

CHILE

In Chile, several different scientific groups 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. Table 1 lists the instruments used to measure ultraviolet radiation, column ozone, ozone concentration with altitude. All these instruments are associated to scientific groups belonging to universities.

Table 1.- UV and ozone measuring instruments in Chile

Station	University	Geo. Coord.	Instruments	Period of observations
Arica	Atacama	18S;70W	Solar Light 501	1998 -
Antofagasta	Santiago	23S;70W	Solar Light 501	2000 -
Santiago	Santiago	33S;70W	Solar Light 501	1999 -
	De Chile		GUV 511	1995 -
Valparaíso	Federico Santa María	33S;71W	Solar Light 501	
Valdivia	Austral	39S;73W	GUV 511	1995 -
			SUV 100	1997 -
Punta Arenas	Magallanes	53S;71W	Brewer MkIV 068	1992-2000
			GUV 511	1993 -
		51S;72W 53S;72W 53S;70W 55S;68 W	Solar Light 501 (4) [1] Puerto Natales [2] Punta Arenas [3] Puerto Porvenir [4] Puerto Williams	1997 -
			Ozonesondes	Campaigns in spring time 1995-1996-1997-2001
			Brewer MkIII 180	2002 -

The GUV 511 instruments in the various stations 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), The database of the GUV instruments are stored and maintained by each group, also exists an archive of all data from all stations.

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 instruments Solar Light of the group of the University of Magallanes are calibrated once per year with the instrument Brewer.

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). The Figure 1 shows the variation of the ozone column measured by Brewer from 1992 until 2000. Part [a] refers to the daily averages (red line refers to the running average, n=30). The horizontal line marks the rim of the threshold of

the “Antarctic Ozone Hole” (AOH), and is defined as ozone values less than, or equal to, 220 DU. Part b. of Figure 1 is the monthly mean which shows an ozone depletion of 3.2% per decade, a rate which is in accord with the latest results published in WMO-98 (Rep. 44) for latitudes similar to Punta Arenas.

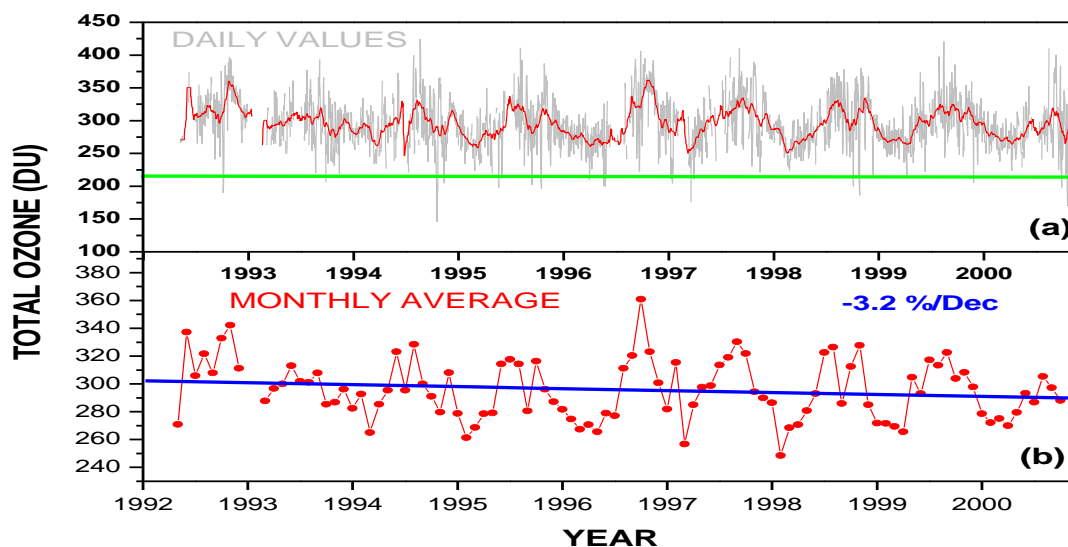


Fig.1 .- Daily and monthly mean values of total column ozone over Punta Arenas Chile 1992-2000 obtained with Brewer spectroradiometer (No 068).

For the past decade or more, the Antarctic Ozone Hole has passed over Punta Arenas with varying intensity for varying periods of time. Table 2 shows several examples of these ozone depletion events measured with the Brewer instrument at Punta Arenas. In the construction of Table 2, an “event” was defined as ozone values less than, or very close to, 220 DU. The largest depletions occurred on 17 October, 1994, with 145.8 DU, on 22 October 1998, with 186.2 and recently on 12 October, 2000, with 170 DU. During the period 1992-2000 there were other instances of ozone depletion which did not reach the threshold of 220 DU, but were, nevertheless, important, considering historical values of column ozone for Punta Arenas. For example, Table 3 shows a series of ozone depletion events for the year 2000. In this case a climatological reference mean was calculated from TOMS overpass data from 1978-1987 and an ozone depletion event was defined as a depletion of 20% compared to the climatological mean, which for August is 321.4 ± 35.8 , for September, 324.6 ± 45.7 and October 336.0 ± 45.7 . During the year 2000, seven significant ozone depletion events were measured which comprised 17 days. For Punta Arenas, the year 2000 was a particularly active year for the Antarctic Ozone Hole.

Table 2. Ozone depletion events over Punta Arenas, Chile period 1992-2000

Events	Year	O3 Low DU	Date (dd-mm)	Duration Days
1	1992	190.3	05-10	3
2	1993	205.9	27-09	1
3	1994	145.8	17-10	6
4	1995	202.1	10-09	1
5	1995	196.5	13-10	3
6	1996	221.6	18-09	1
7	1997	221.5	11-11	1
8	1998	200.3	30-09	2
9	1998	186.2	22-10	3

10	1999	206.1	21-11	1
11	1999	233.2	05-12	1
12	2000	225.6	10-09	1
13	2000	198.4	21-09	3
14	2000	218.0	07-10	2
15	2000	170.0	12-10	4
16	2000	181.1	18-10	3

Table 3.- Low ozone events to Punta Arenas, Chile year 2000.

Events	Date	Ozone (DU)	Decrease %
1	Aug. 22	243.9	24.1
	Aug. 23	243.2	24.3
2	Sept. 11	225.6	30.5
3	Sept. 19	223.1	31.2
	Sept. 20	222.7	31.3
	Sept. 21	198.4	38.9
4	Sept. 24	240.9	25.8
	Sept. 25	252.7	22.1
5	Oct. 6	233.4	30.5
	Oct. 7	218.0	35.1
6	Oct. 11	188.4	43.9
	Oct. 12	170.0	49.4
	Oct. 13	212.4	36.8
	Oct. 14	208.0	38.0
7	Oct. 16	225.0	33.0
	Oct. 17	237.0	29.5
	Oct. 18	180.0	46.4

In order to compare the present with historic ozone levels, in figure 2 we compare the mean monthly climatological values for Punta Arenas from TOMS overpass data for the period 1978-87, represented with the hatched area (average, plus and minus one standard deviation), a period considered "normal", that is, without the influence of the Antarctic Ozone Hole.

Figure 2 shows the monthly means obtained by the Brewer instrument from the daily means for [a] the period 1992-2000 and [b] the year 2000. It can be seen from this figure that the average values of each month within the period 1992-2000 are less than the climatological mean, especially for the months of September, October and November. It is also important to note that the values between November and April are lower than the climatological mean. This observation is being studied in greater detail. For the year 2000, the average monthly means are considerably lower than the climatological average, which would seem to indicate a pronounced deterioration in the ozone layer over latitudes similar to Punta Arenas.

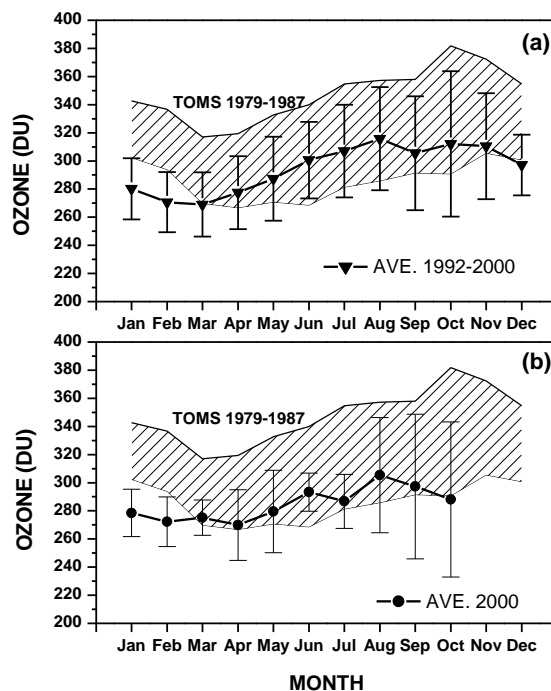


Fig. 2.- Ozone monthly averages for 1992-2000 [a] and 2000 [b], for Punta Arenas. The hatched area represents the monthly climatological averages derived from TOMS data, (average, plus and minus one standard deviation) shown for reference.

Figure 3 shows the average monthly values of Damaging Ultraviolet Radiation (DUV; UVA and UVB). These measurements are taken daily at solar noon. The observed increase is 12.5% per decade.

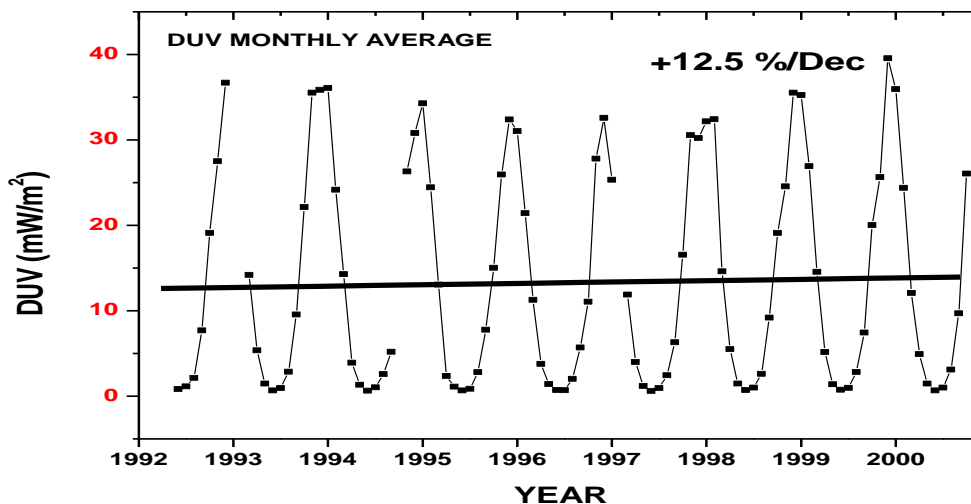


Fig. 3.- Average monthly of ultraviolet radiation (DUV) for Punta Arenas 1992-2000.

The field campaigns of ozone sonde launchings at Punta Arenas have clarified that the greatest stratospheric ozone destruction takes place between 12 and 30 km. (Kirchhoff, V.W.J.H.; Casiccia, C.; Zamorano, F.; Y. Sahai; Valderrama, V. Observations of the 1995 ozone hole over Punta Arenas, Chile, J. Geophys. Res., vol. 102, no D13:16109-16120, July 20, 1997.)

Current Activities

- Complete the installation of a newly purchased Brewer MK-III, No 180, in Punta Arenas. This will allow the continuation of the data set initiated by the Brewer 068 in 1992. The new, instrument will be operated by “The Laboratory for Monitoring Ozone and Ultraviolet Radiation” of the University of Magallanes which will perform all calibrations, archive and analysis of the measurements. This Brewer will contribute greatly to the study of the evolution of the Antarctic Ozone Hole and other atmospheric phenomena over the “Southern Cone” of South America and the Southern Hemisphere.
- The network of broadband GUV instruments will continue in operation until at least 2005, funded by the IAI. All instruments will be calibrated annually.
- Plans are underway to initiate an extensive network of instruments to measure UV

Plans for the Future

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 program of continuous balloon sonde measurements to establish a profile of stratospheric ozone concentrations over Punta Arenas.
