

CHILE

Introduction

According to recommendations of the Sixth Meeting of the Ozone Research Managers of the Parties to the Vienna Convention for the Protection of the Ozone Layer, Vienna 2005 summarized in its report.

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

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

Profile measurements of ozone

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	University of Magallanes	53°18'S	70°54'W	Campaigns spring time 1995-1996-1997-2001-2005
Isla de Pascua	Ozone sondes	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 - 2004
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
Iquique	Pyranometer YES UV – B	20°32'S	70°19'W	52m	1998 – today
	Pyranometer EPPLEY UV (A+B)				
San Pedro de Atacama	Pyranometer YES UV – B	22°55'S	68°12'W	2450m	2006 – today
Antofagasta	Pyranometer YES UV – B	23°27'S	70°26'W	145m	2006 – today
La Serena	Pyranometer YES UV – B	29°54'S	71°12'W	25m	2003 – today
	Pyranometer EPPLEY UV (A+B)				
El Tololo	Pyranometer Kip – Zonen /Li-Cor UV – B	30°10'S	70°48'W	2030m	1997 – today
Valparaiso	Biometer Solar Light	32°56'S	71° 28'W	131m	2002 – today
Cordillera Central	Pyranometer UV – B	33°21'S	70°15'W	3015m	2006 – today
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	2006 – today
Concepción	Pyranometer YES UV – B	36°46'S	73°03'W	8m	2002 – today
	Pyranometer UV (A+B)				
Puerto Montt	Pyranometer YES UV – B	41°25'S	73° 05' W	85m	2001 – today
	Pyranometer EPPLEY UV (A+B)				
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.	Long.	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
Base Prof. Julio Escudero	NILU UV	University Magallanes	62°12'S	58°57'W	2005 - today

Spectroradiometers

Station	Instruments	Institution	Lat.	Long.	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 every two years in Valdivia, until 2005. The calibration of the year 2007 could not carry out, due to

the fact that a fire consumed the department of physics of the University of Valdivia, which caused the loss of valuable information and set of instruments, among them the spectroradiometer (patron instrument) and the pyranometers that were ready for calibration. In view of the cost of the spectroradiometer, reinstatement becomes difficult in the short term.

- b) **BREWER 180 (Punta Arenas):** International Ozone Services Inc. (IOS) completed the ozone and UV calibration and service of two Brazilian (INPE) and one Chilean Brewer Spectrophotometer during period Nov. 21 – 26, 2007 at in Punta Arenas, Chile. The instruments #180 (local), #068 and #124 were calibrated and repair. The World Meteorological Organization (WMO) supported this project. All three instruments produced lower (~5%) ozone results initially with existing constants, when compared to the traveling Brewer #017.



Figure 1: Brewer MKIII #180, MKIV#124, MKIV#068 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 once per year using the Brewer 180 located in Punta Arenas.
- d) **Narrowband GUV:** A Inter-comparison activity was carried out during the period 20-25 February, 2008 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” 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 instrument has been operational at Punta Arenas from May 1992 until today, considering the 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 2007. The black line reefers to the running average (n=30) and the 220 UD threshold line is shown for reference.

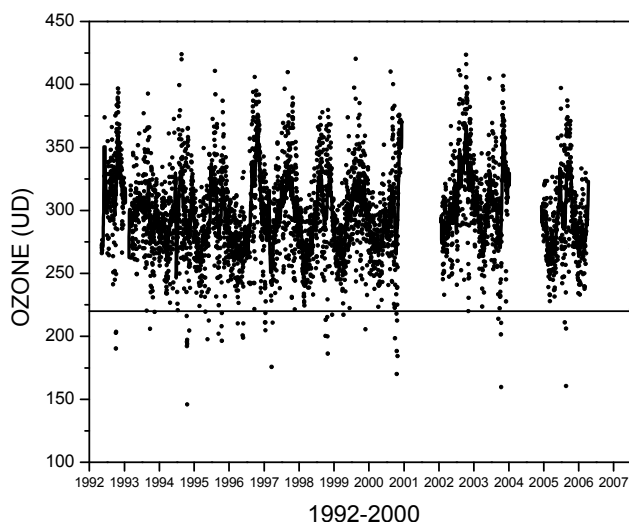


Figure 2: Daily and running average values of total column ozone over Punta Arenas Chile 1992-2007 obtained with Brewer spectroradiometer (No 068 and No. 180).

The number of days in which the Antarctic Ozone Hole (AOH) has been over the Magallanes region varies from 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 - 2σ). 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 2004-2007 the days began to increase again.

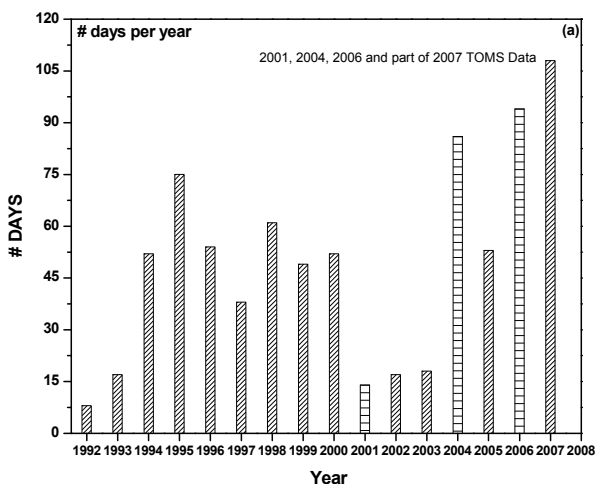


Figure 3: Number of days per year under the climatological (1978-1987) average minus two standard deviations.

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 ozone profile from Isla de Pascua are being regularly sent to the World Ozone Data Centre, Canada.
- The data from Brewer 180 in the course year will be sent to the WOUDC.

Information to the public

- The National Meteorological Service (DMC) gives UV-Index forecast for all 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

- Casiccia, C.; F. Zamorano; A. Hernández, **Erythemat irradiance at the Magellan's región and Antarctic ozone hole 1999-2005**, *Atmósfera* 21(1), p. 1-12, 2008.
- Sanchez, F., **The relationship between the ozone layer and skin cancer**, *REVISTA MEDICA DE CHILE*, Vol: 134(9) p.:1185-1190, 2006.
- Diaz S, Camillon C, Deferrari G, et al., **Ozone and UV radiation over southern South America: Climatology and anomalies**, *PHOTOCHEMISTRY AND PHOTOBIOLOGY*, Vol:82(4), p:834-843, 2006.
- Munakata N., et al., **Biological monitoring of solar UV radiation at 17 sites in Asia, Europe and South America from 1999 to 2004**, *PHOTOCHEMISTRY AND PHOTOBIOLOGY*, Vol: 82(3), p:689-694, 2006.
- Huovinen P, Gomez I, Lovengreen C., **A five-year study of solar ultraviolet radiation in southern Chile (39 degrees S): Potential impact on physiology of coastal marine algae?**, Vol:82(2), p:515-522, 2006.
- Cordero RR, Roth P, Georgiev A, et al. **Climatology of surface ultraviolet-radiation in Valparaiso, Chile**, *ENERGY CONVERSION AND MANAGEMENT* Vol: 46(18-19), p:2907-2918, 2005.
- Diaz S, Booth CR, Armstrong R, et al. **Multichannel radiometer calibration: a new approach**, *APPLIED OPTICS*, Vol:44(26), p:5374-5380, 2005.

PROJECTS AND COLLABORATIONS

UVO₃PATAGONIA: 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 Collaboration Agency (JICA)

The Ozone and Ultraviolet Radiation Laboratory, (Laboratorio de Ozono y Radiación Ultravioleta) LabO₃RUV 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.

IPY: Study of the Mesosphere, Stratosphere and Troposphere Antarctica and its links South America.

The MST – ASA is a study of the Mesosphere-Stratosphere-Troposphere using different techniques in the Brazilian Antarctic Station, Chile, Bolivia and Brazil.

This co-ordination will be directed toward ground-based experimental campaigns, with Radar, Spectrophotometers, radiometers, ECC sonde technique launched on balloons, to increase understanding of the Antarctic atmosphere and the teleconnection to South America.

FUTURE PLANS

- Under the project **UVO₃PATAGONIA** , supported by JICA during 2008 will be implement a long term program of continuous balloon sonde measurements to establish a profile of

stratospheric ozone concentrations over Punta Arenas (Chile), incorporating LIDAR systems for taking measurements of ozone, water vapour and aerosol profiles, and passive sensors for measuring UV radiation at Rio Gallegos (Argentina). The LIDAR was designed and constructed at CEILAP (CITEFA-CONICET).

NEEDS AND RECOMMENDATIONS

- Currently the UVO3Patagonia project financed by JICA is supporting to buy instruments for monitoring the launch of ozonesondes at Punta Arenas. However for the next years, it does not exits support for buying radiosondes, ozonesondes, balloons, and spare hardware required to obtain ozone profiles. Thus, any cooperation is welcome.
- 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.
- 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.
- The experience of the intercomparasion and calibration activities in Punta Arenas was very successful, it would be important to replicate with more instruments.
