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Results of intercomparison and calibration of Dobson spectrophotometer no.112, Japan-1996

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सार — 1996 के दौरान जापान में RAII और V क्षेत्रों में कार्यशील डॉबसन स्पेक्ट्रोमीटर की अन्तर्राष्ट्रीय तुलना की गई। डॉबसन उपकरणों की इस तुलना में भारत, जापान, कोरिया, फिलीपीन और थाईलैंड देशों ने भाग लिया। तुलना के लिए मानक उपकरण, जापान द्वारा प्रयुक्त क्षेत्रीय मानक डॉबसन उपकरण संख्या 116 था। इस तुलना के परिणामों से इस तथ्य की पुष्टि हुई कि भारतीय मानक उपकरण संख्या 112 अंशशोधन की सही-स्थिति में था और इस उपकरण से प्राप्त किए गए आंकड़े विश्वसनीय थे।

ABSTRACT. An international comparison of Dobson spectrophotometer operated in the RA II and V regions was conducted in Japan during 1996. Countries participating with Dobson instruments were India, Japan, Korea, Philippines and Thailand. The reference standard instrument for the comparison was regional standard Dobson instrument no.116 maintained by Japan. The comparisons confirmed that the Indian standard no.112 was in good state of calibration and the data derived from the instrument was reliable.

Key words — Total ozone, Dobson spectrophotometer, Standard instrument, Intercomparison.

1. Introduction

Dobson ozone spectrophotometer serves as a standard for measurement of atmospheric total ozone. International Dobson instrument comparisons in the past have revealed large calibration errors for many of the instruments (Dziewulska- Losiowa and Walshaw 1975; Gushchin 1972). However, the accuracy of the ozone measurements within the global Dobson station network improved markedly following an international Dobson spectrophotometer inter-comparison (Komhyr *et al.* 1981) held in Boulder 1977. At that time eight spectrophotometers, designated by the World Meteorological Organization (WMO), as regional secondary standards, were calibrated relative to instrument no.83 (world primary standard Dobson instrument) with the intent that they may be used to calibrate field instruments within their respective regions. Dobson spectrophotometer no.112 maintained by National Ozone Centre. India Meteorological Department participated in the earlier international inter-comparison of Dobson spectrophotometer held at Boulder in 1977 and Melbourne (Australia)in 1984.

1.1. *Purpose of inter-comparison*

The inter-comparison was organised by WMO in close cooperation with the Japan Ministry of Transport and the Japan Meteorological Agency. The intercomparison helped to ensure the quality of the total ozone data sets created by the member countries.

The main tasks were:

(a) The technical inspection and adjustment of the instrument.

(b) Comparison of the Dobson spectrophotometer with the Regional Standard Dobson instrument no.116, to determine the existing calibration level.

(c) Determination of new calibration constants for each Dobson spectrophotometer, as needed.

(d) To provide a forum for instruction for operation of the Dobson spectrophotometer at home stations and sharing of knowledge concerning the management of an ozone observing program.

1.2. *Operation*

The inter-comparison was held at the Aerological Observatory (AOT) of the Japan Meteorological Agency in Tsukuba during 27 February to 26 March 1996.

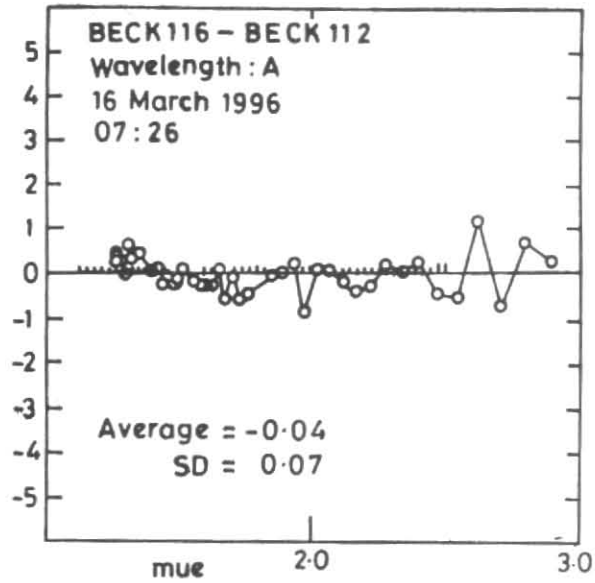

Fig.1. Comparison of 116 with 112 showing the average difference for "A" wavelength

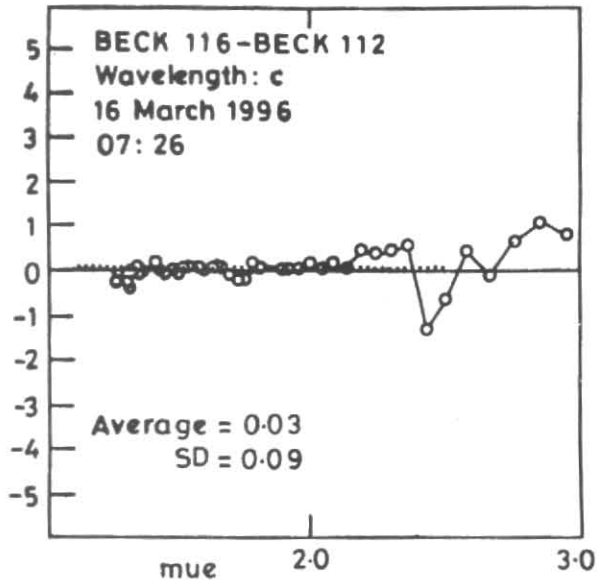

Fig.2. Comparison of 116 with 112 showing the average difference for "C" wavelength

The following national Dobson spectrophotometers were calibrated:

Instrument No.	*Country*
D052	Philippines (Manila)
D090	Thailand (Bangkok)
D112	India (New Delhi)
D124	Korea (Yonsei University, Seoul)

The inter-comparison was performed and all activities were coordinated according to the weather conditions and taking into consideration the technical state of the individual instruments.

2. Instrument and calibration

The Dobson instrument and the method of operation are well documented (Dobson 1957 and Normand, Komhyr *et al.* 1989) Briefly, the instrument measures the intensity ratios of selected wavelength pairs in the ultraviolet by attenuating the more intense wavelength to match the intensity of the other. If the atmospheric ozone absorption coefficients for those wavelengths are known, the total ozone amount can be calculated from the difference found in measurements on direct sun-light or light from the zenith sky. The calibration of the instrument consists of:

(1) The wavelength calibration of the instrument. The instrument should be optically aligned using the published parameters (Dobson and Normand 1957). So that it is operating on the correct wavelengths with the correct bandpass.

(2) The optical attenuator ("wedge") calibration. This relates the attenuator position to the difference in intensity. The "two lamp" method performed by an expert is recommended.

(3) The extra-terrestrial calibration (ETC). The determination of ETC can be done either by the Langley plot method, *i.e.*, making measurements on the rising or setting sun and then extrapolating the results to outside the atmosphere. The Langley plot method assumes that the total ozone amount in the atmosphere does not change during time of the calibration.

(*i*) By direct comparison to a standard. The direct comparison method is recommended. This calibration is thus traceable to a primary standard, which improves the station-to-station consistency. The instrument's performance with respect to the sun's zenith angle is then also evaluated with respect to the standard's.

(*ii*) or by the use of "standard" lamps.

3. Calibration monitoring

Once the calibration has been done, the standard operating procedure is to verify the calibration on a regular schedule. The wavelength calibration can be verified with a simple mercury discharge lamp, and changes in the instrument's ETC can be tracked with a simple quartz halogen lamp (a "standard" lamp).

Changes in the "wedge" calibration can be best tracked with repeated two lamp calibrations. The schedule depends

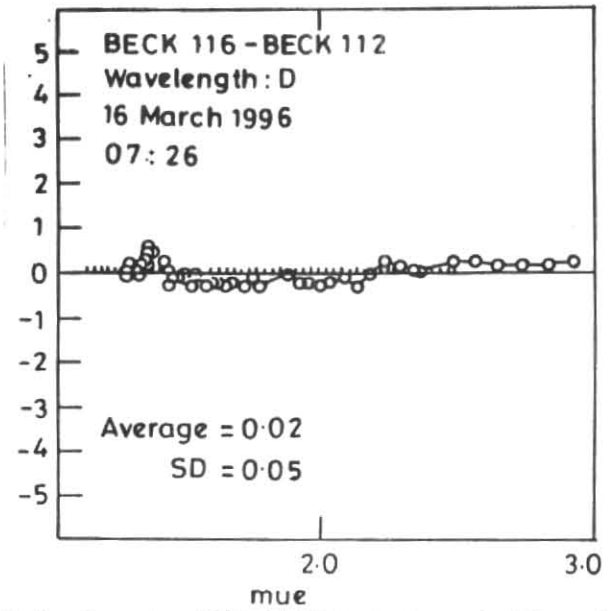

Fig.3. Comparison of 116 with 112 showing the average difference for "D" wavelength

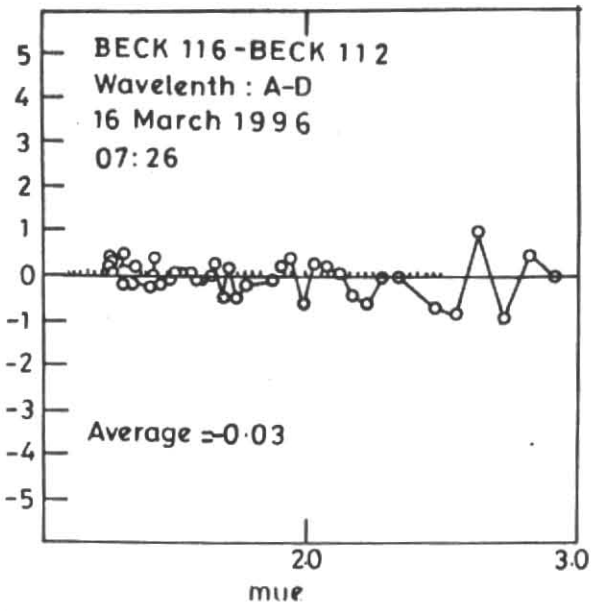

Fig.4. Comparison of 116 with 112 showing the average difference for "A-D" wavelength

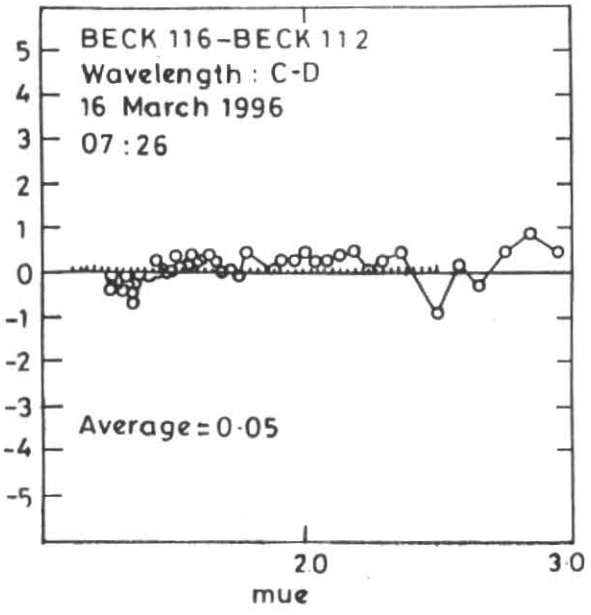

Fig.5. Comparison of 116 with 112 showing the average difference for "C-D" wavelength

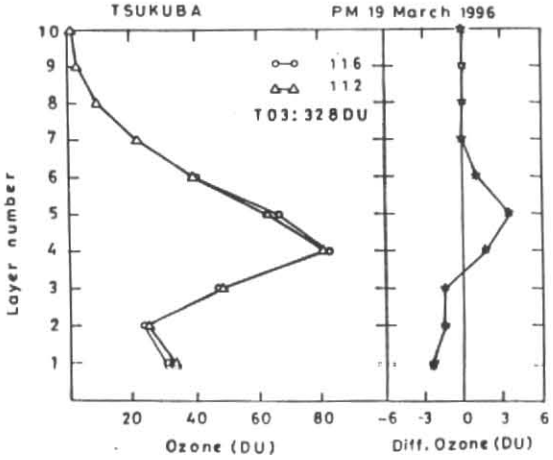

Fig.6. Umkehr observations showing the difference between profiles

on the age and history of the instrument, but every four years is the most common schedule. Now or recently rebuilt instruments should have the calibration checked more often.

The instrument should be compared to a standard instrument on a regular basis, normally four years. The comparison is also a time to review observation techniques and data handling procedures. If there are changes in the calibration, these must be accounted for in the existing data.

4. Results

The results are enlisted below:

(a) Initial calibration results shows that the d-Nad value implies an average +0.0% error in calculated ozone value, mu=1 to 3.Total ozone =300 D.U.

(b) The comparison of 116 with 112 shows the average difference for "A" wavelength -0.04%, for "C" 0.03%, for "D" -0.02%, for "A-D" 0.01% and for "C-D" wavelength 0.05%. Figs.1,2,3,4 and 5.

(c) Highest difference against the standard for ADDSGQP observations in mu range 1.15 to 3.2 was 0.1% in total ozone.

(d) Umkehr observations shows a difference between profile calculated from the instrument no.112 was less than three Dobson units in any of the standard Umkehr layers (Fig.6).

5. Conclusion

The initial inter-comparison data confirms that the existing ozone data derived from the instrument no.112 is accurate. This instrument is used to calibrate other Dobson instruments in the IMD network. Therefore, it confirms that the existing data at various IMD stations meet the international standards of reliability.

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