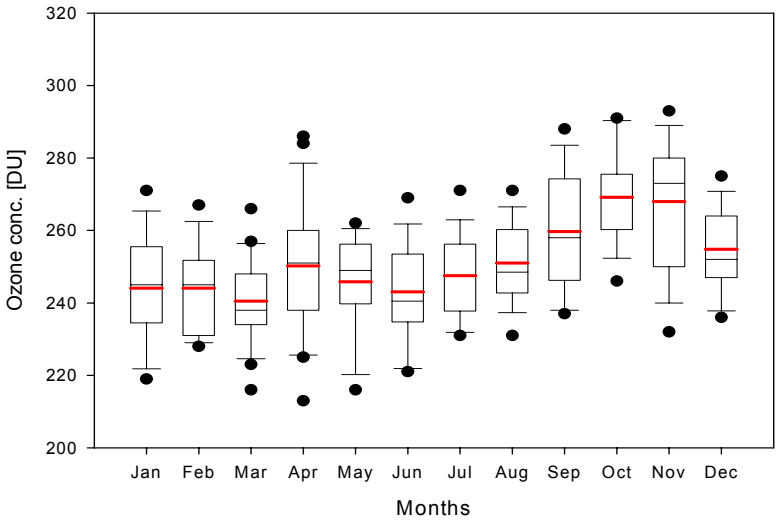

Figure 3: TCO trend for Fiji during 1997-2003.

Ultraviolet-B (UV-B) Radiation

The UV-B data obtained during the one year of monitoring from 2003 to 2004 by the UVB-1 pyranometer is given in Figure 4.

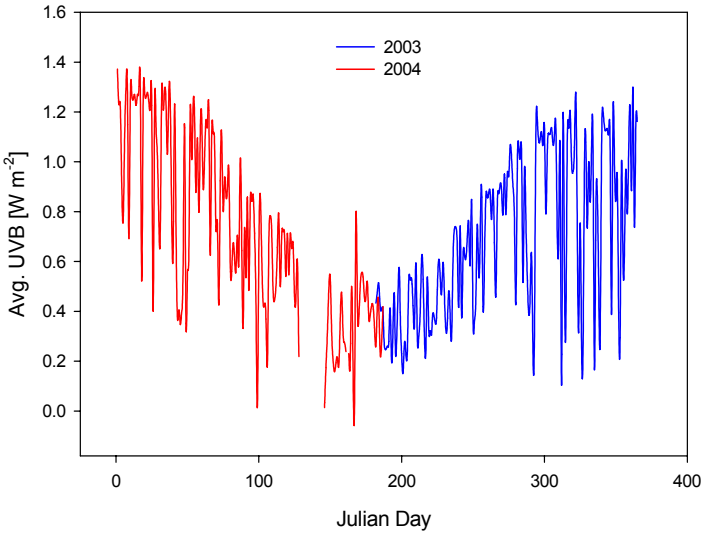

Figure 4: Daily average UV-B levels at Suva, Fiji, from July 2003 to July 2004.

OTHER RESEARCH

Other research relevant to the stratospheric ozone is the studying of the stratosphere-to-troposphere exchange processes.

Stratosphere-to-troposphere Exchange (STE)

One of the ways of studying the complex process of STE events is through tracer studies using cosmogenic radionuclides such as beryllium-7 (^{7}Be) (Dibb *et al*., 1992). Atmospheric aerosols at USP are collected using high-volume air samplers and the activity of ^{7}Be is determined using a high-resolution gamma-ray spectrometer with a hyper-pure germanium (HPGe) detector available at the Department of Physics at USP. The standard filters used for analysis are obtained from the Environmental Monitoring Laboratory (EML) in New York. Data of ^{7}Be measurements are available only from September 1999 to September 2000 and for part of 2003. Correlations with tropospheric ozone (Figures 5 and 6) suggest occurrence of STE events in the region. However, in view of the limited ^{7}Be data, conclusions cannot be definitive. Since ^{7}Be technique is time consuming, there is a need for a better method for determining any STE events in the region. In future studies we propose to attach a frost-point hygrometer to the ozonesonde for studying the STE processes.

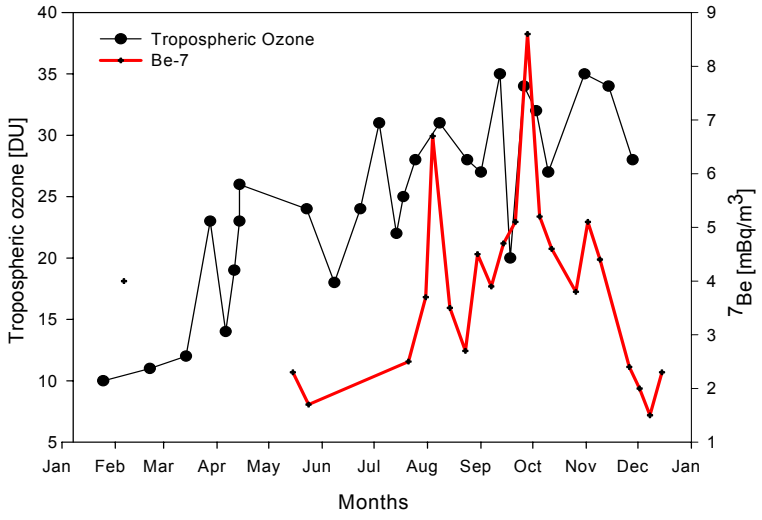

Figure 5: Correlation between ^{7}Be and Tropospheric ozone for Fiji, 2003.

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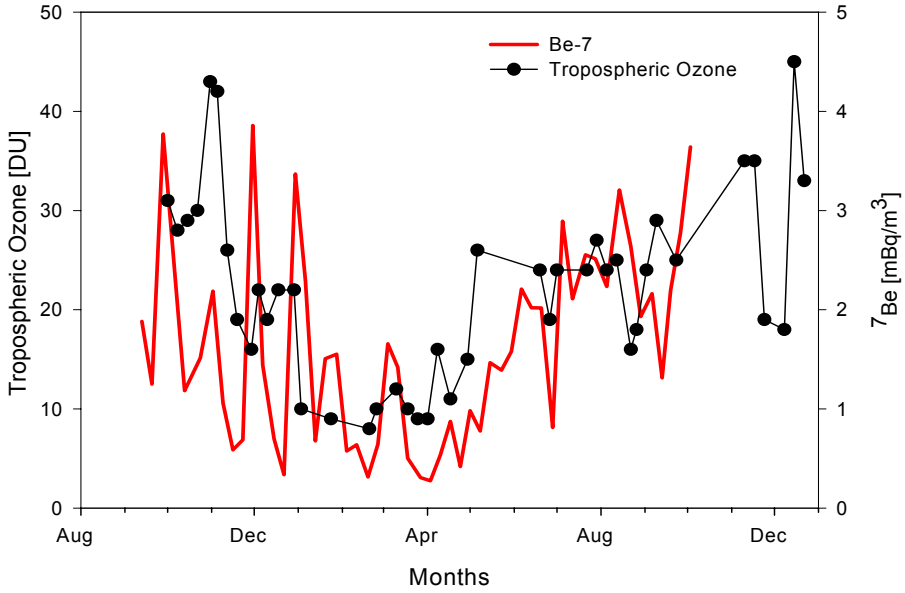

Figure 6: Correlation between ^{7}Be and Tropospheric ozone for Fiji, 1999-2000.

DISSEMINATION OF RESULTS

Data Reporting

The ozone profile data collected in Fiji is sent to NOAA in Boulder, Colorado. The data from there is then transferred to the SHADOZ (Southern Hemispheric Additional Ozonesondes) archives.

PROJECTS AND COLLABORATION

The major international collaboration is with NASA/GSFC/NOAA/CMDL. Under this collaborative effort ozone monitoring in Fiji began during the Pacific Exploratory Mission (PEM)-Tropics A mission of NASA in the spring of 1996. The phase B of this mission (PEM Tropics-B) was conducted in the fall of 1999. Since 1997, ozonesonde measurements are being done on a weekly basis as part of the SHADOZ (Southern Hemispheric Additional Ozonesondes) programme initiated by NASA/GSFC/ NOAA/CMDL. More information can be found in the SHADOZ web site http://croc.gsfc.nasa.gov/shadoz/.

This international collaboration was aimed at studying the atmospheric chemistry over the Pacific region (over two seasons) and to build ozone database for satellite validation, processing and modeling. Moreover, ozonesondes are currently also launched to coincide with the Aura satellite overpass.

At a national level collaborations with the ODS unit of The Department of Environment have provided a means of creating awareness of the ozone hole problems and use of ozone depleting substances such as CFCs.

Collaborations within the Departments (Chemistry, Physics and PACE-SD) of the University has also enabled completion of a number of projects especially, for Master of Science students (Chandra, 2004; Mani, 2004; Gopal, 2000). Recent research at USP has looked into:

- Comparative study of ozone trends at all levels (surface, troposphere and stratosphere) in Fiji, Samoa, Tahiti, San Cristobal (Galapagos) and the South Pole (Amundsen-Scott Station) during 1997-2003, using data collected by NOAA/CMDL.

- Identifying the relationship between tropospheric ozone variations in the South Pacific and biomass burning by using clustered and individual trajectory analysis.

- Investigating vertical mixing of air by relating tropospheric ozone anomaly with surface ^{7}Be levels in Fiji.

- Identifying widespread regional convection (SPCZ) as one of the important sources of variability in surface and tropospheric ozone.

- Investigating the influence of quasi-biennial oscillation and solar cycle on stratospheric ozone trends.

- Relating surface UV-B levels with stratospheric ozone variations.

FUTURE PLANS AND RECOMMENDATIONS

The following activities are planned for the future:

- Continue monitoring vertical ozone profiles under the SHADOZ programme.

- Study the STE processes more accurately by coupling a frost-point hygrometer with the ozonesonde launches, hence monitoring vertical water vapor profile regularly.

- Start a continuous UV-B monitoring programme and study the changes in the influx of surface UV-B radiation as a result of stratospheric ozone variations. It is planned to acquire a good narrow band UV-B pyranometer for the Department of Chemistry and also have a regular standardization and validation programme. For effective study of surface influx of UV-B, the atmospheric aerosol loading and cloud cover also needs to be determined. Hence, it is also planned to introduce a light detection and ranging (lidar) instrument and develop cloud characterization capacity at the university in conjunction with the Fiji Meteorological services. Accurate measurements of surface UV-B levels will also pave the way for the currently incomplete biological studies such as UV-B induced damage to plants, marine organisms, cases of skin cancer and cataracts.

- Introduce a Dobson or a Brewer spectrophotometer to enhance the capacity of ozone monitoring and research at USP.

Being a developing Island nation, funds and expertise are not readily available in Fiji to carry out the above activities effectively. Thus, completion of the above activities will depend heavily on funding from donor organizations.

ACKNOWLEDGEMENTS

The ozone project at USP is funded by NASA/GSFC and implemented through NOAA/CMDL under the SHADOZ programme. Sincere gratitude to Bryan Johnson of CMDL for ensuring timely shipment of supplies for regular ozone monitoring.

Data from measurements made under the SHADOZ programme can also be found in Thompson *et al*. (2003).

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