

## CHILE

### INTRODUCTION

Chile is located on the extreme southwestern coast of South America. Several different scientific groups and institutions are engaged in the investigation of ozone depletion and ultraviolet radiation. The majority are studying changes in incident UV using several types of instruments, mostly broad band.

### OBSERVATIONAL ACTIVITIES

#### Column measurements of ozone

Instruments	Institution	Station	LAT. LONG.	Period of observations
Brewer MKIV 068	University of Magallanes	Punta Arenas	53S;70.9W	1992-2000
Brewer MKIII 180	University of Magallanes	Punta Arenas	53S;70.9W	2002 - today

#### Profile measurements of ozone

Type	Institution	Station	LAT. LONG.	Period of observations
Umkehr	University of Magallanes	Punta Arenas	53S;70I.9	2002 - today
Ozone sondes	University of Magallanes	Punta Arenas	53S;70I.9	Campaigns spring time 1995-1996-1997-2001-2005
Ozone sondes	DMC	Isla de Pascua	27S;109W	1996

DMC: Dirección Meteorológica de Chile (National Meteorological Service)

## UV measurements

### Broadband measurements

#### *Instruments of the groups of research.*

Instruments	Institution	Station	LAT. LONG.	Period of observations
Solar Light 501	University of Atacama	Arica	18S;70W	1998 - today
Solar Light 501	University of Santiago	Antofagasta	23S;70W	2000 - today
Solar Light 501	University of Santiago	Santiago	33S;70W	1999 - today
Solar Light 501	University Federico Santa María	Valparaíso	33S;70l.9	
Solar Light 501	University of Magallanes	Puerto Natales	51S;72W	1997 - today
Solar Light 501	University of Magallanes	Punta Arenas	53S;71W	1997 - today
Solar Light 501	University of Magallanes	Puerto Porvenir	53S;70W	1997- 2002
Solar Light 501	University of Magallanes	Puerto Williams	55S;68 W	1997 - 2004
Solar Light 501	University of Magallanes	Bernardo O'Higgins	63S; 57W	2005 -

#### *Network of DMC.*

Instruments	Institution	Station	LAT. LONG.	Period of observations
Pyranometer UVA-B	DMC	Iquique	20S;70W	1998 - today
Pyranometer UVA-B	DMC	La Serena	29S;71W	2003 - today
Pyranometer UVA-B	DMC	El Tololo	30S;70W	1997 - today
Solar Light 501	DMC	Valparaíso	32S;71W	2002 - today
Pyranometer UVA-B	DMC	Pudahel	33S;70W	1992 - today
Pyranometer UVA-B	DMC	Concepción	36S;73W	2002 – today
SUV 100	DMC	Valdivia	39S;73W	1998 - today
Pyranometer UVA-B	DMC	Puerto Montt	41S;73W	2001 - today
Pyranometer UVA-B	DMC	Coyhaique	45S;72W	2001 - today
Pyranometer UVA-B	DMC	Punta Arenas	53S;70l.9	2001 - today
Pyranometer UVA-B	DMC	Base Presidente Eduardo Frei	62S;58W	1992 - today

### **Narrowband filter instruments**

Instruments	Institution	Station	LAT. LONG.	Period of observations
GUV 511	University of Chile	Santiago	33S; 70W	1995 - today
GUV 511	University Austral	Valdivia	39S;73W	1995 - today
GUV 511	University Magallanes	Punta Arenas	53S;70l.9	1993 - today
NILU UV	University Magallanes	Base Prof. Julio Escudero	62S;58W	2005 -

### **Spectroradiometers**

Instruments	Institution	Station	LAT. LONG.	Period of observations
SUV 100	University Austral	Valdivia	39S;73W	1997 - today
Brewer MKIII 180	University of Magallanes	Punta Arenas	53S;70.9W	2002 - today

### **O<sub>3</sub> Surface**

Instruments	Institution	Station	LAT. LONG.	Period of observations
PM 10	University of La Serena	Cerro Tololo	30S; 70W	1995 - today

### **Calibration activities**

The instruments of the DMC are compared and calibrated at least every two years in Valdivia. GUV 511 instruments are calibrated annually with a standard instrument sent from the factory and are part of the project Latin American, "Enhanced ultraviolet-B radiation in natural ecosystems as an added perturbation due to ozone depletion". This project is directed by Maria Vernet (Scripps Institution of Oceanography, La Jolla, California) and financed by the Inter American Institute for Global Research, (IAI), this project concluded in 2004, is possible that a new project will be approved during 2005 and starting in 2006.

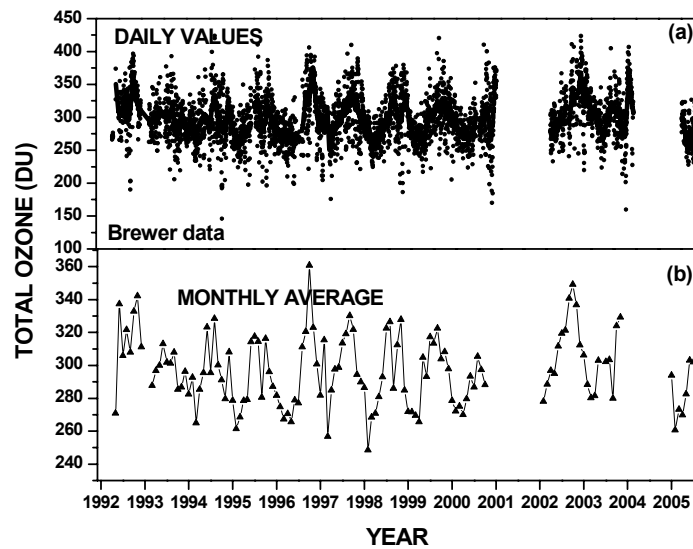
Both the Brewer and the SUV spectroradiometers possess self calibration mechanisms which are constantly checked and updated by the respective scientific group. Additionally, the Brewer is calibrated monthly with an external lamps to verify the stability of the measurements. The last calibration of the Brewer No.180 from the factory was in December, 2004. The instruments Solar Light of the group of the University of Magallanes are calibrated once per year with the instrument Brewer.

## **RESULTS FROM OBSERVATIONS AND ANALYSIS**

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

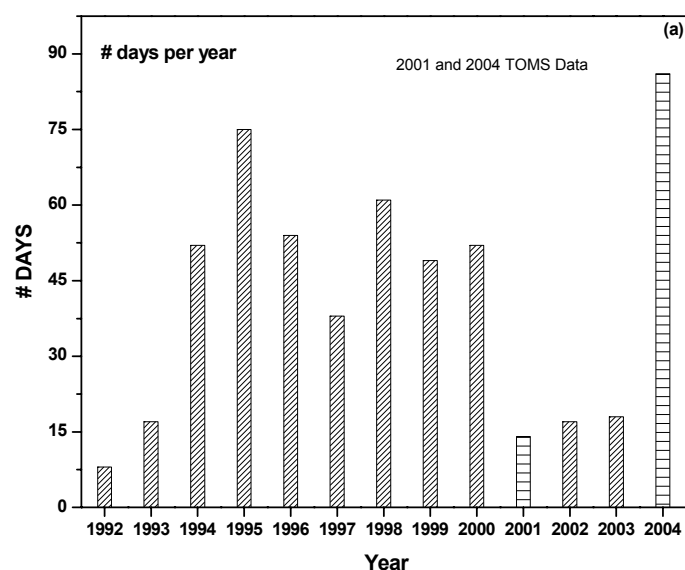
The Brewer instrument No. 068 was operational at Punta Arenas from May 1992 until November 2000 thanks to a cooperative agreement between INPE, Brazil (Brazilian National

Institute for Space Research) and UMAG, Chile (University of Magallanes), a new Brewer (No. 180) was bought by the Magallanes Regional Government and was installed in 2002. The Figure 1 shows the variation of the ozone column measured by Brewer from 1992 until 2005 (June). Part [a] refers to the daily averages (solid line refers to the running average,  $n=30$ ).



**Figure 1: Daily and monthly mean values of total column ozone over Punta Arenas Chile 1992-2000 obtained with Brewer spectroradiometer (No 068 and No. 180).**

The number of days in which the AOH has been over the Magallanes region varies from year to year. Figure 2 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), after 1995 the higher frequency occurred in February of 1998 with 27 days. In the period of 1994-1999 there were many days of low ozone events during summer time. Between 2001 and 2003 there were fewer significant days showing a possible recuperation of the ozone over Punta Arenas. However, during 2004 the days began to increase again. From there we ask the question: Which is the situation of the recovery (if it exists) of the layer of ozone at mid latitudes. The answer to this question must wait some years until much more data is collected.



## DISSEMINATION OF RESULTS

### Data reporting

- GUV-Network: The database of the GUV instruments are stored and maintained by each group, also exists an archive of all data (IAI) from all stations.
- The UV-B data from DMC network and vertical profile from Isla de Pascua are being regularly sent to the World Ozone Data Centre, Canada.
- The data from Brewer 180 in the course of this year will be sent to the WOUDC.

### Information to the public

- The National Meteorological Service gives UV-Index forecast for all the stations shown in 2.3.1.
- Since the summer of 1999 the Ozone Laboratory and RUV of the University of Magallanes provides a UV index daily forecast during spring and summer time.

### Relevant scientific papers

- Abarca, J.F., C. Casiccia, F. Zamorano, "Increase in sunburns and Photosensitivity Disorders at the Edge of Antarctic Ozone Hole, Southern Chile, 1986-2000", *J. Am. Acad. Dermatol*, 46(2):193-199, 2002.
- Abarca J.F.; C. Casiccia, "Skin cancer and ultraviolet-B radiation under the Antarctic ozone hole: southern Chile, 1987-2000", *Photodermatology photoimmunology & photomedicine*, 18(6):294-302, dec. 2002.
- Casiccia, C.; Kirchhoff, V.W.J.H ; Torres, A C., "Simultaneous measurements of ozone and ultraviolet radiation: spring 2000, Punta Arenas, Chile", *J. Atmos. Env.* 37(3):383-389, 2003.
- Aranibar D, Ligia, Cabrera S, and Honeyman M. "Menores quemados por el sol y su relación con la radiación ultravioleta y la cubierta de ozono, durante seis veranos (1996 a 2001) en Santiago de Chile (33,5°S)". *Rev. méd. Chile*, sep. 2003, vol.131, no.9, p.1011-1022. ISSN 0034-9887.
- Lovengreen vd M, C., Alvarez J., Fuenzalida, H., Aritio, M. "Radiación ultravioleta productora de eritema en Valdivia: Comparación entre inferencias satelitales, modelo de transferencia radiativa y mediciones desde Tierra". *Rev. méd. Chile*, Ene 2002, vol.130, no.1, p.17-25. ISSN 0034-9887

## FUTURE PLANS

- A new campaign of ozone sonde launchings at Punta Arenas during spring time 2005.

## **NEEDS AND RECOMMENDATIONS**

We would like to carry out the following activities but funds are needed.

- Construct a network of instruments to measure ozone and ultraviolet radiation along the total length of Chile using the country's unique geographical features and scientific installations, with two or three additional Brewer Spectroradiometers in the northern and central regions.
- Implement a long term programme of continuous balloon sonde measurements to establish a profile of stratospheric ozone concentrations over Punta Arenas.
- Is imperative to implement a plan of calibration of instruments.

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