ARGENTINA

The frequent overpass of the Antarctic Ozone Hole each spring, the extreme UV radiation levels over the northwestern Andean Plateau and their effects put the territory of the Argentine Republic at a strategic situation in studies of atmospheric ozone and solar UV radiation. Research of Argentine institutions in these subjects has an increasing development, both within national projects and in collaboration within international projects, including monitoring and modeling of ozone, UV radiation and related parameters. Argentine is also suffering the consequences of the Global Climate Change, and the increasing evidence of ozone-climate interactions imply that the subject must be taken in an even wider context. The present report is an update of the activities in Argentina and spans the period 2005-2008.

MONITORING

The following are the detailed measurement activities at the principal monitoring institutions and its contact address:

Argentine National Weather Service (SMN)

Lic. Eduardo A. Piacentini
Servicio Meteorológico Nacional. 25 de mayo 658. Buenos Aires. Argentina. Tel: 54-11-51676767.
Email: epiace@smn.gov.ar

		Measured Parameters			
Station	**Location**	**Total O_3 Column**	**Surface O_3**	**Vertical O_3 Profile**	**Broadband Surface UV irradiance**
La Quiaca	22.11ºS, 65.57ºW, 3459m. a.s.l.		X		X
Resistencia	27.45°S, 58.98°W, 50m. a.s.l.				X
Pilar	31.66ºS, 63.88ºW, 338 m. a.s.l.		X		X
Mendoza	32.88ºS, 68.87ºW, 704m. a.s.l.				X
Rosario	32.96ºS, 60.62ºW, 25m. a.s.l.				
Buenos Aires	34.61ºS, 58.41ºW, 25m. a.s.l.	X			X
Comodoro Rivadavia	45.78ºS, 67.50ºW, 46m. a.s.l.	X			X
San Julián	49.32ºS, 67.75ºW, 62m. a.s.l.		X		X
Ushuaia	54.80ºS, 68.27ºW, 14m. a.s.l.	X	X	X	X
Marambio	64.23ºS, 56.72ºW, 300m. a.s.l.	X		X	X

Projects in collaboration with: World Meteorological Organization, Finnish Meteorológical Institute, NOAA/Earth Systems Research/Laboratory's Global Monitoring Division (USA), Instituto Nacional de Meteorología (INM, Spain), Instituto Nacional de Tecnología Aeroespacial (INTA, Spain), International Polar Year Program.

Argentine Antarctic Institute

Sr. Jorge Araujo
Dirección Nacional del Antártico - Instituto Antártico Argentino. Cerrito 1248 - C1010AAZ - Capital Federal. Argentina. Tel: 4812-0071/72. Email: atmosfera@dna.gov.ar

		Measured Parameters			
Station	**Location**	**Total O_3 Column**	**Surface O_3**	**Vertical O_3 Profile**	**Surface UV irradiance**
Marambio	64.23ºS, 56.72ºW, 300m. a.s.l.	X		X	X
San Martín	68.13ºS, 67.13ºW, 40m. a.s.l	X			
Belgrano II	77.86ºS, 34.62ºW, 250m. a.s.l.	X		X	

Projects in collaboration with: Servicio Meteorológico Nacional Argentino, Instituto de Física Atmosférica de Roma (Italy), Instituto Nacional de Meteorología (Spain), Instituto Nacional de Técnica Aeroespacial de España (Spain), Instituto Meteorológico de Finlandia (Finland), Organización Meteorológica Mundial (WMO), Universite du Quebec (Canada).

Argentine National Institute of Genetics and Molecular Biology (INGEBI) - Capital Federal

Dra. Mirtha M. Flawiá
Instituto de Investigaciones en Ingeniería Genética y Biología Molecular (INGEBI). Obligado 2490, Capital Federal. Argentina. Tel: 54-11-47832871. Email: mflawia@dna.uba.ar

Station	Location	Instrument (Narrowband UV and PAR surface irradiances)	Last Calibration
San Salvador de Jujuy	24.17°S, 65.02°W, 1300m. a.s.l.	GUV-511	2007
Buenos Aires	34.58°S, 58.47°W, Sea level	GUV-511	2007
San Carlos de Bariloche	41.01°S, 71.42°W, 700 m. a.s.l.	GUV-511	2007
Trelew	43.25°S, 65.31°W, Sea level	GUV-511	2004
Ushuaia	54.83°S, 68.30°W, Sea level	GUV-511	2007

Projects in collaboration with: National Science Foundation (NSF, USA), Centro Austral de Investigaciones Científicas (CADIC, Argentina), Dirección Nacional de Antártico (DNA, Argentina) y Dirección Nacional de Meteorología (INM, Spain), Instituto Nacional de Tecnologia Aeroespacial (INTA, Spain), Programa Nacional para Investigaciones Antárticas (PNRA, Italy).

Austral Center for Scientific Research (CADIC) - Tierra del Fuego

Ing. Susana B. Diaz
Centro Austral de Investigaciones Cientificas..Ruta 3 y Malvinas Argentinas.CC92 (9410) Ushuaia, Tierra del Fuego. Argentina. Tel: 54-2901-430526. E-mail: subediaz@satlink.com

Station	Location	Measured Parameters	Instrument	Last Calibration
Ushuaia	54.83°S, 68.30°W, Sea level	Spectral solar irradiance (range: 280-620 nm)	SUV-100 spectroradiometer	2005 (every 15 days with secondary lamps)
		Total O_3 Column, NO_x	EVA 4	2007
		Narrowband UV and PAR solar irradiance	GUV-511	2007
		Narrowband UV and PAR solar irradiance	NILU-UV	2008
		Total O_3 Column Spectral solar irradiance (range: 280-325 nm)	Brewer MKIV Spectroradiometer	1999

Projects in collaboration with: National Science Foundation (NSF, USA), Instituto de Investigaciones en Ingeniería Genética y Biología Molecular (INGEBI, Argentina), Dirección Nacional de Antártico (DNA, Argentina) y Dirección Nacional de Meteorología (INM, Spain), Instituto Nacional de Tecnologia Aeroespacial (INTA, Spain), Programa Nacional para Investigaciones Antárticas (PNRA, Italy).

Photo-Biological Station "Playa Union" - Chubut

Dr Walter Helbling
Estación de Fotobiología Playa Unión. Casilla de Correos N°15 (9103). Rawson, Chubut, Argentina. Tel: 54-2965-498019. Email: whelbling@efpu.org.ar, efpu@efpu.org.ar

Station	Location	Measured Parameters	Instrument
Playa Union	43.30°S, 65.03°W, 10m. a.s.l.	Surface broadband UVB, UVA and PAR solar irradiance	ELDONET surface spectrometer
		Underwater broadband UVB, UVA and PAR solar irradiance	ELDONET submersible spectrometer
		Meteorological station Laboratory equipment for biological-sample analysis	

Projects in collaboration with: Universidad de Concepción (Chile), Universidade de Sao Paulo, Fundaçao Universidade Federal do Rio Grande e Instituto Nacional de Pesquisas Espaciais (Brasil), CONICET, Estación de Fotobiología Playa Unión, Instituto Nacional de Investigación y Desarrollo Pesquero (Argentina), University of South Florida (USA), Centro de Procesamiento de Imágenes y Fundación La Salle (Venezuela), Interamerican Institute for Global Change Research (IAI), National Natural Science Foundation of China.

Center for Laser Research and its Applications (CITEFA-CONICET) - Buenos Aires

Dr Eduardo J. Quel
CEILAP. Juan B. de La Salle 4397. B1603ALO - Villa Martelli, Buenos Aires. Argentina. Tel/Fax: 54-11-4709-8217. E-mail: equel@citefa.gov.ar

Station	Location	Measured Parameters	Instrument
Villa Martelli	34.55°S, 58.50ºW, 30m. a.s.l.	Spectral UV irradiance	Jarrell-Ash MonoSpec27 CCD spectroradiometer
		Vertical tropospheric distribution of aerosols, water vapor and cirrus detection	LIDAR
		UV-A irradiance	EKO MS-210A
		UV-B irradiance	EKO MS-210D
		Total solar irradiance	Kipp & Zonen
Río Gallegos	51.60ºS, 69.32ºW, 15m. a.s.l.	Longwave irradiance	Eppley-PIR
		Direct spectral irradiance for aerosol parameters determination	CIMEL – AERONET Project
		Vertical O_3 Profile (range: 14-45 km)	LIDAR
		Total O_3 Column, NO_x	SAOZ differential absorption at zenith
		Narrowband UV channels	GUV-451
		Broadband UVB	YES UVB-1
		Broadband UVA	YES UVA-1

Projects in collaboration with: CONICET Argentina, International Polar Year Program, Institute for Polar and Marine Research (Germany), Japan International Cooperation Agency.

Institute of Physics of Rosario

Dr Rubén Piacentini
Grupo de Radiación Solar – IFIR (CONICET/UNR). 27 de febrero 210bis, 2000, Rosario. Argentina. Tel: 54-341-4472824. E-mail: ruben@ifir.edu.ar, ruben.piacentini@gmail.com

Station	Location	Measured Parameters	Instrument
Rosario	32.96ºS, 60.62ºW, 25m. a.s.l.	UV erythemal irradiance	YES UVB-1
		Total solar irradiance	Kipp & Zonen CM5
		Broadband Total UV	Kahl TUVR
		Broadband UVB	EKO UVB
		Broadband UVA	EKO UVA

Projects in collaboration with: CEILAP (Argentina), International Polar Year Program, Japan International Cooperation Agency.

Institute for Physical-Chemical Investigations – National University of Córdoba
Dra. Beatriz M.Toselli
Departamento de Físico Química – INFIQC. Facultad de Ciencias Químicas, Universidad Nacional de Córdoba. Ciudad Universitaria, 5000 Córdoba. Argentina. Email: tosellib@fcq.unc.edu.ar

Station	Location	Measured Parameters	Instrument
Córdoba	31.40ºS, 64.18ºW, 470m. a.s.l.	UV erythemal irradiance	YES UVB-1
		Total solar irradiance	YES TSP-700

Projects in collaboration with: CONICET (Argentina), The Third World Academy of Sciences. Instituto de Astrofísica de Andalucía (Spain), Institut für Chemie und Dynamik der Geosphaere, Forschungszentrum Juelich (Germany), Nacional Center for Atmospheric Research (USA).

Institute of Ecology "Fundación Miguel Lillo" - Tucumán
Dr Juan A. González
Instituto de Ecologia - Fundacion Miguel Lillo. Miguel Lillo 251, 4000, Tucumán, Argentina
E-mail: lirios@cgcet.org.ar

Location		Measured Parameters	Instrument
San Miguel de Tucumán	26.83ºS, 65.22ºW, 400m. a.s.l.	UVB irradiance	portable Solar Light PMA-2100
		PAR and Total solar irradiance	

Projects in collaboration with: Argentine institutions and The Interamerican Institute for Global Change.

Institute of the Bio-diversity and the Environment (INIBIOMA) - Río Negro
Dra. María Gabriela Perotti
INIBIOMA-Centro regional Universitario Bariloche. Universidad Nacional del Comahue. Quintral 1250, 8400 Bariloche, Argentina. Tel: 54- 2944- 428505. Email: perottigaby@yahoo.com

Location		Measured Parameters	Instrument
San Carlos de Bariloche	41.15ºS, 71.28ºW, 700m. a.s.l.	Narrowband UV channels	GUV 500
		Underwater broadband UV	Ocean Optics submersible

Projects in collaboration with: Universidad Nacional de San Juan, Universidad Nacional de Salta, Universidad Nacional del Comahue, Universidad Nacional de Tucumán, Universidad de San Martín, Universidad Nacional de Tucumán (Argentina), IIB-Intech y CENPAT (CONICET, Argentina), Lehigh University (USA), Innsbruck University (Austria), Universidad de Granada (España), University of California, Northridge, Texas A&M University, Washington University.

CALIBRATION ACTIVITIES

During November-December 2006, the calibration of the Dobson spectrometers and of the UV erythemal solar irradiance instruments (UV-Biometers) of the South-American WMO Network has taken place at the Regional Calibration Center for South America - Buenos Aires Central Station of the Argentine National Weather Service.

Dobson calibration is coordinated by the World Meteorological Organization (WMO) Secretariat and the Argentine National Weather Service with close cooperation and assistance of the USA National Oceanic and Atmospheric Administration's Climate Monitoring and Diagnostics Laboratory (NOAA/CMDL).

UV-Biometers calibration was coordinated by the World Meteorological Organization (WMO) Secretariat and the Argentine National Weather Service with close cooperation and assistance of the Physikalisch-Meteorologisches Observatorium Davos, World Radiation Center. The reference instrument for this intercomparison was the Solar Light 501A Radiometer s/n 1492 from PMOD/WRC which was calibrated during the PMOD/WRC-COST726 intercomparison held at PMOD/WRC in August 2006.

THEORY AND MODELING

Program for the Study of Atmospheric Processes Related to the Global Change (PEPACG UCA/CONICET) – Capital Federal *(Dr Pablo O. Canziani)*

PEPACG is the principal research Group where modeling of the physical-chemical properties of the atmosphere, as well as climatological studies of the coupled troposphere-stratosphere system are carried out. Particularly, PEPACG study the dynamics and climatology of the coupled system Troposphere-Stratosphere over the Southern Hemisphere, included the ozone layer and solar UV radiation. PEPACG is cooperating with University of Reading (U.K.) in the development and application of an adaptive grid Chemistry Transport Model, called Adaptive Mesh Refinement or AMR-CTM, which is currently a 2-D model whose resolution adapts locally in order to better solve the evolving stratospheric features. Also included in this work is an interaction with Max-Planck Institut fur Atmospheric Chemie, University of Mainz, in order to install in the AMR-CTM the MECCA-MESSY Chemistry module. Work is under way, and firsts results were obtained with the AMR-CTM analyzing the evolution of the vortex edge during the 1999 APE-GAIA Campaign, together with Universitá Degli Studi l'Aquila (Italy) as well as the anomalous behavior of the 2002 ozone hole with regards to the tropospheric dynamics of the period. Present work includes the development of a 2-D and 3-D trajectory code.

Modeling of UV radiative transfer in the atmosphere is still limited to 1-D codes using principally the Discrete Ordinates algorithm with semi-spherical correction in the direct component, which is useful for cases of homogeneous composition of the atmosphere. A reference for this type of models is the TUV code (http://cprm.acd.ucar.edu/Models/TUV/).

PRINCIPAL RESULTS 2005-2008

Ultraviolet climatology over Argentina. [Luccini et al., *Journal of Geophysical Research*, 2006]

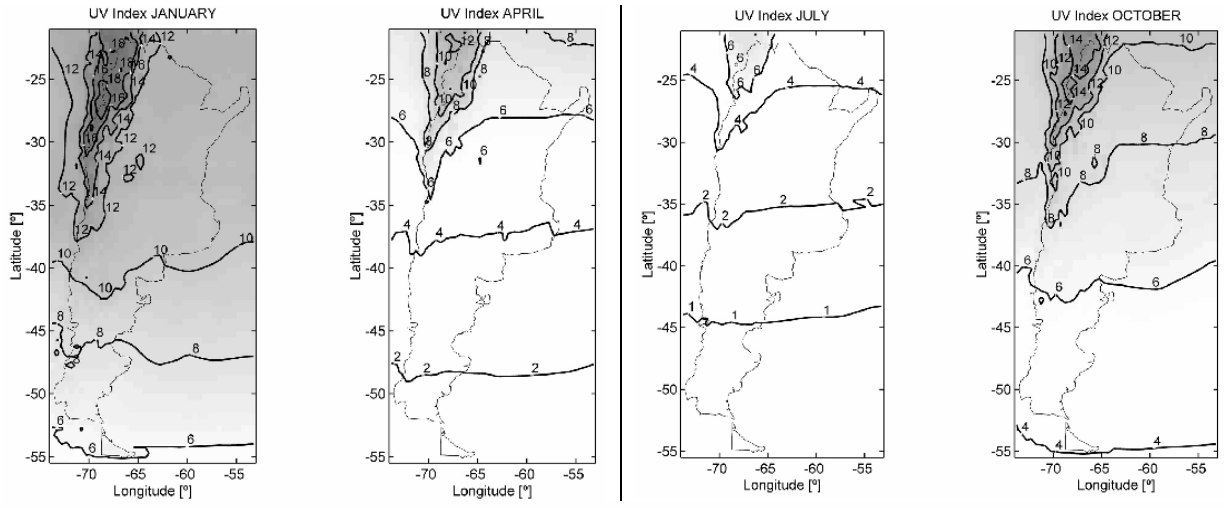


Figure 3. Maps of the satellite-derived monthly mean UV index for January, April, July, and October in Argentina, calculated at a geographical resolution of 0.5° × 0.5°.

Ozone and UV Radiation over Southern South America: Climatology and Anomalies. [Diaz et al., *Photochemistry and Photobiology*, 2006]

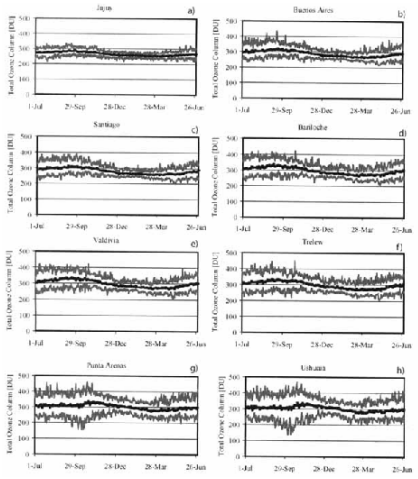


Figure 1. Total column ozone levels. Historical maximum (upper full grey line), minimum (lower full grey line), mean (dotted line) and annual cycle (full black line), calculated from maximum daily irradiance values, based on (Eq. 3), for the period 1979–2004.

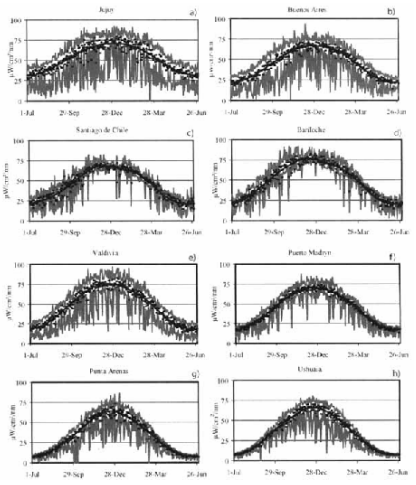


Figure 2. Irradiance channel 340. Historical maximum (upper full grey line), minimum (lower full grey line), mean (dotted line) and annual cycle (full black line), calculated from maximum daily irradiance values for the period 1995–2002, except for Bariloche, which includes values from 1998–2002.

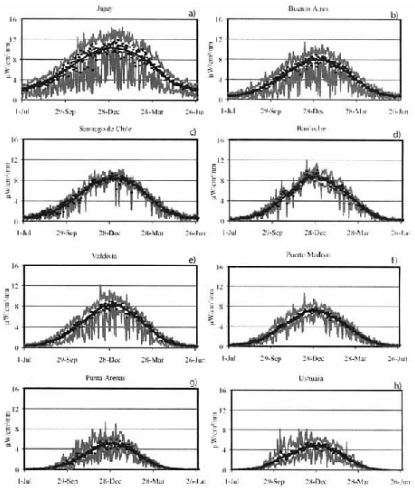


Figure 4. Irradiance channel 305. Historical maximum (upper full grey line), minimum (lower full grey line), mean (dotted line) and annual cycle (full black line), calculated from maximum daily irradiance values for the period 1995–2002, except for Bariloche, which includes values from 1998–2002.

CH_3OCF_2CHFCl and CHF_2OCF_2CHFCl: Reaction with Cl atoms, atmospheric lifetimes, ozone depletion and global warming potentials. [Dalmasso et al., *Atmospheric Environment*, 2006]

Table 3
Estimated atmospheric lifetimes of ethers with Cl atoms and OH radicals, the global lifetime and the ODP[a]

Reactant	τ_{Cl}[b]	τ_{OH}[c]	τ_{global}	ODP
$CFCl_3$	—	—	45 y[d]	1
$CH_3OCH_2CH_3$	3.32 d	3.51 d	1.71 d	0
$CH_3OCH_2CH_2Cl$	9.04 d	4.70 d	3.09 d	0.0001
CH_3OCF_2CHFCl	9.8 y	1.7 y	1.4 y	0.0096
$CHF_2OCH_2CF_3$	198 y	5.3 y	5.2 y	0
CHF_2OCF_2CHFCl	991 y	3.7 y	3.7 y	0.020
$CHF_2OCHClCF_3$	587 y	3.2 y	3.2 y	0.018

[a] When there is more than one value of the rate constant (Table 2), the corresponding average was considered to evaluate the atmospheric lifetimes and ODP.

[b] $\tau_{Cl} = 1/k_{(ether)}$ [Cl], where $k_{(298K)}$ is in units of $cm^3\,molecule^{-1}\,s^{-1}$, $[Cl] = 1 \times 10^4\,atoms\,cm^{-3}$ (Wingenter et al., 1996), d = days and y = years.

[c] $\tau_{OH} = 1/k_{(ether)}$ [OH], where $k_{(298K)}$ is in units of $cm^3\,molecule^{-1}\,s^{-1}$, $[OH] = 5 \times 10^5\,radicals\,cm^{-3}$ (Brauers et al., (1996), d = days and y = years.

[d] World Metereological Organization (2002).

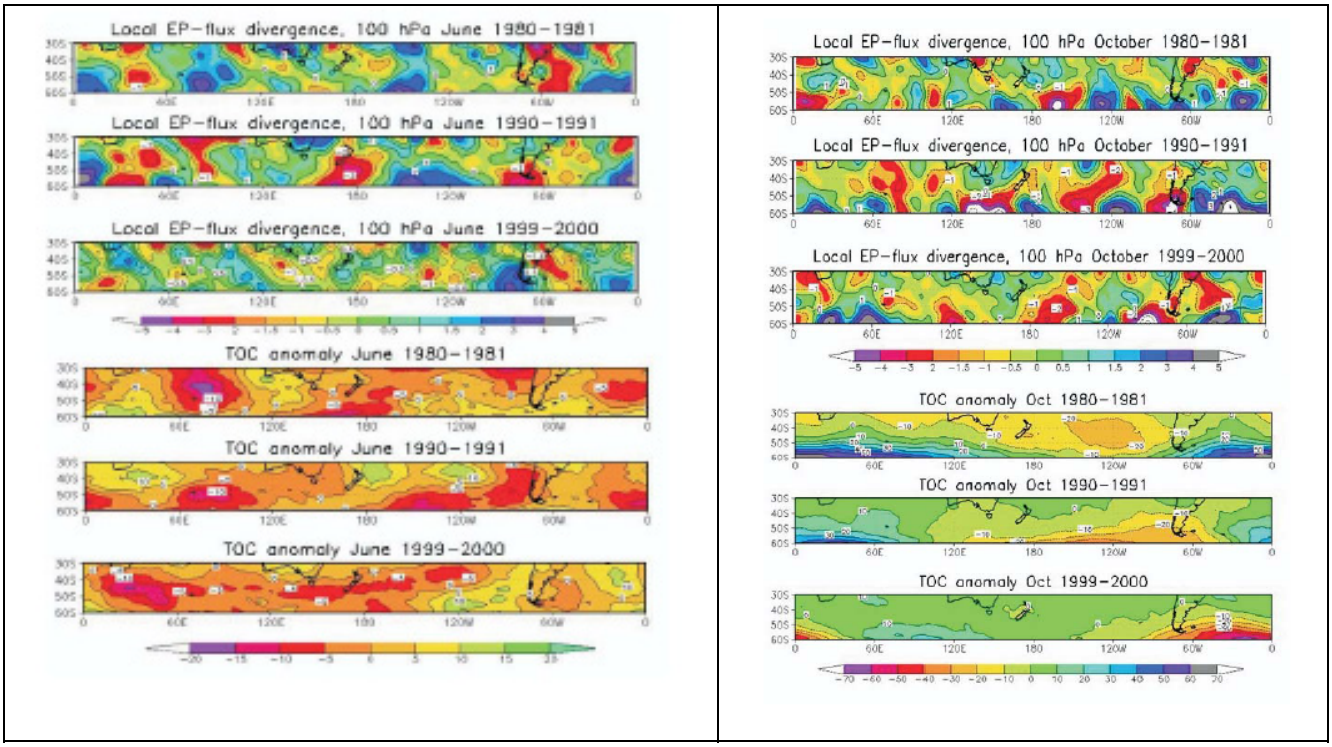
Interactive effects of ultraviolet radiation and nutrient addition on growth and photosynthesis performance of four species of marine phytoplankton. [Marcoval et al., *Journal of Photochemistry and Photobiology B: Biology*, 2007]

Table 1
Growth rates (μ day^{-1}, calculated from chl a measurements) during experiments carried out with *Chaetoceros gracilis*, *Thalassiosira fluviatilis*, *Prorocentrum micans* and *Heterocapsa triquetra* exposed to different nutrient/radiation treatments

Treatment/culture	*Chaetoceros gracilis*	*Thalassiosira fluviatilis*	*Prorocentrum micans*	*Heterocapsa triquetra*
PAB	0.52 (0.01)	0.41 (0.02)	0.44 (0.03)	0.49 (0.02)
PA	0.64 (0.02)	1.02 (0.03)	0.77 (0.01)	0.61 (0.03)
P	0.89 (0.01)	1.05 (0.03)	0.75 (0.01)	0.63 (0.01)
PAB_N	0.62 (0.01)*	0.68 (0.02)*	0.50 (0.02)*	0.61 (0.03)*
PA_N	0.59 (0.01)	1.08 (0.01)	0.74 (0.03)	0.65 (0.02)
P_N	0.85 (0.01)	1.06 (0.01)	0.97 (0.01)*	0.69 (0.01)*
P ($\mu = \mu N$)	<0.05	<0.05	<0.05	<0.05

Radiation treatments are denoted by PAB (PAR + UV-A + UV-B), PA (PAR + UV-A) and P (PAR only); N denotes cultures that received additional nutrients. The asterisks indicate significant differences between nutrient treatments (i.e., comparing the same radiation treatment).

Tropospheric transient baroclinic activity, as given by the local EP-flux in the lower stratosphere (100hPa) and TOMS total ozone anomalies for June and October, sampled over a twenty year period at decadal intervals, over the SH. Total ozone in the early austral winter changes its distribution in response the variability of the transiet baroclinic activity. However main ozone variability in October is clearly controlled by the quasi-stationary wave 1 [Canziani et al., *Journal of Geophysical Research,* 2008]



DISSEMINATION OF RESULTS

Data Reporting

The SMN sends total ozone measurements from Buenos Aires, Ushuaia, Salto (Uruguay), Comodoro Rivadavia and Marambio, as well as the ozonesonde data, routinely to the WOUDC. The database is currently being transformed to the required CSV format. Surface ozone retrievals are submitted to the corresponding centre in Japan.

Information to the public

The SMN continues providing a daily national UV Index forecast map for clear and cloudy conditions both in its webpage as well as to the massive diffusion media. All mentioned institutions often provide information to the media. During the ozone hole season SMN, CADIC and PEPACG send to the media frequent reports describing the ozone hole evolution, using satellite retrievals and meteorological information.

In turn, over 30 conferences open to the public were given in the different specialties in the period 2005-2008.

Relevant scientific papers 2005-2008

Pazmiño, A., Godin-Beekmann Sophie, Luccini Eduardo, Piacentini Rubén, Quel Eduardo and Hauchecorne Alain. Increased UV radiation due to polar ozone chemical depletion and vortex occurrences at southern sub-polar latitudes in the period (1997–2005). Atmospheric Chemistry and Physics Discussions, 8, 6501-6537, 2008.

Canziani, P.O., Malanca, F.E., Agosta, E.A. Ozone and UT/LS variability and change at Southern midlatitudes: 1980-2000: decadal variations, in press, Journal of Geophysical Research, 2008.

Ribeiro-Guevara, S., Queimaliños, C.P., Diéguez, M.C. & M. Arribere. Methylmercury production in the water column of an ultraoligotrophic lake of Northern Patagonia, Argentina. Chemosphere, In print, 2008.

Marcoval, M.A., V.E. Villafañe and E.W. Helbling. Combined effects of solar ultraviolet radiation and nutrients addition on growth, biomass and taxonomic composition of coastal phytoplankton communities of Patagonia. Journal of Photochemistry and Photobiology. B: Biology, In print, 2008.

Ibañez, S., Mariana Rosa, Mirna Hilal, Juan A. González, Fernando E. Prado. Leaves of Citrus aurantifolia exhibit a different sensibility to solar UV-B radiation according to development stage in relation to photosynthetic pigments and UV-B absorbing compounds production. J. of Photochemistry and Photobiology B: Biology 90, 163–169, 2008.

Andrada, G., Gustavo Palancar and Beatriz Toselli. Using the optical properties of aerosols from the AERONET database to calculate surface solar UV-B irradiance in Córdoba, Argentina. Comparison with measurements. Atmospheric Environment, In print, 2008.

Luccini, E. Effect of enhancing of solar radiation by broken clouds in the environment of Paradise Bay, Antarctic Peninsula. Proceedings of the VI Argentine and III Latin-American Symposium on Antarctic Research. Buenos Aires, 10-14 September, 2007.

Bischoff, S.A., Canziani, P.O., Yuchechen, A.E. The tropopause at southern extratropical latitudes: Argentine operational rawinsonde climatology. International Journal of Climatology, vol. 27, Issue 2, 189-209, 2007.

Quel, E., Wolfram E., Otero L., Salvador J., Pallota J., D'Elía R. and Raponi M. Using Lidar to Measure the Ozone Layer. Optics & Photonincs News. 18(10). 2007.

Helbling, E.W., and V.E. Villafañe. Phytoplankton and Primary Production, In: Safran, P. (ed.) Theme 5.5. Fisheries and Aquaculture. Encyclopedia of Life Support Systems (EOLSS), Developed under the auspices of the UNESCO, Eolss Publishers, Oxford, UK [http://www.eolss.net]. 2007.

Marcoval, M.A., V.E. Villafañe and E.W. Helbling. Interactive effects of ultraviolet radiation and nutrient addition on growth and photosynthesis performance of four species of marine phytoplankton. Journal of Photochemistry and Photobiology B: Biology, 89, 78-87. 2007.

Gonçalves, R.J., E.S. Barbieri, V.E. Villafañe and E.W. Helbling. Motility of Daphnia spinulata as affected by solar radiation throughout an annual cycle in mid latitudes of Patagonia. Photochemistry and Photobiology, 83: 824-832. 2007.

Häder, D.-P., M. Lebert, M. Schuster, L. del Ciampo, E.W. Helbling and R. McKenzie. ELDONET Ten years of monitoring solar radiation on five continents. Photochemistry and Photobiology, 83: 1-10. 2007.

Klink, C., J.F. Silva, A. Azócar, J.A. González and R. Herrera-Peraza. Global change effects on the vegetation of tropical high mountains and savannas. Communicating Global Change Science to Society: an Assessment and case studies. Edited by: Tiessen, H, M. Brklacich, G., G. Breulmann and R. S.C.Menezes. Scientific Committee on Problems of the Environment (Scope) Series 68: 165-170. 2007.

Diaz, S.B., Guillermo A. Deferrari, Paula K. Vigliarolo, Don W. Nelson, M. Carolina Camilión, Claudio E. Brunat. Ozone and UV-B irradiances over Antarctica in the last decades. Antarctic Peninsula and Tierra del Fuego. 100 years of Swedish Argentine scientific cooperation at the end of the world, ISBN-13: 978-0-415-41379-4 Editors Jorge Rabassa and Maria Laura Borla, pag 95-108. Taylor & Francis Group, London, UK, 2007.

van den Belt, M., Robert Costanza, Serge Demers, Susana Diaz, Gustavo A. Ferreyra, Sonia M. F. Gianesella, Evamaria W. Koch, Fernando R. Momo, and Maria Vernet. Mediated Modeling for Integrating Science and Stakeholders: Impacts of Enhanced Ultraviolet-B Radiation on Ecosystem Services. SCOPE (Scientific Committee on Problems of the Environment) 68, Communicating Global Change Science to Society. An Assessment and Case Studies. Edited by Holm Tiessen, Mike Brklacich, Gerhard Breulmann, and Rômulo S. C. Menezes. Island Press, Washington, 2007.

González, J.A., M. Gallardo, C. Boero, M. Liberman-Cruz and F.E. Prado. Altitudinal and seasonal variation of protective and photsynthetic pigments in leaves of the world´s highest elevation trees Polyelpis tarapacana (Rosaceae). Acta Oecologica. 2007.

Luccini, E., Cede Alexander, Piacentini Rubén, Villanueva Carlos and Canziani Pablo. Ultraviolet climatology over Argentina. Journal of Geophysical Research, 111(D17312), doi:10.1029/2005JD006580, 2006.

Yuchechen, A.E., S.A. Bischoff and P.O. Canziani. Spatial and temporal perturbations variability in tropical and extratropical systems in South America. Proceedings of the 8th International Conference on Southern Hemisphere Meteorology and Oceanography, 2006.

Perotti, M.G. and M.C. Diéguez. Effect of UV-B exposure in eggs and embryos of patagonian anurans and evidence of photoprotection. Chemosphere, 65(11): 2063-2070. 2006.

Libkind, D, Diéguez, MC, Moliné, M., Pérez, P, Zagarese and M. van Broock. Occurrence of photoprotective Compounds in Yeasts from Freshwater Ecosystems of Northwestern Patagonia. Photochemistry and Photobiology 82(4): 972-980. 2006.

Dalmasso, P.R., Raul A.Taccone, Jorge D.Nieto, Mariano A.Teruel, Silvia I.Lane. CH_3OCF_2CHFCl and CHF_2OCF_2CHFCl: Reaction with Cl atoms, atmospheric lifetimes, ozone depletion and global warming potentials. Atmospheric Environment. 40, 7298-7307. 2006.

Otero, L., P.Ristori, J.Salvador, R.D'Elia, J.Pallotta, E.Wolfram, B.Holben, E.Quel. Lidar and AERONET measurements in Río Gallegos, Patagonia Argentina. 23rd International Laser Radar Conference. Editors Chikao Nagasawa, Nobuo Sugimoto, Part II, 747-750, 2006.

Helbling, E.W., M.E. Farías, M.V. Fernández Zenoff and V.E. Villafañe. In situ responses of phytoplankton from the subtropical Lake La Angostura (Tucumán, Argentina) in relation to solar ultraviolet radiation exposure and mixing conditions. Hydrobiologia, 559: 123-134. 2006.

Vilaplana, J., Cachorro Victoria, Sorribas Mar, Luccini Eduardo, de Frutos Angel, Berjón Alberto, and de la Morena Benito. Modified calibration procedures for a Yankee Environmental System UVB-1 biometer based on spectral measurements with a Brewer spectrophotometer. Photochemistry and Photobiology, 82(2), 508-514, doi:10.1562/2005-06-23-RA-590, 2006.

Olcese, L. and Beatriz Toselli. Recovery of the histogram of hourly ozone distribution from weekly average concentrations. Environmental Pollution, 141, 81-89, 2006.

Diaz, S., C. Camilión, G. Deferrari, H. Fuenzalida, R. Armstrong, C. Booth, A. Paladini, S. Cabrera, C. Casiccia, C. Lovengreen, J. Pedroni, A. Rosales, H. Zagarese and M. Vernet. Ozone and UV Radiation over Southern South America: Climatology and Anomalies. Photochemistry and Photobiology: Vol. 82, No. 4, 834–843, 2006.

Díaz, S., Camilión, C., Escobar, J., Deferrari, G., Roy, S., Lacoste, K., Demers, S., Belzile, C., Ferreyra, G., Gianesella, S., Gosselin, M., Nozais, C., Pelletier, E., Schloss, I., Vernet, M. Simulation of Ozone Depletion Using Ambient Irradiance Supplemented with UV Lamps. Photochemistry and Photobiology 82: 857-864. 2006.

Malanca, F.E., P.O. Canziani and G. Argüello. Trends evolution of ozone between 1980 and 2000 at mid-latitudes over the Southern Hemisphere. Decadal differences in trends. J. Geophys. Res. 110, D05102, doi:10.1029/2004JD004977, 2005.

Klisch, M., R.P. Sinha, E.W. Helbling and D.P. Häder. Induction of thymine dimers by solar radiation in natural freshwater phytoplankton assemblages in Patagonia, Argentina. Aquatic Sciences, 67:72-78. 2005.

Helbling, E.W., E.S. Barbieri, M.A. Marcoval, R.J. Gonçalves and V.E. Villafañe. Impact of solar ultraviolet radiation on marine phytoplankton from Patagonia. Photochemistry and Photobiology, 81: 807-818. 2005.

Palancar, G., Rafael Fernández and Beatriz Toselli. Photolysis rate coefficients calculations from broadband UV-B irradiance: model-measurement interaction. Atmospheric Environment, 39, 857-866, 2005.

Diaz, S., Charles R. Booth, Roy Armstrong, Claudio Brunat, Sergio Cabrera, Carolina Camilion, Claudio Cassiccia, Guillermo Deferrari, Humberto Fuenzalida, Charlotte Lovengreen, Alejandro Paladini, Jorge Pedroni, Alejandro Rosales, Horacio Zagarese and Maria Vernet. Multi-channel radiometers calibration. A new approach. Applied Optics 44(26):5374-5380, 2005.

Vigliarolo, P., C. Vera and S. Díaz. Synoptic-Scale Variability and Its Relationship with Total Ozone and Antarctic Vortex Displacements. Monthly Weather Review, 133(8), 2374–2386, 2005.

Roscoe, H.K., S.R. Colwell, J.D. Shanklin, J.A. Karhu, P. Taalas, M. Gil, M. Yela, S. Rodriguez, C. Rafanelli, H. Cazeneuve, C.A. Villanueva, M. Ginsburg, S.B. Díaz, R.L. de Zafra, G. Muscardi, G. Redaelli and R. Dragani. Measurements from ground and balloons during APE-GAIA – A polar ozone library. Advances in Space Research, 36(5):835-845. 2005.

Stengel, F.M., and J. Förster Fernandez. Education and behavioral change for sun protection. Journal of Cosmetic Dermatology, Volume 4, Issue 2, 83-88, 2005.

Luccini, E., Grossi Gallegos Hugo, Piacentini Rubén and Canziani Pablo. Characterization of meteorological parameters, solar radiation and effect of clouds at two Antarctic sites, and comparison with satellite estimates. Meteorológica, 30(1-2), 27-40, 2005.

FUTURE PLANS

The current monitoring networks are to be maintained in operation. In turn, important future research activities are planned, at the local level and also as part of international projects such as the International Polar Year presently under development. Among the main research activities the following can be remarked:

- Evolution of the total ozone column over the region. Trends of ozone and UV levels. Dynamics, chemistry and inter-annual variation of the Antarctic ozone hole.
- Study of the influence of the near vortex and ozone hole incursions over Patagonia
- Study the relationship between tropospheric and stratospheric dynamic and climatic behavior and the links with ozone change.
- Ozone and climate change interactions.

- The chemistry and dynamics of stratosphere-troposphere exchange.
- Cirrus clouds, the tropopause, and ozone.
- Effects of the UV radiation on the human health in the region. Biological effects of the UV radiation, especially on crops in the region.
- Studies of solar radiation and its components and biological effects in Antarctic Peninsula as part of the International Polar Year 2007-2008.

NEEDS AND RECOMMENDATIONS

One of the main problems faced by the Argentine ozone related monitoring and research activities has been the lack of adequate funding to maintain such activities over time. This is particularly relevant since at this stage the ozone layer seems to have reached the peak state of its depletion and sensitive monitoring and important research is necessary to determine the future evolution and the start of the possible recovery ozone layer and ozone hole. Furthermore there is growing evidence that the ozone layer is both acting in response to current climate variability and change as well as affecting climate over the Southern Hemisphere. Such coupled studies are an important component of understanding needed to assess climate variability and climate change processes. Hence it is important to promote and maintain, if not strengthen all atmospheric measurements relevant to both processes. This also requires a strong support in capacity building at the technician and research levels to continue both with monitoring and relevant research as proposed by SPARC-WCRP and its links with the various WCRP initiatives. The Servicio Meteorológico Nacional, main national institution for atmospheric monitoring, is undergoing a mayor restructuring and requires support for its new strategies, in particular monitoring aspects, and replacement of obsolete and obsolescent equipment and facilities. It also requires including new monitoring activities to provide relevant information for both these topics, including long-term monitoring.
It is essential that research activities be enhanced regionally and globally in the double-pronged aspect of ozone depletion and change within the framework of Climate Change due to the many joint aspects and couplings that are now starting to be known. Hence it is essential to sustain national and international projects regarding these as relevant issues. Until the recovery of the ozone layer does not become evident and sustained in time and as long as the international scientific community does not have a clear and fully developed picture of the linkages between the ozone layer, the stratosphere and the troposphere, within the scope of climate change and variability such research must be supported, nationally, regionally and internationally.

This report was prepared by Dr. Eduardo Luccini and Dr. Pablo Canziani, on the basis of the information provided by the national institutions and research groups involved in Vienna Convention related monitoring and research activities. We gratefully acknowledge all the experts and institutions that have fully cooperated for the preparation of this Report.

****