RELATIONSHIP BETWEEN TOTAL OZONE AND UV DOSE RATE PROVIDED BY THE NILU-UV6 MULTICHANNEL RADIOMETER NETWORK AT THE ANTARCTIC REGION

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SOLAR UV NETWORK – *MAR* PROJECT

"Measurement of Antarctic Radiance for monitoring the ozone layer" (REN2000-0245-C02-02)
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(www.inm.es/mar/)

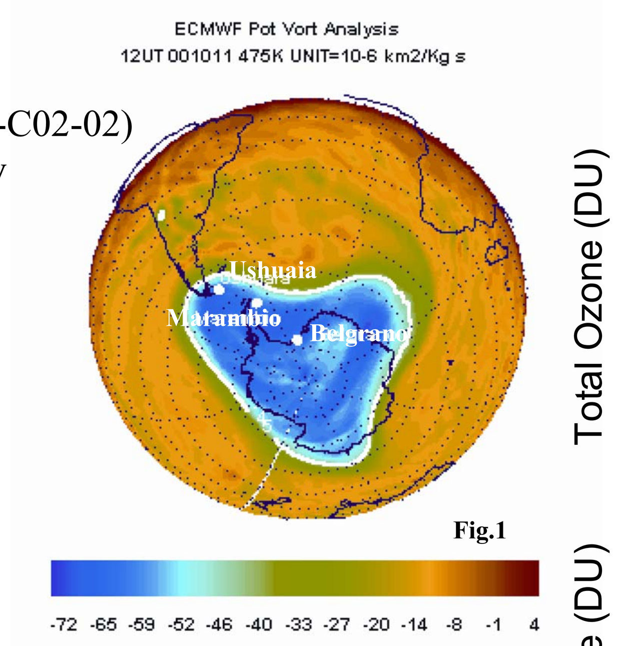

Fig.1

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

NILU-UV6 Multichannel Radiometer
- 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 (Instituto Nacional de Meteorología, INM)
- Two 100-W working lamps every 15 days and one control lamp every month

Quality Assurance (Finnish Meteorological Institute, FMI)
- Traveling reference NILU-UV6 transfers calibration factors from the absolute reference spectroradiometer by direct comparison with the instruments at Ushuaia and Marambio twice a year. The NILU-UV6 from Belgrano is replaced every year by another instrument previously calibrated at the Izaña Observatory.

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 (fig. 2). 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).

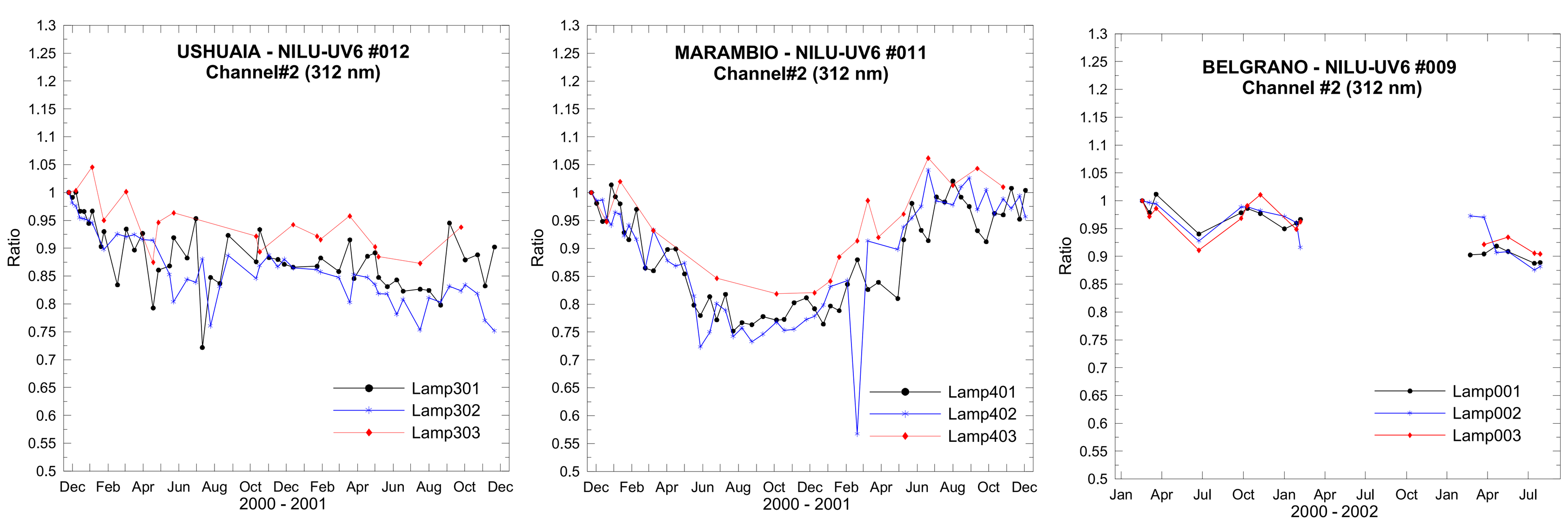

Fig. 2.- Lamp tests at Ushuaia, Marambio and Belgrano

-Ratios between lamps are used to remove outliers. Averaged ratios between lamps for every channel are computed and the points outside 2 SD range are removed (fig. 3).
-A correction polynomial is calculated using the averaged ratios of the three lamps for each channel and instrument (fig. 4). These polynomials are applied to the calibration coefficients, and then irradiance data sets are re-calculated.
- For the stations where the QA is available (Ushuaia and Marambio), this correction method shows very good agreement with the traveling reference (Lakkala, EGS 2002)

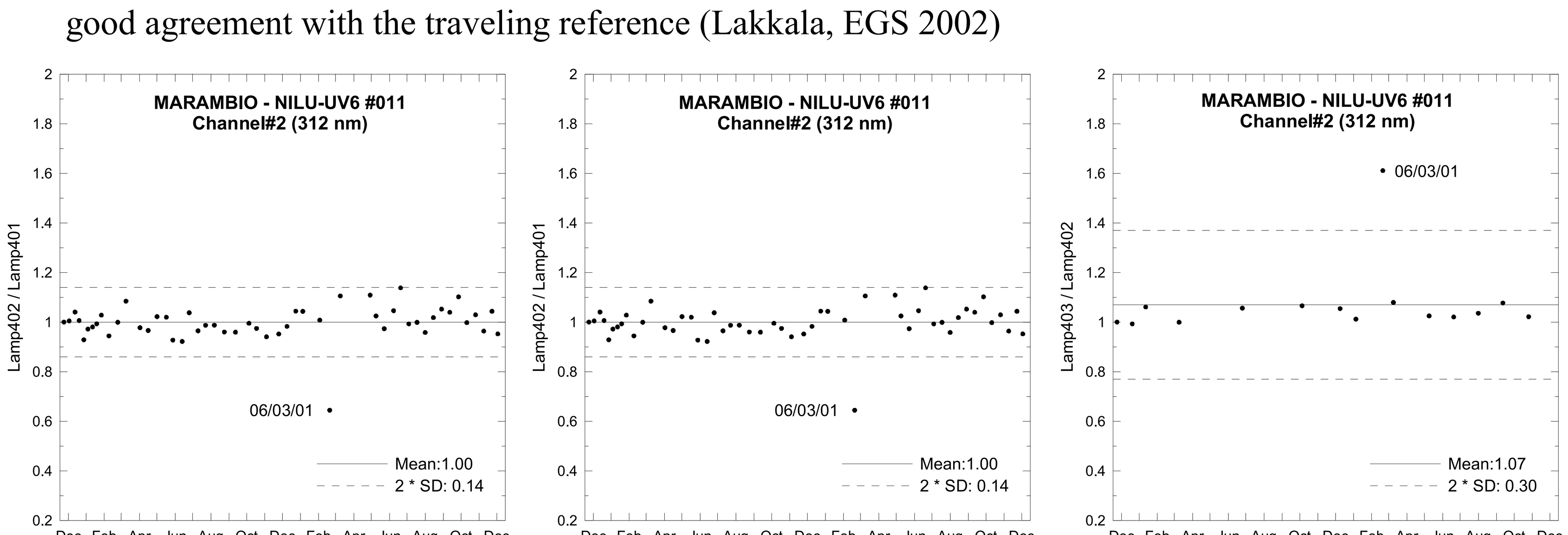

Fig. 3.- Ratio between lamps for channel #2 of NILU-UV6 #011

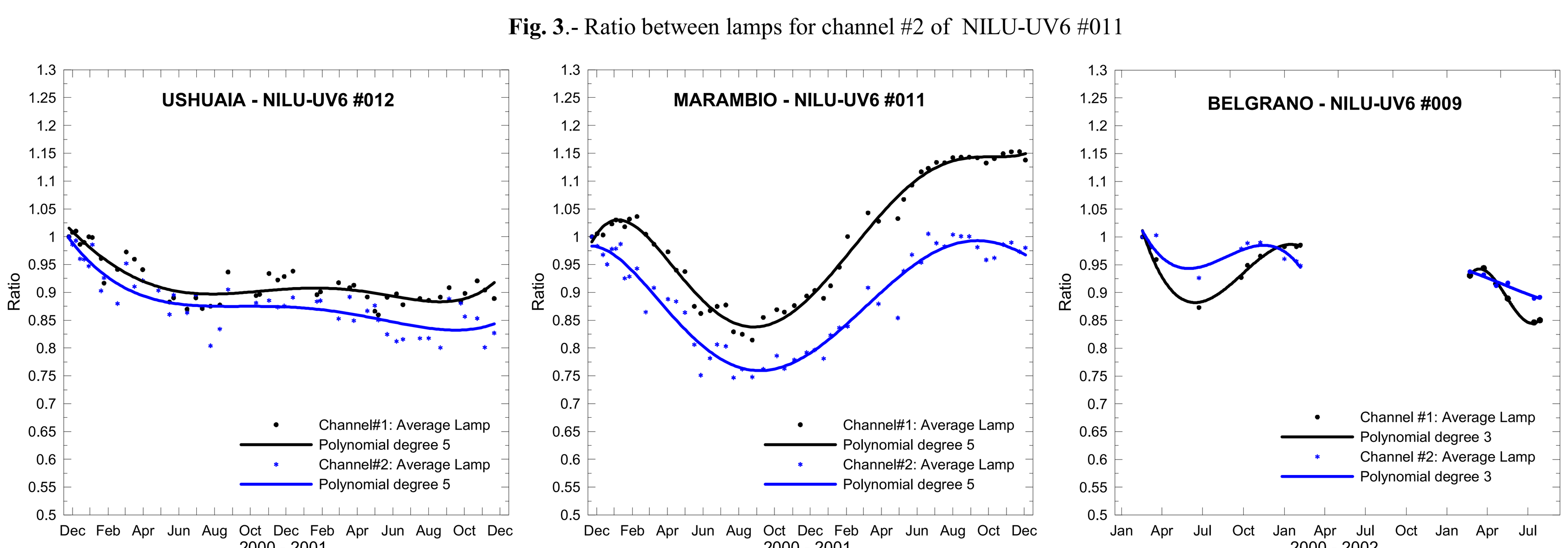

Fig. 4.- Correction polynomial for channel #1 and #2 of each instrument.

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OZONE COMPARISON

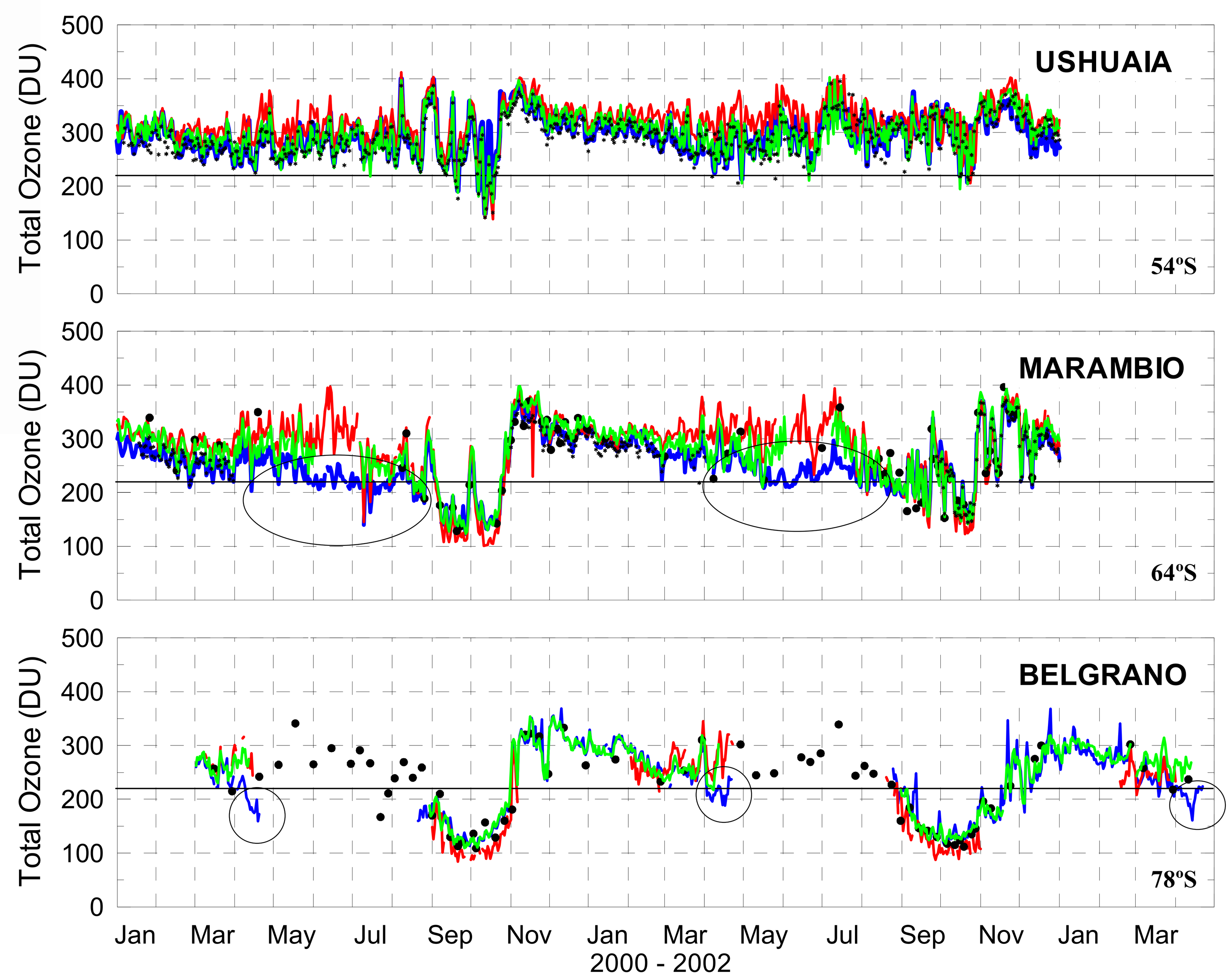
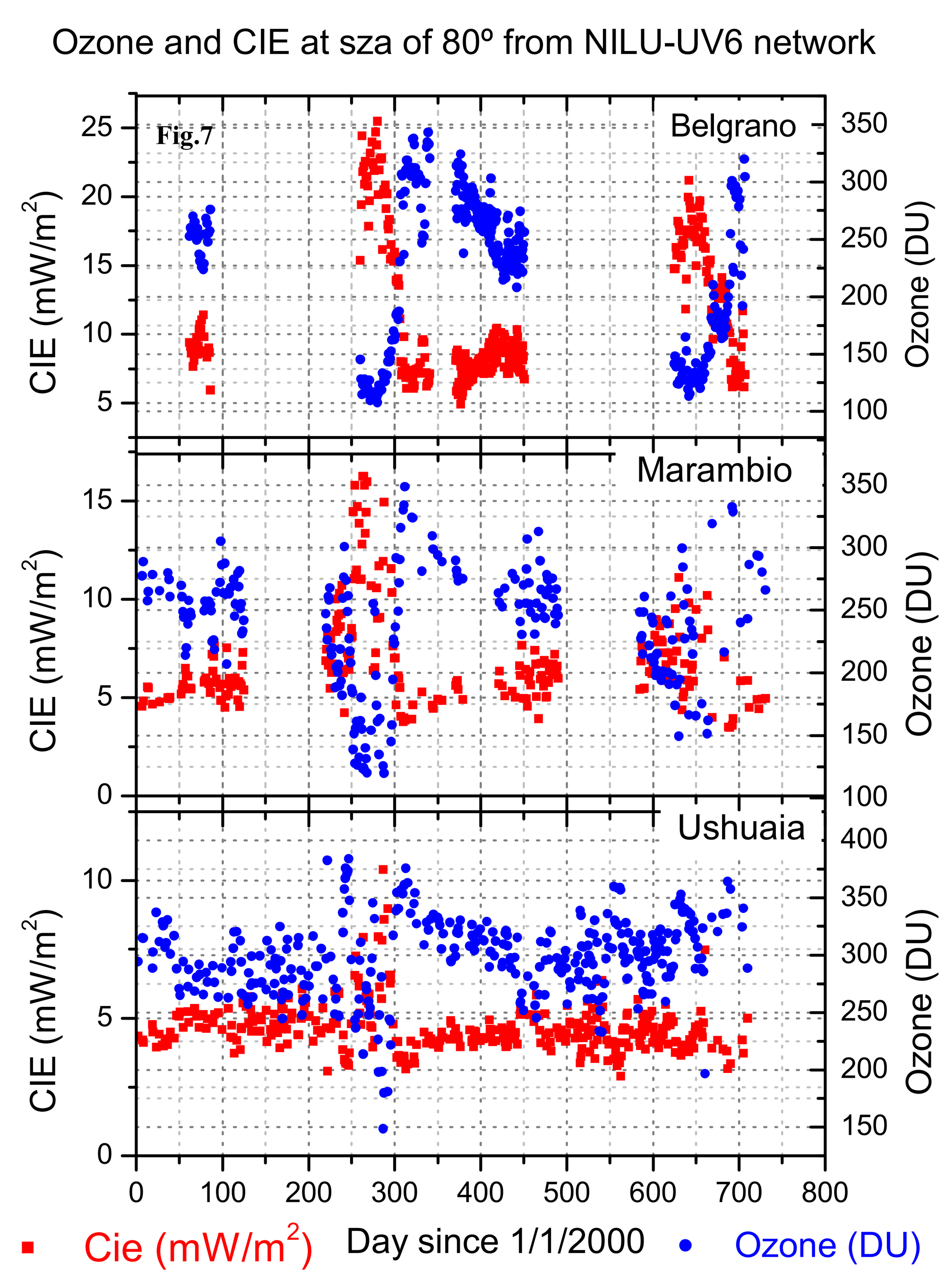


Fig. 5.- Total ozone evolution obtained by the NILU-UV6 (#012 Ushuaia, #011 Marambio, #009 & 0010 Belgrano, blue line), the DOAS Spectrometer 'EVA' (red line), the TOMS (green line), Dobson (#131 Ushuaia, #099 Marambio, **black star**) and ozonesondes (**black cross**) at the three stations. Circles represent large desviation of NILU-UV6 in the comparison with the rest of the instruments for sza > 80º.

Ozone Comparison Relative difference (%) NILU-UV vs	**USHUAIA**		**MARAMBIO**		**BELGRANO**			
	NILU-UV6 #012		NILU-UV6 #011		NILU-UV6 #010		NILU-UV6 #009	
	2000	2001	2000	2001	2000	2001	2000	2001
TOMS (NASA)	-0,07 ± 4,86	-0,48 ± 4,78(1)	-5,78 ± 4,23	-5,70 ± 2,96(1)	---	-3,70 ± 3,04	-0,49 ± 4,65	1,12 ± 2,43(1)
EVA (INTA)	-5,80 ± 7,34	-8,29 ± 10,76	-3,83 ± 14,50	-4,13 ± 10,37	---	16,77 ± 22,97	19,2 ± 18,6	8,00 ± 7,55
Dobson (SMN)	4,14 ± 5,41	1'12 ± 7,73	1,13 ± 2,98	1,84 ± 3,59	---	---	---	---
Ozonesonde	---	---	-0,72 ± 10,82		4,00 ± 15,43			

Table1.- Total ozone relative difference between NILU-UV6 with TOMS (**1**, January to July, 2001), DOAS Spectrometer 'EVA' (INTA, Instituto Nacional de Técnica Aeroespacial, Spain), Dobson (SMN, Servicio Meteorológico Nacional, Argentina) and ozonesondes (Marambio, FMI; Belgrano, INTA) dataset in each stations during 2000-2001 . NILU-UV6´s total ozone at noon (if solar zenith angle is less than 80º).

- Total ozone obtained with NILU-UV6's corrected dataset shows good agreement when compared to external instruments (Fig.5). The averaged relative differences between NILU-UV6 and other external instruments are of the same order as relative differences found among them (Table1). However, significant total ozone underestimations are found when comparing against TOMS and EVA at noon zenith angle higher than 83º (Fig.6). Notice that NILU-UV6 irradiance data is not cosine error corrected.



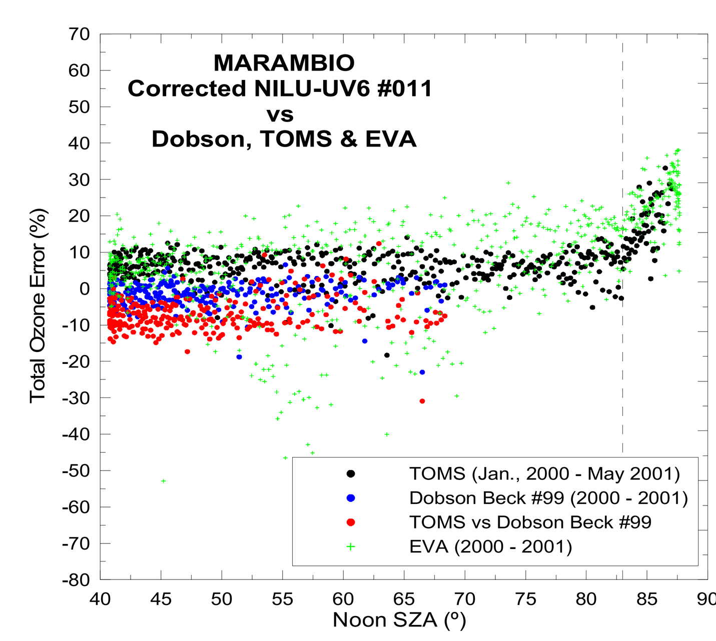


Fig.6.- Total ozone error vs noon zenith angle.

OZONE & CIE EVOLUTION

- The geographic distribution of the three stations allows the polar vortex monitoring. Ushuaia station is rarely inside the polar vortex influence, Marambio station is normally inside but some time is outside whereas Belgrano station is always inside the polar vortex (fig.7).
- Figure1 shows the potential vorticity (475 K) based on ECMWF analysis for day October 11, 2000, where Ushuaia is located inside the polar vortex clearly detected by the NILU-UV6 instruments of the network (around day 300, fig7).

CONCLUSIONS

- The NILU-UV6 radiometers are robust and cheap instruments. These instruments provide excellent ozone and UV monitoring, associated to the polar vortex, if a QA/QC system is well performed on a routine basis (QC every two weeks and QA once a year).
- Cosine error correction is needed to improve results at high zenith angles (greater than 83º), what is important in Polar Regions.