

## Report from Chile

### Eighth meeting of the Ozone Research Managers of the Parties to the Vienna Convention

#### for the Protection of the Ozone Layer

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#### OBSERVATIONAL ACTIVITIES

Continuous monitoring of UV radiation in major cities is mainly operated and maintained by the Meteorological National Service of Chile (DMC). Observations of total column ozone are carry out only in one station, in southern Chile (Punta Arenas), operated and maintained by the University of Magallanes (Umag). Ozone profile measurements, two stations are operating: in Isla de Pascua (Eastern Island) since 1995 and recently in Punta Arenas (2009) started continuous observations with ECC ozonesonde.

#### Ozone Column measurements

Station	Instruments	Institution	LAT.	LONG.	Period of observations	Calibrations
Punta Arenas	Brewer MKIV 068	University of Magallanes	53°18'S	70°54'W	1992-2000	
Punta Arenas	Brewer MKIII 180	University of Magallanes	53°18'S	70°54'W	2002 – Jun.2006	2003-2004
Punta Arenas	Brewer MKIV 124	University of Magallanes (Chile)- INPE (Brazil)	53°18'S	70°54'W	Aug.2007- Nov.2007	
Punta Arenas	Brewer MKIII 180	University of Magallanes	53°18'S	70°54'W	Nov.2007-today	2007-2009

### Ozone Profile measurements

Station	Type	Institution	LAT.	LONG.	Period of observations
Punta Arenas	Umkehr	University of Magallanes	53°18'S	70°54'W	2002 – today
Punta Arenas	Ozone sondes -ECC-Z LMG6	University of Magallanes	53°18'S	70°54'W	2009 – today
Eastern Island	Ozone sondes ECC	DMC	27°09'S	109°27'W	1994- today

DMC: Dirección Meteorológica de Chile (National Meteorological Service)

### UV measurements

#### Broadband measurements

#### Instruments of the groups of research

Station	Instruments	Institution	LAT.	LONG.	Period of observations
Arica	Solar Light 501	University of Atacama	13° 28'S	70° 20'W	1998 - 2005
Santiago	Solar Light 501	University of Santiago	33°26'S	70°40'W	1999 - today
Puerto Natales	Solar Light 501	University of Magallanes	51° 43'S	72° 31'W	1997 - today
Punta Arenas	Solar Light 501	University of Magallanes	53°18'S	70°54'W	1997 - today
Puerto Porvenir	Solar Light 501	University of Magallanes	53° 17'S	70°22'W	1997- 2002
Puerto Williams	Solar Light 501	University of Magallanes	54° 55'S	67° 37'W	1997 - 2010
Bernardo O'Higgins	Solar Light 501	University of Magallanes	63°19'S	56°54'W	2007 - today

### Network of DMC

STATION	TYPE	LAT	LONG	ELEV	PERIOD OF OBSERVATIONS
Arica	Pyranometer YES UV-B	18° 28' S	70° 19' W	23m	2006 – today
Iquique	Pyranometer YES UV-B	20° 33' S	70° 07' W	60m	1998 – today
María Elena	Pyranometer YES UV-B	22° 21' S	69° 40' W	1241m	2008 – today
San Pedro de Atacama	Pyranometer YES UV-B	22° 55' S	68° 12' W	2450m	2007 – today
Antofagasta	Pyranometer YES UV-B	23° 27' S	70° 26' W	145m	2006 – today
Isla de Pascua	Biometer Solar Light	27° 09' S	109° 26' W	47m	2009 – today
La Serena	Pyranometer YES UV-B	29° 54' S	71° 12' W	25m	2003 – today
El Tololo	Pyranometer YES UV-B Kip –Zonen /Li-Cor	30° 10' S	70° 48' W	2030m	1997 – today
Valparaíso	Biometer Solar Light	32° 56' S	71° 28' W	131m	2002 – today
Farellones	Pyranometer YES UV-B	33° 21' S	70° 17' W	2746m	2011 – today
Valle Nevado	Pyranometer YES UV-B	33° 21' S	70° 15' W	3015m	2006 – 2009
Santiago- Pudahuel	Pyranometer YES UV-B	33° 23' S	70° 47' W	475m	1992 – 2006
Santiago- Quinta Normal	Pyranometer YES UV-B	33° 26' S	70° 40' W	520m	2002 – today
Rancagua	Pyranometer YES UV-B	34° 10' S	70° 46' W	491m	2010 – today
Talca	Pyranometer YES UV-B	35° 25' S	71° 40' W	100m	2010 – today
Concepción	Pyranometer YES UV-B	36° 46' S	73° 03' W	8m	2002 – today
Valdivia – UACH	Spectroradiometer SUV 100	39° 48' S	73° 14' W	9m	1998 – 2007
Valdivia – Cecs	Pyranometer YES UV-B	39° 49' S	73° 15' W	18m	2010 – today
Puerto Montt	Pyranometer YES UV-B	41° 25' S	73° 05' W	85m	2001 – today
Coyhaique	Pyranometer YES UV-B	45° 35' S	72° 07' W	310m	2001 – today
Punta Arenas	Pyranometer YES UV-B	53° 00' S	70° 51' W	37m	2001 – today
Centro Meteorológico Antártico Presidente Eduardo Frei	Pyranometer YES UV-B	62° 25' S	58° 53' W	10m	1992 – today

### Narrowband filter instruments

Station	Instruments	Institution	LAT.	LON.	Period of observations
Santiago	GUV 511	University of Chile	33°26'S	70°40'W	1995 – today
Valdivia	GUV 511	University Austral	39°48'S	73°14'W	1995 – 2007
Punta Arenas	GUV 511	University Magallanes	53°18'S	70°54'W	1993 – today
Punta Arenas	NILU UV	University of Magallanes	53°18'S	70°54'W	2010 – today
Base Prof. Julio Escudero	NILU UV	University Magallanes	62°12'S	58°57'W	2005 – 2009

### Spectroradiometers

Station	Instruments	Institution	LAT.	LON.	Period of observations
Valdivia	SUV 100	DMC-University Austral	39°48'S	73°14'W	1997 – 2007
Station	Brewer MKIII 180	University of Magallanes	53°18'S	70°54'W	2002–today

### Calibration activities

- a) **DMC-network:** The instruments of the DMC were compared and calibrated in Antofagasta, 2010. Is expected during next years to establish Antofagasta as a national calibration point, especially the geographical location and facilities available there.
- b) **BREWER 180 (Punta Arenas):** International Ozone Services Inc. (IOS) did the ozone and UV calibration and service of Chilean Brewer Spectrophotometer #180 during period Nov. 09 – 12, 2009 at Punta Arenas, Chile. The World Meteorological Organization (WMO) supported this calibrations activities. The Brewer #180 produced lower (~6%) ozone results initially with existing constants, when compared to the traveling Brewer #017.



Fig. 1.- Ken Lamb (IO3), Brewer MKIII #180, and the traveling Brewer MKIV#017, during the calibration activities at Punta Arenas.

- c) **Biometers network (University of Magallanes):** The Solar Light instruments of the group of the University of Magallanes are calibrated each two year using the Brewer 180 located in Punta Arenas.
- d) **Narrowband GUV:** A second Inter-comparasion activity was carried out during 11-15 of January, 2011 with the instruments GUV of Río Gallegos and Punta Arenas. This activity form part of the objectives of the binational project “PROJECT FOR STRENGTHENING THE CAPACITY TO MEASURE THE OZONE LAYER AND UV RADIATION IN THE SOUTHERN PATAGONIA, AND THE PROJECTION TOWARDS THE COMMUNITY (UVO3Patagonia)” supported by the Japan International Cooperation Agency (JICA).

## RESULTS FROM OBSERVATIONS AND ANALYSIS

### Results of Studies at Punta Arenas Chile (Lat. 53S, Long. 70W).

The Brewer observations has been operational at Punta Arenas from May 1992 until today. Brewer #068 (1992-2000) and Brewer #180 (since year 2002). The Figure 2 shows the variation of the ozone column measured by Brewer from 1992 until 2010. A simple linear fit shows a slight increase in the total ozone column at Punta Arenas.

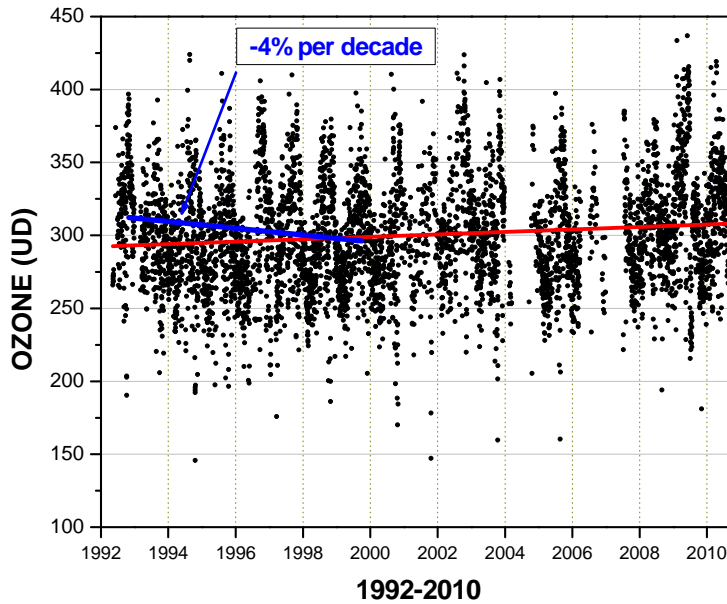


Fig.2 .- Ozone over Punta Arenas Chile 1992-2010 obtained with Brewer spectroradiometer (# 068 and # 180).

The number of days in which the Antarctic Ozone Hole (AOH) has been over South cone region varies year to year. Figure 3 shows the number of events of low ozone to Punta Arenas. The criteria for defining an event of low ozone is that ozone column (daily average) must be lower than the reference (mean monthly climatological values for Punta Arenas from TOMS overpass data for the period 1978-1987), minus twice the standard deviation of the mean (mean monthly -  $2\sigma$ ). The number of days per year is shown in part (a), these data show a cyclical variability of about 10 years. Last three years shows significant minimum, if these values remain low during next years it would be a sign of recovery of total column ozone to pre-80 values.

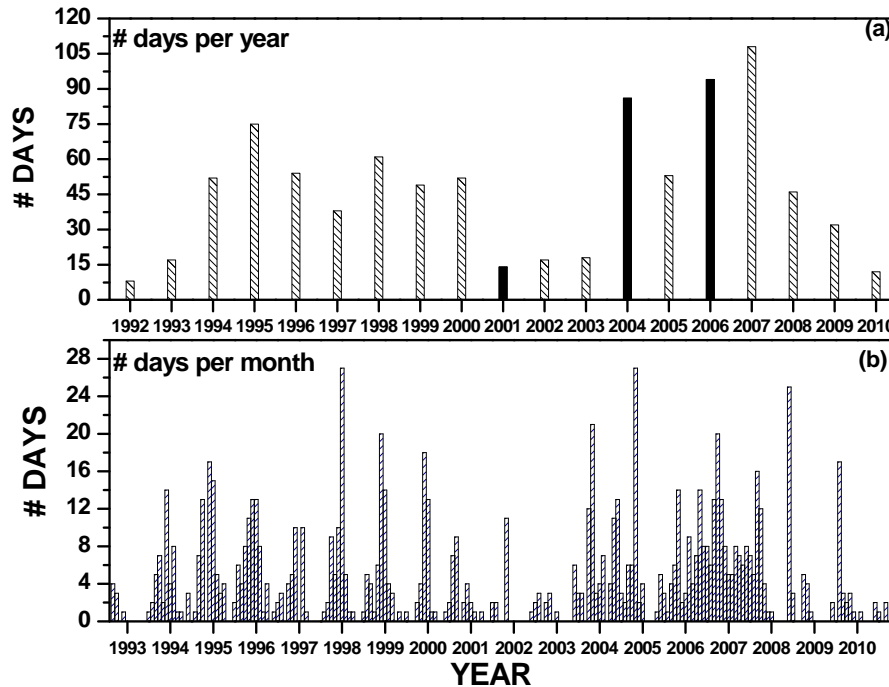


Fig. 3.- Number of days per year under the climatological (1978-1987) average minus two standard deviations, period 1992-2010.

## DISSEMINATION OF RESULTS

### Data reporting

- Data from Brewer 180 being sent to the WOUDC.
- Data of ozone profiles obtained in Punta Arenas being prepared and sent to the WOUDC.

### Information to the public

- The National Meteorological Service (DMC) gives UV-Index forecast for all stations show in DMC network.
- Since 1999 the Ozone Laboratory and RUV of the University of Magallanes provides a UV-Index daily forecast during spring and summer time (TEMIS).

### Relevant scientific papers

de Laat, A.T.J., R.J. van der A, M.A.F. Allaart, M. van Weele, G.C. Benitez, C. Casiccia, N.M. Paes Leme, and E. Wolfram, Getting a sunburn: three weeks of small total O<sub>3</sub> columns and extreme UV radiation over the Southern tip of South America during the 2009 Antarctic O<sub>3</sub> hole season, *Geophysical Research Letters*, Vol. 37, L14805, doi:10.1029/2010GL043699, 2010.

Casiccia C, Zamorano F., Hernández A, "Erythemal irradiance at the Magellan's region and Antarctic Ozone Hole 1999-2005", *Atmosfera*, Vol. 21(1), 1-11, 2008.

Munakata, N (Munakata, Nobuo); Kazadzis, S (Kazadzis, Stelios); Bolsee, D (Bolsee, David); Schuch, N (Schuch, Nelson); Koskela, T (Koskela, Tapani); Karpetchko, A (Karpetchko, Alex); Meleti, C (Meleti, Charoula); Casiccia, C (Casiccia, Claudio); et al; *Variations and trends of biologically effective doses of solar ultraviolet radiation in Asia, Europe and South America from 1999 to 2007; Photochemical & Photobiological Sciences*, 8 (8): 1117-1124 2009.

Vernet, Maria, Susana Diaz, Humberto Fuenzalida, Carolina Camillion, Charles R. Booth, Sergio Cabrera, Claudio Casiccia, Guillermo Deferrari, Charlotte Lovengreen, Alejandro Paladini, Jorge Pedroni, Alejandro Rosales and Horacio Zagarese; *Quality of UVR exposure for different biological systems along a latitudinal gradient*, Photochemical & Photobiological Sciences, 2009, DOI: 10.1039/B904540F.

Wolfram, E. A., Salvador, J., D'Elia, R., Casiccia, C., et al, *New Differential Absorption lidar for Stratospheric Ozone Monitoring in Patagonia*, South Argentina, Journal of Optics: Pure and Applied Optics, No. 10, 104021 (7 pp), 2008.

## PROJECTS AND COLLABORATIONS

**UVO<sub>3</sub>PATAGONIA: PROJECT DESIGNED TO STRENGTHEN THE CAPACITY TO MEASURE THE OZONE LAYER AND UV RADIATION IN CHILEAN-ARGENTINE SOUTHERN PATAGONIA, AND THE PROJECTION TOWARDS THE COMMUNITY**, supported by the Japan International Colaboration Agency (JICA), (2007-2011).

The Ozone and Ultraviolet Radiation Laboratory, (Laboratorio de Ozono y Radiación Ultravioleta) LabO<sub>3</sub>RUV of the University of Magallanes, and the Center for Research into Lasers and Applications (Centro de Investigaciones en Láseres y Aplicaciones), CEILAP (CITEFA-CONICET), in Villa Martelli, in the Province of Buenos Aires, propose to carry out joint research and socially-oriented activities aimed at the communities of Southern Patagonia, in relation to this important issue. These institutions have laboratories located 200 Km from one another: in Punta Arenas (Lat. 53°S; Lon. 70°54'W) and in Rio Gallegos where CEILAP has set up a mobile laboratory (Lat.51°55'S; Lon.69°14'W), both situated in the extreme south of the American continent where the AOH passes over.

## FUTURE PLANS

The research group of the University of Magallanes will be continue ozone observations. Collaboration with other groups will be intensified, especially with the CEILAP group in Rio Gallegos and the GAW station located at Ushuaia (Argentina).



## **NEEDS AND RECOMMENDATIONS**

- Since already it was mentioned, due to the disaster happened in Valdivia the Meteorological National Service suffered the loss, among others, of the spectroradiometer SUV 100, instrument that was in use as patron instrument of calibration who was acquired across the project GEF. In view of the cost of the spectroradiometer, reinstatement becomes difficult in the short term; the Meteorological National Service is looking for the financial support in the acquisition of a new instrument, any help is welcome.
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- Financial support for supplies for ozonesonde of Punta Arenas is a priority, because the UVO3Patagonia project, funded by the International Agency of Japan will end in September 2011.
- The experience of the intercomparasion and calibration activities (Brewer and GUV) in Punta Arenas was very successful, it would be important to replicate with more instruments.

### **Recommendations 7ORM**

- 1) Brewers are the preferred instrument for all expansion efforts around the globe where a new Ozone and UV monitoring programme is to be established. Unused Dobson instruments are a more economical way to expand these networks and to introduce observations into new sites or programmes.

In Chile, there is one Brewer (Lat.53S). Geographical characteristics of this country could build up a network of Brewer instruments to assess the evolution of ozone column and UVR from latitude 18°S to latitude 54°S. any financial support for this project is welcome.

- 2) There is a need to continue and further expand Umkehr sites to maintain this time series in the upper stratosphere. Umkehr observations represent the primary ground technique to observe the upper stratosphere since sondes cannot reach these altitudes.

For Punta Arenas station, there is Umkehr observations records since 2002 Shorthly these data will be able at WOUDC.

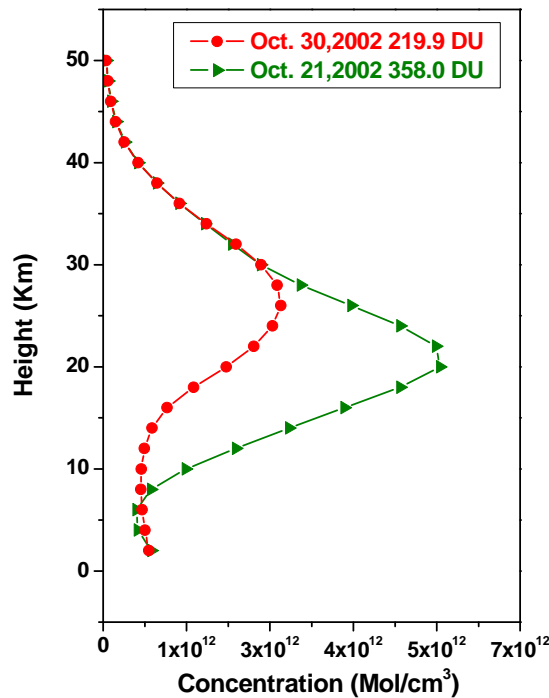


Fig. 4 An example of Umkehr observations at Punta Arenas Chile.

- 3) Balloon sonde networks provide critical observations which give vital high resolution vertical profiles of ozone and water vapour that are needed for multiple scientific activities in ozone research and therefore need to be maintained and increased.

In 2009, an ongoing program of ozone profile observations began, using ECC sonde, supported by the Japan International Cooperation Agency (JICA), this project ends in September 2011, so far not found financing to obtain the inputs that allow continuity of the measurements.

- 4) Intercomparison missions are desirable because they assist in defining and reducing the systematic differences in both identical and different measurement techniques.

Two ozone profile intercomparison campaigns (2010-2011) were held in Rio Gallegos (Argentina). The OZITOS (**O**Zone profile at **Ri**O Gallego**S**) campaigns, this campaigns was planned to validate ozone profiles obtained from LIDAR (DIAL) instrument in Rio Gallegos operated by CEILAP (Argentina).

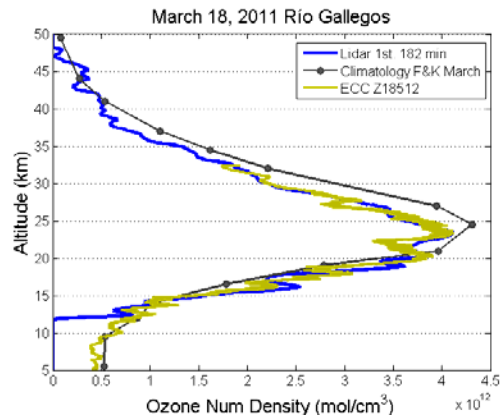


Fig. 5. Ozone profile at Río Gallegos (Argentina) from LIDAR and ozonesonde ECC-Z.

- 5) Provide resources for sustainable, long-term operation of regional centres for research, calibration, and validation in developed and, especially, in developing countries. Several regional centres for Dobson and Brewer instrument calibration have been established. It is of vital importance that these centres receive sufficient support to arrange regular calibration exercises for the instruments in their respective regions.

In Chile there is no center calibration of ozone and ultraviolet instruments, closest activities are carried out in Buenos Aires (Argentina), to calibrate instruments of the DMC network an instrument is sent, last calibration in Buenos Aires was in 2010.

The latest calibration of the Brewer spectrophotometer #180 were made by International Ozone Service Inc. in 2009, it was supported by WMO