# CORRECTION AND VALIDATION OF TOTAL OZONE DATA SERIES FROM AN ANTARCTIC MULTICHANNEL FILTER RADIOMETER SOLAR UV NETWORK

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## *MAR PROJECT*

*"Measurement of Antarctic Radiance for monitoring the ozone layer"* (REN2000-0245-C02-02)
Financed by the National R+D Plan of the Ministry of Science and Technology
(www.izana.go.to/mar/)

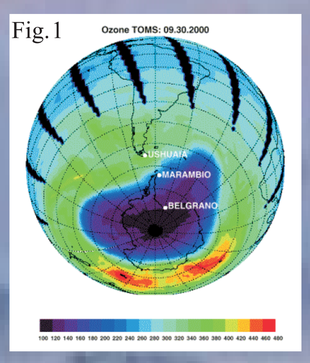
Participating Institutions.-
- Instituto Nacional de Meteorología (INM, Spain)
- Instituto Nacional de Técnica Aeroespacial (INTA, Spain)
- Centro Austral de Investigaciones Científicas (CADIC, Argentina)
- Dirección Nacional del Antártico/ Instituto Antártico Argentino (DNA/IAA, Argentina)
- Finnish Meteorological Institute (FMI, Finland)

Objectives.-
- Observe and characterize the evolution in time and space of $O_3$, $NO_2$, OClO and ultraviolet radiation in the Antarctic and Sub-Antarctic region
- Carry out a dynamic study of the Antarctic polar vortex
-Improve the QA/QC system for the NILU-UV6 Multichannel Radiometers.

Stations (figure 1).-
- Ushuaia (54º49'S, 68º19'W)
- Marambio (64º14'S, 56º38'W)
- Belgrano (77º52'S, 34º37'W)

Instruments.-
- 3 NILU-UV6 multichannel radiometers - INM
- 1 Travelling reference NILU-UV6 - FMI
- 3 UV-VIS (DOAS) Spectrometers ("EVA") - INTA
- 1 Ozonesonde ECC (Belgrano station) - INTA

Fig.1




## SOLAR UV NETWORK

NILU-UV6 Multichannel Radiometer (figure 2)
- Five UV channels centered at: 305, 312, 320, 340 and 380 nm (10nm FWHM)
- PAR (400-700 nm)
- Stabilized temperature: 40 ºC
- Total ozone, biological UV doses rate and cloud optical depth are obtained on a routine basis based on Dahlback's algorithms (Dahlback, 1996)

Quality Control (INM)
- Two 100-W working lamps every 15 days and one control lamp every month

Quality Assurance (FMI)
- See Poster ST005 : "*Quality assurance of a solar UV network in the Antarctic*" (Lakkala et al., 2002)


Fig.2

## THE IRRADIANCE CORRECTION METHOD USING LAMP TESTS

- Lamp irradiance is recorded every second during 15 minutes, after 10 minutes of lamp warming.

- Averaged irradiance of last 10 minutes is calculated for each lamp.

- Lamp test time series are referenced to the first lamp test performed with the three lamps (figure 3). This first test, taken as reference, corresponds to the values of the original calibration coefficients determined using a reference spectroradiometer (Bentham DM-150 spectrometer at the Izaña Observatory).

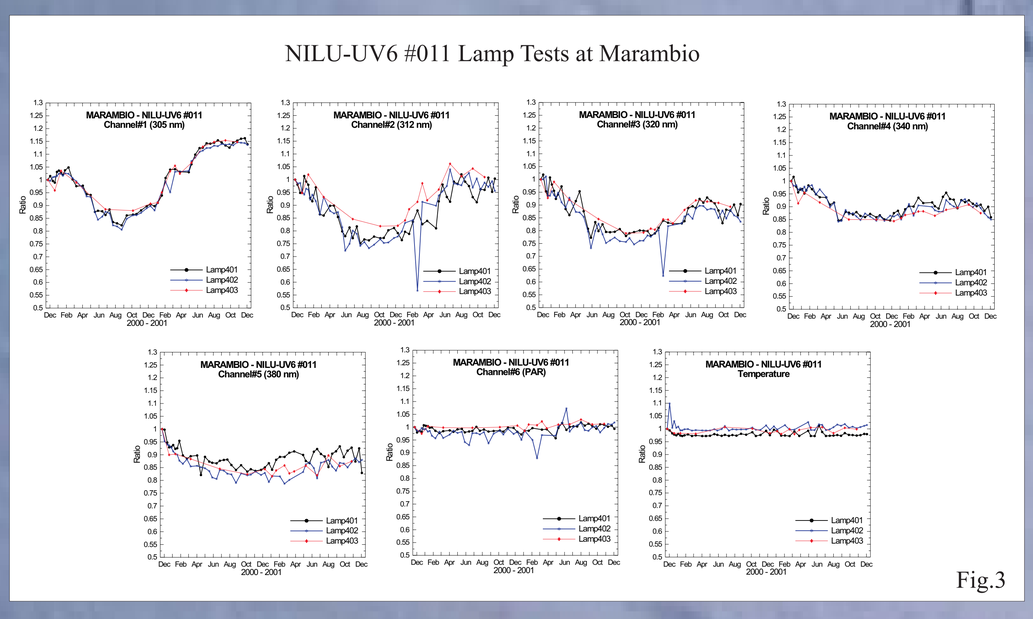



Fig.3

- Ratios between lamps are used to remove outliers. Averaged ratios between lamps for every channel are computed. Points outside 2 SD range are removed (figure 4).

- A five-order correction polynomial is calculated using the averaged ratios of the three lamps for each channel (figure 5). These polynomials are applied to the calibration coefficients, and then irradiance data sets are re-calculated.

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- Dahlback, A., (1996):"Measurements of biologically effective UV doses, total ozone abundances, and cloud effects with multichannel, moderate bandwidth filter instruments". *Appl. Opt.*, **35**, 6514-6521.
- Lakkala, K., A. Redondas, T. Koskela, P. Taalas, C. Torres, E. Cuevas and G. Deferrari (2002): "Quality assurance of a solar UV network in the Antarctic". 27th General Assembly of the European Geophysical Society, Poster Presentation (ST005) in Session ST4.03.

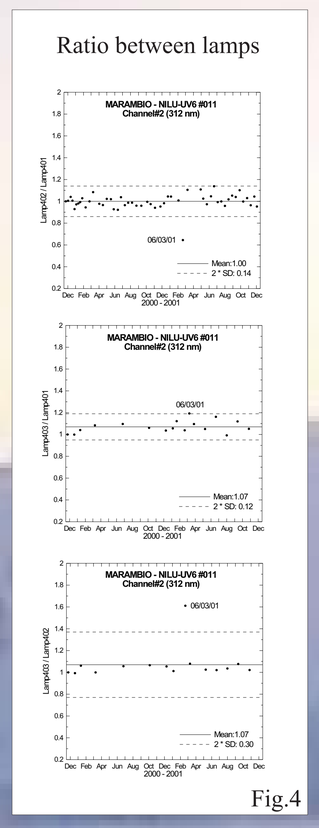
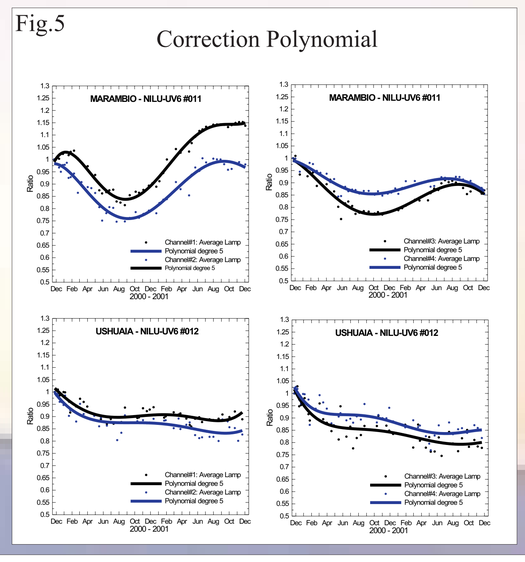



Fig.4

Fig.5



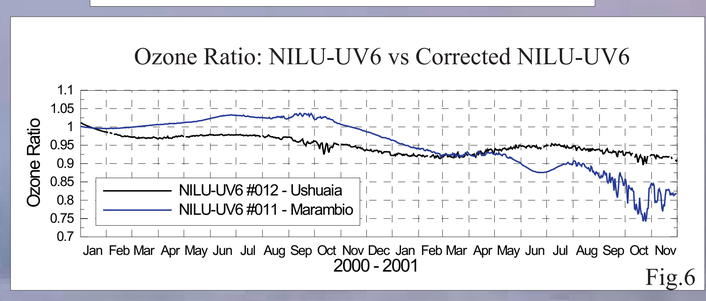




Fig.6

## OZONE COMPARISON

- The different behaviour of channel#2 (312nm) and #3 (320nm) used for the ozone calculation and the possibility of comparisons with other reference instruments, allow us to obtain an estimation of the goodness of the irradiance correction method.

- This correction method produces a correction in the total ozone series up to 25% in some periods (see figure 6 as example). Once total ozone is corrected the agreement with the ozone obtained with the reference instruments is quite good at each station (figures 7 and 8).

- The agreement between the NILU-UV6 instrument and the reference instruments is of the same order as the relative differences found between the reference instruments each other (figure 9). However significant total ozone differences are found when comparing with TOMS and EVA at noon zenith angle higher than 83º. Notice that NILU-UV6 irradiance data is not cosine error corrected.

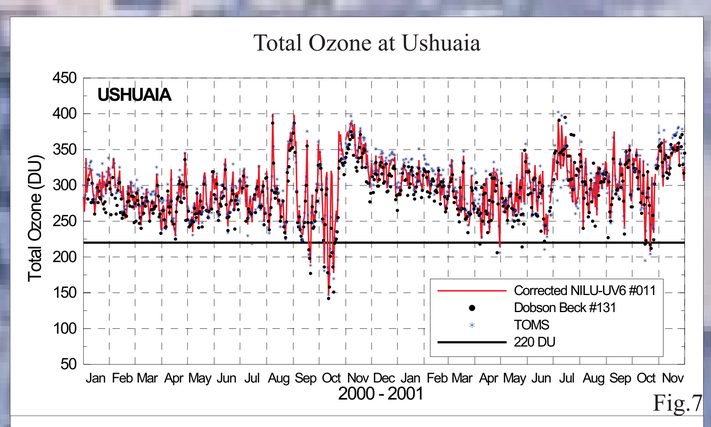



Fig.7

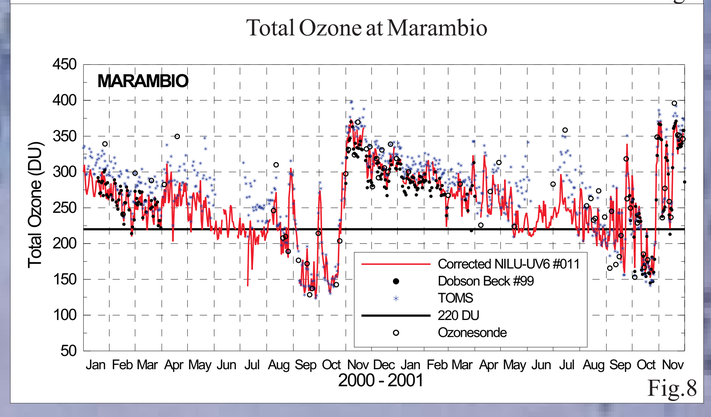



Fig.8

Ozone comparison reference instruments

| | |
|---|---|
| Ushuaia | |
| Dobson Beck #131 | Servicio Meteorológico Argentino (GAW) |
| TOMS | NASA |
| SUV-100 (CIE) | NSF/Biospherical inc. (CADIC) |
| Marambio | |
| Dobson Beck #099 | Servicio Meteorológico Argentino |
| UV-VIS Spectrometer ("EVA") | INTA |
| TOMS | NASA |
| Ozonesonde (ECC) | FMI |

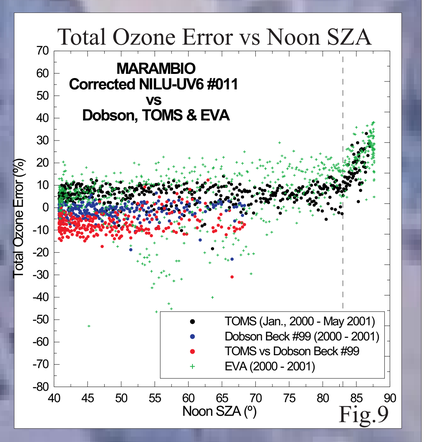



Fig.9

## CIE ERYTHEMATIC DOSE RATE COMPARISON

- Preliminary comparison of CIE Erythematic dose rate with the SUV-100 spectroradiometer at the CADIC Ushuaia station provides a fairly good agreement once the irradiance correction method is applied to the CIE dose rate calculation (figure 10).

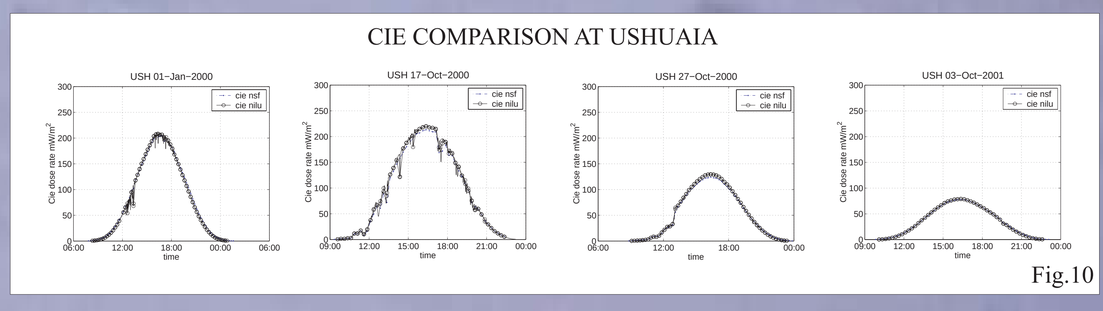



Fig.10

## DISCUSSION AND CONCLUSIONS

- Regular lamp tests (almost every two weeks) performed to the NILU-UV6 instruments of the MAR Project's Antarctic network show a significant instability in the instrument response that is different for each channel and each instrument. These large changes in the instrument response through the time, that can reach a +/- 25%, could question, in principle, NILU-UV6 data quality.

- Lamp tests provides a powerful tool to detect and correct these instrument response observed changes. A method is proposed to correct the irradiance data of the NILU-UV6 which provides excellent results in total ozone and CIE Erythematic dose when comparing with reference instruments. We can conclude that NILU-UV6 is an excellent instrument for ozone and UV monitoring if an accurate Quality Control system is performed on a regular basis (at least every two weeks).

- Future effort will be paid to quantify the accuracy and uncertainty of corrected data.
Quality control system will be improved increasing the accuracy of the voltage and intensity measurements of the lamps during the lamp tests.
Cosine error correction will be also introduced to improve data for high zenith angles.